



2018 WASTEWATER COLLECTION SYSTEM MASTER PLAN



Submitted To



LEWISVILLE


Deep Roots. Broad Wings. Bright Future.



Submitted By



BIRKHOFF, HENDRICKS & CARTER, L.L.P.
***SPECIALIZING IN CIVIL ENGINEERING FOR
MUNICIPALITIES AND GOVERNMENTAL AGENCIES***



July 2018

2018 WASTEWATER COLLECTION SYSTEM MASTER PLAN

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WASTEWATER MASTER PLAN MAP

John W. Birkhoff
7/31/18



CITY OF LEWISVILLE, TEXAS
2018 WASTEWATER COLLECTION SYSTEM
MASTER PLAN UPDATE REPORT

GENERAL

Previous analyses have been performed for the City of Lewisville's Wastewater Collection System, which have resulted in long-range plans for the system. The latest of these reports was completed in 2011. Since 2011, projected conditions have changed enough to warrant a new analysis of the system to take into account the new information from the 2018 Land Use Assumptions prepared by Freese & Nichols and the removal of 364-acres of Lord and Clem tracts from the master plan.

Although the proposed system is designed to accommodate the ultimate development of the City, it should be examined at intervals and revised to conform to any new conditions which may arise in the future. Likewise, prior to undertaking a major expenditure, an examination should be made to verify that design criteria used in developing the overall plan is still valid.

One focus of the 2018 Master Plan Update is the collection system improvements required to support development in the East Side of the City. It is now envisioned that flow in the Indian Creek basin will no longer be intercepted by the Indian Creek Lift Station and Force Main, but it will instead be conveyed through Castle Hills.

The proposed collection system improvements of this Master Plan Update were determined using the City's wastewater hydraulic model. The hydraulic model software is InfoSewer Pro Suite 7.6, running on the ArcGIS 10.4.1 platform. The model has been updated to reflect the most current service areas, future land uses, population projections and flow monitoring observations. The model is named the "Master Plan Model".

The purpose of the 2018 Master Plan update is to present the results from a re-examination of the elements in the wastewater system that will be required to serve the City when full development is reached and is the basis of the impact fee analysis.

PLANNING AREA

The current City Limits, the ETJ (Castle Hills), and the portion of Lakewood Hills are included in the wastewater collection system planning area. The total planning area for this study is approximately 22,223-acres, or 34.7-square miles. The approximately 7,788-acres of the City limits that are comprised of Lewisville Lake and the land owned by the Corp of Engineers, which lay in the corporate City limits where no development will take place, were not included in this study.

Parcels within the planning area were each classified by land use type and were used for wastewater flow calculations. Area that was not contained within the parcels, being typically right-of-way and greenspace, was not included in the calculations. Buildout land use composition by area is as follows: 25%-low density residential, 8%-high density residential, 2%-transportation-oriented development (T.O.D.), 4%-commercial, 9%-retail, 11%-industrial park, 12%-mixed use, 3%-public/semi-public, 17%-Lewisville commons, 2%-City uses, 8%-parks and open space. It should be noted that residential populations were determined for each sub-basin using the Land Use Assumptions reported Traffic Survey Zone (TSZ) populations.

SERVICE AREAS & SUB-BASINS

The planning area is now divided into the seventeen (17) separate drainage basin service areas, revised from sixteen (16) service areas in the previous master plan due to the revision of proposed lift stations for the East Side. These areas are generally defined by the natural topography. These service areas are shown by **Figure 1**. Flows generated from the service areas reach the City's wastewater treatment plant by combination of gravity lines, lift stations and force mains. Each major drainage basin is further divided into sub-basins, and a total of one-hundred two (102) sub-basins were individually assessed for land use composition and estimated for wastewater flows.



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July, 2018



FIGURE 1 MAJOR WASTEWATER SERVICE AREA BASINS

POPULATION

The projected build-out residential population of Lewisville used in this analysis is 163,162-people, which includes the Castle Hills and Lakewood Hills. The 2018, 2028 and Buildout residential populations for Lewisville were provided by the FNI Land Use Assumptions report. The populations are provided in **Table 1**.

TABLE 1
POPULATION PROJECTIONS (CITY LIMITS AND E.T.J.)

Year	Population
2018	120,624
2028	152,864
Buildout	163,162

The Land Use Report provides a table of populations that are divided among seventy-three (73) Traffic Survey Zone areas that were used to distribute the populations among the wastewater sub-basins. The existing population is approximately 74% of the anticipated buildout population.

The 2011 master plan projected a buildout residential population of 186,403-people for Lewisville City limits and ETJ. This master plan update is based on a buildout population projection that is reduced by 23,241-people, or 14% less than the previous master plan study. The actual population of Lewisville since 1980, together with the estimated population to build-out, is shown in **Table 2**.

TABLE 2
RESIDENTIAL POPULATION PROJECTIONS

Year	Status	2018 Report Population
1980	Actual	24,273
1990	Actual	46,521
2000	Actual	79,307
2006	Actual	89,100
2010	Actual	95,290
2015	Actual	99,480
2018	Actual	119,874
2020	Estimated	123,049
Build Out	Estimated	163,162

BUILDOUT WASTEWATER FLOWS

Buildout residential populations were provided by the Land Use Assumptions report for each Traffic Survey Zone. Those populations were distributed among the wastewater sub-basins and used to calculate and distribute the future generated average flows.

Buildout average flows were calculated for the projected 163,162-residents and 6,700-acres of non-residential land uses. Growth to buildout includes the addition of 42,538-residents and 1,819-acres of non-resident land use. The remaining growth represents 26% of the buildout population and 27% of the non-residential land use.

Table 3 summarizes the existing and buildout average flows calculated for each major wastewater collection basin. Generated flows utilized design demands and input from the 2017 Flow Monitoring Program completed by RJN Group, Inc. Existing per capita demands, calculated for the flow meter basins, ranged from 50 to 200-gallons per capita per day (gpcd). It was determined that an average daily flow of 19.60-MGD will be received by the WWTP at buildout. If the effluent flow at the WWTP continues to be reduced to 72% of the influent rate, due to the sludge removal and reuse processes, an effluent discharge rate of 14.2-MGD is expected at buildout. Today, the plant is permitted for 12-MGD.

TABLE 3

MAJOR COLLECTION BASIN DESIGN FLOWS (EXISTING & BUILDOUT)

Collection Basin (Service Area)	Service Area (Acres)	Average Daily Flow (MGD)					
		EXISTING (2018)			BUILDOUT		
		Residential	Non-Res.	Total	Residential	Non-Res.	Total
Castle Hills	2,813	1.59	0.11	1.70	2.63	0.25	2.89
Corporate	580	0.41	0.70	1.11	0.42	0.72	1.15
Denton Creek	2,745	1.08	0.57	1.64	1.18	0.78	1.95
Elm Fork	1,676	0.11	0.07	0.18	0.11	0.17	0.28
Fox Creek	1,253	1.11	0.79	1.90	1.12	0.79	1.91
Indian Creek*	667	0.15	0.15	0.30	1.21	0.19	1.40
Lakeside	714	0.31	0.01	0.33	0.34	0.01	0.35
Midway Branch	552	0.27	0.07	0.35	0.34	0.09	0.43
Midway Branch West	1,343	0.02	0.13	0.14	0.02	0.28	0.30
Old Town	737	0.26	0.21	0.47	0.37	0.23	0.60
Prarie Creek East	1,023	0.07	0.20	0.28	0.26	0.26	0.53
Prarie Creek North	811	0.37	0.14	0.51	0.96	0.21	1.17
Prarie Creek West	1,924	1.56	0.49	2.05	1.57	0.50	2.08
Timber Creek East	2,071	1.14	0.46	1.61	1.35	0.55	1.90
Timber Creek West	2,113	1.50	0.49	1.99	1.51	0.49	2.00
Whipporwill	663	0.22	0.01	0.23	0.36	0.03	0.40
WWTP	539	0.01	0.06	0.06	0.18	0.09	0.27
TOTAL:	22,223	10.19	4.65	14.85	13.95	5.65	19.60

*Lakewood Hills is included in the Indian Creek Basin

EAST SIDE COLLECTION SYSTEM

The Master Plan re-evaluates the Far East Lewisville Collection System. The major drainage basins on the East Side are: Indian Creek, Castle Hills and Midway Branch. A major change in this study is the removal of the Lord & Clem tract from the Indian Creek service area and replacing it with recently annexed Lakewood Hills. The Indian Creek Basin includes Lakewood Hills and the Sysco Food Processing Center. The Castle Hills Drainage Basin is a primarily residential area in the ETJ, and it includes a small area within the City limits. The Midway Branch drainage basin was split into two areas that are divided by S.H. 121 and by Holford Prairie Road.

The Eastside collection system has been reconfigured to allow flow generated in Indian Creek to gravity to the Castle Hills Lift Station by eliminating the intercepting Indian Creek Lift Station at F.M. 544 and Indian Creek. The previously-proposed Cross Roads Lift Station was also eliminated. The existing trunk main through Castle Hills will need to be paralleled to eliminate surcharging and overflow under buildout peak flow, and the Castle Hills Lift Station will require capacity expansion.

Flow generated by the Midway Branch, the Indian Creek and Castle Hills drainage basins is conveyed directly to the WWTP via the proposed Midway Branch Lift Station and Force Main.

EAST SIDE FACILITIES

The Castle Hills Trunk Sewer (Project: Castle Hills Phase-1) is primarily 24-inch and 21-inch diameter PVC sewer line constructed along Indian Creek. South of the railroad crossing (F.M. 544 and Indian Creek), the trunk line has a capacity of 3.2-MGD on the segments with the flattest slopes. The trunk sewer capacity increases downstream to approximately 8.5-MGD for the most downstream sections. Upstream, flow from Indian Creek is 4.2-MGD, and total flow is 10.5-MGD downstream near the Castle Hills Lift Station. At buildout the existing trunk line was surcharged with a predicted overflow in the Master Plan Model that utilized a wet weather peaking factor of 3.0, which is shown by **Figure 2**.

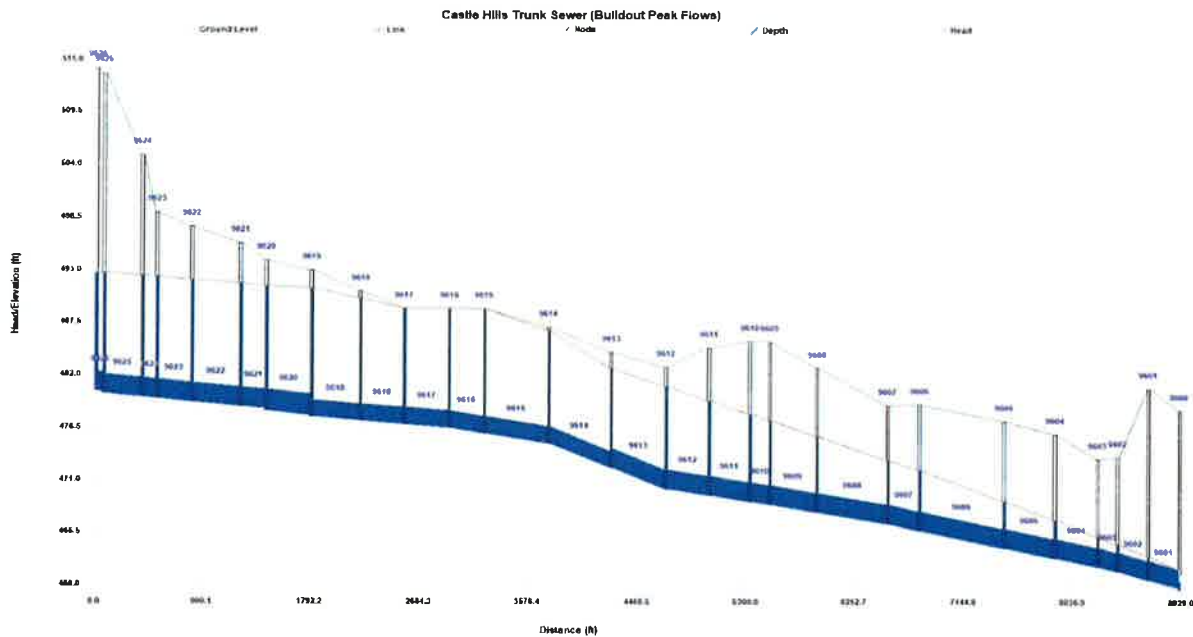


FIGURE 2 - EXISTING CASTLE HILLS TRUNK SEWER (Projected Buildout Flows)

In the future, approximately 7,300-linear feet of 21-inch diameter parallel trunk sewer will be required to eliminate surcharging and overflow. The parallel sewer will allow a free-flowing trunk line. Based on average slopes, the proposed 21-inch parallel sewer would provide an additional capacity in the range of 5.0-MGD. Alternatively, the existing trunk sewer can be replaced with a 30-inch diameter line for capacity in the range of 13.0-MGD.

The Castle Hills Lift Station, located near the intersection of King Arthur Boulevard and Morgan LeFay Lane, will require capacity improvements to convey the buildout peak flow, 10.5-MGD. The existing Lift Station uses a 16-inch diameter force main that is 6,000-linear feet in length. The TCEQ requires force main velocities between 3-feet per second (fps) and 6-fps, therefore the existing lift station pumping capacity, utilizing the 16-inch diameter force main, ranges from 2.7-MGD to 5.4-MGD. Pumping the Castle Hills Lift Station buildout peak flow, 10.5-MGD, would cause a 16-inch force main velocity of approximately 11.6-fps. For the purpose of this Master Plan, a parallel 20-inch force main is proposed to convey the buildout peak flows of the Castle Hills Lift Station. A single 24-inch diameter force main could replace the existing 16-inch for a capacity range of 6.1-MGD to 12.2-MGD.

The Castle Hills Lift Station is proposed for replacement to support the buildout East Side flows, including a new wet well, pumps and control panel. The proposed buildout firm capacity for the Lift Station is 13.5-MGD, based on additional calculations with the land uses and using the ASCE residential peaking factor from Curve A.

The Castle Hills Lift Station Force Main discharges into a 24-inch sewer that was constructed with the Castle Hills Phase-4, Section-A development. Although complete plans for this sewer line were not found, based on the known diameter and upstream and downstream flowline elevations, the 24-inch sewer has adequate capacity for the buildout flows. The Holford's 18-inch and 30-inch parallel sewers (Lewisville Project Nos. 4255 & U90805) also have adequate capacity. Downstream of the Holford's parallel sewers is the location of the proposed Midway Branch Lift Station. Based on calculations with the land uses and using the ASCE residential peaking factor from Curve A, the recommended buildout Firm capacity for the proposed Midway Branch Lift Station is 15.0-MGD.

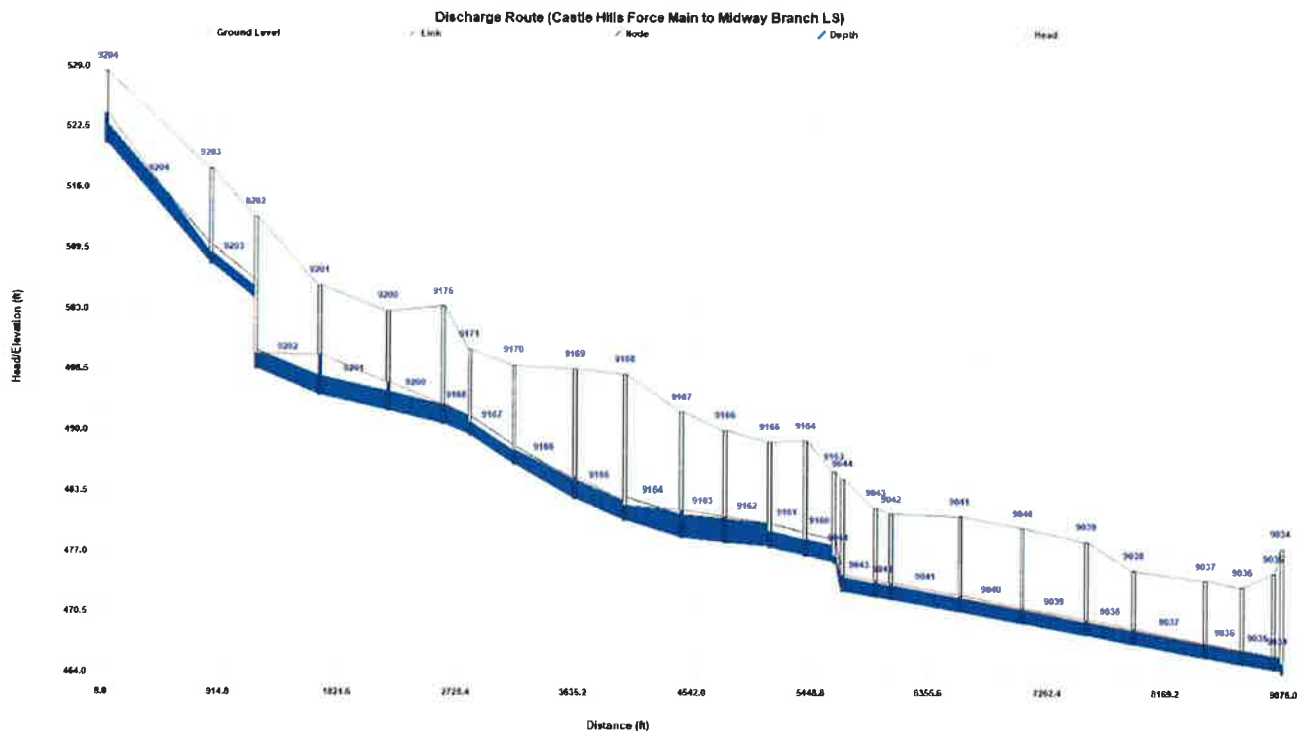


FIGURE 3 - CASTLE HILLS LIFT STATION OUTFALL SEWER (Projected Buildout Flows)

The full length of the route from the Castle Hills Force Main discharge manhole to the proposed Midway Branch Lift station is shown by **Figure 3**. Only minor surcharging is observed under peak buildout flows; 13.0-MGD at the downstream point and 10.9-MGD upstream.

It was determined that the 21-inch and 24-inch Holford's Prairie Trunk Sewer downstream of the Midway Lift Station must remain in service to serve development along Corporate Drive, near Huffines Boulevard. This trunk discharges into the Timber Creek Lift Station.

WASTEWATER LIFT STATIONS

The six (6) lift stations included in the master plan model were: Prairie Creek, Timber Creek, Vista Ridge, Whippoorwill, Midway Branch (proposed) and Castle Hills (existing & proposed configurations). Firm capacity for the future Midway Branch, Castle Hills and rehabilitation of Vista Ridge were based on per capita flows of 100-gpcd, 1,000-gpad for non-residential, 700-gpad for I&I and the ASCE Peaking Factors.

TABLE 4
BUILDOUT FLOWS TO LIFT STATION

Lift Station	Lift Station Service Area (Acres)	Proposed Buildout FIRM Capacity (MGD)
Prairie Creek	6,990	22.0
Timber Creek	10,729	28.0
Vista Ridge	2,745	10.0
Whippoorwill	481	2.0
Castle Hills	2,714	13.5
Midway Branch	4,234	15.0

A. Prairie Creek Lift Station

The Prairie Creek Lift Station is situated at the City of Lewisville Wastewater Treatment Plant. It is a ‘headworks’ lift station that serves to elevate the water surface of the influent flow so that it may be conveyed via gravity through the treatment system components. Total wet well dimensions are approximately 23-feet by 30-feet and 19-feet deep. The 24-inch diameter Timber Creek Lift Station force main is shown by the plans to be routed through, and metered at, the Prairie Creek Lift Station building, but the Prairie Creek Lift Station does not re-lift the Timber Creek flow. The 16-inch diameter cast-iron force main is approximately 500-LF and discharges into the fine screens unit of the treatment plant.

The Lift Station is equipped with six (6) pumps, and has a Firm pumping capacity of 24.0-MGD. The required Firm capacity for buildout is 22.0-MGD.

B. Timber Creek Lift Station

The Timber Creek Lift Station is the largest lift station in the City's collection system. Total wet well dimensions are 32.5-feet by 83-feet and 37.5-feet deep. Timber Creek Lift Station operates dual 24-inch and 36-inch force mains in parallel (Lewisville Project Nos. WPC-TEX-1111 & 4399, respectively). Each force main is approximately 18,500-LF in length. The Lift Station is provided with seven (7) available pump slots, and currently four (4) pumps are installed. There are two larger pumps and two smaller pumps. The calculated existing Firm capacity of the Lift Station is 21.2-MGD. The required Firm capacity for buildout is 28.0-MGD.

This master plan update included model revisions to more accurately simulate the dual force main configuration of the Timber Creek lift station. At the anticipated buildout peak flow rate, 28.0-MGD, the 24-inch force main is calculated to convey approximately 7.2-MGD at 3.6-fps velocity, and the 36-inch force main would convey approximately 20.8-MGD at 4.5-fps velocity. This lift station uses variable frequency drives to throttle the motor speeds allowing flexibility in pumping rates.

C. Vista Ridge Lift Station

The Vista Ridge Lift Station serves the most southerly service area on the West Side, the Denton Creek major drainage basin. Denton Creek is largely composed of non-residential land uses and is approximately 73-percent developed at this time. The Vista Ridge total wet well dimensions are approximately 22-feet by 35-feet and 31-feet deep, and the 24-inch diameter force main is approximately 7,990-LF. Capacity of the 24-inch force main ranges from 6.1-MGD to 12.2-MGD, with force main velocities of 3-fps and 6-fps, respectively.

The City is in the process of pump replacement for Vista Ridge. The existing calculated Firm pumping capacity is 7.9-MGD with two (2) of the three (3) currently-installed pumps running. The required Firm capacity for buildout is 10.0-MGD. This lift station will be furnished with variable frequency drives.

D. Whippoorwill Lift Station

The Whippoorwill Lift Station exists in the northwest City of Lewisville planning area and serves approximately 480-acres of residential units. Constructed in 1987, Whippoorwill was designed and constructed to serve a portion of the City of Highland Village which is outside the current planning area. Highland Village flows are being conveyed to the Upper Trinity Regional Water District facilities. The previous master plan accounted for future connection of the proposed Lakeside TOD lift station to the Whippoorwill service area, but it was recently decided to re-route those flows southerly, to the Prairie Creek North drainage basin. As a result of the planning changes, the Whippoorwill Lift Station is oversized for the projected buildout flows, and the lift station service area is fully developed.

The total wet well dimensions of Whippoorwill are approximately 13-feet by 39-feet and 32-feet deep, and the 20-inch diameter, ductile iron pipe force main is approximately 5,700-LF. Four (4) pump slots are available, and there are three (3) installed two-speed Cornell Pumps ((2)- 8" 8NHTA-8VCX & (1)- 10" 10NHTA-VF12). The existing pumps were installed with the original construction and are approximately 30-years old. The Firm capacity of the two smaller pumps was calculated to be 7.3-MGD. The required Firm capacity for buildout is 2.0-MGD. The City is currently replacing these pumps and motors.

E. Castle Hills Lift Station

The Castle Hills Lift Station is situated in the City's ETJ and is not operated by the City at this time. Constructed in 1997 with Castle Hills Phase-1, the station serves Indian Creek and most of the Castle Hills (ETJ) developments. A 421-acre portion of the western ETJ area, Castle Hills, do not flow to the Castle Hills Lift Station. Two (2) circular wet wells, each 6-feet in diameter, operating in parallel. Each wet well has just one pump installed. The existing 16-inch diameter force main is approximately 6,000-LF, and it is routed northeasterly, discharging to the Midway Branch Drainage Basin.

The Firm pumping capacity was not verified, and we recommend that the pumping capacity of this Lift Station be field measured. The Castle Hills Lift Station is proposed for replacement, including new wet well, pumps, control panel and parallel 20-inch force main. The force main will discharge into the existing 24-inch trunk sewer (Castle Hills - Phase 4 project). The required Firm capacity for buildout is 13.5-MGD.

F. Midway Branch Lift Station (Proposed)

The proposed Midway Branch Lift Station will intercept the East Side-generated flow (a 4,234-acre service area), and pump the flow directly to the WWTP, relieving the Timber Creek Lift Station. The required Firm capacity of the proposed Lift Station is 15.0-MGD.

Preliminary design of the Midway Branch Lift station includes a wet well with total dimensions 48-feet by 20.5-feet and 38-feet deep. Four (4) pump slots are provided.

The currently-proposed 30-inch diameter force main is approximately 19,400-LF and has a capacity range of 9.5-MGD to 19.0-MGD, based on the recommended velocity range of 3-fps to 6-fps. The capacity range of a 27-inch diameter force main is 7.7-MGD to 15.4-MGD.

LEWISVILLE WASTEWATER TREATMENT PLANT

The City owns and operates the wastewater treatment plant which serves the entire planning area, including the ETJ. The plant currently operates under a 12.0-MGD effluent discharge permit. Planning for expansion of treatment plant capacity and permit limits should follow Rule §305.126(a) of the Texas Administrative Code. The rule, known as the ‘75%/90%-Rule’, sets timeline parameters for capacity expansions. The rule states:

“Whenever flow measurements for any sewage treatment plant facility in the state reaches 75% of the permitted average daily or annual average flow for three consecutive months, the permittee must initiate engineering and financial planning for expansion and/or upgrading of the wastewater treatment and/or collection facilities. Whenever the average daily or annual average flow reaches 90% of the permitted average daily flow for three consecutive months, the permittee shall obtain necessary authorization from the commission to commence construction of the necessary additional treatment and/or collection facilities.”

Based on the 75%/90%-Rule, the City should begin planning for WWTP expansion when the monthly effluent, discharge flow, rate averages 9.0-MGD for three (3) consecutive months, and implementation of the expansion shall be triggered when the effluent rate averages 10.8-MGD for three (3) consecutive months.

Today, the average influent flow rate for the planning area is approximately 11.7-MGD, but the average effluent rate is 8.3-MGD which is approximately 72% of the influent flow rate. The effluent

flow rate determines the permit requirements. Two consecutive months in 2018 averaged effluent rates that were greater than 9.0-MGD, thus the requirement to begin planning for WWTP expansion is near. It is estimated that planning for the expansion should begin within the next two years.

The buildout average flow rate for the entire planning area is 19.6-MGD, based on the revised land uses, populations and flow assumptions. (Approximately 2.7-MGD of the total average flow will be generated by the ETJ.) If the effluent discharge flow rate continues to be 72% of the influent flow rate, the required discharge permit for buildout would be approximately 14.1-MGD, due to the sludge removal and reuse processes.

Projected peak buildout influent flow at the WWTP is 64.9-MGD.

EXISTING LINE ANALYSIS

A model-based analysis of the existing collection lines was conducted to determine if lines are of adequate size to carry buildout flows with a reasonable amount of Inflow & Infiltration, which was determined to be at a peak factor of 3.0. Any peak flows having a peaking factor above 3.0 signify excessive Inflow & Infiltration, and steps are required to repair the lines to reduce the Inflow & Infiltration and overall treatment.

The model results predicted one segment of line along the 24-inch and 27-inch Prairie Creek East Trunk, to experience overflow. In this condition, it was determined that future growth exceeds the available capacity and system improvements are warranted. An 18-inch and 15-inch relief sewer along this trunk line, from Manhole No. 2016 to Manhole No. 2004, is required to relieve the over flow condition. The noted lines are the upstream 24-inch sections of the Prairie Creek East Trunk Sewer. The length is approximately 4,200-linear feet. The relief sewer is predicted to eliminate potential overflows, however, surcharging would still occur.

Alternatively, the improvements could be extended downstream to also parallel the existing 27-inch sections of the trunk line. The total length of repair, between Manhole No. 2016 and Manhole No. 1018 is approximately 7,870-linear feet. The full-length relief line allows this segment to be in free flow conditions.



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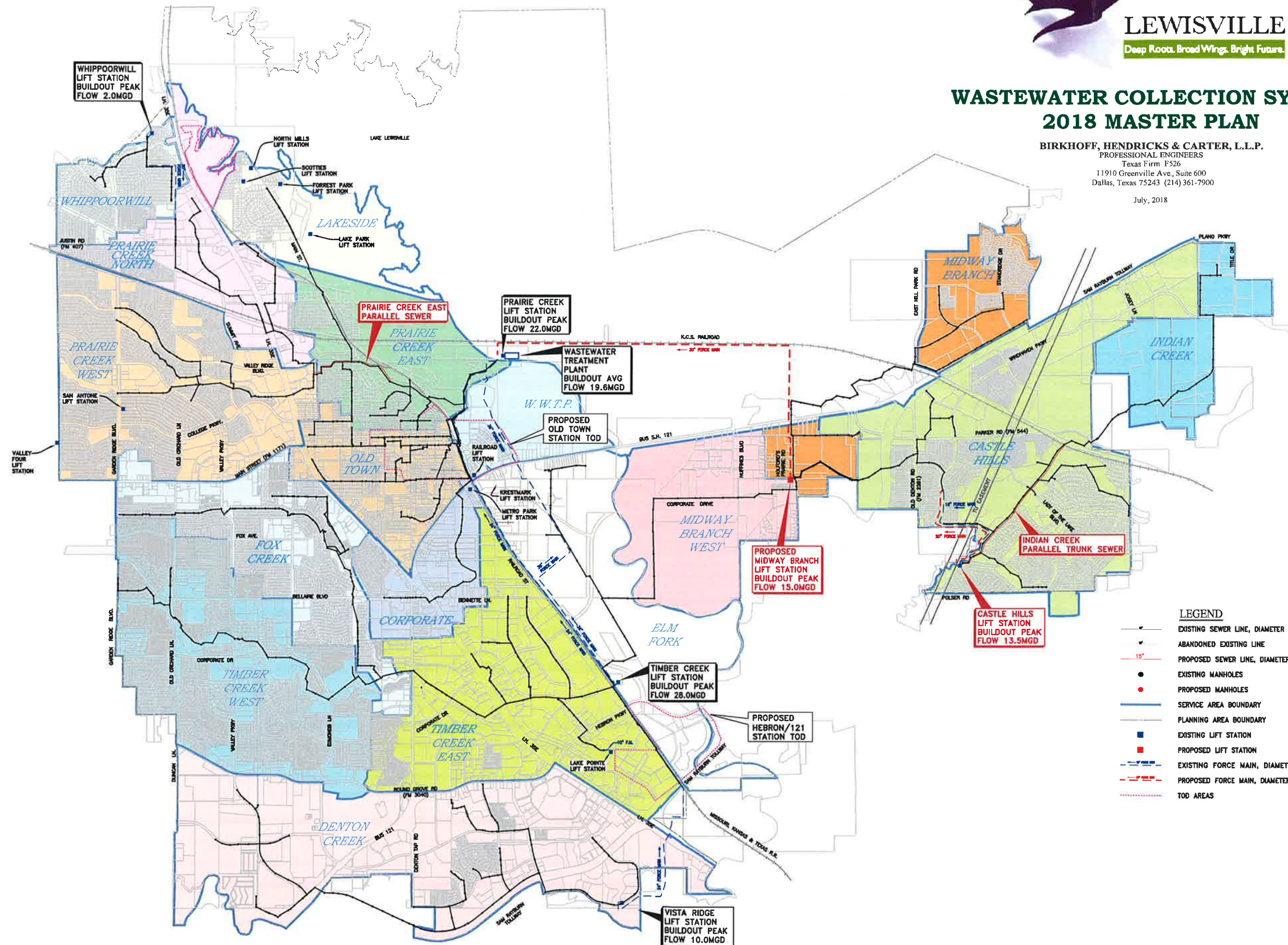
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SCALE: 1"=4500'

LEGEND

- EXISTING SEWER LINE, DIAMETER
- ABANDONED EXISTING LINE
- PROPOSED SEWER LINE, DIAMETER
- EXISTING MANHOLES
- PROPOSED MANHOLES
- SERVICE AREA BOUNDARY
- PLANNING AREA BOUNDARY
- EXISTING LIFT STATION
- PROPOSED LIFT STATION
- EXISTING FORCE MAIN, DIAMETER
- PROPOSED FORCE MAIN, DIAMETER
- TOD AREAS



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