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CENTRAL WEBER SEWER IMPROVEMENT DISTRICT

MARCH 2023

WASTEWATER MASTER PLAN

CENTRAL WEBER SEWER IMPROVEMENT DISTRICT

WASTEWATER MASTER PLAN

March 2023

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EXECUTIVE SUMMARY

INTRODUCTION

The Central Weber Sewer Improvement District (CWSID or District) retained the team of Bowen Collins & Associates (BC&A) and Carollo Engineers (Carollo) to prepare a wastewater master plan of the District's wastewater collection and treatment systems. The purpose of the wastewater master plan is to assemble a comprehensive plan for the development and maintenance of the CWSID wastewater collection and treatment system that addresses the challenges expected to be faced by the District. This includes identifying recommended projects and an implementation plan that can be used for both engineering and financial planning purposes.

REPORT STRUCTURE

This report can be broken into four (4) sections as follows:

1. **Introduction and Future Growth** – This section includes general information about the existing District system as well as growth projections for the expected District service area.

2. **Collection System** – This section includes the description, analysis, and recommended improvements for the District's collection system. This includes improvements associated with both capacity needs and ongoing system maintenance.

3. **Treatment Plant** – This section includes the analysis of the treatment plant including a review of the existing facilities and the alternatives to upgrade the system to meet both existing and future demands and discharge requirements.

4. **Capital Facilities Plan –** This section combines all the recommendations in the wastewater master plan for use in future engineering and financial planning.

INTRODUCTION AND FUTURE GROWTH

As part of this master plan effort, BC&A developed growth and flow projections for the CWSID service area. Growth projections are presented in terms of Equivalent Residential Units (ERUs). A summary of the final ERU projections are presented in Table ES-1. This includes growth associated with both residential and non-residential growth.

It will be noted that there are two totals included in the table, with and without "Weber West 2". Weber West 2 is the area of Weber County located west of both the Weber River and Plain City. While the District has historically assumed that it will serve the currently undeveloped area of the County east of the Weber River, a firm plan has not existed for the area west of the river. To facilitate evaluation of this area, scenarios both with and without Weber West 2 have been considered.

As can be seen in the table, there is still significant potential for growth in the District. Without Weber West 2, the expected number of ERUs served by the District is expected to increase by 80 percent. If Weber West 2 is eventually annexed, this will increase to nearly 100 percent. It should be noted that current projections from the State of Utah show very little growth in the Weber West 2 area prior to 2060. Recent development discussions have contemplated much more aggressive growth. If the District opts to serve this area, growth will need to be carefully monitored and projections may need to be altered to reflect new development plans.

Table ES-1
CWSID ERU Projections

City/Area	2022	2027	2032	2040	Build-Out
Farr West	2,905	3,359	3,696	4,269	6,406
Harrisville	2,643	3,518	4,124	4,451	4,794
Hooper	1,909	2,694	3,304	4,243	7,404
Marriott-Slaterville	295	617	880	1,307	2,007
North Ogden	6,553	7,721	8,680	10,489	13,160
Ogden	56,856	63,935	68,105	74,376	80,246
Plain City	83	246	370	585	1,100
Pleasant View	4,113	5,800	7,026	9,033	18,601
Riverdale	4,481	5,540	6,292	7,639	9,351
Roy	214	214	214	214	214
South Ogden	7,703	8,892	9,834	10,404	10,404
South Weber	2,598	3,293	3,811	4,685	4,685
Uintah	631	675	724	830	1,338
Uintah Highlands	746	904	1,060	1,293	1,548
Washington Terrace	4,269	4,630	4,601	4,575	4,752
Weber West 1	1,367	2,055	2,497	3,116	10,639
West Haven	6,267	7,536	8,111	8,881	9,591
Industrial	2,500	2,733	2,900	3,167	3,500
Total (w/o Weber West 2)	**106,133**	**121,629**	**136,229**	**153,557**	**189,740**
Weber West 2	441	434	430	429	23,037
Total (w/ Weber West 2)	**106,574**	**122,063**	**136,659**	**153,986**	**212,777**

From these growth projections, resulting sewer flows can be projected. Total flow consists of three components: base sanitary flow (wastewater produced by municipal and industrial water users), infiltration (groundwater that enters the system throughout the year), and inflow (additional water entering the system during precipitation events). By looking at these components of flow, projected future flows for various conditions can be developed as shown in Table ES-2.

As can be seen in the table, the District has a significant challenge with infiltration. During periods of high infiltration, infiltration can currently reach levels as high as 120 percent of base sanitary flow. While infiltration will vary between systems depending on groundwater conditions and other factors, modern sewer systems are typically capable of limiting infiltration rates to about 15 percent of base sanitary flow. Continued effort is needed to find and eliminate infiltration in the system.

Flow monitoring completed as part of this study has identified that at least 40 percent of peak infiltration is seasonal infiltration that can be tracked back to the sewershed encompassing the central and northern portions of Ogden City. Additionally, nearly two-thirds of the increase observed in this area occurred over a period of two days in 2022 (June 1 and June 2). This means that this portion of the infiltration is very likely connected to the filling of a canal that occurred on June 1. This gives an excellent clue as to where this increase in infiltration is coming from. Because the increase is occurring so quickly, the connection between the canal and the sewer system must be relatively direct.

Table ES-2
Projected Average Daily Flows

Year	Base Sanitary Flow (mgd)	Low Infiltration - Minimum Month (mgd)	High Infiltration - Maximum Month (mgd)	Total Sewer Flow - Maximum Month, Average Day (mgd)	Total Sewer Flow - Average Day (mgd)	Dry Weather Peak Hour (mgd)	Wet Weather Peak Hour (mgd)
2022	22.02	5.81	25.81	47.84	37.84	56.64	81.64
2025	23.80	5.93	26.18	49.98	39.86	59.83	84.83
2030	26.19	6.11	26.76	52.95	42.62	64.40	89.40
2032	27.11	6.18	26.98	54.09	43.69	66.20	91.20
2035	28.47	6.28	27.31	55.79	45.27	68.90	93.90
2040	30.54	6.44	27.82	58.36	47.67	73.14	98.14
2050	33.80	6.69	28.60	62.40	51.44	80.32	105.32
Build-Out without Weber West 2	**37.64**	**6.98**	**29.53**	**67.17**	**55.89**	**89.75**	**114.75**
Build-Out with Weber West 2	**42.21**	**7.32**	**30.64**	**72.84**	**61.19**	**98.17**	**123.17**

COLLECTION SYSTEM

The District's collection system includes only major conveyance trunklines. All wastewater flow is collected by city or privately owned pipelines and then conveyed to the District's pipes. As a result, all of the District's collection system pipes were included as part of the analysis with this master plan. In total, the District's collection system includes approximately 56 miles of sewer pipe. There are also eight (8) sewer lift stations and three (3) diversions/flow splits within the existing system.

The collection system was evaluated for both future capacity needs and expected ongoing asset management needs:

- **Capacity Evaluation** – A computer model of the District's collection system was updated based on recently completed sewer projects and then used to evaluate the performance of the system for both existing and projected flows. Existing and future capacity deficiencies were identified, alternatives for resolving the deficiencies were evaluated, and final improvement recommendations were selected.

  Most of the District's pipelines were evaluated based on maintaining a peak flow of no more than 75 percent of the full pipe flow during projected dry weather, peak hour flow. This allows for some capacity to be reserved to account for wet weather inflows and other occasional flows higher than those estimated in the model(holidays, special events, etc.). The system was evaluated both with and without projected flows from the Weber West 2 area.

  Based on the capacity analysis, recommended improvements were identified to address the collections system deficiencies. The recommended collections systems improvements are summarized in Table ES-3 and shown in Figure ES-1.

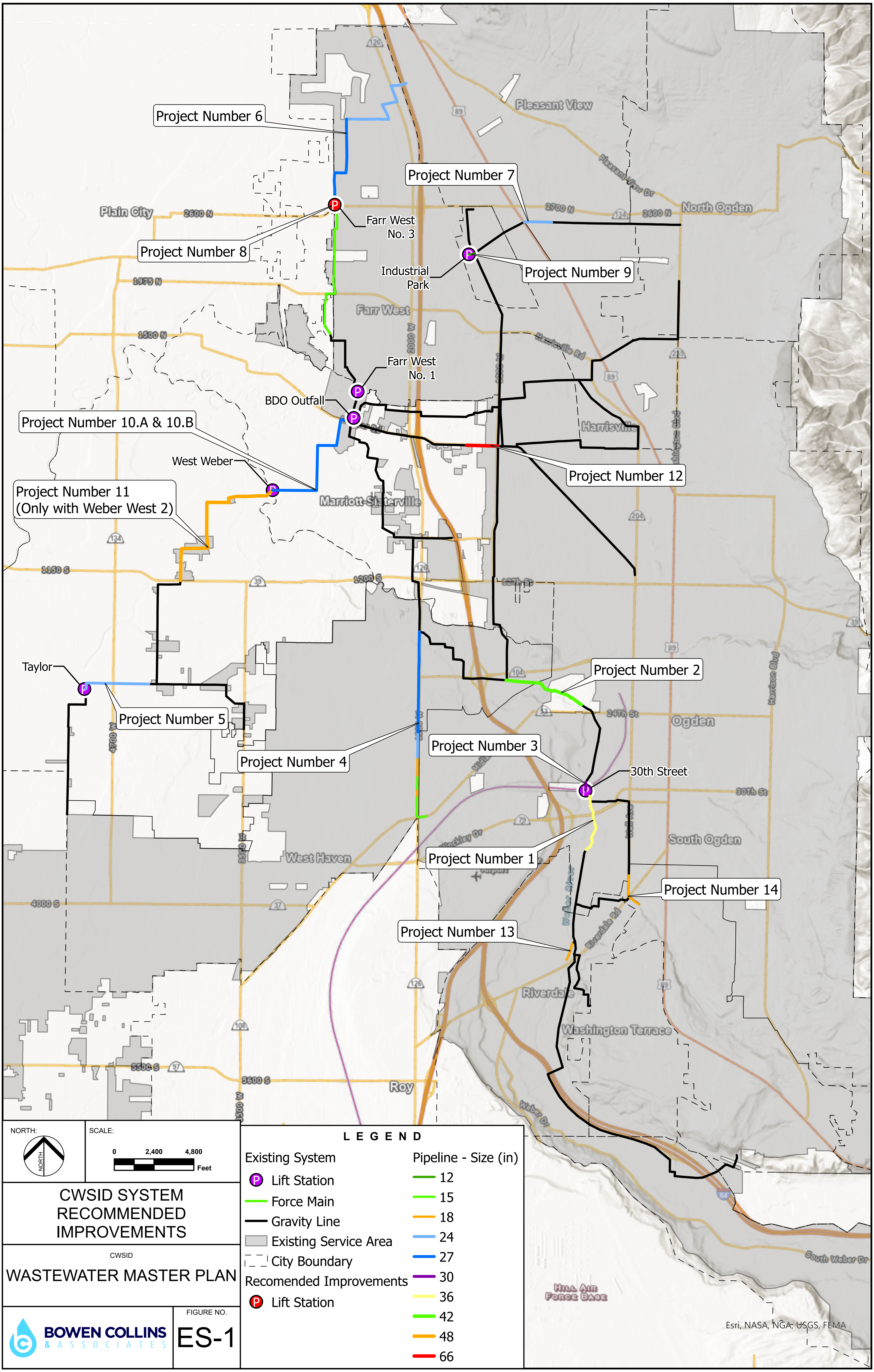
- **Asset Management Planning** – In addition to evaluating the needs of the collection system based on capacity, BC&A used available condition and age data to perform an asset management analysis of the condition of the existing system.

  The CWSID collection system is composed of approximately 56 miles of pipe. The total cost to completely replace all of the pipes in the CWSID collection system would be approximately $294 million based on 2023 construction costs. Even with some cost savings that can be achieved with rehabilitation technologies (e.g., slip lining, cast-in-place pipe, etc.), it is expected that the District will need to spend about $210 million on rehabilitating and/or replacing its collection system over the next 100 years (i.e. an average annual investment of $2.1 million is needed for rehabilitation and replacement).

  The District currently has about $7 million commitment for the rehabilitation of its existing Hooper Trunkline. An additional $14 million (2023 dollars) should be budgeted for rehabilitation and replacement in the District over the next 10 years. A budget line item has been included in Table ES-3 for this purpose.

Table ES-3
Recommended Collection System Improvements

Project Number	Project Identifier	Project Location	Existing Size	Proposed Size	Time Frame
1	Riverdale Railroad Yard Mainline	Within Riverdale Railyard from approximately 35th Street to 31st Street	27-30 inches	36-inch	10-15 years
2	Ogden 30th Street Mainline	From approx. 25th Street to south flow split	36-inch	42-inch	5-10 years
3	30th St. Force Main	Entire 30th Street Force Main	24-26 inches	30-inch	0-5 years
4	West Haven Mainline	Along 1900 West from Midland Dr. to approximately 1715 South	12-18 inches	15-27 inches	0-2 years
5	Taylor Force Main	Entire Taylor Force Main	16-inch (I.D.)	24-inch (I.D.)	15+ years
6	Farr West Mainline	From beginning of gravity line to Farr West Lift Station No. 3	18-inch	24-27 inches	10-15 years
7	North Ogden Mainline	Along 2550 North from approximately 750 West to 1000 West	21-inch	24-inch	15+ years
8	Farr West Lift Station No. 3	Farr West Lift Station No. 3	3.3 MGD	4.7 MGD	10-15 years
9	Industrial Force Main	Industrial Force Main	6-inch (I.D.)	12-inch (I.D)	15+ years
10.A	West Weber Force Main (w/o West Weber 2)	West Weber Force Main	18-inch (I.D.)	27-inch (I.D.)	15+ years
10.B	West Weber Force Main (w/ West Weber 2)	West Weber Main	18-inch (I.D.)	36-inch (I.D.)	15+ years
11	Hooper Mainline (w/ West Weber 2)	From 1200 South to West Weber Lift Station	N/A	48-inch	15+ years
12	Pioneer Road	Approximately 1,900 ft starting at 1200 West	60-inch	66-inch	15+ years
13	Riverdale Stubline	From start of line to Weber River crossing	15-inch	18-inch	15+ years
14	South Ogden Stubline	From the start to approximately 37th Street on Wall Ave.	15-inch	18-inch	0-5 years
--	Annual Maintenance (per year)	District Wide	N/A	N/A	Ongoing
--	Hooper Lining Phase II	Hooper Mainline	N/A	N/A	0-2 years



CWSID SYSTEM RECOMMENDED IMPROVEMENTS

CWSID

WASTEWATER MASTER PLAN

BOWEN COLLINS & ASSOCIATES

FIGURE NO.

ES-1

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TREATMENT PLANT

As part of this master plan effort, Carollo conducted a condition assessment and reviewed the existing facilities currently operated and maintained at CWSID's water reclamation facility (WRF). Currently, the WRF has two process trains for treatment: a new activated sludge (AS) treatment process completed in 2012 and a trickling filter (TF) that was constructed with the original facility in 1957. Flows are being split between the two trains at a ratio of 80/20 AS/TF. When the Phase 2 construction project is completed, the District will divert 100 percent of all raw influent to the AS treatment process and only use the TF treatment process for peak flow events exceeding 75 million gallons per day (mgd). A more detailed description of the WRF is included in Chapter 11 of this master plan.

As a result of the condition assessment, it was found that the majority of the WRF is in moderate to excellent condition. Regarding the TF treatment process facilities, it is recommended to maintain all associated systems for wet weather flows as the AS treatment process continues to adds capacity in the future. Two (2) condition assessment projects are recommended to address condition concerns: apply a new protective coating to the Dewatering Building and do a seismic and structural analysis study on the Digesters and Control Building.

A plant-wide process model was created and calibrated. The process model was used to identify the timing of when the various treatment processes needed to be upgraded to meet both treatment and flow requirements as population and flow increases. In addition to meeting existing requirements, Carollo evaluated hydraulic capacity of the WRF, and what would be required to meet future nutrient regulations as well. Based on these evaluations, recommended improvements were identified for the WRF. Recommended improvements have been grouped into four (4) separate phases based on their estimated timing. Table ES-4 lists the recommended improvements for the WRF, Figure ES-2 shows the locations of the recommended WRF improvements. Figure E2-3 shows the implementation schedule for each current and future phased projects.

Table ES-4
Recommended Treatment System Improvements

Master Plan Phase	Project	Category	Facilities/Equipment	Timing
3	Primary Clarification	Capacity	Primary Clarifier Nos. 3 and 4, Raw Sludge Pump Station, Primary Sludge and Scum Pumps	2029
3	Sludge Thickening	Capacity	Gravity Belt Thickener No. 3, Progressive cavity Cake Pumps	2029
3	Flare Relocation	Capacity	N/A	2029
3	Sidestream Phosphorus Removal	Optional	Sidestream Phosphorus Facility, Fermenter, Co-thickening, Replace Digester Mixing	2029
3	Digester Gas Cleaning Upgrade for Boilers	Optional	N/A	2029
3	Recoat Dewatering Ceiling	Condition Assessment	N/A	2029
3	Trickling Filter Digester Seismic Investigation	Conditions Assessment/Study	N/A	2029
3	Fermenter/Co-Thickening Study	Optional Study(1)	N/A	2029
4	Aeration Basins	Capacity	Aeration Basin Nos. 7 and 8, Mixed Liquor Recycle Pumps, Aeration Diffuser System, Blower No. 5	2035
4	Secondary Clarifiers	Capacity	Secondary Clarifier Splitter Box, Secondary Clarifier Nos. 7 and 8, Return Activated Sludge/Waste Activated Sludge Pump Station, Scum Removal	2035
4	UV Disinfection	Capacity	UV Disinfection Facility, Final Effluent Flow Meter	2035
4	Expand Drying Beds	Capacity	N/A	2035
4	Dewatering Optimization Study	Study	N/A	2035
5	Primary Digestion	Capacity	Primary Digester No. 4, Digester Control Building, Digester Mixing Equipment	2038
6	Headworks	Capacity	Screening Equipment, Vortex Grit, Influent Pumping	2041

[1] The fermenter/co-thickening study is dependent upon CWSID's decision to execute the optional sidestream phosphorus removal project.

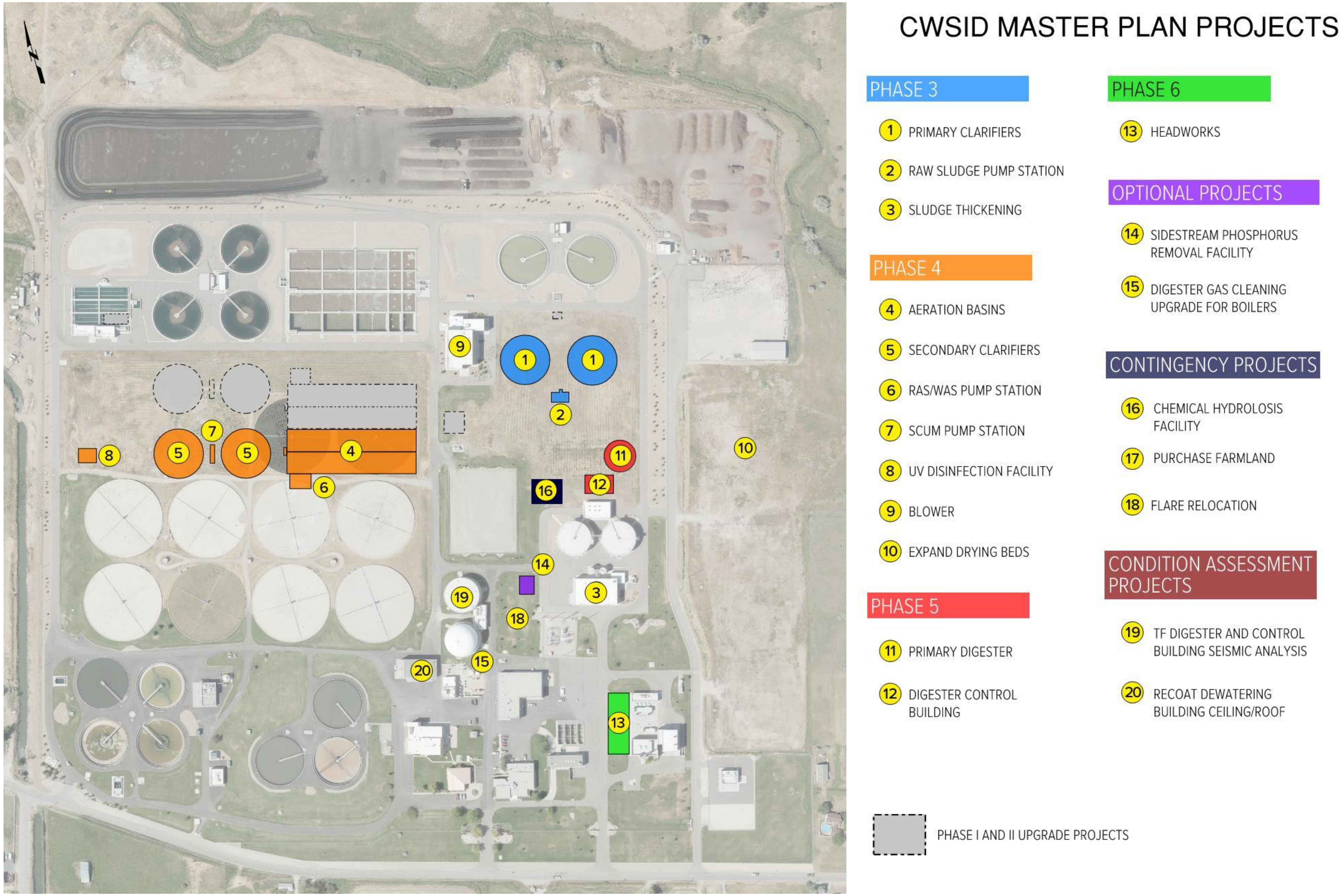


Figure ES-2: Master Plan Projects Site Plan

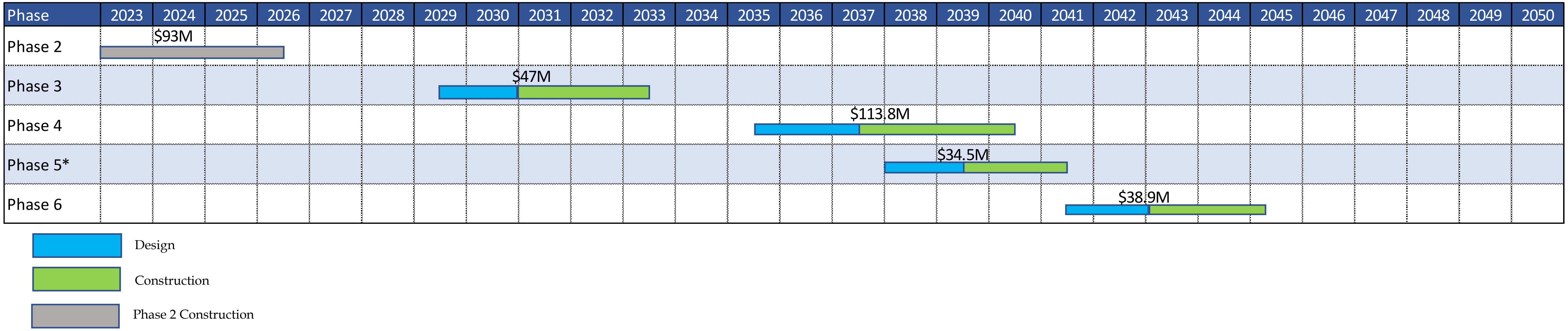


Figure ES-3: Implementation Schedule

CAPITAL FACILITIES PLAN

Based on these combined improvements, a 10-year Capital Facilities Plan has been developed. Table ES-5 lists the improvement projects that are recommended within the next 10 years, the budget required to complete those projects, and the recommended timing of those projects. The table does not reflect bonding, grants, or use of reserves that may be needed to fund the recommended improvements. These types of cash flow issues will need to be considered as part of the District's next rate study. All values contained in the table are in 2023 dollars. For rate calculations and other financial planning, these values will need to be adjusted for inflation. The recommended 10-year capital improvement plan includes a 10-year total cost of $156,974,000 (2023 dollars).

Table ES-5
Recommended 10-Year Capital Improvement Plan (2023 Dollars)

Project ID	Project Description	Project Total Cost (2023 $'s)	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028	FY 2029	FY 2030	FY 2031	FY 2032	FY 2033
Collection System Improvements												
1	Riverdale Railroad Yard Mainline	$5,130,000										
2	Ogden 30th Street Mainline	$8,879,000									$887,900	$7,991,100
3	30th St. Force Main	$640,000					$639,000					
4	West Haven Mainline	$11,516,000	$1,151,600	$10,364,400								
5	Taylor Force Main	$4,076,000										
6	Farr West Mainline	$12,809,000										
7	North Ogden Mainline	$1,626,000										
8	Farr West Lift Station No. 3	$8,110,000										
9	Industrial Force Main	$235,000										
10.A	West Weber Force Main (w/o Weber West 2)	$9,276,000										
10.B	West Weber Force Main (w/ Weber West 2)	$12,067,000										
11	Hooper Mainline (w/ Weber West 2)	$21,607,000										
12	Pioneer Road	$4,856,000										
13	Riverdale Stubline	$880,000										
14	South Ogden Stubline	$1,735,000			$173,500	$1,561,500						
Subtotal		***$94,166,000***	***$1,151,600***	***$10,364,400***	***$173,500***	***$1,561,500***	***$369,000***	***$ -***	***$ -***	***$ -***	***$887,900***	***$7,991,100***
Treatment Plant Improvements												
	Phase 2	$93,000,000	$26,572,00	$26,572,000	$13,286,000							
	Phase 3	$46,200,000						$1,540,000	$3,080,000	$16,632,000	$16,632,000	$8,316,000
	Phase 4	$113,800,000										
	Phase 5	$34,500,000										
	Phase 6	$38,900,000										
Subtotal		**$326,400,000**	**$26,572,000**	**$26,572,00**	**$13,286,000**	**$ -**	**$ -**	**$1,540,000**	**$3,080,000**	**$16,632,000**	**$16,632,000**	**$8,316,000**
Collection System Rehabilitation Improvements												
	Annual Maintenance (per year)	$14,700,000			$2,100,000	$2,100,000	$2,100,000	$2,100,000	$2,100,000	$2,100,000	$2,100,000	
	Hooper Lining Phase II	$6,875,000	$6,875,000									
Total		**$442,141,000**	**$34,598,600**	**$36,936,400**	**$15,559,500**	**$3,661,500**	**$2,739,000**	**$3,640,000**	**$5,180,000**	**$18,732,000**	**$19,619,900**	**$16,307,100**

CHAPTER 1 - INTRODUCTION

INTRODUCTION

Weber County is a growing, dynamic community that will face many changes of the next several decades. As the wholesale sewer provider for most of the County, the Central Weber Sewer Improvement District (CWSID or District) faces multiple challenges to address the County's growing sewer needs:

- **Overall Potential for Growth** – While there are some areas in the District that are fully developed, there is still room for significant population growth and other development within the existing and potential District service area. Weber County is experiencing increasing development on the western side of the County in addition to existing development along and east of the I-15 corridor. Individual cities and communities will be tasked with conveying new flow to District facilities. However, the District will need to address significant increases in population and corresponding sewer flow. Understanding how and where new flows are expected will allow the District to plan for future system demands.
- **Uncertainty of Growth in West Weber –** Of particular interest to the District is the area west of the Weber River. While this is not currently annexed into the District, both the District and the County are interested in better understanding how sewer needs in this area might be served in the future. While many development concepts in this area have been proposed, there does not yet exist any firm plans on how, when, and where development will occur. Correspondingly, the District's plan for future infrastructure will need to consider several different scenarios for what could occur in this area.
- **Existing Infrastructure Distribution** – The majority of existing development within the District's service area is on the east side of I-15. As a result, the existing system facilities are also concentrated on the east side of I-15 with primarily gravity flow to the District's existing treatment plant. West of I-15 there is less existing development and fewer CWSID facilities. Addressing future development needs may require different approaches for the different portions of the District service area.
- **Aging Infrastructure** – While new growth often receives the bulk of attention in master plans of this type, a growing concern for the District is aging infrastructure. Some portions of the District have sewer collection infrastructure that is nearing the end of its useful life. Failure to adequately monitor and then rehabilitate or replace these pipelines as necessary could result in catastrophic failure of these pipelines, with corresponding interruption in service and possible threat to the health and safety of District customers. As part of this master plan, the District needs to plan for its existing pipelines to make sure system renewal is adequately funded, and aging infrastructure issues are addressed.
- **Changing Regulatory Conditions** – In addition to increasing the flow/load capacity of the sewer system, CWISD will need to continue to meet both existing and future regulatory requirements at its treatment plant. Projecting and addressing these needs will require careful planning as it will affect the amount of funding that is available for other system improvements.

The primary purpose of this Wastewater Master Plan is to assemble an updated comprehensive plan for the CWISD wastewater collection and treatment system that addresses these challenges. This will include identification of recommended projects and an implementation plan that can be used for engineering and financial planning purposes. Bowen, Collins & Associates (BC&A) has teamed with Carollo Engineers (Carollo) to develop this master plan to address these needs.

SCOPE OF SERVICES

The general scope of this project involved a thorough analysis of the CWSID's sewer collection system and treatment plant and their ability to meet the present and future wastewater needs of the District's customers. As part of this project, BC&A and Carollo completed the following tasks:

Task 1: Data Collection and Project Management

Data from previous studies was collected and reviewed pertinent to the District's existing facilities including:

- 2015 Collection System Master Plan prepared by Brown & Caldwell including flow monitoring data.
- 2018 Treatment Plant Master Plan prepared by Corollo Engineering
- Historical Treatment Plant Flow Data
- Historical Treatment Plant Water Quality Testing (BOD, TSS, NH3, TP, etc).
- Solids Production Data
- Collection System GIS and Hydraulic Model

Existing facilities are documented in Chapter 3.

Task 2: Flow Monitoring

After reviewing available data, locations for additional flow monitoring were recommended. ADS Environmental Services completed flow meter installation, calibration, and data retrieval services for 20 sites from April 19 to June 13, 2002. Data collected was evaluated for consistency using depth-velocity scattergraphs and then summarized in a report. The full flow monitoring process is discussed in Chapter 4.

Task 3: Growth and Flow Projections

Growth projections were developed for each member city using data from Wasatch Front Regional Council, land use and zoning maps as available, and any other readily available master planning documents. These projections were reviewed by staff of the District and its member cities.

Once growth projections were agreed upon, expected population growth was converted into flow projections based on historic observation of base sanitary flow, groundwater infiltration, and stormwater inflow. This process is summarized in Chapter 2.

As a related task, a separate technical memorandum was prepared identifying the improvements needed if the District wants to begin billing all its member cities based on wastewater volume. This includes recommended locations for permanent flow meters and estimated cost of completing these metering improvements. This technical memorandum is included as an appendix to this report.

Task 4: Collection System Evaluation

The existing and future performance of the District's collection system was evaluated to assemble a plan for system development and maintenance. This included an update to the District's system model using new geometry and flow monitoring data collected since the last study. Models were assembled for existing conditions along with 5-year, 10-year, 2040, and buildout growth conditions. It also included consideration of basic rehabilitation and replacement needs of the District.

Based on the results of the previous tasks, a capital facilities plan was developed for budgeting and planning purposes. This includes a detailed implementation plan for projects needed in the next ten years with master plan level cost estimates. Results of these activities are summarized in Chapters 5 through 9.

Task 5: Treatment Plant Evaluation

Treatment plant performance was evaluated using the growth projections in Task 2 to estimate future wastewater influent loads, in terms of both volume and strength. Based on future flows and loads, the need for and timing of additional liquid treatment and solids handling projects were evaluated. This included consideration of potentially more stringent regulatory requirements, such as a total nitrogen limit.

Other issues evaluated included options for struvite mitigation, Biogas utilization, and solids disposal. A condition assessment of the existing facilities was also completed based on visual assessment of mechanical, structural, and electrical components and consideration of age to develop and plan for recommended facilities and equipment replacement.

Task 6: Facilities Master Plan Report

The results of the tasks above are summarized in this Wastewater Master Plan report. This report includes a planning-level implementation strategy for all identified improvement projects. It also includes an appendix of "Project Summary Worksheets". These worksheets are one-page summaries of each project including a map, summary of project components, project purpose, project triggers (i.e. what is it that will cause the project to be required), consequences of not completing the project, and a project cost estimate.

REPORT ASSUMPTIONS

As a long-term planning document, this report is based on a number of assumptions relative to future growth patterns, service area expansion, and indoor water use patterns. As a result, this document should be considered a working document. Some of the recommended improvements identified in this report are based on the assumption that development and/or potential annexation will occur in a certain manner. If future growth or development patterns change significantly from those assumed and documented in this report, the recommendations may need to be revised. The status of development should be reviewed at least every five years. This report and the associated recommendations should also be updated every five years as well.

PROJECT TEAM

The following individuals are primarily responsible for the production of this report:

Jeff Beckman, BC&A – Overall Project Manager

Keith Larson, BC&A – Lead Engineer, Collection System

Kameron Ballentine, BC&A – Project Engineer, Collection System

Tucker Jorgensen, BC&A – Project Engineer, Collection System

Craig Ashcroft, Carollo – Senior Review, Treatment Plant

Ryan Bench, Carollo – Lead Engineer, Treatment Plant

Jade Echard, Carollo – Project Engineer, Treatment Plant

Mike Hilbert, BC&A – Editing and Production

Questions regarding the project can be directed to the Project Manager, Jeff Beckman, at (801)495-2224 or jbeckman@bowencollins.com.

ACKNOWLEDGEMENT

BC&A and Carollo would like to acknowledge the help and coordination from the following individuals:

Kevin Hall, General Manager

James Dixon, Technical Director

CHAPTER 2 – FUTURE GROWTH AND FLOW PROJECTIONS

A major driving factor for planning and improvements at CWSID treatment and conveyance facilities will be future flow rates and loading. As part of this master plan effort, BC&A developed a Technical Memorandum entitled "Growth Projections for the Central Weber Sewer Improvement District Service Area". A copy of this Technical Memorandum is included in Appendix A. The purpose of this chapter is to summarize the findings from that memorandum.

CWSID SERVICE AREA

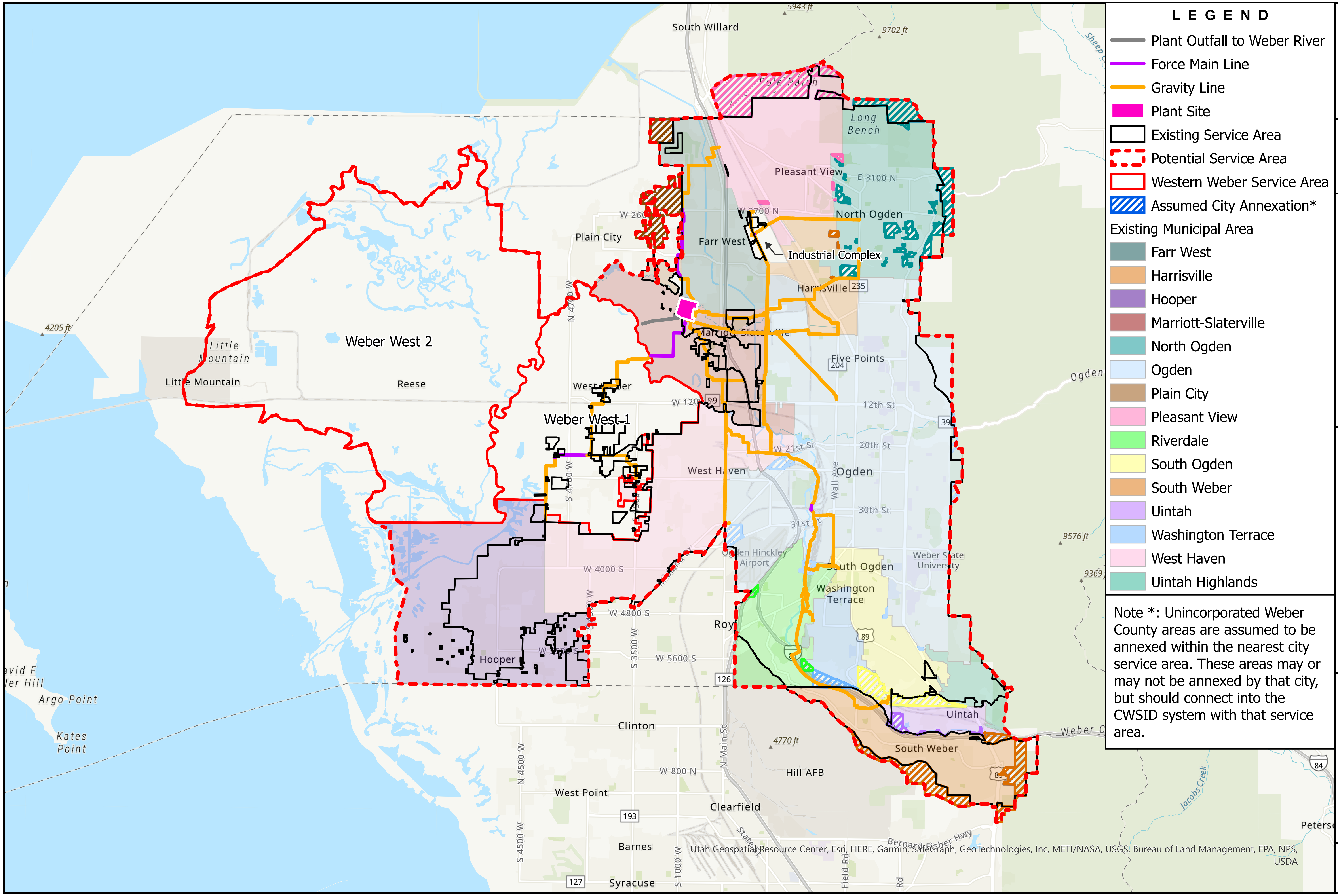
The existing CWSID service area is shown in Figure 2-1. The District currently serves all or a portion of the following cities:

- Farr West
- Harrisville
- Hooper (currently serves approximately 73%)
- Marriott-Slaterville (currently serves approximately 41%)
- North Ogden
- Ogden
- Plain City (currently serves approximately 11%)
- Pleasant View
- Riverdale
- Roy (currently serves approximately 614 persons with no expected growth)
- South Ogden
- South Weber
- Uintah (currently serves a small mobile home park on the west side of the city)
- Washington Terrace
- West Haven
- Portions of Unincorporated Weber County

While existing development has historically been concentrated on the eastern side of the District service area (typically east of I-15), there is significant potential for development throughout the entire District, especially in areas West of the current service boundary. The existing development east of I-15 is typically more dense than the west of I-15 due to individual city landuse and zoning ordinances.

ESTIMATING FUTURE GROWTH

Future population growth was generally estimated based on projections prepared by the Wasatch Front Regional Council (which in turn are based on countywide population projections from the Kem C. Gardner Policy Institute). These projections were then augmented with city general plans and direct coordination with city planning personnel. The 2020 U.S. Census Bureau population estimate was used as the starting population for each entity within the District. For non-residential growth, it was assumed that the ratio of residential to non-residential development would remain approximately proportional for each city in the District. A few exceptions were made to this general assumption in areas of known non-residential growth (see details in Appendix A). To facilitate discussion and analysis, all growth estimates were converted to Equivalent Residential Units (ERUs). This was done by assuming average household size densities (low household size of 2.9 persons and a high household size of 3.6 persons) for residential growth and looking at historic indoor water use for non-residential growth. Table 2-1 shows the projected ERUs for the expected CWSID service area.



Note *: Unincorporated Weber County areas are assumed to be annexed within the nearest city service area. These may or may not be annexed by that city, but should connect into the CWSID system with that service area.

Utah Geospatial Resource Center, Esri, HERE, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USDA

SCALE: 1 in = 10,000 ft

NORTH:

CENTRAL WEBER SEWER IMPROVEMENT DISTRICT SERVICE AREA

CWSID

WASTEWATER MASTER PLAN

BOWEN COLLINS & ASSOCIATES

FIGURE NO.

2-1

P:\Central Weber SID\0616-22-01 CWSID Master Plan\4.0 GIS\4.4 APRX\CWSID Master Plan - 2.aprx ljorgensen 2/24/2023

Table 2-1
CWSID ERU Projections

City/Area	2020	2022	2025	2030	2032	2035	2040	2050	Build-Out (2060+)[1]
Farr West	2,905	3,033	3,227	3,556	3,696	3,909	4,269	5,066	6,406
Harrisville	2,643	2,750	3,170	4,039	4,124	4,254	4,451	4,794	4,794
Hooper	1,909	2,146	2,483	3,011	3,304	3,696	4,243	5,030	7,404
Marriott-Slaterville	295	398	536	738	880	1,064	1,307	1,622	2,007
North Ogden	6,553	6,871	7,356	8,268	8,680	9,305	10,489	12,627	13,160
Ogden	56,856	59,301	62,187	66,558	68,105	70,448	74,376	80,246	80,246
Plain City	83	95	197	319	370	446	585	725	1,100
Pleasant View	4,113	4,591	5,312	6,532	7,026	7,772	9,033	11,615	18,601
Riverdale	4,481	4,843	5,244	5,983	6,292	6,761	7,639	8,531	9,351
Roy	214	214	214	214	214	214	214	214	214
South Ogden	7,703	8,034	8,541	9,419	9,834	10,404	10,404	10,404	10,404
South Weber	2,598	2,792	3,088	3,600	3,811	4,132	4,685	4,685	4,685
Uintah	631	645	660	698	724	763	830	925	1,338
Uintah Highlands	746	762	864	965	1,060	1,165	1,293	1,446	1,548
Washington Terrace	4,269	4,554	4,637	4,620	4,601	4,575	4,575	4,752	4,752
Weber West 1	1,367	1,593	1,896	2,294	2,497	2,758	3,116	3,644	10,639
West Haven	6,267	6,670	7,263	7,945	8,111	8,451	8,881	9,591	9,591
Industrial[1]	2,500	2,567	2,667	2,833	2,900	3,000	3,167	3,500	3,500
Total (w/o Weber West 2)	**106,133**	**111,859**	**119,542**	**131,592**	**136,229**	**143,117**	**153,557**	**169,417**	**189,740**
Weber West 2	441	441	436	431	430	430	429	965	23,037
Total (w/ Weber West 2)	**106,574**	**112,300**	**119,978**	**132,023**	**136,659**	**143,547**	**153,986**	**170,382**	**212,777**

It will be noted that there are two totals included in the table, with and without "Weber West 2". Weber West 2 is the area of Weber County located west of both the Weber River and Plain City. While the District has historically assumed that it will serve the currently undeveloped area of the County east of the Weber River, a firm plan has not existed for the area west of the river. To facilitate evaluation of this area, scenarios both with and without Weber West 2 will be considered.

As can be seen in the table, there is still significant potential for growth in the District. If Weber West 2 is eventually annexed, the expected number of ERUs served by the District will more than double. It will also be noted that current Wasatch Front Regional Council projections show very little growth in the Weber West 2 area prior to 2060. Recent development discussions have contemplated much more aggressive growth. If the District opts to serve this area, growth will need to be carefully monitored and projections may need to be altered to reflect new development plans.

EXISTING AND PROJECTED WASTEWATER FLOWS

The foundation of facility evaluation in this master plan is existing and future wastewater flows. A detailed explanation of the process used to project wastewater flows is provided in the technical memorandum found in Appendix A. A brief summary of the process is contained here.

Wastewater Components

Wastewater can be broken down into three major components: Base Sanitary Flow (BSF, sometimes called domestic flow), Infiltration, and Inflow. Flows associated with each of these components were estimated in the historical flow data at the plant as shown in Figure 2-2. As can be seen in the figure, there are annual, seasonal, and even daily variations in the total flow. These were used to estimate the components of flow as follows:

- **Base Sanitary Flow (BSF)** – Base sanitary flow should not vary significantly seasonally or daily but will slowly grow over time with development. A flow per ERU was estimated using indoor water use and sales data available from the Utah Division of Water Rights website. Wastewater flow per ERU was estimated to be an average of 198.4 gpd for CWSID. This estimate was shown to be consistent with historical data at the treatment plant.
- **Infiltration** – The range of potential infiltration was based on seasonal variations in historical flow data at the CWSID treatment plant. As can be seen in Figure 2-2, there are significant variations to infiltration, both seasonally as well as annually. In dry years, observed flows still follows the basic pattern of seasonal variability but with less than average infiltration. In wet years, additional infiltration is observed in the spring and summer months.

  The maximum month, average day historical infiltration rate was observed to be 25.8 MGD (approximately 230 gpd/ERU). This level of infiltration was observed in 2014, 2017, and 2019. To be conservative, this value was used as the planning infiltration flow rate for existing development conditions. Additional future infiltration associated with new growth has been assumed to be 33.0 gpd/ERU. This is only a small fraction of existing infiltration, but is based on standards for infiltration when using modern materials and construction techniques.

- **Inflow** – Peak inflow was estimated based on the change in total plant flow during and shortly after large storm events. Overall, it was found that, after large storm events (10-year return period or bigger), approximately 25 percent of the peak observed flow at the treatment plant could be attributed to inflow. There was an observed event in the spring of 2017 in which inflow was much greater than this (almost 50 percent of the peak

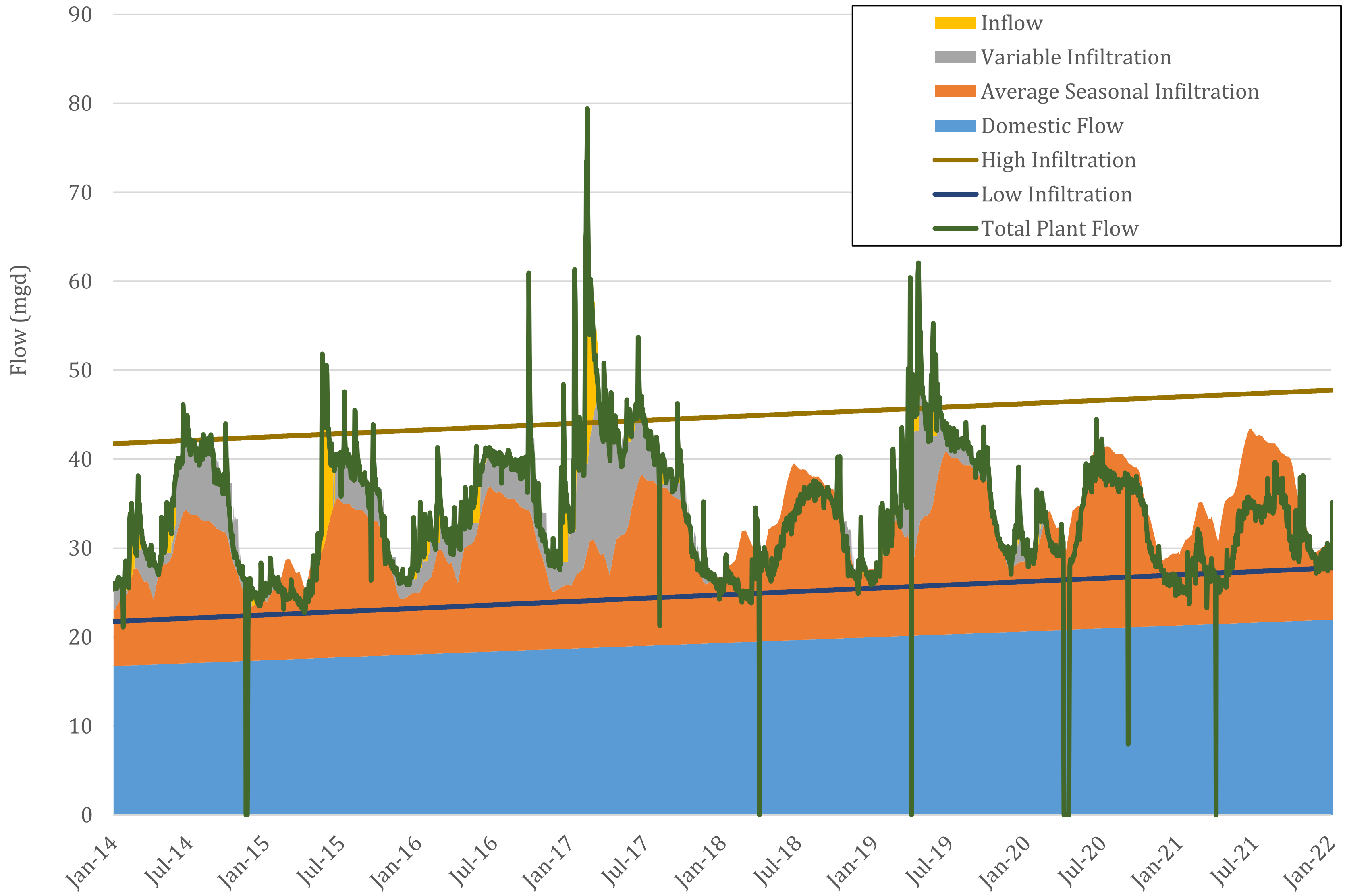


Figure 2-2: Historical Flow Data at the CWSID Treatment Plant

observed flow). However, that increase appears the be the result of isolated inflow issues that should be considered separately and not used as the basis for a District-wide standard. For planning purposes, it has been assumed that inflow will be up to 25 percent of peak observed flows.

Historically there have been known issues with high infiltration and inflow in certain regions of the District and during various times of year. It is recommended that continued efforts be made by the member cities to decrease infiltration and inflow within their service areas through rehabilitating/replacing pipes and laterals in high inflow areas.

Projected CWSID Flows

Projected future flows for CWSID can be seen in Figure 2-3 with values for select years summarized in Table 2-2. As time progresses, population growth in the District as a whole is expected to slow. This can be seen in Figure 2-3 as the slope for future projected flows decreases with time.

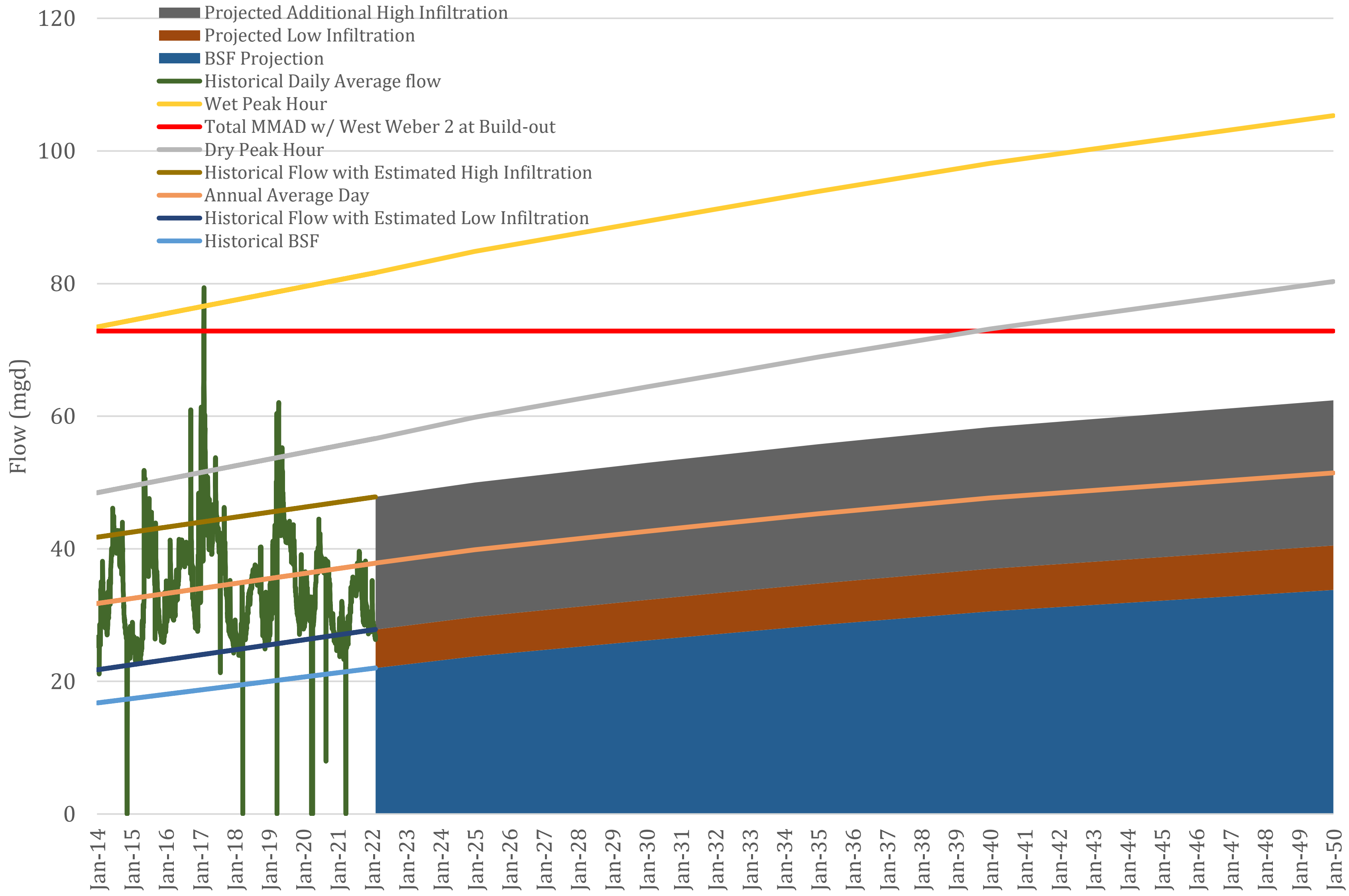


Figure 2-3: Projected CWSID Flow Rates

Table 2-2
Projected Average Daily Flows

Year	Base Sanitary Flow (mgd)	Low Infiltration - Minimum Month (mgd)	High Infiltration - Maximum Month (mgd)	Total Sewer Flow - Maximum Month, Average Day (mgd)	Total Sewer Flow - Average Day (mgd)	Dry Weather Peak Hour (mgd)	Wet Weather Peak Hour (mgd)
2022	22.02	5.81	25.81	47.84	37.84	56.64	81.64
2025	23.80	5.93	26.18	49.98	39.86	59.83	84.83
2030	26.19	6.11	26.76	52.95	42.62	64.40	89.40
2032	27.11	6.18	26.98	54.09	43.69	66.20	91.20
2035	28.47	6.28	27.31	55.79	45.27	68.90	93.90
2040	30.54	6.44	27.82	58.36	47.67	73.14	98.14
2050	33.80	6.69	28.60	62.40	51.44	80.32	105.32
Build-Out without Weber West 2	**37.64**	**6.98**	**29.53**	**67.17**	**55.89**	**89.75**	**114.75**
Build-Out with Weber West 2	**42.21**	**7.32**	**30.64**	**72.84**	**61.19**	**98.17**	**123.17**

CHAPTER 3 – EXISTING COLLECTION SYSTEM

INTRODUCTION

As part of the Wastewater Master Plan, BC&A has assembled an inventory of existing collection system infrastructure. The purpose of this chapter is to present a summary of the inventory that can be used as a reference for future studies.

SERVICE AREA

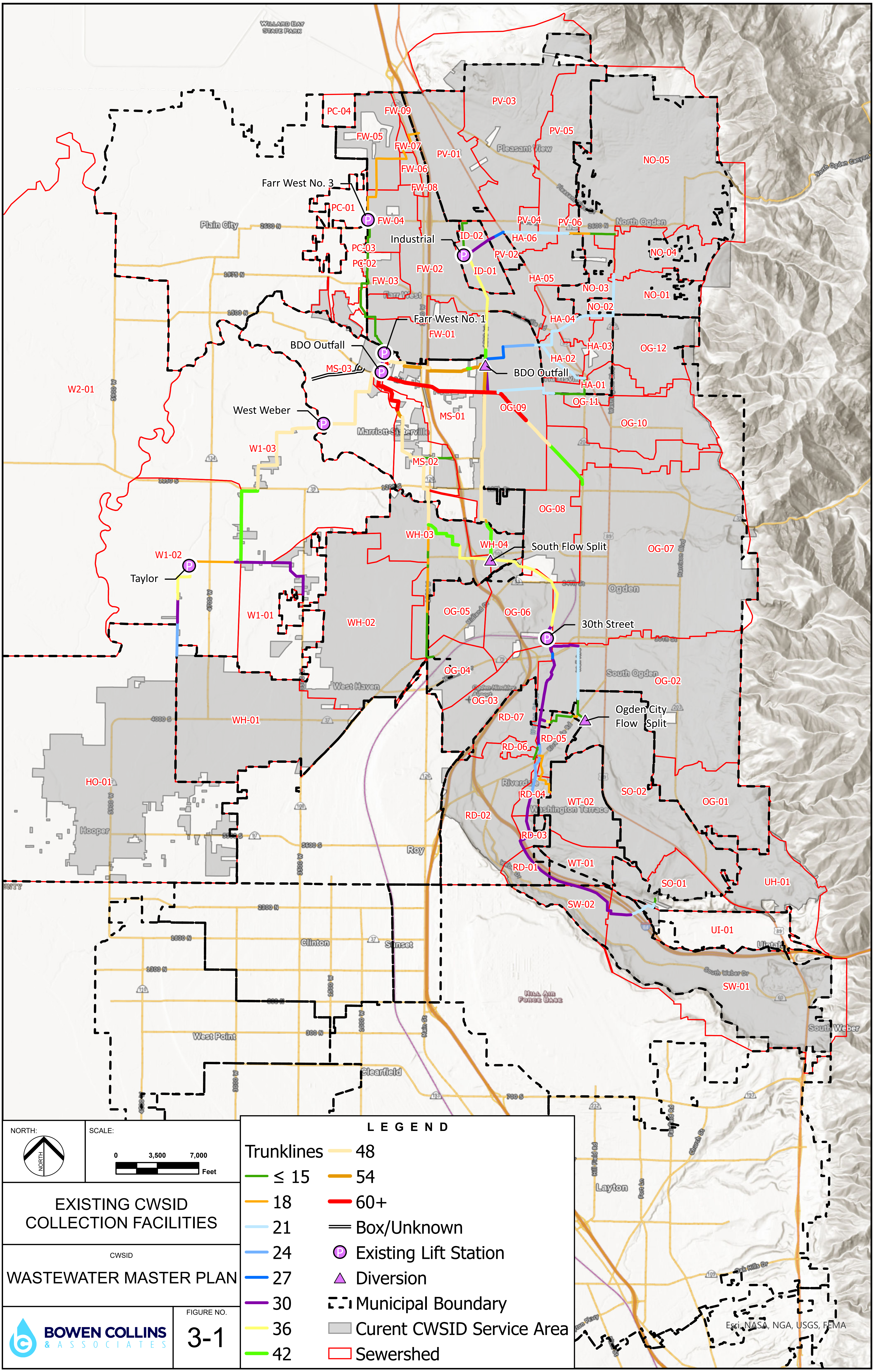
The existing District service area is shown in Figure 2-1 of Chapter 2. The maximum potential service area of the District is also shown in the figure. It is assumed that all of unincorporated area in Weber County east of the Weber River and west of the mountains will eventually be annexed into the District and utilize the District's collection system. The area west of the Weber River is not currently a part of the District and it is uncertain whether this area will be annexed into the District. This portion of Weber County has been designated Weber West 2 within this report. There are no existing CWSID facilities within this area, but there have been discussions on conveying future sewer flow into the existing trunkline that runs from Hooper/West Haven to the West Weber Lift Station.

COLLECTION SYSTEM FACILITIES

The existing CWSID collection system is shown on Figure 3-1. The collection system consists of three major components: pipelines, lift stations, and diversions.

Pipelines

Figure 3-1 shows the location and size of pipes in the CWSID collection system. Individual Cities are responsible for collecting sewer flow from their customers and conveying it to one of the District's conveyance system pipelines. The District then conveys the collected sewer flow to the treatment plant located at 2618 West Pioneer Rd, Marriott-Slaterville, UT. The estimated total length of pipe, excluding service laterals and City pipes, is summarized by diameter and pipeline material in Table 3-1. In total, the District owns and operates approximately 56 miles of sewer pipe. The vast majority of the District's system is reinforced concrete pipe (RCP).



EXISTING CWSID COLLECTION FACILITIES

CWSID

WASTEWATER MASTER PLAN

BOWEN COLLINS & ASSOCIATES

FIGURE NO.
3-1

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Table 3-1
Estimated Pipe Length (feet) by Diameter

Diameter (inch)	RCP	PVC	HDPE	Unknown
≤ 15	18,573	2,088	467	0
18	46,396	297	0	8,720
21	28,981	5,119	314	0
24	10,168	157	1,343	0
27	4,474	0	0	0
30	41,965	4,433	1,011	0
36	24,676	1,745	4,667	0
42	21,023	0	0	0
48	34,874	3,653	0	0
54	9,652	0	0	0
60	19,019	0	0	0
72	127	0	0	0
Boxes	562	0	0	0
Total	**360,488**	**17,492**	**7,802**	**8,720**
Percentage	**88.5%**	**5.9%**	**2.6%**	**3.0%**

Lift Stations

There are eight (8) existing sewer lift stations in the CWSID sewer system as shown in Figure 3-1. Since the last master plan, one of the lift stations (Farr West No. 2) has been removed from service. Table 3-2 lists each of the CWSID lift stations along with a summary of their major characteristics as reported by District personnel. Flow per pumps was based on data collected from design/as-built drawings in addition to operation flow data. The on/off settings and notes were based off the model development and do not necessarily mimic the day to day operation of the lift stations. It should be noted that the district operators often adjust the settings to maintain the life expectancy of the individual pumps. Typically the design capacity is based on having the largest pump offline with the following exceptions:

1. Farr West No. 1, Taylor, and West Weber (River) lift stations will require the installation of the third (4th) pump to meet the design capacity. This should be monitored by operation personnel for when all existing pumps are consistently used during peak flow periods.

2. The Taylor pump design capacity assumes are range of low flow-high head to high flow-low head scenarios (1.7 to 3.4 mgd). To be conservative, it was assumed that for design scenario, the combined peak kflow of the pumps would be 6.6 mgd (2.2 mgd per pump). This value would be consistent with the previous master plan's stated design capacity.

3. The BDO outfall has room for a 4th pump, but the stated design capacity only requires two (2) pumps to meet the Design capacity.

Table 3-2
Existing District Lift Stations

Lift Station	Number of Pumps	Design Values per Pump			On/Off Setting (feet)	Type of Pumps	Back-up Power	VFD	Notes	Design Capacity with Largest Pump Offline (MGD)
		HP	Head (feet)	Flow (MGD)						
30th Street	3	90	28	1 @ 11.5 2 @ 19	Lead: On 8.0, Off 7.6 Lag: On 9.0, Off 8.5 Lag 2: On 10.0, Off 9.5	Vertical, non-clog, dry-pit	Yes	Yes	VFD controls try to maintain a constant level of 8.5 feet in the wet well	19.0
Farr West No. 1	3 (room for 4 pumps)	70	32	5.0	Pumps controlled to maintain a constant level in the wet well	Submersible, non-clog	Yes	Yes	Lifts flow 21 feet at the northeast corner of the WWTP	15.0(1)
Farr West No. 3	3	30	63.3	1.9	Lead: On 7.5, Off 4.0 Lag: on 8.0, Off 5.5 Standby	Submersible, non-clog	Yes	Yes	VFD available but pumps are operated as constant speed	3.8
Industrial Park	2	Unknown		0.5	Pumps are controlled by high and low level switches	Submersible	Yes	No	Inflow is primarily from a frosting factory and contains significant scum	0.5
Slaterville	2	Unknown			Lead: On 7.4, Off 1.2 Lag: On 7.9. Off 1.2	KSB submersible pumps	Portable generator	Yes	Pumps are operated as constant speed	Unknown
Taylor	3 (room for 4 pumps)	40	60	1.7 to 3.4	Lead: On 8.7, Off 5.5 Lag: On 9, Off 6.1 Lag: On 9.5, Off 6.2	Submersible	Yes	No		6.6(1,2)
West Weber	3 (room for 4 pumps)	130	58	8.7	Pumps are controlled by high and low level switches	Submersible with soft start	Yes	Yes	VFD controlled	26.1(1)
BDO Outfall	3 (room for 4 pumps)	40	21	7	Pumps are controlled to maintain wet well level within a 2.8-feet range	Vertical turbine solids handling	Yes	Yes	VFD controlled	23.0(3)

Diversion/Flow Splits

There are three (3) primary locations in the system where flow can be split or diverted in a different direction. These locations are summarized in Table 3-3.

Table 3-3
Existing Diversion/Flow Splits

Diversion	Location	Description
South Flow Split	2150 South 1100 West	Currently splits peak flows almost evenly west and north (based on flow meter data).
BDO Outfall	850 North 1200 West	The BDO outfall is designed to either send all the flow west or south. Current expectation is that all flow will go west, but flow metering results show some flow is still going south.
Ogden City Flow Split	1260 West 400 North	This flow split is in a CWSID manhole but is not operated by CWSID. Flow can either go north or west. Current operation splits flow almost evenly between the two outfalls.

SEWERSHEDS

For the purposes of modeling and planning, it is useful to divide the District service area into areas that drain to a common discharge point into the District collection system. These areas can be referred to as “sewersheds”. The CWSID service area has been subdivided into 72 different sewersheds. These are shown in Figure 3-1. The sewershed boundaries were set by city boundaries and sewer outfall locations. Note that not every outfall into the District system has a unique sewershed. Table 3-4 summarizes the existing characteristics of the sewersheds.

Table 3-4
Existing Sewershed Areas, Populations, and Total ERUs

Sewershed	City	Area (ac)	Existing Population	Residential ERUs	Non-Residential ERUs	Total ERUs
FW-01	Farr West	843.5	1,580	445	39	484
FW-02	Farr West	1,145.0	2,148	603	77	680
FW-03	Farr West	258.3	726	205	0	205
FW-04	Farr West	504.9	1,100	310	39	349
FW-05	Farr West	725.8	1,828	514	0	514
FW-06	Farr West	113.7	205	58	0	58
FW-07	Farr West	48.0	127	36	77	113
FW-08	Farr West	64.0	113	32	270	302
FW-09	Farr West	79.0	203	57	271	328
HA-01	Harrisville	205.1	371	105	517	622
HA-02	Harrisville	304.4	586	165	0	165
HA-03	Harrisville	195.7	670	189	34	223
HA-04	Harrisville	334.5	1,434	404	0	404
HA-05	Harrisville	747.4	3,484	979	69	1,048
HA-06	Harrisville	126.4	778	219	69	288
HO-01	Hooper	9,018.7	7,420	2,089	57	2,146
ID-01	Industrial	279.6	0	0	1,726	1,726
ID-02	Industrial	136.4	0	0	841	841
MS-01	Marriott-Slaterville	1,608.4	584	165	50	215
MS-02	Marriott-Slaterville	956.1	246	69	17	86
MS-03	Marriott-Slaterville	2,162.6	346	97	0	97
NO-01	North Ogden	596.6	3,465	975	0	975
NO-02	North Ogden	82.3	0	0	0	0
NO-03	North Ogden	355.4	3,074	866	174	1,040
NO-04	North Ogden	724.7	3,382	953	349	1,302
NO-05	North Ogden	3,876.9	12,013	3,380	174	3,554
OG-01	Ogden	1,099.4	4,891	1,702	1,379	3,081
OG-02	Ogden	2,997.6	17,678	6,155	1,379	7,534
OG-03	Ogden	727.9	74	26	4,139	4,165
OG-04	Ogden	571.2	59	21	3,448	3,469
OG-05	Ogden	570.7	220	77	3,448	3,525
OG-06	Ogden	911.3	1,544	538	4,139	4,677
OG-07	Ogden	5,014.5	39,434	13,733	1,379	15,112
OG-08	Ogden	1,597.4	7,539	2,627	1,379	4,006
OG-09	Ogden	1,707.1	859	299	5,518	5,817
OG-10	Ogden	1,210.4	9,039	3,145	1,379	4,524
OG-11	Ogden	216.4	2,310	805	0	805

Sewershed	City	Area (ac)	Existing Population	Residential ERUs	Non-Residential ERUs	Total ERUs
OG-12	Ogden	850.7	7,430	2,586	0	2,586
PC-01	Plain City	696.9	137	40	0	40
PC-02	Plain City	14.2	126	35	0	35
PC-03	Plain City	5.0	11	3	0	3
PC-04	Plain City	170.8	62	17	0	17
PV-01	Pleasant View	1,125.1	2,628	740	1,182	1,922
PV-02	Pleasant View	116.6	596	168	21	189
PV-03	Pleasant View	3,105.5	4,653	1,309	0	1,309
PV-04	Pleasant View	78.1	240	68	0	68
PV-05	Pleasant View	1,070.8	3,717	1,046	0	1,046
PV-06	Pleasant View	71.1	201	57	0	57
RD-01	Riverdale	239.0	499	174	0	174
RD-02	Riverdale	1,628.3	4,097	1,426	995	2,421
RD-03	Riverdale	139.2	349	122	0	122
RD-04	Riverdale	172.3	323	113	0	113
RD-05	Riverdale	284.6	842	293	332	625
RD-06	Riverdale	83.8	749	261	0	261
RD-07	Riverdale	426.3	3,237	1,127	0	1,127
--	Roy	--	614	214	0	214
SO-01	South Ogden	752.2	3,555	1,237	436	1,673
SO-02	South Ogden	2,149.9	14,685	5,115	1,246	6,361
SW-01	South Weber	3,332.9	7,878	2,218	412	2,630
SW-02	South Weber	460.7	576	162	0	162
UH-01	Uintah Highlands	1,024.0	2,308	650	112	762
UI-01	Uintah	896.8	1,484	517	128	645
W1-01	West Weber 1	1,511.0	1,659	467	19	486
W1-02	West Weber 1	3,451.8	1,464	412	43	455
W1-03	West Weber 1	4,919.9	2,094	590	62	652
W2-01	West Weber 2	24,861.4	1,294	364	77	441
WH-01	West Haven	2,660.5	10,688	3,009	0	3,009
WH-02	West Haven	2,655.6	4,635	1,304	160	1,464
WH-03	West Haven	1,291.6	1,910	538	160	698
WH-04	West Haven	295.4	796	224	1,275	1,499
WT-01	Washington Terrace	512.0	1,572	548	111	659
WT-02	Washington Terrace	897.3	8,312	2,894	1,001	3,895
Total		**104,069**	**224,951**	**72,091**	**40,209**	**112,300**

CHAPTER 4 – FLOW MONITORING

INTRODUCTION

Flow monitoring was conducted by ADS from April 19, 2022 to June 13, 2022. Meters were deployed with the intention of calibrating individual trunkline portions while capturing the entire flow entering into the CWSID treatment plant. The purpose of this chapter is to describe the flow monitoring approach and summarize the results. A more detailed report of flow monitoring results was prepared by the sub-consultant who completed the flow monitoring (ADS Environmental Service) and is included in Appendix B.

FLOW MONITORING APPROACH

Flow monitoring was performed to accomplish three major goals:

1. Provide general system flow data to be used for model calibration
2. Provide data to develop diurnal curves
3. Provide data for cursory infiltration and inflow analysis

In total 20 meters were deployed throughout the CWSID system as shown in Figure 4-1. Flow monitoring was conducted at 5-minute time intervals. Values of velocity, water depth, and instantaneous flow were recorded to accomplish the goals discussed above. Flow meters were deployed in April and retrieved in June with the goal of capturing flows in the system both before and after infiltration typical increases in early summer (as a result of increased groundwater levels resulting from irrigation activities).

Overall, the flow monitoring effort was overwhelmingly successful. One meter was inadvertently installed on an incorrect manhole and a second meter lost signal about a month early. No other significant challenges or errors were experienced as part of this flow monitoring effort.

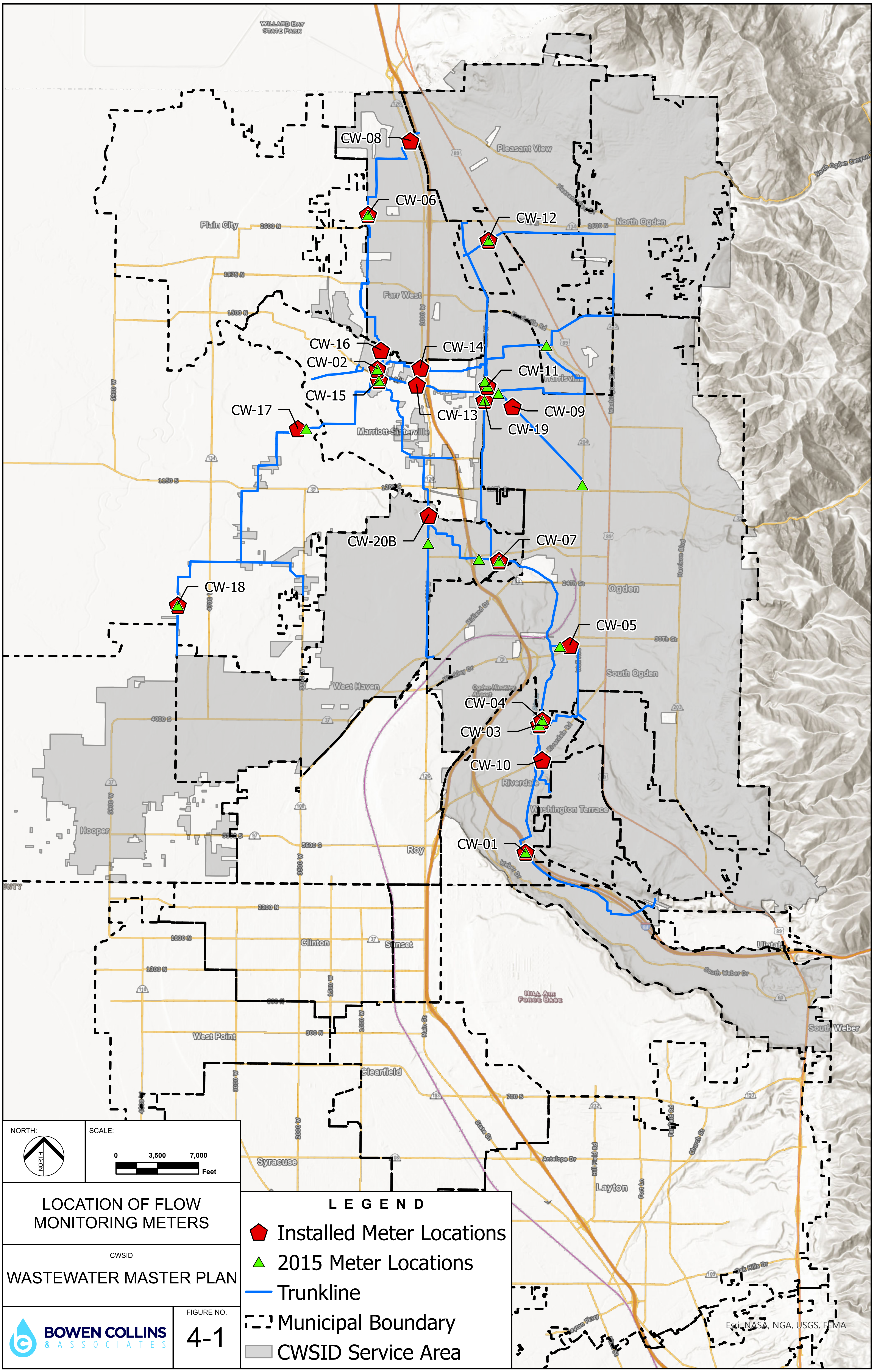
SUMMARY OF FLOW MONITORING RESULTS

Flow monitoring results were used to estimate the existing infiltration and Base Sanitary Flow (BSF). It was hoped that the flow monitors might also capture some significant storm events and provide an estimate of inflow. Unfortunately, no large system-wide storm events occurred during the flow monitoring, so no analysis could be performed in regards to storm inflow response. System wide results are summarized in Table 4-1. Included in the table are results for the first week of monitoring (before increases in infiltration from irrigation) and the last week of monitoring (after increases in infiltration).

Table 4-1
Flow Monitoring Summary

	First Week Averages (MGD)	Last Week Averages (MGD)	Estimated Historic Min. Month (MGD)	Estimated Historic Max. Month (MGD)
Base Sanitary Flow	21.21	21.21	21.21	21.21
Infiltration	6.16	17.11*	5.81	25.81
Total	**27.37**	**38.32**	**27.02**	**47.02**

* Does not include an estimated 2.5 MGD increase after meter CW-19 went out of service.



LOCATION OF FLOW MONITORING METERS

CWSID

WASTEWATER MASTER PLAN

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FIGURE NO.

4-1

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As can be seen from Table 4-1, there was an increase in flow from 27.37 MGD to 38.32 MGD during the eight (8) week monitoring timeframe. This represents an increase of approximately 40%. Due to the short time window, it is unlikely that much if any of the increase in flow can be attributed to BSF. Thus, the increase can be explained almost entirely by an increase in seasonal infiltration.

Based on the observed results, existing flows can be estimated as follows:

Base Sanitary Flow

A total BSF of 21.21 MGD was estimated based on the flow rate predicted from historic flow data. This value was also consistent with observed detailed flow monitoring. Flow patterns at each meter (with the exception of CW-02 which was within the plant) have diurnal curves consistent with the estimated BSF at each meter.

Infiltration

Infiltration has been an historic challenge for CWSID. This has been attributed in the past to shallow water tables and aging infrastructure. The timing of the flow monitoring was based on historical data showing a marked rise in total flow rates during the months of May and June. This was captured on a system wide basis as shown in Table 4-1 with an increase in seasonal infiltration of almost 11 MGD. For the metering period, infiltration peaked at 17.1 mgd. However, the year 2022 was also a notably dry year, with lower than average observed flow at the treatment plant. In a wet year, it is expected that infiltration will return close to the levels observed in 2014, 2017, and 2019, or about 25.8 mgd. Planning flow based on this higher level of infiltration is also summarized in Table 4-1.

Inflow

No large storm events were observed during the monitoring period. Thus, no new information is available to add to the assessment of inflow described in Chapter 2.

NOTABLE RESULTS FOR INDIVIDUAL FLOW METERS

As noted above, the increase in infiltration from April to June was approximately 11 mgd. An analysis was performed to determine how this increase was distributed between the several meters in the collection system.

The analysis shows that nearly 100 percent of this increase can be attributed to one area of the collection system. As can be seen in Figure 4-2, Meter CW-13 shows an increase in flow of approximately 11 mgd from the first week of flow metering to the last. This means the full increase in infiltration observed at the treatment plant is coming through Meter CW-13. Results in Figure 4-3 indicate that 7.3 mgd of the 11 mgd increase can also be observed at the upstream Meter CW-09. This means about two-thirds of the infiltration can be tracked back to the sewershed encompassing the central and northern portions of Ogden City (see Figure 3-1). The remaining one-third of the increase in infiltration is coming from other eastside sewersheds in Ogden, Harrisville, North Ogden, and Pleasant View.

The other important observation that can be made from these two figures is the observed increase in infiltration that occurs over a period of two days (June 1 and June 2). Nearly 65 percent of the total observed increase occurs over these two days. In the District's fight against infiltration, this is good news for two reasons. First, it means that this portion of the infiltration is very likely connected to the filling of a canal that occurred on June 1. If it can be identified which canal or canals were filled on June 1, 2022, this will be a good indication as to where a large portion of this increase in infiltration is coming from. Second, because the increase is occurring so quickly, it can be concluded that the connection between the canal and the sewer system is relatively direct. This makes it more likely that the infiltration is focused in a few point sources that can be eliminated with more limited repairs.

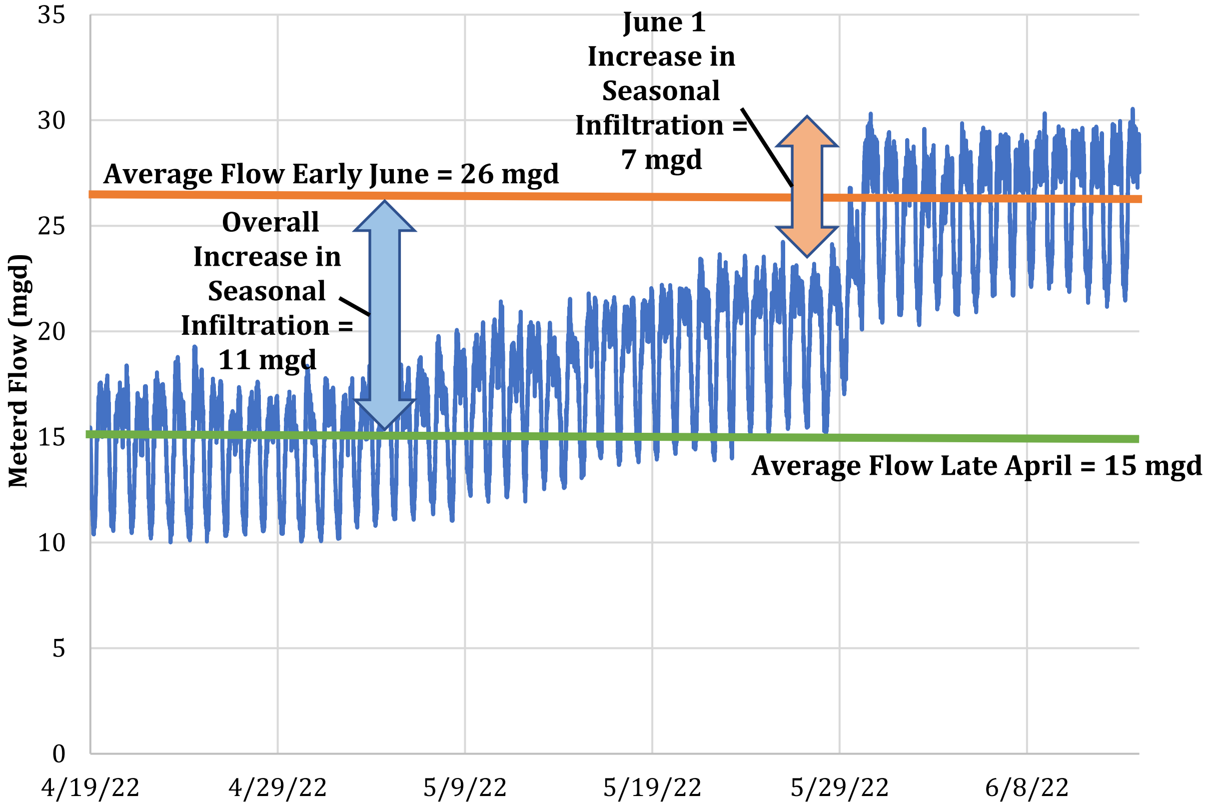


Figure 4-2: Flow Monitoring at CW-13 Showing Increase in Infiltration

It is important to note that this analysis has focused solely on the 11 mgd observed increase in infiltration from April to June of 2022. While the location of this infiltration has now been identified, this does not provide any firm conclusions regarding the remaining 15 mgd of infiltration observed during peak periods. A little more than 6 mgd of the other infiltration occurs year-round and is likely distributed throughout the service area. The remaining 9 mgd of infiltration observed only in high infiltration years could be coming primarily through CW-13 but is equally likely to be coming from other parts of the system.

With that said, looking upstream of Meters CW-09 and CW-13 is a good place to start. If the just the 7 mgd increase in infiltration observed on June 1 could be eliminated, this would represent a 15 percent reduction in design flows and potentially millions in savings to the District.

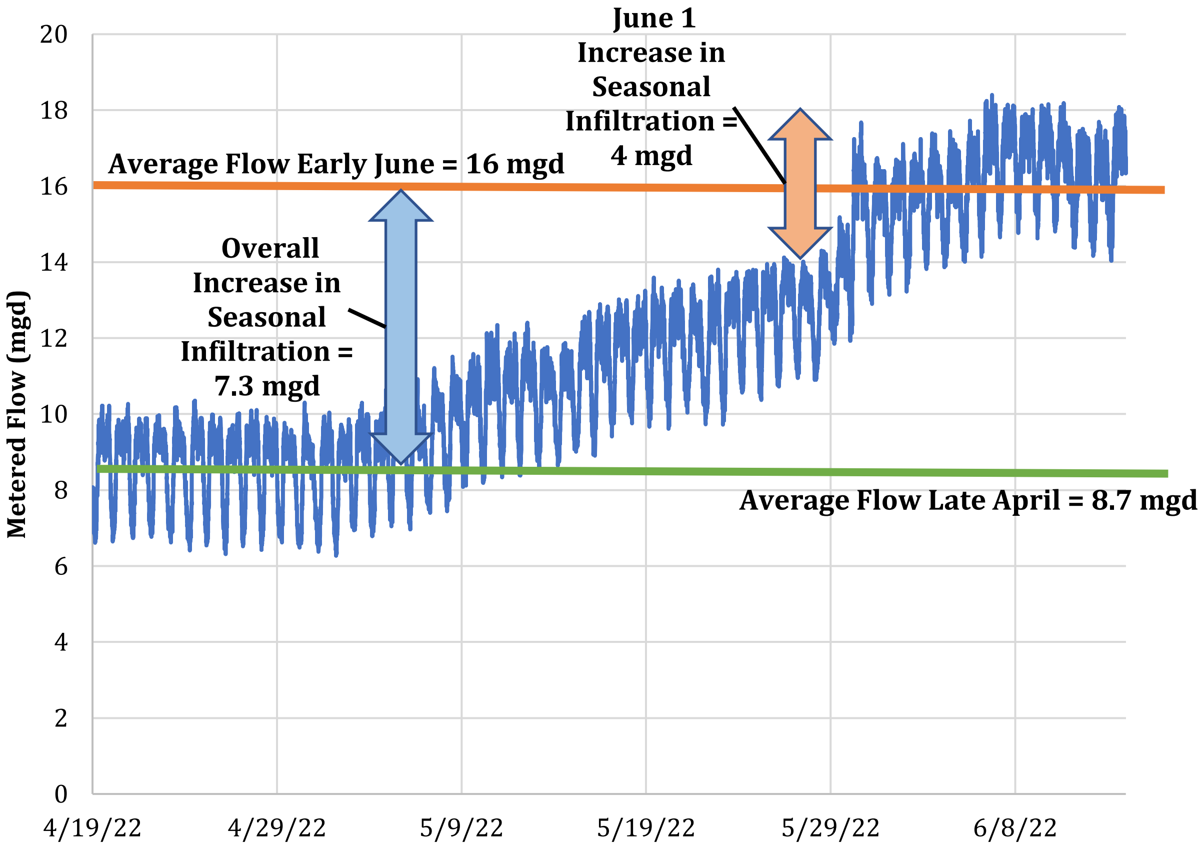


Figure 4-3: Flow Monitoring at CW-09 Showing Increase in Infiltration

FUTURE FLOW MONITORING

CWSID has expressed interest in potentially installing permanent flow meters in the system. These meters would be used to assist with future system evaluation efforts and potentially allow the District to bill member entities on the basis of flow and loading. The results of this investigation explained in detail in a technical memorandum attached as Appendix I. In short, if the District wanted to be able to accurately meter flow from each of its member entities, it would need to install and maintain 31 meters on District pipelines with an additional 24 meters installed and maintained on City pipelines.

CONCLUSIONS

The flow monitoring was successful in providing general system flow data and infiltration analysis. As a result of the flow monitoring, two sewersheds were identified where large increases in infiltration are being observed (OG-07 and OG-08). Addressing and further refining infiltration in this region should be a priority to meet CWSID goals of reducing system infiltration. No additional information on storm inflow response was gathered due to a lack of large storms during the monitoring period.

CHAPTER 5 – HYDRAULIC MODELING

INTRODUCTION

The CWISD sewer system was evaluated as part of this study using a hydraulic modeling computer program. A hydraulic computer model is a mathematical representation of the pipes, manholes, pumps, and wastewater flows found in the sewer collection system. Hydraulic computer models are useful because they allow the user to simulate operation of large, complex sewer systems and consider how future changes in flow will affect those systems. The purpose of this chapter is to document how the model for this project was developed and calibrated.

INFOSWMM

The computer modeling software used in this study was InfoSWMM, developed by Innovyze. InfoSWMM is a sewer model that runs within the geographical information systems (GIS) program ArcGIS. It was chosen since the last master plan model was also in InfoSWMM. This model was provided to BC&A by CWSID.

GEOMETRIC MODEL DEVELOPMENT

There are two major types of data required to create a hydraulic model of a sewer system: geometric data and flow data. Geometric data consists of all information in the model needed to represent the physical characteristics of the system.

Modeled Pipelines

CWSID only has ownership of major trunklines serving multiple cities. As a result, this study includes a model of all District owned pipelines. Information on the physical characteristics of the pipes included in the District's previous model was collected and assembled by CWSID personnel. Two recent sewer projects were added to the model to update the trunklines to match the existing system. This included the North Area Relief Sewer and the Birch Creek Sewer.

Modeled Lift Stations

There are eight (8) existing lift stations in the CWSID system. The only one not included in the model is the Marriott-Slaterville lift station. That lift station has been excluded because its design capacity is unknown and it only provides service for a portion of Marriott-Slaterville.

Details of existing lift station characteristics were summarized in Chapter 3. As part of a recent project, CWSID has installed a meter on the Industrial lift station. As this meter data becomes available and is calibrated, CWSID should re-evaluate the flow and loading modeled for the Industrial Lift Station.

FLOW MODEL DEVELOPMENT

Once all required geometric data has been verified in the developed model of the system, flow data is the second category of information needed to model system performance. Three types of flow information are required for hydraulic modeling: base sanitary wastewater magnitude and distribution, base sanitary wastewater flow timing, and infiltration magnitude and distribution. Each of these flow characteristics is discussed below.

Base Sanitary Wastewater Magnitude & Distribution

The total magnitude of base sanitary wastewater was discussed in detail in the Technical Memorandum in Appendix A. Distribution of these base sanitary flows was as follows:

- For existing conditions, base sanitary flows were distributed based on the distribution of ERUs (both residential and non-residential). Indoor water use was used to estimate the average ERU flow rate. For typical connections, indoor water use is closely related to base sanitary wastewater production. While this is not exactly true for highly consumptive uses such as food processing/bottling, it is representative of most other uses.
- For future flows, areas were defined and used to assign flows associated with growth to specific manholes.

Base Sanitary Flow Timing

The pattern of fluctuating base sanitary flow is often referred to as a diurnal pattern. These patterns vary depending on the type of user. For residential customers, peak flows are generated during the morning hours as residents prepare for the day (including showers for one portion of the population). There is another peak in the early evening as residents return from work and clean up from the day (including showers for another portion of the population). Base sanitary flow is generally lower throughout the remainder of the day and is just a trickle during the early morning hours when most residents are asleep. The District also has some commercial and other non-residential users for which flow patterns can be different. For non-residential customers, wastewater production is often consistent through most waking hours of the day, but also drop substantially during the early morning hours when most businesses are closed.

The combined usage patterns of these different users results in a diurnal pattern for a drainage area. Figure 5-1 shows an example of a diurnal pattern for one specific drainage basin (in this case, CW-12).

Since the District's system conveys flow form areas with very different type of use mixes, there is significant variation in diurnal curves between the various points of discharge within the District service area. To best calibrate the model, 13 different diurnal curves were used. The 13 diurnal curves used in the model are provided in Appendix C.

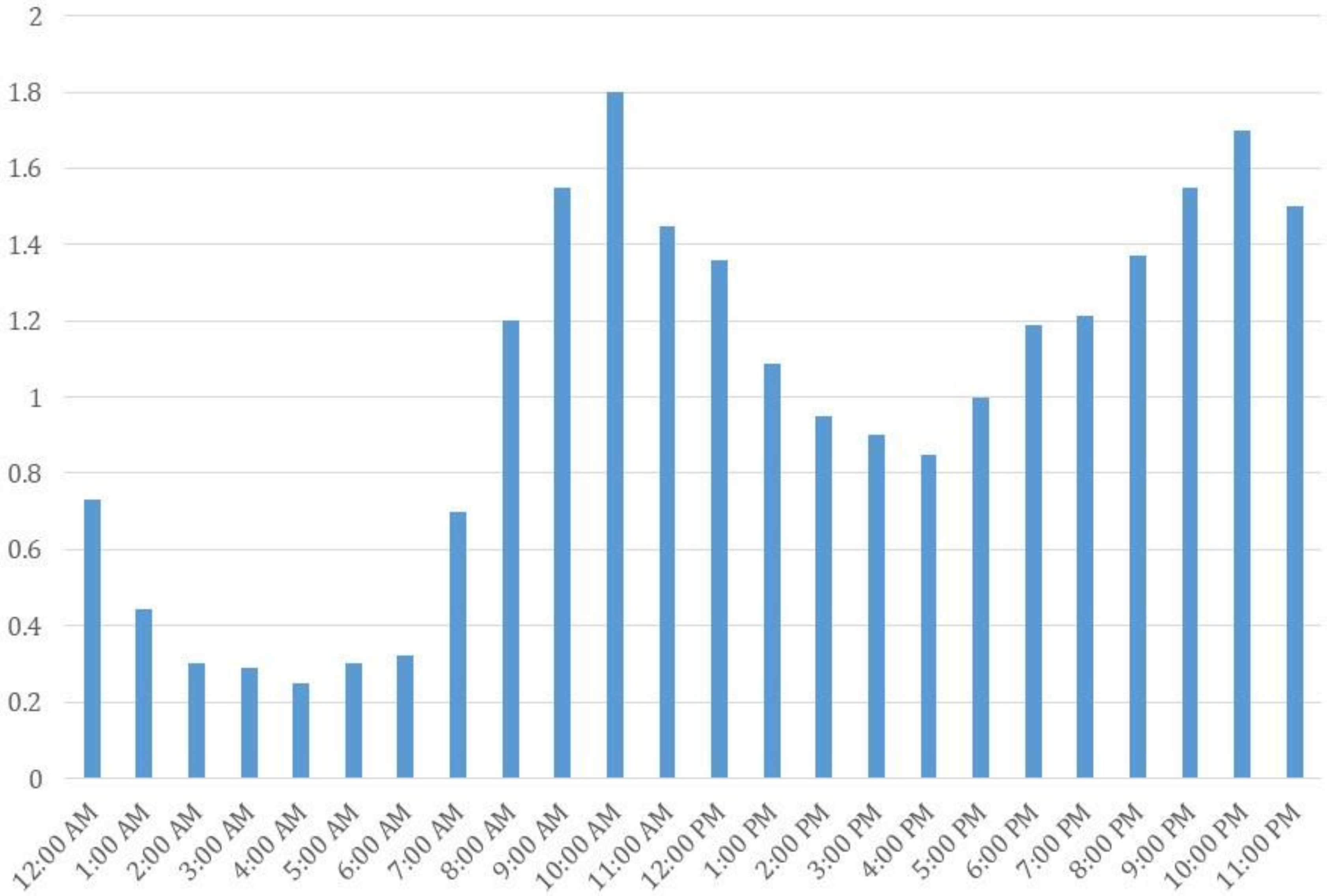


Figure 5-1: Example of Hydraulic Model Diurnal Curve from Meter CW-12

Infiltration Magnitude & Distribution

For existing flow, infiltration was distributed starting with flow monitoring results. Where infiltration was observed in the flow monitoring results, it was added to the model. Based on the historic data, however, the observed infiltration in the recent flow monitoring data was less than the historic max. month average. To create the recommended planning scenario, additional infiltration still needed to be added. The difference between observed infiltration in the flow monitor results and recommended planning levels of infiltration was distributed to all sewersheds based on the average infiltration per acre observed in the sewersheds during monitoring. This essentially assumes that, as additional infiltration is added in the system, it will come from individual sewersheds at the same rate as infiltration for lower levels. While this assumption is undoubtedly incorrect in some way, it is the best assumption available. To most accurately model the distribution of infiltration during peak conditions, the District would need to collect flow data during a period of peak infiltration. This data is not currently available.

For future flows, growth of infiltration within the District was added to the future hydraulic model simulations at a rate of approximately 33 gpd per new connection. Infiltration is typically a function of pipe length, size, and depth, but can reasonably be represented on a per connection basis for future growth.

As discussed in Chapter 2, infiltration may vary on a seasonal basis but does not generally vary on a daily basis. As a result, all infiltration is modeled at a constant flow over the 24 hour modeling period.

Conveyance System Inflow

For this study, inflow has not been modeled directly because of the wide variability in storm events and inflow response possible in the District. For design purposes, the District has included a capacity allowance in its design criteria to account for inflow into its collection system (see Chapter 6).

MODEL CALIBRATION

With the detailed flow monitoring done as part of this study, a calibration of the model was performed. Two (2) of the meters were not used to directly calibrate the model, CW-02 and CW-16. CW-02 was used to help estimate total flow into the plant and CW-16 was installed on an incorrect meter and did not have a significant sewershed area. The calibration process primarily included adjusting infiltration and picking the appropriate diurnal curve to match the existing flow data. In some cases, minor adjustments to base sanitary flow were also made. Figure 5-2 shows examples of the calibration at Meters CW-12 and CW-13. Appendix D includes the calibration results for all other meters. Once the results were calibrated, the infiltration was increased to the max month average day amount and distributed as previously discussed. Table 5-1 includes the calibrated results and planning infiltration information for each sewershed.

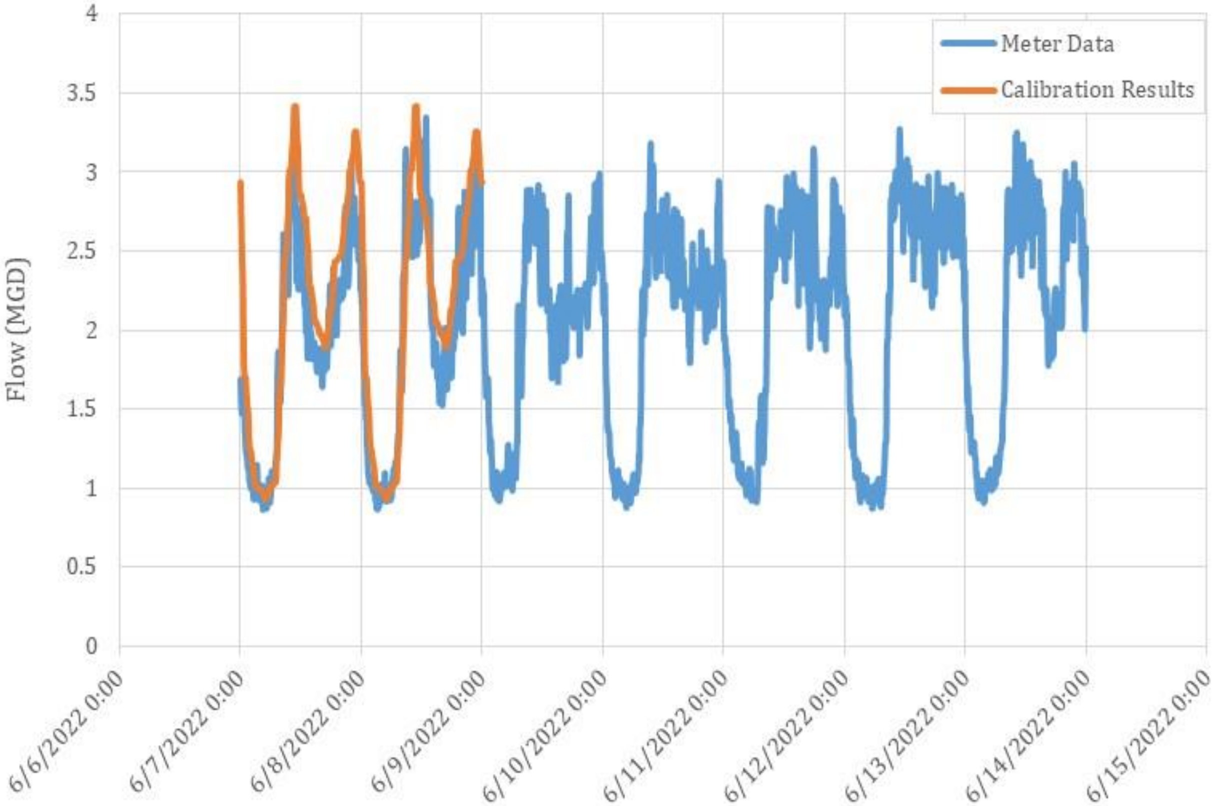


Figure 5-2a: Calibration Results for Meter CW-12

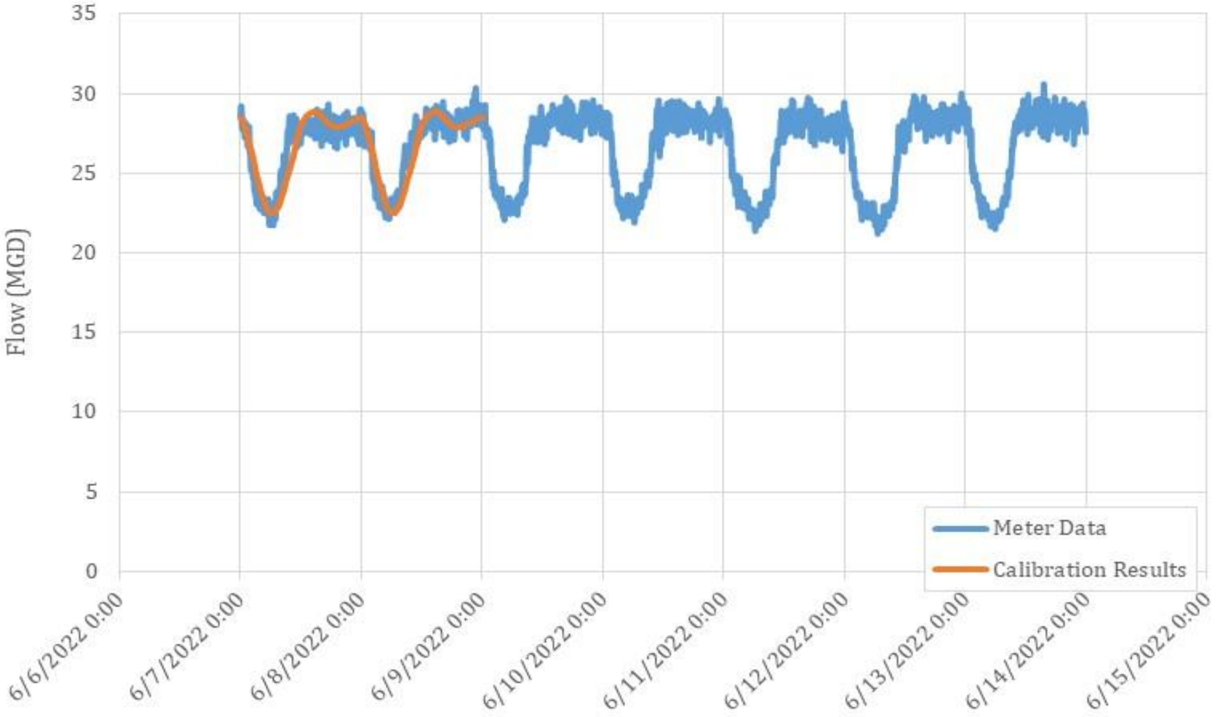


Figure 5-2b: Calibration Results for Meter CW-13

Table 5-1
Calibrated Sewershed Input Data

Sewershed	Diurnal Curve	Calibrated Infiltration (June 2022)	Calibrated Base Sanitary Flow (June 2022)	Planning Infiltration (Max. Month)
FW-01	CW-08	0.000	0.096	0.055
FW-02	CW-08	0.000	0.135	0.074
FW-03	CW-08	0.000	0.041	0.017
FW-04	CW-08	0.000	0.069	0.033
FW-05	CW-08	0.000	0.102	0.047
FW-06	CW-08	0.000	0.012	0.007
FW-07	CW-08	0.000	0.022	0.003
FW-08	CW-08	0.000	0.060	0.004
FW-09	CW-08	0.005	0.012	0.005
HA-01	CW-11	0.242	0.148	0.248
HA-02	CW-11	0.021	0.033	0.022
HA-03	CW-11	0.028	0.044	0.029
HA-04	CW-11	0.051	0.080	0.053
HA-05	CW-09	0.000	0.208	0.052
HA-06	CW-12	0.024	0.073	0.076
HO-01	CW-18	0.103	0.261	0.103
ID-01	CW-12	0.000	0.342	0.000
ID-02	CW-12	0.000	0.167	0.000
MS-01	CW-18	0.070	0.043	0.070
MS-02	CW-18	2.080	0.017	2.096
MS-03	CW-18	0.000	0.019	0.094
NO-01	CW-11	0.124	0.193	0.187
NO-02	CW-11	0.000	0.000	0.018
NO-03	CW-11	0.132	0.206	0.192
NO-04	CW-11	0.166	0.258	0.248
NO-05	CW-12	0.297	0.902	0.343
OG-01	CW-08	0.140	0.263	0.141
OG-02	CW-08	0.341	0.643	0.344
OG-03	CW-08	0.000	0.184	0.246
OG-04	CW-20B	0.000	0.688	0.386
OG-05	CW-20B	0.000	0.699	0.386
OG-06	CW-08	0.000	0.464	0.617
OG-07	CW-09	5.127	3.675	7.076
OG-08	CW-09	1.359	0.974	1.532
OG-09	CW-09	4.473	1.414	4.762
OG-10	CW-09	1.535	1.100	1.686
OG-11	CW-05	0.313	0.192	0.321

Sewershed	Diurnal Curve	Calibrated Infiltration (June 2022)	Calibrated Base Sanitary Flow (June 2022)	Planning Infiltration (Max. Month)
OG-12	CW-11	0.329	0.513	0.353
PC-01	CW-08	0.000	0.008	0.019
PC-02	CW-08	0.000	0.007	0.001
PC-03	CW-08	0.000	0.001	0.000
PC-04	CW-08	0.000	0.003	0.009
PV-01	CW-08	0.075	0.168	0.075
PV-02	CW-12	0.000	0.037	0.008
PV-03	CW-12	0.109	0.331	0.110
PV-04	CW-12	0.006	0.017	0.006
PV-05	CW-12	0.087	0.265	0.088
PV-06	CW-12	0.005	0.014	0.005
RD-01	CW-01	0.008	0.035	0.008
RD-02	CW-04	0.000	0.830	0.021
RD-03	CW-04	0.000	0.042	0.004
RD-04	CW-10	0.003	0.009	0.003
RD-05	CW-04	0.066	0.124	0.066
RD-06	CW-04	0.000	0.089	0.002
RD-07	CW-04	0.000	0.149	0.011
SO-01	CW-04	0.000	0.332	0.226
SO-02	CW-05	0.447	1.262	1.267
SW-01	CW-01	0.117	0.522	0.118
SW-02	CW-01	0.007	0.032	0.007
UH-01	CW-05	0.080	0.151	0.081
UI-01	CW-01	0.029	0.128	0.029
W1-01	CW-18	0.140	0.136	0.142
W1-02	CW-18	0.131	0.127	0.132
W1-03	CW-18	0.188	0.182	0.189
W2-01	CW-18	0.000	0.087	0.000
WH-01	CW-18	0.144	0.366	0.145
WH-02	CW-18	0.423	0.410	0.426
WH-03	CW-20B	0.000	0.138	0.069
WH-04	CW-04	0.528	0.297	0.532
WT-01	CW-10	0.000	0.226	0.031
WT-02	CW-10	0.057	0.334	0.057
Total		**19.6**	**21.2**	**25.81**

DEVELOPMENT OF FUTURE CONDITIONS MODELS

Four future growth scenarios have been modeled as part of this project. This includes 5- and 10-year models, along with models representing projected growth in 2040 and at buildout. The procedure used to develop these future scenarios are described in the following sections.

District Service Area Assumptions

The existing District Service Area does not currently provide service to everyone that lives in each City (see Chapter 2 and Appendix A). It has been assumed that, over time, the District will eventually service the entire proposed service area shown in Figure 2-1. This includes serving all of Uintah City (currently only a small mobile home park is being served) and all of what is currently Unincorporated Weber County west of I-15.

For future modeling scenarios, it has been assumed that all of the population within the sewersheds of Uintah and West Weber 1 will be completely served beginning in the 5-year model. This is almost certainly earlier than will actually occur, but was found to have little effect on the model results in the short-term. The area west of the Weber River (West Weber 2) does not currently send any flow to the District's system. This area was not added to the model until the build-out scenario. This is because current projections do not show this developing significantly until after the 2040 planning window. If development in this area is accelerated, the modeling results will need to be updated accordingly.

The total ERUs projected for each sewershed in the future model scenarios are provided in Table 5-2.

Table 5-2
Projected Sewershed ERUs for Future Models

Sewershed	2022	2027	2032	2040	Build-Out
FW-01	484	535	596	690	1,037
FW-02	680	762	839	979	1,501
FW-03	205	229	251	289	460
FW-04	349	393	448	537	823
FW-05	514	567	617	703	1,041
FW-06	58	63	67	75	114
FW-07	113	121	129	144	198
FW-08	302	332	363	415	605
FW-09	328	357	386	437	627
HA-01	622	791	929	1,017	1,106
HA-02	165	204	239	281	318
HA-03	223	252	278	301	325
HA-04	404	735	994	1,046	1,100
HA-05	1,048	1,201	1,314	1,413	1,527
HA-06	288	335	370	393	418
HO-01	2,146	2,694	3,304	4,243	7,404
ID-01	1,726	1,837	1,949	2,129	2,353
ID-02	841	896	951	1,038	1,147
MS-01	215	318	444	652	987
MS-02	86	132	184	270	419
MS-03	97	167	252	385	601
NO-01	975	1,103	1,231	1,497	1,882
NO-02	0	0	0	0	0
NO-03	1,040	1,089	1,124	1,228	1,367
NO-04	1,302	1,574	1,871	2,447	3,287
NO-05	3,554	3,955	4,454	5,317	6,624
OG-01	3,081	3,245	3,373	3,617	3,821
OG-02	7,534	8,090	8,626	9,428	10,127
OG-03	4,165	4,508	4,815	5,279	5,699
OG-04	3,469	3,744	3,988	4,358	4,702
OG-05	3,525	3,886	4,191	4,621	4,999
OG-06	4,677	5,170	5,609	6,246	6,798
OG-07	15,112	16,276	17,326	18,850	20,354
OG-08	4,006	4,468	4,887	5,544	6,155
OG-09	5,817	6,286	6,705	7,326	7,895
OG-10	4,524	4,752	4,963	5,319	5,735
OG-11	805	840	874	929	978
OG-12	2,586	2,671	2,748	2,859	2,983
PC-01	40	165	257	428	836

Sewershed	2022	2027	2032	2040	Build-Out
PC-02	35	30	37	37	39
PC-03	3	4	5	6	10
PC-04	17	47	71	114	215
PV-01	1,922	2,555	3,195	4,275	9,438
PV-02	189	231	270	333	644
PV-03	1,309	1,649	2,012	2,573	5,009
PV-04	68	88	112	142	282
PV-05	1,046	1,205	1,352	1,602	3,011
PV-06	57	71	85	108	217
RD-01	174	193	215	244	301
RD-02	2,421	2,887	3,365	4,312	5,392
RD-03	122	134	149	168	208
RD-04	113	127	143	162	207
RD-05	625	783	962	1,226	1,506
RD-06	261	267	276	285	324
RD-07	1,127	1,149	1,182	1,242	1,413
Roy	214	214	214	214	214
SO-01	1,673	1,895	2,173	2,262	2,262
SO-02	6,361	6,997	7,661	8,142	8,142
SW-01	2,630	3,071	3,521	4,252	4,252
SW-02	162	222	290	433	433
UH-01	762	904	1,060	1,293	1,548
UI-01	645	675	724	830	1,338
W1-01	486	642	791	1,016	2,537
W1-02	455	571	674	808	3,248
W1-03	652	842	1,032	1,292	4,854
W2-01	441	434	430	429	23,037
WH-01	3,009	3,235	3,377	3,525	3,698
WH-02	1,464	1,627	1,761	1,966	2,162
WH-03	698	1,048	1,281	1,585	1,820
WH-04	1,499	1,626	1,692	1,805	1,911
WT-01	659	698	726	769	826
WT-02	3,895	3,932	3,875	3,806	3,926
Total	**112,300**	**124,796**	**136,659**	**153,986**	**212,777**

Future Flow Assumptions

The calibrated existing conditions model was used to develop the future conditions models. Diurnal curves were maintained from the existing model for all future models. The base sanitary flow and infiltration were increased as follows:

- **Base Sanitary Flow** – As discussed in Chapter 2, the District average base sanitary flow was estimated to be 198.4 gpd/ERU. For each future model this was multiplied by the total number of new ERUs per sewershed. It was assumed that the existing base sanitary flow would remain approximately the same going forward.
- **Infiltration** – It was assumed that the existing max. month infiltration would not change in the future. This assumption is conservative as it assumes the District does not address known infiltration issues within the service area. However, until those issues can be located and eliminated, it seems important to continue to account for the existing infiltration. Future infiltration was added at a rate of 33.0 gpd/ERU for each new connection.

Based on the procedure described above and the total number of ERUs for each sewershed projected in the previous section, planning flows for each sewershed are summarized in Table 5-3.

Future Model System Operation

As part of developing the future models, it has been assumed that the BDO diversion flow split will be adjusted to send all flow west along the BDO mainline. This will help to minimize future projects in Pioneer Road as well as to push the timing back for projects in this area. The other diversions were not changed from the way that they are currently being operated.

Table 5-3
Projected Sewershed Flows for Future Models

Sewershed	2022		2027		2032		2040		Build-Out	
	Infiltration	BSF	Infiltration	BSF	Infiltration	BSF	Infiltration	BSF	Infiltration	BSF
FW-01	0.05	0.10	0.06	0.11	0.06	0.12	0.06	0.14	0.07	0.21
FW-02	0.07	0.13	0.08	0.15	0.08	0.17	0.08	0.20	0.10	0.30
FW-03	0.02	0.04	0.02	0.05	0.02	0.05	0.02	0.06	0.03	0.09
FW-04	0.03	0.07	0.03	0.08	0.04	0.09	0.04	0.11	0.05	0.16
FW-05	0.05	0.10	0.05	0.11	0.05	0.12	0.05	0.14	0.06	0.21
FW-06	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02
FW-07	0.00	0.02	0.00	0.02	0.00	0.03	0.00	0.03	0.01	0.04
FW-08	0.00	0.06	0.01	0.07	0.01	0.07	0.01	0.08	0.01	0.12
FW-09	0.01	0.01	0.01	0.02	0.01	0.02	0.01	0.03	0.02	0.07
HA-01	0.25	0.15	0.25	0.18	0.26	0.21	0.26	0.23	0.26	0.25
HA-02	0.02	0.03	0.02	0.04	0.02	0.05	0.03	0.06	0.03	0.06
HA-03	0.03	0.04	0.03	0.05	0.03	0.06	0.03	0.06	0.03	0.06
HA-04	0.05	0.08	0.06	0.15	0.07	0.20	0.07	0.21	0.08	0.22
HA-05	0.05	0.21	0.06	0.24	0.06	0.26	0.06	0.28	0.07	0.31
HA-06	0.08	0.07	0.08	0.08	0.08	0.09	0.08	0.09	0.08	0.10
HO-01	0.10	0.26	0.12	0.38	0.14	0.50	0.17	0.69	0.28	1.31
ID-01	0.00	0.34	0.00	0.37	0.01	0.39	0.01	0.42	0.02	0.47
ID-02	0.00	0.17	0.00	0.18	0.00	0.19	0.01	0.21	0.01	0.23
MS-01	0.07	0.04	0.07	0.07	0.08	0.09	0.08	0.13	0.10	0.20
MS-02	2.10	0.02	2.10	0.03	2.10	0.04	2.10	0.05	2.11	0.08
MS-03	0.09	0.02	0.10	0.03	0.10	0.05	0.10	0.08	0.11	0.12
NO-01	0.19	0.19	0.19	0.22	0.20	0.25	0.20	0.30	0.22	0.38
NO-02*	0.02	0.00	0.02	0.00	0.02	0.00	0.02	0.00	0.02	0.00
NO-03	0.19	0.21	0.19	0.22	0.19	0.22	0.20	0.24	0.20	0.27
NO-04	0.25	0.26	0.26	0.32	0.27	0.38	0.29	0.49	0.31	0.66
NO-05	0.34	0.90	0.36	0.99	0.37	1.09	0.40	1.26	0.44	1.52
OG-01	0.14	0.26	0.15	0.30	0.15	0.32	0.16	0.37	0.17	0.41

Sewershed	2022		2027		2032		2040		Build-Out	
	Infiltration	BSF	Infiltration	BSF	Infiltration	BSF	Infiltration	BSF	Infiltration	BSF
OG-02	0.34	0.64	0.36	0.76	0.38	0.87	0.41	1.03	0.43	1.17
OG-03	0.25	0.18	0.26	0.26	0.27	0.32	0.28	0.41	0.30	0.49
OG-04	0.39	0.69	0.40	0.75	0.40	0.80	0.42	0.87	0.43	0.94
OG-05	0.39	0.70	0.40	0.78	0.41	0.84	0.42	0.92	0.43	1.00
OG-06	0.62	0.46	0.63	0.57	0.65	0.66	0.67	0.79	0.69	0.89
OG-07	7.08	3.68	7.11	3.93	7.15	4.14	7.20	4.44	7.25	4.74
OG-08	1.53	0.97	1.55	1.08	1.56	1.16	1.58	1.29	1.60	1.41
OG-09	2.26	1.41	2.28	1.52	2.29	1.60	2.31	1.72	2.33	1.84
OG-10	1.69	1.10	1.69	1.15	1.70	1.19	1.71	1.26	1.73	1.35
OG-11	0.32	0.19	0.32	0.20	0.32	0.21	0.33	0.22	0.33	0.23
OG-12	0.35	0.51	0.36	0.53	0.36	0.55	0.36	0.57	0.37	0.59
PC-01	0.02	0.01	0.02	0.04	0.03	0.05	0.03	0.09	0.05	0.17
PC-02	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01
PC-03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PC-04	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.04
PV-01	0.08	0.17	0.10	0.31	0.12	0.43	0.15	0.65	0.32	1.67
PV-02	0.01	0.04	0.01	0.05	0.01	0.05	0.01	0.07	0.02	0.13
PV-03	0.11	0.33	0.12	0.41	0.13	0.48	0.15	0.59	0.23	1.07
PV-04	0.01	0.02	0.01	0.02	0.01	0.03	0.01	0.03	0.01	0.06
PV-05	0.09	0.27	0.09	0.30	0.10	0.33	0.11	0.38	0.15	0.66
PV-06	0.00	0.01	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.05
RD-01	0.01	0.03	0.01	0.04	0.01	0.04	0.01	0.05	0.01	0.06
RD-02	0.02	0.83	0.04	0.93	0.05	1.03	0.08	1.21	0.12	1.43
RD-03	0.00	0.04	0.00	0.04	0.00	0.05	0.01	0.05	0.01	0.06
RD-04	0.00	0.01	0.00	0.01	0.00	0.02	0.00	0.02	0.01	0.03
RD-05	0.07	0.12	0.07	0.16	0.08	0.19	0.09	0.25	0.10	0.30
RD-06	0.00	0.09	0.00	0.09	0.00	0.09	0.00	0.09	0.00	0.10
RD-07	0.01	0.15	0.01	0.15	0.01	0.16	0.01	0.17	0.02	0.21
SO-01	0.23	0.33	0.23	0.38	0.24	0.43	0.25	0.45	0.25	0.45

Sewershed	2022		2027		2032		2040		Build-Out	
	Infiltration	BSF	Infiltration	BSF	Infiltration	BSF	Infiltration	BSF	Infiltration	BSF
SO-02	1.27	1.26	1.29	1.40	1.31	1.53	1.33	1.63	1.33	1.63
SW-01	0.12	0.52	0.13	0.62	0.15	0.71	0.17	0.85	0.17	0.85
SW-02	0.01	0.03	0.01	0.05	0.01	0.06	0.02	0.09	0.02	0.09
UH-01	0.08	0.15	0.09	0.18	0.09	0.21	0.10	0.26	0.11	0.31
UI-01	0.03	0.13	0.03	0.13	0.03	0.14	0.04	0.17	0.05	0.27
W1-01	0.14	0.14	0.15	0.17	0.15	0.20	0.16	0.24	0.21	0.55
W1-02	0.13	0.13	0.14	0.15	0.14	0.17	0.14	0.20	0.22	0.68
W1-03	0.19	0.18	0.20	0.22	0.20	0.26	0.21	0.31	0.33	1.02
W2-01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.75	4.57
WH-01	0.15	0.37	0.15	0.42	0.16	0.44	0.16	0.47	0.17	0.51
WH-02	0.43	0.41	0.43	0.45	0.44	0.47	0.44	0.51	0.45	0.55
WH-03	0.07	0.14	0.08	0.22	0.09	0.26	0.10	0.32	0.11	0.37
WH-04	0.53	0.30	0.54	0.33	0.54	0.34	0.54	0.36	0.55	0.38
WT-01	0.03	0.23	0.03	0.23	0.03	0.24	0.03	0.25	0.04	0.26
WT-02	0.06	0.33	0.06	0.34	0.06	0.33	0.05	0.32	0.06	0.34
Total	**23.31**	**21.13**	**23.73**	**23.86**	**24.12**	**26.21**	**24.69**	**29.65**	**26.63**	**41.40**

* BSF from NO-02 was accounted for in NO-01 and NO-03 while infiltration was not. NO-02 only has a minimal number of ERUs and does not significantly impact flow in the trunkline.

CHAPTER 6 – COLLECTION SYSTEM EVALUATION

INTRODUCTION

With the development and calibration of a hydraulic sewer model, it is possible to simulate sewer system operating conditions for both existing and future conditions. The purpose of this chapter is to evaluate hydraulic performance of the collection system and identify potential hydraulic deficiencies.

EVALUATION CRITERIA

In defining what constitutes a hydraulic deficiency, it is important to consider the assumptions made in estimating sewer flows in the model. As described in Chapters 2 and 5, the sewer flow included in the model is composed of two parts: base sanitary flow and infiltration. Base sanitary flow was estimated based on regional water sales and flow monitoring data. Infiltration was estimated based on flow monitoring data and historical flow data at the treatment plant.

While these estimates are the best available representation of base sanitary flow and infiltration, they are based on average values and rely on a limited data set. Thus, actual flows will fluctuate and may occasionally be greater than the model estimates. For example, infiltration during extremely wet years could be more than estimated in the model (e.g. 1983 was a statewide historically wet year that led to high infiltration and flooding in many areas). These modeled flows are also based on dry weather conditions and do not include inflow (see Chapter 2). Thus, the criteria established for identifying deficiencies should be sufficiently conservative to account for inflows and other occasional flows higher than those estimated in the model. Based on typical industry values and discussion with District personnel, established evaluation criteria is presented in table 6-1.

Table 6-1
Evaluation Criteria

Facility Type	Description	Criteria Value	Notes
Gravity Pipe	Peak flow to Full-pipe flow (q/Q)	75% of q/Q	This is the initial evaluation criteria used for most of the system.
	Maximum depth at peak flow to diameter (d/D)	70% d/D	For short sections of pipe with flat slopes, q/Q criterion may flag pipes that are not actually a problem. This additional criterion should be checked in these cases.
Force Main	Minimum velocity	3 fps	Pumps should generate a flushing flow of at least 3 fps in all force mains.
	Peak velocity	7 fps	Peak flows with storm inflow should be less than 7 fps. Dry weather peak flow should be less than 5.25 fps.
Lift Station Pump	Required Capacity	Planning Dry Weather Flows < 75% of Design Capacity	Design Capacity should not include the largest capacity pump, e.g. assume the largest capacity pump is inoperable.

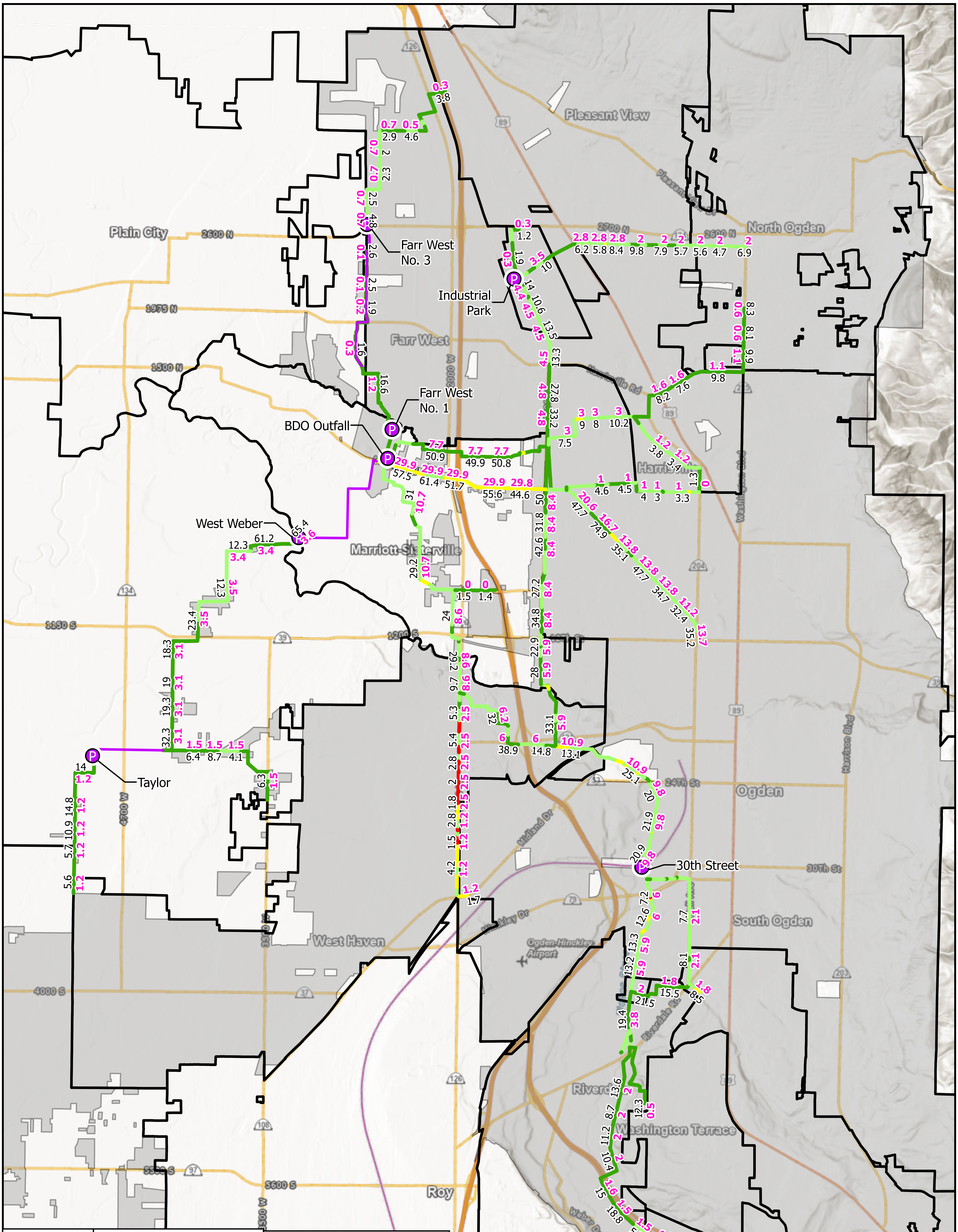
For the existing conditions evaluation, the gravity pipes in certain regions were checked with a 65 percent of q/Q criteria. These areas were primarily Farr West, Northern Ogden City, and parts of Harrisville. This was done to account for observed storm responses in which inflow exceeded the 25 percent allotted under typical evaluation criteria. This criterion was changed back to match the rest of the District by Build-Out. Moving this criterion back to 75 percent is based on two assumptions: that the District will locate and eliminate areas of excess inflow; and that the increase in base sanitary flow and ERUs in these regions will results in larger total flows at build-out such that inflow responses fall within the typical 25 percent allowance.

EXISTING DEFICIENCIES

Figure 6-1 shows the performance of the sewer system under existing flow conditions. Pipes in the figure are color coded to show the ratio of peak flow in the pipe to the pipe's full capacity. Based on these results, there appears to be only one area with existing deficiencies in the system. The area of concern is located along 1900 West in West Haven. While it is always concerning when there are existing deficiencies within a sewer system, this deficiency should not be viewed as an immediate emergency. The reasons for this are described below:

- **Sewer Pipe is Deep** – The existing sewer pipe is relatively deep along the deficient portion of 1900 West (12+ feet). In particular, the area with the greatest deficiency is nearly 15-feet deep. Consequently, a small amount of surcharging can happen along this pipeline without adversely affecting any customers.
- **Mild Slope** – The deficiencies in this area are primarily caused by mild slope. For pipelines with mild slope, a relatively small increase in depth at the upstream end of the pipe can result in a significant increase in capacity. As a result, the actual depth of surcharging associated with any capacity deficiencies along this pipeline is expected to be limited.
- **High Infiltration** – There is over 1 MGD of estimated infiltration in this area. This flow is only anticipated along this mainline during high infiltration periods. Flows during lower infiltration periods will be significantly less. Thus, it will be relatively infrequent that any risk associated with capacity limitations in this pipeline will exist for the District.

While 1900 West does not represent an immediate emergency, flows in the area will continue to grow and the pipeline could become a problem in the very near future. Correspondingly, planning, design, and construction for improvements to increase capacity along this reach should begin in earnest as quickly as possible.



NORTH:

SCALE:

0 2,100 4,200 Feet

CWSID SYSTEM EXISTING DEFICIENCY

CWSID

WASTEWATER MASTER PLAN

FIGURE NO.

6-1

BOWEN COLLINS & ASSOCIATES

LEGEND

Existing Lift Station

- Ⓟ Not Deficient

Waste Water Pipes

Existing Max Flow/Capacity

- ≤ 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75+

Force Main

- Not Deficient
- ☐ Municipalities
- ▨ Existing Service Area

Label ID
XX - Max Flow (MGD)
XX - Capacity (MGD)

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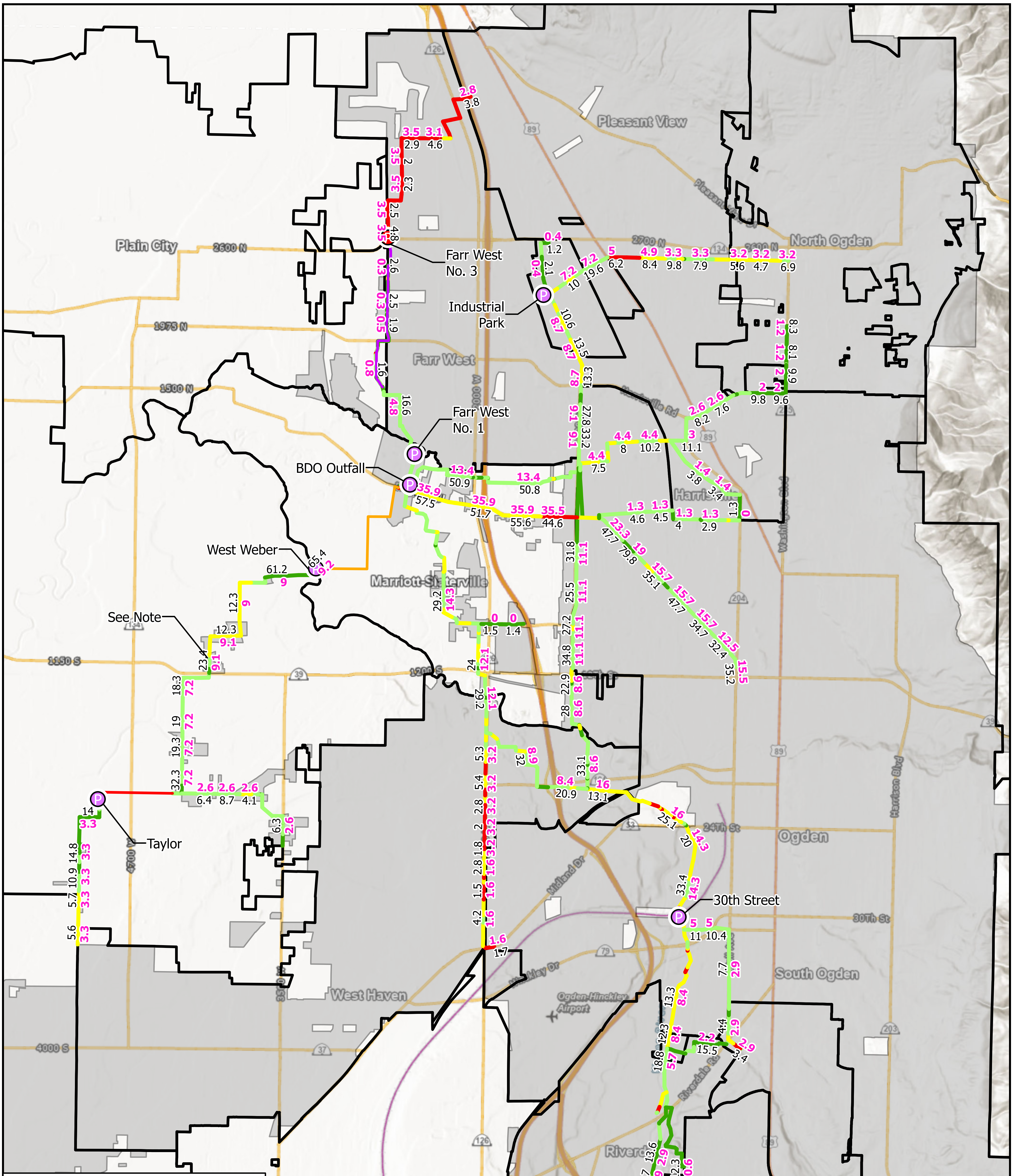
FUTURE DEFICIENCIES

Sewer projects and improvements should be built with buildout conditions in mind whenever possible. As a result, it is useful to look at buildout deficiencies and capacity needs before considering interim flow conditions and phasing. Two scenarios were analyzed for the buildout conditions modeling:

- **Without Weber West 2** – This scenario represents all sewer flow from within the current annexable area of Weber County east of the Weber. Figure 6-2 shows hydraulic performance as calculated by the hydraulic model for this scenario at buildout conditions and assuming no improvements are made to the existing system. As can be seen in the figure, there are a number of capacity deficiencies for the buildout scenario. Deficiencies are scattered throughout the collections system.
- **With Weber West 2** – This scenario includes all the flow identified in the above scenario and then also adds the unincorporated Weber County area west of the Weber River (Weber West 2). Currently this region of the County is not serviced or annexed into the District's service area. As a result, there are no existing District facilities within this region. As part of this scenario, it was assumed that all flow from this region would discharge into the system at approximately 4100 West and 1200 South. If this area is annexed in, a new deficiency from the inflow point up to and including the West Weber Lift Station will be added beyond what is currently shown in Figure 6-2.

As part of both scenarios, it was assumed that all of Uintah will eventually be connected to the system While this assumption is conservative, it was not found to change the number of downstream deficiencies.



Note:
Unless otherwise noted, this figure does not include deficiencies associated with development west of the Weber River. If all flow from that area is added to the existing system, all pipes downstream of that point are anticipated to be deficient.

NORTH:

SCALE:
0 2,100 4,200
Feet

CWSID SYSTEM
BUILDOUT DEFICIENCY

CWSID
WASTEWATER MASTER PLAN

BOWEN COLLINS & ASSOCIATES

FIGURE NO.
6-2

LEGEND
Existing Lift Station
Ⓟ Not Deficient
Ⓟ Deficient
Waste Water Pipes
Buildout Max Flow/Capacity
— ≤ 0.25
— 0.25 - 0.5
— 0.50 - 0.75
— 0.75+
Force Main
— Not Deficient
— Deficient
— Deficient with West Weber 2
▭ Municipalities
▨ Existing Service Area

Label ID
XX - Max Flow (MGD)
XX - Capacity (MGD)

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LIFT STATION AND FORCE MAIN EVALUATION

Based on model results of existing and projected flows, Tables 6-2 and 6-3 evaluate the adequacy of existing capacity at the District's Lift Stations and Force Mains respectively. Scenario in which the lift station or force main are deficient are highlighted in red bold italics.

Table 6-2
Lift Station Flow Summary

Lift Station	Design Capacity with Largest Pump Offline (MGD)	Planning Capacity at 75 % Design Capacity (MGD)	Existing Flow (MGD)[1]	Buildout Flow (MGD)[1]
30th Street	19.0	14.3	9.8	14.3
Farr West No. 1	15.0	11.3	1.2	4.8
Farr West No. 3	3.8	2.9	0.7	***3.5***
Industrial Park	Unknown	Unknown	0.9	1.3
Taylor[2]	6.6	5.0	1.6	4.7
West Weber (w/o Weber West 2)	26.1	19.6	3.6	9.2
West Weber (w/ Weber West 2)[2]	26.1	19.6	3.6	17.3
BDO Outfall	23.0	17.3	7.9	13.7

[1] The flow rates shown are for the dry weather peak flow. Flow from rain events is accounted for in the Design Capacity.

[2] An additional pump will be required to increase the capacity of the West Weber and Taylor lift stations to meet required flows.

Table 6-3
Force Main Flow Summary

Force Main	Existing Inside Diameter (inch)	Existing Dry Weather Peak Flow (MGD)	Buildout Dry Weather Peak Flow (MGD)	Existing Peak Velocity (fps)	Buildout Peak Velocity (fps)
30th Street	24	9.8	14.3	4.8	***7.1***
	26	9.8	14.3	4.8	***6.4***
Farr West No. 3	18	0.7	3.5	0.9	3.6
Industrial Park	6	0.9	1.3	7.7	***10.1***
Taylor	16	1.6	4.7	3.0	***5.5***
West Weber (w/o Weber West 2)	22	3.6	9.2	3.5	***8.4***
West Weber (w/ Weber West 2)	22	3.6	17.3	3.5	***15.6***

As can be seen in Table 6-2, only the Farr West No. 3 lift station needs to be upsized. Note that the West Weber lift station will require an additional pump to be installed if the sewer flow from development west of the Weber River is collected and treated by the District. As can be seen from Table 6-3, all of the force mains except for Farr West No. 3 will be deficient for future build-out conditions.

CHAPTER 7
COLLECTION SYSTEM IMPROVEMENTS

INTRODUCTION

The hydraulic model was used to evaluate various alternatives for correcting the identified deficiencies under projected future conditions. The purpose of this chapter is to summarize the recommended collection system improvements.

RECOMMENDED SYSTEM IMPROVEMENTS

Recommended system improvements have been separated into four (4) groups based on when they are expected to be needed: 0-5 years, 5-10 years, 10-15 years, and greater than 15 years. Expected timing of each project has been based on modeling results observed in the future growth scenarios. Table 7-1 summarizes all of the recommended collection system improvements. Figure 7-1 shows the location and extent of the improvements. A project summary sheet for each improvement is also included in Appendix E.

Included in the table is an estimate of required pipe sizes for each project. These have been included for cost estimating purposes and are based on known or estimated pipe slopes. Once design of a sewer pipeline commences, the actual pipe size should be revisited and updated based on actual slope and the required design capacity of each pipeline. Required design capacities for each reach of pipeline are included in the project summary sheets.

For quick reference, a brief description of each improvement is contained in the following sections.

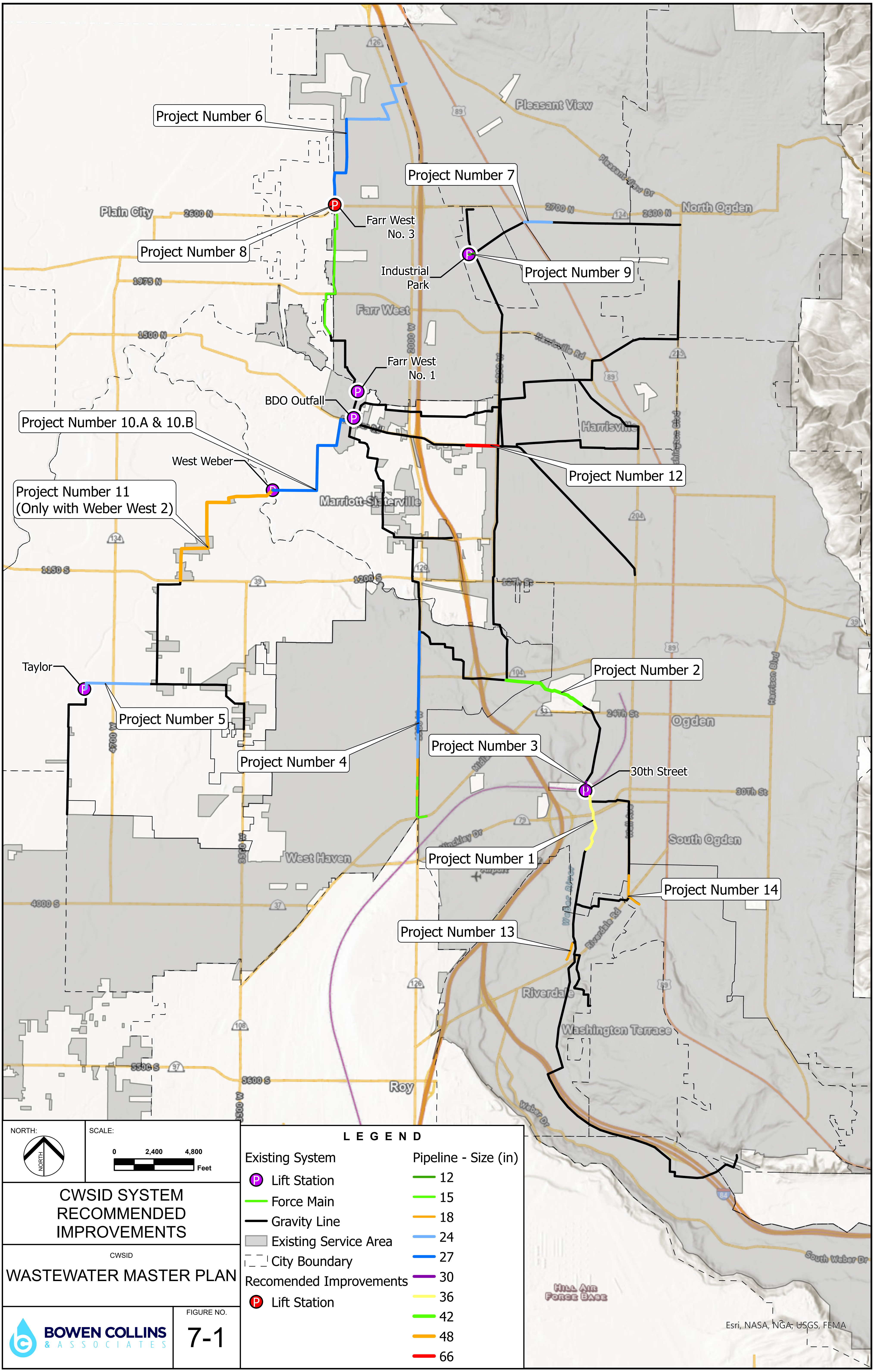
0-5 Year Improvements

The following projects should be constructed within 0 to 5 years.

- **#4 West Haven Mainline** – The West Haven Mainline is an existing system deficiency. Based on flow projections, the project should go from the start of the pipe in Midland Dr. to the junction with the 42-inch system pipeline near 1900 West and 1700 South. The existing 12- to 18-inch sewer pipe should be replaced with 15- to 27-inch sewer pipe. This is the top priority pipeline capacity project for the District.
- **#14 South Ogden Stubline** – The South Ogden Stubline project would replace the pipe on the south side of 40th Street that flows to Wall Ave. The existing 15-inch pipe along this section should be replaced with at least an 18-inch pipe. As shown in Figure 7-1, this project also currently shows replacing the 15-inch pipeline downstream of 40th Street on Wall Avenue. This was done to avoid moving from an 18-inch pipeline in 40th Street to a 15-inch pipeline in the downstream direction. However, it should be noted that the slope of the 15-inch pipeline in Wall Avenue is significantly greater than the slope of the pipeline in 40th Street. As a result, it has more capacity and may not need to be replaced from a capacity standpoint. This should be evaluated as part of final design.
- **#3 30th Street Force Main** – The 30th Street Force Main is between 24-26 inches in size. It should be replaced with at least a 30-inch (inside diameter) pipe. This project will require replacing the length of the force main, including underneath the railroad tracks. The 30th Street lift station is on the border of being upsized and should be reanalyzed as buildout development levels are approached.

Table 7-1
Recommended Collection System Improvements

Project Number	Project Identifier	Project Location	Existing Size	Proposed Size	Time Frame
1	Riverdale Railroad Yard Mainline	Within Riverdale Railyard from approximately 35th Street to 31st Street	27-30 inches	36-inch	10-15 years
2	Ogden 30th Street Mainline	From approx. 25th Street to south flow split	36-inch	42-inch	5-10 years
3	30th St. Force Main	Entire 30th Street Force Main	24-26 inches	30-inch	0-5 years
4	West Haven Mainline	Along 1900 West from Midland Dr. to approximately 1715 South	12-18 inches	15-27 inches	0-2 years
5	Taylor Force Main	Entire Taylor Force Main	16-inch (I.D.)	24-inch (I.D.)	15+ years
6	Farr West Mainline	From beginning of gravity line to Farr West Lift Station No. 3	18-inch	24-27 inches	10-15 years
7	North Ogden Mainline	Along 2550 North from approximately 750 West to 1000 West	21-inch	24-inch	15+ years
8	Farr West Lift Station No. 3	Farr West Lift Station No. 3	3.3 MGD	4.7 MGD	10-15 years
9	Industrial Force Main	Industrial Force Main	6-inch (I.D.)	12-inch (I.D)	15+ years
10.A	West Weber Force Main (w/o West Weber 2)	West Weber Force Main	18-inch (I.D.)	27-inch (I.D.)	15+ years
10.B	West Weber Force Main (w/ West Weber 2)	West Weber Main	18-inch (I.D.)	36-inch (I.D.)	15+ years
11	Hooper Mainline (w/ West Weber 2)	From 1200 South to West Weber Lift Station	N/A	48-inch	15+ years
12	Pioneer Road	Approximately 1,900 ft starting at 1200 West	60-inch	66-inch	15+ years
13	Riverdale Stubline	From start of line to Weber River crossing	15-inch	18-inch	15+ years
14	South Ogden Stubline	From the start to approximately 37th Street on Wall Ave.	15-inch	18-inch	0-5 years
--	Annual Maintenance (per year)	District Wide	N/A	N/A	Ongoing
--	Hooper Lining Phase II	Hooper Mainline	N/A	N/A	0-2 years



CWSID SYSTEM
RECOMMENDED
IMPROVEMENTS

CWSID

WASTEWATER MASTER PLAN

FIGURE NO.

7-1

BOWEN COLLINS & ASSOCIATES

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5-10 Year Improvements

The following project should be constructed within 5 to 10 years.

- **#2 Ogden 30th Street Mainline** – The existing 36-inch sewer from the 24th Street Weber River crossing to the flow split at 2100 South and 1100 West should be replaced with an estimated 42-inch pipe.

10-15 Year Improvements

The following projects should be constructed within 10 to 15 years.

- **#1 Riverdale Railroad Yard Mainline** – The sewer pipe in the Riverdale Railroad Yard will need to be upsized to meet deficiency criteria. The project should start at approximately 35th Street within the Railroad Yard and extend all the way to the 30th Street Lift Station.
- **#6 Farr West Mainline** – The entire Farr West Mainline north of the Farr West Lift Station No. 3 will need to be upsized from its existing 18-inch size to approximately 24 to 27-inch. This project could be done at the same time as Project #8.
- **#8 Farr West Lift Station No. 3** – The Farr West Lift Station No. 3 will need to be expanded to increase the capacity to meet future projected flows. Recommended future design capacity is 4.7 mgd. The existing force main downstream of the pump station has already been sized to accommodate this future flow. This project could be done at the same time as Project #6. There is space for an additional pump that could extend the time until this project is required by a few years. This alternative should be further evaluated with the next mater plan effort.

15+ Year Improvements

The following projects represent the remaining capacity deficiency projects expected by build-out. They are not projected to be needed for at least 15 years.

- **#5 Taylor Force Main** – The Taylor Force Main will need to be upsized to meet future demands. The expected future force main size is 24-inches (I.D.). The lift station will have minimal capacity at build-out and should be verified as part of the force main design, based on this study it will not require upsizing. An additional pump will need to be installed for the lift station to meet design flows.
- **#7 North Ogden Mainline** – The portion of the North Ogden Mainline on 2550 North from approximately 750 West to Highway 89 will need to be upsized from 21 inches to 24 inches in diameter to meet future demands.
- **#9 Industrial Force Main** – A new meter has been installed on the Industrial Lift Station. Because historic data has been unavailable, projections for flows in this area are uncertain. Moving forward, the District should closely monitor flow and velocities in the existing force main. When the Dry Weather Peak Velocity in the force main is consistently greater than 5.25 fps, the force main should be upsized. The recommended I.D. is 12-inches.
- **#10 West Weber Lift Station & Force Main** – This project is directly impacted by the Weber West 2 service area. Correspondingly, there are two scenarios for this project.
    - **#10.A Force Main Only (No Weber West 2):** If the Weber West 2 area is not annexed into the District, the existing lift station appears to have enough capacity for growth and only the force main will need to be upsized. The new force main should have an inside diameter of at least 27-inches.

    - **#10.B Lift Station & Force Main (With Weber West 2):** If the Weber West 2 area is annexed into the District, both the force main and the lift station will need to be upsized. The force main inside diameter would increase to 36 inches and the lift station capacity would need to be increased to at least 23.7 MGD.

- **#11 Hooper Mainline** – This project is only needed if the Weber West 2 area is annexed into the District. With Weber West 2, it is recommended that a new, parallel 48-inch diameter sewer line be installed to meet demands from the Weber West 2 area instead of discharging into the existing pipe. Installing a parallel pipe instead of a replacement pipe would potentially minimize costs as well as allow for possible new alignments.
- **#12 Pioneer Road** – A portion of the 60-inch pipe in Pioneer Road is extremely flat (slope less than 0.01%), before gaining slope after crossing the Willard Canal. To meet the evaluation criteria at buildout, it is projected that the portion of the pipe between 1200 West and the Willard Canal would need to be upsized to 66-inch. However, with no connections in this area and the potential high cost of replacing the pipe, the District may want to collect additional survey information and complete a more detailed hydraulic analysis before proceeding with this project. It is possible that a little surcharging at this location will be acceptable and the project may not be needed.
- **#13 Riverdale Stubline** – All of the existing 15-inch Riverdale Stubline upstream of its crossing the Weber River will need to be upsized. The estimated size needed to meet future flow projections is 18-inch.

COST ESTIMATES

Based on the recommended improvements discussed above, cost estimates were developed. Unit cost estimates were developed based on historical and recent projects and are provided in Table 7-2.

Table 7-2
Conceptual Unit Costs

Description	Unit	Unit Cost[1]
Sewer Pipelines[2]		
12-inch	Linear Foot	$465.41
15-inch	Linear Foot	$525.65
18-inch	Linear Foot	$577.56
21-inch	Linear Foot	$629.47
24-inch	Linear Foot	$681.38
27-inch	Linear Foot	$772.77
30-inch	Linear Foot	$855.82
36-inch	Linear Foot	$1,005.32
42-inch	Linear Foot	$1,237.90
48-inch	Linear Foot	$1,406.09
60-inch	Linear Foot	$1,676.04
66-inch	Linear Foot	$1,777.81
Other		
Contingency	25 Percent of Construction Cost	
Engineering, Legal, and Administration	15 Percent of Construction Cost w/ Contingency	

[1] Costs are in 2023 Dollars

[2] Per foot costs are based on normal components of sewer pipeline including pipe, manholes, and services, all installed.

Using the unit costs in Table 7-2, conceptual cost estimates were done for each of the pipeline projects and are presented in Table 7-3. Lift station costs are a little more complicated than a simple unit cost. However, an equation was developed by BC&A to estimate the relationship between design flow and construction cost. This relationship was based on historical and recent project costs of similar design and flows. Lift station conceptual costs are provided in Table 7-4. Total project cost estimates are summarized in Table 7-5.

Table 7-3
Pipeline Construction Cost Estimates

Project #	Project Name	Diameter (in)	Length (ft)	$/LF	Construction Cost	Contingency	Engineering, Legal, Admin	Total Cost (2023 $)
1	Riverdale Railroad Yard Mainline	36	3,550	$1,005	$3,569,000	$892,000	$669,000	$5,130,000
2	Ogden 30th Street Mainline	42	4,990	$1,238	$6,177,000	$1,544,000	$1,158,000	$8,879,000
3	30th St. Force Main	30	520	$856	$445,000	$111,000	$83,000	$639,000
4	West Haven Mainline	15	2,650	$526	$1,393,000	$348,000	$261,000	$2,002,000
		18	1,530	$578	$884,000	$221,000	$166,000	$1,271,000
		24	1,520	$681	$1,036,000	$259,000	$194,000	$1,489,000
		27	6,080	$773	$4,698,000	$1,175,000	$881,000	$6,754,000
5	Taylor Force Main	24	4,160	$681	$2,835,000	$709,000	$532,000	$4,076,000
6	Farr West Mainline	24	6,420	$681	$4,374,000	$1,094,000	$820,000	$6,288,000
		27	5,870	$773	$4,536,000	$1,134,000	$851,000	$6,521,000
7	North Ogden Mainline	24	1,660	$681	$1,131,000	$283,000	$212,000	$1,626,000
9	Industrial Force Main	12	350	$465	$163,000	$41,000	$31,000	$235,000
10.A	West Weber Force Main (w/o West Weber 2)	27	8,350	$773	$6,453,000	$1,613,000	$1,210,000	$9,276,000
10.B	West Weber Force Main (w/ West Weber 2)	36	8,350	$1,005	$8,394,000	$2,099,000	$1,574,000	$12,067,000
11	Hooper Mainline (w/ West Weber 2)	48	10,690	$1,406	$15,031,000	$3,758,000	$2,818,000	$21,607,000
12	Pioneer Road	66	1,900	$1,778	$3,378,000	$845,000	$633,000	$4,856,000
13	Riverdale Stubline	18	1,060	$578	$612,000	$153,000	$115,000	$880,000
14	South Ogden Stubline	18	2,090	$578	$1,207,000	$302,000	$226,000	$1,735,000

Table 7-4
Lift Station Construction Cost Estimates

Project #	Project Name	Required Capcity (MGD)	Construction Cost	Contingency	Engineering, Legal, Admin	Total Cost (2023 $)
8	Farr West Lift Station No. 3	5.0	$5,642,000	$1,411,000	$1,058,000	$8,111,000

Table 7-5
Total Capacity Project Cost Estimates

Pipe Diameter (in)	Length (ft)	Pipe Cost (2023 $)	Lift Station Cost ($)
1 - Riverdale Railroad Yard Mainline			
36	3550	$5,130,000	$ -
Total Cost of Riverdale Railroad Yard Mainline			$5,130,000
2 - Ogden 30th Street Mainline			
42	4990	$8,879,000	$ -
Total Cost of Ogden 30th Street Mainline			$8,879,000
3 - 30th Street Force Main			
30	520	$639,000	$ -
Total Cost of 30th Street Mainline			$639,000
4 - West Haven Mainline			
15	2650	$2,002,000	$ -
18	1530	$1,271,000	$ -
24	1520	$1,489,000	$ -
27	6080	$6,754,000	$ -
Total Cost of West Haven Mainline			$11,516,000
5 - Taylor Lift Station & Force Main			
24	4160	$4,076,000	$ -
Total Cost of Taylor Force Main			$4,076,000
6 - Farr West Mainline			
24	6420	$6,288,000	$ -
27	5870	$6,521,000	$ -
Total Cost of Farr West Mainline			$12,809,000
7 - North Ogden Mainline			
24	1660	$1,626,000	$ -
Total Cost of North Ogden Mainline			$1,626,000
8 - Farr West Lift Station No. 3			
N/A	N/A	$ -	$8,111,000
Total Cost of Farr West Lift Station No. 3			$8,111,000
9 - Industrial Force Main			
12	350	$235,000	$ -
Total Cost of Industrial Force Main			$235,000
10.A - West Weber Force Main (w/o West Weber 2)			
27	8350	$9,276,000	$ -
Total Cost of West Weber Lift Station & Force Main			$9,276,000
10.B - West Weber Lift Station & Force Main (w/ West Weber 2)			
36	8350	$12,067,000	$ -
Total Cost of West Weber Lift Station & Force Main			$12,067,000
11 - Hooper Mainline			
48	10690	$21,607,000	$ -

Pipe Diameter (in)	Length (ft)	Pipe Cost (2023 $)	Lift Station Cost ($)
Total Cost of Hooper Mainline			$21,607,000
12 - Pioneer Road			
66	1900	$4,856,000	$ -
Total Cost of Pioneer Road			$4,856,000
13 - Riverdale Stubline			
18	1060	$880,000	$ -
Total Cost of Riverdale Stubline			$880,000
14 - South Ogden Stubline			
18	2090	$1,735,000	$ -
Total Cost of South Ogden Stubline			$1,735,000
Cost of All Improvements (w/o West Weber 2)			**$69,768,000**
Cost of All Improvements (w/ West Weber 2)			**$94,166,000**

CHAPTER 8
ASSET MANAGEMENT PLANNING

Determining the cost and timing of expected rehabilitation and replacement of the District's collection system is important for future budgeting purposes. The purpose of this chapter is to estimate the expected required investment in the CWSID sewer collection system to sustainably maintain these assets.

WHAT IS ASSET MANAGEMENT PLANNING?

Key components of asset management planning are collecting data of what assets are in a system, performing a system evaluation of both probability and consequence of asset failure, and analyzing the level of rehabilitation and replacement needs to maintain the system now and in the future. The following sections describe these components in greater detail.

System Inventory

The quality of an asset management plan is dependent on having a reliable system inventory that reflects actual system components, locations, and conditions. This system inventory is most helpful in the form of a GIS shapefile that includes attributes of pipe material, pipe size, and pipe installation year. Additional attributes that contribute to a strong asset management plan are cleaning information, condition assessment, date of last video inspection, and estimates of hydrogen sulfide (H_2S) concentrations in each pipeline. All of these attributes can then be analyzed to identify priority pipelines for maintenance and pipeline with a high risk of failure. Having an accurate system inventory is essential to focusing District maintenance and rehabilitation or replacement efforts in the most critical areas of the collection system.

Consequence of Failure

Consequence of failure is an estimate of the importance of a pipe based on the impacts that would result if the pipe were to fail. The repercussions of sudden failure may be related to public perception, public safety, health concerns, repair costs and other factors. The reliability that the pipe adds to the system is also a factor that is considered in rating its consequence of failure. For example, an 8-inch sewer main that receives the wastewater from 3 houses is obviously not as vital to the reliability and performance of the CWSID sewer system as the 48-inch trunkline along 1200 West in Marriot-Slaterville that collects flow from a quarter of the District.

It should be noted that consequence of failure refers to the overall importance of a pipeline without consideration of its condition. In other words, if there are two pipelines in the same location that are identical in every way except that one is in excellent condition and the other is nearing failure, they will still have the same consequence of failure. For asset management purposes, pipeline condition is considered separately as "probability of failure". To make wise decisions regarding pipeline maintenance, the District will obviously need to consider both consequence of failure and probability of failure. However, to make sure both issues are considered and weighed appropriately, these concepts need to be discussed and considered separately first.

Probability of Failure

Probability of failure is a measurement of the potential for a resource to fail in a given year. Ideally, probability of failure would be defined in terms of an actual probability (i.e., a given segment of pipe has an estimated _% chance of failure in a given year). This would allow for a statistical evaluation of each pipe which would compare the expected cost of continuing without rehabilitation verses the cost of rehabilitation. Unfortunately, estimating the actual probability of failure for a sewer pipe requires an extensive data set on pipe condition and attributes and also extensive information on historic failures that have occurred. CWSID does not yet have this type of data available. Until this pipe condition data can be collected over the next several decades, a general assessment of condition can be used to estimate probability of failure in the District.

Criticality

Criticality is defined as the combined consideration of the consequence of failure and the probability of failure of an asset. The term criticality is often used interchangeably in asset management with the term risk. This is because criticality is used to compare the risk associated with a given asset relative to the rest of the assets in the system. Criticality is the key component used in decision making for asset management. It is the calculation of criticality that prioritizes the attention and resources of the District as they manage the collection system.

Figure 8-1 depicts the theory of criticality. As shown in the figure, the greater the probability of failure, and the more important a pipe is, the higher it will be ranked in criticality.

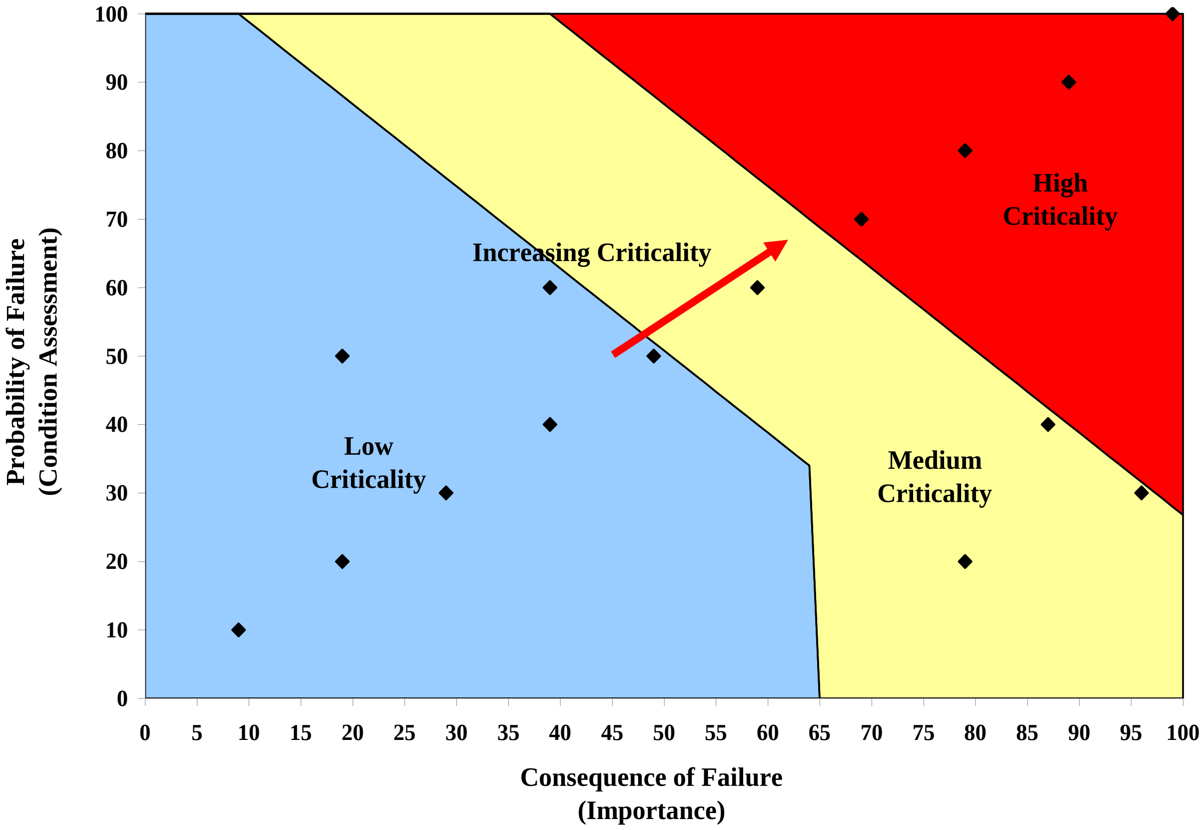


Figure 8-1: Criticality (Risk)

ASSET MANAGEMENT APPROACH

The recommended approach to the components of asset management (system inventory, consequence of failure, probability of failure, and criticality are discussed in the following sections.

CWSID System Inventory

The CWSID system inventory was obtained from the modeling GIS shapefiles created by Brown and Caldwell in 2015 and updated by BC&A in conjunction with this master plan. The system attributes included in the GIS shapefile were:

- Individual pipe identification numbers
- Diameter and length of individual pipes
- Installation year of individual pipes
- Material of individual pipes
- Manhole identification numbers
- Manhole rim and invert elevations

Some of these attributes are not available or are inaccurate for some of the pipes in the GIS database. There are also some critical attributes (relative to asset management in a sewer system) that are missing from the District's sewer collection system GIS database (e.g., estimates of hydrogen sulfide (H2S) concentrations in each pipeline and pipe condition from last inspection). A summary of each of the sewer pipeline attributes noted above is contained in the following sections.

Pipe Diameter and Material. In general, the pipe diameter and pipe material attributes of the GIS database are complete and are believed to be generally accurate. Summary of pipe diameters and pipe materials as listed in the GIS database are shown in Table 3-1 of Chapter 3.

Installation Year. The CWSID GIS collection system dataset included information on the installation year of pipes. These years were largely assumed in the 2015 master plan and were reviewed and corrected by District employees during this master plan update. Though many pipes do not have recorded age data, the years that are reported in the dataset are believed to be accurate. Installation year is critical to estimating the remaining life of pipes in the system. Figure 8-2 shows the estimated pipe installation years for the District's sewer collection system. This information is also summarized in Table 8-1.

Table 8-1
Sewer Collection System by Installation year

Year Range of Installation	Total Length (feet)	Percent of System by Length
1922 or Before	22,657	8.7%
1923 – 1932	0	0.0%
1933 – 1952	0	0.0%
1953-1982	138,964	53.6%
1983-2012	92,159	35.6%
2013-2022	2,397	0.9%
Unknown	2,874	1.1%
Total	259,051	100%

As summarized above, only about 1% of pipe installation dates are unknown. To complete the remainder of the analysis in the chapter, these unknown years were assumed based on installation of surrounding pipes.

Recommended Modifications for Future Data Collection. In addition to the existing GIS database, adding the following pipeline attributes would improve the efficacy of normal maintenance as well as future asset management plans:

- Cleaning and Inspection Data
- Pipe Conditions (specifically PACP ratings as discussed below in Probability of Failure)
- Measured H_2S Concentrations (where available)

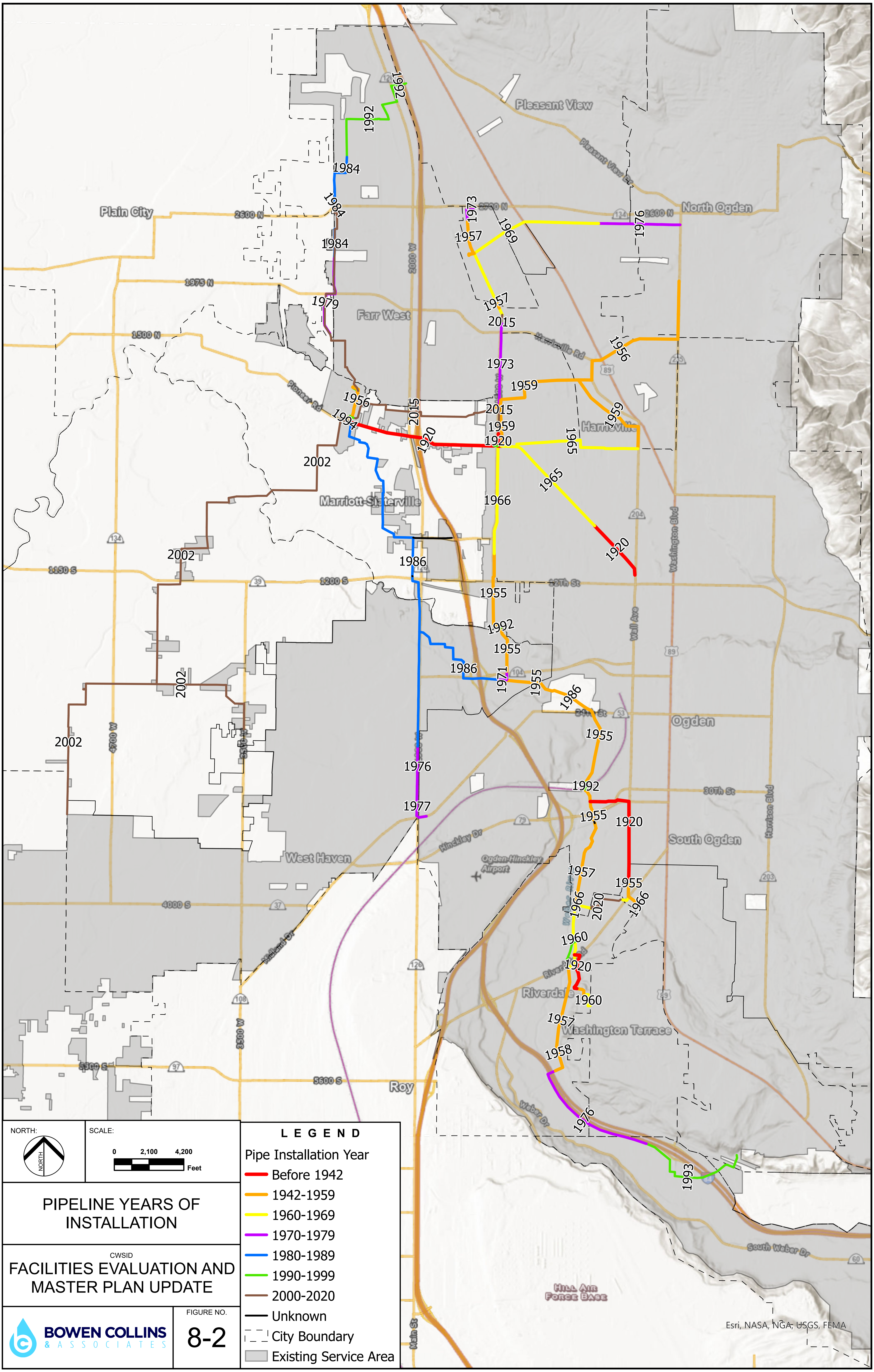
CWSID System Consequence of Failure

As discussed above, consequence of failure is an important metric to understand which pipelines are a priority to maintain for system function as a whole. While it is easy to understand the general principle behind consequence of failure, it is much more difficult to implement a rating system to accurately and objectively represent consequence of failure. While some consequences are easy to quantify from pipe to pipe (e.g. pipeline replacement costs), most consequences of failure are much more difficult to represent quantitatively (e.g. impacts to health and safety or results of regulatory violations). Instead of trying to quantify each category of consequence, BC&A proposes using a few easily quantifiable factors to rank the pipes. This ranking gives a relative indication of consequence of failure. Four factors are proposed to estimate the consequence of failure of a sewer pipe: the flow rate in the pipe, the category of road over the pipe, the zoning of the area, and the depth of the pipe.

Sewer Flow Rate. Flow rate in a sewer pipe is the single most important indicator of the importance of a pipe. In most situations, the higher the flow rate, the larger the area that pipe serves. Pipes that have a higher flow rate that do not service a large area still need to have a have a higher consequence of failure rating than pipes with lower flow rates. Bypass pumping cost, the risk of property damage, environmental and regulatory consequences, the cost of pipe replacement, and problems from sewage backing up in the system are all greater for larger flow rates. In a worst-case scenario, if a pipe collapses or becomes blocked and the manholes surcharge resulting in wastewater flows in basements and the street, there is a greater health hazard to the public with a larger wastewater flow rate.

It is proposed that the maximum daily flow rate be used as the base rating for the consequence of failure for each pipe in the CWSID System. For the purpose of this chapter, estimated flow has been based on 2022 model results.

The other three factors that influence the rating can then be used as multipliers to adjust the sewer flow rate to produce a final rating. Table 8-2 lists the proposed multipliers to be assigned to each rating factor. An explanation of each classification and its proposed multiplier is included in the following sections.



PIPELINE YEARS OF INSTALLATION

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FIGURE NO.
8-2

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Table 8-2
Consequence of Failure Multipliers

Road Class	Multiplier	Zone	Multiplier	Depth	Multiplier
No Road or Residential	1	Open Space/ Industrial	1	0-12 feet	1
Collector	1.2	Residential	1.5	12-20 feet	1.2
Major Arterial	3	Commercial/ Institutional	1.7		
Freeway	10				
Canal X-ing	5				
Rail X-ing	10				

Road Category. There is a direct connection between the density of traffic and the cost and time associated with maintenance and repairs on sewer pipes. Based on pipe geolocation, BC&A grouped streets into four major classifications: interstates, major arterials, collector streets and residential streets.

- **Interstates** – Interstates are assigned the highest ranking, because the cost of crossing the freeway is significantly higher than traditional pipe installation methods. The risks to property and potential social disruption impacts that may result if traffic is affected are additional impacts that are considered in this category. The proposed multiplier for the pipes under the freeway was intentionally set to be high enough to generally push these pipes into the highest level of consequence of failure.
- **Major arterials** – The next classification is the major arterials. They include Harrison Blvd, Washington Blvd, Hwy 126 (2000 W), Highway 89, 12th Street, and other multi-lane major streets. More disruption would result from traffic control for work on these streets than streets in the other categories. The time and money associated with maintaining the pipes in these streets is fairly high.
- **Collector Streets** – The third classification in this category is the collector streets. These streets do not have the volume of traffic that the major arterials have, but still have more traffic than residential streets. Their multiplier is reflective of the traffic volume.
- **Residential Streets** – The fourth classification in this category is residential and other small streets. These streets have the smallest volume of traffic and do not add to the criticality ranking of a pipe. Pipes not located in roadways were also included in this classification.

Also included in the road category is consideration of two additional types of crossings, canal and railroad crossings with multipliers as shown in Table 8-2.

Zoning. Zoning is also a factor that impacts the consequence of failure rating. A sewer pipe in an open field will not have as large a consequence of failure as the same sized pipe located in a residential subdivision or in commercial areas. For this analysis, zoning has been grouped into classifications:

- **Commercial** – In commercial areas, there is high potential for costly impacts since these areas can be congested. The multiplier for commercial areas is the highest out of the three zoning categories.

- **Residential** – Residential areas do not generally have the same potential for costly impacts as do more congested commercial areas. However, they do have more potential for adverse public health effects than do areas of industrial or open space zoning.
- **Open Space and Industrial** – Areas zoned for industrial or open space are assumed to have the least impact from a failed pipe.

Depth of Pipe. The depth of the pipe can have a significant impact on the cost of repairs and rehabilitation of sewer pipe. Extensions on backhoes, very wide trenches, possible dewatering, etc. make repairs and maintenance much more expensive and time consuming on deeper pipes. For the purpose of this analysis, the depth of pipe was grouped into two categories:

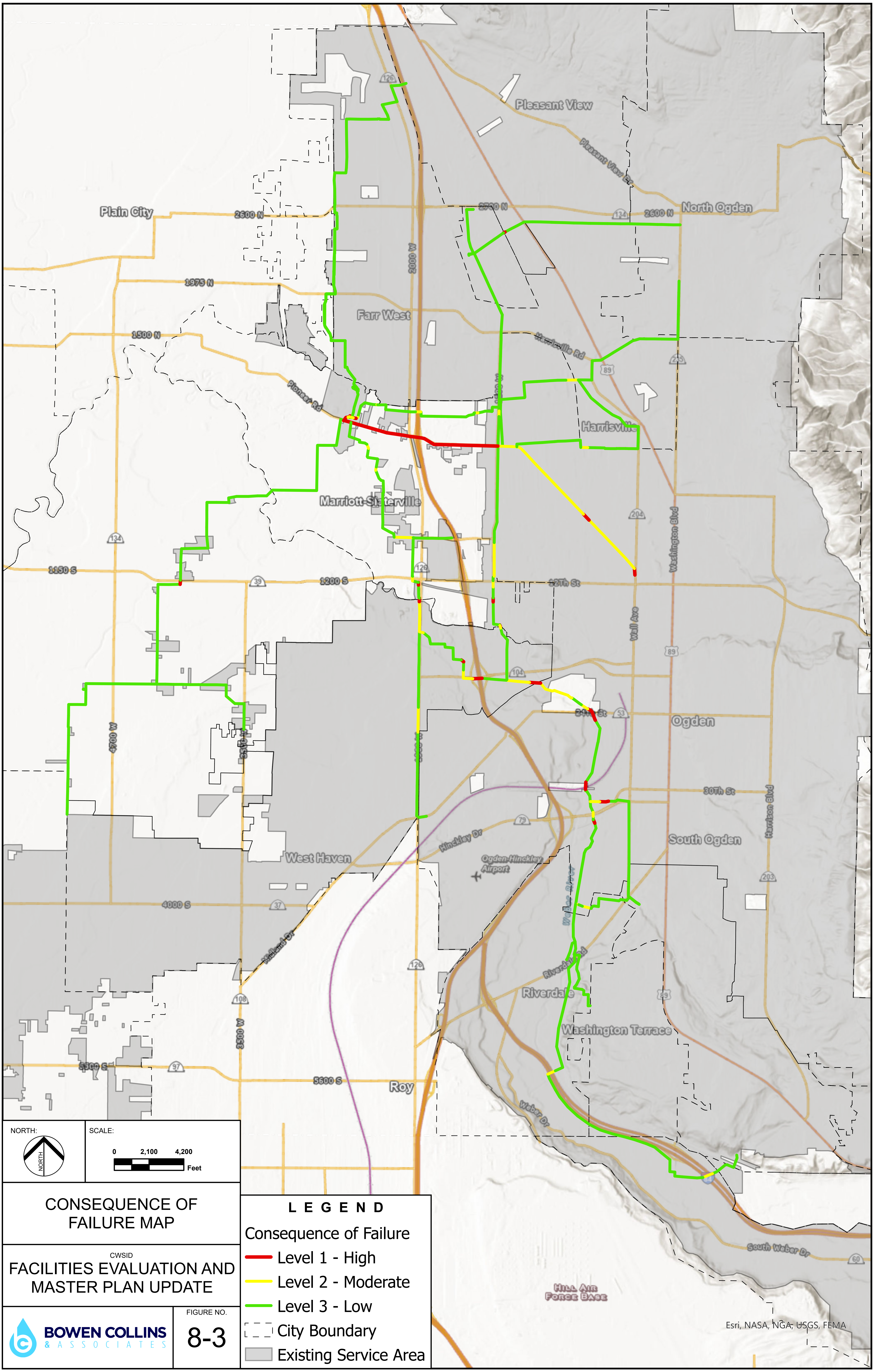
- **Less than 12 feet** – Pipes that are less than 12 feet deep can generally be maintained and repaired using standard construction techniques.
- **12 to 20 feet** – Once the depth of a pipeline exceeds 12 feet, repairs and maintenance begin to become more expensive and can be more time consuming. Additional equipment and special construction techniques add to the cost of working on these deep pipes.

Consequence of Failure Results. Based on the proposed approach described above, ratings were developed for the pipelines in the CWSID collection system. For discussion purposes, the pipe ratings were divided into three levels representing increasing consequence of failure as shown in Figure 8-3. This includes Level 1, 2, and 3 ratings. The consequence of failure is relative only to the rest of the system. The top 5 percent of the pipe ratings are identified as Level 1, the highest importance of pipes in the system. The next 10 percent of the pipes have a consequence of failure Level 2. The rest of the pipes are rated Level 3 (remaining 85 percent of the system). Characteristics of each level are summarized in Table 8-3.

Table 8-3
Consequence of Failure Levels

Level	Total Length of Pipe (feet)
1 – Highest Consequence of Failure	15,800
2 – Moderate Consequence of Failure	29,500
3 – Lowest Consequence of Failure	250,100
Total	**295,400**

Occasionally, well-intentioned policy makers desire to modify the designation of consequence of failure such that a higher portion of pipelines are included in Level 1 or Level 2. Their purpose is to make sure that all the “important” pipelines are receiving the attention they deserve. However, an important principle of asset management is that resources will always be limited. An asset management plan will only be successful if it can properly prioritize and focus its resources on the area of greatest need. In practicality, the five percent identified for Level 1 is already the upper limit of pipelines than can be focused on without overwhelming or diluting available resources.



NORTH:

NORTH

SCALE:

0 2,100 4,200

Feet

CONSEQUENCE OF FAILURE MAP

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FIGURE NO.

8-3

LEGEND

Consequence of Failure

🟥 Level 1 - High

🟨 Level 2 - Moderate

🟩 Level 3 - Low

⬚ City Boundary

▨ Existing Service Area

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CWSID System Probability of Failure

The District currently employs a number of practices to inform them of the condition of assets in their system. Specifically, the District performs regular CCTV inspections of all pipes in the system and saves the recorded videos for reference. Inspection reports from these inspections are created and often include Pipeline Assessment and Certification Program (PACP) coding to identify existing pipe deficiencies.

A common method of defining the probability of failure for individual pipelines is by using the PACP structural condition rating from inspection reports. PACP requires operators to record internal pipe defects in a standardized format. These defects can then be used to assign a condition grade to the pipe. While CWSID CCTV inspection reports (completed by an external company) appear to include PACP coding for each inspected pipe section, these reports are not readily available in a database. Moving forward, it is strongly recommended that the District begin requiring that all inspections are stored in a PACP compatible data base for future analysis. Until additional data can be collected, probability of failure will need to be estimated using other means.

Due to the lack of accessibility to PACP codes for the CWSID collection system, pipe ages were used as an alternative metric for probability of failure. While this does not assign a specific probability of failure for each pipe, it does give a general indication of the typical condition. In general terms, the older the pipe, the higher its probability of failure. The following list outlines the range of pipe ages compared to probability of failure used in this analysis.

- Level of Service Grade A – Pipeline was installed 20 years ago or more recently.
- Level of Service Grade B – Pipeline was installed between 20 and 40 years ago.
- Level of Service Grade C – Pipeline was installed between 40 and 60 years ago.
- Level of Service Grade D – Pipeline was installed between 60 and 80 years ago.
- Level of Service Grade E – Pipeline was installed between 80 and 100 years ago.
- Level of Service Grade F – Pipeline was installed more than 100 years ago.

Figure 8-4: Probability of Failure Levels Based on Age

Table 8-4
Probability of Failure Levels

Probability of Failure Level	Range of Installation	Percent of System by Length
A	2002 and Newer	19%
B	1982-2022	19%
C	1962-1982	27%
D	1942-1962	26%
E	1922-1942	0%
F	Before 1922	9%

Criticality

With probability and consequence of failure defined for each pipe segment, criticality can be calculated. Given current limitations in data, it is proposed that a criticality matrix be developed as shown in Figure 8-5. Instead of using discrete data points for probability of failure and consequence of failure, this matrix groups this information into basic level of service grades for probability of failure and consequence of failure levels. As additional information is gathered in the future, this matrix can be refined. Criticality in the matrix increases from the lower left corner to the upper right.

Included in the matrix are recommended actions based on criticality. The intent of the recommended actions is to provide guidelines for the decision-making process and focus resources on the assets which are most critical. The recommended actions include both condition assessment and regular inspection activities. Condition assessment refers to specific engineering attention and evaluation for the purpose of identifying rehabilitation needs. Regular inspection refers to the systematic, schedule CCTV inspection conducted as part of routine maintenance activities. In both cases, the recommended schedule for the time frames listed in the table are as follows:

Immediate	0-1 year
Short Term	1-3 years
Mid Term	3-5 years
Long Term	More than 5 years

Structural Level of Service	**Pipe Importance Level 3** Recommended Action	**Pipe Importance Level 2** Recommended Action	**Pipe Importance Level 1** Recommended Action
F	Short Term Pipe Condition Assessment	Immediate Pipe Condition Assessment	Immediate Pipe Condition Assessment
E	Mid Term Pipe Condition Assessment	Short Term Pipe Condition Assessment	Immediate Pipe Condition Assessment
D	Short Term Inspection Schedule	Short Term Inspection Schedule	Short Term Pipe Condition Assessment
C	Mid Term Inspection Schedule	Short Term Inspection Schedule	Short Term Inspection Schedule
B	Long Term Inspection Schedule	Mid Term Inspection Schedule	Mid Term Inspection Schedule
A	Long Term Inspection Schedule	Long Term Inspection Schedule	Mid Term Inspection Schedule

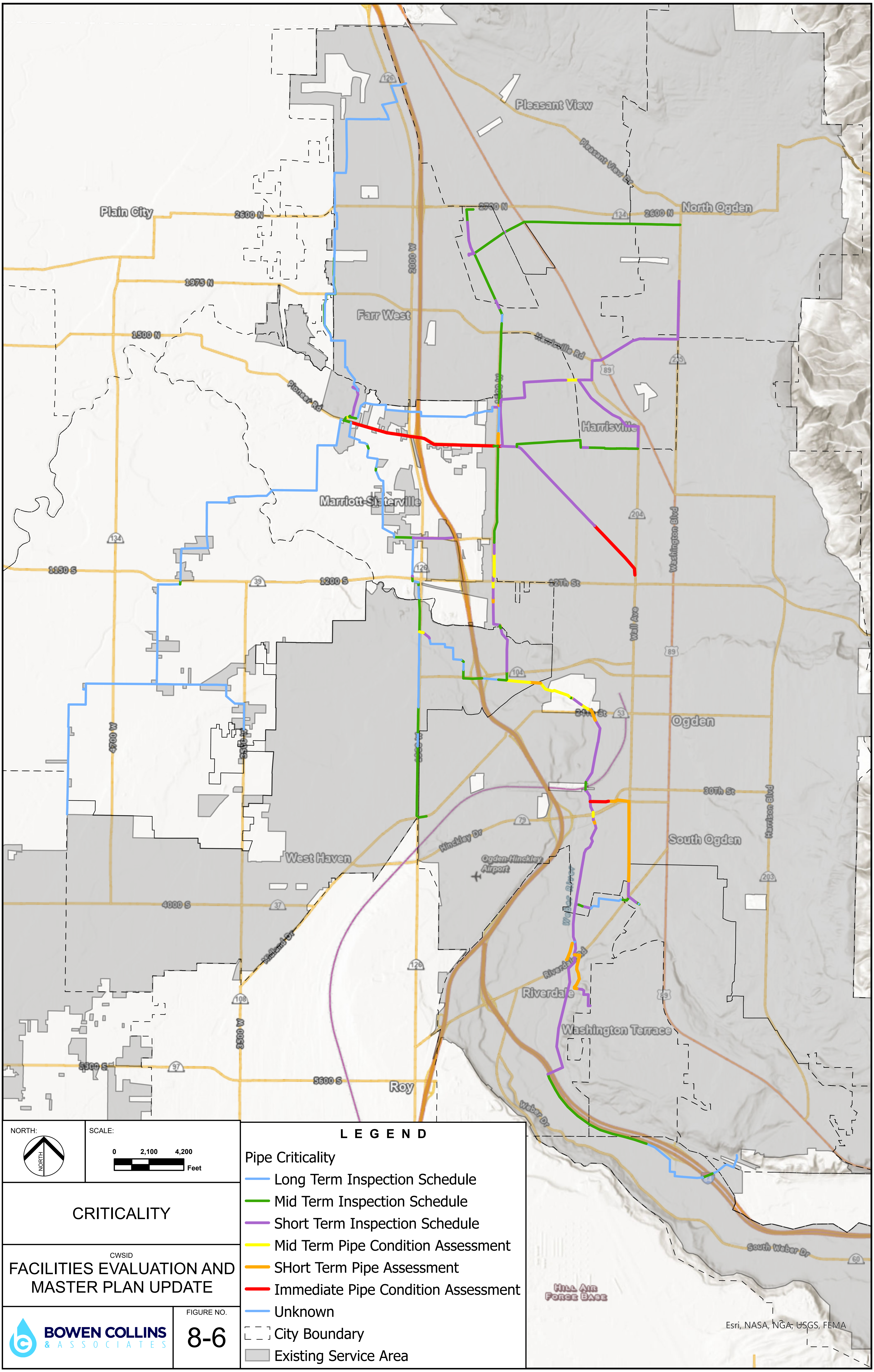
Increasing Probability of Failure

Increasing Consequence of Failure

Figure 8-5: Criticality – Recommended Actions Based on Structural Rating

Figure 8-6 shows the CWISD collection system using this matrix to find pipe criticality. It should be noted that this matrix and criticality 'score' is only a starting point. Two things should be remembered as it is used to help develop future rehabilitation and inspection schedules:

- First, the matrix is not intended as a replacement for engineering judgment. As each pipeline is evaluated, additional issues not covered by the matrix will need to be considered by District personnel when making final rehabilitation and replacement decisions. For example, if a pipe is generally good condition, but has one isolated structural problem, its overall level of service rating may be relatively good. As a result, it may be classified as a low criticality pipeline even though the isolated problem may merit immediate attention. In these cases, it is expected that District personnel will use their judgment to increase the criticality of the pipeline and accelerate resolution of the problem. Despite this limitation, it is believed that using the matrix to augment engineering judgment will enable better asset management than relying on institutional knowledge only.
- Second, the proposed matrix has been developed using only data available in the GIS database. As additional data is collected, there is significantly more analysis the District will be able to do regarding criticality. Some sewer agencies are using the criticality information and cost data to assign a cost of failure and rating the payback of inspections and other maintenance activity. This type of analysis can provide an agency with the best operation and maintenance returns on limited budget resources. It is recommended that the District review this matrix periodically to review the recommended actions and identify possible improvements to the evaluation procedure. Ultimately, the goal of the District is to adopt best practices and maximize the use of resources in addressing system management needs.



CRITICALITY

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FIGURE NO.

8-6

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EXPECTED REHABILITATION AND REPLACEMENT NEEDS

To determine the expected collection system rehabilitation and replacement costs for CWSID, BC&A used a database for sewer system rehabilitation and replacement unit costs that BC&A has developed over the last several years. This database uses past project costs and the current Engineering News Record (ENR) cost index to estimate unit costs for collection system pipes.

Expected Rehabilitation and Replacement Schedule

CWSID collection system is composed of approximately 56 miles of pipe. The total cost to completely replace all of the pipes in the CWSID collection system would be approximately $294 million based on 2023 construction costs. However, it will not be necessary to completely replace the entire system as it ages because of rehabilitation technologies (e.g., slip lining, cast-in-place pipe, etc.). Rehabilitation costs are much lower than replacement costs (20% to 60% depending on pipe diameter). If CWSID were able to rehabilitate the entire system rather than replace components, it would drastically reduce the "replacement value" to $127 million. Unfortunately, it is generally not possible to rehabilitate all system components due to either condition or capacity issues. Some pipes are beyond saving with rehabilitation, while others may require upsizing or correction of grade issues; all of these scenarios would require a replacement.

To account for the limitations on rehabilitation, BC&A recommends budgeting for system renewal based on a combination of rehabilitation and replacement. Assuming pipes in the District's collection systems need to be 50% rehabilitated and 50% replaced, BC&A calculated the rehabilitation and replacement "value" of the sewer collection system at $210 million.

The timing of this investment can be estimated based on expected remaining system life of the existing assets. However, system life can vary, even among identical assets in similar installations. For this reason, it is often useful to represent system life as a statistical probability (i.e., there is an x% chance that a given asset will last "y" years). This probability can be based on data from past asset performance. Because of the limitations of data available in the CWSID system, BC&A assumed expected pipeline life would be similar to that of other local systems as shown in Table 8-5.

Table 8-5
Expected Pipeline Design Life

Expected Design Life	Lifespan Category	Percentage of Selected Pipes
50	Less than Short	8.3%
70	Short to Moderate	17.9%
90	Moderate to Long	46.4%
110	Greater than Long	27.4%
Total		**100.0%**

Based on these expected life spans of pipes, Figure 8-7 shows the rehabilitation and replacement needs for the CWSID collection system based on this asset management analysis. This figure includes:

- The cost of rehabilitation and replacement in each year based on the current estimate of each pipe's end of life.
- A 10-year moving average cost. It should be remembered that most installation dates are approximations based on the time of development and should not be considered exact. This

is evident in the figure, where large spikes in rehabilitation costs are observed in 2030, 2045, 2056, 2076 etc. Thus, the 10-year moving average gives a better overall indication of the recommended level of investment required to meet system needs.

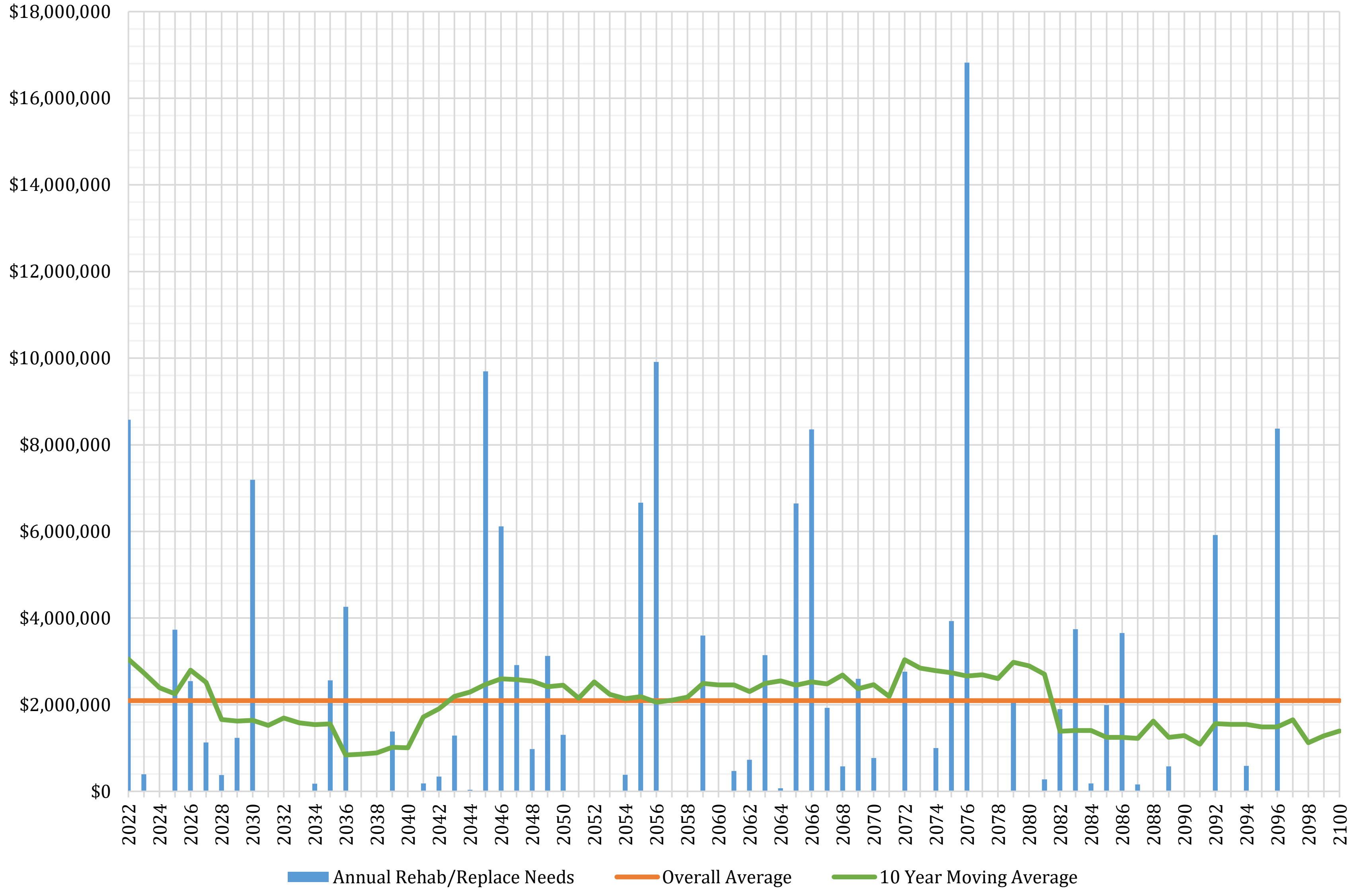
- The average annual cost of investment if the total cost is distributed equally from 2023 to 2100.

From Figure 8-7, a few major conclusions can be made:

- Average recommended investment in rehabilitation and replacement of sewer collection system facilities is $2.1 million/year.
- Based on statistical expectations described above, there may be a large amount of sewer pipe that is at or beyond its useful life. The estimated cost of replacing and/or rehabilitating these pipelines is $8.6 million. Action on these pipelines is recommended as soon as possible if the District wants to avoid the potential for costly pipeline failures.
- There is a relatively high recommended level of investment over the next few years. This is a function of pipelines reaching the end of their useful life as a result of age (in the case of the oldest section of pipes built in the early 1920s). Inspection of these pipelines may reveal that they still have useful service life, but their condition should be closely monitored moving forward.

Figure 8-7

Expected Sewer Rehabilitation and Replacement Needs



RECOMMENDED FUTURE ASSET MANAGEMENT APPROACH

In addition to the District's current asset management approach, implementing several additional tasks and programs will improve the level of asset management and the District's ability to maintain its system. BC&A recommends the following tasks:

1. **Fully Adopt and Implement PACP Standard** – The District is already using the Pipeline Assessment Certification Program (PACP) to conduct pipeline condition assessment inspections. To fully implement PACP, the District will need to accomplish the following tasks:
    a. *Create a District database with the ability to conform to PACP format.*

    b. *Collect additional pipe inventory data to populate database.* Critical pieces of information to include in the District's database are installation dates and pipeline material.

    c. *Develop Methodology for Inspection Data Storage.* The District will need to set up a separate database for inspection and develop a methodology for transferring data from inspection reports to the database.

    d. *Establish District Policy for Inspections by Contractors.* To ensure all inspections completed by contractors are in a consistent format, management and engineering personnel should develop and adopt a District policy that will require all future inspections by outside contractors to be completed in PACP format and stored in a compatible database.

2. **Retrieve PACP Data for Historic Inspections** – The District has a large collection of historic video inspections. Many of these are already in PACP format. For pipelines that have been PACP inspected during the past few years, retrieving the PACP codes from inspection reports will be a quicker way to gather information on the system than conducting completely new field inspections. It is recommended that the District gather the available historic inspection and retrieve the PACP code from the videos or other reports for inclusion in the PACP database. In the future, it is recommended that all inspection coding be prioritized by criticality.

3. **Conduct Field Inspection of System Pipelines Using PACP** – For those pipelines without recent historic inspection data, a new field inspection is recommended. As with the coding of historic pipelines, it is recommended that inspection coding ultimately be prioritized by criticality.

4. **Further Development of Asset Management Program** – As noted above, the main shortfalls of the District's current wastewater collection system asset management approach are the inability to store data from condition assessment activities in a standardized, usable format. The main focus of the plan presented in the previous recommendations is to develop a system for collecting the data required to further develop a comprehensive asset management program for the District. Once this data has been collected, the District will be able to better develop a decision support system to assist in identifying and prioritizing capital improvements associated with maintenance of existing assets. Therefore, it is recommended that the District aggressively move to implement the PACP standard and collect the baseline information about the condition of assets in the system. This will enable the District to further develop the asset management program in a period of 3 to 5 years. This will allow adequate time to gather condition assessment data on all pipelines and manholes and gather cleaning data on nearly all of the system.

Items to consider in 3 to 5 years include:

a. Refining and improving condition assessment activities;

b. Reviewing inspection priorities;

c. Developing better estimates of expected service life and/or probability of failure based on results of condition assessment activities;

d. Revising the criticality matrix used for asset inspection and replacement prioritization to reflect updated estimates of expected service life and/or probability of failure; and

e. Automating the decision-making process for capital facility improvements.

It should be noted that the recommendation to fully develop the asset management program in 3 to 5 years should not prohibit the District from moving forward with needed rehabilitation projects identified during condition assessment activities. Any system deficiencies identified during condition assessment that require immediate attention should be addressed as quickly as budget and resources allow. The criticality of each asset can be categorized as the inspection is completed so that deficiencies can be addressed on a schedule which will take care of the highest risks first. The asset management program developed after the assessment activities have been completed will include an asset maintenance management strategy and also an asset renewal and replacement strategy.

After these recommendations are implemented, asset management will change from a task that requires the District to react to the condition of system features that are found to be defective to a systemwide program to maintain and improve the condition of system components. The asset management will focus on the most critical tasks and provide enough information to identify the critical issues and prioritize the remaining components. System components will therefore get adequate attention without being inspected or serviced unnecessarily.

CHAPTER 9
COLLECTION PROJECT IMPLEMENTATION SCHEDULE

INTRODUCTION

Previous chapters of this sewer master plan have identified deficiencies and improvements related to the District's collection system. The purpose of this chapter is to recommend a timeline and implementation schedule for the collections system improvements to be completed during the next 10-years. This will include both capacity and condition related improvements.

SUMMARY OF CAPITAL IMPROVEMENTS

A discussion of each of the major budget categories for the collections system and how they will be prioritized in the 10-year implementation plan is included below:

- **Collection System Capacity Improvements** – BC&A used the growth projections discussed in Chapter 2 of this report and the existing system hydraulic model to determine when collection system capacity improvements are needed (see Table 7-1 in Chapter 7). Because these projects are based on provided needed capacity for future growth, there is not much flexibility with the scheduling of these projects. While moving a project a few years forward or a few years back may be a possibility, major changes in timing cannot be accommodated. Unless growth occurs at rates significantly different than projected, failure to complete the projects at the recommended dates will result in the District running out of available capacity. The total cost of all recommended collection system improvements projects is $116 million in 2023 dollars (assuming all projects associated with the Weber West 2 area are completed). The cost of improvements needed in the next 10 years is $23 million (2023 dollars).
- **Collection System Rehabilitation Improvements** – A recommended budget level for collection system rehabilitation improvements was developed for the District (see Chapter 8). The recommended average annual budget value is $2.1 million in 2023 dollars. Although this exact amount does not need to be spent in every single year, failure to invest in the system at approximately this level of funding will result in system degradation over time, leading to costly system failures. With this in mind, this implementation plan budgets approximately $7 million for the Hooper Lining Project and then $2.1 million per year in years without other large programmed expenditures. This results in a little over $21 million for rehabilitation and replacement over the 10-year planning window (i.e. an average of $2.1 million per year).

RECOMMENDED 10-YEAR CAPITAL IMPROVEMENT PROGRAM

Based on the total collection system improvements discussed above, Table 9-1 is a recommended improvement implementation plan for the next 10 years. It includes identification of all improvement projects that are recommended within the next 10-years, the budget required to complete those projects, and the recommended timing of those projects. Figure 9-1 illustrates the annual capital expenditures that will be required to support the recommended implementation plan. Expenditures have been grouped by major category for reference. Note that projects with a cost greater than $1 million are split between two years (10% in the first year for initial engineering and administration costs and 90% in the second year for construction costs).

As can be seen, the proposed implementation plan has been set up such that the recommended level of funding is relatively constant from year to year. The exception is in 2025 and 2033 when capacity related improvements are larger than average annual levels of funding. In these cases, the District will either need to bond for the improvements or draw on cash reserves. Chapter 8 also indicates that, based on statistical expectations for facility design life, there may be a larger amount of immediate rehabilitation and replacement needs than is currently budgeted for in the next few years. If inspection activities reveal that this is the case, this too may need to be addressed through reserves or bonding.

Finally, it should be remembered that all values contained in both the table and the figure are in 2023 dollars. For rate calculations and other financial planning, these values will need to be adjusted for inflation.

Table 9-1
Collection System Improvement Plan (2023 Dollars)

Project Number	Project Identifier	2023 Project Cost	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028	FY 2029	FY 2030	FY 2031	FY 2032	FY 2033	Total 10-yr Window Cost	Beyond 10-yr Window[1]
1	Riverdale Railroad Yard Mainline	$5,130,000												$5,130,000
2	Ogden 30th Street Mainline	$8,879,000									$887,900	$7,991,100	$8,879,000	
3	30th St. Force Main	$639,000					$639,000						$639,000	
4	West Haven Mainline	$11,516,000	$1,151,600	$10,364,400									$11,516,000	
5	Taylor Force Main	$4,076,000												$4,076,000
6	Farr West Mainline	$12,809,000												$12,809,000
7	North Ogden Mainline	$1,626,000												$1,626,000
8	Farr West Lift Station No. 3	$8,111,000												$8,111,000
9	Industrial Force Main	$235,000												$235,000
10.A	West Weber Force Main (w/o West Weber 2)	$9,276,000												$9,276,000
10.B	West Weber Force Main (w/ West Weber 2)	$12,067,000												$12,067,000
11	Hooper Mainline (w/ West Weber 2) (w/ West Weber 2)	$21,607,000												$21,607,000
12	Pioneer Road	$4,856,000												$4,856,000
13	Riverdale Stubline	$880,000												$880,000
14	South Ogden Stubline	$1,735,000			$173,500	$1,561,500							$1,735,000	
15	Annual Maintenance (per year)	$14,700,000			$2,100,000	$2,100,000	$2,100,000	$2,100,000	$2,100,000	$2,100,000	$2,100,000		$14,700,000	
	Hooper Lining Phase II	$6,875,000	$6,875,000										$6,875,000	
Total Cost[2]		**$115,741,000**	**$8,026,600**	**$10,364,400**	**$2,273,500**	**$3,661,500**	**$2,739,000**	**$2,100,000**	**$2,100,000**	**$2,100,000**	**$2,987,900**	**$7,991,100**	**$44,344,000**	**$71,397,000**

[1] None of the costs shown have been adjusted for inflation. For rate calculations and other financial planning, these values will need to be adjusted for inflation.

[2] Total costs assume that the Weber West 2 area will be annexed requiring the associated projects. If Weber West 2 is not annexed, the 2023 total would be $ 91,343,000.

[3] Future costs are all in 2023 $'s

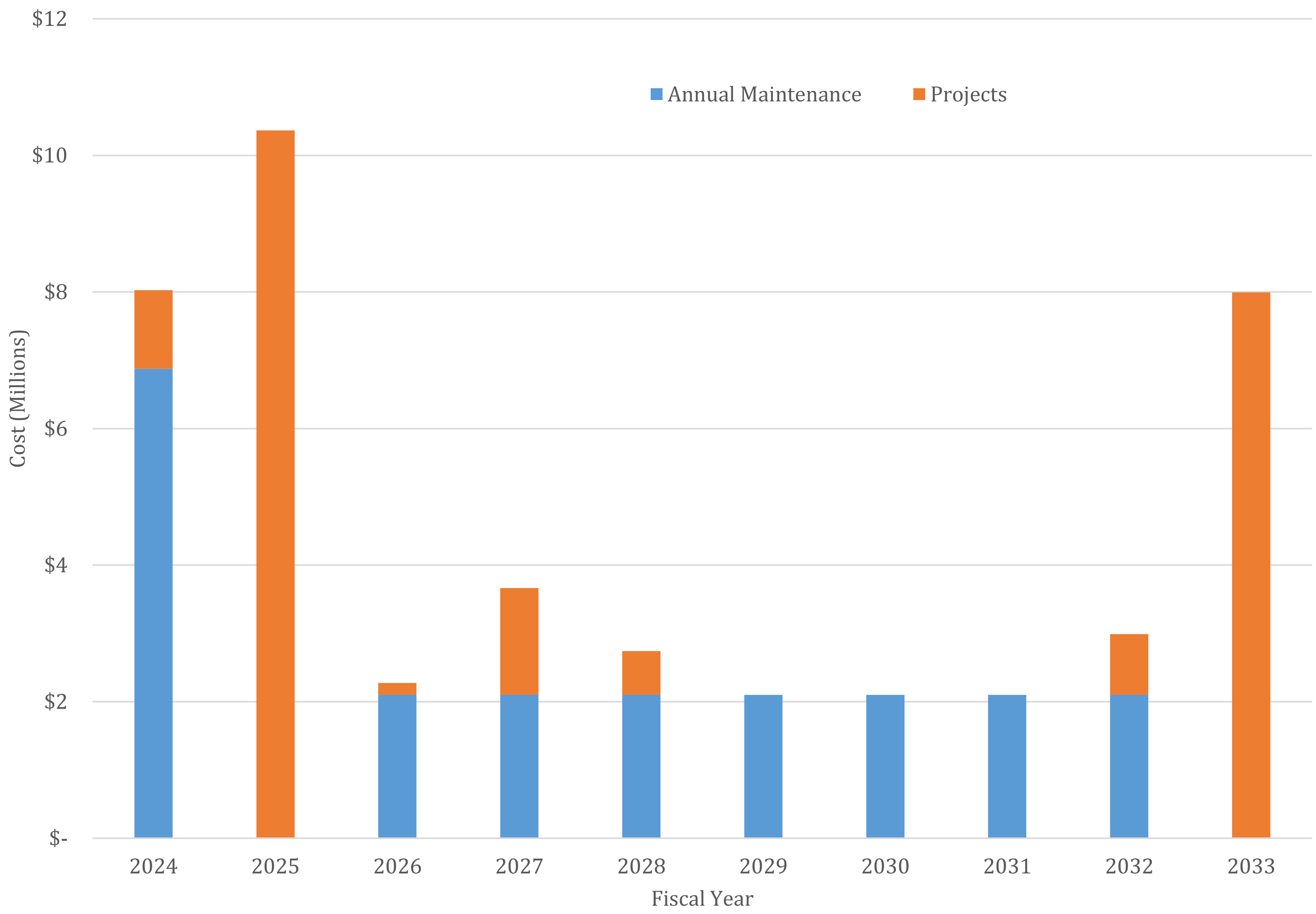


Figure 9-1: Collection System Improvement Plan

CHAPTER 10
PROJECTED FLOWS AND LOADS

PROJECTED WASTEWATER FLOWS AND LOADS

Figure 10-1 is provided to show measured minimum month flow data for 2019, 2020, and 2021, with the projected base flow and a representation of each projected flow rates from Chapter 2. These flow projections alongside historical plant data were used to estimate organic, solids, and nutrient loads to the facility.

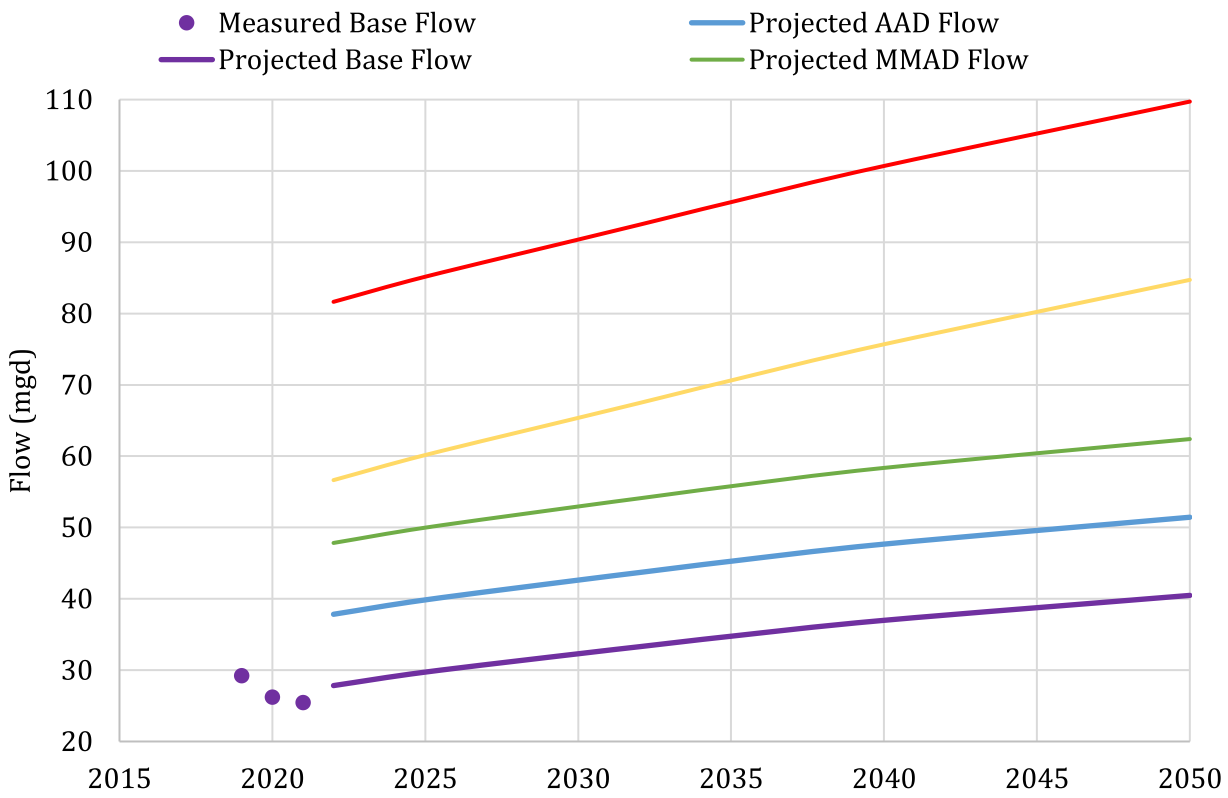


Figure 10-1: Projected CWSID Base, Annual Average Day (AAD), Maximum Month Average Day (MMAD), and Peak Hour Flow Data

The recommended future design loads for key wastewater constituents for Central Weber Sewer Improvement District (CWSID) are shown in Table 10-1. These key constituents include biochemical oxygen demand (BOD), total suspended solids (TSS), ammonia, and total phosphorus (TP). The existing treatment processes and proposed future alternatives must provide capacity to treat maximum (max) month loadings of these key constituents to meet discharge permit limits.

Average annual loads for each constituent were first baselined to existing average day historical data from 2019 to 2021. Using population data, per capita loads were established for each of the years, and the maximum calculated per capita load was applied to the projected population data. It is important to note that totals include the uncertain population growth from Weber West 2 to be conservated in projecting loads. Figures 10-3, 10-4, 10-5, and 10-6 below show projected annual average loads for BOD, TSS, ammonia and TP, respectively.

Table 10-1
CWSID Wastewater Constituents and Projections through 2050

Area	2022	2025	2030	2035	2040	2050
BOD						
Average (ppd)	47,65	50,737	55,488	57,377	60,085	64,114
Max Month (ppd)	53,541	57,004	62,343	64,465	67,507	72,035
TSS						
Average (ppd)	50,139	53,381	58,381	60,368	63,217	67,456
Max Month (ppd)	59,475	63,322	69,252	71,610	74,989	80,018
Ammonia - N						
Average (ppd)	5,337	5,682	6,215	6,426	6,729	7,181
Max Month (ppd)	6,204	6,605	7,223	7,469	7,822	8,346
Total Phosphorus						
Average (ppd)	1,285	1,368	1,496	1,547	1,620	1,729
Max Month (ppd)	1,701	1,811	1,980	2,048	2,144	2,288

[1] Abbreviation: ppd - pounds per day.

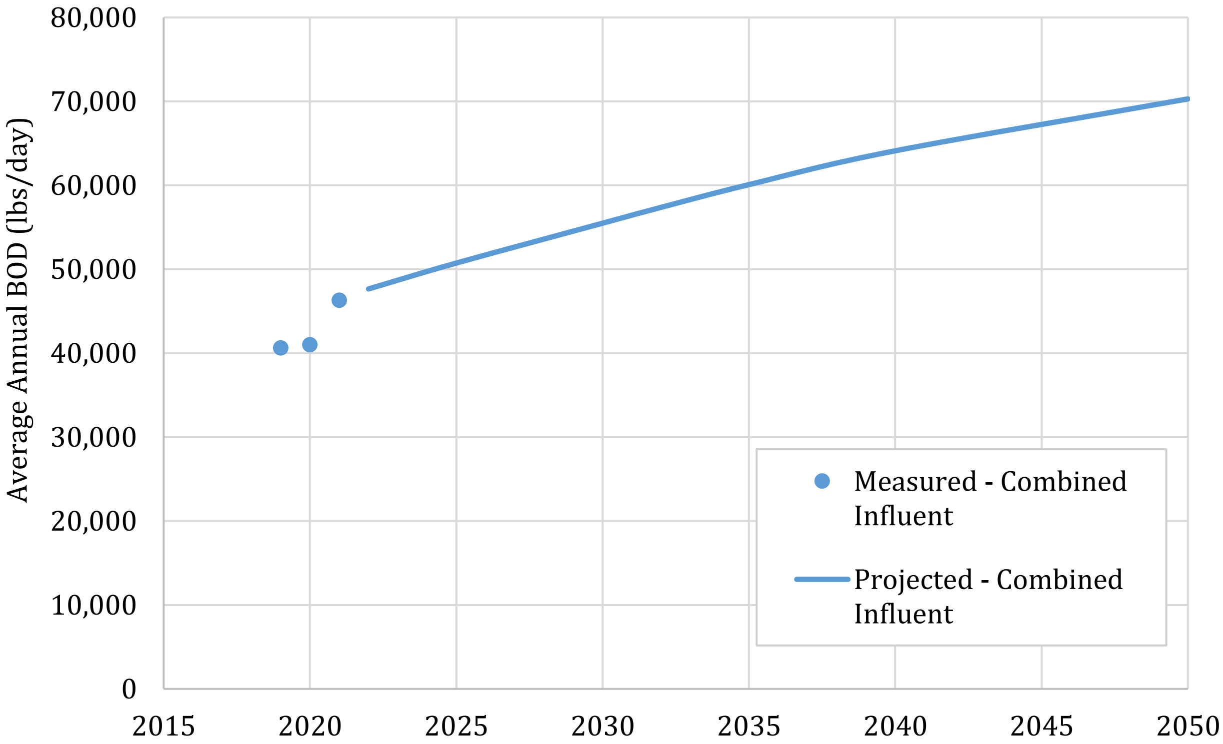


Figure 10-2: Average Annual BOD Loading Projection

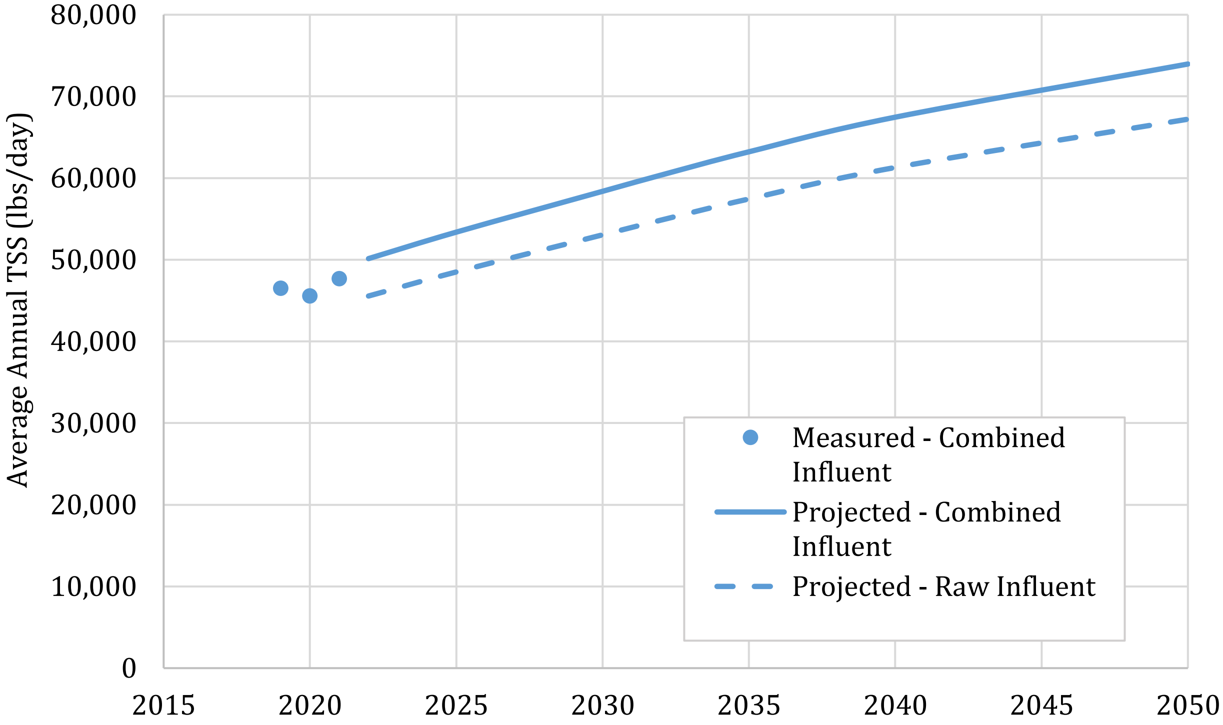


Figure 10-3: Average Annual TSS Loading Projection

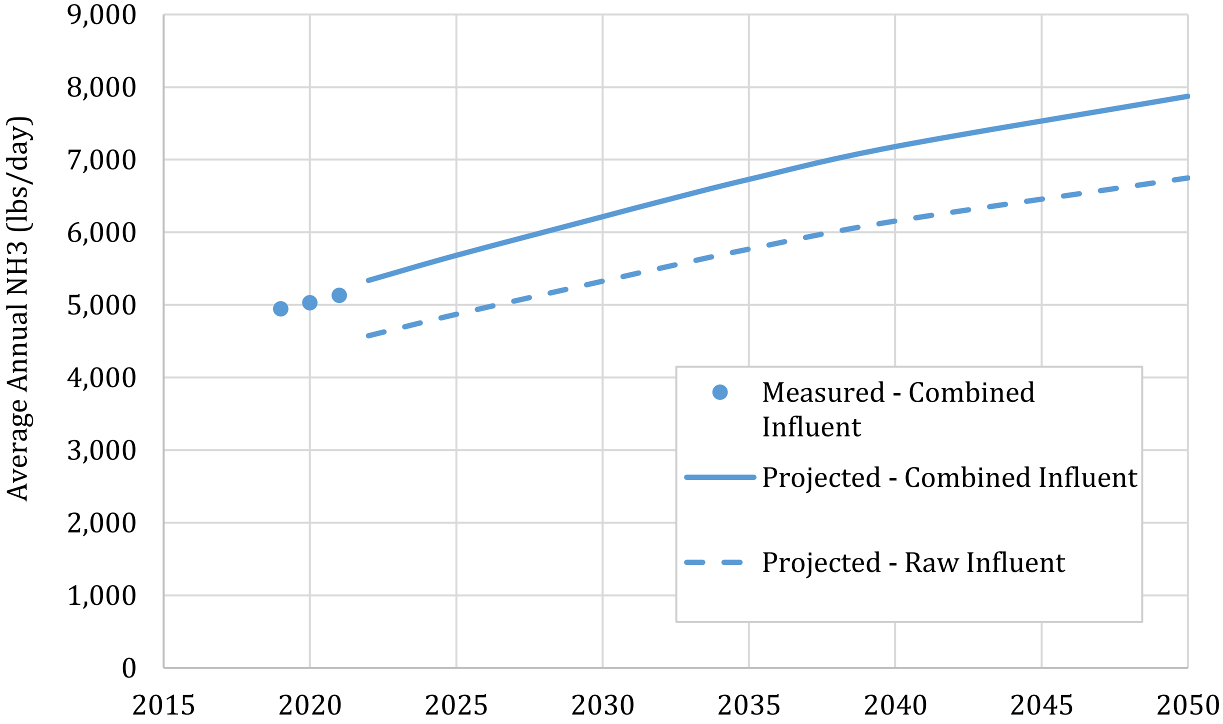


Figure 10-4: Average Annual Ammonia Loading Projection

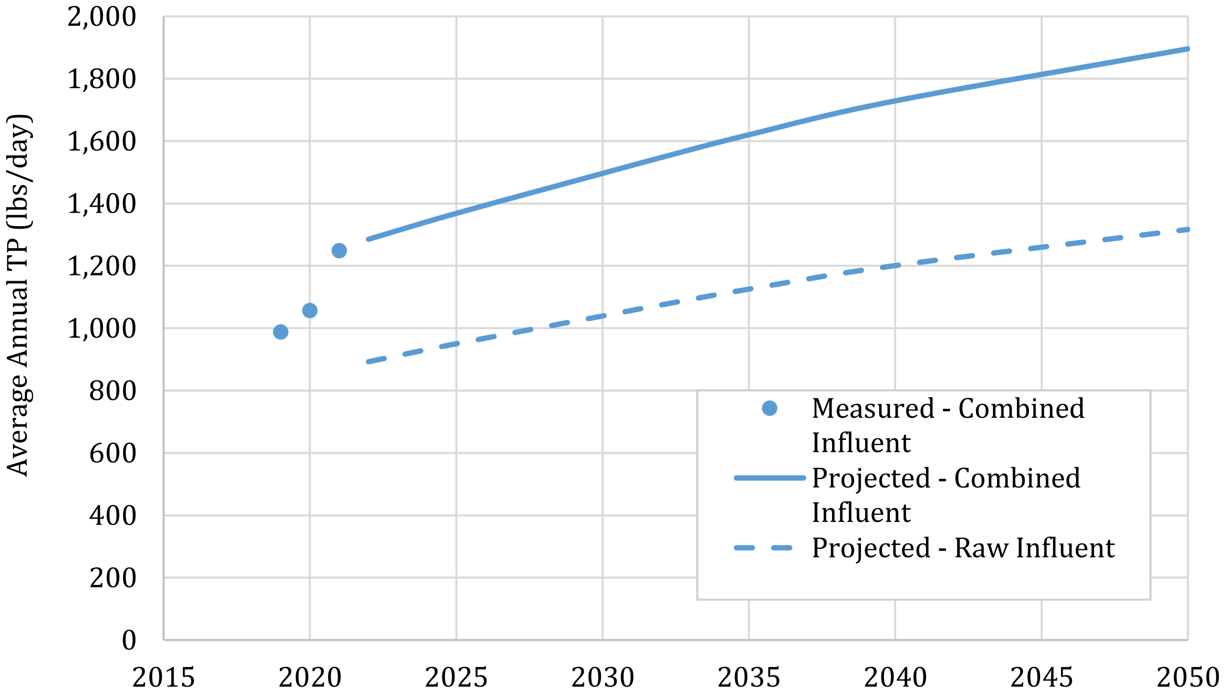


Figure 10-5: Average Annual Total Phosphorus Loading Projection

Influent wastewater samples are collected at the Headworks Building just upstream of the screens and internally processed by CWSID. At this sampling location, return flows from the septage dump station, gravity belt thickeners, and belt filter presses are included in the sample. This is shown as the "Combined Influent" graph in the figures. The "Raw Influent" projected graph represent estimated influent loading before these additional return flows. This helps in understanding the impact that return flows have on overall influent loading and treatment capacities at the plant. BOD does not have a raw influent projection because minimal BOD is returned through recycle flow processes and the projected combined and raw influent loads overlap.

Maximum month loads were established by using the maximum peaking factor for years 2019 through 2021 between average and max month loads. That peaking factor was then applied to the average loadings to produce max month loadings. Facility capacities will be evaluated based on the max month loading values. Table 10-2 shows the peaking factors used for each constituent. Figures 10-7, 10-8, 10-9, and 10-10 show the max month loading rate out to planning year 2050.

Table 10-2
CWSID Max Month Load Peaking Factors

Parameter	Peaking Factor
BOD	1.12
TSS	1.19
Ammonia - N	1.16
Total Phosphorus	1.32

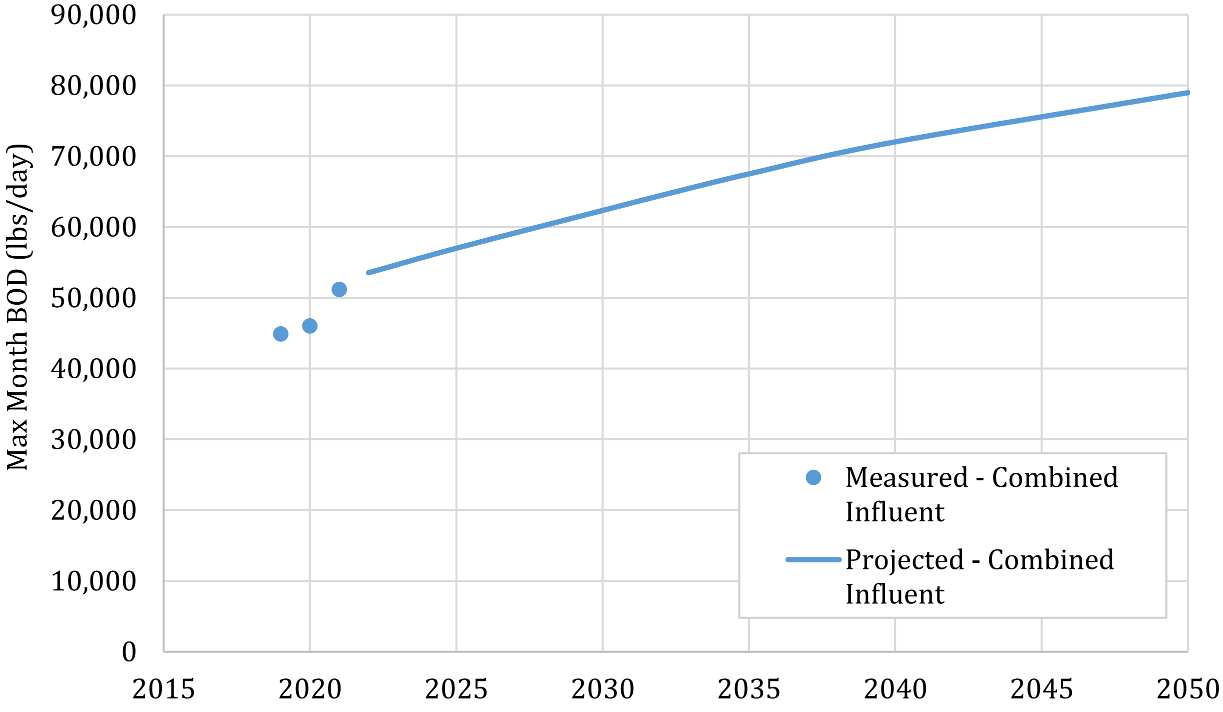


Figure 10-6: Max Month BOD Loading Projection

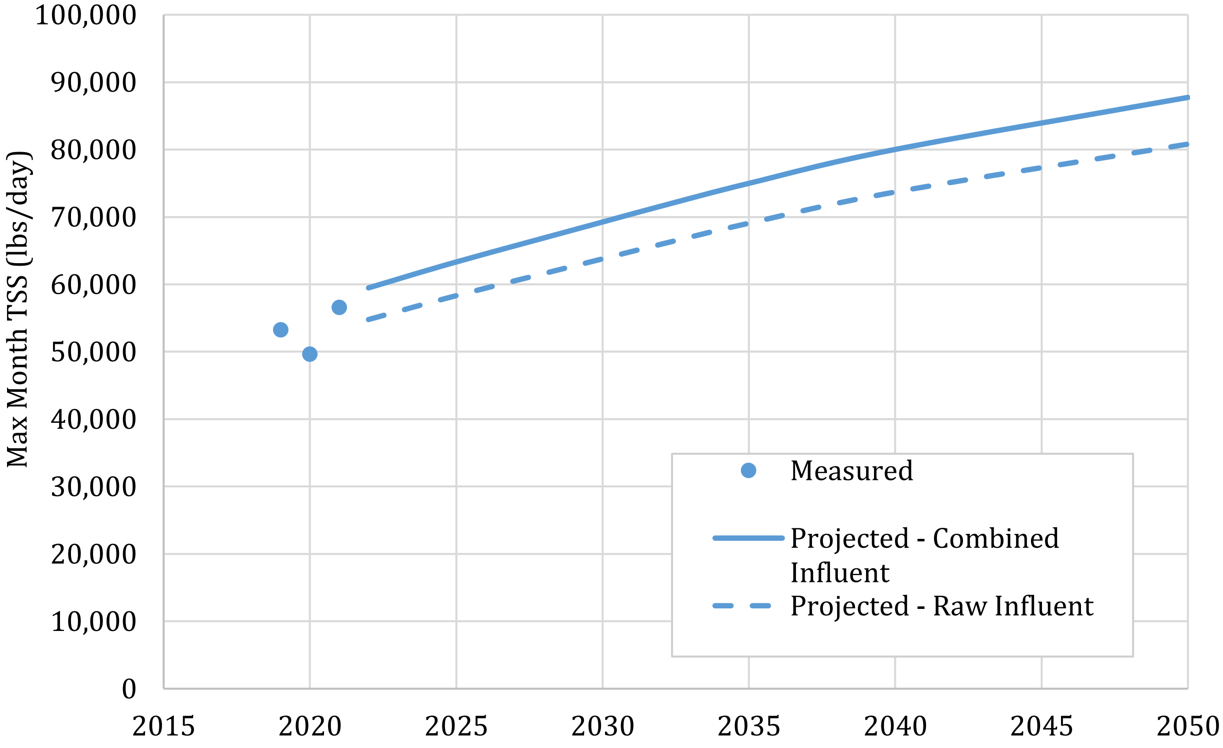


Figure 10-7: Max Month TSS Loading Projection

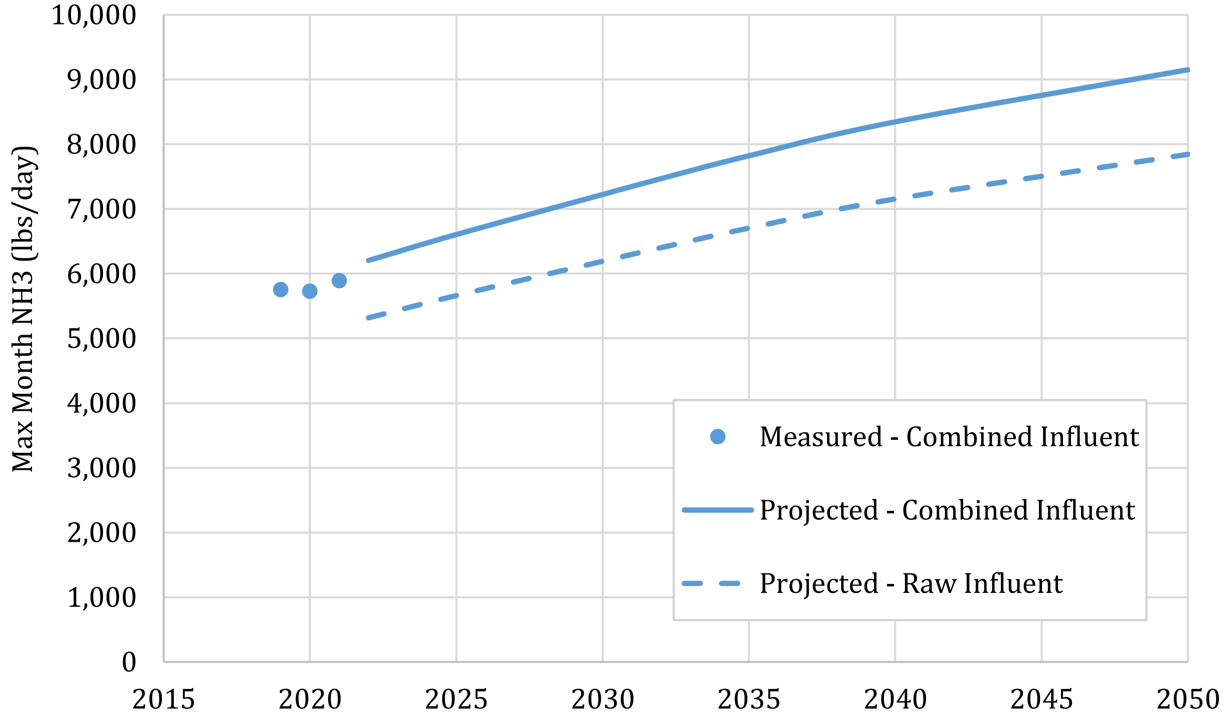


Figure 10-8 Max Month Ammonia Loading Projection

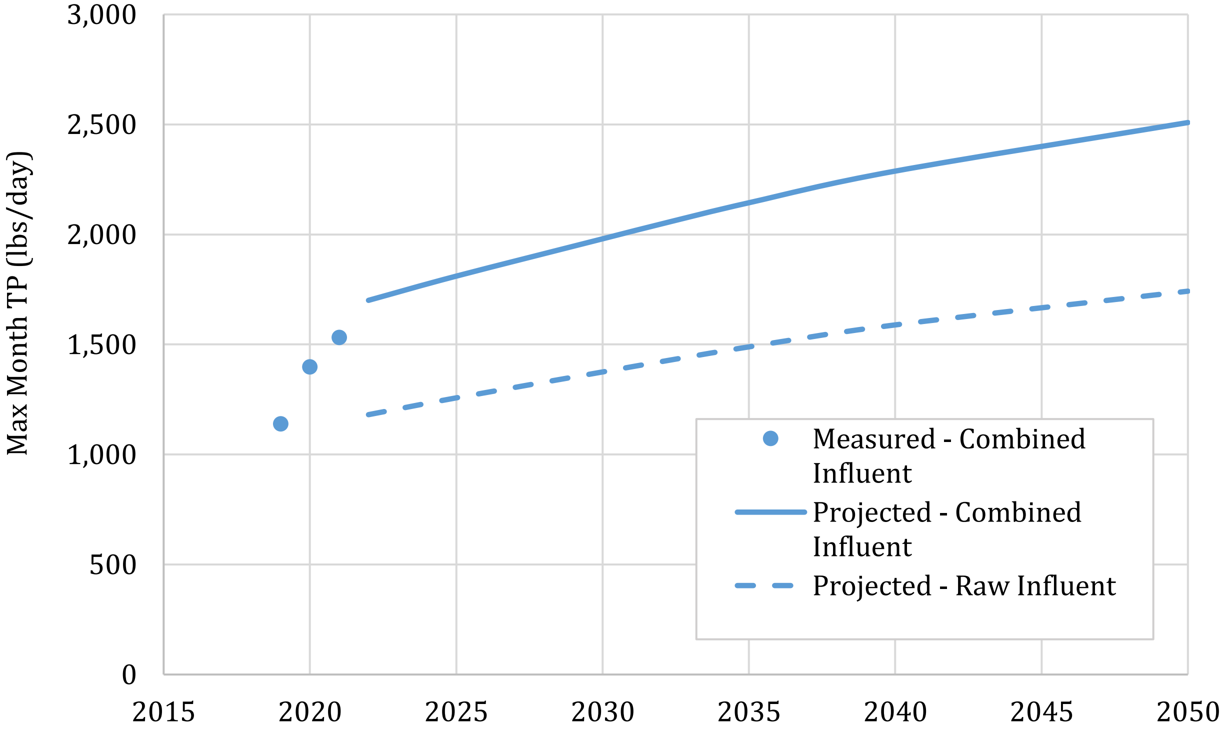


Figure 10-9: Max Month Total Phosphorus Loading Projection

PRIMARY AND WASTE ACTIVATED SLUDGE LOADS AND FLOW PROJECTIONS

A primary focus of the Master Plan is the solids process outlook at CWSID. Many of the near-term capital projects and challenges are solids-focused, so understanding the projected solids production is useful in evaluating existing and future capacities and alternatives. The two main solids streams that feed the solids processes are the primary sludge (PS) flow and the waste activated sludge (WAS). The solids outlook from these two streams are summarized in Tables 10-3 and Table 10-4. Projected PS flows and loads are based on existing primary clarifier TSS percent removal and percent solids of 3 to 4 percent. Project WAS flows and loads were based on solids range of 0.5 to 1.0 percent.

Table 10-3
Projected PS Flows and Loads

Year	Annual Average PS Load (ppd) (1)	Maximum Month PS Load (ppd) (2)	Peak Day PS Load (ppd) (2)	Average Annual PS Flow Range (MGD) (3)	Maximum Month PS Flow (gpm) (3)	Peak Day PS Flow Range (gpm) (3)
2030	31,608	44,042	53,788	60-104	71-122	86-150
2040	36,521	50,461	62,051	70-121	81-140	100-172
2050	40,043	55,478	68,314	77-133	89-154	110-190

[1] Annual average PS load assumes 55% removal through primary clarifiers.

[2] Maximum Month and Peak Day PS load assumes 65% removal through primary clarifiers.

[3] Minimum PS flow range based on 50% removal & 4% solids. Maximum PS flow range based on 65% removal & 3% solids.
Abbreviations: gpm = gallons per minute, MGD = million gallons per day.

Table 10-4
Projected WAS Flows and Load

Year	Annual Average WAS Load (ppd) (1)	Maximum Month WAS Load (ppd)	Peak Day WAS Load (ppd)	Average Annual WAS Flow Range (gpm) (2)	Maximum Month WAS Flow (gpm) (2)	Peak Day WAS Flow Range (gpm) (2)
2030	27,503	30,177	48,302	270-302	268-298	383-428
2040	31,779	35,412	55,810	316-353	317-354	443-494
2050	34,843	38,371	61,192	315-351	315-351	485-542

[1] Annual average WAS load based on return activated sludge (RAS) recycle rate of 53%

[2] Minimum WAS flow range based on RAS recycle rates of 49%. Maximum WAS flow range based on RAS recycle rates of 58%.

Graphical figures of PS load and flow projections are shown below in Figures 10-11, 10-12. Figure 10-11 shows the measured total PS load from 2019 to 2021 for both the activated sludge (AS) primary clarifiers and trickling filter (TF) primary clarifiers. The projected curve on the graph represents future AS PS load only since it is anticipated that flow to TF will be discontinued, and all flow will be sent to the AS side.

The stacked graph in Figure 10-11 shows existing data broken into three categories; measured AS PS, measured TF PS from influent, and measured TF PS remainder. The TF PS load data provided by CWSID are the sum of both influent and remainder stacked graphs. The measured TF PS load from

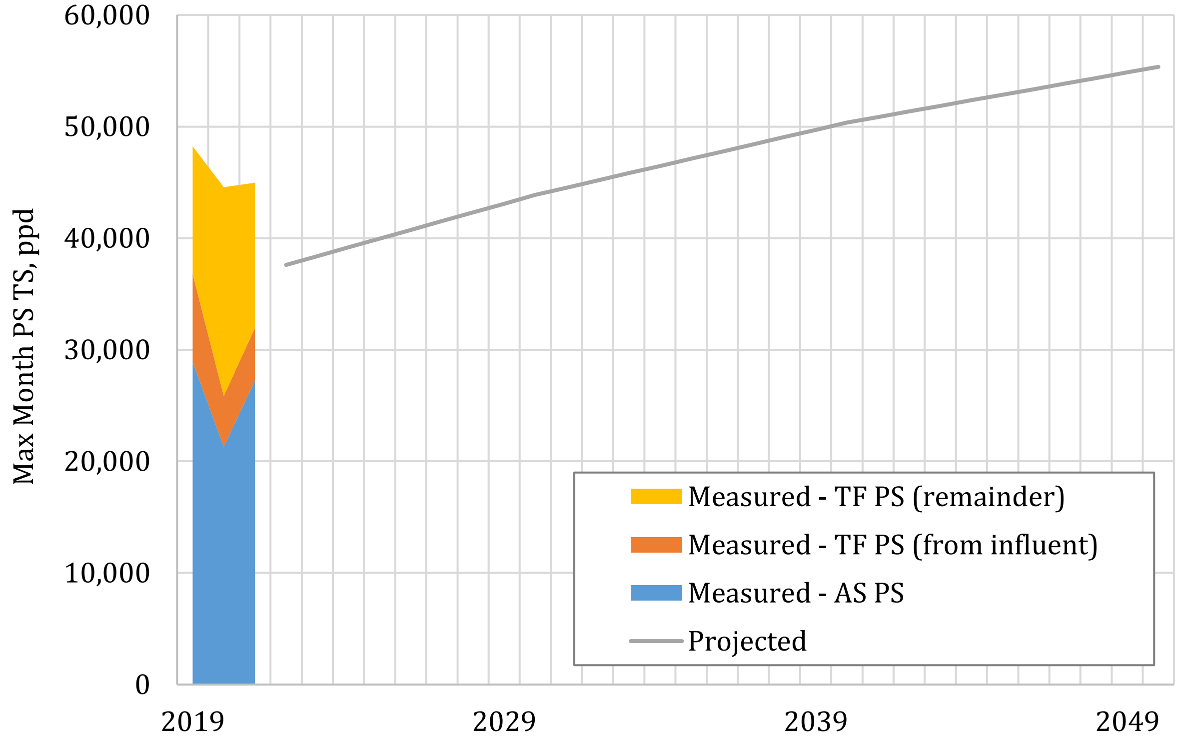


Figure 10-10: Max Month PS Load Projections

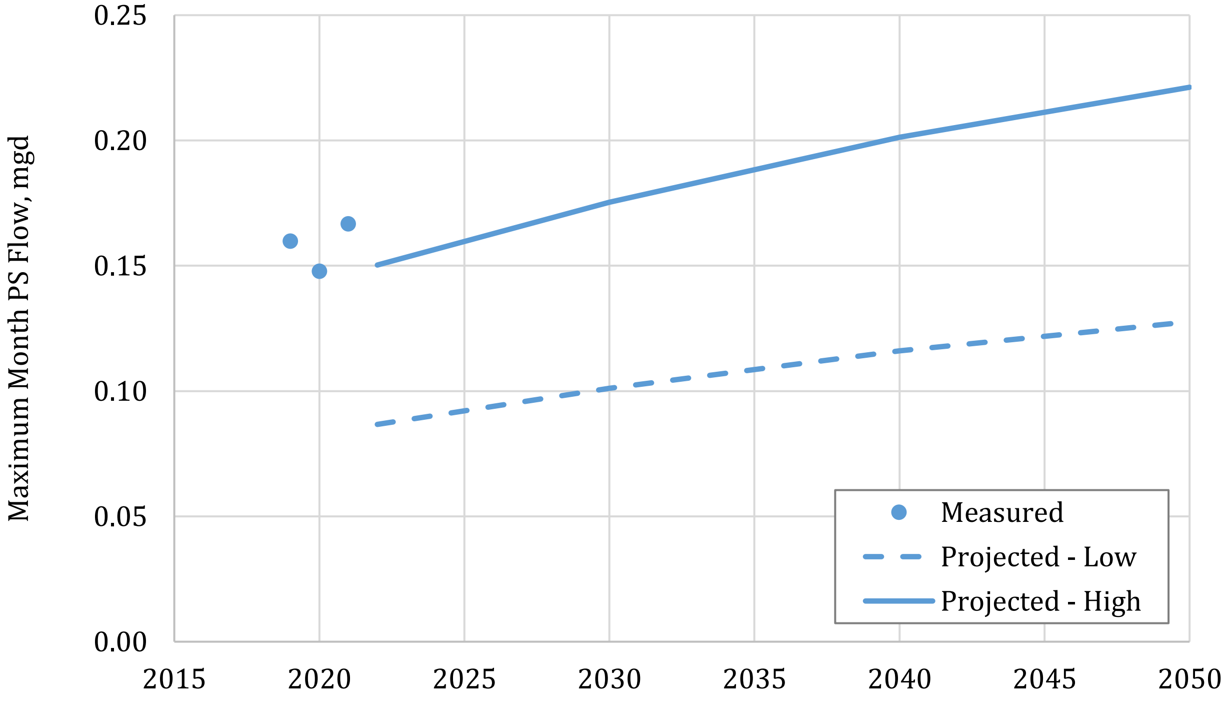


Figure 10-11: Max Month PS Flow Projections

the influent is calculated by the influent flow sent to the TF side and the influent TSS with 55 percent primary clarifier removal. The measured TF PS remainder are unknown solids accumulation in the trickling filter process, either from solids sluffing off the trickling filters returning via humus return or measurement error.

It is important to note that PS percent solids for the AS plant is 3.7 percent and the TF plant is 3.2 percent. Flow data from the PS pumps for both AS and TF are similar even though 1/5 of the total plant flow is going to the TF.

Figures 10-13 and 10-14 show the projected WAS load and flows. The flow projections shown in Figure 10-3 do not show a linear increase in WAS flow because of the addition of new aeration basins during the planning years. Through 2022 to 2030, it is modeled with six aeration basins online, with the solids retention time (SRT) staying the same. As the load to the aeration basins increases, the mixed liquor suspended solids (MLSS) and return activated sludge (RAS) concentrations increase. Because of the increase in RAS concentration, the WAS flow does not need to increase appreciably to increase the wasting. WAS flow needs to gradually increase between years 2030 and 2040 as MLSS and RAS concentrations stay relatively constant since volume increases. The same thing is happening in 2040 when an additional aeration basin (seven total) is constructed online as adjustments to RAS and MLSS concentrations increase but the wasting increase lags behind.

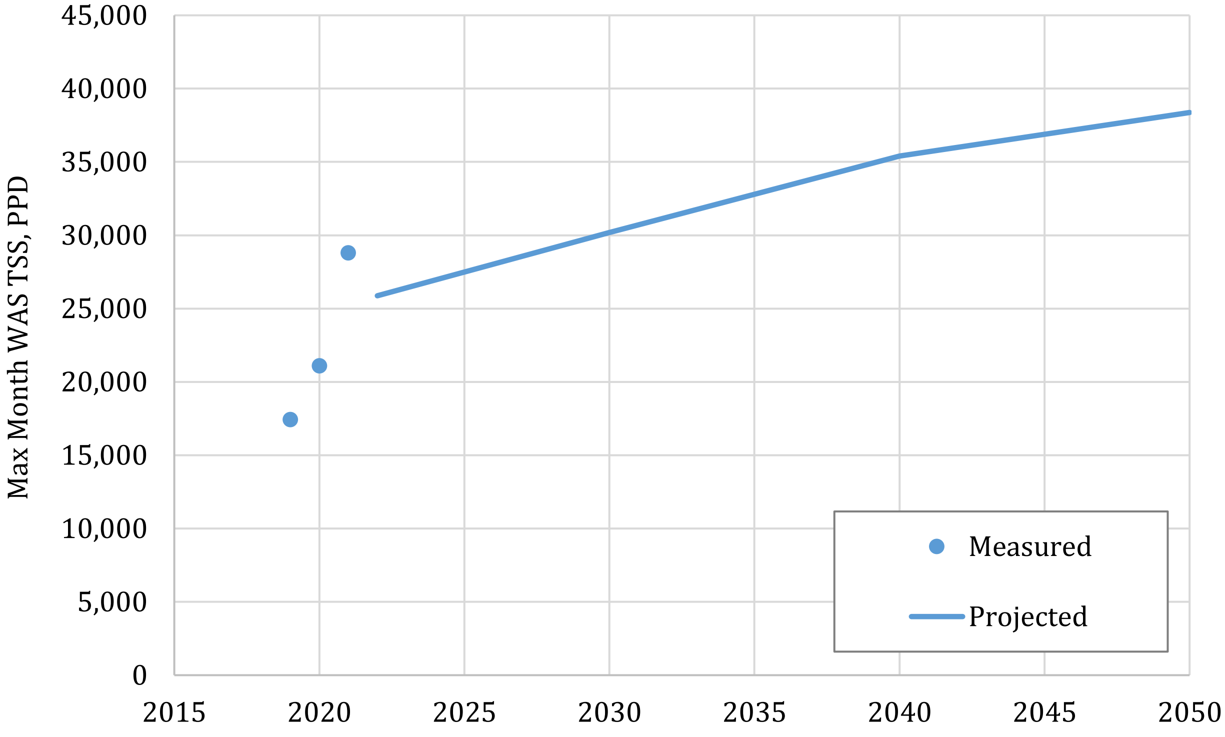


Figure 10-12: Max Month WAS Load Projections

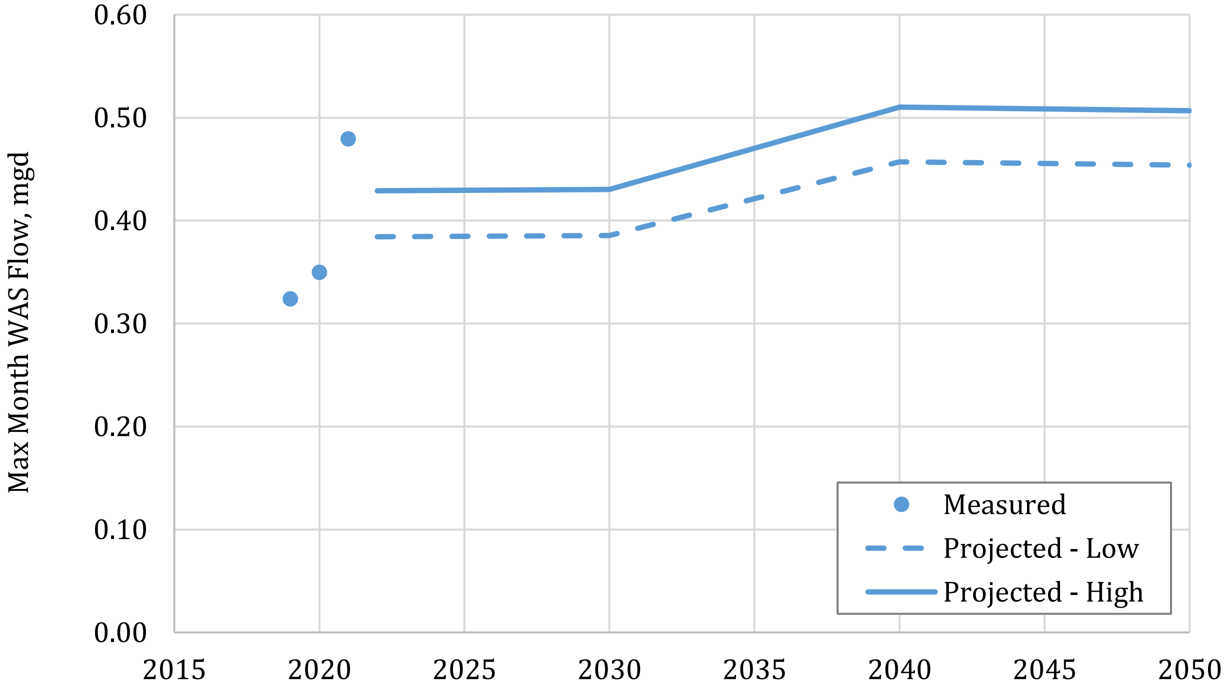


Figure 10-13: Max Month WAS Flow Projections

CHAPTER 11
EXISTING FACILITIES REVIEW AND CONDITION ASSESSMENT

BACKGROUND

As part of the Wastewater Master Plan update, Carollo Engineers, Inc. (Carollo) conducted a condition assessment and reviewed existing facilities currently operated and maintained at Central Weber Sewer Improvement District's (CWSID or District) water reclamation facility (WRF). The condition assessment was conducted over two site visits on May 4th and 11th, 2022 and included process mechanical, structural, and electrical engineers, and involved District staff responsible for various unit treatment processes. This effort documents the current capacities and condition of existing maintained and operated assets. Findings of this task will be used in conjunction with other information (i.e., hydraulic and unit treatment capacity evaluation) as the basis for identifying needed improvements to maintain an acceptable level of service and operational risk.

Scope of Work

This effort documents the current capacity and condition of existing unit processes and related equipment at CWSID's water reclamation facility. Full descriptions of CWSID's plant facilities are included in this chapter, which have been updated referencing information with full descriptions in Chapter 2 - Review of Existing Facilities of the Treatment Plant Evaluation and Master Plan dated February 2018. The previous review effort focused on critical needs or capacity limitations based on CWSID staff experience, Utah Administrative Code R-317 and American Society of Civil Engineers (ASCE)/ Water Environment Federation (WEF) Manual of Practice No. 8. This current effort is similar but primarily relies on documented visual inspections made by professional engineers and CWSID staff. It also considers updated wastewater rules and guidance documents and recommendations made in the previous facility plan, the Treatment Plant Evaluation and Master Plan dated February 2018. Recommended improvement projects will be identified referencing the unit process capacity and condition assessment effort in this chapter.

Water Reclamation Facility

The CWSID water reclamation facility consists of two process trains: (1) a new activated sludge (AS) treatment process completed in 2012; and (2) a trickling filter (TF) treatment process train that is part of the original facility constructed in 1957. The District currently splits flow to both the TF and AS Treatment Processes but most of the influent raw wastewater is directed to the new AS Treatment Process. Facilities operated and maintained by the District are designated by the associated treatment train with a 'TF' or 'AS' prefix. Several facilities, including solids handling, cogeneration, chlorine contact basin and chemical storage facilities, are shared between the two treatment trains. A site plan of the existing treatment facilities for each treatment process is presented in Figure 11-1.

Thickened waste activated sludge (TWAS) and primary sludge from AS Treatment Process is blended with the primary sludge from the TF Treatment Process and digested to meet Class B biosolid quality as defined in the Environmental Protection Agency (EPA)'s "A Plain English Guide to the EPA Part 503 Rule." Through an agreement with Western Basin Land & Livestock, LLC, the CWSID land applies most of its dewatered Class B biosolids and composts the remainder at the Weber County-operated facility located just north of the CWSID water reclamation facility. Refer to Figure 11-2 for a CWSID Solids Handling Schematic.

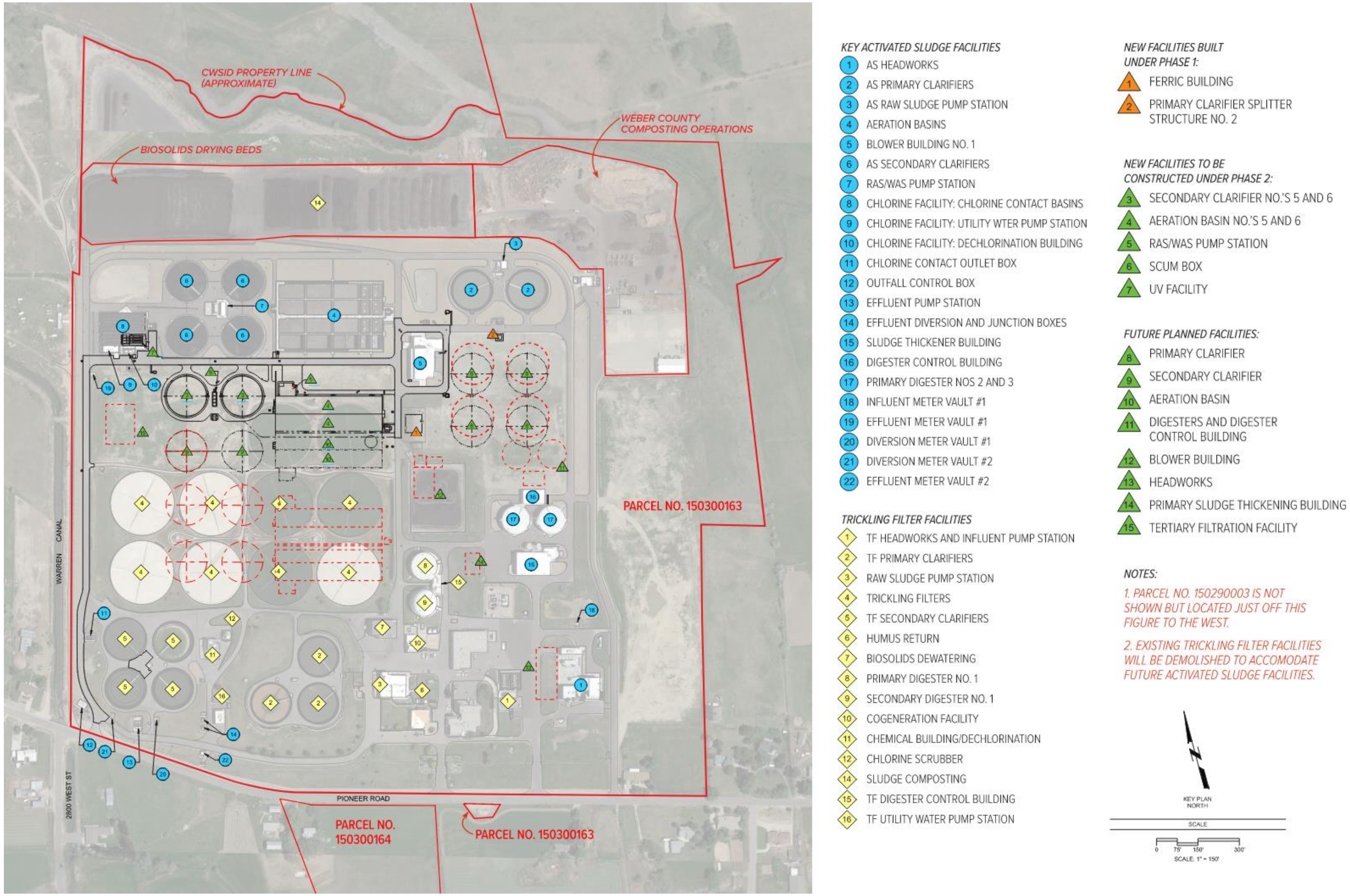
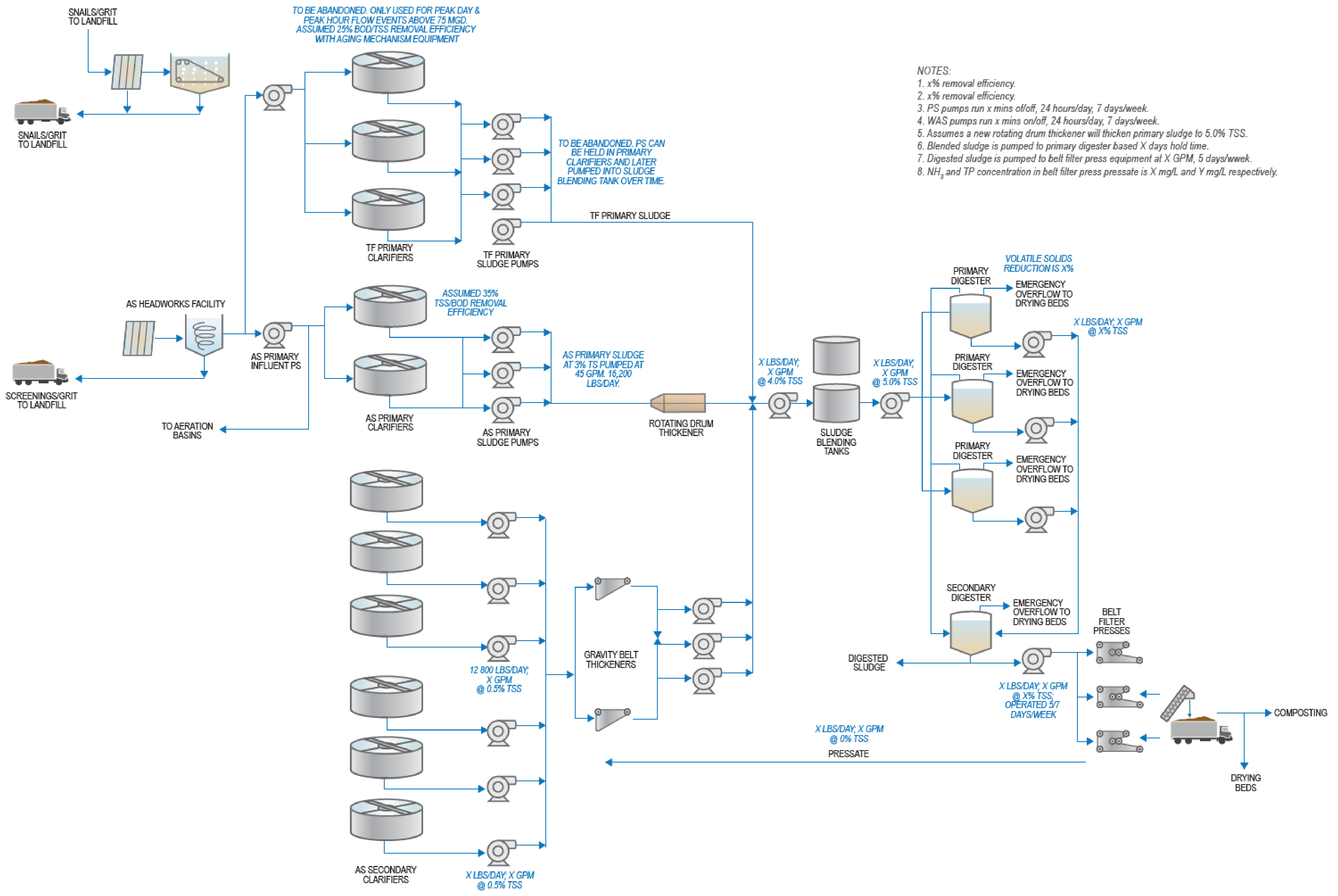


Figure 11-1: CWSID WRF Site Plan



NOTES:
1. x% removal efficiency.
2. x% removal efficiency.
3. PS pumps run x mins of/off, 24 hours/day, 7 days/week.
4. WAS pumps run x mins on/off, 24 hours/day, 7 days/week.
5. Assumes a new rotating drum thickener will thicken primary sludge to 5.0% TSS.
6. Blended sludge is pumped to primary digester based X days hold time.
7. Digested sludge is pumped to belt filter press equipment at X GPM, 5 days/wwek.
8. NH_3 and TP concentration in belt filter press pressate is X mg/L and Y mg/L respectively.

Figure 11-2: CWSID Solids Handling Schematic

Plant Expansion Projects.

The original CWSID water reclamation was first constructed in 1957 and consisted of the following TF Treatment Process and related facilities:

- Control Manhole.
- Screen Chamber.
- Grit Chamber.
- Parshall Flume.
- Primary Clarifiers (Nos. 1 to 3).
- Raw Sludge Pump Station.
- Trickling Filters (Nos. 1 to 12).
- Final Clarifiers (Nos. 1 to 3).
- Chlorination.
- Control Building.
- Sludge Holding Tank.
- Sludge Drying Beds.

The Control Building housed administrative offices, laboratory, locker rooms, an Influent wet well, influent pumps, sludge holding tanks and transfer pumps and sludge conditioning filters and related equipment.

The original facility was expanded and improved under the following additional projects listed in Table 11-1.

Table 11-1
Renovation and Improvement Projects Summary

Project Name	Improvement Description	Year Construction Started
Sewage Treatment Plant Part II - General Contract	• Screen Chamber • Grit Chamber • Control Building • Influent Pump Station • Dewatering/Lime Storage • Garage and Shop Area • TF Primary Clarifiers 1-3 • Chlorine Building • Trickling Filters 1-12 • TF Final Clarifiers 1-3 • Well Building • Sludge Hold Tank • Electrical Substation • Dewatered Storage Area	1957
	• TF Raw Sludge Pump Station • Administration Building? • Maintenance Building?	
Construction of Sludge Processing Facilities	• Primary Digester • Secondary Digester • Digester Control Building • Interim Dewatering • Unit Electrical Substation • Dewatered Sludge Storage Area	1983
Humus Return/Recirculation Pump Station	• Humus Return/Recirculation Pump Station and Flume Structure	1984
Biosolids Dewatering Facility	• New Biosolids Dewatering Facility	1995
Final Clarifier and Chemical Building	• Utility Water and Scum System Facility at TF Primary Clarifiers • TF Final Clarifier No. 4 • Chemical Building (Gas Chlorine) • Chlorine Vapor Removal System (Wet Caustic Scrubber) • Electrical Transformer/Switchgear and Standby Generator • Scum System Facility • New Lab Building	1998

Table 11-1
Renovation and Improvement Projects Summary (continued)

Energy Recovery Facility Improvements	• Energy Recovery Facility • Existing Digester Control Building Modifications	2000
New Utility Water Pump Station and Existing Raw Sludge Pump Station Modifications	• New Utility Water Pump Station • Air Diaphragm Pumps and Related Air Compressors at Control Building (Primary Sludge)	2004
Activated Sludge Plant Expansion	• Activated Sludge Headworks Facility: Influent Screens, Grit Chambers, Influent Pumps 1-3, and Load-Out • AS Primary Clarifiers 1-2 and Splitter Box • AS Raw Sludge Pump Station • Blower Building w/ Blowers 1-3 • AS Aeration Basins 1-4 • AS Secondary Clarifiers 1-4 • Return Activated Sludge (RAS)/Waste Activated Sludge (WAS) Pump Station • Chlorine Facility: Contact Basins 1-3, Dechlorination Building, and Utility Water Pump Station • Chlorine Contact Outlet Box • Outfall Control Box • Effluent Pump Station • Effluent Diversion and Junction Boxes • Sludge Thickening Building and Sludge Blending Tanks • Digester Control Building • Primary Digesters 3-4 • Existing Digester Control Building Modifications • AS Influent and Effluent Metering Vaults • Diversion Metering Vaults	2012

Table 11-1
Renovation and Improvement Projects Summary (continued)

Phase 1 Nutrient Removal and Electrical Upgrades	• Ferric Chloride Building and Chemical Feed Systems • Primary Clarifier Splitter Box • Primary Clarifier Bypass Meter Vault • Primary Clarifier Modifications • Existing Primary Clarifier Splitter Modifications • Trickling Filter Pump Station Modifications • Humus Return Pump Station Modifications • Electrical Site Improvements • Standby Power Improvements: Switchgear, Automatic Transfer Switch (ATS), and New Standby Generator	2019
Drying Bed Expansion	• Drying Bed Expansion	2021
Phase 2 Bioreactor Expansion Project	• Influent Pump 4 at AS Headworks • AS Bioreactors 5-6 • AS Secondary Clarifiers 5-6 and Scum Box • RAS/WAS Pump Station • Aeration Blower 4 at Blower Building • Ultraviolet (UV) Disinfection Building and Existing Chlorine Contact Basin Modifications	2022

Operational Practices.

Federal, State, and CWSID's own standards and rules for owning and operating public water reclamation facilities are referenced in this section when describing and evaluating existing facilities. An exhaustive list of applicable rules and regulations is not provided here.

Wastewater Rules and Governing Codes

Federal rules surrounding the public wastewater systems generally fall under the United States' Clean Water Act (CWA) passed in 1972 and the Water Quality Act (WQA) passed in 1987. The EPA is charged with developing specific requirements, regulations, and new standards for publicly owned treatment works (POTWs) like the CWSID WRF. Some of these include: (1) nutrient removal and impact of a discharge on waters of the United States, (2) control of pathogenic organisms, (3) removal of organic and inorganic substances, (4) identifying priority pollutants (e.g., polyfluoroalkyl substances (PFAS)/ perfluorooctanoic acid (PFOA) type chemicals), and (5) application of biosolids to agricultural and non-agricultural land. The EPA publishes rules in the Federal Register which are codified in Part 40 of the Code of Federal Regulations (CFR).

Water quality regulations for the State of Utah fall under the Utah WQA and specific rules surrounding wastewater collection and treatment, and disposal systems are defined under Title R317 of the Utah Administrative Code as published by the Office of Administrative Rules. The Division of Water Quality (DWQ) under the Utah Department of Environmental Quality (DEQ) is tasked with developing State of Utah rules that protect the water quality of the State's surface and groundwater resources. Proposed rule changes are published in the Utah State Bulletin published by the Office of Administrative Rules and are also posted on DWQ's website.

Some of the other related rules and governing codes that apply to water reclamation facilities include:

- International Building Code (IBC).
- National Electric Code (NEC).
- American National Standards Institute / American Society of Civil Engineers (ANSI/ASCE).
- Utah State Plumbing Code (USPC).
- International Conservation Energy Code ICEC).
- International Mechanical Code (IMC).
- International Fire Code (IFC).
- National Fire Protection Agency (NFPA).
- Occupational Safety and Health Administration (OSHA).

REVIEW OF EXISTING FACILITIES

This section provides an overview of CWSID WRF existing unit treatment processes and identifies any hydraulic capacity or equipment or unit process redundancy limitations. The review of the existing CWSID WRF under this section is organized as follows:

- Facility Overview.
- Influent Conveyance.
- Activated Sludge Treatment Process.
- Trickling Filter Treatment Process.
- Solids Handling.
- Power Distribution and Cogeneration.

Facility Overview

The CWSID WRF is comprised of two different treatment systems: (1) AS Treatment Process, and (2) TF Treatment Process. The TF Treatment Process is older and was constructed as part of the original WRF while the AS Treatment Process is new and was constructed 2012. The CWSID currently operates both the AS and TF Treatment Processes, diverting flow between the two at an approximate 80/20 AS/TF flow split ratio. When the Phase 2 expansion is completed, the CWSID will divert 100 percent of all raw influent flow to the AS Treatment Process and only use the TF Treatment Process to treat wet weather flow events when flow exceeds 75 million gallons per day (mgd). To maintain fixed film growth on the trickling filters, a base flow less than 10 mgd is currently directed to the TF Treatment Process.

Influent Conveyance

There are two 54-inch diameter and 60-inch diameter gravity sewer lines (X and X) from the CWSID wastewater collections located just south of Pioneer Road south of the CWSID WRF. These two sewer trunk lines are connected to a single cast-in-place 9-foot-wide and 5-foot-deep concrete channel that crosses underneath Pioneer Road (as a siphon) and directs sewer to either the TF Headworks or to the AS Headworks. A third gravity sewer line (a 54-inch diameter pipeline constructed under the 2012 expansion project) conveys sewer from the CWSID wastewater collection system, and also conveys septage from the CWSID's septage receiving station.

All raw influent from the CWSID wastewater collection system is currently directed to the AS Headworks, bypassing the TF Headworks by a closed gate located at the Influent Junction Structure. The AS Headworks flow splitter box is not currently used, as it is intended to split flow between the existing and future AS Headworks facilities. The east bifurcation conveys flow to the AS Headworks while the west bifurcation includes a temporary closure wall. In the future when the AF Headworks is expanded, stainless steel stop logs may be dropped into raw influent channels to split flow to each between the two AS Headworks facilities.

Figure 11-3: Headworks Influent Junction Structure

The CWSID WRF is not currently equipped to measure the total raw wastewater flowrate entering the facility. An electromagnetic flowmeter measures the total primary influent (PI) flowrate to the AS Treatment Process from the AS Influent Pump Station. A similar flowmeter is not available on the TF Treatment Process since the Parshall flume located upstream of the TF Headworks (see photo below) is bypassed. Another Parshall flume is used to measure the humus flowrate returned to the TF Headworks (see photo below). This flow is combined with primary influent diverted from the AS Headworks to the TF Treatment Process. CWSID currently adjusts flow from the AS Influent Pump Station and any excess flow overflows walls/weir in the AS Headworks downstream of the vortex grit chambers and flows by gravity in a pipe that connects to the TF Headworks downstream of the aerated grit chambers.

Figure 11-4: TF Headworks Parshall Flume

Figure 11-5: Humus Return Parshall Flume

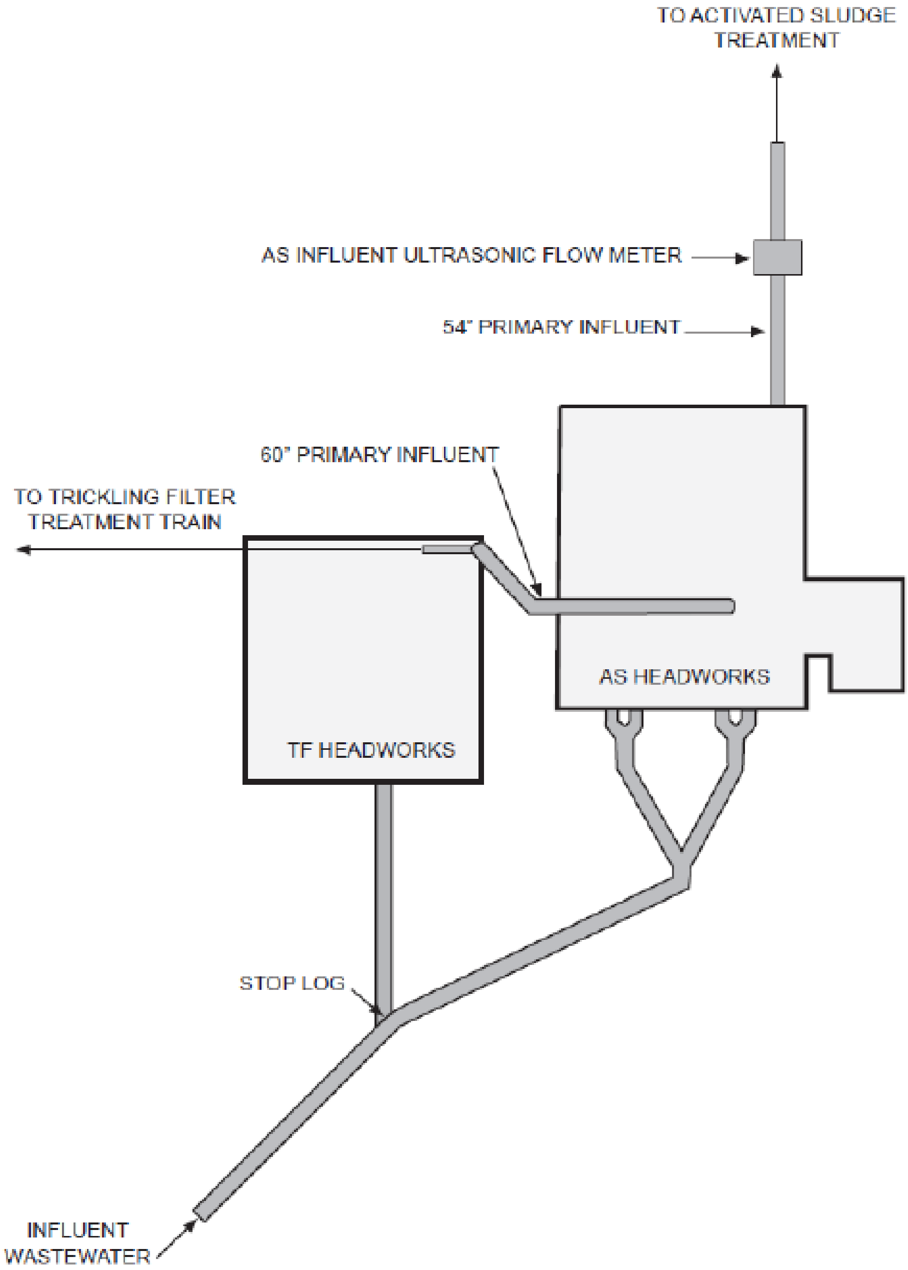


Figure 11-6: CWSID WRF Influent Conveyance

Return Flows and Plant Drains.

AS Treatment Process Plant Drains.

Return flows to the AS Treatment Process include:

- Pressate from the Dewatering Building.
- Filtrate from Gravity Belt Thickeners?
- Groundwater from structural underdrain systems.

The following return flows are currently discharged to the AS Treatment Process plant drain:

- AS Headworks (sump pumps).
- AS Influent Meter Vault.
- WAS Thickening Building.
- AS Blower Building.
- RAS/WAS Pump Station (PS).
- Chlorine Contact Basin Drains.
- Final Effluent Flow Meter Vault.

The following are structural underdrain systems where groundwater is pumped from below structures and discharged to the AS Treatment Process plant drain:

- AS Primary Clarifier and Primary Sludge PS Underdrain Systems.
- Aeration Basin Underdrain System.
- AS Secondary Clarifiers Underdrain System.

Activated Sludge Treatment Process

Figure 11-7 depicts the overall liquid process schematic of the AS Treatment Process.

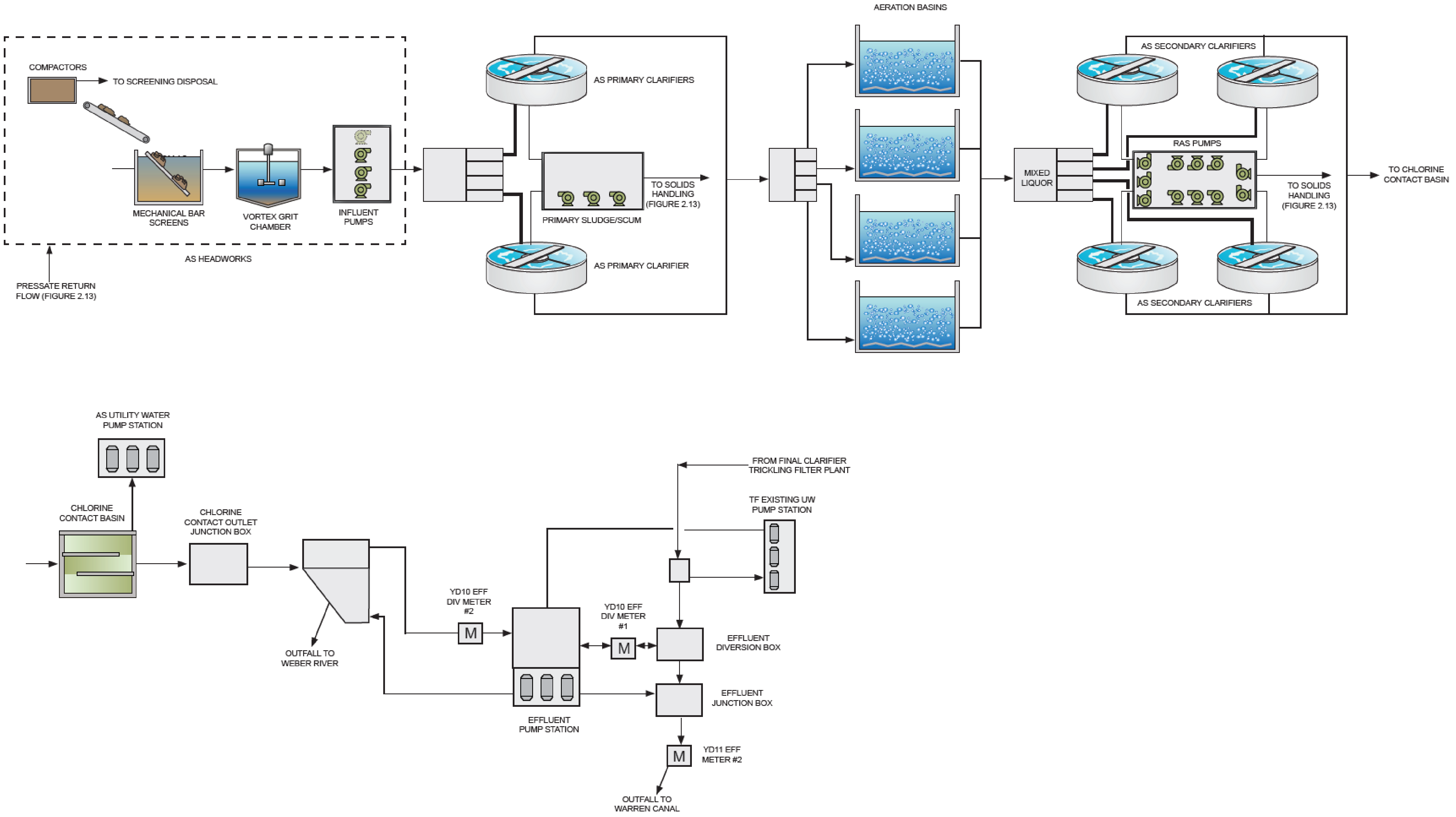


Figure 11-7: AS Treatment Process Liquid Flow Schematic

AS Headworks and Influent Pump Station.

The AS Headworks that was constructed as part of the 2012 expansion is a multi-level structure and houses covered influent wastewater channels, screening equipment, screenings washer/compactor equipment, vortex grit chambers, grit cyclone and classification equipment, conveyors, truck load-out and supporting electrical, heating, ventilation, and air conditioning (HVAC) equipment, and instrumentation and control equipment. CWSID recently reconfigured the screening and washer/compactor equipment and removed sluiceways and the Serpentix™ type screenings conveyor. A future AS Headworks expansion is anticipated where the current facility is extended to the west.

The AS Headworks also includes a septage receiving tank where septage received at the septage receiving facility can be stored and sampled before being introduced to the CWSID WRF.

One climber-type screen is located in each of the two cast-in-place concrete influent channels. The screens are climber-type, front-cleaned mechanical bar screens and discharge screenings to dedicated washer/compactors that in turn discharge washed and compacted screenings to a small, dedicated dumpster. Figure 11-8 shows the front of the influent screens and Figure 11-9 shows the back of the screen and also shows the dedicated washer/compactor and small dumpster. The dumpsters are emptied into haul trucks by CWSID operations staff.

Once screened, the plant influent passes to a vortex grit chamber unit process where grit settles to a bottom hopper and degritted effluent flows to the Influent Pump Station wet well. The settled grit is later pumped upstairs to grit classification equipment above the truck load-out bay. Conveyors are used to convey grit from the classifiers to trucks located below on the first-floor load-out bay.

Figure 11-8: AS Headworks Influent Screen

Figure 11-9: AS Headworks Screen and Compactor

Table 11-2
AS Headworks Equipment Summary

Parameter	Units	Value
Screening		
Type		
Quantity	no.	2
Treatment Capacity, each	mgd	60
Hydraulic Capacity, one out of service	mgd	80
Motor Size	horsepower (hp)	2.0
Bar Size	inches	1/2
Nominal Bar Spacing	inches	1/2
Design Headloss at Peak Hour Flow (PHF)	feet	1.90
Nominal Clean Screen Headloss	inches	6
Screenings Compactor Quantity	no.	2
Screenings Compactor Capacity, each	cubic feet per hour (cfh)	75
Screenings Compactor Motor Sizes	hp	7.5
Screenings Compactor Capacity at Maximum Month Flow (MMF)		
Grit Removal		
Type		Vortex Chamber
Quantity	no.	2
Peak Hydraulic Capacity, each	mgd	70
Design Headloss at PHF	feet	2.4
Motor Size	hp	2.0
Diameter	feet	24
Grit Pump Type		Recessed Impeller, Centrifugal
Grit Pump Design Flow	gallons per minute (gpm)	300
Grit Pump Design Total Dynamic Head (TDH)	feet	63
Grit Pump Motor Size	hp	40
Grit Cyclone Quantity	no.	4
Grit Cyclone Diameter	inches	12

Table 11-2
AS Headworks Equipment Summary (continued)

Grit Pump Motor Size	hp	40
Grit Cyclone Quantity	no.	4
Grit Cyclone Diameter	inches	12
Grit Cyclone Capacity, each	gpm	300
Grit Classifier Quantity	no.	2
Grit Classifier Diameter, each	inches	18
Grit Classifier Motor Size, each	hp	1.0

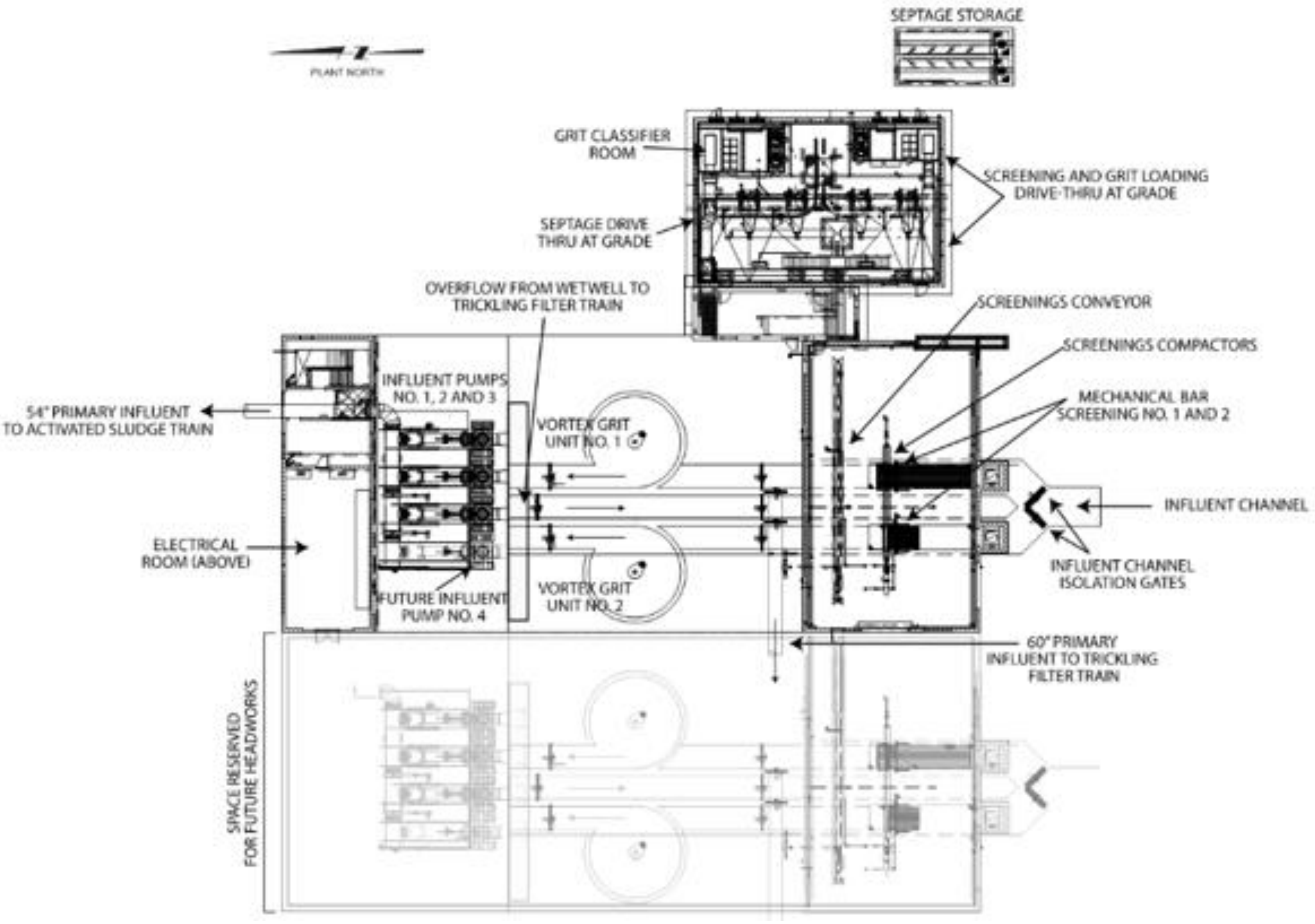


Figure 11-10: CWSID Headworks Plan

The Influent Pump Station is located immediately downstream of the AS Headworks' vortex grit chambers and includes a wet well, three large submersible influent pumps (with space for a fourth pump) located in a dry pit. Each influent pump is driven by a variable frequency drive that is controlled based on wet well water surface elevations (WSE). The current Phase 2 expansion project will add a fourth influent pump and replace one of the existing influent pump variable speed drives. As indicated in the AS Treatment Process hydraulic profile (see Figure 11-3), influent pumps lift plant influent to the AS Primary Clarifier splitter box. CWSID staff can bypass plant influent to the TF Treatment Train by directing plant influent to the bypass channel located between the two vortex grit chambers and ultimately to a 60-inch diameter bypass pipeline.

The total flowrate pumped to the AS Treatment Process is measured by the Influent Flow Meter No. 1. This flowmeter is an electromagnetic type, is located on the discharge pipe/manifold and is housed inside a below grade, cast-in-place concrete vault.

Figure 11-11: Influent Pump Station

Table 11-3
AS Influent Pump Station Summary

Parameter	Units	Value
Pump Type		Dry-Pit Submersible
Existing Pump Quantity	no.	3
Future Pump Quantity	no.	4
Design Flow, each	mgd	30
Design TDH, each	feet	35
Motor Size	hp	350
Firm Pump Capacity (1)	mgd	90
Drive Type, each		Variable Frequency Drive (VFD)

[1] One pump out of service.

AS Primary Clarifiers and Primary Sludge Pump Station.

Primary influent is pumped to a Primary Clarifier Splitter Structure from the AS Influent Pump Station and gravity flows to two existing AS Primary Clarifiers.AS Primary Clarifiers are summarized in Table 11-4.

Table 11-4
CWSID AS Primary Clarifier Nos 1. And 2 Design Criteria

Parameter	Units	Value
Quantity of Primary Clarifiers		2
Diameter, each	feet	145
Surface Area, each	feet	16,500
Side Water Depth, each	feet	12
Recommended Surface Overflow Rate		
Average Annual Flow	gpd/sf	1,000[1]
Max Month Flow	gpd/sf	1,250
Existing Capacity [2]		
Average Annual Flow	mgd	33.0
Max Month Flow	mgd	41.2
Existing Detention Time [1], each		
Average Annual Flow	hours	2.15
Max Month Flow	hours	1.80
Motor Horsepower, each	hp	1.0

[1] Average Annual Surface Overflow Rate Max Value per Utah Administrative Code R317-3-6.

[2] ALL units in service.

[3] Abbreviation: gpd/sf = gallons per day per square feet.

CWSID bypass flows around the AS Primary Clarifier splitter box to downstream Aeration Basins to provide additional carbon for biological nutrient removal processes. Under the Phase I project, a second Primary Clarifier splitter box was constructed that included two new plant influent lines stubbed for future Primary Clarifiers 3 and 4, and a 30-inch diameter bypass line and meter vault that combines plant influent with primary effluent. A motorized slide gate is used to regulate the plant influent flowrate that is bypassed. On average, 1.9 mgd of primary influent is bypassed throughout the year for biological phosphorus removal.

The AS Primary Sludge Pump Station pumps scum and primary sludge from AS Primary Clarifiers through a 10-inch diameter PS pipeline to Sludge Blending Tanks. Both primary sludge and scum pass through in-line grinders located upstream of mechanical diaphragm pumps. Clear water from the Scum Pit is also pumped to the Primary Clarifier splitter box using a dedicated screw centrifugal pump. The AS Primary Sludge Pump Station is summarized in Table 11-5. See Figure 11-12 for a plan view of the AS Primary Sludge/Scum Pump Station.

Table 11-5
CWSID AS Primary Sludge/Scum Pump Station Design Criteria

Parameter	Units	Value
Primary Sludge and Scum Pumps		
Pump Type		Mechanical Diaphragm
Existing Pump Quantity		3 (2 Duty + 1 Standby)
Design Flow, each	gpm	175
Design TDH, each	feet	25 (1)
Motor Horsepower, each	hp	15
Firm Pumping Capacity (1)	gpm	350
Primary Sludge Grinders		
Type		In-Line
Quantity		3 (2 Duty + 1 Standby)
Capacity	gpm	800
Motor Size, each	hp	3
Primary Scum Subnatant Pumps		
Pump Type		Screw Centrifugal
Existing Pump Quantity		1 (1 Duty + 0 Standby)
Design Flow, each	gpm	370
Design TDH, each	feet	25 (1)
Motor Horsepower, each	hp	3

[1] Estimated value from *Wastewater Treatment Plant Expansion* record drawings dated 2012.

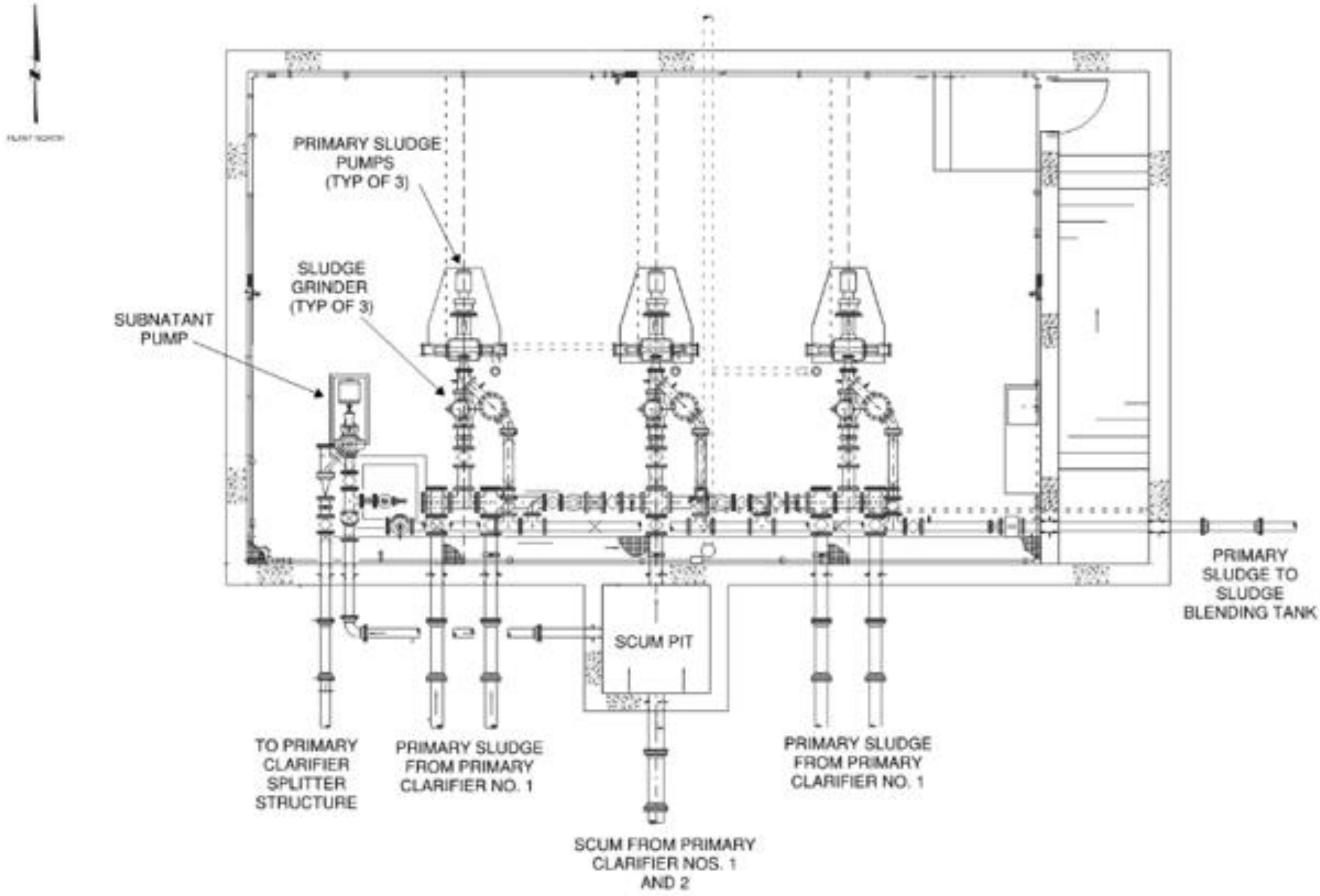


Figure 11-12: AS Treatment Process Primary Sludge Pump Station

Aeration Basins Nos. 1 to 6.

AS Aeration basins are anticipated to be grouped in sets of four with corresponding sets of two primary clarifiers and sets of four secondary clarifiers. The four existing aeration basins, four secondary clarifiers, and two primary clarifiers were constructed in 2012. Two additional aeration basins and two new secondary clarifiers are currently under construction. These facilities are hydraulic, below grade, cast-in-place concrete structures that are open to the atmosphere. Equipment, such as aeration systems, clarifier mechanisms, mixers, and recirculation pumps, are placed inside the structure and operate under submerged conditions. The AS Blower Building provides air for the diffused aeration systems located in the aeration basins. One blower building housing five aeration blowers should provide enough air to support up to eight aeration basins.

Aeration Basins 1 to 4 were constructed as part of the 2012 expansion project, and Aeration Basins 5 to 6 are currently under construction as part of the Phase 2 expansion project. The activated sludge secondary treatment facilities were designed to meet future Utah Pollutant Discharge Elimination System (UPDES) nutrient limits: An annual average total phosphorus (TP) concentration of 1.0 milligram per liter (mg/L) per Technology Based Phosphorus Effluent Limits (TBPEL). Phase 2 will increase the CWSID WRF secondary treatment capacity by adding two new aeration basins (5 and 6) and two new secondary clarifiers (5 and 6). The Aeration Basin Aeration Influent Structures (typical for Aeration Basins 1 to 4 and 5 to 8) receive both PI and RAS and splits this combined flow stream among the in-service aeration basins.

As shown in Figure 11-13, each of the aeration basins is designed to operate in a sequential anaerobic, anoxic, oxic configuration (i.e., A2O) biological wastewater treatment configuration. The anaerobic zones (Zone 1) are provided to stress aerobic phosphate accumulating organisms (PAOs) so they release phosphorus for subsequent excess biological uptake of phosphorus in downstream aerated zones (i.e., via luxury uptake). To mix basin contents, each anaerobic zone is equipped with floating mixers that are attached to mooring cables. The anoxic zones (Zone 2) are designed to utilize portions of the organic carbon in the wastewater along with recycled mixed liquor from the aerated zone to biologically remove nitrates by denitrifying microorganisms that convert nitrates (NO3) to nitrogen gas (N2). The oxic zones each have fine bubble diffused aeration systems that convert air from aeration blowers into fine bubbles that efficiently supply oxygen to nitrifying microorganisms, converting ammonia (NH3) to nitrates. Each of the Aeration Basins contains a total of approximately 13,000 fine bubble diffusers located in Oxic Zones 3, 4 and 5. Mixed liquor (ML) recycle pumps are used to return mixed liquor (approximately 267 percent of the average annual daily flow [AADF] or 72 mgd) from the oxic zones to the anoxic zones. There is a total of eight ML recycle pumps (two per basin) and each is sized to lift 6,250 gpm flowrate 3-foot TDH. The design of AS Aeration Basins Nos. 1 to 6 is summarized in Table 11-6.

The Aeration Basins can be converted from an A2O biological treatment process to a Modified Ludzack-Ettinger (MLE) process by converting the Anaerobic Basin (Zone 1) to an Anoxic Basin. This conversion would eliminate the CWSID's ability to remove phosphorus biologically and would require chemical addition exclusively (ahead of either primary or secondary clarifiers) to meet a total phosphorus discharge limit. A new Chemical Building to store ferric chloride chemical and house chemical dosing equipment was constructed under the Phase I expansion project.

Table 11-6
AS Aeration Basin Nos. 1 to 6 Design Summary

Parameter	Units	Value
Flow		
AADF	mgd	49[1]
MMF	mgd	58.8[1]
PHF	mgd	75.0[2]
Biochemical Oxygen Demand (BOD)		
AADF	pounds per day (lbs/day)	63,162
Average Day Maximum Month (ADMM)	lbs/day	73,559
Total Suspended Solids (TSS)		
AADF	lbs/day	65,124
ADMM	lbs/day	78,953
Total Kjeldahl Nitrogen (TKN)		
AADF	lbs/day	9,808
ADMM	lbs/day	14,810
Total Phosphorus (TP)		
AADF	lbs/day	1,373
MMF	lbs/day	2,109
Temperature		
Winter	degrees Celsius	10
Summer	degrees Celsius	18
Mixed Liquor Suspended Solids (MLSS) Range	mg/L	2,800 to 3,450
Total Solids Retention Time (SRT) Range	days	13-16

[1] Year 2040 design values from Sheet G-03 Phase 2 CWSID WRF expansion.

[2] Maximum Peak Wet Weather Design Capacity.

Each aeration basin provides approximately 7.8 mgd AADF and 9.8 mgd ADMM of treatment capacity. Since the AS Treatment Process is currently limited to 75.0 mgd PHF, the maximum hydraulic capacity per basin is approximately 12.5 mgd PHF. However, as noted in the previous facility plan, CWSID WRF staff observed 59.0 mgd flow through the AS Treatment Process during a high wet weather event that occurred in the year 2017, which may better define aeration basin hydraulic maximum capacity at approximately 14.8 mgd per unit. With one aeration basin offline, the maximum firm aeration basin treatment capacity will be 49.0 mgd ADMM after the Phase 2 expansion is completed.

Figures 11-13 and 11-14 show Aeration Basins 1 to 4 and 5 to 6, respectively.

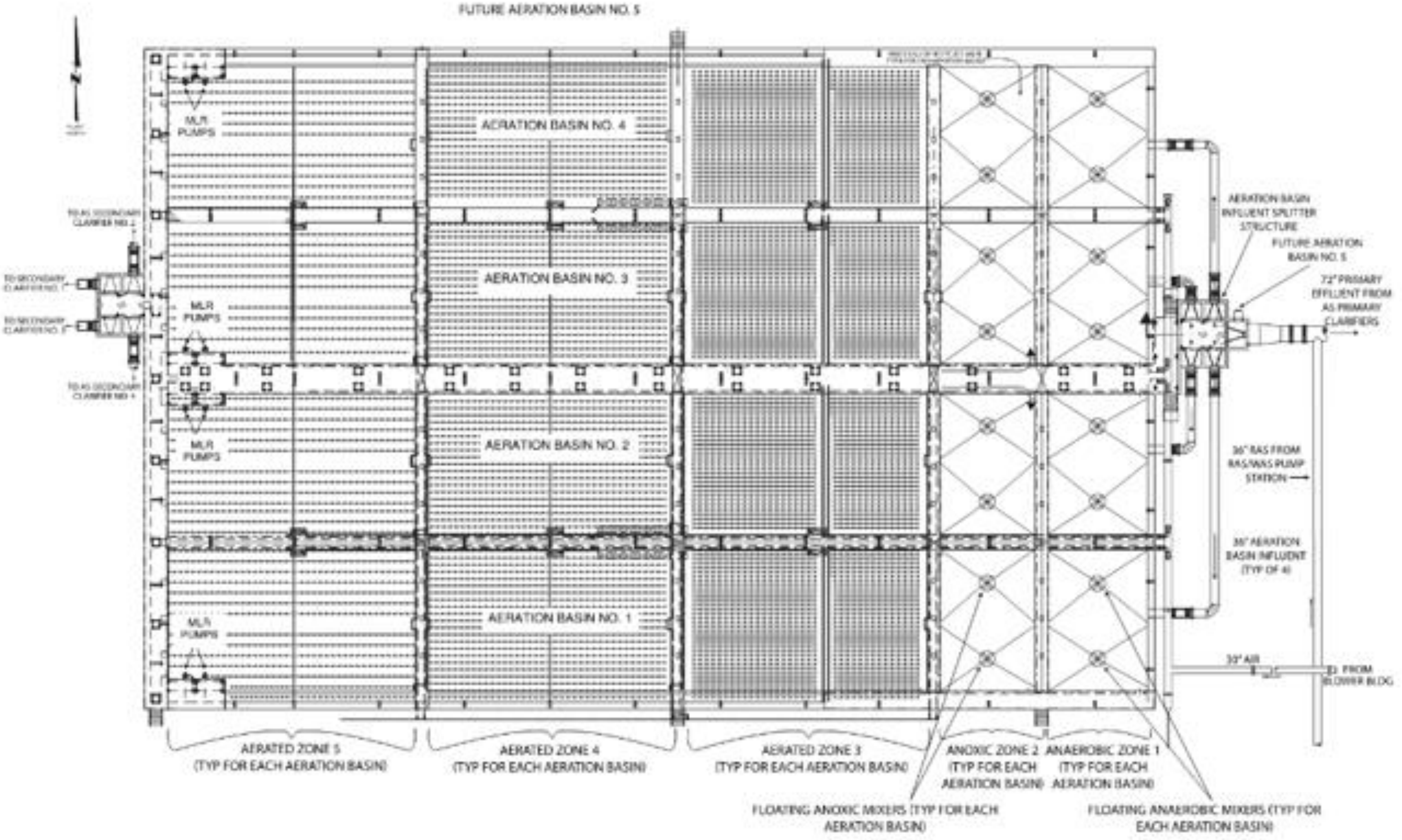


Figure 11-13: AS Treatment Process Primary Sludge Pump Station - AS Aeration Basins Nos. 1 to 4

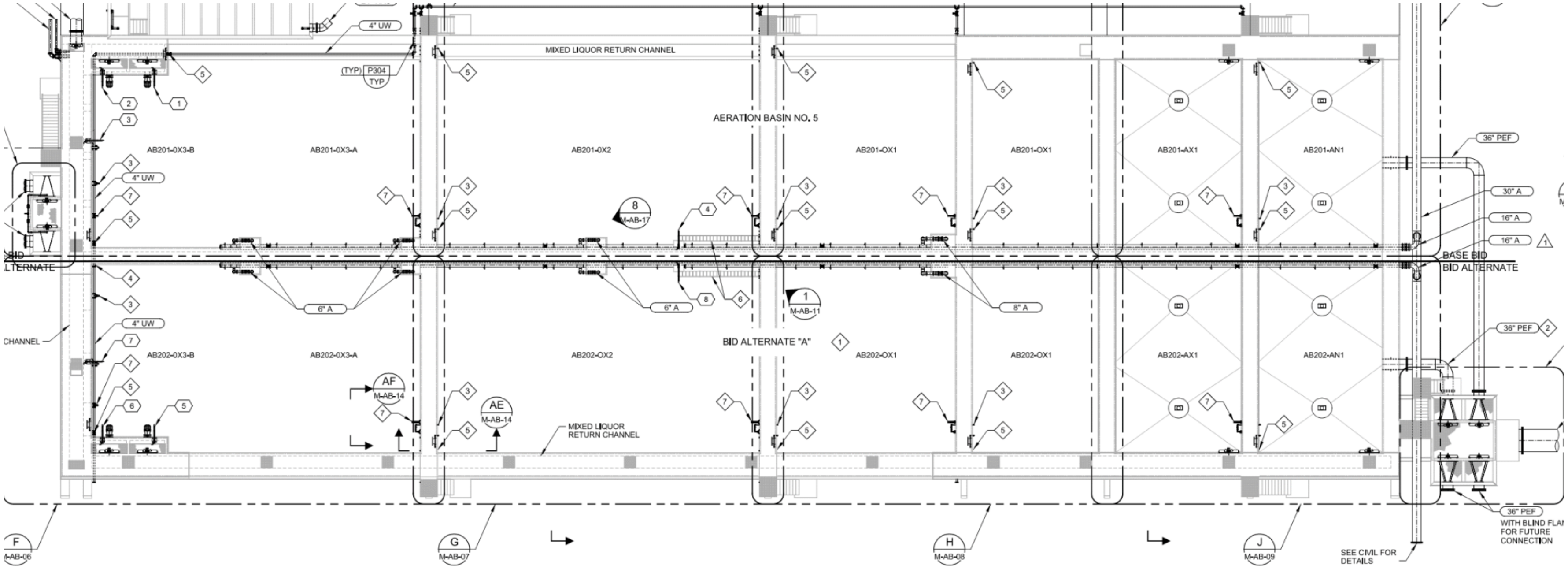


Figure 11-14: AS Treatment Process Primary Sludge Pump Station - AS Aeration Basins Nos. 5 to 6

Table 11-7
CWSID Aeration Basin Nos. 1 through 6

Parameter	Units	Value
Aeration Basin Quantity	no.	6
Process Configuration		A2O
Anaerobic Basin (Zone 1)		
Quantity per Train	no.	1
Volume, each basin	million gallons (MG)	0.37
Total Volume	MG	2.22
Mixer Type		Floating mixer w/ mooring cables
Mixer Quantity	no.	1
Mixer Size, each	hp	5
Anoxic Basin (Zone 2)		
Quantity per Train	no.	1
Volume, each basin	MG	0.36
Total Volume	MG	2.16
Mixer type		Floating w/ mooring cables
Mixer Quantity	mg/L	2
Mixer Size	hp	5
Aeration Basin (Zones 3-5)		
Quantity per Train	no.	3
Volume, each	MG	2.5
Total Volume	MG	10.0
Average Annual Oxygen Demand (Actual Oxygen Requirement [AOR])	lbs/day	34,300
Maximum Day Oxygen Demand (AOR)	lbs/day	44,343
Diffuser Type		Fine bubble, membrane
Diffuser Quantity, each basin	no.	3,336
Diffuser Quantity, Total	no.	13,344
Average Air Flow per Diffuser	standard cubic feet per minute (scfm) per diffuser	1.0
Mixed Liquor Recycle Pumps		
Pump Type		Submersible, propeller
Pump Quantity, per Basin	no.	2 (2 Duty + 0 Standby)
Design Flow, each		6,250
Design TDH, each		3
Motor Size	hp	12.2

AS Secondary Clarifiers and RAS/WAS Pump Station.

Four new AS Secondary Clarifiers were constructed in 2012 along with the four aeration basins and two primary clarifiers. Under the current Phase 2 expansion project another two secondary clarifiers will be constructed. Each secondary clarifier is similar, having a 145-foot diameter, 15.9-foot side water depth and 16,513 cubic feet surface area. Each AS Secondary Clarifier offers approximately 9.4 mgd AADF and 11.8 mgd ADMM firm flow capacity, assuming one unit is out of service. The firm total capacity of the secondary clarification process is approximately 47.0 mgd AADF and 58.8 mgd ADMM. Peak hydraulic capacity, assuming all six secondary clarifiers are online, is approximately 12.5 mgd. However, based on the wet weather flow event observed in the year 2017 by CWSID WRF staff, the unit secondary clarifier hydraulic capacity may be 14.8 mgd.

Flow is directed to each secondary clarifier from the mixed liquor flow splitter box located at the end of each set of aeration basins. Secondary effluent overflows the clarifier weir into the inboard launder and flows by gravity in secondary effluent yard piping to the Chlorine Contact Basins. Settled solids are removed as the clarifier mechanism sweeps settled solids to a sludge hopper located near the center of the structure. RAS pumps located in a nearby RAS/was pump station pull solids from each clarifier sludge hopper using RAS piping encased below the clarifier floor.

RAS pumps are used to empty secondary clarifiers when taken off-line for maintenance. Groundwater dewatering wells are used to lower the surrounding water table to prevent potential damage to the clarifier structure from buoyant groundwater uplift forces.

To prevent algae growth in launders and to keep birds off clarifier water surface, launder covers, and bird wire will be added to all secondary clarifiers under the Phase 2 expansion project.

The existing AS Secondary Clarifier Nos. 1 through 4 are summarized in Table 11-8.

Table 11-8
CWSID AS Secondary Clarifier Nos. 1 to 4 Design Summary

Parameter	Units	Value (1)
Number	no.	4
Diameter	feet	145
Surface Area, each	square feet (sf)	16,513
Side Water Depth	feet	15.9
Max Month Sludge Volume Index (SVI)	milliliters per gram (mL/g)	200
Recommended Surface Overflow Rate (2)		
Average Annual Flow	gpd/sf	900
Max Month Flow	gpd/sf	1,000
Weir Loading Rate		
Max Month Flow	gallons per day per linear feet (gpd/LF)	13,023
Existing Capacity (3)		
Average Annual Flow	mgd	44.6
Max Month Flow	mgd	49.5 (4)
Motor Horsepower	hp	1.0

[1] Values listed are for each clarifier.

[2] Average Annual Surface Overflow Max Value per Utah Administrative Code R317-3-6.

[3] With one unit out of service.

[4] Based on max month surface overflow rate of 1,000 gpd/sf.

The new AS Secondary Clarifiers Nos. 5 to 6 are being added with two additional aeration basins under the Phase II expansion project. Table 11-9 summarizes the basis of design for AS Secondary Clarifier Nos. 5 and 6.

Table 11-9
CWSID AS Secondary Clarifier Nos. 5 to 6 Design Summary

Parameter	Units	Value (1)
Number	no.	2
Diameter	feet	145
Surface Area, each	sf	16,513
Side Water Depth	feet	15.9
Max Month SVI	mL/g	150
Recommended Surface Overflow Rate (2)		
AADF	gpd/sf	475
ADMM	gpd/sf	593
Solids Loading Rate (2)		
AADF	pounds per square foot per day (lbs/sf/day)	18.6
ADMM	lbs/sf/day	23.2
Motor Horsepower	hp	1.0

[1] Values listed are for each clarifier.

[2] RAS flowrate at 50% plant influent.

[3] Target AADF Range: 400 - 700 gpd/sf per MOP8.

[4] Recommended surface overflow rate (SOR) Range 20-30 lbs/sf/day per MOP8.

RAS pumps are used to recycle mixed liquor collected from the AS Secondary Clarifiers to the Aeration Basin Influent Splitter Structure as part of the activated sludge secondary treatment process. CWSID typically recycles RAS at 50 percent of total plant influent flowrate, approximately. There are two duty and one standby RAS pumps for the north AS Secondary Clarifier Nos. 1 and 2 as well as two duty and one standby RAS pump for the south AS Secondary Clarifier Nos. 3 and 4. In a different RAS/WAS Pump Station there are two duty and one standby RAS pump for AS Secondary Clarifier Nos. 5 and 6.

WAS and scum is pumped directly from the RAS/WAS Pump Station located near the AS Secondary Clarifiers directly to gravity belt thickeners (GBTs) located in the Solids Thickening Building. One set of WAS and scum pumps are dedicated to AS Secondary Clarifier Nos. 1 to 4 while a second set of WAS and scum pumps are dedicated to Secondary Clarifiers 5 to 6. Figure 11-15 shows the RAS/WAS Pump Station serving Secondary Clarifiers Nos. 1 to 4 while Figure 11-16 shows the new RAS/WAS Pump Station serving new Secondary Clarifiers 5 to 6.

WAS and scum from each set of pumps is directed into a common 12-inch diameter pipeline that in turn is connected directly to GBTs. Pumps are managed so WAS pumps are stopped when scum pumps start.

Figure 11-15: Secondary Clarifier Mechanism

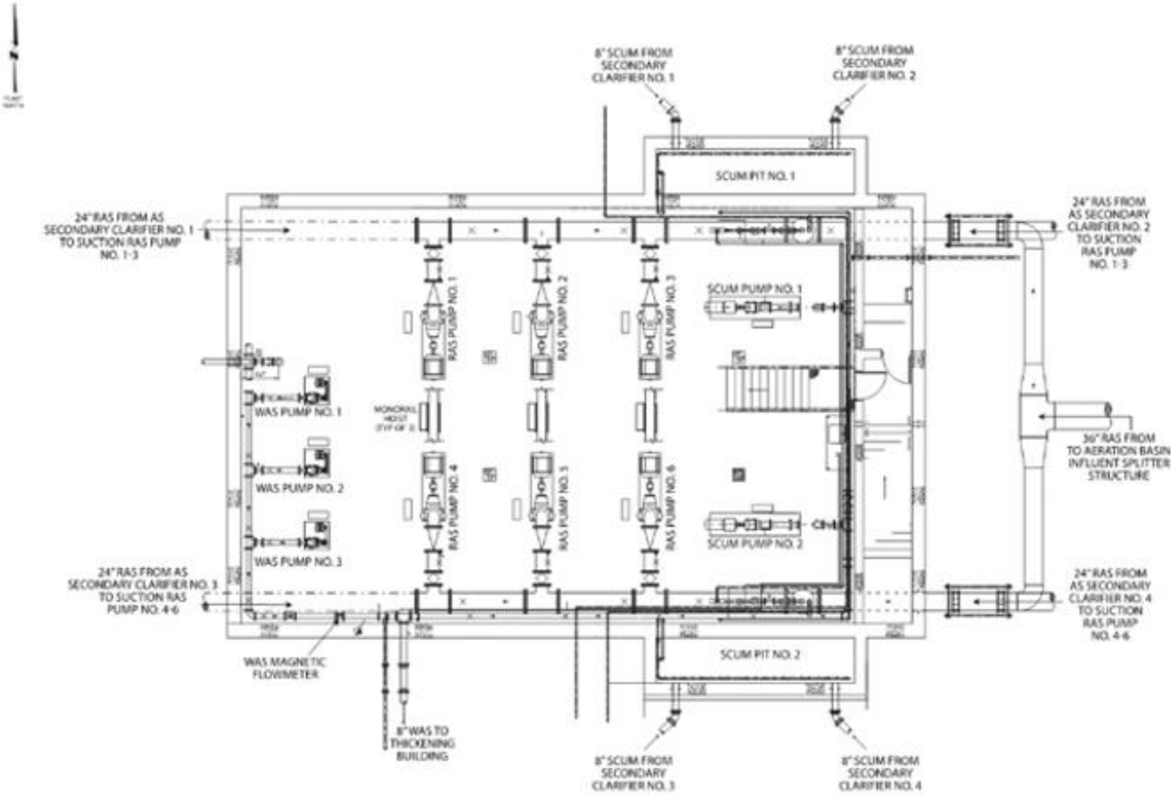


Figure 11-16: RAS/WAS Pump Station for Clarifiers 1 to 4

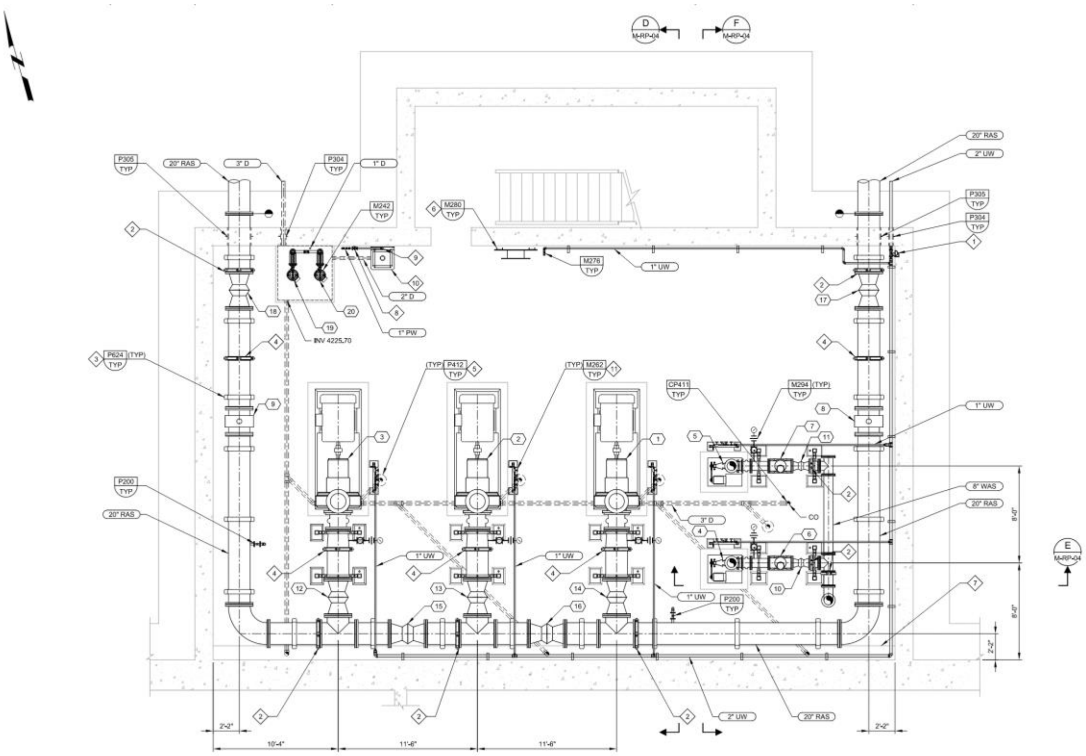


Figure 11-17: RAS/WAS Pump Station for Clarifiers 5 to 6

AS Blower Building.

The Blower Building was constructed in 2012 with the aeration basins and houses single-stage aeration blowers that provide process air for the fine bubble diffused aeration systems installed in aerobic or oxic zones in each of the Aeration Basin Nos. 1 to 4 and 5 to 6. Currently three blowers are installed on three of the five blower equipment pads. A fourth blower will be installed under the Phase 2 expansion project, leaving one remaining equipment pad available for a future fifth blower.

Figure 11-18: Blower Building

This building also houses two 2.0 megawatt (MW), standby, diesel-fired generators. The first generator was installed under the 2012 plant expansion project and the second generator was installed later in 2021 under the Phase 1 plant expansion effort.

Table 11-10
Existing AS Blower Building Summary

Parameter	Units	Value
Blower Type		Single-Stage, centrifugal
Existing Number	no.	4
Future Number	no.	1
Design Air Flowrate, each	scfm	11,500
Firm Blower Capacity (1)	scfm	34,500
Design Pressure	pounds per square inch gauge (psig)	10.3
Motor Size	hp	700

1 One blower out of service.

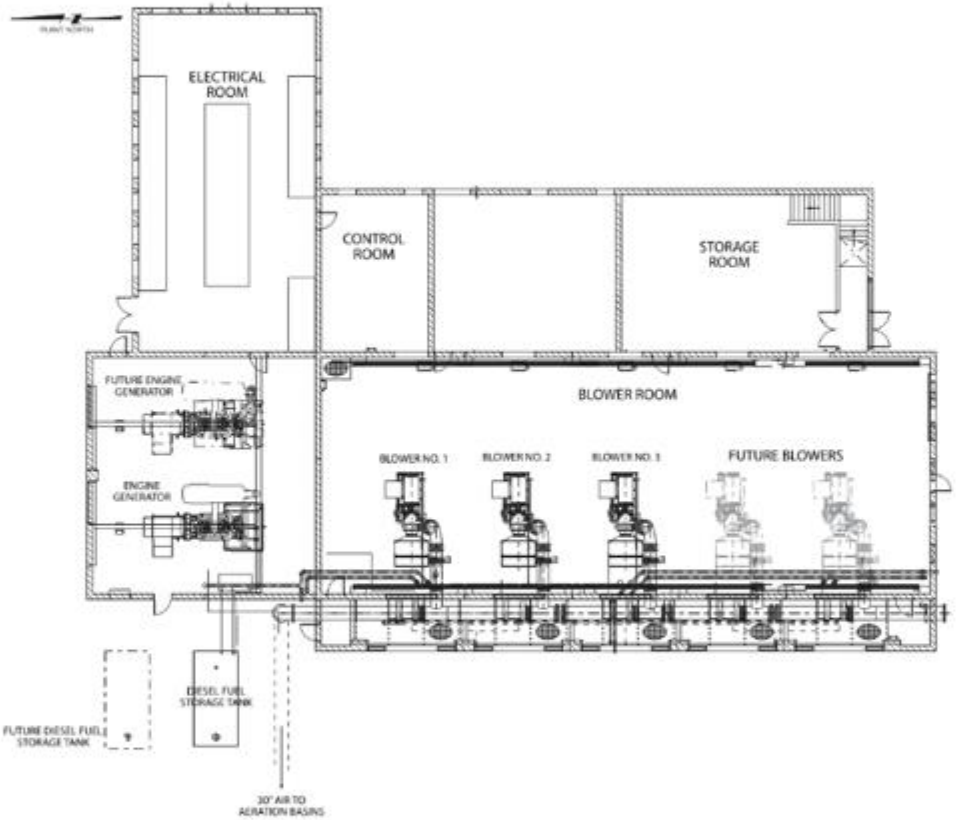


Figure 11-19: Existing AS Blower Building

AS Ferric Building.

The Ferric Building was constructed under the Phase I expansion project in 2021 housing bulk ferric chloride solution used to precipitate phosphates out of solution at various points within the following activated sludge wastewater treatment process:

- AS Primary Clarifier Splitter Structure.
- AS Aeration Basin Mixed Liquor Splitter Structures.
- Dewatering Building (Pressate).
- Existing Control Building and TF Influent Pump Station.

Ferric Chloride is dosed as needed to help CWSID meet the TBPEL of 1.0 mg/L. It is anticipated that the CWSID WRF's A2O activated sludge process employed at the Aeration Basins will meet the TBPEL limit biologically without any ferric chloride chemical addition, and with some primary influent bypass flows. If, however, the Aeration Basins are converted to an MLE biological treatment process, ferric chloride chemical addition would be necessary.

Table 11-11
AS Ferric Building Summary

Parameter	Units	Value
Ferric Chloride	%	34-45
Tanks	no.	2 (1 Future)
	gallons	12,500
Chemical Feed Pumps		
AS Primary and Secondary Clarifiers (1)	no.	2
	gallons per hour (gph)	520
TF Influent Pump Station (1)	no.	1
	gph	110
Dewatering Facility (Pressate)	no.	1
	gph	50

[1] Target Dose for Final Effluent TP < 1.0 mg/L TBPEL.

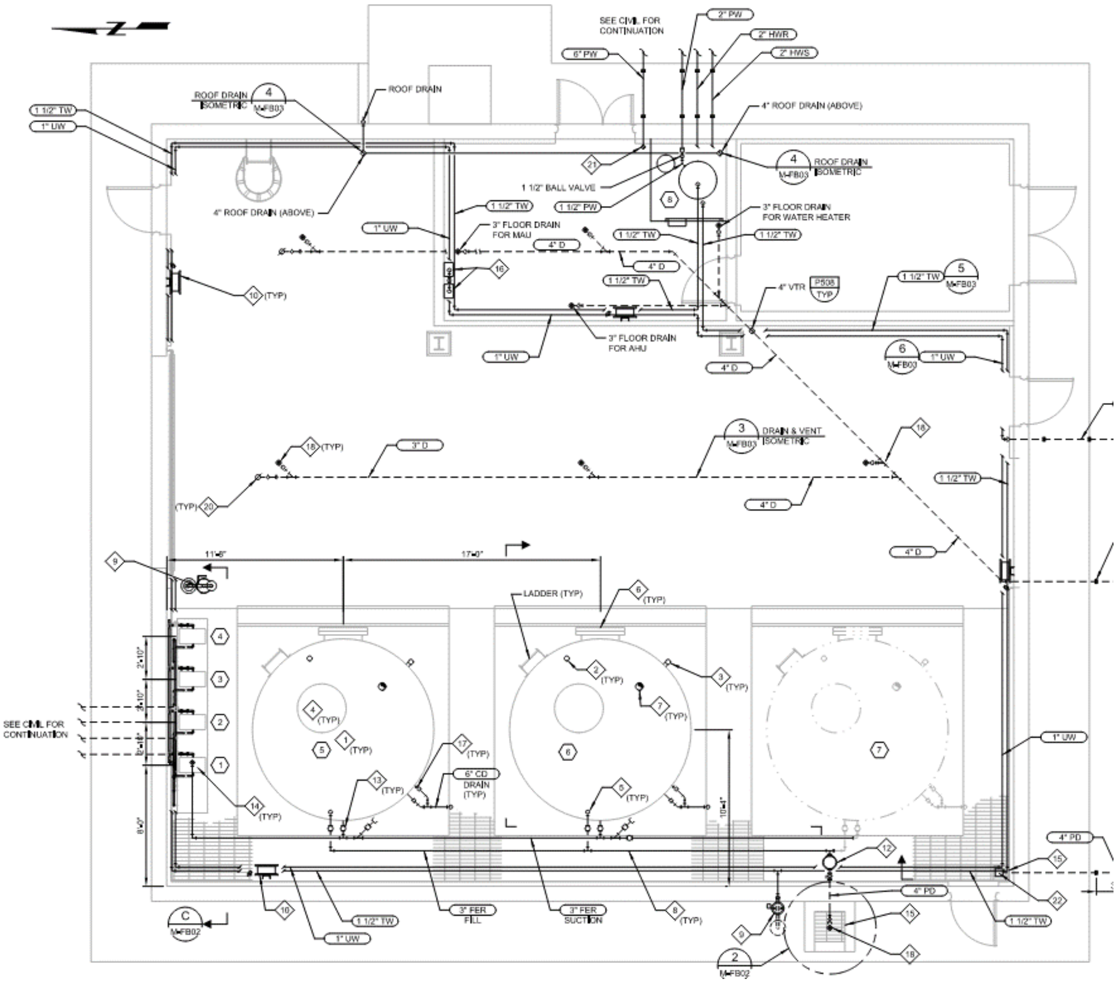


Figure 11-20: AS Ferric Building

Chlorine Contact Basins and Chemical Building.

The CWSID WRF currently employs a chlorine disinfection process using three cast-in-place concrete contact basins constructed under the 2012 expansion project and a gaseous chlorine system housed inside a Chemical Building constructed as part of the Final Clarifier and Chemical Building project completed in 1999. The gaseous chlorine system consists of two large bulk storage tanks, two chlorinators and a wet scrubber. The State of Utah R317 wastewater treatment requires that the chlorine feed system be sized for a 25 mg/L dose at the maximum design rate of flow, a minimum of two contact tanks and the following contact periods for chlorination disinfection systems:

Figure 11-21: Chlorine Contact Basin

- PDF - 30 minutes.
- AADF - 60 minutes.

The contact period may be extended beyond the Chlorine Contact Basins to upstream secondary effluent (SE) pipelines (if chlorine is dosed at secondary clarifier launders) and to downstream final effluent (FE) pipeline(s) before the outfall.

These facilities will be abandoned and replaced with an UV Disinfection Facility constructed under the Phase 2 expansion project.

Table 11-12
Chlorine Contact Basins and Chemical Building Summary

Parameter	Units	Value
Chlorine Feed/Injection System		
Dose		
Average	mg/L	10
Maximum (Future)	mg/L	25
Chlorine Demand		
Average	lbs/day	2,300
Maximum	lbs/day	12,300
Chlorinators		
Number	no.	2
Type		Solution Feed
Capacity, each	lbs/day	4,000
Future Capacity, each	lbs/day	10,000
Evaporators		
Number	no.	2
Capacity, each	lbs/day	10,000
Gas Storage Tanks		
Size, each	tons	37.5
Chlorine Scrubber		
Number	no.	1
Type		Wet Caustic
Capacity	cubic feet per minute	3,000
Recirculation Pump Size	hp	2 @ 25
Chlorine Contact Basins		
Number of Basins	no.	3
Passes per Basin	no.	3
Pass Length	feet	158
Pass Width	feet	11.75

Table 11-12 Chlorine Contact Basins and Chemical Building Summary (continued)

Pass Side Water Depth	feet	12.46
Basin Volume at PHF (Total)		
Peak Flow Detention Time	minutes	47.9
Annual Average Detention Time	minutes	67
Dechlorination System		
Chlorine Residual		
Typical	mg/L	2
Maximum	mg/L	5
Sodium Bisulfite	%	38
Number of Tanks	no.	2
Tank Size	gallons	4,500

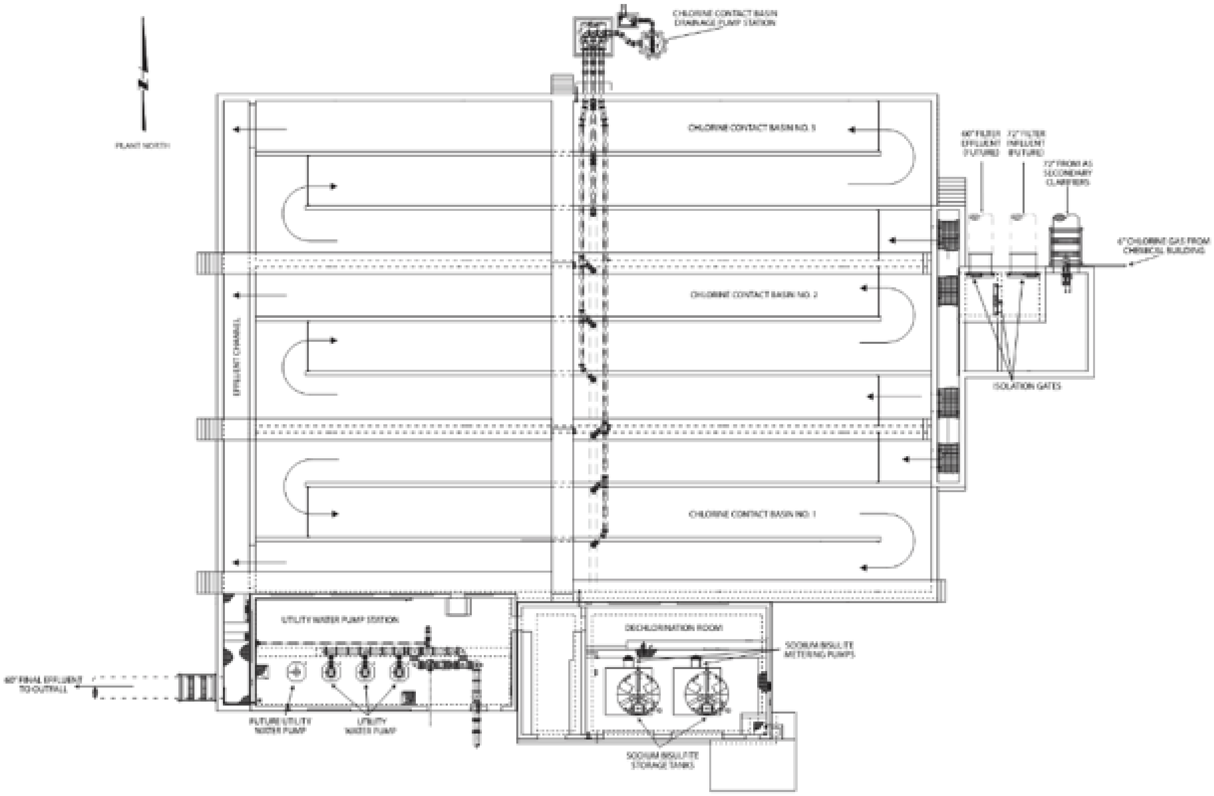


Figure 11-22: Chlorine Contact Basins

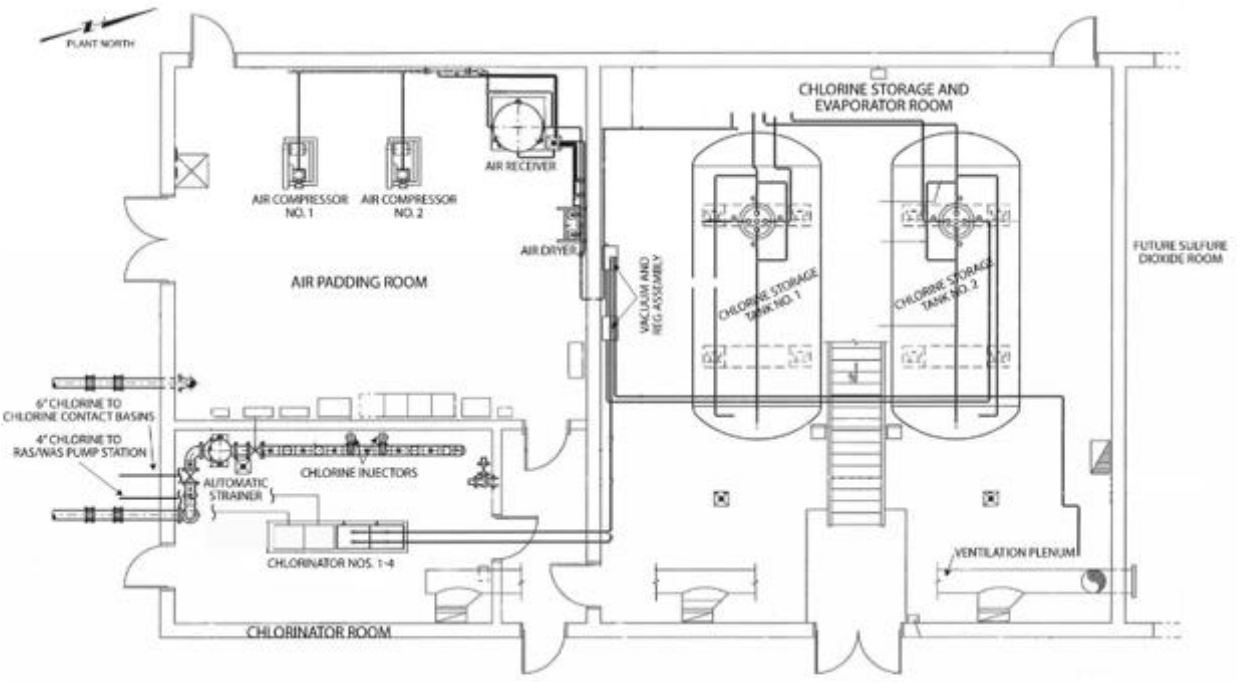


Figure 11-23: Chemical Building

Existing AS Utility Water Pump Station.

The AS Utility Water Pump Station was constructed under the 2012 plant expansion project with the AS Chlorine Contact Basins. Under the current Phase 2 expansion project, the chemical being stored at this facility will be converted from sodium bisulfite to sodium hypochlorite since the chlorine contact basins will be replaced with a new UV Disinfection Facility. To meet IBC requirements, a fire sprinkler system is required to be installed in the chemical storage area. There are three utility water pumps and space to add a fourth in the future. The utility water pumps are vertical turbine type pumps with pump suction columns extending down into the wet well below.

Figure 11-24: AS Utility Water Pump Station

Three utility water pumps are currently installed, each capable of pumping 1,250 gpm flowrate as noted in Table 11-13. There is space to install a fourth utility water pump in the future.

Table 11-13
Utility Water Pump Schedule

Parameter	Units	Value
No.		3 (2 duty, 1 spare, 1 future)
Type		Vertical Turbine
Flowrate	gpm	1,250
Total Dynamic Head	feet	250
Motor Size	hp	125
Driver Type		VFD

Table 11-14
Sodium Hypochlorite Storage Tank Schedule

Parameter	Units	Value
Number	no.	2
Type		High-Density Polyethylene (HDPE)
Capacity	gallons	4,500
Chemical Stored		Sodium Hypochlorite (1)

[1] 12.5% solution strength.

Table 11-15
Sodium Hypochlorite Chemical Feed Pump Schedule

Parameter	Units	Value
Number	no.	2
Type		HDPE
Capacity	gallons	4,500
Chemical Stored		Sodium Hypochlorite (1)

[1] 12.5% solution strength.

New AS UV Disinfection Facility.

The CWSID WRF discharge permit to the Weber River requires residual chlorine to be less than 0.017 mg/L, but the Utah DEQ requires CWSID WRF to meet method of detection level for chlorine at 0.06 mg/L. The District is compliant with the discharge permit requirement as long as its chlorine residual in final effluent is non-detect. Consequently, to reduce the risk of exceeding this low residual chlorine limit, CWSID WRF decided to construct a new UV Disinfection Facility inside existing Chlorine Contact Basins.

The existing three passes inside the Chlorine Contact Basin 101 will be modified and converted into three smaller UV channels. Water level in the UV channels will be maintained using long “finger” type weirs located downstream of the UV banks. The other two basins, Basin Nos. 102 and 103, will remain and will be available if needed. This new facility replaces the existing chlorine disinfection and dechlorination systems. The sodium bisulfite chemical storage tanks and chemical feed system will be repurposed as a liquid chlorine (i.e., sodium hypochlorite) chemical storage/feed system and used to chlorinate CWSID WRF plant utility water. Table 11-16 is a summary of the new UV Disinfection Facility and Figure 11-25 shows a plan view of the new facility.

Table 11-16
New UV Disinfection Facility Summary

Parameter	Units	Value
Flow		
Maximum Month Daily Average	mgd	58.8 (N+1)
PHF	mgd	75 (N+0)
Type		Low Pressure, High Output
Number of Channels	no.	3
Number of Banks/Channel	no.	3
Number of Modules/Bank	no.	1
Number of Lamps per Module	no.	24
Number of Lamps	no.	216
Design Dose (T2 RED)	millijoules per square centimeter (mJ/cm^2)	20
E-Coli		
Max Month	colony forming unit per milliliter (CFU/mL)	126
Max Weekly	colony forming unit per 100 mL	157
UV Transmittance	%	70

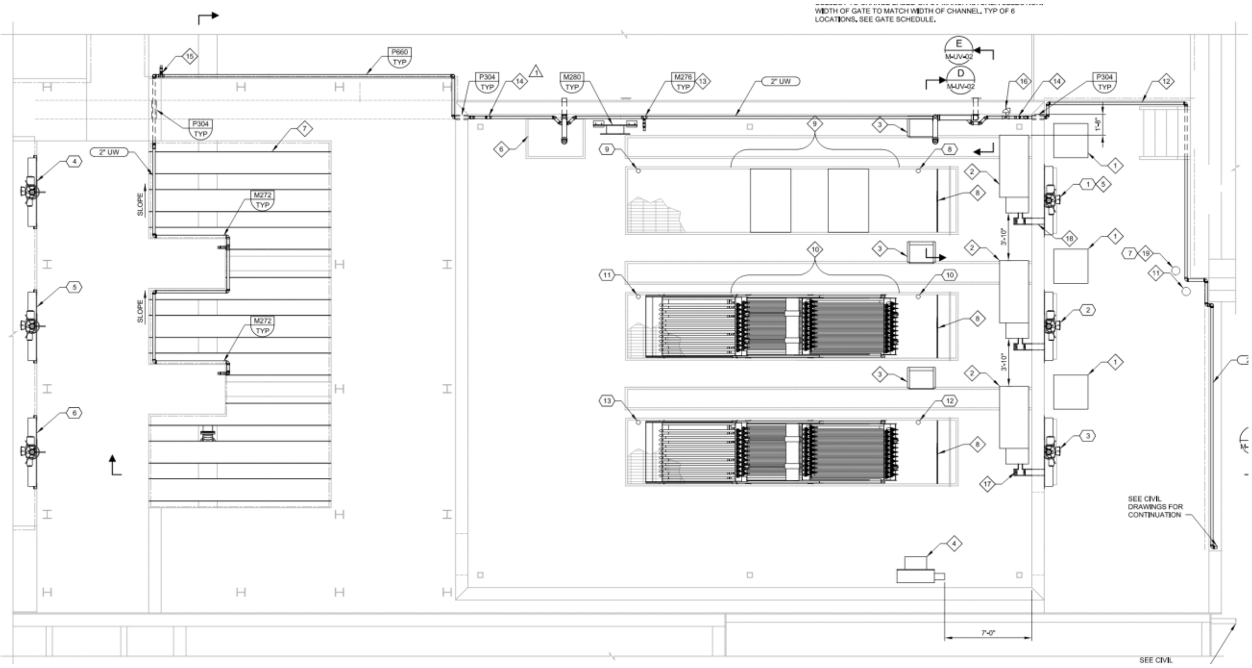


Figure: 11-25 New UV Disinfection Facility

Trickling Filter Treatment Process

Under the previous facility planning effort the District decided to implement a Wet Weather Flow Blending Strategy in meeting water quality limits under its issued National Pollution Discharge Elimination System (NPDES) permit. Under this approach most of the plant influent is directed to the AS Treatment Process as possible and the remaining flow is diverted to the TF Treatment Process where primary and final clarifiers provide some treatment and secondary effluent is disinfected with chlorine addition. Figure 11-26 includes a schematic of the wet weather flow blending strategy to be employed by the CWSID. Although total plant influent is not measured, final effluent flow meters have recorded wet weather flows above 100 mgd. The 2012 expansion project estimated the PHF to be approximately 117 mgd and the wet weather projection from Chapter 2 assumes 110 mgd for PHF by Year 2050. The Phase 2 expansion project will expand AS Treatment Process to 75.0 mgd hydraulic capacity and thus diverting approximately 35 mgd to the TF Treatment Process. Table 11-17 summarizes the CWSID WRF wet weather flow blending strategy and anticipated values.

Table 11-17
CWSID WRF Wet Weather Flow Blending Strategy

Parameter	Units	Activated Sludge (AS) Treatment Process	Trickling Filter (TF) Primary Clarifiers	Blended (AS + TF)
Flow	mgd	75	35	110
Flow Percentage	%	68	26	100
BOD	mg/L	7 (1)	50 (1)	20
TSS	mg/L	7 (1)	50 (1)	20
Ammonia	mg/L	1.05 (1)	6.0 (1)	2.63
Total Phosphorus	mg/L	1.07 (1)	< 1 (2)	< 1 (2)

[1] Assumed values based on plant data recorded during wet weather event.

[2] Chemical phosphorus removal assumed.

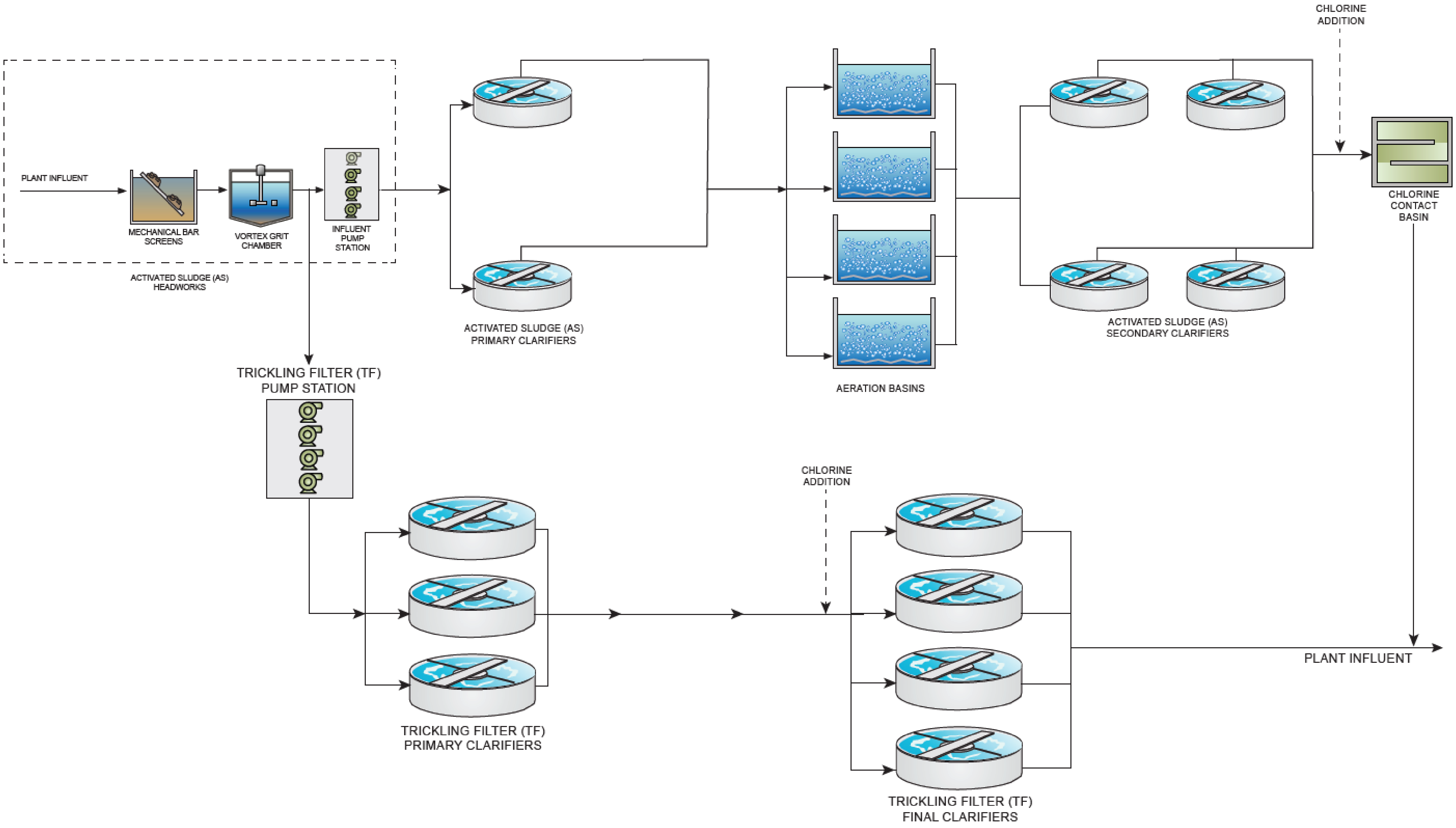


Figure 11-26: CWSID Wet Weather Blending Liquid Process Schematic

TF Headworks.

The existing TF Headworks historically provided coarse screening and grit removal for all plant influent directed to the TF Treatment Process. It currently only screens and degrits humus return from the TF Final Clarifiers as all plant influent is now directed to the newer AS Headworks. The TF Headworks has a Parshall flume immediately up front and outside and the downstream and indoor screening facility consists of four influent channels where three have one climber type screen installed in each while the fourth channel has a manually racked bar screen. Screens are front raked and have bar spacing at approximately 1/2 inch. All three screens discharge to a common belt conveyor, which discharges to an enclosed screw conveyor which in turn discharges to an inclined belt conveyor that lifts screenings up to a load-out bay where screenings are off-loaded into open dump trucks. Under the 2012 plant expansion project humus was rerouted to the TF Headworks, ahead of the Parshall flume, where snails from the tricking filters could be removed using the coarse screens and the aerated grit chambers.

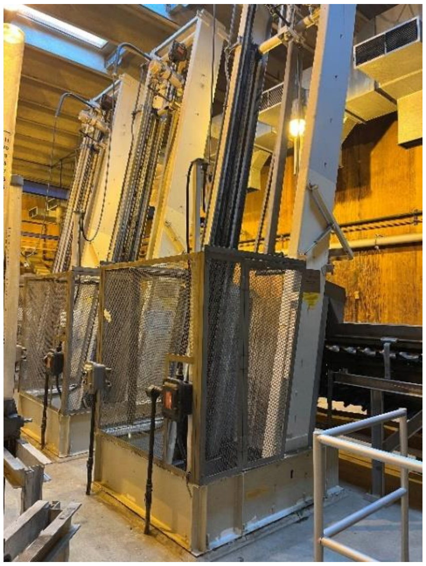


Figure 11-27: TF Headworks Screen

Following the coarse screens, the humus return gravity flows to two downstream aerated grit chambers where it is degritted before combining with bypassed plant influent from the AS Headworks. The combined flow again gravity flows to the wet well upstream of the TF Influent PS located in the basement of the Control Building. Each aerated grit basin is provided with air pump/lift piping and a dedicated inclined screw conveyor to remove settled grit. The two inclined grit conveyors transfer grit to a third inclined grit conveyor that conveys grit to the load-out facility and off-loaded to dump trucks. Dump trucks do not sit on a weight scale inside the drive through load-out facility.

Figure 11-28: TF Headworks Aerated Grit Basin

Table 11-18
Existing TF Headworks Summary

Parameter	Units	Value
Coarse Screening		
Type		Mechanical Bar
Number	no.	3
Screen Capacity	mgd	
Screen Opening Size	inches	0.5
Channel Width	feet	4.0
Motor Size	hp	2
Grit Basins		
Type		Aerated
Number	no.	2
Capacity	mgd	
Motor Size	hp	

[1] One manually raked bar screen (0.5 in openings) is installed in a fourth influent channel. Each influent screen is isolated using a slide gate.

TF Control Building and Influent Pump Station.

The Control Building was constructed in 1957 as part of the original water reclamation facility. It included offices, a laboratory, locker rooms and housed various unit solids handling processes and the TF Influent Pump Station. Most of the space inside this building has been repurposed or is no longer used (e.g., locker room, lab and offices, and primary sludge holding tanks and solids filtering). The TF Influent Pump Station is still used to pump overflow from the AS Treatment Process and humus return to the TF Treatment Process. It consists of a below grade cast-in-place concrete wet well and an interior dry pit located in the basement where the influent pumps are located. Six dry-pit submersible type pumps have individual suction lines connected to the wet well and discharges lines connected to a common 54-inch diameter forcemain that discharges plant influent to the TF Primary Clarifier Splitter Structure. Figure 11-29 is of the pump station dry pit where five influent pumps are currently installed.

Figure 11-29: TF Influent Pump Station

CWSID will continue to maintain four of the six plant influent pumps to convey up to 55 mgd maximum peak hour flow for wet weather flows.

Table 11-19
Existing TF Influent Pump Station Summary

Parameter	Units	Value
Pump Type		Vertical, Dry-Pit Submersible
Existing Pump Quantity	no.	6 spaces (3 Duty, 1 standby) 1 removed and 1 out of service
Firm Pumping Capacity (1)	mgd	66.9
Design Flow, each	mgd	22.3
Design TDH, each	feet	35
Motor Size	hp	200
Max Rated Speed	revolutions per minute (rpm)	705
Drive Type		VFD

[1] One maintained pump out of service.

[2] Four of the existing six pumps are equipped with VFDs.

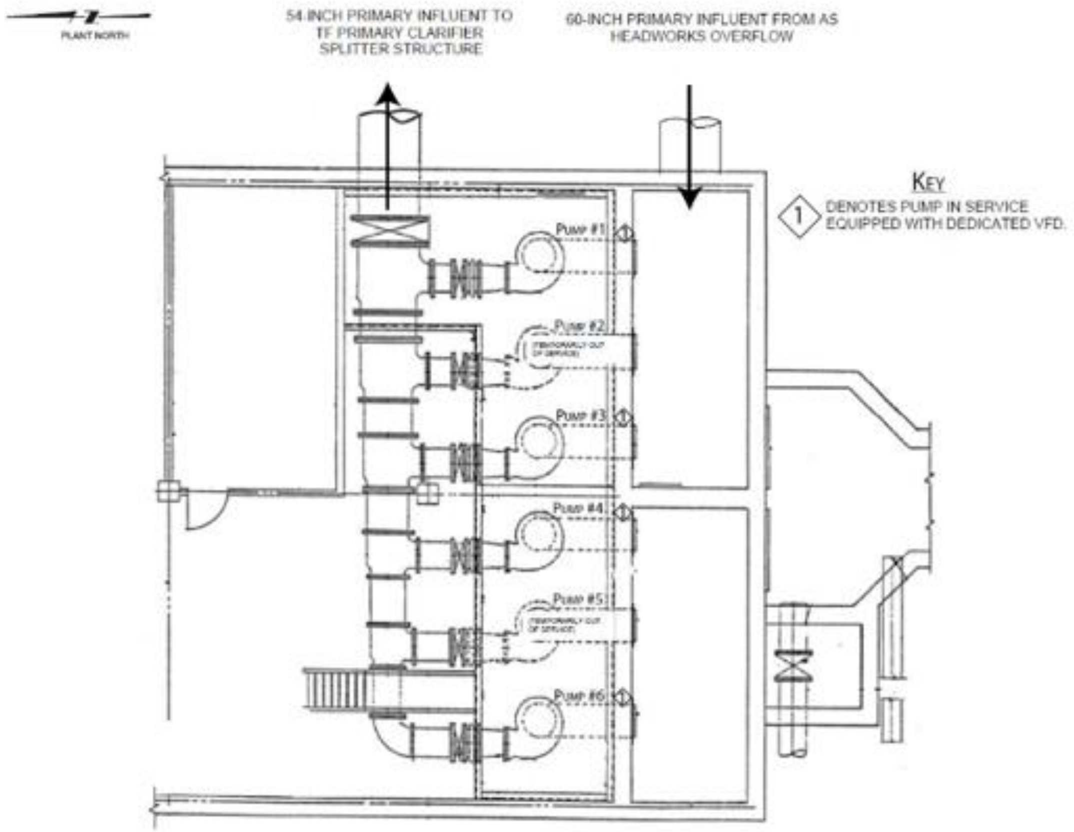


Figure 11-30: Existing TF Influent Pump Station

As with the AS Influent Pump Station, projected flow increases and the wet weather treatment strategy, CWSID will need to maintain the TF Influent Pump Station to provide reliable hydraulic capacity. TF Influent Pump cavitation issues and requirement to measure the total plant influent flowrate identified in the previous facility plan effort will need to be addressed.

TF Primary Clarifiers and Primary Sludge Pump Station.

Figure 11-31: TF Primary Clarifier

The three TF Primary Clarifiers were constructed in the 1950s with the original plant and space is reserved for a fourth primary clarifier. Plant influent and humus return flows are pumped from the TF Influent Pump Station to the TF Primary Clarifier Splitter Structure and directed to each of the three primary clarifiers. To date, CWSID continues to use all three as part of the TF Treatment Process and, depending upon the primary influent flow split between the TF and AS Treatment Processes, will typically employ one TF Primary Clarifier at a time. Primary clarifier effluent flows by gravity to Trickling Filter unit treatment process while settled primary sludge (and co-settled humus) is pumped to the Sludge Blending Tank(s) prior to anaerobic digestion. The TF Primary Clarifier facilities are summarized in Table 11-20.

Table 11-20
CWSID TF Primary Clarifier Facilities

Parameter	Units	Value
Quantity of Primary Clarifiers		3
Diameter, each	feet	140
Surface Area, each	sf	15,394
Side Water Depth, each	feet	6.8
Recommended Surface Overflow Rate		
Average Annual Flow	gpd/sf	800
Max Month Flow	gpd/sf	960
Existing Capacity [1]		
Average Annual Flow	mgd	37.0
Max Month Flow	mgd	44.3
Existing Detention Time [1], each		
Average Annual Flow	hours	1.57
Max Month Flow	hours	1.31
Motor Horsepower, each	hp	1.0

[1] Average Annual Surface Overflow Rate Max Value per Utah Administrative Code R317-3-6.

[2] ALL units in service.

The TF Primary Sludge/Scum Pump Station is a below grade concrete structure located down the hill from the TF Primary Clarifiers and across the street from the TF Control Building. Originally primary sludge flowed by gravity from the primary clarifiers down to below grade sludge holding tanks at the TF Control Building. Sludge pumping and piping located in the TF Control Building basement was used to transfer primary sludge to an above grade sludge holding tank.

The TF Primary Sludge/Scum Pump Station consists of three sludge pumps. It is located at the bottom of the hill, below the primary clarifiers and across the street from the TF Control Building. It is used to transfer primary sludge and scum directly to the Blend Tanks ahead of the digestion process.

Figure 11-32 TF Primary Sludge Pump Station

A Scum System Facility was constructed in 1998 that captures scum from each of the three TF Primary Clarifiers scum beaches.

Table 11-21
CWSID TF Primary Sludge/Scum Pump Station Design Summary

Parameter	Units	Value
Primary Sludge and Scum Pumps		
Pump Type		Mechanical Diaphragm
Existing Pump Quantity	no.	3 (2 Duty + 1 Standby)
Design Flow	gpm	X
Design TDH	feet	X
Motor Size	hp	X
Firm Pumping Capacity	gpm	X
Primary Sludge Grinders		X
Type		In-Line
Quantity	no.	3 (2 Duty + 1 Standby)
Capacity	gpm	X
Motor Size	hp	X
Primary Scum Subnatant Pumps		X
Pump Type		Screw Centrifugal
Quantity	no.	1 (1 Duty + 0 Standby)
Design Flow	gpm	X
Design TDH	feet	X
Motor Sizes	hp	X

Trickling Filters.

Figure 11-33: Existing Trickling Filters

Twelve trickling filters (TFs) were constructed in 1957 as part of the original wastewater treatment plant, but Trickling Filter Nos. 11 and 12 were demolished to accommodate the 2012 expansion project and TF Nos. 9 and 10 will be demolished to accommodate the current Phase 2 expansion effort. Consequently, eight TFs will remain after the completion of the Phase 2 expansion project and, of those, four will remain operable. Under the Wet Weather Flow Blending Strategy the trickling filters no longer provide any treatment and simply serve to transfer flow between primary and final clarifiers. Primary effluent flows by gravity to TFs from TF Primary Clarifiers via a series of transfer boxes and 72-inch, to 48-inch, to 24-inch diameter piping at each TF. Each trickling filter is equipped with rock media and a rotating distribution pipe mechanism that distributes primary effluent through a vertical influent pipe and out through orifices spaced along the four distributor pipes onto the surface of the media. The TFs operate in a single-stage, parallel configuration. Effluent from each TF is directed to a 24-inch diameter pipeline which combines with other effluent lines into a larger 48-inch and ultimately to a 72-inch diameter pipeline that conveys the TF effluent to Final Clarifiers.

The TF Treatment Process relies on attached growth biological treatment by microbiology grown on the surface of the trickling filter media. As the microbiology grows, it will slough off the media surface and settle out in the TF Final Clarifiers as "humus." Nuisance snails also grow on the media surface, slough off the media, and settle out in TF Final Clarifiers. This biological treatment process offers many benefits, including good removal of organics and suspended solids, low energy requirement and operational simplicity, but it is not very effective in removing nitrogen and phosphorus. As final effluent water quality requirements, particularly for nutrients, have increased in recent years, the TF Treatment Process has been phased out and more plant influent is directed to the newer AS Treatment Process. The TF Treatment Process will remain available only to provide primary treatment of wet weather flows above 75 mgd that are diverted to it from the AS Treatment Process.

Table 11-22
Existing TF Summary

Parameter	Units	Value
Trickling Filter Quantity (1)	no.	8
Current Quantity of Trickling Filters Remaining in Service	no.	4
Trickling Filter Media		Rock
Trickling Filter Diameter	feet	230
Nominal AADF Capacity, each	mgd	5.0
Nominal MMF Capacity, each	mgd	6.0

[1] Twelve TFs were originally constructed in 1957.

TF Final Clarifiers.

The TF Final Clarifiers are currently utilized as part of the TF Treatment Process and are located south of the trickling filters on the west side of the CWSID WRF site. The final clarifiers are used to provide the required hydraulic retention time to settle trickling filter humus. Chlorine solution is fed to each Final Clarifier and disinfected final effluent gravity flows to the Effluent Junction Box and directed to CWSID WRF outfalls.

Figure 11-34: TF Final Clarifier No. 4

The District has experienced a number of issues with the existing TF Final Clarifiers. The high groundwater at the CWSID WRF site opens pressure relief valves located in each of the clarifiers and fills the clarifier with groundwater, making it difficult to maintain the clarifiers. The pressure relief valves are designed to relief hydrostatic pressure due to buoyant forces caused by the high groundwater, so TF Final Clarifiers do not “float” or are lifted.

Figure 11-35: TF Final Clarifier No. 3

Table 11-23
CWSID TF Final Clarifier Nos. 1 to 4 Design Summary

Parameter	Units	Value (1)
Number	no.	4
Diameter	feet	120 (155)
Surface Area	sf	11,310 (18,870)
Side Water Depth	feet	6.5 (12.2)
Max Month SVI	mL/g	
Recommended Surface Overflow Rate (2)		
Average Annual Flow	gpd/sf	800
Max Month Flow	gpd/sf	950
Weir Loading Rate		
Max Month Flow	gpd/LF	14,330 (3)
Existing Capacity (4)		
Average Annual Flow	mgd	27.1
Max Month Flow	mgd	32.2
Motor Horsepower	hp	1.0

[1] Values listed are for each clarifier and value in parenthesis is for Final Clarifier No. 4.

[2] Average Annual Flow Surface Overflow Rate of 800 gpd/ft^2 for fixed film process per Utah Administrative Code R317-3-6.

[3] Based on both AS and TF treatment systems operating and all AS Secondary Clarifiers and All TF Final Clarifiers are in service.

[4] Largest diameter unit out of service.

TF Humus Return.

The Trickling Filter Final Clarifiers return settled humus to the TF Headworks, which is then pumped to TF Primary Clarifiers by the TF Influent Pump Station where it is co-settled with primary sludge. The primary sludge and settled humus are later pumped directly to the Sludge Blending Tanks and the anaerobic digestion process. No secondary solids (or WAS) are pumped from TF Final Clarifiers to the Sludge Blending Tanks.

Once the Phase 2 expansion project is completed, this facility will only pump settled solids from the final clarifiers back to the TF Headworks facility. As trickling filters are no longer used for treatment, humus will no longer need to be managed.

Figure 11-36: Humus Return Pump Station

TF Disinfection.

Final effluent from the TF Treatment Process under the Wet Weather Flow Blend Strategy is disinfected using chlorine injected into the pipeline conveying Trickling Filter effluent to TF Final

Clarifiers. Under the Wet Weather Flow Blend Strategy, the TF Primary Clarifiers are used for primary treatment and the TF Final Clarifiers are used for contact time for chlorine disinfection. Under the Phase 2 expansion project, existing sodium bisulfite storage tanks used to dechlorinate final effluent will be repurposed to store sodium hypochlorite (12.5 percent) and larger chemical feed pumps will be installed. Each of the three smaller TF Final Clarifiers offers approximately 550,000 gallons of volume which provides 20 minutes of contact time at 40 mgd flowrate (113 mgd to 75 mgd). Table 11-24 summarizes the new chlorine disinfection system using sodium hypochlorite.

Table 11-24
CWSID WRF TF Treatment Process Disinfection

Parameter	Units	Value
Storage Tanks		
Quantity	no.	2
Volume, each	gallons	4,500
Type		Polyethylene
Chlorine Chemical		Sodium Hypochlorite, 12.5%
Chemical Feed Pumps		
Type		Peristaltic
Number	no.	2
Flow Range	gph	5 - 200
Maximum Pressure	psi	20
Motor Size	hp	1.5
Contact Time (per R317.8.2.A)	minutes	30
Max CL Dose (per R317.8.3.A)	mg/L	25

TF Utility Water Pump Station.

The Utility Water Pump Station pumps disinfected final effluent from a below grade wet well using three vertical turbine pumps. Historically this utility water pump station used final effluent exclusively from the TF Treatment Process, however in 2012 a 16-inch diameter FE pipeline was extended from the AS Treatment Process and connected to the pump station wet well. The utility water is used for washwater hoses, scum spray bars, pump seal water and other uses at the CWSID WRF. Since the construction of the AS - Utility Water Pump Station, this pump station has not been used. It is located near the TF Final Clarifiers and the Chemical Building. Table 11-25 lists the design criteria for the TF Utility Water Pump Station.

Figure 11-37: TF Utility Water Pump Station

Table 11-25
Utility Water Pump Station

Parameter	Units	Value (1)
Pump Type		Vertical Turbine
Existing Pump Quantity	no.	2 Duty (1 Standby)
Design Flow, each	mgd	-
Design TDH, each	feet	-
Firm Design Pumping Capacity	mgd	-
Motor Horsepower, each	hp	75
Drive		VFD

[1] One pump out of service.

Plant Effluent and Effluent Pump Station

The District is permitted to discharge disinfected final effluent into two different water bodies: (1) The Weber River, and/or (2) The Warren Canal. The Warren Canal discharge is limited to 69.5 mgd but based on CWSID experience, the canal is hydraulically limited to 60.0 mgd during wet weather events. The Weber River discharge WSE is typically at EL 4221.00 but can get as high as EL 4231.50 (100-year flood). The Warren Canal WSE is approximately 10 feet higher at EL 4232.20 than the typical Weber River WSE. Disinfected final effluent from the AS and TF Treatment Processes combines at the Outfall Control Box where it can either: (1) Flow by gravity to the Weber River, and/or (2) be directed to the Effluent Pump Station and pumped to the Warren Canal. Typically, final effluent can be discharged to either water body flowing by gravity. However, the Effluent Pump Station can lift final effluent to WSE 4239.00 and be used to lift final effluent to either discharge location during wet weather events when discharge by gravity flow alone is difficult. The existing Effluent Pump Station is summarized in Table 11-26.

Figure 11-38: Final Effluent Pump Station

Table 11-26
CWSID Existing Effluent Pump Station

Parameter	Units	Value (1)
Pump Type		Submersible, Axial Flow
Existing Pump Quantity	no.	3 Duty (0 Standby)
Design Flow, each	mgd	20
Design TDH, each	feet	4.3
Firm Design Pumping Capacity	mgd	40
Motor Horsepower, each	hp	50
Drive		VFD

[1] One pump out of service.

Effluent pumps typically pump against less TDH than designed, and therefore have a larger firm pump capacity than what is listed above in Table 11-26. The District has not needed additional pump capacity to date as the Weber River and Warren Canal WSE have not risen to a point where most of CWSID's final effluent cannot flow by gravity.

The District can operate the Effluent Pump Station to entrain air and increase the dissolved oxygen concentration in discharged disinfected final effluent.

SOLIDS HANDLING

Primary and secondary solids from both the AS and TF Treatment Processes are managed using the following unit processes:

- WAS Thickening.
- TWAS and PS Blending (Sludge Blending Tanks).
- Primary and Secondary Digestion.
- Dewatering.
- Drying Beds.
- Class A Disposal, including composting and land application.

The CWSID WRF also includes related boiler heating systems and biogas management systems, including gas cleaning systems, and a gas flare. Cogeneration systems using cleaned digester biogas have been abandoned.

Primary Solids Thickening

The CWSID currently does not thicken its primary solids from either its AS or TF Treatment Process. Primary solids are pumped directly to the Solids Blend Tanks, mixed with TWAS, and then digested.

WAS Thickening Building

Figure 11-39: Gravity Belt Thickener

CWSID thickens WAS and scum pumped directly from AS Secondary Clarifiers at its WAS Thickening Building utilizing gravity belt thickeners (GBTs). Flow from WAS and scum typically at less than 1 percent total solids is pumped to the WAS Thickening Building in a common 12-inch diameter pipeline. The federate to each GBT is controlled with a dedicated control valve and an electromagnetic flow meter. TWAS that is typically higher than 5 percent total solids is pumped to Solids Blend Tanks using air diaphragm type pumps and removed water in the thickening process is directed to plant drains and returned to the AS Headworks. The WAS Thickening Building is located near the anaerobic digesters and Solids Blend Tanks and is sized to ultimately house four GBTs as shown in Figure 11-40. The existing WAS thickening equipment is described in Table 11-27 as well.

Table 11-27
CWSID WAS Thickening Facility

Parameter	Units	Value
Gravity Belt Thickeners (GBTs)		
Existing Quantity	no.	2 (1 Duty + 1 Standby)
Future Quantity	no.	2
Belt Width	meters	2.0
WAS Flow to GBT, each	gpm	263 (1) (2)
WAS Flow to GBTs, total	gpm	263 (1) (2)
Solids Loading to GBTs, each	dry lbs/day	15,800 (1) (2)
Solids Loading to GBTs, total	dry lbs/day	15,800 (1) (2)
WAS Concentration to GBTs	mg/L	5,000
Solids Belt Loading, each	pounds per hour (lbs/hr)	494
TWAS Concentration	weight percent (wt%)	5.5
GBT Motor Size, each	hp	5.0
Thickening Emulsion Polymer System		
Storage Tote Quantity	no.	2
Blending Unit Quantity	no.	2 (1 Duty + 1 Standby)
Aging Tank Quantity	no.	2
Aging Tank Volume, each	gallons	2,500
Pump Type		Progressive Cavity

Table 11-27
CWSID WAS Thickening Facility (continued)

Parameter	Units	Value
Pump Quantity	no.	3
Capacity, each	gph	100
Metering Pump Motor Size	hp	1.5

[1] Value based on current 24 hours per day and 7 days per week operation.

[2] One GBT out of service.

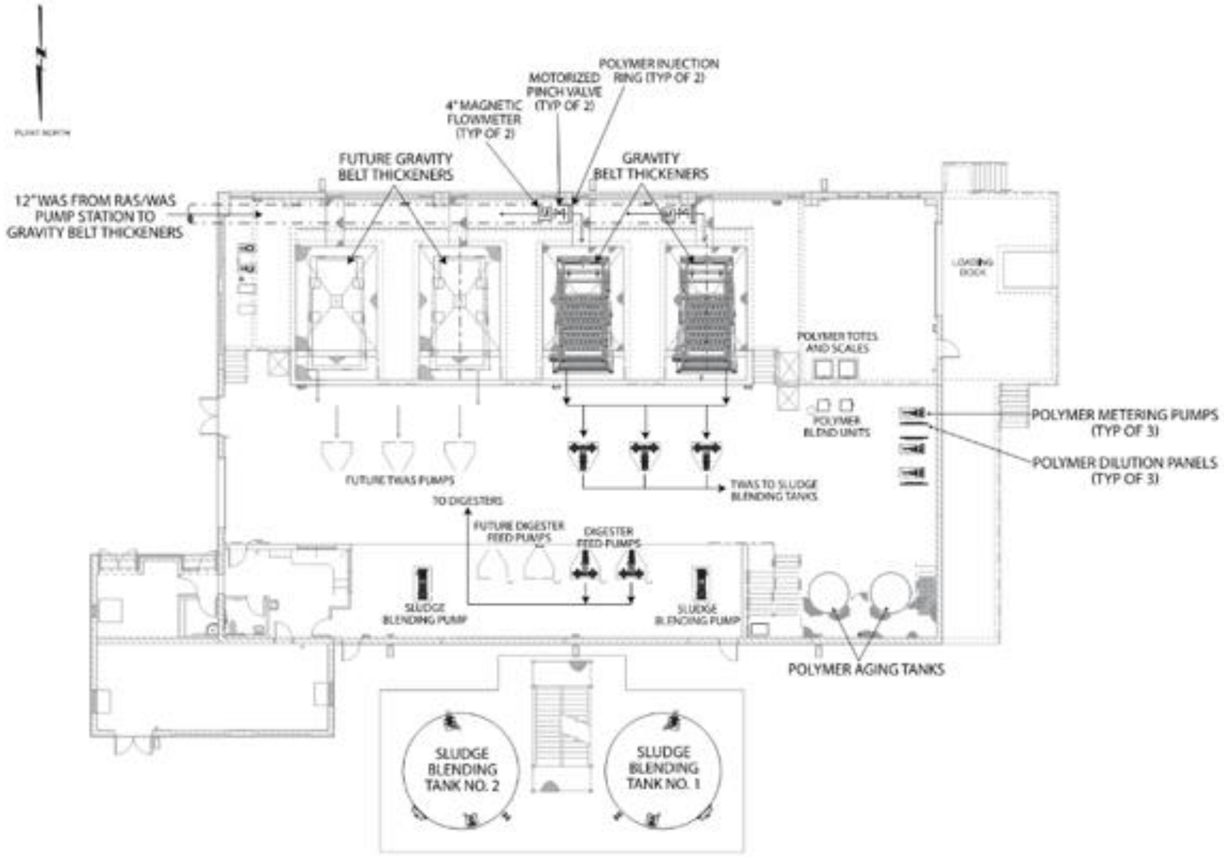


Figure 11-40: CWSID WAS Thickening Building

Sludge Blending and Digestion

To reduce odors, volatile solids, and reduced or deactivate pathogenic organisms, the Utah Wastewater Rules (i.e., Utah Administrative Code 317-3-9) require WRFs to stabilize sludge prior to disposal by: (1) chemical, (2) physical, (3) thermal, or (4) biological treatment processes. CWSID WRF employs a mesophilic digestion process to produce a stabilized Class B biosolid that is either composted or land applied. The CWSID WRF existing sludge digestion system consists of sludge pumping, blending tanks, digester control buildings and digesters, including three primary digesters and one secondary. Primary Digester No. 1 and the Secondary Digester No. 1 were constructed as part of the Trickling Filter Treatment Process while Primary Digester Nos. 2 and 3 were constructed as part of the Activated Sludge Treatment Process.

Struvite formation has been a challenge at the CWSID WRF, generating a significant maintenance effort to keep primary digester draft tube mixers in service. Aerobic phosphorus accumulating organisms wasted from the AS Treatment Process release stored phosphorus when stressed under anaerobic conditions inside primary digesters. The combination of soluble phosphorus and ammonia with magnesium under relative higher pH conditions results in the formation of struvite crystals that coat the inside of piping, pumps, mixers, and other equipment.

Sludge Blend Tanks.

Primary Sludge from AS and TF Primary Clarifiers is combined with TWAS from the AS Treatment Process at Sludge Blending Tank Nos. 1 and 2 located just outside of the WAS Thickening Building. Sludge Blend Tanks are constructed of stainless steel, and each is provided with digester type gas handling pressure and pressure/vacuum release valves with vent and flame arrester. A pump mix system is employed to mix TWAS with mixing nozzles installed inside each tank and mixing pumps are located inside the WAS Thickening Building. Sludge blending pumps and digester feed pumps are housed inside the WAS Thickening Building as shown in Figure 11-40. Primary Sludge is not currently thickened prior to blending with TWAS but the resulting mixture transferred to primary digesters is typically 5.0 percent TS.

Figure 11-41: Sludge Blending Tanks

Digester Control Buildings.

The TF Digester Control Building houses equipment for Primary Digester No. 1 and Secondary Digester No. 1 while the AF Digester Control Building houses equipment for Primary Digester Nos. 2 and 3. The TF and AS Digester Control Buildings house sludge transfer pumps, primary circulation pumps, hot water pumps, and boilers. The boilers are natural gas-fired and provide heat for the hot water recirculation loop that heats the digesters as well as the AS Headworks, WAS Thickening Building and AS Blower Building. The primary digesters are operated as mesophilic, operating between 95 to 100 degrees Fahrenheit.

Before cogeneration operations were discontinued, biogas was cleaned, removing hydrogen sulfide, moisture, and carbon dioxide, Biogas cleaning equipment is housed in the AS and TF Digester Control Buildings. The District’s average digester biogas production is 242 scfm based on recent 2022 annual data.

Digesters.

Figure 11-42: Secondary Digestor No. 1

Primary Digester Nos. 1, 2, and 3 are utilized for digesting sludge from the Sludge Blend Tanks. All three primary digesters are provided with gas safety equipment, including pressure/vacuum relief valves with flame arrestors. Primary Digester Nos. 2 and 3 have fixed, gas-tight concrete covers and are each mixed using four external and one center internal draft tube type mixers. The CWSID currently keeps at least one of the primary digesters out of service to minimize heating cost as there is currently excess primary digester capacity. Primary Digester No. 1 is currently used for primary digester overflow containment and biogas storage and is equipped with a flexible membrane cover. See picture at right of Primary Digester No. 1. Biogas can be transferred to the cogeneration facility to produce power or simply “flared” by burning the biogas at the pressure relief valve.

Since Secondary Digester No. 1 is not currently used for digestion, it is considered “secondary” and is used to hold digested sludge ahead of the solids dewatering and to store biogas generated in primary digesters.

The two primary anaerobic digesters are operated within a mesophilic temperature range, and each provides 2.3 MG of storage capacity that provides 21 days of hydraulic retention time under a 110,000 gallons per day loading rate. However, the current primary digester loading rate can range between 140,000 and 180,000 gallons per day and the corresponding total firm hydraulic retention time ranges between 17.6 and 23 days. Primary digester volatile solids reduction (VSR) is estimated at 50 percent without considering some additional VSR provided in the secondary digester.

Table 11-28
CWSID WRF Sludge Blending and Digestion Summary

Parameter	Units	Value
Sludge Blending Tanks		
Quantity	no.	2 (2 Duty + 0 Standby)
Volume, each	gallons	47,000
Mixing Pump Type		Centrifugal, Chopper
Mixing Pump Quantity	no.	2
Mixing Pump Design Flow	gpm	600
Mixing Pump Design TDH	feet	17
Mixing Pump Motor Sizes	hp	10
Blended Sludge Pump Type		Mechanical Diaphragm
Blended Sludge Pump Quantity	no.	
Blended Sludge Pump Design Flow	gpm	175

Table 11-28
CWSID WRF Sludge Blending and Digestion Summary (continued)

Parameter	Units	Value
Blended Sludge Pump Design TDH	feet	135
Blended Sludge Pump Motor Size	hp	15
Primary Digesters		
Quantity	no.	3 (2 Duty + 1 Standby)
Mixing Type		Mix Pump
Diameter, each	feet	95
Side Water Depth, each	feet	30
Volume, each	MG	2.38
Current MMF Sludge Flow to Digesters	gallons per day	110,000
Current MMF vs. Loading	pounds volatile solids per day (lbs VS/day)	0.065 (4)
Hydraulic Retention Time (1)		
AADF	days	52.6
MMF	days	43.5
Average Current Gas Production (2)	scfm	133
Secondary Digesters		
Quantity	no.	1
Mixing Type		Mix Pump
Diameter, each	feet	95
Side Water Depth, each	feet	30
Volume, each	MG	2.38
Biogas Storage Capacity, each	cf	190,000
Current MMF Sludge Loading (3)	gallons per day	N/A
Current MMF Sludge Flow to Digesters (3)	lbs VS/day	N/A
Hydraulic Retention Time (3)		
AADF	days	N/A
MMF	days	N/A

[1] One digester out of service.

[2] Based on 2015 and 2016 plant data.

[3] Not currently used for sludge digestion.

[4] Utah Wastewater Rule R317-3-9 allows up to 120 lbs VS/day loading rate for a completely mixed system where turnover rate is less than 30 mins.

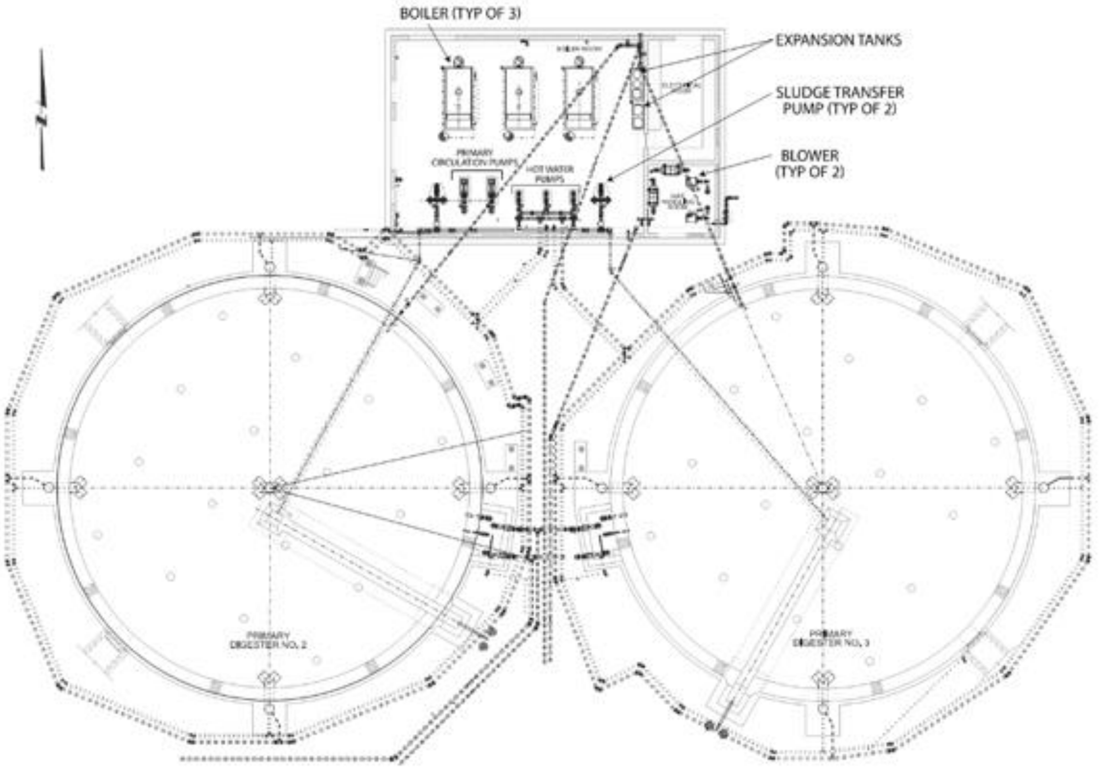


Figure 11-43: CWSID WRF Primary Digester Nos. 2 and 3 and AS Digester Control Building

Solids Dewatering

The CWSID WRF solids dewatering system is housed in the Solids Dewatering Building and includes feed pumps, three belt filter presses (BFPs), conveyors, polymer feed systems and a drive-through load-out facility with a live-bottom bin and truck scale. The original Solids Dewatering Building was constructed in 1995 and housed two BFPs, three sludge feed pumps and two polymer aging tanks. In 2019 the District added a third refurbished BFP and a fourth sludge feed pump. Solids feed pumps are located on the first floor along with polymer feed systems. The BFPs are located on the second floor. Dewatered wet cake is either hauled to sludge drying beds and further dried/dewatered or it is hauled to the Weber County composting operation.

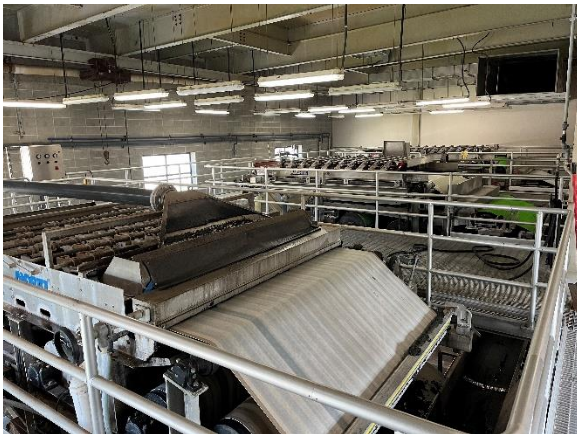


Figure 11-44: Dewatering Belt Filter Press

The Dewatering Facility was designed to process 140,000 gallons per day at 2 percent solids concentration (23,352 DRY lbs/day) initially and be expandable to its current capacity of 236,000 gallons per day at 2 percent solids concentration (39,365 DRY lbs/day). After the dewatering process, the dewatered biosolid cake concentration is approximately 11 percent total solids, which translates to approximately 357,864 WET lbs/day (i.e., 162 WET metric tons/day) current capacity. The dewatering process is typically operated less than 7 days per week (typically 5 days a week and 8 hours a day), with two DUTY presses and one STANDY and currently processes 90 to 115 WET metric tons/day, approximately.

Table 11-29 provides a summary of the CWSID WRF Solids Dewatering System.

Table 11-29
CWSID WRF Solids Dewatering System

Parameter	Units	Value
Feed Pumps		
Type		Progressive Cavity
Quantity	no.	4 (2 Duty + 2 Standby)
Design Flow, each	gpm	300
Design TDH, each	gpm	60
Motor Size	hp	30
Drive		VFD
Belt Filter Press (BFP)		
Quantity	no.	3 (2 Duty + 1 Standby)
Belt Width	meters	2.0
Sludge Flow to BFP, each	gpm	324 (1) (2) (3)
Sludge Flow to BFPs, Total	gpm	324 (1) (2) (3)
Solids Loading to BFPs, each	dry lbs/day	25,900
Solids Loading to BFPs, Total	dry lbs/day	25,900
I Sludge Concentration to BFPs	weight percent (wt%)	2.0
Solids Belt Loading, each	lbs/hr	2,200
Hydraulic Belt Loading, each	gpm/meter	162
Dewatered Sludge Concentration	wt%	12-15
BFP Motor Size	hp	5.0
Dewatering Emulsion Polymer System		
Storage Tote Quantity	no.	2
Blending Unit Quantity	no.	2
Aging Tank Quantity		2
Aging Tank Volume, each	gallons	2,300
Meter Pump Type		Progressive Cavity
Metering Pump Quantity	no.	2
Metering Pump Capacity	gpm	13
Metering Pump Motor Size	hp	1.5

[1] Value based on current 8 hours per day and 5 days a week operation.

[2] One BFP out of service.

[3] Exceeds design criteria.

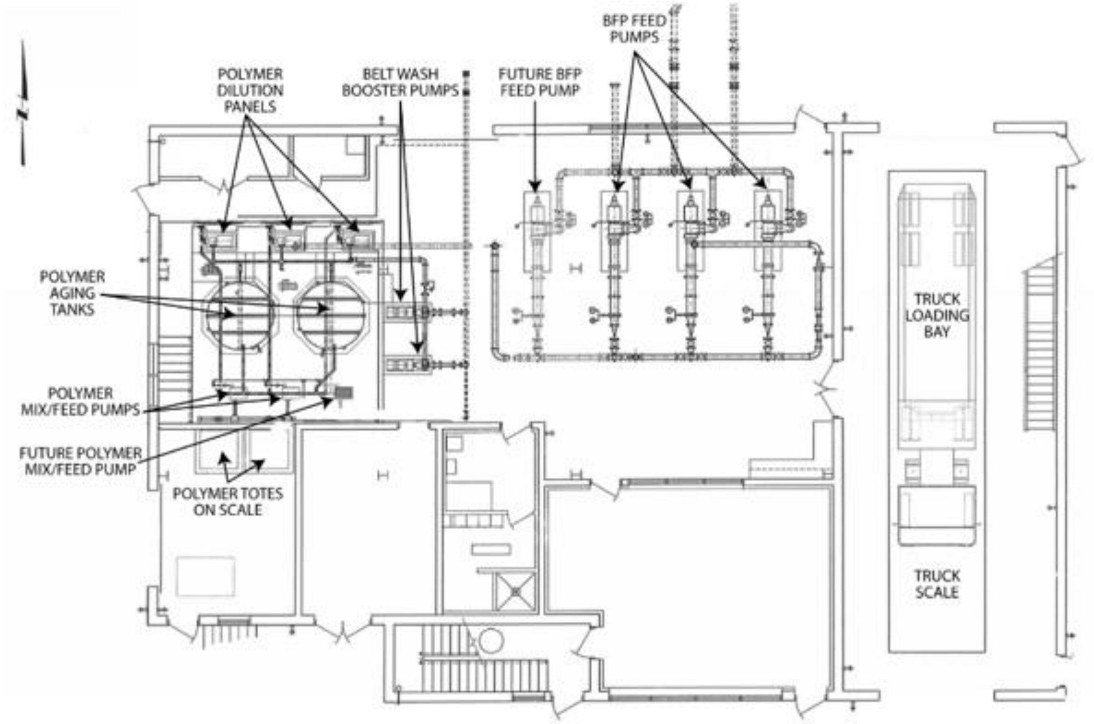


Figure 11-45: CWSID WRF Solids Dewatering Building - First Floor

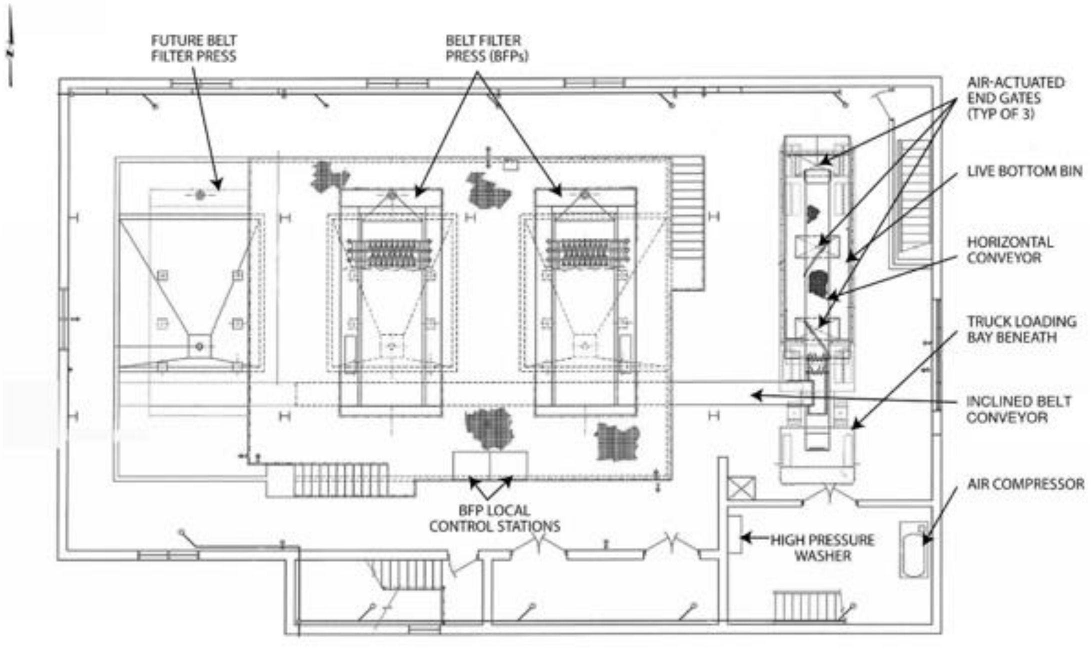


Figure 11-46 CWSID WRF Solids Dewatering Building - Second Floor

POWER DISTRIBUTION AND COGENERATION

Power Distribution

The TF Treatment Train and AS Treatment Trains were originally provided electrical power from two separate Rocky Mountain Power (RMP) primary power services. Two customer owned substation transformers were installed at the 4,160 volt (V) and 2,400 V system voltages. The TF Treatment Process uses 2,400 V switchgear, while the AS Treatment Process uses 4,160 V switchgear to power AS loads. The TF Treatment Process used the cogeneration system with two 525 kilowatt (kW), 2,400 V digester gas-fired generators to provide power to the TF Influent Pump Station. These cogeneration units also served as backup power to the other TF treatment unit processes. Additional 480 V standby generators (55 kW and 350 kW) are dedicated exclusively to the Chemical Building, and the Utility Water Pump Station. In 2020 under the Phase I expansion project the following modifications were made:

- A new electrical duct bank was installed between ATS-HW-2 and the existing 2,400 V switchgear serving the TF plant. A step-down 4,160 V:2,400 V transformer was installed to keep the TF and AS Treatment Processes on the same primary power service, as well as to allow the standby generators to also power the TF plant (rather than relying on the Cogen unit).
- A second 2-MW standby diesel-fired generator was installed in the AS Blower Building to provide backup power to the AS and TF Treatment Processes.

The two standby 4,160 V standby generators are integrated with the utility distribution via 5-kilovolt switchgear and serve as the primary and standby power sources respectively. The controls which start the generators and perform transfer of power sources depend on a hot standby programmable logic controller (PLC), which has reached the "End of Commercialization" phase, according to the manufacturer, Schneider Electric. These PLCs will be replaced under the Phase 2 expansion project.

As part of the infrastructure which transfers between generator and utility power, medium voltage "Automatic Transfer Switches" (ATS-HW1, ATS-HW-2, and ATS-BB1) are used. ATS-HW-2 was added as part of the Phase 2 construction. ATS-HW-1 has reportedly experienced operational issues, and it is recommended this ATS be inspected and serviced if required. ATS-HW-1 may be additionally considered for upgrade to a "Closed Transition" type, depending upon cost and feasibility to do so.

The CWSID WRF currently continues to operate the TF Treatment Process using 2,400 V electrical distribution equipment and maintains and operates dedicated 480V standby generators for the Chemical Building and the Utility Water Pump Station. The new 4,160 V service will provide electrical power distribution in the future as the AS Treatment Process is expanded.

In general, the electrical equipment within the AS part of the plant is in good shape, since the upgrade was performed around the year 2012. The electrical equipment in the TF area has been well maintained but includes motor control centers (MCCs) and switchgear which should be inspected frequently. No immediate concerns were noted with this legacy MCC and switchgear equipment, however. Additional comments appear within the process specific analyses below.

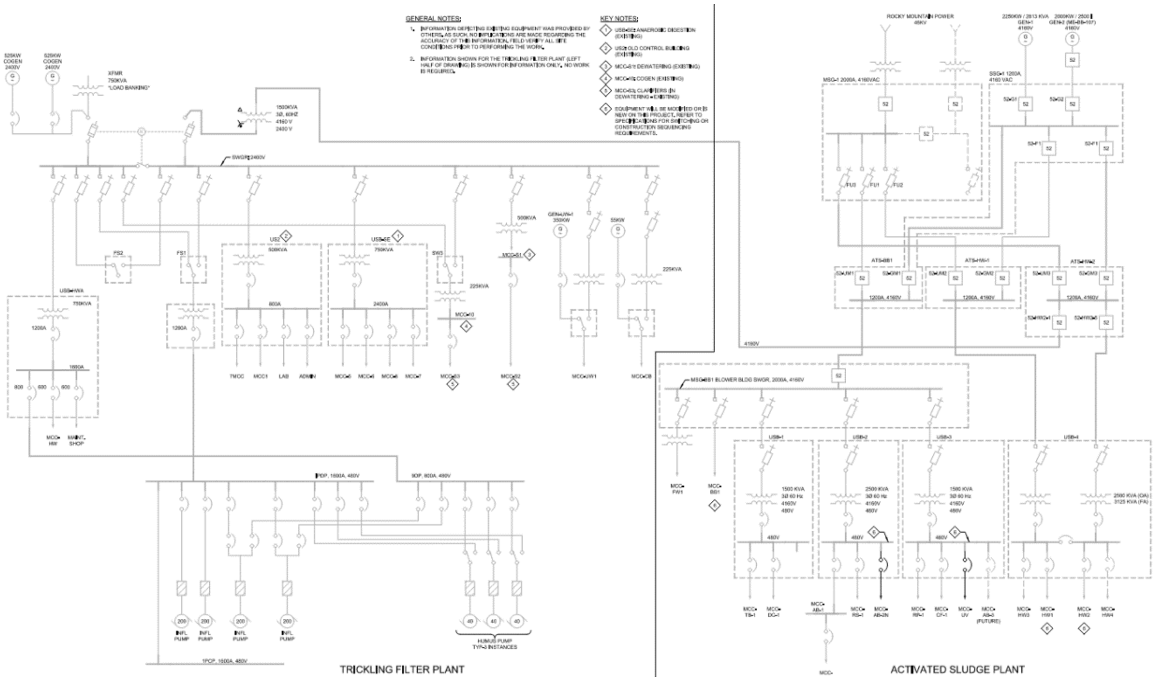
Some existing outdoor liquid-filled transformers appeared to show surface rust on their enclosures (e.g., XF-MCC-FW1A). This does not necessarily mean the transformer is nearing end of life, however for these AS era transformers, it is recommended the oil be tested via qualified lab. Testing should include results of any contaminants, moisture, and evidence of fault or degradation.

Cogeneration

The Cogeneration Facility was installed in the 1990s to provide backup power to the TF Treatment Process to help the District offset the facility's heating and electrical costs. Each cogeneration unit contains two six-cylinder engine generators, uses methane gas from CWSID WRF digestion processes, and are rated 2,400 V. These cogeneration units are not synchronized with the RMP distribution system. Due to the following limitations and increasing age of the equipment and related maintenance cost, the District decided to discontinue using the cogeneration units.

- The TF Treatment Process and AS Treatment Process are served by different RMP service connections at different voltages.
- Standby power for a portion of the TF Treatment Process currently relies on separate generators.
- Cogeneration is not optimized and is isolated (not synchronized with RMP).
- Maintenance costs and difficulty in obtaining spare parts became difficult.

Figure 11-47: Cogeneration Engine



GENERAL NOTES:

1. INFORMATION DEPICTING EXISTING EQUIPMENT WAS PROVIDED BY OTHERS. AS SUCH, NO IMPLICATIONS ARE MADE REGARDING THE ACCURACY OF THIS INFORMATION. FIELD VERIFY ALL SITE CONDITIONS PRIOR TO PERFORMING THE WORK.
2. INFORMATION SHOWN FOR THE TRICKLING FILTER PLANT (LEFT HALF OF DRAWING) IS SHOWN FOR INFORMATION ONLY. NO WORK IS REQUIRED.

KEY NOTES:

① USB-6E: ANAEROBIC DIGESTION (EXISTING)

② US2: OLD CONTROL BUILDING (EXISTING)

③ MCC-61: DEWATERING (EXISTING)

④ MCC-10: COGEN (EXISTING)

⑤ MCC-63: CLARIFIERS (IN DEWATERING - EXISTING)

⑥ EQUIPMENT WILL BE MODIFIED OR IS NEW ON THIS PROJECT. REFER TO SPECIFICATIONS FOR SWITCHING OR CONSTRUCTION SEQUENCING REQUIREMENTS.

Figure 11-48 CWSID WRF Primary Electrical Power Distribution

CONDITION ASSESSMENT

Protocol and Deployment

The condition assessment took place over the course of 2 days (on May 4 and May 11, 2022) and was conducted by a multi-discipline team of mechanical, electrical, and structural engineers. The assessment also involved District staff who accompanied the multi-discipline team as facilities were assessed and helped identify known deficiencies and operating limitations and discussed maintenance and operations history of each unit process. In addition to what was described by plant staff, the assessment team made visual observations to identify noticeable structural deterioration, electrical and structural issues, and mechanical degradation.

Scoring

The condition of assets was ranked using a one-through-five scale at both a general level and across a series of discipline specific questions. A score of 1 represents the best condition assets, while a score of 5 represents the worst condition assets. The purpose of scoring is to provide a common scale to rate assets so they can be compared to one another. Table 11-30 provides the general description of the condition associated with each score.

Table 11-30
General Condition Score Descriptions

Condition Score	General Description
1 (Best)	**Excellent** Installed with very little wear. Fully operable, well maintained, and consistent with current standards. Little wear shown and no further action required.
2	**Good** Sound and well maintained but may be showing slight signs of wear. Delivering full efficiency with little or no performance deterioration. Only minor renewal or rehabilitation may be needed.
3	**Moderate** Functionally sound and acceptable and showing normal signs of wear. May have minor failures or diminished efficiency and with some performance deterioration or increase in maintenance cost. Moderate renewal or rehabilitation needed.
4	**Poor** Functions but requires a high level of maintenance to remain operational. Shows abnormal wear and is likely to cause significant performance deterioration in the near term. Replacement or major rehabilitation needed.
5 (Worst)	**Very Poor** Effective life exceeded and/or excessive maintenance cost incurred. A high risk of breakdown or imminent failure with serious impact on performance. No additional life expectancy with immediate replacement required.

ORGANIZATION OF THIS DOCUMENT

The condition assessment results are organized into the following unit processes, divided between the TF Treatment Process and AS Treatment Process, as listed below and as shown in Figure 11-3:

- TF Treatment Process:
    - Control Building.
    - Headworks.
    - Aerated Grit Chambers.
    - Primary Clarifiers.
    - Primary Sludge Pump Station.
    - Trickling Filters.
    - Humus Return Pump Station.
    - Secondary Clarifiers.
    - Utility Water Pump Station.
    - Primary and Secondary Digester.
    - Digester Control Building.
- AS Treatment Process:
    - Headworks.
    - Influent Pump Station.
    - Primary Clarifiers.
    - Bioreactors.
    - Blower Building.
    - Secondary Clarifiers.
    - RAS/WAS and Scum Pump Stations.
    - Final Clarifiers.
    - Chlorine Contact Basins.
    - Chlorine Gas Building.
    - Dechlorination Facility.
    - Effluent Pump Station.
    - Primary Digesters.
    - Digester Control Building.
- Other Facilities:
    - Biosolids Handling Facilities.
        - Sludge Thickening Building.
        - Dewatering Facility.

  - Cogeneration Facilities.

Each unit process section is organized into the following subsections:

- Description.
- Condition Assessment.
- Recommendations.

TF Treatment Process

The TF Treatment Process is only used to treat a small percentage of the screened and degritted primary influent (approximately 7 mgd) that is currently directed to the TF Primary Influent Pump Station located downstream of the TF Headworks. After the Phase 2 expansion project is finalized, all plant influent will be directed to the AS Treatment Process and only the following unit processes of the TF Treatment Process will be maintained to treat a portion of wet weather flows:

- Primary Influent Pump Station.
- Primary Clarifiers and Primary Sludge Pump Station.
- Secondary Clarifiers and Humus Return Pump Station.
- All related piping.

All other TF Treatment Process facilities, including trickling filters, will be demolished as space is needed for new AS Treatment Process and other facilities. Chlorine will continue to be provided to TF Treatment Process primary effluent upstream of final clarifiers. Consequently, the condition of TF Treatment Process facilities not listed above (i.e., those facilities not needed to treat wet weather flows) was not assessed.

Since the wet weather or total PHF influent flowrate is anticipated to be no more than 115 mgd and the AS Treatment Process sized to provide primary and secondary treatment up to 75.0 mgd PHF, the TF Treatment Process will need to provide primary treatment up to 40.0 mgd PHF. As the AS Treatment Process is designed to accommodate an ADMM flow of 58.8 mgd, it is anticipated that the TF Treatment Process will only be operated less than a few times annually.

TF Headworks.

Description

The TF Headworks facility houses influent channel screens, air compressors for pneumatically operated valves, conveyors for grit and screenings and a load out ramp for trucks that haul away grit, snail shells and screenings to a local landfill. Since the total influent flow is directed to the AS Headworks, the TF Headworks is currently used to screen snail shells and other solids from humus that is returned and co-settled with primary sludge. The facility is comprised of the following rooms or spaces:

- Parshall Flume.
- Screening and Conveyance Space.
- Aerated Grit Chambers.
- Blower and Air Compressor Room.
- Control/Electrical Room.

- Load out.

The TF Headworks facility is a hydraulic structure with foundation and walls constructed of cast-in-place concrete located below grade, including the Parshall flume (with fiber reinforced plastic [FRP] insert), influent channels, and aerated grit chambers. Above grade, the facility is constructed of fluted concrete masonry unit (CMU) exterior walls with either an unpainted CMU or plywood interior finish, a flat roof that is constructed of precast double tee girders (uncoated), and a cast-in-place concrete parapet above the CMU. Grating and handrail is aluminum and doors are coated steel. Openings to influent screening channels are covered with aluminum grating with plywood on top. Mechanical air supply equipment is roof-mounted and supplies air to the interior space via galvanized steel ductwork that penetrates down through the roof. The air supply ducting is located high, close to the ceiling with grilles directing air down toward the floor. Exhaust fans and exterior wall louvers are located in the Blower and Air Compressor Room.

Assets designated to the TF Headworks facility include the following:

- Parshall Flume and Influent Flow Isolation Gate.
- Influent channels 1 to 4.
- Influent climber type screens 1 to 3 and 1 manually raked screen and associated influent channel isolation slide gates.
- Open Belt and Enclosed Pneumatic Screenings Conveyors 1 to 3.
- Aerated Grit Chambers 1 to 2 and associated air piping, stainless steel baffles and weirs and valving.
- Inclined grit screw conveyors 1 to 3.
- Positive Displacement Blowers and Air Compressor for aerated grit chambers and pneumatically operated valves.
- overhead bridge crane spanning the inclined grit conveyors and open belt screenings conveyor (2,000 pounds lift capacity).
- Combustible gas and hydrogen sulfide and other analyzers, sensors, and instruments, including an automated refrigerated auto sampler.

Capacity.

Refer to Headworks Section above for design criteria for the TF Headworks facility.

Condition Assessment.

A condition assessment of this facility was not performed as part of this facility plan update. However, the following items are noteworthy:

- The TF Headworks interior space was clean and well maintained and all equipment, although old and beyond years of anticipated useful service life, was operable.
- The space seemed well ventilated with little odor and few signs of hydrogen sulfide corrosion.
- Although some minor concrete cracking was noted, the structural concrete floors and CMU interior/exterior walls seemed structurally sound.

Recommendations.

As long as the TF Treatment Process is needed to treat large wet weather flows, it is recommended that the TF Headworks be maintained and used to remove solids from the humus return (i.e., solids settled in final clarifiers) and used as a backup to the AS Headworks to screen raw sewage during wet weather events if necessary. In the future as the TF Treatment Process is discontinued and no longer used, CWSID may consider stopping to maintain this equipment and facility and may even consider demolishing it to accommodate the construction of new AS Treatment Process facilities, including an expansion of the AS Headworks.

TF - Control Building and Influent Pump Station.

Description.

The Control Building is comprised of several rooms located on three different floors. The below grade structure is constructed of cast-in-place concrete and includes the following:

- Abandoned primary sludge pump station and wet well.
- Existing influent pump station and wet well.

Primary sludge pump equipment (abandoned) and the influent pumps are located below grade in dry pits, just outside their respective wet wells.

The above grade portion of the structure is a constructed of cast-in-place concrete, brick masonry and glass panels. The first floor (i.e., ground floor) has been repurposed as storage, storage of safety and emergency response equipment, electrical wiring conduit and other items, portable trailer mounted pumps, vac truck, forklift, and other miscellaneous items. The electrical room for the Influent Pump Station is also located on the first floor and is where motor control center, the variable speed drives for the influent pumps and PLC for supervisory control and data acquisition (SCADA) integration are located.

Process mechanical assets designated to the Control Building and the TF Influent Pump Station include:

- Influent Pump Station Wet Well and associated influent pump isolation gates.
- Influent Pump Nos. 1, 2, 3, 4, 5, and 6 and associated discharge piping, valves, and electric drives.
- Air compressors for pneumatic systems, including valve actuators.

Other process mechanical assets designated to the Control Building that have been abandoned and are no longer used include:

- Primary Sludge wet well.
- Primary sludge pumps 1, 2, and 3 and associated piping and valves.

Capacity.

Refer to Influent Pump Station Section above for design criteria, including influent pump capacity, of the Influent Pump Station.

Condition Assessment.

A condition assessment of this facility was performed under this facility plan update but focused exclusively on the Influent Pump Station. The general facility condition is considered to be MODERATE. The building was clean and well maintained. One influent pump was taken offline and was being maintained on the day of the condition assessment site visit. Only minor structural degradation was noted during the condition assessment. Two of the six influent pumps were noted out of service, similar to observations made in the previous facility plan. Since each influent pump has approximately 22.3 mgd flow capacity, the firm total pump capacity is 66.9 mgd (i.e., three duty pumps with one standby) which is more than the 55.0 mgd needed to pump wet weather flows.

The previous facility plan noted the age of the influent pumps and cavitation issue caused by the pump inlet suction elbow not properly baffled. According to the pump manufacturer, four of the six influent pumps were not intended to be operated with variable speed drives which is why they cavitate when operated between 600 and 650 rpm. Rather than replace the pumps with new ones designed to be operated with VFDs, CWSID relies on programmed controls (i.e., a software interlock) to regulate pump speed outside 600 to 650 rpm speed range. VFDs (manufactured by MDI International) serving these pumps were installed in around 2016.

Recommendations.

As the TF Treatment Process continues to be used to treat large influent flowrates experienced during wet weather events, the Influent Pump Station and related facilities at the Control Building will need to be maintained. As this facility and the Influent Pump Station will ultimately be abandoned in favor of the AS Treatment Process, CWSID should continue to make modest investments to properly maintain influent pumps and related electrical drives.

It is recommended that the stability of influent wetwell control be monitored, given the prohibition of operation within speed range of 600 to 650 rpm. To date, no reports of wetwell level control difficulty have been reported. It is recommended that N+1 Influent Pump operation always be available, since the pumps are critical to Wet Weather flows, and must remain in service.

TF - Primary Clarifiers.

Description.

The existing three primary clarifiers are below grade hydraulic structures constructed of cast-in-place concrete. One primary clarifier was in operation on the day of the condition assessment. Due to the design and age of the TF Primary Clarifier concrete structures and the age and condition of the clarifier mechanisms, these unit process will be phased out as the District expands the AS Treatment Process. Primary Clarifier assets include:

- Inlet flow distribution box and associated gates.
- Primary Clarifier Mechanisms 1, 2, and 3.
- Associated scum beaches, FRP weirs and scum baffles.

Capacity.

Refer to Primary Clarifier Section above for design criteria related to the TF Primary Clarifiers. Since each TF Primary Clarifier can treat flows up to 37.0 mgd AADF (44.3 mgd ADMM), two DUTY primary clarifiers can treat wet weather flows up to 55.0 mgd which leaves one unit as a standby.

Condition Assessment.

The primary clarifiers were evaluated to be in overall MODERATE condition where only minor structural items were noted, mostly related to small concrete cracking, deteriorated protective coating and potential safety concerns over handrail. The shallow side water depth is less than the 8-foot recommended depth for a fixed film process per UAC R317-3-6. As noted in the previous facility plan, the TF Primary Clarifiers mechanisms have exceeded their useful life and should be replaced if CWSID intends to operate them continuously for several more years.

Figure 11-49: TF Primary Clarifier Handrail and Access Bridge

Recommendation.

As with other TF Treatment Process items, the primary clarifiers will continue to be operated and maintained to help treat high wet weather flows. In the future as the AS Treatment Process is expanded, the TF Primary Clarifiers will no longer be needed, abandoned, and possibly demolished to make room for new facilities. Therefore, it is recommended to do no more than the minimum to keep the existing clarifier mechanisms operable.

TF - Primary Sludge Pump Station.

Description.

The TF Primary Sludge Pump Station is located down the hill from the primary clarifiers and is used to pump primary sludge from each primary clarifier directly to the mix blend tank where it combines with primary sludge and TWAS from the AS Treatment Process. With the exception of a doghouse, the entire structure is located below grade and is constructed of cast-in-place concrete. Electrical equipment is located in the same space as the mechanical pumping equipment and piping and may not meet current NEC requirements. In-line grinders located outside the building in a dry well in the sludge piping ahead of the double diaphragm, positive displacement type sludge transfer pumps. Only one in-line grinder was in place at the time of the condition assessment. Roof mounted fans supply air to and exhaust air from the interior space.

Assets associated with the TF Primary Sludge Pump Station include:

- Scum Box and Scum Pump.
- In-Line Grinders 1 and 2.
- Primary Sludge Pumps 1, 2, and 3.
- Related piping and valving.

Capacity.

Refer to TF Primary Sludge Section above for TF Primary Sludge Pump Station design criteria. Each pump can be dedicated to a single primary clarifier, thus requiring two duty pumps and one standby when treating wet weather flows up to 40.0 mgd.

Condition Assessment.

The overall condition of the TF Primary Sludge Pump Station is considered MODERATE. The concrete structure is in good condition and the pump equipment and related piping have been well maintained. Since they are located outdoors in a dry pit, the in-line grinders seemed to have experienced more wear than the equipment located indoors. The HVAC system was not evaluated to define air changes per hour as part of this condition assessment.

Recommendation.

Per NEC and NFPA 820, primary sludge pump stations (“Sludge Pumping Station Dry Wells") that have dry pump wells or pits separated from wet wells or pits maybe considered unclassified spaces when the space is continuously vented at least six air changes per hour. If not properly ventilated, all electrical items meet a Division 2 standard where located inside an envelope that extends 18 inches above the water surface and 10 feet beyond wetted clarifier walls. The existing HVAC ventilation equipment capacity should be confirmed and corrected if necessary.

TF - Trickling Filters.

Description.

As the AS Treatment Process is expanded under the current Phase 2 expansion and additional bioreactors are constructed, the trickling filters will no longer be used and will be demolished over time. In fact, several units have already been demolished. Trickling filters will be completely bypassed in the future and primary effluent will be directly piped to the secondary clarifiers for disinfection and to settle out any remaining solids. Assets associated with the trickling filters include:

- Influent flow distribution boxes and associated piping and isolation gates.
- Trickling Filter flow distribution mechanism.
- Secondary Effluent collection boxes and associated piping.

Capacity.

Refer to Trickling Filter Section above for design criteria of the TF - Trickling Filters.

Condition Assessment.

The TF - Trickling Filters were not evaluated as part of this facility plan update.

Recommendation.

Trickling Filters should be demolished over time to accommodate the expansion of the AS Treatment Process.

TF - Final Clarifiers.

Description.

Secondary effluent is collected from the trickling filters and is directed to a final clarifier distribution box where isolation gates can be used to direct flow to each final clarifier. Chlorine solution is dosed to the secondary effluent in a buried vault located upstream of the clarifier distribution box. Buried plug valves on the humus return pipeline are located just outside each of the final clarifiers. Several of these buried valves will be replaced as part of the Phase 2 expansion effort.

Assets associated with TF Final Clarifiers include:

- Chlorine Diffusion Box.
- Final Clarifier Flow Distribution Box with isolation gates.
- Final Clarifier Mechanisms 1, 2, 3, and 4.
- And related clarifier items, including humus piping isolation gates, utility water spray bar systems and FRP scum baffles, weir plates and Stamford baffles.

Capacity.

Refer to Final Clarifiers Section above for design criteria of the TF Final Clarifiers. Since each final clarifier is sized to treat 27.1 mgd AADF (32.2 mgd ADMM), only two final clarifiers are needed to treat the 40.0 mgd wet weather flow.

Condition Assessment.

As noted in the previous facility plan, groundwater passes through pressure relief valves located in the floor of each final clarifier, making it difficult to completely drain the tanks for maintenance. Several final clarifiers have algae and other vegetation growing in the bottom of the clarifier.

In general, the condition of the TF Final Clarifiers is POOR primarily due to the age of the clarifier mechanisms and the groundwater issue. Minor structural concrete cracking, missing handrail and protective coating weathering was noted.

Recommendation.

Since TF - Final Clarifiers will only be used to treat high wet weather flows until the AS Treatment Process is further expanded, improvements are not recommended.

TF - Digesters and Digester Control Building.

Description.

The existing TF Digesters and Digester Control Building are connected cast-in-place concrete structures. The digesters are hydraulic structures and were originally designed with fixed concrete lids, however the fixed lid for Digester no. 2 was replaced with a flexible gas holding membrane cover and converted from a primary to a secondary digester. The Digester Control Building houses boiler equipment on the at-grade first floor and pump mixing and pump transfer equipment in the basement.

Assets that are assigned to these facilities include:

- Sludge Transfer Pumps.
- Mix Pumps.
- Boilers.
- Heat Exchangers.

The activated sludge biomass used in the AS Treatment Process to remove phosphorus (PAOs) in the secondary treatment process releases the stored phosphorus when introduced to anaerobic conditions inside each of the primary digesters. Struvite is formed when magnesium phosphate and ammonia are mixed in solution with the pH above 7.5. CWSID staff report significant struvite formation on AS Digester draft tube mixers and at other locations. To address this issue, several options are being evaluated as part of this facility plan update. See Chapter 5 for additional information regarding this struvite challenge and several alternatives being evaluated to address it.

Per NEC and NFPA 820, Anaerobic Digester Control Buildings that have handling of sludge gas are normally considered Class 1 Division 1 classified areas but may be considered Class 1 Division 2 classified spaces when the space is continuously vented at least six air changes per hour. If not properly ventilated, all electrical items need to meet Division 1 standards. The existing HVAC ventilation equipment capacity should be confirmed and corrected if necessary.

Capacity.

Refer to Digester Section above for basis of design information for both the TF And AS Digesters and Digester Control Buildings.

Condition Assessment.

The TF Digesters and Digester Control Building are considered to be in POOR condition mainly due to structural concerns. Additional structural evaluation is needed to further study the structural damage noted during the assessment. The facility and associated process mechanical equipment seemed to be well maintained and well operated.

Some structural damage due to an earthquake in the spring of 2020 was noted at connections between the Digester Control Building and the Digesters. Some damage was noted on the digesters as well, particularly to the primary digester walls and lid.

MCC-6 (8000 series manufactured by General Electric [GE]) was observed, and a breaker has been replaced following a thermal scan. No other issues have been reported due solely to age. According to GE (now ABB), the 8000 series is still supported by ABB, however VFDs and reduced voltage soft starter units are not available (where applicable).

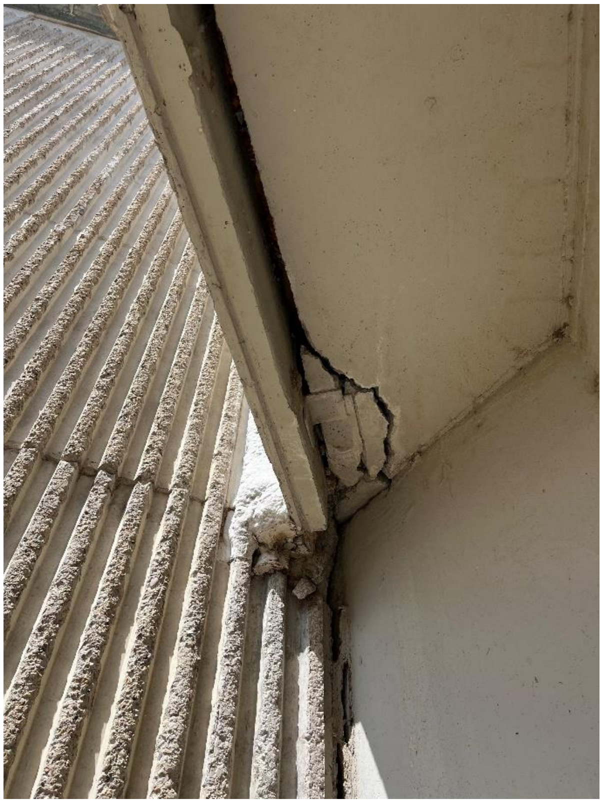


Figure 11-50: Seismic Damage at TF Digesters

Recommendations.

A detailed structural assessment to define the extent of the structural damage noted during the assessment is recommended. Due to its age, the digesters and the digester control building structures likely do not meet current seismic code provisions.

Since CWSID will likely continue to employ an AS Treatment Process that focuses on TP reduction, the potential to form struvite inside digester piping, pumps, mixers, and other equipment will persist. Detailed long-term struvite control strategies evaluated as part of this facility plan update effort are summarized in Chapter 5.

As more biosolids are digested in the future and additional digesters are constructed, CWSID might consider repurposing both existing TF Digesters as secondary digesters.

TF - Utility Water Pump Station.

Description.

The TF Utility Water Pump Station is not currently used while CWSID WRF staff currently operate the AS - Utility Water Pump Station to supply utility water to the CWSID WRF. If used, it would primarily provide utility water to spray bars for scum control at TF Primary and Final Clarifiers.

Process mechanical assets assigned to the TF Utility Water Pump Station include:

- Utility Water Pump Station wet well.
- Utility Water Pump Nos., 1, 2, and 3 and associated piping and valving.

Capacity.

Refer to Utility Water PS Section above for utility water pump station design criteria.

Condition Assessment.

A condition assessment of this facility was not conducted under this facility plan update. The facility was well maintained, clean and no visible structural or mechanical issues were noted.

Recommendations.

Beyond maintaining this equipment in good working order to use during wet weather events as necessary, no recommendations are made at this time. As utility water, irrigation system or other demands increase, CWSID may consider connecting TF Utility Water Pump Station discharge yard piping to AS Utility Water Pump Station discharge yard piping for an interconnected utility water piping system and two pump stations.

AS Treatment Process

The AS Treatment Process will continue to be expanded (currently being expanded under the Phase 2 project) as the TF Treatment Process is abandoned and used only for primary treatment during high wet weather flow conditions. Most of the facilities that make and/or support the AS Treatment Process were constructed under the 2012 Expansion Project and additional AS Treatment Process facilities are currently being constructed under the Phase 2 expansion project. Since these facilities are relatively new, they are in very good condition and do not require much, if any, improvements.

AS - Headworks and Influent Pump Station.

Description.

The AS Headworks and Influent Pump Station is a multi-story structure with one story below grade and two stories above and consists of several unit processes and spaces:

- Screening Room with Influent Channels 1 and 2.

- Vortex Grit Chambers w/ grit removal pumps located in the basement.
- Grit classification area.
- Wet well.
- Dry pit pump station.
- Truck Load out area.
- Electrical Room.
- Control Room.

A septage receiving facility is also attached to the headworks. HVAC equipment used to vent and condition the building space is primarily located outdoors and indoor air is exhausted vertically, high above finish grade without odor treatment provisions. An overflow channel located between the vortex grit chambers allows CWSID WRF to direct plant influent or have it passively overflow to the TF Treatment Process.

The following assets are designated to the AS - Headworks:

- Influent Channels 1 and 2 and related slide gates.
- Influent Screens 1 and 2.
- Screenings washer/compactors 1 and 2 and bins.
- Vortex Grit Chambers 1 and 2 and related slide gates.
- Grit Classifiers and Cyclones 1, 2, and 3 and related piping and valves.
- Grit pumps 1 and 2 and related piping and valves.

Assets designated to the Influent Pump Station include:

- Influent pumps 1, 2, 3, and 4.
- Related piping, knife gates, check valves and electrical equipment.

The facility is designed to be expanded to the west where a mirror image of the existing headworks facility and influent pump station may be constructed.

Capacity.

See AS Headworks Section above for AS - Headworks and Influent Pump Station design criteria.

Condition Assessment.

Due to the limited age of the facility and high level of maintenance, the overall condition of the AS - Headworks and Influent Pump Station is EXCELLENT. The following minor items were noted during the assessment:

1. Wall openings, open pipe ends and missing handrail due to removal of Serpentix™ conveyor. This project was performed in-house by CWSID WRF operations staff, and a few items finalized to limit safety risk.

Figure 11-51: In-House Project to Remove SerpentixTM Open Conveyor

Recommendations.

Since influent flows are not anticipated to exceed the capacity of the influent channels and process equipment before the next facility plan update, a facility expansion is not recommended.

AS - Primary Clarifiers.

Description.

The two existing primary clarifiers and influent flow splitter box are below grade, hydraulic, cast-in-place concrete structures originally constructed as part of the 2012 expansion project. The following assets are designated to the AS - Primary Clarifiers:

- Primary Clarifier Nos. 1 and 2 Influent Flow Distribution Structure and related slide gates and piping.
- Primary Clarifier Nos. 1 and 2 concrete structure, walkway, and access bridge.
- Primary Clarifier Nos. 1 and 2 mechanism, including center column, drive and rake arms.
- Primary Clarifier Nos. 1 and 2 scum beach.

Capacity.

Refer to AS Primary Clarifier Section above for design criteria for the AS Primary Clarifiers. Both primary clarifiers are used as DUTY units and current unit capacity does not allow CWSID WRF staff to take one primary clarifier off-line for maintenance without negatively impacting downstream aeration basins.

Condition Assessment.

Due to its limited age, the AS Primary Clarifiers are in EXCELLENT condition. Clarifier mechanisms may need to be recoated based on manufacturer recommendations and further evaluation of protective coating thickness. CWSID WRF staff noted that material floating on the surface are not being efficiently captured at the scum beach as the material escapes around the end of the skimmer as it travels up the beach.

Recommendations.

Recommended unit process improvements, including recommendations for a new primary clarifier(s), are outlined in Chapter 4. Options to improve the capture of scum and other floatables should be discussed with the clarifier mechanism manufacturer.

Figure 11-52: AS Primary Clarifier Scum Beach

AS - Primary Sludge Pump Station.

Description.

The primary sludge pump station was constructed with the primary clarifiers in 2012 and is a below-grade cast-in-place concrete structure with a scum pit located just outside. Pumps are located in a below grade dry pump pit, electrical and HVAC equipment is located above on the at-grade floor. The following process mechanical assets are designated to the AS - Primary Sludge Pump Station:

- Primary Scum Pump No. 1.
- Primary Sludge Pump Nos. 1 and 2.
- Scum Pit Subnatant Pump No. 1.
- In-line Grinder Nos. 1, 2, and 3.

Capacity.

Refer to AS Primary Sludge PS Section above for design criteria for the AS Primary Sludge Pump Station. Current sludge and subnatant pump capacity and redundancy meet process objectives.

Condition Assessment.

The condition of the AS - Primary Sludge Pump Station is EXCELLENT and deficient items were not observed.

Recommendations.

As no deficiencies were observed, recommended improvements are not provided.

AS - Aeration Basins.

Description.

Each set of aeration basins includes one influent flow splitter box and one mixed liquor flow splitter box. The influent flow splitter box distributes primary influent flow between each aeration basin while the mixed liquor flow splitter box distributes secondary effluent flow between secondary clarifiers.

The following assets are designated part of the aeration basins:

- Influent Flow Splitter Box, weirs, and associated slide gates.
- Aeration Basin Nos. 1 to 4, 5 to 6 concrete basin and channels.
- Mixed Liquor Return Pump Nos. 1 to 8 and 9 to 12.
- Air piping and associated air control valves.
- Diffused air piping and submerged fine bubble air diffusers.
- Floating Mixer Nos. 1 to 16 and 17 to 24.
- Mixed Liquor Flow Splitter Box and associated slide gates.

Capacity.

Refer to Aeration Basins Section above for design criteria for AS Aeration Basins.

Condition Assessment.

The general condition of the existing aeration basins is GOOD due to some concrete cracking due to differential ground settlement below the structure. It is believed that water stop placed in the control joints limit any leakage to the groundwater outside the basins. Some leakage was noted at control joints in mixed liquor return channels, but leakage was interior to the basins and at joints that did not have waterstops. Cracking was noted in the control joints located in suspended slabs (i.e., walkways located on top of basin walls).

Recommendations.

Aeration basins should be taken off-line during regularly scheduled maintenance activities to visually inspect control joints located below the waterline. If any control joints are found to be allowing groundwater into the basins, they should be repaired using a typical control joint repair method. Uplift cracking in suspended decks is a safety concern and not structural or process mechanical concern. To limit the potential for tripping hazards, the edges of concrete slabs at different elevations can be ground flush.

Figure 11-53: Cracking Noted at AS Aeration Basins

In the event UPDES permitted outfalls required new limits for total nitrogen, the aeration basins are designed with provisions to convert to an MLE process where the anaerobic zone of the current A2O process configuration is changed to an anoxic zone. This change would limit the biological removal of total phosphorus and require CWSID to remove phosphorus chemically. This switch is only recommended if, in the future, a low nitrogen limit is required.

AS - Secondary Clarifiers.

Description.

The following assets are designated to the AS - Secondary Clarifiers:

- Secondary Clarifier Nos. 1 to 6 concrete structures, FRP weirs/baffles and walkway bridges.
- Secondary Clarifier Nos. 1 to 6 mechanism with rake arms.
- Secondary Clarifier Nos. 1 to 6 scum beach.

Capacity.

Refer to Secondary Clarifiers Section above for design criteria for the AS Secondary Clarifiers.

Condition Assessment.

No deficiencies were noted during the condition assessment effort and the condition of the AS Secondary Clarifiers was deemed EXCELLENT. Earlier in the year one of the secondary clarifiers was “floated” due to buoyant groundwater uplift forces when it was taken offline and emptied. A portion of the clarifier floor needed to be replaced to repair the damage.

Recommendations.

Recommended launder cover and bird wire improvements are being made under the Phase 2 expansion project. No other recommended improvements are made at this time.

Figure 11-54: AS Secondary Clarifier with Repaired Floor

AS - RAS/WAS and Scum Pump Station.

Description.

The AS RAS/WAS Pump Station is primarily a below grade structure constructed of cast-in-place concrete. The portion of the structure located above grade that houses an electrical room is constructed of CMU. A scum pit is attached to each side of the structure that serves two secondary clarifiers each. RAS, WAS and scum pumps are located downstairs in the below grade portion of the pump station. Three RAS pumps are dedicated to each set of two secondary clarifiers (i.e., two duty and one standby configuration). The following process mechanical assets are designated to the AS - RAS/WAS Pump Station:

Figure 11-55: AS RAS/WAS Pump Station Scum Box

- Scum Pit Nos 1 to 2.
- RAS Pump Nos. 1 to 6.
- WAS Pump Nos. 1 to 3.
- Scum Pump Nos. 1 to 2.
- All related piping and valves.

Capacity.

Refer to Section RAS/WAS and Scum Pump Station Section above for basis of design criteria for the RAS/WAS Pump Station.

Condition Assessment.

The AS RAS/WAS Pump Station was evaluated and found to be in EXCELLENT condition.

Recommendations.

No recommended improvements are provided under this condition assessment.

AS - Digesters and Digester Control Building.

Description.

The two primary digesters are constructed of cast-in-place concrete with a fixed lid and veneer CMU finish on walls and the digester control building is constructed of CMU. The Digester Control Building consists of the following rooms:

- Boiler Room.
- Gas Handling Room.
- Electrical Room.

The AS Digesters and Digester Control Building consist of the following assets:

- Sludge Blend Tank Nos. 1 and 2.

- Sludge Blend Tank Mixing Pump Nos. 1 and 2.
- Blended Sludge Tank Transfer Pump Nos. 1 and 2.
- Primary Digester Nos. 1 and 2.
- Primary Digester No. 1 Draft Tube Mixers 1 to 5.
- Primary Digester No. 2 Draft Tube Mixers 1 to 5.
- Boiler Nos. 1 to 3.
- Primary Recirculation Pumps 1 to 3.
- Hot Water Pump Nos. 1 to 3.
- Sludge Transfer Pump Nos. 1 to 2.
- Gas Drying Unit Nos 1 to 2.
- Blower Nos. 1 to 2.
- Expansion Tank Nos. 1 to 4.
- Glycol Unit.

Capacity.

Refer to AS Digesters Section above for design criteria related to the AS Digesters and Digester Control Building and for discussion regarding TF Digesters and Digester Control as these two facilities are very related.

Condition Assessment.

Similar to other AS Treatment Process facilities which were constructed as part of the 2012 expansion project, the AS Primary Digesters and Control Building are relatively new and are considered to be in EXCELLENT condition.

Struvite formation inside the primary digesters has been a challenge for CWSID WRF staff and the operate two digesters at a time so they can remove struvite from the third. Options to limit struvite formation in the primary digesters is being studied as part of this facility plan update and evaluated alternatives are summarized in Chapter 5.

A fourth primary digester is not anticipated before the next facility plan update if the struvite formation problem is addressed and all three existing primary digesters can be used at same time.

Recommendations.

Based on observations and findings described above, the following actions are recommended:

- Identify and implement a phosphorus sidestream treatment process that will reduce struvite formation in the primary digesters.
- Review alternatives beneficially use digester biogas, including:
  - Operate boilers using digester biogas and discontinue using natural gas.
  - Refer to Chapter 5 for alternative uses of biogas evaluated as part of this facility plan update.

AS - Utility Water Pump Station.

Description.

This facility consists of the following three spaces or rooms:

- Utility Water Wet well.
- Utility Water Pump Station.
- Dechlorination Chemical Storage.

The below grade wet well portion of the structure is a water holding hydraulic structure made of cast-in-place concrete below grade. The above-grade portion of the structure is constructed concrete foundations, split face CMU and metal roof.

The following assets are assigned to this facility:

- Utility Water Pump Station Wet Well and related hydraulic slide gates.
- Utility Water Pump Nos. 1, 2 and 3.
- Utility Water Strainer (Auto backwashing type).
- Sodium Hypochlorite Storage Tank Nos. 1 and 2.
- Repurposed Hypochlorite Feed Pump Nos. 1 and 2.
- Hypochlorite Feed Pump Nos. 1 and 2.

Capacity.

Refer to Section AS Utility Water Pump Station Section above for design criteria for the AS Utility Water Pump Station.

Condition Assessment.

The condition of the AS - Utility Water Pump Station was deemed EXCELLENT. It is a relatively new facility, similar to other AS Treatment Process facilities constructed in 2012 and is well maintained.

Recommendations.

The following deficiencies should be considered:

- Add a flowmeter to the Utility Water distribution piping in the yard to measure utility water flowrate to document and define utility water use and to flow pace chemical sodium hypochlorite dosing to maintain a desired chlorine residual.
- To reduce potential downstream maintenance caused by solids buildup, CWSID might consider replacing the existing strainer with a pressure filter (by Amiad Water Systems or equal).

Other Facilities

Chlorine Contact Basins.

Since the Chlorine Contact Basins will be replaced by a new UV Disinfection Facility under the Phase 2 expansion, they were not evaluated as part of this condition assessment effort.

Dewatering Building.

Description.

The Dewatering Building is an above grade two-story structure constructed of cast-in-place concrete and CMU. This facility was constructed in the 1995 and originally houses two belt filter presses on the second floor and three sludge feed pumps on the first floor. The original facility also employed polymer mix/feed pumps and aging tanks and polymer metering pumps. CWSID has since added a third belt filter press, a fourth sludge feed pump and two polymer mix/dilution panels to feed polymer emulsion from totes and discontinued using the original polymer feed system. The Dewatering Building consists of the following rooms or spaces:

- Belt Press Room (Second Floor).
- Compressor Room (Second Floor).
- Polymer Handling Area (First Floor).
- Pump Room (First Floor).
- Truck Bay (First Floor).
- Office/Control Room (First Floor).
- Electrical Room (First Floor).
- Locker Room (First Floor).

Figure 11-56: Dewatered Cake Haul Truck and Scale

Process mechanical assets attributed to the solids dewatering process include:

- Solids Feed Pump Nos. 1 to 4.
- Belt Filter Press Nos. 1 to 3.
- Troughing Belt Conveyor.
- Flat Horizontal Belt Conveyor.
- Sludge Cake Bin.
- Washwater Booster Pumps.
- Truck Bay with Scale.
- Polymer Emulsion Totes 1 to 2.
- Polymer Mix/Dilution Panels 1 to 2.
- Biosolid Haul Truck.

Capacity.

Refer to Dewatering Section above for basis of design information for the solids dewatering process.

Condition Assessment.

Due to age of the structure, the Dewatering Building is considered to be in MODERATE condition.

The previous facility plan noted that CWSID WRF staff was diluting the sludge feed to the belt filter presses to limit struvite formation. Since then, CWSID WRF staff has been adding flowsperes to limit struvite formation.

The protective coating applied to the building's metal roof framing (i.e., second floor ceiling) was cracking and coming off due to high moisture in the Belt Press Room. A portable fan had been installed by CWSID WRF staff to help address this high moisture.

The low 11 percent solids in dewatered cake and the low percent solids capture (i.e., less than 90 percent) by belt filter press equipment has been noted. To further investigate the cause of low percent solids in the dewatered cake, samples of dewatered cake, feed sludge, pressate, polymer emulsion and makeup water were taken on October 26, 2022 and shipped to the Klaranlagen Beratun Kopp laboratory in Germany for analysis by Dr. Julia Kopp (See website: www.kbkopp.de). Findings from the lab results and analysis will be presented in Chapter 5.

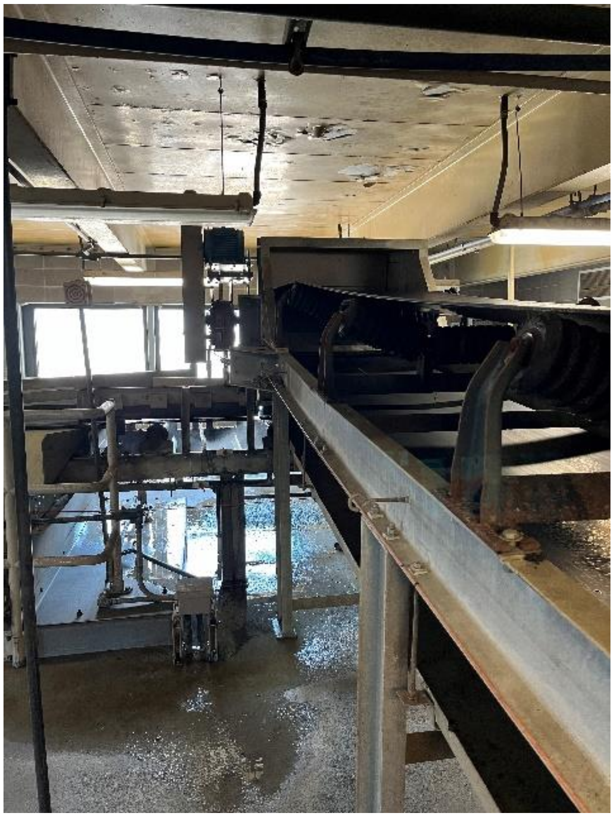


Figure 11-57: Dewatering Building Second Floor Ceiling

Recommendations.

Based on observations and findings described above, the following actions are recommended for the Dewatering Building:

- Identify a side stream treatment option that addresses the potential formation of struvite of eliminates need to dilute sludge feed or add a separate chemical.
- Evaluate ways in which the building's metal framing for the roof can be recoated and address the high humidity in the Belt Press Room. This evaluation will include an evaluation of existing HVAC systems to define current room air changes and ways in which it might be improved.
- Based on findings from the dewatered cake dewaterability study, further evaluate options to improve dewatering. This may likely include additional analysis, discussion with belt filter press manufacturer(s) and other efforts.
- An older model UPS (manufactured by "BEST") serves the area housing the Fiber Optics Patch Cabinet. It is likely that parts and service are no longer available. It is recommended the unit be evaluated for criticality of operation, availability of replacement battery, and possibly replaced with new unit if determined to be difficult to maintain.

Cogeneration Facility.

The condition of the existing Cogeneration Facility was not assessed as part of this facility plan update as this facility has been abandoned and biogas is now flared.

Chlorine Gas Building.

The condition of this facility was not assessed as part of this facility plan update as it will be abandoned as final effluent from the AS Treatment Process is disinfected using the new UV Disinfection facility and final effluent from the TF Treatment Process will be disinfected using stored sodium hypochlorite (12.5 percent solution strength).

CONCLUSIONS AND RECOMMENDATIONS

Since the Trickling Filter Treatment Process is being phased out in favor of the Activated Sludge Treatment Process, it is recommended that only a minimal investment be made in operating and maintaining those facilities and equipment that is used to treat wet weather flows. Consequently, only a few recommendations have been made to maintain these facilities. Since the Activated Sludge Treatment Process is relatively new and well maintained by CWSID WRF staff, related facilities are in excellent condition. Consequently, only a few recommendations have been made to potentially improve these facilities as well. Some improvements or expansion of existing facilities will be required to accommodate new growth, new regulations and to replace items that are now operating beyond their intended service life.

A summary of the facility or unit process condition and a list of potential projects is included in Table 11-31:

Table 11-31
CWSID Condition Assessment Summary Table

Assessed Facility or Unit Process	Condition Assessment	Proposed Improvement or Maintenance Project
TF Headworks	MODERATE	Minimal investment to maintain operational for wet weather flows. Consider demolition when AS Headworks is expanded.
TF Influent Pump Station	MODERATE	Influent pump and/or drive rehabilitation or replacement to maintain firm pump capacity above 40 mgd
TF Primary Clarifiers and Primary Sludge PS	MODERATE	Minimal investment to maintain operational for wet weather flows. Consider demolition as AS Treatment Process is expanded.
		Review NFPA 820 requirements and confirm air exchange rate qualifies space as unclassified
TF Final Clarifiers and Humus Return PS	MODERATE	Minimal investment to maintain operational for wet weather flows. Consider demolition as AS Treatment Process is expanded.
TF Digesters and Digester Control Building	POOR	Further evaluate structural seismic damage and define associated cost to correct.

Table 11-31
CWSID Condition Assessment Summary Table (continued)

		Improve digester gas cleaning system and use digester gas for boilers.
		Consider using both TF Digesters as Secondary Digesters when new AS Digesters are constructed.
TF Utility Water PS	EXCELLENT	Potentially interconnect yard piping between both AS and TF Utility Water Pump Stations
AS Headworks and Influent PS	EXCELLENT	Complete ongoing remodel work to remove Serpentix™ open screenings conveyor.
AS Primary Clarifiers	EXCELLENT	Construct additional primary clarifier(s) to increase capacity
		Explore ways to improve capture of floating material by skimmer and scum beach
AS Primary Sludge Pump Station	EXCELLENT	Construct additional primary sludge pump station with primary clarifier(s)
		Evaluate primary sludge thickening; See Chapter 5
AS Aeration Basins	GOOD	Evaluate expansion joint cracks for potential leaks and correct.
AS Secondary Clarifiers	EXCELLENT	Review standard operating procedures and evaluate options to reduce risk of "floating" clarifier when taken off-line for service.
AS WAS Thickening	EXCELLENT	
AS Digesters and Digester Control Building	EXCELLENT	Evaluate options to address struvite formation. See Chapter 5.
		Improve existing digester gas cleaning system and use digester gas to fuel boilers.
		Evaluate construction of new primary digester against other options. See Chapter 5.
		Review options to better use digester gas. See Chapter 5.
AS Utility Water PS	EXCELLENT	Add a flow meter in yad piping to flow pace chlorine additional and define utility water use
		Evaluate options to remove TSS and improve water quality
Dewatering Building	MODERATE	Review options to improve belt press solids capture.
		Apply new protective coatings to metal framing in second story ceiling.
		Consider options to improve percent solids in dewatered cake.

CWSID may also want to consider the following when addressing plant deficiencies:

- Define the minimal operation and maintenance effort for the following TF Treatment Process equipment:
    - Headworks:
        - Influent Screens.
        - Grit Removal.
    - Control Building:
        - Influent Pumps and related drives.
    - Primary Clarifier and Primary Sludge Pump Station.
    - Final Clarifiers and Humus Return Pump Station.
- Consider demolition or repurposing the following TF treatment Process facilities:
    - Trickling Filters.
    - Cogeneration Building.
    - Chemical Building.
    - Utility Water Pump Station.
    - Chlorine Contact Basin.

As TF Treatment Process primary and secondary clarifiers and associated mechanisms used to treat wet weather flows continue to deteriorate and need to be replaced, CWSID may prefer to invest in new AS Treatment Process equipment and expand its hydraulic capacity to treat 100 percent of wet weather flows over continued investment in TF Treatment Process equipment maintenance and replacement.

Recommended Condition Assessment Projects

From the list on Table 11-31, the following two projects are recommended to extend the useful life of the asset:

1. <u>Dewatering Building:</u> Apply new protective coating to metal framing in second story ceiling. Estimated cost to apply new coating is $150,000.
2. <u>TF Digesters and Control Building:</u> It is recommended to do a seismic and structural analysis study on the Digesters and Control Building to review options to mitigate the risk of structural failure. Estimated cost of the study is $50,000.

CHAPTER 12
PROCESS EVALUATION AND MODELING

INTRODUCTION

This chapter defines the projected capacity ratings and identifies any deficiencies for the various liquid and solids stream treatment processes at Central Weber Sewer Improvement District (CWSID or District) Water Reclamation Facility (WRF or Plant). Evaluation of future activated sludge (AS) treatment process capacity is developed using BioWin® process modeling software to predict the performance of the Plant under future loading conditions and Utah Pollution Discharge Elimination System (UPDES) outfall water quality constraints as described in this Chapter. The hydraulic capacity of WRF under peak flow conditions is also defined. Refer to Chapter 11 for process descriptions and unit capacities of the AS and trickling filter (TF) treatment process major unit processes and their existing capacity. Alternatives to address capacity limitations identified herein and/or to meet potential future UPDES effluent limits are developed and evaluated in Chapter 13. Assessments and recommendations for improving systems that support each major unit processes (e.g., drain pumps, solids pumps, chemical systems) are also considered in Chapter 13.

UPDES PERMIT REQUIREMENTS

The CWSID WRF is operating under a UPDES permit issued in Year 2021 by the Utah Division of Water Quality (UDWQ), Major Municipal Permit No. UT0021911. The UPDES permit allows CWSD to discharge two different receiving bodies, i.e., the Weber River or Warren Canal, where different permit limits are required at each. Table 12-1 summarizes the existing UPDES discharge permit limits for the Weber River and Warren Canal. The current UPDES permit is flow limited where CWSID may discharge 49 million gallons per day (mgd) to each outfall (or 69.5 mgd total flow to both outfalls) as an average day maximum month flow (ADMM) under the following three scenarios:

- Scenario 1: 49 mgd is discharged to the Weber River.
- Scenario 2: 49 mgd is discharged to the Warren Canal.
- Scenario 3: 24.5 mgd is discharged to the Weber River and 45 mgd is discharged to the Warren Canal (total flow of 69.5 mgd).

Daily maximum limits for total residual chlorine (TRC) and low monthly maximum limits for ammonia required by the UPDES discharge permit are significantly higher for the Warren Canal than they are for the Weber River. For this reason, CWSID currently discharges all final effluent to the Warren Canal. However, since the Phase 2 expansion project replaces the existing chlorine gas disinfection process with a new ultraviolet (UV) disinfection process and eliminates any chlorine in the final effluent, it is expected that CWSID will discharge to the Weber River when completed. The Phase 2 expansion project expands the secondary treatment process and improves the nitrification process, helping the AS treatment process meet the lower seasonal ammonia limits on the Weber River.

The existing UPDES permit limits are the primary criteria used in the AS treatment process capacity evaluation. Updated permit requirements are anticipated every 5 years for increasing plant discharge flow but are not anticipating a lower or a new limit for total phosphorus (TP) or total inorganic nitrogen (TIN) for this Master Plan planning period. In contrast to the Technology-Based Phosphorus Effluent Limit (TBPEL) where TP limits of 1.0 milligrams per liter (mg/L) were based on limits of technology, UDWQ has indicated that TIN and lower TP limits will be based on the scientific evaluation of receiving waters throughout the State. The timeline for the establishment of a nitrogen limit or lower phosphorus limits is not clear. CWSID might receive a lower TP or TIN limit by the year 2050 and have one permit cycle or 5 years to comply. Effects on treatment capacities for more stringent nutrient limits are discussed in Section 12.9.

Table 12-1
CWSID UPDES Requirements

	Scenario 1: Weber River (Outfall 001)	Scenario 2: Warren Canal (Outfall 002)	Scenario 3: Weber River and Warren Canal												
Parameter	**Maximum (Max.) Monthly Average (Avg.)**	**Max. Weekly Avg.**	**Yearly Avg.**	**Daily Minimum (Min.)**	**Daily Max.**	**Max. Monthly Avg.**	**Max. Weekly Avg.**	**Yearly Avg.**	**Daily Min.**	**Daily Max.**	**Max. Monthly Avg.**	**Max. Weekly Avg.**	**Yearly Avg.**	**Daily Min.**	**Daily Max.**
Total Flow, mgd	49	-	-	-	-	49	-	-	-	-	69.5(1)	-	-	-	-
BOD(1), mg/L	25	35	-	-	-	25	35	-	-	-	25	35	-	-	-
TSS(1), mg/L	25	35	-	-	-	25	35	-	-	-	25	35	-	-	-
Dissolved Oxygen, mg/L	-	-	-	5.0	-	-	-	-	5.0	-	-	-	-	5.0	-
Total Ammonia, mg/L															
Summer (Jul-Sep)	3.88	-	-	-	19.24	8.22	-	-	-	34.64	3.11	-	-	-	11.55
Fall (Oct-Dec)	4.93	-	-	-	18.11	7.30	-	-	-	25.90	3.05	-	-	-	9.29
Winter (Jan-Mar)	5.14	-	-	-	20.98	9.27	-	-	-	36.06	4.36	-	-	-	14.02
Spring (Apr-Jun)	5.78	-	-	-	23.72	8.84	-	-	-	34.85	4.36	-	-	-	14.39
Total Phosphorus, mg/L	-	-	1.0(2)	-	-	-	-	1.0(2)	-	-	-	-	1.0(2)	-	-
Total Residual Chlorine, mg/L															
Summer (Jul-Sep)	0.014	-	-	-	-	2.032	-	-	-	-	0.017	-	-	-	-
Fall (Oct-Dec)	0.019	-	-	-	-	0.223	-	-	-	-	0.027	-	-	-	-
Winter (Jan-Mar)	0.016	-	-	-	-	0.595	-	-	-	-	0.020	-	-	-	-
Spring (Apr-Jun)	0.018	-	-	-	-	0.208	-	-	-	-	0.024	-	-	-	-
E. coli, No. per 100 milliliters (mL)	126	157	-	-	-	126	157	-	-	-	126	-	157	-	-
pH, Standard Units	-	-	-	6.5	9	-	-	-	6.5	9	-	-	-	6.5	9

[1] Abbreviations: BOD = biochemical oxygen demand; TSS = total suspended solids.

[2] Flow total is divided between 24.5 mgd to the Weber River and 45 mgd to the Warren Canal. Limits under Scenario 3 where a portion of flow is split between the outfalls is not listed.

[3] Effective January 1st, 2025. Interim Total Phosphorus limit is 1.5 mg/L.

UNIT PROCESS TREATMENT CAPACITY

The primary purpose of the treatment capacity evaluation is to define when a certain unit process needs to be upgraded and its treatment or hydraulic capacity increased. Typically, facilities are expanded due to changing permit limits or to meet new growth. For each unit process, there is different design criteria that may “trigger” the need for additional capacity. Table 12-2 defines the “trigger” with treatment and hydraulic design and redundancy criteria used in the process model evaluation. Liquid stream unit processes for the TF Plant are not a part of this treatment capacity evaluation except those that are critical to treatment during wet weather flows (TF influent pumps and TF disinfection).

Table 12-2
CWSID Unit Process Modeling Design Criteria

Unit Process	Design Parameter	Treatment Criteria	Hydraulic Criteria	Redundancy Criteria
Primary Treatment				
Screening (2)	PHF(1)	60 mgd	80 mgd (1)	OOS(1)
Grit Removal	PHF	70 mgd	80 mgd (1)	OOS
Influent Pumping				
AS Influent PS(1) (4)	PHF	-	75 mgd (2)	One Pump OOS
TF Influent PS (4)	PHF	-	40 mgd (115(4) - 75)	One Pump OOS
Primary Clarifiers (2)	PHF MMDF(1) AADF(1)	- 1,200 gpd/sf(1) 1,000 gpm/sf	Hydraulically Pass - -	All units in service
Secondary Treatment				
Aeration Basins (6)	PHF Max. Month Wet Weather MMDF	- aSRT(1) = 8 days aSRT = 12 days	Hydraulically Pass - -	All basins in service All basins in service All basins in service
Secondary Clarifiers (6)	PHF MMDF AADF	SOR(1) = 1200 gpd/sf SOR = 600 gpd/sf SOR = 400 gpd/sf	- - -	All units in service All units in service All units in service
Disinfection				
AS UV Disinfection	PHF Max. Monthly Flow	75 mgd 58.8 mgd	- -	All Channels in service One Channel OOS
TF Sodium Hypochlorite	PHF	CT(1) = 30 mg/L-min	40 mgd	One Chem Feed Pump OOS; 10 mg/L Dose

Unit Process	Design Parameter	Treatment Criteria	Hydraulic Criteria	Redundancy Criteria
Solids Handling				
WAS(1) Thickening GBTs(1) (2)	Max. Week WAS Flow	?(5)	HLR(1): 300 gpm	One unit OOS
Anaerobic Digestion				
Primary Digesters (3)	Max. Month Load Max. Month Load	SRT(1) = 20 days, VSL = 0.12 ppd/cf SRT = 15 days, VSL = 0.15 ppd/cf	- -	All units in service One unit OOS
Dewatering Belt Filter Presses (3)	Max. Week Load	SLR(1): 4,400 lbs/day(1)	HLR: 400 gpm	One unit OOS

[1] Abbreviations: AADF = annual avg. daily flow, aSRT = average solids retention time, CT = contact time, GBT = gravity belt thickener, gpd/sf = gallons per day per square foot, gpm = gallons per minute, HLR = hydraulic loading rate, lbs/day = pounds per day, MMDF = max. monthly daily flow, OOS = out of service, PHF = peak hour flow, ppd/cf = pounds per day per cubic foot, PS = pump station, SLR = sludge loading rate, SOR = surface overflow rate, SRT = solids retention time, WAS = waste activated sludge, VSL = volatile solids loading.

[2] Hydraulically modeled capacity of unit with one unit out of service.

[3] Hydraulically modeled AS Plant capacity. See Section 12.7.

[4] Projected 2050 wet weather PHFs. See Chapter 10 for flow projections.

[5] Solids loading capacity of GBTs is unknown at this time.

MODELING CALIBRATION AND RESULTS

A plant-wide process model was created using BioWin version 6.2 and calibrated to the latest year of operation, January to December of 2021. Existing plant data from 2019 to 2021 was used to estimate projected loads as discussed in Chapter 10. It is assumed that all future flows will be directed to the AS treatment process once the Phase 2 project is completed in 2025.The TF treatment process is used only for high wet weather flow events. From 2019 to 2021, approximately 21 percent of the total influent flow was sent to the TF treatment process. Results from the process model are discussed in this Chapter and supplemental data and supporting figures are found in Appendix A showing modeled vs historically measured values.

The treatment capacity limitations for both liquid and solids streams are discussed in the following sections. Hydraulic capacity of each unit process is discussed in Section 12.8.

LIQUID STREAM TREATMENT CAPACITY

Screening

The two existing headworks screens located in the AS Headworks were installed in 2012, are rated for 60 mgd each, and 120 mgd total capacity when both units are in service. Guidelines for influent screening reliability set forth by UDWQ in Utah Administrative Code R317-3.5.2 indicate each screen must be sized to handle the peak design flow rate. CWSID normally operates with both screens in service, providing sufficient capacity to meet the 2050 weather peak hour flows (110 mgd) but in the event only one screen is available during a peak hour event, its hydraulic capacity can be pushed to 80 mgd while surcharging the upstream influent channel. Under this scenario, the water surface elevation in the influent channel increases by 1 inch of freeboard in the channel, and screening and capture performance is negatively impacted. However, the occurrence of a high wet weather event exceeding 80 mgd with one screen in service is unlikely, and the impact to overall plant performance is negligible. Although influent flow can be directed to the older screens located in the TF Headworks, if necessary, it is recommended that additional AS Headworks influent screening capacity be evaluated when maximum month flows exceed the rated capacity of one influent screen (estimated to be in 2045).

Grit Removal

CSWID has two vortex grit basins, sized for 70 mgd each. Under normal operation, both units run continuously for a total combined capacity of 140 mgd. The same UDWQ reliability guidelines that apply to influent screens also apply to grit removal. Peak hour flows must not exceed the unit capacity of a single unit (i.e., duty plus standby configuration). Consequently, an additional grit removal basin is needed to pass peak hour flows when the other basin is out of service or grit removal performance will decrease. Since the hydraulic capacity of one grit basin is 80 mgd, it is recommended that a new grit removal basin(s) be constructed at the same time as the new influent screen(s).

Influent Pumps

Under the Phase 2 expansion project upgrades, CWSID will have a total of four influent pumps rated at 30 mgd each. With one pump out of service, total firm pump capacity is 90 mgd. New influent pumps will be added in the future when the headworks building is expanded. In the meantime, influent pumping will be limited to the hydraulic capacity of the AS treatment process which, after the Phase 2 expansion project, will be 75 mgd. As additional primary clarifiers, aeration basins, and secondary clarifiers are constructed, and AS treatment process is expanded, influent pump capacity will need to be increased to match.

The TF Influent Pump Station has four available pumps and a firm hydraulic capacity of 66.9 mgd, which exceeds the projected maximum wet weather flow of 40 mgd that would be diverted to the TF treatment process. Replacement of TF pumps is contingent upon maintenance and service life of the equipment. See Chapter 11 for condition assessment of TF influent pumps.

Primary Clarifiers

CWSID continuously operates two 145-foot primary clarifiers to remove surface scum and TSS from primary influent, including non-soluble BOD. Primary clarifier performance was modeled assuming the values shown in Table 12-3.

Table 12-3
Primary Clarifier Modeling Assumptions

Parameter	Selected Parameter
Primary Clarifiers	
Percent Primary Clarifier Bypass, %	1.9[1]
Minimum Primary Sludge Flows	
Maximum Primary Sludge Total Solids, %	4[3]
Minimum Primary Clarifier TSS Removal, %	50[2]
Minimum Primary Sludge Flows	
Maximum Primary Sludge Total Solids, %	3[3]
Minimum Primary Clarifier TSS Removal, %	65[2]
Maximum Month Primary Clarifier Percent TSS Removal, %	57[2]
Maximum Month Primary Clarifier Percent BOD Removal, %	35

[1] Average annual bypass flow for 2021.

[2] Average calculated PC TSS removal is 57% (accounting for bypass); 25th percentile TSS removal is 51% and 75th percentile TSS removal is 65%.

[3] 25th percentile primary sludge total solids (TS) concentration is 3.1% and 75th percentile is 4.1%.

The performance of the primary treatment system is linked to the capacity of the secondary system since lower primary clarifier removal rates result in higher loads (and thus reduced capacity) to the secondary process. For CWSID, this link is even more prevalent with the ability to bypass primary influent directly to the Aeration Basins. The ability to bypass primary clarification provides needed carbon for biological phosphorus removal in downstream aeration basins. It is recommended to only bypass enough primary influent to sustain effluent phosphorus concentrations below the permit limit of 1.0 mg/L TP. Once Phase 2 is completed, modeling has shown that 20 mgd of primary influent can be bypassed under average flow conditions and still meet BOD and ammonia discharge permit limits.

To reduce BOD and TSS loading to the secondary treatment process, primary clarifier performance is best achieved at certain design SORs. The existing primary clarifiers were sized for an average annual day SOR of 1,024 gpd/sf with anticipated TSS removal rates of 60 percent and BOD removal rates of 35 percent. A review of historical data shows a correlation between clarifier TSS removal performance and the clarifier SOR, where higher removal rates are typically seen at lower SORs as illustrated in Figure 12-1. As primary clarifier removal rates for BOD and TSS decrease due to increasing SORs, more load is placed on aeration basins, thus reducing the capacity of secondary treatment.

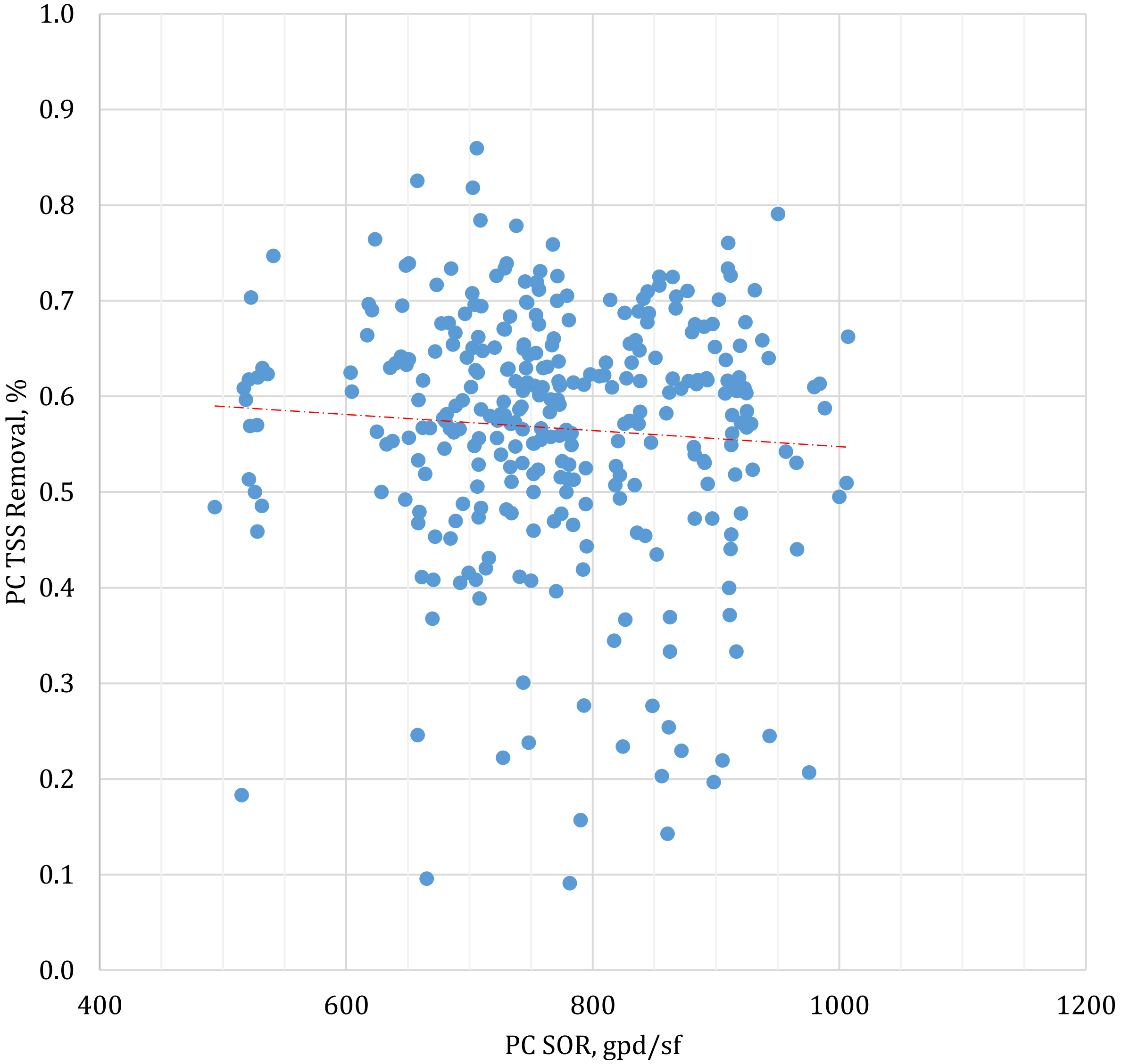


Figure 12-1: Primary Clarifier TSS Removal versus Surface Overflow Rate

CWSID should consider adding additional primary clarifiers when design SOR of 1,200 gpd/sf for MMADFs and 1,000 gpd/sf for AADFs is exceeded. Table 12-4 shows the SORs for the current two, and future three primary clarifiers with projected future flows for AADF and MMADF. Table 12-4 assumes all primary clarifiers are in service with an additional 1 mgd of recycle flows. SOR values highlighted in red exceed the designated design criteria.

Table 12-4
PC Surface Overflow Rates for Projected AADF and MMADFs

	Average Annual Day Flow		Max Month Average Day Flow	
Year	**2 Primary Clarifiers SOR (gpd/sf)**	**3 Primary Clarifiers SOR (gpd/sf)**	**2 Primary Clarifiers SOR (gpd/sf)**	**3 Primary Clarifiers SOR (gpd/sf)**
2022	1,175	783	1,478	985
2025	1,238	826	1,544	1,029
2030	1,320	880	1,632	1,088
2035	1,402	935	1,720	1,147
2040	1,475	983	1,799	1,199
2045	1,531	1,020	1,859	1,239
2050	1,556	1,058	1,889	1,260

Based on the projected SORs, it is recommended that a third primary clarifier be designed and constructed. The 2017 Master Plan also recommended a new primary clarifier be constructed in Phase 3 estimated to begin in 2029. A fourth primary clarifier would not be required until the 2042-to-2045-time frame, but CWSID might consider constructing the third and fourth primary clarifiers together since considering earthwork and yard piping effort would be easier and cost less and the additional clarifiers offers improved process performance and cost savings. The new primary clarifier(s) would be designed with all ancillary equipment and include a new primary sludge and scum pumping facility that would serve both Primary Clarifiers 3 and 4.

Aeration Basins

Modeling secondary treatment processes included six Aeration Basins in anaerobic-anoxic-aerobic (A2O) and the assumptions shown in Table 12-5. Aeration Basin treatment capacity is limited during winter months when colder water temperatures lead to lower oxygen transfer efficiencies and reduce BOD removal and decrease rates for nitrification. The addition of a new aeration basin(s) is based on a 12-day aSRT during the winter months and a maximum allowable mixed liquor suspended solids (MLSS) concentration of 3,450 mg/L. The model assumes all Aeration Basins are in service and that one secondary clarifier is not in service due to maintenance. Modeling projections show the 12-day aSRT starts to drop during the winter months of year 2035.

Expanding the AS treatment process to include additional Aeration Basin capacity is recommended by the year 2035. It is recommended that CWSID construct new Aeration Basins 7 and 8 together, to help with constructability, save on construction costs, and accommodate the pre-planned location of the new return activated sludge (RAS)/WAS building on the southwest wall of Aeration Basin 8. Constructing Aeration Basins 7 and 8 together will also allow CWSID the ability to have one basin out of service during the winter months and still be able to meet CWSID permit limits. To support the new aeration basins, a new blower should be purchased and installed in the existing Blower Building, but only if both aeration basins are built together.

Since nutrient limits are not anticipated to change over the planning period, the new aeration basins would be constructed with similar tank configuration and A2O process flow scheme.

Table 12-5
Aeration Basin Modeling Assumptions

Parameter	Selected Parameter
Aeration Basins	
Minimum winter month temperature, Celsius	10
Minimum winter month temperature, Celsius	14
Minimum winter aSRT, days	12
Minimum summer aSRT, days	8
Maximum allowable MLSS	3,450
RAS rate, %	50
Observed Yield	0.79

Secondary Clarifiers

CWSID currently has four secondary clarifiers with two new clarifiers under construction as part of the Phase 2 expansion project. The six 145-foot-diameter secondary clarifiers settle suspended solids from Aerations Basins 1 through 6. Process capacity of secondary clarifiers depends on settling performance of MLSS, which is defined by the measured sludge volume index (SVI), MLSS concentrations, RAS recycle rates, and SORs. Secondary clarifier process modeling used the following assumptions for projecting future process performance.

Table 12-6
Secondary Clarifier Modeling Assumptions

Parameter	Selected Parameter
Secondary Clarifiers	
SVI	150
Maximum MLSS concentration, mg/L	3,450
RAS Recycle Rate, %	50

Properly designed SORs for secondary clarifiers ranges between 400 and 450 gpd/sf at AADF and between 500 and 560 gpd/sf at MMADF. Table 12-7 shows SORs for secondary clarifiers at projected AADF and MMADFs. The table assumes all secondary clarifiers are in service with an additional 1 mgd in recycle flows. Highlighted SOR values indicate SORs exceed the designated design criteria, indicating a need to expand capacity.

Table 12-7
Secondary Clarifier (SC) Surface Overflow Rates for Projected AADF & MMADFs

Year	Average Annual Day Flow			Max Month Average Day Flow		
	6 SC SOR (gpd/sf)	7 SC SOR (gpd/sf)	8 SC SOR (gpd/sf)	6 SC SOR (gpd/sf)	7 SC SOR (gpd/sf)	7 SC SOR (gpd/sf)
2022	392	336	294	493	422	369
2025	413	354	354	515	441	386
2030	440	377	377	544	466	408
2035	467	401	401	573	491	430
2040	492	421	421	600	514	450
2050	529	453	453	640	548	480

Based on the projected SORs, a seventh secondary clarifier is needed by the year 2035. Since this timeframe coincides with the timeframe for new aeration basin(s), it is expected that both Secondary Clarifiers 7 and 8 will be constructed at the same time as Aeration Basins 7 and 8. A scum removal pump station and RAS/WAS pumps station would be constructed as well.

Sludge Volume Index. The SVI is a calculation that represents the settleability of MLSS. A high SVI value (milliliters per gram [mL/g]) indicates poor settling performance and compaction while a low value (e.g., below 80 mL/g or less) indicates a dense sludge with rapid settling characteristics. SVI values for conventional activated sludge processes typically range between 80 and 250 mL/g. Review of historical SVI data at the AS Secondary Clarifiers shows that during winter months, SVI is mostly below 150 mL/g but during the summer months it is often above 150 mL/g. The 30-day running average for winter months is 134 mL/g and for summer months it is 214 mL/g. See Figure 12-2 for historical SVI data. Higher SVI during the summer months increases RAS recycle rates and reduces the maximum allowable MLSS in the Aeration Basins, thus reducing the secondary treatment capacity. Should SVI values during the summer months continue to increase, the aSRT would drop below 8 days and a new Aeration Basins would be needed sooner.

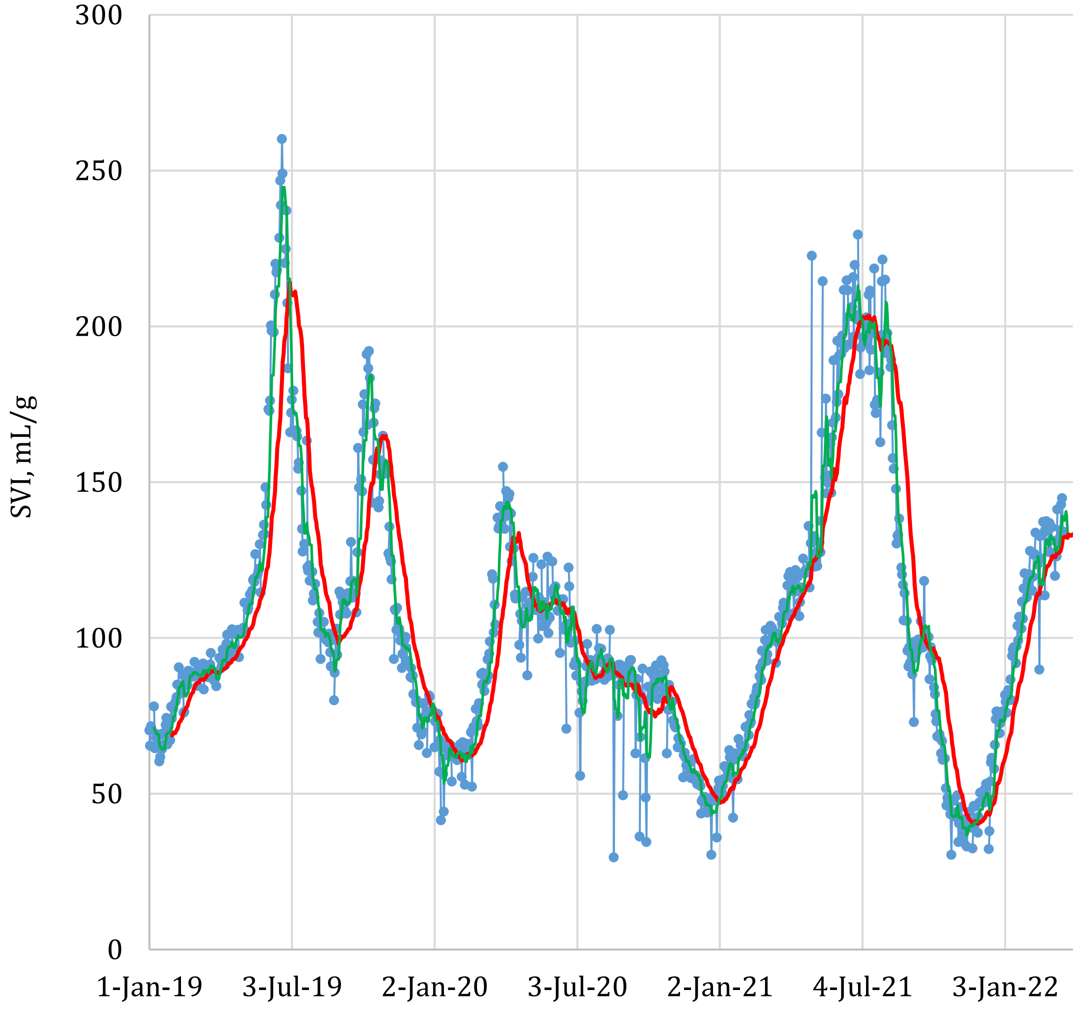


Figure 12-2: Historical Sludge Volume Index (SVI)

UV Disinfection

A new UV Disinfection Facility was designed and is currently being constructed under the Phase 2 project that replaces the existing chlorine gas disinfection process. The UV Facility is built inside the existing chlorine contact basin (CCB) by retrofitting one of basins. Sizing for the UV Facility was based on the AS treatment process hydraulic capacity for Aeration Basins 1 through 6. The Facility was designed for peak hour flows of 75 mgd and max month flows of 58.8 mgd with one channel out of service. The ability to add more UV treatment within the existing CCB is restricted by final effluent pipe hydraulics and constructability; therefore, additional UV treatment will require a new building located south of the CCB. A new UV facility will be needed when Aeration Basins 7 and 8 are constructed but should be sized to accommodate future flows from Aeration Basins 7 through 12. New final effluent pipe(s) and effluent flow meters would also be constructed with the new UV facility.

Sodium Hypochlorite

Sodium hypochlorite will be used to disinfect a 40 mgd flow sent to the TF treatment process during wet weather events. As the AS treatment process is expanded, less wet weather flow will be sent to the TF treatment process and therefore, future capacity upgrades will not be needed.

Figure 12-3 summarizes the timeline for capacity upgrades of each liquid stream unit process. Refer to Table 12-2 for triggering criteria for each unit process.

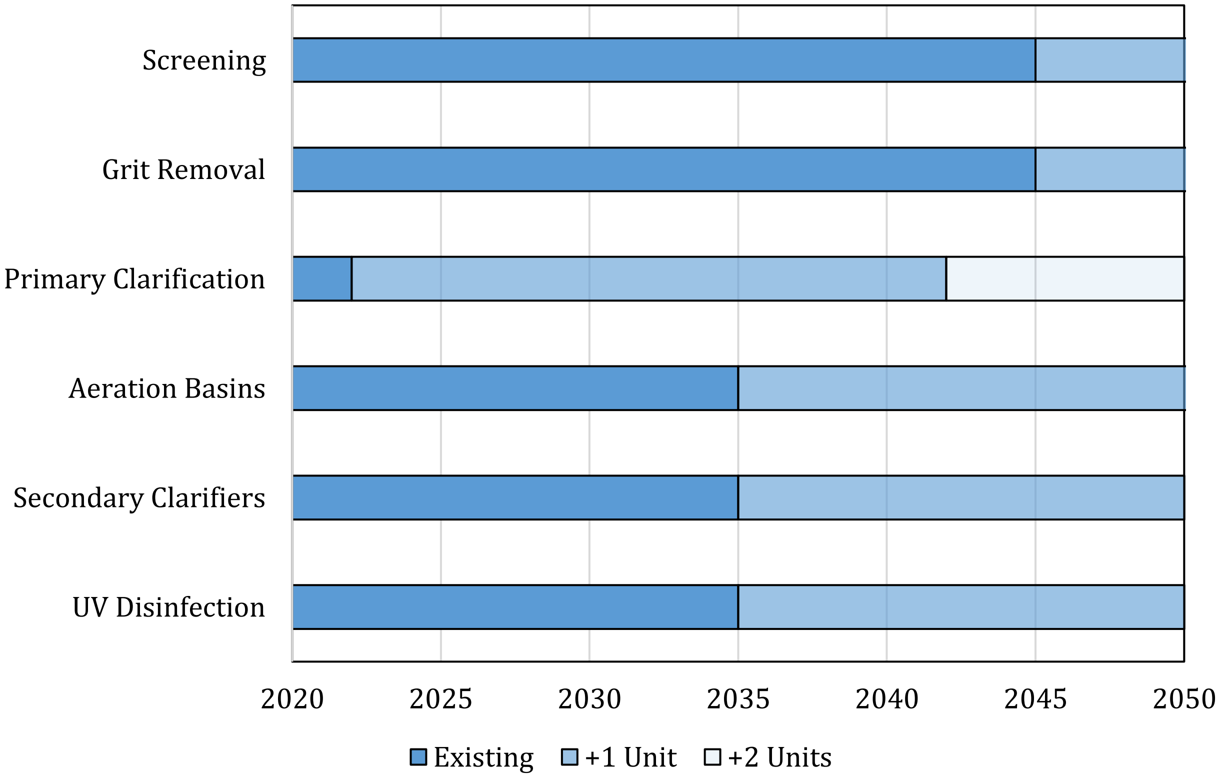


Figure 12-3: Liquid Stream Unit Processes Upgrade Timeline

SOLID STREAM TREATMENT CAPACITY

WAS Thickening

WAS is thickened from between 0.5 and 0.8 percent to between 4 and 5 percent using two 2-meter gravity belt thickeners before being pumped to pre-digestion blend tanks. WAS thickening is operated continuously, 7 days a week. Projected WAS flows and loads for thickening were discussed previously in Chapter 10 and thickening process assumptions for modeling are outlined in Table 12-8.

Table 12-8
WAS Thickening Modeling Assumptions

Parameter	Selected Parameter
Thickening	
WAS Thickening Percent Capture Rate, %	95
WAS Total Solids, %	0.5-0.8
Thickened WAS (TWAS) Total Solids, %	4

The nameplate hydraulic capacity for each gravity belt thickener is 150 gpm per meter of belt width, or 300 gpm per unit. CWSID staff have indicated gravity belt performance drastically decreases when flows exceed 300 gpm. For this reason, it is recommended that the gravity belt thickeners not be operated beyond hydraulic loading rate of 300 gpm and the total number of units should include one unit out of service. Equipment operation and maintenance manuals indicate solids throughput is 1,200 pounds per hour at a solids sludge feed concentration ranging between 2 and 4 percent. Since the current WAS sludge feed concentration ranges between 0.5 and 0.8 percent, the solids loading rate capacity for each unit is unknown at this time. Future projected WAS solids flow rates shown in Chapter 10 show 2030 and 2040 maximum month WAS flows in the range of 268 to 298 gpm and 317 to 354 gpm, respectively. A new gravity belt thickener with associated TWAS pumping/piping should be installed by the year 2034.

Primary Digestion

CWSID has three Primary Digesters used for volatile solids reduction and gas production and one Secondary Digester that is used to store biogas and digested sludge storage before it is dewatered. The design criteria are listed in Table 12-2, projected WAS and PS flows are listed in Chapter 10, and other modeling assumptions are shown in Table 12-9.

Table 12-9
Primary and Secondary Digestion Modeling Assumptions

Parameter	Selected Parameter
Primary and Secondary Digestion	
Active Volume of Primary Digesters, %	95
Active Volume of Secondary Digester, %	50
Gas Composition, % Methane (CH4)	60

To comply with the Environmental Protection Agency Part 503 biosolids requirements for Class B biosolids, an SRT greater than 15 days is required. A Class B biosolids designation allows CWSID to continue to land apply biosolids and to reduce odors of biosolids placed on drying beds for additional dewatering. Meeting the Class B 503 requirement is crucial to the solid disposal avenues available to the District. Table 12-10 shows the firm and total SRTs for three and four Primary Digesters. At year 2040, the firm SRT for three Primary Digesters is at 15 days, indicating the need for more digester capacity. Additional digester capacity would need to also include a new Digester Control Building to house transfer recirculation pumps, boilers, electrical room, and all associated piping/valves.

VSL criteria is critical to assure the sludge in the digester is not too thick for effective mixing. Analysis of VSL shows that VSL is not the controlling parameter when considering expanding digesters capacity.

Table 12-10
Maximum Month Digester Capacity

Year	3 Digesters				4 Digesters			
	Total SRT, days	Firm SRT, days	Total VSL, ppd/cf	Firm VSL, ppd/cf	Total SRT, days	Firm SRT, days	Total VSL, ppd/cf	Firm VSL, ppd/cf
2022	28.9	20.6	0.06	0.09	-	-	-	-
2030	24.7	17.6	0.08	0.11	-	-	-	-
2040	21.4	15.0	0.09	0.12	27.5	21.4	0.07	0.09
2050	19.4	13.8	0.10	0.13	25.0	19.5	0.07	0.10

Biogas produced from the primary digesters is currently stored in the secondary digester and flared. Other potential beneficial uses of biogas are evaluated and discussed in Chapter 13. Historical biogas flows and projected biogas production are shown in Figure 12-4.

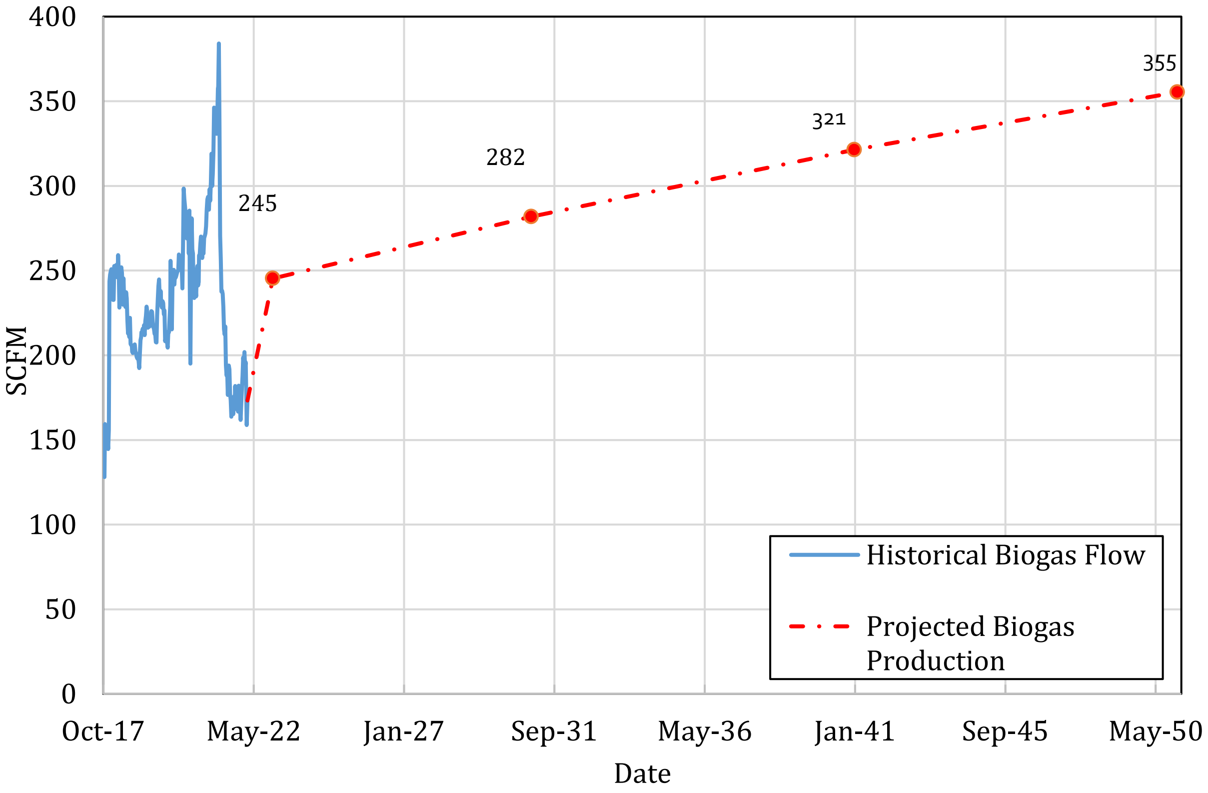


Figure 12-4: Annual Average Gas Projection

Dewatering

CWSID currently operates three belt filter press units where each unit has a hydraulic capacity of 200 gpm and can accommodate a solid loading rate of 2,200 dry pounds per hour. The assumptions used to model the dewatering process are listed in Table 12-11.

Table 12-11
Dewatering Modeling Assumptions

Parameter	Selected Parameter
Dewatering	
Percent Capture Rate, %	90
Cake Solids, %	10
Washwater flow per unit, gpm	220

Figure 12-5 shows measured daily dewatered cake in pounds per day (ppd) versus modeled cake produced. The percent capture rate assumed for modeling is 10 to 15 percent higher than measured data. Since the normal capture rates for belt filter presses typically ranges between 90 and 97 percent, the assumed 90 percent value is low. Low measured values suggest solids are not being captured on the belt and are being recycled back to the headworks with the pressate. This could be due to either high washwater flows, polymer dose, or performance of the belt. Since solids production projections with lower solids dewatering capture rates risks overestimating solids projections and timeline for capacity improvements, it is recommended that further investigation of poor solids capture rates. Carollo Engineers, Inc. (Carollo) also recommends further sampling of scheduled solids concentrations of the pressate and review of ways to improve belt filter press performance, such as polymer optimization, washwater flow rates, or verification of performance with only two belt presses in service.

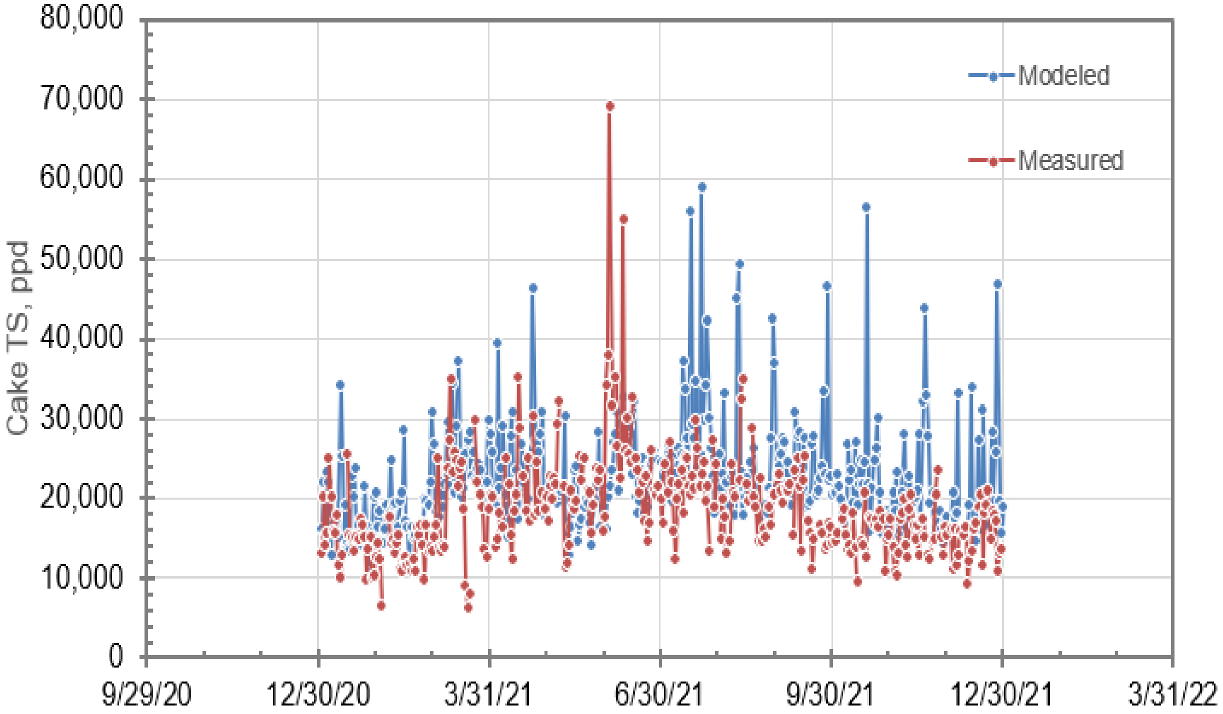


Figure 12-5: Dewatered Cake Total Solids (TS) Loading - Modeled vs Measured

Projected solids production for max week loads and flows are shown in Table 12-12. Projected 2050 firm HLR and SLRs can be met with two belt filter presses in operation, allowing for one unit out of service as a standby. Belt filter press capacity is sufficient until planning year 2050 when additional capacity is reassessed in sequential facility plan updates.

Table 12-12
Projected Solids Production, Max Week Load

Year	Firm HLR, gpm	Firm SLR, pound per hour per unit	Cake Solids, ppd	Cake, wet tons per day
2030	167	1,836	39,658	198
2040	193	2,154	46,530	233
2050	216	2,242	50,580	253

Figure 12-6 summarizes the timeline for capacities upgrades of each solids stream unit process. Refer to Table 12-2 for triggering criteria for each unit process.

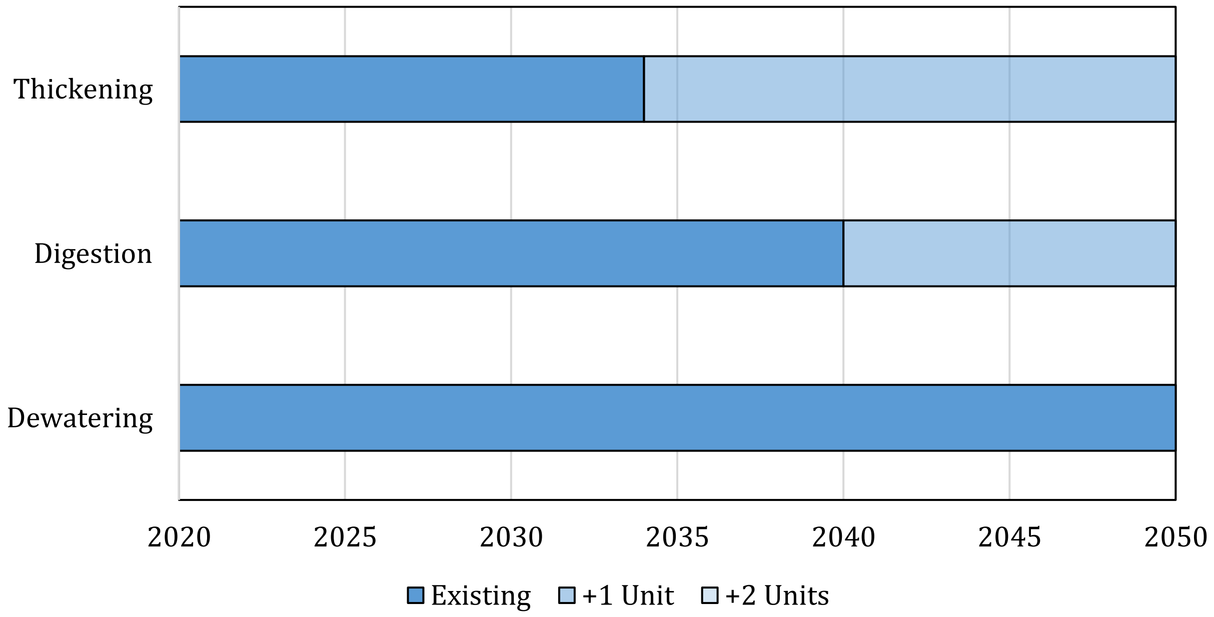


Figure 12-6: Solids Stream Unit Processes Upgrade Timeline

HYDRAULIC CAPACITY

A hydraulic profile was developed for the CWSID wastewater treatment plant during design of the Phase 2 expansion project, together with existing 2012 plant expansion drawings. The limits of the analysis extend from the Headworks Facility through the AS plant and out to the Weber River/Warrant Canal. Carollo hydraulic plant modeling software Hydraulics® was used for the analysis.

Approach and Assumptions

The model developed individual unit process hydraulic capacities as well as an overall peak hydraulic capacity (i.e., hydraulic profile) through the Plant at the PHF and average day conditions. The following criteria were used to define hydraulic capacity of each unit process:

- Weir Submergence. Under PHF conditions a 3.5-inch minimum elevation should be maintained between the weir elevation and the downstream water surface elevation.
- Freeboard. Freeboard was defined as the distance between the water surface elevation and the top of a structure wall and/or bottom of the concrete slab. The required freeboard to establish capacity was assumed to be 30 inches, and plant hydraulic capacity was defined as the flow that can be passed through the WRF without violating the minimum freeboard criterion at any processes structure.

The following general assumptions were made in evaluating the capacity of each unit process:

- Influent pumping can only pump the hydraulic capacity of the AS Plant. All other flows must be sent to the TF plant.
- Firm hydraulic capacities are evaluated for aeration basins and secondary clarifiers. It is assumed that both Primary Clarifiers and all UV channels are in service for hydraulic evaluation.

- Plant drain flows, pressate and filtrate recycle flows, and non-potable water flows are not accounted for in this analysis.
- RAS recycle flows are 50 percent of influent flow.
- The hydraulic profile assumes the gate opening at the inlet box of the CBB is fully open.

Results and Limitations

See Table 12-13 for hydraulic capacities of each liquid stream process. In most cases, a unit process' hydraulic capacity was defined by a submerged weir condition, except for UV disinfection where the freeboard water surface elevation (WSE) to finished floor is 8 inches.

Table 12-13
Hydraulic Capacities of Each Liquid Stream Process

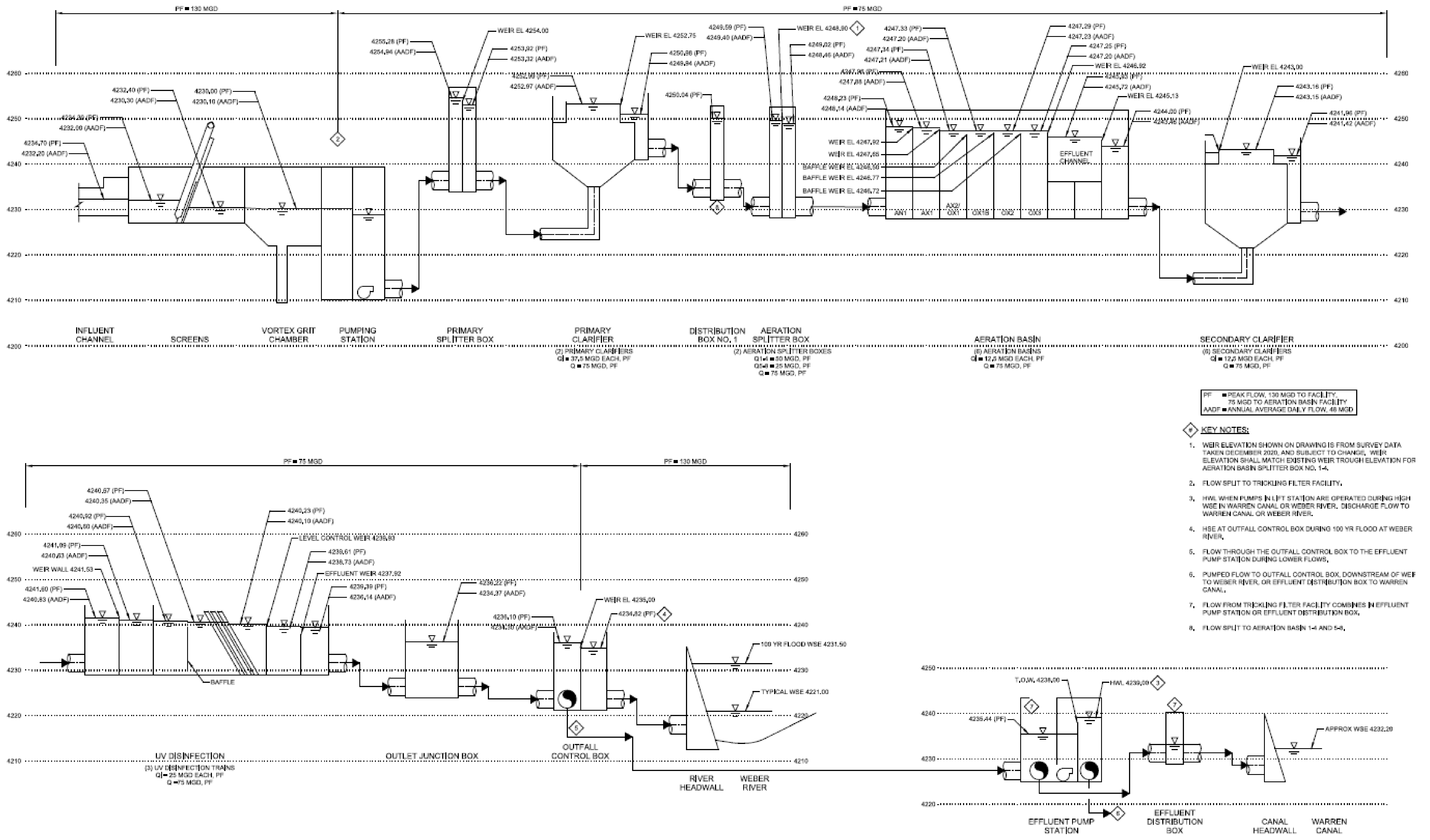
Unit Process	Downstream Control	Upstream Control	Weir Limit (mgd)	Freeboard limit (mgd)
Primary Clarifiers (PC)	PC Weirs	PC Splitter Box Weirs	66	102
Primary Effluent (PE) Piping	AB Splitter Box Weirs	PC Weirs	98	98
Aeration Basins (AB)	AB Effluent Weir	AB Splitter Box Weir	84	100
Secondary Clarifiers (SC)(1)	SC Weirs	Mixed Liquor Splitter Box Weirs	105	-
UV Disinfection	UV Control Weirs	SC Weirs	82	-
Final Effluent (FE) Pipe	100-year flood elevation, Weber River	UV Control Weirs	75	-

[1] Assumes one SC out of service

The hydraulic capacity of the AS plant when the Weber River is at the 100-year flood elevation is estimated to be 75 mgd, limited by the FE piping and Aeration Basin Splitter Boxes. This condition is reflected on the hydraulic profile shown in Figure 12-7 and is the maximum hydraulic capacity of the AS Treatment Plant.

The following hydraulic choke points and general observations are as follows:

- Each additional Aeration Basin/Secondary Clarifier adds 15 to 16 mgd of hydraulic capacity for the secondary process.
- Hydraulic choke points are located at the secondary clarifier weir and the UV control weir. The limited freefall over the UV control weir is due to the hydraulic capacity of the final effluent pipe.
- During 100-year flood elevations on the Weber River, the outlet control box has 2 inches of freefall over the weir. Submergence of weir would cause effluent to flow to the Warren Canal.



PF = PEAK FLOW, 130 MGD TO FACILITY,
75 MGD TO AERATION BASIN FACILITY
AADF = ANNUAL AVERAGE DAILY FLOW, 48 MGD

KEY NOTES:

1. WEIR ELEVATION SHOWN ON DRAWING IS FROM SURVEY DATA TAKEN DECEMBER 2020, AND SUBJECT TO CHANGE. WEIR ELEVATION SHALL MATCH EXISTING WEIR TROUGH ELEVATION FOR AERATION BASIN SPLITTER BOX NO. 1-4.
2. FLOW SPLIT TO TRICKLING FILTER FACILITY.
3. HWL WHEN PUMPS IN LIFT STATION ARE OPERATED DURING HIGH WSE IN WARREN CANAL OR WEBER RIVER. DISCHARGE FLOW TO WARREN CANAL OR WEBER RIVER.
4. HSE AT OUTFALL CONTROL BOX DURING 100 YR FLOOD AT WEBER RIVER.
5. FLOW THROUGH THE OUTFALL CONTROL BOX TO THE EFFLUENT PUMP STATION DURING LOWER FLOWS.
6. PUMPED FLOW TO OUTFALL CONTROL BOX, DOWNSTREAM OF WEIR TO WEBER RIVER, OR EFFLUENT DISTRIBUTION BOX TO WARREN CANAL.
7. FLOW FROM TRICKLING FILTER FACILITY COMBINES IN EFFLUENT PUMP STATION OR EFFLUENT DISTRIBUTION BOX.
8. FLOW SPLIT TO AERATION BASIN 1-4 AND 5-8.

Figure 12-7: CWSID AS Plant Hydraulic Profile

FUTURE NUTRIENT REGULATIONS

This Section will examine the potential for future TIN or TP limits at CWSID and address process options to meet such limits.

Future Total Inorganic Nitrogen Limit

Potential TIN regulation is less than 10 mg/L as outlined UDWQ's 2009 Statewide Nutrient Removal Cost Impact Study, though an anticipate schedule of compliance is unknown at this time. Future total nitrogen limits are drastic changes putting significant demand and capital costs upgrades on WRFs to meet. Though compliance for a future TIN limit may not be a part of this Master Plan planning period, it is important to understand the impacts on plant capacity and outline pathways for CWSID to meet a lower limit.

A review of historical data shows an average effluent TIN of 10.5 mg/L from 2019 to 2022. Figure 12-8 shows historical data for secondary effluent (SE) N03 and primary effluent (PE) BOD/NH3 ratios. The higher the ratio of BOD/NH3 the more carbon is available to yield more denitrification.

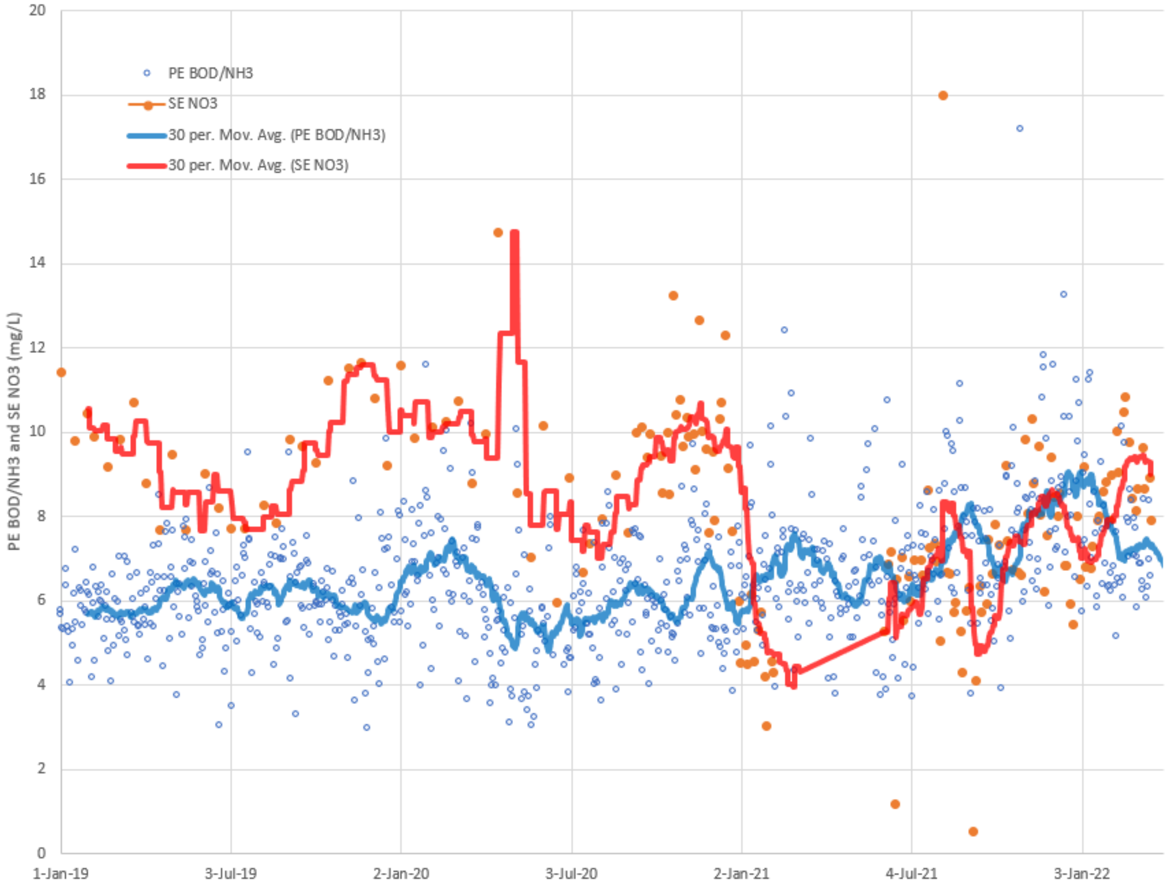


Figure 12-8: Processes Upgrade Timeline

Current biological process for the aeration basins is A20 mode. Under this mode, conditions are set up for both biological phosphorus removal and denitrification. The effluent NO3 data from 2019 to 2022, under A20 mode, show plant performance on average is close to meeting a TIN of 10 mg/L as shown in Figure 12-9.

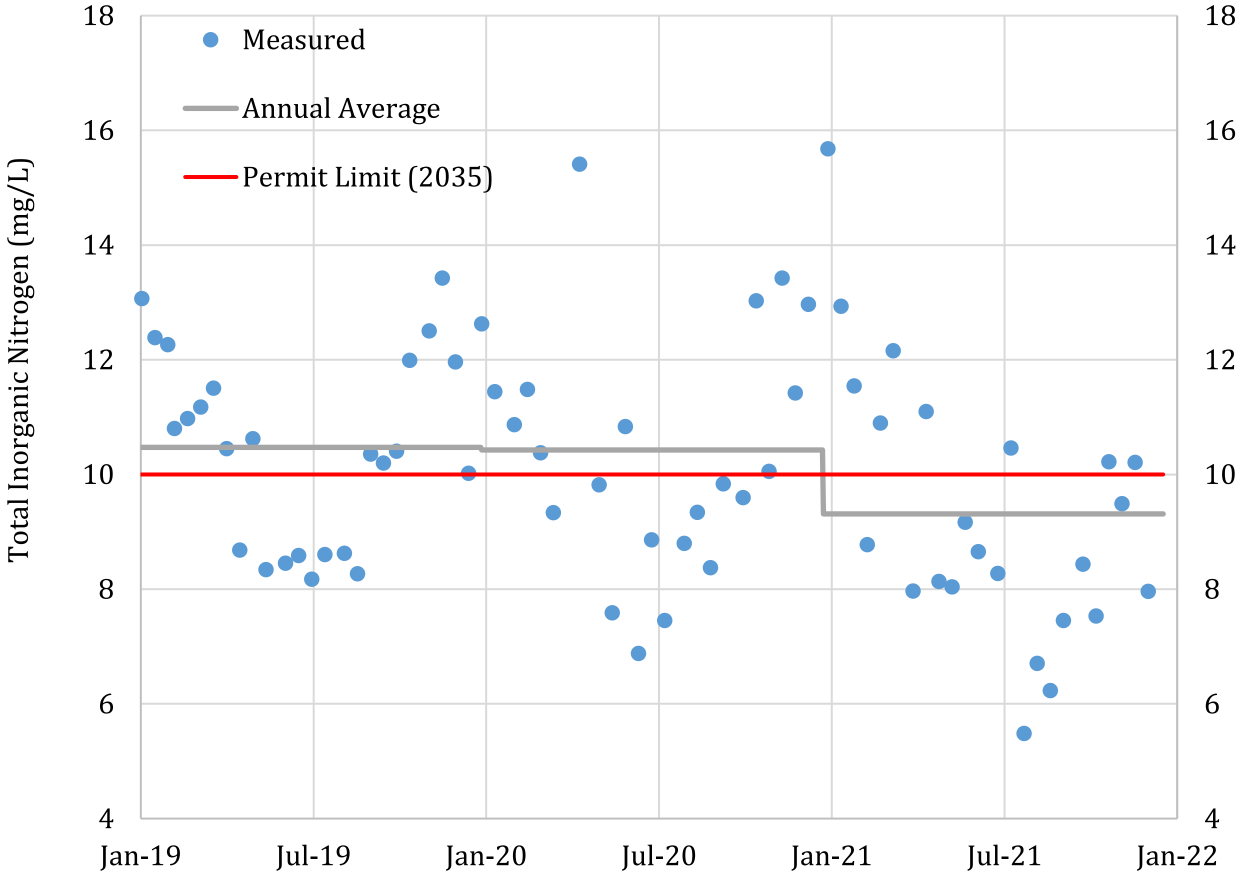


Figure 12-9: Historical TIN Data (2019-2021) and Future Permit Limits

To ensure that effluent TIN is below the estimated limit, the following recommendations are listed to optimize plant performance while continuing in A20 mode:

1. Regularly track dissolved oxygen (DO) concretions in the mixed liquor recycle (MLR) streams prior to discharging to the anoxic zone. Operators can check DO concentrations daily for all basins using handheld DO probes. Limiting DO back to the anoxic zone may increase denitrification by decreasing the risk of DO poisoning. Lower DO concentrations in the MLR stream can be done by reducing air in the last oxic zone or removing diffuser plates closest to the mixed liquor (ML) return pumps.
2. Process modeling has shown that increasing the PE bypass flow will increase the BOD/NH3 ratio and provide more carbon to drive more denitrification. Increasing bypass to 10 percent of primary influent flow reduces TIN concentrations to below 10 mg/L.
3. Modeling has shown that decreasing MLR rates slightly increases NO3 removal by 0.1 to 0.2 mg/L.

Process modeling has verified that changing the aeration basins' biological process to Modified Ludzak-Ettinger (MLE) mode will reliably meet the TIN limit. This is done by moving the mixed liquor return stream to the first anaerobic zone, converting it to anoxic, and doubling the anoxic zone capacity. Phosphorus removal in this mode will now require chemical dosing as biological removal is given up for additional anoxic capacity. Estimated average chemical costs per year to meet effluent TP limits are shown in Table 12-14. It is important to note that ferric chloride costs have increased drastically over the past few years with difficulty in shipment availability.

Table 12-14
Estimated Chemical Costs for Chemical Phosphorus Removal to meet 1.0 mg/L TP

Year	2025	2030	2035	2040	2050
AADF (mgd)	39.9	42.6	45.3	47.7	51.4
Pounds Iron (Fe) per Day	1,200.1	1,281.3	1,362.6	1,434.7	1,546.0
Pounds Ferric Chloride ($FeCl_3$) per Day	3,485.6	3,721.5	3,957.3	4,167.0	4,490.2
Cost per Day(1)	$3,660	$3,908	$4,155	$4,375	$4,715
Annual Cost	$1,336,000	$1,427,000	$1,517,000	$1,598,000	$1,721,000

[1] Calculated with ferric chloride costs of $2,100 per dry tons and 39% strength. Shipment costs are included.

Should CWSID receive a TIN of 10 mg/L, it is recommended to continue to run the aeration basins in A20 mode with optimization to verify that the TIN limit can be met before operating the basins in MLE mode with chemical addition.

Future Phosphorus Regulations

For TP, UDWQ recently adopted a TBPEL of 1 mg/L as annual mean that CWSID must meet by 2025 within their existing permit as shown in Table 12-1. This limit is being met through biological phosphorus removal in the aeration basin process. CWSID also has the ability to chemically treat phosphorus with ferric chloride addition. Both phosphorus removal processes are important, as it gives CWSID the option to operate in MLE or A20 mode. TP effluent data is presented in Figure 12-10, which shows that CWSID is below the future permit limit with biological phosphorus removal.

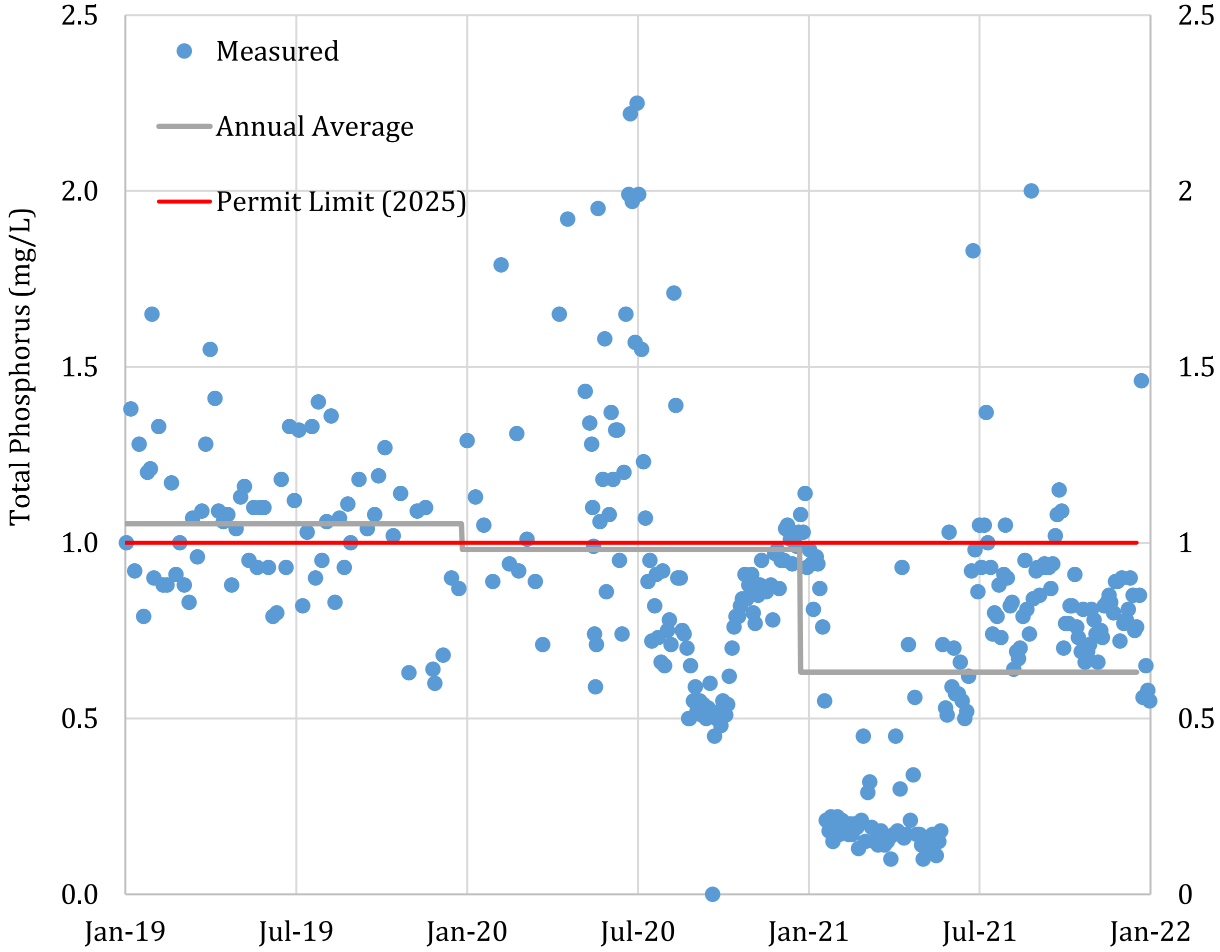


Figure 12-10: TP Effluent Data

With the ecosystem and characteristics of the Great Salt Lake, a future more stringent TP limit is not expected for this Master Plan planning cycle. A more stringent limit would require a site-specific nutrient load analysis on the Warren Canal or Weber River. Any potential new TP limit imposed on either receiving water body is highly unlikely. For this reason, no treatment options or alternatives will be evaluated.

CHAPTER 13
TREATMENT ALTERNATIVES DEVELOPMENT AND SUMMARY

INTRODUCTION

The purpose of this chapter is to summarize the development and evaluation of various treatment alternatives from the capacity process upgrades indicated in Chapter 12 for both the liquid and solid treatment processes at the CWSID water reclamation facility (WRF). The liquid and solid process stream projects identified in this Chapter are primarily capacity driven that are required by the year 2050. Other goals for this Chapter will be to review alternatives to improve CWSID WRF solids handling processes by:

- Identifying additional Class B and Class A biosolid management options.
- Address operational challenges caused by struvite.
- Evaluate biogas beneficial use alternatives.
- Recommendations to improve dewatering.

As part of this Master Plan update CWSID is evaluating process alternatives to improve unit process performance, meet treatment capacity and permit requirements through the year 2050 to improve operating efficiency, reduce maintenance, and economically recover resources.

LIQUID CAPACITY UPGRADES - TREATMENT ALTERNATIVES

The AS liquid stream process upgrades identified in Chapter 12 are shown in Table 13-1 with timelines for design and estimated start of construction dates. Discussions for each liquid process upgrade will include the following information:

- Process upgrade review and scope of work.
- Potential site layout.
- Technology evaluation and recommendation.
- Project design criteria.
- Estimated project costs forecasted to anticipated project construction start.

Table 13-1
Anticipated Design & Construction Start Dates for Liquid Stream Process Upgrades

Process Upgrade	Anticipated Design Start Date	Anticipated Construction Start Date
Screening and Grit Removal	2041	2043
Primary Clarification (1)	2029	2031
Aeration Basins (2)	2035	2037
Secondary Clarifiers (3)	2035	2037
UV Disinfection	2035	2037

[1] Primary Clarifiers 3 and 4

[2] Aeration Basins 7 and 8

[3] Secondary Clarifiers 7 and 8.

Screening and Grit Removal

Expansion of screening and grit removal capacities is recommended by the year 2045 when maximum month flows exceed the rated capacity of one influent screen or grit removal process. The headworks expansion scope of work includes the following features:

- Headworks influent screen channels and screens (two).
- Washer compactors (two).
- Grit removal basins (two) and grit pumps (four).
- Grit washing equipment (three).
- Expanded influent wet well and influent pumps (two).
- Odor control and heating, ventilation, and air conditioning (HVAC).
- Electrical and instrumentation and controls (I&C) upgrades.
- Civil improvements.

The 2012 Expansion Project allocated space for additional headworks capacity adjacent to the existing headworks as shown in Figure 13-1.

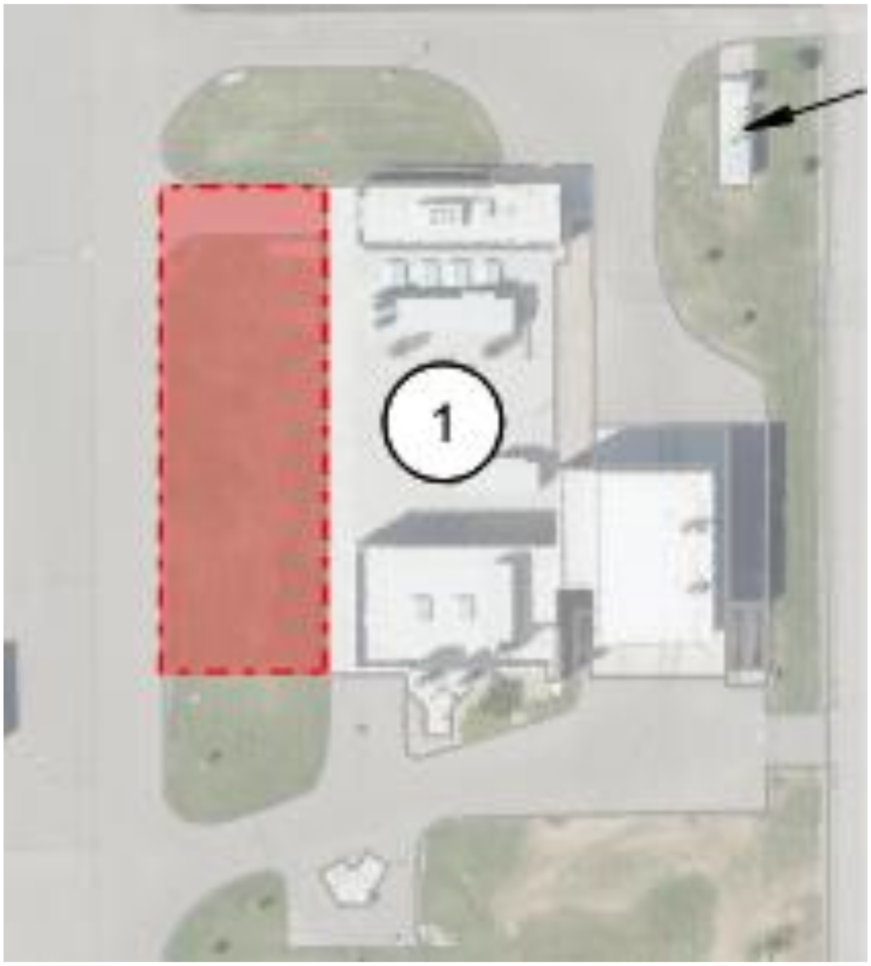


Figure 13-1: Headworks Expansion Site Plan

Technology Evaluation. The existing headworks equipment and unit treatment processes have been functioning properly and it is recommended to continue with similar equipment for the headworks expansion. It is also favorable for CWSID operational staff to match existing equipment and avoid operating and maintaining different screening and grit removal equipment.

Preliminary Design Criteria. For master planning purposes, cost estimates are based on existing headworks equipment selection and the preliminary design criteria listed in Table 13-2.

Table 13-2:
Headworks Design Criteria (1)

Parameter	Units	Value
Screening		
Number	-	2
Type (1)	-	Bar Screens
Capacity (each)	mgd	60
Screen Opening Size	millimeters (mm)	6
Channel Size	feet	6
Screening Compactor		
Number	-	2
Capacity (each)	gallons per minute (gpm)	400
Grit Removal		
Number	-	Vortex
Type	-	2
Diameter	feet	24
Capacity	mgd	70
Grit Pumps		
Number	-	4
Type	-	Recessed Impeller
Total Dynamic Head (TDH)	feet	65
Capacity	gpm	300
Grit Washer		
Number	-	2
Type	-	
Capacity	gpm	300
Influent Pumps		
Number	-	2
Type	-	Dry Pit Submersible
Capacity	gpm	21,000
TDH	feet	38

[1] Matches design criteria for existing equipment.

Opinion of Probable Cost. The Engineer's opinion of probable construction costs for the Headworks Expansion Project are shown in Table 13-3. For all costs, estimates or projected economic evaluations shown in this Chapter are based on Engineers' experience and judgement. Ultimate construction costs or project economics will vary from these opinions based on market conditions.

Table 13-3
Headworks Expansion Estimated Construction Costs

Item	Unit	Quantity	Unit Cost	Cost
Mobilization/Demobilization/General Conditions	LS	1	4,044,683	$ 4,045,000
Headworks Building	LS	1	12,379,950	$ 12,380,000
Equipment	LS	1	4,032,300	$ 4,032,000
Mechanical Piping/HVAC	LS	1	980,000	$ 980,000
Civil Improvements/Demolition	LS	1	1,700,000	$ 1,700,000
Electrical/I&C	LS	1	4,700,000	$ 4,700,000
Total Direct Costs				**$ 27,837,000**
Contingency (25%)				$ 6,960,000
Engineering and Permitting (15%)				$ 4,176,000
2023 Total Estimated Project Costs				**$ 38,973,000**

[1] Abbreviations: LS = lump sum.

Primary Clarification

Two new primary clarifiers will be needed to increase primary clarifier removal performance and meet future flows and loads and reduce organic load passed to the downstream secondary treatment process. Timeline to expand primary clarification would begin design in 2029 and construction started by 2031. The primary clarifier expansion project would include the following items:

- Primary Clarifiers Nos. 3 and 4.
- Raw sludge pump station.
- Primary sludge pumps (three).
- Grinders (two).
- Scum removal box and pumping.
- Civil and yard piping.

The splitter box for future Primary Clarifier Nos. 3 and 4 was constructed in 2021 as part of Phase 1.

Location of the new primary clarifiers will symmetrically align south of the existing primary clarifiers on the northeast end portion of the site. Primary influent pipelines will come from the existing splitter box and primary effluent lines will connect to Distribution Box No. 2. Weir heights will match existing primary clarifier v-notch overflow weirs. See Figure 13-2 for site layout for new primary clarifiers and raw sludge pump station.

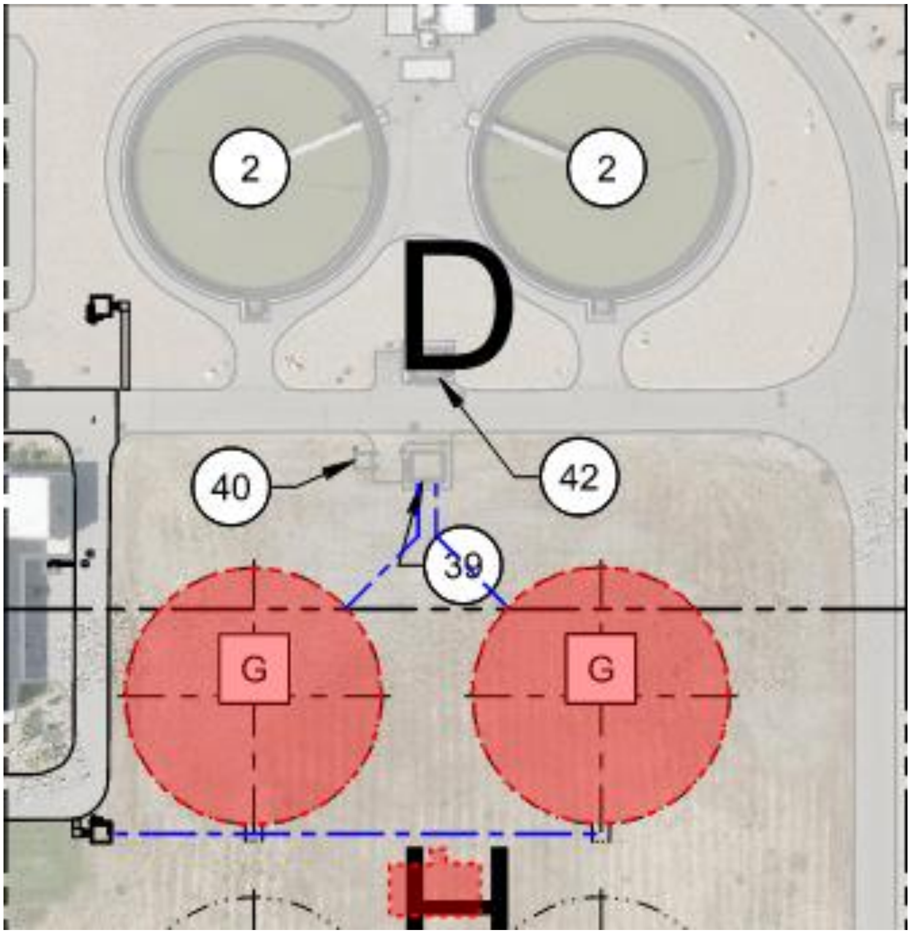


Figure 13-2: Primary Clarifier Project Site Plan

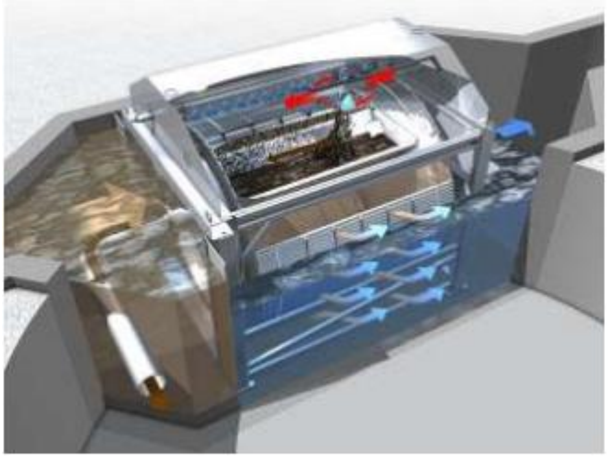


Figure 13-3: Huber Microscreen Primary Clarifier

Technology Evaluation. The primary treatment technologies currently utilized in the industry consist of conventional circular clarifiers or rectangular clarifiers, lamellas, ballasted clarification, chemically enhanced primary treatment, and mechanical primary filtration. CWSID's existing primary clarifiers are conventional circular open concrete tank basins with clarifier mechanisms to direct sludge to a central hopper for pumping out settled primary or raw sludge. Conventional primary clarifiers are typically recommended with no site constraints and for ease of operation, capital and O&M costs, and performance. New mechanical primary technologies are starting to emerge into the wastewater market that utilize micro screens or disk filters to remove total suspended solids (TSS) and biological oxygen demand (BOD) and have shown increased removal efficiency compared to convention primary clarifiers. Mechanical primary clarifiers are typically housed in a building and greatly reduce the footprint of primary clarification. Disadvantages are increased maintenance costs, sludge thickening, odor control, and replacement costs.

It is recommended to continue with conventional circular primary clarifiers and not evaluate other primary clarifier technologies at this time for the following reasons:

1. Matches existing primary clarifiers for streamlined operation and maintenance.
2. No plant site constraints (i.e., plenty of space at CWSID WRF site) that typically would lean towards using other technologies.
3. Odor control is not a pressing issue.
4. Conventional primary clarifiers have performed as designed.

New primary sludge pumps will pump raw sludge (typically at 3 percent total solids) to existing blend tanks before being sent to the primary digesters. Pump selection for primary sludge and scum pumps will be evaluated during design.

Design Criteria. Design criteria for conventional circular primary clarifiers is shown in Table 13-4.

Table 13-4
Primary Clarifier Design Criteria (1)

Parameter	Units	Value
Primary Clarifiers		
Number	-	2
Type	-	Circular
Diameter	feet	145
Side Water Depth	feet	12
Anticipated TSS Removal	%	60
Anticipated BOD Removal	%	35
Primary Sludge Pumps		
Number	-	3 (2+1)
Type		Diaphragm
Capacity (each)	gpm	175
Scum Pumps		
Number	-	2
Type	-	Recirculating Chopper Pumps
Flow	gpm	150
TDH	feet	38

[1] Matches existing primary clarifiers.

Opinion of Probable Cost. The engineers' opinion of probable cost is shown in Table 13-5.

Table 13-5
Primary Clarifier Estimate Construction Costs

Item	Unit	Quantity	Unit Cost	Cost
Mobilization/Demobilization/General Conditions	LS	1	2,575,055	$ 2,575,000
Primary Clarifiers	LS	1	9,129,593	$ 9,130,000
Primary Sludge Pump Station	LS	1	1,917,789	$ 1,918,000
Civil Improvements/Yard Piping	LS	1	1,200,000	$ 1,200,000
Electrical/I&C	LS	1	2,900,000	$ 2,900,000
Total Direct Costs				**$ 17,723,000**
Contingency (25%)				$ 4,431,000
Engineering and Permitting (15%)				$ 2,695,000
2023 Total Estimated Project Costs				**$ 24,813,000**

Aeration Basins

Additional aeration basins for secondary treatment are expected to be needed between 2035 to 2040 timeframe, assuming all key capacity parameters identified in Chapter 12, such as secondary and primary clarifier performance, mixed liquor suspended solids (MLSS) concentrations, and reactor solids retention times (SRTs) are maintained as modeled. Decreased performance in these parameters would move up the timeline for additional aeration basin capacity. Key project elements of the aeration basin expansion include:

- Aeration Basin Nos. 7 and 8.
- Secondary Clarifier Splitter Box.
- Diffused aeration equipment (two).
- ML return pumps (four).
- Blower No. 5.
- Floating surface mixers (eight).
- Structural underdrain system.

Aeration Basin Nos. 7 and 8 will be constructed adjacent to Aeration Basin No. 6 using common wall construction as shown in Figure 13-3. Aeration Basin Influent Splitter Box for Aeration Basins 5 through 8 is being constructed under the Phase 2 project.

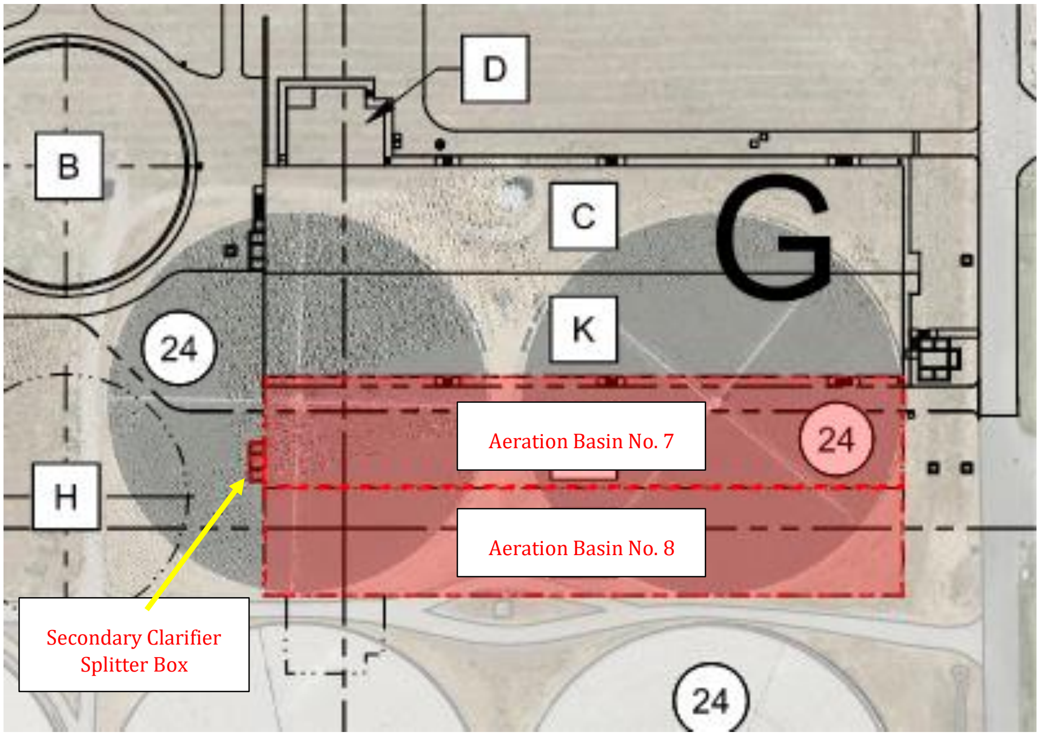


Figure 13-4: Aeration Basin Nos. 7 and 8 Site Plan

Technology Evaluation. The existing conventional aeration basin configuration for biological nutrient removal (BNR) is removing high levels of nitrogen and phosphorus levels and meeting both ammonia and BOD effluent permit limits effectively. It is recommended that Aeration Basin Nos. 7 and 8 match the design and layout of existing reactors and continue in anaerobic, anoxic, oxic (A20) mode prioritizing biological removal of phosphorus.

The total estimated maximum number of aeration basins at buildout for CWSID WRF is 10 to 12 basins with half of the total basins being constructed after the Phase 2 expansion project is completed in 2024. At this point, implementing an intensifications process could postpone the need to build more concrete basins into the future. Intensification processes are capable of reducing the volume necessary for treating the wastewater by increasing the MLSS concentration with an improved liquid/solid separation technology. Intensification processes include:

- Membrane bioreactor (MBR) technology.
- Integrated fixed film activated sludge (IFAS).
- Ballasted clarification (e.g., BioMag™).
- Aerobic granular sludge (AGS).

Most intensification processes are selected based on site constraints or to avoid long term capital costs, but often come at the expense of increased complex operations and added maintenance. Of the many intensification processes in the industry, one of the more promising intensification processes is AGS. While several AGS technologies are in varying stages of research and development, only two commercially viable AGS systems have been installed at full-scale treatment facilities. The first is Aqua Nereda™ which uses selective wasting in a sequencing batch reactor (SBR) configuration to induce aerobic sludge granulation that leads to reductions in bioreactor treatment volume through higher MLSS concentrations. However, this granulation technology would currently require conversion to an SBR process which is not likely at CWSID WRF. The second AGS technology uses hydrocyclones for selective wasting of light floc material and accumulation of heavier floc granules in a continuous flow reactor, similar to reactors at CWSID. This flowthrough option would still require the use of secondary clarifiers unlike the Aqua Nereda™ SBR process. Only one manufacturer has trademarked a hydrocyclone configuration (World WaterWorks inDENSE™) and has them installed in several facilities. This is a continuous flow AGS technology that can be retrofitted into existing BNR flowthrough processes, but currently only partial granulation has been achieved. Although partial granulation does not provide the potential savings in bioreactor volume, it does lead to increased capacity by improving the sludge settleability which saves secondary clarifier volume.

It is recommended that intensification processes continue to be evaluated in subsequent Master Plan updates as newer technologies emerge and current technologies become more proven in the industry.

Design Criteria. Design criteria for Aeration Basin Nos. 7 and 8 are shown in Table 13-6 that match the existing BNR secondary treatment process.

Table 13-6
Aeration Basin Design Criteria (1)

Parameter	Units	Value
Aeration Basins		
Number	-	2
Configuration	-	A20
Side Water Depth	feet	20
MLSS Concentration	milligrams per liter (mg/L)	3,450
Design SRT range	days	13 to 16
Diffuser Type	-	Fine Bubble Membrane
Mixers		
Number	-	8
Type	-	Floating Surface Mixers
Mixed Liquor (ML) Return Pumps		
Number	-	2
Type	-	Submersible Axial Flow
Flow	gpm	13,000
Blowers		
Number	-	1
Type	-	Single Stage Centrifugal
Capacity	standard cubic feet per minute (scfm)	11,500

[1] Same design criteria used for existing aeration basins.

Opinion of Probable Cost. The engineers' opinion of probable cost is shown in Table 13-7.

Table 13-7
Aeration Basin Estimate Construction Cost

Item	Unit	Quantity	Unit Cost	Cost
Mobilization/Demobilization/General Conditions	LS	1	5,877,240	$ 5,877,000
Aeration Basins and Secondary Splitter Box	LS	1	23,222,000	$ 23,222,000
Blower	LS	1	950,000	$ 950,000
Civil Improvements/Yard Piping	LS	1	3,500,000	$ 3,500,000
Electrical/I&C	LS	1	6,900,000	$ 6,900,000
Total Direct Costs				**$ 40,449,000**
Contingency (25%)				$ 10,113,000
Engineering and Permitting (15%)				$ 6,068,000
2023 Total Estimated Project Costs				**$ 56,630,000**

Secondary Clarifiers

The secondary clarifiers are used to separate or settle out the microbial biosolids generated in the aeration basin treatment process mixed liquor and discharge clarified secondary effluent. The timeline for additional secondary clarifier capacity coincides with aeration basin expansion and should be designed and constructed under the same capital project. The secondary clarifier expansion project includes the following items:

- Secondary Clarifiers Nos. 7 and 8.
- Recycle activated sludge (RAS) pumps (three).
- Waste activated sludge (WAS) pumps (two).
- Grinders (two).
- RAS/WAS Building.
- Scum removal.

The location of the new Secondary Clarifiers Nos. 7 and 8 is shown in Figure 13-5.

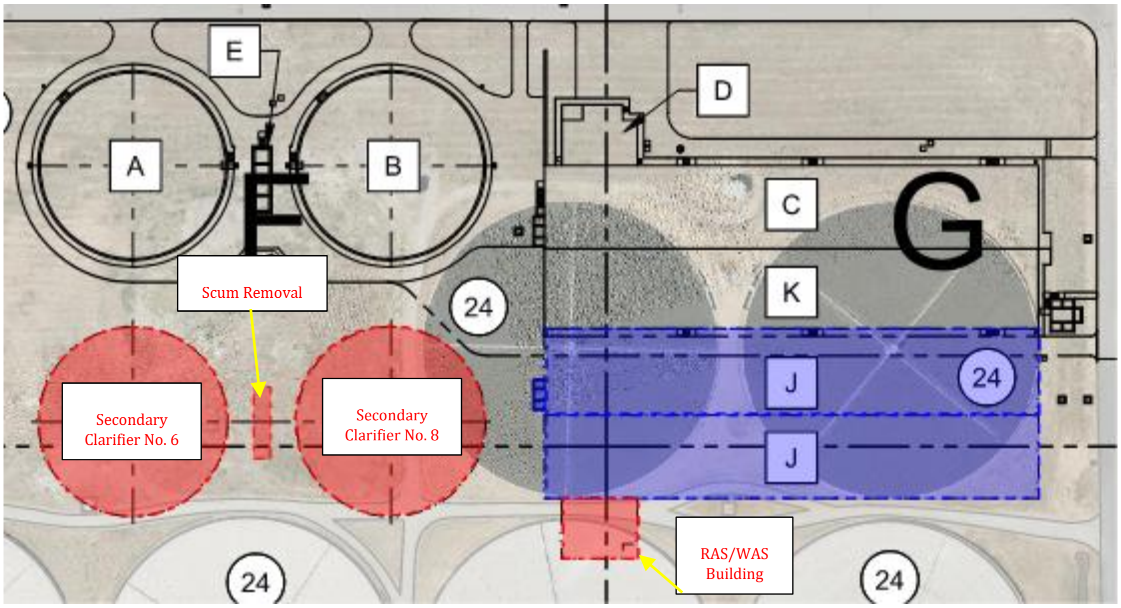


Figure 13-5: Secondary Clarifier Nos. 7 and 8 Site Plan Technology Evaluation

Existing secondary clarifiers use spiral scraper type mechanisms to direct settled solids to a central hopper where it is removed from the clarifier with return activated sludge (RAS) and WAS pumps. Since this unit treatment process has performed well, it is recommended to continue to match the existing clarifiers for Secondary Clarifier Nos. 7 and 8.

Chapter 12 noted that secondary clarifier capacity is dependent upon the settleability of the MLSS, which is calculated as the sludge volume index (SVI). Existing SVI data for the past 3 years shows the average SVI is 150 milliliters per gram (mL/g) which is typical for a BNR secondary treatment process. This SVI value was used in modeling the existing biological treatment process and was also used in projection models. Newer technologies have emerged that can enhance the secondary clarifier performance without additional tankage. The use of hydrocyclones, or previously mentioned InDENSE process, aides in partial granulation of the sludge by passing the waste sludge flow through the hydrocyclones to retain the heaviest fraction of the sludge and waste only the lightest fraction, thus decreasing the SVI overtime. The InDENSE has a proven track record or improving clarifier performance with many installations nationwide, including one locally in Utah at the South Davis Sewer District. This technology can provide CWSID increased clarifier performance with minimal capital costs and is recommended to be piloted and fully evaluated in the future if the SVI gradually starts to increase above the value modeled.

Secondary Clarifier Design Criteria. Secondary clarifier design criteria and ancillary processes are shown in Table 13-8.

Table 13-8
Secondary Clarifier Design Criteria (1)

Parameter	Units	Value
Secondary Clarifiers		
Number	-	2
Type	-	Circular Spiral Scrapper
Side Water Depth	feet	16
Diameter	feet	145
Surface Overflow Rate	gallons per day per square foot (gpd/sf)	400 to 600
Scum Pumps		
Number	-	2
Type	-	Recirculating Chopper Pumps
Capacity	gpm	100
RAS Pumps		
Number	-	3
Type	-	Screw Centrifugal
Capacity	gpm	4,000
WAS Pumps		
Number	-	2
Type	-	Screw Centrifugal
Capacity	gpm	350

[1] Basis of design is the same as existing secondary clarifiers.

Opinion of Probable Costs. Estimated construction costs for 2023 are in Table 13-9.

Table 13-9
Secondary Clarifier Estimated Construction Costs

Item	Unit	Quantity	Unit Cost	Cost
Mobilization/Demobilization/General Conditions	LS	1	3,326,900	$ 3,327,000
Secondary Clarifiers	LS	1	9,820,000	$ 9,820,000
RAS/WAS Building	LS	1	3,600,000	$ 3,600,000
Civil Improvements/Yard Piping	LS	1	2,200,000	$ 2,200,000
Electrical/I&C	LS	1	3,950,000	$ 3,950,000
Total Direct Costs				**$ 22,897,000**
Contingency (25%)				$ 5,725,000
Engineering and Permitting (15%)				$ 3,435,000
2023 Total Estimated Project Costs				**$ 32,057,000**

UV Disinfection

A new UV Disinfection Facility will be operational at CWSID WRF when the Phase 2 expansion project is completed. This new facility replaces the existing chlorine gas disinfection system and disinfects secondary effluent from Secondary Clarifier Nos. 1 to 6. A second UV Disinfection Facility is needed to disinfect additional secondary effluent from future Secondary Clarifier Nos. 7 to 12. A new UV Disinfection Facility will include the following elements:

- UV channels
- LPHO UV lamps.
- New final effluent piping and metering.

The future UV Disinfection Facility is located along the west side of new secondary clarifiers located just north of the trickling filter access road as seen in Figure 13-6. At this location the facility can also accommodate any future secondary effluent piping from future clarifiers.

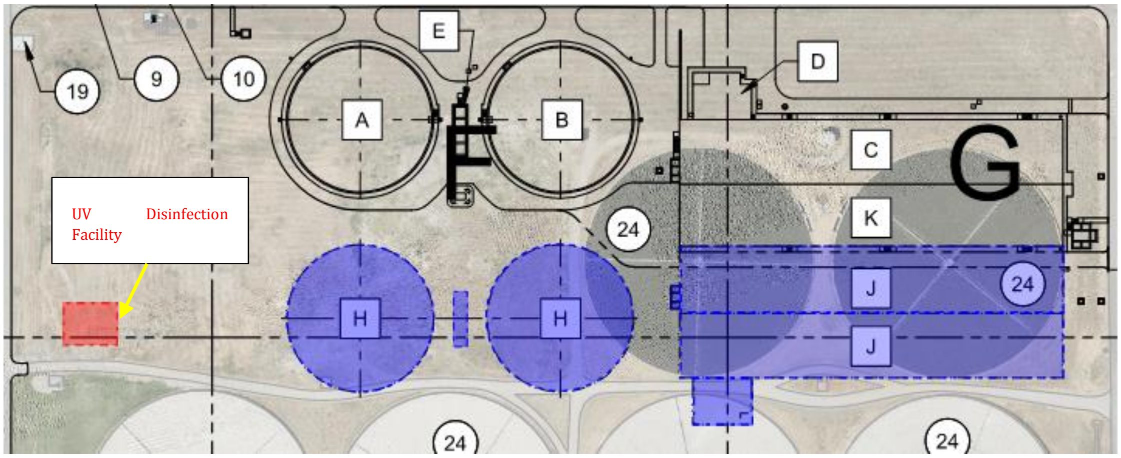


Figure 13-6: UV Disinfection Facility Site Layout

Technology Evaluation. Alternative disinfection technologies were reviewed previously in the 2017 Master Plan and the UV Disinfection option was recommended. No other disinfection alternatives are evaluated under this current master plan update effort. It is also recommended to continue with low pressure, high output (LPHO) UV lamps versus medium pressure lamps. Considering the size of the CWSID WRF, LPHO lamps are generally the most cost effective and preferred choice in the industry because of the greater energy efficiency compared to medium pressure. For this reason, LPHO-type lamps are established as the primary lamp option. Selection of UV manufacturers will be evaluated during design.

Design Criteria. Design criteria for the new UV Facility is shown in Table 13-10. It is recommended that the facility be sized to handle secondary effluent from Secondary Clarifier Nos. 7 and 8 and future build out flows from Secondary Clarifiers Nos. 9 to 12.

Table 13-10
UV Disinfection Facility Design Criteria

Parameter	Units	Value
UV Disinfection		
Type	-	LPHO
Treatment Capacity	mgd	25
Hydraulic Capacity	mgd	30
Total No. of Channels, buildout	-	3
No. of Operating Channels	-	2 (1+1)
UV Transmittance	%	70
Dose - T1 RED	millijoules per square centimeter (mj/cm^2)	20

Opinion of Probable Costs. Engineers' opinion of probable costs is shown in Table 13-11.

Table 13-11
UV Disinfection Estimated Construction Costs

Item	Unit	Quantity	Unit Cost	Cost
Mobilization/Demobilization/ General Conditions	LS	1	2,402,270	$ 2,402,000
UV Disinfection Facility	LS	1	7,781,000	$ 7,781,000
Civil Improvements/Yard Piping	LS	1	3,500,000	$ 3,500,000
Electrical/I&C	LS	1	2,850,000	$ 2,850,000
Total Direct Costs				**$ 16,533,000**
Contingency (25%)				$ 4,134,000
Engineering and Permitting (15%)				$ 2,480,000
2023 Total Estimated Project Costs				**$ 23,147,000**

SOLIDS CAPACITY UPGRADES - TREATMENT ALTERNATIVES

The solids stream process upgrades identified in Chapter 12 are shown in the Table 13-12. The following sections review treatment technology options for each recommended process upgrade and associated process upgrade costs that forecasted to project construction start date shown. The same information provided for liquid stream process upgrades are also provided in a similar format for each solids process upgrade.

Table 13-12
Solids Stream Process Upgrades

Process Upgrade	Estimated Design Start Date	Estimated Construction Start Date
Solids Thickening	2030	2031
Primary Digestion	2036(1)	2038(1)
Dewatering	+2050(2)	+2050(2)

[1] Timeframe to add digesters can be pushed past year 2050 if improved thickening is implemented. See Section 13.4.1.

[2] Timeframe for dewatering capacity upgrades exceed this Master Plan planning period.

Solids Thickening

Primary sludge is currently pumped directly from AS and TF primary clarifiers to one of two sludge blend tanks located outside the Solids Thickening Building. Although the primary sludge typically ranges between 2.5 and 3 percent total solids (TS), the District does not currently thicken primary sludge prior to digestion. Anticipated primary sludge concentration was 4 percent based on record design drawings.

The District's WAS Thickening Facility utilizes two gravity belt thickeners (GBTs) that currently thicken WAS from RAS/WAS Pump Stations. Thickened waste activated sludge (TWAS) is currently 4 percent TS before it is pumped to the Sludge Blend Tanks and mixed with primary sludge and scum. The GBTs can thicken TWAS to a higher solids concentration but existing air diaphragm pumps are unable to transfer TWAS thickened beyond the 4 percent TS. Space is provided inside the WAS Thickening Facility for additional GBT equipment to thicken additional WAS as the AS Treatment Process is expanded.

To reduce the volume of water sent to primary digesters and other downstream unit processes (e.g., dewatering), thickening primary sludge is being considered under this master plan update. This is a relatively common practice pursued by facilities to increase digester capacity and to reduce their heating demand for the digesters (i.e., less water to heat). Co-thickening WAS and primary sludge was considered under the rotary drum thickener (RDT) and GBT options. Co-thickening is done in many cases and is viewed as more flexible and a simpler operation since there is essentially a single set of thickening units. The North Davis Sewer District co-thickens its primary sludge solids (2 percent TS) and wasted secondary solids from their Solids Contact Basin process (1 percent TS). The combined solids streams are co-thickened to approximately 6.5 percent total solids before being pumped to digesters. To avoid the need to construct additional primary digester capacity, it is recommended that CWSID thicken primary sludge and WAS (or co-thicken) to approximately 4.5 to 6.0 percent total solids.

Treatment Alternatives. The following sludge thickening alternatives may be considered:

- Dissolved air flotation thickeners (DAFT).
- Thickening centrifuges.
- RDTs.
- GBTs with improved thickening sludge pumps.

Dissolved Air Flotation Thickeners (DAFT). A DAFT receives preconditioned incoming sludge with polymer to increase the removal efficiency and solids content of the thickened sludge. The DAFT utilizes a recycle stream from the DAFT subnatant and passes it through a pressurized tank where pressurized air is dissolved into solution at high saturation levels. This recycle stream then enters the DAFT tank, depressurizes, and the dissolved air is released as fine bubbles. The bubbles attach to the solids making them rise to surface where they are removed. The heavy solids that settle out and are removed as DAFT underflow.

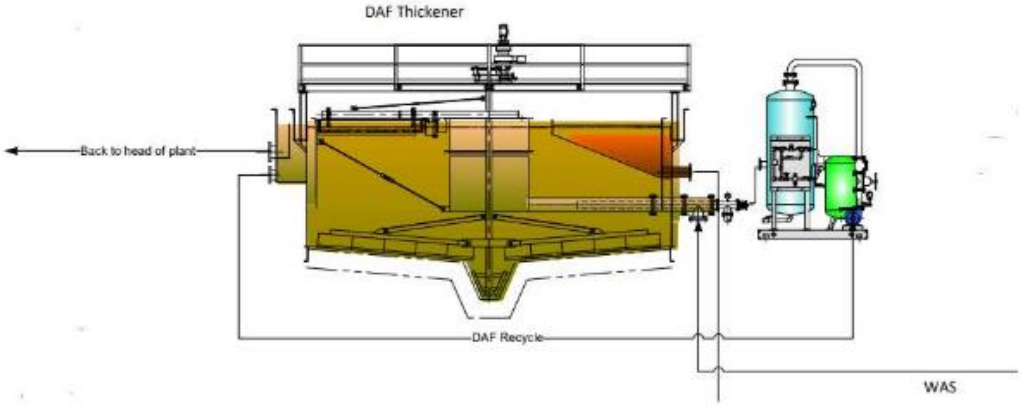


Figure 13-7: DAFT Process Flow Diagram

Table 13-13 lists some of the advantages and disadvantages in using DAFT equipment to thicken primary sludge.

Table 13-13
DAFT Advantages and Disadvantages

Advantages	Disadvantages
Effective on WAS	Several equipment items (Pump, pressure tank, compressors, etc.)
Total Solids (TS) concentrations to 4 to 6% with minimal polymer use	Large footprint
Accommodates varying hydraulic loading rates	Potential high power demand
Allow mixed liquor wasting	Odor control may be costly
Accommodates primary scum	
Can be configured in circular or round tanks	

Thickening Centrifuges. With minor differences, the same centrifuge used to dewater biosolids can also be used as a sludge thickener. The feed sludge is continuously fed to a conical shaped bowl that rotates at a high speed to create the force required to separate the solids. The conical shape helps lift the solid out of the liquid to further reduce the liquid content. A scroll conveyor inside the centrifuge operates at a lower speed to convey the solids and discharges the remaining liquid over a weir.

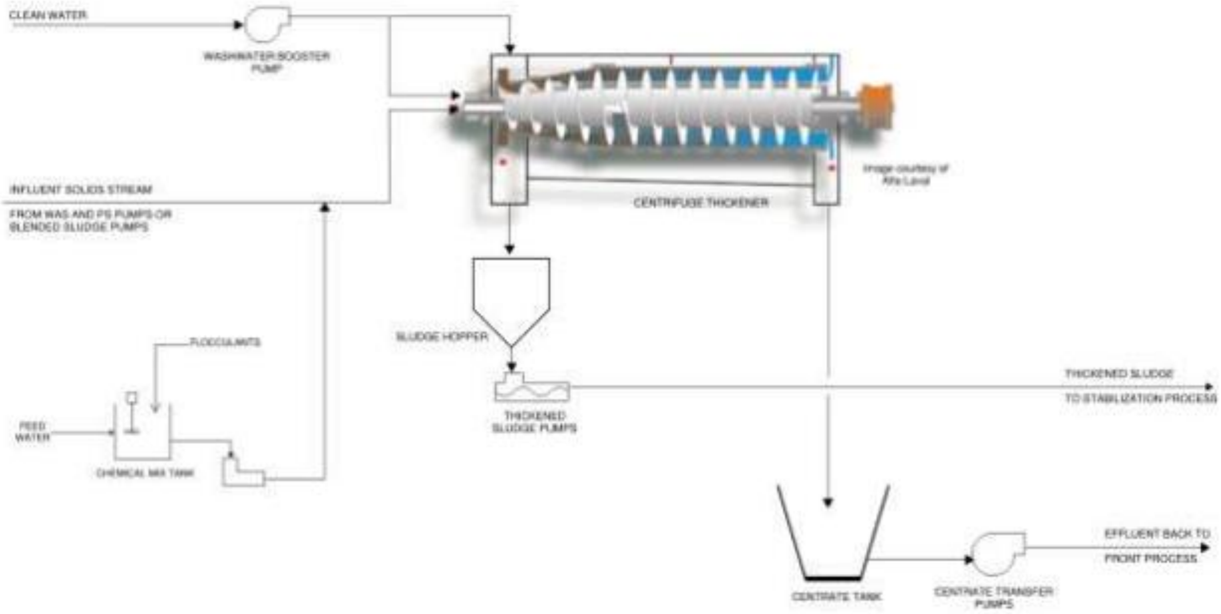


Figure 13-8: Sludge Thickening Centrifuge Process Flow Diagram

The advantages and disadvantages of centrifuge thickening are listed in Table 13-14.

Table 13-14
Sludge Thickening Centrifuge Advantages and Disadvantages

Advantages	Disadvantages
Effective on Primary Sludge (PS), WAS, and Co-thickening	High speed equipment, more complicated to operate and maintain
Thickened sludge ranges between 4 and 8%	
Odors are contained	Higher power consumption
Low wash water demand	Higher noise
Some models can thicken with low polymer use	Susceptible to grit

Rotary Drum Thickeners. Rotary Drum Thickeners (RDTs) utilize a low-speed rotating screen that retains the sludge solids while allowing free water to drain through the screen openings and collects in a trough underdrain. Thickened sludge is conveyed through the rotating drum and out the discharge end using a continuously operated internal screw. Polymer is added to sludge just upstream of the RDT to condition the sludge.

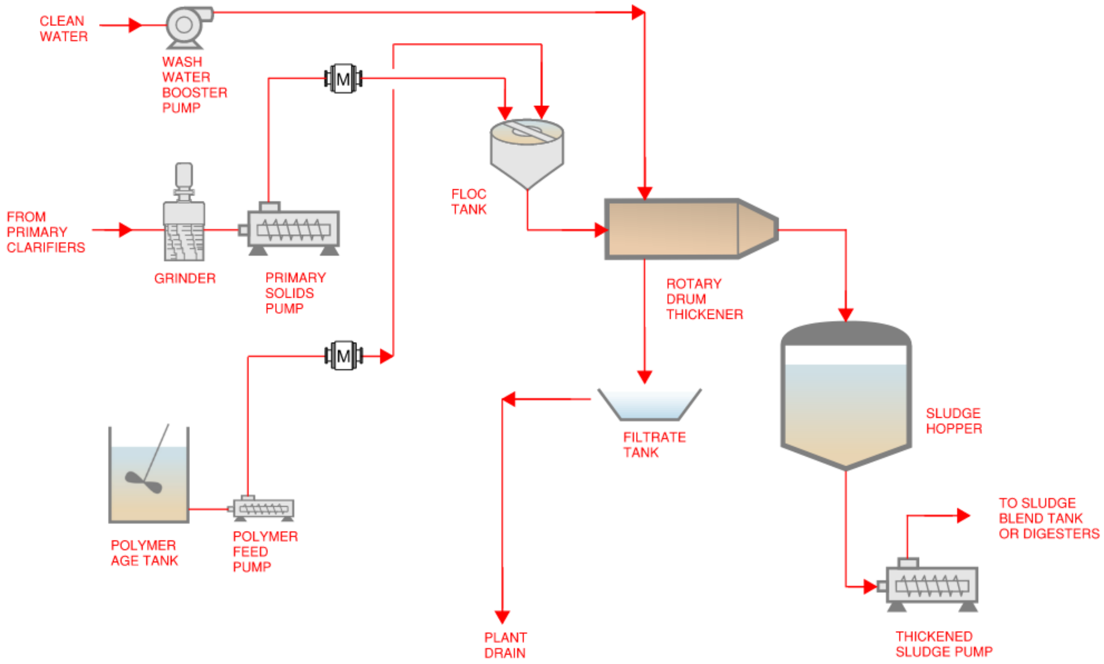


Figure 13-9: RDT Process Flow Diagram

Advantages and disadvantages of rotary drum thickeners are listed in Table 13-15.

Table 13-15
RDT Advantages and Disadvantages

Advantages	Disadvantages
Effective on PS, WAS, and Co-thickening	Screen can blind with grease
Odors are contained	Limited to 400 gpm per unit
Thickened solids concentrations between 5 and 9% with polymer addition	Typically, more polymer required than for thickening centrifuge
Low wash water demand	
Lower power consumption than a centrifuge or GBT	
Simple operation	

Gravity Belt Thickeners. CWSID currently uses GBTs to thicken WAS. GBTs are taken from dewatering belt filter presses where only the gravity section of the belt filter press is used. Polymer is introduced to help condition the sludge prior to being discharged to the GBT. The conditioned sludge travels across the GBT belt and discharges out the opposite end as thickened sludge while filtrate or pressate water falls by gravity through the belt and directed to the plant drain.

Advantages and disadvantages of gravity belt thickeners are listed in Table 13-16.

Table 13-16
GBT Advantages and Disadvantages

Advantages	Disadvantages
Effective on PS, WAS, and Co-Thickening	Grease can blind belt
Thickened sludge concentrations between 6-8%	High wash water demand
Low power consumption, similar to RDT	Polymer addition required
Odors can be contained by enclosing the belt	

Recommendation. Alternatives for meeting thickening goals of 4.3 to 6 percent solids before entering primary digestion can be accomplished through a variety of options at relatively low-capacity costs, using as much existing infrastructure as possible. This can be achieved by the following two options:

1. Option 1 - Continue thickening WAS with GBTs. - To meet the minimum 4.3 percent solids requirement to offset the need for additional primary digester capacity, TWAS solids concentrations need to be greater than 5 percent solids while maintaining a PS concentration of 3 percent. The GBTs anticipated TWAS solids concentration from record design drawings to show 5 percent, but historical performance solids concentrations have been around 4 percent, mainly due to the inability to pump higher concentrations from existing diagram pumps. Once TWAS pumps are replaced, GBT optimization will be needed to achieve percent solids goals. Under this option, a new GBT will be required by year 2033 for capacity and replacement of all TWAS pumps to handle higher percent solids. Also, this option is recommended if optional sidestream phosphorus removal technologies are not considered. See Section 13.6.
2. Option 2 - Co-thicken PS and WAS together with RDT or Thickening Centrifuges - This is the preferred option should CWSID implement a sidestream phosphorus technology, as it allows PS and WAS to be combined in the existing blend tanks before thickening to allow for soluble phosphorus release prior to digestion. It is recommended that current GBTs be replaced in kind with an enclosed thickening technology (RDT or Centrifuge Thickeners) to control odors inside the existing thickening building. Figure 13-10 shows equipment layouts for both RDTs and Thickening Centrifuges in the existing space provided in the Thickening Building. Either technology can be placed in the existing space or replace the GBTs with anticipated solids concentration from either technology is 6 percent. Thickened transfer pumps will also need to be replaced for this option. This option more reliable meets percent solids goals to offset primary digester expansion as both WAS and PS are thickened.

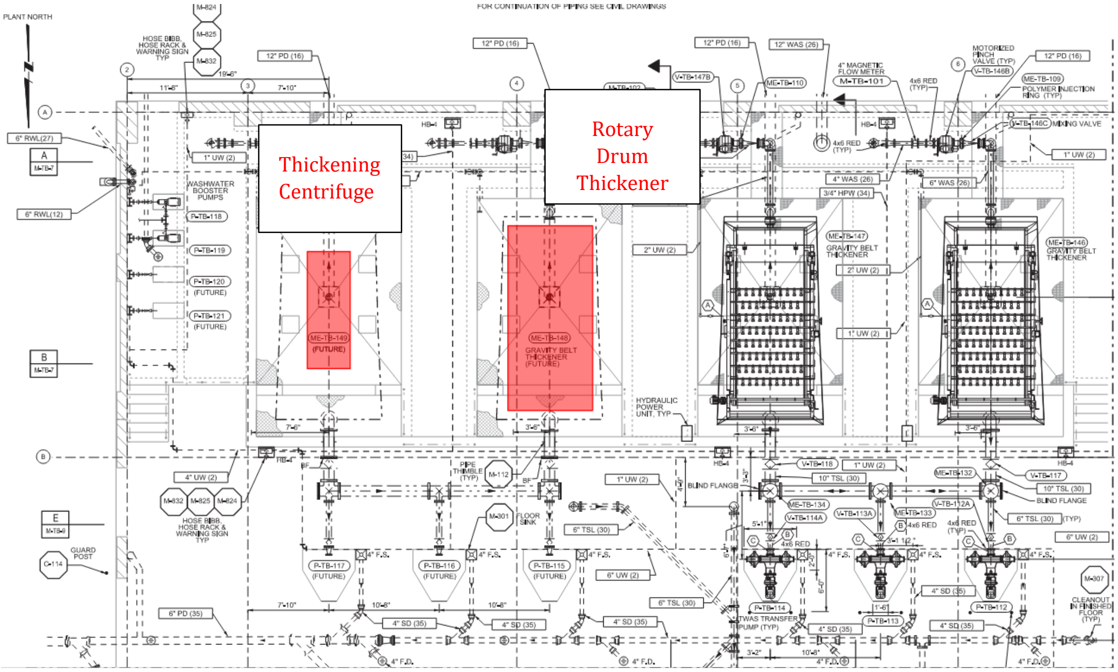


Figure 13-10: RDT and Thickening Centrifuge Equipment Layout

Design Criteria. The basis of design in evaluating both thickening options is listed in Table 13-17.

Table 13-17
Primary Sludge Thickening Design Criteria

Parameter	Units	Value
Option 1 - WAS Thickening Only		
Thickening		
Type	-	Gravity Belt Thickener
Number, new	-	1
Solids Loading Rate	pounds per hour (lbs/hr)	1,000
Hydraulic Capacity	gpm	300
WAS Concentration to GBTs	mg/L	8,000
Minimum Solids Concentration	%	5.0
Minimum Solids Capture Rate	%	94
TWAS Pumps	-	2 (1+1)
Type	-	Progressive Cavity Cake Pumps
Number	-	5 (3+2)
Flow	gpm	100
Option 2 - Co-Thickening		
Thickening		
Type	-	RDT or Thickening Centrifuges

Table 13-17
Primary Sludge Thickening Design Criteria (continued)

Parameter	Units	Value
Number, new	-	2
Solids Loading Rate	lbs/hr	1900
Hydraulic Loading Rate	gpm	500 to 600
PS/WAS Concentration to Thickener	mg/L	13,000 to 14,000
Minimum Solids Concentration	%	5
Maximum Solids Concentration	%	6
Solids Capture Rate	%	94
Thickened Sludge Transfer Pumps		
Type	-	Progressive Cavity Cake Pumps
Number	-	3 (2+1)
Flow	gpm	150

Opinion of Probable Cost. Cost estimate for both options to expand thickening are shown in Table 13-18.

Table 13-18
Solids Thickening Process Upgrades Cost Estimate

Item	Unit	Quantity	Option 1	Option 2
Mobilization/Demobilization/General Conditions	LS	1	$ 208,500	$ 408,170
Thickening and Pump Equipment	LS	1	$ 627,000	$ 1,181,000
Miscellaneous Mechanical/Yard Piping/Civil	LS	1	$ 350,000	$ 770,000
Electrical/I&C	LS	1	$ 250,000	$ 450,000
		Total Direct Costs	**$ 1,425,500**	**$ 2,809,170**
Contingency (25%)			$ 359,000	$ 703,000
Engineering and Permitting (15%)			$ 216,000	$ 422,000
		2023 Total Estimated Project Costs	**$ 2,010,500**	**$ 3,934,170**

Primary Digestion

CWSID has three primary digesters and one secondary digester. To continue with Class B biosolids for land application, and volatile suspended solids (VSS) reduction performance, a 15-day SRT needs to be maintained in the primary digesters, which is estimated to be exceeded by the year 2040. To reduce the solids sent to the primary digesters, it is recommended to thicken WAS to 5 percent solids or co-thicken WAS and PS to 5 to 6 percent and gain digester capacity. Modeling has shown that timeline for primary digester improvements will go beyond year 2050 if thickening is increased. For this evaluation, site layout, design criteria, and cost estimates will be presented for one new primary digester and control building to help contrast between constructing more digester volume or improve thickening of solids.

Construction of a new primary digester contains the following elements:

- Primary Digester No. 4.
- Digester mixing equipment.
- Digester Control Building.
- Boilers (two).
- Sludge transfer pumps (one).
- Hot water pumps (two).
- Primary circulation pumps (one).
- Blower (one).
- Gas drying unit (one).

Site layout for new primary digester and control building are shown in Figure 13-11.

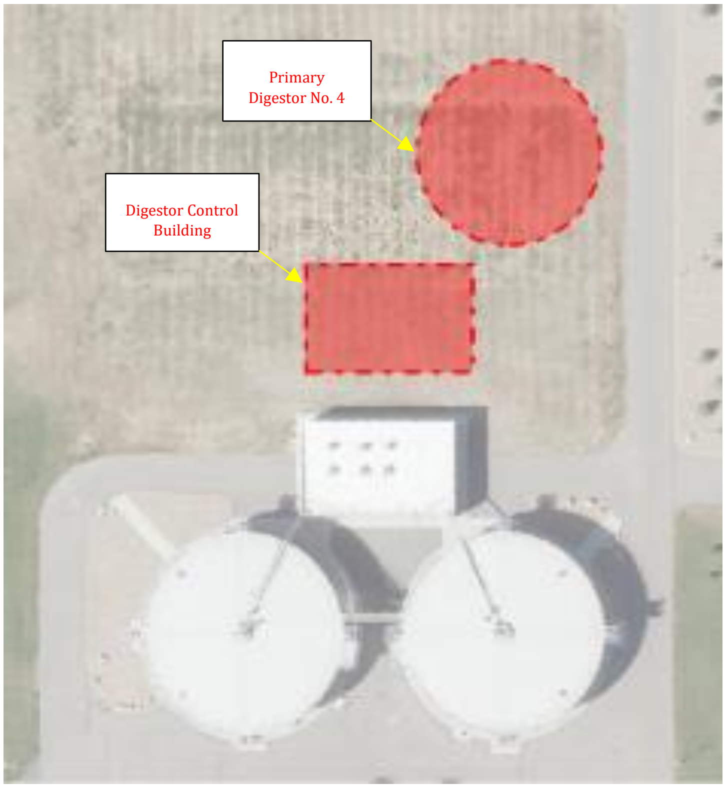


Figure 13-11: Primary Digester Site Layout

Treatment Alternatives. For this Master Plan effort, alternative technologies to conventional circular tank digesters will not be evaluated. It is assumed that digester tanks similar in size, volume, and aesthetics will be designed to match existing infrastructure except for the selected mixing technology. The draft tube air mixers in the existing tanks create extensive struvite buildup in the tubes that maintenance staff clean out every year and is major nuisance for the District. Proper selection of mixing technology for the new digester should consider mixing that minimizes the struvite build up. The following mixing technologies should be considered in order of preference when considering struvite migration:

1. Linear motion mixing.
2. Submersible propeller mixers.
3. Gas mixing.
4. Pump mixing.

Each of these technologies has advantages and disadvantages but certain tradeoffs will be required if the goal is to reduce struvite while still providing efficient mixing. If side stream phosphorus treatment is implemented, and struvite mitigation becomes less of a driver for mixing selection, then other technologies should be considered based on performance and lifecycle costs.

Options to replace primary digester mixing in the existing tanks can be evaluated using the same mixing technologies listed above. Feasibility of each option is greatly dependent upon structural analysis of the concrete cover because all options either create the need to puncture additional holes in the concrete covering or full removal of the cover to install the equipment. It is recommended that a full structural analysis and feasibility study for mixing options be evaluated to replace the existing draft tube mixers.

Design Criteria. Design criteria for primary digestion is shown in Table 13-19.

Table 13-19
Primary Digestion Design Criteria

Parameter	Units	Value
Primary Digestion		
Number	-	1
Diameter	feet	95
Side Water Depth	feet	30
Digester Volume	gallons	1,580,000
Mixing Type	-	Linear Motion or Propeller Mixing
Minimum VSS Destruction	%	50
Gas Production	cubic feet per pound VS destroyed	15
Gas Composition, Methane (CH4)	%	60

Opinion of Probable Cost. Estimate costs for a new primary digester building are shown in Table 13-20.

Table 13-20
Primary Digester Estimated Construction Costs

Item	Unit	Quantity	Unit Cost	Cost
Mobilization/Demobilization/ General Conditions	LS	1	3,579,950	$ 3,580,000
Primary Digester No. 4	LS	1	9,920,432	$ 9,920,000
Digester Control Building	LS	1	4,538,100	$ 4,538,000
Civil/Yard Piping	LS	1	2,500,000	$ 2,500,000
Electrical/I&C	LS	1	4,100,000	$ 4,100,000
			Total Direct Costs	**$ 24,638,000**
Contingency (25%)				$ 6,160,000
Engineering and Permitting (15%)				$ 3,696,000
			2023 Total Estimated Project Costs	**$ 34,494,000**

Dewatering

The three existing belt filter presses have sufficient capacity out to 2050 planning period. Options to improve dewatering for process implications will be discussed in this section based on findings from BioWin® modeling and discussions with District staff. It is important to note that dewaterability and increased cake performance is not critical to plant operations as dewatered biosolids are hauled close onsite to drying beds located on the north end on the plant site. Increasing percent solids in dewatered biosolids provides minimal benefit unless biosolids are hauled off-site by the District. At that point, benefits for higher cake dryness are then proportional to hauling distance and sludge volume hauled. Data from December 2020 to 2021 show dewatered cake total solids performance is between 10 to 12 percent as shown in Figure 13-12.

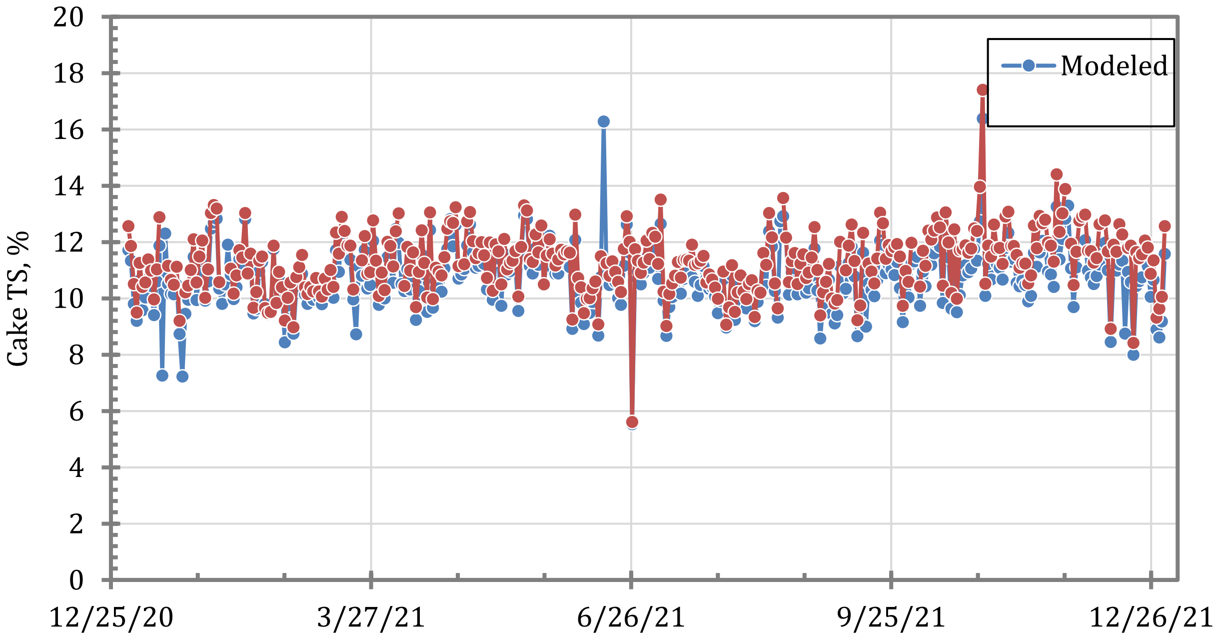


Figure 13-12: Historical Dewatered Cake Total Solids

Dewaterability Study. To better understand the dewaterability of the sludge at CWSID, a dewaterability study was performed by Klaranlagen Beratung Kopp (KBKopp), a company in Germany led by Professor Dr.-Ing. Julia Kopp that assesses industrial and municipal sludge. Goals of the study were to understand the maximum dewaterability of the sludge (percent solids) and optimum polymer dose (pounds active polymer [AS]/ ton of digested sludge [DS]). Samples were taken the 26th of October from the digestate/solids feed and dewatered cake and shipped to Germany for analysis, performed on the 1st of November 2022. The following services were conducted on the sample:

1. Determination of water distribution with thermogravimetric measurements.
2. Microscopic characterization of the floc structure.
3. Definition of the polymer dosage.
4. Determination of the active substance content of the polymer.
5. Prediction of the full-scale dewatering results.
6. Final report on the test results.

Total solids concentration of the sludge cake depends on the physical water distribution. The various types of water in sewage sludge are mainly distinguished by type and intensity of their physical bonding to the solids. In a sewage sludge suspension, four different types of water can be distinguished: free water, which is not bound to the particles; interstitial water, which is bound by capillary forces between the sludge flocs; surface water, which is bound by adhesive forces; and intracellular water. Only free water can be separated during mechanical dewatering and can be measured by 5 to 26 thermos-gravimetric measurements of the free water content, resulting in a prediction of full-scale dewatering results.

A summary of the results from study are provided in Table 13-21. Maximum dewaterability for belt filter presses is estimated to be 2 percent less than the dewatered cake from centrifuge sample performed by KBKopp. Results show that the current belt filter presses can achieve 15.6 to 16.6 percent cake, based on the optimal and acceptable values from centrifugal testing as shown below. For full report and analysis see Appendix H.

Table 13-21
Dewaterability Study Results

Parameter	Unit	Sludge Sample
Sampled Digested Sludge Percent Solids	%	1.87
Volatile Suspended Solids	%	68.66
Maximum Dewaterability per KBKopp, DS(A)	%	19.1
Optimal Dewatering with Centrifuge, DS(A)	%	18.6
Acceptable Dewatering with Centrifuge, (DS(A)	%	17.6
Dewaterability with Belt Filter Press	%	DS(A) - 2%
Capture Rate	%	96.1
Sampled Dewatered Cake	%	9.67
Phosphate (PO_4P)	mg/L	248
Polymer Dose	pounds active polymer/ton DS	43.8

Dewatering Recommendations. Modeling the dewatering processes has identified two items of concern that effect plant recycle flow and solids recirculation.

1. High Washwater Usage. Rule of thumb for washwater flow for belt filter presses is 1:1 washwater to solids feed flow ratio. Total flow for dewatering solids feed pumps range between 50 and 150 gpm according to historical data shown in Figure 13-13. Current washwater flow for each belt filter press is around 250 gpm, so an additional 100 to 150 gpm of washwater is being used. The additional washwater flow is recycled back to the headworks and pumped to the primary clarifiers. The utility water, though minimal, does contain the same concentration of total phosphorus, nitrogen, and BOD as the plant effluent, thus recycling nutrients. The additional washwater may be negatively affecting the solids capture rate or polymer usage but further investigation is needed. Also, additional washwater flow may also be the reasons for decreased cake dryness.
2. Low Solids Capture Rate. As started in Chapter 12, solids data for dewatering feed and hauled cake indicated that 76 percent of the solids were being removed in the belt filter presses, and 24 percent were being recycled back to the head of the plant. This performance is extremely low when belt filter presses typically see solid captures rates between 90 and 97 percent. It is recommended that CWSID take daily TSS samples of the pressate flow and install a permanent flow meter to understand recycled solids load. Other potential solutions and recommendations are verifying sampling data, lower washwater flows, and vary polymer dose concentrations.

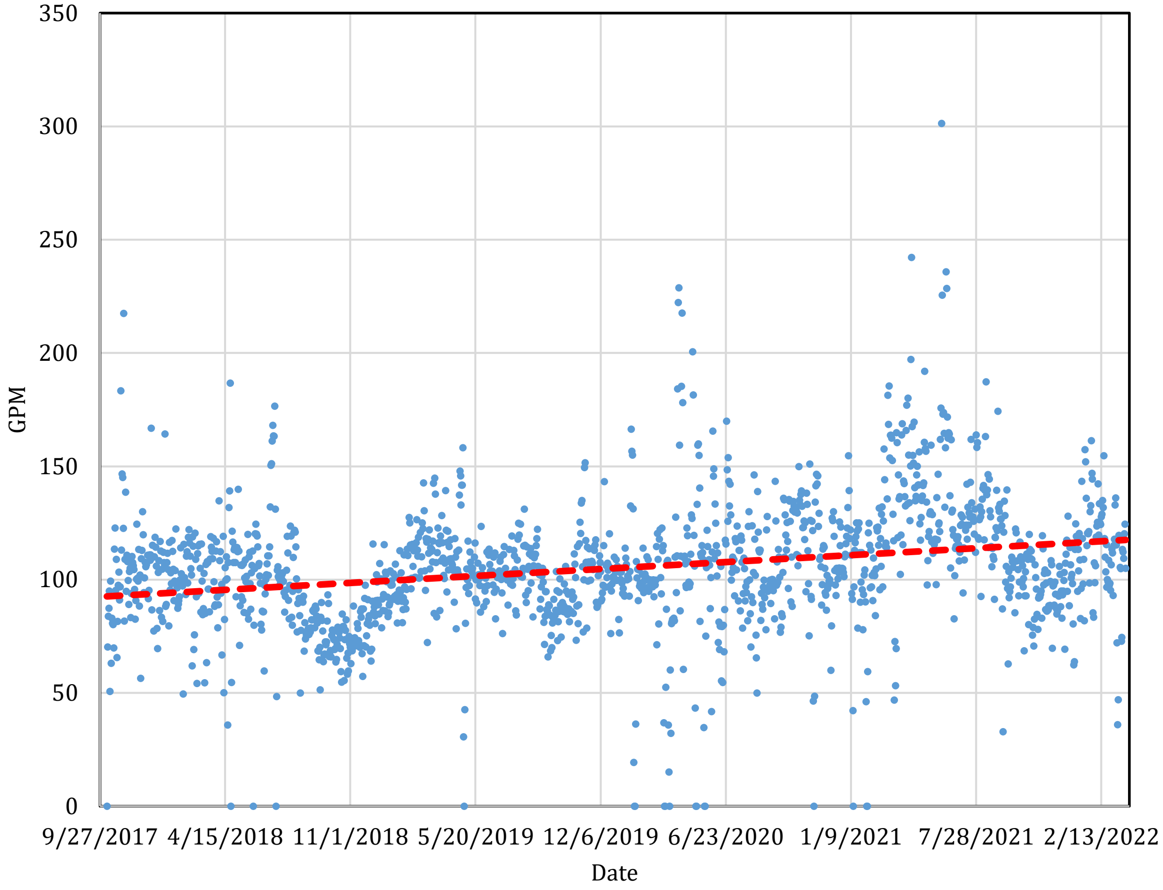


Figure 13-13: Total Belt Filter Press Flow

BIOSOLIDS MANAGEMENT

The District desires to better manage and beneficially use its biosolids, to identify potential "triggers" that force change and to develop a plan to address change. Change is inevitable and the District wishes to have a diverse and flexible biosolids management plan in plan place that helps inform future decisions. A Biosolids Workshop was held with CWSID WRF staff on June 1, 2022 at which the following agenda items were discussed:

- Biosolids roadmap and workshop objectives.
- Current CWSID solids management.
- Future biosolids regulation outlook.
- Biosolids beneficial use options.
- Biosolids Treatment Technology Options and Evaluation.

By referencing a "Biosolids RoadMap," the District can identify potential "Trigger Points" and make plans to address them and take steps to guide biosolids management practices into the future. Figure 13-14 below shows several different beneficial use options which may be pursued given certain trigger points.

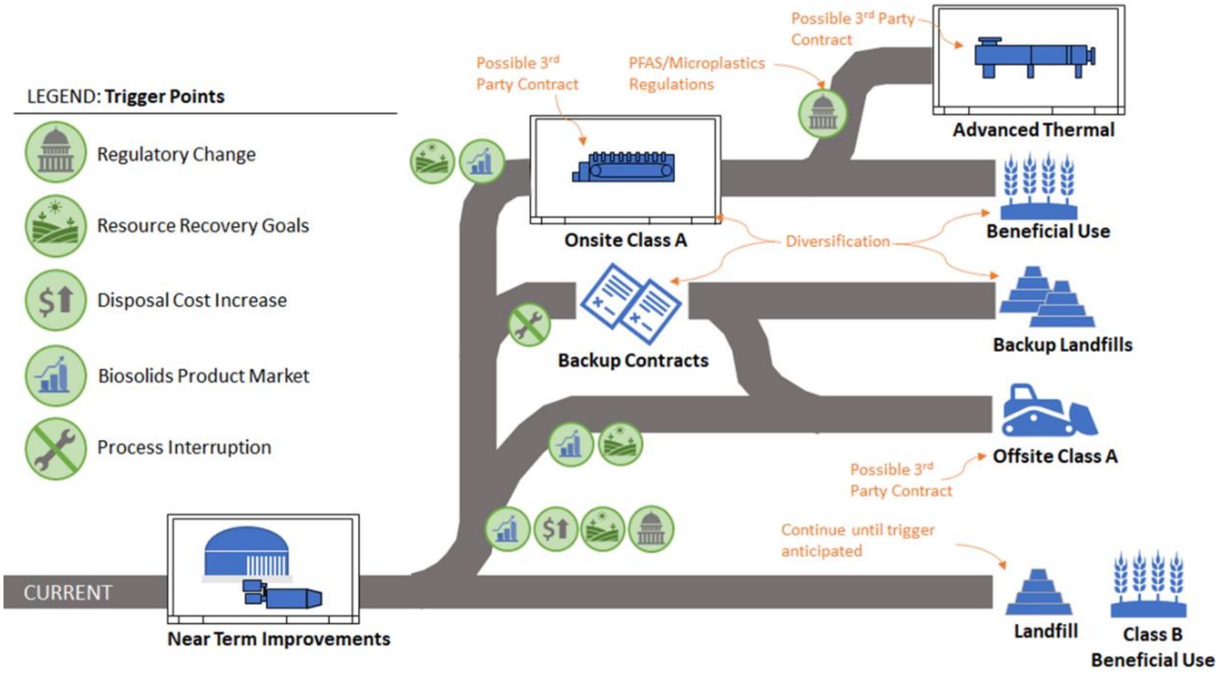


Figure 13-14: Biosolids Roadmap

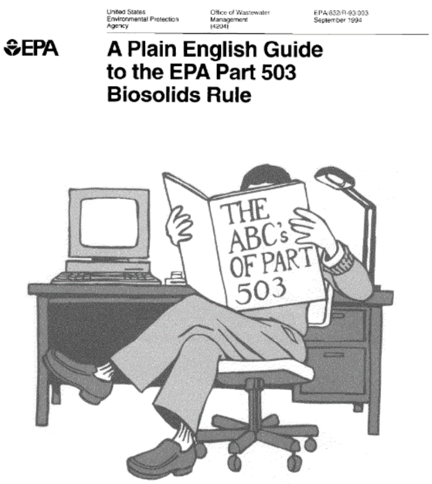
Municipal water reclamation facilities along the Wasatch Front have faced growing challenges in recent years in managing biosolids. These challenges impact the long-term reliability of solids management practices and may include increased growth, residential encroachment around water reclamation facilities and landfills, odor complaints, public acceptance, increasing operating costs, and the potential for additional biosolids regulations. The following CWSID WRF challenges or Trigger Points are identified:

- Residential encroachment to the north that forces the District to abandon sludge drying beds due to odor complaints and pressure.
- Weber County discontinues composting operations due to residential development to north and related odor complaints and pressure.
- New contaminants of emerging concern (CECs) that restrict land application and limit other beneficial use options for biosolids.
- Third party private farmland application of CWSID WRF is discontinued.

Existing Biosolids Production and Current Regulations

Current Biosolids Regulations. Biosolids management is regulated by the United States Environmental Protection Agency (EPA) under the 40 CFR Part 503 Municipal Sewage Sludge Disposal Regulation (for incineration, land application, marketing/distribution surface disposal). This rule is contained in the EPA publication entitled "A Plain English Guide to the EPA Part 503 Biosolids Rule," which was published by the Office of Wastewater Management in September 1994 (EPA/832/R-93/003). Biosolids in Utah are regulated by the Division of Water Quality (DWQ) under its Utah Pollutant Discharge Elimination System (UPDES) permit program. The CWSID WRF operates under Biosolids Permit No. UTL-021911 which is included in its UPDES permit (Major Municipal Permit No. UT0021911) This rule establishes requirements for pathogen reduction and vector attraction reduction for biosolids and provides flexibility in how those requirements are met. Under its current UPDES permit, CWSID is permitted to dispose of its biosolids under one of the following three options:

1. Class A biosolids may be sold or given away to the public for lawn and garden use or land application.
2. Class B biosolids may be land applied for agricultural use or at reclamation sites at agronomic rates.
3. Biosolids may be disposed of in a landfill or transferred to another facility for treatment/disposal.



United States
Environmental Protection
Agency

Office of Wastewater
Management
(4204)

EPA/832/R-93/003
September 1994

EPA

A Plain English Guide
to the EPA Part 503
Biosolids Rule

Based on meeting certain pathogen and vector reduction requirements, the Part 503 Rule classifies biosolids into two primary categories: (1) Class A or (2) Class B. The Part 503 Rule separates pathogen reduction requirements from vector attraction reduction requirements as follows:

- The Class A and B designations refer only to the reduction achieved in pathogens.
- Vector attraction reduction is governed by a separate set of requirements.
- Both pathogen and vector attraction reduction requirements must be met. To minimize the potential for re-growth of pathogenic in Class A biosolids, the pathogen reduction requirements must be meet at the same time as most of the vector attraction reduction requirements.

Pathogen Reduction. The pathogen reduction requirements of the Part 503 Rule can be met using certain specified technologies to treat biosolids or showing the quality of the biosolids meets certain performance results. The Part 503 Rule requires pathogen or pathogen indicator measurements for all Class A alternatives and pathogen indicator measurements for the first three Class B alternatives.

Vector Attraction Reduction. The Part 503 Rule contains twelve options in satisfying vector attraction reduction requirements. Biosolids produced at the CWSID WRF would be considered Class B and would need to be dried to X percent total solids (percent TS) to satisfy the vector attraction reduction requirements under the Part 503 Rule.

Table 13-22
Summary of Six Alternatives to Meet Class A Biosolid Pathogen Requirements

Option No.	Description
1	Meet 38 percent reduction in volatile solids content
2	Demonstrate vector attraction reduction with additional anaerobic digestion in a bench-scale unit
3	Demonstrate vector attraction reduction with additional aerobic digestion in a bench-scale unit
4	Meet a specific oxygen uptake rate for aerobically digested biosolids
5	Use aerobic processes at great then 40 degrees Celsius for 14 days or longer
6	Alkali additional under specified conditions
7	Dry biosolids with no unstabilized solids to at least 75 percent solids (%TS)
8	Dry biosolids with unstabilized solids to at least 90 %TS
9	Inject biosolids beneath the soil surface
10	Incorporate biosolids into the soil with 6 hours of application to or placement on the land
11	Cover biosolids placed on a surface disposal site with soil or other material at the end of each operating day (Note: Only for surface disposal)
12	Alkaline treatment of domestic septage to pH 12 or above for 30 minutes without adding more alkaline material.

CWSID WRF meets vector attraction reduction requirements under Option No. 1 by reducing its volatile solids content through its anaerobic digestion process.

Class A Biosolids. To be classified as a Class A biosolid under the Part 503 Rule, biosolids are required to be treated using one of the six treatment alternatives listed in Table 13-23.

Table 13-23
Summary of Six Alternatives to Meet Class A Biosolid Pathogen Requirements

Alternative No.	Name	Description
1	Thermally Treated Biosolids	Biosolids must be subjected to one of four time-temperature regimes
2	Biosolids Treated in a High pH-High Temperature Process	Biosolids must meet specific pH, temperature, and air-drying requirements
3	Biosolids Treated in Other Processes	Demonstrate that the process can reduce enteric viruses and viable helminth ova. Maintain operating conditions used in the demonstration after pathogen reduction demonstration is completed.
4	Biosolids Treated in Unknown Processes (1) (2)	Biosolids must be tested for pathogens - Salmonella sp. or fecal coliform bacteria, enteric viruses, and viable helminth ova at the time the biosolids are used or disposed, or, in certain situations, prepared for use or disposal.
5	Biosolids Treated in a Process to Further Reduce Pathogens (PFRP)	Biosolids must be treated in one of PFRPs. (See Table 5-4 of Part 503 Rule)
6	Biosolids Treated in a Process Equivalent to a PFRP	Biosolids must be treated in a process equivalent to one of the PFRPs, as determined by the permitting authority.

[1] The density of fecal coliform in the biosolids must be less than 1,000 most probable number (MPN) per gram of solids (dry weight basis).

[2] The density of Salmonella sp. bacteria in the biosolids must be less than 3 MPN per 4 grams of total solids (dry weight basis).

To achieve Class A biosolids designation with drying beds, the most applicable method is Alternative No. 4 - Biosolids Treated in Unknown Processes. This method requires that when biosolids are standard tested for fecal coliform bacteria or salmonella sp., that they also be tested for enteric viruses and viable helminth ova. Testing must be done at the time at which biosolids are used or disposed for every batch. CWSID WRF is permitted to use its drying bed operations under a "Two Summer Method" to achieve the required reductions in enteric viruses and viable helminth ova. However, the CWSID WRF conducts tests to demonstrate Class A requirements are met and do not hold biosolids over two summers.

Under its Biosolids Permit UTL-021911, the CWSID WRF is permitted to manage its biosolids using the following treatment and disposal methods.

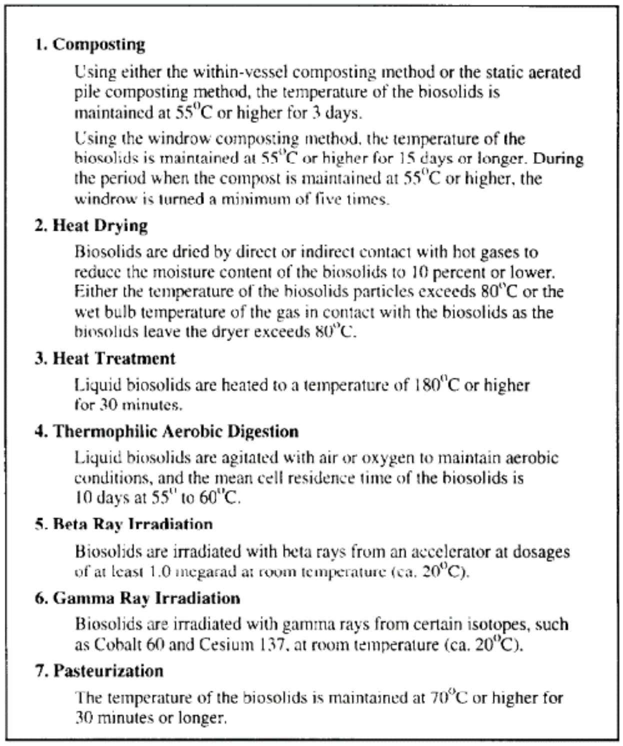
Treatment: The solids are "stabilized" and meet Class B pathogen reduction requirements in primary and secondary anaerobic digesters where solids are held with a mean cell residence time of at least 15 days with a minimum temperature of at least 95 degrees Fahrenheit (36.6 degrees Celsius). Biosolids can be further treated to meet a Class A standard by either:

1. Class A Biosolids (Compost). The biosolids are dewatered with a belt press to about 17 percent solids and composted using the windrow method of composting. Using the

windrow method of composting, the temperature needs to be maintained at 55 degrees Celsius (131 degrees Fahrenheit) or higher for fifteen days, with a minimum of five turnings during those 15 days.

2. Class A biosolids (Two Summer Method). The District currently does not follow this method as they have found through testing that Class A biosolids can be achieved without holding biosolids over two summers. However, if this option is pursued, the biosolids are dewatered with a belt press to about 11 percent solids and stored in batches over at least two summers. The biosolids have a total solids content of at least 14 percent, but no more than 40 percent, when piles are formed. The piles are formed in windrows 3.5 to 6.0 feet in height. During the first summer the total solids of the pile does not exceed 60 percent. The average temperature of the pile exceeds 20 degrees Celsius for 12 months of the storage period (These 12 months are not necessarily consecutive months). The pile is turned at least three times (at evenly spaced intervals during each summer period. When tested, the finished biosolids do not contain more than one viable helminth ova per four grams of total solids (dry weight basis).

TABLE 5-4
Processes to Further Reduce Pathogens (PFRPs)
Listed in Appendix B of 40 CFR Part 503



1. Composting

Using either the within-vessel composting method or the static aerated pile composting method, the temperature of the biosolids is maintained at 55°C or higher for 3 days.

Using the windrow composting method, the temperature of the biosolids is maintained at 55°C or higher for 15 days or longer. During the period when the compost is maintained at 55°C or higher, the windrow is turned a minimum of five times.

2. Heat Drying

Biosolids are dried by direct or indirect contact with hot gases to reduce the moisture content of the biosolids to 10 percent or lower. Either the temperature of the biosolids particles exceeds 80°C or the wet bulb temperature of the gas in contact with the biosolids as the biosolids leave the dryer exceeds 80°C.

3. Heat Treatment

Liquid biosolids are heated to a temperature of 180°C or higher for 30 minutes.

4. Thermophilic Aerobic Digestion

Liquid biosolids are agitated with air or oxygen to maintain aerobic conditions, and the mean cell residence time of the biosolids is 10 days at 55° to 60°C.

5. Beta Ray Irradiation

Biosolids are irradiated with beta rays from an accelerator at dosages of at least 1.0 megarad at room temperature (ca. 20°C).

6. Gamma Ray Irradiation

Biosolids are irradiated with gamma rays from certain isotopes, such as Cobalt 60 and Cesium 137, at room temperature (ca. 20°C).

7. Pasteurization

The temperature of the biosolids is maintained at 70°C or higher for 30 minutes or longer.

Class B Biosolids. Unlike Class A biosolids, Class B biosolids may contain some pathogens and, therefore, land application of biosolids includes site restrictions to prevent crop harvesting, animal grazing, and public access for a certain period of time. Class B pathogen requirements are met when one of the following three alternatives listed in Table 13-24 are met.

Table 13-24
Summary of Three Alternatives to Meet Class B Biosolid Pathogen Requirements

Alternative No.	Name	Description
1	The Monitoring of Indicator Organisms	Test for fecal coliform density as an indicator for all pathogens. The geometric mean of seven samples shall be less than 2 million MPNs per gram per total solids or less than 2 million CFUs per gram of total solids at the time of use or disposal.
2	Biosolids Treated in a Process to Significantly Reduce Pathogens (PSRP)	Biosolids must be treated in one of the PSRPs. (See Table 5-7 or the Part 503 Rule)
3	Biosolids Treated in a Process Equivalent to a PSRP	Biosolids must be treated in a process equivalent to one of the PSRPs, as determined by the permitting authority

CWSID WRF currently meets Part 503 Rule Class B biosolid requirements via Alternative No. 2 - Biosolids Treated in a Processes to Significantly Reduce Pathogens (PSRP) and anaerobically digests wasted solids.

Current Biosolids Production. The first step in developing a Biosolids Roadmap is to define anticipated biosolids production over a given planning period. The District manages Total Suspended Solids (TSS) as indicated in the solids mass balance included in Figure 13-15. Solids from both the TF and AS Treatment Systems are combined before the anaerobic digestion process, blended, digested, dewatered and moved off-site. Secondary solids or WAS is generated by: (1) the Activated Sludge Treatment Process where it is captured in secondary clarifiers and TWAS before being pumped to the Sludge Blend Tanks, or (2) as humus generated in the Trickling Filter Treatment Process where it is captured in secondary clarifiers and is returned to the TF Influent Pump Station, co-settled in TF Primary Clarifiers and wasted as primary sludge to the Sludge Blend Tanks. TWAS and primary sludge are combined or blended in one of two Blend Tanks located just outside the Thickening Building. Existing TWAS air diaphragm type transfer pumps limit the TWAS percent total solids to a maximum 4 to 5 percent TS.

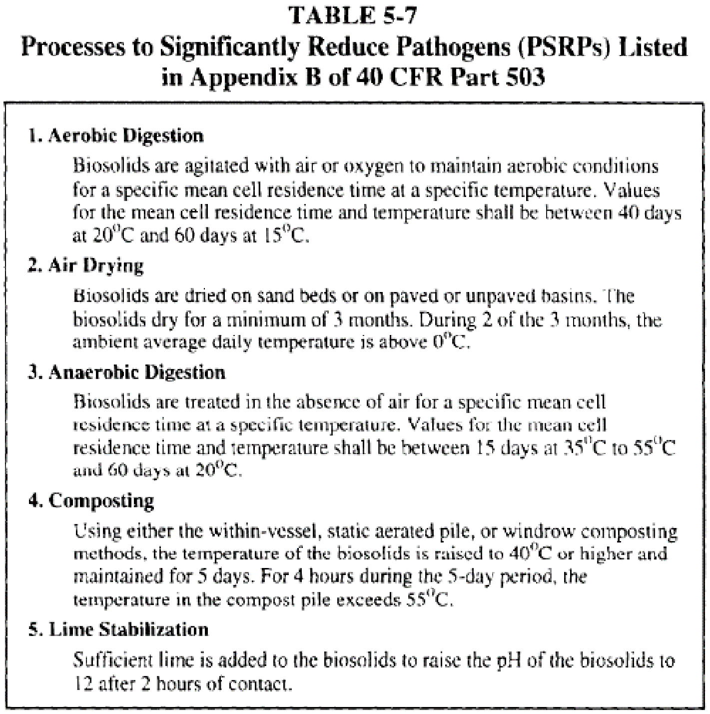


TABLE 5-7
Processes to Significantly Reduce Pathogens (PSRPs) Listed in Appendix B of 40 CFR Part 503

1. Aerobic Digestion

Biosolids are agitated with air or oxygen to maintain aerobic conditions for a specific mean cell residence time at a specific temperature. Values for the mean cell residence time and temperature shall be between 40 days at 20°C and 60 days at 15°C.

2. Air Drying

Biosolids are dried on sand beds or on paved or unpaved basins. The biosolids dry for a minimum of 3 months. During 2 of the 3 months, the ambient average daily temperature is above 0°C.

3. Anaerobic Digestion

Biosolids are treated in the absence of air for a specific mean cell residence time at a specific temperature. Values for the mean cell residence time and temperature shall be between 15 days at 35°C to 55°C and 60 days at 20°C.

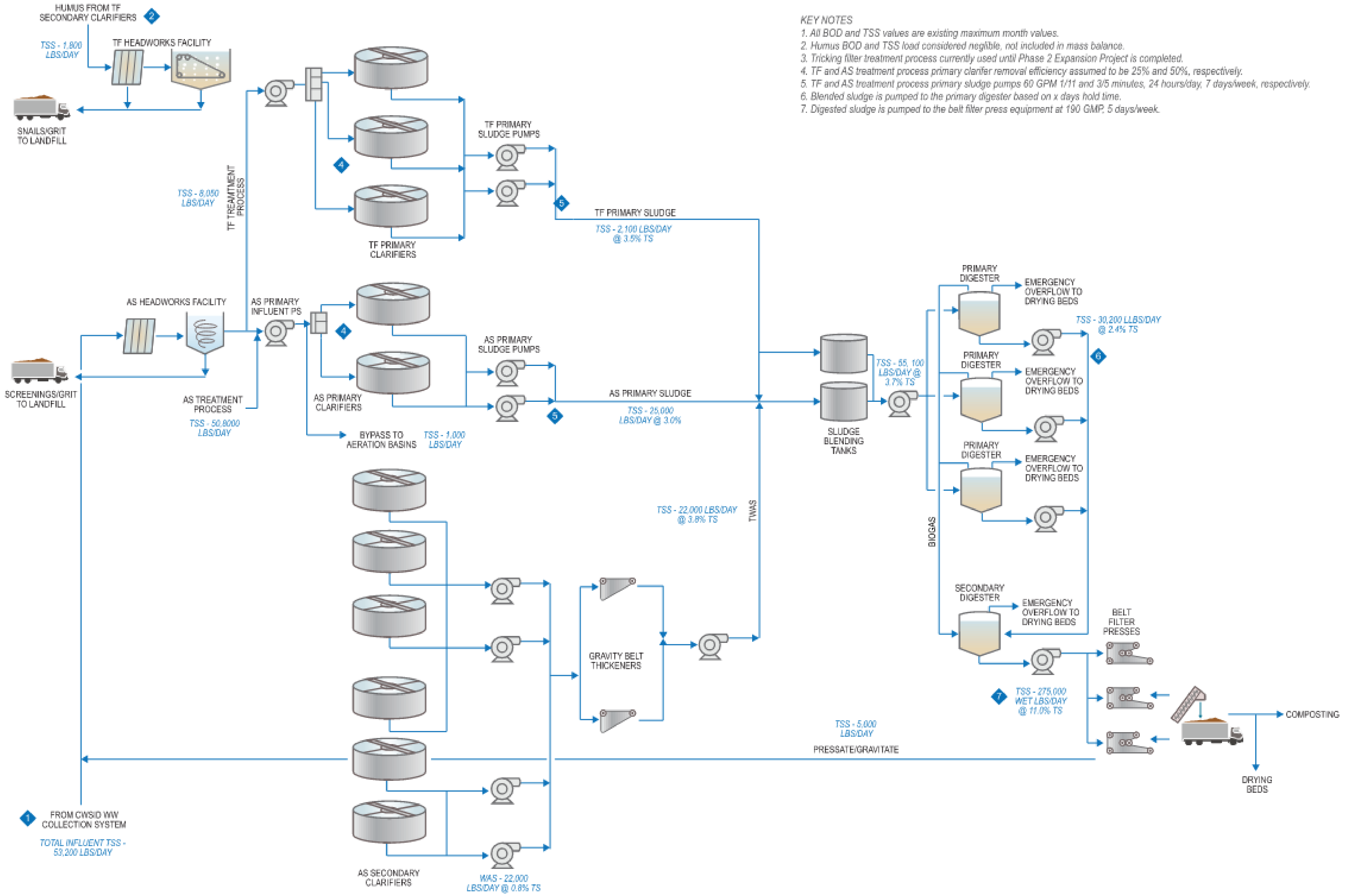
4. Composting

Using either the within-vessel, static aerated pile, or windrow composting methods, the temperature of the biosolids is raised to 40°C or higher and maintained for 5 days. For 4 hours during the 5-day period, the temperature in the compost pile exceeds 55°C.

5. Lime Stabilization

Sufficient lime is added to the biosolids to raise the pH of the biosolids to 12 after 2 hours of contact.

The District employs three primary anaerobic digesters and one secondary digester to digest primary solids, scum, and TWAS. Refer to Part 3.3.3.3 and Table 3-28 of Chapter 3 for additional information for the digesters. Digested sludge from the primary digesters is pumped to a secondary digester where it is held before being dewatered, dried in drying beds, and later hauled off-site and land applied. Gravitate from WAS thickening unit process and pressate from the dewatering unit process are both currently returned to the front of the CWSID WRF without any treatment.



KEY NOTES
1. All BOD and TSS values are existing maximum month values.
2. Humus BOD and TSS load considered neglible, not included in mass balance.
3. Tricking filter treatment process currently used until Phase 2 Expansion Project is completed.
4. TF and AS treatment process primary clarifer removal efficiency assumed to be 25% and 50%, respectively.
5. TF and AS treatment process primary sludge pumps 60 GPM 1/11 and 3/5 minutes, 24 hours/day, 7 days/week, respectively.
6. Blended sludge is pumped to the primary digester based on x days hold time.
7. Digested sludge is pumped to the belt filter press equipment at 190 GMP, 5 days/week.

Figure 13-15: Existing Solids Mass Balance Process Flow Diagram

Sludge Drying Beds. CWSID hauls dewatered cake to drying beds located at the north end of the CWSID WRF where it shares the area with the Weber County composting operations. CWSID recently expanded their dry beds, adding 3 acres and increasing total drying bed space to a total of 8.5 acres, approximately. The drying beds are asphalt paved with underdrains to collect drainage water and a tractor is used to regularly mix and aerate the sludge. Once dried to approximately 75 percent solids, the biosolids are hauled off-site and land applied. Table 13-25 summarizes the current operation of the CWSID sludge drying beds.

Table 13-25
Current Drying Bed Parameters

Parameter	Units	Value
Final Dry Solids Target	%TS	75
Sludge Loading After Dewatering	%TS	10
Available Drying Bed Area	acres	8.5
Free Water Pan Evaporation Rate	inches per year	40-50
Precipitation	inches per year	11

Sludge drying bed capacity was evaluated using methods presented in Environmental Protection Agency Design Manual entitled, “Dewatering Municipal Wastewater Sludges.” The evaluation is a mass balance where the amount of water applied to the sludge drying bed (i.e., water in sludge and from precipitation) is balanced against an estimated evaporation rate. Table 13-26 summarizes the results of this analysis which shows the CWSID sludge drying beds are likely undersized according to the engineered calculation. However, results vary significantly based on an estimated reduction factor used when estimating the evaporation rate.

It should be noted that calculations for drying bed capacity are extremely conservative and should not take precedent over operational experience and real-life application. For this reason, it is recommended that drying beds should be expanded contingent on current operations and perceived future need based on experience. It is estimated that drying bed could need expansion in the 2035 to 2040 timeframe.

Table 13-26
Evaluation of CWSID WRF Sludge Drying Bed Capacity

Year	Solids Loading Rate (lbs/day)	Estimated Required Area 1 (acres) (1)	Estimated Required Area 2 (acres) (2)
2022	31,959	28	15
2030	37,951	33	18
2040	44,029	38	21
2050	48,032	42	23

[1] Based on an evaporation rate of 140 pounds per square foot per year (lbs/sf/yr) using a 0.6 reduction factor.

[2] Based on an evaporation rate of 211 lbs/sf/yr using a 0.9 reduction factor.

Composing. The District currently provides biosolids (i.e., wet cake directly from the dewatering process) to Weber County for their composting operations located at the very northern portion of the CWSID WRF site. The Weber County composting operation occupies approximately 7 acres of District-owned property. The District does not have a contract in place with Weber County that specifies biosolids quantities for composting, but Weber County typically takes approximately 10 to 15 percent of CWSID's total biosolids.

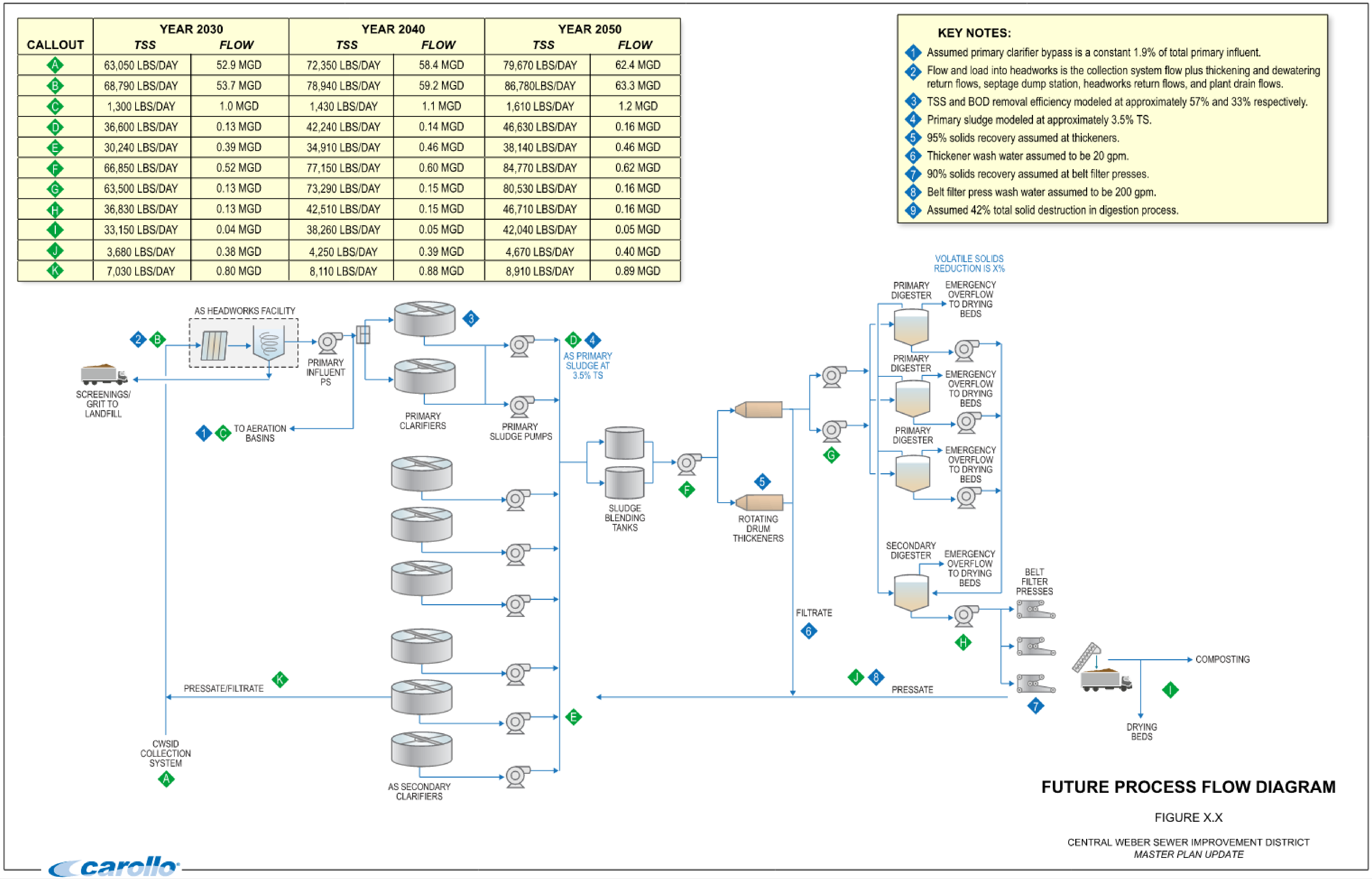
Land Application. Under a 5-year agreement with the CWSID, a private landowner hauls and land applies CWSID WRF biosolids to several local properties. This same private landowner owns several properties in and outside of Weber County and takes biosolids from several local water reclamation facilities including, North Davis Sewer District, Salt Lake City Department of Public Utilities and Central Valley Water Reclamation Facility. The agreement with CWSID includes agreed upon rates with escalation. Biosolids are not typically hauled away from CWSID WRF sludge drying beds until biosolids have dried to approximately 75 percent TS. CWSID conducts soil testing at private properties where biosolids are land applied, sets the agronomic application rates and prepares and submits an annual summary report to the DWQ.

Although there is no agreement in place, CWSID has also hauled biosolids to other private landowners who in turn land apply CWSID WRF biosolids. These private landowners also work with other local water reclamation facilities, including South Valley Sewer District. To date, CWSID has only hauled a small amount of biosolids to other private landowners on just a few occasions in hopes of sparking an interest in land application and helping the District to diversify its pool of private landowners willing to take and land apply biosolids.

Other. The District currently meets its UPDES permit requirements for a Class A biosolids by conducting enteric virus testing. CWSID has provided a small amount of Class A biosolids to Evergreen Soils for their soil blending operation. Since the Evergreen Soils soil blending operation is relatively small and unable to take large amounts of biosolids at this point in time, this beneficial use option has not been further explored by CWSID.

Future Biosolids Production and Regulatory Outlook

Future Biosolids Production. The future CWSID WRF biosolids production was estimated using BioWin® biological process simulation models assuming current biosolids management practices are continued forward throughout the planning period through the year 2050. A summary of future biosolids production is shown in Figure 13-16.



CALLOUT	YEAR 2030		YEAR 2040		YEAR 2050	
	TSS	*FLOW*	*TSS*	*FLOW*	*TSS*	*FLOW*
A	63,050 LBS/DAY	52.9 MGD	72,350 LBS/DAY	58.4 MGD	79,670 LBS/DAY	62.4 MGD
B	68,790 LBS/DAY	53.7 MGD	78,940 LBS/DAY	59.2 MGD	86,780LBS/DAY	63.3 MGD
C	1,300 LBS/DAY	1.0 MGD	1,430 LBS/DAY	1.1 MGD	1,610 LBS/DAY	1.2 MGD
D	36,600 LBS/DAY	0.13 MGD	42,240 LBS/DAY	0.14 MGD	46,630 LBS/DAY	0.16 MGD
E	30,240 LBS/DAY	0.39 MGD	34,910 LBS/DAY	0.46 MGD	38,140 LBS/DAY	0.46 MGD
F	66,850 LBS/DAY	0.52 MGD	77,150 LBS/DAY	0.60 MGD	84,770 LBS/DAY	0.62 MGD
G	63,500 LBS/DAY	0.13 MGD	73,290 LBS/DAY	0.15 MGD	80,530 LBS/DAY	0.16 MGD
H	36,830 LBS/DAY	0.13 MGD	42,510 LBS/DAY	0.15 MGD	46,710 LBS/DAY	0.16 MGD
I	33,150 LBS/DAY	0.04 MGD	38,260 LBS/DAY	0.05 MGD	42,040 LBS/DAY	0.05 MGD
J	3,680 LBS/DAY	0.38 MGD	4,250 LBS/DAY	0.39 MGD	4,670 LBS/DAY	0.40 MGD
K	7,030 LBS/DAY	0.80 MGD	8,110 LBS/DAY	0.88 MGD	8,910 LBS/DAY	0.89 MGD

KEY NOTES:

1. Assumed primary clarifier bypass is a constant 1.9% of total primary influent.
2. Flow and load into headworks is the collection system flow plus thickening and dewatering return flows, septage dump station, headworks return flows, and plant drain flows.
3. TSS and BOD removal efficiency modeled at approximately 57% and 33% respectively.
4. Primary sludge modeled at approximately 3.5% TS.
5. 95% solids recovery assumed at thickeners.
6. Thickener wash water assumed to be 20 gpm.
7. 90% solids recovery assumed at belt filter presses.
8. Belt filter press wash water assumed to be 200 gpm.
9. Assumed 42% total solid destruction in digestion process.

FUTURE PROCESS FLOW DIAGRAM

FIGURE X.X

CENTRAL WEBER SEWER IMPROVEMENT DISTRICT
MASTER PLAN UPDATE

Figure 13-16: Future Solids Mass Balance Process Flow Diagram

Table 13-27
Current and Future CWSID WRF Biosolids Production

Parameter	Units	Existing	Year 2030	Year 2040	Year 2050
MMF Influent Flow	mgd	47.8	52.9	58.4	62.4
Primary Sludge Flowrate	gallons per day (gpd)	110,000	130,000	140,000	160,000
Primary Sludge Load (1)	lbs/day	34,907	40,972	47,566	52,517
WAS Flowrate	gpd	400,000	410,000	470,000	530,000
WAS Load (2)	lbs/day	29,833	35,102	40,516	45,976
Dewatered Cake (3)	lbs/day	33,356	39,658	46,530	50,580
	wet tons (WT) per day	167	198	233	253

[1] Existing Primary Sludge TS Concentration is 3% TS.

[2] Existing WAS concentration is 0.8% TS.

[3] Dewatered cake is assumed to have 10% TS and dewatering equipment has 90% capture efficiency.

Regulatory Outlook. To continue to protect public health and the environment, several states and federal agencies are evaluating biosolid land application practices that are approved under the Environmental Protection Agency's 503 Rule under Part 40 of Code of Federal Regulations (CFR). The Part 503 Rule was published in 1993 and established requirements for the final use or disposal of municipal biosolids. This federal standard was described in an EPA publication entitled "A Plan English Guide to the EPA Part 503 Biosolids Rule," which is commonly used by state regulators to oversee disposal of municipal biosolids. As new regulations surrounding biosolids are potentially promulgated by the EPA, municipalities will likely need to change their biosolids management practices and need to identify new beneficial uses and corresponding treatment technologies. Figure 13-17 is a simple graphic showing how future regulations can be significant Trigger Points that may cause the CWSID WRF to significantly change how it treats and beneficially uses its biosolids.

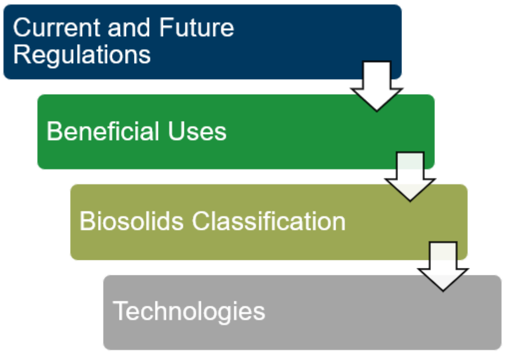


Figure 13-17 Regulatory Impact

In 2018 the Office of Inspector General (OIG) published a report entitled "EPA Unable to Assess the Impact of Hundreds of Unregulated Pollutants in Land-Applied Biosolids on Human Health and the Environment," and EPA published a formal response, a final report in May 2019. Under this effort the EPA developed probabilistic risk assessment and screening tools, updated communication/reporting protocols and identified the following as area of concern:

- Unregulated pollutants (352).
- Statements about biosolids safety and labels.
- Methods/sampling for pathogen reduction.
- Recordkeeping.

Based on biennial reviews of sewage sludge surveys and a pollutant risk screening process, the EPA evaluates the need to monitor and report certain chemical pollutants, contaminants of emerging concern.

Contaminants of Emerging Concern. Per- and polyfluoroalkyl substances (PFAS) as well as microplastics and pharmaceuticals are contaminants of emerging concern in the wastewater biosolids management. Recent studies indicate that PFAS are potentially carcinogenic, and this has already led some industries to begin monitoring these in groundwater. None of these are currently regulated.

Several states are taking actions to assess the risk of land applying PFAS compounds and the state of Main has gone so far as to place a moratorium on land application of biosolids due to PFAS concerns and continues to be the most conservative of all states in managing PFAS. The treatment technologies typically used to process solid in the wastewater industry today provide little to no PFAS destruction as these compounds exhibit high stability. Figure 13-18 provides a "snapshot" of the current status of pending PFAS regulations by each state.

EGLE MICHIGAN DEPARTMENT OF ENVIRONMENT, GREAT LAKES, AND ENERGY

SUMMARY REPORT:

Initiatives to Evaluate the Presence of PFAS in Municipal Wastewater and Associated Residuals (Sludge/Biosolids) in Michigan

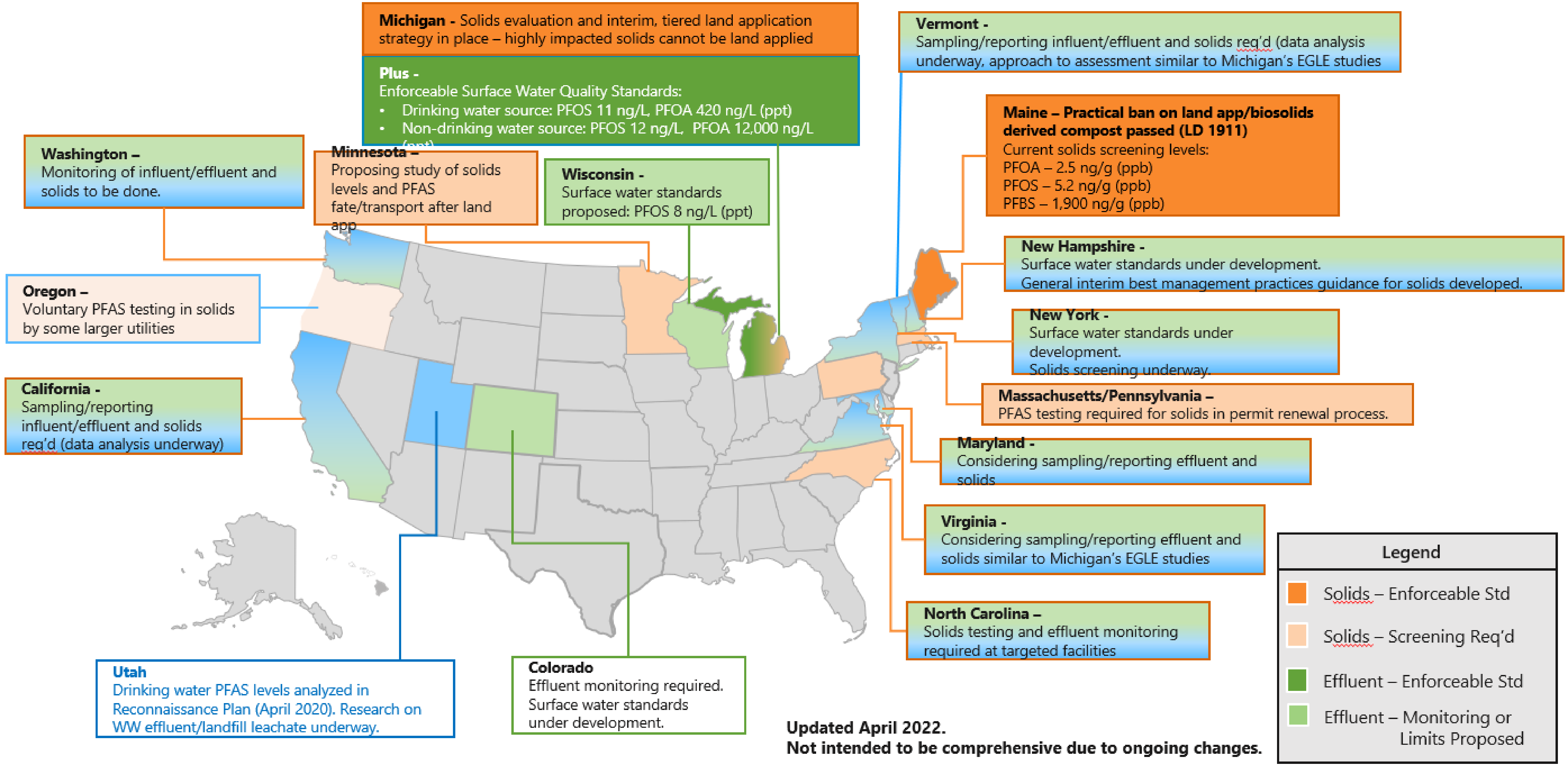
June 2020

WATER RESOURCES DIVISION

800-662-9278 | Michigan.gov/EGLE

The EPA is currently developing a "roadmap" that emphasizes a science-based approach that holistically protects public health and the environment. Table 13-28 lists recent and current research activities by EPA to address risk of PFAS in biosolids. It is recommended that CWSID do the following while waiting for EPA's final risk assessment for PFAS which is anticipated in the winter of 2024:

- Sample for PFAS and track your own data.
- Identify potential industrial contributors in your service area.
- Work with regulators on source control.
- Stay on top of research and regulatory changes.
- Seek out third party reviewed information or peer-reviewed performance data regarding holistic fate of PFAS in biosolids.
- Educate yourself so you are prepared to address public questions.
- Develop biosolid management options that accommodate future PFAS rules.



Michigan - Solids evaluation and interim, tiered land application strategy in place – highly impacted solids cannot be land applied

Plus -
Enforceable Surface Water Quality Standards:
- Drinking water source: PFOS 11 ng/L, PFOA 420 ng/L (ppt)
- Non-drinking water source: PFOS 12 ng/L, PFOA 12,000 ng/L (ppt)

Washington –
Monitoring of influent/effluent and solids to be done.

Minnesota –
Proposing study of solids levels and PFAS fate/transport after land app

Wisconsin -
Surface water standards proposed: PFOS 8 ng/L (ppt)

Oregon –
Voluntary PFAS testing in solids by some larger utilities

California -
Sampling/reporting influent/effluent and solids req'd (data analysis underway)

Utah
Drinking water PFAS levels analyzed in Reconnaissance Plan (April 2020). Research on WW effluent/landfill leachate underway.

Colorado
Effluent monitoring required. Surface water standards under development.

Vermont -
Sampling/reporting influent/effluent and solids req'd (data analysis underway, approach to assessment similar to Michigan's EGLE studies

Maine – Practical ban on land app/biosolids derived compost passed (LD 1911)
Current solids screening levels:
PFOA – 2.5 ng/g (ppb)
PFOS – 5.2 ng/g (ppb)
PFBS – 1,900 ng/g (ppb)

New Hampshire -
Surface water standards under development.
General interim best management practices guidance for solids developed.

New York -
Surface water standards under development.
Solids screening underway.

Massachusetts/Pennsylvania –
PFAS testing required for solids in permit renewal process.

Maryland -
Considering sampling/reporting effluent and solids

Virginia -
Considering sampling/reporting effluent and solids similar to Michigan's EGLE studies

North Carolina –
Solids testing and effluent monitoring required at targeted facilities

Updated April 2022.
Not intended to be comprehensive due to ongoing changes.

Legend
🟧 Solids – Enforceable Std
🟧 Solids – Screening Req'd
🟩 Effluent – Enforceable Std
🟩 Effluent – Monitoring or Limits Proposed

Figure 13-18: Current "Snapshot" of PFAS Regulations by States

Table 13-28
EPA Roadmap in Assessing Risk Posed by PFAS in Biosolids

Action	Completion Date
Evaluate and develop technologies for reducing PFAS in the environment	Ongoing
Restrict PFAS discharges from industrial sources	Ongoing
Finalize risk assessment for PFAS in biosolids that serves as basis for determining whether regulation and any subsequent biosolids standards is appropriate.	Winter 2024
Publish improved multi-laboratory validated analytical method for PFAS	Fall 2024
Issue updated guidance on destroying and disposing of PFAS	Fall 2023
Leverage National Pollution Discharge Elimination System permitting to reduce PFAS discharge to waterways and "require pretreatment program to include source control and best management practices to protect [wastewater treatment plant] discharges and biosolid[s] applications."	Winter 2022
Publish multi-laboratory validated analytical method for 40 PFAS	Fall 2022
Undertake nationwide monitoring for PFAS in drinking water	Fall 2021

Beneficial Use Alternatives

To best address change and always have a means to dispose of biosolids, a biosolids management plan should identify and include several viable beneficial use alternatives. Figure 13-19 is a map of the Wasatch Front showing the location of wastewater utilities and the following potential biosolids management alternatives:

- Private, public landfills and transfer stations including the Wasatch Regional Landfill, Davis County landfill, the Salt Lake Valley Landfill, Bay View Landfill, and the Trans-Jordan Landfill.
- The Dugway Aragonite Incinerator.
- Cement kilns.
- Areas where biosolids are currently land applied and areas where large parcels of land or farms might be purchased and managed by the District to land apply biosolids.
- Biograss sod farm.

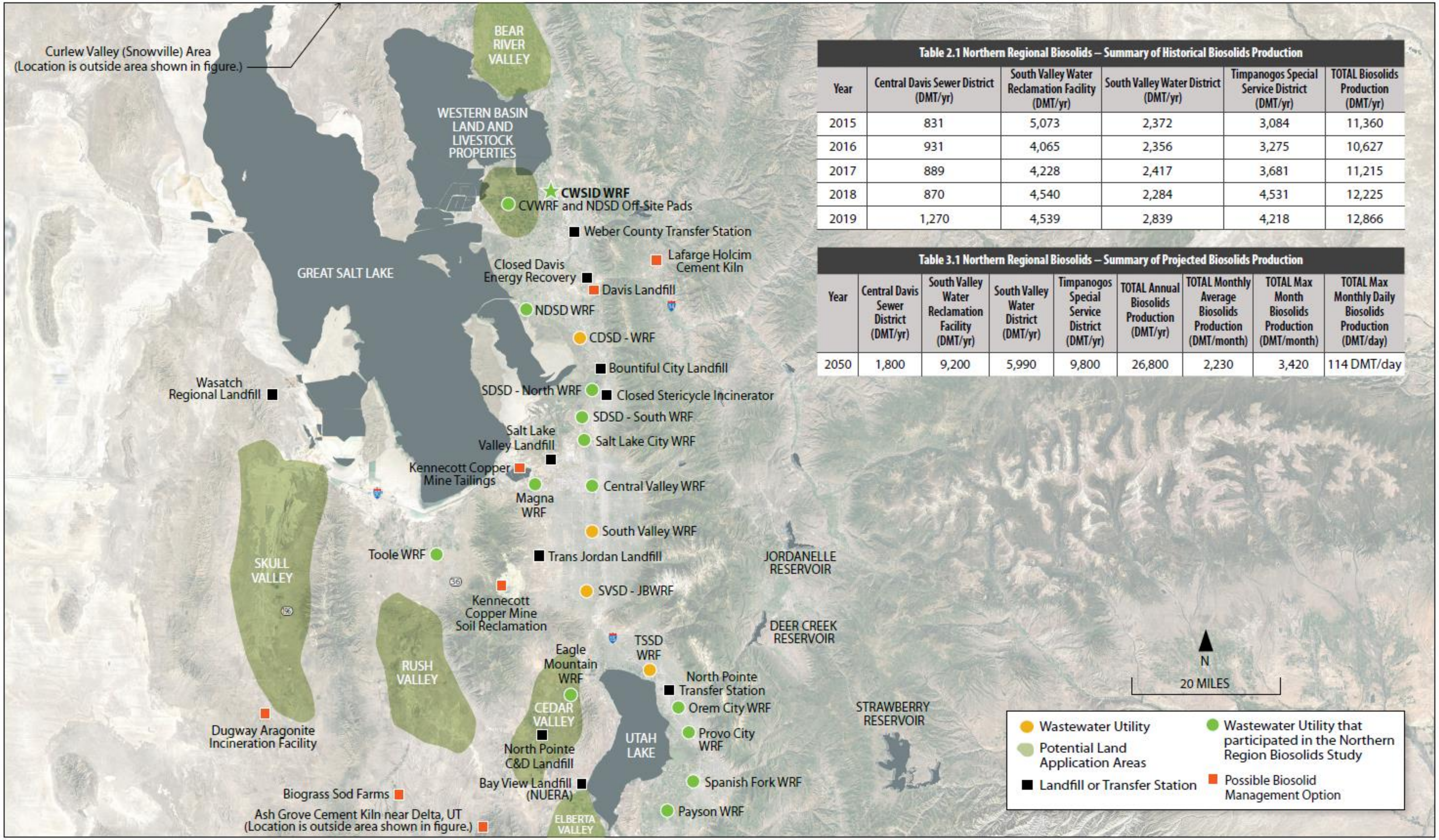


Table 2.1 Northern Regional Biosolids – Summary of Historical Biosolids Production

Year	Central Davis Sewer District (DMT/yr)	South Valley Water Reclamation Facility (DMT/yr)	South Valley Water District (DMT/yr)	Timpanogos Special Service District (DMT/yr)	TOTAL Biosolids Production (DMT/yr)
2015	831	5,073	2,372	3,084	11,360
2016	931	4,065	2,356	3,275	10,627
2017	889	4,228	2,417	3,681	11,215
2018	870	4,540	2,284	4,531	12,225
2019	1,270	4,539	2,839	4,218	12,866

Table 3.1 Northern Regional Biosolids – Summary of Projected Biosolids Production

Year	Central Davis Sewer District (DMT/yr)	South Valley Water Reclamation Facility (DMT/yr)	South Valley Water District (DMT/yr)	Timpanogos Special Service District (DMT/yr)	TOTAL Annual Biosolids Production (DMT/yr)	TOTAL Monthly Average Biosolids Production (DMT/month)	TOTAL Max Month Biosolids Production (DMT/month)	TOTAL Max Monthly Daily Biosolids Production (DMT/day)
2050	1,800	9,200	5,990	9,800	26,800	2,230	3,420	114 DMT/day

Figure 13-19: Northern Utah Biosolids Management

Table 13-29
Possible Beneficial Use Options for Biosolids

Description	Landfill	Land Application (Class A or B)	Outdoor Composting	Indoor Composting	Private Monofill	Soil Regeneration	Incineration
Satisfies Existing EPA 503 Rule	Yes	Yes	No	Yes	Yes	Yes	Yes
Mitigates or Removes PFAS	No	No	No	No	No	No	TBD
Sufficient Industry Experience	Yes	Yes	Yes	Yes	Yes	No	Yes
Yields Beneficial Product for Community	No	Yes	Yes	Yes	No	Yes	No

The options listed in Table 13-29 are provided. The first three management options were considered most suitable to CWSID: (1) landfill, (2) land application, (3) and outdoor composting. CWSID would like to develop these three management options with majority of the biosolids being land applied as shown in graphically in Figure 13-20 and as described below:

- Land Application will be the predominantly favored option where most CWSID WRF biosolids are beneficially used. Those wastewater utilities that have anaerobic digesters at their WRF and can meet 40 CFR Part 503 Rule requirements for a Class B biosolid typically land apply those biosolids using a third-party private landowner. In some instances, the landowner will haul and land apply the biosolids, calculate the agronomic application rates based on crop type and nutrient needs and perform the required soil testing and submit annual reports to the Division of Water Quality. Currently, most Class B biosolids along the Wasatch Front are land applied to property located in Weber County that is owned by private landowners. The following wastewater utilities currently have contracts of various forms in place with private landowners:
  - SLCDPU.
  - CVWRF.
  - North Davis Sewer District (NDSD).
  - CWSID.

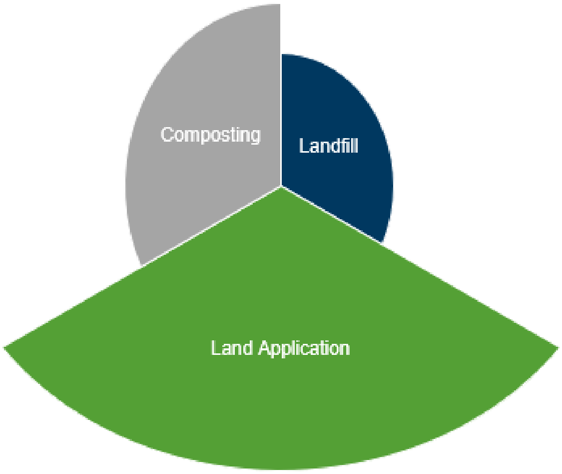


Figure 13-20 CWSID Preferred Beneficial Use Options

Both SVWRF and South Valley Sewer District (SVSD) operate thermal dryers to dry unstabilized biosolids sufficiently to meet 40 CFR Part 503 requirements for Class A biosolids. SVSD has a contract in place with a large landowner in Weber County, to land apply the biosolids and SVWRF landfills its Class A biosolids along with its unstabilized dewatered biosolids.

Composting will continue to be supported but will not be further developed to beneficially use more biosolids. Historically, several wastewater utilities along the Wasatch Front composted their biosolids and sold it to the public, but development brought new subdivisions closer to the composting operations and odor complaints forced most utilities to discontinue this practice. Currently only the Central Valley Water Reclamation Facility (CVWRF), the Central Davis Sewer District (CDSD) and the CWSID (via Weber County) have composting operations at the water reclamation facilities. Under this option the District would begin to manage the composting operation currently managed by Weber County. Outdoor composting would continue at the CWSID WRF site until odor complaints force the District to discontinue composting or relocate the operations to a more remote site. This alternative is an approved method to meet a Class A biosolid standard set by 40 CFR Part 503 and is listed in the CWSID UPDES permit as a Class A biosolid option. To meet Class A requirements, bacteria counts must be within limits, and EPA time and temperature requirements. A Class A biosolids compost is produced when temperature is maintained above 55 degrees Celsius for 3 days and vector attraction reduction (VAR) requirements are met when the temperature is maintained above 40 degrees Celsius (and the average temperature is greater than 45 degrees Celsius) for 14 consecutive days. Composting of biosolids has been practiced by several Utah wastewater utilities, including CVWRF, who composts a small portion of their biosolids at the CVWRF WRF site and market the compost product as Oquirrh Mountain Compost (See website: https://www.omcompost.com/).

Oquirrh Mountain
COMPOST PRODUCTS

Table 13-30 lists advantages and disadvantages of this beneficial use option.

Table 13-30
Advantages and Disadvantages of Composting Biosolids

Advantages	Disadvantages
Proven industry experience	Large land requirement
Meets Part 503 Rule for Class A unrestricted beneficial use	Large odor potential
Provides self-reliance	Large quantity of green waste
Odor issues can be mitigated	Increase material handling and hauling
Provides a sustainable means of managing residential green waste	

Aerated Static Pile. If pursued by the District, the aerated static pile (ASP) is recommended over the current windrow composting operation currently practiced by Weber County. The ASP practice offers a higher rate of composting, the compost pile will dry out more quickly than in a windrow system, generally drying out within 7 to 14 days. The ASP system consists of a fan system that pulls air down through the piles to an air collection piping network and then directs the air to a biofilter system. Maintaining air flow throughout the entire pile is often accomplished by installing the piping in a rock layer at the bottom of the bin or an aeration floor can be used. Process air temperature is monitored to maintain optimum temperature between 122 and 133 degrees Fahrenheit.

After completion of the main high rate composting phase, compost is typically moved to curing piles for an additional 28 days. These piles can be aerated with a fan system or naturally aerated. Larger chips used as Bulking material is removed from the cured composted and reused.

Compost Mix. Volumetric compost mix is typically 3:1 of building agent to biosolids, with the building agent assumed to be 60 percent fresh and 40 percent recycle where the recycle is defined as the quantity of material returned to seed new piles. This translates to: (1) one-part biosolids, (2) one-and-three-quarters parts fresh green waste, and (3) one-and-a-quarter parts recycle. Green waste is typically the main fresh bulking agent with supplemental wood chips used to provide larger recyclable bulk.

Odor Control. Odor control is a primary concern with a composting operation. The sue of in-ground biofilter is a low cost option that utilizes blowers to draw foul air into buried piping that discharge through perforated distribution pies vertically into a lined cell containing a media which is typically mixture of wood chips seeded with wastewater sludge. The microorganisms present in the media mitigate odor compounds such as sulfides and mercaptans.

General Requirements. An off-site outdoor composting facility will require additional evaluation to define the compost mix quantities, including green waste and building material, and to define a property, its size, and potential need for odor controls.

Landfilling biosolids is not preferred and will only be used when beneficial use options are not available. Several local wastewater utilities currently haul their biosolids to private or public landfills. Timpanogos Special Service District, CDSD and South Valley Water Reclamation Facility (SVWRF) currently haul unclassified dewatered biosolids to the Wasatch Regional Landfill in the West Dessert. Salt Lake City Department of Public Utilities (SLCDPU) typically land applies its Class B biosolids but, if necessary, can also haul biosolids to the Salt Lake Valley Landfill.

Although not a beneficial use option, landfilling biosolids provides CWSID with a way to dispose of its biosolids in the event preferred beneficial use options become unavailable. Under this alternative CWSID would haul its biosolids to a private or public landfill and pay a tipping fee to dispose of its biosolids. The following landfills located near CWSID and might accept Class B biosolids:

- Davis County Landfill.
- Wasatch Regional Landfill.

These landfills will need to be contacted by the District to determine if they are accepting municipal biosolids at this time and would be willing to enter into a contract with CWSID. It is believed the Davis County Landfill does not accept municipal. Weber County operates a Transfer Station, but it is unclear if they would be willing to accept CWSID Class B biosolids beyond what they currently compost. Additional discussions between the District and Weber County might lead to a landfill alternative or additional beneficial use options.

Table 13-31 lists anticipated costs to landfill biosolids assuming the District were to haul all 25 percent of its biosolids to Wasatch Regional Landfill (100 mile one way trip distance) using their own fleet of haul trucks. Haul dump trucks are assumed to carry 44,000 pounds (22 wet tons) each, get 15 miles per gallon and cost approximately $300,000 each. Four haul trucks are needed through Year 2030, but seven haul trucks are required by Year 2040 assuming each truck can get two round trips done in one day. The largest single cost is the landfill tipping fee, and it should be noted that the prices per wet ton values listed in Table 13-31 are estimates based on current tipping fee that Wasatch Regional Landfill charges the South Valley Water Reclamation Facility.

Table 13-31
Estimated Costs to Landfill 25 percent of CWSID Biosolids

Item	Units	Year 2030	Year 2040	Year 2050
Landfill Tip Fee	$ per ton	$ 75 per ton (5)	$ 100 per ton	$ 125 per ton
Annual Landfill Cost	$	$ 1,289,195	$ 2,016,785	$ 2,740,409
Haul Cost (2)	$	$ 913,333	$ 1,154,400	$ 1,212,800
Annualized Capital Cost (3) (4)	$	$ 117,340	$ 140,808	$ 140,808
Total Annualized Cost	$	$ 2,319,868	$ 3,311,993	$ 4,094,017

[1] Assumes 10% TS.

[2] Haul cost includes gas, driver and haul truck maintenance and replacement.

[3] Return period is 20 years.

[4] Discount rate is 6%.

[5] SVWRF currently pays $45.59/WT tip fee at Wasatch Regional Landfill.

Biosolids RoadMap

The following scenarios offer "trigger point" examples of what might occur in the future and which options the District might pursue in response.

Scenario 1 - Private Landowners Stop Taking Biosolids. If private landowners who currently take CWSID WRF biosolids and land apply them to their private property were to decide not to renew their agreement with the District, the District might consider the following land application options:

- Option 1 - Contract with Large Landowners. This is the "status quo" alternative as the District already does. However, additional private landowners might also enter into contracts with the District to haul and/or land apply CWSID WRF biosolids on their properties and help the District diversify this option and reduce the risk associated with this option becoming unavailable. Under this option CWSID avoids the cost to purchase property, haul and land apply biosolids and manage a farm operation.
- Option 2 - Land Application on District-Owned Property. Under this option the District would purchase private property itself and haul and land apply biosolids. This option provides the District with increased control and reduces potential risk of it being unavailable. And as land continues to appreciate in Utah, a property purchase by the District is considered low risk.
- Option 3 - Landfill.

The first option is much less expensive, however the second options increases District control and decreases the risk of losing a private landowner deciding to no longer accept CWSID biosolids.

Other wastewater utilities in Utah have pursued this option. On November 14, 2022, Carollo Engineers, Inc. (Carollo) and CWSID interviewed CVWRF personnel about their CVWRF-owned farm. CVWRF purchased a 2,700-acre dry farm located near Fairfield, Utah in the 1990s for $2 million ($741 per acre) and originally intended to operate the farm and haul and land apply biosolids to it. However, since the purchase CVWRF has leased it back to the farmer as it continues to land apply biosolids to a private land owner. In the future, CVWRT intends to plant native grasses and make property improvements based on a "Ranch Plan" developed by Soil Conservation Services. This property is not currently permitted for biosolids land application by DWQ but was previously. CVWRF will continue to keep and maintain the property in case current land application of biosolids to private land is no longer an option. CVWRF noted the appreciation of land value makes the purchase of a property a safe investment. Their Fairfield farm property has increased in value and a current purchase price is estimated to be $13.5 million ($5,000 per acre). CVWRF staff made the following recommendations:

- Purchase land in an unincorporated area of a county, preferably a large farm with water rights where crops with high nutrient uptake rates can be grown and rotated. CVWRF staff recommended CWSID consider looking in the Snowville area, approximately 100 miles from CWSID.
- To reduce the amount of farm equipment needed (or to reduce the need to haul equipment between multiple parcels), purchase one large parcel or farm.
- It is reassuring to have an alternative, a "backup plan", to current land application approach using third party landowners.
- Work with someone who has extensive biosolids land application experience and can talk to local farmers about their operations. They recommended working with Bill Fast, a retired engineer who used to work with Brown & Caldwell.

The land application alternative is ultimately limited by nutrient uptake based on crop type and the amount of nitrogen applied to it. Table 13-32 lists the estimated acreage required for a District-owned farm assuming the District would primarily grow alfalfa which has a relatively large nitrogen uptake rate of 400 pounds per acre per year (lbs/acre/yr) potentially. As a comparison, corn and wheat have a 250 and 140 lbs/acre/yr potential nitrogen uptake rate, respectively. The values listed in Table 13-32 are preliminary and provide a rough estimate of potential farm size and further evaluation to detail agronomic rate analysis, confirm crop nitrogen uptake rate, and determine nitrogen components of CWSID biosolids is recommended.

Table 13-32
CWSID-Owned Farm Area Requirements Based on Growing Alfalfa Crop

Item	Units	Year 2030	Year 2040	Year 2050
Crop Area Requirements				
Nitrogen Components (1)				
Total Kjeldahl Nitrogen (TKN)	mg/kg	79,900	79,900	79,900
NH3-N	mg/kg	3,480	3,480	3,480
Total Organic Nitrogen	mg/kg	76,420	76,420	76,420
Plant Available Nitrogen (PAN)				
Mineralization	%	35	35	35
Volatization	%	5	5	5
PAN	mg/kg	30,053	30,053	30,053
Crops				
Alfalfa Uptake (2)	lbs/acre/yr	400	400	400
	acres	1,499	1,739	1,897
Other Property Area Requirements				
Buffer Area (3)	acres	375	435	474
Roads and Shop Buildings (4)	acres	94	109	119
Storage Pad	acres	15	18	19
Total Land Requirement	acres	2,357	2,735	2,983

[1] Based on analysis of SVSD unstabilized biosolids.

[2] Acreage doubled for crop rotation.

[3] 30%.

[4] 5%.

[5] Hold time on pad is assumed to be 365 days/year and 1.19 cubic yards per ton dewatered cake.

[6] Abbreviations: mg/kg = milligram per kilogram.

Table 13-33 lists the estimated capital and annual operation and maintenance costs related to District-owned and operated farming operations on which it beneficially uses its Class B biosolids.

Table 13-33
Estimated Costs for Land Application of Biosolids on District-Owned Property

Item	Units	Year 2030	Year 2040	Year 2050
Capital Expenses				
Haul Trucks	$	$ 1,200,000	$ 1,500,000	$ 1,500,000
Farm Equipment	$	$ 720,000	$ 720,000	$ 720,000
Property Purchase (2)	acres	3,782	4,365	4,761
	$	$ 15,046,714	$ 17,458,894	$ 19,043,665
Annualized Capital Cost (3) (4)	$ per year	$ 2,328,552	$ 2,548,540	$ 2,680,334
Annual O&M Expenses				
Hauling Truck	$ per year	$ 730,667	$ 962,000	$ 1,010,667
Farm Equipment O&M	$ per year	$ 150,000	$ 150,000	$ 150,000
Farm Improvements	$ per year	$ 500,000	$ 500,000	$ 500,000
Total Annualized Cost	$ per year	$ 3,709,219	$ 4,160,540	$ 4,341,001

[1] Includes truck scale, front end loader, manure spreader, hay baler and tractor.

[2] Assumes $4,000 per acre.

[3] Return period is 20 years.

[4] Discount rate is 6%.

The Cedar Mountain Farm located in Snowville area (Box Elder County) is an example of the type of property the District might consider purchasing. Refer to https://hciutah.com/search-farms-ranches/242-cedar-mountain-farm?bts=116. The property is a 5,260-acre hay farm and includes 36 Zimmatic center pivots over 3,765 acres. The farm currently grows alfalfa, orchard grass, timothy hay and oats. It has a 13,055 acre-feet per year of water rights and groundwater wells are interconnected. The property includes the following improvements: (1) four homes, (2) large hay barns shown in picture at left, (3) storage buildings, (4) shops, and (5) grain silos. The property is listed at $19,000,000 ($3,600 per acre).

Scenario 2 - Drying Beds Become Unavailable. Due to the potential for odor complaints from a new residential subdivision located on the adjacent property located on the north side of the CWSID WRF, the drying beds may become unavailable and other biosolid treatment options should be considered to reduce the amount of biosolids managed or to reduce water content. Potential biosolids treatment technologies the District might consider include:

- Class A Biosolids.
- Thermal hydrolysis.
- Thermal-alkaline hydrolysis.
- Temperature-phased anaerobic digestion (TPAD).

- Expand single-stage mesophilic digestion.
- Post aerobic digestion (PAD).
- Thermal drying.

There are a wide array of methods and processes that can be implemented to enhance the solids handling facilities at the CWSID WRF and maximize resource recovery. These processes can be located both upstream of digesters, integrated into digestion, and/or downstream of digestion. Many of the potential processes for solids handling are interdependent as the input or performance of one process will be dictated by effects from another. For example, the inclusion of thermal hydrolysis upstream of digestion will improve the dewaterability of sludge and reduce the necessary polymer dose in a downstream dewatering process but will also increase input head demands. For this reason, each process cannot be examined in isolation.

While the primary goal of the CWSID WRF solids management plan is to provide the capacity to treat and offload solids at the future loading values, the following solids treatment processes have the potential to provide enhanced benefits that go above and beyond this basic need:
Only thermal and thermal-alkaline hydrolysis and thermal drying were believed to be most suitable for the CWSID WRF and were further evaluated as part of this master plan update effort. Expanding the mesophilic digestion process is discussed above in an earlier section.

Evaluation Criteria. In addition to life cycle costs, any proposed biosolids treatment technologies should be evaluated against the following criteria:

- Complexity and ease of operation.
- Digester capacity.
- Odor potential.
- Dewaterability.
- Beneficial use and sustainability.
- Integration with other existing unit processes

Thermal Hydrolysis. Thermal hydrolysis (THP) is an anaerobic digestion intensification pretreatment system that is used at full-scale water reclamation facilities in Europe and in the United States since 1995 and 2014, respectively. The predominant supplier of this technology in the United States is CAMBI. CAMBI utilizes THP in a three-stage pretreatment process where primary sludge and WAS are combined and concentrated to 16 to 18 percent dry solids. These thickened solids are continually fed into the first stage called pulper and heated to 176 to 194 degrees Fahrenheit using recovered steam from the flash tank as heat source. The heated solids homogenize in the pulper and then are continually fed sequentially to a series of two to six reactors, depending on hydraulic retention time (HRT), sludge volume and reactor size. The reactors are fed sequentially to ensure sealed batches and treatment of the sludge.

Once a reactor is filled, the reactor is sealed, and steam is used to increase the temperature to 320 to 356 degrees Fahrenheit and the pressure to 6 bars approximately for 20 to 30 minutes. This ensures pathogens are killed in the batch and the sludge is hydrolyzed. Once the batch process is completed, the sterilized sludge is discharged to a flash tank at atmospheric pressure. The sudden drop in pressure leads to cell destruction in the sludge and generates steam that is recycled to heat the pulper. The sludge discharged from the flash tank is cooled further and diluted for anaerobic digestion. The CAMBI process is shown below in Figure 13-21.

CAMBI pretreatment THP allows for a higher volatile solid reduction (VSR) in anaerobic digesters. The increase in volatile destruction in turn increases the amount of biogas produced, potentially increasing renewable natural gas revenues. However, this THP process can be expensive and typically requires significant capital investment to implement since it operates at higher temperatures and pressures and significantly increases the overall footprint of the system.

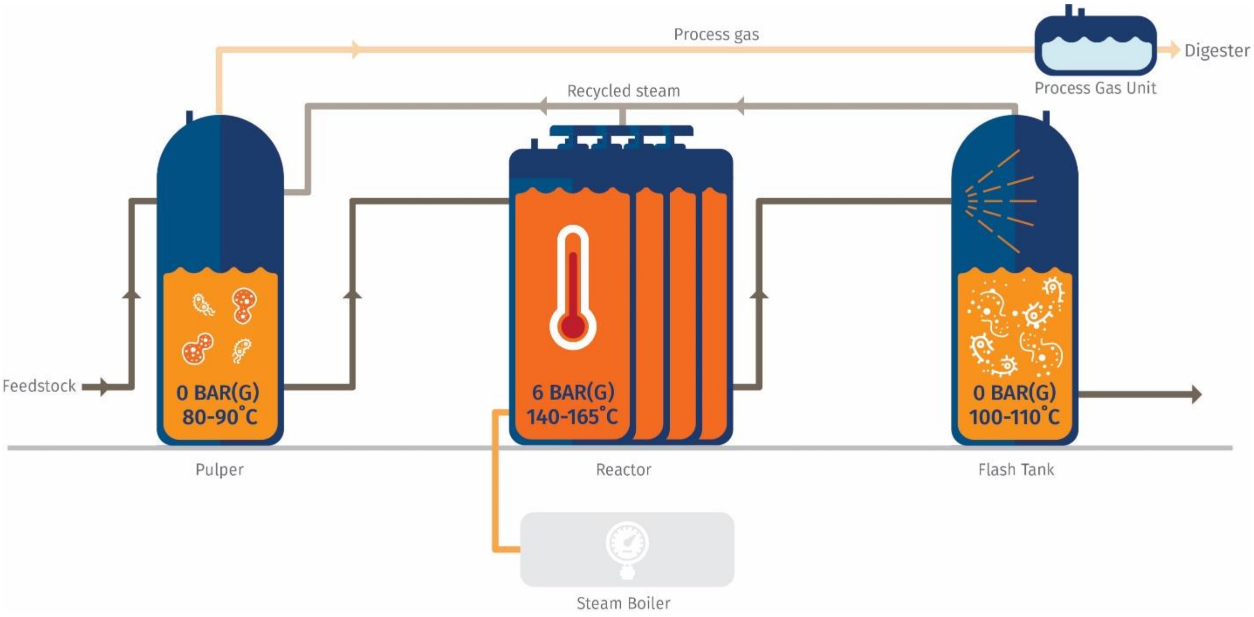


Figure 13-21: CAMBI Process Schematic

Since a thermal-alkaline hydrolysis process is typically less expensive, an estimate of the anticipated project cost of a CAMBI thermal hydrolysis system was not developed under this master plan update effort. Advantages and disadvantages associated with thermal hydrolysis are included in Table 13-34.

Table 13-34
Thermal Hydrolysis Advantages and Disadvantages

Advantages	Disadvantages
Increased digester hydraulic loading rates as a reduction in viscosity allows feed sludge of 10-11% TS to be pumped to the digesters.	Requirements for sludge pre-screening and pre-thickening
Increased digester SRT without increasing tank volume requirements.	High energy requirements
Significant increases in sludge digestibility leading to increased biogas production	Operator requirements to produce the high pressure steam needed to run the process
Lower dewatering and disposal loads	
Reduction of pathogens to meet Class A biosolids requirements	Large footprint required for system construction
Dewaters much more readily compared to typical digested sludge with measured solids concentration increases of 10% TS documented for dewatered cake material	Lots of equipment

Thermal-Alkaline Hydrolysis. Thermal-alkaline hydrolysis is a pre-digestion process that uses caustic soda to raise pH to 11 and hot water heating (to 150 degrees Fahrenheit) to hydrolyze WAS. This increases sludge degradability, improves dewaterability and decreases viscosity similar to thermal hydrolysis. Thermal alkaline hydrolysis requires much less equipment and less heat input than a thermal hydrolysis system. It also is designed to treat only WAS to maximize hydrolysis effects (although this prevents it from achieving Class A). WAS is chemically treated and heated to 150 degrees Fahrenheit in the thermal alkaline hydrolysis reactor. The resulting lysis of cells causes a release of organic acids that return the pH to near neutral. Heated WAS is then mixed with cold primary sludge and fed to the anaerobic digesters. For mesophilic digestion, the digester heating loads are similar with or without the thermal hydrolysis and recovered hot water heat from combined heat and power (CHP) can be used. Thermal alkaline system has a small footprint and have relatively low operations and maintenance requirements. A disadvantage of this process is that it introduces chemical handling (caustic soda) into the solids handling scheme. Additionally, while there is no pre-thickening step, so the system can only feed sludge to the digesters at the same thickness at which it is received, so the digester feed thickness would be limited by the performance of the sludge thickening unit process. The PONDUS system manufactured by CNP Technologies (CNP) was the thermal alkaline hydrolysis system solicited for a budgetary quotation and vendor supplied information is included in Appendix G.

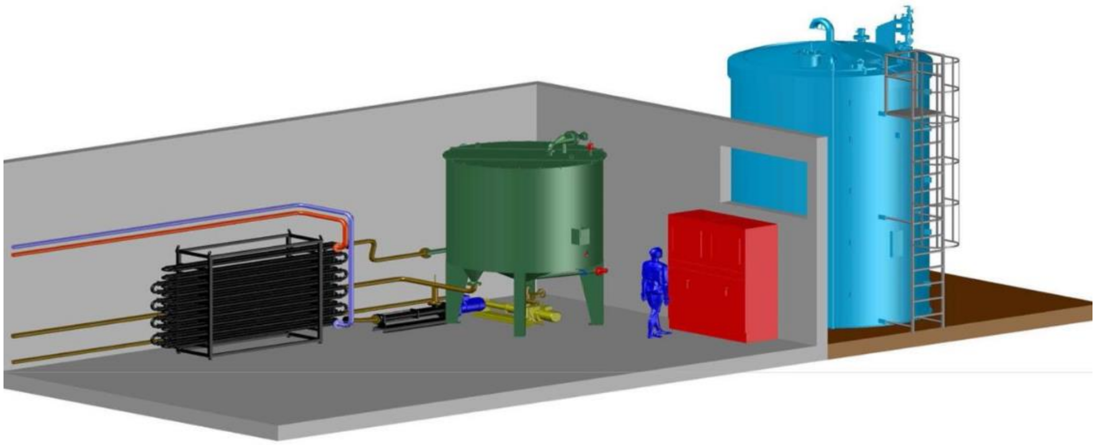


Figure 13-22: PONDUS Thermo-Alkaline Hydrolysis System Graphic 1

Table 13-35 summarizes the estimated capital cost to install a PONDUS thermal-alkaline type hydrolysis system at the CWSID WRF to hydrolyze TWAS. In addition to the advantages mentioned above, the PONDUS system also:

- Enhanced biogas production.
- Improve volatile solids reduction.
- Reduce digester foaming.
- Significantly reduces sludge viscosity (possibly up to 80 percent), which
    - Reduces needed energy for heating, pumping, and mixing.
    - Increase sludge loading rate to primary digesters.
    - Less digester retention time.
    - Reduces needed digester volume possibly up to 50 percent.
    - Improves digested sludge dewaterability.
    - Dryer cake by 3 to 6 percent.
    - Reduces polymer usage.

Table 13-35
Estimated Project Cost of a PONDUS Hydrolysis Project

Item	Unit	Quantity	Unit Cost	Cost
Mobilization/Demobilization/General Conditions	LS	1	1,964,475	$ 1,964,000
Hydrolysis Building	LS	1	2,816,833	$ 2,817,000
Equipment	LS	1	3,888,900	$ 3,889,000
HVAC/Mechanical	LS	1	2,100,000	$ 2,100,000
Civil Improvements/Demolition	LS	1	1,000,000	$ 1,000,000
Electrical/I&C	LS	1	1,750,000	$ 1,750,000
Total Direct Costs				**$ 13,520,000**
Contingency (25%)				$ 3,380,000
Engineering and Permitting (15%)				$ 2,028,000
2023 Total Estimated Project Costs				**$ 18,928,000**

Thermal Drying. Thermal dryers can be used to process dewatered cake to produce a dry solid material with dryness that ranges between 90 and 98 percent. These units operate in a compact and enclosed footprint when compared to air drying technologies. The dryer solids products, generally referred to as pellets or granules, are widely recognized as Class A biosolids material that have good aesthetics and significant nutrient content. These products can be marketed and distributed as a soil amendment product in a wide variety of applications. Typically for higher end soil amendment application, additional screening, and classification of granules to a specific size range is desirable but not required. The main drawback to any thermal drying system is the high capital cost and the large amount of energy needed to evaporate the water content of the biosolids.

There is a wide variety of drying technologies that generally fall into the following two categories:

1. Convection or "direct" dryers use direct contact of hot air passed over sludge to remove water. Some types of direct dryers include rotary drum dryers, belt dryers, and fluidized bed dryers.
2. Conduction or "indirect" dryers are technologies where the heat source does not come in direct contact with the solids, and instead transfers the heat through a metal surface. Some types of indirect dryers include rotating chamber dryers, paddle dryers, and batch dryers.

While there are various pros and cons for direct versus indirect drying, and for individual dryer technologies, this analysis will focus on belt dryers as a direct drying technology and paddle dryers as an indirect technology. Belt dryers are less established domestically but provide the opportunity to utilize medium temperature waste heat recovered from CHP.

SVSD utilizes a low temperature direct-type belt dryer while the SVWRF employs an indirect-type paddle dryer. SVWRF has been challenged in working with the paddle dryer and have expended a lot of resources in making operating and maintaining it. SVWRF's dried end product is very dusty which makes it difficult to land apply and use by farmers as a fertilizer. SVSD thermal drying facility was brough online in 2020 and produces a dried unstabilized product that can be land applied. SVSD has also had some unexpected operational challenges due to bio growth in the air condensing equipment that inhibits air flow and requires the thermal dryer to be taken offline so the media in the air condenser can be clean and the biogrowth removed. It should be noted that the Timpanogos Special Services District (TSSD) recently reviewed thermal drying equipment options and decided to purchase a new belt dryer(s) for their water reclamation facility.

The belt dryer is a relatively new drying technology for municipal sludge applications that has gained popularity in Europe and has expanded to several installations in the United States, with the main driver being that they are currently the only standard dyer technology that can utilize a "medium temperature" heat source (195 to 215 degrees Fahrenheit). Compared to indirect paddle dryers, belt dryers have a marginally lower drying efficiency at approximately 1,250 British thermal units per pound (BTU/lb) evaporation. They also require larger footprints and have large parasitic electrical demands mostly associated with air circulation fans. Belt dryers can be built with a two train design that provides operational redundancy as one train can be taken offline while maintaining partial drying capacity. This also allows only one train to be run during lower loading conditions to increase efficiency. Belt dryers can also be built modularly allowing for additional modules to be added as needed in the future provide enough building space and fac capacity is available. While both direct and indirect dryers will require exhaust air capture and treatment for odor control, direct dryers generate a larger volume of air to be treated.

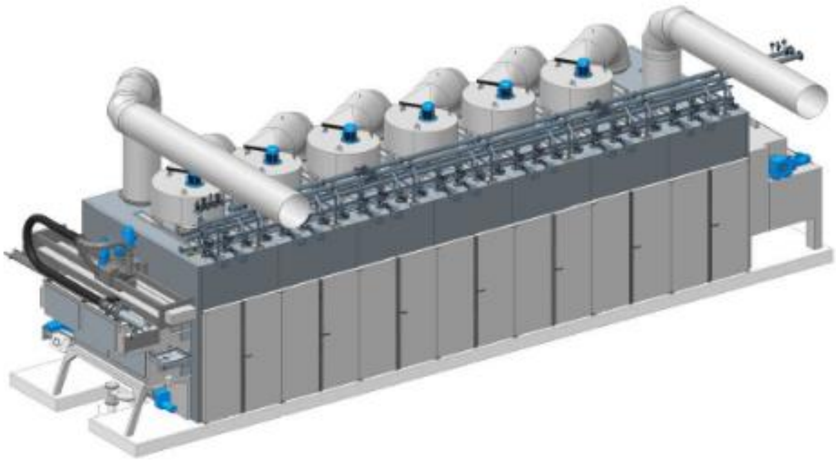


Figure 13-23 PONDUS Thermo-Alkaline Hydrolysis System Graphic 2

The dual screw, hollow core paddle dryers with and internal thermal fluid are a common indirect dryer technology used to perform thermal drying on sludge. Since these units use thermal fluids (either thermal oil or steam) at temperatures ranging from 350 to 400 degrees Fahrenheit, CHP waste heat cannot be used. Heat source energy is typically provided by firing either natural gas or biogas in a boiler. While firing biogas in a boiler to power an indirect thermal dryer is a way to offset outside energy demands for thermal drying, it would eliminate the opportunity to use biogas for other beneficial applications such as power production or generation of compressed natural gas (CNG) vehicle fuel. The paddle dryers benefit from having a smaller footprint than belt dryers and require less energy to dry at approximately 1,100 BTU/lb evaporation due to increased thermal transfer efficiency through the heated metal surface. Paddle dryers have large parasitic electrical loads similar to the belt dryers but require less air circulation and less exhaust air treatment leading that in turn lead to reduced odor control. Paddle dryers are a single pass through unit meaning there is no operational redundancy if the dryer is taken out of service. They also are of a fixed capacity meaning additional units would need to be installed to meet future loading increases.

Table 13-36
Estimated Project Cost of a Thermal Drying Facility

Item	Unit	Quantity	Unit Cost	Cost
Mobilization/Demobilization/General Conditions	LS	1	6,790,956	$ 6,791,000
Thermal Drying Building	LS	1	7,788,798	$7,789,000
Equipment	LS	1	20,408,000	$ 20,408,000
HVAC/Mechanical	LS	1	4,800,000	$ 3,500,000
Civil Improvements	LS	1	950,000	$ 950,000
Electrical/I&C	LS	1	6,000,000	$ 6,000,000
			Total Direct Costs	**$ 46,738,000**
Contingency (25%)				$ 11,685,000
Engineering and Permitting (15%)				$ 7,011,000
			2023 Total Estimated Project Costs	**$ 65,434,000**

Recommendations

Biosolids roadmaps are useful by knowing how to navigate alternative options based on changing conditions, such as new regulatory drivers or loss of an asset due to external circumstances. The priority for this roadmap is grant CWSID more control over their biosolids operations and limit the effects of changing conditions that are outside of CWSID's control. Some of following recommendations listed are contingent upon changing conditions and are therefore not mandatory projects. These recommendations are listed as "contingency" projects as shown in Chapter 14.

1. Continue land applying Class B or Class A biosolids on third-party private farmland. In the meantime, continue to search out other private farm owners willing to accept biosolids.
2. Continue to utilize and expand drying beds operations for the foreseeable future. This asset is critical to managing biosolids and allows for Class A biosolid capabilities.
3. Search out and purchase Farmland for land application. A CWSID owned farmland would give CWSID the most control over their biosolids operations.
4. If land applying biosolids on private farmland is discontinued, it is recommended to implement solids treatment technologies, such as thermal-alkaline hydrolysis to improve dewatering and reduce biosolids. Solids would still be categorized as Class B.
5. If land application of Class B biosolids is not the future desired outcome and drying beds are lost, then Class A technologies can be implemented, such as thermal hydrolysis or thermal drying and solids can be marketed and sold as a bioproduct.

BIOGAS UTILIZATION

This section outlines current and alternative biogas utilization options available to CWSID and an alternatives evaluation to determine the likelihood to be implemented. The following options will be discussed:

- Flare.
- Plant use:
  - Boiler systems.
  - Cogeneration.
- Fleet use.
- Gas conditioning for renewable natural gas market.

Current Biogas Utilization

CWSID WRF has historically used its biogas in a cogeneration process to power the TF Treatment Process and as feed gas for its digester boiler systems. However, currently all the CWSID WRF generated biogas is flared since the cogeneration system has been abandoned and natural gas is used for digester boiler systems. CWSID WRF would like to better use its biogas and requested that Carollo Engineers explore the following options: (1) continue to flare, (2) plant use such as boilers or cogeneration, (3) fleet vehicle use, and (4) renewable natural gas.

CWSID WRF biogas flows have ranged between 150 cubic feet per minute (cfm) and 375 cfm. This wide range in gas production range may be due to:

- Inaccurate gas flow measurements.

- An anomaly in early spring of 2021 due to high wasting rates caused by significant change in water temperature or influent BOD load.
- Change in digester reactor heating.

Since CWSID WRF has flared all its gas for several years and has been fully operating the AS Treatment Process for less than 10 years, carbon management has been focused on meeting effluent water quality limits (particularly ammonia) and less attention has been given to the solids digestion process to improve VSR and increase biogas production. Despite some concern over accurate biogas flow measurements, data has suggested that current biogas production is approximately 225 cfm. Figure 13-24 shows the amount of biogas that has historically been produced and how much is projected to be produced in the future. In evaluating the potential biogas uses, it is assumed that CWSID WRF will produce approximately 300 cfm of biogas between years 2025 and 2045.

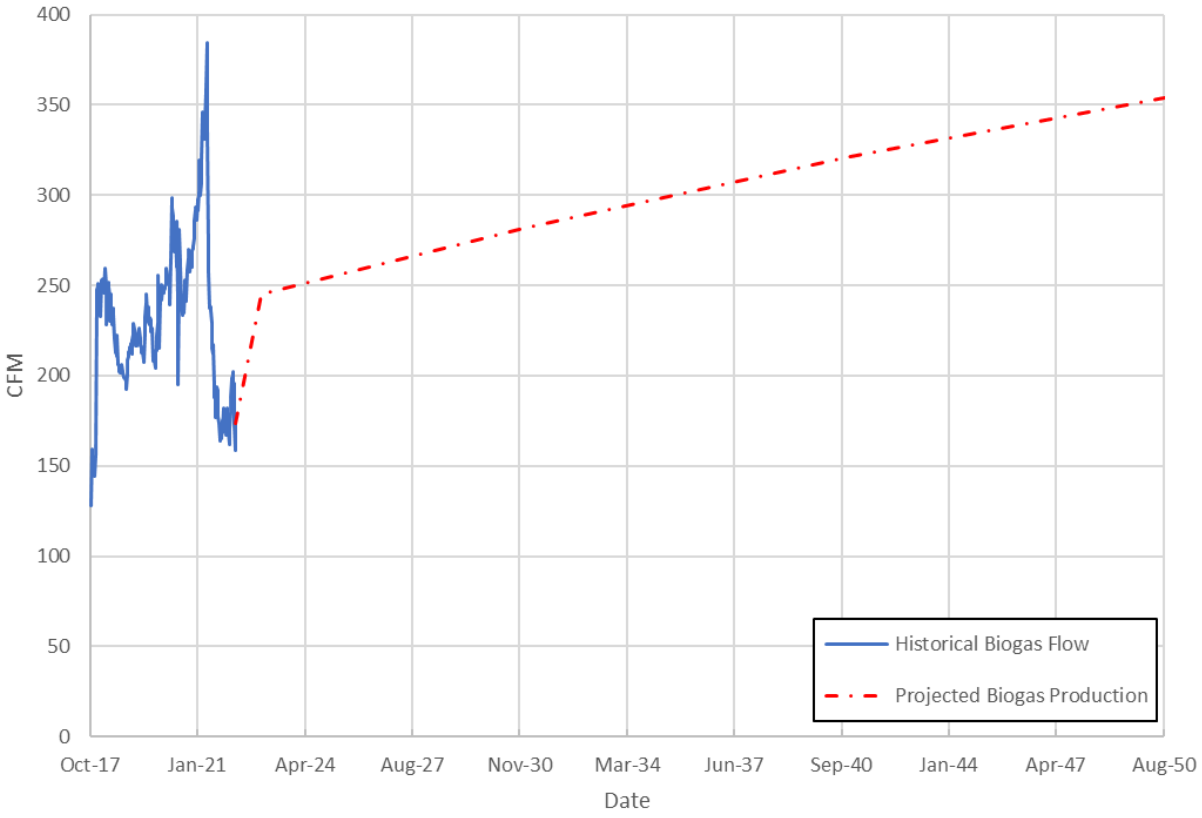


Figure 13-24: CWSID WRF Historical Flow and Projected Biogas Production

Biogas Beneficial Use Options

Flaring. Flaring is necessary to allow CWSID WRF an option to dispose of its biogas when beneficial uses are not available or are not feasible. CWSID WRF currently flares all its biogas. The current industry guidelines for flare safety, are covered under ANSI/CSA B 149.6-15, code for digester gas, landfill gas and biogas generation and utilization. Some of the guidelines are listed below:

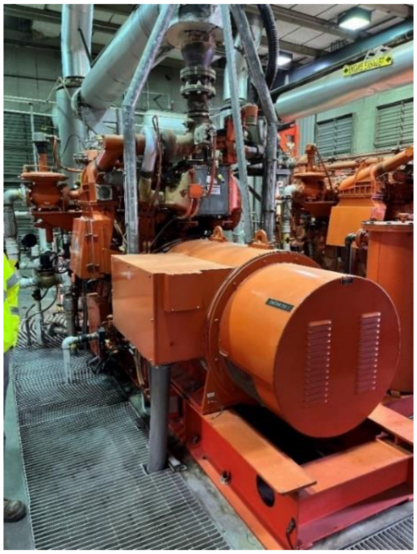
- Waste gas burner and igniter shall be at least 4 meters above grade.
- Waste gas burner stack termination shall be at least 1.5 meters above any obstruction.
- Waste gas burner and ignitor shall be not less than 15 meters from the perimeter of any digester or other potential source of combustible gas.
- Waste gas burner shall be located not less than 7.5 meters from traveled portion of any road.
- It is recommended to inspect the flare for fouling and corrosion. Improvements or relocation to the existing flare can be combined with the beneficial use of biogas in the boilers

Plant Use

Boiler Systems. The CWSID WRF currently uses natural gas as fuel for its boiler systems employed to heat the primary digesters, but it has used biogas in the past. CWSID WRF staff believe the biogas was not cleaned sufficiently before being used by boiler systems and to extend boiler service life and reduce maintenance, a decision was made to switch to cleaner utility natural gas. It is recommended that CWSID further evaluate existing gas cleaning systems that may be used to improve the quality of the biogas so it may be used by plant boiler systems.

The existing boiler control room houses three boilers that are almost 15 years old. The boilers were designed to use natural gas as the fuel source. The existing boilers are not designed to run with biogas and the typical life span of boilers is around 15 years old, which puts the existing boilers at the end of their design life. A beneficial use of the existing biogas produced at the plant will be as a fuel for the boiler system.

The older boiler system can be replaced with new boilers, designed to used biogas as a fuel source. An improved gas cleaning system can be also installed to provide the boilers with higher quality biogas, extend their design life and minimize maintenance. A complete system analysis/upgrade will be required to incorporate all the boiler components such as blowers, recirculation pumps, hot water pumps, gas handling equipment, etc.



Cogeneration. The cogeneration facility was installed in the 1990s to provide backup power to the TF Treatment Process (then the original CWSID WRF) and to help CWSID offset its heating and electrical costs. The cogeneration facility is equipped with two 525 kilowatt (kW) cogeneration units that utilize the methane gas from CWSID WRF digesters to produce electricity and heat. The District operated one unit to provide primary power for the TF Treatment Process equipment, including influent pumps, humus return pumps, and aeration grit blowers at the TF Headworks. However, the cogeneration units are 2,400 volts (V) and are not synchronized with the 4,160 V primary service provided by Rocky Mountain Power (RMP) that powers the rest of the CWSID WRF. Additionally, the District identified several operational issues, including varying electrical loads that cause the engines to operate at a less efficient point at varying biogas production that causes pressure drops and forces a switch to natural gas. The CWSID WRF decided to abandon this facility due to 2,400 V that cannot be synchronized and the operational issues. It is not recommended that CWSID consider improving or replacing the cogeneration units at this time due to the age of the cogeneration units and the voltage at which they operate.

Fleet Use. Since CWSDI does not own a large number of vehicles itself nor is there a private company or municipality (e.g., city busses) located nearby that employs a large fleet of vehicles, this beneficial use option was not evaluated as part of this master plan update effort.

Renewable Natural Gas (RNG). Production of renewable natural gas (RNG) is an alternative the District has to monetize the biogas currently produced at the facility. RNG refers to anaerobically produced biogas that has gone through a treatment or refinement process and replaces natural gas from fossils. The pretreatment process of the biogas to convert it to RNG includes but is not limited to removal of moisture, carbon dioxide, total sulfur, siloxanes, H_2S and volatile organic compounds (VOCs) as well as the reduction of oxygen and nitrogen. RNG can be used for the generation of electricity, as vehicle fuel, it can be injected into existing natural gas transmission or distribution pipelines or in thermal applications.

Currently, approximately 13 percent of RNG facilities in the United States (US) are in wastewater treatment plants. RNG has greater market value than conventional natural gas from fossils and has a smaller carbon footprint than natural gas from fossils. The capture of the produced biogas and its subsequent conditioning to RNG contributes to the reduction of Methane into the environment. Methane is defined as one of the major greenhouse gases with large contributions towards climate change.

Biogas Quality Requirements. Dominion Energy has specific natural gas requirements for any natural gas transported on or delivered to their system. The natural gas must meet requirements provided by FERC-approved tariff specifications or requirements given per Dominion Tariff section 7.07. To meet natural gas pipeline quality requirements, biogas requires treatment to remove hydrogen sulfide, siloxanes, VOCs, carbon dioxide (CO_2), and moisture. The biogas is compressed at the beginning, middle, or end of the treatment process and is then injected into a natural gas pipeline. Upgrading systems also require a treatment step for the stream of CO_2 separated from the methane, termed tail gas. The separation of methane from CO_2 is not 100 percent efficient, so a portion of the methane leaves the system in the tail gas.

H_2S must be treated prior to discharge, either by removal or combustion to prevent odor and air permit issues. Tail gas is treated by a thermal oxidizing flare or third stage membrane (if membranes are used as the main treatment).

Once the gas is treated to pipeline quality and further compressed (if needed), it can be injected into the Dominion Energy natural gas pipeline. There are several gas quality requirements that must be met prior to connecting to Dominion Energy. Quality Standard tariff requirements given in Dominion Tariff section 7.07 are shown in Table 13-37.

Table 13-37
Dominion Energy RNG Tariff Requirements

Constituent	Dominion Energy Standard
CO_2, %, by Volume	2
Oxygen, % by Volume	0.1
H_2S, ppm	4
Total Sulfur, ppm by Volume	8.4
Inert Substances, % by Volume	3
Wobbe Index	1,309 to 1,382
Water Vapor Content, lbs/MMcf	5
Cricondentherm Hydrocarbon Dew Point, degrees Fahrenheit (maximum)	15
Temperature, degrees Fahrenheit	35 to 120

[1] Abbreviations: lbs/MMcf = pounds per million cubic feet, ppm = parts per million, psig = pounds per square inch gauge.

Additional gas quality requirements are given for health protective constituents, for carcinogenic and non-carcinogenic compounds. Compounds such as ammonia, halocarbons, hydrogen, mercury, siloxanes, and biological compounds are regulated for protection of pipeline integrity.

Once a biogas generator is accepted into Dominion Energy (DE) distribution/connection system, the generator is responsible for all the initial and ongoing testing required to maintain compliance with DE requirements.

If the biogas supplied by the generator fails to comply with any of the gas quality specifications at any time, DE can refuse the acceptance of the gas until the gas meets the quality requirements.

Additional gas quality limits may be required by DE and can include health protective constituents and pipeline integrity protective constituents.

Interconnection Scoping Assessment. DE requires the submission of a biomethane interconnect scoping sheet that contains information regarding proposed volume of biomethane produced with minimum and maximum volumes among other data. DE will use the information provided to identify the nearest injection point, equipment required to measure and monitor the quality and quantity of the biomethane going to the distribution system. Information provided will be used by DE to map, plan and develop a cost estimate of the costs associated with the injection interconnect, piping, and monitoring/testing/measuring building.

RNG Connection Fee. All the associated engineering costs, for construction of new facilities required to connect to a DE natural gas system are responsibility of the biogas supplier. Some of the components required for connection include but are not limited to valves, taps, piping, gas flowmeters, gas sampling and monitoring equipment, odorizing equipment, instrumentation and control equipment, scheduling systems, etc. All this equipment will be and remain as property of DE.

The closest high-pressure pipeline to CWSID is approximately 5,000 linear feet and it is located on 2000 W Pioneer Road. The maximum allowable operating pressure (MAOP) of the high-pressure pipeline is approximately 472 psig.

RNG Biogas Conditioning System. Prior to connecting to DE natural gas system, the biogas will require pre-conditioning to meet Tariff requirements. The installation of a system to remove H_2S in addition to the installation of a 3-pass membrane upgrading system to remove CO_2 and a siloxane/VOC removal system will be required to condition the biogas. The cost estimated was developed under the assumption that a prefabricated metal building would be used to house all the gas conditioning equipment. Additional pretreatment for pipeline integrity protection may be required by DE and can include limits on ammonia, halocarbons, hydrogen, mercury, and siloxanes.

Capital and Life Cycle Cost Assumptions. The economic analysis for the RNG evaluation includes the following cost criteria:

- Capital costs (including direct and indirect construction costs, as well as engineering and administration costs).
- Revenue generated or costs offset.
- Operations and Maintenance (O&M) costs.
- Payback period.

The estimated capital costs for the RNG project are presented in Table 13-38. The costs include all the infrastructure and equipment needed to perform the gas conditioning, monitoring, and connection to the high-pressure DE pipeline.

Table 13-38
Estimated Capital Costs for RNG Project

Item	Description	Quantity	Unit	Unit Cost	Total
Summary of Construction Costs					
Civil/Structure					
Mobilization/Demobilization/ General Conditions		10%	LS		$ 806,500
Prefabricated Building (10,00 square feet, including complete design/installation work)		1	SF	$ 200	$ 2,000,000
HVAC/Mechanical		1	50%		$ 1,000,000
Dominion Gas Interconnect		1	EA	$ 1,500,000	$ 1,500,000
RNG Pipe to Injection Point (high-pressure)		1	EA	$ 5,000	$ 2,000,000
Equipment					
H2S Reduction System		1	EA	$ 460 000	$ 460,000
Unison Equipment Shipping		1	EA	$65,000	$65,000
Equipment Installation/Piping/ Valve Allowance		50%	%		$ 1,355,000
Electrical, Instrumentation, and Controls (EI&C) Allowance		25%			$ 1,016,000

Table 13-38
Estimated Capital Costs for RNG Project (continued)

Item	Description	Quantity	Unit	Unit Cost	Total
Three-Pass Membrane Upgrading System (siloxane and VOC removal)				$ 2,250,000	$ 2,250,000
Startup and Commissioning Allowance		1	EA		$ 80,000
				Total Equipment	**$ 5,226,000**
				Subtotal Equipment and Itemized Direct Costs	**$ 12,532,500**
Construction Allowances					
Construction Contingency (estimating, design development)		25%			$ 3,133,125
Construction Escalation Rate (to bid day, 1 year)		5.0%			$ 838,000
				Subtotal Direct Costs	**$ 16,504,000**
General Conditions, Contractor Markups, Taxes, and Escalation					
General Conditions Overhead, Profit, Bonds, Mobilization		15.0%			$ 2,476,000
				Total Construction Cost	**$ 18,980,000**
Summary of Engineering and Administrative Costs					
Engineering, Permitting, and Construction Management		15%			$ 2,847,000
				Total Project Cost Estimate	**$ 21,827,000**

The estimates were prepared using pricing from similar projects, conceptual unit cost factors, vendor quotes, equipment pricing, historic pricing databases, and knowledge of typical rates for local construction crews using the Carollo Cost Estimating System (CCES). The CCES is an estimating database that can be used for planning purposes to provide long-term budgeting estimates. Modifications to the scope will alter the final values, and future fluctuations in the cost of material, labor, and equipment will affect the total.

A net present value (NPV) was developed to provide a comprehensive total life-cycle analysis comparison.

Capital Estimating Assumptions. A level 5 class estimate for the RNG project provided a total project cost estimate of $21,827,000. This cost estimate assumed that all the gas conditioning equipment will be housed in a metal prefabricated building with an estimated total area of 10,000 square feet. Cost estimates developed represent the Association for the Advancement of Cost Engineering International (AACE) criteria for a Class 5 Conceptual Planning Level Estimate. For this class, estimating accuracy is typically -30 to +50 percent. Class 5 estimates are used to determine a project's feasibility and to compare and select alternatives. A design contingency value of 25 percent was used to account for lack of design detail at this preliminary stage.

Cost estimating was conducted by identifying equipment and construction costs in 2022 dollars and escalating those to 2023, which is assumed to be the mid-point of construction. The total project cost estimates include direct and indirect costs, and engineering, administrative, and legal services costs.

Direct costs include subcontractor costs and costs for materials, labor, and construction equipment involved with project construction. The indirect (non-distributable) costs consist of general conditions, contingency, general contractor's overhead and profit, escalation, and bid market allowance. At a Class 5 level of estimate, many of the contractor costs and other indirect costs are assumed to be allowances as a percentage of equipment procurement costs. Table 13-39 summarizes these assumptions.

Table 13-39
Construction Allowances, Contingencies, and Assumptions

Criteria	Assumption Used
Construction Allowances	
Equipment Installation/Piping/Valve Allowance	50% of equipment costs
HVAC and Mechanical	50%
Contractor / Construction Contingency	25%
E I&C Allowance on Equipment	25%
General Conditions, Contractor Mark-Ups, Escalation	
Mobilization, Demobilization, and General Conditions	10%
General Conditions Overhead, Profit, Bonds, Mobilization	15%
Construction Cost Escalation Rate	5%
Engineering and Administrative Costs	
Engineering, Permitting and Construction Management	15%

Life Cycle Costs. Lifecycle costs were calculated to determine the projected payback period for pipeline injection of RNG. Lifecycle costs include O&M costs, operating cost savings, and revenue projections. Estimated lifecycle costs developed assume linear increases in the cost of energy, labor, and materials throughout the planning period.

Net Present Value Cost Factors. All future costs are adjusted for inflation based on applying assumed annual escalation rates to the current costs for each year of the planning period. For the purposes of comparison, all costs were calculated in terms of NPV for a 24-year planning analysis assuming facility operation in 2023 and projected to the year 2047. Annual inflation for electricity and natural gas was assumed to be 3 percent annually. An annual discount rate was assumed to be 3.375 percent. For the year 2023, the estimated total O&M costs were $332,078 per year with a net revenue of $611,573. The net revenue was obtained by adding the revenues from biomethane gas sale to pipeline plus the D5 RIN revenue and subtracting the total O&M costs. The estimated payback period based on the initial assumptions and data is 36.81 years. This assumption is based on capital costs completely covered by the sewer district and no monetary incentives/funding was included in this preliminary analysis. Table 13-40 summarizes some of the inputs for the revenue and life cycle cost analysis.

Table 13-40
Inputs for Operation, Maintenance, Revenue, and Life Cycle Analysis

O&M/Revenue and Life Cycle Cost Inputs		
Revenue Inputs		
Btu (lower heating value [LHV]) RIN		77,000
LHV to higher heating value (HHV) conversion factor		0.903
Life Cycle Cost Inputs		
2023 Project Cost		$ 21,827,000
Escalation Rate		3%
Discount Rate		3.375%
Present Value (PV) Year		2023

Unit costs included in Table 13-41 are based on historic or current pricing for Utah, including a $0.065/kilowatt-hour (kWh) electric charge, and an estimated $6.80/MMBtu natural gas.

Table 13-41
Unit Cost Assumptions

Parameter	Value	Unit
Utility Cost Assumptions		
Electricity(1)	$0.065	$/kWh
Natural Gas(2)	$6.80	$/MMBtu, $/Dth
RNG Cost/Revenue Assumptions		
Renewable Identification Number (RIN) Brokerage Costs	20%	RIN Revenue
D5 RIN Value(3)	$0.87	$/RIN
Sale of Brown Gas(4)	$6.50	$/MMBtu
Biogas Upgrading System Annual Operating Cost	0.0015 to 0.0020	$/scf raw biogas
Biogas Upgrading System Annual Maintenance Cost	2%	of equipment costs

[1] Estimated rates calculated from 2022.

[2] Average natural gas cost for CWSID in 2022.

[3] Average D5 RIN value from 2015 through 2022 equals $0.87, ranges from $0.10 to $2.98 during this period.

[4] Rate from the sale of brown gas provided by Dominion Energy.

[5] Abbreviations: $/Dth dollars per dekatherm, $/MMBtu dollars = per million British thermal units, $/kWh = dollars per kilowatt-hour, $/RIN = dollars per Renewable Identification Number, $/MT CO_2 = dollars per metric ton of carbon dioxide, $/scf = dollars per standard cubic foot.

RNG Financial Markets**.** This section summarizes the financial incentive markets available for pipeline injection of RNG and provides some indication of their long-term viability and potential impact from current and future policies. The value of RNG can be broken into the physical natural gas value (e.g., brown gas) and the environmental attribute. The value of a physical molecule of gas is typically tied to a regional gas index. A value of $6.50/MMBtu was used for this evaluation using data provided by DE.

Most of the value of RNG comes from the environmental attribute and there are number of opportunities to monetize this resource, including:

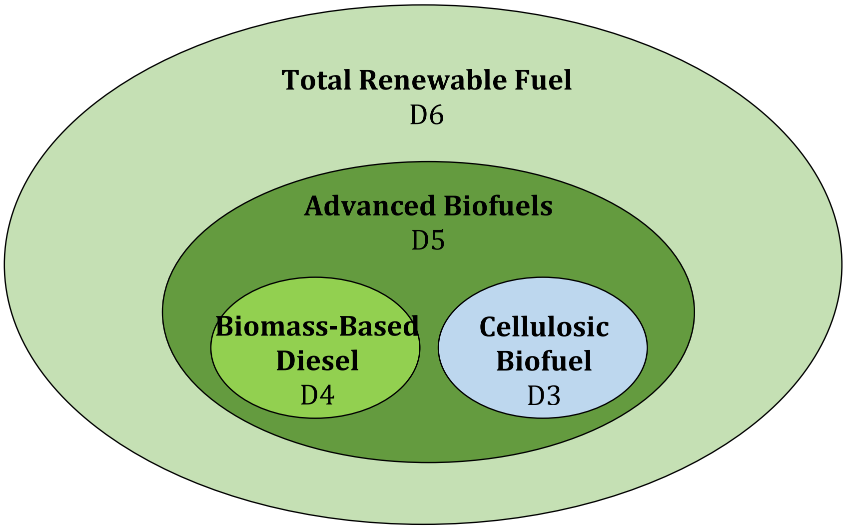
- **Renewal Fuel Standard (RFS) Program.** The RFS program is managed by the EPA and used to offset carbon emissions in the transportation sector.
- **Low Carbon Fuel Standard (LCFS).** LCFS programs are managed at the state or regional levels and establish compliance goals to reduce carbon emissions.
- **Voluntary Markets.** These local and regional programs are implemented by corporations or regional natural gas utilities that are focused on sustainability. In some cases, the corporations or utilities may have compliance requirements to achieve long-term sustainability goals, some of which can be accomplished by using RNG.

EPA's Renewable Fuel Standard Program. The EPA's RFS Program was created under the Energy Policy Act of 2005 (https://www.epa.gov/renewable-fuel-standard-program) and established the first renewable fuel volume mandate in the United States. The program requires oil and gas producers to purchase specified amounts of fuel credits each year to increase the amount of renewable fuel used. Each 77,000 Btu of biogas (based on the LHV) used for vehicle fuel represents one RIN.

To become a RIN producer through the RFS program, the sewer district must be certified with the EPA. This is typically done by a third-party environmental attribute developer but can also be done in-house. Environmental attribute developers or RIN brokers can provide RIN registration and ongoing reporting and management as well as handle the sale of RINs to obligated parties. In exchange, they receive a management fee based on an agreed upon percentage of the RIN value, anticipated to be 20 percent for this size project. Another option is for an obligated party (e.g., oil and gas producer) to purchase the RINs directly from the generator, eliminating management fees.

The RIN broker also typically manages the sale of the brown gas. However, this can also be managed by the sewer district if a dedicated user is identified, such as a compressed natural gas (CNG)-fueled waste hauler fleet.

The RFS program defines four types of renewable fuels: cellulosic biofuel, biomass-based diesel, advanced biofuel, and renewable fuel. The biogas produced by municipal digesters can either be designated as a cellulosic biofuel (D3) or advanced biofuel (D5), depending on the feedstock. Figure 13-25 illustrates the four renewable fuel categories under the RFS Program.

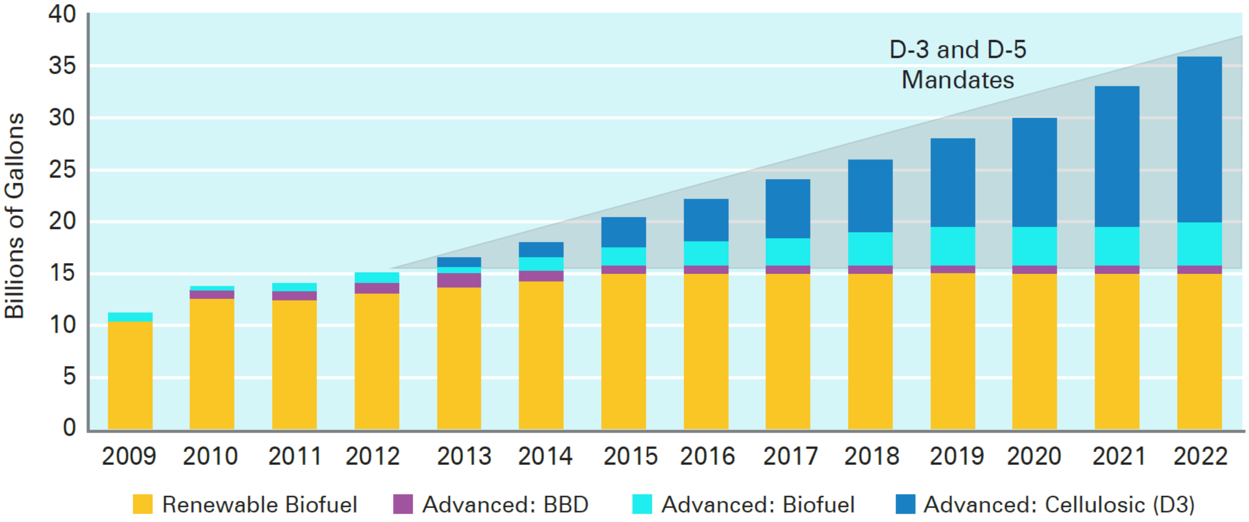


Source: House of Representatives Energy and Commerce Committee (EPA, 2016)

Figure 13-25: Nested Renewable Fuel Categories

Renewable Fuel Mandates

The U.S. Congress, through the EPA, has established renewable fuel volumes through 2022, as shown in Figure 13-26. The renewable volume obligations (RVO) under the RFS are set to expire at the end of 2022, giving the EPA unilateral authority to set biofuel blending requirements post-2022 unless new statutory volumes are established through the legislative process. Members of Congress have voiced support for the replacement of the RFS with a national LCFS program (similar to California's) that provides incentives for a wider range of low carbon fuels (e.g., hydrogen, electricity, biofuels, etc.).



Source: RIN Trades and Price Information *(EPA,*

Figure 13-26: EPA Published Renewable Fuel Volumes 2009-2022

Congress established the RVOs 15 years ago and EPA modifies the D3 and D5 levels every year. Adjustments are made if the available production is not enough to satisfy the original intended volumes.

According to Anew (third-party environmental attribute developer), RNG made up 99.9 percent of the D3 RINs generated in 2021. There are 190 operating RNG plants in North America with 137 plants under construction and another 95 plants planned to be built. The existing operating plants send approximately 450 million gasoline gallon equivalents (GGE) to the transportation market for RIN generation. When the plants under construction and planned become operational, the total RNG facilities could supply over 1 billion GGE annually.

Based on the initial goals established by the EPA, the D3 volume target in 2022 is over 15 billion gallons and the D5 volume target is 5 million gallons. As such, there remains a significant gap in RNG supply to meet the originally planned RVOs.

Low Carbon Fuel Standard Programs**.** Additional revenue for the RNG credits may be available through LCFS programs. LCFS programs incentivize the use of RNG for transportation by providing financial benefits, which are in addition to the RIN credits discussed above. States like California, Oregon and Washington lead the way regarding low carbon fuel standards. Currently the state of Utah does not have a low carbon fuel standard program, therefore this program would not be applicable.

A synopsis and discussion of the program in other states is presented below.

RNG from dairy waste has the lowest (or most negative) carbon intensity score. This RNG has the highest likelihood of receiving LCFS credits in states with LCFS programs in place. A few water resource recovery facilities have been able to receive LCFS credits by packaging their facility-generated RIN credits with those from the dairy industry. However, this is becoming more difficult as additional dairy RNG projects come on-line and compete for LCFS credits.

Oregon was the first state to follow California in implementing an LCFS-like program (called the Clean Fuels Program), which began in 2015. The aim of the Clean Fuels Program is to reduce the carbon intensity of transportation fuels used in Oregon by at least 20 percent (relative to 2015) by 2030, and 25 percent by 2035, making it one of the most aggressive goals in the US. Selling CNG to the Oregon markets may be challenging as there are less than 10 CNG fueling stations currently operating in the state. The market demand may increase in the future as more CNG fueling stations come on-line.

Several other states are looking at creating similar LCFS programs to California and Oregon. Other states that are evaluating LCFS programs include Colorado, Iowa, Illinois, Minnesota, Nebraska, New Jersey, New Mexico, South Dakota, and New York.

Based on the increase in RNG being produced from the dairy industry, and the associated negative carbon index of those facilities, and the lack of legislation in Utah regarding the low carbon fuel standard program, LCFS credits are not applicable to the Districts RNG revenue calculations.

Voluntary Markets**.** Like the vehicle fuel markets, voluntary purchasers are utilizing RNG as a part of their companies' solution to meet environmental, social, and governance goals. Natural gas utilities are also starting to diversify their sustainability portfolios into the RNG markets. Some large utilities in other states are providing long term offtake agreements for sizable volumes of RNG, like Xcel Energy and the Southern California Gas Company (SoCalGas). A few companies that have initiated these types of programs include the following (BlueSource, 2021).

Cargill GM L'ORÉAL Stonyfield ORGANIC P&G
Google amazon Apple

Dominion Energy developed a program in 2019 to support the RNG market, called GreenTherm. The program allows Utah consumers the opportunity to purchase RNG in blocks. Dominion customers located in Utah and Idaho, can purchase blocks of RNG, with each block equivalent to 5 therms. Total block sales experienced a 160 percent increase over projected demand from the years 2020 to 2021. This increased in demand indicate high interest on the RNG market by Utah consumers and could increase the demand-side economics and should increase value for RNG producers.

With D3 and D5 RIN prices at historic highs in 2022, the availability of RNG to voluntary buyers has been minimal, causing buyers to increase their price point dramatically. Table 13-42 shows the pricing variability for the voluntary markets and illustrates the significant increases in the market based on current conditions and drivers towards RNG sustainability goals.

Table 13-42
Historical Voluntary Market Pricing

	Low (5 years ago)	Average (Past 2 to 5 years)	Current
Voluntary Market Pricing	$8 to 10/MMBtu	$10 to 12/MMBtu	$18 to 23/MMBtu

It is very reasonable to assume that 100 percent of the Districts RNG could be purchased by a single voluntary buyer, with market prices above that of a D5 RIN through the RFS program.

D3 and D5 RIN Classification and Pricing**.** Although the RNG produced from D3 and D5 RINs is identical, the digester feedstock differs. A D3 RIN must be sourced from a primarily cellulosic feedstock (cellulose, hemicellulose, or lignin), whereas D5 RINs are issued for fuels from any qualifying biomass outside of corn starch. Additional feedstock introduced at the facility (such as separately trucked-in fats, oil, and grease [FOG]) leads to the declassification of all biogas from a D3 to D5 RIN unless the separate feedstock is introduced to a single digester, whereas only that digester's biogas would be classified as a D5 RIN. This has a significant impact on financial analyses because the D3 RINs are worth significantly more than a D5 RIN.

RINs are traded on the open market, and their value is dependent upon supply and demand, which is greatly influenced by the price of oil and the renewable volume obligation (i.e., amount of RINs obligated parties have to purchase). When D3 RINs were first introduced to the market, they had a value of approximately $1.00 per RIN. In 2022, D3 RIN values were around $3.50, their peak value. D5 RINs were also introduced at approximately $1.00 per RIN, and their value remained stable for several years before dropping to a low of $0.10 per RIN in early 2019. They are currently trading for $1.58 per RIN. Table 13-43 and Figure 13-27 illustrate the average, minimum, and maximum D3 and D5 RIN pricing from 2015 through present day (late 2022).

Table 13-43
D3 and D5 RIN Pricing

Type of RIN	Average ($)	Minimum ($)	Maximum ($)
D3	$1.98	$0.46	$3.50
D5	$0.87	$0.10	$2.98

Source of RIN Pricing: [RIN Trades and Price Information | EPA].

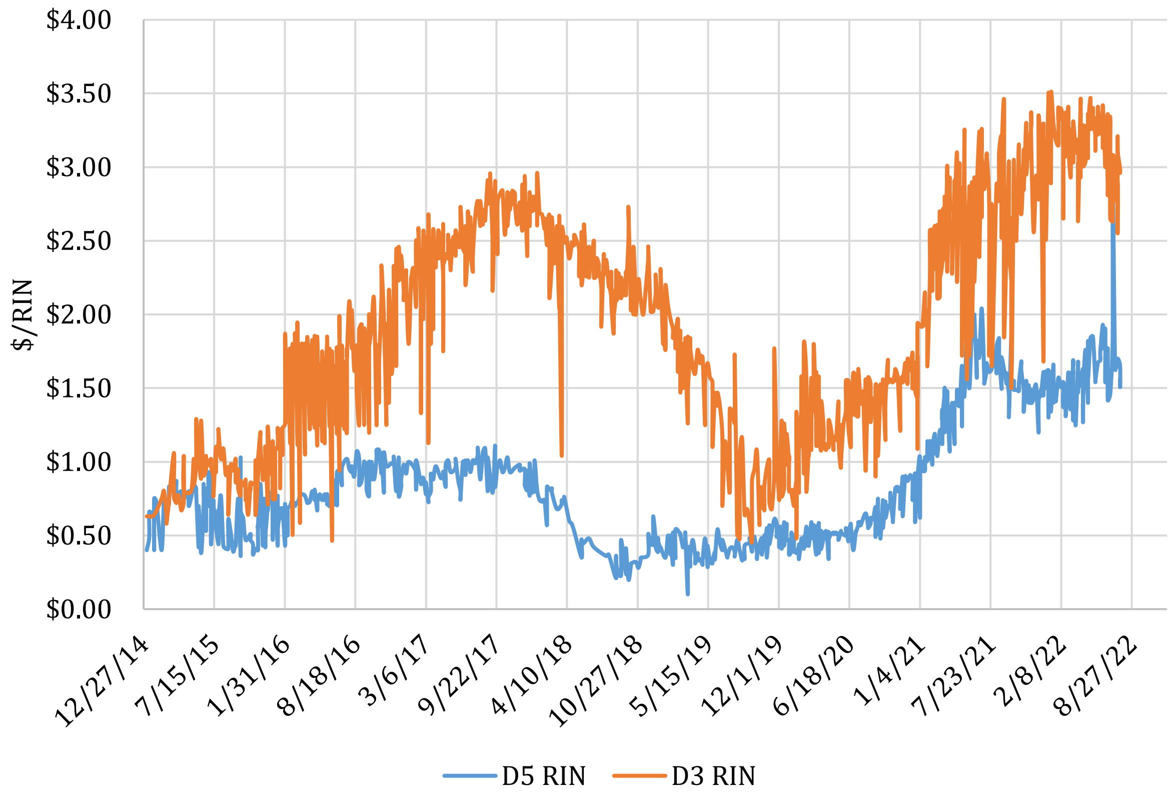


Figure 13-27: Historical RIN Pricing

Open market trading will influence the value of RINs over time. As demand for RIN credits associated with cellulosic biofuels grows due to renewable volume obligations, RINs can have an increasing market value, as discussed in the next section. Using the average RIN values for 2023 the payback period of the investment was calculated for D5 and D3 average values. See Table 13-44 for payback period results.

Inflation Reduction Act. The passage in 2022 of the Inflation Reduction Act provides a pathway to reduce the capital costs of biogas projects. As part of this act, the Section 48 Energy Investment Tax Credit (ITC) program has been expanded to include biogas capture and interconnection distribution. Construction of the biogas project must begin the latest, end of 2024 to quality for the ITC. The ITC can range from a 6 percent base rate up to 30 percent, based on: 1) Project maximum net output being less than one megawatt of thermal energy or electrical power, 2) The construction of the project starts before the 60th day from the publication of requirements regarding prevailing wage and apprenticeship requirements, 3) The project complies with prevailing wage and apprenticeship requirements. Additional 10 percent can be obtained by using domestic products and an additional 10 percent can be obtained through an energy community bonus. Overall, the ITC can be as high as a 50 percent, provided all the requirements are met. Assuming a conservative 30 percent ITC for the project, the total project cost estimate would be $16,875,800 and provides a payback period of 28 years. Table 13-44 shows the payback period under different scenarios including a 30 percent federal grant.

Table 13-44
Estimated Payback Period under Different Scenarios

Criteria	**Costs/Revenues Avg D5 RIN price**	**Costs/Revenues Avg D3 RIN price**	**Costs/Revenues Avg D5 RIN price With 30% grant**	**Costs/Revenues Avg D3 RIN price With 30% grant**
Estimated Project Cost	21,827,000	21,827,000	16,875,800	16,875,800
Annual O&M Costs	332,078	332,078	332,078	332,078
Annual Revenues				
Natural Gas Sale to Pipeline, $/year	394,732	394,732	394,732	394,732
RIN Revenue, $/year	548,918	1,249,263	548,918	1,249,263
Net Annual (Cost)/Revenues $/year	612,434	1,312,778	612,434	1,312,778
Payback Period, years	36.81	16.2	28.46	12.5

Recommendations

The following recommendations are listed for biogas utilization at CWSID:

1. Use Biogas for Boiler Systems: This optional project for the District is recommended to better utilize the biogas at the plant. Investigation would be needed to understand the cleaning system upgrades and the existing boilers would need to be replaced to accept biogas in lieu of commercial natural gas, thus saving utility costs. This project will also help offset any capacity limitations at the flare. Estimated cost for this project is around $2 million dollars.
2. Relocate the Flare: This project is contingent upon whether the boiler systems project is implemented. There are some concerns over the overall capacity of the flare since cogeneration and boiler operations have been discontinued, and all biogas is flared. Redesign of the flare could help with redundancy and isolation concerns. Relocating and upsizing the flare would require air quality and state permitting.

SIDESTREAM PHOSPHORUS TREATMENT

CWSID operates an A_2O process for enhanced biological phosphorus removal (EBPR) that successfully keeps the effluent total phosphorus below current permitted levels. EBPR relies on the selection and proliferation of a specialized microbial population capable of storing orthophosphate in excess of their biological growth requirements. These organisms, called phosphate accumulating organisms (PAOs), can internally store up to 0.38 magnesium phosphorus per milligram of VSS. In doing so, a significant portion of the soluble phosphorus in the liquid stream can be converted to the "solid" form (stored within biomass) and wasted from the system in the WAS.

In the anaerobic zone of the A_2O process, PAOs consume volatile fatty acids (VFAs) while simultaneously releasing phosphorus into the bulk liquid. In the aerobic zone, PAOs undergo internal metabolic reactions which require the uptake of orthophosphate (more than previously released in the anaerobic zone) from the bulk liquid-stream. Net phosphorus removal is realized when the phosphorus-rich biomass is wasted from the system downstream of the aerobic zone to the anaerobic digesters.

During anaerobic digestion, high concentrations of soluble phosphorus (>300 mg/L) and ammonia (>1,000 mg/L) may be observed due to phosphorus release from PAOs in the WAS and from biomass cell breakdown (i.e., volatile solids reduction). With availability of background magnesium in the digested sludge and suitable pH conditions, magnesium ammonium phosphate, or struvite, can form as a nuisance precipitant in the digesters, successive piping, and dewatering equipment. Struvite is a hard, rock-like material that can plate out on the surfaces of tanks, pipes, and equipment, reducing the volume and transfer capacity of the system. High levels of ammonia and phosphorus that do not precipitate out as struvite are returned to the front of the liquid-stream treatment train as recycled nutrients, which increases the overall nutrient load to the secondary treatment processes (by as much as 20 to 40 percent for phosphorus, specifically). The high nutrient loads in the dewatering return increases carbon demand for phosphorus uptake (in the anaerobic zone) and denitrification (in the anoxic zone), and aeration air requirements (in the oxic zone). Depending on the effluent permit requirements, these excess nutrient loads could reduce a secondary treatment system's overall capacity. There are several options for mitigating struvite accumulation and nutrient recycle. This section of the report presents commercially available sidestream technologies, as well as chemical addition for phosphorus removal.

Several commercially available sidestream phosphorus removal systems, which either sequester or harvest struvite, have been developed and implemented at the full-scale over the last decade. These systems provide and engineered environment in a designated location where struvite can precipitate and be harvested for commercial use or sequestered back into the solids. Chemically dosing magnesium, which is usually the limiting component of struvite in municipal solids handing systems, allows for additional struvite precipitation and less total nutrient recycle. Typically, each manufacturer of these system targets 90 percent or greater conversion of soluble phosphorus into struvite for either sequestration in the dewatered biosolids or for harvesting.

In lieu of constructing a sidestream struvite harvesting/sequestration system, chemical addition can also be used to reduce soluble phosphorus concentrations and minimize nuisance struvite formation. For example, metal salts such as ferric chloride or aluminum sulfate can be added to bind with soluble phosphorus. By significantly reducing the availability of soluble phosphorus in the digested sludge, struvite is formation potential is reduced, and the bound phosphorus is removed through the dewatering process.

Project Drivers and Baseline Assumptions

For many facilities operating with EBPR and anaerobic digestion, sidestream phosphorus treatment processes have been implemented to ensure compliance with low total phosphorus (TP) limits (0.1 to 0.5 mg/L). This is particularly true for facilities that struggle with maintaining sufficient aeration basin influent carbon load to meet both effluent phosphorus and nitrogen limits. For CWSID, the main driver is instead struvite mitigation to reduce operational maintenance, as the facility is expected to continue meeting effluent phosphorus limits into the future without sidestream treatment. Therefore, this analysis and future design will be directed towards such objective.

Currently, nuisance struvite is found in the digesters adhered to the draft air tube mixing equipment, and successive piping from the primary digester to the secondary digester, particularly in areas that have significant turbulence such as pipe bends, fitting, and pumps. CWSID currently takes a primary digester offline annually to clean and remove the struvite buildup. Completing this maintenance is very costly and time consuming, and the downtime required for maintenance reduces the overall digestion capacity of the facility. A sidestream phosphorus treatment process is anticipated to help mitigate the historical struvite buildup and better manage return streams.

Based on discussions with CWSID, operations staff are interested in sidestream treatment opportunities that decrease the phosphorus loading into the digesters (e.g., WASSTRIP® or similar, as introduced below) rather than an approach that only target the digested sludge stream or dewatering filtrate alone. Furthermore, CWSID prefers sequestering the struvite in the biosolids, so it is easily removed through dewatering in lieu of harvesting the struvite and creating another dewatering and waste stream. Harvesting struvite can be a form of revenue generation for WRFs to help offset operation costs, but add additional capital costs for larger tanks, dewatering and drying equipment, and increase operational complexity. Future analysis of harvesting will be discussed below.

A workshop with Carollo and CWSID staff was conducted on December 1, 2022 to outline project goals, verify project assumptions, and review alternatives analysis results outlined below. In summary, the following goals or objectives for the Master Plan analysis when considering sidestream phosphorus removal for CWSID are:

1. Mitigate struvite by minimizing phosphorus loading into the digesters, to the extent possible.
2. Utilize existing infrastructure to reduce capital costs and meet project goals.
3. Preference to sequester the struvite in the biosolids, unless harvesting lifecycle costs outweigh the capital costs.
4. Incorporating a sidestream phosphorus removal project at CWISD is optional and not driven by treatment capacity or current/future effluent permit limits.

To accomplish the objectives outlined above, one possible solution is to modify the solids thickening process to release ortho-phosphorus from the PAOs in the WAS before digestion and route the concentration phosphorus stream directly to a sidestream technology. This can be done by pumping PS and WAS to the blend tanks, providing suitable anaerobic environment for phosphorus release before co-thickening and diverting the filtrate around the digesters. See Figure 13-28 for the modified solids process flow diagram which will be used as a baseline when evaluating sidestream phosphorus technologies, including chemical addition.

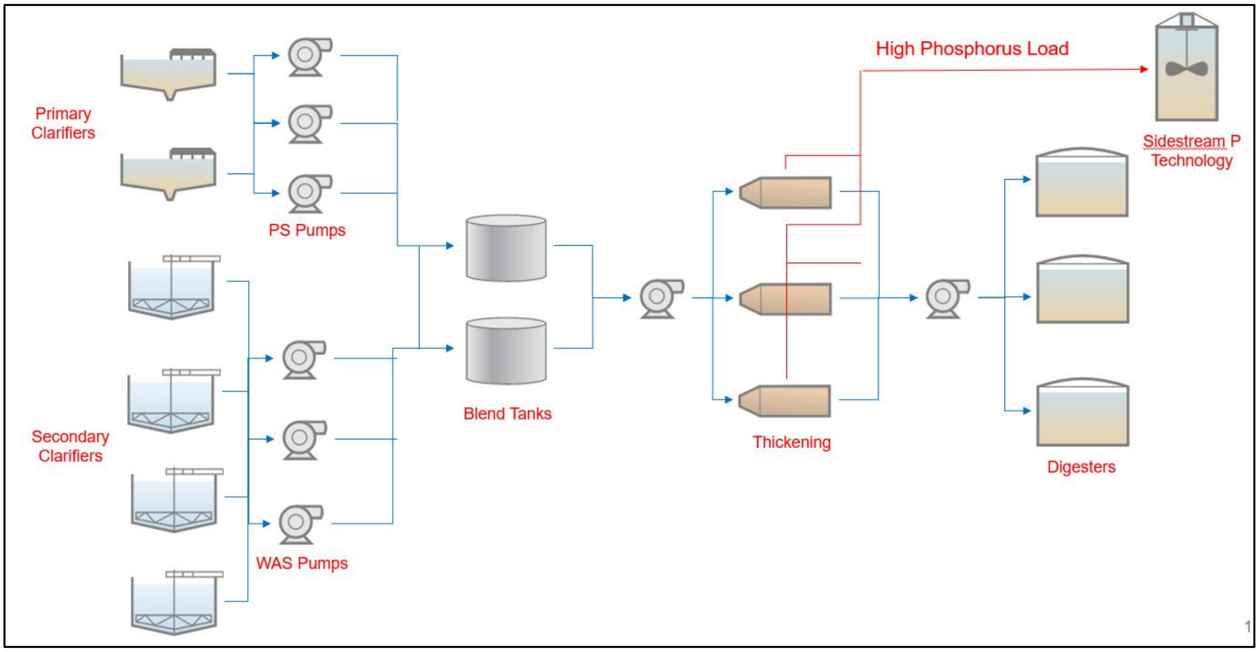


Figure 13-28: Process Flow Diagram: Co-Thickening Primary Sludge and WAS Before Digestion

It is important to understand the phosphorus mass balance through the liquid and solid-stream treatment processes for sizing the sidestream phosphorus treatment process and to estimate the potential phosphorus load that could be diverted around digesters. See Table 13-45 for current and modeled future maximum month TP, orthophosphate (OP), and ammonia (NH_3) loads in the solids process flows. These values were sent to manufacturers to obtain budgetary estimates and for properly size equipment. Presented 2030 and 2050 values are based on BioWin® modeling.

Table 13-45
Anticipated Future Solids Phosphorus Balance

Parameter	2030	2050
Raw Influent		
Flow (mgd)	52.9	62.4
TP (lbs/day)	1,369	1,718
OP (lbs/day)	684	859
NH_3 (lbs/day)	6,119	8,249
Primary Sludge		
Flow (mgd)	0.13	0.16
TP (lbs/day)	498	624
OP (lbs/day)	67	81
NH_3 (lbs/day)	49	64
WAS		
Flow (mgd)	0.39	0.46
TP (lbs/day)	1,455	1,806

Table 13-45
Anticipated Future Solids Phosphorus Balance (continued)

Parameter	2030	2050
OP (lbs/day)	0.24	0.29
NH_3 (lbs/day)	2.19	2.37
Thickened WAS		
Flow (mgd)	0.09	0.11
TP (lbs/day)	1,382	1,715
OP (lbs/day)	0.05	0.07
NH_3 (lbs/day)	0.48	0.56
Digestate		
Flow (mgd)	0.21	0.27
TP (lbs/day)	1,880	2,339
OP (lbs/day)	650	798
NH_3 (lbs/day)	1,382	1,834
Dewatering Pressate + Washwater		
Flow (mgd)	0.49	0.54
TP (lbs/day)	661	798
OP (lbs/day)	537	643
NH_3 (lbs/day)	1,143	1,480

Sidestream Processes Considered

For this report, budgetary proposals were obtained from four different manufacturers that provide sidestream phosphorus removal technologies. It was communicated to vendors that the primary objective of implementation was the reduction of struvite buildup in the digesters and successive piping with a secondary objective being soluble phosphorus sequestration at solids handling and overall reduction of recycled phosphorus back to the mainstream process. Harvesting was evaluated as a tertiary objective to determine whether the benefits outweighed the costs. Vendors were asked to submit the following as part of each budgetary proposal:

- A system configuration (and preliminary layout/footprint requirements) that meets CWSID's objectives from design conditions in 2030 to 2050.
- Equipment supply costs for the proposed system configuration.
- O&M (e.g., chemical, power, labor) costs for the proposed system configuration.
- Details regarding the recoverable phosphorus product and struvite marketing services provided by the manufacturer or a third party vs. sequestering.
- Soluble phosphorus removal efficiencies and anticipated chemical dosing requirements.
- Redundancy recommendations.

The budgetary proposals received from each manufacturer are included in Appendix G. A summary table of inquired manufacturers is provided in Table 13-46.

Table 13-46
Manufacturers that Provided Proposals

Manufacturer	Technology	Removal Location	Harvest or Sequester
CNP/Centrisys	MagPrex™	Digestate	Harvest/Sequester
Schwing Bioset	NuReSys®	Digestate/ Filtrate+Pressate	Harvest/Sequester
Ostara	Pearl®	Filtrate+Pressate	Harvest Only
Ovivo	EloVac® PhosPAQ™	Digestate Filtrate+Pressate	Sequester Harvest

Each of the systems proposed below incorporate the WAS and primary sludge co-thickening process describe above. Co-thickening removes additional water from entering the digesters, increasing hydraulic capacity, and delaying the need for new digesters. This process would also have a positive effect for struvite mitigation. Based on Carollo's process modeling for this Master Plan, blending the sludges in anaerobic and mixed conditions provides the PAOs in the WAS with a suitable carbon source via the primary sludge. With this carbon source, the wasted PAOs release their stored phosphorus, as well as magnesium and potassium. Thickening the sludge after this release creates a filtrate stream of concentrated phosphorus, magnesium, and potassium. The stream can be routed around the digesters, reducing the nutrient load and thus struvite precipitation in the digesters. The project team anticipates that routing that stream around the digesters is what is best for each of the system alternatives to achieve CWSID's objectives.

CNP/Centrisys: MagPrex™ and CalPrex™**.** CNP/Centrisys is a manufacturer that currently provides two different phosphorus removal systems, or a hybrid combination in the future. MagPrex™ is a nutrient recovery process that is installed between anaerobic digestion and dewatering. This system utilizes high concentrations of soluble phosphorus and ammonia in the anaerobically digested sludge and introduces the limiting struvite component in the form of magnesium chloride ($MgCl_2$). The reactor creates an ideal environment for the controlled precipitation of struvite by using air for fluidization, while simultaneously increasing the pH by stripping carbon dioxide. The struvite is then sequestered in the biosolids, removing phosphorus from the nutrient recycle loop. MagPrex™ claims to improve cake dryness by up to 3 percent and to reduce polymer consumption by up to 30 percent as an added benefit; these claims have been verified at several existing installations in recent years.

CNP/Centrisys also provides CalPrex™, a system implemented before digestion. In this process, WAS fermentation to achieve phosphorus release is required, after which dewatering or thickening is necessary. CalPrex™is implemented in the centrate or pressate of the WAS thickening process, where calcium hydroxide is introduced and brushite is precipitated out and harvested as fertilizer. To optimize CalPrex™, dewatering is recommended. The dewatered cake would need to be rehydrated to allow for better flow through the digesters and mixing with existing equipment. Due to the complexity this process adds, CalPrex™was not investigated further.

In the future, CNP/Centrisys will likely be able to take a hybrid approach for the MagPrex™ process to route released phosphorus around the digesters and still remove the additional phosphorus that will be released during anaerobic digestion. This option uses only one reactor and does not require a full dewatering process before digestion. This layout provides the best results for CWSID and meets their primary and secondary objectives. See the process flow diagram for this proposed system in Figure 13-29.

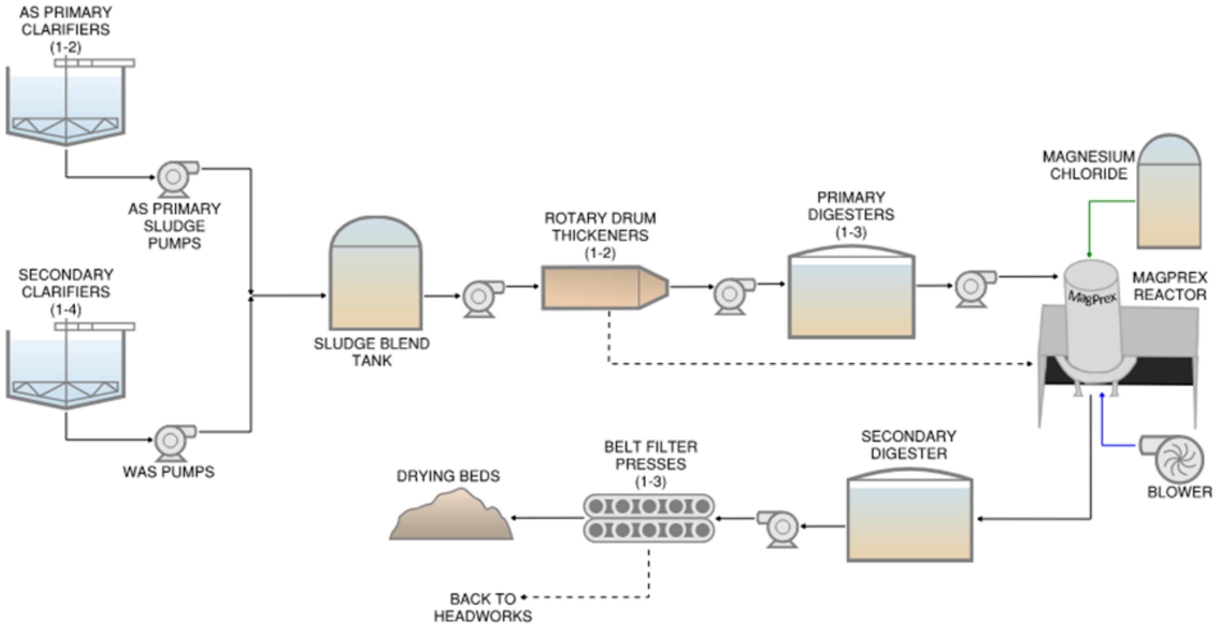


Figure 13-29: MagPrex™ Process Flow Diagram

CNP/Centrisys provided proposals for both harvesting and sequestering the struvite using MagPrex™. Harvesting required two reactors with more volume for longer HRT to precipitate larger struvite crystals. This option also required the addition of equipment to dewater and dry the struvite to produce a marketable product. It will create another waste stream the facility has to deal with as well as additional equipment they must operate and maintain. For these reasons, harvesting struvite was not evaluated further for MagPrex™.

Schwing Bioset: NuReSys®. Schwing Bioset's phosphorus technology, NuReSys®, offers the flexibility of being implemented in the digestate, the dewatering pressate and thickening filtrate, or a hybrid combination of both. NuReSys® typically employs a two-tank process configuration that consists of an air stripping CO_2 release tank to adjust pH and a crystallization reactor where $MgCl_2$ is dosed to drive the precipitation of struvite crystals. The reactor operates as a completely stirred tank with a vertical mixer. These crystals can either be incorporated into the biosolids or harvested as fertilizer.

Schwing Bioset provided two system layouts that may be beneficial for CWSID. Schwing Bioset's recommended layout, a hybrid approach, would provide a CO_2 release tank immediately downstream of the digesters. Placing the tank here allows for any struvite that may have formed (with high concentrations of phosphorus, ammonia, and any background magnesium that may be in the water) in the pipes or dewatering equipment to form in the tank and be sequestered in the solids. The pH adjusted dewatering pressate and thickening filtrate would then flow to the crystallization reactor, where $MgCl_2$ is dosed, and additional struvite precipitation occurs. The thickening filtrate, however, would not be pH adjusted. Schwing Bioset recommends adding sodium hydroxide (NaOH) in the reactor to meet pH requirements. See the process flow diagram below for the proposed layout.

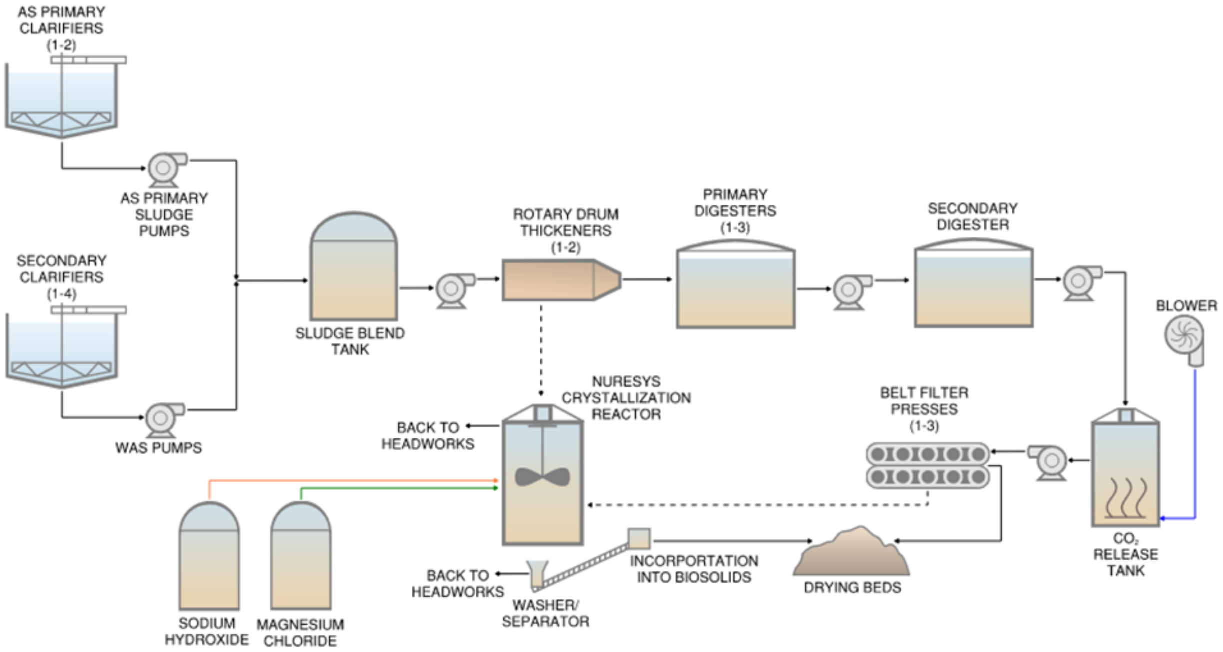


Figure 13-30: NuReSys® Process Flow Diagram - Layout 1

Schwing Bioset recommended this layout because the crystallization reactor can produce a better product and have higher phosphorus reduction rates with cleaner influent streams. An optional cyclone can also be used for phosphorus recovery, which helps separate the finer struvite crystals from the system overflow. This allows flexibility to control struvite growth in the reactor and produce a better harvestable product. However, if CWSID chose not to harvest, the dewatering equipment would still be necessary to separate the solids which would then need additional equipment to combine the struvite solids with the biosolids. The second layout places both tanks in the digestate and allows the struvite to be sequestered, reducing equipment, chemical addition, and complexity.

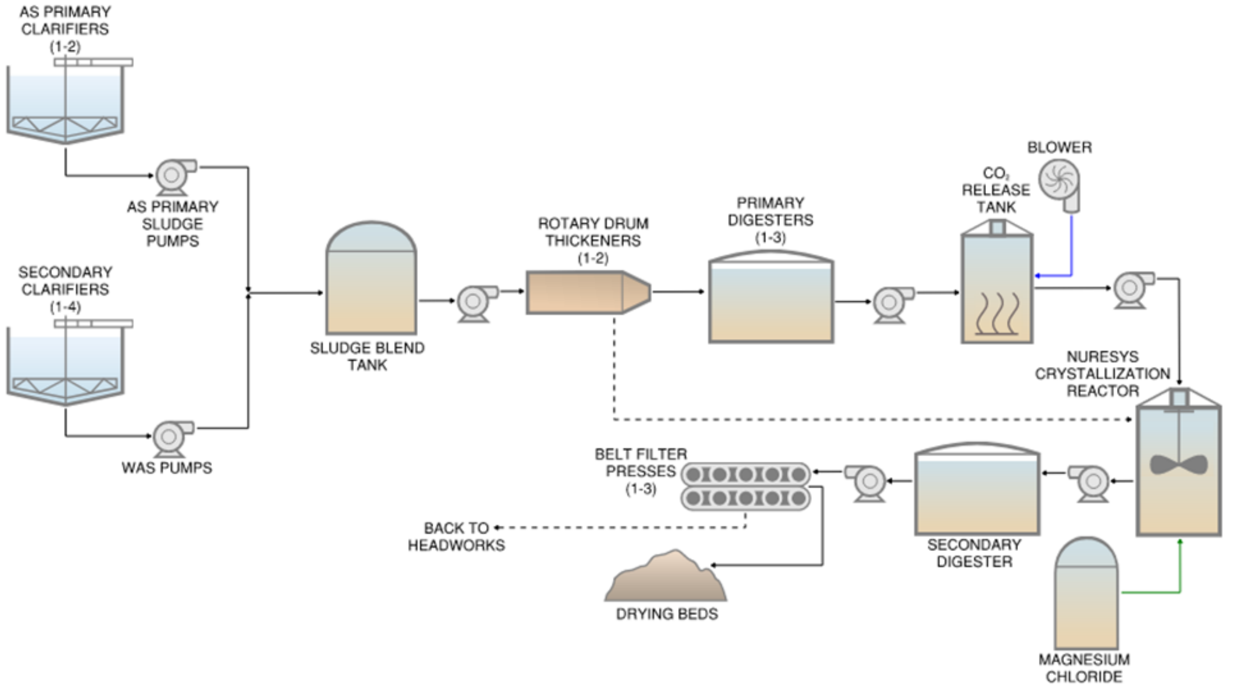


Figure 13-31: NuReSys® Process Flow Diagram - Layout 2

Although both tanks being in the digestate seems to be a simpler option to meet CWSID's objectives, the proposal received from Schwing Bioset was for the hybrid layout. The hybrid layout was used to produce a cost estimate and will be the layout compared to other alternatives.

Ostara: Pearl®. Ostara offers the Pearl® phosphorus recovery system which takes the highly concentrated phosphorus liquid streams from both thickening and dewatering processes. These two streams enter a fluidized bed reactor and are combined with magnesium oxide to produce struvite "seeds" or small spherical precipitates that are grown to a specific size. These struvite pearls are then harvested, dried, and sold as fertilizer. Ostara Pearl reactors typically utilize relatively low pH (7.5 to 7.8) and a high recycle ratio inside the fluidized bed reactor to drive the struvite precipitation and growth process. The reactor is fed continuously while struvite harvesting occurs as needed in batch processes. Treated effluent is discharged from the top of the reactor and returned to the front of the plant. The Figure 13-32 shows how the Pearl reactor would be added to CWSID's existing process.

Harvesting the struvite is the only option offered by Ostara. Ostara plays a vital role in marketing, selling, and shipping the harvested struvite, and in return, offers a payback. Contracts between the District and Ostara are required so that harvesting specification and performance is met for Ostara to sell the product. Penalties for not meeting specifications is unknown and would be negotiated with Ostara in the contract.

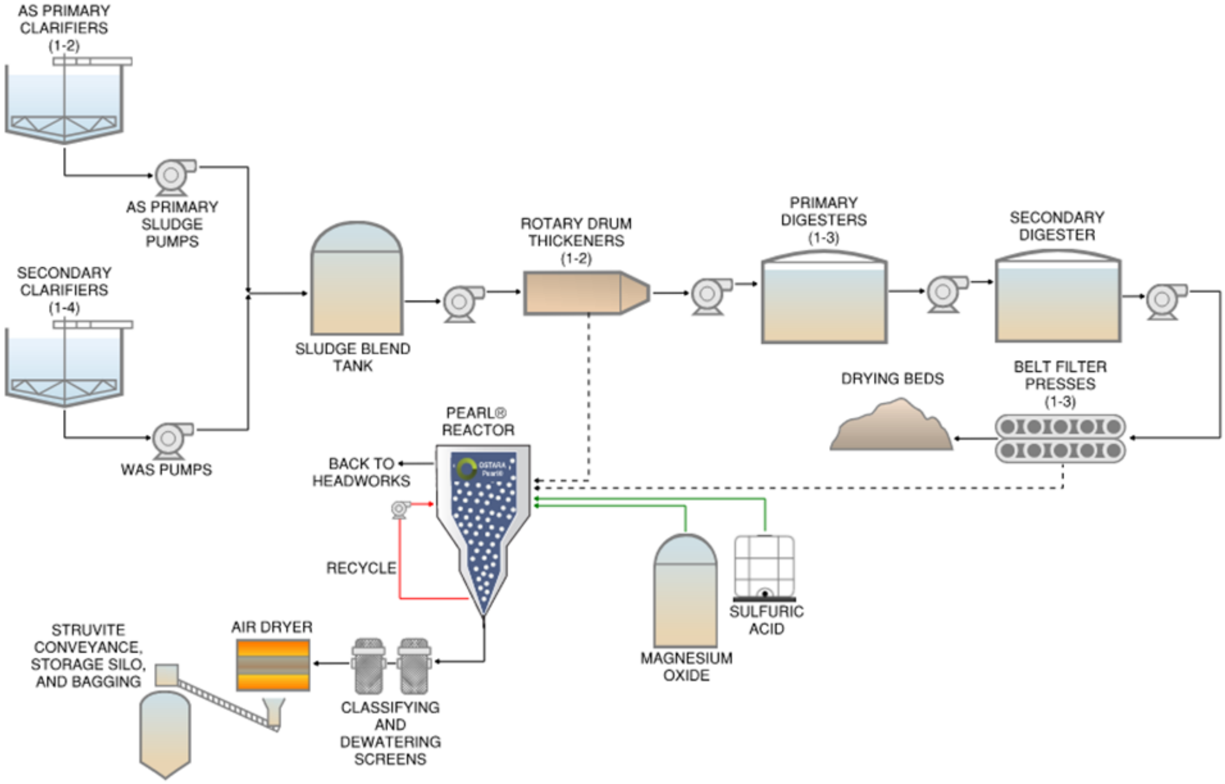


Figure 13-32: Pearl Process Flow Diagram

EloVac® and PhosPAQ™. Ovivo offers two solutions to removing sidestream phosphorus. The first system is the EloVac®, which is a reactor that is positioned in the digestate stream. In lieu of aeration for pH adjustment, this reactor has a degassing module that uses controlled vacuum pressure allowing the capture of sulfide, ammonia, methane gas which contribute to odor. In this reactor, the limiting reactor component, magnesium chloride, is added and small struvite crystals are formed and then sequestered in the biosolids for removal.

Ovivo additionally offers a system that is placed in the dewatering pressate called PhosPAQ™. PhosPAQ™ is an aerated reactor that adjust pH and adds magnesium oxide to create a controlled environment for struvite to precipitate out and be harvested. Both the EloVac® and PhosPAQ™ are newer technologies in the United States. The PhosPAQ™ does not have U.S. installations and has very few municipal installations throughout the world, while the EloVac® has a single full-scale pilot installed in Utah; no full-scale installations in the US are known at this time. For this reason, technologies were not investigated further, but maybe consider in the future as their presence and experience expands in the US.

Chemical Mitigation

Chemical phosphorus removal can be accomplished by adding a metal salt, ferric chloride or aluminum sulfate, usually between a 1:1 and 1:3 molar ratio of P:Fe or P:Al. The metal salt binds with the phosphate, creating a precipitate that can be dewatered and removed from the process. CWSID currently has a ferric chloride ($FeCl_3$) system that can be repurposed for sidestream chemical phosphorus removal to dose at designated locations.

Sulfides in the digested sludge stream reduce ferric to ferrous and bind to produce ferrous sulfide (FeS). This reaction is chemically favorable as compared to precipitating ferric hydroxide and binding with phosphate. As such, ferric chloride dosing would need to increase to meet needs for phosphorus removal and for quenching sulfides in the process stream. Hydrogen peroxide (H_2O_2) can be added upstream of ferric addition to oxidize FeS back to elemental sulfur and ferric ions, thus making the ferric available for phosphate ions. By regenerating ferric ions that otherwise are consumed by sulfur, struvite control can be effectively achieved with lower doses of iron. See the process flow diagram below for possible dosing locations of $FeCl_3$ and H_2O_2.

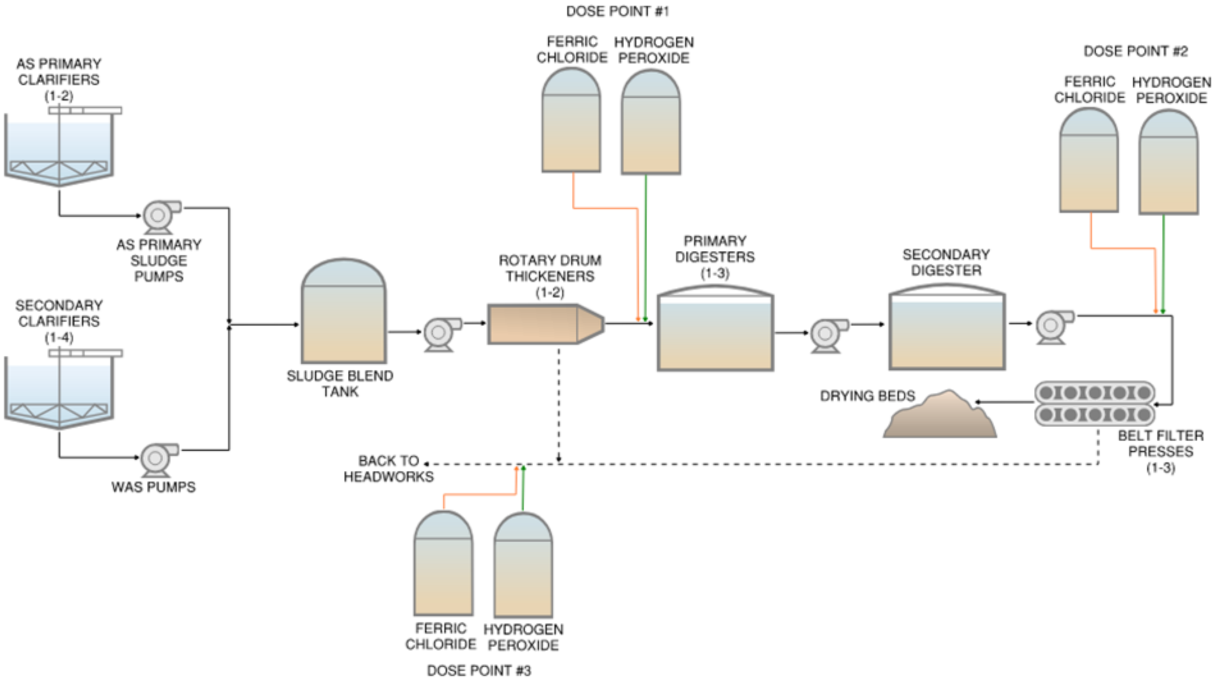


Figure 13-33: Chemical Addition Process Flow Diagram

Jar testing and full-scale piloting testing is recommended to optimize dose, location, and to quantify achievable phosphorus reduction in the system. The first dose point in Figure 13-33 shows dosing to the thickened sludge. This location would bind up phosphorus before digestion, reducing the phosphorus available for struvite production and deposition in the digesters. However, further testing would be required to ensure that chemical addition at the doses required will not create upsets in the digester, as ferric chloride consumes alkalinity and reduces pH. The second dosing point would be directly after digestion, producing a precipitate that is immediately removed in the dewatering process. This option protects the dewatering equipment and reduces return nutrient load but does not provide protection for struvite buildup inside the digesters and successive piping, therefore this dosing location would work in tandem with dosing upstream of digestion.

The third dosing location would allow phosphorus removal from each of the return streams. This option binds phosphorus so that it can be settled out in primary clarifiers and eventually removed through the solids process. This location will be important because the thickener filtrate will have high concentrations of phosphorus. However, this means that the sludge (and phosphorus) has to loop through the entirety of the solids process. A combination of dosing points may be required to optimize the chemical treatment system.

Full Scale Implementation

Implementing any of the processes described above would be a change to the layout and operating conditions of the facility. The technology facts in Table 13-47 summarize characteristics of each alterative for struvite mitigate and advantages and disadvantages of each system.

Table 13-47
Technology Summarization

Process Criteria	MagPrex™	NuReSys®	Pearl®	Chemical Precipitation
Total/United States Installations	13/6	8/2	22/14	-
Estimated Footprint	30' by 42' Chemical Pad 60' by 60' Building	30' by 42' Chemical Pad 80' by 60' Building	25' by 20' Chemical Pad 75' by 60' Building	-
Estimated Energy Use	698 kilowatt hours per day (kW-h/d)	820 kW-h/d	428 kW-h/d 40 therms per day	120 kW-h/d
Estimated Chemical Use	$MgCl_2$ 2030: up to 804 gallons per day (gal/d) 2050: up to 997 gal/d	$MgCl_2$ 2050: up to 1,095 gal/d NaOH 2050: up to 329 gal/d	MgO 2030: up to 295 dry tons per day 2050: up to 311 dry tons per day	$FeCl_3$ 2030: 590 gal/d 2050: 690 gal/d H_2O_2 2030: 147 gal/d 2050: 172 gal/d
Estimated Staffing Requirements	~25 hours per week	~30 hours per week	~40 hours per week	~5 hours per week
Advantages	Customizable options for varying flow and P concentrations Reactor is in digestate (easy sequestration) Smaller feed flow that pressate + filtrate Dewatering improvements (drier cake and/or reduced polymer usage)	Customizable options for varying flow and P concentrations Can be located in the digestate or in the pressate + filtrate or a hybrid combination of both	Customizable options for varying flow and P concentrations Revenue from struvite sales	Lowest capital cost Infrastructure is already in place CWSID would have full control

Table 13-47
Technology Summarization (continued)

Process Criteria	MagPrex™	NuReSys®	Pearl®	Chemical Precipitation
Disadvantages	Dilutes digestate for dewatering Several additional pieces of equipment to operate and maintain (blowers, pumps, etc.)	Two reactors in different locations In pressate + filtrate stream struvite must be harvested or transported to solids Several additional pieces of equipment to operate and maintain (blowers, pumps, dryers, conveyance, etc.)	Large capital cost Harvest is the only option Vendor is highly involved in the day to day Several additional pieces of equipment to operate and maintain (pumps, dryers, washer/classifier, conveyance, bagging, etc.)	Greatly increases chemical sludge (~2000 lbs/day) System is subject to ferric cost increases and availability Alkalinity adjustment is necessary In certain conditions, rerelease may be possible in digesters Phosphorus must loop through entire solids system depending on dose location

Cost Evaluation

Budgetary direct cost estimates were provided by each manufacturer. The chemical addition option will include piping for new dosing locations, but new equipment will not be required, as dosing pumps and ferric tanks are already installed at CWSID. Each alternative cost is summarized in Table 13-48.

Table 13-48
Proposed Alternative Equipment Costs

Technology	Proposed System	Equipment Costs
MagPrex™	Digestate (no thickening filtrate) treatment without any struvite product recovery.	$ 1,518,000
NuReSys®	Hybrid treatment with struvite collection and combination with biosolids.	$ 1,989,100
Pearl®	Pearl 2K reactor with struvite harvesting.	$ 5,950,000
Chemical Precipitation	Ferric chloride and hydrogen peroxide feed in pressate, filtrate, or digestate flow.	-

A net present value analysis was performed on each phosphorus reducing technology with provided vendor equipment costs. To evaluate the full cost of constructing and installing these systems at CWSID, a more complete cost estimate was completed. The total project cost included equipment, concrete pads for chemical, buildings, piping, electrical, etc. along with taxes, bid market allowance, project contingencies, and contractor overhead and profit. Each total project capital cost for the project was then escalated at 2 percent to the year 2031, an estimate of when this project would be constructed.

Lifecycle costs were also developed for each alternative. Lifecycle costs of O&M requirements including chemical usage, energy usage (power and natural gas), labor requirements, and consumable product costs were estimated and assumed to have a linear increase in cost. All future costs were factored for inflation by applying an assumed annual escalation rate to the current costs for each year of the planning period. For comparison, all costs were calculated in terms of NPV for a 20-year planning horizon starting in 2031. The basis and assumptions for developing the 20-year NPV consists of the following:

- Discount rate: 5 percent.
- Escalation rate: 3 percent.
- Chemical costs:
    - $FeCl_3$: $4.91 per gallon.
    - H_2O_2: $4.25 per gallon.
    - $MgCl_2$: $1.00 per gallon.
    - Magnesium oxide (MgO): $600 per dry ton.

  - NaOH: \$1.73 per gallon.
- Energy costs:
  - Power: \$0.07 per kWh.
  - Natural gas: \$4.50 per therm.
- Labor and oversite: \$55 per hour.
- Parts and maintenance: 0.7 percent of equipment cost per year.
- Struvite revenue: \$150 per ton.

Table 13-49 provides the estimated O&M costs for each alternative. Ostara Pearl included the revenue generated by the sale of struvite represented as a negative cost. Many of the technologies claim a 30 percent polymer reduction for dewatering once the system is installed. For example, Denver Metropolitan Water Recovery has offset additional magnesium chloride costs needed for sidestream process with reduction in polymer usage. That reduction in polymer and the associated cost was not quantified or included as savings in this analysis. Other added benefits, such as ammonia and nutrient load reduction in the recycle stream was not evaluate but will provide some increase capacity in the secondary treatment process and slightly reduce blower air demand.

Table 13-49
Alternative O&M Costs and 20-year NPV

Technology	2031 Net O&M Costs	2050 Net O&M Costs	O&M Net Present Value
MagPrex™	\$ 450,000	\$ 574,000	\$ 8,417,000
NuReSys®	\$ 660,000	\$ 809,000	\$ 12,067,000
Pearl®	\$ 446,000 -\$109,00	\$ 569,000 -\$122,000	\$ 6,349,000
Chemical Precipitation	\$1,368,000	\$ 2,031,000	\$ 27,400,000

Ostara Pearl has the lowest operating cost, mainly due to reduced chemical cost and struvite revenue. Chemical costs for Ostara are less because use of MgO, which is significantly cheaper per pound than $MgCl_2$ that both NuReSys® and MagPrex™ use. This chemical serves two purposes; supplying the magnesium needed for struvite and adjusting pH to ideal precipitation conditions. By using the chemical rather than blowers or a separate chemical aid in offsetting the addition energy costs, Ostara Pearl requires recycling flow for larger crystal growth and harvesting. Without considering struvite revenue, MagPrex™ and Pearl have nearly the same overall O&M cost.

NuReSys® shows higher values for O&M than both MagPrex™ and Pearl. The difference in cost comes from NaOH addition to adjust pH in the hybrid configuration proposed by Schwing Bioset. The hybrid approach also increases labor costs as staff would need to operate and maintain two chemical dosing systems and two tanks, one in the digestate and one in the filter and pressate stream. If both tanks were to be placed in the digestate, that would remove the need for NaOH, which is a significant yearly cost. With this configuration, O&M costs would be very similar to MagPrex™ and Pearl.

Chemical precipitation shows the highest O&M costs with a very large yearly cost for chemical. That cost is also subject to change as the chemical availability and production costs are extremely uncertain. A breakdown of the individual 2050 O&M costs is shown in Figure 13-34.

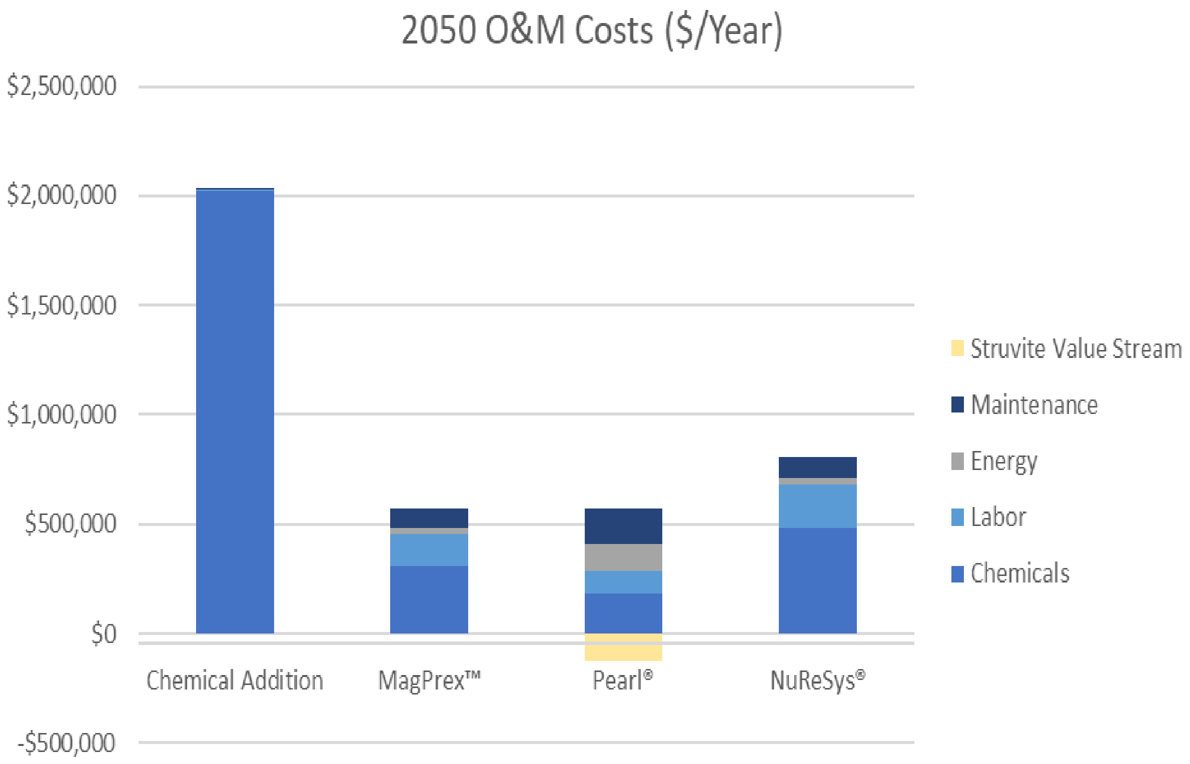


Figure 13-34: 2050 O&M Cost Breakdown for Alternatives

The 20-year net present value costs in Table 13-50 were developed using the assumptions discussed above. The net present value analysis shows an approximately $12 million spread between the most expensive and least expensive alternative. When providing estimate construction costs, an average value of the three systems will be provided.

Table 13-50
20-Year Net Present Value Estimates

Technology	Total Estimated Project Costs	2050 Net O&M Costs	20-Year Net Present Value
MagPrex™	$ 11,940,000	$ 574,000	$ 20,357,000
NuReSys®	$ 13,995,000	$ 809,000	$ 26,062,000
Pearl®	$ 26,204,000	$ 569,000 -$122,000	$ 32,553,000
Chemical Precipitation	$ 500,000	$ 2,031,000	$ 27,900,000

The contribution of upfront capital total project costs and the 20-year O&M cost are shown visually in Figure 13-35 Ultimately MagPrex showed highest cost savings over the 20-year period. The Pearl system was had the lowest cost savings over a 20-year period, and the benefits offered from brining in revenue from struvite sales did not offset the capital costs and associated maintenance costs of the system.

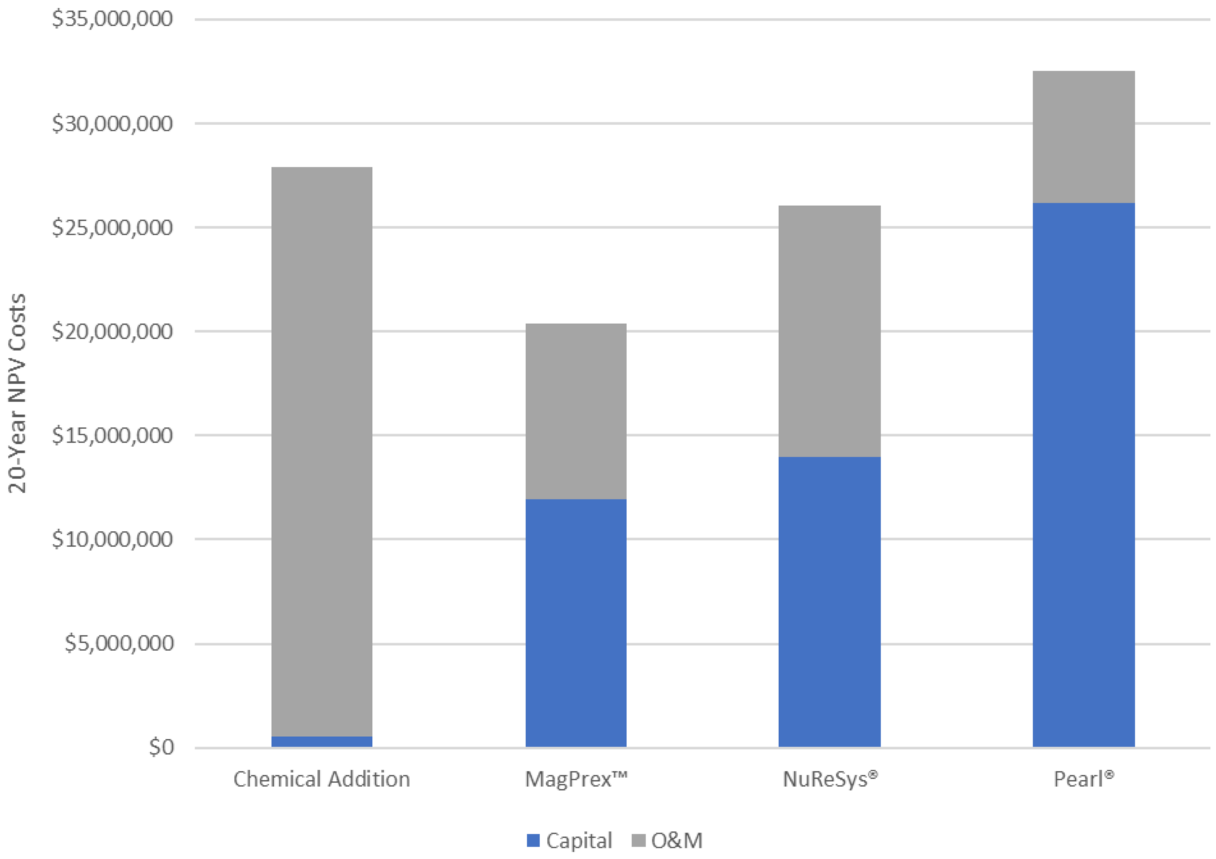


Figure 13-35: 20-Year Net Present Value at 3 Percent Escalation

It is also important to consider that a 3 percent escalation was estimated over the 20-year time period. If escalation were to be higher, it would have a significant impact on the costs over 20 years. Figure 13-36 shows how a 5 percent escalation rate would change the values.

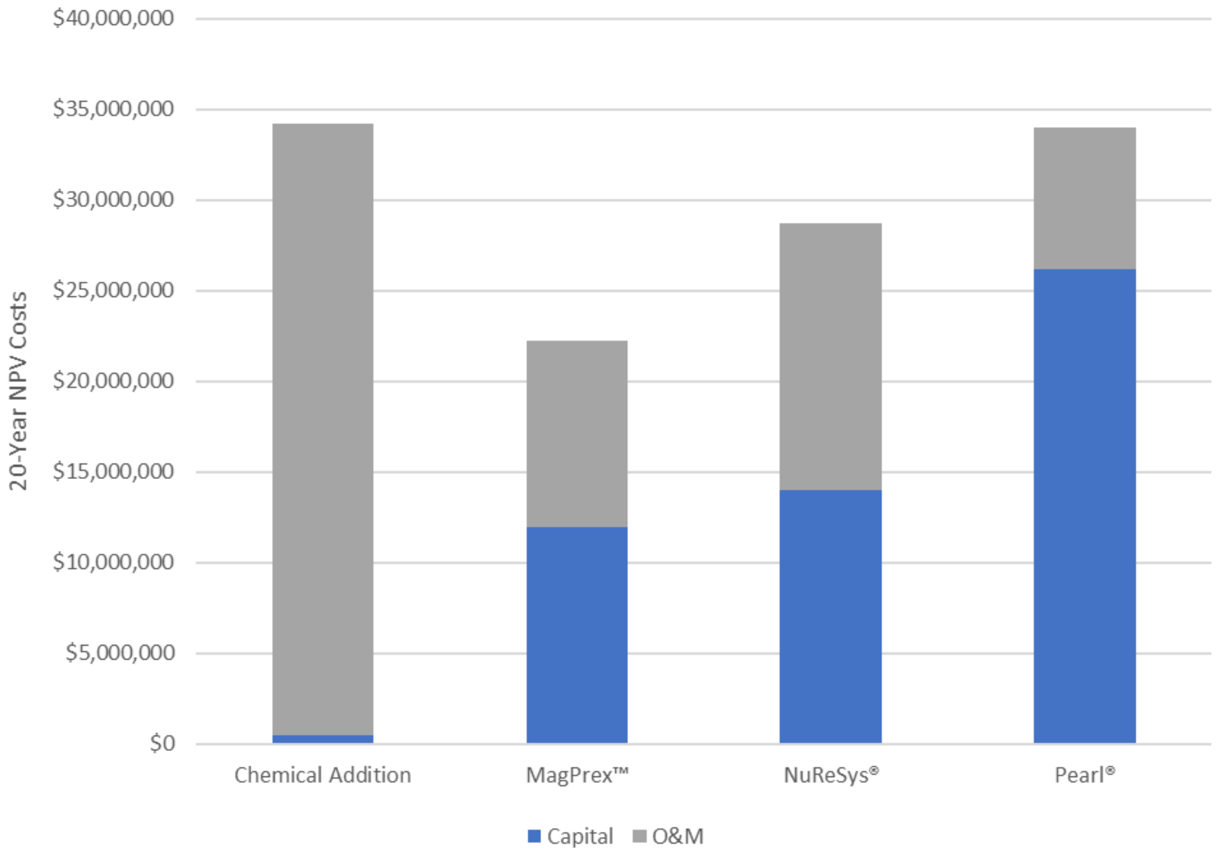


Figure 13-36 20-Year Net Present Value at 5 percent Escalation

The escalation rate has a greater impact on the alternatives that are more O&M dependent, especially alternatives that heavily rely on chemical addition. By increasing the escalation rate to 5 percent, the chemical addition alternative becomes the highest cost over the 20-year period.

Site Layout

Equipment for MagPrex, NuReSys® or Pearl will be housed in a building located near the primary digesters and thickening building. Options for building location has been discussed with CWSID staff and two options were identified. Each option has benefits depending on whether the sidestream process is treating the digestate or pressate. See Figure 13-37 for building location options. Final building location to be decided during pre-design.

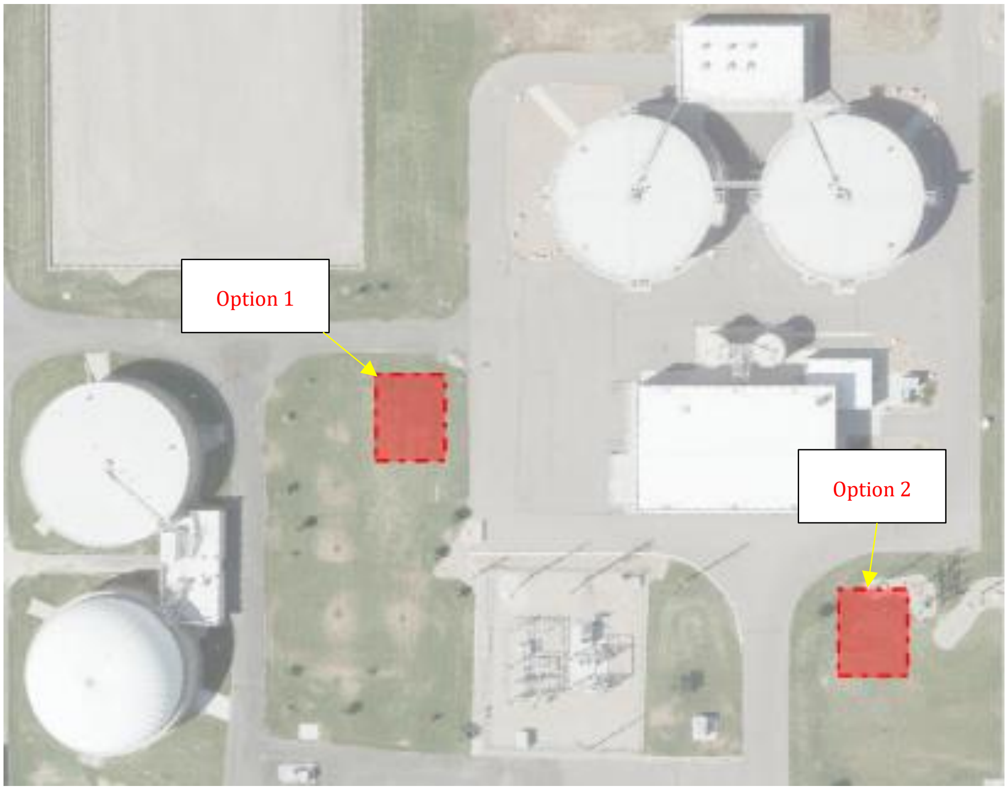


Figure 13-37 Sidestream Phosphorus Facility Site Layout Options

Summary and Recommendations

In summary the following recommendations and observations are provided when considering sidestream phosphorus removal at CWSID:

1. A sidestream phosphorus removal project is optional to CWSID as a struvite mitigation benefit. Total project cost will use the average of the alternatives outline above with an estimated construction date of 2031.
2. Recommend jar testing to simulate the PS and WAS blending tanks as potential fermenters for phosphorus release and to confirm process modeling results. Piloting goals would be to understand the amount of soluble ortho-phosphorus released with varying hydraulic retention times and varying soluble carbon concentrations.
3. Recommend piloting thickening equipment better suitable for co-thickening WAS and PS together in lieu of gravity belt thickeners. Options can be rotary drum thickeners or thickening centrifuges.
4. Recommend piloting chemical phosphorus removal alternative and dosing locations. Piloting effort can be congruent with blend tank piloting to understand dosing molar dose ratios, hydrogen peroxide concentrations, solids generation, chemical costs, and alkalinity and pH adjustments.
5. Should CWSID decide to implement a sidestream technology, preselection of equipment based on selection criteria and lifecycle costs is recommended between the manufacturers during pre-design.
6. Recommend an engineering study to review digester mixing replacement options and feasibility. See list of mixing technology options listed in Section 13.3.2.1.

CHAPTER 14
TREATMENT PLANT PROJECT SUMMARY AND IMPLEMENTATION SCHEDULE

14.1 INTRODUCTION

The objective of this chapter is to arrange the recommended projects identified in Chapter 13 into defined categories to prioritize projects. Once in a category, projects will be placed into phases to offset the capital cost of recommended projects until planning year 2050. Final summary of recommended wastewater master plan project tables and implementation schedule are shown at the end of this chapter.

14.2 PROJECT CATEGORIES

A description of each project category is listed below. Each project will be placed into one of the following:

1. Capacity Projects: Projects that need to be completed to continue to meet Central Weber Sewer Improvement District's (CWSID's or District's) discharge permit limits. Key drivers for these projects are based on projected growth, flows, and plant loads. Projects identified are for both the liquid and solid stream processes.
2. Optional Projects: Projects that are not required to meet permit limits but are optional to the District to save on operation and maintenance (O&M) costs or improve/optimize processes.
3. Condition Assessment Projects: Key condition assessment projects identified in Table 3-31 that are most likely to impact the longevity of an asset.
4. Study: Studies or pilots required to further understand design criteria of a recommended project.
5. Contingency Projects: Projects that are currently not needed to meet permit limits but may be required to reduce substantial operating costs in case of loss of an asset that is outside the District's control, such as loss of drying beds from odor complaints or loss of access to third party private farmland for land application of biosolids. Projects can also fall under this category if other optional projects listed are not executed which would trigger the contingency project to be needed.

14.3 PROJECT PHASING

The 2017 Master Plan identified three phases or scheduled groups of projects for CWSID to implement. Phasing these projects has allowed the District to offset capital costs and execute projects on a timeline suitable to meet capacity needs for each process area. Phase 1 was completed in 2019, while Phase 2 is currently under construction. In the 2017 Master Plan, Phase 3 included an additional aeration basin (Aeration Basin No. 6), ultraviolet (UV) disinfection, and primary clarifiers. Primary clarification is the only process upgrade left to be completed in Phase 3, as Phase 2 incorporated the extra aeration basin and UV Disinfection Facility. For continuality, this Master Plan will continue the phasing convention, starting with Phase 3 and ending with Phase 6.

14.3.1 Phase 3 Projects

Under Phase 3, the following recommended projects are presented in Table 14-1. The two main capacity-driven projects for this phase are primary clarification and sludge thickening, with optional and conditional assessment projects listed. Phase 3 is estimated to begin in 2029.

Table 14-1
Phase 3 Projects

Project	Facilities/Equipment	Category
Primary Clarification		Capacity
	Primary Clarifier Nos. 3 and 4	
	Raw Sludge Pump Station	
	Primary Sludge and Scum Pumps	
Sludge Thickening		Capacity
	Gravity Belt Thickener No. 3	
	Progressive Cavity Cake Pumps	
Flare Relocation		Capacity
Sidestream Phosphorus Removal		Optional
	Sidestream Phosphorus Facility	
	Fermenter	
	Co-thickening	
	Replace Digester Mixing	
Digester Gas Cleaning Upgrade for Boilers		Optional
Recoat Dewatering Ceiling		Condition Assessment
Trickling Filter (TF) Digester Seismic Investigation		Condition Assessment/Study
Fermenter/Co-thickening Study		Study(1)

[1] The fermenter/co-thickening study is dependent upon CWSID's decision to execute the optional sidestream phosphorus removal project.

14.3.2 Phase 4 Projects

Phase 4 recommended projects are the show in Table 14-2. Capacity improvement projects are highlighted by secondary treatment expansion and UV disinfection. Phase 4 is estimated to begin in 2035.

Table 14-2
Phase 4 Projects

Project	Facilities/Equipment	Category
Aeration Basins		Capacity
	Aeration Basin Nos. 7 and 8	
	Mixed Liquor (ML) Recycle Pumps	
	Aeration Diffuser System	
	Blower No. 5	
Secondary Clarifiers		Capacity
	Secondary Clarifier Splitter Box	
	Secondary Clarifiers No. 7 and 8	
	Return Activated Sludge (RAS)/Waste Activated Sludge (WAS) Pump Station	
	Scum Removal	
UV Disinfection		Capacity
	UV Disinfection Facility	
	Final Effluent Flow Meter	
Expand Drying Beds		Capacity
Dewatering Optimization Study		Study

14.3.3 Phase 5 Projects

The Phase 5 recommended project is for expanding primary digestion to meet capacity. Capacity can be met by adding more tankage (i.e., more primary digesters), intensifying digestion with thermal or chemical hydrolysis, or by improving sludge thickening. Process modeling has shown that increasing combined sludge (WAS and primary sludge) to 4.3 percent solids will postpone Phase 5 past planning year 2050. Therefore, improvement of WAS thickening is recommended during Phase 3 to achieve combined solids concentrations required to offset digestion. For this Master Planning effort, it is assumed that no thickening process improvements are made and CWSID is required to purchase an additional primary digester by the year 2040.

Table 14-3
Phase 5 Projects

Project	Facilities/Equipment	Category
Primary Digestion		Capacity
	Primary Digester No. 4	
	Digester Control Building	
	Digester Mixing Equipment	

14.3.4 Phase 6 Projects

Phase 6 includes the headworks expansion project as shown in Table 14-4, estimated to begin in 2041. No other projects have been included as part of this Phase.

Table 14-4
Phase 6 Projects

Project	Facilities/Equipment	Category
Headworks		Capacity
	Screening Equipment	
	Vortex Grit	
	Influent Pumping	

14.3.5 Contingency Projects

The following two projects are listed as contingency projects that do not fall under one of the phases:

1. Purchase Farmland: Purchasing farmland for land application of Class B biosolids gives CWSID full control of biosolids disposal in lieu of relying upon third party private farmers.
2. Chemical Hydrolysis: Intensifying digestion to increase volatile suspended solids (VSS) reduction and improve dewaterability is advantageous if CWSID must haul biosolids to a District-owned farm. Chemical hydrolysis also helps with digestion capacity and reduces dewatered solids before being placed on drying beds but does not produce a Class A biosolid.
3. Flare Relocation: Consider relocating the flare to meet ANSI/CSA guidelines. This is not an adopted code but is viewed as best practice or standard of care for designing flares. Consideration for flare relocation would also address any capacity concerns or ability to isolate the flare for maintenance and added redundancy. This project would be contingent upon CWSID not deciding to implement the optional project to use biogas for existing boilers.

The first two contingency projects recommended are to continue as a Class B biosolid disposal option for CWSID. A District-owned farm would only require meeting Class B biosolids, which is already being accomplished via digestion. Placing the dewatered biosolids on drying beds can provide a Class A byproduct if solids are tested and met 503 regulations for vector attraction reduction. If drying beds are discontinued due to odor complaints, and CWSID still wants options to produce Class A biosolids, thermal hydrolysis (Cambi®) or thermal drying technologies are to be considered. Timeline for contingency projects is unknown at this time but is prudent to include in planning in case land application on private farmland is lost.

Table 14-5
Contingency Projects

Project	Project Type	Basis for Recommendation	Phase	Cost Opinion ($million [M])
Purchase Farmland	Contingency	CWSID control of land application operations of biosolids. Dependent upon loss of access to private farmland.	-	$20M
Chemical Hydrolysis	Contingency	Solids reduction, increased digester gas production and dewaterability. Dependent upon loss of access to private farmland for land application	-	$18.9M
Flare Relocation	Contingency	Relation of flare to meet best practice standards and address any redundancy, maintenance, and capacity issues.	-	$0.75M

14.4 RECOMMENDED PROJECT SUMMARY AND IMPLEMENTATION SCHEDULE

Figure 14-1 shows the site plan for projects. Location of structures is subject to change during conceptual and pre-design efforts of each facility. Table 14-6 summarizes all recommended projects with phases and cost opinions. A recommended implementation schedule for each phase is shown in Figure 14-2.

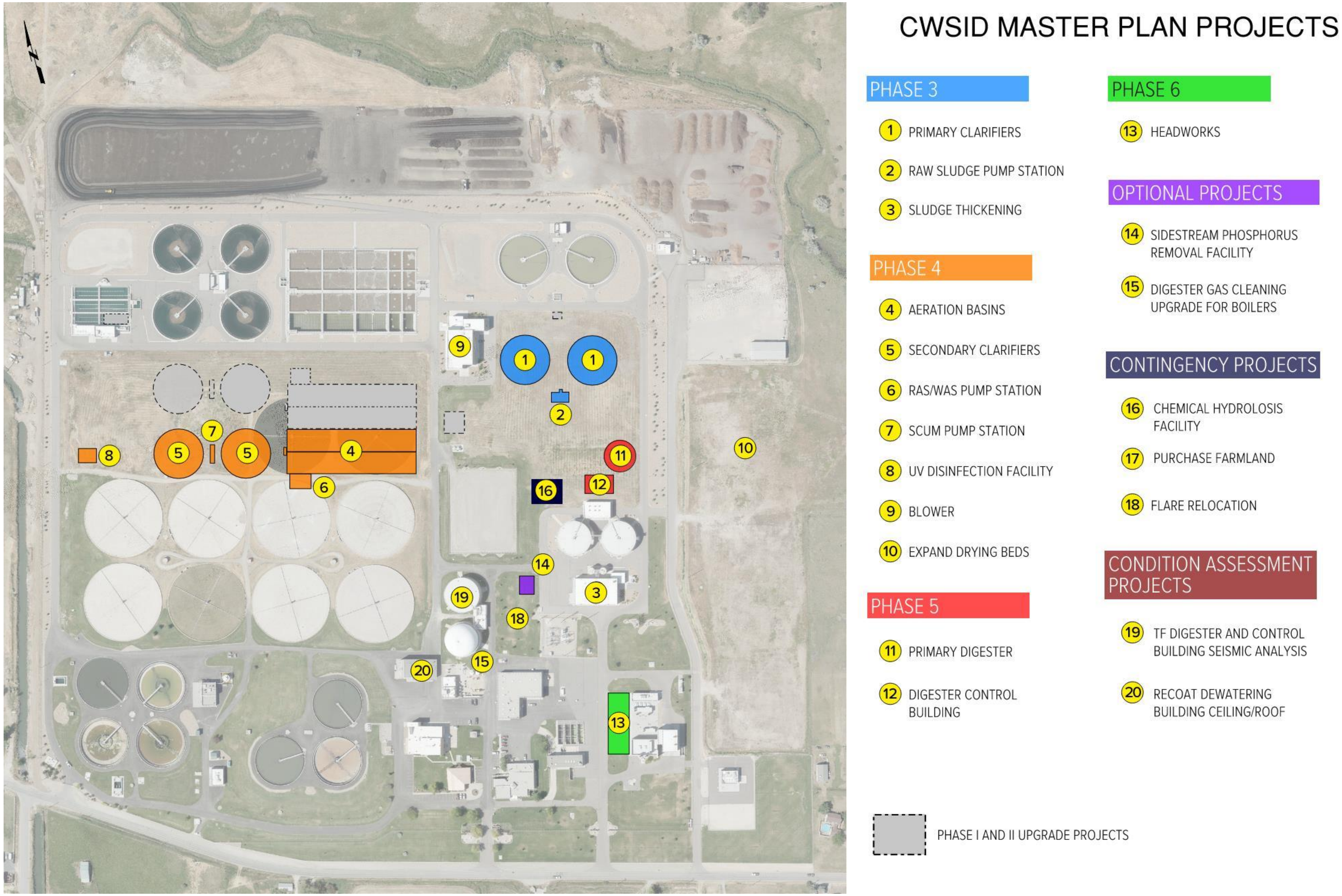


Figure 14-1: Master Plan Projects Site Plan

Table 14-6
Master Plan Projects Summary

Project	Project Type	Basis for Recommendation	Master Plan Phase	Cost Opinion ($M)
Primary Clarifiers	Capacity	Meet projected growth and load.	3	$24.8M
Sludge Thickening	Capacity	Meet projected growth and load.	3	$2M
Aeration Basins	Capacity	Meet projected growth and load.	4	$56.6M
Secondary Clarifiers RAS/WAS	Capacity	Meet projected growth and load.	4	$32M
UV Disinfection	Capacity	Meet projected growth and load.	4	$23.1M
Primary Digester	Capacity	Meet projected growth and load.	5	$34.5M
Headworks	Capacity	Meet projected growth and load.	6	$38.9M
Expand Drying Bed	Capacity	Meet projected growth and load.	4	$2M
Sidestream Phosphorus Removal	Optional	Struvite mitigation.	3	$17.9M(1)
Digester Gas Cleaning Upgrade for Boilers	Optional	Utilize digester gas for boilers.	3	$2M
TF Digesters and Digester Control Building Seismic Investigation	Condition Assessment	Structural damage to TF Digester and Control Building due to earthquake.	3	$0.05M
Recoat Dewatering Framing/Ceiling	Condition Assessment	Corrosion of coated joist/decking in the Dewatering Building.	3	$0.15M
Dewatering Optimization Study	Study	Evaluate dewatering operations to increase dewaterability. Dependent upon loss of drying beds or private farmland.	4	$0.1M
Fermentation/Co-Thickening Study	Study	Simulate sludge blending tanks as a fermenter for phosphorus release and pilot co-thickened sludge technologies. Congruent with sidestream phosphorus removal project.	3	$0.15M

[1] Capital costs based on average costs of each equipment manufacturer.

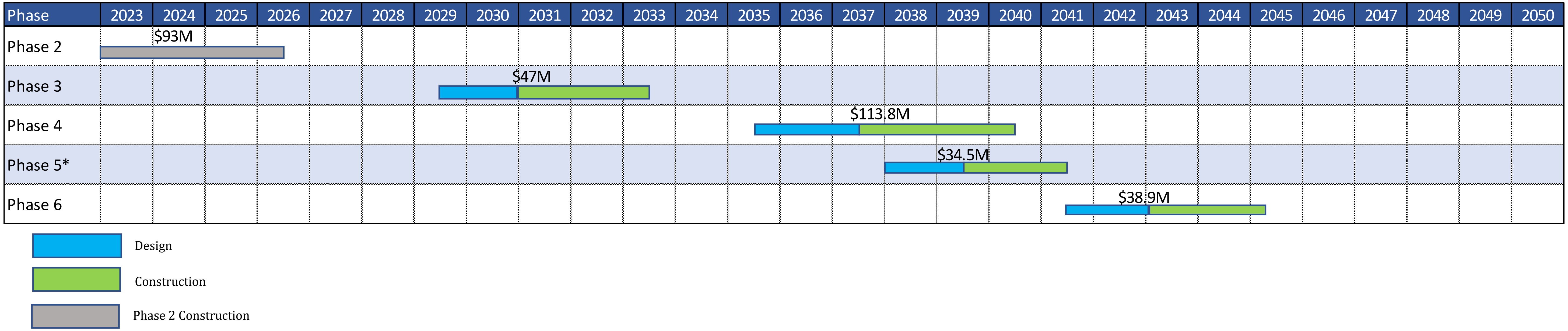


Figure 14-2: Implementation Schedule

CHAPTER 15
CAPITAL FACILITIES PLAN

INTRODUCTION

Previous chapters of this Wastewater Master Plan have identified improvements to resolve existing and future deficiencies and to accommodate wastewater flow from future growth while providing an acceptable level of service. The purpose of this chapter is to assemble a 10-year capital facilities plan to implement the recommended improvements for both the collection system and treatment plant. This plan should be updated at least every five years to re-prioritize system improvements to achieve District goals.

RECOMMENDED 10-YEAR CAPITAL FACILITIES PLAN

Improvements for both the collection system and the treatment plant have been summarized previously in this report:

- **Collection System –** A full implementation plan was developed for collection system improvements in Chapter 9 (see Table 9-1 and Figure 9-1). Because there is some flexibility in how rehabilitation and replacement is completed, the proposed implementation plan has been set up such that the recommended level of funding is relatively constant from year to year. The exception is in 2025 and 2033 when capacity related improvements require larger than average annual levels of funding.
- **Treatment Plant –** A full implementation plan was developed for treatment plant improvements in Chapter 14 (see Table 14-6 and Figure 14-2). The majority of the treatment plant improvements are related to meeting projected growth and load. As such, there is not much flexibility with the scheduling of these projects. All treatment projects in the 10-year window have been grouped together into “Phase 3” improvements. The cost of this entire phase has been spread out across 5-years starting with design in 2029. As part of the 10-year window, ongoing projects associated with Phase 2 will also be completed.

Based on these combined improvements, a 10-year Capital Facilities Plan has been developed. Table 15-1 lists the improvement projects that are recommended within the next 10 years, the budget required to complete those projects, and the recommended timing of those projects. For budgeting purposes, capital costs for most major improvements have been split up into at least two years; the first year usually includes about 10 percent of the total project cost for design services, while future years include the remaining budget for actual construction.

Figure 15-1 shows the annual capital expenditures that will be required to support the recommended capital improvement plan. Expenditures have been grouped by major category for reference. Neither Table 15-1 nor Figure 15-1 reflect bonding, grants, or use of reserves that may be needed to fund the recommended improvements. These types of cash flow issues will need to be considered as part of the District’s next rate study. Also, it should be remembered that all values contained in both the table and the figure are in 2023 dollars. For rate calculations and other financial planning, these values will need to be adjusted for inflation.

The recommended 10-year capital improvement plan includes a 10-year total cost of $156,974,000 (2023 dollars).

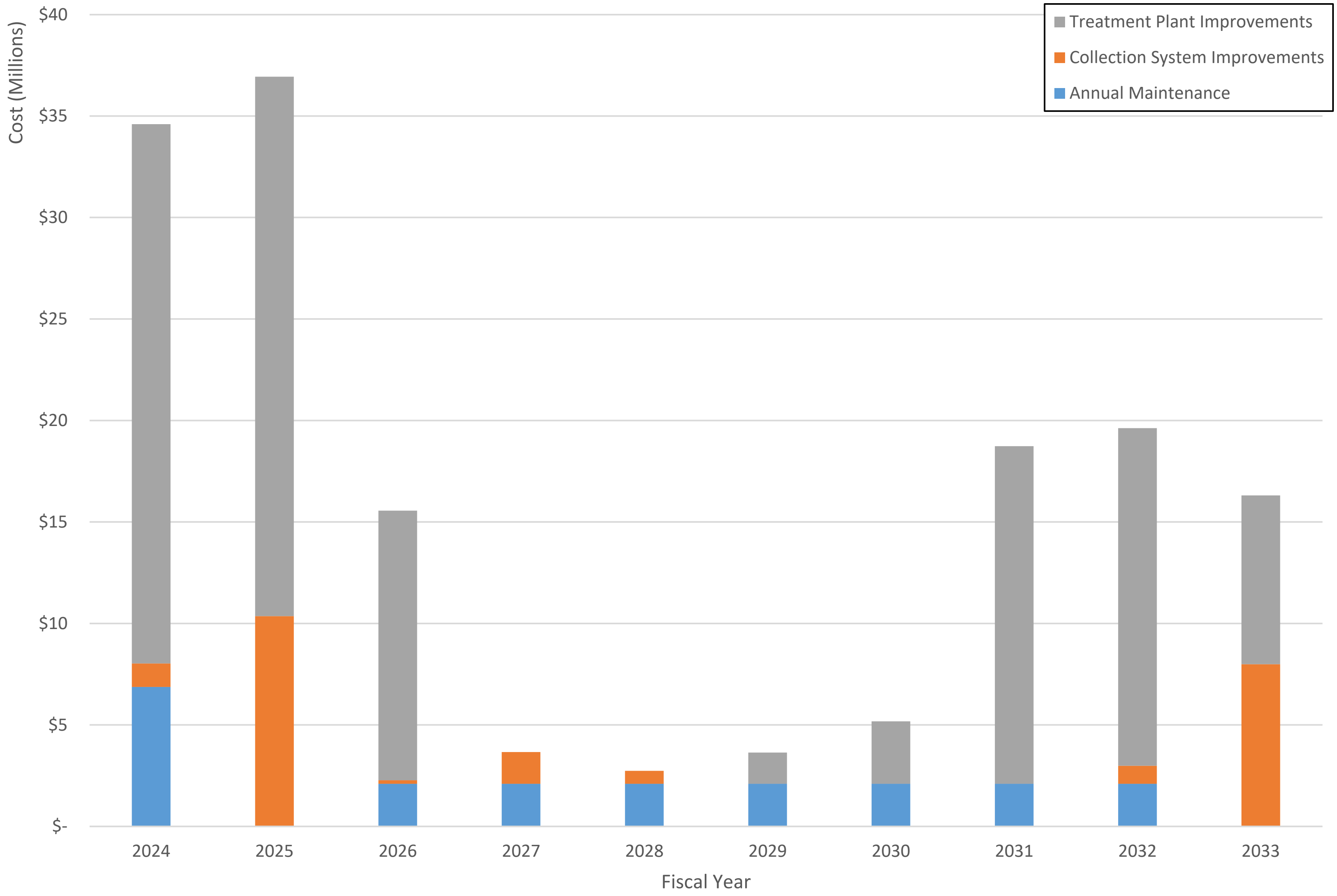


Figure 15-1: 10-Year Revenue and Expenditures – CWSID Capital Improvements

Table 15-1
Recommended 10-Year Capital Improvement Plan (2023 Dollars)

Project ID	Project Description	Project Total Cost (2023 $'s)	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028	FY 2029	FY 2030	FY 2031	FY 2032	FY 2033
Collection System Improvements												
1	Riverdale Railroad Yard Mainline	$5,130,000										
2	Ogden 30th Street Mainline	$8,879,000									$887,900	$7,991,100
3	30th St. Force Main	$639,000					$639,000					
4	West Haven Mainline	$11,516,000	$1,151,600	$10,364,400								
5	Taylor Force Main	$4,076,000										
6	Farr West Mainline	$12,809,000										
7	North Ogden Mainline	$1,626,000										
8	Farr West Lift Station No. 3	$8,111,000										
9	Industrial Force Main	$235,000										
10.A	West Weber Force Main (w/o Weber West 2)	$9,276,000										
10.B	West Weber Force Main (w/ Weber West 2)	$12,067,000										
11	Hooper Mainline (w/ Weber West 2)	$21,607,000										
12	Pioneer Road	$4,856,000										
13	Riverdale Stubline	$880,000										
14	South Ogden Stubline	$1,735,000			$173,500	$1,561,500						
Subtotal		***$94,166,000***	***$1,151,600***	***$10,364,400***	***$173,500***	***$1,561,500***	***$639,000***	***$ -***	***$ -***	***$ -***	***$887,900***	***$7,991,100***
Treatment Plant Improvements												
	Phase 2	$93,000,000	$26,572,000	$26,572,000	$13,286,000							
	Phase 3	$46,200,000						$1,540,000	$3,080,000	$16,632,000	$16,632,000	$8,316,000
	Phase 4	$113,800,000										
	Phase 5	$34,500,000										
	Phase 6	$38,900,000										
Subtotal		**$326,400,000**	**$26,572,000**	**$26,572,000**	**$13,286,000**	**$ -**	**$ -**	**$1,540,000**	**$3,080,000**	**$16,632,000**	**$16,632,000**	**$8,316,000**
Collection System Rehabilitation Improvements												
	Annual Maintenance (per year)	$14,700,000			$2,100,000	$2,100,000	$2,100,000	$2,100,000	$2,100,000	$2,100,000	$2,100,000	
	Hooper Lining Phase II	$6,875,000	$6,875,000									
Total		**$442,141,000**	**$34,598,600**	**$36,936,400**	**$15,559,500**	**$3,661,500**	**$2,739,000**	**$3,640,000**	**$5,180,000**	**$18,732,000**	**$19,619,900**	**$16,307,100**

APPENDIX A

Growth Projections for the Central Weber Sewer Improvement District Service Area

BOWEN COLLINS
& ASSOCIATES

TECHNICAL MEMORANDUM

TO:	Kevin Hall, P.E. Central Weber Sewer Improvement District 2618 Pioneer Road Ogden, UT 84404
COPIES:	James Dixon, P.E.
FROM:	Keith Larson, P.E. and Tucker Jorgensen, E.I.T.
DATE:	August 2, 2022
SUBJECT:	Growth Projections for the Central Weber Sewer Improvement District Service Area
JOB NO.:	016-22-01

SECTION 1 INTRODUCTION

The Central Weber Sewer Improvement District (CWSID or District) is currently working with Bowen Collins & Associates (BC&A) to prepare a Facilities Evaluation and Master Plan Update. This update will include an evaluation of the District's collection and treatment facilities and identify recommended capital facilities to meet future District needs.

To properly evaluate the system, an estimate of the current and projected future wastewater flows needs to be developed. These flow projections are based on existing and future population estimates within the CWSID service area. Population projections for this project were derived from multiple sources including the previous master plan, the Wasatch Front Regional Council, local municipality projections, and Weber County planning information. Population projections were then converted to flow projections based on historical plant flow data provided by CWSID. The purpose of this document is to summarize existing and future population projections and flow estimates within the CWSID service area that will be used as the basis of growth in the District's Master Plan.

SECTION 2 EXISTING AND FUTURE CWSID SERVICE AREA.

The CWSID treatment plant is located in Marriott-Slaterville and collects and treats wastewater for a significant portion of Weber County shown on Figure 2-1. The existing service area is approximately 85-square miles and includes all, or part of: Farr West, Harrisville, Hooper, Marriott-Slaterville, North Ogden, Ogden, Plain City, Pleasant View, Riverdale, Roy, South Ogden, South Weber, Uintah, Washington Terrace, West Haven, and Unincorporated Weber County. The District does not collect or treat wastewater from the Ogden Valley which consists of the eastern portion of Weber County.

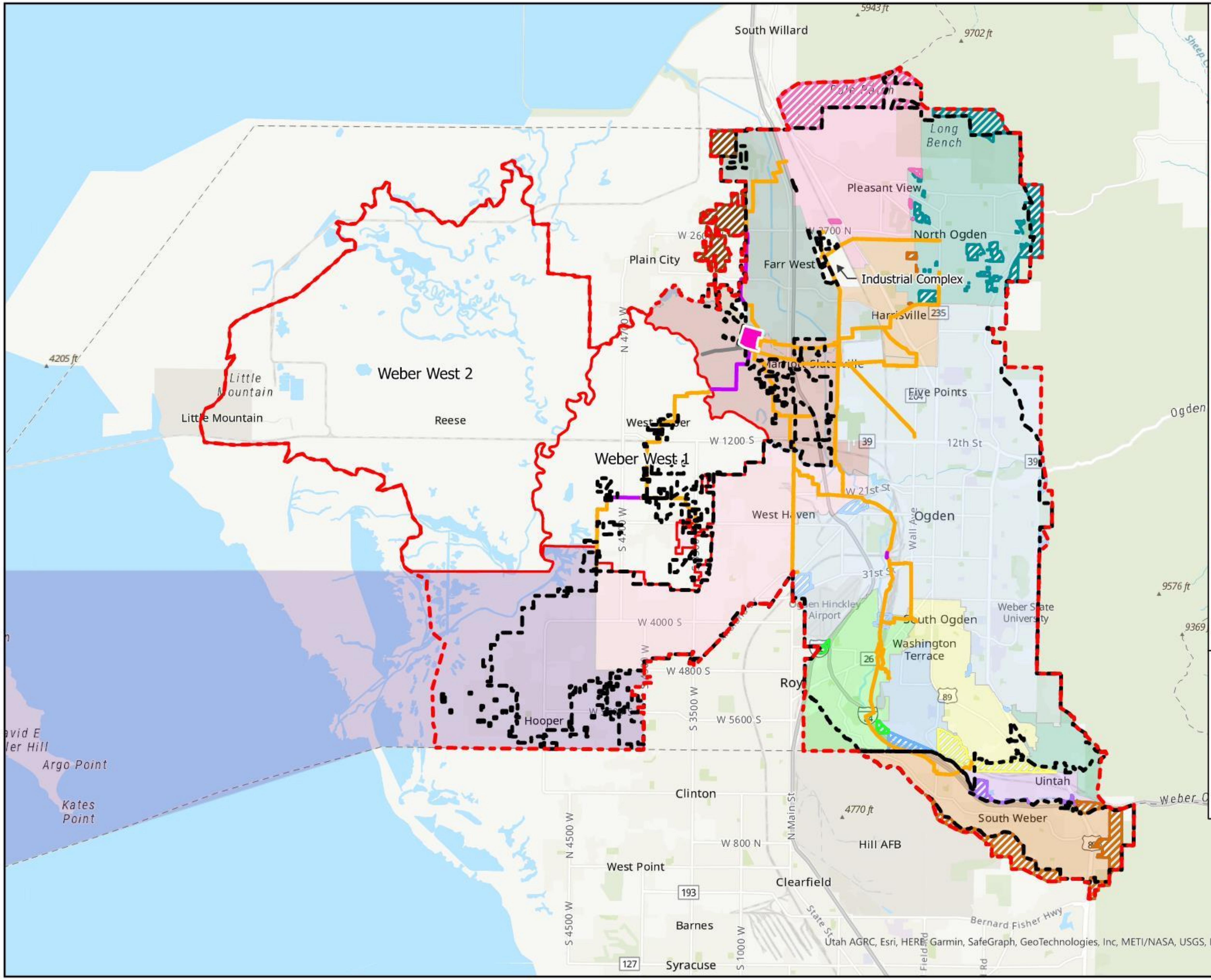
The existing service area can be divided into two portions:

- **East Area** - The eastern portion of the service area includes nearly all of Weber County between the Wasatch Mountains and I-15. It also includes South Weber which is part of Davis County. Most of this area is at or near build-out conditions with the exception of the extreme northern and southern ends of the area. The East Area is generally more densely developed than the rest of Weber County. Any existing "islands" of land not currently part of the service area are anticipated to be annexed into the nearest municipality and consequently into the CWSID service area as they are developed.
- **West Area** – To the west of I-15 there is significantly more open space. As shown on Figure 2-1, much of the existing developed area is already part of the existing CWSID service area. The developed areas to the west of I-15 that are not part of CWSID are typically on septic systems (except for Plain City and the Little Mountain Service Area which have separate sewer systems). Similar to the East Area, it is anticipated that much of the West Area will be annexed into the CWSID service area as it is developed. Density in the West Area is not anticipated to be as high as in the East Area. However, as sewer services are expanded it is expected that development density will increase from current averages.

To assist in analyzing the population growth within the CWSID service area, the service area has been divided into sub-service areas typically by city. Figure 2-1 shows the assumed annexation and sub-service areas for the potential future CWSID service area.

As can be seen in the figure, most of the future service area is included within existing municipal boundaries. However, there are a few areas that have been broken out separately as follows:

- **Western Unincorporated Weber County:** This portion of Weber County has the potential to be annexed into both existing and future municipalities. Due in part to this uncertainty, this region has been divided into two (2) separate service areas; Weber West 1 and Weber West 2.
    - Weber West 1 includes the portion of Unincorporated Weber County that is already planned for annexation into the CWSID service area and is generally bounded by the Weber River to the west and north and West Haven and Hooper to the east and south.
    - Weber West 2 includes the developable lands to the west of the Weber River. Existing development in this area is very sparse. For this service area to connect into the CWSID system it will require the placement of a new trunkline and agreements to expand the future CWSID service area.
- **Industrial Complex:** There is an area of industrial/commercial development between Farr West, Harrisville, and Pleasant View. This region is broken out since its flows and population changes will not be consistent with a single adjacent city, nor is it expected to see significant levels of new development. Note that this area does not include the Business Depot of Ogden which is accounted for within the Ogden City projections.



Note *: Unincorporated Weber County areas are assumed to be annexed within the nearest city service area. These areas may or may not be annexed by that city, but should connect into the CWSID system with that service area.

SCALE: 1 in = 10,000 ft

NORTH:

POPULATION PROJECTION CITY SERVICE AREAS

CWSID

2022 MASTER PLAN

BOWEN COLLINS & ASSOCIATES

FIGURE NO.

2-1

P:\Central Weber SID\016-22-01 CWSID Master Plan\4.0 GIS\4.4 APRX\CWSID Master Plan.aprx tjorgensen 8/1/2022

SECTION 3 EXISTING DEVELOPMENT

Existing development can be broken into two major components, Residential and Non-Residential. The existing population for Residential development can be obtained from the U.S. Census Bureau and other resources. Non-Residential development typically includes industrial, commercial, and institutional development that must be estimated using other methods. The estimated existing level of development is discussed in the following sections.

3.1 RESIDENTIAL DEVELOPMENT/POPULATION

In 2020, the U.S. Census Bureau conducted a decennial population census of the entire United States. These population estimates for each city as reported in the census are shown in Table 3-1. It is important to note that not all of the cities' population falls within existing service area of the District. Thus, included in Table 3-1 is also the approximate population of the city currently served by CWSID in 2022 (existing population). The process of estimating the 2022 and other future populations is presented in Section 4.

Table 3-1 [1]
Historical and Existing Population Estimates and Service Areas

City/Area	2020 U.S. Census Estimate	2022 Estimated Population Served
Farr West	7,691	8,030
Harrisville	7,036	7,323
Hooper[2]	9,087	7,420
Marriott-Slaterville	2,135	1,176
North Ogden	20,916	21,934
Ogden	87,321	91,077
Plain City[2]	9,364	336
Pleasant View	11,083	12,035
Riverdale	9,343	10,096
Roy[3]	39,306	614
South Ogden	17,488	18,240
South Weber	7,867	8,454
Uintah[2]	1,454	166
Washington Terrace	9,267	9,884
West Haven	16,739	18,029
Unincorporated Weber County	13,420	4,166
Total	**269,517**	**218,980**

[1] Table 3-1 does not include populations breakouts for the Uintah Highlands, Weber West 1, and Weber West 2 sub-service areas because they are not established municipalities. Their populations are included in the Unincorporated Weber County Populations.

[2] Only a portion of Hooper and Marriott-Slaterville are currently serviced by CWSID. It is anticipated that all of these communities will eventually be serviced.

[3] A small portion of Plain City, Roy, and Uintah are serviced by CWSID. Little, if any, growth is expected from these areas.

As can be seen from Table 3-1 and Figure 2-1, the majority of the existing service population is on the east side of the service area. This is consistent with the existing development patterns. The areas west of I-15 typically have lower densities for new and existing construction while the cities to the east of I-15 have higher densities as well as less undeveloped/open space.

3.2 NON-RESIDENTIAL

Non-Residential areas include commercial/retail space as well as institutional or industrial developments. Estimating the impacts to the system from Non-Residential areas requires defining flow usage in terms of an Equivalent Residential Unit (ERU). A single ERU is meant to represent the wastewater flow produced by a typical single-family detached dwelling unit. Further description of how ERUs are defined, as well as the resulting estimate of existing Non-Residential ERUs is provided below.

3.2.1 ESTIMATING ERUS

ERUs were estimated using published water usage/production for the applicable entities from the Utah Department of Water Quality website. The process used for this study is as follows:

- Acquire Data: The majority of the culinary distribution entities for the CWSID service area have data going back beyond 10 years. This includes both water sales and production data.
- Estimate average flow per ERU: Average flow was estimated by dividing the total residential water sales/production by the number of residential connections for a given year.
- Estimate Number of Non-Residential ERUs: The total annual water sales/production (including non-residential) was divided by the estimated flow per ERU to calculate the total number of ERUs for the entity. The difference between the total ERUs and the residential ERUs then becomes the estimate of non-residential ERUs.

Depending on the entity/area, some of the usage data includes both indoor and outdoor water use. Outdoor water use does not correspond to the definition of an ERU for sewer systems. Outdoor water use was estimated using the ratio between the non-summer month use (October to March) to the total water usage and was removed in the calculation of flow per ERU. Based on these calculations, the average indoor water usage per ERU for residential customers in the CWSID service area is 220.4 gpd/ERU. Once indoor consumption is removed (estimated at 10 percent of total flow), the resulting wastewater flow is 198.4 gpd/ERU. For future connections, it is estimated that there will be approximately 33 gpd/ERU associated with infiltration. This value comes from previous studies done for nearby service districts. As a result, the future flow per ERU should be 231.4 gpd/ERU.

Table 3-2 shows the estimated Non-Residential ERUs for each city/area within the CWSID service area. Since data for 2022 water usage/sales was not available during this study, the year 2020 was used as the basis for the table. Included in the table is the ratio of non-residential to residential ERUs in each city/area. This is will be used for calculating future non-residential ERUs as will be discussed later in this report.

Table 3-2
Non-Residential 2020 ERU Estimates and Service Areas

City/Area	2020 ERU	Non-Residential/ Residential ERU Ratio	Culinary Water Entity
Farr West	740	0.34	Bona Vista Water Improvement District[2]
Harrisville	662	0.33	Bona Vista Water Improvement District[2]
Hooper	51	0.03	Hooper Water Improvement District
Marriott-Slaterville	50	0.20	Bona Vista Water Improvement District[2]
North Ogden	665	0.11	North Ogden Municipal Water
Ogden	26,450	0.87	Ogden City Division of Water Utilities
Plain City[1]	0	N/A	Bona Vista Water Improvement District[2]
Pleasant View	993	0.03[3]	Various[3]
Riverdale	1,228	0.38	Riverdale City
Roy[1]	0	N/A	Roy City
South Ogden	1,613	0.26	South Ogden City
South Weber	383	0.17	South Weber
Uintah	126	0.25	Uintah
Washington Terrace	1,042	0.32	Washington Terrace
West Haven	1,555	0.2-0.33	Various[4]
Unincorporated Weber County	294	0.08-0.21	Various[4]
Total	**35,851**	**0.56**	**--**

[1] The portions of Plain City, Roy, and Uintah serviced by CWSID are not anticipated to develop any non-residential area.
[2] The existing Bona Vista Water Improvement District Non-Residential/Residential ERU ratio is 1.27. City level ratios were adjusted based on future/existing general plans.
[3] Pleasant View is serviced by both Pleasant View City Culinary Water and Bona Vista Water Improvement District. The Non-Residential/Residential ERU Ratio does not include the portion serviced by Bona Vista Water Improvement District.
[4] West Haven and Unincorporated Weber County are serviced by a combination of Bona Vista Water Improvement District, Hooper Water Improvement District, West Warren Water Improvement District, and the Taylor Water Improvement District.

As can be seen from Table 3-2, the majority of the service areas have significantly fewer non-residential ERUs than residential.

SECTION 4 FUTURE CONDITIONS DEVELOPMENT

Weber County has potential for significant development and redevelopment. Projections for the CWSID service area have been developed using the following methodology:

1. Divide the projected service area into a number of smaller sub-areas using geographic information system (GIS) mapping (see Figure 2-1).

2. Project residential populations for each sub-area based on existing and projected patterns of development. This generally includes the following:
    a. Establish baseline population (2020 U.S. Census Bureau).
    b. Project populations using available data and development information.
    c. Project build-out population based on expected future landuse and zoning.

3. Project non-residential growth for each sub-area based on existing and projected patterns of development.

Each step of this process is summarized in the sections below.

4.1 SERVICE SUB-AREAS

Division of the service area into smaller sub-areas is important for two reasons. First, it increases the accuracy of the population and flow projections by examining land use and development patterns at a smaller scale. Second, it yields projections that are distributed spatially across the service area, an important requirement for future modeling efforts.

For this project, sub-service areas were established based on existing City boundaries. Sub-service areas were adjusted to include Unincorporated Weber County islands within the City Boundaries as well as surrounding Unincorporated Weber County based on City General Plans and ground slopes (e.g. potential flow direction of future sewer flow).

4.2 PROJECT RESIDENTIAL POPULATIONS

For each sub-area, baseline residential populations were set using 2020 U.S. Census Bureau information. From this baseline, future populations were projected using one of two available data sources:

- Wasatch Front Regional Council (WFRC) Projections – WFRC Projections are based on the State of Utah Governor's Office of Planning & Budget State population projections. Those projections are broken down into Traffic Analysis Zones (TAZ) based on City General Plans, existing infrastructure, and regional economic projections. Projections for each city can be developed by aggregating the WFRC projections for each TAZ within the City.
- Available City General Plan Projections – City General Plans are required to include existing and future landuse maps. Cities will often use these maps to project populations into the future based on existing development. City general plans came from the applicable city engineering department or website as applicable.

Detailed consideration on the projection selection for individual Cities is provided in Appendix A. In general, the projection was chosen based on past growth rates, 2020 projection estimate vs. Census estimate, and developable open space. When the two projections are similar, the more conservative estimate is chosen.

The WFRC projections and many of the General Plans' projections end at 2050. The planning window for this master plan is build-out. It is anticipated that some of the cities will be at build-out by 2060, but many will not reach build-out until much later. Thus, build-out populations for each sub- area were estimated as follows:

1. Observe Growth Rate of Projection – It was assumed that if the growth rate of the projection appeared to be reaching an asymptote by approximately 2050 (e.g. little to no growth between 2045 & 2050) that any new development would have an insignificant impact in relationship to this study. In these cases, the 2050 population projection was assumed to be near enough to full build-out for this study.
2. Density of Total Developable Area – In cases where growth is anticipated to continue beyond 2050, the total developable area was considered. Areas not considered developable included areas with slope greater than 30 percent grade, large regional parks/golf courses, and the 100-year FEMA Floodplain associated with the Great Salt Lake. Density of existing build-out areas of similar zoning was then used to estimate the density of future development to fill in the open space to calculate the full build-out population.

Results of the population projections are shown in Figure 4-1. This figure includes the recommended population projection for the total District service area compared to projections contained in the previous master plan as well as the current WFRC projections. As can be seen, the projection of overall population growth is not too much different than the previous master plan. There has been more growth through 2020 than was previously predicted, but the rate of growth moving forward is about the same. The one significant difference between the updated projections and the last master plan is the population at buildout. The new projections include about 80,000 more people than previously planned for. This is largely the result of additional potential growth to the west. Projections for individual cities are included in Appendix A.

The results of the final population projections by City have also been included in Table 4-1. As can be seen in the Table 4-1, the total service area population is expected to grow by 58 percent by 2050 and by 111 percent at Build-Out. Most of the population growth beyond 2050 is expected to occur west of I-15, specifically in the Weber West 2 area.

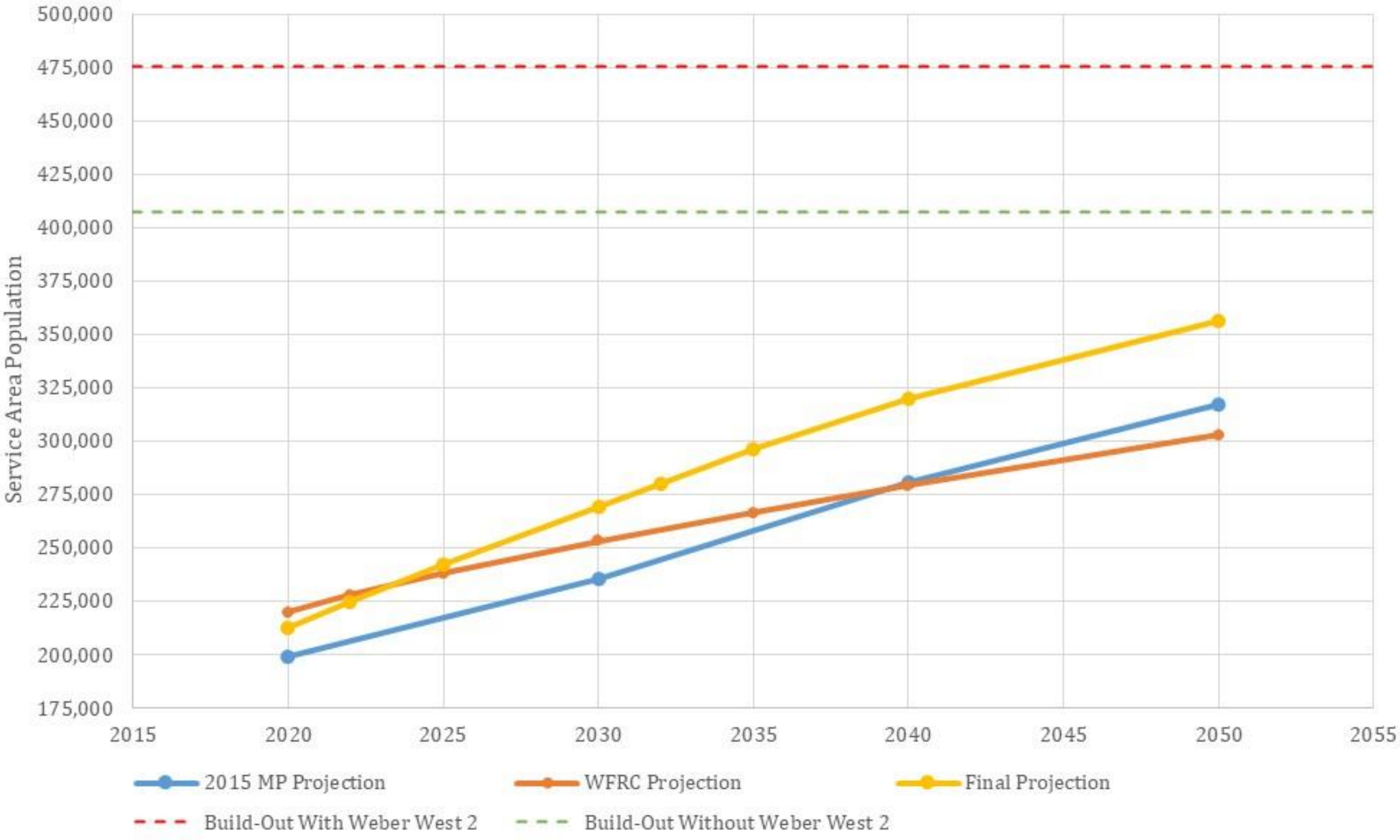


Figure 4-1. CWSID Service Area Projected Population

Table 4-1
City/Area Population Projections

City/Area	2020	2022	2025	2030	2032	2035	2040	2050	Build-Out (2060+)[1]
Farr West	7,691	8,030	8,544	9,413	9,785	10,348	11,301	13,409	16,961
Harrisville	7,063	7,323	8,439	10,753	10,981	11,325	11,851	12,765	12,765
Hooper	6,600	7,420	8,588	10,412	11,424	12,783	14,671	17,394	25,601
Marriott-Slaterville	870	1,176	1,586	2,183	2,602	3,143	3,862	4,794	5,928
North Ogden	20,916	21,934	23,479	26,390	27,704	29,703	33,480	40,302	42,000
Ogden	87,321	91,077	95,509	102,223	104,596	108,196	114,230	123,245	123,245
Plain City	295	336	700	1,134	1,313	1,585	2,077	2,574	3,907
Pleasant View	11,083	12,035	13,475	15,908	16,892	18,381	20,896	26,047	39,981
Riverdale	9,343	10,096	10,934	12,476	13,119	14,098	15,927	17,789	19,498
Roy	614	614	614	614	614	614	614	614	614
South Ogden	17,488	18,240	19,394	21,385	22,328	23,624	23,624	23,624	23,624
South Weber	7,867	8,454	9,353	10,903	11,541	12,515	14,190	14,190	14,190
Uintah[2]	1,454	1,484	1,519	1,606	1,666	1,756	1,909	2,126	3,080
Uintah Highlands	2,259	2,308	2,617	2,925	3,213	3,526	3,916	4,380	4,689
Washington Terrace	9,267	9,884	10,066	10,027	9,989	9,932	9,932	10,316	10,316
Weber West 1	4,477	5,217	6,209	7,515	8,178	9,035	10,207	11,938	34,848
Weber West 2	1,294	1,294	1,280	1,264	1,263	1,261	1,256	2,832	67,584
West Haven	16,739	18,029	20,054	22,439	23,206	24,371	25,862	28,280	28,280
Total with Weber West 2	**212,614**	**224,951**	**242,362**	**269,569**	**280,412**	**296,196**	**319,803**	**356,623**	**477,111**
Total without Weber West 2	**211,320**	**223,658**	**241,082**	**268,305**	**279,149**	**294,935**	**318,547**	**353,791**	**409,527**

[1] Note that build-out populations for individual cities are expected to be reached at 2060 **or greater**. Therefore, one should not attempt to calculate annual growth rates between the year 2050 and build-out based on a 10-year window. Timing to build-out will vary for each entitiy.

[2] CWSID currently services only 166 persons in a trailer park within Uintah. To be conservative, it is assumed that all of Uintah will connect into the CWSID system.

4.2.2 CONVERTING POPULATION PROJECTIONS TO ERUS

To estimate the impacts of future populations on the sewer system, they need to be converted to ERUs. For this study, it was assumed that the average existing household size would be an accurate representation of the number of individuals per ERU. Using information from the U.S. Census Bureau, it was estimated that there are two typical household sizes within the CWSID Service Area:

1. Low Household Size: For the more urban areas of CWSID's service area (Ogden, Riverdale, South Ogden, Washington Terrace, and Uintah), the existing average household size was calculated to be 2.9 persons per household.
2. Higher Household Size: For the remainder of the CWSID service area, the existing average household size was calculated to be 3.6 persons per household.

Applying the average household size to the population projections provided in Table 4-1 results in the estimated Residential ERU projections shown in Table 4-2.

Table 4-2
Residential ERU Projections

City/Area	2020	2022	2025	2030	2032	2035	2040	2050	Build-Out (2060+)[1]
Farr West	2,165	2,261	2,405	2,650	2,754	2,913	3,181	3,775	4,774
Harrisville	1,981	2,061	2,376	3,027	3,091	3,188	3,336	3,593	3,593
Hooper	1,858	2,089	2,418	2,931	3,216	3,598	4,130	4,896	7,207
Marriott-Slaterville	245	331	446	614	732	885	1,087	1,350	1,669
North Ogden	5,888	6,174	6,609	7,429	7,798	8,361	9,424	11,345	11,824
Ogden	30,406	31,714	33,257	35,595	36,422	37,675	39,776	42,915	42,915
Plain City	83	95	197	319	370	446	585	725	1,100
Pleasant View	3,120	3,388	3,793	4,478	4,755	5,174	5,882	7,332	11,255
Riverdale	3,253	3,516	3,807	4,344	4,568	4,909	5,546	6,194	6,789
Roy	214	214	214	214	214	214	214	214	214
South Ogden	6,090	6,352	6,753	7,447	7,775	8,226	8,226	8,226	8,226
South Weber	2,215	2,380	2,633	3,069	3,249	3,523	3,994	3,994	3,994
Uintah	506	517	529	559	580	612	665	742	1,072
Uintah Highlands	636	650	737	823	904	993	1,102	1,233	1,320
Washington Terrace	3,227	3,442	3,505	3,492	3,478	3,458	3,458	3,592	3,592
Weber West 1	1,260	1,469	1,748	2,115	2,302	2,543	2,873	3,360	9,810
Weber West 2	364	364	360	356	355	355	354	797	19,024
West Haven	4,712	5,075	5,645	6,316	6,532	6,860	7,280	7,961	7,961
Industrial[1]	--	--	--	--	--	--	--	--	--
Total	**68,622**	**72,092**	**77,432**	**85,778**	**89,095**	**93,933**	**101,113**	**112,244**	**146,339**

[1] The industrial area does not include any residential connections.

4.3 NON-RESIDENTIAL PROJECTIONS

In projecting future growth of non-residential development, it has been anticipated that the ratio between residential and non-residential ERUs for each sub-service area will be generally maintained This means that the number of ERUs and sewer flow from the non-residential users will remain proportional to the number of ERUs and flow from the residential areas. The existing ratio of non-residential to residential is included in Table 3-2. Using these ratios and the residential population projections from Table 4-1, the projected future non-residential ERUs are calculated and shown in Table 4-3.

The one exception to this is the area served by the Bona Vista Water Improvement District. The Bona Vista Water Improvement District has an existing non-residential/residential ERU ratio of 1.27. This is significantly higher than the ratio of every other entity within the CWSID service area, including Ogden City. It is likely that this is due to the large non-residential area between I-15 and US-89 north of 1650 North. Projecting this ratio forward would likely overestimate future non-residential use in the area. Instead, for each City within Bona Vista Water, the ratio of non-residential development to residential development was revised based on developed land use areas excluding the non-residential area noted above. Future growth was then calculated based on these revised ratios.

Finally, growth in the industrial area was projected by taking the existing estimated ERUs per acre (approximately 4-5 ERUs/acre) and using that density for the remaining developable open space within the industrial area. It was assumed that the number of ERUs in this area would increase at a constant rate until build-out. Due to the uncertain nature of the relationship between industrial development and ERUs, this growth assumption should be revisited as the area begins to develop.

4.4 WEST WEBER AREAS 2

There is significant uncertainty with development in Western Weber County, especially within the area defined as West Weber 2 in Figure 2-1. Zoning and development expectations for this area are still being defined. As a result, the ERU values associated with this area are estimates only and might not be accurate predictions of future growth. Impacts from this area will be addressed in later reports with relationship to existing and potential system capacities.

4.5 SUMMARY OF ERU PROJECTIONS

Table 4-4 combines projected growth for both residential and non-residential ERUs. It is recommended that the projection of growth within the District shown in the table be used as the basis for planning. This represents a potentially significant increase in future flows and loading for the District. The total population served by the District is expected to nearly double between 2022 and build-out based on current projections.

Table 4-3
Non-Residential ERU Projections

City/Area	2020	2022	2025	2030	2032	2035	2040	2050	Build-Out (2060+)[1]
Farr West	740	773	822	906	942	996	1088	1,291	1,632
Harrisville	662	689	794	1,012	1,033	1,066	1,115	1,201	1,201
Hooper	51	57	66	80	88	98	113	134	197
Marriott-Slaterville	50	67	90	124	148	179	220	273	338
North Ogden	665	697	747	839	881	944	1,065	1,282	1,336
Ogden	26,450	27,587	28,930	30,963	31,683	32,773	34,600	37,331	37,331
Plain City	0	0	0	0	0	0	0	0	0
Pleasant View	993	1,203	1,519	2,054	2,271	2,598	3,151	4,283	7,347
Riverdale	1228	1,327	1,437	1,639	1,724	1,852	2,093	2,337	2,562
Roy	0	0	0	0	0	0	0	0	0
South Ogden	1,613	1,682	1,788	1,972	2,059	2,178	2,178	2,178	2,178
South Weber	383	412	455	531	562	609	691	691	691
Uintah	125	128	131	139	144	152	165	184	266
Uintah Highlands	110	112	127	142	156	172	191	213	228
Washington Terrace	1,042	1,112	1,132	1,128	1,123	1,117	1,117	1,160	1,160
Weber West 1	107	124	148	179	195	215	243	284	829
Weber West 2	77	77	76	75	75	75	75	168	4,012
West Haven	1,555	1,595	1,618	1,629	1,579	1,591	1,601	1,630	1,630
Industrial	2,500	2,567	2,667	283	2,900	3,000	3,167	3,500	3,500
Total	**38,351**	**40,209**	**42,547**	**46,245**	**47,563**	**49,615**	**52,873**	**58,140**	**66,438**

Table 4-4
CWSID ERU Projections

City/Area	2020	2022	2025	2030	2032	2035	2040	2050	Build-Out (2060+)[1]
Farr West	2,905	3,034	3,227	3,556	3,696	3,909	4,269	5,066	6,406
Harrisville	2,643	2,750	3,170	4,039	4,124	4,254	4,451	4,794	4,794
Hooper	1,909	2,146	2,484	3,011	3,304	3,696	4,243	5,030	7,404
Marriott-Slaterville	295	398	536	738	880	1,064	1,307	1,623	2,007
North Ogden	6,553	6,871	7,356	8,268	8,679	9,305	10,489	12,627	12,627
Ogden	56,856	59,301	62,187	66,558	68,105	70,448	74,376	80,246	80,246
Plain City	83	95	197	319	370	446	585	725	1,100
Pleasant View	4,113	4,591	5,312	6,532	7,026	7,772	9,033	11,615	18,602
Riverdale	4,481	4,843	5,244	8,983	6,292	6,761	7,639	8,531	9,351
Roy	214	214	214	214	214	214	214	214	214
South Ogden	7,703	8,034	8,541	9,419	9,834	10,404	10,404	10,404	10,404
South Weber	2,598	2,792	3,088	3,600	3,811	4,132	4,685	4,685	4,685
Uintah	631	645	660	698	724	764	830	926	1,338
Uintah Highlands	746	762	864	965	1,060	1,165	1,293	1,446	1,548
Washington Terrace	4,269	4,554	4,637	4,620	4,601	4,575	4,575	4,572	4,572
Weber West 1	1,367	1,593	1,896	2,294	2,497	2,758	3,116	3,644	10,639
Weber West 2	441	441	436	431	430	430	429	965	23,035
West Haven	6,267	6,670	7,263	7,495	8,111	8,451	8,881	9,591	9,591
Industrial	2,500	2,567	2,667	2,833	2,900	3,000	3,167	3,500	3,500
Total with Weber West 2	**106,574**	**112,300**	**119,979**	**132,023**	**136,658**	**143,548**	**153,986**	**170,384**	**212,777**
Total Without Weber West 2	**106,133**	**111,860**	**119,543**	**131,592**	**136,228**	**143,118**	**153,557**	**169,419**	**189,740**

SECTION 5 FLOW PROJECTIONS

Understanding the impacts of future growth on the sewer collection system includes estimating the future flow to the system. This memo will focus on the average daily flows. Peak flowrates will be estimated and discussed as part of later reports once the hydraulic modeling has been completed.

5.1 WASTEWATER COMPONENTS

Before projecting future growth in wastewater, one must first have an accurate understanding of wastewater flows. For most wastewater service providers, including CWSID, wastewater flow can be grouped into three major components: domestic wastewater, infiltration, and inflow. Each of these components are discussed in further detail in the following sections.

5.1.1 DOMESTIC WASTEWATER

Domestic flow consists of the wastewater contributions of residential and non-residential customers. While domestic flow varies significantly throughout the day, it is relatively consistent from year to year and its growth can be closely tied to the growth of development in the District. Correspondingly, estimating domestic flows in the District is relatively straightforward. For this study, domestic flows have been estimated based on ERUs as defined previously.

5.1.2 INFILTRATION

The next component of wastewater flow that must be considered is infiltration. Infiltration is defined as water that enters into the sewer system which is not directly or indirectly related to either domestic wastewater or to a specific storm event. While the District and its member agencies generally try to keep their systems from capturing groundwater, some amount of groundwater will make its way into the sewer system as infiltration. While magnitude may vary, this is true for both new and old pipes alike. Groundwater that enters the system over an extended period of time is considered infiltration. Temporary increases in the amount of water that enters the system after a storm because of an increase in ground water or direct connection to collection lines will be considered as inflow (see next section).

Infiltration can be difficult to estimate because it can vary over time. Infiltration is generally a function of groundwater levels. Groundwater levels in the service area fluctuate depending on climate and season. Infiltration rates will correspondingly change seasonally and from year to year depending on climate. To account for these challenges, infiltration must be estimated by looking at long-term flow trends.

Infiltration will be accounted for under two categories for this analysis:

- ***Infiltration Directly Connected to Development* –** There is a portion of infiltration that is directly associated with growth and development. This includes infiltration at lateral connections and with the collection piping that must be installed to accommodate new growth in each individual neighborhood. For new development, it is estimated that the contribution to infiltration from these sources will be 33 gpd/ERU. This is based on industry standards for leakage allowances in new sewer pipelines and manholes and the average density of infrastructure required to serve development in the District. This type of infiltration has been isolated for impact fee purposes. Only this type of infiltration will be included in the level of service for future development.
- ***Additional Base Infiltration Associated with Existing Pipelines* –** In ideal situations and in a modern sewer system, the infiltration identified above would be the only type of infiltration

seen by the District. However, due to the age of existing pipelines and other external factors, additional base infiltration occurs in many of the existing facilities owned by both the District and its entities. As a result, observed infiltration in the District is much higher than would be predicted by the standard for new infrastructure. Factors that can affect infiltration include pipe age, material, and number and condition of lateral connections. Age can contribute to infiltration in two ways. First, older pipes are more likely to be in poor condition. Cracks, separated joints, and other defects can contribute to increased infiltration. Second, older pipes do not have the benefit of improvements in construction techniques that have occurred over time. Gasketed pipe joints, rubber boots at manholes and laterals, and other improvements have contributed to reducing system infiltration over time. To account for these several issues, additional base infiltration must be included in the model. The value of base infiltration to be included in this study will be calibrated to existing flow based on observed long-term trends. No base infiltration will be included in the level of service for future development.

5.1.3 INFLOW

Similar to infiltration, inflow is also the intrusion of unwanted water into the sewer system. In the case of inflow, however, this water comes from rainfall and snowmelt instead of groundwater. Inflow may enter the sewer system through roof and foundation drains, yard and area drains, manhole covers, and illicit storm drain connections. In the case of the assorted roof and yard drains, discharge into the sanitary system is against District ordinances. However, illegal connections occasionally exist and can affect the performance of the sewer system.

Inflow into a collection system can be highly variable and depends on the placement and construction of sewer collection systems as well as the type of storm events that occur. In addition, a long record of rainfall and flow monitoring data is needed to accurately predict how storm events may impact the District’s collection system or treatment plant. Thus, no inflow is specifically shown in the projections used in this report. Instead, inflow is accounted for in the collection system evaluation by reserving a portion of capacity in pipelines and in the treatment plant for inflow. In other words, a pipe will be identified as having inadequate capacity at projected flows less than the full flow capacity of the pipe. The District’s design criteria for pipe capacity includes a 25 percent capacity buffer for all pipelines. This buffer provides capacity for inflow, temporarily lost capacity through sediment deposition, and unusual flow events when sewer production may peak beyond typical values (e.g. Super Bowl, holidays, etc.).

5.2 CALCULATED WASTEWATER COMPONENTS

The contribution of each type of wastewater can be estimated based on historic flows. Average daily flows at the treatment plant from 2014 through 2021 are shown in Figure 5-1. Plotted against this data is the estimated contribution from each type of flow. Projecting the sewer domestic flow is straight forward. Domestic sewer flow projections can be estimated by multiplying the average flow per connection (198.4 gpd/ERU) by the historic number of ERUs. This results in a range of estimated domestic flows from 16.75 MGD in 2014 to 21.6 MGD in 2022. The remaining portion of flow was assumed to be from infiltration or inflow.

As shown in the figure, the infiltration varies from year to year and seasonally throughout the year. Included in the figure is an estimate of average seasonal infiltration (i.e. seasonal variations you would expect to see most years) and variable infiltration (i.e. additional infiltration resulting from elevated groundwater conditions during wet years). From this data, a “low infiltration” condition was identified to correlate with the lowest average daily infiltration (troughs) as well as a “high infiltration" condition to correlate with the highest average daily infiltration rates (peaks including variable infiltration). Based on this information, the existing infiltration per day ranges from about 5.81 MGD to 26.3 MGD (this does not include effect from rainfall induced inflow). On the high end, the infiltration flow is even more than the flow from domestic flow. Historically, the infiltration per connection ranges from an average of 56 gpd/ERU to 264 gpd/ERU.

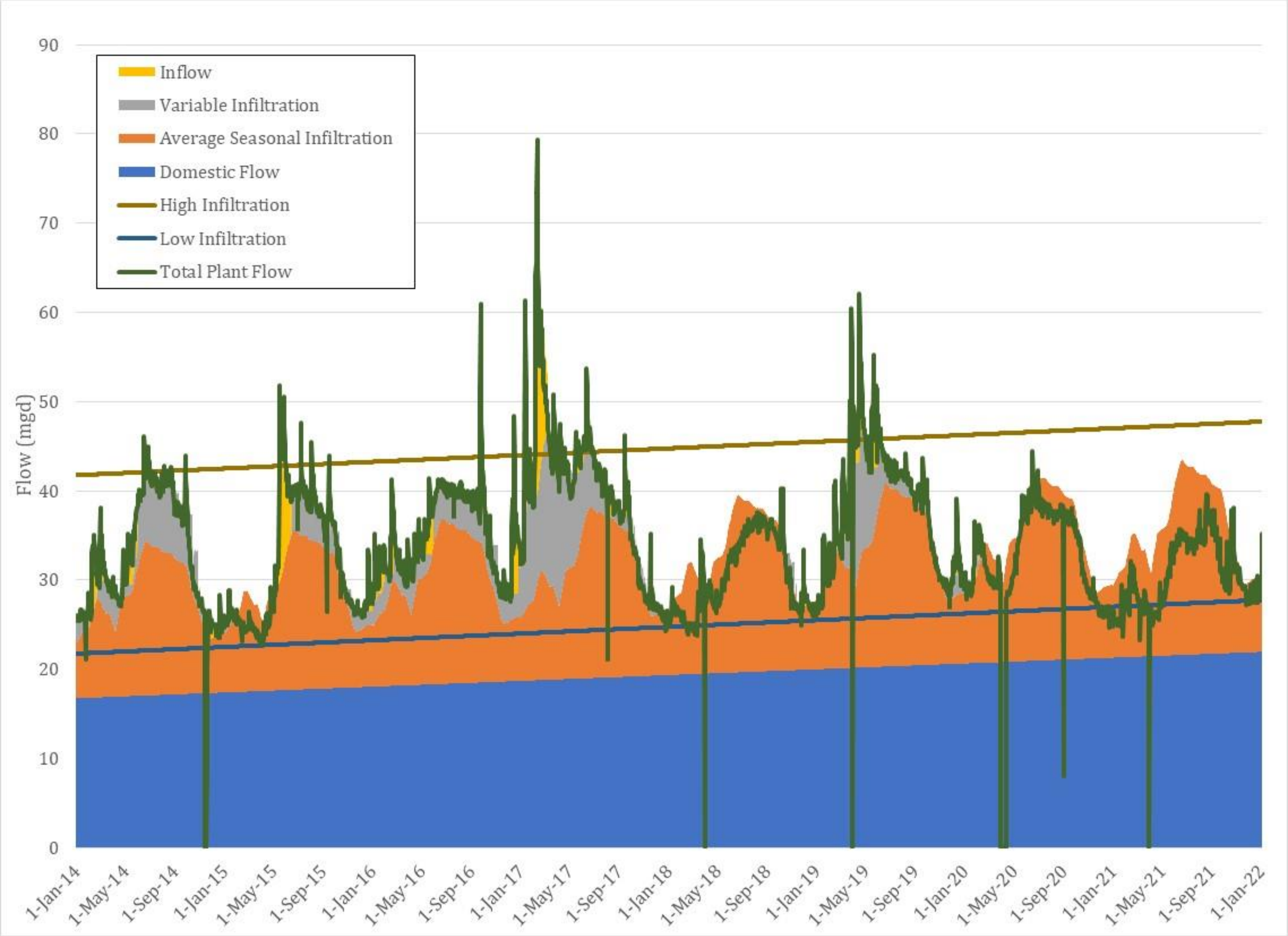


Figure 5-1. Historical Daily Average Flow From CWSID Plant

5.3 INFILTRATION FLOW PROJECTIONS

Once existing flow has been identified, projection of future flows is relatively straight forward. Domestic sewer flow projections can be calculated by multiplying the average flow per connection (198.4 gpd/ERU) by the projected number of ERUs. As noted previously, it is expected that new connections and new pipelines will experience significantly less groundwater related infiltration. A rate of 33 gpd/ERU will be used for future infiltration based on modern materials and current construction standards. Historic infiltration is assumed to remain unchanged.

The results of these projections are shown in Figure 5-2. Flows are expected to increase to nearly 60 MGD by the year 2050. At buildout, flows may be near 73 MGD. As can be seen from Figure 5-2, the growth rate of sewer flow is anticipated to decrease over time. This is due to the decreasing rate of population growth within the potential CWSID service area as the area approaches full development.

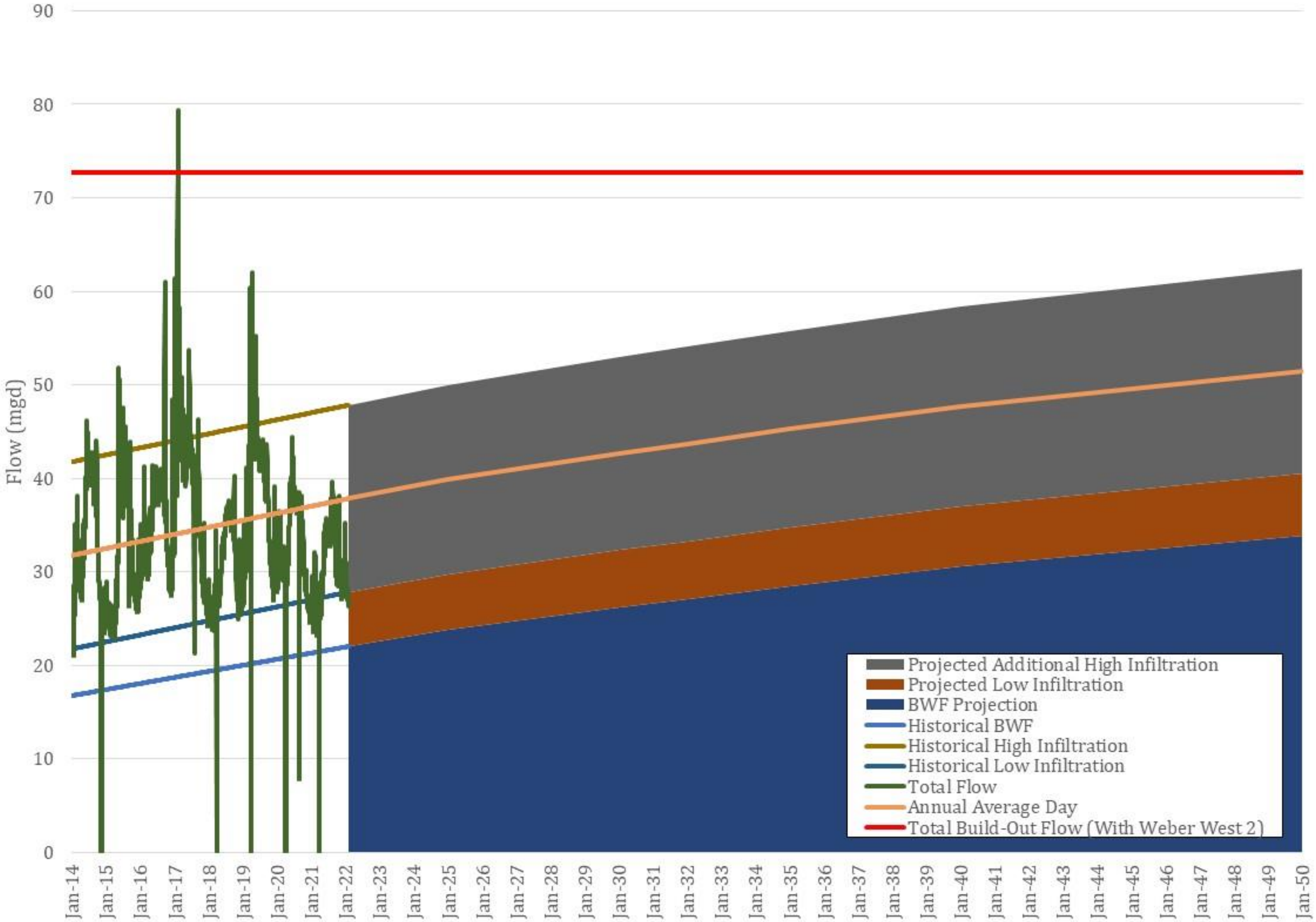


Figure 5-2. Daily Average Flow Projections

5.4 SUMMARY OF FLOW PROJECTION RESULTS

The final range of projected average daily flows is provided in Table 5-1.

Table 5-1
Projected Average Daily Flows

Year	Domestic Flow (mgd)	Low Infiltration – Minimum Month (mgd)	High Infiltration – Maximum Month (mgd)	Total Sewer Flow – Maximum Month, Average Day (mgd)	Total Sewer Flow – Average Month, Average Day (mgd)
2022	22.02	5.81	25.81	47.84	37.84
2025	23.80	5.93	26.18	49.98	39.86
2030	26.19	6.11	26.76	52.95	42.62
2032	27.11	6.18	26.98	54.09	43.69
2035	28.47	6.28	27.31	55.79	45.27
2040	30.54	6.44	27.82	58.36	47.64
2050	33.80	6.69	28.60	62.40	51.44
Build-Out with Weber West 2	**42.21**	**7.32**	**30.64**	**72.84**	**61.19**
Build-Out without Weber West 2	**37.64**	**6.98**	**29.53**	**67.17**	**55.89**
Percent Change with Weber West 2	**91.7%**	**25.9%**	**18.7%**	**52.3%**	**61.7%**
Percent Change without Weber West 2	**70.9%**	**20.0%**	**14.4%**	**40.4%**	**47.7%**

As can be seen from Table 5-1 and Figure 5-2, the future maximum month, average daily flow into the plant is expected to increase by approximately 40-50% depending on what development ultimately occurs in Weber West 2. This represents a significant increase in total flow and will likely require increased capacity to portions of the CWSID collections system. Even more significant may be the increase in domestic flow. This type of flow is expected to nearly double. Because nearly all the wastewater strength loading comes from this component, the impacts of this increase will need to be considered as part of treatment master planning. Peak flows and system capacity deficiencies will be discussed in a later report.

SECTION 6 CONCLUSIONS AND RECOMMENDATIONS

Based on the growth projections discussed above, the following conclusions and recommendations can be made regarding future planning for CWSID service area growth:

1. **Service Area Growth Projections** – The recommended growth projections are summarized in Table 4-4. These projections should be used as the basis for planning within the District. The total population served by the District is expected to nearly double between 2022 and build-out based on current projections.
2. **West Area Growth** – Most of the District's growth is expected to occur on its west side. This is especially true for growth beyond 2050. Of the 119,000 persons projected to be added after 2050, more than half (65,000) are expected to come from the Weber West 2 area. Much about the West Weber 2 area is unknown at this time. Development patterns, densities, and even whether the District will serve the area or not are still in flux. It is recommended that the District pursue additional clarity from County planners before making any significant investments in capacity to serve the area.
3. **Daily Average Flow Projections** – It is recommended that the projection of flow within the District shown in Table 5-1 be used as the basis for planning. The maximum month daily average flow is expected to increase by 40-50% depending on whether or not West Weber 2 is annexed into the District. This represents a significant increase in total flow. Even though more than half of the existing to the plant comes from infiltration (during peak months), most of the projected increase in flow is expected to be due to growth in domestic flow. Deficiencies and peak flows will be discussed with later reports.
4. **Ongoing Updates –** The projections contained here are based on assumptions regarding future development patterns. While these assumptions reflect the best available existing information, future changes to development plans are expected. It is recommended that, as development occurs throughout the District, the pattern and distribution of actual development be compared to these projections. The plan should then be updated reflect any major deviations from assumed growth patterns. Updates should also be made to reflect any changes in city general plans or expected annexation.

APPENDIX A

INDIVIDUAL CITY PROJECTIONS

FARR WEST

The City of Farr West is located on the North Side of Weber County along both the East and West Sides of I-15. Recent growth in Farr West has exceeded previous CWSID projections. As of the 2020 U.S. Census, Farr West had a population of 7,691. Figure A-1 compares the population projections for Farr West based on the last CWSID master plan, the City General Plan, and the WFRC projections.

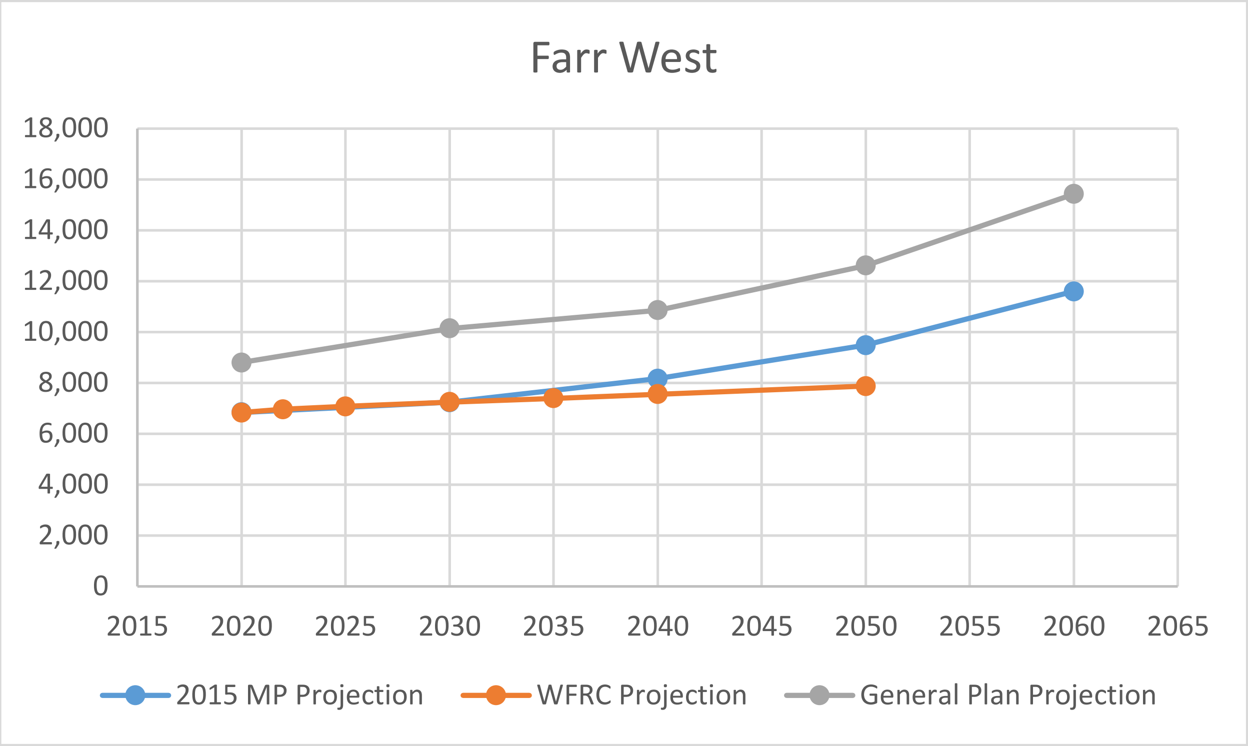


Figure A-1: Farr West Population Projections

As can be seen in Figure A-1, the newer WFRC projections show that the Growth in Farr West would be stagnant of the next 30 years. This would imply that the majority of the City is at Build-Out conditions; this is not the case. The 2015 Master Plan Projections and the City General Plan Projections follow a similar growth pattern. However, neither of these two accurately predicted the 2020 population estimates from the U.S. Census. The final projections for Farr West were estimated by doing the following:

1. **Base Population Estimate** – The Population projections started by using the 2020 Census estimates.
2. **Approximate Growth Percent** – Between 2020 and 2030 it was assumed that the population would grow by approximately 20%. This is the average between the growth experienced in the 2020's as well as the projected growth by Farr West for the 2030's.
3. **Use Density's/Developable Space for Build-Out** – The population at build-out was estimated by taking the existing developed space density and extending it over the entire developable city. This assumed that the relationship between non-residential and residential would be the same. This resulted in an estimate of 14,600 which is within 10% of the City General Plan Projections. The small amount of additional growth in the general plan may

reflect expected increases in density beyond current zoning in the future. As a result, the City Projections are used beyond the year 2030.

Table A-1 includes all of the population projections for Farr West. As actual growth occurs, these population projections should be updated to reflect new development.

Table A-1
Population Projections for Farr West

Year	Final Projections	City General Plan	2015 CWSID MP	WFRC
2020	7,691	8,799	6,835	6,830
2022	7,999	--	--	6,962
2025	8,460	--	--	7,074
2030	9,229	10,141	7,238	7,245
2032	9,555	--	--	--
2035	10,043	--	--	7,386
2040	10,856	10,856	8,163	7,548
2050	12,607	12,607	9,479	7,686
Build-Out[1]	15,419	15,419	11,593	--

[1] Build-Out projections are used primarily to verify that any CWSID projects will have adequate capacity for the entire service area.

HARRISVILLE

The City of Harrisville is located centrally within Weber County along Highway 89 between Ogden on the South and Pleasant View on the north. Recent growth in Harrisville has exceeded the projections from the previous CWSID Master Plan. As of the 2020 U.S. Census the population of Harrisville is 7,036. Figure A-2 compares the population projections for Farr West based on the last CWSID master plan, the City General Plan, and the WFRC projections.

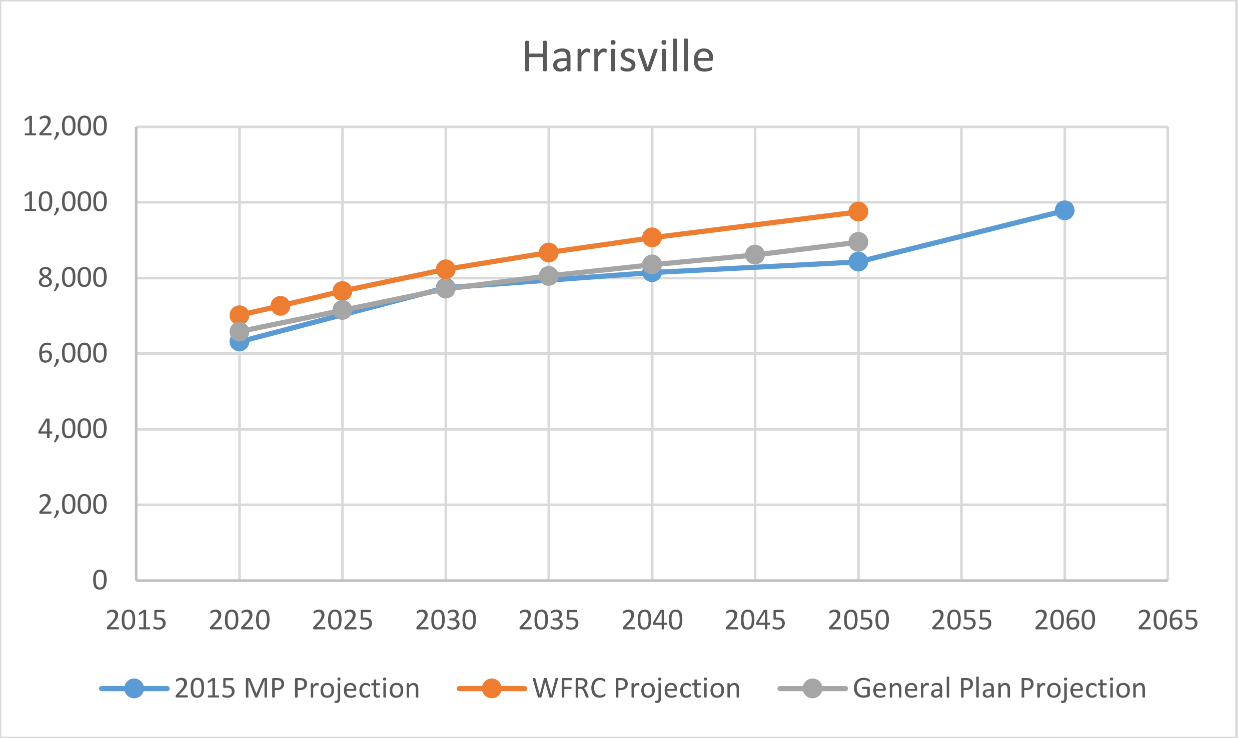


Figure A-2: Harrisville Population Projections

As can be seen from Figure A-2, the population projection for Harrisville are within a few percent of one another. To be conservative, the WRFC projections have been adjusted for the 2020 U.S. Census estimates and used as the final projections. However, since the WFRC projections have been created, a new 500-unit development has approached CWSID for sewer connections within the now closed Ben Lomond Golf Course. This development has been incorporated into the final projections as follows:

1. **Split Units into Two Timelines** – It is assumed that 150 units will be built by 2025 with the remainder by 2030. This is an aggressive timeline to be conservative with the current housing climate.
2. **Associate Population with Units –** Based on the 2020 U.S. Census estimates, the average household size in Harrisville is 3.65 people. It was assumed that this would be the average population for each unit.
3. **Build-Out Estimates** – The build-out estimate was verified by comparing the density of Harrisville to estimated density of surrounding cities. Build-Out density of 4.94 (population over entire city area) is slightly higher than cities with similar landuse. This is to be expected with the new 500-unit development.

Table A-2 includes all of the population projections for Harrisville. As actual growth occurs, these population projections should be updated to reflect new development.

Table A-2
Population Projections for Harrisville

Year	Final Projections	City General Plan	2015 CWSID MP	WFRC
2020	7,036	6,577	6,314	7,013
2022	7,284	--	--	7,260
2025	8,225	7,151	--	7,652
2030	10,081	7,711	7,741	8,229
2032	10,258	--	--	--
2035	10,522	8,052	--	8,669
2040	10,922	8,351	8,146	9,067
2050	11,605	8,613	8,428	9,748
Build-Out[1]	11,605	8,946	9,782	--

[1] Build-Out projections are used primarily to verify that any CWSID projects will have adequate capacity for the entire service area.

HOOPER

Hooper City is located on the southwest corner of Weber County and Includes Fremont Island as well as a large portion of the Great Salt Lake Wetlands. Fremont Island as well as the 100-yr Floodplain of the Great Salt Lake is not anticipated to be developed. This will decrease the potential growth for Hooper City. Not all of Hooper City is currently served by CWSID. Approximately 24% of the City population is still on Sceptic Tanks instead of the sewer system. These projections are for the entire population of Hooper. It is expected that as Hooper City is developed the entire population will eventually be serviced by CWSID.

Hooper City General Plan Population Projections where not available when the CWISD projections were estimated. Instead, projections were compared to the 2015 CWSID Master Plan and updated WFRC projections, as shown in Figure A-3. Based on the U.S. Census, the population for Hooper City as of 2020 was 9,087.

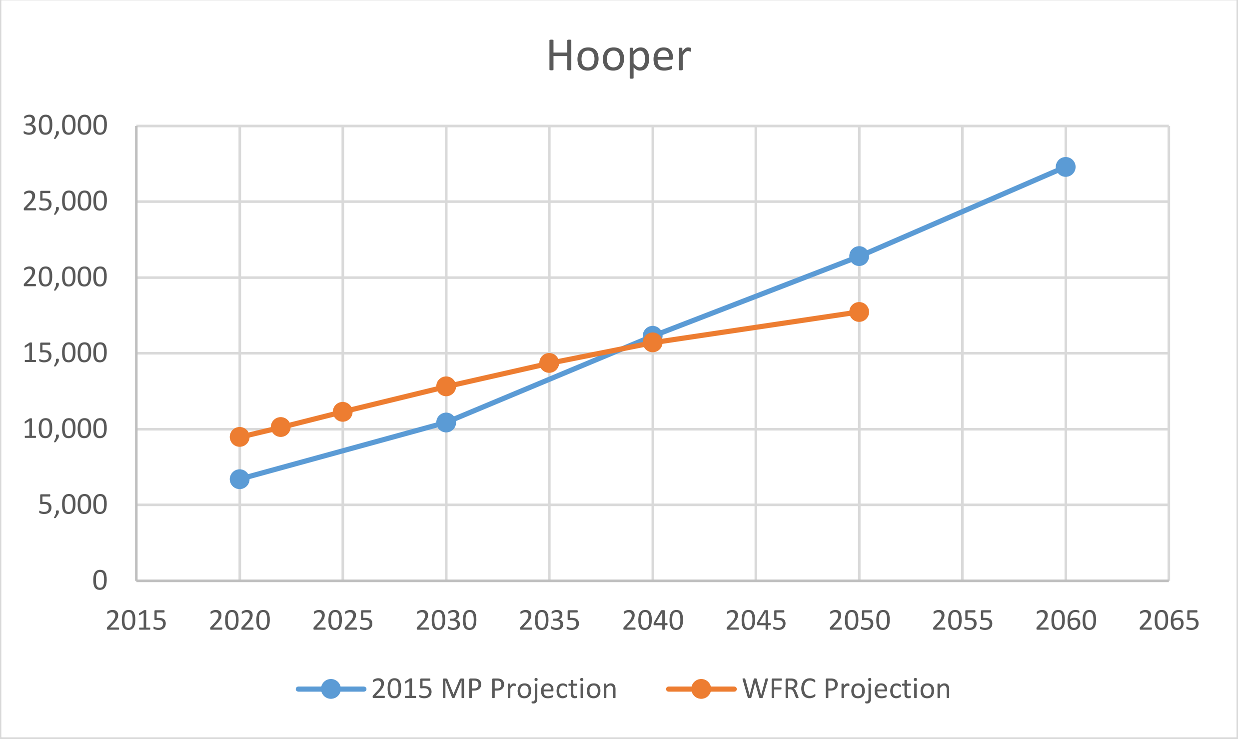


Figure A-3: Hooper City Population Projections

As can be seen from Figure A-3, the 2015 Master Plan projections significantly underestimated the population growth within Hooper City. However, after about 2038, the 2015 Master Plan projections exceed the newer WFRC estimates. It is believed that this is due to the methodology used in the estimates. For this project, it is assumed that the boundaries of Hooper City will not change. Instead, population growth within annexable areas are accounted for by the service Area “West Weber 1”. As a result, the WFRC projections are used (once adjusted for the 2020 U.S. Census Values). Build-out population was estimated by using an approximate density of 3.5 over the developable space. This resulted in a population of 23,274.

Table A-3 includes all of the population projections for Hooper. As actual growth occurs, these population projections should be updated to reflect new development.

Table A-3
Population Projections for Hooper

Year	Final Projections[2]	2015 CWSID MP	WFRC
2020	6,600	6,688	9,467
2022	7,385	--	10,116
2025	8,492	--	11,132
2030	10,192	10,434	12,809
2032	11,122	--	--
2035	12,356	--	14,345
2040	14,044	16,141	15,706
2050	16,426	21,400	17,719
Build-Out[1]	23,274	27,289	--

[1] Build-Out projections are used primarily to verify that any CWSID projects will have adequate capacity for the entire service area.

[2] The final projections are reduced based on a portion of Hooper Not being serviced. In 2022 76% of Hooper is served by CWSID.

For this project it is assumed that the percentage of the City served by CWSID will increase at a steady rate until the entire City is within the service area.

MARRIOTT-SLATERVILLE

Marriott-Slaterville is located in Central Weber County along both the East and West sides of I-15. On the east is the City of Ogden and on the west is unincorporated Weber County. As of 2020, the City had a population of 2,135 based on the U.S. Census. Based on estimates from CWSID, only about 48% of the city is currently connected to the sewer system. The remaining portion of the City's wastewater is treated via locale sceptic tanks. The projections included here are for the entire population of Marriott-Slaterville. Figure A-4 compares the 2015 Master Plan Projections and the WFRC projections for Marriott-Slaterville population.

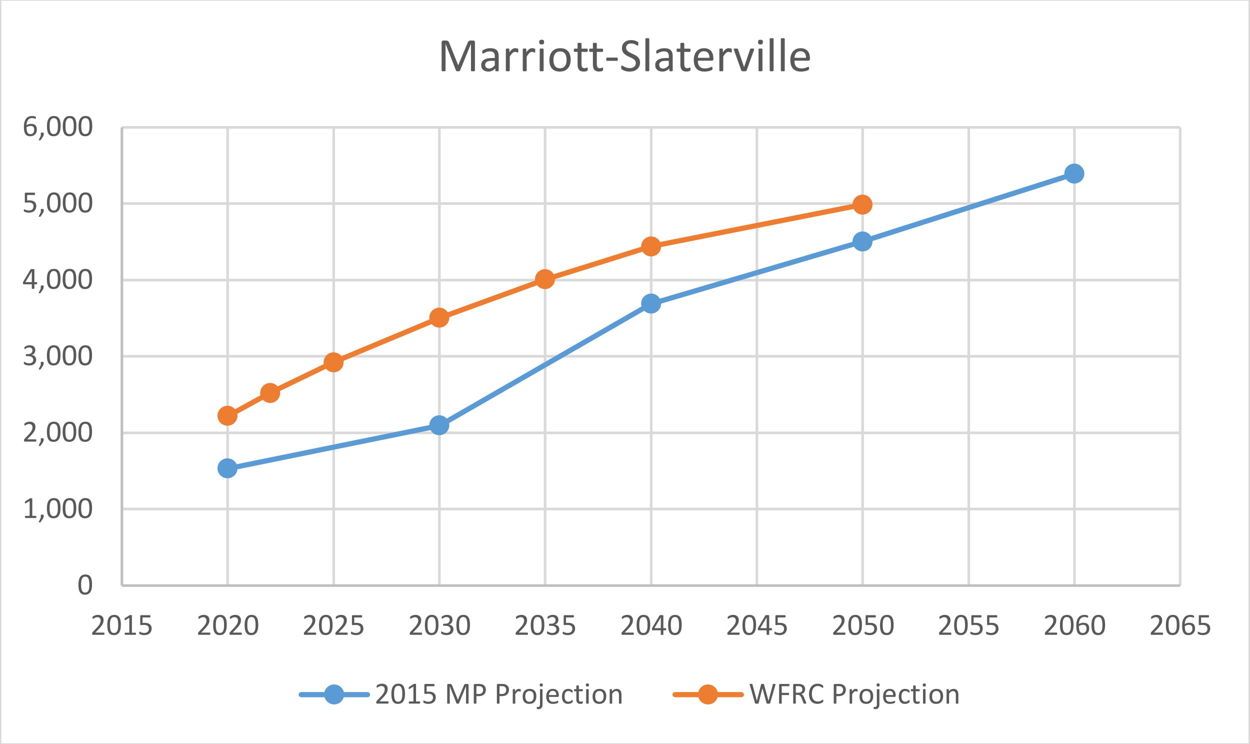


Figure A-4: Marriott-Slaterville City Population Projections

As can be seen in Figure A-4, the newer WFRC projections for Marriott-Slaterville estimate a higher quicker growth till 2030. Then, there is a gradual reduction in population growth. This pattern of growth is to be expected with a City like Marriott-Slaterville that has a lot of undeveloped space. Since the WFRC projections do not go as far out as the 2015 Master Plan projections, the 2015 Master Plan projections will be used as Build-Out for Marriott-Slaterville.

Table A-4 includes all of the population projections for Marriott-Slaterville. As actual growth occurs, these population projections should be updated to reflect new development.

Table A-3
Population Projections for Marriott-Slaterville

Year	Final Projections	2015 CWSID MP	WFRC
2020	2,135	1,530	2,218
2022	2,426	--	2,520
2025	2,812	--	2,921
2030	3,374	2,094	3,505
2032	3,568	--	--
2035	3,858	--	4,008
2040	4,272	3,687	4,438
2050	4,798	4,503	4,985
Build-Out[1]	5,389	5,389	--

[1] Build-Out projections are used primarily to verify that any CWSID projects will have adequate capacity for the entire service area.

For this project it is assumed that the percentage of the City served by CWSID will increase at a steady rate until the entire City is within the service area.

NORTH OGDEN

North Ogden City is located in the Northeast corner of Weber County bordering Pleasant View to the west and Ogden to the South. As North Ogden continues to develop, new population projections are needed to estimate future growth based on changes in Landuse and existing growth patterns. Figure A-5 compares projections of North Ogden Population growth from WFRC, 2015 Master Plan, and the Update City General Plan.

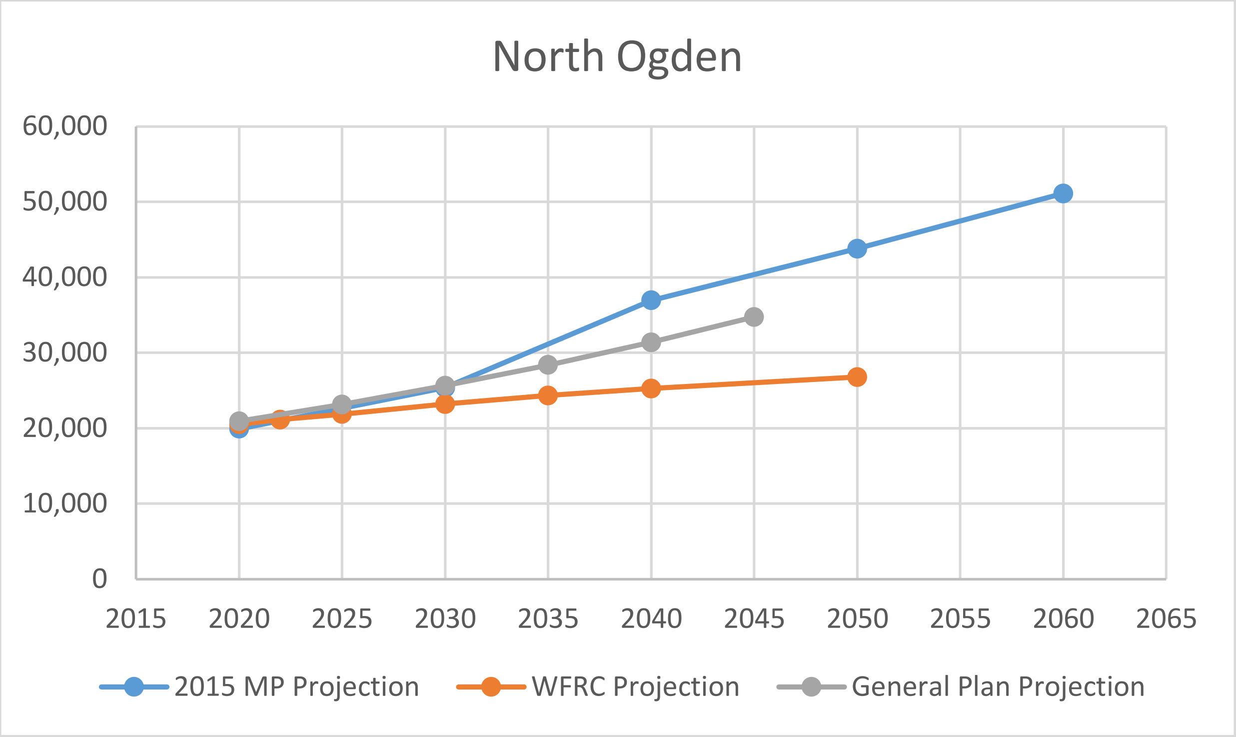


Figure A-5: North Ogden City Population Projections

As can be seen in Figure A-5, each of the three (3) population projections have nearly the same estimate for the 2020 population. However, after the year 2030, the population projections diverge. Based on Landuse within North Ogden City as well as the existing population growth, the City Population Projections have been selected for North Ogden City. Included with the projections is a build-out population of 36,638. Values of the final projections are include in Table A-5.

Table A-5
Population Projections for North Ogden

Year	Final Projections	City General Plan	2015 CWSID MP	WFRC
2020	20,916	20,916	19,927	20,505
2022	21,810	--	--	21,141
2025	23,510	23,150	--	21,880
2030	25,623	25,623	25,351	23,200
2032	26,718	--	--	--
2035	28,360	28,360	--	24,320
2040	31,389	24,742	36,923	25,257
2050	36,638	--	43,802	26,773
Build-Out[1]	36,638	36,638	51,103	--

[1] Build-Out projections are used primarily to verify that any CWSID projects will have adequate capacity for the entire service area.

OGDEN

Ogden City is the largest and most populous city in Weber County. Ogden is located on the Eastern side of the County between North and South Ogden. The majority of the developable portion Ogden City has been built-out. As a result, there will be minimal additional growth within Ogden City compared to the existing population. The population of Ogden City in 2020 was 87,321 based on the U.S. Census. Projections for Ogden City are shown in Figure A-6.

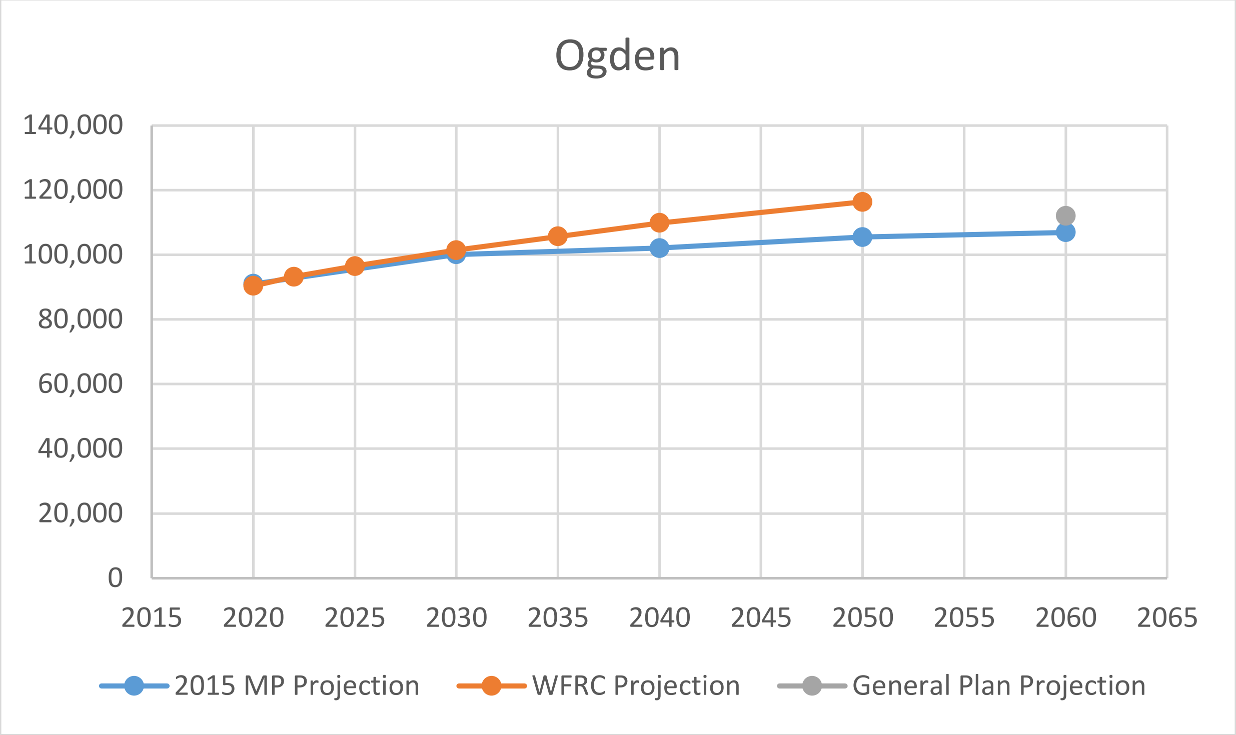


Figure A-6: Ogden City Population Projections

As can be seen from Figure A-6, the population projections are nearly the same until 2030, where the WFRC projections continue to increase at nearly the same rate. However, the WFRC projections overshoot the City estimated Build-Out population. The final projections for Ogden incorporate the WFRC projections, but are adjusted with a build-out population of 112,041 to match the City's estimate. Table A-6 provides the final projections for Ogden City.

Table A-6
Population Projections for Ogden

Year	Final Projections	City General Plan	2015 CWSID MP	WFRC
2020	87,321	--	90,971	90,349
2022	90,074	--	--	93,197
2025	93,266	--	--	96,500
2030	97,993	--	100,123	101,391
2032	99,634	--	--	--
2035	102,095	--	--	105,635
2040	106,146	--	102,059	109,827
2050	112,041	--	105,457	116,333
Build-Out[1]	112,041	112,041	106,934	--

[1] Build-Out projections are used primarily to verify that any CWSID projects will have adequate capacity for the entire service area.

PLAIN CITY

Plain City is located in the northwest corner of Weber County. The majority of Plain City wastewater is not collected by CWSID. Instead, Plain City provides sewer services to its residents. A small portion of Plain City bordering Marriott-Slaterville to the South as well as Farr West to the east is serviced by CWSID. It is estimated that in 2022 approximately 336 individuals are served by CWSID. Based on conversations with Plain City representatives, it has been identified that only areas that are currently unincorporated Weber County within Plain City will be serviced. The following projections represent these areas.

Within Plain City, there is approximately 881 acres of land that will eventually be served by CWSID. The majority of this land is currently Unincorporated Weber County with little to no existing development. Projections for this portion of Plain City are presented in Figure A-7 and Table A-7. Population projections for the entirety of Plain City are also included in Table A-7.

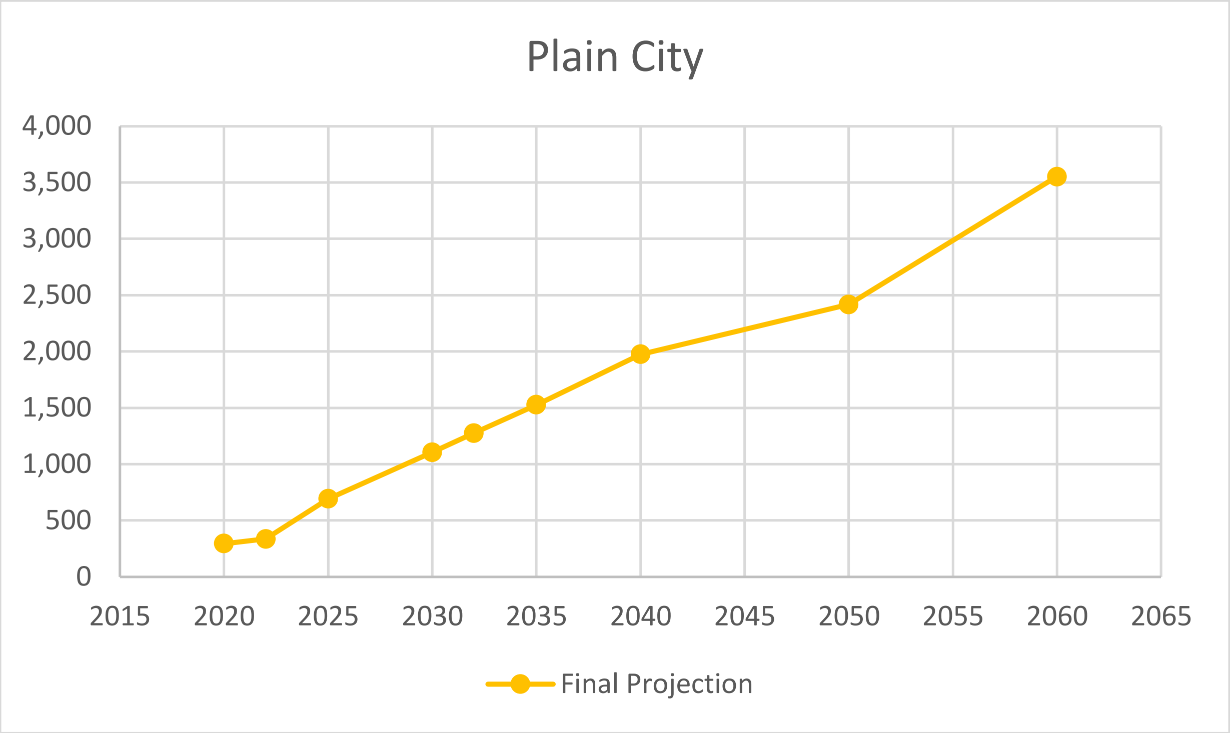


Figure A-7: Plain City Served Population Projections

Table A-7
Population Projections for Plain City

Year	Final Projections²	City General Plan	WFRC
2020	295	7,895	4,187
2022	336	--	4,730
2025	692	--	5,393
2030	1,106	--	6,439
2032	1,274	12,470	--
2035	1,527	--	7,238
2040	1,975	14,611	7,924
2050	2,417	--	9,085
Build-Out¹	3,552	--	--

[1] Build-Out projections are used primarily to verify that any CWSID projects will have adequate capacity for the entire service area.

[2] Final projections only represent the area of Plain City that is expected to be serviced by CWSID.

As can be seen from Figure A-7 and Table A-7, the growth within Plain City is expected to remain nearly constant until 2040. This is fairly consistent with other projections for the entire city. The graph in Figure A-7 is slightly deceptive where the Build-Out population is represented by the year 2060. This projection is not intended to show an increase in the growth rate after 2050, rather to verify that new projects have adequate capacity during the entirety of their service life.

PLEASANT VIEW

Pleasant View City is located to the east of I-15 on the north end of Weber County. As of 2020, the population in Pleasant View was 11,083 based on the U.S. Census Bureau. Previous populations projections from CWSID underestimated the 2020 population while the City projection overestimated it, see Figure A-8.

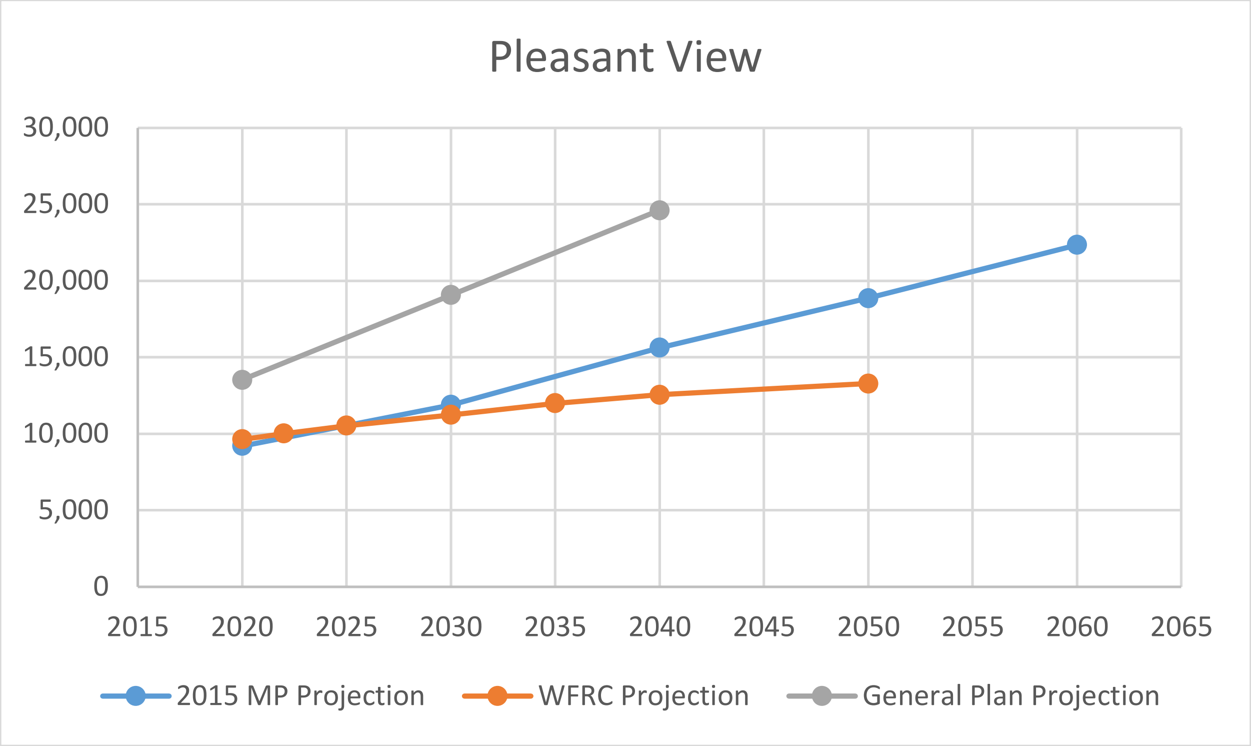


Figure A-8: Pleasant View Population Projections

As can be seen in Figure A-8, the estimated growth rate for both the City General Plan and the last CWSID Master Plan are similar. Final projections for Pleasant View City were based on this growth rate using the 2020 U.S. Census as a starting point. Build-Out population for Pleasant View was estimated using the City Landuse map and comparing the population of existing built-out areas to estimate final growth. Table A-8 presents the final population projections.

Table A-7
Population Projections for Pleasant View

Year	Final Projections	City General Plan	2015 CWSID MP	WFRC
2020	11,083	13,523	9204	9,635
2022	11,992	--	--	10,018
2025	13,355	--	--	10,524
2030	15,627	19,067	11,876	11,236
2032	16,535	--	--	11,997
2035	17,899	--	--	--
2040	20,170	24,611	15,626	12,542
2050	24,714	--	18,860	13,279
Build-Out[1]	36,183	--	22,337	--

[1] Build-Out projections are used primarily to verify that any CWSID projects will have adequate capacity for the entire service area.

It is important to notice that on the east side of Pleasant View between I-15 and US-89, the undeveloped area is designated for Industrial/Business use. This has the potential to change the ratio of flow between residential and non-residential areas and should be monitored as development occurs.

RIVERDALE

Riverdale is located on the south edge of Weber County just north of Hill Airforce Base. Prior population projections expected Riverdale to have neared Build-Out population around the year 2020. This has not been the case. Within Riverdale there is still the potential for significant development, especially towards the southern portion of the City. As of 2020 the population of Riverdale was 9,343. Existing population projections for Riverdale are shown in Figure A-9.

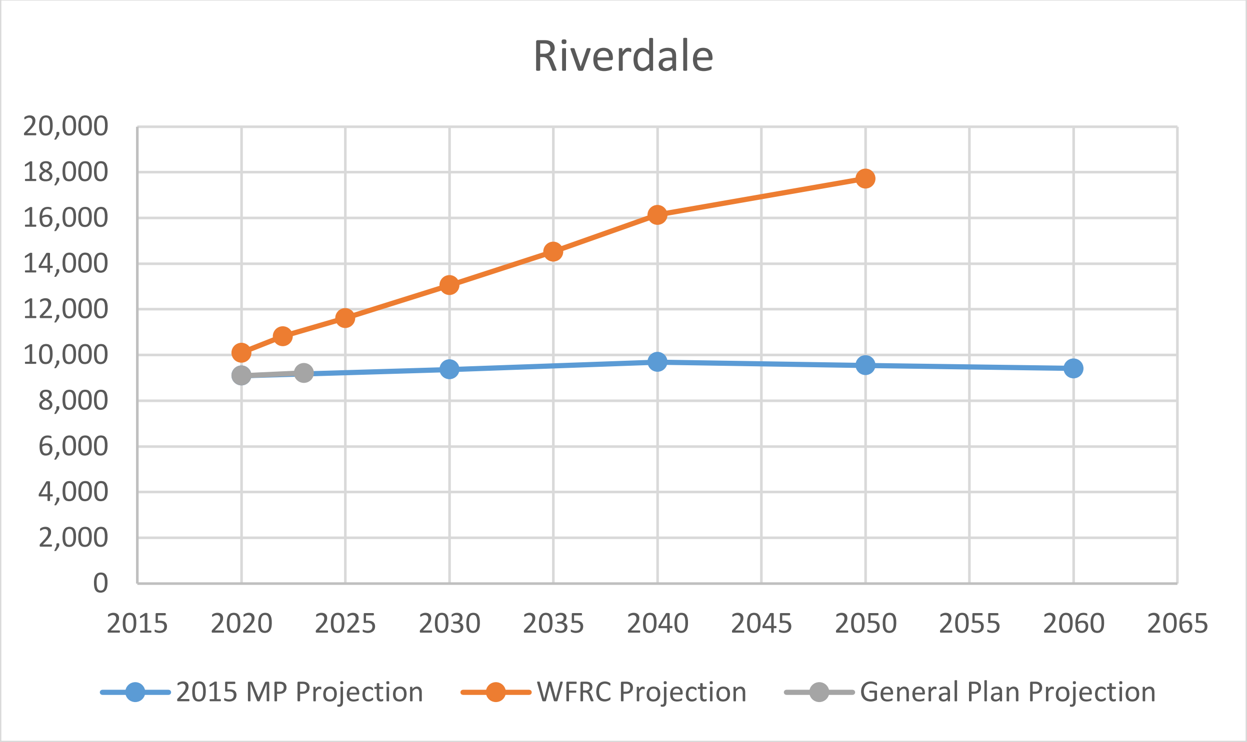


Figure A-9: Riverdale City Population Projections

As can be seen from Figure A-9, the old Master Plan Projections and General plan projections show little to no growth within Riverdale for the next 40 years. As mentioned earlier, this is not realistic due the potential for growth within the city limits. Instead, the WFRC projections were adjusted to match the 2020 U.S. Census Estimate and are used as the final projections. Table A-9 shows the population projections for Riverdale.

Table A-9
Population Projections for Riverdale

Year	Final Projections	City General Plan	2015 CWSID MP	WFRC
2020	11,083	13,523	9204	9,635
2022	11,992	--	--	10,018
2025	13,355	--	--	10,524
2030	15,627	19,067	11,876	11,236
2032	16,535	--	--	11,997
2035	17,899	--	--	--
2040	20,170	24,611	15,626	12,542
2050	24,714	--	18,860	13,279
Build-Out[1]	36,183	--	22,337	--

[1] Build-Out projections are used primarily to verify that any CWSID projects will have adequate capacity for the entire service area.

SOUTH OGDEN

South Ogden is located on the south west side of Weber County. Much of South Ogden has already been developed. Past projections for South Ogden are shown in Figure A-10. Based on the 2020 U.S. Census, the population in South Ogden in 2020 was 17,488.

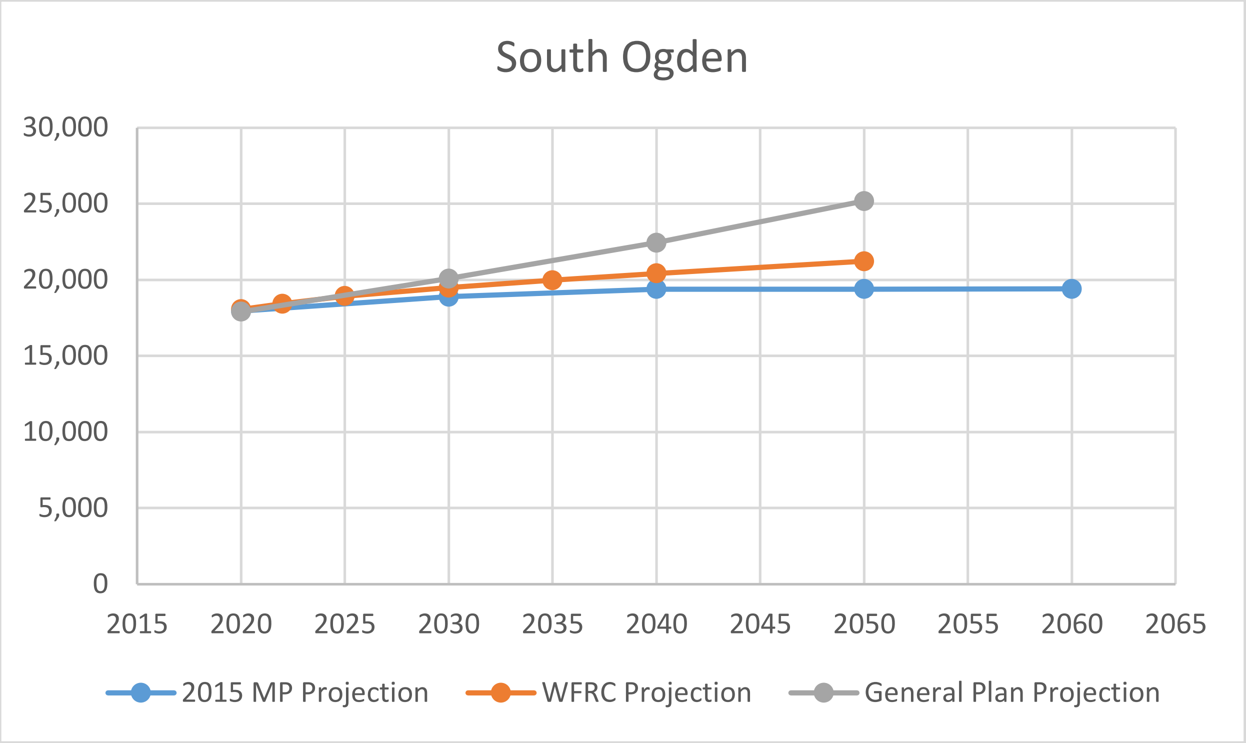


Figure A-10: South Ogden Population Projections

As can be seen from Figure A-10, the three projections are initially similar. As the projections expand to the future they diverge. Based on aerial photographs of South Ogden and the existing city boundary, it is believed that the South Ogden General Plan projections include annexing a portion of unincorporated land to the south or allowing for more extensive redevelopment within the City limits. Based on this, the City General Plan projections are used as the basis for the final projections with a few modifications:

1. **Adjust for 2020 U.S. Census** – Population projections from the General Plan were decreased so that is starts with a 2020 population of 17,488.0
2. **Buildout Conditions** – It is assumed that the ratio of residential and non-residential growth will remain constant. The current relationship results in a build-out density of approximately 7.4 persons/acre. Projected this to the potential service area of South Ogden results in a build-out population of approximately 21,476 persons.

The final projections for South Ogden are provided in Table A-10.

Table A-10
Population Projections for South Ogden

Year	Final Projections	City General Plan	2015 CWSID MP	WFRC
2020	17,488	17,893	17,941	18,063
2022	18,006	--	--	18,421
2025	18,748	--	--	18,922
2030	20,080	20,080	18,885	19,480
2032	20,675	--	--	--
2035	21,476	--	--	19,965
2040	--	22,440	19,387	20,423
2050	--	25,174	19,387	21,220
Build-Out[1]	21,476	--	19,399	--

[1] Build-Out projections are used primarily to verify that any CWSID projects will have adequate capacity for the entire service area.

SOUTH WEBER

South Weber City is located in Davis County boarding Uintah and Washington Terrace. Due to hydraulic concerns, CWSID has agreed to treat the Sewer from South Weber. Within South Weber, there is a large open gravel pit. It is assumed for these projections that this open pit will not be developed into residential housing in the future. If this changes, these projections should be updated to reflect the potential for increased population. Population projections for South Weber are shown in Figure A-11.

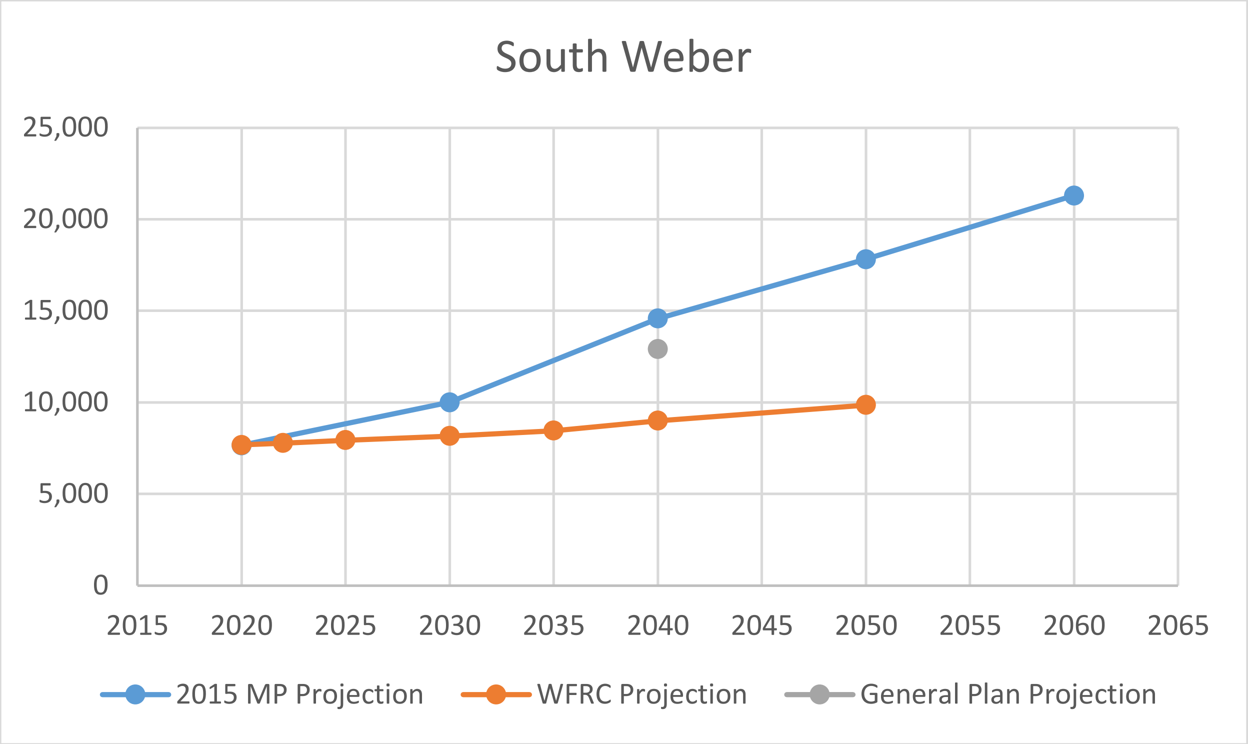


Figure A-11: South Weber Population Projections

From Figure A-11, it can be seen that the WFRC do not project as rapid growth as the previous master plan projections. The General Plan projections for the year 2040 corresponds with the City projected Build-Out Population. For South Weber, the build-out population projection was used to create a constant growth projection for South Weber. The final population projections are included in Table A-11.

Table A-11
Population Projections for South Weber

Year	Final Projections	City General Plan	2015 CWSID MP	WFRC
2020	7,867	--	7,656	7,672
2022	8,370	--	--	7,781
2025	9,125	--	--	7,935
2030	10,387	--	10,001	8,163
2032	10,887	--	--	--
2035	11,642	--	--	--
2040	12,900	12,900	14,578	8,454
2050	--	--	17,819	9,001
Build-Out[1]	12,900	12,900	21,292	9,851

[1] Build-Out projections are used primarily to verify that any CWSID projects will have adequate capacity for the entire service area.

UINTAH

Uintah is located in the southwest corner of Weber County. Currently, the majority of Uintah City is not serviced by CWSID. There is a small trailer court located in the west corner of the City that is serviced by CWSID. The current estimated population of the trailer court is 166 persons with an estimated buildout capacity of 332 persons. Unless Uintah decides to install a new sewer system to collect flows from the rest of the City, CWSID will continue to only service the single trailer court. As a result, for this project the timing of Uintah growth will not be the concern. Instead, it is the additional loading from the potential build-out population. Based on the current City General Plan and past sewer master plan, the build-out population for Uintah is 2,800.

WASHINGTON TERRACE

Washington Terrace is located between the Weber River on the west and south and South Ogden on the east. Most of Washington Terrace is already build-out. There is a portion of the City to the extreme south that is undeveloped. This is due to the steep slopes as the elevation changes from the City Bench down to the Weber River. It is not anticipated that this portion of the city will ever develop. As a result, the population in Washington Terrace is only expected to increase by a few hundred persons.

As of 2020, the population of Washington Terrace was 9,267 based on the U.S. Census. Accounting for the occasional infill development, the build-out population for Washington Terrace is expected to be nearly 9,378 persons. This assumes there will be little or no redevelopment within Washington Terrace. If this changes in the future, new projections will be required to account for changes in the required level of service.

WEST HAVEN

West Haven is located on the south end of Weber County between Hooper to the west and Ogden to the east with Marriott-Slaterville and Unincorporated County to the north. West Haven has the potential for annexing a large portion of the Unincorporated County. This would result in significant increases in potential population. For the purpose of this study, all of the Unincorporated Weber County around West Haven will be accounted for separately from any surrounding City. The projections for West Haven will only include the current annexed are within city limits.

Past projections underestimated the growth within West Haven. The 2020 population of West Haven based on the U.S. Census was 16,739. New projections are needed to represent growth within the City. Figure A-12 shows population projections for West Haven.

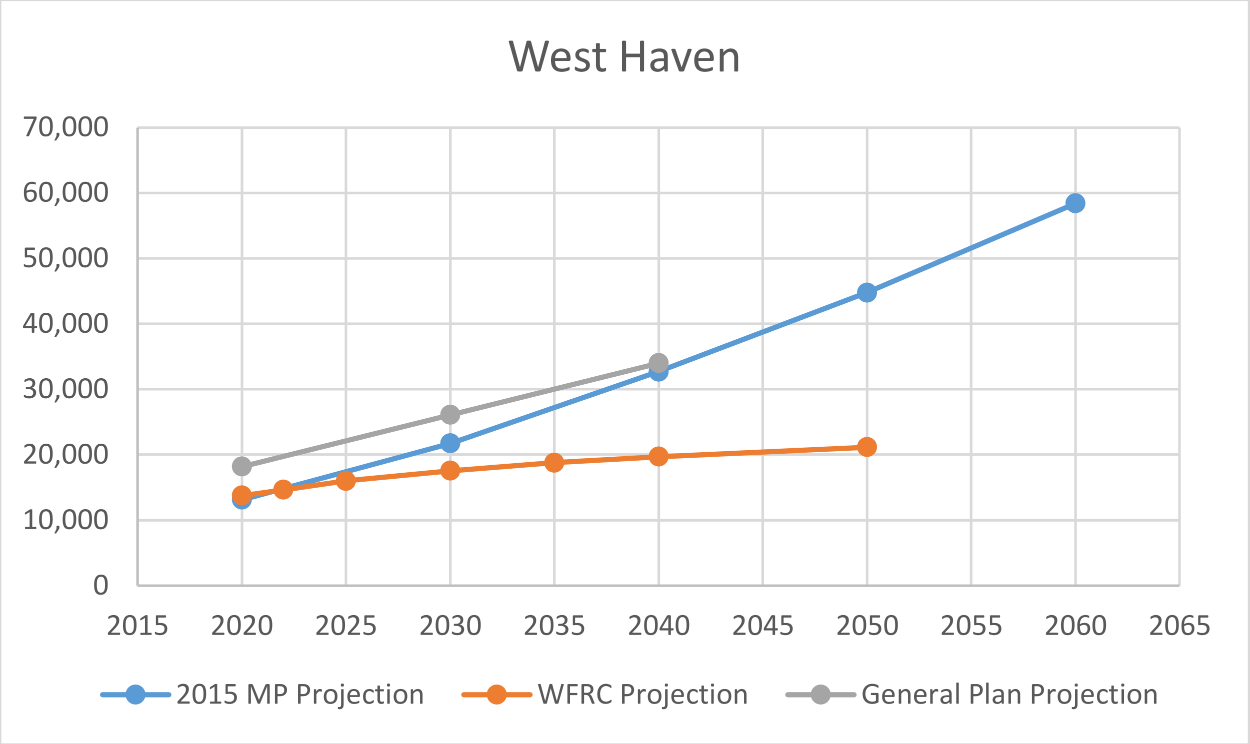


Figure A-12: West Haven Population Projections

As can be seen from Figure A-12, the growth rate for the General Plan and old Master Plan projections continue at a much faster rate than the WFRC projections. This is believed to be due to future annexation being included in the other projections. To not double count future population within the CWSID area, the WFRC projections are used as the basis for the final projections. However, the WFRC underestimated the 2020 U.S. Census estimates by over 20%. Final projections were adjusted by a constant factor based on the 2020 U.S. Census population. This also allowed for the WFRC growth rate to be closer to the City General Plan projections for the first 5-10 years. West Haven population projections are provided in Table A-12.

Table A-12
Population Projections for West Haven

Year	Final Projections	City General Plan	2015 CWSID MP	WFRC
2020	16,739	18,180	13,121	13,764
2022	17,815	--	--	14,649
2025	19,463	--	--	16,004
2030	21,343	26,087	21,731	17,550
2032	21,935	--	--	18,767
2035	22,823	--	--	--
2040	23,940	33,995	32,674	19,685
2050	25,709	--	44,760	21,140
Build-Out[1]	25,709	--	58,405	--

[1] Build-Out projections are used primarily to verify that any CWSID projects will have adequate capacity for the entire service area.

UNINCORPORATED WEBER COUNTY (UINTAH HIGHLANDS, WEBER WEST 1 & WEBER WEST 2)

Unincorporated Weber County is split into three planning regions for this study; Uintah Highlands, Weber West 1 and Weber West 2. The Uintah Highlands consists of the developed, uincorporated county to the east of the valley. The Weber West areas include all of the unincorporated county to the west of existing city boundaries.

Any "islands" of Unincorporated County that are complete surrounded by an existing city are accounted for within the surrounding city estimates. Population projections for each of these three regions are discussed below.

UINTAH HIGHLANDS

The area known as the "Uintah Highlands" is located on the eastern side of Weber County bordering Uintah and South Ogden to the west and Ogden to the north. Uintah Highlands has not been previously broken out as part of population projections. However, based on information from CWSID there are currently 2,303 persons within Uintah Highlands serviced by CWSID. Projections from the WFRC were adjusted to reflect the existing population projections. Final projections for Uintah Highlands are provided in Table A-13.

Table A-13
Population Projections for Uintah Highlands

Year	Final Projections
2020	2,259
2022	2,303
2025	2,576
2030	2,842
2032	3,085
2035	3,345
2040	3,660
2050	4,025
Build-Out	4,263

As can be seen from Table A-13, there is the potential for the population within Uintah Highlands to nearly double. This is reasonable with the amount of available developable space within the region.

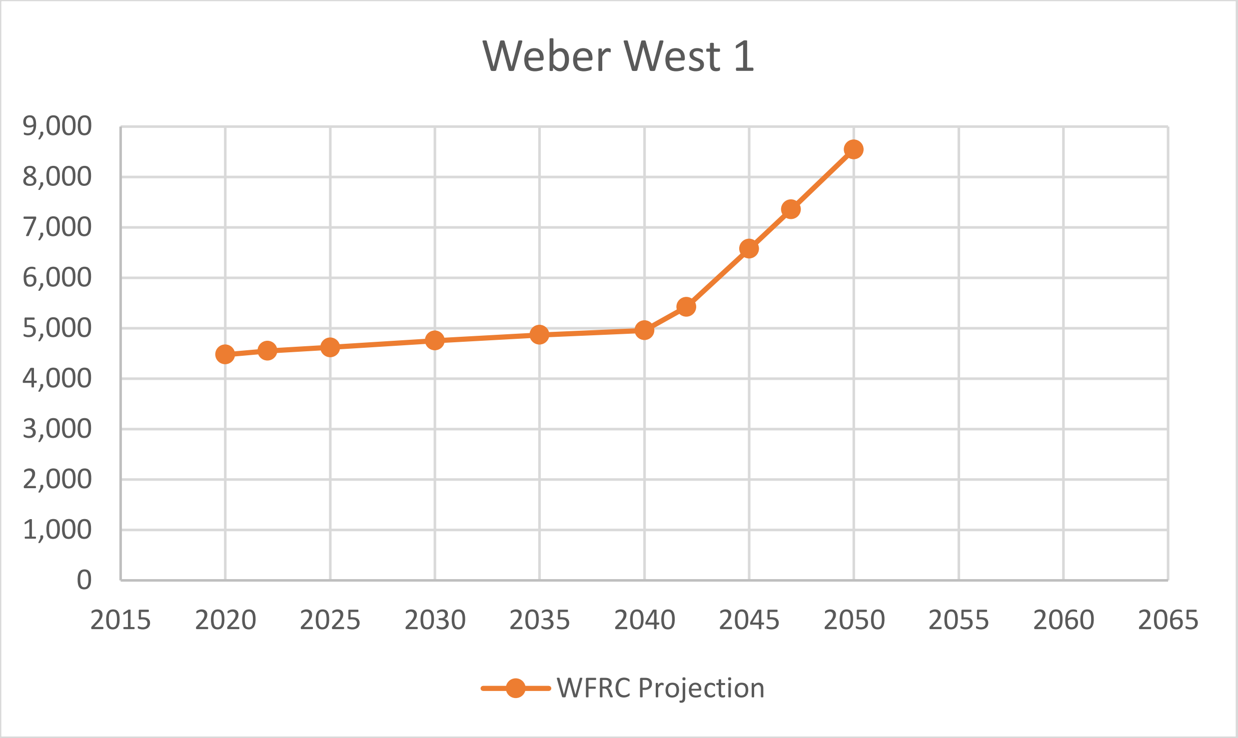
WEBER WEST 1 AND WEBER WEST 2

The Weber West areas include the western unincorporated county. Current zoning requirements limit the average lot size to be no smaller than 1 unit per acre. Based on this assumption, the Weber County Planning Department estimates that there could be an additional 16,000 residential units built within these regions. Based on discussions with Weber County personnel, it is possible that as sewer services become more readily available the minimum lot size requirements might be adjusted to as many as 4 units per acre. This analysis will assume that the average lot size remains approximately 1 unit per acre. If this assumption significantly changes new projections would be required.

Projecting the rate of growth for Western Weber County is difficult. Currently there are not many services provided, especially west of the Weber River. To account for this, the Weber West area have been divided into two separate areas; Weber West 1 and Weber West 2. Weber West 1 includes all of the unincorporated area to the east and south of the Weber River while the Weber West 2 area includes the rest of the unincorporated county. This also follows closely with the current boundaries of the CWSID annexable service area. Discussions of each area are below.

WEBER WEST 1

The Weber West 1 area includes Unincorporated Weber County east of the Weber River. Portions of this area are expected to be annexed into existing cities, but the populations will only be counted for with this area. The WFRC includes projections for this area and are shown in Figure A-13.



As can be seen from Figure A-13, the WFRC projections show minimal growth through 2040, when the growth rate is expected to increase to nearly 7.2% annually. This would not be consistent with growth in the surrounding areas. Instead, the projections for the Weber West 1 area are based on the average annual growth for the surrounding cities (West Haven, Hooper, Marriott-Slaterville, & Plain City). Table A-14 provides the average annual growth rate and projections for the Weber West 1 area.

Table A-14
Population Projections for West Weber 1

Year[1]	Surrounding City Average Annual Growth	Final Population Projection	WFRC Projections
2010	4.3%	--	--
2020	4.9%	4,477	4,477
2022	4.3%	4,916	4,547
2025	3.0%	5,551	4,616
2030	2.2%	6,397	4,753
2032	2.1%	6,676	--
2035	1.8%	7,094	4,864
2040	1.3%	7,722	4,953
2050	2.6%	8,710	8,544

[1] Growth Rates are the average annual percent increase in population till the next year provided.

By using the surrounding area growth rates, the Weber West 1 population projections increase quicker than the WFRC projections. However, both projections are nearly the same by the year 2050. Since projections and the master plan recommendations should be reevaluated every 5-10 years, the values for the future will be updated as needed. If the Weber County estimates of 1 unit per acre is used, there would be approximately 8,800 units within the area. Based on an average household size of 3.6, that would result in a build-out density of 31,680 persons. Using an annual growth rate of 2.6%, build-out might not be obtained until after the year 2100.

WEBER WEST 2

The Weber West 2 area is not currently part of the CWSID annexable service area. However, there has been significant development pressure west of the Weber River. A proposal has been made to pump sewer from this area across the Weber River and to tie-into the CWSID system. Projecting potential population (and flow) growth from this area is complicated. In addition to potential residential growth, there is the potential for significant flow from large industrial/non-residential users. So, instead of projecting future population and flow growth within Weber West 2, a relationship between the ERUs and the CWSID system capacity will be established. This will allow for identifying potential required projects based on any proposed development west of the Weber River.

APPENDIX B

ADS Flow Monitoring Report

Central Weber Sewer Improvement District System Metering 2022

Final Report Submitted to **BOWEN COLLINS & ASSOCIATES**
August 4, 2022

ADS ENVIRONMENTAL SERVICES

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San Diego, CA 92111

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A Division of ADS LLC

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August 4, 2022

Tucker Jorgensen
BOWEN COLLINS
& ASSOCIATES
154 E. 14075 South
Draper, Utah 84020
801.495.2224 Ofice
801.495.2225 Fax

SUBJECT: Central Weber Sewer Improvement District System Metering 2022

Dear Tucker,

ADS is pleased to submit the report for the project referenced above completed on behalf of BOWEN COLLINS & ASSOCIATES. The metering was conducted at twenty (20) locations. The study covered the period of Tuesday, April 19, 2022 to Monday, June 13, 2022. The report contains depth, velocity, and quantity hydrographs as well as daily long tables for the metering period. Excel data for depth, quantity, and velocity entities can be exported via the Prism web platform based on user defined parameters.

In addition, we would be happy to further explain any details about the report that may seem unclear. Should you have any questions or comments, you may contact the Project Manager, Ashura Takanohara at (256) 929-0075.

It has been our pleasure to be of service to you in the performance of this project. Thank you for choosing ADS products and services to meet your flow monitoring needs.

Sincerely,
ADS ENVIRONMENTAL SERVICES

Jackie Crutcher
Data Manager

Central Weber Sewer Improvement District System Metering 2022

April 19, 2022 - June 13, 2022

Prepared for:

Tucker Jorgensen
BOWEN COLLINS
& ASSOCIATES
154 E. 14075 South
Draper, Utah 84020
801.495.2224 Office

Prepared by:

ADS, LLC
4820 Mercry Street, Suite C
San Diego, CA 92111

Table of Contents

Scope and Methodology

Introduction

BOWEN COLLINS & ASSOCIATES entered into an agreement with ADS Environmental Services to conduct flow monitoring at (20) twenty locations in the Central Weber Sanitary Collection System. The study was scheduled for a period of (56) fifty-six days. Once in place, the flow monitoring equipment was used to measure depth, velocity, and to quantify flows. Data obtained from the study will be used to evaluate capacity for master planning purposes.

Project Scope

The scope of this study involved using a flow monitor to quantify wastewater flow at the designated locations for the 56-day time period. Specifically, the study included the following key components.

- Investigate the proposed flow-monitoring sites for adequate hydraulic conditions
- Flow monitor installations
- Flow monitor confirmations and data collections
- Flow data analysis

Equipment installation was completed on April 18, 2022. The monitoring began on April 19, 2022 and was completed on June 13, 2022. Upon completion of the study, equipment was removed from the system.

Flow Monitoring Equipment

The ***ADS Trinton+*** monitor was selected for this project. This flow monitor is an area velocity flow monitor that uses both the Continuity and Manning's equations to measure flow.

The ADS Triton+ monitor consists of data acquisition sensors and a battery-powered microcomputer. The microcomputer includes a processor unit, data storage, and an on-board clock to control and synchronize the sensor recordings. The monitor was programmed to acquire and store depth of flow and velocity readings at 5-minute intervals.

The Triton+ monitor features cross-checking using multiple technologies in each sensor for continuous running of comparisons and tolerances. The Triton+ monitor can support two (2) sets of sensors. The sensor option used for this project was:

<u>The Peak Combo Sensor</u> installed at the bottom of the pipe includes three types of data acquisition technologies.

The ***up looking ultrasonic depth*** uses sound waves from two independent transceivers to measure the distance from the sensor upward toward the flow surface; applying the speed of sound in the water and the temperature measured by sensor to calculate depth.

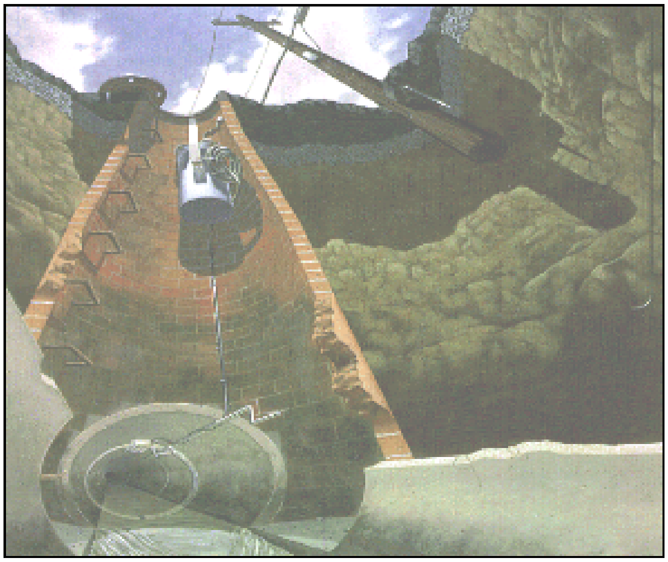
The ***pressure depth*** is calculated by using a piezo-resistive crystal to determine the difference between hydrostatic and atmospheric pressure. The pressure sensor is temperature compensated and vented to the atmosphere through a desiccant filled breather tube.

To obtain ***peak velocity*****,** the sensor sends an ultrasonic signal at an angle upward through the widest cross-section of the oncoming flow. The signal is reflected by suspended particles, air bubbles, or organic matter with a frequency shift proportional to the velocity of the reflecting objects. The reflected signal is received by the sensor and processed using digital spectrum analysis to determine the peak flow velocity.

Installation

Installation of flow monitoring equipment typically proceeds in four steps. First, the site is investigated for safety and to determine physical and hydraulic suitability for the flow monitoring equipment. Second, the equipment is physically installed at the selected location. Third, the monitor is tested to assure proper operation of the velocity and depth of flow sensors and verify that the monitor clock is operational and synchronized to the master computer clock. Fourth, the depth and velocity sensors are confirmed and line confirmations are performed.

In pipes up to 42 inches in diameter, the sensors were mounted on expandable stainless steel rings, inserted at least a foot upstream into influent pipes and tightened against the inside walls of the pipes. Influent pipe installations reduce the influences of turbulence and backwater often caused by changes in channel geometry in manholes.



Data Collection, Confirmation, and Quality Assurance

Data collection was done remotely via wireless connect on a weekly basis via ADS Field Representatives. During the monitoring period, field crews visit each monitoring location to verify proper monitor operation and document field conditions. The following quality assurance steps are taken to assure the integrity of the collected data:

Measure power supplies: monitors were powered by dry cell battery packs. Voltages were recorded and battery packs replaced, as necessary. Separate batteries provided back-up power to memory allowing primary batteries to be replaced without loss of data.

Clock synchronization: Field crews synchronized monitor clocks to master clocks.

Confirm depth and velocity readings: Field crews descended into meter manholes to manually measure depths and velocities and compare them meter readings to confirm that they agreed. They also measured silt levels, if any, in the inverts of the pipes. Silt areas were subtracted from flow areas to compute true areas of flow.

Confirm average velocities through cross-sectional velocity profiles: Since ADS velocity sensors measure peak velocity, field crews collected cross-sectional velocity profiles in order to develop a relationship between peak and average velocity in lines that meet the hydraulic criteria.

Upload and Review Data: Data collected from the monitors were uploaded and reviewed by a Data Analyst for completeness, outliers and deviations in the flow patterns, which indicate system anomalies or equipment failure.

Flow Quantification Methods

There are two main equations used to measure open channel flow: the ***Continuity Equation*** and the ***Manning Equation.*** The Continuity Equation, which is considered the most accurate, can be used if both depth of flow and velocity are available. In cases where velocity measurements are not available or not practical to obtain, the Manning Equation can be used to estimate velocity from the depth data based on certain physical characteristics of the pipe (i.e. the slope and roughness of the pipe being measured). However, the Manning equation assumes uniform, steady flow hydraulic conditions with non-varying roughness, which are typically invalid assumptions in most sanitary sewers. The Continuity Equation was used exclusively for this study.

Continuity Equation

The Continuity Equation states that the flow quantity (Q) is equal to the wetted area (A) multiplied by the average velocity (V) of the flow.

$$Q = A * V$$

This equation is applicable in a variety of conditions including backwater, surcharge, and reverse flow.

Data Analysis and Presentation

Data Analysis

A flow monitor is typically programmed to collect data at 5-minute intervals throughout the monitoring period. The monitor stores raw data consisting of (1) the ultrasonic depth, (2) the peak velocity and (3) the pressure depth. The data is imported into ADS's proprietary software and is examined by a data analyst to verify its integrity. The data analyst also reviews the daily field reports and site visit records to identify conditions that would affect the collected data.

Velocity profiles and the line confirmation data developed by the field personnel are reviewed by the data analyst to identify inconsistencies and verify data integrity. Velocity profiles are reviewed and an average to peak velocity ratio is calculated for the site. This ratio is used in converting the peak velocity measured by the sensor to the average velocity used in the Continuity equation. The data analyst selects which depth sensor entity will be used to calculate the final depth information. Silt and/or debris are often present in sewer lines. When present, silt levels are measured at each site visit. They are reviewed by the data analyst and representative silt levels established. Silt reduces the cross sectional area of the flow. Debris causes flow to become deeper and slower. Calculated flow should remain consistent in both hydraulic conditions. Debris may result in reduced line capacity.

Occasionally the velocity sensor's performance may be compromised resulting in invalid readings sporadically during the monitoring period. This is generally caused by excessive debris (silt) blocking the sensor's crystals, shallow flows (~< 1") that may drop below the top of the sensor or very clear flows lacking the particles needed to measure rate. In order to use the Continuity equation to quantify the flow during these periods, a Data Analyst and/or Engineer will use the site's historical pipe curve (depth vs. velocity) data along with valid field confirmations to reconstitute and replace the false velocity recordings with expected velocity readings for a given historical depth along the curve.

Selections for the above parameters can be constant or can change during the monitoring period. While the data analysis process is described in a linear manner, it often requires an iterative approach to accurately complete.

Data Presentation

This type of flow monitoring project generates a large volume of data. To facilitate review of the data, results have been provided in graphical and tabular formats. The flow data is presented graphically in the form of scattergraphs and hydrographs. Hydrographs are based on 15 minute averaging. Tables are provided in daily average format. These tables show the flow rate for each day, along with the daily minimum and maximums, the times they were observed, the total daily flow, and total flow for the month (or monitoring period). The following explanation of terms may aid in interpretation of the tables and hydrographs.

DFINAL - Final calculated depth measurement (in inches)

QFINAL - Final calculated flow rate (in MGD)

VFINAL - Final calculated flow velocity (in feet per second)

REPORT TOTAL - Total volume of flow recorded for the indicated time period (in MG)

Site Commentary

Site Information

CW01	
Pipe Dimensions	30"
Silt Level	0.00"

Overview

Site CW01 functioned under normal conditions during the period Tuesday, April 19, 2022 to Monday, June 13, 2022. No surcharge conditions were experienced at this location. Review of the scattergraph shows that the line was impacted by debris and backwater conditions were observed. Although debris caused depth to become deeper and velocity slower, the calculated flow remained consistent. The presence of debris may result in reduced line capacity. Flow is subcritical.

Flow depth and velocity measurements recorded by the flow monitor are consistent with field confirmations conducted to date and support the relative accuracy of the flow monitor at this location.

This site along with CW10 was positioned upstream of location CW03 (See CW03 Site Commentary For Balancing Details).

Observations

Average flow depth, velocity, and quantity data observed during Tuesday, April 19, 2022 to Monday, June 13, 2022 , along with observed minimum and maximum data, are provided in the following table. Values in the Observed Flow Conditions are based on 5-minute averages. Graphs are based on 15-minute averages. As a result, the values shown in the table below may differ from those shown on the graph.

In regard to depth, based on an average depth of 6.94 inches, this site utilized 23.13 percent of full pipe depth. The hourly averaged peak depth of 8.69 inches represented 28.97 percent of full pipe depth.

Observed Flow Conditions			
Item	Depth (in)	Velocity (ft/s)	Quantity (MGD)
Average	6.94	1.96	1.117
Minimum	5.29	1.25	0.515
Maximum	8.79	2.58	1.991
Time of Minimum	5/15/2022 07:10	6/12/2022 07:10	4/19/2022 03:40
Time of Maximum	5/30/2022 13:10	5/22/2022 22:00	5/30/2022 13:20

Data Quality

Data uptime observed during the Tuesday, April 19, 2022 to the Monday, June 13, 2022 monitoring period is provided in the table below. Based upon the quality and consistency of the observed flow depth and velocity data, the Continuity equation was used to calculate flow rate and quantities during the monitoring period.

Percent Uptime	
Depth (in)	100
Velocity (ft/s)	100
Quantity (MGD)	100

Ogden.BowenClns.TFM.UT22

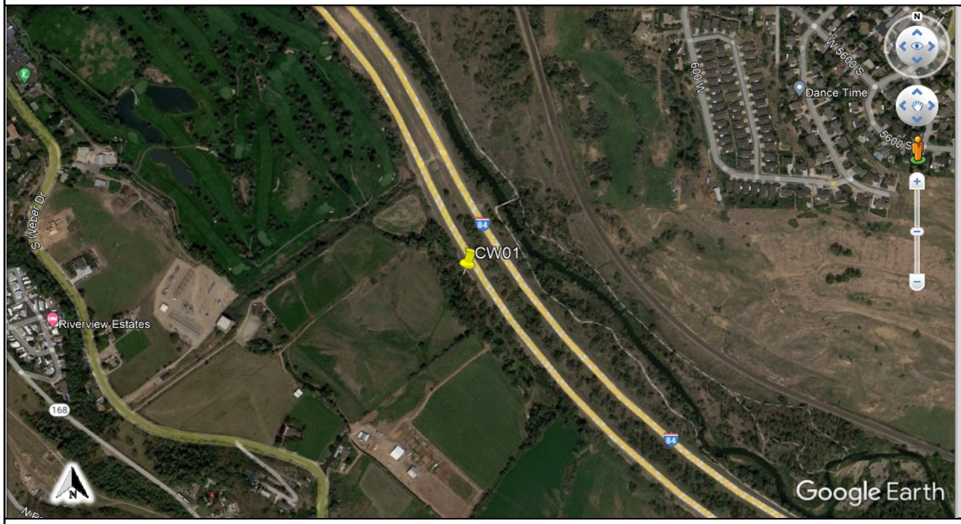
Flow Monitoring Site Report

22773.11.325

CW01

Site Address /Location:	5838 S WEBER DR		
Site Access Details:	NEED HELP FROM CITY TO CONTACT OWNER FOR ACCESS	Latitude: Longitude:	41.160401 -111.995138

Monitor Series	Location Type
TRITON+ VZ	Temporary
Pipe Size (H x W)	Pipe Shape
30.00X30.13	Elliptical



Manhole #	System Characteristics
SW029	Residential/Commercial
Access	Traffic
Drive	None

ADS Project Name:	Ogden.BowenClns.TFM.UT22
ADS Project Number:	22773.11.325

Installation Information

Installation Date:	Installation Type:
04/18//2022	Doppler Standard Ring and Crank
Monitoring Location (Sensors):	Monitor Location:
Upstream 0-5 FT	Manhole
Sensors / Devices:	Pressure Sensor Range (psi)
Peak Combo (CS4)	0 - 5 psi

Installation Confirmation:

Confirmation Time:	Pipe Size (HxW)
9:07AM	30.00X30.13
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
7.63	
Downlooker Physical Offset (in)	Measurement Confidence (in)
NA	0.25"
Peak Velocity (fps)	Velocity Sensor Offset (in)
1.99	0"
Silt (in)	Silt Type
0	

Hydraulic Comments:

Smooth flow

Manhole / Pipe Information:

Manhole Depth (Approx. FT):	Manhole Configuration
180	Single
Manhole Material:	Manhole Condition:
Concrete	Good
Manhole Opening Diameter (in)	Manhole Diameter (Approx.):
26"	54"
Manhole Cover	Manhole Frame
vented	Normal
Active Drop Connections	Air Quality:
No	Normal
Pipe Material	Pipe Condition:
Concrete	Good

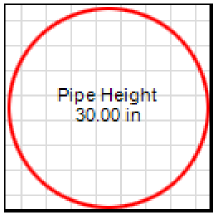
Communication Information:

Communication Type	Antenna Location
Wireless	Manhole Pick / Vent Hole

Additional Site Info. / Comments:

Flow Monitor

CW01



Report Period

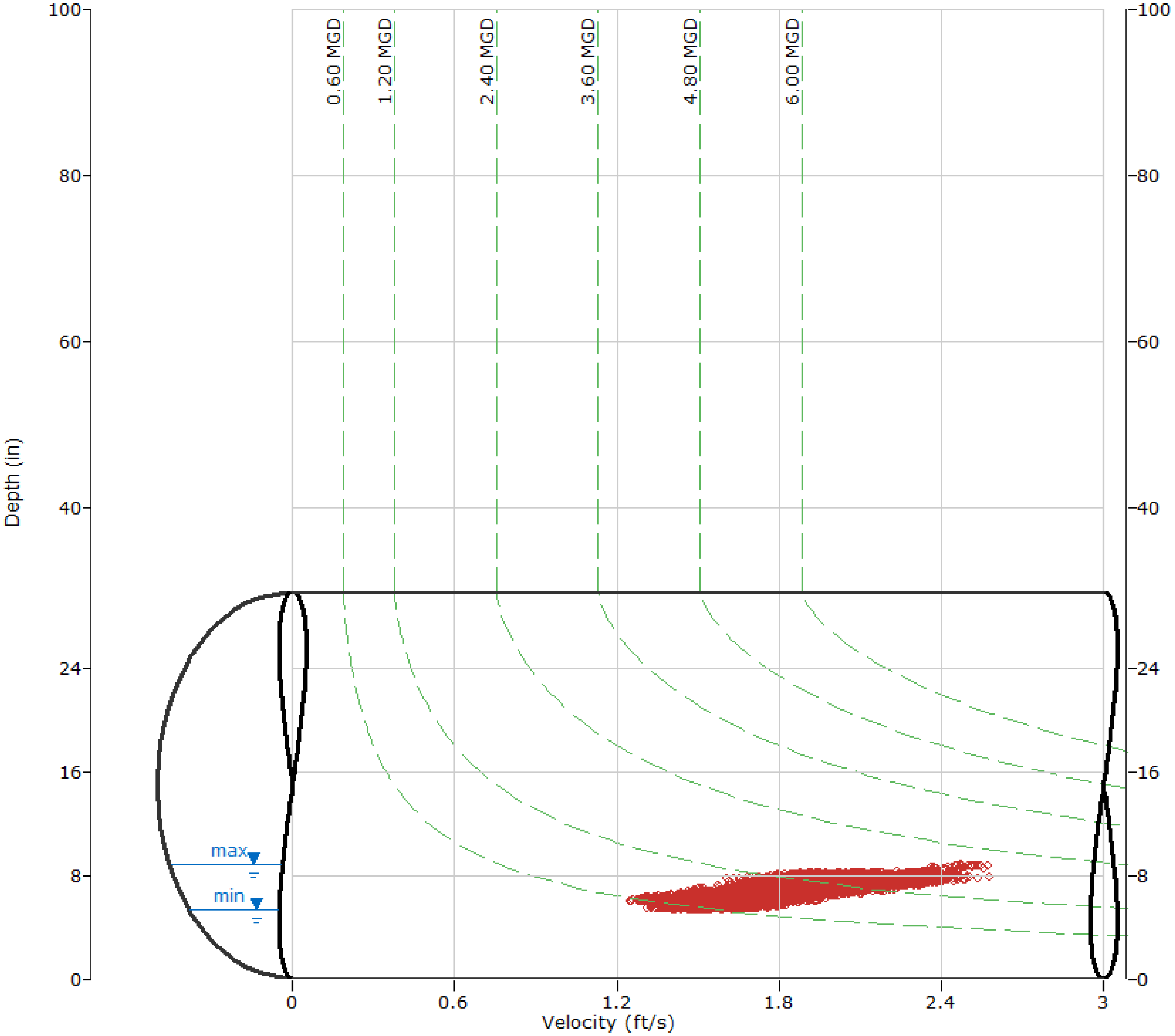
4/19/2022
To
6/13/2022

Legend

○	Depth - Velocity
---	Iso-Q™
---	Silt
▼	Min-Max Depth

SCATTERGRAPH REPORT

CW01

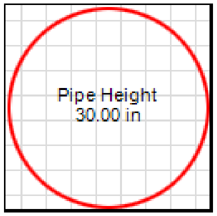


HYDROGRAPH REPORT

CW01

Flow Monitor

CW01

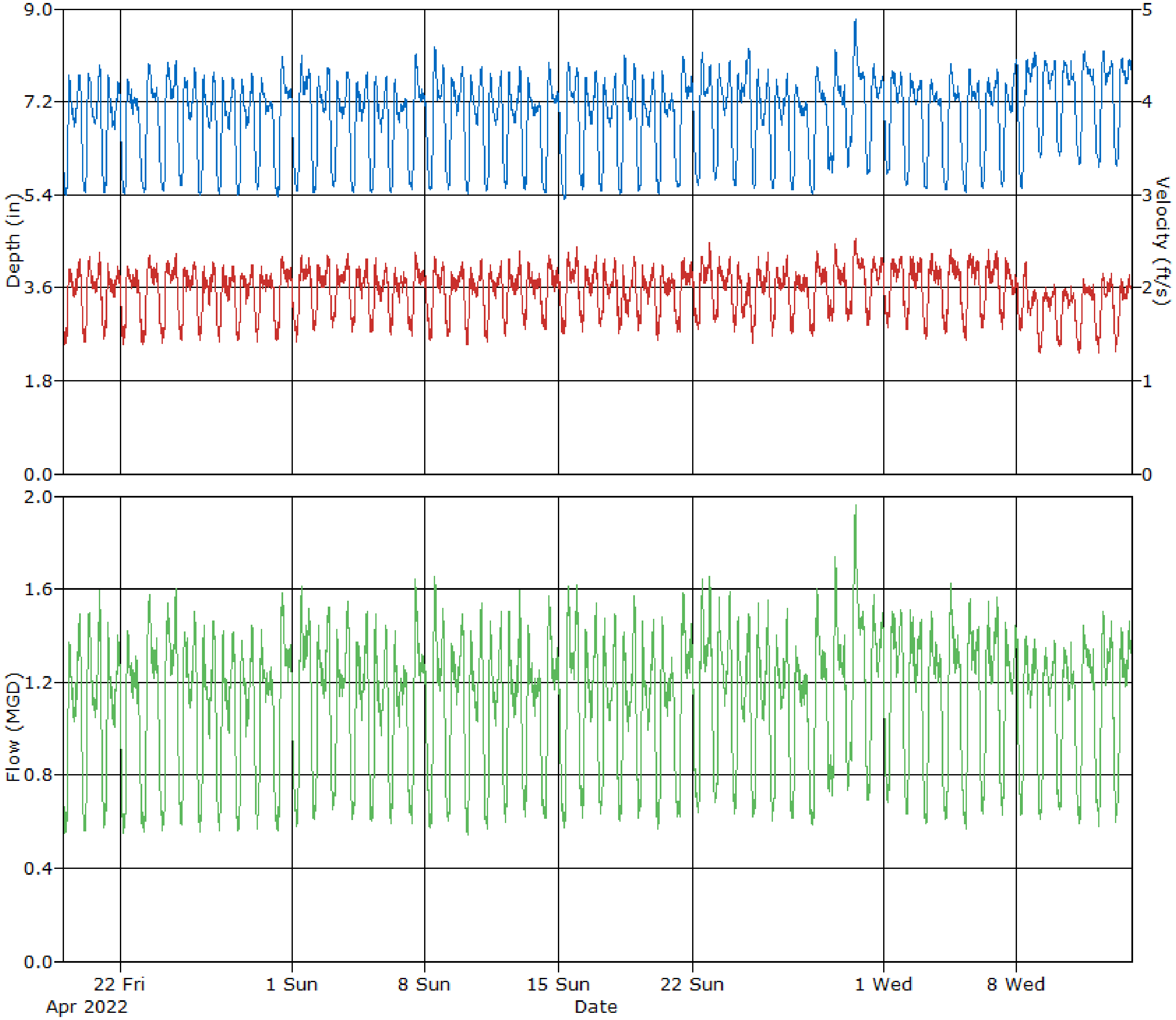


Report Period

4/19/2022
To
6/13/2022

Legend

🟦	Depth
🟥	Velocity
🟩	Quantity



Daily Tabular Report For The Period 04/19/2022 00:00 - 06/13/2022 23:59

CW01, Pipe Height: 30.00 in, Silt: 0.00 in

Daily Tabular Report

Date	Depth (in)					Velocity (ft/s)					Quantity (MGD - Total MG)						Rain (in)
	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Total	Total
04/19/2022	04:20	5.38	08:35	7.75	6.79	03:40	1.31	20:05	2.31	1.94	03:40	0.515	21:40	1.505	1.071	1.071	
04/20/2022	04:20	5.45	23:15	7.93	6.84	04:05	1.40	23:05	2.43	1.98	04:05	0.556	23:05	1.623	1.105	1.105	
04/21/2022	05:35	5.44	09:55	7.72	6.77	03:40	1.36	09:15	2.28	1.94	05:40	0.554	09:20	1.472	1.064	1.064	
04/22/2022	05:20	5.41	10:25	7.64	6.81	05:05	1.35	09:00	2.28	1.94	05:05	0.535	10:25	1.453	1.076	1.076	
04/23/2022	07:20	5.43	11:55	7.95	6.86	06:30	1.33	12:50	2.37	1.95	06:30	0.532	11:55	1.596	1.101	1.101	
04/24/2022	07:30	5.46	22:45	8.05	6.96	06:05	1.38	22:25	2.41	1.97	06:05	0.549	22:25	1.648	1.135	1.135	
04/25/2022	05:10	5.55	22:25	7.86	6.91	05:15	1.38	22:25	2.34	1.98	05:15	0.561	22:25	1.556	1.120	1.120	
04/26/2022	04:30	5.38	22:35	7.79	6.77	04:25	1.41	21:30	2.33	1.93	04:30	0.547	21:30	1.513	1.063	1.063	
04/27/2022	05:30	5.40	09:30	7.70	6.77	06:00	1.37	10:35	2.28	1.94	06:00	0.547	10:35	1.445	1.067	1.067	
04/28/2022	04:40	5.39	22:15	7.81	6.78	05:35	1.41	22:35	2.32	1.93	05:35	0.551	22:35	1.489	1.064	1.064	
04/29/2022	05:25	5.50	10:35	7.67	6.80	05:15	1.38	10:40	2.23	1.93	05:15	0.554	10:40	1.433	1.068	1.068	
04/30/2022	07:00	5.34	12:15	8.09	6.87	07:00	1.41	11:15	2.35	1.96	07:00	0.540	12:15	1.611	1.110	1.110	
05/01/2022	07:55	5.46	12:30	8.12	6.96	06:45	1.38	12:25	2.43	1.99	06:45	0.548	12:25	1.664	1.144	1.144	
05/02/2022	03:45	5.43	21:15	7.90	6.90	05:05	1.48	20:50	2.38	2.00	05:05	0.593	21:55	1.557	1.131	1.131	
05/03/2022	05:15	5.53	22:10	7.81	6.85	03:10	1.53	22:05	2.39	2.02	04:15	0.634	22:10	1.572	1.127	1.127	
05/04/2022	05:25	5.45	22:50	7.78	6.84	04:55	1.50	22:15	2.36	1.99	04:55	0.596	22:45	1.531	1.107	1.107	
05/05/2022	04:00	5.44	10:10	7.72	6.77	04:00	1.46	09:20	2.38	1.95	04:00	0.575	09:20	1.537	1.069	1.069	
05/06/2022	05:30	5.42	10:20	7.65	6.75	05:05	1.47	10:15	2.27	1.95	05:05	0.576	10:15	1.447	1.060	1.060	
05/07/2022	07:35	5.48	12:05	8.12	6.88	07:20	1.45	11:45	2.46	1.97	07:35	0.581	11:45	1.700	1.111	1.111	
05/08/2022	06:55	5.47	12:05	8.29	6.98	06:50	1.40	11:30	2.37	1.97	06:50	0.559	12:10	1.685	1.138	1.138	
05/09/2022	05:20	5.51	22:40	7.91	6.94	06:00	1.43	23:10	2.35	1.96	05:15	0.582	23:10	1.535	1.114	1.114	
05/10/2022	05:25	5.40	22:45	7.91	6.85	05:25	1.34	22:10	2.36	1.94	05:25	0.523	22:45	1.569	1.083	1.083	
05/11/2022	05:00	5.47	23:10	7.83	6.83	06:05	1.39	23:30	2.38	1.95	06:05	0.557	23:30	1.555	1.084	1.084	
05/12/2022	05:30	5.53	22:40	7.91	6.89	04:15	1.43	22:35	2.42	1.98	04:15	0.589	22:35	1.624	1.115	1.115	
05/13/2022	05:10	5.49	09:45	7.70	6.79	06:20	1.52	10:55	2.31	1.98	05:05	0.611	09:40	1.464	1.085	1.085	
05/14/2022	06:50	5.44	11:50	7.98	6.83	06:25	1.48	11:10	2.37	1.99	06:25	0.588	11:50	1.589	1.110	1.110	
05/15/2022	07:10	5.29	12:25	7.97	6.89	03:45	1.45	22:20	2.49	2.01	07:10	0.556	22:20	1.658	1.141	1.141	
05/16/2022	06:15	5.47	23:25	7.81	6.87	06:10	1.50	22:55	2.39	2.01	06:10	0.598	22:50	1.558	1.123	1.123	
05/17/2022	05:35	5.46	23:30	7.77	6.79	04:40	1.55	22:50	2.37	1.97	04:40	0.620	23:10	1.526	1.086	1.086	
05/18/2022	05:20	5.41	10:40	8.12	6.92	03:50	1.47	22:50	2.35	1.91	05:10	0.584	22:50	1.589	1.081	1.081	
05/19/2022	04:35	5.47	22:35	7.81	6.82	04:25	1.51	22:55	2.29	1.95	04:25	0.604	22:40	1.483	1.080	1.080	
05/20/2022	05:30	5.41	09:55	7.83	6.80	04:50	1.41	10:05	2.31	1.94	04:20	0.557	10:05	1.511	1.068	1.068	
05/21/2022	05:45	5.54	12:35	8.14	6.95	07:45	1.49	14:15	2.36	1.98	07:45	0.607	14:15	1.602	1.134	1.134	
05/22/2022	07:25	5.57	12:55	8.16	7.04	06:50	1.52	22:00	2.58	2.03	06:50	0.624	22:00	1.706	1.186	1.186	
05/23/2022	05:05	5.67	22:45	8.06	7.04	03:40	1.60	22:55	2.41	2.03	05:00	0.677	22:55	1.629	1.175	1.175	
05/24/2022	06:05	5.57	22:05	8.23	7.13	04:25	1.46	09:30	2.35	1.91	04:25	0.600	09:30	1.535	1.121	1.121	
05/25/2022	05:25	5.50	00:00	8.04	6.91	03:45	1.39	23:30	2.41	1.97	04:05	0.610	23:30	1.592	1.113	1.113	
05/26/2022	05:10	5.53	23:20	7.76	6.84	04:05	1.45	22:55	2.42	1.99	04:05	0.589	22:55	1.567	1.109	1.109	
05/27/2022	05:40	5.49	10:50	7.57	6.76	05:20	1.49	10:30	2.23	1.95	05:20	0.602	10:25	1.388	1.065	1.065	
05/28/2022	07:35	5.42	13:05	7.90	6.81	05:30	1.44	13:00	2.47	1.98	07:35	0.572	13:00	1.653	1.106	1.106	
05/29/2022	07:55	5.81	12:00	8.22	7.00	07:55	1.60	12:00	2.48	2.04	07:55	0.693	12:00	1.759	1.170	1.170	
05/30/2022	03:45	5.94	13:10	8.79	7.35	03:40	1.63	13:20	2.57	2.10	03:40	0.728	13:20	1.991	1.301	1.301	
05/31/2022	04:20	5.78	12:30	8.00	7.08	04:10	1.55	21:40	2.38	2.06	04:10	0.670	12:30	1.609	1.203	1.203	
06/01/2022	04:20	5.79	10:40	7.82	7.09	06:25	1.54	21:25	2.39	2.07	06:25	0.667	21:25	1.549	1.211	1.211	
06/02/2022	05:25	5.56	10:40	7.77	6.96	05:55	1.49	10:45	2.54	2.03	05:55	0.610	10:45	1.651	1.161	1.161	
06/03/2022	06:25	5.51	12:45	7.64	6.86	05:10	1.40	12:40	2.49	2.02	05:10	0.567	12:40	1.589	1.130	1.130	

Date	**Depth (in)**					**Velocity (ft/s)**					**Quantity (MGD - Total MG)**						**Rain (in)**
	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Total	Total
06/04/2022	06:00	5.50	12:25	7.96	6.87	07:05	1.48	12:55	2.47	2.03	07:20	0.596	12:55	1.647	1.144	1.144	
06/05/2022	07:20	5.44	12:10	7.83	6.86	07:40	1.37	13:30	2.43	2.02	07:40	0.545	12:10	1.579	1.137	1.137	
06/06/2022	04:30	5.53	23:05	7.85	6.95	04:35	1.51	12:30	2.46	2.06	04:35	0.612	22:55	1.594	1.178	1.178	
06/07/2022	05:25	5.54	23:55	8.04	6.97	05:25	1.52	00:00	2.40	2.00	05:25	0.615	00:00	1.556	1.138	1.138	
06/08/2022	05:10	5.53	22:10	8.17	7.23	03:00	1.52	10:20	2.33	1.86	05:35	0.620	10:20	1.441	1.109	1.109	
06/09/2022	05:25	6.12	00:10	8.10	7.39	05:00	1.28	23:05	2.09	1.76	05:25	0.598	12:45	1.402	1.090	1.090	
06/10/2022	06:10	6.13	19:50	8.02	7.34	04:45	1.31	00:00	2.08	1.77	04:45	0.629	19:50	1.407	1.085	1.085	
06/11/2022	06:20	5.99	12:45	8.21	7.31	06:25	1.25	11:45	2.14	1.79	06:25	0.567	11:45	1.483	1.100	1.100	
06/12/2022	07:05	5.93	13:25	8.19	7.31	07:10	1.25	12:25	2.18	1.84	07:10	0.557	12:25	1.538	1.132	1.132	
06/13/2022	05:20	5.94	12:10	8.06	7.32	04:25	1.29	21:20	2.14	1.83	04:25	0.585	21:20	1.466	1.126	1.125	

Report Summary For The Period 04/19/2022 00:00 - 06/13/2022 23:59

	Depth (in)	Velocity (ft/s)	Quantity (MGD - Total MG)
Total			62.523
Avg	6.94	1.96	1.117

Site Commentary

Site Information

CW02	
Pipe Dimensions	60.38"
Silt Level	0.00"

Overview

Site CW02 functioned under normal conditions during the period Tuesday, April 19, 2022 to Monday, June 13, 2022. No surcharge conditions were experienced at this location. Review of the scattergraph shows that both free flow and backwater conditions were recorded. Flow is subcritical.

Flow depth and velocity measurements recorded by the flow monitor are consistent with field confirmations conducted to date and support the relative accuracy of the flow monitor at this location.

Observations

Average flow depth, velocity, and quantity data observed during Tuesday, April 19, 2022 to Monday, June 13, 2022 , along with observed minimum and maximum data, are provided in the following table. Values in the Observed Flow Conditions are based on 5-minute averages. Graphs are based on 15-minute averages. As a result, the values shown in the table below may differ from those shown on the graph.

In regard to depth, based on an average depth of 26.58 inches, this site utilized 44.02 percent of full pipe depth. The hourly averaged peak depth of 28.85 inches represented 47.78 percent of full pipe depth.

Observed Flow Conditions

Item	Depth (in)	Velocity (ft/s)	Quantity (MGD)
Average	26.58	0.62	3.364
Minimum	12.32	0.19	0.996
Maximum	32.96	2.34	7.834
Time of Minimum	4/28/2022 07:50	6/4/2022 14:05	4/24/2022 15:40
Time of Maximum	5/5/2022 13:55	4/28/2022 07:55	5/5/2022 13:55

Data Quality

Data uptime observed during the Tuesday, April 19, 2022 to the Monday, June 13, 2022 monitoring period is provided in the table below. Based upon the quality and consistency of the observed flow depth and velocity data, the Continuity equation was used to calculate flow rate and quantities during the monitoring period.

Percent Uptime	
Depth (in)	100
Velocity (ft/s)	100
Quantity (MGD)	100

Ogden.BowenClns.TFM.UT22

Flow Monitoring Site Report

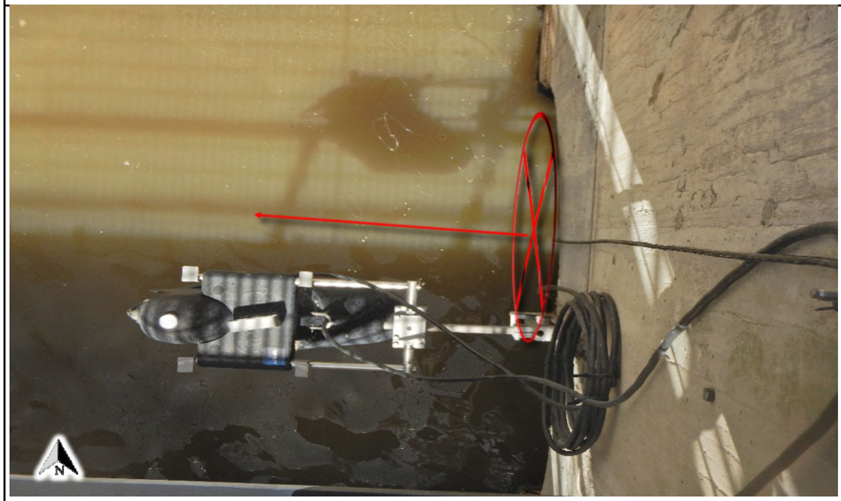
ADS ENVIRONMENTAL SERVICES®

22773.11.325

CW02

Site Address /Location:	W PIONEER RD			Monitor Series TRITON+ VZ	Location Type Temporary
Site Access Details:	INSIDE CENTRAL WEBER SEWER DISTRICT	Latitude: Longitude:	41.272425 -112.041658	Pipe Size (H x W) 60.38X60.38	Pipe Shape Elliptical

Manhole #	System Characteristics
	Residential/Commercial
Access	Traffic
Drive	None



Installation Information

Installation Date:	Installation Type:
04/18//2022	Doppler Standard Ring and Crank
Monitoring Location (Sensors):	Monitor Location:
Upstream 0-5 FT	Manhole
Sensors / Devices:	Pressure Sensor Range (psi)
Peak Combo (CS4)	0 - 5 psi

Installation Confirmation:

Confirmation Time:	Pipe Size (HxW)
1:22PM	60.38X60.38
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
27.13	
Downlooker Physical Offset (in)	Measurement Confidence (in)
NA	0.38"
Peak Velocity (fps)	Velocity Sensor Offset (in)
0.91	0"
Silt (in)	Silt Type
0	

Hydraulic Comments:
Smooth flow

Manhole / Pipe Information:

Manhole Depth (Approx. FT):	Manhole Configuration
180	Single
Manhole Material:	Manhole Condition:
Concrete	Good
Manhole Opening Diameter (in)	Manhole Diameter (Approx.):
26"	54"
Manhole Cover	Manhole Frame
vented	Normal
Active Drop Connections	Air Quality:
No	Normal
Pipe Material	Pipe Condition:
Concrete	Good

Communication Information:

Communication Type	Antenna Location
Wireless	Manhole Pick / Vent Hole

Additional Site Info. / Comments:

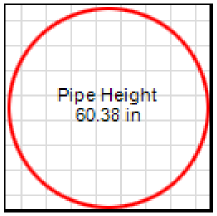
ADS Project Name:	Ogden.BowenClns.TFM.UT22
ADS Project Number:	22773.11.325

SCATTERGRAPH REPORT

CW02

Flow Monitor

CW02

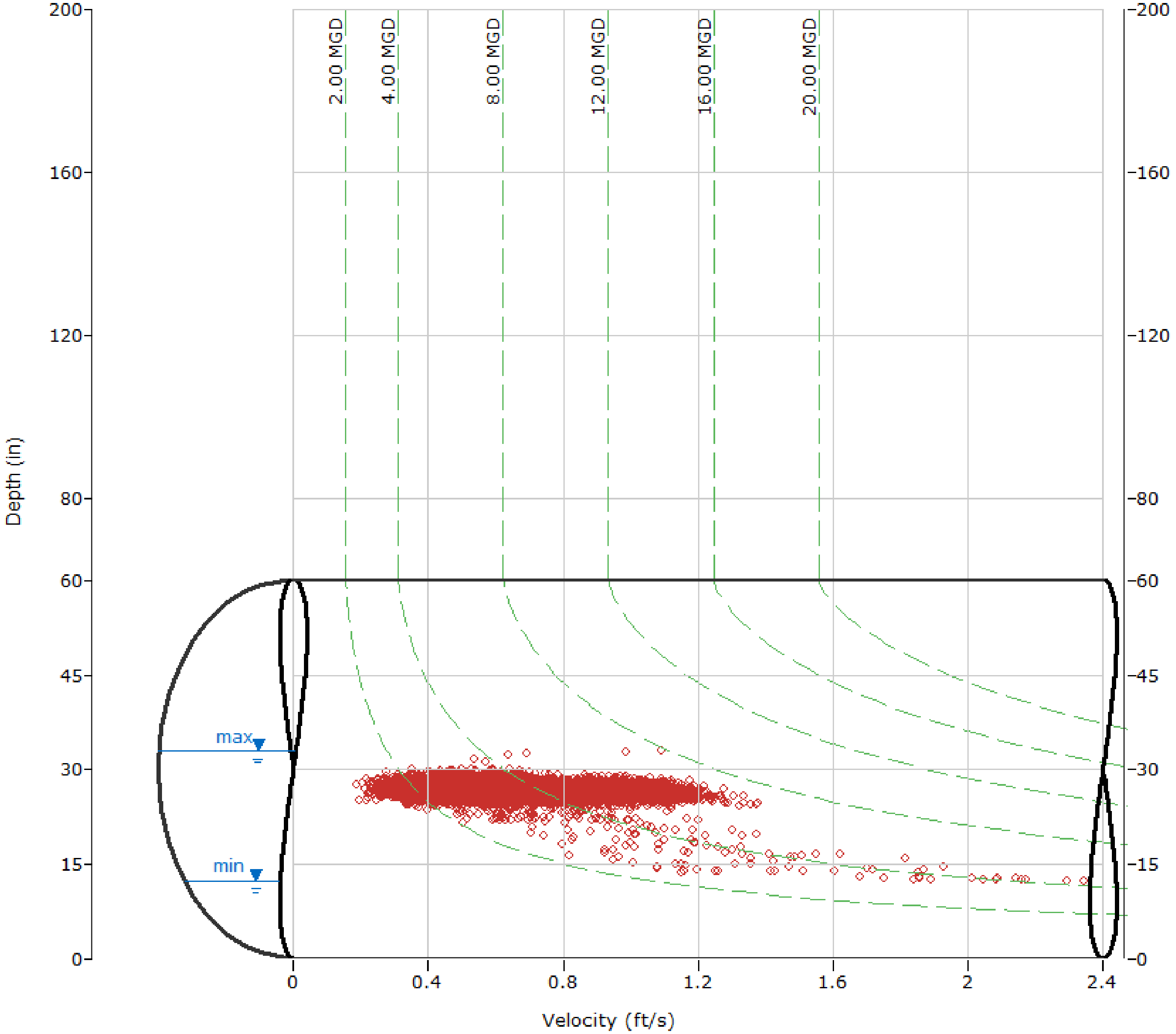


Report Period

4/19/2022
To
6/13/2022

Legend

○ Depth - Velocity
--- Iso-Q™
--- Silt
▼ Min-Max Depth

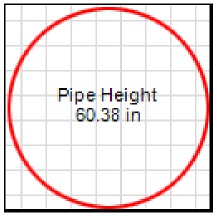


HYDROGRAPH REPORT

CW02

Flow Monitor

CW02

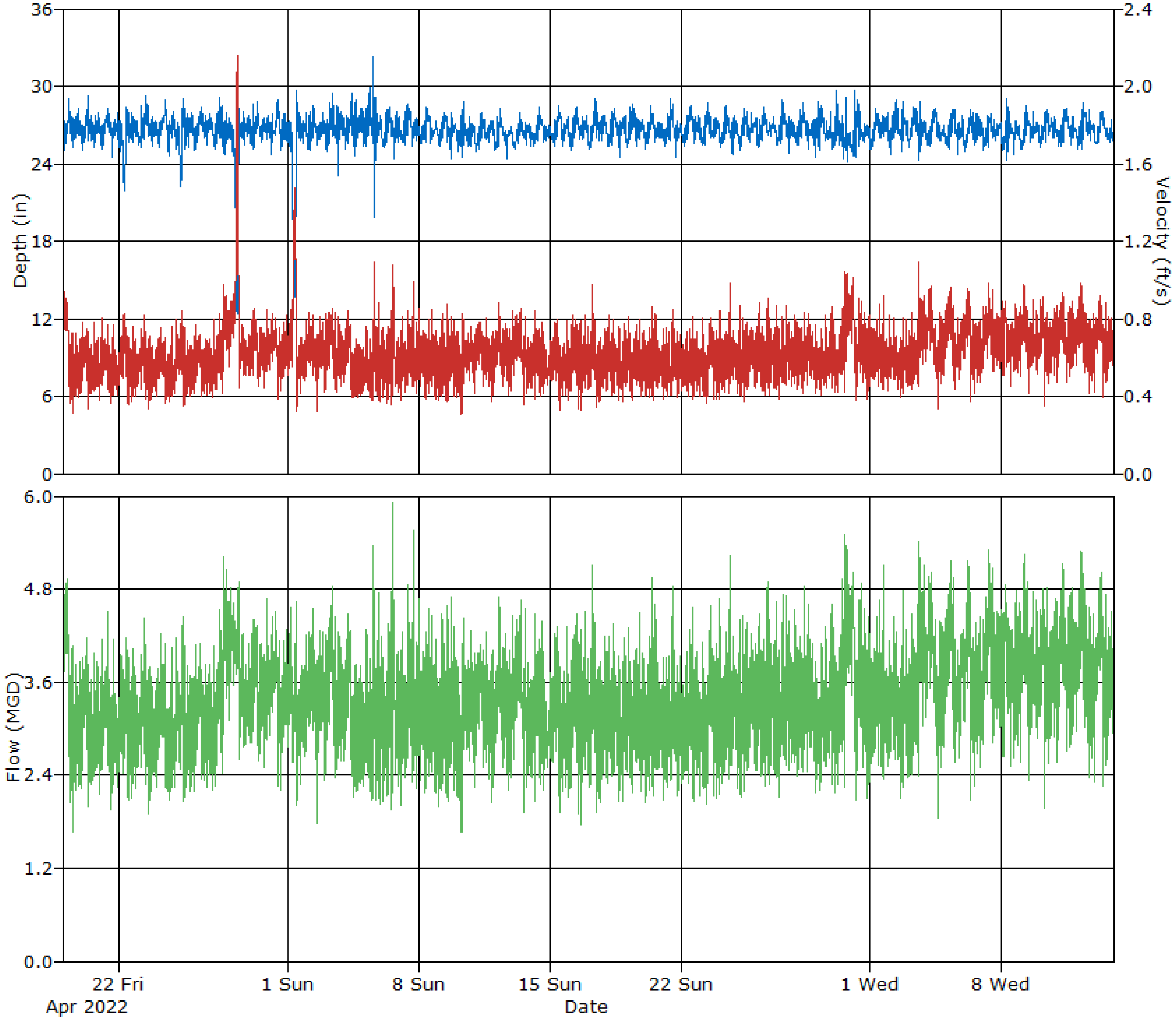


Report Period

4/19/2022
To
6/13/2022

Legend

- — Depth
- — Velocity
- — Quantity



ADS ENVIRONMENTAL SERVICES

Daily Tabular Report For The Period 04/19/2022 00:00 - 06/13/2022 23:59

CW02, Pipe Height: 60.38 in, Silt: 0.00 in

Daily Tabular Report

Date	Depth (in)					Velocity (ft/s)					Quantity (MGD - Total MG)						Rain (in)
	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Total	Total
04/19/2022	01:40	24.59	07:45	29.20	26.67	13:30	0.23	13:45	1.12	0.62	13:30	1.292	12:45	6.193	3.359	3.359	
04/20/2022	01:10	24.89	08:25	29.46	26.79	08:50	0.25	09:40	1.13	0.56	09:25	1.460	20:05	5.949	3.084	3.084	
04/21/2022	16:10	24.39	09:40	28.87	26.68	10:35	0.29	10:55	1.14	0.55	15:40	1.614	10:55	6.359	3.000	3.000	
04/22/2022	07:00	21.83	10:10	28.90	26.18	16:10	0.25	16:50	1.14	0.58	16:10	1.493	16:50	5.925	3.062	3.062	
04/23/2022	00:55	25.07	10:40	29.49	26.75	12:55	0.27	13:55	1.15	0.56	15:20	1.459	13:55	6.195	3.044	3.044	
04/24/2022	15:50	24.42	11:40	29.54	26.91	15:40	0.20	20:50	1.07	0.54	15:40	0.996	20:50	5.564	2.999	2.999	
04/25/2022	07:25	22.10	09:45	29.31	26.38	16:40	0.25	12:55	1.16	0.57	16:40	1.429	12:55	6.513	3.046	3.046	
04/26/2022	01:45	24.87	09:40	28.87	26.80	23:25	0.26	12:00	1.12	0.56	23:25	1.440	12:00	6.157	3.062	3.062	
04/27/2022	16:05	24.23	09:00	29.17	26.58	11:30	0.32	15:05	1.24	0.66	03:50	1.755	15:05	6.474	3.609	3.609	
04/28/2022	07:50	12.32	09:55	28.57	24.81	15:30	0.32	07:55	2.34	0.81	15:30	1.716	23:00	5.811	3.670	3.670	
04/29/2022	03:05	24.98	08:50	29.68	26.75	11:25	0.26	20:45	1.16	0.64	11:25	1.486	20:45	6.196	3.524	3.524	
04/30/2022	02:25	24.74	12:15	29.22	26.71	12:40	0.28	13:55	1.04	0.64	15:45	1.594	12:10	6.019	3.482	3.482	
05/01/2022	08:45	13.54	11:45	30.03	24.84	12:05	0.22	08:50	1.85	0.70	12:05	1.309	02:15	6.015	3.298	3.298	
05/02/2022	04:45	24.79	09:05	28.56	26.62	13:20	0.22	20:10	1.15	0.64	13:20	1.143	20:10	6.162	3.488	3.488	
05/03/2022	16:10	22.76	09:20	29.58	26.75	00:50	0.35	12:15	1.10	0.64	00:50	1.801	09:10	6.154	3.496	3.496	
05/04/2022	13:35	24.00	09:50	29.64	26.97	22:40	0.36	19:10	1.16	0.56	15:25	1.983	19:10	6.337	3.111	3.111	
05/05/2022	14:45	19.67	13:55	32.96	26.84	13:10	0.31	14:50	1.37	0.57	17:25	1.667	13:55	7.834	3.108	3.108	
05/06/2022	16:15	24.17	09:55	28.55	26.65	01:45	0.32	16:15	1.32	0.57	16:10	1.636	20:00	6.438	3.121	3.121	
05/07/2022	15:15	25.19	10:35	28.79	26.76	11:05	0.32	09:30	1.24	0.59	02:25	1.765	09:30	6.499	3.262	3.262	
05/08/2022	01:35	25.21	09:40	28.59	26.69	06:50	0.33	06:45	1.14	0.59	06:25	1.754	19:20	6.119	3.214	3.214	
05/09/2022	16:30	24.22	17:45	28.26	26.56	07:00	0.32	06:15	1.27	0.59	01:50	1.742	17:55	6.588	3.183	3.183	
05/10/2022	08:15	23.82	09:10	29.25	26.40	05:10	0.23	22:30	1.18	0.58	05:10	1.324	09:25	6.504	3.140	3.140	
05/11/2022	01:40	24.63	07:30	28.10	26.44	00:10	0.25	20:35	1.20	0.62	00:10	1.344	20:35	6.485	3.337	3.337	
05/12/2022	16:20	24.20	06:55	28.54	26.29	01:40	0.22	10:45	1.17	0.62	01:40	1.097	10:45	6.210	3.327	3.327	
05/13/2022	02:05	24.73	08:35	28.07	26.34	13:45	0.26	22:50	1.18	0.63	13:45	1.388	19:20	6.328	3.378	3.378	
05/14/2022	03:25	25.02	08:55	28.81	26.56	21:40	0.24	04:50	1.22	0.57	21:40	1.306	04:50	6.251	3.105	3.105	
05/15/2022	04:55	25.08	10:40	28.79	26.69	12:35	0.24	21:10	1.21	0.57	12:35	1.390	21:10	6.527	3.094	3.094	
05/16/2022	02:10	24.60	09:10	28.60	26.69	11:40	0.23	03:40	1.19	0.57	11:40	1.308	22:30	6.352	3.142	3.142	
05/17/2022	02:35	24.67	09:55	29.22	26.74	00:10	0.28	06:10	1.17	0.57	00:10	1.513	06:10	6.208	3.139	3.139	
05/18/2022	16:30	24.26	09:40	28.52	26.74	20:30	0.33	09:10	1.19	0.57	01:05	1.722	09:10	6.736	3.122	3.122	
05/19/2022	02:05	24.84	09:00	28.82	26.69	02:35	0.33	03:30	1.24	0.58	02:35	1.773	03:30	6.266	3.161	3.161	
05/20/2022	01:25	24.85	08:35	28.54	26.61	12:20	0.32	04:15	1.25	0.58	01:15	1.728	09:15	6.868	3.155	3.155	
05/21/2022	16:45	23.98	09:50	29.14	26.66	11:25	0.32	03:50	1.20	0.57	17:05	1.678	12:55	6.585	3.117	3.117	
05/22/2022	02:05	25.09	11:20	28.83	26.78	11:35	0.33	09:20	1.15	0.56	17:55	1.814	11:50	6.340	3.097	3.097	
05/23/2022	02:45	24.93	09:05	28.95	26.76	18:55	0.33	04:35	1.19	0.57	01:25	1.795	23:10	6.347	3.139	3.139	
05/24/2022	16:35	24.10	09:15	28.76	26.64	13:55	0.34	02:00	1.28	0.60	16:35	1.790	09:25	6.918	3.259	3.259	
05/25/2022	02:15	24.54	08:30	28.40	26.71	08:55	0.34	21:05	1.14	0.60	01:55	1.812	16:30	6.433	3.267	3.267	
05/26/2022	03:05	24.70	08:40	28.83	26.75	14:05	0.33	03:05	1.33	0.61	14:05	1.790	03:05	6.595	3.327	3.327	
05/27/2022	16:55	24.62	08:55	29.35	26.67	23:00	0.32	04:30	1.23	0.61	23:00	1.710	21:45	6.621	3.340	3.340	
05/28/2022	18:15	25.01	10:35	29.01	26.70	12:30	0.34	17:25	1.18	0.61	01:30	1.897	17:25	6.531	3.331	3.331	
05/29/2022	03:40	24.30	07:20	29.10	26.67	16:25	0.33	16:10	1.17	0.58	16:25	1.768	22:50	6.510	3.150	3.150	
05/30/2022	19:35	23.75	05:55	29.97	26.33	09:30	0.33	19:25	1.36	0.70	15:15	1.654	17:55	6.963	3.730	3.730	
05/31/2022	03:10	24.11	04:50	29.84	26.44	18:25	0.32	14:25	1.17	0.69	18:25	1.660	14:25	6.337	3.692	3.692	
06/01/2022	01:05	24.76	08:40	28.35	26.66	21:10	0.32	18:40	1.27	0.62	21:10	1.772	18:40	7.057	3.360	3.360	
06/02/2022	03:40	24.53	09:55	29.08	26.84	19:20	0.33	02:10	1.24	0.59	17:05	1.698	18:30	6.437	3.282	3.282	
06/03/2022	15:55	24.25	17:00	29.12	26.76	10:55	0.33	15:40	1.37	0.65	14:40	1.868	15:40	6.691	3.580	3.580	

Date	Depth (in)					Velocity (ft/s)					Quantity (MGD - Total MG)						Rain (in)
	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Total	Total
06/04/2022	03:05	25.11	11:00	28.47	26.64	14:05	0.19	03:35	1.19	0.70	14:05	1.090	10:15	6.270	3.810	3.810	
06/05/2022	17:10	24.69	10:45	28.44	26.56	13:30	0.25	03:50	1.24	0.71	13:30	1.457	03:50	6.298	3.831	3.831	
06/06/2022	02:25	24.77	08:50	28.26	26.50	09:10	0.23	04:40	1.23	0.68	10:00	1.308	04:40	6.340	3.664	3.664	
06/07/2022	02:00	24.80	07:15	27.99	26.56	19:15	0.37	18:20	1.16	0.74	14:00	2.007	10:10	6.306	4.014	4.014	
06/08/2022	08:20	23.86	07:30	29.60	26.50	12:45	0.29	02:50	1.28	0.70	12:45	1.604	02:50	6.336	3.796	3.796	
06/09/2022	03:15	24.77	07:50	28.57	26.61	12:15	0.27	06:05	1.20	0.72	12:15	1.535	11:45	6.319	3.927	3.927	
06/10/2022	02:35	24.72	07:40	28.23	26.70	19:55	0.28	02:35	1.38	0.69	13:10	1.594	02:35	6.828	3.794	3.794	
06/11/2022	02:10	24.88	11:10	28.49	26.69	15:55	0.23	08:55	1.21	0.71	15:55	1.233	08:55	6.669	3.915	3.915	
06/12/2022	02:35	24.91	09:45	28.81	26.78	23:20	0.21	07:15	1.18	0.70	23:20	1.186	19:45	6.365	3.844	3.844	
06/13/2022	02:45	25.02	10:55	28.35	26.57	15:00	0.22	01:25	1.19	0.69	15:00	1.196	07:40	6.262	3.770	3.768	

Report Summary For The Period 04/19/2022 00:00 - 06/13/2022 23:59

	Depth (in)	Velocity (ft/s)	Quantity (MGD - Total MG)
Total			188.356
Avg	26.58	0.62	3.364

Site Commentary

Site Information

CW03	
Pipe Dimensions	30"
Silt Level	0.00"

Overview

Site CW03 functioned under normal conditions during the period Tuesday, April 19, 2022 to Monday, June 13, 2022. No surcharge conditions were experienced at this location. Review of the scattergraph shows that the line remained free flowing throughout the study period. Flow is transitional as it operates between subcritical and supercritical conditions. Unstable conditions may be experienced during transitional periods.

Flow depth and velocity measurements recorded by the flow monitor are consistent with field confirmations conducted to date and support the relative accuracy of the flow monitor at this location.

This site was positioned downstream of locations CW01 and CW10. Flows are balanced.

Observations

Average flow depth, velocity, and quantity data observed during Tuesday, April 19, 2022 to Monday, June 13, 2022 , along with observed minimum and maximum data, are provided in the following table. Values in the Observed Flow Conditions are based on 5-minute averages. Graphs are based on 15-minute averages. As a result, the values shown in the table below may differ from those shown on the graph.

In regard to depth, based on an average depth of 7.68 inches, this site utilized 25.60 percent of full pipe depth. The hourly averaged peak depth of 9.76 inches represented 32.53 percent of full pipe depth.

Observed Flow Conditions

Item	Depth (in)	Velocity (ft/s)	Quantity (MGD)
Average	7.68	3.71	2.432
Minimum	5.26	2.30	0.932
Maximum	9.92	4.78	4.377
Time of Minimum	4/24/2022 07:05	5/28/2022 05:40	5/12/2022 04:40
Time of Maximum	5/30/2022 13:55	5/30/2022 13:55	5/30/2022 13:55

Data Quality

Data uptime observed during the Tuesday, April 19, 2022 to the Monday, June 13, 2022 monitoring period is provided in the table below. Based upon the quality and consistency of the observed flow depth and velocity data, the Continuity equation was used to calculate flow rate and quantities during the monitoring period.

Percent Uptime	
Depth (in)	100
Velocity (ft/s)	100
Quantity (MGD)	100

Ogden.BowenClns.TFM.UT22

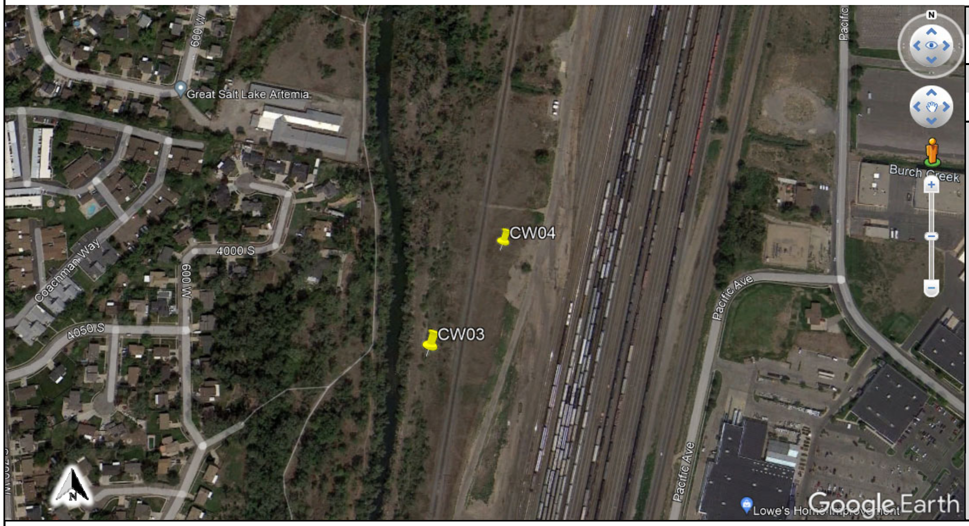
Flow Monitoring Site Report

22773.11.325

CW03

Site Address /Location:	RAILROAD AVE		
Site Access Details:	USE G.P.S TO LOCATE MH	Latitude:	41.190054
		Longitude:	-111.991214

Monitor Series	Location Type
TRITON+ VZ	Temporary
Pipe Size (H x W)	Pipe Shape
30X30	Elliptical
Manhole #	System Characteristics
SW050	Residential/Commercial
Access	Traffic
Walk (Wooded)	None



Installation Information

Installation Date:	Installation Type:
Friday, April 15, 2022	Doppler Standard Ring and Crank
Monitoring Location (Sensors):	Monitor Location:
Upstream 0-5 FT	Manhole
Sensors / Devices:	Pressure Sensor Range (psi)
Peak Combo (CS4)	0 - 5 psi

Installation Confirmation:

Confirmation Time:	Pipe Size (HxW)
9:01AM	30X30
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
8.50	
Downlooker Physical Offset (in)	Measurement Confidence (in)
NA	0.25"
Peak Velocity (fps)	Velocity Sensor Offset (in)
4.92	0"
Silt (in)	Silt Type
0	

Hydraulic Comments:

Smooth flow

Manhole / Pipe Information:

Manhole Depth (Approx. FT):	Manhole Configuration
180	Single
Manhole Material:	Manhole Condition:
Concrete	Good
Manhole Opening Diameter (in)	Manhole Diameter (Approx.):
26"	54"
Manhole Cover	Manhole Frame
vented	Normal
Active Drop Connections	Air Quality:
No	Normal
Pipe Material	Pipe Condition:
Concrete	Good

Communication Information:

Communication Type	Antenna Location
Wireless	Manhole Pick / Vent Hole

Additional Site Info. / Comments:

ADS Project Name:	Ogden.BowenClns.TFM.UT22
ADS Project Number:	22773.11.325

SCATTERGRAPH REPORT

CW03

Flow Monitor

CW03

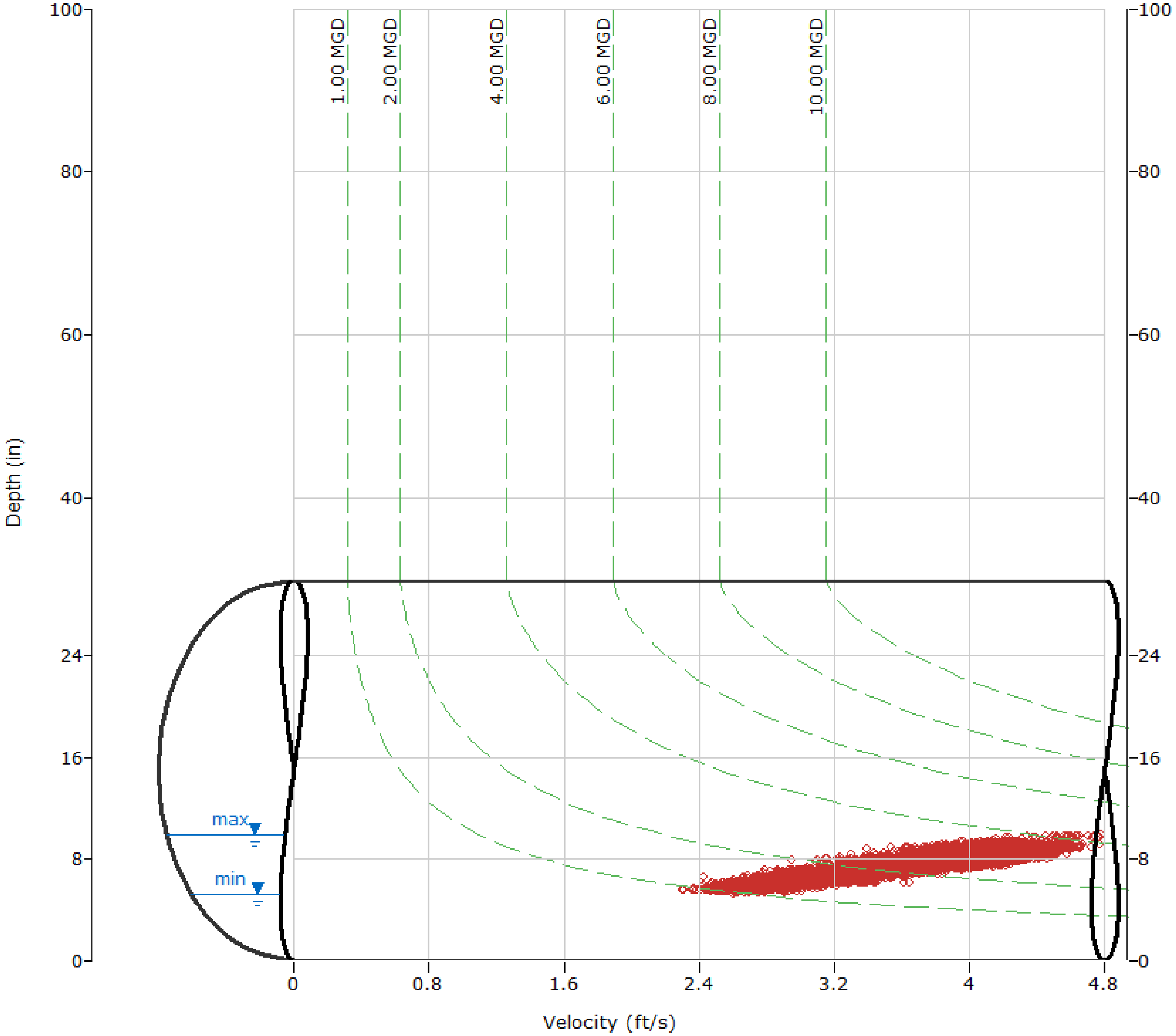
Pipe Height
30.00 in

Report Period

4/19/2022
To
6/13/2022

Legend

- ○ Depth - Velocity
- --- Iso-Q™
- --- Silt
- ▼ Min-Max Depth



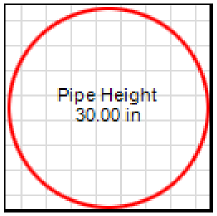
ADS ENVIRONMENTAL SERVICES

HYDROGRAPH REPORT

CW03

Flow Monitor

CW03

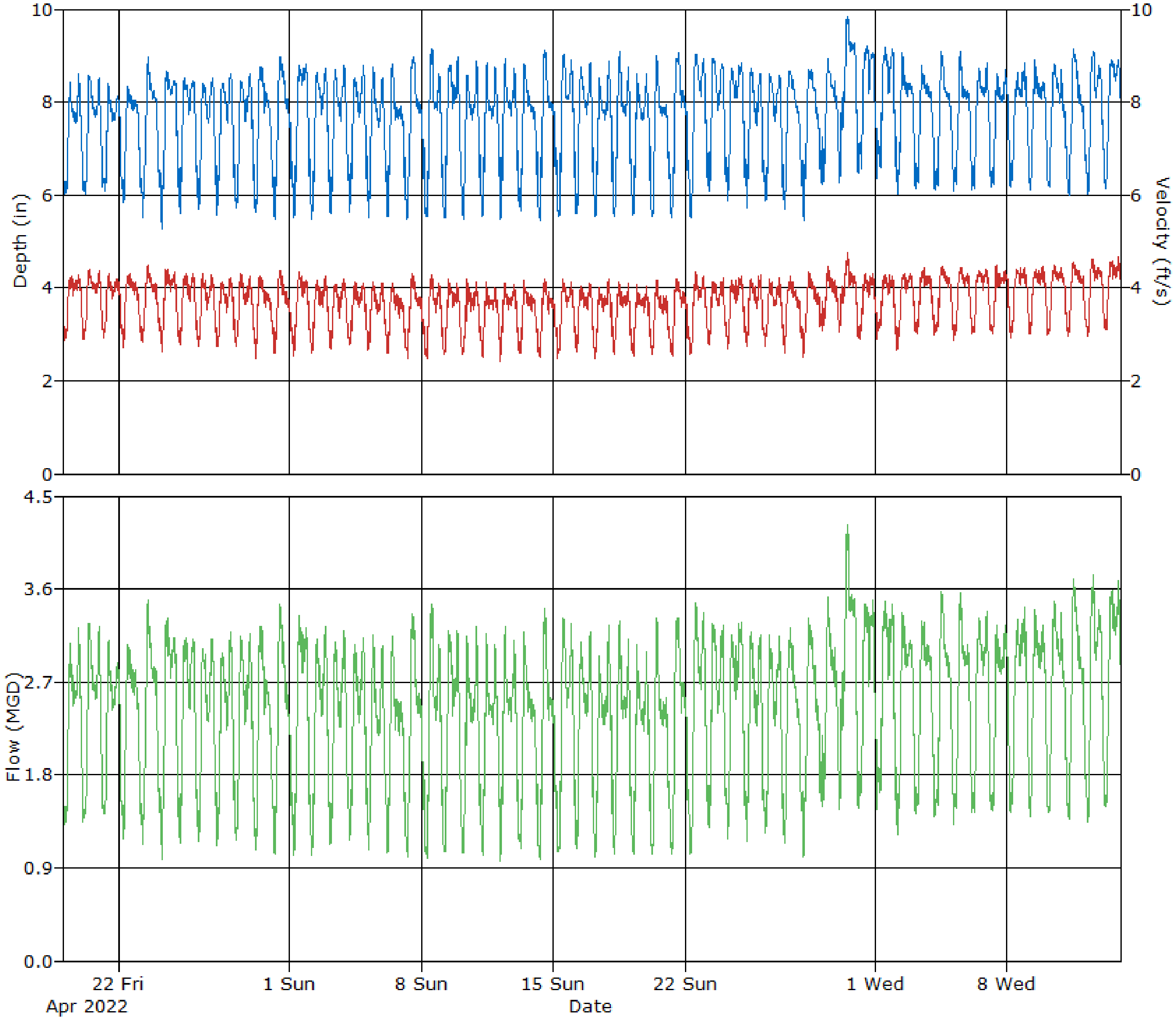


Report Period

4/19/2022
To
6/13/2022

Legend

- Depth
- Velocity
- Quantity



Daily Tabular Report For The Period 04/19/2022 00:00 - 06/13/2022 23:59

CW03, Pipe Height: 30.00 in, Silt: 0.00 in

Daily Tabular Report

Date	Depth (in)					Velocity (ft/s)					Quantity (MGD - Total MG)						Rain (in)
	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Total	Total
04/19/2022	04:00	5.96	21:00	8.67	7.44	03:15	2.78	20:55	4.35	3.81	03:15	1.269	20:55	3.298	2.380	2.380	
04/20/2022	06:00	5.99	09:40	8.58	7.56	01:50	2.60	09:00	4.43	3.85	01:50	1.195	22:20	3.287	2.462	2.462	
04/21/2022	05:55	6.04	10:30	8.44	7.45	04:05	2.88	11:05	4.40	3.80	04:05	1.396	11:05	3.165	2.373	2.373	
04/22/2022	04:40	5.79	10:45	8.34	7.46	04:55	2.67	13:50	4.48	3.79	04:50	1.165	13:50	3.125	2.375	2.375	
04/23/2022	06:25	5.43	13:00	9.02	7.52	06:25	2.74	13:40	4.52	3.77	06:25	1.073	13:00	3.582	2.410	2.410	
04/24/2022	07:05	5.26	12:20	8.67	7.56	07:05	2.60	11:00	4.53	3.78	07:05	0.973	12:05	3.431	2.447	2.447	
04/25/2022	05:05	5.57	10:35	8.53	7.68	05:15	2.68	12:50	4.40	3.76	05:15	1.109	22:00	3.196	2.462	2.462	
04/26/2022	04:55	5.62	22:30	8.52	7.54	05:00	2.65	21:40	4.37	3.69	05:00	1.123	21:40	3.193	2.357	2.357	
04/27/2022	04:20	5.44	22:05	8.63	7.57	04:40	2.60	20:15	4.31	3.65	04:20	1.025	22:00	3.195	2.346	2.346	
04/28/2022	05:30	5.68	22:50	8.61	7.58	04:00	2.60	10:40	4.34	3.71	05:25	1.127	23:05	3.220	2.383	2.383	
04/29/2022	05:50	5.52	12:30	8.82	7.60	05:25	2.43	09:40	4.31	3.63	05:50	1.029	15:00	3.303	2.345	2.345	
04/30/2022	07:00	5.40	13:10	9.00	7.59	05:50	2.54	14:10	4.48	3.64	07:00	0.990	13:10	3.567	2.364	2.364	
05/01/2022	06:15	5.46	13:00	8.85	7.71	06:20	2.50	12:50	4.37	3.67	06:20	0.990	12:20	3.390	2.438	2.438	
05/02/2022	04:10	5.45	21:45	8.74	7.62	04:10	2.53	21:40	4.34	3.64	04:10	0.994	21:40	3.321	2.368	2.368	
05/03/2022	04:15	5.57	22:05	8.84	7.61	03:55	2.58	21:20	4.23	3.62	04:25	1.091	22:05	3.258	2.341	2.341	
05/04/2022	05:10	5.57	22:25	8.80	7.61	04:10	2.65	22:10	4.20	3.63	05:05	1.132	22:10	3.230	2.346	2.346	
05/05/2022	05:35	5.49	10:30	8.79	7.52	05:00	2.54	22:45	4.21	3.58	05:00	1.031	10:40	3.189	2.278	2.278	
05/06/2022	05:35	5.52	10:50	8.83	7.46	05:35	2.50	12:00	4.20	3.52	05:35	1.003	12:00	3.189	2.212	2.212	
05/07/2022	06:15	5.44	14:30	8.98	7.50	06:50	2.36	12:55	4.39	3.51	06:45	0.949	13:10	3.420	2.248	2.248	
05/08/2022	07:15	5.50	13:45	9.17	7.58	07:15	2.41	12:45	4.34	3.54	07:15	0.960	13:50	3.491	2.304	2.304	
05/09/2022	06:05	5.47	22:00	9.01	7.66	04:45	2.49	11:00	4.37	3.54	04:45	1.031	21:55	3.360	2.327	2.327	
05/10/2022	06:00	5.46	21:55	8.88	7.52	03:15	2.47	10:05	4.35	3.51	05:45	1.007	21:55	3.267	2.240	2.240	
05/11/2022	05:40	5.55	11:25	8.88	7.57	04:25	2.44	10:20	4.20	3.52	05:50	0.989	10:20	3.232	2.259	2.259	
05/12/2022	04:10	5.45	10:35	8.94	7.66	04:40	2.31	10:30	4.15	3.56	04:40	0.932	10:30	3.258	2.322	2.322	
05/13/2022	06:05	5.61	10:45	8.83	7.56	06:25	2.36	10:15	4.24	3.51	06:25	0.990	10:15	3.257	2.248	2.248	
05/14/2022	06:35	5.42	12:40	9.19	7.54	07:00	2.45	12:30	4.28	3.50	06:35	0.963	12:30	3.461	2.259	2.259	
05/15/2022	06:25	5.54	13:35	9.05	7.63	04:35	2.42	11:20	4.29	3.52	04:35	1.037	11:20	3.396	2.312	2.312	
05/16/2022	04:40	5.58	22:15	8.88	7.64	05:15	2.57	22:10	4.18	3.56	04:45	1.055	22:15	3.259	2.323	2.323	
05/17/2022	05:05	5.50	22:35	8.91	7.53	05:20	2.44	22:15	4.38	3.53	05:20	0.987	22:15	3.380	2.251	2.251	
05/18/2022	04:30	5.52	11:55	9.12	7.61	03:55	2.53	13:05	4.20	3.53	05:25	1.023	11:55	3.322	2.294	2.294	
05/19/2022	04:30	5.55	10:15	8.65	7.45	06:20	2.46	22:25	4.23	3.49	06:20	1.008	22:25	3.146	2.193	2.193	
05/20/2022	05:10	5.52	11:05	9.01	7.46	05:00	2.48	11:30	4.33	3.49	05:00	1.005	11:30	3.423	2.199	2.199	
05/21/2022	05:55	5.45	14:45	9.05	7.60	06:55	2.45	14:35	4.24	3.53	05:55	1.013	14:50	3.369	2.303	2.303	
05/22/2022	06:30	5.50	11:30	9.09	7.75	07:25	2.49	14:30	4.42	3.62	06:30	1.025	12:35	3.522	2.434	2.434	
05/23/2022	05:20	5.92	11:15	8.97	7.90	04:55	2.60	22:50	4.29	3.68	04:55	1.227	22:50	3.310	2.502	2.502	
05/24/2022	05:30	5.80	22:55	8.89	7.86	06:00	2.64	22:15	4.31	3.71	05:30	1.173	22:15	3.317	2.511	2.511	
05/25/2022	06:00	5.68	11:15	8.73	7.69	05:40	2.68	23:20	4.37	3.68	05:40	1.142	11:00	3.265	2.406	2.406	
05/26/2022	05:00	5.85	22:25	8.59	7.66	04:50	2.72	10:05	4.28	3.67	05:45	1.200	10:05	3.210	2.388	2.388	
05/27/2022	05:50	5.60	12:05	8.70	7.62	05:35	2.57	16:25	4.40	3.65	05:30	1.110	13:05	3.289	2.364	2.364	
05/28/2022	05:55	5.42	12:30	8.74	7.54	05:40	2.30	12:35	4.37	3.63	05:40	0.934	12:35	3.345	2.331	2.331	
05/29/2022	04:05	6.16	12:50	8.92	7.75	04:55	3.04	12:45	4.49	3.81	05:15	1.458	12:45	3.550	2.513	2.513	
05/30/2022	02:55	6.22	13:55	9.92	8.49	02:15	2.95	13:55	4.78	3.99	03:10	1.445	13:55	4.377	3.003	3.003	
05/31/2022	03:00	6.39	13:30	9.28	8.23	02:25	2.83	20:50	4.39	3.78	03:00	1.409	13:25	3.595	2.719	2.719	
06/01/2022	03:00	6.33	13:40	9.19	8.19	02:30	2.72	19:25	4.45	3.80	02:30	1.410	13:35	3.542	2.715	2.715	
06/02/2022	05:25	5.98	11:15	9.06	7.84	04:20	2.60	22:40	4.39	3.80	05:05	1.192	11:10	3.433	2.562	2.562	
06/03/2022	03:30	6.11	11:35	8.82	7.75	02:55	2.91	14:15	4.49	3.87	03:30	1.413	11:25	3.333	2.559	2.559	

Date	Depth (in)					Velocity (ft/s)					Quantity (MGD - Total MG)						Rain (in)
	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Total	Total
06/04/2022	05:00	6.10	13:00	9.09	7.72	03:20	2.94	13:15	4.58	3.87	04:05	1.398	13:10	3.657	2.558	2.558	
06/05/2022	04:50	6.07	12:20	9.11	7.68	04:30	2.75	12:45	4.51	3.88	04:30	1.265	13:10	3.616	2.543	2.543	
06/06/2022	06:40	6.07	22:15	8.87	7.76	03:05	2.92	21:40	4.53	3.91	03:05	1.391	22:05	3.413	2.597	2.597	
06/07/2022	04:00	6.13	22:05	8.72	7.72	06:30	2.97	10:20	4.52	3.91	04:00	1.429	21:30	3.305	2.575	2.575	
06/08/2022	04:10	6.16	22:35	8.86	7.81	05:40	2.84	13:55	4.50	3.95	05:40	1.383	22:40	3.441	2.641	2.641	
06/09/2022	05:50	6.05	11:35	8.93	7.83	05:45	2.96	20:50	4.53	3.96	05:45	1.375	11:35	3.458	2.654	2.654	
06/10/2022	05:50	6.16	11:55	8.85	7.82	02:50	2.78	11:45	4.59	3.96	05:30	1.399	11:45	3.543	2.655	2.655	
06/11/2022	06:45	5.97	12:50	9.15	7.79	05:15	2.88	11:30	4.60	3.96	06:55	1.363	12:25	3.718	2.651	2.651	
06/12/2022	06:40	5.99	13:20	9.08	7.88	06:45	2.91	13:20	4.77	4.01	06:45	1.316	13:20	3.864	2.727	2.727	
06/13/2022	05:05	6.13	13:05	8.96	7.97	06:35	3.04	21:05	4.72	4.08	05:30	1.446	21:05	3.724	2.816	2.814	

Report Summary For The Period 04/19/2022 00:00 - 06/13/2022 23:59

	Depth (in)	Velocity (ft/s)	Quantity (MGD - Total MG)
Total			136.192
Avg	7.68	3.71	2.432

Site Commentary

Site Information

CW04	
Pipe Dimensions	30.13"
Silt Level	0.00"

Overview

Site CW04 functioned under normal conditions during the period Tuesday, April 19, 2022 to Monday, June 13, 2022. No surcharge conditions were experienced at this location. Review of the scattergraph shows that free flow conditions were maintained throughout the study period. Flow is supercritical.

Flow depth and velocity measurements recorded by the flow monitor are consistent with field confirmations conducted to date and support the relative accuracy of the flow monitor at this location.

This site along with CW03 and CW05 was positioned upstream of location CW07 (See CW07 Site Commentary For Balancing Details).

Observations

Average flow depth, velocity, and quantity data observed during Tuesday, April 19, 2022 to Monday, June 13, 2022 , along with observed minimum and maximum data, are provided in the following table. Values in the Observed Flow Conditions are based on 5-minute averages. Graphs are based on 15-minute averages. As a result, the values shown in the table below may differ from those shown on the graph.

In regard to depth, based on an average depth of 3.64 inches, this site utilized 12.08 percent of full pipe depth. The hourly averaged peak depth of 4.93 inches represented 16.36 percent of full pipe depth.

Observed Flow Conditions

Item	Depth (in)	Velocity (ft/s)	Quantity (MGD)
Average	3.64	6.62	1.481
Minimum	2.76	5.38	0.834
Maximum	4.98	7.70	2.665
Time of Minimum	6/1/2022 04:45	5/7/2022 04:45	6/12/2022 06:40
Time of Maximum	5/30/2022 12:45	5/30/2022 12:45	5/30/2022 12:45

Data Quality

Data uptime observed during the Tuesday, April 19, 2022 to the Monday, June 13, 2022 monitoring period is provided in the table below. Based upon the quality and consistency of the observed flow depth and velocity data, the Continuity equation was used to calculate flow rate and quantities during the monitoring period.

Percent Uptime	
Depth (in)	100
Velocity (ft/s)	100
Quantity (MGD)	100

Ogden.BowenClns.TFM.UT22

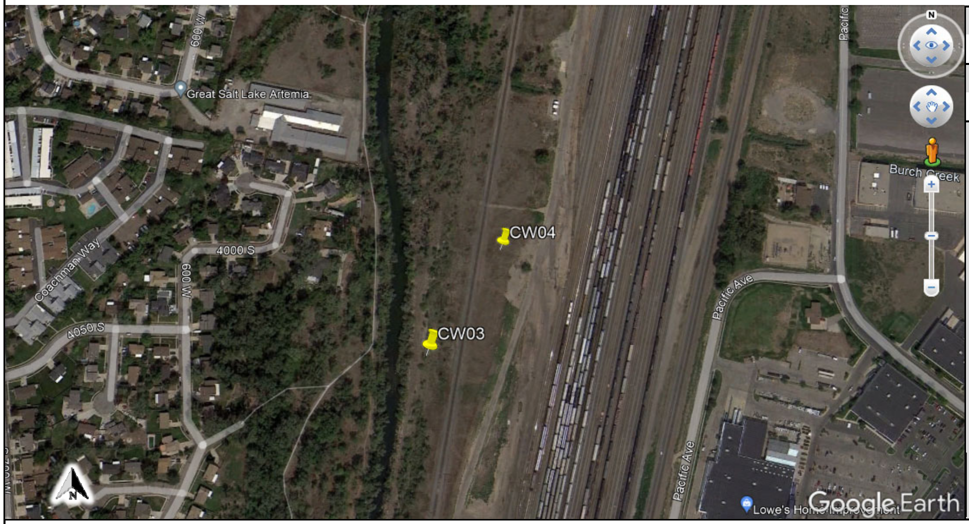
Flow Monitoring
Site Report

ADS ENVIRONMENTAL SERVICES®

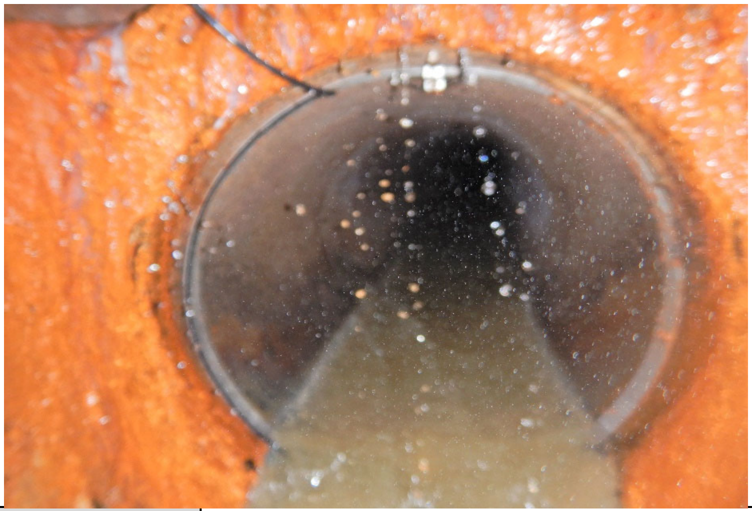
22773.11.325

CW04

Site Address /Location:	RAILROAD AVE			Monitor Series TRITON+ VZ	Location Type Temporary
Site Access Details:	USE G.P.S TO LOCATE MH	Latitude: Longitude:	41.191086 -111.990289	Pipe Size (H x W) 30.13X30.13	Pipe Shape Elliptical



Manhole #	System Characteristics
OC115	Residential/Commercial
Access	Traffic
Walk (Wooded)	None



Installation Information

Installation Date:	Installation Type:
Friday, April 15, 2022	Doppler Standard Ring and Crank
Monitoring Location (Sensors):	Monitor Location:
Upstream 0-5 FT	Manhole
Sensors / Devices:	Pressure Sensor Range (psi)
Peak Combo (CS4)	0 - 5 psi

Installation Confirmation:

Confirmation Time:	Pipe Size (HxW)
819AM	30.13X30.13
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
4.13	
Downlooker Physical Offset (in)	Measurement Confidence (in)
NA	0.38"
Peak Velocity (fps)	Velocity Sensor Offset (in)
7.87	0"
Silt (in)	Silt Type
0	

Hydraulic Comments:
Smooth flow

Manhole / Pipe Information:

Manhole Depth (Approx. FT):	Manhole Configuration
180	Single
Manhole Material:	Manhole Condition:
Concrete	Good
Manhole Opening Diameter (in)	Manhole Diameter (Approx.):
26"	54"
Manhole Cover	Manhole Frame
vented	Normal
Active Drop Connections	Air Quality:
No	Normal
Pipe Material	Pipe Condition:
Concrete	Good

Communication Information:

Communication Type	Antenna Location
Wireless	Manhole Pick / Vent Hole

Additional Site Info. / Comments:

ADS Project Name:	Ogden.BowenClns.TFM.UT22
ADS Project Number:	22773.11.325

SCATTERGRAPH REPORT

CW04

Flow Monitor

CW04

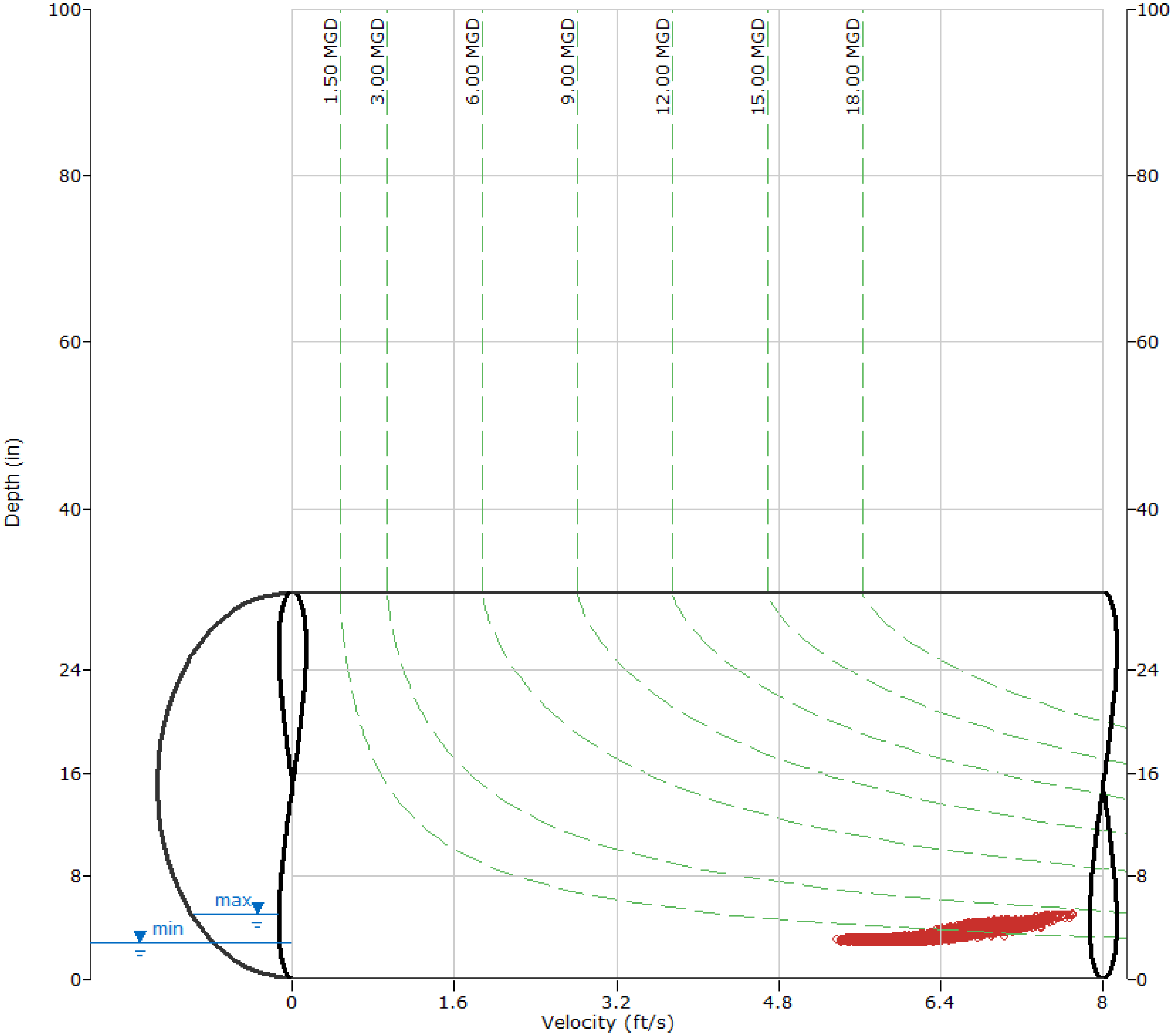
Pipe Height
30.13 in

Report Period

4/19/2022
To
6/13/2022

Legend

- ○ Depth - Velocity
- --- Iso-Q™
- --- Silt
- ▼ Min-Max Depth



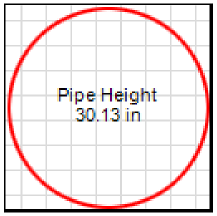
ADS ENVIRONMENTAL SERVICES

HYDROGRAPH REPORT

CW04

Flow Monitor

CW04

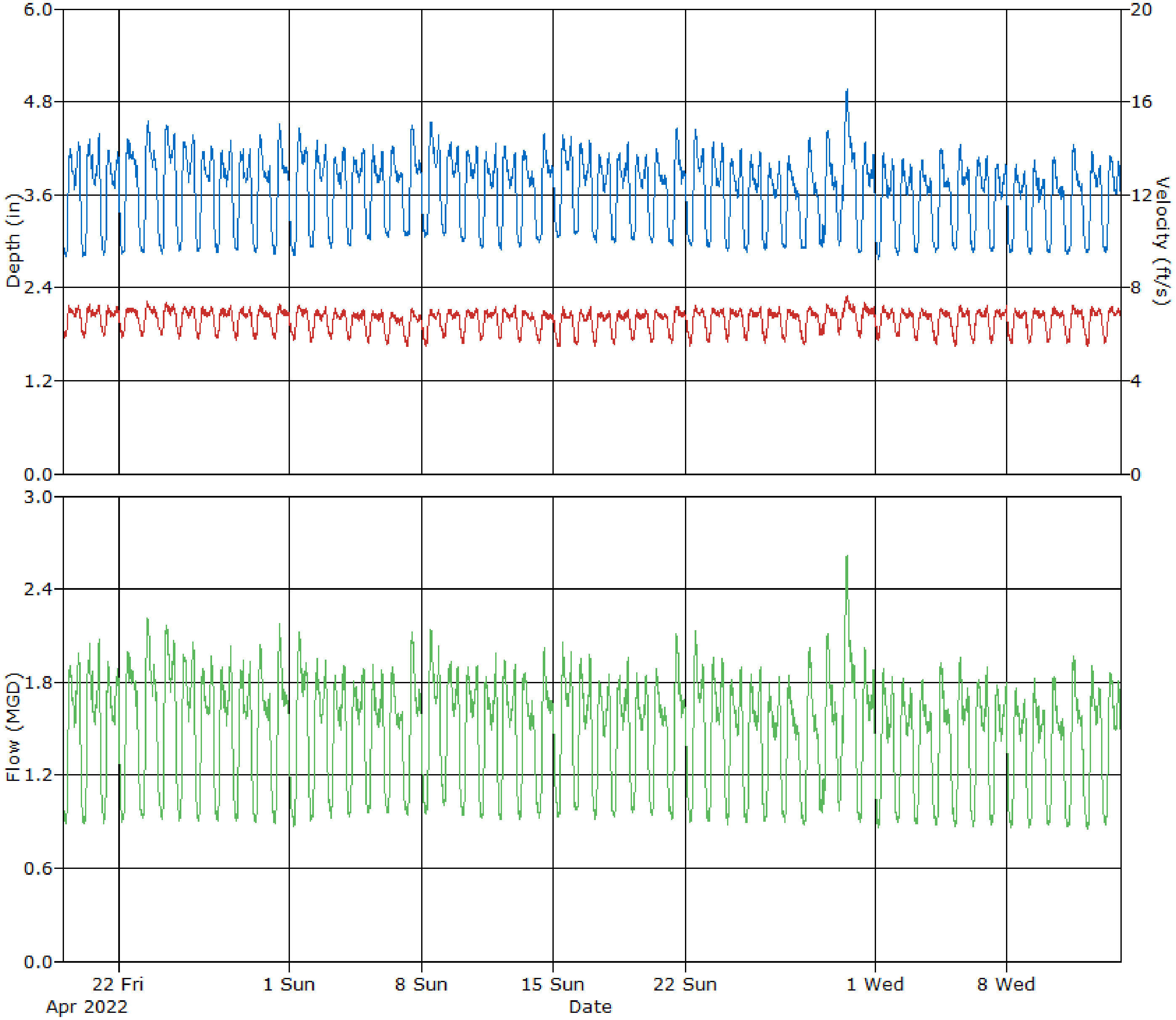


Report Period

4/19/2022
To
6/13/2022

Legend

- Depth
- Velocity
- Quantity



ADS ENVIRONMENTAL SERVICES

Daily Tabular Report

Date	Depth (in)					Velocity (ft/s)					Quantity (MGD - Total MG)						Rain (in)
	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Total	Total
04/19/2022	04:40	2.79	20:30	4.30	3.66	02:35	5.80	08:20	7.32	6.73	03:50	0.878	20:15	1.991	1.512	1.512	
04/20/2022	02:40	2.80	22:40	4.40	3.71	03:00	5.81	10:15	7.40	6.75	03:00	0.876	22:40	2.128	1.551	1.551	
04/21/2022	04:50	2.81	10:55	4.20	3.64	05:00	5.83	09:25	7.37	6.72	05:00	0.879	09:25	1.963	1.500	1.500	
04/22/2022	03:55	2.84	10:50	4.32	3.72	03:45	5.72	11:15	7.30	6.73	03:45	0.877	11:15	2.024	1.553	1.553	
04/23/2022	05:30	2.84	13:00	4.59	3.72	06:40	5.84	11:45	7.51	6.76	06:40	0.907	11:45	2.241	1.566	1.566	
04/24/2022	06:30	2.83	12:50	4.51	3.79	05:55	5.89	11:40	7.42	6.80	06:50	0.905	11:40	2.211	1.615	1.615	
04/25/2022	04:40	2.85	22:30	4.39	3.74	04:50	5.71	20:20	7.31	6.72	04:50	0.893	22:40	2.068	1.565	1.565	
04/26/2022	05:35	2.86	21:25	4.23	3.68	04:50	5.79	21:25	7.26	6.69	04:35	0.906	21:25	1.986	1.514	1.514	
04/27/2022	04:20	2.84	22:20	4.32	3.66	05:45	5.74	22:30	7.30	6.67	05:45	0.890	22:20	2.042	1.504	1.504	
04/28/2022	05:20	2.88	13:00	4.21	3.67	05:35	5.69	22:15	7.31	6.68	05:30	0.894	13:00	1.975	1.508	1.508	
04/29/2022	05:55	2.83	11:15	4.39	3.67	04:10	5.74	11:40	7.27	6.66	06:00	0.884	11:40	2.056	1.505	1.505	
04/30/2022	06:45	2.82	12:15	4.53	3.67	05:15	5.70	11:55	7.36	6.68	06:30	0.884	11:55	2.197	1.512	1.512	
05/01/2022	06:35	2.80	12:55	4.48	3.71	06:15	5.71	13:40	7.30	6.68	06:05	0.864	12:55	2.157	1.544	1.544	
05/02/2022	05:40	2.91	11:00	4.30	3.69	03:40	5.60	22:50	7.26	6.60	03:40	0.892	11:10	1.965	1.506	1.506	
05/03/2022	05:10	2.90	22:10	4.23	3.67	05:05	5.77	23:10	7.15	6.61	05:10	0.911	22:10	1.941	1.490	1.490	
05/04/2022	04:45	2.93	23:00	4.21	3.68	03:35	5.70	21:30	7.14	6.56	03:35	0.920	21:30	1.922	1.485	1.485	
05/05/2022	06:20	3.02	10:25	4.26	3.69	04:30	5.56	22:00	7.09	6.52	04:30	0.934	10:25	1.953	1.478	1.478	
05/06/2022	05:25	3.03	11:30	4.24	3.69	04:40	5.52	09:55	7.01	6.43	05:30	0.941	11:45	1.906	1.457	1.457	
05/07/2022	05:55	3.06	11:40	4.52	3.74	04:45	5.38	11:35	7.21	6.43	04:45	0.927	11:35	2.145	1.496	1.496	
05/08/2022	04:35	3.06	12:00	4.55	3.81	06:05	5.47	13:10	7.16	6.49	05:55	0.942	12:00	2.169	1.555	1.555	
05/09/2022	05:35	3.06	13:00	4.29	3.78	05:25	5.78	12:15	7.18	6.62	05:35	0.991	13:05	1.944	1.553	1.553	
05/10/2022	05:30	2.99	22:35	4.24	3.70	05:00	5.53	21:40	7.22	6.59	05:00	0.925	22:50	1.925	1.504	1.504	
05/11/2022	04:45	2.91	22:55	4.27	3.66	03:30	5.68	22:30	7.19	6.64	04:15	0.904	22:35	1.990	1.492	1.492	
05/12/2022	04:45	2.87	10:20	4.24	3.68	04:00	5.71	22:35	7.28	6.66	04:35	0.904	09:55	1.969	1.505	1.505	
05/13/2022	05:30	2.93	11:00	4.17	3.63	05:15	5.65	11:15	7.08	6.56	05:30	0.917	11:00	1.882	1.454	1.454	
05/14/2022	04:50	2.98	12:00	4.42	3.67	05:05	5.51	12:25	7.08	6.49	05:05	0.906	12:00	2.057	1.468	1.468	
05/15/2022	04:20	3.05	12:15	4.38	3.76	06:10	5.43	12:00	7.31	6.47	06:10	0.922	12:00	2.096	1.520	1.520	
05/16/2022	03:50	3.07	21:55	4.31	3.74	05:55	5.53	22:30	7.24	6.50	05:55	0.961	21:55	2.012	1.506	1.506	
05/17/2022	06:05	2.97	22:15	4.15	3.65	04:50	5.41	22:40	7.05	6.51	04:25	0.908	22:20	1.860	1.456	1.456	
05/18/2022	05:15	2.97	22:15	4.29	3.67	04:35	5.54	22:15	7.22	6.53	05:05	0.923	22:15	2.012	1.474	1.474	
05/19/2022	04:15	3.01	21:50	4.14	3.66	03:45	5.69	10:25	7.18	6.56	04:15	0.951	10:25	1.887	1.471	1.471	
05/20/2022	05:45	2.97	10:30	4.20	3.63	05:00	5.61	10:40	7.15	6.55	05:00	0.925	10:40	1.920	1.451	1.451	
05/21/2022	07:30	2.93	12:10	4.48	3.66	06:30	5.54	12:10	7.31	6.59	06:30	0.899	12:10	2.172	1.489	1.489	
05/22/2022	06:20	2.93	12:35	4.46	3.70	05:50	5.46	12:35	7.35	6.62	06:20	0.886	12:35	2.172	1.520	1.520	
05/23/2022	05:05	2.91	10:55	4.29	3.66	03:15	5.59	22:45	7.22	6.65	04:55	0.889	10:40	1.992	1.494	1.494	
05/24/2022	04:35	2.86	22:00	4.21	3.59	05:45	5.55	21:10	7.25	6.66	04:55	0.871	22:00	1.936	1.452	1.452	
05/25/2022	06:00	2.85	22:20	4.16	3.59	05:45	5.63	22:45	7.31	6.64	05:45	0.882	22:45	1.947	1.450	1.450	
05/26/2022	04:40	2.89	22:35	4.05	3.54	05:10	5.59	22:15	7.24	6.60	03:45	0.895	22:15	1.856	1.408	1.408	
05/27/2022	05:20	2.90	10:30	4.11	3.52	06:05	5.60	10:20	7.16	6.59	06:05	0.892	10:35	1.857	1.394	1.394	
05/28/2022	07:20	2.90	12:45	4.35	3.52	06:20	5.48	14:30	7.27	6.55	06:20	0.867	12:55	2.048	1.398	1.398	
05/29/2022	05:05	2.92	11:50	4.45	3.63	05:00	5.91	11:55	7.36	6.71	04:55	0.947	11:55	2.135	1.490	1.490	
05/30/2022	02:35	2.94	12:45	4.98	3.96	02:30	5.85	12:45	7.70	6.96	02:30	0.942	12:45	2.665	1.761	1.761	
05/31/2022	04:25	2.83	12:10	4.30	3.61	06:00	5.84	10:50	7.41	6.76	06:00	0.896	10:50	2.048	1.491	1.491	
06/01/2022	04:45	2.76	11:00	4.15	3.52	05:15	5.68	09:55	7.25	6.68	05:15	0.846	11:00	1.908	1.421	1.421	
06/02/2022	05:50	2.82	11:55	4.07	3.52	05:00	5.81	19:50	7.19	6.64	05:15	0.896	11:45	1.841	1.410	1.410	
06/03/2022	03:30	2.84	12:25	4.07	3.52	04:30	5.65	13:10	7.16	6.60	06:25	0.874	12:25	1.825	1.401	1.401	

Date	**Depth (in)**					**Velocity (ft/s)**					**Quantity (MGD - Total MG)**						**Rain (in)**
	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Total	Total
06/04/2022	05:20	2.85	11:45	4.20	3.53	06:40	5.45	12:30	7.21	6.56	06:40	0.858	12:30	1.948	1.405	1.405	
06/05/2022	05:30	2.88	12:30	4.25	3.56	06:35	5.46	12:20	7.33	6.57	06:35	0.860	13:05	1.985	1.423	1.423	
06/06/2022	04:45	2.84	22:05	4.10	3.57	05:00	5.57	22:05	7.33	6.61	05:00	0.861	22:05	1.918	1.437	1.437	
06/07/2022	05:25	2.85	12:25	4.01	3.53	04:55	5.55	22:55	7.40	6.61	04:55	0.866	22:55	1.829	1.411	1.411	
06/08/2022	05:10	2.84	11:45	4.01	3.50	06:05	5.47	10:05	7.16	6.57	05:15	0.848	11:55	1.772	1.383	1.383	
06/09/2022	03:25	2.83	10:30	4.08	3.48	03:45	5.55	10:20	7.20	6.59	03:30	0.848	10:40	1.837	1.375	1.375	
06/10/2022	05:25	2.84	12:15	4.09	3.49	04:05	5.59	11:20	7.26	6.60	04:05	0.866	10:45	1.857	1.386	1.386	
06/11/2022	03:55	2.83	12:15	4.25	3.51	04:25	5.57	11:10	7.30	6.60	04:55	0.855	13:20	1.993	1.403	1.403	
06/12/2022	06:30	2.84	12:20	4.16	3.52	06:40	5.42	13:15	7.30	6.60	06:40	0.834	12:10	1.939	1.408	1.408	
06/13/2022	05:35	2.85	10:40	4.12	3.55	04:40	5.59	14:20	7.25	6.64	05:30	0.875	10:50	1.895	1.433	1.432	

Report Summary For The Period 04/19/2022 00:00 - 06/13/2022 23:59

	Depth (in)	Velocity (ft/s)	Quantity (MGD - Total MG)
Total			82.909
Avg	3.64	6.62	1.481

Site Commentary

Site Information

CW05	
Pipe Dimensions	35.75"
Silt Level	0.00"

Overview

Site CW05 functioned under normal conditions during the period Tuesday, April 19, 2022 to Monday, June 13, 2022. No surcharge conditions were experienced at this location. Review of the scattergraph shows that free flow conditions were maintained throughout the study period. Flow is subcritical.

Flow depth and velocity measurements recorded by the flow monitor are consistent with field confirmations conducted to date and support the relative accuracy of the flow monitor at this location.

This site along with CW03 and CW04 was positioned upstream of location CW07 (See CW07 Site Commentary For Balancing Details).

Observations

Average flow depth, velocity, and quantity data observed during Tuesday, April 19, 2022 to Monday, June 13, 2022 , along with observed minimum and maximum data, are provided in the following table. Values in the Observed Flow Conditions are based on 5-minute averages. Graphs are based on 15-minute averages. As a result, the values shown in the table below may differ from those shown on the graph.

In regard to depth, based on an average depth of 10.02 inches, this site utilized 28.03 percent of full pipe depth. The hourly averaged peak depth of 13.00 inches represented 36.36 percent of full pipe depth.

Observed Flow Conditions

Item	Depth (in)	Velocity (ft/s)	Quantity (MGD)
Average	10.02	2.28	2.370
Minimum	7.80	1.93	1.418
Maximum	13.40	2.71	4.067
Time of Minimum	4/24/2022 05:30	5/25/2022 04:30	4/24/2022 05:50
Time of Maximum	5/30/2022 05:45	5/30/2022 12:40	5/30/2022 05:45

Data Quality

Data uptime observed during the Tuesday, April 19, 2022 to the Monday, June 13, 2022 monitoring period is provided in the table below. Based upon the quality and consistency of the observed flow depth and velocity data, the Continuity equation was used to calculate flow rate and quantities during the monitoring period.

Percent Uptime	
Depth (in)	100
Velocity (ft/s)	100
Quantity (MGD)	100

Ogden.BowenClns.TFM.UT22

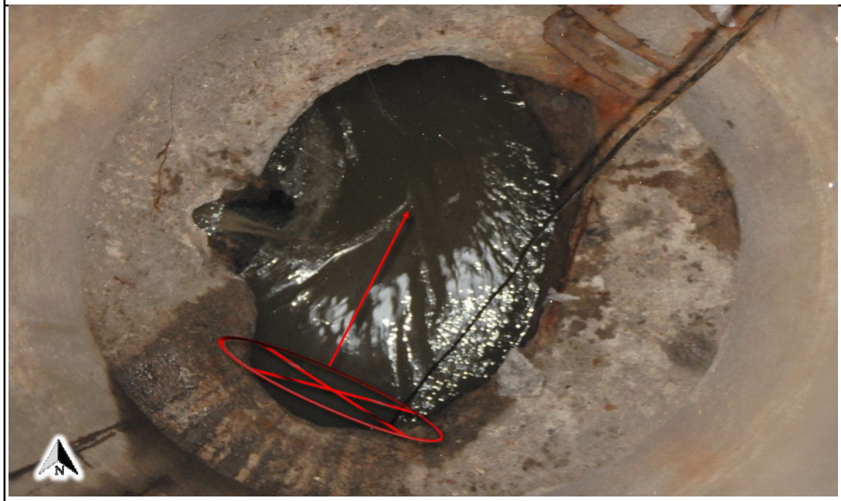
Flow Monitoring
Site Report

22773.11.325

CW05

Site Address /Location:	S 200 W AND W 31st ST			Monitor Series TRITON+ VZ	Location Type Temporary
Site Access Details:	DRIVE	Latitude: Longitude:	41.208508 -111.981918	Pipe Size (H x W) 35.75X35.50	Pipe Shape Elliptical

Manhole #	System Characteristics
OC215	Residential/Commercial
Access	Traffic
Drive	Light



Installation Information

Installation Date:	Installation Type:
Friday, April 15, 2022	Doppler Standard Ring and Crank
Monitoring Location (Sensors):	Monitor Location:
Upstream 0-5 FT	Manhole
Sensors / Devices:	Pressure Sensor Range (psi)
Peak Combo (CS4)	0 - 5 psi

Installation Confirmation:

Confirmation Time:	Pipe Size (HxW)
10:12AM	35.75X35.50
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
11.75	
Downlooker Physical Offset (in)	Measurement Confidence (in)
NA	0.25"
Peak Velocity (fps)	Velocity Sensor Offset (in)
2.73	0"
Silt (in)	Silt Type
0	

Hydraulic Comments:
Smooth flow

Manhole / Pipe Information:

Manhole Depth (Approx. FT):	Manhole Configuration
180	Single
Manhole Material:	Manhole Condition:
Concrete	Good
Manhole Opening Diameter (in)	Manhole Diameter (Approx.):
26"	54"
Manhole Cover	Manhole Frame
vented	Normal
Active Drop Connections	Air Quality:
No	Normal
Pipe Material	Pipe Condition:
Concrete	Good

Communication Information:

Communication Type	Antenna Location
Wireless	Manhole Pick / Vent Hole

Additional Site Info. / Comments:

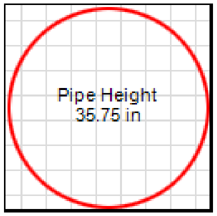
ADS Project Name:	Ogden.BowenClns.TFM.UT22
ADS Project Number:	22773.11.325

SCATTERGRAPH REPORT

CW05

Flow Monitor

CW05



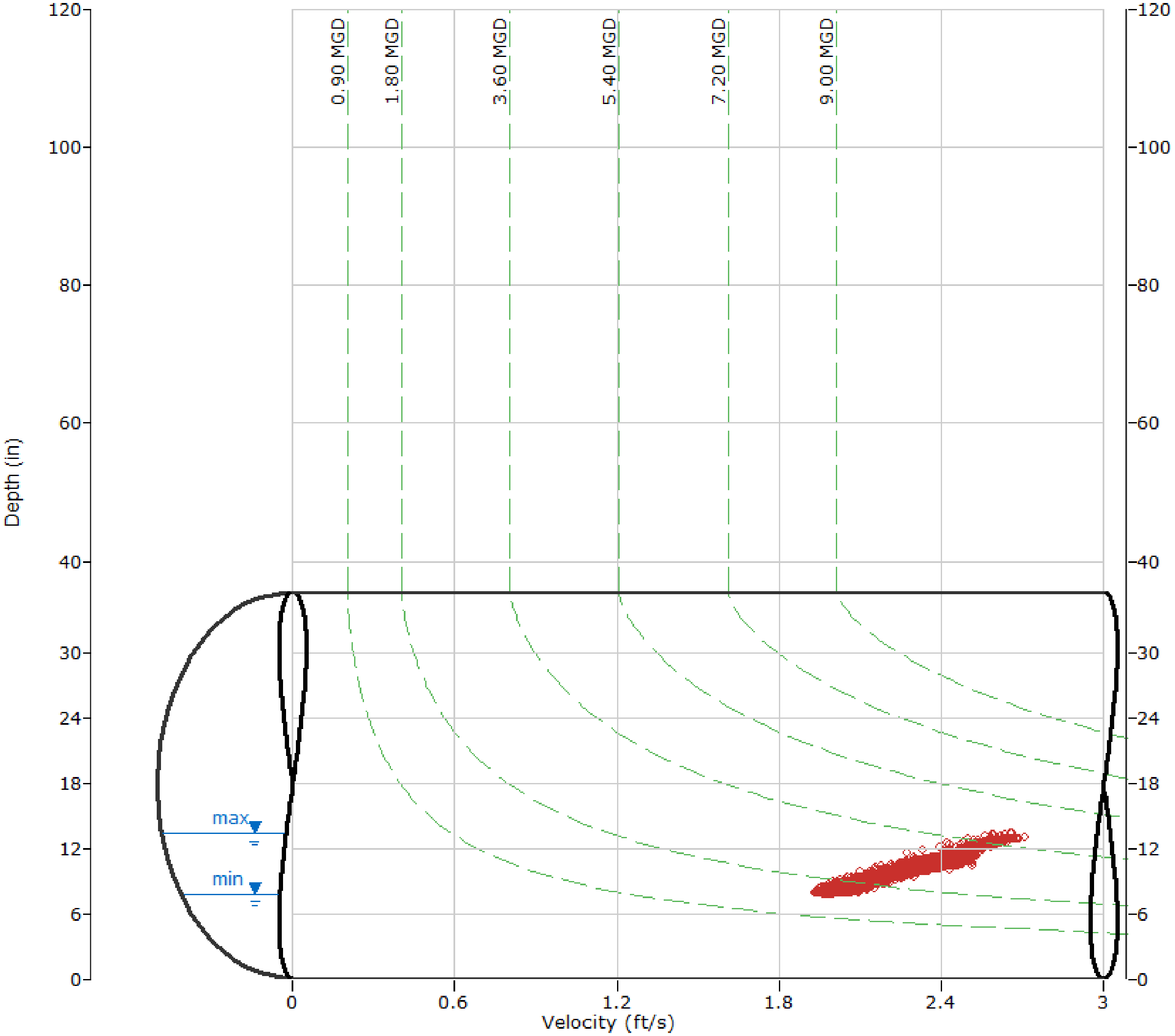
Report Period

4/19/2022
To
6/13/2022

Legend

○ Depth - Velocity
--- Iso-Q™
--- Silt
▼ Min-Max Depth

ADS ENVIRONMENTAL SERVICES



HYDROGRAPH REPORT

CW05

Flow Monitor

CW05

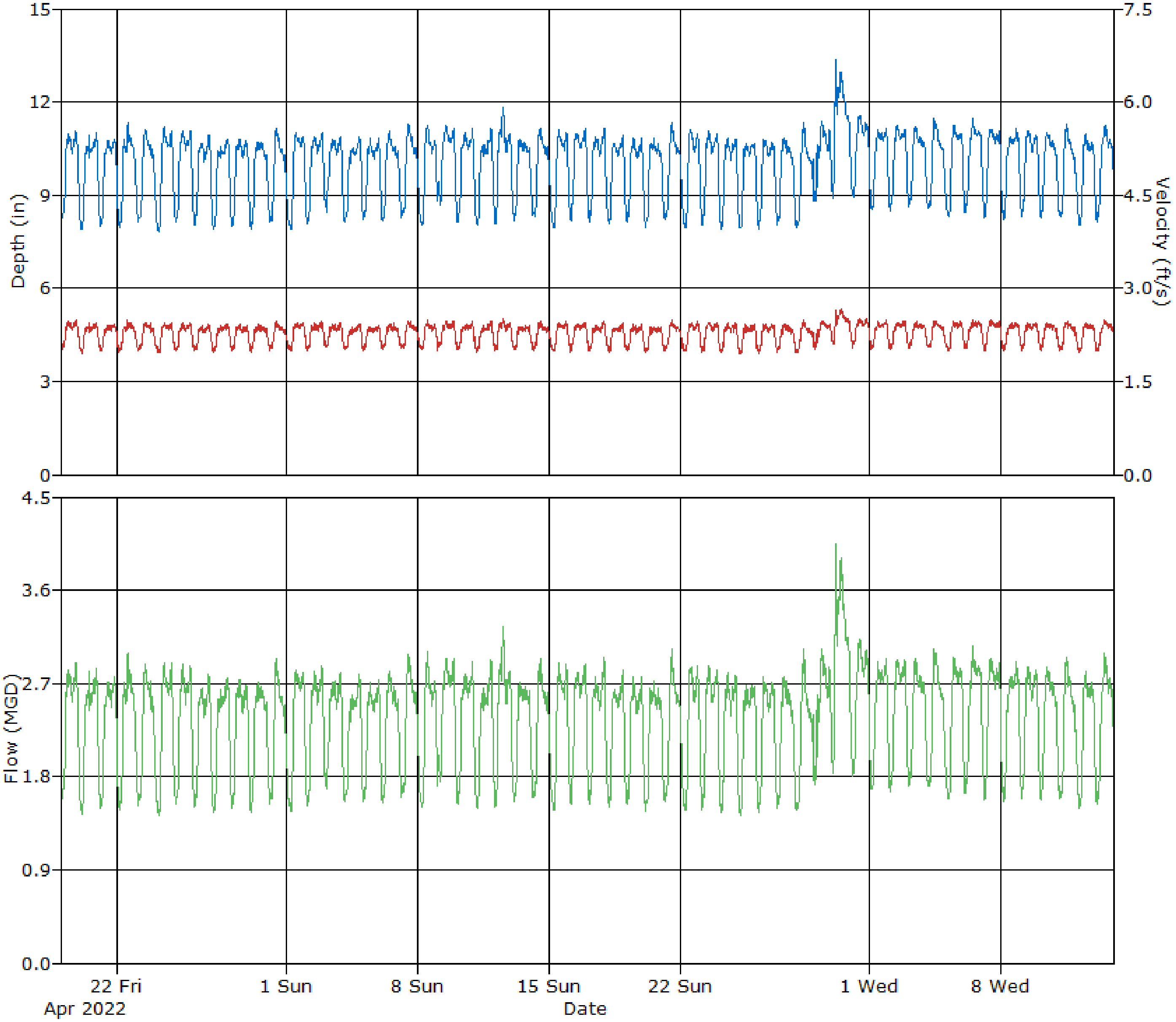
Pipe Height
35.75 in

Report Period

4/19/2022
To
6/13/2022

Legend

- Depth
- Velocity
- Quantity



Daily Tabular Report For The Period 04/19/2022 00:00 - 06/13/2022 23:59

CW05, Pipe Height: 35.75 in, Silt: 0.00 in

Daily Tabular Report

Date	Depth (in)					Velocity (ft/s)					Quantity (MGD - Total MG)						Rain (in)
	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Total	Total
04/19/2022	02:20	8.23	19:35	11.07	10.02	02:10	2.00	20:30	2.51	2.31	02:15	1.565	19:45	2.923	2.395	2.395	
04/20/2022	03:05	7.89	12:35	11.10	9.88	03:35	1.94	12:40	2.51	2.27	03:35	1.428	12:40	2.955	2.314	2.314	
04/21/2022	03:20	7.98	20:15	10.82	9.85	04:45	1.96	20:30	2.46	2.27	03:20	1.467	20:30	2.796	2.294	2.294	
04/22/2022	03:15	7.94	13:50	11.34	9.91	03:40	1.96	17:45	2.51	2.27	03:40	1.454	13:55	3.034	2.325	2.325	
04/23/2022	03:20	8.11	12:10	11.11	9.84	03:10	1.97	18:35	2.51	2.25	03:10	1.504	12:25	2.899	2.283	2.283	
04/24/2022	05:30	7.80	12:25	11.23	9.84	06:50	1.95	21:15	2.49	2.26	05:50	1.418	12:25	2.934	2.299	2.299	
04/25/2022	03:15	8.12	21:50	11.10	10.05	01:55	1.97	11:40	2.48	2.27	03:05	1.517	11:40	2.932	2.369	2.369	
04/26/2022	03:35	8.02	22:10	10.93	9.88	04:15	1.97	20:10	2.46	2.26	03:10	1.494	20:10	2.821	2.293	2.293	
04/27/2022	04:10	7.91	21:35	10.82	9.77	04:15	1.95	20:20	2.45	2.25	04:15	1.439	20:20	2.773	2.256	2.256	
04/28/2022	03:20	7.99	12:30	10.82	9.86	04:05	1.98	11:35	2.44	2.27	03:25	1.492	11:35	2.777	2.300	2.300	
04/29/2022	03:20	7.88	13:00	10.71	9.81	02:45	1.94	12:05	2.44	2.26	02:45	1.438	12:05	2.718	2.277	2.277	
04/30/2022	02:55	8.13	11:20	11.15	9.79	03:05	1.99	11:30	2.51	2.26	03:05	1.531	11:30	2.992	2.269	2.269	
05/01/2022	06:35	7.88	12:45	11.03	9.82	05:55	1.95	21:20	2.46	2.27	06:40	1.430	13:00	2.852	2.298	2.298	
05/02/2022	03:10	8.09	22:00	11.03	10.01	03:30	1.96	20:10	2.49	2.29	03:20	1.502	21:50	2.897	2.376	2.376	
05/03/2022	04:20	8.45	21:30	10.91	10.09	04:15	2.00	20:55	2.47	2.29	04:15	1.623	21:35	2.843	2.393	2.393	
05/04/2022	02:50	8.12	21:45	10.94	9.83	03:35	1.99	21:15	2.44	2.25	02:40	1.537	21:35	2.822	2.274	2.274	
05/05/2022	03:15	8.19	21:55	10.83	9.90	03:15	1.97	22:25	2.41	2.26	03:15	1.525	21:55	2.749	2.299	2.299	
05/06/2022	02:55	8.15	11:50	11.08	9.91	02:50	1.98	17:15	2.51	2.27	02:50	1.522	12:25	2.836	2.312	2.312	
05/07/2022	03:15	8.25	12:00	11.34	9.96	03:10	2.03	11:55	2.49	2.28	03:10	1.585	11:55	3.011	2.346	2.346	
05/08/2022	05:45	8.01	12:50	11.25	9.88	05:45	1.99	12:45	2.52	2.27	05:45	1.495	12:45	3.036	2.315	2.315	
05/09/2022	04:50	8.69	12:00	11.27	10.30	01:15	1.99	21:50	2.51	2.31	01:15	1.699	21:50	2.989	2.487	2.487	
05/10/2022	03:45	8.11	21:45	11.14	10.06	03:40	1.98	21:45	2.48	2.29	03:40	1.518	21:45	2.949	2.383	2.383	
05/11/2022	04:10	8.02	21:40	11.15	9.93	02:35	1.95	21:05	2.51	2.27	04:25	1.493	21:25	2.978	2.327	2.327	
05/12/2022	03:15	8.07	12:45	11.84	10.32	03:10	1.98	13:10	2.55	2.31	03:10	1.497	13:10	3.294	2.503	2.503	
05/13/2022	03:20	8.13	09:45	10.81	9.94	02:40	2.00	08:40	2.41	2.27	03:25	1.555	09:50	2.732	2.321	2.321	
05/14/2022	03:10	8.31	12:40	11.14	9.93	03:50	1.96	13:35	2.48	2.27	03:50	1.578	12:55	2.940	2.322	2.322	
05/15/2022	05:45	7.93	12:00	11.11	9.89	06:30	1.96	22:00	2.49	2.27	06:30	1.449	12:10	2.931	2.324	2.324	
05/16/2022	03:45	8.13	21:55	11.16	10.11	03:45	1.97	14:55	2.48	2.29	03:45	1.505	21:55	2.910	2.407	2.407	
05/17/2022	03:20	8.11	22:30	11.17	10.05	02:45	1.98	22:15	2.50	2.27	03:25	1.525	22:15	2.983	2.367	2.367	
05/18/2022	04:15	8.11	22:10	10.92	9.91	04:20	1.96	21:55	2.46	2.26	04:20	1.491	21:55	2.837	2.307	2.307	
05/19/2022	03:20	8.12	11:40	10.87	9.89	04:00	1.96	14:00	2.46	2.25	03:20	1.510	11:40	2.812	2.290	2.290	
05/20/2022	03:15	7.94	13:20	10.84	9.84	05:10	1.95	09:45	2.43	2.24	03:15	1.452	13:10	2.768	2.269	2.269	
05/21/2022	03:20	8.21	12:05	11.34	9.90	04:15	1.98	12:05	2.51	2.26	04:15	1.553	12:05	3.061	2.312	2.312	
05/22/2022	06:35	7.95	12:30	11.09	9.87	04:15	1.95	21:20	2.49	2.27	06:40	1.460	21:20	2.900	2.311	2.311	
05/23/2022	03:20	8.03	11:35	11.05	10.01	03:20	1.94	13:10	2.50	2.29	03:20	1.459	11:35	2.895	2.374	2.374	
05/24/2022	03:05	7.92	11:25	10.86	9.88	03:10	1.95	21:40	2.47	2.27	03:10	1.441	11:30	2.822	2.314	2.314	
05/25/2022	04:05	7.92	12:00	10.70	9.79	04:30	1.93	10:30	2.46	2.25	04:05	1.431	12:20	2.699	2.264	2.264	
05/26/2022	03:05	7.90	08:55	10.86	9.87	03:35	1.93	13:10	2.47	2.26	03:35	1.440	08:50	2.782	2.300	2.300	
05/27/2022	03:35	8.05	11:00	10.89	9.86	03:15	1.95	12:50	2.44	2.26	03:15	1.475	11:00	2.793	2.286	2.286	
05/28/2022	03:20	7.95	13:15	11.38	9.69	04:40	1.95	13:05	2.53	2.24	03:15	1.455	13:05	3.082	2.225	2.225	
05/29/2022	02:15	8.69	12:20	11.40	10.39	02:25	2.00	12:25	2.48	2.32	02:20	1.710	12:25	3.044	2.524	2.524	
05/30/2022	02:15	8.87	05:45	13.40	11.62	01:55	2.07	12:40	2.71	2.46	02:15	1.810	05:45	4.067	3.135	3.135	
05/31/2022	04:20	8.91	13:00	11.57	10.59	03:00	2.01	12:25	2.52	2.35	03:00	1.765	12:40	3.137	2.632	2.632	
06/01/2022	04:05	8.54	22:25	11.17	10.26	03:00	1.99	21:40	2.51	2.31	03:00	1.658	21:40	2.975	2.476	2.476	
06/02/2022	03:10	8.47	11:35	11.27	10.32	03:15	1.97	22:05	2.48	2.32	03:15	1.600	12:10	2.960	2.499	2.499	
06/03/2022	03:05	8.62	11:15	11.23	10.24	03:10	2.02	12:35	2.48	2.30	03:10	1.686	10:50	2.953	2.455	2.455	

Date	Depth (in)					Velocity (ft/s)					Quantity (MGD - Total MG)						Rain (in)
	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Total	Total
06/04/2022	03:20	8.58	11:30	11.49	10.16	03:30	2.02	14:15	2.52	2.29	03:30	1.683	11:30	3.064	2.423	2.423	
06/05/2022	05:40	8.28	12:45	11.24	10.11	05:15	1.97	21:20	2.50	2.29	06:20	1.571	12:30	2.979	2.409	2.409	
06/06/2022	03:00	8.43	12:05	11.49	10.30	03:00	2.01	13:40	2.49	2.32	03:00	1.618	12:05	3.084	2.500	2.500	
06/07/2022	03:20	8.26	10:35	11.14	10.22	03:35	1.98	11:20	2.50	2.32	03:35	1.559	10:35	2.963	2.472	2.472	
06/08/2022	04:25	8.23	20:40	11.15	10.10	04:00	1.97	19:10	2.49	2.29	04:50	1.538	20:50	2.937	2.401	2.401	
06/09/2022	03:15	8.26	12:25	11.07	10.14	03:40	1.97	21:45	2.47	2.30	03:15	1.564	12:35	2.886	2.421	2.421	
06/10/2022	03:20	8.26	11:35	11.04	10.05	03:35	1.98	10:45	2.47	2.29	03:35	1.556	11:45	2.889	2.385	2.385	
06/11/2022	05:20	8.30	12:25	11.31	9.94	03:40	1.99	13:40	2.48	2.27	03:25	1.582	12:25	2.971	2.334	2.334	
06/12/2022	04:50	8.04	12:30	10.97	9.83	05:10	1.95	12:50	2.47	2.26	05:10	1.480	12:45	2.853	2.289	2.289	
06/13/2022	03:15	8.12	13:40	11.26	10.04	02:50	1.97	13:20	2.50	2.29	02:50	1.521	13:25	2.997	2.383	2.382	

Report Summary For The Period 04/19/2022 00:00 - 06/13/2022 23:59

	Depth (in)	Velocity (ft/s)	Quantity (MGD - Total MG)
Total			132.718
Avg	10.02	2.28	2.370

Site Commentary

Site Information

CW06	
Pipe Dimensions	17.75"
Silt Level	0.00"

Overview

Site CW06 functioned under normal conditions during the period Tuesday, April 19, 2022 to Monday, June 13, 2022. No surcharge conditions were experienced at this location. Review of the scattergraph shows that free flow conditions were maintained throughout the study period. Flow is subcritical.

Flow depth and velocity measurements recorded by the flow monitor are consistent with field confirmations conducted to date and support the relative accuracy of the flow monitor at this location.

This site was positioned downstream of location CW08. Flows are balanced.

Observations

Average flow depth, velocity, and quantity data observed during Tuesday, April 19, 2022 to Monday, June 13, 2022 , along with observed minimum and maximum data, are provided in the following table. Values in the Observed Flow Conditions are based on 5-minute averages. Graphs are based on 15-minute averages. As a result, the values shown in the table below may differ from those shown on the graph.

In regard to depth, based on an average depth of 6.45 inches, this site utilized 36.34 percent of full pipe depth. The hourly averaged peak depth of 7.72 inches represented 43.49 percent of full pipe depth.

Observed Flow Conditions

Item	Depth (in)	Velocity (ft/s)	Quantity (MGD)
Average	6.45	1.28	0.478
Minimum	4.65	0.74	0.181
Maximum	7.82	1.67	0.776
Time of Minimum	4/26/2022 05:20	6/7/2022 05:35	4/20/2022 04:25
Time of Maximum	5/16/2022 22:50	5/11/2022 22:00	5/11/2022 22:00

Data Quality

Data uptime observed during the Tuesday, April 19, 2022 to the Monday, June 13, 2022 monitoring period is provided in the table below. Based upon the quality and consistency of the observed flow depth and velocity data, the Continuity equation was used to calculate flow rate and quantities during the monitoring period.

Percent Uptime	
Depth (in)	100
Velocity (ft/s)	100
Quantity (MGD)	100

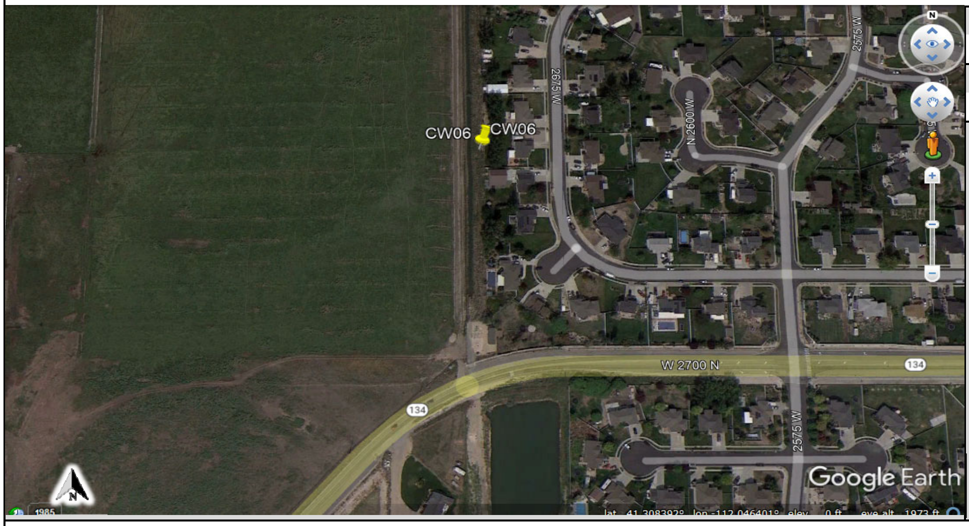
Ogden.BowenClns.TFM.UT22

Flow Monitoring
Site Report

22773.11.325

CW06

Site Address /Location:	W 2700 N			Monitor Series TRITON+ VZ	Location Type Temporary
Site Access Details:	ACCESS THROUGHT LIFT STATION NEED A KEY FOR GATE	Latitude: Longitude:	41.3082452 -112.0448047	Pipe Size (H x W) 17.75X17.75	Pipe Shape Elliptical



Manhole #	System Characteristics
FW029	Residential/Commercial
Access	Traffic
Drive	None

Installation Information

Installation Date:	Installation Type:
Saturday, April 16, 2022	Doppler Standard Ring and Crank
Monitoring Location (Sensors):	Monitor Location:
Upstream 0-5 FT	Manhole
Sensors / Devices:	Pressure Sensor Range (psi)
Peak Combo (CS4)	0 - 5 psi

Installation Confirmation:

Confirmation Time:	Pipe Size (HxW)
8:56AM	17.75X17.75
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
6.25	
Downlooker Physical Offset (in)	Measurement Confidence (in)
NA	0.25"
Peak Velocity (fps)	Velocity Sensor Offset (in)
1.51	0"
Silt (in)	Silt Type
0	

Hydraulic Comments:
Smooth flow

Manhole / Pipe Information:

Manhole Depth (Approx. FT):	Manhole Configuration
180	Single
Manhole Material:	Manhole Condition:
Concrete	Good
Manhole Opening Diameter (in)	Manhole Diameter (Approx.):
26"	54"
Manhole Cover	Manhole Frame
vented	Normal
Active Drop Connections	Air Quality:
No	Normal
Pipe Material	Pipe Condition:
Concrete	Good

Communication Information:

Communication Type	Antenna Location
Wireless	Manhole Pick / Vent Hole

Additional Site Info. / Comments:

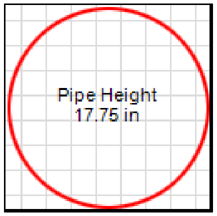
ADS Project Name:	Ogden.BowenClns.TFM.UT22
ADS Project Number:	22773.11.325

SCATTERGRAPH REPORT

CW06

Flow Monitor

CW06

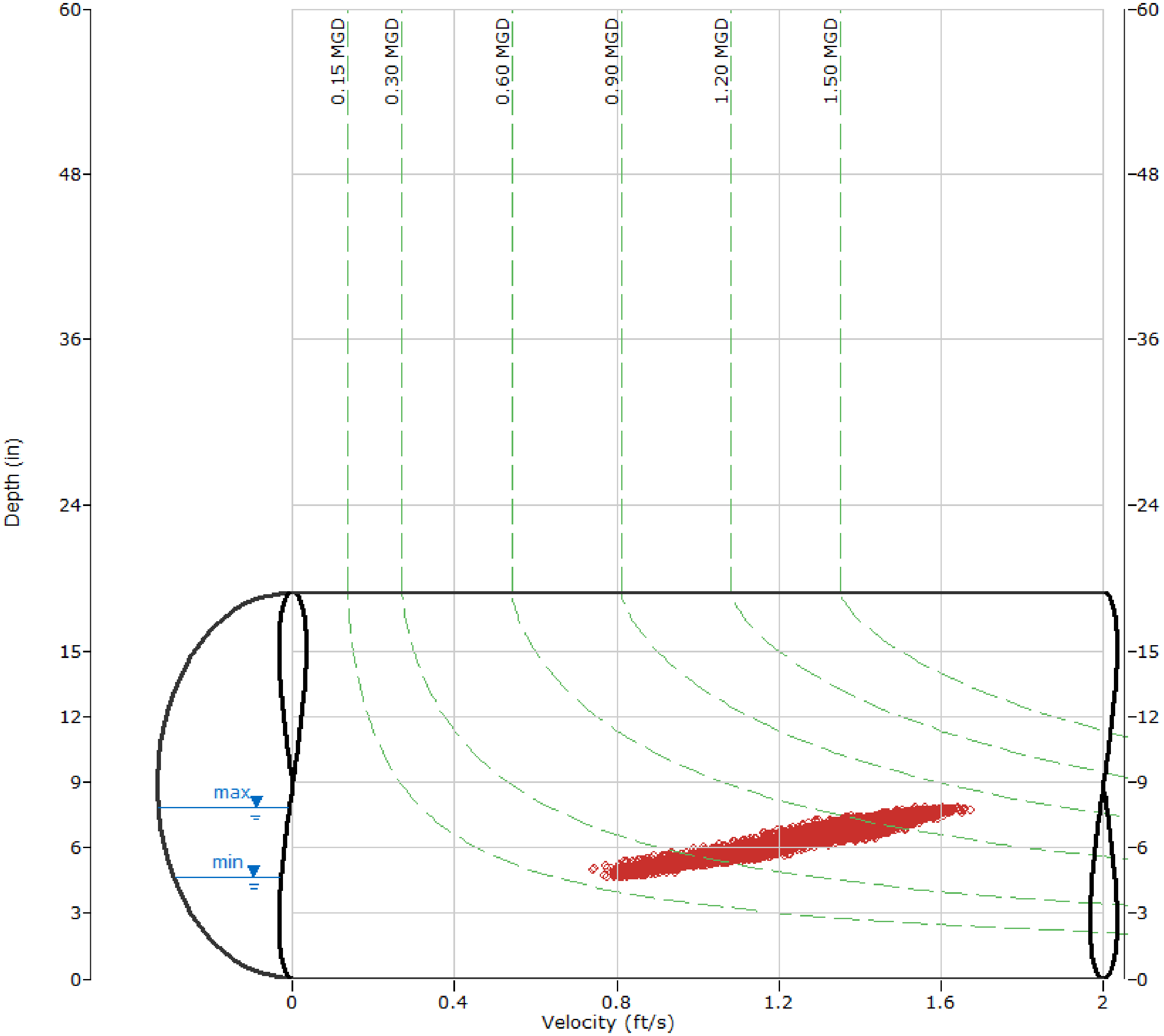


Report Period

4/19/2022
To
6/13/2022

Legend

- ○ Depth - Velocity
- --- Iso-Q™
- --- Silt
- ▼ Min-Max Depth



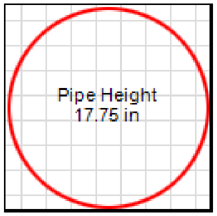
ADS ENVIRONMENTAL SERVICES

HYDROGRAPH REPORT

CW06

Flow Monitor

CW06

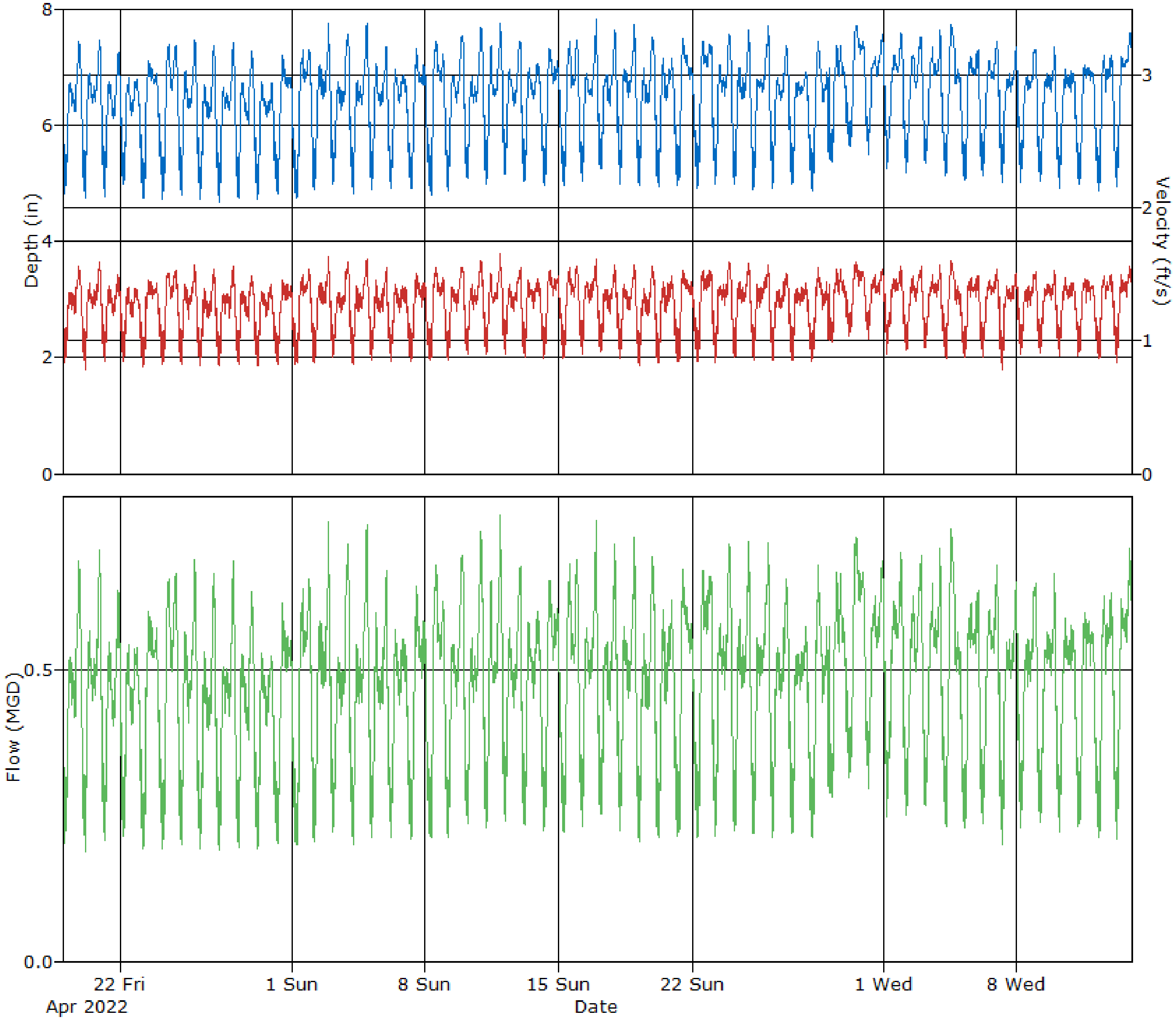


Report Period

4/19/2022
To
6/13/2022

Legend

- Depth
- Velocity
- Quantity



ADS ENVIRONMENTAL SERVICES

Daily Tabular Report For The Period 04/19/2022 00:00 - 06/13/2022 23:59

CW06, Pipe Height: 17.75 in, Silt: 0.00 in

Daily Tabular Report

Date	Depth (in)					Velocity (ft/s)					Quantity (MGD - Total MG)						Rain (in)
	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Total	Total
04/19/2022	03:30	4.75	21:05	7.44	6.37	03:25	0.83	21:10	1.56	1.27	03:25	0.197	21:10	0.690	0.464	0.464	
04/20/2022	04:25	4.69	23:05	7.47	6.37	04:25	0.77	23:00	1.61	1.27	04:25	0.181	23:00	0.710	0.467	0.467	
04/21/2022	05:35	4.72	22:20	7.25	6.28	05:25	0.82	22:10	1.52	1.25	05:30	0.197	22:10	0.646	0.449	0.449	
04/22/2022	04:45	4.92	00:00	6.88	6.25	04:35	0.81	21:15	1.44	1.23	04:35	0.206	10:45	0.563	0.435	0.435	
04/23/2022	07:35	4.67	12:25	7.11	6.31	05:15	0.80	13:10	1.46	1.24	07:35	0.188	12:20	0.606	0.452	0.452	
04/24/2022	06:05	4.69	13:45	7.39	6.40	07:00	0.81	22:45	1.56	1.28	07:00	0.191	22:45	0.677	0.477	0.477	
04/25/2022	05:20	4.75	22:40	7.46	6.34	05:20	0.81	22:20	1.59	1.27	05:20	0.194	22:20	0.697	0.460	0.460	
04/26/2022	05:20	4.65	21:45	7.37	6.22	05:15	0.78	22:40	1.54	1.23	05:15	0.181	22:40	0.668	0.437	0.437	
04/27/2022	05:50	4.66	22:35	7.42	6.24	05:55	0.80	22:35	1.58	1.25	05:55	0.187	22:35	0.695	0.445	0.445	
04/28/2022	05:40	4.68	22:10	7.27	6.23	05:40	0.81	21:55	1.50	1.24	05:40	0.189	21:55	0.641	0.439	0.439	
04/29/2022	05:15	4.69	00:00	6.84	6.13	05:25	0.81	21:35	1.44	1.22	05:25	0.190	00:05	0.564	0.422	0.422	
04/30/2022	07:10	4.79	12:50	7.20	6.29	06:15	0.81	14:20	1.47	1.24	06:15	0.196	12:55	0.619	0.446	0.446	
05/01/2022	07:20	4.69	22:35	7.30	6.35	05:30	0.80	22:45	1.56	1.25	07:15	0.189	22:45	0.665	0.463	0.463	
05/02/2022	04:55	4.82	22:15	7.77	6.45	05:45	0.80	22:05	1.65	1.28	04:55	0.198	22:05	0.769	0.477	0.477	
05/03/2022	04:30	4.88	23:05	7.55	6.41	04:30	0.83	23:05	1.60	1.27	04:30	0.205	23:05	0.722	0.468	0.468	
05/04/2022	05:20	4.76	22:45	7.77	6.42	05:15	0.79	22:35	1.64	1.28	05:15	0.191	22:40	0.765	0.474	0.474	
05/05/2022	04:45	4.81	22:40	7.34	6.38	05:30	0.84	23:20	1.59	1.25	04:40	0.206	23:20	0.690	0.459	0.459	
05/06/2022	05:25	4.87	00:00	7.23	6.33	04:35	0.81	00:00	1.45	1.26	04:35	0.200	00:00	0.618	0.453	0.453	
05/07/2022	06:00	4.75	13:20	7.31	6.39	05:50	0.82	13:30	1.55	1.26	06:00	0.200	13:30	0.667	0.465	0.465	
05/08/2022	07:20	4.76	14:05	7.44	6.49	07:10	0.82	14:05	1.57	1.29	07:10	0.200	14:05	0.693	0.485	0.485	
05/09/2022	05:10	4.82	22:00	7.54	6.43	05:05	0.83	21:35	1.59	1.28	05:05	0.206	22:05	0.709	0.477	0.477	
05/10/2022	05:30	4.97	22:20	7.68	6.50	05:30	0.87	22:00	1.65	1.30	05:30	0.222	22:25	0.748	0.490	0.490	
05/11/2022	05:00	4.94	22:20	7.75	6.56	05:00	0.86	22:00	1.67	1.31	05:00	0.218	22:00	0.776	0.500	0.500	
05/12/2022	04:40	5.10	23:10	7.44	6.53	04:35	0.87	23:30	1.56	1.30	04:35	0.233	23:30	0.685	0.489	0.489	
05/13/2022	04:35	5.00	00:00	7.27	6.42	05:20	0.84	00:00	1.52	1.28	05:30	0.225	00:00	0.649	0.472	0.472	
05/14/2022	07:10	4.93	12:10	7.32	6.49	05:05	0.86	12:35	1.55	1.31	05:05	0.220	12:35	0.665	0.492	0.492	
05/15/2022	06:25	4.93	23:00	7.46	6.50	05:25	0.85	23:05	1.58	1.31	05:25	0.218	23:05	0.698	0.495	0.495	
05/16/2022	05:15	4.98	22:50	7.82	6.51	05:10	0.88	22:55	1.64	1.33	05:10	0.224	22:55	0.773	0.499	0.499	
05/17/2022	04:50	5.18	22:30	7.64	6.53	04:45	0.89	22:20	1.60	1.28	04:45	0.241	22:20	0.729	0.483	0.483	
05/18/2022	05:50	4.98	22:35	7.73	6.55	05:40	0.86	22:45	1.60	1.28	05:50	0.221	22:45	0.742	0.485	0.485	
05/19/2022	04:50	4.93	21:55	7.51	6.47	05:40	0.79	22:00	1.58	1.26	04:50	0.201	22:00	0.705	0.469	0.469	
05/20/2022	05:50	4.91	00:00	7.23	6.43	05:35	0.81	22:10	1.50	1.25	05:45	0.208	22:10	0.629	0.464	0.464	
05/21/2022	05:20	4.92	12:35	7.49	6.51	05:15	0.83	12:15	1.54	1.28	05:15	0.210	12:15	0.680	0.483	0.483	
05/22/2022	06:10	4.91	13:15	7.45	6.59	07:10	0.82	21:10	1.55	1.30	06:05	0.206	14:00	0.682	0.503	0.503	
05/23/2022	04:55	4.94	21:55	7.56	6.54	04:55	0.82	22:40	1.62	1.31	04:55	0.207	22:40	0.727	0.496	0.496	
05/24/2022	05:05	4.95	22:25	7.63	6.50	05:55	0.85	22:15	1.62	1.31	05:05	0.216	22:15	0.736	0.491	0.491	
05/25/2022	04:45	4.84	23:35	7.71	6.50	05:40	0.80	23:15	1.58	1.31	05:40	0.200	23:35	0.725	0.491	0.491	
05/26/2022	05:15	4.86	00:00	7.57	6.46	04:45	0.82	23:15	1.53	1.28	05:05	0.208	00:00	0.688	0.475	0.475	
05/27/2022	05:00	4.91	00:00	7.13	6.34	04:35	0.82	22:20	1.48	1.25	05:50	0.213	00:00	0.611	0.454	0.454	
05/28/2022	07:30	4.83	14:40	7.45	6.33	06:00	0.79	14:20	1.56	1.25	06:00	0.204	14:20	0.689	0.455	0.455	
05/29/2022	07:10	5.30	18:00	7.39	6.60	05:10	0.97	13:35	1.56	1.32	07:10	0.273	13:35	0.679	0.504	0.504	
05/30/2022	06:05	5.60	14:35	7.71	6.87	04:20	1.04	13:55	1.62	1.38	04:20	0.313	13:55	0.741	0.559	0.559	
05/31/2022	05:25	5.45	23:25	7.57	6.78	05:25	1.01	23:25	1.56	1.36	05:25	0.293	23:25	0.706	0.537	0.537	
06/01/2022	04:40	5.20	22:15	7.59	6.69	04:40	0.86	22:10	1.58	1.33	04:40	0.232	22:10	0.712	0.519	0.519	
06/02/2022	05:20	5.15	22:50	7.53	6.62	05:20	0.90	23:50	1.59	1.31	05:20	0.240	23:50	0.711	0.502	0.502	
06/03/2022	05:30	5.24	23:20	7.62	6.67	04:35	0.93	23:05	1.59	1.32	04:40	0.257	23:05	0.720	0.510	0.510	

Date	Depth (in)					Velocity (ft/s)					Quantity (MGD - Total MG)						Rain (in)
	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Total	Total
06/04/2022	06:15	5.04	13:15	7.74	6.63	07:05	0.82	13:20	1.65	1.30	07:05	0.219	13:20	0.765	0.505	0.505	
06/05/2022	06:15	5.02	23:20	7.29	6.50	06:10	0.85	14:20	1.50	1.28	06:10	0.220	23:05	0.641	0.482	0.482	
06/06/2022	04:40	5.10	22:35	7.45	6.55	05:30	0.81	22:00	1.56	1.30	05:30	0.219	22:40	0.683	0.494	0.494	
06/07/2022	05:35	4.99	22:45	7.35	6.48	05:35	0.74	22:40	1.52	1.27	05:35	0.190	22:45	0.658	0.473	0.473	
06/08/2022	05:20	4.99	23:15	7.30	6.48	04:25	0.85	23:40	1.55	1.29	05:20	0.226	23:40	0.662	0.481	0.481	
06/09/2022	05:30	4.96	22:35	7.36	6.41	04:20	0.81	22:40	1.55	1.29	05:30	0.218	22:40	0.672	0.476	0.476	
06/10/2022	05:25	4.88	00:00	7.00	6.37	06:20	0.89	20:40	1.51	1.29	06:20	0.220	12:45	0.602	0.469	0.469	
06/11/2022	07:30	4.95	13:25	7.04	6.38	04:50	0.84	13:20	1.49	1.29	04:50	0.218	13:20	0.608	0.470	0.470	
06/12/2022	06:05	4.84	22:05	7.20	6.43	07:55	0.83	21:45	1.52	1.29	06:05	0.208	21:45	0.637	0.478	0.478	
06/13/2022	05:10	4.86	22:15	7.61	6.61	05:05	0.81	22:05	1.58	1.31	05:10	0.201	22:05	0.715	0.506	0.506	

Report Summary For The Period 04/19/2022 00:00 - 06/13/2022 23:59

	Depth (in)	Velocity (ft/s)	Quantity (MGD - Total MG)
Total			26.765
Avg	6.45	1.28	0.478

Site Commentary

Site Information

CW07	
Pipe Dimensions	35.88"
Silt Level	0.00"

Overview

Site CW07 functioned under normal conditions during the period Tuesday, April 19, 2022 to Monday, June 13, 2022. No surcharge conditions were experienced at this location. Review of the scattergraph shows that free flow conditions were maintained throughout the study period. Flow is subcritical.

Flow depth and velocity measurements recorded by the flow monitor are consistent with field confirmations conducted to date and support the relative accuracy of the flow monitor at this location.

This site was positioned downstream of locations CW03, CW04 and CW05. Flows are balanced. In addition, flow exits entering CW20 further downstream and portions of flow also enters CW19 (via a diverstion line).

Observations

Average flow depth, velocity, and quantity data observed during Tuesday, April 19, 2022 to Monday, June 13, 2022 , along with observed minimum and maximum data, are provided in the following table. Values in the Observed Flow Conditions are based on 5-minute averages. Graphs are based on 15-minute averages. As a result, the values shown in the table below may differ from those shown on the graph.

In regard to depth, based on an average depth of 16.94 inches, this site utilized 47.21 percent of full pipe depth. The hourly averaged peak depth of 21.34 inches represented 59.48 percent of full pipe depth.

Observed Flow Conditions			
Item	Depth (in)	Velocity (ft/s)	Quantity (MGD)
Average	16.94	3.04	6.516
Minimum	13.56	2.35	3.822
Maximum	21.48	3.69	10.420
Time of Minimum	5/25/2022 05:30	4/21/2022 04:30	5/22/2022 06:30
Time of Maximum	5/30/2022 13:10	5/30/2022 12:50	5/30/2022 12:50

Data Quality

Data uptime observed during the Tuesday, April 19, 2022 to the Monday, June 13, 2022 monitoring period is provided in the table below. Based upon the quality and consistency of the observed flow depth and velocity data, the Continuity equation was used to calculate flow rate and quantities during the monitoring period.

Percent Uptime	
Depth (in)	100
Velocity (ft/s)	100
Quantity (MGD)	100

Ogden.BowenClns.TFM.UT22

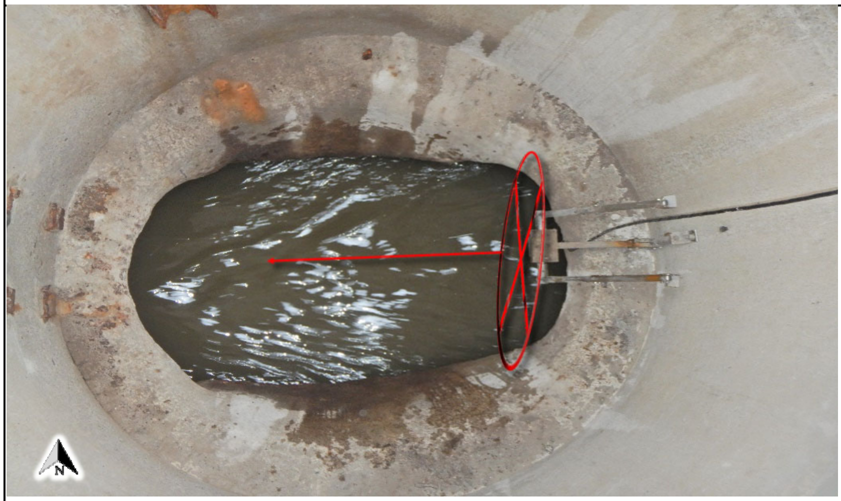
Flow Monitoring
Site Report

22773.11.325

CW07

Site Address /Location:	1011 WILSON LN			Monitor Series TRITON+ VZ	Location Type Temporary
Site Access Details:	DRIVE	Latitude: Longitude:	41.228063 -112.003857	Pipe Size (H x W) 35.88X36.13	Pipe Shape Elliptical

Manhole #	System Characteristics
0C053	Residential/Commercial
Access	Traffic
Drive	Light



Installation Information

Installation Date:	Installation Type:
Friday, April 15, 2022	Doppler Standard Ring and Crank
Monitoring Location (Sensors):	Monitor Location:
Upstream 0-5 FT	Manhole
Sensors / Devices:	Pressure Sensor Range (psi)
Peak Combo (CS4)	0 - 5 psi

Installation Confirmation:

Confirmation Time:	Pipe Size (HxW)
11:24AM	35.88X36.13
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
19.63	
Downlooker Physical Offset (in)	Measurement Confidence (in)
NA	0.25"
Peak Velocity (fps)	Velocity Sensor Offset (in)
3.79	0"
Silt (in)	Silt Type
0	

Hydraulic Comments:
Smooth flow

Manhole / Pipe Information:

Manhole Depth (Approx. FT):	Manhole Configuration
180	Single
Manhole Material:	Manhole Condition:
Concrete	Good
Manhole Opening Diameter (in)	Manhole Diameter (Approx.):
26"	54"
Manhole Cover	Manhole Frame
vented	Normal
Active Drop Connections	Air Quality:
No	Normal
Pipe Material	Pipe Condition:
Concrete	Good

Communication Information:

Communication Type	Antenna Location
Wireless	Manhole Pick / Vent Hole

Additional Site Info. / Comments:

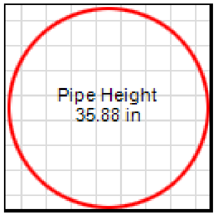
ADS Project Name:	Ogden.BowenClns.TFM.UT22
ADS Project Number:	22773.11.325

SCATTERGRAPH REPORT

CW07

Flow Monitor

CW07

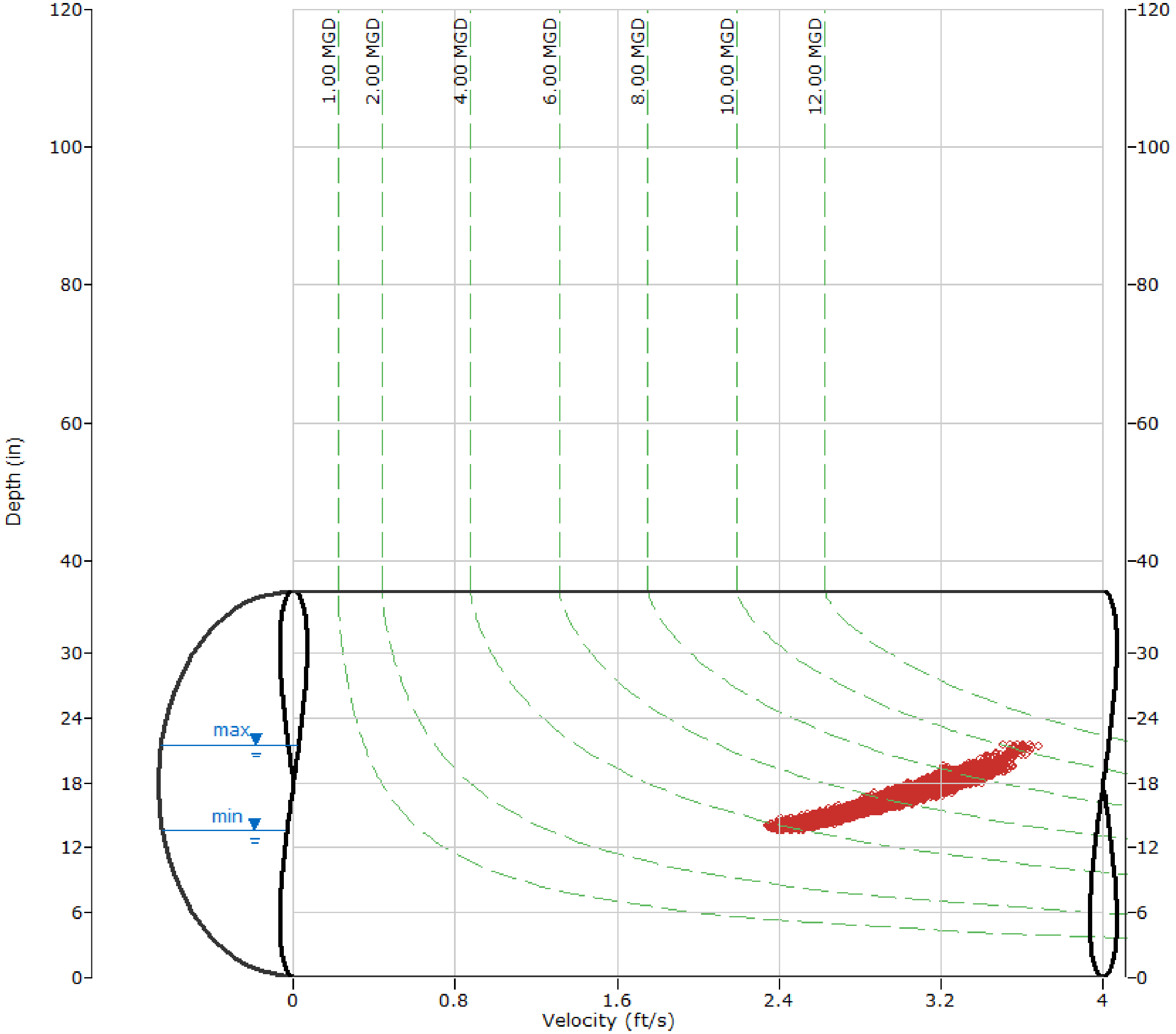


Report Period

4/19/2022
To
6/13/2022

Legend

○ Depth - Velocity
--- Iso-Q™
--- Silt
▼ Min-Max Depth



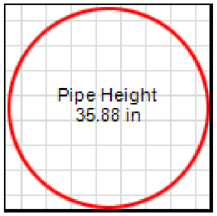
ADS ENVIRONMENTAL SERVICES

HYDROGRAPH REPORT

CW07

Flow Monitor

CW07

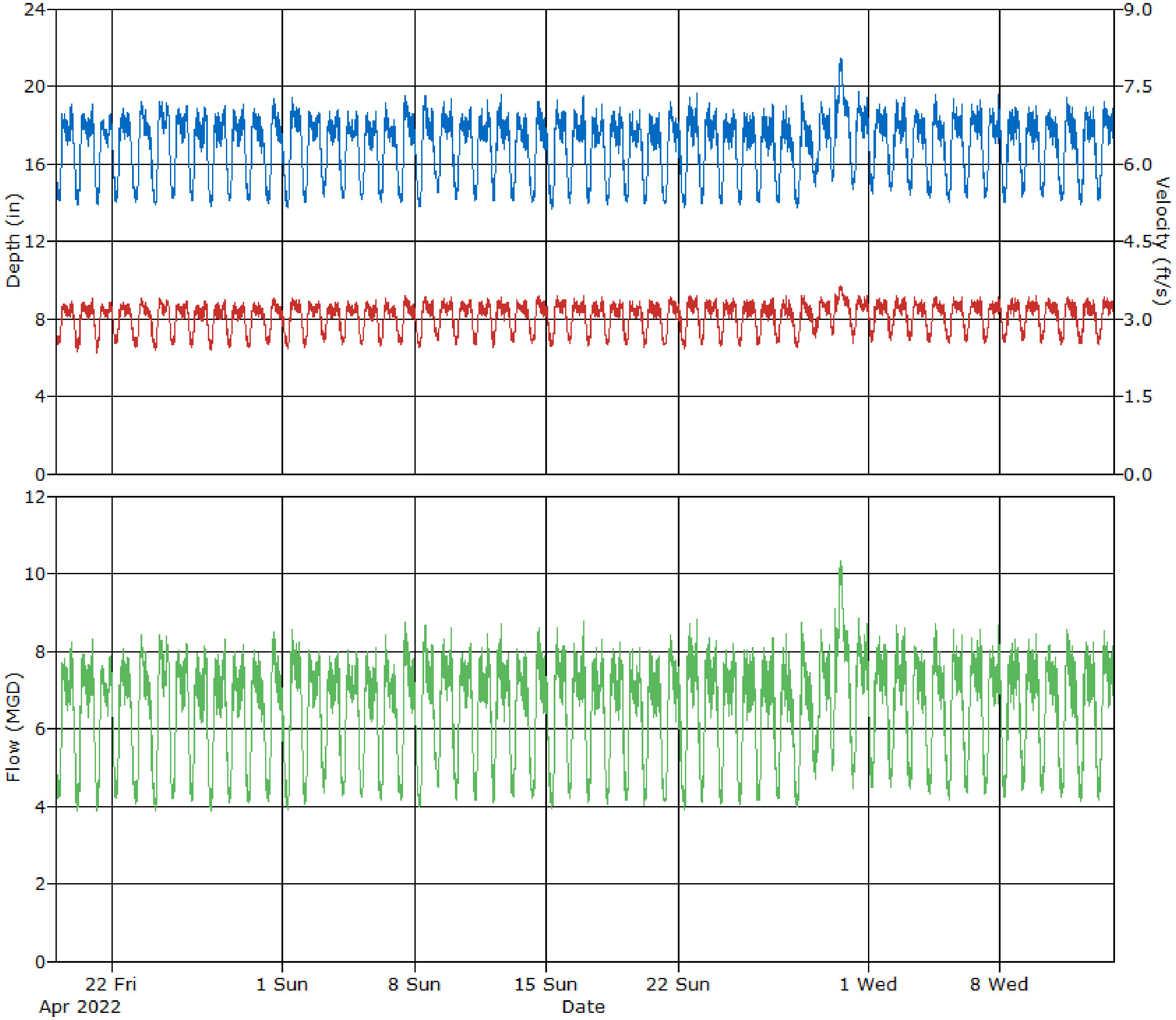


Report Period

4/19/2022
To
6/13/2022

Legend

- Depth
- Velocity
- Quantity



Daily Tabular Report For The Period 04/19/2022 00:00 - 06/13/2022 23:59

CW07, Pipe Height: 35.88 in, Silt: 0.00 in

Daily Tabular Report

Date	Depth (in)					Velocity (ft/s)					Quantity (MGD - Total MG)						Rain (in)
	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Total	Total
04/19/2022	05:45	13.91	21:20	19.30	16.90	05:50	2.48	22:00	3.42	3.01	05:50	4.072	21:20	8.541	6.432	6.432	
04/20/2022	03:55	13.84	22:10	19.35	16.92	03:45	2.35	23:05	3.43	2.99	03:45	3.834	23:05	8.507	6.422	6.422	
04/21/2022	05:20	13.84	22:50	18.78	16.77	04:30	2.35	22:55	3.38	2.99	04:30	3.875	22:55	8.172	6.327	6.327	
04/22/2022	05:35	14.01	14:35	19.06	16.86	04:05	2.51	14:40	3.38	3.01	05:35	4.151	14:40	8.326	6.423	6.423	
04/23/2022	06:15	13.86	13:40	19.42	16.82	06:15	2.39	13:20	3.44	2.97	06:15	3.888	13:20	8.654	6.342	6.342	
04/24/2022	07:10	13.82	13:25	19.50	16.99	06:30	2.36	14:15	3.45	3.00	06:30	3.857	13:30	8.700	6.483	6.483	
04/25/2022	04:40	14.18	20:40	19.61	17.10	04:40	2.48	20:45	3.44	3.01	04:40	4.157	20:45	8.722	6.544	6.544	
04/26/2022	06:10	14.08	11:50	19.23	16.94	04:15	2.40	21:15	3.42	2.99	04:45	4.068	21:15	8.406	6.405	6.405	
04/27/2022	05:15	13.77	21:55	19.30	16.85	05:15	2.37	23:15	3.44	2.98	05:15	3.823	23:15	8.604	6.349	6.349	
04/28/2022	05:10	14.07	21:30	19.24	17.01	04:00	2.43	12:05	3.38	2.99	05:05	4.071	22:50	8.390	6.447	6.447	
04/29/2022	06:20	14.09	15:00	19.17	16.88	06:00	2.44	12:30	3.37	2.99	06:00	4.074	12:30	8.372	6.393	6.393	
04/30/2022	06:30	13.94	12:25	19.67	16.81	05:40	2.49	12:30	3.48	3.01	06:40	4.102	12:30	8.882	6.402	6.402	
05/01/2022	06:45	13.68	12:50	19.51	16.90	06:40	2.41	14:25	3.48	3.01	06:40	3.878	14:25	8.824	6.473	6.473	
05/02/2022	04:30	13.99	23:15	19.30	16.98	03:50	2.40	22:45	3.42	3.03	03:50	4.029	22:45	8.553	6.520	6.520	
05/03/2022	05:00	14.24	21:10	19.02	17.03	04:55	2.52	23:35	3.39	3.03	04:55	4.261	21:15	8.293	6.518	6.518	
05/04/2022	04:30	14.17	12:15	18.92	16.84	04:25	2.45	12:15	3.36	3.01	04:25	4.136	12:15	8.208	6.400	6.400	
05/05/2022	05:55	14.18	23:40	18.87	16.84	04:40	2.49	11:10	3.40	3.01	05:35	4.223	23:40	8.218	6.411	6.411	
05/06/2022	05:45	14.03	12:05	19.27	16.80	04:50	2.46	12:05	3.46	3.00	05:20	4.103	12:05	8.647	6.373	6.373	
05/07/2022	06:55	14.00	12:30	19.61	16.87	06:30	2.48	12:35	3.45	3.01	06:30	4.100	12:35	8.815	6.436	6.436	
05/08/2022	07:20	13.81	12:15	19.98	16.87	06:35	2.42	12:15	3.51	3.02	06:35	3.953	12:15	9.167	6.468	6.468	
05/09/2022	05:45	14.41	22:25	19.66	17.18	06:05	2.54	22:20	3.48	3.08	04:40	4.377	22:25	8.836	6.718	6.718	
05/10/2022	03:50	14.05	22:55	19.55	16.96	05:25	2.43	22:55	3.48	3.04	05:25	4.072	22:55	8.846	6.530	6.530	
05/11/2022	05:05	14.06	21:20	19.38	16.87	03:25	2.44	23:55	3.44	3.03	05:05	4.120	21:20	8.655	6.460	6.460	
05/12/2022	04:40	14.08	14:10	19.70	17.15	04:30	2.44	14:10	3.49	3.06	04:30	4.082	14:10	8.976	6.672	6.672	
05/13/2022	05:55	14.08	22:45	19.06	16.77	05:55	2.50	19:00	3.43	3.04	05:55	4.159	22:45	8.413	6.440	6.440	
05/14/2022	06:25	14.01	13:45	19.63	16.69	05:45	2.52	12:30	3.52	3.03	06:15	4.193	13:50	8.851	6.394	6.394	
05/15/2022	06:45	13.63	13:20	19.39	16.76	04:15	2.42	12:50	3.48	3.03	07:05	3.917	12:50	8.725	6.442	6.442	
05/16/2022	05:35	13.96	22:15	19.61	16.95	05:40	2.52	22:20	3.50	3.06	05:40	4.153	22:20	8.945	6.570	6.570	
05/17/2022	04:05	13.91	22:15	19.44	16.81	03:55	2.45	22:45	3.49	3.04	03:55	4.033	22:45	8.604	6.446	6.446	
05/18/2022	05:10	13.82	21:35	19.04	16.79	05:00	2.46	21:35	3.42	3.03	05:00	4.018	21:35	8.435	6.419	6.419	
05/19/2022	06:05	14.00	12:30	19.20	16.75	03:45	2.48	12:35	3.41	3.03	06:05	4.118	22:40	8.489	6.393	6.393	
05/20/2022	03:50	13.76	22:30	18.86	16.65	03:50	2.37	12:10	3.41	3.01	03:50	3.829	13:45	8.211	6.312	6.312	
05/21/2022	06:25	13.91	14:15	19.61	16.77	05:05	2.48	14:45	3.48	3.01	06:15	4.098	14:15	8.885	6.398	6.398	
05/22/2022	06:35	13.65	23:15	20.14	16.87	06:30	2.39	21:25	3.54	3.04	06:30	3.822	23:20	9.275	6.506	6.506	
05/23/2022	05:05	13.91	11:40	19.45	16.95	04:35	2.47	23:40	3.47	3.06	05:00	4.062	23:40	8.759	6.564	6.564	
05/24/2022	05:10	13.90	20:15	19.44	16.82	04:00	2.46	20:20	3.46	3.04	05:05	4.035	20:15	8.660	6.460	6.460	
05/25/2022	05:30	13.56	11:30	19.00	16.72	05:30	2.42	11:30	3.44	3.02	05:30	3.828	11:30	8.448	6.377	6.377	
05/26/2022	06:20	13.96	23:30	19.43	16.70	04:50	2.48	22:55	3.47	3.01	04:50	4.102	23:30	8.700	6.343	6.343	
05/27/2022	06:25	13.98	15:35	19.20	16.66	04:20	2.52	15:35	3.52	3.02	06:30	4.169	15:35	8.768	6.341	6.341	
05/28/2022	07:05	13.72	12:15	19.71	16.49	06:40	2.42	14:30	3.51	2.98	06:40	3.929	12:20	8.898	6.193	6.193	
05/29/2022	05:20	14.71	11:45	19.51	17.16	04:45	2.62	11:45	3.55	3.09	04:45	4.655	11:45	9.010	6.709	6.709	
05/30/2022	03:25	14.98	13:10	21.48	18.65	03:30	2.62	12:50	3.69	3.29	03:30	4.761	12:50	10.420	7.954	7.954	
05/31/2022	05:20	14.59	13:00	20.16	17.48	05:20	2.47	23:35	3.52	3.13	05:20	4.304	13:00	9.262	6.976	6.976	
06/01/2022	05:50	14.40	22:10	19.79	17.23	04:45	2.51	20:25	3.48	3.08	04:45	4.322	22:15	8.822	6.749	6.749	
06/02/2022	04:50	14.51	11:35	19.82	17.17	04:55	2.54	12:10	3.51	3.10	04:50	4.424	12:05	9.055	6.755	6.755	
06/03/2022	06:00	14.36	22:20	19.12	17.01	05:15	2.54	23:55	3.45	3.07	06:05	4.398	23:55	8.459	6.613	6.613	

Date	Depth (in)					Velocity (ft/s)					Quantity (MGD - Total MG)						Rain (in)
	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Total	Total
06/04/2022	07:30	14.20	13:30	20.04	16.89	07:20	2.54	13:35	3.49	3.05	07:20	4.286	13:35	8.956	6.525	6.525	
06/05/2022	07:30	13.99	13:35	19.53	16.94	07:30	2.51	22:45	3.49	3.05	07:30	4.139	13:35	8.786	6.556	6.556	
06/06/2022	06:05	14.24	23:00	19.73	17.13	05:10	2.53	23:00	3.49	3.07	06:05	4.310	23:00	8.975	6.678	6.678	
06/07/2022	04:40	14.24	22:20	19.78	17.07	04:05	2.51	23:55	3.49	3.05	04:40	4.265	22:20	8.990	6.612	6.612	
06/08/2022	06:15	13.94	20:20	19.43	16.94	05:30	2.52	15:45	3.48	3.07	05:30	4.179	15:45	8.679	6.581	6.581	
06/09/2022	03:55	14.32	11:10	19.50	16.99	03:55	2.51	22:00	3.52	3.08	03:55	4.272	22:00	8.893	6.620	6.620	
06/10/2022	06:00	14.28	15:30	19.32	16.91	03:50	2.52	22:55	3.48	3.07	04:15	4.314	22:55	8.703	6.550	6.550	
06/11/2022	06:15	14.08	13:05	19.63	16.83	05:20	2.48	14:15	3.50	3.04	05:20	4.210	13:05	8.787	6.461	6.461	
06/12/2022	07:10	13.86	14:10	19.33	16.80	07:35	2.51	13:10	3.45	3.02	07:05	4.098	13:10	8.588	6.424	6.424	
06/13/2022	05:15	14.04	14:10	19.59	17.00	05:10	2.45	15:30	3.50	3.06	05:10	4.071	15:30	8.807	6.604	6.599	

Report Summary For The Period 04/19/2022 00:00 - 06/13/2022 23:59

	Depth (in)	Velocity (ft/s)	Quantity (MGD - Total MG)
Total			364.905
Avg	16.94	3.04	6.516

Site Commentary

Site Information

CW08	
Pipe Dimensions	18"
Silt Level	0.00"

Overview

Site CW08 functioned under normal conditions during the period Tuesday, April 19, 2022 to Monday, June 13, 2022. No surcharge conditions were experienced at this location. Review of the scattergraph shows that free flow conditions were maintained throughout the study period. Flow is subcritical.

Flow depth and velocity measurements recorded by the flow monitor are consistent with field confirmations conducted to date and support the relative accuracy of the flow monitor at this location.

This site was positioned upstream of location CW06 (See CW06 Site Commentary For Balancing Details).

Observations

Average flow depth, velocity, and quantity data observed during Tuesday, April 19, 2022 to Monday, June 13, 2022 , along with observed minimum and maximum data, are provided in the following table. Values in the Observed Flow Conditions are based on 5-minute averages. Graphs are based on 15-minute averages. As a result, the values shown in the table below may differ from those shown on the graph.

In regard to depth, based on an average depth of 4.08 inches, this site utilized 22.67 percent of full pipe depth. The hourly averaged peak depth of 5.00 inches represented 27.78 percent of full pipe depth.

Observed Flow Conditions

Item	Depth (in)	Velocity (ft/s)	Quantity (MGD)
Average	4.08	1.25	0.251
Minimum	3.14	0.75	0.107
Maximum	5.03	1.71	0.440
Time of Minimum	4/19/2022 04:05	4/26/2022 04:45	4/28/2022 05:00
Time of Maximum	6/4/2022 11:55	6/2/2022 22:55	6/4/2022 12:55

Data Quality

Data uptime observed during the Tuesday, April 19, 2022 to the Monday, June 13, 2022 monitoring period is provided in the table below. Based upon the quality and consistency of the observed flow depth and velocity data, the Continuity equation was used to calculate flow rate and quantities during the monitoring period.

Percent Uptime	
Depth (in)	100
Velocity (ft/s)	100
Quantity (MGD)	100

Ogden.BowenClns.TFM.UT22

***Flow Monitoring
Site Report***

22773.11.325

CW08

Site Address /Location:	3700 N 2000 W, FARR WEST, UT			Monitor Series TRITON+ VZ	Location Type Temporary
Site Access Details:	DRIVE	Latitude: Longitude:	41.3254032 -112.0318935	Pipe Size (H x W) 18.00X18.13	Pipe Shape Elliptical

Manhole #	System Characteristics
FW003	Residential/Commercial
Access	**Traffic**
Drive	None

Installation Information

Installation Date:	Installation Type:
Saturday, April 16, 2022	Doppler Standard Ring and Crank
Monitoring Location (Sensors):	Monitor Location:
Upstream 0-5 FT	Manhole
Sensors / Devices:	Pressure Sensor Range (psi)
Peak Combo (CS4)	0 - 5 psi

Installation Confirmation:

Confirmation Time:	Pipe Size (HxW)
8:03AM	18.00X18.13
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
3.50	
Downlooker Physical Offset (in)	Measurement Confidence (in)
NA	0.25"
Peak Velocity (fps)	Velocity Sensor Offset (in)
1.33	0"
Silt (in)	Silt Type
0	

Hydraulic Comments:

Smooth flow

Manhole / Pipe Information:

Manhole Depth (Approx. FT):	Manhole Configuration
180	Single
Manhole Material:	Manhole Condition:
Concrete	Good
Manhole Opening Diameter (in)	Manhole Diameter (Approx.):
26"	54"
Manhole Cover	Manhole Frame
vented	Normal
Active Drop Connections	Air Quality:
No	Normal
Pipe Material	Pipe Condition:
Concrete	Good

Communication Information:

Communication Type	Antenna Location
Wireless	Manhole Pick / Vent Hole

Additional Site Info. / Comments:

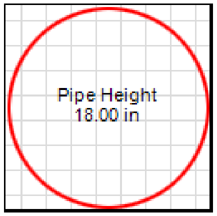
ADS Project Name:	Ogden.BowenClns.TFM.UT22
ADS Project Number:	22773.11.325

SCATTERGRAPH REPORT

CW08

Flow Monitor

CW08

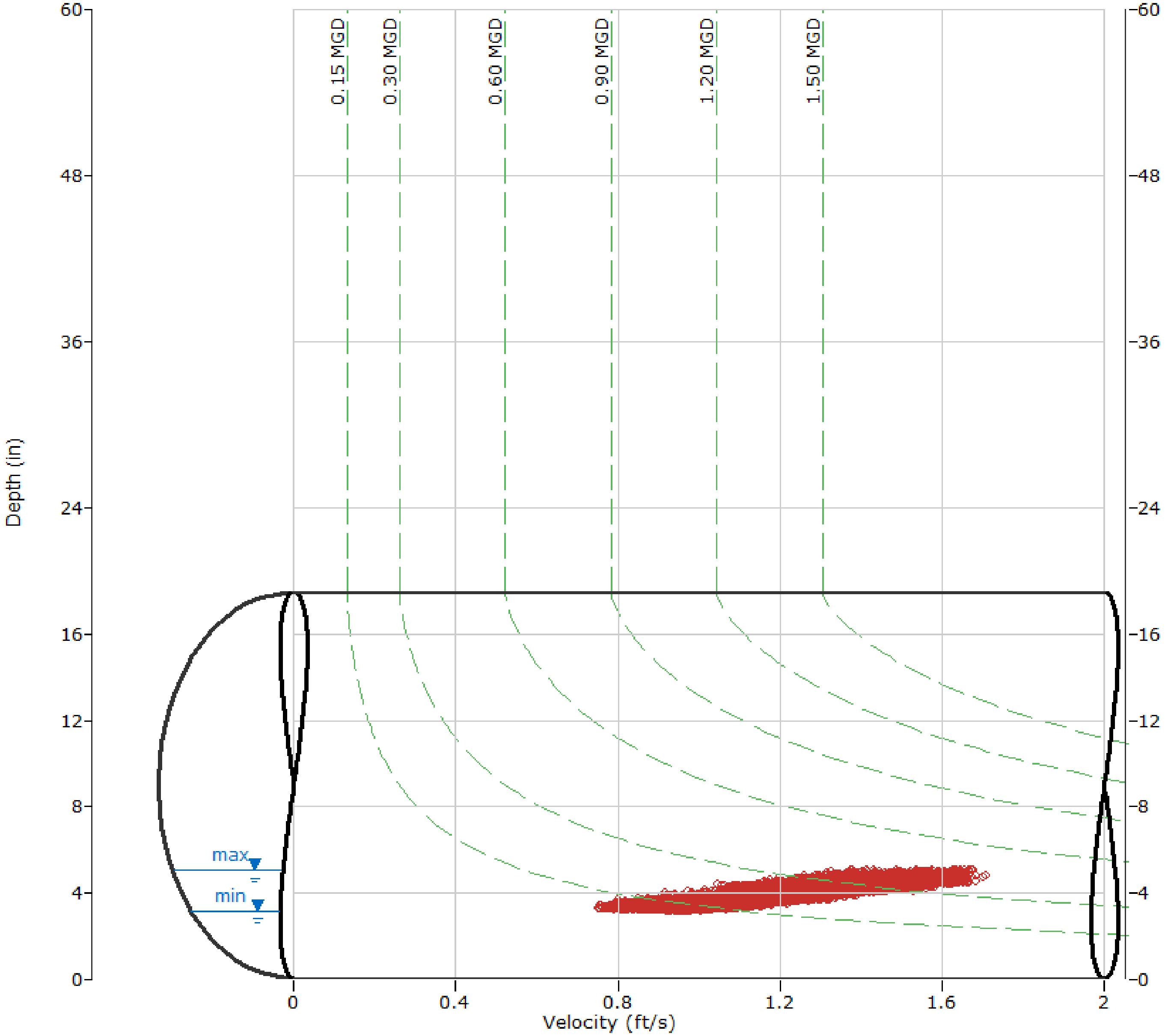


Report Period

4/19/2022
To
6/13/2022

Legend

- ○ Depth - Velocity
- --- Iso-Q™
- --- Silt
- ▼ Min-Max Depth

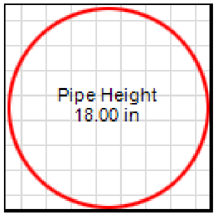


HYDROGRAPH REPORT

CW08

Flow Monitor

CW08

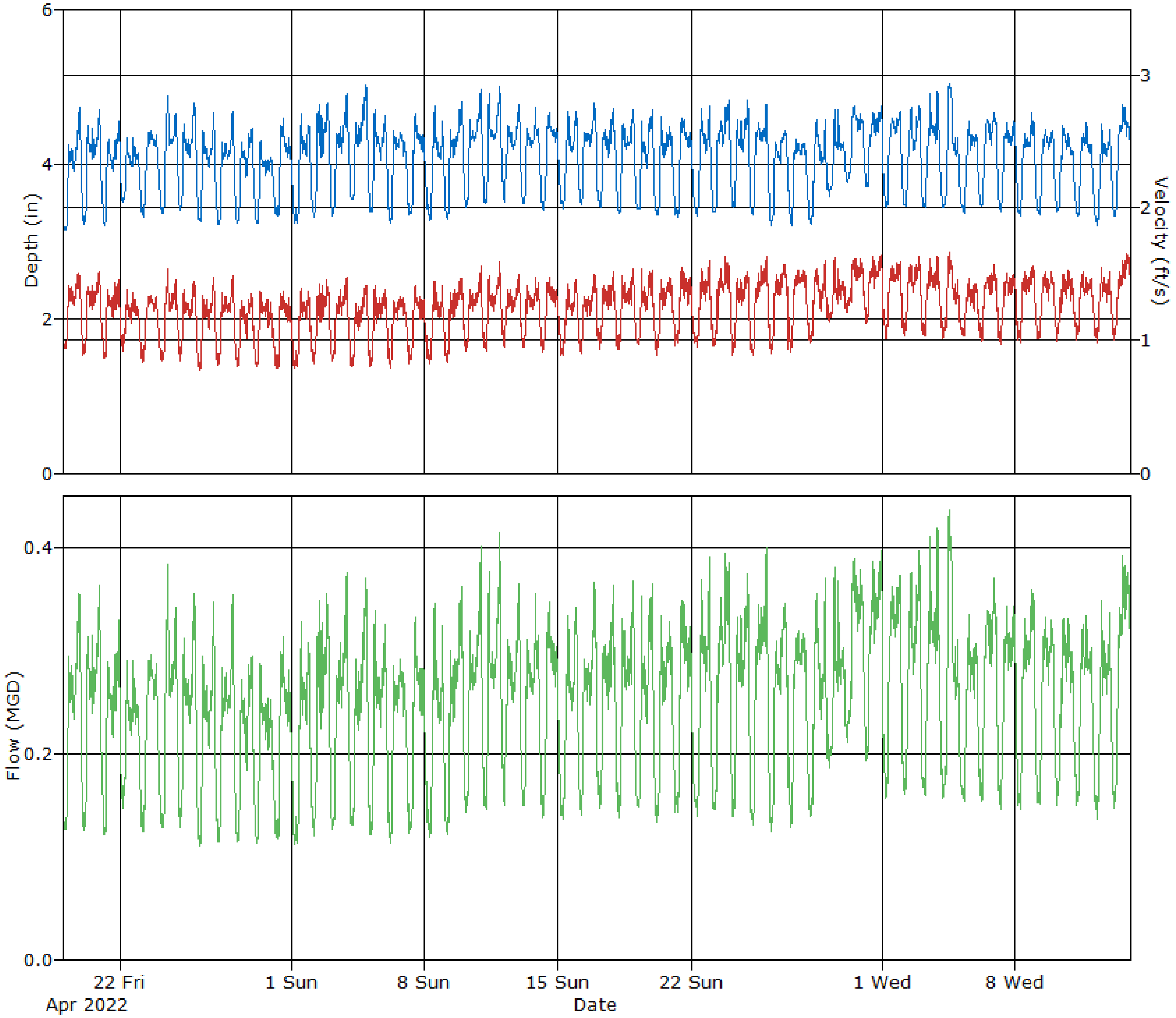


Report Period

4/19/2022
To
6/13/2022

Legend

- Depth
- Velocity
- Quantity



ADS ENVIRONMENTAL SERVICES

Daily Tabular Report For The Period 04/19/2022 00:00 - 06/13/2022 23:59

CW08, Pipe Height: 18.00 in, Silt: 0.00 in

Daily Tabular Report

Date	Depth (in)					Velocity (ft/s)					Quantity (MGD - Total MG)						Rain (in)
	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Total	Total
04/19/2022	04:05	3.14	21:35	4.73	3.93	03:25	0.92	20:05	1.52	1.26	03:25	0.124	21:35	0.360	0.241	0.241	
04/20/2022	03:25	3.21	23:00	4.71	4.04	02:10	0.88	22:45	1.57	1.25	03:25	0.122	22:45	0.374	0.249	0.249	
04/21/2022	05:45	3.20	23:00	4.55	3.95	04:30	0.84	17:55	1.48	1.21	04:30	0.117	22:30	0.333	0.232	0.232	
04/22/2022	04:30	3.51	16:45	4.35	3.97	04:10	0.88	09:10	1.44	1.18	04:10	0.140	09:10	0.305	0.225	0.225	
04/23/2022	06:30	3.31	14:55	4.44	4.00	05:40	0.81	16:00	1.36	1.16	05:40	0.120	14:55	0.301	0.226	0.226	
04/24/2022	05:35	3.37	12:25	4.89	4.10	04:00	0.82	12:00	1.58	1.18	05:40	0.124	12:00	0.392	0.239	0.239	
04/25/2022	04:10	3.38	22:30	4.80	4.12	04:00	0.84	20:30	1.46	1.19	04:10	0.127	22:30	0.358	0.240	0.240	
04/26/2022	06:15	3.24	21:55	4.68	3.98	04:45	0.75	21:55	1.50	1.14	04:45	0.107	21:55	0.356	0.221	0.221	
04/27/2022	04:40	3.21	22:20	4.68	3.98	04:55	0.79	22:20	1.52	1.18	04:55	0.110	22:20	0.361	0.228	0.228	
04/28/2022	05:00	3.23	22:50	4.47	3.93	05:00	0.76	22:25	1.37	1.12	05:00	0.107	22:50	0.302	0.213	0.213	
04/29/2022	05:40	3.23	09:15	4.31	3.83	05:40	0.78	09:10	1.38	1.13	05:40	0.109	09:10	0.291	0.206	0.206	
04/30/2022	06:40	3.32	13:55	4.60	3.97	07:50	0.76	13:35	1.40	1.12	06:30	0.113	13:35	0.318	0.216	0.216	
05/01/2022	04:25	3.23	13:00	4.66	3.97	04:00	0.78	12:55	1.44	1.12	07:50	0.110	12:55	0.340	0.216	0.216	
05/02/2022	04:25	3.29	12:30	4.85	4.16	04:40	0.79	12:30	1.51	1.17	04:40	0.115	12:30	0.377	0.241	0.241	
05/03/2022	04:00	3.33	22:10	4.91	4.14	03:10	0.82	21:55	1.49	1.19	03:55	0.122	22:10	0.378	0.243	0.243	
05/04/2022	04:25	3.53	22:25	5.02	4.27	03:20	0.80	22:05	1.44	1.14	05:55	0.128	22:20	0.374	0.244	0.244	
05/05/2022	04:05	3.37	09:20	4.70	4.10	04:35	0.79	09:15	1.44	1.16	04:35	0.120	09:15	0.344	0.233	0.233	
05/06/2022	05:50	3.23	17:10	4.43	4.02	05:15	0.78	17:10	1.37	1.15	05:40	0.110	17:10	0.301	0.224	0.224	
05/07/2022	04:25	3.34	12:05	4.64	4.03	04:25	0.80	12:00	1.47	1.15	04:25	0.117	12:00	0.344	0.226	0.226	
05/08/2022	07:10	3.27	12:50	4.76	3.98	07:05	0.81	11:50	1.48	1.15	07:05	0.116	11:50	0.347	0.222	0.222	
05/09/2022	05:20	3.28	22:30	4.81	4.10	05:20	0.81	22:35	1.50	1.20	05:20	0.117	22:35	0.370	0.243	0.243	
05/10/2022	04:30	3.44	22:45	4.96	4.22	03:35	0.91	22:40	1.61	1.24	04:35	0.139	22:40	0.414	0.261	0.261	
05/11/2022	04:00	3.49	22:00	5.00	4.27	06:00	0.89	22:10	1.62	1.26	06:00	0.142	22:10	0.420	0.269	0.269	
05/12/2022	04:25	3.51	22:20	4.78	4.22	04:20	0.94	22:30	1.51	1.26	04:20	0.148	22:30	0.369	0.261	0.261	
05/13/2022	05:00	3.48	19:20	4.73	4.15	04:10	0.89	19:20	1.51	1.24	04:10	0.142	19:20	0.365	0.253	0.253	
05/14/2022	05:30	3.40	13:10	4.65	4.13	06:30	0.89	12:35	1.51	1.23	06:30	0.135	12:35	0.356	0.251	0.251	
05/15/2022	06:55	3.41	12:30	4.69	4.08	04:00	0.84	21:45	1.48	1.19	04:00	0.131	23:00	0.346	0.236	0.236	
05/16/2022	05:20	3.47	21:50	4.78	4.18	06:05	0.87	21:55	1.52	1.23	05:15	0.137	21:55	0.373	0.253	0.253	
05/17/2022	05:55	3.44	22:00	4.72	4.13	04:05	0.91	21:45	1.52	1.26	04:10	0.142	21:50	0.363	0.256	0.256	
05/18/2022	04:35	3.35	22:25	4.70	4.13	02:20	0.89	22:25	1.57	1.27	04:40	0.135	22:25	0.375	0.259	0.259	
05/19/2022	04:20	3.41	22:55	4.71	4.08	04:50	0.96	23:00	1.60	1.27	04:50	0.146	23:00	0.382	0.253	0.253	
05/20/2022	04:20	3.34	09:20	4.62	4.03	03:35	0.88	22:35	1.51	1.25	03:35	0.132	09:05	0.337	0.246	0.246	
05/21/2022	06:40	3.30	11:20	4.60	4.04	03:55	0.93	16:15	1.62	1.28	03:55	0.137	13:00	0.369	0.253	0.253	
05/22/2022	06:55	3.31	22:35	4.77	4.05	06:50	0.94	22:40	1.62	1.28	06:50	0.136	22:40	0.393	0.254	0.254	
05/23/2022	05:10	3.37	23:00	4.83	4.16	06:30	0.94	19:00	1.66	1.32	06:30	0.141	19:05	0.397	0.272	0.272	
05/24/2022	04:15	3.42	22:20	4.82	4.17	03:25	0.87	22:10	1.55	1.28	04:10	0.134	22:10	0.382	0.263	0.263	
05/25/2022	05:15	3.34	22:10	4.78	4.15	05:15	0.87	22:15	1.68	1.31	05:15	0.127	22:15	0.411	0.270	0.270	
05/26/2022	04:25	3.20	22:10	4.43	3.98	04:15	0.89	20:45	1.62	1.31	04:15	0.123	20:45	0.350	0.254	0.254	
05/27/2022	06:40	3.20	12:15	4.31	3.95	04:30	0.88	13:50	1.56	1.32	04:30	0.124	14:35	0.324	0.253	0.253	
05/28/2022	06:20	3.22	13:20	4.57	3.90	06:10	0.96	23:45	1.64	1.29	06:10	0.135	23:45	0.370	0.242	0.242	
05/29/2022	06:10	3.58	16:35	4.70	4.11	03:40	1.12	12:15	1.64	1.35	06:00	0.184	12:25	0.382	0.269	0.269	
05/30/2022	04:20	3.75	12:55	4.75	4.30	02:15	1.17	20:40	1.65	1.44	04:15	0.205	12:50	0.399	0.307	0.307	
05/31/2022	06:15	3.70	22:10	4.75	4.32	04:15	1.07	22:05	1.70	1.44	04:15	0.183	22:05	0.410	0.310	0.310	
06/01/2022	06:35	3.43	22:55	4.68	4.22	04:35	0.97	21:50	1.61	1.38	04:35	0.148	22:15	0.377	0.289	0.289	
06/02/2022	06:00	3.45	22:55	4.76	4.16	04:05	1.02	22:55	1.71	1.38	04:05	0.158	22:55	0.415	0.282	0.282	
06/03/2022	06:20	3.43	21:55	4.94	4.21	02:55	1.00	21:35	1.67	1.37	05:15	0.155	22:00	0.422	0.288	0.288	

Date	Depth (in)					Velocity (ft/s)					Quantity (MGD - Total MG)						Rain (in)
	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Total	Total
06/04/2022	06:10	3.42	11:55	5.03	4.16	05:20	1.00	12:55	1.68	1.33	05:20	0.153	12:55	0.440	0.275	0.275	
06/05/2022	07:30	3.36	13:10	4.56	4.01	07:20	1.00	13:10	1.51	1.27	07:20	0.149	13:10	0.346	0.246	0.246	
06/06/2022	04:30	3.46	21:10	4.68	4.17	05:25	0.95	20:55	1.60	1.33	05:25	0.148	20:55	0.374	0.274	0.274	
06/07/2022	05:35	3.38	22:05	4.56	4.12	05:10	0.95	22:25	1.54	1.32	05:10	0.143	22:25	0.350	0.267	0.267	
06/08/2022	06:25	3.32	19:50	4.65	4.08	06:35	0.97	22:55	1.62	1.34	06:30	0.142	22:55	0.372	0.268	0.268	
06/09/2022	06:25	3.33	13:20	4.45	4.04	03:25	0.98	20:20	1.56	1.32	06:35	0.147	22:15	0.338	0.260	0.260	
06/10/2022	04:20	3.38	11:50	4.49	4.03	04:20	0.97	19:30	1.57	1.33	04:20	0.145	11:55	0.339	0.259	0.259	
06/11/2022	07:00	3.33	17:20	4.54	3.99	04:50	0.97	13:00	1.55	1.32	04:50	0.145	17:20	0.336	0.254	0.254	
06/12/2022	06:25	3.19	12:20	4.51	3.91	06:10	0.98	12:20	1.59	1.30	06:25	0.135	12:20	0.358	0.244	0.244	
06/13/2022	05:25	3.31	15:10	4.77	4.16	03:30	0.95	19:15	1.68	1.39	03:30	0.139	15:10	0.403	0.287	0.286	

Report Summary For The Period 04/19/2022 00:00 - 06/13/2022 23:59

	Depth (in)	Velocity (ft/s)	Quantity (MGD - Total MG)
Total			14.061
Avg	4.08	1.25	0.251

Site Commentary

Site Information

CW09	
Pipe Dimensions	60.38"
Silt Level	0.00"

Overview

Site CW09 functioned under normal conditions during the period Tuesday, April 19, 2022 to Monday, June 13, 2022. Flows progressively increased in this line as both depth and velocity shifted higher beginning May 7, 2022 through the remainder of the study. The pattern is also exhibited by downstream site CW13. No surcharge conditions were experienced at this location. Review of the scattergraph shows that free flow conditions were maintained throughout the monitoring period. Flow is subcritical.

Flow depth and velocity measurements recorded by the flow monitor are consistent with field confirmations conducted to date and support the relative accuracy of the flow monitor at this location.

This site along with CW11 and CW19 was positioned upstream of location CW13 (See CW13 Site Commentary For Balancing Details).

Observations

Average flow depth, velocity, and quantity data observed during Tuesday, April 19, 2022 to Monday, June 13, 2022 , along with observed minimum and maximum data, are provided in the following table. Values in the Observed Flow Conditions are based on 5-minute averages. Graphs are based on 15-minute averages. As a result, the values shown in the table below may differ from those shown on the graph.

In regard to depth, based on an average depth of 21.08 inches, this site utilized 34.91 percent of full pipe depth. The hourly averaged peak depth of 26.03 inches represented 43.11 percent of full pipe depth.

Observed Flow Conditions

Item	Depth (in)	Velocity (ft/s)	Quantity (MGD)
Average	21.08	2.92	11.839
Minimum	16.36	2.21	6.273
Maximum	26.09	3.56	18.399
Time of Minimum	5/1/2022 05:45	5/2/2022 04:45	5/2/2022 04:45
Time of Maximum	5/30/2022 16:05	6/6/2022 17:50	6/6/2022 17:50

Data Quality

Data uptime observed during the Tuesday, April 19, 2022 to the Monday, June 13, 2022 monitoring period is provided in the table below. Based upon the quality and consistency of the observed flow depth and velocity data, the Continuity equation was used to calculate flow rate and quantities during the monitoring period.

Percent Uptime	
Depth (in)	100
Velocity (ft/s)	100
Quantity (MGD)	100

Ogden.BowenClns.TFM.UT22

Flow Monitoring
Site Report

22773.11.325

CW09

Site Address /Location:	267 DEPOT DR			Monitor Series	Location Type
				TRITON+ VZ	Temporary
Site Access Details:	DRIVE	Latitude:	41.263869	Pipe Size (H x W)	Pipe Shape
		Longitude:	-111.999992	60.38X60.25	Elliptical

Manhole #	System Characteristics
WA016	Residential/Commercial
Access	Traffic
Drive	None

Installation Information

Installation Date:	Installation Type:
04/18//2022	Doppler Standard Ring and Crank
Monitoring Location (Sensors):	Monitor Location:
Upstream 0-5 FT	Manhole
Sensors / Devices:	Pressure Sensor Range (psi)
Peak Combo (CS4)	0 - 5 psi

Installation Confirmation:

Confirmation Time:	Pipe Size (HxW)
10:49AM	60.38X60.25
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
19.88	
Downlooker Physical Offset (in)	Measurement Confidence (in)
6.75	0.38"
Peak Velocity (fps)	Velocity Sensor Offset (in)
3.02	0"
Silt (in)	Silt Type
0	

Hydraulic Comments:
Smooth flow

Manhole / Pipe Information:

Manhole Depth (Approx. FT):	Manhole Configuration
180	Single
Manhole Material:	Manhole Condition:
Concrete	Good
Manhole Opening Diameter (in)	Manhole Diameter (Approx.):
26"	54"
Manhole Cover	Manhole Frame
vented	Normal
Active Drop Connections	Air Quality:
No	Normal
Pipe Material	Pipe Condition:
Concrete	Good

Communication Information:

Communication Type	Antenna Location
Wireless	Manhole Pick / Vent Hole

Additional Site Info. / Comments:

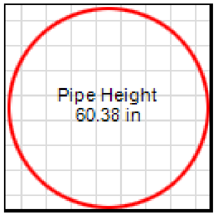
ADS Project Name:	Ogden.BowenClns.TFM.UT22
ADS Project Number:	22773.11.325

SCATTERGRAPH REPORT

CW09

Flow Monitor

CW09



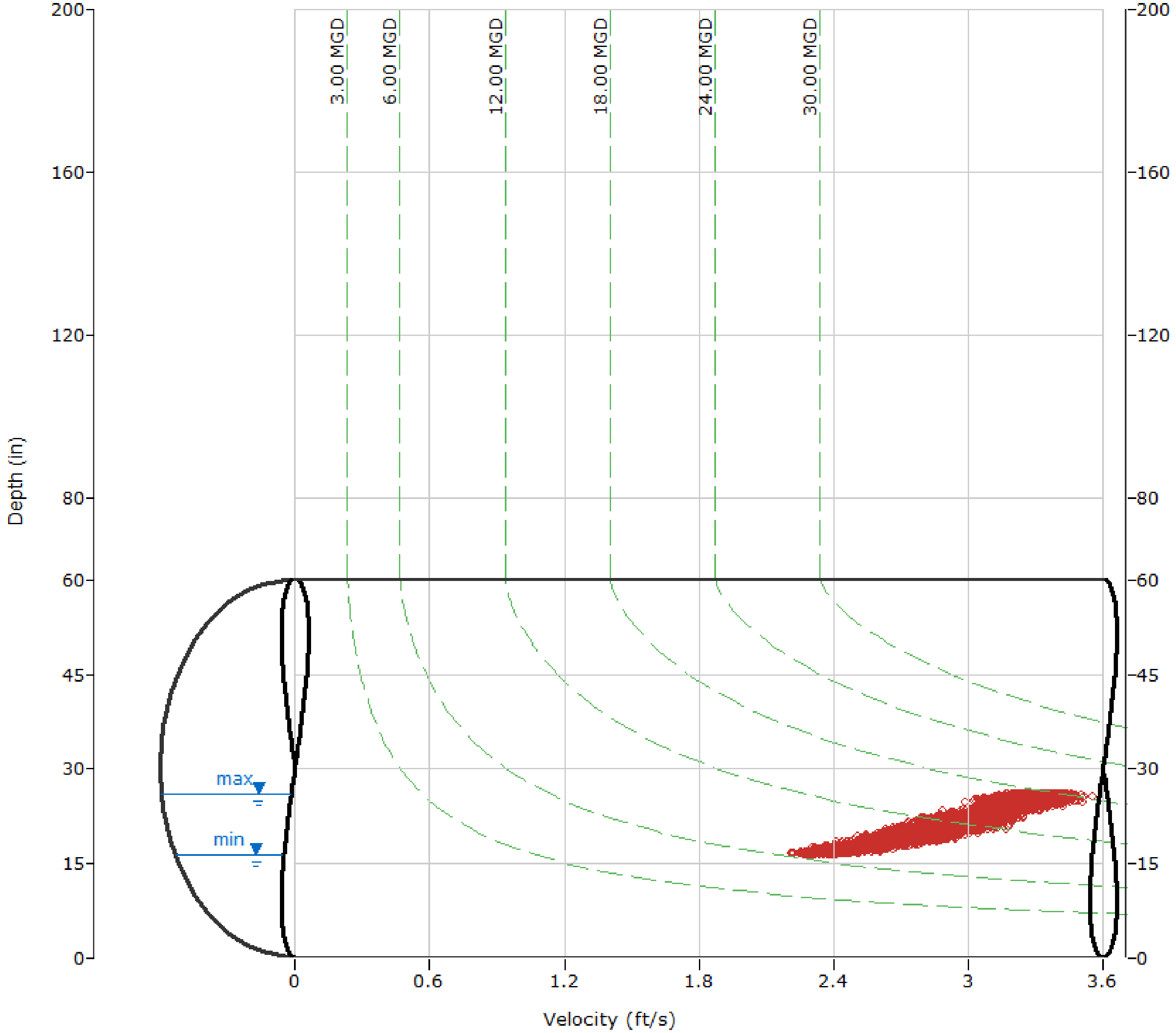
Report Period

4/19/2022
To
6/13/2022

Legend

○ Depth - Velocity
--- Iso-Q™
--- Silt
▼ Min-Max Depth

ADS ENVIRONMENTAL SERVICES

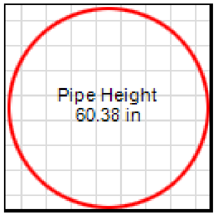


HYDROGRAPH REPORT

CW09

Flow Monitor

CW09

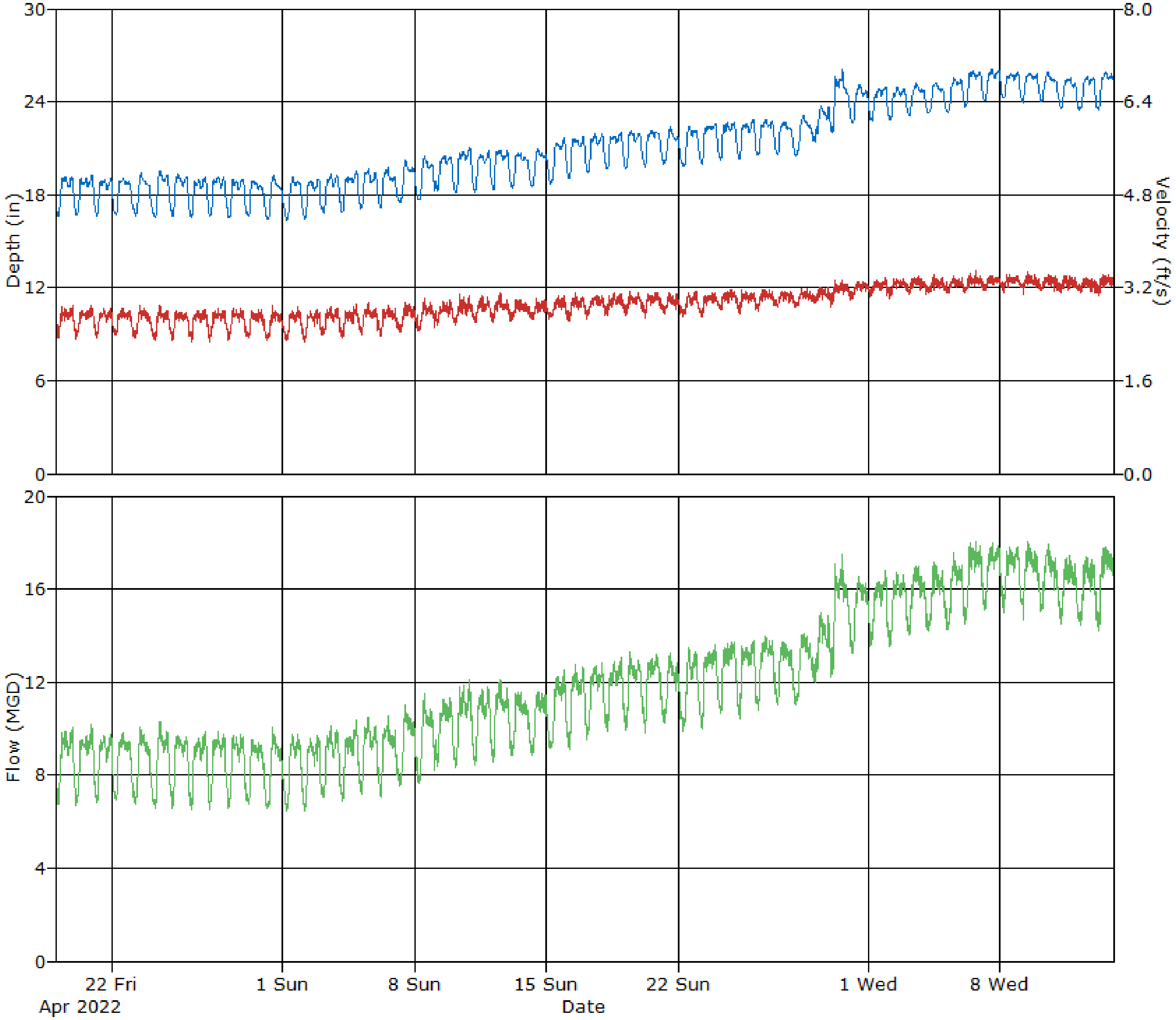


Report Period

4/19/2022
To
6/13/2022

Legend

🟦 Depth
🟥 Velocity
🟩 Quantity



Daily Tabular Report For The Period 04/19/2022 00:00 - 06/13/2022 23:59

CW09, Pipe Height: 60.38 in, Silt: 0.00 in

Daily Tabular Report

Date	Depth (in)					Velocity (ft/s)					Quantity (MGD - Total MG)						Rain (in)
	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Total	Total
04/19/2022	03:35	16.64	12:55	19.16	18.30	03:10	2.29	21:40	2.94	2.66	03:10	6.607	12:30	10.223	8.756	8.756	
04/20/2022	02:55	16.67	22:15	19.23	18.30	02:25	2.29	22:05	2.92	2.67	02:25	6.648	22:05	10.265	8.799	8.799	
04/21/2022	04:50	16.65	22:45	19.05	18.23	04:20	2.32	12:50	2.90	2.66	05:05	6.737	21:15	9.892	8.695	8.695	
04/22/2022	05:10	16.66	14:35	19.05	18.21	03:35	2.34	12:30	2.89	2.66	04:35	6.771	14:35	9.964	8.695	8.695	
04/23/2022	06:05	16.62	12:50	19.41	18.16	05:50	2.31	11:35	2.92	2.64	05:50	6.621	11:35	10.182	8.592	8.592	
04/24/2022	06:55	16.55	12:30	19.53	18.27	06:45	2.25	12:00	2.90	2.62	06:45	6.411	13:20	10.352	8.614	8.614	
04/25/2022	04:25	16.58	11:30	19.38	18.35	04:15	2.29	12:25	2.86	2.63	04:15	6.546	11:30	9.994	8.692	8.692	
04/26/2022	04:20	16.51	22:00	19.17	18.21	05:10	2.22	20:25	2.89	2.63	05:10	6.315	22:40	10.019	8.613	8.613	
04/27/2022	03:35	16.63	22:00	19.18	18.32	03:50	2.27	14:35	2.89	2.64	03:50	6.516	21:25	10.106	8.706	8.706	
04/28/2022	04:40	16.52	09:20	18.99	18.17	03:40	2.25	10:20	2.91	2.64	03:40	6.427	10:20	9.922	8.622	8.622	
04/29/2022	05:50	16.60	11:10	18.86	18.07	06:15	2.30	18:40	2.88	2.62	06:15	6.622	09:55	9.769	8.478	8.478	
04/30/2022	05:50	16.46	13:15	19.20	17.97	05:10	2.28	11:50	2.95	2.60	05:10	6.481	11:50	10.297	8.349	8.349	
05/01/2022	05:45	16.36	13:40	19.18	18.02	06:00	2.27	19:50	2.94	2.60	06:00	6.372	19:50	10.037	8.402	8.402	
05/02/2022	04:45	16.47	22:05	19.00	18.11	04:45	2.21	21:25	2.86	2.61	04:45	6.273	21:25	9.864	8.478	8.478	
05/03/2022	05:00	16.83	14:30	19.30	18.38	01:50	2.34	14:10	2.91	2.66	03:55	6.940	14:25	10.286	8.823	8.823	
05/04/2022	03:35	16.88	22:05	19.52	18.48	02:05	2.31	21:40	2.99	2.65	03:45	6.790	21:40	10.639	8.858	8.858	
05/05/2022	04:15	17.10	13:50	19.70	18.69	04:40	2.35	13:15	2.95	2.70	04:40	7.052	12:30	10.576	9.156	9.156	
05/06/2022	05:20	17.12	14:40	19.78	18.72	05:20	2.33	14:50	3.00	2.67	05:20	6.961	14:50	10.917	9.066	9.066	
05/07/2022	05:45	17.49	12:55	20.26	18.97	07:10	2.37	12:20	2.99	2.71	07:10	7.405	12:20	11.215	9.397	9.397	
05/08/2022	05:40	17.67	12:50	20.51	19.21	05:10	2.37	17:40	3.04	2.73	05:10	7.442	12:15	11.506	9.598	9.598	
05/09/2022	05:40	18.25	15:05	20.51	19.71	02:00	2.47	21:25	3.04	2.79	02:00	8.089	15:10	11.584	10.153	10.153	
05/10/2022	04:05	18.13	22:25	21.00	19.93	03:50	2.52	09:00	3.17	2.83	04:05	8.187	22:35	12.340	10.464	10.464	
05/11/2022	04:45	18.17	22:35	20.88	19.85	04:40	2.56	21:05	3.13	2.85	04:40	8.335	21:05	12.119	10.482	10.482	
05/12/2022	04:20	18.31	14:30	20.85	20.09	03:40	2.54	13:45	3.18	2.86	04:20	8.378	13:45	12.399	10.690	10.690	
05/13/2022	04:10	18.44	15:35	20.70	19.91	04:55	2.57	15:20	3.05	2.84	04:55	8.550	15:20	11.762	10.481	10.481	
05/14/2022	05:40	18.52	13:05	20.92	19.97	05:20	2.59	21:40	3.04	2.83	05:20	8.643	14:40	11.874	10.500	10.500	
05/15/2022	04:45	18.72	21:55	21.66	20.40	02:00	2.61	16:10	3.14	2.87	04:50	9.011	22:00	12.688	10.966	10.966	
05/16/2022	05:10	19.04	23:00	21.78	20.81	03:35	2.55	12:10	3.15	2.88	05:40	8.902	12:10	12.887	11.323	11.323	
05/17/2022	04:25	19.45	12:45	21.93	21.03	03:40	2.63	14:20	3.10	2.92	03:40	9.407	12:45	13.022	11.614	11.614	
05/18/2022	05:25	19.67	22:40	22.01	21.17	01:50	2.68	13:30	3.15	2.94	05:35	9.757	22:50	13.242	11.790	11.790	
05/19/2022	04:20	19.68	11:50	22.13	21.28	04:15	2.66	10:10	3.20	2.95	04:15	9.669	10:10	13.591	11.951	11.951	
05/20/2022	05:20	19.78	11:55	22.12	21.37	06:00	2.62	18:40	3.20	2.96	05:20	9.609	18:40	13.512	12.037	12.037	
05/21/2022	04:45	19.94	12:55	22.35	21.27	05:45	2.69	11:20	3.15	2.94	05:45	10.045	13:15	13.405	11.881	11.881	
05/22/2022	05:35	19.82	13:05	22.41	21.33	05:20	2.65	21:40	3.24	2.94	05:20	9.732	21:40	13.803	11.925	11.925	
05/23/2022	05:30	19.99	22:00	22.63	21.70	04:05	2.62	17:50	3.18	2.95	04:05	9.725	21:30	13.743	12.262	12.262	
05/24/2022	05:10	20.25	22:20	22.68	21.86	06:10	2.78	17:20	3.19	3.01	05:05	10.555	19:15	13.802	12.605	12.605	
05/25/2022	05:20	20.29	22:45	22.88	21.93	05:45	2.73	08:20	3.19	3.00	05:45	10.374	13:35	13.948	12.638	12.638	
05/26/2022	04:55	20.55	14:05	22.90	22.06	03:15	2.77	11:30	3.23	3.03	04:55	10.717	11:30	14.117	12.849	12.849	
05/27/2022	05:05	20.54	15:30	22.65	21.95	05:15	2.84	12:30	3.21	3.02	05:15	10.949	12:30	14.015	12.749	12.749	
05/28/2022	04:55	20.51	14:10	23.10	21.94	03:25	2.82	18:10	3.24	3.02	03:25	10.897	12:10	14.295	12.748	12.748	
05/29/2022	04:50	21.38	12:35	23.78	22.73	03:35	2.90	11:40	3.28	3.07	04:45	11.854	11:40	15.185	13.562	13.562	
05/30/2022	02:05	22.01	16:05	26.09	24.46	01:25	2.79	06:30	3.36	3.16	01:40	11.931	15:35	17.681	15.441	15.441	
05/31/2022	04:30	22.62	13:35	25.14	24.13	01:40	2.88	10:30	3.38	3.18	05:45	12.895	12:25	16.738	15.230	15.230	
06/01/2022	05:40	22.77	22:45	24.95	24.15	04:30	2.96	22:25	3.42	3.22	04:30	13.139	22:25	17.113	15.417	15.417	
06/02/2022	04:15	22.79	12:45	24.95	24.16	02:50	2.94	21:10	3.48	3.24	02:50	13.234	21:10	17.245	15.519	15.519	
06/03/2022	04:15	23.07	13:30	25.21	24.37	04:50	3.05	12:00	3.49	3.26	04:50	13.820	12:00	17.386	15.798	15.798	

Date	Depth (in)					Velocity (ft/s)					Quantity (MGD - Total MG)						Rain (in)
	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Total	Total
06/04/2022	04:40	23.29	14:10	25.23	24.39	03:55	3.03	11:35	3.48	3.25	03:55	13.866	11:35	17.454	15.767	15.767	
06/05/2022	06:15	23.28	13:25	25.53	24.61	08:35	3.05	23:45	3.45	3.25	06:30	14.005	13:15	17.718	15.991	15.991	
06/06/2022	03:40	23.65	12:55	25.97	25.19	04:05	3.03	17:50	3.56	3.29	04:05	14.139	17:50	18.399	16.672	16.672	
06/07/2022	04:20	24.05	13:45	26.07	25.36	04:15	3.07	08:50	3.45	3.30	04:15	14.650	14:20	18.136	16.860	16.860	
06/08/2022	05:10	24.21	22:35	25.87	25.31	04:05	3.06	17:25	3.47	3.31	04:05	14.767	22:45	18.017	16.877	16.877	
06/09/2022	05:35	23.91	12:30	25.84	25.23	05:05	3.08	19:25	3.51	3.30	05:05	14.631	19:25	18.159	16.760	16.760	
06/10/2022	03:40	24.01	12:10	25.92	25.14	23:35	3.07	15:15	3.52	3.29	03:50	14.796	15:15	18.179	16.644	16.644	
06/11/2022	05:35	23.54	17:15	25.53	24.81	04:05	3.06	09:15	3.51	3.28	05:45	14.377	15:55	17.513	16.290	16.290	
06/12/2022	04:20	23.46	15:30	25.62	24.79	23:55	3.03	10:15	3.47	3.25	05:40	14.161	13:10	17.691	16.144	16.144	
06/13/2022	05:50	23.45	14:05	25.90	25.01	04:50	3.04	18:00	3.51	3.29	05:20	14.043	15:15	18.079	16.511	16.500	

Report Summary For The Period 04/19/2022 00:00 - 06/13/2022 23:59

	Depth (in)	Velocity (ft/s)	Quantity (MGD - Total MG)
Total			662.969
Avg	21.08	2.92	11.839

Site Commentary

Site Information

CW10	
Pipe Dimensions	17.88"
Silt Level	0.00"

Overview

Site CW10 functioned under normal conditions during the period Tuesday, April 19, 2022 to Monday, June 13, 2022. No surcharge conditions were experienced at this location. Review of the scattergraph shows that free flow conditions were maintained throughout the study period. Flow is supercritical.

Flow depth and velocity measurements recorded by the flow monitor are consistent with field confirmations conducted to date and support the relative accuracy of the flow monitor at this location.

This site along with CW01 was positioned upstream of location CW03 (See CW03 Site Commentary For Balancing Details).

Observations

Average flow depth, velocity, and quantity data observed during Tuesday, April 19, 2022 to Monday, June 13, 2022 , along with observed minimum and maximum data, are provided in the following table. Values in the Observed Flow Conditions are based on 5-minute averages. Graphs are based on 15-minute averages. As a result, the values shown in the table below may differ from those shown on the graph.

In regard to depth, based on an average depth of 2.65 inches, this site utilized 14.82 percent of full pipe depth. The hourly averaged peak depth of 3.42 inches represented 19.13 percent of full pipe depth.

Observed Flow Conditions

Item	Depth (in)	Velocity (ft/s)	Quantity (MGD)
Average	2.65	3.27	0.347
Minimum	1.84	2.39	0.165
Maximum	3.54	3.70	0.578
Time of Minimum	4/19/2022 02:55	5/20/2022 03:20	4/19/2022 03:20
Time of Maximum	5/30/2022 11:25	5/17/2022 22:45	5/30/2022 11:25

Data Quality

Data uptime observed during the Tuesday, April 19, 2022 to the Monday, June 13, 2022 monitoring period is provided in the table below. Based upon the quality and consistency of the observed flow depth and velocity data, the Continuity equation was used to calculate flow rate and quantities during the monitoring period.

Percent Uptime	
Depth (in)	100
Velocity (ft/s)	100
Quantity (MGD)	100

Ogden.BowenClns.TFM.UT22

Flow Monitoring Site Report

22773.11.325

CW10

Site Address /Location:	4465 600 W, RIVERDALE, UT			Monitor Series TRITON+ VZ	Location Type Temporary
Site Access Details:	IN FRONT OF CLASSIC WATERSLIDES	Latitude: Longitude:	41.181867 -111.990288	Pipe Size (H x W) 17.88X17.88	Pipe Shape Elliptical

Manhole #	System Characteristics
SW114	Residential/Commercial
Access	Traffic
Drive	None

Installation Information

Installation Date:	Installation Type:
Friday, April 15, 2022	Doppler Standard Ring and Crank
Monitoring Location (Sensors):	Monitor Location:
Upstream 0-5 FT	Manhole
Sensors / Devices:	Pressure Sensor Range (psi)
Peak Combo (CS4)	0 - 5 psi

Installation Confirmation:

Confirmation Time:	Pipe Size (HxW)
721AM	17.88X17.88
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
2.88	
Downlooker Physical Offset (in)	Measurement Confidence (in)
NA	0.25"
Peak Velocity (fps)	Velocity Sensor Offset (in)
3.97	0"
Silt (in)	Silt Type
0	

Hydraulic Comments:

Smooth flow

Manhole / Pipe Information:

Manhole Depth (Approx. FT):	Manhole Configuration
240	Single
Manhole Material:	Manhole Condition:
Concrete	Good
Manhole Opening Diameter (in)	Manhole Diameter (Approx.):
26"	54"
Manhole Cover	Manhole Frame
vented	Normal
Active Drop Connections	Air Quality:
No	Normal
Pipe Material	Pipe Condition:
Concrete	Good

Communication Information:

Communication Type	Antenna Location
Wireless	Manhole Pick / Vent Hole

Additional Site Info. / Comments:

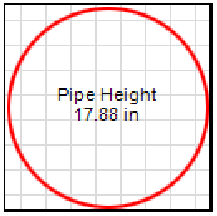
ADS Project Name:	Ogden.BowenClns.TFM.UT22
ADS Project Number:	22773.11.325

SCATTERGRAPH REPORT

CW10

Flow Monitor

CW10

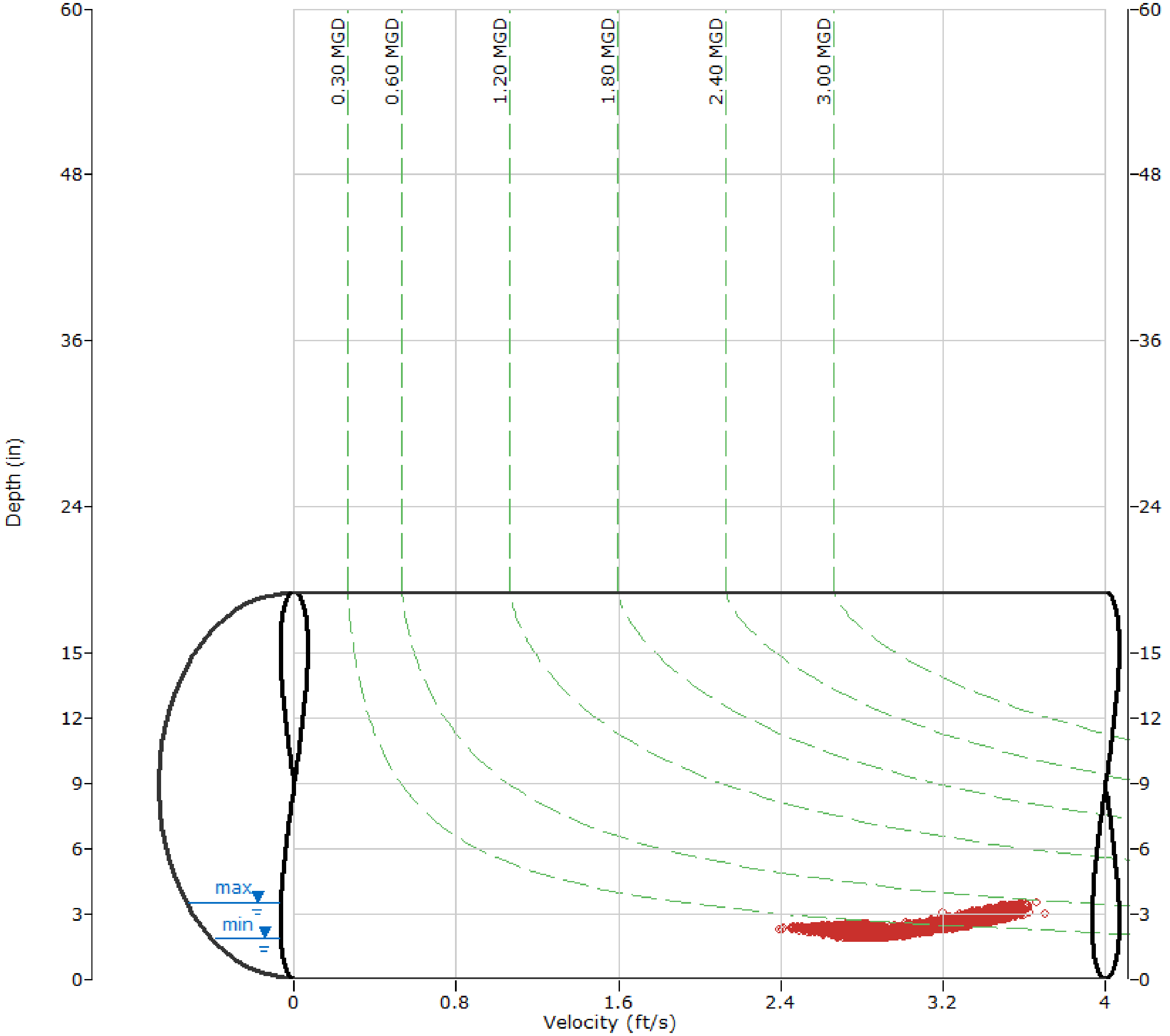


Report Period

4/19/2022
To
6/13/2022

Legend

○ Depth - Velocity
--- Iso-Q™
--- Silt
▼ Min-Max Depth

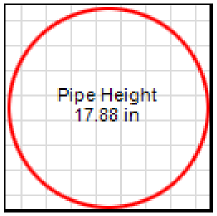


HYDROGRAPH REPORT

CW10

Flow Monitor

CW10

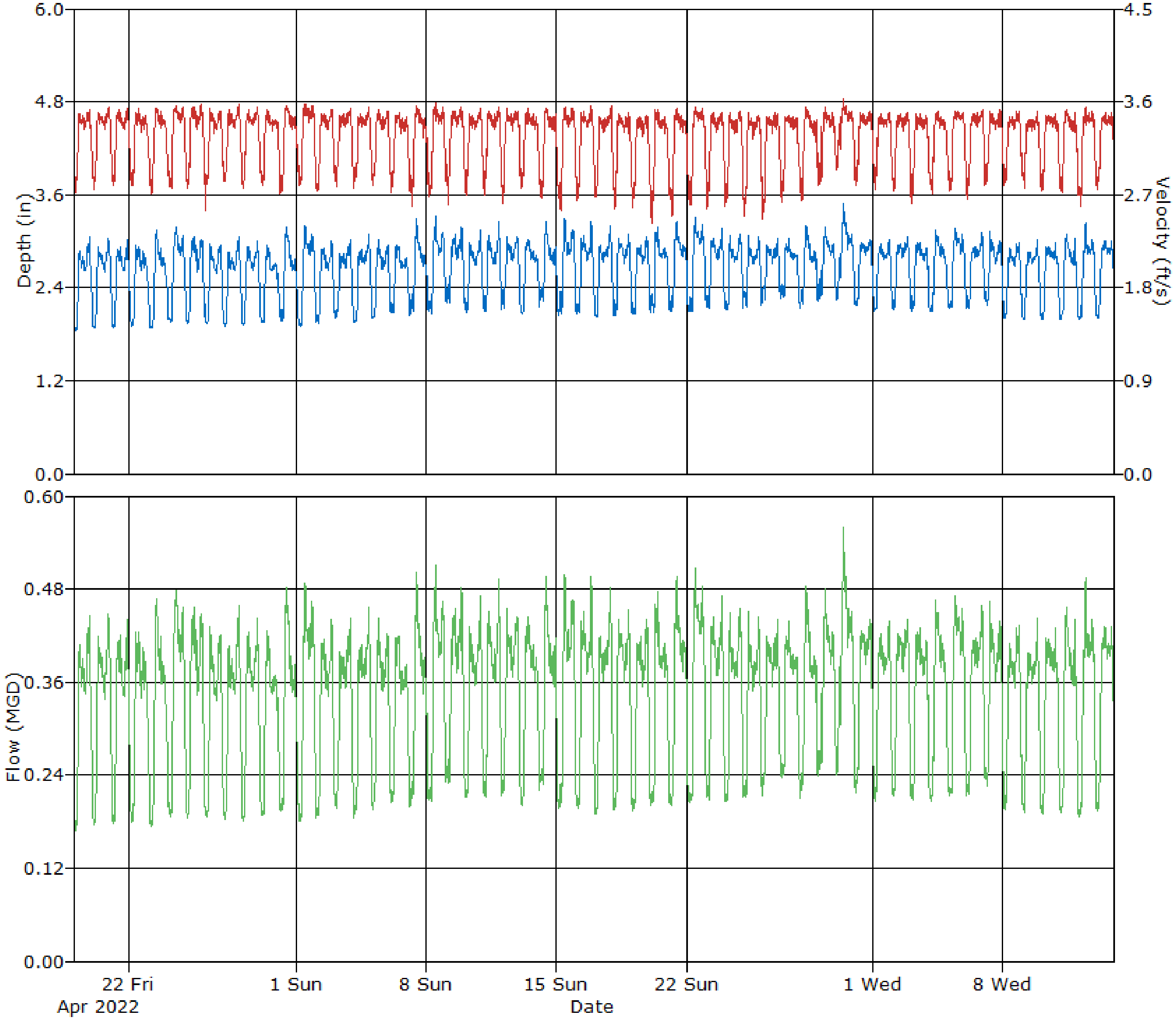


Report Period

4/19/2022
To
6/13/2022

Legend

- Depth
- Velocity
- Quantity



Daily Tabular Report For The Period 04/19/2022 00:00 - 06/13/2022 23:59

CW10, Pipe Height: 17.88 in, Silt: 0.00 in

Daily Tabular Report

Date	Depth (in)					Velocity (ft/s)					Quantity (MGD - Total MG)						Rain (in)
	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Total	Total
04/19/2022	02:55	1.84	20:50	3.08	2.53	03:20	2.68	20:10	3.56	3.28	03:20	0.165	20:50	0.454	0.327	0.327	
04/20/2022	02:10	1.87	20:45	3.06	2.59	02:35	2.71	08:10	3.56	3.31	02:35	0.172	20:45	0.456	0.340	0.340	
04/21/2022	04:25	1.88	21:40	3.02	2.57	03:00	2.73	08:40	3.56	3.30	04:25	0.174	21:25	0.445	0.334	0.334	
04/22/2022	03:55	1.89	12:05	2.95	2.55	04:25	2.74	12:05	3.56	3.28	02:30	0.177	12:05	0.434	0.328	0.328	
04/23/2022	04:15	1.87	11:10	3.16	2.54	04:35	2.68	12:45	3.57	3.25	04:00	0.172	10:55	0.473	0.327	0.327	
04/24/2022	05:25	1.96	12:30	3.21	2.65	03:40	2.72	20:55	3.59	3.29	03:40	0.185	12:20	0.484	0.353	0.353	
04/25/2022	03:00	1.94	11:25	3.10	2.62	03:50	2.75	19:40	3.59	3.30	03:50	0.183	11:25	0.463	0.345	0.345	
04/26/2022	04:10	1.94	08:05	2.97	2.55	02:40	2.49	08:55	3.56	3.27	03:45	0.183	07:55	0.435	0.329	0.329	
04/27/2022	04:00	1.90	21:35	3.07	2.55	02:20	2.78	21:35	3.58	3.30	04:00	0.182	21:35	0.463	0.331	0.331	
04/28/2022	03:30	1.91	21:20	3.02	2.57	03:05	2.75	21:00	3.56	3.29	03:05	0.180	21:20	0.447	0.335	0.335	
04/29/2022	04:10	1.95	09:25	2.97	2.51	04:25	2.77	09:30	3.53	3.27	03:20	0.186	09:30	0.432	0.321	0.321	
04/30/2022	05:00	1.97	11:45	3.20	2.59	02:45	2.67	11:30	3.60	3.27	05:30	0.189	11:45	0.490	0.336	0.336	
05/01/2022	04:50	1.89	10:50	3.20	2.63	05:40	2.78	21:00	3.62	3.31	04:50	0.179	12:10	0.489	0.350	0.350	
05/02/2022	04:50	1.93	21:40	3.02	2.56	03:05	2.65	21:25	3.55	3.27	01:55	0.183	21:40	0.444	0.331	0.331	
05/03/2022	02:05	2.01	21:45	3.03	2.59	04:25	2.75	21:35	3.55	3.29	04:00	0.196	21:45	0.446	0.337	0.337	
05/04/2022	02:35	1.94	21:15	3.09	2.59	02:15	2.74	21:35	3.57	3.28	02:15	0.183	21:05	0.460	0.337	0.337	
05/05/2022	01:55	2.00	10:50	3.07	2.60	03:20	2.75	10:55	3.55	3.29	03:20	0.192	10:50	0.455	0.339	0.339	
05/06/2022	02:00	2.06	11:00	2.95	2.59	02:50	2.66	16:20	3.51	3.26	02:15	0.202	08:40	0.425	0.334	0.334	
05/07/2022	04:15	2.05	11:10	3.29	2.64	05:25	2.52	10:50	3.60	3.24	02:45	0.196	11:10	0.508	0.343	0.343	
05/08/2022	06:50	2.05	12:20	3.33	2.71	03:30	2.64	11:50	3.61	3.27	07:05	0.204	12:05	0.514	0.361	0.361	
05/09/2022	05:45	2.19	21:40	3.26	2.74	04:05	2.58	21:40	3.57	3.28	05:45	0.227	21:40	0.501	0.365	0.365	
05/10/2022	04:35	2.09	21:40	3.17	2.66	02:45	2.65	21:15	3.58	3.28	03:15	0.207	21:45	0.481	0.350	0.350	
05/11/2022	04:50	2.09	20:55	3.28	2.69	02:45	2.64	21:35	3.58	3.30	04:15	0.207	20:55	0.499	0.357	0.357	
05/12/2022	01:45	2.11	08:40	3.08	2.73	03:40	2.58	12:55	3.56	3.30	01:55	0.212	08:40	0.458	0.363	0.363	
05/13/2022	04:05	2.06	10:35	3.03	2.65	02:50	2.74	10:35	3.58	3.28	04:05	0.198	10:35	0.452	0.348	0.348	
05/14/2022	02:05	2.14	10:35	3.28	2.69	04:20	2.64	10:50	3.56	3.24	02:20	0.217	10:35	0.499	0.350	0.350	
05/15/2022	02:55	2.05	11:05	3.31	2.72	06:05	2.46	20:10	3.59	3.23	02:30	0.193	11:10	0.509	0.357	0.357	
05/16/2022	02:10	2.05	21:20	3.26	2.70	04:45	2.55	21:10	3.62	3.25	04:15	0.194	21:10	0.505	0.355	0.355	
05/17/2022	04:15	2.02	21:25	3.21	2.67	02:25	2.61	22:45	3.70	3.25	02:25	0.184	21:40	0.487	0.349	0.349	
05/18/2022	02:05	2.04	21:35	3.10	2.68	04:10	2.54	21:35	3.53	3.24	03:00	0.191	21:35	0.461	0.349	0.349	
05/19/2022	05:30	2.06	20:10	3.07	2.66	02:45	2.52	20:30	3.51	3.22	04:10	0.192	20:10	0.445	0.343	0.343	
05/20/2022	01:50	2.08	10:45	3.22	2.69	03:20	2.39	10:45	3.57	3.20	01:50	0.195	10:45	0.493	0.348	0.348	
05/21/2022	04:15	2.09	11:30	3.27	2.71	05:55	2.46	11:25	3.56	3.21	05:00	0.196	11:25	0.499	0.354	0.354	
05/22/2022	02:55	2.09	11:55	3.35	2.77	05:30	2.58	12:00	3.59	3.25	04:25	0.202	12:00	0.522	0.370	0.370	
05/23/2022	05:40	2.12	21:45	3.17	2.72	02:50	2.52	21:50	3.51	3.25	05:10	0.203	21:50	0.473	0.357	0.357	
05/24/2022	03:55	2.11	21:50	3.10	2.67	02:20	2.54	08:10	3.53	3.24	03:25	0.202	21:50	0.460	0.348	0.348	
05/25/2022	01:25	2.13	08:05	3.09	2.68	03:00	2.45	08:00	3.52	3.21	01:30	0.202	08:00	0.454	0.345	0.345	
05/26/2022	01:25	2.17	21:50	3.05	2.71	02:30	2.45	08:30	3.51	3.22	02:45	0.211	21:50	0.444	0.352	0.352	
05/27/2022	01:40	2.25	12:50	3.07	2.71	03:30	2.57	12:40	3.51	3.25	03:30	0.230	12:45	0.447	0.352	0.352	
05/28/2022	02:50	2.13	10:50	3.21	2.69	06:15	2.63	10:45	3.59	3.24	03:50	0.208	10:45	0.487	0.350	0.350	
05/29/2022	02:00	2.21	11:50	3.19	2.74	02:25	2.73	11:35	3.57	3.28	01:55	0.236	11:50	0.484	0.364	0.364	
05/30/2022	02:20	2.23	11:25	3.54	2.88	01:50	2.91	11:25	3.66	3.37	02:20	0.237	11:25	0.578	0.402	0.402	
05/31/2022	02:45	2.16	22:05	3.03	2.72	04:10	2.74	09:05	3.52	3.30	02:50	0.215	22:05	0.443	0.362	0.362	
06/01/2022	03:40	2.11	22:10	3.02	2.67	04:25	2.73	22:00	3.51	3.28	04:25	0.205	22:10	0.439	0.351	0.351	
06/02/2022	03:15	2.12	17:40	3.07	2.70	04:40	2.66	22:15	3.53	3.28	02:40	0.212	17:40	0.455	0.356	0.356	
06/03/2022	04:10	2.10	13:45	3.00	2.67	02:40	2.53	09:25	3.53	3.25	04:15	0.203	13:45	0.437	0.348	0.348	

Date	Depth (in)					Velocity (ft/s)					Quantity (MGD - Total MG)						Rain (in)
	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Total	Total
06/04/2022	06:40	2.09	10:20	3.16	2.66	05:30	2.69	12:50	3.54	3.25	03:55	0.204	10:20	0.469	0.347	0.347	
06/05/2022	03:40	2.14	11:05	3.18	2.73	04:55	2.69	21:25	3.55	3.28	03:20	0.209	11:05	0.476	0.363	0.363	
06/06/2022	05:40	2.12	21:45	3.10	2.69	03:45	2.60	21:35	3.53	3.27	02:05	0.211	21:55	0.460	0.354	0.354	
06/07/2022	05:00	2.16	08:50	3.14	2.70	04:15	2.73	21:40	3.55	3.29	04:15	0.222	08:50	0.472	0.356	0.356	
06/08/2022	03:20	2.00	18:20	3.03	2.62	02:20	2.73	18:20	3.54	3.28	03:30	0.193	18:20	0.447	0.340	0.340	
06/09/2022	04:05	1.99	21:30	3.12	2.59	05:10	2.73	21:30	3.56	3.26	05:10	0.188	21:30	0.470	0.334	0.334	
06/10/2022	04:30	1.99	21:50	3.03	2.62	02:25	2.70	21:50	3.55	3.26	04:45	0.187	21:50	0.449	0.340	0.340	
06/11/2022	03:05	1.99	21:30	3.10	2.61	05:15	2.70	21:35	3.56	3.25	04:35	0.191	11:55	0.459	0.338	0.338	
06/12/2022	03:50	1.99	12:00	3.29	2.65	05:40	2.55	12:05	3.59	3.24	03:50	0.186	12:00	0.509	0.346	0.346	
06/13/2022	04:05	2.01	21:35	3.02	2.65	02:30	2.74	20:55	3.55	3.27	02:30	0.193	20:55	0.445	0.347	0.347	

Report Summary For The Period 04/19/2022 00:00 - 06/13/2022 23:59

	Depth (in)	Velocity (ft/s)	Quantity (MGD - Total MG)
Total			19.445
Avg	2.65	3.27	0.347

Site Commentary

Site Information

CW11	
Pipe Dimensions	30"
Silt Level	0.00"

Overview

Site CW11 functioned under normal conditions during the period Tuesday, April 19, 2022 to Monday, June 13, 2022. No surcharge conditions were experienced at this location. Review of the scattergraph shows that free flow conditions were maintained throughout the study period. Flow is subcritical.

Flow depth and velocity measurements recorded by the flow monitor are consistent with field confirmations conducted to date and support the relative accuracy of the flow monitor at this location.

This site along with CW09 and CW19 was positioned upstream of location CW13 (See CW13 Site Commentary For Balancing Details).

Observations

Average flow depth, velocity, and quantity data observed during Tuesday, April 19, 2022 to Monday, June 13, 2022 , along with observed minimum and maximum data, are provided in the following table. Values in the Observed Flow Conditions are based on 5-minute averages. Graphs are based on 15-minute averages. As a result, the values shown in the table below may differ from those shown on the graph.

In regard to depth, based on an average depth of 8.77 inches, this site utilized 29.23 percent of full pipe depth. The hourly averaged peak depth of 11.71 inches represented 39.03 percent of full pipe depth.

Observed Flow Conditions

Item	Depth (in)	Velocity (ft/s)	Quantity (MGD)
Average	8.77	2.45	1.928
Minimum	6.39	1.75	0.869
Maximum	11.74	3.19	3.655
Time of Minimum	4/30/2022 05:35	5/11/2022 04:20	4/30/2022 05:05
Time of Maximum	5/30/2022 12:25	5/30/2022 12:00	5/30/2022 13:00

Data Quality

Data uptime observed during the Tuesday, April 19, 2022 to the Monday, June 13, 2022 monitoring period is provided in the table below. Based upon the quality and consistency of the observed flow depth and velocity data, the Continuity equation was used to calculate flow rate and quantities during the monitoring period.

Percent Uptime	
Depth (in)	100
Velocity (ft/s)	100
Quantity (MGD)	100

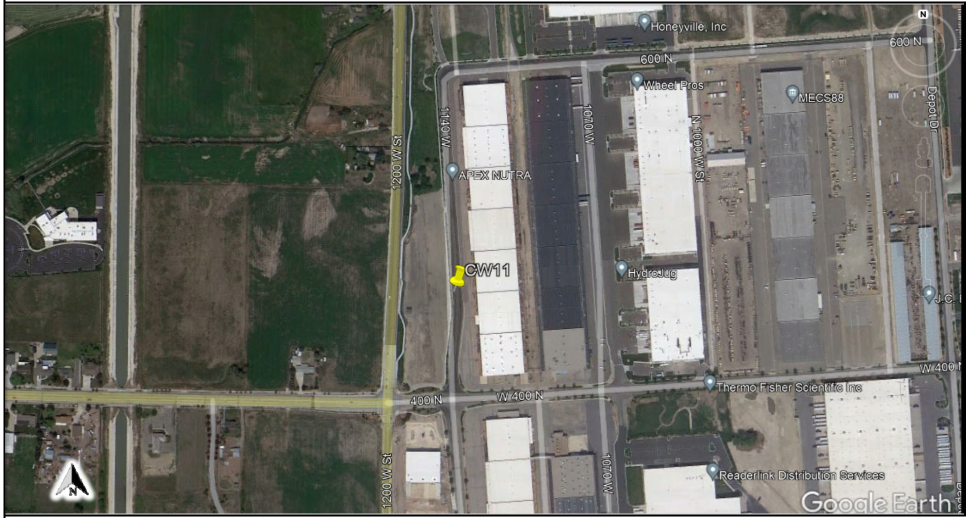
Ogden.BowenClns.TFM.UT22

Flow Monitoring
Site Report

22773.11.325

CW11

Site Address /Location:	395 1140 W			Monitor Series TRITON+ VZ	Location Type Temporary
Site Access Details:	DRIVE	Latitude: Longitude:	41.268603 -112.0077305	Pipe Size (H x W) 30X30	Pipe Shape Elliptical



Manhole #	System Characteristics
HA045	Residential/Commercial
Access	**Traffic**
Drive	Light

Installation Information

Installation Date:	Installation Type:
Friday, April 15, 2022	Doppler Standard Ring and Crank
Monitoring Location (Sensors):	Monitor Location:
Upstream 0-5 FT	Manhole
Sensors / Devices:	Pressure Sensor Range (psi)
Peak Combo (CS4)	0 - 5 psi

Installation Confirmation:

Confirmation Time:	Pipe Size (HxW)
12:17PM	30X30
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
9.38	
Downlooker Physical Offset (in)	Measurement Confidence (in)
NA	0.25"
Peak Velocity (fps)	Velocity Sensor Offset (in)
3.07	0"
Silt (in)	Silt Type
0	

Hydraulic Comments:
Smooth flow

Manhole / Pipe Information:

Manhole Depth (Approx. FT):	Manhole Configuration
180	Single
Manhole Material:	Manhole Condition:
Concrete	Good
Manhole Opening Diameter (in)	Manhole Diameter (Approx.):
26"	54"
Manhole Cover	Manhole Frame
vented	Normal
Active Drop Connections	Air Quality:
No	Normal
Pipe Material	Pipe Condition:
Concrete	Good

Communication Information:

Communication Type	Antenna Location
Wireless	Manhole Pick / Vent Hole

Additional Site Info. / Comments:

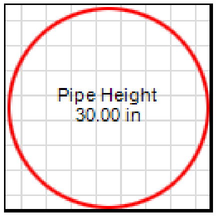
ADS Project Name:	Ogden.BowenClns.TFM.UT22
ADS Project Number:	22773.11.325

SCATTERGRAPH REPORT

CW11

Flow Monitor

CW11



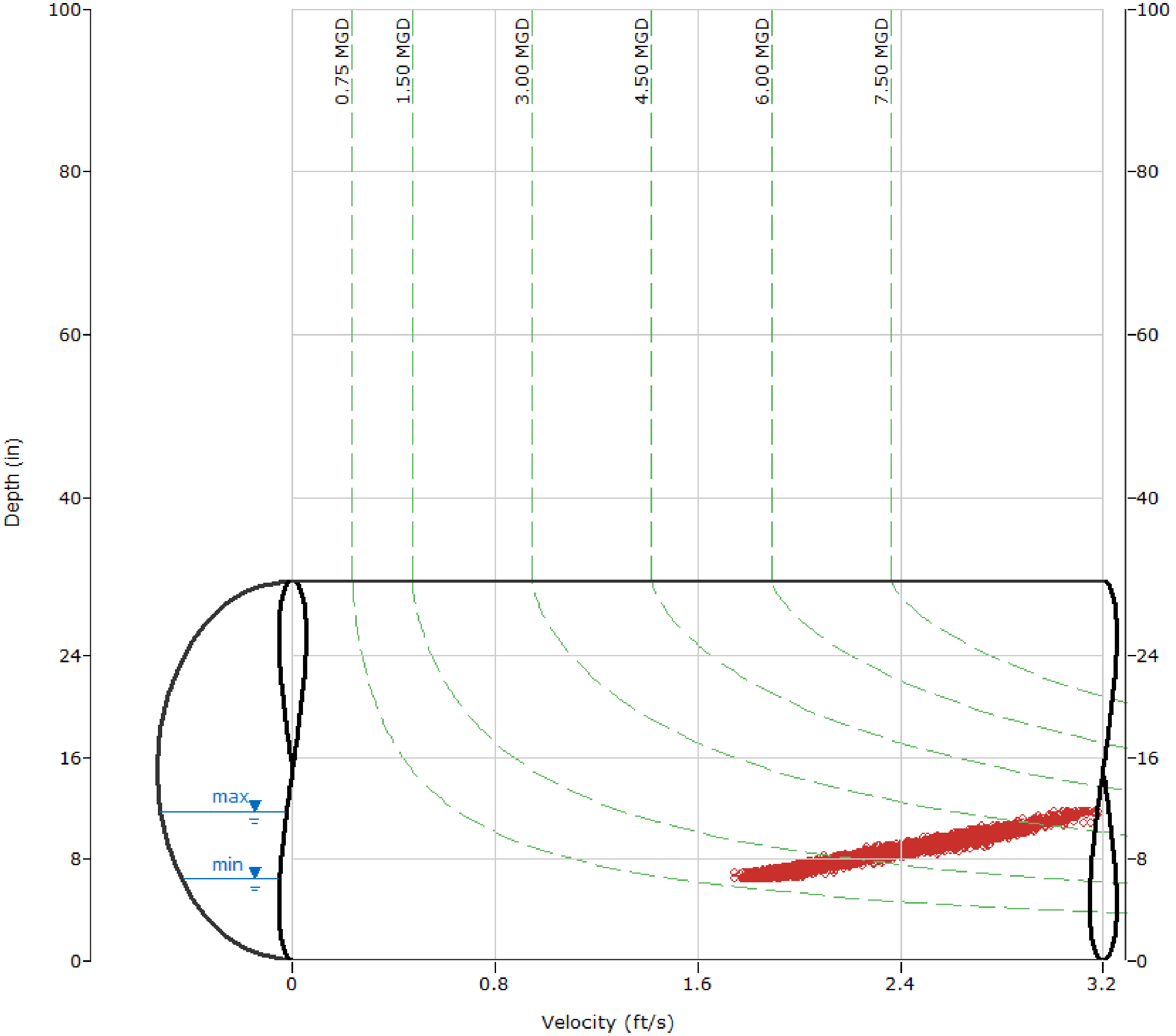
Report Period

4/19/2022
To
6/13/2022

Legend

- ○ Depth - Velocity
- --- Iso-Q™
- --- Silt
- ▼ Min-Max Depth

ADS ENVIRONMENTAL SERVICES



HYDROGRAPH REPORT

CW11

Flow Monitor

CW11

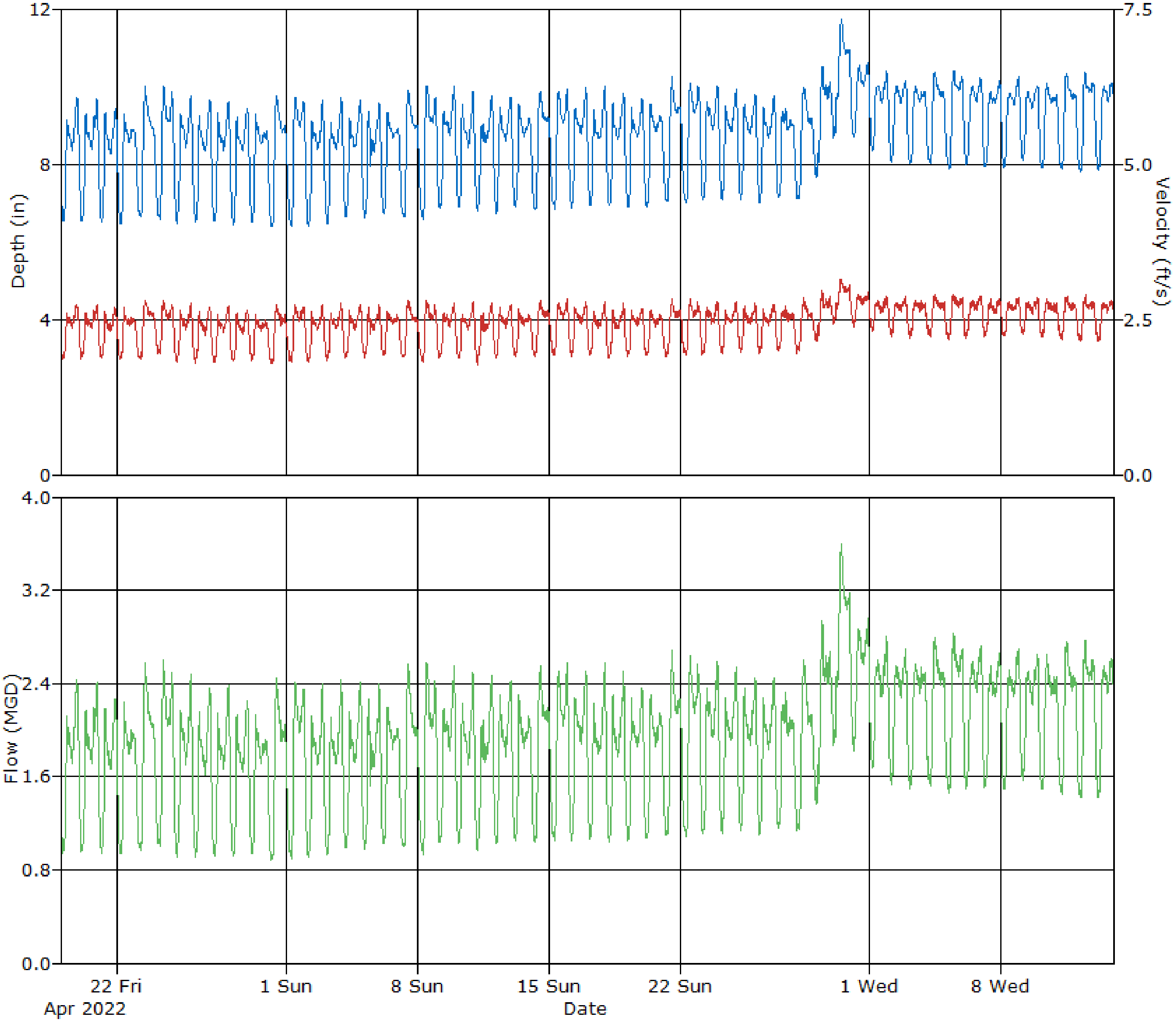
Pipe Height
30.00 in

Report Period

4/19/2022
To
6/13/2022

Legend

- Depth
- Velocity
- Quantity



Daily Tabular Report For The Period 04/19/2022 00:00 - 06/13/2022 23:59

CW11, Pipe Height: 30.00 in, Silt: 0.00 in

Daily Tabular Report

Date	Depth (in)				Velocity (ft/s)				Quantity (MGD - Total MG)					Rain (in)
	Time	Min Time	Max	Avg	Time	Min Time	Max	Avg	Time	Min Time	Max	Avg	Total	Total
04/19/2022	03:40	6.52 21:00	9.71	8.34	03:20	1.83 21:00	2.77	2.37	03:20	0.934 21:00	2.464	1.738	1.738	
04/20/2022	03:10	6.53 22:10	9.68	8.35	02:55	1.84 22:55	2.78	2.37	02:55	0.937 22:55	2.442	1.746	1.746	
04/21/2022	04:45	6.49 22:25	9.44	8.26	04:35	1.85 21:40	2.71	2.34	04:35	0.936 22:25	2.304	1.690	1.690	
04/22/2022	04:20	6.45 09:25	9.28	8.22	04:10	1.85 09:20	2.71	2.33	04:10	0.926 09:20	2.261	1.674	1.674	
04/23/2022	07:00	6.63 12:15	10.01	8.42	06:30	1.84 12:50	2.83	2.39	07:05	0.960 12:20	2.598	1.791	1.791	
04/24/2022	07:30	6.57 11:50	10.01	8.54	04:55	1.92 11:40	2.81	2.43	07:15	1.002 11:50	2.607	1.854	1.854	
04/25/2022	04:50	6.47 22:15	9.75	8.40	04:55	1.78 22:05	2.80	2.34	04:55	0.895 22:05	2.504	1.740	1.740	
04/26/2022	04:20	6.49 22:45	9.66	8.30	04:10	1.78 21:30	2.73	2.32	04:20	0.904 22:35	2.391	1.692	1.692	
04/27/2022	04:40	6.52 22:25	9.63	8.30	05:25	1.79 22:10	2.74	2.30	04:45	0.916 22:30	2.405	1.682	1.682	
04/28/2022	04:40	6.42 22:25	9.42	8.24	04:30	1.81 22:15	2.67	2.29	04:30	0.901 22:15	2.276	1.650	1.650	
04/29/2022	04:25	6.52 09:20	9.27	8.22	03:50	1.82 09:05	2.61	2.28	05:20	0.933 09:05	2.157	1.636	1.636	
04/30/2022	05:35	6.39 11:25	9.75	8.32	05:05	1.75 11:35	2.77	2.32	05:05	0.869 11:35	2.474	1.710	1.710	
05/01/2022	07:15	6.39 12:05	9.70	8.42	07:55	1.79 11:25	2.76	2.36	07:20	0.888 11:25	2.435	1.772	1.772	
05/02/2022	04:25	6.40 22:15	9.64	8.25	04:35	1.80 22:05	2.74	2.32	04:35	0.893 22:05	2.404	1.683	1.683	
05/03/2022	05:05	6.45 22:35	9.70	8.28	04:45	1.82 22:25	2.81	2.34	04:45	0.914 22:25	2.485	1.704	1.704	
05/04/2022	04:20	6.64 22:55	9.64	8.35	03:35	1.86 22:10	2.79	2.36	04:20	0.980 22:55	2.450	1.731	1.731	
05/05/2022	04:30	6.62 22:50	9.57	8.33	04:40	1.86 22:30	2.77	2.36	04:40	0.970 22:30	2.406	1.726	1.726	
05/06/2022	04:45	6.73 09:50	9.33	8.37	05:30	1.88 09:25	2.65	2.37	05:30	1.006 09:50	2.211	1.740	1.740	
05/07/2022	07:05	6.65 12:15	9.91	8.46	06:40	1.87 12:10	2.84	2.38	06:40	0.981 12:10	2.597	1.791	1.791	
05/08/2022	07:40	6.56 12:10	10.02	8.59	07:15	1.79 11:05	2.84	2.38	07:15	0.922 11:05	2.602	1.838	1.838	
05/09/2022	03:55	6.87 22:40	9.99	8.60	03:45	1.85 22:40	2.80	2.37	03:45	1.016 22:40	2.591	1.815	1.815	
05/10/2022	04:50	6.88 22:50	9.87	8.53	04:45	1.85 23:35	2.79	2.36	04:45	1.017 23:10	2.516	1.785	1.785	
05/11/2022	05:20	6.80 22:05	9.74	8.46	04:20	1.75 23:15	2.79	2.33	04:20	0.953 22:10	2.486	1.745	1.745	
05/12/2022	04:30	6.72 22:55	9.73	8.56	03:30	1.87 22:55	2.78	2.40	04:40	1.018 22:55	2.475	1.816	1.816	
05/13/2022	04:25	6.90 09:25	9.55	8.51	04:30	1.87 09:05	2.69	2.36	04:30	1.032 09:05	2.312	1.775	1.775	
05/14/2022	05:20	6.83 12:40	9.87	8.61	05:20	1.89 12:40	2.84	2.42	05:20	1.028 12:40	2.584	1.863	1.863	
05/15/2022	07:00	6.84 22:55	9.96	8.68	06:15	1.91 22:30	2.86	2.44	07:00	1.046 22:35	2.604	1.901	1.901	
05/16/2022	04:20	6.86 22:50	9.95	8.64	03:55	1.87 22:00	2.83	2.43	03:55	1.035 23:10	2.546	1.869	1.869	
05/17/2022	04:30	6.93 22:55	10.03	8.58	04:00	1.89 22:50	2.82	2.39	04:00	1.048 22:50	2.612	1.816	1.816	
05/18/2022	04:35	6.95 23:10	9.83	8.62	03:30	1.86 23:00	2.80	2.37	05:10	1.039 23:00	2.532	1.812	1.812	
05/19/2022	04:45	6.89 22:30	9.71	8.58	04:05	1.85 21:20	2.71	2.38	04:25	1.035 22:25	2.386	1.811	1.811	
05/20/2022	04:20	6.91 09:25	9.55	8.57	04:15	1.88 09:25	2.66	2.37	04:15	1.041 09:25	2.316	1.796	1.796	
05/21/2022	06:40	7.05 12:40	10.25	8.79	05:30	1.88 13:15	2.87	2.42	05:30	1.077 12:50	2.737	1.915	1.915	
05/22/2022	07:10	7.02 11:45	10.08	8.86	07:05	1.91 11:45	2.88	2.45	07:05	1.081 11:45	2.690	1.967	1.967	
05/23/2022	04:35	7.09 22:40	10.03	8.80	03:15	1.93 22:50	2.81	2.43	04:20	1.104 22:50	2.601	1.915	1.915	
05/24/2022	04:30	7.07 22:40	9.93	8.74	04:35	1.92 22:10	2.83	2.42	04:35	1.093 22:50	2.548	1.891	1.891	
05/25/2022	04:10	7.09 23:05	9.79	8.71	04:00	1.95 22:15	2.80	2.43	04:35	1.119 22:15	2.488	1.887	1.887	
05/26/2022	04:10	7.00 22:55	9.75	8.65	03:55	1.92 23:10	2.79	2.42	03:55	1.084 23:10	2.485	1.860	1.860	
05/27/2022	05:05	7.16 00:00	9.50	8.62	03:50	1.96 14:20	2.74	2.42	03:50	1.149 14:20	2.340	1.849	1.849	
05/28/2022	04:40	7.10 13:00	9.96	8.69	04:05	1.94 12:50	2.86	2.44	04:20	1.121 12:50	2.619	1.899	1.899	
05/29/2022	05:25	7.66 12:45	10.55	9.23	05:55	2.10 12:40	3.05	2.58	05:55	1.352 12:40	3.028	2.174	2.174	
05/30/2022	02:30	8.67 12:25	11.74	10.38	01:55	2.34 12:00	3.19	2.85	02:15	1.814 13:00	3.655	2.805	2.805	
05/31/2022	04:35	8.70 22:50	10.62	9.90	04:20	2.32 22:50	2.97	2.74	04:20	1.775 22:50	2.988	2.513	2.513	
06/01/2022	04:40	8.36 22:20	10.41	9.54	05:10	2.28 22:25	2.90	2.64	05:10	1.648 22:25	2.834	2.310	2.310	
06/02/2022	04:40	8.07 22:55	10.15	9.42	04:55	2.20 23:10	2.90	2.62	04:55	1.514 23:10	2.731	2.250	2.250	
06/03/2022	04:35	8.00 11:35	10.01	9.32	04:30	2.16 11:00	2.85	2.60	04:35	1.466 11:00	2.607	2.204	2.204	

Date	Depth (in)					Velocity (ft/s)					Quantity (MGD - Total MG)						Rain (in)
	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Total	Total
06/04/2022	06:55	8.01	11:55	10.40	9.39	06:20	2.19	13:05	2.92	2.61	06:20	1.496	13:05	2.815	2.242	2.242	
06/05/2022	06:55	7.88	11:55	10.42	9.43	05:30	2.16	12:00	2.93	2.62	06:40	1.441	12:00	2.865	2.268	2.268	
06/06/2022	04:30	7.99	22:20	10.24	9.39	03:00	2.10	21:35	2.93	2.62	04:35	1.480	23:10	2.749	2.247	2.247	
06/07/2022	04:15	7.94	22:45	10.14	9.31	03:35	2.19	21:10	2.87	2.60	03:35	1.488	23:00	2.695	2.199	2.199	
06/08/2022	04:55	7.92	23:10	10.26	9.31	05:00	2.20	20:55	2.89	2.60	05:00	1.476	22:45	2.728	2.202	2.202	
06/09/2022	04:30	8.08	00:00	10.02	9.34	03:30	2.26	22:15	2.90	2.62	04:25	1.559	22:15	2.686	2.220	2.220	
06/10/2022	05:30	7.91	11:35	10.06	9.26	05:00	2.20	10:55	2.87	2.59	04:25	1.470	10:55	2.657	2.176	2.176	
06/11/2022	06:40	7.87	11:50	10.32	9.31	06:30	2.16	13:20	2.90	2.59	06:30	1.436	13:20	2.781	2.194	2.194	
06/12/2022	06:50	7.81	11:30	10.39	9.36	07:00	2.12	12:45	2.92	2.58	07:00	1.392	12:45	2.807	2.210	2.210	
06/13/2022	04:50	7.85	22:35	10.06	9.31	04:15	2.11	22:45	2.86	2.57	04:15	1.401	22:45	2.674	2.183	2.181	

Report Summary For The Period 04/19/2022 00:00 - 06/13/2022 23:59

	Depth (in)	Velocity (ft/s)	Quantity (MGD - Total MG)
Total			107.966
Avg	8.77	2.45	1.928

Site Commentary

Site Information

CW12	
Pipe Dimensions	27.25"
Silt Level	0.00"

Overview

Site CW12 functioned under normal conditions during the period Tuesday, April 19, 2022 to Monday, June 13, 2022. No surcharge conditions were experienced at this location. Review of the scattergraph shows that free flow conditions were maintained throughout the study period. Flow is transitional as it operates between subcritical and supercritical conditions. Unstable conditions may be experienced during transitional periods.

Flow depth and velocity measurements recorded by the flow monitor are consistent with field confirmations conducted to date and support the relative accuracy of the flow monitor at this location.

This site was positioned upstream of location CW14 (See CW14 Site Commentary For Balancing Details).

Observations

Average flow depth, velocity, and quantity data observed during Tuesday, April 19, 2022 to Monday, June 13, 2022 , along with observed minimum and maximum data, are provided in the following table. Values in the Observed Flow Conditions are based on 5-minute averages. Graphs are based on 15-minute averages. As a result, the values shown in the table below may differ from those shown on the graph.

In regard to depth, based on an average depth of 7.19 inches, this site utilized 26.39 percent of full pipe depth. The hourly averaged peak depth of 8.51 inches represented 31.23 percent of full pipe depth.

Observed Flow Conditions

Item	Depth (in)	Velocity (ft/s)	Quantity (MGD)
Average	7.19	3.15	1.789
Minimum	5.37	1.77	0.682
Maximum	8.85	5.55	3.673
Time of Minimum	5/10/2022 03:25	4/23/2022 06:50	4/23/2022 06:50
Time of Maximum	4/24/2022 10:15	5/30/2022 11:55	5/30/2022 11:55

Data Quality

Data uptime observed during the Tuesday, April 19, 2022 to the Monday, June 13, 2022 monitoring period is provided in the table below. Based upon the quality and consistency of the observed flow depth and velocity data, the Continuity equation was used to calculate flow rate and quantities during the monitoring period.

Percent Uptime	
Depth (in)	100
Velocity (ft/s)	100
Quantity (MGD)	100

Ogden.BowenClns.TFM.UT22

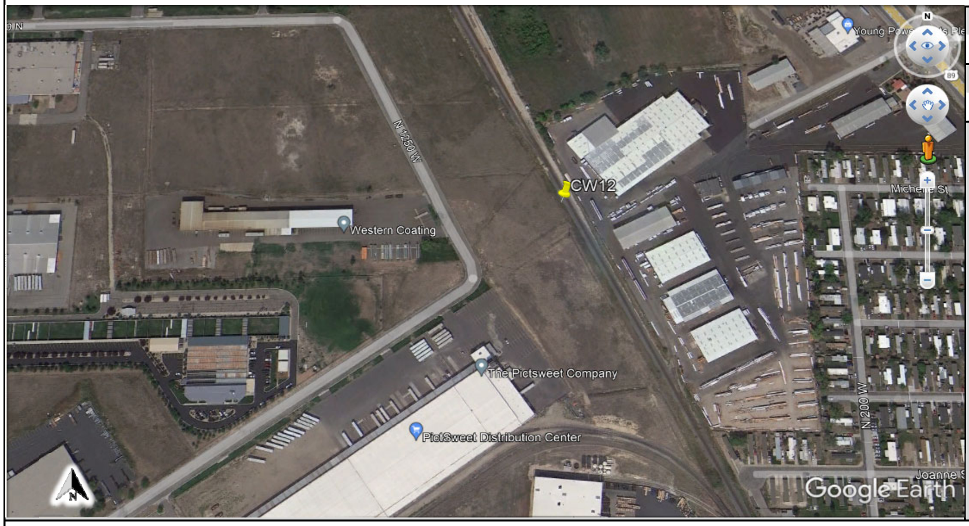
Flow Monitoring
Site Report

22773.11.325

CW12

Site Address /Location:	N 1250 W		
Site Access Details:	100 YARDS AWAY FROM STREET	Latitude: Longitude:	41.302642 -112.007669

Monitor Series	Location Type
TRITON+ VZ	Temporary
Pipe Size (H x W)	Pipe Shape
27.25X27.13	Elliptical



Manhole #	System Characteristics
NO028	Residential/Commercial
Access	Traffic
Drive	None

Installation Information

Installation Date:	Installation Type:
Saturday, April 16, 2022	Doppler Standard Ring and Crank
Monitoring Location (Sensors):	Monitor Location:
Upstream 0-5 FT	Manhole
Sensors / Devices:	Pressure Sensor Range (psi)
Peak Combo (CS4)	0 - 5 psi

Installation Confirmation:

Confirmation Time:	Pipe Size (HxW)
9:48AM	27.25X27.13
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
8.88	
Downlooker Physical Offset (in)	Measurement Confidence (in)
NA	0.25"
Peak Velocity (fps)	Velocity Sensor Offset (in)
4.38	0"
Silt (in)	Silt Type
0	

Hydraulic Comments:
Smooth flow

Manhole / Pipe Information:

Manhole Depth (Approx. FT):	Manhole Configuration
180	Single
Manhole Material:	Manhole Condition:
Concrete	Good
Manhole Opening Diameter (in)	Manhole Diameter (Approx.):
26"	54"
Manhole Cover	Manhole Frame
vented	Normal
Active Drop Connections	Air Quality:
No	Normal
Pipe Material	Pipe Condition:
Concrete	Good

Communication Information:

Communication Type	Antenna Location
Wireless	Manhole Pick / Vent Hole

Additional Site Info. / Comments:

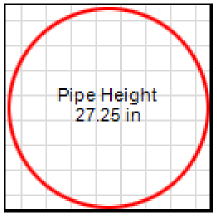
ADS Project Name:	Ogden.BowenClns.TFM.UT22
ADS Project Number:	22773.11.325

SCATTERGRAPH REPORT

CW12

Flow Monitor

CW12

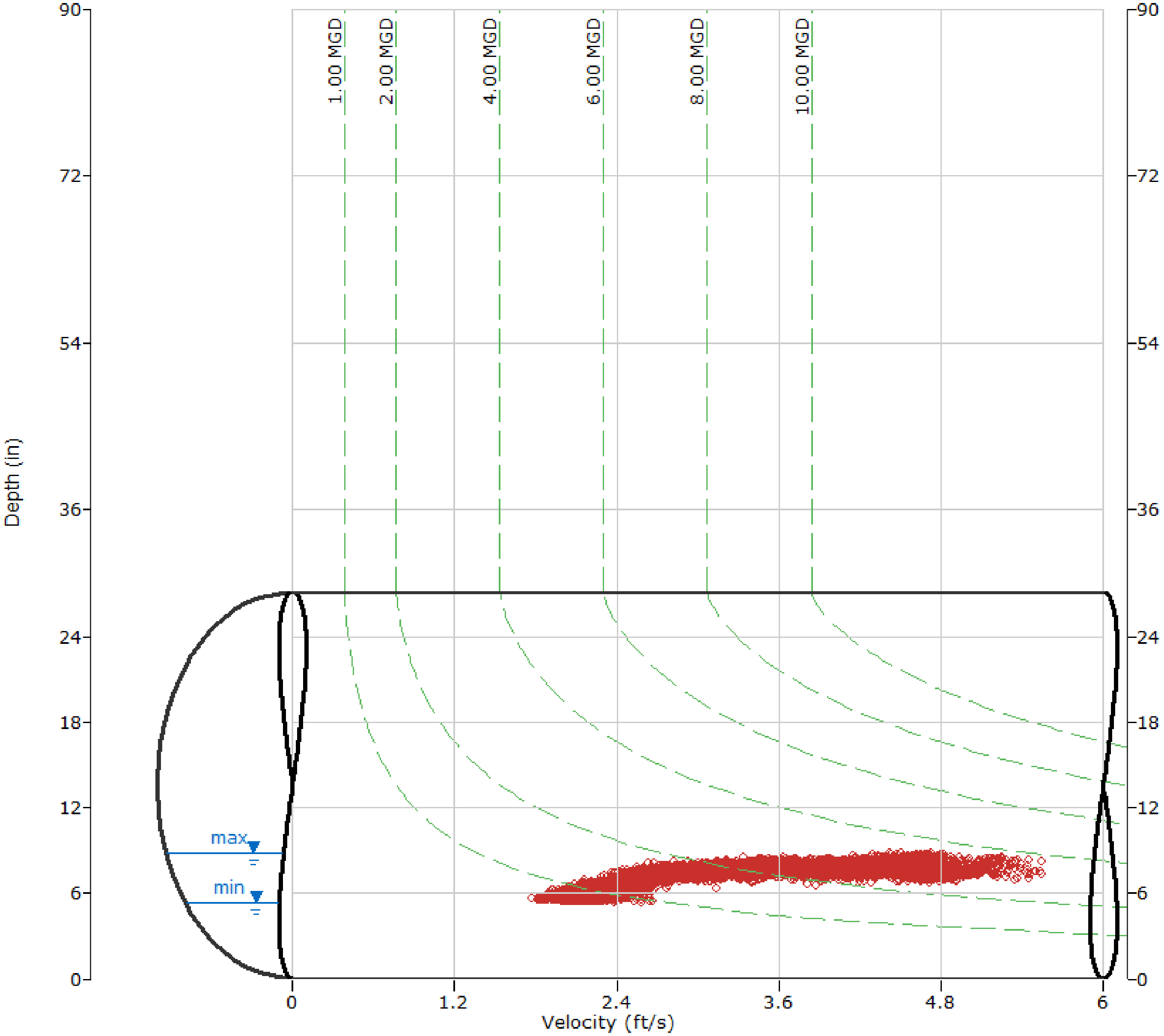


Report Period

4/19/2022
To
6/13/2022

Legend

○	Depth - Velocity
---	Iso-Q™
---	Silt
▼	Min-Max Depth

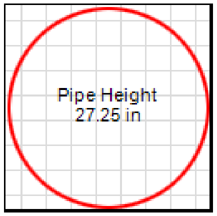


HYDROGRAPH REPORT

CW12

Flow Monitor

CW12

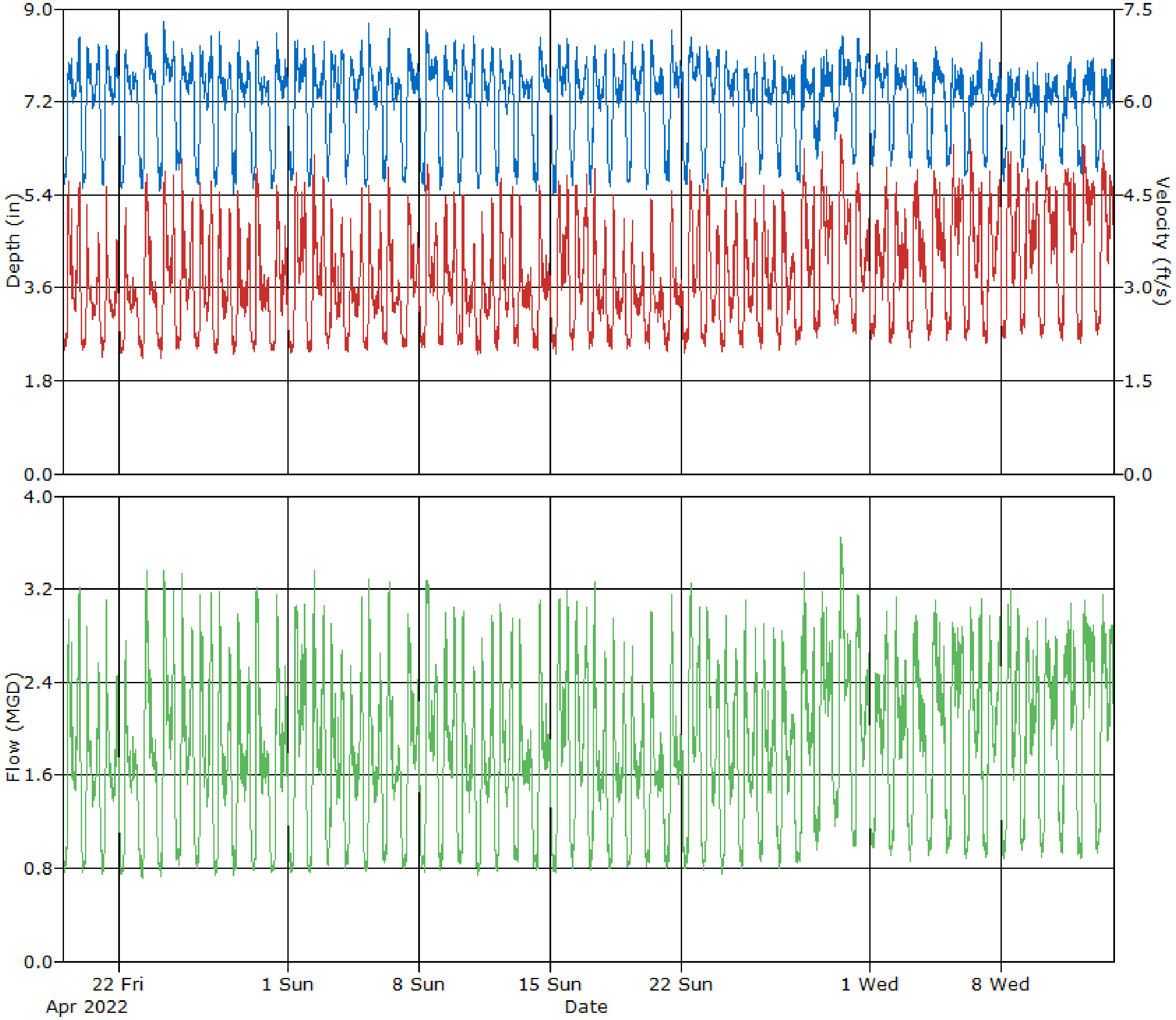


Report Period

4/19/2022
To
6/13/2022

Legend

- Depth
- Velocity
- Quantity



ADS ENVIRONMENTAL SERVICES

Daily Tabular Report

Date	Depth (in)					Velocity (ft/s)					Quantity (MGD - Total MG)						Rain (in)
	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Total	Total
04/19/2022	02:50	5.60	21:25	8.59	7.19	02:45	1.89	21:50	4.79	3.12	02:45	0.731	21:30	3.288	1.780	1.780	
04/20/2022	02:05	5.53	22:25	8.34	7.21	01:05	1.94	07:30	4.58	2.80	02:00	0.739	07:30	3.043	1.596	1.596	
04/21/2022	04:10	5.57	08:25	8.34	7.19	02:35	1.85	08:20	4.77	2.72	04:00	0.727	08:20	3.210	1.543	1.543	
04/22/2022	03:05	5.51	09:35	8.21	7.13	04:10	1.90	08:40	4.35	2.68	03:05	0.732	08:40	2.801	1.498	1.498	
04/23/2022	05:50	5.51	12:40	8.59	7.25	06:50	1.77	12:20	4.93	2.98	06:50	0.682	12:20	3.443	1.740	1.740	
04/24/2022	04:35	5.45	10:15	8.85	7.32	06:30	1.81	11:15	5.08	3.15	06:30	0.691	10:00	3.468	1.860	1.860	
04/25/2022	05:55	5.80	09:00	8.47	7.32	01:35	1.97	08:20	5.14	3.09	05:55	0.809	08:20	3.423	1.798	1.798	
04/26/2022	05:25	5.59	22:00	8.72	7.23	03:40	1.94	08:35	4.80	3.04	03:40	0.761	22:00	3.348	1.749	1.749	
04/27/2022	03:35	5.55	09:25	8.74	7.10	03:15	1.86	09:35	4.71	2.87	03:15	0.721	09:35	3.391	1.602	1.602	
04/28/2022	03:20	5.40	10:20	8.68	7.15	02:55	1.89	10:20	4.70	2.90	02:55	0.719	10:20	3.357	1.633	1.633	
04/29/2022	03:25	5.52	07:50	8.43	7.11	05:25	1.92	08:15	5.09	2.94	04:35	0.754	08:20	3.313	1.652	1.652	
04/30/2022	03:45	5.49	10:40	8.56	7.14	05:45	1.88	10:00	4.81	2.98	05:45	0.737	10:40	3.238	1.687	1.687	
05/01/2022	03:40	5.63	22:00	8.47	7.22	05:50	1.88	11:00	5.05	3.26	05:50	0.740	22:00	3.205	1.890	1.890	
05/02/2022	03:20	5.53	22:30	8.47	7.12	03:30	1.90	09:50	5.32	3.25	03:25	0.743	09:50	3.543	1.838	1.838	
05/03/2022	03:15	5.63	21:10	8.25	7.31	04:40	1.98	08:20	4.56	2.92	03:15	0.772	08:20	3.006	1.682	1.682	
05/04/2022	03:35	5.60	22:45	8.52	7.23	02:05	1.94	22:45	4.78	2.86	02:05	0.776	22:45	3.328	1.628	1.628	
05/05/2022	04:20	5.51	08:20	8.77	7.14	06:00	1.99	08:05	4.75	2.90	04:20	0.756	08:20	3.404	1.633	1.633	
05/06/2022	04:25	5.62	09:45	8.80	7.12	03:35	2.05	09:05	5.09	2.89	03:35	0.811	09:45	3.440	1.614	1.614	
05/07/2022	05:35	5.62	10:40	8.42	7.15	07:15	2.01	10:40	4.59	3.01	04:20	0.783	10:40	3.145	1.706	1.706	
05/08/2022	06:55	5.43	11:10	8.76	7.29	07:10	1.99	10:20	5.14	3.14	07:10	0.748	11:10	3.470	1.838	1.838	
05/09/2022	03:30	5.45	21:55	8.67	7.26	04:10	1.97	10:00	4.81	3.08	04:10	0.768	10:00	3.257	1.781	1.781	
05/10/2022	03:25	5.37	22:15	8.50	7.22	05:55	1.95	08:30	4.60	2.84	05:55	0.800	08:30	3.114	1.616	1.616	
05/11/2022	03:10	5.50	21:25	8.60	7.21	02:55	1.83	21:30	4.54	2.85	03:25	0.725	21:25	3.160	1.630	1.630	
05/12/2022	03:40	5.55	22:00	8.29	7.20	03:15	1.90	08:30	4.79	3.09	03:40	0.737	08:20	3.079	1.751	1.751	
05/13/2022	05:45	5.57	08:30	8.60	7.11	06:35	2.03	08:25	4.80	2.87	05:15	0.819	08:30	3.368	1.595	1.595	
05/14/2022	06:00	5.46	10:50	8.50	7.16	05:50	1.98	10:10	4.73	2.92	06:05	0.756	11:15	3.234	1.651	1.651	
05/15/2022	04:10	5.39	21:25	8.49	7.19	06:40	1.88	21:50	4.89	3.23	06:40	0.736	11:35	3.246	1.864	1.864	
05/16/2022	03:45	5.54	22:30	8.37	7.16	04:15	1.95	22:00	4.92	3.25	04:15	0.764	21:35	3.189	1.841	1.841	
05/17/2022	03:00	5.41	08:30	8.59	7.14	02:05	1.97	08:20	5.00	2.89	03:00	0.737	08:20	3.358	1.622	1.622	
05/18/2022	04:05	5.54	22:20	8.42	7.16	05:35	1.93	08:20	4.57	2.83	04:45	0.769	08:30	3.055	1.599	1.599	
05/19/2022	03:25	5.62	08:25	8.39	7.23	02:25	1.95	08:35	4.25	2.74	04:00	0.782	08:35	2.871	1.560	1.560	
05/20/2022	03:20	5.51	09:45	8.46	7.18	06:35	1.95	08:30	4.58	2.76	03:15	0.791	08:25	3.140	1.556	1.556	
05/21/2022	06:55	5.64	11:20	8.65	7.24	06:20	1.89	10:45	4.69	2.86	04:40	0.773	11:00	3.282	1.641	1.641	
05/22/2022	07:15	5.51	22:40	8.71	7.31	03:05	1.88	10:00	5.04	3.19	05:25	0.750	22:50	3.405	1.878	1.878	
05/23/2022	04:05	5.46	08:45	8.37	7.20	06:30	2.01	09:15	5.03	3.00	04:05	0.767	08:20	3.123	1.718	1.718	
05/24/2022	03:35	5.56	09:05	8.43	7.19	03:35	1.88	09:15	4.78	2.99	03:35	0.717	08:15	3.075	1.697	1.697	
05/25/2022	03:00	5.56	22:25	8.20	7.06	04:00	1.98	09:10	5.23	3.07	04:00	0.766	09:10	3.268	1.696	1.696	
05/26/2022	04:05	5.79	09:40	8.38	7.14	05:15	1.98	08:40	4.74	3.11	03:50	0.839	08:40	2.984	1.734	1.734	
05/27/2022	05:25	5.73	23:35	8.21	7.14	05:20	1.93	09:00	4.83	3.09	05:20	0.770	08:50	2.931	1.719	1.719	
05/28/2022	06:55	5.59	14:00	8.26	7.00	05:40	2.06	13:05	5.32	3.27	05:40	0.817	13:10	3.420	1.795	1.795	
05/29/2022	05:10	6.08	19:10	8.39	7.31	05:10	2.11	12:00	5.38	3.67	05:10	0.916	12:05	3.334	2.115	2.115	
05/30/2022	04:25	6.46	14:35	8.61	7.56	04:00	2.29	11:55	5.55	3.75	04:00	1.118	11:55	3.673	2.261	2.261	
05/31/2022	04:05	5.98	10:05	8.52	7.41	06:20	2.19	08:30	5.01	3.36	06:20	0.964	11:15	3.220	1.977	1.977	
06/01/2022	03:25	5.92	22:55	8.39	7.33	01:50	2.13	21:20	5.01	3.28	03:30	0.948	22:30	3.183	1.897	1.897	
06/02/2022	03:50	5.93	10:20	8.33	7.28	02:35	2.05	09:55	4.81	3.27	02:35	0.886	10:20	3.157	1.878	1.878	
06/03/2022	04:10	5.93	11:05	8.28	7.22	04:05	1.96	12:35	4.98	3.33	04:05	0.825	11:05	3.104	1.889	1.889	

Date	Depth (in)					Velocity (ft/s)					Quantity (MGD - Total MG)						Rain (in)
	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Total	Total
06/04/2022	06:30	5.83	12:45	8.36	7.25	03:45	2.09	11:10	5.05	3.48	03:40	0.874	12:45	3.222	1.992	1.992	
06/05/2022	06:30	5.92	09:50	8.13	7.12	03:05	2.07	11:30	5.45	3.71	03:05	0.899	09:50	3.022	2.066	2.066	
06/06/2022	02:50	5.75	22:30	8.40	7.15	02:35	2.09	09:55	5.54	3.57	03:00	0.863	22:30	3.275	1.999	1.999	
06/07/2022	03:40	5.88	10:10	8.08	7.10	05:10	2.05	10:25	5.07	3.44	04:25	0.864	10:25	3.142	1.909	1.909	
06/08/2022	03:15	5.62	12:50	7.95	7.04	03:00	2.14	08:50	5.30	3.60	03:15	0.863	12:50	3.344	1.977	1.977	
06/09/2022	03:30	5.83	23:20	8.09	7.08	03:25	2.19	11:05	4.99	3.62	03:25	0.914	23:20	2.988	1.990	1.990	
06/10/2022	04:35	5.85	23:00	7.89	7.06	04:40	2.12	09:30	5.14	3.65	04:40	0.872	09:30	3.176	2.009	2.009	
06/11/2022	05:55	5.97	17:55	8.17	7.12	06:30	2.10	13:15	5.01	3.71	06:30	0.908	17:50	3.146	2.055	2.055	
06/12/2022	05:40	5.78	21:20	8.12	7.13	05:35	2.05	10:55	5.54	3.84	05:30	0.868	10:55	3.268	2.155	2.155	
06/13/2022	03:40	5.84	21:35	8.31	7.11	03:50	2.21	10:00	5.35	3.78	03:40	0.904	10:15	3.244	2.106	2.105	

Report Summary For The Period 04/19/2022 00:00 - 06/13/2022 23:59

	Depth (in)	Velocity (ft/s)	Quantity (MGD - Total MG)
Total			100.184
Avg	7.19	3.15	1.789

Site Commentary

Site Information

CW13	
Pipe Dimensions	60.25"
Silt Level	0.00"

Overview

Site CW13 functioned under normal conditions during the period Tuesday, April 19, 2022 to Monday, June 13, 2022. Flows progressively increased in this line as both depth and velocity shifted higher beginning May 7, 2022 through the remainder of the study. The pattern is also exhibited by upstream site CW09. No surcharge conditions were experienced at this location. Review of the scattergraph shows that free flow conditions were maintained throughout the study period. Flow is subcritical.

Flow depth and velocity measurements recorded by the flow monitor are consistent with field confirmations conducted to date and support the relative accuracy of the flow monitor at this location.

This site was positioned downstream of location CW09, CW11 and CW19. Flows are balanced.

Observations

Average flow depth, velocity, and quantity data observed during Tuesday, April 19, 2022 to Monday, June 13, 2022 , along with observed minimum and maximum data, are provided in the following table. Values in the Observed Flow Conditions are based on 5-minute averages. Graphs are based on 15-minute averages. As a result, the values shown in the table below may differ from those shown on the graph.

In regard to depth, based on an average depth of 24.61 inches, this site utilized 40.85 percent of full pipe depth. The hourly averaged peak depth of 30.27 inches represented 50.25 percent of full pipe depth.

Observed Flow Conditions

Item	Depth (in)	Velocity (ft/s)	Quantity (MGD)
Average	24.61	3.89	19.428
Minimum	18.47	2.95	10.018
Maximum	30.65	4.80	30.541
Time of Minimum	4/30/2022 06:15	4/23/2022 06:45	4/23/2022 06:45
Time of Maximum	5/30/2022 16:00	6/13/2022 12:30	6/13/2022 15:35

Data Quality

Data uptime observed during the Tuesday, April 19, 2022 to the Monday, June 13, 2022 monitoring period is provided in the table below. Based upon the quality and consistency of the observed flow depth and velocity data, the Continuity equation was used to calculate flow rate and quantities during the monitoring period.

Percent Uptime	
Depth (in)	100
Velocity (ft/s)	100
Quantity (MGD)	100

Ogden.BowenClns.TFM.UT22

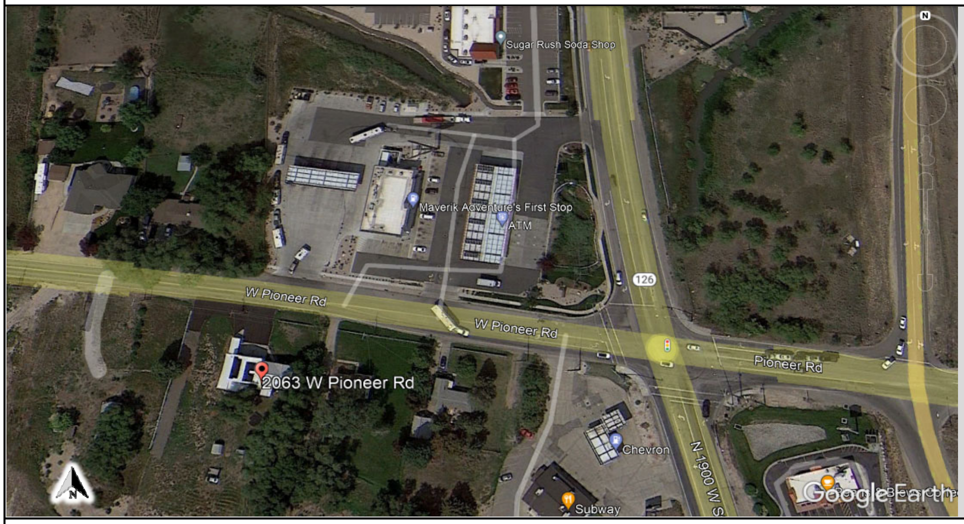
Flow Monitoring Site Report

ADS ENVIRONMENTAL SERVICES®

22773.11.325

CW13

Site Address /Location:	2063 W. PIONEER RD			Monitor Series TRITON+ VZ	Location Type Temporary
Site Access Details:	DRIVE	Latitude: Longitude:	41.2688051 -112.0294849	Pipe Size (H x W) 60.25X60.13	Pipe Shape Elliptical



Manhole #	System Characteristics
PR016	Residential/Commercial
Access	Traffic
Drive	Light

Installation Information

Installation Date:	Installation Type:
04/14//2022	Doppler Standard Ring and Crank
Monitoring Location (Sensors):	Monitor Location:
Upstream 0-5 FT	Manhole
Sensors / Devices:	Pressure Sensor Range (psi)
Peak Combo (CS4)	0 - 5 psi

Installation Confirmation:

Confirmation Time:	Pipe Size (HxW)
3:31PM	60.25X60.13
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
23.38	
Downlooker Physical Offset (in)	Measurement Confidence (in)
NA	0.38"
Peak Velocity (fps)	Velocity Sensor Offset (in)
4.02	0"
Silt (in)	Silt Type
0	

Hydraulic Comments:

Smooth flow

Manhole / Pipe Information:

Manhole Depth (Approx. FT):	Manhole Configuration
144	Single
Manhole Material:	Manhole Condition:
Concrete	Good
Manhole Opening Diameter (in)	Manhole Diameter (Approx.):
26"	54"
Manhole Cover	Manhole Frame
vented	Normal
Active Drop Connections	Air Quality:
No	Normal
Pipe Material	Pipe Condition:
Concrete	Good

Communication Information:

Communication Type	Antenna Location
Wireless	Manhole Pick / Vent Hole

Additional Site Info. / Comments:

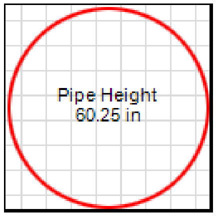
ADS Project Name:	Ogden.BowenClns.TFM.UT22
ADS Project Number:	22773.11.325

SCATTERGRAPH REPORT

CW13

Flow Monitor

CW13

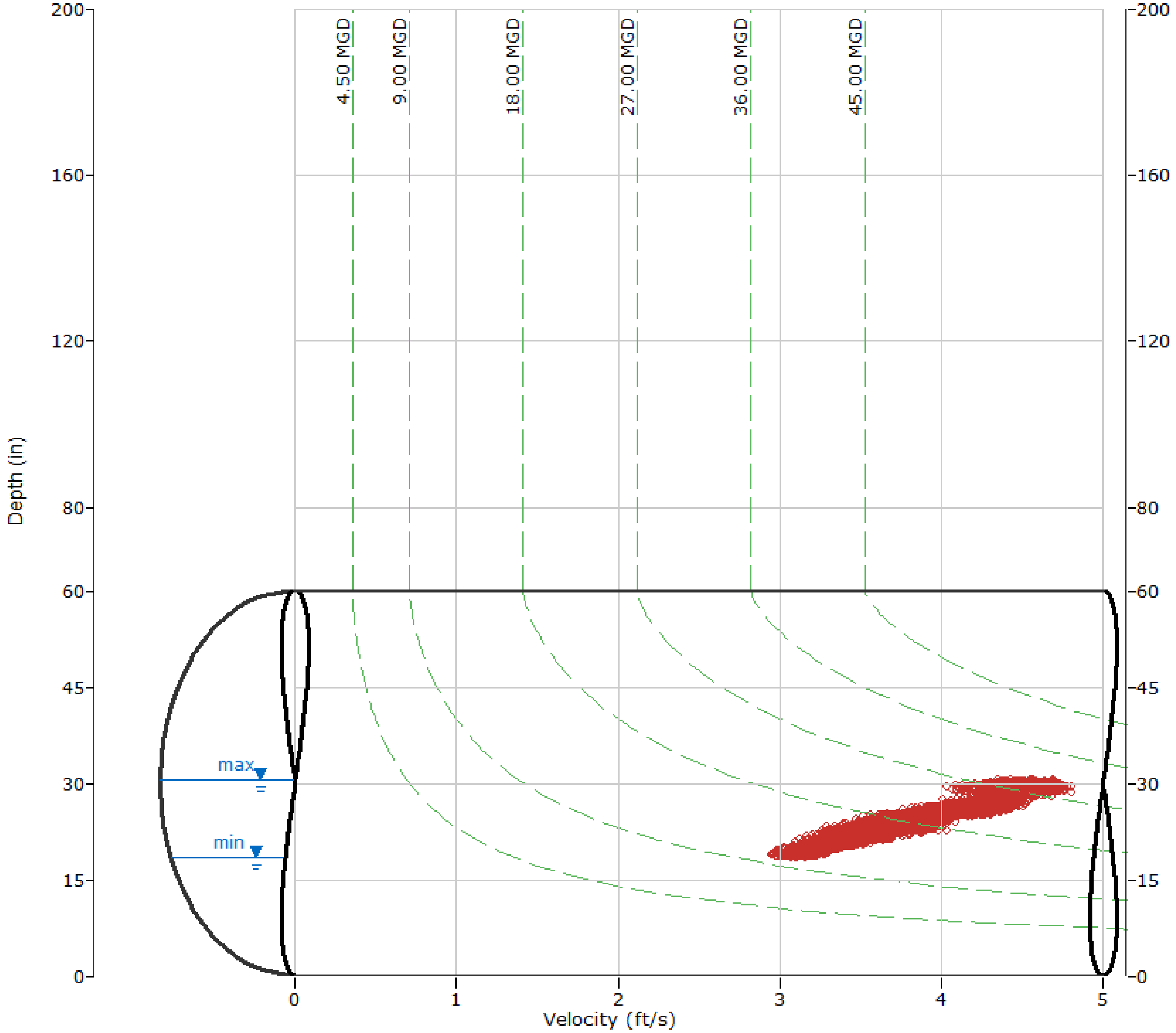


Report Period

4/19/2022
To
6/13/2022

Legend

- ○ Depth - Velocity
- --- Iso-Q™
- --- Silt
- ▼ Min-Max Depth

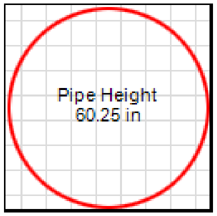


HYDROGRAPH REPORT

CW13

Flow Monitor

CW13



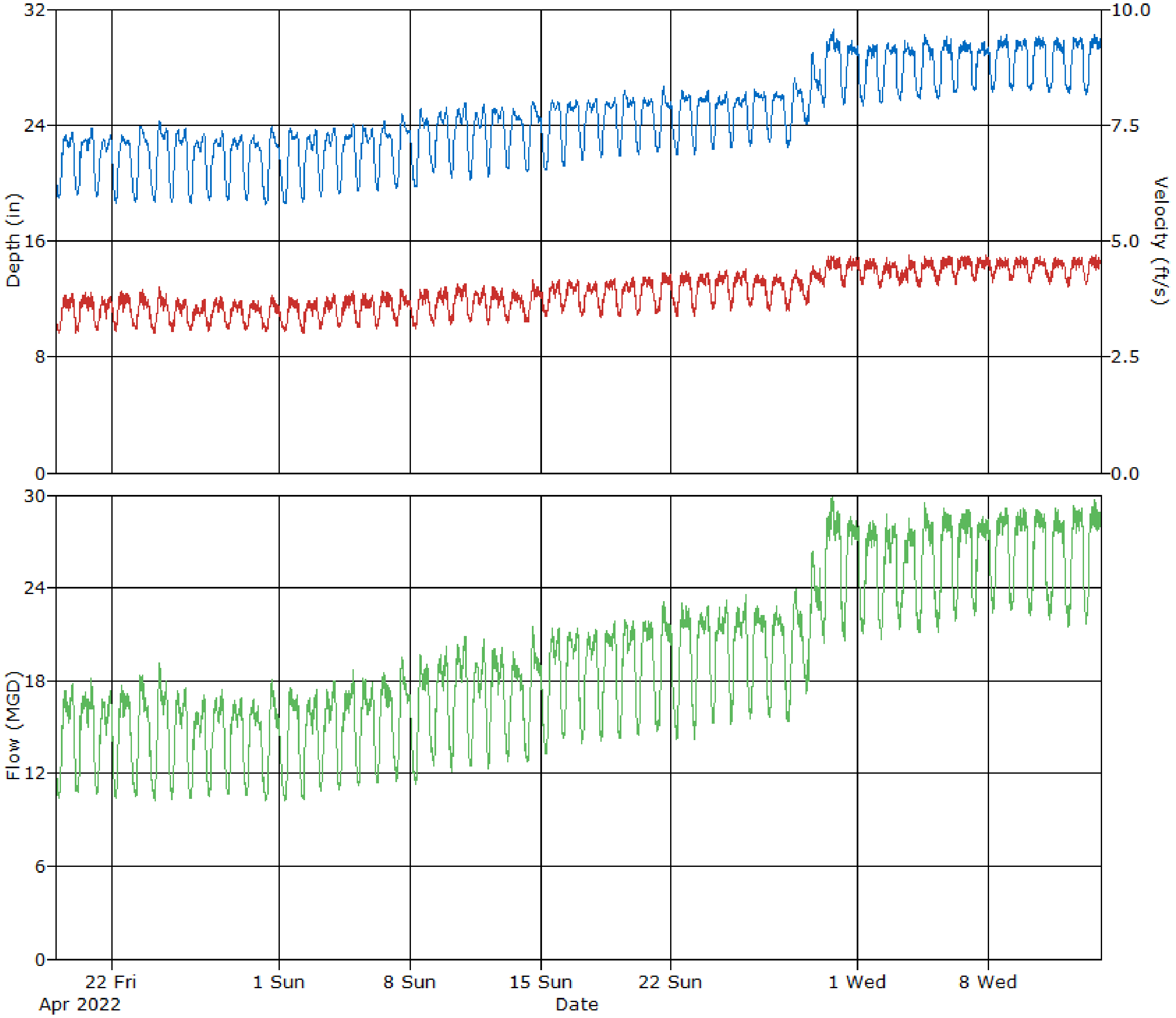
Report Period

4/19/2022
To
6/13/2022

Legend

Depth
Velocity
Quantity

ADS ENVIRONMENTAL SERVICES



Daily Tabular Report

Date	Depth (in)					Velocity (ft/s)					Quantity (MGD - Total MG)						Rain (in)
	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Total	Total
04/19/2022	04:25	18.91	21:45	23.53	21.89	04:25	3.03	21:50	3.89	3.53	04:25	10.388	21:50	17.911	14.906	14.906	
04/20/2022	04:15	19.10	22:30	23.79	21.88	02:55	2.98	22:20	3.96	3.55	05:20	10.555	22:20	18.392	14.941	14.941	
04/21/2022	05:10	19.05	00:00	23.44	21.75	05:00	3.01	22:00	3.88	3.50	05:00	10.450	23:05	17.411	14.627	14.627	
04/22/2022	06:00	18.62	13:30	23.30	21.72	05:35	2.99	11:30	4.04	3.58	05:35	10.186	13:25	18.064	14.946	14.946	
04/23/2022	06:15	18.70	14:40	24.00	21.72	06:45	2.95	15:55	4.04	3.52	06:45	10.018	15:55	18.789	14.724	14.724	
04/24/2022	07:40	18.69	14:00	24.31	21.86	06:05	2.96	13:30	4.05	3.51	07:35	10.101	13:30	19.283	14.810	14.810	
04/25/2022	05:55	18.69	22:50	23.78	21.98	05:20	2.96	13:05	3.83	3.48	05:20	10.052	13:05	17.762	14.754	14.754	
04/26/2022	06:05	18.62	22:30	23.46	21.69	04:55	3.01	22:30	3.77	3.42	04:55	10.311	22:30	17.361	14.247	14.247	
04/27/2022	06:20	18.76	22:40	23.72	21.76	05:10	3.01	20:55	3.88	3.48	06:40	10.381	22:10	17.618	14.559	14.559	
04/28/2022	06:00	18.82	00:00	23.30	21.77	04:55	3.06	15:10	3.78	3.46	05:30	10.532	23:10	16.952	14.492	14.492	
04/29/2022	06:00	18.77	14:50	23.33	21.65	05:00	2.99	20:40	3.84	3.44	06:25	10.415	15:00	17.144	14.277	14.277	
04/30/2022	06:15	18.47	14:00	23.88	21.54	06:45	2.98	14:45	3.92	3.43	06:05	10.049	13:55	18.373	14.202	14.202	
05/01/2022	07:20	18.56	14:15	23.83	21.65	07:40	2.98	12:40	3.82	3.45	07:40	10.065	13:15	17.787	14.374	14.374	
05/02/2022	06:20	18.68	22:35	23.66	21.78	05:25	2.96	21:15	3.84	3.46	05:25	10.175	23:35	17.785	14.491	14.491	
05/03/2022	05:55	19.06	22:45	23.86	22.10	05:50	3.08	21:30	3.92	3.52	05:50	10.707	21:30	18.368	15.044	15.044	
05/04/2022	05:15	19.23	22:15	24.12	22.19	05:45	3.07	22:25	4.02	3.55	05:15	10.798	22:25	19.094	15.265	15.265	
05/05/2022	05:00	19.40	11:30	23.97	22.35	06:40	3.05	14:00	3.94	3.56	05:30	11.102	14:00	18.432	15.435	15.435	
05/06/2022	06:25	19.48	14:35	24.34	22.45	05:30	3.09	17:20	3.98	3.59	06:10	11.079	15:10	18.778	15.646	15.646	
05/07/2022	07:00	19.61	13:45	24.83	22.50	07:10	3.11	12:35	4.05	3.59	07:10	11.343	14:05	19.781	15.728	15.728	
05/08/2022	08:10	19.70	13:40	25.15	22.76	07:00	3.03	15:00	4.02	3.59	08:00	11.030	13:30	20.070	16.013	16.013	
05/09/2022	06:40	20.73	23:00	25.19	23.39	07:05	3.10	21:25	4.04	3.65	07:05	12.213	23:05	20.429	16.839	16.839	
05/10/2022	05:45	20.23	22:35	25.61	23.54	04:45	3.15	21:50	4.18	3.72	05:50	11.934	21:50	21.415	17.296	17.296	
05/11/2022	06:00	20.24	23:20	25.46	23.39	04:55	3.18	23:20	4.08	3.67	05:55	12.154	23:20	20.928	16.924	16.924	
05/12/2022	05:15	20.40	22:25	25.27	23.83	05:20	3.12	10:20	4.09	3.71	05:20	11.942	12:20	20.439	17.528	17.528	
05/13/2022	05:20	20.92	13:00	25.26	23.63	05:25	3.17	12:55	4.05	3.64	05:25	12.531	12:55	20.410	16.979	16.979	
05/14/2022	06:35	20.75	14:25	25.72	23.58	03:45	3.16	14:40	4.19	3.69	06:55	12.577	14:35	21.538	17.192	17.192	
05/15/2022	05:50	20.85	14:30	25.82	23.81	06:15	3.31	23:15	4.20	3.81	05:25	13.053	14:30	21.795	17.977	17.977	
05/16/2022	06:20	21.20	22:00	25.72	24.26	03:05	3.37	23:15	4.20	3.89	06:10	14.003	23:15	21.619	18.791	18.791	
05/17/2022	05:10	21.49	22:35	25.88	24.38	05:20	3.32	00:05	4.18	3.82	05:20	13.675	23:05	21.602	18.610	18.610	
05/18/2022	06:10	21.76	23:35	25.93	24.48	06:15	3.31	22:45	4.25	3.87	06:15	13.800	22:45	22.036	18.933	18.933	
05/19/2022	06:10	21.82	12:25	26.48	24.73	05:40	3.32	23:00	4.28	3.87	05:40	13.931	12:15	22.196	19.184	19.184	
05/20/2022	05:30	21.91	13:45	25.96	24.62	05:40	3.36	19:30	4.28	3.93	05:40	14.201	11:15	22.035	19.370	19.370	
05/21/2022	05:40	22.11	13:35	26.81	24.51	05:15	3.38	15:30	4.40	3.94	07:10	14.410	13:30	23.442	19.335	19.335	
05/22/2022	06:55	21.91	13:55	26.43	24.60	07:45	3.29	14:25	4.44	3.95	07:45	13.891	14:25	23.648	19.493	19.493	
05/23/2022	05:50	21.94	22:45	26.44	24.86	06:05	3.31	23:10	4.42	4.00	06:05	13.976	22:40	23.592	19.971	19.971	
05/24/2022	05:50	22.27	23:00	26.33	24.90	05:35	3.47	22:50	4.43	4.04	06:00	15.080	22:50	23.544	20.205	20.205	
05/25/2022	05:00	22.39	23:20	26.42	24.97	05:05	3.46	23:25	4.50	4.06	05:05	14.981	23:25	24.245	20.368	20.368	
05/26/2022	05:40	22.44	11:00	26.47	25.17	06:15	3.52	00:10	4.35	4.00	05:45	15.378	16:30	23.134	20.298	20.298	
05/27/2022	06:40	22.79	14:55	26.37	25.21	07:20	3.47	15:25	4.33	3.98	06:10	15.444	15:25	23.204	20.202	20.202	
05/28/2022	06:35	22.44	14:40	27.32	25.09	04:15	3.45	16:10	4.37	3.96	06:35	15.172	14:20	24.128	20.022	20.022	
05/29/2022	05:55	24.05	13:35	29.03	26.20	05:55	3.58	14:10	4.48	4.09	05:55	17.022	13:00	26.798	21.894	21.894	
05/30/2022	04:35	25.20	16:00	30.65	28.60	04:45	3.95	17:25	4.78	4.43	04:45	20.087	15:50	30.308	26.540	26.540	
05/31/2022	05:35	25.35	15:35	30.04	28.18	04:35	3.94	13:10	4.75	4.40	06:40	20.408	15:30	29.443	25.837	25.837	
06/01/2022	06:05	25.34	21:50	29.97	27.99	04:25	3.98	10:40	4.68	4.41	06:25	20.771	14:35	29.049	25.655	25.655	
06/02/2022	05:45	25.47	12:30	29.84	28.10	03:25	3.93	12:30	4.69	4.34	06:00	20.302	12:30	29.577	25.419	25.419	
06/03/2022	06:15	25.63	16:05	29.87	28.12	05:05	3.99	17:55	4.74	4.34	05:05	21.037	00:25	28.811	25.373	25.373	

Date	Depth (in)					Velocity (ft/s)					Quantity (MGD - Total MG)						Rain (in)
	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Total	Total
06/04/2022	07:25	25.82	13:45	30.32	28.17	05:35	3.94	12:55	4.73	4.38	07:45	20.779	12:55	29.865	25.711	25.711	
06/05/2022	06:45	25.79	18:20	30.28	28.19	07:00	3.98	20:30	4.76	4.42	07:00	20.899	16:00	29.653	25.964	25.964	
06/06/2022	04:30	26.20	16:55	30.04	28.46	04:20	4.03	17:35	4.80	4.47	04:20	21.665	20:45	29.343	26.587	26.587	
06/07/2022	05:50	26.35	00:10	30.03	28.49	06:30	4.03	23:40	4.77	4.46	06:30	21.692	17:25	29.308	26.571	26.571	
06/08/2022	04:55	26.29	22:45	30.42	28.71	05:30	4.06	14:10	4.70	4.45	05:30	22.095	22:45	30.326	26.767	26.767	
06/09/2022	06:10	26.36	21:50	30.14	28.67	04:25	4.05	17:20	4.74	4.46	04:25	22.023	16:40	29.712	26.756	26.756	
06/10/2022	06:25	26.32	16:45	30.18	28.69	04:45	4.07	15:10	4.75	4.44	06:15	21.874	23:00	29.638	26.678	26.678	
06/11/2022	06:45	26.22	15:10	30.19	28.47	06:15	3.98	13:35	4.72	4.42	06:15	21.351	16:45	29.696	26.279	26.279	
06/12/2022	07:30	26.14	23:15	30.42	28.52	06:35	3.94	14:10	4.71	4.40	06:35	21.161	23:15	29.955	26.269	26.269	
06/13/2022	05:55	26.06	15:35	30.59	28.66	05:40	4.05	12:30	4.80	4.44	05:55	21.458	15:35	30.541	26.645	26.627	

Report Summary For The Period 04/19/2022 00:00 - 06/13/2022 23:59

	Depth (in)	Velocity (ft/s)	Quantity (MGD - Total MG)
Total			1087.925
Avg	24.61	3.89	19.427

Site Commentary

Site Information

CW14	
Pipe Dimensions	43.13"
Silt Level	0.00"

Overview

Site CW14 functioned under normal conditions during the period Tuesday, April 19, 2022 to Monday, June 13, 2022. No surcharge conditions were experienced at this location. A drop in depth and velocity was observed on May 5, 2022 for a couple of hours followed by a significant and brief increase in both depth and velocity. Normal sampling then resumed. No explanation is known for the changes shown however, data is valid. Review of the scattergraph shows that free flow conditions were maintained throughout the study period. Flow is supercritical.

Flow depth and velocity measurements recorded by the flow monitor are consistent with field confirmations conducted to date and support the relative accuracy of the flow monitor at this location.

This site was positioned downstream of location CW12. Flows are not balanced. An explanation for the imbalance was not determined.

Observations

Average flow depth, velocity, and quantity data observed during Tuesday, April 19, 2022 to Monday, June 13, 2022 , along with observed minimum and maximum data, are provided in the following table. Values in the Observed Flow Conditions are based on 5-minute averages. Graphs are based on 15-minute averages. As a result, the values shown in the table below may differ from those shown on the graph.

In regard to depth, based on an average depth of 4.39 inches, this site utilized 10.18 percent of full pipe depth. The hourly averaged peak depth of 7.21 inches represented 16.72 percent of full pipe depth.

Observed Flow Conditions

Item	Depth (in)	Velocity (ft/s)	Quantity (MGD)
Average	4.39	4.63	1.649
Minimum	2.67	3.86	0.662
Maximum	13.57	6.59	11.602
Time of Minimum	5/5/2022 11:50	5/5/2022 11:40	5/5/2022 11:40
Time of Maximum	5/5/2022 13:20	5/5/2022 13:25	5/5/2022 13:25

Data Quality

Data uptime observed during the Tuesday, April 19, 2022 to the Monday, June 13, 2022 monitoring period is provided in the table below. Based upon the quality and consistency of the observed flow depth and velocity data, the Continuity equation was used to calculate flow rate and quantities during the monitoring period.

Percent Uptime	
Depth (in)	100
Velocity (ft/s)	100
Quantity (MGD)	100

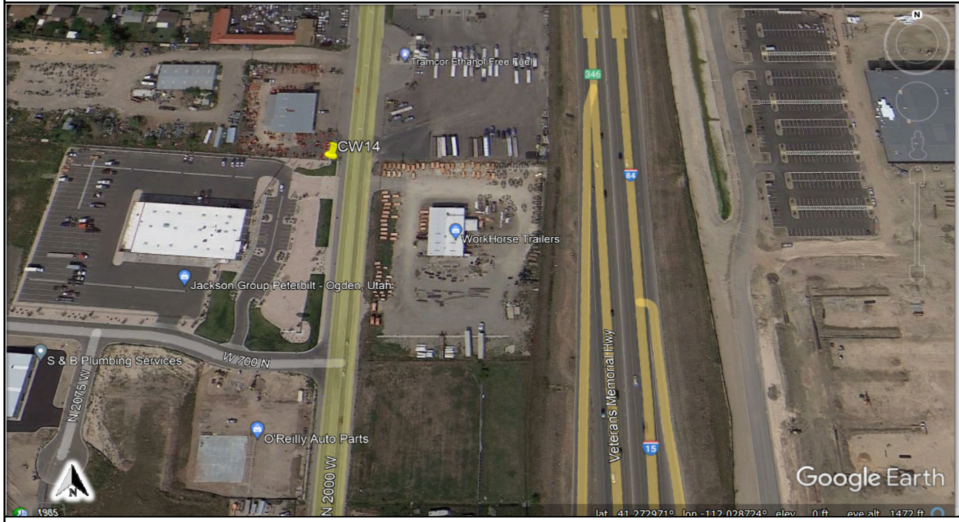
Ogden.BowenClns.TFM.UT22

Flow Monitoring Site Report

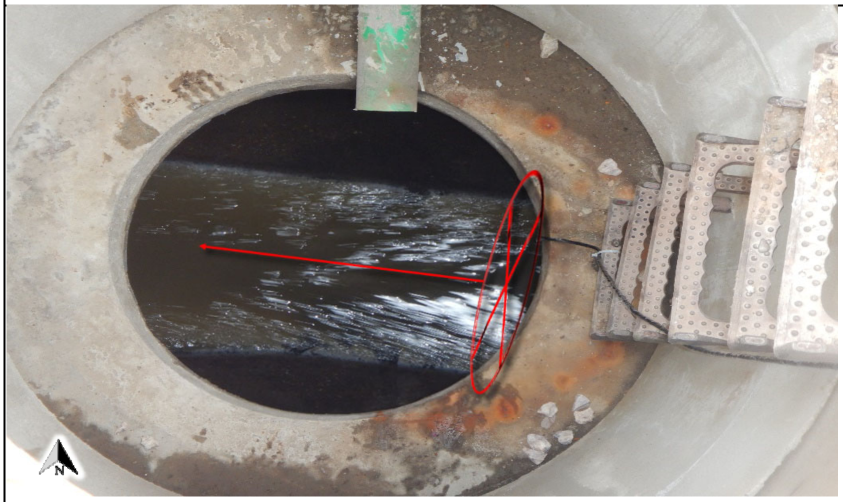
22773.11.325

CW14

Site Address /Location:	732 N. 2000 W			Monitor Series TRITON+ VZ	Location Type Temporary
Site Access Details:	DRIVE	Latitude: Longitude:	41.2727276 -112.0284053	Pipe Size (H x W) 48.25X43.13	Pipe Shape Elliptical



Manhole #	System Characteristics
BD018	Residential/Commercial
Access	Traffic
Drive	Light



Installation Information

Installation Date:	Installation Type:
04/14//2022	Doppler Standard Ring and Crank
Monitoring Location (Sensors):	Monitor Location:
Upstream 0-5 FT	Manhole
Sensors / Devices:	Pressure Sensor Range (psi)
Peak Combo (CS4)	0 - 5 psi

Installation Confirmation:

Confirmation Time:	Pipe Size (HxW)
12:56PM	48.25X43.13
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
4.75	
Downlooker Physical Offset (in)	Measurement Confidence (in)
NA	0.25"
Peak Velocity (fps)	Velocity Sensor Offset (in)
5.12	0"
Silt (in)	Silt Type
0	

Hydraulic Comments:

Smooth flow

Manhole / Pipe Information:

Manhole Depth (Approx. FT):	Manhole Configuration
172.38	Single
Manhole Material:	Manhole Condition:
Concrete	Good
Manhole Opening Diameter (in)	Manhole Diameter (Approx.):
26"	54"
Manhole Cover	Manhole Frame
vented	Normal
Active Drop Connections	Air Quality:
No	Normal
Pipe Material	Pipe Condition:
Concrete	Good

Communication Information:

Communication Type	Antenna Location
Wireless	Manhole Pick / Vent Hole

Additional Site Info. / Comments:

ADS Project Name:	Ogden.BowenClns.TFM.UT22
ADS Project Number:	22773.11.325

SCATTERGRAPH REPORT

CW14

Flow Monitor

CW14

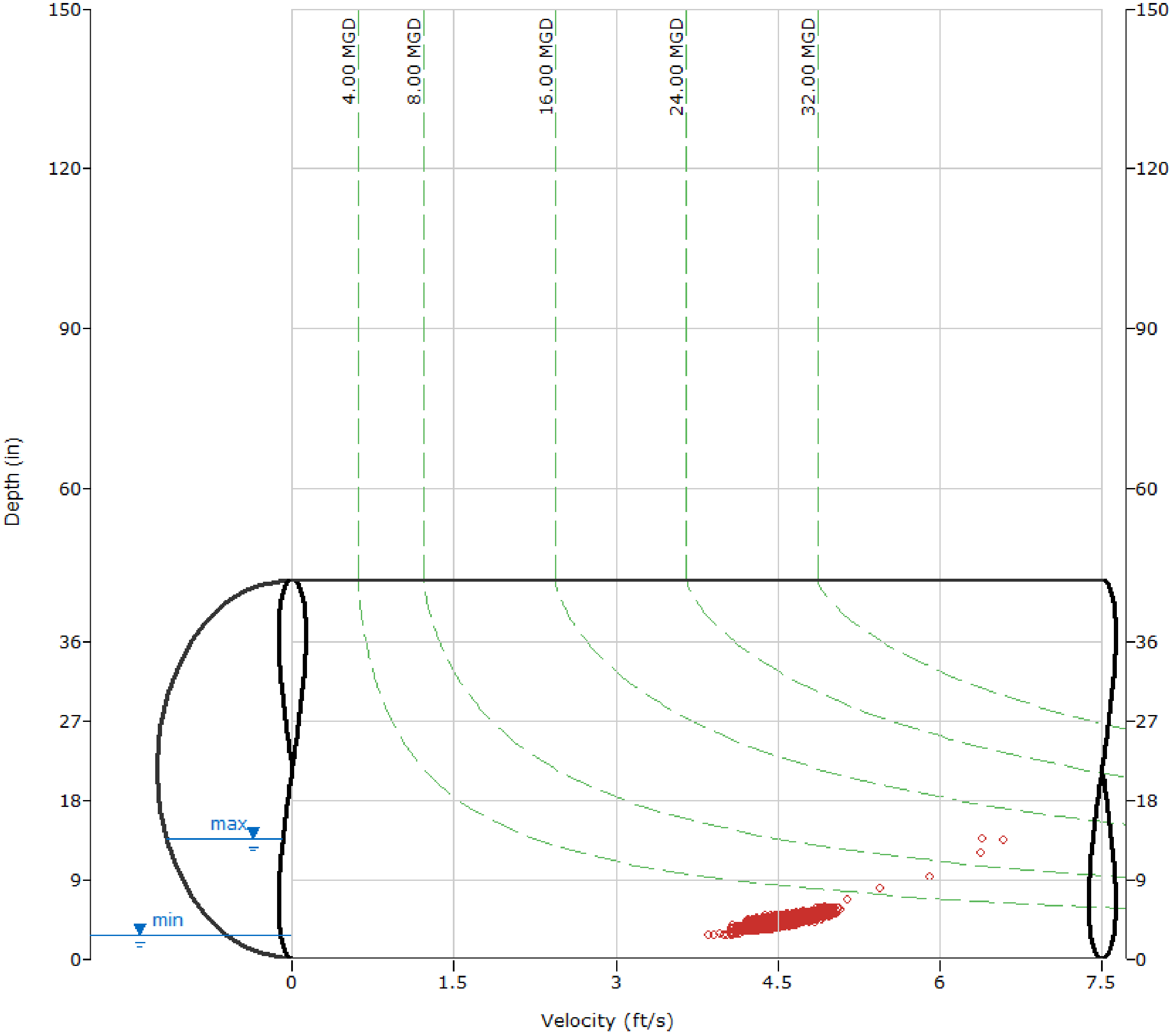
Pipe Height
43.13 in

Report Period

4/19/2022
To
6/13/2022

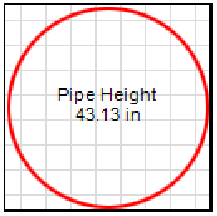
Legend

○ Depth - Velocity
--- Iso-Q™
--- Silt
▼ Min-Max Depth



Flow Monitor

CW14



Report Period

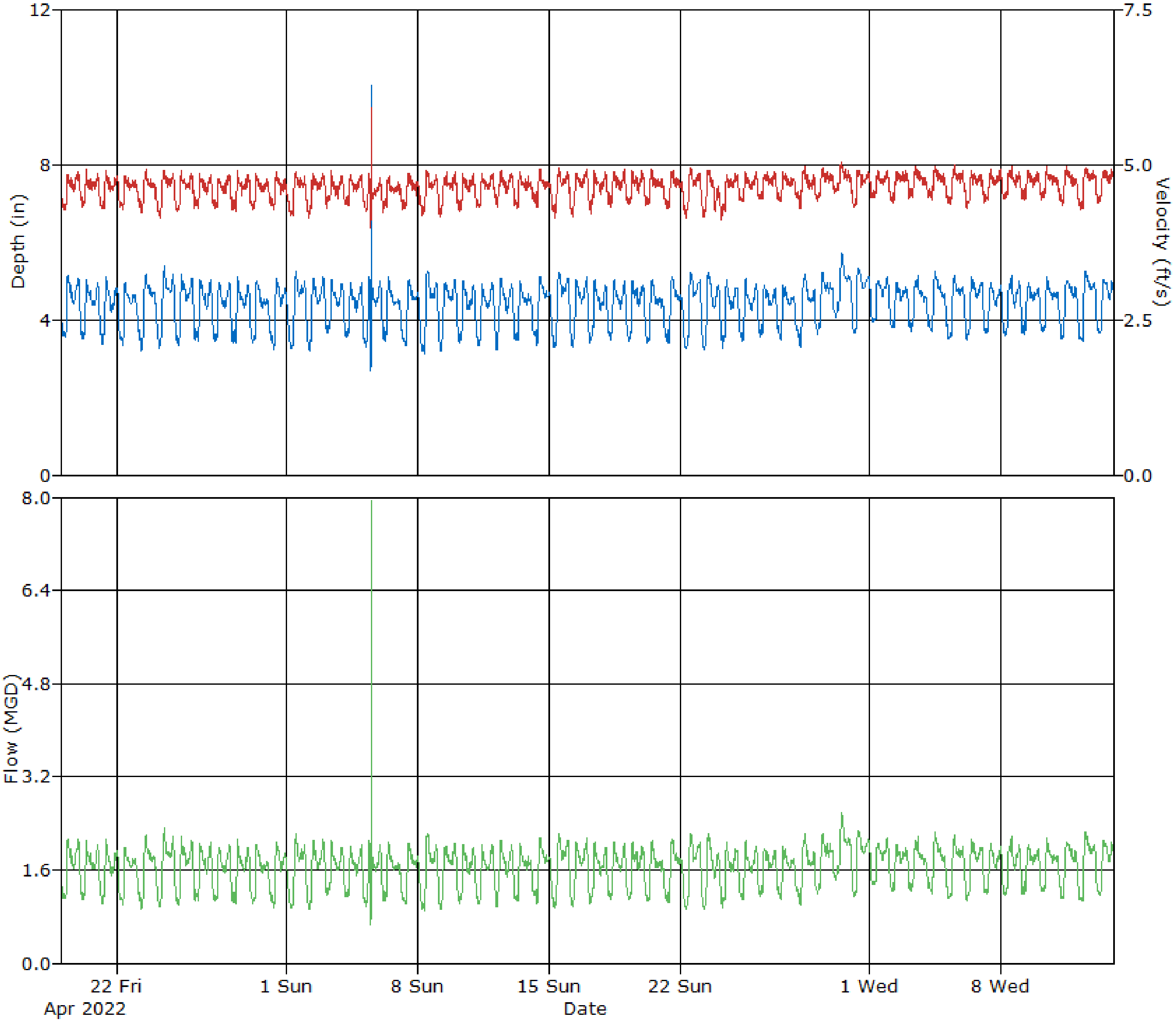
4/19/2022
To
6/13/2022

Legend

Depth
Velocity
Quantity

HYDROGRAPH REPORT

CW14



Daily Tabular Report

Date	Depth (in)					Velocity (ft/s)					Quantity (MGD - Total MG)						Rain (in)
	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Total	Total
04/19/2022	05:35	3.56	09:10	5.14	4.46	06:40	4.22	21:50	4.92	4.61	05:30	1.101	09:00	2.155	1.676	1.676	
04/20/2022	04:40	3.49	09:20	5.02	4.37	04:30	4.25	09:20	4.99	4.62	04:30	1.075	09:20	2.137	1.624	1.624	
04/21/2022	05:45	3.35	10:05	5.12	4.33	07:50	4.23	10:45	5.00	4.60	05:45	1.002	10:15	2.140	1.600	1.600	
04/22/2022	07:50	3.34	10:20	4.94	4.30	07:50	4.22	11:00	4.85	4.60	07:50	0.994	10:15	1.995	1.583	1.583	
04/23/2022	07:35	3.18	13:00	5.18	4.34	07:30	4.14	13:25	4.99	4.60	07:30	0.910	13:00	2.227	1.610	1.610	
04/24/2022	06:25	3.27	12:55	5.39	4.45	07:35	4.12	11:15	4.95	4.60	06:10	0.962	12:55	2.313	1.674	1.674	
04/25/2022	06:25	3.34	10:10	5.18	4.43	05:10	4.16	23:30	4.91	4.61	06:25	1.002	10:05	2.176	1.659	1.659	
04/26/2022	07:30	3.44	00:00	5.07	4.39	03:25	4.28	09:50	4.89	4.60	07:25	1.054	23:50	2.089	1.633	1.633	
04/27/2022	06:05	3.45	00:00	5.02	4.32	05:45	4.23	21:25	4.88	4.59	05:45	1.048	00:05	2.069	1.590	1.590	
04/28/2022	07:25	3.39	10:20	5.11	4.32	07:30	4.21	09:55	4.92	4.59	07:30	1.012	10:20	2.145	1.595	1.595	
04/29/2022	06:10	3.40	10:10	5.00	4.28	06:45	4.21	09:35	4.90	4.59	06:10	1.021	10:35	2.057	1.571	1.571	
04/30/2022	08:50	3.23	11:35	5.05	4.29	08:35	4.22	11:35	4.94	4.59	08:45	0.954	11:35	2.130	1.577	1.577	
05/01/2022	05:45	3.24	12:45	5.25	4.34	05:50	4.13	13:10	4.93	4.56	05:50	0.929	12:35	2.228	1.605	1.605	
05/02/2022	06:00	3.18	23:25	5.12	4.35	04:20	4.08	10:25	4.94	4.58	06:00	0.903	23:35	2.153	1.613	1.613	
05/03/2022	06:15	3.67	10:00	5.04	4.43	03:10	4.24	09:45	4.92	4.60	03:35	1.153	09:55	2.097	1.650	1.650	
05/04/2022	04:15	3.56	10:30	4.97	4.34	07:35	4.30	11:00	4.86	4.62	04:20	1.123	10:30	2.033	1.605	1.605	
05/05/2022	11:50	2.67	13:20	13.57	4.33	11:40	3.86	13:25	6.59	4.54	11:40	0.662	13:25	11.602	1.643	1.643	
05/06/2022	06:15	3.44	10:40	5.09	4.35	03:45	4.19	11:45	4.86	4.55	03:50	1.061	10:35	2.107	1.588	1.588	
05/07/2022	09:00	3.34	12:50	5.02	4.27	05:05	4.23	14:10	4.90	4.58	08:35	1.012	12:30	2.071	1.563	1.563	
05/08/2022	09:00	3.11	13:20	5.25	4.33	05:35	4.12	11:15	4.94	4.58	09:05	0.892	12:20	2.227	1.606	1.606	
05/09/2022	05:10	3.18	23:15	5.03	4.36	04:40	4.13	12:50	4.92	4.59	05:10	0.906	23:35	2.062	1.618	1.618	
05/10/2022	06:15	3.40	10:35	4.99	4.32	06:10	4.19	00:10	4.90	4.61	06:10	1.014	00:20	2.069	1.600	1.600	
05/11/2022	05:50	3.33	23:00	4.96	4.29	03:30	4.28	09:40	4.91	4.61	05:40	1.009	23:00	2.039	1.581	1.581	
05/12/2022	05:05	3.22	10:10	5.08	4.37	05:05	4.27	11:05	4.98	4.65	05:05	0.953	10:10	2.125	1.639	1.639	
05/13/2022	07:35	3.46	10:25	5.00	4.33	07:25	4.20	10:10	4.91	4.62	07:25	1.042	10:25	2.083	1.608	1.608	
05/14/2022	07:55	3.33	11:50	5.12	4.36	08:50	4.28	11:40	4.96	4.62	07:55	1.013	11:40	2.174	1.626	1.626	
05/15/2022	06:00	3.27	13:05	5.22	4.41	07:35	4.07	12:45	4.97	4.60	07:35	0.942	12:50	2.238	1.657	1.657	
05/16/2022	06:05	3.31	23:40	5.10	4.39	05:40	4.12	23:35	4.98	4.63	05:40	0.961	23:35	2.178	1.650	1.650	
05/17/2022	03:55	3.39	10:05	5.05	4.31	04:50	4.14	09:55	4.95	4.62	03:40	1.015	09:55	2.109	1.594	1.594	
05/18/2022	06:25	3.47	11:00	5.02	4.36	06:00	4.29	23:35	4.99	4.65	06:20	1.072	11:00	2.103	1.632	1.632	
05/19/2022	05:35	3.45	11:20	5.01	4.39	03:50	4.34	09:55	4.94	4.66	05:25	1.085	11:30	2.097	1.650	1.650	
05/20/2022	05:25	3.41	11:15	5.03	4.31	07:10	4.28	10:00	4.99	4.64	05:25	1.057	10:00	2.123	1.604	1.604	
05/21/2022	08:25	3.39	12:25	5.09	4.34	06:05	4.26	14:00	4.95	4.62	08:25	1.034	12:10	2.138	1.613	1.613	
05/22/2022	07:30	3.24	12:35	5.20	4.39	06:25	4.10	11:45	4.98	4.61	06:25	0.927	12:35	2.235	1.648	1.648	
05/23/2022	05:55	3.21	11:00	5.22	4.36	04:50	4.08	11:10	4.94	4.54	05:50	0.916	11:10	2.220	1.602	1.602	
05/24/2022	05:50	3.26	10:50	5.04	4.32	03:45	4.07	10:00	4.88	4.57	05:55	0.949	10:45	2.074	1.583	1.583	
05/25/2022	05:40	3.44	10:45	5.08	4.30	05:35	4.34	10:25	4.96	4.64	05:35	1.068	10:50	2.108	1.598	1.598	
05/26/2022	06:00	3.54	00:30	4.91	4.36	04:10	4.36	23:45	4.92	4.68	06:00	1.133	00:35	2.020	1.640	1.640	
05/27/2022	07:30	3.47	10:30	4.90	4.34	05:40	4.38	13:50	4.90	4.67	07:25	1.093	10:25	2.008	1.625	1.625	
05/28/2022	08:50	3.30	14:55	5.18	4.32	08:10	4.26	14:45	4.98	4.65	08:50	0.999	14:45	2.220	1.612	1.612	
05/29/2022	06:50	3.62	13:40	5.23	4.54	05:55	4.37	12:35	4.95	4.71	06:40	1.171	13:40	2.242	1.753	1.753	
05/30/2022	06:00	4.05	13:25	5.71	4.86	03:30	4.51	12:40	5.08	4.77	05:50	1.417	13:25	2.584	1.959	1.959	
05/31/2022	05:45	3.64	10:00	5.32	4.67	05:10	4.26	10:10	4.94	4.67	05:50	1.148	10:10	2.287	1.819	1.819	
06/01/2022	05:05	3.93	23:05	5.10	4.60	04:45	4.37	12:15	4.94	4.69	04:45	1.327	23:00	2.155	1.777	1.777	
06/02/2022	05:45	3.78	00:00	4.99	4.48	06:05	4.32	12:00	4.94	4.69	06:05	1.224	12:00	2.067	1.711	1.711	
06/03/2022	06:10	3.68	14:40	5.14	4.48	03:55	4.40	12:15	5.03	4.72	06:05	1.223	14:40	2.179	1.718	1.718	

Date	Depth (in)					Velocity (ft/s)					Quantity (MGD - Total MG)						Rain (in)
	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Total	Total
06/04/2022	08:20	3.67	12:35	5.23	4.49	08:25	4.42	12:20	4.99	4.71	08:20	1.195	12:20	2.262	1.722	1.722	
06/05/2022	05:20	3.51	13:00	5.14	4.42	08:05	4.34	13:10	5.02	4.69	05:25	1.102	13:10	2.220	1.681	1.681	
06/06/2022	04:45	3.46	11:30	5.11	4.48	05:35	4.27	00:05	4.92	4.67	04:45	1.063	11:15	2.130	1.706	1.706	
06/07/2022	05:55	3.66	12:05	4.97	4.40	03:25	4.30	23:40	4.96	4.67	05:55	1.186	11:55	2.065	1.660	1.660	
06/08/2022	05:35	3.59	13:55	5.13	4.41	03:55	4.42	14:45	5.04	4.71	05:35	1.159	14:45	2.193	1.681	1.681	
06/09/2022	06:15	3.61	00:10	4.98	4.44	05:25	4.40	10:35	4.92	4.70	04:00	1.174	12:25	2.052	1.689	1.689	
06/10/2022	06:20	3.71	11:35	5.11	4.45	03:40	4.35	11:35	4.99	4.70	06:25	1.218	11:35	2.188	1.698	1.698	
06/11/2022	05:45	3.52	14:40	4.99	4.44	07:40	4.33	12:00	5.01	4.68	05:50	1.113	12:00	2.097	1.687	1.687	
06/12/2022	08:50	3.45	12:25	5.26	4.50	05:35	4.22	13:55	5.01	4.67	08:50	1.053	12:25	2.278	1.728	1.728	
06/13/2022	06:10	3.64	11:40	5.05	4.50	06:25	4.34	21:55	4.94	4.71	06:25	1.160	11:45	2.113	1.733	1.732	

Report Summary For The Period 04/19/2022 00:00 - 06/13/2022 23:59

	Depth (in)	Velocity (ft/s)	Quantity (MGD - Total MG)
Total			92.368
Avg	4.39	4.63	1.649

Site Commentary

Site Information

CW15	
Pipe Dimensions	59.88"
Silt Level	1.13"

Overview

Site CW15 functioned under normal conditions during the period Tuesday, April 19, 2022 to Monday, June 13, 2022. No surcharge conditions were experienced at this location. Review of the scattergraph shows that the line exhibited both free flow and backwater conditions during the study period. Flow is subcritical.

Flow depth and velocity measurements recorded by the flow monitor are consistent with field confirmations conducted to date and support the relative accuracy of the flow monitor at this location.

This site was positioned downstream of location CW20b. Flows are balanced.

Observations

Average flow depth, velocity, and quantity data observed during Tuesday, April 19, 2022 to Monday, June 13, 2022 , along with observed minimum and maximum data, are provided in the following table. Values in the Observed Flow Conditions are based on 5-minute averages. Graphs are based on 15-minute averages. As a result, the values shown in the table below may differ from those shown on the graph.

In regard to depth, based on an average depth of 24.86 inches, this site utilized 41.52 percent of full pipe depth. The hourly averaged peak depth of 28.90 inches represented 48.26 percent of full pipe depth.

Observed Flow Conditions

Item	Depth (in)	Velocity (ft/s)	Quantity (MGD)
Average	24.86	1.57	7.734
Minimum	21.46	1.27	5.575
Maximum	28.97	1.84	9.810
Time of Minimum	4/24/2022 08:50	6/4/2022 08:35	5/1/2022 09:10
Time of Maximum	5/30/2022 16:20	4/20/2022 15:15	5/30/2022 13:40

Data Quality

Data uptime observed during the Tuesday, April 19, 2022 to the Monday, June 13, 2022 monitoring period is provided in the table below. Based upon the quality and consistency of the observed flow depth and velocity data, the Continuity equation was used to calculate flow rate and quantities during the monitoring period.

Percent Uptime	
Depth (in)	100
Velocity (ft/s)	100
Quantity (MGD)	100

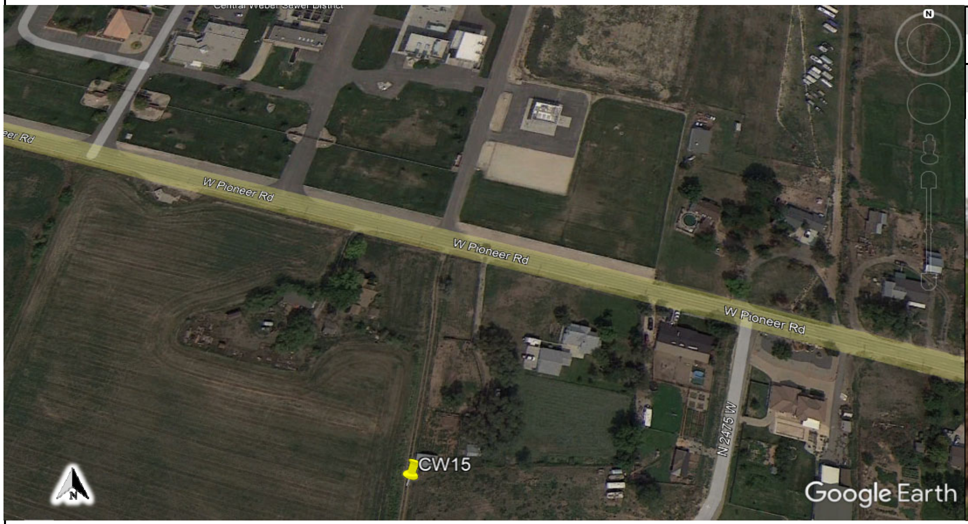
Ogden.BowenClns.TFM.UT22

Flow Monitoring
Site Report

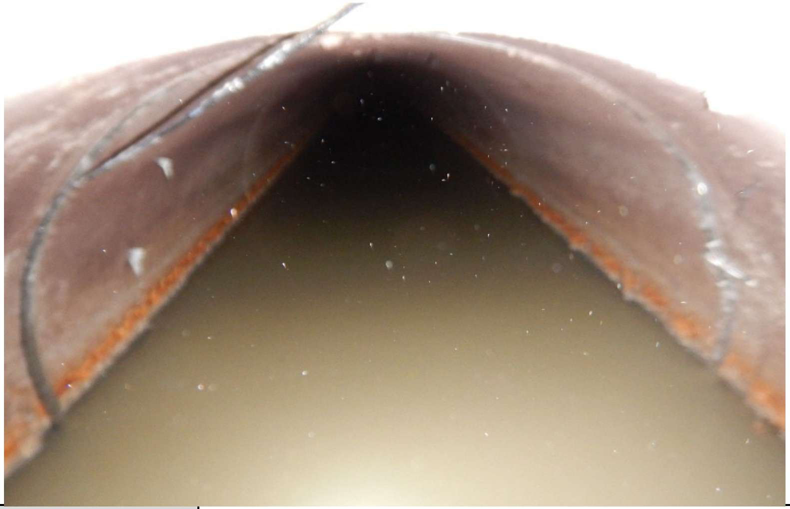
22773.11.325

CW15

Site Address /Location:	2553 W. PIONEER RD			Monitor Series TRITON+ VZ	Location Type Temporary
Site Access Details:	DOWN DIRT ROAD SOUTH OF DRIVEWAY TO PLANT	Latitude: Longitude:	41.2697859 -112.0410891	Pipe Size (H x W) 59.88X60.13	Pipe Shape Elliptical



Manhole #	System Characteristics
WH083	Residential/Commercial
Access	Traffic
Drive	None



Installation Information

Installation Date:	Installation Type:
04/14//2022	Doppler Standard Ring and Crank
Monitoring Location (Sensors):	Monitor Location:
Upstream 0-5 FT	Manhole
Sensors / Devices:	Pressure Sensor Range (psi)
Peak Combo (CS4)	0 - 5 psi

Installation Confirmation:

Confirmation Time:	Pipe Size (HxW)
2:09PM	59.88X60.13
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
25.25	
Downlooker Physical Offset (in)	Measurement Confidence (in)
NA	0.38"
Peak Velocity (fps)	Velocity Sensor Offset (in)
2.04	0"
Silt (in)	Silt Type
1.25	Sandy / Gravel

Hydraulic Comments:
Smooth flow

Manhole / Pipe Information:

Manhole Depth (Approx. FT):	Manhole Configuration
144	Single
Manhole Material:	Manhole Condition:
Concrete	Good
Manhole Opening Diameter (in)	Manhole Diameter (Approx.):
26"	54"
Manhole Cover	Manhole Frame
vented	Normal
Active Drop Connections	Air Quality:
No	Normal
Pipe Material	Pipe Condition:
Concrete	Good

Communication Information:

Communication Type	Antenna Location
Wireless	Manhole Pick / Vent Hole

Additional Site Info. / Comments:

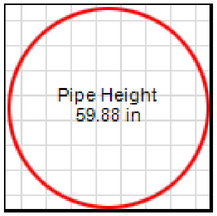
ADS Project Name:	Ogden.BowenClns.TFM.UT22
ADS Project Number:	22773.11.325

SCATTERGRAPH REPORT

CW15

Flow Monitor

CW15

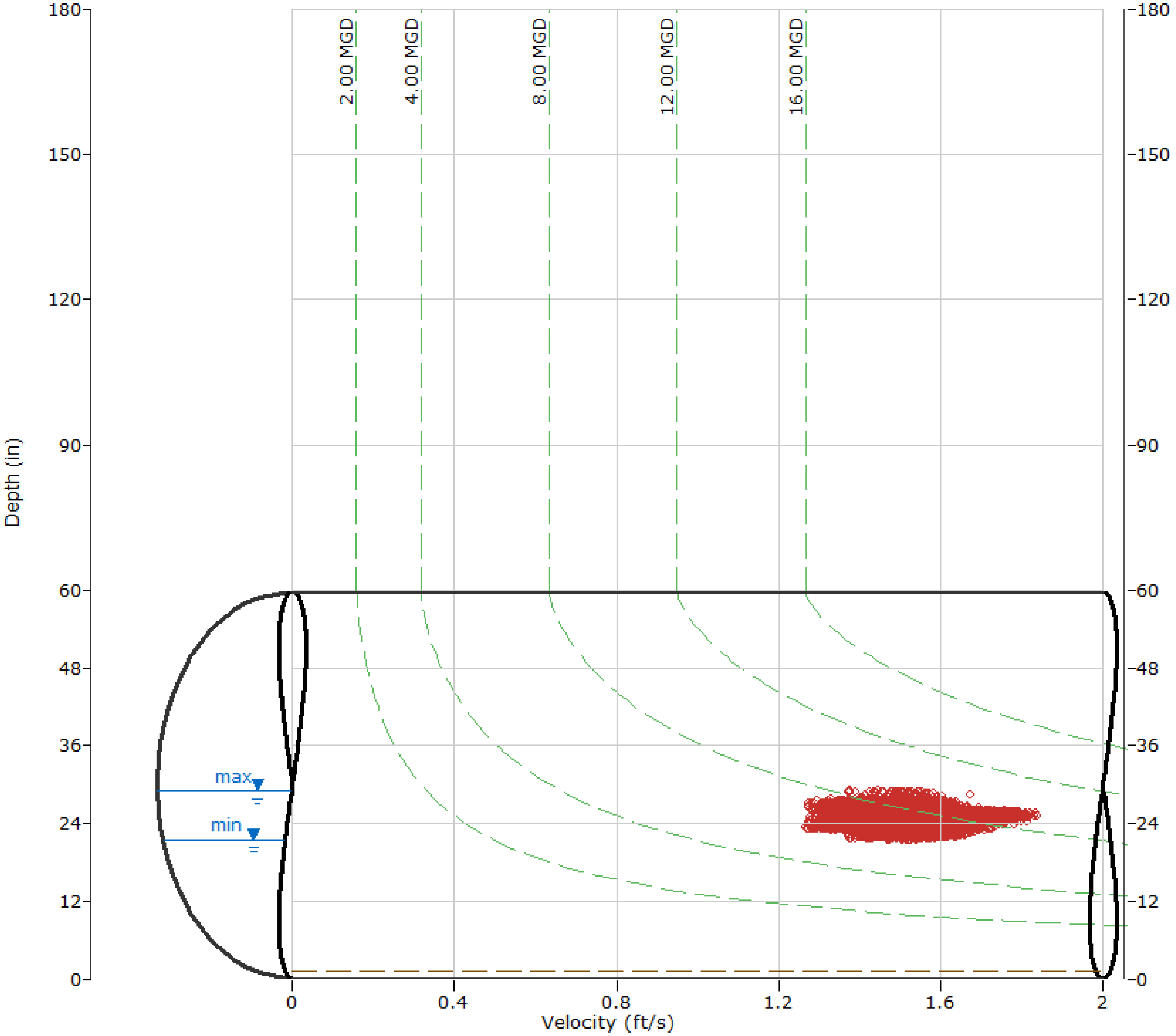


Report Period

4/19/2022
To
6/13/2022

Legend

○ Depth - Velocity
--- Iso-Q™
--- Silt
▼ Min-Max Depth

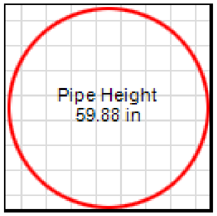


HYDROGRAPH REPORT

CW15

Flow Monitor

CW15

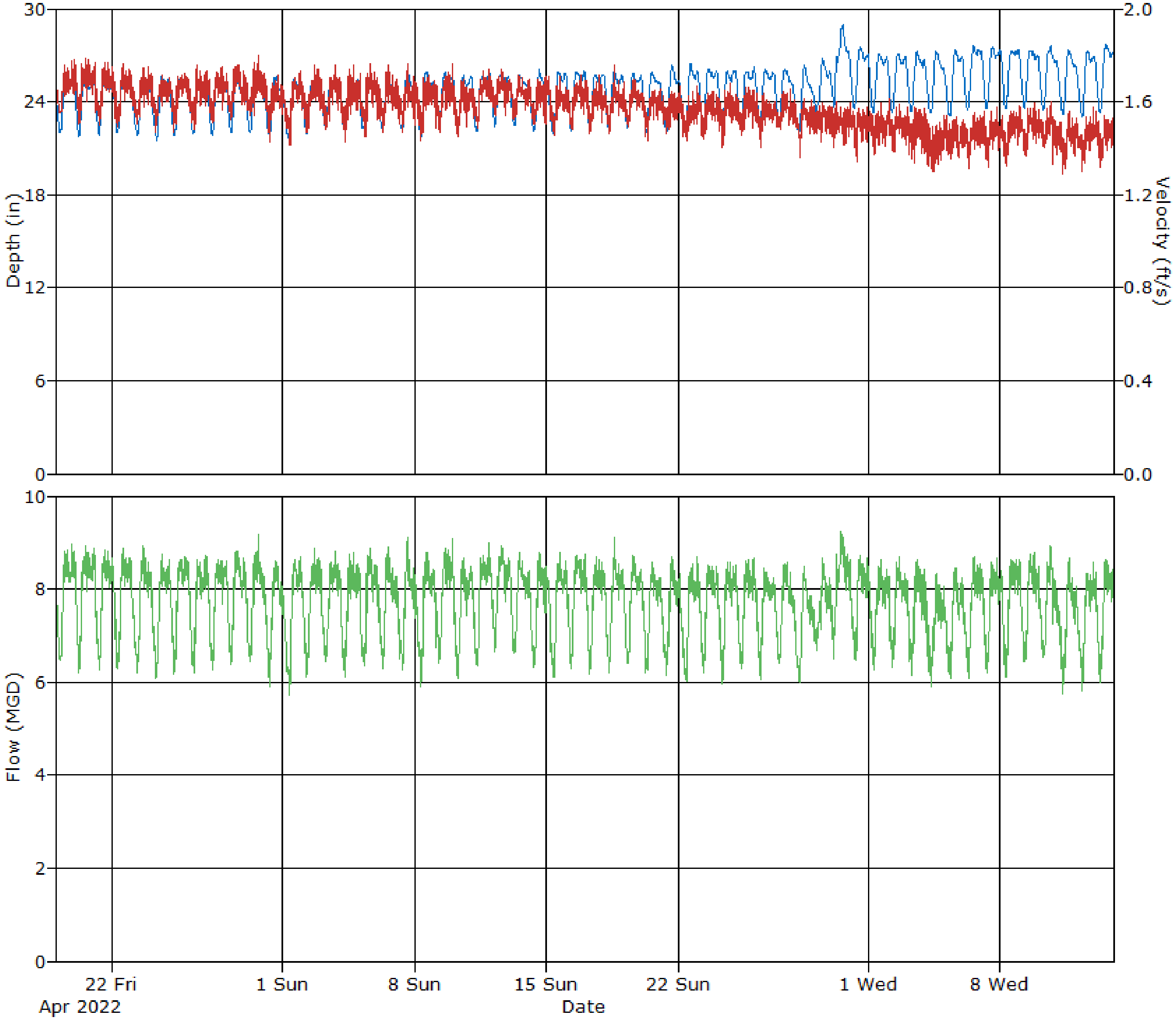


Report Period

4/19/2022
To
6/13/2022

Legend

- Depth
- Velocity
- Quantity



Daily Tabular Report For The Period 04/19/2022 00:00 - 06/13/2022 23:59

CW15, Pipe Height: 59.88 in, Silt: 1.13 in

Daily Tabular Report

Date	Depth (in)					Velocity (ft/s)					Quantity (MGD - Total MG)						Rain (in)
	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Total	Total
04/19/2022	06:20	22.02	12:45	25.47	24.32	06:20	1.55	21:25	1.82	1.66	06:20	6.472	21:25	9.199	7.952	7.952	
04/20/2022	05:55	21.74	00:10	25.34	24.25	06:45	1.47	15:15	1.84	1.67	06:45	6.122	15:15	9.201	7.963	7.963	
04/21/2022	07:00	21.87	00:50	25.53	24.26	08:15	1.45	01:50	1.81	1.66	08:15	6.090	00:15	9.119	7.925	7.925	
04/22/2022	06:40	22.03	16:40	25.38	24.28	07:25	1.48	12:30	1.80	1.65	07:25	6.223	13:55	9.062	7.878	7.878	
04/23/2022	08:10	21.84	15:40	25.74	24.12	08:40	1.46	17:25	1.82	1.63	08:10	6.021	17:25	9.271	7.733	7.733	
04/24/2022	08:50	21.46	15:15	25.62	24.08	07:45	1.42	00:55	1.77	1.63	07:45	5.838	15:40	8.991	7.703	7.703	
04/25/2022	07:05	21.82	23:55	25.46	24.34	05:50	1.43	16:10	1.75	1.64	06:25	5.988	13:55	8.896	7.849	7.849	
04/26/2022	06:35	21.91	00:20	25.48	24.25	08:25	1.41	11:45	1.80	1.63	08:25	5.955	21:55	8.962	7.764	7.764	
04/27/2022	07:10	21.88	00:00	25.36	24.23	08:20	1.47	19:20	1.79	1.65	08:20	6.173	16:00	8.935	7.849	7.849	
04/28/2022	07:10	21.99	14:50	25.31	24.29	07:55	1.47	17:40	1.78	1.66	07:55	6.201	14:00	8.976	7.916	7.916	
04/29/2022	07:10	22.00	18:15	25.59	24.26	12:15	1.50	17:45	1.83	1.66	06:45	6.284	17:45	9.345	7.903	7.903	
04/30/2022	08:25	21.76	16:45	25.63	24.04	08:10	1.40	00:35	1.77	1.62	08:10	5.784	14:40	8.831	7.622	7.622	
05/01/2022	08:45	21.49	15:10	25.43	23.98	09:10	1.38	23:55	1.81	1.60	09:10	5.575	23:55	9.067	7.527	7.527	
05/02/2022	06:15	21.91	23:50	25.33	24.24	08:20	1.42	16:35	1.81	1.63	08:20	5.972	16:35	9.111	7.759	7.759	
05/03/2022	06:50	22.36	00:00	25.34	24.37	08:30	1.42	19:40	1.77	1.62	08:30	6.244	19:40	8.878	7.792	7.792	
05/04/2022	06:55	22.19	23:50	25.41	24.33	08:05	1.39	18:25	1.83	1.61	08:05	5.939	18:25	9.126	7.710	7.710	
05/05/2022	06:15	22.28	14:05	25.56	24.42	09:25	1.41	15:15	1.80	1.63	07:30	6.195	15:15	9.039	7.845	7.845	
05/06/2022	07:25	22.21	15:00	25.66	24.38	00:05	1.42	16:40	1.82	1.62	08:10	6.217	16:40	9.186	7.769	7.769	
05/07/2022	08:35	22.09	14:35	25.90	24.28	08:20	1.43	15:55	1.79	1.61	08:20	5.990	15:55	9.304	7.717	7.717	
05/08/2022	08:55	21.76	15:20	25.95	24.25	08:30	1.40	18:20	1.75	1.60	08:30	5.760	16:20	8.946	7.660	7.660	
05/09/2022	07:45	22.59	14:55	25.87	24.69	08:25	1.43	16:45	1.78	1.62	07:15	6.254	16:45	9.149	7.909	7.909	
05/10/2022	06:45	22.10	00:30	25.83	24.54	07:35	1.40	00:10	1.77	1.60	06:50	5.910	00:10	9.142	7.745	7.745	
05/11/2022	07:20	22.10	22:20	25.84	24.55	09:00	1.45	22:40	1.77	1.62	07:30	6.219	22:40	9.144	7.862	7.862	
05/12/2022	05:55	22.34	16:05	25.82	24.78	19:05	1.49	10:55	1.77	1.64	06:15	6.510	14:00	9.075	8.075	8.075	
05/13/2022	07:30	22.44	13:00	25.72	24.58	05:30	1.50	17:05	1.73	1.63	08:00	6.531	13:05	8.839	7.922	7.922	
05/14/2022	08:05	22.13	14:40	26.06	24.41	23:50	1.34	01:45	1.75	1.61	07:50	6.236	15:35	8.981	7.735	7.735	
05/15/2022	09:20	21.85	13:55	25.91	24.40	09:45	1.43	03:00	1.80	1.60	09:20	5.945	23:45	8.927	7.686	7.686	
05/16/2022	06:50	22.15	23:20	25.98	24.76	06:55	1.44	15:30	1.73	1.61	06:55	6.088	15:30	8.965	7.879	7.879	
05/17/2022	06:15	22.15	00:05	25.90	24.68	06:00	1.44	19:20	1.77	1.60	06:00	6.094	19:20	8.922	7.795	7.795	
05/18/2022	07:30	22.21	13:45	25.94	24.71	06:30	1.44	14:50	1.78	1.59	07:25	6.089	14:50	9.258	7.804	7.804	
05/19/2022	06:40	22.31	14:05	25.82	24.64	06:25	1.45	15:25	1.77	1.60	06:25	6.190	15:25	9.073	7.793	7.793	
05/20/2022	07:05	22.03	14:10	25.95	24.56	09:00	1.37	16:05	1.68	1.58	08:20	6.058	14:10	8.695	7.649	7.649	
05/21/2022	08:25	22.11	15:10	26.37	24.52	08:05	1.39	22:10	1.70	1.57	08:05	5.861	15:10	8.880	7.592	7.592	
05/22/2022	08:35	21.89	15:05	26.49	24.60	04:55	1.38	00:45	1.70	1.55	09:35	5.872	14:40	8.854	7.550	7.550	
05/23/2022	07:00	22.24	14:05	26.09	24.86	08:25	1.42	20:20	1.69	1.56	07:10	6.050	14:25	8.730	7.682	7.682	
05/24/2022	06:55	22.29	20:50	26.05	24.84	07:55	1.37	10:45	1.73	1.57	07:55	5.866	13:10	8.927	7.722	7.722	
05/25/2022	07:35	22.39	23:30	26.29	24.87	08:45	1.41	13:05	1.70	1.57	07:05	6.151	13:05	8.839	7.761	7.761	
05/26/2022	07:05	22.40	00:05	26.11	24.85	07:10	1.37	10:25	1.69	1.55	07:10	5.879	12:20	8.603	7.642	7.642	
05/27/2022	08:00	22.44	15:10	26.07	24.82	08:10	1.43	22:05	1.70	1.56	08:10	6.157	18:00	8.797	7.696	7.696	
05/28/2022	08:55	21.99	15:05	26.33	24.39	10:40	1.33	02:30	1.69	1.52	09:15	5.756	15:10	8.714	7.324	7.324	
05/29/2022	06:25	23.35	14:40	26.80	25.09	20:00	1.37	10:30	1.64	1.53	07:15	6.423	14:50	8.823	7.611	7.611	
05/30/2022	05:00	23.66	16:20	28.97	26.74	20:40	1.36	13:40	1.67	1.51	04:35	6.418	13:40	9.810	8.190	8.190	
05/31/2022	07:05	23.56	14:15	27.58	26.05	10:20	1.31	01:00	1.63	1.50	08:00	6.167	14:20	8.917	7.848	7.848	
06/01/2022	07:15	23.26	14:25	27.14	25.77	08:05	1.30	16:55	1.66	1.49	08:05	5.935	16:55	9.024	7.686	7.686	
06/02/2022	06:50	23.30	14:30	27.13	25.77	09:20	1.34	02:55	1.67	1.50	07:30	6.259	15:20	8.908	7.746	7.746	
06/03/2022	07:15	23.34	14:10	27.28	25.76	04:50	1.30	23:45	1.69	1.48	07:25	5.936	23:45	9.094	7.644	7.644	

Date	Depth (in)					Velocity (ft/s)					Quantity (MGD - Total MG)						Rain (in)
	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Total	Total
06/04/2022	07:30	23.23	14:55	27.26	25.54	08:35	1.27	04:10	1.59	1.41	08:35	5.715	15:05	8.535	7.224	7.224	
06/05/2022	07:25	23.05	15:25	27.33	25.56	19:30	1.27	01:45	1.59	1.45	09:40	5.943	16:40	8.713	7.413	7.413	
06/06/2022	07:00	23.39	14:25	27.65	26.07	09:00	1.28	15:20	1.61	1.45	07:40	5.906	15:20	8.990	7.641	7.641	
06/07/2022	06:15	23.50	15:25	27.52	26.14	07:45	1.27	19:20	1.64	1.45	07:45	5.896	19:20	8.979	7.657	7.657	
06/08/2022	07:25	23.52	00:00	27.39	26.15	04:50	1.31	18:05	1.62	1.47	07:20	5.983	18:05	8.896	7.756	7.756	
06/09/2022	07:10	23.57	13:25	27.35	26.07	09:50	1.30	15:20	1.63	1.49	06:40	6.059	15:20	9.027	7.810	7.810	
06/10/2022	07:15	23.41	16:15	27.60	25.99	18:50	1.31	17:00	1.64	1.48	05:50	6.298	17:00	9.172	7.757	7.757	
06/11/2022	08:00	23.11	15:15	27.39	25.66	08:00	1.27	16:10	1.61	1.44	08:00	5.686	16:10	8.944	7.406	7.406	
06/12/2022	08:40	22.98	14:45	27.31	25.61	08:15	1.27	22:25	1.61	1.45	08:15	5.700	22:25	8.736	7.438	7.438	
06/13/2022	07:20	23.24	14:20	27.71	26.02	07:45	1.28	01:15	1.61	1.45	07:45	5.827	15:25	8.917	7.619	7.614	

Report Summary For The Period 04/19/2022 00:00 - 06/13/2022 23:59

	Depth (in)	Velocity (ft/s)	Quantity (MGD - Total MG)
Total			433.095
Avg	24.86	1.57	7.734

Site Commentary

Site Information

CW16	
Pipe Dimensions	18"
Silt Level	2.50"

Overview

Site CW16 functioned under normal conditions during the period Tuesday, April 19, 2022 to Monday, June 13, 2022. No surcharge conditions were experienced at this location. Review of the scattergraph shows that both free flow and backwater conditions were reported during the study period. Flow is subcritical.

Flow depth and velocity measurements recorded by the flow monitor are consistent with field confirmations conducted to date and support the relative accuracy of the flow monitor at this location.

Observations

Average flow depth, velocity, and quantity data observed during Tuesday, April 19, 2022 to Monday, June 13, 2022 , along with observed minimum and maximum data, are provided in the following table. Values in the Observed Flow Conditions are based on 5-minute averages. Graphs are based on 15-minute averages. As a result, the values shown in the table below may differ from those shown on the graph.

In regard to depth, based on an average depth of 5.93 inches, this site utilized 32.94 percent of full pipe depth. The hourly averaged peak depth of 8.25 inches represented 45.83 percent of full pipe depth.

Observed Flow Conditions			
Item	Depth (in)	Velocity (ft/s)	Quantity (MGD)
Average	5.93	0.93	0.222
Minimum	5.01	0.59	0.098
Maximum	11.19	1.68	0.766
Time of Minimum	5/2/2022 05:10	5/2/2022 04:35	5/2/2022 04:35
Time of Maximum	5/29/2022 02:10	5/30/2022 14:10	5/29/2022 02:20

Data Quality

Data uptime observed during the Tuesday, April 19, 2022 to the Monday, June 13, 2022 monitoring period is provided in the table below. Based upon the quality and consistency of the observed flow depth and velocity data, the Continuity equation was used to calculate flow rate and quantities during the monitoring period.

Percent Uptime	
Depth (in)	92
Velocity (ft/s)	92
Quantity (MGD)	92

Ogden.BowenClns.TFM.UT22

Flow Monitoring
Site Report

22773.11.325

CW16

Site Address /Location:	2553 W. PIONEER RD			Monitor Series TRITON+ VZ	Location Type Temporary
Site Access Details:	BEHIND CENTRAL WEBER SEWER DISTRICT	Latitude: Longitude:	41.2767336 -112.0405399	Pipe Size (H x W) 18.00X18.13	Pipe Shape Elliptical

Manhole #	System Characteristics
FW069	Residential/Commercial
Access	Traffic
Drive	None

Installation Information

Installation Date:	Installation Type:
04/14//2022	Doppler Standard Ring and Crank
Monitoring Location (Sensors):	Monitor Location:
Upstream 0-5 FT	Manhole
Sensors / Devices:	Pressure Sensor Range (psi)
Peak Combo (CS4)	0 - 5 psi

Installation Confirmation:

Confirmation Time:	Pipe Size (HxW)
5:41PM	18.00X18.13
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
6.38	
Downlooker Physical Offset (in)	Measurement Confidence (in)
NA	0.38"
Peak Velocity (fps)	Velocity Sensor Offset (in)
1.19	0"
Silt (in)	Silt Type
2.5	Sandy / Gravel

Hydraulic Comments:
Smooth flow

Manhole / Pipe Information:

Manhole Depth (Approx. FT):	Manhole Configuration
144	Single
Manhole Material:	Manhole Condition:
Concrete	Good
Manhole Opening Diameter (in)	Manhole Diameter (Approx.):
26"	54"
Manhole Cover	Manhole Frame
vented	Normal
Active Drop Connections	Air Quality:
No	Normal
Pipe Material	Pipe Condition:
Concrete	Good

Communication Information:

Communication Type	Antenna Location
Wireless	Manhole Pick / Vent Hole

Additional Site Info. / Comments:

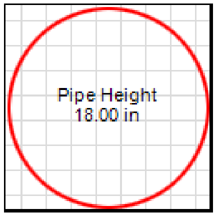
ADS Project Name:	Ogden.BowenClns.TFM.UT22
ADS Project Number:	22773.11.325

SCATTERGRAPH REPORT

CW16

Flow Monitor

CW16



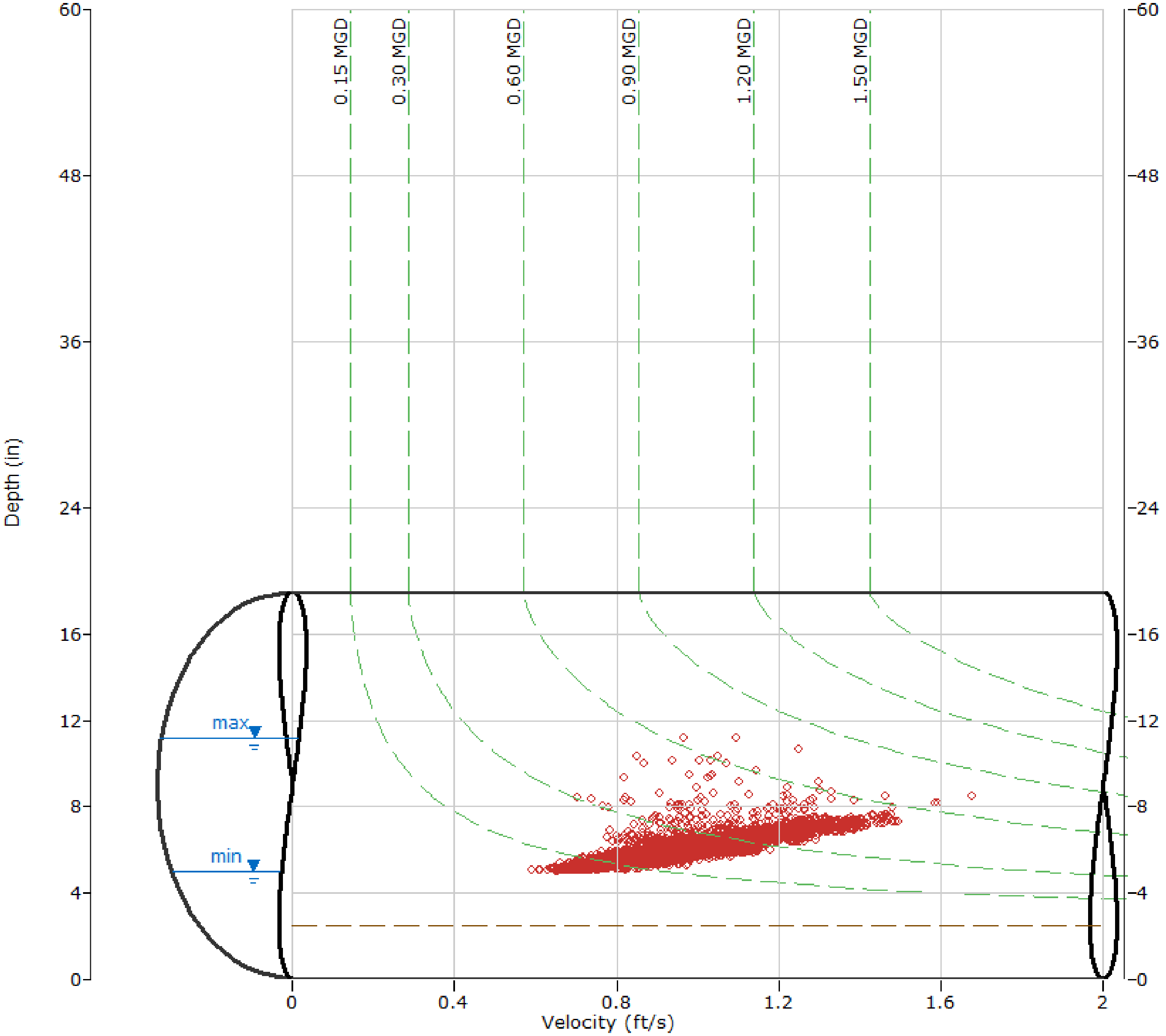
Report Period

4/19/2022
To
6/13/2022

Legend

○	Depth - Velocity
---	Iso-Q™
---	Silt
▼	Min-Max Depth

ADS ENVIRONMENTAL SERVICES

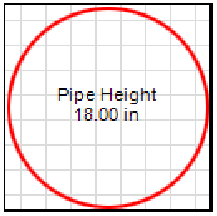


HYDROGRAPH REPORT

CW16

Flow Monitor

CW16

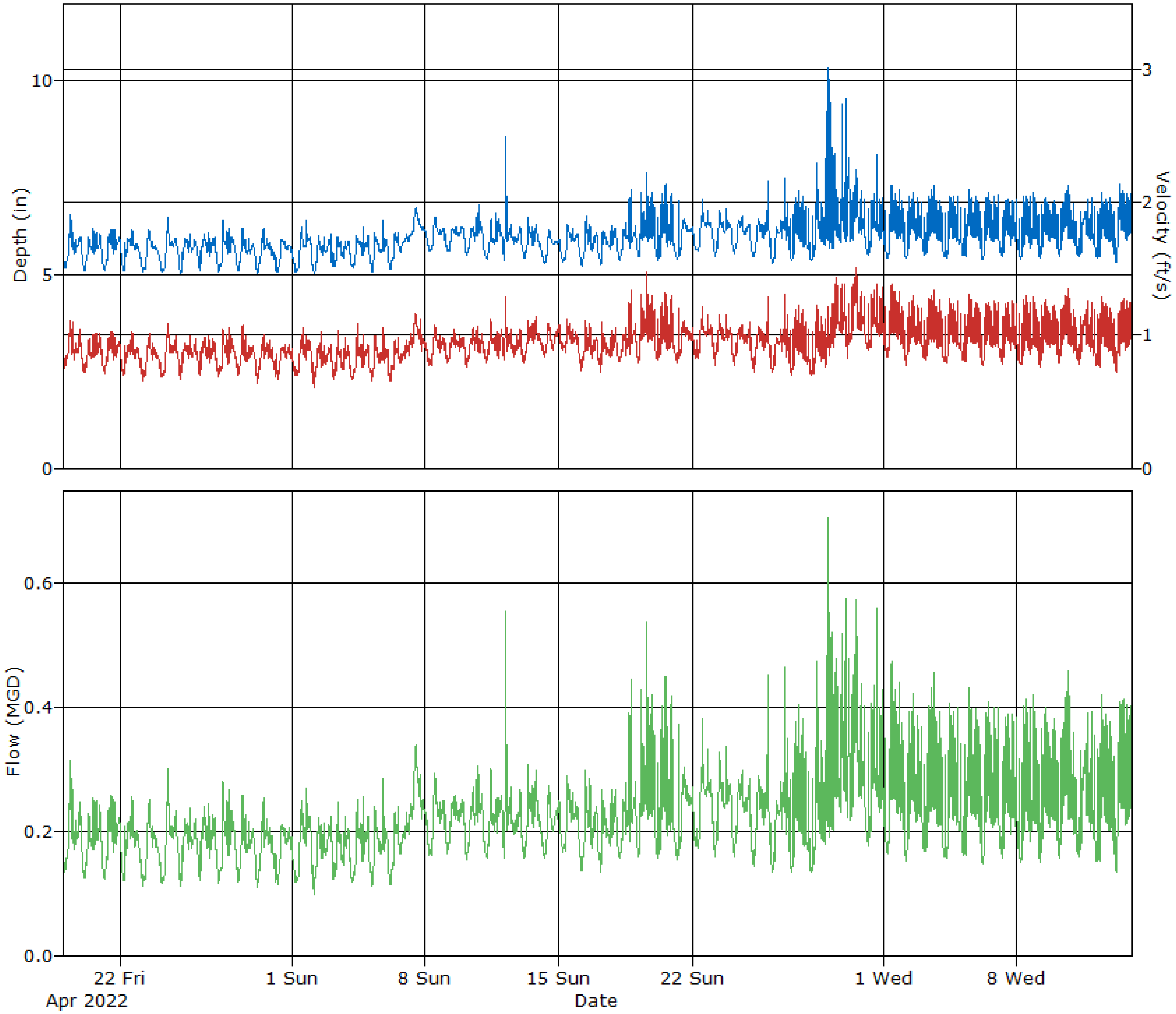


Report Period

4/19/2022
To
6/13/2022

Legend

- Depth
- Velocity
- Quantity



ADS ENVIRONMENTAL SERVICES

Daily Tabular Report For The Period 04/19/2022 00:00 - 06/13/2022 23:59

CW16, Pipe Height: 18.00 in, Silt: 2.50 in

Daily Tabular Report

Date	Depth (in)					Velocity (ft/s)					Quantity (MGD - Total MG)						Rain (in)
	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Total	Total
04/19/2022	03:35	5.17	09:40	6.62	5.70	04:45	0.75	09:45	1.19	0.89	03:20	0.133	09:45	0.332	0.194	0.194	
04/20/2022	04:35	5.11	13:40	6.37	5.64	04:45	0.70	13:40	1.09	0.87	04:05	0.120	13:40	0.291	0.185	0.185	
04/21/2022	05:15	5.08	16:55	6.22	5.67	04:55	0.70	15:35	1.06	0.88	04:55	0.120	13:25	0.269	0.189	0.189	
04/22/2022	05:20	5.09	16:45	6.14	5.68	05:25	0.68	17:05	1.07	0.86	05:25	0.116	15:40	0.262	0.186	0.186	
04/23/2022	05:15	5.06	11:55	6.15	5.59	05:00	0.64	13:30	1.03	0.84	05:00	0.109	13:30	0.256	0.176	0.176	
04/24/2022	05:20	5.07	11:55	6.47	5.63	05:00	0.66	11:55	1.11	0.86	05:00	0.113	11:55	0.306	0.183	0.183	
04/25/2022	04:50	5.03	16:30	6.04	5.63	04:35	0.65	22:55	1.02	0.85	04:35	0.109	16:10	0.241	0.181	0.181	
04/26/2022	04:55	5.09	15:15	6.08	5.67	04:40	0.68	11:05	1.02	0.86	04:40	0.116	15:20	0.246	0.186	0.186	
04/27/2022	04:30	5.07	09:40	6.41	5.66	04:25	0.68	09:35	1.12	0.86	04:25	0.115	09:35	0.301	0.186	0.186	
04/28/2022	05:05	5.09	10:15	6.18	5.59	05:00	0.67	13:05	1.09	0.85	05:00	0.115	10:15	0.258	0.179	0.179	
04/29/2022	05:40	5.03	12:35	6.19	5.58	04:25	0.64	20:35	1.04	0.84	04:25	0.109	12:35	0.254	0.175	0.175	
04/30/2022	07:15	5.08	12:40	5.89	5.57	04:20	0.66	16:10	1.06	0.83	06:45	0.114	16:10	0.230	0.172	0.172	
05/01/2022	05:25	5.05	18:45	6.52	5.62	07:00	0.69	14:35	1.06	0.85	04:45	0.117	18:45	0.282	0.181	0.181	
05/02/2022	05:10	5.01	16:25	6.01	5.57	04:35	0.59	13:30	1.03	0.82	04:35	0.098	16:25	0.234	0.171	0.171	
05/03/2022	04:05	5.20	01:10	6.15	5.61	04:10	0.66	10:05	1.15	0.82	04:10	0.119	10:05	0.272	0.173	0.173	
05/04/2022	05:35	5.16	18:15	6.21	5.64	05:35	0.66	10:20	1.09	0.82	05:35	0.117	17:45	0.255	0.176	0.176	
05/05/2022	05:40	5.04	19:00	6.42	5.65	04:55	0.65	09:25	1.14	0.83	04:55	0.110	19:05	0.296	0.179	0.179	
05/06/2022	04:10	5.13	14:05	6.13	5.67	03:55	0.65	14:05	1.03	0.83	04:10	0.114	14:05	0.256	0.179	0.179	
05/07/2022	03:30	5.86	12:00	6.73	6.22	03:30	0.85	11:45	1.16	0.98	03:30	0.194	12:00	0.340	0.253	0.253	
05/08/2022	04:55	5.60	12:25	6.47	6.01	04:50	0.76	11:35	1.09	0.91	04:50	0.158	11:35	0.299	0.221	0.221	
05/09/2022	03:15	5.59	21:45	6.23	5.99	03:15	0.79	12:35	1.14	0.92	03:15	0.163	12:35	0.279	0.220	0.220	
05/10/2022	04:25	5.51	19:10	6.89	6.02	03:30	0.75	13:15	1.10	0.92	04:15	0.152	18:40	0.311	0.223	0.223	
05/11/2022	05:45	5.38	16:40	6.62	5.87	03:50	0.77	10:35	1.14	0.93	03:50	0.153	10:40	0.310	0.213	0.213	
05/12/2022	04:10	5.35	04:55	8.73	6.07	03:40	0.79	05:00	1.33	0.95	03:40	0.151	05:00	0.602	0.235	0.235	
05/13/2022	05:05	5.41	09:45	6.50	5.87	03:35	0.77	20:20	1.16	0.96	04:25	0.154	09:50	0.318	0.222	0.222	
05/14/2022	06:50	5.29	12:10	6.16	5.71	05:35	0.81	10:30	1.14	0.96	05:35	0.151	12:20	0.279	0.209	0.209	
05/15/2022	05:15	5.30	11:00	6.30	5.81	08:20	0.85	10:45	1.13	0.98	05:00	0.164	10:50	0.291	0.220	0.220	
05/16/2022	05:05	5.22	11:05	6.69	5.80	04:00	0.68	10:40	1.14	0.91	04:00	0.126	09:30	0.301	0.205	0.205	
05/17/2022	05:05	5.26	17:55	6.25	5.80	04:05	0.72	07:05	1.14	0.89	04:45	0.133	07:05	0.280	0.202	0.202	
05/18/2022	04:15	5.36	18:30	7.29	5.91	04:05	0.78	18:30	1.39	0.95	04:05	0.149	18:30	0.474	0.223	0.223	
05/19/2022	04:45	5.46	14:10	7.61	6.15	04:00	0.78	14:05	1.48	1.03	05:00	0.156	14:05	0.540	0.265	0.265	
05/20/2022	04:35	5.32	14:00	7.35	6.04	02:50	0.80	13:55	1.34	0.98	04:15	0.154	13:55	0.464	0.243	0.243	
05/21/2022	04:50	5.39	07:10	6.92	5.98	05:05	0.78	07:10	1.22	0.97	05:05	0.151	07:10	0.378	0.231	0.231	
05/22/2022	07:45	5.60	13:00	6.99	6.13	06:40	0.79	13:00	1.28	0.99	06:40	0.167	13:00	0.405	0.248	0.248	
05/23/2022	04:45	5.47	18:10	6.74	6.10	04:10	0.76	10:10	1.18	0.98	04:10	0.154	18:05	0.343	0.243	0.243	
05/24/2022	04:45	5.53	15:30	6.54	6.07	04:15	0.76	23:20	1.17	0.96	04:15	0.156	15:25	0.308	0.236	0.236	
05/25/2022	05:00	5.45	23:10	7.43	6.06	04:55	0.70	23:10	1.32	0.95	04:55	0.139	23:10	0.463	0.235	0.235	
05/26/2022	05:00	5.28	20:25	7.51	6.01	04:30	0.69	20:15	1.32	0.92	04:30	0.128	20:25	0.470	0.225	0.225	
05/27/2022	04:40	5.34	14:10	7.25	6.00	04:40	0.69	14:05	1.25	0.90	04:40	0.131	14:10	0.420	0.219	0.219	
05/28/2022	05:35	5.34	23:55	9.35	6.08	06:35	0.66	12:10	1.29	0.88	06:35	0.127	12:10	0.503	0.221	0.221	
05/29/2022	04:10	5.65	02:10	11.19	6.65	09:15	0.82	12:15	1.49	1.07	04:20	0.180	02:20	0.766	0.313	0.313	
05/30/2022	07:10	5.85	01:30	10.33	6.58	03:15	0.80	14:10	1.68	1.13	07:20	0.210	14:10	0.728	0.323	0.323	
05/31/2022	05:15	5.48	15:35	8.46	6.14	05:15	0.85	15:40	1.48	1.06	05:15	0.170	15:35	0.636	0.270	0.270	
06/01/2022	04:40	5.41	10:15	7.32	6.13	05:15	0.81	10:20	1.40	1.04	05:15	0.159	10:20	0.479	0.264	0.264	
06/02/2022	05:25	5.42	13:25	7.19	6.13	04:45	0.76	13:20	1.32	0.99	04:45	0.148	13:25	0.435	0.251	0.251	
06/03/2022	03:35	5.50	16:30	7.41	6.15	04:55	0.77	16:30	1.40	1.00	04:55	0.159	16:30	0.490	0.255	0.255	

Date	Depth (in)					Velocity (ft/s)					Quantity (MGD - Total MG)						Rain (in)
	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Total	Total
06/04/2022	07:35	5.43	16:05	7.06	6.05	06:45	0.79	11:15	1.30	0.97	07:10	0.155	21:35	0.411	0.241	0.241	
06/05/2022	08:25	5.46	11:10	7.22	6.13	07:05	0.79	11:10	1.32	1.00	08:25	0.157	11:10	0.443	0.253	0.253	
06/06/2022	04:15	5.38	11:45	7.44	6.10	04:30	0.75	11:45	1.37	0.99	04:30	0.144	11:45	0.483	0.248	0.248	
06/07/2022	05:05	5.45	00:30	7.11	6.13	06:10	0.77	00:30	1.30	0.99	05:05	0.154	00:30	0.424	0.251	0.251	
06/08/2022	04:40	5.38	20:10	7.14	6.06	05:10	0.75	07:25	1.31	0.97	05:10	0.146	20:05	0.425	0.240	0.240	
06/09/2022	04:45	5.43	23:25	7.00	6.12	04:40	0.75	23:25	1.28	0.99	04:40	0.146	23:25	0.405	0.250	0.250	
06/10/2022	05:25	5.47	17:05	7.33	6.15	05:20	0.74	17:10	1.37	1.00	05:20	0.148	17:10	0.469	0.256	0.256	
06/11/2022	07:05	5.47	22:20	7.00	6.07	06:50	0.76	14:25	1.29	0.97	06:50	0.152	22:15	0.401	0.241	0.241	
06/12/2022	04:45	5.40	11:00	7.18	6.08	04:05	0.75	10:50	1.32	0.97	04:45	0.147	10:50	0.437	0.242	0.242	
06/13/2022	05:10	5.31	09:25	7.45	6.18	05:10	0.70	11:45	1.29	0.97	05:10	0.130	09:25	0.453	0.251	0.251	

Report Summary For The Period 04/19/2022 00:00 - 06/13/2022 23:59

	Depth (in)	Velocity (ft/s)	Quantity (MGD - Total MG)
Total			12.410
Avg	5.93	0.93	0.222

Site Commentary

Site Information

CW17	
Pipe Dimensions	47.5"
Silt Level	8.00"

Overview

Site CW17 functioned under normal conditions during the period Tuesday, April 19, 2022 to Monday, June 13, 2022. No surcharge conditions were experienced at this location. Review of the scattergraph shows that free flow conditions were maintained throughout the study period. Flow is subcritical.

Flow depth and velocity measurements recorded by the flow monitor are consistent with field confirmations conducted to date and support the relative accuracy of the flow monitor at this location.

This site was positioned downstream of location CW18. Flows are balanced.

Observations

Average flow depth, velocity, and quantity data observed during Tuesday, April 19, 2022 to Monday, June 13, 2022 , along with observed minimum and maximum data, are provided in the following table. Values in the Observed Flow Conditions are based on 5-minute averages. Graphs are based on 15-minute averages. As a result, the values shown in the table below may differ from those shown on the graph.

In regard to depth, based on an average depth of 19.88 inches, this site utilized 41.85 percent of full pipe depth. The hourly averaged peak depth of 23.66 inches represented 49.81 percent of full pipe depth.

Observed Flow Conditions

Item	Depth (in)	Velocity (ft/s)	Quantity (MGD)
Average	19.88	1.07	2.458
Minimum	16.58	0.81	1.306
Maximum	23.76	1.28	3.658
Time of Minimum	4/29/2022 08:10	4/25/2022 07:40	4/25/2022 07:40
Time of Maximum	5/30/2022 16:10	5/5/2022 12:05	5/8/2022 14:20

Data Quality

Data uptime observed during the Tuesday, April 19, 2022 to the Monday, June 13, 2022 monitoring period is provided in the table below. Based upon the quality and consistency of the observed flow depth and velocity data, the Continuity equation was used to calculate flow rate and quantities during the monitoring period.

Percent Uptime	
Depth (in)	100
Velocity (ft/s)	100
Quantity (MGD)	100

Ogden.BowenClns.TFM.UT22

Flow Monitoring
Site Report

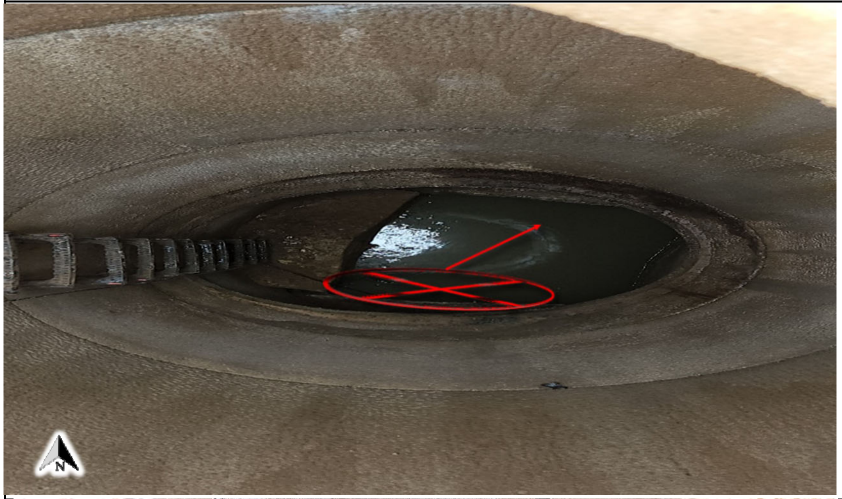
22773.11.325

CW17

Site Address /Location:	462 S 3600 W ST		
Site Access Details:	DRIVE TO SITE	Latitude: Longitude:	41.2584657 -112.0659894

Monitor Series	Location Type
TRITON+ VZ	Temporary
Pipe Size (H x W)	Pipe Shape
47.50X47.75	Elliptical

Manhole #	System Characteristics
HP046	Residential/Commercial
Access	Traffic
Drive	None



Installation Information

Installation Date:	Installation Type:
Saturday, April 16, 2022	Doppler Standard Ring and Crank
Monitoring Location (Sensors):	Monitor Location:
Upstream 0-5 FT	Manhole
Sensors / Devices:	Pressure Sensor Range (psi)
Peak Combo (CS4)	0 - 5 psi

Installation Confirmation:

Confirmation Time:	Pipe Size (HxW)
11:11AM	47.50X47.75
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
19.63	
Downlooker Physical Offset (in)	Measurement Confidence (in)
NA	0.38"
Peak Velocity (fps)	Velocity Sensor Offset (in)
1.09	0"
Silt (in)	Silt Type
8	Soft / Loose

Hydraulic Comments:
Smooth flow

Manhole / Pipe Information:

Manhole Depth (Approx. FT):	Manhole Configuration
240	Single
Manhole Material:	Manhole Condition:
Concrete	Good
Manhole Opening Diameter (in)	Manhole Diameter (Approx.):
26"	54"
Manhole Cover	Manhole Frame
vented	Normal
Active Drop Connections	Air Quality:
No	Normal
Pipe Material	Pipe Condition:
Concrete	Good

Communication Information:

Communication Type	Antenna Location
Wireless	Manhole Pick / Vent Hole

Additional Site Info. / Comments:

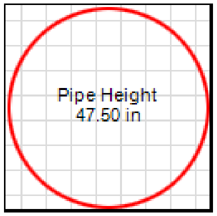
ADS Project Name:	Ogden.BowenClns.TFM.UT22
ADS Project Number:	22773.11.325

SCATTERGRAPH REPORT

CW17

Flow Monitor

CW17

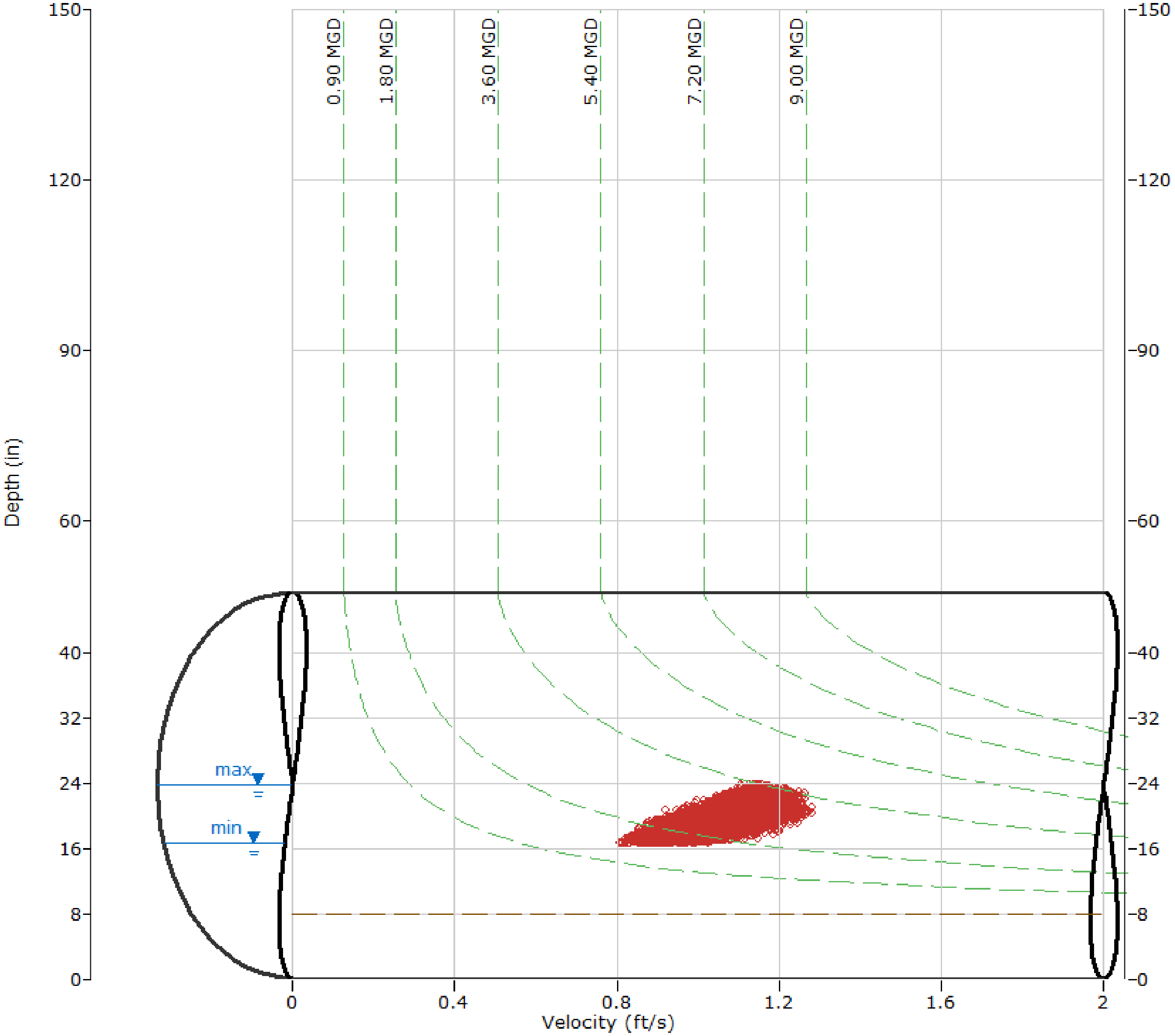


Report Period

4/19/2022
To
6/13/2022

Legend

- ○ Depth - Velocity
- --- Iso-Q™
- --- Silt
- ▼ Min-Max Depth



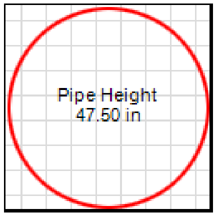
ADS ENVIRONMENTAL SERVICES

HYDROGRAPH REPORT

CW17

Flow Monitor

CW17

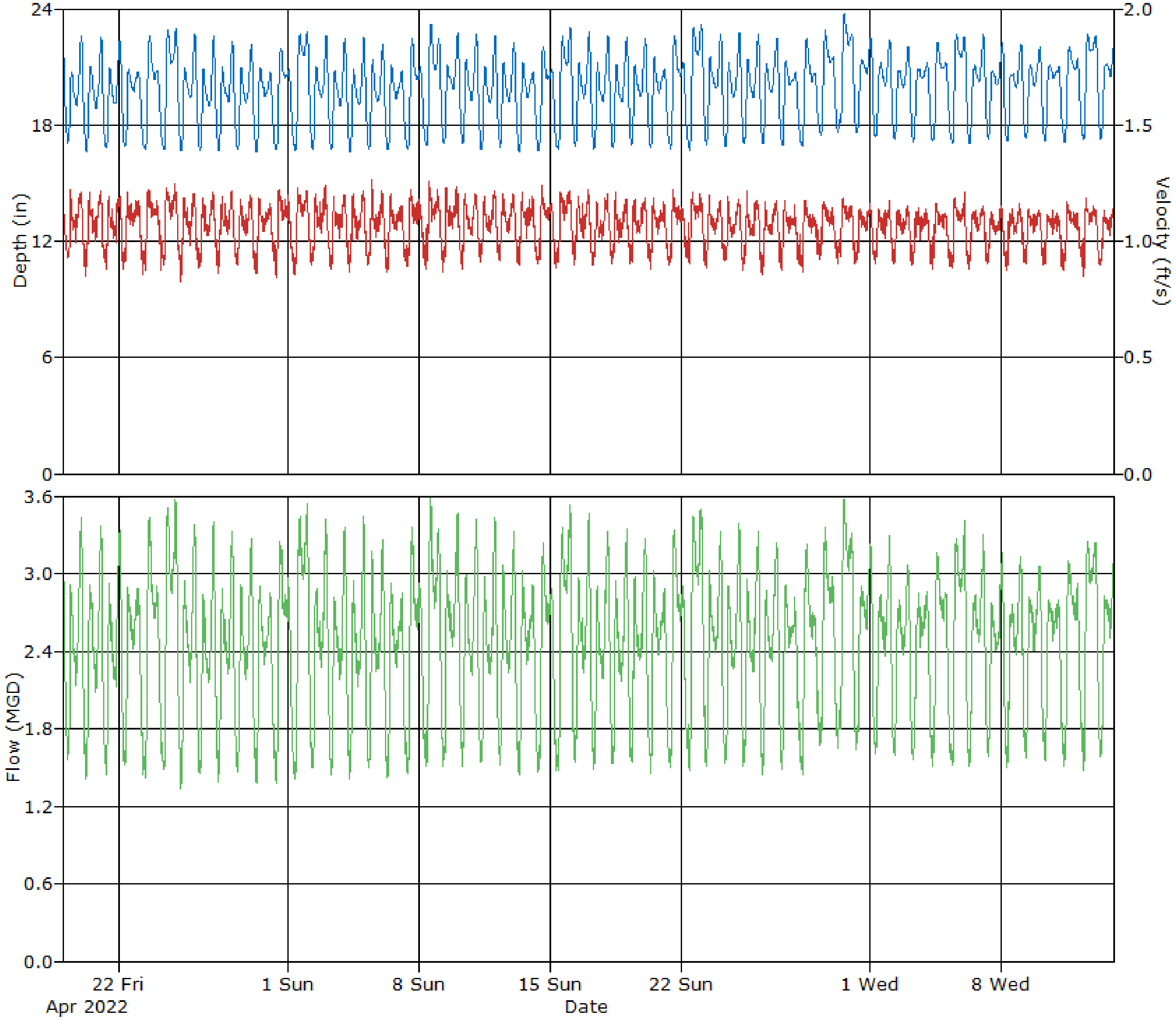


Report Period

4/19/2022
To
6/13/2022

Legend

- Depth
- Velocity
- Quantity



ADS ENVIRONMENTAL SERVICES

Daily Tabular Report

Date	Depth (in)					Velocity (ft/s)					Quantity (MGD - Total MG)						Rain (in)
	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Total	Total
04/19/2022	06:40	17.01	00:25	23.09	19.74	06:40	0.93	10:40	1.24	1.08	06:40	1.559	23:15	3.443	2.450	2.450	
04/20/2022	06:35	16.63	00:15	22.60	19.45	05:50	0.82	23:15	1.24	1.06	05:50	1.362	00:10	3.483	2.349	2.349	
04/21/2022	08:05	16.83	01:40	22.51	19.57	08:00	0.85	00:00	1.25	1.07	08:00	1.403	00:50	3.423	2.397	2.397	
04/22/2022	07:35	16.89	01:25	22.29	19.71	06:20	0.86	11:20	1.24	1.07	07:30	1.488	01:25	3.371	2.438	2.438	
04/23/2022	10:25	16.74	15:35	22.60	19.75	07:25	0.83	12:15	1.25	1.08	10:30	1.370	14:55	3.488	2.470	2.470	
04/24/2022	10:20	16.74	14:55	22.88	20.05	06:30	0.84	13:10	1.26	1.09	09:15	1.449	14:50	3.559	2.574	2.574	
04/25/2022	07:45	16.68	01:15	22.93	19.73	07:40	0.81	00:25	1.26	1.07	07:40	1.306	00:25	3.630	2.441	2.441	
04/26/2022	08:10	16.67	01:30	22.67	19.50	06:45	0.85	23:55	1.23	1.06	08:25	1.385	01:20	3.462	2.359	2.359	
04/27/2022	07:50	16.68	01:35	22.61	19.59	07:30	0.84	01:10	1.22	1.07	07:30	1.356	01:10	3.480	2.403	2.403	
04/28/2022	07:45	16.74	01:20	22.30	19.50	07:25	0.86	23:35	1.23	1.06	07:25	1.411	01:00	3.406	2.367	2.367	
04/29/2022	08:10	16.58	01:40	22.19	19.51	08:25	0.82	01:00	1.21	1.06	08:25	1.314	01:20	3.327	2.367	2.367	
04/30/2022	10:00	16.72	15:15	21.94	19.65	09:15	0.84	12:35	1.24	1.07	09:25	1.365	14:20	3.303	2.433	2.433	
05/01/2022	10:10	16.71	15:50	22.66	20.11	09:20	0.84	13:30	1.25	1.08	09:40	1.375	15:40	3.500	2.565	2.565	
05/02/2022	07:45	16.76	01:05	22.83	19.70	06:00	0.85	23:40	1.25	1.08	07:50	1.473	00:55	3.544	2.445	2.445	
05/03/2022	08:00	16.79	01:25	22.62	19.54	06:00	0.86	00:20	1.26	1.07	08:00	1.417	01:05	3.442	2.383	2.383	
05/04/2022	07:50	16.61	01:20	22.44	19.49	07:10	0.84	23:25	1.23	1.07	07:10	1.369	01:35	3.402	2.375	2.375	
05/05/2022	07:50	16.79	01:30	22.53	19.64	06:05	0.87	12:05	1.28	1.07	07:25	1.464	01:10	3.554	2.420	2.420	
05/06/2022	08:15	16.74	01:30	22.13	19.55	07:15	0.82	11:45	1.24	1.07	07:15	1.357	00:50	3.347	2.386	2.386	
05/07/2022	09:35	16.72	15:05	22.49	19.73	09:40	0.86	12:50	1.24	1.07	09:40	1.395	14:45	3.414	2.445	2.445	
05/08/2022	10:05	16.98	15:10	23.16	20.14	08:25	0.83	12:45	1.26	1.09	08:25	1.413	14:20	3.658	2.580	2.580	
05/09/2022	08:10	17.06	01:15	22.48	19.88	06:30	0.83	23:20	1.26	1.08	06:30	1.452	00:15	3.404	2.489	2.489	
05/10/2022	07:55	17.05	01:45	22.75	19.85	07:25	0.84	11:10	1.27	1.08	07:25	1.446	01:25	3.553	2.475	2.475	
05/11/2022	07:35	16.77	01:35	22.66	19.63	05:45	0.88	12:10	1.22	1.08	07:15	1.514	01:05	3.456	2.424	2.424	
05/12/2022	07:50	16.82	01:40	22.62	19.74	08:00	0.88	01:10	1.24	1.08	08:00	1.448	01:10	3.516	2.462	2.462	
05/13/2022	08:20	16.64	01:30	22.22	19.60	06:15	0.86	11:50	1.24	1.08	08:05	1.393	01:15	3.376	2.417	2.417	
05/14/2022	08:40	16.68	15:15	22.00	19.68	07:25	0.88	12:50	1.27	1.08	08:35	1.437	14:50	3.300	2.451	2.451	
05/15/2022	11:00	16.72	15:50	22.58	20.00	05:50	0.87	23:15	1.25	1.09	10:45	1.445	15:35	3.417	2.546	2.546	
05/16/2022	08:10	16.92	01:30	23.00	19.87	06:20	0.87	00:45	1.23	1.08	07:55	1.491	00:45	3.573	2.480	2.480	
05/17/2022	07:55	16.76	01:35	22.80	19.68	06:45	0.87	00:35	1.24	1.06	07:40	1.451	01:10	3.504	2.398	2.398	
05/18/2022	07:45	16.79	01:40	22.63	19.70	07:05	0.88	11:25	1.22	1.07	07:30	1.458	00:45	3.404	2.417	2.417	
05/19/2022	07:25	16.99	01:55	22.49	19.81	08:10	0.87	00:45	1.21	1.07	08:10	1.472	01:55	3.396	2.442	2.442	
05/20/2022	08:25	16.81	01:35	22.48	19.81	08:05	0.87	12:05	1.21	1.07	08:05	1.430	01:40	3.359	2.445	2.445	
05/21/2022	09:55	16.76	15:00	22.62	19.89	09:40	0.88	12:45	1.28	1.07	09:40	1.442	15:00	3.460	2.471	2.471	
05/22/2022	10:40	16.71	15:15	23.03	20.32	09:55	0.86	13:10	1.24	1.08	09:55	1.410	15:15	3.504	2.608	2.608	
05/23/2022	07:55	16.94	00:35	23.17	20.07	07:05	0.87	00:30	1.21	1.06	07:05	1.478	00:30	3.612	2.497	2.497	
05/24/2022	07:45	16.89	01:45	22.66	19.80	07:00	0.86	11:15	1.22	1.05	07:00	1.459	01:10	3.357	2.412	2.412	
05/25/2022	07:35	17.04	01:50	22.75	19.90	06:50	0.83	21:00	1.25	1.06	06:50	1.432	01:15	3.438	2.438	2.438	
05/26/2022	07:30	17.07	01:50	22.66	19.92	07:20	0.82	11:10	1.19	1.05	07:20	1.393	01:40	3.332	2.431	2.431	
05/27/2022	08:45	16.95	01:45	22.47	19.95	06:10	0.85	12:00	1.19	1.06	07:35	1.470	01:05	3.290	2.449	2.449	
05/28/2022	10:20	16.88	15:40	22.45	19.76	10:05	0.85	12:40	1.21	1.04	10:05	1.413	15:45	3.262	2.380	2.380	
05/29/2022	10:20	17.46	15:50	22.87	20.28	09:00	0.85	04:25	1.22	1.07	09:00	1.541	15:25	3.395	2.545	2.545	
05/30/2022	07:30	17.63	16:10	23.76	20.78	07:00	0.90	14:00	1.22	1.07	07:00	1.643	15:30	3.608	2.673	2.673	
05/31/2022	07:40	17.59	01:35	22.68	20.43	07:35	0.88	13:30	1.19	1.06	07:35	1.577	01:00	3.343	2.561	2.561	
06/01/2022	07:20	17.38	01:45	22.48	20.09	06:25	0.88	10:50	1.18	1.06	08:05	1.553	00:20	3.269	2.476	2.476	
06/02/2022	08:05	17.29	01:55	22.41	19.97	08:20	0.87	01:20	1.20	1.05	08:20	1.525	01:20	3.352	2.432	2.432	
06/03/2022	08:35	17.14	01:50	22.00	19.93	06:15	0.86	03:00	1.18	1.05	08:05	1.504	01:30	3.117	2.425	2.425	

Date	Depth (in)					Velocity (ft/s)					Quantity (MGD - Total MG)						Rain (in)
	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Total	Total
06/04/2022	08:50	17.18	15:30	22.26	20.05	08:35	0.86	13:05	1.19	1.05	08:35	1.478	15:05	3.211	2.462	2.462	
06/05/2022	10:25	17.02	15:30	22.68	20.28	07:05	0.86	12:40	1.22	1.06	09:35	1.490	15:25	3.337	2.535	2.535	
06/06/2022	08:15	17.02	01:00	22.52	20.08	07:35	0.86	01:50	1.26	1.05	07:35	1.463	01:50	3.560	2.471	2.471	
06/07/2022	08:20	17.26	01:50	22.65	20.04	06:25	0.88	01:15	1.19	1.05	07:45	1.554	01:45	3.373	2.448	2.448	
06/08/2022	08:25	17.18	02:10	22.27	19.91	08:20	0.85	23:15	1.17	1.05	08:20	1.466	01:50	3.200	2.416	2.416	
06/09/2022	08:45	17.33	01:50	22.17	20.01	06:45	0.87	00:05	1.17	1.05	08:50	1.535	01:20	3.165	2.457	2.457	
06/10/2022	09:00	17.17	02:05	22.06	20.01	05:35	0.86	19:20	1.17	1.05	08:10	1.517	02:00	3.093	2.437	2.437	
06/11/2022	10:10	17.11	15:20	21.98	20.03	09:15	0.84	12:35	1.18	1.05	09:15	1.441	17:15	3.162	2.451	2.451	
06/12/2022	09:35	17.25	15:20	22.64	20.50	09:35	0.83	13:15	1.20	1.06	09:35	1.448	15:30	3.315	2.591	2.591	
06/13/2022	07:55	17.29	01:20	22.62	20.27	06:50	0.87	00:55	1.16	1.05	07:45	1.536	00:55	3.318	2.499	2.497	

Report Summary For The Period 04/19/2022 00:00 - 06/13/2022 23:59

	Depth (in)	Velocity (ft/s)	Quantity (MGD - Total MG)
Total			137.656
Avg	19.88	1.07	2.458

Site Commentary

Site Information

CW18	
Pipe Dimensions	28.63"
Silt Level	0.00"

Overview

Site CW18 functioned under normal conditions during the period Tuesday, April 19, 2022 to Monday, June 13, 2022. A hydraulic shift was experienced April 21, 2022 through May 3, 2022. No surcharge conditions were experienced at this location. Review of the scattergraph shows that the line was impacted by debris. The accumulation of debris caused depth to become deeper and velocity slower. The calculated flow remained consistent. The presence of debris may result in reduced line capacity. Free flow conditions were maintained throughout the study period. Flow is transitional as it operates between subcritical and supercritical conditions. Unstable conditions may be experienced during transitional periods.

Flow depth and velocity measurements recorded by the flow monitor are consistent with field confirmations conducted to date and support the relative accuracy of the flow monitor at this location.

This site was positioned upstream of location CW17 (See CW17 Site Commentary For Balancing Details).

Observations

Average flow depth, velocity, and quantity data observed during Tuesday, April 19, 2022 to Monday, June 13, 2022 , along with observed minimum and maximum data, are provided in the following table. Values in the Observed Flow Conditions are based on 5-minute averages. Graphs are based on 15-minute averages. As a result, the values shown in the table below may differ from those shown on the graph.

In regard to depth, based on an average depth of 4.62 inches, this site utilized 16.14 percent of full pipe depth. The hourly averaged peak depth of 6.04 inches represented 21.24 percent of full pipe depth.

Observed Flow Conditions

Item	Depth (in)	Velocity (ft/s)	Quantity (MGD)
Average	4.62	2.82	0.878
Minimum	2.92	1.60	0.330
Maximum	6.11	3.38	1.468
Time of Minimum	5/8/2022 08:05	5/3/2022 05:20	4/20/2022 03:20
Time of Maximum	5/2/2022 22:50	5/8/2022 12:30	5/1/2022 11:55

Data Quality

Data uptime observed during the Tuesday, April 19, 2022 to the Monday, June 13, 2022 monitoring period is provided in the table below. Based upon the quality and consistency of the observed flow depth and velocity data, the Continuity equation was used to calculate flow rate and quantities during the monitoring period.

Percent Uptime	
Depth (in)	100
Velocity (ft/s)	100
Quantity (MGD)	100

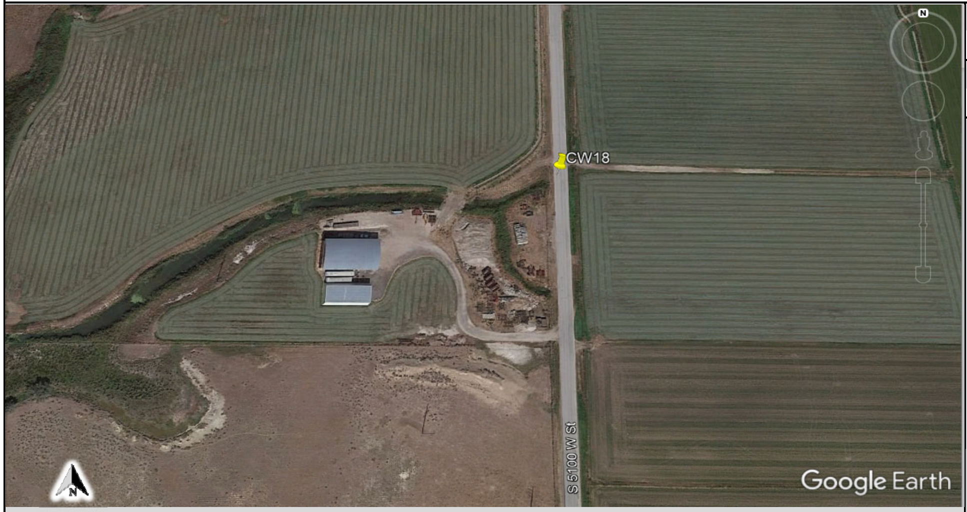
Ogden.BowenClns.TFM.UT22

Flow Monitoring
Site Report

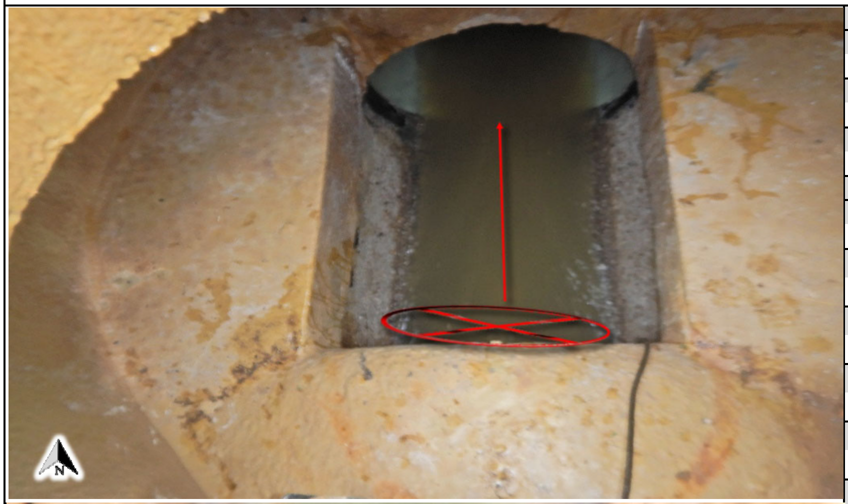
22773.11.325

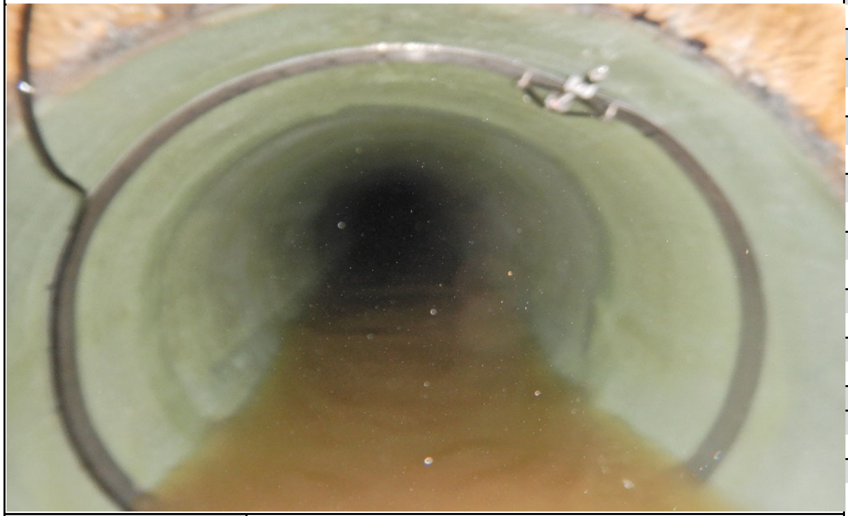
CW18

Site Address /Location:	S 5100 W ST			Monitor Series TRITON+ VZ	Location Type Temporary
Site Access Details:	DRIVE TO SITE	Latitude: Longitude:	41.2173224 -112.1025546	Pipe Size (H x W) 28.63X28.75	Pipe Shape Elliptical



Manhole #	System Characteristics
HP010	Residential/Commercial
Access	Traffic
Drive	Light





Installation Information

Installation Date:	Installation Type:
Saturday, April 16, 2022	Doppler Standard Ring and Crank
Monitoring Location (Sensors):	Monitor Location:
Upstream 0-5 FT	Manhole
Sensors / Devices:	Pressure Sensor Range (psi)
Peak Combo (CS4)	0 - 5 psi

Installation Confirmation:

Confirmation Time:	Pipe Size (HxW)
12:06PM	28.63X28.75
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
5.63	
Downlooker Physical Offset (in)	Measurement Confidence (in)
	0.25"
Peak Velocity (fps)	Velocity Sensor Offset (in)
3.68	0"
Silt (in)	Silt Type
0	

Hydraulic Comments:
Smooth flow

Manhole / Pipe Information:

Manhole Depth (Approx. FT):	Manhole Configuration
72	Single
Manhole Material:	Manhole Condition:
Concrete	Good
Manhole Opening Diameter (in)	Manhole Diameter (Approx.):
26"	54"
Manhole Cover	Manhole Frame
vented	Normal
Active Drop Connections	Air Quality:
No	Normal
Pipe Material	Pipe Condition:
Concrete	Good

Communication Information:

Communication Type	Antenna Location
Wireless	Manhole Pick / Vent Hole

Additional Site Info. / Comments:

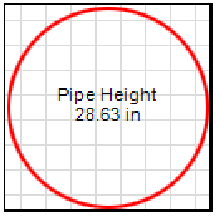
ADS Project Name:	Ogden.BowenClns.TFM.UT22
ADS Project Number:	22773.11.325

SCATTERGRAPH REPORT

CW18

Flow Monitor

CW18

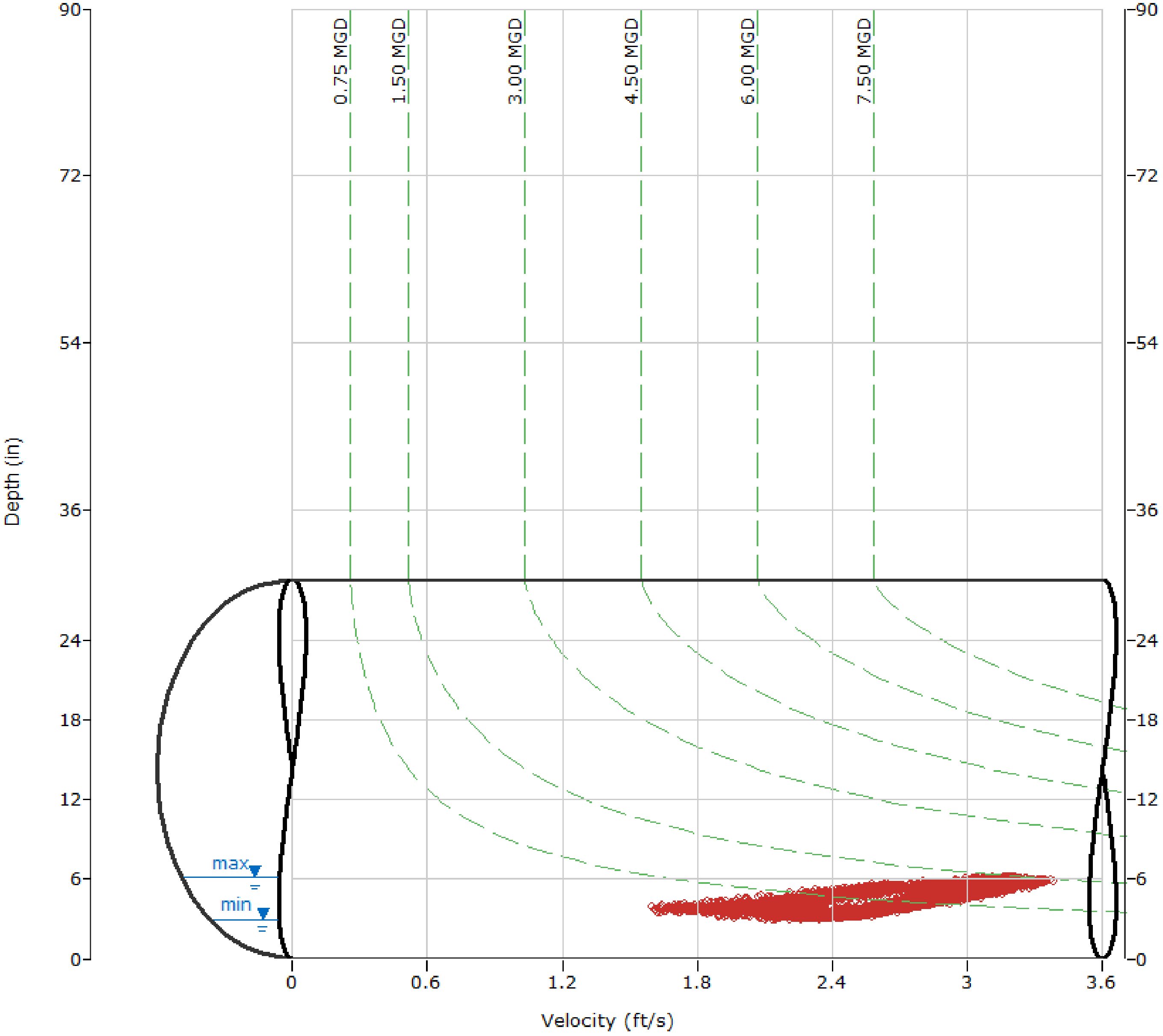


Report Period

4/19/2022
To
6/13/2022

Legend

- ○ Depth - Velocity
- - - - Iso-Q™
- - - - Silt
- ▼ Min-Max Depth



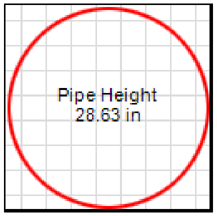
ADS ENVIRONMENTAL SERVICES

HYDROGRAPH REPORT

CW18

Flow Monitor

CW18

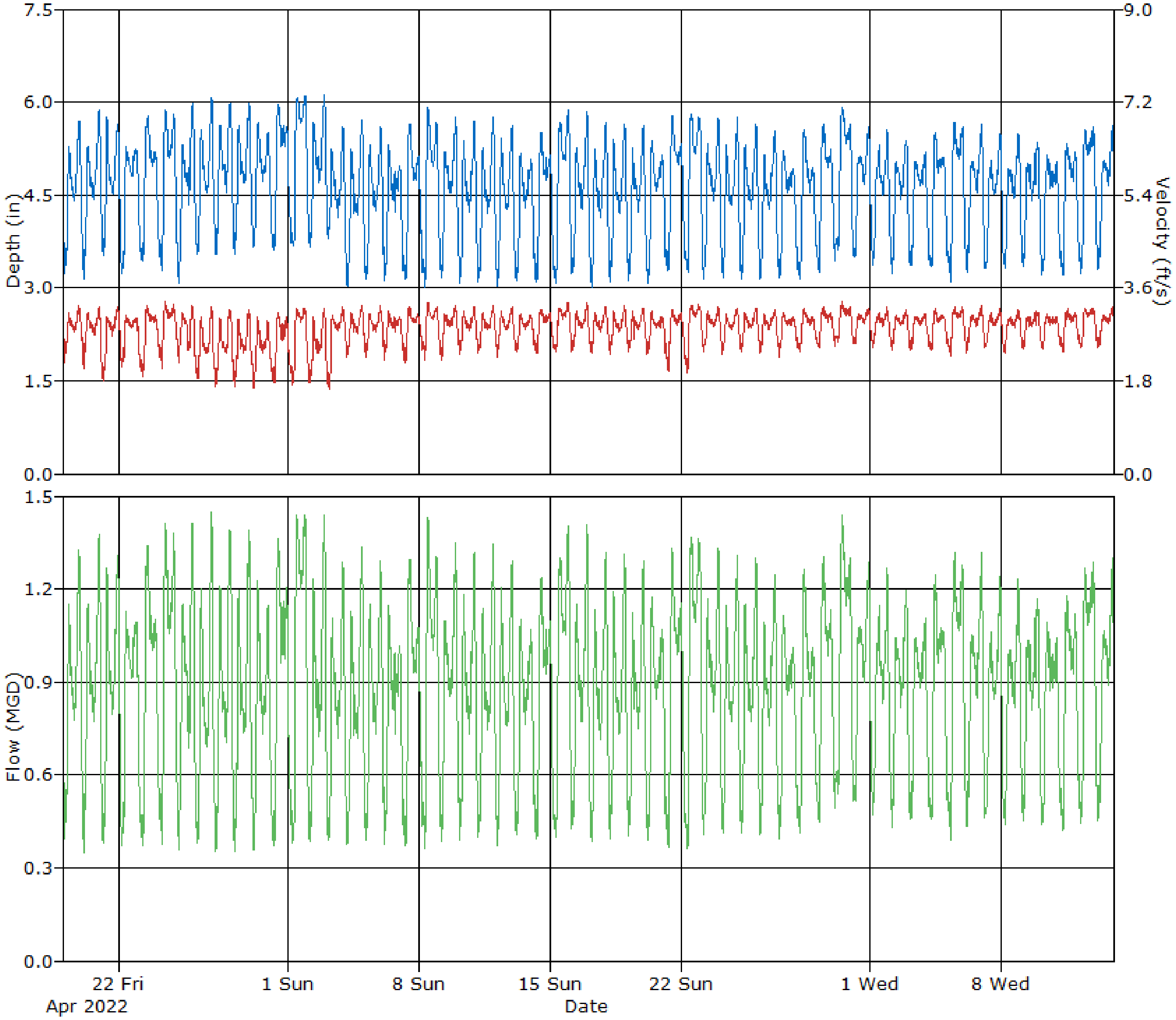


Report Period

4/19/2022
To
6/13/2022

Legend

- Depth
- Velocity
- Quantity



Daily Tabular Report For The Period 04/19/2022 00:00 - 06/13/2022 23:59

CW18, Pipe Height: 28.63 in, Silt: 0.00 in

Daily Tabular Report

Date	Depth (in)					Velocity (ft/s)					Quantity (MGD - Total MG)						Rain (in)
	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Total	Total
04/19/2022	03:05	3.20	21:30	5.71	4.58	03:35	2.14	21:05	3.29	2.83	03:35	0.385	21:05	1.344	0.869	0.869	
04/20/2022	03:20	3.08	22:40	5.86	4.61	03:20	1.97	23:10	3.25	2.80	03:20	0.330	22:35	1.385	0.871	0.871	
04/21/2022	04:35	3.51	08:50	5.79	4.72	04:25	1.72	22:00	3.27	2.69	04:25	0.351	22:00	1.323	0.871	0.871	
04/22/2022	03:15	3.15	00:00	5.35	4.64	03:15	1.92	08:50	3.11	2.79	03:15	0.334	00:00	1.153	0.873	0.873	
04/23/2022	04:05	3.38	13:20	5.77	4.75	07:10	1.83	12:55	3.29	2.72	07:15	0.360	12:55	1.354	0.895	0.895	
04/24/2022	07:45	3.24	12:10	5.87	4.82	07:45	1.90	11:35	3.35	2.88	07:45	0.345	11:35	1.416	0.966	0.966	
04/25/2022	04:40	3.03	22:35	5.99	4.70	04:40	2.09	21:50	3.28	2.81	04:40	0.344	22:35	1.423	0.896	0.896	
04/26/2022	03:45	3.52	22:35	6.08	4.82	03:45	1.72	22:20	3.26	2.53	03:45	0.353	22:20	1.457	0.845	0.845	
04/27/2022	04:40	3.50	22:25	6.00	4.89	04:05	1.63	22:10	3.20	2.53	04:05	0.331	22:10	1.407	0.863	0.863	
04/28/2022	03:55	3.51	22:40	5.99	4.87	03:55	1.64	22:50	3.19	2.50	03:55	0.334	22:50	1.401	0.847	0.847	
04/29/2022	04:20	3.62	10:50	5.68	4.86	04:25	1.61	08:50	3.06	2.47	04:50	0.347	08:50	1.243	0.828	0.828	
04/30/2022	07:05	3.58	12:20	5.97	4.99	07:05	1.67	12:05	3.16	2.56	07:05	0.349	12:05	1.377	0.905	0.905	
05/01/2022	06:45	3.68	22:10	6.10	5.16	06:30	1.68	11:55	3.27	2.68	06:45	0.374	11:55	1.468	1.006	1.006	
05/02/2022	04:20	3.64	22:50	6.11	4.94	03:40	1.69	22:40	3.21	2.50	03:40	0.365	22:50	1.454	0.868	0.868	
05/03/2022	03:35	3.78	00:00	5.81	4.66	05:20	1.60	22:20	3.26	2.64	03:40	0.378	22:30	1.297	0.829	0.829	
05/04/2022	04:40	2.95	23:00	5.72	4.42	04:40	2.15	22:15	3.31	2.84	04:40	0.339	22:35	1.352	0.831	0.831	
05/05/2022	03:35	3.08	22:55	5.59	4.45	03:35	2.14	22:40	3.28	2.84	03:35	0.360	22:40	1.310	0.836	0.836	
05/06/2022	03:35	3.05	09:15	5.30	4.42	03:40	2.08	09:05	3.19	2.83	03:40	0.348	09:05	1.163	0.820	0.820	
05/07/2022	05:50	3.11	12:10	5.68	4.51	07:00	2.08	11:45	3.25	2.83	07:00	0.359	12:30	1.315	0.859	0.859	
05/08/2022	08:05	2.92	11:20	5.93	4.71	06:55	2.11	12:30	3.38	2.92	08:05	0.333	11:15	1.445	0.946	0.946	
05/09/2022	05:00	3.12	22:50	5.77	4.57	04:50	2.17	22:45	3.30	2.86	04:55	0.374	22:45	1.363	0.879	0.879	
05/10/2022	04:35	3.05	23:05	5.70	4.49	04:35	2.25	22:00	3.28	2.86	04:35	0.373	23:10	1.332	0.854	0.854	
05/11/2022	03:35	3.05	23:05	5.75	4.50	03:35	2.30	22:25	3.29	2.87	03:35	0.381	23:05	1.361	0.857	0.857	
05/12/2022	04:25	2.98	22:45	5.61	4.49	04:20	2.23	22:45	3.26	2.87	04:20	0.360	22:45	1.309	0.856	0.856	
05/13/2022	04:30	3.01	00:00	5.28	4.40	04:30	2.29	00:05	3.17	2.84	04:30	0.372	00:05	1.163	0.818	0.818	
05/14/2022	05:50	3.06	12:00	5.53	4.53	07:10	2.27	11:05	3.21	2.87	05:50	0.379	12:00	1.255	0.870	0.870	
05/15/2022	07:45	3.02	22:35	5.88	4.71	07:45	2.28	22:05	3.34	2.92	07:45	0.373	22:35	1.425	0.949	0.949	
05/16/2022	03:20	3.18	23:05	5.85	4.55	05:25	2.32	23:10	3.34	2.88	05:25	0.413	23:10	1.422	0.877	0.877	
05/17/2022	04:45	3.01	23:00	5.69	4.44	04:25	2.31	22:50	3.28	2.86	04:35	0.381	22:50	1.338	0.840	0.840	
05/18/2022	03:55	2.98	22:50	5.65	4.47	03:55	2.21	22:15	3.28	2.85	03:55	0.354	22:50	1.326	0.846	0.846	
05/19/2022	04:10	3.10	22:50	5.63	4.49	03:40	2.33	22:50	3.24	2.85	04:10	0.395	22:50	1.305	0.849	0.849	
05/20/2022	05:20	3.02	09:30	5.40	4.52	03:40	2.16	09:10	3.20	2.83	05:20	0.369	09:30	1.199	0.850	0.850	
05/21/2022	06:40	3.17	11:40	5.79	4.74	06:40	1.90	11:05	3.22	2.81	06:40	0.332	11:40	1.341	0.917	0.917	
05/22/2022	08:05	3.21	12:15	5.82	4.84	07:20	1.93	21:40	3.34	2.88	08:05	0.345	12:10	1.391	0.976	0.976	
05/23/2022	04:40	3.06	22:55	5.76	4.58	04:40	2.26	23:00	3.26	2.89	04:40	0.376	23:00	1.350	0.886	0.886	
05/24/2022	04:35	3.12	23:05	5.77	4.51	04:30	2.24	23:05	3.25	2.86	04:30	0.392	23:05	1.358	0.858	0.858	
05/25/2022	04:40	3.07	23:05	5.65	4.51	04:35	2.34	21:45	3.28	2.88	04:40	0.392	22:50	1.311	0.864	0.864	
05/26/2022	04:40	3.06	23:05	5.54	4.48	04:40	2.26	23:05	3.19	2.86	04:40	0.376	23:05	1.257	0.848	0.848	
05/27/2022	04:55	3.09	00:00	5.34	4.46	04:55	2.24	09:50	3.14	2.85	04:55	0.378	00:00	1.164	0.839	0.839	
05/28/2022	07:10	3.10	12:20	5.55	4.45	06:45	2.32	12:25	3.25	2.85	07:10	0.394	12:25	1.284	0.841	0.841	
05/29/2022	07:30	3.21	13:10	5.66	4.66	07:30	2.41	13:40	3.25	2.91	07:30	0.432	13:10	1.314	0.917	0.917	
05/30/2022	04:15	3.38	12:45	5.91	4.86	04:15	2.40	13:00	3.37	2.96	04:15	0.463	13:00	1.456	0.999	0.999	
05/31/2022	04:30	3.45	22:30	5.61	4.68	06:15	2.48	22:35	3.22	2.93	04:30	0.497	22:35	1.291	0.921	0.921	
06/01/2022	04:40	3.33	22:55	5.56	4.57	04:45	2.41	22:30	3.28	2.89	04:45	0.457	22:45	1.286	0.878	0.878	
06/02/2022	05:20	3.21	22:40	5.39	4.52	05:20	2.36	23:30	3.21	2.88	05:20	0.422	23:30	1.211	0.863	0.863	
06/03/2022	04:45	3.33	00:00	5.30	4.52	04:45	2.35	22:45	3.11	2.86	04:45	0.443	00:00	1.135	0.857	0.857	

Date	Depth (in)					Velocity (ft/s)					Quantity (MGD - Total MG)						Rain (in)
	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Total	Total
06/04/2022	07:40	3.26	11:50	5.50	4.58	07:40	2.31	12:05	3.21	2.87	07:40	0.421	12:05	1.247	0.882	0.882	
06/05/2022	07:45	3.02	12:05	5.68	4.70	07:45	2.15	22:40	3.30	2.91	07:45	0.351	12:50	1.333	0.934	0.934	
06/06/2022	05:25	3.21	23:00	5.64	4.59	04:25	2.26	23:10	3.31	2.89	04:25	0.410	23:10	1.337	0.888	0.888	
06/07/2022	05:10	3.25	22:45	5.49	4.53	03:50	2.39	22:50	3.22	2.89	03:50	0.443	22:50	1.252	0.867	0.867	
06/08/2022	05:05	3.25	22:35	5.49	4.52	05:05	2.24	22:30	3.21	2.87	05:05	0.408	22:30	1.246	0.857	0.857	
06/09/2022	04:35	3.30	22:50	5.36	4.52	04:35	2.38	21:20	3.20	2.86	04:35	0.444	23:00	1.179	0.857	0.857	
06/10/2022	04:25	3.13	00:05	5.25	4.46	05:55	2.34	00:10	3.15	2.86	04:25	0.404	00:10	1.138	0.841	0.841	
06/11/2022	07:20	3.16	12:25	5.35	4.53	07:20	2.31	14:25	3.20	2.88	07:20	0.403	12:25	1.191	0.868	0.868	
06/12/2022	06:45	3.19	22:30	5.61	4.74	07:10	2.39	11:55	3.23	2.94	06:45	0.427	22:40	1.290	0.953	0.953	
06/13/2022	04:00	3.28	22:35	5.61	4.61	03:55	2.38	22:35	3.27	2.90	03:55	0.443	22:35	1.311	0.896	0.895	

Report Summary For The Period 04/19/2022 00:00 - 06/13/2022 23:59

	Depth (in)	Velocity (ft/s)	Quantity (MGD - Total MG)
Total			49.177
Avg	4.62	2.82	0.878

Site Commentary

Site Information

CW19	
Pipe Dimensions	48"
Silt Level	5.25"

Overview

Site CW19 functioned under normal conditions during the period Tuesday, April 19, 2022 to Monday, June 13, 2022**.** No surcharge conditions were experienced at this location. Review of the scattergraph shows that free flow conditions were maintained throughout the study period. Flow is subcritical.

Flow depth and velocity measurements recorded by the flow monitor are consistent with field confirmations conducted to date and support the relative accuracy of the flow monitor at this location.

This site along with CW09 and CW11 was positioned upstream of location CW13 (See CW13 Site Commentary For Balancing Details). In addition, the site is downstream of a diversion line and receives some portion of CW07 flows. A balance check was done with upstream meter CW07 using the sum of CW19 and CW20b. Flows are balanced.

Observations

Average flow depth, velocity, and quantity data observed during Tuesday, April 19, 2022 to Monday, June 13, 2022 , along with observed minimum and maximum data, are provided in the following table. Values in the Observed Flow Conditions are based on 5-minute averages. Graphs are based on 15-minute averages. As a result, the values shown in the table below may differ from those shown on the graph.

In regard to depth, based on an average depth of 12.99 inches, this site utilized 27.06 percent of full pipe depth. The hourly averaged peak depth of 17.53 inches represented 36.52 percent of full pipe depth.

Observed Flow Conditions

Item	Depth (in)	Velocity (ft/s)	Quantity (MGD)
Average	12.99	1.14	1.569
Minimum	9.65	0.54	0.373
Maximum	17.57	1.81	4.028
Time of Minimum	4/24/2022 09:15	4/24/2022 08:55	4/24/2022 08:55
Time of Maximum	5/30/2022 14:20	5/30/2022 14:30	5/30/2022 14:30

Data Quality

Data uptime observed during the Tuesday, April 19, 2022 to the Monday, June 13, 2022 monitoring period is provided in the table below. Based upon the quality and consistency of the observed flow depth and velocity data, the Continuity equation was used to calculate flow rate and quantities during the monitoring period. Data loss was experienced beginning late May 30, 2022 through June 13, 2022 due to an equipment malfunction.

Percent Uptime	
Depth (in)	76
Velocity (ft/s)	76
Quantity (MGD)	76

Ogden.BowenClns.TFM.UT22

Flow Monitoring
Site Report

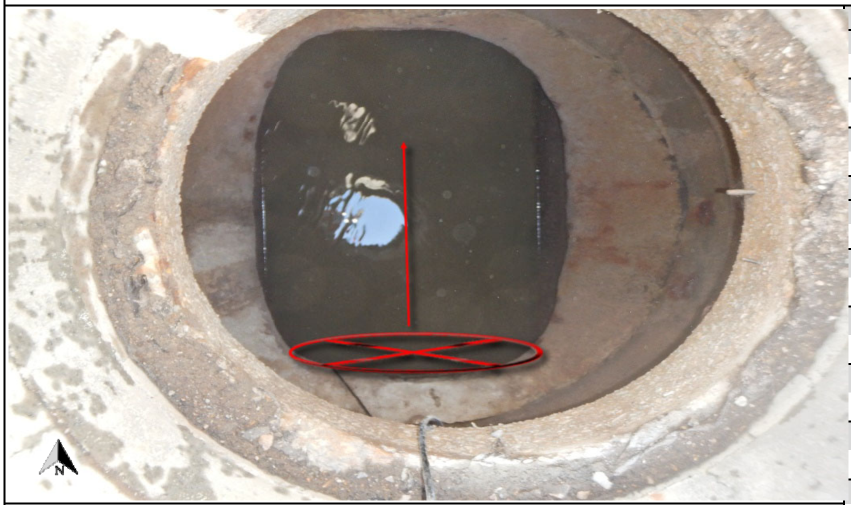
22773.11.325

CW19

Site Address /Location:	305 1140 W		
Site Access Details:	DRIVE	Latitude: Longitude:	41.265226 -112.008632

Monitor Series	Location Type
TRITON+ VZ	Temporary
Pipe Size (H x W)	Pipe Shape
48.00X48.25	Elliptical

Manhole #	System Characteristics
OC083	Residential/Commercial
Access	Traffic
Drive	None



Installation Information

Installation Date:	Installation Type:
04/18//2022	Doppler Standard Ring and Crank
Monitoring Location (Sensors):	Monitor Location:
Upstream 0-5 FT	Manhole
Sensors / Devices:	Pressure Sensor Range (psi)
Peak Combo (CS4)	0 - 5 psi

Installation Confirmation:

Confirmation Time:	Pipe Size (HxW)
11:59AM	48.00X48.25
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
15.38	
Downlooker Physical Offset (in)	Measurement Confidence (in)
7.5	0.38"
Peak Velocity (fps)	Velocity Sensor Offset (in)
1.71	0"
Silt (in)	Silt Type
6.5	Sandy / Gravel

Hydraulic Comments:
Smooth flow

Manhole / Pipe Information:

Manhole Depth (Approx. FT):	Manhole Configuration
180	Single
Manhole Material:	Manhole Condition:
Concrete	Good
Manhole Opening Diameter (in)	Manhole Diameter (Approx.):
26"	54"
Manhole Cover	Manhole Frame
vented	Normal
Active Drop Connections	Air Quality:
No	Normal
Pipe Material	Pipe Condition:
Concrete	Good

Communication Information:

Communication Type	Antenna Location
Wireless	Manhole Pick / Vent Hole

Additional Site Info. / Comments:

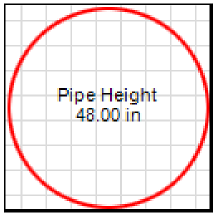
ADS Project Name:	Ogden.BowenClns.TFM.UT22
ADS Project Number:	22773.11.325

SCATTERGRAPH REPORT

CW19

Flow Monitor

CW19

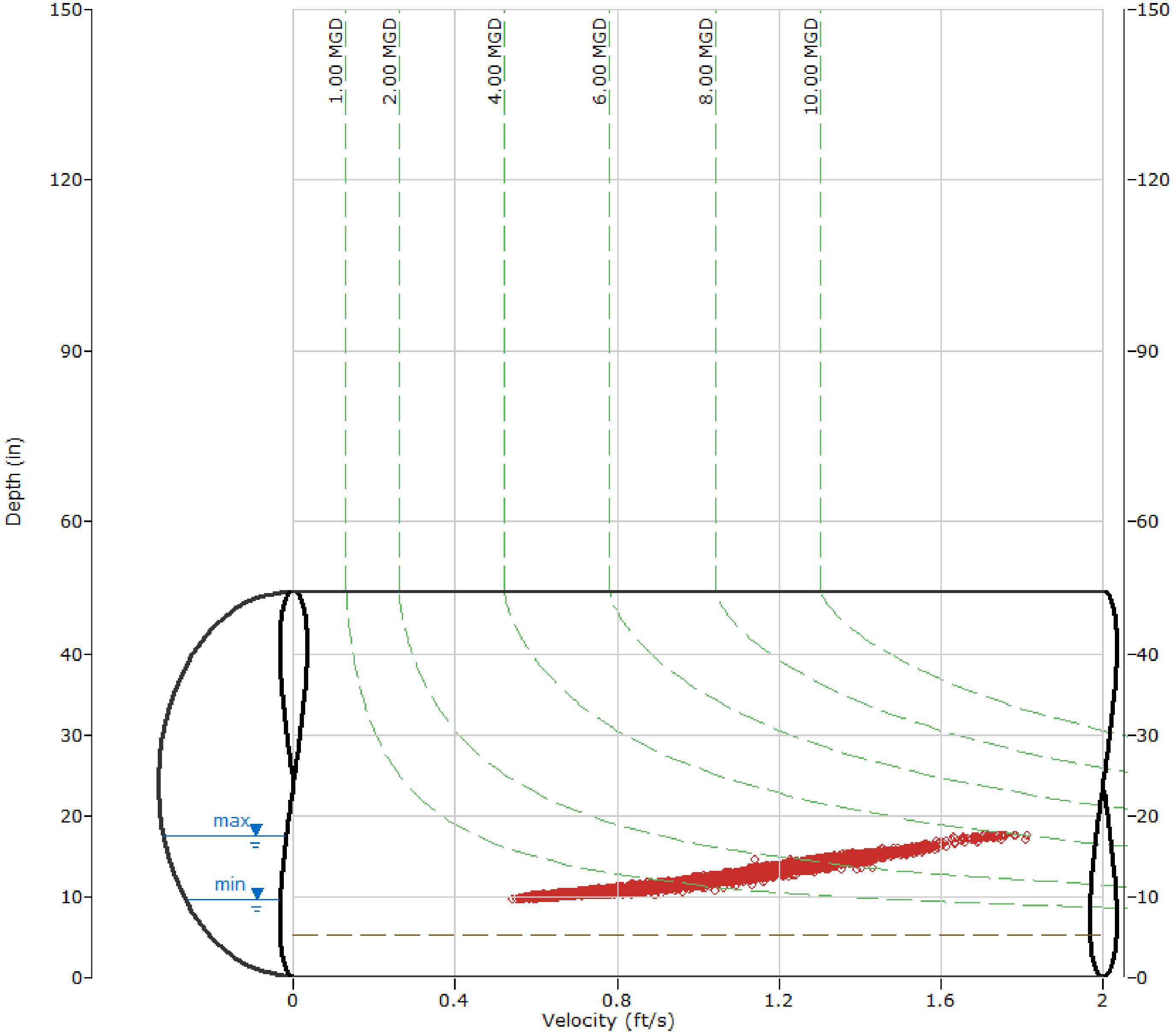


Report Period

4/19/2022
To
6/13/2022

Legend

○ Depth - Velocity
--- Iso-Q™
--- Silt
▼ Min-Max Depth



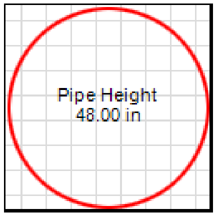
ADS ENVIRONMENTAL SERVICES

HYDROGRAPH REPORT

CW19

Flow Monitor

CW19

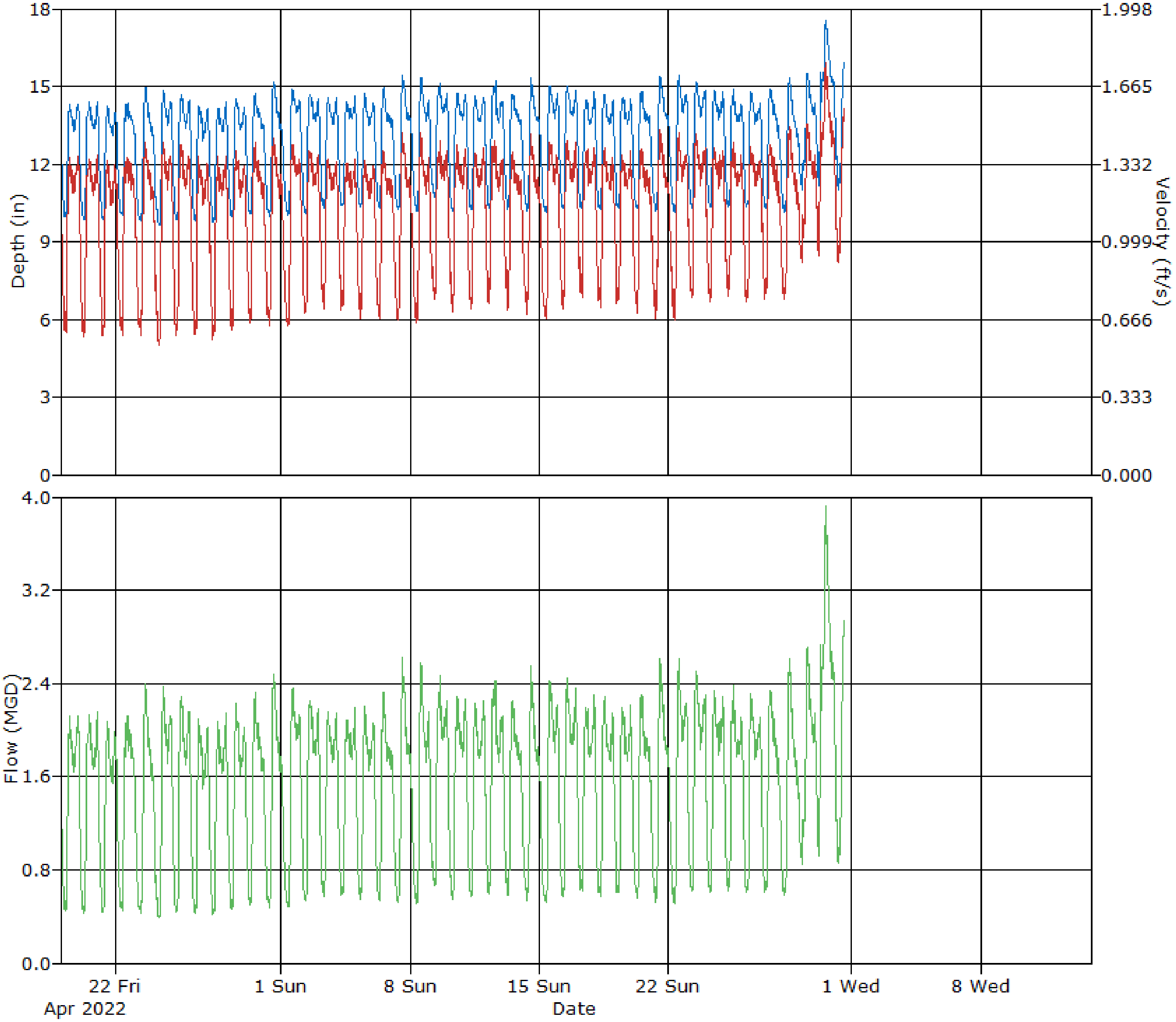


Report Period

4/19/2022
To
6/13/2022

Legend

- Depth
- Velocity
- Quantity



ADS ENVIRONMENTAL SERVICES

Daily Tabular Report For The Period 04/19/2022 00:00 - 06/13/2022 23:59

CW19, Pipe Height: 48.00 in, Silt: 5.25 in

Daily Tabular Report

Date	Depth (in)					Velocity (ft/s)					Quantity (MGD - Total MG)						Rain (in)
	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Total	Total
04/19/2022	05:40	9.94	11:40	14.32	12.74	07:05	0.60	22:15	1.40	1.11	05:35	0.442	22:15	2.172	1.474	1.474	
04/20/2022	07:25	9.89	13:40	14.42	12.65	07:10	0.58	13:40	1.38	1.09	07:10	0.423	13:40	2.185	1.432	1.432	
04/21/2022	06:45	9.87	00:20	14.39	12.62	07:55	0.58	11:25	1.39	1.09	07:55	0.426	00:15	2.158	1.416	1.416	
04/22/2022	08:50	10.05	15:50	14.37	12.70	08:40	0.59	15:35	1.37	1.10	08:40	0.448	15:50	2.150	1.450	1.450	
04/23/2022	08:30	9.80	15:10	14.97	12.49	08:30	0.57	14:35	1.45	1.07	08:30	0.409	14:35	2.427	1.390	1.390	
04/24/2022	09:15	9.65	14:10	14.84	12.50	08:55	0.54	14:05	1.45	1.07	08:55	0.373	14:05	2.416	1.402	1.402	
04/25/2022	07:55	9.84	13:35	14.68	12.82	06:00	0.59	13:00	1.43	1.13	06:35	0.433	13:30	2.309	1.520	1.520	
04/26/2022	07:25	9.80	00:10	14.48	12.61	07:15	0.59	12:15	1.39	1.09	07:15	0.424	00:15	2.168	1.421	1.421	
04/27/2022	06:30	9.74	23:35	14.40	12.59	06:15	0.57	12:55	1.42	1.09	06:30	0.406	23:30	2.162	1.422	1.422	
04/28/2022	06:45	9.95	13:20	14.54	12.78	08:15	0.61	13:20	1.41	1.12	06:35	0.452	13:20	2.268	1.487	1.487	
04/29/2022	08:05	10.06	13:50	14.74	12.85	08:10	0.63	13:35	1.44	1.13	08:10	0.480	13:35	2.344	1.519	1.519	
04/30/2022	08:20	9.99	14:30	15.15	12.77	09:05	0.62	13:40	1.45	1.10	08:40	0.466	13:40	2.498	1.478	1.478	
05/01/2022	08:50	10.04	14:20	14.91	12.77	08:35	0.63	15:25	1.44	1.10	08:35	0.473	15:25	2.383	1.486	1.486	
05/02/2022	07:45	10.10	14:10	14.69	12.96	06:10	0.68	12:30	1.41	1.14	07:45	0.524	14:15	2.299	1.560	1.560	
05/03/2022	07:45	10.30	13:40	14.60	13.03	07:35	0.70	13:05	1.37	1.15	07:35	0.565	13:45	2.193	1.563	1.563	
05/04/2022	08:05	10.38	23:55	14.63	12.96	05:30	0.70	23:55	1.37	1.12	06:25	0.578	23:55	2.215	1.517	1.517	
05/05/2022	08:00	10.35	13:05	14.75	12.99	07:45	0.65	00:10	1.36	1.11	07:45	0.530	00:10	2.214	1.513	1.513	
05/06/2022	08:15	10.30	14:05	14.94	13.02	08:15	0.66	13:20	1.41	1.12	08:15	0.528	13:20	2.365	1.531	1.531	
05/07/2022	08:45	10.22	13:50	15.46	12.92	08:25	0.65	14:25	1.48	1.11	08:25	0.512	13:45	2.650	1.516	1.516	
05/08/2022	08:25	10.17	14:30	15.35	12.92	09:00	0.64	13:35	1.49	1.10	09:00	0.498	14:10	2.607	1.516	1.516	
05/09/2022	08:35	10.71	15:25	15.17	13.34	08:10	0.74	15:25	1.44	1.17	08:10	0.653	15:25	2.496	1.672	1.672	
05/10/2022	07:55	10.18	14:10	14.73	13.06	07:40	0.68	12:55	1.44	1.16	07:40	0.536	13:00	2.316	1.598	1.598	
05/11/2022	08:10	10.24	00:10	14.70	13.01	08:10	0.70	23:40	1.40	1.15	08:10	0.552	00:15	2.262	1.573	1.573	
05/12/2022	06:35	10.30	15:30	15.22	13.32	06:35	0.69	14:35	1.45	1.19	06:35	0.555	15:20	2.456	1.690	1.690	
05/13/2022	06:35	10.21	12:50	14.70	13.05	06:05	0.70	13:55	1.41	1.15	06:25	0.561	13:55	2.290	1.569	1.569	
05/14/2022	08:45	10.20	14:15	15.36	12.91	08:30	0.66	13:25	1.49	1.12	08:30	0.521	14:10	2.602	1.523	1.523	
05/15/2022	09:25	10.14	14:45	15.04	12.85	09:40	0.66	14:55	1.44	1.11	09:40	0.509	14:55	2.441	1.514	1.514	
05/16/2022	07:55	10.28	13:30	15.05	13.21	07:55	0.69	13:25	1.47	1.17	07:55	0.551	13:25	2.498	1.654	1.654	
05/17/2022	06:35	10.31	00:05	14.83	13.03	08:30	0.76	00:10	1.43	1.18	08:40	0.611	00:10	2.373	1.608	1.608	
05/18/2022	08:25	10.22	00:10	14.80	12.99	08:25	0.71	13:50	1.42	1.16	08:25	0.556	13:50	2.331	1.574	1.574	
05/19/2022	08:50	10.30	13:25	14.57	13.04	05:50	0.71	23:30	1.42	1.15	05:50	0.589	23:30	2.264	1.576	1.576	
05/20/2022	08:50	10.27	15:15	14.81	13.01	08:20	0.68	13:10	1.41	1.14	08:20	0.541	15:20	2.317	1.560	1.560	
05/21/2022	08:25	10.17	14:10	15.37	12.99	08:25	0.65	14:00	1.50	1.13	08:25	0.502	14:00	2.642	1.564	1.564	
05/22/2022	09:05	10.12	14:40	15.42	13.01	08:55	0.65	14:35	1.47	1.14	08:55	0.504	14:35	2.624	1.580	1.580	
05/23/2022	07:15	10.30	14:30	15.15	13.28	08:15	0.75	13:30	1.49	1.19	07:15	0.603	13:30	2.565	1.696	1.696	
05/24/2022	08:00	10.34	13:15	14.87	13.19	07:30	0.73	13:20	1.42	1.18	07:30	0.597	13:20	2.363	1.649	1.649	
05/25/2022	06:20	10.35	13:50	14.93	13.04	06:20	0.76	13:45	1.44	1.17	06:20	0.615	13:45	2.407	1.597	1.597	
05/26/2022	06:20	10.34	12:55	14.78	13.08	06:05	0.73	12:35	1.42	1.17	06:05	0.596	12:35	2.332	1.604	1.604	
05/27/2022	08:40	10.29	14:25	14.89	13.06	06:35	0.73	23:00	1.43	1.18	06:35	0.590	14:20	2.356	1.614	1.614	
05/28/2022	08:10	10.15	15:05	15.31	12.77	08:05	0.74	16:35	1.51	1.15	08:05	0.577	14:50	2.649	1.526	1.526	
05/29/2022	07:25	11.01	14:10	15.51	13.39	07:20	0.89	13:20	1.53	1.23	07:20	0.827	14:20	2.749	1.745	1.745	
05/30/2022	05:15	11.16	14:20	17.57	14.96	05:05	0.89	14:30	1.81	1.42	05:05	0.862	14:30	4.028	2.487	2.487	
05/31/2022	06:25	11.01	14:20	15.90	13.40	06:05	0.88	13:45	1.59	1.22	06:05	0.827	13:45	2.985	1.772	1.126	
06/01/2022																	
06/02/2022																	
06/03/2022																	

Date	Depth (in)					Velocity (ft/s)					Quantity (MGD - Total MG)						Rain (in)
	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Total	Total
06/04/2022																	
06/05/2022																	
06/06/2022																	
06/07/2022																	
06/08/2022																	
06/09/2022																	
06/10/2022																	
06/11/2022																	
06/12/2022																	
06/13/2022																	

Report Summary For The Period 04/19/2022 00:00 - 06/13/2022 23:59

	Depth (in)	Velocity (ft/s)	Quantity (MGD - Total MG)
Total			66.916
Avg	12.99	1.14	1.569

Site Commentary

Site Information

CW20b	
Pipe Dimensions	47.75"
Silt Level	0.00"

Overview

Site CW20b functioned under normal conditions during the period Tuesday, April 19, 2022 to Monday, June 13, 2022**.** No surcharge conditions were experienced at this location. Review of the scattergraph shows that free flow conditions were maintained throughout the study period. Flow is subcritical.

Flow depth and velocity measurements recorded by the flow monitor are consistent with field confirmations conducted to date and support the relative accuracy of the flow monitor at this location.

This site was positioned upstream of location CW15 (See CW15 Site Commentary For Balancing Details). In additon, this site along with CW19 receives flow from upstream site CW07. Flows are balanced.

Observations

Average flow depth, velocity, and quantity data observed during Tuesday, April 19, 2022 to Monday, June 13, 2022 , along with observed minimum and maximum data, are provided in the following table. Values in the Observed Flow Conditions are based on 5-minute averages. Graphs are based on 15-minute averages. As a result, the values shown in the table below may differ from those shown on the graph.

In regard to depth, based on an average depth of 6.94 inches, this site utilized 23.13 percent of full pipe depth. The hourly averaged peak depth of 8.69 inches represented 28.97 percent of full pipe depth.

Observed Flow Conditions			
Item	Depth (in)	Velocity (ft/s)	Quantity (MGD)
Average	15.12	2.58	5.642
Minimum	12.99	2.17	3.934
Maximum	16.74	2.89	7.019
Time of Minimum	4/24/2022 07:25	5/6/2022 05:50	4/20/2022 04:40
Time of Maximum	5/30/2022 14:00	6/5/2022 13:20	5/30/2022 14:15

Data Quality

Data uptime observed during the Tuesday, April 19, 2022 to the Monday, June 13, 2022 monitoring period is provided in the table below.   Based upon the quality and consistency of the observed flow depth and velocity data, the Continuity equation was used to calculate flow rate and quantities during the monitoring period.

Percent Uptime	
Depth (in)	100
Velocity (ft/s)	100
Quantity (MGD)	100

Ogden.BowenClns.TFM.UT22

Flow Monitoring
Site Report

22773.11.325

CW20b

Site Address /Location:	1593 S 1900 W			Monitor Series TRITON+ VZ	Location Type Temporary
Site Access Details:	DRIVE	Latitude: Longitude:	41.238512 -112.025603	Pipe Size (H x W) 47.75X47.50	Pipe Shape Elliptical

Manhole #	System Characteristics
HA045	Residential/Commercial
Access	Traffic
Drive	Heavy

Installation Information

Installation Date:	Installation Type:
Friday, April 15, 2022	Doppler Standard Ring and Crank
Monitoring Location (Sensors):	Monitor Location:
Upstream 0-5 FT	Manhole
Sensors / Devices:	Pressure Sensor Range (psi)
Peak Combo (CS4)	0 - 5 psi

Installation Confirmation:

Confirmation Time:	Pipe Size (HxW)
2:26PM	47.75X47.50
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
17.38	
Downlooker Physical Offset (in)	Measurement Confidence (in)
NA	0.38"
Peak Velocity (fps)	Velocity Sensor Offset (in)
2.82	0"
Silt (in)	Silt Type
0	

Hydraulic Comments:
Smooth flow

Manhole / Pipe Information:

Manhole Depth (Approx. FT):	Manhole Configuration
180	Single
Manhole Material:	Manhole Condition:
Concrete	Good
Manhole Opening Diameter (in)	Manhole Diameter (Approx.):
26"	54"
Manhole Cover	Manhole Frame
vented	Normal
Active Drop Connections	Air Quality:
No	Normal
Pipe Material	Pipe Condition:
Concrete	Good

Communication Information:

Communication Type	Antenna Location
Wireless	Manhole Pick / Vent Hole

Additional Site Info. / Comments:

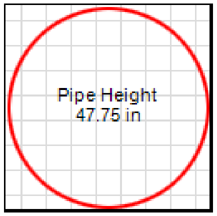
ADS Project Name:	Ogden.BowenClns.TFM.UT22
ADS Project Number:	22773.11.325

SCATTERGRAPH REPORT

CW20b

Flow Monitor

CW20b

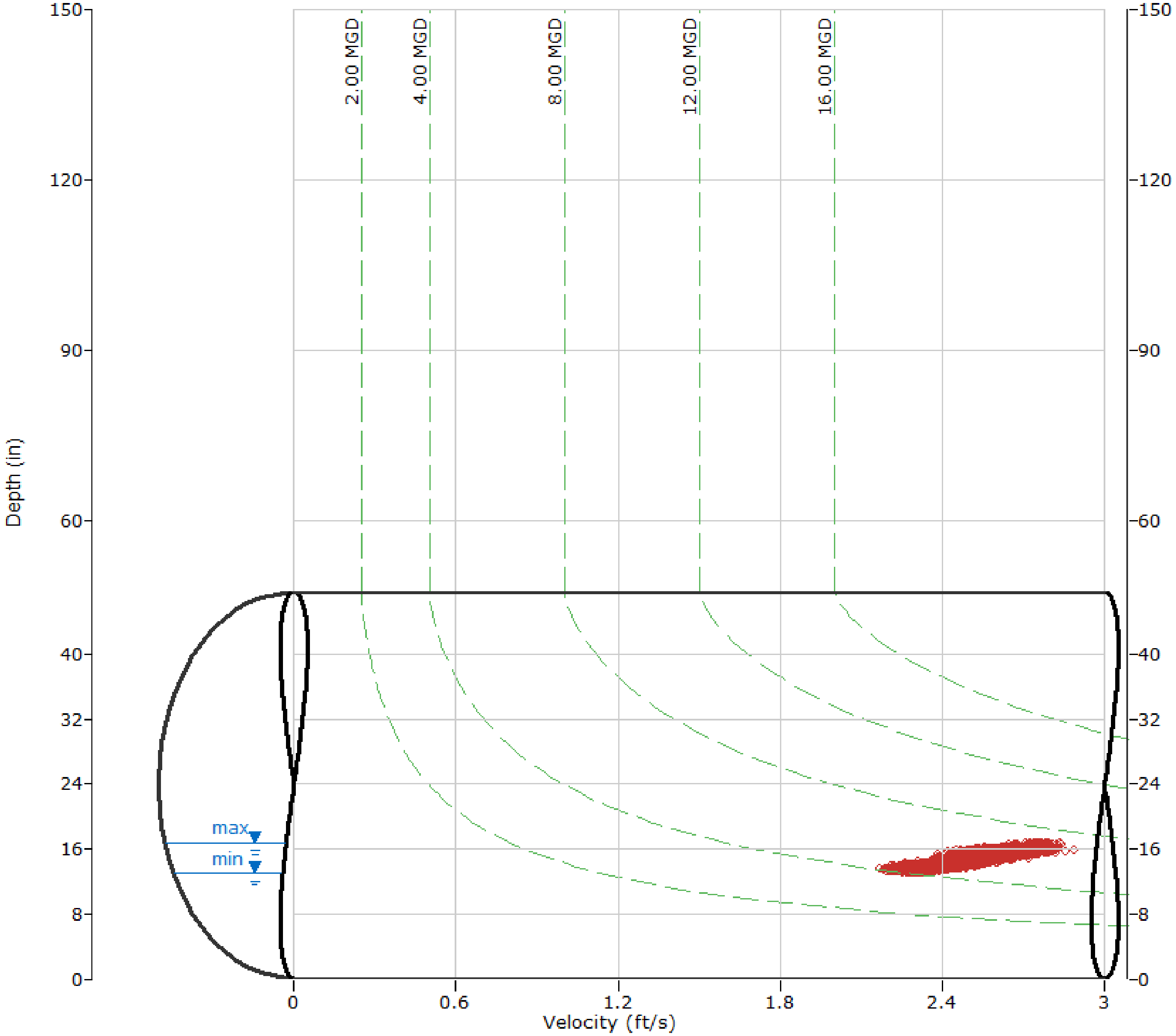


Report Period

4/19/2022
To
6/13/2022

Legend

- ○ Depth - Velocity
- - - - Iso-Q™
- - - - Silt
- ▼ Min-Max Depth

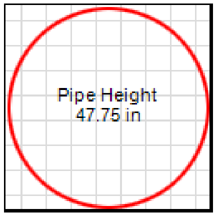


HYDROGRAPH REPORT

CW20b

Flow Monitor

CW20b

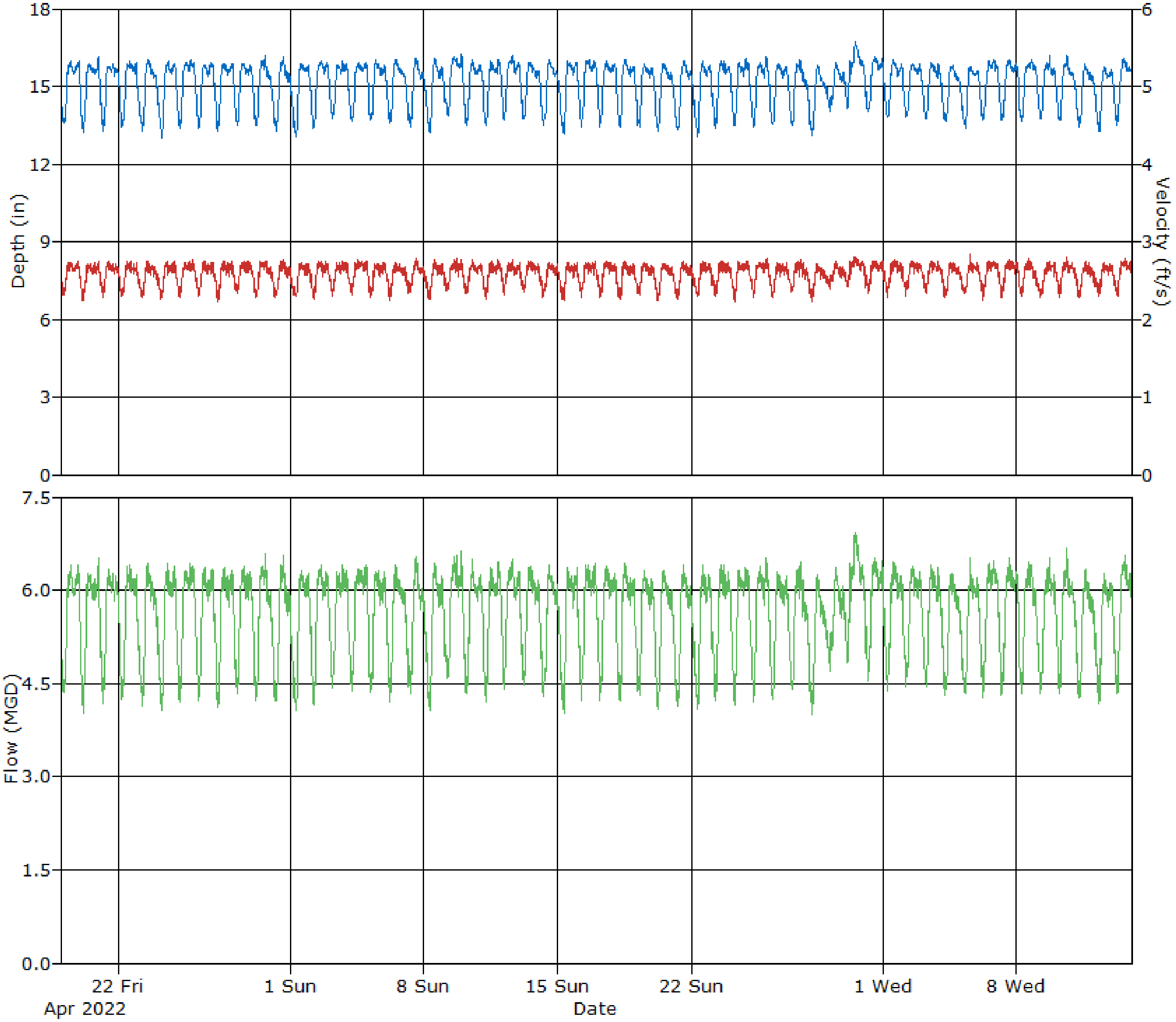


Report Period

4/19/2022
To
6/13/2022

Legend

- Depth
- Velocity
- Quantity



ADS ENVIRONMENTAL SERVICES

Daily Tabular Report For The Period 04/19/2022 00:00 - 06/13/2022 23:59

CW20b, Pipe Height: 47.75 in, Silt: 0.00 in

Daily Tabular Report

Date	Depth (in)					Velocity (ft/s)					Quantity (MGD - Total MG)						Rain (in)
	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Total	Total
04/19/2022	05:05	13.57	13:35	16.00	15.18	03:20	2.29	21:55	2.79	2.60	04:00	4.295	21:55	6.451	5.697	5.697	
04/20/2022	04:45	13.16	23:40	16.18	15.12	04:00	2.18	23:35	2.75	2.57	04:40	3.934	23:35	6.551	5.617	5.617	
04/21/2022	05:50	13.26	00:05	16.06	15.11	05:40	2.28	10:35	2.78	2.59	05:40	4.144	12:00	6.398	5.657	5.657	
04/22/2022	04:35	13.41	15:10	15.97	15.14	04:05	2.26	15:05	2.77	2.58	04:20	4.182	15:05	6.487	5.649	5.649	
04/23/2022	06:50	13.26	14:35	16.03	14.97	06:40	2.23	12:20	2.79	2.56	06:40	4.073	13:55	6.478	5.503	5.503	
04/24/2022	07:25	12.99	15:20	15.96	14.96	05:40	2.23	14:15	2.80	2.57	07:50	4.009	14:15	6.525	5.526	5.526	
04/25/2022	05:55	13.35	19:30	16.03	15.18	06:10	2.23	21:55	2.78	2.59	06:10	4.167	18:50	6.503	5.693	5.693	
04/26/2022	05:20	13.39	20:55	15.96	15.14	06:35	2.27	23:10	2.81	2.59	06:35	4.190	23:10	6.527	5.658	5.658	
04/27/2022	05:50	13.28	23:55	15.95	15.10	05:20	2.19	14:30	2.79	2.58	05:55	4.023	14:35	6.463	5.615	5.615	
04/28/2022	05:45	13.48	00:00	15.93	15.17	06:20	2.29	20:50	2.80	2.60	05:30	4.294	13:40	6.440	5.689	5.689	
04/29/2022	05:40	13.47	17:10	16.22	15.12	05:35	2.24	17:05	2.80	2.58	05:35	4.160	17:05	6.692	5.642	5.642	
04/30/2022	07:20	13.27	15:35	16.14	14.97	05:55	2.22	16:00	2.79	2.56	05:55	4.101	16:00	6.589	5.514	5.514	
05/01/2022	07:20	13.04	14:05	15.87	14.92	08:30	2.24	20:50	2.81	2.56	08:30	4.008	20:50	6.414	5.494	5.494	
05/02/2022	04:50	13.37	15:30	16.00	15.14	07:15	2.23	20:15	2.81	2.59	06:10	4.147	14:20	6.504	5.661	5.661	
05/03/2022	05:35	13.76	18:05	15.97	15.22	04:45	2.28	12:15	2.79	2.59	05:35	4.371	18:05	6.508	5.708	5.708	
05/04/2022	05:10	13.64	23:10	15.94	15.18	05:10	2.30	12:20	2.82	2.61	05:10	4.343	12:20	6.481	5.720	5.720	
05/05/2022	04:45	13.71	12:10	16.03	15.22	05:30	2.23	00:45	2.78	2.59	05:30	4.273	00:45	6.428	5.701	5.701	
05/06/2022	05:50	13.58	12:40	16.05	15.16	05:50	2.17	12:10	2.76	2.57	05:50	4.063	12:40	6.513	5.628	5.628	
05/07/2022	07:05	13.44	13:05	16.09	15.03	03:50	2.28	13:50	2.81	2.58	07:15	4.290	13:50	6.614	5.581	5.581	
05/08/2022	07:30	13.18	14:05	16.07	14.98	07:30	2.21	12:55	2.79	2.56	07:30	3.972	14:30	6.511	5.521	5.521	
05/09/2022	06:40	13.84	23:00	16.26	15.33	05:20	2.35	14:10	2.81	2.60	06:30	4.544	23:00	6.660	5.779	5.779	
05/10/2022	05:20	13.45	00:00	16.07	15.16	04:50	2.31	13:20	2.78	2.59	05:05	4.304	13:20	6.544	5.675	5.675	
05/11/2022	05:50	13.48	21:15	16.07	15.21	06:05	2.22	22:00	2.81	2.59	06:05	4.119	22:00	6.607	5.707	5.707	
05/12/2022	04:35	13.68	14:45	16.18	15.37	04:40	2.29	15:20	2.80	2.60	04:40	4.339	14:40	6.666	5.805	5.805	
05/13/2022	05:55	13.74	11:10	15.95	15.20	05:50	2.33	14:25	2.80	2.60	05:50	4.445	14:25	6.503	5.718	5.718	
05/14/2022	06:50	13.48	13:25	16.04	15.08	05:25	2.22	11:45	2.77	2.57	05:25	4.201	13:15	6.479	5.595	5.595	
05/15/2022	07:50	13.17	12:35	15.97	15.02	06:30	2.19	23:35	2.77	2.56	07:45	3.965	23:35	6.481	5.538	5.538	
05/16/2022	05:30	13.43	15:30	16.02	15.24	05:20	2.27	23:10	2.77	2.60	05:20	4.204	22:00	6.470	5.728	5.728	
05/17/2022	05:00	13.42	13:20	16.01	15.19	05:00	2.26	14:15	2.77	2.59	05:00	4.157	13:20	6.490	5.694	5.694	
05/18/2022	06:35	13.43	12:55	16.05	15.18	05:30	2.21	11:30	2.77	2.58	05:30	4.101	14:10	6.478	5.656	5.656	
05/19/2022	06:50	13.44	13:10	15.86	15.08	07:10	2.26	16:50	2.77	2.57	07:10	4.238	12:40	6.383	5.593	5.593	
05/20/2022	06:00	13.28	12:55	15.91	14.99	06:25	2.20	11:45	2.76	2.56	06:05	4.020	11:45	6.369	5.516	5.516	
05/21/2022	07:05	13.32	13:55	15.98	14.94	05:40	2.24	13:30	2.78	2.56	07:15	4.089	13:30	6.508	5.491	5.491	
05/22/2022	07:05	13.06	13:50	15.99	14.95	07:50	2.24	14:35	2.78	2.57	07:50	4.046	14:35	6.484	5.522	5.522	
05/23/2022	05:40	13.37	13:50	16.00	15.14	05:30	2.25	14:45	2.78	2.58	05:30	4.138	17:00	6.503	5.644	5.644	
05/24/2022	05:50	13.48	19:50	16.13	15.14	05:05	2.20	10:55	2.77	2.59	06:00	4.095	19:40	6.496	5.662	5.662	
05/25/2022	06:05	13.41	22:10	16.15	15.14	06:05	2.26	21:55	2.81	2.61	06:05	4.163	21:55	6.653	5.700	5.700	
05/26/2022	05:30	13.49	15:15	15.88	15.12	05:15	2.22	16:40	2.79	2.58	05:15	4.172	16:40	6.406	5.630	5.630	
05/27/2022	07:05	13.51	16:10	16.08	15.07	04:20	2.30	16:55	2.79	2.59	07:05	4.346	16:55	6.500	5.622	5.622	
05/28/2022	07:35	13.13	14:00	15.81	14.73	07:40	2.22	13:30	2.76	2.53	07:40	3.974	13:30	6.351	5.330	5.330	
05/29/2022	06:10	14.03	13:10	15.97	15.09	05:15	2.37	12:45	2.77	2.59	06:05	4.660	13:35	6.402	5.616	5.616	
05/30/2022	03:35	14.12	14:00	16.74	15.72	04:15	2.37	15:40	2.84	2.66	04:15	4.742	14:15	7.019	6.116	6.116	
05/31/2022	05:55	13.96	14:20	16.13	15.37	06:00	2.29	11:45	2.80	2.61	06:00	4.462	11:45	6.603	5.835	5.835	
06/01/2022	06:05	13.78	13:05	16.04	15.21	05:35	2.25	13:50	2.80	2.60	06:05	4.336	13:50	6.522	5.728	5.728	
06/02/2022	05:30	13.82	13:25	15.90	15.19	05:10	2.24	11:45	2.77	2.60	05:10	4.336	13:50	6.424	5.717	5.717	
06/03/2022	06:10	13.74	12:35	15.95	15.14	05:40	2.29	13:05	2.79	2.61	06:25	4.387	13:05	6.472	5.696	5.696	

Date	Depth (in)					Velocity (ft/s)					Quantity (MGD - Total MG)						Rain (in)
	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Total	Total
06/04/2022	07:35	13.64	15:45	15.87	14.96	06:20	2.24	13:20	2.75	2.57	06:20	4.265	16:35	6.322	5.517	5.517	
06/05/2022	08:05	13.37	14:05	15.77	14.92	05:55	2.30	13:20	2.89	2.57	05:55	4.281	13:20	6.639	5.515	5.515	
06/06/2022	05:55	13.69	18:40	16.05	15.20	05:55	2.22	21:55	2.78	2.60	05:55	4.213	20:05	6.551	5.716	5.716	
06/07/2022	04:50	13.72	14:20	16.03	15.21	06:00	2.24	14:15	2.82	2.60	05:10	4.286	14:15	6.628	5.718	5.718	
06/08/2022	06:20	13.63	19:10	16.06	15.24	06:00	2.26	00:35	2.81	2.59	06:00	4.276	14:20	6.497	5.708	5.708	
06/09/2022	04:45	13.68	17:10	16.19	15.19	05:05	2.22	22:25	2.79	2.56	04:50	4.294	17:00	6.602	5.620	5.620	
06/10/2022	06:40	13.71	14:40	16.22	15.15	05:05	2.26	15:05	2.83	2.60	05:05	4.305	15:05	6.747	5.699	5.699	
06/11/2022	06:55	13.44	13:55	15.86	14.93	05:05	2.23	18:40	2.82	2.56	06:10	4.177	14:45	6.368	5.485	5.485	
06/12/2022	07:40	13.25	13:40	15.78	14.88	07:30	2.29	12:45	2.76	2.57	07:30	4.145	13:40	6.320	5.480	5.480	
06/13/2022	05:50	13.49	14:20	16.06	15.16	07:05	2.26	16:10	2.83	2.60	07:05	4.276	16:10	6.648	5.704	5.700	

Report Summary For The Period 04/19/2022 00:00 - 06/13/2022 23:59

	Depth (in)	Velocity (ft/s)	Quantity (MGD - Total MG)
Total			315.947
Avg	15.12	2.58	5.642

APPENDIX C

Collection System Diurnal Flow Curves

Meter Location: CW-01

Time	Peak Factor
12:00 AM	1.184
1:00 AM	0.898
2:00 AM	0.644
3:00 AM	0.499
4:00 AM	0.425
5:00 AM	0.406
6:00 AM	0.411
7:00 AM	0.495
8:00 AM	0.78
9:00 AM	1.109
10:00 AM	1.28
11:00 AM	1.311
12:00 PM	1.318
1:00 PM	1.257
2:00 PM	1.211
3:00 PM	1.143
4:00 PM	1.116
5:00 PM	1.112
6:00 PM	1.159
7:00 PM	1.213
8:00 PM	1.231
9:00 PM	1.249
10:00 PM	1.27
11:00 PM	1.279

Max PF: 1.318

Meter Location: CW-04

Time	Peak Factor
12:00 AM	0.918
1:00 AM	0.675
2:00 AM	0.527
3:00 AM	0.45
4:00 AM	0.431
5:00 AM	0.426
6:00 AM	0.445
7:00 AM	0.561
8:00 AM	0.832
9:00 AM	1.136
10:00 AM	1.364
11:00 AM	1.418
12:00 PM	1.421
1:00 PM	1.372
2:00 PM	1.289
3:00 PM	1.228
4:00 PM	1.149
5:00 PM	1.121
6:00 PM	1.137
7:00 PM	1.172
8:00 PM	1.217
9:00 PM	1.254
10:00 PM	1.28
11:00 PM	1.177

Max PF: 1.421

Meter Location: CW-05

Time	Peak Factor
12:00 AM	0.854
1:00 AM	0.661
2:00 AM	0.526
3:00 AM	0.5
4:00 AM	0.54
5:00 AM	0.6
6:00 AM	0.63
7:00 AM	0.795
8:00 AM	0.975
9:00 AM	1.144
10:00 AM	1.231
11:00 AM	1.24
12:00 PM	1.26
1:00 PM	1.24
2:00 PM	1.23
3:00 PM	1.217
4:00 PM	1.203
5:00 PM	1.16
6:00 PM	1.18
7:00 PM	1.2
8:00 PM	1.2
9:00 PM	1.18
10:00 PM	1.17
11:00 PM	1.06

Max PF: 1.26

Meter Location: CW-07

Time	Peak Factor
12:00 AM	1.04
1:00 AM	0.911
2:00 AM	0.837
3:00 AM	0.797
4:00 AM	0.769
5:00 AM	0.764
6:00 AM	0.811
7:00 AM	0.906
8:00 AM	0.993
9:00 AM	1.042
10:00 AM	1.065
11:00 AM	1.07
12:00 PM	1.075
1:00 PM	1.08
2:00 PM	1.085
3:00 PM	1.09
4:00 PM	1.095
5:00 PM	1.095
6:00 PM	1.09
7:00 PM	1.085
8:00 PM	1.08
9:00 PM	1.075
10:00 PM	1.07
11:00 PM	1.065

Max PF: 1.095

Meter Location: CW-08

Time	Peak Factor
12:00 AM	1.036
1:00 AM	0.768
2:00 AM	0.45
3:00 AM	0.4
4:00 AM	0.39
5:00 AM	0.38
6:00 AM	0.4
7:00 AM	0.45
8:00 AM	0.794
9:00 AM	1.01
10:00 AM	1.16
11:00 AM	1.3
12:00 PM	1.425
1:00 PM	1.3
2:00 PM	1.25
3:00 PM	1.2
4:00 PM	1.2
5:00 PM	1.2
6:00 PM	1.2
7:00 PM	1.28
8:00 PM	1.3
9:00 PM	1.5
10:00 PM	1.35
11:00 PM	1.25

Max PF: 1.5

Meter Location: CW-09

Time	Peak Factor
12:00 AM	0.973
1:00 AM	0.911
2:00 AM	0.837
3:00 AM	0.797
4:00 AM	0.769
5:00 AM	0.764
6:00 AM	0.811
7:00 AM	0.906
8:00 AM	0.993
9:00 AM	1.042
10:00 AM	1.085
11:00 AM	1.093
12:00 PM	1.107
1:00 PM	1.118
2:00 PM	1.113
3:00 PM	1.09
4:00 PM	1.079
5:00 PM	1.059
6:00 PM	1.064
7:00 PM	1.072
8:00 PM	1.083
9:00 PM	1.082
10:00 PM	1.086
11:00 PM	1.064

Max PF: 1.118

Meter Location: CW-10

Time	Peak Factor
12:00 AM	0.862
1:00 AM	0.593
2:00 AM	0.413
3:00 AM	0.396
4:00 AM	0.382
5:00 AM	0.417
6:00 AM	0.549
7:00 AM	0.795
8:00 AM	1.093
9:00 AM	1.221
10:00 AM	1.279
11:00 AM	1.333
12:00 PM	1.302
1:00 PM	1.266
2:00 PM	1.231
3:00 PM	1.177
4:00 PM	1.173
5:00 PM	1.199
6:00 PM	1.22
7:00 PM	1.228
8:00 PM	1.255
9:00 PM	1.291
10:00 PM	1.229
11:00 PM	1.096

Max PF: 1.333

Meter Location: CW-11

Time	Peak Factor
12:00 AM	0.845
1:00 AM	0.6
2:00 AM	0.5
3:00 AM	0.4
4:00 AM	0.45
5:00 AM	0.5
6:00 AM	0.622
7:00 AM	0.873
8:00 AM	1.081
9:00 AM	1.25
10:00 AM	1.4
11:00 AM	1.3
12:00 PM	1.207
1:00 PM	1.182
2:00 PM	1.161
3:00 PM	1.119
4:00 PM	1.12
5:00 PM	1.142
6:00 PM	1.184
7:00 PM	1.214
8:00 PM	1.237
9:00 PM	1.253
10:00 PM	1.245
11:00 PM	1.117

Max PF: 1.4

Meter Location: CW-12

Time	Peak Factor
12:00 AM	0.731
1:00 AM	0.445
2:00 AM	0.3
3:00 AM	0.29
4:00 AM	0.25
5:00 AM	0.3
6:00 AM	0.32
7:00 AM	0.7
8:00 AM	1.2
9:00 AM	1.55
10:00 AM	1.8
11:00 AM	1.45
12:00 PM	1.359
1:00 PM	1.086
2:00 PM	0.95
3:00 PM	0.9
4:00 PM	0.85
5:00 PM	1
6:00 PM	1.189
7:00 PM	1.212
8:00 PM	1.371
9:00 PM	1.55
10:00 PM	1.7
11:00 PM	1.5

Max PF: 1.8

Meter Location: CW-17

Time	Peak Factor
12:00 AM	1.229
1:00 AM	0.878
2:00 AM	0.59
3:00 AM	0.4
4:00 AM	0.32
5:00 AM	0.36
6:00 AM	0.39
7:00 AM	0.532
8:00 AM	0.794
9:00 AM	1.053
10:00 AM	1.2
11:00 AM	1.295
12:00 PM	1.25
1:00 PM	1.2
2:00 PM	1.05
3:00 PM	1.05
4:00 PM	0.99
5:00 PM	0.99
6:00 PM	1.15
7:00 PM	1.2
8:00 PM	1.225
9:00 PM	1.5
10:00 PM	1.75
11:00 PM	1.6

Max PF: 1.75

Meter Location: CW-18

Time	Peak Factor
12:00 AM	1.229
1:00 AM	0.878
2:00 AM	0.59
3:00 AM	0.4
4:00 AM	0.32
5:00 AM	0.36
6:00 AM	0.39
7:00 AM	0.532
8:00 AM	0.794
9:00 AM	1.053
10:00 AM	1.227
11:00 AM	1.295
12:00 PM	1.267
1:00 PM	1.249
2:00 PM	1.168
3:00 PM	1.113
4:00 PM	1.106
5:00 PM	1.104
6:00 PM	1.135
7:00 PM	1.216
8:00 PM	1.249
9:00 PM	1.323
10:00 PM	1.55
11:00 PM	1.45

Max PF: 1.55

Meter Location: CW-20B

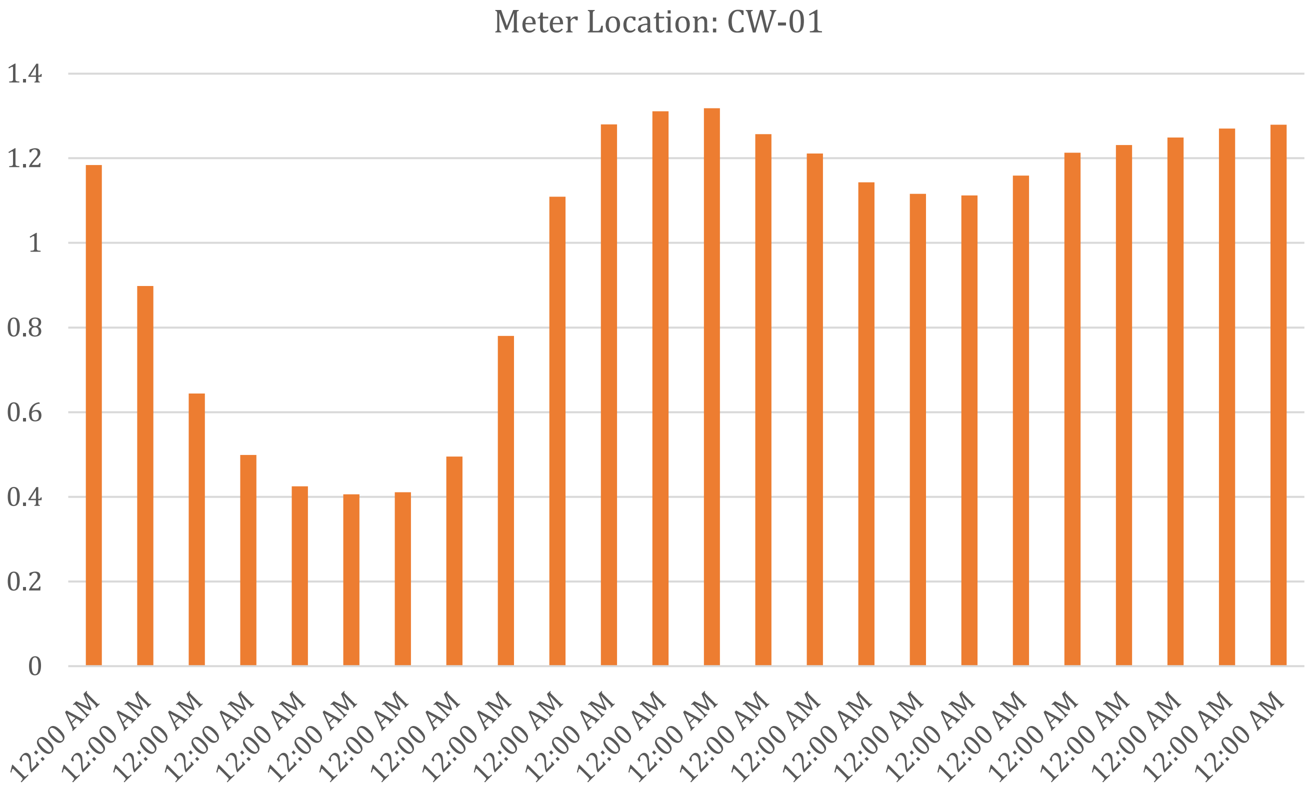
Time	Peak Factor
12:00 AM	1.071
1:00 AM	0.983
2:00 AM	0.889
3:00 AM	0.775
4:00 AM	0.669
5:00 AM	0.632
6:00 AM	0.619
7:00 AM	0.645
8:00 AM	0.768
9:00 AM	0.906
10:00 AM	1.045
11:00 AM	1.141
12:00 PM	1.177
1:00 PM	1.176
2:00 PM	1.214
3:00 PM	1.207
4:00 PM	1.189
5:00 PM	1.162
6:00 PM	1.154
7:00 PM	1.121
8:00 PM	1.116
9:00 PM	1.123
10:00 PM	1.112
11:00 PM	1.104

Max PF: 1.214

Industrial

Time	Peak Factor
12:00 AM	1
1:00 AM	1
2:00 AM	1
3:00 AM	1
4:00 AM	1
5:00 AM	1
6:00 AM	1
7:00 AM	1
8:00 AM	1
9:00 AM	1
10:00 AM	1
11:00 AM	1
12:00 PM	1
1:00 PM	1
2:00 PM	1
3:00 PM	1
4:00 PM	1
5:00 PM	1
6:00 PM	1
7:00 PM	1
8:00 PM	1
9:00 PM	1
10:00 PM	1
11:00 PM	1

Max PF: 1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0.6
0.4
0.2
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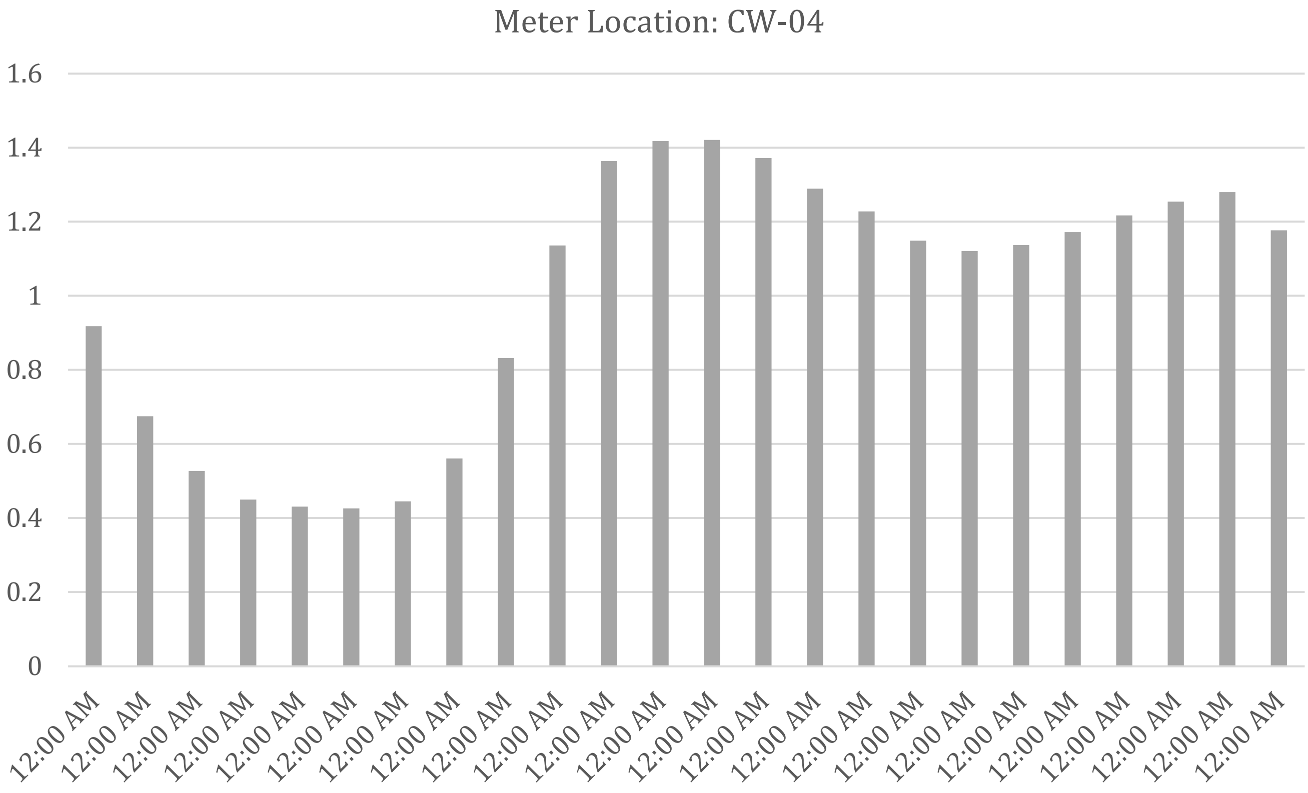
12:00 AM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0.4
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0
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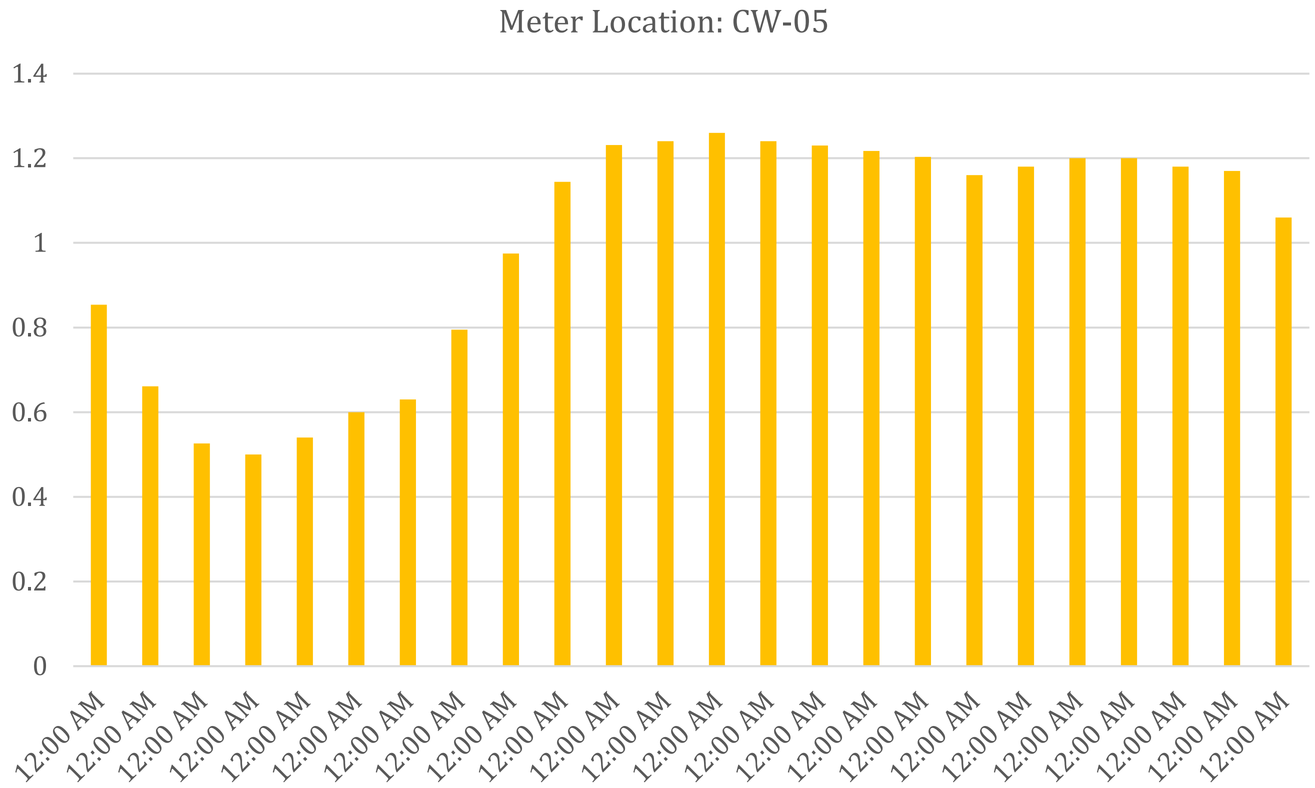
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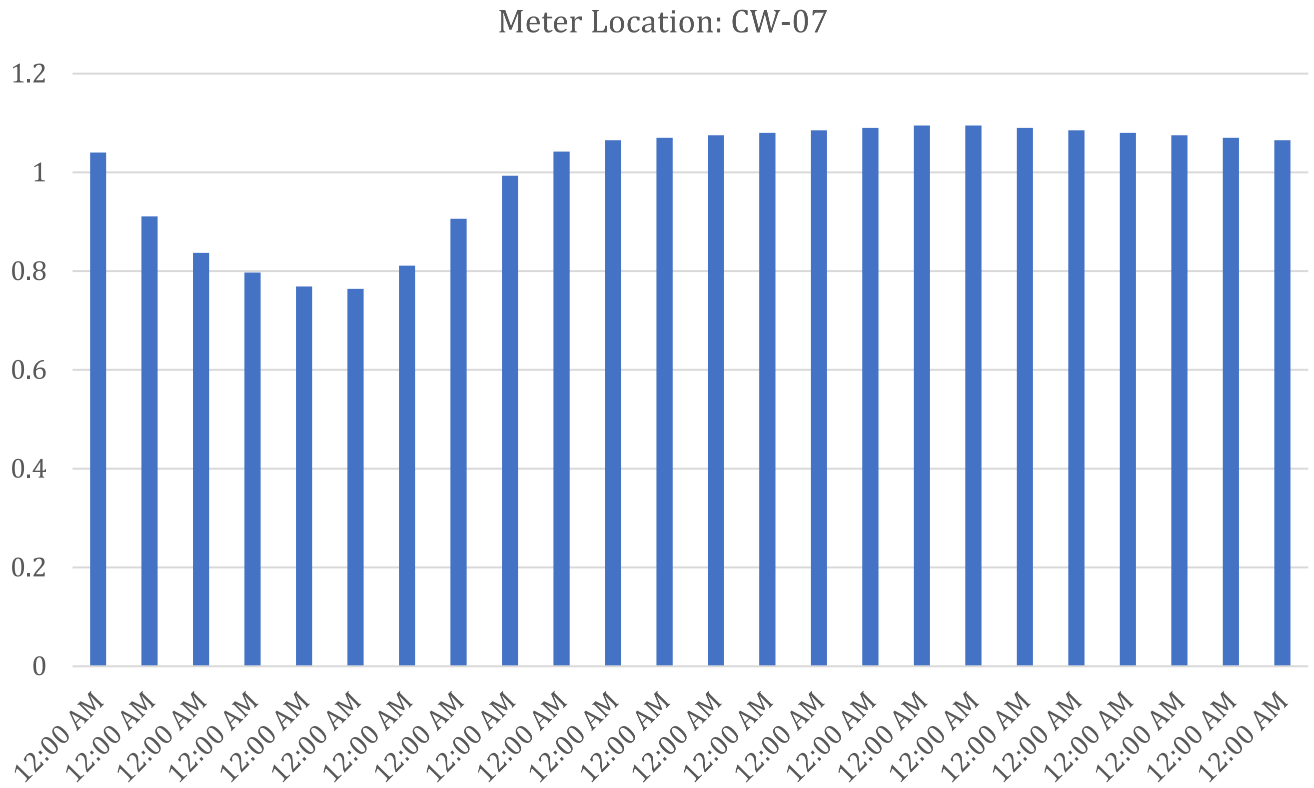
12:00 AM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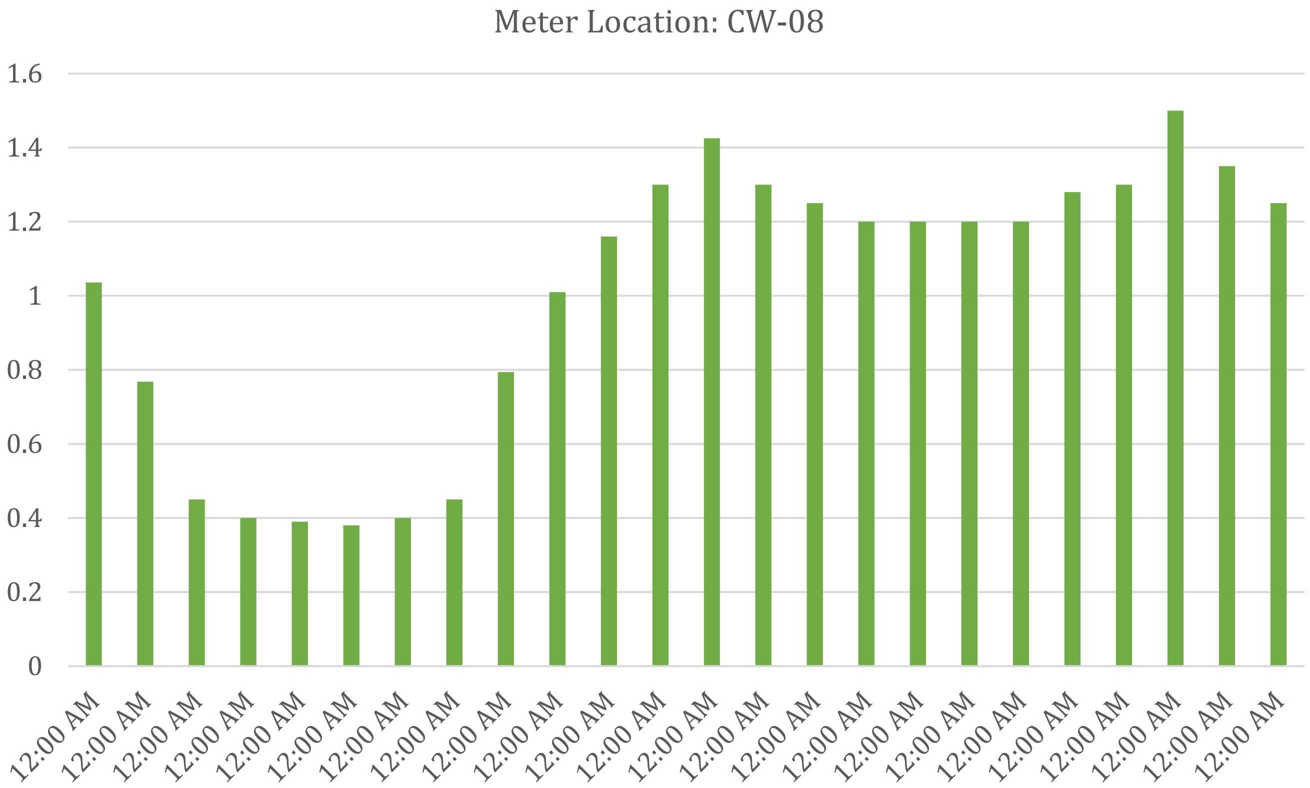
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0.4
0.2
0
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12:00 AM
12:00 AM
12:00 AM
12:00 AM
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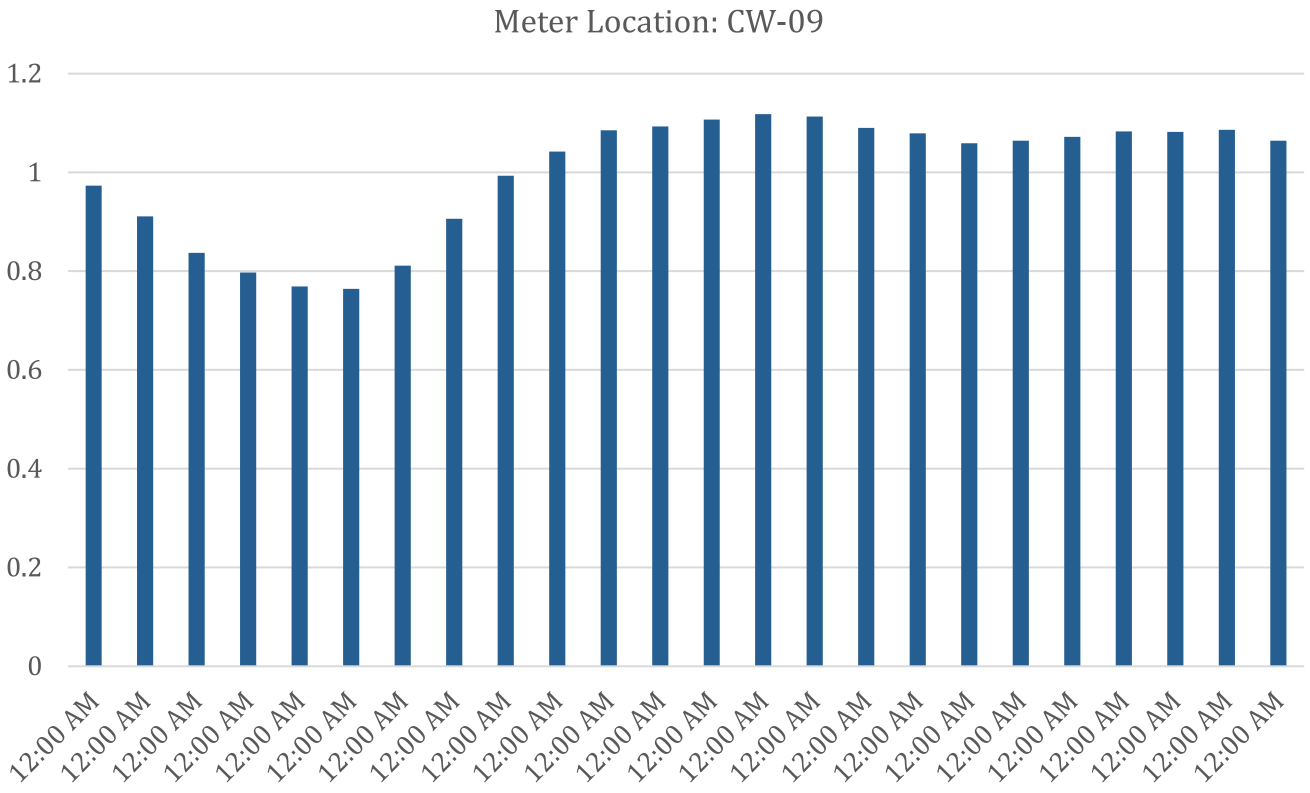
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12:00 AM
12:00 AM
12:00 AM
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12:00 AM
12:00 AM
12:00 AM
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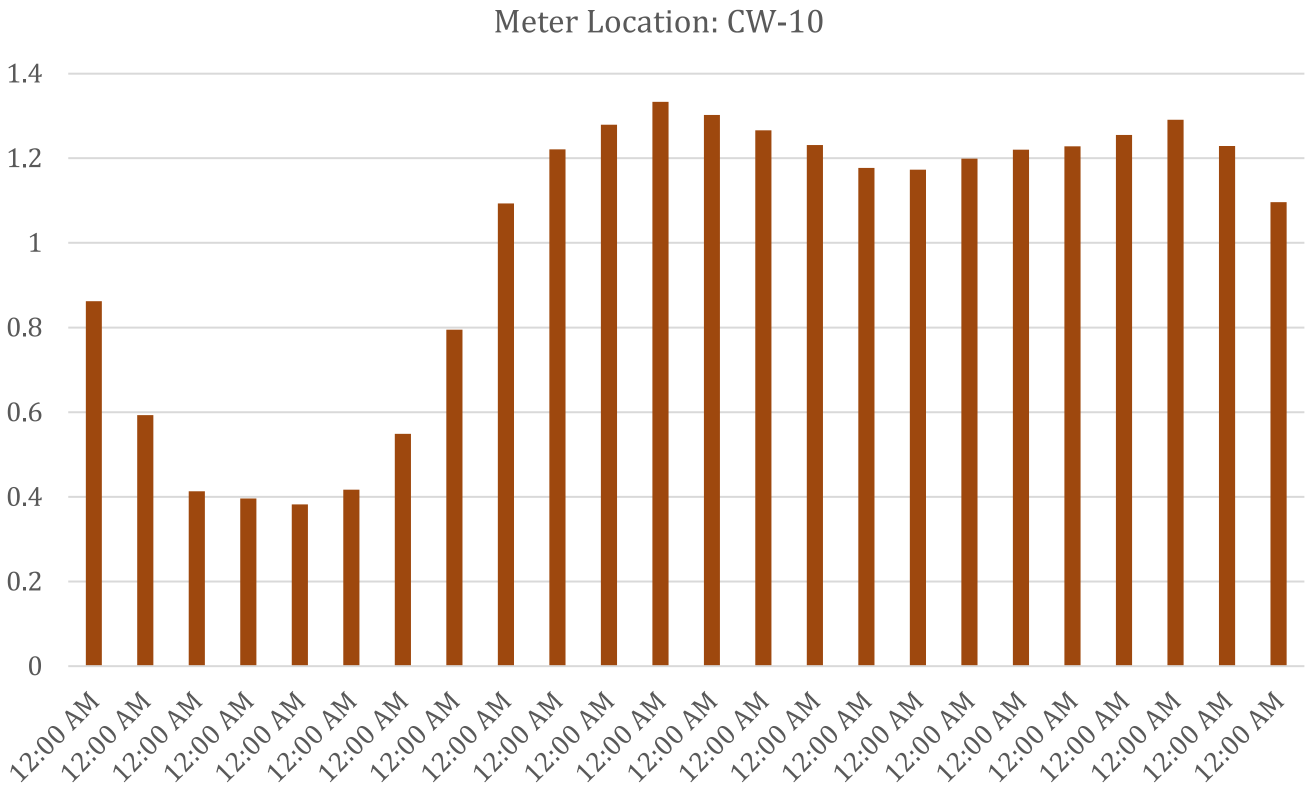
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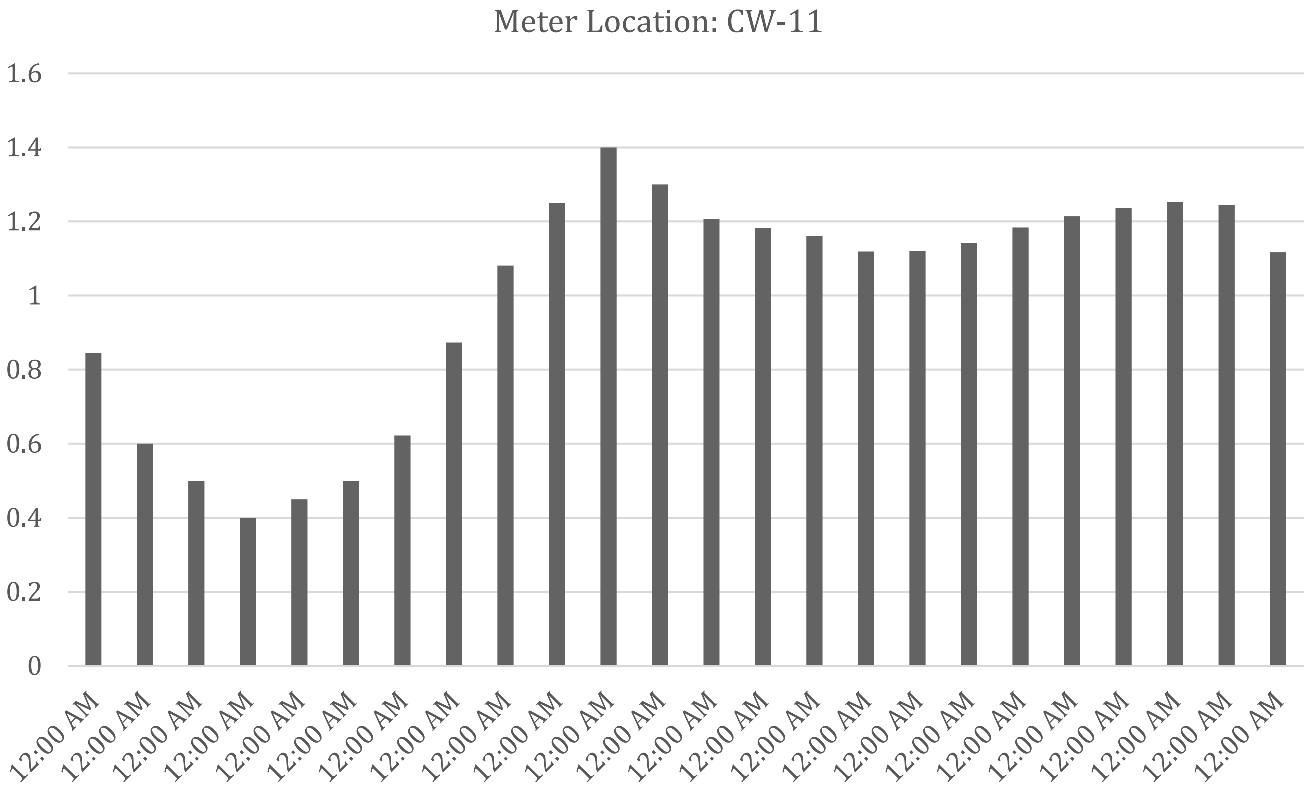
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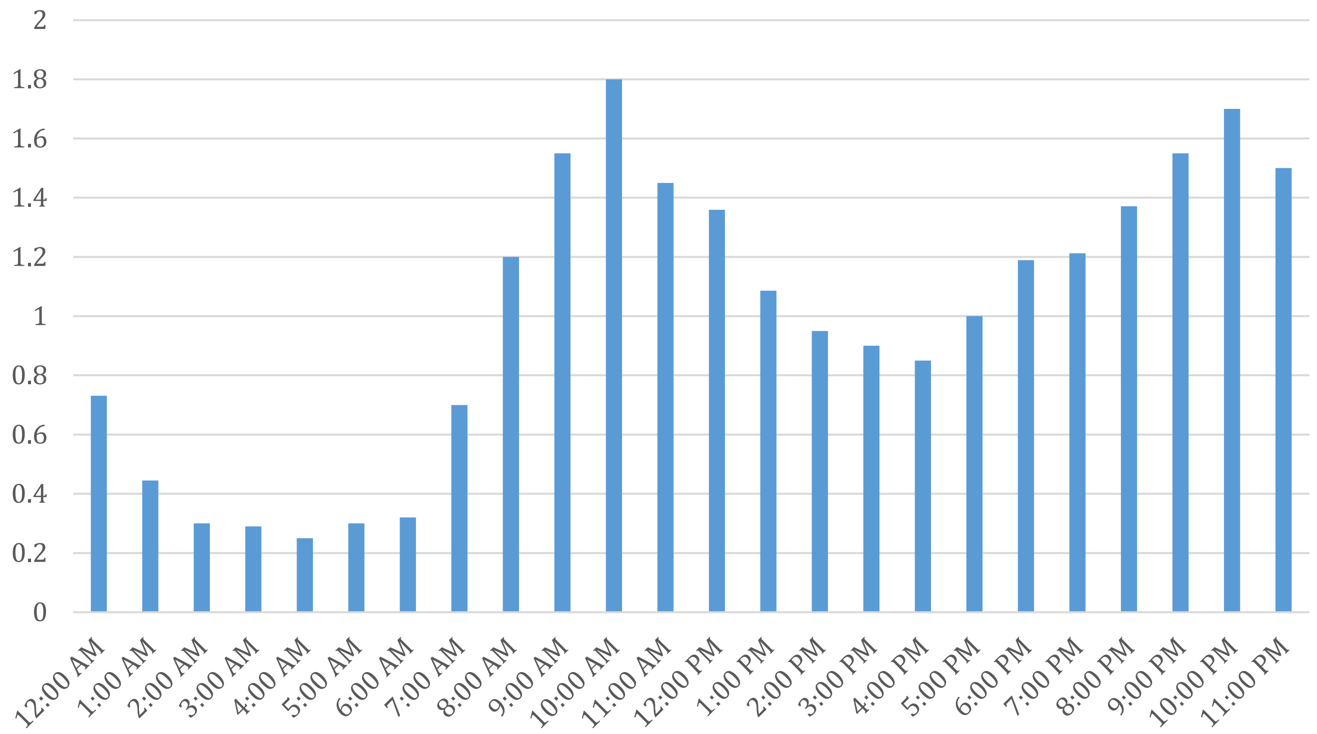
Meter Location: CW-12



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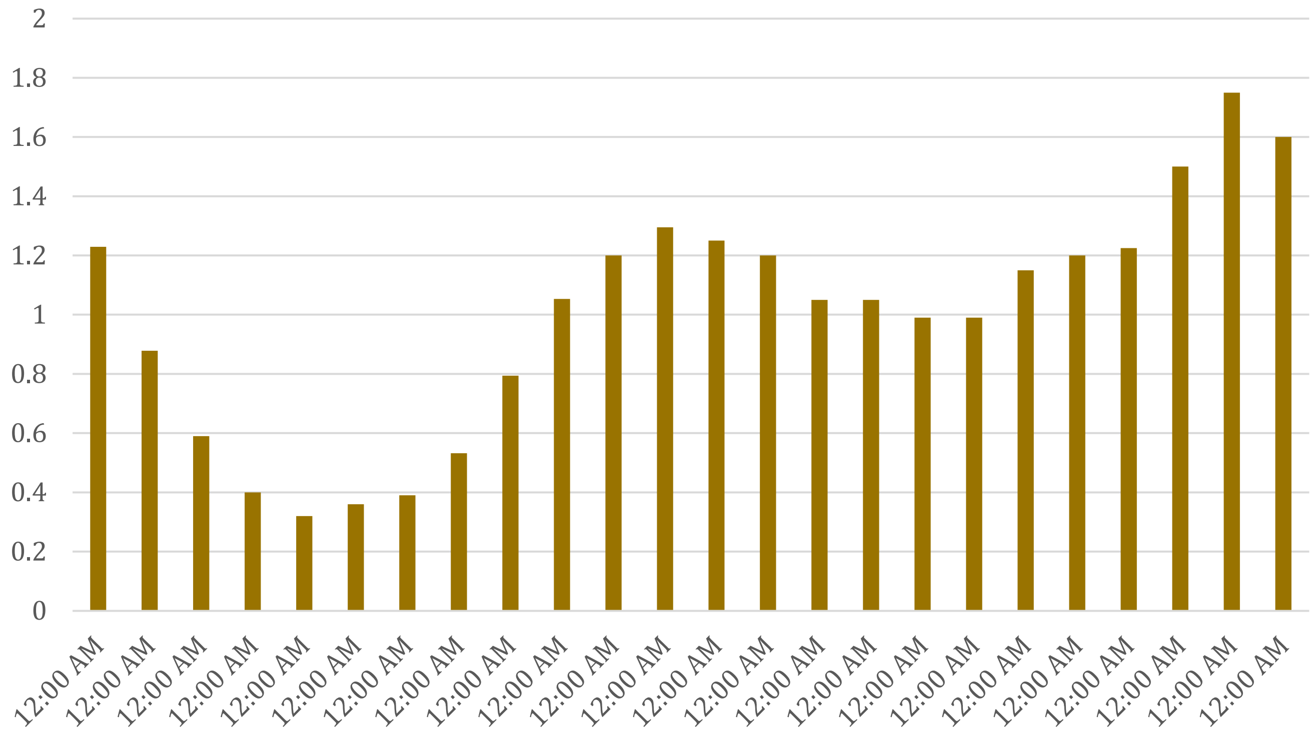

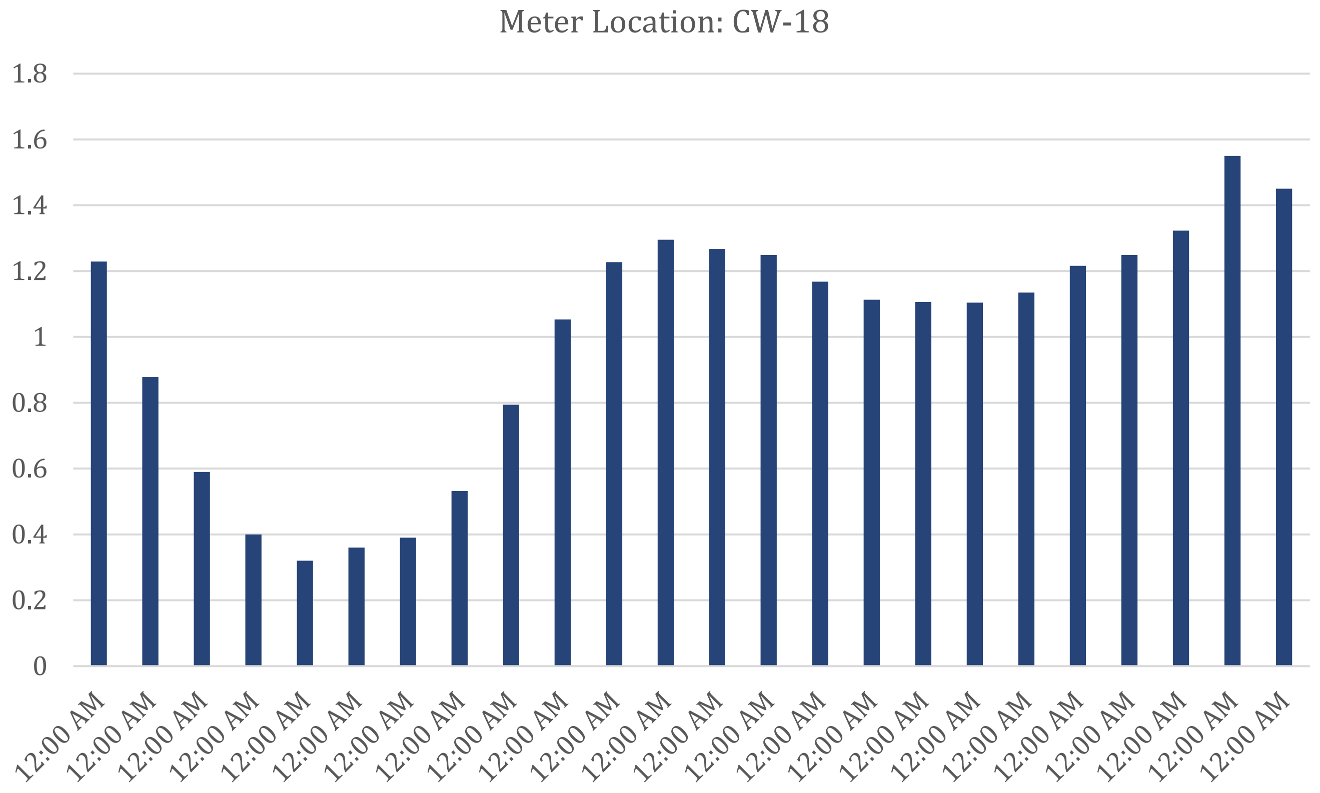
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12:00 AM
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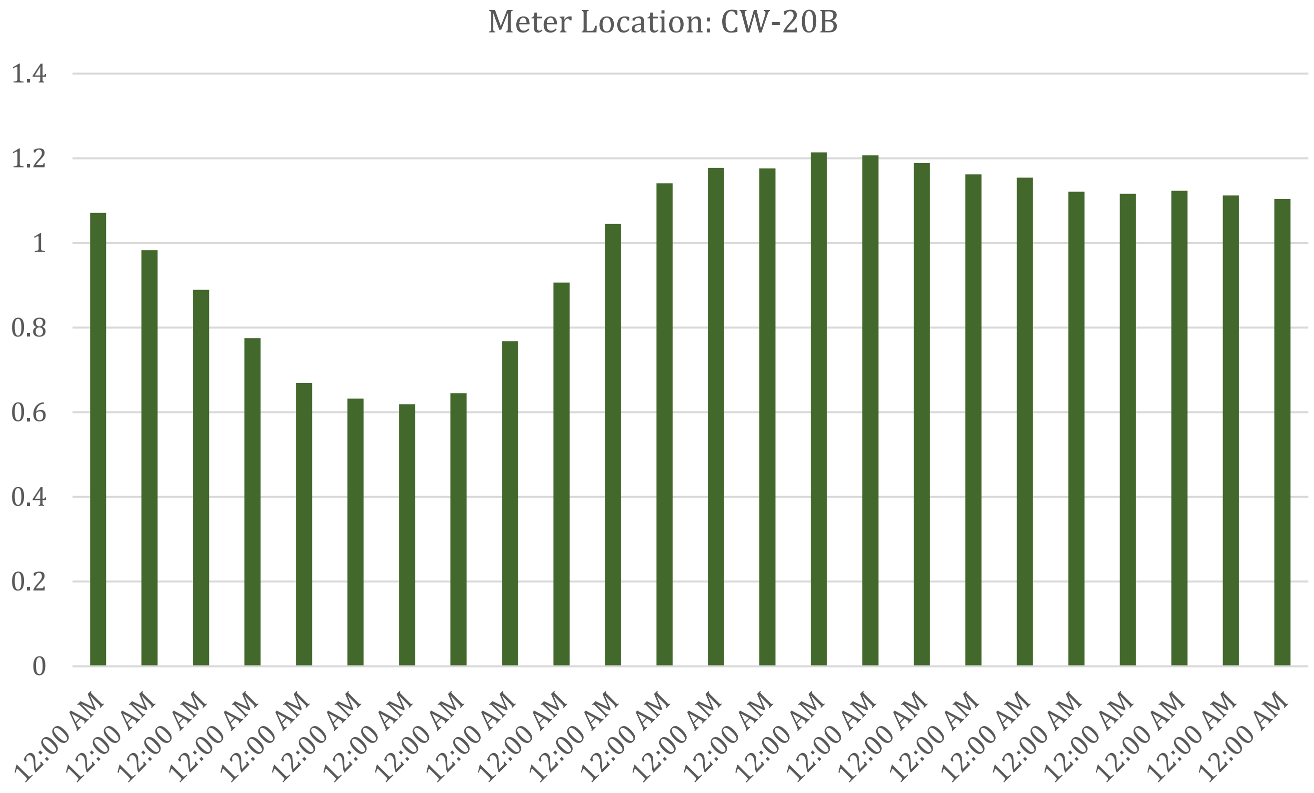
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12:00 AM
12:00 AM
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12:00 AM
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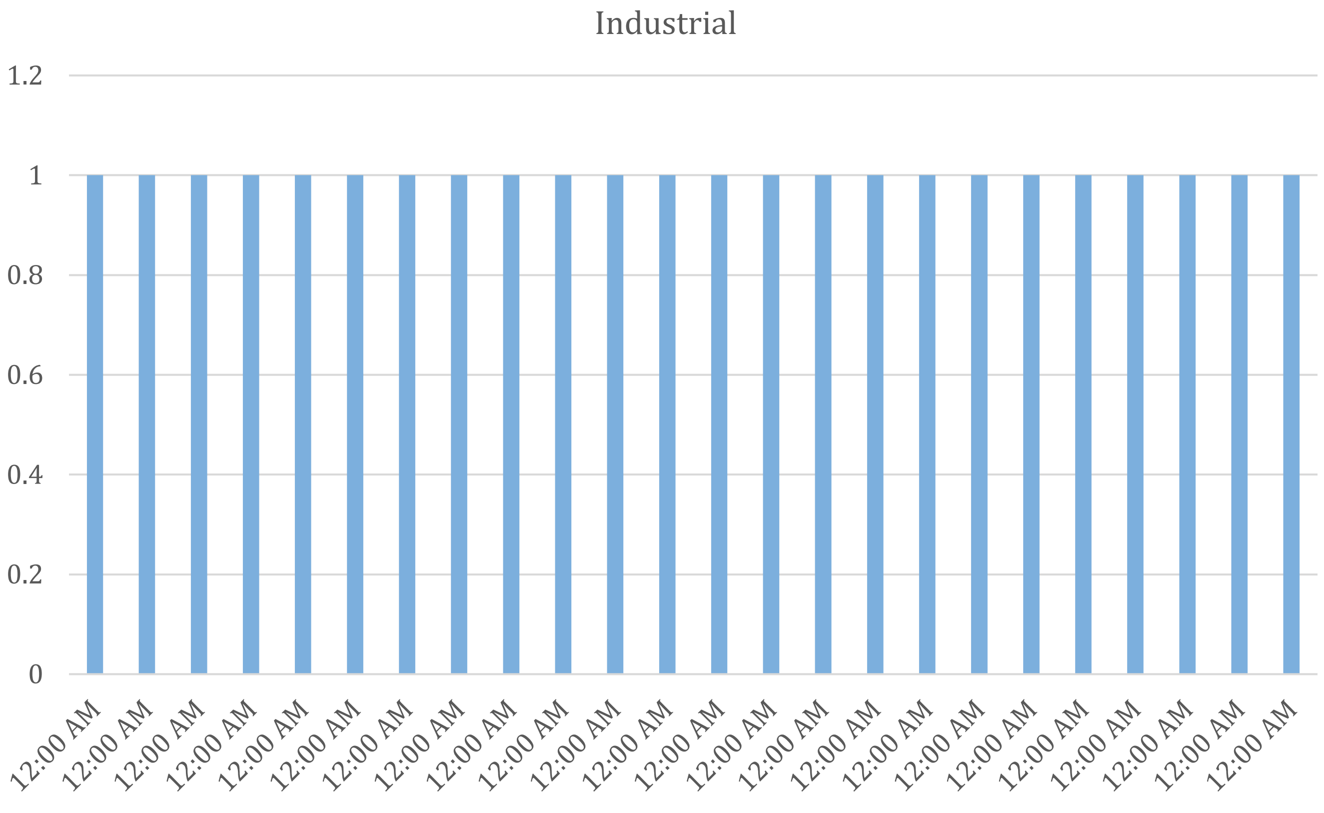
Industrial
1.2
1
0.8
0.6
0.4
0.2
0
12:00 AM
12:00 AM
12:00 AM
12:00 AM
12:00 AM
12:00 AM
12:00 AM
12:00 AM
12:00 AM
12:00 AM
12:00 AM
12:00 AM
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12:00 AM
12:00 AM
12:00 AM
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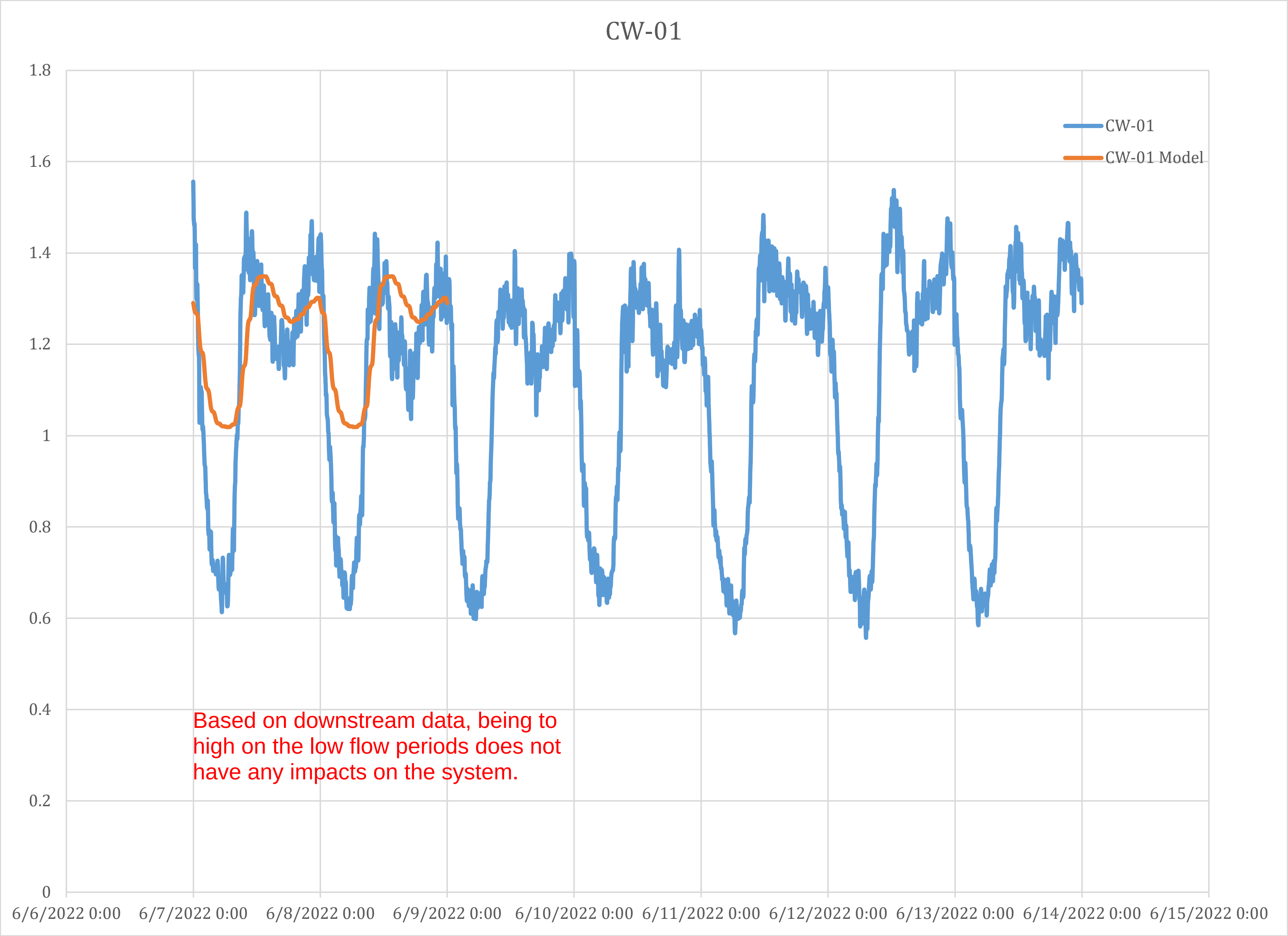
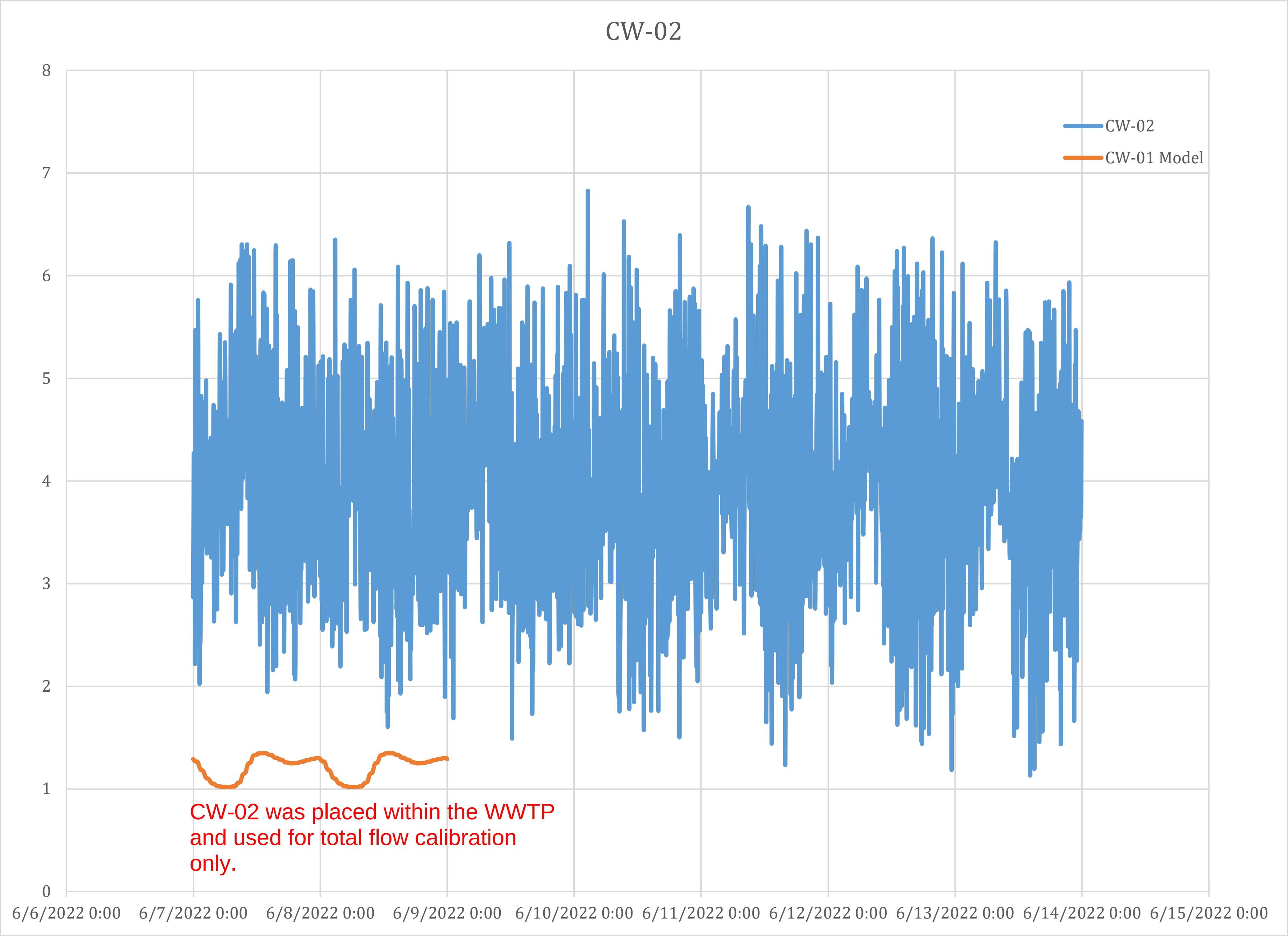
12:00 AM

APPENDIX D

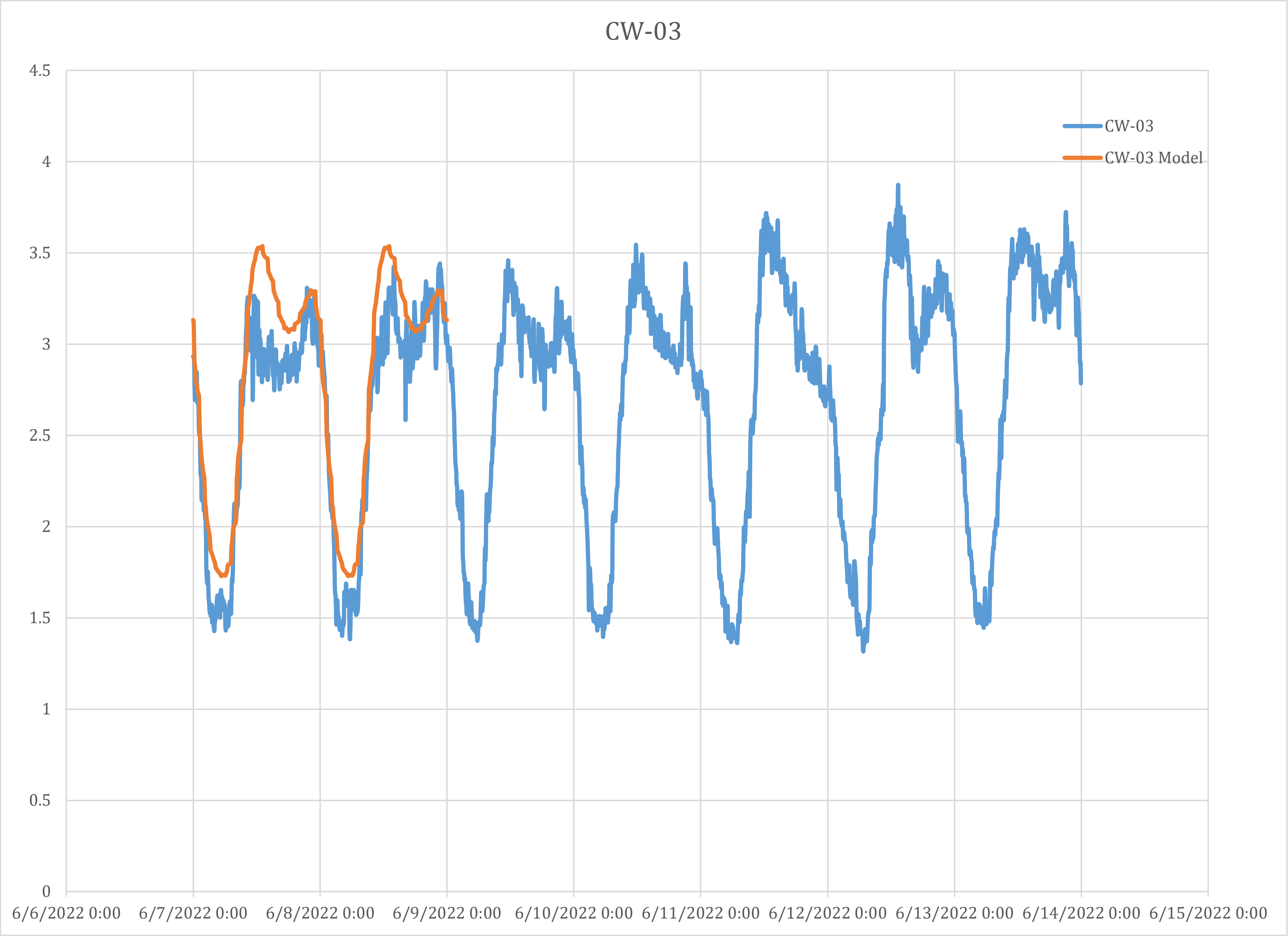
Model Calibration Results



Based on downstream data, being to high on the low flow periods does not have any impacts on the system.



CW-02 was placed within the WWTP and used for total flow calibration only.


CW-03
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4
3.5
3
2.5
2
1.5
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0.5
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6/6/2022 0:00
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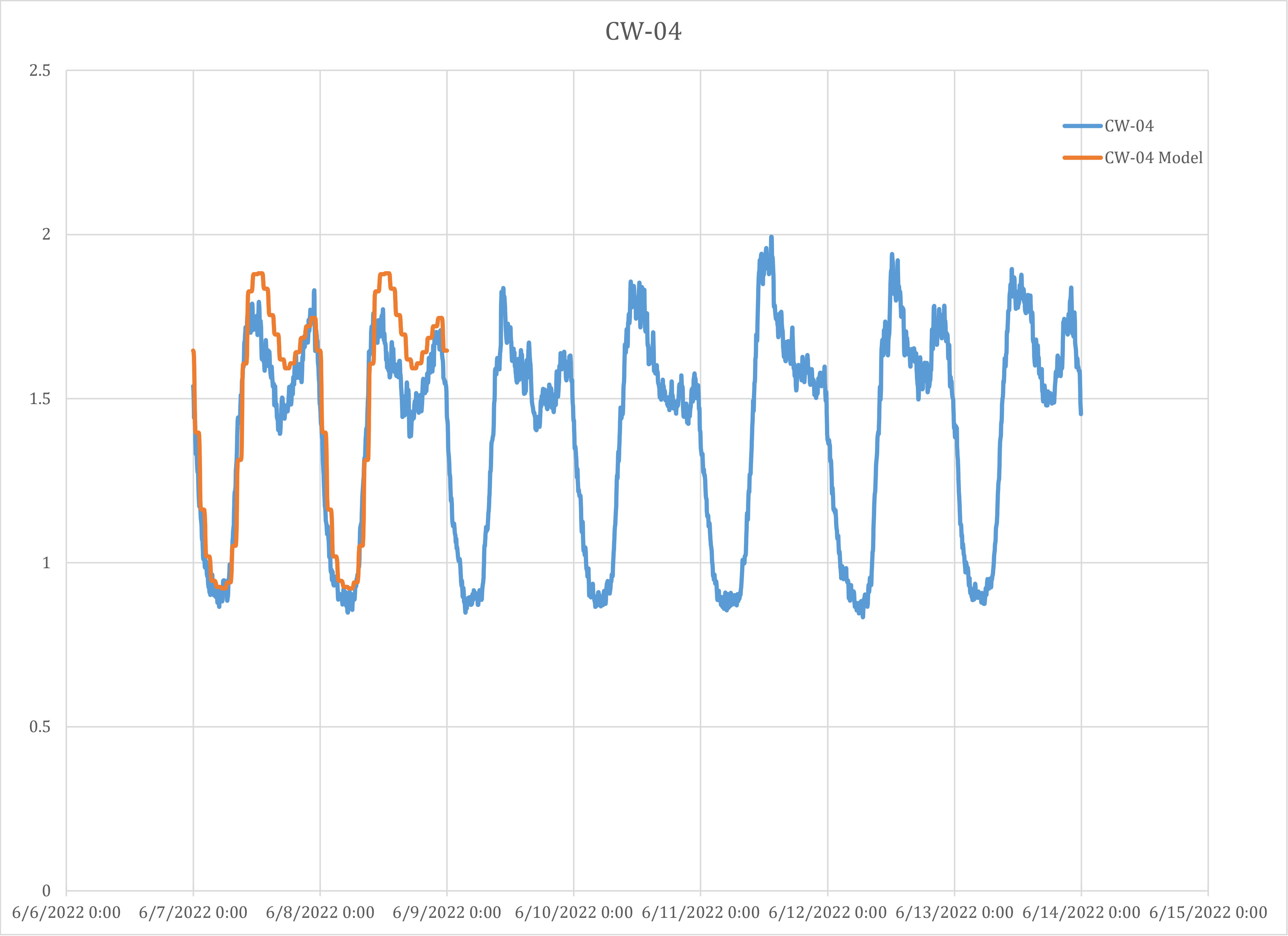
6/8/2022 0:00
6/9/2022 0:00
6/10/2022 0:00
6/11/2022 0:00
6/12/2022 0:00
6/13/2022 0:00
6/14/2022 0:00
6/15/2022 0:00
CW-03
CW-03 Model


CW-04
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1.5
1
0.5
0
6/6/2022 0:00
6/7/2022 0:00
6/8/2022 0:00
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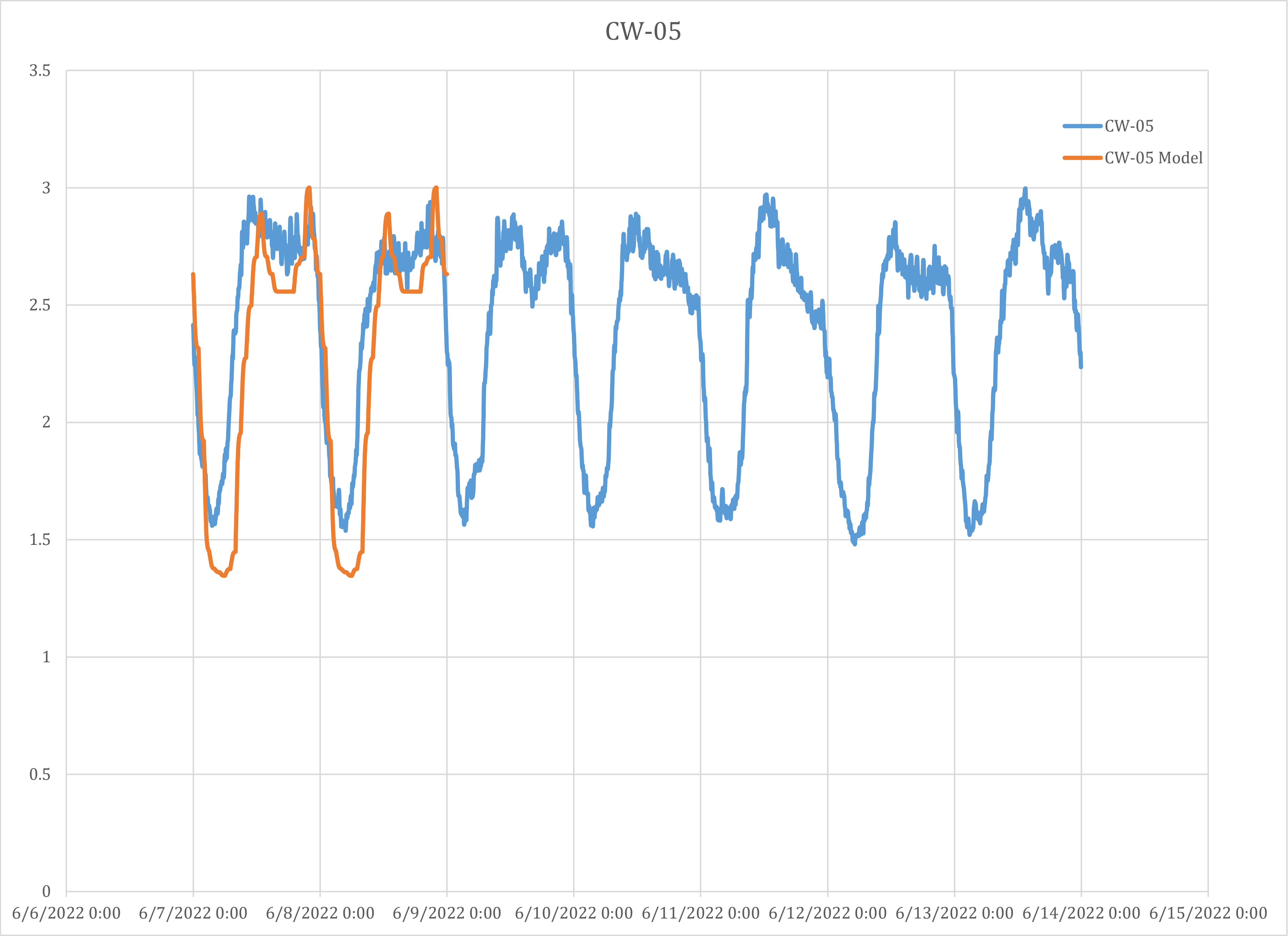
CW-04
CW-04 Model


CW-05
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6/6/2022 0:00
6/7/2022 0:00
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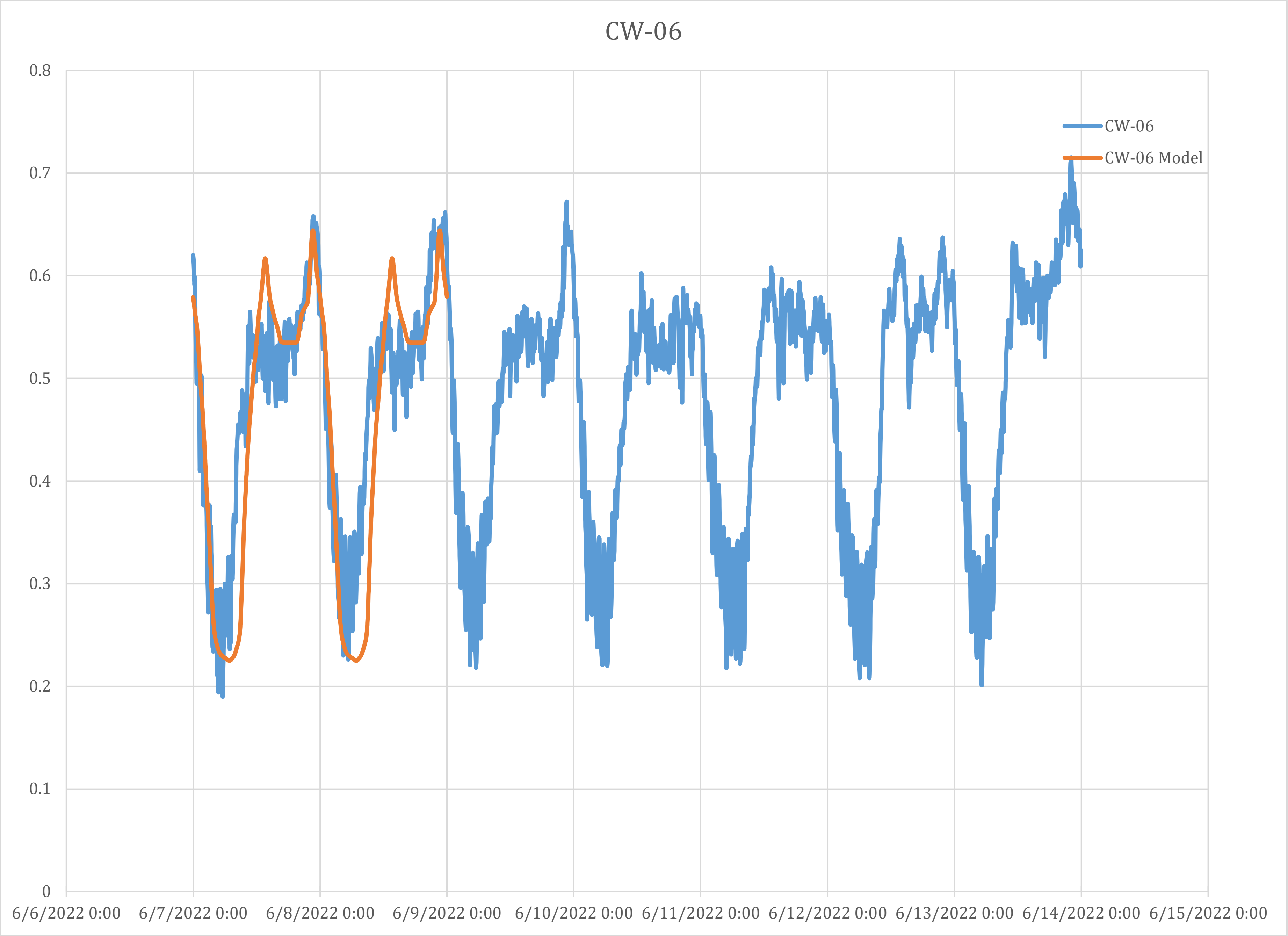
CW-05
CW-05 Model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6/8/2022 0:00
6/9/2022 0:00
6/10/2022 0:00
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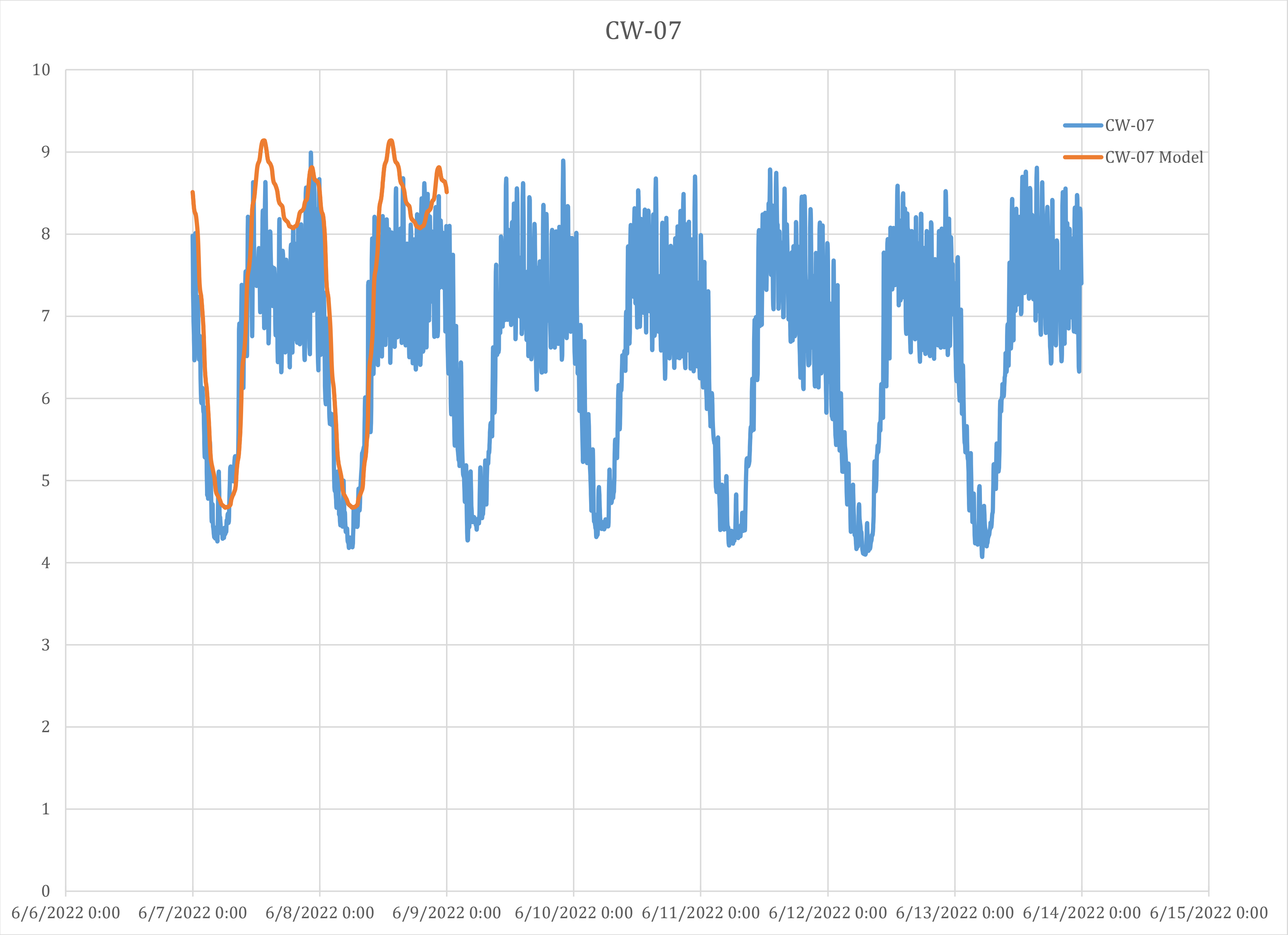
CW-06
CW-06 Model


CW-07
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9
8
7
6
5
4
3
2
1
0
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6/7/2022 0:00
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6/9/2022 0:00
6/10/2022 0:00
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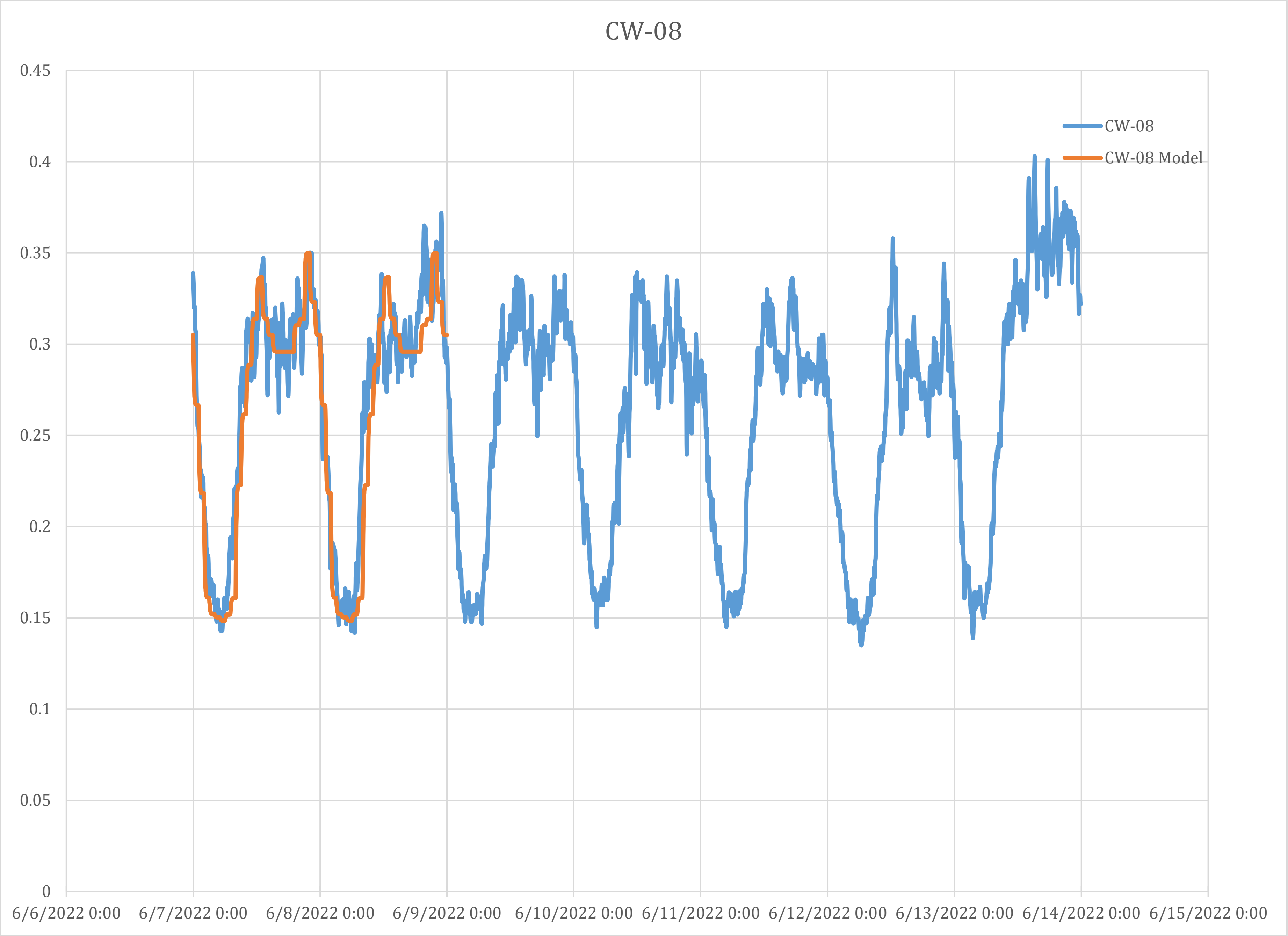
CW-07
CW-07 Model


CW-08
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0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
6/6/2022 0:00
6/7/2022 0:00
6/8/2022 0:00
6/9/2022 0:00
6/10/2022 0:00
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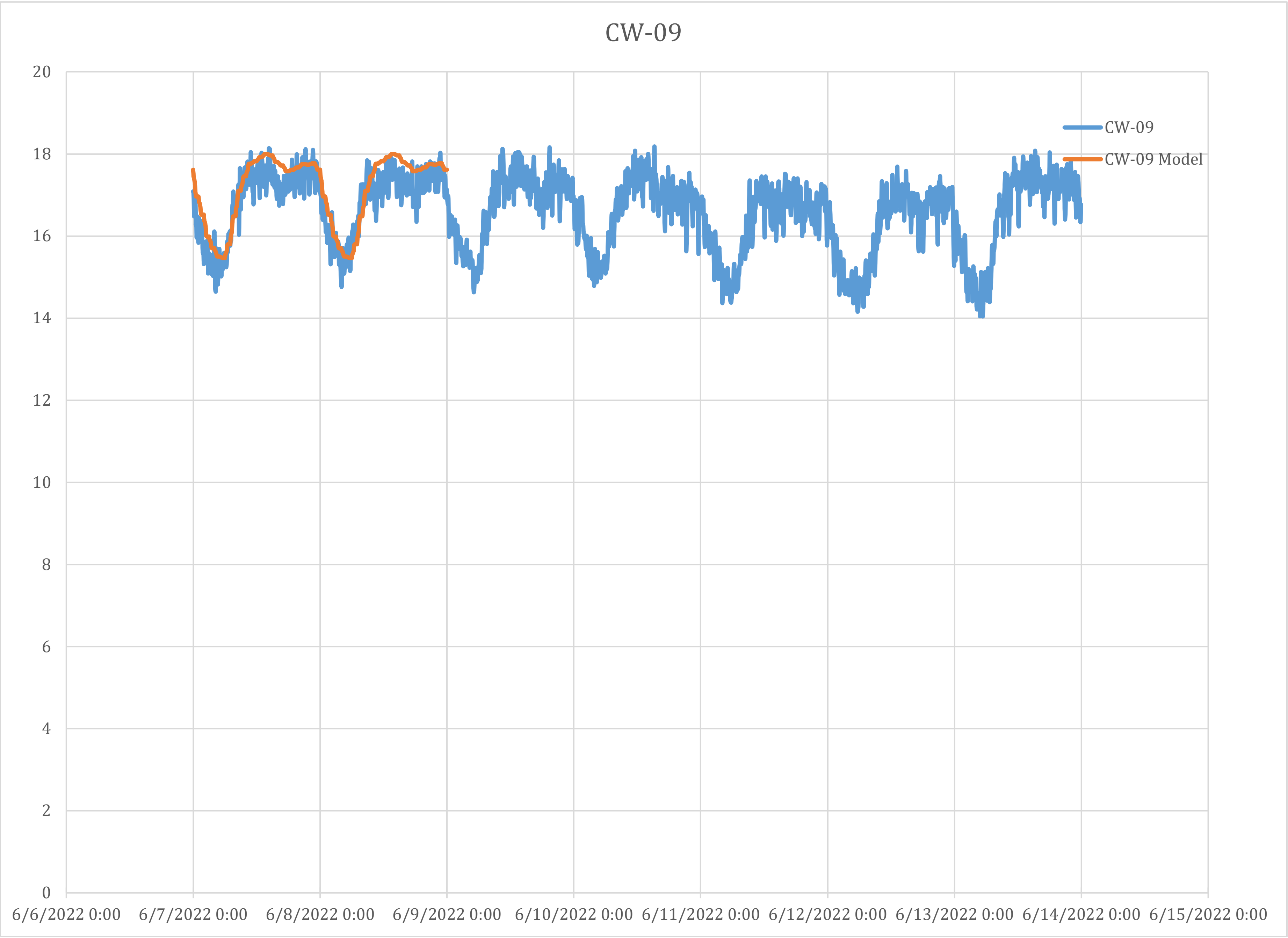
CW-08
CW-08 Model


CW-09
20
18
16
14
12
10
8
6
4
2
0
6/6/2022 0:00
6/7/2022 0:00
6/8/2022 0:00
6/9/2022 0:00
6/10/2022 0:00
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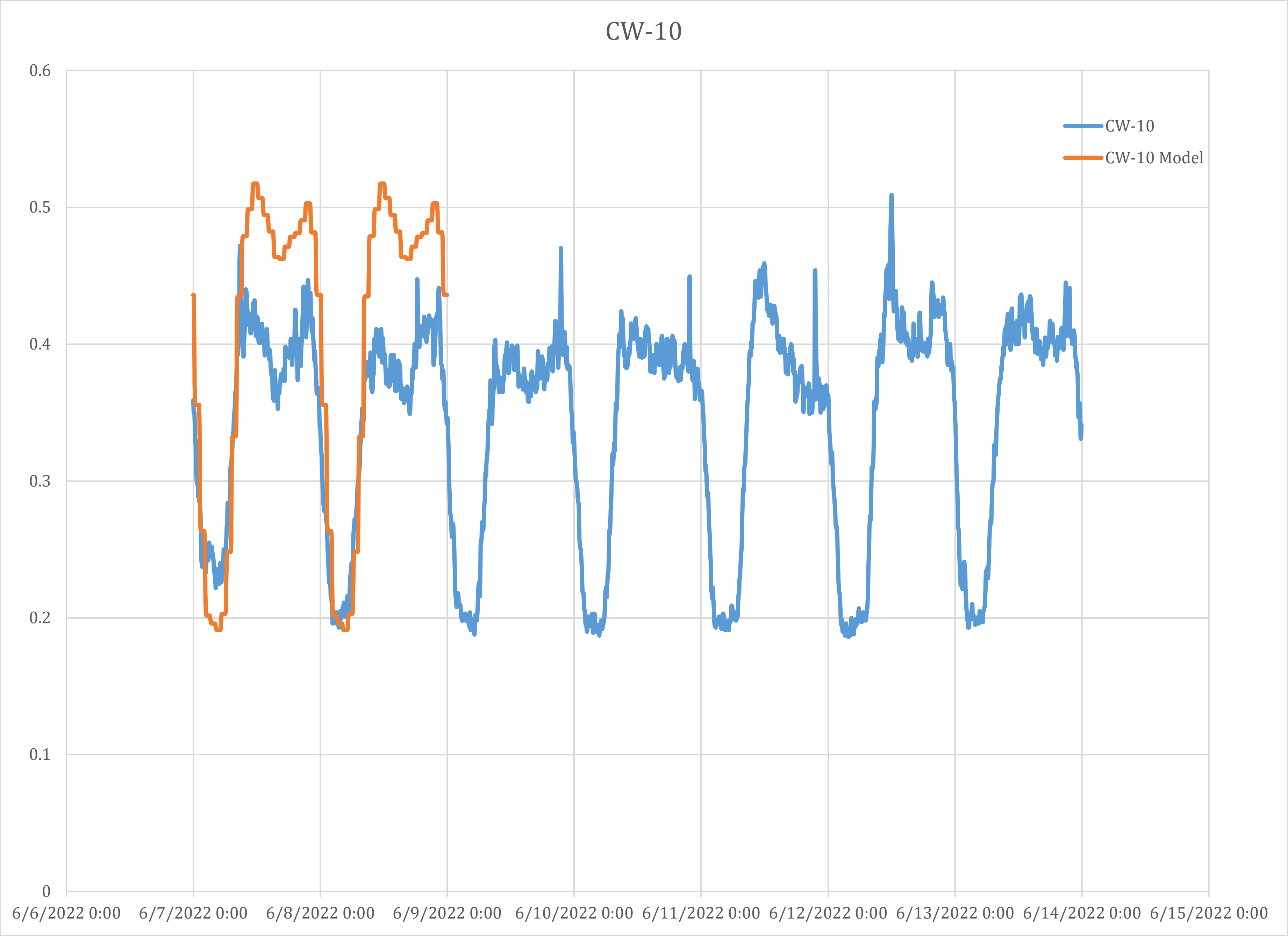
CW-09
CW-09 Model


CW-10
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0.5
0.4
0.3
0.2
0.1
0
6/6/2022 0:00
6/7/2022 0:00
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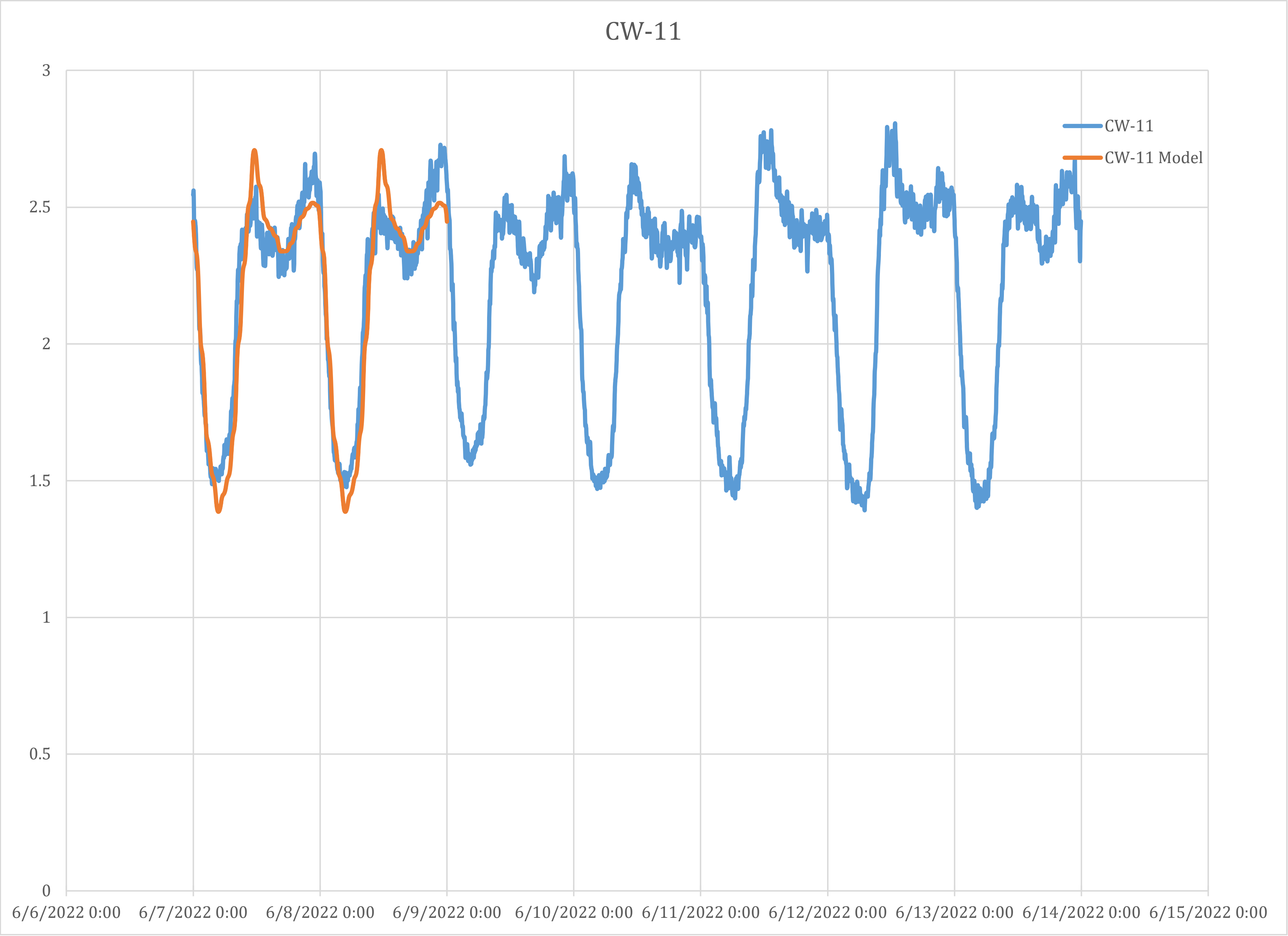
CW-10
CW-10 Model


CW-11
3
2.5
2
1.5
1
0.5
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6/6/2022 0:00
6/7/2022 0:00
6/8/2022 0:00
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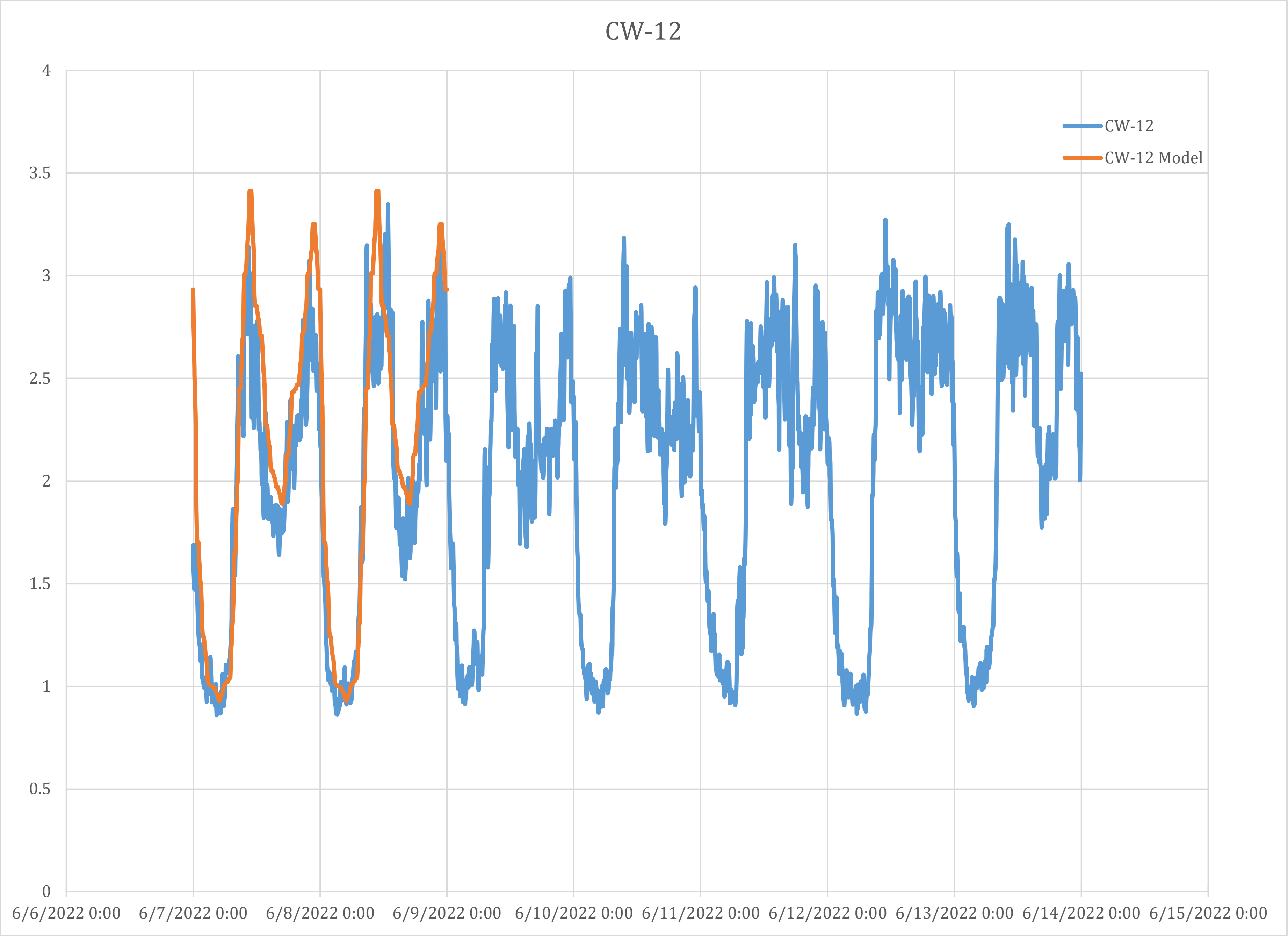
CW-11
CW-11 Model


CW-12
4
3.5
3
2.5
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1.5
1
0.5
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6/7/2022 0:00
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6/9/2022 0:00
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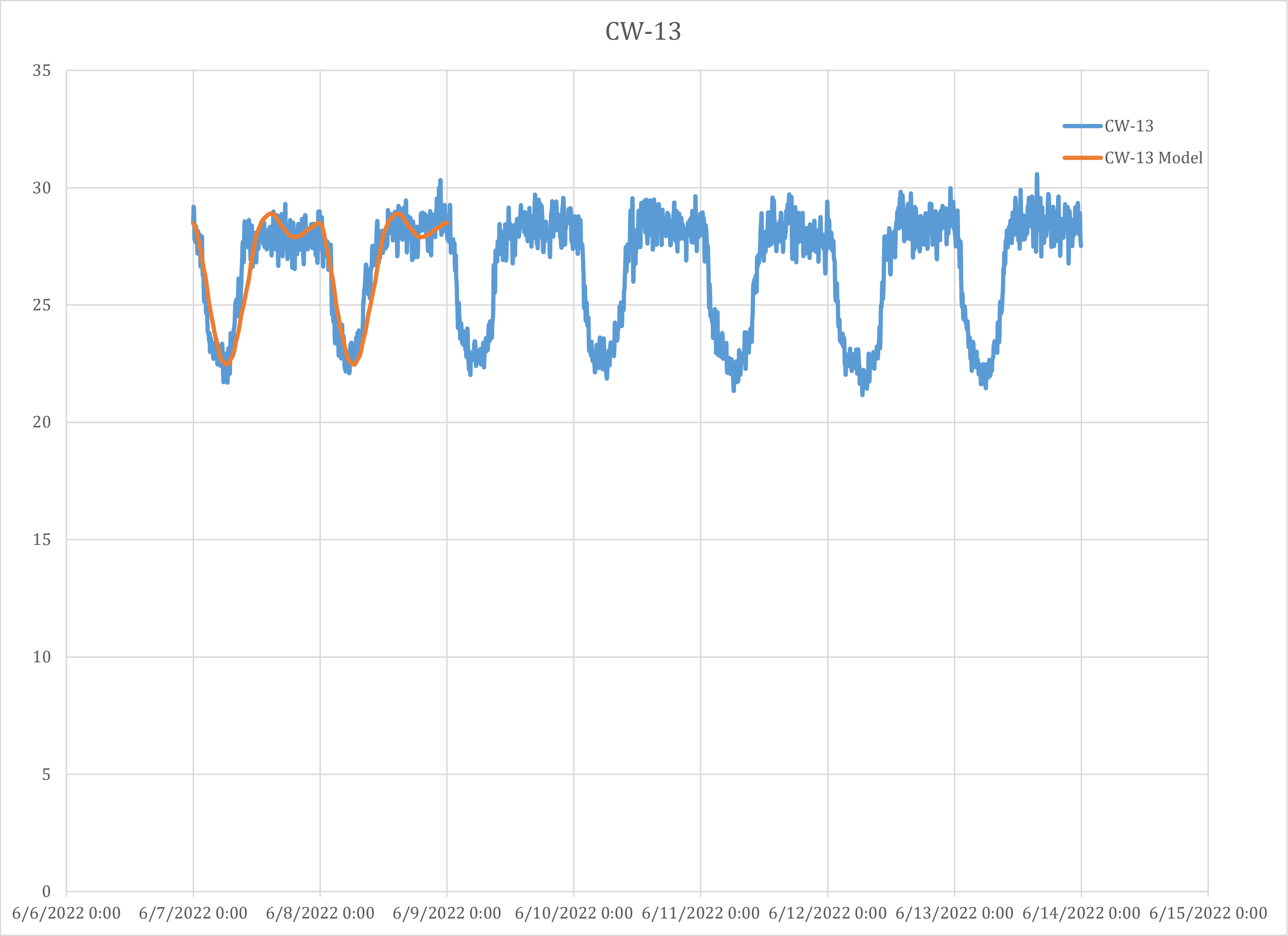
CW-12
CW-12 Model


CW-13
35
30
25
20
15
10
5
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6/6/2022 0:00
6/7/2022 0:00
6/8/2022 0:00
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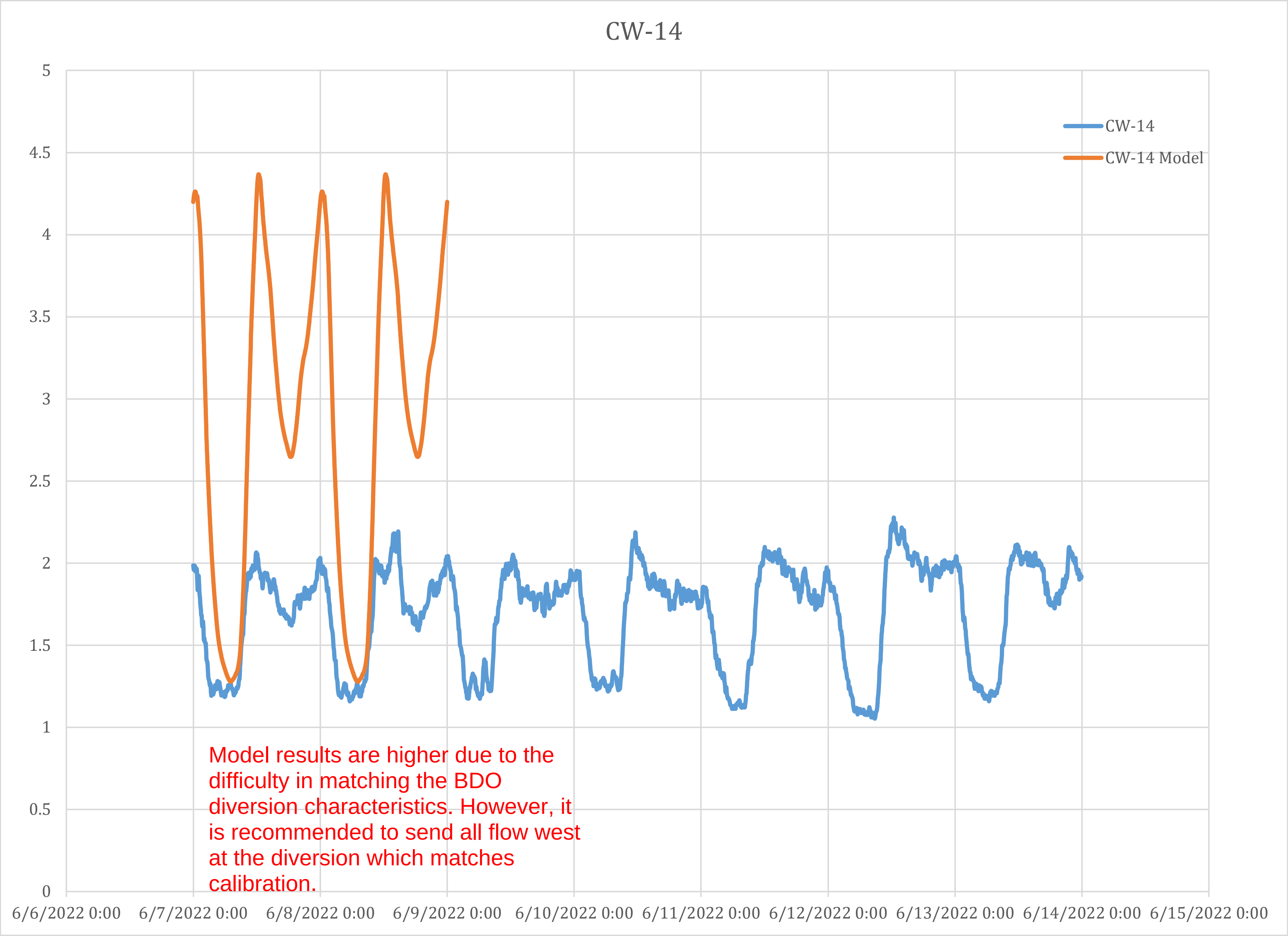
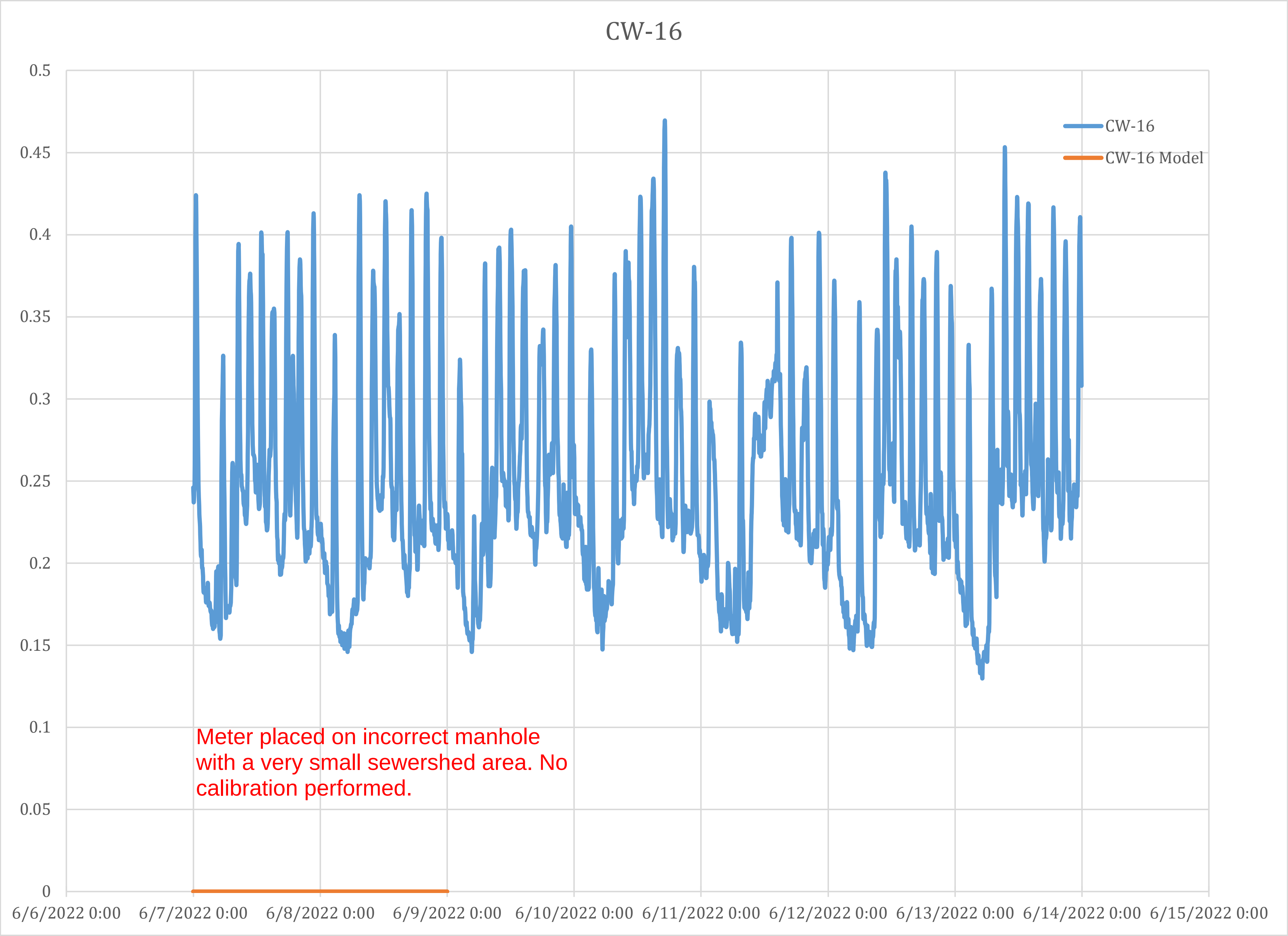
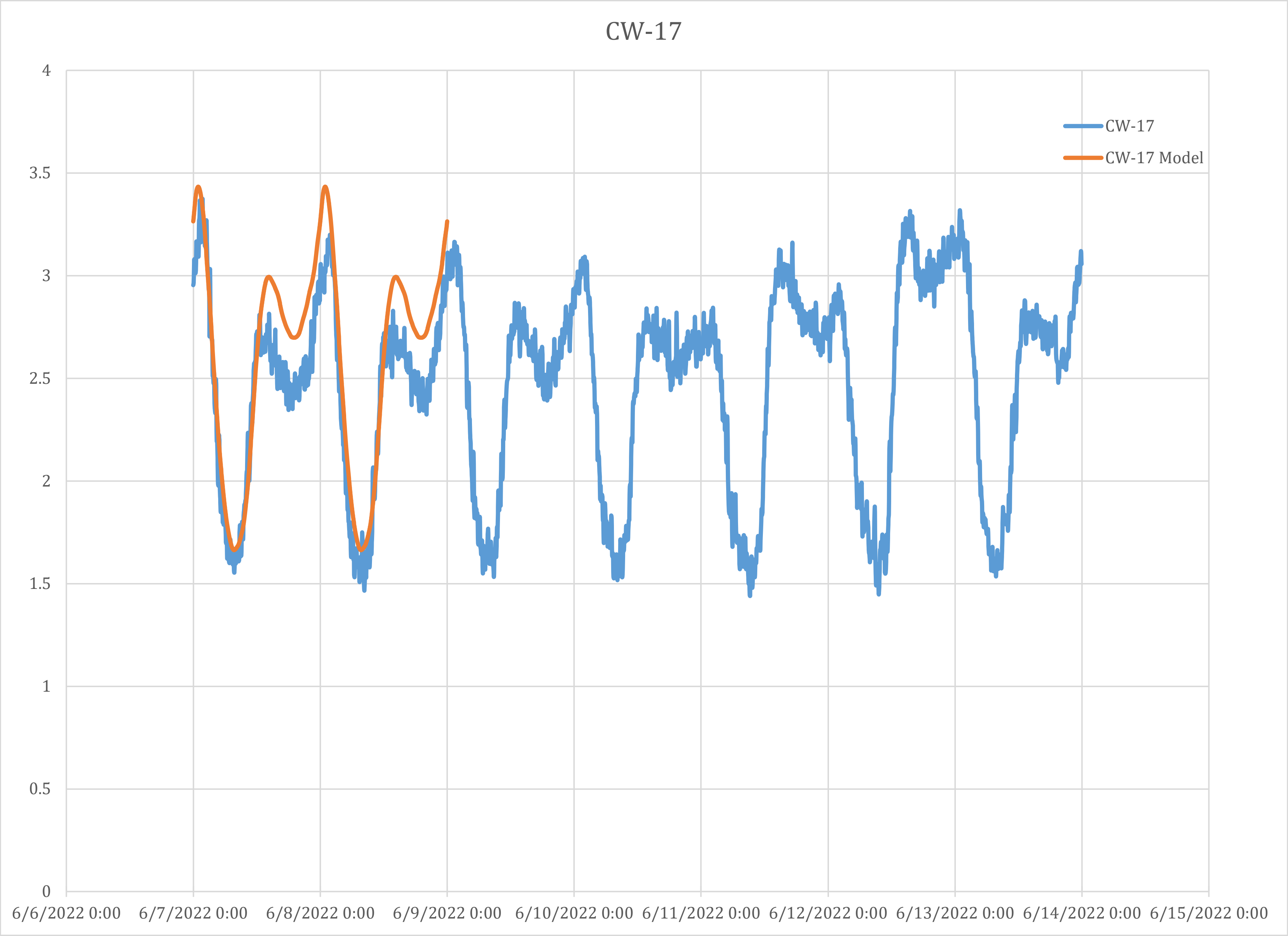
CW-13
CW-13 Model



Model results are higher due to the difficulty in matching the BDO diversion characteristics. However, it is recommended to send all flow west at the diversion which matches calibration.



Meter placed on incorrect manhole with a very small sewershed area. No calibration performed.


CW-17
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3.5
3
2.5
2
1.5
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0.5
0
6/6/2022 0:00
6/7/2022 0:00
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6/9/2022 0:00
6/10/2022 0:00
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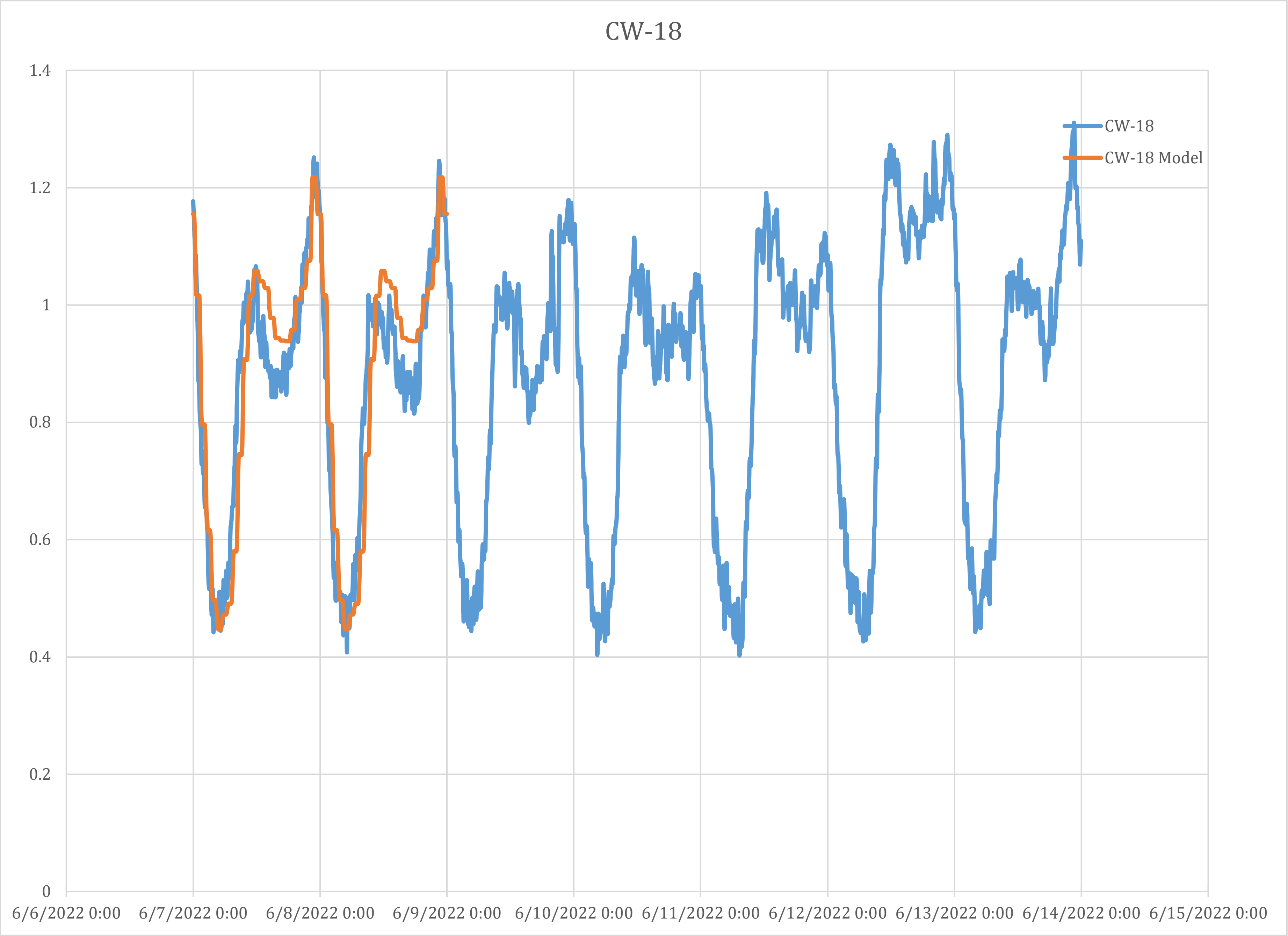
CW-17
CW-17 Model


CW-18
1.4
1.2
1
0.8
0.6
0.4
0.2
0
6/6/2022 0:00
6/7/2022 0:00
6/8/2022 0:00
6/9/2022 0:00
6/10/2022 0:00
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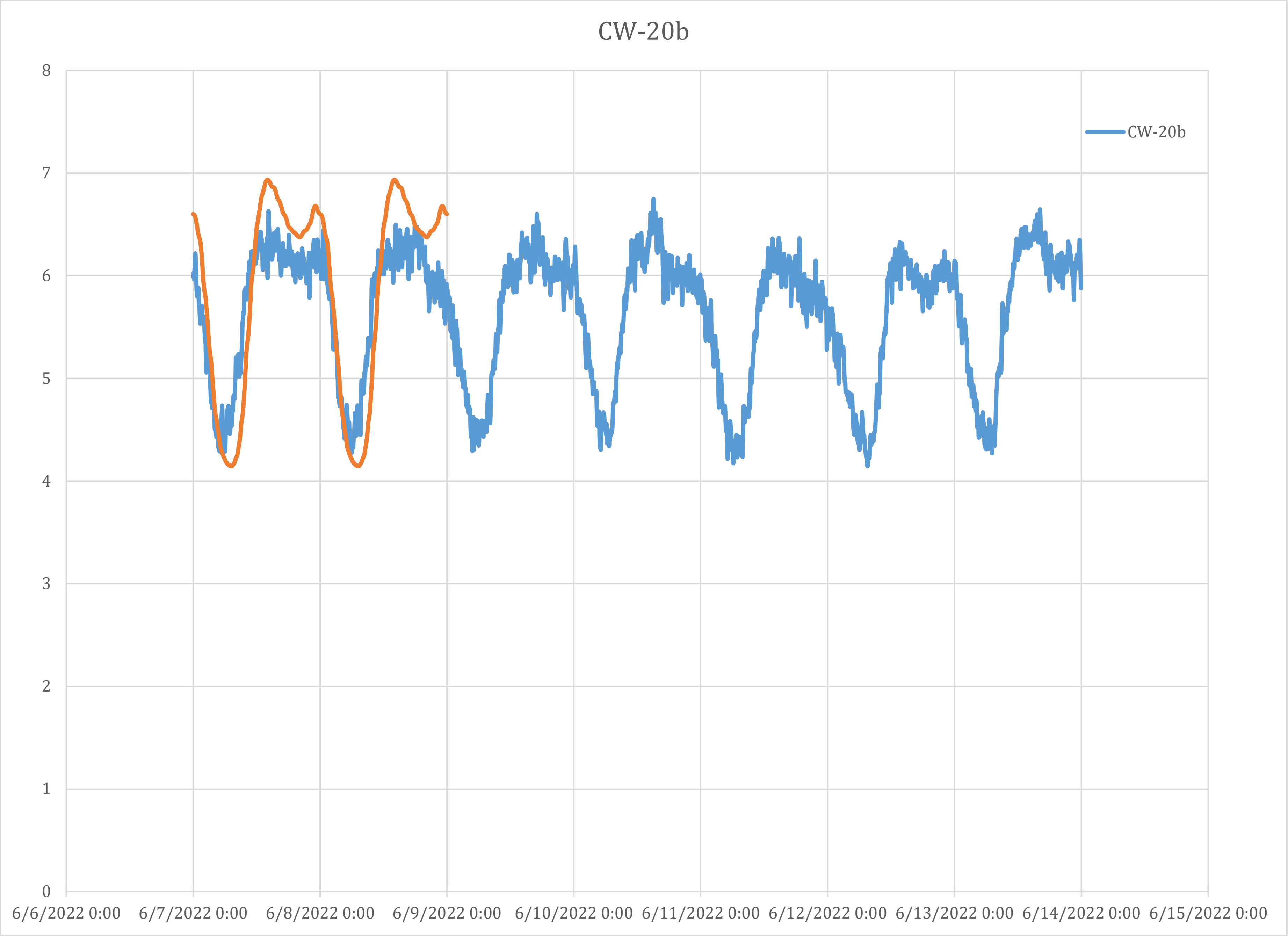
CW-18
CW-18 Model


CW-20b
8
7
6
5
4
3
2
1
0
6/6/2022 0:00
6/7/2022 0:00
6/8/2022 0:00
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6/10/2022 0:00
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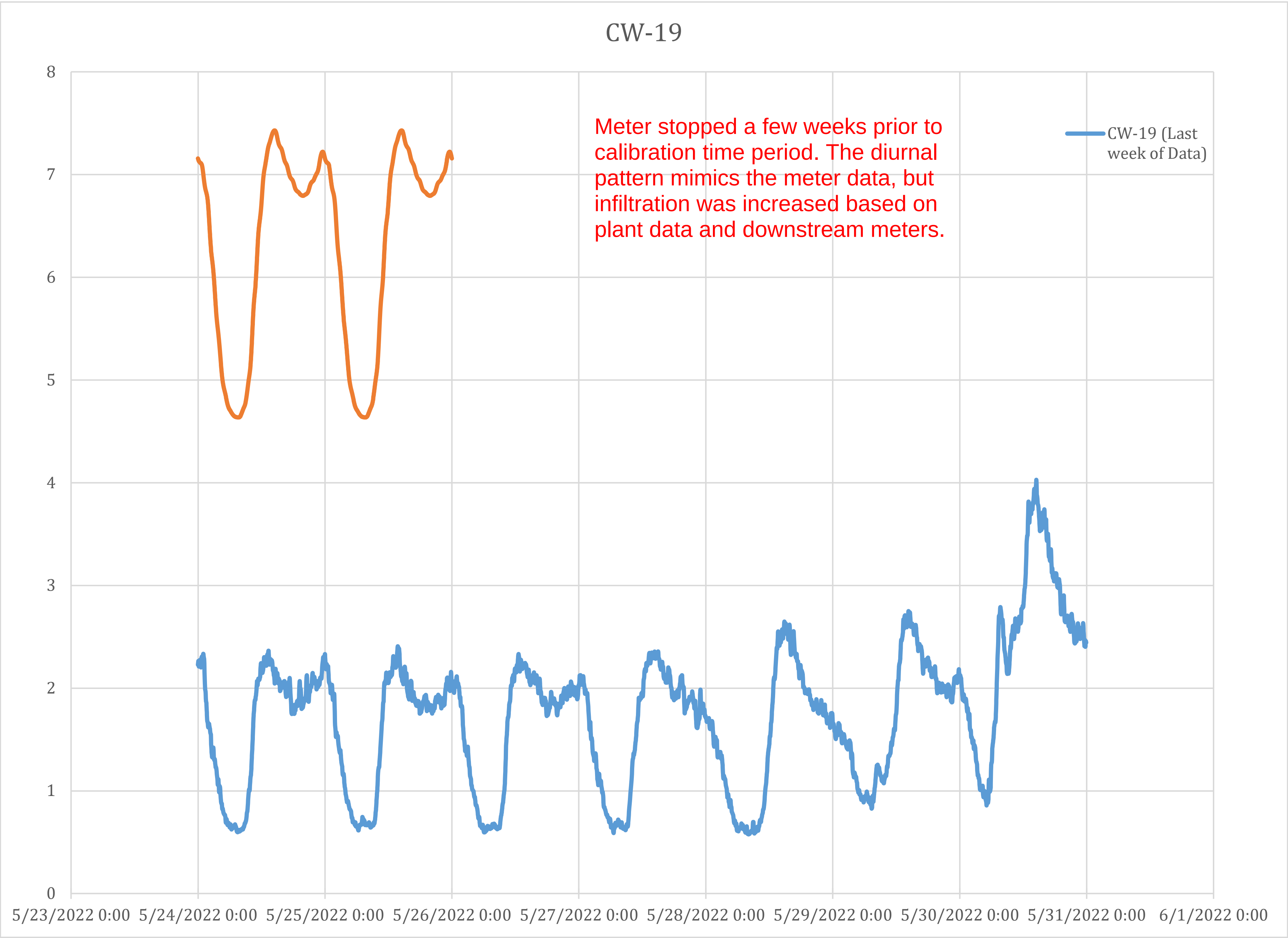
6/15/2022 0:00
CW-20b

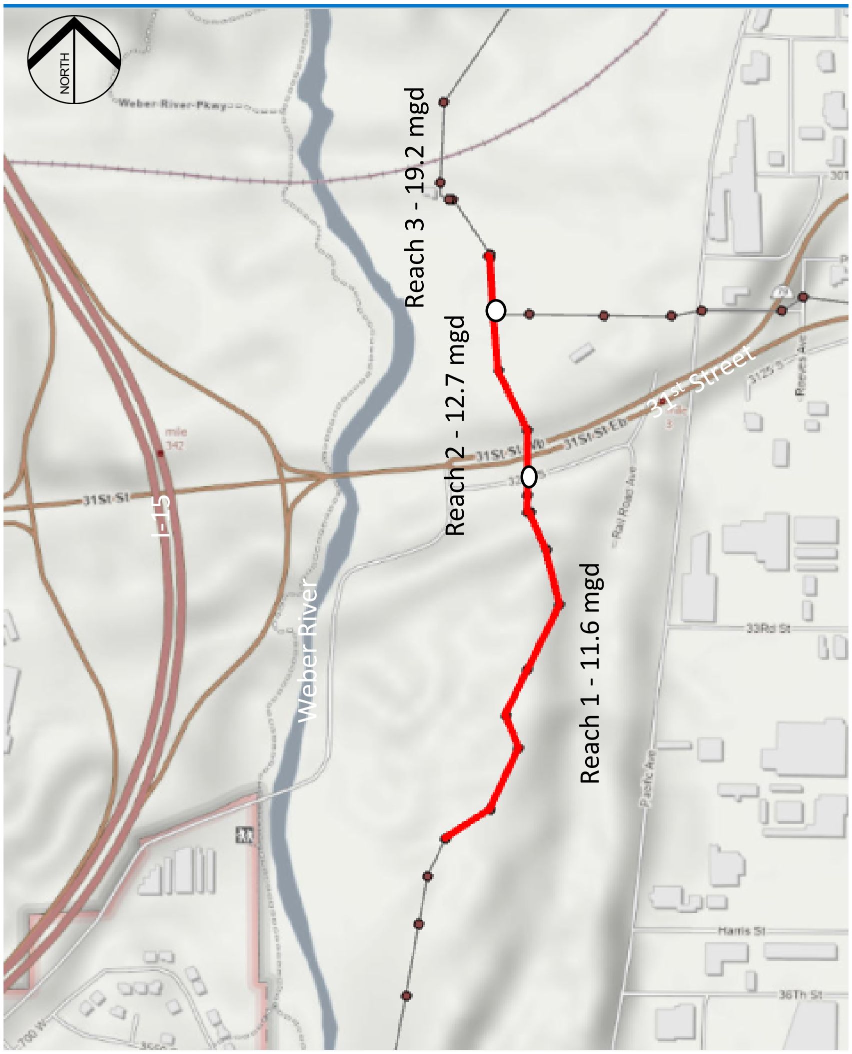


CW-19
8
7
6
5
4
3
2
1
0
5/23/2022 0:00
5/24/2022 0:00
5/25/2022 0:00
5/26/2022 0:00
5/27/2022 0:00
5/28/2022 0:00
5/29/2022 0:00
5/30/2022 0:00
5/31/2022 0:00
6/1/2022 0:00
CW-19 (Last week of Data)
Meter stopped a few weeks prior to calibration time period. The diurnal pattern mimics the meter data, but infiltration was increased based on plant data and downstream meters.

APPENDIX E

Collection System Project Data Sheets

Project ID:	1
Project Name: Riverdale Railroad Yard Mainline	
Description: Upsize the existing 27-inch to 30-inch pipeline to a 36-inch pipeline. Growth projected within 10-15 years is anticipated to exceed the design criteria along this section of pipe. Pipes are fairly deep in this area (10+-feet) with minimal slope (0.2%). The minimal number of connections minimizes the hazard of exceeding the design criteria.	



Project Map

Project Components		
Quantity	***Size***	***Design Flow****
2,190 LF	36-inch	11.6 MGD
1,040 LF	36-inch	12.7 MGD
320 LF	36-inch	19.2 MGD

** Design flow is based on full flow capacity of pipe and includes all peaking and safety factors for projected flows.*

Cost Estimate (2023 $s): $5,130,000

Project Need:

Capacity for Future Growth. Projected growth will exceed the existing capacity of the pipeline in the Riverdale Railyard.

Potential Consequences of Failing to Complete Project:

Projected growth will result in flows in the pipeline exceeding design capacity. Failure to complete this project will eventually require a moratorium on any growth to the south once this pipeline reaches its capacity. If additional growth is allowed, the District risks SSOs along the Weber River and within the Railyard.

Project Triggers:

The project will be trigged when the peak flow in pipe OC014.1 (between manholes OC014 & OC015) exceeds 8.2 mgd. The pipeline is currently at 6.0 mgd. This means approximately 7,400 additional ERUs can be developed upstream of the bottleneck. It is not excepted that this project will be needed for at least 10 years.

Current Estimated Project Completion Year: 2033-2038

Improvement Project Summary

Central Weber Sewer Improvement District

BOWEN COLLINS & ASSOCIATES

Project Map

Project ID: 2

Project Name:
Ogden 30th Street Mainline

Description:
Upsize the existing 36-inch pipeline to a 42-inch pipeline. The pipes are nearing capacity for existing conditions. Growth projected within 10-years is anticipated to exceed the design criteria along this section of pipe. The existing pipes are relatively deep (12+ feet) with minimal number of connections.

Project Components

Quantity	***Size***	***Design Flow****
4,990 LF	42-inch	21.5 MGD

** Design flow is based on full flow capacity of pipe and includes all peaking and safety factors for projected flows.*

Cost Estimate (2023 $s): $8,880,000

Project Need:
Capacity for Future Growth. Projected growth to the south and east will exceed the capacity of the existing 36-inch pipeline.

Potential Consequences of Failing to Complete Project:
Projected growth will result in flows in the 36-inch trunkline exceeding design criteria. Failure to complete this project will eventually require a moratorium on any growth in areas to contribute to this pipeline. If additional growth is allowed, the District risks SSOs along the Weber River.

Project Triggers:
The project will be trigged when the peak flow in pipe OC041.1 (between manholes OC041 & OC042) exceeds 14.7 mgd. The pipeline is currently at 10.9 mgd. This mean approximately 12,800 additional ERUs can be developed upstream of the bottleneck. It is not excepted that this project will be needed for 10 years.

Current Estimated Project Completion Year: 2033

Improvement Project Summary

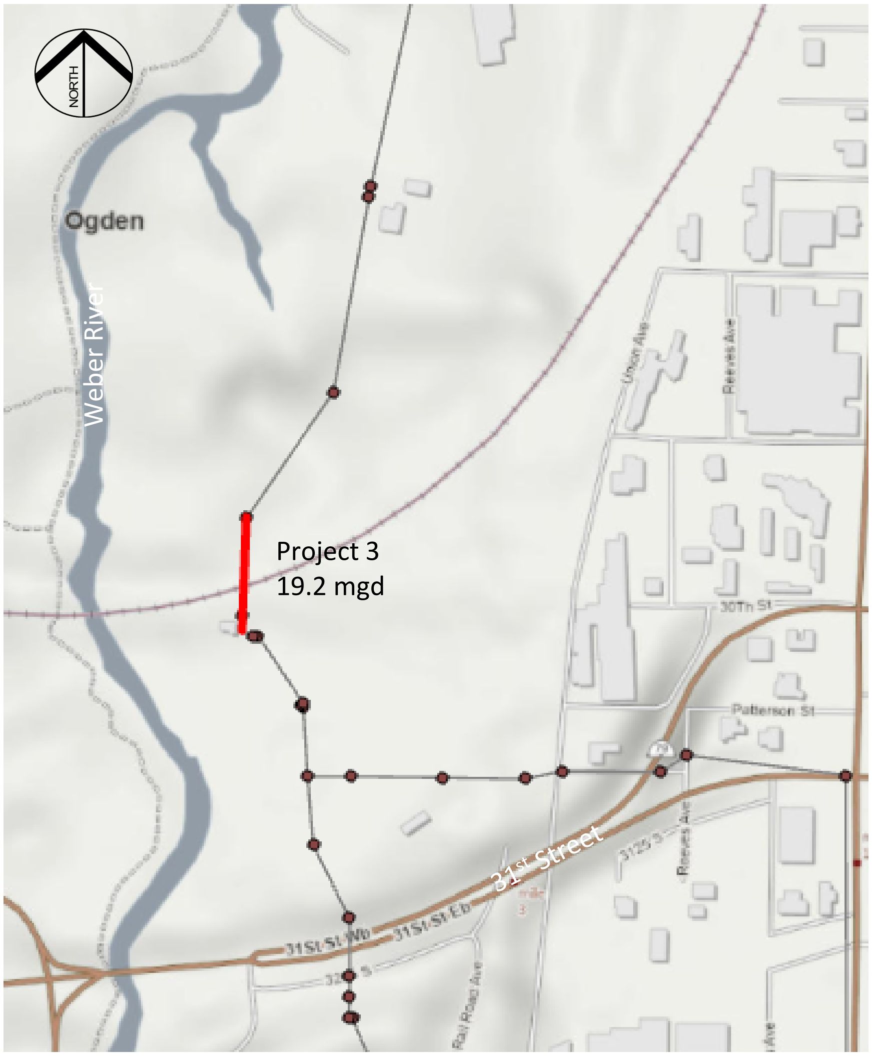
Central Weber Sewer Improvement District

BOWEN COLLINS
& ASSOCIATES

Project ID: 3

Project Name:
30th St. Force Main

Description:
The existing 30th St. Force Main crosses underneath the railroad. The lift station has sufficient capacity to convey the flow, but the Force Mains is too small to meet design criteria. Replacing the Force Main underneath the railroad will require additional permits with the railroad and most likely a non-trench method of construction.



Project Map

Project Components		
Quantity	***Size***	***Design Flow****
520 LF	30-inch	19.2 MGD

** Design flow is based on full flow capacity of pipe and includes all peaking and safety factors for projected flows.*

Cost Estimate (2023 $s): $640,000

Project Need:
Capacity for Future Growth. Projected growth associated will exceed existing capacity of force main from the 30th Street Lift Station.

Potential Consequences of Failing to Complete Project:
Projected growth will result in flows in the Force Main exceeding design criteria. Failure to complete this project will eventually require a moratorium on any growth to the south once this pipeline reaches its capacity. If additional growth is allowed, the District risks SSOs underneath the railroad line.

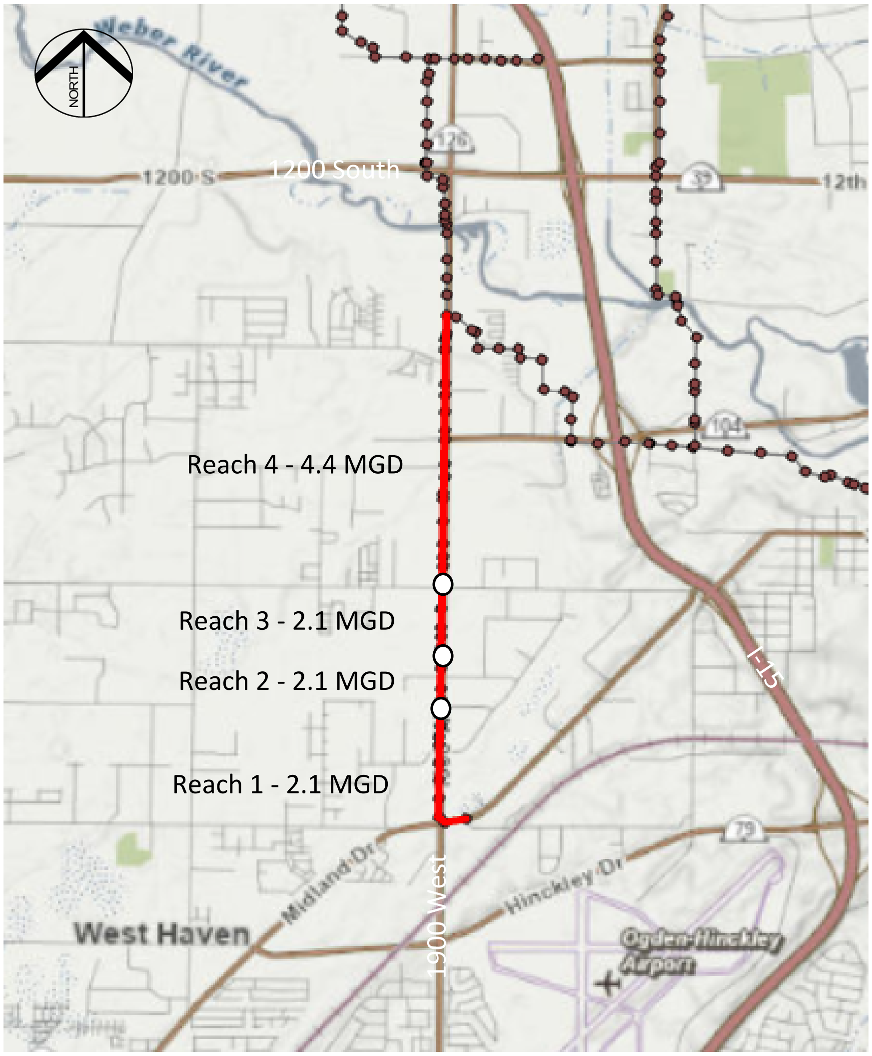
Project Triggers:
The project will be trigged when the peak flow in the force main exceeds 10.7 mgd. The pipeline is currently at 9.8 mgd. This mean approximately 3,000 additional ERUs can be developed upstream of the bottleneck. It is excepted that this project will be needed to be completed in 5 years.

Current Estimated Project Completion Year: 2028

Project ID:	4
Project Name:	
West Haven Mainline	

Description:

Upsize the existing West Haven mainline from the downstream end to the junction near 1700 South on 1900 West with pipe sizes ranging from 15-inch to 27-inch. Portions of the existing pipe are at or near the design capacity. Projected growth includes the majority of the line needing to be upsized and it is recommended to pursue the entire project length at one time. The existing pipe is relatively deep (12+ feet), giving time for design and construction.



Project Map

Project Components

Quantity	*Size*	*Design Flow**
2,650 LF	15-inch	2.1 MGD
1,530 LF	18-inch	2.1 MGD
1,520 LF	24-inch	2.1 MGD
6,080 LF	27-inch	4.4 MGD

** Design flow is based on full flow capacity of pipe and includes all peaking and safety factors for projected flows.*

Cost Estimate (2023 $s): $11,515,000

Project Need:

Resolve Existing Deficiency. Portions of the existing pipe exceed capacity under existing conditions. This project will replace those existing pipes.

Capacity for Future Growth. Projected growth within West Haven and the West side of Ogden will exacerbate existing capacity issues in the West Haven Mainline.

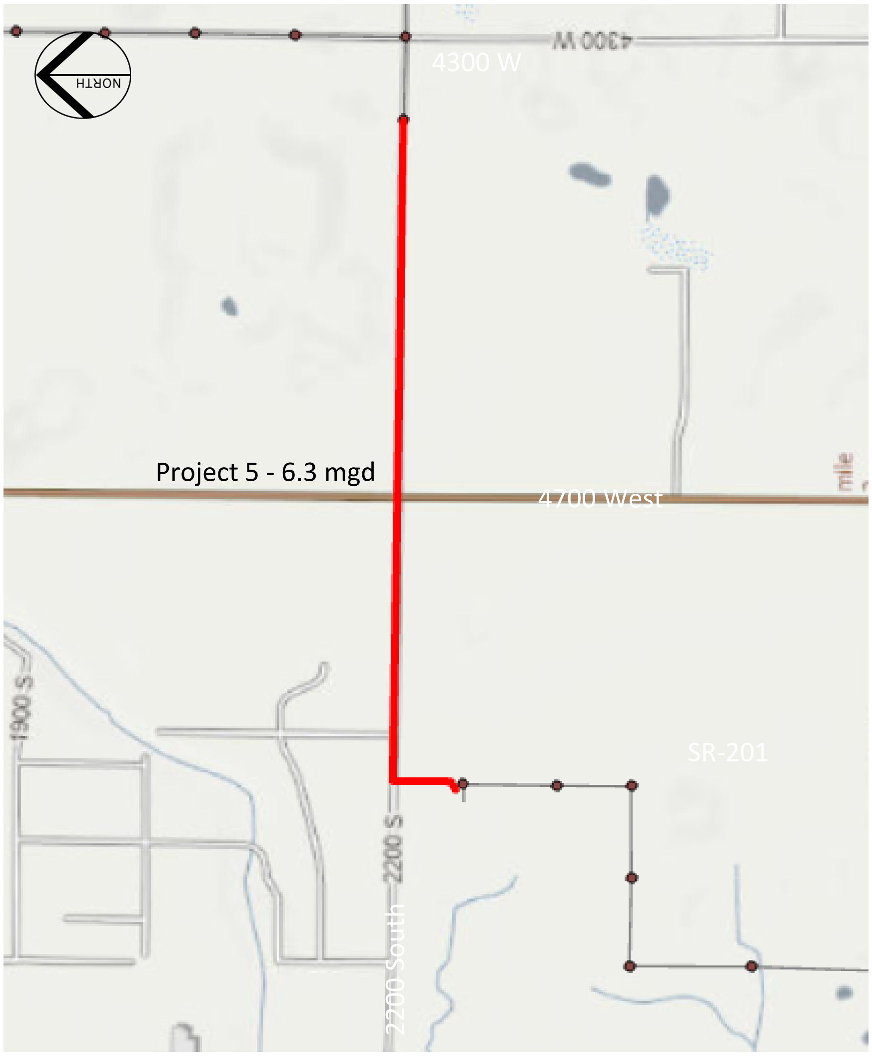
Potential Consequences of Failing to Complete Project:

The pipes in the West Haven mainline are relatively deep (12+ feet). In addition, the existing conditions deficiencies are along segments of the pipe that have little slope. This resudes the risk to damages associated with surcharging. As projected growth develops in the surrounding area, the risk of surcharging increases. 1900 West is a primary side road and consequences due to failure could be far reaching and expensive. If additional growth is allowed, the District risks SSOs along 1900 West.

Project Triggers:

Portions of the existing pipe are deficient under existing conditions. This project should be designed and constructed as soon as possible to relive the existing deficiencies.

Current Estimated Project Completion Year: 2025



Project Map

Project ID: 5

Project Name:
Taylor Lift Station & Force Main

Description:
The Taylor Lift Station and Force Main will need to be upsized to meet projected growth. Both the Lift Station and the Force Main have capacity to meet existing demand and won't need to be replaced for more than 15-years.

Project Components

Quantity	*Size*	*Design Flow**
4,160 LF	24-inch	6.3 MGD

** Design flow is based on full flow capacity of pipe and includes all peaking and safety factors for projected flows.*

Cost Estimate (2023 $s): $4,075,000

Project Need:
Capacity for Future Growth. Projected growth is excepted to exceed the design capacity of the existing Taylor Lift Station and Force Main.

Potential Consequences of Failing to Complete Project:
Projected growth will result in flows exceeding design capacity. Failure to complete this project will eventually require a moratorium on any growth to the south once capacity is reached. If additional growth is allowed, the District risks SSOs at the Taylor lift station.

Project Triggers:
The project will be triggered when the peak flow into the lift station exceeds 4.0 mgd. The existing flow is 1.6 mgd. This means approximately 7,000 additional ERUs can be developed upstream of the lift station. It is not expected that this project will be needed for more than 15 years.

Current Estimated Project Completion Year: Beyond 2038

Project ID: 6

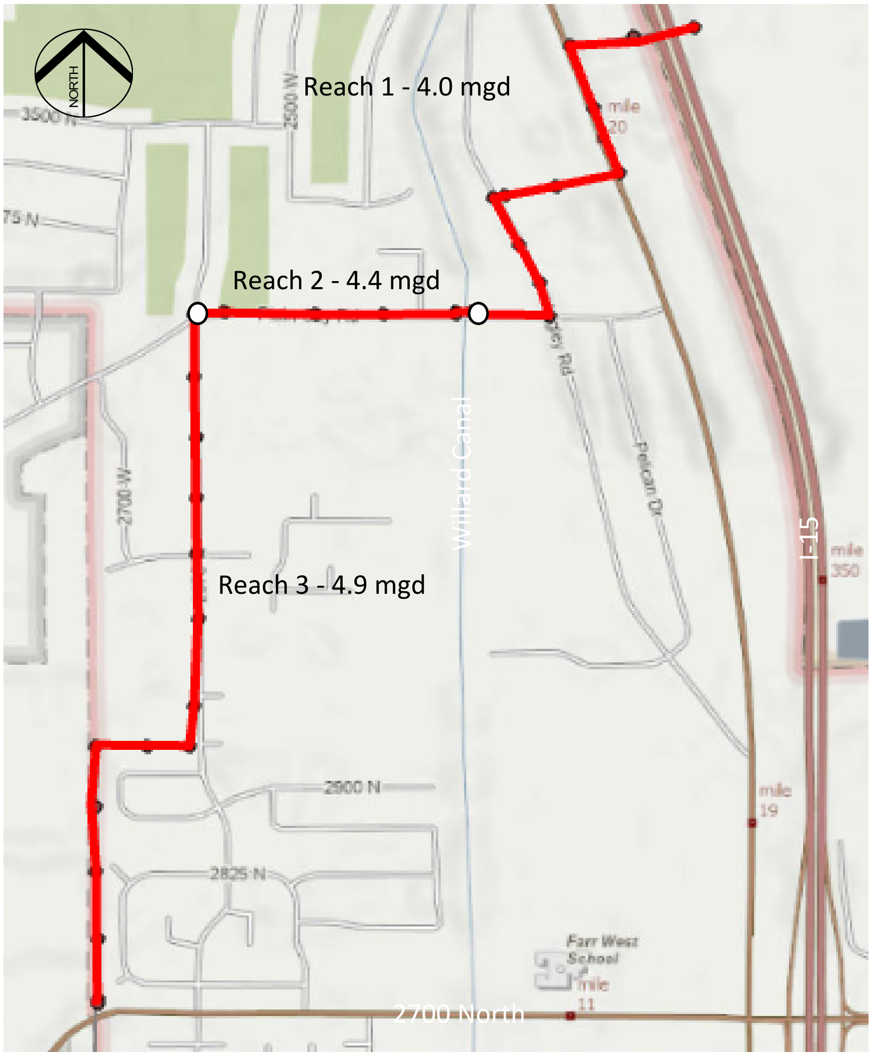
Project Name:
Farr West Mainline

Description:
The Farr West Gravity line will need to be upsized to 24-27 inches. Growth projected in the next 10-15 years is expected to exceed the existing pipe design criteria.

Project Components		
Quantity	***Size***	***Design Flow****
4,385 LF	24-inch	4.0 MGD
2,035 LF	24-inch	4.4 MGD
5,870 LF	27-inch	4.9 MGD

** Design flow is based on full flow capacity of pipe and includes all peaking and safety factors for projected flows.*

Cost Estimate (2023 $s): $12,809,000



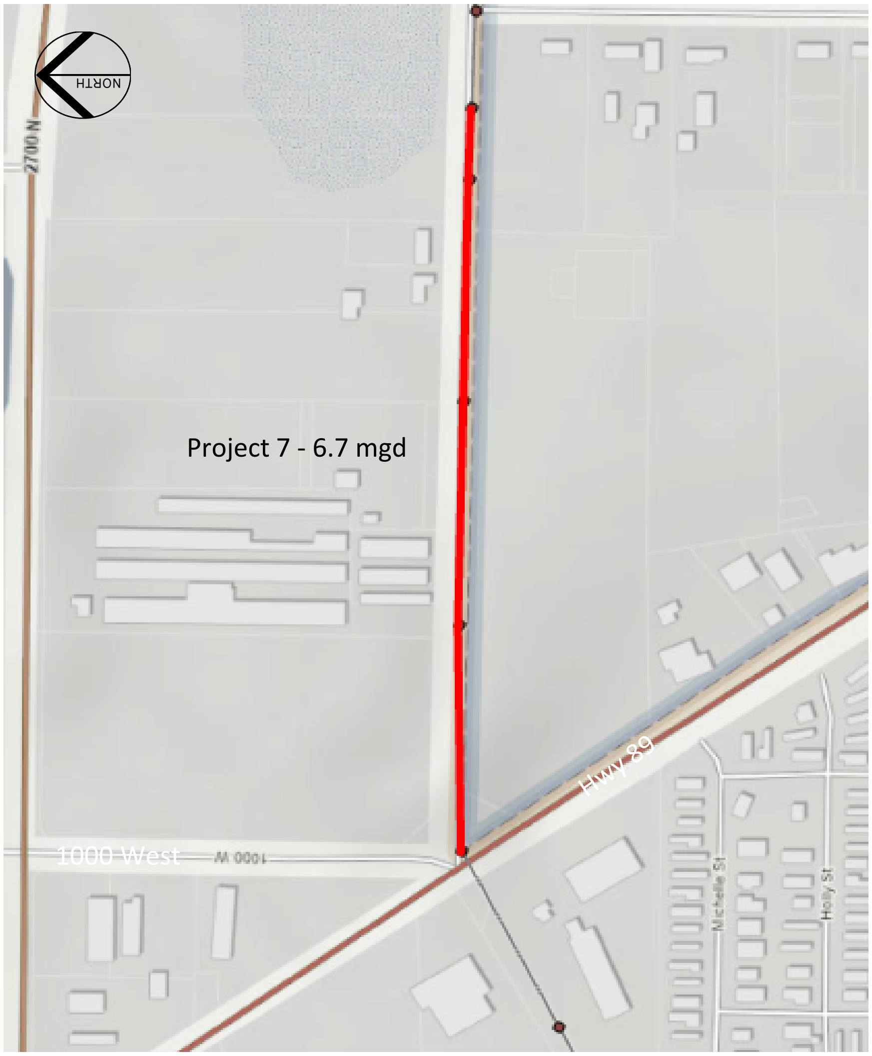
Project Map

Project Need:
Capacity for Future Growth. Projected growth in Farr West and Pleasant View will exceed existing capacity of the Farr West Gravity line.

Potential Consequences of Failing to Complete Project:
Projected growth will result in flows in the trunkline exceeding design capacity. Failure to complete this project will eventually require a moratorium on any growth once this pipeline reaches its capacity. If additional growth is allowed, the District risks SSOs throughout the northern portion of Farr West.

Project Triggers:
The project will be triggered when the peak flow in pipe FW012.1 (between manholes FW012 & FW013) exceeds 1.2 mgd. The flow in the pipe is currently at 0.7 mgd. This means approximately 2,400 additional ERUs can be developed upstream of the bottleneck. It is not expected that this project will be needed for at least 10 years.

Current Estimated Project Completion Year: 2033-2038



Project Map

Project ID: 7

Project Name:
North Ogden Mainline

Description:
Upsize the existing 21-inch pipeline to a 24-inch pipeline. The North Ogden pipeline is not expected to exceed the design criteria for at least 15-years.

Project Components

Quantity	*Size*	*Design Flow**
1,660 LF	24-inch	6.7 MGD

** Design flow is based on full flow capacity of pipe and includes all peaking and safety factors for projected flows.*

Cost Estimate (2023 $s):
$1,626,000

Project Need:
Capacity for Future Growth. Projected growth associated with the area that contributes to the North Ogden Mainline will cause the pipe to exceed the existing design capacity of the 21-inch pipeline.

Potential Consequences of Failing to Complete Project:
Projected growth will result in flows in the 21-inch main trunkline exceeding design capacity. Failure to complete this project will eventually require a moratorium on growth to the north once this pipeline reaches its capacity. If additional growth is allowed, the District risks SSOs along 2550 North.

Project Triggers:
The project will be triggered when the peak flow in pipe NO021.1 (between manholes NO021 & NO022) exceeds 4.0 mgd. The flow in the pipe is currently at 2.8 mgd. This means approximately 3,100 additional ERUs can be developed upstream of the bottleneck. It is not expected that this project will be needed for at least 15 years.

Current Estimated Project Completion Year: Beyond 2038

Project Map

Project ID:	8
Project Name:	Farr West Lift Station No. 3
Description:	The existing Farr West Lift Station No. 3 is not expected to have adequate capacity for the projected future growth. The Lift Station should be replaced or expanded to increase total capacity. The force main has been previously upsized and has adequate capacity for projected growth.

Project Components

Quantity	*Size*	*Design Flow**
		4.7 MGD

** Design flow is based on full flow capacity of pipe and includes all peaking and safety factors for projected flows.*

Cost Estimate (2023 $s): $8,110,000

Project Need:
Capacity for Future Growth. Projected growth will exceed existing capacity for the Farr West Lift Station No. 3.

Potential Consequences of Failing to Complete Project:
Projected growth will result in flows exceeding design capacity of the Farr West Lift Station No. 3. Failure to complete this project will eventually require a moratorium on any growth once this lift station reaches its capacity. If additional growth is allowed, the District will risk SSOs at the Farr West Lift Station No. 3.

Project Triggers:
The project will be trigged when the peak flow into the lift station exceeds 2.9 mgd. The flow in the pipe is currently at 0.7 mgd. This means approximately 5,600 additional ERUs can be developed upstream of the lift station. It is not expected that the lift station will need to be upsized for at least 15 years.

Current Estimated Project Completion Year: Beyond 2038

Project ID: 9

Project Name:
Industrial Force Main

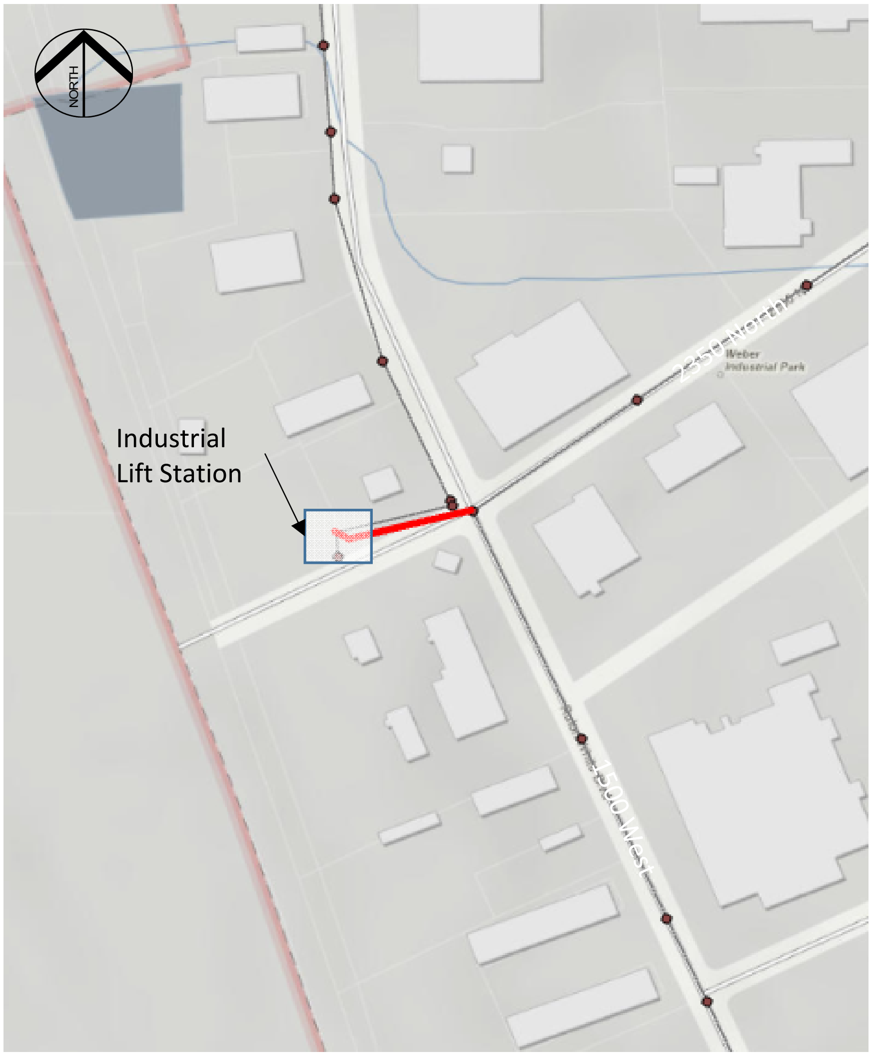
Description:
Based on available data, the Industrial Lift Station Force Main will eventually become deficient. A recent project installed a meter on the Lift Station pumps. This meter should be used to evaluate when the dry weather peak flows consistently exceed 5.25 fps in the Force Main.

Project Components

Quantity	*Size*	*Design Flow**
350 LF	12-inch	

** Design flow is based on full flow capacity of pipe and includes all peaking and safety factors for projected flows.*

Cost Estimate (2023 $s): $234,000



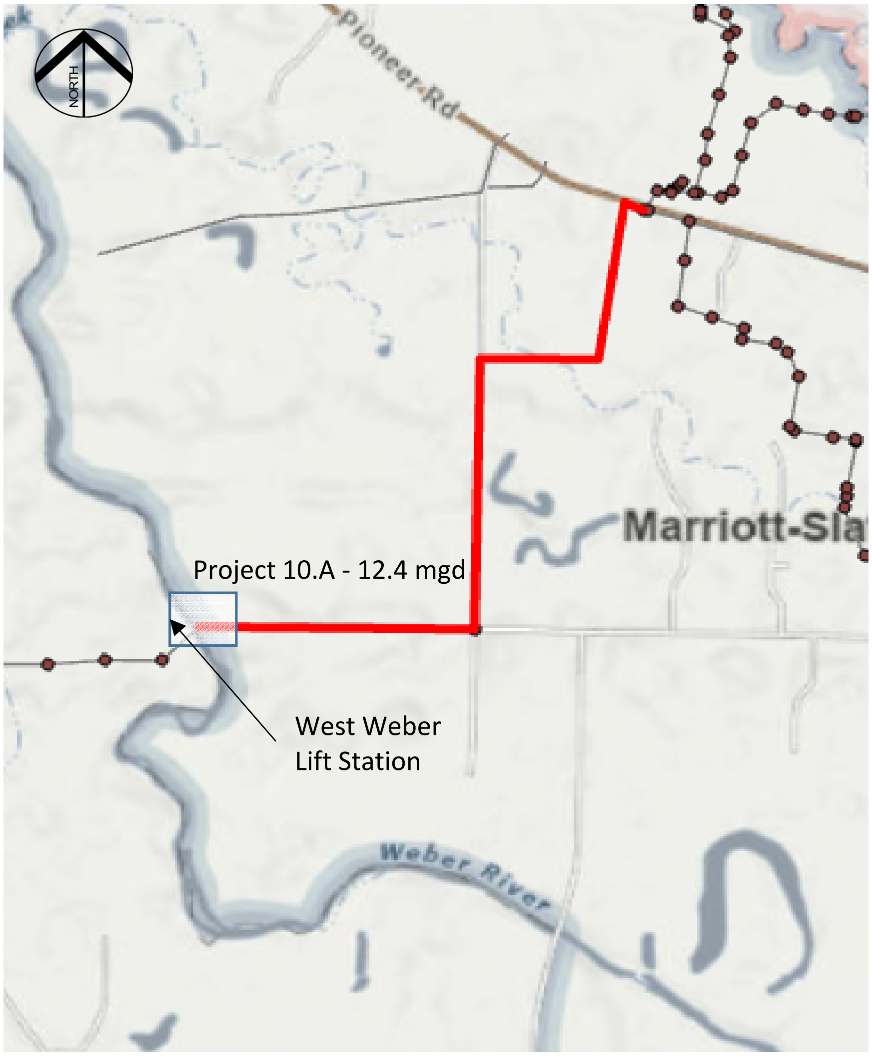
Project Map

Project Need:
Capacity for Future Growth. Future growth is excepted to exceed the design capacity of the Industrial Force Main.

Potential Consequences of Failing to Complete Project:
The existing section of pipe that this project is intended to replace is not deficient under existing conditions. A new meter has been installed and should be used to further evaluate the need to replace the Force Main.

Project Triggers:
The Force Main should be replaced when the meter on the Industrial Lift Station pumps shows that the dry weather velocities in the Force Main consistently exceed 5.25 fps. Due to uncertainty in the inflow locations from the industrial area, this project will need to be watched. It is not expected that the project will be required for at least 5 years.

Current Estimated Project Completion Year: Unknown



Project Map

Project ID: 10.A

Project Name:
West Weber Force Main (w/o Weber West 2)

Description:
Upsize the existing 17.8-inch (I.D.) force main with 27-inch (I.D.) pipe. Projected growth is not expected to exceed capacity for at least 15 years.

Project Components		
Quantity	***Size***	***Design Flow****
8,350	27-inch	12.4 MGD

** Design flow is based on full flow capacity of pipe and includes all peaking and safety factors for projected flows.*

Cost Estimate (2023 $s): $9,276,000

Project Need:
Capacity for Future Growth. Projected growth associated with western Weber County will exceed existing capacity of the West Weber Force Main.

Potential Consequences of Failing to Complete Project:
Projected growth will result in flows in the 17.8-inch Force Main exceeding design capacity. Failure to complete this project will eventually require a moratorium on any growth once this pipeline reaches its capacity. If additional growth is allowed, the District risks SSOs into the Weber River.

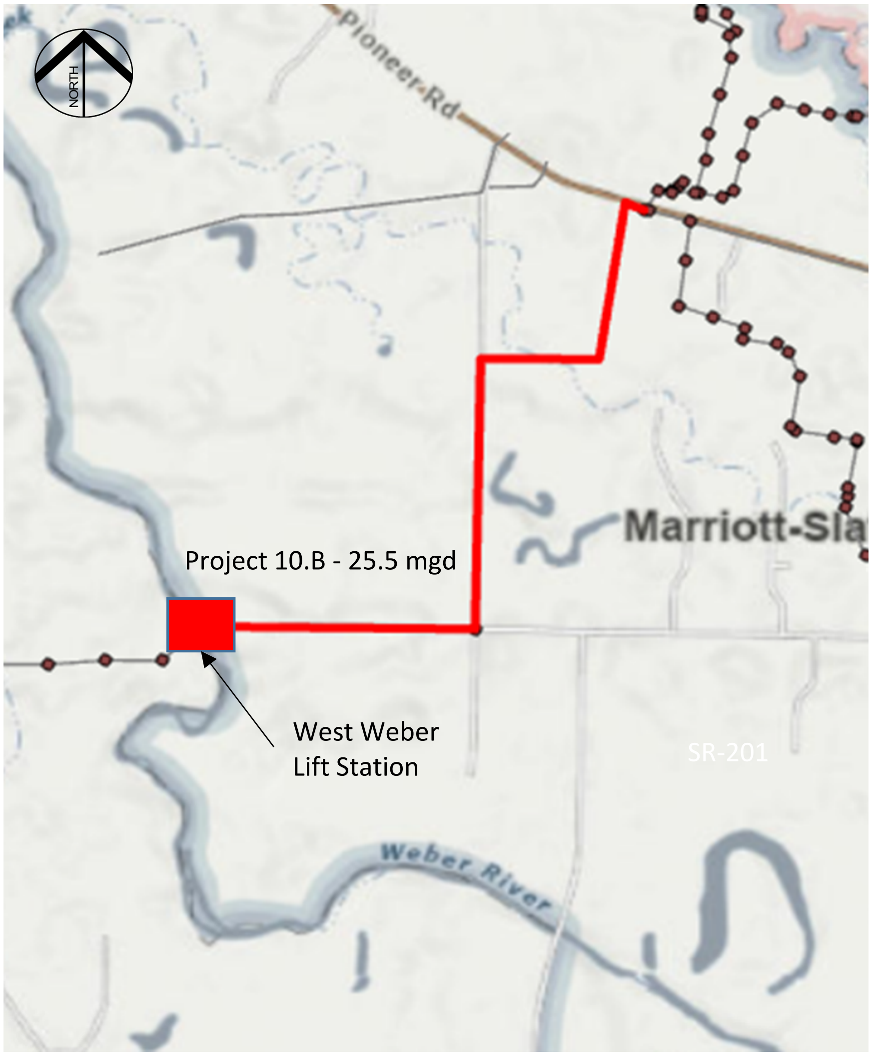
Project Triggers:
The project will be triggered when the peak flow into the lift station exceeds 5.7 mgd. The flow into the lift station is currently 3.6 mgd. This means approximately 6,200 additional ERUs can be developed upstream of the bottleneck. It is not expected that this project will be needed for at least 15 years.

Current Estimated Project Completion Year: Beyond 2038

Project ID: 10.B

Project Name:
West Weber Lift Station & Force Main (w/ Weber W

Description:
Upsize the existing 17.8-inch (I.D.) force main with 36-inch (I.D.) pipe. Projected growth is not expected to exceed capacity for at least 15 years. This project assumes that the Weber West 2 area develops and the District collects and treates the sewer flow. The existing Lift Station will also be insufficentt to handle projected growth.



Project Map

Project Components

Quantity	*Size*	*Design Flow**
8,350 LF	36-inch	25.5 MGD

** Design flow is based on full flow capacity of pipe and includes all peaking and safety factors for projected flows.*

Cost Estimate (2023 $s): $39,456,000

Project Need:
Capacity for Future Growth. Projected gorwth will result in flows exceeding both the West Weber Lift Station and Force Main design capacity.

Potential Consequences of Failing to Complete Project:
Projected growth will result in flows exceeding design capacity. Failure to complete this project will eventually require a moritorium on any gorwth once this pipeling and force main reach capacity. If additional growth is allowed, the District risks SSOs into the Weber River.

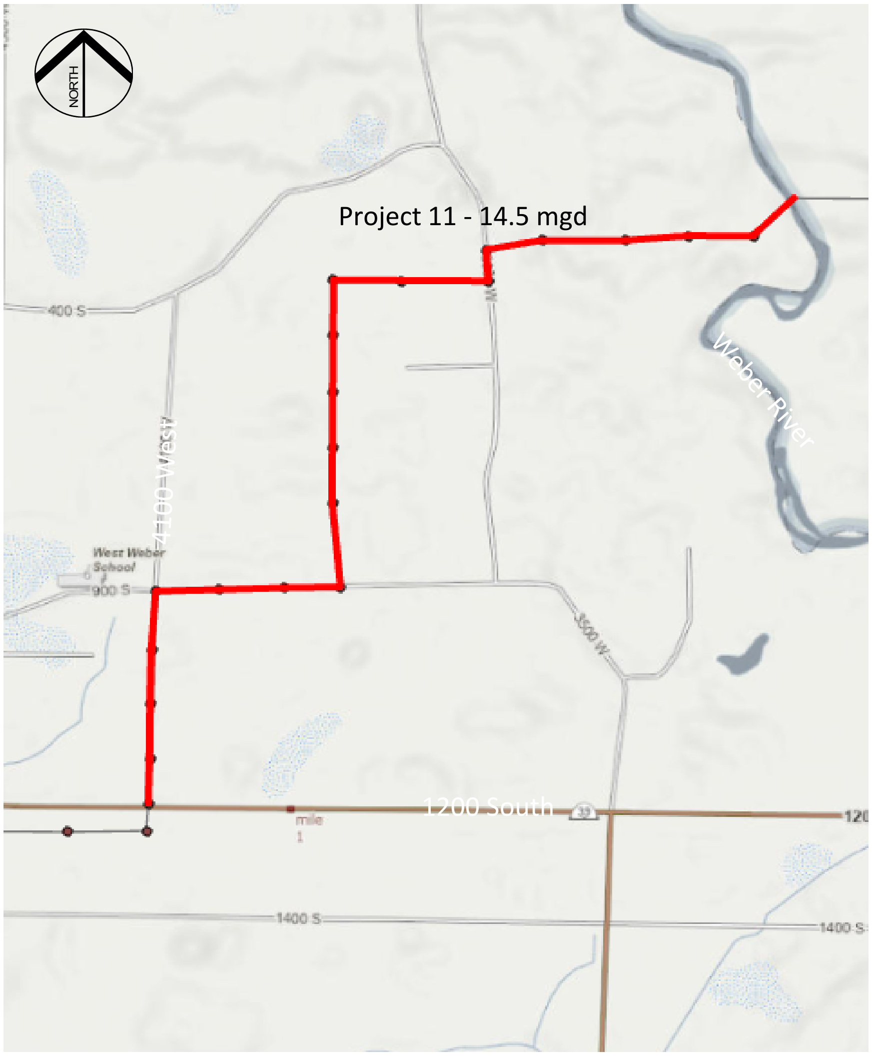
Project Triggers:
The project will be triggered when the peak flow into the lift station exceeds 5.7 mgd. The flow into the lift station is currenlty 3.6 mgd. This means approximately 6,200 additonal ERUs can be developed upstream of the bottleneck. It is not expected that this project will be needed for at least 15 years. Lift station only needs to be upsized if an additional 30,000 ERUs are developed in Weber West 2.

Current Estimated Project Completion Year: Beyond 2038

Project ID:	11

Project Name:
Hooper Mainline (w/ Weber West 2)

Description:
A new 48-inch pipeline should be installed to convey sewer flow from the Weber West 2 area to the West Weber Lift Station. The alignment shows would parallel the existing pipe, but it is recommended to evaluate a preferred alignment as part of this project.



Project Map

Project Components

Quantity	*Size*	*Design Flow**
10,690 LF	48-inch	14.5 MGD

** Design flow is based on full flow capacity of pipe and includes all peaking and safety factors for projected flows.*

Cost Estimate (2023 $s):
$21,607,000

Project Need:
Capacity for Future Growth. Projected growth will result in flows exceeding the Hooper Mainline.

Potential Consequences of Failing to Complete Project:
Projected growth will result in flows exceeding design capacity. Failure to complete this project will eventually require a moratorium on any growth once this pipeline and force main reach capacity. If additional growth is allowed, the District risks SSOs into the Weber River.

Project Triggers:
The project will be triggered when the peak flow in pipe HP038.1(north of 1200 South) exceeds 9.2 mgd. The flow in the pipe is currently at 3.5 mgd. This means approximately 16,800 additional ERUs can be developed upstream of the bottleneck. It is not expected that this project will be needed for more than 15 years. This project would require significant development to Weber West 2 in addition to the existing District service area.

Current Estimated Project Completion Year: Beyond 2038

Project Map

Project ID:	12

Project Name:
Pioneer Road

Description:
Upsize the existing 60-inch pipeline to a 66-inch pipeline. The existing pipes are 12+ feet deep, but are nearly flat. Due to the difficulty and cost of installing a 66-inch pipe in Pioneer Road, it is not recommended to upsize the pipe all of the way to the treatment plant.

Project Components		
Quantity	***Size***	***Design Flow****
1,900 LF	66-inch	14.5 MGD

** Design flow is based on full flow capacity of pipe and includes all peaking and safety factors for projected flows.*

Cost Estimate (2023 $s): $4,856,000

Project Need:
Capacity for Future Growth. Projected growth will exceed design criteria of the main 60-inch trunkline into the treatment plant.

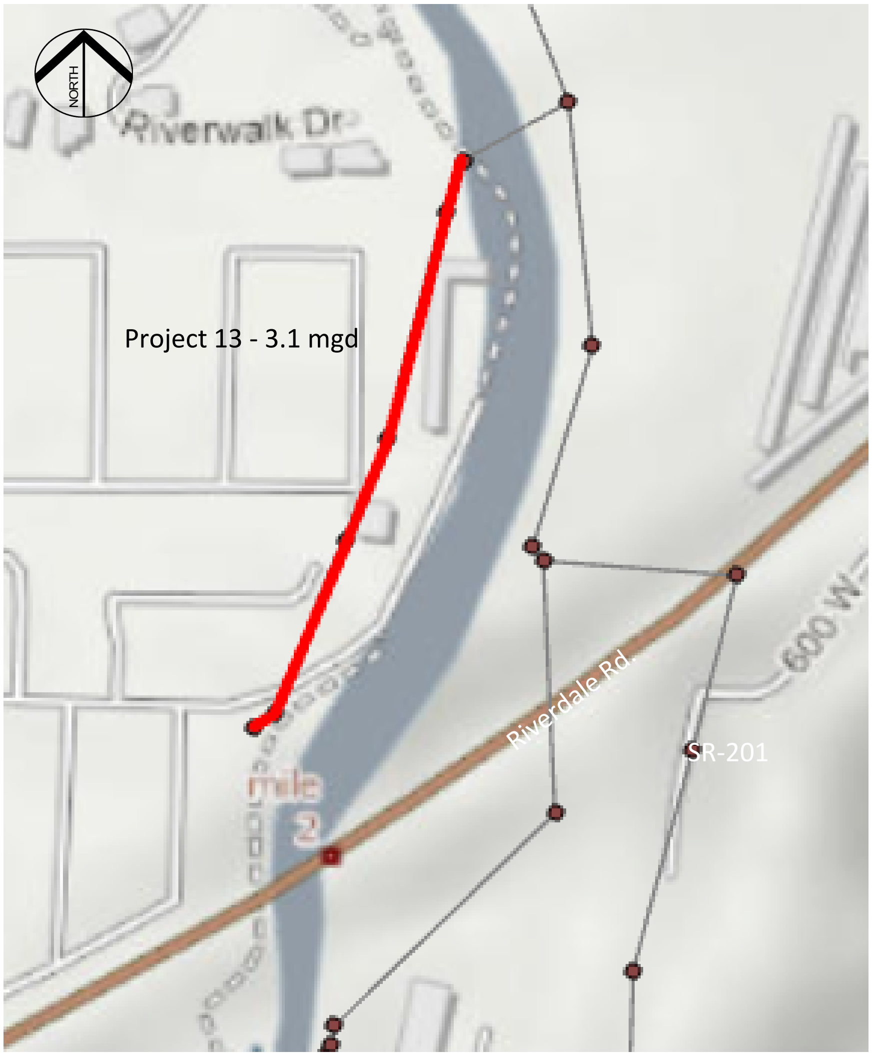
Potential Consequences of Failing to Complete Project:
Projected growth will result in flows in the 60-inch main trunkline into the treatment plant. Due to the size of the pipes and the lack of direct connections along this reach of pipe, there would be minimal consequences due to failure. However, flows in this pipe should be monitored as growth nears buildout.

Project Triggers:
The project will be triggered when the peak flow in pipe PR007.1 (west of 1200 West) exceeds 33.4 mgd. The flow in the pipe is currently at 29.8 mgd. This means approximately 14,400 additional ERUs can be developed upstream of the bottleneck. It is not expected that this project will be needed for more than 15 years.

Current Estimated Project Completion Year: Beyond 2038

Improvement Project Summary

Central Weber Sewer Improvement District



Project Map

Project ID:	13

Project Name:
Riverdale Stubline

Description:
Replace the existing 15-inch pipeline with 18-inch pipeline. The pipes along the Weber River are nearing capacity for existing capacity. Growth projected beyond 15 years is anticipated to exceed the design criteria along this section of pipe.

Project Components

Quantity	***Size***	***Design Flow****
1,060 LF	18-inch	3.1 MGD

** Design flow is based on full flow capacity of pipe and includes all peaking and safety factors for projected flows.*

Cost Estimate (2023 $s): $880,000

Project Need:
Capacity for Future Growth. Projected growth associated with Riverdale will exceed existing capacity of the 15-inch pipeline to the main District trunkline.

Potential Consequences of Failing to Complete Project:
Projected growth will result in flows in the 15-inch Stubline exceeding design capacity. Failure to complete this project will eventually require a moratorium on any growth once this pipeline reaches its capacity. If additional growth is allowed, the District risks SSOs into the Weber River.

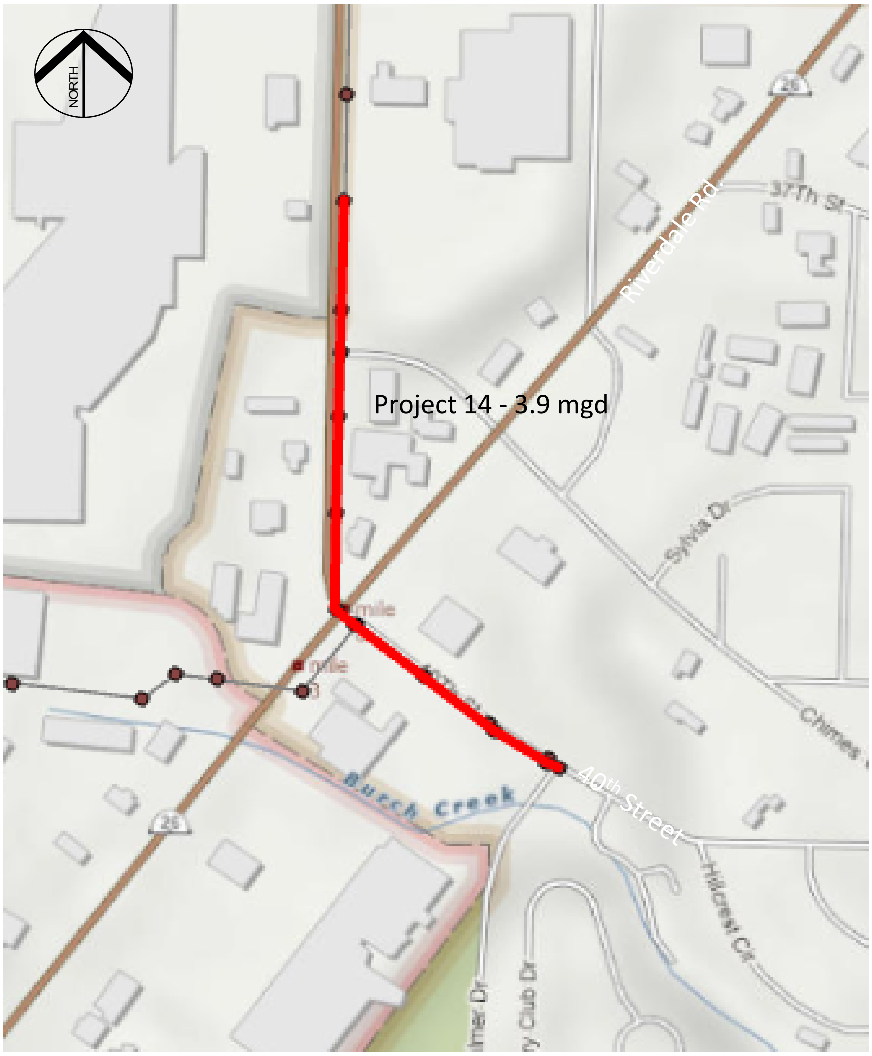
Project Triggers:
The project will be triggered when the peak flow in pipe SW204.2 (upstream of Weber River crossing) exceeds 2.0 mgd. The flow in the pipe is currently at 1.2 mgd. This means approximately 2,500 additional ERUs can be developed upstream of the bottleneck. It is not expected that this project will be needed for more than 15 years.

Current Estimated Project Completion Year: Beyond 2038

Improvement Project Summary

Central Weber Sewer Improvement District

BOWEN COLLINS
& ASSOCIATES



Project Map

Project ID: 13

Project Name:
Riverdale Stubline

Description:
Upsize the existing 15-inch South Ogden Stubline with 18-inch pipeline. Growth projected within the next 5-years is anticipated to exceed the design criteria along this section of pipe.

Project Components

Quantity	*Size*	*Design Flow**
2,090 LF	18-inch	3.9 MGD

** Design flow is based on full flow capacity of pipe and includes all peaking and safety factors for projected flows.*

Cost Estimate (2023 $s): $880,000

Project Need:
Capacity for Future Growth. Projected growth associated with Riverdale will exceed existing capacity of the 15-inch pipeline.

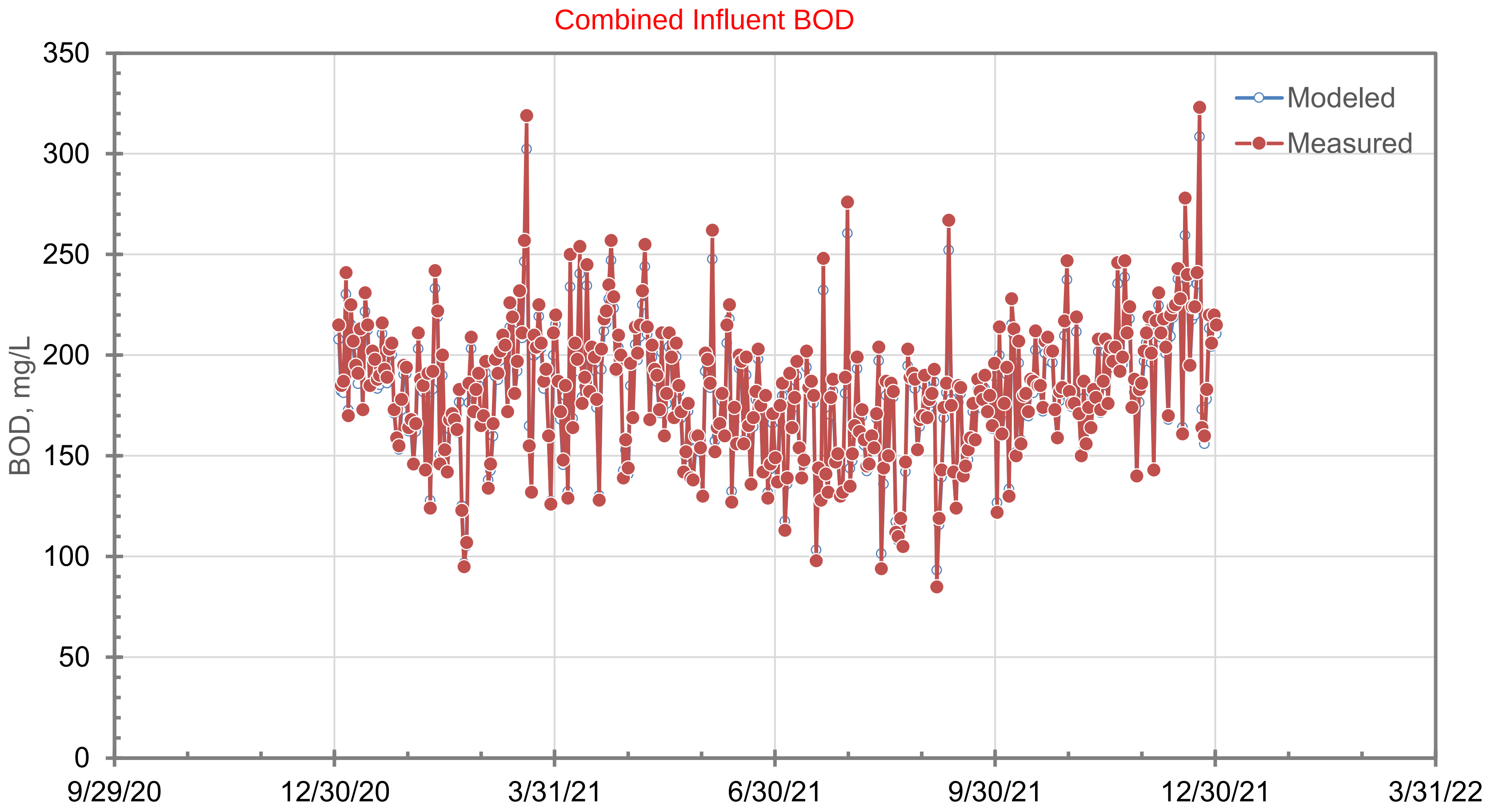
Potential Consequences of Failing to Complete Project:
Projected growth will result in flows in the 15-inch Stubline exceeding design capacity. Failure to complete this project will eventually require a moratorium on any growth once this pipeline reaches its capacity. If additional growth is allowed, the District risks SSOs into Birch Creek.

Project Triggers:
The project will be triggered when the peak flow in pipe OC204.1 (just east of Riverdale Rd.) exceeds 2.4 mgd. The flow in the pipe is currently at 2.1 mgd. This means approximately 1,000 additional ERUs can be developed upstream of the bottleneck. It is expected that this project will be needed in 5 years.

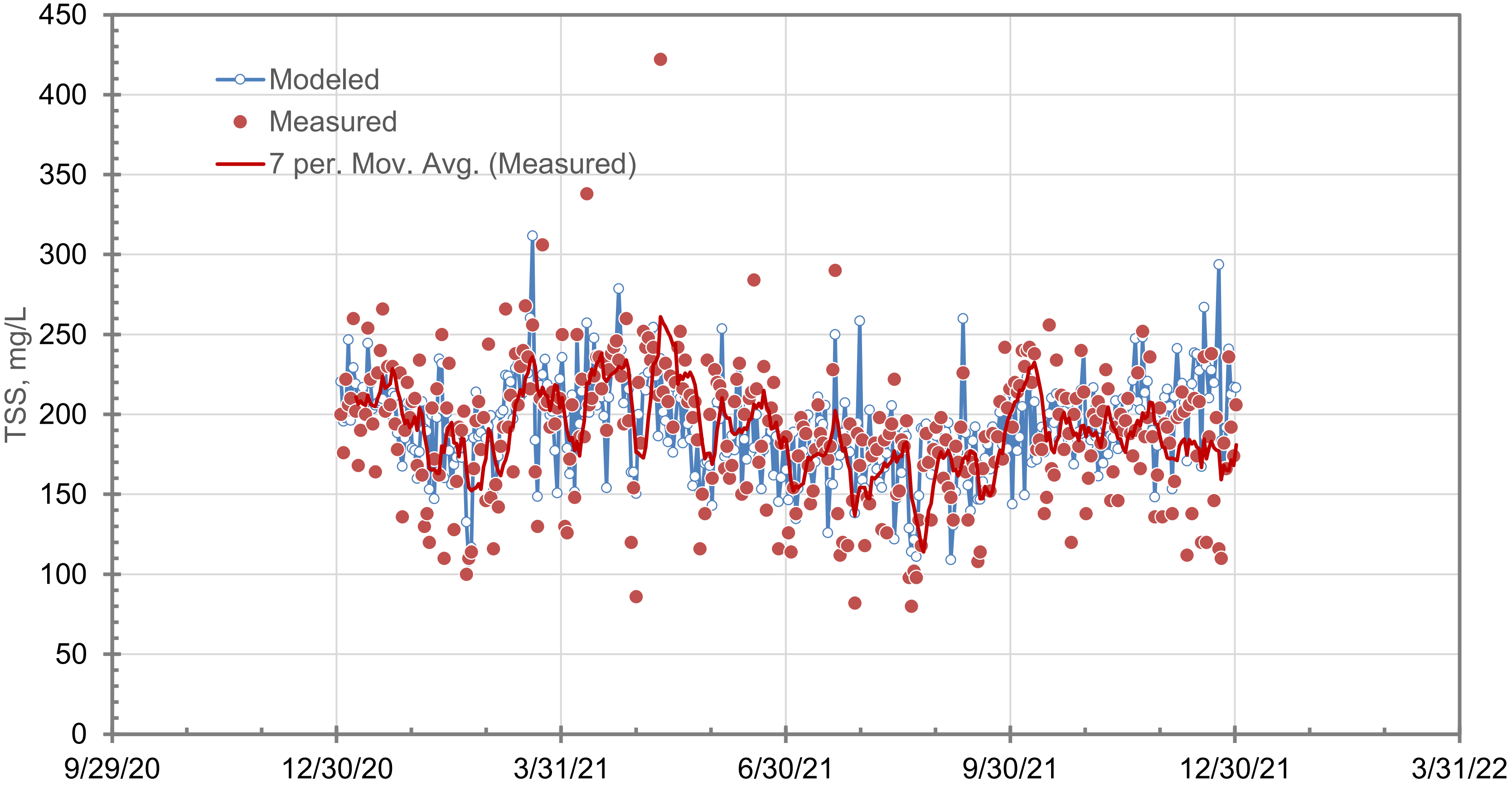
Current Estimated Project Completion Year: 2027

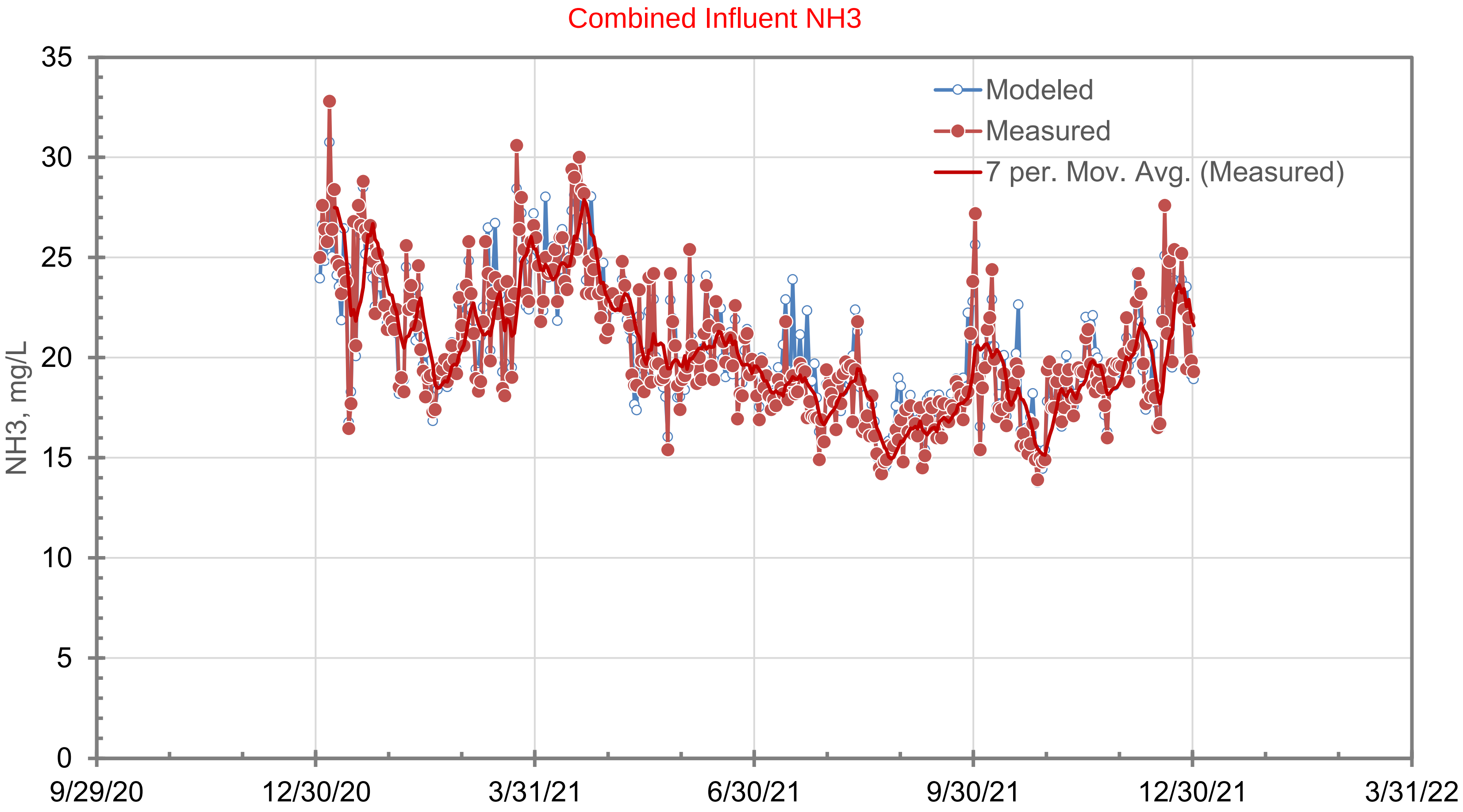
APPENDIX F

Treatment Plant Process Modeling Supplementary Data

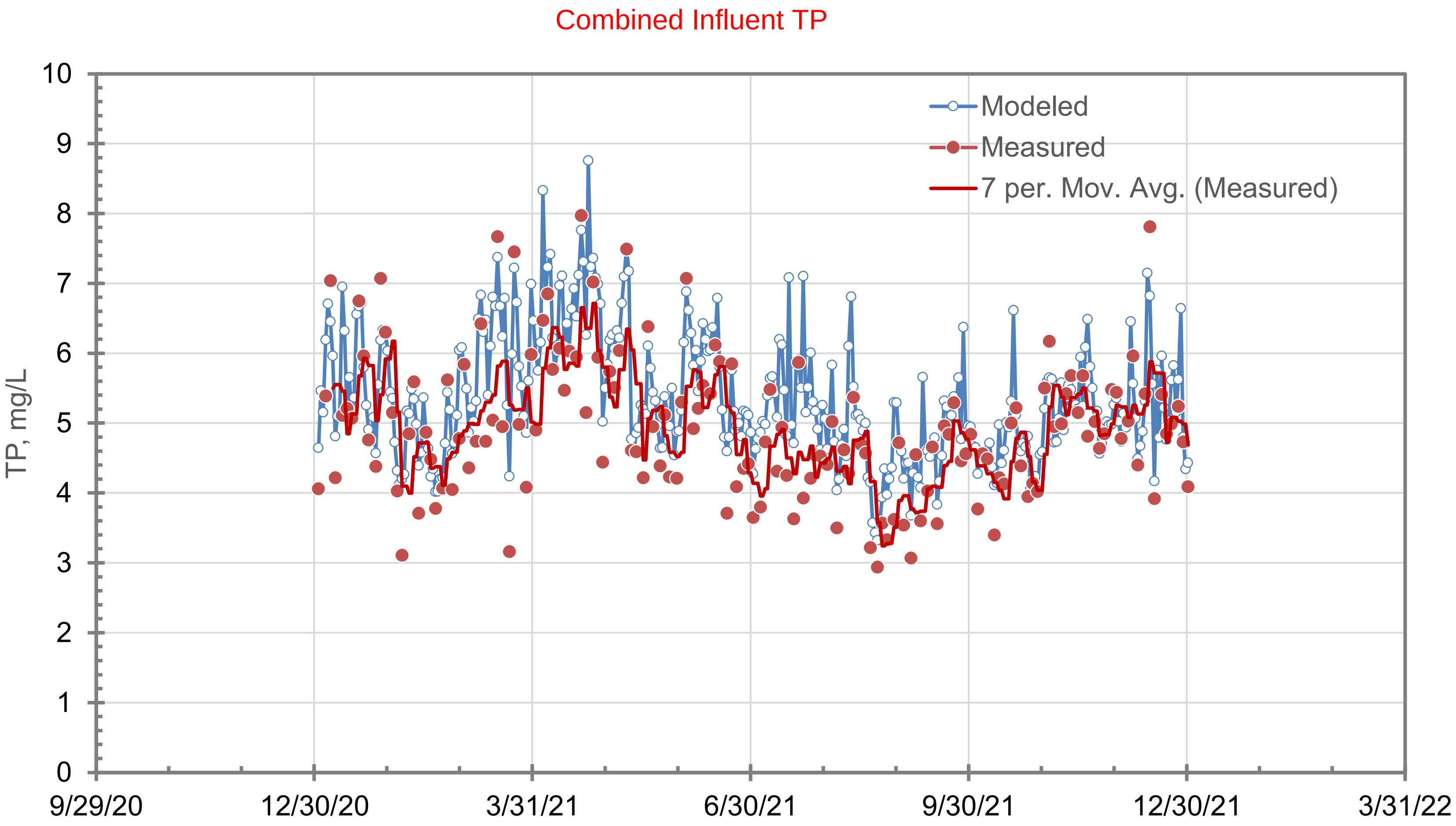

Combined Influent BOD
BOD, mg/L
350
300
250
200
150
100
50
0
9/29/20
12/30/20
3/31/21
6/30/21
9/30/21
12/30/21
3/31/22
Modeled
Measured

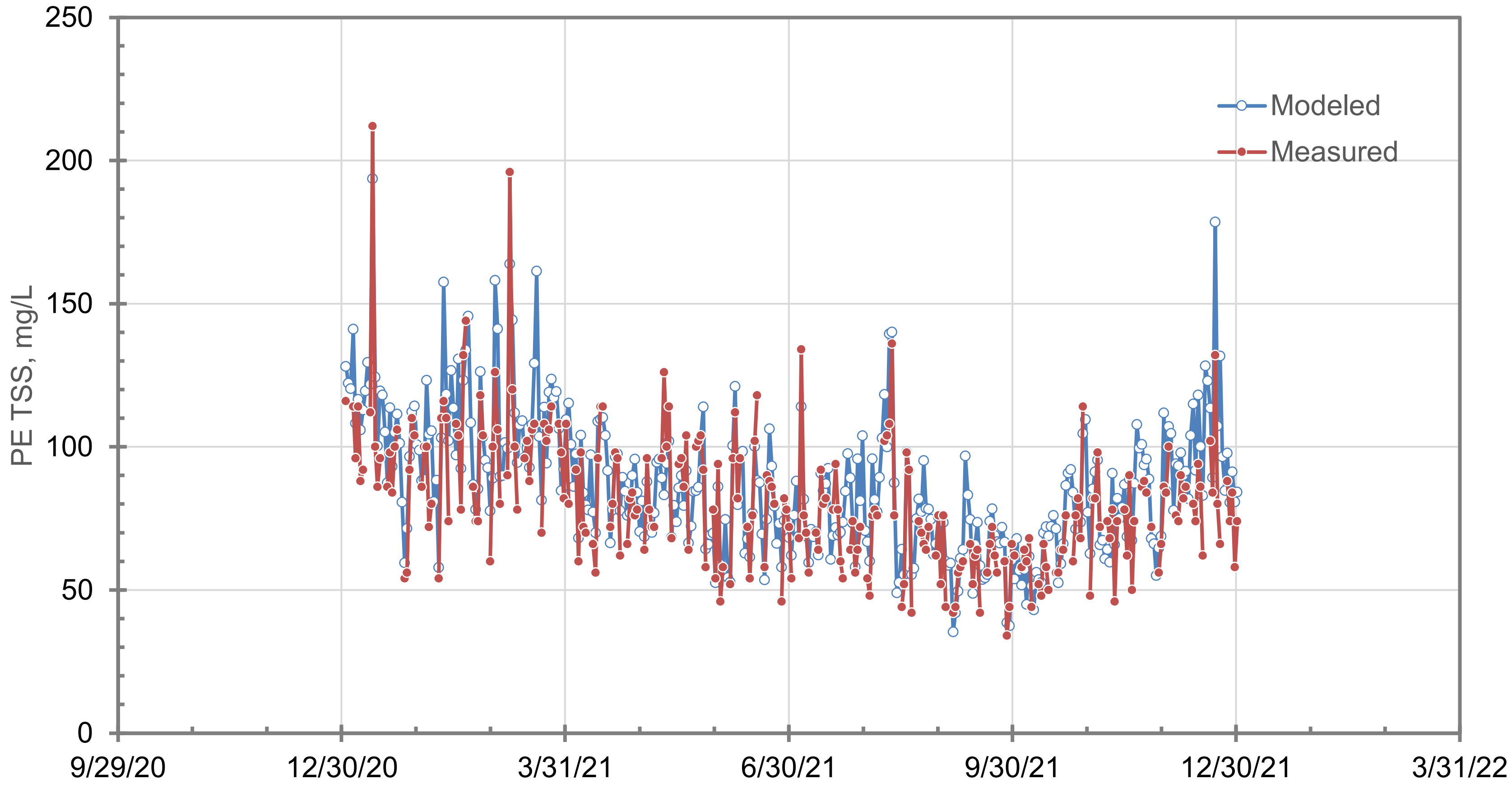
Combined Influent TSS



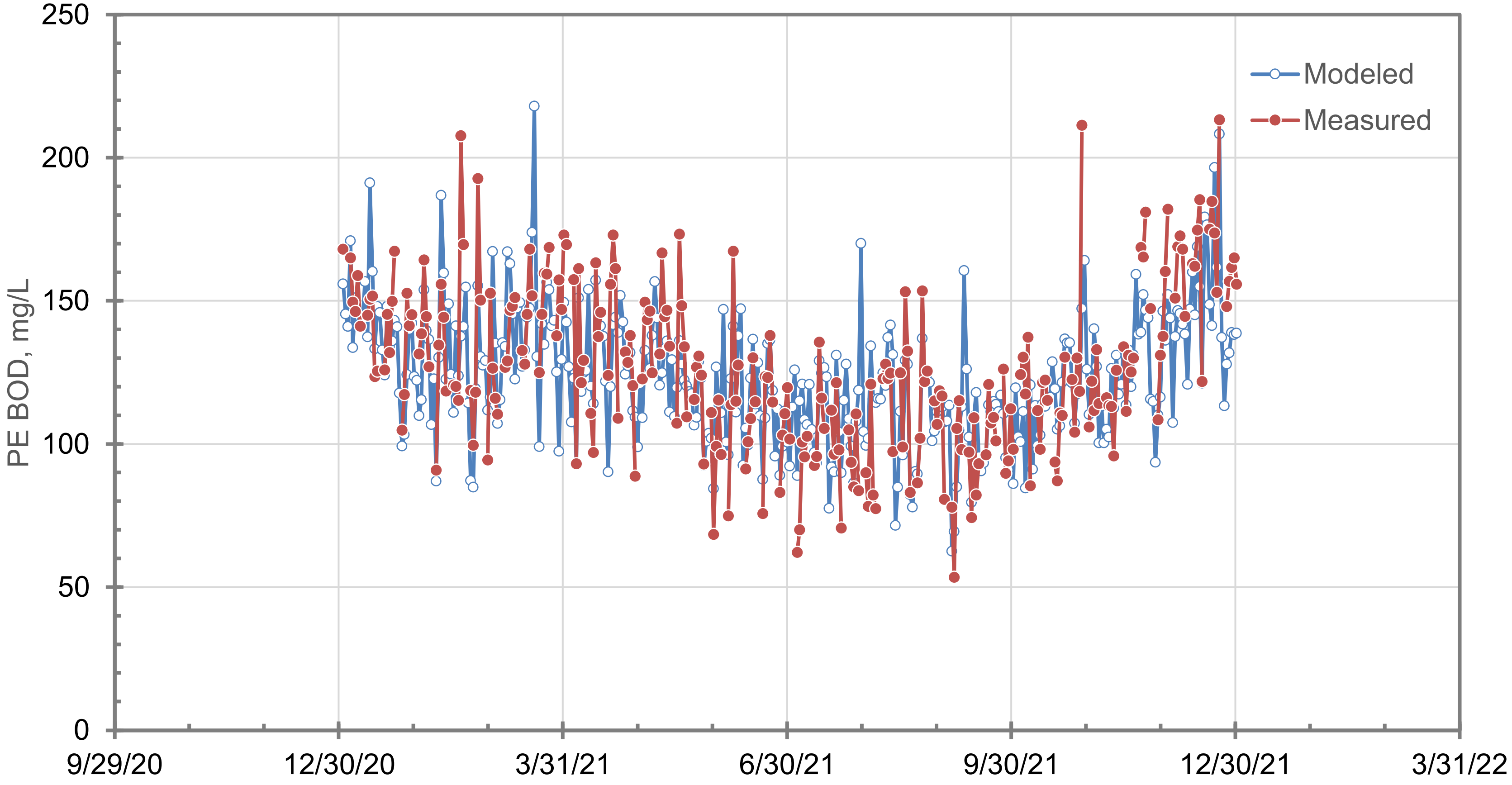


Combined Influent NH3
NH3, mg/L
35
30
25
20
15
10
5
0
9/29/20
12/30/20
3/31/21
6/30/21
9/30/21
12/30/21
3/31/22
Modeled
Measured
7 per. Mov. Avg. (Measured)

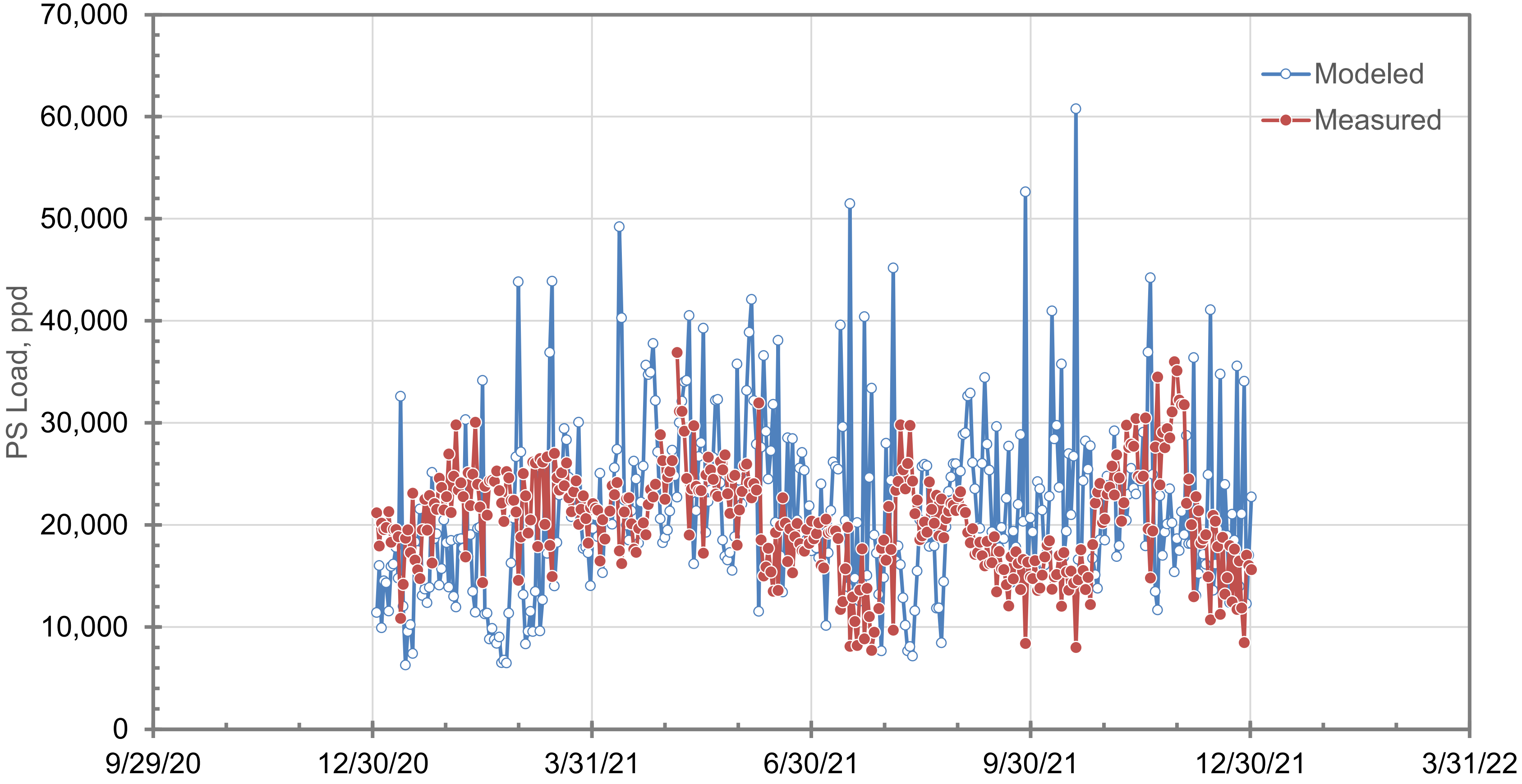

Combined Influent TP
TP, mg/L
0
1
2
3
4
5
6
7
8
9
10
9/29/20
12/30/20
3/31/21
6/30/21
9/30/21
12/30/21
3/31/22
Modeled
Measured
7 per. Mov. Avg. (Measured)



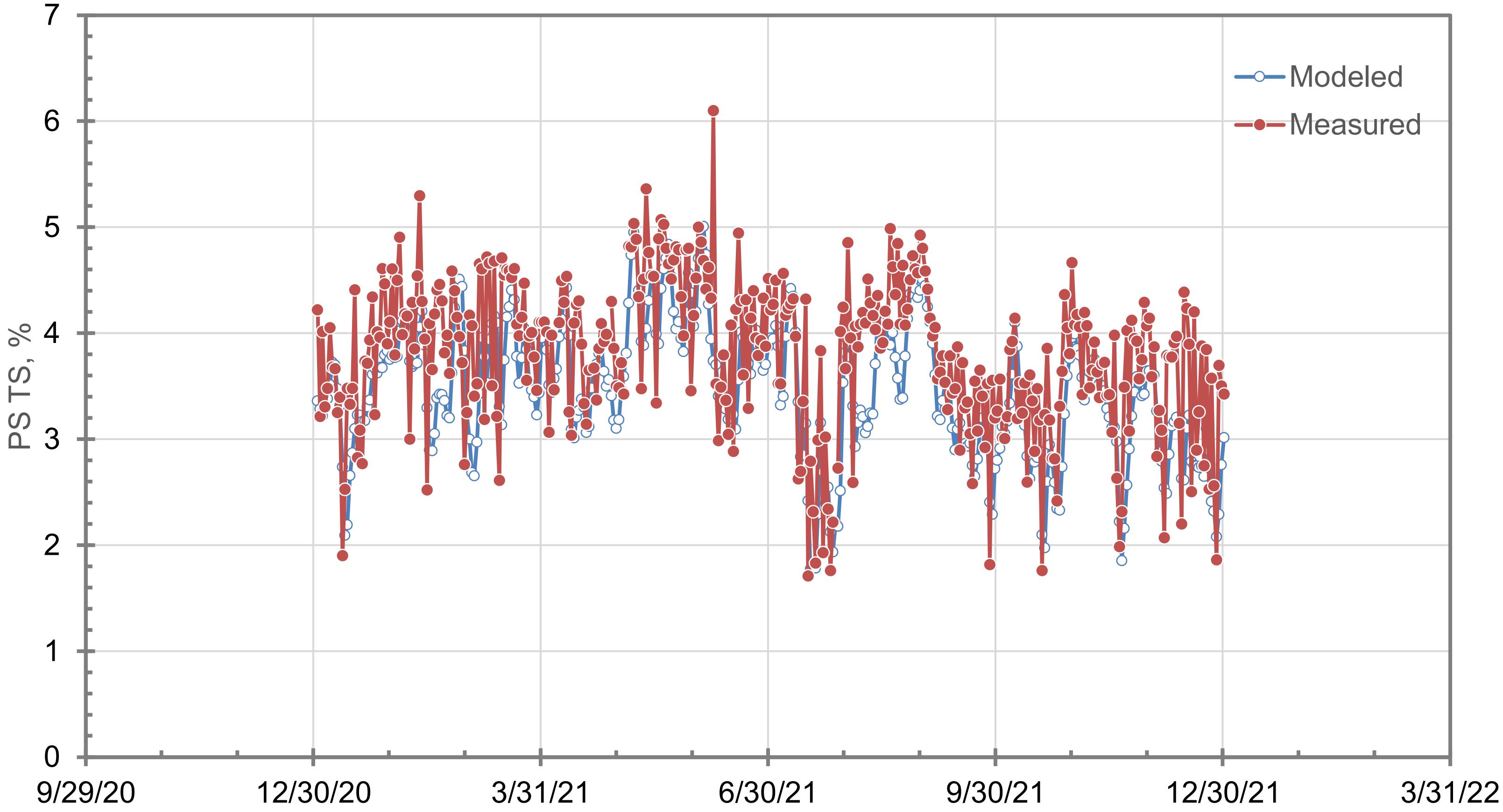
PE TSS, mg/L
250
200
150
100
50
0
9/29/20
12/30/20
3/31/21
6/30/21
9/30/21
12/30/21
3/31/22
Modeled
Measured

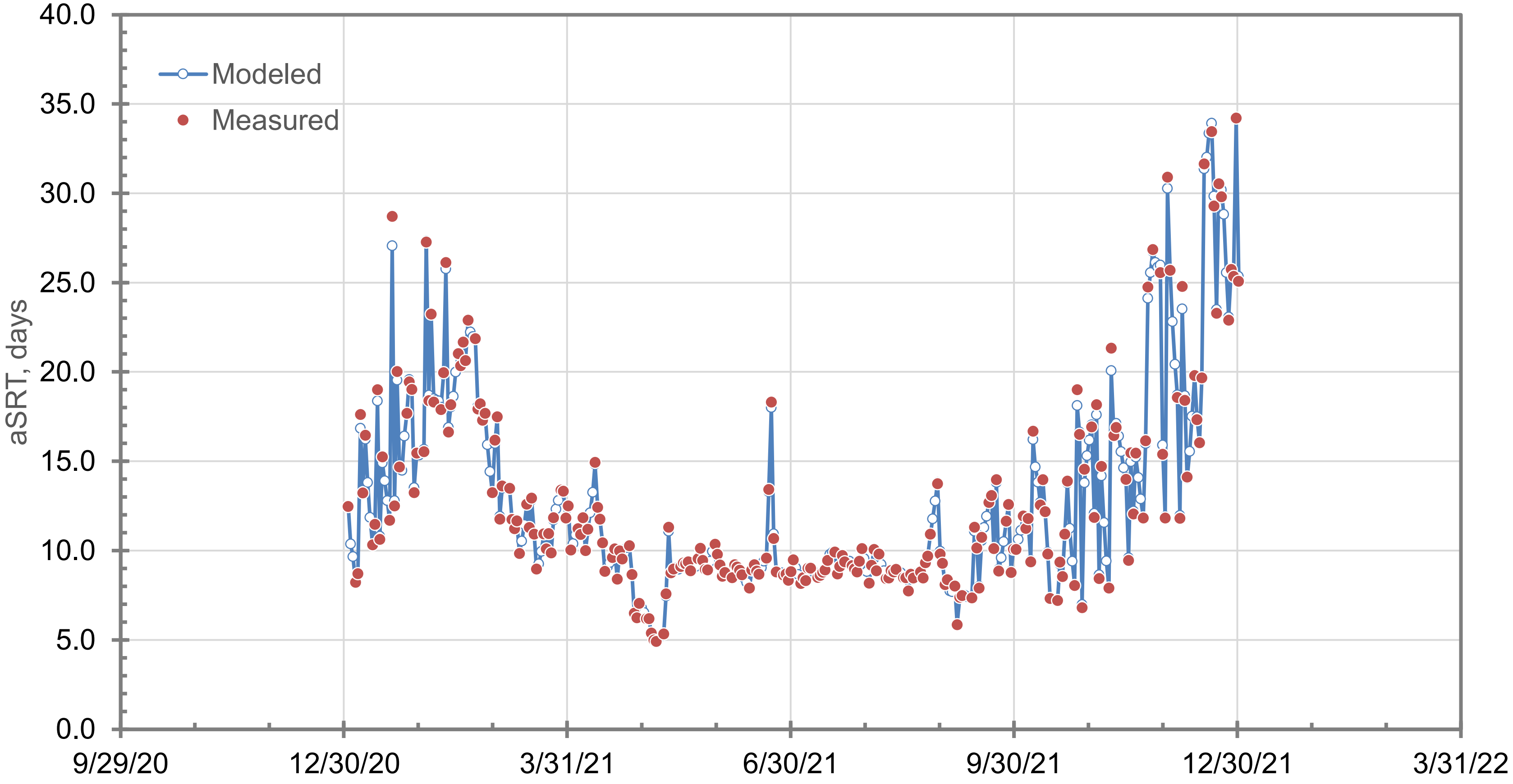


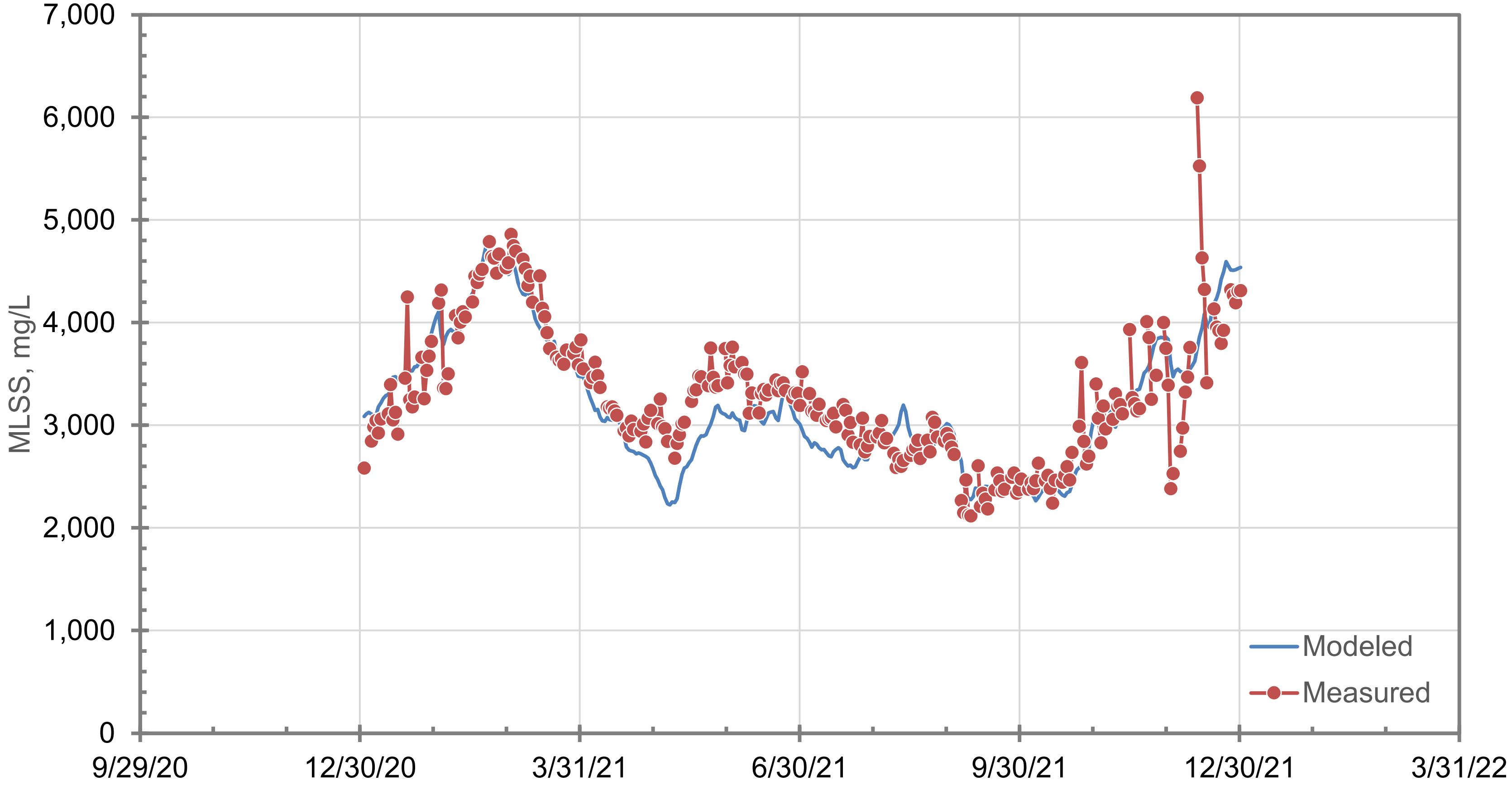
250
200
150
100
50
0
PE BOD, mg/L
9/29/20
12/30/20
3/31/21
6/30/21
9/30/21
12/30/21
3/31/22
Modeled
Measured

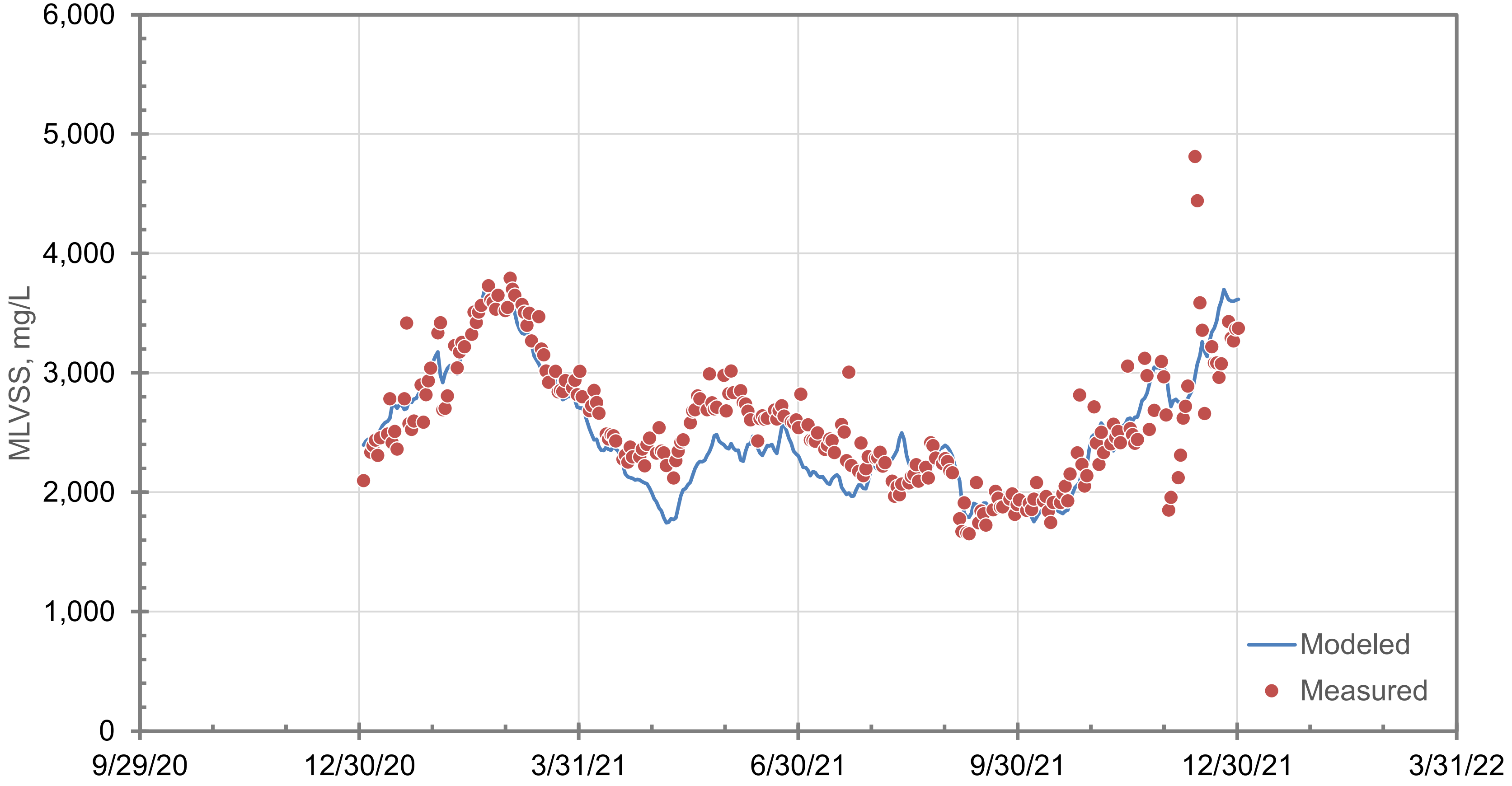


70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
PS Load, ppd
9/29/20
12/30/20
3/31/21
6/30/21
9/30/21
12/30/21
3/31/22
Modeled
Measured

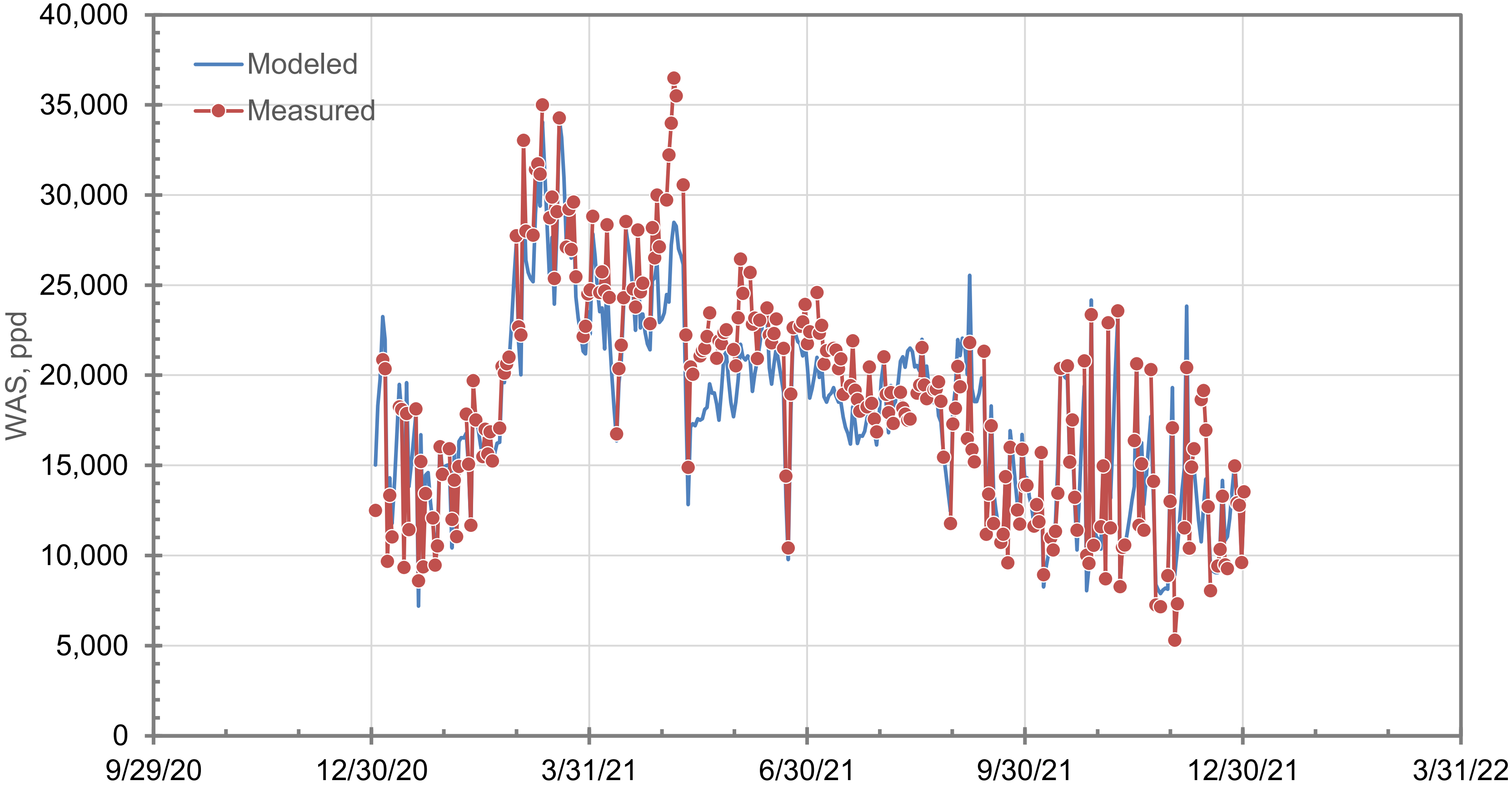

PS TS, %
0
1
2
3
4
5
6
7
9/29/20
12/30/20
3/31/21
6/30/21
9/30/21
12/30/21
3/31/22
Modeled
Measured


40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
aSRT, days
Modeled
Measured
9/29/20
12/30/20
3/31/21
6/30/21
9/30/21
12/30/21
3/31/22

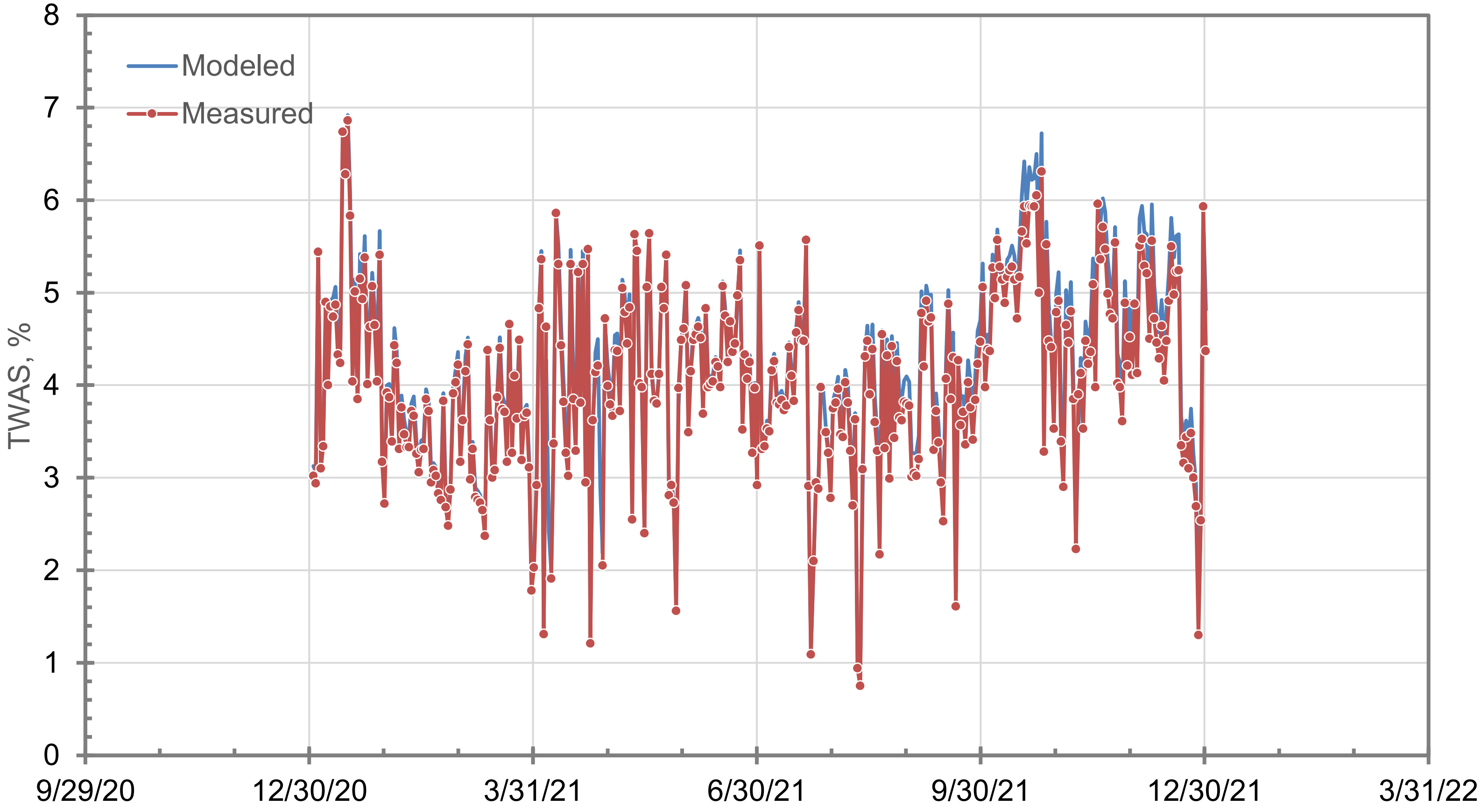

7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
MLSS, mg/L
9/29/20
12/30/20
3/31/21
6/30/21
9/30/21
12/30/21
3/31/22
Modeled
Measured

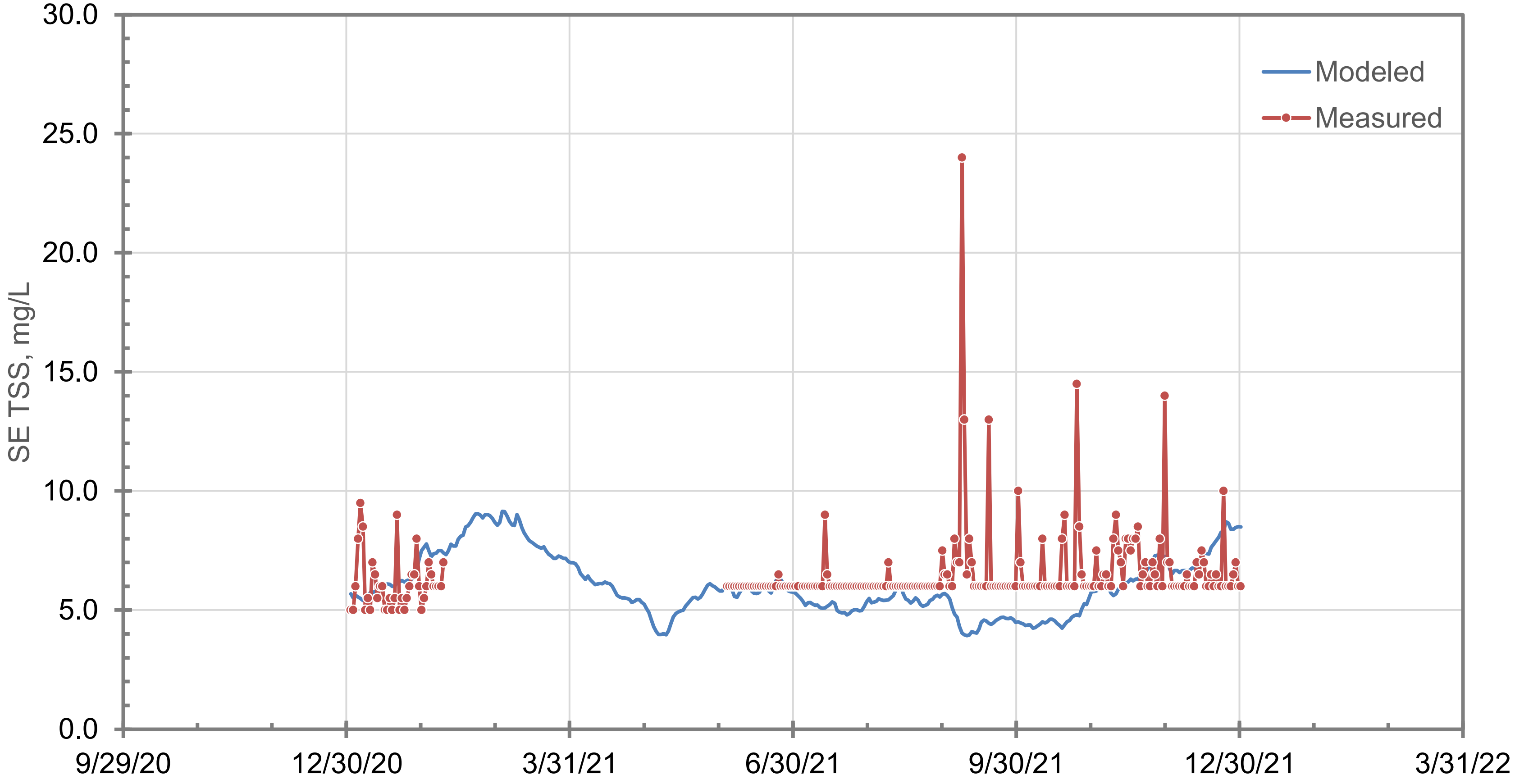


6,000
5,000
4,000
3,000
2,000
1,000
0
MLVSS, mg/L
9/29/20
12/30/20
3/31/21
6/30/21
9/30/21
12/30/21
3/31/22
Modeled
Measured

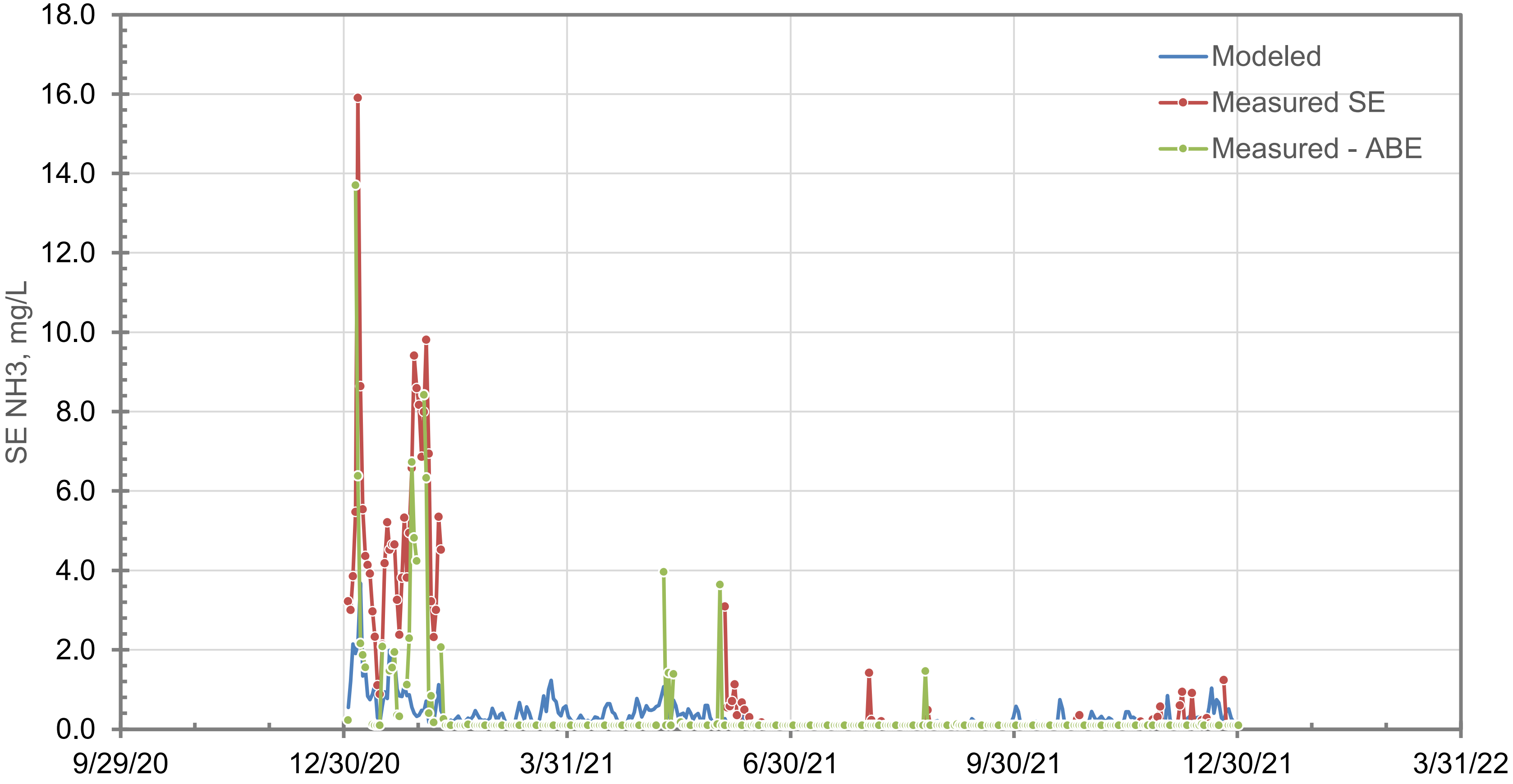


WAS, ppd
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
9/29/20
12/30/20
3/31/21
6/30/21
9/30/21
12/30/21
3/31/22
Modeled
Measured

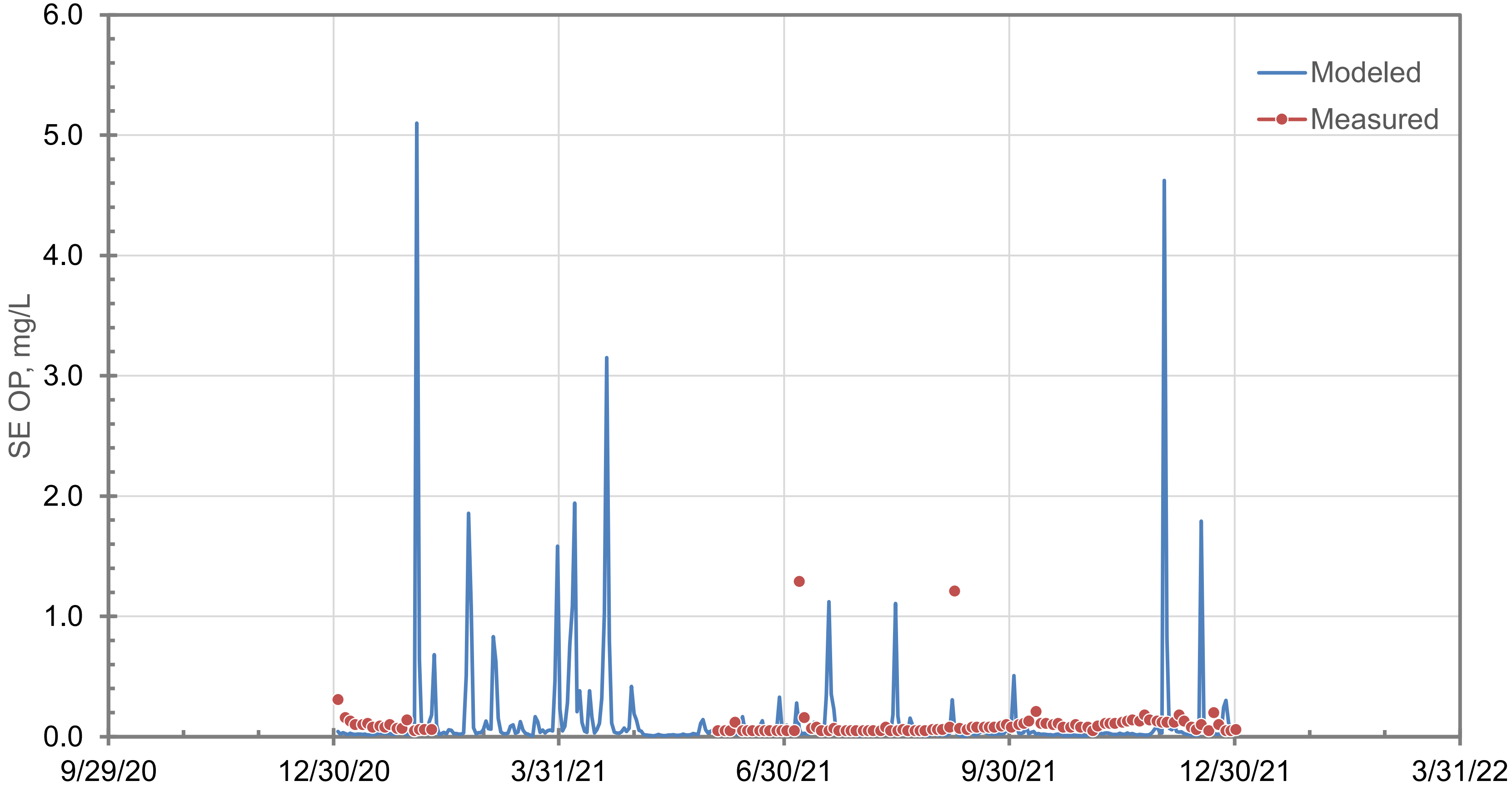

8
7
6
5
4
3
2
1
0
TWAS, %
Modeled
Measured
9/29/20
12/30/20
3/31/21
6/30/21
9/30/21
12/30/21
3/31/22

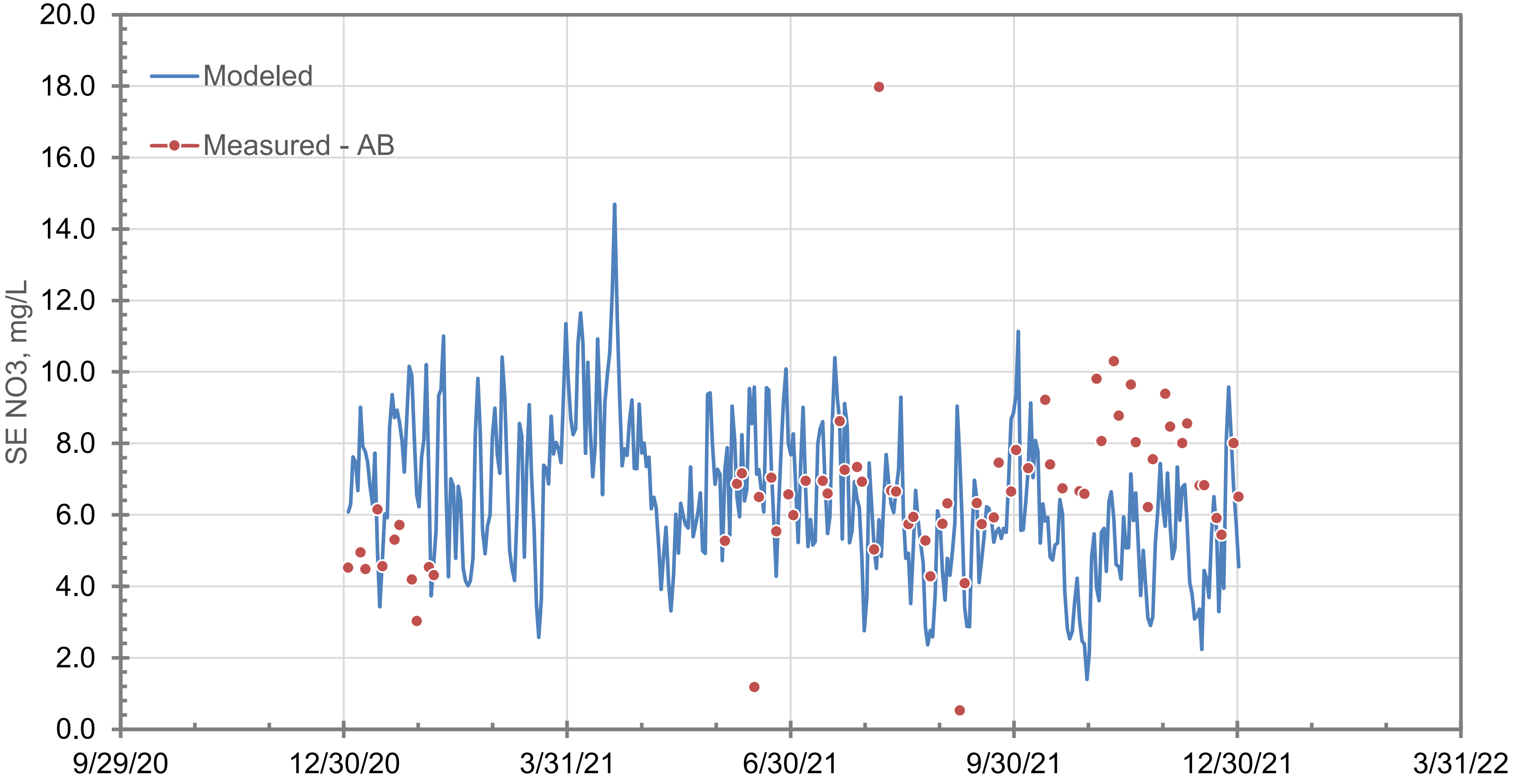


30.0
25.0
20.0
15.0
10.0
5.0
0.0
SE TSS, mg/L
9/29/20
12/30/20
3/31/21
6/30/21
9/30/21
12/30/21
3/31/22
Modeled
Measured

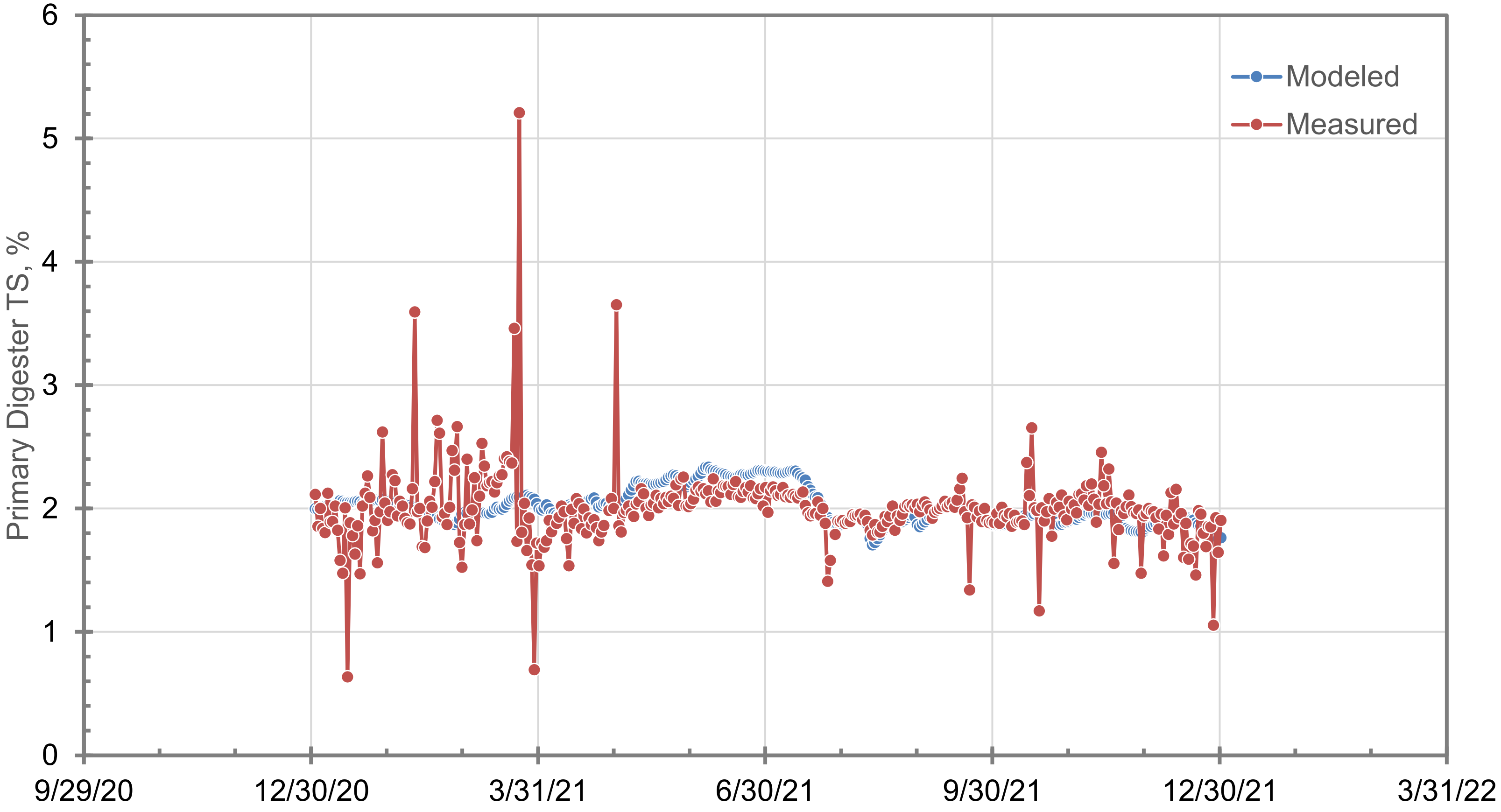


SE NH3, mg/L
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
9/29/20
12/30/20
3/31/21
6/30/21
9/30/21
12/30/21
3/31/22
Modeled
Measured SE
Measured - ABE

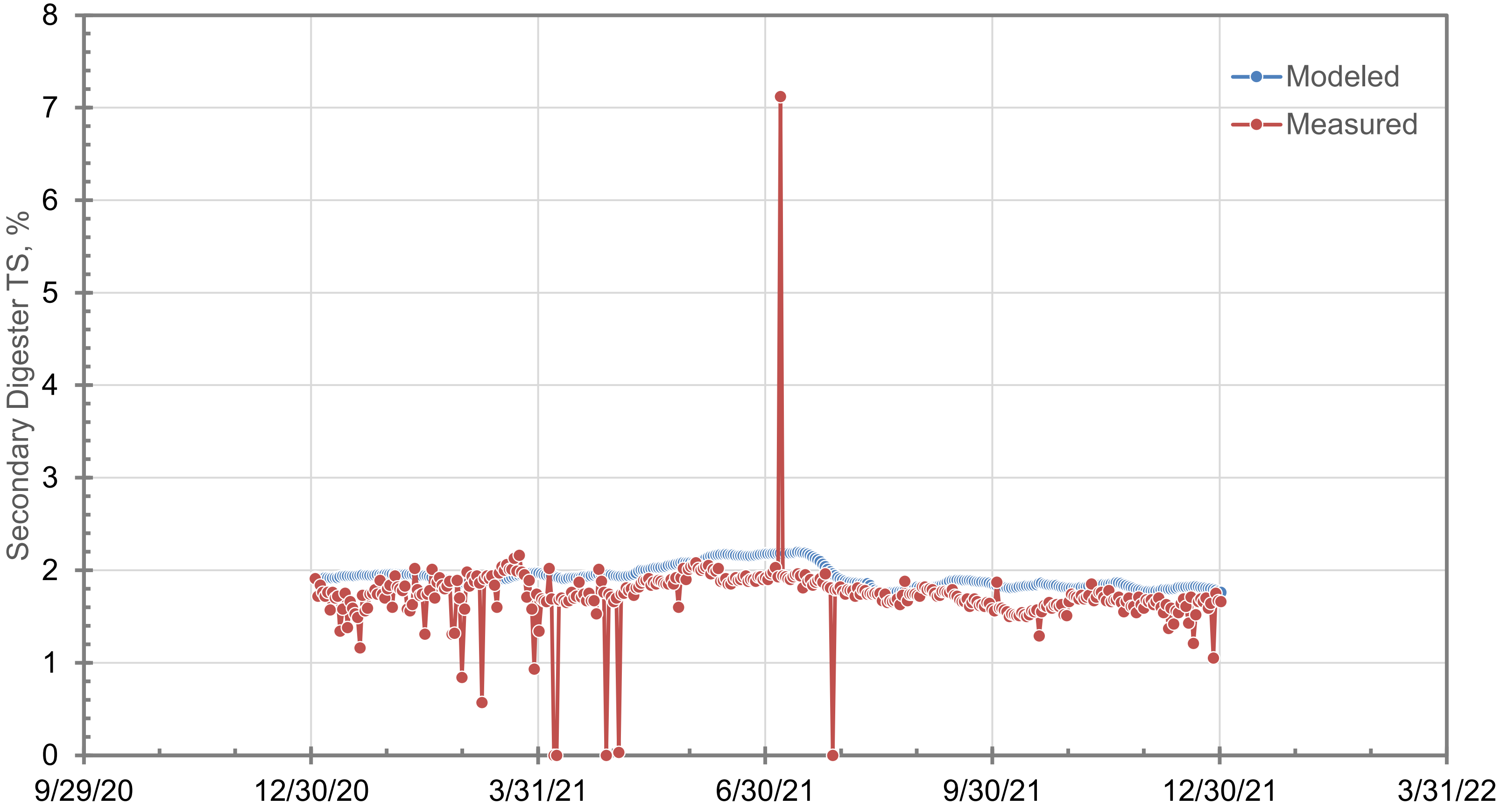

6.0
5.0
4.0
3.0
2.0
1.0
0.0
SE OP, mg/L
9/29/20
12/30/20
3/31/21
6/30/21
9/30/21
12/30/21
3/31/22
Modeled
Measured



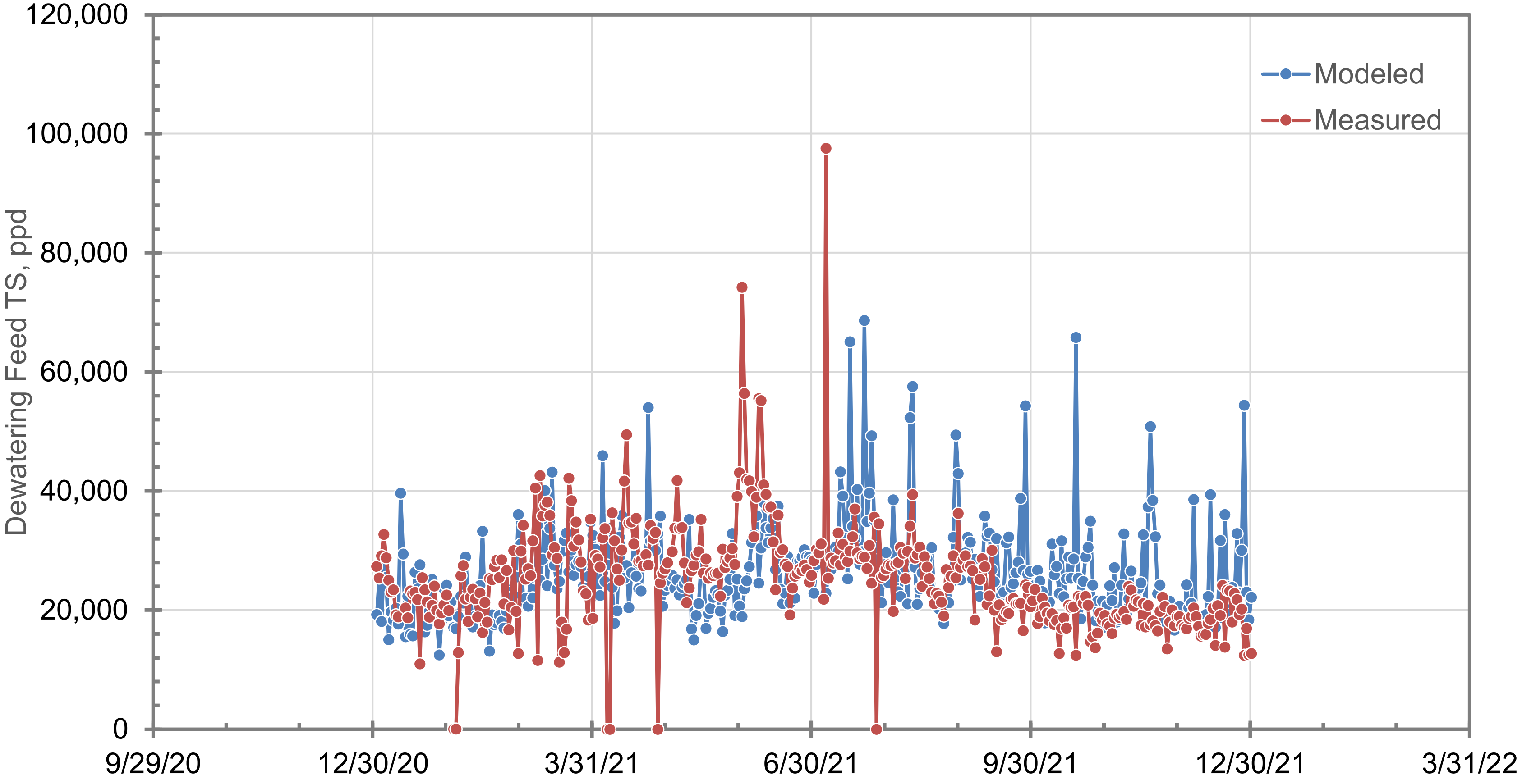
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
SE NO3, mg/L
Modeled
Measured - AB
9/29/20
12/30/20
3/31/21
6/30/21
9/30/21
12/30/21
3/31/22



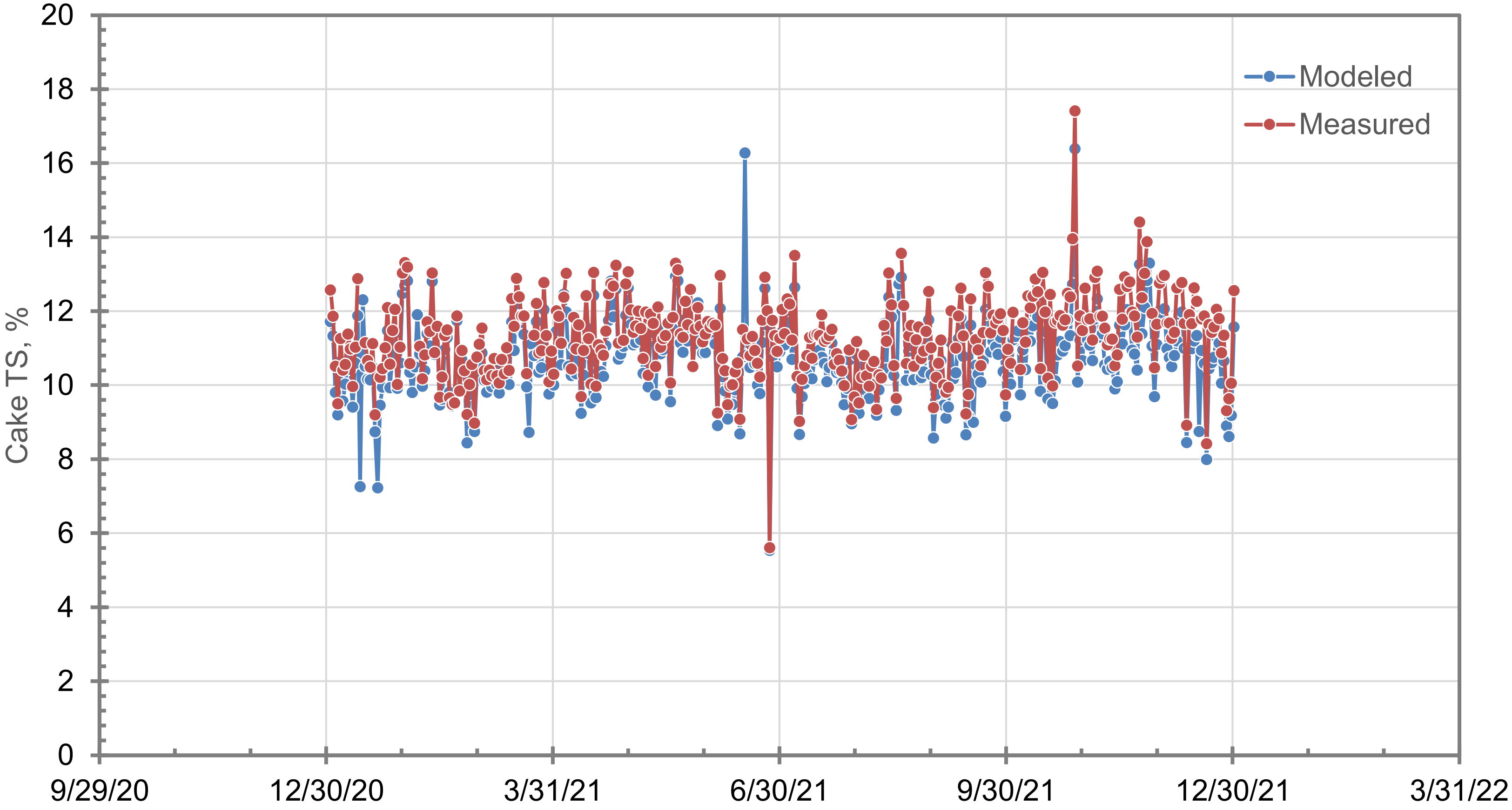
6
5
4
3
2
1
0
Primary Digester TS, %
9/29/20
12/30/20
3/31/21
6/30/21
9/30/21
12/30/21
3/31/22
Modeled
Measured



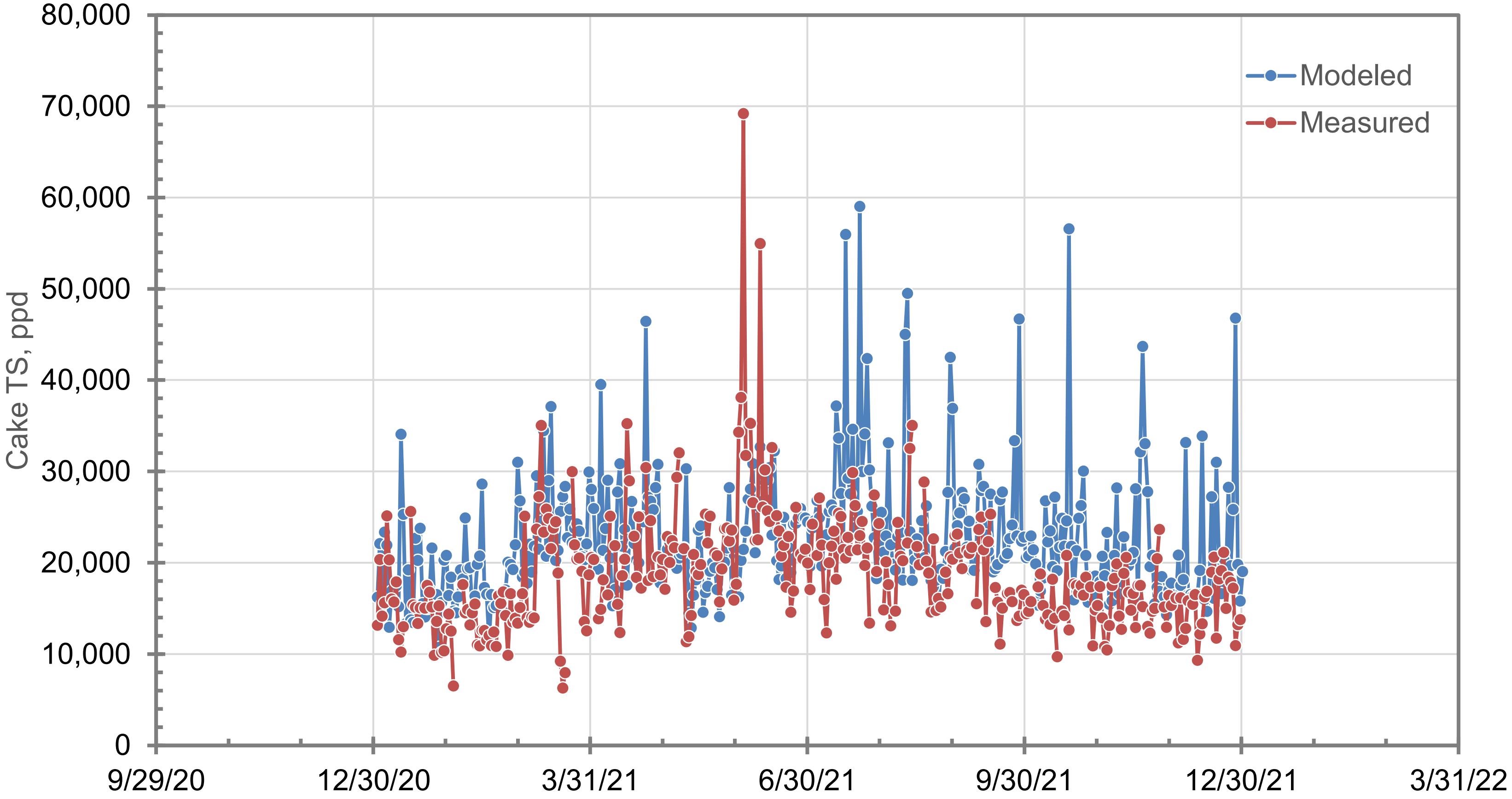
8
7
6
5
4
3
2
1
0
Secondary Digester TS, %
9/29/20
12/30/20
3/31/21
6/30/21
9/30/21
12/30/21
3/31/22
Modeled
Measured

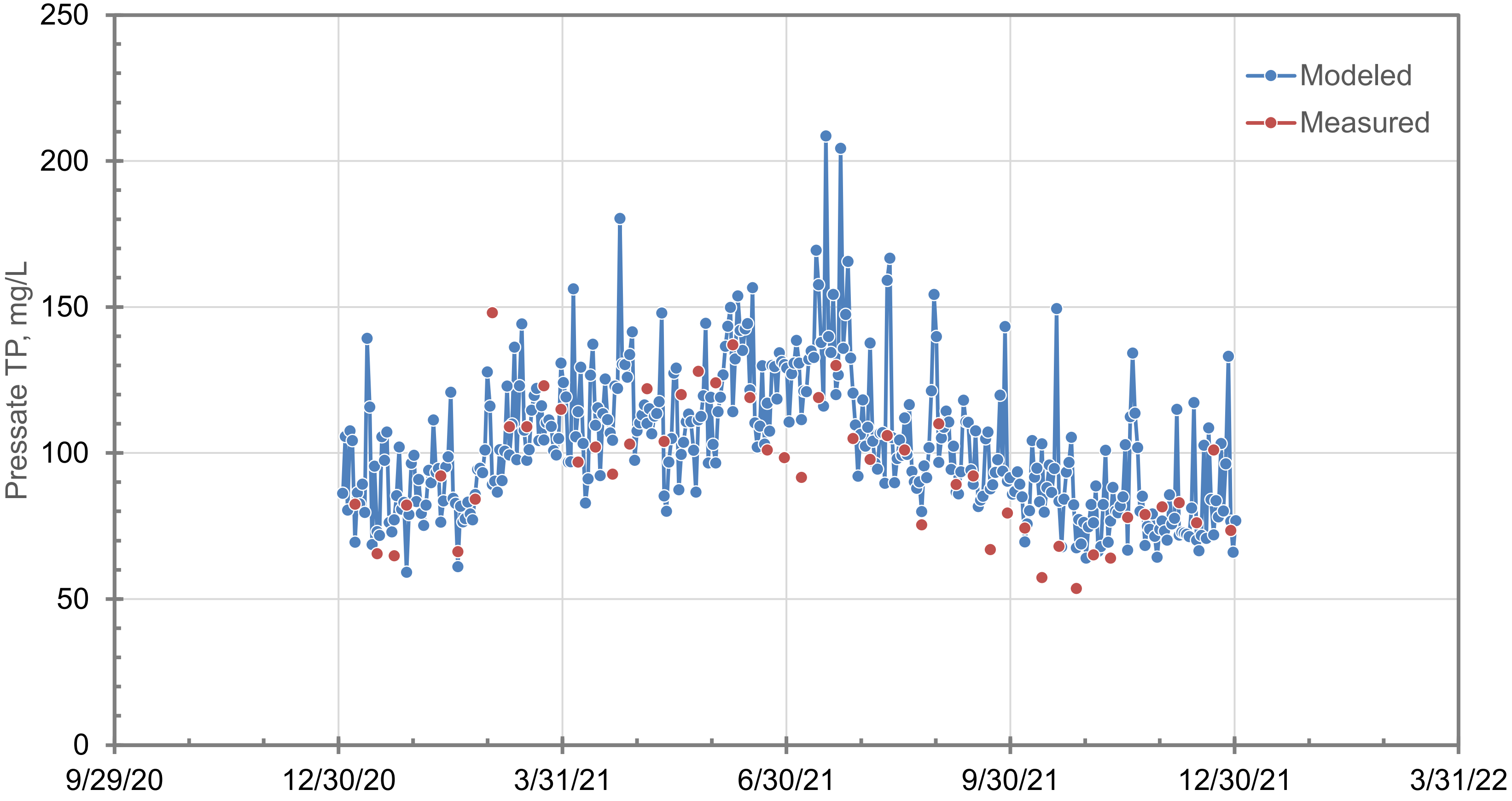


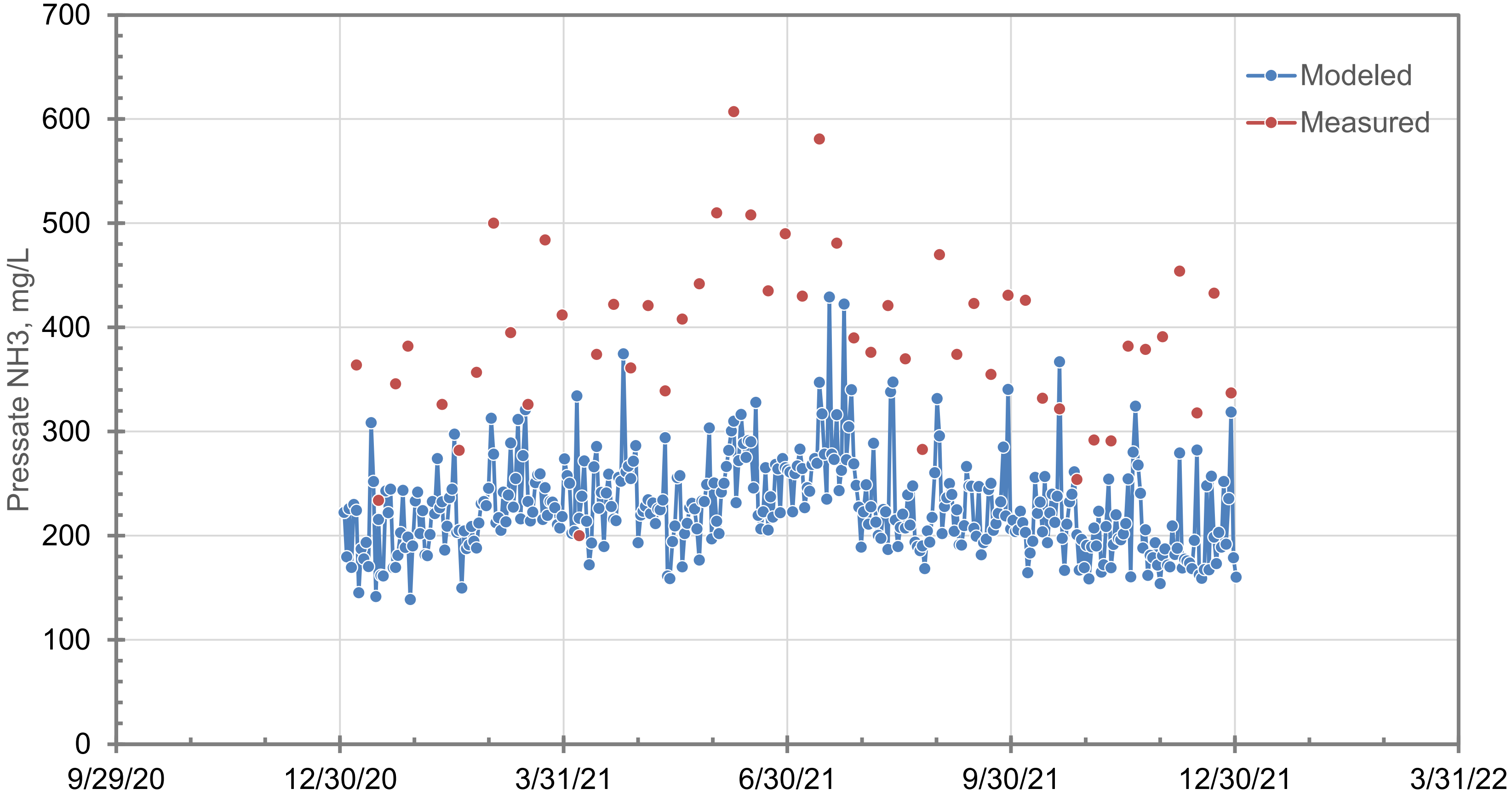
120,000
100,000
80,000
60,000
40,000
20,000
0
Dewatering Feed TS, ppd
9/29/20
12/30/20
3/31/21
6/30/21
9/30/21
12/30/21
3/31/22
Modeled
Measured



Cake TS, %
0
2
4
6
8
10
12
14
16
18
20
9/29/20
12/30/20
3/31/21
6/30/21
9/30/21
12/30/21
3/31/22
Modeled
Measured


Cake TS, ppd
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
9/29/20
12/30/20
3/31/21
6/30/21
9/30/21
12/30/21
3/31/22
Modeled
Measured


Pressate TP, mg/L
250
200
150
100
50
0
9/29/20
12/30/20
3/31/21
6/30/21
9/30/21
12/30/21
3/31/22
Modeled
Measured


Pressate NH3, mg/L
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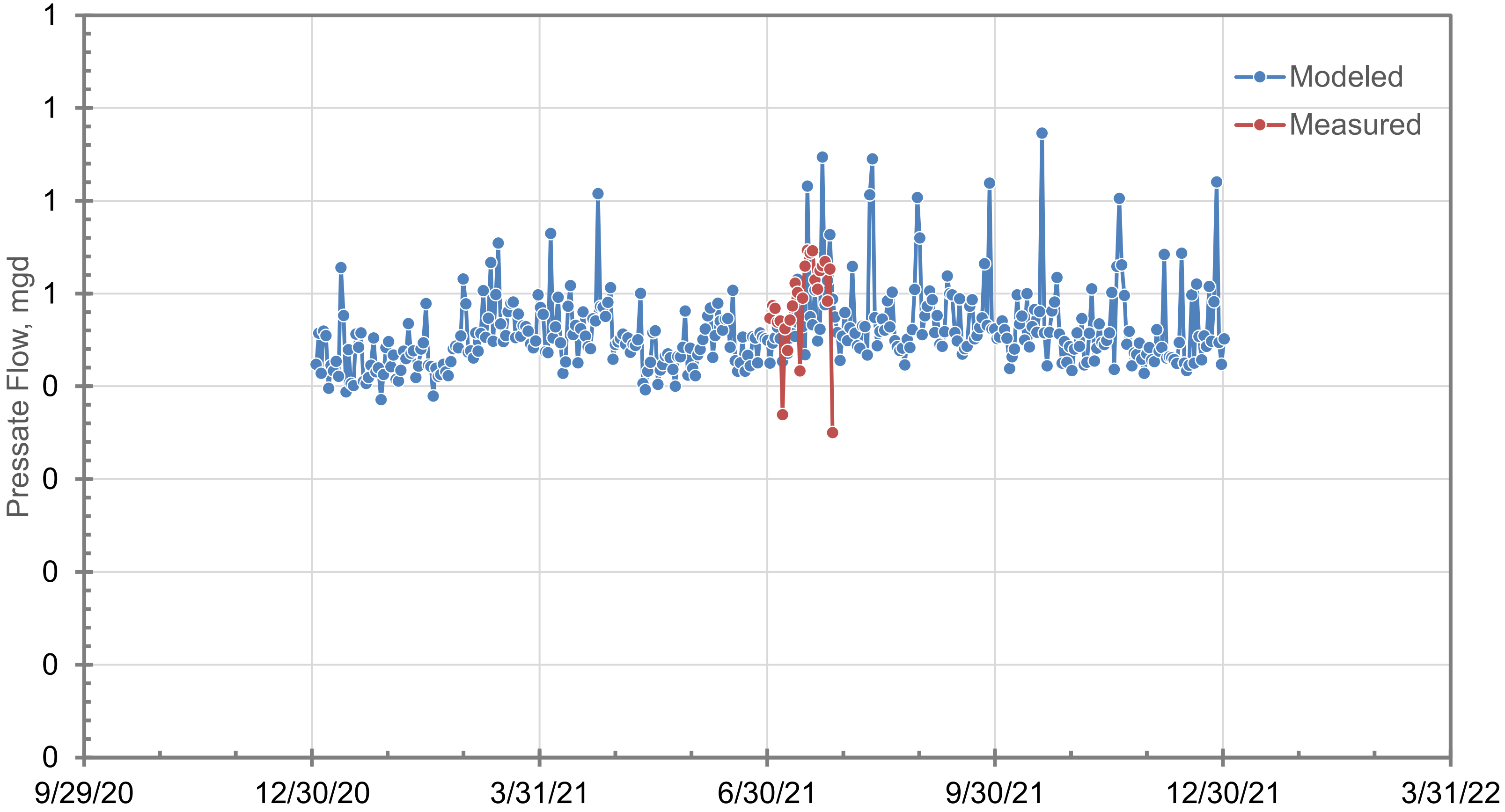
600
500
400
300
200
100
0
9/29/20
12/30/20
3/31/21
6/30/21
9/30/21
12/30/21
3/31/22
Modeled
Measured


1
1
1
1
0
0
0
0
0
Pressate Flow, mgd
9/29/20
12/30/20
3/31/21
6/30/21
9/30/21
12/30/21
3/31/22
Modeled
Measured

APPENDIX G

Treatment Plant Equipment Proposals

BUDGET PROPOSAL

Ogden, UT

Equipment:
HUBER BT 24 Belt Dryer

Represented by:
Goble Sampson Associates
Dave Ritter
(801) 268-8790
dritter@goblesampson.com

Regional Sales Director:
Ron Maiorana
704-718-4477
ron.maiorana@hhusa.net

Project Number: 481453
Revision: 1
Date: 10/6/2022

HUBER Technology, Inc.
1009 Airlie Pkwy, Denver, NC 28037
704-949-1010 | www.huber-technology.com

Design Information

Technical Data[1]

Sludge Type	**Digested Sludge**		**Assumption**
Digestion Process	**Anaerobic Digester**		**Assumption**
Digestion Process SRT	**≥ 30**	**days**	**Assumption**
Industrial Sludge by weight	**≤ 15**	**% wt**	**Assumption**
Design Feed Rate	**41000**	**dry lbs/day**	**Given**
Dry Mass Loading Rate	**7482.5**	**dry ton/yr**	**Calculated**
Wet Mass Loading Rate	**46765.625**	**wet ton/yr**	**Calculated**
Feed Cake Concentration	**16**	**%**	**Given**
Cake Dewaterability	**≥ 90% of maximum dewaterability[2]**		**Assumption**
Cake Volatile Suspended Solids	**≤ 70**	**%**	**Assumption**
Cake Protein Content	**≤ 30**	**%**	**Assumption**
Sludge pH	**6.5-7.5**	**SU**	**Assumption**
Cake Storage Time	**≤ 8**	**hr**	**Assumption**
Cake Pumping Distance	**≤ 50 with max 4 bends**	**ft**	**Assumption**
Cake Consistency	**Non-thixotrophic**		**Assumption**
Dewatering Polymer Consumption	**≤ 30**	**lb act/dry ton**	**Assumption**
Estimated Operational Schedule	**8000**	**hr**	**Assumption**
Cake Density (assumed)	**55**	**lb/cuft**	**Assumption**
Dried Product Density (assumed)	**25**	**lb/cuft**	**Assumption**

[1] Assumptions are made based on no sample being available for analysis. Assumptions apply to the stated performance of the HUBER dryer, not the ability of the dryer to process sludge which varies from these assumptions.

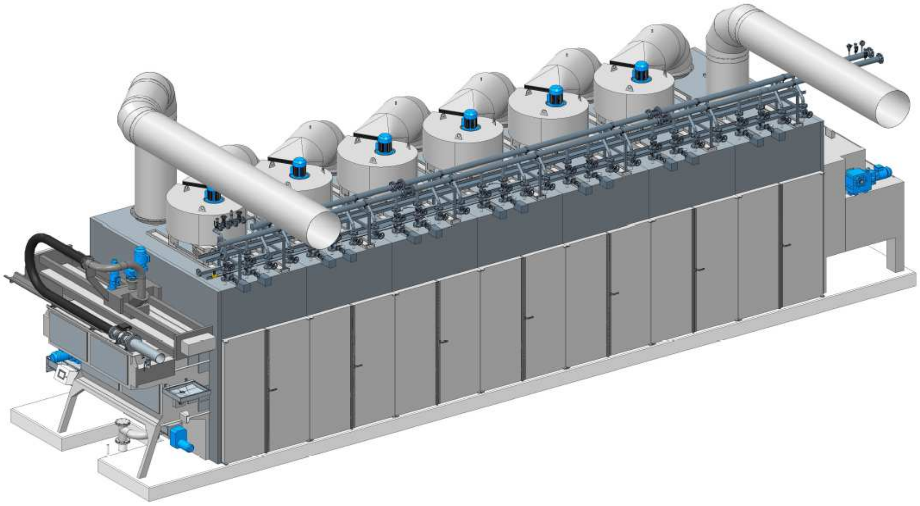
[2] Maximum dewaterability determination, if required, shall be based on the acceptable equipment dewaterability determined by the KB Kopp laboratory.

Design Calculations

Calculated Feed Rate to Dryer	**1,871**	**dry lb/hr**
Calculated Feed Rate to Dryer	**11,691**	**wet lb/hr**
Estimated Product Dry Solids	**92**	**%**
Annual Water Evaporation Requirement	**38,632**	**ton water/yr**
Hourly Water Evaporation Requirement	**9,658**	**lb water/hr**
Annual Product Discharge Rate	**8,133**	**wet ton/yr**
Hourly Product Discharge Rate	**2,033**	**wet lb/hr**

Dryer Design Parameters

Recommended Unit Model	**BT 24**	
Recommended Unit Quantity	**2**	
Air Flow Design	**Fresh Air System**	
Thermal Heat Source	**Hot Water Boiler (Digester Gas)**	
Estimated Heat Supply Temperature	**203**	**°F**
Estimated Heat Required for Evaporation (at dryer)	**1,300**	**Btu/lb water**
Estimated Heat Demand (at dryer)	**12.56**	**MMBTU/hr**
Estimated Electrical Consumption	**0.031**	**kWh/lb water**
Estimated Dryer Power	**299**	**kWh**
Estimated Exhaust Air Flow	**14,700**	**CFM**



Equipment Details

Model	**BT 24**
Quantity	2

Items indicated below are per dryer unless stated otherwise

Dryer Belts	
Number of Belts	Two (2) per dryer
Belt Material	Temperature Resistant Plastic
Upper Belt Drive	5 hp, 460 VAC, 3 ph, 60 Hz, VFD driven (estimated)
Lower Belt Drive	1 hp, 460 VAC, 3 ph, 60 Hz, VFD driven (estimated)
Belt Washing System	Two (2), one for each belt
Belt Washing System Drive	0.5 hp, 460 VAC, 3 ph, 60 Hz
Washwater Booster Pump	One (1) common pump; 5 hp, 460 VAC, 3 ph, 60 Hz
Support Frame	
Internal Frame	304L Stainless Steel
Head Pieces	304L Stainless Steel
Interior Panels	304L Stainless Steel
Exterior Panels	Painted Steel
Extruder System	
Traction Drive System	1.5 hp, 460 VAC, 3 ph, 60 Hz, VFD driven (estimated)
Cutter Knife System	7.5 hp, 460 VAC, 3 ph, 60 Hz, VFD driven (estimated)
Materials	304L Stainless Steel
Feed Hose	6-inch, proprietary rubber (connects at end of dryer, see drawings)
Heat Exchangers	
Main Heat Exchangers	Twenty four (24)
Heat Exchanger Material	Combination 304 stainless steel, AlMg
Heat Exchanger Valve	24 modulating valves (one per heat exchanger); 120 VAC
Preheat Heat Exchanger	One (1); combination of galvanized steel, copper, and AlMg
Recovery Heat Exchangers	Two (2); combination of 304 stainless steel, galvanized steel, copper, and AlMg
Recovery Recirculation Pump	1 hp, 460 VAC, 3 ph, 60 Hz
Recovery HX Cleaning System	0.5 hp, 460 VAC, 3 ph, 60 Hz with 6 Brass SV remotely mounted
Washwater Booster Pump	Pump; 15 hp, 460 VAC, 3 ph, 60 Hz
Process Air Fans	
Number of Process Fans	Eleven (11)
Materials	304 stainless steel
Drive Motor	10 hp, 460 VAC, 3 ph, 60 Hz
Exhaust Air Fan(s)	
Number of Exhaust Fans	One (1)
Materials	304 stainless steel
Drive Motor	50 hp, 460 VAC, 3 ph, 60 Hz (estimated)
Fresh Air Inlet Box	
Materials	304 stainless steel
Outlet Conveyor	
Type	Shafted screw conveyor
Materials	304 stainless steel
Drive Motor	2 hp, 460 VAC, 3 ph, 60 Hz
Safety Systems	
Emergency Cooling System	Brass Bodied SV, pipe work on top of the dryer
Firefighting System	Pipe work on top of the dryer, Valve by others

Instrumentation (HUBER standard*)			
Moisture Sensors	Temperature Sensors	Level Sensors	Proximity Sensors
Pressure Sensors	Motion Sensors	Flow Meters	Calorimeter
Safety Switches (Access Door)	Camera (Extruder)		

*Instrumentation subject to change based on latest design. HUBER will provide the most current controls design for the HUBER BT dryer.

Ancillary Equipment

Ancillary Equipment	
Control Panel	with Allen Bradley PLC and HMI
Motor Control Center	Allen Bradley
Scrubber System	Two-stage Odor Scrubber System
Hot Water Boiler	Digester Gas Fired Boiler
Heat Recovery and Cleaning Pump	

Pricing

Equipment	Model	Quantity	Pricing
HUBER Belt Dryer	BT 24	2	Included
Ancillary Equipment			Included
Freight and Startup Services	Standard HUBER Start-up Services		Included
TOTAL:			**$10,880,000.00**

Optional Ancillary Equipment

(Optional equipment may be supplied by HUBER but are not included in pricing shown above.)

Option	Description
HUBER's Standard Feed Cake Hopper	Live Bottom Hopper
HUBER's Standard Feed Cake Pump	Progressive Cavity
HUBER's Standard Dry Product Conveyor	Tubular Drag Conveyor
HUBER's Standard Pelletizer	Pellet Mill
HUBER's Standard Product Storage Silo	Storage Silo w/ Nitrogen System

Standard delivery is 36-42 weeks from approval of submittals.

Thank you for your interest in HUBER Technology, Inc. If you have any questions, please do not hesitate to contact our Regional Sales Director or our local sales representative.

This proposal has been reviewed for accuracy and approved for issue by: ZMA

Notes and Technical Clarifications

1. Equipment specification and drawings are available upon request.
2. If there are site-specific hydraulic constraints that must be applied, please consult the manufacturer's representative to ensure compatibility with the proposed system.
3. Huber Technology warrants all components of the system against faulty workmanship and materials for a period of 12 months from date of start-up or 18 months after shipment, whichever occurs first.
4. Budget estimate is based on Huber Technology's standard Terms & Conditions and is quoted in US dollars unless otherwise stated.
5. Equipment recommendations are based on information provided to Huber Technology. Subsequent information which differs from what has been provided may alter the equipment recommendation.
6. Pricing is based HUBER's standard equipment, standard dryer system design, standard controls, and standard warranty.
7. The offer is based on normal, homogenous municipal sludge with a minimum organic content of 30% and a maximum organic content of 70%. Sludge with organic content around 70% is assumed to have less than 45% protein value.
8. Feed sludge must be free of any foreign matter to the greatest extent possible. Maximum particle size allowed is 8 mm (spherical diameter). A Huber Strainpress is recommended between the digester or sludge storage tank and the dewatering operation to provide this screening and to extend the operational life of the dryer's extruder.
9. Feed sludge must be free of any pollutants which could be hazardous, toxic, radioactive, corrosive, flammable, or explosive.
10. Dewatered cake feed characteristics have been assumed based on the information provided to Huber. Please notify Huber if the cake conditions will differ from those described in this proposal.

Items Not Supplied by HUBER

Items to be provided by others

- Piping between all supplied equipment, including but not limited to:
    - Piping between boiler system and dryer
    - Piping between boiler system and preheat heat exchanger
    - Piping between water supply and belt cleaning system
    - Piping for emergency cooling and fire suppression systems
    - Piping for heat recovery system
    - Piping for scrubber process water (if required)
    - Piping for scrubber cooling water and recirculation water (if required)
    - Piping for cake feed between cake feed pump and dryer extruder hose
    - Insulation of hot water supply and return piping (as required)
- Wiring between all supplied equipment
- Polymer systems for cake pumps (if required)
- Piping and electrical building layouts (assistance in design can be provided)
- Site preparation
- Unloading and storage of equipment
- Installation
- Building structures
- Maintenance platforms and cranes (if required)
- Concrete pad and insulation in concrete pad
- Support Frames unless specifically called out (if required)
- Ductwork not specifically listed in HUBER's scope, including:
    - Ductwork (and insulation of ductwork) supplying fresh air to the dryer
    - Ductwork (and insulation of ductwork) for exhaust air
    - Ductwork (and insulation of ductwork) between odor control and exhaust air fan
    - Covers and insulation of ductwork between modules ("connecting elbows")
- Valves not specifically listed in HUBER's scope (if required)
- Odor control and/or dust suppression for dried product conveyance, storage, or loading area (if required)
- Boiler system fresh air duct and exhaust stack (if required)
- Gas cleaning system for digester gas (if required)
- Gas supply to the burner/boiler system
- Laboratory costs, material costs, and disposal costs for performance testing
- DHA, HAZOP, or other safety analyses
- Pricing does not include an applicatable taxes and bonds (if required)

EVOQUA
WATER TECHNOLOGIES

PRELIMINARY PROPOSAL FOR PEARL® NUTRIENT RECOVERY SYSTEM

CENTRAL WEBER SEWER IMPROVEMENT DISTRICT

OGDEN, UT

ENGINEER

Version: 0
Date: October 2022
Prepared By: Brett Woods

Questions relative to this preliminary proposal should be directed to:

Cory Firzlaff

cory@tcsalesco.com

Table of Contents

1 Introduction

The Pearl® and WASSTRIP® systems provide the most comprehensive and cost-effective nutrient recovery solution proven on the market. Instead of discharging phosphorus into waterways, the Pearl system recovers phosphorus as a high-quality fertilizer, called Crystal Green®, reducing phosphorus discharge to the environment. The Pearl system offers significant savings on chemical demand, maintenance, and operations combined with the production of high value fertilizer ensuring a shortened payback period on the upfront investment of the system.

Traditional wastewater treatment processes allow for two “exits” for incoming phosphorus, one being the plant effluent, and the other being wasted biosolids. Production of struvite-based Crystal Green® fertilizer provides a third, beneficial, exit for the incoming phosphorus load to the plant. Many parts of the world are looking to limit the phosphorus content in their effluent as well as the phosphorus content in their biosolids. The combination of WASSTRIP and Pearl provides a cost-effective means of recovering phosphorus to lower its content in the effluent and biosolids generated by the plant. The phosphate rich Crystal Green® fertilizer, is a slow-release fertilizer and does not contribute to agricultural nutrient run-off.

The Pearl and WASSTRIP systems can be easily integrated into the plant’s solids handling stream as shown Figure 1 below.

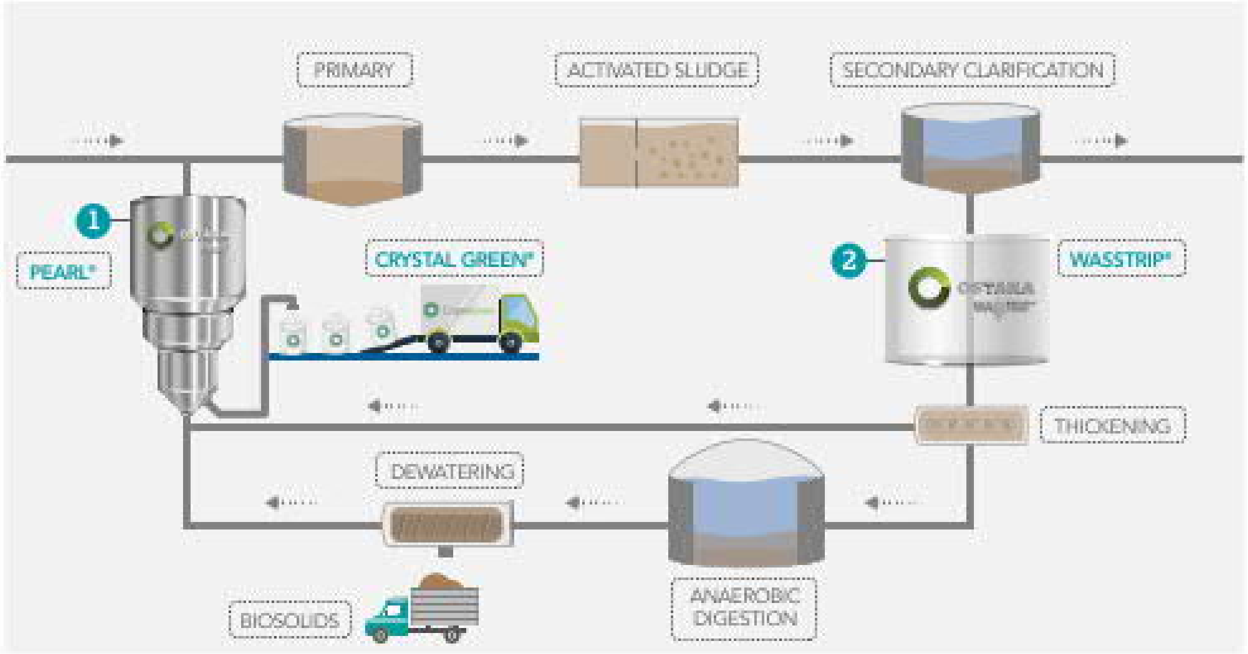


Figure 1: Location of Pearl and WASSTRIP Processes

The value of nutrient recovery extends beyond generating revenue from the reclaimed nutrients in the Crystal Green® fertilizer. Many wastewater treatment plants suffer from struvite precipitation in pipes, tanks, and other equipment. The precipitated struvite can affect reliability of these systems and increase annual maintenance costs. Plants generally dose metal salts (such as ferric chloride) into plant recycle streams to manage unwanted struvite precipitation. However, this creates significant volumes of chemical sludge, and adds ongoing operating costs for dewatering and disposal of this additional sludge. Circulating chemical in the plant also inhibits enhanced biological phosphorus removal (EBPR) in the balance of the plant and destroys the commercial value of phosphorus as a nutrient. Phosphorus is a finite natural resource we rely on to produce food globally and binding it chemically with metal salts is an unsustainable means of struvite management. Chemical phosphorus removal imposes significant ongoing treatment costs including:

1. Purchase costs for chemicals
2. Dosing system O&M costs
3. Disposal costs for the chemical sludge produced
4. Impacts of chemical sludge "dead weight" on biological treatment process performance (e.g. reduced digestion efficiency due to inter material load)
5. Consumption of side stream alkalinity

2 About the Pearl® System

The Pearl system recovers phosphorus from the dewatering and thickening centrate streams before they accumulate as nuisance struvite in pipes and on other equipment. Nutrient rich primary sludge and waste activated sludge is treated through the anaerobic digestion process. In this anaerobic process, the breakdown of organic matter causes phosphorus to be released into solution. When the digested sludge is dewatered, the dissolved phosphorus will be concentrated in the post-digestion dewatering centrate. This phosphorus rich stream is then feed to the Pearl system.

Using a tightly controlled chemical precipitation process, the Pearl system takes this centrate stream and facilitates the growth of struvite "seeds". Like an oyster-cultivated pearl, the seeds grow in diameter until they reach a desired size suitable for sale to established fertilizer markets. They are then dried and collected on site in a fully automated process. The end-product is greater than 99.6% pure and ready for sale to a global network of professionals in turf, horticulture, and agriculture applications.

The revenue generated by the Crystal Green fertilizer differentiates the Pearl nutrient recovery system from other removal processes such as chemical phosphate removal using metal salts. The Pearl system uses a multi-barrier approach to ensure the fertilizer product is consistently pathogen free in accordance with all known regulatory requirements including Part 503 of the US EPA standard for the use or disposal of sewage sludge. This process has been demonstrated to consistently render Crystal Green product, free of pathogen indicators, over more than ten years of commercial operating experience at all our operating sites.

Figure 2: Crystal Green fertilizer product.

3 About the WASSTRIP® System

The WASSTRIP system can be combined with the Pearl reactor to maximize phosphorus recovery. Waste activated sludge (WAS) is rich in stored phosphorus, magnesium, and potassium. This is particularly true at plants using enhanced biological phosphorus removal (EBPR). In traditionally designed systems these nutrients release under anaerobic conditions in the digester and combine with ammonia to form uncontrolled struvite. This struvite can accumulate in digesters and result in several negative impacts such as: reduced digestion volume (and performance), scale formation on digester and dewatering equipment, and scale formation in transfer pipes. Further, any digester struvite formation that is not attached as scale will remain entrained in biosolids and increase both the volume of biosolids produced by the plant and phosphorus concentration of these biosolids.

Wastewater treatment plants operating a combination of EBPR and anaerobic digestion typically have 5 to 10% (dry weight) of their biosolids as struvite. This unwanted struvite results in increased sludge processing costs for the plant and may limit the amount of biosolids that can be spread on land due to the imbalance in phosphorus and nitrogen nutrient levels. The release of phosphorus, magnesium, and potassium and other ions in the digester has also been shown to provide an ionic balance that results in poor sludge dewaterability (high ratio of monovalent to divalent ions).

The WASSTRIP system tackles these challenges by releasing the phosphorus, magnesium, and potassium ahead of the digester and bypassing these nutrients around the digester and dewatering systems where they cause problems. Following the WASSTRIP tank where the phosphorus, magnesium and potassium are released (becoming soluble), they are then separated from the solids by pre-digestion thickening. The WAS thickening centrate is then bypassed around the digester and sent directly to the Pearl reactor, where the soluble phosphorus and magnesium are transformed into Crystal Green fertilizer.

The WASSTRIP system offers many benefits including:

BENEFITS	SIDE STREAM CHEMICAL ADDITION	STRUVITE PRECIPITATION IN SLUDGE	PEARL & WASSTRIP SOLUTION
Reduced Phosphorus in Recycle	✓	✓	✓
Reduced Struvite Maintenance	✓	✓	✓
Mitigate Digester Struvite Buildup	✗	✗	✓
Improve Dewaterability	✗	✓	✓
Reduce Polymer	✗	✓	✓
Reduce Sludge Generation	✗	✗	✓
Reduce Biosolids Phosphorus Content	✗	✗	✓
Revenue Generation	✗	✗	✓

4 Design Basis - 2030

Table 1 below outlines the design basis for the centrate streams used for sizing of the proposed Pearl nutrient recovery system.

Table 1: 2030 Design basis for Pearl system.

ITEM	Pearl			UNIT
	WASSTRIP Centrate	Post-Digestion Centrate	COMBINED FEED	
Flow				
Feed Liquor Flow	300,000	490,000	790,000	gpd
Reactor Feed				
PO4-P Concentration	200	130	157	mg/L
PO4-P Mass Loading	500	531	1,032	lb/day
NH3-N Concentration	50	277	191	mg/L
NH3-N Mass Loading	125	1,132	1,257	lb/day
Mg Concentration	40	10	21	mg/L
Mg Mass Loading	100	41	141	lb/day
pH	6.50	7.00	6.8	SU
TSS	1,000	0	380	mg/L
Alkalinity	500	1,096	870	mg/L
Conductivity	2,000	7,000	5,101	µS/cm

5 Design Basis – 2050

Table 2 below outlines the design basis for the centrate streams used for sizing of the proposed Pearl nutrient recovery system.

Table 2: 2050 Design basis for Pearl system.

ITEM	Pearl			UNIT
	WASSTRIP Centrate	Post-Digestion Centrate	COMBINED FEED	
Flow				
Feed Liquor Flow	350,000	540,000	890,000	gpd
Reactor Feed				
PO4-P Concentration	200	114	148	mg/L
PO4-P Mass Loading	584	513	1,097	lb/day
NH3-N Concentration	50	331	220	mg/L
NH3-N Mass Loading	146	1,491	1,637	lb/day
Mg Concentration	40	10	22	mg/L
Mg Mass Loading	117	45	162	lb/day
pH	6.50	7.00	6.8	SU
TSS	1,000	1,000	1,000	mg/L

ITEM	Pearl			UNIT
	WASSTRIP Centrate	Post-Digestion Centrate	COMBINED FEED	
Alkalinity	500	1,264	964	mg/L
Conductivity	2,000	7,000	5,034	µS/cm

6 Pearl Performance

Treated effluent is discharged from the top of the Pearl reactor and returned to the plant. Typically, the reactor is fed continuously while product harvesting occurs periodically. Table 3 below outlines the effluent performance of the proposed Pearl nutrient recovery system.

Table 3: Pearl system effluent performance.

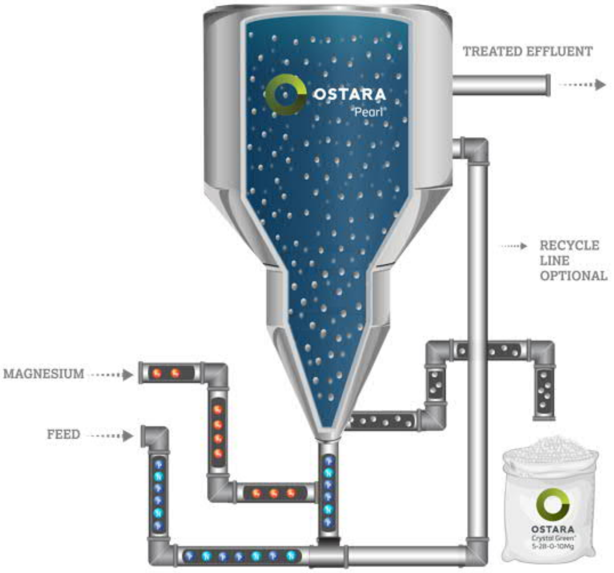
Rector Effluent	2030 Value	2050 Value	Units
PO4-P Concentration	40	40	mg/L
PO4-P Mass Loading	263	297	lb/day
NH3-N Concentration	138	172	mg/L
NH3-N Mass Loading	909	1,274	lb/day
pH	7.9 – 8.2	7.8 - 8.1	SU
Pearl Performance			
PO4-P Removal	74	73	%
	768	801	lb/day
NH3-N Removal	28	22	%
	347	362	lb/day
Crystal Green Production	778 - 890	811 - 927	tons/yr

6.1 Pearl System Design

The Pearl system, depicted below, is an up-flow fluidized bed reactor engineered for controlled struvite precipitation. Two principles are fundamental in the process: maximizing efficient nutrient removal and consistently producing high quality fertilizer.

Struvite is a crystal containing one mole each of magnesium, ammonium and phosphate, together with six waters of hydration ($NH_4MgPO_4 \cdot 6H_2O$). Struvite crystallization occurs when the three ions (magnesium, ammonium, and phosphate) are present in a solution above the saturation point. This condition – termed “super saturation” – causes the ions to come out of solution and form a struvite crystal. The saturation point is influenced by several factors, but pH has the greatest influence.

For certain Pearl reactor models a portion of treated effluent from the top of the reactor is returned to the bottom of the reactor in a recycle loop. This allows for control of upflow velocity, feed concentrations (recycle water acts as dilution), as well as adaption of the system to variable feed flow rates. Recycle rates are automatically controlled by the Pearl control system, and do not impact overall phosphorus removal efficiency.



Note 1: Recycle line not included for Pearl Fx models.

The inventory of fertilizer in the reactor is managed using differential pressure measurement in combination with an automated harvest system. When a target fertilizer inventory in the reactor is reached, the reactor will automatically batch harvest the fertilizer by sending it to the product handling system. During harvest, the reactor will continue operation without interruption or loss of efficiency.

Table 4 below outlines the design details of the proposed Pearl system.

Table 4: Pearl nutrient recovery system design conditions and specifications.

PEARL NUTRIENT RECOVERY SYSTEM SPECIFICATIONS	
	2030 & 2050 DESIGN
Reactor Size	P2K
Quantity of Reactors	1
Reactor Name	**1 x P2K**

Item	Value	Unit
Reactor Feed Total Suspended Solids (TSS) Concentration	< 1,000	mg/L
Reactor Feed PO4-P Concentration Range	> 50	mg PO4-P/L

PEARL NUTRIENT RECOVERY SYSTEM SPECIFICATIONS				
Reactor Feed Flow Range	1	-	1,340	gpm
Reactor Phosphorus Loading Range	0	-	1,100	lb PO4-P/day
Typical % of Plant Influent TP Treated with Pearl® Only	15	-	25	%
Typical % of Plant Influent TP Treated with Pearl® and WASSTRIP®	25	-	40	%
Average Daily Crystal Green Production Capacity Range	0	-	5,630	lbs CG/day
Average Annual Crystal Green Production Capacity Range	0	-	1,025	tons CG/yr
Reactor Design Operating Temperature	Ambient			
Reactor Design Operating Pressure	Atmospheric			
Approximate Reactor Footprint	10.6’ (D) x 36’ (H) per reactor			
Approximate Pearl Nutrient Recovery System Footprint	36’ (W) x 64’ (L) x 36’ (H)			
Life Expectancy of Pearl Nutrient Recovery System	> 20 years			
Noise Level	TBC, typically 85 dB			
Non-Potable Water Demand @ 40-60 psi	TBC Typically, 50,000 – 62,000 gpd 150 - 200 gpm instantaneous			
Indoor/Outdoor Installation	Indoor			

Non-potable water is required on a continuous basis to provide reactor effluent dilution (scale prevention) and for harvest operations. A higher instantaneous demand is required for up to 15 minutes to restart the reactor in the event of a power failure or uncontrolled shutdown. If this flow or pressure is not available, Evoqua can deliver design alternatives.

6.2 WASSTRIP System Design

Table 5 below outlines the design basis for the WASSTRIP system. WAS is delivered to the WASSTRIP tank and allowed to ferment and release phosphorus and magnesium. If appropriate tankage exists on site, Evoqua can assist in the evaluation of this tank. The WAS exiting the WASSTRIP tank will then be thickened, producing a centrate stream that is rich in phosphorus and magnesium which bypasses the anaerobic digesters and goes directly to the Pearl reactor.

Table 5: WASSTRIP system design.

WASSTRIP® DESIGN			
ITEM	**2030 VALUE**	**2050 VALUE**	**UNIT**
Waste Activated Sludge (WAS)			
WAS Flow Rate	390,000	460,000	gpd
WAS Solids	9,267	9,999	mg/L
WASSTRIP® Design Basis			
WASSTRIP P Release Portion	35-45	35-45	%

WASSTRIP® DESIGN			
WASSTRIP Tank Retention Time	24	24	hr
WASSTRIP Tank Volume Required	390,000	460,000	gal
WASSTRIP® Filtrate			
TWAS Flow Rate	90,000	110,000	gpd
TWAS % Solids	4.0	4.0	%
WASSTRIP Centrate Flow Rate	300,000	350,000	gpd
WASSTRIP PO4-P Concentration	200	200	mg/L

When WASSTRIP (pre-digestion phosphorus release) is employed, phosphate that would otherwise be consumed by nuisance precipitation (e.g. struvite) and surface adsorption in the digester is liberated, making more of the influent total phosphorus available for recovery. As a result of WASSTRIP PO_4-P release upstream of the digester, the PO_4-P loads in the centrate were reduced in our models. This is an estimate that is based on experience at existing WASSTRIP sites. The exact design numbers are dependent on influent plant characteristics, local water hardness, digestion design, WAS thickening and digested sludge dewatering design, and the import of sludges or other organic material into the plant.

As the project progresses, it is recommended that bench-top testing be completed using representative WAS and primary sludge streams from the site to characterize the release rates of phosphate and counter ions and assist in sizing and process control design for the WASSTRIP release tank. For planning purposes, however, it is recommended that a WASSTRIP release tank with approximately 24 hours of hydraulic residence time (HRT) is allowed for in the instance of endogenous release or 12 hours of HRT in the instance of fermented primary sludge addition.

7 Operation and Maintenance

7.1 Energy, Consumables and Chemical Consumption

Table 6 below summarizes the estimated O&M costs for the proposed system. Utility and maintenance estimates are based on existing projects. Evoqua has assumed natural gas as the heat source for drying the Crystal Green product. Requirements for other heat sources such as electricity are also provided in the table below.

Table 6: Estimated O&M costs.

ITEM	UNIT	UNIT COST	2030 ANNUAL COST	2050 ANNUAL COST
Maintenance and Labor				
Operating and Maintenance Labor	FTE	60,000/ FTE	$30,000	$30,000
Utilities				
Power - Pearl Process	kWh	$ 0.08/kWh	$12,400	$12,500
Heat for Crystal Green Drying				
As Electricity	kWh	-	-	-
As Natural Gas	therm	$ 0.50/therm	$6,400	$6,700
As Hot Water @190°F	gal	-	-	-
Chemicals				
Magnesium Oxide (15%)	dry ton	$ 600.00/dry ton	$177,300	$186,400
Sodium Hydroxide (50%)	dry ton	$ 600.00/dry ton	$0	$0
Ammonia (not used)	dry ton	$ 500.00/dry ton	$0	$0
H2SO4 (98%)	gal	$ 1.00/gal	$60	$60
Consumables				
Lab analysis (Hach)	sample	$ 2.00/sample	$5,300	$5,300
Pallets/Bags	ton	$ 25.00/ton	$22,200	$23,200
TOTAL			**$253,660**	**$264,160**

With regard to the above O&M estimates, please note the following:

- The power estimate does not include the feed pump required to deliver dewatering centrate and WASSTRIP filtrate to the Pearl reactor, WAS transfer pumps or WASSTRIP tank mixers. Feed liquors should enter the reactor at approximately 30 psi.
- Heat required for drying Crystal Green can be provided as electricity, biogas, natural gas, steam or hot water.
- Acid is used for periodic (1-2x per year) descaling of the Pearl reactor through clean in-place control loops. This improves the operational reliability of the Pearl reactor and eliminates the need to mechanically clean feed lines.

8 Economic Benefits

In addition to turning struvite into revenue generating Crystal Green fertilizer, incorporating the Pearl system into the overall treatment process provides several economic benefits. Table 7 presents an analysis of the financial benefits achieved by removing phosphorus with Pearl system. We compared this removal to phosphorus removal using ferric chloride.

Furthermore, by removing phosphorus upstream of the digester, precipitation of struvite and other phosphate compounds elsewhere in the treatment process can be mitigated. This can result in substantial maintenance savings, in addition to improved reliability.

Table 7: Pearl revenue and financial benefits

ITEM	**2030 VALUE**	**2050 VALUE**	**UNITS**	**NOTES/SOURCE**
Ferric Chloride avoidance				
P removal	140	146	tons/yr	P removed by Pearl
FeCl3 (40%) required	1,103	1,149	dry ton/y	1.5:1 Fe:P Ratio
Purchase price of FeCl3 (40%)	$600	$600	$/dry ton	
FeCl3 (40%) purchase cost avoidance	$661,600	$689,300	$/yr	
Alkalinity Consumption	0	0	dry ton NaOH	Consumed by excess Fe dose
Purchase price of NaOH	$0	$0	$/dry ton	
Total Alkalinity Benefit	$0	$0	$/yr	
Fe sludge produced	926	964	dry ton/y	6.6 lb sludge/lb P removed
Cost of sludge processing	$30	$30	$/dry ton	Cost of polymer
Cost of sludge disposal	$125	$125	$/dry ton	
Fe sludge cost avoidance	$143,500	$149,500	$/yr	
Total Value of Ferric Chloride avoidance	**$805,100**	**$838,800**	***$/yr***	
Biosolids Cost Avoidance				
Biosolids production	6,570	6,570	dry ton/y	
WASSTRIP struvite sludge avoidance	183	213	dry ton/y	Mg diversion around digester
Dry sludge production avoidance	$28,300	$33,000	$/yr	Cost of polymer + disposal
Cake solids	20	20	% TS	
WASSTRIP cake solids improvement	1.5	1.5	%	
Wet ton production avoidance	2,228	2,218	wet ton/y	
Wet ton avoidance value	$55,700	$55,400	$/yr	
WASSTRIP polymer reduction	10.0	10.0	%	
WASSTRIP polymer avoidance	12,775	12,714	lb/y	
Dewatering improvement value	$19,200	$19,100	$/yr	Cost of polymer + disposal
Total dewatering improvement value	$74,900	$74,500	$/yr	
Total Biosolids Cost avoidance	**$103,200**	**$107,500**	***$/yr***	

ITEM	2030 VALUE	2050 VALUE	UNITS	NOTES/SOURCE
Ammonia				
Cost of ammonia removal	$1.00	$1.00	$/lb	Aeration savings
Quantity of ammonia removed	126,787	132,101	lb/y	
Value of ammonia removal	**$126,800**	**$132,100**	***$/yr***	
Crystal Green® Revenue				
CG Production	890	927	ton/y	
Purchase price of CG	$150	$150	$/ton	
CG revenue	**$133,400**	**$139,000**	***$/yr***	
Total Value of Financial Benefits	**$1,168,500**	**$1,217,400**	**$/yr**	
Less Operating Cost	$253,660	$264,160	$/yr	
Total Value of Financial Benefits	**$914,840**	**$953,240**	**$/yr**	

9 Scope of Supply

ITEM	EVOQUA	OTHERS
Centrate feed pumps		X
Pearl 2K reactor	X	
Reactor support frame and access stairways		X
Automated WASSTRIP centrate feed valves	X	
Automated post digestion centrate feed valves	X	
WASSTRIP centrate feed flow meters	X	
Post digestion centrate feed flow meters	X	
Chemical injection quills for reactor	X	
Pearl reactor instrumentation	X	
Crystal green harvesting automated valves	X	
Pearl reactor recycle automated valves	X	
Pearl reactor recycle pump	X	
Pearl reactor recycle pump flow meter	X	
Crystal green fertilizer dewatering screen (support frame by others)	X	
Crystal green fertilizer dryer	X	
Crystal green fertilizer bucket conveyors	X	
Crystal green fertilizer silo	X	
Compressed air system for Pearl reactor equipment	X	
Pearl reactor seeding system	X	
MgO make-down and feed system	X	
Interconnecting piping and wiring to/from Pearl system equipment		X
Support frames and access stair for equipment		X
Dryer air ductwork		X

ITEM	EVOQUA	OTHERS
Acid storage and feed system		X
Manual valves		X
Pearl system controls equipment including: • NEMA 4X main control panel with PLC, HMI, I/O, and Ethernet switch for Evoqua supplied equipment • Remote I/O cabinet as required	X	
Motor control center for Pearl system equipment		X
Power supply to Pearl system equipment		X
Design and supply of building, slab materials, chemical containment, and concrete equipment pads		X
Start-up, commissioning, and training	X	
Engineering submittals and O&M	X	

10 Excluded Items

- WASSTRIP infrastructure: tank, mixers, tank feed pump, tank effluent pump
- WASSTRIP filtrate and dewatering centrate feed pumps
- Anchor bolts
- Bonding
- Permitting
- Any construction or installation of the Evoqua-supplied equipment including:
    - Earthworks
    - Concrete work, including the building slab and chemical containment walls
    - Building HVAC, lighting, drainage and utilities not associated with the Pearl process
    - System tie-ins to the building footprint, including potable water, non-potable water, power, side stream feed, effluent and plant drains, and all utility connection fees
    - A new building, or modification of an existing building to house Pearl
    - Safety showers and eyewash stations
    - Standby pumps or equipment
    - Spare parts

11 Budget Pricing

The budgetary price for the proposed Pearl system, as defined herein, including engineering, field services, and equipment supply is $5,950,000 (USD).

This price makes no provision for taxes, tariffs, duties, permitting fees and other fees and charges that are not made explicit above.

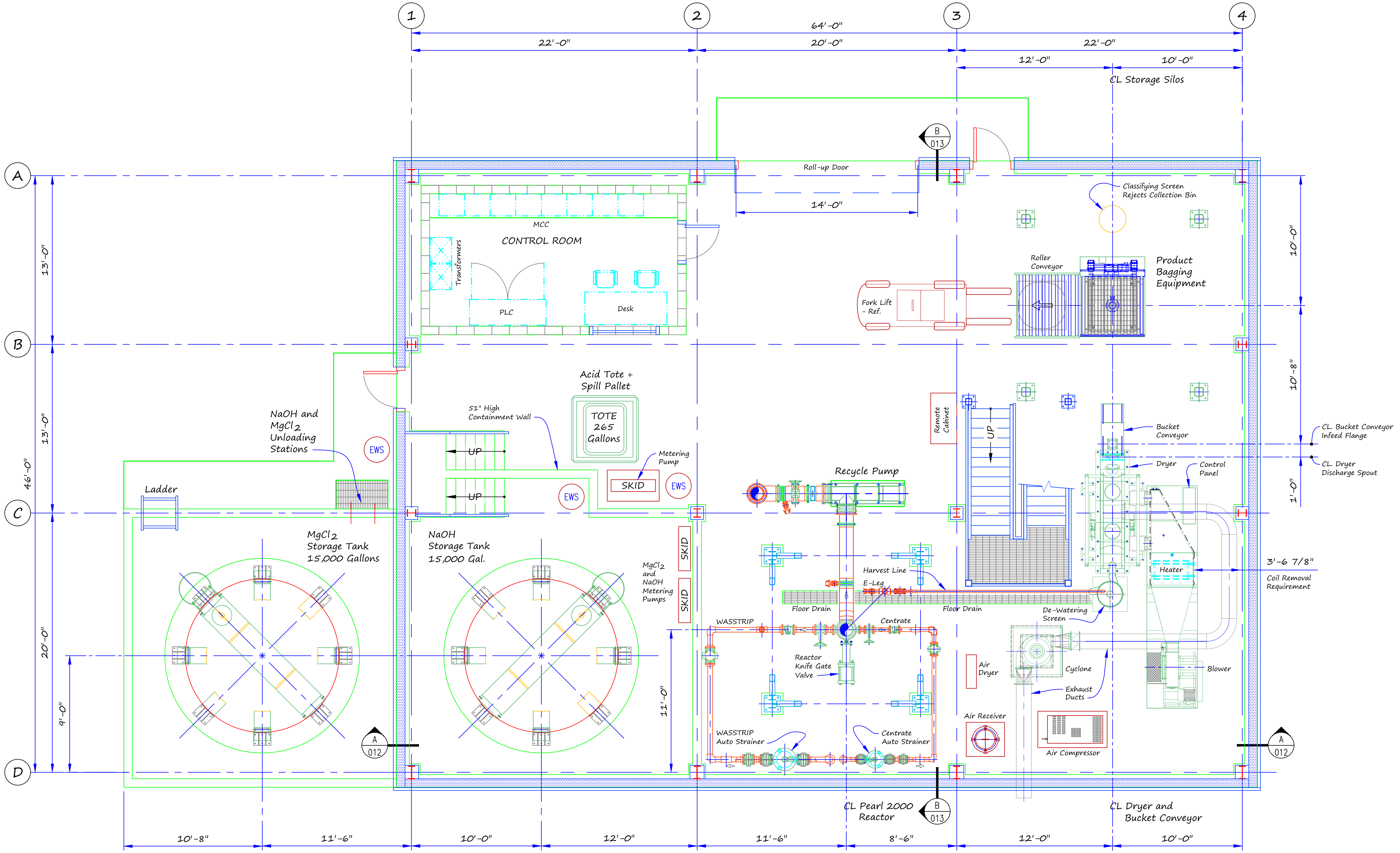
All pricing is quoted at FCA, Factory (full freight allowed). No taxes, regulatory fees or other costs related to the procurement and installation of the system are included.

The scope of supply and pricing are based on Evoqua standard equipment selection, standard terms of sale and warranty terms. Any variations from these standards may affect this budgetary quotation. Additionally, please note this budgetary quotation is for review and informational purposes only and does not constitute an offer for acceptance.

Should you have any questions regarding this quotation, or would like to request a firm proposal and order form, please contact the following Evoqua Regional Representative:

Cory Firzlaff
TC Sales
cory@tcsalesco.com
801-201-3121

Appendix A: Typical Layout



LAYOUT AT SLAB LEVEL
1/4"=1'-0"

PRELIMINARY
NOT TO BE USED FOR
CONSTRUCTION
PURPOSES

BAR = 1" AT PLOT SCALE

STD:24x36_D v4.0

REV	DESCRIPTION	DATE	DWN	CHKD	APVD	ECN

DWN BY: ---- DATE ----
CKD BY: ---- DATE ----
APPD BY: ---- DATE ----
MGD BY: ---- SCALE 3/16" = 1'-0"

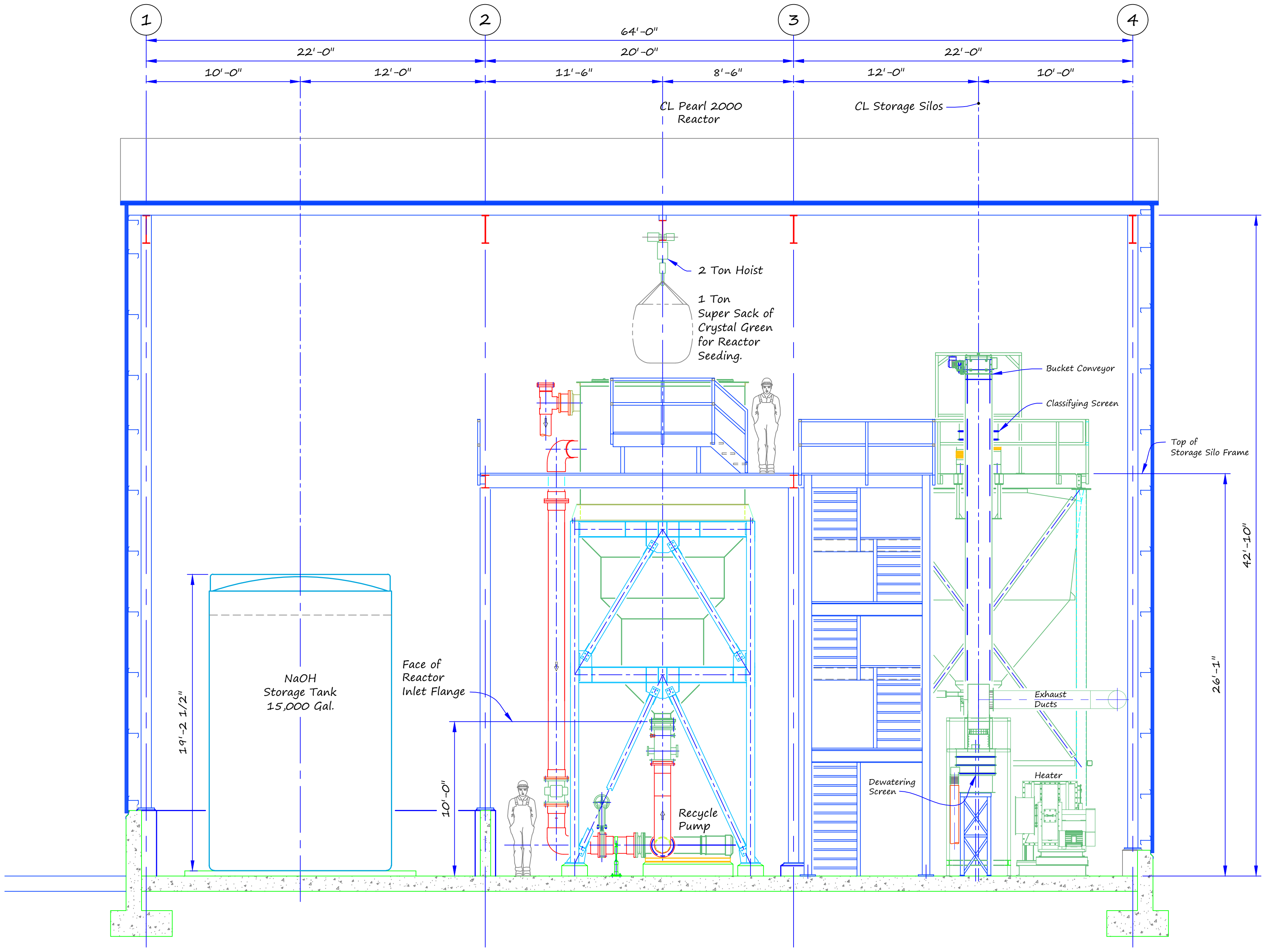
TITLE
PEARL NUTRIENT RECOVERY SYSTEM
GENERAL ARRANGEMENT
P2K REACTOR

CLIENT

----

evoqua
WATER TECHNOLOGIES
EVOQUA WATER TECHNOLOGIES
WAUKESHA WI USA
262-547-0141

PART NUMBER	PROJ/PROD NUMBER	CODE	FILE/DRAWING NUMBER	SHEET	REV
----	----	----	----	1 OF 1	A



SECTION (A/010) (A/011)
1/4"=1'-0"

PRELIMINARY
NOT TO BE USED FOR
CONSTRUCTION
PURPOSES

REV	DESCRIPTION	DATE	DWN	CHKD	APVD	ECN

DWN BY: ---- DATE ----
CKD BY: ---- DATE ----
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TITLE PEARL NUTRIENT RECOVERY SYSTEM
GENERAL ARRANGEMENT
P2K REACTOR

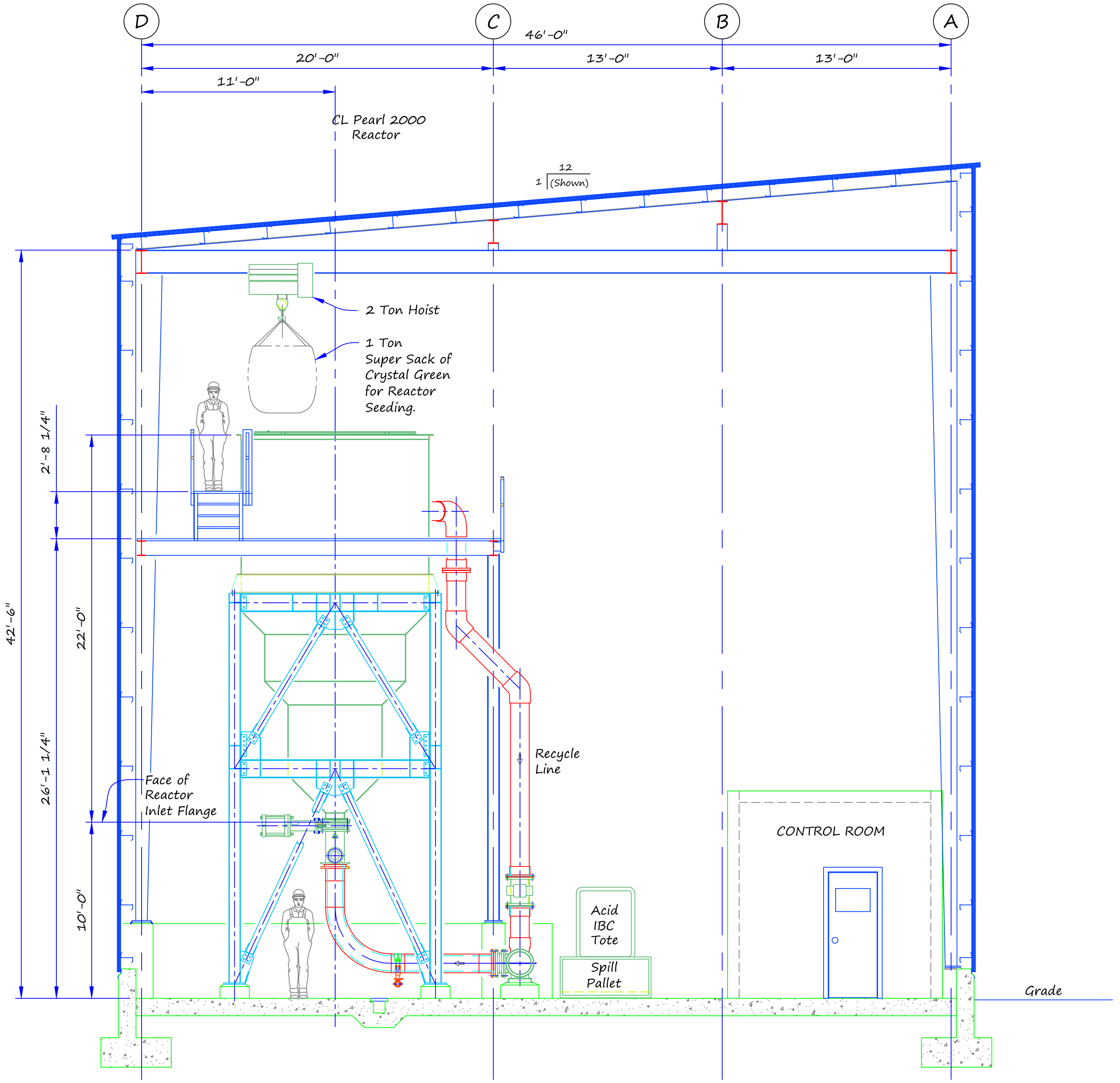
CLIENT

EVOQUA WATER TECHNOLOGIES
WAUKESHA WI USA
262-547-0141

PART NUMBER	PROJ/PROD NUMBER	CODE	FILE/DRAWING NUMBER	SHEET	REV
----	----	----	----	1 OF 1	A

STD 24x36_D v4.0

BAR = 1" AT PLOT SCALE



SECTION B/010 B/011
1/4"=1'-0"

PRELIMINARY
NOT TO BE USED FOR
CONSTRUCTION
PURPOSES

STD 24x36_D v4.0

BAR = 1" AT PLOT SCALE

REV	DESCRIPTION	DATE	DWN	CHKD	APVD	ECN

DWN BY: ----	DATE ----
CKD BY: ----	DATE ----
APPD BY: ----	DATE ----
MGD BY: ----	SCALE 3/16" = 1'-0"

TITLE
PEARL NUTRIENT RECOVERY SYSTEM
GENERAL ARRANGEMENT
P2K REACTOR

CLIENT

EVOQUA WATER TECHNOLOGIES
WAUKESHA WI USA
262-547-0141

PART NUMBER	PROJ/PROD NUMBER	CODE	FILE/DRAWING NUMBER	SHEET	REV
----	----	----	----	1 OF 1	A

Budget Proposal

MagPrex™ Post-Digestion P Recovery

To:	Central Weber Sewer Improvement District
Centrisys/CNP Ref/Opp#:	12401
Project Name:	CWSID
Location:	Ogden, Utah
Date:	11/08/2022
Prepared by:	Ethan Banks Applications Engineer

Contact Info

Centrisys/CNP Contact
Jerod Swanson
Regional Sales Manager
9586 58th Place
Kenosha, WI 53144
Ph: (262) 654 6006
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Email: Jerod.swanson@centrisys.us

Centrisys/CNP Representative
Scott Marshall
Misco Water - Mountain States
651 Corporate Circle Suite #100
Golden, CO 80401
Ph: (303) 309-6150
Email: smarshall@miscowater.com

ITEM 1. CNP Clarifications

- Equipment cost estimate including, shipping, submittals, O&Ms, startup, training, and 2-year warranty based on date of substantial completion. Include information on how you would design the system for 2030 and then how that could be expanded to conditions in 2050. A modular approach? Provide cost estimates of the upgrades/additions to the system.
  For both sequestration and harvesting options, the system will not require any expansion. A single 50' reactor for sequestration will provide sufficient HRT at both 2030 and 2050 flows. Two 50' reactors for harvesting will provide sufficient HRT at both 2030 and 2050 flows.

- Operational costs for 2030 and for operations out to 2050 under maximum month operation conditions
  - operational costs
  - chemical costs
  - power costs
  - costs for other consumables required to operate the system.

  Operational and Performance estimate tables for each system have been provided. Estimated MgCl2 consumption is provided for each system, costs for MgCl2 varies in price across the United States. Operational hours have been provided, CWSID will estimate costs based on staffing costs. Electrical consumption for each system is provided, local electrical costs will have to be applied.

- Provide information on phosphorus removal efficiency of the system along with a mass balance.
  Mass balance of orthophosphate, total phosphorus, and ammonia are included in the performance estimate tables for each system

- Provide an estimate of manpower requirements for operating and maintaining the system. Does this change from 2030 to 2050 conditions.
  Daily maintenance estimates are included in the operational estimates and range from 15 to 60 minutes per day. Operation and maintenance include weekly adjustments to operating parameters (measured PO4-P, dosing ratio, speed SPs for equipment) and scheduled maintenance for equipment. In general, the system is able to operate without any constant observation from operations staff. With no future expansion planned for this proposal there is no expected increase in O&M for the system from 2030 to 2050. A Recommended O&M Schedule has been included with the proposal.

- Provide a preliminary layout of the system including proposed footprint requirements for 2030 to 2050 conditions
  Layouts from previous projects have been included in the proposal. A single reactor (sequestration) and dual reactor (harvesting) layout from previous projects have been provided for reference only. There is no proposed change to the layout from the expected 2030 to 2050 flow rate

- Provide recommendations on what equipment or system components should be considered for redundancy in order to ensure proper phosphorus control.
  CNP would recommend a redundant reactor tank to allow for continued operations while the duty reactor undergoes annual cleaning and maintenance, which from previous projects can lead to 1-4 weeks of downtime depending on the number of reactors. Similarly, a redundant backup blower would be recommended to prevent downtimes from any long-term maintenance. This proposal comes standard with redundant chemical dosing pumps for MgCl2.

- Include costs for sequestering vs harvesting (for MagPrex and just harvesting for CalPrex). Provide information on handling, marketing, distribution/disposal, and revenue generation services that the supplier is capable of providing as well as agreements that are available between client and supplier.

  CNP and its partner NRU will enter into an agreement with CWSID if so desired to market he recovered struvite from your MagPrex system. Our discussions with potential MagPrex plants show quite varying interests in the disposition of the struvite and brushite products, all the way from wanting to monetize the product themselves to revenue sharing with CNP/NRU in charge of identifying the market. CNP/NRU can accommodate client's wishes in customized arrangement.

  We have identified a fertilizer blender willing to buy all the struvite we can provide. That same blender may be interested in same arrangement for brushite, after some further in-house research. Additionally, NRU has tested direct to consumer marketing of brushite-containing NPK home and garden fertilizer, which was compounded using brushite from the 2018 pilot. Our year-over-year sales have increased but are still too small to indicate a long-term trend.

  The achievable price will depend on the quality (and dryness) of the recovered struvite. At the current market rate we estimate the price of struvite per ton to be around $100. We will be able to provide a more accurate number once we get closer to an agreement.

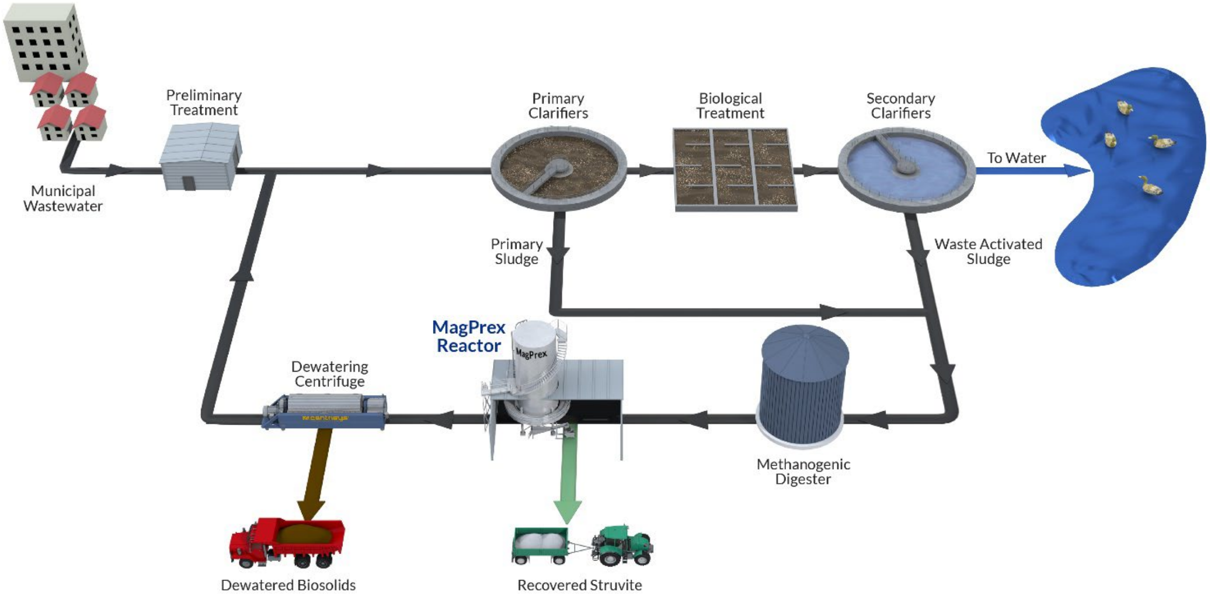
			Price paid to customer ($/year) As of 11/2022
Estimated Struvite Recovered Product (tons/year)	2030	129-215	12,900-21,500
	2040	151 -252	15,100-25,200
	2050	156-260	15,600-26,000

ITEM 2. DESCRIPTION

Centrisys/CNP is pleased to provide a MagPrex budget proposal for CWSID

MagPrex is a nutrient recovery process owned by Centrisys/CNP and installed between the anaerobic digester and dewatering equipment. The MagPrex process forms struvite by using the soluble phosphorus and ammonia present in anaerobically digested sludge. Using aeration, MagPrex strips out the CO2 to increase the pH and adds magnesium chloride ($MgCl_2$) to augment the magnesium (Mg^{2+}). The struvite precipitates and is sequestered in the biosolids where it's removed in final dewatering. Additionally, MagPrex can increase the dryness of dewatered Bio-P sludge and/or reduce polymer use. Depending on the needs of the plant, either cake solids improvement or polymer used will be optimized, or both can be improved simultaneously but to a lesser extent.

When the harvesting option is used, MagPrex turns struvite into an opportunity for resource recovery. Struvite, when given time to fully form under a controlled environment, can be harvested from the bottom of the reactor and utilized as a beneficial fertilizer.



Advantages:

- **MagPrex can achieve >90%** reduction of soluble Ortho-P concentration from dewatering return side-stream.
- **MagPrex can achieve 2-3%** increase of dewatering cake dryness and/or up to **20-30%** reduction in polymer consumption vs. non- MagPrex Bio-P digested sludge

ITEM 3. MAGPREX SEQUESTRATION AND HARVESTING OPTIONS

Our proposal includes two options – one for sequestration and one for harvesting. The performance for both options will be similar in terms of reduction in ortho phosphorous levels and the resulting benefits in improved dewaterability and or reduced polymer use.

In our proposal, we also indicate an approximate reduction in levels of ammonia by way of struvite formation. However, if this is determined to be higher, we will see a commensurate increase in levels of reduction of ammonia. Higher ammonia reduction will also favorably impact mixing energy requirements.

OPTION 1: MagPrex with Sequestration Process (No Harvesting)

1.1. Design Parameters & Performance

	Year	Influent to MagPrex	Effluent from MagPrex	% Removal	Notes/Assumptions
Orthophosphate (mg PO_4-P/L)	2030	368	36.8	90%	$MgCl_2$ is dosed in the range of Mg:P molar ratio of 1.1-1.3.
	2040	387	38.7		
	2050	356	35.6		
Ammonia (mg NH_3 /L)	2030	782	593-632	19%-24%	Including ammonia removal by struvite formation and evaporation (0-5%)
	2040	799	602-642	20%-25%	
	2050	819	633-674	18%-23%	

1.2. O&M Requirements

Operational Parameters	Usage	
MgCl2 (30% solution)	2030	681 to 804 gallons/day
	2040	819 to 968 gallons/day
	2050	843 to 997 gallons/day
Electricity*	698 kWH/day	
Maintenance	15 to 60 min/day	
Reactor Cleaning	2 to 4 weeks/year	

**Power consumption estimate assumes constant operation of all duty equipment as a conservative estimate. Actual power consumption is expected to be lower.*

O&M labor requirements:	<1	hours/day
Total installed power (includes standby equipment):	35 HP	

1.3. Scope of Supply

Item	Description	Qty
A	**MagPrex Reactors** as per the sample drawing attached • 14 ft. diameter x 50 ft. high • MOC: Painted Epoxy Carbon Steel	ONE (1)
B	**Blower and air distribution system** • VMS type diffusers and internal air distribution for each reactor • One (1)Aerzen blower(s) per reactor • Installed power: 25HP per blower	ONE (1)
C	**$MgCl_2$ storage tank** (12,000 gallons) • Manufacturer: Snyder	TWO (2)
D	**$MgCl_2$ dosing skid system** • 2 dosing pumps per reactor system, controls and panel, no VFD • Includes two (2) dosing pumps per skid (one (1) duty, one (1) standby) • Manufacturer: Blue-White	TWO (2)
E	**Defoamer dosing system** • One (1) pump per reactor system, controls and panel, no VFD • Manufacturer: Blue-White	ONE (1)
F	**Struvite discharge pumps** • One (1) per each reactor system • Flow rate: 100 gpm • Pump operating speed: 202 RPM • Power requirement: 3ph, 60hz, 230/460V • Installed power: 7.5 HP per pump • Manufacturer: Netzsch	ONE (1)
G	**Standard valves set** • Includes one (1) electrically actuated knife gate valve per reactor system • Includes one (1) manual knife gate valve per reactor system	ONE (1)

H	**Standard instrumentation set**	ONE (1)
I	**Control panel for independent control of each system** • PanelView Plus 7 10” screen, NEMA 12, VFDs in MCC, no panel cooling	ONE (1)
J	**Start-up and commissioning services**	20 Days

OPTION 2: MagPrex with Harvesting Process

2.1. Design Parameters & Performance

		Influent to MagPrex	Effluent from MagPrex	% Removal	Notes/Assumptions
Orthophosphate (mg PO_4-P/L)	2030	368	36.8	90%	$MgCl_2$ is dosed in the range of Mg:P molar ratio of 1.1-1.3.
	2040	387	38.7		
	2050	356	35.6		
Ammonia (mg NH_3 /L)	2030	782	593-632	19%-24%	Including ammonia removal by struvite formation and evaporation (0-5%)
	2040	799	602-642	20%-25%	
	2050	819	633-674	18%-23%	
Total Phosphorus (mg/L)	2030	1064	981-1014	4.7%-7.8%	Estimated removal through struvite recovered product (Harvesting Only)
	2040	1086	999-1034	4.8%-8%	
	2050	1045	965-997	4.6%-7.7%	
Estimated Struvite Recovered Product (tons/year)	2030	129-215		15%-25%	Estimated recovered product via struvite classifier
	2040	151 -252			
	2050	156-260			

2.2. O&M Requirements

Operational Parameters	Usage	
MgCl2 (30% solution)	2030	681 to 804 gallons/day
	2040	819 to 968 gallons/day
	2050	843 to 997 gallons/day
Electricity*	838 kWH/day	
Maintenance	15 to 60 min/day	
Reactor Cleaning	2 to 4 weeks/year	

**Power consumption estimate assumes constant operation of all duty equipment as a conservative estimate. Actual power consumption is expected to be lower*

O&M labor requirements:	<1 hours/day
Total installed power (includes standby equipment):	72 HP

2.3. Scope of Supply

Item	Description	Qty
A	**MagPrex Reactors** as per the sample drawing attached • 14 ft. diameter x 50 ft. high • MOC: Painted Epoxy Carbon Steel	TWO (2)
B	**Blower and air distribution system** • VMS type diffusers and internal air distribution for each reactor • One (1)Aerzen blower(s) per reactor • Installed power: 25 HP per blower	TWO (2)
C	**$MgCl_2$ storage tank** 12,000 (gallons) • Manufacturer: Snyder	TWO (2)
D	**$MgCl_2$ dosing skid system** • 2 dosing pumps per reactor system, controls and panel, no VFD • Includes two (2) dosing pumps per skid (one (1) duty, one (1) standby) • Manufacturer: Blue-White	FOUR (4)
E	**Defoamer dosing system** • One (1) pump per reactor system, controls and panel, no VFD • Manufacturer: Blue-White	TWO (2)
F	**Struvite discharge pumps** • One (1) per each reactor system • Flow rate: 100 gpm • Pump operating speed: 202 RPM • Power requirement: 3ph, 60hz, 230/460V • Installed power: 7.5 HP per pump • Manufacturer: Netzsch	TWO (2)
G	**Standard valves set** • Includes one (1) electrically actuated knife gate valve per reactor system	TWO (2)

	- Includes one (1) manual knife gate valve per reactor system	
H	**Standard instrumentation set**	TWO (2)
I	**Control panel for independent control of each system** - PanelView Plus 7 10” screen, NEMA 12, VFDs in MCC, no panel cooling	TWO (2)
J	**Start-up and commissioning services**	40 Days
K	**Grit Washer**	ONE (1)

ITEM 4. SERVICES

Sequestration: Centrisys/CNP will furnish one factory representative for 20 days during 4 trips to assist in installation inspection, start-up supervision, and operator training. Dates of service to be scheduled upon Buyer’s written request.

Harvesting: Centrisys/CNP will furnish one factory representative for 40 days during 8 trips to assist in installation inspection, start-up supervision, and operator training. Dates of service to be scheduled upon Buyer’s written request.

ITEM 5. PRICING

	Budget Price per the Above Scope
MagPrex Sequestration System Base Price	$**1,518,000** USD
MagPrex Harvesting System Base Price	$**2,442,000** USD

Taxes, Customs, and Duties are not included.

Due to the current fluctuating material prices, Centrisys/CNP reserves the right to review the quote with a possible recalculation of the price at the time of purchase order issuance. Centrisys/CNP reserves the right to adjust the tank pricing and staircase pricing according to the steel index such as MEPS - NORTH AMERICAN STAINLESS-STEEL PURCHASING PRICE INDEX (SPPI)

ITEM 6. LEADTIME

	Submittal Preparation Time	**Delivery Time After Approved Submittals**
MagPrex Sequestration System	10 weeks	40 weeks
MagPrex Harvesting System	10 weeks	40 weeks

ITEM 7. PAYMENT TERMS

Price validity: 30 days from the quoted date
Payment target: 30 days net
Delivery terms: FOB, job site

Payment Schedule

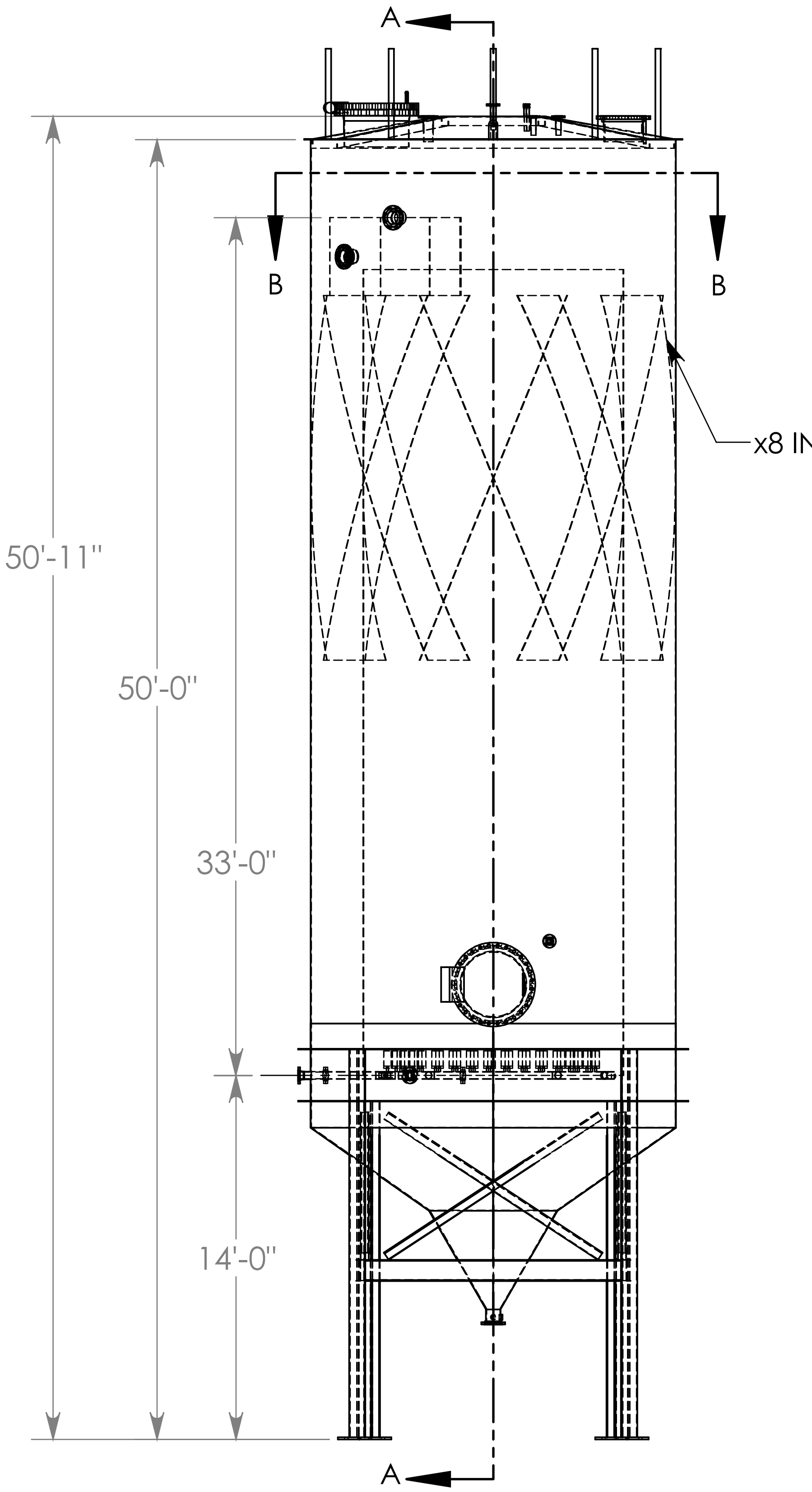
10% for contract approval and signing
Receipt of submittals, 70 days per proposal
10% for approved shop drawing submittals
10% for approved operation and maintenance manuals
60% for delivery of equipment
10% for start-up and commissioning

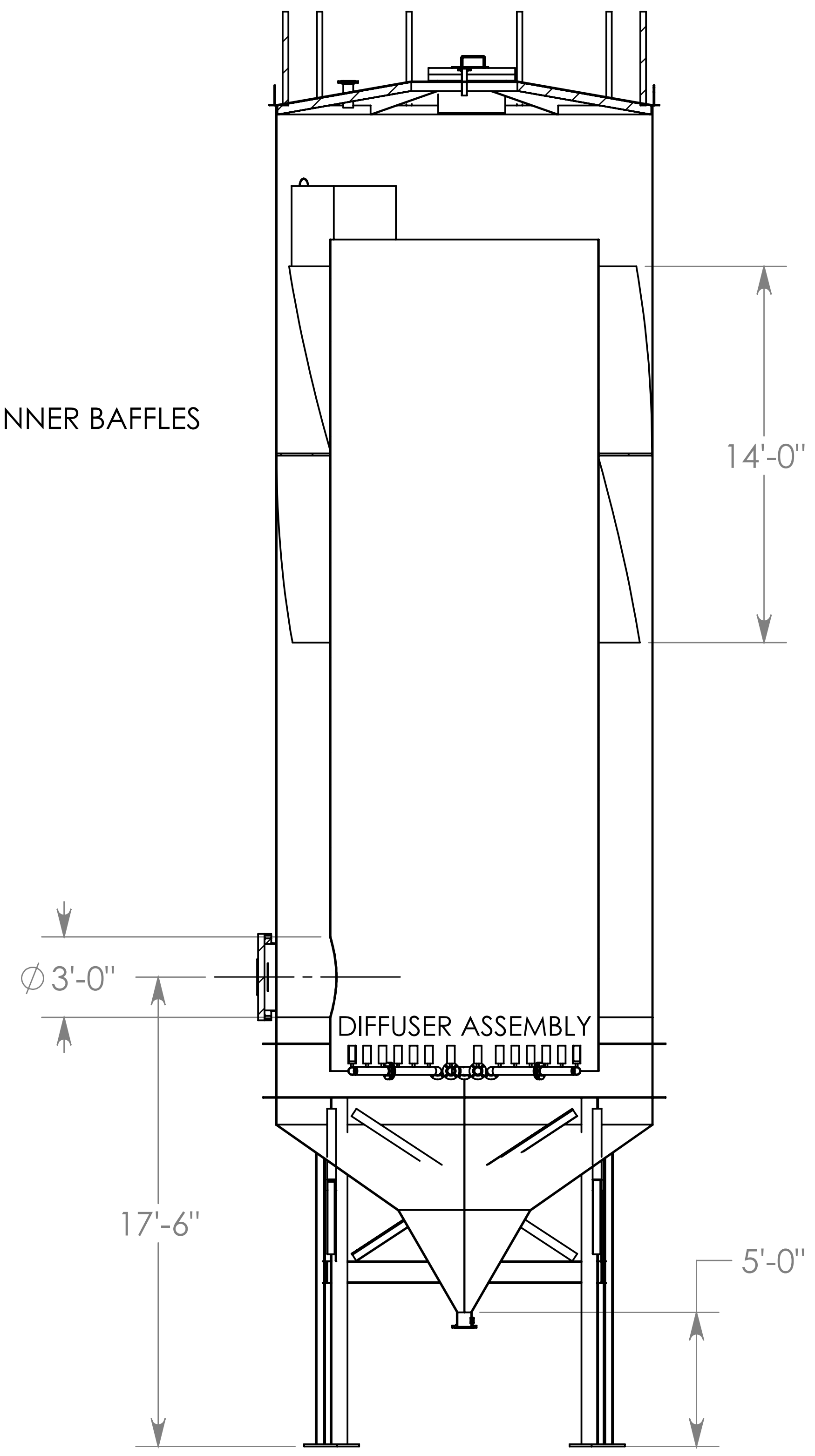
ITEM 8. WARRANTY

Two (2) years after the equipment startup date or thirty (30) months after shipment, whichever comes first. Components that are subject to usual wear, as well as damages caused by inadequate attendance or faulty operation shall not be covered by this warranty.

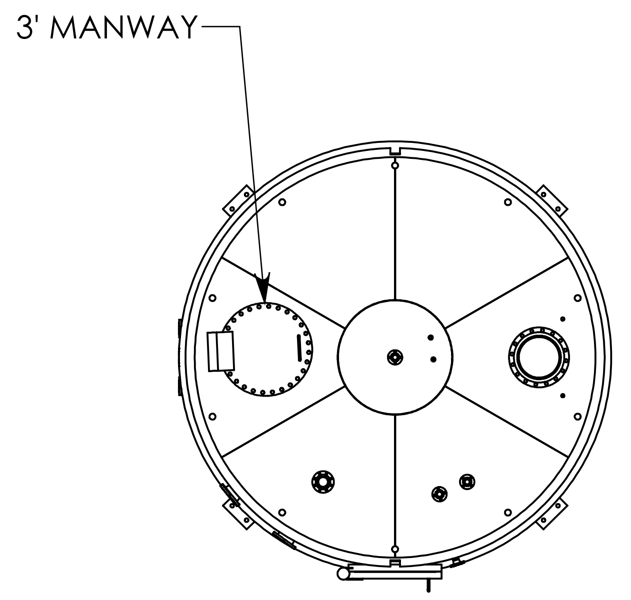
ITEM 9. SCOPE EXCLUSIONS

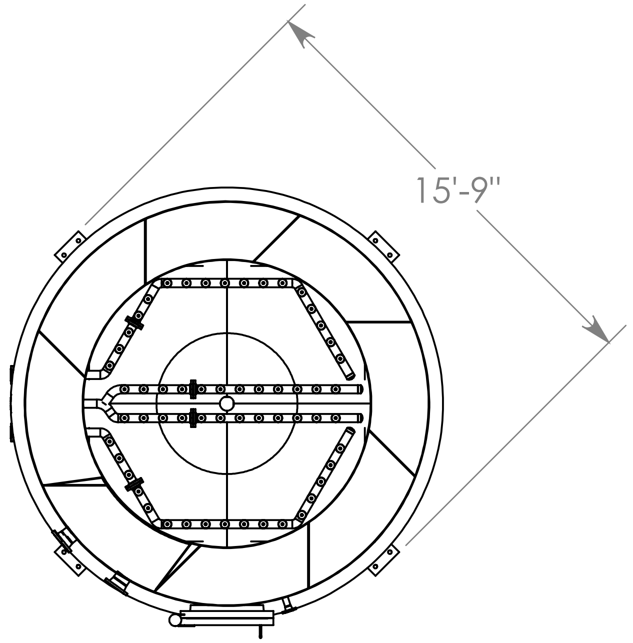
- Stairwell and stairs
- Upstream grit/rag screening (if required)
- Reactor structural supports will be constructed with carbon steel
- Any site preparation work including surveying and soil sampling
- Building and building plans; civil works such as the foundation plate for the system or the building
- Structural and civil engineering labor
- Payment, performance, or bid bonds
- Pipes and piping (except from the outside flange of the reactor to the aeration ring inside the reactor)
- Sludge holding or storage tanks for sludge equalization
- Blowers do not include MCC starter, VFD, external controls, isolation, valves, anchor bolts and installation hardware
- Anchor bolts
- Supply lines (water and electricity) as well as building services (lighting, water supply/sink) in the office building
- Concrete work and core drill holes
- Permits
- Readiness of the equipment before requesting start-up service. Non-readiness may incur additional charges
- Any other auxiliary equipment or service not detailed above



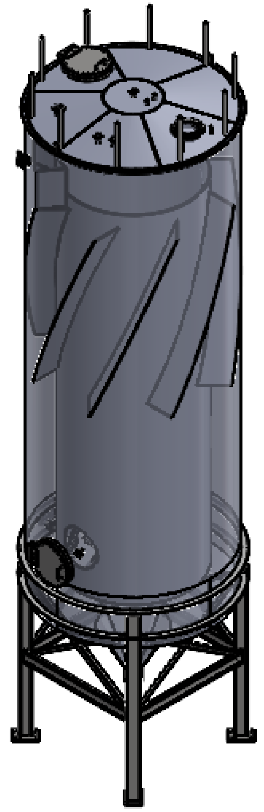


SECTION A-A





SECTION B-B



REV.	DATE	DESCRIPTION	INI.	ECN

REVISION TABLE

REVISE ON CAD ONLY

centrisys cnp

9586 58th Place
Kenosha, WI 53144
Tel: (262) 654-6006
Fax: (262) 764-8705

Title: 50FT MAGPREX REACTOR GA
Project: SAWS
Designed by: Date:
Drawn by: ED Date: 6/24/21
Approved by: Date:
GD&T ASME Y14.5-2009+ Tolerancing Std. & Rules apply
3rd Angle Projection
Material(s): N/A
Estimated weight (lbs):
Sheet Size: B
Drawing #:
Sht: 1 OF 1
Scale: 1:80

MagPrex Recommended O&M Schedule

The following describe the maintenance intervals for specific parts of the plant process. Additional information for maintenance of specific equipment and instruments can be found in the manufacturer's O&M.

Components	Action*	Description of work
pH probe [H681]	C	Cleaning
Pipes	V	Visual tightness check
Chemical Storage Tank	V	Check for sufficient stocks
Blowers/Pumps	Ch	See manufacturer maintenance schedule
* V = Visual check, Ch = Check, R = Replace, C = Clean		

Table 1: Weekly Maintenance

Components	Action*	Description of work
pH probe [H681]	Ch, C	Calibrate (as required)
Reactor Level Probe [L681]	C	Clean
* V = Visual check, Ch = Check, R = Replace, C = Clean		

Table 2: Monthly Maintenance

Components	**What needs to be done***	**Description of work**
pH probe [H681]	R	Replace as necessary
Valves	Ch	Check smooth movement and function
Blowers	Ch/R	– Check inlet/outlet openings of the noise hood – Check belt and belt pulley for wear – Check the pressure valve functions See manufacturer maintenance schedule
Overflow Standpipe	Ch, C	– Lower reactor tank level. – Inspect overflow pipe for struvite formation in discharge lines and lower wye cleanout. – Jet pipe as required to remove struvite buildup as necessary.
* V = Visual check, Ch = Check, R = Replace, C = Clean		

Table 3: Semi-annual Maintenance

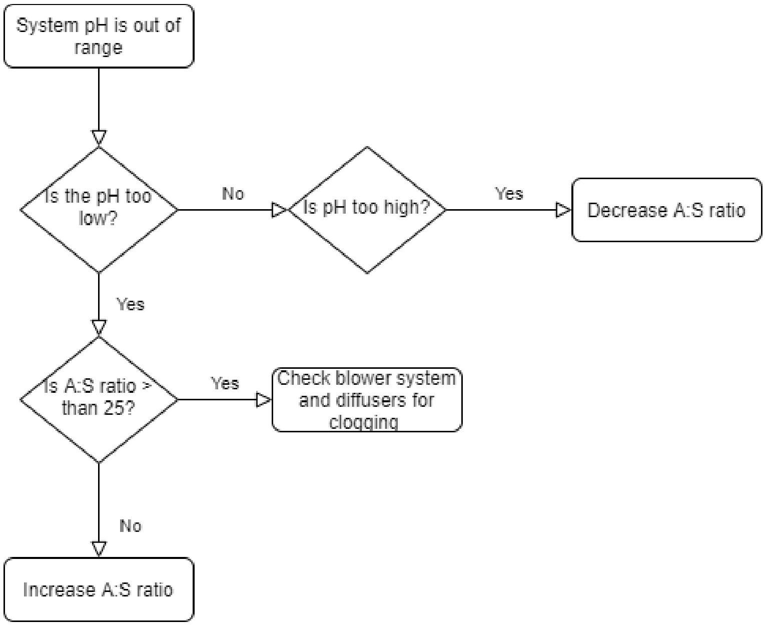
Components	What needs to be done*	Description of work
Leakage sensors and overfill sensors	Ch	Function check through triggering
Electrical connections, switchgear and connection cables	V, Ch	Visual check for damage, check for tight fit of electrical connections
Touch panel	Ch	Visual check for damage
CPU	Ch	Function check
Emergency stop	PR	Function check
Blowers	R	– Replace suction filters – Replace lubricating oil and grease See manufacturer maintenance schedule
Reactor Tank	Ch, C	– Empty reactor tank – Power wash walls and diffusers – Remove any struvite buildup, debris, or rag

* V = Visual check, Ch = Check, R = Replace, C = Clean

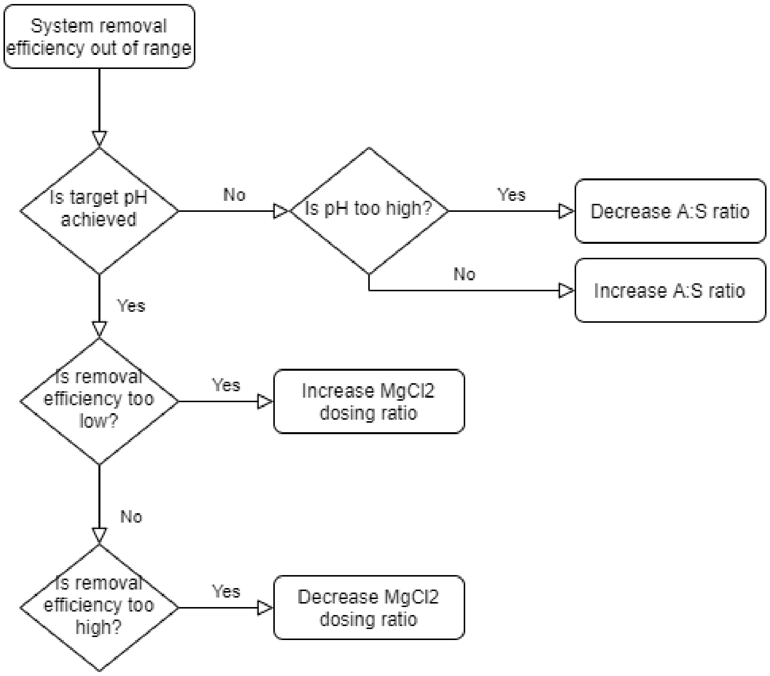
Table 4: Annual Maintenance

Troubleshooting Flow Charts

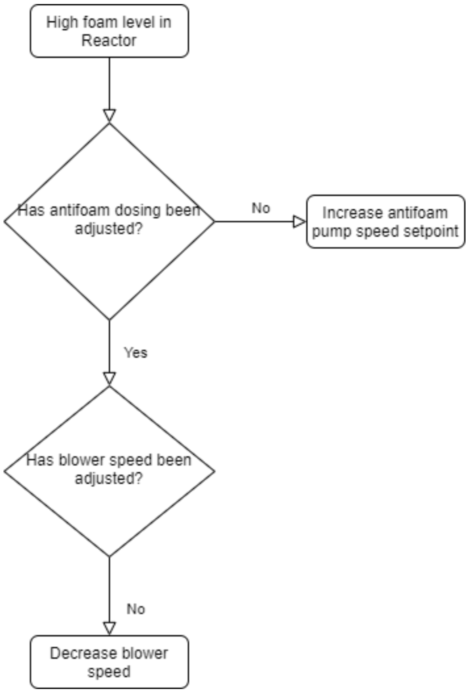
1. System pH Adjustments



2. System $MgCl_2$ Dosing Adjustments



3. System Foaming Adjustments



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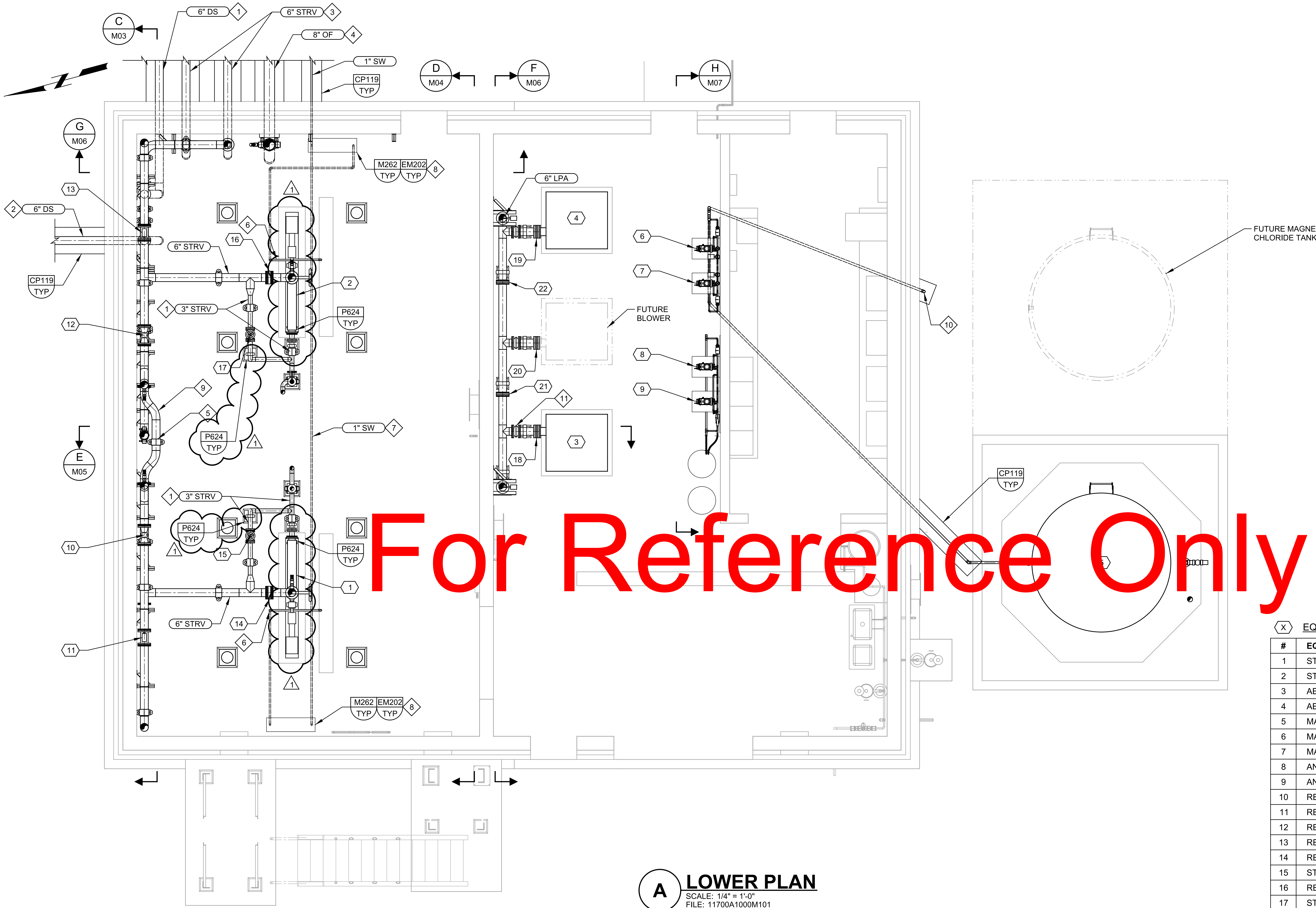


A LOWER PLAN

SCALE: 1/4" = 1'-0"
FILE: 11700A1000M101

GENERAL NOTES:

1. ALL DS AND STRV PIPING SHALL BE HDPE MATERIAL WITH BUTT FUSION WELDS. REFER TO SECTION 40_05_33.03. ALL BENDS SHALL BE SWEEP BENDS (LONG RADIUS).
2. ALL PIPE CONNECTIONS TO THE REACTORS SHALL BE FLANGED.
3. ROUTE PROCESS PIPES AROUND STRUCTURAL FOOTINGS. DO NOT PENETRATE FOOTINGS.
4. SEAL ALL ROOF PENETRATIONS IN ACCORDANCE WITH APPROVED ROOFING MANUFACTURER'S WARRANTY.

KEY NOTES:

1 REACTOR FEED FROM DIGESTERS 4 AND 5. EXISTING FEED PUMPS LOCATED IN THE NORTH DIGESTER CONTROL BUILDING. REFER TO CIVIL DRAWINGS FOR CONTINUATION.

2 REACTOR FEED FROM DIGESTER 6. REFER TO CIVIL DRAWINGS FOR CONTINUATION.

3 STRUVITE DISCHARGE TO DIGESTER 3. INCLUDES NORMAL GRAVITY DISCHARGE AND STRUVITE PUMP DISCHARGE. REFER TO CIVIL DRAWINGS FOR CONTINUATION.

4 REACTOR TANK BACKUP OVERFLOW PIPE TO PLANT DRAIN. REFER TO CIVIL DRAWINGS FOR CONTINUATION.

5 VICTAULIC STYLE 905 COUPLING FOR HDPE PIPE. TYPICAL OF ALL LOCATIONS FOR HDPE PIPE. REFER TO PIPE SCHEDULE.

6 STUB UP SEAL WATER PIPING FROM UNDER SLAB NEXT TO PUMP PADS.

7 INSTALL SEAL WATER LINE UNDER THE SLAB. ALL FLOOR PENETRATIONS PER TYPICAL DETAIL P402.

8 SEAL WATER PANEL SIZE TO BE 3'6" WIDE BY 3'0" TALL. SUPPORTED WITH TWO LEGS.

9 ROUTE THE STRV PIPING AROUND THE VERTICAL DS FEED PIPING USING 45-DEGREE BENDS.

10 MAGNESIUM CHLORIDE FEED PIPING FOR FUTURE TANK. STUB UP PIPE FROM THE GROUND AND TERMINATE 1 FOOT ABOVE GRADE. PROVIDE PVC BALL VALVE AND PVC CAP.

11 RUBBER EXPANSION JOINTS. TYP OF 3.

X EQUIPMENT TAGS

#	EQUIPMENT NAME	SIZE	TYPE	ASSET TAG
1	STRUVITE PUMP 1	SEE SPEC	PROGR. CAVITY	SSPR1PMP0120
2	STRUVITE PUMP 2	SEE SPEC	PROGR. CAVITY	SSPR1PMP0220
3	AERATION BLOWER 1	SEE SPEC	SEE SPEC	SSPR1BLW0300
4	AERATION BLOWER 2	SEE SPEC	SEE SPEC	SSPR1BLW0400
5	MAGNESIUM CHLORIDE STORAGE TANK	10,000 GAL	POLYETHYLENE	SSPR1TNK0500
6	MAGNESIUM CHLORIDE METERING PUMP 1	SEE SPEC	DIAPHRAGM	SSPR1PMP0510
7	MAGNESIUM CHLORIDE METERING PUMP 2	SEE SPEC	DIAPHRAGM	SSPR1PMP0520
8	ANTI-FOAM DOSING PUMP 1	SEE SPEC	DIAPHRAGM	SSPR1PMP0610
9	ANTI-FOAM DOSING PUMP 2	SEE SPEC	DIAPHRAGM	SSPR1PMP0620
10	REACTOR 1 FEED VALVE	6"	PLUG	SSPR1VAL0001
11	REACTOR 1 FEED FLOW METER	SEE SPEC	MAGNETIC	SSPR1FIT0003
12	REACTOR 2 FEED VALVE	6"	PLUG	SSPR1VAL0002
13	REACTOR 2 FEED FLOW METER	SEE SPEC	MAGNETIC	SSPR1FIT0004
14	REACTOR 1 GRAVITY DISCHARGE VALVE	6"	KNIFE GATE	SSPR1VAL0107
15	STRUVITE PUMP 1 DISCHARGE VALVE	3"	PLUG	SSPR1VAL0111
16	REACTOR 2 GRAVITY DISCHARGE VALVE	6"	KNIFE GATE	SSPR1VAL0207
17	STRUVITE PUMP 2 DISCHARGE VALVE	3"	PLUG	SSPR1VAL0211
18	BLOWER 1 DISCHARGE VALVE	6"	BUTTERFLY	SSPR1VAL0301
19	BLOWER 2 DISCHARGE VALVE	6"	BUTTERFLY	SSPR1VAL0401
20	BLOWER 3 DISCHARGE VALVE	6"	BUTTERFLY	SSPR1VAL0404
21	BLOWER BUTTERFLY VALVE 1	6"	BUTTERFLY	SSPR1VAL0303
22	BLOWER BUTTERFLY VALVE 2	6"	BUTTERFLY	SSPR1VAL0403

NO.	REVISION	BY	DATE
1	BID SET UPDATES	NJW	12-22-21

DESIGN NJW
DRAWN MM
CHECKED TRT
APPROVED

Digitally signed by Nicholas J. Webber
PROFESSIONAL ENGINEER 20159 NICHOLAS J. WEBBER

ENGINEERING AND ENVIRONMENTAL SOLUTIONS
1161 W. RIVER ST. SUITE 130
BOISE, IDAHO 83702
208.780.3990

IDAHO OFFICES
BOISE · LEWISTON · MCCALL

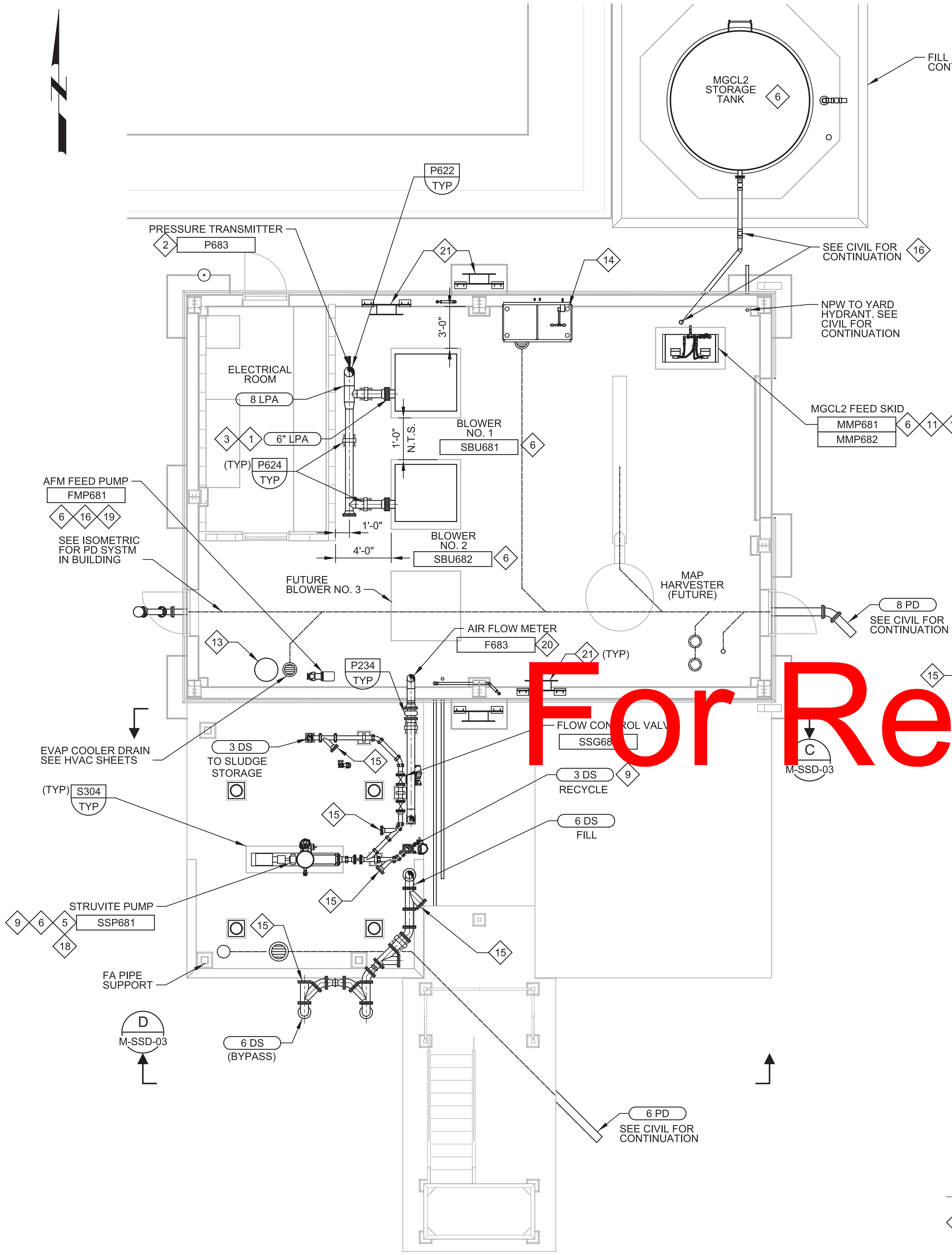
MERIDIAN WASTEWATER FACILITY
MERIDIAN, IDAHO
MECHANICAL
SIDE STREAM FACILITY
LOWER PLAN

VERIFY SCALE
BAR IS ONE INCH ON FULL SIZE DRAWING
0 1"

PROJECT 11700A.10
DATE JANUARY 2022
DRAWING NO. M01
SHEET NO. 42

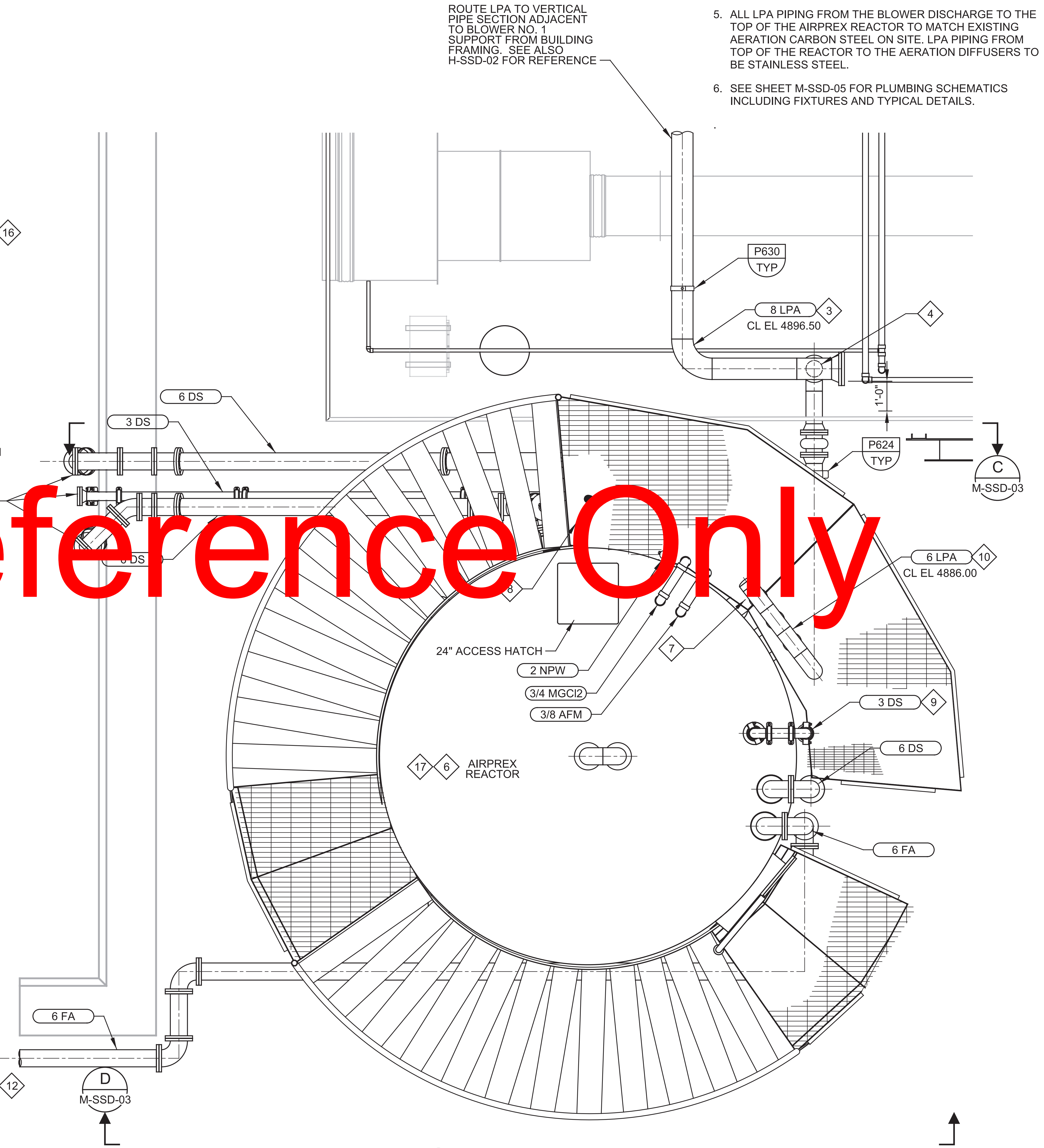
LAST SAVED BY: mmorris

PROJECT NO. 11700A10 FILE NAME: 11700A1000M01.dgn



A LOWER PLAN

SCALE: 3/16" = 1'-0"
FILE: FILE



B TOP PLAN

SCALE: 3/8" = 1'-0"
FILE: FILE

GENERAL NOTES

1. SEE SPECIFICATION SECTION 01_14_00 FOR WORK RESTRICTIONS.
2. ALL DIGESTED SLUDGE AND STRUVITE PUMP PIPING SHALL USE GROOVED END COUPLINGS REGARDLESS OF COUPLINGS SHOWN. PROVIDE FLANGE ADAPTORS WHERE CONNECTED TO FLANGED EQUIPMENT OR COMPONENTS. ALL ELBOWS ARE TO BE LONG RADIUS.
3. PROVIDE FLANGED OR GROOVED END COUPLINGS FOR ALL PIPE CONNECTIONS AT THE TOP OF THE AIRPREX REACTOR. ALL PIPES TO BE DISMANTLED FOR REACTOR LID INSTALLATION AND REMOVAL.
4. ALL DIGESTED SLUDGE AND STRUVITE PUMP PIPING LOCATED OUTSIDE OF THE AIRPREX SUPPORT BUILDING SHALL BE JACKETED AND INSULATED UNLESS NOTED OTHERWISE. ALL STRUVITE PUMP PIPING TO BE HEAT TRACED.
5. ALL LPA PIPING FROM THE BLOWER DISCHARGE TO THE TOP OF THE AIRPREX REACTOR TO MATCH EXISTING AERATION CARBON STEEL ON SITE. LPA PIPING FROM TOP OF THE REACTOR TO THE AERATION DIFFUSERS TO BE STAINLESS STEEL.
6. SEE SHEET M-SSD-05 FOR PLUMBING SCHEMATICS INCLUDING FIXTURES AND TYPICAL DETAILS.

KEY NOTES =

1 6 INCH LPA CL EL TO MATCH DISCHARGE ELEVATION OF BLOWER FURNISHED BY CNP. PROVIDE RUBBER EXPANSION JOINT (P234/TYP) AND 6 INCH BFV AT DISCHARGE OF EACH BLOWER. PROVIDE PIPE SUPPORTS PER TYPICAL DETAIL P624.

2 INSTALL PRESSURE TRANSMITTER IN VERTICAL PIPE SECTION.

3 JACKET AND INSULATE AIR PIPE, FITTINGS, AND VALVES AT ALL LOCATIONS WITHIN THE BUILDING PER THE SPECIFICATIONS.

4 6 INCH BFV WITH ACTUATOR ACCESSIBLE FROM FINISHED FLOOR ELEVATION.

5 KNIFE GATE VALVES TO BE USED ON THE STRUVITE PUMP AND ALL ASSOCIATED PIPING REGARDLESS OF VALVE SHOWN.

6 EQUIPMENT FURNISHED BY CNP AND INSTALLED BY CONTRACTOR. REFER TO MANUFACTURER SHOP DRAWINGS SUBMITTED UNDER SEPARATE COVER. NOTIFY ENGINEER IMMEDIATELY IF CONDITIONS NOT COVERED BY THESE DRAWINGS ARE EXPOSED DURING CONSTRUCTION INCLUDING BUT NOT LIMITED TO:
  a DIFFERING SIZES OR DIMENSIONS.
  b DAMAGE TO MATERIALS AND COMPONENTS.
  c CONDITIONS OR DETAILS DIFFERENT THAN THOSE SHOWN ON THE DRAWINGS.

7 CUT AND BAND GRATING TO ACCOMMODATE CHEMICAL FEED PIPE, AIR PIPE, NON-POTABLE WATER STANDPIPE, AND ELECTRICAL CONDUIT.

8 PROVIDE HINGED AND REMOVABLE SECTION IN GRATING FOR ACCESS TO PIPE FLUSHING CONNECTIONS LOCATED AT THE TOP OF THE OVERFLOW AND EMERGENCY OVERFLOW PIPES.

9 HEAT TRACE AND INSULATE PIPING AND VALVES LOCATED OUTSIDE THE AIRPREX SUPPORT BUILDING PER SPECIFICATION SECTION 40_41_00.

10 JACKET AND INSULATE AIR PIPE, FITTINGS, AND VALVES ACCESSIBLE TO OPERATIONS STAFF. JACKET AND INSOLATE THE ENTIRE LENGTH OF EACH DROPLEG TO THE FLANGE CONNECTION AT THE CONE OF THE REACTOR.

11 INSTALL FLOW METER (F680) DOWNSTREAM OF PUMP SKID PER MANUFACTURER'S RECOMMENDATIONS USING PVC PIPE. TRANSITION TO 3/4 INCH FLEXIBLE TUBING INSIDE 2 INCH CONDUIT DOWNSTREAM OF THE FLOW METER.

12 ROUTE FA PIPING TO EXISTING ODOR CONTROL PIPE ON SOUTH SIDE OF SLUDGE STORAGE TANK.

13 RELOCATABLE ANTI-FOAM CHEMICAL STORAGE TANK.

14 STAINLESS STEEL SINK, EYE WASH STATION, AND PLUMBING APPURTENANCES SEE DETAIL 2 ON SHEET M-SSD-04; SEE SPECIFICATIONS. SEE ISOMETRIC ON SHEET M-SSD-05 FOR PW SYSTEM REQUIREMENTS IN BUILDING.

15 PROVIDE FLUSHING CONNECTION PER TYPICAL DETAIL P202.

16 CONTRACTOR TO FIELD ROUTE CHEMICAL CARRIER PIPE AND FLEXIBLE TUBING BETWEEN THE REACTOR AND APPROPRIATE CONNECTION POINTS INSIDE THE AIRPREX SUPPORT BUILDING.

17 TANK LIQUID LEVEL RADAR, LEVEL SWITCH, AND PH PROBE LOCATED AT TOP OF REACTOR AND ACCESSIBLE FROM THE PLATFORM.

18 STRUVITE PUMP LOCATION DICATED BY REACTOR LOCATION - FIELD COORDINATE.

19 ANTI-FOAM CHEMICAL FEED PUMP. MOUNT ON WALL OR PROVIDE CONCRETE PUMP PAD.

20 INSTALL BFV AND AIR FLOW METER IN VERTICAL PIPE SECTION. INSTALL AIR FLOW METER WITH UPSTREAM AND DOWNSTREAM LAY LENGTH PER MANUFACTURER RECOMMENDATION. BFV SHALL BE EQUIPPED WITH CHAINWHEEL ACTUATOR.

21 NPW HOSE BIB AND HOSE RACK. SEE NPW ISOMETRIC ON SHEET M-SSD-05 FOR NPW INSTALLATION REQUIREMENTS. LOCATE NPW HB SERVING OUTDOOR AREAS INDOORS WITH VALVE DISCHARGE PIPING AND STEM EXTENSION THROUGH THE EXTERIOR WALL TO ALLOW OPERATION OF THE VALVE FROM OUTSIDE THE BUILDING. EXTEND OUTDOOR NPW PIPING MINIMUM 9 INCHES BEYOND EXTERIOR WALL.

REV	DATE	BY	DESCRIPTION
			ISSUED FOR CONSTRUCTION

DESIGNED
BDC
DRAWN
JPC
CHECKED
JCG
DATE
AUGUST, 2019

JASON C. GARSIDE
38073
Digitally signed by Jason C. Garside
Contact Info: Carollo Engineers, Inc.
Date: 2019.07.31 17:00:41-07'00'

DRAKE WATER RECLAMATION FACILITY (DWRF)
SIDESTREAM-P TREATMENT PROJECT
MECHANICAL
SIDESTREAM FACILITY
PLAN

1.00 in
VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

JOB NO.
10992B.10
DRAWING NO.
M-SSD-02
SHEET NO.
44 OF 98

Plot Date: 31-JUL-2019 7:08:40 AM
User: svcPW
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ColorTable: gshade.ctb
Model: Layout1
LAST SAVED BY: tlockwood

PROJECT NO. 10992B10
FILE NAME: 10992B1000MSSD02.dgn

TO:
Erin Andersen, PE
7090 South Union Park Avenue, Suite 600
Salt Lake City, UT 84047
O 801.233.2506 C 801.814.7774
eandersen@carollo.com

DATE: 12/9/2022
REF.: Thickening THK

Budget Proposal
Central Weber, UT
THK600

Centrisys Contact
Jerod Swanson
Regional Sales Manager
Frisco, CO
Direct: (612) 401-2006
Email: Jerod.swanson@centrisys.us

Centrisys Representative
Scott Perry
Misco Water
651 Corporate Circle Suite #100
Golden, CO 80401
Ph: (720) 491-7400
Email: sperry@miscowater.com

Disclaimer: Please note that this is a very preliminary budget proposal .Centrisys would require basis of design, existing facility information and any lab or pilot testing data to confirm the sizing before moving forward with the design stage.

Centrisys is pleased to provide this budget quotation for the following:

ITEM 1 TWO (2) DECANTER CENTRIFUGE UNIT COMPLETE WITH AUTOMATIC HYDRAULIC BACKDRIVE

1.A Centrifuge Specification

No. of units:	2
Model:	THK600
Inside bowl diameter (in):	26
Bowl length (in):	121
Bowl length to diameter ratio:	4.0:1
Main Motor HP:	150
Back Drive Motor HP:	25

1.B. Scope of supply

1. Each unit will be provided based on the attached drawing
   (i) Duplex SS Solid bowl
   (ii) Scroll conveyor with Duplex SS Scroll shaft; 304SS flights
   (iii) 304 SS lower and upper casing
   (iv) Solid and liquid flexible connectors
   (v) Dewatered Sludge and Centrate Chutes/Hoppers
   (vi) Powder coated carbon steel base/frame
   (vii) Vibration isolators
   (viii) Spare parts/tools
   (ix) Control Panel (water cooled)
      A. 304SS NEMA 4X Enclosure for each centrifuge
      B. Main circuit breaker
      C. VFD for main drive motor
      D. Allen Bradley PLC (compact logix), valve amplifier and motor starter for automatic hydraulic back drive system
      E. Ethernet communication and historical trending of key parameters
      F. 10” Allen-Bradley panel view touch screen
   (x) Instrumentation
      A. One (1) vibration sensor per unit
      B. One (1) main bearing temperature sensor, type PT100 on each bearing
      C. One (1) each Bowl/Scroll speed sensor/unit
      D. One (1) Hydraulic oil level/temp, hydraulic pressure sensor/unit
   (xi) Lubrication System
   (xii) One (1) trip and 5 days of startup assistance

Budget Price:

All the above for... **$ 1,510,200.00**

F.O.B. Job Site, freight included, Taxes Excluded

PAYMENT TERMS:

30% with order; 60% upon shipment; 10% after startup not to exceed 90 days after shipment.

Lead Time: 60 weeks following receipt of the Approved drawings

BUYER/OWNER RESPONSIBILITY (UNLESS INCLUDED AS ADDER):

- Stand
- Feed pump
- Polymer system
- Flow meter
- Cake conveyor
- Anchor bolts.
- Building and building plans (Centrisys provides only the layout drawings without any responsibility of updating any plans or building)
- Building modifications
- Structural and Civil engineering labor
- Lubricants
- All utilities that are required for operation
- Unloading, uncrating, installation and installation supervision. Installation will, at minimum, require a forklift and possibly a crane/hoist.
- Readiness of the Equipment before requesting start-up service. Non-readiness may incur additional charges.
- Compatibility of Equipment materials of construction with process environment.
- Piping connections, platforms, gratings and railings unless stated otherwise.
  Any other auxiliary equipment or service not detailed above.

NUMBER: 12918 **DATE:** 12/19/22

TO: Central Weber **REF.:** PONDUS THP Process

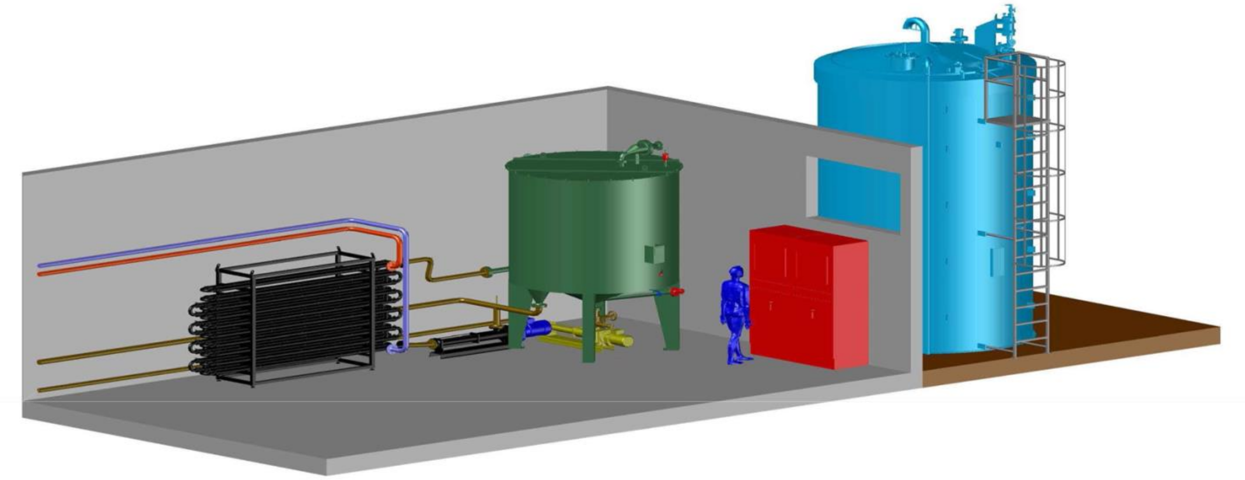
Budget Proposal
Central Weber Sewer Improvement District
PONDUS Thermal Hydrolysis Process

Centrisys Contact
Jerod Swanson
Regional Sales Manager
9586 58th place
Kenosha, WI 53144
Ph: (262) 654-6006
Direct: (612) 401-2006
Email: Jerod.swanson@centrisys.us

Centrisys Representative
Scott Perry
Misco Water
651 Corporate Circle Suite #100
Golden, CO 80401
Ph: (720) 491-7400
Email: sperry@miscowater.com

CNP is pleased to offer a budgetary proposal for the following system:

PONDUS THERMAL HYDROLYSIS PROCESS – WAS-ONLY



System Description:
Thickened Waste Activated Sludge (TWAS) is mixed with a small dose of caustic soda before the PONDUS reactor recirculation line. The chemically treated TWAS is mixed with recirculated hydrolyzed sludge and heated to around 150F, using waste heat from the cogeneration process or other heat source. The combination of heat and caustic soda destroy the cell membrane of the WAS.

During the hydrolysis process, organic acids are released. These organic acids are now converted more quickly during the anaerobic digestion process – producing 20 - 30% more biogas in the anaerobic digester. The process results in at least a 5-fold reduction of dynamic viscosity of TWAS. Therefore, more solids can be process in the digester with less energy required to heat, pump, and mix. The hydrolyzed sludge generates dryer cake and lowers the polymer consumption during dewatering (lower dewatering and disposal costs).

Benefits:

- Improved efficiency of anaerobic digestion
    i. Enhance biogas production between 20-30%
    ii. Improve volatile solids reduction ratio up to 6% points

    iii. Reduce digester foaming
- Reduced sludge viscosity by up to 80%
    i. Less energy for heating, pumping, and mixing
    ii. Increased solid loading rates in the digester
    iii. Less digester retention time
    iv. Reduce digester volume up to 50%
- Improved digested sludge dewaterability
    i. Dryer cake – DS improvement of 3-6%
    ii. Polymer usage reduction up to 20%
    iii. Reduction of dewatering and disposal costs up to 30%
- Optional – Class A biosolids

ITEM 1 DESIGN PARAMETERS

Our design calculations are based on the hydrolysis of thickened activated sludge:

PARAMETER	UNIT	VALUE
Digested sludge flow rate to PONDUS THP	gallon/min	60
Total Solids % of feed sludge	%	6
50% w/w NaOH solution consumption (24 hr/d operation)	gallon/day	144
Target SRT	min	150
Reactor Dimensions	Ft x Ft	10 x 20
O&M Labor requirements	hours/day	<1
Hot water required for heat exchanger	243 gpm @ 185˚F	Supply water: 185F Return water: 158F

ITEM 2 SCOPE OF SUPPLY

ITEM	QUANTITY	DESCRIPTION
1	1	**PONDUS THP reactor** **- 10 ft. diameter x 20 ft. high** **- MOC: 304SS**
2	2	**Reactor feed pump**
3	2	**Recirculation pump**
4	1	**Reactor discharge pump**
5	1	**Hot Water Heat Exchanger**
6	1	**Cold Water Heat Exchanger**
7	2	**Hot Water Centrifugal Pump**
8	1	**Cooling Water Centrifugal Pump**

9	1	**NaOH Solution Dosing Skid System**
10	1	**NaOH Solution Storage Tank**
11	1	**NaOH Storage Tank Heater**
12	1	**Set of Instrumentation (flow meters, level sensors, etc)**
13	1	**Control Panel** **- NEMA4X 304SS Cabinet** **- Allen Bradley CompactLogix PLC**
14	**1**	**Start-up and commissioning services**

ITEM 3 SYSTEM PERFORMANCE

Reduce TWAS viscosity	up to 80%
Enhance biogas production	up to 30%
Improve volatile solids reduction ratio	up to 6% points

ITEM 4 SERVICES

4.A <u>Drawings and Installation, Operation and Maintenance (IO&M) Manuals:</u>

1.	Submittal Drawings:	One (1) electronic copy; prints by request
2.	Final Drawings:	Two (2) prints & One (1) electronic copy included
3.	O&M Manuals:	Two (2) prints & One (1) electronic copy included

4.B <u>Start-Up Assistance:</u>

CNP will furnish one factory representative for 15 days during 3 trips to assist in installation inspection, start-up supervision, and operator training. Dates of service to be scheduled upon Buyer’s written request.

<u>BUDGET PRICE:</u>

All of the above for .... $**<u>2,430,900</u>** USD

F.O.B. Jobsite, freight included, taxes excluded.

<u>PAYMENT TERMS:</u>

30% with order; 60% upon shipment; 10% after startup not to exceed 90 days after shipment.

ITEM 5 TIMETABLE

Submittal phase:	6-8 weeks after the order receipt
Approval phase:	4 weeks for the customer to approve the drawings
Shipment phase:	40-50 weeks following receipt of the Approval drawings

Additional on-sit installation time (by others): 3 weeks after delivery

Dates are subject to confirmation upon receipt of written Purchase Order.

ITEM 6 WARRANTY

One (1) year from the equipment start up or eighteen (18) months from delivery.

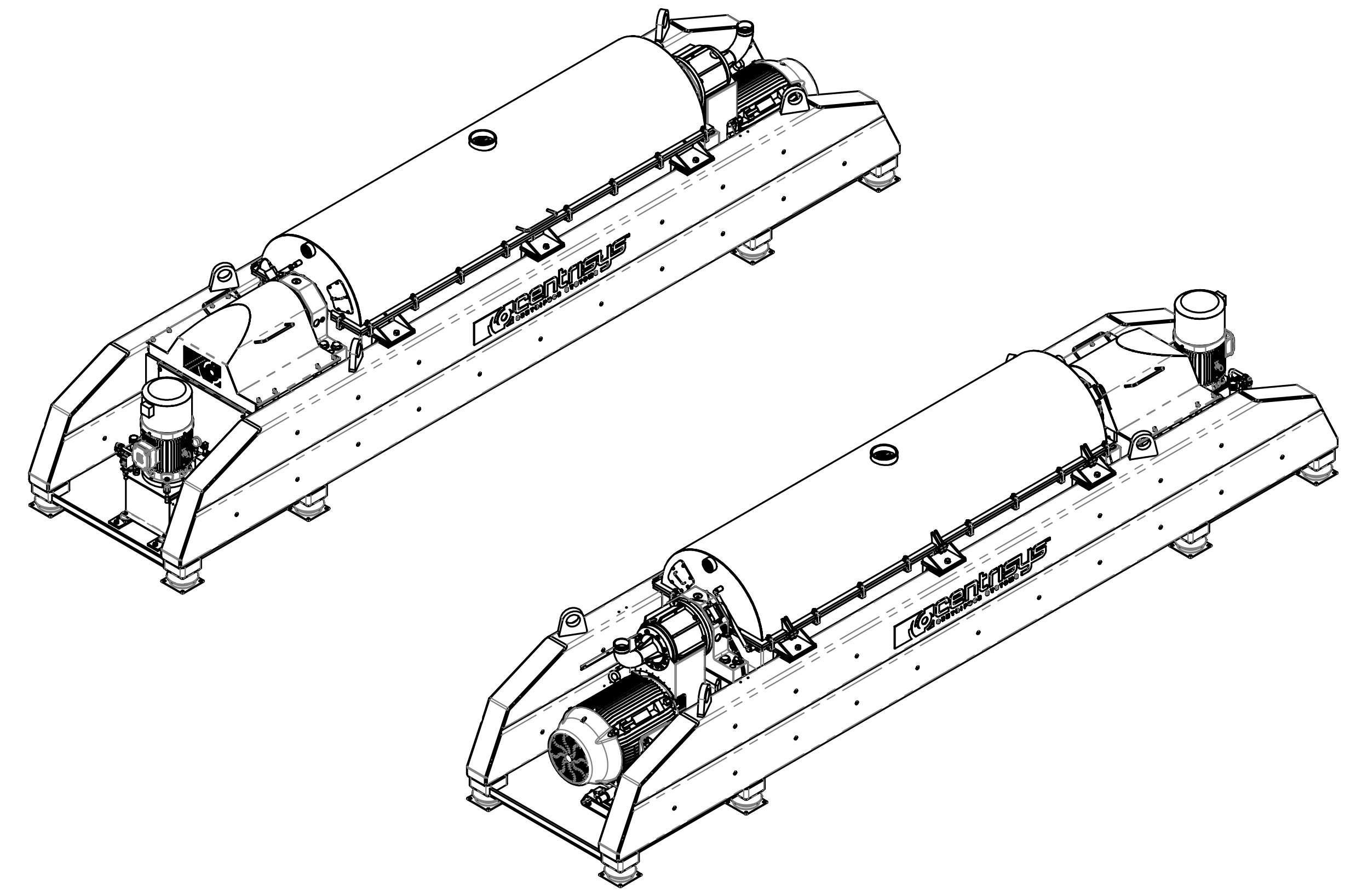
BUYER/OWNER RESPONSIBILITY:

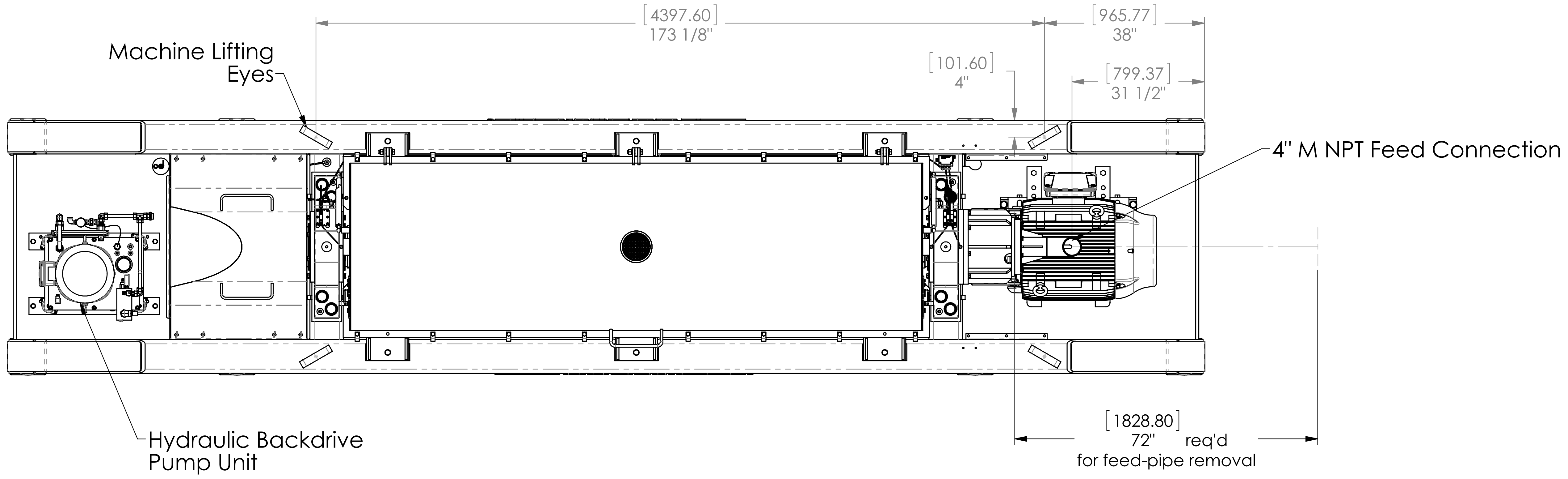
- Any site preparation work including surveying and soil sampling
- Civil works such as the foundation plate for the system or the building
- Pipes and piping (except from the outside flange of the reactor the aeration ring inside the reactor)
- Sludge holding or storage tanks for sludge equalization
- We have assumed that all components except the storage tank will be installed underneath the reactor in the associated machine room. The storage tank with the filling station will be installed at a distance of max. 15 m (45 ft) from the building.
- Supply lines (water and electricity) as well as building services (lighting, water supply / sink) in the office building
- Concrete work and core drill holes
- Permits
- Building and building plans (Centrisys provides only the layout drawings without any responsibility of updating any plans or building)
- Building modifications
- Structural and Civil engineering labor
- All utilities that are required for operation
- Unloading, uncrating, installation and installation supervision. Installation will, at minimum, require a forklift and possibly a crane/hoist.
- Readiness of the Equipment before requesting start-up service. Non-readiness may incur additional charges.
- Compatibility of Equipment materials of construction with process environment.
- Any other auxiliary equipment or service not detailed above.

Issued by

Brett Bevers
Applications Engineer

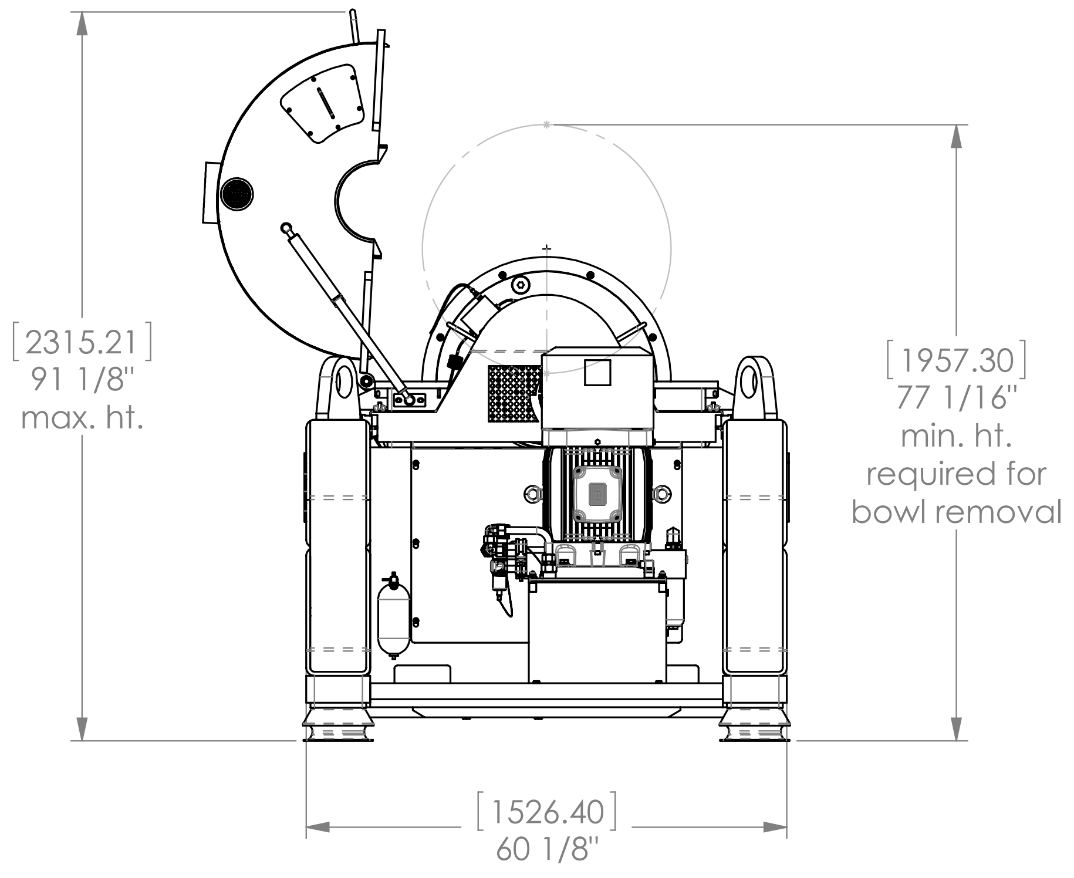
Date:12/19/22

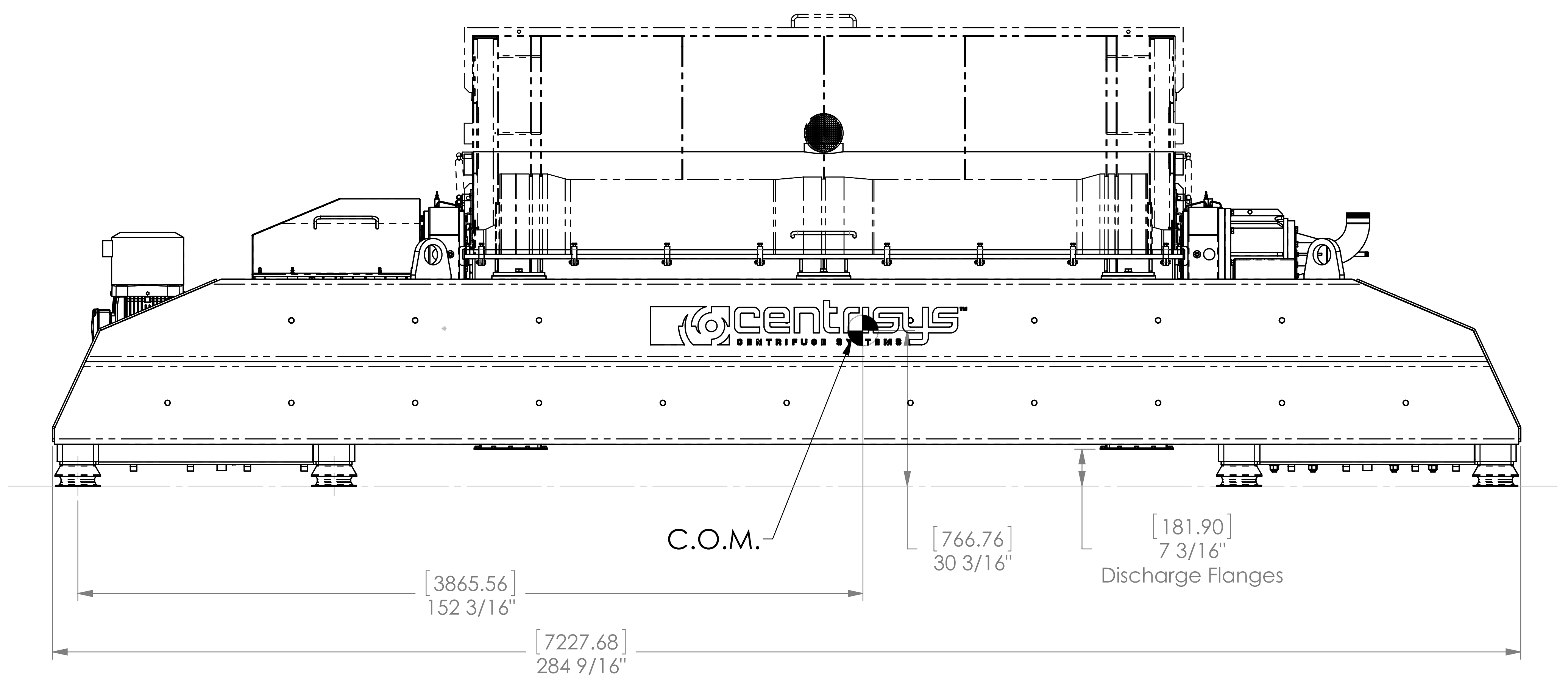


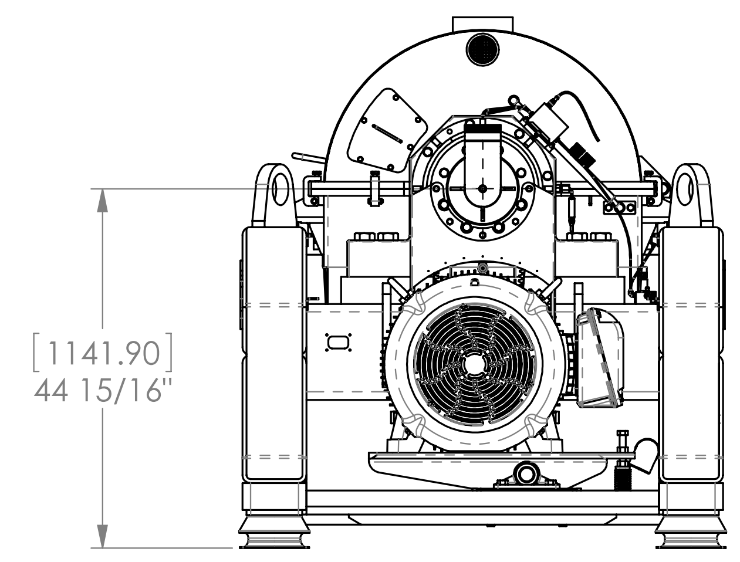


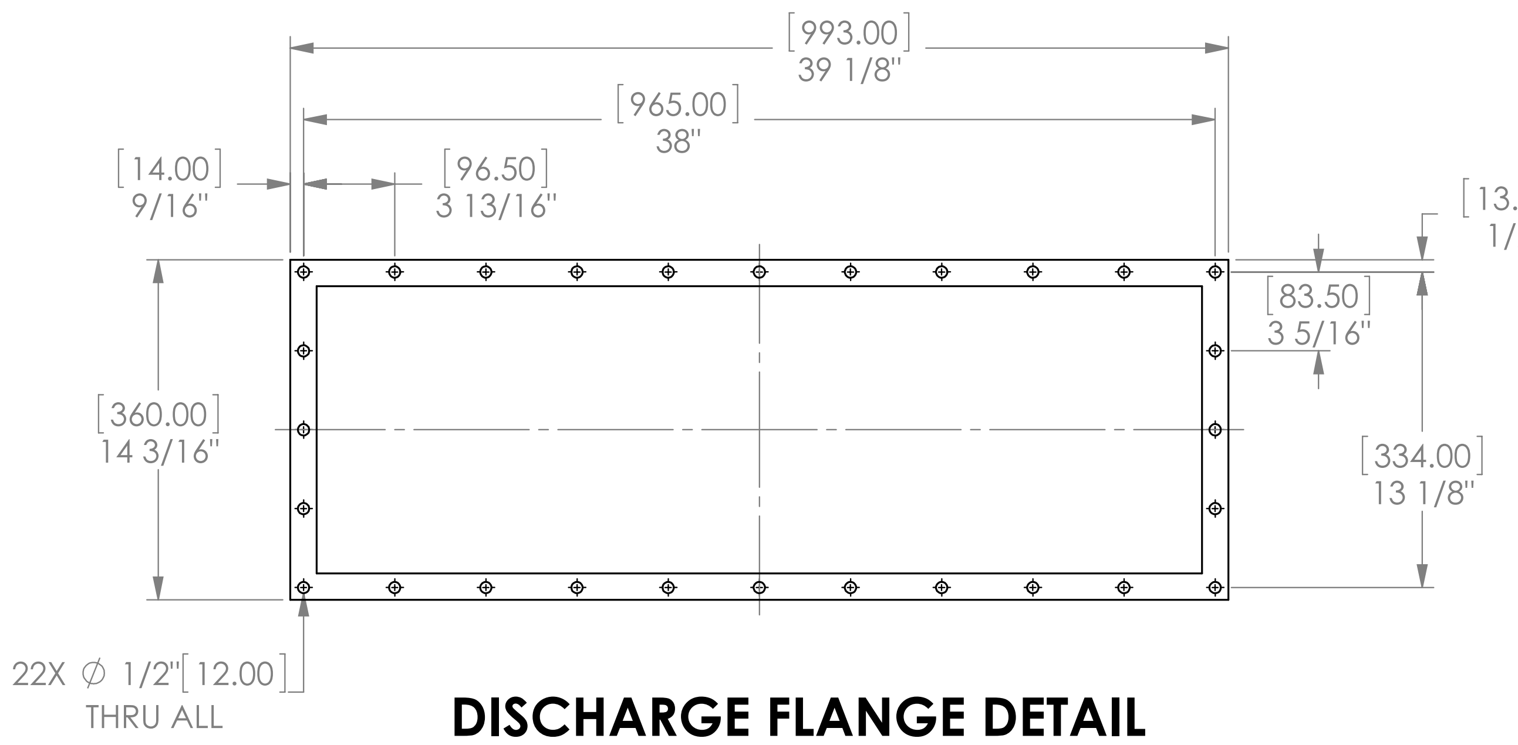
Est. Centrifuge Loading:	*lbs [kg]*
Rotating Assembly	9150 [4150]
Bowl Filling w/SP 1.0	2000 [907]
Complete Centrifuge (w/o filling)	27000 [12247]
Static loads below foot pads:	
A	3821 [1733]
B	3821 [1733]
C	3821 [1733]
D	3821 [1733]
E	2929 [1329]
F	2929 [1329]
G	2929 [1329]
H	2929 [1329]
Dynamic loads below each corner of complete centrifuge:	
A	4203 [1906]
B	4203 [1906]
C	4203 [1906]
D	4203 [1906]
E	3222 [1461]
F	3222 [1461]
G	3222 [1461]
H	3222 [1461]
Dynamic loads below each corner of complete centrifuge with full bowl @ start-up during critical:	
A	4575 [2075]
B	4575 [2075]
C	4575 [2075]
D	4575 [2075]
E	3400 [1542]
F	3400 [1542]
G	3400 [1542]
H	3400 [1542]

*Assume horizontal loads approximately 5% of vertical loads



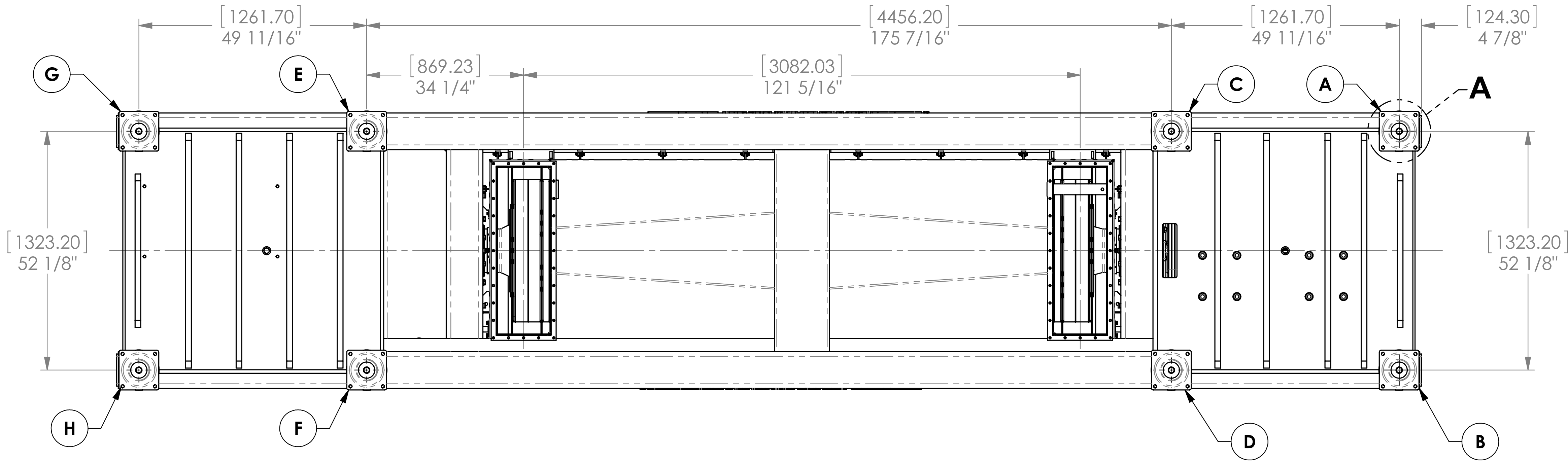


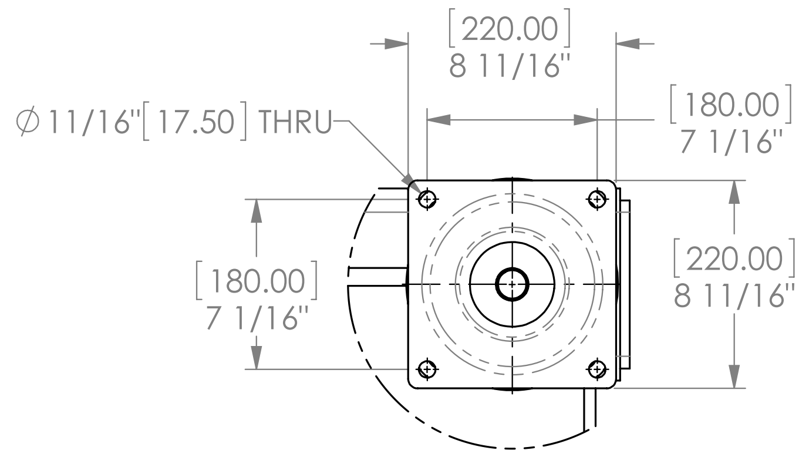




DISCHARGE FLANGE DETAIL

Scale 1 : 8





DETAIL A
SCALE 1 : 8

REVISE ON CAD ONLY

centrisys
CENTRIFUGE SYSTEMS

9586 58th Place
Kenosha, WI 53144

Tel: (262) 654-6006
Fax: (262) 764-8705

Designed by:	Date:
A.A.	---
Drawn by: A.A.	Date: 8/26/13
Chk'd by: -	Date: -
Approved by: -	Date: -

GD&T ASME Y14.5M1994+ Tolerancing Std. & Rules apply

3rd Angle Projection

Material(s): See BOM

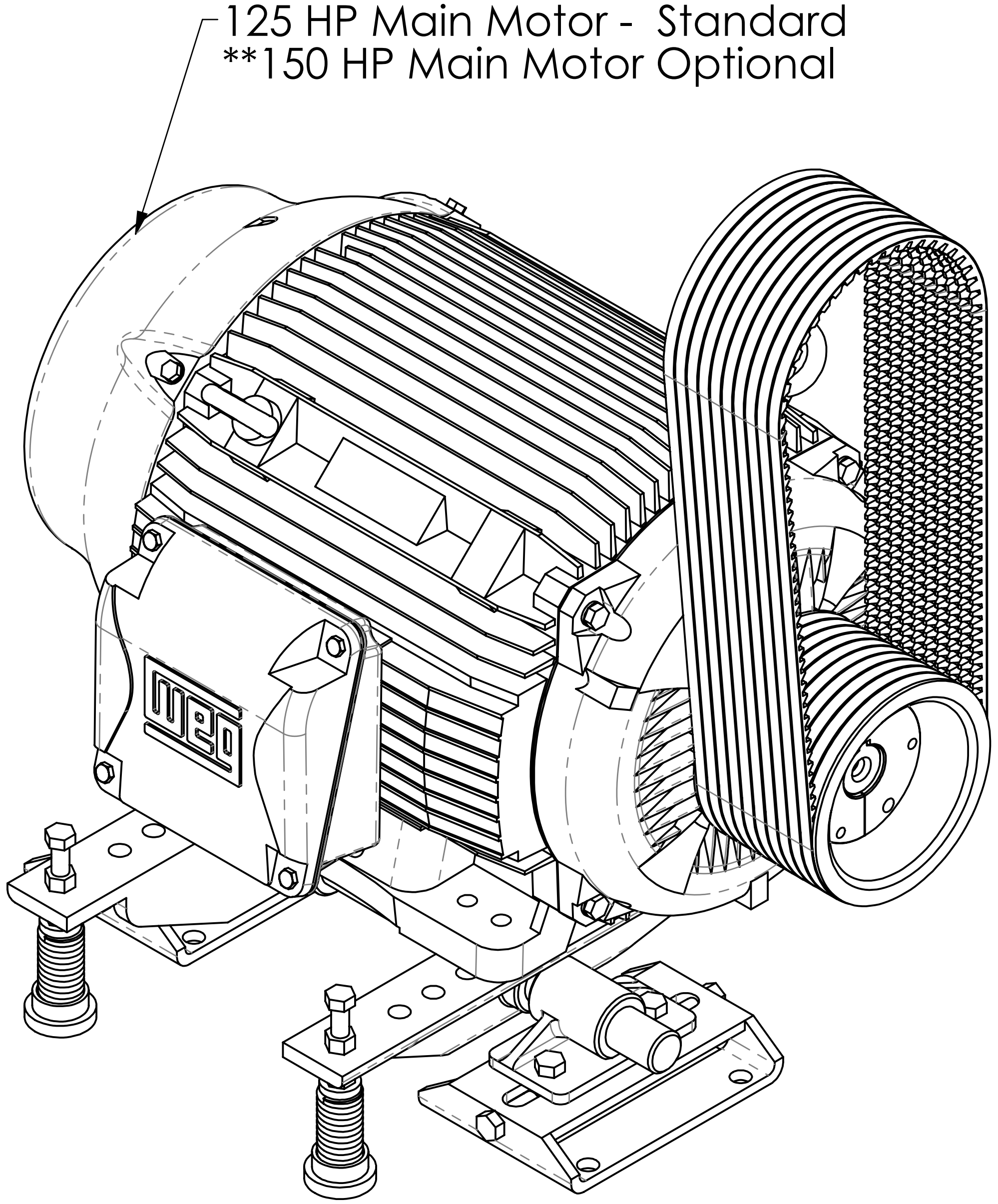
Estimated weight (lbs): See Note

THIS PRINT IS PROVIDED ON A RESTRICTED BASIS AND IS NOT TO BE USED IN ANY WAY DETRIMENTAL TO THE INTERESTS OF CENTRISYS.

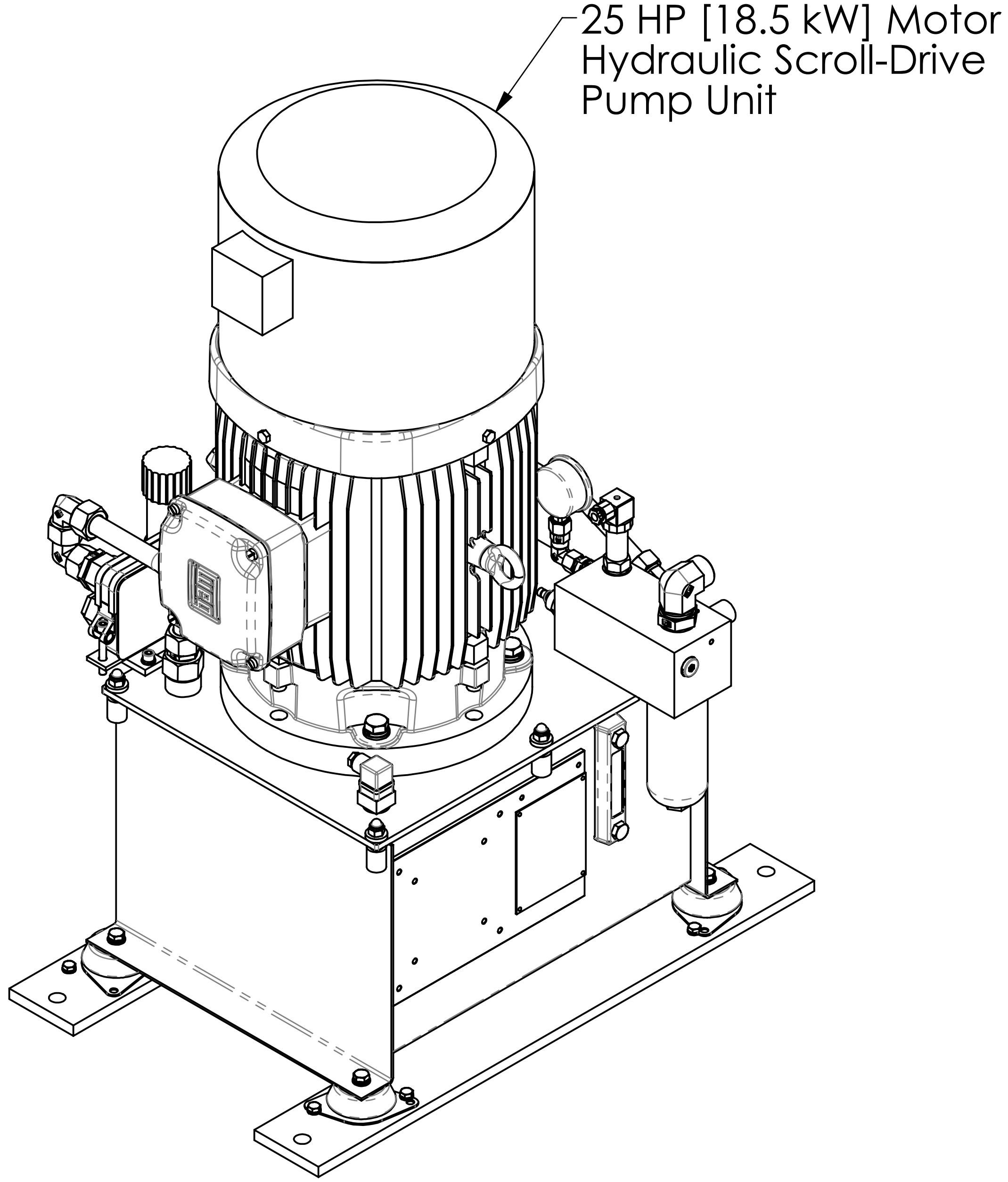
Title: THK 26-600 General Arrangment

Project:

Sheet Size: D
Drawing #: GA23210
Sht: 1 OF 3
Scale: 1:24
REV



125 HP Main Motor - Standard
**150 HP Main Motor Optional



25 HP [18.5 kW] Motor
Hydraulic Scroll-Drive
Pump Unit

REVISE ON CAD ONLY

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9586 58th Place
Kenosha, WI 53144

Tel: (262) 654-6006
Fax: (262) 764-8705

THIS PRINT IS PROVIDED ON A RESTRICTED BASIS AND IS NOT TO BE USED IN ANY WAY DETRIMENTAL TO THE INTERESTS OF CENTRISYS.

Title: THK 26-600 General Arrangment
Drive Info

Project:

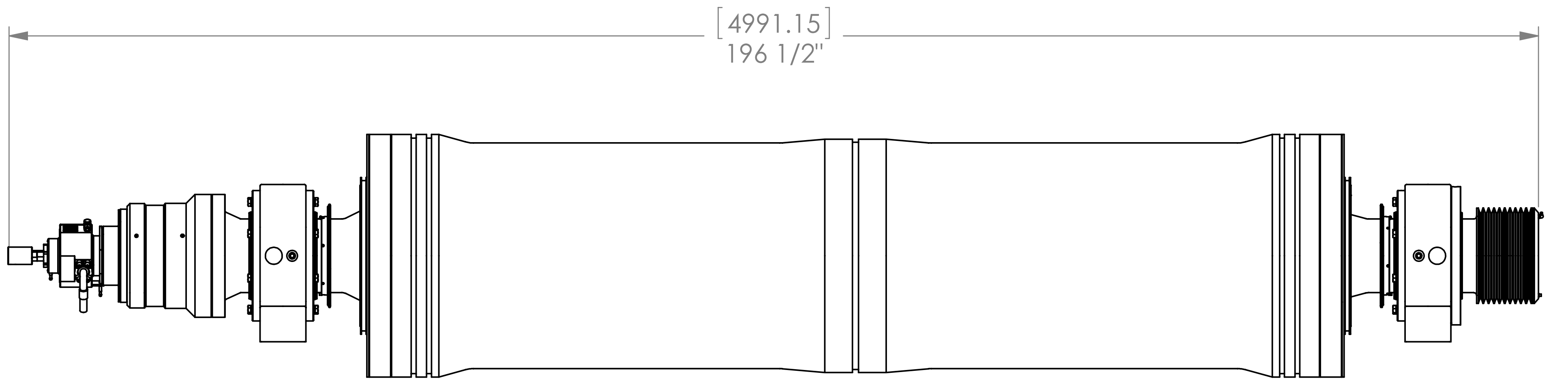
Designed by: A.A.
Date: ---
Drawn by: A.A.
Date: 8/26/13
Chk'd by: -
Date: -
Approved by: -
Date: -

GD&T ASME Y14.5M1994+ Tolerancing Std. & Rules apply

3rd Angle Projection

Material(s): See BOM
Estimated weight (lbs):

Sheet Size: B
Drawing #: GA23210
Sht: 2 OF 3
Scale: 1:8
REV



REVISE ON CAD ONLY

centrisys™
CENTRIFUGE SYSTEMS

9586 58th Place
Kenosha, WI 53144

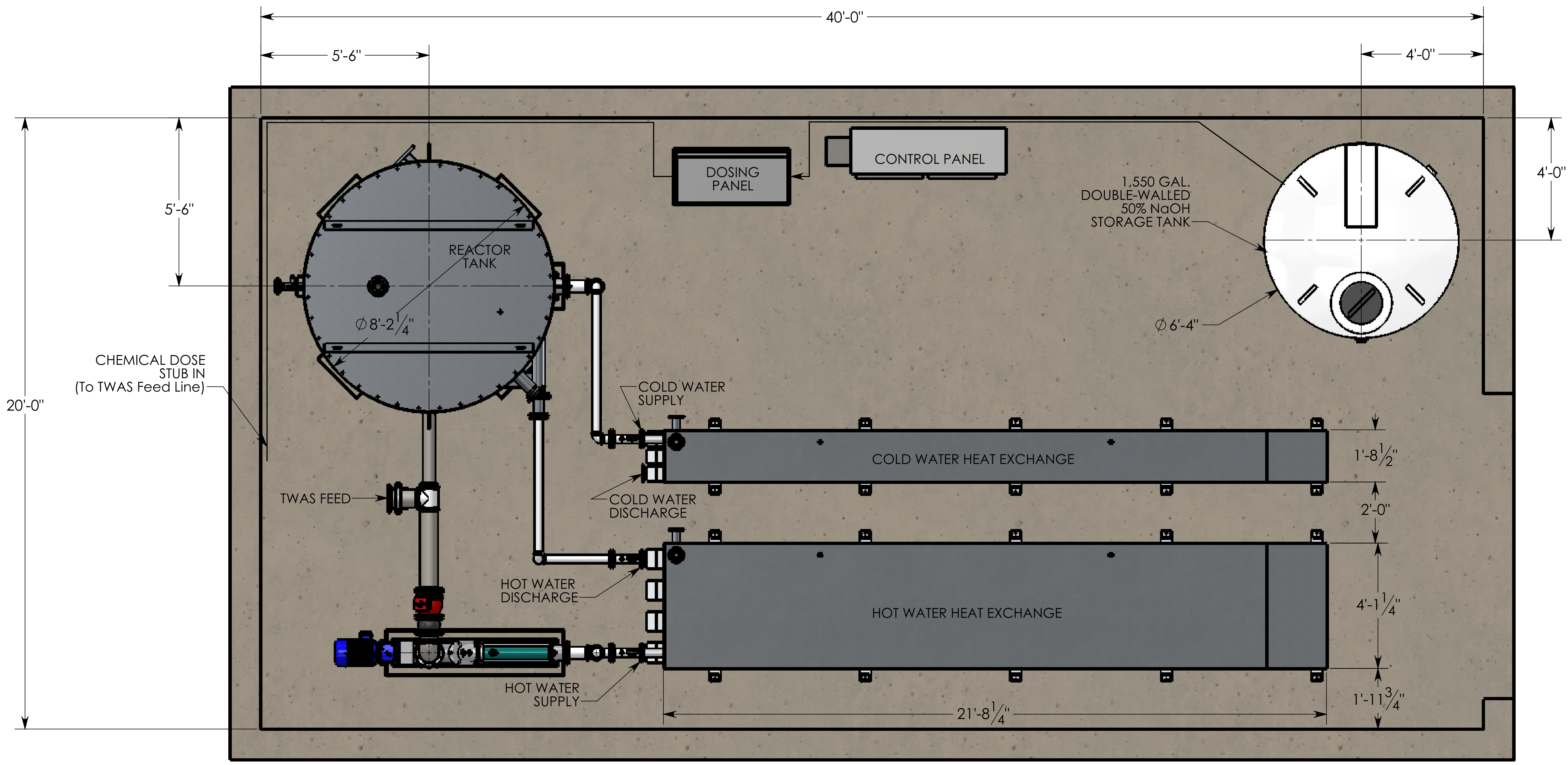
Tel: (262) 654-6006
Fax: (262) 764-8705

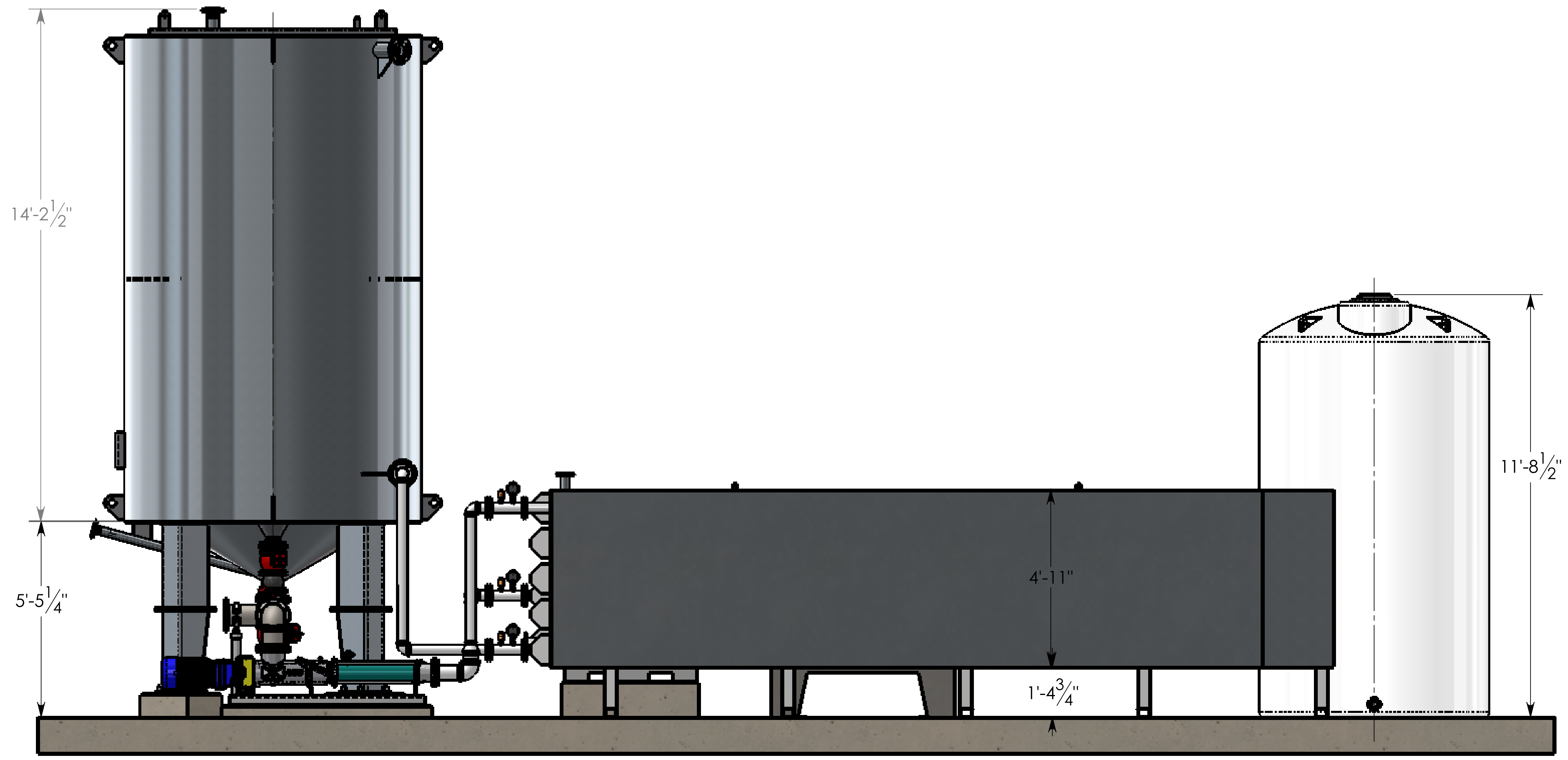
THIS PRINT IS PROVIDED ON A RESTRICTED BASIS AND IS NOT TO BE USED IN ANY WAY DETRIMENTAL TO THE INTERESTS OF CENTRISYS.

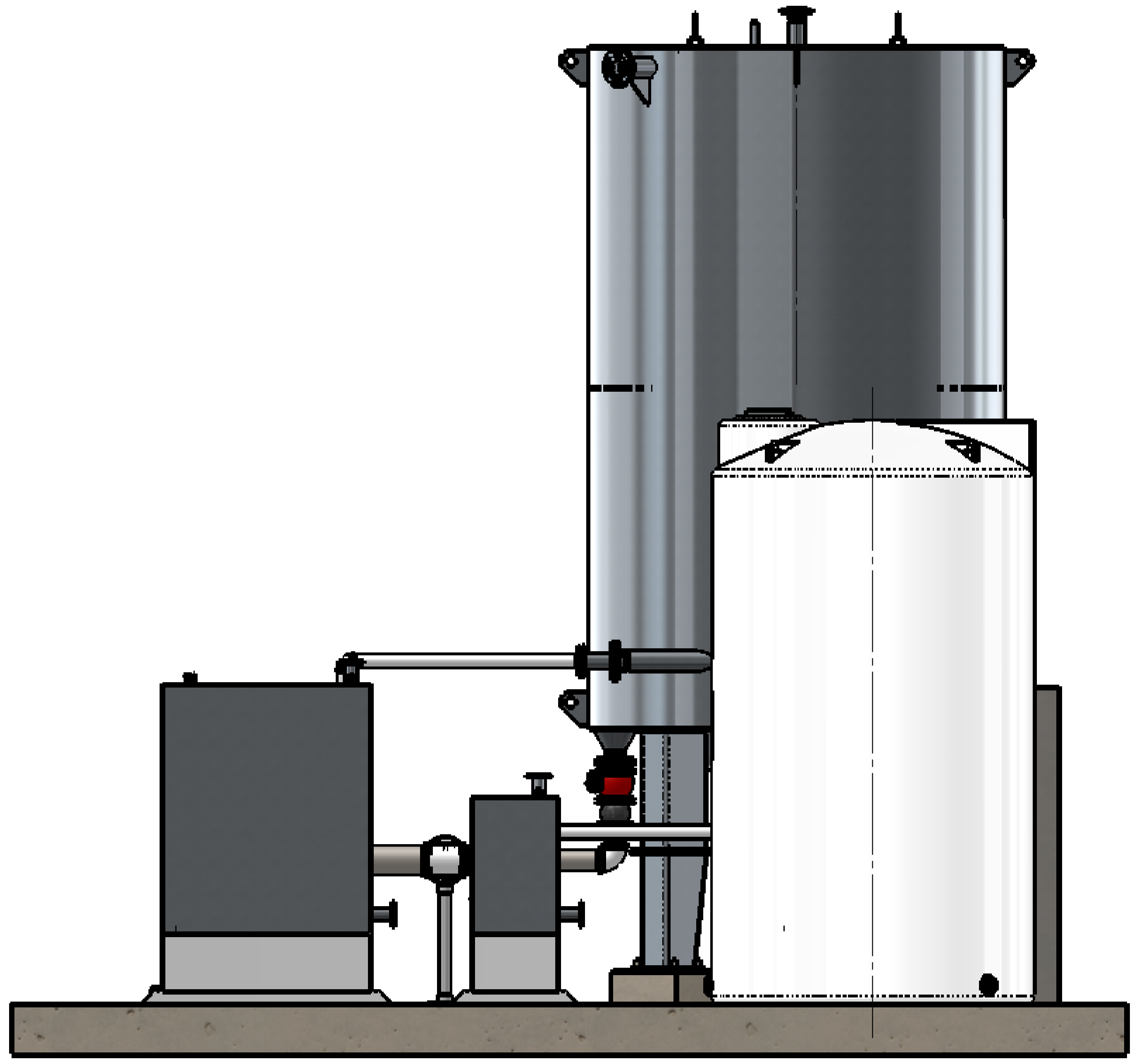
Title: THK 26-600 General Arrangment
Rotating Assembly

Project:

Designed by: A.A.	*Date:* ---				
Drawn by: A.A.	*Date:* 8/26/13	*GD&T ASME Y14.5M1994+ Tolerancing Std. & Rules apply*	*3rd Angle Projection*	*Material(s):* See BOM	*Sheet Size:* B *Drawing #:* GA23210
Chk'd by: -	*Date:* -			*Estimated weight (lbs):* 9150	*Sht:* 3 OF 3 *Scale:* 1:20 REV
Approved by: -	*Date:* -				







REV.	DATE	DESCRIPTION	INI.	ECN

REVISION TABLE

REVISE ON CAD ONLY

centrisys cnp
9586 58th Place
Kenosha, WI 53144
Tel: (262) 654-6006
Fax: (262) 764-8705

Designed by:	Date:	GD&T ASME Y14.5-2009+ Tolerancing Std. & Rules apply	3rd Angle Projection	Material(s): NA
Drawn by: LG	Date: 12/14/22			Estimated weight (lbs): NA
Approved by:	Date:			

Title: Pondus Plant Layout

Project: City of Flagstaff Rio

Sheet Size: D
Drawing #: IA43162
Sht: 1 OF 1
Scale: 1:32

354 State Route 29, Greenwich, New York 12834
Phone No 518-695-6851
E-mail: jake@bdpindustries.com

Date: Wednesday, December 21, 2022

To: Carollo
7090 South Union Park Ave, Suite 600
Midvale, UT 84047

Attn: Randy Zollinger, PE
(801) 989-8971
rzollinger@carollo.com

Re: Central Weber, UT
One (1) 2.0m GBT Gravity Belt Thickener
BDP Budget Quotation # 121922-1311

BDP Industries, Inc. is pleased to offer our quotation for one (1) GBT Gravity Belt Thickener and accessories. The new machine will be identical to the existing machines at the Central Weber WWTP. Below is a summary of our scope of work.

EQUIPMENT DESCRIPTION

The GBT equipment package includes One (1) complete gravity belt thickener and appurtenant equipment described as follows:

1. One (1) 2.0m GBT with the following design features:
    - a. 304 stainless steel tubular frame per ASTM A554-304.
    - b. Polyurethane clear coat on the gravity zone slide decks zone.
    - c. Machined bearing pads.
    - d. Up-flow feedbox.
    - e. Sixteen-foot, variable speed gravity section at operator level.
    - f. ¼" x 3" 316 stainless steel gravity deck support spaced every 12 inches.
    - g. Ten (10) rows of adjustable, furrowing plows with 304 stainless steel support bars.
    - h. UHMW scraper blades.
    - i. Nylon covered rollers.
    - j. 316 stainless steel wetted parts.
    - k. 316 stainless steel hardware.
    - l. 50 PLI hydraulic tensioning and tracking.
    - m. 316 stainless steel sludge dam.
    - n. Corrosion resistant composite cylinders with 316 stainless steel rods and stainless-steel hardware.
    - o. Self-cleaning, adjustable angle belt showers with Victualic connections.
    - p. Dodge, closed end, split case bearings rated for 1,000,000 hours at 50 PLI at 15 ft/min.
    - q. Nylon coated bearings.
    - r. TEFC, IP 65 severe duty variable speed motors.
    - s. PVC conduit.
    - t. Zero speed switches for the gravity belts.
    - u. Low water pressure switch.
    - v. Electrically actuated full port valve for shower bar.
    - w. NEMA 4X low voltage junction boxes.

  x. Main incoming power 460/3/60

2. One (1) electrical control panel for all the GBT system control functions and drives.
    a. NEMA 4X.
    b. UL508.
    c. 304 stainless steel.
    d. One (1) Allen Bradley CompactLogix PLC controls.
    e. One (1) Allen Bradley 12" color PanelView Plus OIT.
    f. IEC motor starters for hydraulic unit.
    g. 120-volt transformer.
    h. Ethernet communication.
    i. 460/3/60
3. One (1) 316L stainless steel, 4-inch diameter polymer injection and polymer/sludge mixing system consisting of an injection ring, variable vortex mixer and reducing fittings.
4. One (1) 1 HP hydraulic power unit with a 10-gallon, 304 stainless steel reservoir, including filters, switches and gauges as specified.
5. One (1) 7.5 HP Goulds model SSH wash water booster pump capable of boosting from 60 to 120 PSI at a flow rate of 35 GPM.
6. One (1) 316 stainless steel discharge hopper.
7. One (1) Odor Control Hood spanning the GBT.
    a. Type 304 stainless steel.
    b. Two (2) 8" connections for odor control.
    c. Supported from the GBT frame.
    d. Removable Lexan sliding side panels.
    e. LED lights mounted inside the enclosure.
8. One (1) lot of start-up spare parts.
9. All start-up, mechanical checkout and operator training as specified. Service to include three (3) separate trips with nine (9) days of on-site services.
10. One-year machine warranty. Five year warranty on the frame, frame coating, rollers, roll coatings and bearings.
11. Freight to the jobsite.

<u>Optional and Ancillary:</u>

12. Two (2) Odor Control Hood Retrofits for the existing GBTs (BDP Job #1176).
    a. Type 304 stainless steel.
    b. Two (2) 8" connections for odor control.
    c. Supported from the GBT frame.
    d. Removable Lexan sliding side panels.
    e. LED lights mounted inside the enclosure.
    f. Freight to jobsite included above with new machine.
    g. Two (2) guys onsite for Four (4) days to install odor hoods on existing machines.

The model GBT will come completely factory-assembled, tested and will be shipped in one piece. The polymer injection device, booster pump, control panel, hydraulic unit, spare parts, and belt media will be packed separately. This quotation is for furnishing equipment only and does not include any other installation labor or field services other than checkout, start up and testing services as listed above. All installation, on-site assembly, anchorage, pads and other work required to facilitate the setting of the equipment is to be by others. All labor and material for interconnecting between the press and the auxiliary equipment is to be completed by others.

ITEMS NOT INCLUDED IN THIS SCOPE OF SUPPLY

1. **Temporary thickening.**
2. **Unloading at the jobsite.**
3. **Installation.**
4. **Operator platforms.**
5. **Sludge feed pump.**
6. **Polymer system.**
7. **TWAS pump.**
8. **Exhaust fans for Odor Hoods.**
9. **Exhaust pipe for Odor Hoods.**
10. **Sump grating.**
11. **Anchor bolts.**
12. **Applicable taxes of any kind.**

SUBMITTAL DATA

Submittals will be made in the number of copies specified and will be available within 8 to 10 weeks after firm purchase order and all information is received at the factory.

SHIPMENT

Approximate shipping weight of each unit is 12,000 pounds. Estimated shipping time is 36 to 46 weeks after receipt of submittal approval.

FIELD SERVICE

Installation observation, testing and operator instruction services as listed above will be supplied. Additional service can be supplied at a service rate of $1,400 per day plus travel expenses.

BUDGET PRICING

The total price for the above equipment is listed below (US Dollars). This price includes the shipping cost to the job site or nearest unloading point. The price does not include unloading cost and applicable taxes of any kind. This quotation will be valid for sixty (60) days from the date of this proposal.

Qty	Description	Unit Price
1	2.0m GBT	$200,000
1	304 SS Frame	$15,000
1	316 Wetted Parts & Hardware	$10,000
1	Control Panel	$40,000
1	Wash Water Booster Pump	$5,500
1	Discharge Hopper	$10,000
1	Odor Hoods	$20,000
1	Freight	$22,000
1	Startup Services	$16,500
	Total	**$339,000.00**
	Optional and Ancillary	
1	Odor Hoods Retrofit for Two Existing BDP Machines (BDP Job #1176). Installation Included, Freight included in Machine Freight Above	$60,000

TERMS

Terms of payment are 30% upon purchase order, 60% upon shipment of equipment and 10% upon start up. The attached Conditions of Sale are hereby made a part of this proposal.

We appreciate this opportunity to extend our quotation. If we can answer questions or supply additional information, please do not hesitate to contact Scott Perry of MISCOwater at (720)-491-7400.

Sincerely,

Jake DeFoe
BDP Industries, Inc.

cc: A.J. Schmidt, BDP Industries, Inc.
Dan Fronhofer, BDP Industries, Inc.
&
Scott Perry
MISCOwater
720-491-7400-cell
sperry@miscowater.com

CONDITIONS OF SALE - COS 5-86

1.1. General –

This contract will exist between BDP Industries, Inc. (hereafter referred to as BDP) and the buyer only when accepted in writing by an officer of BDP. The prices quoted herein are firm for a period of 60 days if a contract is entered within thirty (30) days from the date on the face of this proposal. Any amendment to this contract must by in writing and acknowledged by both parties.

1.2. Terms of Payment –

Payment is to be made on a net basis within thirty (30) days after invoice, subject to credit approval by BDP. The buyer's payment obligation is not dependent upon the buyer's receipt of payment from any other party. BDP reserves the right to invoice on partial shipments. Any balance owed by the buyer beyond thirty (30) days or more after due is subject to delinquency charges of 1.5% per month or any fraction thereof. This shall be in addition to any other amounts due and buyer shall reimburse BDP for all collection costs, including attorney's fees BDP may incur with respect to collection of past due amounts from the buyer.

1.3. Taxes –

This proposal does not include any Federal, State or Local Sales, Privilege, Use or any other taxes of any kind applicable to the sale of the equipment covered under this agreement. The buyer shall pay these taxes or the buyer shall provide BDP with a tax exemption certificate applicable to proper taxing authority.

1.4. Shipment –

All shipment will be F.O.B. factory. Shipping estimates contained herein are based on time of receipt at BDP's factory of all details pertaining to the order which are essential to contract completion.

1.5. Force Majeure –

BDP shall not be liable for any loss or damage of any nature whatsoever incurred or suffered as a result of any failures or delays in performance due to any cause or circumstances beyond its, or its subcontractors' or suppliers' control, including, but not by way of limitation, failure or delays in performance caused by strikes, lockouts or labor disputes, acts of purchaser, fires, acts of God or the public enemy, riots, incendiaries, interferences by civil or military authorities, compliance with the laws of the United States or with the orders or policies of any Governmental authority, delays in transit or delivery on the part of transportation companies or communication facilities or failure of sources of raw material. In the event of such delay, the time of delivery or completion shall be extended by a period of time equal to the period of delay plus such time as needed for startup and/or remobilization, provided however, should the Force Majeure situation extend beyond six months the contract may be canceled by either party. Purchaser shall reimburse BDP for all costs and expenses including overhead costs which BDP may have reasonably incurred in terminating the contract, plus an amount as reasonable profits on that portions to the contract which has been completed.

1.6. Warranty –

BDP warrants the equipment manufactured by it to be free from defects in materials and workmanship for a period of 12 months from the date of acceptance. For the frame, frame coating, rollers, roller coatings, bearings and hydraulic power unit, BDP warrants the equipment to be free from defects in materials and workmanship for a period of 36 months from the date of acceptance. BDP will repair or replace, at its option, F.O.B. its factory, any defective part or material, provided prompt notification is rendered in writing. The repair or replacement of items such as light bulbs, grease, oil, drive belts or chains, pump seals, etc. are not covered by this warranty and are considered normal consumption and routine maintenance items. In addition to the replacement of defective parts, BDP will also provide such labor as it deems necessary, to repair a defect in the main frame structure. BDP will not assume the cost of any modification or repair of its equipment unless it specifically gives authority for such action. THIS WARRANTY IS EXCLUSIVE AND IN LIEU OF ALL OTHERS. BDP MAKES NO WARRANTY AS TO FITNESS OF ITS PRODUCTS FOR PARTICULAR PURPOSE OR MERCHANTABILITY.

1.7. Limitation of Liability –

In no event, be it due to breach of any warranty hereunder or any other cause rising out of performance or non-performance of the obligations herein, whether any such breach or cause be or sound in tort, contract or otherwise, shall BDP be liable for:

a) Indirect, special or consequential damages (such as, but not limited to, loss of profits, plant downtime, fines, penalties, or cost of replacement services) or suet by third parties against the purchaser (excluding suits regarding patents on title to the goods furnished hereunder).

b) BDP's total cumulative liability for any and all reasons, shall not exceed an amount equal to the contract price.

1.8. Claims –

The buyer shall immediately inspect equipment within ten (10) days after receipt, BDP is not obligated to consider any claim for shortages or non-conformance unless notified by the buyer within ten (10) days after his receipt of the goods in question, BDP is not responsible for loss or damage in transit, however they will lend any possible assistance to the buyer in his pursuit of claim recovery.

1.9. Cancellation –

BDP will accept cancellation of this order upon receipt of payment for percentage of the contract equal to a percentage of the work completed. This shall be, at a minimum, 20% of the contract price.

1.10.*Storage –*

If the buyer delays shipment, then the buyer agrees to pay all invoices as they become due. The buyer further agrees to pay, in addition, storage charges computed at 1.5% per month of the invoice price of equipment stored.

1.11.*Permits –*

The buyer shall assume full cost and responsibility to obtain all permits or licenses with respect to the installation and operation of the equipment covered under this agreement. This shall include all requirements by Federal, State and Local governmental bodies.

This contract shall be governed in accordance with the laws of the State of New York. These conditions and terms are the only terms and conditions that will be binding upon the parties unless amended, and acknowledged, in writing by both parties. No assignment of this proposal or any purchase order resulting here from shall be binding on BDP unless accepted in writing by BDP.

BUDGET PROPOSAL

Central Weber, UT

Equipment:
HUBER Multi-Rake Bar Screen: RakeMax®
HUBER Coanda Grit Washer RoSF4 3
Represented by:
Goble Sampson Associates
Dave Ritter
(801) 268-8790
dritter@goblesampson.com

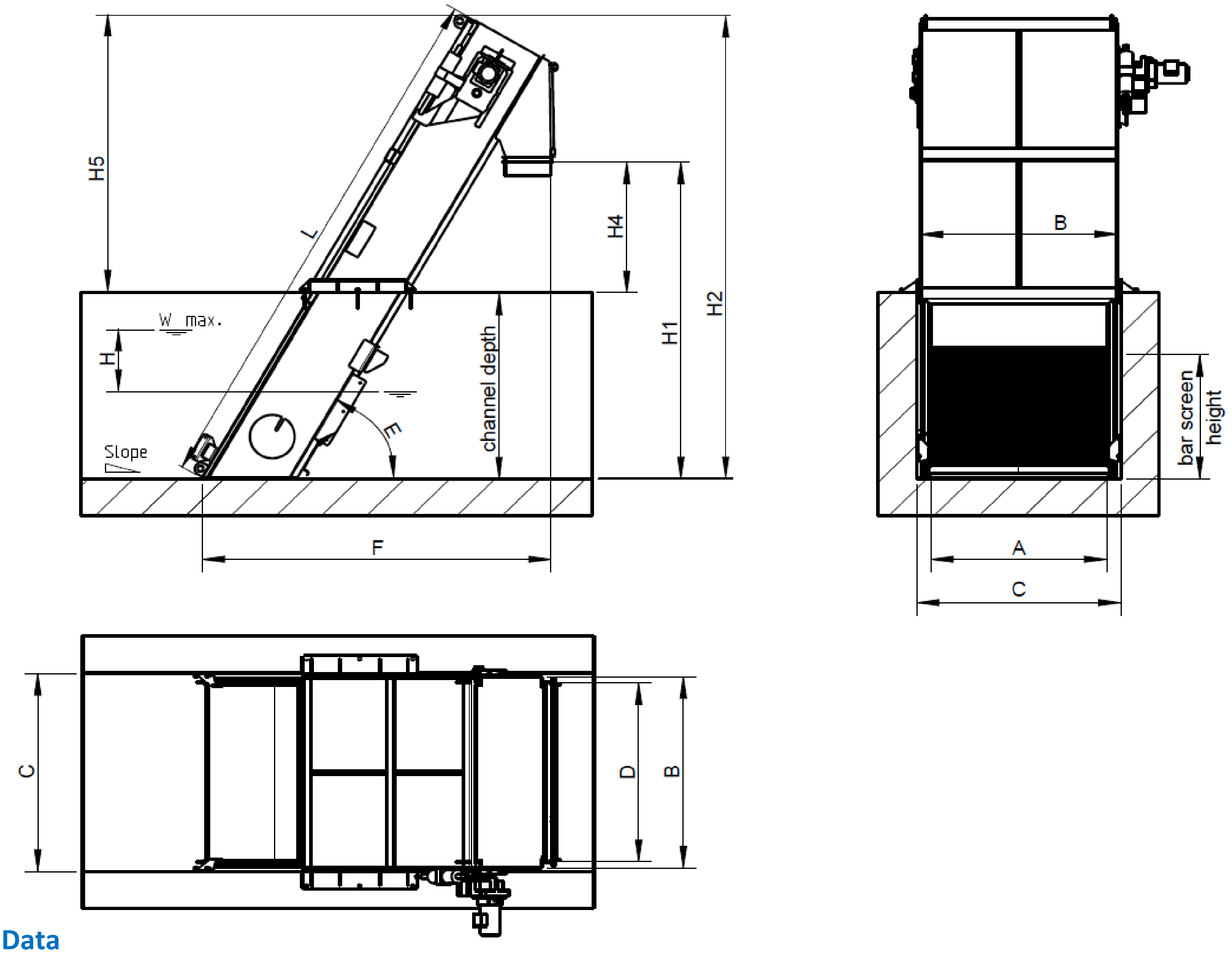
Regional Sales Director:
Ron Maiorana
(704) 718-4477
ron.maiorana@hhusa.net

Project Number:	FILL IN
Revision:	0
Date:	12/15/2022

HUBER Technology, Inc.
1009 Airlie Pkwy, Denver, NC 28037
704-949-1010 | www.huber-technology.com

Design Information

Technical Data



Project Data

		Imperial		Metric	
Channel Width	C	**6.00**	**ft**	1829	mm
Channel Depth		**10.00**	**ft**	3048	mm
Depth to Operation Deck EL (if Applicable)		**10.00**	**ft**	3048	mm
Peak Hourly Flow (per Screen)		**60.00**	**MGD**	2629	l/s
Clear Bar Spacing		**1/4**	**in**	6	mm
Headloss @ 30% Blinding	H	**6**	**in**	151	mm
Through-Bar Slot Velocity @ 30% Blinding		**6.55**	**ft/s**	2.00	m/s
Channel Approach Velocity @ 30% Blinding		**1.75**	**ft/s**	0.53	m/s

Screen Dimensions

		Imperial		Metric	
Overall Discharge Height above Channel Invert	H1	**13.64**	**ft**	4158	mm
Discharge Height above Operation Deck EL	H4	**3.64**	**ft**	1109	mm
Overall Height	H2	**17.16**	**ft**	5232	mm
Height above Operation Deck EL	H5	**7.16**	**ft**	2184	mm
Total Screen Length	L	**17.76**	**ft**	5412	mm
Length of Screen in Channel	F	**7.49**	**ft**	2282	mm
Sieve Width	A	**5.17**	**ft**	1575	mm
Total Screen Width	B	**5.72**	**ft**	1743	mm
Screen Weight		**4429**	**lbs**	2013	kg
Inclination from Horizontal	E	**75°**			

Screen Details

Screen Model	RakeMax® 4480x1575/6
Quantity	2
Material	304L stainless steel construction; pickled and passivated in acid bath
Screening Bars	Teardrop 8/5/60; 304L stainless steel construction
Chains	316L links with ANSI-431 pins & polyamide rollers
Upper Sprocket & Bearing	304L stainless steel, split; greasable flange bearings
Lower Sprocket & Bearing	304L stainless steel, solid; silicon carbide slide bearings
Scraper	Polyethylene blade
Motor Data	BK40 1.5HP, VFD, C1D1, 480VAC, 3 phase, 60Hz, SF 1.0
Anchor Bolts	M12, 316L stainless steel
Local Control Station	Included, 3-hole NEMA7
Level Control Device(s)	VEGAPULS differential with two (2) sensors (per screen)
Optional Adder(s)	No optional adders included

Screenings Treatment Details

Washer/Compactor Data	Imperial		Metric	
Maximum Screenings Capacity	**210**	**ft^3/hr**	6	m^3/hr
Wash Water Demand	**24**	**gpm**	1.5	l/s
Wash Water Pressure	**30-60**	**psi**	2-4	bar
Weight (Empty)	**1450**	**lbs**	659	kg

Wash/Compactor Model	WAP® 6
Quantity	2
Body Material	304L stainless steel construction; pickled and passivated in acid bath
Screw Auger	Shafted; 304L stainless steel construction with stainless-backed nylon brush in wash & compaction zones
Drain	5mm perforations; latched and sealed with 3.5in NPT drain connection
Inlet Hopper	304L stainless steel construction; inspection hatch included
Discharge Pipe	Tapered, conical pipe flanged connection, endless bagger attachment
Motor Data	7.5HP, C1D1, 480VAC, 3 phase, 60Hz, SF 1.15 (auger)
Water Manifold	Mounted to body; 304L stainless steel construction with two (2) solenoid valves, brass-bodied, C1D1, 120VAC
Anchor Bolts	M12, 316L stainless steel
Local Control Station	Included, 4-hole NEMA7
Dewatering Piece	Not included
Hopper Level Device	Not included
Optional Adder(s)	No optional adders included

Screen System Control Details

Two (2) HUBER Standard Control Panel	
Enclosure	NEMA 4X, 304 stainless steel
PLC	Allen Bradley MicroLogix
HMI	Allen Bradley PanelView 4"
Motor Starters	VFD (screen), NEMA reversing (WAP, Ro8t), as required
Components	HUBER standard
Climate control components available upon request and are not included in this proposal	
Pre-programmed and factory tested	

Grit Washing Design Information

Technical Data		
Grit Processing Capacity	**1.5**	**ton/hr**
Design Pumped Flow Rate	**250**	**gpm**
Maximum Pumped Flow Rate	**500**	**gpm**
Removal Efficiency at Design Flow	**95% ≥ 100µm**	**micron**
Maximum volatile content in washed grit at Design Flow	**5**	**%**
Maximum water content in washed grit at Design Flow	**10**	**%**
Minimum weir length	**23.7**	**feet**
Headloss @ Design flow rate	**11.80**	**inch**
Approximate empty weight	**3090**	**lbs**
Approximate loaded weight	**23370**	**lbs**
Wash Water Consumption	**22**	**gpm**
Wash Water minimum pressure	**29**	**psi**
Installation Angle of Auger	**45**	**°**
ANSI Inlet Diameter	**6**	**inch**
ANSI Outlet Diameter	**8**	**inch**
ANSI Organics Outlet Diameter	**4**	**inch**

Equipment Details

Model	HUBER Coanda Grit Washer
Quantity	3
Material	304L stainless steel construction; pickled and passivated in acid bath
Tank Design	Coanda® tulip inlet chamber design and tank fully enclosed with perforated plate bottom to generate a fluidized bed
Hatch & Drain	Top located inspection hatch with 2” lower diameter grit screw drain
Stirrer	304L stainless steel centrally located internal stirrer
Wash Water Valve	One (1) Solenoid valve for fluidized grit bed, 1-inch, 120 VAC, 2-way, Class 1 Division 1, Brass body
Actuator/Ball Valve	AUMA Electric actuator with PVC Ball Valve for organics discharge
Level Sensor	VEGA pressure probe for grit bed level with 1.5" diameter connection
Grit Screw Design	304L stainless steel shafted grit screw conveyor inside of grit transport tube
Motor Data - Grit Stirrer	0.75 HP, 480 VAC, 3ph, 60 Hz, S.F. 1.15, Class 1 Division 1
Motor Data - Grit Screw	1.5 HP, 480 VAC, 3ph, 60 Hz, S.F. 1.15, Class 1 Division 1
Supports	304L Stainless Steel Construction
Anchor Bolts	M12, 316L, Included

Control Details

Three (3) Main Control Panel	
Enclosure	NEMA 4X, Stainless Steel
PLC	Allen Bradley MicroLogix
HMI	Allen Bradley PanelView Plus 800
Pre-programmed and Factory Tested	

Pricing

Equipment	Model	Quantity	Pricing
HUBER Multi-Rake Bar Screen	RakeMax® 4480x1575/6	2	Included
HUBER Wash Press	WAP® 6	2	Included
HUBER Coanda Grit Washer	RoSF4 3	3	Included
HUBER Control Panel- Screenings System	HUBER Standard	2	Included
HUBER Control Panel Grit System	HUBER Standard	3	Included
Freight and Startup Services	Standard HUBER Start-up Services	1 trip(s), 5 day(s)	Included
TOTAL:			**$1,420,000.00**

Standard delivery is 24-30 weeks from approval of submittals.

Thank you for your interest in HUBER Technology, Inc. If you have any questions, please do not hesitate to contact our Regional Sales Director or our local sales representative.

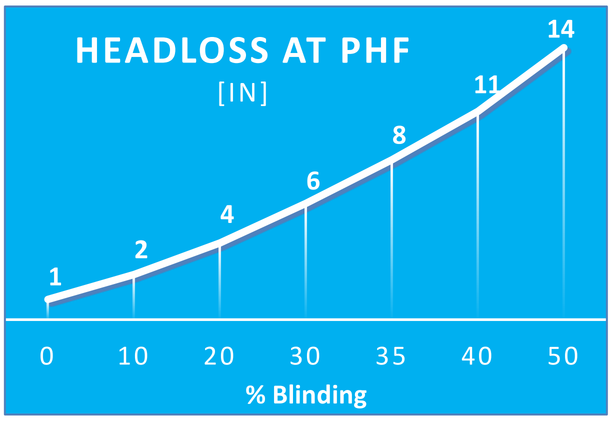
This proposal has been reviewed for accuracy and approved for issue by: BG

Notes and Technical Clarifications

1. Equipment specification and drawings are available upon request.
2. If there are site-specific hydraulic constraints that must be applied, please consult the manufacturer's representative to ensure compatibility with the proposed system.
3. Electrical disconnects required per local NEC code are not included in this proposal.
4. All electrical interconnections, wirings, junction boxes, and terminations between the equipment and electrical components are to be provided by installing contractor.
5. Huber Technology warrants all components of the system against faulty workmanship and materials for a period of 12 months from date of start-up or 18 months after shipment, whichever occurs first.
6. Budget estimate is based on Huber Technology's standard Terms & Conditions and is quoted in US dollars unless otherwise stated.
7. Equipment recommendations are based on information provided to Huber Technology. Subsequent information which differs from what has been provided may alter the equipment recommendation.
8. Any item not specifically listed is not considered part of this scope of supply. Please contact the HUBER Technology representative listed for further clarification.
9. Equipment pricing that has been broken out from the Total in the table above are only valid when packaged together.

Screen Blinding Calculation Table

Blinding	Headloss		Upstream Head		Flow Velocity Between Slots		Channel Approach Velocity	
[%]	*[in]*	*[mm]*	*[in]*	*[mm]*	*[ft/s]*	*[m/s]*	*[ft/s]*	*[m/s]*
0	1	101	101	2566	4.81	1.47	1.84	0.56
10	2	102	102	2599	5.28	1.61	1.81	0.55
20	4	104	104	2639	5.84	1.78	1.79	0.54
30	6	106	106	2691	6.55	2.00	1.75	0.53
35	8	108	108	2747	6.91	2.11	1.72	0.52
40	11	111	111	2810	7.32	2.23	1.68	0.51
50	14	114	114	2892	8.53	2.60	1.63	0.50

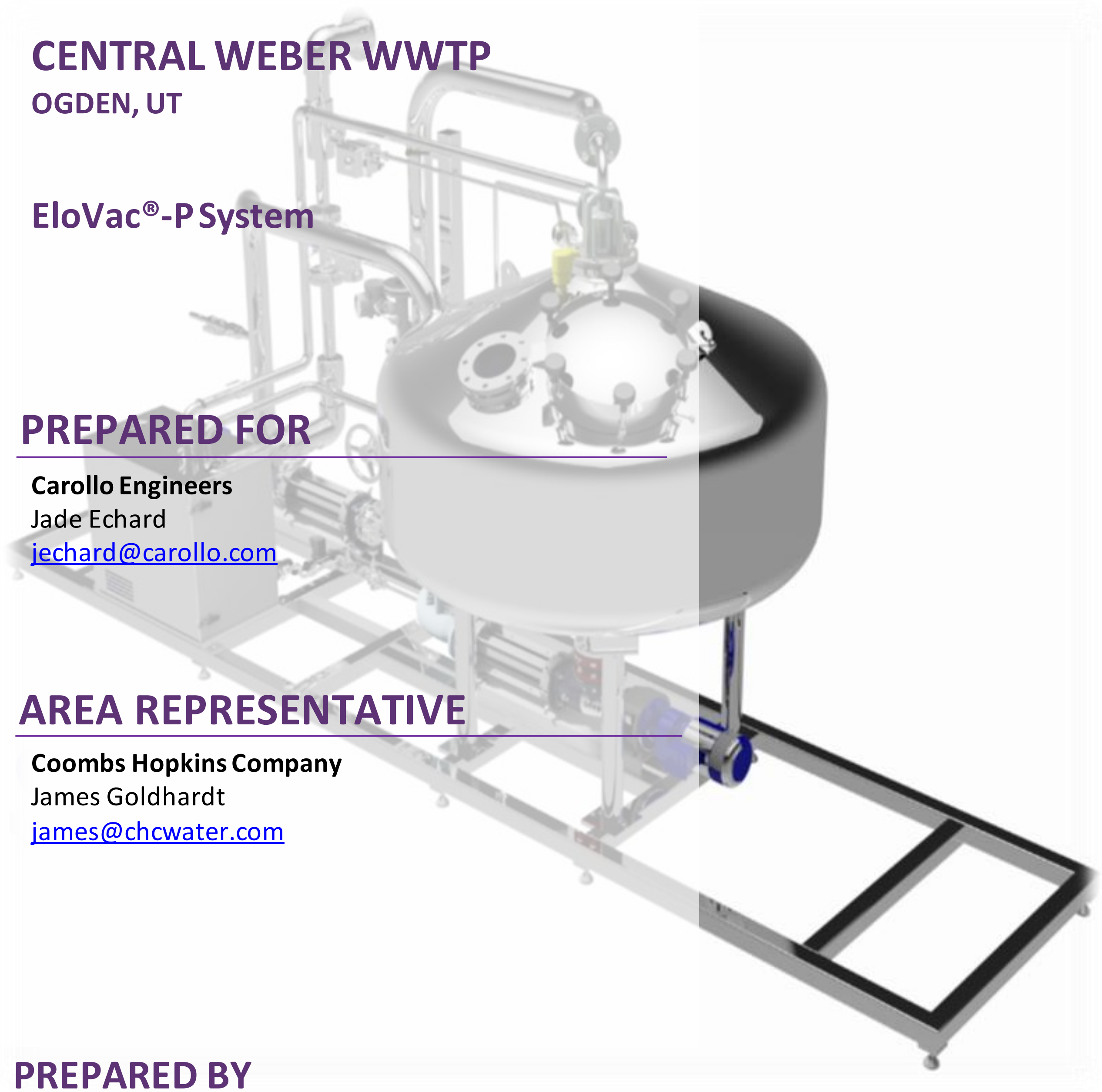


Worldwide Experts in Water Treatment

PROPOSAL LETTER

1-MB-NP-221110

NOVEMBER 11, 2022



CENTRAL WEBER WWTP

OGDEN, UT

EloVac®-P System

PREPARED FOR

Carollo Engineers
Jade Echard
jechard@carollo.com

AREA REPRESENTATIVE

Coombs Hopkins Company
James Goldhardt
james@chcwater.com

PREPARED BY

Nimesh Patel
c/o Merima Beganovic
Phone: (801) 931-3000
Merima.Beganovic@ovivowater.com

Ovivo USA, LLC
4246 Riverboat Road – Suite 300
Salt Lake City, Utah 84123-2583
http://www.ovivowater.com

NOVEMBER 11, 2022

Attn: Jade Echard,
Carollo Engineers

Re: Central Weber WWTP
Ovivo EloVac®-P System
Proposal No. 1-MB-NP-221110

Dear Ms. Echard,

With regard to your recent request for the Central Weber WWTP, UT, Ovivo USA, LLC along with ELIQUO Water Group, GMBH, is pleased to submit this preliminary proposal for its EloVac®-P system. The system design is based on treating the influent high phosphorus digested sludge stream from the mesophilic digesters at the plant with different equalized design flows for max month flows of 190,000 and 250,000 gpd, with an EloVac® P30 or P40, respectively. The EloVac®-P system is designed to achieve 90% Phosphorus removal for maximized struvite mitigation. It is assumed that the digested sludge from the digesters will be available 24 hours a day and 7 days a week with EloVac®-P system operation 7 days a week.

The EloVac®-P system has excellent struvite mitigation capabilities as shown in our full scale pilot in Provo, Utah. The struvite is precipitated in the solid stream (as explained below in the proposal) but the EloVac®-P system does not offer struvite harvesting due to the fine particle nature of the struvite precipitated, and continuous function of the system. For a system that mitigates struvite and allows harvesting, we have proposed a separate system called the PhosPAQ™.

In addition to struvite mitigation, due to the completely skid mounted design and compact footprint, the EloVac®-P system can be placed indoors or outdoors on a small concrete pad or inside of a modified shipping container, significantly reducing project construction costs. Moreover, the energy positive nature of the system entails, significantly lower complete life cycle costs for the system.

We have endeavored to provide complete information in this proposal. However, if you have any questions or need additional information, please feel free to contact James Goldhardt, our regional sales representative, or me directly.

Sincerely,

Merima Beganovic
Product Manager – Nutrient Removal
Biosolids Management and Resource Recovery
Ovivo USA, LLC
C: 470-686-9715

INTRODUCTION

Central Weber WWTP together with Carrollo Engineering is in the process of evaluating technologies for struvite removal in their digested sludge stream. Ovivo in partnership with ELIQUO is pleased to offer an innovative and highly efficient solution: EloVac®-P system.

Table 1 below lists the parameters provided for the system design. It is important to note that the EloVac®-P is a simple and elegant solution to address the existing operational issues related to struvite formation downstream of the digestion process.

BASIS OF DESIGN

The EloVac®-P system design and performance are based on the design information provided by Carrollo Engineering. Table 1 summarizes the parameters used for developing the proposed solution.

Table 1. Design parameters

Treatment Parameter	Unit	Design Max Flow Scenario 1	Design Max Flow Scenario 2
Equalized Design Flow	gal/day	190,000	250,000
Solids Concentration	%TS	2.2	2.1
Ortho Phosphate (PO_4-P)	mg/l	368	356
Ammonium (NH_4-N)	mg/l	782	819
Ortho Phosphate Removal	%	90%	90%
Treated Effluent Ortho Phosphate	mg/l	36.8	35.6

The design is based on the following assumptions:

- The influent flows are produced seven (7) days a week, twenty-four (24) hours a day.
- The Phosphate (PO_4-P) in the digested sludge is reactive and the chemical reaction of the magnesium added to the digested sludge and the ammonium present in the digested sludge can occur.
- The goal of the installation is the sequestration of the phosphate to avoid uncontrolled struvite scaling in downstream process steps.
- The existing Mg^{2+} contained in the digested sludge provided to the EloVac®-P is non-reactive.

TREATMENT APPROACH FOR STRUVITE SEQUESTRATION/P-REMOVAL

The EloVac®-P is a system for the removal of Phosphate from digested sewage in the form of Magnesium-Ammonium-Phosphate (“MAP” OR “Struvite”). The EloVac®-P process is based on the precipitation of dissolved phosphate from digested sludge using Magnesium Salts, usually magnesium chloride ($MgCl_2$).

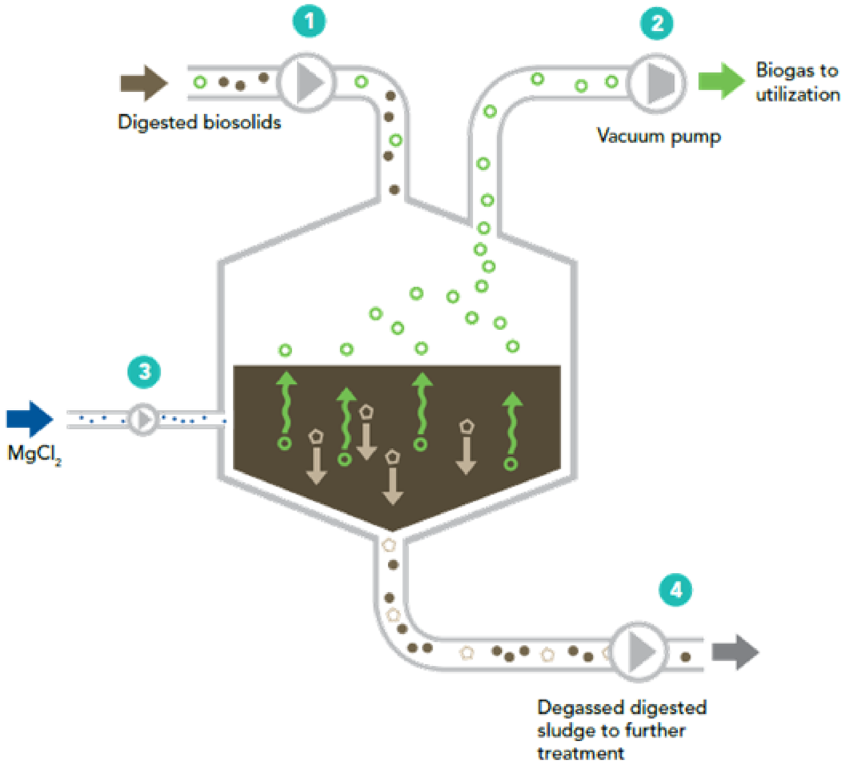


Figure 1: EloVac® -P System Working Principle

The struvite precipitated in the EloVac®-P Vacuum Degassing Reactor remain small due to the reaction conditions inside the reactor vessel. This results in several operational benefits like mitigating the risk for struvite scaling, improving the dewaterability of the digested sludge with lower polymer consumption as well as reducing of the return load of phosphate to the headworks of the plant.

EloVac®-P Degassing Module

For efficient struvite precipitation, the pH value of the sewage sludge has to be increased. Conventional technologies achieve this by adding an alkaline solution, usually sodium hydroxide solution (NaOH), or by aerating the sludge, which leads to a pH increase due to the stripping of dissolved carbon dioxide in the sludge. However, in addition to carbon dioxide, digested sludge also contains dissolved hydrogen sulfide gas, ammonia gas and methane. Therefore, aeration causes a high degree of undesirable odors in addition to methane emissions.

The EloVac®-P degassing module prevents odors and uncontrolled G*reenhouse Gas Emissions* presenting an elegant alternative to conventional aeration technologies. In the EloVac®-P module, the digested sewage sludge is degassed under vacuum, resulting in a small pH increase which is just sufficient for struvite precipitation. The gas mixture extracted from the sewage sludge can be fed into the gas stream of the anaerobic digestion system thereby increasing biogas capture for beneficial use as well as reduction in Greenhouse Gas Emissions. Simultaneously, in the Vacuum Degassing Reactor the contained and reactive phosphate is precipitated by the addition of the Magnesium Chloride solution to the reactor.

EloVac®-P

Ovivo in partnership with ELIQUO designed the system for the Central Weber WWTP using proprietary models to perform process selection and determine essential operating parameters.

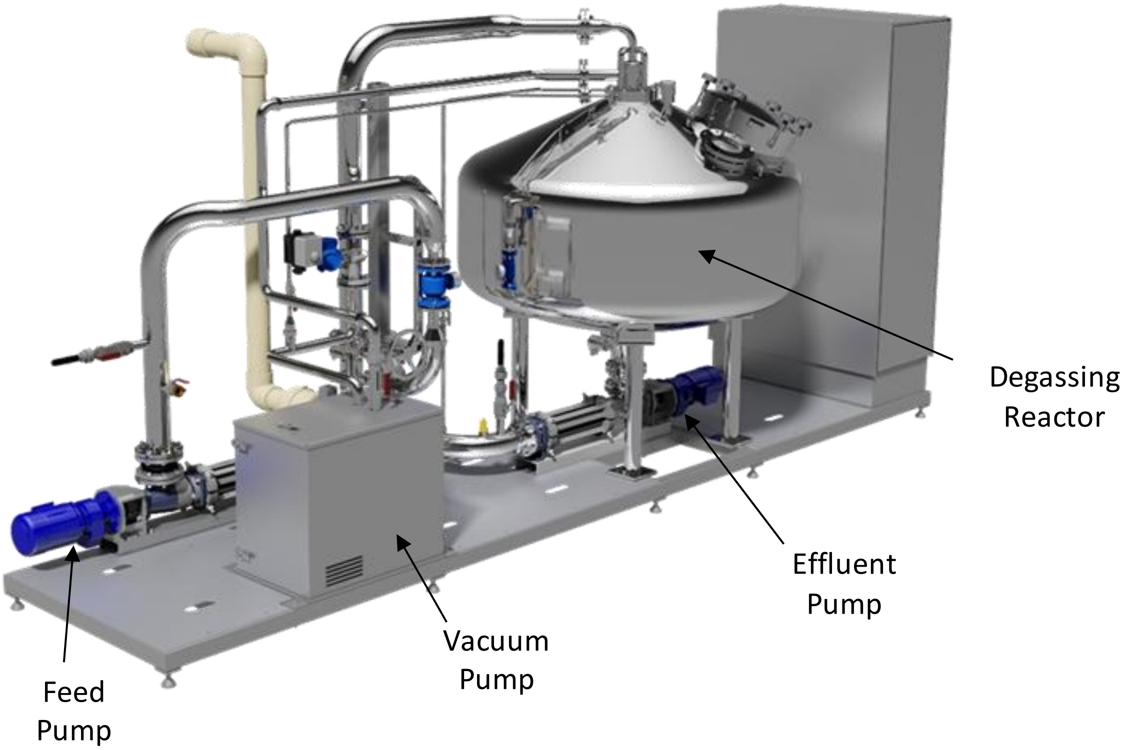


Figure 2: EloVac® -P System

Table 2 provides a summary of the EloVac®-P system design for the Phosphorus removal objectives. This table provides number of EloVac®-P system required to achieve desired effluent PO_4-P reduction and the associated process design details.

Ovivo offers two options based on the maximum month digested sludge flows presented in Scenario 1 and Scenario 2 in Table 1 above. This will address the full range of digested sludge flows as described in the design criteria.

Option 1: For the maximum month flow of Scenario 1, Ovivo offers one (1) EloVac® P30 system which will handle a maximum of 190,000 gpd. The plant can add a second P30 unit for the maximum month flow of Scenario 2, which takes into account a larger flow produced by the plant over time. Two (2) P30 units will handle the digested sludge flow in Scenario 2.

Option 2: Ovivo offers an alternate solution of one (1) P40 unit which can treat digested sludge up to 250,000 gpd. This option will handle flows from Scenario 1 up to Scenario 2.

Table 2. Design Summary EloVac®-P[1]

Treatment Parameter	Unit	Design Max Flow Scenario 1	Design Max Flow Scenario 2
Design Flow	gal/day	190,000[2]	250,000
Effluent PO_4-P[1]	mg/l	36.8	35.60
Total No. of EloVac®-P reactors	#	**One (1)**	**One (1)**
EloVac®-P Model	#	**P30**	**P40**
EloVac®-P Footprint	ft	24' (Length) 8.2' (Width) 12' (Height)	24' (Length) 8.2' (Width) 12' (Height)

[1] The design is based on the assumption that the chemical reaction under the chosen conditions can occur. We recommend conducting lab tests to simulate the process conditions of the full-scale plant and determine that the 90% reduction can be achieved with a β factor of 1.5 or if this can be optimized further.

[2] Scenario 1 requires a second P30 to be put in place for higher flows at a later date. Two P30 units can work in tandem to process 270,000 gpm.

POWER REQURIMENT

Table 3 Power Requirment[1]	Scenario 1	Scenario 2
Electrical power requirement (Installed power)	20 kW	25 kW
Electrical Power Consumed		
Daily Power Consumption	192 kWh (approx.)	240 kWh (approx.)
Annual Power Consumption	70,000 kWh (approx.)	87,600 kWh (approx.)
Number to EloVac System	One (1) P30	One (1) P40

[1] The consumed power is generally more than compensated for by the captured additional biogas by EloVac®-P.

CHEMICAL DOSING DATA TABLE

Table 4 provides a summary of chemical dosing required for the EloVac®-P system at Future Design Max Month condition as per Design Parameter Table 1.

Table 4. Chemical Dosing Data Table

Chemical Name	Design Max Flow Scenario 1 Dosage Rate[2]	Design Max Flow Scenario 2 Dosage Rate[2]
Magnesium Chloride ($MgCl_2$)[1] (30% $MgCl_2$ in Water)	741 gpd[3]	944 gpd[3]
	8,040 lbs/day	10,246 lbs/day

[1] *Based on chemical density of 1.3 kg/m³*

[2] *The Magnesium Chloride dose listed assumes that the existing Mg^{2+} contained in the digested sludge provided to the EloVac®-P is non-reactive. If this is not the case, a lower Magnesium Chloride dose can be expected.*

[3] *The design is based on the assumption that the chemical reaction under the chosen conditions can occur. We recommend conducting lab tests to simulate the process conditions of the full-scale plant and determine that the 90% reduction can be achieved with a β factor of 1.5 or if this can be optimized further.*

CONTROLS SYSTEM

One (1) Allen Bradley ControlLogix PLC based control panel will be provided to control the operation of the EloVac®-P system.

opsCTRL™

In addition to our System, Ovivo offers a mobile-based platform (opsCTRL™) allowing to reserve workforce's expertise by uploading media and procedures, access itemized OEM operator manuals for all of your Ovivo Installations, create and update service logs, maintenance schedules, performance alerts.

The opsCTRL™ platform is unique in the industry and allows the end user to any new content in addition to getting instant access to expert support and monitor equipment performance with live data readings with any cellphone, tablet or PC. See the link below for additional information:

https://www.youtube.com/watch?v=qWvU6fjlypY&feature=youtu.be

SCOPE OF SUPPLY

Items Included
EloVac® system, skid mounted, including vacuum pump, feed pump, effluent pump, ready-to-run. • Scenario 1: One (1) EloVac® P30 system for year 190,000 gpd maximum month flow and total two (2) EloVac® P30 systems for 270,000 gpd max month flow design. • Option 2: One (1) EloVac® P40 system for maximum 250,000 gpm month design.
One (1) Lot controls and Instrumentation
Two (2) Sets of O&M Manuals
Two (2) Sets of detailed shop drawings
Ten (10) days total service at site to inspect equipment installation, test all supplied components, assist in start-up and train plant personnel.
FOB Shipping Point, Full Freight Allowed
One (1) year subscription to opsCTRL™ System
Items Not Included (But Not Limited to The Following)
All piping outside the EloVac®-P skid (gas, feed, treated sludge, potable water for the vacuum pump, process water for the spraying system, Magnesium Chloride solution, defoamer) and all accessories including valves, bolts gaskets and connectors for attaching to drop pipes
Chemical Feed Systems and CIP System (if needed)
Any type of chemicals for Operation & CIP (if needed)
Cleanouts, Drains, Hoses or Bibs
Preparation of Concrete to receive equipment
Electrical energy supply and connection to EloVac®-P switch cabinet
Foam control
Influent/Feed Pumps
Laboratory
Handrail, Grating, ladder, walkways or any other platform item not specifically listed above
Lighting
Liquid sampling and analytical work
Network connection for supervisory control and remote access
Non-potable and potable water supply
Power
Sludge handling and disposal
Transformers
Valves of any kind unless noted above
Ventilation
Wiring, conduit
Yard Hydrants
Yard Piping

ADDITIONAL ITEMS BY INSTALLING CONTRACTOR

Obtain necessary construction permits and licenses, construction drawings (including interconnecting piping drawings) field office space, telephone service, and temporary electrical service.
All site preparation, grading, locating foundation placement, excavation for foundation, underground piping, conduits and drains.
Demolition and/or removal of any existing structures, equipment or facilities required for construction and installation of the EloVac®-P system.
Installation of all foundation - supply and installation of all embedded or underground piping, conduits and drains.
All backfill, compaction, finish grading, earthwork and final paving.
Receiving (preparation of receiving reports), unloading, storage, maintenance preservation and protection of all equipment and materials supplied by Ovivo.
Installation of all equipment and materials supplied by Ovivo.
Supply, fabrication, installation, cleaning, pickling and/or passivation of all interconnecting steel piping components.
Provide and install all embedded pipe sections and valves for tank drains and reactor inlets and elbows.
All cutting, welding, fitting and finishing for all field fabricated piping.
Supply and installation of all flange gaskets and bolts for all piping components.
Supply and installation of all pipe supports and wall penetrations.
Install and provide all motor control centers, motor starters, panels, field wiring, wireways, supports and transformers.
Install all control panels and instrumentation as supplied by Ovivo, as applicable.
Supply and install all electrical power and control wiring and conduit to the equipment served plus interconnection between the Ovivo equipment as required, including wire, cable, junction boxes, fittings, conduit, cable trays, safety disconnect switches, circuit breakers, etc.
Supply and install all insulation, supports, drains, gauges, hold down clamps, condensate drain systems, flanges, flex pipe joints, expansion joints, boots, gaskets, adhesives, fasteners, safety signs, and any specialty items such as traps.
All labor, materials, supplies and utilities as required for start-up including laboratory facilities and analytical work.
Provide all chemicals required for plant operation and all chemicals, lubricants, glycol, oils or grease and other supplies thereafter.
Install all anchor bolts and mounting hardware supplied by Ovivo; and supply and install all anchor bolts and mounting hardware not specifically supplied by Ovivo.
Provide all nameplates, safety signs and labels.
Provide all additional support beams and/or slabs.
Provide and install all manual valves.
Provide and install all piping required to interconnect to the Ovivo's equipment.
The Contractor shall coordinate the installation and timing of interface points such as piping and electrical with the Ovivo Supplier.

All other necessary equipment and services not otherwise listed as specifically supplied by Ovivo.

OPERATION AND MAINTENANCE PROCEDURE

Plant component	Maintenance Procedure	Expected Duration	Skills required	Maintenance schedule
Feed pump to vacuum degassing tank	Renewal of stator and rotor	2 hours	Standard WWTP Operations Pump Maintenance	Once a year
Drain pump from vacuum degassing tank	Renewal of stator and rotor	2 hours	Standard WWTP Operations Pump Maintenance	Once a year
Vacuum pump	Maintenance kit, containing rotor, gaskets and assembly aids	6 hours	Standard WWTP Operations Pump Maintenance	Every two years
Metering pump for $MgCl_2$	Maintenance kit, containing diaphragm, gaskets, ball check valves and assembly aids (2 pcs.)	2 hours	Standard WWTP Operations Pump Maintenance	Every two years
Gas flow meter	Flow sensor	1 hour	Standard WWTP Operations Pump Maintenance	Spare part in case of a damage
pH measurement	pH probe	30 minutes	Standard WWTP Operations Pump Maintenance	Recalibration: once a week

BUDGET PRICE

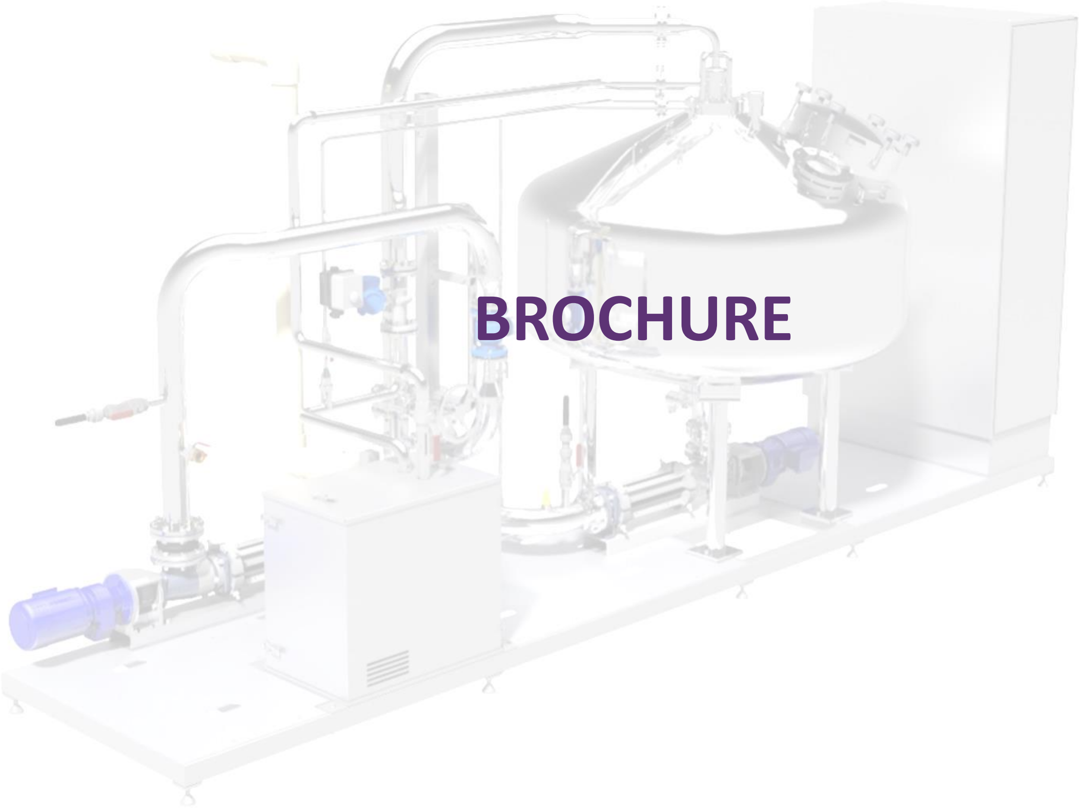
Our current budget estimate price for the EloVac®-P system, as described in this proposal is:

Description	Price*
EloVac®-P System	**Option 1a: $1,100,650** **Option 1b: $1,850,300** **Option 2: $1,420,900**

*Options Key:
Option 1a: (1) EloVac P-30 to treat flows described above
Option 1b: (2) EloVac P-30's to treat flows out to 2050
Option 2: (1) EloVac P-40 to treat flows out to 2050

NOTES

1. Our Price and Payment Terms are based on Ovivo's standard terms and conditions, which can be provided upon request.
2. This price will be valid for thirty (30) days.
3. All prices are excluding Utah State sales and use taxes and any federal taxes which shall be the sole responsibility of the Client. No additional duties will have to be paid for the equipment supplied by Ovivo.
4. Pricing is subject to the London Metal exchange index for stainless steel rolled coil calculated from the original proposal date and is in accordance with the Scope of Supply and terms of this proposal and any changes may require the price to be adjusted.



BROCHURE

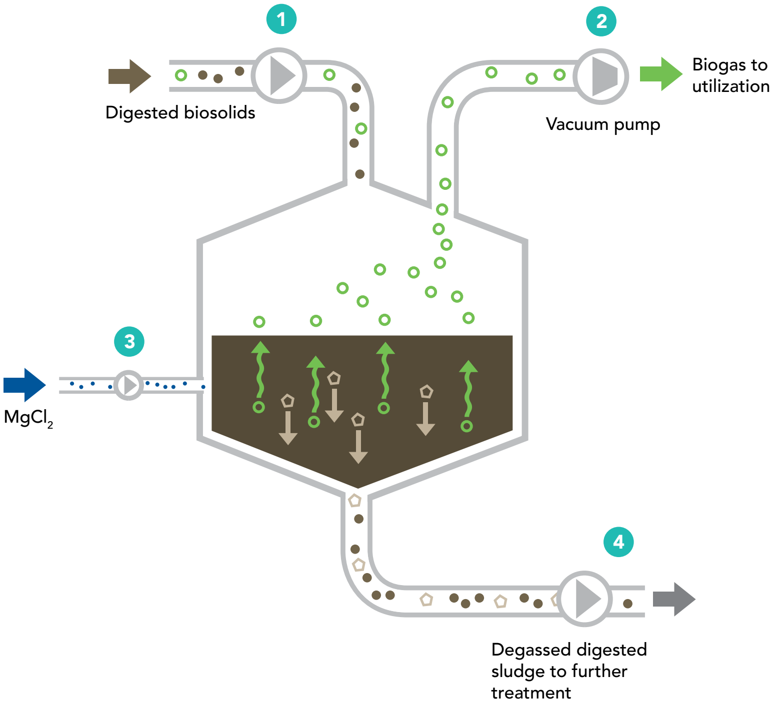
EloVac™-P

Completely skid-mounted, plug and play, compact phosphorus sequestration system that prevents struvite scaling

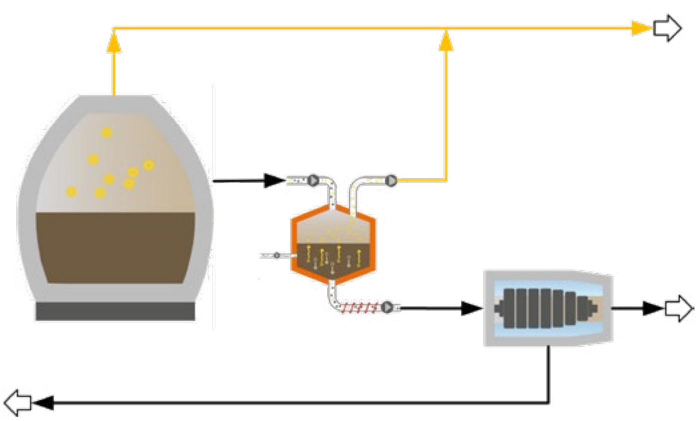
- Simple, compact and modular system
- Increase dewaterability by up to 5%
- Reduction of the phosphorous return load to the head works of the plant
- Degassing allows for additional recovery of methane from digested biosolids
- Plug and play design with no aeration required

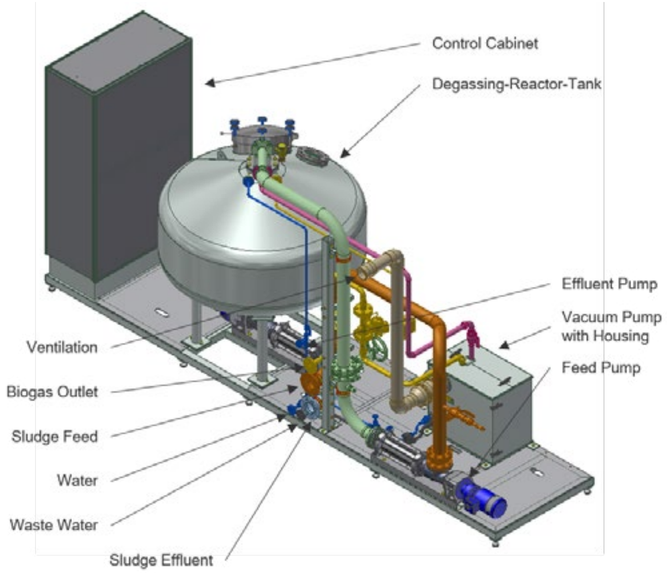
OPERATING PRINCIPLE

1. Sludge is continuously fed to the degassing reactor tank.
2. A vacuum pump extracts the methane and CO_2 from the digested sludge to raise the pH in the reactor tank. The vacuumed gas enables an energy-positive operation by capturing additional biogas, while drastically reducing greenhouse gas emissions.
3. $MgCl_2$ is added to the digested sludge in the reactor tank and together with the higher pH, creates the perfect environment within the reactor tank to precipitate and remove the phosphorus present in the biosolids.
4. Continuous discharge of degassed biosolids with the precipitated struvite to dewatering. The EloVac™-P system improves dewatering up to 5%-points. The combined effect of the degassing together with the phosphorus precipitation results in disposal cost savings up to 20%.



HOW IT WORKS





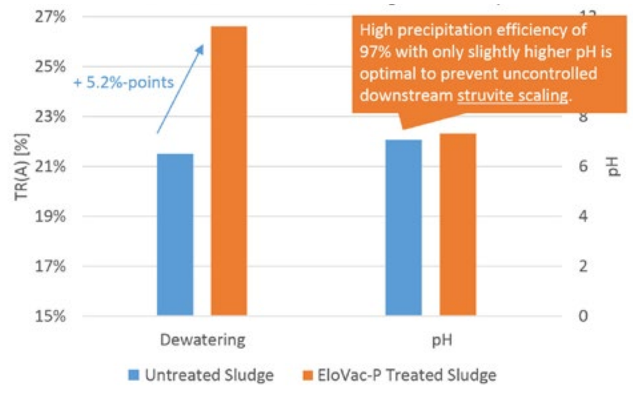
Typically EloVac™-P is installed downstream the digester and upstream the dewatering.

The system is fully automated to minimize operator attention. The system can be remotely monitored by Ovivo through its proprietary WaterExpert™ app for constant Ovivo support.

PROVEN SUCCESS

Performance shows that the technology has produced results above predicted values. In addition, maintenance costs are lower because of the simplicity of the system so downtime is minimized due to cleaning of tanks and regular pump maintenance.

Effect of the EloVac™-P on Dewatering result and pH

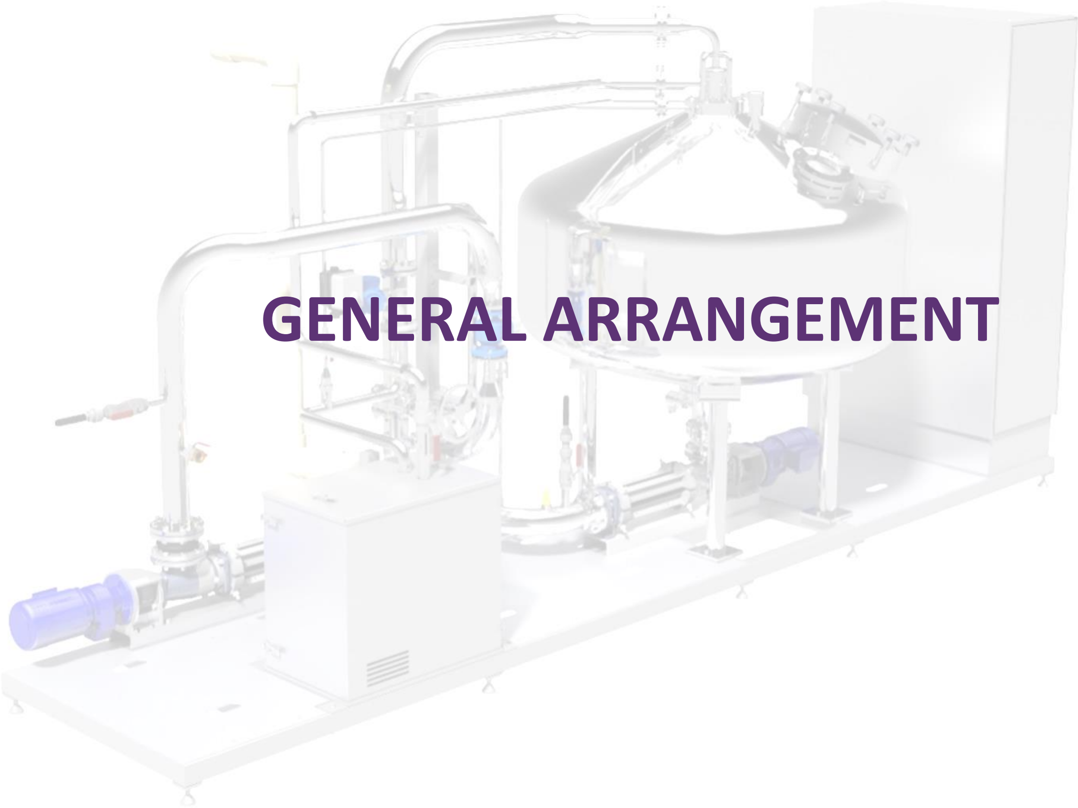


*) Results of installed EloVac-P™ in Lingen (Ems), Germany

Ovivo's Biosolids Management division also offers products such as the LM Mixer, LysoTherm™ Process, DigestivorePAD™ Process, AnammoPAQ™ Process, PHOSPAQ™ Process, Ultrastore® Membranes, BioAlgaNyx™ Treatment, G-TAD, M-TAD and Silc-TAD Processes.

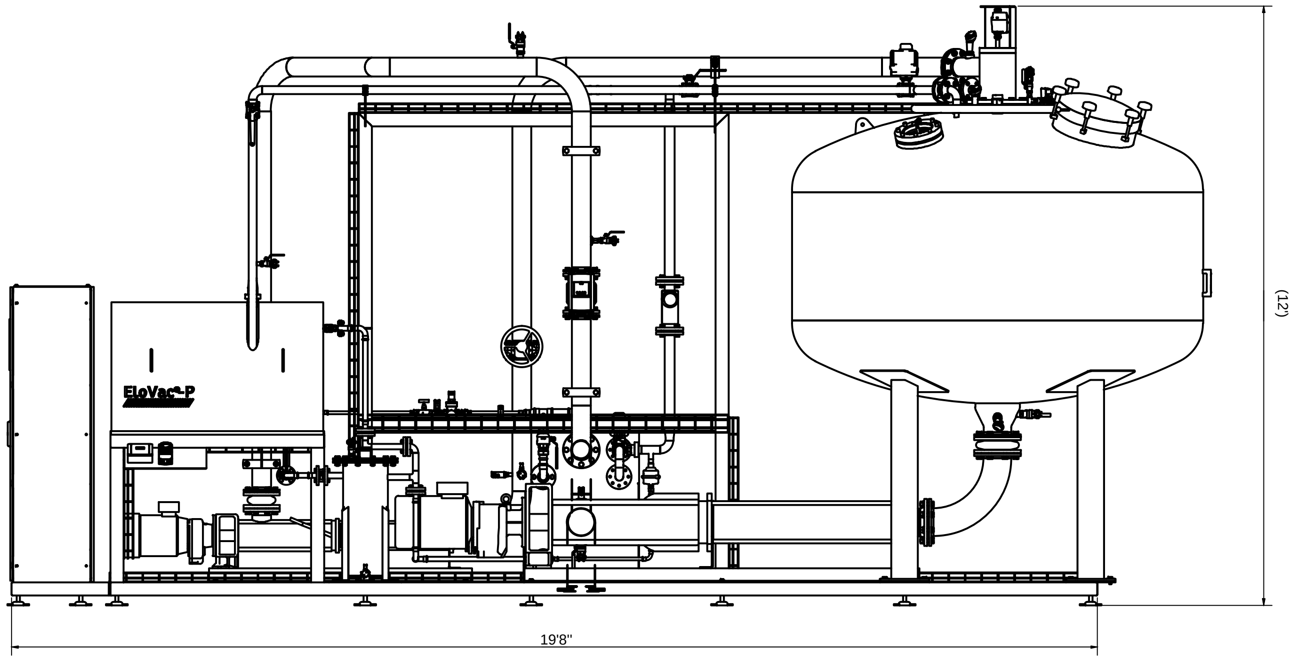
CONTACT

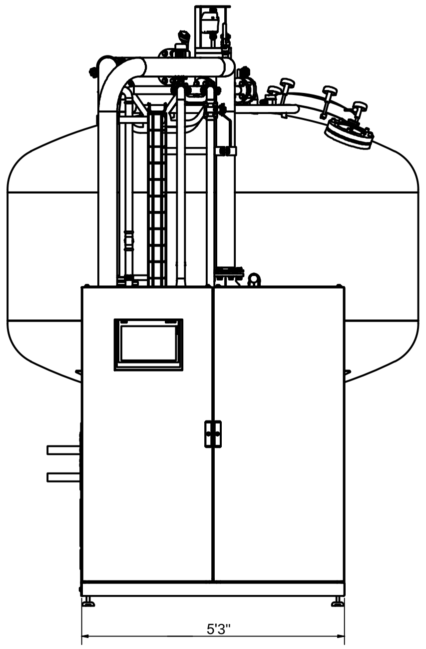
1-855-GO-OVIVO ☎
info@ovivowater.com ✉
www.ovivowater.com



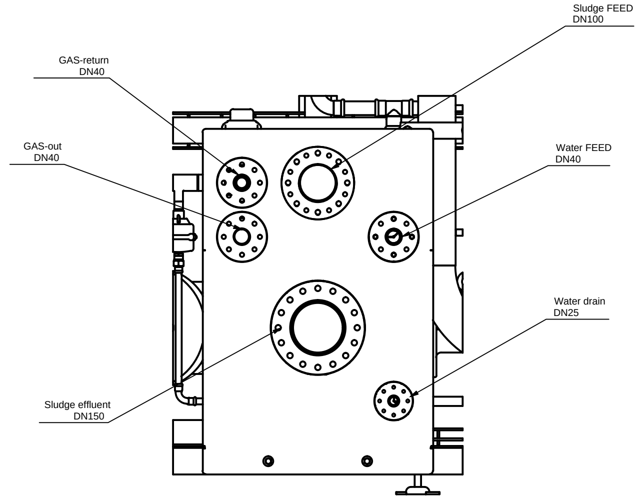
GENERAL ARRANGEMENT

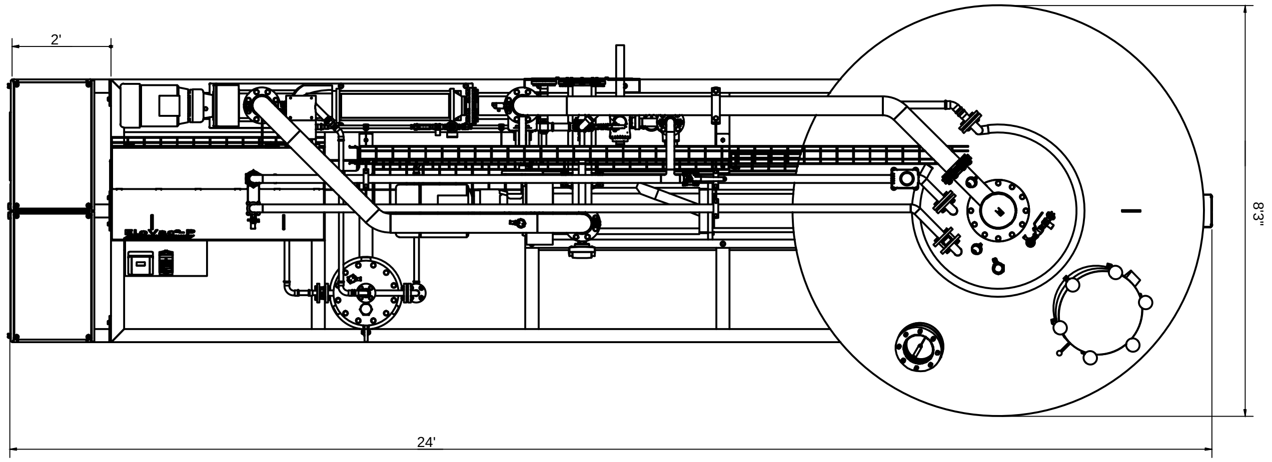
EloVac®-P30

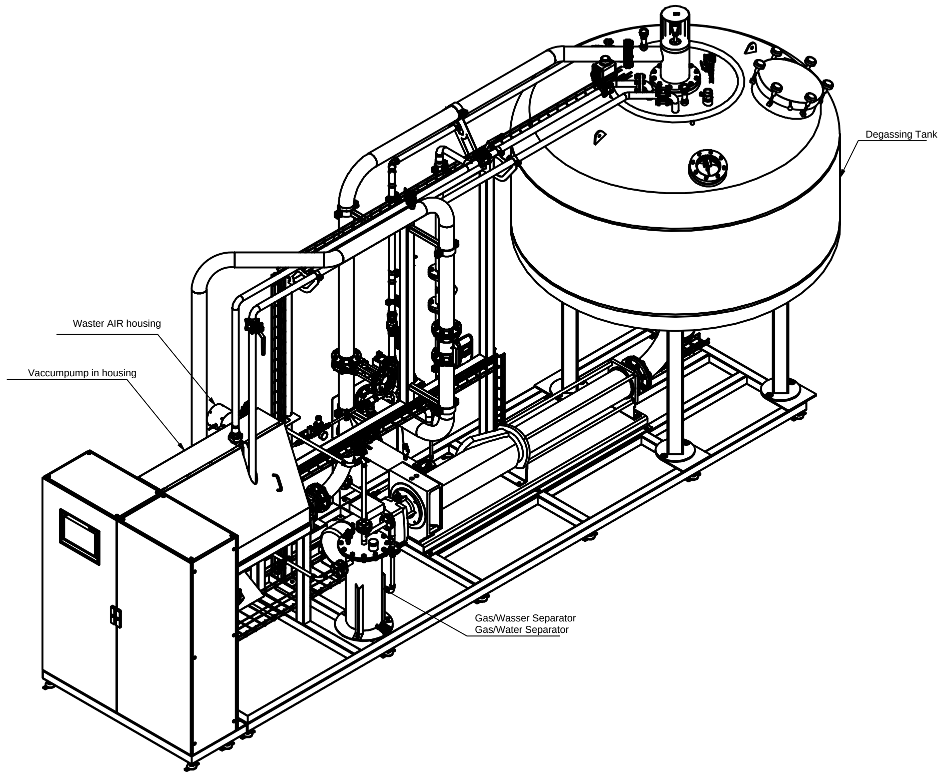




Connection panel on the back







Please note: P30 and P40 units have the same footprint.

REVISION	EN/ECO	BY	CHECK'D	DATE
-	-	-	-	-

D
SIZE SHEET
(DO NOT SCALE PRINTS)
THIRD ANGLE PROJECTION

DRAWN BY	SG
CHECKED BY	----
DATE(mm/dd/yyyy)	02/15/22
PROJECT	-
REF	

EloVac®-P30
GENERAL ARRANGEMENT
DRAWING

WORKMANSHIP STANDARD ES0001 APPLIES

DWG NO. **GA-ELOVAC®-P30**

SHEET 1 OF 1

A
REVISION

PROPOSAL LETTER

PROPOSAL # 221109-1-MG-R0

NOVEMBER 11, 2022

CENTRAL WEBER SEWER DISTRICT

OGDEN, UT

PhosPAQ™ System

PREPARED FOR

Carollo
Jade Echard
jechard@carollo.com

AREA REPRESENTATIVE

Coombs Hopkins Company
James Goldhardt
james@chcwater.com

PREPARED BY

Merima Beganovic
Phone: 470-686-9715
Merima.Beganovic@ovivowater.com

Ovivo USA, LLC
2300 Greenhill Dr. Bldg. #1
Round Rock, Texas, 78664, USA

NOVEMBER 11, 2022

Attn: Ms. Jade Echard
Carollo

Re: Central Weber Sewer District
Ovivo PhosPAQ™ System
Proposal No. 221109-1-MG-R0

Dear Ms. Echard,

With regard to your recent request for the Central Weber Sewer District Ovivo USA, LLC is pleased to submit this preliminary proposal for its PhosPAQ™ side stream Phosphorus Removal/Recovery system. The system has been designed for a Max Month 2050 flow of 0.54 MGD to achieve effluent PO_4-P < 20 mg/l for maximum struvite mitigation.

It is assumed that the dewatering will occur 24 hours a day and 7 days a week with PhosPAQ™ system operation 7 days a week. It is also assumed enough equalization will be provided (by others) for optimized process sizing a consistent operation and all equipment in the equalization tank including feed pumps will be by others.

We have endeavored to provide complete information in this proposal. However, if you have any questions or need additional information, please feel free to contact James Goldhardt, our regional sales representative, or me directly.

Sincerely,

Merima Beganovic
Product Group Manager
Biosolids Management and Resource Recovery
Ovivo USA, LLC
2300 Green Hill, Round Rock, Texas 78664
C: 470-686-9715

INTRODUCTION

The Central Weber Sewer District is in the process of evaluating technologies to mitigate its struvite buildup issues. The PhosPAQ™ treats phosphorous in the side stream to break the recycle loop of phosphorous to the main liquid line, thus breaking the struvite formation process throughout the process. In addition to struvite mitigation, the PhosPAQ™ allows for struvite harvesting, which can be used in other applications as fertilizer. Struvite mitigation with the PhosPAQ™ also reduces overall Phosphorus load at the plant to help meet its effluent permits in an efficient manner. The design flows and loads required to be treated by using the PhosPAQ™ treatment process to reduce the PO_4-concentration in the effluent stream being discharged to more acceptable limits are provided in Table 1 below.

BASIS OF DESIGN

The PhosPAQ™ system design and performance are based on the design information provided by Carollo. Table 1 summarizes the parameters used for developing the proposed solution. Please note, the lower the phosphorous effluent levels, the better the struvite mitigation achieved.

Table 1: Design Parameters

Treatment Parameter	Units	Influent 2030 MM	Influent 2040 MM	Influent 2050 MM	Treated Effluent
Equalized Design Flow	MGD	0.49	0.52	0.54	
Design Temperature	°C	25*			
TKN	mg/l	277*	305*	331*	
NH_4-N	mg/l	277	305	331	
TP	mg/l	160	181	178	
PO4-P	mg/l	130	148	144	< 20
TSS	mg/l	926	1,005	1,072	1,150 – 1,350**
BOD	mg/l	< 300*			
CODs	mg/l	< 750*			

* Assumed

** If lower TSS is required, then an ASTRASEPARATOR® downstream of the PHOSPAQ^{TM} reactor would be required

The design is based on the following assumption(s):

The influent flows are produced seven (7) days a week, twenty-four (24) hours a day.

The Central Weber Sewer District PhosPAQ™ system was designed using extensive modeling and experience from Ovivo's pilot and full-scale installations. The modeling assists in process selection and determining the optimal volumes for treatment and the overall process operating parameters.

OVIVO PHOSPAQ™ EXPERIENCE

The Ovivo PhosPAQ™ system currently has over 11 operating Phosphorus removal and recovery systems worldwide. Further, Ovivo's PhosPAQ™ installation base cumulatively treats globally Phosphorus loads in excess of 11,000 lbs P/d with installations in operation for over 10 years, which is second to none.

Figure:1 PHOSPAQ™ setup at Lomm, The Netherland (275 lds P/day)

TREATMENT APPROACH

PhosPAQ™ is a process for removal of phosphate by means of controlled struvite precipitation. In this way it is possible to remove and recover relative large quantities of phosphate from wastewater and make it available as a useful fertilizer product.

In the PhosPAQ™ reactor, wastewater is pre-treated aerobically. Ortho-phosphate (PO_4^{3-}) and ammonium (NH_4^+) are removed from the wastewater by precipitation with magnesium (Mg_2^+). Simultaneously organic compounds (COD) are biologically converted.

By flow proportionally dosing magnesium (Mg_2^+, as MgO) into the PhosPAQ™ reactor, magnesium, ortho-phosphate (PO_4^{3-}) and ammonium (NH_4^+) precipitate as struvite ($MgNH_4PO_4.6H_2O$ or MAP), if the concentrations of these three components exceed the chemical equilibrium.

The PhosPAQ™ reactor can be described as an aerated crystallization reactor where phosphorous and residual COD removal is combined. Under addition of MgO, phosphate is removed by precipitation as struvite.

Struvite is discharged from the bottom of the reactor via several discharge strands leading to a dewatering unit. Water and small solids are separated and fed back to the PhosPAQ™ reactor. The dewatered struvite is stored in a conventional container (skip) where further dewatering takes place before it is transported.

In the PhosPAQ™ reactor as the struvite is kept in suspension by aerated mixing, the organic compounds (COD) are converted to new biomass and CO_2. The reactor consists of 3 main compartments:

- the aerated mixing section
- the settler section for struvite retention
- the struvite discharge (harvesting)

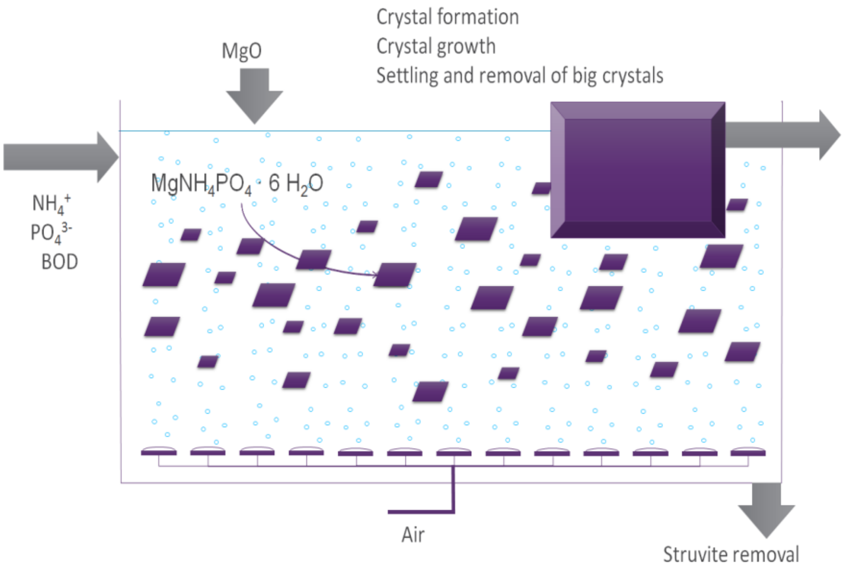


Figure:2 PhosPAQ™ Working Principle)

PhosPAQ™ PROCESS DESIGN

The system for the Central Weber Sewer District has been designed using proprietary models to perform process selection and to determine essential operating parameters.

A summary of the PhosPAQ™ system design is provided in Table 2. This table demonstrates the volumes required to achieve desired effluent PO_4-P reduction, and provides associated process design details.

Table 2. Design Summary

Treatment Parameter	Unit	Value 2030MM	Value 2040MM	Value 2050MM
Equalized Design Flow	MGD	0.49	0.52	0.54
Total No. of PhosPAQ™ Reactors	#	1		
Volume of PhosPAQ™ Reactor	Gallons	113,000		
PhosPAQ™ Reactor Length	ft	26.5		
PhosPAQ™ Reactor Width	ft	26.5		
PhosPAQ™ Reactors SWD	ft	23		
Air Flow for PhosPAQ™ Reactor	scfm	500		
MgO Consumption	Lbs/day	334	490	453
Struvite Production	Lbs-100% DS/d	3,317	4,127	4,146

opsCTRL™

In addition to our System, Ovivo offers a mobile-based platform (opsCTRL) allowing to reserve workforce's expertise by uploading media and procedures, access itemized OEM operator manuals for all of your Ovivo Installations, create and update service logs, maintenance schedules, performance alerts.

The opsCTRL platform is unique in the industry and allows the end user to any new content in addition to getting instant access to expert support and monitor equipment performance with live data readings with any cellphone, tablet or PC. See the link below for additional information: https://www.opsctrl.com/

SCOPE

SCOPE OF SUPPLY

The following table outlines the Ovivo PhosPAQ™ system scope of supply for the proposed project.

Scope of Supply		
Item	Qty	Description
1	1	PhosPAQ™ reactor <u>internals</u> (suitable for 113,000 gallons tank) • Two (2) Type 17 Settler and support construction • Coarse Bubble aeration system, basin piping for c/w drop legs, flanged diffuser pipes, mounting brackets and connection fasteners • Piping for aeration, influent, effluent, biomass sampling
2	2 (1+1)	Process Air Blowers for PhosPAQ™ without VFD; Capacity: 500 scfm each
3	Lot	Controls and Instrumentation (Flow, PO_4-P, pH, T)
4	2	Sets of O&M Manuals
5	2	Sets of Detailed Shop Drawings
6	1	One (1) year subscription to OpsCTRL™ System
7	10	Service Days, to inspect equipment installation, test all supplied components, assist in start-up and train plant personnel.

ITEMS BY OTHERS

The following items are specifically not by Ovivo. They may or may not be required.

Items Not Included	
Air Main Piping and all accessories including valves, bolts gaskets and connectors for attaching to drop pipes	Motor Control Center (MCC)
Chemical Feed Systems for alkalinity correction, magnesium oxide, nutrients, methanol and defoamer	Non-potable water supply
Chemicals for operation: Including methanol, nutrients, alkaline solution, defoamer	Overflow structures including baffles and weir plates
Cleanouts	Power
Concrete	Pre-treatment systems for deammonification system (e.g. influent/ effluent TSS removal system, COD removal system)
Drains	Sludge handling and disposal
Dryers	**Struvite extraction and dewatering systems and pelletizers**
Engines/Generators	**Struvite Cleaning/Washing Systems like Hydrocyclones**
Equalization Tank and equipment therein	Struvite removal and Sludge withdrawal Pumps
Foam control	Support Platforms
Hoses /Bibs	Tanks (and modifications to tankage – existing or new)
Influent/Feed Pumps	Transformers
Interconnecting Piping	Valves – Manual and Automatic
Laboratory	Variable Frequency Drives for blowers and pumps
Ladders (caged or other types) and Handrails	Ventilation
Lighting	Walkways/Roofing/Stairs/Gratings/Handrails
Liquid sampling and analytical work	Wireways/Wiring
Local control panels for blowers etc.	Yard Piping
Mixers	Yard Hydrants

ADDITIONAL ITEMS BY INSTALLING CONTRACTOR

1 Obtain necessary construction permits and licenses, construction drawings (including interconnecting piping drawings) field office space, telephone service, and temporary electrical service.

2 All site preparation, grading, locating foundation placement, excavation for foundation, underground piping, conduits and drains.

3 Demolition and/or removal of any existing structures, equipment or facilities required for construction and installation of the PhosPAQ™ system.

4 Installation of all foundation - supply and installation of all embedded or underground piping, conduits and drains.

5 All backfill, compaction, finish grading, earthwork and final paving.

6 Receiving (preparation of receiving reports), unloading, storage, maintenance preservation and protection of all equipment and materials supplied by Ovivo.

7 Installation of all equipment and materials supplied by Ovivo.

8 Supply, fabrication, installation, cleaning, pickling and/or passivation of all interconnecting steel piping components.

9 Provide and install all embedded pipe sections and valves for tank drains and reactor inlets and elbows.

10 All cutting, welding, fitting and finishing for all field fabricated piping.

11 Supply and installation of all flange gaskets and bolts for all piping components.

12 Supply and installation of all pipe supports and wall penetrations.

13 Install and provide all motor control centers, motor starters, panels, field wiring, wireways, supports and transformers.

14 Install all control panels and instrumentation as supplied by Ovivo, as applicable.

15 Supply and install all electrical power and control wiring and conduit to the equipment served plus interconnection between the Ovivo equipment as required, including wire, cable, junction boxes, fittings, conduit, cable trays, safety disconnect switches, circuit breakers, etc.

16 Supply and install all insulation, supports, drains, gauges, hold down clamps, condensate drain systems, flanges, flex pipe joints, expansion joints, boots, gaskets, adhesives, fasteners, safety signs, and any specialty items such as traps.

17 All labor, materials, supplies and utilities as required for start-up including laboratory facilities and analytical work.

18 Provide all chemicals required for plant operation and all chemicals, lubricants, glycol, oils or grease and other supplies thereafter.

19 Install all anchor bolts and mounting hardware supplied by Ovivo; and supply and install all anchor bolts and mounting hardware not specifically supplied by Ovivo.

20 Provide all nameplates, safety signs and labels.

21 Provide all additional support beams and/or slabs.

22 Provide and install all manual valves.

23 Provide and install all piping required to interconnect to the Ovivo's equipment.

24 The Contractor shall coordinate the installation and timing of interface points such as piping and electrical with the Ovivo Supplier.

All other necessary equipment and services not otherwise listed as specifically supplied by Ovivo.

BUDGET PRICE

Our current budget estimate price for the PhosPAQ™ system, as described in this proposal is:

Description	Price
PhosPAQ™ system as described above	**$1,792,500**

NOTES –

1. Our Price and Payment Terms are based on Ovivo's standard terms and conditions, which can be provided upon request.
2. This price will be valid for thirty (30) days.
3. All prices are excluding Utah state sales and use taxes and any federal taxes which shall be the sole responsibility of the Client. No additional duties will have to be paid for the equipment supplied by Ovivo.
4. Pricing is subject to the London Metal exchange index for stainless steel rolled coil calculated from the original proposal date and is in accordance with the Scope of Supply and terms of this proposal and any changes may require the price to be adjusted.

Shipping Terms
FOB Shipping Point, Full Freight Allowed

BROCHURE

PHOSPAQ™ PROCESS

SUSTAINABLE PHOSPHORUS REMOVAL AND RECOVERY

HOW WE CREATE VALUE

Cost effective removal or recovery of Phosphorus as Magnesium Ammonium Phosphate (struvite)

Option to implement Phosphorus removal only

Phosphorus recovery produces a coarse slow release fertilizer product, an added revenue stream

No additional alkalinity addition and no excessive sludge production

Free organics and Sulfides removal

THE CHALLENGE

- Sidestreams from anaerobic digestion while representing only about 1% to 3% of the flow to the mainstream, can contain 10% to 25% of the Phosphorus load, with concentrations often in excess of 100 mg/L PO4-P
- Thermal Hydrolysis Process (THP) in biosolids management and Biological Phosphorus (Bio-P) Removal in main treatment works can significantly increase the Phosphorus content in the sidestreams
- Strict BNR Phosphorus limits and struvite issues in the plant due to cycling of Phosphorus between and mainstream and sidestreams
- Conventional Phosphorus removal methods consume large amounts of chemicals while generating high amounts of waste sludge while also severely depleting the alkalinity of the sidestream

THE OVIVO SOLUTION

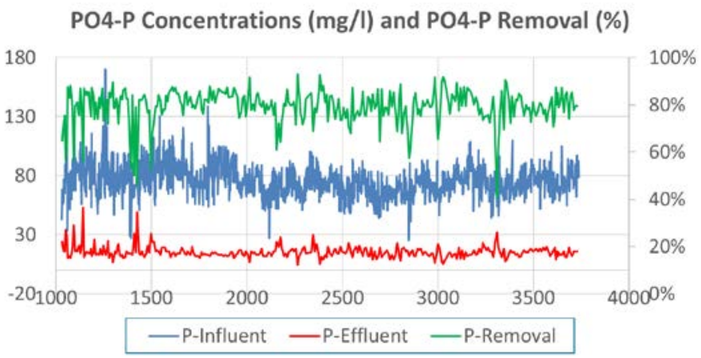
The PHOSPAQ™ process addresses a critical need of struvite mitigation at plants with high levels of Phosphorus in their sidestreams (typically due to Biological Phosphorus (Bio-P) Removal or Thermal Hydrolysis Processes (THP) in their treatment schemes). The process can further be enhanced to include Phosphorus recovery in the form of a slow release fertilizer i.e. struvite formed as a byproduct in the process which can be used as an additional source of revenue for the plant. Additionally, the system provides an excellent protective pre-treatment step ahead of deammonification particularly for plants with THP by eliminating inhibitory and competition inducing organic compounds and Sulfides thereby allowing for optimization and uninterrupted operation of the downstream process without the need to add additional chemicals.

The PHOSPAQ™ ADVANTAGE

- Flexibility of design – Can do just Phosphorus removal or upgrade to recovery as well
- Low O&M Costs
- Simple and compact construction
- Enhanced Struvite precipitation with free BOD and Sulfides removal
- Longest experience with large reference base

OPERATING PRINCIPLE

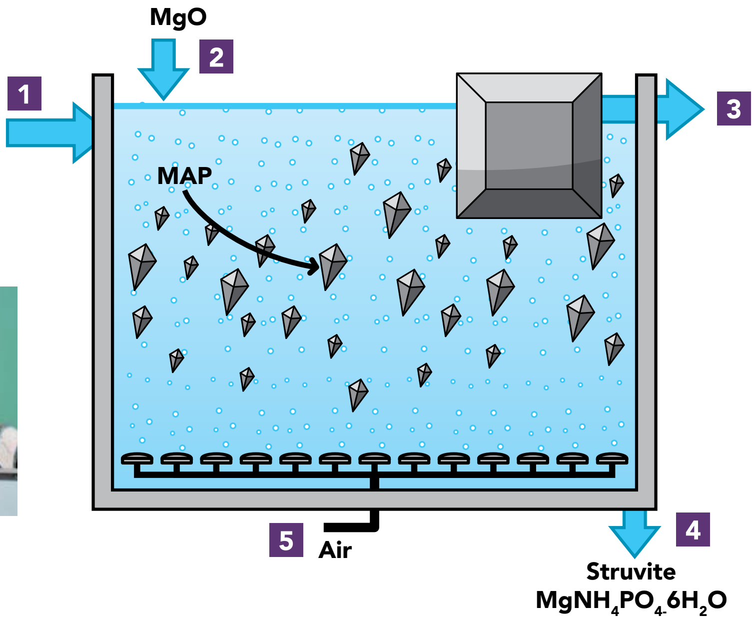
The PHOSPAQ™ process comprises an aerated tank to which the Nitrogen and Phosphorus rich sidestream is added. Magnesium Oxide or Magnesium Hydroxide is used to provide the Magnesium content to form Magnesium Ammonium Phosphate (MAP) aka Struvite. Air is primarily added to mix the tank but also helps strip out the Carbon Dioxide increasing the pH thereby aiding formation of MAP while also providing free BOD removal. The aeration further helps with the crystallization process and as the crystals grow and become heavier and pass through the specially designed separator, the heavier crystals settle into the tank (to be withdrawn from the bottom), while the cleaned effluent leaves through the top of the separator. The withdrawn struvite can just be dewatered with a drain belt, mixed with biosolids and disposed in case of the removal configuration. Alternately, additional unit processes can be added to further increase the dry matter content of the struvite enabling recovery as a bespoke fertilizer (typically coarse crystals with average diameter 0.7 mm).



10 Years of Operational data for the Olburgen WWTP, Netherlands

HOW IT WORKS

1. Phosphorus rich influent
2. Magnesium Oxide/Hydroxide feed
3. Treated effluent
4. Struvite removal
5. Coarse bubble diffused aeration system



CONTACT

1-855-GO-OVIVO ☎
info@ovivowater.com ✉
www.ovivowater.com

FKC CO., LTD.

2708 West 18th Street
Port Angeles, WA 98363

(360) 452-9472
FAX (360) 452-6880

September 13, 2022

Erin Andersen, PE
Carollo Engineering
7090 South Union Park Avenue, Suite 600
Salt Lake City, UT 84047

Tel: 801.233.2506
Cell: 801.814.7774
Email: eandersen@carollo.com

Re: FKC Co., Ltd. QT07-091322Btb Rotary Drum Thickening Skid for Central Weber Sewer Improvement District, Ogden, UT

Cc: Jeff Wiest, Waterford Systems

Erin:

FKC is pleased to provide a rotary screen thickener quotation based on your email dated September 8, 2022. This proposal includes:

(1) One FKC Model RST-S480x2000L Rotary Drum Thickeners (RDT)
(1) One FKC Model 100GL Flocculation Tank (FT)
(1) One FKC Standard, RST & FT control panel, no PLC or OIT
(1) One Solenoid Valve

The rotary drum thickener is quoted to thicken primary sludge from solids concentration of 3.0% - 4.0% to 6 - 7% total solids.

Please note that the pricing found in this quote does not include all the other equipment necessary for a complete thickening application; i.e. polymer system, pumps, logic control, field instrumentation, valves, etc.

We hope this information is helpful. Please contact this office if you have questions, or if you need anything further to issue the purchase order.

Sincerely,
FKC Co., Ltd.

Trent Bohman

FKC
Rotary Drum Thickener
with
Flocculation Tank

for
Central Weber Sewer Improvement District
Ogden, UT

QT07-091322Btb
September 13, 2022

Table of Contents

A.1. Proposed Equipment

Units	**Description**	**FOB Ogden, Utah ***
1	FKC Rotary Screen Thickener Model RST-S480x2000L	**See Paragraph B.3. for Pricing**
	Material:	100% Municipal Primary Sludge
	Hydraulic capacity:	50 gpm
	Inlet consistency:	3 to 4 % TS
	Outlet consistency:	6 to 7% TS
	Materials of construction:	SS-304 wetted parts SS-304 Base SS-304 Support Legs & Frame Other Painted Carbon Steel
	Speed reducer:	SEW Eurodrive Gearbox Motor: 1.0HP 480V/3PH/60Hz
	Other:	One (1) 100GL Flocculation Tank SS-304 wetted parts SS-304 Support Legs & Frame SEW Eurodrive Gearbox/motor Motor: 1.0HP 480V/3PH/60Hz One (1) 1.5-inch Solenoid Valve One (1) FKC standard control panel, no PLC, no OIT. See paragraph B.14 for details.
	Delivery:	Delivery within five (5) months after notice to proceed with manufacturing.

*Prices do not include taxes or bonding requirements

B. Miscellaneous

1. Delivery

On-site delivery will be within five (5) months after notice to proceed with manufacturing.

2. Shipping Arrangements

The FKC thickening equipment will be shipped best way overland from Port Angeles, Washington to the CWSID facility.

Shipping Terms are FOB Ogden, Utah.

3. Equipment Summary

The following summarizes the equipment offered:

- (1) One FKC Model RST-S480x2000L Rotary Drum Thickeners (RDT)
- (1) One FKC Model 100GL Flocculation Tank (FT)
- (1) One FKC Standard, RST & FT control panel, no PLC or OIT
- (1) One Solenoid Valve

Total – US$ 118,000 FOB Ogden, Utah

This proposal and pricing to be offered does not include taxes or bonding.

This proposal does not include all the equipment necessary for a complete thickening system. For example, pumps, polymer makedown systems, other valves, flow meters, field instrumentation, logic control, etc. are not included in this proposal or pricing.

4. Options Offered

None.

5. Effective Period

This proposal shall remain valid 30 days from the date of the proposal.

6. Payment Terms

100% with delivery
Net 30 days

FKC understands that with some contract requirements, up to 10% may be retained until successful performance is demonstrated.

7. Installation

The Rotary Screen Thickener and Flocculation Tank are shipped ready for installation.

All equipment proposed are delivered separate and independent of one another for installation by Contractor.

8. Operator Training and Start Up

One (1) trip, three (3) person-days are provided for on-site services for the start-up, of the Rotary Screen Thickener and Flocculation Tank.

One (1) trip, two (2) person-days are provided for on-site services including performance testing and training of the Rotary Screen Thickener and Flocculation Tank.

Other installation and erection assistance are not included in the price of the equipment and generally are not required. However, the service is available for our standard service rates (see the enclosed rate sheet).

9. Warranty

FKC's mechanical warranty covers material and workmanship for a period of 18 months after delivery or 12 months after 1st date of beneficial use, whichever comes first.

10. Documentation Schedule

The drawings provided with this scope of supply are reference drawings only.

A. Approval Drawings - within 6 weeks after receipt of purchase order
    Buyer must return approval drawings within 14 days
    or delivery schedule will be affected
B. Certified Drawings - within 2 weeks after return of approval drawings
C. Operation and Maintenance Manuals – Before shipment

11. Performance Guarantee

The performance figures and conditions denoted in section A of this proposal constitute FKC Co., Ltd.'s performance guarantee and the conditions required to meet the guarantee. All of the consistency figures are based on total solids (TS) not total suspended solids (TSS) unless otherwise indicated.

In the event that performance is not met, FKC will provide all parts, engineering, and labor associated with the work necessary to bring the equipment into conformance with the performance guarantee.

12. Notes and Clarifications

This Scope of Supply and pricing offered does not include taxes or bonding. It is expected that the taxes will be paid directly by the Purchaser to the applicable government agencies.

This proposal does not include all the equipment necessary for a complete thickening system. For example, pumps, polymer makedown systems, other valves, flow meters, field instrumentation, logic control, etc. are not included in this proposal or pricing.

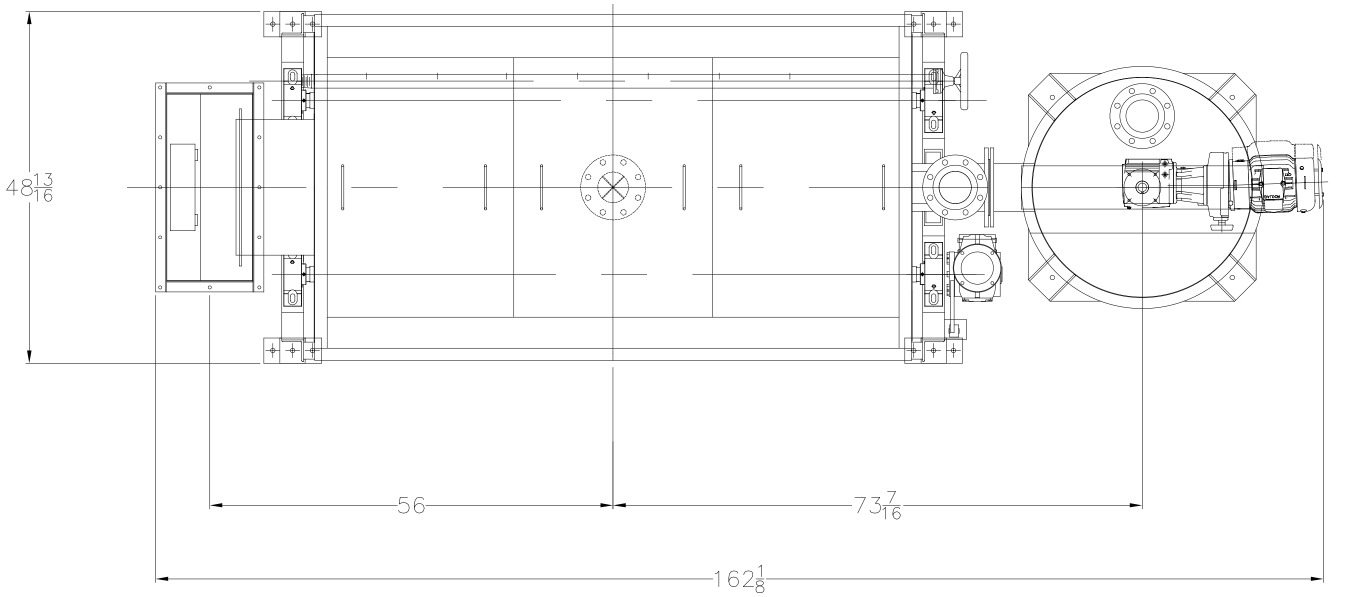
Anchor bolts will be sized by FKC with PE Structural Engineer stamped calculations, but anchor bolts will be provided by the Purchaser.

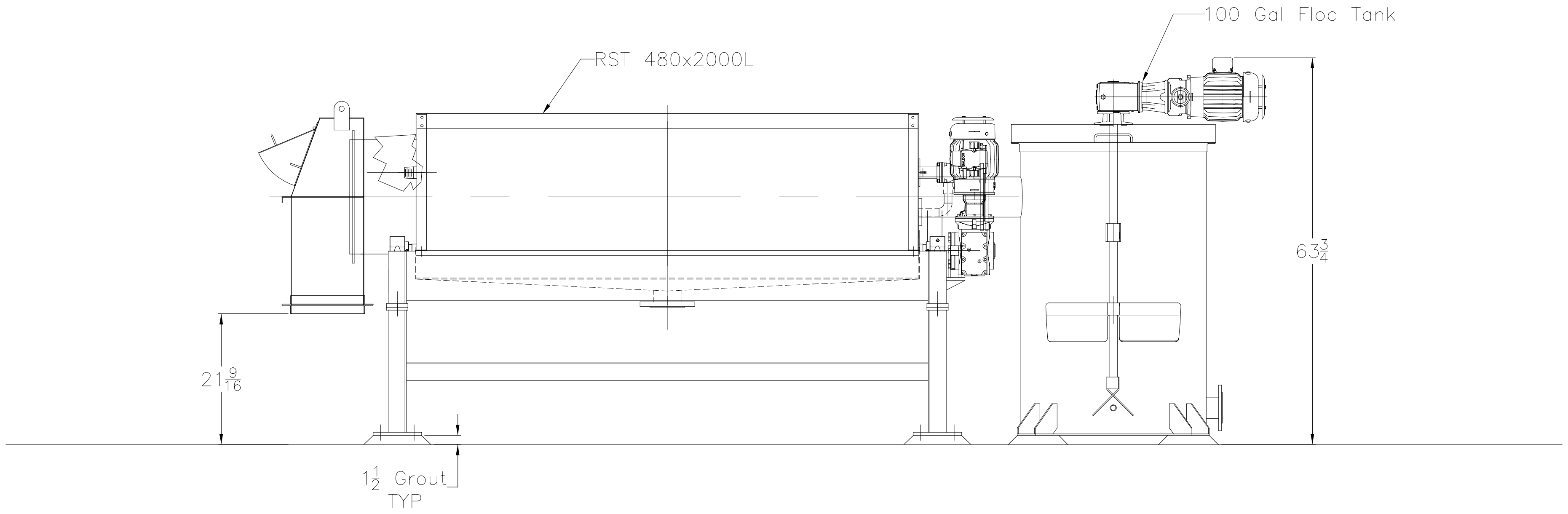
13. Spare Parts List

None.

14. Control Panel Information

- NEMA 4X 304SS enclosure
- VFD for the floc tank motor, 1 HP with line reactor & ethernet connection
- VFD for the thickener motor, 1HP with line reactor & ethernet connection
- Process E-stop on Panel Door
- Floc Tank OOR switch, ON/OFF, FAIL, and SPEED indicators with SPEED potentiometer
- Rotary Drum Thickener OOR switch, ON/OFF, FAIL, and SPEED indicators with SPEED potentiometer
- NO PLC
- NO OIT
- NO Ethernet Switch
- The 2 AI, 2 AO, 2 DI, and 7 DO external interfaces
    - 2 AI's, RDT speed command, FT speed command
    - 2 AO's, RDT speed feedback, FT speed feedback
    - 2 DI's, RDT run command, FT run command
    - 7 DO's, RDT in remote, RDT on, RDT fail, FT in remote, FT on, FT fail, Estop status
- Side mounted 800 BTU air conditioner
- power supply/control for one solenoid valve
- TVSS & 480/120 VAC Transformer





Mark	Description	Material	pcs.	Weight kg.	Remarks

JOB No.

Messrs. REFERENCE

Quantity 1

Scale

Drawing No. L255-100a

Title *S480x2000L w/ Floc Tank Layout*

Date 6/1/30

Drawn by RTB

Ref. JOB No.

FKC CO., LTD.

2708 W, 18TH ST.
PORT ANGELES, WA 98363
(360) 452-9472 FAX (360) 452-6880

REVISION 1

SHEET 1 OF 1

No.	Alteration	Date	Sign.
1	Issued for Reference	6/1/12	RTB

Paul Mora
Davidson Sales & Engineering

Phone: (801) 977 9200

Email: Paul_mora@dseslc.com

Date: 12/20/22

Scope#: MIP033536-01
Customer: Carollo Engineers
Project: Central Weber Sewer - TWAS pumps - Carollo
Contact: Randy Zollinger

Scope Letter - MIP033536-01 Central Weber Sewer - WAS pumps - Carollo

Bid Date: 12/20/22
Engineer:
Addendum:

Clarifications

Please note there are clarifications to your quote. Please see detailed clarification items in the section labeled Scope of Supply.

Terms

Offer is firm if accepted in writing by 90 days of bid date and released for manufacture and shipment prior to one year of bid date. Orders not released per above are subject to escalation.

Terms: Terms are to be negotiated and are subject to NOV's Credit Department approval. Orders accepted on the basis that we are to furnish the material and services covered by our scope only and that the purchase order is made out to:

National Oilwell Varco, LP.

PO Box 205155

Dallas, TX 75320-5155

Contents

Paul Mora
Davidson Sales & Engineering

Scope#: MIP033536-01
Customer: Carollo Engineers
Project: Central Weber Sewer - TWAS pumps - Carollo
Contact: Randy Zollinger

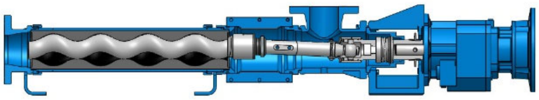
Phone: (801) 977 9200

Email: Paul_mora@dseslc.com
Date: 12/20/22

Section: Paragraph: Item(s):

Pump and Application Details

Moyno® Z37AC11RMB/E Pump



Pump Materials

Castings	C - Cast Iron	**Shaft Seal**	Standard Mechanical Seal
Internals	1 - Code 1	**Suction**	6.00IN 125LB ANSI Flat Faced Flange
Stator	R - Nitrile Rubber (NBR)	**Discharge**	6.00IN 125LB ANSI Flat Faced Flange
Rotor	Standard Size Mark 1	**Speed**	259 RPM
Suction:	Force: 450 lbf Moment: 750 ft*lbf	**Discharge:**	Force: 450 lbf Moment: 750 ft*lbf

Conditions of Service

Material Description	Sludge				
Viscosity	Assumed 500 CP	**Capacity**	90GPM	**Vap Press**	PSI
Sp Gravity	1.03	**Suct Pressure**	0 FT	**NPSH Avail**	Assumed Flooded
Temp	70 F	**Disch Pressure**	35 FT	**NPSH Reqd**	2.58 ft
Abrasives	None	**Diff Pressure**	35 FT	**pH**	7
Solids %	0%	**Hrs/Day**	24	**Duty Cycle**	Continuous

Mechanical Seal Information

Vulcan Single Mechanical Seal	
Type:	147
Shaft Size:	65mm
Rotary Face:	Silicon Carbide
Stationary Face:	Silicon Carbide
Elastomer:	Fluoroelastomer
Gland:	316 Stainless Steel

Paul Mora
Davidson Sales & Engineering

Scope#: MIP033536-01
Customer: Carollo Engineers
Project: Central Weber Sewer - TWAS pumps - Carollo
Contact: Randy Zollinger

Phone: (801) 977 9200

Email: Paul_mora@dseslc.com
Date: 12/20/22

Section: Paragraph: Item(s):

Scope Of Supply

Qty	Item	Description
3	PUMP	Moyno EZ Pump Model: Z37AC11RMB/E; w/ Vulcan Single Mechanical Seal Type: 147; Std Moyno Seal PN: M065139G;
3	BASEASM	Carbon Steel Brake Bent Base;
3	MOTOR	PN: 4242453004; Weg 5HP 184TC C-Faced Premium Efficient AC Motor; Weg PN: 00518ET3ER184TC-W22
3	GEAR REDUCER	NORD C-Faced Reducer; Model: SK672.1F-184TC-200MM; RPM: 259; Ratio: 6.75:1; Flange Mounted w/ 250mm Flange, 40mm X 100mm Shaft; 14.2mm Cross Drilled Pin Hole;Ref Drw: REF Shaft PN; Mount Position: M1; Class: II; Options: PN: 4242479012
3	Std Warranty	Moyno Standard Warranty: The warranty period is 18 months from the date of shipment from the factory or 12 months from the date of installation at the customer's facility, which ever period expires first;

Total Price for (3) pkgs.:	**$32,133.00**	Estimated Delivery 14-16 Weeks from receipt of order, or approval for manufacture. Please verify with factory for actual lead time at time of purchase or release for manufacture.

Clarifications

Unless specifically mentioned in our detailed offer for each item listed, the following are NOT included in our price whether specified or not:

> Anchor Bolts, Gauges, Panels, Seal or Packing Flush Hardware, Controls, Contacts, VFDs, Starters (AC Motors), Tools, Valves, Video Equipment/Taping, Lubricants, Pressure Switches, Special Paint or Paint Preparation, Timers, Taxes and Noise & Vibration Testing.

Additional Comments/Notes

COVID-19 NOTICE: Due to the on-going COVID-19 pandemic and various Governmental directives, company measures and uncertainties arising therefrom (collectively "COVID-19 Effects"), all quoted delivery dates for products and completion dates for the work are NOV's best estimates made at the time of the quote and are not binding on NOV. Accordingly, NOV assumes no risk for COVID-19 Effects on NOV's ability to deliver the products or perform the work by the dates quoted. If the delivery of products or execution of work is affected by COVID-19 Effects, NOV shall be entitled to take reasonable measures with respect to COVID-19 Effects, to have an extension of time as needed, to deliver the products or complete the work and to obtain a reasonable compensation for all additional direct costs incurred by NOV as agreed with Customer in good faith. For purposes of this COVID-19 Notice, NOV shall mean the NOV affiliate named above and Customer shall mean the customer to which NOV issued to quote, order acknowledgement or other documents. We are monitoring this situation extremely closely and formulating plans on a case-by-case basis to try to ensure seamless support for our customers. We would ask that you contact your NOV Sales representative if you have any specific challenges or concerns.

Paul Mora
Davidson Sales & Engineering

Scope#: MIP033536-01
Customer: Carollo Engineers
Project: Central Weber Sewer - TWAS pumps - Carollo
Contact: Randy Zollinger

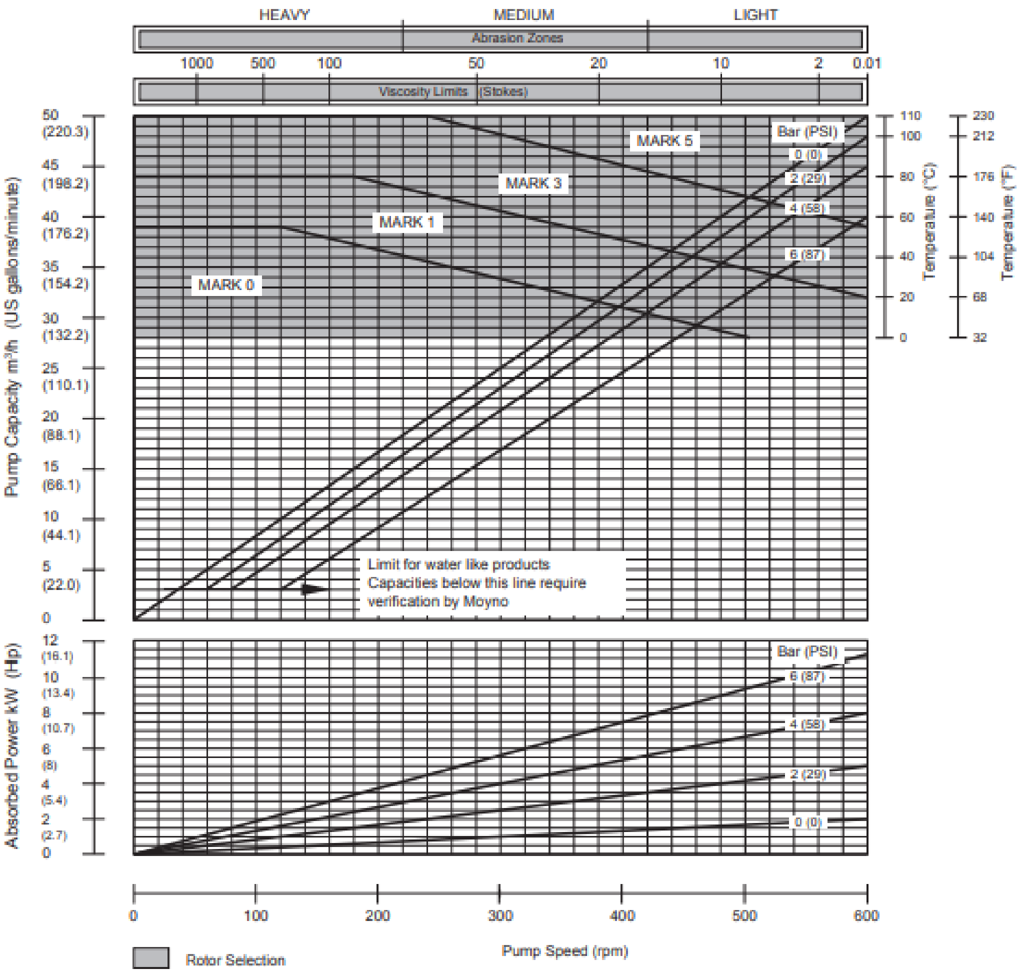
Phone: (801) 977 9200

Email: Paul_mora@dseslc.com
Date: 12/20/22

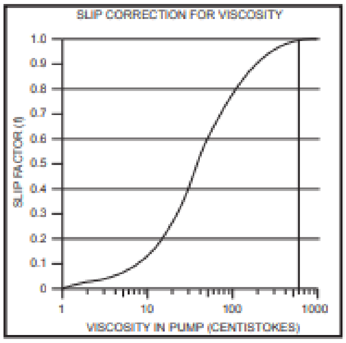
Section: Paragraph: Item(s):

Performance Curve – EZ Z37AC11RMB/E

PERFORMANCE DATA



SLIP CORRECTION	n = corrected duty speed, n_o = rpm @ 0 bar, n_p = rpm @ duty press. n_s = Slip Speed = $n_p - n_o$, f x n_s = Slip Speed Correction = $f.n_s$ ***Slip Corrected Speed ($n = n_p - f.n_s$)***					
TEST PARAMETERS	Above data represents tests on water @ 20°C (68°F) using RR and RA stator materials					
▨	**SOLIDS HANDLING (mm)**		**▨STARTING TORQUE (Nm)**			
	Hard Angular	**Soft and compressible**	**Mark 0**	**Mark 1**	**Mark 3**	**Mark 5**
COMPACT	14	44	220	100	100	100
	SOLIDS HANDLING (in)		**▨STARTING TORQUE (ft/lb)**			
	0.6	1.7	162	74	74	74



Published information other than that marked certified is to be used as a guide only

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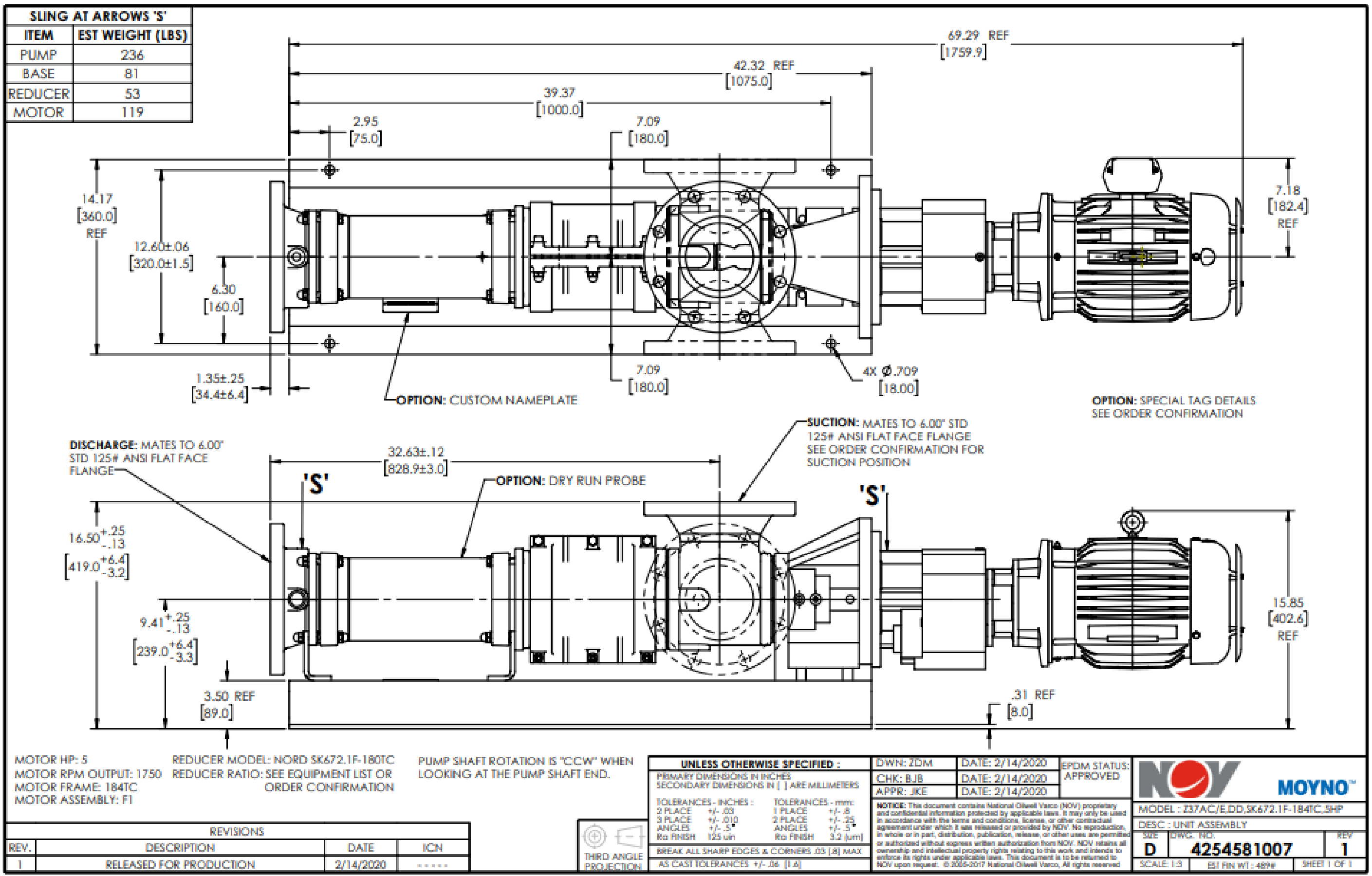

SLING AT ARROWS 'S'

ITEM	EST WEIGHT (LBS)
PUMP	236
BASE	81
REDUCER	53
MOTOR	119

MOTOR HP: 5
MOTOR RPM OUTPUT: 1750
MOTOR FRAME: 184TC
MOTOR ASSEMBLY: F1

REDUCER MODEL: NORD SK672.1F-180TC
REDUCER RATIO: SEE EQUIPMENT LIST OR ORDER CONFIRMATION

PUMP SHAFT ROTATION IS "CCW" WHEN LOOKING AT THE PUMP SHAFT END.

REVISIONS

REV.	DESCRIPTION	DATE	ICN
1	RELEASED FOR PRODUCTION	2/14/2020	- - - - -

UNLESS OTHERWISE SPECIFIED :
PRIMARY DIMENSIONS IN INCHES
SECONDARY DIMENSIONS IN [ ] ARE MILLIMETERS

TOLERANCES - INCHES :		TOLERANCES - mm:	
2 PLACE	+/- .03	1 PLACE	+/- .8
3 PLACE	+/- .010	2 PLACE	+/- .25
ANGLES	+/- .5°	ANGLES	+/- .5°
Ra FINISH	125 uin	Ra FINISH	3.2 [um]

BREAK ALL SHARP EDGES & CORNERS .03 [.8] MAX
AS CAST TOLERANCES +/- .06 [1.6]

DWN: ZDM DATE: 2/14/2020
CHK: BJB DATE: 2/14/2020
APPR: JKE DATE: 2/14/2020
EPDM STATUS: APPROVED

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MODEL : Z37AC/E,DD,SK672.1F-184TC,5HP
DESC : UNIT ASSEMBLY
SIZE D DWG. NO. 4254581007 REV 1
SCALE: 1:3 EST FIN WT : 489# SHEET 1 OF 1

TYPICAL G. A. DRAWING PLEASE USE AS REFERENCE DO NOT USE FOR MOUNTING PURPOSES

NOV Process & Flow Technologies US, Inc.AND ITS AFFILIATES
TERMS AND CONDITIONS FOR THE PROVISION OF EQUIPMENT, PARTS, SERVICES OR RENTAL

PAGE 1 OF 3

1. ACCEPTANCE

Orders or other requests, whether oral or written, for the supply or sale of machinery or equipment ("Equipment"), or for the supply or sale of spare or replacement parts ("Parts"), or for the provision of services ("Services"), or for the rental of machinery or equipment ("Rental") to be provided by NOV Process & Flow Technologies US, Inc., on behalf of itself and its divisions and subsidiaries, or by its affiliates ("Seller") to its customers (each a "Buyer") (the "Order(s)") are subject to Seller's written acceptance by an authorized representative of Seller and any Orders so accepted will be governed by (a) the terms and conditions stated in these Terms and Conditions for provision of Equipment, Parts, Services or Rental (the "Terms and Conditions"); (b) the written proposal submitted by Seller to Buyer ("Proposal"), if any; (c) the written order acknowledgment issued by Seller to Buyer ("Acknowledgment"), if any; and, (d) any change orders identified as such and agreed to in writing by Seller (the Order, Terms and Conditions, Proposal, Acknowledgment, and any such change order, and any such additional terms as agreed to in writing by an authorized representative of Seller collectively referred to herein as the "Agreement"). Buyer's submission of a purchase order (or other similar document) shall be deemed to be an express acceptance of these Terms and Conditions notwithstanding language in Buyer's purchase order (or other similar document) inconsistent herewith, and any inconsistent language in Buyer's purchase order (or other similar document) is hereby rejected. Buyer's purchase order (or other similar document) is incorporated in this Agreement, only to the extent of specifying the nature and description of the Equipment, Parts, Services or Rental and then only to the extent consistent with the Proposal or Acknowledgment. In the event of any conflict between a Proposal and an Acknowledgement, the Acknowledgment shall prevail.

2. PRICES

Prices of Equipment, Parts, Services or Rental shall be as stated in the Proposal or Acknowledgment, or if there is no Proposal or Acknowledgment, as otherwise agreed to in writing by Seller. Unless otherwise specified, all prices contained in a Proposal are valid for thirty (30) days from date of issue of the Proposal. All price quotations are EXW Seller's premises (INCOTERMS 2010), or as agreed per the Proposal or Acknowledgement and are subject to change without notice. Seller bears no responsibility for any consular fees, fees for legalizing invoices, certificates of origin, stamping bills of lading, or other charges required by the laws of any country of destination, or any fines, penalties or interest imposed due to incorrect declarations. Charges will be added for factory preparation and packaging for shipment. Minimum freight and invoice charges in effect at the time of the Order shall apply. If by reason of any act of government, the cost to Seller of performing its obligations hereunder is increased, such increase shall be added to the quoted price.

3. TAXES

Transaction Taxes. In addition to the charges due under this Agreement, the Buyer shall be responsible for, and shall protect, indemnify, defend and save harmless Seller from and against the reporting, filing and payment of any taxes, duties, charges, licenses, or fees (and any related fines, penalties or interest and the like) imposed directly on Buyer as a result of this Agreement and all liabilities, costs, and associated expenses (including lawyers' and experts' fees) which may be incurred in connection therewith. Such taxes, duties, charges, licenses, or fees include but are not limited to any local, state, federal, foreign, or international sales, use, value added tax ("VAT"), goods and services tax ("GST"), rental, import, export, personal property, stamp, excise and like taxes and duties. If Seller pays any such tax, Buyer shall, within thirty (30) days of Seller's demand, reimburse Seller for the tax including interest, fines, and penalties, paid by the Seller. It shall be Buyer's sole obligation after payment to Seller to challenge the applicability of any tax.

Notwithstanding the foregoing, the Buyer shall provide Seller with a copy of all exporting documents and any other documents reasonably requested by Seller to prove or substantiate to the appropriate tax authorities the goods were timely exported.

Withholding Taxes. If Buyer is required by any appropriate government department or agency to withhold compensation due Seller to satisfy any obligation of Seller for taxes due, Buyer shall give at least 30 days' notice to Seller that Buyer will withhold. Buyer agrees to pay on a timely basis the amounts so withheld over to the appropriate government department or agency, on behalf of Seller, and to provide Seller with any tax receipts (originals, if possible) or other reliable evidence of payment issued by such government department or agency within 30 days of the date required for withholding. Buyer shall not withhold compensation due Seller if Seller produces evidence, acceptable to Buyer, that Seller is not subject to the withholding of such taxes. Buyer agrees that it shall not unreasonably withhold such acceptance. Buyer shall reimburse Seller for any taxes withheld for which receipts or other reliable evidence substantiating the remittance of taxes to the appropriate government department or agency are not provided to Seller. Buyer's obligation to deliver to Seller tax receipts or other reliable evidence issued by the taxing authority shall not apply if Buyer establishes to the reasonable satisfaction of Seller that the appropriate government department or agency does not provide such documentation. Notwithstanding the above, if Buyer is required to pay any such taxes or amounts that Buyer believes is directly attributable to Seller, Buyer shall first provide notice to Seller and give Seller an opportunity to intervene to protect its interest before Buyer makes any payment.

Protest Rights. If the Buyer receives any demand or request for payment of any levies, charges, taxes or contributions for which it would seek indemnity or reimbursement from Seller, Buyer shall promptly and timely notify the Seller in writing of such demand or request. "Promptly and timely" as used in this sub clause means that Buyer must notify Seller so that Seller has enough time and a reasonable opportunity to appeal, protest or litigate the levies, charges, taxes or contributions in an appropriate venue. To the extent that Buyer fails to give prompt and timely notice, Seller has no obligation to, and will not, reimburse Buyer for these levies, charges, taxes or contributions. At Seller's request and cost, Buyer shall initiate an appeal, protest or litigation in Buyer's own name if Buyer is the only party that can legally initiate this appeal, protest or litigation. The Buyer shall allow the Seller to control the response to such demand or request and the Buyer shall use its best efforts to appeal against such demand or request. If Buyer is required to pay any levies, charges, taxes or contributions in order to pursue an appeal, protest or litigation, Seller shall reimburse Buyer for that amount promptly upon receipt of a written request from Buyer. Seller shall not be responsible for any compromise made by Buyer without Seller's prior written consent.

Cooperation. Buyer shall cooperate with Seller, and at the request of Seller, Buyer shall use its best efforts to supply to Seller such information (including documentary information) in connection with its activities as may be required by Seller for any of the following purposes:

a) To enable Seller to comply with the lawful demand or requirement for such information by any appropriate government authority or to ensure that all requirements of the applicable law are being complied with;
b) To enable Seller to conduct, defend, negotiate or settle any claim arising out of, or in connection with, such activities, whether or not such claim shall have become the subject of arbitration or judicial proceedings;
c) To enable Seller to make any application (including, but without limitation, any claim for any allowances or relief) or representation in connection with, or to contest any assessment on, or liability of Seller to any taxes, duties, levies, charges and contributions (and any interest or penalties thereon); or
d) To secure for Seller any beneficial tax treatment and legally minimize any tax obligations in connection with this Agreement.

Seller's request for such information and documents shall allow Buyer a reasonable time to prepare, provide and submit that information requested. The obligations set forth above shall exist for a period of six (6) years commencing with the date of agreement by Buyer of Seller's final statement of account under the Agreement, and the Buyer shall retain and shall procure any subcontractor hereunder to retain, all information and documents in connection with its activities under or pursuant to the Agreement as shall enable the Buyer to comply with the above obligations.

4. PAYMENT TERMS

Unless alternate payment terms are specified and agreed to by Seller in writing, all charges, including applicable packing and transportation costs, billed by Seller are payable within net 30 days of the date of invoice. Seller reserves the right to modify or withdraw credit terms at any time without notice. Unless otherwise specified, all payments are due in the currency specified in Seller's Proposal, Acknowledgment and/or invoice. Interest shall be due from Buyer to Seller on overdue accounts at the maximum rate allowed by law. When partial shipments are made, the goods will be invoiced as shipped and each invoice will be treated as a separate account and be payable accordingly. Payment for goods is due whether or not technical documentation and/or any third party certifications are complete at the time of shipment. Seller shall be entitled to recover all reasonable attorneys' fees and other costs incurred in the collection of overdue accounts. Seller reserves the right, where a genuine doubt exists as to Buyer's financial position or if Buyer is in default of any payment obligation, to suspend delivery or performance of any Agreement or any part thereof without liability and without prejudice to, and without limitation of, any other remedy available to Seller until Buyer cures the default or satisfactory security for payment has been provided. Seller shall have the option to extend the delivery date by a time at least equal to the period of such suspension. In the event of Rental, should Buyer default in meeting any of the terms hereunder for any reason, Seller has the right to retrieve all Rentals as detailed in the Proposal and also to collect rental payments due. If Buyer elects to exercise a purchase option for Rental equipment, rental charges will be incurred and will be invoiced until the later of; (i) the end of the agreed rental period; or (ii) 30 days prior to the receipt of total purchase price and all other rental amounts due.

5. DELIVERY

Unless otherwise agreed to by Seller in writing, delivery terms shall be EXW Seller's premises (INCOTERMS 2010), except to the extent modified by these Terms and Conditions. Where goods are to be supplied from stock, such supply is subject to availability of stocks at the date of delivery. Partial shipments may be made as agreed to by Buyer and Seller. Stated delivery dates are approximate only and cannot be guaranteed. Seller shall have no liability for damages arising out of the failure to keep a projected delivery date, irrespective of the length of the delay. In the event Buyer is unable to accept delivery of goods when tendered, Seller may, at its option, arrange for storage of the goods at Buyer's sole risk and Buyer shall be liable to Seller for the reasonable cost of such storage. This provision is without prejudice to any other rights which Seller may have with respect to Buyer's failure to take delivery of goods, which includes the right to invoice Buyer for the goods. Buyer agrees that title to the stored goods will transfer to Buyer upon invoicing notwithstanding Buyer's inability to accept delivery and that Buyer assumes all risk of loss or damage to the goods from the date title passes to Buyer. Buyer is responsible for all shipping costs from Seller's premises to the location as designated by the Buyer. All shipping costs for the return of goods from the location specified by Buyer to Seller's premises shall also be for Buyer's account.

6. FORCE MAJEURE

If either party is unable by reason of Force Majeure to carry out any of its obligations under this Agreement, other than the obligations to pay money when due and indemnification obligations assumed hereunder, then on such party giving notice and particulars in writing to the other party within a reasonable time after the occurrence of the cause relied upon, such obligations shall be suspended. "Force Majeure" shall include acts of God, laws and regulations, government action, war, civil disturbances, strikes and labor problems, delays of vendors, carriers, lightening, fire, flood, washout, storm, breakage or accident to equipment or machinery, shortage of raw materials, and any other causes that are not reasonably within the control of the party so affected. Seller shall be paid its applicable standby rate, if any, during any such Force Majeure event.

7. CANCELLATION

Orders placed by Buyer and accepted by Seller may be canceled only with the consent of Seller and will subject Buyer to cancellation charges. All of Seller's documents, drawings and like information shall be returned to Seller upon Buyer's request for cancellation. No Orders may be canceled subsequent to delivery or shipment, whichever occurs earlier. As estimated actual damages, Buyer agrees to pay Seller the greater of Seller's actual costs incurred prior to cancellation plus a reasonable profit, or the following minimum cancellation charges:

a) 20% of Agreement value if canceled 30 or more days prior to the original delivery/shipment date;
b) 50% of the Agreement value if canceled thereafter; or
c) 100% of the value of any non-standard items (which are items not built for stock or built to customer specifications).

In the event of Rental, minimum rental charges as stated in the Proposal will apply. Buyer shall verify the amount of the cancellation charges prior to canceling an order.

NOV Process & Flow Technologies US, Inc. AND ITS AFFILIATES
TERMS AND CONDITIONS FOR THE PROVISION OF EQUIPMENT, PARTS, SERVICES OR RENTAL
PAGE 2 OF 3

8. TITLE AND RISK OF LOSS
For purchased goods, ownership and risk of loss pass to Buyer upon the earlier of (a) Seller's delivery of the goods, or (b) invoicing by Seller for the goods where Buyer is unable to accept delivery on the scheduled date. Seller retains a security interest in the goods until the purchase price has been paid, and Buyer agrees to perform upon request all acts required to secure Seller's interest. Seller accepts no responsibility for any damage, shortage or loss in transit. Seller will attempt to pack or prepare all shipments so that they will not break, rust or deteriorate in shipment, but Seller does not guarantee against such damage. Claims for any damage, shortage or loss in transit must be made by Buyer on the carrier.

In the event of Rental, Buyer assumes all risk and liability whether or not covered by insurance, for loss or damage to the Rental machinery or equipment. Risk and liability passes to Buyer upon delivery by Seller. Title to Rental machinery or equipment shall remain with Seller at all times. Buyer acquires no ownership, title or property rights to the Rental machinery or equipment except the right to use the Rental machinery or equipment subject to the terms of this Agreement.

9. LIMITED WARRANTY
New Equipment/Parts. In the case of the purchase of new Equipment/Parts, and solely for the benefit of the original user, Seller warrants, for a period of eighteen (18) months from delivery or twelve (12) months from installation, whichever is earlier, that new Equipment/Parts of its own manufacture shall conform to the material and technical specifications set forth in the Agreement. Goods manufactured by others are sold "as is" except to the extent the manufacturer honors any applicable warranty made by the manufacturer. Secondhand goods are sold "as is". If the new Equipment/Parts fail to conform with such specifications upon inspection by Seller, Seller will, at its option and as Buyer's sole remedy, either repair or replace such defective Equipment/Parts with the type originally furnished.

Remanufactured to "As New" Equipment/Parts. Seller warrants to Buyer, that for a period of six (6) months from the date of delivery by Seller or installation of the Equipment/Parts, whichever is earlier, that reconditioned to "as new" Equipment/Parts will be free from defects in material and workmanship. If the reconditioned to "as new" Equipment/Parts fail to conform with such warranty upon inspection by Seller, Seller will, at its option and as Buyer's sole remedy, either repair or replace such defective Equipment/Parts with the type originally furnished.

Overhauled Equipment/Parts. Seller warrants that for a period of four (4) months from the date of delivery by Seller or three (3) months from installation, whichever is earlier, that overhauled Equipment/Parts will be free from defects in workmanship. If the overhauled Equipment/Parts fail to conform with such warranty upon inspection by Seller, Seller will, at its option and as Buyer's sole remedy, either repair or replace such defective Equipment/Parts with the type originally furnished. This warranty expressly assumes that parts normally considered consumables (including, but not limited to rubber goods, seals (rubber, polymer and/or metallic) and/or bearings, are replaced during overhaul. If Buyer requests that such parts not be replaced, Seller hereby disclaims any warranty for said overhauled Equipment/Parts.

Service. Seller warrants that the Services to be provided pursuant to this Agreement shall conform to the material aspects of the specifications set forth in the Agreement. Seller shall re-perform that part of the non-conforming Services, provided Seller is notified by Buyer prior to Seller's departure from the worksite.

Rental. Seller warrants that the Rental equipment to be provided pursuant to this Agreement shall conform to the material aspects of the specifications set forth in the Agreement. Provided Seller is notified by Buyer prior to Seller's departure from the worksite, Seller shall repair or replace non-conforming Rental equipment. In the event of failure or other non-performance of Seller's Rental equipment's contributing to loss of hole, rental rates will apply during re-drill to equivalent TD.

Seller's warranty obligations hereunder shall not apply if non-conformity or failure was caused by (a) Buyer's failure to properly store or maintain the equipment or parts; (b) the unauthorized modification, repair or service of the equipment or parts by Buyer; (c) utilization of replacement parts not manufactured by Seller; or (d) use or handling of the equipment by Buyer in a manner inconsistent with Seller's recommendations. Further, Seller's warranty obligations under this Article 9 shall terminate if (a) Buyer fails to perform its obligations under this or any other Agreement between the parties, or (b) if Buyer fails to pay any charges due Seller. Any third party warranties provided on equipment or parts not manufactured by Seller are assigned to Buyer, without recourse, at the time of delivery, provided such warranties are assignable.

THIS ARTICLE 9 SETS FORTH BUYER'S SOLE REMEDY AND SELLER'S EXCLUSIVE OBLIGATION WITH REGARD TO NON-CONFORMING EQUIPMENT, PARTS, SERVICES OR RENTAL. EXCEPT AS OTHERWISE EXPRESSLY PROVIDED PURSUANT TO THE PROVISIONS OF THIS ARTICLE 9, SELLER MAKES NO OTHER WARRANTIES OR REPRESENTATIONS OF ANY KIND, EXPRESS OR IMPLIED, AND SELLER DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTIBILITY AND FITNESS FOR A PARTICULAR PURPOSE.

10. CHANGES
Seller expressly reserves the right to change, discontinue or modify the design and manufacture of its products without obligation to furnish, retrofit or install products previously or subsequently sold.

11. RETURN OF MAKE TO STOCK GOODS
With Seller's written approval, unused, incorrectly shipped or "Made to Stock" goods ordered incorrectly, in new condition and of current manufacture and catalog specifications may be returned by Buyer for credit (subject to a restocking fee), provided written request is received within one (1) year after the purchase date. Non-standard goods are not returnable for credit and such goods shall only be accepted for return with the prior written agreement of Seller. Requests for return of goods must show the original purchase order number, invoice number, description of material, and date of purchase. Return of goods does not relieve Buyer of the obligation to make payment against Seller's invoice, and any credit or refund allowed will be issued following Seller's receipt of the goods. The credit allowed on returned goods, if any, is a merchandise credit and is applicable only against future purchases of Seller goods. The credit given will be solely in Seller's discretion and may be based on the original or a subsequently adjusted price. A charge will be assessed to clean-up, refinish and restock the goods, if applicable. No rubber or electronic products or components may be returned for credit after six (6) months from date of purchase.

12. LIABILITIES, RELEASES AND INDEMNIFICATION
For purpose of this Article12, the following definitions shall apply:
"Seller Group" shall mean (i) Seller, its parent, subsidiary or related companies, (ii) its and their working interest owners, co-lessees, co-owners, partners, joint venturers, if any, and their respective parents, subsidiary or related companies and (iii) the officers, directors, employees, consultants, agents and invitees of all of the foregoing.

"Buyer Group" shall mean (i) Buyer, its parent, subsidiary or related companies, (ii) its and their working interest owners, co-lessees, co-owners, partners, joint venturers, if any, and their respective parents, subsidiary or related companies and (iii) the officers, directors, employees, consultants, agents and invitees of all of the foregoing.

"Claims" shall mean all claims, demands, causes of action, liabilities, damages, judgments, fines, penalties, awards, losses, costs, expenses (including, without limitation, attorneys' fees and costs of litigation) of any kind or character arising out of, or related to, the performance of or subject matter of this Agreement (including, without limitation, property loss or damage, personal or bodily injury, sickness, disease or death, loss of services and/or wages, or loss of consortium or society).

a) Seller shall release, indemnify, defend and hold Buyer Group harmless from and against any and all Claims in respect of personal or bodily injury to, sickness, disease or death of any member of Seller Group or Seller Group's subcontractors or their employees, agents or invitees, and all Claims in respect of damage to or loss or destruction of property owned, leased, rented or hired by any member of Seller Group or Seller Group's subcontractors or their employees, agents or invitees.
b) Buyer shall release, indemnify, defend and hold Seller Group harmless from and against any and all Claims in respect of personal or bodily injury to, sickness, disease or death of any member of Buyer Group or Buyer Group's other contractors or their employees, agents or invitees, and all Claims in respect of damage to or loss or destruction of property owned, leased, rented or hired by any member of Buyer Group or Buyer Group's other contractors or their employees, agents or invitees.
c) Each party covenants and agrees to support the mutual indemnity obligations contained in Paragraphs (a) and (b) above, by carrying equal amounts of insurance (or qualified self insurance) in an amount not less than U.S. ,000,000.00.
d) Notwithstanding anything contained in this Agreement to the contrary, in all instances where Seller is providing Services at a well site, Buyer, to the maximum extent permitted under applicable law, shall release, indemnify, defend and hold Seller Group and Seller Group subcontractors harmless from and against any and all Claims asserted by or in favor of any person or party, including Seller Group, Buyer Group or any other person or party, resulting from: (i) loss of or damage to any well or hole (including but not limited to the costs of re-drill), (ii) blowout, fire, explosion, cratering or any uncontrolled well condition (including but not limited to the costs to control a wild well and the removal of debris), (iii) damage to any reservoir, geological formation or underground strata or the loss of oil, water or gas therefrom, (iv) pollution or contamination of any kind (other than surface spillage of fuels, lubricants, rig sewage or garbage, to the extent attributable to the negligence of Seller Group, including but not limited to the cost of control, removal and clean-up, or (v) damage to, or escape of any substance from, any pipeline, vessel or storage facility.
e) NOTWITHSTANDING ANYTHING CONTAINED IN THIS AGREEMENT TO THE CONTRARY, NEITHER PARTY SHALL BE LIABLE TO THE OTHER AND EACH PARTY RELEASES THE OTHER FOR ANY INDIRECT, SPECIAL, PUNITIVE, EXEMPLARY OR CONSEQUENTIAL DAMAGES OR LOSSES (WHETHER FORESEEABLE AT THE DATE OF THIS AGREEMENT, INCLUDING WITHOUT LIMITATION, DAMAGES FOR LOST PRODUCTION, LOST REVENUE, LOST PRODUCT, LOST PROFIT, LOST BUSINESS OR BUSINESS OPPORTUNITIES.
f) Seller's total liability for all claims, damages, causes of action, demands, judgments, fines, penalties, awards, losses, costs and expenses (including attorney's fees and cost of litigation) shall be limited to and shall not exceed the value of the Equipment, Parts, Services or Rental purchased under the Agreement.
g) THE EXCLUSIONS OF LIABILITY, RELEASES AND INDEMNITIES SET FORTH IN PARAGRAPHS A. THROUGH F. OF THIS ARTICLE 12 SHALL APPLY TO ANY CLAIM(S), LOSSES OR DAMAGES WITHOUT REGARD TO THE CAUSE(S) THEREOF, INCLUDING BUT NOT LIMITED TO PRE-EXISTING CONDITIONS, WHETHER SUCH CONDITIONS BE PATENT OR LATENT, THE UNSEAWORTHINESS OF ANY VESSEL OR VESSELS, IMPERFECTION OF MATERIAL, DEFECT OR FAILURE OF PRODUCTS OR EQUIPMENT, BREACH OF REPRESENTATION OR WARRANTY (EXPRESS OR IMPLIED), ULTRAHAZARDOUS ACTIVITY, STRICT LIABILITY, TORT BREACH OF CONTRACT, BREACH OF DUTY (STATUTORY OR OTHERWISE), BREACH OF ANY SAFETY REQUIREMENT OR REGULATION, OR THE NEGLIGENCE OR OTHER LEGAL FAULT OR RESPONSIBILITY OF ANY PERSON (INCLUDING THE INDEMNIFIED OR RELEASED PARTY), WHETHER SUCH NEGLIGENCE BE SOLE, JOINT OR CONCURRENT, ACTIVE OR PASSIVE.
h) Redress under the indemnity provisions set forth in this Article 12 shall be the exclusive remedy(ies) available to the parties hereto for the matters, claims, damages and losses covered by such provisions.

NOV Process & Flow Technologies US, Inc.AND ITS AFFILIATES
TERMS AND CONDITIONS FOR THE PROVISION OF EQUIPMENT, PARTS, SERVICES OR RENTAL

PAGE 3 OF 3

13. INSURANCE

Upon written request, each party shall furnish to the other party certificates of insurance evidencing the fact that the adequate insurance to support each party's obligations hereunder has been secured. To the extent of each party's release and indemnity obligations expressly assumed by each party hereunder, each party agrees that all such insurance policies shall, (a) be primary to the other party's insurance; (b) include the other party, its parent, subsidiary and affiliated or related companies, and its and their respective officers, directors, employees, consultants and agents as additional insured; and, (c) be endorsed to waive subrogation against the other party, its parent, subsidiary and affiliated or related companies, and its and their respective officers, directors, employees, consultants and agents.

14. GOVERNING LAW

Except for Equipment, Parts, Services or Rental provided, or to be provided, by Seller in North or South America (the "America's"), this Agreement shall be governed by and interpreted in accordance with the laws of England and Wales, excluding conflicts and choice of law principles. All disputes arising out of or in connection with this Agreement shall be finally settled under the Rules of Arbitration of the International Chamber of Commerce by one or more arbitrators appointed in accordance with said rules. Arbitration shall be held in London, England and shall be conducted in the English language.

For Equipment, Parts, Services or Rental provided, or to be provided, by Seller in the America's, this Agreement shall be governed by and interpreted in accordance with the substantive laws of the State of Texas, excluding conflicts and choice of law principles. Any dispute, action or proceeding arising out of or relating to this Agreement must be brought in a state or federal court sitting in Harris County, Texas, and each of the parties hereby agrees to irrevocably submit itself to the exclusive jurisdiction of each such court in any such action or proceeding and waives any objection it may now or hereafter have to venue or convenience of forum.

Seller retains the right to arbitrate any all disputes that may arise in connection with the provision of the Equipment, Parts, Services or Rental.

15. OWNERSHIP AND PATENT INDEMNITY

All software used in connection with the Equipment, Parts, Services or Rental, either purchased or rented from Seller, is copyrighted and owned by Seller and licensed to Buyer. Seller warrants that the use or sale of Equipment or Parts hereunder will not infringe patents of others by reason of the use or sale of such Equipment or Parts per se, and hereby agrees to hold Buyer harmless against judgment for damages for infringement of any such patent, provided that Buyer shall promptly notify Seller in writing upon receipt of any claim for infringement, or upon the filing of any such suit for infringement, whichever first occurs, and shall afford Seller full opportunity, at Seller's option and expense, to answer such claim or threat of suit, assume the control of the defense of such suit, and settle or compromise same in any way Seller sees fit. Seller does not warrant that such Equipment or Parts: (a) will not infringe any such patent when not of Seller's manufacture, or specially made, in whole or in part, to the Buyer's design specifications; or (b) if used or sold in combination with other materials or apparatus or used in the practice of processes, will not, as a result of such combination or use, infringe any such patent, and Seller shall not be liable and does not indemnify Buyer for damages or losses of any nature whatsoever resulting from actual or alleged patent infringement arising pursuant to (a) and (b) above. **THIS ARTICLE STATES THE ENTIRE RESPONSIBILITY OF SELLER CONCERNING PATENT INFRINGEMENT.**

16. REGULATORY COMPLIANCE

By acceptance of delivery under this Agreement, Buyer warrants it has complied with all applicable governmental, statutory and regulatory requirements and will furnish Seller with such documents as may be required. Seller warrants and certifies that in the performance of this Agreement, it will comply with all applicable statutes, rules, regulations and orders in effect at the time of Agreement execution, including laws and regulations pertaining to labor, wages, hours and other conditions of employment, and applicable price ceilings if any. Seller will not provide any certification or other documentation nor agree to any contract provision or otherwise act in any manner which may cause Seller to be in violation of applicable United States law, including but not limited to the Export Administration Act of 1979 and regulations issued pursuant thereto. **No provision in this Agreement shall be interpreted or applied which would require any party to do or refrain from doing any act which would constitute a violation of, or result in a loss of economic benefit under, any anti-boycott including but not limited to any such law of the United States.** All Orders shall be conditional upon granting of export licenses or import permits which may be required. Buyer shall obtain at its own risk any required export license and import permits and Buyer shall remain liable to accept and pay for material if licenses are not granted or are revoked.

17. CONFIDENTIAL INFORMATION

Each party recognizes and acknowledges that it shall maintain all data, information, disclosures, documents, drawings, specifications, patterns, calculations, technical information and other documents (collectively, "Confidential Information") obtained from the other party in strict confidence. However, nothing hereinabove contained shall deprive the party receiving the Confidential Information of the right to use or disclose any information: (a) which is, at the time of disclosure, known to the trade or public; (b) which becomes at a later date known to the trade or the public through no fault of the party receiving the Confidential Information and then only after said later date; (c) which is possessed by the party receiving the Confidential Information, as evidenced by such party's written records, before receipt thereof from the party disclosing the Confidential Information; (d) which is disclosed to the party receiving the Confidential Information in good faith by a third party who has an independent right to such information; (e) which is developed by the party receiving the Confidential Information as evidenced by documentation, independently of the Confidential Information; or, (f) which is required to be disclosed by the party receiving the Confidential Information pursuant to an order of a court of competent jurisdiction or other governmental agency having the power to order such disclosure, provided that the party receiving the Confidential Information uses its best efforts to provide timely notice to the party disclosing the Confidential Information of such order to permit such party an opportunity to contest such order. In the event that Seller owns copyrights to, patents to or has filed patent applications on, any technology related to the Equipment, Parts, Services or Rental furnished by Seller hereunder, and if Seller makes any improvements on such technology, then Seller shall own all such improvements, including drawings, specifications, patterns, calculations, technical information and other documents.

18. INDEPENDENT CONTRACTOR

It is expressly understood that Seller is an independent contractor, and that neither Seller nor its principle, partners, employees or subcontractors are servants, agents or employees of Buyer. In all cases where Seller's employees (defined to include Seller's and its subcontractors, direct, borrowed, special, or statutory employees) are covered by the Louisiana Worker's Compensation Act. La. R.S. 23:102 et seg., Seller and Buyer agreed that all Equipment, Parts, Services or Rental provided by Seller and Seller's employees pursuant to this Agreement are an integral part of and are essential to the ability of Buyer to generate Buyer's goods, products, and services for the purpose of La. R.S. 23:106(A) (1). Furthermore, Seller and Buyer agree that Buyer is the statutory employer of all of Seller's employees for the purpose of La. R.S. 23:1061(A) (3).

19. ADDITIONAL RENTAL TERMS AND CONDITIONS

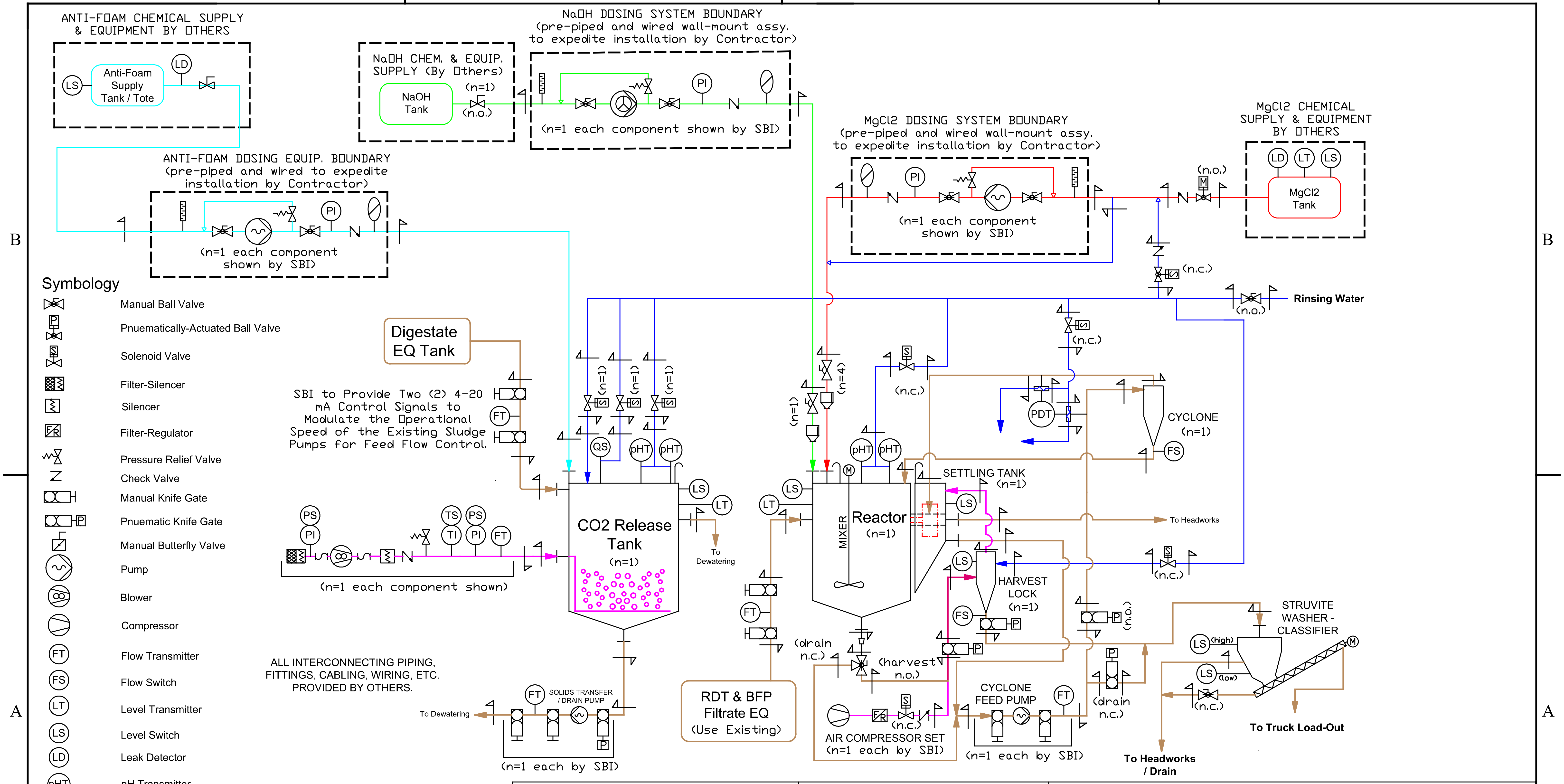
Unless otherwise indicated, the rental rates contained in Seller's Proposal are on a per day basis and such rates shall apply to each piece of equipment or part rented. Seller represents that it has fully inspected the Rental equipment and parts as detailed in the Agreement and that said equipment and parts are in good condition and repair, and are fully acceptable for use as specified in the Agreement. Furthermore, Seller represents that the Rental equipment and parts are not subject to any encumbrances or liens, and that Seller has full title to the equipment and parts, and thus, Seller is authorized to enter into and execute this Agreement.

Buyer represents that it shall use the Rental equipment and parts in a careful and proper manner and shall comply with all laws, ordinances and regulations relating to the possession, use and maintenance of the equipment and parts in accordance with Seller's approved procedures. In the event the parties agree that the Buyer shall operate the Rental equipment and parts, Buyer further represents that the Rental equipment and parts will be operated by skilled employees trained in the use of the Rental equipment and parts. Buyer shall keep the Rental equipment and parts free and clear of all liens and encumbrances arising in connection with Buyer's operations and/or use of the Rental equipment and parts. Buyer, at its sole cost, shall provide and maintain insurance against the loss, theft, damage or destruction of the Rental equipment and parts. The coverage shall be in an amount not less than the new replacement price of the Rental equipment and parts. NOV shall provide equipment and parts prices at execution of this Agreement.

At the expiration of the applicable rental term, Buyer will at its sole cost return the Rental equipment to the facility designated by Seller, in working condition (reasonable wear and tear excepted). Upon receipt of the returned Rental equipment, Seller will service and inspect the Rental equipment. In the event Seller determines that the Rental equipment is materially damaged or not in working condition (reasonable wear and tear excepted), any service work required to bring the Rental equipment to good working condition will be charged back to the Buyer. Such charges may include service, inspection, and spare parts.

20. GENERAL

Failure of Buyer or Seller to enforce any of the terms and conditions of this Agreement shall not prevent a subsequent enforcement of such terms and conditions or be deemed a waiver of any subsequent breach. Should any provisions of this Agreement, or portion thereof, be unenforceable or in conflict with applicable governing country, state, province, or local laws, then the validity of the remaining provisions, and portions thereof, shall not be affected by such unenforceability or conflict, and this Agreement shall be construed as if such provision supersedes all prior oral or written agreements or representations. Buyer acknowledges that it hast not relied on any representations other than those contained in this Agreement. This Agreement shall not be varied, supplemented, qualified, or interpreted by any prior course of dealing between the parties or by any usage of trade and may only be amended by an agreement executed by an authorized representative of each party.



Pressure Transmitter Flushing Ring

DIMENSIONS OF NEW AND EXISTING STRUCTURES:

WHERE THE DIMENSIONS OF NEW AND EXISTING STRUCTURES ARE OF IMPORTANCE IN THE INSTALLATION OR CONNECTION OF ANY EQUIPMENT SUPPLIED BY SCHWING BIOSET, THE CONTRACTOR MUST VERIFY SUCH DIMENSIONS AND NOTIFY SCHWING BIOSET OF ANY REQUIRED CHANGES TO ITS SUBMITTAL DRAWINGS PRIOR TO THE FABRICATION OF ANY MATERIAL OR EQUIPMENT WHICH IS DEPENDENT UPON THE CORRECTNESS OF SUCH INFORMATION.

PROPRIETARY INFORMATION:

THE DATA AND INFORMATION CONTAINED IN THIS DOCUMENT IS CONSIDERED PROPRIETARY AND SHALL NOT BE REPRODUCED, RELEASED OR DISCLOSED, IN WHOLE OR PART, WITHOUT PRIOR WRITTEN CONSENT OF SCHWING BIOSET INC. OF SOMERSET WI.

SCHWING BIOSET

SCHWING BIOSET INC.
350 SMC DRIVE
SOMERSET, WI 54025

HYBRID MODE PID-PFD
Approx. 85% Struvite Harvest

DRAWN BY JAS	NEW RELEASE	SIZE B	DRAWING NUMBER	REV.
CHECKED BY CW	DATE 12/7/2022	SHEET NUMBER 1 OF 1	2022413	1
APPROVED BY	SCALE PLOTTED NTS			

Carollo Engineers, Inc. – CWSID, UT
Quotation No.: 2022413
December 7, 2022

Proposal

Prepared for:

Jade Echard

Carollo Engineers, Inc.

Project:

Hybrid Mode Phosphorus Removal

With Struvite Harvest

Engineered to Excel

SCHWING BIOSET

350 SMC DRIVE
SOMERSET, WI 54025
PH: (715) 247-3433
FAX: (715) 247-3438
www.schwingbioset.com

A message from our President/CEO:

Thank you for your inquiry. We are honored you have chosen to discuss how a Schwing Bioset solution can solve your specific challenges. We feel you will soon discover our contributions will provide recognizable value, and our solution will provide the long-term peace of mind only felt when quality products have been selected. Along each step of the way, we are sure your confidence will build that you have made the right choice in selecting Schwing Bioset to assist with the development, design, and execution of your project.

Schwing Bioset has been solving the challenges faced by Wastewater Treatment Plants and Biosolids Management professionals for over thirty years from our simple beginnings as a piston pump supplier. Now in our fourth decade, we offer a wide range of products with best-in-class performance and reliability that we feel is unmatched by anyone in our industry.

Additionally, Schwing Bioset offers best-in-class aftermarket service and spare parts to support our ever expanding customer base. After all, without the support of quality trained service technicians and rapid spare parts delivery, the best technology in the world can’t do its job if you can’t turn it on.

But we aren’t stopping here. Schwing Bioset continues to invest in Research & Development to continually improve our current products and to develop and identify new technology that will help sustain our Cities for the next generations to come. Reducing power demands, recovering nutrients, increased efficiency, and creating value-added products from biosolids are just a few of the many ways we are evolving from our beginnings in this business as a pump supplier.

And speaking of our business, it is guided by the Core Values shared on the following page. These values act as a beacon to guide us into the future as we grow, keeping us in line with our original goals. Also included is your list of primary contacts into our company. As you communicate your challenges and work towards a solution with us, know that each of these individuals, along with everyone else in our Company, was hired with these Core Values as a benchmark. This team of experts, collectively known as Schwing Bioset, will be working diligently to make your project a success.

Continually looking to the future, we believe the solution offered in this proposal will prove to be your most cost effective and sustainable option to implement within your project. We look forward to your favorable review and to welcoming you to the hundreds of other Wastewater Plants who already enjoy the benefits of a Schwing Bioset solution. We are *Engineered to Excel.*

Sincerely,
Thomas Anderson
President/CEO

Core Values:

- Caring: Every employee has pride of ownership in their work with a genuine interest in our Client's success. We offer a workplace that allows a healthy balance between work and home life to inspire exceptional performance.
- Decent People: We are true professionals who respect the people we work with, both inside and outside of the company, and earn the respect of others.
- Dedicated Experts: We are comprised of the top talent in our respective fields, recruited and trained for the singular goal of contributing to the success of our Clients and our Company.
- Solutions Above and Beyond: We develop, provide, and support customer solutions that surpass our Client's expectations.
- Absolute Customer Satisfaction: We sleep well knowing our customers are happy.

Your Schwing Bioset, Inc. Contacts:

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ewanstrom@schwingbioset.com

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Outside US & Canada
Chuck Wanstrom
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cwanstrom@schwingbioset.com

Service
Jim Dickerman
715-500-1912
jdickerman@schwingbioset.com

Spare Parts
Brad Dopp
715-350-6912
bdopp@schwingbioset.com

Capabilities:

(Ctrl-Click the images below to link to web page)

PISTON PUMPS

MORE WASTEWATER PLANTS HAVE RELIED ON THE DURABILITY OF OUR PISTON PUMPS THAN ALL OTHER MANUFACTURERS COMBINED

SCREW PRESSES

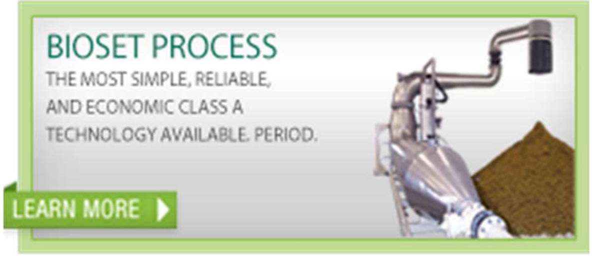
OFFERING THE BEST DEWATERING PERFORMANCE IN THE MOST COMPACT FOOTPRINT WITH THE WIDEST RANGE OF MODEL SIZES AVAILABLE

STRUVITE RECOVERY

MOST VERSITLE PHOSPHORUS RECOVERY TECHNOLOGY AVAILABLE THAT CAN BE APPLIED ON DIGESTATE, CENTRATE, OR A COMBINATION OF BOTH

SCREW CONVEYORS

DESIGNED FOR USE IN DEMANDING APPLICATIONS AND TO MOVE A WIDE RANGE OF MATERIALS



BIOSET PROCESS

THE MOST SIMPLE, RELIABLE, AND ECONOMIC CLASS A TECHNOLOGY AVAILABLE. PERIOD.

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VERSATILITY IN DESIGN AND SAFETY UNMATCHED BY OTHER DRYING TECHNOLOGIES TO PRODUCE CLASS A GRANULES

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LIVE BOTTOM HOPPERS

MULTI-SCREW LIVE BOTTOM HOPPER SYSTEMS COMPLETE WITH SINGLE OR VARIABLE SPEED DRIVES

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350 SMC DRIVE
SOMERSET, WI 54025
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FAX: (715) 247-3438
www.schwingbioset.com

December 7, 2022

Jade Echard
Carollo Engineers, Inc.
7090 South Union Park Avenue, Suite 600
Midvale, UT 84047

Attention: Ms. Echard
Phone: 801-233-2527
Mobile: 435-671-2687
Email: jechard@carollo.com

Subject: NuReSys Process – Phosphorus Removal System
Hybrid Mode Operation with Struvite Harvest

Schwing Bioset, Inc. Budgetary Quotation No. 2022413

Dear Ms. Echard,

We thank you for the opportunity to provide you with this proposal for your Phosphorus Recovery project. Schwing Bioset Inc. (SBI) is pleased to provide the following budgetary proposal, subject to the following General Comments, which form an integral part of this offer.

GENERAL COMMENTS:

1. This proposal is configured in our Hybrid operating mode, with the CO_2 Release Tank (CO2RT) receiving digestate and the Crystallization Reactor receiving filtrate from Rotary Drum Thickener (RDT) and Belt Filter Press (BFP) operations (WITH 100 GPM BFP wash water). The CO2RT is aerated to adjust / optimize the pH of the digestate material to a range more conducive for Struvite crystallization (approx. 7.6-7.8), with the formed crystals from the CO2RT typically captured with the wet cake in dewatering operations. $MgCl_2$ is dosed to the Reactor to maintain a Mg^{2+} concentration that efficiently promotes Struvite ($MgNH_4PO_4 *6H_2O$) crystallization within the Reactor. The Reactor is equipped with a mixer to maintain well-mixed conditions within the tank for the filtrate and $MgCl_2$ feed streams and to promote efficient reaction conditions.
2. As we do not have pH data or titration information for the individual and / or combined Reactor filtrate stream(s), per our experience, this will likely require the addition of NaOH at the Reactor for

pH adjustment. As such, we have added a small NaOH dosing pump set in our scope of supply for final pH adjustments in the Reactor, as necessary

3. Please see attachment "SBI Proposal 2022413 Schematic PFD-P&ID - HYBRID" for details on the presently offered Phosphorus Removal system.

NURESYS NUTRIENT RECOVERY SYSTEM SUMMARY

NUTRIENT PROCESSING SUMMARY

Process Medium:	• Anaerobic Digestate to the CO2RT • RDT, BFP & Wash Water to the Crystallization Reactor	
Feed Rate:	Digestate to CO2RT: Maximum 0.1698 MGD / 117.9 GPM RDT, BFP & Wash Water to Reactor: Maximum 0.6621 MGD / 459.8 GPM	
Average Feed Temperature:	75-95 deg F Assumed for Digestate Feed 68-75 deg F Assumed for the Combined Filtrate Feed	
Operating Conditions:	24 hr/day, 7 days/week	
Solids Concentration (wt%):	~ 2.5 wt% TSS per supplied data	
Parameter	NuReSys Feed	NuReSys Effluent
PO_4-P Concentration (mg/L):	758 to the CO2RT 214 to the Reactor	~ 742 15-20 mg/L[1]
PO_4-P Conversion / Reduction Rate (%):	~97-98%	
NH_4-N (mg/L):	TBD	TBD
pH:	TBD for Digestate and Filtrate Streams	~ 7.6-7.8
Struvite Mass Balance (lb/day):	Estimated REACTOR Struvite Production Rate (based on above-estimated PO_4-P to hexahydrate Struvite conversion rate and without superficial moisture): 8,503 to 8,722 lb/day Estimated Struvite Recovery / Harvest Rate (without superficial moisture): 7,228 to 7,414 lb/day (based on an 85% Struvite harvest rate)	

<table>
<tr><td></td><td>Estimated Struvite Recovery / Harvest Rate (with approx. 10 wt% superficial moisture from Grits Washer to Truck Loading):
8,031 to 8,238 lb/day</td></tr>
<tr><td>Electrical Power Estimate:
Normal Operating BHP [kW]:
Installed HP [kW]:</td><td>
41.3 to 50.3 [30.8 to 37.5]
93.5 [69.7]</td></tr>
<tr><td>$MgCl_2$ Dosage Rate Expected Range[2]:
Liters Per Day (LPD) and Gallons Per Day (GPD) per Various Molar Dosing Rates (MDR)</td><td><table>
<tr><td>Reactor Feed GPM</td><td>459.8</td><td>459.8</td><td>459.8</td><td>459.8</td></tr>
<tr><td>MDR</td><td>1.0</td><td>1.13</td><td>1.27</td><td>1.4</td></tr>
<tr><td>LPD</td><td>4,144</td><td>4,696</td><td>5,249</td><td>5,801</td></tr>
<tr><td>GPD</td><td>1,095</td><td>1,241</td><td>1,387</td><td>1,533</td></tr>
</table></td></tr>
<tr><td>NaOH Dosage Rate Expected Range[3]:
Liters Per Day (LPD) and Gallons Per Day (GPD) per Various pH Increase</td><td><table>
<tr><td>Reactor Feed GPM</td><td>459.8</td><td>459.8</td><td>459.8</td><td>459.8</td></tr>
<tr><td>pH Increase</td><td>0.5</td><td>0.75</td><td>1.00</td><td>1.25</td></tr>
<tr><td>LPD</td><td>622</td><td>933</td><td>1,244</td><td>1,556</td></tr>
<tr><td>GPD</td><td>164</td><td>246</td><td>329</td><td>411</td></tr>
</table></td></tr>
</table>

[1] Residual concentration may be lower depending on reagent dosage rate, pH, and retention time.

[2] Calculations are based on a 30 wt% $MgCl_2$ Solution at 20 deg C.

[3] Calculations are based on a 50 wt% NaOH solution at a 1.512 SG.

NURESYS SYSTEM EQUIPMENT SUMMARY

A. CO2 Release Tank -_ Aerated tank that receives the feed material and adjusts the pH of the material to optimize Struvite formation in the Crystallization Reactor.
B. Crystallization Reactor - Continuously-mixed Reactor tank provides environment for Struvite crystal formation and growth.
C. Chemical Dosing System - Provides metered dosing of Magnesium Chloride ($MgCl_2$) and NaOH at the Reactor and Antifoam solution at the CO2RT.
D. Struvite Harvesting System - Recovers a portion of the formed Struvite.
E. Process Controls - PLC-based control logic for process automation and networking.

A. CO2 RELEASE TANK

Quantity:	**One (1) Unit**
Material of Construction:	304 stainless steel, with upper four (4) feet strake, roof and internals in 316 SS
Vessel Volume:	21,150 Gallons (80.1 m^3) NET liquid volume 23,688 Gallons (89.7 m^3) GROSS volume

	(includes headspace)
Vessel Height X Diameter:	12’ Ø x 25.67’ tall (overall vessel height, not including top-side safety railing or clearance below vessel to grade)
Aeration Blower:	
Normal Operating kW:	11.74 to 15.08 [8.76 to 11.24]
Installed kW:	25.0 [18.6]
CO_2 Release Tank Underflow Pump[1]	
Normal Operating BHP [kW]:	0.26 [0.20]
Installed HP [kW]:	3.0 [2.24]

[1] Active approx. 4 hr. / day for solids transfer operations from CO_2 Release Tank to dewatering. Normal BHP [kW] adjusted over a 24-hr period (example: BHP, adjusted = BHP, normal * (4/24)).

<u>Scope includes:</u>

1. One (1) CO_2 Release Tank for trimming pH of process stream with ancillary instruments and equipment shipped separately for field erection.
2. One (1) factory-installed air manifold with coarse diffuser nozzles provided near the bottom of the tank for air dispersion.
3. One (1) rotary lobe, positive displacement, variable speed blower to provide compressed ambient air to the CO_2 Release tank. Blower includes sound attenuation enclosure, air inlet filter, pressure relief valve, temperature & pressure instruments, variable frequency drive (VFD) and controls.
4. One (1) rotary lobe pump to intermittently transfer settled solids from the CO_2 Release Tank to the Reactor and from the Reactor to dewatering operations. Pump is provided with manual inlet / discharge isolation valves, inlet / discharge flexible connectors, discharge check valve and a discharge pressure indicator with gauge isolation.
5. One (1) pneumatically actuated knife gate is included to automate intermittent solids transfer operations for the above-noted solids transfer pump (knife gate acts as pump’s inlet isolation valve).
6. Two (2) pH probes are provided for monitoring sludge pH in the CO2RT and adjusting the aeration rate to the tank. One (1) 4-channel pH transmitter will be provided for the CO2RT that will support both the CO2RT and Reactor pH probes.
7. One (1) 120 V, normally closed, energize-to-open solenoid valve is provided for intermittent, automated pH probe rinsing.
8. One (1) magnetic flowmeter to monitor the influent material flow. Flow meter is provided with two (2) manual isolation valves.
9. One (1) magnetic flowmeter to monitor flow during solids transfer operations from the CO2RT to the Reactor and from the Reactor to dewatering operations. Flow meter is provided with isolation valve(s) as needed.
10. One (1) tank level transmitter and one (1) level switch are provided for monitoring digestate level in the tank.
11. One (1) tank foam switch is provided to provide a foam signal to the control system and initiate anti foam automated actions.
12. One (1) 120 V, normally closed, energize-to-open solenoid valve is provided for intermittent,

automated foam switch probe rinsing.

13. CO2RT is provided with three (3) internal water spray nozzles for foam control. One (1) 120 V (or per local supply), normally closed, energize-to-open solenoid valve is provided for each foam control spray nozzle - three (3) foam control water solenoid valves & spray assemblies total. Should the foam condition persist for a pre-determined duration, the anti-foam chemical dosing system will automatically be activated to provide additional foam control / relief. See following Chemical Dosing Equipment section for further details in this regard.
14. CO2RT for each case is supplied with support steel to elevate the unit to achieve approx. 4 ft clearance under the unit to grade. Support steel is provided in painted steel materials or 304 SS, whichever is more economical at the time the order is placed or per customer preference.
15. Top-side access to the CO_2 Release Tank is via the SBI-provided ladder for the vessel. Ladder is per OSHA requirements.
16. CO_2 Release Tank to be provided with top-side safety railing, toe-boards, etc. per OSHA requirements.
17. One (1) overflow connection to the dewatering operations.
18. SBI will provide one (1) set of external feed pipe supports from four (4) ft above grade to the feed piping's termination point on the vessel's exterior (external piping to be supplied and installed by others). SBI will also provide one (1) set of vertically oriented, minimum twelve (12) inch-wide, channel-style supports (hole pattern TBD) up the external vertical wall of the vessel for the installing Contractor to install external wash water and chemical dosing piping and electrical / instrumentation conduit, etc. All internal feed, and wash water / chemical dosing piping and pipe supports are factory-installed by SBI in the vessel. Upper 4 ft of internal piping (from tank eave height) is in316 SS materials. Balance of internal piping is in 304 SS materials

SBI scope of supply does not include the following items:

- CO_2 Release Tank feed pump(s) or their motor starters / control. SBI will provide a flow measurement signal (via the SBI-provided flow meter) to the plant for controlling customer-supplied (or existing) digestate feed pumps to the proposed system.
- Odor control or treatment of odorous air from CO_2 Release Tank. The estimated exhaust air rate from the CO_2 Release Tank is approx. 250 to 350 ft^3/min (depending on operating conditions) that is at the approx. material temperature within the vessel and 100% relative humidity. To prevent the buildup of potentially corrosive gases in the Reactor and Settling Tank units' headspace areas, we would recommend aspirating these freeboard volumes as well. The Reactors' freeboard / headspace volume is approx. 462 ft^3. The Settling Tank's headspace is also approx. 462 ft^3 (total 924 ft^3 for the Reactor and Settling Tank).
- All interconnecting piping, fittings, etc.
- Water supply and pumps.

B. CRYSTALLIZATION REACTOR

Quantity:	**One (1)**
Material of Construction:	304 stainless steel, with upper four (4) feet strake, roof and internals in 316 SS
Vessel Volume:	31,120 Gallons (117.8 m^3) NET liquid volume

	34,575 Gallons (130.9 m^3) GROSS volume (includes headspace)
Vessel Height X Diameter:	14’ Ø x 31’ tall (overall vessel height, not including top-side safety railing or clearance below vessel to grade)
Tank Mixer: Normal Operating BHP [kW]: Installed HP [kW]:	 5.0 to 10.0 [3.7 to 7.5] 15.0 [11.2]

Scope includes:

1. One (1) agitated Crystallization Reactor with circulating flow to promote intensive mixing of the centrate material and dosed $MgCl_2$, optimize Struvite crystal formation and maximize Struvite precipitation.
2. Reactor includes one (1) roof-mounted variable speed agitator to promote blending of $MgCl_2$ solution with the centrate fed to the unit. Impellers are coated with Halar. Shaft is supplied in 316 SS (not coated). Impellers are standard design for centrate service.
3. Two (2) pH probes and one (1) pH transmitter are provided for monitoring sludge pH in the Reactor and adjusting the final NaOH injection rate to the tank.
4. One (1) 120 V solenoid valve is provided by SBI to automate pH probe daily wash water rinsing operations.
5. One (1) tank high level switch is included for the unit to provide a high-level alarm for the tank.
6. One (1) tank level transmitter included for the tank.
7. One (1) overflow connection is provided for an overflow feed arrangement from the Crystallization Reactor to the Harvest Settling Tank.
8. Four (4) manually adjustable diaphragm valves are provided in PVC / CPVC materials to act as “flow-balancing” valves for the four (4) MgCl2 injection points for the Reactor tank. Valves to be supplied by SBI as a “matched set” to the following vacuum breaker valves.
9. Four (4) vacuum breaker valves are supplied to assure proper flow of MgCl2 solution into the Reactor tank. Flow from the one (1) MgCl2 solution supply header to the four (4) injection point “branches” from the header is balanced via the above-noted manually adjustable diaphragm valves.
10. One (1) vacuum breaker valve is supplied to assure proper flow of NaOH solution into the Reactor tank if caustic dosing is required to complete pH adjustment.
11. Vessel is supplied with support steel to elevate the unit to achieve approx. four (4) ft clearance under the unit. Support steel is provided in painted steel materials or 304 SS, whichever is more economical at the time the order is placed or per customer preference.
12. Top-side access to the Reactor is via the SBI-provided ladder for the vessel. Ladder is per OSHA requirements.
13. Reactor to be provided with top-side safety railing, toe-boards, etc. per OSHA requirements.
14. SBI will provide one (1) set of external feed pipe supports from four (4) ft above grade to the feed piping’s termination point on the vessel’s exterior (external piping to be supplied and installed by others). SBI will also provide one (1) set of vertically oriented, minimum twelve (12) inch-wide, channel-style supports (hole pattern TBD) up the external vertical wall of the vessel for the installing Contractor to install external wash water and chemical dosing piping and electrical /

instrumentation conduit, etc. All internal feed, and wash water / chemical dosing piping and pipe supports are factory-installed by SBI in the vessel. Upper 4 ft of internal piping (from tank eave height) is in316 SS materials. Balance of internal piping is in 304 SS materials.

C. CHEMICAL DOSING SYSTEM

Antifoam Chemical Pump Qty:	One (1)
Antifoam Pump Electrical: Normal Operating BHP [kW]: Installed HP [kW]:	 0.17 to 0.33 [0.12 to 0.25] 0.50 [0.37]

NaOH Chemical Pump Qty:	One (1)
NaOH Pump Electrical: Normal Operating BHP [kW]: Installed HP [kW]:	 0.17 to 0.33 [0.12 to 0.25] 0.50 [0.37]

$MgCl2_2$ Pump Qty:	One (1)
$MgCl2_2$ Pump: Normal Operating BHP [kW]: Installed HP [kW]:	 0.33 to 0.67 [0.25 to 0.50] 1.0 [0.75]

Scope includes:

1. One (1) variable speed antifoam chemical dosing pump for CO2RT foam control. Pump will be factory-mounted in a wall-mount assembly that is pre-piped and pre-wired to expedite field installation of the equipment (field installation by others). Pump operation is automated in response to CO2RT foam switch detection / activation.
2. Antifoam pump assembly will be provided with one (1) calibration column and the calibration data will be used to develop a flow curve as a function of pump operational speed. As such, we are not providing separate flow-measuring equipment for the antifoam pump assembly.
3. Antifoam pump assembly to be provided with a pressure relief valve, pressure reducing valve, isolation valves and all other necessary accessories for a completely functioning system.
4. One (1) variable speed NaOH chemical dosing pump for Reactor pH control. Pump will be factory-mounted in a wall-mount assembly that is pre-piped and pre-wired to expedite field installation of the equipment (field installation by others).
5. NaOH pump assembly will be provided with one (1) calibration column and the calibration data will be used to develop a flow curve as a function of pump operational speed. As such, we are not providing separate flow-measuring equipment for the antifoam pump assembly.
6. NaOH pump assembly to be provided with a pressure relief valve, pressure reducing valve, isolation valves and all other necessary accessories for a completely functioning system
7. One (1) variable speed $MgCl_2$ chemical metering pump to be provided to control magnesium chloride flow into Reactor to support efficient Struvite formation reaction. $MgCl_2$ pump will be factory assembled to a wall-mount unit, with all accessories, at the factory so that the assembly is pre-piped and pre-wired for expedient field installation by the installing Contractor.

8. $MgCl_2$ pump wall-mount assy. will be provided with a calibration column and the calibration data will be used to develop a flow curve as a function of pump operational speed. As such, we are not providing separate flow-measuring equipment for measuring the rate of $MgCl_2$ being dosed into the system.
9. $MgCl_2$ pump assembly to be provided with a pressure relief valve, pressure reducing valve, isolation valves and all other necessary accessories for a completely functioning system.
10. All wiring and plumbing to and from the wall and / or floor-mount assemblies is by others.

D. STRUVITE HARVESTING SYSTEM

Quantity:	**One (1)**
Struvite Settling Tank	304 stainless steel, with upper four (4) feet strake, roof and internals in 316 SS
Vessel Volume:	18,343 Gallons (69.4 m^3) NET liquid volume 21,798 Gallons (82.5 m^3) GROSS volume, including headspace
Struvite Settling Tank Diameter X Height: (overall vessel height)	14’ Ø x 27’ tall (overall vessel height, not including top-side safety railing or clearance below vessel to grade)
Struvite Harvest Washer Capacity:	Up to 158 GPM
Struvite Harvest Washer Est. Footprint:	13.5’ L x 3.7’ W x 7.5’ H
Struvite Washer: Normal Operating BHP [kW]: Installed HP [kW]:	 0.75 [0.56] At Average Daily Flow 1.0 [0.75]
Struvite Recovery Cyclone Feed Pump: Normal Operating BHP [kW]: Installed kW:	 21.42 [15.98] 40.0 [29.8]
Harvest Lock Air Compressor[1]: Normal Operating BHP [kW]: Installed kW:	 1.41 [1.05] 7.5 [5.59]

[1] Harvest Air Compressor electrical consumption multiplied by a factor of 0.25 (15/60), as it typically operates approx. 15 minutes per hour for harvest operations.

Scope includes:

1. One (1) Settling Tank to receive overflow centrate from the Reactor and cyclone overflow stream to help separate smaller Struvite crystals from larger particles, promote additional Struvite crystal growth and maximize Struvite precipitation.
2. Top-side access to the Settling Tank is via the SBI-provided walkway from the top of the Reactor tank.
3. One (1) Harvest Cyclone (“cyclone,” “hydrocyclone”) shall be utilized to separate Struvite fed to it from the Settling Tank.

4. One (1) rotary lobe Cyclone Feed Pump is supplied to feed the above-noted cyclone from the Settling Tank's Cyclone Feed Pump connection. Pump is provided with isolation valves, instruments, etc. as needed.
5. One (1) Harvest Lock (intermittent operation), to receive the centrate / Struvite slurry from the Reactor prior to the Struvite Washer and prevent Struvite Washer volumetric overloading.
6. Harvest Lock is provided with pneumatically actuated inlet and discharge knife gates and necessary control instrumentation.
7. One (1) Harvest Air Compressor to air-boost the centrate / Struvite slurry from the bottom of the Reactor to the Harvest Lock. Assembled air compressor package includes low oil level switch and automatic accumulator tank drain. Air compressor additionally equipped with a filter-regulator, discharge check valve and solenoid valve for harvest operations.
8. One (1) Struvite Washer-Classifier shall wash and separate Struvite from the centrate from the Harvest Lock.
    a. Struvite Washer shall utilize an integral, shaftless, inclined conveyor with replaceable UHMW liner.
    b. Struvite Washer trough shall be provided with a drain valve. Piping beyond the drain valve to be supplied by others.
    c. Tank is provided with flanged inlet, overflow drain connections.
    d. Wash water / overflow shall be returned to head of plant.
    e. Struvite discharged to following Struvite Distribution Screw.

E. CONTROLS

Quantity:	**One (1) Lot**

Scope includes:

1. Main Process Control Panel enclosure shall be NEMA 4X, 304 stainless steel, free standing.
2. External power supply shall be 480V / 3∅ / 60Hz. A circuit breaker disconnect switch shall be provided at the front of the panel (or per local electrical supply voltage / frequency).
3. Allen Bradley ControlLogix PLC shall be used to control panel functions.
4. Touch-screen interface shall be used for operator input, status monitoring, local controls, and alarm notification.
5. A POWER ON/OFF indicator light, EMERGENCY STOP pushbutton, ALARM indicator light, and ALARM RESET pushbutton shall be provided at the front of the panel.
6. Variable speed drives and / or starters for the following equipment shall be furnished by Schwing Bioset and either placed in the above-noted panel enclosure (with appropriate air conditioning or cooling / ventilation, as needed) or in a separate, enclosure from the control panel enclosure (with ventilation and / or air conditioning, as needed), or remote mounted near equipment:
    - Qty = 1 Aeration Blower, VFD.
    - Qty = 1 CO2RT Solids Transfer Pump, VFD.
    - Qty = 1 Crystallization Reactor Mixer, VFD.
    - Qty = 1 Magnesium Chloride Dosing Pump, VFD.
    - Qty = 1 NaOH Dosing Pump, VFD.
    - Qty = 1 CO2RT Antifoam Chemical Dosing Pump, VFD.

- Qty = 1 Cyclone Feed Pump, VFD.
- Qty = 1 Harvest Air Compressor, Starter.
- Qty = 1 Struvite Washer, Starter.

SPARE PARTS

No spare parts are provided in this proposal. As the project progresses and final equipment selections are made, a priced spare parts list will be provided.

SPECIAL TOOLS

No special tools are provided in this proposal. As the project progresses and final equipment selections are made, a priced special tools list will be provided.

FIELD SERVICE

Schwing Bioset shall provide a NuReSys systems specialist to supervise system installation, assist start-up and / or to train the owner's personnel in the operation and maintenance of the Schwing Bioset supplied equipment and for Performance Testing. The NuReSys systems specialist shall be made available for up to Twelve (12) days over up to Three (3) trips. If required, additional service may be purchased at the prevailing rates at the time service is performed.

Schwing Bioset shall provide a trained service technician to supervise NuReSys System installation, assist start-up, optimize system controls and / or to train the owner's personnel in the operation and maintenance of the Schwing Bioset supplied equipment and for Performance Testing. The service technician shall be made available for up to Twelve (12) days over up to Three (3) trips. If required, additional service technician is required, assistance may be purchased at the prevailing rates at the time service is performed.

Schwing Bioset shall provide an Electrical Engineer to supervise NuReSys System installation, assist start-up, optimize system controls and / or to train the owner's personnel in the operation and maintenance of the Schwing Bioset supplied equipment and for Performance Testing. The Electrical Engineer shall be made available for up to Twelve (12) days over up to Three (3) trips. If required, additional service technician is required, assistance may be purchased at the prevailing rates at the time service is performed.

SCOPE OF SUPPLY SUMMARY

Item	Quantity
A. CO2 Release Tank	One (1) Unit
B. Crystallization Reactor:	One (1) Unit
C. Chemical Dosing System:	One (1) Lot
D. Harvesting System W/Settling Tank, Washer-Classifier & Bagging Stations:	One (1) Lot
E. Process Controls:	One (1) Lot
Field Service:	One (1) Lot

Total Budgetary Price for above listed scope of supply ………………………………………………………………… **TBD**

All prices are quoted:
DAP Plant Site, Ogden, UT, USA
Price is in US Dollars (USD)

UNFORSESEEN MARKET CONDITIONS

Unforeseen Market Conditions shall mean an increase in the price of a finished material or equipment due to an increase in the price of the materials used to fabricate said materials or equipment which occurs after the date of the quotation that was unknown to the manufacturer prior to the date of the quotation.

The OWNER recognizes the potential for Unforeseen Market Conditions in the current COVID environment. Bids submitted are based on current pricing available at the time of bidding. Should actual costs, or appropriate Producer Index, increase more than 3% between the date of the quotation and major equipment deliveries the OWNER will allow a change of cost through a Change Order. The escalation shall be based upon increases in labor and material and other costs to Schwing Bioset, Inc. that occur in the time-period between quotation and shipment by Schwing Bioset, Inc. Buyer agrees to this potential escalation regardless of contradicting terms in the contract.

Any claim of Unforeseen Market Conditions shall include one of the following as substantiation:

1. Copy of the actual quote(s) used for the basis of the bid compared to current quote(s).
2. In the case of customized or structural items where finished product quotes are not available at time of quotation, an appropriate Producer Index such as those listed below managed by the US Bureau of Labor & Statistics (https://data.bls.gov/PDQWeb/pc) shall apply:
    a. Steel Product Manufacturing from Purchased steel; code 3312
    b. Conveyor & Conveyor Equipment Manufacturing; code 333922
    c. Pump and Compressor Manufacturing; code 33391
    d. Other agreed upon representative Index
3. Supporting information from Vendors and Suppliers providing further detail on the reported increase in costs.

SUBMITTALS

Submittals shall be delivered Sixteen (16) to Twenty (20) weeks after receipt of approved order. Printed / “hard” and electronic copies shall be furnished per customer requirement.

O&M MANUALS

Four (4) final copies shall be furnished in print form, 2 electronic copies (CD, DVD, or via FTP site), or per customer requirement / per specification.

DELIVERY

Equipment shall be delivered approx. Thirty-six (36) to Forty (40) weeks after final design submittals are approved.

PAINTING

Equipment shall be provided with manufacturer’s standard coating system, except as noted above. Stainless steel surfaces shall be unpainted, with weld stains chemically treated with water rinse. Does not include blasting for uniform appearance. All field touch-up painting of equipment shall be performed by installing contractor.

EQUIPMENT AND SERVICES TO BE PROVIDED BY OTHERS

1. Installation, offloading, field assembly, and erection of the Schwing Bioset, Inc. (SBI) supplied equipment.
2. Storage of equipment and/or costs for long-term storage (longer than 3 months).
3. Racks, trays or supports for hydraulic lines, sludge lines, or control wiring.
4. Miscellaneous metal.
5. Field painting of any of the SBI supplied equipment. All touch up painting required due to normal wear and tear during shipping shall the responsibility of others.
6. Field wiring of any kind.
7. Labor and material for preliminary, final field, system performance, and system integrity tests (SBI shall supervise only).
8. It is the contractor’s responsibility to field verify building dimensions, equipment access, and that equipment layout/dimensions are suitable to accommodate the SBI supplied equipment.
9. Water and drain piping of any kind.
10. Spare parts not specifically mentioned in this scope.
11. Anchor bolts, nuts, and washers for the SBI supplied equipment.
12. Cost for Engineer, Owner, or Contractor to witness any shop test.
13. Additional costs to supply alternate products other than specifically mentioned in this scope.

14. Networking, hardware, communication modules, or power supplies not specifically mentioned in this scope.
15. PLC programming software or software licenses not specifically mentioned in this scope.
16. Field service technicians or special tools not specifically mentioned in this scope.
17. Motor starters or variable frequency drives not specifically mentioned in this scope.
18. After equipment is delivered to site, disposal of any hydraulic oil shall be by others.
19. Spare parts not specifically mentioned in this scope.

We thank you for the opportunity to provide you with this information and your interest in our Nutrient Recovery System (NuReSys) technology. We would be pleased to further clarify various aspects of this proposal, in accordance with your interest and project requirements. If you have any questions, please don't hesitate to contact me by cellular phone (612-867-4429), or E-mail (jdivalentino@Schwingbioset.com).

Yours very truly,

Schwing Bioset, Inc.

Joshua R. DiValentino
Western Regional Sales Manager

Attachments: SBI Proposal 2022413 Schematic PFD-P&ID - HYBRID

Schwing Bioset, Inc. New Equipment Sales Terms and Conditions

1. Acceptance and Prices. These terms and conditions are an integral part of Schwing Bioset,Inc ("Seller")'s firm offer and form the basis of any agreement resulting from Seller's proposal. The proposal is subject to acceptance within thirty days from its date, and the prices are subject to change without notice prior to acceptance by the party to whom this offer is made, or its authorized agent ("Buyer"). Following acceptance without addition of any other terms and conditions of sale or any other modification by Buyer, the prices stated are firm provided that notification of release for immediate production and shipment is received at Seller's factory not later than five months from Seller's submittals. If through no fault of Seller, the order is not released for manufacture within 5 months from Seller's submittals, Seller reserves the right to increase the price of the order. Any delay in shipment caused by Buyer's actions will subject prices to increase equal to the percentage increase in list prices during that period of delay. In no event will prices be decreased.

Acceptance will have occurred if Buyer: signs Seller's proposal; issues written order pursuant to submission of proposal; or permits or accepts performance; or other commercially reasonable manner. If Buyer's order is an acceptance of Seller's proposal, Seller's return of such order with these terms and conditions attached serves as an acknowledgement and confirmation of receipt of order. If order is expressly conditioned upon Seller's acceptance or assent to terms other than those expressed herein, return of order by Seller with these terms and conditions attached serves as notice of objection to such terms and a counter-offer to provide equipment in accordance with scope and terms of the original proposal. If Buyer does not reject or object within ten days, counter-offer will be deemed accepted. If Buyer permits or accepts performance, such terms will be deemed accepted. In order for Seller's acknowledgement of order to be valid it must be made at the corporate level.

2. Performance. Seller shall be obligated to furnish only the goods described in Seller's proposal, and submittal data (if such data is issued in connection with this order), and Seller may rely on the acceptance of proposal and submittal data as acceptance of the suitability of the equipment for the particular project. Seller's duty to perform under any order and the price thereof is dependent upon Seller's corporate approval of the order and Seller shall not be responsible for delays in contract formation caused by inclusion of new or different terms by Buyer, or delays in credit approval due to delayed or incomplete credit information by Buyer. Seller's duty to perform is contingent upon the non-occurrence of an Event of Force Majeure. If the order is not approved at the corporate level, Seller may elect to delay performance or to renegotiate with Buyer. If Seller and Buyer are unable to agree on revised prices or terms, the order may be canceled without any liability. If Seller shall be unable to carry out any material obligation under this Agreement due to an Event of Force Majeure, this Agreement shall at Seller's election (i) remain in effect but Seller's obligations shall be suspended until the uncontrollable event terminates or (ii) be terminated upon ten (10) days' notice to Buyer, in which event Buyer shall pay Seller for all parts of the Work furnished to the date of termination. An "Event of Force Majeure" shall mean any cause or event beyond the control of Seller. Without limiting the foregoing, "Event of Force Majeure" includes: acts of God; acts of terrorism, war or the public enemy; flood; earthquake; tornado; storm; fire; civil disobedience; pandemic insurrections; riots; labor disputes; labor or material shortages; sabotage; restraint by court order or public authority (whether valid or invalid); and action or non-action by or inability to obtain or keep in force the necessary governmental authorizations, permits, licenses, certificates or approvals if not caused by Seller; and the requirements of the United States Government in any manner that diverts either the material or the finished product to the direct or indirect benefit of the Government.

3. Escalation. In the event of a significant delay or price increase of material, equipment or energy occurring during the performance of the contract through no fault of Seller, the Contract Sum, time of completion or contract requirements shall be equitably adjusted by Change Order. A change in price of an item of material, equipment or energy will be considered significant when the price of an item increases 10% between the date of this Contract and the date of shipment of the goods. The amount of the price increase shall be capped at 10%. Such price increases shall be documented through quotes, invoices, receipts or a generally accepted index as offered by a US federal or state government agency. All pricing offered is only allowed based on the quoted validity date.

4. Taxes. No taxes are included in this quote/order. The amount of any applicable present or future state/local sales/use tax or other government charge upon the production, sale, shipment, and/or use of the goods covered by this quotation shall be paid directly to the taxing authorities by purchaser, and paid tax receipts will be furnished to Schwing Bioset upon request, unless purchaser provides us with an exemption certificate acceptable to the taxing authorities.

5. Warranty and Liability. Seller warrants its new equipment against defects in material and workmanship under normal use and service, and which shall not have been subject to misuse, negligence, or accident, for a period of one (1) year that shall commence upon startup or ninety (90) days from delivery, whichever occurs first. Seller will replace or repair free of charge, F.O.B. jobsite, such part or parts thereof as in its sole judgment shall be deemed defective. Due to the specialized nature of Seller material handling equipment, Seller field service technicians shall not be restricted in adjusting or repairing Seller furnished equipment, regardless of collective bargaining agreements entered into by other parties. This warranty shall not apply to any equipment manufactured by us which shall have been loaded or operated beyond its rated capacity as specified by Seller Damage resulting from improper installations or alterations outside our plant will be considered as misuse and not as a defect. Certain parts of the equipment provided by Seller such as the pumping cylinders, valves, pumping rams, screw flights, sliding frame components, trough liners for screws etc. in contact with material, are subject to normal wear. This normal wear is not covered under this warranty. Seller shall not be liable for consequential damages or injuries of any kind, or for expenses, losses, or delays incidental to any failure. Seller reserves the right to make changes and improvements in its product without incurring any obligation to install any such changes or improvements in its products previously manufactured. All warranty is void if equipment is not serviced by a Schwing Bioset certified technician from delivery through termination of warranty period. In the event of a defect or issue with Schwing Bioset supplied equipment, buyer shall notify Schwing Bioset in writing of said defect and offer Schwing Bioset reasonable opportunity to cure. This warranty is in lieu of any other warranty expressed or implied or any other obligation or liability on the part of Seller, and no other person is authorized to make any representations or warranties beyond those herein expressed. Without limiting the generalities of the foregoing, **THERE IS NO IMPLIED WARRANTY OF MARKETABILITY AND NO IMPLIED WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE.**

6. Indemnity. Seller agrees to indemnify and hold Buyer harmless from the amount of any final judgment entered against Buyer for injury or death to any person (including employees of Buyer and Seller) or damage to tangible property of Buyer and based solely upon: (a) Seller's defective manufacture of equipment sold to Buyer; (b) Seller's violation of any applicable laws, rules or regulations in connection with the manufacture of said equipment, or (c) Seller's gross negligence or intentional misconduct. The duty to indemnify will continue in full force and effect, notwithstanding the expiration or early termination hereof, with respect to any claims based on facts or conditions that occurred prior to expiration or termination.

7. Insurance. Seller agrees to maintain the following insurance during the term of the contract with limits not less than shown below and will, upon request from Buyer, provide a Certificate of Insurance evidencing this coverage:

Commercial General Liability	$2,000,000 per occurrence
Automobile Liability	$2,000,000 CSL
Workers Compensation	Statutory Limits

In the event Seller agrees to name Buyer or others as an additional insured, Seller will do so but only under its primary Commercial General Liability policies to the extent of the indemnity obligation assumed herein. In no event does Seller waive its right of subrogation.

8. Liability Disclaimer. NOTWITHSTANDING ANY PROVISION TO THE CONTRARY, IN NO EVENT SHALL SELLER BE LIABLE FOR ANY SPECIAL, INCIDENTAL, LIQUIDATED, CONSEQUENTIAL (INCLUDING WITHOUT LIMITATION LOST REVENUE OR PROFITS), OR PUNITIVE DAMAGES. This exclusion applies regardless of whether such damages are sought based on breach of warranty, breach of contract, negligence, strict liability in tort, or any other legal theory. Should Seller nevertheless be found liable for any damages they shall be limited to the purchase price of the equipment under the order. **SELLER DISCLAIMS ANY LIABILITY FOR DAMAGES OF ANY KIND (WHETHER DIRECT OR INDIRECT) ARISING FROM MOLD, FUNGUS, BACTERIA, MICROBIAL GROWTH, OR ANY OTHER CONTAMINATES OR AIRBORNE BIOLOGICAL AGENTS.**

9. Patent Indemnity. The Seller shall protect and indemnify the Buyer from and against all claims, damages, judgments and loss arising from infringement or alleged infringement of any United States patent by any of the articles or material delivered hereunder, provided that in the event of suit or threat of suit for patent infringement, Seller shall promptly be notified and given full opportunity to negotiate a settlement. Seller does not warrant against infringement by reason of Buyer's design of the articles or the use thereof in combination with other materials or in the operation of any process. In the event of litigation Buyer agrees to reasonably cooperate with Seller. In connection with any proceeding under the provisions of this Article all parties concerned shall be entitled to be represented by counsel at their own expense.

10. Shipment Dates. Shipment dates are estimates only. No valid contract may be made to ship within or at a specified time unless in writing, signed by an authorized signatory of Seller. Shipments shall be f.o.b. factory or warehouse at named shipping point with title and risk of loss passing to Buyer upon delivery to the carrier unless quoted otherwise and stated as such in our formal written offer. Seller shall not be liable for damages of any kind including Liquidated, Consequential, and/or Incidental.

11. Cancellation. If, following acceptance of proposal by Buyer, all or any portion of the resulting order is canceled by Buyer without default on the part of Seller or without Seller's written consent, Buyer shall be liable to Seller for cancellation charges including but not limited to Seller's incurred costs and such profit as would have been realized by Seller from the transaction had the agreement not been breached by Buyer.

12. Payment. Pending Credit approval, Payment terms are 20% due at time of order, 20% due at time of submittal approval, 55% due at time goods are shipped, and 5% due upon acceptance of goods, not to exceed 90 days from shipment, unless otherwise expressly agreed to in writing by Seller. Seller reserves the right to add to any account outstanding for more than 30 days a service charge the lesser of 1-1/2% of the principal amount due at the end of each month, or the maximum allowable legal interest rate. Buyer shall be liable to Seller for all collection expenses, including reasonable attorney's fees and court costs, incurred by Seller in attempting to collect any amounts due from Buyer. If requested, Seller will provide appropriate lien waivers upon receipt of payment. Seller reserves the right to suspend or terminate performance in the event of Buyer's non-payment.

13. Returns. Products may be returned only with permission of Seller and shall be subject to a 25% restocking fee.

14. Applicable Law. Any agreement resulting from Seller's proposal will be governed and construed according to Minnesota law.

15. U.S. Government Work. This provision applies only to indirect sales by Seller to the US Government. If the Work is in connection with a U.S. Government contract, Buyer certifies that it has provided and will provide current, accurate, and complete information, representations and certifications to all government officials, including but not limited to the contracting officer and officials of the Small Business Administration, on all matters related to the prime contract, including but not limited to all aspects of its ownership, eligibility, and performance. Anything herein notwithstanding, Seller will have no obligations to Buyer unless and until Buyer provides Seller with a true, correct and complete executed copy of the prime contract. Upon request, Buyer will provide copies to Seller of all requested written communications with any government official related to the prime contract prior to or concurrent with the execution thereof, including but not limited to any communications related to Buyer's ownership, eligibility or performance of the prime contract. Buyer will obtain written authorization and approval from Seller prior to providing any government official any information about Seller's performance of the work that is the subject of this offer or agreement, other than this written offer or agreement.

16. Storage at SBI. Should the customer desire to store the equipment purchased at SBI's facilities, these services can be completed at a rate of $250.00 per week, or $1,000 per calendar month. Customer shall issue the original equipment purchase order with a contingency of 12 months storage that can be drawn from if required. These funds will not be utilized unless written approval from customer is offered. Terms for Storage Fees are 100% N30 from invoice date. Retainages and/or offsets do not apply.

APPENDIX H

Dewatering Study

Kläranlagen
Beratung
Kopp

Dewaterability of a sludge sample
WWTP Central Weber Sewer Improvement District (CWSID) in State of Utah

Determination of max dewaterability DS(A)$_{KBKopp}$

Report: November 21th 2022

Samples: October 26th 2022

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Steuernummer
Finanzamt Peine
38-123-02634

Gerichtsstand
Braunschweig
Germany

1. Background

According to your assignment the dewaterability of a sewage sludge sample from WWTP Central Weber Sewer Improvement District (CWSID) in State of Utah was investigated by KBKopp. The samples were taken 26th of October and the measurements were started on 1st of November. Due to leakage of polymer preparation water, we use drinking water from Lengede for measurements.

The following services were offered:

- determination of water distribution with thermogravimetric measurements $DS(A)_{KBKopp}$
- microscopic characterization of the floc-structure
- definition of the polymer dosage using streaming current detector or dripp off test for delivered polymer sample
- determination of the active substance content of the polymer
- prediction of the full-scale dewatering results with the water distribution measuring the PO_4-P concentration and CI (**C**ation **I**ndex) in the sludge
- compilation of a report on the test results

The dewaterability of the investigated sludge samples is assessed on basis of recorded measuring values.

2. Dewatering Results

All measured values are shown in the following table 1.

Table 1: Results for sludge samples of WWTP Central Weber

WWTP CWSID	**Sludge sample** 26th October 2022
DS [%]	**1,8768,66**
VSS [%]	**68,66**
$DS(A)_{KBKopp}$ [%]	**19.1**
DS(A) - 0.5 [%] by optimal dewatering with centrifuge	18.6
DS(A) - 1.5 [%] by acceptable dewatering with centrifuges	17.6
DS cake [%]	**9,67**
FiS-Filtrate/Centrate [mg/l]	894
Capture rate [%]	**96.1**
pH [-]	7.28
el. conductivity [mS/cm]	7.70
Polymer type for determination of polymer demand (pd)	Not declared , assumed 50% active substances AS
∑ pd* [kg AS/ton DS]	**19.9**
Phosphate PO_4P [mg/l]	**248**
Ammonium NH_4N [mg/l]	1004
Calcium [mg/l]	22,8
Magnesium [mg/l]	9.62
Cation-Index [-]	36.9
Sand content** [% of VSS]	30.9
PO_4-P and cations measured in centrate after 1000 g × 30 min without polymer and filtration (0.45 µm)	
AS = active substance of polymer	
* method: dripp off test	
** as a residue insoluble in hydrochloric acid from the VSS accordance with DWA M-383	

3. Evaluation of Test Results

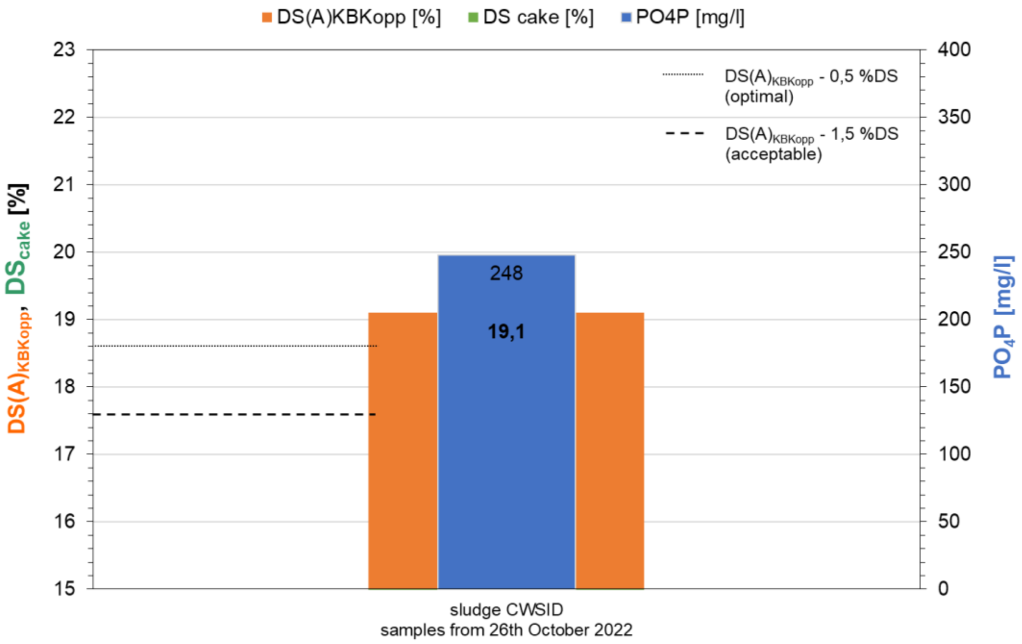


Fig. 3.1: Results DS(A)KBKopp for WWTP CWSID

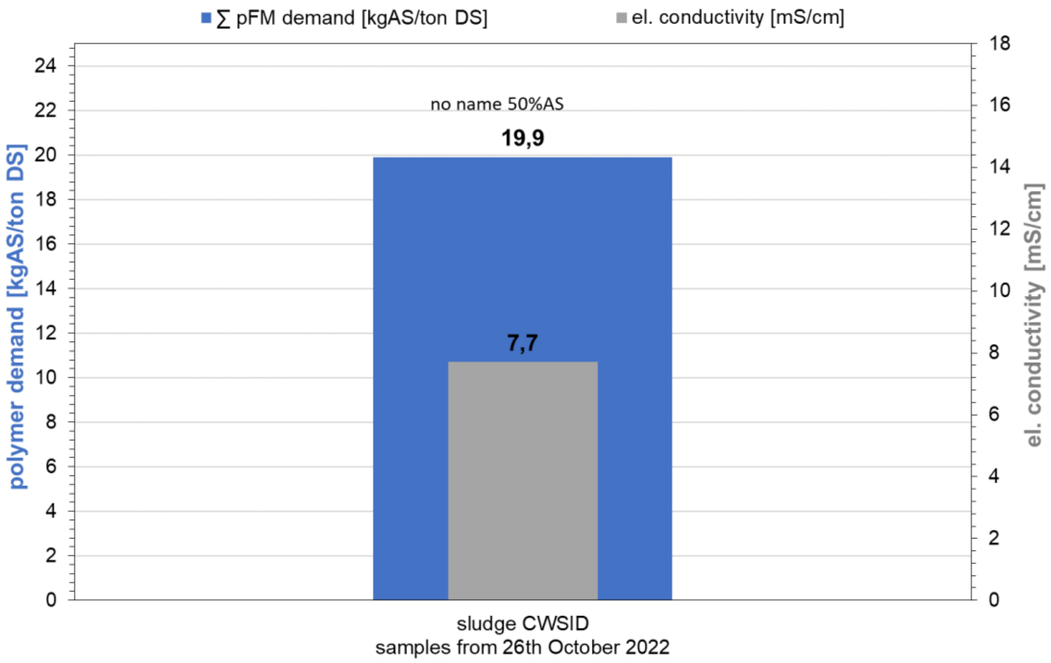


Fig. 3.2: polymer demand (emulsion, no name, 50% AS, prepared with drinking-water from Lengede KBKopp Germany)

3.1 Maximum dewaterability and dewatering results

The digested sludge of WWTP CWSID dated 26th October 2022 had a maximum dewaterability (DS(A) KBKopp) of 19.1% DS.

- dewatering results ≥ 18.6% DS can be classified as optimal (DS(A) KBKopp - 0.5% DS)
- dewatering results ≥ 17.6% DS can be classified as acceptable for centrifuges according to DWA-M 383 (German DWA Standards 2008) (DS(A) KBKopp - 1.5% DS).

The dewatered sample of WWTP CWSID from 26th October 2022 reached only 9.671% DS and this is only acceptable for thickening processes according to the state of technology of centrifuges due to sampling time. This can also be confirmed by the simple quick test for visual assessment of the water content in dewatered sludge (Chapter 3.4).

3.2 Polymer demand

For the sludge sample from WWTP CWSID the optimal polymer dosage was determined with the delivered polymer sample emulsion-not named, with 50% assumed active substance content. For this purpose, the polymer was mixed with drinking water KBKopp Lengede due to leakage of polymer preparation water by transport. The polymer was prepared in laboratory of KBKopp as a 0.1% solution according to an AS concentration of 50% in the commercial product and used for the streaming potential titration. The flocs are not shearstable and it will be recommended to add ferric salt or a cationic coagulant to optimize flocculation.

Optimum polymer dosage **= 19.9 kg AS / ton DS**

3.3 Capture Rate

In centrate sample was 894 mg/l suspended solids. The capture rate was only 96.1% due to time of sampling. Capture rates of at least 98% should always be maintained during dewatering in order to minimize the backload of the sewage treatment plant by the resulting centrate water (i.e. FiS-max = 454 mg/l with optimum dewatering results and ~ 1.87% DS in the inlet of the dewatering unit for capture rates ≥ 98%. Use of black ribbon paper filters with 9-10 seconds filter speed according to DIN 53137).

3.4 sand content

A sand content of 30.9% of inorganic DS, which is usual for digested sludge, was determined as a residue insoluble in hydrochloric acid from VSS for the sludge sample CWSID. Usually, municipal digested sludge has an average sand content of approx. 32.7% as residue insoluble in hydrochloric acid from VSS according to DWA M-383.

In 1 m^3 of sludge are: 981.3 kg of water,
12.8 kg organic substance
5.8 kg inorganic substance (of which 1.8 kg sand)

3.5 simple quick test to evaluate the moisture content of the cake

A simple quick test to evaluate the moisture content of the cake shows how much free water is still in the dewatered sludge. For the quick test, a handful of the dewatered sludge is squeezed out on a three-ply sheet of paper. Layer three was dry. On second layer there was seen a little bit water. The dewatered sludge from WWTP CWSID was therefore acceptable dewatered. Fig. 3.3 shows an example of not acceptable dewatered sludge, with shows water on all three layers. This method is only illustrative but not scientific, but can be easily carried out by operating personnel to check the dewatering performance.

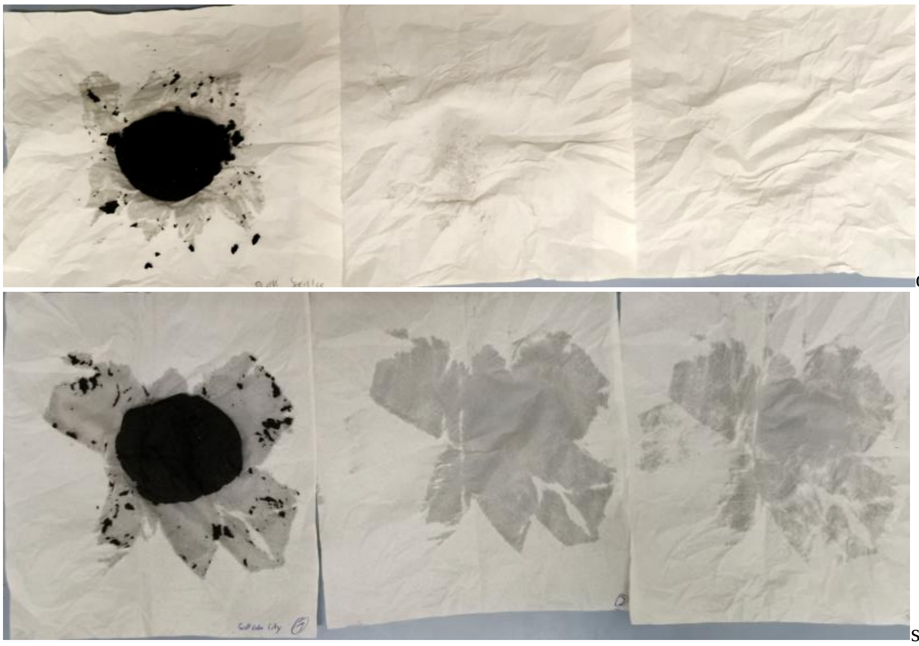


Fig. 3.3: simple quick dry test of dewatered sludge WWTP CWSID and an optimal dewatered sludge in comparison

3.7 Notes on the high PO_4P concentration of sludge sample

The maximum dewaterability of a sludge depends among other parameters on the PO_4P concentration (dissolved phosphate, measured after 0,45 µm filtration) of the sludge. High dissolved phosphate concentrations means that the sludge has a high-water binding capacity, so that the dewaterability is negatively affected.

There is also a risk of struvite crystallization in sludge. Struvite can lead to deposits and incrustations in transport lines, post-stabilization/storage tank, centrifuge or centrate line. Because of this fact that Mg^{2+} concentration is very low in sludge (this value is usually in the range 30 – 40 mg/l Mg^{2+} for digested sludge depending on the drinking water quality of the region) can give a hint that maybe struvite is already precipitate before dewatering step.

It will be recommended to reduce phosphate by struvite precipitation downstream the digestion, for example by vacuum degassing.

The signer is pleased to be at your disposal for further investigations and optimization steps in sludge dewatering and sludge conditioning.

Lengede, 21th of November 2022

Dr.-Ing. J. Kopp

4. Measured Values / Diagrams

4.1 DS(A)$_{KBKopp}$ – maximum Dewaterability

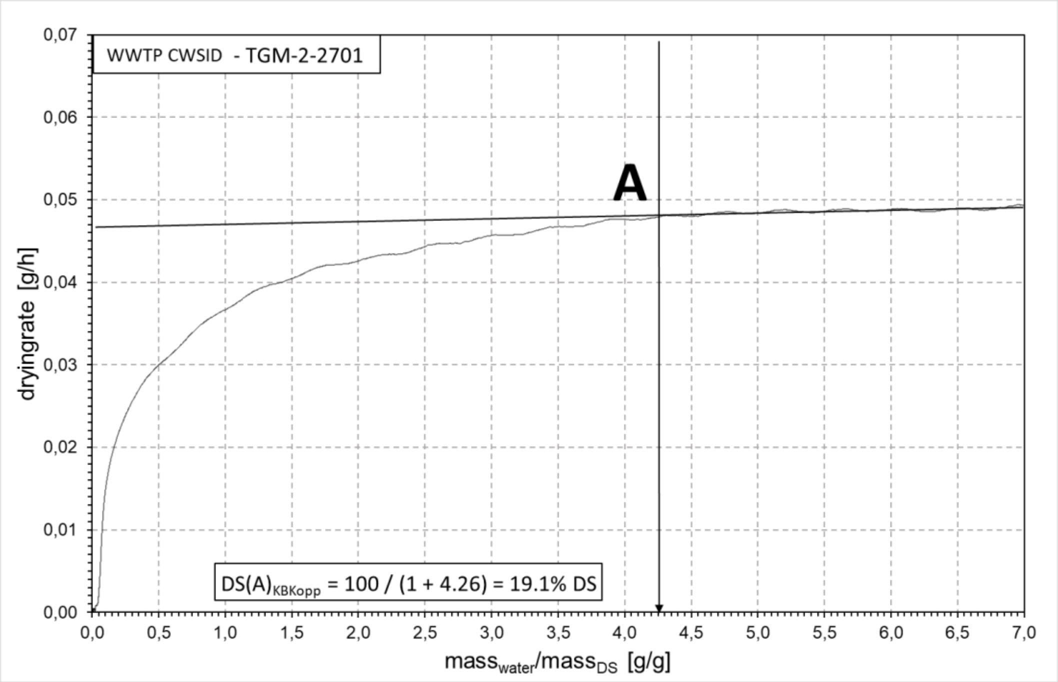


Fig. 4.1: Drying Curve sludge WWTP CWSID, 26th October 2022

4.2 titration curve – polymer demand

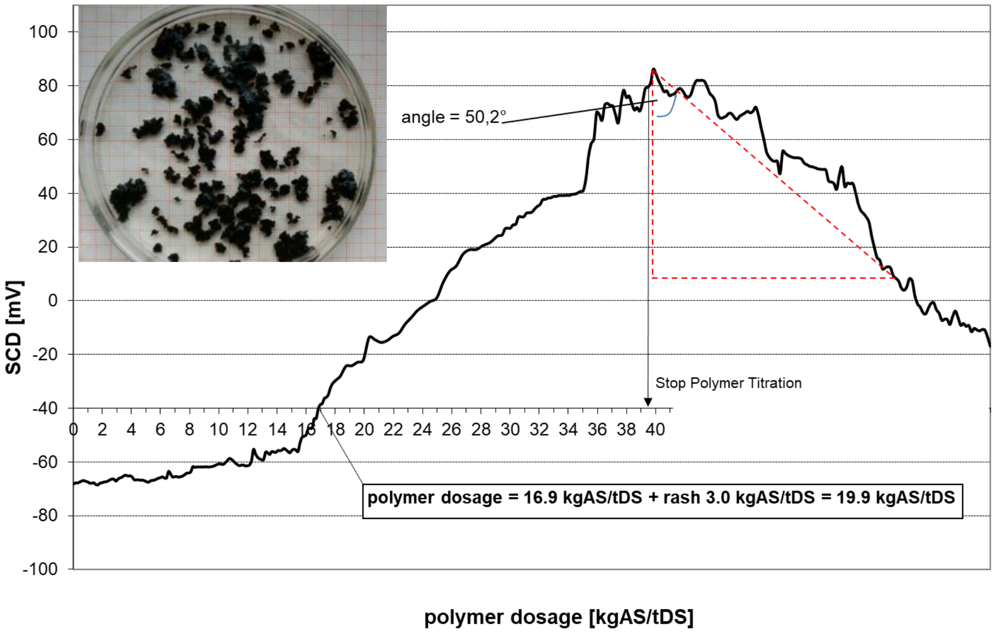


Fig. 4.2: SCD measurement sludge WWTP CWSID, 26th October 2022

4.3 Floc Structure

The floc structure of the sewage sludge was microscopically examined in dark field at about 100x magnification. The sludge sample WWTP CWSID consists of small to medium sized flocs with partially compact structure. A usual number of fines in the sludge is noted.

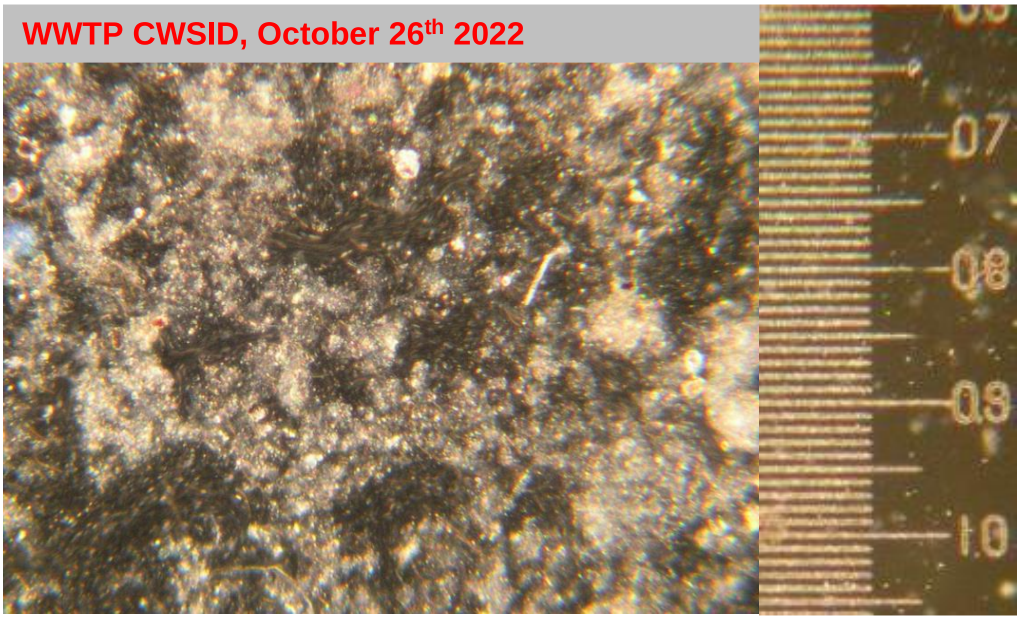


Fig. 4.3: floc structure sludge sample WWTP CWSID, magnification 100x in darkfield.

5. Measuring Methods

Table 5.1 lists the used methods and dewatering characteristics. The water distribution and the polymer demand will also be described in more detail in the following part of the report.

Tabelle 5.1: measuring methods

characteristic value	**index**	**description**	**source**
DS	%	Dried solids according to DIN EN 12880	DWA M-383
VSS	%	Volatile suspended solids according to DIN EN 12879	DWA M-383
pH, el. conductivity	-; mS/cm	pH-value (DIN 38414), el. conductivity (DIN EN ISO 27888) probe measurement	DWA M-383
DS(A)$_{KBKopp}$	%	Water Distribution of the sludge samples, depends on distribution of water types in the sludge	DWA M-383, Kopp
ortho-phosphate concentration	mg/l	Dissolved PO$_4$-P concentration in sludge liquor	DIN 38414
Capture rate	%	Ratio of the separated to the inputted solids load	DWA M-383
Concentration PO4-P and cations measured in centrate after 1000 g × 30 min without polymer and filtration (0.45 µm)			

5.1 Water Distribution of the sludge samples

Achieved total solids concentration of the sludge cake depends on distribution of water types in the sludge, since only share of free water can be separated during mechanical dewatering.

Various types of water in sewage sludge are mainly distinguished by the type and the intensity of their physical bonding to solids. The bonding forces counteract the steam pressure of the water molecules, thus decreasing the steam pressure [1]. That means the higher the bonding forces, the lower the steam pressure. To explain this clearly the bonding forces can be understood as an attraction between sludge particles and adsorbed water molecules.

In sewage sludge suspensions four different types of water can be distinguished according to their physical bonding to sludge particles. These are (fig. 5.1):

- free water, which is not bound to particles
- internal water, which is bound by capillary forces in sludge flocs
- surface water, which is bound by adhesive forces and
- intracellular water

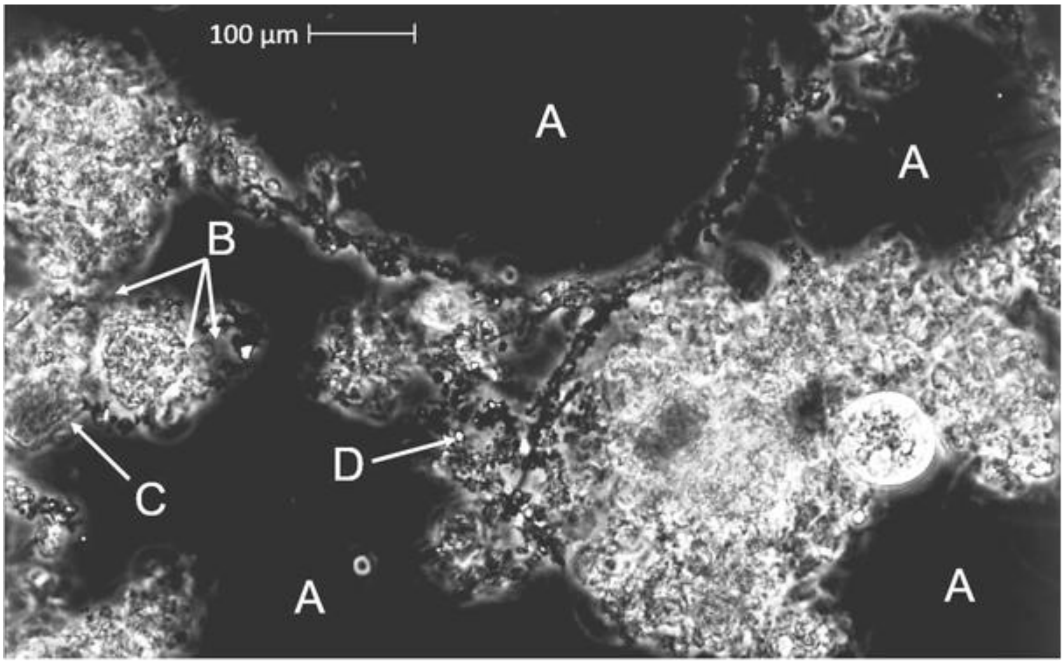
The free water content represents the largest part in sewage sludge. The water moves freely between individual sludge particles, is not adsorbed by them, not bound to them and is not influenced by capillary forces. This type of water can be separated mechanically, for example by centrifugal forces or filtration.

The internal water is kept in the interstice of sludge and in particles and microorganisms in sludge floc. This water is bound physically by active capillary forces.

The surface water covers the entire surface of sludge particles in several layers of water molecules and is bound by adsorptive and adhesive forces. The surface water is physically bound to particles and cannot move freely. The intracellular water contains water in cells and water of hydration. Intracellular water can only be determined together with the surface water and is often called bound water content [2].

Bound water is the smallest water content, has the strongest physical-chemical bonding to particles and can only be removed thermally. It must be taken into account that the term ”bound water” is not clearly defined and differs according to the used method of measuring [3].

For the measuring of water distribution thermo-gravimetric and dilatometric laboratory tests [4, 5] are used. At the Technical University of Braunschweig those methods were adjusted and calibrated from the consultant, so that a direct statement can be made concerning the maximum suspended solid content in sludge cake after mechanical dewatering in centrifuges and filter-presses [6].



A free water	B-D bound water
- no mechanical binding to sludge particles - can be separated by mechanical dewatering - release is influenced by polymer-conditioning - amount = total water – bound water	**- physical or chemical binding to sludge** - can not be separated mechanically - is not influenced by polymer-conditioning - amount is mainly determined by floc structure
Subcategories: supernatant water: by gravity thickening bulk water: is trapped between large flocs	Subcategories: **B: internal water**: water which is bound in the interstices inside flocs and particles physically by capillary forces. In pores up to approx. 10µm **C: surface water**: water which is bound on the surface of particles physically and chemically by adhesive forces **D: chemical bound water**: high binding energy water is bound chemically in gels/EPS, cell-water and water of hydration

Fig 5.1: Water distribution in a sewage sludge floc [14]

For thermo-gravimetric measurements the sludge sample is dried at constant conditions (air flow, temperature of 35°C). The water distribution can be derived from the curve of the drying rate in dependence on moisture content ($mass_{water}/mass_{DS}$) of the sample. In order to differentiate the corresponding amounts of water, before drying the sample is thickened in a laboratory beaker centrifuge at 1000 x g for 30 min. The drying procedure has to take place very slowly, because otherwise a distinction of the various types of water on the basis of the drying curve is not possible anymore because of high energy input. To dry one sample with a mass of nearly 1 gram we need approximately 20 hours.

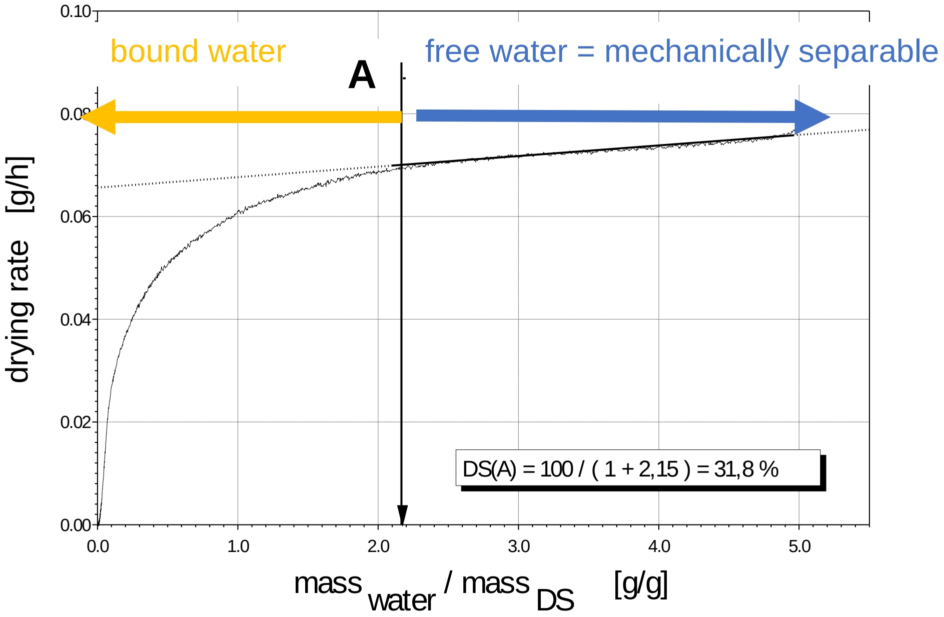


Fig. 5.2: Drying curve of a digested sewage sludge for an arithmetical abscissaas an example from digested sludge sample WWTP Hildesheim Germany

The most interesting fact for mechanical dewatering is the exact determination of free water content, which means point A of the drying curve. Therefore, it is useful, to plot the drying curve with an arithmetical scale (Fig. 5.2). As long as there is free water in sludge sample, the drying rate is linear. Here the drying rate is described by weight loss of the sludge for each time unit. At point A the drying rate decreases, because of capillary bonding of internal water to sludge and the calculated tangent does not describe the curve anymore. The solid content of sludge DS (A) can be derived from the moisture content of the sample.

Due to the present state of the art in science and technology, mechanical dewatering processes can only remove the free water content (w_{free}) from sludge. This water content is calculated with the drying instrument. The solids content in sludge cake, which would exist after removal of free water content, is derived as parameter DS(A)$_{KBKOPP}$. The solids content at point A – DS(A)$_{KBKOPP}$ is therefore the maximum solids content in sludge cake, which can be achieved with mechanical dewatering.

Fig. 5.3 compares the DS(A)$_{KBKOPP}$ of digested sewage sludges with dewatering results obtained with full-scale centrifuges and filter-presses. The accuracy of thermogravimetric measurement lies at about ± 1.5 % DS, thus giving an exact prediction of solids content after dewatering. With centrifuges and chamber filter presses it is possible to dewater at state of technology. When using belt filter presses or screw presses, energy input for dewatering is lower and therefore the dewatering result lies 2 %DS points below DS(A)$_{KBKOPP}$ (see fig. 5.4).

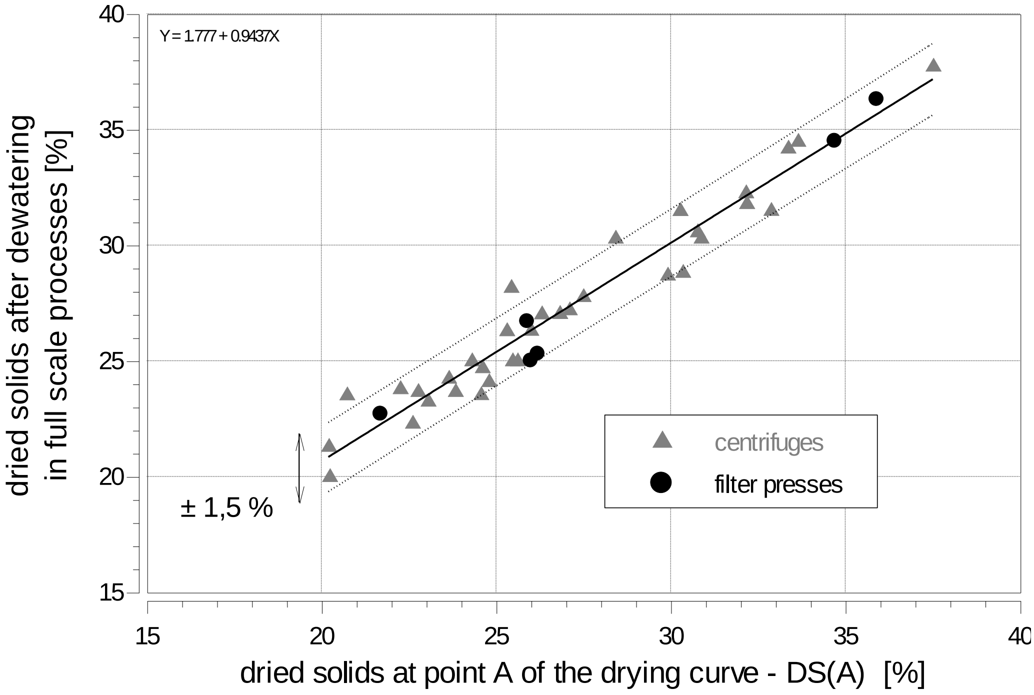
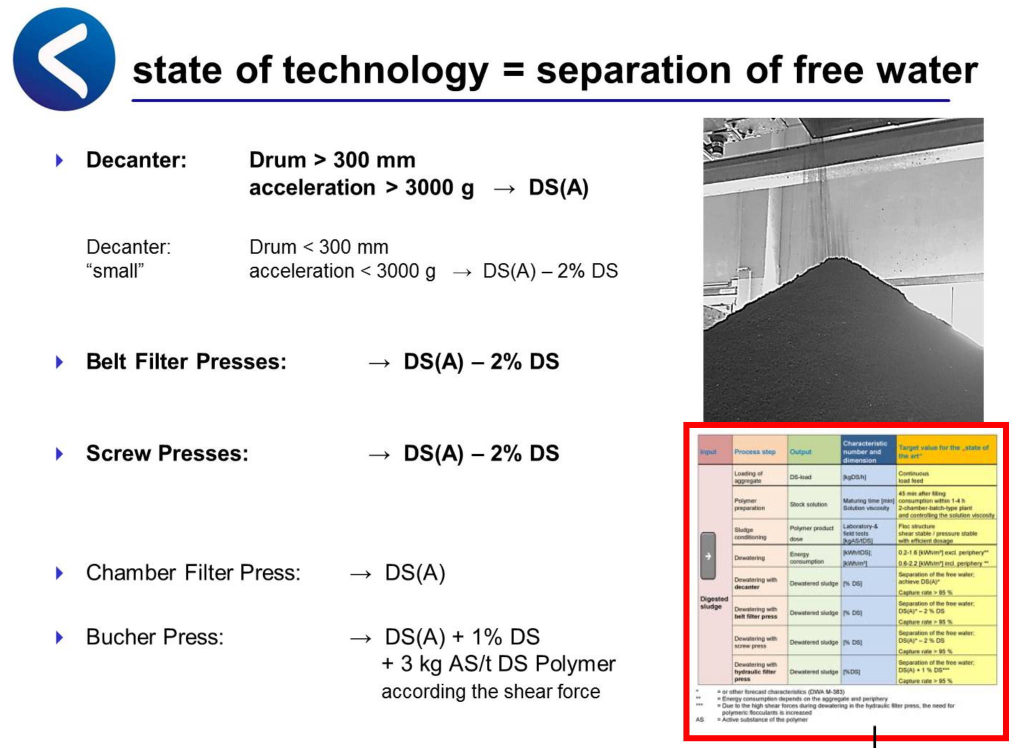


Fig. 5.3: Correlation between DS(A)$_{KBKOPP}$ - solids content at point A of the drying curve in dependence on the solids contents after dewatering in full scale centrifuges and filter presses



state of technology = separation of free water

- **Decanter:** **Drum > 300 mm**
  acceleration > 3000 g → DS(A)

Decanter: “small” Drum < 300 mm
acceleration < 3000 g → DS(A) – 2% DS

- **Belt Filter Presses:** **→ DS(A) – 2% DS**
- **Screw Presses:** **→ DS(A) – 2% DS**
- Chamber Filter Press: → DS(A)
- Bucher Press: → DS(A) + 1% DS
  + 3 kg AS/t DS Polymer
  according the shear force

Input	Process step	Output	Characteristic number and dimension	Target value for the „state of the art“
Digested sludge	Loading of aggregate	DS-load	[kgDS/h]	Continuous load feed
	Polymer preparation	Stock solution	Maturing time [min] Solution viscosity	45 min after filling consumption within 1-4 h 2-chamber-batch-type plant and controlling the solution viscosity
	Sludge conditioning	Polymer product dose	Laboratory-& field tests [kgAS/tDS]	Floc structure shear stable / pressure stable with efficient dosage
	Dewatering	Energy consumption	[kWh/tDS]; [kWh/m³]	0.2-1.6 [kWh/m³] excl. periphery** 0.6-2.2 [kWh/m³] incl. periphery **
	Dewatering with **decanter**	Dewatered sludge	[% DS]	Separation of the free water; achieve DS(A)* Capture rate > 95 %
	Dewatering with **belt filter press**	Dewatered sludge	[% DS]	Separation of the free water; DS(A)* – 2 % DS Capture rate > 95 %
	Dewatering with screw press	Dewatered sludge	[% DS]	Separation of the free water; DS(A)* – 2 % DS Capture rate > 95 %
	Dewatering with **hydraulic filter press**	Dewatered sludge	[%DS]	Separation of the free water; DS(A) + 1 % DS*** Capture rate > 95 %

* = or other forecast characteristics (DWA M-383)
** = Energy consumption depends on the aggregate and periphery
*** = Due to the high shear forces during dewatering in the hydraulic filter press, the need for polymeric flocculants is increased
AS = Active substance of the polymer

Fig. 5.4: State of technology = separation of free water [13],

the **table** is also shown at the end of the report

The specification for prognostic accuracy does not refer to reproducibility of the measurements and accuracy of thermo-gravimetric analyses, but to possible fluctuations of DS in cake of mechanical dewatering devices, which is also influenced by ratio of the effective- to the nominal-capacity of the aggregates.

Figure 5.5 clearly shows the relationship between the solids concentration of the dewatered sludge as a function of the feed rate of the centrifuge. A reduction in feed rate of the centrifuge can cause a significant improvement in the solids content in dewatered sludge.

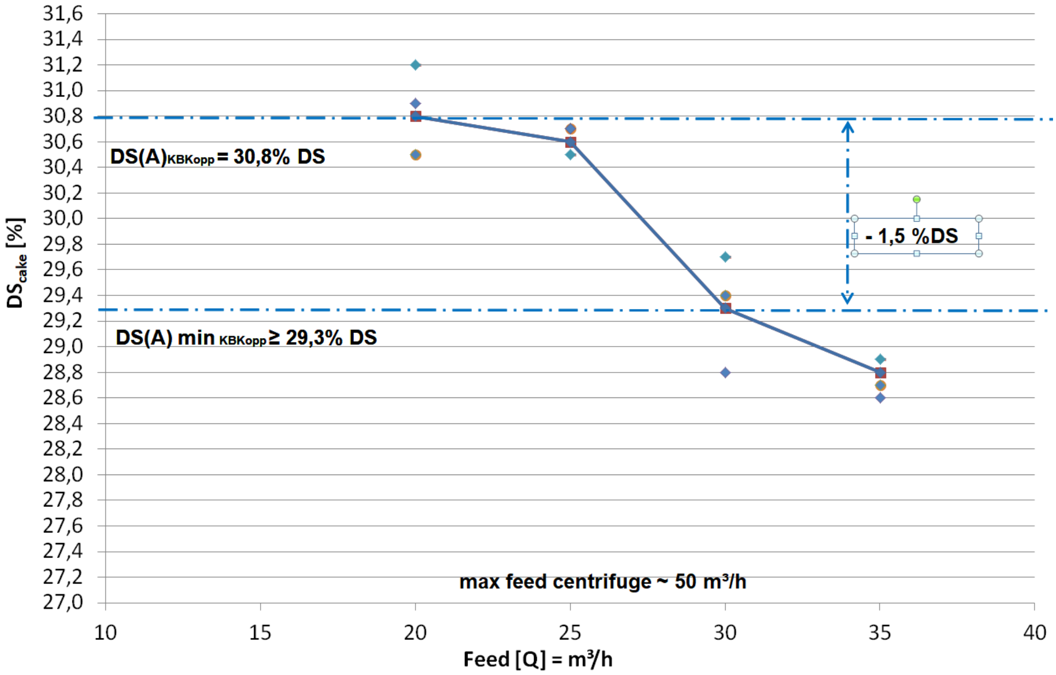


Fig. 5.5: Solids concentration in the dewatered sludge cake depending on the feed rate of centrifuge

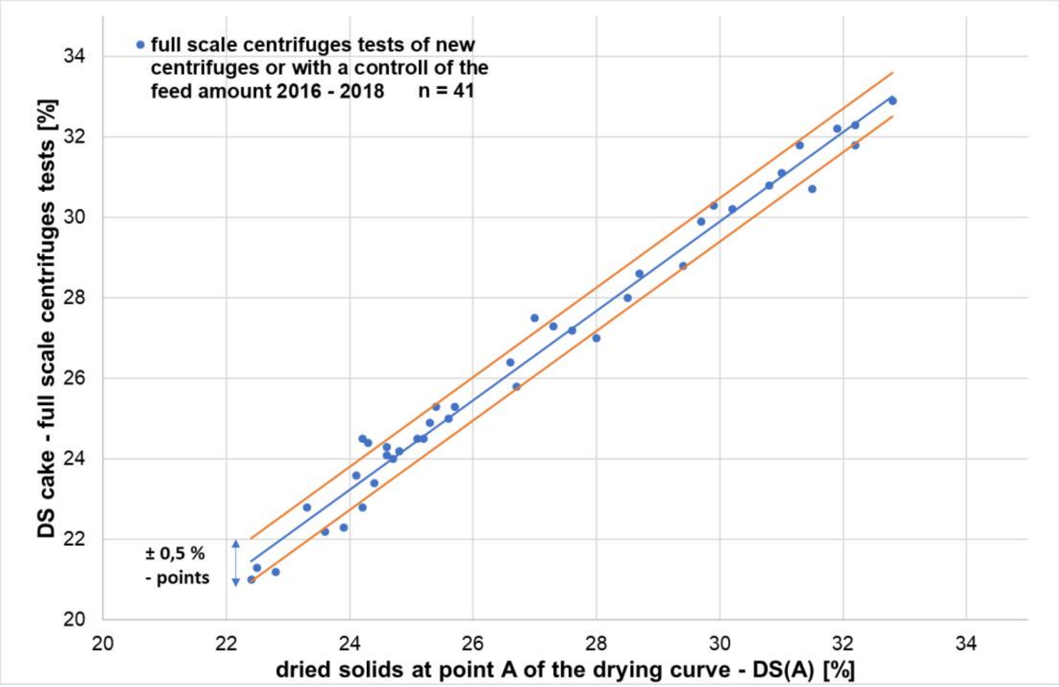


Fig. 5.6: Comparison characteristic value DS(A) with large-scale optimal dewatering results with centrifuges

In the years 2016-2018, the influence of the feed rate on the large-scale achievement of dewatering results was intensively investigated in the performance tests with centrifuges accompanied by KBKopp. If the characteristic value DS(A)$_{\text{KBKopp}}$ is compared with the DS output of an optimized dewatering, the prognostic accuracy can be limited to ± 0.5% DS (Fig. 5.5)!

Therefore, it makes sense, to contrast the achieved dewatering performance of the aggregates to the different feed rates. In the course of the dewatering experiments, dewatering performance of installed dewatering aggregates should therefore be investigated for different feed rates and with the polymeric flocculant (pFM) used on site. In addition, it must be taken into consideration to test the same machine size during preliminary tests that is to be installed later (notes DWA M-366, [3]).

The volatile suspended solids content represents the organic part of sewage sludge. This parameter most often is used to characterize dewaterability of sludge. The higher the amount of organic compounds in sludge, the lower the density of the sludge particles. In addition, more water is bound, since contact angle of organic particles is smaller than that of inorganic particles thus binding more water by means of capillary forces. That means that sludges with high volatile suspended solids content (VSS) are in general more difficult to dewater. Fig. 5.7 illustrates how solids content after separation of free water content DS(A)$_{\text{KBKOPP}}$ is affected by the volatile suspended solids content. One detects a general trend whereby dewatering result improves with decreasing volatile solids content. The measured values are so scattered, however, that dewatering result of sludges cannot be determined from volatile suspended solids content alone.

Fig. 5.8 shows the relation between characteristic value DS(A)$_{\text{KBKopp}}$ and the waste activated sludge (WAS) fraction. With increasing WAS fraction resp. with shortening of the retention time in primary clarifiers, the achievable dewatering result decreases significantly

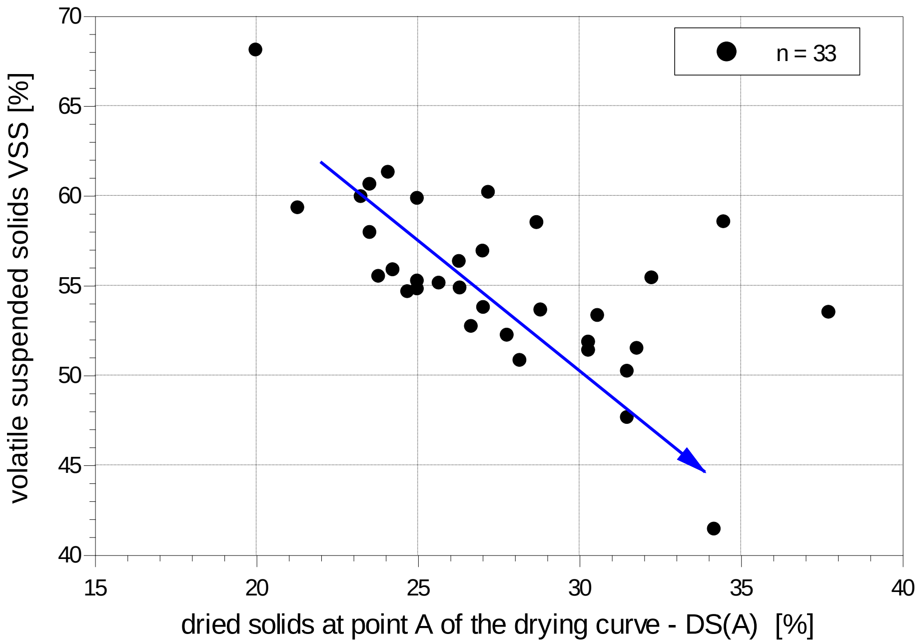


Fig. 5.7: Dependency of parameter DS(A)$_{KBKOPP}$ on volatile suspended solids for municipal digested sludges

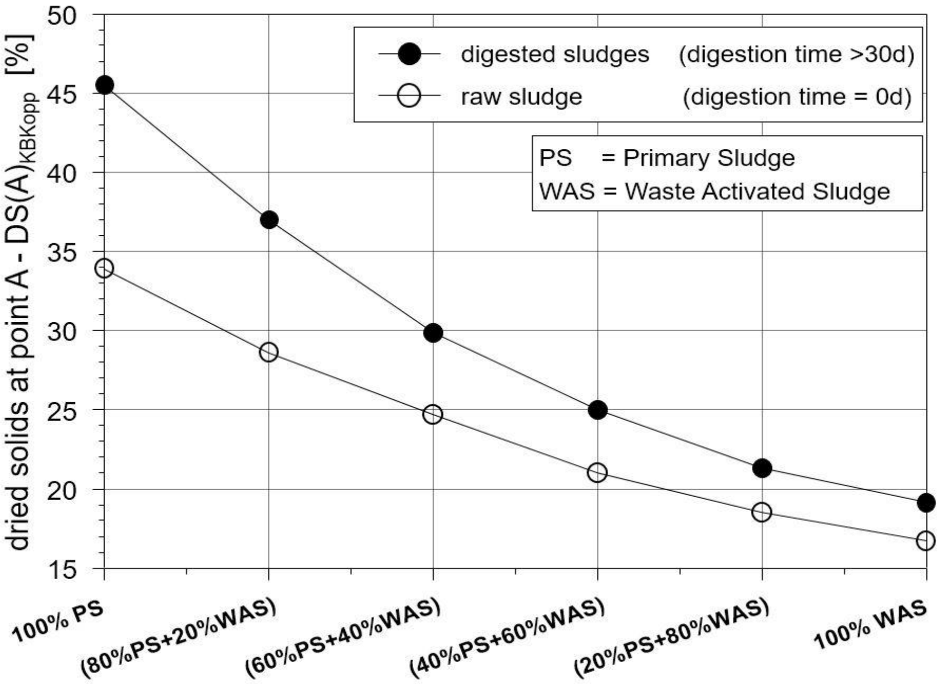


Fig. 5.8: Dependency of parameter DS(A)$_{KBKopp}$ on WAS fraction
Example: dewatering tests with sludge from WWTP Hildesheim Germany

The water binding in sewage sludge is mainly influenced by the organic content of the waste activated sludge and the phosphate concentration (see Fig. 5.11).

It is recommended to record the WAS fraction on the basis of monthly averages in the operating log and to measure phosphate concentration in sludge water.

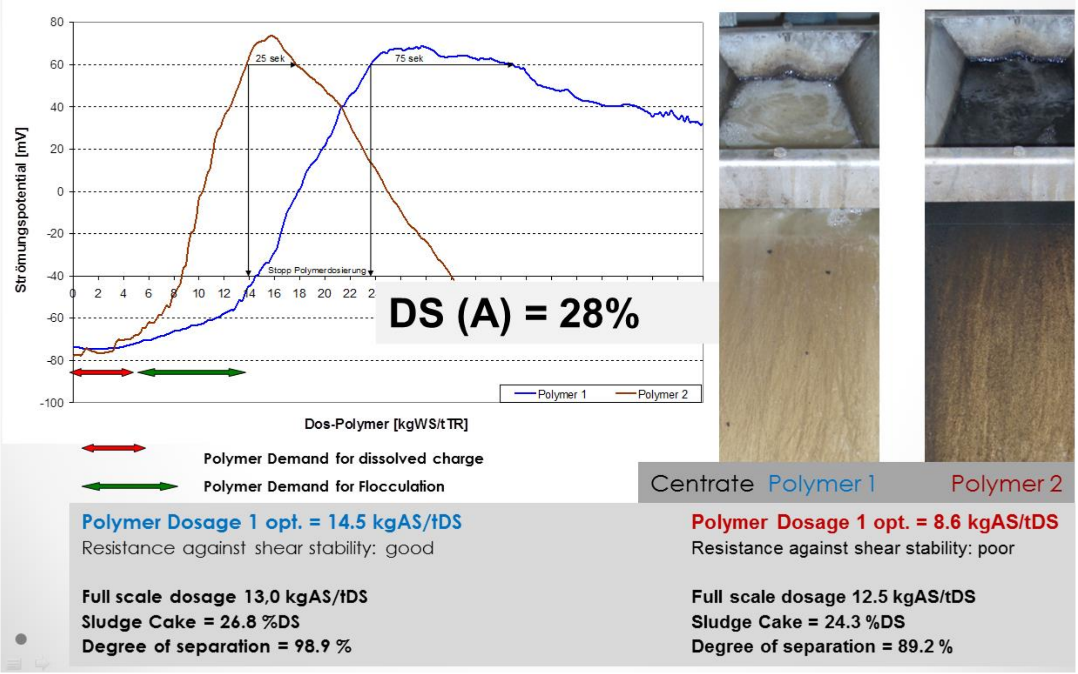
5.2 Polymer-demand

Conditioning before dewatering enhances water removal and improves solid capture. The most typical conditioning systems use inorganic chemicals and organic polymers. During conditioning the sludge coagulates because of addition of cationic polymers for example and release of free water is accelerated.

It is possible to use the streaming potential for determination of the polymer demand. An optimum polymer dose is reached, when no electrostatic repulsive forces affect the sludge particles anymore and the value of the streaming potential in sample amounts to -40 mV (due to actual calibration of the measuring device the measuring point with no electrostatic repulsive forces was shifted to – 40 mV). Fig. 5.9 shows the measurement unit and Fig. 5.10 an example for measurement results.

Polymer-demand is basically determined by the anionic surface charge of sludge particles [8]. The sludge surface charge on the other hand is determined by entire surface area and charge carriers. Exopolysaccharides (EPS) and other exopolymers contain a highly negative surface charge [9]. EPS are very voluminous and bind a lot of water because of their strong polarity. By staining the EPS, it can be shown, that when excess sludge is concerned, the entire surface area of sludge particles is covered with a gel-like slime. The amount of EPS is basically responsible for the polymer demand of sludge.

Fig. 5.9: measurement unit SCD



Polymer Demand for dissolved charge

Polymer Demand for Flocculation

Polymer Dosage 1 opt. = 14.5 kgAS/tDS
Resistance against shear stability: good

Full scale dosage 13,0 kgAS/tDS
Sludge Cake = 26.8 %DS
Degree of separation = 98.9 %

Polymer Dosage 1 opt. = 8.6 kgAS/tDS
Resistance against shear stability: poor

Full scale dosage 12.5 kgAS/tDS
Sludge Cake = 24.3 %DS
Degree of separation = 89.2 %

Fig. 5.10: polymer titration curve for a polymer with high and with low shearing stability

Criteria shear stability of the conditioned sludge flocs:

angle	< 40 °	not recommended for decanter
angle	< 45° ≥ 40°	+ 4,0 kgAS/tDS
angle	< 50° ≥ 45°	+ 3,5 kgAS/tDS
angle	< 55° ≥ 50°	+ 3,0 kgAS/tDS
angle	< 60° ≥ 55°	+ 2,5 kgAS/tDS
angle	< 65° ≥ 60°	+ 2,0 kgAS/tDS
angle	< 70° ≥ 65°	+ 1,5 kgAS/tDS
angle	< 75° ≥ 70°	+ 1,0 kgAS/tDS
angle	< 80° ≥ 75°	+ 0,5 kgAS/tDS
angle	>80°	polymer extra dosage 0,0 kgAS/tDS

5.3 Influence of Cations and Phosphate

Cation Index CI - Ratio of ammonium to calcium and magnesium

Not only high phosphate concentrations (Fig. 5.11) in the digested sludge have in many cases negative effects on the sludge dewatering and / or the polymer demand.

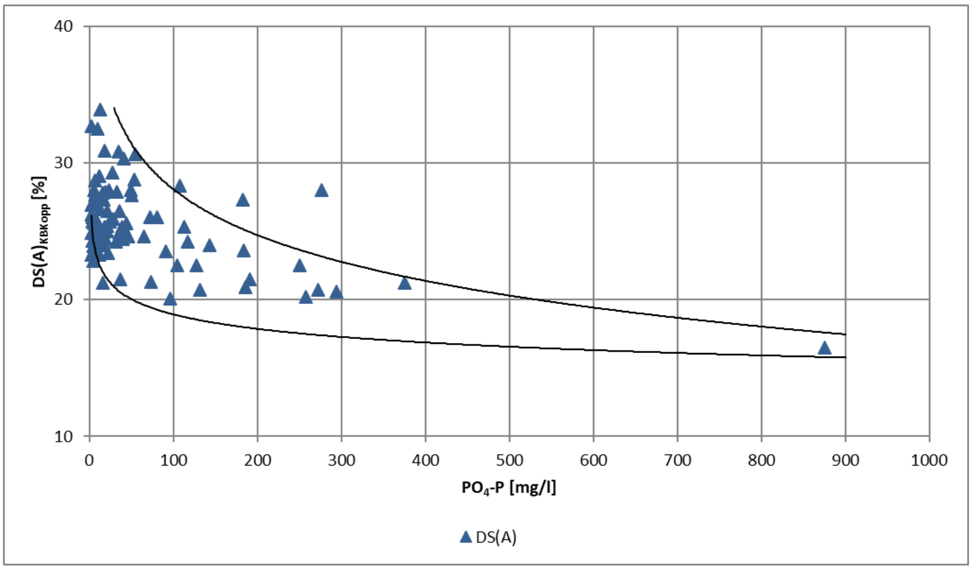


Fig. 5.11: DS(A)$_{KBKOPP}$ in relation to the sludge PO_4-P concentration [KBKopp 2016]

The ammonium concentration of the sludge is determined mainly by the proportion of waste activated sludge (WAS) in the digested sludge. A higher WAS content has a negative effect on the dewaterability of the sludge due to higher water binding. Thus, the cation index (CI) can be used for an extended description of sludge dewatering (source: Kopp, J., MWR-Denver: Dewaterability Workshop 07/2018).

$$\mathrm{CI} \quad = \frac{c\ (NH_4^+)}{c\ (Mg^{2+})\ + c\ (Ca^{2+})}\ [-]$$

Annotation: c (cation) in (mval / l)

It should be taken into consideration that MAP precipitation with magnesium salts changes the concentration of cations (magnesium, ammonium). The lower the cation index, the better the dewaterability of the sewage sludge (Fig. 5.12).

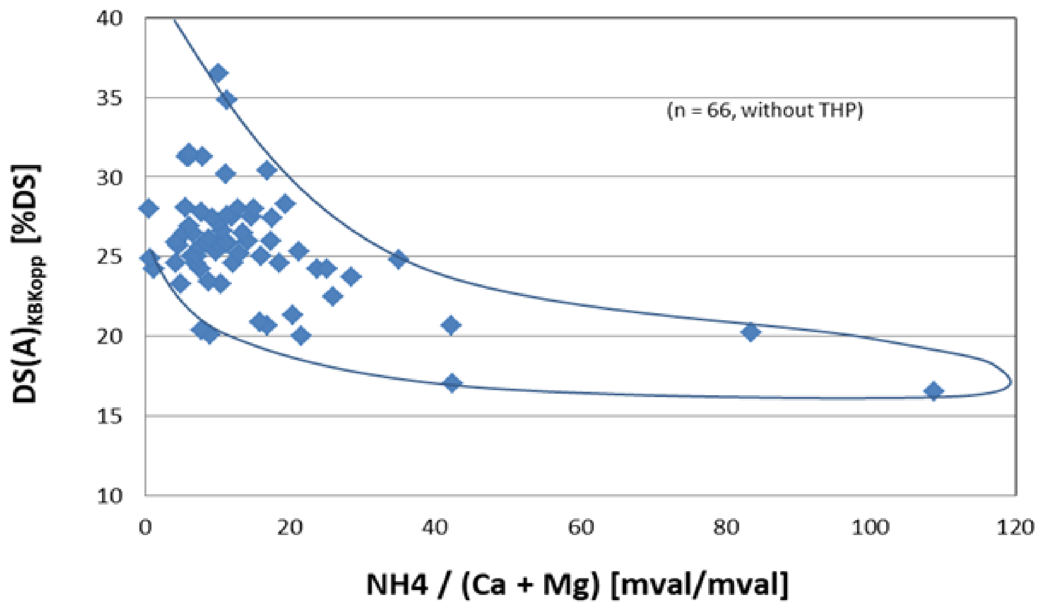


Fig. 5.12: Maximum dewaterability DS $(A)_{KBKopp}$ (%), depending on the cation index (CI) (Source: Kopp, J., MWR-Denver: Dewaterability Workshop 07/2018)

5.4 Capture Rate

The capture rate is a parameter used to describe quality of dewatering process. If the degree of separation is low (< 95%, better 98%) the amount of solids in centrate is very high and quality of the separation process is insufficient. The capture rate is calculated as

$$\text{Capture rate} = [((DS_S - FS_C) * DS_C) / ((DS_C - FS_C) * DS_S)] * 100 \quad [\%]$$

where

DS_S is dried solids of the sludge [g/l],

DS_C is dried solids of the sludge cake [g/l] and

FS_C is suspended solids of centrate [g/l].

With centrifuges and chamber filter presses it is possible to dewater at state of technology.

When using belt filter presses or screw presses, the energy input for dewatering is lower and therefore the dewatering result lies 2 %DS points below $DS(A)_{KBKOPP}$ (see fig. 5.4).

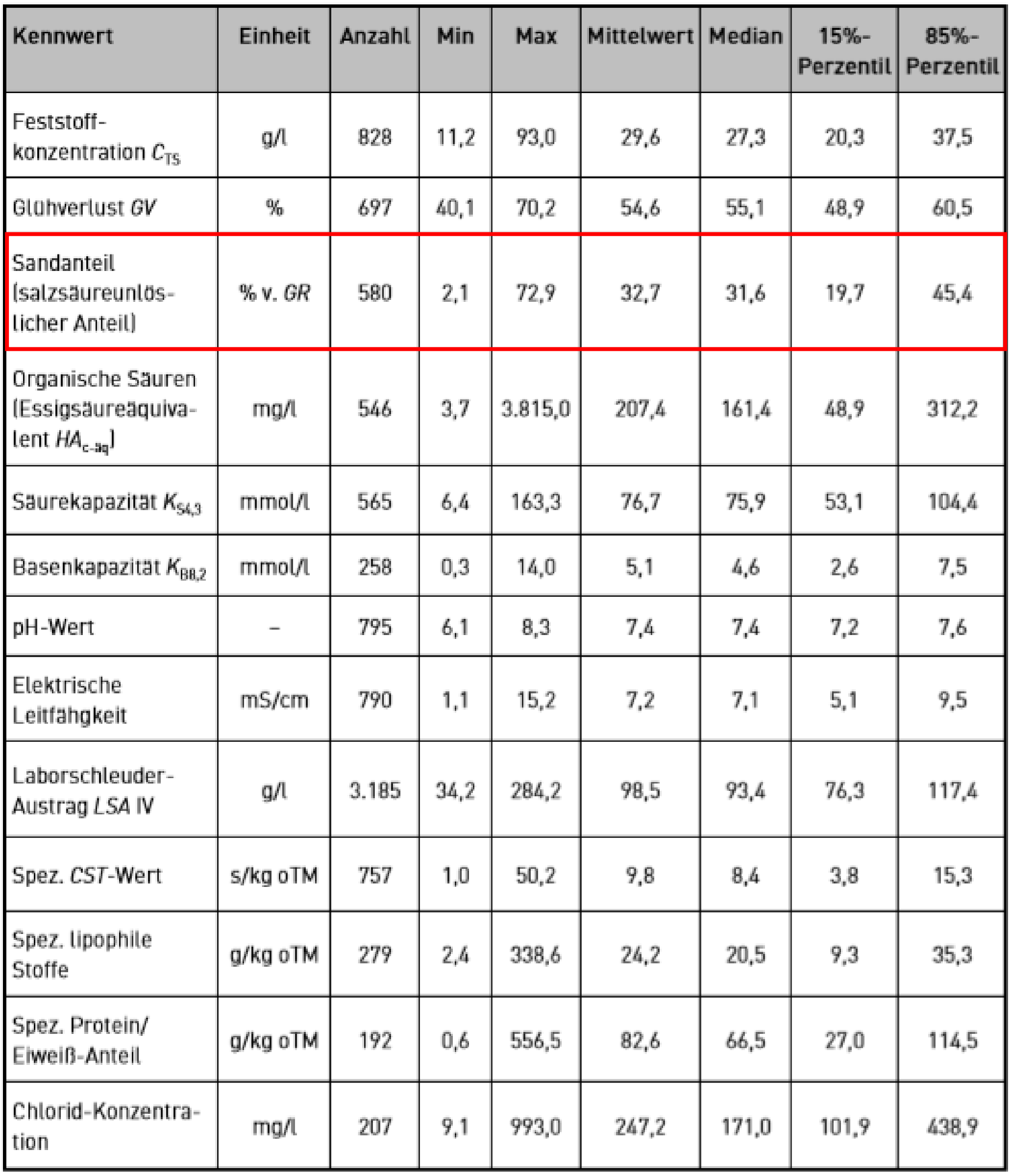
A capture rate of at least ≥ 95% (better 98%) should be always kept with dewatering process, in order to keep back load for WWTP by filtrate water as small as possible (i.e. filterable solids in centrate max = 490 mg/l with DS = 2.2 % and optimal dewatering result, using black ribbon filters with 9 - 10 sec filtration rate, DIN 53137).

5.5 Sand content

The sand fraction / content was measured as the non-soluble rest of the ignition residue (IR) after treatment with hydrochloric acid.

Communal digested sludges normally have a sand content of 32.7% IR and VSS = 40-70% (M-383 DWA [12]).

Table 5.2: Characteristics of digested sludge (WAS) [12]



Kennwert	Einheit	Anzahl	Min	Max	Mittelwert	Median	15%-Perzentil	85%-Perzentil
Feststoff-konzentration C_{TS}	g/l	828	11,2	93,0	29,6	27,3	20,3	37,5
Glühverlust *GV*	%	697	40,1	70,2	54,6	55,1	48,9	60,5
Sandanteil (salzsäureunlöslicher Anteil)	% v. *GR*	580	2,1	72,9	32,7	31,6	19,7	45,4
Organische Säuren (Essigsäureäquivalent $HA_{c\text{-}äq}$)	mg/l	546	3,7	3.815,0	207,4	161,4	48,9	312,2
Säurekapazität $K_{S4,3}$	mmol/l	565	6,4	163,3	76,7	75,9	53,1	104,4
Basenkapazität $K_{B8,2}$	mmol/l	258	0,3	14,0	5,1	4,6	2,6	7,5
pH-Wert	–	795	6,1	8,3	7,4	7,4	7,2	7,6
Elektrische Leitfähgkeit	mS/cm	790	1,1	15,2	7,2	7,1	5,1	9,5
Laborschleuder-Austrag *LSA* IV	g/l	3.185	34,2	284,2	98,5	93,4	76,3	117,4
Spez. *CST*-Wert	s/kg oTM	757	1,0	50,2	9,8	8,4	3,8	15,3
Spez. lipophile Stoffe	g/kg oTM	279	2,4	338,6	24,2	20,5	9,3	35,3
Spez. Protein/Eiweiß-Anteil	g/kg oTM	192	0,6	556,5	82,6	66,5	27,0	114,5
Chlorid-Konzentration	mg/l	207	9,1	993,0	247,2	171,0	101,9	438,9

6. Literature

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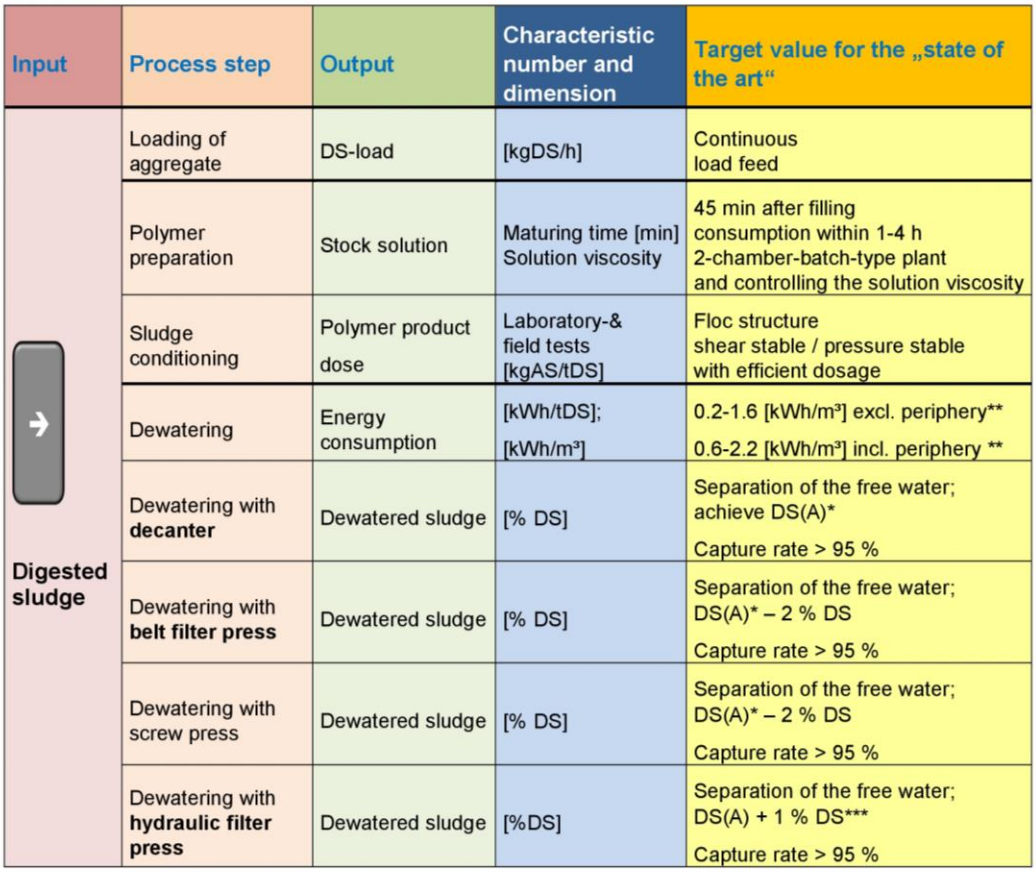
Table 5.3: performance indicators sludge dewatering [13]



Input	Process step	Output	Characteristic number and dimension	Target value for the „state of the art“
Digested sludge	Loading of aggregate	DS-load	[kgDS/h]	Continuous load feed
	Polymer preparation	Stock solution	Maturing time [min] Solution viscosity	45 min after filling consumption within 1-4 h 2-chamber-batch-type plant and controlling the solution viscosity
	Sludge conditioning	Polymer product dose	Laboratory-& field tests [kgAS/tDS]	Floc structure shear stable / pressure stable with efficient dosage
	Dewatering	Energy consumption	[kWh/tDS]; [kWh/m³]	0.2-1.6 [kWh/m³] excl. periphery** 0.6-2.2 [kWh/m³] incl. periphery **
	Dewatering with **decanter**	Dewatered sludge	[% DS]	Separation of the free water; achieve DS(A)* Capture rate > 95 %
	Dewatering with **belt filter press**	Dewatered sludge	[% DS]	Separation of the free water; DS(A)* – 2 % DS Capture rate > 95 %
	Dewatering with screw press	Dewatered sludge	[% DS]	Separation of the free water; DS(A)* – 2 % DS Capture rate > 95 %
	Dewatering with **hydraulic filter press**	Dewatered sludge	[%DS]	Separation of the free water; DS(A) + 1 % DS*** Capture rate > 95 %

*	= or other forecast characteristics (DWA M-383)
**	= Energy consumption depends on the aggregate and periphery
***	= Due to the high shear forces during dewatering in the hydraulic filter press, the need for polymeric flocculants is increased
AS	= Active substance of the polymer

APPENDIX I

Metering TM

TECHNICAL MEMORANDUM

TO:	Kevin Hall, P.E. Central Weber Sewer Improvement District 2618 Pioneer Road Ogden, UT 84404
COPIES:	James Dixon, P.E.
FROM:	Keith Larson, P.E. and Tucker Jorgensen, E.I.T.
DATE:	March 1, 2023
SUBJECT:	District Wide Metering
JOB NO.:	016-22-01

SECTION 1 INTRODUCTION

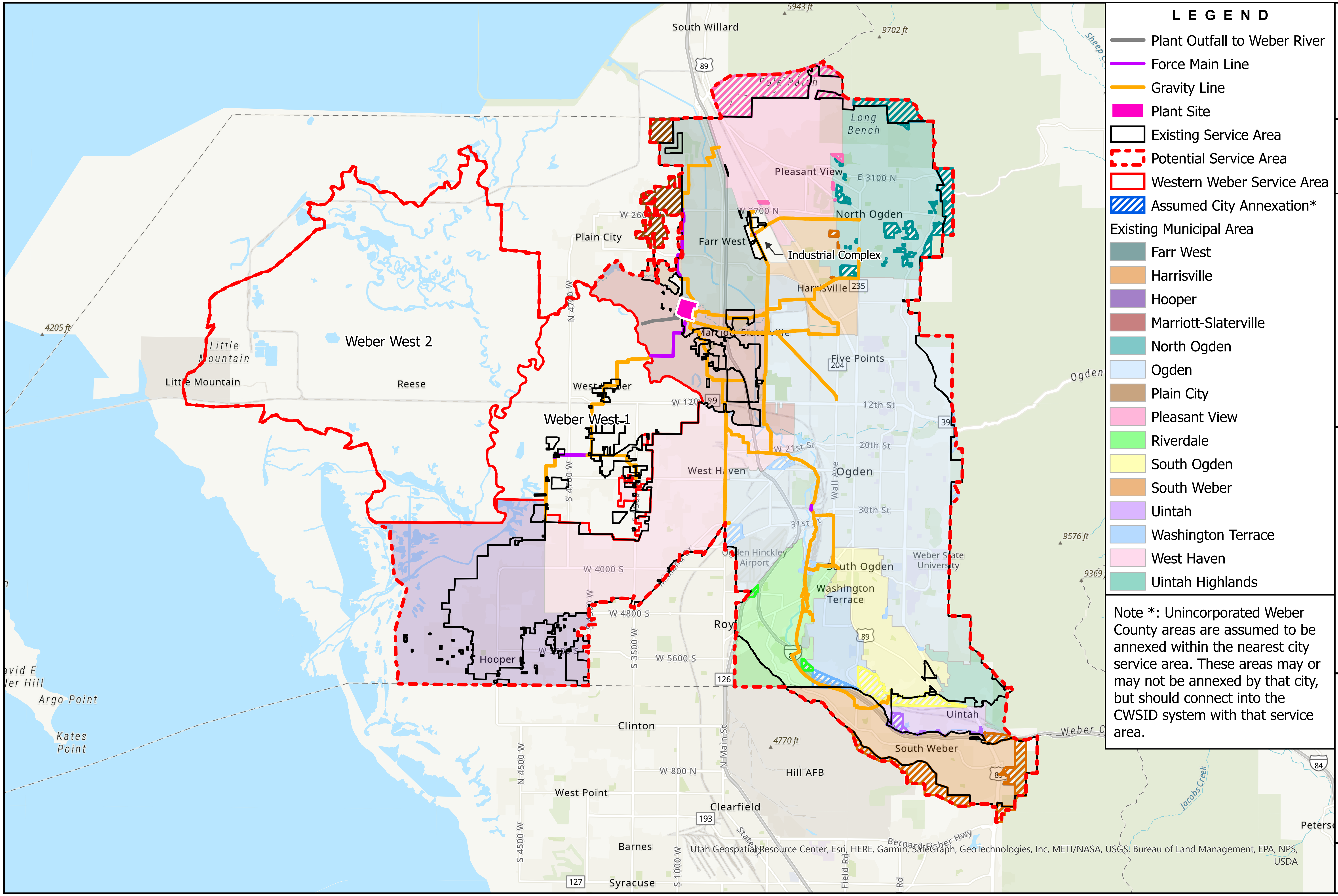
The Central Weber Sewer Improvement District (CWSID or District) collects and treats wastewater for a significant portion of Weber County as shown on Figure 1-1. The existing service area includes all, or a part of: Farr West, Harrisville, Hooper, Marriott-Slaterville, North Ogden, Ogden, Plain City, Pleasant View, Riverdale, Roy, South Ogden, South Weber, Uintah, Washington Terrace, West Haven, and Unincorporated Weber County.

The District's current approach to billing each community is based on the estimated population in each community and the value of property in each community. While this approach is simple to administer, it does not capture any difference in flow or strength loading that may existing between different communities. As a result, there has been some interest in exploring options for changing how each community is charged for service. An option of specific interest is for each community to be billed based on their specific flow rate and loading. To implement this type of billing system, the District would need to install and maintain a flow metering system. The purpose of this technical memorandum is to evaluate the metering efforts that would be required to individually meter flow from each community and estimate the associated cost of this potential change.

SECTION 2 DISTRICT BILLING

The current billing approach used by the District is based on the population and property value in each member entity. While looking at population will roughly capture differences in total Base Sanitary Flow (BSF), it does not account for any other wastewater variations between member agencies. This includes variations from entity to entity in the following components:

- Variations in Base Sanitary Flow associated with different household size, water use, etc.
- Inflow
- Infiltration
- Wastewater strength



Utah Geospatial Resource Center, Esri, HERE, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USDA

LEGEND

- ▬ Plant Outfall to Weber River
- ▬ Force Main Line
- ▬ Gravity Line
- ■ Plant Site
- ☐ Existing Service Area
- ☐ Potential Service Area
- ☐ Western Weber Service Area
- ▨ Assumed City Annexation*

Existing Municipal Area

- ■ Farr West
- ■ Harrisville
- ■ Hooper
- ■ Marriott-Slaterville
- ■ North Ogden
- ■ Ogden
- ■ Plain City
- ■ Pleasant View
- ■ Riverdale
- ■ South Ogden
- ■ South Weber
- ■ Uintah
- ■ Washington Terrace
- ■ West Haven
- ■ Uintah Highlands

Note *: Unincorporated Weber County areas are assumed to be annexed within the nearest city service area. These areas may or may not be annexed by that city, but should connect into the CWSID system with that service area.

SCALE: 1 in = 10,000 ft

NORTH:

CENTRAL WEBER SEWER IMPROVEMENT DISTRICT SERVICE AREA

CWSID

WASTEWATER MASTER PLAN

BOWEN COLLINS & ASSOCIATES

FIGURE NO.

1-1

P:\Central Weber SID\016-22-01 CWSID Master Plan\4.0 GIS\4.4 APRX\CWSID Master Plan - 2.aprx tjorgensen 2/23/2023

By using population alone to estimate demands on the wastewater system, it is likely that member entities are being billed different amounts for the same level of impact on the system. Entities with large inflows or high strength wastewater are paying less (per gallon of flow) than those with smaller inflows and lower strength wastewater. This memorandum explores the potential option of collecting enough information to allow the District to bill based on total flow and loading rates for each member entity. To adjust the billing method for the District, new detailed information will be required for each member entity in the two following areas:

- **Sewer Flow (Volume)** - The sewer flow associated with each individual entity will need to be calculated/measured. This can be done by using permanent flow meters distributed throughout the District service area based on individual entity discharge points. While the District does have a few flow meters it can deploy, the only permanent meters the District has installed are near and within the treatment plant. In addition, the number of meters owned by the District is inadequate to breakout the flow for any individual entity. To collect the flow data necessary to meter flow from all member entities, a large number of additional permanent flow meters will be needed. This is detailed in Section 3.
- **Sewer Loading (Strength)** – Wastewater strength is commonly reported based on Biological Oxygen Demand (BOD) and Total Suspended Solids (TSS). Estimating the BOD and TSS of wastewater generally requires obtaining representative samples of sewer flow. These samples are then taken to a laboratory where BOD and TSS are calculated. To consider wastewater strength for each of the District's member agencies, a detailed plan would need to be developed to implement a sampling methodology that would capture the characteristic strength of wastewater for each City. This is discussed in Section 4.

SECTION 3 POTENTIAL METER LOCATIONS

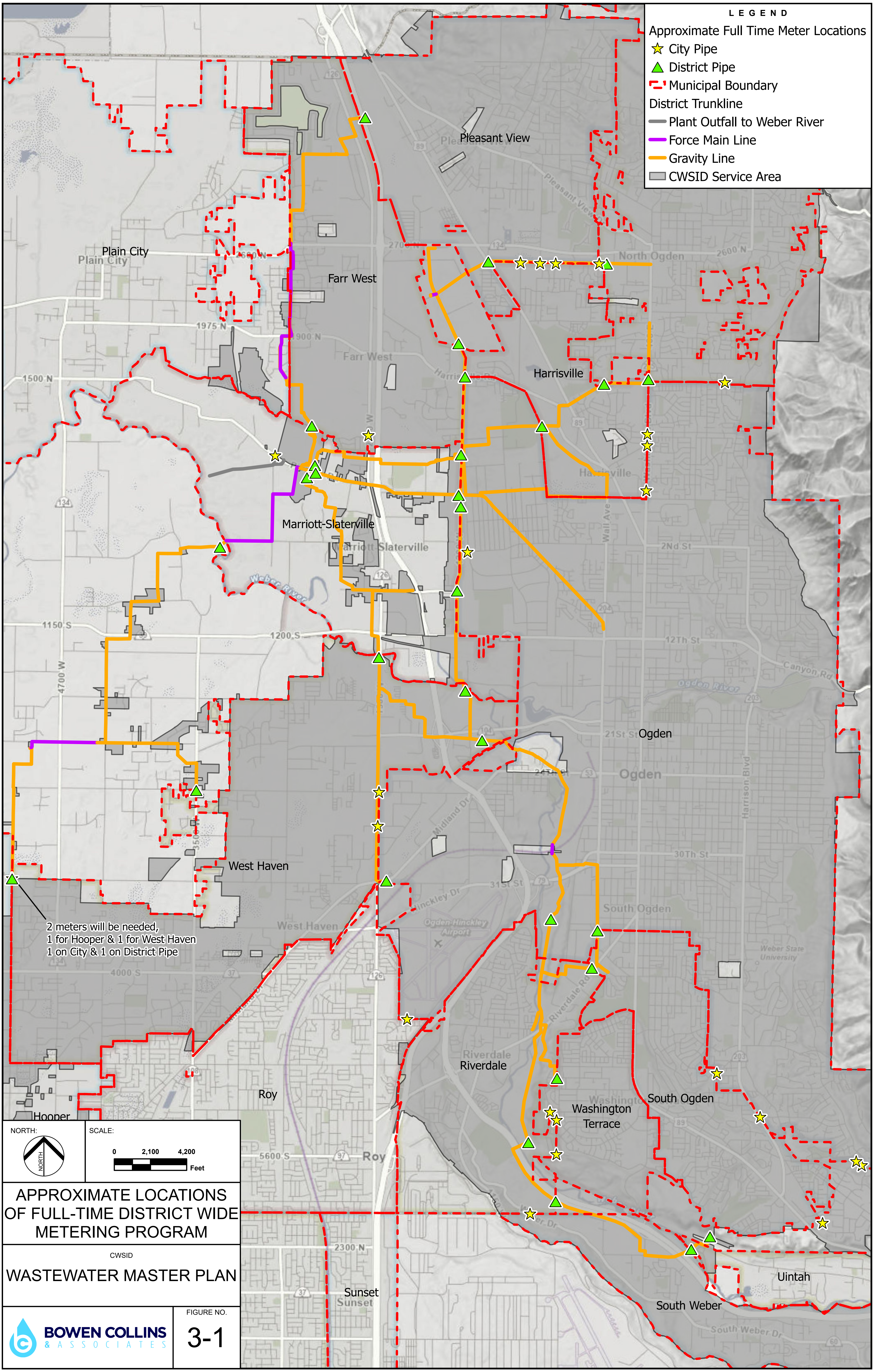
As part of the District's recent master plan effort, Bowen Collins & Associates collected sewer maps and sewer master plans for the cities within the District. Based on these maps and master plans, it was determined that 31 meters would be needed on District pipelines with an additional 24 meters on city owned pipelines to be able to isolate the flow rate from each city. The approximate locations of these meters are shown in Figure 3-1. A summary of the meters required for each City is discussed below. Table 3-1 (at the end of this section) summarizes the total meter information for the District.

3.1 FARR WEST AND PLAIN CITY

The inflow from Farr West and Plain City are intermingled along the Farr West gravity line. This makes it difficult to separate the two cities' flows. However, since the number of existing connections is minimal in Plain City, the flow from these connections can likely be estimated reasonably closely based simply on number of connections. This would allow for the City of Farr West to be metered using two meters, one on a District pipe and the other on a city pipe. There is the potential that both meters could be installed on District pipes, but based on the sewer map from Marriott-Slaterville and Farr West, it is difficult to determine if the flow from Farr West in 2000 west can be metered individually. This would need to be verified during a final meter location design.

3.2 HOOPER AND WEST HAVEN

Hooper City has a single outfall into the District collection system at approximately 5100 West and 3300 West. This outfall is shared with West Haven. As a result, a meter will be required for both the Hooper and West Haven flow at or near this location. This will mean one District and one city pipe meter. In addition to the outfall shared with Hooper City, West Haven has one other major outfall



2 meters will be needed,
1 for Hooper & 1 for West Haven
1 on City & 1 on District Pipe

APPROXIMATE LOCATIONS OF FULL-TIME DISTRICT WIDE METERING PROGRAM

CWSID

WASTEWATER MASTER PLAN

BOWEN COLLINS
& ASSOCIATES

FIGURE NO.

3-1

P:\Central Weber SID\016-22-01 CWSID Master Plan\4.0 GIS\4.4 APRX\CWSID Master Plan - 2.aprx tjorgensen 2/23/2023

located along 3500 West at approximately 2550 South. A meter could be installed at this location. The east side of West Haven has multiple outfall points along the West Haven Mainline along 1900 West. This line is shared with Ogden City, but since Ogden City has less inflow points along this line, the eastern portion of West Haven could be metered with a third meter installed in 1900 West at approximately 1400 South.

3.3 UNINCORPORATED WEBER COUNTY (WESTERN WEBER AND UINTAH HIGHLANDS)

The unincorporated portions of Weber County currently serviced by the District can be broken into three categories:

- **Islands** – In this case, "Islands" of unincorporated Weber County reference areas that are surrounded by incorporated cities (not necessarily a single entity). These areas have been grouped in with nearby cities as seen in Figure 1-1. It has been assumed that these areas will not require their own meters.
- **Uintah Highlands** – Uintah highlands refers to the developed area of unincorporated County to the southeast of South Ogden. This area discharges into the South Ogden System at a single point on Wasatch Dr. at approximately 6100 South. A meter on the South Ogden City pipe would be required for Uintah Highlands.
- **Western Weber County** – This refers to the area west of existing city limits. This area has multiple distributed outfalls into the District's collection system. However, no other entity discharges in the same area. As a result, a single meter at or near the West Weber Lift Station could be installed to meter flow for this area. This assumption would need to be reevaluated as the Unincorporated Weber County areas become annexed into various Cities.

In total, there would need to be two meters, one on a District pipe and one on a city pipe, to meter the unincorporated portions of Weber County.

3.4 UINTAH AND SOUTH WEBER

Both Uintah and South Weber have a single outfall into the District's collection system. While not all of Uintah is currently served by CWSID, it is assumed that due to the Weber River and I-84, when/if Uintah is annexed into the district it will continue to have a single outfall point. Uintah could be metered by a single meter on district pipe somewhere between I-84 and 6600 South. South Weber has multiple outfall points along the Southern District Sewer line. Due to I-84, South Weber is the only City that discharges along this section of pipe. There is a small subarea of South Weber that flows into Riverdale. Currently this represents a small fraction of the Cities existing flow, but as development increases an additional meter on either South Weber or Riverdale pipe would be needed.

3.5 SOUTH OGDEN, WASHINGTON TERRACE, AND RIVERDALE

South Ogden has three primary discharges into the District's system, one into the start of the south District line and two along 40th street. Each of these three discharges could be metered using a single meter on a District pipe at or near the South Ogden Border. There are minor flows between both Uintah Highlands and Ogden with South Ogden. Meters on City pipes would identify the flow from these entities into South Ogden, especially for Uintah Highlands as discussed in Section 3.3.

The flow from Washington Terrace has a single outfall directly into the District system on 4900 South. Washington Terrace also shares a pipe with Riverdale that discharges into the District system at approximately 5500 South and 500 West. In addition to a meter on a District pipe in this area, three meters on city pipes would be required to divide the flow from Washington Terrace and Riverdale in this area.

Riverdale City has multiple outfalls into the District's collection system. Despite this, only one additional meter would be needed to calculate flow from Riverdale. This is because all other flow in the District pipe along this reach will have been metered and accounted for upstream. The meter would need to be installed between 35th and 31st Street. This will potentially require coordinating with the Riverdale Railroad Yard to install the meter.

3.6 NORTH OGDEN, PLEASANT VIEW, AND HARRISVILLE

North Ogden, Pleasant View and Harrisville all discharge into the sewer line along 2550 North. Flow from North Ogden can be metered at its border with Pleasant View/Harrisville. Both Pleasant View and Harrisville have multiple outfalls along the 2550 North sewer line. A meter can be placed near Hwy 89 to calculate the flow from Pleasant View, assuming meters are placed on each Harrisville City outfall. It is important to note that the area and total flow from Harrisville is significantly less than the flow from Pleasant View. Flow from Harrisville into the 2550 North line could potentially be estimated based on the number of connections served in lieu of installing four meters on the Harrisville City pipe.

In addition to outfalls along 2550 North, both North Ogden and Harrisville also have outfalls into the District pipe that goes from 400 East to Independence Blvd. Flow from North Ogden in this line can be calculated with a meter at approximately 1500 North and 400 East as well as one at 100 East. Due to a small portion of Harrisville that flows into the line between the two meters, the 100 East meter might need to be installed on the North Ogden City pipe. Harrisville flow along this pipe can be calculated by installing a meter at approximately 1100 North and 550 West. This meter would also capture flow from portions of Ogden City that flow into the Harrisville City System. Meters would be required between Harrisville and Ogden City. There is also a small portion of North Ogden that flows into Ogden City that would need an additional meter on city pipe.

To capture the rest of the flow from Harrisville City, a meter would be required near Harrisville Rd. and 1200 West. Calculating the rest of the flow from Harrisville would require a meter near the start of the Farr West Gravity line, preferably upstream of I-15.

3.7 INDUSTRIAL COMPLEX

There is an industrial/commercial complex between Harrisville, Pleasant View, and Farr West. A permanent meter has already been planned and is expected to be installed soon on the Industrial Lift Station. In addition to this, a meter should be installed on 1500 West at approximately 1850 North.

3.8 MARRIOTT-SLATERVILLE

There are no outfalls downstream of Marriott-Slaterville from other cities with the exception of the Farr West No. 1 Lift Station and the West Weber Force Main. Flow from Marriott-Slaterville can be calculated by installing meters on the sewer line in Pioneer Road, just upstream of the BDO Lift Station, and on the pipe from the South that outfalls into Pioneer Road at approximately 2600 West. Due to backwater effects and low slope, combining the Pioneer Road and Southern pipes into a single metering location is impractical. A small flow from the western portion of Marriott-Slaterville flows directly into the treatment plant. Currently one meter on a city pipe would capture this flow, however, as this portion of Marriott-Slaterville is developed there is the potential that more meters might be required.

3.9 OGDEN CITY

Breaking out the flow from Ogden City has unique challenges due to the geographical size of the City and the number of locations with connection to other cities. There are about 10 locations where either Ogden City flow enters into a different city's system or vice versa. This does not include the approximately four locations where Ogden City outfalls into the District system that would need to be metered on City pipe. All of these locations are shown in Figure 3-1 along the Ogden City Border. In addition to the meters on city pipes, 6 meters would be needed on District pipe between 2100 South and 1200 West.

3.10 METER SUMMARY

To isolate flow for all the entities in the District, it would be necessary to install at least 31 meters on District pipes. With these meters in place, and a few assumptions regarding small areas of flow, it would be possible to meter approximately 85-90% of the total District flow. If the District and member cities agree to install an additional 24 meters on city pipes, the flow could be calculated for every entity with the exception of Plain City and Roy. These two cities have only very small areas serviced by the District making it difficult to meter. It would continue to be most practical to estimate flows for those two cities based on number of connections. Installation of meters on individual city pipes will require coordination with individual cities. The total need for meters is summarized in Table 3-1.

Table 3-1
Flow Meter Installation Summary by City and Pipe Location

City/Area [1]	Number of Meters on District Pipe	Numbers of Meters on City Pipe
Farr West	1	1
Harrisville	3	6
Hooper	1[2]	0
Marriott-Slaterville	4	1
North Ogden	3	1
Ogden	5	8
Pleasant View	1	0
Riverdale	2	2
South Ogden	3	0
South Weber	1	1
Uintah	1	0
Washington Terrace	1	1
West Haven	3	1[2]
Unincorporated Weber County	1	1
Industrial Complex	1	0
Total	**31**	**24**

[1] Plain City and Roy City don't have any proposed meter locations

[2] It is assumed that Hooper will have a meter on the District pipe and West Haven on the city pipe, but this could be swapped. Two meters are required, regardless of configuration.

SECTION 4 WASTEWATER SAMPLING PLAN

Developing an appropriate load sample collection methodology will require a detailed study beyond the scope of this memorandum. However, the general approach is expected to be grab sampling at strategic locations in the District to represent each member entity. Approximate frequency of sampling is expected to be:

- Each City's strength characteristics will be updated at least Quarterly.
- Each entity will have a minimum of three samples. Sampling will be increased for larger entities.
- Total samples for each quarter to be approximately 75.

SECTION 5 COST ESTIMATES

Costs for installing a permanent metering system can be broken down into three parts as follows:

- **Capital Costs** – This includes the equipment, materials, and labor required to install the required permanent meters. It also includes the cost of engineering design to plan and install the metering and sampling improvements.
- **Wastewater Strength Samples** – This cost includes the associated increase in workload required to collect sewer samples. It also includes laboratory costs for testing the samples.
- **Annual Operation and Maintenance** – This type of billing system will require ongoing operation and maintenance costs. Beyond the strength sampling costs noted above, operation costs are expected to include review of the raw data from each meter to verify accuracy, generate quarterly rates based on flow and strength data, upkeep the installed system (e.g. meters, power supply, transmitter, etc.), and routinely calibrate each of the meters. Meters have a limited expected life span and will need to be replaced periodically.

All cost estimates provided are in 2023 dollars.

5.1 CAPITAL COST ESTIMATE

Installation costs are assumed to be controlled in part by the size of pipe to be metered. Table 5-1 summarizes the number of meters for each size of pipe based on the District collection system. For this cost estimate it was assumed that all meters used on City systems will be installed on 15-inch pipes. As City pipe meter locations are finalized, this should be verified and could potentially change.

Table 5-1
Meter Installation Size and Cost Estimates

Meter Size (inch)	Number of Meters	Unit Cost of Meter	Capital Cost of Meter Size	Engineering (15% of Capital Cost)	Total Cost
12 -18	30[(1)]	\$100,000	\$3,000,000	\$450,000	\$3,450,000
21 - 30	11	\$140,000	\$1,540,000	\$231,000	\$1,771,000
36+	14	\$200,000	\$2,800,000	\$420,000	\$3,220,000
Total	**55**	**--**	**\$7,340,000**	**\$1,101,000**	**\$8,441,000**

[1] 24 are assumed City pipe meters

These cost estimates are based on a long-term, permanent metering installation. This includes identification of or installation of a manhole with hydraulic characteristics required for accurate metering, electrical conduit and power to the meters, and a data communications system. For larger meters, a flume and level gauge may be the best solution. For other applications, a radar-based flow sensor may be acceptable. The unit cost estimate shown here assumes a mix of both flumes and radar-based flow meter setups. If one type of setup is use significantly more than the other, cost estimates will vary.

5.2 STRENGTH SAMPLE COST ESTIMATE

For cost estimate purposes BC&A has assumed the following:

- 75 total quarterly samples as detailed previously.
- Average manhours for sample collection of 0.5 hrs at cost of $100/hr.
- Average laboratory cost per sample of $100/each.

Based on these assumptions, the wastewater strength sample cost would be approximately $50,000/year.

5.3 ANNUAL OPERATION AND MAINTENANCE COST ESTIMATE

It is estimated the cost of operation and maintenance would be approximately $110,000 per year. This includes an estimated $10,000/year for data collection and accounting as well as $40,000 per year for meter maintenance and calibration. It also includes assumed replacement of meter components once every 10-years for an annual cost of $60,000. It should be noted that this is not the full cost of meter construction. It includes replacing the meter sensor, but not the structural and electrical components necessary for initial setup. Total cost is based on $20,000 per meter replacement for 31 District meters.

5.4 TOTAL COSTS

Table 5-2 summarizes the total costs for moving to this alternative billing approach.

Table 5-2
Cost Estimates Associated with Permanent Metering

Meter Location	Capital Cost	Engineering (15% of Capital Cost)	Strength Sample Cost	Annual O&M Cost
District Meters	$4,940,000	$741,000	$50,000/year	$110,000/year
City Meters[1]	$2,400,000	$360,000	--	--
Total	**$7,340,000**	**$1,101,000**	**$50,000/year**	**$110,000/year**

[1] Strength sample cost for City meters is included in district meter cost.

[2] Annual maintenance of city meters should be done by the city that installed the meter. Operation cost is included with the District estimate.

SECTION 6 CONCLUSIONS

The Central Weber Sewer Improvement District is looking into the possibility of changing the current billing method to a flow and load based method. Creating a billing system based on both flow and BOD loading would require the following:

- **Installation of Meters** – At least 31 meters would need to be permanently installed and maintained on District pipes. This would allow for estimating directly the flow coming from individual member cities for approximately 85-90% of the total District flow. To calculate the remaining portion of the flow, approximately 24 meters would need to be installed on City pipes. Capital cost of installation would range from $5,681,000 to $8,441,000 for installing meters on District pipelines only or all meters respectively.
- **Wastewater Strength Samples** – Wastewater strength would need to be calculated by obtaining representative grab samples throughout each city. A grab sample plan would need to be developed and performed to estimate the total BOD and TSS load from each of the cities. BOD costs would be approximately $50,000 per year.
- **Operation and Maintenance** – A billing plan would need to be developed to use the flow and load data. This would need to include revieing flow and strength data, generating billing charges based on the data for each billing cycle, and maintaining the meters. Total annual O&M cost of $50,000.

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