LAWRENCE STATION AREA PLAN

PROPOSED INCREASE IN HOUSING POTENTIAL WITHIN THE LSAP (HOUSING EXPANSION BUILDOUT) INFRASTRUCTURE IMPACT STUDY

June 22, 2020

BkF 100+ YEARS
ENGINEERS . SURVEYORS . PLANNERS

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SECTION 1: INTRODUCTION AND PROJECT DESCRIPTION

1.1 Project Overview

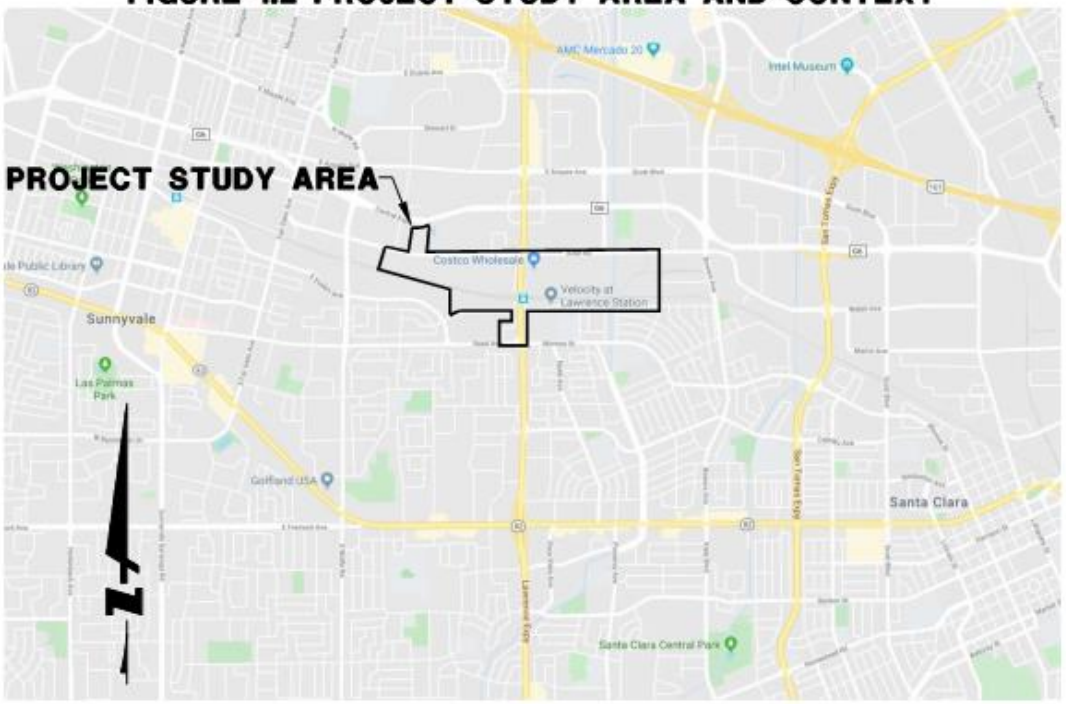
The proposed Lawrence Station Area Plan (LSAP) Amendment Project (Project) is generally centered around a ½ mile radius of the existing Lawrence Caltrain Station at 137 San Zeno Way in Sunnyvale, California and is approximately 252.09 acres. The overall LSAP project is divided into two study areas: the Housing Expansion Study Area (i.e. proposed modifications to the adopted LSAP would allow for an addition of 3,612 net new units within portions of the adopted LSAP) and the Office Expansions Study Area. This Infrastructure Study will address the Housing Expansion Study Area which is bounded by the City of Santa Clara to the north and east, Reed Avenue, Aster Avenue, and the railroad right of way (ROW) to the south, and the Intuitive Surgical (ISI) offices to the west. The project site is located in the far eastern area of the City of Sunnyvale around the Lawrence Caltrain station. Figure 1.1 - Project Location - illustrates the regional location of the Project.

The Housing Expansion Study Area is approximately 219.70 acres that include 25.27 acres of public ROW, 17.94 acres of railroad ROW, and 176.49 acres of existing developments.

The Office Expansion Study Area is approximately 32.39 acres industrial land owned by ISI that is proposed for redevelopment as office/R&D that encompasses existing developments for ISI and an industrial site. The office LSAP is bounded by Central Expressway and Kifer Road to the north, City of Santa Clara and the Housing Expansion Study Area to the east, railroad ROW to the south, and commercial developments east of Commercial Street and San Lucar Court. Figure 1.2 - Project Study Area and Context - illustrates the Study Area Boundaries and the location of the Project within the City. Please refer to the Office Expansion Buildout Infrastructure Impact Study for analysis within the Office Expansion Study Area.

FIGURE 1.1 PROJECT LOCATION

FIGURE 1.2 PROJECT STUDY AREA AND CONTEXT



The housing expansion study area includes a mixed-use community with a wide range of residential, retail, and office. Existing utility infrastructure requiring upgrades to serve the

proposed increase in allowable housing potential within the adopted LSAP (i.e. the addition of 3,612 net new units within the LSAP) will be identified in this study.

1.2 Lawrence Station

1.2.1 Existing Conditions and Land Use

The LSAP area is approximately 252.09 acres. The study area includes portions of the Lawrence Caltrain station as well as existing commercial, industrial, and residential properties. Existing conditions and Land Uses within the LSAP include several development projects under construction, including new office buildings, mixed-use residential and retail, and self-storage.

1.2.2 Adopted LSAP Conditions

In December 2016, the Sunnyvale City Council approved the LSAP and its associated General Plan Amendment and Rezoning. The LSAP consisted of primarily residential redevelopment with office and research and development (R&D) developments interspersed. The adopted LSAP includes 2,323 residential units and 1,200,000 square feet (sf) of net new office/R&D development.

1.2.3 Proposed Conditions

At the time of the City's LSAP adoption (December 2016), the Sunnyvale City Council directed staff to return with a plan to study additional housing opportunities within the LSAP area. There are no planned increases to office/R&D development potential. The City Council subsequently selected a preferred land use alternative on June 26, 2018, which studies an increase in the residential density allowance for both MXD-I (Flexible Mixed-Use I) and MXD-II (Flexible Mixed-Use II) zoned areas, and expands the area where housing may be considered to the M-S/LSAP (Industrial and Service, LSAP Combining District) and O-R (Office/Retail) zoning districts.

Residential development capacity under the adopted LSAP allows for a maximum of 2,323 net new dwelling units under the plan's 'Estimated Likely Development Scenario'. A

total of 1,261 net new housing units have been approved by the City since the LSAP was adopted in December 2016; therefore, a balance of 1,062 net new housing units currently remains for buildout within the adopted LSAP. With implementation of the proposed LSAP Update, the addition of 3,612 net new units would be allowable within the plan area. In addition, the maximum density allowance (with incentives) for MXD-I and MXD-II zoned areas within the LSAP would increase from 68 dwelling units per acre (du/ac) to 100 du/ac. The project would also expand where new housing may be considered to the M-S/LSAP zoning district with a maximum density allowance (with incentives) of 100 du/ac and O-R zoning district with a maximum density allowance (with incentives) of 54 du/ac. The housing expansion study area for the LSAP update is shown in Figure 1.3 – Proposed LSAP Study Area Layout.

1.3 Project Datum

All elevations referenced herein are based on the following:

- Vertical datum used in the City of Sunnyvale's Utility and GIS Maps
- Record drawings provided by the City for Aster Avenue and Willow Avenue
- Manhole survey data provided by the City for Lawrence Expressway

CENTRAL EXPWY
CITY OF SUNNYVALE
CITY OF SANTA CLARA
CENTRAL EXPWY
COMMERCIAL ST
945 KIFER
955 KIFER
KIFER RD
KIFER RD
932 KIFER
950 KIFER
JPB RIGHT-OF-WAY
MXD-II
SAN ZENO WAY
MXD-I
LAWRENCE EXPWY
MXD-I
LAWRENCE STATION RD
CALABAZAS CREEK
MXD-II
M-S/LSAP
URANIUM DR
SONORA CT
MXD-I
LAWRENCE VTA STATION
JPB RIGHT-OF-WAY
E EVELYN AVE
MXD-III
ASTER AVE
AGATE DR
EL CAMINO CHANNEL
WILLOW AVE
R-5
EL CAMINO CHANNEL
O-R
FRENCH ST
MONROE ST
REED AVE
CITY OF SUNNYVALE
CITY OF SANTA CLARA
GRAPHIC SCALE
600 0 600

LEGEND

- CITY BOUNDARY
- HOUSING EXPANSION STUDY AREA
- OFFICE EXPANSION STUDY AREA
- PUBLIC RIGHT-OF-WAY

DATE:	06/22/2020
SCALE:	1"=600'
DESIGN:	BPB
DRAWN BY:	NRF
APPROVED:	TRM
JOB NO:	20180080

BKF ENGINEERS / SURVEYORS / PLANNERS
255 SHORELINE DRIVE SUITE 200
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LSAP HOUSING EXPANSION BUILDOUT INFRASTRUCTURE IMPACT STUDY

FIGURE 1.3 – PROPOSED LSAP STUDY AREA LAYOUT

DRAWING NAME: \\bkf-fs\VOL4\2018\180080_LSAP_Housing\ENG\EXHIBITS\Master Plan\Figure 1.3 – Proposed Site Layout.dwg
PLOT DATE: 06-19-20
PLOTTED BY: lnou

SECTION 2: POTABLE WATER SYSTEM

2.1 Potable Water System Design Criteria

The design criteria used for the development of the potable water model is based upon established industry operations standards and regulatory agency requirements. The potable water system will be designed in accordance to the City of Sunnyvale's Standard Plans and Specifications and to applicable City, State, and Federal water and fire codes and standards unless otherwise permitted. Since the City of Sunnyvale does not have written standards for water generation, this report will use Redwood City's Design Standards to estimate project water demands based on correspondence between the City and BKF. The one exception is that this analysis will calculate residential demand using 55 gallons per day per capita based on correspondence between BKF and the City of Sunnyvale. The intent of this study is to identify which existing City water mains will need to be upgraded in order to provide adequate water supply to the LSAP. All existing water mains are located within the City Right-of-Way except for an existing 12-inch main running between Kifer Road and Sonora Court located in a public utility easement.

The design criteria are dependent on the demand scenario. Table 2.1 – Potable Water System Demand and Peaking Factor presents the potable water system demand and peaking factor for the demand scenario. Assumed peaking factors for max day demand and peak hour demand scenarios are based on correspondence between BKF and the City of Sunnyvale.

Table 2.1
Potable Water System Demand and Peaking Factor

Parameter	Value
Average Day Demand (ADD)	1,319,228 gpd
Fire Flow Demand (FF)	4,500 gpm
Maximum Day Demand (MDD)	MDD = 2.0 ADD
Peak Hour Demand (PHD)	PHD = 3.0 ADD

Notes:
1. Fire flow demand based on an assumed R-2 Occupancy type building and construction Type III-A,

assuming 25% fire flow reduction for sprinkling.
2. gpd = gallons per day
3. gpm = gallons per minute

Table 2.2 – Potable Water System Design Criteria presents the potable water system design criteria.

Table 2.2
Potable Water System Design Criteria

Parameter	Value
Pipe size	Pipe diameters of 8, 10, 12, and 16 inches shall be used for all distribution and feeder mains.
Pipe Material	For water mains 12-inches and smaller shall be C900 DR14 PVC pipe or AWWA C-151/A21.51 ductile iron pipe (DIP). Water mains larger than 12-inches shall be C905 DR14 PVC or AWWA C-151/A21.51 DIP.
Hazen Williams C-value for recommended pipes	140 for DIP, 150 for PVC
Maximum static pressure	120 psi
Maximum velocity during PHD	7 fps
Maximum velocity during MDD+FF	15 fps
Minimum system pressure during MDD+FF	20 psi

Notes:
fps = feet per second
psi = pounds per square inch

2.2 Potable Water System Layout

Potable water is supplied to the LSAP by the City of Sunnyvale through an existing 12-inch diameter cast iron pipe (CIP) in Lawrence Expressway from the north and a 12-inch diameter asbestos-concrete pipe from the south. Additionally, there is an existing 12-inch diameter CIP in Kifer Road. Aster Avenue and Reed Avenue both contain existing 10-inch diameter CIPs. Existing potable water system layout is shown on Figure 2.1 – Existing Potable Water System.

2.3 Upgraded Potable Water System

2.3.1 Proposed Water Demand Factors

The potable water demand factors used for the Project's various land uses are shown in Table 2.3 – LSAP Potable Water Demand Factors (ADD). The total estimated water demands for the Project land uses are shown on Table 2.4 – Total Buildout Potable Water Demand Summary (ADD). Water demands are derived from Redwood City's Design Standards with the exception of indoor water demands. Per capita demands for indoor residential demand was determined based on input from the City of Sunnyvale.

Table 2.3
LSAP Potable Water Demand Factors (ADD)

Land Use	Indoor Potable Water Demand Factors (ADD)	Outdoor Potable Water Demand Factors (ADD)	Total Water Demand (ADD)
Residential[1]	121 gpd/unit	37.4 gpd/unit	158.4 gpd/unit
Office/R&D	0.13 gpd/sf	0.072 gpd/sf	0.202 gpd/sf
Industrial	0.21 gpd/sf	0 gpd/sf	0.21 gpd/sf
Restaurant	30 gpd/seat	0 gpd/seat	30 gpd/seat
Storage Facility	0.003 gpd/sf	0 gpd/sf	0.003 gpd/sf

Notes:
1. Indoor potable water demand based on 55 gpd/person * 2.2 persons/unit. Outdoor potable water demand based on 17 gpd * 2.2 persons/unit. 55 gpd/person was determined after a phone conversation between BKF and Eric Evans with the City of Sunnyvale.
2. sf = square feet

2.3.2 Model Results Discussion

The existing potable water system is sufficient to supply the potable water demands as well as provide fire flow to the study area. Under the scenario of max day demand and fire flow, the water model analysis determined that the flow demand would be at its highest of any scenario at 4,820 gpm as seen in Appendix C-3 – Model Demand Scenario 3: Max Day Demand + Fire Flow. However, the existing potable water system is able to provide a flow between 5,000 and 6,000 gpm, which sufficiently meets the max day and fire flow demands. The impact of the proposed LSAP indicates that no improvements are required for the City's potable water system.

2.4 Potable Water System Model Water Demands

2.4.1 Sources of Land Use Water Demand Data

Potable water demand factors for the model analyses are shown in Table 2.3 – LSAP Potable Water Demand Factors (ADD) and were applied to the project program to develop the project potable water demand total. Table 2.4 – Total Buildout Potable Water Demand Summary (ADD) provides water demands by land use including proposed sites associated with the LSAP and existing parcels expected to remain within the LSAP area.

See Appendix E – Potable Water System Demand Calculations, for model demand calculations on a block by block basis. Total project development will not exceed the demands presented in Table 2.4 – Total Buildout Potable Water Demand Summary.

2.4.2 Average Day Demand (ADD)

The demand factors are presented in Table 2.3 – LSAP Project Potable Water Demand Factors (ADD). The demand summary for the overall LSAP Housing Expansion including proposed sites associated with the LSAP and existing parcels to remain is presented in Table 2.4 – Total Buildout Potable Water Demand Summary (ADD). Table 2.5 – Office Expansion Study LSAP Potable Water Demand Summary (ADD) reflects the average day demand for the Office Expansion Study.

Table 2.4
Total Buildout Potable Water Demand Summary (ADD)

Land Use	Number	Unit	Demand/Unit (gpd)	Total (gpd)
Residential	5,935	Units	158.4	940,104
Office/R&D	1,212,374	sf	0.202	244,900
Industrial	614,598	sf	0.21	129,065
Restaurant[1,2]	156	seat	30	4,680
Storage Facility	159,637	sf	0.003	532
			Total	1,319,281

Notes:

1. Existing restaurant located at 1210 Kifer Road is assumed to have 156 seats. This is based on the assumption that 50% of restaurant space (7,800 sf total) is for patrons and one 10'x10' table has seating for 4 people. The calculation is as follows:

$$(7{,}800\ sf \times 0.5) \times \left(\frac{4\ seats}{100\ sf}\right) = 156\ seats$$

2. Restaurant is defined as employee amenity space.
3. The square footage numbers provided in this table present the project buildout numbers and the existing parcels expected to remain.

Table 2.5
Office Expansion Study LSAP Potable Water Demand Summary (ADD)

Land Use	Number	Unit	Demand/Unit (gpd)	Total (gpd)
Office/R&D	351,000	sf	0.202	70,902
Industrial	831,000	sf	0.21	174,510
Restaurant[1,3]	580	seat	30	17,400
			Total	262,812

Notes:

1. Total restaurant seating is assumed to be 580 seats. This is based on the assumption that 50% of restaurant space (29,000 sf total) is for patrons and one 10'x10' table has seating for 4 people. The calculation is as follows:

$$(29{,}000\ sf \times 0.5) \times \left(\frac{4\ seats}{100\ sf}\right) = 580\ seats$$

2. Block by block water demand calculations shown in Appendix E.
3. Restaurant is defined as employee amenity space.

2.4.3 Maximum Day Demand

Maximum Day Demand (MDD) represents the maximum volume of water used in a 24-hour period for the entire year. A water system is typically evaluated under a maximum day plus fire flow demand condition as this condition allows the system to be stressed at a higher demand rate to ascertain if pipeline carrying capacities are adequate in a fire emergency. As identified in Table 2.1 – Potable Water System Demand and Peaking Factor, a peaking factor of 2 was applied to ADD.

2.4.4 Peak Hour Demand

Peak Hour Demand (PHD) represents the highest hourly demand for the entire system, and simulates the highest flow rate expected. To determine the PHD, a peaking factor was applied to increase the ADD. Peaking factors represent the increase above ADD and are a statistical concept typically obtained from historical data. As identified in Table 2.1 – Potable Water System Demand and Peaking Factor, a peaking factor of 3 was applied to ADD.

2.4.5 Fire Flow Demand

The fire flow (FF) demand is assumed to be 4,500 gallons per minute (gpm) based on correspondence between the City of Sunnyvale, Ascent Environmental, and BKF Engineers.

2.5 Potable Water System Model Boundary Conditions

The recommended potable water system is modeled based on calibrated boundary conditions and fire hydrant flow data received from the city completed for the LSAP Project. Since the LSAP Project is redeveloping existing lots, the recommended water model is analyzing existing City water mains and identifying which water mains will need to be upgraded in order to provide adequate water supply for the redevelopment.

2.6 Potable Water System Model Scenario

The LSAP water model was created in Bentley Water CAD V8i SELECT series 1. A series of model scenarios were created to reflect the range of demand usage patterns and confirm conformance to the Potable Water System Design Criteria outline in Table 2.2 – Potable Water System Design Criteria. Three model runs are prepared for the Housing Expansion Study Area and are shown in Table 2.6 – LSAP Project Model Runs – Housing Expansion Study.

Table 2.6
LSAP Project Model Runs – Housing Expansion Study

Run	Description
1	Static Pressures
2	Peak Hour Demand
3	Maximum Day Demand + Fire Flow

See Appendix C – LSAP Potable Water Model Reports for model run results.

2.7 Recommended Potable Water System Model Results

The existing potable water system, as shown in Appendix C – LSAP Potable Water Model Reports, is designed to meet the design criteria outlined in Table 2.2 – Potable Water System Design Criteria. Table 2.7 – Potable Water System Results for Housing Expansion Study summarizes the pressure and velocity results for the referenced model scenarios listed in Table 2.6 – LSAP Project Model Runs – Housing Expansion Study. Refer to Appendix C – LSAP Potable Water Model Reports for detailed results of model scenarios.

Table 2.7
Potable Water System Results for Housing Expansion Study

Parameter	Requirement	Minimum	Maximum
Static ADD Pressure (psi)	120 max	68	85
PHD Velocity (fps)	7 max	-	2.96
MDD+FF Pressure (calculated system lower limit at total flow available) (psi)	20 min	33	-
MDD+FF Velocity (fps)	15 max	-	< 15

Note:
MDD+FF pressure was 4,820 gpm, however the model was allowed to run with flows higher than 5,000 gpm, which resulted in it stopping at 15 fps.

2.8 Potable Water System Conclusion

Based on the results shown in Appendix C-2 – Model Demand Scenario: Peak Hour Demand and C-3 – Model Demand Scenario: Max Day Demand + Fire Flow, the existing potable water system is sufficient to meet proposed potable water and fire flow (FF) demands during average day demand (ADD), max day demand (MDD), and peak hour demand (PHD). No new upgrades to the potable water system were determined to be needed at this time. A water supply analysis will be prepared by Ascent Environmental.

EX 8" PW
EX 8" PW
CENTRAL EXPWY
CITY OF SUNNYVALE
CITY OF SANTA CLARA
CENTRAL EXPWY
EX 8" PW
COMMERCIAL ST
EX 8" PW
EX 12" PW
EX 12" PW
KIFER RD
EX 12" PW
EX 12" PW
KIFER RD
SAN ZENO WAY
EX 12" PW
EX 10" PW
LAWRENCE EXPWY
CALABAZAS CREEK
URANIUM DR
EX 12" PW
JPB RIGHT-OF-WAY
LAWRENCE STATION RD
EX 10" PW
SONORA CT
EX 10" PW
LAWRENCE VTA STATION
EX 10" PW
E EVELYN AVE
JPB RIGHT-OF-WAY
EX 10" PW
AGATE DR
ASTER AVE
EX 10" PW
EL CAMINO CHANNEL
WILLOW AVE
EX 10" PW
EL CAMINO CHANNEL
EX 10" PW
EX 12" PW
FRENCH ST
MONROE ST
EX 10" PW
EX 10" PW
REED AVE
EX 10" PW
CITY OF SUNNYVALE
CITY OF SANTA CLARA

GRAPHIC SCALE
600 0 600

LEGEND

- CITY BOUNDARY
- EX 8" PW
- EX 10" PW
- EX 12" PW

DATE:	06/22/2020
SCALE:	1"=600'
DESIGN:	BPB
DRAWN BY:	NRF
APPROVED:	TRM
JOB NO:	20180080

BKF ENGINEERS / SURVEYORS / PLANNERS
255 SHORELINE DRIVE SUITE 200
REDWOOD CITY, CA 94065
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LSAP HOUSING EXPANSION BUILDOUT INFRASTRUCTURE REPORT

FIGURE 2.1 – EXISTING POTABLE WATER SYSTEM

DRAWING NAME: \\bkf-fs\VOL4\2018\180080_LSAP_Housing\ENG\EXHIBITS\Master Plan\Water\Housing\Figure 2.1 – LSAP Existing Potable Water System.dwg
PLOT DATE: 06-19-20
PLOTTED BY: lnou

SECTION 3: SANITARY SEWER SYSTEM

3.1 Sanitary Sewer System Design Criteria

The design criteria used for the development of the sanitary sewer model is based upon established industry operations standards and regulatory agency requirements. The sanitary sewer system will be designed in accordance to the City of Sunnyvale's Standard Plans and Specifications and to applicable City, State, and Federal water codes and standards unless otherwise permitted. At certain locations within the project area, City design guidelines were supplemented with manhole survey data and record drawings provided by the City. Sanitary sewer generation is assumed to be 95% of indoor potable water demands. This infrastructure study will identify which existing City sewer mains will need to be upgraded in order to support the anticipated sewer flows from the development within Housing Expansion Study Area. All existing sewer mains are located within the City right-of-way. The pipe material of existing sewer mains is vitrified clay pipe (VCP). The design criteria are dependent on the demand scenario. Table 3.1 – Sanitary Sewer System Design Criteria presents the sanitary sewer system design criteria based on the supplemental information received from the City.

Table 3.1
Sanitary Sewer System Design Criteria

Parameter	Value
Minimum pipe size	8-inch inside diameter
Pipe Material	PVC SDR-26 or better
Manning's coefficient, n, for recommended PVC pipes	0.01
Minimum Slope	0.5% (0.005 feet/feet) for sewer diameters 8-inches and smaller, 0.4% (0.004 feet/feet) for sewer diameters 10-inches and larger.
Maximum Slope	14.0% (0.14 feet/feet)
PWWF Maximum Pipe Flow Depth Ratio, *d/D*	0.5 for sewer diameters 10-inches and smaller, 0.75 for sewer diameters 12-inches and larger
Minimum Depth of Cover	5 feet below finished grade
Sewer Generation	95% of indoor potable water demand

Notes
ADWF = Average Dry Weather Flow
d/D = ratio of depth of flow (*d*) to the pipe inside diameter (*D*)
fps = feet per second
PWWF = Peak Wet Weather Flow

Four flow conditions were analyzed:

1. Average Dry Weather Flow (ADWF) in Existing City Sewer System
2. ADWF in Recommended City Sewer System
3. Peak Wet Weather Flow (PWWF) in Existing City Sewer System
4. PWWF in Recommended City Sewer System

The ADWF is 95% of the indoor potable water demand. To account for existing flows entering the project area from other areas of the city, existing sewer flows collected from flow monitoring sites at Lawrence Road north of Warburton Avenue, Kifer Road west of Lawrence Expressway, and Aster Avenue west of Willow Avenue were incorporated into the sanitary sewer model analysis. Existing sewer flow data collected from the flow monitoring sites were received

from the City on February 6, 2020. According to the City of Sunnyvale's Sanitary Sewer Systems Design Standards, the PDWF peaking factor is dependent upon ADWF. We have assumed a Peak Dry Weather Flow (PDWF) peaking factor that varies between 2.5 and 3.5 which is based on individual parcel demands. PWWF is based on PDWF and a design inflow and infiltration rate based on a 10-year storm event that is 65% of the ADWF. Table 3.2 – Sanitary Sewer System Peaking Factor summarizes the peaking factor to achieve PWWF based on the supplemental information received from the City.

Table 3.2
Sanitary Sewer System Peaking Factor

Parameter	Value
Indoor Potable Water Demand	1,010,021 gpd
Average Dry Weather Flow (95% of Indoor Water Demand)	959,520 gpd
PDWF[1]	PDWF = (varies between 2.5 and 3.5) * ADWF
PWWF	PWWF = ADWF * (PDWF peaking factor + 0.65)

Notes:
PDWF peaking factor is dependent upon ADWF for each parcel.
PDWF = Peak Dry Weather Flow
PWWF = Peak Wet Weather Flow
ADWF = Average Dry Weather Flow

3.2 Sanitary Sewer Collection System

3.2.1 Existing Sanitary Sewer Collection System

The existing sanitary sewer collection system within the vicinity of the LSAP consists of sewer mains that vary in size between 6-inches to 27-inches and a single lift station on Kifer Road located at the crossing over Calabazas Creek. Pipe material of the existing sewer mains is VCP. The lift station consists of a wet well system.

The existing sanitary sewer system within the LSAP boundary consists of a single drainage area. Sanitary sewer flows generally drain by gravity and ultimately drain to the existing 27-inch sanitary sewer main in Lawrence Expressway. The City provided BKF with record drawings, sewer manhole survey data and construction documents for sanitary

sewer mains in Lawrence Expressway, Willow Avenue, and Aster Avenue. A layout of the existing sanitary sewer system is shown on Figure 3.1 – Existing Sanitary Sewer System and existing sanitary sewer manholes are represented on Figure 3.2 – Existing Sanitary Sewer Manholes.

3.3 Recommended Sanitary Sewer System Layout

Figure 3.3 – Recommended Sanitary Sewer Pipe Sizing and Figure 3.4 – Recommended Sanitary Sewer Model Pipe Labels shows the sanitary sewer system collection system with recommended sewer main upgrades required for the LSAP. Figure 3.3 – Recommended Sanitary Sewer Pipe Sizing shows which existing sanitary sewer mains will require upgrades in order to handle the increased sanitary sewer demands from the proposed LSAP.

3.3.1 Kifer Road Lift Station

The analysis of the existing Kifer Lift Station involved reviewing the existing and proposed sanitary sewer ADWF flows into the lift station. The existing sanitary sewer flow during ADWF was determined to be 83 gpm as derived from the building square footages from the M-S/LSAP zone adjacent to Uranium Drive as shown on Figure 3.2 – Existing Sanitary Sewer Manholes. The proposed sanitary sewer ADWF flow into the lift station was determined to be 160 gpm based on the sewer analysis model used throughout this report. BKF provided the existing and proposed sewer flows to the city. The City reviewed the information provided and confirmed the existing Kifer Road Lift Station has enough capacity to serve the LSAP buildout condition.

3.4 Sanitary Sewer System Model Sewer Flows

3.4.1 Land Use Sewer Generation Data

The sanitary sewer flows used are based on the indoor potable water for each land use. Outdoor water demands are not included in sanitary sewer flows because outdoor drains connect to the storm drain system.

3.4.2 Average Dry Weather Flow

The sanitary sewer ADWF is intended to be representative of the average day sanitary sewer generation. The sanitary sewer ADWF is a function of the indoor water use ADD. Table 3.3 – Total Buildout Sanitary Sewer Demand Summary represents the indoor water use ADD and sanitary sewer demands generated for each land use shown in Table 2.4 – Total Buildout Potable Water Demand Summary (ADD) including proposed sites associated with the LSAP and existing parcels to remain. The sanitary sewer ADWF is based on 95% of the indoor potable water ADD. Total sewer demand use for each development is detailed in Appendix F - Sanitary Sewer Demand Calculations. Sewer generation (gpm) that was calculated for each parcel was applied to each sewer line in the street that was adjacent to that particular parcel. This allows an even distribution of sewer generated for a particular parcel to account for existing sanitary sewer lines in the street. Table 3.6 – Office Expansion Study LSAP Sanitary Sewer Demand Summary represents the indoor water use and sanitary sewer demands generated from the office expansion.

Table 3.3
Total Buildout Sanitary Sewer Demand Summary

Land Use[1]	Number	Unit	Indoor Domestic Water Demand (gpd)	Sanitary Sewer Demand (gpd)
Residential	5,935	sf	718,135	682,228
Office/R&D	1,212,374	sf	157,609	149,728
Industrial	614,598	sf	129,065	122,612
Restaurant[2]	156	seat	4,680	4,446
Storage Facility	159,637	sf	532	506
		Total	1,010,021	959,520

Notes:
1. Existing restaurant located at 1210 Kifer Road is assumed to have 156 seats. This is based on the assumption that 50% of restaurant space (7,800 sf total) is for patrons and one 10'x10' table has seating for 4 people. The calculation is as follows:

$$(7{,}800\ sf \times 0.5) \times \left(\frac{4\ seats}{100\ sf}\right) = 156\ seats$$

2. Restaurant is defined as employee amenity space.
3. The square footage numbers provided in this table represent project buildout numbers including nonresidential buildings expected to remain.

3.4.3 Peak Dry Weather Flow (PDWF)

The sanitary sewer PDWF is the highest sanitary sewer generation during the day due to diurnal peaks associated with higher water usage in the morning and early evening hours. PDWF is determined by applying a peaking factor to ADWF. City of Sunnyvale has varying peaking factors for PDWF which is dependent upon ADWF for each parcel. Peaking factors for the LSAP vary between 2.5 and 3.5.

3.3.3 Peak Wet Weather Flow (PWWF)

The sanitary sewer PWWF incorporates infiltration and inflow rate at 65% of the ADWF. This rate is added to the PDWF peaking factor.

Inflow is surface water that enters the wastewater system from yards, roof drains, downspouts, storm drain cross connections, or through manhole covers due to overland flow runoff. Similar to infiltration, inflow is a result of storm events, and peak inflow

flow runoff. Similar to infiltration, inflow is a result of storm events, and peak inflow typically occurs during heavy storm events or prolonged periods of precipitation.

Infiltration is groundwater that enters sewer facilities such as pipelines, laterals, and manholes through holes, breaks, joint/connection failures, and other openings. Infiltration is directly correlated to the total amount of piping and appurtenances in the ground. Infiltration quantities vary due to seasonal variation in the groundwater levels influenced by storm events, surface and soil conditions, condition of sanitary sewer systems, and type of pipe joints. The highest infiltration flows are typically observed following significant storm events and during the winter or peak precipitation months, when groundwater levels are high.

3.5 Sanitary Sewer Flow Distribution

Each parcel's total sanitary sewer generation was determined by reviewing the planned parcel land use and applying applicable land use sanitary sewer generation. The parcel land use summary is included in Appendix F – Sanitary Sewer System Demand Calculations for reference. Sanitary sewer flows from the proposed LSAP Office Expansion (i.e. ISI project) was included in the model results due to the LSAP Office Expansion located within the LSAP Housing Expansion Buildout Infrastructure on Kifer Road. Refer to the Lawrence Station Area Plan Office Expansion Buildout Infrastructure Impact Study for a detailed analysis with the expanded office use.

Each parcel's total sanitary sewer flow was divided equally amongst the sanitary sewer manholes bordering the parcel as shown in Figures 3.2 – Existing Sanitary Sewer Manholes and 3.4 – Recommended Sanitary Sewer Model Pipe Labels. The parcel flow entering a manhole represents a sanitary sewer lateral point of connection.

3.6 Hydraulic Grade Line Considerations

The analysis of the sanitary sewer system is assumed to be a free outfall condition.

3.7 Sanitary Sewer Boundary Conditions

In addition to the flow monitoring survey data provided by the City, the recommended sanitary sewer system is modeled based on boundary conditions taken from Technical Memorandum 7 attached to the City of Sunnyvale's 2015 Wastewater Collection System Master Plan. Since the LSAP Project is redeveloping existing lots, the proposed sewer model is analyzing existing City sewer mains and identifying the sewer mains that will need to be upgraded in order to abide by supplemental information provided by the City.

3.8 Model Scenario Results and Analysis

The LSAP sanitary sewer model was created using a Bentley StormCAD V8i SELECT series 5.

The following sanitary sewer model flow conditions were developed:

1. Average Dry Weather Flow (ADWF) in Existing City Sewer System
2. ADWF in Recommended City Sewer System
3. Peak Wet Weather Flow (PWWF) in Existing City Sewer System
4. PWWF in Recommended City Sewer System

Sanitary sewer model inside diameters were based on JM Eagle PVC Pipe Size for SDR 26 (160 psi). Installation of the sewer system should be based on the modeling of the product.

3.8.1 Pipe Diameter

The recommended sanitary sewer pipe sizes are shown on Figure 3.3 – Recommended Sanitary Sewer Pipe Sizing. The recommended sanitary sewer system consists of 12-inch to 30-inch diameter pipes. Exhibits show nominal pipe diameters. The sewer systems were modelled with the inside pipe diameters. Pipe upgrades for portions of the sanitary sewer system were based on the d/D exceeding the allowable depth of flow of 0.50 for pipe sizes 10-inches and smaller, and 0.75 for pipe sizes greater than 12-inches per the supplemental information the City provided.

3.8.2 Flow Velocity

The flow velocities through the pipes were calculated using the Manning's equation. The Manning's equation calculates the flow velocities using the pipe's roughness coefficient, the hydraulic radius, and the slope of the pipe.

While most of the existing sewer mains are able to provide 2 fps during PWWF conditions, this was not achievable for all existing sewer mains. For sewer mains that flowed under 2 fps during PWWF conditions, these sewer mains are flowing at less than half pipe capacity. Therefore, these existing sewer mains will not be upgraded as it has sufficient capacity for future sewer demands and will achieve minimum 2 fps flow velocity requirements when flowing half-full. The existing sewer mains are upsized if found to be flowing greater than the d/D at PWWF requirements (0.5 or 0.75).

3.8.2.1 Average Dry Weather Flow (ADWF)

Figure 3.5 – Average Dry Weather Flow Pipe Velocity illustrates the ADWF pipe velocities for the sanitary sewer system. The sanitary sewer system ADWF pipe velocity results are detailed in Appendix D – LSAP Sewer Model Reports. The results shown in this appendix account for flows from the overall LSAP area including the office and housing expansion areas. The results of the analysis show LSAP ADWF velocities ranging from approximately 0.61 fps to 7.36 fps in the City's existing sewer system. ADWF velocities in the recommended City sewer system range from approximately 0.84 fps to 7.28 fps.

3.8.2.2 Peak Wet Weather Flow (PWWF)

Figure 3.6 – Peak Wet Weather Flow Pipe Velocity illustrates the PWWF pipe velocities for the sanitary sewer system. The sanitary sewer system PWWF pipe velocity results are detailed in Appendix D – LSAP Sewer Model Reports. The results shown in this appendix account for flows from the overall LSAP area including the office and housing expansion areas. The results of the analysis

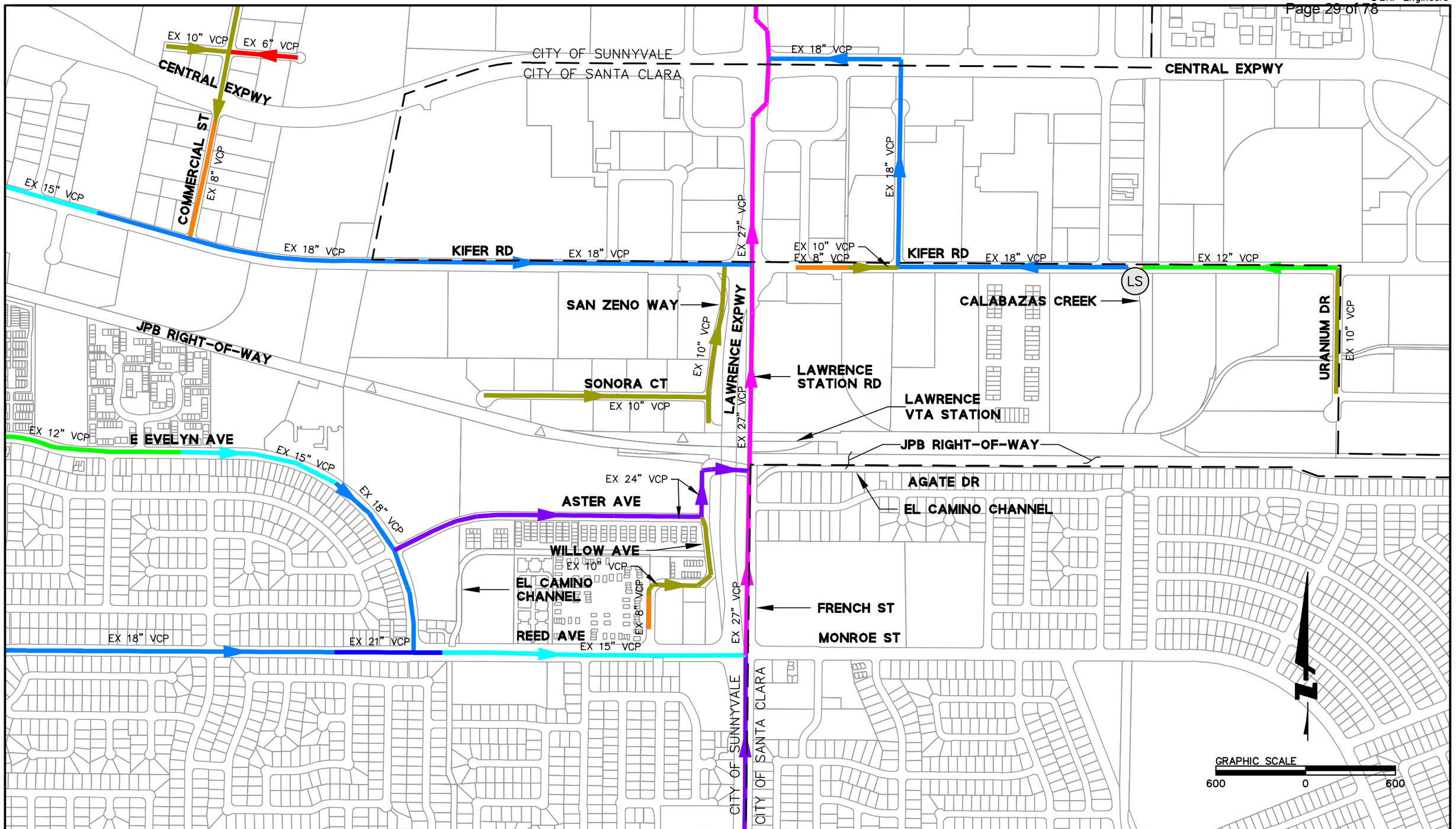
show LSAP PWWF velocities ranging from approximately 0.25 fps to 11.04 fps in the City's existing sewer system. PWWF velocities in the recommended City sewer system range from approximately 1.27 fps to 10.94 fps.

3.9 Sanitary Sewer System Conclusion

The existing Sanitary Sewer system had three pipes that did not meet design criteria based on the supplemental information provided by the City for maximum pipe flow depth (*d/D*). These pipes were the following:

- Existing 10-inch VCP sewer main located in San Zeno Way connecting into Kifer Road between manholes 305-201 and 336-201 has an existing pipe flow depth of 0.53 during PWWF conditions as seen in Appendix D – LSAP Sewer Model Reports. Per supplemental information provided by the City, maximum depth for pipes 10-inches and smaller is 0.5. BKF recommends upsizing to 12-inch PVC sewer main to provide sufficient capacity.

- Existing 10-inch VCP sewer main located at the intersection of Willow Avenue and Aster Avenue between manholes 296-208 and 296-209 has an existing pipe flow depth of 1.06 during PWWF conditions as seen in Appendix D – LSAP Sewer Model Reports. Per supplemental information provided by the City, maximum depth for pipes 10-inches and smaller is 0.5. BKF recommends upsizing to a 18-inch PVC sewer main to provide sufficient capacity.
- Existing 27-inch VCP sewer main is in Santa Clara, but the City of Sunnyvale has jurisdiction over the pipe segment. It is located in Lawrence Expressway north of Kifer Road between manholes 336-202 and 336-207. It has an existing pipe flow depth of 0.80 during PWWF conditions as seen in Appendix A – LSAP Sewer Model Reports. Per supplemental information provided by the City, maximum depth for pipes 12-inches and larger is 0.75. BKF recommends upsizing the existing 27-inch VCP to a 30-inch PVC sewer main to provide sufficient capacity.



LEGEND

- CITY BOUNDARY
- EX 6" SEWER
- EX 8" SEWER
- EX 10" SEWER
- EX 12" SEWER
- EX 15" SEWER
- EX 18" SEWER
- EX 21" SEWER
- EX 24" SEWER
- EX 27" SEWER
- (LS) KIFER ROAD LIFT STATION

DATE:	06/22/2020
SCALE:	1"=600'
DESIGN:	BPB
DRAWN BY:	EYS
APPROVED:	TRM
JOB NO:	20180080

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LSAP HOUSING EXPANSION BUILDOUT INFRASTRUCTURE REPORT

FIGURE 3.1 – EXISTING SANITARY SEWER SYSTEM

DRAWING NAME: \\bkf-rc\VOL4\2018\180080_LSAP_Housing\ENG\EXHIBITS\Master Plan\Sewer\Housing\Figure 3.1 - LSAP Existing Sanitary Sewer System - Housing.dwg
PLOT DATE: 06-19-20
PLOTTED BY: Inou

CITY OF SUNNYVALE
CITY OF SANTA CLARA
CENTRAL EXPWY
COMMERCIAL ST
KIFER RD
SAN ZENO WAY
LAWRENCE EXPWY
CALABAZAS CREEK
URANIUM DR
JPB RIGHT-OF-WAY
SONORA CT
LAWRENCE STATION RD
LAWRENCE VTA STATION
E EVELYN AVE
ASTER AVE
WILLOW AVE
EL CAMINO CHANNEL
AGATE DR
FRENCH ST
MONROE ST
REED AVE
MXD-I
MXD-II
MXD-III
M-S/LSAP
R-5
O-R
LS

NODE IDENTIFICATION	
1	295–203
2	295–207
3	295–208
4	295–209
5	295–204
6	295–210
7	295–211
8	295–212
9	296–211

GRAPHIC SCALE
600 0 600

LEGEND

- CITY BOUNDARY
- HOUSING EXPANSION STUDY AREA
- OFFICE EXPANSION STUDY AREA
- KIFER ROAD LIFT STATION
- EX SEWER
- EX MANHOLE

DATE:	06/22/2020
SCALE:	1"=600'
DESIGN:	BPB
DRAWN BY:	NRF
APPROVED:	TRM
JOB NO:	20180080

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LSAP HOUSING EXPANSION BUILDOUT INFRASTRUCTURE REPORT

FIGURE 3.2 – EXISTING SANITARY SEWER MANHOLES

DRAWING NAME: \\bkf-rs\VOL4\2018\180080_LSAP_Housing\ENG\EXHIBITS\Master Plan\Sewer\Housing\Figure 3.2 - LSAP Proposed Sanitary Sewer Nodes - Housing.dwg
PLOT DATE: 06-19-20
PLOTTED BY: Inou

CENTRAL EXPWY
CITY OF SUNNYVALE
CITY OF SANTA CLARA
EX 10" VCP
EX 6" VCP
EX 18" VCP
COMMERCIAL ST
EX 8" VCP
EX 15" VCP
REPLACE EX 27" VCP WITH PR 30" PVC
EX 27" VCP
EX 18" VCP
KIFER RD
EX 10" VCP
EX 8" VCP
EX 12" VCP
REPLACE EX 10" VCP WITH PR 12" PVC
SAN ZENO WAY
MXD-II
MXD-I
JPB RIGHT-OF-WAY
EX 10" VCP
LAWRENCE EXPWY
LS
CALABAZAS CREEK
M-S/LSAP
URANIUM DR
LAWRENCE STATION RD
LAWRENCE VTA STATION
SONORA CT
E EVELYN AVE
EX 12" VCP
EX 15" VCP
EX 18" VCP
MXD-III
EX 24" VCP
ASTER AVE
AGATE DR
EL CAMINO CHANNEL
REPLACE EX 10" VCP WITH PR 18" PVC
WILLOW AVE
R-5
O-R
FRENCH ST
MONROE ST
EX 21" VCP
REED AVE
EX 15" VCP
CITY OF SUNNYVALE
CITY OF SANTA CLARA
GRAPHIC SCALE
600 0 600

LEGEND

- CITY BOUNDARY
- HOUSING EXPANSION STUDY AREA
- OFFICE EXPANSION STUDY AREA
- (LS) KIFER ROAD LIFT STATION
- EX SEWER
- PR 12" SEWER
- PR 18" SEWER
- PR 30" SEWER

DATE:	06/22/2020
SCALE:	1"=600'
DESIGN:	BPB
DRAWN BY:	NRF
APPROVED:	TRM
JOB NO:	20180080

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LSAP HOUSING EXPANSION BUILDOUT INFRASTRUCTURE REPORT

FIGURE 3.3 – RECOMMENDED SANITARY SEWER PIPE SIZING

DRAWING NAME: \\bkf-rc\VOL4\2018\180080_LSAP_Housing\ENG\EXHIBITS\Water Plan\Sewer\Housing\Figure 3.3 - LSAP Proposed Sanitary Sewer Pipe Sizing - Housing.dwg
PLOT DATE: 06-19-20
PLOTTED BY: Inou

CITY OF SUNNYVALE
CITY OF SANTA CLARA
CENTRAL EXPWY
COMMERCIAL ST
KIFER RD
PR-KR-P1
PR-KR-P2
PR-KR-P3
PR-KR-P4
PR-KR-P5
PR-KR-P6
PR-LE-P7
PR-SZW-P5
SAN ZENO WAY
PR-SZW-P4
PR-SZW-P3
PR-SZW-P2
PR-SC-P3
PR-SC-P1
PR-SC-P2
SONORA CT
PR-SC-P4
PR-SC-P5
PR-SZW-P1
PR-AA-P14
LAWRENCE EXPWY
PR-CR-P2
PR-CR-P1
PR-KR-P10
PR-KR-P7
PR-LE-P6
PR-LE-P5
PR-KR-P8
LAWRENCE STATION RD
PR-LE-P4
LAWRENCE VTA STATION
PR-LE-P3
JPB RIGHT-OF-WAY
PR-KR-P11
PR-KR-P12
PR-KR-P13
PR-KR-P14
PR-KR-P16
PR-KR-P17
PR-KR-P18
PR-KR-P19
LS
CALABAZAS CREEK
PR-KR-P9
PR-KR-P15
URANIUM DR
PR-UD-P4
PR-UD-P3
PR-UD-P2
PR-UD-P1
MXD-II
MXD-I
MXD-III
M-S/LSAP
E EVELYN AVE
JPB RIGHT-OF-WAY
AGATE DR
EL CAMINO CHANNEL
PR-WA-P9
PR-WA-P8
PR-LE-P2
PR-WA-P7
PR-WA-P6
PR-WA-P5
PR-LE-P1
FRENCH ST
MONROE ST
PR-WA-P4
PR-WA-P3
ASTER AVE
1 2 3 4 5 6 7 8 9
PR-AA-P1
PR-AA-P3
PR-AA-P4
WILLOW AVE
R-5
O-R
EL CAMINO CHANNEL
PR-WA-P2
REED AVE
PR-WA-P1
CITY OF SUNNYVALE
CITY OF SANTA CLARA

PIPE IDENTIFICATION	
1	PR-AA-P5
2	PR-AA-P6
3	PR-AA-P7
4	PR-AA-P8
5	PR-AA-P9
6	PR-AA-P10
7	PR-AA-P11
8	PR-AA-P12
9	PR-AA-P13

NOTES:

1. PIPE LABELS SHOWN ON THIS SHEET REPRESENT THE PIPES USED IN THE SANITARY SEWER MODEL. THESE LABELS CORRESPOND TO THE PROPOSED MODEL RESULTS TABLE SHOWN IN APPENDIX D.
2. REFER TO FIGURE 3.3 FOR RECOMMENDED SANITARY SEWER UPGRADES.

GRAPHIC SCALE
600 0 600

LEGEND

- CITY BOUNDARY
- HOUSING EXPANSION STUDY AREA
- OFFICE EXPANSION STUDY AREA
- (LS) KIFER ROAD LIFT STATION
- SEWER MAIN
- MANHOLE
- PR-KR-P1 ← PIPE NUMBER
- STREET LOCATION PROPOSED

DATE:	06/22/2020
SCALE:	1"=600'
DESIGN:	BPB
DRAWN BY:	NRF
APPROVED:	TRM
JOB NO:	20180080

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LSAP HOUSING EXPANSION BUILDOUT INFRASTRUCTURE REPORT

FIGURE 3.4 – RECOMMENDED SANITARY SEWER MODEL PIPE LABELS

DRAWING NAME: \\bkf-rs\VOL4\2018\180080_LSAP_Housing\ENG\EXHIBITS\Master Plan\Sewer\Housing\Figure 3.4 - LSAP Proposed Sanitary Sewer Pipes - Housing.dwg
PLOT DATE: 06-19-20
PLOTTED BY: Inou

CENTRAL EXPWY
COMMERCIAL ST
CITY OF SUNNYVALE
CITY OF SANTA CLARA
CENTRAL EXPWY
KIFER RD
KIFER RD
JPB RIGHT-OF-WAY
MXD-II
SAN ZENO WAY
MXD-I
LAWRENCE EXPWY
MXD-I
LAWRENCE STATION RD
CALABAZAS CREEK
LS
MXD-II
M-S/LSAP
URANIUM DR
SONORA CT
MXD-I
LAWRENCE VTA STATION
JPB RIGHT-OF-WAY
E EVELYN AVE
MXD-III
ASTER AVE
AGATE DR
EL CAMINO CHANNEL
WILLOW AVE
R-5
EL CAMINO CHANNEL
O-R
FRENCH ST
REED AVE
MONROE ST
CITY OF SUNNYVALE
CITY OF SANTA CLARA
GRAPHIC SCALE
600 0 600

LEGEND

- CITY BOUNDARY
- HOUSING EXPANSION STUDY AREA
- OFFICE EXPANSION STUDY AREA
- (LS) KIFER ROAD LIFT STATION
- EX SEWER

SS GRAVITY MAIN VELOCITY

- 0.00 FT/S TO 1.99 FT/S
- 2.00 FT/S TO 9.99 FT/S

DATE:	06/22/2020
SCALE:	1"=600'
DESIGN:	BPB
DRAWN BY:	NRF
APPROVED:	TRM
JOB NO:	20180080

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LSAP HOUSING EXPANSION BUILDOUT INFRASTRUCTURE REPORT

FIGURE 3.5 - AVERAGE DRY WEATHER FLOW PIPE VELOCITY

DRAWING NAME: \\bkf-rc\VOL4\2018\180080_LSAP_Housing\ENG\EXHIBITS\Water Plan\Sewer\Housing\Figure 3.5 - LSAP Average Dry Weather Flow Pipe Velocity - Housing.dwg
PLOT DATE: 06-19-20
PLOTTED BY: Inou

CENTRAL EXPWY
COMMERCIAL ST
CITY OF SUNNYVALE
CITY OF SANTA CLARA
CENTRAL EXPWY
KIFER RD
KIFER RD
SAN ZENO WAY
MXD-II
MXD-I
JPB RIGHT-OF-WAY
LAWRENCE EXPWY
MXD-I
LAWRENCE STATION RD
CALABAZAS CREEK
LS
MXD-II
M-S/LSAP
URANIUM DR
SONORA CT
MXD-I
LAWRENCE VTA STATION
JPB RIGHT-OF-WAY
E EVELYN AVE
MXD-III
ASTER AVE
AGATE DR
EL CAMINO CHANNEL
WILLOW AVE
R-5
EL CAMINO CHANNEL
O-R
FRENCH ST
MONROE ST
REED AVE
CITY OF SUNNYVALE
CITY OF SANTA CLARA
GRAPHIC SCALE
600 0 600

LEGEND

- CITY BOUNDARY
- HOUSING EXPANSION STUDY AREA
- OFFICE EXPANSION STUDY AREA
- (LS) KIFER ROAD LIFT STATION
- EX SEWER

SS GRAVITY MAIN VELOCITY

- 0.00 FT/S TO 1.99 FT/S
- 2.00 FT/S TO 9.99 FT/S
- 10.00 FT/S TO 11.99 FT/S

DATE:	06/22/2020
SCALE:	1"=600'
DESIGN:	BPB
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JOB NO:	20180080

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LSAP HOUSING EXPANSION BUILDOUT INFRASTRUCTURE REPORT

FIGURE 3.6 – PEAK WET WEATHER FLOW PIPE VELOCITY

DRAWING NAME: \\bkf-rs\VOL4\2018\180080_LSAP_Housing\ENG\EXHIBITS\Master Plan\Sewer\Housing\Figure 3.6 – LSAP Peak Wet Weather Flow Pipe Velocity – Housing.dwg
PLOT DATE: 06-19-20
PLOTTED BY: Inou

SECTION 4: CONSTRUCTION COSTS

4.1 Sanitary Sewer System Construction Costs

The associated construction costs to complete the recommended pipe upsizing upgrades are based off of the cost estimates prepared by Schaaf & Wheeler for the Downtown Specific Study prepared in September 2019. The anticipated construction cost based on linear footage has been prepared in Table 4.1 – Anticipated Construction Cost. The unit cost provided includes the costs associated with mobilization, demobilization, traffic control, shoring, trenching, manholes, laterals, bypass pumping, offhaul and disposal.

Table 4.1
Anticipated Construction Cost

Pipe Diameter	Recommended Costs ($/LF)[2]
12" PVC pipe	$700
18" PVC pipe	$900
30" PVC pipe[1]	$2000

Note:
1. The 30" PVC pipe recommended unit cost has been adjusted to account increased costs for construction work required on Lawrence Expressway including sewer bypass pumping, expressway traffic control, and pavement thickness.
2. Unit cost values are derived from 2019 Downtown Specific Plan Amendments Utility Impact Study.

Total project construction was estimated by factoring expected additional costs related to construction contingency, design, inspection, miscellaneous costs, and city administration. These additional project costs have been provided in Table 4.2 – Additional Project Costs shown below.

Table 4.2
Additional Project Costs

Project Item	Percentage of Total Cost
Construction Contingency	25%
Design	20%
Inspection	10%
Miscellaneous Costs	10%
City Administration	5%

The sewer analysis model finds that a total of 671 linear feet of 27-inch VCP sewer pipe in Lawrence Expressway must be upsized to a 30-inch PVC sewer pipe, which creates an estimated cost of $1,342,000. With additional costs, the total cost for upsizing sewer pipe in Lawrence Expressway amounts to $2,214,300. The model concludes that a total of 324 linear feet of 10-inch VCP sewer pipe in San Zeno Way must be upsized to a 12-inch PVC sewer pipe, which creates an estimated cost of $226,800. With additional costs, the total cost for upsizing the sewer pipe in San Zeno Way amounts to $374, 220. For Willow Avenue, a total of 69 linear feet of 10-inch VCP sewer pipe must be upsized to 18-inch PVC sewer pipe, which creates an estimated cost of $62,100. With additional costs, the total cost for upsizing the sewer pipe in Willow Avenue amounts to $102,465. The total cost associated with the recommended sewer upgrades for the LSAP Housing Expansion is $2,690,985. A detailed breakdown of the project's cost estimate can be seen in Appendix G – Cost Estimate for City Sanitary Sewer System Upgrades.

SECTION 5: STORM DRAIN SYSTEM

5.1 Existing Storm Drain Layout

The existing storm drain for LSAP is shown on Figure 4.1 – Existing Storm Drain System. Existing storm drain mains are maintained by the City of Sunnyvale. The LSAP area is currently served by existing storm drain mains that vary in size between 12-inches to 60-inches. Within the vicinity of the LSAP, there are four points where the existing storm drain system discharges into a City flood easement (El Camino Channel) listed below.

- Discharge point #1 located near Reed Avenue and East Evelyn Avenue
- Discharge point #2 located at Aster Avenue east of East Evelyn Avenue
- Discharge point #3 located at French Street south of Agate Drive
- Discharge point #4 located at the intersection of French Street and Willow Avenue.

There are also two points where the existing storm drain system discharges into Calabazas Creek at Kifer Road coming from the West and East (Discharge points #5 and #6 respectively). Discharge points are shown in Figure 4.1 – Existing Storm Drain System.

5.2 Storm Drain System Conclusion

While the project does not have pervious/impervious areas of the existing developments, it is assumed that the pervious areas in the existing development are below 20% pervious. The existing LSAP site, using Google Earth aerial images, show significant impervious surfaces throughout the project area consisting primarily of existing buildings and surface parking for each lot. While the project does not have a pervious/impervious area breakdown for the proposed development, the City of Sunnyvale's Municipal Code requires a minimum of 20% landscaping for each development parcel. It is also assumed that stormwater flows from the proposed developments within the LSAP will be designed to infiltrate within their own development site. Therefore, the proposed Housing Expansion Study Area project assumes no increase in stormwater runoff to the existing storm drain system.

CENTRAL EXPWY
EX 18" RCP
EX 24" RCP
EX 30" RCP
EX 36" RCP
CITY OF SUNNYVALE
CITY OF SANTA CLARA
EX 39" RCP
EX 42" RCP
EX 54" RCP
EX 60" RCP
CENTRAL EXPWY
COMMERCIAL ST
EX 24" RCP
EX 27" RCP
KIFER RD
EX 30" RCP
EX 33" RCP
EX 36" RCP
DISCHARGE POINT #6
DISCHARGE POINT #5
EX 27" RCP
EX 18" RCP
KIFER RD EX 30" RCP
EX 33" RCP
EX 27" RCP
EX 18" RCP
SAN ZENO WAY
CALABAZAS CREEK
URANIUM DR
EX 24" RCP
JPB RIGHT-OF-WAY
EX 27" RCP
EX 36" RCP
LAWRENCE EXPWY
LAWRENCE STATION RD
SONORA CT
LAWRENCE VTA STATION
EX 48" RCP
EX 39" RCP
JPB RIGHT-OF-WAY
EX 33" RCP
EX 30" RCP
E EVELYN AVE
EX 39" RCP
EX 60" RCP
EX 48" RCP
EX 24" RCP
EX 18" RCP
ASTER AVE
AGATE DR
EL CAMINO CHANNEL
DISCHARGE POINT #4
DISCHARGE POINT #3
WILLOW AVE
EX 42" CMP
DISCHARGE POINT #2
EL CAMINO CHANNEL
EX 30" RCP
EX 39" RCP
FRENCH ST
MONROE ST
EX 42" RCP
EX 48" RCP
EX 54" CMP
REED AVE
EX 12" RCP
EX 24" RCP
DISCHARGE POINT #1
CITY OF SUNNYVALE
CITY OF SANTA CLARA

GRAPHIC SCALE
600 0 600

LEGEND

- CITY BOUNDARY
- EX 12" STORM
- EX 18" STORM
- EX 21" STORM
- EX 24" STORM
- EX 27" STORM
- EX 30" STORM
- EX 33" STORM
- EX 36" STORM
- EX 39" STORM
- EX 42" STORM
- EX 48" STORM
- EX 54" STORM
- EX 60" STORM
- CHANNEL/CREEK

DATE:	06/22/2020
SCALE:	1"=600'
DESIGN:	BPB
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APPROVED:	TRM
JOB NO:	20180080

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LSAP HOUSING EXPANSION BUILDOUT INFRASTRUCTURE REPORT

FIGURE 4.1 – EXISTING STORM DRAIN SYSTEM

DRAWING NAME: \\bkf-rc\VOL4\2018\180080_LSAP_Housing\ENG\EXHIBITS\Master Plan\Storm\Residential\Figure 4.1 – Existing Storm Syatem – Housing.dwg
PLOT DATE: 06-19-20
PLOTTED BY: Inou

APPENDIX A

Block Book Pages for Lawrence Station Area Plan

SUNNYVALE - SEWER
Appendix A

Legend

Lines

- Active Sunnyvale Main
- Abandoned Sunnyvale Main
- Active Private Main
- Others Main
- Active Sunnyvale Lateral
- Abandoned Sunnyvale Lateral
- Active Private Lateral
- Active Force Main
- Abandoned Force Main
- Active Santa Clara Main
- Active Cupertino Main

Points

	Flushing Inlet	S	Clean Out
2	Active Manhole		Active Plug
2	Abandoned Manhole		Abandoned Plug
2	Active Drop Manhole		Meter
2	Diversion Structure		Pump Station
	Grade Break	T	Lift Station
1	Main Line Clean Out	S	Riser
	Network Structure		Drain Inlet

Polygons

- Easement
- City Boundary
- Concrete Casing
- Steel Casing
- Detail Polygon
- Blockgrid

Basemap

- Constructed Centerline
- Street Centerline
- Parcel

Annotation

365'	- Pipe Length	**BORREGAS AVENUE**	- Street Name
6"	- Diameter	129	- Lot Number
VCP	- Material	1405	- Address Number
0.2%	- Slope	ONSITE PRIVATE SYSTEM	- Miscellaneous Annotation
US=19.48	- Upstream Elevation		
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209	- Manhole Number		
R=23.58	- Rim Elevation		
6" CO	- Clean Out Annotation		
F.I.	- Flushing Inlet Annotation		
10' P.U.E	- Easement Annotation		
80'-42" Steel Casing	- Casing Annotation		

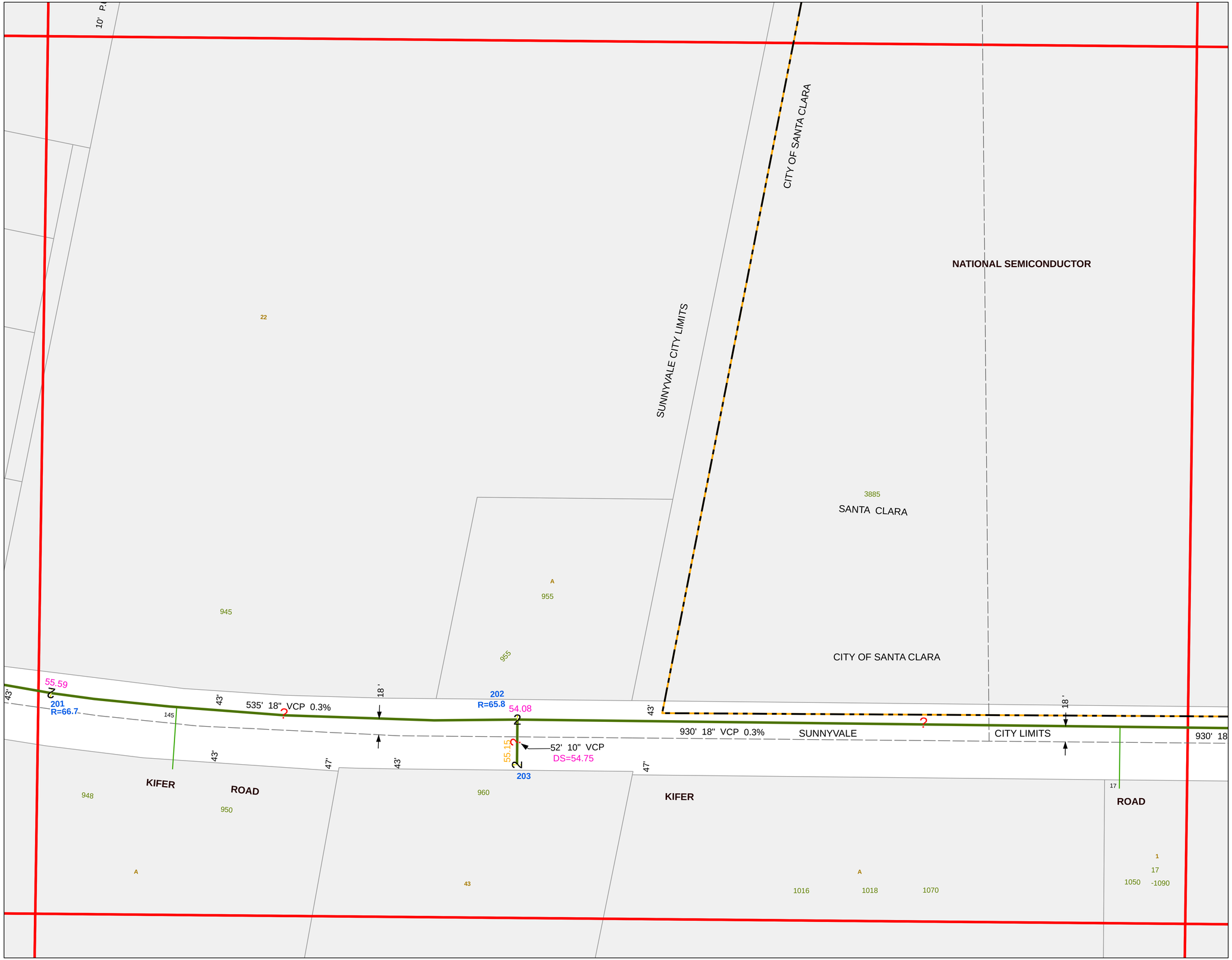
349	348	347
332	333	334
309	308	307

333

0 50 Feet

Nov 11, 2019

SUNNYVALE - SEWER
Appendix A



Legend

Lines

- Active Sunnyvale Main
- Abandoned Sunnyvale Main
- Active Private Main
- Others Main
- Active Sunnyvale Lateral
- Abandoned Sunnyvale Lateral
- Active Private Lateral
- Active Force Main
- Abandoned Force Main
- Active Santa Clara Main
- Active Cupertino Main

Points

- Flushing Inlet
- Active Manhole
- Abandoned Manhole
- Active Drop Manhole
- Diversion Structure
- Grade Break
- Main Line Clean Out
- Network Structure
- Clean Out
- Active Plug
- Abandoned Plug
- Meter
- Pump Station
- Lift Station
- Riser
- Drain Inlet

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80'-42" Steel Casing	- Casing Annotation		

348	347	346
333	334	335
308	307	306

334

0 50 Feet

Nov 11, 2019

SUNNYVALE - SEWER
Appendix A

NATIONAL SEMICONDUCTOR

CITY OF SANTA CLARA

SUNNYVALE CITY LIMITS

TAHOE WAY

SEMICONDUCTOR DRIVE

KIFER ROAD

KIFER ROAD

204
R=55.56

48.91

10" VCP

10"

31'

31'

37' 37'

51.46

301' 8" VCP

301'

203
R=58.3

10' P.U.E.

10'

10'

10'

930' 18" VCP 0.3%

43'

51.29

201
R=64.5

18'

900' 18" VCP 0.3%

43'

48.59

202
R=61.2

18" VCP 0.3%

43'

47'

47'

8" VCP

6" VCP

6" VCP

24

23

25

26

27

30

29

28

1050

1090

1130

1

14

Legend

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- Abandoned Force Main
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Points

''	Flushing Inlet	S	Clean Out
2	Active Manhole	⁞	Active Plug
2	Abandoned Manhole	⁞	Abandoned Plug
2	Active Drop Manhole	)	Meter
2	Diversion Structure	Ü	Pump Station
<	Grade Break	T	Lift Station
1	Main Line Clean Out	S	Riser
	Network Structure	''	Drain Inlet

Polygons

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334	335	336
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335

0 50 Feet

Nov 11, 2019

SUNNYVALE - SEWER
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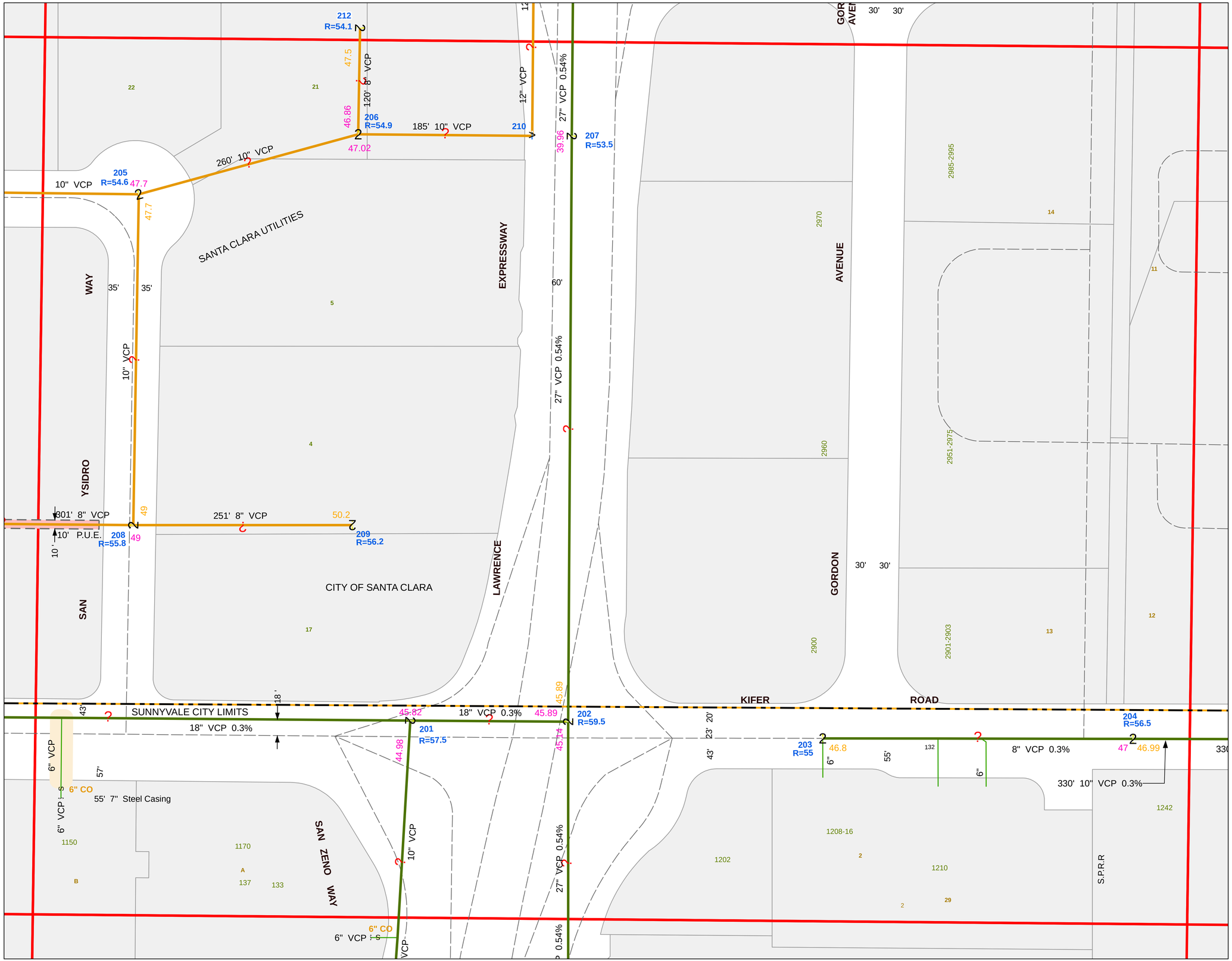

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Points

	Flushing Inlet	S	Clean Out
2	Active Manhole		Active Plug
2	Abandoned Manhole		Abandoned Plug
2	Active Drop Manhole		Meter
2	Diversion Structure		Pump Station
	Grade Break	T	Lift Station
1	Main Line Clean Out		Riser
	Network Structure		Drain Inlet

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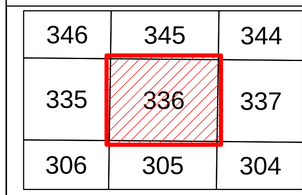

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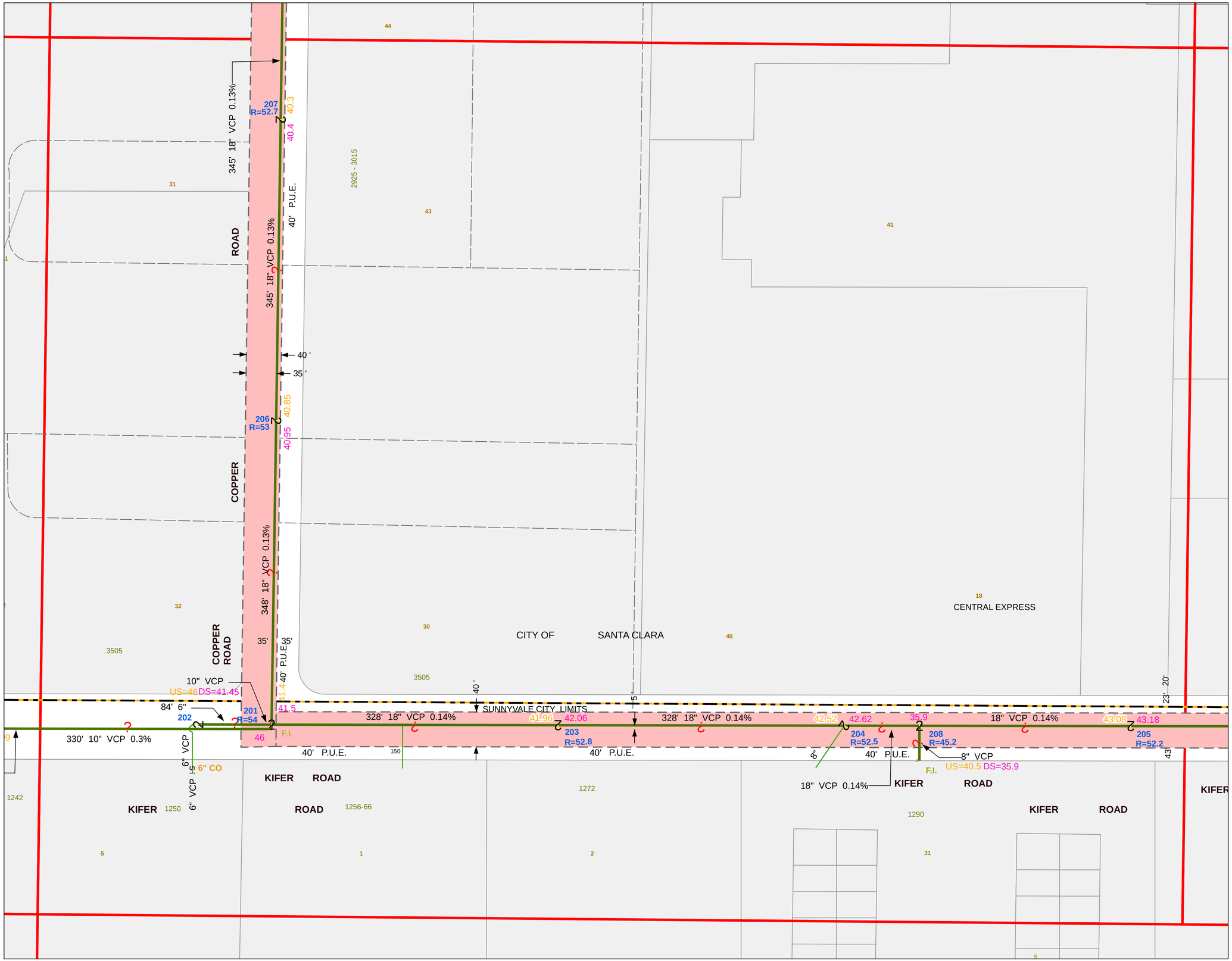
Nov 11, 2019

SUNNYVALE - SEWER
Appendix A



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- Flushing Inlet
- Active Manhole
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- Active Drop Manhole
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- Grade Break
- Main Line Clean Out
- Network Structure
- Clean Out
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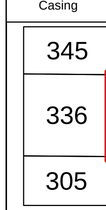

337

0 50 Feet

Nov 11, 2019

SUNNYVALE - SEWER
Appendix A

Legend

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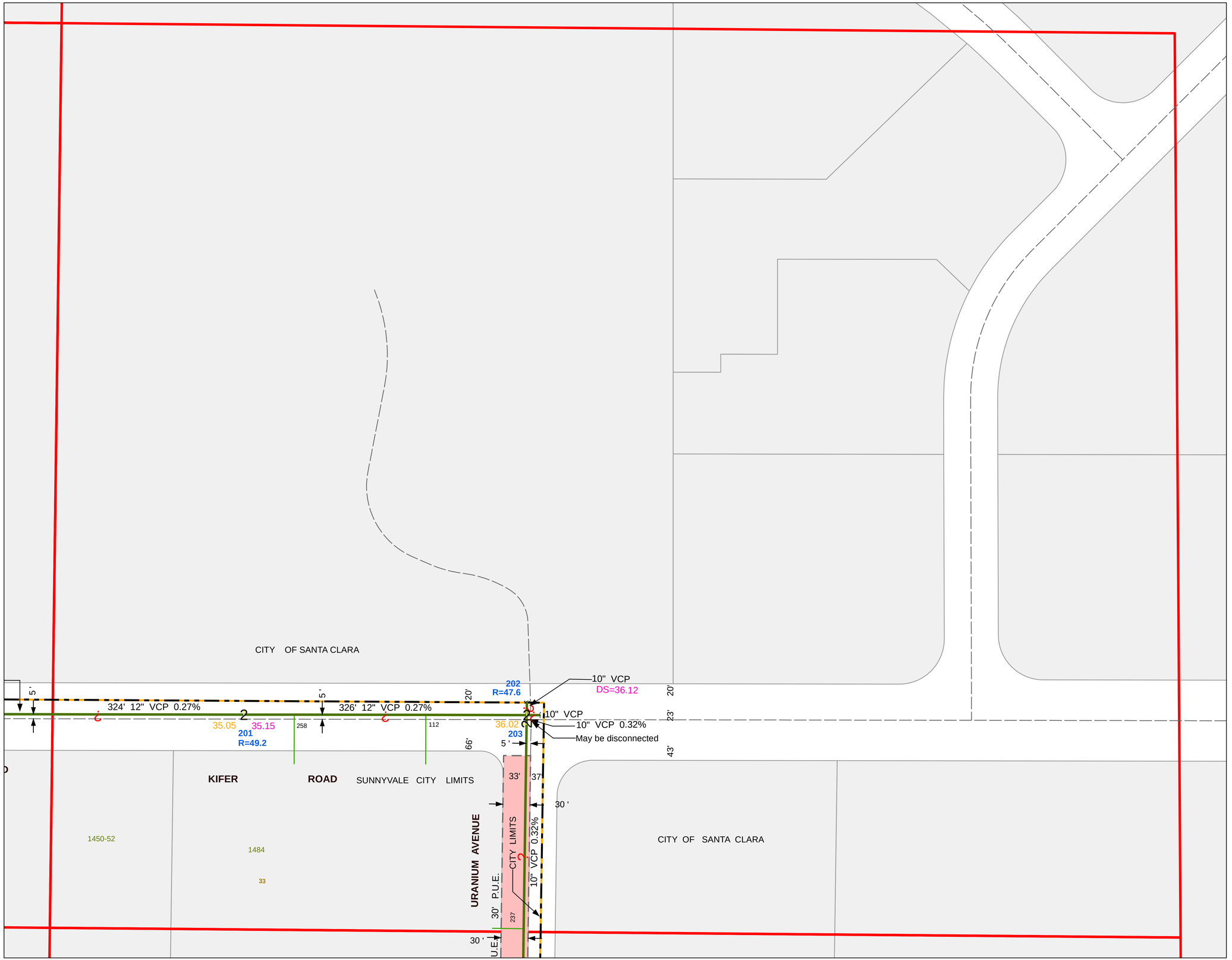
344	343	
337	338	339
304	303	302

338

0 50 Feet

Nov 11, 2019

SUNNYVALE - SEWER
Appendix A



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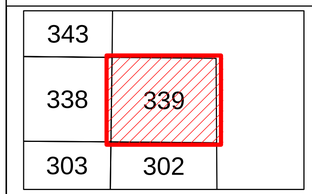

339

0 50 Feet

Nov 11, 2019

SUNNYVALE - SEWER
Appendix A

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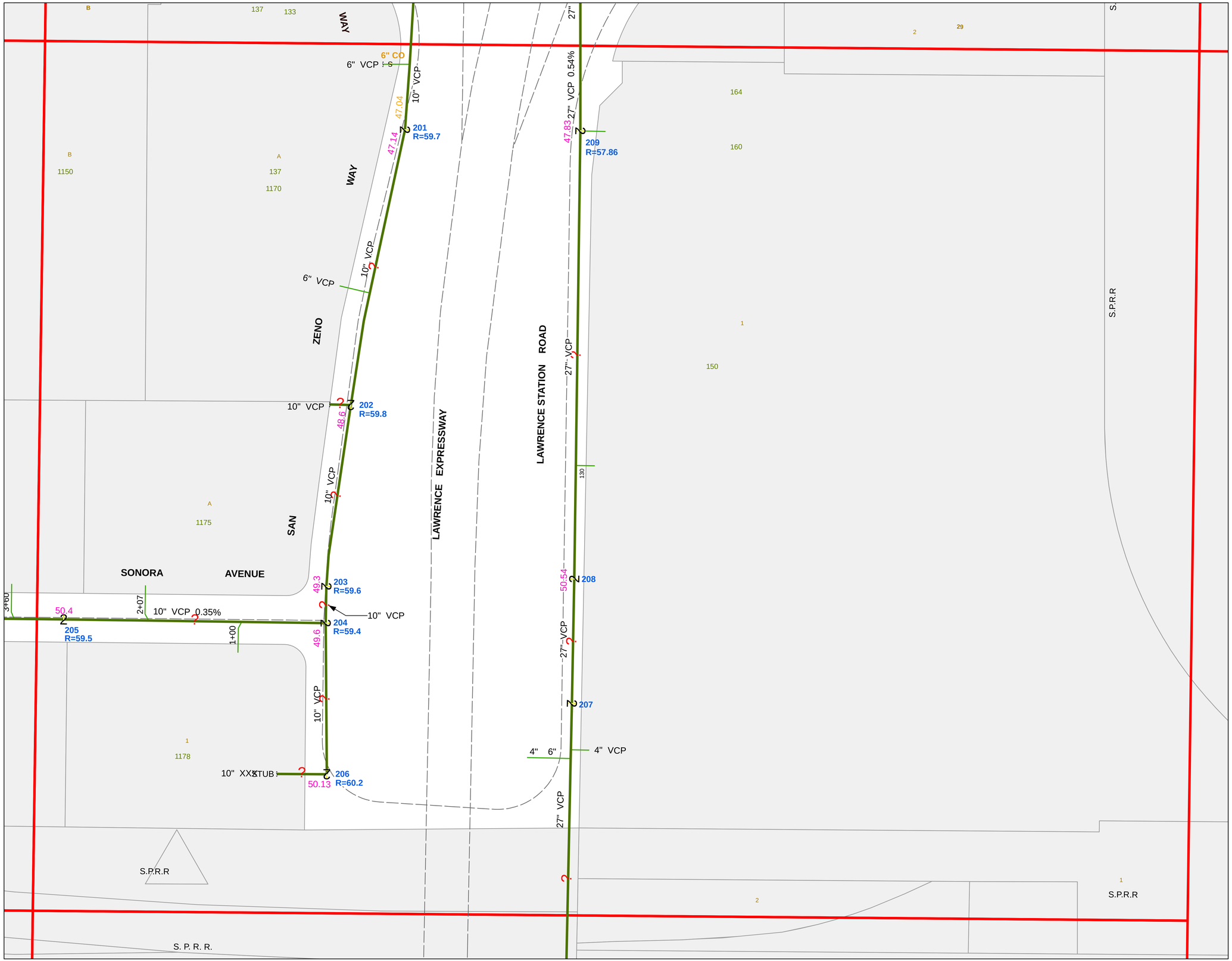
334	335	336
307	306	305
294	295	296

306

0 50 Feet

Nov 11, 2019

SUNNYVALE - SEWER
Appendix A



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Points

"	Flushing Inlet	S	Clean Out
2	Active Manhole	⁞	Active Plug
2	Abandoned Manhole	⁞	Abandoned Plug
2	Active Drop Manhole	)	Meter
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<	Grade Break	T	Lift Station
1	Main Line Clean Out	S	Riser
%	Network Structure	"	Drain Inlet

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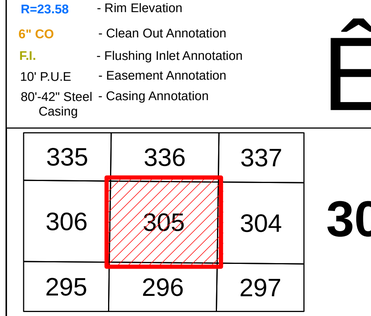

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Nov 11, 2019

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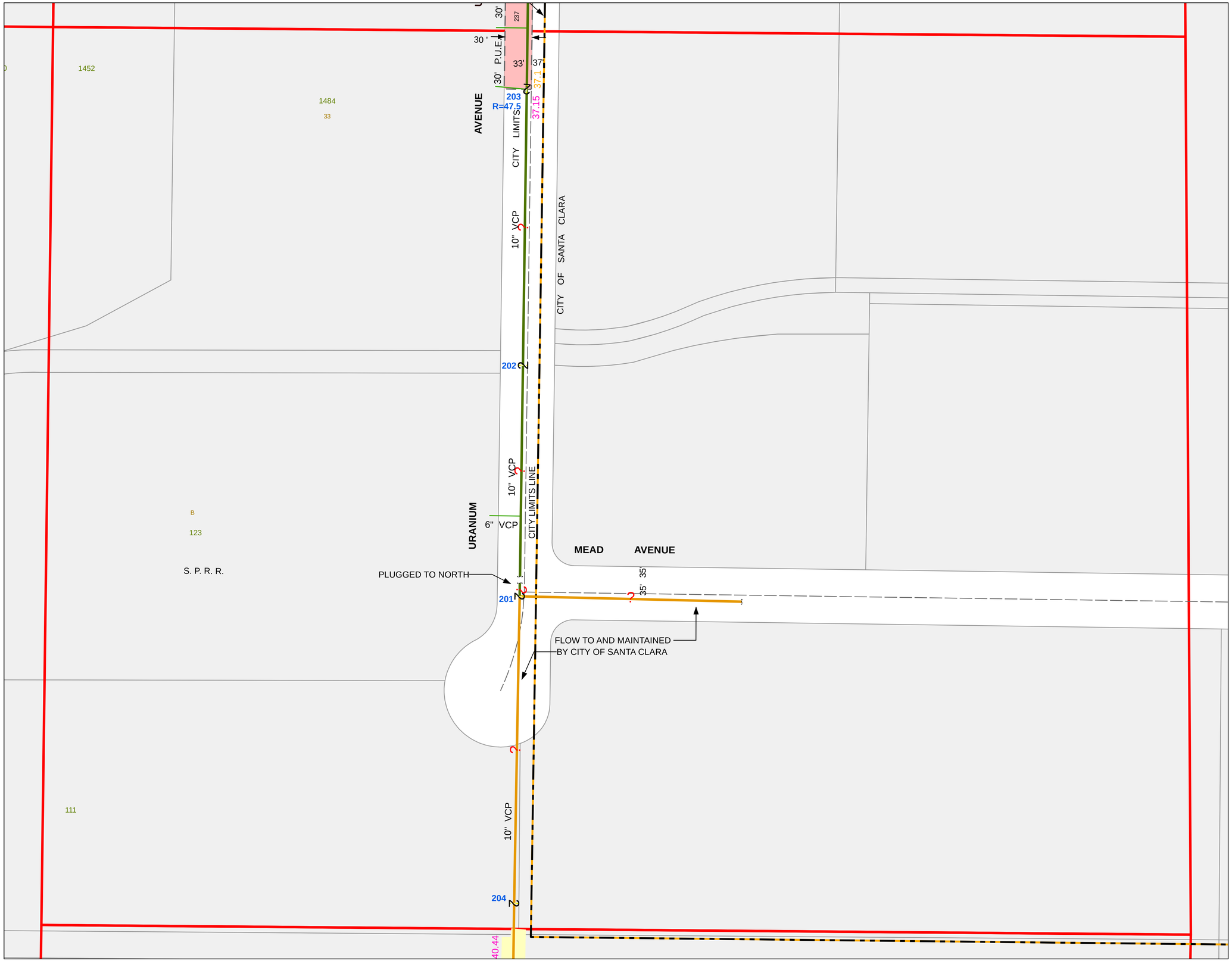

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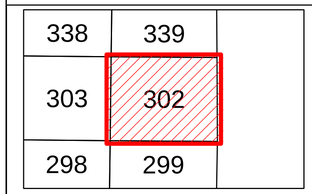

0 50 Feet

Nov 11, 2019

SUNNYVALE - SEWER
Appendix A

Legend

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2	Active Manhole	⨟	Active Plug
2	Abandoned Manhole	⨟	Abandoned Plug
2	Active Drop Manhole	)	Meter
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308	307	306
293	294	295
268	267	266

294

0 50 Feet

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SUNNYVALE - SEWER
Appendix A

S. P. R. R.

S. P. R. R.

PM 1033

1175

A= 24" VCP 0.35% US=52.62
B= 24" VCP 0.35% DS=52.03
C= 131' 24" VCP 0.35% US=52.03 DS=51.57
D= 20' 24" VCP 0.35% US=51.57 DS=51.5
E= 111' 24" VCP 0.35% US=51.5 DS=51.15
F= 131' 24" VCP 0.35% US=51.15 DS=50.69
G= 59' 24" VCP 0.35% US=50.69 DS=50.48

ASTER AVENUE

24" VCP 0.3% 57.72 201 R=69.2

24" VCP 0.3% 56.82 202 R=67.3

24" VCP 0.3% 55.92 203 R=62.64 207

208 R=61.5 209 R=61.3 204 R=61.5 210 R=61.3 211 R=60.4 212 R=60.33

6" PVC S 6" CO

33' 18' 28' 27' 13' 24' 17'

SWEETWOOD TERRACE TAN OAK TREE TEA TREE TERRACE TEAK TREE

PM 1088

P.U.E. EXCLUSION P.U.E. EXCLUSION

TRACT 9758

R/S 591

S. C. C. FLOOD CONTROL

TR. 5987

SUNNYVALE MEADOWS

TR. 5049

R/S : 591

6" CAS 6" CAS 8" CAS

F.I.

1122 1134 1156 1168 1172 1176 1095 1119 1121 1123 1129 1131 1127 1125 1115 1117 1093 1038 1042 1047 1049 1041 1043 1045 1133 1135 1159

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Points

- Flushing Inlet
- Clean Out
- Active Manhole
- Active Plug
- Abandoned Manhole
- Abandoned Plug
- Active Drop Manhole
- Meter
- Diversion Structure
- Pump Station
- Grade Break
- Lift Station
- Main Line Clean Out
- Riser
- Network Structure
- Drain Inlet

Polygons

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295

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Nov 11, 2019

SUNNYVALE - SEWER
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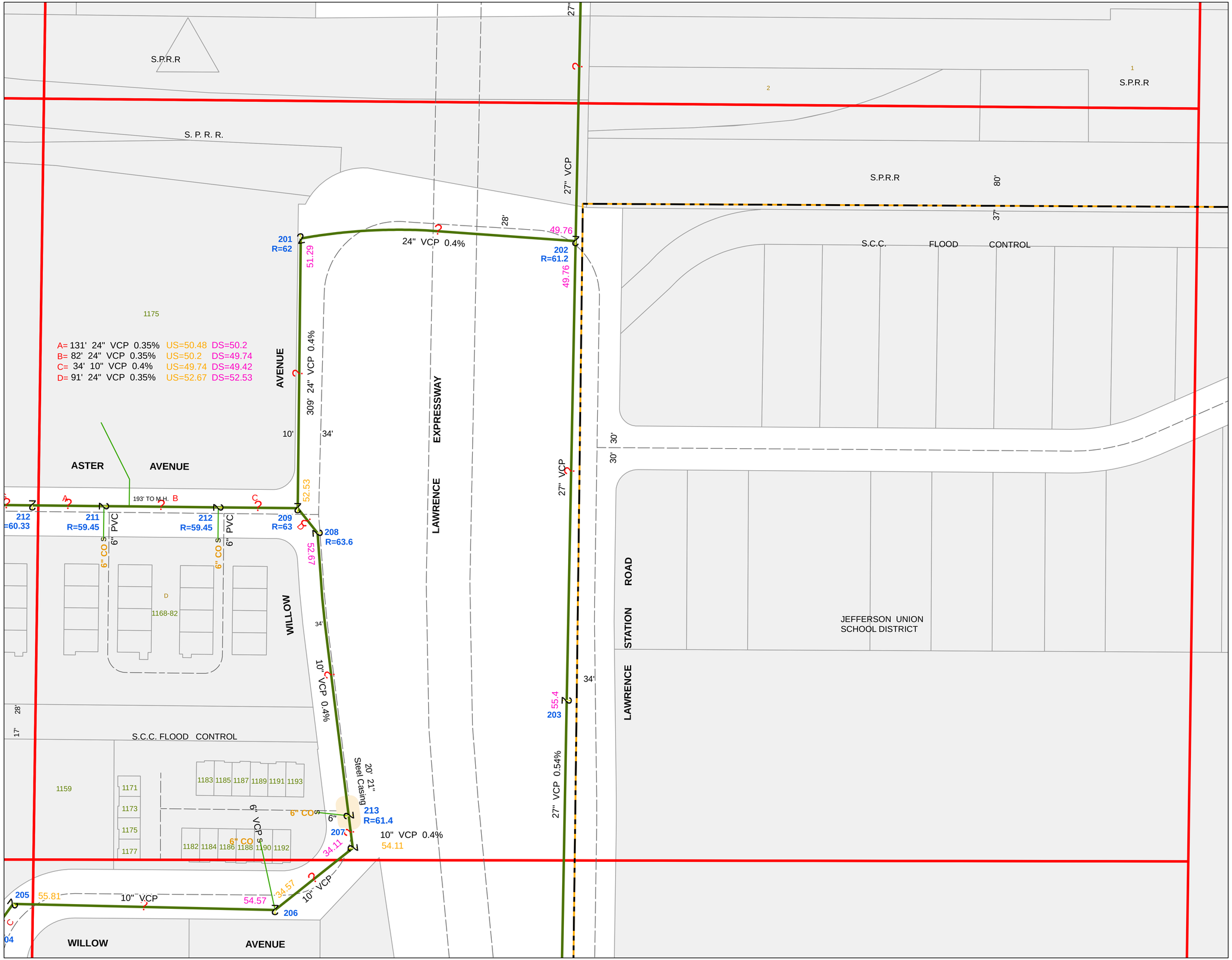

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2	Abandoned Manhole	⁞	Abandoned Plug
2	Active Drop Manhole	)	Meter
2	Diversion Structure	Ú	Pump Station
<	Grade Break	T	Lift Station
1	Main Line Clean Out	S	Riser
%	Network Structure	"	Drain Inlet

Polygons

- Easement
- City Boundary
- Concrete Casing
- Steel Casing
- Detail Polygon
- Blockgrid

Basemap

- Constructed Centerline
- Street Centerline
- Parcel

Annotation

365'	- Pipe Length	**BORREGAS AVENUE**	- Street Name
6"	- Diameter	129	- Lot Number
VCP	- Material	1405	- Address Number
0.2%	- Slope	ONSITE PRIVATE SYSTEM	- Miscellaneous Annotation
US=19.48	- Upstream Elevation		
DS=18.48	- Downstream Elevation		
209	- Manhole Number		
R=23.58	- Rim Elevation		
6" CO	- Clean Out Annotation		
F.I.	- Flushing Inlet Annotation		
10' P.U.E	- Easement Annotation		
80'-42" Steel Casing	- Casing Annotation		

306	305	304
295	296	297
266	265	

296

0 50 Feet

Nov 11, 2019

SUNNYVALE - SEWER
Appendix A

Legend

Lines

- Active Sunnyvale Main
- Abandoned Sunnyvale Main
- Active Private Main
- Others Main
- Active Sunnyvale Lateral
- Abandoned Sunnyvale Lateral
- Active Private Lateral
- Active Force Main
- Abandoned Force Main
- Active Santa Clara Main
- Active Cupertino Main

Points

"	Flushing Inlet	S	Clean Out
2	Active Manhole	S	Active Plug
2	Abandoned Manhole	S	Abandoned Plug
2	Active Drop Manhole	)	Meter
2	Diversion Structure	Ú	Pump Station
<	Grade Break	T	Lift Station
1	Main Line Clean Out	S	Riser
%	Network Structure	"	Drain Inlet

Polygons

- Easement
- City Boundary
- Concrete Casing
- Steel Casing
- Detail Polygon
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Basemap

- Constructed Centerline
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365'	- Pipe Length	BORREGAS AVENUE	- Street Name
6"	- Diameter	129	- Lot Number
VCP	- Material	1405	- Address Number
0.2%	- Slope	ONSITE PRIVATE SYSTEM	- Miscellaneous Annotation
US=19.48	- Upstream Elevation		
DS=18.48	- Downstream Elevation		
209	- Manhole Number		
R=23.58	- Rim Elevation		
6" CO	- Clean Out Annotation		
F.I.	- Flushing Inlet Annotation		
10' P.U.E	- Easement Annotation		
80'-42" Steel Casing	- Casing Annotation		

294	295	296
267	266	265
254	255	256

266

0 50 Feet

Nov 11, 2019

SUNNYVALE - SEWER
Appendix A

Legend

Lines

- Active Sunnyvale Main
- Abandoned Sunnyvale Main
- Active Private Main
- Others Main
- Active Sunnyvale Lateral
- Abandoned Sunnyvale Lateral
- Active Private Lateral
- Active Force Main
- Abandoned Force Main
- Active Santa Clara Main
- Active Cupertino Main

Points

"	Flushing Inlet	S	Clean Out
2	Active Manhole	⁞	Active Plug
2	Abandoned Manhole	⁞	Abandoned Plug
2	Active Drop Manhole	)	Meter
2	Diversion Structure	Ú	Pump Station
<	Grade Break	T	Lift Station
1	Main Line Clean Out	S	Riser
%	Network Structure	"	Drain Inlet

Polygons

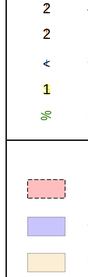
- Easement
- City Boundary
- Concrete Casing
- Steel Casing
- Detail Polygon
- Blockgrid

Basemap

- Constructed Centerline
- Street Centerline
- Parcel

Annotation

365'	- Pipe Length	BORREGAS AVENUE	- Street Name
6"	- Diameter	129	- Lot Number
VCP	- Material	1405	- Address Number
0.2%	- Slope	ONSITE PRIVATE SYSTEM	- Miscellaneous Annotation
US=19.48	- Upstream Elevation		
DS=18.48	- Downstream Elevation		
209	- Manhole Number		
R=23.58	- Rim Elevation		
6" CO	- Clean Out Annotation		
F.I.	- Flushing Inlet Annotation		
10' P.U.E	- Easement Annotation		
80'-42" Steel Casing	- Casing Annotation		



295	296	297
266	265	
255	256	

265

0 50 Feet

Nov 11, 2019

APPENDIX B

LSAP Parcels with Development Assumptions

Appendix B
Lawrence Station Area Plan
LSAP Parcels with Devleopment Assumptions
Received from George Schroeder of the City of Sunnyvale on March 16, 2019

Residential development cap under the adopted LSAP (net new dwelling units)	**2,323**		
Net new housing units approved by the City since LSAP adoption in 2016	**1261**	**Addition of net new units proposed within the adopted LSAP**	**Total net new housing unit cap proposed with implementation of LSAP update**
Balance of net new housing units that currently remain for buildout within the adopted LSAP	**1,062**	**3,612**	**5,935**

Existing — Parcels highlighted in green will be analyzed as the existing condition.
Proposed — Parcels highlighted in blue will be analyzed as the proposed condition.

Parcels not expected to redevelop to residential or change (Caltrain properties also excluded)

APN	Addr #	Street	St. Type	Lot Sq. Ft.	Lot Acres	Zoning District
20549008	960	Kifer	Rd	214,751	4.93	MXD-2
20550001	1016-1020	Kifer	Rd	344,734	7.91	MXD-2
20550036	1050-1090	Kifer	Rd	426,364	9.79	MXD-1
20550029	1127	Sonora	Ct	175,982	4.04	MXD-2
20550004	1120-1130	Kifer	Rd	348,698	8.01	MXD-1
21627018	1202	Kifer	Rd	21,621	0.50	MXD-1
21627053	1210	Kifer	Rd	69,696	1.60	MXD-1
21627052	150	Lawrence Station	Rd	561,052	12.88	MXD-1
21627059	106	Lawrence Station	Rd	321,037	7.37	MXD-2
Various	1286-1298	Kifer	Rd	501,498	11.51	MXD-2
Various	1171-1193	Buttercup	Tr	32,800	0.75	R5
21301034	1155	Aster	Av	708,198	16.26	MXD-3
21301032	"	"		7,841	0.18	MXD-3
21301033	"	"		21,344	0.49	MXD-3

East of Calbazas Creek - 50% of these sites developed at 100 du/ac

APN	Addr #	Street	St. Type	Lot Sq. Ft.	Lot Acres	Zoning District	Existing or Approved Land Use	Existing SF (Nonres)	Estimated Units for Proposed LSAP
21627023	1484	Kifer	Rd	207,781	4.77	MS/LSAP	Industrial	128,628	382
21627068	1382-1388	Kifer	Rd	155,191	3.56	MS/LSAP	Office	88,222	338
21627069	1400	Kifer	Rd	276,231	6.34	MS/LSAP	Industrial	76,905	634
21627033				30,492	0.70	MS/LSAP	N/A, Rail Spur	N/A	0
21627035				43,124	0.99	MS/LSAP	N/A. Rail Spur	N/A	0
21627044	1450	Kifer	Rd	234,353	5.38	MS/LSAP	Office	78,000	0
21627045	123	Uranium	Dr	250,470	5.75	MS/LSAP	Industrial	105,000	0
21627047	111	Uranium	Dr	252,212	5.79	MS/LSAP	Industrial	126,788	328
21627048				16,117	0.37	MS/LSAP	N/A, Rail Spur	N/A	0
					Total of all sites				
					50% of total				

Lawrence/Reed/Willow - developed at 54 du/ac

APN	Addr #	Street	St. Type	Lot Sq. Ft.	Lot Acres	Zoning District	Existing or Approved Land Use	Existing SF (Nonres)	Estimated Units for Proposed LSAP	Estimated Retail under Proposed LSAP (SF)
21301001	1170	Willow	Av	10,550	0.24	OR	Commercial	19,145	13	1000
21301002	1165	Reed	Av	41,700	0.96	OR	Commercial	16,750	52	2000
21301003	1155	Reed	Av	67,082	1.54	OR	Commercial	11,448	83	2000
21301004	1164	Willow	Av	14,849	0.34	OR	Commercial	6,500	18	2000
					Total of all sites				**166**	**7,000**

Kifer/Sonora - developed at 100 du/ac

APN	Addr #	Street	St. Type	Lot Sq. Ft.	Lot Acres	Adopted LSAP DEC 2016 Existing Max @ 68 du/ac	Delta	Existing or Approved Land Use	Existing SF (Nonres)	Estimated Units for Proposed LSAP	Estimated Retail under Proposed LSAP (SF)
20550013	1178	Sonora	Ct	54,886	1.26	86	40	Industrial	19,440	126	1000
20550014	1170	Sonora	Ct	47,480	1.09	74	35	Industrial	14,850	109	N/A
20550015	1162	Sonora	Ct	51,401	1.18	80	38	Industrial	19,463	0	N/A
20550016	1154	Sonora	Ct	82,328	1.89	129	60	Industrial	41,062	168	N/A
20550017	1146	Sonora	Ct	32,670	0.75	51	24	Industrial	11,055	0	N/A
20550019	1175	Sonora	Ct	57,064	1.31	89	42	Industrial	19,098	111	N/A
20550022	1151	Sonora	Ct	55,757	1.28	87	41	Industrial	19,512	0	N/A
20550024	1171	Sonora	Ct	56,628	1.30	88	42	Industrial	19,512	130	N/A
20550025	1159	Sonora	Ct	49,658	1.14	78	36	Industrial	16,830	0	N/A
20550026	1145	Sonora	Ct	54,450	1.25	85	40	Industrial	19,990	0	N/A
20550028	1135	Sonora	Ct	64,033	1.47	100	47	Industrial	24,000	125	N/A
20550034	1150	Kifer	Rd	114,127	2.62	178	84	Office	46,849	262	2500
20550035	1170	Kifer	Rd	139,392	3.20	218	102	Office	57,649	320	2500
21627037	1360	Kifer	Rd	635,105	14.58	991	467	Industrial	286,800	1458	N/A
21627042	1256	Kifer	Rd	182,516	4.19	285	134	Industrial	61,758	0	N/A
21627043	1272	Kifer	Rd	426,452	9.79	666	313	Industrial	147,842	0	N/A
21627067	1242	Kifer	Rd	297,384	6.83	464	218	Office	152,758	0	N/A
					Total of all sites	**3,749**	**1,764**			**2,810**	**6,000**

R-5 Site - no change, 16 units allowed

APN	Addr #	Street	St. Type	Lot Sq. Ft.	Lot Acres	Zoning District	Estimated Units for Proposed LSAP
21301023	1159	Willow	Av	20708	0.48	R5	16

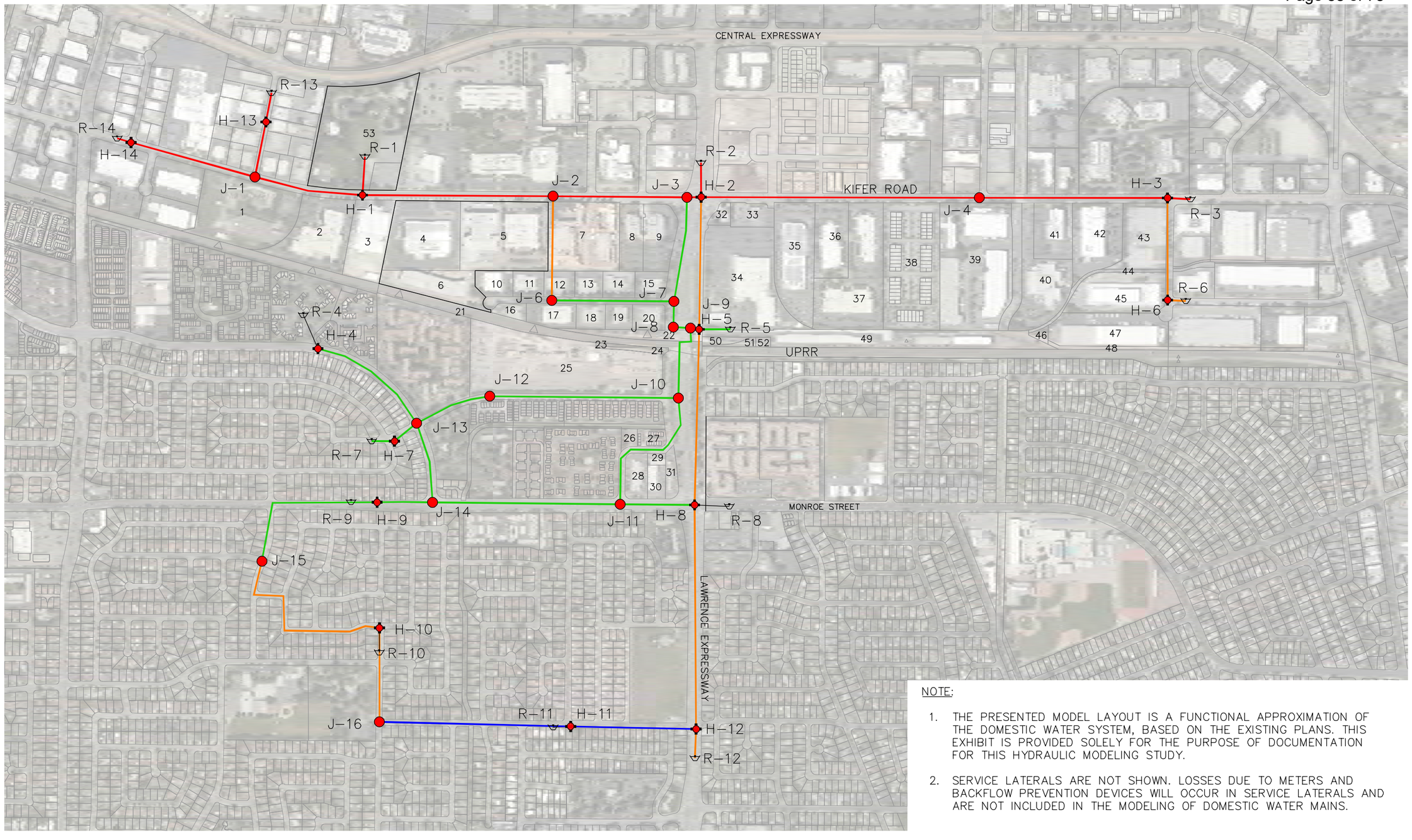
Railroad Properties

APN	Lot Sq. Ft.	Lot Acres
21627058	10,019	0.23
21627056	23,522	0.54
21627057	13,939	0.32
20550038	N/A	N/A
20550039	N/A	N/A
20550040	N/A	N/A
20550043	532,739	12.23
20550032	111,514	2.56

Note:
1. The square footage numbers provided in these tables represent project buildout numbers including nonresidential buildings expected to remain.

APPENDIX C

LSAP Potable Water Model Reports



NOTE:

1. THE PRESENTED MODEL LAYOUT IS A FUNCTIONAL APPROXIMATION OF THE DOMESTIC WATER SYSTEM, BASED ON THE EXISTING PLANS. THIS EXHIBIT IS PROVIDED SOLELY FOR THE PURPOSE OF DOCUMENTATION FOR THIS HYDRAULIC MODELING STUDY.
2. SERVICE LATERALS ARE NOT SHOWN. LOSSES DUE TO METERS AND BACKFLOW PREVENTION DEVICES WILL OCCUR IN SERVICE LATERALS AND ARE NOT INCLUDED IN THE MODELING OF DOMESTIC WATER MAINS.

EXHIBIT 1. WaterCAD Model Layout

Lawrence Station Area Plan

Housing Study Project

SCALE 1" = 800'

BKF No. 20180080-10

GRAPHIC SCALE
800 0 800 1600

LEGEND

- MODEL NODE
- MODEL RESERVOIR
- J-00 NODE ID
- H-00 HYDRANT ID
- HYDRANT LOCATION
- 12" CAST IRON PIPE (EXISTING)
- 12" DUCTILE IRON PIPE (EXISTING)
- 10" DUCTILE IRON PIPE (EXISTING)
- 8" DUCTILE IRON PIPE (EXISTING)

BKF 100+ YEARS
ENGINEERS . SURVEYORS . PLANNERS

APPENDIX C-1

Model Demand Scenario 1: Static

Node Report

Node ID	Elevation (ft)	Hydraulic Grade (ft)	Pressure (psi)
J-1	63.00	240.00	77
J-2	60.00	240.00	78
J-3	57.00	240.00	79
J-4	49.24	240.00	83
J-6	61.00	240.00	77
J-7	61.00	240.00	77
J-8	61.00	240.00	77
J-9	61.00	240.00	77
J-10	65.00	240.00	76
J-11	68.00	240.00	74
J-12	69.95	240.00	74
J-13	72.00	240.00	73
J-14	77.00	240.00	71
J-15	83.00	240.00	68
J-16	83.00	240.00	68
H-1	63.00	240.00	77
H-2	57.00	240.00	79
H-3	44.00	240.00	85
H-4	72.00	240.00	73
H-5	61.00	240.00	77
H-6	50.00	240.00	82
H-7	72.00	240.00	73
H-8	68.00	240.00	74
H-9	77.00	240.00	71
H-10	83.00	240.00	68
H-11	82.00	240.00	68
H-12	77.00	240.00	71
H-13	63.00	240.00	77
H-14	67.00	240.00	75

APPENDIX C-2

Model Demand Scenario 2: Peak Hour Demand

Node Report

Label	Demand (gpm)	Available Flow with System-wide Constraint * (gpm)	Minimum Residual Pressure @ PHD (psi)	Maximum Pipe Velocity (ft/s)	Satisfies Criteria?
J-1	500	1,000	76	1.73	TRUE
J-2	500	1,000	77	1.32	TRUE
J-3	500	1,000	79	1.87	TRUE
J-4	500	1,000	80	1.57	TRUE
J-6	500	1,000	76	1.80	TRUE
J-7	500	1,000	77	2.03	TRUE
J-8	500	1,000	77	2.66	TRUE
J-9	500	1,000	77	0.80	TRUE
J-10	500	1,000	75	1.86	TRUE
J-11	500	1,000	74	1.87	TRUE
J-12	500	1,000	72	2.55	TRUE
J-13	500	1,000	72	1.85	TRUE
J-14	500	1,000	70	1.84	TRUE
J-15	500	1,000	67	1.69	TRUE
J-16	500	1,000	66	2.96	TRUE
H-1	500	1,000	77	0.18	TRUE
H-2	500	1,000	79	0.42	TRUE
H-3	500	1,000	85	0.06	TRUE
H-4	500	1,000	73	0.14	TRUE
H-5	500	1,000	77	0.29	TRUE
H-6	500	1,000	82	0.26	TRUE
H-7	500	1,000	73	0.38	TRUE
H-8	500	1,000	74	0.30	TRUE
H-9	500	1,000	71	0.08	TRUE
H-10	500	1,000	68	0.15	TRUE
H-11	500	1,000	68	0.36	TRUE
H-12	500	1,000	71	0.06	TRUE
H-13	500	1,000	77	0.29	TRUE
H-14	500	1,000	75	0.10	TRUE

* Available flow reported is based on system-wide constraint of 20 psi and 15 fps applied every where in the system. During simulation, if the pressure were to drop below 20 psi or velocity exceed 15 fps at any location system-wide due to demand placed at that specific node in question, then the simulation ends and the resulting flow calculated at the end of that simulation is reported for that node in question.

APPENDIX C-3

Model Demand Scenario 3: Max Day Demand + Fire Flow

Node Report

Label	Demand (gpm)	Available Flow with System-wide Constraint * (gpm)	Minimum Residual Pressure @ MDD (psi)	Maximum Pipe Velocity (ft/s)	Satisfies Criteria?
J-1	4,820	6,000	73	10.40	TRUE
J-2	4,820	6,000	61	7.93	TRUE
J-3	4,820	6,000	74	11.25	TRUE
J-4	4,820	5,788	38	9.09	TRUE
J-6	4,820	6,000	56	10.78	TRUE
J-7	4,820	6,000	68	12.17	TRUE
J-8	4,820	5,648	70	15.00	TRUE
J-9	4,820	6,000	74	4.80	TRUE
J-10	4,820	6,000	62	11.16	TRUE
J-11	4,820	6,000	63	11.23	TRUE
J-12	4,820	5,881	49	15.00	TRUE
J-13	4,820	6,000	68	11.10	TRUE
J-14	4,820	6,000	62	11.02	TRUE
J-15	4,820	6,000	47	10.12	TRUE
J-16	4,820	5,065	33	15.00	TRUE
H-1	4,820	6,000	76	1.06	TRUE
H-2	4,820	6,000	78	2.50	TRUE
H-3	4,820	6,000	85	0.33	TRUE
H-4	4,820	6,000	72	0.87	TRUE
H-5	4,820	6,000	77	1.75	TRUE
H-6	4,820	6,000	82	1.56	TRUE
H-7	4,820	6,000	72	2.30	TRUE
H-8	4,820	6,000	74	1.80	TRUE
H-9	4,820	6,000	70	0.45	TRUE
H-10	4,820	6,000	68	0.90	TRUE
H-11	4,820	6,000	67	2.15	TRUE
H-12	4,820	6,000	70	0.33	TRUE
H-13	4,820	6,000	76	1.77	TRUE
H-14	4,820	6,000	75	0.59	TRUE

* Available flow reported is based on system-wide constraint of 20 psi and 15 fps applied every where in the system. During simulation, if the pressure were to drop below 20 psi or velocity exceed 15 fps at any location system-wide due to demand placed at that specific node in question, then the simulation ends and the resulting flow calculated at the end of that simulation is reported for that node in question.

APPENDIX D

LSAP Sewer Model Reports

Appendix D
Lawrence Station Area Plan
Sanitary Sewer - Average Dry Weather Flow (ADWF) Hydraulics - Existing System

Pipe [5] #	Upstream Node	Downstream Node	Total Flow (gpm)	Capacity @ Constructed Slope (gpm)	Pipe Size (inches)	Length (feet)	Constructed Slope (ft/ft)	Pipe Roughness (Mannings n)	Invert Elevation		Ground/Rim Elevation		HGL Elevation		Upstream Freeboard [2] (feet)	Upstream Cover (feet)	Velocity (ft/s)	d/D
									Upstream	Downstream	Upstream	Downstream	Upstream	Downstream				
EX-AA-P1	294-206	294-207	**1173.61**	6027.72	24	278.00	0.004	0.013	59.36	58.38	73.50	71.62	59.96	58.98	13.54	12.14	3.31	**0.30**
EX-AA-P2	294-207	295-201	**1173.61**	6002.76	24	320.40	0.003	0.013	58.38	57.26	71.62	69.20	58.98	57.86	12.64	11.24	3.30	**0.30**
EX-AA-P3	295-201	295-202	**1173.61**	5982.64	24	293.80	0.003	0.013	57.26	56.24	69.20	67.30	57.86	56.85	11.34	9.94	3.29	**0.30**
EX-AA-P4	295-202	295-203	**1203.25**	6012.36	24	305.10	0.004	0.013	56.24	55.17	67.30	62.64	56.85	55.78	10.45	9.06	3.33	**0.31**
EX-AA-P5	295-203	295-207	**1203.25**	5946.41	24	29.20	0.003	0.013	55.17	55.07	62.64	62.42	55.78	55.68	6.86	5.47	3.30	**0.31**
EX-AA-P6	295-207	295-208	**1203.25**	6011.31	24	119.80	0.004	0.013	55.07	54.65	62.42	61.50	55.68	55.26	6.74	5.35	3.33	**0.31**
EX-AA-P7	295-208	295-209	**1203.25**	6015.10	24	131.10	0.004	0.013	54.65	54.19	61.50	61.30	55.26	54.79	6.24	4.85	3.33	**0.31**
EX-AA-P8	295-209	295-204	**1203.25**	6076.51	24	19.50	0.004	0.013	54.19	54.12	61.30	61.50	54.79	54.73	6.51	5.11	3.36	**0.30**
EX-AA-P9	295-204	295-210	**1203.25**	6012.78	24	111.20	0.004	0.013	54.12	53.73	61.50	61.30	54.73	54.34	6.77	5.38	3.33	**0.31**
EX-AA-P10	295-210	295-211	**1203.25**	6020.16	24	130.80	0.004	0.013	53.73	53.27	61.30	60.40	54.34	53.87	6.96	5.57	3.33	**0.31**
EX-AA-P11	295-211	295-212	**1203.25**	6063.28	24	58.90	0.004	0.013	53.27	53.06	60.40	60.33	53.87	53.67	6.53	5.13	3.35	**0.30**
EX-AA-P12	295-212	296-211	**1203.25**	5948.20	24	81.60	0.003	0.013	53.06	52.78	60.33	59.45	53.67	53.39	6.66	5.27	3.30	**0.31**
EX-AA-P13	296-211	296-212	**1232.89**	6020.30	24	130.80	0.004	0.013	52.78	52.32	59.45	59.45	53.39	52.93	6.06	4.67	3.36	**0.31**
EX-AA-P14	296-212	296-209	**1232.89**	6030.04	24	90.70	0.004	0.013	52.32	52.00	59.45	63.00	52.93	52.58	6.52	5.13	3.36	**0.31**
EX-CR-P1	337-202	337-201	**24.75**	8049.63	10	5.00	0.670	0.013	44.81	41.45	54.00	54.00	44.91	41.89	9.09	8.36	7.36	**0.12**
EX-CR-P2	337-201	337-206 (EX)	**338.45**	1786.38	18	348.20	0.001	0.013	41.45	40.95	54.00	53.00	41.89	41.27	12.11	11.05	1.73	**0.29**
EX-KR-P1	333-206	334-201	**336.11**	2809.64	18	534.90	0.004	0.013	57.49	55.59	67.86	66.70	57.84	56.04	10.02	8.87	2.39	**0.23**
EX-KR-P2	334-201	334-202	**492.82**	2505.53	18	534.60	0.003	0.013	55.59	54.08	66.70	65.80	56.04	54.54	10.66	9.61	2.45	**0.30**
EX-KR-P3	334-202	335-201	**519.37**	2582.18	18	930.00	0.003	0.013	54.08	51.29	65.80	64.50	54.54	51.77	11.26	10.22	2.55	**0.31**
EX-KR-P4	335-201	335-202	**571.01**	2582.16	18	900.00	0.003	0.013	51.29	48.59	64.50	61.20	51.77	49.06	12.73	11.71	2.61	**0.32**
EX-KR-P5	335-202	336-201	**634.28**	2982.83	18	692.00	0.004	0.013	48.59	45.82	61.20	57.50	49.06	46.30	12.14	11.11	2.99	**0.31**
EX-KR-P6	336-201	336-202	**733.54**	6905.33	18	180.90	0.021	0.013	45.82	41.94	57.50	57.04	46.30	42.90	11.20	10.18	5.67	**0.32**
EX-KR-P7	336-203	336-204	**3.09**	296.15	8	335.40	0.003	0.013	46.80	45.80	55.00	56.50	46.85	45.90	8.15	7.53	0.61	**0.08**
EX-KR-P8	336-204	337-202	**16.19**	538.35	10	330.30	0.003	0.013	45.80	44.81	56.50	54.00	45.90	44.91	10.60	9.87	0.98	**0.12**
EX-KR-P9	337-203	337-201	**313.70**	1858.32	18	328.20	0.002	0.013	41.96	41.45	52.80	54.00	42.38	41.89	10.42	9.34	1.74	**0.28**
EX-KR-P10	337-204	337-203	**293.22**	1764.29	18	328.50	0.001	0.013	42.52	42.06	52.50	52.80	42.93	42.38	9.57	8.48	1.65	**0.27**
EX-KR-P11	337-208	337-204	**276.10**	1963.22	18	86.50	0.002	0.013	42.77	42.62	52.40	52.50	43.15	42.93	9.25	8.13	1.75	**0.25**
EX-KR-P12	337-205	337-208	**276.10**	1686.94	18	242.10	0.001	0.013	43.08	42.77	52.20	52.40	43.49	43.15	8.71	7.62	1.57	**0.27**
EX-KR-P13	338-201	337-205	**276.10**	1765.25	18	328.10	0.001	0.013	43.64	43.18	51.50	52.20	44.04	43.49	7.46	6.36	1.62	**0.27**
EX-KR-P14	338-202	338-201	**159.71**	1758.45	18	265.90	0.001	0.013	44.11	43.74	51.00	51.50	44.42	44.04	6.58	5.39	1.38	**0.21**
EX-KR-P15	338-203	338-204 (EX)	**159.71**	5139.47	12	28.20	0.088	0.012	32.18	29.70	51.00	49.00	32.43	29.82	18.57	17.82	6.61	**0.25**
EX-KR-P16	338-207	338-203	**159.71**	783.86	12	387.00	0.002	0.013	33.11	32.18	49.80	51.00	33.42	32.43	16.38	15.69	1.75	**0.31**
EX-KR-P17	338-209	338-207	**82.12**	828.07	12	324.40	0.003	0.013	34.08	33.21	49.60	49.80	34.29	33.42	15.31	14.52	1.50	**0.21**
EX-KR-P18	339-201	338-209	**71.31**	828.61	12	324.00	0.003	0.013	35.05	34.18	49.20	49.60	35.25	34.34	13.95	13.15	1.44	**0.20**
EX-KR-P19	339-202	339-201	**56.02**	825.85	12	326.10	0.003	0.013	36.02	35.15	47.60	49.20	36.20	35.29	11.40	10.58	1.34	**0.18**
EX-LE-P1	265-204	296-203	**1539.58**	10356.75	27	706.10	0.006	0.013	56.12	52.20	67.83	69.82	56.75	52.79	11.08	9.46	4.16	**0.28**
EX-LE-P2	296-203	296-202	**1539.58**	10321.07	27	526.00	0.006	0.013	52.20	49.30	69.82	61.19	52.83	50.15	16.99	15.37	4.15	**0.28**
EX-LE-P3	296-202	305-207	**2787.60**	9722.92	27	400.60	0.005	0.013	49.30	47.34	61.19	60.50	50.15	48.16	11.04	9.64	4.70	**0.38**
EX-LE-P4	305-207	305-208	**2787.60**	10276.48	27	142.70	0.005	0.013	47.34	46.56	60.50	58.98	48.19	47.41	12.31	10.91	4.90	**0.38**
EX-LE-P5	305-208	305-209	**2793.45**	10397.94	27	512.90	0.006	0.013	46.56	43.69	58.98	56.98	47.41	44.54	11.57	10.17	4.94	**0.38**
EX-LE-P6	305-209	336-202	**2799.30**	10219.40	27	323.70	0.005	0.013	43.69	41.94	56.98	57.04	44.54	42.90	12.44	11.04	4.88	**0.38**
EX-LE-P7	336-202	336-207 (EX)	**3533.54**	10208.70	27	671.10	0.005	0.013	41.94	38.32	57.04	54.28	42.90	39.23	14.14	12.85	5.20	**0.43**
EX-SC-P1	306-201	306-202	**9.98**	982.14	10	300.70	0.010	0.013	56.78	53.78	64.90	62.40	56.84	53.87	8.06	7.29	1.30	**0.07**
EX-SC-P2	306-202	306-203	**14.28**	616.32	10	300.40	0.004	0.013	53.78	52.60	62.40	60.85	53.87	52.73	8.53	7.79	1.04	**0.11**
EX-SC-P3	306-203	306-204	**30.39**	595.79	10	299.60	0.004	0.013	52.60	51.50	60.85	60.80	52.73	51.64	8.12	7.42	1.28	**0.16**
EX-SC-P4	306-204	305-205	**35.42**	595.39	10	300.00	0.004	0.013	51.50	50.40	60.80	59.50	51.64	50.58	9.16	8.47	1.33	**0.17**
EX-SC-P5	305-205	305-204	**54.50**	507.31	10	300.60	0.003	0.013	50.40	49.60	59.50	59.40	50.58	49.77	8.92	8.27	1.35	**0.22**
EX-SZW-P1	305-206	305-204	**10.14**	544.00	10	173.20	0.003	0.013	50.13	49.60	60.20	59.40	50.21	49.77	9.99	9.24	0.86	**0.10**

Appendix D
Lawrence Station Area Plan
Sanitary Sewer - Average Dry Weather Flow (ADWF) Hydraulics - Existing System

Pipe [5] #	Upstream Node	Downstream Node	Total Flow (gpm)	Capacity @ Constructed Slope (gpm)	Pipe Size (inches)	Length (feet)	Constructed Slope (ft/ft)	Pipe Roughness (Mannings n)	Invert Elevation		Ground/Rim Elevation		HGL Elevation		Upstream Freeboard [2] (feet)	Upstream Cover (feet)	Velocity (ft/s)	d/D
									Upstream	Downstream	Upstream	Downstream	Upstream	Downstream				
EX-SZW-P2	305-204	305-203	**73.50**	832.77	10	41.80	0.007	0.013	49.60	49.30	59.40	59.60	49.77	49.50	9.63	8.97	2.10	**0.20**
EX-SZW-P3	305-203	305-202	**73.50**	568.08	10	209.70	0.003	0.013	49.30	48.60	59.60	59.80	49.50	48.79	10.10	9.47	1.60	**0.24**
EX-SZW-P4	305-202	305-201	**73.50**	663.21	10	321.00	0.005	0.013	48.60	47.14	59.80	59.70	48.79	47.31	11.01	10.37	1.79	**0.23**
EX-SZW-P5	305-201	336-201	**86.38**	602.90	10	324.50	0.004	0.013	47.04	45.82	59.70	57.50	47.25	46.30	12.45	11.83	1.75	**0.25**
EX-UD-P1	302-201	302-202	**26.18**	563.71	10	234.30	0.003	0.013	38.89	38.12	50.00	49.00	39.01	38.27	10.99	10.28	1.17	**0.14**
EX-UD-P2	302-202	302-203	**40.73**	553.58	10	306.10	0.003	0.013	38.12	37.15	49.00	47.50	38.27	37.28	10.73	10.05	1.32	**0.18**
EX-UD-P3	302-203	339-203	**56.02**	566.65	10	295.10	0.003	0.013	37.10	36.12	47.50	47.60	37.28	36.27	10.22	9.57	1.48	**0.22**
EX-UD-P4	339-203	339-202	**56.02**	972.06	10	10.20	0.010	0.013	36.12	36.02	47.60	47.60	36.27	36.20	11.33	10.65	2.16	**0.18**
EX-WA-P1	266-210	266-204	**6.80**	342.80	8	245.30	0.004	0.013	56.27	55.29	68.00	67.00	56.34	55.35	11.66	11.06	0.86	**0.11**
EX-WA-P2	266-204	266-205	**6.80**	627.96	10	61.30	0.004	0.013	55.29	55.04	67.00	66.00	55.35	55.11	11.65	10.88	0.84	**0.07**
EX-WA-P3	266-205	265-206	**8.08**	622.31	10	299.60	0.004	0.013	55.04	53.84	66.00	65.00	55.11	53.93	10.89	10.13	0.88	**0.08**
EX-WA-P4	265-206	296-207	**14.01**	617.62	10	114.10	0.004	0.013	53.84	53.39	65.00	62.50	53.93	53.48	11.07	10.33	1.04	**0.11**
EX-WA-P5	296-207	296-213	**15.13**	633.75	10	36.10	0.004	0.013	53.39	53.24	62.50	61.40	53.48	53.33	9.02	8.28	1.08	**0.11**
EX-WA-P6	296-213	296-208	**15.13**	620.62	10	326.40	0.004	0.013	53.24	51.94	61.40	63.60	53.33	52.40	8.07	7.33	1.07	**0.11**
EX-WA-P7	296-208	296-209	**15.13**	628.88	10	34.20	0.004	0.013	51.94	51.80	63.60	63.00	52.40	52.40	11.20	10.83	1.07	**0.55**
EX-WA-P8	296-209	296-201	**1248.02**	6427.38	24	309.40	0.004	0.013	51.80	50.56	63.00	62.00	52.40	51.16	10.60	9.20	3.53	**0.30**
EX-WA-P9	296-201	296-202	**1248.02**	6413.14	24	315.80	0.004	0.013	50.56	49.30	62.00	61.19	51.16	50.15	10.84	9.44	3.52	**0.30**

Note:
The system accounts for flows from the overall LSAP area including the existing areas to remain for the proposed housing expansion scenario.

Appendix D
Lawrence Station Area Plan
Sanitary Sewer - Average Dry Weather Flow (ADWF) Hydraulics - Proposed System

Pipe [5] #	Upstream Node	Downstream Node	Total Flow (gpm)	Capacity @ Constructed Slope (gpm)	Pipe Size (inches)	Length (feet)	Constructed Slope (ft/ft)	Pipe Roughness (Mannings n)	Invert Elevation		Ground/Rim Elevation		HGL Elevation		Upstream Freeboard [2] (feet)	Upstream Cover (feet)	Velocity (ft/s)	d/D
									Upstream	Downstream	Upstream	Downstream	Upstream	Downstream				
PR-AA-P1	294-206 (P)	294-207 (P)	**1173.61**	6028.52	24.00	278.00	0.004	0.013	59.36	58.38	73.50	71.62	59.96	58.98	13.54	12.14	3.31	**0.30**
PR-AA-P2	294-207 (P)	295-201 (P)	**1173.61**	6003.00	24.00	320.40	0.003	0.013	58.38	57.26	71.62	69.20	58.98	57.86	12.64	11.24	3.30	**0.30**
PR-AA-P3	295-201 (P)	295-202 (P)	**1173.61**	5982.68	24.00	293.80	0.003	0.013	57.26	56.24	69.20	67.30	57.86	56.85	11.34	9.94	3.29	**0.30**
PR-AA-P4	295-202 (P)	295-203 (P)	**1203.25**	6012.41	24.00	305.10	0.004	0.013	56.24	55.17	67.30	62.64	56.85	55.78	10.45	9.06	3.33	**0.31**
PR-AA-P5	295-203 (P)	295-207 (P)	**1203.25**	5946.35	24.00	29.20	0.003	0.013	55.17	55.07	62.64	62.42	55.78	55.68	6.86	5.47	3.30	**0.31**
PR-AA-P6	295-207 (P)	295-208 (P)	**1203.25**	6011.14	24.00	119.80	0.004	0.013	55.07	54.65	62.42	61.50	55.68	55.25	6.74	5.35	3.33	**0.31**
PR-AA-P7	295-208 (P)	295-209 (P)	**1203.25**	6079.61	24.00	131.10	0.004	0.013	54.65	54.18	61.50	61.30	55.25	54.80	6.25	4.85	3.36	**0.30**
PR-AA-P8	295-209 (P)	295-204 (P)	**1203.25**	5624.90	24.00	19.50	0.003	0.013	54.18	54.12	61.30	61.50	54.80	54.73	6.50	5.12	3.17	**0.31**
PR-AA-P9	295-204 (P)	295-210 (P)	**1203.25**	6012.26	24.00	111.20	0.004	0.013	54.12	53.73	61.50	61.30	54.73	54.34	6.77	5.38	3.33	**0.31**
PR-AA-P10	295-210 (P)	295-211 (P)	**1203.25**	6020.88	24.00	130.80	0.004	0.013	53.73	53.27	61.30	60.40	54.34	53.87	6.96	5.57	3.33	**0.31**
PR-AA-P11	295-211 (P)	295-212 (P)	**1203.25**	6062.16	24.00	58.90	0.004	0.013	53.27	53.06	60.40	60.33	53.87	53.67	6.53	5.13	3.35	**0.30**
PR-AA-P12	295-212 (P)	296-211 (P)	**1203.25**	5948.96	24.00	81.60	0.003	0.013	53.06	52.78	60.33	59.45	53.67	53.39	6.66	5.27	3.30	**0.31**
PR-AA-P13	296-211 (P)	296-212 (P)	**1232.89**	6020.86	24.00	130.80	0.004	0.013	52.78	52.32	59.45	59.45	53.39	52.93	6.06	4.67	3.36	**0.31**
PR-AA-P14	296-212 (P)	296-209 (P)	**1232.89**	6040.64	24.00	90.40	0.004	0.013	52.32	52.00	59.45	63.00	52.93	52.58	6.52	5.13	3.36	**0.31**
PR-CR-P1	337-202 (P)	337-201 (P)	**24.75**	7952.27	10.00	5.10	0.654	0.013	44.81	41.45	54.00	54.00	44.91	41.89	9.09	8.36	7.28	**0.12**
PR-CR-P2	337-201 (P)	337-206 (P)	**338.45**	1789.33	18.00	347.10	0.001	0.013	41.45	40.95	54.00	53.00	41.89	41.27	12.11	11.05	1.73	**0.29**
PR-KR-P1	333-206 (P)	334-201 (P)	**336.11**	2809.84	18.00	534.90	0.004	0.013	57.49	55.59	67.86	66.70	57.84	56.04	10.02	8.87	2.39	**0.23**
PR-KR-P2	334-201 (P)	334-202 (P)	**492.82**	2505.44	18.00	534.60	0.003	0.013	55.59	54.08	66.70	65.80	56.04	54.54	10.66	9.61	2.45	**0.30**
PR-KR-P3	334-202 (P)	335-201 (P)	**519.37**	2582.15	18.00	930.00	0.003	0.013	54.08	51.29	65.80	64.50	54.54	51.77	11.26	10.22	2.55	**0.31**
PR-KR-P4	335-201 (P)	335-202 (P)	**571.01**	2582.22	18.00	900.00	0.003	0.013	51.29	48.59	64.50	61.20	51.77	49.06	12.73	11.71	2.62	**0.32**
PR-KR-P5	335-202 (P)	336-201 (P)	**634.28**	2981.31	18.00	692.70	0.004	0.013	48.59	45.82	61.20	57.50	49.06	46.30	12.14	11.11	2.99	**0.31**
PR-KR-P6	336-201 (P)	336-202 (P)	**733.54**	6904.37	18.00	180.90	0.021	0.013	45.82	41.94	57.50	57.04	46.30	42.87	11.20	10.18	5.67	**0.32**
PR-KR-P7	336-203 (P)	336-204 (P)	**3.09**	529.77	8.00	335.40	0.010	0.013	49.00	45.80	55.00	56.50	49.04	45.90	5.96	5.33	0.92	**0.06**
PR-KR-P8	336-204 (P)	337-202 (P)	**16.19**	538.33	10.00	330.30	0.003	0.013	45.80	44.81	56.50	54.00	45.90	44.91	10.60	9.87	0.98	**0.12**
PR-KR-P9	337-203 (P)	337-201 (P)	**313.70**	1858.54	18.00	328.20	0.002	0.013	41.96	41.45	52.80	54.00	42.38	41.89	10.42	9.34	1.74	**0.28**
PR-KR-P10	337-204 (P)	337-203 (P)	**293.22**	1764.27	18.00	328.50	0.001	0.013	42.52	42.06	52.50	52.80	42.93	42.38	9.57	8.48	1.65	**0.27**
PR-KR-P11	337-208 (P)	337-204 (P)	**276.10**	1963.59	18.00	86.50	0.002	0.013	42.77	42.62	52.40	52.50	43.15	42.93	9.25	8.13	1.75	**0.25**
PR-KR-P12	337-205 (P)	337-208 (P)	**276.10**	1686.95	18.00	242.10	0.001	0.013	43.08	42.77	52.20	52.40	43.49	43.15	8.71	7.62	1.57	**0.27**
PR-KR-P13	338-201 (P)	337-205 (P)	**276.10**	1765.17	18.00	328.10	0.001	0.013	43.64	43.18	51.50	52.20	44.04	43.49	7.46	6.36	1.62	**0.27**
PR-KR-P14	338-202 (P)	338-201 (P)	**159.71**	1758.49	18.00	265.90	0.001	0.013	44.11	43.74	51.00	51.50	44.42	44.04	6.58	5.39	1.38	**0.21**
PR-KR-P15	338-203 (P)	Kifer Lift Station	**159.71**	5132.80	12.00	28.20	0.088	0.012	32.18	29.70	51.00	49.00	32.43	29.82	18.57	17.82	6.60	**0.25**
PR-KR-P16	338-207 (P)	338-203 (P)	**159.71**	783.86	12.00	387.00	0.002	0.013	33.11	32.18	49.80	51.00	33.42	32.43	16.38	15.69	1.75	**0.31**
PR-KR-P17	338-209 (P)	338-207 (P)	**82.12**	828.11	12.00	324.40	0.003	0.013	34.08	33.21	49.60	49.80	34.29	33.42	15.31	14.52	1.50	**0.21**
PR-KR-P18	339-201 (P)	338-209 (P)	**71.31**	827.69	12.00	324.70	0.003	0.013	35.05	34.18	49.20	49.60	35.25	34.34	13.95	13.15	1.44	**0.20**
PR-KR-P19	339-202 (P)	339-201 (P)	**56.02**	825.91	12.00	326.10	0.003	0.013	36.02	35.15	47.60	49.20	36.20	35.29	11.40	10.58	1.34	**0.18**
PR-LE-P1	265-204 (P)	296-203 (P)	**1539.58**	10360.63	27.00	705.50	0.006	0.013	56.12	52.20	67.83	69.82	56.75	52.79	11.08	9.46	4.17	**0.28**
PR-LE-P2	296-203 (P)	296-202 (P)	**1539.58**	10316.94	27.00	526.40	0.006	0.013	52.20	49.30	69.82	61.19	52.83	50.15	16.99	15.37	4.15	**0.28**
PR-LE-P3	296-202 (P)	305-207 (P)	**2787.60**	9715.82	27.00	401.10	0.005	0.013	49.30	47.34	61.19	60.50	50.15	48.16	11.04	9.64	4.70	**0.38**
PR-LE-P4	305-207 (P)	305-208 (P)	**2787.60**	10306.34	27.00	141.90	0.005	0.013	47.34	46.56	60.50	58.98	48.19	47.41	12.31	10.91	4.91	**0.38**
PR-LE-P5	305-208 (P)	305-209 (P)	**2793.45**	10400.80	27.00	512.60	0.006	0.013	46.56	43.69	58.98	56.98	47.41	44.54	11.57	10.17	4.94	**0.38**
PR-LE-P6	305-209 (P)	336-202 (P)	**2799.30**	10208.66	27.00	324.40	0.005	0.013	43.69	41.94	56.98	57.04	44.54	42.87	12.44	11.04	4.88	**0.38**
PR-LE-P7	336-202 (P)	336-207 (P)	**3533.54**	17889.16	30.19	670.50	0.005	0.010	41.94	38.32	57.04	54.28	42.87	39.08	14.17	12.58	6.24	**0.37**
PR-SC-P1	306-201 (P)	306-202 (P)	**9.98**	982.15	10.00	300.70	0.010	0.013	56.78	53.78	64.90	62.40	56.84	53.87	8.06	7.29	1.30	**0.07**
PR-SC-P2	306-202 (P)	306-203 (P)	**14.28**	616.25	10.00	300.40	0.004	0.013	53.78	52.60	62.40	60.85	53.87	52.73	8.53	7.79	1.04	**0.11**
PR-SC-P3	306-203 (P)	306-204 (P)	**30.39**	595.86	10.00	299.60	0.004	0.013	52.60	51.50	60.85	60.80	52.73	51.64	8.12	7.42	1.28	**0.16**
PR-SC-P4	306-204 (P)	305-205 (P)	**35.42**	595.40	10.00	300.00	0.004	0.013	51.50	50.40	60.80	59.50	51.64	50.58	9.16	8.47	1.33	**0.17**
PR-SC-P5	305-205 (P)	305-204 (P)	**54.50**	507.29	10.00	300.60	0.003	0.013	50.40	49.60	59.50	59.40	50.58	49.77	8.92	8.27	1.35	**0.22**
PR-SZW-P1	305-206 (P)	305-204 (P)	**10.14**	707.09	10.00	173.20	0.003	0.010	50.13	49.60	60.20	59.40	50.20	49.77	10.00	9.24	1.04	**0.08**

Appendix D
Lawrence Station Area Plan
Sanitary Sewer - Average Dry Weather Flow (ADWF) Hydraulics - Proposed System

Pipe [5] #	Upstream Node	Downstream Node	Total Flow (gpm)	Capacity @ Constructed Slope (gpm)	Pipe Size (inches)	Length (feet)	Constructed Slope (ft/ft)	Pipe Roughness (Mannings n)	Invert Elevation		Ground/Rim Elevation		HGL Elevation		Upstream Freeboard [2] (feet)	Upstream Cover (feet)	Velocity (ft/s)	d/D
									Upstream	Downstream	Upstream	Downstream	Upstream	Downstream				
PR-SZW-P2	305-204 (P)	305-203 (P)	**73.50**	833.08	10.00	41.80	0.007	0.013	49.60	49.30	59.40	59.60	49.77	49.50	9.63	8.97	2.10	**0.20**
PR-SZW-P3	305-203 (P)	305-202 (P)	**73.50**	568.20	10.00	209.60	0.003	0.013	49.30	48.60	59.60	59.80	49.50	48.79	10.10	9.47	1.60	**0.24**
PR-SZW-P4	305-202 (P)	305-201 (P)	**73.50**	662.80	10.00	321.40	0.005	0.013	48.60	47.14	59.80	59.70	48.79	47.31	11.01	10.37	1.78	**0.23**
PR-SZW-P5	305-201 (P)	336-201 (P)	**86.38**	1148.49	11.54	324.50	0.004	0.010	47.04	45.82	59.70	57.50	47.22	46.30	12.48	11.70	2.07	**0.19**
PR-UD-P1	302-201 (P)	302-202 (P)	**26.18**	563.74	10.00	234.30	0.003	0.013	38.89	38.12	50.00	49.00	39.01	38.27	10.99	10.28	1.17	**0.14**
PR-UD-P2	302-202 (P)	302-203 (P)	**40.73**	567.61	10.00	306.10	0.003	0.013	38.12	37.10	49.00	47.50	38.27	37.28	10.73	10.05	1.35	**0.18**
PR-UD-P3	302-203 (P)	339-203 (P)	**56.02**	566.91	10.00	294.90	0.003	0.013	37.10	36.12	47.50	47.60	37.28	36.27	10.22	9.57	1.48	**0.22**
PR-UD-P4	339-203 (P)	339-202 (P)	**56.02**	975.12	10.00	10.20	0.010	0.013	36.12	36.02	47.60	47.60	36.27	36.20	11.33	10.65	2.16	**0.18**
PR-WA-P1	266-210 (P)	266-204 (P)	**6.80**	342.80	8.00	245.30	0.004	0.013	56.27	55.29	68.00	67.00	56.34	55.35	11.66	11.06	0.86	**0.11**
PR-WA-P2	266-204 (P)	266-205 (P)	**6.80**	628.19	10.00	61.30	0.004	0.013	55.29	55.04	67.00	66.00	55.35	55.11	11.65	10.88	0.84	**0.07**
PR-WA-P3	266-205 (P)	265-206 (P)	**8.08**	622.28	10.00	299.60	0.004	0.013	55.04	53.84	66.00	65.00	55.11	53.93	10.89	10.13	0.88	**0.08**
PR-WA-P4	265-206 (P)	296-207 (P)	**14.01**	617.62	10.00	114.10	0.004	0.013	53.84	53.39	65.00	62.50	53.93	53.48	11.07	10.33	1.04	**0.11**
PR-WA-P5	296-207 (P)	296-213 (P)	**15.13**	634.18	10.00	36.10	0.004	0.013	53.39	53.24	62.50	61.40	53.48	53.33	9.02	8.28	1.08	**0.11**
PR-WA-P6	296-213 (P)	296-208 (P)	**15.13**	620.91	10.00	326.10	0.004	0.013	53.24	51.94	61.40	63.60	53.33	52.40	8.07	7.33	1.07	**0.11**
PR-WA-P7	296-208 (P)	296-209 (P)	**15.13**	3466.83	17.20	34.30	0.004	0.010	51.94	51.80	63.60	63.00	52.40	52.40	11.20	10.23	1.19	**0.32**
PR-WA-P8	296-209 (P)	296-201 (P)	**1248.02**	6431.76	24.00	309.00	0.004	0.013	51.80	50.56	63.00	62.00	52.40	51.16	10.60	9.20	3.53	**0.30**
PR-WA-P9	296-201 (P)	296-202 (P)	**1248.02**	6424.85	24.00	314.70	0.004	0.013	50.56	49.30	62.00	61.19	51.16	50.15	10.84	9.44	3.53	**0.30**

Note:
The system accounts for flows from the overall LSAP area including the existing areas to remain for the proposed housing expansion scenario.

Appendix D
Lawrence Station Area Plan
Sanitary Sewer - Peak Wet Weather Flow (PWWF) Hydraulics - Existing System

Pipe [5] #	Upstream Node	Downstream Node	Total Flow (gpm)	Capacity @ Constructed Slope (gpm)	Pipe Size (inches)	Length (feet)	Constructed Slope (ft/ft)	Pipe Roughness (Mannings n)	Invert Elevation		Ground/Rim Elevation		HGL Elevation		Upstream Freeboard [2] (feet)	Upstream Cover (feet)	Velocity (ft/s)	d/D
									Upstream	Downstream	Upstream	Downstream	Upstream	Downstream				
EX-AA-P1	294-206	294-207	**3110.07**	6027.72	24	278.00	0.004	0.013	59.36	58.38	73.50	71.62	60.38	59.40	13.12	12.14	4.31	**0.51**
EX-AA-P2	294-207	295-201	**3110.07**	6002.76	24	320.40	0.003	0.013	58.38	57.26	71.62	69.20	59.40	58.28	12.22	11.24	4.30	**0.51**
EX-AA-P3	295-201	295-202	**3110.07**	5982.64	24	293.80	0.003	0.013	57.26	56.24	69.20	67.30	58.28	57.28	10.92	9.94	4.28	**0.51**
EX-AA-P4	295-202	295-203	**3203.44**	6012.36	24	305.10	0.004	0.013	56.24	55.17	67.30	62.64	57.28	56.21	10.02	9.06	4.33	**0.52**
EX-AA-P5	295-203	295-207	**3203.44**	5946.41	24	29.20	0.003	0.013	55.17	55.07	62.64	62.42	56.21	56.11	6.43	5.47	4.30	**0.52**
EX-AA-P6	295-207	295-208	**3203.44**	6011.31	24	119.80	0.004	0.013	55.07	54.65	62.42	61.50	56.11	55.69	6.31	5.35	4.33	**0.52**
EX-AA-P7	295-208	295-209	**3203.44**	6015.10	24	131.10	0.004	0.013	54.65	54.19	61.50	61.30	55.69	55.22	5.81	4.85	4.33	**0.52**
EX-AA-P8	295-209	295-204	**3203.44**	6076.51	24	19.50	0.004	0.013	54.19	54.12	61.30	61.50	55.22	55.16	6.08	5.11	4.37	**0.52**
EX-AA-P9	295-204	295-210	**3203.44**	6012.78	24	111.20	0.004	0.013	54.12	53.73	61.50	61.30	55.16	54.77	6.34	5.38	4.33	**0.52**
EX-AA-P10	295-210	295-211	**3203.44**	6020.16	24	130.80	0.004	0.013	53.73	53.27	61.30	60.40	54.77	54.30	6.53	5.57	4.34	**0.52**
EX-AA-P11	295-211	295-212	**3203.44**	6063.28	24	58.90	0.004	0.013	53.27	53.06	60.40	60.33	54.30	54.11	6.10	5.13	4.36	**0.51**
EX-AA-P12	295-212	296-211	**3203.44**	5948.20	24	81.60	0.003	0.013	53.06	52.78	60.33	59.45	54.11	53.84	6.22	5.27	4.30	**0.52**
EX-AA-P13	296-211	296-212	**3296.81**	6020.30	24	130.80	0.004	0.013	52.78	52.32	59.45	59.45	53.84	53.37	5.61	4.67	4.37	**0.53**
EX-AA-P14	296-212	296-209	**3296.81**	6030.04	24	90.70	0.004	0.013	52.32	52.00	59.45	63.00	53.37	52.96	6.08	5.13	4.37	**0.52**
EX-CR-P1	337-202	337-201	**94.00**	8049.63	10	5.00	0.670	0.013	44.81	41.45	54.00	54.00	45.01	42.32	8.99	8.36	11.04	**0.24**
EX-CR-P2	337-201	337-206 (EX)	**1147.19**	1786.38	18	348.20	0.001	0.013	41.45	40.95	54.00	53.00	42.32	41.56	11.68	11.05	2.39	**0.58**
EX-KR-P1	333-206	334-201	**957.91**	2809.64	18	534.90	0.004	0.013	57.49	55.59	67.86	66.70	58.09	56.41	9.77	8.87	3.21	**0.40**
EX-KR-P2	334-201	334-202	**1460.66**	2505.53	18	534.60	0.003	0.013	55.59	54.08	66.70	65.80	56.41	54.92	10.29	9.61	3.28	**0.55**
EX-KR-P3	334-202	335-201	**1557.58**	2582.18	18	930.00	0.003	0.013	54.08	51.29	65.80	64.50	54.92	52.19	10.88	10.22	3.41	**0.56**
EX-KR-P4	335-201	335-202	**1720.26**	2582.16	18	900.00	0.003	0.013	51.29	48.59	64.50	61.20	52.19	49.47	12.31	11.71	3.48	**0.60**
EX-KR-P5	335-202	336-201	**1940.67**	2982.83	18	692.00	0.004	0.013	48.59	45.82	61.20	57.50	49.47	46.69	11.73	11.11	4.00	**0.59**
EX-KR-P6	336-201	336-202	**2314.89**	6905.33	18	180.90	0.021	0.013	45.82	41.94	57.50	57.04	46.69	43.71	10.81	10.18	7.84	**0.58**
EX-KR-P7	336-203	336-204	**12.81**	296.15	8	335.40	0.003	0.013	46.80	45.80	55.00	56.50	46.89	45.99	8.11	7.53	0.94	**0.14**
EX-KR-P8	336-204	337-202	**60.63**	538.35	10	330.30	0.003	0.013	45.80	44.81	56.50	54.00	45.99	45.01	10.51	9.87	1.46	**0.23**
EX-KR-P9	337-203	337-201	**1053.19**	1858.32	18	328.20	0.002	0.013	41.96	41.45	52.80	54.00	42.77	42.32	10.03	9.34	2.42	**0.54**
EX-KR-P10	337-204	337-203	**978.43**	1764.29	18	328.50	0.001	0.013	42.52	42.06	52.50	52.80	43.31	42.77	9.19	8.48	2.28	**0.53**
EX-KR-P11	337-208	337-204	**915.93**	1963.22	18	86.50	0.002	0.013	42.77	42.62	52.40	52.50	43.48	43.31	8.92	8.13	2.43	**0.47**
EX-KR-P12	337-205	337-208	**915.93**	1686.94	18	242.10	0.001	0.013	43.08	42.77	52.20	52.40	43.86	43.48	8.34	7.62	2.17	**0.52**
EX-KR-P13	338-201	337-205	**915.93**	1765.25	18	328.10	0.001	0.013	43.64	43.18	51.50	52.20	44.40	43.86	7.10	6.36	2.25	**0.51**
EX-KR-P14	338-202	338-201	**549.31**	1758.45	18	265.90	0.001	0.013	44.11	43.74	51.00	51.50	44.69	44.40	6.31	5.39	1.96	**0.39**
EX-KR-P15	338-203	338-204 (EX)	**549.31**	5139.47	12	28.20	0.088	0.012	32.18	29.70	51.00	49.00	32.65	29.92	18.35	17.82	9.51	**0.47**
EX-KR-P16	338-207	338-203	**549.31**	783.86	12	387.00	0.002	0.013	33.11	32.18	49.80	51.00	33.73	32.65	16.07	15.69	2.41	**0.62**
EX-KR-P17	338-209	338-207	**285.50**	828.07	12	324.40	0.003	0.013	34.08	33.21	49.60	49.80	34.49	33.73	15.11	14.52	2.13	**0.41**
EX-KR-P18	339-201	338-209	**246.06**	828.61	12	324.00	0.003	0.013	35.05	34.18	49.20	49.60	35.42	34.49	13.78	13.15	2.05	**0.37**
EX-KR-P19	339-202	339-201	**194.09**	825.85	12	326.10	0.003	0.013	36.02	35.15	47.60	49.20	36.35	35.42	11.25	10.58	1.91	**0.33**
EX-LE-P1	265-204	296-203	**4079.89**	10356.75	27	706.10	0.006	0.013	56.12	52.20	67.83	69.82	57.16	53.18	10.67	9.46	5.46	**0.46**
EX-LE-P2	296-203	296-202	**4079.89**	10321.07	27	526.00	0.006	0.013	52.20	49.30	69.82	61.19	53.24	50.77	16.58	15.37	5.44	**0.46**
EX-LE-P3	296-202	305-207	**7437.78**	9722.92	27	400.60	0.005	0.013	49.30	47.34	61.19	60.50	50.77	48.76	10.42	9.64	6.00	**0.65**
EX-LE-P4	305-207	305-208	**7437.78**	10276.48	27	142.70	0.005	0.013	47.34	46.56	60.50	58.98	48.76	47.98	11.74	10.91	6.27	**0.63**
EX-LE-P5	305-208	305-209	**7459.14**	10397.94	27	512.90	0.006	0.013	46.56	43.69	58.98	56.98	47.98	45.12	11.00	10.17	6.34	**0.63**
EX-LE-P6	305-209	336-202	**7480.50**	10219.40	27	323.70	0.005	0.013	43.69	41.94	56.98	57.04	45.12	43.71	11.86	11.04	6.25	**0.64**
EX-LE-P7	336-202	336-207 (EX)	**9798.29**	10208.70	27	671.10	0.005	0.013	41.94	38.32	57.04	54.28	43.71	39.96	13.33	12.85	6.51	**0.79**
EX-SC-P1	306-201	306-202	**38.92**	982.14	10	300.70	0.010	0.013	56.78	53.78	64.90	62.40	56.91	53.95	7.99	7.29	1.95	**0.16**
EX-SC-P2	306-202	306-203	**56.77**	616.32	10	300.40	0.004	0.013	53.78	52.60	62.40	60.85	53.95	52.85	8.45	7.79	1.57	**0.20**
EX-SC-P3	306-203	306-204	**116.94**	595.79	10	299.60	0.004	0.013	52.60	51.50	60.85	60.80	52.85	51.77	8.00	7.42	1.89	**0.30**
EX-SC-P4	306-204	305-205	**137.81**	595.39	10	300.00	0.004	0.013	51.50	50.40	60.80	59.50	51.77	50.78	9.03	8.47	1.98	**0.32**
EX-SC-P5	305-205	305-204	**212.52**	507.31	10	300.60	0.003	0.013	50.40	49.60	59.50	59.40	50.78	49.95	8.72	8.27	1.98	**0.46**
EX-SZW-P1	305-206	305-204	**39.56**	544.00	10	173.20	0.003	0.013	50.13	49.60	60.20	59.40	50.28	49.95	9.92	9.24	1.29	**0.18**

Appendix D
Lawrence Station Area Plan
Sanitary Sewer - Peak Wet Weather Flow (PWWF) Hydraulics - Existing System

Pipe [5] #	Upstream Node	Downstream Node	Total Flow (gpm)	Capacity @ Constructed Slope (gpm)	Pipe Size (inches)	Length (feet)	Constructed Slope (ft/ft)	Pipe Roughness (Mannings n)	Invert Elevation		Ground/Rim Elevation		HGL Elevation		Upstream Freeboard [2] (feet)	Upstream Cover (feet)	Velocity (ft/s)	d/D
									Upstream	Downstream	Upstream	Downstream	Upstream	Downstream				
EX-SZW-P2	305-204	305-203	**286.64**	832.77	10	41.80	0.007	0.013	49.60	49.30	59.40	59.60	49.95	49.72	9.45	8.97	3.08	**0.42**
EX-SZW-P3	305-203	305-202	**286.64**	568.08	10	209.70	0.003	0.013	49.30	48.60	59.60	59.80	49.72	48.98	9.88	9.47	2.33	**0.50**
EX-SZW-P4	305-202	305-201	**286.64**	663.21	10	321.00	0.005	0.013	48.60	47.14	59.80	59.70	48.98	47.49	10.82	10.37	2.61	**0.46**
EX-SZW-P5	305-201	336-201	**330.43**	602.90	10	324.50	0.004	0.013	47.04	45.82	59.70	57.50	47.48	46.69	12.22	11.83	2.52	**0.53**
EX-UD-P1	302-201	302-202	**89.02**	563.71	10	234.30	0.003	0.013	38.89	38.12	50.00	49.00	39.11	38.41	10.89	10.28	1.68	**0.26**
EX-UD-P2	302-202	302-203	**142.12**	553.58	10	306.10	0.003	0.013	38.12	37.15	49.00	47.50	38.41	37.44	10.59	10.05	1.89	**0.35**
EX-UD-P3	302-203	339-203	**194.09**	566.65	10	295.10	0.003	0.013	37.10	36.12	47.50	47.60	37.44	36.41	10.06	9.57	2.10	**0.41**
EX-UD-P4	339-203	339-202	**194.09**	972.06	10	10.20	0.010	0.013	36.12	36.02	47.60	47.60	36.41	36.35	11.19	10.65	3.10	**0.35**
EX-WA-P1	266-210	266-204	**26.51**	342.80	8	245.30	0.004	0.013	56.27	55.29	68.00	67.00	56.40	55.41	11.60	11.06	1.30	**0.19**
EX-WA-P2	266-204	266-205	**26.51**	627.96	10	61.30	0.004	0.013	55.29	55.04	67.00	66.00	55.41	55.17	11.59	10.88	1.27	**0.14**
EX-WA-P3	266-205	265-206	**31.81**	622.31	10	299.60	0.004	0.013	55.04	53.84	66.00	65.00	55.17	54.01	10.83	10.13	1.33	**0.16**
EX-WA-P4	265-206	296-207	**56.42**	617.62	10	114.10	0.004	0.013	53.84	53.39	65.00	62.50	54.01	53.56	10.99	10.33	1.57	**0.20**
EX-WA-P5	296-207	296-213	**61.08**	633.75	10	36.10	0.004	0.013	53.39	53.24	62.50	61.40	53.56	53.42	8.94	8.28	1.64	**0.20**
EX-WA-P6	296-213	296-208	**61.08**	620.62	10	326.40	0.004	0.013	53.24	51.94	61.40	63.60	53.42	52.83	7.98	7.33	1.61	**0.22**
EX-WA-P7	296-208	296-209	**61.08**	628.88	10	34.20	0.004	0.013	51.94	51.80	63.60	63.00	52.83	52.83	10.77	10.83	0.25	**1.07**
EX-WA-P8	296-209	296-201	**3357.89**	6427.38	24	309.40	0.004	0.013	51.80	50.56	63.00	62.00	52.83	51.59	10.17	9.20	4.61	**0.52**
EX-WA-P9	296-201	296-202	**3357.89**	6413.14	24	315.80	0.004	0.013	50.56	49.30	62.00	61.19	51.59	50.77	10.41	9.44	4.60	**0.52**

Note:
The system accounts for flows from the overall LSAP area including the existing areas to remain for the proposed housing expansion scenario.

Appendix D
Lawrence Station Area Plan
Sanitary Sewer - Peak Wet Weather Flow (PWWF) Hydraulics - Proposed System

Pipe [5] #	Upstream Node	Downstream Node	Total Flow (gpm)	Capacity @ Constructed Slope (gpm)	Pipe Size (inches)	Length (feet)	Constructed Slope (ft/ft)	Pipe Roughness (Mannings n)	Invert Elevation		Ground/Rim Elevation		HGL Elevation		Upstream Freeboard [2] (feet)	Upstream Cover (feet)	Velocity (ft/s)	d/D
									Upstream	Downstream	Upstream	Downstream	Upstream	Downstream				
PR-AA-P1	294-206 (P)	294-207 (P)	**3110.07**	6028.52	24.00	278.00	0.004	0.013	59.36	58.38	73.50	71.62	60.38	59.40	13.12	12.14	4.31	**0.51**
PR-AA-P2	294-207 (P)	295-201 (P)	**3110.07**	6003.00	24.00	320.40	0.003	0.013	58.38	57.26	71.62	69.20	59.40	58.28	12.22	11.24	4.30	**0.51**
PR-AA-P3	295-201 (P)	295-202 (P)	**3110.07**	5982.68	24.00	293.80	0.003	0.013	57.26	56.24	69.20	67.30	58.28	57.28	10.92	9.94	4.28	**0.51**
PR-AA-P4	295-202 (P)	295-203 (P)	**3203.44**	6012.41	24.00	305.10	0.004	0.013	56.24	55.17	67.30	62.64	57.28	56.21	10.02	9.06	4.33	**0.52**
PR-AA-P5	295-203 (P)	295-207 (P)	**3203.44**	5946.35	24.00	29.20	0.003	0.013	55.17	55.07	62.64	62.42	56.21	56.11	6.43	5.47	4.30	**0.52**
PR-AA-P6	295-207 (P)	295-208 (P)	**3203.44**	6011.14	24.00	119.80	0.004	0.013	55.07	54.65	62.42	61.50	56.11	55.68	6.31	5.35	4.33	**0.52**
PR-AA-P7	295-208 (P)	295-209 (P)	**3203.44**	6079.61	24.00	131.10	0.004	0.013	54.65	54.18	61.50	61.30	55.68	55.24	5.82	4.85	4.37	**0.52**
PR-AA-P8	295-209 (P)	295-204 (P)	**3203.44**	5624.90	24.00	19.50	0.003	0.013	54.18	54.12	61.30	61.50	55.24	55.16	6.06	5.12	4.12	**0.53**
PR-AA-P9	295-204 (P)	295-210 (P)	**3203.44**	6012.26	24.00	111.20	0.004	0.013	54.12	53.73	61.50	61.30	55.16	54.77	6.34	5.38	4.33	**0.52**
PR-AA-P10	295-210 (P)	295-211 (P)	**3203.44**	6020.88	24.00	130.80	0.004	0.013	53.73	53.27	61.30	60.40	54.77	54.30	6.53	5.57	4.34	**0.52**
PR-AA-P11	295-211 (P)	295-212 (P)	**3203.44**	6062.16	24.00	58.90	0.004	0.013	53.27	53.06	60.40	60.33	54.30	54.11	6.10	5.13	4.36	**0.51**
PR-AA-P12	295-212 (P)	296-211 (P)	**3203.44**	5948.96	24.00	81.60	0.003	0.013	53.06	52.78	60.33	59.45	54.11	53.84	6.22	5.27	4.30	**0.52**
PR-AA-P13	296-211 (P)	296-212 (P)	**3296.81**	6020.86	24.00	130.80	0.004	0.013	52.78	52.32	59.45	59.45	53.84	53.37	5.61	4.67	4.37	**0.53**
PR-AA-P14	296-212 (P)	296-209 (P)	**3296.81**	6040.64	24.00	90.40	0.004	0.013	52.32	52.00	59.45	63.00	53.37	52.96	6.08	5.13	4.38	**0.52**
PR-CR-P1	337-202 (P)	337-201 (P)	**94.00**	7952.27	10.00	5.10	0.654	0.013	44.81	41.45	54.00	54.00	45.01	42.32	8.99	8.36	10.94	**0.24**
PR-CR-P2	337-201 (P)	337-206 (P)	**1147.19**	1789.33	18.00	347.10	0.001	0.013	41.45	40.95	54.00	53.00	42.32	41.56	11.68	11.05	2.39	**0.58**
PR-KR-P1	333-206 (P)	334-201 (P)	**957.91**	2809.84	18.00	534.90	0.004	0.013	57.49	55.59	67.86	66.70	58.09	56.41	9.77	8.87	3.21	**0.40**
PR-KR-P2	334-201 (P)	334-202 (P)	**1460.66**	2505.44	18.00	534.60	0.003	0.013	55.59	54.08	66.70	65.80	56.41	54.92	10.29	9.61	3.28	**0.55**
PR-KR-P3	334-202 (P)	335-201 (P)	**1557.58**	2582.15	18.00	930.00	0.003	0.013	54.08	51.29	65.80	64.50	54.92	52.19	10.88	10.22	3.41	**0.56**
PR-KR-P4	335-201 (P)	335-202 (P)	**1720.26**	2582.22	18.00	900.00	0.003	0.013	51.29	48.59	64.50	61.20	52.19	49.47	12.31	11.71	3.48	**0.60**
PR-KR-P5	335-202 (P)	336-201 (P)	**1940.67**	2981.31	18.00	692.70	0.004	0.013	48.59	45.82	61.20	57.50	49.47	46.69	11.73	11.11	4.00	**0.59**
PR-KR-P6	336-201 (P)	336-202 (P)	**2314.89**	6904.37	18.00	180.90	0.021	0.013	45.82	41.94	57.50	57.04	46.69	43.53	10.81	10.18	7.84	**0.58**
PR-KR-P7	336-203 (P)	336-204 (P)	**12.81**	529.77	8.00	335.40	0.010	0.013	49.00	45.80	55.00	56.50	49.08	45.99	5.92	5.33	1.42	**0.12**
PR-KR-P8	336-204 (P)	337-202 (P)	**60.63**	538.33	10.00	330.30	0.003	0.013	45.80	44.81	56.50	54.00	45.99	45.01	10.51	9.87	1.46	**0.23**
PR-KR-P9	337-203 (P)	337-201 (P)	**1053.19**	1858.54	18.00	328.20	0.002	0.013	41.96	41.45	52.80	54.00	42.77	42.32	10.03	9.34	2.42	**0.54**
PR-KR-P10	337-204 (P)	337-203 (P)	**978.43**	1764.27	18.00	328.50	0.001	0.013	42.52	42.06	52.50	52.80	43.31	42.77	9.19	8.48	2.28	**0.53**
PR-KR-P11	337-208 (P)	337-204 (P)	**915.93**	1963.59	18.00	86.50	0.002	0.013	42.77	42.62	52.40	52.50	43.48	43.31	8.92	8.13	2.43	**0.47**
PR-KR-P12	337-205 (P)	337-208 (P)	**915.93**	1686.95	18.00	242.10	0.001	0.013	43.08	42.77	52.20	52.40	43.86	43.48	8.34	7.62	2.17	**0.52**
PR-KR-P13	338-201 (P)	337-205 (P)	**915.93**	1765.17	18.00	328.10	0.001	0.013	43.64	43.18	51.50	52.20	44.40	43.86	7.10	6.36	2.25	**0.51**
PR-KR-P14	338-202 (P)	338-201 (P)	**549.31**	1758.49	18.00	265.90	0.001	0.013	44.11	43.74	51.00	51.50	44.69	44.40	6.31	5.39	1.96	**0.39**
PR-KR-P15	338-203 (P)	Kifer Lift Station	**549.31**	5132.80	12.00	28.20	0.088	0.012	32.18	29.70	51.00	49.00	32.65	29.92	18.35	17.82	9.50	**0.47**
PR-KR-P16	338-207 (P)	338-203 (P)	**549.31**	783.86	12.00	387.00	0.002	0.013	33.11	32.18	49.80	51.00	33.73	32.65	16.07	15.69	2.41	**0.62**
PR-KR-P17	338-209 (P)	338-207 (P)	**285.50**	828.11	12.00	324.40	0.003	0.013	34.08	33.21	49.60	49.80	34.49	33.73	15.11	14.52	2.13	**0.41**
PR-KR-P18	339-201 (P)	338-209 (P)	**246.06**	827.69	12.00	324.70	0.003	0.013	35.05	34.18	49.20	49.60	35.42	34.49	13.78	13.15	2.05	**0.37**
PR-KR-P19	339-202 (P)	339-201 (P)	**194.09**	825.91	12.00	326.10	0.003	0.013	36.02	35.15	47.60	49.20	36.35	35.42	11.25	10.58	1.91	**0.33**
PR-LE-P1	265-204 (P)	296-203 (P)	**4079.89**	10360.63	27.00	705.50	0.006	0.013	56.12	52.20	67.83	69.82	57.16	53.18	10.67	9.46	5.46	**0.46**
PR-LE-P2	296-203 (P)	296-202 (P)	**4079.89**	10316.94	27.00	526.40	0.006	0.013	52.20	49.30	69.82	61.19	53.24	50.77	16.58	15.37	5.44	**0.46**
PR-LE-P3	296-202 (P)	305-207 (P)	**7437.78**	9715.82	27.00	401.10	0.005	0.013	49.30	47.34	61.19	60.50	50.77	48.76	10.42	9.64	6.00	**0.65**
PR-LE-P4	305-207 (P)	305-208 (P)	**7437.78**	10306.34	27.00	141.90	0.005	0.013	47.34	46.56	60.50	58.98	48.76	47.98	11.74	10.91	6.29	**0.63**
PR-LE-P5	305-208 (P)	305-209 (P)	**7459.14**	10400.80	27.00	512.60	0.006	0.013	46.56	43.69	58.98	56.98	47.98	45.12	11.00	10.17	6.34	**0.63**
PR-LE-P6	305-209 (P)	336-202 (P)	**7480.50**	10208.66	27.00	324.40	0.005	0.013	43.69	41.94	56.98	57.04	45.12	43.53	11.86	11.04	6.25	**0.64**
PR-LE-P7	336-202 (P)	336-207 (P)	**9798.29**	17889.16	30.19	670.50	0.005	0.010	41.94	38.32	57.04	54.28	43.53	39.65	13.51	12.58	8.20	**0.63**
PR-SC-P1	306-201 (P)	306-202 (P)	**38.92**	982.15	10.00	300.70	0.010	0.013	56.78	53.78	64.90	62.40	56.91	53.95	7.99	7.29	1.95	**0.16**
PR-SC-P2	306-202 (P)	306-203 (P)	**56.77**	616.25	10.00	300.40	0.004	0.013	53.78	52.60	62.40	60.85	53.95	52.85	8.45	7.79	1.57	**0.20**
PR-SC-P3	306-203 (P)	306-204 (P)	**116.94**	595.86	10.00	299.60	0.004	0.013	52.60	51.50	60.85	60.80	52.85	51.77	8.00	7.42	1.89	**0.30**
PR-SC-P4	306-204 (P)	305-205 (P)	**137.81**	595.40	10.00	300.00	0.004	0.013	51.50	50.40	60.80	59.50	51.77	50.78	9.03	8.47	1.98	**0.32**
PR-SC-P5	305-205 (P)	305-204 (P)	**212.52**	507.29	10.00	300.60	0.003	0.013	50.40	49.60	59.50	59.40	50.78	49.95	8.72	8.27	1.98	**0.46**
PR-SZW-P1	305-206 (P)	305-204 (P)	**39.56**	707.09	10.00	173.20	0.003	0.010	50.13	49.60	60.20	59.40	50.26	49.95	9.94	9.24	1.56	**0.16**

Appendix D
Lawrence Station Area Plan
Sanitary Sewer - Peak Wet Weather Flow (PWWF) Hydraulics - Proposed System

Pipe [5] #	Upstream Node	Downstream Node	Total Flow (gpm)	Capacity @ Constructed Slope (gpm)	Pipe Size (inches)	Length (feet)	Constructed Slope (ft/ft)	Pipe Roughness (Mannings n)	Invert Elevation		Ground/Rim Elevation		HGL Elevation		Upstream Freeboard [2] (feet)	Upstream Cover (feet)	Velocity (ft/s)	d/D
									Upstream	Downstream	Upstream	Downstream	Upstream	Downstream				
PR-SZW-P2	305-204 (P)	305-203 (P)	**286.64**	833.08	10.00	41.80	0.007	0.013	49.60	49.30	59.40	59.60	49.95	49.72	9.45	8.97	3.09	**0.42**
PR-SZW-P3	305-203 (P)	305-202 (P)	**286.64**	568.20	10.00	209.60	0.003	0.013	49.30	48.60	59.60	59.80	49.72	48.98	9.88	9.47	2.33	**0.50**
PR-SZW-P4	305-202 (P)	305-201 (P)	**286.64**	662.80	10.00	321.40	0.005	0.013	48.60	47.14	59.80	59.70	48.98	47.49	10.82	10.37	2.61	**0.46**
PR-SZW-P5	305-201 (P)	336-201 (P)	**330.43**	1148.49	11.54	324.50	0.004	0.010	47.04	45.82	59.70	57.50	47.40	46.69	12.30	11.70	3.04	**0.37**
PR-UD-P1	302-201 (P)	302-202 (P)	**89.02**	563.74	10.00	234.30	0.003	0.013	38.89	38.12	50.00	49.00	39.11	38.40	10.89	10.28	1.68	**0.26**
PR-UD-P2	302-202 (P)	302-203 (P)	**142.12**	567.61	10.00	306.10	0.003	0.013	38.12	37.10	49.00	47.50	38.40	37.44	10.60	10.05	1.93	**0.34**
PR-UD-P3	302-203 (P)	339-203 (P)	**194.09**	566.91	10.00	294.90	0.003	0.013	37.10	36.12	47.50	47.60	37.44	36.41	10.06	9.57	2.10	**0.41**
PR-UD-P4	339-203 (P)	339-202 (P)	**194.09**	975.12	10.00	10.20	0.010	0.013	36.12	36.02	47.60	47.60	36.41	36.35	11.19	10.65	3.11	**0.35**
PR-WA-P1	266-210 (P)	266-204 (P)	**26.51**	342.80	8.00	245.30	0.004	0.013	56.27	55.29	68.00	67.00	56.40	55.41	11.60	11.06	1.30	**0.19**
PR-WA-P2	266-204 (P)	266-205 (P)	**26.51**	628.19	10.00	61.30	0.004	0.013	55.29	55.04	67.00	66.00	55.41	55.17	11.59	10.88	1.27	**0.14**
PR-WA-P3	266-205 (P)	265-206 (P)	**31.81**	622.28	10.00	299.60	0.004	0.013	55.04	53.84	66.00	65.00	55.17	54.01	10.83	10.13	1.33	**0.16**
PR-WA-P4	265-206 (P)	296-207 (P)	**56.42**	617.62	10.00	114.10	0.004	0.013	53.84	53.39	65.00	62.50	54.01	53.56	10.99	10.33	1.57	**0.20**
PR-WA-P5	296-207 (P)	296-213 (P)	**61.08**	634.18	10.00	36.10	0.004	0.013	53.39	53.24	62.50	61.40	53.56	53.42	8.94	8.28	1.64	**0.20**
PR-WA-P6	296-213 (P)	296-208 (P)	**61.08**	620.91	10.00	326.10	0.004	0.013	53.24	51.94	61.40	63.60	53.42	52.83	7.98	7.33	1.61	**0.22**
PR-WA-P7	296-208 (P)	296-209 (P)	**61.08**	3466.83	17.20	34.30	0.004	0.010	51.94	51.80	63.60	63.00	52.83	52.83	10.77	10.23	1.82	**0.62**
PR-WA-P8	296-209 (P)	296-201 (P)	**3357.89**	6431.76	24.00	309.00	0.004	0.013	51.80	50.56	63.00	62.00	52.83	51.59	10.17	9.20	4.61	**0.52**
PR-WA-P9	296-201 (P)	296-202 (P)	**3357.89**	6424.85	24.00	314.70	0.004	0.013	50.56	49.30	62.00	61.19	51.59	50.77	10.41	9.44	4.61	**0.52**

Note:
The system accounts for flows from the overall LSAP area including the existing areas to remain for the proposed housing expansion scenario.

APPENDIX E

Potable Water System Demand Calculations

Appendix E
Lawrence Station Area Plan
Potable Water System Demand Calculations

LSAP Housing Expansion Study

Lot[3]	Residential Units	Commercial/Office/Retail (sf)	Industrial (sf)	Restaurant (sf)	Storage Facility (sf)	LPW (GPD)	LPW (GPM)
3	--	--	96,000	--	--	20,160	14.00
4	--	154,540	--	--	--	31,217	21.68
5	--	602,173	--	--	--	121,639	84.47
6	--	--	--	--	--	--	--
7	520	7,400	--	--	--	83,863	58.24
8	262	2,500	--	--	--	42,006	29.17
9	320	2,500	--	--	--	51,193	35.55
10	125	--	--	--	--	19,800	13.75
11	--	--	19,990	--	--	4,198	2.92
12	--	--	19,512	--	--	4,098	2.85
13	--	--	16,830	--	--	3,534	2.45
14	130	--	--	--	--	20,592	14.30
15	111	--	--	--	--	17,582	12.21
16	--	--	11,055	--	--	2,322	1.61
17	168	--	--	--	--	26,611	18.48
18	--	--	19,463	--	--	4,087	2.84
19	109	--	--	--	--	17,266	11.99
20	126	1,000	--	--	--	20,160	14.00
21	--	--	--	--	--	--	--
22	--	--	--	--	--	--	--
23	--	--	--	--	--	--	--
24	--	--	--	--	--	--	--
25	741	1,500	--	--	--	117,677	81.72
26	16	--	--	--	--	2,534	1.76
27	16	--	--	--	--	--	--
28	83	2,000	--	--	--	13,551	9.41
29	18	2,000	--	--	--	3,255	2.26
30	52	2,000	--	--	--	8,641	6.00
31	13	1,000	--	--	--	2,261	1.57
32	--	8,156	--	--	--	1,648	1.14
33	--	--	--	7,800	--	4,680	3.25
34	--	136,438	--	--	--	27,560	19.14
35	--	152,758	--	--	--	30,857	21.43
36	--	--	61,758	--	--	12,969	9.01
37	--	--	147,842	--	--	31,047	21.56
38	--	136,409	39,148	--	--	35,776	24.84
39	1,458	--	--	--	--	230,947	160.38
40	634	--	--	--	--	100,426	69.74
41	338	--	--	--	--	53,539	37.18
42	--	--	78,000	--	--	16,380	11.38
43	383	--	--	--	--	60,667	42.13
44	--	--	--	--	--	--	--
45	--	--	105,000	--	--	22,050	15.31

Appendix E
Lawrence Station Area Plan
Potable Water System Demand Calculations

Lot[3]	Residential Units	Commercial/Office/Retail (sf)	Industrial (sf)	Restaurant (sf)	Storage Facility (sf)	LPW (GPD)	LPW (GPM)
46	--	--	--	--	--	--	--
47	328	--	--	--	--	51,955	36.08
48	--	--	--	--	--	--	--
49	--	--	--	--	159,637	532	0.37
50	--	--	--	--	--	--	--
51	--	--	--	--	--	--	--
52	--	--	--	--	--	--	--
Subtotal	5,935	1,212,374	614,598	7,800	159,637	1,319,281	916.17

LSAP Office Expansion Study

Lot	Residential Units	Commercial/Office/Retail (sf)	Industrial (sf)	Restaurant (sf)	Storage Facility (sf)	LPW (GPD)	LPW (GPM)
1 & 2	--	351,000	--	13,000	--	78,702	54.65
53	--	--	831,000	16,000	--	184,110	127.85
Subtotal	--	351,000	831,000	29,000	--	262,812	182.51

Note:

1. The square footage numbers provided in these tables represent project buildout numbers including nonresidential buildings expected to remain.
2. Residential units within Lot 27 existed prior to the LSAP and have not been included within the total residential numbers.
3. Lots 11, 12, 13, 16, 18, 35, 36, 37, 42, and 45 are existing parcels within the LSAP area expected to remain.

Abbreviations:

Symbol	Description
GPD	gallons per day
GPM	gallons per minute
LPW	low pressure water
sf	square footage

APPENDIX F

Sanitary Sewer System Demand Calculations

Appendix F
Lawrence Station Area Plan
Sanitary Sewer System Demand Calculations

LSAP Housing Expansion Study

Lot[3]	Residential Units	Commercial/Office/ Retail (sf)	Industrial (sf)	Restaurant (sf)	Storage Facility (sf)	SS (GPD)	SS (GPM)	SS PDWF (GPM)	SS PWWF (GPM)
3	--	--	96,000	--	--	19,152	13.30	39.90	48.55
4	--	154,540	--	--	--	19,086	13.25	39.76	48.38
5	--	602,173	--	--	--	74,368	51.64	129.11	162.68
6	--	--	--	--	--	--	--	--	--
7	520	7,400	--	--	--	60,688	42.14	115.90	143.29
8	262	2,500	--	--	--	30,426	21.13	63.39	77.12
9	320	2,500	--	--	--	37,093	25.76	70.84	87.58
10	125	--	--	--	--	14,369	9.98	32.43	38.92
11	--	--	19,990	--	--	3,988	2.77	9.69	11.49
12	--	--	19,512	--	--	3,893	2.70	9.46	11.22
13	--	--	16,830	--	--	3,358	2.33	8.16	9.68
14	130	--	--	--	--	14,944	10.38	33.73	40.47
15	111	--	--	--	--	12,759	8.86	28.80	34.56
16	--	--	11,055	--	--	2,205	1.53	5.36	6.36
17	168	--	--	--	--	19,312	13.41	40.23	48.95
18	--	--	19,463	--	--	3,883	2.70	9.44	11.19
19	109	--	--	--	--	12,530	8.70	28.28	33.93
20	126	1,000	--	--	--	14,607	10.14	32.97	39.56
21	--	--	--	--	--	--	--	--	--
22	--	--	--	--	--	--	--	--	--
23	--	--	--	--	--	--	--	--	--
24	--	--	--	--	--	--	--	--	--
25	741	1,500	--	--	--	85,363	59.28	148.20	186.73
26	16	--	--	--	--	1,839	1.28	4.47	5.30
27	16	--	--	--	--	--	--	--	--
28	83	2,000	--	--	--	9,788	6.80	22.09	26.51
29	18	2,000	--	--	--	2,316	1.61	5.63	6.67
30	52	2,000	--	--	--	6,224	4.32	15.13	17.94
31	13	1,000	--	--	--	1,618	1.12	3.93	4.66
32	--	8,156	--	--	--	1,007	0.70	2.45	2.90
33	--	--	--	7,800	--	4,446	3.09	10.81	12.81
34	--	136,438	--	--	--	16,850	11.70	35.10	42.71
35	--	152,758	--	--	--	18,866	13.10	39.30	47.82
36	--	--	61,758	--	--	12,321	8.56	27.81	33.37
37	--	--	147,842	--	--	29,494	20.48	61.45	74.76
38	--	136,409	39,148	--	--	24,657	17.12	51.37	62.50
39	1,458	--	--	--	--	167,597	116.39	290.97	366.62
40	634	--	--	--	--	72,878	50.61	139.18	172.07
41	338	--	--	--	--	38,853	26.98	74.20	91.74

Appendix F
Lawrence Station Area Plan
Sanitary Sewer System Demand Calculations

Lot[3]	Residential Units	Commercial/Office/ Retail (sf)	Industrial (sf)	Restaurant (sf)	Storage Facility (sf)	SS (GPD)	SS (GPM)	SS PDWF (GPM)	SS PWWF (GPM)
42	--	--	78,000	--	--	15,561	10.81	32.42	39.44
43	383	--	--	--	--	44,026	30.57	84.08	103.95
44	--	--	--	--	--	--	--	--	--
45	--	--	105,000	--	--	20,948	14.55	43.64	53.10
46	--	--	--	--	--	--	--	--	--
47	328	--	--	--	--	37,704	26.18	72.00	89.02
48	--	--	--	--	--	--	--	--	--
49	--	--	--	--	159,637	506	0.35	1.23	1.46
50	--	--	--	--	--	--	--	--	--
51	--	--	--	--	--	--	--	--	--
52	--	--	--	--	--	--	--	--	--
Subtotal	5,935	1,212,374	614,598	7,800	159,637	959,520	666.33	1,862.89	2,296.00

LSAP Office Expansion Study

Lot	Residential Units	Commercial/Office/ Retail (sf)	Industrial (sf)	Restaurant (sf)	Storage Facility (sf)	SS (GPD)	SS (GPM)	SS PDWF (GPM)	SS PWWF (GPM)
1 & 2	--	351,000	--	13,000	--	50,759	35.25	96.93	119.85
53	--	--	831,000	16,000	--	174,905	121.46	303.65	382.60
Subtotal	--	351,000	831,000	29,000	--	225,663	156.71	400.59	502.45

Note:
1. The square footage numbers provided in these tables represent project buildout numbers including nonresidential buildings expected to remain.
2. Residential units within Lot 27 existed prior to the LSAP and have not been included within the total residential numbers.
3. Lots 11, 12, 13, 16, 18, 35, 36, 37, 42, and 45 are existing parcels within the LSAP area expected to remain.

Abbreviations:

Symbol	Description
GPD	gallons per day
GPM	gallons per minute
LPW	low pressure water
PDWF	peak dry weather flow
PWWF	peak wet weather flow
sf	square footage

APPENDIX G

Cost Estimate for City Sanitary Sewer System Recommendations

BKF Engineers
255 Shoreline Drive, Suite 200
Redwood City, California 94065

APPENDIX G
ESTIMATE OF CONSTRUCTION
COSTS FOR CITY SANITARY SEWER UPGRADES

LAWRENCE EXPRESSWAY SANITARY SEWER IMPROVEMENTS					
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST[5]	TOTAL COST
1	Replace existing 27" VCP main with proposed 30" PVC SS main	671	LF	$2,000.00	$1,342,000
				LAWRENCE EXPRESSWAY SUBTOTAL	**$1,342,000**

ADDITIONAL PROJECT COSTS (PERCENTAGE OF LAWRENCE EXPRESSWAY SUBTOTAL)			
ITEM	DESCRIPTION	QUANTITY	TOTAL COST
1	Construction Fees	25%	$335,500
2	Design Fees	20%	$268,400
3	Inspection Fees	10%	$134,200
4	Miscellaneous Costs	5%	$67,100
5	City Administration Fees	5%	$67,100
		ADDITIONAL COSTS SUBTOTAL	**$872,300**
		LAWRENCE EXPRESSWAY TOTAL	**$2,214,300**

SAN ZENO WAY SANITARY SEWER IMPROVEMENTS					
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL COST
1	Replace existing 10" VCP main with proposed 12" PVC SS main	324	LF	$700.00	$226,800
				SAN ZENO WAY SUBTOTAL	**$226,800**

ADDITIONAL PROJECT COSTS (PERCENTAGE OF SAN ZENO WAY SUBTOTAL)			
ITEM	DESCRIPTION	QUANTITY	TOTAL COST
1	Construction Fees	25%	$56,700
2	Design Fees	20%	$45,360
3	Inspection Fees	10%	$22,680
4	Miscellaneous Costs	5%	$11,340
5	City Administration Fees	5%	$11,340
		ADDITIONAL COSTS SUBTOTAL	**$147,420**
		SAN ZENO WAY TOTAL	**$374,220**

WILLOW AVENUE SANITARY SEWER IMPROVEMENTS					
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL COST
1	Replace existing 10" VCP main with proposed 18" PVC SS main	69	LF	$900.00	$62,100
				WILLOW AVENUE SUBTOTAL	**$62,100**

ADDITIONAL PROJECT COSTS (PERCENTAGE OF WILLOW AVENUE SUBTOTAL)			
ITEM	DESCRIPTION	QUANTITY	TOTAL COST
1	Construction Fees	25%	$15,525
2	Design Fees	20%	$12,420
3	Inspection Fees	10%	$6,210
4	Miscellaneous Costs	5%	$3,105
5	City Administration Fees	5%	$3,105
		ADDITIONAL COSTS SUBTOTAL	**$40,365**
		WILLOW AVENUE TOTAL	**$102,465**

LSAP HOUSING TOTAL	**$2,690,985**

Abbreviations:

Symbol	Description
PVC	polyvinyl chloride
VCP	vitrified clay pipe

Notes:

1. For location of Sanitary Sewer improvements, refer to Figure 3.3 - LSAP Proposed Sanitary Sewer Pipe Sizing.
2. This cost estimate does not include the costs associated with the installation of intermediary manholes for segments of sanitary sewer main that violate City requirements for running length of sewer mains between manholes.
3. Unit cost values are derived from 2019 Downtown Specific Plan Amendments Utility Impact Study.
4. Unit cost for the sewer main upgrades includes cost for mobilization, demobilization, traffic control, shoring, trenching, manholes, laterals, bypass pumping, offhaul, and disposal.
5. Unit cost for sewer main upgrade within Lawrence Expressway has been adjusted to account higher anticipated costs for increased pavement thickness, expressway traffic control, bypass pumping, and tunneling in addition to the costs listed in Note 4.
6. This cost estimate is approximate and may not be representative of actual construction costs.

BKF Job No.: 20180080
Estimate Date: 05/19/2020