4.0 CURRENT WASTEWATER SYSTEM

There are two main components of the wastewater system. The first component is the collection system to collect and convey the wastewater to the WWTP. As part of past LRPs a hydraulic model of the collection system has been prepared to identify potential bottlenecks in the system. This model has been updated as part of this LRP Update. The second aspect of the wastewater system is the Tri-Lakes Wastewater Treatment Facility (TL-WWTF). A description of the TL-WWTF, the District's contributions to the plant, and future improvements of the plant are presented in this section.

4.1 CURRENT SYSTEM SUMMARY

The District sewer service boundary currently includes approximately 7,960 acres with 3,722 sewer taps (approximately 66% of current build-out). As shown in Figure 4-1, the District has constructed the complete system of trunk sewers and lift stations to the furthest reaches of the existing boundary. The collection system consists of gravity sewers, forcemains and lift stations, relief sewers, and diversions. Figure 4-2 simplifies the major components of the sewer system into a single line flow diagram. Exhibit 4-1 shows the overall collection system map and the setup of the collection system model.

The wastewater collection system begins on the northern end of the District boundary and generally flows south and west. Two outfalls, located at the southwestern end of the system, discharge to the TLWWTP as shown in Figure 4-1. The existing wastewater collection system consists primarily of 8-inch sewer lines with approximately 10% of the system operating with 10-inch sewer lines. The north and south outfalls consist almost completely of 12-inch sewer lines. Sewer lines in the system are a mixture of clay and PVC material. Some clay pipes employ a PVC slip lining as part of an ongoing renewal and replacement program.

Since the 2012 LRP Update, the District has not installed any additional lift stations and has not performed any significant upgrades to existing lift stations. The District has seven lift stations currently in operation. The existing locations provide service to all hydraulically isolated sewer basins within the existing District boundary (please refer to Figures 4-1 for lift station locations). Details of the lift stations are outlined in Table 4-1.

Table 4-1 District Lift Stations Summary

Lift Station	Total Lift Station Capacity (gpm)	No. of Pumps	Type of Pumps	Year Installed
Crystal Creek	648	2	Constant Speed	1999
North/Lost Arrowhead	530	2	Constant Speed	1982
Silver Horn/Top of Moor (TOM) IV	159	2	Constant Speed	1987/2004
Highlands	198	3	Constant Speed	1987
Forest	86	2	Constant Speed	1987
Cove	110	2	Constant Speed	1987
Greenland	100	2	Constant Speed	2006

The TL-WWTF is an activated sludge plant rated for 4.2 MGD of flow. Located in Monument, Colorado, the plant services three special districts in the area: the District, Monument Sanitation District (Monument) and, the Palmer Lake Sanitation District (Palmer Lake). The three districts have joint venture agreement to collectively own and operate the TL-WWTF as the Tri-Lakes Joint Use Committee (JUC).

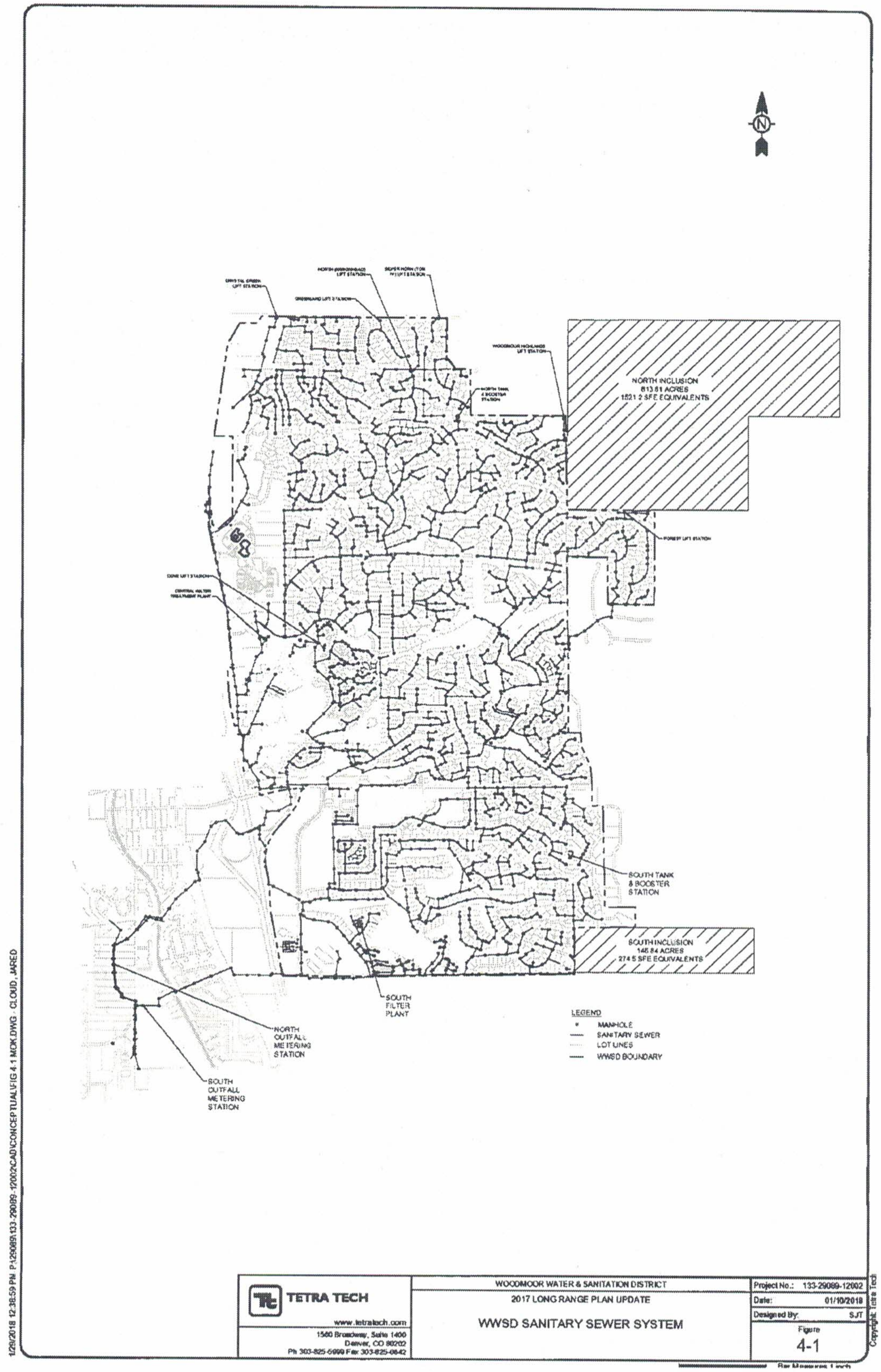

Figure 4-1 WWSD Sanitary Sewer Syste

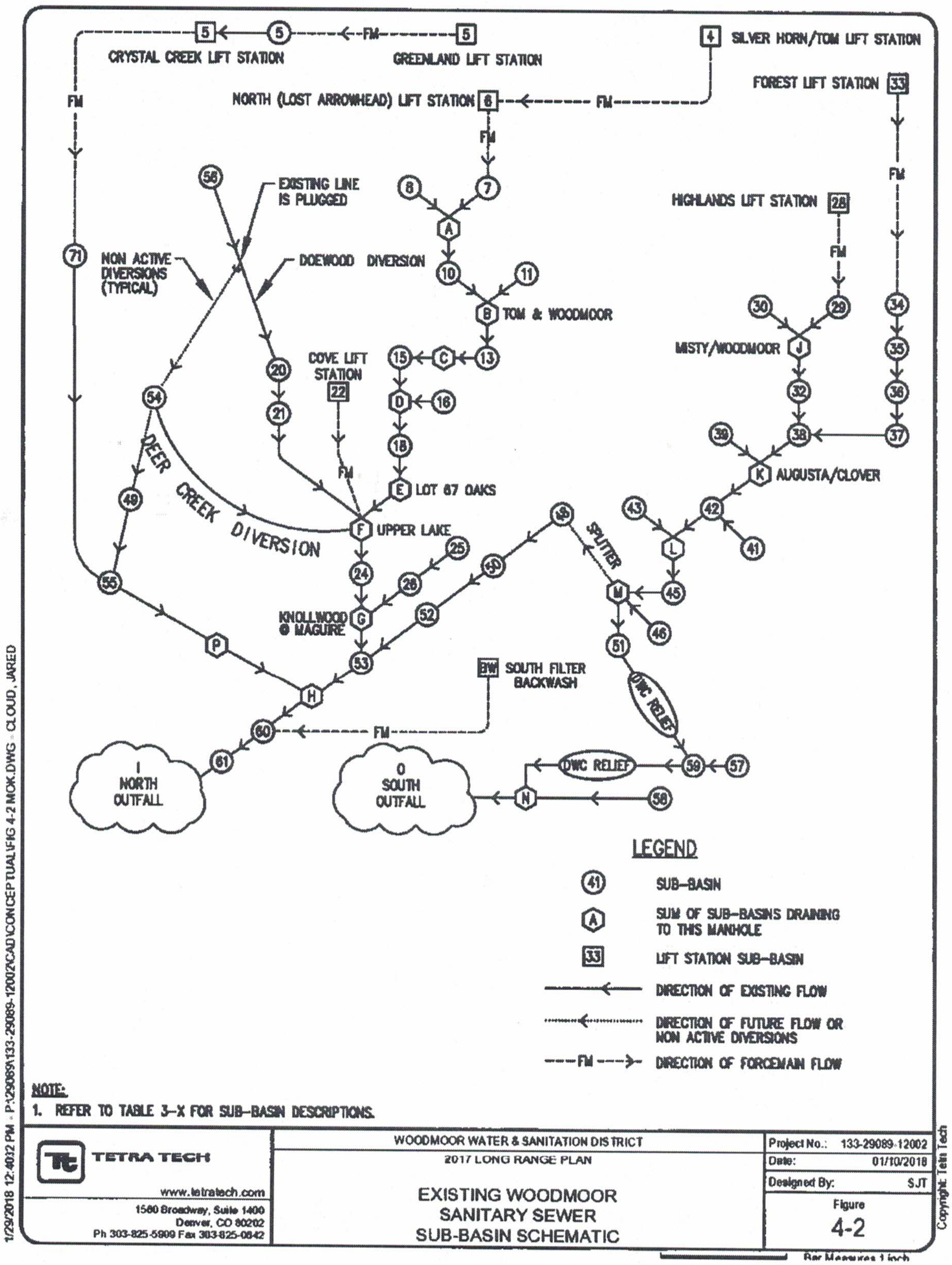

Figure 4-2 Existing Woodmoor Sanitary Sewer Sub-Basin Schematic

4.1.1 Connections

The water system discusses growth rates in terms of the number SFEs, while the wastewater system discusses growth rates in terms of the number of taps. Taps and SFE's are not interchangeable numbers. A SFE corresponds to a derived flow value for a typical domestic residence. A SFE produces an average sewer flow of 205 gpd in the District, based on flow monitoring evaluations. This value is often used to describe flows discharged from types of uses. For example, a school may have only one tap but may generate a sewer flow equal to 50 SFE's.

Alternately, taps refer to the specific service at the tap location. The District divides the total number of sewer taps into four categories including: single family, multi family, commercial, and schools. Each of these categories generates different volumes and patterns of wastewater use and must be accounted for separately. The tap distribution for the current build-out is depicted below in Table 4-2. The existing tap distribution between the four tap categories is used to forecast current and ultimate build-out numbers. At build-out conditions within the current boundary, the District projects to serve a total of 5,596 taps. The tap count broken down by sub basin is presented in Appendix G.

Table 4-2 Wastewater Taps Customer Class Distribution

Growth Condition	Single Family Taps	Multi-Family Taps	Comm. Taps	School Taps	Total Taps
Existing	3,268	370	78	6	3,722
Current Build-Out	4,914	556	117	9	5,596
Ultimate Build-Out	6,013	681	143	11	6,848

Since a single tap may not equal flows from a single SFE, a conversion factor was calculated. Using historic tap to SFE ratios, Tetra Tech created a tap to SFE conversion factor. Existing tap information above is based on data from January 2006 to December 2016. For build-out conditions, the calculated conversion factor of 0.89 (where 0.89 x SFE = Taps) is used to compute the total number of taps from the current and ultimate build-out SFE projections, 6,287 and 7,693 respectively. The specific class tap allocation values were determined based on the current class tap percent distribution.

In the 2012 LRP update, a conversion factor of 0.89 tap/SFE was also calculated. The percent class distribution slightly changed from the 2012 LRP. The percent of single family taps increased from 86.6% to 87.8% with an increase from 2,943 to 3,268 taps. The number of multi-family, commercial, and school taps has not changed since 2010; however, the percent distribution of the total number of taps decreased by 1% or less.

4.1.2 Wastewater Flows and Loads

As part of the agreement, each entity is allocated a certain amount of flow and load it can contribute to the TL-WWTF. The District is currently limited to a maximum contribution of 2.7 MGD of flow and 3,600 lbs of 5-day biochemical oxygen demand (BOD_5) per day based on a 30-day average. Tetra Tech reviewed the wastewater flow and load data from January 2006 through the present for the TL-WWTF. The TL-WWTF supplied both plant-specific operational data and historical sewer flow interceptor records from North and South Woodmoor, North and South Monument, and Palmer Lake. Table 4-3 provides a summary of the influent flow into the TL-WWTF from the District, which incorporates all single family housing, multi-family housing, commercial, and school taps

Table 4-3 TLWWTP Influent Flow Summary – Woodmoor Contributions

Year	Average Annual Flow		Peak Month	Max Day	Max Day Peaking Factor
	gpd/tap	MGD	MGD	MGD	
2006	210	0.62	0.72	0.99	1.63
2007	310	0.95	1.69	2.40	1.65
2008	218	0.71	0.79	1.07	1.37
2009	231	0.77	0.97	1.35	1.52
2010	227	0.76	1.17	1.82	1.82
2011	192	0.65	0.70	0.95	1.54
2012	193	0.66	0.73	1.04	1.43
2013	197	0.68	0.80	1.35	1.69
2014	198	0.69	0.74	0.90	1.33
2015	252	0.89	1.78	2.65	1.49
2016	222	0.81	1.10	1.34	1.44

The peak month data, which is the maximum monthly average for that year, shows that the District meets the allotment of 2.7 MGD. This is the value that is important to look at since the allocation to each entity is based on a monthly average value. In 2007, the peak month was higher than normal due to the optimization of the South Filter Plant \ which discharged fully or partially-treated water directly into the collection system increasing the overall monthly average flow. A maximum day (peak day) flow of 2.40 MGD was measured on May 8.

In 2015, the higher than normal peak month may have been caused by rainfall events. In May 2015, flows exceeded 2.0 MGD for a number of days. For 14 days out of that month, flows ranged from 2.05 MGD to 2.65 MGD. Historical weather data shows that continuous rainfall occurred during the same timeframe that high flows occurred in the system. The peak day flow of 2.65 MGD for that year occurred on May 19, 2015, which had a corresponding rainfall of 1.65 inches.

Data provided by the TL-WWTF also included lab results of composite samples. Table 4-4 shows the peak month for BOD_5 and total suspended solids (TSS).

Table 4-4 District's Portion of Peak Month Flows and Loads

Year	Flow (MGD)	BOD_5 Conc. (mg/L)	BOD_5 Load (lb/day)	BOD_5 Load per tap (lb/d/tap)	TSS Conc. (mg/L)	TSS Load (lb/day)	TSS per tap (lb/d/tap)
2006	0.72	267	1,608	0.55	481	2,900	0.99
2007	1.69	109	1,538	0.50	233	3,287	1.07
2008	0.79	227	1,496	0.46	377	2,490	0.77
2009	0.97	184	1,495	0.45	280	2,270	0.68
2010	1.17	239	2,326	0.69	376	3,671	1.09
2011	0.70	272	1,595	0.47	504	2,951	0.87
2012	0.73	278	1,694	0.50	335	2,041	0.60
2013	0.80	259	1,725	0.50	362	2,413	0.70

Year	Flow (MGD)	BOD_5 Conc. (mg/L)	BOD_5 Load (lb/day)	BOD_5 Load per tap (lb/d/tap)	TSS Conc. (mg/L)	TSS Load (lb/day)	TSS per tap (lb/d/tap)
2014	0.74	303	1,879	0.54	388	2,408	0.69
2015	1.78	136	2,015	0.57	230	3,408	0.96
2016	1.10	242	2,221	0.61	377	3,466	0.95

The District meets the allocation for BOD_5 load. In the 2012 LRP, the annual average values were shown; however, the following table has been revised to show the monthly values since this is how the District is monitored. Based on annual average values the load per tap basis is 0.44 lbs/day/tap and based on monthly average values the load per tap is 0.61 lbs/day/tap. This shows the potential variance on between the two values.

In 2010, the higher than normal load is due to higher load values seen in the month of November. On November 9, 2010 the District contributed 3,701 lbs/day of BOD_5 to the system. It is Even though peak day is not the controlling parameter it is a good practice to look at it. There have been instances where the District has been close to exceeding or have exceeded the allotment on a peak day, such as on January 24, 2012 the District contributed 3,371 lbs/day of BOD_5 and. These peak days will increase the monthly average.

Table 4-5 shows the District's percent contribution (relative to the total from the District, Palmer Lake and South Monument) of the influent flow and, BOD_5 and TSS loads into the TL-WWTF.

Table 4-5 District's Percentage of TLWWTP Flows and Loads

Year	% Influent Flow	% Influent BOD_5	%Influent TSS
2006	62%	59%	64%
2007	67%	57%	64%
2008	63%	57%	63%
2009	62%	55%	58%
2010	62%	57%	62%
2011	61%	56%	58%
2012	62%	59%	63%
2013	61%	57%	60%
2014	61%	58%	62%
2015	65%	59%	63%
2016	64%	60%	65%
Avg.	63%	58%	62%

As shown in the table, the District is a large contributor with approximately 60% of the total flow, BOD_5, and TSS loading to the TL-WWTF. This is similar to the data shown in the 2012 LRP. In addition, this aligns with the District's flow and load allocation compared to the plant's discharge permit. The District is allotted 64.28% of the permitted (rated) flow and 64.28% of the permitted BOD_5 load of the TL-WWTF. The plant is rated for 4.2 MGD of flow and 5,600 lbs/day of BOD_5.

4.2 COLLECTION SYSTEM

A model of the District's collection system was developed by Tetra Tech in 2006 using MWH Soft, Inc. (now Innovyze, Inc.) H2OMap Sewer and the model has been maintained by the District.

The model was received from the District and assumed to be updated for the purposes of modeling runs for this report. Assumptions include the following:

- Pipe diameter, length and slope is representative of existing facilities
- All lift stations are representative in number of current pumps and their respective capacities
- Existing and Future gravity flows applied at manholes represent the existing and build-out systems
- Model scenarios include peak flows applied to manholes (No additional peaking factor applied to model runs)

Previously, it was recommended that a new I&I study be performed; however, this study has not been completed. Tetra Tech recommends that an I&I study be completed before the next LRP update so that the collection system model can be more representative of wet weather conditions. In the interim period between the 2012 update and today, the District has performed most of the capital improvements recommended previously within the collection system. This includes a significant quantity of sewer main rehabilitation to minimize I&I related flows. The District continues on an annual basis to rehabilitate manholes via industry-standard interior lining products to further protect against infiltration into the gravity sewer system.

4.2.1 Collection System Model Update

Existing Conditions

The collection system model was run at current loading conditions to identify if there were any potential bottlenecks. Typical industry standards recommend that sewer lines 12 inches in diameter and smaller, maintain a design depth over diameter ratio (d/D) less than or equal to 0.5. This d/D ratio does not include unexpected flows, such as infiltration events. The remaining capacity in excess of a 0.5 d/D ratio is available to carry intangible flows such as infiltration. Since Tetra Tech's modeling accounts for these intangible flows, a d/D ratio of 0.8 was used as an upsizing trigger. Once the model calculated a d/D ratio greater than 0.8, that pipe was flagged for improvement.

Under current and future flow conditions, two sewer lines have a d/D ratio greater than 0.8, and need to be considered as to their future mitigation and maintenance (Pipe 829 and Pipe 1089).

Pipe 829 has been increased to 10-inch diameter but is laid at flat grade. It runs from MH 2652 to MH 2653 and is found in the open space behind the lots on Clear Brook Ln in the Heights at Rock Ledge subdivision at the south end of Woodmoor Golf Course. It is recommended that the District pay high-frequency attention to this main during periodic maintenance operations.

Pipe 1089 is found along the north side of Hole 3 of Woodmoor Golf Course. This 8-inch line remains at a slope less than the 0.4% recommended minimum for 8-inch sewers. This main has been rehabilitated using cured in place pipe (CIPP) lining according to the WWSD 2017 Sewer Folding Map found in Appendix G.

It is recommended that the District pay particular attention to gravity mains 829 and 1089 during periodic maintenance operations on an annual basis.

Ultimate Build-Out

The future system model was run and the results indicated the same piping was overtaxed as listed above. Under the build-out scenario, main interceptors from the Wissler Trust area down through the system are pushed close to a 0.8 d/D ratio but not exceeding. The Wissler Trust flow is modeled as a flow through a lift station and can be split two directions for alternative analysis either outfalling into MH 2130 (on Indian Summer Ln in Sewer

Basin 29) or into MH 2296 (on Lincoln Green Ln – the same outfall as the Forest Lift Station). The MH 2296 option on Indian Summer Ln. is an appropriate choice to route the majority of the flow as it contains the larger diameter piping. The MH 2130 outfall option has additional capacity that can take some of the flow from Wissler Trust but it routes the flow through some 6-inch piping decreasing the route's ability to handle all flows.

In the build-out scenario the North and South Outfalls both indicate sufficient capacity for the future development. However, several mains on each run contain are in the range between 0.75 and 0.78 d/D which is below the 0.8 d/D criteria for capacity upgrades but very little room for additional flow exists in the South Outfall. The South Outfall is on average closer to capacity throughout its pipe reaches than the North Outfall (South d/D approximately 0.55, North d/D approximately 0.65). Design flows flowing through the North and South Outfalls at build-out were 1257 gpm (1.81 MGD) and 2,477 gpm (3.56 MGD), respectively.

Tetra Tech recommends performance of periodic flow monitoring studies as development continues to connect to the system in the coming years and to use the results to calibrate the sewer model.

4.2.2 Lift Stations

The modeling indicated that the existing lift stations are adequately sized to handle wastewater flows under the current loading scenario. Each lift station was modeled with one pump out of service to simulate firm capacity.

The District maintains 7 lift stations throughout the system summarized below in Table 4-6.

Table 4-6 District Lift Stations Summary

Lift Station	Firm Capacity (gpm)[1]	Total Lift Station Capacity (gpm)	No. of Pumps	Type of Pumps	Year Installed
Crystal Creek	324	648	2	Constant Speed	1999
North/Lost Arrowhead	200	530	2	Constant Speed	1982
Silver Horn/Top of Moor (TOM) IV	38	93	2	Constant Speed	1987/2004
Highlands	112	178	2	Constant Speed	1987
Forest	43	86	2	Constant Speed	1987
Cove	55	110	2	Constant Speed	1987
Greenland[2]	50	100	2	Constant Speed	2006

1. All capacities shown are as indicated in District sewer model
2. Greenland preserve lift station was not included in sanitary sewer model. Values indicated for Greenland LS are as stated in the 2012 LRP.

The firm capacity evaluation of the lift stations is compared to the build-out influent flow in the sewer model in Table 4-7, below. The lift stations all have firm capacity to handle the flows that are applied in the model at build-out. However, analysis of the projected taps served by the lift stations suggest that Crystal Creek LS and Cove LS may be undersized at the build-out condition using wastewater population based flow estimates and peaking. Future modeling flow loading should be calibrated to the flow monitoring that is performed in the recommended I&I field study in the coming years.

Table 4-7 District Lift Stations Firm Capacity Evaluation

Lift Station	Number of Build-Out Taps Served	Future Maximum Influent In Model (gpm)[1]	Firm Capacity (gpm)
Crystal Creek	701	92	324
North/Lost Arrowhead	121	21	200
Silver Horn/Top of Moor (TOM) IV	16	2	38
Highlands	116	16	112
Forest	12	2	43
Cove	63	20	55
Greenland	40+/-	2.5	50

1. All capacities shown are as indicated in District sewer model received by Tetra Tech

4.3 WASTEWATER TREATMENT PLANT

The TL-WWTF is an activated sludge plant that is designed for nitrogen removal through the use of alternating zones of on/off aeration. The plant is comprised of a headworks facility, three activated sludge basins, three final clarifiers, four flocculation basins, two tertiary plate clarifiers, chemical feed systems, and final effluent disinfection using UV. The three rectangular basins operate in parallel for plug flow design with each divided into alternating aerated and anoxic zones. Aeration is provided by micro-perforated, floating aerators. Biosolids are treated in solids lagoons that provide partial digestion and storage. Decant from the lagoon is pumped back to the head of the plant for retreatment. After a certain amount of time, operations staff dredges the lagoon and a third-party contractor dewaters the solids with mobile dewatering equipment. The dewatered solids are then hauled and disposed of by the contractor.

The plant underwent an expansion in the late 90's that increased the overall hydraulic and organic treatment. Currently the plant is rated at 4.2 MGD and 5600 lbs/day for hydraulic and organic treatment capacities respectively . In 2017, the TL-WWTF finalized construction of improvements (chemical addition for phosphorus removal and, flocculation and sedimentation basins) to meet Regulation 85 limits that established total phosphorus (TP) and total inorganic nitrogen limits (TIN). Since the-WWTF is in compliance with TIN limits, improvements to meet TP was only required.

4.3.1 Capacity

As part of the 90's plant expansion, one new activated sludge aeration basin and one new clarifier were installed to mitigate future increases in flow and loading. Meanwhile, flow to the plant has not yet become sufficient enough to warrant the simultaneous use of all three biological treatment trains. Operators have taken full advantage of this increased redundancy by cycling mixed liquor flow between all three clarifiers. Two of the original activated sludge aeration basins, A and B, are currently in continuous operation along with two of the three clarifiers. Basin C is not being utilized at this time due to insufficient loading to justify the financial burden of increased aeration demand. Table 4-8 shows the principal loading criteria governing the treatment plant's capacity.

Table 4-8 TLWWTP Design Capacity

Parameter[1]	Units	Influent	Current Operation	Full-Scale Design
Flow	MGD	1.2 / 1.5	1.75 / 2.8	2.64 / 4.2
BOD_5 Conc.	mg/L	252 / 311	243 / 303	244 / 330
BOD_5 Load	lb/day	2,402 / 2,810	3,576 / 4,379	4,978 / 5,781
Ammonia Conc.	mg/L	30 / 36	35.6 / 41.5	
Ammonia Load	lb/day	287 / 320	772 / 1,047	

(1) All capacities shown as average annual to 30-day maximum average

For all parameters the plant is currently operating below current rated loading capacity prior to full-scale system utilizationThe treatment plant is achieving good removal of BOD, TSS, and total inorganic nitrogen (TIN) of 99.2%, 99.1%, and 92.4%, respectively. Effluent BOD concentrations are typically around 3-5 mg/L and TIN is typically 4.1 to 6.2. The reduction in TIN is mainly due to the aerobic/anoxic zones present in the activated sludge basins which allow for nearly simultaneous nitrification and denitrification. While influent loading has not yet reached significant capacity, operation of only two treatment trains, instead of three, substantially reduces electricity and equipment maintenance costs.