FINAL
WASTEWATER MASTER PLAN

Prepared for:

Crestline Sanitation District

24516 Lake Drive
Crestline, CA 92325
Contact: Rick Dever

Prepared by:

DUDEK

605 Third Street
Encinitas, California 92024
Contact: Phil Giori, PE

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ACKNOWLEDGMENTS

This Wastewater Master Plan is a result of the combined efforts of the management and staff of Crestline Sanitation District and the Dudek team. This partnership has resulted in a comprehensive evaluation of the collection system, wastewater treatment facilities and operations, and establishes framework for capital improvement planning to ensure sustainable, high-quality service to Crestline Sanitation District customers. In particular, the efforts of the following individuals are acknowledged and appreciated:

Crestline Sanitation District

Rick Dever .... General Manager
Ron Scriven .... Operations Manager
Jordan Dietz .... Electrical Mechanical Specialist
Rob Lasher .... Operator I
Cory Hubbell .... Operator I
Brandon Ricksecker .... Operator II
Dave Crabtree .... Maintenance Worker

Dudek Study Team

Mike Metts, PE .... Principal-In-Charge
Phil Giori, PE .... Project Manager
Greg Guillen, PhD, PE .... Senior Engineer/Process Specialist
Wyatt Troxel, Grade V .... Senior Technical Advisor
Elizabeth Caliva, PE .... Senior Engineer/Collection System Task Lead
Hanna Dodd, PE .... Project Engineer
Kasey Harvey .... Project Engineer

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ABBREVIATIONS

AACEI	The Association for Advancement of Cost Estimating International
ABS	Acrylonitrile-Butadiene-Styrene
ACP	Asbestos Cement Pipe
AD	Assessment District
ADWF	Average Dry Weather Flow
AWWF	Average Wet Weather Flow
BOD	Biochemical Oxygen Demand
BOD_5	5-day Biochemical Oxygen Demand
CCI	Construction Cost Index
CCTV	Closed Circuit Television
CEQA	California Environmental Quality Act
CIP	Capital Improvement Plan
CL	Cleghorn
CM	Construction Management
CMU	Concrete Masonry Unit
CoF	Consequence of Failure
CoFA	Consequence of Failure Analysis
CSD or District	Crestline Sanitation District
CWA	Clean Water Act
CWSRF	Clean Water State Revolving Fund
d/D	Depth over Diameter Ratio
DAC	Disadvantaged Community
DBE	Disadvantaged Business Enterprise
DFA	Division of Financial Assistance
ENR	Engineering News Record
ESDC	Engineering Services During Construction
FY	Fiscal Year
GIS	Geographic Information System

gpd	Gallons per Day
gpm	Gallons per Minute
HC	Huston Creek
HCTS	Huston Creek Trunk Sewer
HPE	High Pressure Effluent
I/I	Infiltration and Inflow
IUP	Intended Use Plan
LF	Linear Feet
MCC	Motor Control Center
M&E	Metcalf & Eddy
MGD	Million Gallons per Day
MH	Manhole
MPDA	Maximum Population Density Average
NEPA	National Environmental Policy Act
O&M	Operations and Maintenance
PDCA	Plan-Do-Check-Act
PDWF	Peak Dry Weather Flow
PF	Principal Forgiveness
PoF	Probability of Failure
PVC	Polyvinyl Chloride
PWWF	Peak Wet Weather Flow
RAS	Return Activated Sludge
RO	Reverse Osmosis
RWQCB	Regional Water Quality Control Board
SC	Seeley Creek
SCADA	Supervisory Control and Data Acquisition
SCG	Small Community Grant
SFY	State Fiscal Year
SRT	Solids Retention Time
TSS	Total Suspended Solids

VCP	Vitrified Clay Pipe
VFD	Variable Frequency Drive
WMP	Wastewater Master Plan
WWTP	Wastewater Treatment Plant

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1 INTRODUCTION

Crestline Sanitation District (CSD or District) was formed on January 16, 1947 to provide sewer services to the Lake Gregory area of the San Bernardino Mountains. The District was managed by the San Bernardino County Special Districts until voters elected to move CSD toward an independently run district in 2008, which ultimately led to formation of the District's first independent Board of Directors in October 2010. The District has been independent ever since.

Table 1-1 below summarizes the District's major treatment and collection system facilities, original year of construction, and dates of substantial upgrades or modifications.

Table 1-1: Crestline Sanitation District Facilities

Facility	Original Construction	Upgrades/Modifications
Huston Creek (HC)	1952	1972, 1983, 1996, 2001
Seeley Creek (SC)	1974	1984
Cleghorn (CL)	1974	-
Collection System	1952	1968, 1969, 1974, 1975, 1977

Much of the District's wastewater facilities are now between 45 and 65 years old, with many original processes, core infrastructure and facilities remaining in service today. The District has been successful by maintaining and prolonging the use of these facilities without expensive overhauls proposed in past studies. The District intends to continue to maintain, rehabilitate, repurpose, or otherwise extend the useful life of serviceable assets while investing necessary funds to continue to meet regulatory compliance and customer service objectives.

1.1 Purpose

This Wastewater Master Plan identifies, prioritizes, and budgets recommended capital improvement projects for the District.

1.2 Relationship to Current and Ongoing Work

This WMP identifies projects independently of previous District planning. The District has currently initiated design and/or construction of several improvements to their facilities. Project concepts discussed with District staff that and already initiated are not included in the CIP project recommendations, including Supervisory Control and Data Acquisition

(SCADA) system upgrades and collection system rehabilitation. The recommended projects included in this WMP supplement the District's annual planning and budgeting efforts.

1.3 Methodology

The development of this WMP involved three primary tracks of evaluation and data analysis to identify and define CIP project recommendations. These three tracks of analysis function to assess capacity and reliability of District facilities. Figure 1-1 depicts these tracks and this WMP approach.

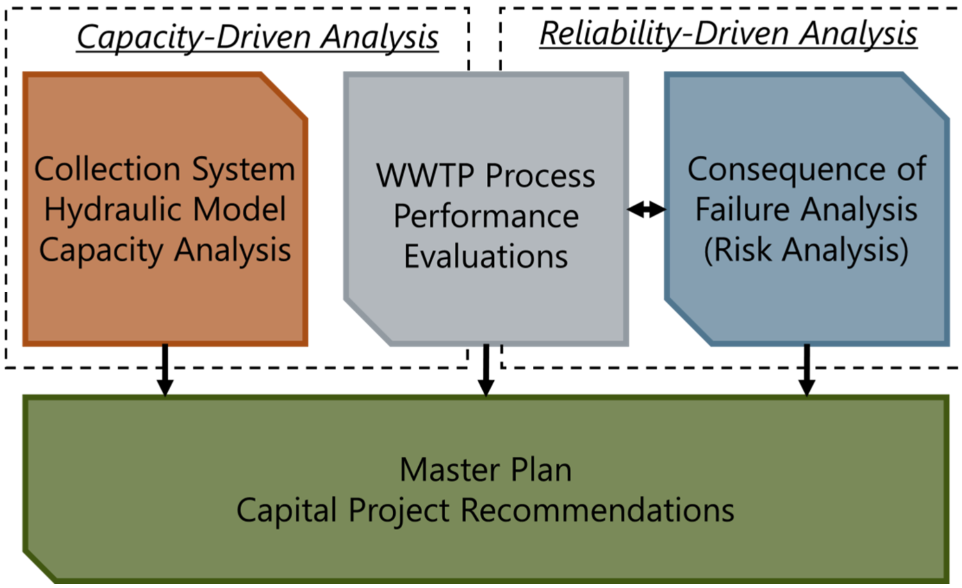


Figure 1-1. Master Plan Development Approach

<u>*Collection System Hydraulic Model Capacity Analysis:*</u> a wastewater collection system hydraulic model of the main sewer trunk lines was developed and calibrated using flow meters.

<u>*WWTP Process Performance Evaluations:*</u> process performance evaluations were performed to identify existing capacity and performance constraints at the WWTPs.

<u>*Consequence of Failure Analysis (Risk Analysis):*</u> a CoFA was performed on each of the WWTP's and lift stations to identify reliability and deficiencies in a workshop environment. Recommended CIP projects are prioritized based on the CoFA risk designation of the deficiencies that define the project need.

1.3.1 PROPOSITION 218

This WMP supports the District's initiatives to set wastewater system fees, which are subject to Proposition 218. Proposition 218, the "Right to Vote on Taxes Act" was passed by California voters in November 1996, requiring voter approval prior to imposition or increase of general taxes, assessments, and certain user fees. Wastewater service fees are subject to Proposition 218 regulations, which carefully define rules and restrictions for benefit assessments. As it applies to wastewater service providers, rates must be tied to the specific benefits realized by the fee payer. Fees charged to property owners should not exceed the cost of providing the service, which includes maintaining infrastructure.

The WMP establishes immediate to long-term planning budgets for the District. The development of the WMP project recommendations is founded on process performance and risk and reliability analyses, which aim to maximize return on capital investments and allow for sustainable capital expenditure planning. The District's budgets should support a rate structure that generates revenue necessary to maintain District facilities in optimum operable condition and meet current regulatory requirements.

1.3.2 COLLECTION SYSTEM HYDRAULIC MODEL

The principal tool utilized in the capacity analysis is a hydraulic model that simulates flow conditions, such as wastewater depth, flow rate, and velocity within the District's wastewater collection system. The development of a new computer model for the District included use of InfoSewer® software, which is an ArcGIS-based computer program developed by Innovyze.

Using record drawing data for the District's trunk system, including pipeline diameter, length, invert elevations, rim elevations and pipeline roughness coefficients, a hydraulic model was developed to assess capacity restrictions in the system, under wet and dry conditions, both currently and for anticipated future build-out conditions for the system.

1.3.3 CONSEQUENCE OF FAILURE ANALYSIS (COFA)

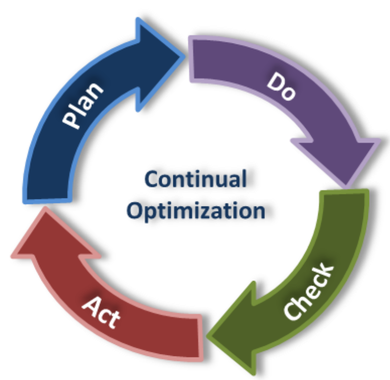
A Consequence of Failure Analysis (CoFA) was performed on District WWTP's and lift stations through a series of collaborative workshops and onsite meetings with District staff. The CoFA analyzed process unit functions at a system level and estimated the probability and consequences of system failure. The consequence and probability of failure establish a risk designation that allows prioritization of risk-based strategic planning. Depending on the risk designation and the nature of the defined failure mode, operational-based and/or capital-based recommendations are made to mitigate the risk by either reducing the defined consequence and/or probability of failure. Consequence of Failure Analysis methodology and results are included in Section 5.2.

1.3.4 PROCESS EVALUATION

The project team performed a process technical evaluation to support CIP project decision-making and provide context to recent operational challenges at the WWTP's. The process evaluation analyzes the current process configuration and most recent two years of daily, or less-frequent process data. The process data was compared to the facilities intended design as well as accepted industry standards from Metcalf & Eddy (M&E), Wastewater Engineering, 5th edition for operations, design, and process performance. The analysis includes a high-level evaluation of existing unit processes and the current plant configurations with an emphasis on process performance and capacity. Ancillary/support systems (i.e. size of pumps, piping, etc.) are not considered in the analysis. The full process evaluation (Technical Memorandum 1) is included in Appendix A.

1.3.5 OPERATIONAL CHANGES

The declining condition and performance of existing facilities have led the District Operations staff to implement innovative modifications in an attempt to enhance plant performance and meet discharge requirements. Some additional operational adjustments are recommended as part of this Master Plan. Operational changes are most productive if executed in a methodical approach that allows for ongoing performance evaluation and adjustments. The "Plan-Do-Check-Act" (PDCA) approach, also known as the iterative 4-step "Deming Cycle", is recommended for the execution of proposed operational adjustments. As District staff prepare to make operational changes, it is recommended that thorough implementation plans be prepared in advance. The implementation plans will allow evaluation of performance improvements and should include step-wise approach with monitoring protocols that continuously check process performance against expected outcomes to allow adjustments to be made that effectively produce the anticipated results and so that unanticipated consequences do not jeopardize goals.



1.4 Budgetary Cost Estimating

A budgetary cost is estimated for each defined project. The cost estimates are based on anticipated construction cost values with a contingency and "soft cost" (e.g. planning, design, administrative) multipliers added to define a total "project cost".

Estimates of probable construction costs include consideration of:

- Vendor quotes and published catalog costs for major equipment and mechanical components. Material and equipment quotes. Multipliers for delivery, in-field services, installation, tools, parts, labor, and contractor overhead and profit were applied to derive an installed unit cost.
- Parametric unit cost values derived from recent similar projects for demolition, piping, civil work, and electrical work. Scaling factors were applied to adjust for size and complexity.
- Unit cost factors developed for specific components of the project, as applicable.
- Project location factors used to normalize costs to the appropriate locale using RS Means.

1.4.1 COST INDICES

In developing project cost estimates, it is common to use historical data from similar projects, (e.g. detailed cost estimates, bids from constructed projects). To be relevant to the immediate project, one must consider the date and geographical region of the cost data. The industry standard barometer of changes in construction market conditions over time is the Engineering News Record's (ENR) Construction Cost Index (CCI). This index is computed from constant quantities of structural steel (weighted 15%), Portland cement (2%), lumber (10%), and common labor (73%) in 20 cities, the average of which is considered to be the national average and based on a value of 100 in 1913 (Sanks, 852). Similarly, the CCI is regionalized using the Los Angeles ENR-CCI index. Construction estimates are normalized in time by proportioning values to the index existing at the time of the estimate or bid. The cost estimates for the work of this WMP are normalized to the Los Angeles ENR-CCI for March 2018 of 11,935.82.

1.4.2 COST ESTIMATE CLASSIFICATIONS

The Associations for Advancement of Cost Estimating International (AACEI) provides guidelines for cost estimating practices and classification. The Cost Estimate Classification System – As Applied in Engineering, Procurement, and Construction for the Process Industries (AACEI Recommended Practice No. 18R-97) provides guidelines for applying the principles of estimate classification to infrastructure projects such as those defined in this Master Plan. A summary of the AACEI classification system is presented in Table 1-2.

Table 1-2. Summary of Cost Estimate Classification System

Estimate Class	Primary Characteristic	Secondary Characteristic			
	Level of Project Definition *Expressed as % of complete definition*	**End Usage** *Typical purpose of estimate*	**Methodology** *Typical estimating method*	**Expected Accuracy Range [a]** *Typical variation in low and high ranges*	**Preparation Effort [b]** *Typical degree of effort relative to least cost index of 1*
Class 5	0% to 2%	Concept Screening	Capacity Factored, Parametric Models, Judgement or Analogy	L: -20% to -50% H: +30% to +100%	1
Class 4	1% to 15%	Study or Feasibility	Equipment Factored or Parametric Models	L: -15% to -30% H: +20% to +50%	2 to 4
Class 3	10% to 40%	Budget, Author-ization, or Control	Semi-detailed Unit Costs with Assembly Level Line Items	L: -10% to -20% H: +10% to +30%	3 to 10
Class 2	30% to 70%	Control or Bid/Tender	Detailed Unit Cost with Forced Detailed Take-Off	L: -5% to -15% H: +5% to +20%	4 to 20
Class 1	50% to 100%	Check Estimate or Bid Tender	Detailed Unit Cost with Detailed Take-Off	L: -3% to -10% H: +3% to +15%	5 to 100

Notes:

a) The state of process technology and availability of applicable reference cost data affect the range markedly. The +/- value represents typical percentage variation of actual costs from the cost estimate after application of contingency (typically at a 50% level of confidence) for a given scope.

b) If the range index value of "1" represents 0.0005% of project costs, then an index value of 100 represents 0.5%. Estimate preparation effort is highly dependent upon the size of the project and the quality of estimating data and tools.

For the development of CIP project recommendations, Class 5 estimates are used. Class 5 estimates ("Order of Magnitude") are defined by AACEI as follows:

<u>Description:</u>

Class 5 estimates are generally prepared based on very limited information, and subsequently have wide accuracy ranges. As such, some companies and organizations have elected to determine that due to the inherent inaccuracies, such estimates cannot be classified in a conventional and systematic manner. Class 5 estimates, due to the requirements of end use, may be prepared within a very limited amount of time and with little effort expended – sometimes requiring less than an hour to prepare. Often, little more than a proposed plant type, location, and capacity are known at the time of estimate preparation.

<u>Estimating Methods Used:</u>

Class 5 estimates virtually always use stochastic estimating methods such as cost/capacity curves and factors, scale of operations factors, Lang factors, Hand factors, Chilton factors, Peters-Timmerhaus factors, Guthrie factors, and other parametric and modeling techniques.

<u>Expected Accuracy Range:</u>

Typical accuracy ranges for Class 5 estimates are -20%to -50% on the low side, and +30% to +100% on the high side, depending on the technological complexity of the project, appropriate reference information, and the inclusion of an appropriate contingency determination. Ranges could exceed those shown in unusual circumstances.

<u>End Usage:</u>

Class 5 estimates are prepared for any number of strategic business planning purposes, such as but not limited to market studies, assessment of initial viability, evaluation of alternate schemes, project screening, project location studies, evaluation of resource needs and budgeting, long-range capital planning, etc.

1.4.3 CONTINGENCY

Project contingencies are applied to cover uncertainties in the estimating practice including unknown or unforeseen costs. Industry standard contingencies can range from 10% to 35%, depending on the confidence level of the estimate (i.e., project stage, risk, scope development, engineering constraints, etc.). Unless noted otherwise, a 35% contingency was added to the estimated construction costs herein.

1.4.4 IMPLEMENTATION COSTS

Implementation cost allowances (a.k.a. "soft costs") are included in the project estimates for costs directly associated with delivering a project from planning through construction that are not included in the construction estimate (i.e. planning, design, permitting, construction management/inspection, project administration, and commissioning and closeout). Projects with lower construction costs have a larger percentage of project delivery (soft) costs, while the larger projects have a smaller percentage of soft costs. This is primarily due to the number of implementation cost tasks that have relatively fixed costs such as contract processing, permit fees, bidding, etc. These fixed costs have a greater impact on the smaller projects.

Seven of the largest municipalities in California (Cities of Long Beach, Los Angeles, Oakland, Sacramento, San Diego, San Jose, and City and County of San Francisco) have collaborated to study the actual cost of delivering capital improvement projects. The California Multi-Agency CIP Benchmarking Study first published in 2002 has been updated yearly to reflect a larger number of projects. The results of this benchmarking study provide insight into soft costs of California projects as a function of project type and size. Of 112 municipal projects (median construction value of $0.86 million), the project implementation or delivery costs averaged 36% to 37% of the construction costs. Table 1-3 presents the project implementation allowances (soft cost) classification system utilized in the CIP recommendations. Each project is assigned a "Soft Cost Class" of A, B, C, or D, depending on the project size and complexity. Projects that do not fit into one of these four classifications are listed as "Project Specific", and soft costs are assigned based on recent similar projects and experience.

Table 1-3. Summary of Soft Cost Classification System

Soft Cost Class	Category	% of Construction Cost	Comments
A	Engineering CM & ESDC Administration *Total Soft Costs*	8% 15% 2% *25%*	Projects that are relatively simple (e.g. long pipelines, large pond liners, large (+300k) equipment replacement) and/or larger (e.g. full treatment plant design), possibly with repetitive aspects.
B	Engineering CM & ESDC Administration *Total Soft Costs*	10% 18% 3% *31%*	Projects that are average size and/or complexity (e.g. new lift stations, treatment plant components, and major equipment replacement).
C	Engineering CM & ESDC Administration *Total Soft Costs*	15% 20% 5% *40%*	Complex and/or small projects (e.g. electrical upgrades, SCADA upgrades, small lift station replacement/rehab).
D	Engineering CM & ESDC Administration *Total Soft Costs*	5% 5% 5% *15%*	City replaced/installed equipment (e.g. small pump replacement, instrument replacement projects).

Engineering = Study, Preliminary and Final Design
CM = Construction Management (Contract management and inspection)
ESDC = Engineering Services During Construction
Administration = District administrative and legal costs

1.5 Prioritization

CIP project recommendations are prioritized according to the results of the CoFA and grouped into three categories: immediate works (recommend to initiate project within 0-2 years), mid-term (recommend to initiate project within 3-6 years), and long-term (recommend to initiate project in 7+ years). Within those primary groups, the projects are ranked by default according to the CoFA. Deviation from this risk-based prioritization occurs based on engineering judgement.

2 DESCRIPTION OF EXISTING FACILITIES

The District provides collection, treatment, and disposal for primarily domestic sewage for customers within their service area. In addition, the District owns and operates a wastewater treatment plant that services the Silverwood Lake State Park, and an effluent pipeline to convey treated effluent from four wastewater treatment systems to the District's disposal site at Las Flores Ranch, near Hesperia, CA.

Wastewater collected within the District service area is treated at two District-owned treatment plants, Seeley Creek WWTP to the west and Huston Creek WWTP to the east.

The area served by Huston Creek WWTP is the largest of the two collection system areas, providing service for 75 percent of the sewered area. The service area for Seeley Creek WWTP comprises the remaining 25 percent within the present boundary of the District.

2.1 Collection System

The District's collection system facilities include gravity mains, force mains and lift stations. Information regarding the existing wastewater collection system facilities was obtained from previous reports and District staff input.

2.1.1 GRAVITY MAINS

The District's existing wastewater collection system is shown in Figure 2-1, and is comprised of approximately 73 miles of gravity sewer pipelines with pipe diameters ranging from 6- to 15-inches. The District's collection system is subdivided into eleven Assessment Districts (AD). All assessment districts flow into Huston Creek WWTP, except for AD-5, which flows into Seeley Creek WWTP. Table 2-1 and Table 2-2 detail the facilities in the Huston Creek and Seeley Creek service areas by assessment district. AD-5 is the largest assessment district by miles of pipe (16 miles) followed by AD-1 (15-miles).

Table 2-1. Huston Creek WWTP Service Area Facilities

Assessment District	Year Constructed	Number of Manholes	Sewer Length (feet)	Sewer Length (miles)	Percentage of Huston Creek WWTP Service Area Pipelines	Number of Available Connections	Pipe Material
AD-1	1952	580	77,712	15	26%	1,665	VCP[1]
AD-2	1968	270	42,500	8	14%	556	ACP[2]
AD-3	1969	200	33,257	6	11%	528	ACP
AD-4	1968	159	37,643	7	13%	555	VCP
AD-6	1975	133	26,000	5	9%	397	VCP
AD-8	1975	149	26,329	5	9%	397	ABS[3]
AD-9	1977	82	17,500	3	6%	210	PVC[4]
AD-10	1977	70	11,380	2	4%	182	ABS
AD-11	1977	61	12,316	2	4%	187	PVC
AD-12	1977	76	13,501	3	5%	228	ABS
TOTALS		**1,780**	**298,138**	**56**	**100%**	**4,905**	

[1]Vitrified Clay Pipe; [2]Asbestos Cement Pipe; [3]Acrylonitril-Butadiene-Styrene; [4]Polyvinyl Chloride

Table 2-2. Seeley Creek WWTP Service Area Facilities

Assessment District	Year Constructed	Number of Manholes	Sewer Length (feet)	Sewer Length (miles)	Number of Available Connections	Pipe Material
AD-5	1974	410	86,182	16	1,573	ACP
TOTALS		**410**	**86,182**	**16**	**1,573**	

Approximately, 50% percent of the District's collection system was constructed prior to 1970. Generally, the older portions of the collection system are found in the area directly adjacent to Lake Gregory and Lake Drive. The majority of the District's collection system is constructed of asbestos cement pipe (ACP) (42% of total system) and vitrified clay pipe (VCP) (37% of total system).

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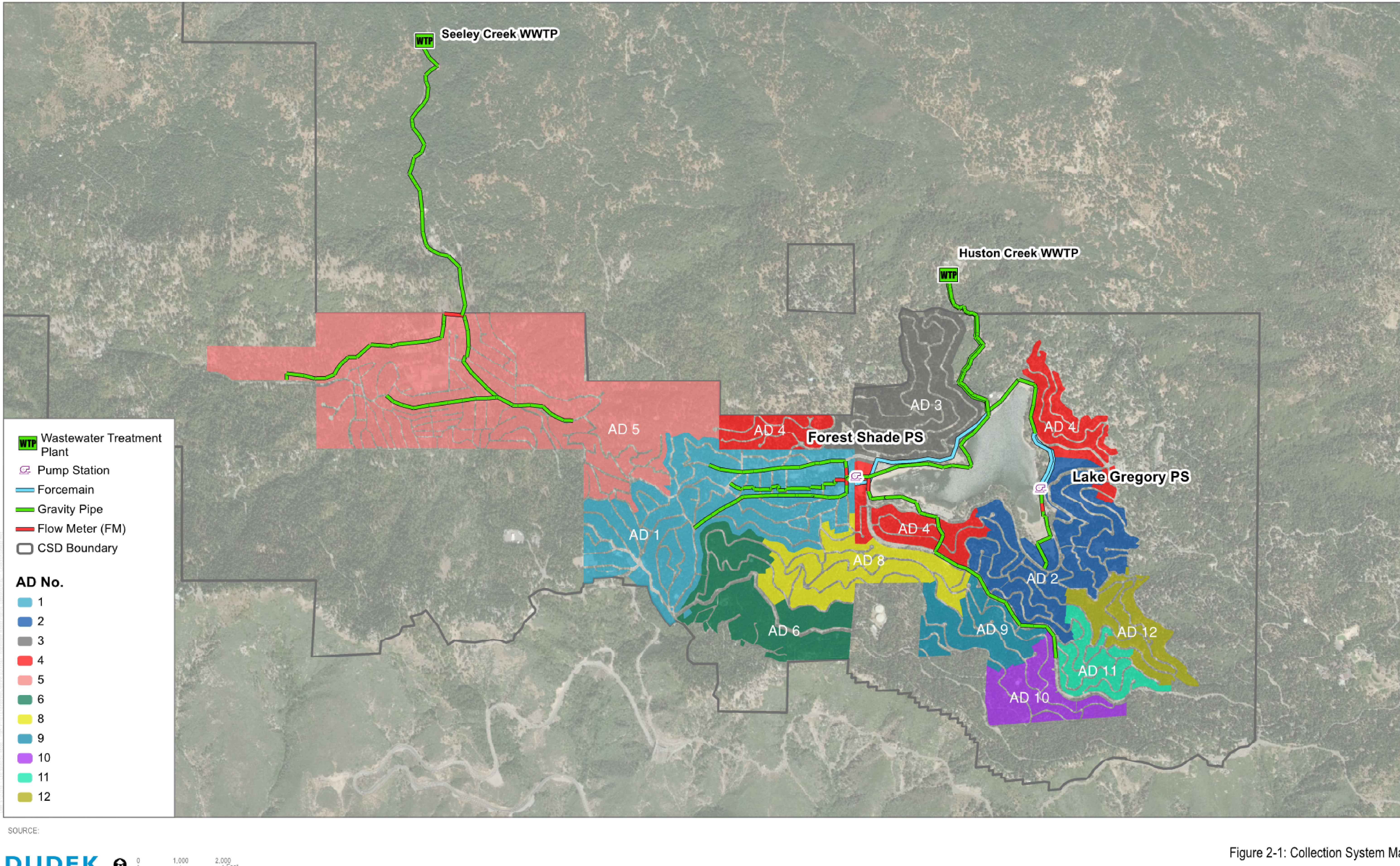

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Figure 2-1: Collection System Map

Crestline Sanitation District

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2.1.2 LIFT STATIONS AND FORCE MAINS

The District has two primary sewage lift stations within the collection system with characteristics shown in Table 2-3. Each lift station consists of two pumps that are duty units alternating automatically as a lead or lag pump. Each lift station also has a stand-by generator for backup power supply.

Table 2-3. Lift Stations and Force Mains

Lift Station Name	Location	Year Built	Force Main(s) Diam (inch)	Force Main(s) Length (feet)	Lift (feet)
Lake Gregory[1]	24658 San Moritz Dr	1968	6 8	1,488 1,495	20 20
Forest Shade	565 Forest Shade Rd	1979	10	3,350	11

Notes:
[1] Lake Gregory Lift Station pumps have dedicated force mains.

The Lake Gregory Lift Station is located on the east side of Lake Gregory along San Moritz Way and receives raw sewage from AD-2, AD-11, AD-12, and the Pinecrest area. The station contains two vertical mount, close-coupled dry pit pumps, as detailed in Table 2-4. The pumps discharge sewage through dedicated 6-inch and 8-inch force mains to a vault at the intersection of Lake Drive and San Moritz Way.

Table 2-4. Lake Gregory Lift Station Pumps

Pump No.	Flow (gallons per minute [gpm])	Head (feet)	HP	RPM	Manuf.	On Level Setting1 (in)	Off Level Setting1 (in)
1	650	88	20	1,750	Cornell	46	24
2	650	92	20	1,750	Cornell	48	24

Notes:
[1] As measured from bottom of wet well.

The Forest Shade Lift Station is located east of Forest Shade Road and south of Lake Drive. It operates only when sewage backs up in the 15-inch gravity trunk main along Lake Gregory and overflows into the wet well; therefore, it predominantly operates under peak wet weather flow conditions. This station contains two submersible pumps within a single wet well, as detailed in Table 2-5. The pumps discharge through a 10-inch force main, located in Lake Drive, to a discharge structure located just west of Lake Gregory Dam.

Table 2-5. Forest Shade Lift Station Pumps

Pump No.	Flow (gpm)	Head (feet)	Pump HP	RPM	Manuf	On Level Setting1 (in)	Off Level Setting1 (in)
1	1,200	65	30	1,750	Ebara	38	18
2	1,200	65	30	1,750	Ebara	42	18

Notes:
[1] As measured from bottom of wet well.

2.2 Wastewater Treatment Plants

The District owns and operates three WWTPs: Huston Creek WWTP, Seeley Creek WWTP and Cleghorn WWTP. All three WWTPs discharge disinfected secondary effluent through the District's outfall pipeline to Las Flores Ranch. In addition, the District disposes of treated effluent from the Pilot Rock WWTP (owned by the California Department of Parks and Recreation) pumped into the District's effluent outfall.

Table 2-6. District Wastewater Treatment Plants

WWTP	Original Construction	Major Upgrades/ Modifications	Design Capacity (MGD)	Level of Treatment
Huston Creek	1952	1972, 1983, 1996, 2001	0.7	Disinfected Secondary-23
Seeley Creek	1972	1984	0.5	Disinfected Secondary-23
Cleghorn	1972	-	0.2	Disinfected Secondary-23

2.2.1 HUSTON CREEK WWTP

Huston Creek WWTP is a 0.7 MGD treatment facility consisting of: headworks, primary clarification, low-rate tricking filter, secondary clarification, and chlorine contact disinfection to achieve disinfected secondary-23 effluent, as defined by the California Code of Regulations Title 22. Effluent is discharged into the District's gravity outfall pipeline. Sludge is wasted from the primary clarifiers, thickened in a gravity sludge thickener, and dewatered using a belt-press. No sludge digestion takes place at any of the District's facilities. Huston Creek contains all sludge processing equipment for the District.

The Huston Creek WWTP process flow diagram and site map are shown on Figure 2-2 and Figure 2-3, respectively.

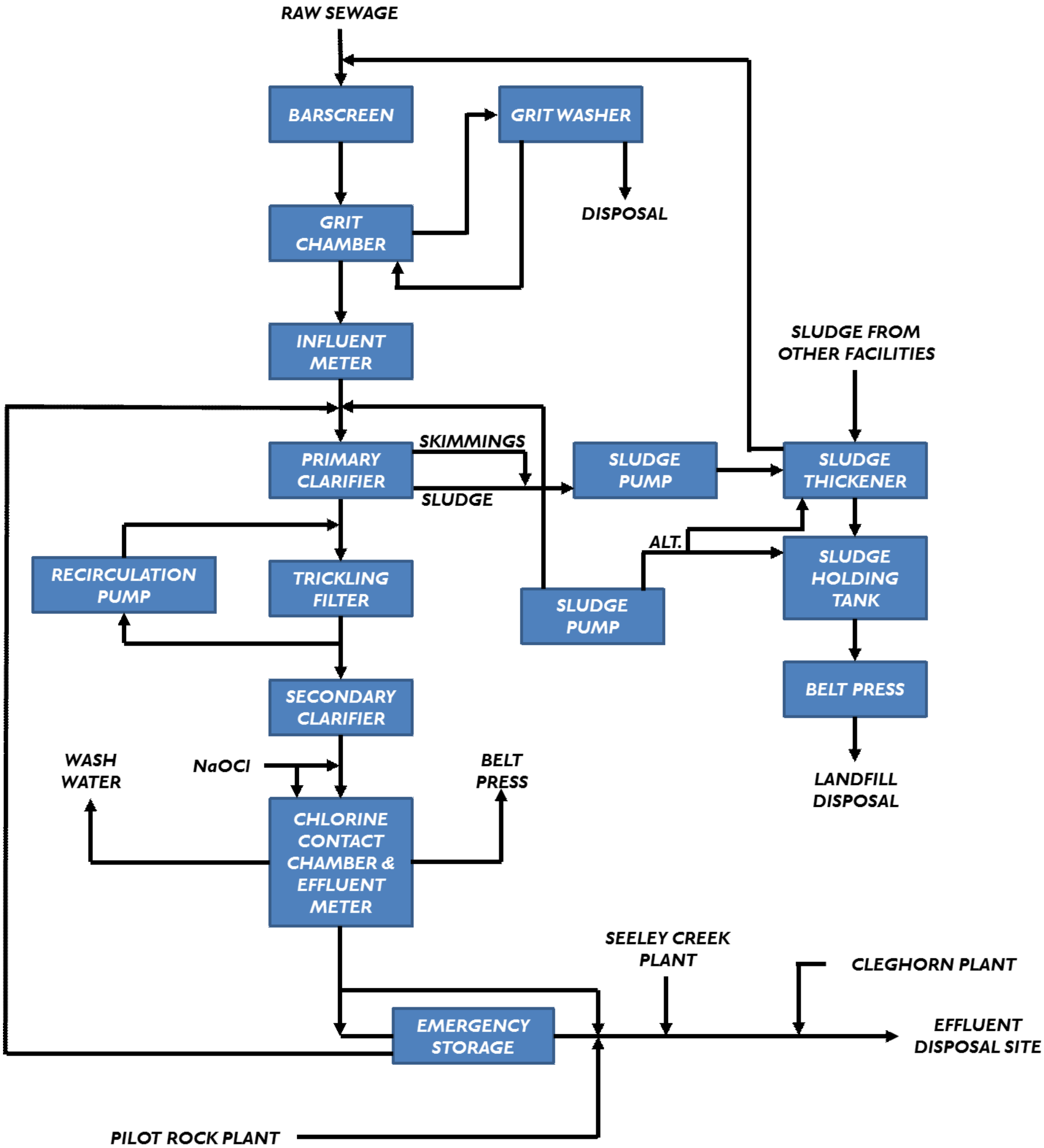

Figure 2-2. Huston Creek WWTP Process Flow Diagram

Figure 2-3. Huston Creek WWTP Site Map

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2.2.2 SEELEY CREEK WWTP

Seeley Creek WWTP is a 0.5 MGD treatment facility consisting of: headworks, primary clarification, high-rate trickling filter, secondary clarification, and chlorine contact disinfection to achieve disinfected secondary-23 effluent. Sludge is wasted from the primary clarifier into a holding tank, which is periodically emptied and sludge hauled to Huston Creek WWTP for processing. Effluent is discharged into the District's gravity outfall pipeline.

The Seeley Creek WWTP process flow diagram and site map are shown on Figure 2-4 and Figure 2-5, respectively.

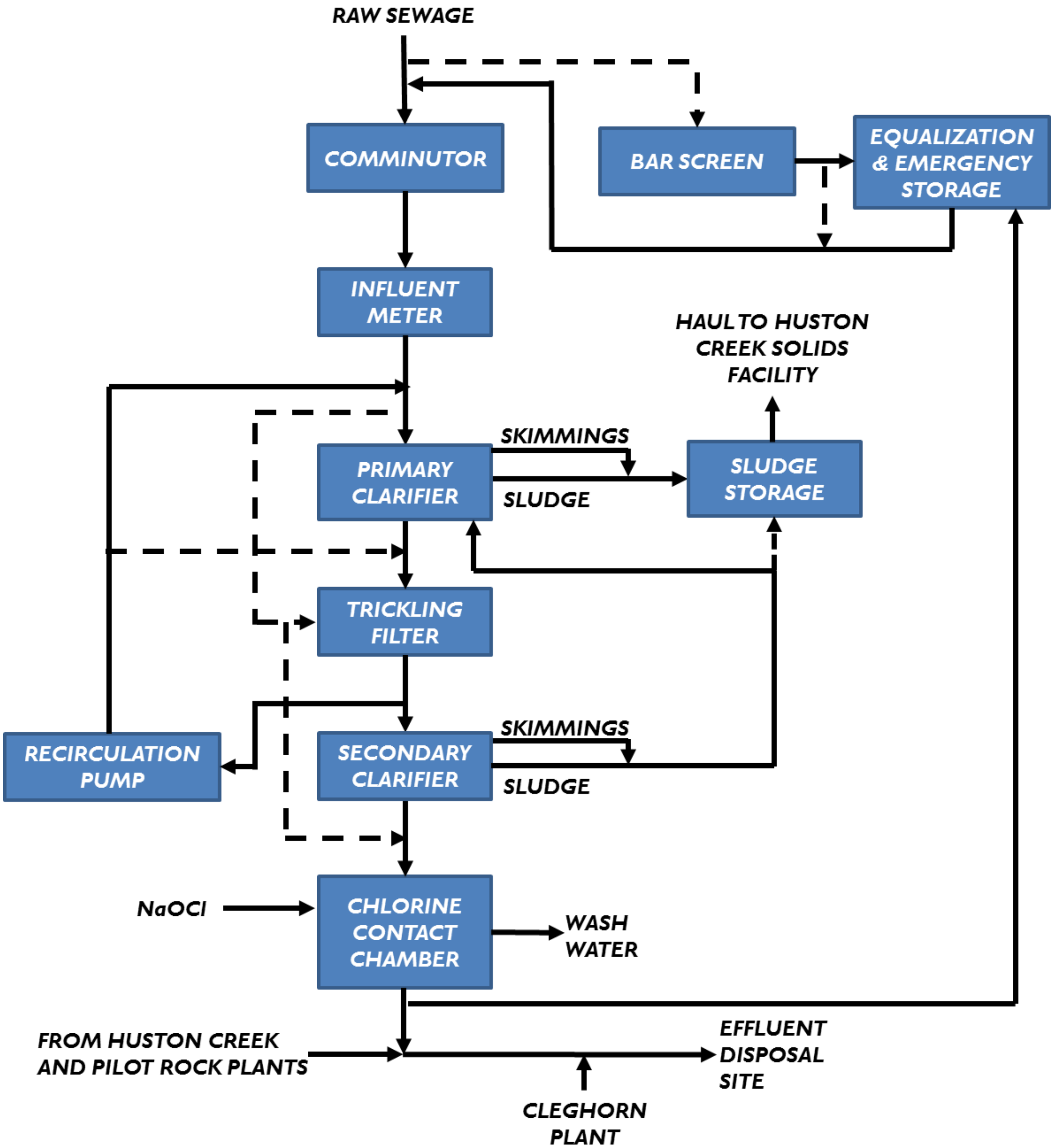

Figure 2-4. Seeley Creek WWTP Process Flow Diagram

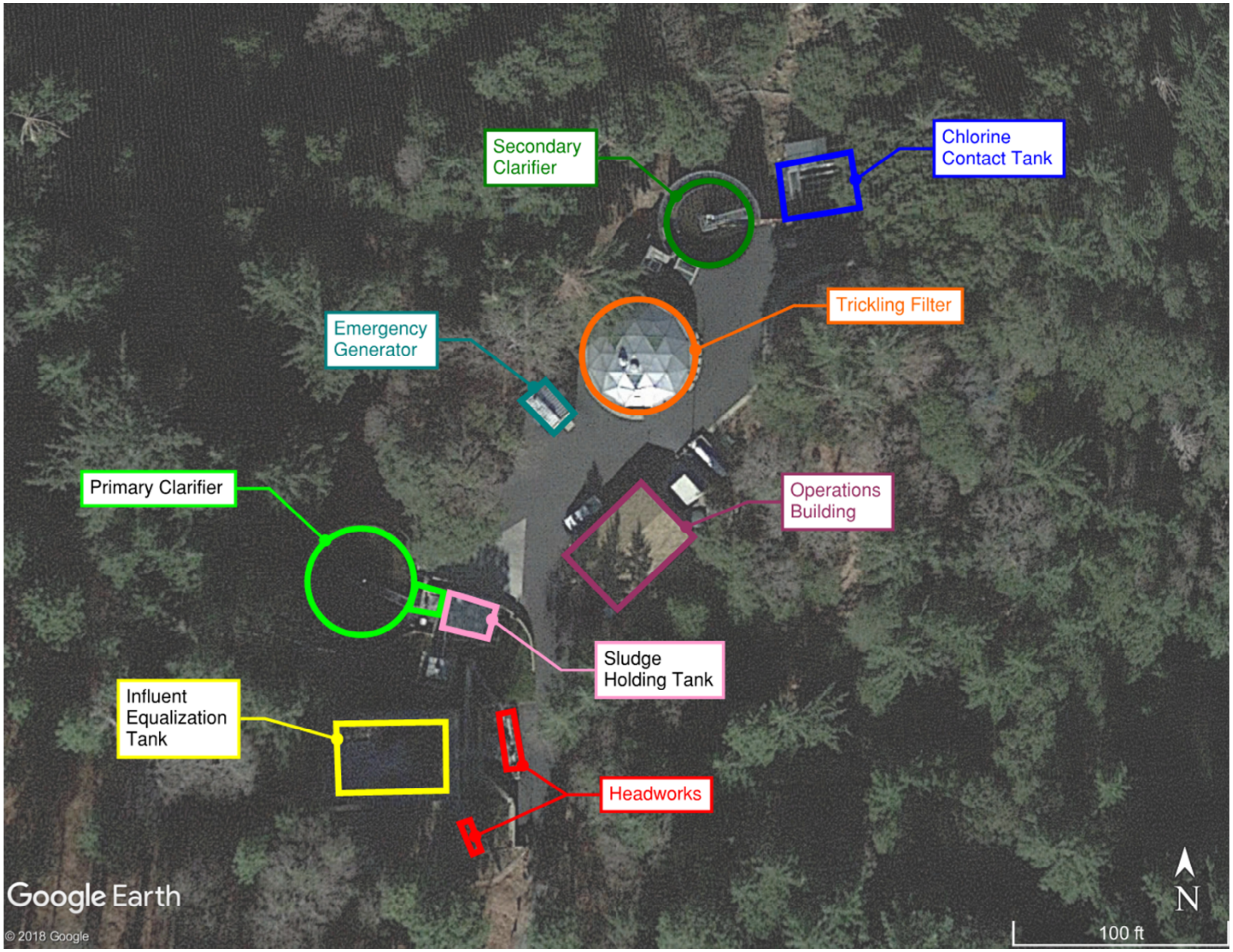

Figure 2-5. Seeley Creek WWTP Site Map

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2.2.3 CLEGHORN WWTP

Cleghorn WWTP is a 0.4 MGD treatment facility consisting of: headworks, oxidation ditch, secondary clarification, and chlorine contact disinfection to achieve disinfected secondary-23 effluent. Sludge is periodically pumped out of the secondary clarifier and hauled to Huston Creek WWTP for processing. Effluent is pumped to the District's gravity outfall pipeline.

The Cleghorn WWTP process flow diagram and site map are shown on Figure 2-6 and Figure 2-7, respectively.

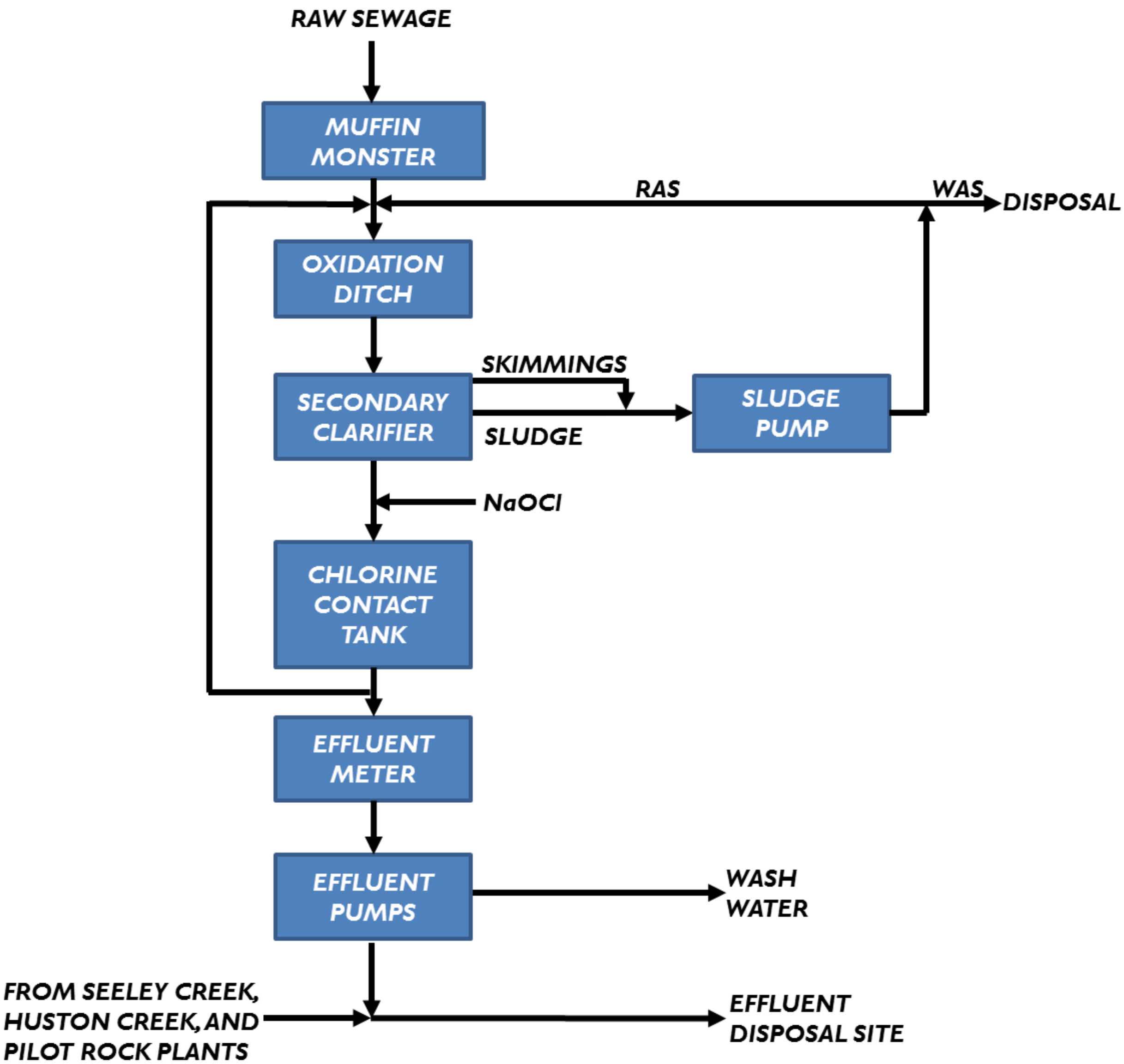

Figure 2-6. Cleghorn WWTP Process Flow Diagram

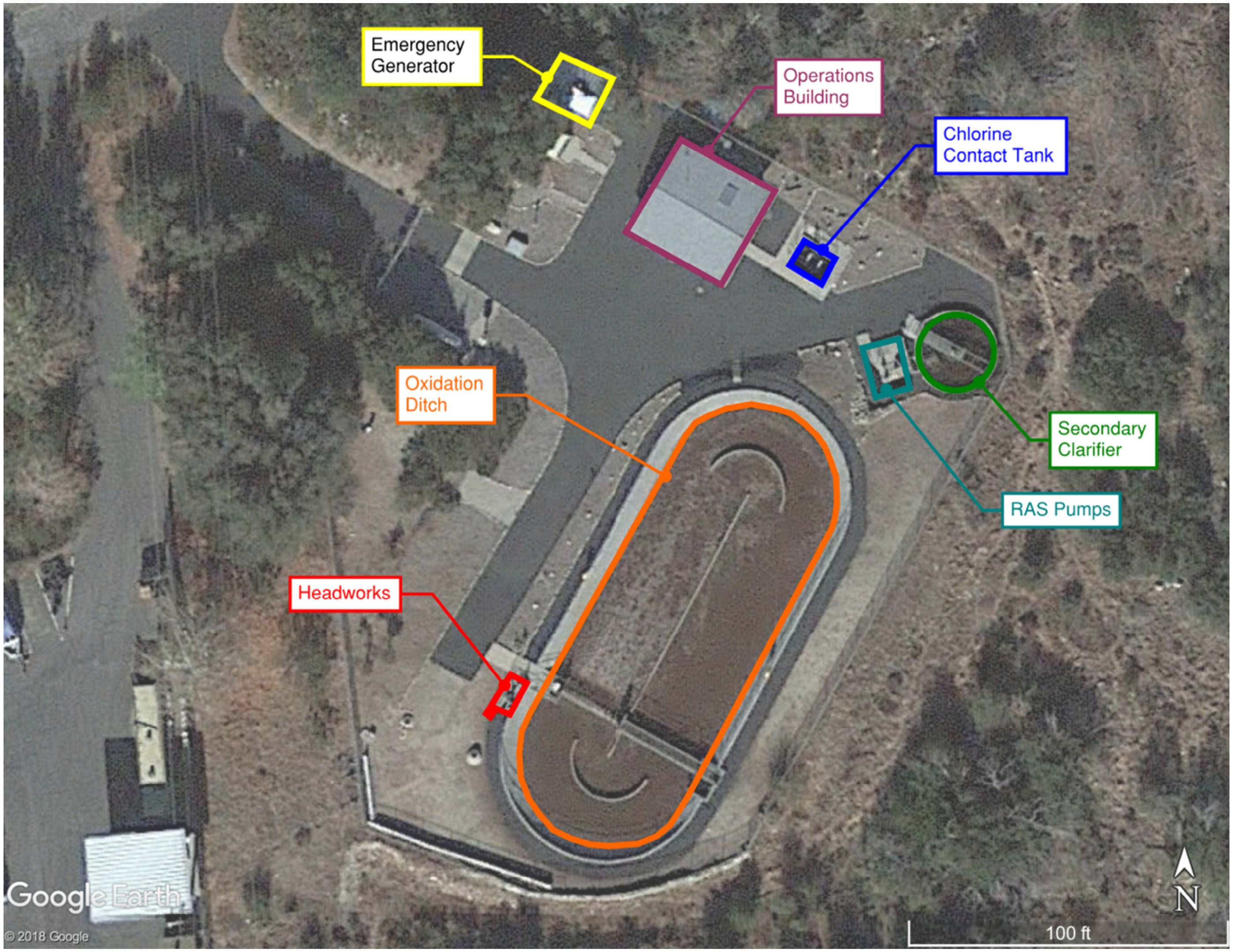

Figure 2-7. Cleghorn WWTP Site Map

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2.3 Effluent Management

The District conveys effluent from their three WWTP's through an eleven-mile asbestos cement outfall pipeline to the Las Flores Ranch, a pastureland adjacent to the Mojave River that uses the water for flood irrigation. The District has been discharging disinfected secondary-23 effluent to this site since the outfall pipeline was constructed in 1973. The District also receives effluent produced by the Pilot Rock WWTP, a small prison camp treatment plant that treats up to 10,000 gallons per day, and is contracted to discharge it through the outfall pipeline.

The District's effluent management facilities are shown in Figure 2-8.

2.3.1 REGULATORY OVERVIEW

The District is currently regulated by the Lahontan Regional Water Quality Control Board (RWQCB) Waste Discharge Requirements (WDR), Board Order 6-94-57 and Las Flores Ranch WDR, Board Order 6-96-24 for effluent discharged at the Las Flores Ranch. CSD has recently obtained a permit in November 2016 from the State Water Resources Control Board (SWRCB) Board Order WQ 2016-0068-DDW to supply a portion of their disinfected secondary-23 effluent as dust control for a recent nearby highway realignment project in San Bernardino County. Through the permitting process, the District developed an approved Title 22 Engineering Report for the four wastewater treatment plants and effluent conveyance facilities producing disinfected secondary-23 recycled water.

In the future, the District will be required to update their Title 22 Engineering Report to include new use areas if new recycled water project opportunities become available. Improvements to the WWTP's would be required if the District pursues recycled water projects that require higher water quality than disinfected secondary-23 recycled water (i.e. tertiary treated recycled water). The District recently completed an Integrated Water Reuse Plan (2016) that outlines alternatives for pursuing recycled water projects in the future.

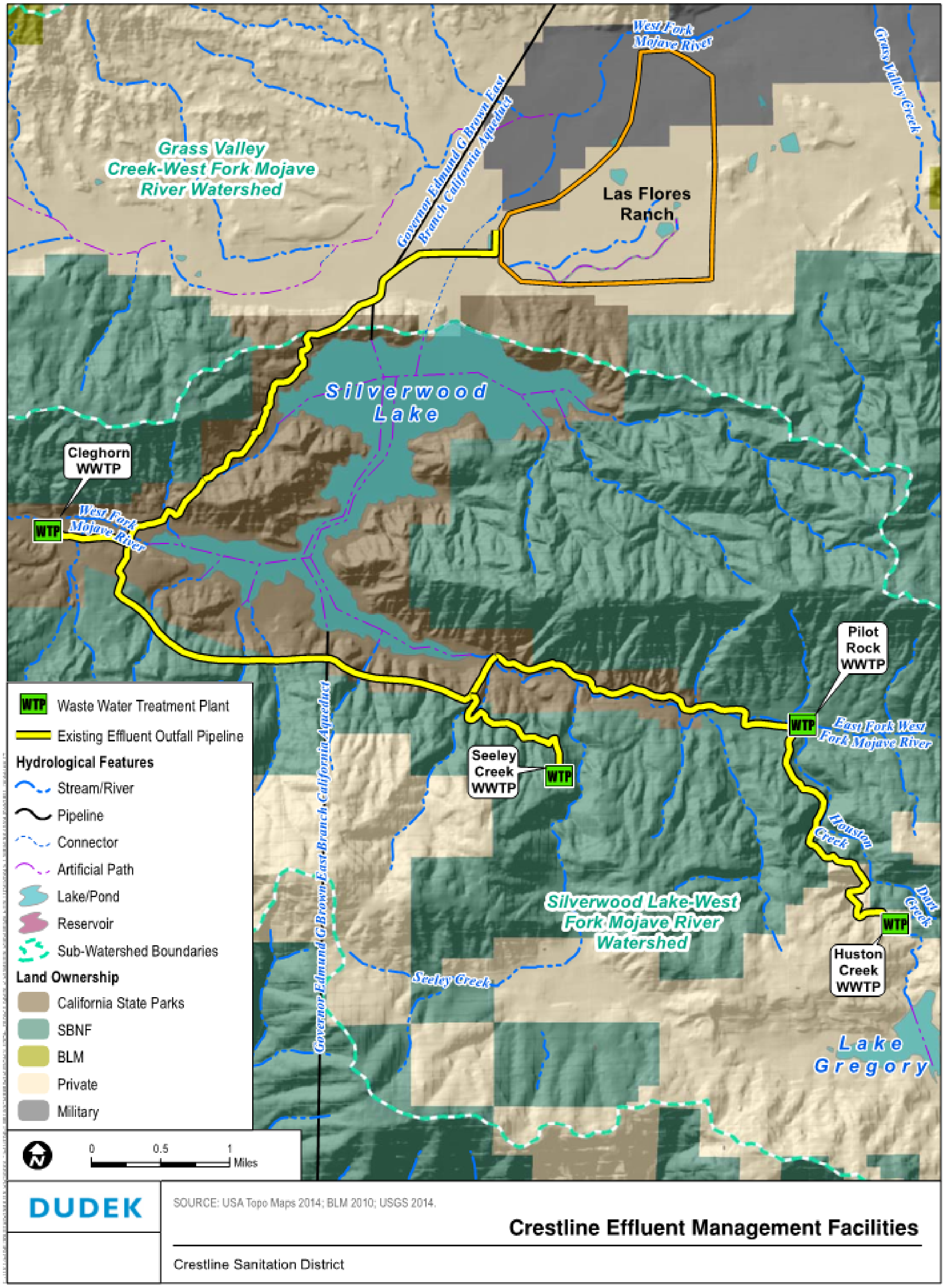

Figure 2-8 Crestline Effluent Management Facilities

3 LAND USE AND POPULATION

This section summarizes the existing land use and population in Crestline, California.

3.1 Land Use

Crestline is a census-designated place located in the San Bernardino Mountains of San Bernardino County. The area within the District boundary consists primarily of vacant land and designated open space (forest). The next most common land use is residential; 95% of this residential area has single-family residences. There is also a commercial area located on Lake Drive west of Lake Gregory, as shown in Figure 3-1.

Within the District's service area boundary, there are both sewered and unsewered (property owner operated septic tank and leach field system) areas. The sewered area consists of about 45% of the total District service area. Within the sewered area, the most common land use type is residential (single family and multifamily) at about 72%. Vacant parcels make up about 22% of the sewered area. These vacant parcels constitute the future developable area within the District's current sewered area.

Table 3-1 presents County land use data for the areas both within the District's service area boundary and the current sewered area. Figure 3-1 and Figure 3-2 present the land use data within the District's service area boundary and sewered area, respectively.

Table 3-1: Land Use Type Areas in District Boundary Area vs. Sewered Boundary

	CSD Boundary Area			CSD Sewered Area		
Land Use Type	No. Parcels	Area (acres)	Percentage of Total Sewered Area	No. Parcels	Area (acres)	Percentage of Boundary Area
Single Family Residential	6,596	1,565	30%	4,477	854	68%
Multi-Family Residential	108	59	1.1%	94	49	4%
Commercial	151	42	0.82%	139	36	3%
Industrial	36	39	0.75%	13	8	1%
Institutional	34	53	1.03%	21	23	2%
Open Space	42	35	0.67%	6	0	0.03%
Vacant	6,194	3,394	65%	1,258	280	22.4%
TOTALS	**13,158**	**5,187**	**100%**	**6,008**	**1250**	**100%**

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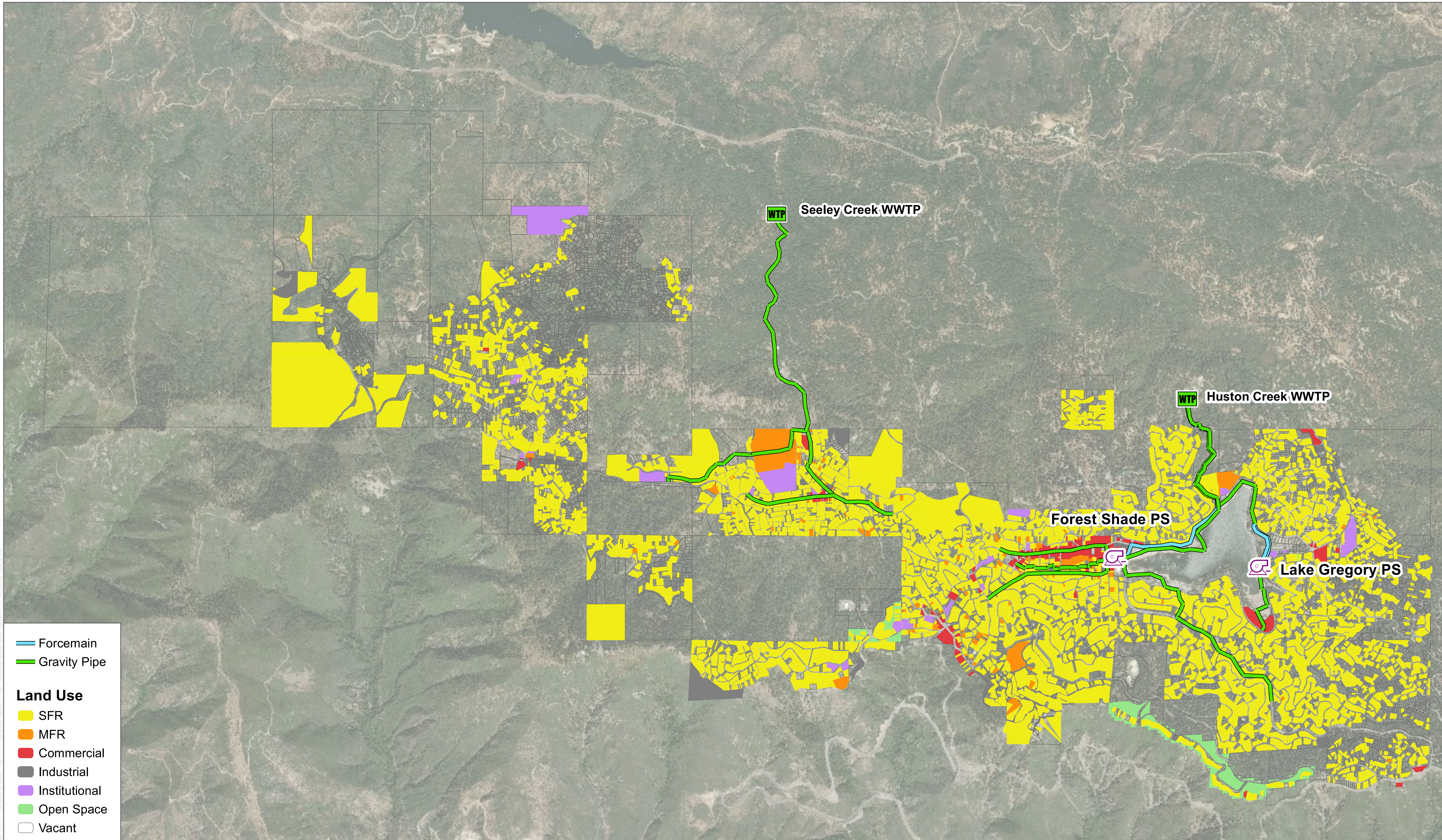

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Figure 3-1: Land Use Within District Service Area Boundary

Crestline Sanitation District

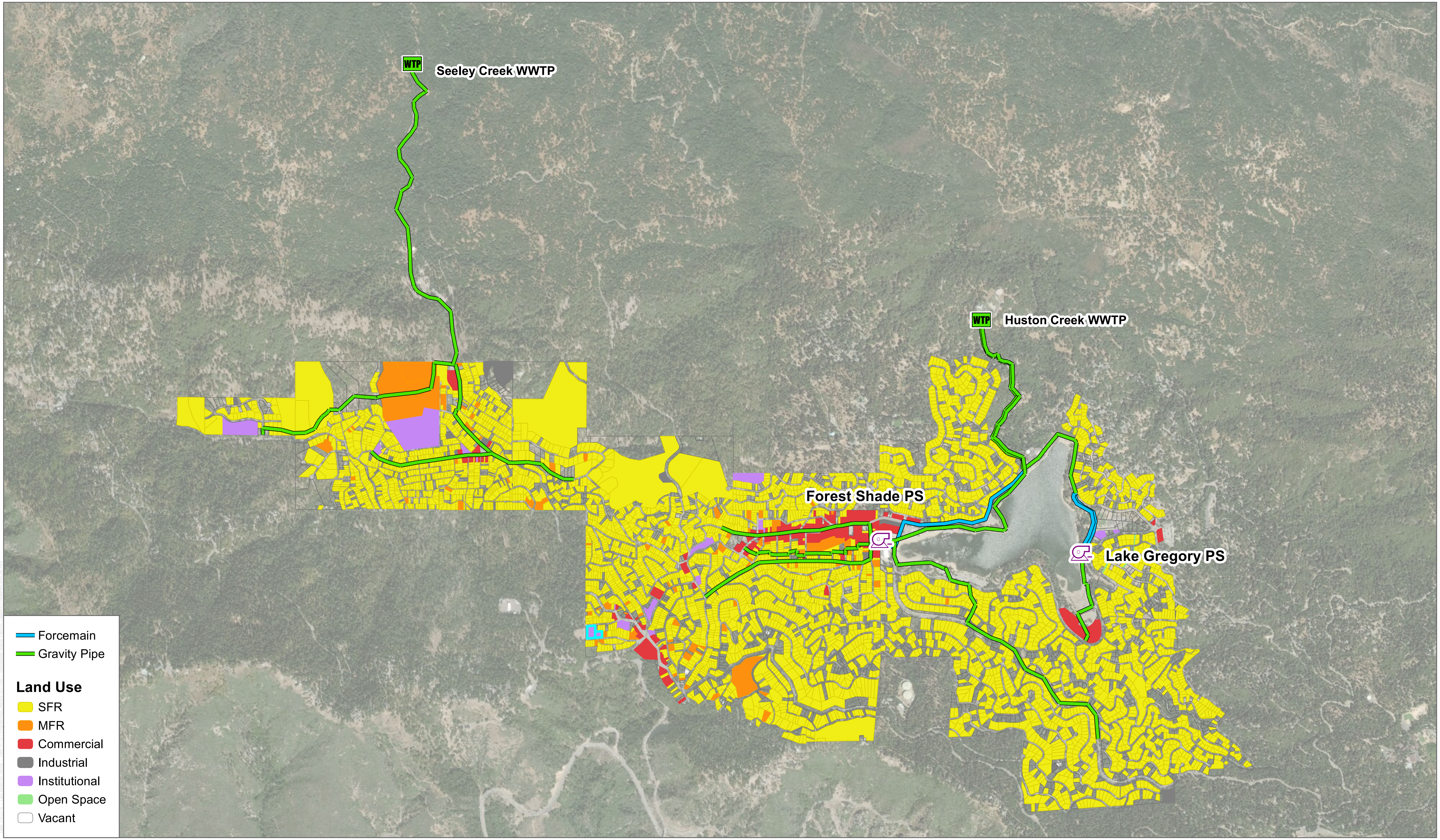

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Figure 3-2: Land Use Within District Sewered Area

Crestline Sanitation District

3.2 Population

The population of Crestline was 10,770 at the 2010 census. This is up from 10,218 at the 2000 census, a 5% increase. Current population data for Crestline is not available. Extrapolating the 5% growth rate to 2018 puts the population at an estimated 11,093. The Crest Forest Communities Profile working draft, downloaded from the San Bernardino County General Plan website, projects a 2020 population estimate of 11,118.

4 COLLECTION SYSTEM FLOW AND CAPACITY EVALUATION

The collection system of a sewer agency commonly represents the largest and most expensive of its capital investments. The planned development of the collection system as the service area matures is critical to ensure proper capacity towards ultimate buildout.

In the early development of a collection system, components are generally new and reliable with major concern to provide adequate future capacity. As the collection systems mature, there is often a gradual transition to system maintenance and upgrade to ensure proper and reliable operation. Early system development is often driven and financed by developers, whereas more intense maintenance and upgrade are most often financed with service fees.

The existing collection system customer base is estimated at approximately 66% build-out, with a relatively slow and steady growth pattern. Therefore, consideration as to the capacity impacts of future development will be discussed in this section. In addition, the collection system has capacity impacts from historic defect flows (inflow and/or infiltration). A computerized hydraulic model for evaluating existing and future system capacity is used in conjunction with field flow monitoring to provide insight as to the type, severity and general location and capacity impact of defect flow.

The District's collection system is evaluated using a Geographic Information System (GIS)-based hydraulic modeling software. Flow meters were installed in the collection system during January and February 2018 in order to capture wet and dry weather flow data to calibrate the model and conduct capacity analysis. This chapter will include the following subsections:

- Design Criteria: Summary of collection system design criteria.
- Hydraulic Model Development: Process for model creation and calibration.
- Sewer Flow Monitoring: Selection and process for sewer flow monitoring.
- Flow Generation Factors and Diurnal Flow Patterns: Initial sewer system characteristics revised during the model calibration process
- Dry and Wet Weather Model Calibration: Calibration of model to field conditions
- Existing Dry Weather Flow Analysis: Evaluation of system performance.
- Defect Flow Analysis: Evaluates potential inflow/infiltration impacts
- Ultimate System Capacity Analysis: Evaluates the existing system with future flows.

4.1 Design Criteria

Wastewater collection system design criteria provide a standard against which the existing collection system is evaluated and recommended improvements are sized. These criteria are also the basis for planning of new facilities to improve existing service or to handle future wastewater flows. The District does not currently maintain formal collection system design criteria as development within the service area is slow and each new connection/development is reviewed on a case-by-case basis. Therefore, typical system design criteria used by other southern California wastewater service providers was prepared in collaboration with District staff. Table 4-1 summarizes the design criteria used in this evaluation.

Table 4-1: Sewer Design Criteria

Design Criteria	Crestline Sanitation District
Minimum Size	6-inches
Minimum Slope (8")	0.40%
Minimum Slope (12" and larger)	0.20%
Manning's "n"	0.013
Minimum Velocity (fps)	2
Maximum d/D[1] (<12")	0.5
Maximum d/D (12" and larger)	0.75
Maximum Distance between Manholes (ft)	400
Notes: [1] d/D = ratio of depth of flow in a pipeline by pipeline diameter in inches	

One of the key evaluation criteria for gravity sewers is the depth over diameter ratio (d/D). Gravity pipelines are designed to accommodate head space at the top of the pipe for conveyance of sewage gasses and to provide contingent capacity for wet weather inflow and infiltration. Therefore, depending on the size of the pipeline, maximum d/D values are preferred to be maintained at less than 0.5 (pipelines less than 12-in diameter) and 0.75 (12-in diameter pipelines and larger) during average day peak hour periods.

4.2 Hydraulic Model Development

The principal tool utilized in the capacity analysis is a computerized hydraulic model that simulates flow conditions, such as wastewater depth, flow rate, and velocity within the District's wastewater collection system. The project team has developed a new hydraulic model for the District using Innovyze InfoSewer®, an ArcGIS-based sewer hydraulic modeling program.

The District does not currently have the sewer collection system within a GIS system. Therefore, the approach for hydraulic modeling was to develop a GIS foundation for only trunk lines in the system. All pipelines greater than 8-inches in diameter plus some key 8-inch diameter trunk mains defines the extent of the modeled system. Future hydraulic model updates can augment the current modeled system to provide a more complete and accurate representation of the system.

The District trunk pipelines, all lift stations, force mains, and associated manholes were input into the InfoSewer® model to form the basis of the model's links (pipelines) and nodes (manholes). The physical parameters of the model, including pipe diameter, slope, rim elevation, and invert elevation are based on the District's existing wastewater collection system record drawing data. Background GIS layers placed in the model for reference also include land use and District parcels. The hydraulic model is shown graphically in Figure 4-1.

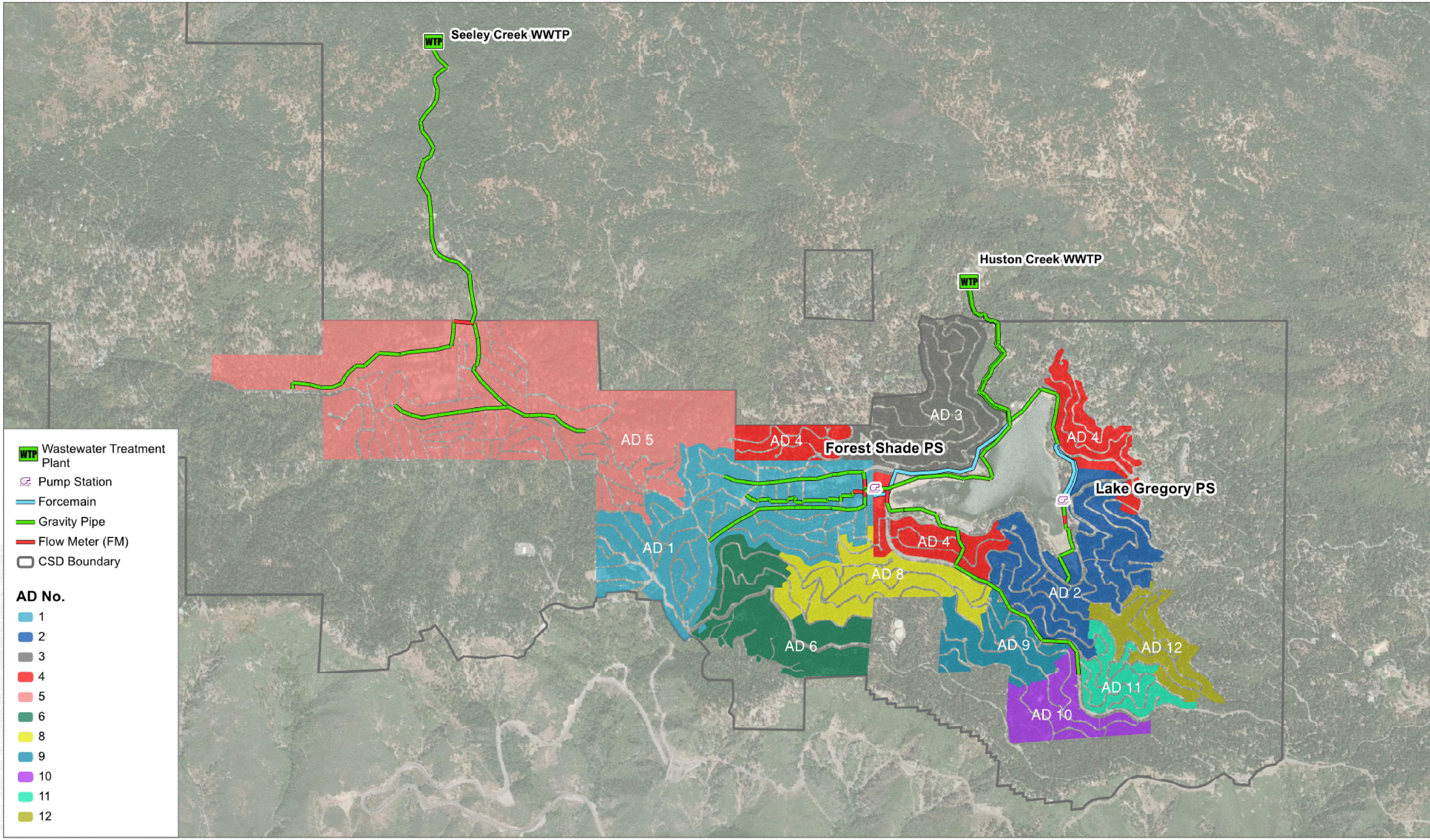

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Figure 4-1: Sewer Collection System Model

Crestline Sanitation District

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4.3 Sewer Flow Monitoring

To simulate existing sewer flow conditions through a hydraulic model, a basis of flows over an extended period is used to develop a typical 24-hour flow pattern. The installation and capture of dry and wet weather flows within a collection system using flow meters provides both the real-world flow patterns needed for model calibration and ideally, if a rain event occurs during the monitoring period, a glimpse at the relative response to the rain event within the collection system.

Seven (7) flowmeters were installed for a period of 5 weeks in January to mid-February 2018. Flow meter locations were selected to measure flow from the seven drainage basin areas of the District's system as described in Table 4-2and shown in Figure 4-2.

Table 4-2. Flow Monitoring Location Descriptions

Flow Meter No.	Location	Manhole (MH) ID	Upstream Pipeline Diam (inches)	Upstream Assessment District(s)	No. of Developed Parcels	Land Use Notes
1	24089 Lake Gregory Dr	MH51-AD1	10	AD4, AD8, AD9, & AD10	1,592	Residential
2	607 Forest Shade Rd	MH54-AD1	8	AD1 & AD8	1,297	Residential
3	607 Forest Shade Rd	MH54-AD1	8	AD1	658	Residential
4	565 Forest Shade Rd	MH53-AD1	8	AD1, AD3, & AD4	535	Commercial District
5	St Hwy 138 & Vista Ln	MH34-AD5	12	AD 5	1,362	Commercial on St Hwy 138
6	St Hwy 138 & Vista Ln	MH34-AD5	12	AD5	596	Residential
7	24658 San Mortiz Dr	MH8-AD2	10	AD2 & AD12	1,461	Residential

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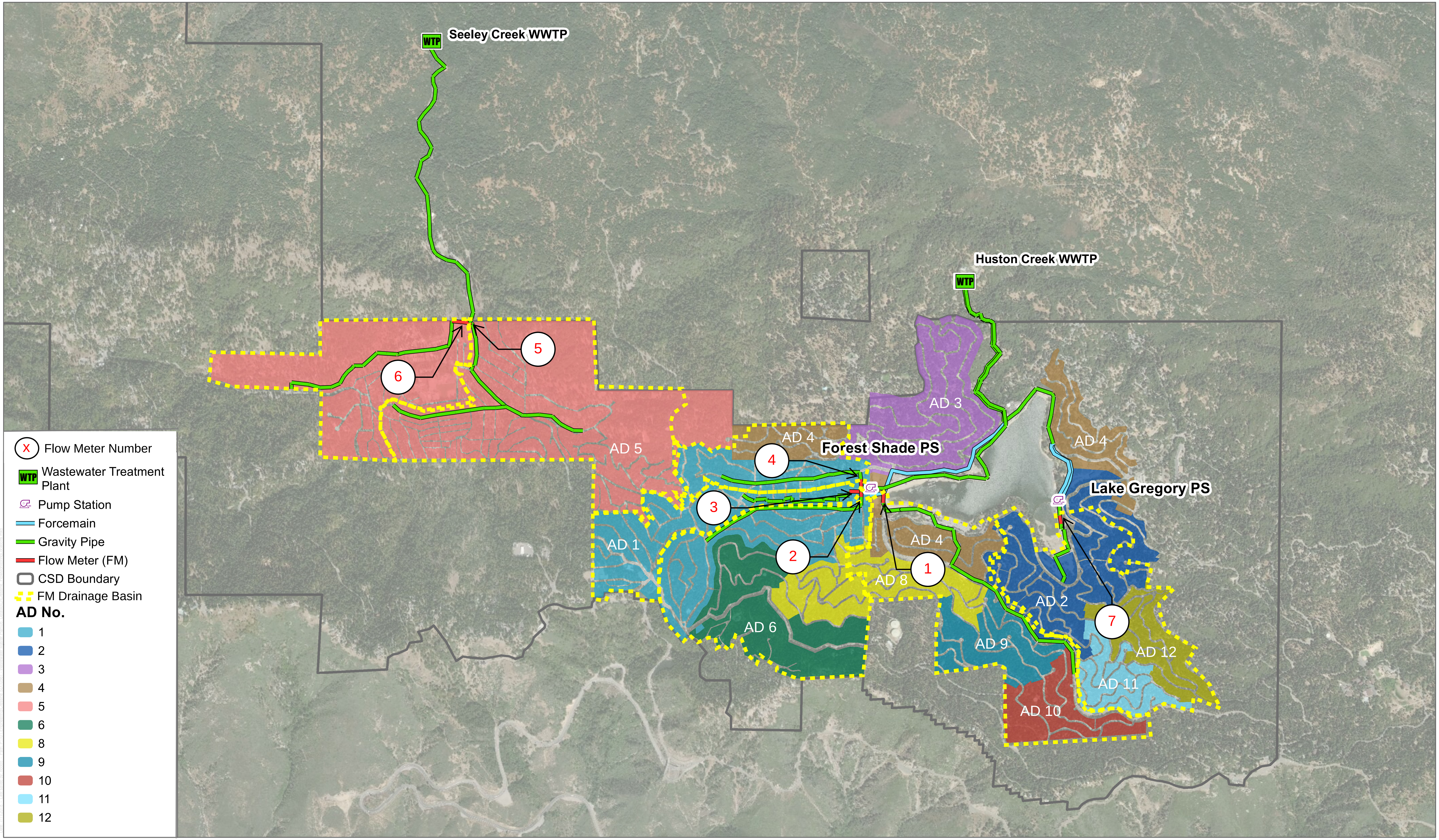

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Figure 4-2: Flow Monitoring Locations

Crestline Sanitation District

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During the flow monitoring period, Flow Meter #7 experienced daily surcharging and frequent backwater conditions from the operation of the Lake Gregory Lift Station. As a result, the wet weather response from this flow meter was unable to be determined.

4.3.1 DRY WEATHER FLOWS

The first application of flow monitoring results is the development of each basin-specific average dry weather flow (ADWF) pattern. Flow monitoring data is used to define the existing ADWF and peak dry weather flow (PDWF) for each of the flow metered drainage basins for the purpose of calibrating the hydraulic model. PDWF is the highest, or peak, flow rate during a typical dry weather day.

The ADWF and PDWF values calculated for each of the flow meter sewersheds are presented in Table 4-3.

Table 4-3. Flow Metering ADWF and PDWF

Flow Meter No.	Overall Calculated ADWF (MGD)	Overall Calculated PDWF (MGD)
1	0.056	0.087
2	0.034	0.051
3	0.068	0.100
4	0.025	0.051
5	0.094	0.122
6	0.030	0.046
7	0.116	N/A[1]
Total[2]	**0.423**	**--**

Notes:
[1] Flow Meter No. 7 experienced daily backflow from the operation of the Lake Gregory Lift Station; therefore, no PDWF could be determined.
[2] 81% of ADWF was captured by the flow meters during the 2018 flow monitoring study.

4.3.2 WET WEATHER FLOWS

A key outcome of a flow monitoring study performed during wet weather months is to capture and quantify the impact of storm water inflow and infiltration on a collection system. Inflow and infiltration (I/I) (also known as defect flow) is the combination of wet weather infiltration and direct storm inflow into a collection system.

- *Infiltration* enters the collection system underground through holes, cracks and leaky pipes or manhole joints, due to a permanently high groundwater table or as a result of rainfall percolation and temporary rising of groundwater levels. While the amount of infiltration from rainfall events can be estimated from an evaluation of flow data and rainfall records, infiltration that occurs year-round can typically only be detected from pipeline video inspection or manhole inspections. The presence of excessive amounts of infiltration indicates broken or poorly constructed pipes, pipe joints or manholes in areas with high groundwater elevations. When evaluating 24-hour flow graphs, infiltration can be recognized as a spike during a rain event, followed by a slow gradual reduction in defect flow over an extended period.

- *Inflow* in a collection system generally refers to extraneous water that flows directly into the system as a result of storm water runoff. Entry points may be at temporarily submerged manhole covers or from illicit connections to the sewer system, such as roof and yard drains. The primary characteristics of inflow are the rapid response to the onset and cessation of rainfall. The rate of inflow depends on the amount and intensity of rainfall and the ground saturation level.

To measure rainfall during the flow monitoring study period, two rain gauges were installed to measure rainfall events. Rain Gauge #1, located at the Forest Shade Lift Station, measured 3.93 inches during the storm from 12:00 p.m. 1/8/2018 to 12:00 p.m. 1/9/2018. Rain Gauge #2, located at San Bernardino County Fire Station #25, measured 4.40 inches during the same period.

Each flow meter saw an increase in flow during the 1/9/18 rain event, with several basins showing a flow increase that more than doubled, indicating that some parts of the system are having measurable I/I coming into the collection system during rain events, as presented in Table 4-4.

Table 4-4. Increase in Measured Sewage Flows due to 1/9/2018 Rain Event

Flow Meter[1]	Average Dry Weather Flows (MGD)	Average Wet Weather Flows (MGD)[2]	Increase in Average Flow (MGD)	Percentage Increase in Average Flow
1	0.056	0.067	0.011	20%
2	0.034	0.094	0.060	176%
3	0.068	0.162	0.094	138%
4	0.025	0.073	0.048	192%
5	0.094	0.117	0.023	24%
6	0.031	0.062	0.031	100%

Note:
[1] Flow Meter No. 7 experienced daily backflow from the operation of the Lake Gregory Lift Station; therefore, no average wet weather flow could be determined.
[2] Average wet weather flows calculated as the average flow on all wet weather days during the flow monitoring period. In this study there was only one wet weather day from 12 p.m. on 1/8/2018 to 12 p.m. on 1/9/18.

Flow monitoring data indicated rapid response of flow measurements during storm events for Flow Meters #1, 2, 3 and 4, indicating inflow is very likely present in these basins. Flow meter #5 showed a minimal response to the rainfall event. Flow meter #6 showed a rapid increase and gradual decrease in flow measured during and after the storm event, indicating that there is likely both an inflow and infiltration present. Rainfall responses for Flow Meters #4, #5 and #6 are presented in Figure 4-3 through Figure 4-5, respectively, to provide examples of a rapid response, minimal response and a more gradual response to rainfall.

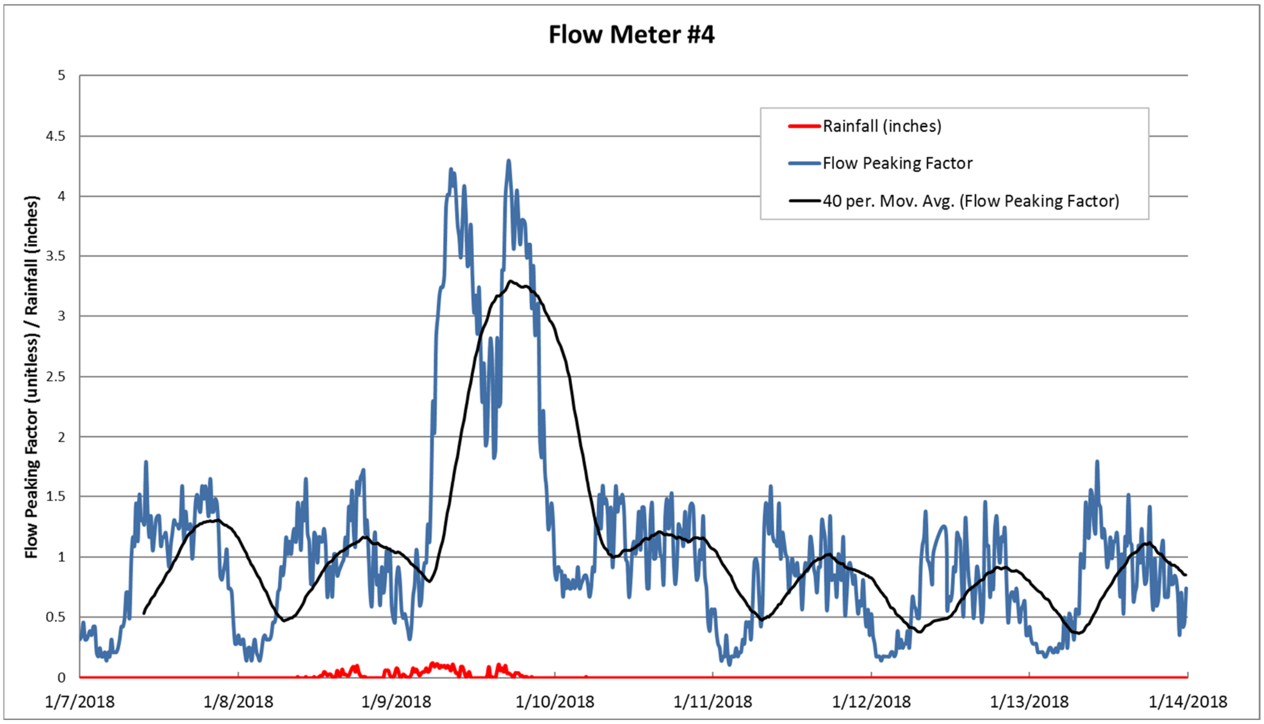

Figure 4-3. Flow Meter #4 Rapid Response to Onset and Cessation of Rainfall Event

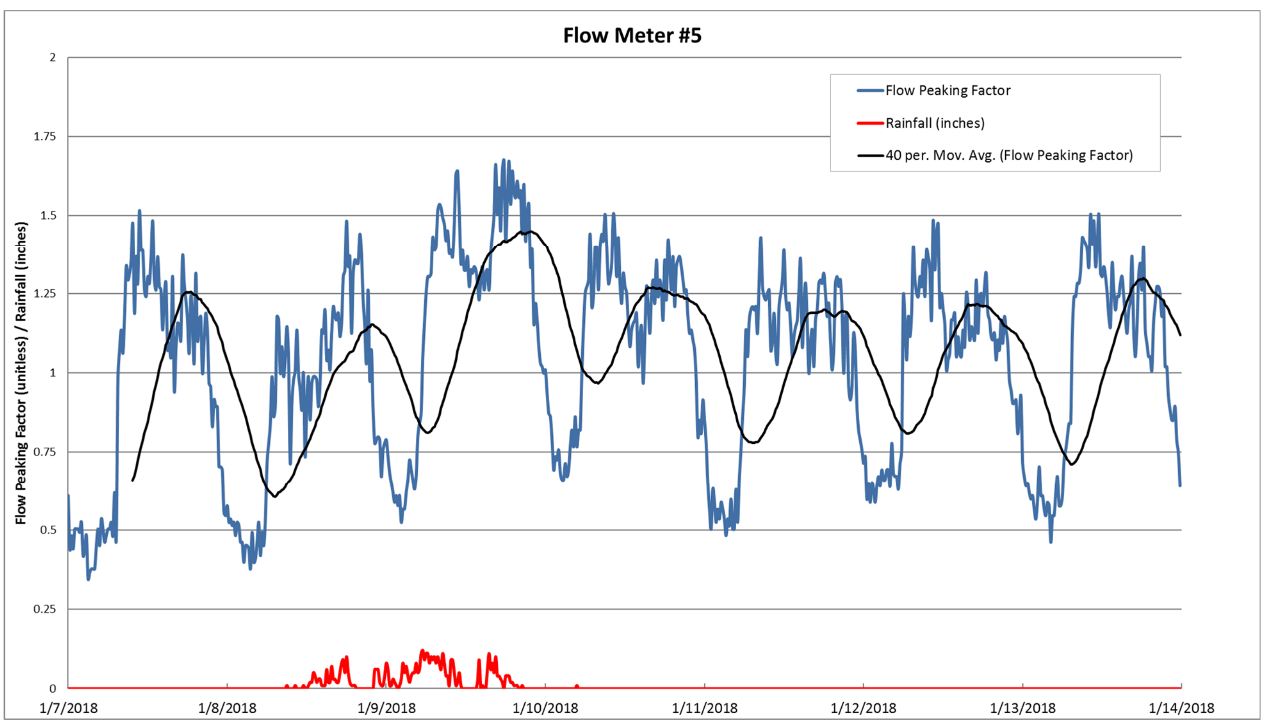

Figure 4-4. Flow Meter #5 Minimal Response to Rainfall Event

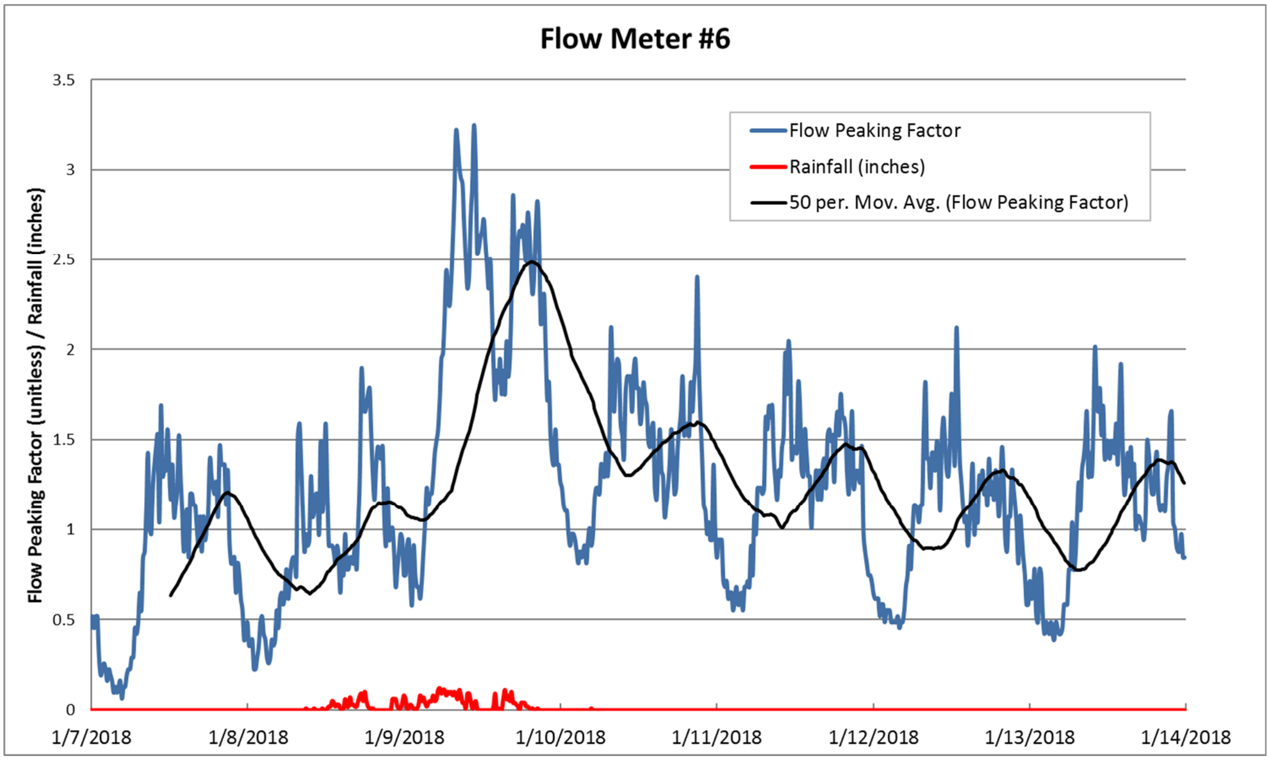

Figure 4-5. Flow Meter #6 Rapid Onset and Delayed Cessation to Rainfall Event

As evidenced in Table 5-4 and Figures 5-3 through 5-5, Flow Meter Basins #2, 3, 4 and 6 have significant I/I impacts (total flow rates more than doubled due to the rainstorm), indicating illicit connections and pipeline defects are leading to high rates of I/I in these basins. The results indicate that further investigation is needed to better locate the areas where illicit connections and pipeline defects are resulting in increased flows to better target pipeline rehabilitation and lining efforts. Recommendations for further investigation are in Section 6.

4.4 Flow Generation Factors

Flow generation factors are values that estimate average sewage flow volumes generated by a particular land use type. As part of the development of the hydraulic model, each developed parcel within the District's boundary is assigned a flow generation factor based on its land use type. The initial flow generation factors used in this study are presented in Table 4-5. Flow generation factors combined with parcel data are used to calculate initial sewer system "loads" for each parcel. These loads are then assigned to the closest corresponding model node to simulate each building's sewage contribution to the system.

Table 4-5. Initial Flow Generation Factors

Land Use Type	Load Factor
Commercial	625 gallons per day per acre (gpd/ac)
Residential	125 gpd per parcel
Vacant	0 gpd per parcel

During the calibration process, flow generation factors were calculated. These calibrated flow generation factors are used to estimate future flows from newly developed areas.

4.5 Diurnal Flow Patterns

Diurnal flow patterns, or diurnal curves, characterize flow patterns in a particular flow metered sewershed. They provide an hourly peaking factor for the hydraulic model as it simulates sewer flow loading into the model. Diurnal flow patterns will vary based on the mix of land use within a sewershed. In sewersheds consisting of mostly residential parcels, the flow pattern will have the typical double peak due to the higher water usage in the morning, when residents are starting their day, and the early evening hours when residents return home from their daily activities. In sewersheds that are primarily commercial, the typical flow pattern has a single peak with higher flows during business hours. Sewersheds that are a combination of land use types will show a blend of these patterns.

Flow meter data was used to identify the characteristic flow patterns for each of the sewersheds metered. These diurnal flow patterns serve as the initial (uncalibrated) diurnal curves used during development of the model. Diurnal curves were created with flow meter data for Flow Meters #1 through #6. Flow Meter #7 experienced daily backflow from the operation of the Lake Gregory Lift Station; therefore, an accurate diurnal flow pattern could not be determined. The average of the six diurnal curves developed were combined to create an initial residential flow curve used for the hydraulic model analysis.

No flow meter measured isolated commercial flows in Crestline; therefore, a typical commercial diurnal pattern is used for this analysis. Commercial flows typically occur consistently during business hours (from 8:00 a.m. to 6:00 pm). Figure 4-6 presents the initial residential and commercial diurnal flow patterns used for this analysis. These diurnal flow patterns are combined with the sewer flow generation factors within the model to simulate how flow is entering the collection system at a particular time of day.

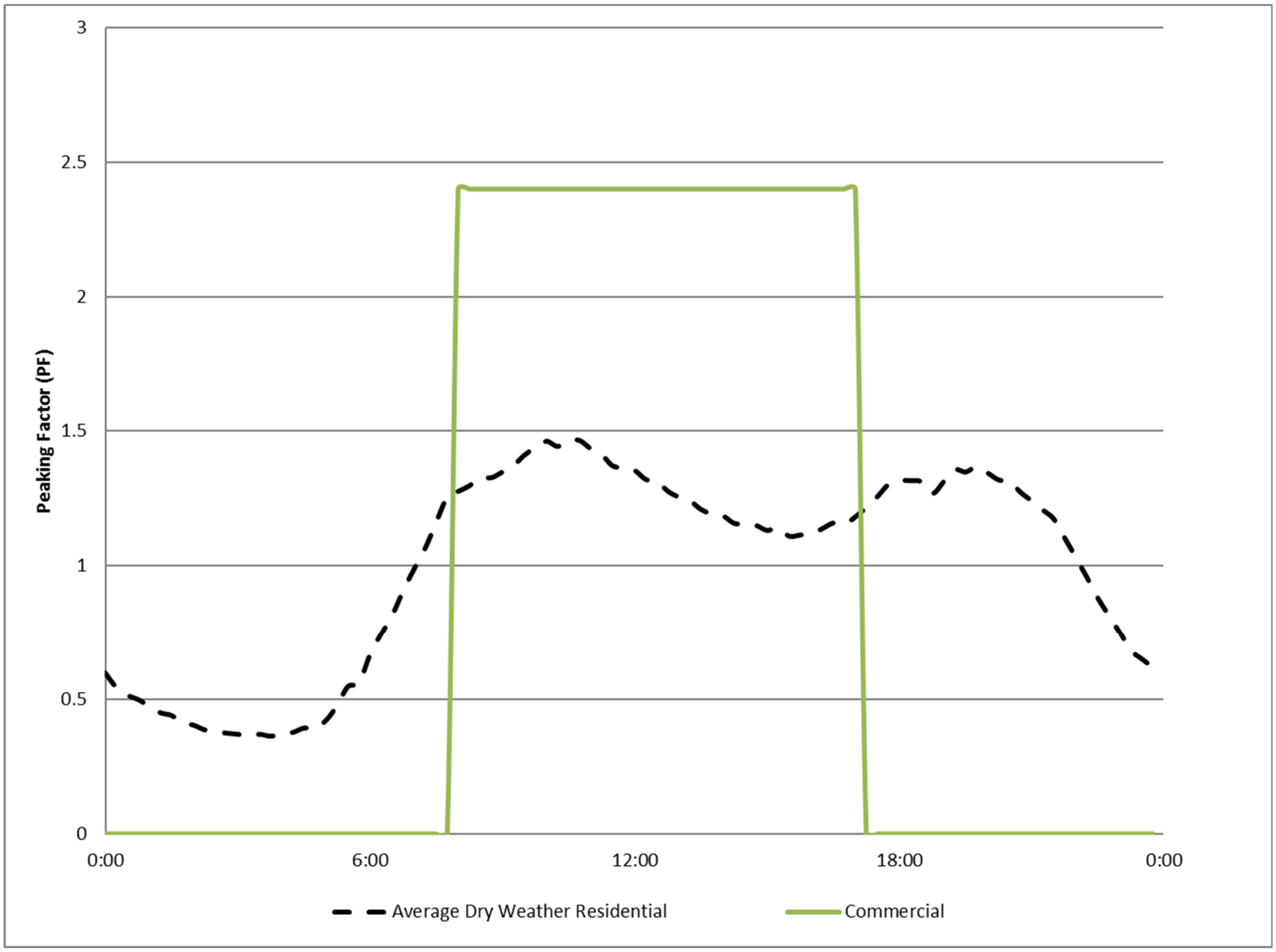

Figure 4-6. Initial (Uncalibrated) Diurnal Curves

During the calibration process, each sewershed's residential flow patterns are adjusted until modeled peak flows match measured peak flows. Model calibration is discussed in the following section.

4.6 Dry Weather Model Calibration

A hydraulic model is only useful when simulated outputs closely match field conditions; therefore, calibration of a hydraulic model based on existing field measurements is a necessary step to accurately simulate system-wide flow conditions for capacity analysis. The calibration process consists of making minor adjustments to flow input loads and patterns such that modeled flows closely reflect field measurements. Target accuracy for calibration is to achieve modeled flows over 24-hours within 10% of field measurements at each flow meter location. The typical model input data that are adjusted include flow generation factors to calibrate average flow values and diurnal curves to calibrate peak flow values. District flow generation factors, based on land use, include Commercial, Residential and Vacant land uses. The resulting average dry weather day calibrated flow generation factors by land use are shown in Table 4-6.

Table 4-6. Calibrated Flow Generation Factors

Land Use Type	Load Factor
Commercial	535 gpd per acre
Residential	106 gpd per parcel
Vacant	0 gpd per parcel

4.6.1 PEAK FLOW CALIBRATION

In addition to total average day flow, 24-hour peaking curves are developed during the calibration process. As each basin metered is unique in its size and distribution of input locations, a unique 24-hour diurnal curve is created for each basin. The diurnal curve pattern is the resultant sewer flow peaking factor multiplied by the average day flow for any given hour during the day. As flows are attributed to each representative manhole node, a dampening effect is present due to simulated time delay for water to reach the downstream metering location. Therefore, the input 24-hour peaking curve will be of greater amplification than the 24-hour flow curves measured at the flow meter locations. As with the average dry weather flow volume, calibration is targeted at achieving hourly flow rates over the 24-hour modeling period with 10% of measured flows at the meters. The diurnal profile, which resulted in the best calibration for a given calibration basin, is used within the hydraulic model.

Figure 4-7 illustrates the calibrated set of diurnal profiles used for modeling dry weather flows for residential land use types in the drainage basins upstream of Flow Meter #1 through #6. (Note: the commercial diurnal curve remained unchanged.)

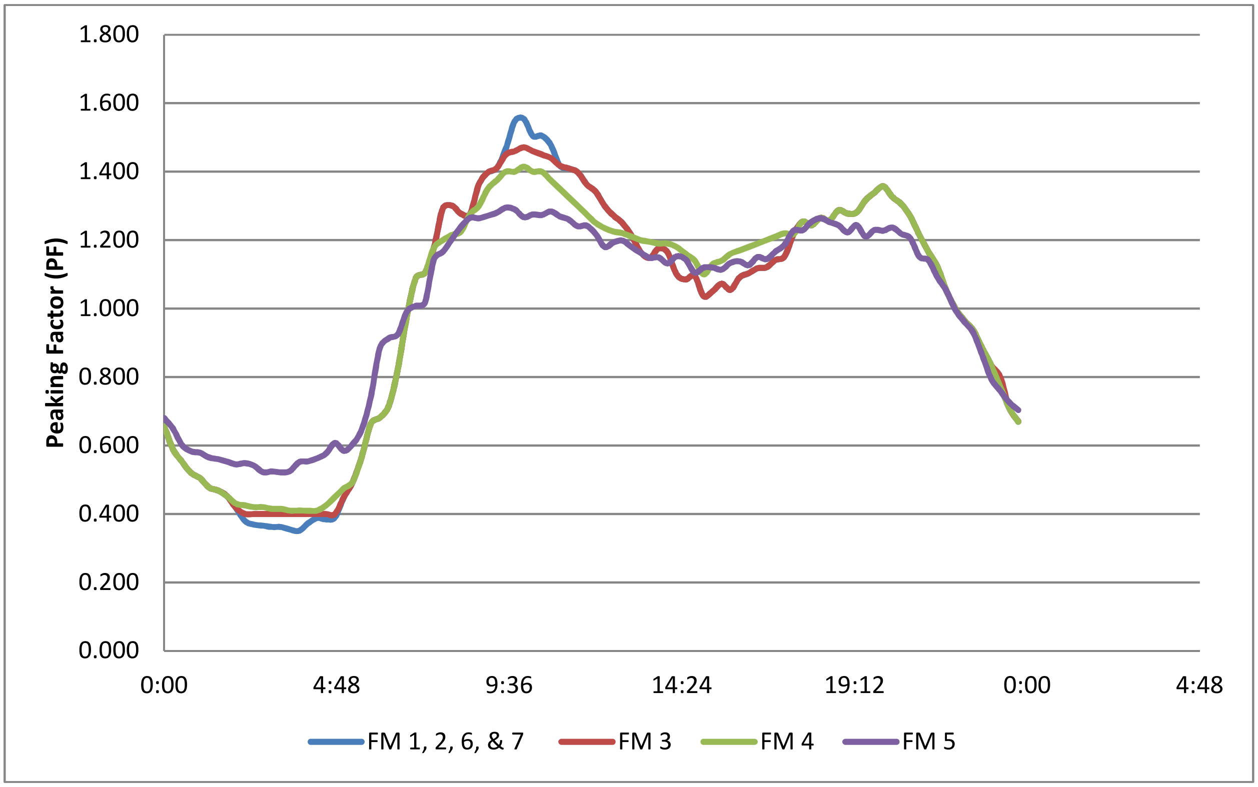

Figure 4-7. Calibrated Dry Weather Residential Diurnal Curves

4.6.2 DRY WEATHER CALIBRATION TO HISTORIC WWTP INFLOWS

WWTP inflow data is also used for calibration in the hydraulic model. Huston Creek WWTP modeled average dry weather inflows are within 10%; therefore, no adjustment to the model is required. Seeley WWTP average dry weather inflows are adjusted by adding an additional sewer flow load to a manhole node downstream of Flow Meters #5 and #6 to account for the Camp Seely connection downstream of the flow meters and match modeled average dry weather inflows to within 10%.

4.6.3 DRY WEATHER CALIBRATION RESULTS SUMMARY

Table 4-7 presents the results of the calibration of the dry weather scenario of the hydraulic model. Note that modeled average and peak values are within 10% of measured values for all flow meter drainage basins.

Table 4-7. Summary of Dry Weather Flow Meter Calibration Results

Flow Meter	Average Dry Weather Flows (MGD)			Peak Dry Weather Flows (MGD)		
	Measured	Modeled	% Error	Measured	Modeled	% Error
1	0.056	0.056	0%	0.087	0.087	0%
2	0.034	0.033	2%	0.051	0.053	5%
3	0.068	0.068	1%	0.100	0.106	6%
4	0.025	0.025	1%	0.038	0.038	0%
5	0.094	0.094	0%	0.122	0.125	3%
6	0.031	0.030	2%	0.046	0.047	2%
7	0.116	0.116	0%	N/A[1]	0.183	N/A[1]
Average % Error			**0.86%**			**2.7%**

Note:
[1] Flow Meter No. 7 experienced daily backflow from the operation of the Lake Gregory Lift Station; therefore, no average peak dry weather flow could be determined.

4.7 Wet Weather Model Calibration

Wet weather flow calibration is used to allocate wet weather I/I in the collection system. Areas with higher I/I will have higher rainfall loadings in the specific sewersheds in the model to simulate the effect of illicit connections and pipeline defects in those areas. To calibrate a wet weather scenario, additional flows are added to the model to account for rainfall-induced I/I. For this analysis, the model is calibrated to the wet weather flows captured during the 1/9/18 rain event. As with dry flow calibration, during wet weather calibration, rainfall flow patterns are adjusted until modeled peak wet weather flows are within 10% of measured peak wet weather flows.

The 1/9/18 rain event was determined to be a 1-year storm event, which is a storm that statistically occurs once per year. There can be a significant increase in I/I if a larger storm event occurs. For the Crestline area, the National Oceanic and Atmospheric Administration (NOAA), estimates a 10-year storm (a storm estimated to occur once every 10 years) as more than double the total 24-hour rainfall of a 1-year storm. A 25-year storm is estimated as approximately three times the total 24-hour rainfall of a 1-year storm. As a result, the potential for increased I/I is high during more severe rainfall events. While the model is calibrated to the 1-year storm event captured, additional data collection is recommended to obtain a more accurate representation of the collection system response to I/I in larger storm events.

Table 4-8 presents the results of the calibration of wet weather scenario of the hydraulic model. Note the modeled average and peak wet weather flows are within 10% of measured peak wet weather flows for each flow meter sewershed measured.

Table 4-8. Summary of Wet Weather Calibration Results

Flow Meter	Average Wet Weather Flows (MGD)			Peak Wet Weather Flows (MGD)		
	Measured	Modeled	% Error	Measured	Modeled	% Error
1	0.068	0.068	0%	0.102	0.099	3%
2	0.094	0.094	0%	0.164	0.166	1%
3	0.163	0.162	0%	0.247	0.239	3%
4	0.073	0.073	0%	0.122	0.130	7%
5	0.117	0.118	1%	0.159	0.148	7%
6	0.062	0.062	0%	0.100	0.100	0%
7	0.134	0.133	1%	N/A[1]	0.199	N/A[1]
Average % Error			**0.29%**			**3.5%**

Note:
[1] Flow Meter No. 7 experienced daily backflow from the operation of the Lake Gregory Lift Station; therefore, no average peak wet weather flow could be determined.

4.8 Existing System Evaluation

4.8.1 EXISTING DRY WEATHER FLOW CAPACITY EVALUATION

A capacity analysis of the existing collection system is performed for existing dry weather flow conditions. Model simulations are performed to identify capacity deficiencies within the collection system. Maximum d/D ratios for the dry weather flow scenario are compared against the evaluation criteria from Section 4.1.

Figure 4-8 illustrates the results of the analysis. Two 10-inch pipe segments just downstream of the Lake Gregory LS force main exhibit a modeled capacity deficiency at existing PDWF conditions due to having comparatively flat slopes. While these pipelines are operating above the design d/D of 0.5 for 10-inch diameter pipes, the potential for increased sewer flow is minimal as flows are predominantly limited to the discharge capacity of the Lake Gregory Lift Station. It is recommended that Smart Covers be installed in these manholes. No other improvements are recommended at this time.

No other pipelines modeled during the ADWF scenario exhibited peak hour flow conditions that had d/D levels in excess of allowable based on design criteria listed in Table 4-1.

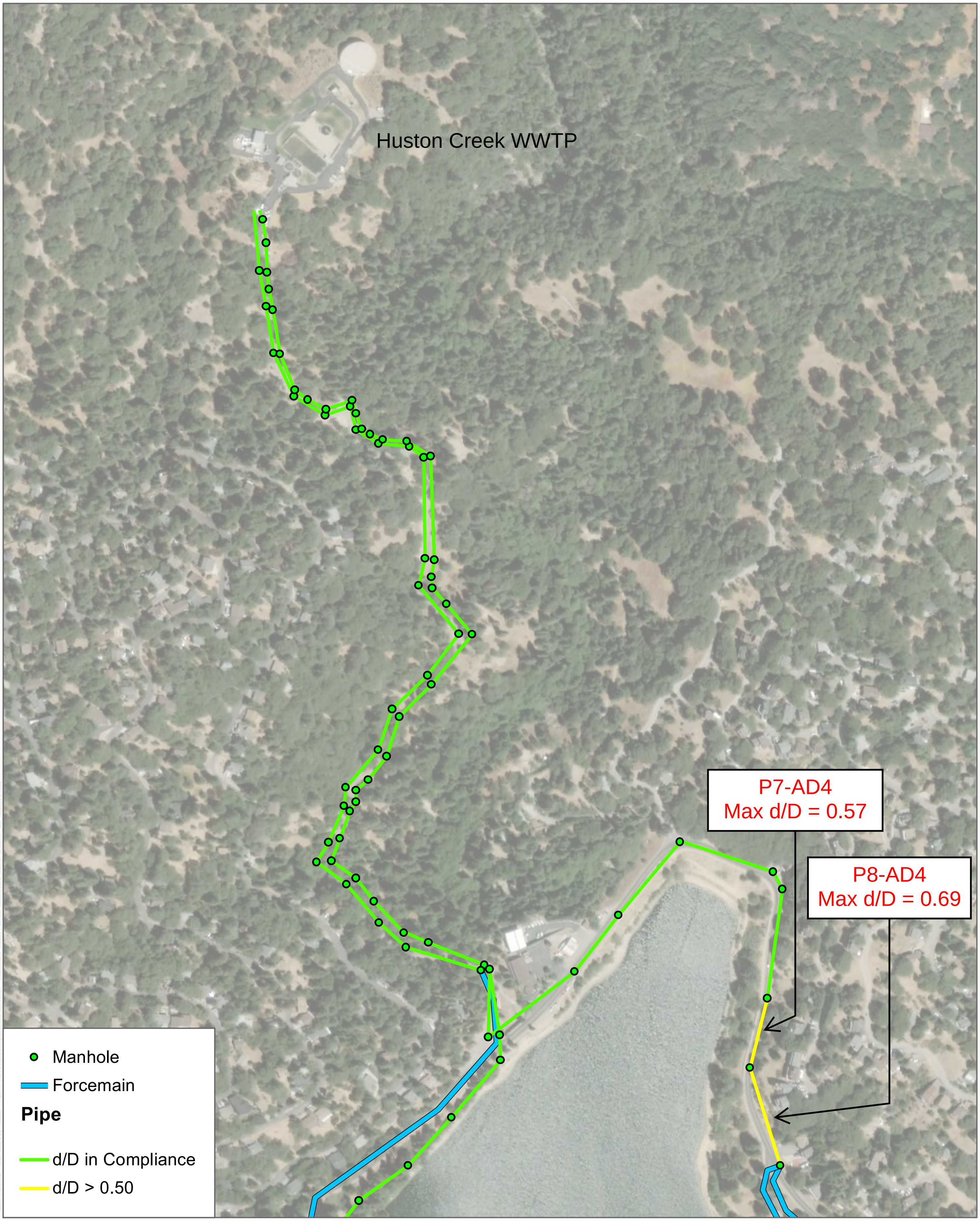

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Figure 4-8: Existing PDWF Capacity Analysis

Crestline Sanitation District

4.8.2 DEFECT FLOW ANALYSIS

Flow monitoring was successful in capturing an I/I response at several meters in association with the 1-year storm event that occurred on 1/9/2018. As discussed under section 4.3.2, the flow pattern recorded during the rain event provides an indication as to the nature of the defect flow.

Flow Meters #2, #3, and #4 showed an immediate increase defect flow, followed by immediate decrease in defect flow as the rain subsided. This flow pattern is associated with defect “inflow” typically reflected as illicit storm drain connections or surface runoff entering the collection system through manholes. While a response was recorded for this minor rain event, the hydraulic modeling of this event did not result in any of the collection system pipelines exceeding their design capacity or surcharging. Without capture of a more significant rain event and recording of the relative volume of defect flows, the severity of defect flow within each basin cannot be quantified or prioritized. The only conclusion that can be made from the captured event is that the defect flows within these basins is generally caused by inflow, versus the longer sustained response of infiltration.

Flow Meter #6 indicated both a rapid response representing inflow and also had an extended response for an additional 48-hours after the rain had subsided. This pattern of response reflects a combination of inflow and infiltration. Similar to other metered basins as described above, no pipelines exceeded design capacity during this minor rain event and that the degree of defect flows within the basin cannot be fully prioritized without a capturing the response from a more significant storm event. However, based on what was captured, infiltration appears to be an issue in Flow Metering Basin #6 to a greater extent than other basins measured in the collection system.

The recommended approach for further investigations for each basin are described in Section 6.1.

Typically, when rain events are captured during the flow monitoring period, the resultant defect flows can be amplified to simulate larger rain events. The larger the captured rain event, the greater accuracy can be achieved when simulating more severe storm events. Unfortunately, the single storm event captured on 1/9/18 was very small. With such a minimal event, amplifying this event to a 25- or 50-year storm event would introduce a high degree of error potential. Therefore conducting additional flow monitoring during subsequent wet weather seasons is recommended.

With the absence of stronger wet weather flow monitoring data, the developed hydraulic model was used to simulate a flow stress test in an effort to identify specific locations that could be more vulnerable to defect flows. An overall peaking factor was applied to the entire set of flow inputs to the model and the model run for a 24-hour simulation. The peaking factor was incrementally increased until portions of the collection system began to exhibit surcharging. The results from this analysis showed that with a peaking factor of 4 (four times the average dry weather flow), portions of the collection system in basin #3, and specifically pipeline upstream and downstream of the Lake Gregory lift station began to show surcharging. The following Figure 4-9 shows the location of surcharged pipelines as a result of this stress test simulation.

As a result of this finding, further investigation of potential inflow in Flow Metering Basin #3 is considered higher priority than the other flow metering basins. Investigation of sources of inflow in Flow Metering Basins #2, #4 and #6 are of lower priority as the trunk sewers in those basins have higher available capacity.

Two other locations are recommended for additional flow monitoring. It is recommended the HCTS be monitoring at the discharge structure and at each of the two AD3 connection points. This flow monitoring investigation will determine if there are any large sources of defect flow into the Huston Creek Trunk Sewer. It is also recommended that Flow Metering Basin #7 be re-evaluated at locations further upstream of FM#7 to determine if there is a significant I/I concern in the areas tributary to the Lake Gregory Lift Station.

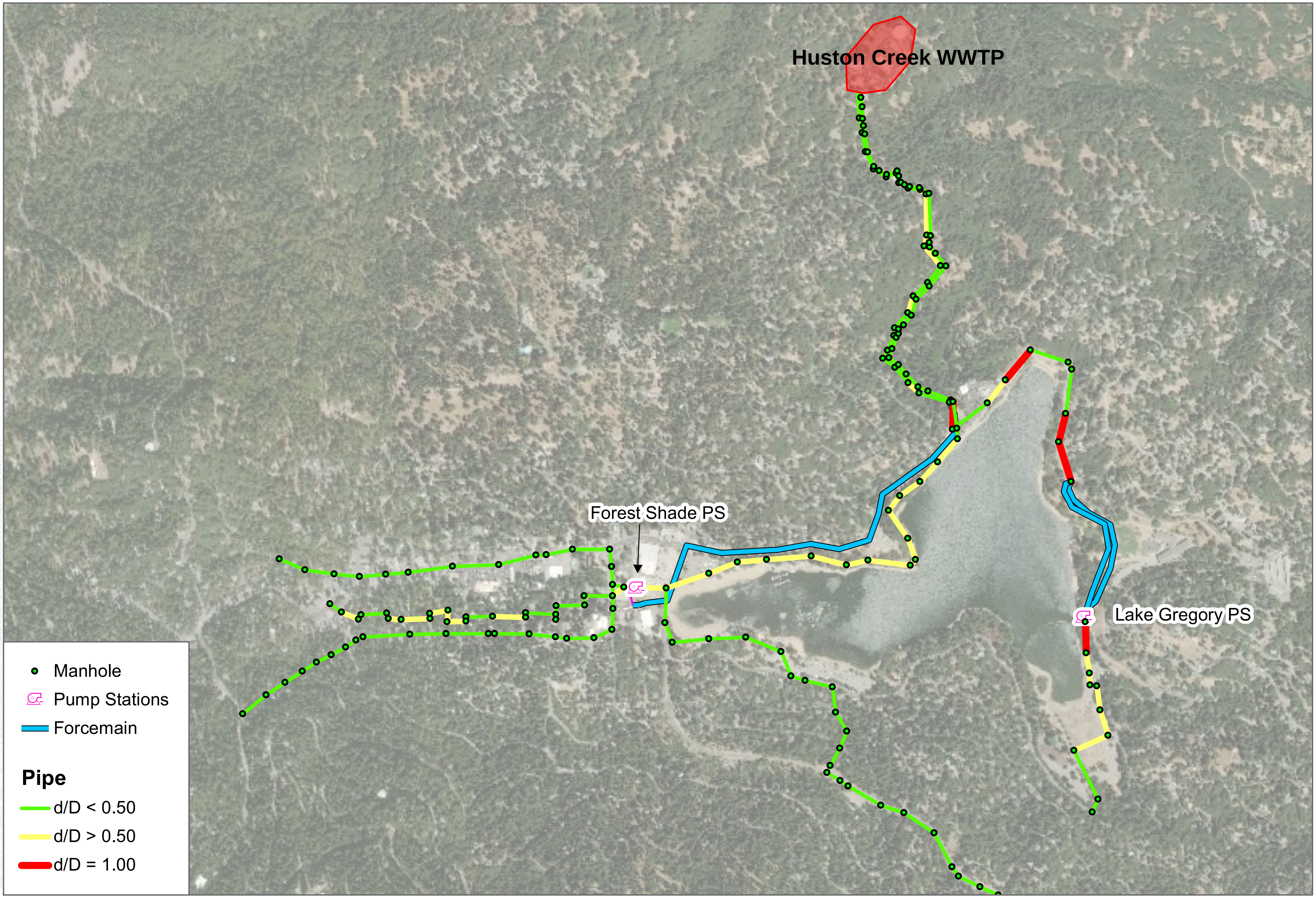

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Figure 4-9: Stress Test Simulation Results (4xADWF)

Crestline Sanitation District

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4.9 Ultimate Flow Projections and Analysis

This section discusses analysis performed to identify the anticipated additional sewer flows from future development within the service area and its effect on capacity within the collection system.

4.9.1 ANTICIPATED ULTIMATE FLOWS

As discussed in Section 4, there are approximately 1,258 vacant parcels within the sewer service area that can be developed and connected to the collection system. Based on discussions with the District, it is estimated that only half of these parcels have potential to be developed and connected in the future. This estimate is based on existing topography challenges and general trends observed by District staff. For evaluation of ultimate build-out sewer flows, one-half of all existing vacant residential parcels (629 equivalent dwelling units) were added to the existing system model. As vacant parcels span across several drainage basins, the 24-hour diurnal curve associated with each unique basin was used for the simulation. Flows were injected to the nearest model node for each vacant parcel.

Table 4-9 compares the existing and ultimate ADWFs and PDWFs for each flow meter drainage basin and both WWTPs as a result of the additional infill loads added to simulate the build-out condition of the system. The total average WWTP inflow increased by approximately 50% for both WWTPs after the infill loads were added to the model.

Table 4-9. Ultimate Dry Weather Flow Scenario Infill Flow

Flow Meter	Average Dry Weather Flows (MGD)				Peak Dry Weather Flows (MGD)			
	Existing	Ultimate	Increase	% Increase	Existing	Ultimate	Increase	% Increase
1	0.056	0.118	0.062	111%	0.087	0.159	0.072	83%
2	0.033	0.058	0.025	76%	0.053	0.080	0.027	52%
3	0.068	0.079	0.011	16%	0.106	0.116	0.010	9%
4	0.025	0.034	0.009	36%	0.038	0.043	0.005	13%
5	0.094	0.126	0.032	34%	0.125	0.156	0.031	25%
6	0.030	0.048	0.018	60%	0.047	0.066	0.019	40%
7	0.116	0.166	0.050	43%	0.183	0.248	0.065	36%
Seeley Creek WWTP	0.142	0.216	0.074	52%	0.178	0.272	0.094	53%
Huston Creek WWTP	0.455	0.676	0.221	49%	0.584	0.883	0.299	51%

4.9.2 ULTIMATE DRY WEATHER CAPACITY ANALYSIS RESULTS

Capacity analysis of the existing collection system was performed under projected future dry weather flow conditions. Model simulations are performed in order to identify capacity restrictions that may occur as a result of infill within the District's sewered area. Maximum d/D ratios for pipes for the ultimate dry weather flow scenario are compared against the evaluation criteria from Section 4.1. Pipes that exceeded these criteria are flagged for potential future upsizing as a CIP project.

Figure 4-10 illustrates segments of pipe in yellow (four with a total length of 1,115 linear feet {LF}) that exhibit flows above design level capacity for dry weather flow conditions. The maximum d/D values range from 0.63 to 0.72, as shown. The profile of this segment of pipeline, presented in Figure 4-11, shows that the four pipelines showing excess water level are more flat (constructed at minimum slope of 0.004 ft/ft).

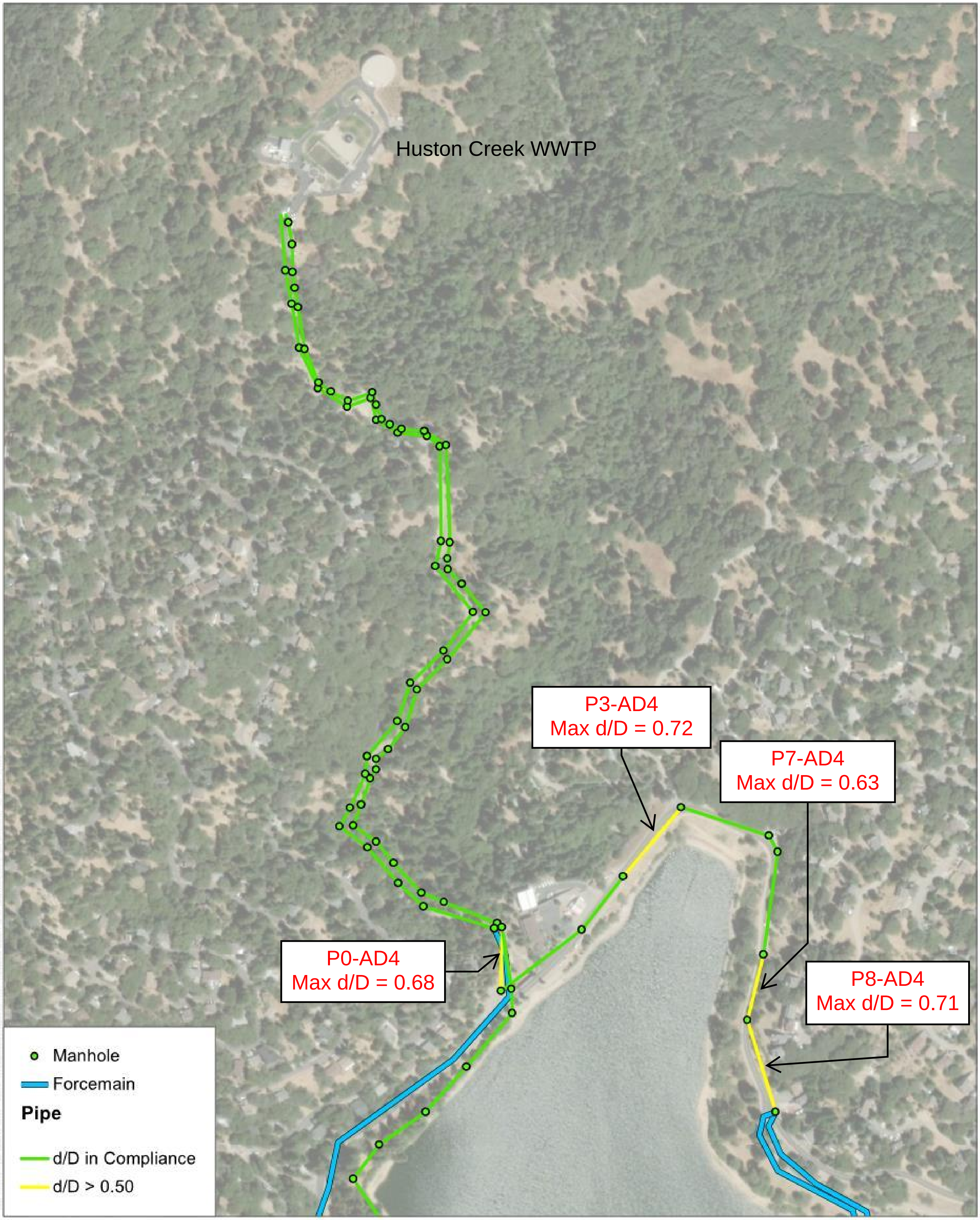

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Figure 4-10: Future PDWF Capacity Analysis

Crestline Sanitation District

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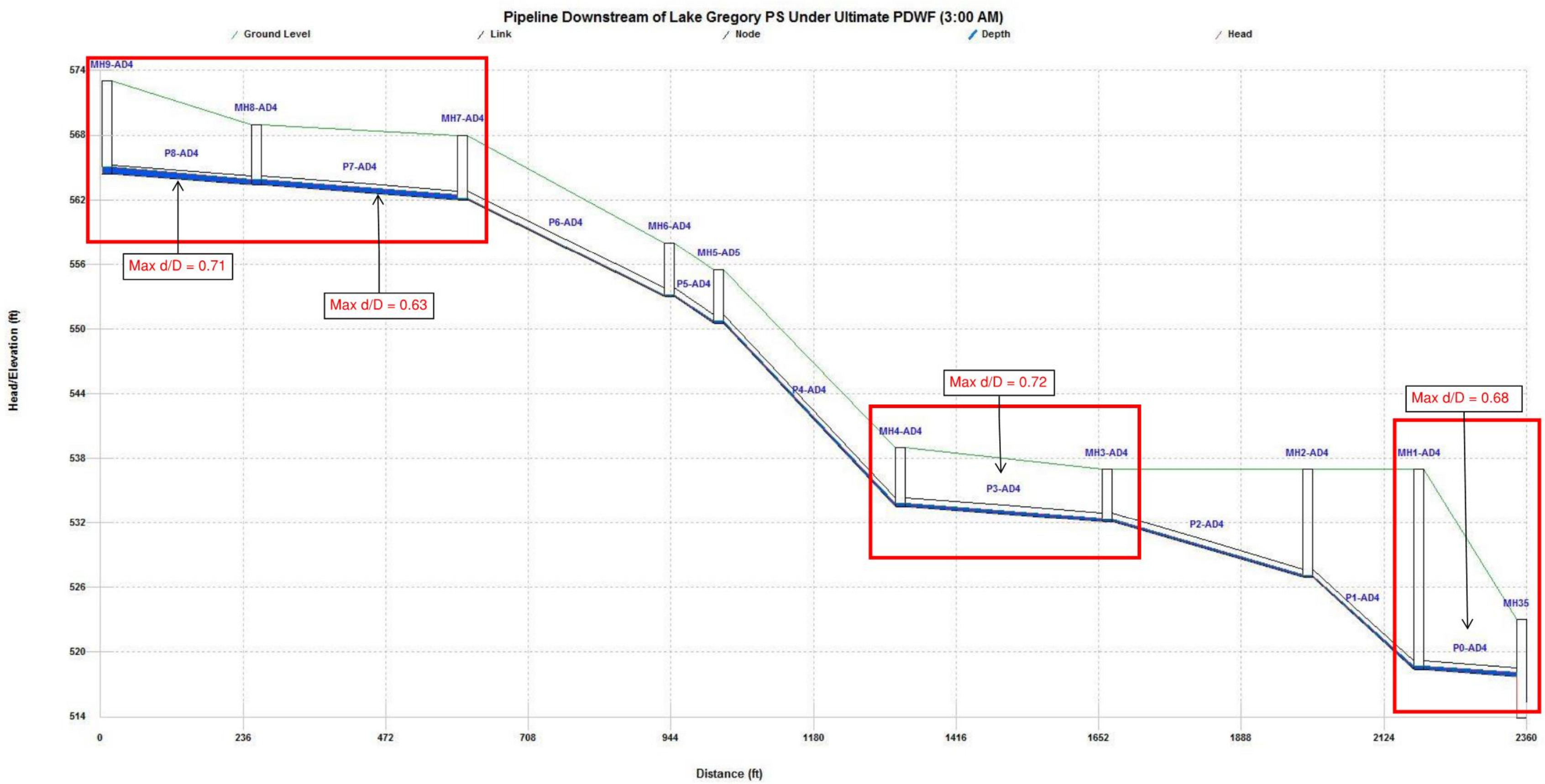

Figure 4-11. Ultimate PDWF Pipe Profile

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Figure 4-12 and Figure 4-13 on the following pages show the calculated full flow capacity versus modeled ultimate peak dry weather flow for each pipe in the two parallel (west and east) 12-inch diameter Huston Creek Trunk Sewers (HCTS) that flow from the Huston Creek Discharge Structure to the Huston Creek WWTP. As shown, the HCTS can readily accommodate Ultimate PDWF, estimated at 0.90 MGD total for the combined pipes. Maximum capacity of the combined pipes is estimated at 3.8 MGD. The maximum capacity is more than four times the estimated Ultimate PDWF for the system, which infers the HCTS can accommodate a wet weather peaking factor of four without surcharging.

4.9.3 ULTIMATE WET WEATHER CAPACITY ANALYSIS

Typically, evaluation of the collection system considers its ability to contain and convey ultimate peak wet weather flows. In this simulation, the pipeline is allowed to run up to 100% full (d/D = 1) during peak hour effectually utilizing all available capacity. Depending on pipeline location and existence of lateral connections, surcharging to a minor level (up to 2-feet) may also be acceptable during a major storm event (for example a 25-year storm).

For this master plan development, flow monitoring efforts were unsuccessful at capturing a meaningful storm event useful for accurately scaling to a 25-year storm event and evaluating an ultimate wet weather flow simulation. Additionally, the hydraulic model only includes pipelines 10-inches and larger, with several 8-inch collector pipelines. Therefore, development of an ultimate wet weather scenario for evaluation capacity is not reasonable at this time. Included as part of recommendations for future projects is the additional wet weather flow monitoring to capture a significantly larger storm event (>5-year storm) and associated wet weather defect flows. This information, coupled with a complete hydraulic model incorporating all collector pipelines will provide the necessary foundation for consideration of ultimate wet weather capacity analysis.

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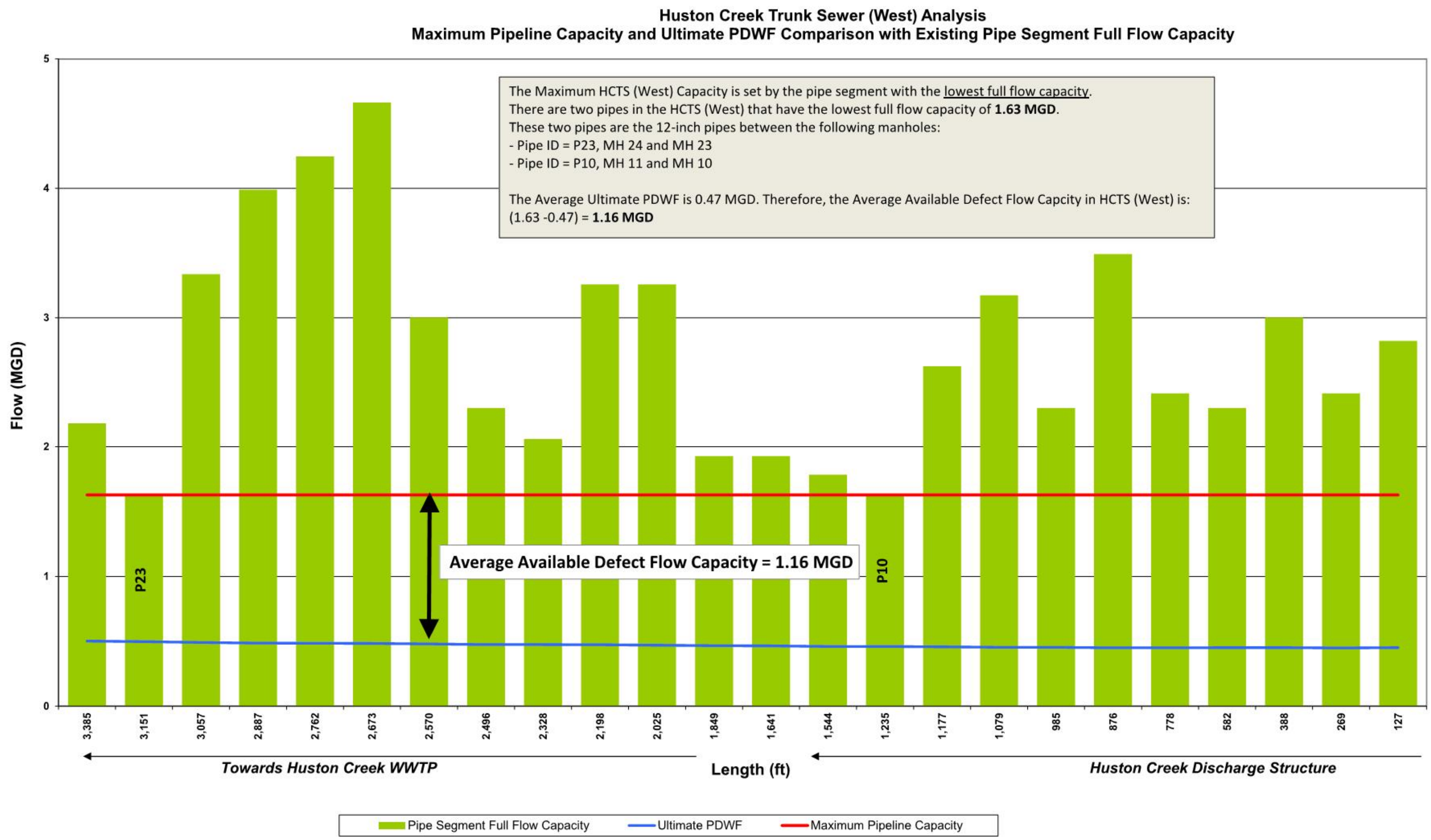


Figure 4-12. HCTS (West) Analysis

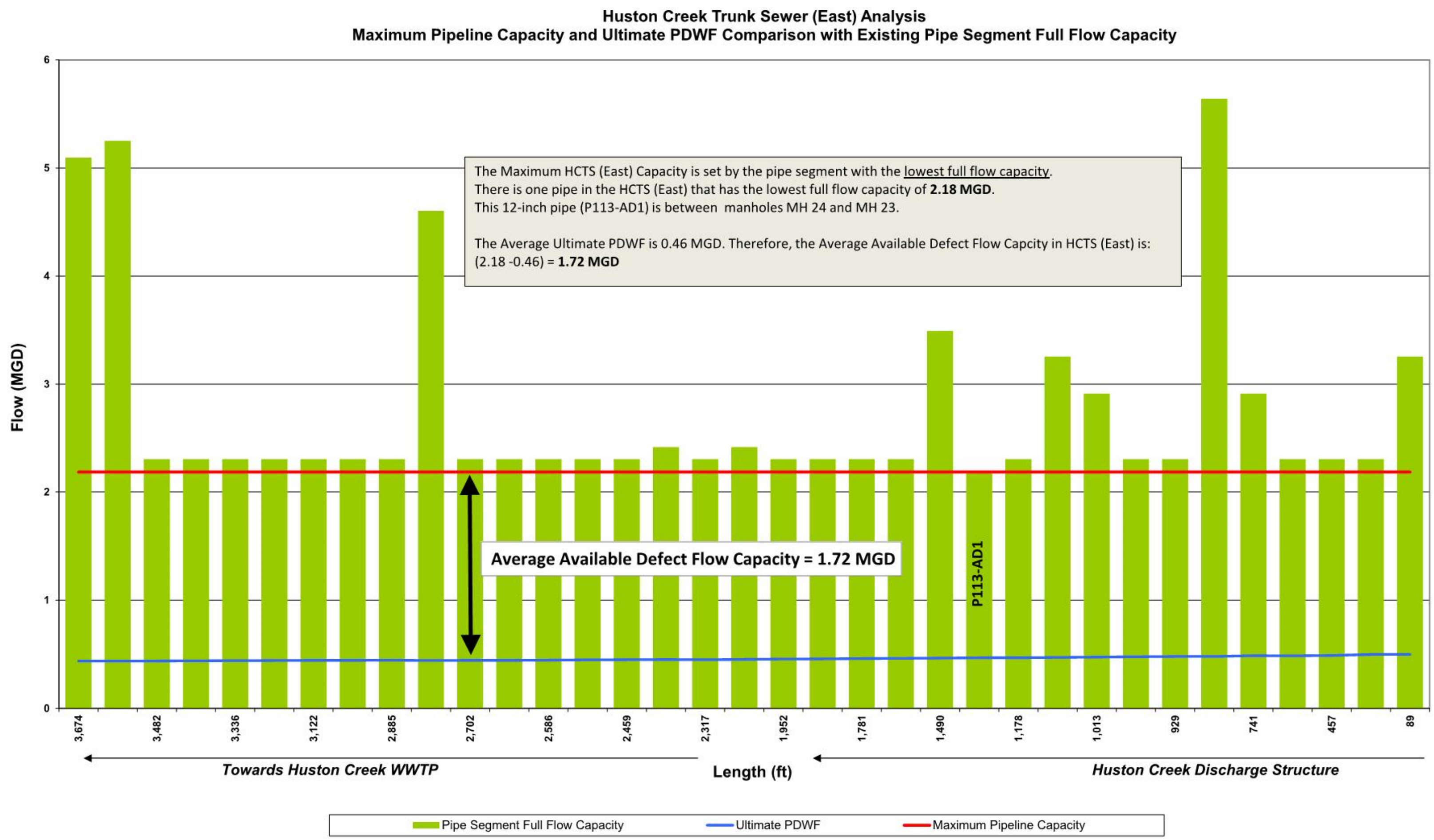


Figure 4-13. HCTS (East) Analysis

5 TREATMENT FACILITIES EVALUATION

The District's wastewater treatment facilities are between 45 and 65 years old, with most original processes, core infrastructure and facilities remaining in service today. The District has been successful by maintaining and prolonging use of these facilities without expensive treatment overhauls.

The treatment facilities evaluation approach included a process evaluation and a Consequence of Failure Analysis (CoFA) for Huston Creek WWTP, Seeley Creek WWTP, and Cleghorn WWTP. In summary, the process evaluation consisted of gathering and analyzing key process flow, constituent, and other measured data to evaluate the current conditions affecting plant processes and comparing the data to both design criteria from plant record drawings and typical design criteria. The CoFA was performed on each of the WWTP's and lift stations to identify plant reliability and deficiencies in a workshop environment. Treatment facilities are evaluated based on current performance and discharge requirements.

5.1 Process Performance and Capacity Evaluation

A process performance overview for Huston Creek, Seeley Creek, and Cleghorn WWTP's are provided in Table 5-1, Table 5-2, and Table 5-3, respectively. Average, maximum, and minimum values of the data are provided as available, along with the sample size, design criteria, M&E typical ranges, and regulatory limits, as applicable. All of the data summarized was captured between January 1, 2015 and August 9, 2017. The full process evaluation (Technical Memorandum 1) is included in Appendix A.

Table 5-1. Huston Creek WWTP Process Performance Summary (Jan 2015-Aug 2017)

Parameter	No. of Data Points	Units	Values			Design Criteria	Metcalf & Eddy Typical Range	Regulatory Limit
			Average	Maximum	Minimum			
Plant Influent								
Total Plant Influent Flow	952	MGD	0.500	2.020	0.015	0.700	-	-
Influent BOD_5	63	mg/L	313	447	117	200	200-400	-
Influent TSS	63	mg/L	258	650	8	-	195-389	-
Influent TKN	-	mg/L	-	-	-	-	35-69	-
Influent Ammonia	-	mg/L	-	-	-	-	20-41	-
Primary Treatment								
BOD Removal	63	%	47%	74%	6%	-	20-40	-
Effluent BOD	63	mg/L	163	252	50	-	-	-
TSS Removal	62	%	73%	99%	7%	-	45-65	-
Effluent TSS	63	mg/L	61	131	5	-	-	-
Primary Solids (to waste)	49	%	1.17	4.90	0.01	-	4-10	-
Secondary Treatment								
Effluent BOD	64	mg/L	29	57	5	-	<30	-
Effluent TSS	64	mg/L	15	38	2	-	-	-
Recirculation Rate (vs. influent)	952	-	1.9	3.6	0.5	-	0-1	-
Disinfection								
Chlorine Dose	952	mg/L	23	73	7	15	18-22	-
Chlorine Residual (Plant Effluent)	951	mg/L	17	38	2	-	-	-
Chlorine Residual (Disposal Site)	269	mg/L	6	17	1	-	-	>0
Solids Thickening								
TS%	49	%	4.2	10.0	2.4	-	3-9	-
Solids Dewatering								
Cake Solids %	137	%	31.9	46.4	20.1	-	16-30	-
Plant Effluent								
Effluent Flow	952	MGD	0.347	1.480	0.086	0.700	-	0.700
Effluent BOD	124	mg/L	18.6	27.0	13.8	30	-	30
Effluent TSS	124	mg/L	16.6	38.0	0.1	-	-	-

Table 5-2. Seeley Creek WWTP Process Performance Summary (Jan 2015-Aug 2017)

Parameter	No. of Data Points	Units	Values			Design Criteria	Metcalf & Eddy Typical Range	Regulatory Limit
			Average	Maximum	Minimum			
Plant Influent								
Total Plant Influent Flow	949	MGD	0.163	0.900	0.000	0.500	-	-
Influent BOD_5	63	mg/L	309	592	106	200	200-400	-
Influent TSS	63	mg/L	271	675	25	-	195-389	-
Influent TKN	-	mg/L	-	-	-	-	35-69	-
Influent Ammonia	-	mg/L	-	-	-	-	20-41	-
Primary Treatment								
BOD Removal	63	%	86%	94%	60%	-	20-40	-
Effluent BOD	63	mg/L	39	91	17	-	-	-
TSS Removal	63	%	89%	99%	25%	-	45-65	-
Effluent TSS	63	mg/L	22	156	4	-	-	-
Primary Solids (to waste)	49	%	2.81	11.80	0.14	-	4-10	-
Secondary Treatment								
Effluent BOD	63	mg/L	11	32	3	-	<30	-
Effluent TSS	63	mg/L	5	35	0	-	-	-
Recirculation Rate (vs. influent)	949	-	6.1	21.6	1.2	-	0-1	-
Disinfection								
Chlorine Dose	949	mg/L	30	105	7	-	18-22	-
Chlorine Residual (Plant Effluent)	948	mg/L	9	25	1	-	-	-
Chlorine Residual (Disposal Site)	269	mg/L	6	17	1	-	-	>0
Plant Effluent								
Effluent Flow	-	MGD	-	-	-	0.500	-	0.500
Effluent BOD	123	mg/L	17.5	25.5	11.0	30	-	30
Effluent TSS	125	mg/L	2.5	11.0	0.0	-	-	-

Table 5-3. Cleghorn WWTP Process Performance Summary (Jan 2015-Aug 2017)

Parameter	No. of Data Points	Units	Values: Average	Values: Maximum	Values: Minimum	Design Criteria	Metcalf & Eddy Typical Range	Regulatory Limit
Plant Influent								
Total Plant Influent Flow	-	MGD	-	-	-	0.200	-	-
Influent BOD_5	63	mg/L	289	776	40	-	200-400	-
Influent TSS	63	mg/L	227	1220	5	-	195-389	-
Influent TKN	-	mg/L	-	-	-	-	35-69	-
Influent Ammonia	-	mg/L	-	-	-	-	20-41	-
Secondary Treatment								
Mixed Liquor Suspended Solids (MLSS)	49	mg/L	3847	11000	500	-		-
Return Activated Sludge (RAS) Rate	946	% of ADF	306	1080	30	-	50-75	-
RAS Concentration	49	mg/L	9588	71000	900	-	6000-12000	-
Hydraulic Retention Time (HRT) in Ox. Ditch	-	hours	132	-	-	-	15-30	
Solids Retention Time (SRT)	-	days	182	-	-	-	15-30	-
Dissolved Oxygen (DO)	-	mg/L	-	-	-	-	1.5-2.0	-
Secondary Effluent								
Effluent BOD	64	mg/L	14	57	1	-	<30	-
Effluent TSS	63	mg/L	38	252	0	-	-	-
Disinfection								
Chlorine Dose	946	mg/L	87	599	0	-	18-22	-
Chlorine Residual (Plant Effluent)	946	mg/L	9	141	0	-	-	-
Chlorine Residual (Disposal Site)	269	mg/L	6	17	1	-	-	>0
Plant Effluent								
Effluent Flow	947	MGD	0.010	0.680	0.000	0.200	-	0.200
Effluent BOD	61	mg/L	18	29	11	30	-	30
Effluent TSS	63	mg/L	24.3	130.6	2.0	-	-	-

5.1.1 PROCESS EVALUATION CONCLUSIONS AND RECOMMENDATIONS

The following preliminary conclusions and recommendations were derived from the process evaluation. Preliminary conclusions and recommendations below are not listed in order of priority. Priority was assessed in the Consequence of Failure analysis.

Huston Creek WWTP

- Huston Creek WWTP influent Biological Oxygen Demand (BOD) loading exceeds the design capacity of the plant. A portion of the organic load is removed in the primary clarifiers, but the main process for BOD removal occurs in the trickling filter. The trickling filter utilizes an older, less efficient fixed-nozzle design with rock media. The rock media does provide better thermal insulation for the media than a more modern plastic media, and therefore retrofit design conversion to plastic media and alternative distributers is not recommended without covering the filter. It is recommended that the District continue to monitor the effectiveness of the trickling filter for compliance with effluent BOD discharge requirements. In the future, a biological treatment expansion or process change may be necessary to address organic and nutrient removal requirements imposed by the Regional Water Quality Control Board (RWQCB).
- Huston Creek WWTP discharge violations since 2015 are all due to exceeding the average day flow limit of 0.7 MGD. No treatment violations for BOD and/or TSS removal have occurred in this time. It is recommended that the District continue to rehabilitate the collection system in effort to reduce I/I and pursue a wet weather hydraulic discharge limit with the next permit update.
- The primary clarifiers are at hydraulic capacity during current flow conditions. Primary clarifier redundancy is needed for reliability and improved performance. Construction of a redundant primary clarifier is recommended.
- Secondary clarification has no redundancy, and is an unconventional design. Consider construction of a new secondary clarifier for redundancy and capacity in conjunction with a future biological treatment process upgrade.
- Huston Creek WWTP is the District's biosolids thickening, dewatering, and hauling hub for all of their facilities. Consider evaluating sludge digestion technologies and alternative disposal options to determine if alternate disposal locations and/or digestion may reduce hauling and disposal costs.
- Monitor trend and consider investigating the cause of slowly increasing effluent BOD concentrations since January 2015.

Seeley Creek WWTP

- Consider construction of a grit chamber and classifier equipment for grit removal. Grit accumulation in the primary clarifier adds inorganic material to the waste sludge stream and can contribute to wear on primary sludge pumps.
- Consider construction of an automatic screenings unit in the headworks to reduce operator labor and improve screenings removal.
- Construct an effluent flow meter for more consistent data monitoring and reporting purposes. An effluent flow meter can also be used to flow-pace chlorine disinfection dose.
- Current data show that plant effluent BOD is higher on average than secondary effluent BOD. This discrepancy in BOD measurements should be investigated to determine where and how misrepresentative data is being measured.
- Relatively little emergency storage tank volume (100,000 gallons) is currently available at the Seeley Creek WWTP. Consider lining the downhill pond near the treatment plant for additional emergency storage capacity during peak wet weather flow events, outfall breaks, or other emergency failure scenarios.
- Monitor trend and consider investigating the cause of slowly increasing effluent BOD concentrations since January 2015.

Cleghorn WWTP

- Evaluate influent hydraulics in the headworks channel to determine if overflow conditions exist at peak flow.
- Consider construction of an influent flow meter. An influent flow meter provides valuable data for operators to calculate loading conditions and adjust operations set points, when applicable.
- Consider construction of an automatic screenings unit in the headworks to reduce operator labor and improve screenings removal.
- Consider construction of sludge drying beds or other sludge handling facility to allow for appropriate wasting operation and solids retention time (SRT) control in the oxidation ditch.
- Investigate the discrepancy in BOD measurements that show plant effluent BOD is higher on average than secondary effluent BOD.
- Monitor trend and consider investigating the cause of slowly increasing effluent BOD concentrations since January 2015.

5.2 Consequence of Failure Analysis

The CoFA is a process that facilitates deliberate discussion and analysis of the criticality of process systems, drilling down to the component-level. Each unit process (e.g. Headworks) is analyzed through the major assets and functions of that process (e.g. Mechanical Bar Screens) and further by the failure modes of that asset (e.g. mechanical failure, control failure, etc.) that leads to a functional failure of that asset. Through a workshop format, critical Operations staff input is captured to expeditiously define applicable scoring. Figure 5-1 presents the CoFA flowchart. The outcome from the CoFA process identifies operating and maintenance (O&M) adjustments and/or capital improvement projects that improve the reliability and efficient operation of the treatment facilities. Complete CoFA notes, analysis, O&M recommendations, and preliminary CIP recommendations are documented in Appendix B.

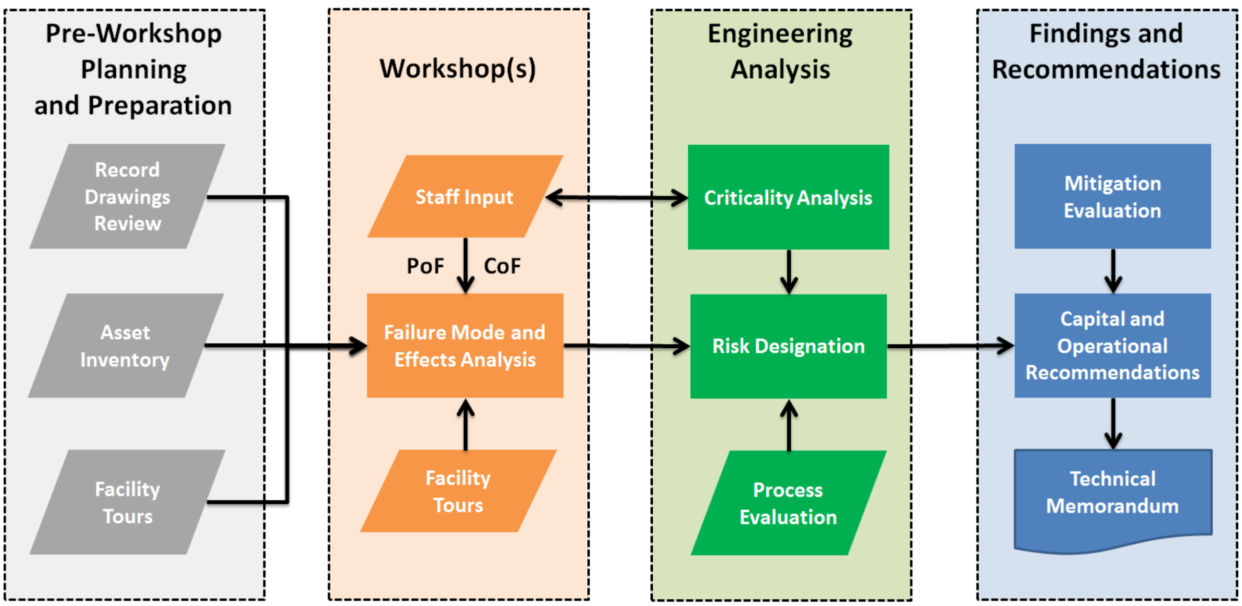


Figure 5-1. Consequence of Failure Analysis Flow Chart

The Consequence of Failure (CoF) and Probability of Failure (PoF) are used to establish a risk designation that allows for the prioritization of risk-based strategic planning. The project team used information gathered from the process evaluation to drive workshop discussion and identify potential causes of process deficiencies. Depending on the risk designation and the nature of the defined failure mode, operational-based and/or capital-based recommendations are made to mitigate the risk. Risk mitigation is achieved by reducing the defined consequence and/or probability of failure.

Consequence of Failure

CoF is a scoring metric to provide context to the effect of a failure and are focused on capacity, level of service, and mortality. The effects of a failure were categorized among four distinct categories:

- Health and Safety,
- Treatment Performance/Regulatory,
- Economic/Personnel Resources, and
- Public Image.

Each CoF category is weighted to align with the District's risk management priorities and philosophies. The CoF categories, weight factors, and descriptions are summarized in Table 5-4.

Table 5-4. Description of Consequence of Failure Categories

CoF Categories	Weight Factor	Description
Health & Safety	7	Failure results in potential health and safety risk for District staff or visitors on Plant site.
Treatment Performance/Regulatory	5	Failure results in treatment performance impacts and potential regulatory violations, penalties, fines, etc.
Economic/Personnel Resources	5	Failure results in economic resources cost and/or major staff time and resource allocation.
Public Image	3	Failure results in potential negative public attention and scrutiny.

Each consequence category received a numerical score, 1 to 5, for each failure mode based on the tolerance of failure of the process or equipment. The CoF scores for each category generally apply as follows:

1. Insignificant Consequence,
2. Minor Consequence,
3. Moderate Consequence,
4. Major Consequence, or
5. Catastrophic Consequence.

After the CoF score was determined for each category, the category scores are multiplied by the corresponding weight factor and summed (i.e. a sum-product is performed) to produce a comprehensive score defined as "criticality". The criticality of each unit process or asset is established by the criticality score(s) associated with its failure mode(s). Based on the weight factors recommended in Table 5-4, the highest criticality score, assuming each CoF category is assigned a score of "5", would be 100. The lowest criticality score, assuming each CoF category is assigned a score of "1", would be 20. The guidelines used to score each CoF category in detail are presented in Table 5-5

Table 5-5. Consequence of Failure Scoring Guideline

CoF Category	Weight Factor	CoF Score				
		1	2	3	4	5
Health & Safety	7	Negligible Injury	Minor injury, medical attention required	Serious injury hospitalization required	Serious injury, extensive hospitalization and/or permanent health impacts	Loss of Life
Treatment Performance / Regulatory	5	Insignificant loss of treatment performance	Minor loss of treatment performance, impacts on multiple processes. No regulatory violations.	One-time regulatory violation.	Major loss of treatment performance, extended violation or multiple violations, regulatory sanctions	Plant-wide catastrophic failure, treatment process uncontrollable for 48 hrs+ regulatory sanctions.
Economic/ Personnel Resources	5	<$500	<$2,500	<$10,000	<$100,000	>$100,000
Public Image & Board Concerns	3	Insignificant effect or community/ Board concern	Minor community/ Board interest or complaints	Public community discussion and local paper coverage	Loss of confidence by community/ Board. Public agitation for action.	Public investigation, news coverage, management changes demanded.

The baseline (existing conditions) CoF scores were defined given the assumption that no activity is performed to mitigate the consequence of failure to the process or equipment. The baseline CoF score is important for prioritizing recommendations and subsequent analysis and recommendations have considered mitigation or activities that reduce the risk potential of a given failure mode.

Probability of Failure

While Consequence of Failure evaluates the effects of failure modes it lacks the context of defining the likelihood of the failure scenario actually happening. Therefore, it is equally important to evaluate the probability of the failure mode to complete a comprehensive risk assessment. Probability of a failure mode occurring can be assessed in a qualitative or quantitative way. PoF was qualitatively assessed in this CoFA due to a lack of comprehensive data upon which to support quantitative scoring. Qualitative assessment was achieved by assigning a relative probability level derived primarily upon input from Operations staff regarding past failures, current condition assessment, and current operational procedures. Probability of Failure was ranked according to the system described in Table 5-6.

The baseline (existing conditions) PoF scores were defined given the assumption that no activity is performed to mitigate the probability of failure to the process or equipment (i.e. routine maintenance, preventative maintenance, condition assessment, etc.). The baseline PoF score is important for justifying current O&M practices and identifying needs for additional mitigation measures to reduce the risk of a given failure.

Table 5-6. Probability of Failure Scoring Guideline

PoF	Likelihood of Occurrence	Current Probability of Condition Based Occurrence
A	Rare	3+ years
B	Unusual	Within 1 – 3 years
C	Annual	Within 6 – 12 months
D	Occasional	Within 1 – 6 months
E	Common	Within 1 month
F	Certain - Ongoing	Daily

Risk Exposure Designation

Following the workshop from which CoF and PoF scores were established for each failure mode, a risk exposure designation was established by combining the two scores. The risk exposure designation represents the relative level of risk associated with the failure mode evaluated. Risk exposure is designated according to four levels described in Table 5-7.

Table 5-7. Risk Exposure Designations

Risk Designation		Strategy for Risk Mitigation
L	Low	Reactive strategy is acceptable. The risk level does not suggest proactive monitoring strategies or capital improvement projects are necessary.
M	Medium	Proactive strategy for monitoring performance and condition may be recommended. Mix of proactive and reactive strategies may also apply. Capital Improvement projects may be recommended to mitigate risk where applicable.
H	High	Proactive planning and risk mitigation strategy is required. Capital Improvement projects will be recommended if operations and maintenance strategies are insufficient to mitigate risk to an acceptable level.
E	Extra High	Proactive planning and risk mitigation strategy is required immediately. Capital Improvement projects and operations and maintenance strategies must be developed and implemented as soon as possible to mitigate risk to an acceptable level.

These levels of risk designations are assigned to a failure mode associated with a unit process or asset according to the criticality score and PoF ranking generated through workshop discussion. The risk designation level is assigned to a failure mode scenario according to the matrix presented in Table 5-8.

Table 5-8. Risk Exposure Designation Matrix

PoF	Criticality							
	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-100
A	L	L	L	L	L	M	M	M
B	L	L	L	M	M	H	H	H
C	L	L	M	M	H	H	H	E
D	L	M	M	H	H	E	E	E
E	L	M	H	H	E	E	E	E
F	L	M	H	H	E	E	E	E

Recommendations for risk mitigation are prioritized based on the resulting risk designations. Mitigation measures are categorized as O&M procedural adjustments or as defined CIP projects. Depending on the risk designation and benefit/cost analyses, the recommendations are prioritized over the planning horizon. Items with significant risk potential that cannot be adequately mitigated by O&M measures and recommendations are evaluated for potential CIP projects, which supersede programmed replacement scheduling such that the upgrade or betterment project is implemented appropriately in the CIP timeframe.

Analysis and Recommendations

Each unit process and asset failure mode is categorized and ranked according to the risk designation that it received. Failure modes designated to result in high-to-extra high exposure to risk are prioritized and mitigation measures aimed to reduce the probability or consequence of failure are identified to mitigate risk to an acceptable level. Capital projects identified through the CoFA process are prioritized according to their risk designation and the criticality score within the designation.

In most cases, medium risk is acceptable for critical assets and unit processes, and a low risk designation may not be achievable. This means that if five failure modes are designated to be high-risk, the priority of capital project implementation will be made to address the highest criticality scores within the five failure modes and probability of failure ranking will be a secondary measure of priority.

The complete CoFA workshop input, analysis, and results are included in Appendix B.

6 CAPITAL IMPROVEMENT PROJECT RECOMMENDATIONS

The following sections describe background information, capital improvement project needs, and recommended capital improvement projects for the collection system and each process area at the WWTPs. The project needs were identified through the collection system hydraulic model, CoFA, and process evaluation. Recommended CIP projects are identified to best address the reliability, performance, and capacity deficiencies identified through the technical analysis and based on the most current information available. Each CIP project should be re-evaluated relative to most current data and information prior to implementation to verify if the project is the best solution for the District at that time.

Recommended CIP projects are introduced by facility in the following sections. Each section will describe the process and background information, discuss project needs derived from reliability, performance, and capacity evaluations, and list recommended projects and estimated project costs.

The District's wastewater system is categorized into the following facilities:

- Collection System
- Huston Creek WWTP
- Seeley Creek WWTP
- Cleghorn WWTP

Each WWTP is further subdivided into the following process areas:

- Headworks and grit removal
- Primary treatment
- Biological treatment
- Disinfection
- Sludge handling and dewatering
- Plant-wide projects

If one or more CIP projects are recommended to improve a process area, project summary sheets are included at the end of each section with a description and cost breakdown of the project.

Construction costs are broken down into five categories:

- *General*: Captures costs associated with Contractor General Requirements, Mobilization/Demobilization, and other miscellaneous costs.
- *Civil & Mechanical*: Captures costs associated with new piping, fittings, valves, and appurtenances, as well as earthwork, excavation, backfill, and grading. May include costs associated with maintaining operations, such as bypassing, if applicable.
- *Structural*: Captures costs associated with new structures including concrete tanks, foundations, buildings, anchoring, and rehabilitation and/or retrofit of existing structures.
- *Electrical & Controls*: Captures costs associated with new electrical equipment, conduit, and wiring. Also includes control systems and programming requirements.
- *Equipment*: Captures costs associated with major equipment such as new clarifier mechanisms, dewatering equipment, headworks screens, pumps, etc.

6.1 Collection System

Background

As discussed in Section 5.0, high I/I in the system is determined to be the most significant concern of the collection system capacity analysis. Rather than recommend pipelines are upsized to handle the large amount of defect flows, it is recommended the District locate and correct the sources of I/I into the collection system.

Project Needs

While the District has a pipeline lining program in place that will correct I/I from cracks and joints, lining does not correct inflow from illicit connections or leaky manholes. As a result, it is recommended the District implement the following:

(1) Additional flow monitoring in two critical basins to better characterize I/I in those areas, and

(2) Inflow correction programs in four known problem-basins to further isolate and remediate areas of high inflow.

The two areas recommended for additional flow monitoring include the Huston Creek Trunk Sewer (HCTS) and Flow Metering Basin #7. The HCTS conveys the vast majority of the system flows and includes two tie-ins from AD-3, which were not monitored during the 2018 flow monitoring study. It is recommended that the HCTS and these AD-3 tie-ins is monitored to determine if there are any sources of inflow and/or infiltration that need to be corrected.

Wet weather impacts in Flow Metering Basin #7 were unable to be accurately characterized in the 2018 flow metering study due to the flow meter being submerged. It is recommended that additional flow meters are installed further upstream, in unsubmerged pipes, to determine if inflow or infiltration is a concern in this basin.

Flow monitoring performed in the 2018 flow monitoring study identified high inflow in areas draining to Flow Meter Basins #2, #3, #4 and #6. It is recommended that sources of inflow be identified and corrected in these basins though the use of additional flow metering, smoke testing and point repairs. The trunk sewer in Flow Metering Basin #3 was identified as being higher risk due to flat (low slope) pipes near the downtown area; as a result, correction of inflow in this basin was given a higher priority.

Project Recommendation

Table 6-1 presents the recommended capital improvement project for the collection system. Project description worksheets follow that detail the specific needs and cost breakdown for each project.

Table 6-1. Collection System Capital Projects

Project No.	Project Name	Project Cost
CS-1	HCTS Inflow/Infiltration Analysis	$39,000
CS-2	Flow Metering Basin 3 Inflow Isolation and Correction	$138,000
CS-3	Flow Metering Basin 7 Inflow/Infiltration Analysis	$36,000
CS-4	Flow Metering Basin 2 Inflow Isolation and Correction	$100,000
CS-5	Flow Metering Basin 4 Inflow Isolation and Correction	$89,000
CS-6	Flow Metering Basin 6 Inflow Isolation and Correction	$148,000

Project No.	**CS-1**		
Project Name	**Huston Creek Trunk Sewer Inflow/Infiltration Analysis**		
Description	Perform a flow monitoring study on the HCTS to assess the impact of rainfall dependent inflow and infiltration (RDII) on the trunk sewer. The proposed flow monitoring project is to address the following: 1. Sources of inflow into the HCTS that require improvement 2. Sources of infiltration into the HCTS that require improvement 3. Capacity deficiencies that result in large depth of water in gravity pipes Recommended Project: (1) Install four flow meters, two downstream of the Huston Creek Discharge Structure in each 12-inch pipe and two at each of the AD-3 discharge points into the HCTS. (2) Monitor flow for up to 3 months to capture at least one rainfall event		
Priority	Immediate Works (0-2 Years)		
Project Need			
Reliability		Process Performance	
Capacity	X	Regulatory	
City Policy & Goals			

Project Cost		
Capital Costs		
General		$ 28,000
Civil & Mechanical		$ -
Structural		$ -
Electrical & Controls		$ -
Equipment		$ -
Capital Cost Subtotal:		**$ 28,000**
Soft Costs		
Project Specific		
Engineering & Permitting	0 % of capital cost	$ -
CM & ESDC	0 % of capital cost	$ -
Administration	2 % of capital cost	$ 1,000
Soft Cost Subtotal		**$ 1,000**
Contingency		
Contingency	35 % of capital cost	$ 10,000
Total Project Cost		**$ 39,000**

Project No.	**CS-2**
Project Name	**Flow Metering Basin #3 Inflow Isolation and Correction**
Description	Perform an inflow isolation analysis within Flow Metering Basin #3 to isolate and correct areas of high inflow. The FM Basin #3 Trunk Sewer is a higher risk area due to capacity restrictions at low slope pipelines near the downtown area. Project will consist of wet weather flow monitoring followed by smoke testing to locate sources of inflow, including illicit connections. Point repairs will correct illicit connections. The proposed flow monitoring project is to address the following: 1. Locating and correcting sources of inflow into the basin. Recommended Project: (1) Install three flow meters and 1 rain gauge within FM Basin #3 for 5 weeks. (2) Smoke test areas of suspected inflow to identify illicit connections (30,000 LF assumed). (3) Correct any illicit connections identified (3 assumed).
Priority	Mid-Term (2-6 Years)

Project Need

Reliability		Process Performance	
Capacity	X	Regulatory	
City Policy & Goals			

Project Cost

Capital Costs			
General		$	35,000
Civil & Mechanical		$	45,000
Structural		$	-
Electrical & Controls		$	-
Equipment		$	-
Capital Cost Subtotal:		**$**	**80,000**
Soft Costs			
Project Specific			
Engineering & Permitting	15 % of capital cost	$	12,000
CM & ESDC	20 % of capital cost	$	16,000
Administration	2 % of capital cost	$	2,000
Soft Cost Subtotal		**$**	**30,000**
Contingency			
Contingency	35 % of capital cost	$	28,000
Total Project Cost		**$**	**138,000**

Project No.	**CS-3**
Project Name	**Flow Metering Basin #7 Inflow and Infiltration Analysis**
Description	Perform a flow monitoring study within FM Basin #7 to assess the impact of rainfall dependent inflow and infiltration (RDII) in the basin. Project will consist of wet weather flow monitoring to identify whether additional investigation is needed to isolate sources of inflow and infiltration within the basin. The proposed flow monitoring project is to address the following: 1. Sources of inflow into the basin that require improvement 2. Sources of infiltration into the basinS that require improvement 3. Capacity deficiencies that result in large depth of water in gravity pipes <u>Recommended Project</u>: (1) Install four flow meters and 1 rain gauge within FM Basin #7 for 5 weeks.
Priority	Mid-Term (2-6 Years)

Project Need

Reliability		Process Performance	
Capacity	X	Regulatory	
City Policy & Goals			

Project Cost			
Capital Costs			
General		$	26,000
Civil & Mechanical		$	-
Structural		$	-
Electrical & Controls		$	-
Equipment		$	-
Capital Cost Subtotal:		**$**	**26,000**
Soft Costs			
Project Specific			
Engineering & Permitting	0 % of capital cost	$	-
CM & ESDC	0 % of capital cost	$	-
Administration	2 % of capital cost	$	1,000
Soft Cost Subtotal		**$**	**1,000**
Contingency			
Contingency	35 % of capital cost	$	9,000
Total Project Cost		**$**	**36,000**

Project No.	**CS-4**		
Project Name	**Flow Metering Basin #2 Inflow Isolation and Correction**		
Description	Perform an inflow isolation analysis within Flow Metering Basin #2 to isolate and correct areas of high inflow. Project will consist of wet weather flow monitoring followed by smoke testing to locate sources of inflow, including illicit connections. Point repairs will correct illicit connections. The proposed flow monitoring project is to address the following: 1. Locating and correcting sources of inflow into the basin. Recommended Project: (1) Install three flow meters and 1 rain gauge within FM Basin #2 for 5 weeks. (2) Smoke test areas of suspected inflow to identify illicit connections (15,000 LF assumed). (3) Correct any illicit connections identified (2 assumed).		
Priority	Mid-Term (2-6 Years)		
Project Need			
Reliability		Process Performance	
Capacity	X	Regulatory	
City Policy & Goals			

Project Cost		
Capital Costs		
General		$ 28,000
Civil & Mechanical		$ 30,000
Structural		$ -
Electrical & Controls		$ -
Equipment		$ -
Capital Cost Subtotal:		**$ 58,000**
Soft Costs		
Project Specific		
Engineering & Permitting	15 % of capital cost	$ 9,000
CM & ESDC	20 % of capital cost	$ 12,000
Administration	2 % of capital cost	$ 1,000
Soft Cost Subtotal		**$ 22,000**
Contingency		
Contingency	35 % of capital cost	$ 20,000
Total Project Cost		**$ 100,000**

Project No.	**CS-5**
Project Name	**Flow Metering Basin #4 Inflow Isolation and Correction**
Description	Perform an inflow isolation analysis within Flow Metering Basin #4 to isolate and correct areas of high inflow. Project will consist of wet weather flow monitoring followed by smoke testing to locate sources of inflow, including illicit connections. Point repairs will correct illicit connections. The proposed flow monitoring project is to address the following: 1. Locating and correcting sources of inflow into the basin. Recommended Project: (1) Install two flow meters and 1 rain gauge within FM Basin #4 for 5 weeks. (2) Smoke test areas of suspected inflow to identify illicit connections (15,000 LF assumed). (3) Correct any illicit connections identified (2 assumed).
Priority	Mid-Term (2-6 Years)

Project Need

Reliability		Process Performance	
Capacity	X	Regulatory	
City Policy & Goals			

Project Cost

Capital Costs			
General		$	22,000
Civil & Mechanical		$	30,000
Structural		$	-
Electrical & Controls		$	-
Equipment		$	-
Capital Cost Subtotal:		**$**	**52,000**
Soft Costs			
Project Specific			
Engineering & Permitting	15 % of capital cost	$	8,000
CM & ESDC	20 % of capital cost	$	10,000
Administration	2 % of capital cost	$	1,000
Soft Cost Subtotal		**$**	**19,000**
Contingency			
Contingency	35 % of capital cost	$	18,000
Total Project Cost		**$**	**89,000**

Project No.	**CS-6**		
Project Name	**Flow Metering Basin #6 Inflow Isolation and Correction**		
Description	Perform an inflow isolation analysis within Flow Metering Basin #6 to isolate and correct areas of high inflow. Project will consist of wet weather flow monitoring followed by smoke testing to locate sources of inflow, including illicit connections. Point repairs will correct illicit connections. The proposed flow monitoring project is to address the following: 1. Locating and correcting sources of inflow into the basin. Recommended Project: (1) Install four flow meters and 1 rain gauge within FM Basin #6 for 5 weeks. (2) Smoke test areas of suspected inflow to identify illicit connections (30,000 LF assumed). (3) Correct any illicit connections identified (3 assumed).		
Priority	Mid-Term (2-6 Years)		
Project Need			
Reliability		Process Performance	
Capacity	X	Regulatory	
City Policy & Goals			

Project Cost			
Capital Costs			
General		$	41,000
Civil & Mechanical		$	45,000
Structural		$	-
Electrical & Controls		$	-
Equipment		$	-
Capital Cost Subtotal:		**$**	**86,000**
Soft Costs			
Project Specific			
Engineering & Permitting	15 % of capital cost	$	13,000
CM & ESDC	20 % of capital cost	$	17,000
Administration	2 % of capital cost	$	2,000
Soft Cost Subtotal		**$**	**32,000**
Contingency			
Contingency	35 % of capital cost	$	30,000
Total Project Cost		**$**	**148,000**

6.2 Lift Stations

6.2.1 LAKE GREGORY LIFT STATION

Background

The Lake Gregory Lift Station consists of two 20-horsepower VFD pumps with a wet well plus dry well arrangement. The lift station is equipped with parallel force mains, one 6-inch main and one 8-inch main. Both force mains have full lift station capacity to convey the lift station flow.

Project Needs

The lift station is undersized and lacks emergency storage. Currently, the following layers of mitigation measures are in place to compensate for the limited capacity of the wet well and avoid spills: a backup force main, generator, automatic transfer switch, battery backup on the control system, and standpipe for full lift station bypass pumping.

Projects to address the following deficiencies are recommended:

- Lack of emergency storage capacity

Project Recommendations

Capital improvement projects identified for the Lake Gregory Lift Station are summarized in Table 6-7. Project descriptions including cost estimates are provided on the following pages.

Table 6-2. Lake Gregory Lift Station Capital Projects

Project No.	Project Name	Project Cost
LS-1	Lake Gregory Wet Well Capacity Upgrade	$609,000

Project No.	**LS-1**
Project Name	**Lake Gregory Wet Well Capacity Upgrade**
Description	The Lake Gregory pump station wet well is under-sized and currently, layers of mitigation measures are in place to compensate for a limited hydraulic capacity of the wet well and lack of emergency storage. Mitigation measures already in place to avoid a spill include a backup force main, generator, automatic transfer switch, battery backup on the control system, and a standpipe for full lift station bypass pumping. Recommended Project: Construct emergency storage capacity to allow for additional failure response time. Project assumes 50,000 gallons of below-grade emergency storage capacity. Recommend this project if and when additional connections come on-line, as this will otherwise further decrease wet well detention time.
Priority	Immediate Works (0-2 Years)

Project Need

Reliability	X	Process Performance	
Capacity	X	Regulatory	X
City Policy & Goals			

Project Cost

Capital Costs			
General		$	20,000
Civil & Mechanical		$	175,000
Structural		$	128,000
Electrical & Controls		$	10,000
Equipment		$	15,000
Capital Cost Subtotal:		**$**	**348,000**
Soft Costs			
Classification 'C'			
Engineering & Permitting	15 % of capital cost	$	52,000
CM & ESDC	20 % of capital cost	$	70,000
Administration	5 % of capital cost	$	17,000
Soft Cost Subtotal		**$**	**139,000**
Contingency			
Contingency	35 % of capital cost	$	122,000
Total Project Cost		**$**	**609,000**

6.2.2 FOREST SHADE LIFT STATION

Background

The Forest Shade Lift Station operates as a bypass in the event the gravity line along Lake Gregory surcharges, which occurs during high flows. When water backs up into the wet well, pumps turn on to prevent spills into the lake. The lift station consists of two 30-horsepower submersible pumps in a duty-standby configuration.

Project Needs

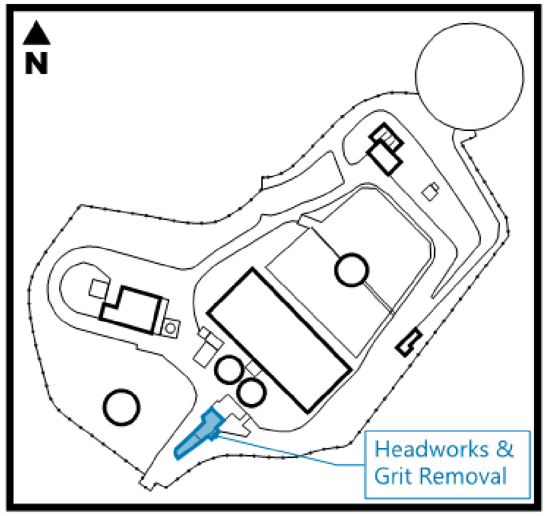
The lift station underwent a recent major upgrade to install new pumps and electrical equipment. The lift station is in good operating condition; therefore, there are no project needs at this time.

Project Recommendations

None.

6.3 Huston Creek WWTP

6.3.1 HEADWORKS & GRIT REMOVAL



Background

Influent wastewater enters the Huston Creek WWTP facility through parallel 12-inch sewer mains. The headworks consists of a single automatic Reciprocating Rake (Climber) screenings unit, as well as a backup manual bar screen in series. Screened effluent enters a small aerated grit chamber for grit removal. Grit accumulated in the chamber is dewatered in a single grit washer/classifier unit. Both screenings and grit removed from the headworks is discharged into a waste dumpster.

Project Needs

The Reciprocating Rake (Climber) screenings unit has loose bolts that require checks and tightening each week to prevent failure. If left unmitigated, loose bolts would cause rake failure within one to two weeks. Failure of the rake causes a flow backup that results in screenings bypass and raw plant influent flow directly to the primary clarifiers. It is important to ensure the bolts remain in place to prevent damage and/or failure at the rake, primary sludge pumps, and scraper mechanism.

Projects to address the following deficiencies are recommended:

- Loose bolts on the screenings rake

Project Recommendations

Capital improvement projects identified for the headworks and grit removal process are summarized in Table 6-3. Project descriptions including cost estimates are provided on the following pages.

Table 6-3. Huston Creek Headworks & Grit Removal Capital Projects

Project No.	Project Name	Project Cost
HC-7	Huston Creek WWTP Headworks Upgrade	$429,000

Project No.	**HC-7**
Project Name	**Huston Creek WWTP Headworks Upgrade**
Description	Screens remove large solids, rags, and other debris larger than 1/4-inch. Screenings consist of a single mechanical 1/4-inch bar screen, and two manual bar screens. They discharge to a dumpster. Recommended Project: Replace screenings equipment.
Priority	Long-Term (7+ Years)

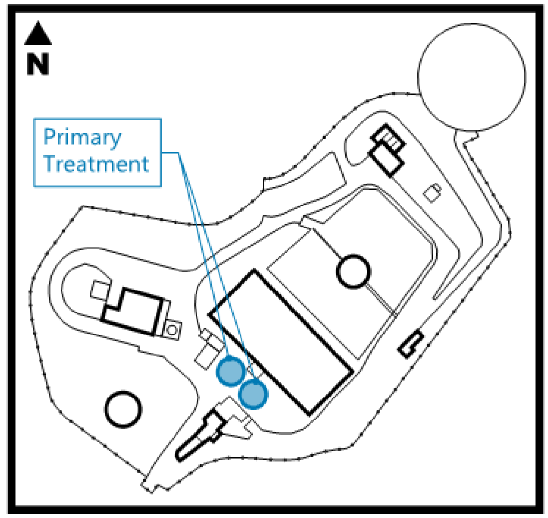
Project Need

Reliability	X	Process Performance	
Capacity		Regulatory	
City Policy & Goals			

Project Cost

Capital Costs			
General		$	15,000
Civil & Mechanical		$	10,000
Structural		$	10,000
Electrical & Controls		$	28,000
Equipment		$	182,000
Capital Cost Subtotal:		**$**	**245,000**
Soft Costs			
Classification 'C'			
Engineering & Permitting	15 % of capital cost	$	37,000
CM & ESDC	20 % of capital cost	$	49,000
Administration	5 % of capital cost	$	12,000
Soft Cost Subtotal		**$**	**98,000**
Contingency			
Contingency	35 % of capital cost	$	86,000
Total Project Cost		**$**	**429,000**

6.3.2 PRIMARY TREATMENT



Background

Huston Creek WWTP primary treatment consists of two identical primary clarifiers. The primary clarifiers were originally constructed as cone-shaped "Imhoff"-style tanks, and later retrofitted to resemble traditional clarifiers. A section view of the clarifiers is shown in Figure 6-1.

Primary effluent is collected in an effluent junction box adjacent to the clarifiers before being fed by gravity to the downstream trickling filter. Primary sludge is pumped from the primary clarifiers to a gravity thickener.

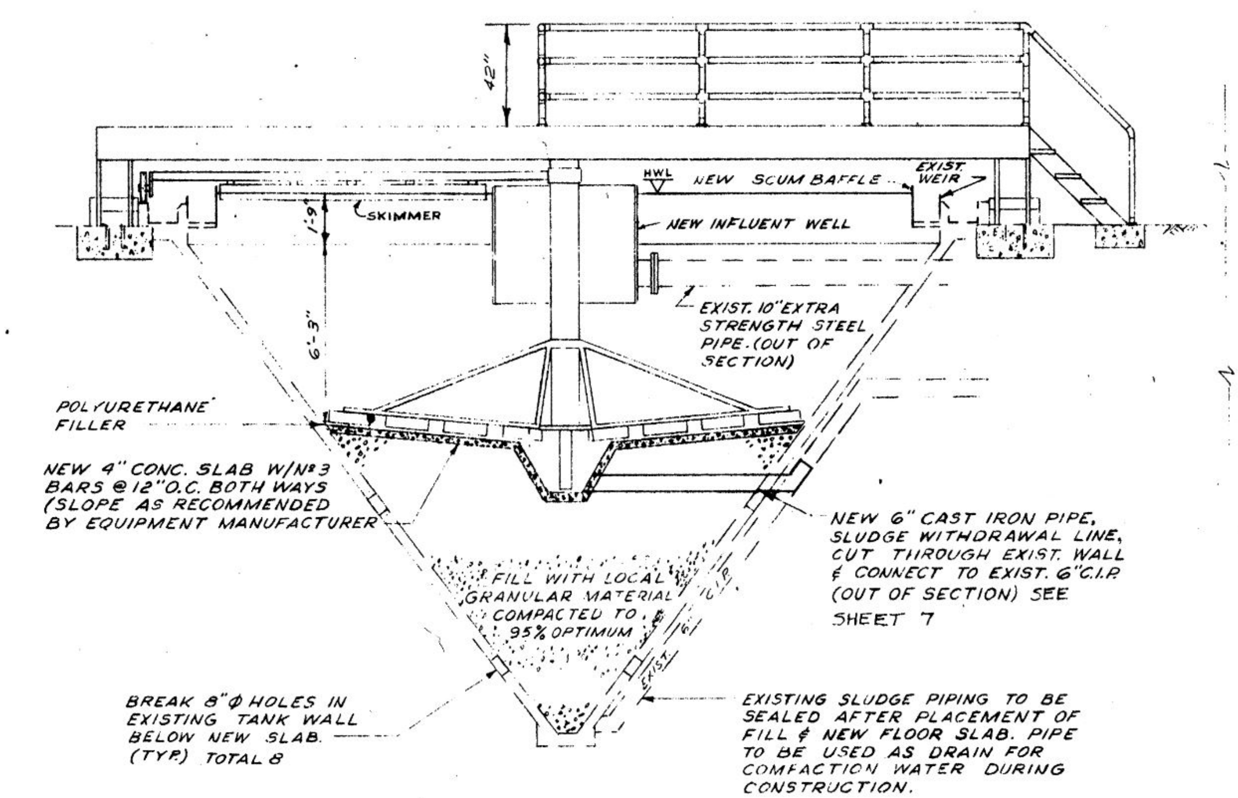


Figure 6-1. Huston Creek Primary Clarifier Section

Project Needs

The Primary Clarifiers have been identified as the most critical concern of District operations staff. The clarifiers have experienced ground settling issues compromising its structural integrity. The thin walls of the clarifiers lead operations staff to believe structural failure could occur in the event of seismic activity.

Additionally, BOD removal efficiency in the primary clarifiers is declining. Increased BOD levels in the primary effluent are believed to be a result of higher concentrations of soluble BOD in the primary influent, and not necessarily a failure mode of the primary clarifier. This trend should be monitored, as a reduction in BOD removal in the primary clarifiers results in additional organic treatment load on the biological treatment process (trickling filter). The primary's remove an average of 73% of influent total suspended solids (TSS), a high performing sedimentation rate compared to industry averages between 45% and 65%.

The Primary Clarifiers are hydraulically overloaded during operation of the belt press, when sidestream flows are pumped back to the headworks. The additional sidestream flow is especially problematic when compounded with wet weather events.

Projects to address the following deficiencies are recommended:

- Ground settling concerns compromising structural integrity of the clarifiers
- Declining BOD removal efficiency (likely due to higher soluble BOD concentrations)
- Lack of primary clarifier redundancy and resiliency to peak hydraulic loading events

Project Recommendations

Capital improvement projects identified for the primary treatment process are summarized in Table 6-4. Project descriptions including cost estimates are provided on the following pages.

Table 6-4. Huston Creek Primary Treatment Capital Projects

Project No.	Project Name	Project Cost
HC-1	Huston Creek WWTP Primary Clarifier Replacement	$1,428,000

Project No.	**HC-1**
Project Name	**Houston Creek WWTP Primary Clarifier Replacement**
Description	Primary treatment is an extra high risk at Houston Creek due to geotechnical and structural failure modes, which require rehabilitation and soil stabilization. Additionally, Primary clarifiers are hydraulically under-sized for peak wet weather and dewatering sidestream return flows, operating with no redundancy. Project scope is estimated to be: Recommended Project: Construct new (25-foot) primary clarifier on the north side of the existing clarifiers. After completion and startup, existing primaries would be taken offline and rehabilitated in place one at a time. Install a new splitter box to divert flow to third clarifier. Clarifier is assumed to be same size as existing units, but with equal top and bottom diameter. Project also includes cost for soil stabilization around existing primary clarfiers.
Priority	Immediate Works (0-2 Years)

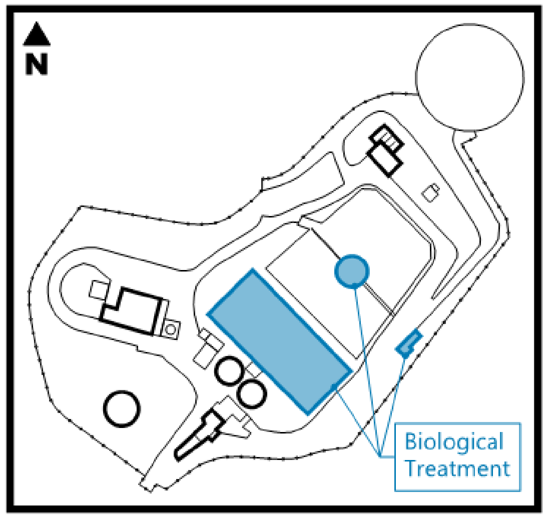
Project Need

Reliability	X	Process Performance	X
Capacity	X	Regulatory	
District Policy & Goals			

Project Cost

Capital Costs			
General		$	82,000
Civil & Mechanical		$	175,000
Structural		$	193,000
Electrical & Controls		$	143,000
Equipment		$	223,000
Capital Cost Subtotal:		**$**	**816,000**
Soft Costs			
Classification 'C'			
Engineering & Permitting	15 % of capital cost	$	122,000
CM & ESDC	20 % of capital cost	$	163,000
Administration	5 % of capital cost	$	41,000
Soft Cost Subtotal		**$**	**326,000**
Contingency			
Contingency	35 % of capital cost	$	286,000
Total Project Cost		**$**	**1,428,000**

6.3.3 BIOLOGICAL TREATMENT



Background

Huston Creek WWTP biological treatment consists of a single fixed-nozzle, low-rate trickling filter unit. The trickling filter was part of the original plant construction in 1952, and is rectangular shaped with coarse rock media. Trickling filter effluent either flows to the secondary clarifier, or is recirculated by a pair of recirculation pumps back into the primary effluent junction box.

Huston Creek WWTP secondary clarification consists of a single secondary clarifier unit. This unit, similar to Huston Creek's primary clarifiers, was constructed as part of the original plant construction in 1952 as a cone-shaped "Imhoff"-style tank. Unlike the primary clarifiers, the secondary clarifier has not been retrofitted to resemble a traditional clarifier (i.e. with slow-rotating scraper and skimmer arm).

Project Needs

Projects to address the following deficiencies are recommended:

- Progressive degradation of the trickling filter media over time
- Excessive sloughing and clogging in the trickling filter media causing ponding on the media and reducing filter hydraulic capacity, airflow, and performance.
- Plugged trickling filter nozzles
- Trickling filter freezing in cold weather, causing a layer of ice on the rock, as well as frozen nozzles
- Hydraulic overloading of the trickling filter during rain events, which causes a backup in the small primary effluent equalization tank.

- Loss of power and/or controls for the trickling filter recirculation pumps, which typically occurs two to four times per year, often during storms.

Project Recommendations

Capital improvement projects identified for the biological treatment process are summarized in Table 6-5. Project descriptions including cost estimates are provided on the following pages.

Table 6-5. Huston Creek Biological Treatment Capital Projects

Project No.	Project Name	Project Cost
HC-5	Huston Creek WWTP Biological Treatment Upgrade	$6,163,000

Project No.	HC-5
Project Name	**Houston Creek WWTP Biological Treatment Upgrade**
Description	Houston Creek WWTP relies on a 60+ year old trickling filter with rock media and fixed nozzles for biological treatment. The media has degraded and several failure modes of the unit are common, including degraded media/grit accumulation, media clogging, nozzle plugging, cold-weather freezing, and treatment capacity. Although the District is not currently regulated on nitrogen in their effluent, it is possible that the Regional Board will impose stricter discharge requirements on the District in the future, which would require a biological treatment upgrade. Recommended Project: Depending on the effluent water quality requirements and recycled water opportunities available, construct either two circular trickling filters with plastic media and rotating distributor arms downstream of the existing trickling filter (in series) or change treatment technology to an activated sludge process, depending on the requirements. For the purposes of this estimate, we have assumed additional trickling filter process.
Priority	Mid-Term (2-6 Years)

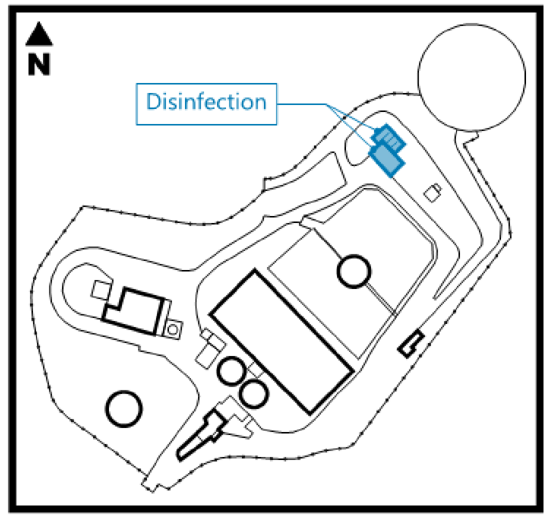
Project Need

Reliability	X	Process Performance	X
Capacity	X	Regulatory	
City Policy & Goals	X		

Project Cost

Capital Costs			
General		$	225,000
Civil & Mechanical		$	1,165,000
Structural		$	500,000
Electrical & Controls		$	750,000
Equipment		$	882,000
Capital Cost Subtotal:		**$**	**3,522,000**
Soft Costs			
Classification 'C'			
Engineering & Permitting	15 % of capital cost	$	528,000
CM & ESDC	20 % of capital cost	$	704,000
Administration	5 % of capital cost	$	176,000
Soft Cost Subtotal		**$**	**1,408,000**
Contingency			
Contingency	35 % of capital cost	$	1,233,000
Total Project Cost		**$**	**6,163,000**

6.3.4 DISINFECTION



Background

Due to its remote location and limited accessibility, Huston Creek WWTP utilizes Micro-Chlor® on-site generation equipment to generate chlorine disinfectant from sodium chloride (salt). After the dosing point, effluent flows through a 44,734 gallon concrete serpentine chlorine contact basin, which provides approximately 30 minutes of detention time at average-day flow. While this detention time is less than regulatory limits, chlorine contact and residual are regulated at the District's combined effluent discharge point at the Las Flores Ranch. Since the outfall pipeline is over 11 miles long, sufficient chlorine contact time occurs prior to the regulatory point.

Project Needs

Projects to address the following deficiencies are recommended:

- Potential failure at a multitude of points on the on-site generation Micro-Chlor skid. If left unmitigated, failure would occur within a month, resulting in downtime of greater than one day.
- Lack of flow-paced control instrumentation for the on-site generation equipment, which is currently operated with a manual set point. Flow-paced control can improve chemical usage efficiency and reduce operating costs.
- Variable frequency drive (VFD) failures on the chlorine dosing pumps.
- Inaccurate effluent flow meter instrumentation and/or calibration.

Project Recommendations

Capital improvement projects identified for the disinfection process are summarized in Table 6-6. Project descriptions including cost estimates are provided on the following pages.

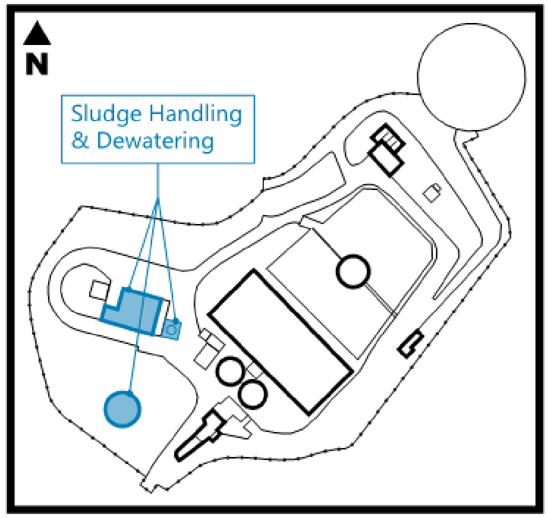
Table 6-6. Huston Creek Disinfection Capital Projects

Project No.	Project Name	Project Cost
HC-6	Huston Creek WWTP Disinfection System Upgrade	$53,000

Project No.	**HC-6**		
Project Name	**Huston Creek WWTP Disinfection System Upgrade**		
Description	HC has a chlorine generation equipment that consists of one Micro-Chlor onsite generation unit (single-duty, five cells, ability to run on four cells) capable of 200 lb/d chlorine generation. Salt bags are stored at the facility, and potable water is used for mixture with the salt in a 360-gallon brine tank. Chlorine is manually dosed, day-to-day. Two chemical feed pumps dose generated sodium hypochlorite into the old dosing tank for disinfection. Pumps run on VFD and are manually paced with a constant flow rate each day by operators. Recommended Project: Install sensors/alarms to identify system failures. Install flow-paced control instrumentation. Perform cost-benefit analysis for disinfection to determine preferred low-cost alternative. Consider purchasing a shelf-spare dosing pump.		
Priority	Mid-Term (2-6 Years)		
Project Need			
Reliability	X	Process Performance	X
Capacity		Regulatory	
City Policy & Goals			

Project Cost		
Capital Costs		
General		$ 5,000
Civil & Mechanical		$ -
Structural		$ -
Electrical & Controls		$ 20,000
Equipment		$ 10,000
Capital Cost Subtotal:		**$ 35,000**
Soft Costs		
Classification 'D'		
Engineering & Permitting	5 % of capital cost	$ 2,000
CM & ESDC	5 % of capital cost	$ 2,000
Administration	5 % of capital cost	$ 2,000
Soft Cost Subtotal		**$ 6,000**
Contingency		
Contingency	35 % of capital cost	$ 12,000
Total Project Cost		**$ 53,000**

6.3.5 SLUDGE HANDLING & DEWATERING



Background

Primary sludge is wasted to an above-grade, steel, cone-bottom gravity thickening tank. All of the District's sludge, as well as septic deliveries are accepted at Huston Creek WWTP for sludge thickening and dewatering. Once a week, sludge is drawn off the bottom of the gravity thickener and fed to a single 1.5 m belt press for dewatering. Polymer is added to the feed sludge to improve dewatering performance. Dewatered sludge is discharged onto a belt conveyor and load trucks, which haul the dewatered sludge to a disposal facility.

No sludge digestion or treatment is performed at any of the District's facilities. If sludge digestion and treatment is performed in the future, more disposal facilities may be willing to accept District biosolids. The District currently relies on a single facility for biosolids disposal.

Project Needs

Sludge handling and dewatering is identified as a high risk unit process at the Huston Creek WWTP. The primary source of risk is the poor state of the biosolids dewatering equipment and criticality of the equipment to District operations.

Projects to address the following deficiencies are recommended:

- Presence of septic conditions and hydrogen sulfide gas in the sludge feed to the belt press, which causes corrosion (primarily to electrical equipment) and potential health and safety concerns.
- Belt press equipment is over 30 years old and prone to mechanical failures due to polymer clogging, grease blinding, and wear and tear. Replacement parts are difficult to come by, and obsolete. Staff burdened with exhaustive maintenance, and no equipment redundancy.
- Stringent disposal schedule associated with reliance on single-facility for biosolids disposal. Failure to dewater and/or dispose on Tuesday (only day available for disposal) creates a disposal backlog.

- Lack of polymer dosing equipment redundancy.
- Lack of belt press sump pump redundancy.
- Sludge septicity in gravity thickener. Septicity leads to floating sludge, or "corking", which defeats the function of the gravity thickener and disrupts operations.

Project Recommendations

Capital improvement projects identified for the sludge handling and dewatering process are summarized in Table 6-7. Project descriptions including cost estimates are provided on the following pages.

Table 6-7. Huston Creek Sludge Handling & Dewatering Capital Projects

Project No.	Project Name	Project Cost
HC-2	Huston Creek WWTP Biosolids Dewatering Upgrade	$4,739,000
HC-4	Huston Creek WWTP Biosolids Management Plan	$42,000

Project No.	**HC-2**
Project Name	**Houston Creek WWTP Biosolids Dewatering Upgrade**
Description	Biosolids dewatering is an extra high risk at Houston Creek due to aging equipment, corrosion, and maintenance-intensive systems. Existing singular belt press, electrical equipment, and ancillary components are beyond expected useful life and maintaining operation is increasingly difficult. Recommended Project: Replace belt press with new belt filter press dewatering equipment. Construct equipment redundancy for process reliability. New dewatering equipment, electrical, polymer feed system, odor control, etc. would be located in new 2-story dewatering and operations building on the north side of the road from the existing belt filter press.
Priority	Immediate Works (0-2 Years)

Project Need

Reliability	X	Process Performance	X
Capacity		Regulatory	
City Policy & Goals			

Project Cost

Capital Costs			
General		$	371,000
Civil & Mechanical		$	305,000
Structural		$	338,000
Electrical & Controls		$	331,000
Equipment		$	1,363,000
Capital Cost Subtotal:		**$**	**2,708,000**
Soft Costs			
Classification 'C'			
Engineering & Permitting	15 % of capital cost	$	406,000
CM & ESDC	20 % of capital cost	$	542,000
Administration	5 % of capital cost	$	135,000
Soft Cost Subtotal		**$**	**1,083,000**
Contingency			
Contingency	35 % of capital cost	$	948,000
Total Project Cost		**$**	**4,739,000**

Project No.	**HC-4**
Project Name	**Huston Creek WWTP Biosolids Management Plan**
Description	There is currently no waste sludge digestion process at Huston Creek WWTP, or any of the District's facilities. The District relies on a single, private entity biosolids disposal facility, which schedules deliveries over a year in advance and only accept's the District's sludge on Tuesdays. Scheduling or getting additional disposal availability is very difficult, if possible at all. If the belt press is down on Tuesday and disposal is missed, playing catch-up is difficult and not always possible week-to-week. If the private biosolids facility were to ever close down, lose their permit, or decide to no longer accept primary biosolids, the District would not have another disposal option readily available. Recommended Project: Conduct a biosolids management plan that evaluates alternative disposal options and prepares an life-cycle cost analysis for sludge digestion. Update life-cycle cost analysis over time to determine if/when digestion or alternative disposal is a cost-effective approach.
Priority	Immediate Works (0-2 Years)

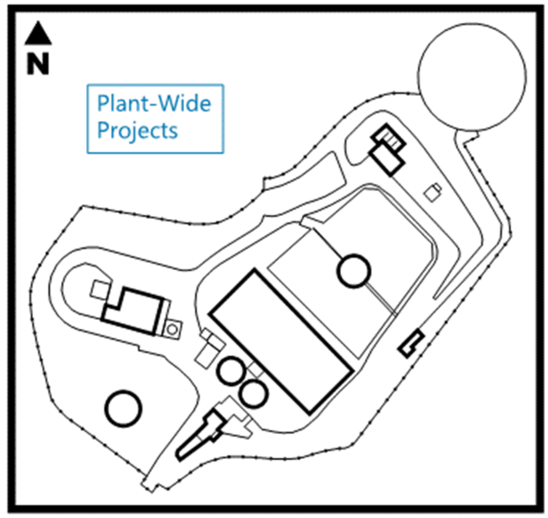
Project Need

Reliability	X	Process Performance	X
Capacity		Regulatory	
City Policy & Goals	X		

Project Cost

Capital Costs		
General	$	-
Civil & Mechanical	$	-
Structural	$	-
Electrical & Controls	$	-
Equipment	$	-
Capital Cost Subtotal:	**$**	**-**
Soft Costs		
Project Specific		
Engineering & Permitting	$	42,000
CM & ESDC	$	-
Administration	$	-
Soft Cost Subtotal	**$**	**42,000**
Contingency		
Contingency	$	-
Total Project Cost	**$**	**42,000**

6.3.6 PLANT-WIDE PROJECTS



Background

Plant-wide projects are defined as assets utilized as support systems, connecting unit process areas, or plant-wide planning and engineering studies. Areas for potential safety upgrades were evaluated as part of this analysis.

Project Needs

Several failure modes at Houston Creek WWTP pose a safety risk to plant operations and maintenance staff. The District had previously identified these safety risks, and are in the process of implementing solutions to address the following deficiencies:

- Lack of safety railing on the inside wall of the secondary clarifier tank.
- Structural failure of interior concrete masonry unit (CMU) walls in the chlorine contact basin.
- Structural failure of the secondary effluent box due to backpressure from clarifier effluent overflow.
- Aging grating anchors and concrete in the headworks, which could affect grating structural integrity.

The District is also in the process of implementing electrical and SCADA improvements at the plant. In addition to these improvements, a project to install a backup generator for power supply reliability is recommended.

Project Recommendations

Capital improvement projects identified plant-wide at Huston Creek WWTP are summarized in Table 6-8. Project descriptions including cost estimates are provided on the following pages.

Table 6-8. Huston Creek Plant-Wide Capital Project Recommendations

Project No.	Project Name	Project Cost
HC-3	Huston Creek WWTP Ongoing Facility Safety Upgrades	$217,000
HC-8	Huston Creek WWTP Emergency Generator	$944,000

Project No.	HC-3		
Project Name	**Houston Creek WWTP Ongoing Facility Safety Upgrades**		
Description	Several failure modes at Houston Creek WWTP pose a safety risk to plant operations and maintenance staff, including the safety railing on the secondary clarifier, maintenance needs to address grit accumulation in the TF recirculation pumping well, structural failure of interior CMU walls in the chlorine contact basin, structural failure of the secondary effluent box, and grating failure in the headworks. Staff has stated that there are ongoing projects to address these failure modes. The ongoing project has the following general scope: Project: Install new safety railing on the secondary clarifier and bridge. Repair damaged concrete and corrosion on secondary effluent box. Patch structural failure of CMU interior walls of chlorine contact basin with concrete mortar or cedar wood or replace interior walls with new concrete. Repair damaged grating supports and rehabilitate concrete in influent channels or replace influent channel grating all-together, depending on condition. Design improvement to allow for cleaning of grit accumulated in the recirculation wet well.		
Priority	Immediate Works (0-2 Years)		
Project Need			
Reliability	X	Process Performance	
Capacity		Regulatory	
City Policy & Goals	X		

Project Cost		
Capital Costs		
General	$	20,000
Civil & Mechanical	$	-
Structural	$	123,000
Electrical & Controls	$	-
Equipment	$	-
Capital Cost Subtotal:	**$**	**143,000**
Soft Costs		
Classification 'D'		
Engineering & Permitting — 5 % of capital cost	$	8,000
CM & ESDC — 5 % of capital cost	$	8,000
Administration — 5 % of capital cost	$	8,000
Soft Cost Subtotal	**$**	**24,000**
Contingency		
Contingency — 35 % of capital cost	$	50,000
Total Project Cost	**$**	**217,000**

Project No.	**HC-8**
Project Name	**Huston Creek WWTP Emergency Generator**
Description	Huston Creek WWTP relies on local utility power. Outages occur during storms or for unknown reasons. Currently, during a power outage the District utilizes portable generators, bypass pumps, and manual process control when needed and as possible. <u>Recommended Project:</u> Install an emergency generator capable of powering all of Huston Creek WWTP equipment and processes during a power outage.
Priority	Mid-Term (2-6 Years)

Project Need

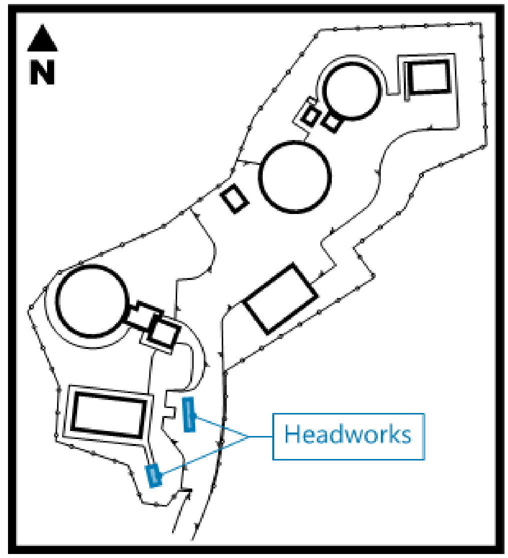
Reliability	X	Process Performance	
Capacity		Regulatory	
City Policy & Goals			

Project Cost

Capital Costs			
General		$	15,000
Civil & Mechanical		$	10,000
Structural		$	20,000
Electrical & Controls		$	65,000
Equipment		$	429,000
Capital Cost Subtotal:		**$**	**539,000**
Soft Costs			
Classification 'C'			
Engineering & Permitting	15 % of capital cost	$	81,000
CM & ESDC	20 % of capital cost	$	108,000
Administration	5 % of capital cost	$	27,000
Soft Cost Subtotal		**$**	**216,000**
Contingency			
Contingency	35 % of capital cost	$	189,000
Total Project Cost		**$**	**944,000**

6.4 Seeley Creek WWTP

6.4.1 HEADWORKS & GRIT REMOVAL

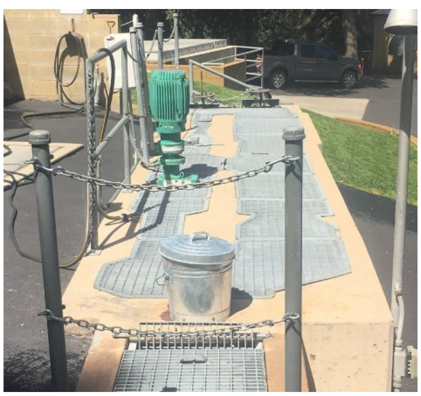


Background

Seeley Creek WWTP influent enters the facility via a 15-inch sewer main. A Wye with valves on the influent sewer allows operations staff to divert influent flow in one of two directions: 1) to a manual bar screen and subsequent 100,000 gal influent equalization basin; and 2) to a second manual bar screen followed by a "Muffin Monster" comminutor.

The influent equalization basin is typically not used, unless in the event that the effluent outfall pipeline fails, as it is the only form of emergency storage at the treatment plant.

Project Needs



The screens in place at the headworks pose maintenance and performance challenges. The bar screens are manually cleaned and have relatively large spacing, which allows rags, grit, and debris to flow through the screens and into the primary clarifier. The Muffin Monster grinder does not perform effectively, and is expensive to maintain. The grinder teeth are corroded from exposure to sulfides. In general, grinders are not ideal for modern treatment plants. They function to break down larger trash and debris into smaller pieces, instead of removing them from the waste stream, which end up being more difficult to remove from the treatment processes.

There is currently no grit removal system in place at the headworks. Grit accumulates in the influent channels, where it is manually cleaned out by the maintenance staff. The lack of grit removal can result in grit pass-through to downstream processes and increase wear on the sludge pumps and clarifier scrapers. Grit shoveling and management by staff also pose access/egress challenges and risk back injuries for the maintenance staff.

Projects to address the following deficiencies are recommended:

- Absence of grit removal, contributing to buildup in the plant and potential wear on downstream process equipment.
- Ineffective grinder equipment
- Ineffective screenings removal, due to a lack of automatic screenings equipment.

Project Recommendations

Capital improvement projects identified for the headworks and grit removal process are summarized in Table 6-9. Project descriptions including cost estimates are provided on the following pages.

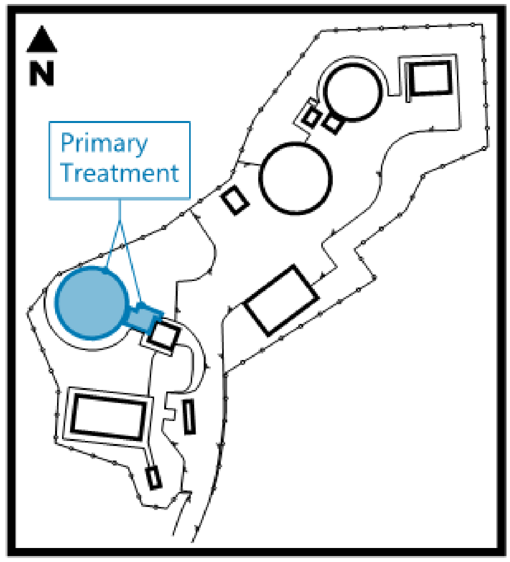
Table 6-9. Seeley Creek Headworks & Grit Removal Capital Projects

Project No.	Project Name	Project Cost
SC-4	Seeley Creek WWTP Headworks Upgrades	$977,000

Project No.	**HC-7**		
Project Name	**Huston Creek WWTP Headworks Upgrade**		
Description	Screens remove large solids, rags, and other debris larger than 1/4-inch. Screenings consist of a single mechanical 1/4-inch bar screen, and two manual bar screens. They discharge to a dumpster. District should consider constructing the new headworks to allow the operator to utilize the existing emergency storage tank (formerly equalization tank) to be used again for equalization, or bypassed, at the operator's discretion. <u>Recommended Project:</u> Replace screenings equipment.		
Priority	Long-Term (7+ Years)		
Project Need			
Reliability	X	Process Performance	
Capacity		Regulatory	
City Policy & Goals			

Project Cost			
Capital Costs			
General		$	15,000
Civil & Mechanical		$	10,000
Structural		$	10,000
Electrical & Controls		$	28,000
Equipment		$	182,000
Capital Cost Subtotal:		**$**	**245,000**
Soft Costs			
Classification 'C'			
Engineering & Permitting	15 % of capital cost	$	37,000
CM & ESDC	20 % of capital cost	$	49,000
Administration	5 % of capital cost	$	12,000
Soft Cost Subtotal		**$**	**98,000**
Contingency			
Contingency	35 % of capital cost	$	86,000
Total Project Cost		**$**	**429,000**

6.4.2 PRIMARY TREATMENT



Background

Seeley Creek WWTP primary treatment consists of a single primary clarifier. The primary clarifier was originally constructed as a packaged activated sludge treatment plant, including an aeration zone, settling zone, chlorine contact zone, and sludge digester zone. The activated sludge unit was later retrofitted into a large primary clarifier, and a trickling filter, secondary clarifier, and chlorine contract basin were constructed at the facility.

Primary effluent is fed by gravity to the downstream trickling filter. Primary sludge is wasted from the primary clarifiers to a sludge holding tank. The sludge holding tank is periodically emptied and the sludge is hauled to Huston Creek WWTP for thickening and dewatering.

Project Needs

The single-duty ODS-style primary sludge pump is at risk of electrical failure due to a cracked conduit that is infiltrated when the lawn is saturated with water. Failure has occurred in the past.

Projects to address the following deficiencies are recommended:

- Cracked conduit on Primary ODS pump electrical power supply.

Project Recommendations

Capital improvement projects identified for the primary treatment process are summarized in Table 6-10. Project descriptions including cost estimates are provided on the following pages.

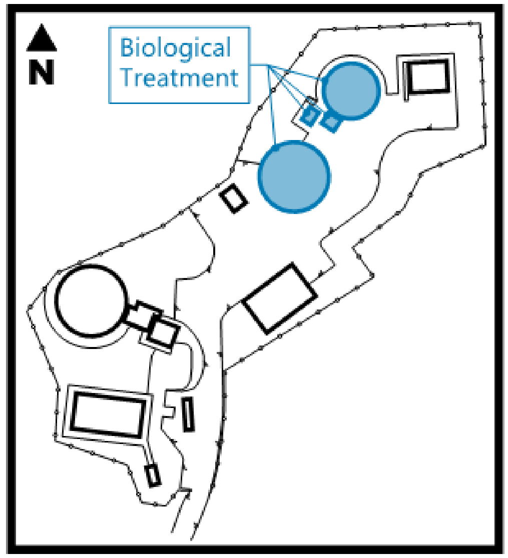
Table 6-10. Seeley Creek Primary Treatment Capital Projects

Project No.	Project Name	Project Cost
SC-6	Seeley Creek WWTP Primary ODS Electrical Upgrades	$160,000

Project No.	**SC-6**			
Project Name	**Seeley Creek WWTP Primary ODS Electrical Upgrade**			
Description	An old but reliable single-duty ODS-style primary sludge pump sends primary sludge to the old holding tank. Conduit has failed, causing failure when water from lawn infiltrates into the panel. Recommended Project: Replace panel and conduit.			
Priority	Mid-Term (2-6 Years)			
Project Need				
Reliability	X		Process Performance	X
Capacity			Regulatory	
City Policy & Goals				

Project Cost			
Capital Costs			
General		$	5,000
Civil & Mechanical		$	-
Structural		$	-
Electrical & Controls		$	86,000
Equipment		$	-
Capital Cost Subtotal:		**$**	**91,000**
Soft Costs			
Classification 'C'			
Engineering & Permitting	15 % of capital cost	$	14,000
CM & ESDC	20 % of capital cost	$	18,000
Administration	5 % of capital cost	$	5,000
Soft Cost Subtotal		**$**	**37,000**
Contingency			
Contingency	35 % of capital cost	$	32,000
Total Project Cost		**$**	**160,000**

6.4.3 BIOLOGICAL TREATMENT



Background

Seeley Creek WWTP biological treatment consists of a single rotating distributer, high-rate trickling filter unit. The trickling filter was constructed as part of the major plant upgrade in 1984. The unit is circular shaped with plastic media and covered with a steel dome enclosure (see image right). Trickling filter effluent either flows to the secondary clarifier, or is recirculated by a pair of recirculation pumps back into the primary influent.

Seeley Creek WWTP secondary clarification consists of a single secondary clarifier unit (see image right). This unit was constructed as part of the major plant upgrade in 1984 along with the trickling filter. Unlike Huston Creek WWTP, the secondary clarifier at Seeley Creek WWTP is a traditional secondary clarifier design (i.e. with slow-rotating scraper and skimmer arm).

Project Needs

The area of focus for improvements to the biological treatment process area is the recirculation pumping system. Projects to address the following deficiencies are recommended:

- Aging recirculation pumps. The pumps have not been replaced since the original installation, and consist of equipment from the 1970s in a cabinet from the 1980s. Seal failure has occurred in the past.
- Aging electrical components in the recirculation pumping system. The main issue lies in the wires, which are undersized and wearing out. Additionally, the transformers have died.
- Inadequate grating strength. The original heavy grating was cut in order to create a smaller piece easier to lift, resulting in a weak point.
- Lake of control and efficiency in the recirculation pumping system. The energy consumption of the pumps is an expensive part of the biological treatment process area.

Project Recommendations

Capital improvement projects identified for the biological treatment process are summarized in Table 6-11. Project descriptions including cost estimates are provided on the following pages.

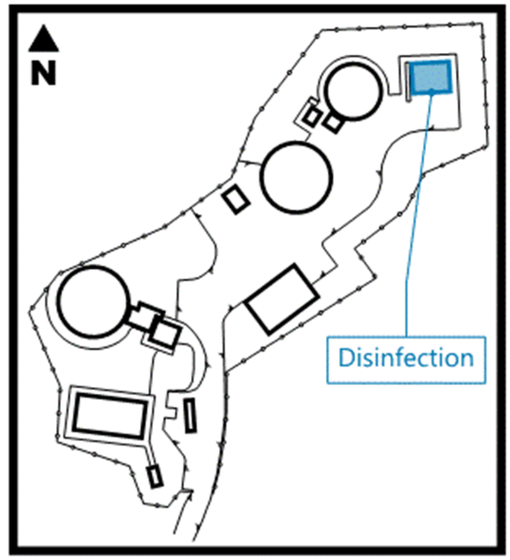
Table 6-11. Seeley Creek Biological Treatment Capital Projects

Project No.	Project Name	Project Cost
SC-2	Seeley Creek WWTP Recirculation Pumping Upgrades	$155,000

Project No.	**SC-2**		
Project Name	**Seeley Creek WWTP Recirculation Pumping Upgrade**		
Description	The existing recirculation pumps are original from the 1970s and run on 1980s electrical equipment. The check valves on each pump are also original and prone to failure. The age of the equipment has led to ongoing failures and maintenance challenges for this critical process. Additionally, the pumping efficiency is unknown and VFD control could help the District reduce energy consumption. <u>Recommended Project:</u> Full replacement of recirculation pumps, check valves, and electrical equipment, including upgrading conduit. New design would include VFD control for the pumps that could be controlled by a BOD measuring device to adjust recirculation pumping based on the process needs and reduce energy consumption. Replace grating with re-engineered lightweight grating for easier access and operator safety.		
Priority	Immediate Works (0-2 Years)		
Project Need			
Reliability	X	Process Performance	X
Capacity		Regulatory	
City Policy & Goals			

Project Cost			
Capital Costs			
General		$	5,000
Civil & Mechanical		$	12,000
Structural		$	6,000
Electrical & Controls		$	12,000
Equipment		$	58,000
Capital Cost Subtotal:		**$**	**93,000**
Soft Costs			
Classification 'B'			
Engineering & Permitting	10 % of capital cost	$	9,000
CM & ESDC	18 % of capital cost	$	17,000
Administration	3 % of capital cost	$	3,000
Soft Cost Subtotal		**$**	**29,000**
Contingency			
Contingency	35 % of capital cost	$	33,000
Total Project Cost		**$**	**155,000**

6.4.4 DISINFECTION



Background

Similar to Huston Creek WWTP, Seeley Creek WWTP utilizes Micro-Chlor® on-site generation equipment to generate chlorine disinfectant from sodium chloride. After the dosing point, effluent flows through a 20,833-gallon concrete serpentine chlorine contact basin.

Project Needs

The on-site generation Micro-Chlor equipment is unreliable and lacks control. Potential failure could occur at multiple unreliable points throughout the skid, including the brine tank, if left unmitigated. One weak point in particular lies in the Reverse Osmosis (RO) unit, as the membranes are likely degrading due to lower pressures and higher TDS in the RO effluent.

The Micro-Chlor equipment lacks controls, and is currently operated manually. Without controls, the disinfection process is not operating as efficiently as possible in terms of salt, chemical, and salinity usage. Additionally, there is no effluent flow meter to provide the real-time flow measurement and monitoring necessary for chlorine pacing and process control.

Projects to address the following deficiencies are recommended:

- Unreliable Micro-Chlor skid
- Lack of on-site generation control

Project Recommendations

Capital improvement projects identified for the disinfection process are summarized in Table 6-12. Project descriptions including cost estimates are provided on the following pages.

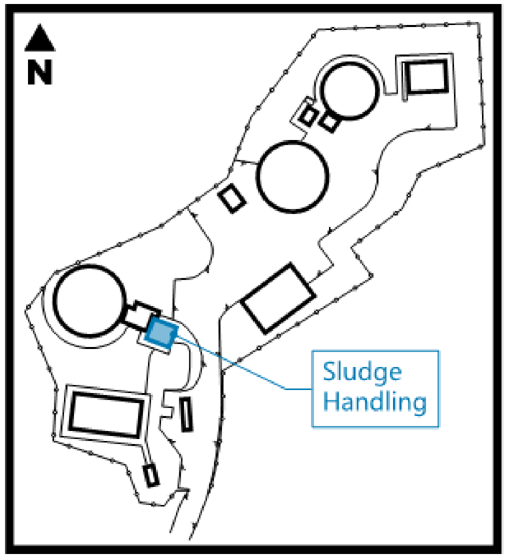
Table 6-12. Seeley Creek Disinfection Capital Projects

Project No.	Project Name	Project Cost
SC-3	Seeley Creek WWTP Chlorine On-site Generation System Upgrades	$1,893,000

Project No.	**SC-3**		
Project Name	**Seeley Creek WWTP Chlorine On-site Generation System Upgrade**		
Description	Chlorinated secondary effluent first goes through a wye-strainer, then through cartridge filter, media filter, water softener, carbon filter, UV, RO, then into the on-site chlorine generation skid as supply water. The skid consists of one Micro-Chlor on-site generation unit capable of 100 lb/d chlorine dose. Salt bags are stored at the facility. Plant effluent is treated with a small RO unit to produce water for mixture with the salt in a brine tank. Chlorine is manually dosed, day-to-day operation. No effluent flow meter is installed. <u>Recommended Project:</u> Drill well for reliable water supply to reduce risk of failure from the multitude of water treatment components. Alternatively, provide City potable water supply line to plant. Install flow-paced instrumentation. Install flow meter (flume) capable of relay for chlorine dose flow-pacing and other process control uses.		
Priority	Mid-Term (2-6 Years)		
Project Need			
Reliability	X	Process Performance	X
Capacity		Regulatory	
City Policy & Goals			

Project Cost			
Capital Costs			
General		$	20,000
Civil & Mechanical		$	1,101,000
Structural		$	-
Electrical & Controls		$	20,000
Equipment		$	-
Capital Cost Subtotal:		**$**	**1,141,000**
Soft Costs			
Classification 'B'			
Engineering & Permitting	10 % of capital cost	$	114,000
CM & ESDC	18 % of capital cost	$	205,000
Administration	3 % of capital cost	$	34,000
Soft Cost Subtotal		**$**	**353,000**
Contingency			
Contingency	35 % of capital cost	$	399,000
Total Project Cost		**$**	**1,893,000**

6.4.5 SLUDGE HANDLING & DEWATERING



Background

Primary and Secondary Sludge at Seeley Creek WWTP is wasted from the primary clarifiers to a sludge holding tank adjacent to the primary sludge pumps. The sludge holding tank is periodically emptied with vacuum trucks and hauled to Huston Creek WWTP for dewatering. No biosolids handling or dewatering equipment exist at the Seeley Creek WWTP other than the sludge holding tank.

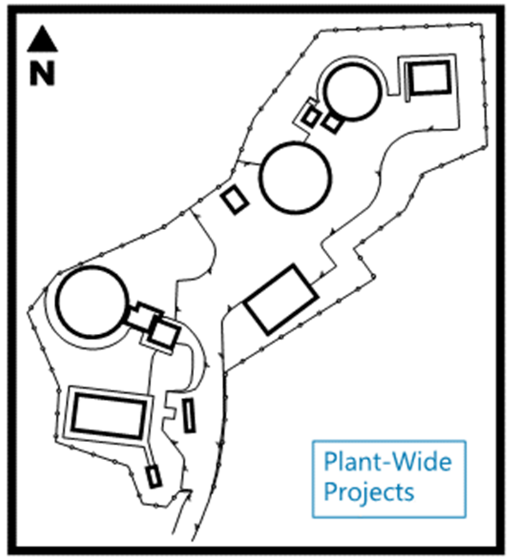
Project Needs

None.

Project Recommendations

None.

6.4.6 PLANT-WIDE PROJECTS



Background

Plant-wide projects are defined as assets utilized as support systems, connecting unit process areas, or plant-wide planning and engineering studies. The emergency storage pond and compression distribution system were evaluated as part of this analysis.

The emergency storage infrastructure at Seeley Creek WWTP consists of a 100,000-gallon tank and a pond. The pond is not permitted for use because it is unlined.

The original air compression system at the Seeley Creek WWTP was one large compressor distributed via an underground system. This system failed, and was abandoned and replaced by the use of local compressors, which use high pressure effluent (HPE) piping for irrigation, hose bibs, and feed water for on-site chlorine generation.

Project Needs

The existing 100,000-gallon tank is not sufficient for 24-hour dry weather flows, and well below wet weather flows. Additional emergency storage capacity is needed, but there is not enough space onsite. The existing out-of-service emergency storage pond is not permitted for use since it is unlined, and is considered a failed asset.

The smaller local compressors used to replace the original larger compressor are local and temporary. A more permanent setup of the smaller local compressors would be beneficial. Additionally, the HPE piping is currently leaking at an unknown location or potentially multiple locations. The system does not have isolation valves, so locating the leak is difficult. Ongoing failure without knowing the leak location(s) will likely require a full HPE system replacement.

Projects to address the following deficiencies are recommended:

- Unusable abandoned emergency storage pond
- Lack of a permanent compressor system for HPE

Project Recommendations

Capital improvement projects identified plant-wide at Seeley Creek WWTP are summarized in Table 6-13. Project descriptions including cost estimates are provided on the following pages.

Table 6-13. Seeley Creek Plant-Wide Capital Projects

Project No.	Project Name	Project Cost
SC-1	Seeley Creek WWTP Emergency Storage Pond	$196,000
SC-5	Seeley Creek WWTP Ancillary Systems Upgrade	$303,000

Project No.	**SC-1**		
Project Name	**Seeley Creek WWTP Emergency Storage Pond**		
Description	Currently, Seeley Creek WWTP only has a 100,000 gallon tank for emergency storage, which offers only a short period of storage time during wet weather events. Additional emergency storage capacity is needed, and not enough space exists on the site. An existing emergency storage pond exists near the effluent pipeline downstream of the Seeley Creek WWTP. The pond is a failed asset because it is not permitted for use because it is not lined. A project is needed to line the pond and install proper valving and control to utilize the pond for emergency storage. Recommended Project: Line existing pond with HDPE or alternative liner material and install piping and valves with appropriate control mechanisms in order to divert flow to and from the pond as needed in case of an emergency.		
Priority	Immediate Works (0-2 Years)		
Project Need			
Reliability	X	Process Performance	
Capacity	X	Regulatory	X
City Policy & Goals			

Project Cost			
Capital Costs			
General		$	10,000
Civil & Mechanical		$	102,000
Structural		$	-
Electrical & Controls		$	-
Equipment		$	-
Capital Cost Subtotal:		**$**	**112,000**
Soft Costs			
Classification 'C'			
Engineering & Permitting	15 % of capital cost	$	17,000
CM & ESDC	20 % of capital cost	$	22,000
Administration	5 % of capital cost	$	6,000
Soft Cost Subtotal		**$**	**45,000**
Contingency			
Contingency	35 % of capital cost	$	39,000
Total Project Cost		**$**	**196,000**

Project No.	SC-5
Project Name	**Seeley Creek WWTP Ancillary Systems Upgrade**
Description	Plant compressed air is delivered to processes as-needed by local compressors around the plant. The system used to be one, large compressor, but underground air piping failed and the larger system was abandoned. High pressure effluent (HPE) feeds plant water for multiple uses around the plant. HPE is used for irrigation, hose bibs, feed water for on-site chlorine generation, and other uses. There is currently an HPE piping leak at an unidentified location(s). Recommended Project: Establish permanent solutions for ex. smaller compressors. Locate leak, if possible, and replace HPE line(s) with new pipe. Consider installing pipe in an accessible concrete trench with trench plates for easier access for maintenance.
Priority	Mid-Term (2-6 Years)

Project Need

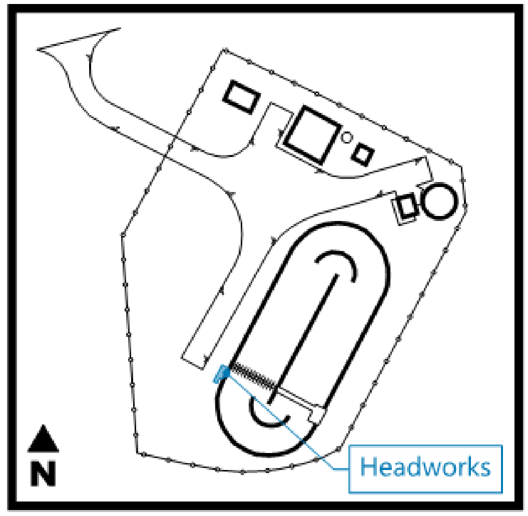
Reliability	X	Process Performance	X
Capacity	X	Regulatory	
City Policy & Goals			

Project Cost

Capital Costs			
General		$	10,000
Civil & Mechanical		$	133,000
Structural		$	66,000
Electrical & Controls		$	-
Equipment		$	-
Capital Cost Subtotal:		**$**	**209,000**
Soft Costs			
Classification 'C'			
Engineering & Permitting	15 % of capital cost	$	31,000
CM & ESDC	20 % of capital cost	$	42,000
Administration	5 % of capital cost	$	10,000
Soft Cost Subtotal		**$**	**83,000**
Contingency			
Contingency	35 %	$	11,000
Total Project Cost		**$**	**303,000**

6.5 Cleghorn WWTP

6.5.1 HEADWORKS & GRIT REMOVAL



Background

The Cleghorn WWTP influent enters the facility via an 8-inch sewer main. Influent flows through a manual bar screen and a "Muffin Monster" comminutor before entering the oxidation ditch. The District has expressed concern that their influent channels are not large enough to contain peak wet weather flow events. Field investigation and hydraulic calculations may be done in the future to determine the flow capacity of the influent channels.

Project Needs

There are opportunities for multiple improvements to the headworks and grit removal process area. Projects to address the following deficiencies are recommended:

- Ineffective Muffin Monster. The in-line channel monster restricts flow and is expensive, difficult to maintain, and not operating due to failure. The teeth wear out quickly and are expensive to replace.
- Lack of grit removal. Grit accumulates in influent channels, leading to a reduction in capacity, and in the oxidation ditch or secondary clarifier, leading to wear and tear on the sludge pumping and clarifier equipment. It is manually cleaned out by maintenance crews, posing access/egress and injury risks.
- Bar screen failure and lack of screenings removal. Bar screens have wide spacing to avoid clogging due to the high volume of rags and other screenings in the influent. This wide spacing allows rags, grit, and debris to enter the secondary clarifier, damaging the return activated sludge (RAS) pump. Clearing a clogged bar screen is labor-intensive and time consuming.
- Inadequate hydraulic capacity in the influent channels. High flow conditions potentially due to upgrades in State-operated lift stations have resulted in spills in the plant area.
- Lack of flow equalization. High flow do to wet weather and/or influx of people to the camp leads to a decline in effluent quality.

Project Recommendations

Capital improvement projects identified for the headworks and grit removal process are summarized in Table 6-14. Project descriptions including cost estimates are provided on the following pages.

Table 6-14. Cleghorn Headworks & Grit Removal Capital Projects

Project No.	Project Name	Project Cost
CL-5	Cleghorn WWTP Headworks Upgrade	$1,670,000

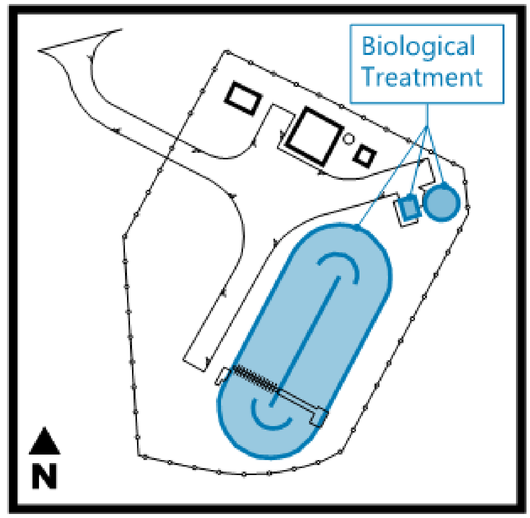
Project No.	**CL-5**
Project Name	**Cleghorn WWTP Headworks Upgrade**
Description	Plant influent flows through one bar screen, with 2-inch wide bar spacing, then through a channel Muffin Monster unit before flowing into the oxidation ditch. Influent contains higher levels of rags, debris, clothes, and other items found at a campsite, some of which can make it through the 2-inch bar screen. No engineered grit removal process exists at the plant. Grit is manually shoveled out of the influent channels and typically settles out near the screens or in the oxidation ditch. Spills could occur during high flow conditions. Collection system is owned, operated, and maintaned by the State. Therefore, the District has limited information and control over the influent characteristics. Influent tends to vary widely depending on lift station activity, septic dumps, wet weather, holidays, and other factors. <u>Recommended Project:</u> Remove Muffin Monster and install an automatic screenings unit in place of existing bar screen. Install grit removal system. If hydraulic capacity issue exists, enlarge influent channels or install new upsized channels. New screenings and grit removal will likely require low-head pumping system to account for hydraulic head losses through new equipment.
Priority	Mid-Term (2-6 Years)

Project Need

Reliability	X	Process Performance	X
Capacity	X	Regulatory	
City Policy & Goals			

Project Cost			
Capital Costs			
General		$	35,000
Civil & Mechanical		$	60,000
Structural		$	44,000
Electrical & Controls		$	250,000
Equipment		$	565,000
Capital Cost Subtotal:		**$**	**954,000**
Soft Costs			
Classification 'C'			
Engineering & Permitting	15 % of capital cost	$	143,000
CM & ESDC	20 % of capital cost	$	191,000
Administration	5 % of capital cost	$	48,000
Soft Cost Subtotal		**$**	**382,000**
Contingency			
Contingency	35 % of capital cost	$	334,000
Total Project Cost		**$**	**1,670,000**

6.5.2 BIOLOGICAL TREATMENT



Background

Cleghorn WWTP biological treatment consists of a single oxidation ditch with a single brush aerator. Oxidation ditches are a common design for the extended aeration activated sludge treatment process. The oxidation ditch was constructed as part of the original plant construction in 1972. Mixed liquor is sent to the secondary clarifier, and return activated sludge is pumped back to the oxidation ditch.

Cleghorn WWTP secondary clarification consists of a single secondary clarifier unit. This unit was constructed as part of the original plant construction in 1972. Like Seeley Creek WWTP, the secondary clarifier at Seeley Creek WWTP is a traditional secondary clarifier design (i.e. with slow-rotating scraper and skimmer arm).

Project Needs

There are opportunities for multiple improvements to the biological treatment process area. Projects to address the following deficiencies are recommended:

- Unreliable oxidation ditch brush. The brush is missing some paddles, and can get stuck on debris, branches, animals, etc. Past failure has occurred due to operator error.
- Inadequate oxidation ditch liner. The liner is peeling, failing, bubbling, and difficult to maintain.
- Inadequate secondary clarifier liner. The liner is peeling, at some places in large sections that could potentially clog the overflow.
- Structural deficiencies in oxidation ditch. The top layer of concrete on the basin discharge side is exposed, corroded, and/or degraded. The highest potential for corrosion is in the “splash zone” near the aerator.
- Lack of process control for oxidation ditch. No sludge-wasting mechanism is in place, and RAS pumps operate on a timer. Failure could result in washout conditions and continuously results in energy inefficiency.

- Unreliable secondary clarifier drive unit. The drive unit is noisy and has failed frequently.

Project Recommendations

Capital improvement projects identified for the biological treatment process are summarized in Table 6-15. Project descriptions including cost estimates are provided on the following pages.

Table 6-15. Cleghorn Biological Treatment Capital Projects

Project No.	Project Name	Project Cost
CL-1	Cleghorn WWTP Oxidation Ditch Upgrade	$557,000
CL-3	Cleghorn WWTP Concrete Structures Rehabilitation	$147,400
CL-6	Cleghorn WWTP Secondary Clarification Upgrade	$38,000

Project No.	**CL-1**
Project Name	**Cleghorn WWTP Oxidation Ditch Upgrade**
Description	Oxidation ditch is an extended-aeration activated sludge process, which is a simple process designed with a long SRT. The activated sludge process is designed to remove BOD. Cleghorn has a single-duty racetrack-style oxidation ditch with a single mechanical brush aerator. It is powered by a 30-hp motor horizontally mounted across the width of the track. The brush aerator acts to mix, maintan velocity, and entrain DO into the activated sludge in the ditch. Recommended Project: Add a second aerator for redundancy. Alternatively, consider changing aeration technology. Single-duty critical equipment carries high risk even when mitigation is in place. Better influent screening would protect brushes.
Priority	Mid-Term (2-6 Years)

Project Need

Reliability	X	Process Performance	X
Capacity		Regulatory	
City Policy & Goals			

Project Cost			
Capital Costs			
General		$	15,000
Civil & Mechanical		$	-
Structural		$	30,000
Electrical & Controls		$	63,000
Equipment		$	210,000
Capital Cost Subtotal:		**$**	**318,000**
Soft Costs			
Classification 'C'			
Engineering & Permitting	15 % of capital cost	$	48,000
CM & ESDC	20 % of capital cost	$	64,000
Administration	5 % of capital cost	$	16,000
Soft Cost Subtotal		**$**	**128,000**
Contingency			
Contingency	35 % of capital cost	$	111,000
Total Project Cost		**$**	**557,000**

Project No.	**CL-3**		
Project Name	**Cleghorn WWTP Concrete Structures Rehabilitation**		
Description	Oxidation ditch is an extended-aeration activated sludge process, which is a simple process designed with a long SRT designed to remove BOD. Liner is peeling, and bubbling out, and increasing corrosion potential to the concrete once it's breached. Basin discharge side of ditch experincing corrosion and degradation, especially in the "splash zone" by the aerator. Single-duty circular secondary clarifier functions to capture and settle sloughed solids from the trickling filter and return them to the primary clarifier. Liner is peeling off. Recommended Project: Remove failed oxidation ditch and secondary clarifier liners, inspect structural integrity, rehab concrete, reline. Perform concrete rehab on basin discharge side of ditch.		
Priority	Mid-Term (2-6 Years)		
Project Need			
Reliability	X	Process Performance	
Capacity		Regulatory	
City Policy & Goals			

Project Cost			
Capital Costs			
General		$	20,000
Civil & Mechanical		$	-
Structural		$	68,400
Electrical & Controls		$	-
Equipment		$	-
Capital Cost Subtotal:		**$**	**88,400**
Soft Costs			
Classification 'B'			
Engineering & Permitting	10 % of capital cost	$	9,000
CM & ESDC	18 % of capital cost	$	16,000
Administration	3 % of capital cost	$	3,000
Soft Cost Subtotal		**$**	**28,000**
Contingency			
Contingency	35 % of capital cost	$	31,000
Total Project Cost		**$**	**147,400**

Project No.	**CL-6**
Project Name	**Cleghorn WWTP Secondary Clarification Upgrade**
Description	Single-duty circular secondary clarifier functions to capture and settle sloughed solids from the trickling filter and return them to the primary clarifier. Drive unit has been somewhat problematic compared to the other clarifier drives. Excessive noise has occurred in the past, and failure has happened more frequently. Recommended Project: Replace clarifier drive unit.
Priority	Mid-Term (2-6 Years)

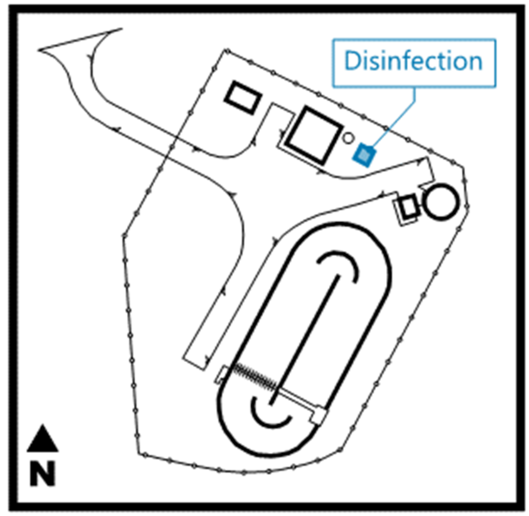
Project Need

Reliability	X	Process Performance	
Capacity	X	Regulatory	
City Policy & Goals			

Project Cost

Capital Costs			
General		$	2,000
Civil & Mechanical		$	-
Structural		$	-
Electrical & Controls		$	4,000
Equipment		$	20,000
Capital Cost Subtotal:		**$**	**26,000**
Soft Costs			
Classification 'D'			
Engineering & Permitting	5 % of capital cost	$	1,000
CM & ESDC	5 % of capital cost	$	1,000
Administration	5 % of capital cost	$	1,000
Soft Cost Subtotal		**$**	**3,000**
Contingency			
Contingency	35 % of capital cost	$	9,000
Total Project Cost		**$**	**38,000**

6.5.3 DISINFECTION



Background

Like both of the District's other treatment plants, Cleghorn WWTP utilizes Micro-Chlor on-site generation equipment to generate chlorine disinfectant from bags of sodium chloride. After the dosing point, effluent flows through a 4,039 gallon concrete serpentine chlorine contact basin.

Project Needs

The on-site generation Micro-Chlor equipment is unreliable and lacks control. Multiple weak points exist, including the brine tank. If left unmitigated, failure would occur within a month, resulting in a downtime of greater than one day. Additionally, the equipment is manually operated. It lacks an instrumentation for flow-paced control that could provide efficiencies to salinity and chemicals.

Projects to address the following deficiencies are recommended:

- Unreliable Micro-Chlor skid
- Lack of on-site generation control

Project Recommendations

Capital improvement projects identified for the disinfection process are summarized in Table 6-16. Project descriptions including cost estimates are provided on the following pages.

Table 6-16. Cleghorn Disinfection Capital Projects

Project No.	Project Name	Project Cost
CL-4	Cleghorn WWTP On-Site Generation System Upgrade	$45,000

Project No.	**CL-4**
Project Name	**Cleghorn WWTP On-Site Generation System Upgrade**
Description	Chlorine generation equipment consists of 1 Micro-Chlor onsite generation unit. Salt bags are stored at the facility. Potable water used for mixture with the salt in a brine tank. Chlorine is manually dosed day-to-day. Residual testing is done via grab sample. Skid failure could occur under a multitude of points, including brine tank. Manual operatoin with no control or flow-pacing. Recommended Project: Consider shifting chlorine dosing to chlorine pallets or puck system to reduce maintenance needs and risk of failure. Do an in-house test to check for organo-chloramines which occur when free chlorine react with organics and can read as residual even though they provide no disinfection power. Reads as di-chloramine in a DPD test, which shouldn't occur in the free mode. Install instrumentation for flow-paced control.
Priority	Mid-Term (2-6 Years)

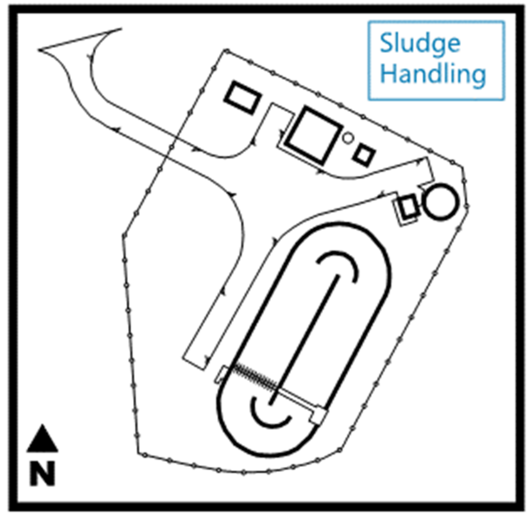
Project Need

Reliability	X	Process Performance	X
Capacity		Regulatory	
City Policy & Goals			

Project Cost

Capital Costs			
General		$	2,000
Civil & Mechanical		$	-
Structural		$	-
Electrical & Controls		$	15,000
Equipment		$	10,000
Capital Cost Subtotal:		**$**	**27,000**
Soft Costs			
Classification 'B'			
Engineering & Permitting	10 % of capital cost	$	3,000
CM & ESDC	18 % of capital cost	$	5,000
Administration	3 % of capital cost	$	1,000
Soft Cost Subtotal		**$**	**9,000**
Contingency			
Contingency	35 % of capital cost	$	9,000
Total Project Cost		**$**	**45,000**

6.5.4 SLUDGE HANDLING & DEWATERING



Background

There is currently no infrastructure in place to facilitate sludge wasting. Sludge is manually drawn of the RAS line and loaded into a tanker truck, which hauls it to Huston Creek.

Project Needs

Cleghorn WWTP currently lacks sludge wasting equipment. Activated sludge is wasted from the system manually approximately two times a year. No mechanism is in place for controlled wasting.

Projects to address the following deficiencies are recommended:

- Lack of sludge wasting equipment

Project Recommendations

Capital improvement projects identified for the sludge handling and dewatering process are summarized in Table 6-17. Project descriptions including cost estimates are provided on the following pages.

Table 6-17. Cleghorn Sludge Handling & Dewatering Capital Projects

Project No.	Project Name	Project Cost
CL-7	Cleghorn WWTP Sludge Wasting and Clarifier Upgrades	$210,000

Project No.	**CL-7**
Project Name	**Cleghorn WWTP Sludge Wasting and Clarifier Upgrades**
Description	Cleghorn has a single duty racetrack-style oxidation ditch with a single mechanical brush aerator. Little to no process control exists for the activated sludge. DO is monitored but not used as a control parameter, and RAS pumps operate on a timer. Activated sludge wasting functions to remove aged biomass from the activated sludge for biomass control. Currently, no infrastructure mechanism is in place to facilitate sludge wasting, other than to manually draw off the RAS line and fill a tanker truck, which hauls the waste sludge to Houston Creek. This wasting process currently occurs approximately two times per year. Recommended Project: Construct a sludge wasting bed for more consistent and reliable wasting schedule. Construct a redundant RAS pump and pipe gallery configuration to facilitate wasting.
Priority	Mid-Term (2-6 Years)

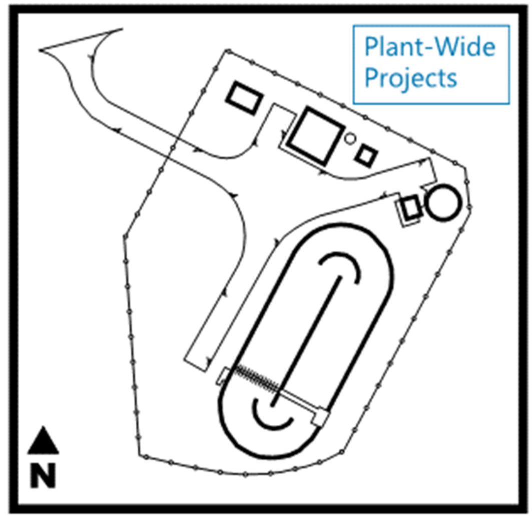
Project Need

Reliability	X	Process Performance	X
Capacity		Regulatory	
City Policy & Goals			

Project Cost

Capital Costs			
General		$	10,000
Civil & Mechanical		$	70,000
Structural		$	5,000
Electrical & Controls		$	20,000
Equipment		$	21,000
Capital Cost Subtotal:		**$**	**126,000**
Soft Costs			
Classification 'B'			
Engineering & Permitting	10 % of capital cost	$	13,000
CM & ESDC	18 % of capital cost	$	23,000
Administration	3 % of capital cost	$	4,000
Soft Cost Subtotal		**$**	**40,000**
Contingency			
Contingency	35 % of capital cost	$	44,000
Total Project Cost		**$**	**210,000**

6.5.5 PLANT-WIDE PROJECTS



Background

Plant-wide projects are defined as assets utilized as support systems, connecting unit process areas, or plant-wide planning and engineering studies. The emergency generator is evaluated as part of this analysis.

Project Needs

The emergency generator is used to power the plant in the vent of a power outage. It is old and has proved problematic since installation. Frequent maintenance is required to keep it operational. Mechanical failures include vaporizer failure and fuel injection. Propane venting triggers the gas shutdown alarm and shuts down the generator.

Projects to address the following deficiencies are recommended:

- Unreliable emergency generator

Project Recommendations

Capital improvement projects identified plant-wide at Cleghorn WWTP are summarized in Table 6-18. Project descriptions including cost estimates are provided on the following pages.

Table 6-18. Cleghorn Plant-Wide Capital Projects

Project No.	Project Name	Project Cost
CL-2	Cleghorn WWTP Emergency Generator Upgrades	$673,000

Project No.	**CL-2**		
Project Name	**Cleghorn WWTP Emergency Generator Upgrades**		
Description	Old emergency generator runs the plant in the event of a power outage. It has been a problem since installation. Frequent maintenance is required to keep it operational. Mechanical failures include vaporizer failure and fuel injection. Propane venting triggers the gas shutdown alarm and shuts down the generator. Recommended Project: Replace generator at end of service life with more reliable unit.		
Priority	Mid-Term (2-6 Years)		
Project Need			
Reliability	X	Process Performance	X
Capacity		Regulatory	
City Policy & Goals			

Project Cost			
Capital Costs			
General		$	20,000
Civil & Mechanical		$	10,000
Structural		$	25,000
Electrical & Controls		$	50,000
Equipment		$	300,000
Capital Cost Subtotal:		**$**	**405,000**
Soft Costs			
Classification 'B'			
Engineering & Permitting	10 % of capital cost	$	41,000
CM & ESDC	18 % of capital cost	$	73,000
Administration	3 % of capital cost	$	12,000
Soft Cost Subtotal		**$**	**126,000**
Contingency			
Contingency	35 % of capital cost	$	142,000
Total Project Cost		**$**	**673,000**

7 IMPLEMENTATION PLAN

The following section summarizes the recommended implementation schedule for capital improvement projects. The recommended implementation schedule for projects is estimated based on priority, size, and complexity. The implementation schedule does not consider scheduling constraints such as environmental review, permitting, and funding.

7.1 CIP Cost Distribution

The CIP includes a total project value of $22.2 million. Figure 7-1 presents the distribution of CIP budget between the District's facilities.

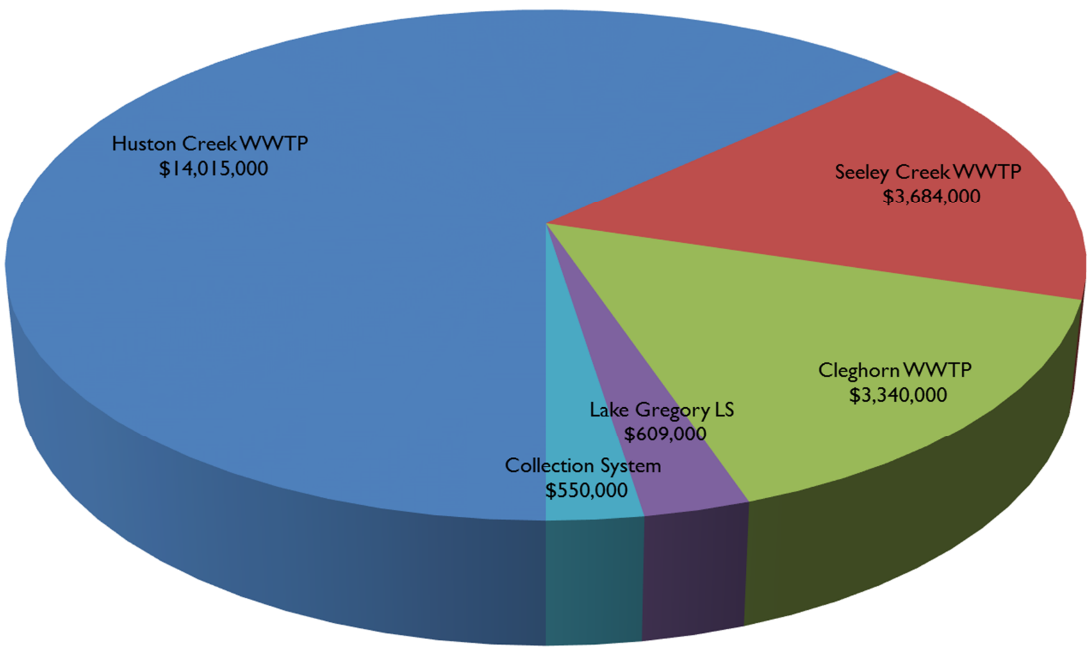


Figure 7-1. CIP Budget Distribution by Facility

As can be seen in Figure, nearly two-thirds of the budget for recommended CIP projects consists of upgrades to the Huston Creek WWTP, the District's largest and oldest WWTP. The remaining third of the budget predominantly consist of upgrades to the Seeley Creek WWTP and Cleghorn WWTP, with modest needs in the collection system and lift stations.

Additionally, it is recommended that the District initiate necessary planning, environmental, engineering, and permitting efforts immediately for priority projects to support funding and construction of these projects. Figure 7-2 presents the CIP cost breakdown by project phase. The figure shows that investments into planning, environmental, engineering, and permitting is necessary in the next fiscal year to support major capital (construction) investments in following years.

For projects that span multiple years, the first year is mostly dedicated to planning, environmental, engineering, and permitting. Subsequent years include construction cost, construction management (CM), and engineering services during construction (ESDC) soft costs. The majority of administrative costs and contingency is reserved for the project's construction phase.

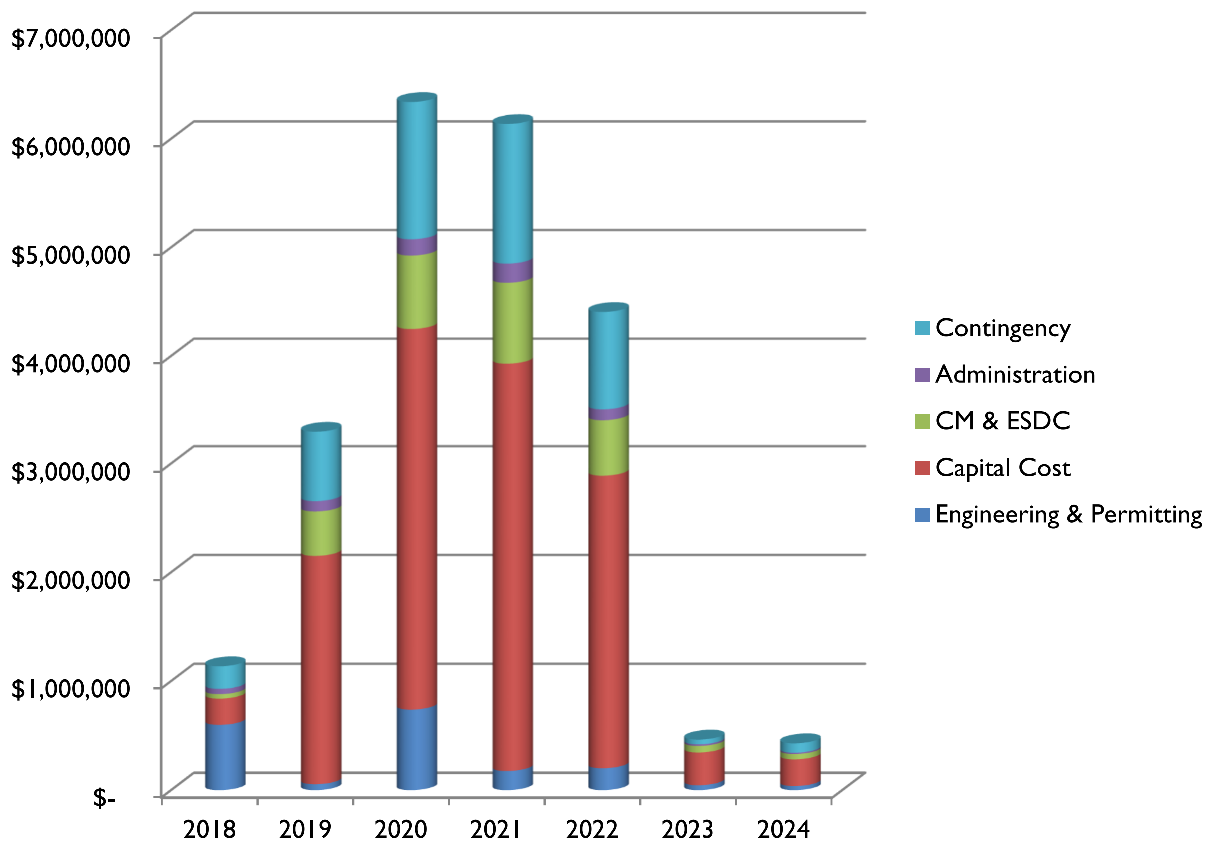


Figure 7-2. CIP Budget Distribution by Project Phase

Project costs are presented and distributed for each project according to priority and anticipated implementation schedule. The CIP implementation schedule is presented in Table 7-1.

Table 7-1. Recommended CIP Implementation Schedule and Cost Breakdown

Project No.	Project Name	Priority	CIP Budget for Fiscal Year Beginning In							Total
			2018	2019	2020	2021	2022	2023	2024+	
HC-1	Houston Creek WWTP Primary Clarifier Replacement	Immediate Works (0-2 Years)	$ 161,000	$ 639,000	$ 628,000					$ 1,428,000
HC-2	Houston Creek WWTP Biosolids Dewatering Upgrade	Immediate Works (0-2 Years)	$ 528,000	$ 2,492,000	$ 1,720,000					$ 4,740,000
HC-3	Houston Creek WWTP Ongoing Facility Safety Upgrades	Immediate Works (0-2 Years)	$ 54,000	$ 54,000	$ 54,000	$ 54,000				$ 216,000
HC-4	Huston Creek WWTP Biosolids Management Plan	Immediate Works (0-2 Years)	$ 42,000							$ 42,000
SC-1	Seeley Creek WWTP Emergency Storage Pond	Immediate Works (0-2 Years)	$ 196,000							$ 196,000
SC-2	Seeley Creek WWTP Recirculation Pumping Upgrade	Immediate Works (0-2 Years)	$ 155,000							$ 155,000
LS-1	Lake Gregory Wet Well Capacity Upgrade	Immediate Works (0-2 Years)		$ 68,000	$ 541,000					$ 609,000
CS-1	Huston Creek Trunk Sewer Inflow/Infiltration Analysis	Immediate Works (0-2 Years)		$ 39,000						$ 39,000
HC-5	Houston Creek WWTP Biological Treatment Upgrade	Mid-Term (2-6 Years)			$ 607,000	$ 5,556,000				$ 6,163,000
HC-8	Huston Creek WWTP Emergency Generator	Mid-Term (2-6 Years)			$ 944,000					$ 944,000
CS-2	Flow Metering Basin #3 Inflow Isolation and Correction	Mid-Term (2-6 Years)			$ 138,000					$ 138,000
CS-3	Flow Metering Basin #7 Inflow and Infiltration Analysis	Mid-Term (2-6 Years)			$ 36,000					$ 36,000
CS-4	Flow Metering Basin #2 Inflow Isolation and Correction	Mid-Term (2-6 Years)				$ 100,000				$ 100,000
CS-5	Flow Metering Basin #4 Inflow Isolation and Correction	Mid-Term (2-6 Years)				$ 89,000				$ 89,000
CS-6	Flow Metering Basin #6 Inflow Isolation and Correction	Mid-Term (2-6 Years)				$ 148,000				$ 148,000
HC-6	Huston Creek WWTP Disinfection System Upgrade	Mid-Term (2-6 Years)					$ 53,000			$ 53,000
SC-3	Seeley Creek WWTP Chlorine On-site Generation System Upgrade	Mid-Term (2-6 Years)					$ 1,893,000			$ 1,893,000
SC-4	Seeley Creek WWTP Headworks Upgrade	Mid-Term (2-6 Years)					$ 977,000			$ 977,000
SC-5	Seeley Creek WWTP Ancillary Systems Upgrade	Mid-Term (2-6 Years)						$ 303,000		$ 303,000
SC-6	Seeley Creek WWTP Primary ODS Electrical Upgrade	Mid-Term (2-6 Years)						$ 160,000		$ 160,000
HC-7	Huston Creek WWTP Headworks Upgrade	Long-Term (7+ Years)							$ 429,000	$ 429,000
	Total		**$1,136,000**	**$3,292,000**	**$4,668,000**	**$5,947,000**	**$2,923,000**	**$ 463,000**	**$ 429,000**	**$18,858,000**
Cleghorn WWTP Project Recommendations										
CL-1	Cleghorn WWTP Oxidation Ditch Upgrade	Mid-Term (2-6 Years)			$ 557,000					$ 557,000
CL-2	Cleghorn WWTP Emergency Generator Upgrades	Mid-Term (2-6 Years)			$ 673,000					$ 673,000
CL-3	Cleghorn WWTP Concrete Structures Rehabilitation	Mid-Term (2-6 Years)			$ 147,000					$ 147,000
CL-4	Cleghorn WWTP On-Site Generation System Upgrade	Mid-Term (2-6 Years)			$ 45,000					$ 45,000
CL-6	Cleghorn WWTP Secondary Clarification Upgrade	Mid-Term (2-6 Years)			$ 38,000					$ 38,000
CL-7	Cleghorn WWTP Sludge Wasting and Clarifier Upgrades	Mid-Term (2-6 Years)			$ 210,000					$ 210,000
CL-5	Cleghorn WWTP Headworks Upgrade	Mid-Term (2-6 Years)				$ 188,000	$ 1,482,000			$ 1,670,000
	Total		**$ -**	**$ -**	**$1,670,000**	**$ 188,000**	**$1,482,000**	**$ -**	**$ -**	**$ 3,340,000**

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8 FINANCIAL CONSIDERATIONS

Project recommendations in this Master Plan are good candidates for Clean Water State Revolving Fund (CWSRF) loans and grants because they offer a low-interest funding source that will meet the CWRSF goals to reduce the negative impacts of sewage on water quality and protect public health. This section will discuss Crestline's CWSRF funding options, requirements, procedures, and recommendations to provide the best financing options available to the District as projects are implemented.

It is recommended that the District contact appropriate representatives of State Parks about a funding plan and schedule for Cleghorn WWTP project recommendations.

8.1 CWSRF Background

The federal Clean Water Act (CWA) established the CWSRF Program to finance the protection and improvement of water quality. The CWSRF Program has protected and promoted the health, safety, and welfare of Californians since 1989. Every CWSRF-eligible project is directly related to protecting or improving public health, water quality, or both.

The California CWSRF Program is run by the State Water Board's Division of Financial Assistance (DFA). Every State Fiscal Year (SFY), the DFA releases a business plain or Intended Use Plan (IUP) on how it plans to allocate CWSRF funds in the upcoming SFY, including eligibility requirements and a financing forecast.

The IUPs change from year to year. Due to potential changes in CWSRF requirements, <u>it is highly recommended that the current IUP is reviewed before beginning work on a CWSRF application</u>.

8.2 Disadvantaged Community (DAC)

The District serves a disadvantage community (DAC) as defined in the DRAFT SFY 2018-2019 CWSRF IUP. Being a DAC, the District is eligible for two (2) specific funding subprograms of CWSRF:

1. CWRSF Loan with Principal Forgiveness (PF), or

2. CWSRF Small Community Grant (SCG) Fund Construction Grant.

These two (2) subprograms are less competitive than the main CWSRF program, CWSRF Loans, because only certain communities (e.g. small communities, DACs) can apply to them. These subprograms each have their own requirements on top of the standard CWSRF Loan requirements. The next few sections summarize:

- Standard CWSRF Loan requirements,
- CWSRF Loan Application Package,
- Additional requirements for the two (2) subprograms (Loan with Principal Forgiveness & SCG Fund Construction Grant),
- Amount of PF or grant funds the upgrade project is eligible for under CWSRF, and
- Recommendations on the CWSRF Application.

8.3 Standard CWSRF Loan Requirements

Per the DRAFT SFY 2018-2019 IUP, all projects funded by CWSRF must meet the following requirements:

A. *Davis-Bacon Requirements* – The District must comply with State and Federal Davis-Bacon rules by providing the most current prevailing wage listings in the bid documents.

B. *Generally Accepted Accounting Principles (GAAP)* - CWA requires that recipients of CWSRF financing maintain project accounts in accordance with generally accepted government accounting standards, including standards relating to the reporting of infrastructure assets. Recipients must agree to comply with GAAP.

C. *Cost and Effectiveness Analysis* – The District must certify they have conducted a cost and effectiveness analysis. This analysis includes an evaluation of the costs and effectiveness of the proposed project, and selection of a project that, to the maximum extent practicable, maximizes the potential for energy conservation, and efficient water use, reuse, recapture, and conservation, considering construction, operation and maintenance, and replacement costs. This certification must be provided before CWSRF assistance is provided for final design or construction.

D. *Procurement for Architectural and Engineering Contracts* – Contracts for the project must comply with the qualifications based procurement process described in 40 United States Code section 1101 et seq. or an equivalent state requirement.

E. *Fiscal Sustainability Plan* – The District must develop and implement a fiscal sustainability plan, which includes an inventory and evaluation of critical assets, evaluation and implementation of water and energy conservation efforts, a plan for maintaining, repairing, and replacing the treatment works, and a plan for funding such activities.

F. *American Iron and Steel* – The project must use iron and steel products that are produced in the United States.

G. *Environmental Reviews*- the District must follow the requirements of the California Environmental Quality Act (CEQA), National Environmental Policy Act (NEPA) and additional supporting documents requested by the State Environmental Review Process.

H. *Disadvantaged Business Enterprise (DBE)* – The District must comply with DBE requirements for all CWSRF financing. These DBE requirements include the DBE Good Faith Effort requirement that bidders provide an opportunity for DBE subcontractors to bid on elements of the project through a web based outreach program.

I. *Climate Change Mitigation and Adaption* - Applications must account for impacts related to climate change (e.g. greenhouse gas reduction, energy savings), including potential effects of climate change on the viability of funded projects.

Requirements B, C, D, E, G, and I must be submitted in the CWSRF Loan Application package.

8.4 CWSRF Loan Application Package

A CWSRF Loan Application contains four (4) packages:

1. *General Information* – details project, proposed schedules, type of assistance requested, and applicant information.

2. *Technical* – includes a project engineering report as well as information about water rights, water conservation, Architecture/Engineering procurement, and other attachments.

3. *Environmental* – includes CEQA+, environmental studies as required by adjacent habitat type and federal cross-cutter documents.

4. *Financial Security*- details funding sources, median household income, current population served, active service connections, O&M costs, and other attachments.

It is recommended that the Environmental package is submitted as early as possible because the review of this package usually has the longest lead-time.

8.5 CWSRF Loan with Principal Forgiveness

Under federal law, principal forgiveness (PF) may be provided to "a municipality or intermunicipal, interstate, or State agency" if the recipient meets the State's affordability criteria (i.e. CWSRF Loan requirements and the Green Project Reserve Requirements), or if the project will address water or energy efficiency, mitigate stormwater runoff, or encourage sustainable project planning, design, and construction.

The District must go through the CWSRF Loan application process to receive PF. Using the eligibility criteria from the DRAFT SFY 2018-2019 IUP, the District's $6.2M Huston Creek WWTP upgrades project is eligible for $3.1M (or 50% of the total project cost) in PF on any CWRSF Loan they receive for the project. Therefore, the District could get a CWSRF Loan (with a 30-year pay back at around one-half of the State's most recent general obligation bond rate) for $6.1M and make payments up to paying back $3.1M of the original loan and get the remaining $3.1M of the original loan "forgiven" (i.e. the District does not have to pay CWSRF back for this amount of PF).

8.6 CWSRF Small Community Grant Fund Construction Grant

SCG Fund allows the State Water Board to help finance communities with the most need in California, helping those that cannot otherwise afford a loan or similar financing to move forward with water quality improvements. The revenue deposited in the SCG Fund is provided in the form of grants to small DACs for CWSRF-eligible wastewater projects.

Recipients of grant funds from the SCG Fund must serve primarily (greater than or equal to 50%) residential communities of 20,000 or less. The District's service area meets these criteria.

The District must go through the CWSRF Loan application process to receive a SCG Fund Construction Grant. Using the eligibility criteria from the DRAFT SFY 2018-2019 IUP, the District's $6.2M Huston Creek WWTP upgrades project is eligible for a $4.65M (or 75% of the total project cost) SCG Fund Construction Grant.

8.7 Funding Recommendations

The CWSRF program is current oversubscribed. For SFY 2018-2019 (per the DRAFT SFY 2018-2019 IUP), the SCG Fund is fully allocated to DACs that have already submitted applications. To receive SCG Fund grant funding in SFY 2018-2019, the District would need to prove to the DFA that their project is more beneficial to implement this SFY than the other DACs that have already submitted applications. Since the District has not yet submitted any portion of their CWSRF application and therefore, no portion of the District's application has been reviewed by DFA, it is highly unlikely that the District could receive an SCG Fund Construction Grant in SFY 2018-2019.

It is recommended that either the District plan to receive an SCG Fund Construction Grant in a future SFY or that they apply for a CWSRF Loan with PF for SFY 2018-2019. Either way, it is highly recommended that the District submit its CWSRF application (or any portion of its CWSRF application) as soon as possible, so that the DFA has sufficient time to review it before the District needs funds.

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APPENDIX A

TM 1: Process Evaluation

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TECHNICAL MEMORANDUM #1

To:	**Rick Dever, Crestline Sanitation District**
Author(s):	**Phil Giori, P.E.**
Reviewer(s):	**Greg Guillen, P.E., Ph.D.; Mike Metts, P.E.**
Date:	**November, 2017**
Subject:	**Treatment Facilities Process Evaluation**

1 INTRODUCTION

The Crestline Sanitation District (District) contracted with Dudek to assist with preparation of a Wastewater Master Plan that will help guide strategic planning and investments for the District's collection, treatment, and reuse programs.

2 DOCUMENT PURPOSE

This Technical Memorandum #1 (TM1) documents the project team's evaluation of the District's three existing treatment facilities and potential process improvements, evaluation of facility treatment capacity and bottlenecks, as well as recommendations for process monitoring and control improvements. This TM is based on analysis of the current process configuration and most recent 2 years of daily, or less-frequent process data. The process data was compared to the facility's intended design as well as accepted industry standards from Metcalf & Eddy (M&E) for operations, design, and process performance. This analysis will be used in the project to inform the project team, assist in subsequent Failure Modes and Effects Analysis workshops, and developing capital improvement project concepts.

The analysis includes a high-level evaluation of existing unit processes and the current plant configurations with an emphasis on process performance and capacity. Ancillary/support systems (i.e. size of pumps, piping, etc.) were not considered for this analysis.

The contents of this TM1 will be utilized in the Wastewater Master Plan final report.

3 TREATMENT PLANT SUMMARY

3.1 Huston Creek WWTP

Huston Creek WWTP is a 0.7 MGD treatment facility consisting of a headworks, primary clarification, low-rate tricking filter, secondary clarification, and chlorine contact disinfection to achieve disinfected secondary-23 effluent, as defined by the California Code of Regulations Title 22. Sludge is wasted from the primary clarifiers, thickened in a gravity sludge thickener, and dewatered using a belt-press. No sludge digestion takes place at any of the District's facilities. Huston Creek contains all sludge processing equipment for the District. Effluent is discharged into the District's gravity outfall pipeline.

3.2 Seeley Creek WWTP

Seeley Creek WWTP is a 0.5 MGD treatment facility consisting of a headworks, primary clarification, high-rate trickling filter, secondary clarification, and chlorine contact disinfection to achieve disinfected secondary-23 effluent. Sludge is wasted from the primary clarifier into a sludge holding tank, which is periodically emptied and sludge hauled to Huston Creek WWTP for processing. Effluent is discharged into the District's gravity outfall pipeline.

3.3 Cleghorn WWTP

Cleghorn WWTP is a 0.4 MGD treatment facility consisting of a headworks, oxidation ditch, secondary clarification, and chlorine contact disinfection to achieve disinfected secondary-23 effluent. Sludge is periodically pumped out of the secondary clarifier and hauled to Huston Creek WWTP for processing. Effluent is pumped to the District's gravity outfall pipeline.

4 PROCESS PERFORMANCE SUMMARY

A process performance overview for Huston Creek WWTP, Seeley Creek WWTP, and Cleghorn WWTP are provided in Tables 1, 2, and 3 respectively. Average, maximum, and minimum values of the data are provided as available, along with the sample size, design criteria, M&E typical ranges, and regulatory limits, as applicable. All of the data summarized in this report was captured between January 1, 2015 and August 9, 2017.

Table 1. Huston Creek Process Performance Summary (Jan 2015-Aug 2017)

Parameter	No. of Data Points	Units	Values			Design Criteria	Metcalf & Eddy Typical Range	Regulatory Limit
			Average	Maximum	Minimum			
Plant Influent								
Total Plant Influent Flow	952	MGD	0.500	2.020	0.015	0.700	-	-
Influent BOD_5	63	mg/L	313	447	117	200	200-400	-
Influent TSS	63	mg/L	258	650	8	-	195-389	-
Influent TKN	-	mg/L	-	-	-	-	35-69	-
Influent Ammonia	-	mg/L	-	-	-	-	20-41	-
Primary Treatment								
BOD Removal	63	%	47%	74%	6%	-	20-40	-
Effluent BOD	63	mg/L	163	252	50	-	-	-
TSS Removal	62	%	73%	99%	7%	-	45-65	-
Effluent TSS	63	mg/L	61	131	5	-	-	-
Primary Solids (to waste)	49	%	1.17	4.90	0.01	-	4-10	-
Secondary Treatment								
Effluent BOD	64	mg/L	29	57	5	-	<30	-
Effluent TSS	64	mg/L	15	38	2	-	-	-
Recirculation Rate (vs. influent)	952	-	1.9	3.6	0.5	-	0-1	-
Disinfection								
Chlorine Dose	952	mg/L	23	73	7	15	18-22	-
Chlorine Residual (Plant Effluent)	951	mg/L	17	38	2	-	-	-
Chlorine Residual (Disposal Site)	269	mg/L	6	17	1	-	-	>0
Solids Thickening								
TS%	49	%	4.2	10.0	2.4	-	3-9	-
Solids Dewatering								
Cake Solids %	137	%	31.9	46.4	20.1	-	16-30	-
Plant Effluent								
Effluent Flow	952	MGD	0.347	1.480	0.086	0.700	-	0.700
Effluent BOD	124	mg/L	18.6	27.0	13.8	30	-	30
Effluent TSS	124	mg/L	16.6	38.0	0.1	-	-	-

Table 2. Seeley Creek Process Performance Summary (Jan 2015-Aug 2017)

Parameter	No. of Data Points	Units	Values			Design Criteria	Metcalf & Eddy Typical Range	Regulatory Limit
			Average	Maximum	Minimum			
Plant Influent								
Total Plant Influent Flow	949	MGD	0.163	0.900	0.000	0.500	-	-
Influent BOD_5	63	mg/L	309	592	106	200	200-400	-
Influent TSS	63	mg/L	271	675	25	-	195-389	-
Influent TKN	-	mg/L	-	-	-	-	35-69	-
Influent Ammonia	-	mg/L	-	-	-	-	20-41	-
Primary Treatment								
BOD Removal	63	%	86%	94%	60%	-	20-40	-
Effluent BOD	63	mg/L	39	91	17	-	-	-
TSS Removal	63	%	89%	99%	25%	-	45-65	-
Effluent TSS	63	mg/L	22	156	4	-	-	-
Primary Solids (to waste)	49	%	2.81	11.80	0.14	-	4-10	-
Secondary Treatment								
Effluent BOD	63	mg/L	11	32	3	-	<30	-
Effluent TSS	63	mg/L	5	35	0	-	-	-
Recirculation Rate (vs. influent)	949	-	6.1	21.6	1.2	-	0-1	-
Disinfection								
Chlorine Dose	949	mg/L	30	105	7	-	18-22	-
Chlorine Residual (Plant Effluent)	948	mg/L	9	25	1	-	-	-
Chlorine Residual (Disposal Site)	269	mg/L	6	17	1	-	-	>0
Plant Effluent								
Effluent Flow	-	MGD	-	-	-	0.500	-	0.500
Effluent BOD	123	mg/L	17.5	25.5	11.0	30	-	30
Effluent TSS	125	mg/L	2.5	11.0	0.0	-	-	-

Table 3. Cleghorn Process Performance Summary (Jan 2015-Aug 2017)

Parameter	No. of Data Points	Units	Values			Design Criteria	Metcalf & Eddy Typical Range	Regulatory Limit
			Average	Maximum	Minimum			
Plant Influent								
Total Plant Influent Flow	-	MGD	-	-	-	0.200	-	-
Influent BOD_5	63	mg/L	289	776	40	-	200-400	-
Influent TSS	63	mg/L	227	1220	5	-	195-389	-
Influent TKN	-	mg/L	-	-	-	-	35-69	-
Influent Ammonia	-	mg/L	-	-	-	-	20-41	-
Secondary Treatment								
Mixed Liquor Suspended Solids (MLSS)	49	mg/L	3847	11000	500	-		-
Return Activated Sludge (RAS) Rate	946	% of ADF	306	1080	30	-	50-75	-
RAS Concentration	49	mg/L	9588	71000	900	-	6000-12000	-
Hydraulic Retention Time (HRT) in Ox. Ditch	-	hours	132	-	-	-	15-30	
Solids Retention Time (SRT)	-	days	182	-	-	-	15-30	-
Dissolved Oxygen (DO)	-	mg/L	-	-	-	-	1.5-2.0	-
Secondary Effluent								
Effluent BOD	64	mg/L	14	57	1	-	<30	-
Effluent TSS	63	mg/L	38	252	0	-	-	-
Disinfection								
Chlorine Dose	946	mg/L	87	599	0	-	18-22	-
Chlorine Residual (Plant Effluent)	946	mg/L	9	141	0	-	-	-
Chlorine Residual (Disposal Site)	269	mg/L	6	17	1	-	-	>0
Plant Effluent								
Effluent Flow	947	MGD	0.010	0.680	0.000	0.200	-	0.200
Effluent BOD	61	mg/L	18	29	11	30	-	30
Effluent TSS	63	mg/L	24.3	130.6	2.0	-	-	-

5 HUSTON CREEK WWTP

5.1 Influent and Headworks

Huston Creek WWTP influent characteristics are summarized in Table 4.

Table 4. Huston Creek Influent Summary

Parameter	No. of Data Points	Units	Values			Design Criteria	Metcalf & Eddy Typical Range	Regulatory Limit
			Average	Maximum	Minimum			
Plant Influent								
Total Plant Influent Flow	952	MGD	0.500	2.020	0.015	0.700	-	-
Influent BOD_5	63	mg/L	313	447	117	200	200-400	-
Influent BOD_5	63	lb/d	1202	1910	537	1168	-	-
Influent TSS	63	mg/L	258	650	8	-	195-389	-
Influent TSS	63	lb/d	983	2539	118	-	-	-

Wastewater is characterized as medium-high strength. Average day flow does not exceed the plant's design criteria. However, average day mass loading of BOD exceeds plant design criteria.

5.1.1 Hydraulic Loading

Figure 1 depicts Huston Creek influent flow data.

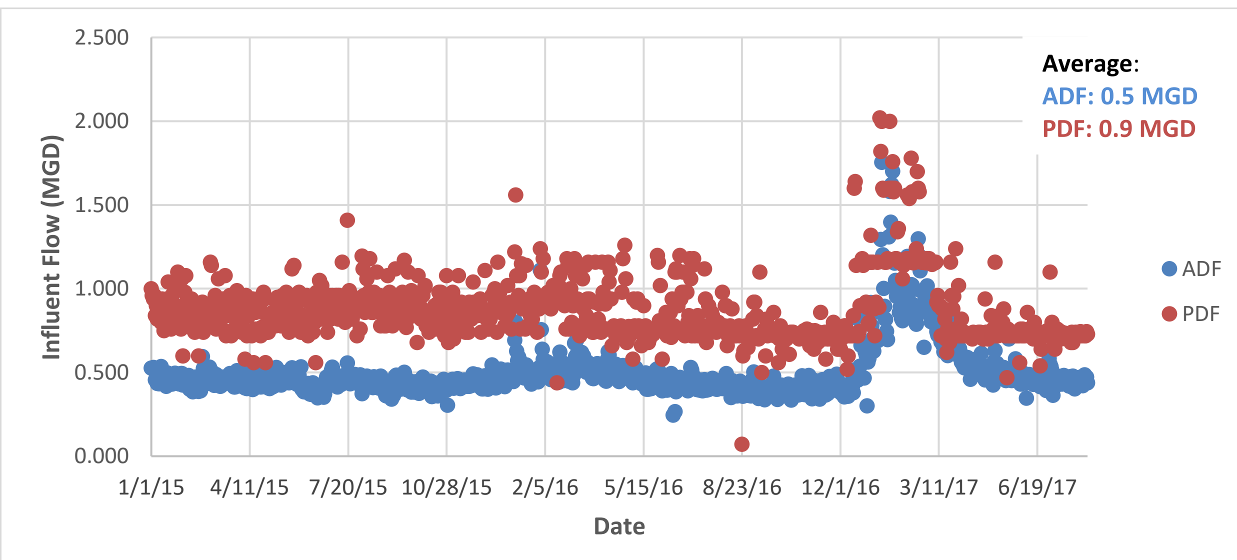

Figure 1. Huston Creek Influent Flows

Influent flows have stayed relatively consistent with minor seasonal fluctuation (higher flows in the winter, lower flows in the summer) with the major exception of the rainfall-heavy winter between December 2016 and March 2017. This notable flow spike, both in peak and average day flows, suggests that Infiltration and Inflow (I/I) is still an issue in the collection system and is contributing hydraulic loading to the plant in excess of its design capacity.

5.1.2 BOD and TSS Loading

Influent constituent loading (biochemical oxygen demand (BOD) & total suspended solids (TSS)) is measured infrequently compared to hydraulic loading (63 data points compared to 952 data points). BOD loading is depicted in Figure 2 and TSS loading is depicted in Figure 3.

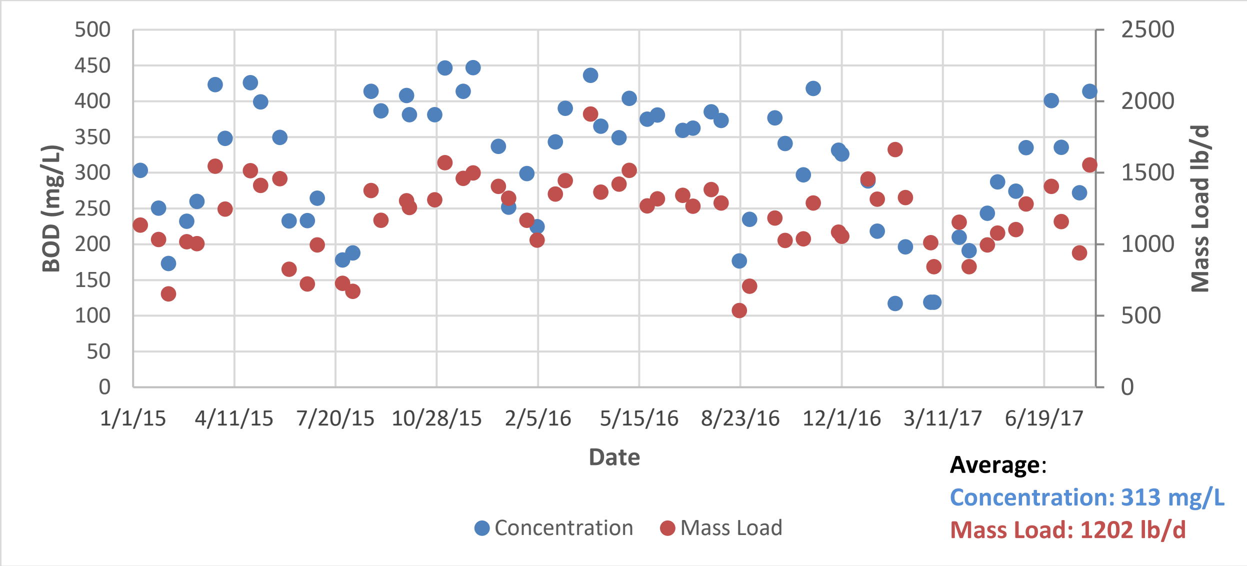

Figure 2. Huston Creek Influent BOD Loading

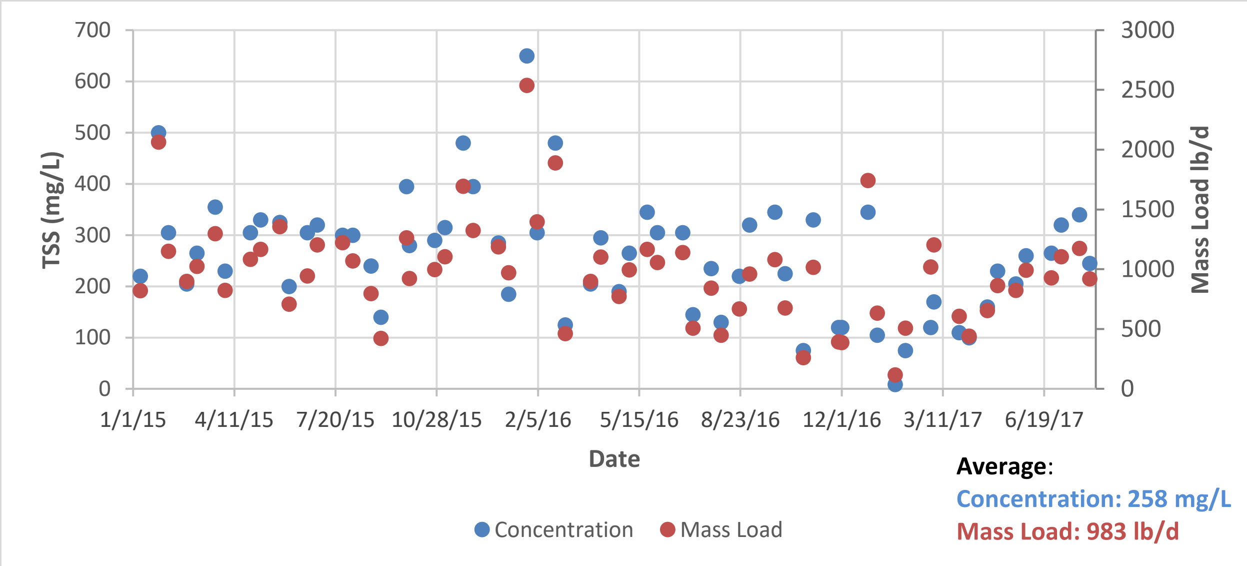

Figure 3. Huston Creek Influent TSS Loading

The data is less consistent than flow data, which is likely a result of infrequent sampling as well as a small sample size. Although Huston Creek WWTP only receives 0.5 MGD (71% of 0.7 MGD design hydraulic capacity), it receives an average BOD mass load of 1,202 lb/d (103% of 1,163 lb/d design BOD mass load capacity). Therefore, BOD loading to the plant both in terms of concentration (mg/L) and mass load (lb/d) exceed the plant design capacity. This is not a unique issue to Crestline. Many southern California agencies have experienced rising BOD mass loading and concentrations, even as plant flows remain constant, or even decrease due to widespread water conservation efforts.

TSS is sampled at the same frequency as BOD, and displays similar variation in the data. No design criteria for TSS was defined in Record Drawings for the facility, and the District is not regulated on effluent TSS. However, TSS is a useful metric from which to determine solids loading and evaluate treatment process performance.

5.1.3 Other Constituents

The Huston Creek WWTP is not regulated on effluent nitrogen, and therefore, influent Total Kjeldahl Nitrogen (TKN) and Ammonia are not measured by the District. Influent dissolved sulfide is also not measured by the District. High concentrations of dissolved sulfide can be toxic to the biological process and has become an issue for other southern California plants. The design of the collection system and cooler temperatures in Crestline lower the propensity of sulfide formation. At this time there is no indication that dissolved sulfide has impacted the biological treatment process.

5.1.4 Headworks Facilities

The Huston Creek WWTP influent enters the facility through parallel 12-inch sewer mains. The headworks consists of a single automatic Reciprocating Rake (Climber) screenings unit (see image right), as well as a backup manual bar screen in series. Screened effluent enters a small aerated grit chamber for grit removal. Grit accumulated in the chamber is dewatered in a single grit washer/classifier unit. Both screenings and grit removed from the headworks is discharged into a waste dumpster.

5.2 Primary Treatment

5.2.1 Primary Treatment Facilities

Huston Creek WWTP primary treatment consists of two identical primary clarifiers (see image left). The primary clarifiers were originally constructed as cone-shaped “Imhoff”-style tanks, and later retrofitted to resemble traditional clarifiers. A section view of the clarifiers is shown in Figure 4.

Primary effluent is collected in an effluent junction box adjacent to the clarifiers before being fed by gravity to the downstream trickling filter. Primary sludge is pumped from the primary clarifiers to a gravity thickener.

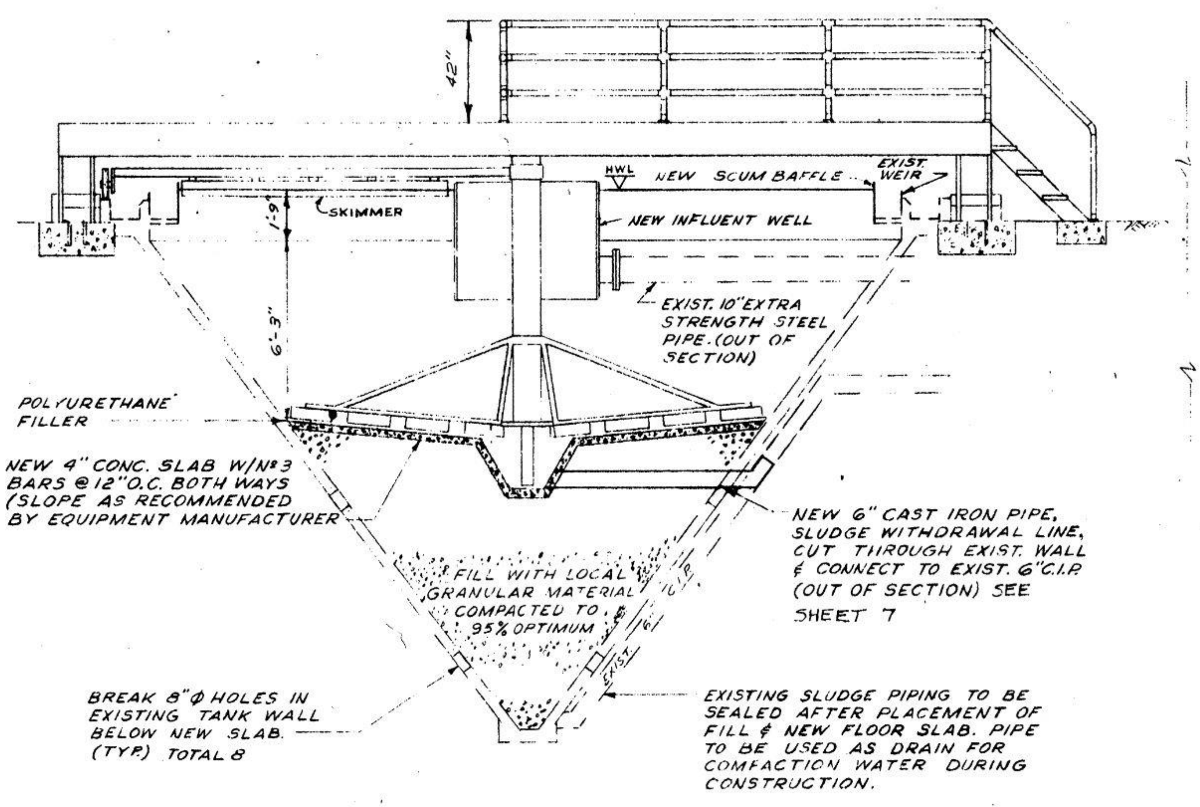

Figure 4. Huston Creek Primary Clarifier Section

5.2.2 Primary Treatment Performance

Despite their unconventional shape, the primary clarifiers have typically performed well when both units are in service, especially during average flow conditions. A breakdown of the Huston Creek Primary clarifier operation compared to typical design and ranges is shown in Table 5.

Table 5. Huston Creek Primary Treatment Operational Parameters

Parameter	Units	Huston Creek Operation	Metcalf & Eddy Typical Design	Metcalf & Eddy Typical Range
Number of Clarifiers Online	#	2 of 2	-	-
Detention Time (avg)	hours	2.06	2	1.5-2.5
Detention Time (peak)	hours	0.51	-	-
Side Water Depth	ft	8.5	14	10-16
Surface Overflow Rate (avg)	gpd/sf	552	1,000	800-1,200
Surface Overflow Rate (peak)	gpd/sf	2,223	2,500	2,000-3,000
CEPT	yes/no	no	-	-
TSS Removal	%	73	63	45-65
BOD Removal	%	47	40	20-40
Primary Sludge Thickness	%TS	1.17	3	-

Primary BOD and TSS Removal are depicted in Figures 5 and 6.

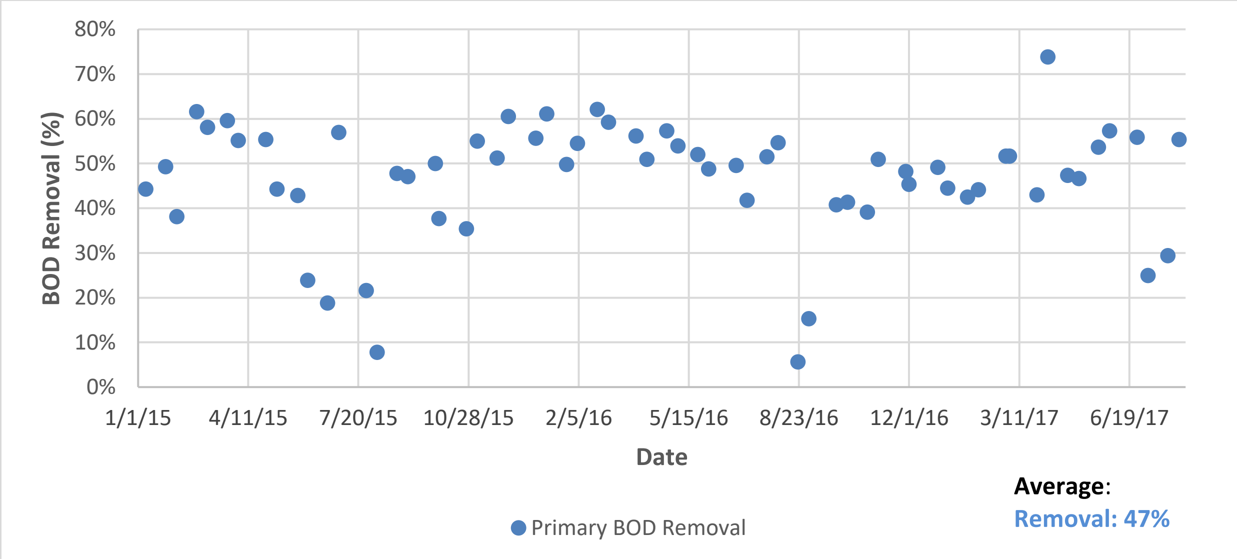

Figure 5. Primary BOD Removal

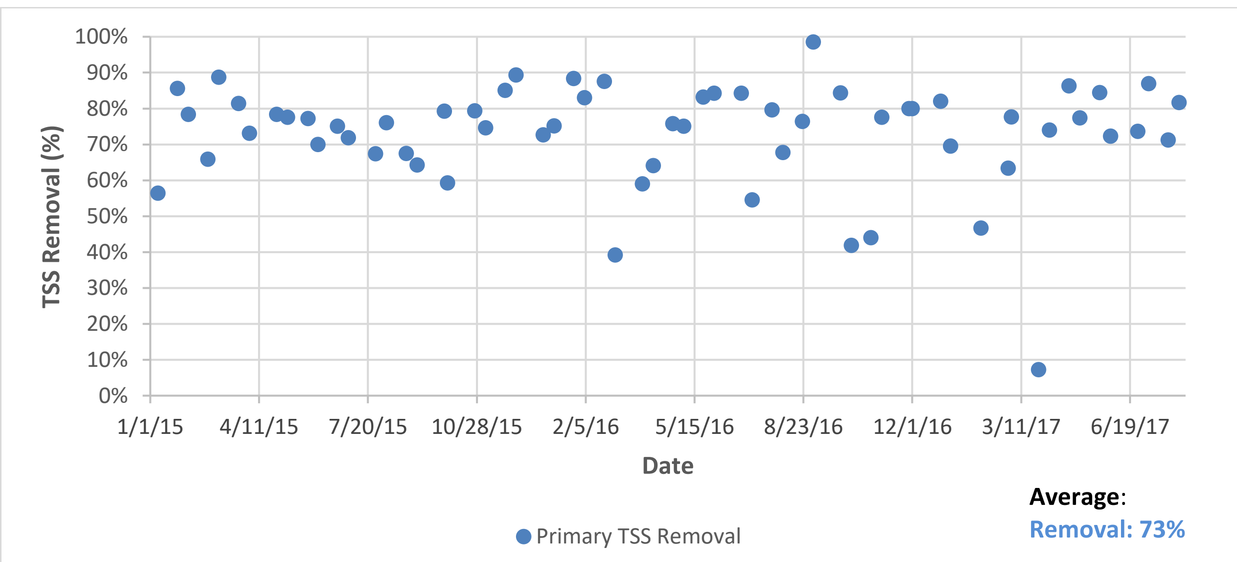

Figure 6. Primary TSS Removal

Aside from no operating clarifier redundancy, a key deficiency of the primary treatment process at Huston Creek is the lack of primary clarifier volume, which results in low detention times during peak flow events. With both units in service during peak flow, the detention time in the primary clarifiers is only 30 minutes. This results in inadequate time for primary sludge to settle in the clarifier, diminishing the primary clarifier performance. Additionally, Huston Creek WWTP contains no influent equalization to mitigate flow peaks to the primary clarifiers.

Additional hydraulic load from belt press dewatering operation is sent to the primary clarifiers every Tuesday. This increases the hydraulic load to the primary clarifiers by approximately 410 gpm, which more than doubles the hydraulic load to the primaries relative to average day flow. Operations has noted that visually, poorer solids separation occurs in the primary clarifiers when pressing.

5.3 Biological Treatment

5.3.1 Biological Treatment Facilities

Huston Creek WWTP biological treatment consists of a single fixed-nozzle, low-rate trickling filter unit. The trickling filter was part of the original plant construction in 1952, and is rectangular shaped with coarse rock media (see image right). Trickling filter effluent either flows to the secondary clarifier, or is recirculated by a pair of recirculation pumps back into the primary effluent junction box.

5.3.2 Biological Treatment Performance

The Huston Creek WWTP trickling filter operational parameters are summarized in Table 6.

Table 6. Huston Creek Biological Treatment Operational Parameters

Parameter	Units	Huston Creek Operation	Metcalf & Eddy Typical Design	Metcalf & Eddy Typical Range
Number of Trickling Filter Units	#	1 of 1	-	-
Total Media Volume	ft^3	72188	-	-
Hydraulic Loading (avg)	gpd/sf	143	-	25-100
Hydraulic Loading (peak)	gpd/sf	301	-	-
Organic Loading	lb/cf/d	0.004	-	0.005-0.02
Depth	ft	7.5	-	3-8
Recirculation Flow Rate	gpm	612	-	-
Recirculation Rate (avg)	% of Q	176%	-	0-100%
Recirculation Rate (peak)	% of Q	44%	-	0-100%

In general, hydraulic loading to the trickling filter is higher than typical ranges, while organic loading is slightly below typical ranges. The high hydraulic loading is a product of a high recirculation rate for this type of trickling filter. The hydraulic and organic loading rates being outside of typical ranges has not appeared to inhibit treatment performance.

5.4 Secondary Clarification

5.4.1 Secondary Clarifier Facilities

Huston Creek WWTP secondary clarification consists of a single secondary clarifier unit. This unit, similar to Huston Creek's primary clarifiers, was constructed as part of the original plant construction in 1952 as a cone-shaped "Imhoff"-style tank (see Figure 7 for section). Unlike the primary clarifiers, the secondary clarifier has not been retrofitted to resemble a traditional clarifier (i.e. with slow-rotating scraper and skimmer arm).

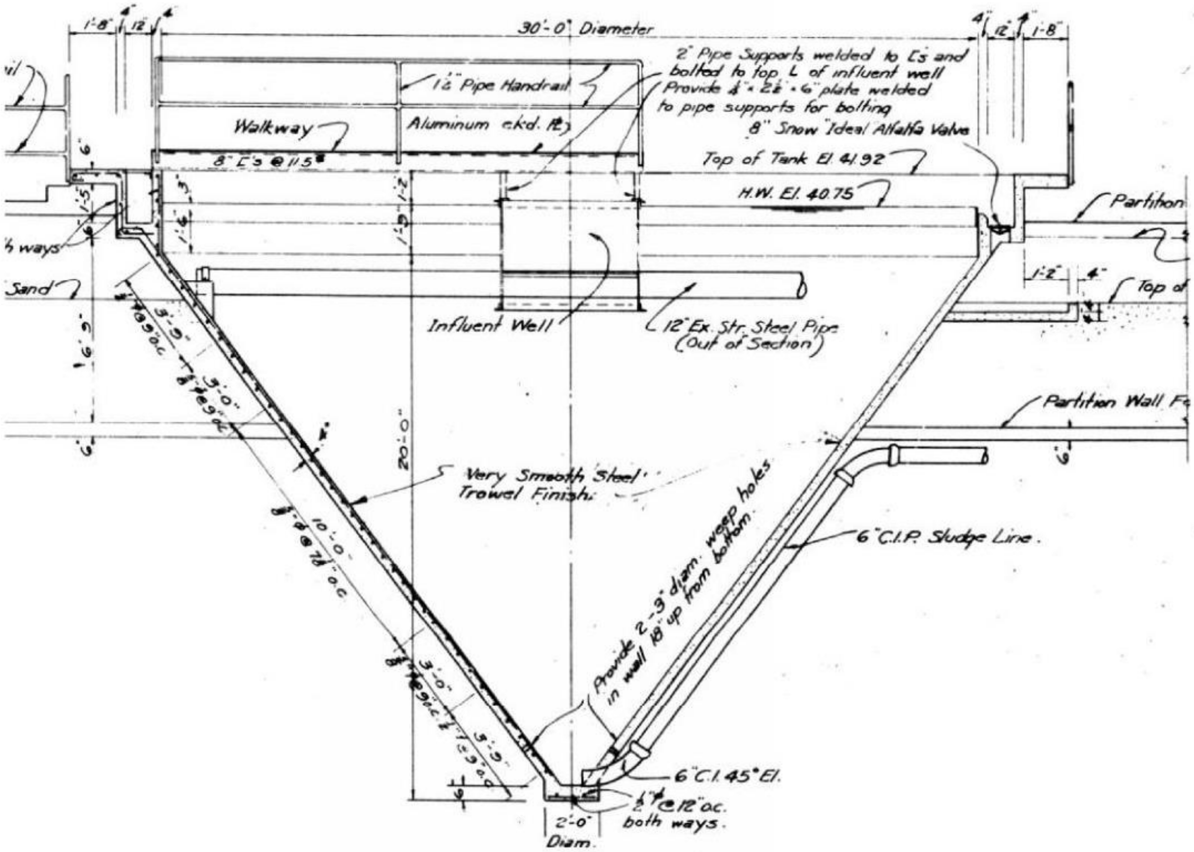

Figure 7. Huston Creek Secondary Clarifier Section

5.4.2 Secondary Clarifier Performance

Table 7 summarizes the secondary clarifier's operational parameters.

Table 7. Huston Creek Secondary Treatment Operational Parameters

Parameter	Units	Huston Creek Operation	Metcalf & Eddy Typical Design	Metcalf & Eddy Typical Range
Number of Clarifiers Online	#	1 of 1	-	-
Surface Overflow Rate (avg)	gpd/sf	491	700	600-800
Surface Overflow Rate (peak)	gpd/sf	818		
Detention Time (avg)	hours	2.6	-	-
Secondary Effluent BOD	mg/L	29	<30	-
Secondary Effluent TSS	mg/L	15	-	-

The secondary clarifier, despite its unconventional design, does produce effluent below 30 mg/L BOD, which is the common maximum target benchmark for a trickling filter plant. Trickling filter effluent, unlike traditional activated sludge, is low in TSS. Suspended solids sent to the secondary clarifier are typically the result of trickling filter *sloughing*, where a portion of the biofilm layer is washed off of the packing media.

Trickling filter slough will settle in the secondary clarifier and ultimately be returned to the primary clarifiers and sludge processing. Secondary effluent BOD and TSS are depicted in Figures 8 and 9.

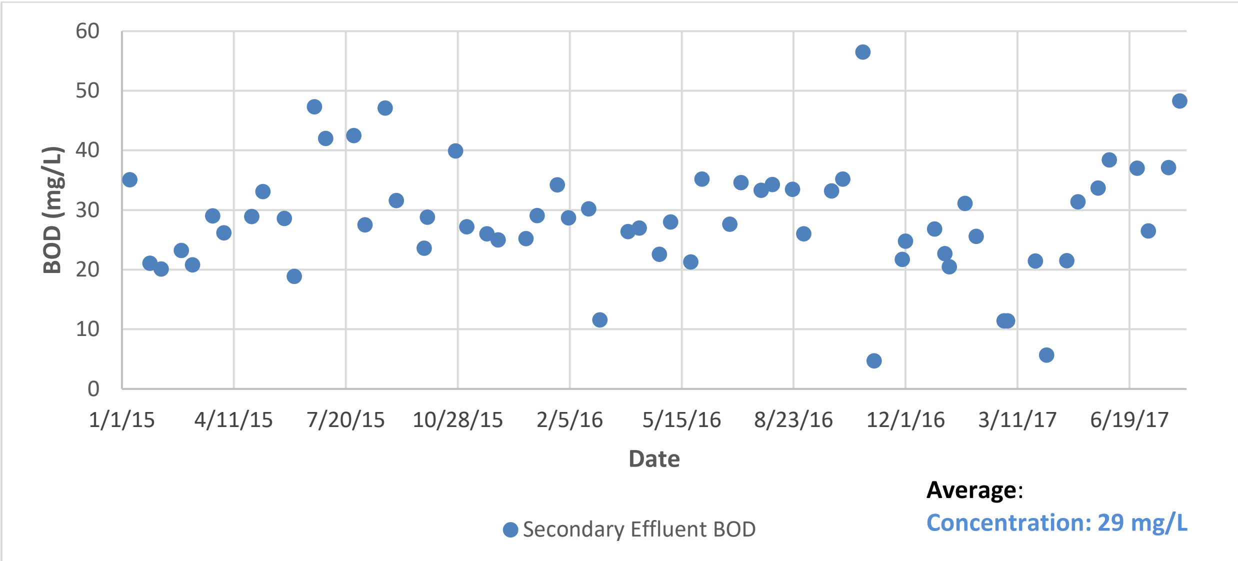

Figure 8. Secondary Effluent BOD

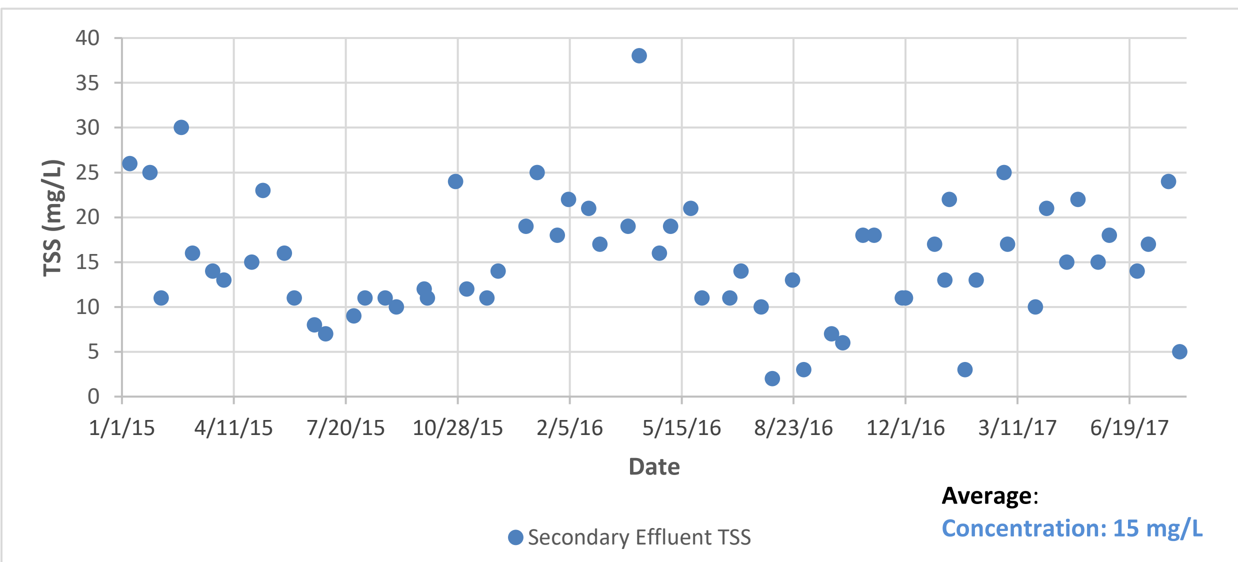

Figure 9. Secondary Effluent TSS

5.5 Chlorine Disinfection

5.5.1 Chlorine Disinfection Facilities

Due to its remote location and limited accessibility, Huston Creek WWTP utilizes Micro-Chlor® on-site generation equipment to generate chlorine disinfectant from sodium chloride. After the dosing point, effluent flows through a 44,734 gallon concrete serpentine chlorine contact basin, which provides approximately 30 minutes of detention time at average-day flow. While this detention time is less than regulatory limits, chlorine contact and residual are regulated at the District's combined effluent discharge point at the Las Flores Ranch. Since the outfall pipeline is over 11 miles long, sufficient chlorine contact time is accomplished prior to the regulatory point.

5.5.2 Chlorine Disinfection Performance

Table 8 summarizes the Huston Creek WWTP chlorine contact disinfection operational parameters.

Table 8. Chlorine Contact Disinfection Operational Parameters

Parameter	Units	Huston Creek Operation
Number of Tanks Online	#	1 of 1
Total Volume	gal	44734
Hydraulic Retention Time	min	186
Chlorine Dose	mg/L	23
Chlorine Residual	mg/L	17

The chlorine dose is very conservative (high) compared to most facilities and is likely due to the fact that residual needs to carry all the way to the District's effluent disposal site at Las Flores Ranch.

5.6 Sludge Thickening and Dewatering

5.6.1 Sludge Thickening and Dewatering Facilities

Primary sludge is wasted to an above-grade, steel, cone-bottom gravity thickening tank. All of the District's sludge, as well as septic deliveries are accepted at Huston Creek WWTP for sludge thickening and dewatering. Once a week, sludge is drawn off the bottom of the gravity thickener and fed to a single 1.5 m belt press for dewatering. Polymer is added to the feed sludge to improve dewatering performance. Dewatered sludge is discharged onto a belt conveyor which is used to load trucks which haul the dewatered sludge to a disposal facility.

It should be noted that no sludge digestion or treatment is performed at any of the District's facilities. If sludge digestion and treatment is performed, more disposal facilities may be available to the District as opposed to relying on a single facility.

5.6.2 Sludge Thickening and Dewatering Performance

Table 9 summarizes the Huston Creek WWTP sludge thickening and dewatering operational parameters.

Table 9. Sludge Thickening and Dewatering Operational Parameters

Parameter	Units	Huston Creek Operation	Metcalf & Eddy Typical Range
Feed Sludge	%	3.7	3-6
Loading per Meter of Belt Press	gal/hr	3108	2378-7133
Dry Polymer	lb/dry ton	19	6-14
Cake Solids	%	32	16-30
Dry Solids Produced	dry tons/yr	220	-

Sludge Thickening and dewatering performance at the Huston Creek WWTP is effective and within typical industry ranges. In particular, the facility produces very high cake solids percentage, which helps minimize hauling costs. Sludge dewatering performance does vary week-to-week depending on the quantity and nature of septic deliveries, however, overall performance is good and reliable.

5.7 Plant Effluent

Final plant effluent discharges into the District's outfall pipeline, which conveys effluent to the District's disposal site at the Las Flores Ranch. The District is regulated on effluent flow and BOD. The District's plant effluent, regulatory limits, and violations since January 2015 are summarized in Table 10.

Table 10. Huston Creek Plant Effluent Summary

Parameter	Units	Huston Creek Operation	Regulatory Limit	Number of Discharge Violations
Plant Effluent Flow (avg.)	MGD	0.347	0.7	17
Plant Effluent Flow (peak)	MGD	0.578	2.5	0
Plant Effluent BOD (avg.)	mg/L	18.6	30	0
Plant Effluent BOD (peak)	mg/L	27.0	45	0
Plant Effluent TSS (avg.)	mg/L	16.5	-	-
Plant Effluent TSS (peak)	mg/L	38.0	-	-

The District's regulatory violations that have occurred since January 2015 have been Huston Creek WWTP exceeding 24-hr average effluent flow of the plant's design capacity of 0.7 MGD, which has occurred 17 times. The plant's BOD removal has been consistently in compliance during this time. The hydraulic discharge violations at Huston Creek occurred during heavy rainfall events, which commonly contribute to excessive infiltration and inflow (I/I) into the collection system. These heavy rainfall events are often the most difficult and costly challenges for wastewater agencies to manage.

Plant Effluent Flow, BOD, and TSS are depicted in Figures 10 through 12.

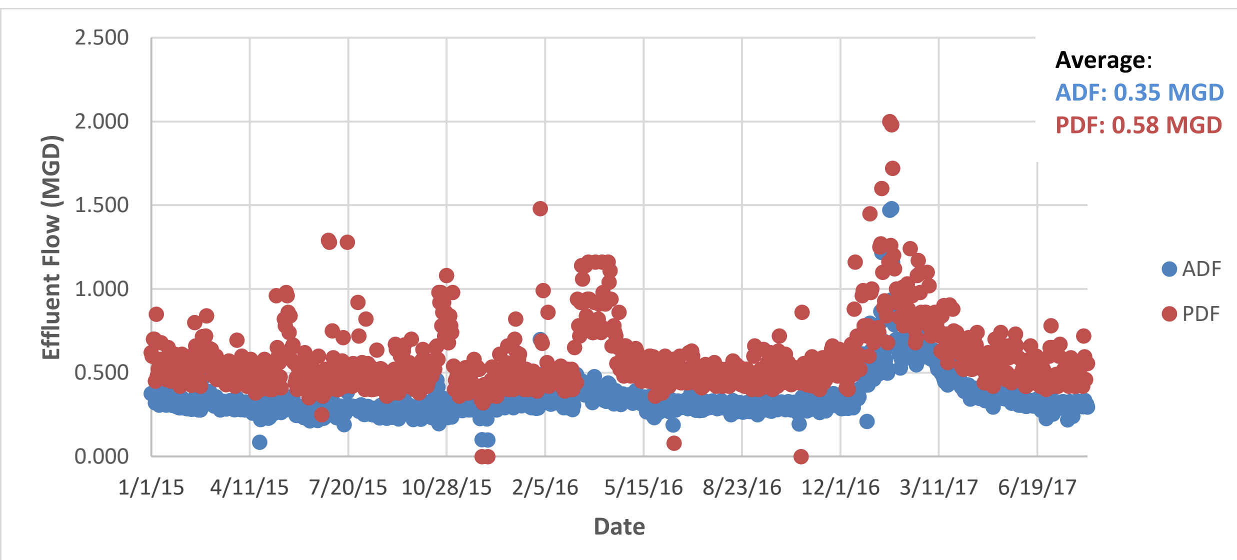

Figure 10. Huston Creek Plant Effluent Flow

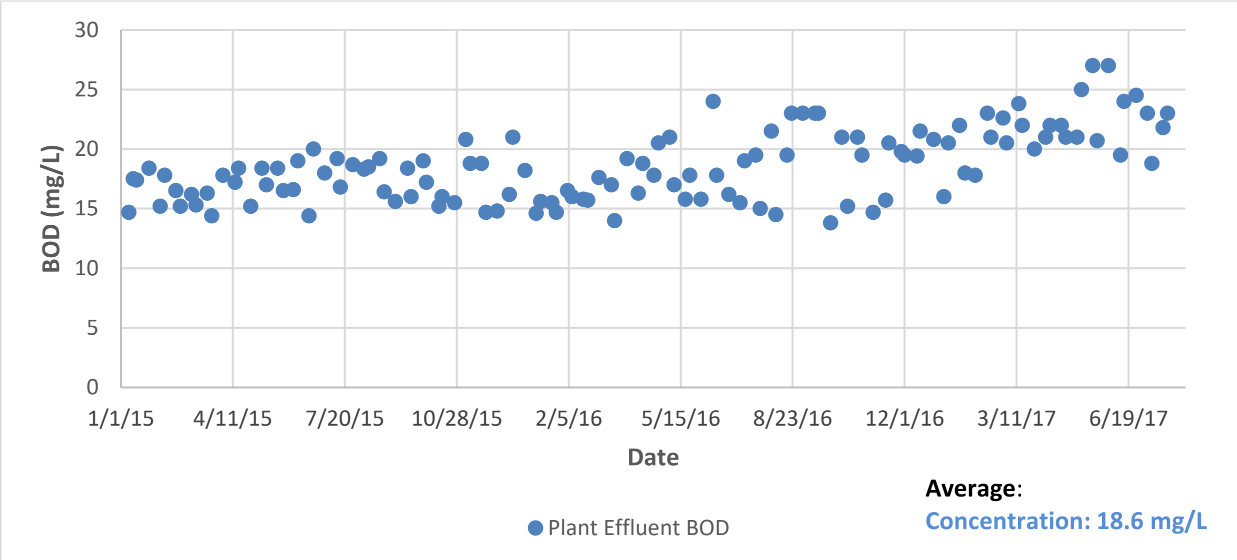

Figure 11. Huston Creek Plant Effluent BOD

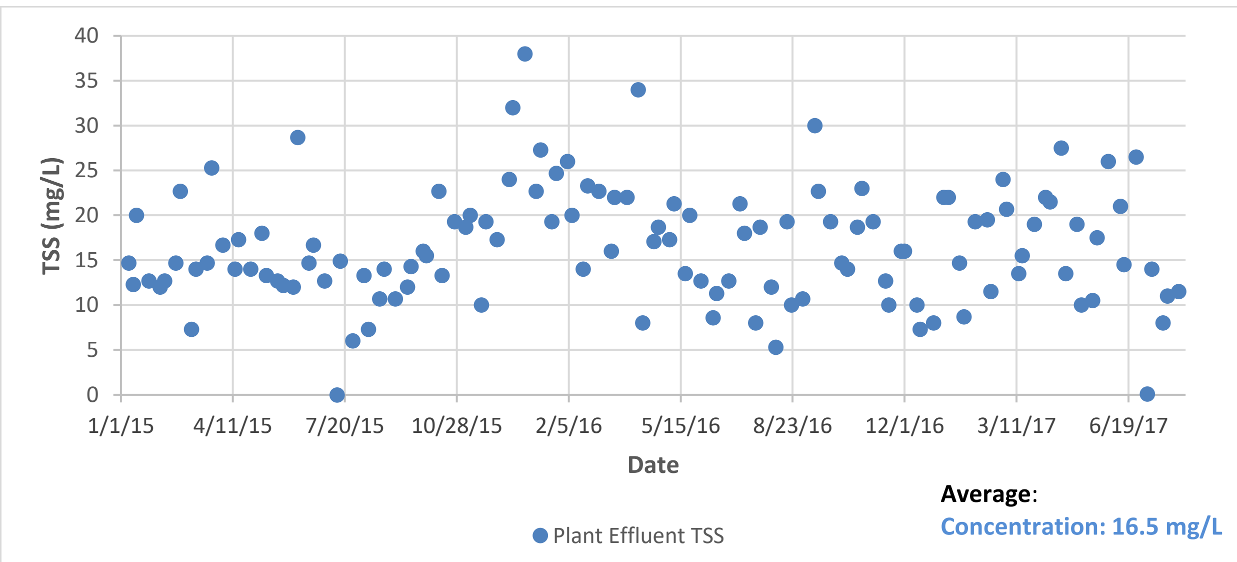

Figure 12. Huston Creek Plant Effluent TSS

Although overall plant effluent BOD concentrations have historically been well below the 30 mg/L average and 45 mg/L peak regulatory limits, average effluent BOD concentrations have risen from an average of 17.2 mg/L in 2015 to 21.7 mg/L in 2017 to-date. This increase in effluent BOD concentration can be visually observed in Figure 11. Although there are not yet regulatory implications, this rising BOD effluent trend should be monitored.

Also unusual is the fact that plant effluent TSS is slightly higher, on average, than secondary effluent TSS. This data discrepancy may be due to different sampling schedules, lab testing procedures, or other factors, however, this trend should be monitored to ensure that TSS is being measured consistently.

6 SEELEY CREEK WWTP

6.1 Influent and Headworks

Seeley Creek influent characteristics are summarized in Table 11.

Table 11. Seeley Creek WWTP Influent Characteristics

Parameter	No. of Data Points	Units	Values			Design Criteria	Metcalf & Eddy Typical Range	Regulatory Limit
			Average	Maximum	Minimum			
Plant Influent								
Total Plant Influent Flow	949	MGD	0.163	0.694	0.040	0.500	-	-
Influent BOD_5	63	mg/L	309	592	106	200	200-400	-
Influent BOD_5	63	lb/d	379	668	97	834	-	-
Influent TSS	63	mg/L	271	675	25	-	195-389	-
Influent TSS	63	lb/d	335	1335	32	-	-	-

Wastewater is characterized as medium-high strength. Average day flow and average day mass loading of BOD do not exceed the plant's design criteria.

6.1.1 Hydraulic Loading

Figure 13 depicts Seeley Creek influent flow data.

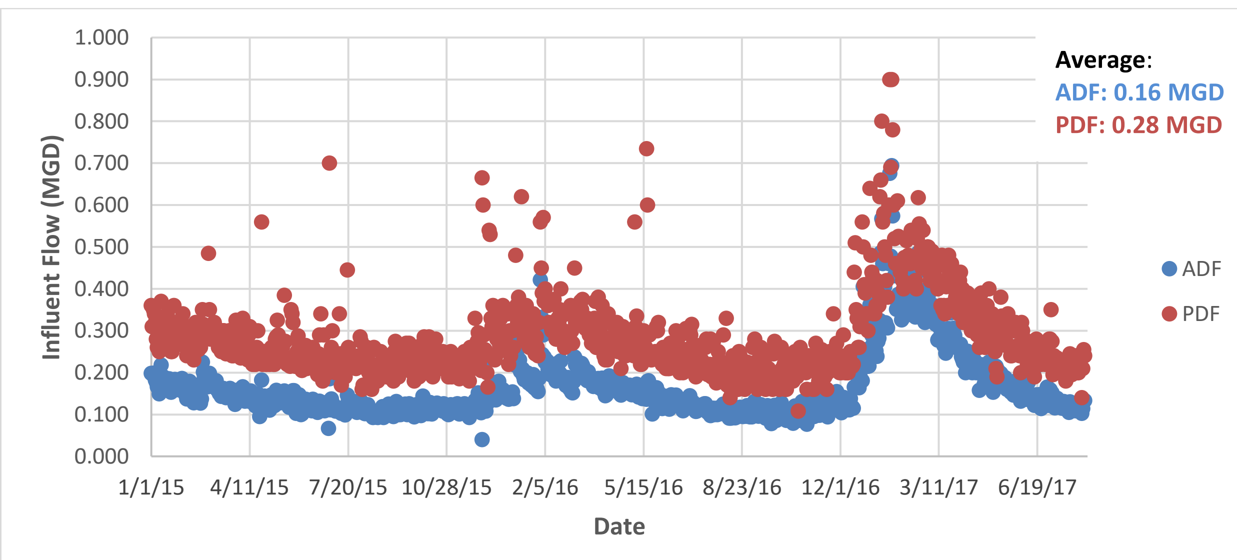

Figure 13. Seeley Creek Influent Flows

Flows to the Seeley Creek WWTP exhibit more seasonal fluctuation than what is seen at the Huston Creek WWTP overall. However, influent flows have still stayed relatively consistent with observed seasonal fluctuation (higher flows in the winter, lower flows in the summer). The major spike corresponds with the rainfall-heavy winter between December 2016 and March 2017. Like at Huston Creek WWTP, the data suggests that Infiltration and Inflow (I/I) is still an issue in the collection system, and is contributing hydraulic loading to the plant in excess of its design capacity.

6.1.2 BOD and TSS Loading

Similar to the Huston Creek WWTP, BOD and TSS is sampled and measured infrequently compared to influent flow. Influent BOD and TSS loading are presented in Figures 14 and 15, respectively.

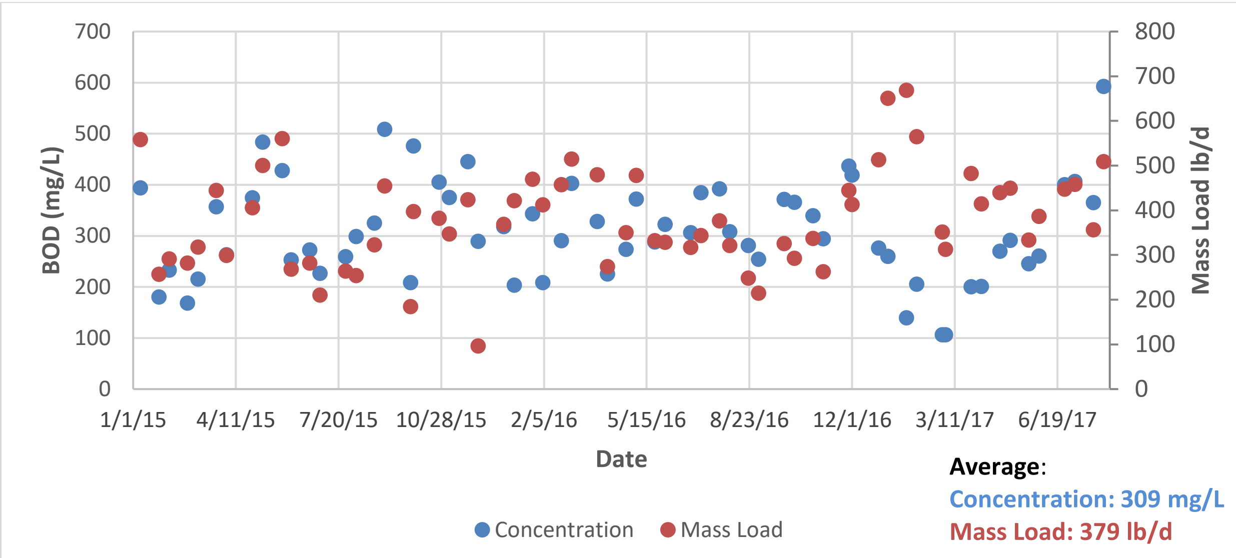

Figure 14. Seeley Creek Influent BOD

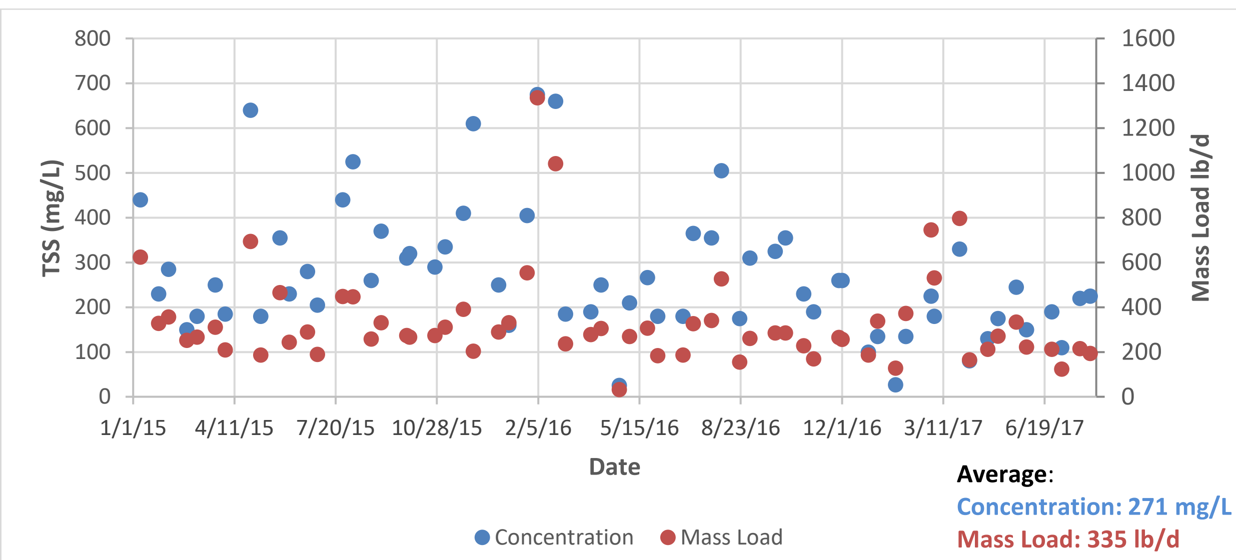

Figure 15. Seeley Creek Influent TSS

Similar to the Huston Creek WWTP, the data is less consistent than flow data, which is likely a result of infrequent sampling as well as a small sample size. BOD loading to the plant in terms of concentration (mg/L) is higher than the plant design criteria of 200 mg/L, however, BOD mass load (lb/d) does not exceed the plant design capacity. This is due to the fact that average hydraulic flows to the plant are substantially lower than the capacity of the plant.

TSS is sampled at the same frequency as BOD, and displays similar variability in the data. No design criteria for TSS was defined in Record Drawings for the facility, and the District is not regulated on effluent TSS.

6.1.3 Other Constituents

Like the Huston Creek WWTP, Seeley Creek WWTP is not regulated on effluent nitrogen, and therefore, Influent Total Kjeldahl Nitrogen (TKN) and Ammonia are not measured by the District. Influent dissolved sulfide is also not measured by the District. At this time there is no indication that dissolved sulfide has impacted the biological treatment process.

6.1.4 Headworks Facilities

Seeley Creek WWTP influent enters the facility via a 15-inch sewer main. A Wye with valves on the influent sewer allows operations staff to divert influent flow in one of two directions: 1) to a manual bar screen and subsequent 100,000 gal influent equalization basin; and 2) to a second manual bar screen followed by a "Muffin Monster" comminutor.

The influent equalization basin is typically not used, unless in the event that the effluent outfall pipeline fails, as it is the only form of emergency storage at the treatment plant.

6.2 Primary Treatment

6.2.1 Primary Treatment Facilities

Seeley Creek WWTP primary treatment consists of a single primary clarifier (see image right). The primary clarifier was originally constructed as a packaged activated sludge treatment plant, including an aeration zone, settling zone, chlorine contact zone, and sludge digester zone. This original plan is shown in Figure 16. The activated sludge unit was later retrofitted into a large primary clarifier, and a trickling filter, secondary clarifier, and chlorine contract basin were constructed at the facility.

Primary effluent is fed by gravity to the downstream trickling filter. Primary sludge is wasted pumped from the primary clarifiers to a sludge holding tank. The sludge holding tank is periodically emptied and the sludge is hauled to Huston Creek WWTP for thickening and dewatering.

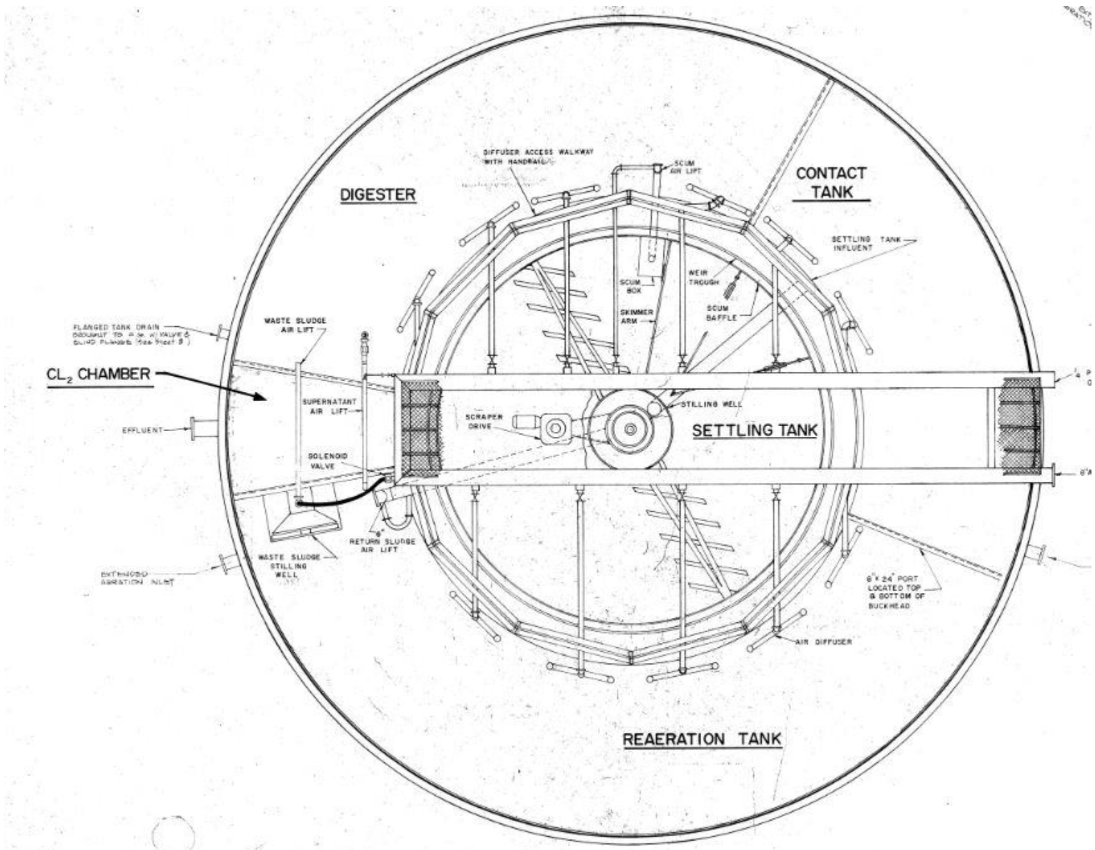

Figure 16. Original Activated Sludge Unit

6.2.2 Primary Treatment Performance

Since the primary clarifier was retrofitted from the original activated sludge unit, the primary clarifier is oversized relative to current and design flow conditions. The Seeley Creek primary clarifier operational parameters are summarized in Table 12. Primary effluent BOD and TSS are shown in Figures 17 and 18, respectively.

Table 12. Primary Treatment Operational Parameters

Parameter	Units	Seeley Creek Operation	Metcalf & Eddy Typical Design	Metcalf & Eddy Typical Range
Number of Clarifiers Online	#	1 of 1	-	-
Detention Time (avg)*	hours	3.2	2	1.5-2.5
Detention Time (peak)*	hours	1.9	-	-
Side Water Depth	ft	12	14	10-16
Surface Overflow Rate (avg)*	gpd/sf	676	1,000	800-1,200
Surface Overflow Rate (peak)*	gpd/sf	1,160	2,500	2,000-3,000
CEPT	yes/no	no	-	-
TSS Removal	%	89	63	45-65
BOD Removal	%	86	40	20-40
Primary Sludge Thickness	%TS	2.81	3	-
* Includes Trickling Filter Recirculation Flow				

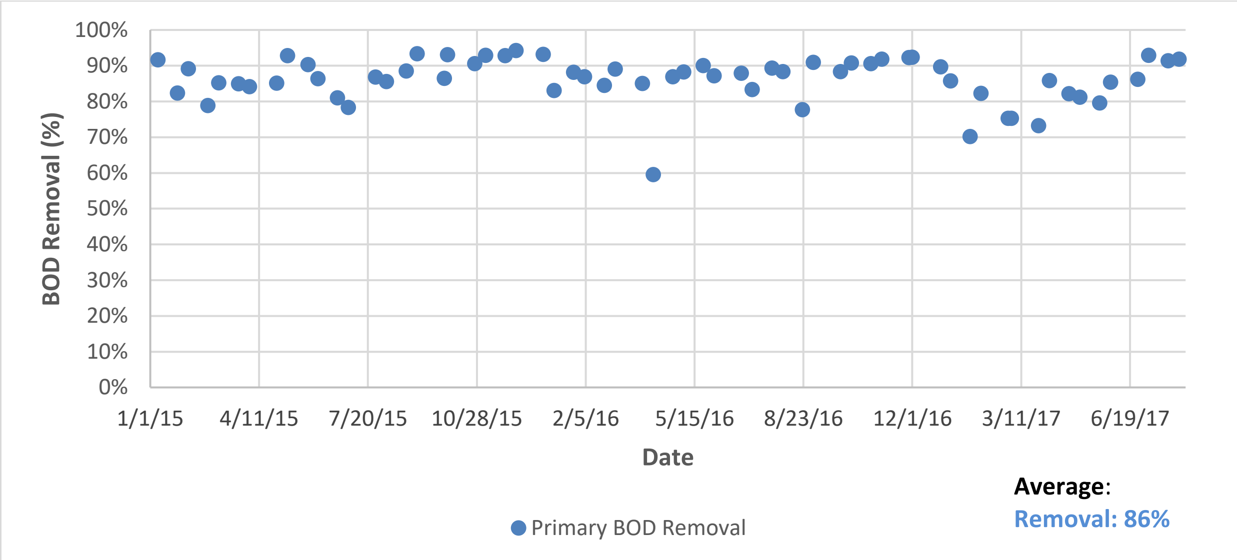

Figure 17. Seeley Creek Primary Effluent BOD

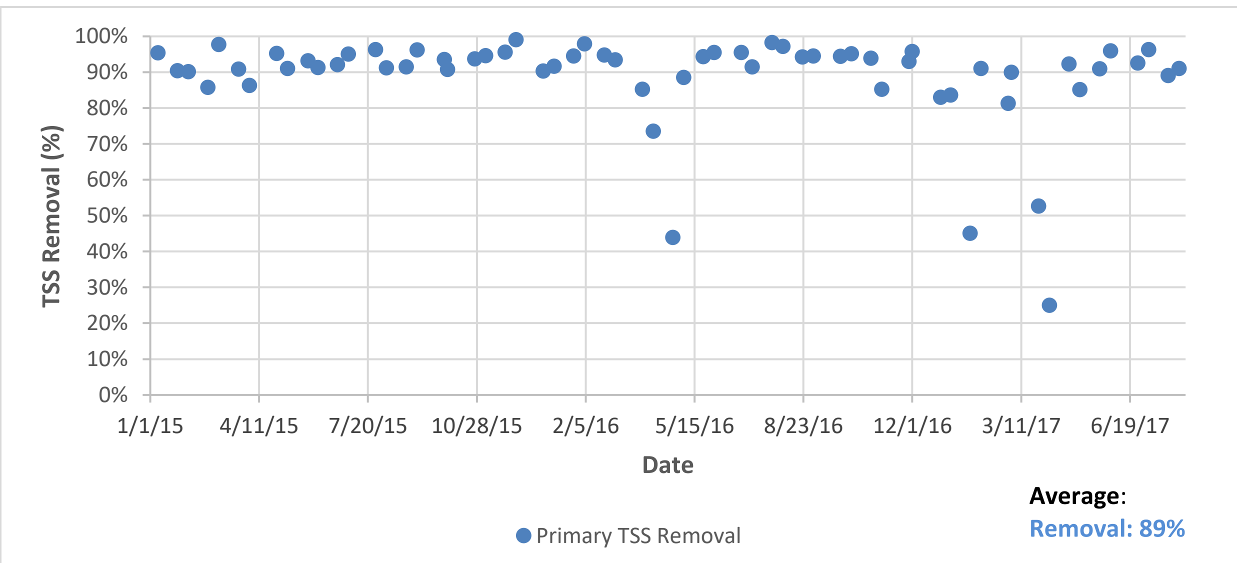

Figure 18. Seeley Creek Primary Effluent TSS

The data show that primary BOD and TSS removal is extremely high relative to typical ranges. This is likely a product of

a) Trickling Filter recirculation flow is returned to the primary influent. This will skew primary effluent water quality measurements due to the fact that the vast majority of flow through the primary clarifier during the average day is trickling filter recirculation (0.864 MGD recirculation vs. 0.163 MGD ADF).

b) Oversized clarifier resulting in long detention and settling times

Because of these factors, it is difficult to analyze the performance of the primary clarifier. However, there is no indication that primary clarifier performance is deficient.

6.3 Biological Treatment

6.3.1 Biological Treatment Facilities

Seeley Creek WWTP biological treatment consists of a single rotating distributer, high-rate trickling filter unit. The trickling filter was constructed as part of the major plant upgrade in 1984. The unit is circular shaped with plastic media and covered with a steel dome enclosure (see image right). Trickling filter effluent either flows to the secondary clarifier, or is recirculated by a pair of recirculation pumps back into the primary influent.

6.3.2 Biological Treatment Performance

Seeley Creek biological treatment performance is summarized in Table 13.

Table 13. Seeley Creek Biological Treatment Operational Parameters

Parameter	Units	Seeley Creek Operation	Metcalf & Eddy Typical Design	Metcalf & Eddy Typical Range
Number of Trickling Filter Units	#	1 of 1	-	-
Total Media Volume	ft^3	19080	-	-
Hydraulic Loading	gpd/sf	646	-	350-1850
Organic Loading	lb/cf/d	0.0003	-	0.05-0.15
Depth	ft	12	-	8-40
Recirculation Rate	gpm	600	-	-
Recirculation Rate (avg)	% of Q	610%	-	100-200%

In general, hydraulic loading to the trickling filter is within typical ranges, while organic loading is well below typical ranges. The hydraulic loading is a product of a high recirculation rate for this type of trickling filter. The operations staff maintains a high recirculation rate in order to allow enough flow to the trickling filter to rotate the distributer arm and keep the unit operating effectively. If average day flows consistently increase in the future, operations can decrease the recirculation rate to reduce pumping costs and optimize loading to the filter.

6.4 Secondary Clarification

6.4.1 Secondary Clarifier Facilities

Seeley Creek WWTP secondary clarification consists of a single secondary clarifier unit (see image right). This unit was constructed as part of the major plant upgrade in 1984 along with the trickling filter. Unlike Huston Creek WWTP, the secondary clarifier at Seeley Creek WWTP is a traditional secondary clarifier design (i.e. with slow-rotating scraper and skimmer arm).

6.4.2 Secondary Clarifier Performance

Seeley Creek WWTP secondary clarifier operational parameters are summarized in Table 14.

Table 14. Seeley Creek Secondary Clarifier Operational Parameters

Parameter	Units	Seeley Creek Operation	Metcalf & Eddy Typical Design	Metcalf & Eddy Typical Range
Number of Clarifiers Online	#	1 of 1	-	-
Surface Overflow Rate (avg)	gpd/sf	160	700	600-800
Surface Overflow Rate (peak)	gpd/sf	884	1,000	2,000-3,000
Detention Time (avg)	hours	15.7	-	-
Detention Time (peak)	hours	2.8	-	-
Secondary Effluent BOD	mg/L	11	<30	-
Secondary Effluent TSS	mg/L	5	-	-

The secondary process (trickling filter + secondary clarifier) produces a very high effluent quality relative to other similar trickling filter facilities according to the data. However, as will be discussed, the final plant effluent concentrations of BOD are higher than the secondary effluent BOD, which is highly unusual. After discussions with operations staff, this discrepancy could be due to the fact that in-house lab measurements of secondary effluent BOD are not as accurate as the outsourced lab measurements of BOD for plant effluent. TSS removal in the secondary process is very good, indicating the trickling filter and secondary clarifier in tandem are performing above industry expectations for suspended solids removal.

Secondary effluent BOD and TSS are depicted in Figures 19 and 20.

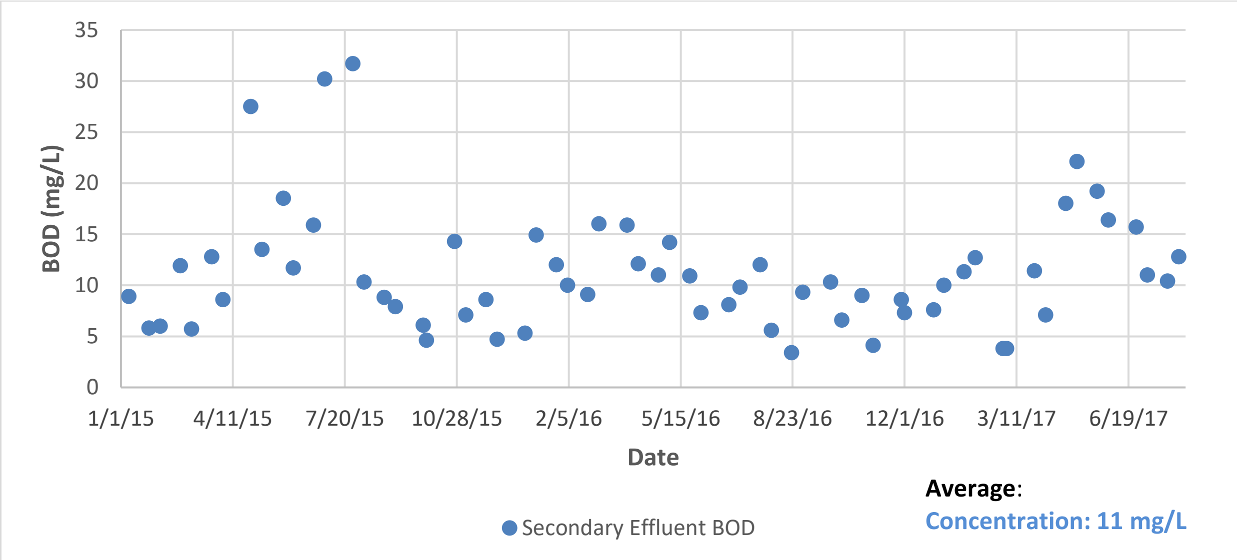

Figure 19. Seeley Creek Secondary Effluent BOD

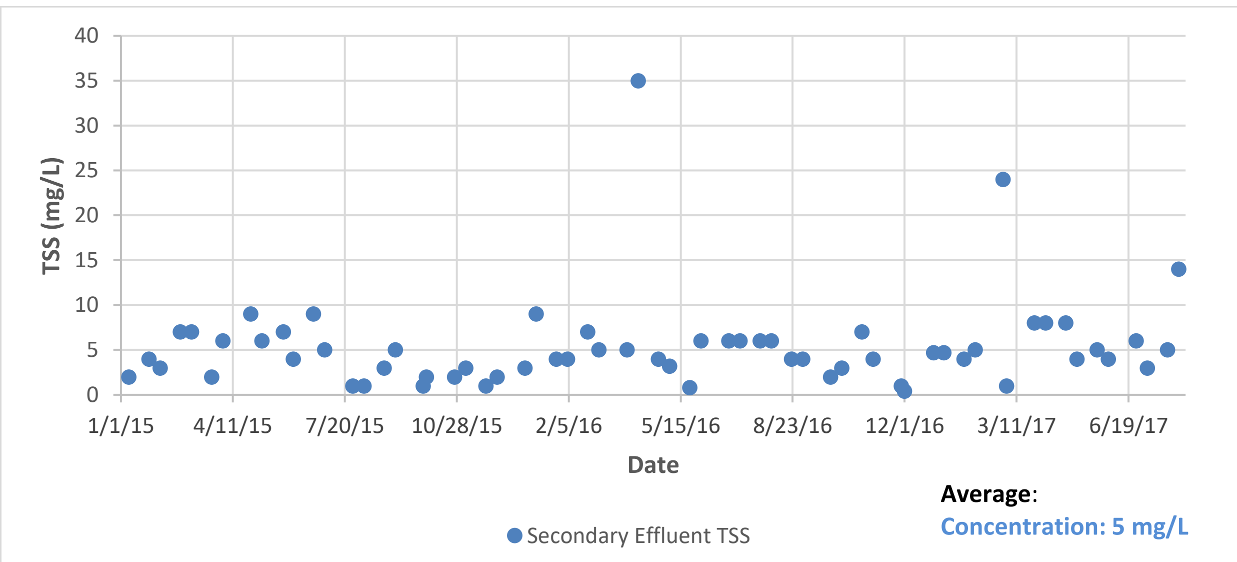

Figure 20. Seeley Creek Secondary Effluent TSS

6.5 Disinfection

6.5.1 Chlorine Disinfection Facilities

As is the case with Huston Creek WWTP, Seeley Creek WWTP utilizes Micro-Chlor® on-site generation equipment to generate chlorine disinfectant from sodium chloride. After the dosing point, effluent flows through a 20,833 gallon concrete serpentine chlorine contact basin.

6.5.2 Chlorine Disinfection Performance

Table 15 summarizes the Seeley Creek WWTP chlorine contact disinfection operational parameters.

Table 15. Seeley Creek Chlorine Contact Operational Parameters

Parameter	Units	Seeley Creek Operation
Number of Tanks Online	#	1 of 1
Total Volume	gal	20833
Hydraulic Retention Time (avg)	min	184
Chlorine Dose	mg/L	30
Chlorine Residual	mg/L	9

Like Huston Creek, the chlorine dose is very conservative (high) compared to most facilities, and is likely due to the fact that residual needs to carry all the way to the District's effluent disposal site at Las Flores Ranch.

6.6 Plant Effluent

Like all of the District's treatment facilities, final plant effluent discharges into the District's outfall pipeline. The District is regulated on effluent flow and BOD. Unlike the other treatment facilities, Seeley Creek does not have an effluent flow meter. Therefore, flow measurement is reported from the influent flow data as opposed to the effluent. This is not a preferred arrangement, due to the fact that effluent flow is consistently lower and more equalized than influent flow. By not measuring plant effluent flow, the District is incurring additional regulatory risk that may occur during peak flow events. The District's plant effluent (flow reported as influent), regulatory limits, and violations since January 2015 are summarized in Table 16.

Table 16. Seeley Creek Plant Effluent Summary

Parameter	Units	Seeley Creek Operation	Regulatory Limit	Number of Discharge Violations
Plant Effluent Flow (avg)	MGD	0.163	0.5	0
Plant Effluent Flow (peak)	MGD	0.900	1.0	0
Plant Effluent BOD (avg)	mg/L	17.5	30	0
Plant Effluent BOD (peak)	mg/L	25.5	45	0
Plant Effluent TSS (avg)	mg/L	2.5	-	-
Plant Effluent TSS (peak)	mg/L	11.0	-	-

The District's has not had any regulatory violations that have occurred since January 2015 at the Huston Creek WWTP due to hydraulic flow or BOD. The plant appears most vulnerable to hydraulic discharge violations at Seeley Creek during heavy rainfall events.

Plant effluent BOD and TSS are depicted in Figures 21and 22, respectively.

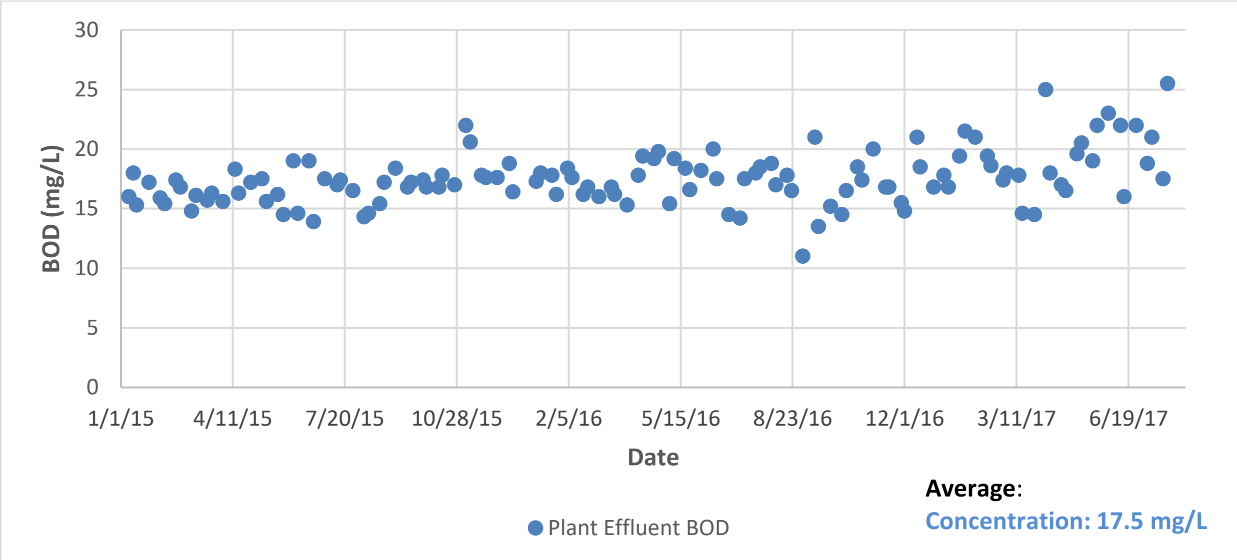

Figure 21. Seeley Creek Plant Effluent BOD

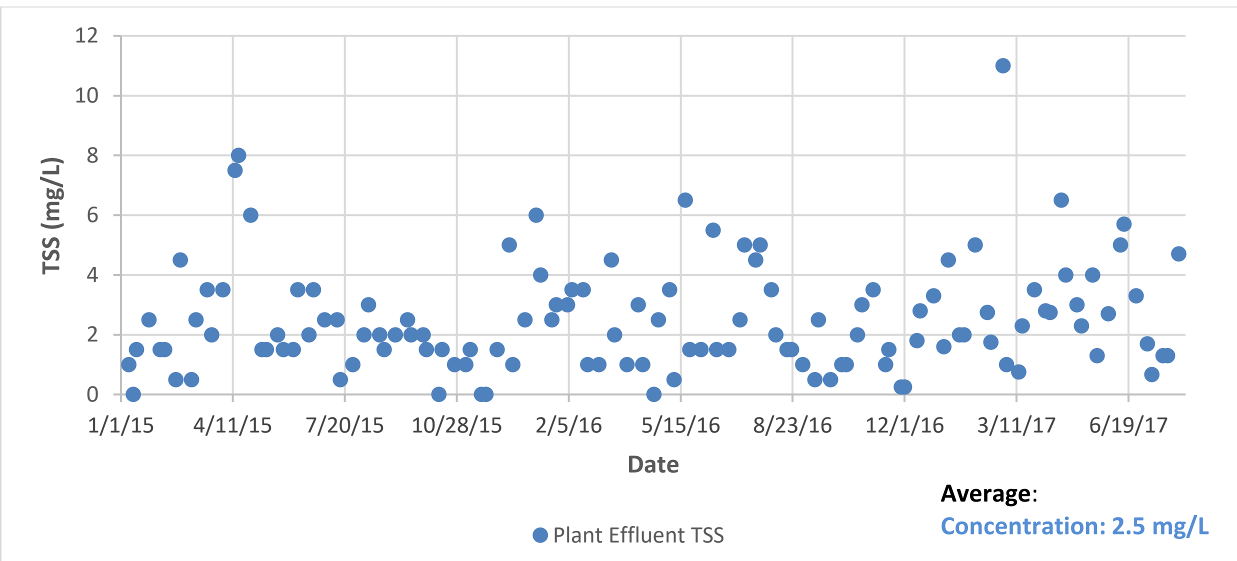

Figure 22. Seeley Creek Plant Effluent TSS

Like Huston Creek WWTP, average effluent BOD concentrations have risen slightly from an average of 16.8 mg/L in 2015 to 19.3 mg/L in 2017 to-date. This increase in effluent BOD concentration can be visually observed in Figure 21. Although there are not yet regulatory implications, this rising BOD effluent trend should be monitored.

It is also unusual that plant effluent BOD is higher, on average, than secondary effluent BOD (17.5 mg/L vs. 11 mg/L). This data discrepancy may be due to different sampling schedules, lab testing procedures, or other factors. These discrepancies are a trend among the District’s treatment facilities, and should be explored to determine the cause to improve data reliability.

7 CLEGHORN WWTP

7.1 Influent and Headworks

Cleghorn WWTP influent characteristics are summarized in Table 17.

Table 17. Cleghorn Influent Characteristics

Parameter	No. of Data Points	Units	Values			Design Criteria	Metcalf & Eddy Typical Range	Regulatory Limit
			Average	Maximum	Minimum			
Plant Influent								
Total Plant Influent Flow	-	MGD	-	-	-	0.200	-	-
Influent BOD_5	63	mg/L	289	776	40	200	200-400	-
Influent BOD_5	63	lb/d	12.6	78.9	1.0	-	-	-
Influent TSS	63	mg/L	227	1220	5	-	195-389	-
Influent TSS	63	lb/d	9	50	0	-	-	-

7.1.1 *Hydraulic Loading*

Influent flow at Cleghorn is not currently measured. The only flow meter for the plant is at the plant discharge. Therefore, there is no data from which to evaluate the influent and headworks structures for peak wet weather hydraulic loads.

7.1.2 *BOD and TSS Loading*

Influent BOD and TSS loading are presented in Figures 23 and 24, respectively.

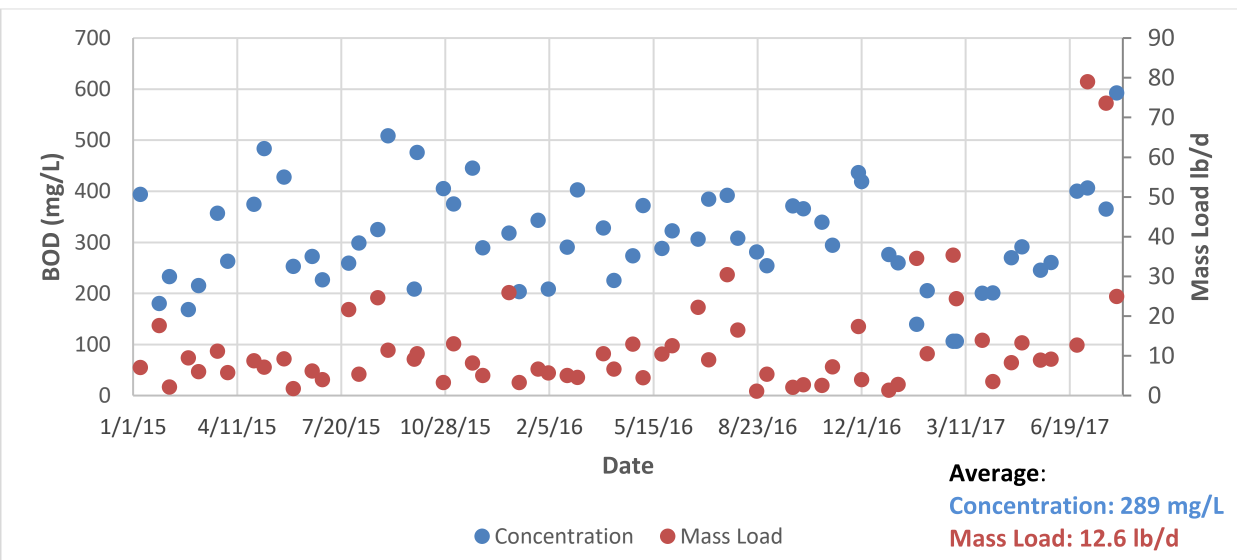

Figure 23. Cleghorn Influent BOD Loading

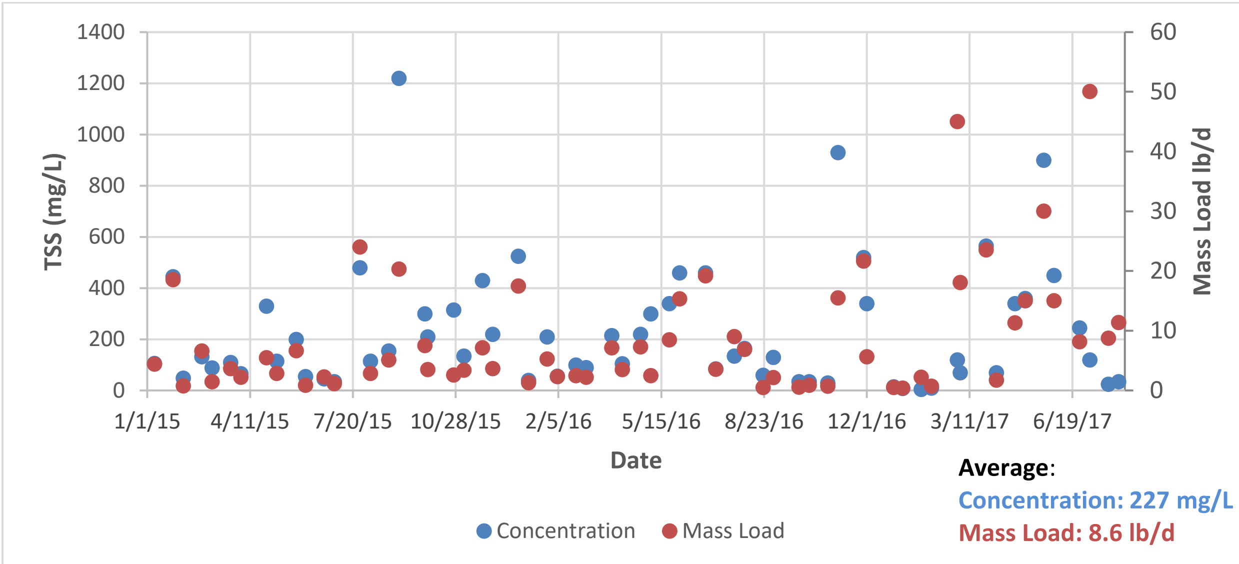

Figure 24. Cleghorn Influent TSS Loading

Although influent flow is not measured, influent BOD and TSS concentrations are sampled. Influent mass load is estimated based on the effluent flow data available.

Cleghorn WWTP is a unique plant compared to the District's other facilities. Cleghorn treats wastewater generated at the State of California Silverwood Lake Park, which is not open year-round, and is most popular during the summer. During the summer, plant flows will typically spike on the weekends and drop during the week. This is a challenge for wastewater treatment facilities which rely on sustaining a biological population to achieve treatment goals.

7.1.3 Other Constituents

Like the District's other treatment plants, Cleghorn WWTP is not regulated on effluent nitrogen, and therefore, influent Total Kjeldahl Nitrogen (TKN) and Ammonia are not measured by the District. Influent dissolved sulfide is also not measured by the District. At this time there is no indication that dissolved sulfide has impacted the biological treatment process.

7.1.4 Headworks Facilities

The Cleghorn WWTP influent enters the facility via an 8-inch sewer main. Influent flows through a manual bar screen and a "Muffin Monster" comminutor before entering the oxidation ditch. The District has expressed concern that their influent channels are not large enough to contain peak wet weather flow events. Field investigation and hydraulic calculations may be done in the future to determine the flow capacity of the influent channels.

7.2 Biological Treatment

7.2.1 Biological Treatment Facilities

Cleghorn WWTP biological treatment consists of a single oxidation ditch with a single brush aerator. Oxidation ditches are a common design for the extended aeration activated sludge treatment process. The oxidation ditch was constructed as part of the original plant construction in 1972. Mixed liquor is sent to the secondary clarifier, and return activated sludge is pumped back to the oxidation ditch.

7.2.2 Biological Treatment Performance

Cleghorn WWTP biological treatment performance is summarized in Table 18.

Table 18. Cleghorn Biological Treatment Operational Parameters

Parameter	Units	Cleghorn Operation	Metcalf & Eddy Typical Design	Metcalf & Eddy Typical Range
Number of Oxidation Ditch Units	#	1 of 1	-	-
Total Ditch Volume	ft^3	53779	-	-
HRT (avg)	hrs	991	-	15-30
HRT (peak)	hrs	56	-	15-30
SRT	days	182	-	15-30
MLSS	mg/L	3847	-	3000-5000
RAS Rate	% of ADF	306	-	50-75
WAS Rate	% of ADF	0	-	-
RAS Concentration	mg/L	9,600	-	6000-12000
DO	mg/L		-	1.5-2.0

As can be seen in the data, operation of the oxidation ditch is highly unusual. Most notably, the District does not waste activated sludge except for bi-annually using a vacuum pumping truck to clear solids from the secondary clarifier. Overall, the HRT and SRT in the ditch are astronomically high compared to typical facility operation, which means there is significant room for optimization.

Complicating operation of the oxidation ditch is the seasonal and weekly flow variance in addition to a non-existent base flow to the plant. Upgrades to the facility to accommodate these challenges is key.

7.3 Secondary Clarification

7.3.1 Secondary Clarifier Facilities

Cleghorn WWTP secondary clarification consists of a single secondary clarifier unit. This unit was constructed as part of the original plant construction in 1972. Like Seeley Creek WWTP, the secondary clarifier at Seeley Creek WWTP is a traditional secondary clarifier design (i.e. with slow-rotating scraper and skimmer arm).

7.3.2 Secondary Clarifier Performance

Cleghorn WWTP secondary clarifier performance is summarized in Table 19.

Table 19. Cleghorn Secondary Clarifiers Operational Parameters

Parameter	Units	Cleghorn Operation	Metcalf & Eddy Typical Design	Metcalf & Eddy Typical Range
Number of Clarifiers online	#	1 of 1	-	-
Surface Overflow Rate (avg)	gpd/sf	26	700	600-800
Surface Overflow Rate (peak)	gpd/sf	453	1,500	2,000-3,000
Detention Time (avg)	hours	70	2	1.5-2.5
Detention Time (peak)	hours	4	-	-
Solids Loading Rate	lbs/sf/d	4.5	-	2.4-24
Secondary Effluent BOD	mg/L	14	<30	-
Secondary Effluent TSS	mg/L	38	-	-

The secondary clarifiers produce an adequate effluent quality according to the data. However, similar to Seeley Creek WWTP, the final plant effluent concentrations of BOD is higher than the secondary effluent BOD, which is highly unusual. After discussions with operations staff, this discrepancy could be due to the fact that in-house lab measurements of secondary effluent BOD are not as accurate as the outsourced lab measurements of BOD for plant effluent.

TSS removal in the secondary process had been relatively stable from January 2015 to December 2016. In early 2017 a spike in effluent TSS and disruption of the data occurred at the plant. This is likely due to the heavy rain events that the region occurred during this time. Secondary Effluent BOD and TSS quality appear to be tied to wet weather events, which tend to result in poorer effluent quality.

Secondary Effluent BOD and TSS are depicted in Figures 25 and 26, respectively.

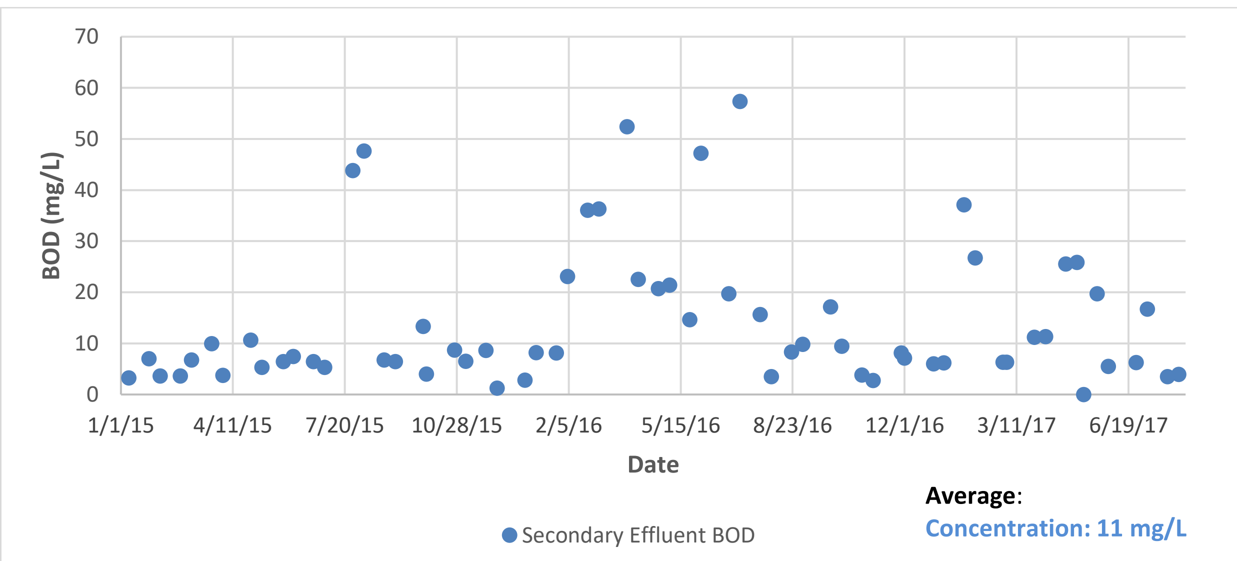

Figure 25. Cleghorn Secondary Effluent BOD

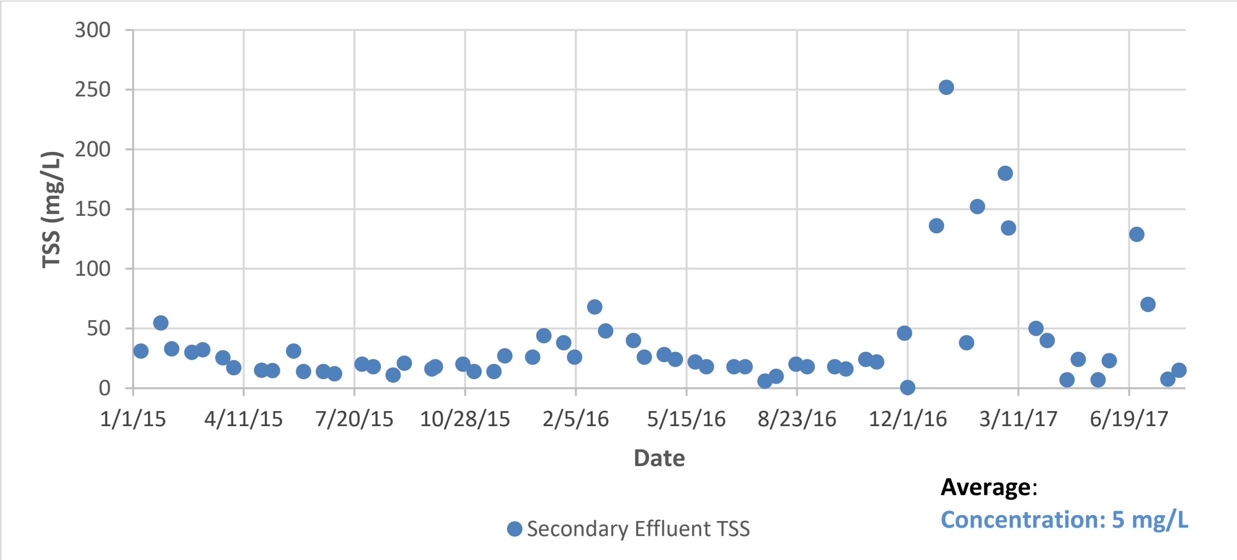

Figure 26. Cleghorn Secondary Effluent TSS

7.4 Disinfection

7.4.1 Chlorine Disinfection Facilities

Like both of the District's other treatment plants, Cleghorn WWTP utilizes Micro-Chlor on-site generation equipment to generate chlorine disinfectant from bags of sodium chloride. After the dosing point, effluent flows through a 4,039 gallon concrete serpentine chlorine contact basin.

7.4.2 Chlorine Disinfection Performance

Cleghorn WWTP Chlorine disinfection operational parameters are summarized in Table 20.

Table 20. Cleghorn Chlorine Disinfection Operational Parameters

Parameter	Units	Cleghorn Operation
Number of Tanks online	#	1 of 1
Total Volume	gal	4039
Hydraulic Retention Time	min	597
Chlorine Dose	mg/L	87
Chlorine Residual	mg/L	9

Because flows are so low, the chlorine dose is very high compared to most facilities. District staff have said that they set the chlorine dose conservatively for what they flows they expect for the day, but there is no way to flow-pace or otherwise optimize chlorine dosing at this time.

7.5 Plant Effluent

Like all of the District's treatment facilities, final plant effluent discharges into the District's outfall pipeline. The District is regulated on Effluent Flow and BOD. Unlike the other treatment facilities, Cleghorn WWTP effluent is pumped in a roughly 2000 foot 6" force main from the treatment plant into the outfall pipeline. The District's plant effluent, regulatory limits, and violations since January 2015 are summarized in Table 21.

Table 21. Cleghorn Plant Effluent Summary

Parameter	Units	Cleghorn Operation	Regulatory Limit	Number of Discharge Violations
Plant Effluent Flow (avg.)	MGD	0.010	0.2	0
Plant Effluent Flow (peak)	MGD	0.425	0.4	2
Plant Effluent BOD (avg.)	mg/L	17.8	30	0
Plant Effluent BOD (peak)	mg/L	28.5	45	0
Plant Effluent TSS (avg.)	mg/L	24.3	-	-
Plant Effluent TSS (peak)	mg/L	130.6	-	-

Cleghorn has had 2 instances of peak flow discharge in excess of design plant capacity of 0.4 MGD, which occurred during the heavy rain events in early 2017. Cleghorn does not have any flow equalization or emergency storage facilities, making it susceptible to peak flow events.

Plant effluent BOD removal is on-par with the District's other facilities. TSS removal is not as effective as the District's other treatment plants, likely due to the lack of primary clarification and the nature of the extended aeration activated sludge process and operation of the plant, which results in long sludge ages and poorer-settling sludge.

Plant effluent flow, BOD, and TSS are depicted in Figures 27 through 29.

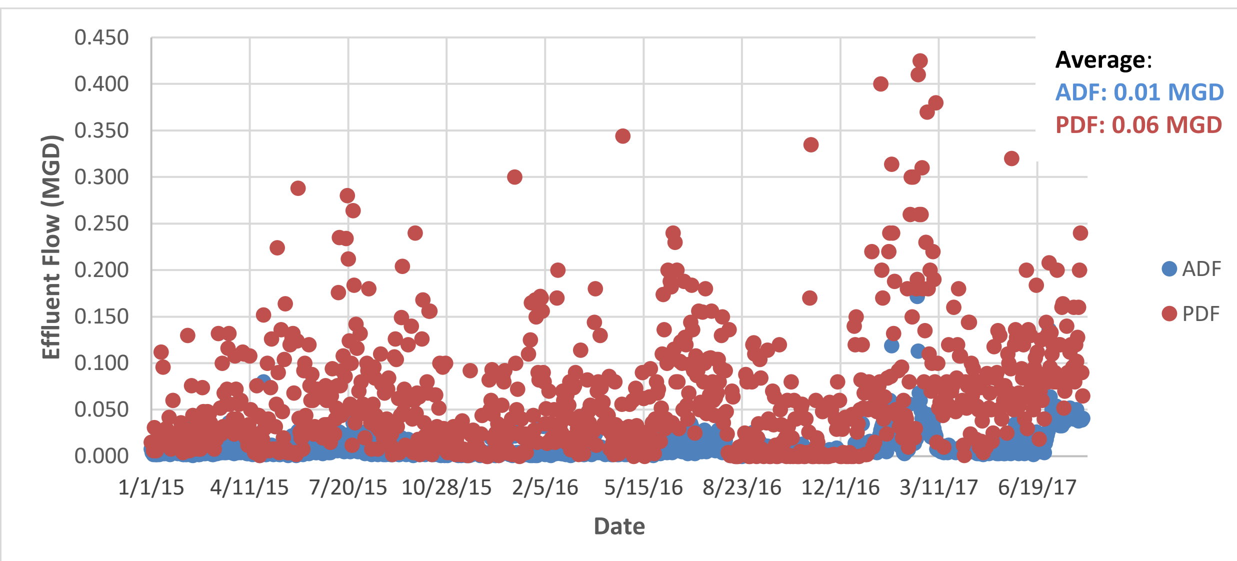

Figure 27. Cleghorn Plant Effluent Flow

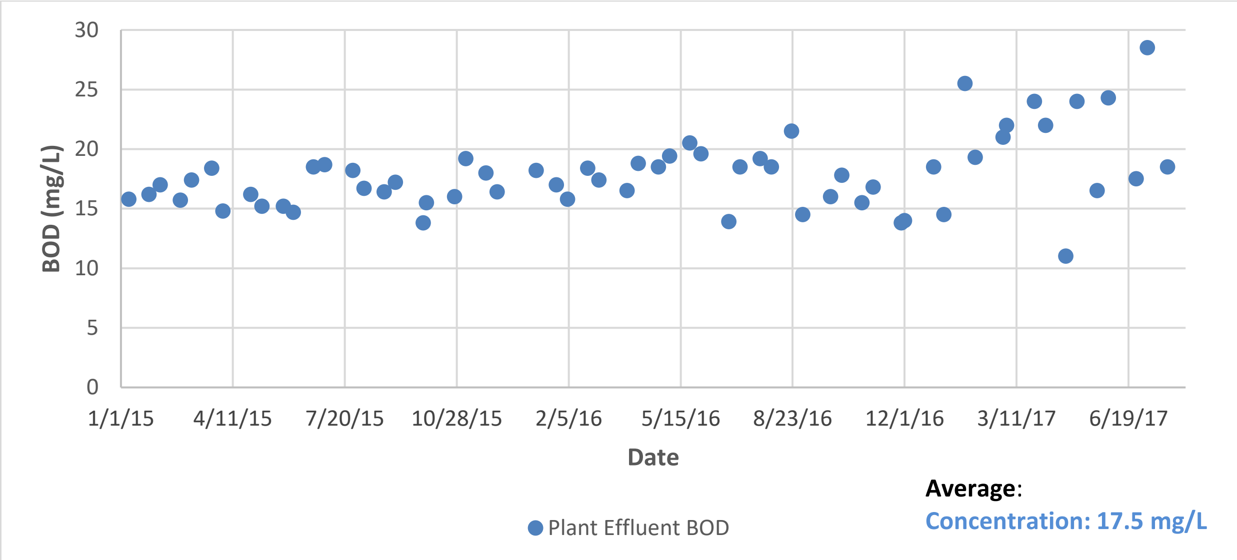

Figure 28. Cleghorn Plant Effluent BOD

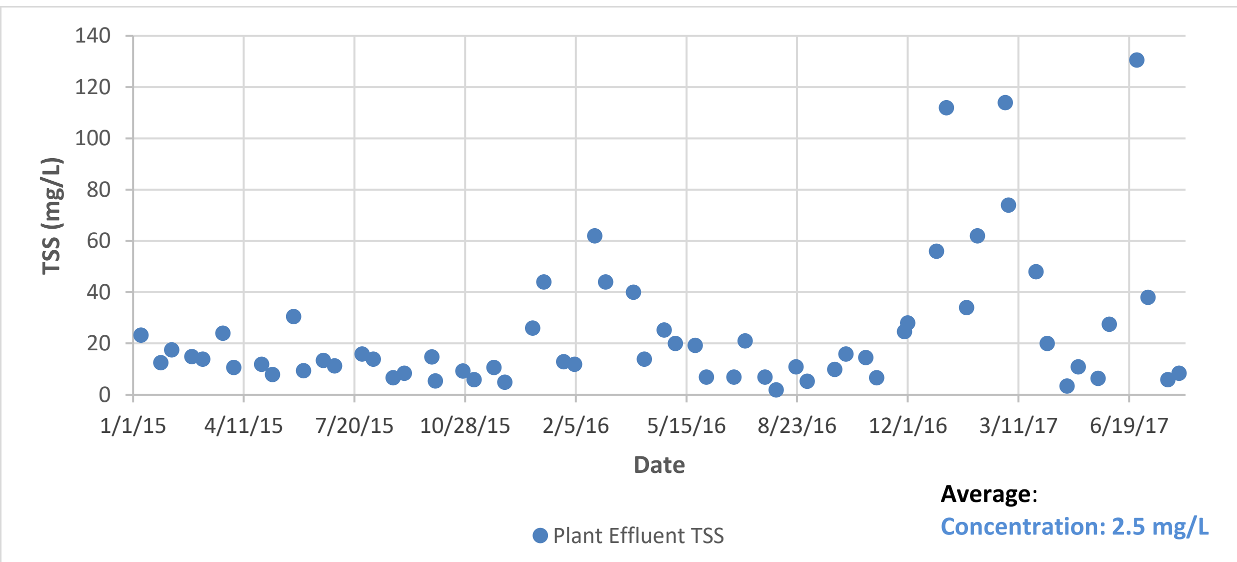

Figure 29. Cleghorn Plant Effluent TSS

The challenges of the Cleghorn WWTP can be observed in Figure 27. Since January 1, 2015, the plant has discharged less than 5,000 gallons 454 times, and discharged greater than 50,000 gallons 14 times. While flow to the plant is typically minimal, the order-of-magnitude of peaking events to the plant is a unique challenge and the District must prepare for the several times a year that the plant will get 5 to 10 times its typical flow.

Similar to the District's other facilities, average effluent BOD concentrations have risen slightly from an average of 16.6 mg/L in 2015 to 20.6 mg/L in 2017 to-date. This increase in effluent BOD concentration can be visually observed in Figure 28. Although there are not yet regulatory implications, this rising BOD effluent trend should be monitored.

It is also unusual that plant effluent BOD is higher, on average, than secondary effluent BOD (17.8 mg/L vs. 14 mg/L). This data discrepancy may be due to different sampling schedules, lab testing procedures, or other factors. These discrepancies are a trend among the District's treatment facilities, and should be explored to determine the cause to improve data reliability.

8 CONCLUSIONS AND RECOMMENDATIONS

The following sections summarize preliminary conclusions and recommendations.

8.1 Huston Creek WWTP

1. Houston Creek WWTP influent BOD loading exceeds the design capacity of the plant. Organic load is primarily treated with the trickling filter, which utilizes an older, less efficient fixed-nozzle design with rock media. The rock media does provide better thermal insulation for the media than a more modern plastic media, and therefore retrofit design conversion to plastic media and alternative distributers is not recommended without covering the filter. It is recommended that a future biological upgrade project considers alternative technology, such as an activated sludge process, in addition to evaluating expansion of trickling filter capacity.
2. Huston Creek WWTP discharge violations since 2015 are all due to exceeding the average day flow limit of 0.7 MGD. Construction of primary influent equalization would help reduce the risk of effluent flow violations, however, there is no space to construct meaningful equalization. It is recommended that the District continue to rehabilitate the collection system in effort to reduce I/I that can exceed the plant hydraulic capacity.
3. Primary clarifiers are at hydraulic capacity during current flow conditions. Primary clarification redundancy is needed for reliability and improved performance. Consider construction of a new redundant primary clarifier.
4. Secondary clarification has no redundancy, and is an unconventional design. Consider construction of a new secondary clarifier for redundancy and capacity in conjunction with a future biological treatment process upgrade.
5. Huston Creek is the District's biosolids thickening, dewatering and hauling hub for all of their facilities. Consider evaluating sludge digestion technologies and alternative disposal options with a cost/benefit analysis to determine if alternate disposal locations and/or digestion may reduce hauling and disposal costs associated with unclassified biosolids.
6. Monitor trend and consider investigating the cause of slowly increasing effluent BOD concentrations since January 2015.

8.2 Seeley Creek WWTP

1. Consider construction of a grit chamber and classifier equipment for grit removal. Grit accumulation in the primary clarifier adds inorganic material to the waste sludge stream and can contribute to wear on primary sludge pumps.
2. Consider construction of an automatic screenings unit in the headworks to reduce operator labor and improve screenings removal.
3. Construct an effluent flow meter for more consistent data monitoring and reporting purposes. An effluent flow meter can also be used to flow-pace chlorine disinfection dose.

4. Current data show that plant effluent BOD is higher on average than secondary effluent BOD. This discrepancy in BOD measurements should be investigated to determine where and how misrepresentative data is being measured.
5. Relatively little emergency storage tank volume (100,000 gallons) is currently available at the Seeley Creek WWTP. Consider lining the downhill pond near the treatment plant for additional emergency storage capacity during peak wet weather flow events, outfall breaks, or other emergency failure scenarios.
6. Monitor trend and consider investigating the cause of slowly increasing effluent BOD concentrations since January 2015.

8.3 Cleghorn WWTP

1. Evaluate influent hydraulics in the headworks channel to determine if overflow conditions exist at peak flow.
2. Consider construction of an influent flow meter. An influent flow meter provides valuable data for operators to calculate loading conditions and adjust operations set points, when applicable.
3. Consider construction of an automatic screenings unit in the headworks to reduce operator labor and improve screenings removal.
4. Consider construction of sludge drying beds or other sludge handling facility to allow for appropriate wasting operation and SRT control in the oxidation ditch.
5. Investigate the discrepancy in BOD measurements that show plant effluent BOD is higher on average than secondary effluent BOD.
6. Monitor trend and consider investigating the cause of slowly increasing effluent BOD concentrations since January 2015.

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APPENDIX B

CoFA Notes and Analysis Tables

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CoFA - Crestline Sanitation District, Huston Creek WWTP

Unit Process / Asset / Failure Mode/Scenario	Consequence of Failure (CoF): Health & Safety 7	Treatment Performance/ Regulatory 5	Economic/ Personnel Resources 5	Public Image 3	Criticality	Probability of Failure (PoF)	Risk Designation	General Notes	Current O&M Mitigation Measures	O&M Recommendations	Capital Project Ideas
Headworks											
Influent Channels								Influent channels function to convey flow through the headworks from the influent sewer . Combines flows from parallel 12" gravity sewer mains.			
Influent channels grating failure	5	1	2	5	65	B	M	Grating anchors and concrete is old and O&M staff feel that there could be a risk to staff safety and grating structural integrity. Staff has stated that there is an ongoing project to address potential safety issues.	Ongoing project to address potential grating failure.	Perform a grating inspection of grating anchors, concrete supporting anchors, and load testing of influent channel grating annually to observe extent of corrosion and structural integrity. Reduce frequency of inspection when grating and/or anchors are replaced. Perform location-specific inspection of grating immediately if structural integrity is questioned by an operator.	Replace all Headworks grating. Rehabilitate supports and/or concrete (currently ongoing).
Influent channels corrosion/structural failure	1	1	1	1	20	A	L	Cracking and degradation of influent channel concrete observed by O&M staff. There are no major structural integrity concerns at this time, but they have not been thoroughly inspected.	Run to fail (Repaired when failure occurs).	Perform a concrete inspection of influent channels in conjunction with grating inspection to observe extent of corrosion and structural integrity. Reduce frequency of inspection if concrete repair is performed. Repair/Rehab concrete and seal cracks when observed.	None.
Screens								Function of the screens is to remove large solids, rags, and other debris larger than 1/4". Screenings consists of a single mechanical 1/4" Bar Screen, as well as two manual bar screens. The Bar Screen discharges screenings to a dumpster.			
Screenings power loss	1	3	1	2	33	C	L	Power loss causes functional failure of screen. Screen blinds, causing a flow backup that results in screenings bypass and raw plant influent flow directly to Primary clarifier no. 1. Cascade effect can lead to damage/failure of primary sludge pumps and/or scraper/mechanism.	Staff notified when loss of power occurs. Operator comes out to check on equipment and pull slide gate to allow for bypass while equipment is down. Mitigation measures and plan in place.	Existing staff mitigation measures are sufficient.	None.
Screenings float failure	1	3	1	2	33	C	L	Hidden failure, no way to know if the switch has failed unless high water occurs and float does not respond. Consequences of failure similar to power loss. No redundancy or backup.	Mitigation plan in place when float is functioning, but if not, no measures in place.	Perform a float switch test to verify float is functioning properly every 6 months.	None.
Screenings rake failure	1	3	3	1	40	E	H	If left unmitigated, bolts would get loose and cause rake failure within 1-2 weeks. Failure has occurred in the past. Treatment consequences the same as power/float failure, however, cost for parts and personnel resources much higher than other screen failure modes.	Mitigation in place to check on and tighten loose bolts every week. Alarm to signify failure of equipment.	Existing staff mitigation measures are appropriate. Recommend performing annual detailed inspection of full screenings unit for wear-and-tear, loose parts, etc. in addition to routine maintenance.	Replace screenings equipment at end of useful life.
Grit Removal								Functions to remove grit from the primary influent. Grit removal consists of one aerated grit chamber. A weir gate at the end of the grit chamber controls flow. Aeration is provided by a blower dedicated to the tank. Grit is discharged into a single grit screw unit for dewatering. Grit is captured in a dumpster.			
Grit blower failure	1	1	1	1	20	C	L	Rotary lobe blower for grit chamber aeration has failed in past (for as long as 2 months or more), but consequences are generally minor. Staff believes that the grit tank is sized such that minimal grit carryover occurs, even if the blower fails.	Oil replacement and routine maintenance.	Minimal maintenance/attention needs to be placed on this piece of equipment, considering the consequences of failure. Recommend run-to-fail operation with oil replacement approximately every 6 months.	None.
Grit motor failure	1	1	1	1	20	C	L	Same consequences as blower failure.	Routine maintenance.	Minimal maintenance/attention needs to be placed on this piece of equipment, considering the consequences of failure. Recommend run-to-fail operation.	None.
Grit screw failure	1	1	3	2	33	A	L	Grit screw is an older piece of equipment. Consequences of failure are same as blower/motor failure, except for parts and labor for repair are significantly higher. Grit screw does not run for a long time so failure has only occurred twice in last 12 years.	Routine maintenance.	Existing staff mitigation measures are sufficient.	Replace grit screw equipment at end of useful life.

CoFA - Crestline Sanitation District, Huston Creek WWTP

Unit Process / Asset / Failure Mode/Scenario	Consequence of Failure (CoF): Health & Safety 7	Treatment Performance/ Regulatory 5	Economic/ Personnel Resources 5	Public Image 3	Criticality	Probability of Failure (PoF)	Risk Designation	General Notes	Current O&M Mitigation Measures	O&M Recommendations	Capital Project Ideas
Influent Flow Meter								Influent Flow Meter consists of a single Parshall Flume which functions to measure influent flow.			
Influent flow meter calibration failure	1	1	1	1	20	A	L	Consequences of failure are minimal. Operations staff are not relying on influent flow data for process adjustments in the plant.	Flow meter is calibrated once per year.	Existing staff mitigation measures are sufficient.	None.
Influent flow meter instrumentation failure	1	1	2	1	25	A	L	Ultrasonic level sensor used for instrumentation. No maintenance is performed on the instrumentation. Failed one time in 8 years. Consequences similar to calibration failure.	None.	Minimal maintenance/attention needs to be placed on this equipment. Recommend run-to-fail operation.	None.
Influent fow meter power surge/outage	1	1	2	1	25	A	L	Power surge/outage happened recently and caused failure of the flow meter. Cost to replace is roughly $1,500.	None.	Minimal maintenance/attention needs to be placed on this equipment. Recommend run-to-fail operation.	None.
Primary Sedimentation											
Primary Clarifiers								Primary Clarifiers function to separate solids, grease, and reduce load on trickling filter. In-house BOD & TSS monitoring. Plant operates two 24 ft diameter (top diameter) circular Primary Clarifiers originally constructed in the late 1950 and later retrofitted in the 1970s. Primary Clarifiers were originally cone-shaped Imhoff-style tanks, so the sides slope in to a 16 ft bottom diameter.			
Primary clarifiers poor BOD removal	1	3	3	2	43	C	M	Not technically a failure mode of Primary Clarifier, but BOD removal can lag TSS removal substantially, especially during the summer. This is a result of BOD solubilizing in the sewer, and passing through the Primaries as a result. This will increase BOD loading to the trickling filter. This is not a result of poor primary performance but a change in the nature of the influent BOD. This could be a factor influencing a trending rise in effluent BOD concentration.	No intentional measures. Sewer cleaning is performed in the spring before summer. Not helping significantly.	Monitor BOD removal through the primaries during the summer and evaluate Trickling Filter performance during times when high soluble BOD carryover impacts the Trickling Filter. Consider solutions to mitigate solubilization of BOD in the sewer, either through more frequent cleaning or chemical addition.	Possible solutions in the collection system, as well as improving treatment/performance of trickling filter. Primary clarifiers will not remove soluble BOD.
Primary clarifiers drive failure	1	4	3	2	48	B	L	Would cause failure of the mechanical sludge removal equipment. Sludge buildup occurs, leading to potential septic conditions and additional solubilization of BOD. Higher carryover of solids. Parts are old, hard to come-by. Not sure what the repair would entail, failure of gearbox has not yet occurred.	Routine maintenance.	Existing staff mitigation measures are sufficient.	Replace clarifier drive at end of useful life.
Primary sludge pump failure	1	2	4	2	43	B	L	Reduced treatment consequences of failure due to pumping redundancy. Two pumps exist and can pump from either clarifier. Depending on the failure, parts can be hard to come by and can be very expensive and difficult to fix, highest economic/personnel resources consequences. Failure would most likely occur with grit/screenings getting through the headworks and damaging the pumps.	Routine maintenance. Pumps are fairly new.	Existing staff mitigation measures are sufficient.	Replace primary sludge pumps at end of useful life.
Primary clarfiers scraper arm failure	2	4	1	2	45	A	L	Catastrophic failure could bend a scraper arm and over torque the failure mechanism. Never happened, but could happen in a storm and when the headworks is bypassed. Consider this in conjunction with a screenings failure.	None.	Due to high treatment/regulatory consequence of failure, recommend pumping down and inspecting each primary clarifier scrapers/mechanical equipment annually to identify wear & tear, broken/damaged scrapers, or other issues.	Replace primary clarifier mechanical equipment at end of useful life.
Primary clarifiers structural failure	3	5	5	5	86	F	E	Most critical concern of operations staff plant-wide, and District-wide. Major ground settling issues have occurred. Hill is being undermined by ground squirrels. Situation is ongoing and is actively compromising the structural integrity of the primary clarifiers. Consequences of failure are catastrophic. Clarifier walls are thin (4" thick), and operations believe catastrophic failure likely to occur in an earthquake (not seismically safe).	Operations staff have addressed ongoing structural/ground settling issues on a case-by-case basis. Have used whatever means necessary to mitigate effects of ongoing failure, but the ongoing issues are persistent.	O&M measures are not sufficient to address ongoing major settling and structural failure of primary clarifiers. Capital project is needed.	Full primary clarifier replacement is likely necessary. May require Primary Screens because of space limitations. Project should address capacity, redundancy, and geotechnical issues. More detailed geotechnical assessment of conditions needed.
Primary clarifiers pipe gallery plugging/valve failure	1	2	2	2	33	B	L	Consequences of failure similar to primary sludge pump failure, except for economic/personnel resources much less.	Routine maintenance.	Existing staff mitigation measures are sufficient.	None.

CoFA - Crestline Sanitation District, Huston Creek WWTP

Unit Process / Asset / Failure Mode/Scenario	Consequence of Failure (CoF): Health & Safety	Treatment Performance/ Regulatory	Economic/ Personnel Resources	Public Image	Criticality	Probability of Failure (PoF)	Risk Designation	General Notes	Current O&M Mitigation Measures	O&M Recommendations	Capital Project Ideas
	7	5	5	3							
Primary clarifiers hydraulic Failure	1	3	1	1	30	D	M	Primary Clarifiers become hydraulically overloaded during belt filter press operation, due to side stream flows returning to the headworks, and resulting in a high hydraulic load to the clarifiers, which was not accounted for in the original clarifier design. This is a major issue during wet weather events.	None.	No direct O&M adjustments could be made to mitigate this failure.	Several projects could address this issue. One - Additional Primary clarifier capacity could be constructed with capacity to accommodate the hydraulic surge. Two - side stream flow could be diverted to the abandoned digester tank for flow equalization and storage, and trickled back through the plant.
Biological Treatment											
Trickling Filter								Trickling Filter is a single rectangular, low-rate, fixed-nozzle trickling filter with coarse rock media constructed in the 1950s. It's designed to remove BOD from the wastewater by allowing for a biological slime layer to form on the filter media.			
Trickling filter nozzle plugging failure	2	4	1	2	45	D	M	Nozzles will plug with rags, grit, or other solids. Staff needs to walk out on the rocks, which can be slick, or icy, to clear the nozzles.	Routine maintenance by cleaning nozzles and flushing end caps.	No additional O&M adjustments could be made to mitigate this failure.	Investigate potential project to replace media and water distribution on the filter to mitigate nozzle plugging risk.
Trickling filter capacity failure	2	3	1	2	40	C	M	During rain, hydraulic backup can occur, causing the "dosing tanks" or primary effluent holding tanks to overflow directly into the trickling filter. This adds a large, undistributed load onto the trickling filter and can cause ponding. Overall, the trickling filter does not perform well hydraulically during peak flow events. Additionally, BOD mass loading may exceed the design capacity of the plant, although design BOD concentration is not clearly defined. Some reports list 200 mg/L design concentration while an O&M manual lists 300 mg/L.	Open end caps, no mitigation for overflow of dose tanks, ponding, etc.	No additional O&M adjustments could be made to mitigate this failure.	Investigate potential project to replace media and water distribution on the filter to improve hydraulic capacity. Consider additional trickling filter capacity.
Trickling filter excessive sloughing/clogging failure	2	4	4	3	63	B	M	Grit, rock degradation, and sloughing contribute to filter clogging and ponding on the filter as a result. Degradation of rock over time will reduce void space in the media and therefore reduce hydraulic capacity, airflow through the filter, and filter performance. This can result in clogging and sloughing of the filter biomass inhibiting performance and BOD removal. Currently, the extent of media degradation is unknown. Media has not been changed since original construction in 1950.	High recirculation rate, digging, clearing of end caps.	No additional O&M adjustments could be made to mitigate this failure.	Investigate potential project to replace media to improve hydraulic capacity, airflow, and mitigate sloughing/clogging risk. Consider additional trickling filter capacity.
Trickling filter cold-weather freezing failure	3	1	1	3	40	D	M	During winter, layer of ice forms on the rock, temperatures can get very low. Nozzles can freeze up. Operators need to walk out on the media to break up ice if it gets bad enough. Slipping/Health/Injury hazard is higher during these conditions.	None, clean nozzles before storm.	No additional O&M adjustments could be made to mitigate this failure.	Consider covering filter to maintain warmer temperatures (like Seeley Creek).
Trickling filter structural failure	2	4	3	2	55	A	L	Weeping occurring, thin (4" thick) walls. Unknown integrity below the rock line. Hidden Failure. No known structural issues observed.	None.	Monitor structural condition for structural defects.	Rehabilitate concrete as-needed with retrofit - consider adding wall thickness and extra structural support.
Trickling filter media degradation failure	1	3	5	4	59	F	H	Media has slowly degraded. "Grit" accumulated is likely degraded rock media. More and more occurring each year. Distribution pipes now showing at the top of media, was not likely the scenario originally.	None.	Take grit samples from recirculation well and have it analyzed relative to the media to determine percentage of media degradation vs influent grit that is accumulating.	Retrofit trickling filter with plastic media.

CoFA - Crestline Sanitation District, Huston Creek WWTP

Unit Process / Asset / Failure Mode/Scenario	Consequence of Failure (CoF): Health & Safety 7	Treatment Performance/ Regulatory 5	Economic/ Personnel Resources 5	Public Image 3	Criticality	Probability of Failure (PoF)	Risk Designation	General Notes	Current O&M Mitigation Measures	O&M Recommendations	Capital Project Ideas
Recirculation Pumping								Recirculation Pumps act to recirculate a portion of trickling filter effluent back into the primary effluent/trickling filter influent. Recirculation allows for additional treatment and BOD removal, as well as sustaining wetting of the filter media and slime layer biomass.			
Recirculation pumping power/control failure	1	3	3	2	43	C	M	New 4-year old VFD. Single VFD runs both pumps at 90% capacity. Primary concern for Operators is loss of power. Happens between 2 and 4 times a year, generally, and often happens during a storm which takes down a line.	Alarm occurs when power loss, no alarm specifically for VFD/individual systems. Observe failure by impact on TF.	Add alarm for individual electrical equipment systems. Don't run pumps 50-50, instead run 60-40 or 70-30.	Consider a second VFD for redundancy.
Reciculation pumping mechanical failure	1	3	3	2	43	B	L	Full pumping redundancy - typically cycling 50-50. Bad seals contribute to losing prime during a power blip.	Routine maintenance. Pumping redundancy. No alarm, visually can see lack of flow to TF.	Replace seals.	None.
Recirculation pumping well grit accumulation	3	3	4	3	65	F	E	Grit has accumulated over time in the recirculation wet well, after years of high flow conditions. Operators unsure about how to clean it out, no clean-out mechanism or easy way to drain the wet well was designed. Would also disrupt all recirculation pumping while cleanout occurs. Ongoing failure could be resulting in damage to volutes and impeller, ruining the pumps and impeller/volute tolerance and contributing significantly to loss of efficiency and increased energy cost.	None.	No additional O&M adjustments could be made to mitigate this failure.	Design improvement to allow for proper maintenance and grit cleanout of the tank.
Secondary Clarifiers								The process consists of a single, cone-shaped "Imhoff-style" secondary clarifier constructed in the 1950s. Secondary Clarifiers settle "sloughing" solids from the trickling filter effluent and waste solids back to the Primary Clarifiers.			
Secondary clarifier safety railing failure	5	1	5	5	80	F	E	Guard railing is on the outside of the tank wall instead of both the inside and outside of the tank wall. Staff have stated that there is an ongoing project to address the safety railing issue.	None.	Buddy system until fix in place.	Install safety railing on inside of clarifier wall for operator safety (ongoing project). Consider second clarifier for redundancy.
Secondary clarifier structural failure of effluent box	3	1	2	3	45	F	H	Structural failure of effluent box is an issue due to the retrofit of the clarifier design. The design was to have the clarifier effluent overflow into the sand bed filter surrounding the clarifier. Now, the effluent is conveyed to the disinfection process, and boxes fill up and create back-pressure on the structure.	Brush twice a week.	Buddy system until fix in place.	Repair structural issues and reinforce box walls.
Secondary Sludge Pumps								A single secondary sludge pump functions to return secondary sludge to the Primary clarifiers to mix with primary influent.			
Secondary sludge pumping mechanical Failure	1	3	2	2	38	C	L	Pump does really well. Trunnion fails once a year or so. Hidden failure occurred in the past when a cap got caught in the check ball, solids built up in the clarifier.	Routine maintenance. Can manually pump out of secondary if pump goes down.	No additional O&M adjustments could be made to mitigate this failure.	None.
Secondary sludge pumping electrical/control failure	2	3	3	2	50	C	M	No VFD, contactor run, and main power feed to the building is an issue. Could be weakest point in the plant electrically. Pump control runs once an hour for 5 min. Issue getting an arc-flash study done, due to an OSHA loophole. Currently only arc-flash risk stickers posted on the panel.	Routine maintenance.	No additional O&M adjustments could be made to mitigate this failure.	Replace power feed to the building.
Secondary sludge pumps Sump pump/drain failure	3	3	2	3	55	C	M	Caused by the trunnion failing. Water would spill into room and drain into sump. Sump drain is a small 3/4" drain line that can be blocked by leaves/debris. When full, water would spill out the door to the room and out past the fence line.	Run sump pump. Clean room occasionally. Trunnion replaced every year.	Regularly inspect sump for leaf/debris accumulation.	Level alarm in the sump. Upsize drain size to mitigate clogging.
Disinfection											
Chlorine Contact Basin								Chlorine contact consists of a dosing tank (called the Old Dosing Tank) which feeds the Chlorine Contact Basin, a serpentine style contact tank with a detention time of approximately 30 minutes. Old dosing tank feeds both the High Pressure Effluent (HPE) for the plant, as well as the contact tank and emergency storage tank.			
Chlorine contact old dosing tank valve failure	2	1	1	2	30	A	L	Valving in place to control where to divert flow. Valve to CCB failure would be a problem.	Exercising Valves.	None required.	None.
Chlorine contact basin structural failure/short circuiting	3	2	3	3	55	F	H	Visible holes exist in the chlorine contact tank walls. Walls were added as masonry block walls later, after original construction. Short circuiting not a critical issue because of contact time in outfall pipe upstream of eventual disposal site. If water recycling on the mountain is pursued, additional contact tank capacity and rehabilitation would be required.	None.	No additional O&M adjustments could be made to mitigate this failure.	Rehabilitate Concrete walls with either concrete/mortar fill, or cedar wood. Consider additional chlorine contact capacity and tank volume.

CoFA - Crestline Sanitation District, Huston Creek WWTP

Unit Process Asset Failure Mode/Scenario	Consequence of Failure (CoF) Health & Safety	Treatment Performance/ Regulatory	Economic/ Personnel Resources	Public Image	Criticality	Probability of Failure (PoF)	Risk Designation	General Notes	Current O&M Mitigation Measures	O&M Recommendations	Capital Project Ideas
	7	5	5	3							
On-site Generation Equipment								Chlorine generation equipment consists of one Micro-Chlor on-site generation unit (1 duty, 5 cells, can run on 4 cells) capable of 200 lb/d chlorine generation. Salt bags are stored at the facility, potable water for mixture with the salt in a 360-gal brine tank. Chlorine is manually dosed, day-to-day operation.			
On-site generation Micro-Chlor skid failure	1	4	4	2	53	E	H	Skid failure can occur under a multitude of points. Includes brine tank. Installed 2012. A failure would occur if left unmitigated within a month. Downtime would be greater than one day. Generated hypochlorite storage is roughly a day to a day and a half worth of chemical.	Order and pick up sodium hypochlorite totes. Routine (frequent) maintenance. Can increase dosing at Seeley to compensate. Exhaustive staff effort, cost. Spare parts where feasible. Keep extra salt on site.	Look into hypochlorite deliveries as primary chlorine supply, with OSG as backup.	Look into more reliable OSG systems. Additional sensors and alarms can be installed to identify system failures, but not mitigate the failures themselves.
On-site generation control/efficiency failure	1	2	4	3	46	F	H	No control. Manual operation, no flow-pacing. Needs instrumentation in order to establish a flow-paced control. Could optimize and save salt, reduce chemical, and reduce salinity significantly. Currently dosing 45 lbs chlorine per day, 15 gal/lb = 675 gallons of water consumed. Could dose as high as 200 lbs at 15 gal/lb = 3000 gallons of water consumed.	None.	No additional O&M adjustments could be made to mitigate this failure.	Install flow-paced instrumentation. Recommend cost/benefit analysis for disinfection to determine preferred low-cost alternative.
Chemical Feed								Two chemical feed pumps dose generated sodium hypochlorite into the old dosing tank for disinfection. Pumps run on VFD and are manually paced with a constant flow rate each day by operators.			
Chlorine dosing pumps failure	1	4	4	2	53	C	M	Controlled by the skid, but separate room and separate process. Two pumps, one redundant. Diaphragm, VFD failures occur.	Redundant pump, routine maintenance, power loss reset. Inspected once a week. Lots of mitigation in place.	Dose at Seeley Creek can be increased to account for loss of chlorine at Huston to an extent, but cannot cover max flow conditions. Consider a shelf-spare dosing pump.	None.
Chlorine dose point efficiency failure	1	2	3	2	38	C	L	Currently, chlorine dose is added straight to the old dose tank. No mixing is installed in the tank. Mixing directly at the point of injection will increase chlorine dispersion and reduce settling, maximizing the effectiveness of the dose.	None.	No additional O&M adjustments could be made to mitigate this failure.	Consider installing a rapid mixer or equivalent mixing system at the dose point in the Old dose tank
Sludge Thickening											
Gravity Thickener								Gravity Thickener functions to settle primary sludge in a tank in order to increase solids percentage in the sludge before it enters the GBT and belt press. Single duty 9,230 gallon steel Gravity Thickener tank functions to settle all of the District's sludge from all three WWTPs as well as septage deliveries.			
Gravity thickener sludge settling failure	2	2	2	2	40	D	M	Corking failure. Happens every summer. Result of sludge going septic in the thickener.	Operations will transfer the first 2,000 to 3,000 gallons, decant the next 7,000 gallons back to headworks, and then transfer the last 1,000 gallons or so of floated sludge.	Consider installing a simple chlorine injection setup in order to keep sludge settled and prevent septicity. Use when needed during the summer. Could be as simple as a bucket with pool tablets and a small metering pump connected to a tap in the primary sludge pipe gallery.	None.
Gravity thickener sludge pump functional failure	2	1	3	2	40	B	L	Single unit. Was replaced 6 years ago. Failed due to ragging twice in 6 years. Electrical needs to be replaced.	None. Run to fail. Can bypass using a primary pump or connect to a tanker.	No additional O&M adjustments could be made to mitigate this failure.	None.
Gravity thickener structural failure	2	3	4	2	55	A	L	Some wall thickness loss has occurred, rehab has been done and tank has been re-coated. Overall tank, while old, seems to be in pretty good condition. O&M not really concerned about its integrity	Weld patch where needed. Have sand blasted and re-coated in the past.	Periodically perform condition assessment/rehab to extend useful life.	None.
Sludge Dewatering											
Belt Filter Press								Single 1.5 m belt filter press. Pressing typically occurs once a week on Tuesday. Function to dewater sludge to approximately 30% solids. No redundancy. Reaching the end of the useful life, good when works, but failing more and more. Installed in '84.			
Sulfide/septic sludge feed to belt press	3	5	5	3	80	F	E	Caused by septic conditions in the gravity thickener. Sulfide corrosion is primarily impacting the electrical equipment and corrosion of conduits is a major issue. H_2S gas can enter the MCC. High H_2S gas levels can result in headache, odor, itchy eyes, and other health and safety concerns, however, staff have stated that H_2S levels have not been a health and safety issue and a sulfide gas monitor and alarm is currently being installed in the building.	Adding peroxide into sludge holding tank and mix overnight to oxidize sulfide. Run chemical scrubber for building ventilation but without chemicals. Staff is currently installing a sulfide monitor and alarm in the building for safety.	Chlorinate primary sludge entering thickener. Prevent septic conditions.	Replace residual sulfide damage to electrical and mechanical equipment, conduits, and components as applicable. Install robust ventilation/odor control system.

CoFA - Crestline Sanitation District, Huston Creek WWTP

Unit Process / Asset / Failure Mode/Scenario	Consequence of Failure (CoF): Health & Safety 7	Treatment Performance/ Regulatory 5	Economic/ Personnel Resources 5	Public Image 3	Criticality	Probability of Failure (PoF)	Risk Designation	General Notes	Current O&M Mitigation Measures	O&M Recommendations	Capital Project Ideas
Belt press mechanical/system failure	2	5	4	3	68	F	E	Belts get plugged with polymer and replaced every 2 years. Grease blinding also occurs on the belt. Mechanical system has a lot of moving parts and requires exhaustive maintenance. Reliability is a major concern. No redundancy for the single unit. Maintenance costs to maintain service is very high. Failure may result in hauling sludge to other local agencies such as Lake Arrowhead CSD, San Bernardino, or other.	Frequent routine maintenance, weekly inspection, bi-annual overhaul maintenance. Upgrading electrical components, motors, controls over time.	No additional O&M adjustments could be made to mitigate this failure.	Evaluate replacement of the Belt Press. Consider alternative technology, such as screw presses, centrifuge, etc.
Biosolids disposal failure	2	5	4	3	68	E	E	Risk associated with having "One-Stop" as only disposal location. Currently, One-Stop accepts one truckload per week on Tuesday, and scheduling or getting additional disposal availability is very difficult, if possible at all. Disposals need to be scheduled over a year in advance. For this reason, if a failure results in no pressing, and no disposal, playing catch-up is very difficult and not often possible the next week.	Can sometimes haul sludge to other local agencies, about 20% of the time One-Stop has an opening and can accept another load, but most often they cannot.	Investigate alternative disposals to One-Stop, and determine feasibility. Negotiate a backup disposal agreement in case of a failure or One-Stop is shut down.	Identify alternatives for digestion/hauling options. Consider sludge drying beds to store dewatered sludge.
Belt press polymer feed failure	1	5	4	3	61	D	H	Critical to operation of presses. Cannot press without polymer. No redundancy.	Routine maintenance and cleaning. Have replaced parts when needed.	Have shelf spare parts. Consider redundancy.	None.
Belt press sump pump failure	2	4	4	3	63	B	M	Pump filtrate back to the headworks, sump for entire building. One pump currently not pumping and has failed. Float failure could occur. There is redundancy - lead/lag.	Routine maintenance. Mitigation measure in place to manually pump out of the sump before it overflows.	Replace/Repair currently failed pump.	None.
Ancillary Systems											
Effluent Flow Meter								Currently, effluent flow from the plant is measured with an instrument that measures head over a weir at the end of the chlorine contact basin.			
Effluent flow meter instrument/calibration failure	1	2	3	1	35	F	M	Operations believes that the level instrument that acts as the effluent flow meter is placed incorrectly and there is a high level of inaccuracy with the instrument. Currently does not allow for flow-pacing of the chlorine dosing system, and accurate measurement for plant knowledge and reporting.	None.	Regular calibration of flow metering instrumentation.	Replace current effluent flow metering equipment with new, more accurate flow metering equipment capable of relay for chlorine dose flow-pacing.
Water Supply Line								City water supply line supplies potable water to plant for disinfection, lab, and other key plant uses.			
City water supply failure	1	5	3	3	56	A	L	If City water supply line were to break, it would have major impacts at the treatment plant.	None.	No additional O&M adjustments could be made to mitigate this failure.	None.
HPE Pumps								High pressure effluent feeds plant water for multiple uses around the plant. Critical to running belt press, wash-down, and other plant processes.			
HPE pumping failure	1	5	4	2	58	B	M	Two pumps, full redundancy, running lead (primary). Primary HPE pump is pumped directly from line feeding the CCB after the old dose tank. Backup HPE pump is pumped directly from the CCB, and therefore level needs to be maintained in the CCB in order to maintain prime for the secondary.	Routine maintenance.	No additional O&M adjustments could be made to mitigate this failure.	None.
Emergency Storage Tank								2.5 million gallon emergency storage tank available to store effluent in the event the outfall pipeline breaks. Can store flow for multiple days.			
Emergency storage tank telemetry failure	1	1	2	1	25	F	L	Currently no telemetry in the tank to view level. Some pumps also currently down.	Occasional cleaning and routine maintenance.	Install telemetry and repair failed pumps.	None.
Plant-Wide Electrical											
Motor Control Centers								Plant contains two Motor Control Centers (MCCs), one for the belt press, and one for the rest of the plant. MCC's at the plant control electromechanical equipment critical to successful operation.			
Motor control center failure (Plant)	1	4	4	2	53	F	H	MCC's provide critical power control for equipment. When power supply goes down, or an MCC goes down, no backup power is currently available. Portable generators are used at each individual process if an extended outage occurs. Operations is consistently worrying about how to respond to power losses. Mouse recently blew out an MCC and the plant was down for a week. Does not meet current code standards, and therefore currently failing. Electrical in the Belt Press room is a major concern, not to code, and requires significant upgrade.	Utilize portable generators when needed. Bypass pumping, manual process control as applicable. Alarms in place to signal to operators when power failure or electrical failure occurs.	Perform electrical reliability analysis to identify electrical risk and reliability, as well as energy optimization measures.	Consider installing a backup generator and replace Dewatering building MCC. There is an ongoing project to address plant-wide electrical failure.

CoFA - Crestline Sanitation District, Seeley Creek WWTP

Unit Process / Asset / Failure Mode/Scenario	Consequence of Failure (CoF): Health & Safety (7)	Treatment Performance/ Regulatory (5)	Economic/ Personnel Resources (5)	Public Image (3)	Criticality	Probability of Failure (PoF)	Risk Designation	General Notes	Current O&M Mitigation Measures	O&M Recommendations	Capital Project Ideas
Headworks											
Influent Channels								Influent channels function to convey flow through the headworks from the influent 15" diameter sewer main. All flow entering the plant is gravity flow.			
Influent channels grating failure	3	1	1	3	40	A	L	Grating is in good condition. Operators feel safe and secure walking on grating. No failures have occurred.	None.	None.	None.
Influent channels structural failure	1	1	1	1	20	A	L	Structure is in good condition. Operators have not observed corrosion or degradation of the structure.	None.	None.	None.
Screens								Normal operation at the plant flow goes through two bar screens in series, upstream has 1.5" wide bar spacing and downstream with 1" wide bar spacing. After the screens, flow travels through a channel Muffin Monster unit before flowing into the primary clarifier.			
Bar screen failure	2	3	1	2	40	E	H	Bar screens are manually cleaned. Since the spacing is relatively large, rags, grit, and debris have the ability to flow through the screens and can end up in the primary clarifier. Overall, operators have not had significant problems with rags and other debris getting through the headworks and causing problems to downstream processes because most of it ends up in the primary sludge which is pumped using an ODS (air-operated diaphragm pump).	Manually clean bar screens.	None.	Consider installing an Automatic screenings unit in place of an existing bar screen.
Muffin Monster failure	2	2	4	3	53	F	H	Sulfide corrosion is causing major damage to the teeth. In line channel monster doesn't work and is expensive and difficult to maintain. Teeth wear out every 6-8 months and new hardened steel teeth cost $12,000 for replacement. Ops does not believe that it is helping very much.	Nothing, too expensive to maintain.	Evaluate potential methods of corrosion mitigation and control. Wash water or iron salt addition could help control sulfide corrosion.	Consider installing an Automatic screenings unit in place of an existing bar screen. Would negate need of muffin monster.
Grit Removal								No engineered grit removal process exists at the plant. Grit is manually shoveled out of the influent channels where it is known to accumulate.			
Lack of grit removal	3	3	2	3	55	F	H	Grit accumulates in influent channels, in eddy locations or channel dips. Manually cleaned out by maintenance crew. Leads to increased wear on sludge pumping and clarifier. Access/egress and back injury from carrying drums of grit present a health risk to maintenance crew.	Manually shoveled out of influent channels by maintenance staff.	Consider using dollies, safe lifting straps, or other heavy lifting support devices or equipment for staff safety.	Install grit removal system
Influent Flow Meter								Influent Flow Meter consists of a single Parshall Flume which functions to measure influent flow.			
Influent flow meter calibration failure	1	1	1	1	20	A	L	Consequences of failure are minimal, operations staff not relying on influent flow data for process adjustments in the plant.	Flow meter is calibrated once per year.	Existing staff mitigation measures are sufficient.	None.
Influent flow meter instrumentation failure	1	1	2	1	25	A	L	Ultrasonic level sensor used for instrumentation. No maintenance is performed on the instrumentation. Failed one time in 8 years. Consequences same as calibration failure.	None.	Minimal maintenance/attention needs to be placed on this equipment. Recommend run-to-fail operation.	None.
Equalization Tank								100,000 gallon influent equalization tank was part of initial plant construction when the plant was designed as an activated sludge packaged plant. Now, the eq. tank is only used in the event of an outfall break to store influent wastewater while effluent flows are stopped. The equalization tank is essentially acting as an emergency storage tank, however, the capacity is only 20% of the plant's design capacity, and can be exceeded in less than 24 hours during high flows.			
Equalization tank blower failure	1	1	1	1	20	A	L	Blower is seldom used, maybe gets run for an hour a year. Blower is throttled on the outtake for control. Would only become a bigger issue if the tank is used again as an equalization tank in the future.	None. Rarely operated.	None.	None.
Equalization tank air piping failure	2	1	1	1	27	A	L	4" PVC Piping. Piping is sagging and in poor to fair condition overall. Would only become a bigger issue if the tank is used again as an equalization tank in the future.	None. Rarely operated.	None.	None.
Equalization tank structural failure	1	3	4	1	45	A	L	Structural is in good condition. Debris gets stuck on the bottom but just needs to be cleaned out after enough time.	None. Cleaned when needed.	None.	None.

CoFA - Crestline Sanitation District, Seeley Creek WWTP

Unit Process Asset Failure Mode/Scenario	Consequence of Failure (CoF) Health & Safety 7	Treatment Performance/ Regulatory 5	Economic/ Personnel Resources 5	Public Image 3	Criticality	Probability of Failure (PoF)	Risk Designation	General Notes	Current O&M Mitigation Measures	O&M Recommendations	Capital Project Ideas
Primary Sedimentation											
Primary Clarifier								Primary Clarifier function to separate solids, grease, and reduce load on trickling filter. In-house BOD & TSS monitoring. Single-unit circular primary clarifier. Clarifier is oversized resulting in long detention time and good particulate removal. Tank was originally a packaged activated sludge plant.			
Primary clarifier drive failure	1	4	3	2	48	B	L	Would cause failure of the mechanical sludge removal equipment. Sludge buildup occurs, leading to potential septic conditions and higher percentage of soluble BOD. Higher carryover of solids. Parts are old, hard to come-by. Not sure what the repair would entail, failure of gearbox has not yet occurred.	Routine maintenance.	Existing staff mitigation measures are sufficient.	Replace clarifier drive at end of useful life. Add redundant primary clarifier.
Primary clarifier scraper arm failure	2	4	1	2	45	A	L	Catastrophic failure could bend a scraper arm and over torque the failure mechanism. Never happened.	None.	Due to high treatment/regulatory consequence of failure, recommend pumping down and inspecting each primary clarifier scrapers/mechanical equipment annually to identify wear & tear, broken/damaged scrapers, or other issues.	Replace primary clarifier mechanical equipment at end of useful life. Add redundant primary clarifier.
Primary clarifier structural failure	3	5	5	5	86	A	M	Structure is in very good condition. Operators not concerned. Structural failure might only occur in a large seismic event.	Low maintenance structure and equipment requires very little attention and maintenance.	None.	Add redundant primary clarifier.
Primary Sludge Pumps								Single-Duty Primary Sludge pump - ODS style that pumps primary sludge to the sludge holding tank. Old but reliable pump.			
Primary sludge pump electrical failure	2	3	2	1	42	F	H	Conduit is cracked or failed somewhere under the lawn. When the lawn gets saturated with water, water has infiltrated into the panel and caused failure.	Reactive maintenance.	None, panel and conduit need to be replaced.	Replace panel and conduit
Primary sludge pump mechanical failure	1	3	2	2	38	B	L	Air relay is most common failure mode. Fails every 2 to 3 years. Pump itself is old but in good condition and highly reliable. Failure of air relay results in loss of primary and secondary sludge pumping. Failure is only identified by an operator on-site - no remote alarm.	Ops has a shelf spare air relay and a spare compressor.	Install remote alarm system for primary sludge pump failure (already planned for next year).	None.
Biological Treatment											
Trickling Filter								Single-duty circular trickling filter with four hydraulically driven rotating distributer arms. Unit is covered with a dome and consists of plastic media with a grid-like pattern. Trickling Filter functions to remove BOD from the primary effluent.			
Trickling filter bearing failure	2	2	3	2	45	B	L	Bearing failure has occurred once in the past 14 years and is difficult to repair. Likely occurred because grease was not applied properly during maintenance.	Lube bearing, flush nozzles.	No additional O&M adjustments could be made to mitigate this failure.	None.
Trickling filter flies	1	1	1	1	20	F	L	Heavy filter fly's exist year-round. More of a nuisance than a process performance issue. Don't get any filter snails.	None.	Wench the arm and slow the rotation down to flush the fly larvae out of the filter once a week or as-needed.	None.
Recirculation Pumping								Two recirculation pumps run constant speed and produce 600 gpm. 1 duty, 1 standby unit recirculate trickling filter effluent back to the primary influent channel. This adds additional load onto the primary clarifier, however, since the primary is oversized, it does not create a hydraulic burden.			
Recirculation pumping mechanical failure	3	3	3	3	60	F	E	Constant speed pumping, 600 gpm. Old, electrical issues, Pumps haven't been replaced since original. 70s equipment in an 80s cabinet. Includes check valve issues. Full pumping redundancy. Seal failure has occurred in the past.	Routine maintenance, alternating usage, run-to-fail on pumps. Check valves have a lot of issues, shear pins would fail once a month.	No additional O&M adjustments could be made to mitigate this failure.	Replace pumps and check valves.
Reciculation pump well grating failure	3	1	2	3	45	F	H	Grating was modified because of the weight, and the the grating was cut in order to create a smaller piece that is easier to lift out. This has resulted in a weak point in the grating. Staff has stated that there is an ongoing project for a permanent fix to the grating at this location.	Temporary support for the modified grating until ongoing project for permantent fix to the grating is completed..	No additional O&M adjustments could be made to mitigate this failure.	Replace grating with re-engineered light-weight grating for easier access and operator safety (ongoing project).
Recirculation pumping efficiency/lack of control failure	1	2	3	2	38	F	M	Pumps are a major power consumer for the plant - over $10,000 a year in energy costs. Efficiency of pumps is unknown. Energy savings and efficiency should be considered with replacement projects.	None.	Can install cBOD measuring devices to control recirculation pumping. De-couple rotor control from the pumping rate	Consider addition of VFD with electrical update to reduce amp draw.

CoFA - Crestline Sanitation District, Seeley Creek WWTP

Unit Process Asset Failure Mode/Scenario	Consequence of Failure (CoF) Health & Safety 7	 Treatment Performance/ Regulatory 5	 Economic/ Personnel Resources 5	 Public Image 3	Criticality	Probability of Failure (PoF)	Risk Designation	General Notes	Current O&M Mitigation Measures	O&M Recommendations	Capital Project Ideas
Reciculation pumping electrical failure	3	4	4	3	70	B	H	Electrical system is a weak point. Main issues are wire faults. Wire is wearing out. Transformers have died. Wire size and conduit are undersized, upgrade would require wire and conduit upgrade. Hidden failure - would require an operator observing the TF or the secondary clarifier to notice.	None, not much left that staff can do. The panel is too old to continue to fix.	No additional O&M adjustments could be made to mitigate this failure.	Replace electrical for recirculation pumping. Would require upgrading conduit.
Secondary Clarifier								Single-duty circular secondary clarifier functions to capture and settle sloughed solids from the trickling filter and return them to the primary clarifier.			
Secondary clarifier drive unit failure	1	2	4	2	43	A	L	Drive unit doesn't hold oil but hasn't failed in 14 years. Pretty much no maintenance required. Gear moves so slow that there is low probability for failure.	None, oil added when needed.	Consider fixing the gear box to retain oil with a seal fix, if applicable.	Consider adding redundant secondary clarifier.
Excessive algae growth on secondary clarifier weirs	2	3	1	2	40	D	M	Algae has tendency to grow on the effluent weirs, especially during the summer months.	Staff manually uses HTH to kill algae every week during the summer or as-needed.	Consider installing a brush on the skimmer arm and/or perforated tubing around the weir and dose with hypochlorite to mitigate algae growth.	Consider adding redundant secondary clarifier.
Secondary clarifier skimmer arm failure	2	2	3	2	45	F	H	Currently held up by a ratchet strap. Unknown condition, but assumed that ratchet strap is holding skimmer arm together. Ratchet strap has been there for a long time and doesn't seem to be an issue.	Ratchet strap is used to support skimmer arm. Operations hoses the skimmer arm down periodically.	Permanently repair skimmer arm when ratchet strap fails.	Consider adding redundant secondary clarifier.
Secondary Sludge Pump								Single-duty ODS air diaphragm pump. Old but highly reliable and in good condition. Pumps secondary solids back to the primary clarifier.			
Secondary sludge pump mechanical failure	1	3	2	2	38	B	L	Air relay is most common failure mode. Fails every 2 to 3 years. Pump itself is old but in good condition and highly reliable. Failure of air relay results in loss of primary and secondary sludge pumping. Failure is only identified by an operator on-site - no remote alarm.	Ops has a shelf spare air relay and a spare compressor.	Install remote alarm system for secondary sludge pump failure (already planned for next year).	None.
Secondary sludge pumping sump access failure	2	1	1	1	27	B	L	Difficult to access and clean out sump residual because a 4-inch pipe and air compressor is blocking the sump from operator access. Sump is manually cleaned.	Floor is manually cleaned every 1-3 years. Sludge builds up below the sump pump on the floor of the sump.	Investigate ways to improve access for cleaning of sump.	None.
Disinfection											
Chlorine Contact Basin								Chlorine contact basin consists of a dosing tank and serpentine contact tank connected with a pipe. Structurally concrete is in excellent condition. In break-point chlorination.			
Chlorine contact effluent weir failure	1	2	3	1	35	F	M	Weir slide-gate has been used as a weir, but the slide gate stem failed by shearing off of the slide gate. Now the slide gate is not adjustable and the weir isn't effective.	None.	Install a plastic/fiberglass v-notch weir for effluent flow measurement. Repair downstream slide gate if desired, but slide gate is not necessarily needed.	None.
On-site Generation Equipment								Chlorinated secondary effluent first goes through a wye-strainer, then through cartridge filter, media filter, water softener, carbon filter, UV, RO, then into the on-site Chlorine generation skid as supply water. The skid consists of one Micro-Chlor on-site generation unit capable of 100 lb/d chlorine dose. Salt bags are stored at the facility. Plant effluent is treated with a small RO unit to produce water for mixture with the salt in a brine tank. Chlorine is manually dosed, day-to-day operation.			
On-site generation Micro-Chlor skid failure	1	4	4	3	56	E	H	Skid failure can occur under a multitude of points. Includes brine tank. Installed 2012. Something would fail if left unmitigated within a month. Downtime is greater than one day. Generated hypochlorite storage is roughly a day to a day and a half worth of chemical. Requires RO unit and other ancillary water treatment components. RO is another weak point, as membranes are likely degrading due to lower pressures and higher TDS in the RO effluent. Most maintenance is done in-house.	Excessive maintenance required for the on-site generation skid and ancillary components. Major headache for O&M staff.	Additional O&M probably not possible. Extensive measures in place to keep skid operational.	Need City water feed or a well for reliable water supply. Would reduce risk of failure from the multitude of water treatment components.
On-site generation electrical failure	1	4	4	2	53	A	L	Electrical system was cleaned up recently by a contractor 2 years ago. Mice had been an issue in the past. Panels are upgraded and low probability of failure. Code Failure - electrical system is not set up properly.	Routine Maintenance.	No additional O&M mitigation measures are recommended.	Needs to be replaced
On-site generation control/efficiency failure	1	2	4	3	46	F	H	No control. Manual operation, no flow-pacing. Needs instrumentation in order to establish a flow-paced control. Could optimize and save salt, reduce chemical, and reduce salinity significantly.	None.	Install flow-paced instrumentation.	None.

CoFA - Crestline Sanitation District, Seeley Creek WWTP

Unit Process / Asset / Failure Mode/Scenario	Consequence of Failure (CoF)				Criticality	Probability of Failure (PoF)	Risk Designation	General Notes	Current O&M Mitigation Measures	O&M Recommendations	Capital Project Ideas
	Health & Safety	Treatment Performance/ Regulatory	Economic/ Personnel Resources	Public Image							
	7	5	5	3							
Chemical Feed								Chemical feed pumps function to pump generated 0.8% sodium hypochlorite solution to the dosing tank for disinfection. The system consists of two dosing pumps, one duty, one standby.			
Chlorine dosing pumps failure	1	4	4	2	53	C	M	Controlled by the skid, but separate room and separate process. Two pumps, one redundant. Diaphragm, VFD failure occurs.	Routine maintenance, power loss reset. Inspected once a week. Lots of mitigation in place.	Dose at Huston Creek can be increased to account for loss of chlorine at Seeley to an extent. Consider purchasing a shelf-spare dosing pump.	None.
Sludge Handling											
Sludge Holding Tank								Solids are stored in a concrete sludge holding tank adjacent to the Primary Clarifier at Seeley. The tank is in excellent structural condition. Sludge is gravity thickened in the tank, and decant is returned to the primary clarifier. Thickened sludge is pumped out of the holding tank by tanker trucks and transported to Huston Creek for dewatering. Odors are treated with an Chemically treated iron and redwood media air scrubber.			
Sludge holding tank fan failure	2	1	2	1	32	B	L	The fan is located on the discharge side of the media and draws air through the media. The motor on the fan gets corroded very quickly, and needs to be replaced after failure every 2 to 3 years. Not sure what the cause is.	None.	Investigate cause of corrosion to extend life of motors.	None.
Ancillary Systems											
Effluent Flow Meter								Seeley Creek WWTP currently does not have an effluent flow meter. Effluent flow is calculated and reported to the regional board on a comparative calculation (i.e. flow at the ranch minus the effluent flow at Huston, Cleghorn, and Pilot Rock)			
No effluent flow meter	1	3	3	2	43	F	H	Lack of an effluent flow meter is a significant issue. While comparative flow analysis can be used for reporting, proper chlorine pacing and process control requires real-time flow measurement and monitoring.	None. Flow is comparatively calculated.	Regular calibration of flow metering instrumentation	Install proper effluent flow metering equipment with new, accurate equipment capable of relay for chlorine dose flow-pacing and other process control uses.
Plant compressed air								Plant compressed air is delivered to processes as-needed by local compressors around the plant. The system used to be on one, large compressor, but underground air piping failed and the larger system was abandoned.			
Plant compressor/piping failure	1	2	4	3	46	F	H	Individual smaller compressors have been installed next to equipment that need it after large compressor failure. Parts from the large compressor at Seeley have been used to repair Huston Creek compressor.	Individual smaller compressors have been installed where needed around the plant.	Investigate potential permanent locations for smaller, individual compressors to eliminate the need for full compressor/piping replacement of larger system.	Consider permanent solutions for smaller compressors or piping replacement and compressor fix for full system.
HPE Pumps								High pressure effluent (HPE) feeds plant water for multiple uses around the plant. HPE is used for irrigation, hose bibs, feed water for on-site chlorine generation, and other uses.			
HPE pumping failure	1	2	4	2	43	B	L	HPE Pumps have full pumping redundancy.	Routine Maintenance.	None.	None.
HPE piping failure	1	2	4	3	46	F	H	There is currently an HPE piping failure (leak) somewhere in the plant and could be in a multitude of locations. No isolation valves are installed to determine leg of pipe where the failure has occurred. Ongoing failure likely requires full HPE system replacement due to unknown location of failure.	None, system is still run as designed.	No additional mitigation measures can be recommended to address this failure mode.	Replace the galvanized steel HPE lines with new pipe. Consider installing pipe in an accessible concrete trench with trench plates.

CoFA - Crestline Sanitation District, Seeley Creek WWTP

Unit Process / Asset / Failure Mode/Scenario	Consequence of Failure (CoF) Health & Safety	Treatment Performance/ Regulatory	Economic/ Personnel Resources	Public Image	Criticality	Probability of Failure (PoF)	Risk Designation	General Notes	Current O&M Mitigation Measures	O&M Recommendations	Capital Project Ideas
	7	5	5	3							
Emergency Storage								There currently is an unlined pond adjacent to the Seeley Creek effluent outfall that was originally designed for effluent storage, but cannot be legally used, presumably because it is unlined and the water would percolate into the ground and end up in Silverwood Lake.			
Emergency storage failure	1	5	5	5	72	F	E	The existing abandoned storage pond is a failed asset because it is not permitted for use. The pond would provide valuable emergency storage for Seeley Creek WWTP flows, as only 100,000 gpd storage exists at the plant, below 24-hrs of current dry weather flows, and well-below wet weather flows and plant capacity flows. Additional emergency storage capacity is needed to hold water in the event of an outfall break.	Use EQ tank for emergency storage, turn on the HPE system, can use the chlorine generation as well.	No additional O&M adjustments could be made to mitigate this failure.	Line pond, install piping and valving for control.
Motor Control Centers											
Motor Control Centers								Motor Control Centers (MCCs) around the plant control electromechanical equipment critical to the successful operation of the plant.			
Motor control center failure (Plant)	1	4	4	2	53	B	M	Not discussed.	Unknown.	Unknown.	Unknown.

CoFA - Crestline Sanitation District, Cleghorn WWTP

Unit Process / Asset / Failure Mode/Scenario	Consequence of Failure (CoF): Health & Safety 7	Treatment Performance/ Regulatory 5	Economic/ Personnel Resources 5	Public Image 3	Criticality	Probability of Failure (PoF)	Risk Designation	General Notes	Current O&M Mitigation Measures	O&M Recommendations	Capital Project Ideas
Headworks											
Influent Channels								Influent channels function to convey flow through the headworks from the influent 8" diameter sewer main. Collection system is not owned, operated, or maintained by the District but by the State. Influent characteristics vary widely depending on lift station activity, septic dumps, wet weather, and other factors.			
Influent source control / failure to control influent flow	1	3	2	2	38	F	M	Collection system is not owned, operated, or maintained by the District but by the State. Influent characteristics vary widely depending on lift station activity, septic dumps, wet weather, and other factors. District is unaware of when and what is coming into the plant, especially in septage/port-a-potty dumps.	None.	Coordinate with State on operation and maintenance of collection system. Suggest operations or information that would prepare plant for swings in influent conditions. Potentially loop CSD into the SCADA & Alarm systems at State Pump Stations. Separately install a level sensor in the influent channels to monitor water level and alarm if channel water level gets too high. Track septage dumps and volume.	None.
Influent channels structural failure	1	1	2	1	25	A	L	Structure is in good condition. Operators have not observed corrosion or degradation of the structure.	None.	None.	None.
Influent channels hydraulic capacity failure	1	3	2	3	41	E	H	Hydraulic capacity of the influent channels is challenged by high flow conditions. Has led to spills contained in the plant area in the past. Staff believes that recent upgrades to State operated lift stations increased pumping capacity may be in excess of the hydraulic capacity of the channels. Hydraulic analysis must be completed to determine if this is the case.	The slide gate controlling flow to the oxidation ditch was cut down to allow for additional flow to the oxidation ditch and alleviate hydraulic issues in the influent channels. Bar screen is cleared to maintain hydraulic flow.	Evaluate channel capacity based on upgraded lift station pumping capacity and determine if a hydraulic capacity issue exists.	If a hydraulic capacity issue exists, influent channels must be enlarged or new channels constructed with sufficient hydraulic capacity.
Screens								Normally plant influent flows through one bar screen, with 2" wide bar spacing. After the screens, flow travels through a channel Muffin Monster unit before flowing into the oxidation ditch. Influent contains higher levels of rags, debris, clothes, and other items found at a campsite.			
Bar screen failure / lack of screenings removal	1	3	3	2	43	E	H	Wide bar screen (2" wide) is used due to the high volume of rags and other screenings that come in with the influent. Tighter screen would blind too quickly and cause an overflow. Wet weather can cause screen blinding and overflow conditions quickly. Bar screens are manually cleaned. Since the spacing is relatively large, rags, grit, and debris have the ability to flow through the screens and can end up in the oxidation ditch and secondary clarifier. Has resulted in failure of RAS pump. Often clearing the bar screen is only labor duty and someone has to drive out 40 minutes round trip to clear the screen.	Manually clean bar screens.	None.	Consider an automatic screenings unit to more effectively and reliably remove screenings from the influent. Consider screens with decreasing bar spacings in series to decrease rate of blinding.
Muffin Monster failure	2	2	4	3	53	F	H	In line channel monster doesn't work and is expensive and difficult to maintain. Teeth wear out every 6-8 months and new hardened steel teeth cost $12,000 for replacement. Ops does not believe that it is helping very much, and muffin monster is essentially run as an ineffective and failed piece of equipment. Muffin monster also restricts flow. Slide gate had to but cut down and altered to allow for sufficient hydraulic capacity in the channels.	Nothing, too expensive to maintain.	None. Cost of maintenance does not justify the benefit.	Consider installing an Automatic screenings unit in place of an existing bar screen. Would negate need of muffin monster. Space could be used to capture grit.
Grit Removal								No engineered grit removal process exists at the plant. Grit is manually shoveled out of the influent channels where it is known to accumulate. Typically settles out near the screens or in oxidation ditch.			
Lack of grit removal	1	2	4	3	46	F	H	Grit accumulates in influent channels, in eddy locations or channel dips. Grit that gets through the headworks ends up in the oxidation ditch or secondary clarifier. Grit is manually cleaned out by maintenance crew. Leads to reduction in ditch capacity over time and wear on sludge pumping and clarifier equipment if it reaches that far. Access/egress and back injury from carrying drums of grit present a health risk to maintenance crew.	Manually shoveled out of influent channels by maintenance staff.	Consider using dollies, safe lifting straps, or other heavy lifting support devices or equipment for staff safety.	Install grit removal system

CoFA - Crestline Sanitation District, Cleghorn WWTP

Unit Process / Asset / Failure Mode/Scenario	Consequence of Failure (CoF)				Criticality	Probability of Failure (PoF)	Risk Designation	General Notes	Current O&M Mitigation Measures	O&M Recommendations	Capital Project Ideas
	Health & Safety	Treatment Performance/ Regulatory	Economic/ Personnel Resources	Public Image							
	7	5	5	3							
Flow Equalization								No flow equalization currently exists at the plant. Traditionally, activated sludge treatment plants include flow equalization at some point in the treatment process to avoid rapid changes to the biological reactor, washout, effluent water quality degradation, and plant upset conditions.			
Lack of Flow equalization	1	4	4	3	56	C	M	Lack of flow equalization impacts the Cleghorn plant in predictable ways. High flow due to influx of people to the camp and/or high wet weather flows can lead to a decline in effluent water quality, suggesting that some wash-out is occurring. The oxidation ditch is large for the flow, which helps equalize flow under most circumstances, but in higher peak events, it still impacts treatment performance. Additionally, flow equalization capacity could be used in the event of high flows during an outfall break for emergency storage capacity.	None, to a limited extent flow can be equalized in the ditch, but is limited based on the elevation of the rotor. In the event of outfall failure, flow can be trucked to Huston Creek.	No meaningful O&M options available.	Construct flow equalization for process performance improvement and double benefit of emergency storage in the event of an outfall break. Include additional grit and screenings removal with this process.
Biological Treatment											
Oxidation Ditch								Oxidation Ditch is an extended-aeration activated sludge process, which is a simple process designed with a long SRT. The activated sludge process is designed to remove BOD. Cleghorn has a single-duty racetrack-style oxidation ditch with a single mechanical brush aerator.			
Oxidation ditch mechanical/brush failure	3	3	3	3	60	D	H	Single-duty mechanical brush aerator powered by a 30 HP motor is horizontally mounted across the width of the track. The brush aerator acts to mix, maintain velocity, and entrain DO into the activated sludge in the ditch. The brush is missing some paddles but has negligible impact on performance. Past failure has occurred due to operator error. Brush can get stuck on debris, branches, animals, etc.	Routine maintenance. Lube and oil changes. District recently pulled the aerator to replace the bearings, observed the condition of the paddles, and took measurements to find rehab/replacement options for the paddles.	No additional O&M recommendations can be made to mitigate this failure mode.	Consider changing aeration technology or adding a second aerator for redundancy. Single-duty critical equipment carries high-risk even when mitigation is in place. Better influent screening would protect brushes.
Oxidation ditch structural failure	2	5	5	5	79	A	M	Basin discharge side of the ditch is showing exposed aggregate, much of top layer of concrete has been corroded or degraded away. Highest potential for corrosion would be in the "splash zone" near the aerator.	Hose down the water line in the ditch every other day.	Continue to proactively clean and monitor condition of concrete.	Rehab concrete where needed.
Oxidation ditch liner failure	1	2	5	5	57	F	H	Some sort of a liner exists in the ditch, but is peeling and actively failed at numerous locations. Liner bubbles out and actually increases corrosion potential to the concrete once breached. Now the liner is a hindrance on condition of the track and an O&M challenge.	Difficulty dealing with breached liner. Hose down breaches in liner to clear out solids and corrosive conditions every other day.	Remove existing breached liner. Consider a new lining alternative, concrete repair, or none of the above based on condition of concrete under failed liner.	Removal of failed liner and inspection of structural integrity is recommended. Execute concrete rehab and re-line clarifier if deemed necessary.
Oxidation ditch process control failure	1	2	3	1	35	F	M	Little to no process control exists for the activated sludge. DO is monitored but not used in any sort of meaningful control, no sludge wasting mechanism is in place, and RAS pumps operate on a timer. Failure could result in washout conditions and continuously results in energy inefficiency.	Manually set RAS rate, ditch water level to attempt to hit DO set point.	No additional O&M recommendations can be made to mitigate this failure mode.	Consider constructing sludge wasting beds for more consistent and reliable wasting schedule.
RAS Pumping								Single-duty RAS pump functions to return activated sludge to the oxidation ditch to sustain biomass and consume BOD. RAS pump is installed in a below-grade concrete pit with the HPE pump.			
RAS pumps mechanical failure	2	4	4	2	60	A	L	RAS pump is in good condition. A new pump was installed in 2005 and the impeller has been replaced since then. The pump is considered highly reliable.	Routine Maintenance.	No additional O&M recommendations can be made to mitigate this failure mode.	None.
RAS pumps electrical / sump pump failure	3	4	4	4	73	A	M	Corrosion, degradation, saturation of the underground electrical. Electrically limited in capacity. No alarm on individual breaker trips, could lose a section without knowing. No alarms or safety controls on RAS, HPE, sump pump, etc. In addition, the electrical is undersized and therefore no ability to install new equipment or do replacement/upgrade project without replacing electrical.	Daily checks, monthly alarm testing.	Add relays to each individual bucket on the MCC to mitigate risk of flooding to the area in the event of an electrical area.	Replace electrical in the area when pumping upgrades are made.

CoFA - Crestline Sanitation District, Cleghorn WWTP

Unit Process / Asset / Failure Mode/Scenario	Consequence of Failure (CoF)				Criticality	Probability of Failure (PoF)	Risk Designation	General Notes	Current O&M Mitigation Measures	O&M Recommendations	Capital Project Ideas
	Health & Safety	Treatment Performance/ Regulatory	Economic/ Personnel Resources	Public Image							
	7	5	5	3							
Secondary Clarifiers								Single-duty circular secondary clarifier functions to capture and settle sloughed solids from the trickling filter and return them to the primary clarifier.			
Secondary clarifer drive unit failure	1	2	4	2	43	C	M	Drive unit has been somewhat problematic compared to other clarifier drives. Excessive noise has occurred in the past, and failure has happened more frequently. Has been fixed on an as-needed basis.	Change oil, routine maintenance	No additional O&M recommendations can be made to mitigate this failure.	Consider replacement of the drive unit. Add redundant secondary clarifier.
Excessive algae growth on secondary clarifier weirs	2	3	1	2	40	F	H	Excessive algae growth is most prevalent at Cleghorn compared to other plants. Will often times happen on a daily basis.	HTH chlorination around effluent weirs to kill algae growth daily, or as needed.	Consider installing a brush on the skimmer arm and/or perforated tubing around the weir and dose with hypochlorite to mitigate algae growth.	None.
Secondary clarifier skimmer arm failure	2	2	3	2	45	A	L	No history of failure or issues with the skimmer arm.	Routine maintenance.	No additional O&M recommendations can be made to mitigate this failure.	Add redundant secondary clarifier.
Secondary clarfier liner failure	1	2	5	5	57	F	H	Liner is peeling off. Large sections peeling could come off and clog the overflow. Result is unknown condition of the underlying structure because the liner blocks the view of concrete to see evidence of corrosion.	Hose out the bubbles in the liner every other day.	No additional O&M recommendations can be made to mitigate this failure.	Removal of failed liner and inspection of structural integrity is recommended. Execute concrete rehab and re-line clarifier if deemed necessary.
Disinfection											
Chlorine Contact Basin								Chlorine contact basin consists of a single-duty dosing tank and serpentine contact tank. Structurally concrete is in excellent condition. In break-point chlorination.			
Chlorine contact basin structural failure	1	4	4	2	53	A	L	Structurally sound, in good condition. Very minor lining corrosion on the effluent weir side.	None.	None.	None.
On-site Generation Equipment								Chlorine generation equipment consists of 1 Micro-Chlor on-site generation unit. Salt bags are stored at the facility, potable water for mixture with the salt in a brine tank. Chlorine is manually dosed, day-to-day operation. Residual testing is done via grab sample.			
On-site generation Micro-Chlor skid failure	1	4	4	3	56	E	H	Skid failure can occur under a multitude of points. Includes brine tank. Something would fail if left unmitigated within a month. Downtime is greater than one day. Generated hypochlorite storage is roughly a day to a day and a half worth of chemical.	Order and pick up totes. Routine (frequent) maintenance. Can increase dosing at other plants to mitigate. Exhaustive staff effort, cost. Spare parts where feasible. Keep extra salt on site.	Consider shifting chlorine dosing to a pool or spa style chlorination, with chlorine pellets or puck system. Do an in-house test to check for organo-chloramines which occur when free chlorine react with organics and can read as a residual even though they provide no disinfection power. Reads as di-chloramine in a DPD test, which shouldn't occur in the free mode.	None.
On-site generation electrical failure	1	4	4	2	53	B	M	Electrical system is more problematic than at Seeley Creek and Huston Creek, with more frequent failure.	Routine maintenance and testing.	None.	None.
On-site generation control/efficiency failure	1	2	4	3	46	F	H	No control. Manual operation, no flow-pacing. Needs instrumentation in order to establish a flow-paced control. Could optimize and save salt, reduce chemical, and reduce salinity significantly.	None.	Install flow-paced instrumentation.	None.
Chemical Feed											
Chlorine dosing pumps failure	1	4	4	2	53	C	M	Controlled by the skid. Two pumps, one redundant. Diaphragm, VFD failure occurs.	Routine maintenance, power loss reset. Inspected once a week.	Dose at Huston or Seeley Creek can be increased to account for loss of chlorine at Cleghorn to an extent. Consider purchasing a shelf-spare dosing pump.	None.

CoFA - Crestline Sanitation District, Cleghorn WWTP

Unit Process / Asset / Failure Mode/Scenario	Consequence of Failure (CoF): Health & Safety 7	Treatment Performance/ Regulatory 5	Economic/ Personnel Resources 5	Public Image 3	Criticality	Probability of Failure (PoF)	Risk Designation	General Notes	Current O&M Mitigation Measures	O&M Recommendations	Capital Project Ideas
Sludge Handling											
Sludge Wasting								Activated Sludge wasting functions to remove aged biomass from the activated sludge for biomass control. Currently, no infrastructure mechanism is in place to facilitate sludge wasting, other than to manually draw off the RAS line and fill a tanker truck, which hauls the waste sludge to Huston Creek.			
Lack of Sludge wasting	1	2	2	1	30	F	M	Activated sludge is wasted from the system approximately two times a year, where solids are drawn off the RAS line into a tanker truck and hauled to Huston Creek. No mechanism is in place for controlled wasting.	Manual wasting approximately twice a year.	None.	Consider construction of a redundant RAS pump for reliability and pipe gallery configuration to facilitate wasting.
Ancillary Systems											
On-Site Emergency Generator								Old emergency generator can run the plant in the event of a power outage. Generator has been a problem for operators since installation and requires frequent maintenance to keep operational.			
Emergency generator mechanical failure	2	3	4	3	58	E	H	Slew of mechanical failure points. Can include vaporizer failure and fuel injection. Generator has been a problem since installation. Propane venting triggers the gas shutdown alarm and shuts down the generator.	Regular testing, load testing and building transfer once a month on the transfer and generator. Service contract with Yale Chase for servicing. Daily monitoring for propane level, alarms, etc.	Look into portable generator hookup.	Replace generator at end of service life with more reliable unit.
Effluent Pumps								Two vertical turbine 25 HP effluent pumps, lead/lag alternating operation. Controlled by wet well level and sometimes can run rarely in the winter.			
Effluent pumps mechanical/pumping failure	2	2	4	2	50	A	L	Packing failure can occur. Operations unsure of the condition of the pumps, need to pull out the vertical turbine pumps with a crane through the roof if they are replaced or repaired. Check valve has been replaced.	Routine maintenance, oil changes, and lube.	Consider doing a pumping capacity/efficiency test to evaluate performance.	None.
Effluent pumps electrical failure	2	3	3	2	50	A	L	No issues with the electrical. Independent feed to each pump.	Routine maintenance and testing.	None.	None.
Motor Control Centers											
Motor Control Centers								Motor Control Centers (MCCs) around the plant control electromechanical equipment critical to the successful operation of the plant.			
Motor control center failure (Plant)	3	5	5	5	86	B	H	No spare buckets, or spare parts available for the MCC but the cabinet is clean. Critical system but very well maintained.	Routine maintenance. Frequently maintained.	No additional O&M recommendations can be made to mitigate this failure.	None. Replace MCC at end of useful life.

CoFA - Crestline Sanitation District, Lift Stations

Unit Process / Asset / Failure Mode/Scenario	Consequence of Failure (CoF): Health & Safety	Functional Performance/ Regulatory	Economic/ Personnel Resources	Public Image	Criticality	Probability of Failure (PoF)	Risk Designation	General Notes	Current O&M Mitigation Measures	O&M Recommendations	Capital Project Ideas
	7	5	5	3							
Lake Gregory Lift Station											
Mechanical Components								Lake Gregory LS has two 20 HP pumps, both running on VFDs, wet well plus dry well arrangement, and pumps into one 6-inch line and one 8-inch line.			
Pumping failure	1	3	3	4	49	D	M	Pump & Motor mechanical failure or loss of performance. If a pump goes down, redundant pump is available to maintain station function. If both pumps are down, connection available for diesel-driven bypass pump available nearby.	Redundancy, spare parts, and trailer pump provides multiple layers of redundancy. Always have a trailer pump within 5 minutes away and stage trailer pump on site during holidays. Automated switch-over if a pump fails. Typically the bypass pump is staged at the lift station on holiday weekends.	None, current O&M mitigation measures are very robust, as they need to be to respond quickly to a failure.	Larger wet well, spare submersible pump in emergency storage.
Piping/valve failure	1	3	3	4	49	C	M	Pipe plugging or valve failure. Would have same consequences as a pumping failure. Response to failure is also the same.	Same mitigation measures as pumping failure.	None, current O&M mitigation measures are very robust, as they need to be to respond quickly to a failure.	None.
Electrical Components								Power is 240V main, with no switchgear. Electrical equipment is relatively new and in good condition.			
Utility power failure	1	1	3	2	33	B	L	240V main system. New equipment. Backup generator is on-site with ability to run the full station if a utility power outage occurs.	Backup generator, and a backup to the backup generator. ATS automatically kicks on generator if utility power is lost. Battery backup on the control system if utility power is lost.	None, current O&M mitigation measures are very robust, as they need to be to respond quickly to a failure.	None.
Electrical gear failure	1	1	3	2	33	A	L	No switchgear, just MCC. If MCC fails, could power full station with backup generator. All electrical equipment is less than 10 years old, in excellent condition, according to staff.	MCC in good condition, maintained regularly.	None, current O&M mitigation measures are very robust, as they need to be to respond quickly to a failure.	None.
Instrumentation & Control Components								PLC control system at the lift station, pumps controlled off level.			
Instrumentation failure	1	1	2	1	25	C	L	Level control is backed up by floats. Would be easy to repair. New upgrade will set auto-fail to floats automatically.	Redundancy built-in. Automatic switch to backup system if primary fails. Multiple alarm systems installed, including 3 different level sensors, and automatic-shut down of failed equipment.	None, current O&M mitigation measures are very robust, as they need to be to respond quickly to a failure.	None.
Control system failure	1	1	2	1	25	C	L	All controls are set up above grade in a safe place to look at and work on.	PLC and control equipment is in good condition. Maintenance when needed.	None, current O&M mitigation measures are sufficient.	None.
Building and Structures								Building is in good condition. Only minor issue is that building does not contain a restroom for operations and maintenance staff who may need to be at the lift station for an extended period of time.			
Wet well capacity / emergency storage failure	2	4	4	5	69	F	E	Currently, layers of mitigation measures are in place to compensate for the fact that the hydraulic capacity of the wet well and lack of the emergency storage tank. Operators predict that approximately 45 minutes of storage capacity exist in the wet well.	Mitigation measures include backup force main, backup generator, ATS, battery backup on the control system, and a standpipe for full lift station bypass pumping.	None, current O&M mitigation measures are very robust, as they need to be to respond quickly to a failure.	Construct emergency storage capacity to allow for additional failure response time. Recommend this project if and when additional connections come on-line, as this will otherwise further decrease wet well detention time.
Structural failure	2	1	3	1	37	A	L	Building and structural failure. Whole building is concrete & block. No leaks, structurally sound. No corrosion observed.	Station has gas detection, blower and dehumidifier and forced ventilation for the drywell. Gas detector is for LEL, H2S, O2, and CO2 and is connected to the alarm system.	None, current O&M mitigation measures are sufficient.	None.
Force Main								Two force mains exist for this pump station. Pump 1 pumps to the 8 inch force main and Pump 2 pumps to the 6 inch force main. Connecting piping and an isolation valve exist to allow for either pump to pump to either force main. Currently, connecting valve is closed. Pumps are cycled to pump out both force mains.			
Force main failure	1	3	3	4	49	A	L	Failure mode is a force main break. Redundant force main available for full redundancy. Both force mains can convey full station capacity.	Pressure sensors on both force mains to alert staff to a failure if line pressure is lost. Pressure loss sets off alarm.	None, current O&M mitigation measures are sufficient.	None.

CoFA - Crestline Sanitation District, Lift Stations

Unit Process / Asset / Failure Mode/Scenario	Consequence of Failure (CoF): Health & Safety	Functional Performance/ Regulatory	Economic/ Personnel Resources	Public Image	Criticality	Probability of Failure (PoF)	Risk Designation	General Notes	Current O&M Mitigation Measures	O&M Recommendations	Capital Project Ideas
	7	5	5	3							
Forest Shade Lift Station											
Mechanical Components								Forest Shade has two 30 HP submersible pumps, rehabbed recently with new pump parts and electrical. The station operates as a bypass lift station in the event that the gravity line along Lake Gregory surcharges, which can happen in very high flow conditions. The water will back up into the Forest Shade wet well, and the pumps will kick on to prevent a spill into the lake. Station was only used once or twice out of necessity in the past 5 years.			
Pumping failure	1	3	3	4	49	A	L	1200gpm pumps are new, and 90%+ efficient. Both pumps are submersible solids handling and non-clog. Separate standpipe is available for full station bypass pumping with temporary pump setup.	Routine maintenance. Pump testing is performed every week, and the pumps are run to clear the force main every two weeks to prevent the force main from going septic. Full emergency bypass pump exercise is performed once a year for the station.	None, current O&M mitigation measures are sufficient.	None.
Piping/valve failure	1	3	3	4	49	A	L	One gate valve is on the force main. Once check valve per pump. Plug valve exists to drain FM back into the wet well.	Routine maintenance. Full emergency bypass pump exercise is performed once a year for the station.	None, current O&M mitigation measures are sufficient.	None.
Electrical Components								Electrical was just replaced approximately 4 years ago. Equipment is in excellent condition. All electrical conduit is sealed and gasketed.			
Utility power failure	1	1	3	2	33	A	L	Station is equipped with a backup generator and automatic transfer switch. Backup generator will kick-on automatically if utility power is lost.	Station is equipped with a backup generator and automatic transfer switch. Full emergency bypass pump exercise is performed once a year for the station.	None, current O&M mitigation measures are sufficient.	Tap box for external/ temporary backup generator.
Electrical gear failure	1	1	3	2	33	A	L	Plant electrical has no switchgear, just a main breaker. MCC has just been re-done in the past couple years, so electrical equipment is in excellent condition. There is a 460V panel and a 160V panel. VFD's were installed with latest upgrade and are in sealed cabinets.	Full emergency bypass pump exercise is performed once a year for the station.	None, current O&M mitigation measures are sufficient.	None.
Instrumentation & Control Components								Panel and Control system is new, in good condition.			
Instrumentation failure	1	1	2	1	25	A	L	Pumps are controlled off of level transducer instrumentation. Backup floats are not installed, but staff is planning on it.	Ongoing upgrades to add backup floats. Currently transducer.	Install backup floats for level transducer.	None.
Control system failure	1	1	2	1	25	A	L	Panel and Control system was upgraded along with the major upgrade done just a few years ago, so controls are all new and in excellent condition. VFDs are new, there is also hand control on the panel. Alarms exist to signal a control failure.	Routine maintenance. Alarms on control system.	None, current O&M mitigation measures are sufficient.	None.
Building and Structures								Wet well is inside the building. No roof hatch exists, but there is a steel I-beam that can be used to support a chain lift to pull the pumps out, when needed. Building also has a roll-up door, and maintenance staff can back up a boom truck to lift the pumps out that way as well. Currently temporary sulfide monitor is used before entering building, but permanent is planned for install. Exterior vent fan is used for constant passive ventilation.			
Structural failure	1	1	3	1	30	B	L	Building and structural failure. Concrete building, wood framed roof. Roof frames have rotting and leaking. Bilco hatch is used to cover wet well inside building.	None, temporary sulfide monitor is used.	Install reliable permanent sulfide monitor in building.	Replace roof.
Force Main								Pump station pumps into an approximately 1/2 mile force main that bypasses the main gravity sewer along Lake Dr. Force main connects into the junction box with the gravity sewer before flowing by gravity the rest of the way to Huston Creek WWTP.			
Force main failure	1	4	3	4	54	A	L	Force main and lift station is only used in very high wet weather flow conditions. Force main is pumped out every two weeks. Ability in place to drain the force main back to the wet well if maintenance is needed on the pipeline or air vac valves.	Service air release valves every 3 months, replace when needed.	None, current O&M mitigation measures are sufficient.	None.