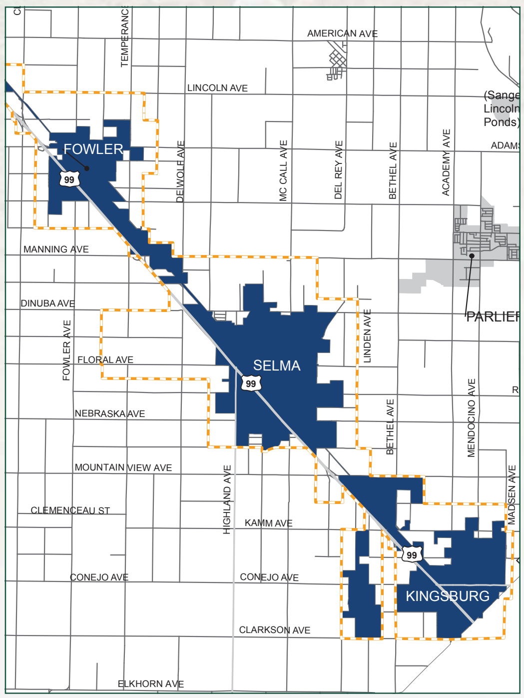

SELMA-KINGSBURG-FOWLER COUNTY SANITATION DISTRICT | OCTOBER 2016

2016 Collection System Master Plan Update

WEST YOST ASSOCIATES

2016 Collection System Master Plan Update

Prepared for

Selma-Kingsburg-Fowler County Sanitation District

October 2016

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499-21-15-03

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ES.1 BACKGROUND

The Selma Kingsburg Fowler County Sanitation District (District) is located in Fresno County (County), in the central section of the San Joaquin Valley, south of the City of Fresno. The District serves the member cities of Selma, Kingsburg, and Fowler as a local government agency that provides sewer service. The District collects, treats, and disposes of wastewater originating from the residential, commercial, institutional, and industrial dischargers within the District service area. The majority of the collection system is owned by the individual member cities, but is maintained and operated by the District. The larger shared interceptors and some of the lift stations within the collection system are owned and maintained by the District.

The District finalized the 2006 Sewer System Master Plan (2006 Master Plan) in September of 2006. The 2006 Master Plan incorporated a flow monitoring study and the development of a collection system hydraulic model with growth projections from the three member cities to provide a Capital Improvement Plan (CIP) for the District. Because the development projections for the three member cities have changed greatly since 2006, the 2016 Master Plan Update updates the development and flow projects to provide an updated CIP. Furthermore, the 2016 Master Plan Update integrates an operational and condition risk assessment into the prioritization of the CIP. Further information of the Background for the 2016 Master Plan can be found in Chapter 1.

ES.2 STUDY AREA DESCRIPTION

The District currently serves approximately 8,650 acres (13.5 square miles). The current service boundary includes the area inside each city's City Limits (a total of 7,120 acres), as well as small areas of the County to the southeast of Fowler, to the south of Selma along McCall Avenue, and to the east of Kingsburg (a total of 1,530 acres). The 2016 Master Plan Study Area encompasses the existing Spheres of Influence (SOIs) for Selma, Kingsburg, and Fowler in addition to limited areas that are outside of and adjacent to these SOIs. The 2016 Master Plan Study Area comprises 30,100 acres (47.0 square miles), of which 22,340 acres are inside of the SOIs and 7,040 acres are outside of the existing SOIs. The 2016 Master Plan Study Area is approximately 50 percent of the area of the 2006 Master Plan Study Area. The 2016 Master Plan Study Area was focused to the area of the City's SOIs, and to limited areas specifically identified by the cities as potential growth areas, in order to focus on planning infrastructure that is likely needed by the 2035 planning horizon, and to avoid planning infrastructure for growth that is expected to remain outside of member city jurisdiction. Figure ES-1 shows the study area boundary, each city's limits, and the portions of the County serviced by the District.

ES.2.1 Land Use

Each of the member cities maintains an adopted general plan that guides development within their respective City Limits and SOI. The general plans provide land use and population projections for each city and the study area. Land use and population information are an integral component in determining the amount of wastewater generated for any collection system. The type of land use in an area will affect the volume and character of the wastewater generated. Adequately estimating

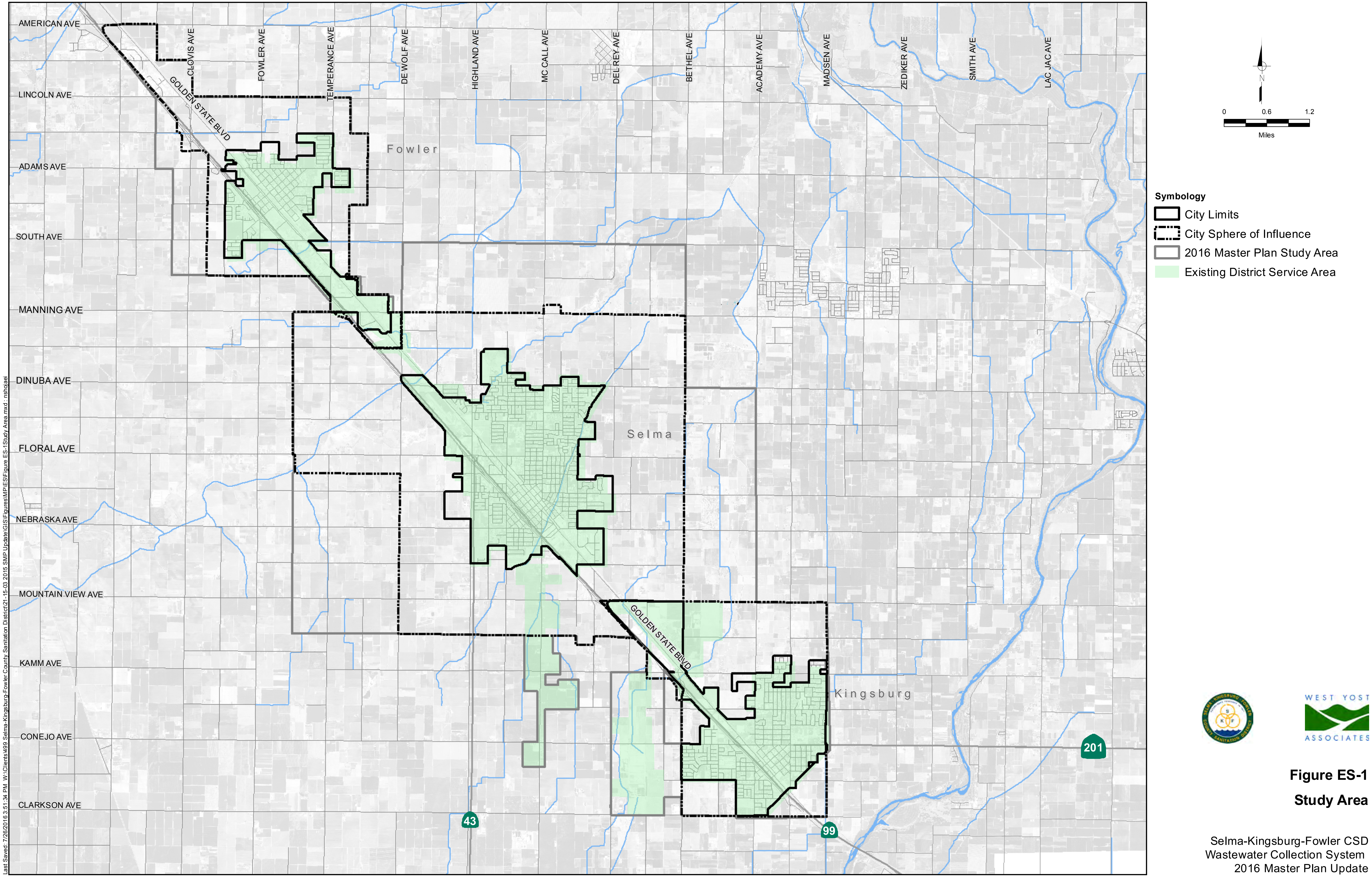


Figure ES-1

Study Area

Selma-Kingsburg-Fowler CSD
Wastewater Collection System
2016 Master Plan Update

the generation of wastewater from various land use types is important in sizing and maintaining sewer system facilities.

Each member city's adopted land use map shows the limits of the SOI and the general plan boundary. Land use assumptions used in this study are consistent with each city's general plan. Since the land use assumptions forecast the type of growth within each city's SOI, this association to the 2016 Master Plan should ensure that the wastewater projections and facilities required to serve future growth are consistent with each member city's guiding document on development. Specific information concerning the general plan land use for each member City can be found in the figures and tables contained within Chapter 2. Existing land use characteristics within the District are summarized in Table ES-1.

Table ES-1. Existing District Service Area General Land Use Classification

General Land Use Classification	Selma, acres	Kingsburg, acres	Fowler, acres	Unincorporated County, acres	Total, acres
Residential	1,613	763	527	183	3,521
Commercial and Industrial	743	715	758	356	2,572
Institutional/Other	142	82	65	474	763
Non-Wastewater Generating	785	675	253	512	1,790
Total	3,283	2,235	1,603	1,525	8,646

At buildout of the 2016 Master Plan Study Area, the District will serve approximately 30,100 acres (47.0 square miles). Buildout is defined as complete development of all lands to the general plan density. The breakdown of the different land use categories for the 2016 Master Plan Study Area at buildout is provided in Table ES-2.

Table ES-2. 2016 Master Plan Study Area General Land Use Classification

General Land Use Classification	Selma, acres	Kingsburg, acres	Fowler, acres	Unincorporated County, acres	Total, acres
Residential	14,046	1,759	1,448	—	17,253
Commercial and Industrial	4,822	1,448	2,166	—	8,436
Institutional/Other	280	82	65	—	427
Non-Wastewater Generating	930	1,409	1,216	435	3,990
Total	20,078	4,698	4,895	435	30,106

ES.2.2 Existing Collection System

The District's infrastructure includes the wastewater treatment plant (WWTP) and the wastewater collection system. The wastewater collection system consists of approximately 165 miles of pipeline and 22 lift stations. The existing collection system is summarized below. Detailed information can be found in Chapter 2.

The City of Selma is located in the center of the District's service area. Wastewater enters Selma from Fowler in the northwest through the interceptor gravity main in Golden State Boulevard (Golden State Interceptor). The Golden State Interceptor enters Selma as a 30-inch diameter gravity main and exits Selma as a 42-inch diameter gravity main to the southeast. In general, wastewater flow generated in Selma to the northeast of the Golden State Interceptor is carried to the Golden State Interceptor to be conveyed out of Selma. Wastewater flow generated to the southwest of the Golden State Interceptor is conveyed to the 24-inch diameter trunk gravity main (currently being lined to an effective diameter of 21 inches) in McCall Avenue.

The City of Kingsburg is located in the southern part of the service area and is nearest to the WWTP. The majority of wastewater flow from Kingsburg is carried to 36-inch diameter trunk sewer in Conejo Avenue and conveyed to the WWTP. A few industries located in north Kingsburg convey their flows to the 42-inch diameter Golden State Interceptor in the northwest corner of Kingsburg.

The city of Fowler is located in the northern-most, farthest upstream, portion of the District. All wastewater flows from Fowler are carried to the Golden State Interceptor, through which they are conveyed out of the city to the southeast to Selma.

ES.3 DESIGN AND PERFORMANCE CRITERIA

The 2016 Master Plan utilizes existing and future design flows to evaluate the capacity requirements of the District's collection system. The design flow factors and design storm that were combined to develop design flows used in the capacity evaluation are summarized below, along with the performance criteria by which the collection system performance was evaluated. Detailed information about the design and performance criteria applied during the development of the 2016 Master Plan can be found in Chapter 3.

ES.3.1 Design Flow

The design flow is the maximum hourly wastewater flow rate under a given growth condition. In the District's collection system design flow is composed of the Peak Dry Weather Flow (PDWF) generated by typical residential, commercial, institutional, and light industrial customers, the flow created by the Industrial Dischargers identified within the District, and Rainfall Dependent Inflow and Infiltration (RDII) that enters the collection system during a design storm wet weather event. The values for the design factors used in developing the design flows for the 2016 Master Plan are detailed in Chapter 3.

ES.3.2 Performance Criteria

The capacity of the District's collection system was evaluated as part of the 2016 Master Plan based on the performance criteria detailed in Chapter 3. The criteria include standards from the District's Collection System Construction Standards (Construction Standards), as well as other industry typical criteria. The planning criteria address the gravity main capacity, gravity main slopes, maximum depth of flow within a gravity main, lift station wet well capacity criteria, lift station capacity criteria, and force main velocity criteria.

ES.4 EXISTING AND FUTURE DESIGN FLOWS

For the 2016 Master Plan, design flows used in assessing the hydraulic capacity of the collection system consist of Peak Wet Weather Flows (PWWF) that are developed using (Average Dry Weather Flow (ADWF) and PDWF components. The design flow components are described in more detail in Chapter 4 and are summarized below.

ES.4.1 Flow Component Summary

ADWF is generally accepted to include two components: base wastewater flow (BWF) and Groundwater Infiltration (GWI). BWF represents the sanitary and process flow contributions from residential, commercial, institutional, and industrial users of the collection system. GWI is groundwater that infiltrates into defects in sewer pipes and manholes, particularly in winter and springtime in low-lying areas. BWF is typically not discharged into the collection system at a constant rate during the day. BWF varies throughout the day, but typically follows predictable diurnal patterns depending on the type of land use. PDWF is the peak flow experienced in a collection system during dry conditions, and it is determined by the diurnal discharge patterns of the collection system users. PDWF is typically 1.2 times to 3.0 times the ADWF in a collection system, depending on the mixture of discharger types and the layout of the collection system.

PWWF is composed of PDWF with the addition of RDII. RDII is storm water inflow and infiltration that enter the system in direct response to rainfall events, either through direct connections such as holes in manhole covers or illegally connected roof leaders or area drains, or, more commonly, through defects in sewer pipes, manholes, and service laterals. RDII typically results in short term peak flows that recede relatively quickly after the rainfall ends. The magnitude of RDII flows are related to the intensity and duration of the rainfall, the relative soil moisture at the time of the rainfall event, and the condition of the sewers.

Significant Industrial Dischargers are those collection system users whose industrial processes produce more wastewater than is predicted by sanitary flow design factors. Because the amount of wastewater flow discharged to the collection system depends upon the type and size of the industrial process involved, the wastewater flow from Significant Industrial Dischargers is difficult to project using standard flow coefficients, and flow projections from these users must usually be handled on an individual basis.

The well-developed industrial base within the three stakeholder cities results in a large number of Significant Industrial Dischargers in the District's collection system. A comprehensive list of these dischargers was developed. The list is based upon that developed for the 2006 Master Plan, with updates performed to make it current for the 2016 Master Plan. These updates were identified by District staff and by review of District budget documents. The updates include the removal of some Significant Industrial Dischargers who are no longer active, and the addition of some users who have become active since 2006.

ES.4.2 Design Flow Development

For the 2016 Master Plan, existing and future ADWF values were developed starting with the design flow values from the 2006 Master Plan and adding projected development within the 2016 Master Plan Study Area. ADWF values for developments were calculated using the Design Wastewater Flow Coefficients that are described in Chapter 3. A development timeline was created for each member city at 2015, 2020, 2025, 2035. The development timeline is the basis for determining the collection system infrastructure required to accommodate the growth of the member cities and critical to the phasing of the construction of the infrastructure. The 2015 development timeframe was used to identify projects that have been recently completed, and was used to establish a new starting point for the 2016 Master Plan. The development timeline in each member City was identified and refined through multiple meetings with the management, engineering, and planning staff for each member City. The resulting development timelines for the 2016 Master Plan, and the ADWF flow projections that result from the development timelines, represent considerable collaborative effort on the part of District and member City staff.

Where specific development projects were identified by member City or District staff, the development project is identified by name in the development timeline. In some cases, Equivalent Single Family Residential, (ESFR) values were known for residential developments, and these known values are included in the development timeline. In cases of residential development for which the ESFR count is not known, the acreage of the development is used to calculate ADWF for the development. For all non-residential development, acreage values were used to calculate ADWF. Where specific projects have not been identified, but where development is expected to occur, the development has been identified as “General Development” in the development timeline. General development is projected to take place according to the General Plan Land Use as described for each member City in Chapter 2.

Detailed development timelines for each member City, encapsulated in both tabular and graphic format, can be found in Chapter 4. The design flows resulting from these development timelines are summarized in Table ES-3.

Table ES-3. Summary of Design Flow Projections by Development Timeframe

Description	Existing (2015), mgd	5-Year (2020), mgd	10-Year (2025), mgd	20-Year (2035), mgd
ADWF	4.30	5.53	5.64	23.45
PDWF	7.87	9.93	10.09	38.85
PWWF (Design Flow)	15.91	17.54	17.75	44.85

ES.5 HYDRAULIC MODEL UPDATE AND CAPACITY EVALUATION

As part of the 2016 Master Plan, an updated hydraulic model of the City's sanitary sewer system was developed and utilized for the collection system hydraulic analysis. Chapter 5 describes the model software, the modeled system network, future design flow allocation, and hydraulic capacity evaluation, all of which are summarized below.

ES.5.1 Model Description

As part of the 2006 Master Plan, a hydraulic model was developed utilizing H2O Map Sewer Pro software (H2O Map Sewer), a product of Innovyze, Inc. as the modeling program. H2O Map Sewer was developed specifically for collection system capacity analysis and is widely used in California. The H20 Map Sewer hydraulic model, updated appropriately, was used to identify hydraulic deficiencies under existing and future timeframe conditions, and to evaluate potential relief sewers or other infrastructure improvements to address the possible hydraulic deficiencies for the 2016 Master Plan.

The hydraulic model simulates a skeletonized system with about 78.5 total miles of modeled pipelines and 22 lift stations. The skeletonized system includes all the major trunk sewers 10-inch diameter and larger. Additional smaller diameter pipelines were added to the model as needed to keep tributary areas at a reasonable size and to provide for hydraulic conductivity.

The hydraulic model as developed for the 2006 was updated as follows:

- Structural improvements or developments that have occurred since the time of the 2006 Master Plan were updated into the model.
- Instances of inconsistent gravity main diameters between the hydraulic model and the Geographic Information System (GIS) were identified and investigated. In some instances, field investigation by District staff was utilized to determine the correct diameter. The hydraulic model was updated as the investigations indicated was appropriate.
- Infrastructure that appeared in the hydraulic model, but not in the District's GIS was investigated to determine which source correctly represented field conditions. The hydraulic model was updated as appropriate.

Design flows as described in Chapter 4 were added to the updated hydraulic model. Tributary areas were identified for allocating future wastewater flows to the appropriate modeled gravity main, either existing or new. Each tributary area has at least one connection node in the hydraulic model. Current and future land uses for each tributary area were tabulated using the land use information in Chapter 2 and the development information presented in Chapter 4 as applicable.

The tributary areas represent the locations where projected flows from study area tributary areas were loaded into the modeled collection system network. The load allocation is based upon the local topography. Certain larger tributary areas were loaded to more than one manhole, with each link representing an equal percentage of the total projected flows from a given parcel. The intent of this methodology was to load wastewater flows as realistically as possible in the hydraulic model. The detailed tributary areas can be found in Chapter 5.

ES.5.2 Capacity Analysis

The updated hydraulic model was utilized to perform a capacity analysis of the District's collection system using the design flows developed in Chapter 4. Hydraulic analysis was performed at each step in the development timeline. Existing gravity mains, lift stations, and force mains were evaluated with the design flows, and those with insufficient capacity in any of the development timeframes were identified. Furthermore, future infrastructure that will need to be constructed in addition to the existing infrastructure was identified and sized during the hydraulic evaluations. The results of the hydraulic capacity analysis are detailed in Chapter 5.

ES.6 OPERATIONAL ANALYSIS

An evaluation was performed of the condition and day-to-day operation of the District's collection system. Maintaining the condition of the collection system and providing effective operation of the collection system are equally important to providing adequate hydraulic capacity in meeting the needs of the member cities and their customers. The results of the evaluation are detailed in Chapter 6 and summarized below.

ES.6.1 Gravity Main Risk Assessment

A risk assessment of the gravity sewer mains was performed. For the gravity mains in the collection system, a risk model was developed in InfoMaster™ Sewer, an advanced ArcGIS-based analytical asset management and capital planning software for wastewater networks. A rating for both likelihood and consequence of failure was assigned by the model to each gravity main. For this analysis, a failure is considered to be a deficiency that results in a sanitary sewer overflow (SSO). SSOs are violations of state and federal laws, and can adversely impact the environment and public health. SSOs can also require costly emergency repairs which are disruptive to the community.

The risk assessment model then combines the likelihood of failure ratings with the consequence of failure ratings to develop a comprehensive risk rating. The 165 miles of gravity mains are summarized by comprehensive risk rating in Table ES-4. Comprehensive risk rating can be seen graphically on Figure ES-2.

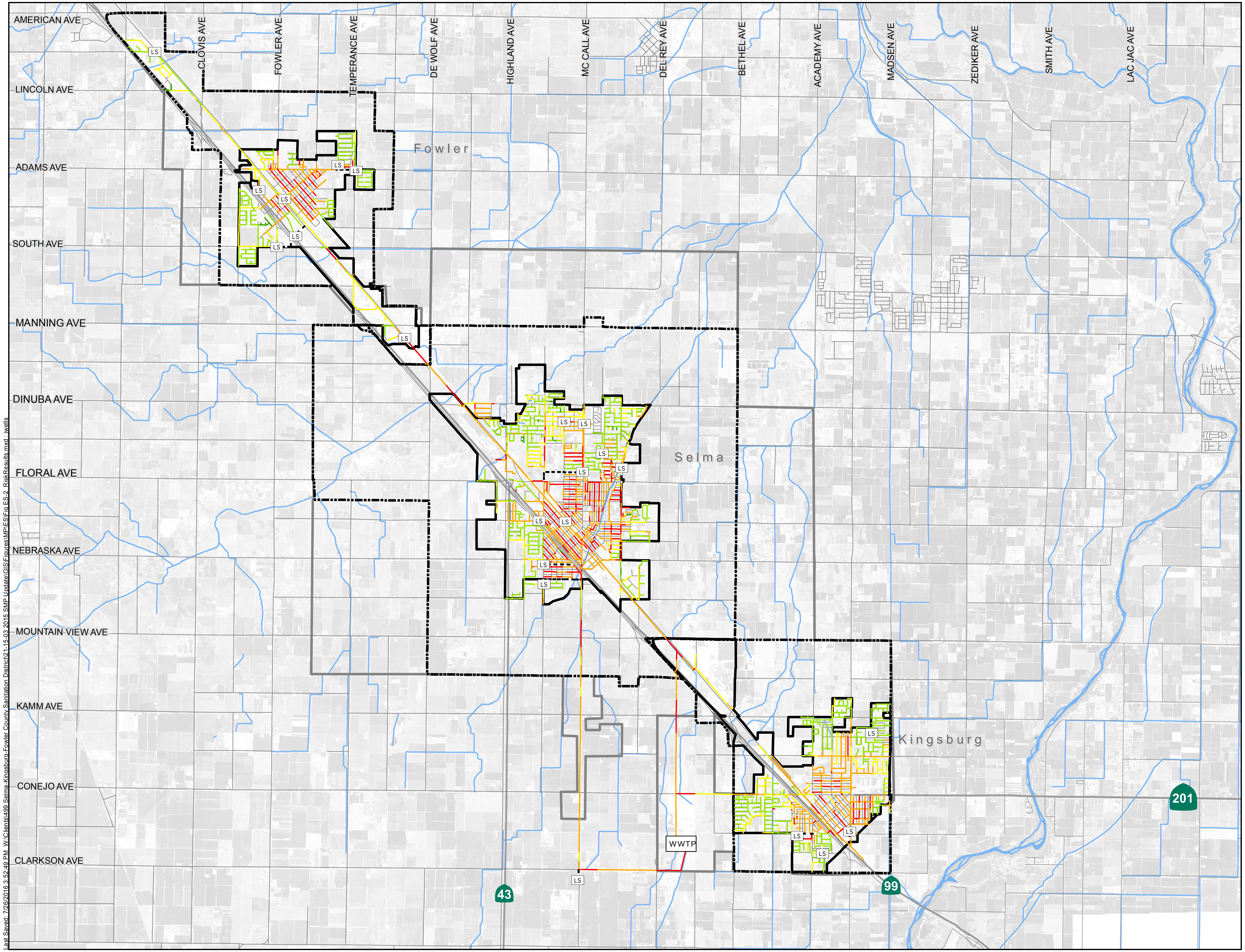


Figure ES-2

Gravity Sewer Risk Assessment Results

Selma-Kingsburg-Fowler CSD
Wastewater Collection System
2016 Master Plan Update

Table ES-4. Gravity Sewer Risk Assessment Results

Miles of Gravity Sewer Mains		Likelihood of Failure A (3)	B (4)	C (5)	D (6 – 7)	E (8-13)	Total
Consequence of Failure	A (20-26)	1.32	1.77	2.37	5.96	1.36	12.78
	B (27-39)	41.46	9.88	7.56	27.06	12.73	98.69
	C (40-58)	11.23	2.10	5.30	12.66	3.60	34.88
	D (59-73)	1.38	0.62	9.06	3.39	0.85	15.30
	E (78-97)	0.25	0.00	2.42	0.95	0.12	3.73
	Total	55.63	14.37	26.70	50.02	18.66	165.38

Risk Levels: Dark Green = Low, Light Green = Medium-Low, Yellow = Medium, Orange = Medium-High, Red = High

ES.6.2 Lift Station Risk Assessment

The District operates and maintains 22 lift stations. The District owns the four lift stations along the interceptor, while each City owns the lift stations within its own local sewer collection system.

District Facilities. Merced Street Lift Station (D-1), Manning Lift Station (D-2), North Street Lift Station (D-3), and 18th Street Lift Station (D-4).

City of Selma Facilities. Rose Street Lift Station (S-3), Goldridge/Wright Lift Station (S-4), North Hill Lift Station (S-5), Dockery Lift Station (S-6), Sunset Lift Station (S-7), Barbara Lift Station (S-8), Valley View Lift Station (S-9), Maple/McCall Lift Station (S-10), and Clarkson/McCall Lift Station (S-11).

City of Kingsburg Facilities. Mehlert Lift Station (K-1), Kern Lift Station (K-2), and Skansen Lift Station (K-3).

City of Fowler Facilities. North 10th Street Lift Station (F-2), Peach Street Lift Station (F-3), Gleason Lift Station (F-4), South Avenue Lift Station (F-5), Jefferson Avenue Lift Station (F-6), and Adams/Temperance Lift Station (F-7).

The likelihood of failure analysis for lift stations considers the probability that a failure will occur in a given lift station. Lift stations have the following principal failure modes: maintenance failure, structural failure, and hydraulic capacity failure. For each failure mode, one or more factors are considered in determining the likelihood of a failure.

The consequence of failure considers the potential impacts from a SSO in each lift station. For each category, one or more factors are considered in determining the potential consequence of a failure, as discussed below. The consequence of failure analysis is divided into three categories: potential spill volume, environmental and public health, and emergency response and construction impact.

A MS Access database model was developed to perform the risk assessment calculations. The model applies a series of algorithms to calculate total consequence and likelihood of failure scores for each station. By plotting the consequence of failure and the likelihood of failure scores against each other, an overall risk level was assigned to each station. Risk levels are prioritized into five risk levels: Low Risk, Medium-Low Risk, Medium Risk, Medium-High Risk, and High Risk, each of which is shown in Table ES-5. These risk levels are assigned to the various cells using best engineering judgment to determine which combinations of score warrant the highest levels of concern versus those that warrant lesser levels of concern.

Table ES-5. Lift Station Risk Assessment Results

Name of Lift Station		Likelihood of Failure				
		A (23 – 35)	B (36 – 45)	C (46 – 68)	D (69 – 91)	E (92-115)
Consequence of Failure	A (18 – 28)	K-2 F-2				
	B (29 – 35)	F-4, F-5 S-9	K-1	S-3, S-5		
	C (36 – 53)	F-6, F-7 S-7, S-8	K-3 S-4	S-6, S-10	F-3 S-11	
	D (54 – 71)			D-4	D-3	D-1, D-2
	E (72 – 90)					

Risk Levels: Dark Green = Low, Light Green = Medium-Low, Yellow = Medium, Orange = Medium-High, Red = High

ES.7 PRIORITIZED CAPITAL IMPROVEMENTS PROGRAM

A recommended CIP for the gravity main, lift stations, and force mains that have been identified for improvement in Chapter 5 and Chapter 6 was developed for the 2016 Master Plan. This CIP has been prioritized based on the development timeline and risk assessment performed, and includes conceptual costs for the recommended projects. Chapter 7 details the prioritized CIP, which is summarized below.

Costs below are presented in May 2016 dollars based on an Engineering News Record (ENR) Construction Cost Index (CCI) of 10337 (20-city average). Construction costs are to be used for conceptual-level cost estimating only. The cost estimates prepared for the 2016 Master Plan are in accordance with the guidelines of the Association for the Advancement of Cost Engineering (AACE) International for a Class 5 Estimate, suitable for long-range capital planning, with an accuracy range of -50 percent to +100 percent.

Contingency cost and implementation mark-ups must be reviewed on a case-by-case basis because they will vary considerably with each construction project. However, to assist District staff with budgeting for these recommended collection system improvements, the following percentages were developed.

- Contingency: 30 percent
- Implementation Costs: 30 percent

Design:	10 percent
Construction Management and Inspection:	10 percent
Permitting, Regulatory and CEQA Compliance	5 percent
District Administration, Public Outreach, and Legal:	5 percent
Total:	30 percent

The total contingency and implementation costs are compounded, so the total markup of the base construction cost is 69 percent. For the 2016 Master Plan, it is assumed that new facilities will be developed in public rights-of-way or on public property. Therefore, land acquisition costs have not been included. Proposed costs do not include costs for annual operation and maintenance.

ES.7.1 Proposed CIP

Proposed CIP projects have been developed to meet the hydraulic capacity requirements presented in Chapter 5. The projects are categorized by the development timeline for which they are required. Projects identified for the 2015 timeframe are required under existing hydraulic conditions. Further, the proposed CIP projects have been prioritized according to the risk assessment that was performed as described in Chapter 6. Using the risk assessment, District and member City funds are being prioritized to projects that will most improve the overall condition of the collection system, as well as provide needed capacity.

ES.7.1.1 Proposed Gravity Main CIP

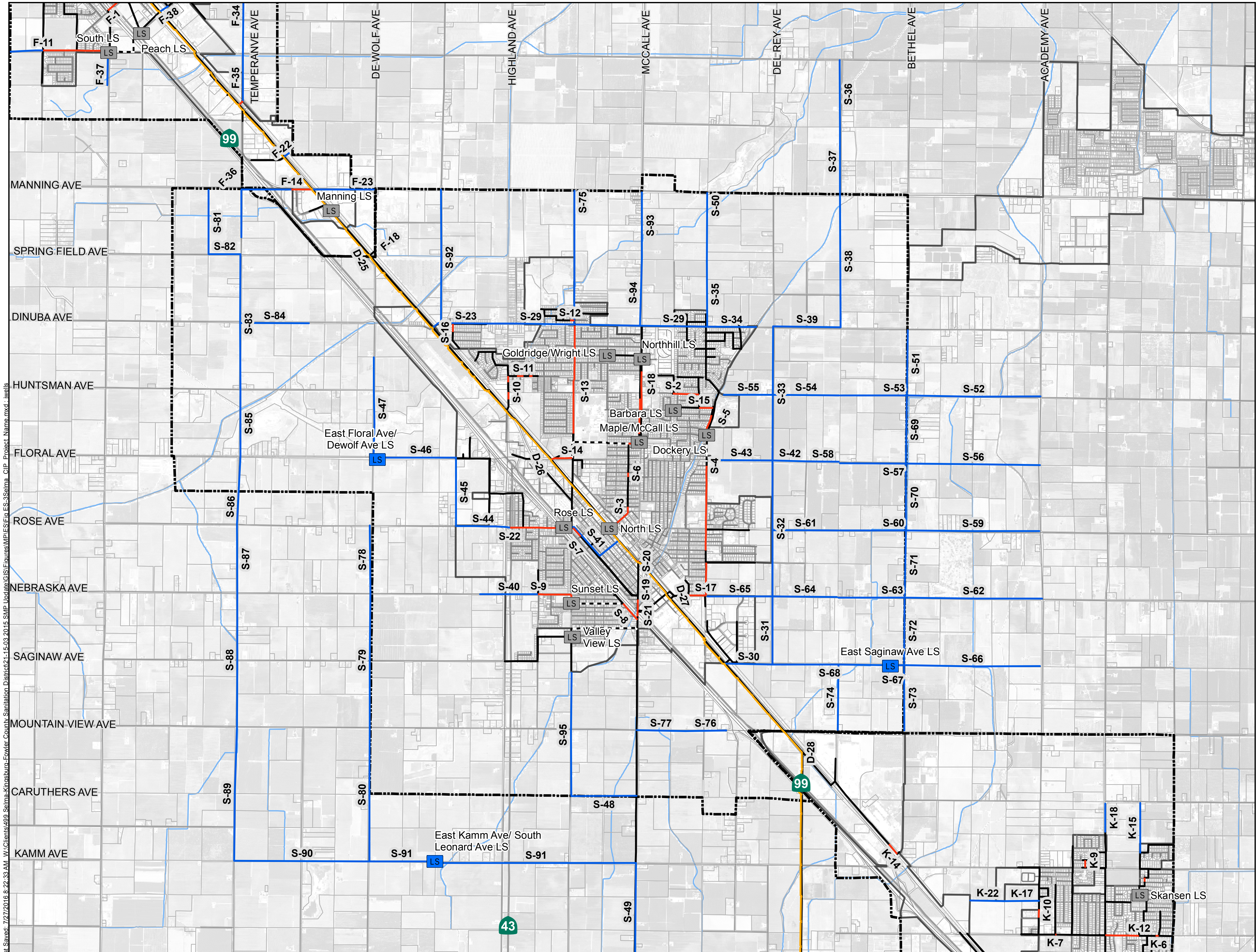
The recommended gravity main projects for the existing and future collection system were developed based on the methodologies and criteria presented in previous chapters. Additionally, already-completed plans such as the Dinuba North Line have been integrated into the proposed CIP. The District's current project to line and improve the condition of the existing McCall Avenue Trunk sewer has been taken into account in all evaluations.

For gravity main capacity improvement projects identified as part of the 2016 Master Plan, replacement or new gravity mains were sized to convey design flows. Existing pipe slopes and depths were preserved when upsizing sewers in-place. Diameters were increased as minimally as possible in order to prevent oversizing and subsequent low velocities during dry weather conditions. Model runs with all capacity projects in place were made to determine the impact of increased capacity from upstream projects on peak flows in pipes downstream of those projects to verify that no additional collection system capacity deficiencies would result.

In some cases, the hydraulic model identified short reaches of gravity main (often a single pipeline), which have insufficient capacity because of flat or even negative slopes. In these cases, a construction project to correct such a small lack of capacity may not be advisable. For such cases, the proposed CIP recommends inspection to confirm the slope, alignment, and capacity of the reach, rather than a replacement project. For these projects, inspection costs, rather than replacement costs are reflected in the prioritized CIP.

The proposed gravity main CIP for Selma can be seen on Figure ES-3, for Kingsburg on Figure ES-4, and for Fowler on Figure ES-5. The CIP projects are labeled on these figures. The projects are listed in detail for each City in Appendix C. The development timeline, prioritization, and estimated conceptual costs are included for each project in the Appendix.

The proposed CIP for gravity mains is summarized in Table ES-6. Estimated conceptual capital costs are summarized by development timeline and member City in the table. As shown in Table ES-6, approximately $228M in gravity main improvements are required to meet the collection system requirements of the development and design flows that are described in Chapter 4. Approximately four percent of the improvements, with an approximate estimate cost of $10M, are required for existing conditions. Another 20 percent of the gravity main improvements totaling approximately $46M are required for development that is projected to occur in the 2020 development timeframe. Seventy-five percent of the improvements are not required until the 2035 development timeframe at the end of the study period.



Symbology

- LS Proposed Lift Station
- Proposed Gravity Main
- Parallel District Gravity Main
- Replace Existing Gravity Mian
- WWTP Wastewater Treatment Plant
- LS Existing Lift Station
- Modeled Gravity Main
- Modeled Force Main
- Unmodeled Gravity Main
- City Limits
- City SOIs

N

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Miles

Note:
1. Labels indicate the name of the CIP project. Project details may be found in the detailed CIP tables.
2. Project name starting with S indicates Selma's collection system; D indicates the District's collection system.
3. Detailed CIP Project information can be found in Appendix C.

WEST YOST ASSOCIATES

Figure ES-3

Recommended CIP Projects
City of Selma

Selma-Kingsburg-Fowler CSD
Wastewater Collection System
2016 Master Plan Update

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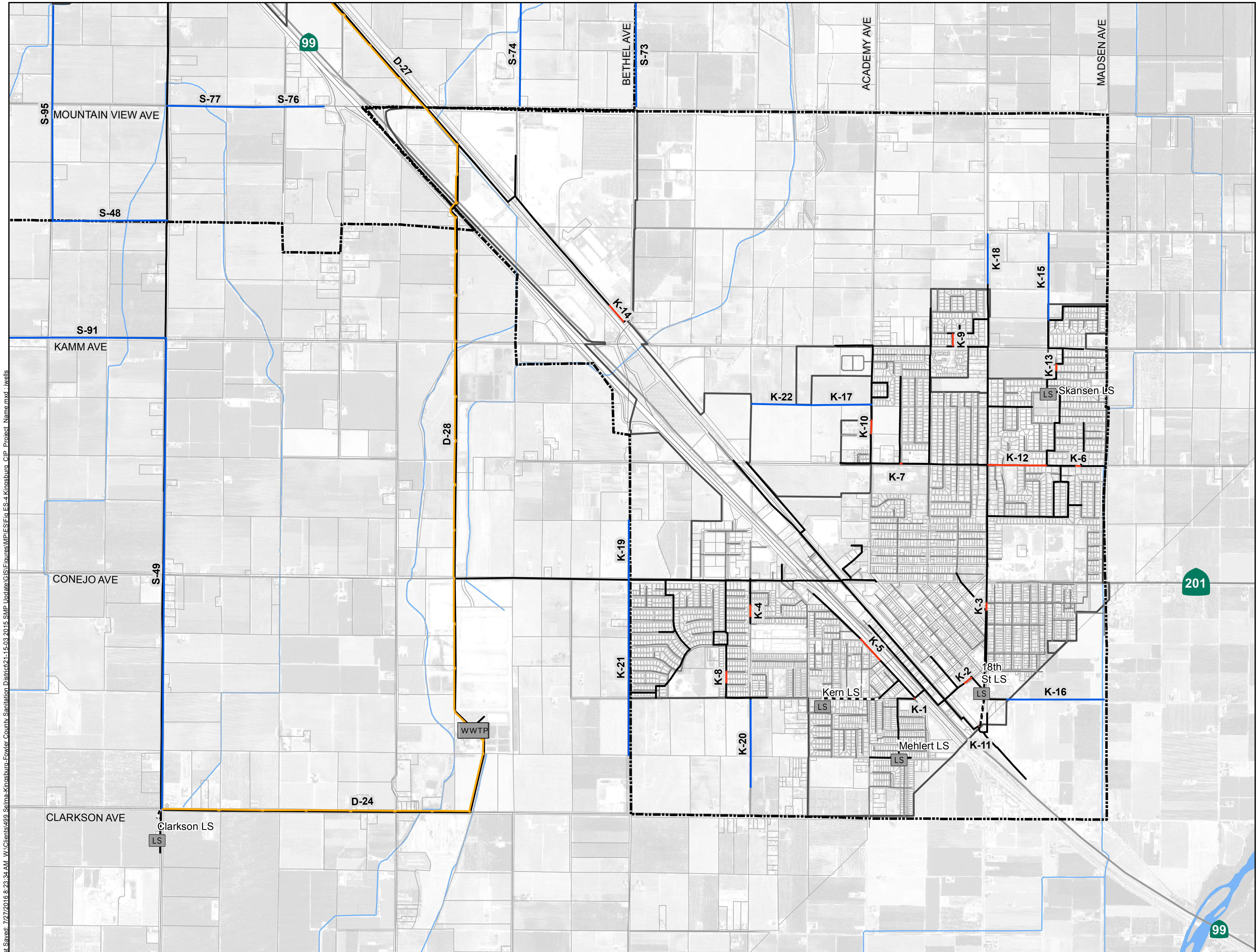

Symbology

- LS Proposed Lift Station
- Proposed Gravity Main
- Parallel Existing District Gravity Main
- Replace Existing Gravity Mian
- WWTP Wastewater Treatment Plant
- LS Existing Lift Station
- Modeled Gravity Main
- Modeled Force Main
- Unmodeled Gravity Main
- City Limits
- City SOIs

Note:
1. Labels indicate the name of the CIP project. Project details may be found in the detailed CIP tables..
2. Project name starting with K indicates Kingsburg's collection system; D indicates the District's collection system.
3. Detailed CIP Project information can be found in Appendix C.

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Figure ES-4

Recommended CIP Projects
City of Kingsburg

Selma-Kingsburg-Fowler CSD
Wastewater Collection System
2016 Master Plan Update

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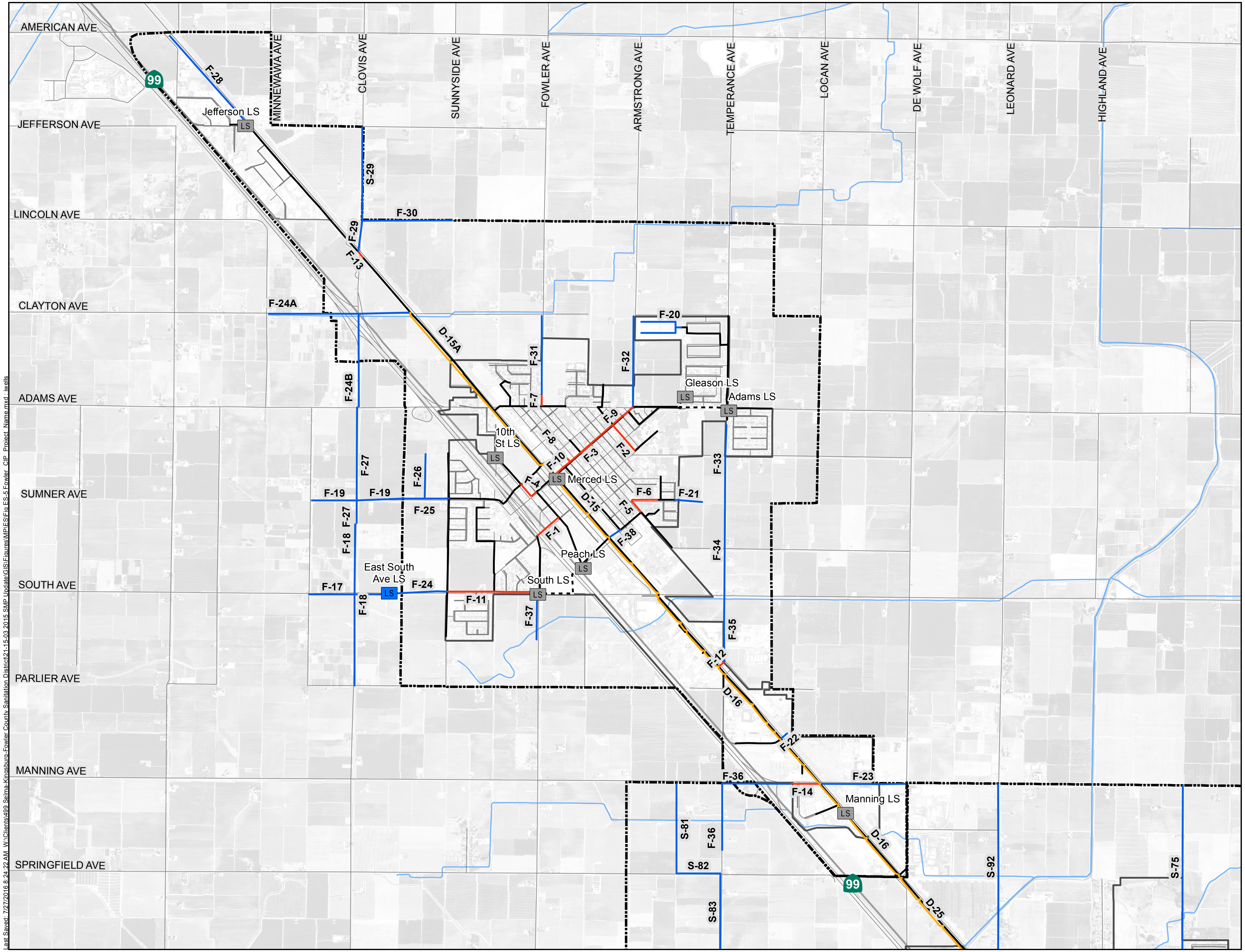

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Miles

Symbology

- LS Proposed Lift Station
- Proposed Gravity Main
- Parallel District Gravity Main
- Replace Existing Gravity Main
- WWTP Wastewater Treatment Plant
- LS Existing Lift Station
- Modeled Gravity Main
- Modeled Force Main
- Unmodeled Gravity Main
- City Limits
- City SOIs

Note:
1. Labels indicate the name of the CIP project. Project details may be found in the detailed CIP tables.
2. Project name starting with F indicates Fowler's collection system; D indicates the District's collection system.
3. Detailed CIP Project information can be found in Appendix C.

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Figure ES-5

Recommended CIP Projects
City of Fowler

Selma-Kingsburg-Fowler CSD
Wastewater Collection System
2016 Master Plan Update

Table ES-6. Summary of Proposed Gravity Main CIP Conceptual Capital Costs					
Development Timeframe	Selma, dollars	Kingsburg, dollars	Fowler, dollars	District, dollars	Entire 2016 Master Plan Update Study Area, dollars
2015	8,170,880	617,780	955,190	—	9,743,850
2020	38,076,340	2,361,260	5,488,060	—	45,925,660
2025	—	—	1,063,820	—	1,063,820
2035	99,757,470	2,955,460	19,166,530	49,561,270	171,440,730
Total	$146,004,690	$5,934,500	$26,673,600	$49,561,270	$228,174,060

ES.7.1.2 Proposed Lift Station CIP

As described in Chapter 5, the hydraulic model identified existing lift stations that have insufficient capacity under existing design flows. The model also identified existing lift stations that have insufficient capacity under future design flows. Finally, the hydraulic model was used to identify the capacity and location of proposed lift stations needed in the future to convey flow from development. The proposed lift station CIP has been developed from these results. The required lift station capacity increases with estimated conceptual capital costs are provided in Table ES-7. The location of these lift stations can be seen on Figure ES-3 through Figure ES-5.

Table ES-7. Proposed Lift Station Capacity CIP with Estimated Capital Costs						
Lift Station Name	Lift Station ID	Location	Development Timeline	Action	Required Design Firm Capacity, gpm	Estimated Conceptual Capital Cost, dollars
Merced Street	D-1	Fowler	2015	Capacity Upgrade	1,200	605,000
Manning	D-2	Fowler	2015	Capacity Upgrade	2,200	803,000
North Street	D-3	Selma	2015	Capacity Upgrade	5,000	1,324,000
Clarkson & Mc Call	S-11	Selma	2015	Capacity Upgrade	3,000	957,000
South Avenue	F-5	Fowler	2035	Capacity Upgrade	1,250	615,000
Rose Street	S-3	Selma	2035	Capacity Upgrade	1,250	615,000
Proposed East Kamm Avenue	N/A	Selma	2035	New Construction	8,400	5,794,000
Proposed East Floral Avenue	N/A	Selma	2035	New Construction	650	1,499,000

Table ES-7. Proposed Lift Station Capacity CIP with Estimated Capital Costs						
Lift Station Name	Lift Station ID	Location	Development Timeline	Action	Required Design Firm Capacity, gpm	Estimated Conceptual Capital Cost, dollars
Proposed East Saginaw Avenue	N/A	Selma	2035	New Construction	5,100	4,119,000
Proposed East South Avenue	N/A	Fowler	2035	New Construction	580	1,454,000
Total						17,785,000

As described in Chapter 6, the three District lift stations Merced Street, Manning, and North Street are most critical and highest priority for upgrade. Additionally, the 18th Street Lift Station, which is also a District lift station, does not require a capacity upgrade but requires rehabilitation with a high priority. A conceptual capital cost of $609,500 is estimated for this rehabilitation. This cost has been developed by District staff and is currently budgeted.

The capacity increases for the Merced Street Lift Station, Manning Lift Station, and North Street Lift Station are being phased as part of the 2016 Master Plan Update. The required firm design capacities presented in Table ES-7 will sufficient capacity for existing design flows, and will be sufficient to the 2035 development time frame. Further capacity upgrades will be required at this time. The full capacity analysis for each lift station is provided in Appendix D.

ES.7.1.3 Proposed Force Main CIP

A single existing force main was determined to have insufficient capacity for future design flows. The North Street Lift Station will require a 12-inch diameter force main in the 2035 development timeframe. Because the capacity improvements to the North Street Lift Station are being phased as described above, the upgrade of this force main is not included as part of the proposed CIP for the 2016 Master Plan Update.

ES.7.2 Proposed Inspection and Refurbishment/Replacement Budgets

In addition to the proposed CIP for the capacity improvements described above, the District's collection system will require regular investment in refurbishment/replacement (R/R) to maintain the working order of the collection system. In order to prioritize R/R projects for gravity mains, the condition of each main must be assessed in a systematic manner so that needed repairs can be located and planned for.

ES.7.2.1 CCTV Inspection Program

It is recommended that the District implement an ongoing Closed Circuit Television (CCTV) Inspection Program in order to collect baseline information about the condition of the existing gravity mains for the development of a long-term gravity sewer R/R program. The inspection plan can be phased over the next seven years (at a maximum) and should use the standardized National

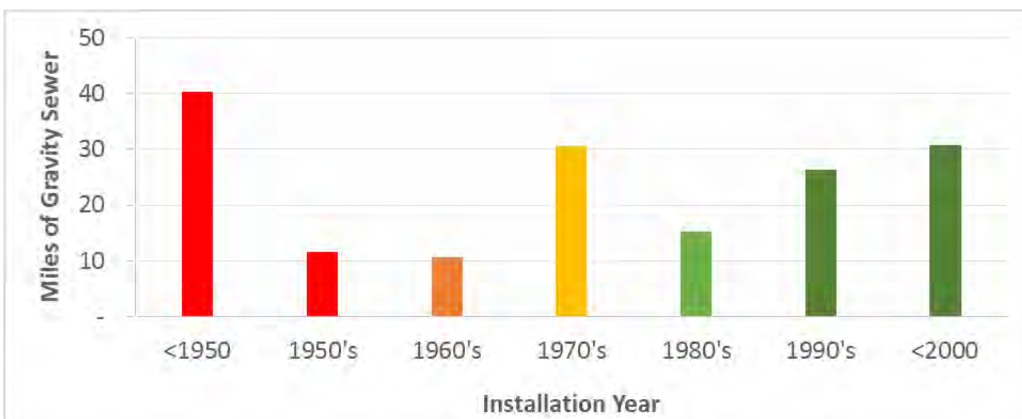
Association of Sewer Service Companies (NASSCO) Pipe Assessment Certification Program (PACP) defect coding system so that the condition of one pipe can be compared directly with another.

The risk assessment results in Chapter 6 should be used to prioritize gravity sewers for CCTV inspection so that higher risk pipes are inspected in the first few phases of the program. This inspection program will require that approximately 23.6 miles of gravity main be inspected each year over the seven-year program. At $2.00 per linear foot, the annual budgetary cost for this recommended CCTV inspection program is approximately $250,000 per year.

ES.7.2.2 Refurbishment/Replacement Program

When developing an adequate gravity sewer R/R program without the benefit of CCTV data, it's important to look at the remaining useful lives of the assets in the system. In fairly newer communities, R/R funds can remain significantly lower than in communities where significant portions of the infrastructure are past its useful life and requires replacement. In order to approximate the remaining useful life of the District's gravity sewers, county housing construction dates were used to estimate the installation year of many of the District's assets in Chapter 6. Figure ES-6 shows the number of miles of pipe estimated to be installed in past decades. As a result of this analysis, it was found that as much as 24 percent of the gravity sewers in the District service area may be nearing or past the end of their useful lives (assuming a standard useful life of 70 years for VCP pipe). Given this potentially significant amount of replacement project backlog, it is recommended that the District consider developing a proactive program for funding the replacement of these sewers.

Figure ES-6. Approximate Gravity Sewer Installation Dates



One useful, albeit ideal, rule-of-thumb is to consider the cost of replacing 1/70 of the system each year to keep up with the average rate of assets passing the end of their useful life each year. Assuming an average of $15 per inch-diameter per linear foot of pipe for the District's service area, the replacement costs of the gravity sewers owned by each agency are shown in Table ES-8. As shown, the total replacement value of the gravity sewer system is approximately $147M, and a 70-year replacement plan would invest $2.1M per year to replace sewers that are past their useful lives.

Table ES-8. Gravity Sewer Replacement Values

Owner	Replacement Cost, dollars	70-yr Replacement Plan, dollars	FY 2015-16 R/R Fund, dollars
District	26,051,445	372,164	—
Fowler	25,506,660	364,381	128,474
Kingsburg	41,971,290	599,590	214,568
Selma	53,832,579	769,037	282,784
Grand Total	$147,361,974	$2,105,171	$625,826

Currently, the District operates four separate R/R funds: one for District-owned facilities, and one for each of the three member cities. The member cities R/R funds are replenished at the rate of $34 per ESFR for gravity sewer and lift station improvements. As shown in Table ES-8, the fiscal year 2015-16 R/R funds for each member city are currently funded at the rate of approximately 36 percent of the ideal 70-year replacement plan. At this current funding rate, it would take approximately 195 years to replace the gravity sewer system.

Once additional CCTV data is collected, the District will be able to make more specific asset management decisions (such as employing rehabilitation methods such as spot repairs or CIPP lining, as discussed above) to help extend the useful life of the system and maximize R/R funds. For now, it is recommended that the District consider increasing R/R funding to 50 percent of the ideal 70-year replacement plan, which would result in an increase from $34 to $47 per ESFR for each city. This recommendation assumes that lift station improvements will be funded by the capital improvement budget, instead of the R/R budget.

Additionally, the District should budget for the replacement or major rehabilitation of approximately 25 laterals per year, as laterals are the cause of a significant number of emergency maintenance call-outs. The cost of such a program would be approximately $190,000 per year.

CHAPTER 1
Background

Chapter 1 presents the background and a brief summary of the 2016 Collection System Master Plan Update (2016 Master Plan Update) study.

1.1 BACKGROUND

The Selma Kingsburg Fowler County Sanitation District (District) is located in Fresno County (County), in the central section of the San Joaquin Valley, south of the City of Fresno. The District serves the member cities of Selma, Kingsburg, and Fowler as a local government agency that provides sewer service. The District collects, treats, and disposes of wastewater originating from the residential, commercial, institutional, and industrial dischargers within the District service area. The majority of the collection system is owned by the individual member cities, but is maintained and operated by the District. The larger shared interceptors and some of the lift stations within the collection system are owned and maintained by the District.

1.2 PREVIOUS COLLECTION SYSTEM MASTER PLAN

The District finalized the 2006 Sewer System Master Plan (2006 Master Plan) in September of 2006. This document was prepared by Carollo Engineers. The 2006 Master Plan incorporated a flow monitoring study and the development of a collection system hydraulic model with growth projections from the three member cities to provide a Capital Improvement Plan (CIP) for the District. Because the development projections for the three member cities have changed greatly since 2006, the 2016 Master Plan Update updates the development and flow projects to provide an updated CIP. Furthermore, the 2016 Master Plan Update integrates an operational and condition risk assessment into the prioritization of the CIP.

1.3 PROJECT AUTHORIZATION

The District and West Yost Associates (West Yost) entered into a professional services agreement on June 9, 2015, for the completion of the 2016 Master Plan Update. This agreement included the following primary tasks:

- Review of Existing System Data
- Development of Updated Planning and Flow Projections
- Evaluation of Existing and Future Capacity Using Hydraulic Model
- Analysis of Operational Parameters
- Development and Prioritization of CIP
- Preparation of Master Plan
- Development of Advanced Master Planning Tools

1.4 REPORT ORGANIZATION

The 2016 Master Plan Update contains seven chapters followed by supporting appendices. The chapters are briefly described below:

Chapter 1 – Background. This chapter presents the background and a brief summary of the 2016 Master Plan Update study.

Chapter 2 – Study Area Description. This chapter presents a description of the study area for the 2016 Master Plan, defines the land use classifications for each city within the study area, and summarizes the historical population trends within the study area. Further, this chapter presents an overview of the District's existing wastewater collection system within the study area.

Chapter 3 – Design and Performance Criteria. This chapter summarizes the design flow factors and design storm that are combined to develop design flows used in the capacity evaluation. In addition, this chapter summarizes the performance criteria by which the collection system performance is evaluated.

Chapter 4 – Existing and Future Design Flows. This chapter summarizes flow projection methodology, wastewater flow components, and wastewater flow data for the 2016 Master Plan Update.

Chapter 5 – Hydraulic Model Update and Capacity Evaluation. This chapter contains a summary overview of the model software, the modeled system network, future design flow allocation, and hydraulic capacity evaluation using the design flows described in Chapter 4.

Chapter 6 – Operational Analysis. This chapter summarizes the evaluation of the condition and day-to-day operation of the District's collection system. Maintaining the condition of the collection system and providing effective operation of the collection system are equally important to providing adequate hydraulic capacity in meeting the needs of the member cities and their customers.

Chapter 7 – Prioritized Capital Improvement Program. This chapter provides an overview of the recommended CIP for the gravity main, lift stations, and force mains that have been identified for improvement in Chapter 5 and Chapter 6. This CIP has been prioritized based on the development timeline and risk assessment performed, and includes conceptual costs for the recommended projects.

1.5 ACKNOWLEDGEMENTS

The 2016 Master Plan Update was a collaborative project involving the member cities, the District, and West Yost. West Yost acknowledges the following individuals for their collaboration and hard work throughout the course of the project:

- Ben Muñoz, Jr, District General Manager
- Veronica Cazares, District Engineer
- Frank Hernandez, District Engineering Technician
- Raymond Kinser, California CAD Solutions
- Ken Grey, City of Selma
- Dan Bond, City of Selma
- Bryant Hemby, City of Selma
- Alex Henderson, City of Kingsburg
- Holly Owen, City of Kingsburg
- David Peters, City of Kingsburg/City of Fowler
- David Elias, City of Fowler
- David Weisser, City of Fowler
- Bruce O'Neal, City of Fowler

1.6 ABBREVIATIONS AND DEFINITIONS

To conserve space and to improve the readability of the 2016 Master Plan Update, the following abbreviations are used throughout this document.

AACE	Advancement of Cost Engineering
ADWF	Average Dry Weather Flow
BWF	Base Wastewater Flow
CCI	Construction Cost Index
cfs	Cubic Feet Per Second
CIP	Capital Improvement Plan
CIPP	Cured in Place Pipe
CCTV	Closed-Circuit Television
CMMS	Computerized Maintenance Management System
Construction Standards	Collection System Construction Standards
County	Fresno County
d/D	Depth to Pipe Diameter Ratio

District	Selma Kingsburg Fowler County Sanitation District
ENR	Engineering News Record
ESFR	Equivalent Single Family Residential
fps	Feet Per Second
GIS	Geographic Information Systems
gpda	Gallons Per Day Per Acre
gpd/ESFR	Gallons Per Day Per Equivalent Single Family Residential
Golden State Interceptor	Golden State Boulevard
GWI	Groundwater Infiltration
H2O Map Sewer	H2O Map Sewer Pro Software
HDPE	High-Density Polyethylene
Inventive Resources	Inventive Resources, Inc.
MOE	Manhole Odor Eliminator
2006 Master Plan	2006 Sewer System Master Plan
2016 Master Plan Update	2016 Collection System Master Plan Update
NASSCO	National Association of Sewer Service Companies
PACP	Pipe Assessment Certification Program
PDWF	Peak Dry Weather Flow
PWWF	Peak Wet Weather Flows
RDII	Rainfall Dependent Inflow and Infiltration
R/R	Refurbishment/Replacement
SOIs	Spheres of Influence
SOP	Standard Operating Procedure
SSO	Sanitary Sewer Overflow
West Yost	West Yost Associates
WWTP	Wastewater Treatment Plant

This chapter presents a description of the study area for the 2016 Master Plan Update, defines the land use classifications for each city within the study area, and summarizes the historical population trends within the study area. Further, this chapter presents an overview of the District's existing wastewater collection system within the study area.

2.1 STUDY AREA

The District currently serves approximately 8,650 acres (13.5 square miles). The current service boundary includes the area inside each city's City Limits (a total of 7,120 acres), as well as small areas of the County to the southeast of Fowler, to the south of Selma along McCall Avenue, and to the east of Kingsburg (a total of 1,530 acres). The 2016 Master Plan Study Area encompasses the existing Spheres of Influence (SOIs) for Selma, Kingsburg, and Fowler in addition to limited areas that are outside of and adjacent to these SOIs. The 2016 Master Plan Study Area comprises 30,100 acres (47.0 square miles), of which 22,340 acres are inside of the SOIs and 7,040 acres are outside of the existing SOIs. The 2016 Master Plan Study Area is approximately 50 percent of the area of the 2006 Master Plan Study Area. The 2016 Master Plan Study Area was focused to the area of the City's SOIs, and to limited areas specifically identified by the cities as potential growth areas, in order to focus on planning infrastructure that is likely needed by the 2035 planning horizon, and to avoid planning infrastructure for growth that is expected to remain outside of member city jurisdiction. Figure 2-1 shows the study area boundary, each city's limits, and the portions of the County serviced by the District.

2.1.1 City of Selma

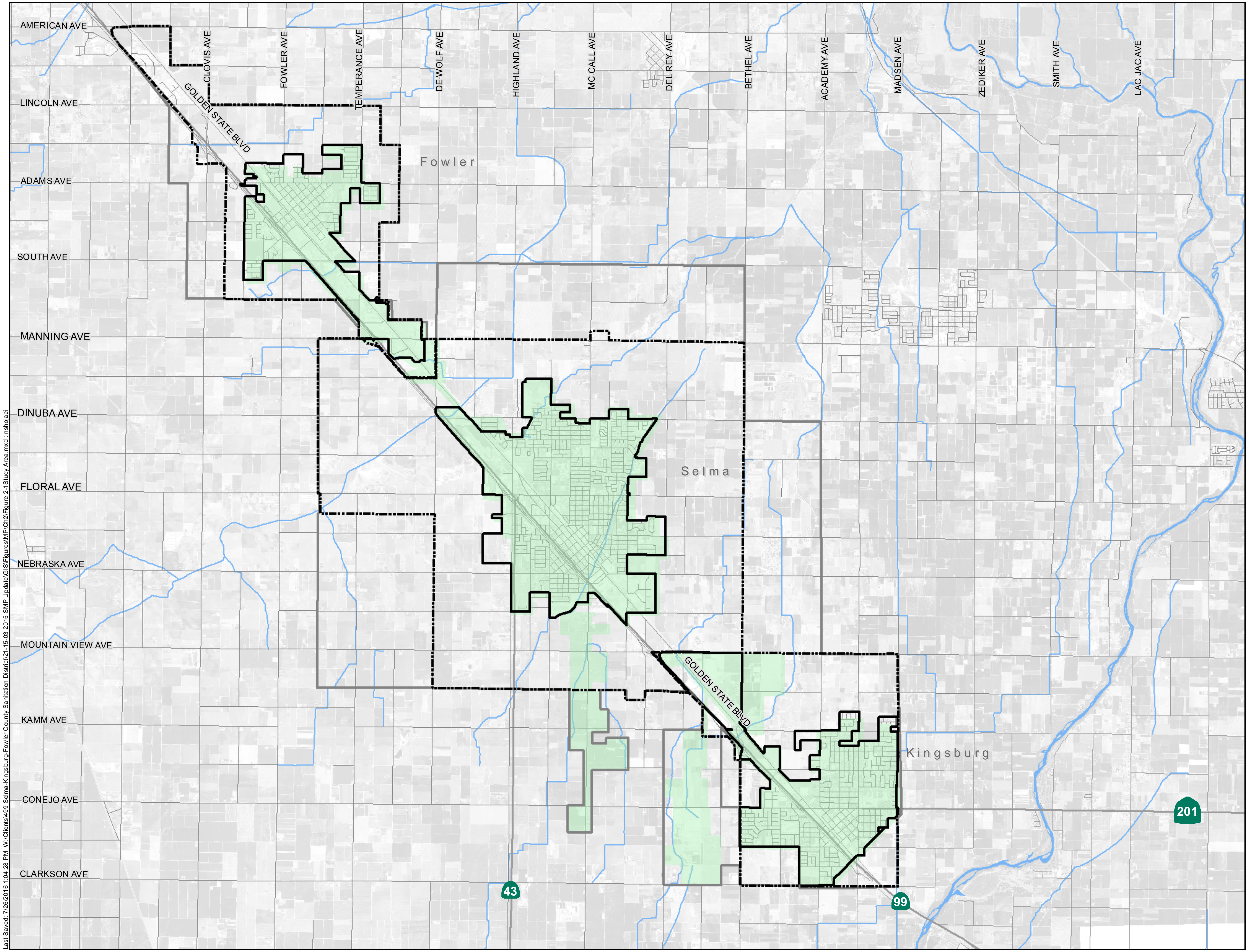
Selma is located in the southern portion of the County and is the fourth largest city in this county. Selma is an agricultural based community and supports food processing facilities, agricultural equipment sales outlets and related agricultural services. Recently, Selma has broadened its economic base beyond agriculture, including the Team Selma initiative which is a public and private partnership to support business development within Selma. Selma is currently experiencing a considerable increase in housing and other economic development.

2.1.2 City of Kingsburg

Kingsburg is located at the southern border of the County immediately north of the Kings River where it crosses Highway 99. Similar to Selma, Kingsburg is also an agricultural based community and supports similar industries. Kingsburg has well-established growth management policies in place, which, since 1988, have limited annual growth in housing units. The target population growth rate is 3 percent per year.

2.1.3 City of Fowler

Fowler is the smallest of the three member cities when measured by population. It is also the northern most city in the sewer service area and is located approximately 10 miles from Fresno. Fowler supports industries that discharge large volumes into the sewer system. Fowler also adopted a growth management policy in 2004. The policy states that the desirable annual population and housing growth rate should not exceed the average of the planned growth rate through 2025 of 3 percent over any five-year period (50-60 units), and should not exceed 6 percent in any single year (80-90 units).



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Symbology
- City Limits
- City Sphere of Influence
- 2016 Master Plan Study Area
- Existing District Service Area

WEST YOST ASSOCIATES

Figure 2-1

Study Area

Selma-Kingsburg-Fowler CSD
Wastewater Collection System
2016 Master Plan Update

2.2 CLIMATE

The District's service area climate is considered Mediterranean. The summers are hot and dry, and the winters are cold. Rainfall generally consists of less than 10 inches annually, with 80 percent of the annual rainfall occurring between October and March. In the winter months, fog conditions often persist for several days, but the season is generally short.

2.3 LAND USE

Each of the member cities maintains an adopted general plan that guides development within their respective City Limits and SOI. The general plans provide land use and population projections for each city and the study area. Land use and population information are an integral component in determining the amount of wastewater generated for any collection system. The type of land use in an area will affect the volume and character of the wastewater generated. Adequately estimating the generation of wastewater from various land use types is important in sizing and maintaining sewer system facilities.

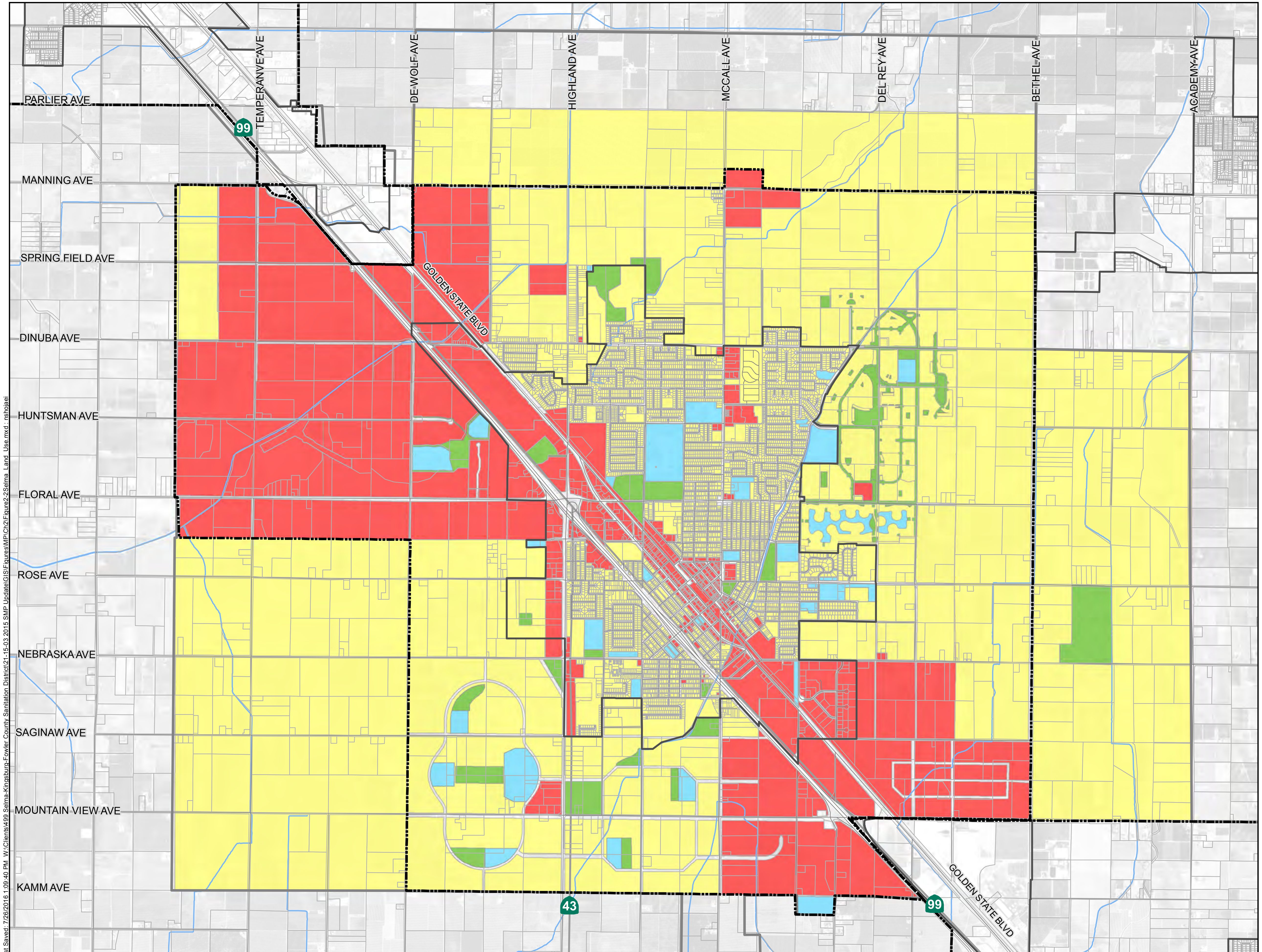
Each member city's adopted land use map shows the limits of the SOI and the general plan boundary. Land use assumptions used in this study are consistent with each city's general plan. Since the land use assumptions forecast the type of growth within each city's SOI, this association to the 2016 Master Plan should ensure that the wastewater projections and facilities required to serve future growth are consistent with each member city's guiding document on development. Figure 2-2 through Figure 2-4 illustrate the different land uses found in the general plans for each city. In order to standardize the land use designations among the three cities, a common designation (e.g. commercial) was used to group similar uses within this category (e.g. regional, highway, service neighborhood). This approach allowed for one common designation to be applied to all three cities. Appendix A provides a description of the different land uses for each city. The descriptions are excerpts from each city's general plan.

2.3.1 Sewer Service Area by Land Use

The following sections summarize the 2016 Master Plan Study Area by land use.

2.3.1.1 Existing District Service Area Land Use

In addition to the three cities, the District also provides wastewater collection and treatment service to certain unincorporated areas with sewer service agreements. Table 2-1 provides the acreage totals for the District's current service area for each city and the unincorporated areas. The District currently provides sewer service to approximately 8,646 acres (includes developed and undeveloped land) or 13.5 square miles.



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Symbology

- City Limits
- City SOIs
- 2016 Master Plan Study Area

Land Use Category

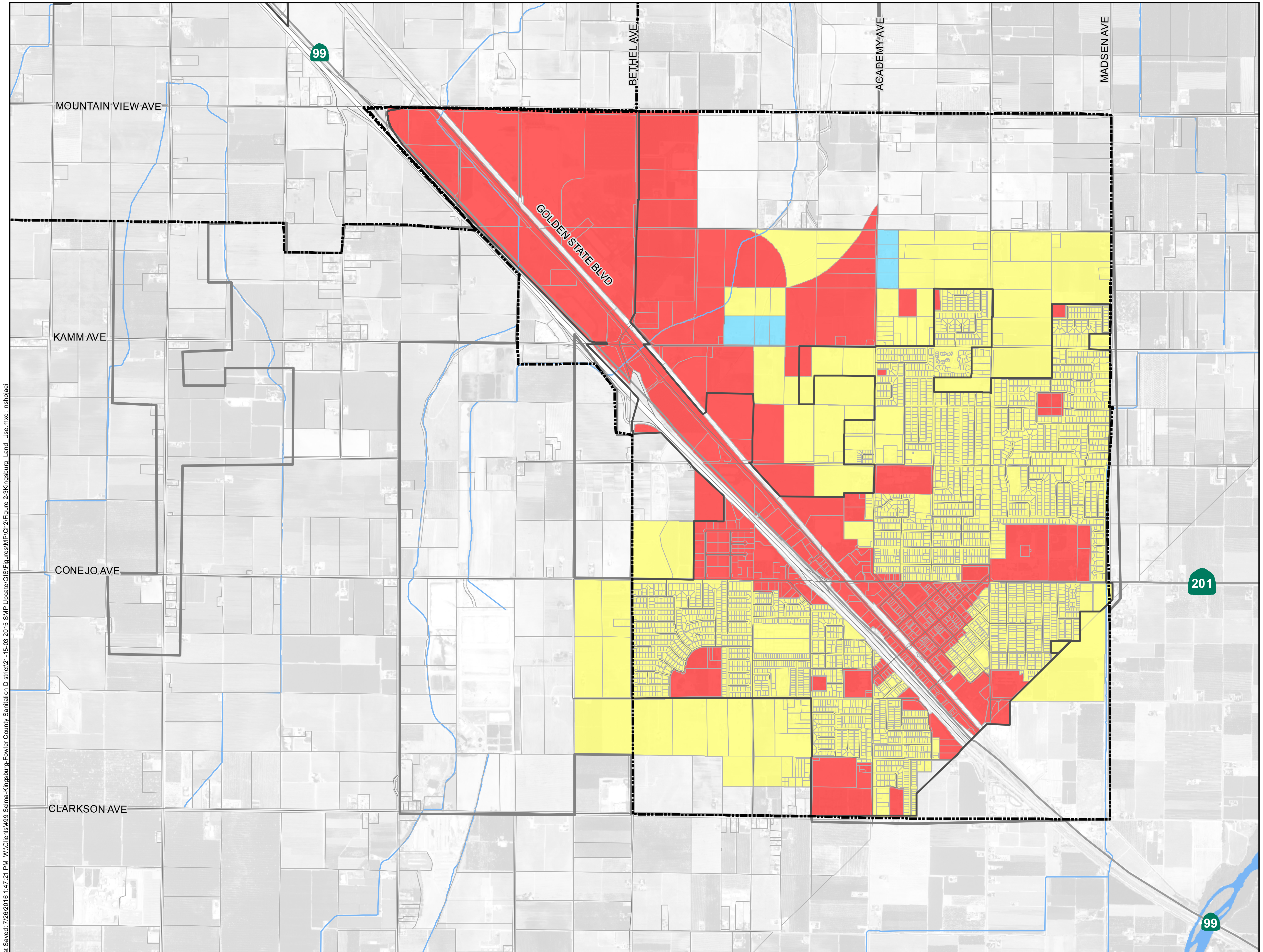
- Residential
- Commercial and Industrial
- Institutional/Other
- Non-Wastewater Generating

WEST YOST ASSOCIATES

Figure 2-2

General Plan Land Use
City of Selma

Selma-Kingsburg-Fowler CSD
Wastewater Collection System
2016 Master Plan Update



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Symbology

- City Limits
- City SOIs
- 2016 Master Plan Study Area

Land Use Category

- Residential
- Commercial and Industrial
- Institutional/Other

Figure 2-3

General Plan Land Use
City of Kingsburg

Selma-Kingsburg-Fowler CSD
Wastewater Collection System
2016 Master Plan Update

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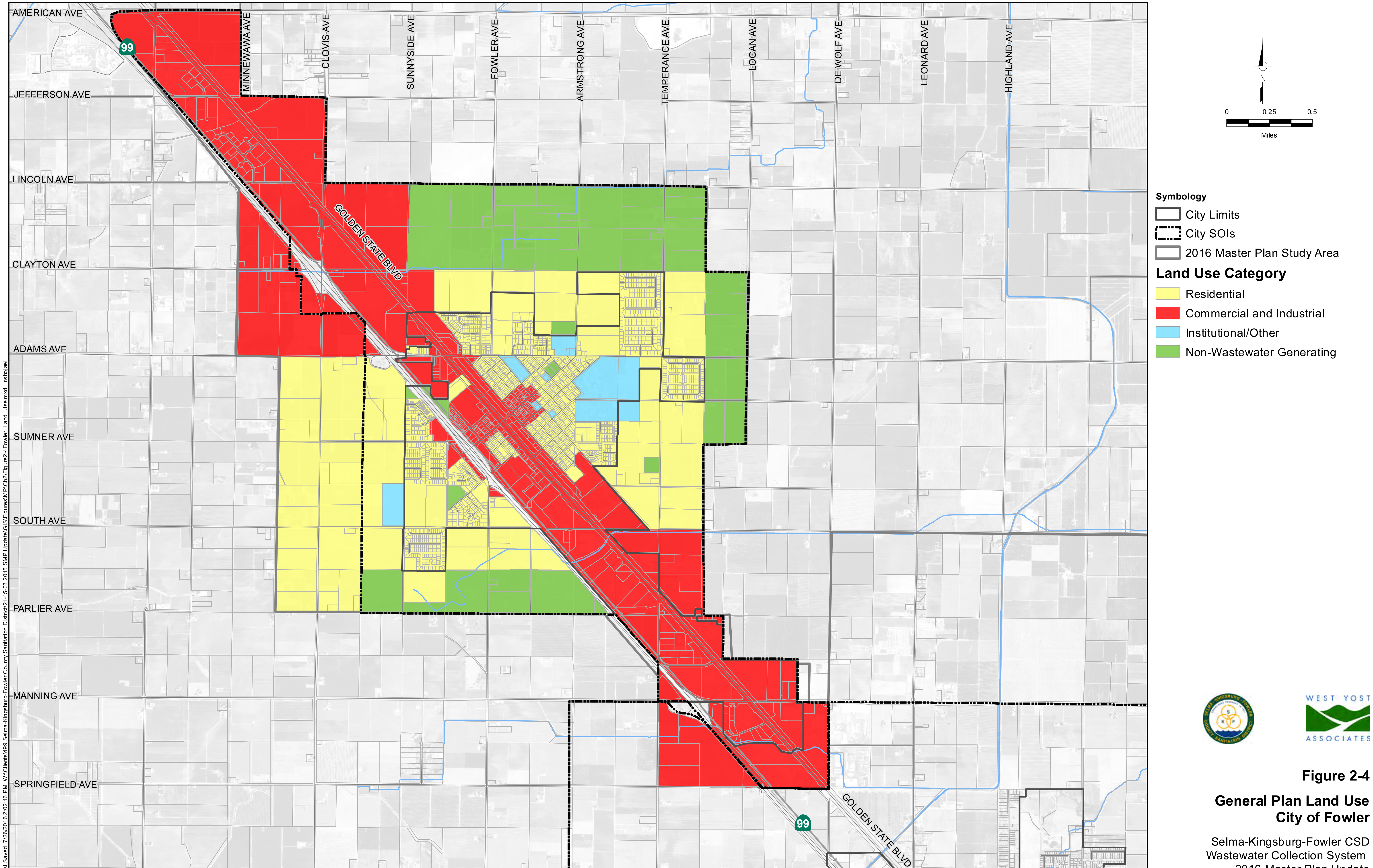

Figure 2-4

General Plan Land Use
City of Fowler

Selma-Kingsburg-Fowler CSD
Wastewater Collection System
2016 Master Plan Update

Table 2-1. Existing District Service Area General Land Use Classification					
General Land Use Classification	Selma, acres	Kingsburg, acres	Fowler, acres	Unincorporated County, acres	Total, acres
Residential	1,613	763	527	183	3,521
Commercial and Industrial	743	715	758	356	2,572
Institutional/Other	142	82	65	474	763
Non-Wastewater Generating	785	675	253	512	1,790
Total	3,283	2,235	1,603	1,525	8,646

The largest land use classification is residential, which accounts for approximately 3,521 acres, or approximately 41 percent of the total acreage. Commercial and industrial areas make up approximately 2,572 acres, or 30 percent of the total. Institutional facilities such as schools, government buildings, and hospitals make up approximately 763 acres, or 9 percent. Non-wastewater generating land uses like parks, streets, agricultural, and railroad land uses account for 1,790 acres, or 21 percent of the total existing District service area. The unincorporated County areas currently served by the District total 1,525 acres, which is 18 percent of the District's existing service area.

2.3.1.2 Future Service Area Land Use

At buildout of the 2016 Master Plan Study Area, the District will serve approximately 30,100 acres (47.0 square miles). Buildout is defined as complete development of all lands to the general plan density. The breakdown of the different land use categories for the 2016 Master Plan Study Area at buildout is provided in Table 2-2.

Table 2-2. 2016 Master Plan Study Area General Land Use Classification					
General Land Use Classification	Selma, acres	Kingsburg, acres	Fowler, acres	Unincorporated County, acres	Total, acres
Residential	14,046	1,759	1,448	—	17,253
Commercial and Industrial	4,822	1,448	2,166	—	8,436
Institutional/Other	280	82	65	—	427
Non-Wastewater Generating	930	1,409	1,216	435	3,990
Total	20,078	4,698	4,895	435	30,106

For the 2016 Master Plan Study Area, the largest land use classification remains residential. Residential land use has grown to 17,253 acres, which is approximately 57 percent of the total area of the 2016 Master Plan Study Area. Commercial and industrial areas comprise approximately 2,572 acres, or 28 percent of the total. Institutional facilities such as schools, government buildings, and hospitals make up approximately 427 acres, or 1 percent. The amount of institutional acreage is shown to decrease because future institutional facilities, especially schools, are included in residential land use projections and are not specified until development actually begins. Non-wastewater generating land uses like parks, streets, agricultural, and railroad land uses account for 3,990 acres, or 13 percent of the total 2016 Master Plan Study Area.

The 2016 Master Plan Study Area can also be characterized by the relationship of the land within the area to the existing political boundaries for the three member cities. As presented in Table 2-3, 7,121 acres representing 24 percent of the total area is within the existing City Limits of the three cities. Another 15,943 acres, or 53 percent of the total, is found outside the existing City Limits, but within the existing SOI boundaries of the three cities. Finally, 7,042 acres (23 percent) of the 2016 Master Plan Study Area is outside of the existing SOI boundaries.

Table 2-3. 2016 Master Plan Study Area General Locations

General Location	Selma, acres	Kingsburg, acres	Fowler, acres	Unincorporated County, acres	Total, acres
Inside Existing City Limits	3,283	2,235	1,603	—	7,121
Outside Existing City Limits but Inside Existing SOI	10,655	2,463	2,825	—	15,943
Outside Existing SOI	6,140	—	467	435	7,042
Total	20,078	4,698	4,895	435	30,106

2.4 HISTORICAL AND FUTURE POPULATION

In 1970, the District's service area population for the three member cities totaled 13,500. Since then, the population increased by approximately 29,300 to the current service area population (excluding residents living in unincorporated areas) of approximately 42,889. This increase reflects a yearly growth rate of 3.0 percent for the entire service area. Selma is the largest city at 22,411 residents; followed by Kingsburg with 11,237; and Fowler with 4,729.

Figure 2-5 summarizes the population for each city dating back to 1970. The compounded annual growth rates for Selma, Kingsburg, and Fowler over the last 45 years averaged 2.7, 2.5, and 2.2 percent, respectively. These values are lower than the growth rates reported for the 2006 Master Plan because the economic downturn significantly reduced population growth between 2006 and 2016. If Selma grows at its pre- economic downturn rate of 3.2 percent annually, and Kingsburg and Fowler grow at the allowed rate of 3.0 percent annually, the population of the three cities will be approximately 77,000 by the end of the study period in 2035. Projected population as described herein is shown on Figure 2-5.

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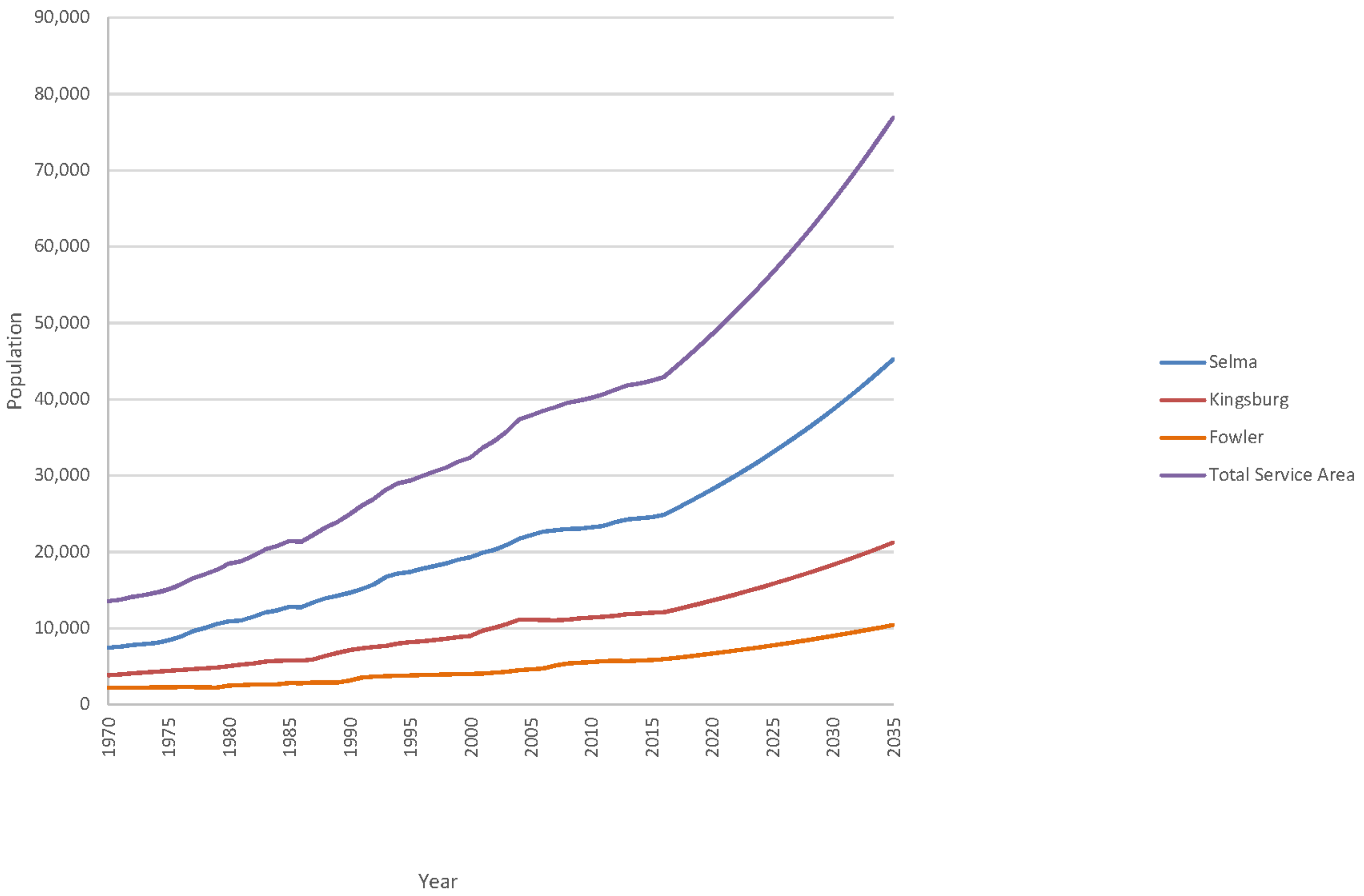


Figure 2-5

Historical and Projected Population in Selma, Kingsburg, and Fowler

Selma-Kingsburgh-Fowler CSD
Wastewater Collection System
2016 Master Plan Update

2.5 EXISTING COLLECTION SYSTEM

The District's infrastructure includes the wastewater treatment plant (WWTP) and the wastewater collection system. The wastewater collection system consists of approximately 165 miles of pipeline and 22 lift stations. The existing collection system is discussed in greater detail below, broken down by member city.

2.5.1 City of Selma

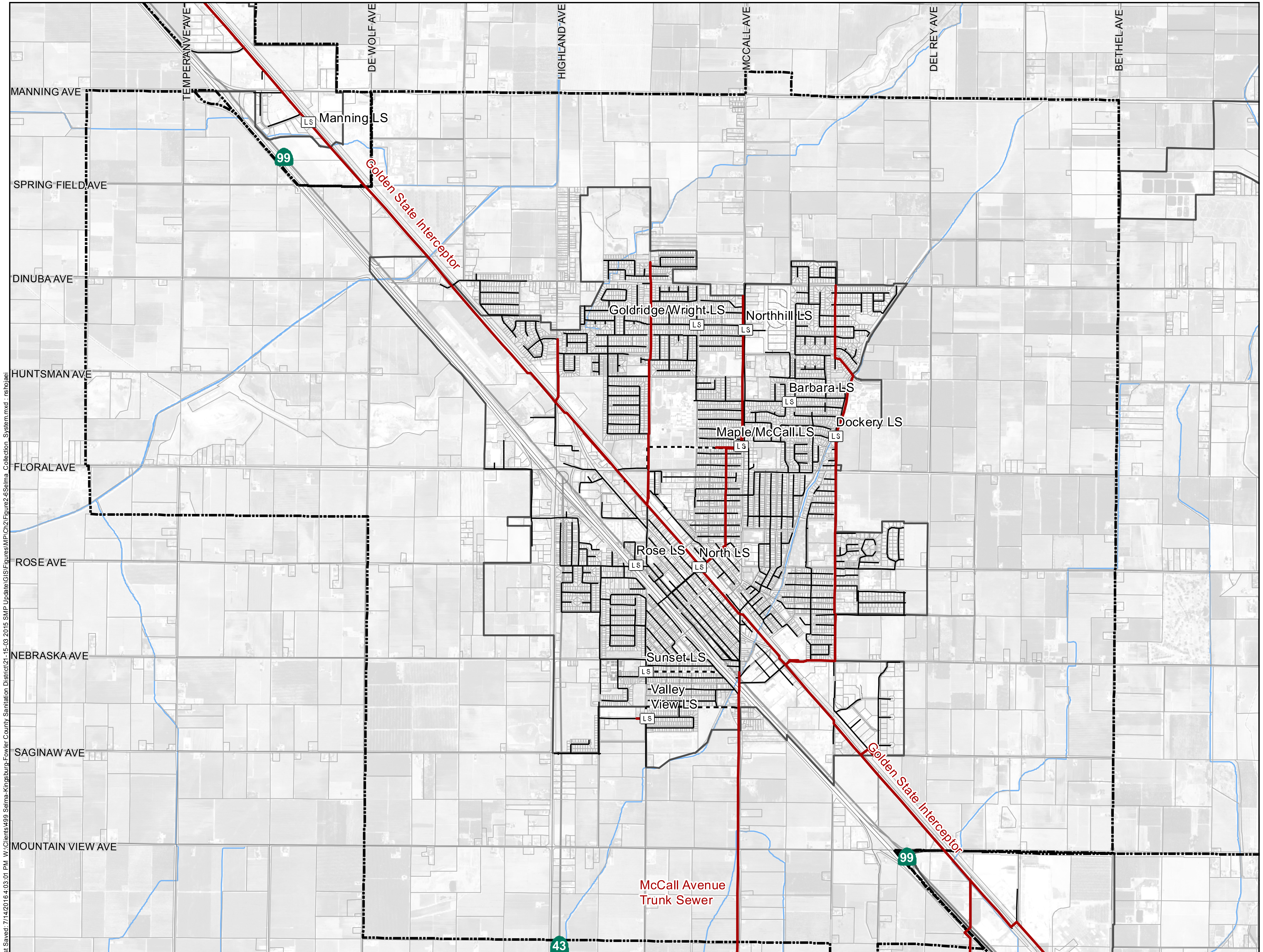
The City of Selma is located in the center of the District's service area. Wastewater enters Selma from Fowler in the northwest through the interceptor gravity main in Golden State Boulevard (Golden State Interceptor). The Golden State Interceptor enters Selma as a 30-inch diameter gravity main and exits Selma as a 42-inch diameter gravity main to the southeast. In general, wastewater flow generated in Selma to the northeast of the Golden State Interceptor is carried to the Golden State Interceptor to be conveyed out of Selma. Wastewater flow generated to the southwest of the Golden State Interceptor is conveyed to the 24-inch diameter trunk gravity main (currently being lined to an effective diameter of 21 inches) in McCall Avenue. An overview of the existing wastewater collection system within Selma is provided on Figure 2-6.

The gravity mains within Selma are summarized by diameter in Table 2-4. As shown in the table, approximately 66 percent of these gravity mains are 8-inch diameter or smaller. The capacity analysis of the collection system, which is described later in the 2016 Master Plan Update, generally includes those gravity mains that are 10 inches in diameter or larger.

Table 2-4. Selma Existing Gravity Mains by Diameter[(a)]

Diameter, in	Length, ft	Length, miles	Percentage
4	141	0.03	0.04%
6	104,245	19.74	26.91%
8	157,349	29.80	40.61%
10	30,992	5.87	8.00%
12	47,395	8.98	12.23%
15	9,570	1.81	2.47%
18	2,387	0.45	0.62%
21	3,180	0.60	0.82%
24	19,119	3.62	4.93%
27	470	0.09	0.12%
Unknown	12,573	2.38	3.25%
Total	387,421	73.37	100.00%

[(a)]Does not include the Golden State Interceptor, which is a District Facility.



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Symbology

- LS Lift Station
- Major Trunk Sewer/Interceptor
- Gravity Main
- Force Main
- City Limits
- City SOIs

SELMA-KINGSBURG-FOWLER COUNTY SANITATION DISTRICT

WEST YOST ASSOCIATES

Figure 2-6

Existing Collection System
City of Selma

Selma-Kingsburg-Fowler CSD
Wastewater Collection System
2016 Master Plan Update

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2.5.2 City of Kingsburg

The City of Kingsburg is located in the southern part of the service area and is nearest to the WWTP. The majority of wastewater flow from Kingsburg is carried to 36-inch diameter trunk sewer in Conejo Avenue and conveyed to the WWTP. A few industries located in north Kingsburg convey their flows to the 42-inch diameter Golden State Interceptor in the northwest corner of Kingsburg. An overview of the existing wastewater collection system within Kingsburg is provided on Figure 2-7.

The gravity mains within Kingsburg are summarized by diameter in Table 2-5. As shown in the table, approximately 60 percent of these gravity mains are 8-inch diameter or smaller. The capacity analysis of the collection system, which is described later in the 2016 Master Plan Update, generally includes those gravity mains that are 10 inches in diameter or larger.

Table 2-5. Existing Collection System Gravity Mains, City of Kingsburg[(a)]

Diameter, in	Length, ft	Length, miles	Percentage
4	693	0.13	0.27%
6	50,095	9.49	19.35%
8	100,661	19.06	38.88%
10	26,092	4.94	10.08%
12	35,618	6.75	13.76%
14	220	0.04	0.08%
15	3,949	0.75	1.53%
18	9,394	1.78	3.63%
21	2,935	0.56	1.13%
24	5,438	1.03	2.10%
36	13,858	2.62	5.35%
Unknown	9,979	1.89	3.85%
Total	258,932	49.04	100.00%

[(a)]Does not include the Golden State Interceptor or the Conejo Avenue Interceptors, which are District Facilities.

2.5.3 City of Fowler

The city of Fowler is located in the northern-most, farthest upstream, portion of the District. All wastewater flows from Fowler are carried to the Golden State Interceptor, through which they are conveyed out of the city to the southeast to Selma. An overview of the existing wastewater collection system within Kingsburg is provided on Figure 2-8.

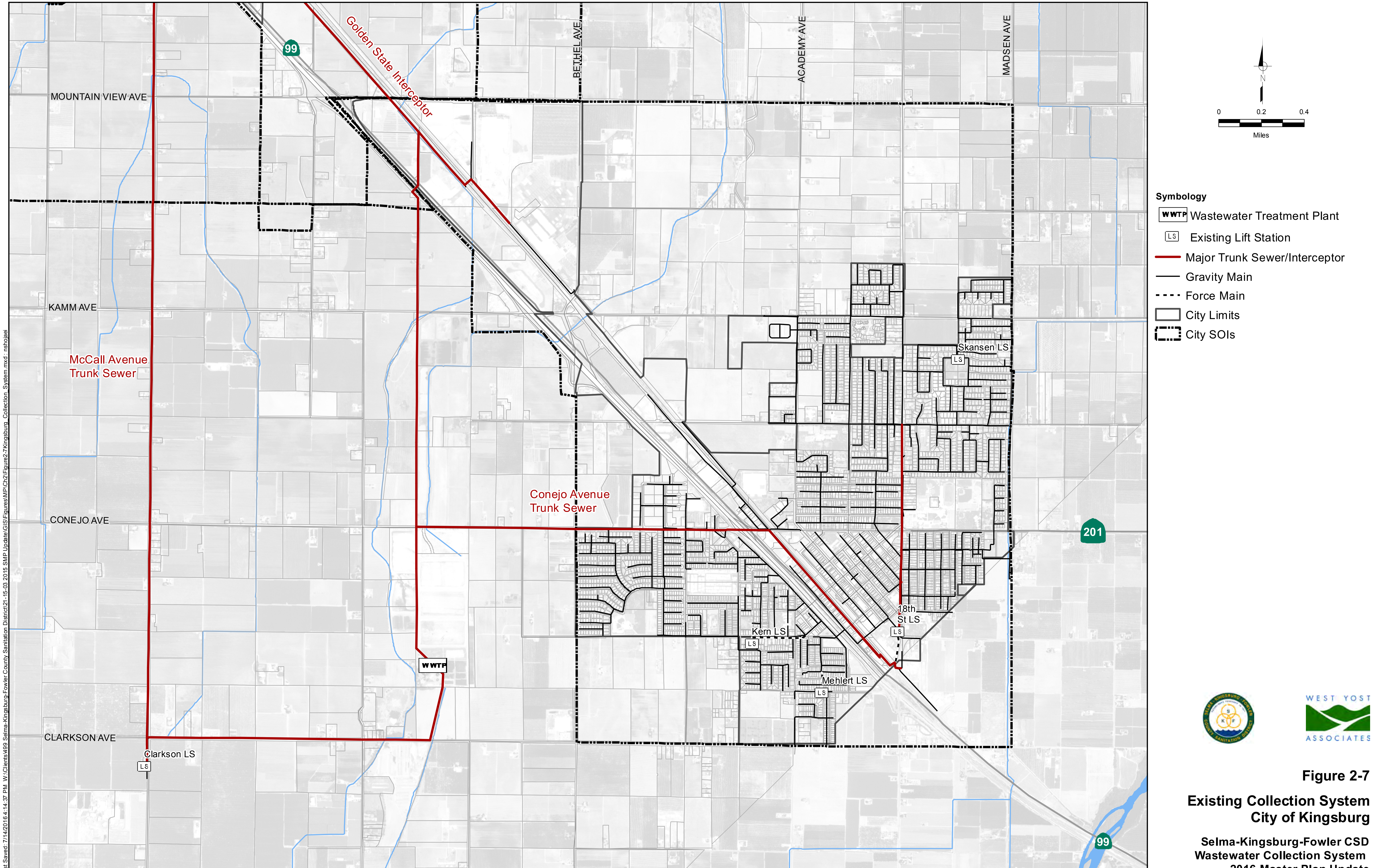


Figure 2-7

Existing Collection System
City of Kingsburg

Selma-Kingsburg-Fowler CSD
Wastewater Collection System
2016 Master Plan Update

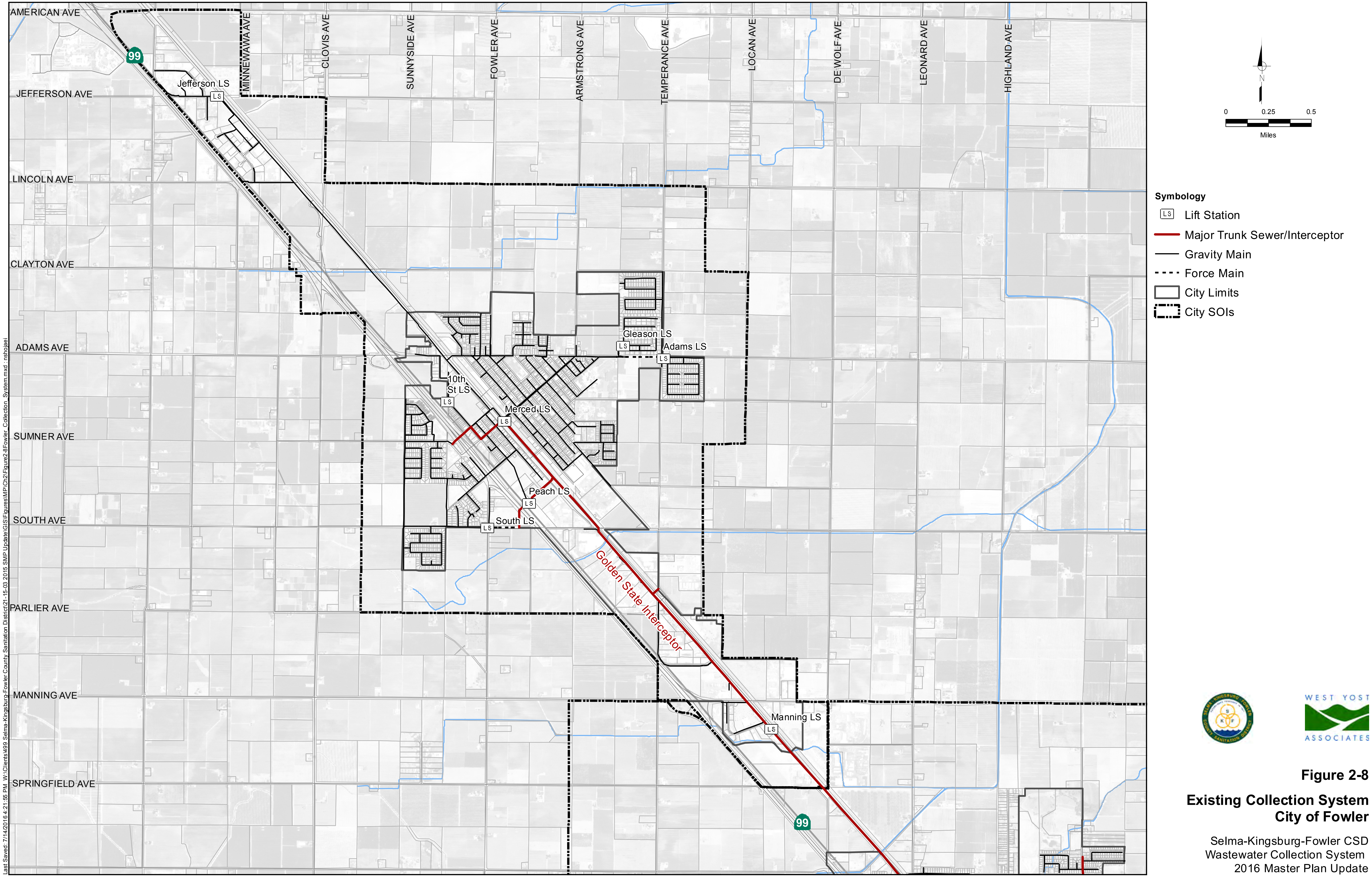


Figure 2-8

Existing Collection System
City of Fowler

Selma-Kingsburg-Fowler CSD
Wastewater Collection System
2016 Master Plan Update

The gravity mains within Fowler are summarized by diameter in Table 2-6. As shown in the table, approximately 60 percent of these gravity mains are 8-inch diameter or smaller. The capacity analysis of the collection system, which is described later in the 2016 Master Plan Update, generally includes those gravity mains that are 10 inches in diameter or larger.

Table 2-6. Existing Collection System Gravity Mains, City of Fowler

Diameter, in	Length, ft	Length, miles	Percentage
4	200	0.04	0.11%
6	34,888	6.61	19.87%
8	58,156	11.01	33.13%
10	20,340	3.85	11.59%
12	29,311	5.55	16.70%
15	4,400	0.83	2.51%
18	12,984	2.46	7.40%
24	12,973	2.46	7.39%
30	2,300	0.44	1.31%
Unknown	7	0.00	0.00%
Total	175,559	33.25	100.00%

Design and Performance Criteria

The 2016 Master Plan Update utilizes existing and future design flows to evaluate the capacity requirements of the District's collection system. Chapter 3 summarizes the design flow factors and design storm that are combined to develop design flows used in the capacity evaluation. In addition, this chapter summarizes the performance criteria by which the collection system performance is evaluated.

3.1 DESIGN FLOW

The design flow is the maximum hourly wastewater flow rate under a given growth condition. In the District's collection system design flow is composed of the Peak Dry Weather Flow (PDWF) generated by typical residential, commercial, institutional, and light industrial customers, the flow created by the Industrial Dischargers identified within the District, and Rainfall Dependent Inflow and Infiltration (RDII) that enters the collection system during a design storm wet weather event. The values for the design factors used in developing the design flows for the 2016 Master Plan Update are presented below, in the following sections:

- Peak Dry Weather Flow
- Maximum Industrial Discharge
- Design Storm RDII

3.1.1 Peak Dry Weather Flow

PDWF is typically calculated by determining the Average Dry Weather Flow (ADWF) and then peaking that value. ADWF consists of Base Wastewater Flow, which is the sanitary flow generated by typical residential, commercial, institutional, and light industrial users, combined with Groundwater Infiltration (GWI). Because of the low water table and generally dry soil conditions throughout the District, GWI is considered to negligible, and it is not calculated separately.

For the 2006 Master Plan, ADWF coefficients were calculated using flow monitoring and land use data. These coefficients provide wastewater flow values in terms of gallons per day per Equivalent Single Family Residential unit (gpd/ESFR) and gallons per day per acre (gpda). Review of District wastewater flow and demographic data, in conjunction with discussion with both District and stakeholder City staff, indicates that the unit flow coefficients have not changed. Therefore, for the 2016 Master Plan, the design flow coefficients used to calculate ADWF have not changed from the 2006 Master Plan. The design flow coefficient is 270 gpd/ESFR. The design flow coefficients based upon land use designation are shown in Table 3-1.

Table 3-1. Design Wastewater Flow Coefficients

Land Use Designation	Flow Coefficient, gpda
Residential Land Use	
Low Density	1,250
Medium Density	1,750
High Density	2,075
Residential Reserve	1,250
Commercial and Industrial	
Industrial	725
Industrial Discharge	1250
Commercial	850
Other	
School	950
Community Facility	725
Hospital	950

The 2016 Master Plan Update uses a typical method for calculating PDWF by applying a diurnal pattern to the ADWF for each collection system user. The diurnal pattern approximates the variation in wastewater discharge over a typical 24-hour period, and varies according to whether the user is primarily residential or non-residential. The design diurnal patterns are independent of location or flow monitoring basin within the collection system, and provide all new development and growth with consistent peak factors. The design residential diurnal curve can be seen on Figure 3-1. The design non-residential diurnal curve can be seen on Figure 3-2.

3.1.2 Maximum Industrial Discharge

Significant Industrial Dischargers are those collection system users whose industrial processes produce more wastewater than is predicted by sanitary flow design factors. Because the amount of wastewater flow discharged to the collection system depends upon the type and size of the industrial process involved, the wastewater flow from Significant Industrial Dischargers is difficult to project using standard flow coefficients, and flow projections from these users must usually be handled on an individual basis.

The well-developed industrial base within the three stakeholder cities results in a large number of Significant Industrial Dischargers in the District's collection system. A comprehensive list of these dischargers was developed. The list is based upon that developed for the 2006 Master Plan, with updates performed to make it current for the 2016 Master Plan. These updates were identified by District staff and by review of District budget documents. The updates include the removal of some Significant Industrial Dischargers who are no longer active, and the addition of some users who have become active since 2006. The maximum industrial discharge for each Significant Industrial Discharger was calculated by using the recorded average hourly flow for the maximum month (where available) or the baseline discharge entitlement, whichever was greater.

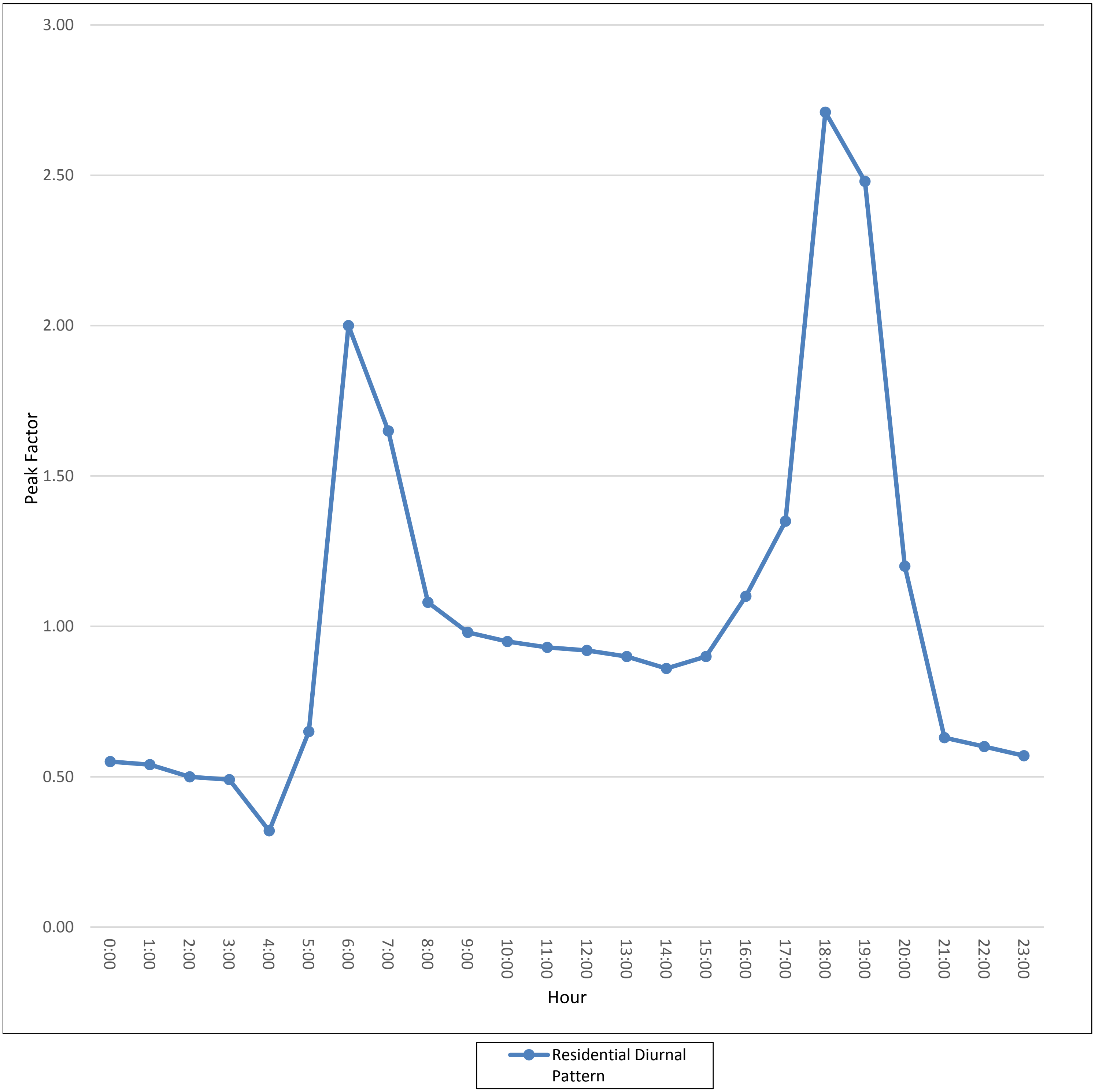


Figure 3-1

Residential
Design Diurnal Pattern

Selma-Kingsburg-Fowler
County Sanitation District
2016 Collection System Master Plan Update

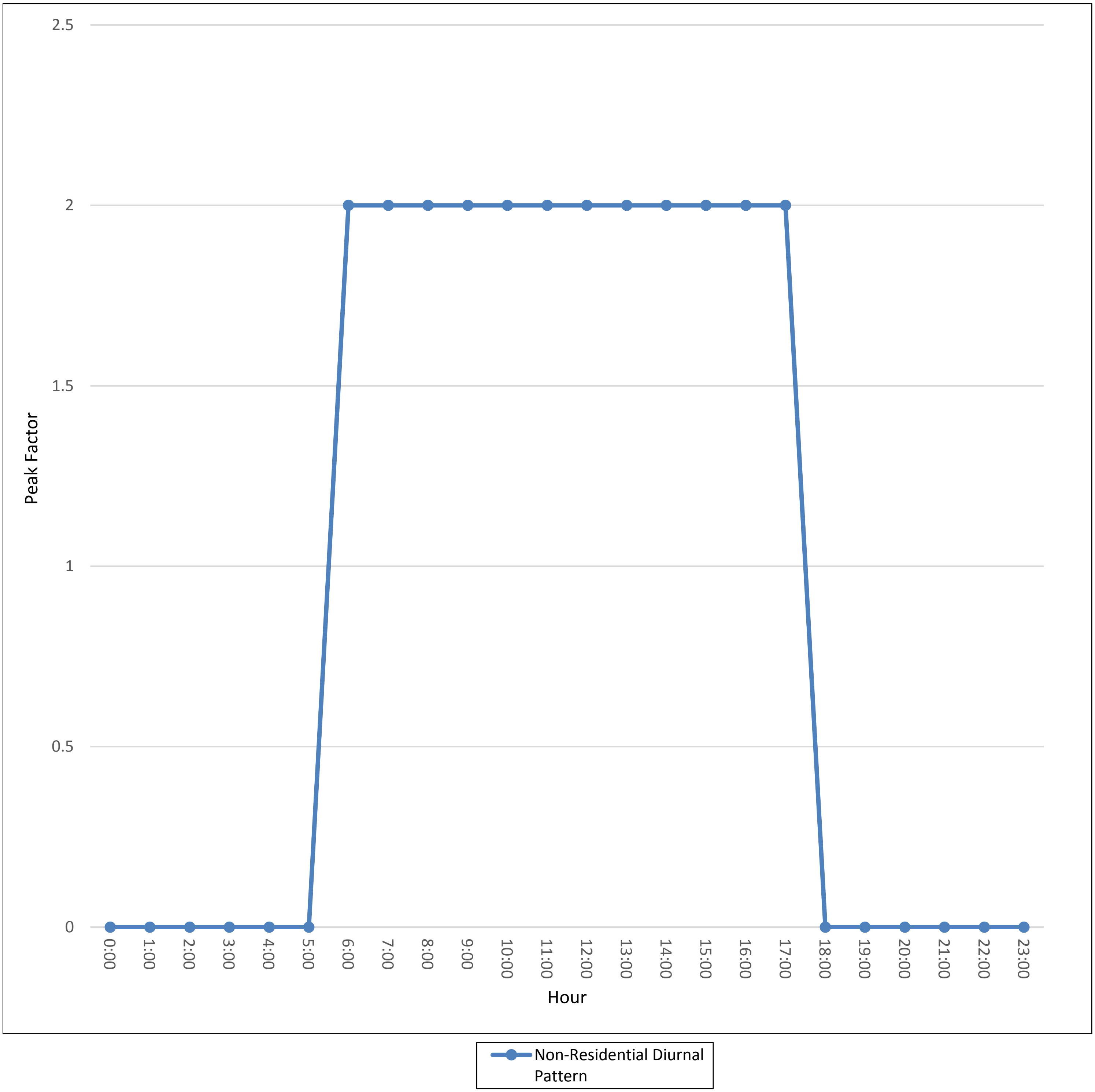


Figure 3-2

Non-Residential Design Diurnal Pattern

Selma-Kingsburg-Fowler County Sanitation District
2016 Collection System Master Plan Update

The collection system design flow includes the individual maximum industrial discharge for each Significant Industrial Discharger in the District. Such inclusion assumes a worst case scenario of each Significant Industrial Discharger generating flow at the maximum rate at the same time that the design storm described in the section below is occurring. This assumption is not unreasonable in maintaining a conservative assessment of the collection system capacity. The Significant Industrial Dischargers in the District and the maximum industrial discharge for each are presented in Table 3-2.

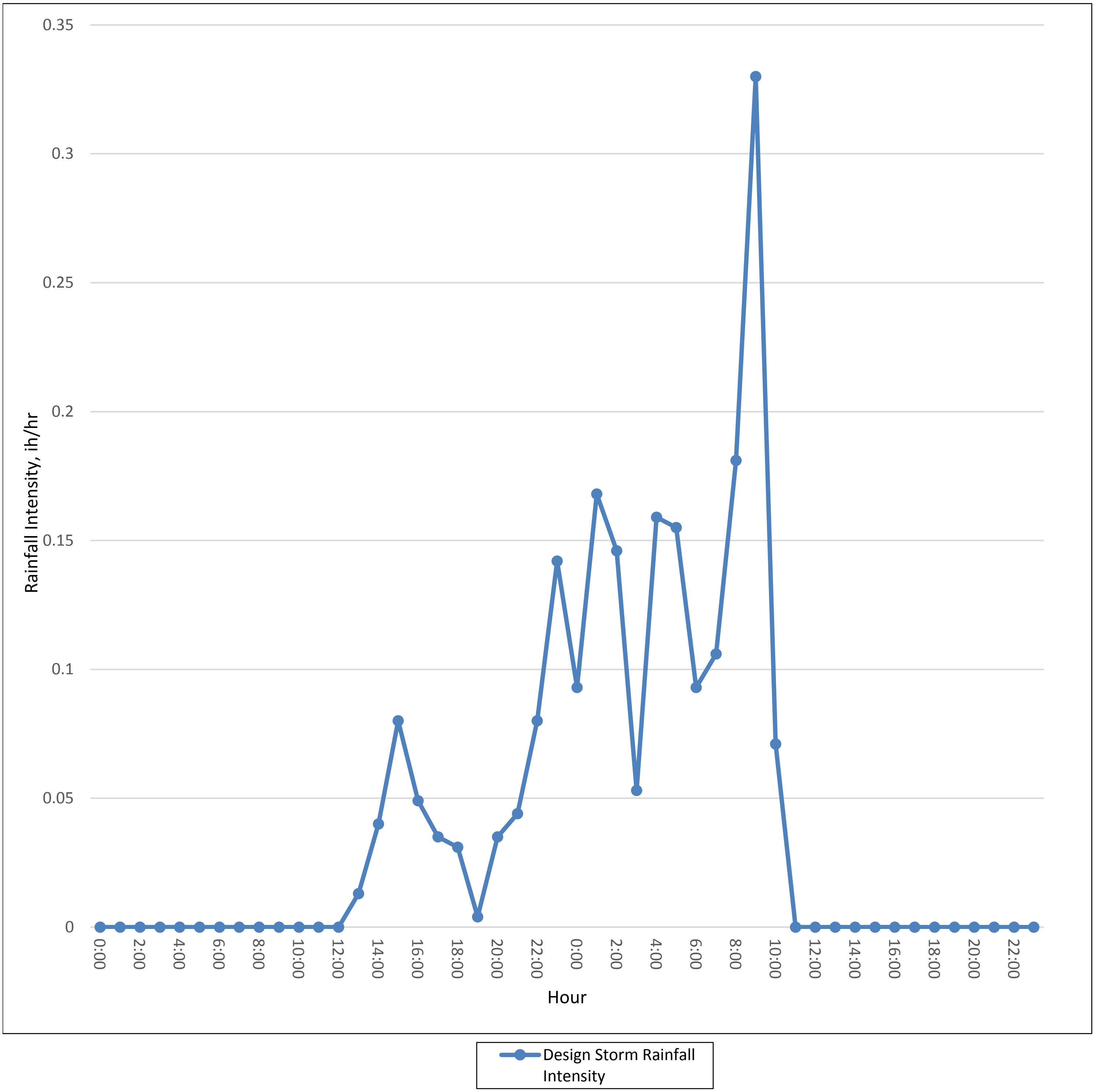
3.1.3 Design Storm RDII

The use of wet weather design events as the basis for sewer capacity evaluation is a well-accepted practice. The approach is to first calibrate a hydraulic model of the collection system to match wet weather flows from observed storm(s), and then apply the calibrated model to a design rainfall event to identify capacity deficiencies and size improvement projects. The design event may be synthesized from rainfall statistics, or may be an actual historical rainfall event of appropriate duration and intensity. Other considerations for the design event include the spatial variation of the rainfall and the timing of the storm relative to the diurnal base wastewater flow pattern.

Selection of a design storm is typically based on an allowable level of risk within the collection system, and the description of the design storm is most often expressed as the return period and duration of the storm. It is recognized that while wet weather overflows are highly undesirable, the cost of providing capacity increases as the return period of the design storm, and therefore the design flow, increases. Regulatory agencies have not adopted standard criteria for return periods, so wastewater agencies utilize a target return period based on a balance of desired level of service, potential impacts of overflows, and cost of providing capacity. The District developed a 10-year return period, 24-hour duration design storm for the 2006 Master Plan. This design storm was retained for the 2016 Master Plan Update. A 10-year, 24-hour design storm is common and within accepted practice for wastewater agencies within California.

The amount of rainfall in the design storm was developed from the National Oceanic and Atmospheric Administration Atlas 2 Isopluvial Map of California. Total rainfall of 2.1 inches was approximated as the 10-year, 24-hour storm. (In a given year, there is a 10 percent chance that there will be a 24-hour period with 2.1 inches or greater of rainfall). Total rainfall in a design storm is typically distributed over the storm duration using either a synthetic distribution such as one of the Soil Conservation Service distributions, or using a distribution from a real storm that was recorded. Flow and rainfall monitoring that was conducted for the 2006 Master Plan captured a robust 24-hour storm over January 1 and January 2, 2006. The rainfall distribution from this storm was incorporated into the District's design storm. The resulting 10-year, 24-hour design storm, developed for the 2006 Master Plan and used as well in the 2016 Master Plan Update, is presented on Figure 3-3.

Table 3-2. Significant Industrial Dischargers with Maximum Industrial Discharge for Design Flow			
Description	Address	City	Maximum Industrial Discharge, gpm
Allegre Trucking/Truck Cleaning	Corner S. 8th St. and W. Peach St.	F	10.30
American Raisin/Raisin Processing	Chandler St. and Stillman St.	S	47.60
Asian Cold Storage/Fruit Processing	1045 Simpson St.	K	16.00
Bee Sweet/Citrus Processing	416 E. South Ave.	F	182.10
Boghosian Raisin/Raisin Processing	726 S. 8th St., Fowler	F	154.00
Cacciatore/Storage	39400 Clarkson Drive	K	28.10
Foster Commodities/Animal Feed	1900 Kern St.	K	22.50
Fowler Dehydrator/Grape Dehydrating	8th St. (adjacent to Boghosian Raisin)	F	61.10
Fresno Valves and Castings/Metal Castings	7736 E. Springfield Ave.	S	10.00
Guardian Industries/Glass Manufacturing	11535 E. Mountain View Ave.	K	89.80
KES Kingsburg LP Cogeneration	11765 Mountain View Ave.	K	103.90
Lion Dehydrator/Grape Dehydrating	9400 S. De Wolf Ave.	S	96.20
Lion Raisin/Raisin Processing	9500 S. De Wolf Ave.	S	298.30
National Raisin/Raisin Processing	626 S. 5th St.	F	195.50
Quinn Group/Caterpillar Sales and Repair	10273 S. Golden State Blvd.	S	7.10
Simonian Fruit/Fruit Packing	511 N. 7th St.	F	52.30
Sun Maid Growers Bethel Ave./Raisin Processing	13525 S. Bethel Ave.	K	598.20
Sun Maid Nebraska Ave./Storage	1445 Nebraska Ave.	S	0.70
USA Waste/Garbage Collection and Transfer	4333 E. Jefferson Ave.	F	2.70
Central California Sheets	909 Union St.	K	1.46
Daniels Sharpsmart	4144 E Therese Ave.	F	0.63
D&W Fine Pack	7595 E Manning Ave.	F	20.14
9th Street Cheese	128 N 9th St.	F	1.11
Healthwise Services LLC	4800 E Lincoln Ave.	F	0.14
Maple Leaf	1775 Park St.	S	1.18
PHX Recycling	2581 S Golden State Blvd	F	0.90
Ramos Torres Winery	1665 Simpson St.	K	0.07
Sacramento Container	909 Union St.	K	1.04
Stericycle Medical Waste	4800 East Lincoln Ave	F	0.56



Notes:

1. Taken From 2006 Master Plan

Figure 3-3

10-year, 24-hour Design Storm

Selma-Kingsburg-Fowler
County Sanitation District
2016 Collection System Master Plan Update

3.2 PERFORMANCE CRITERIA

The capacity of the District's collection system is evaluated as part of the 2016 Master Plan Update based on the performance criteria defined in the following sections. The criteria include standards from the District's Collection System Construction Standards (Construction Standards), as well as other industry typical criteria. The planning criteria address the gravity main capacity, gravity main slopes, maximum depth of flow within a gravity main, lift station wet well capacity criteria, lift station capacity criteria, and force main velocity criteria.

3.2.1 Gravity Mains

Capacity analysis of the District's gravity mains is performed using the hydraulic model in accordance with the criteria established in this section. The District's Construction Standards stipulate general policies of the District and outline sewer design criteria. Some of these criteria are discussed below. If not discussed in the 2016 Master Plan Update, it should be assumed that the design criteria conform to the District's Construction Standards.

3.2.1.1 Gravity Main Capacity

Gravity main flow capacities depend on the roughness of the pipe interior, its geometric configuration (cross-section and length), and slope. The Continuity equation and the Manning equation for steady-state flow are used to calculate flow in a gravity main:

Continuity Equation: $Q = V*A$

Where:

Q = peak flow, cubic feet per second (cfs)

V = velocity, feet per second (fps)

A = cross-sectional area of pipe, sq. ft.

Manning Equation: $V = (1.486*R^{2/3}*S^{1/2})/n$

Where:

V = velocity, fps

N = Manning's coefficient of friction

R = hydraulic radius (area divided by wetted perimeter), ft

S = slope of pipe, feet per foot

3.2.1.2 Manning Coefficient (n)

The Manning coefficient 'n' is a friction coefficient and varies with respect to pipe material, size of pipe, depth of flow, smoothness of pipe and joints, and extent of root intrusion. For sewer pipes, the Manning coefficient typically ranges between 0.011 and 0.017, with 0.013 being a typical value used for sewer system master planning. The default value of for the Manning coefficient used in the 2016 Master Plan is 0.013, which is consistent with the District's Construction Standards.

3.2.1.3 Flow Depth Criteria (d/D)

The primary criterion used to identify capacity deficient trunk sewers or to size new improvements is the maximum flow depth to pipe diameter ratio (d/D). This approach is consistent with both the 2006 Master Plan and the District's Construction Standards. The d/D value is defined as the depth (d) of flow in a pipe during peak flow conditions divided by the pipe's diameter (D). The District's construction standards define the acceptable d/D values for various pipe diameters.

When designing sewers, it is common practice to adopt variable flow depth criteria for different pipe sizes. Design d/D ratios typically range from 0.5 to 0.92, with the lower values used for smaller pipes which may experience flow peaks greater than design flow or may experience blockages from debris, paper or rags.

According to District Construction Standards, sewers less than 12 inches in diameter shall be designed to flow half full at peak flow rates. Sewers 12 inches to 18 inches in diameter shall be designed to flow two-thirds depth at peak flow rates. Sewers larger than 18-inches diameter shall be designed to flow at 90 percent depth at peak flow rate. The maximum allowable d/D ratios for design flow conditions are summarized in Table 3-3.

Table 3-3. d/D Ratios for Design Flow Conditions[(a)]

Gravity Main Diameter	Design Flow Maximum d/D Ratio
Less than 12 inches	0.50
Greater than or equal to 12 inches, but less than or equal to 18 inches	0.67
Greater than 18 inches	0.90

(a) Source: 2006 Master Plan

3.2.1.4 Design Velocities and Minimum Slopes

In order to minimize the settlement of sewage solids, the District's Construction Standards requires that sewer velocity by equal to or greater than 2 fps for all gravity mains when flowing at their maximum capacity. At this velocity, the sewer flow will typically provide self-cleaning for the gravity main. Table 3-4 lists the recommended minimum slopes and their corresponding maximum flows for maintaining velocities greater than 2 fps when the gravity main is flowing at maximum depth.

The District's Construction Standards also list the "Absolute Minimum Slope" for commonly used gravity main sizes. The absolute minimum slopes is not used as a criteria in the 2016 Master Plan Updatebecause these minimum slopes result in velocities that are less than 2 fps at maximum flow depth.

Table 3-4. Gravity Main Minimum Slope and Maximum Flow Criteria[a]

Gravity Main Diameter	Minimum Slope[b], feet/feet	Absolute Minimum Slope, feet/feet	Design Flow Maximum d/D Ratio	Maximum Flow, mgd	Maximum Flow, ESFRs
6-inch	0.0050[c]	0.0045	0.50	0.181	200
8-inch	0.0033[c]	0.0025	0.50	0.224	250
10-inch	0.0025[c]	0.0019	0.50	0.354	400
12-inch	0.0016[c]	0.0012	0.67	0.727	820
15-inch	0.0012[c]	0.0009	0.67	1.142	1,280
18-inch	0.0009[c]	0.0007	0.67	1.608	1,800
21-inch	0.0007[c]	0.0006	0.90	2.888	3,240
24-inch	0.0006[c]	0.0005	0.90	3.818	4,290
27-inch	0.0006	0.0005	0.90	5.227	5,870
30-inch	0.0005	0.0005	0.90	6.319	7,090
33-inch	0.0005	0.0005	0.90	8.148	9,140
36-inch	0.0004	0.0004	0.90	9.191	10,320
42-inch	0.0003	0.0003	0.90	12.006	13,470
48-inch	0.0003	0.0003	0.90	17.141	19,240
54-inch	0.0003	0.0003	0.90	23.466	26,340
60-inch	0.0002	0.0002	0.90	25.375	28,480
66-inch	0.0002	0.0002	0.90	32.718	36,720
72-inch	0.0002	0.0002	0.90	41.263	46,310
84-inch	0.0002	0.0002	0.90	62.241	69,860

(a) Source: 2006 Master Plan.
(b) Recommended minimum slope for maximum gravity main flow at various d/D values and minimum velocity of 2 fps.
(c) District Construction Standards for standard minimum slopes of gravity mains. Construction Standards provided slopes for diameters less and or equal to 24-inch only. Slopes for gravity mains 27-inch diameter and greater were calculated based upon maximum d/D and minimum velocity criteria.

3.2.1.5 Changes in Pipe Sizes

When a smaller gravity main joins a larger one, the invert of the larger gravity main will be lowered such that a constant energy gradient is maintained. An approximate method for maintaining a constant energy gradient is to place the 0.80 d/D point of both gravity mains at the same elevation. Placing the 0.80 d/D point at the same elevation can be effectively accomplished by matching the gravity main soffits for the differently-sized gravity mains.

3.2.2 Lift Station Wet Wells

According to District Construction Standards, holding capacity in a wet well that has an overflow relief mechanism shall be equivalent to two hours accumulation of the maximum design flow from the fully developed area tributary to the lift station. Wet wells that do not have overflow relief shall have a holding capacity equivalent to four hours accumulation of the maximum design flow from the fully developed area tributary to the lift station. These criteria are applied in the 2016 Master Plan Update.

3.2.3 Lift Stations

The District's Construction Standards require that all sewage lift stations have sufficient capacity to pump the peak design flow with the largest pump out of service (firm capacity). Standby power is not required by the District's Construction Standards, but should be considered by the District as standard on all new lift stations, and should be considered as part of all lift station rehabilitation projects.

3.2.4 Force Mains

The District's Construction Standards do not include specific hydraulic criteria for force mains. Force main hydraulic criteria are often based on velocity in the force main. Force mains are typically sized such that the velocity in the force main will exceed 3 fps under normal operating condition so that the force main will remain free of settled debris. Similarly, force mains are typically sized such that the maximum velocity in the force main will not exceed 8 fps under peak conditions. This maximum velocity prevents excessive wear and tear on the force main, and limits excessive energy expenditures in the lift station due to the high losses that result from higher velocities.

For the 2016 Master Plan Update, the force main design criteria of a minimum velocity of 3 fps under normal operating conditions and a maximum velocity of 8 fps under peak operating conditions are applied. The Hazen-Williams formula is used to calculate the velocity of force mains. The formula is:

Velocity Equation: $V = 1.32*C*R^{0.63}*S^{0.54}$

Where:

V = velocity, fps

C = Hazen-Williams roughness coefficient

R = hydraulic radius (area divided by wetted perimeter), ft

S = slope of pipe, feet per foot

The value of the Hazen-Williams roughness coefficient varies with the type of pipe material and is influenced by the type of construction and age of the pipe. A value of 120 is assumed to be the default value for the 2016 Master Plan Update.

CHAPTER 4

Existing and Future Design Flows

This chapter discusses flow projection methodology, wastewater flow components, and wastewater flow data for the 2016 Master Plan Update.

4.1 DESIGN FLOW COMPONENTS

For the 2016 Master Plan Update, design flows used in assessing the hydraulic capacity of the collection system consist of Peak Wet Weather Flows (PWWF) that are developed using ADWF and PDWF components. The design flow components are described in more detail in the sections below.

4.1.1 Average Dry Weather Flow

ADWF is generally accepted to include two components: base wastewater flow (BWF) and GWI. BWF represents the sanitary and process flow contributions from residential, commercial, institutional, and industrial users of the collection system. GWI is groundwater that infiltrates into defects in sewer pipes and manholes, particularly in winter and springtime in low-lying areas. GWI is typically seasonal in nature and can remain relatively constant over periods of several days or months. However, rainfall clearly has long-term impacts on GWI rates, as evidenced by measurable increases in GWI after prolonged periods of rainfall.

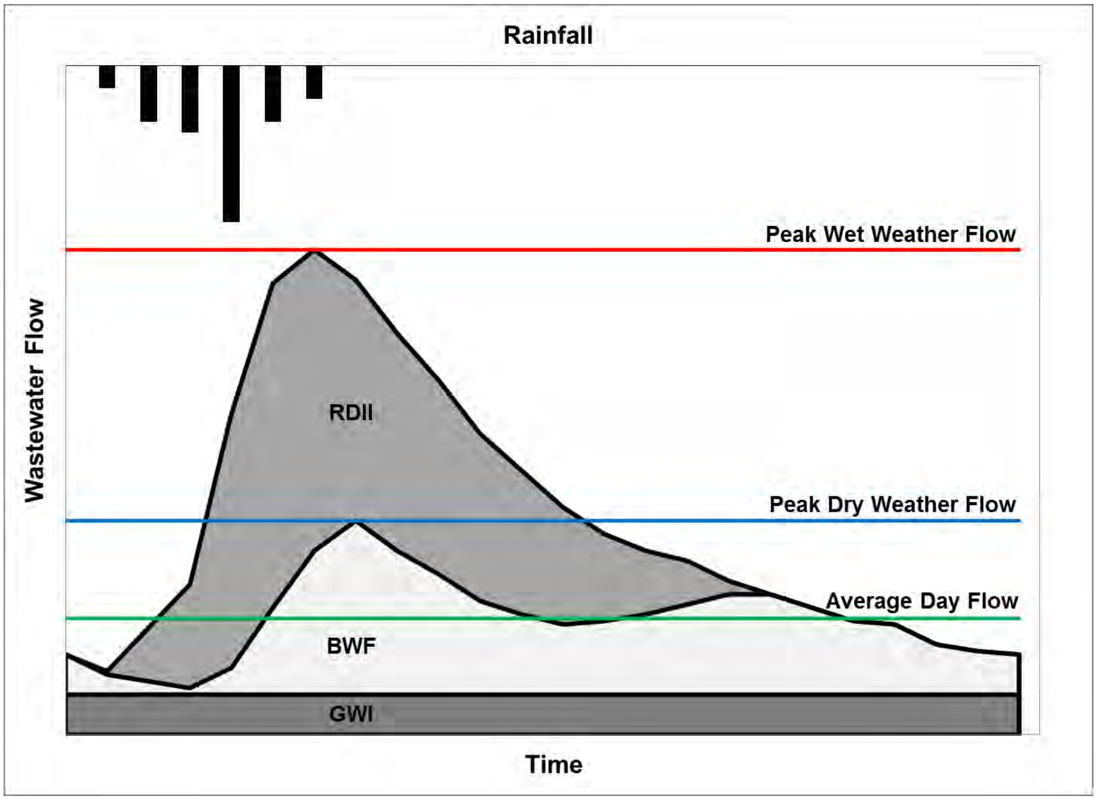
4.1.2 Peak Dry Weather Flow

BWF is typically not discharged into the collection system at a constant rate during the day. BWF varies throughout the day, but typically follows predictable diurnal patterns depending on the type of land use. For example, residential dischargers tend to have high discharge in the morning hours as users wake up and in the evening hours as users return to the home, commercial dischargers tend to have fairly steady discharge during business hours, but very low discharge outside of business hours, and industrial dischargers have flow patterns that depend upon their individual processes. PDWF is the peak flow experienced in a collection system during dry conditions, and it is determined by the diurnal discharge patterns of the collection system users as described above. PDWF is typically 1.2 times to 3.0 times the ADWF in a collection system, depending on the mixture of discharger types and the layout of the collection system.

4.1.3 Peak Wet Weather Flow

PWWF is composed of PDWF with the addition of RDII. RDII is storm water inflow and infiltration that enter the system in direct response to rainfall events, either through direct connections such as holes in manhole covers or illegally connected roof leaders or area drains, or, more commonly, through defects in sewer pipes, manholes, and service laterals. RDII typically results in short term peak flows that recede relatively quickly after the rainfall ends. The magnitude of RDII flows are related to the intensity and duration of the rainfall, the relative soil moisture at the time of the rainfall event, and the condition of the sewers. The wastewater flow components described in this section are presented on Figure 4-1.

Figure 4-1. Wastewater Components for Typical PWWF Conditions



4.2 DESIGN FLOW DEVELOPMENT

The following sections described how the ADWF, PDWF, and PWWF components for existing and future conditions were developed in order to calculate existing and future design flows for the 2016 Master Plan Update.

4.2.1 ADWF Projections

For the 2016 Master Plan, existing and future ADWF values were developed starting with the design flow values from the 2006 Master Plan and adding projected development within the 2016 Master Plan Study Area. ADWF values for developments were calculated using the Design Wastewater Flow Coefficients that are described in Chapter 3. A development timeline was created for each member city at 2015, 2020, 2025, 2035. The development timeline is the basis for determining the collection system infrastructure required to accommodate the growth of the member cities and critical to the phasing of the construction of the infrastructure. The 2015 development timeframe was used to identify projects that have been recently completed, and was used to establish a new starting point for the 2016 Master Plan. The development timeline in each member City was identified and refined through multiple meetings with the management, engineering, and planning staff for each member City. The resulting development timelines for the 2016 Master Plan, and the ADWF flow projections that result from the development timelines, represent considerable collaborative effort on the part of District and member City staff.

Where specific development projects were identified by member City or District staff, the development project is identified by name in the development timeline. In some cases, Equivalent Single Family Residential, (ESFR) values were known for residential developments, and these known values are included in the development timeline. In cases of residential development for which the ESFR count is not known, the acreage of the development is used to calculate ADWF for the development. For all non-residential development, acreage values were used to calculate ADWF. Where specific projects have not been identified, but where development is expected to occur, the development has been identified as “General Development” in the development timeline. General development is projected to take place according to the General Plan Land Use as described for each member City in Chapter 2.

4.2.1.1 Selma Development Timeline

There are no development projects identified for Selma in the 2015 timeframe. However, there are a substantial number of development projects located at the periphery of the existing Selma City Limits that are projected to take place by 2020. A single development project is identified for the 2025 timeframe, and a large amount of general development is projected to take place out to the 2016 Master Plan Study Area boundary for the 2035 timeframe. Portions of this general development are projected to be non-wastewater generating land uses. The development timeline for Selma can be seen in Table 4-1, and is presented on Figure 4-2.

4.2.1.2 Kingsburg Development Timeline

There are no development projects identified for Kingsburg in the 2015 timeframe. There are several Low Density Residential development projects located at the edge of the existing Kingsburg City Limits that are projected to take place by 2020, and a single Industrial development near the center of Kingsburg anticipated by 2020. Additionally, two areas of general development Low Density Residential Land Use were identified at the west and southwestern boundaries of the current City Limits. The development timeline for Kingsburg can be seen in Table 4-2, and is presented on Figure 4-3.

4.2.1.3 Fowler Development Timeline

Three development projects were completed in Fowler in the 2015 timeframe. Several development projects comprising both residential and non-residential land uses are projected to occur by 2020. Two development projects are identified for the 2025 timeframe, and a large amount of general development consisting of non-residential land uses along the Golden State Corridor and residential land uses elsewhere is projected to take place out to the 2016 Master Plan Study Area boundary for the 2035 timeframe. Portions of this general development, particularly in the north and west, are projected to be non-wastewater generating land uses including Agricultural Land Use because of restriction in development placed on these parcels. The development timeline for Fowler can be seen in Table 4-3, and is presented on Figure 4-4.

Table 4-1. City of Selma Development Timeline

Land Use Designation	2015 Development		2020 Development			2025 Development			2035 Development		
	Name	Acres	Name	ESFR	Acres	Name	ESFR	Acres	Name	ESFR	Acres
Residential Land Use											
Low Density			Synergy Tract	66		Raven Family		12	Amberwood	2,078	
			Vineyard Estates - Phase II & III	101					General Development		9,328
			Valley View - Phase III	43							
			Amberwood - Phase I	480							
			Raven Tract	106							
			Country View		10						
			Emmett		27						
			County Rose Estate II		20						
Medium Density									General Development		1,154
High Density									General Development		64
Residential Reserve									General Development		1,011
Subtotal	**0**	**0**		**796**	**57**		**0**	**12**			**11,557**
Commercial and Industrial											
Industrial									Selma Crossing - Phase III		69
									General Development		2,580
Industrial Discharger											
Commercial			Rockwell - Phase I		32				Selma Crossing - Phase II		142
			Canales Commercial		22				General Development		812
			Rose Commercial		16						
			Floral Commercial Center		4						
			V-5 Mini Storage Commercial		6						
			Selma Crossing - Phase I		84						
			Rockwell Commercial - Phase I		29						
Subtotal	**0**	**0**		**0**	**193**		**0**	**0**			**3,603**
Other											
School											103
Community Facility											
Hospital											
Rural Residential											
Subtotal	**0**	**0**		**0**	**0**		**0**	**0**			**103**
Non-Wastewater Generating											
Open Spacer/Park/Basin/Play Field/Cemetery											327
Agriculture											
Freeway/Railroad											
Streets											
Subtotal	**0**	**0**		**0**	**0**		**0**	**0**			**327**
Total	**0**	**0**		**796**	**250**		**0**	**12**		**2,078**	**15,590**

Table 4-2. City of Kingsburg Development Timeline

Land Use Designation	2015 Development			2020 Development			2025 Development			2035 Development		
	Name	ESFR	Acres	Name	ESFR	Acres	Name	ESFR	Acres	Name	ESFR	Acre
Residential Land Use												
Low Density				Kings Crossings/Covington - Phase II	45					General Development		295
				Gary Nelson	130							
				Hash Property	194							
				Low Density Developments	239							
						31						
Medium Density												
High Density												
Residential Reserve												
Subtotal		**0**	**0**		**608**	**31**		**0**	**0**		**0**	**295**
Commercial and Industrial												
Industrial						5						
Industrial Discharger												
Commercial												
Subtotal		**0**	**0**			**5**		**0**	**0**		**0**	**0**
Other												
School												
Community Facility												
Hospital												
Rural Residential												
Subtotal		**0**	**0**		**0**	**0**		**0**	**0**		**0**	**0**
Non-Wastewater Generating												
Open Spacer/Park/Basin/Play Field/Cemetery												
Agriculture												
Freeway/Railroad												
Streets												
Subtotal		**0**	**0**		**0**	**0**		**0**	**0**		**0**	**0**
Total		**0**	**0**		**608**	**36**		**0**	**0**		**0**	**295**

Table 4-3. City of Fowler Development Timeline

Land Use Designation	2015 Development			2020 Development			2025 Development			2035 Development		
	Name	ESFR	Acre	Name	ESFR	Acre	Name	ESFR	Acre	Name	ESFR	Acre
Residential Land Use												
Low Density	Kensington Estates - Phase II	55		Kensington Estates - Phase I	55		Kandarian Development	250		General Development		839
	R.J. Hill Silverton 3	145		R.J. Hill Silverton - Phase II		39						
				Residential Development 2	50							
				R.J. Hill Silverton 2	170							
				R.J. Hill Silverton 1	132							
				Kensington Estates - Phase III	60							
Medium Density	Estrella Condos	80		Potential Single Family Tract	80					General Development		332
High Density												
Residential Reserve												
Subtotal		**280**			**547**	**39**		**250**				**1,171**
Commercial and Industrial												
Industrial				Industrial Development 1		14	Fresno Valve & Castings		51			
				Industrial Development 2		137						1,071
Industrial Discharger												
Commercial				Commercial Development 1		237						124
Subtotal		**0**			**0**	**388**		**0**	**51**			**1,195**
Other												
School												
Community Facility												
Hospital				Children's Hospital		14						
Rural Residential												
Subtotal		**0**			**0**	**16**		**0**	**0**			
Non-Wastewater Generating												
Open Spacer/Park/Basin/Play Field/Cemetery												26
Agriculture												906
Freeway/Railroad												
Streets												
Subtotal		**0**			**0**	**0**		**0**	**0**			**932**
Total		**280**			**547**	**680**		**250**	**51**			**3,298**

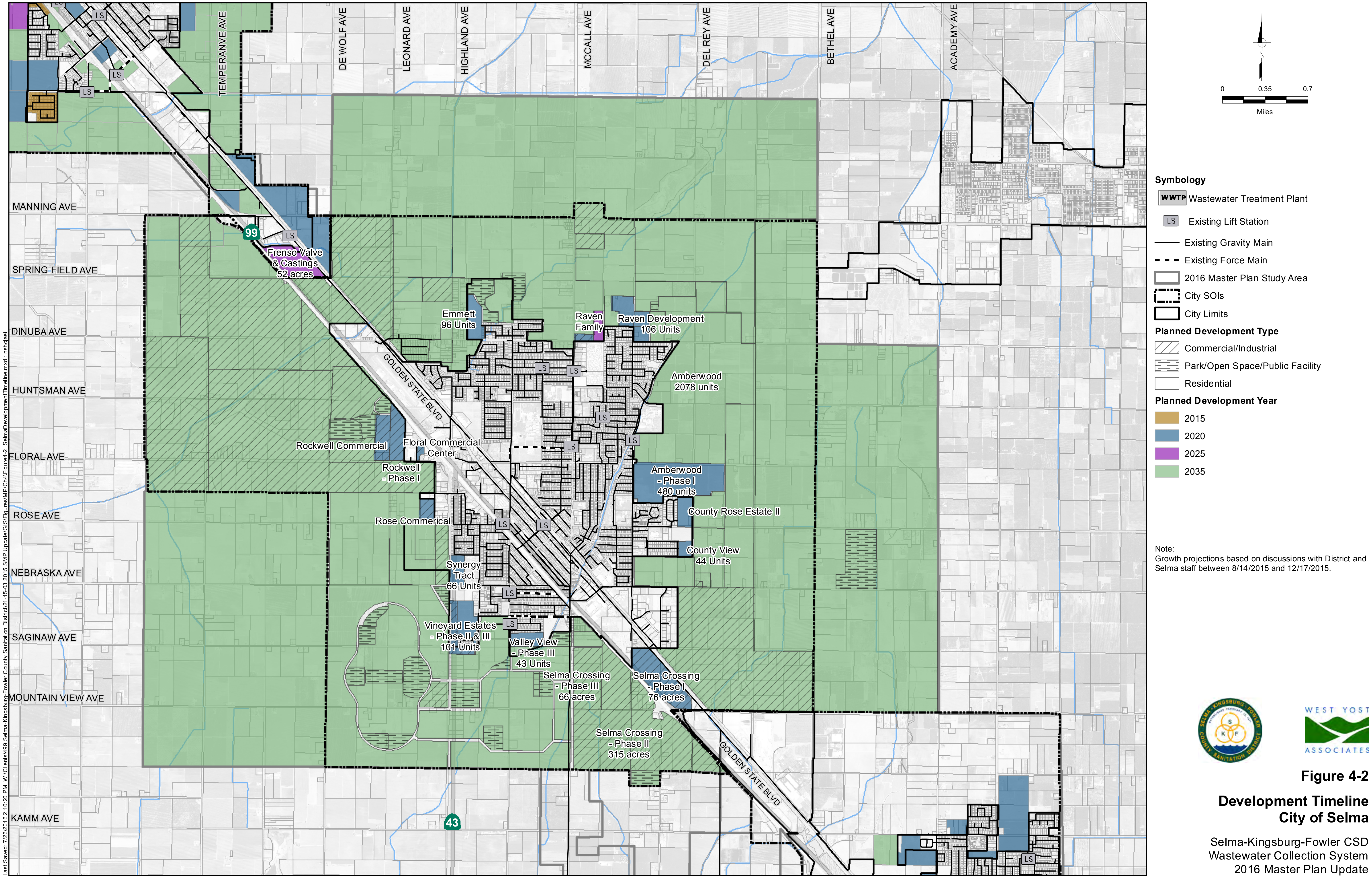
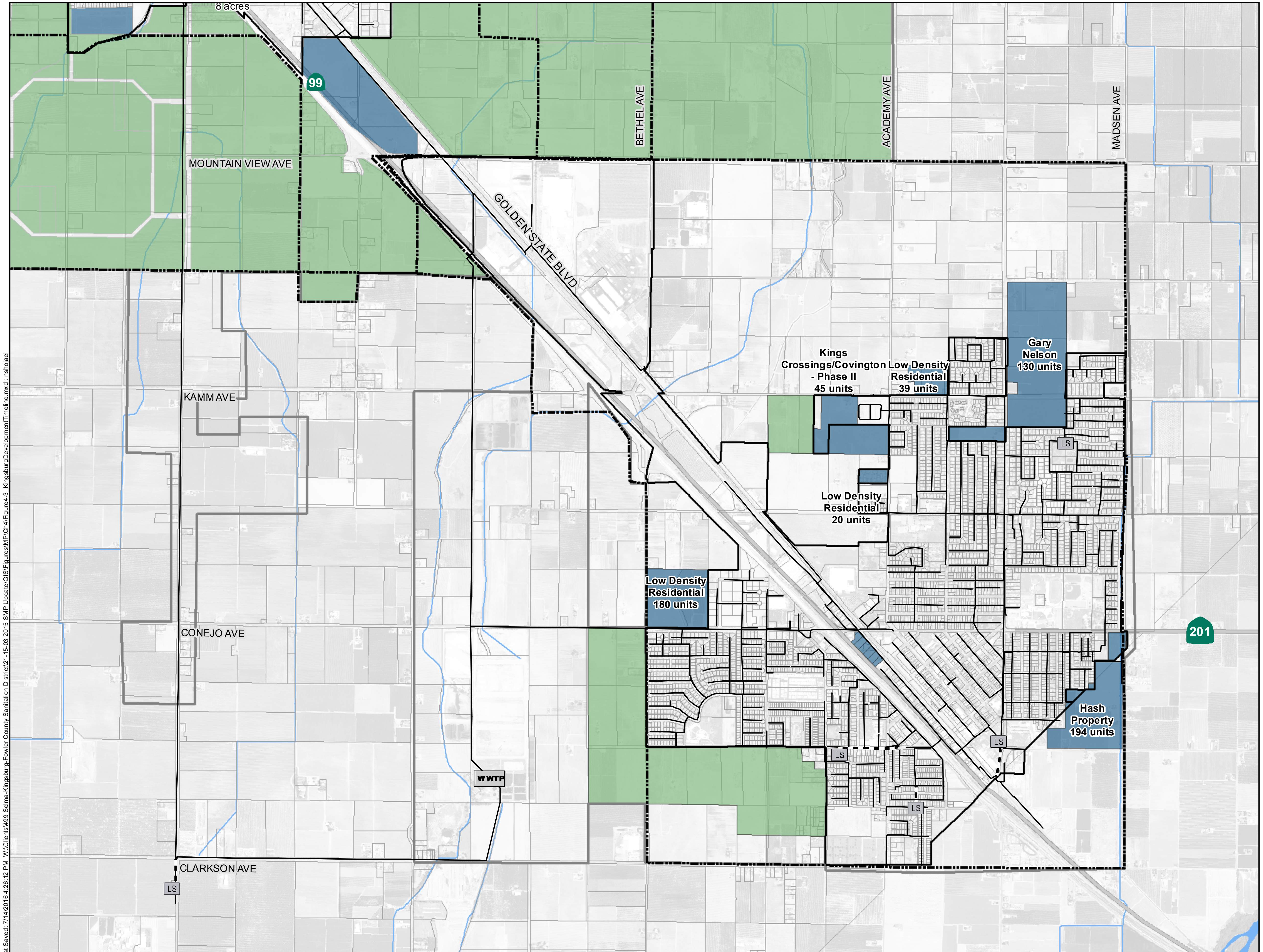


Figure 4-2

Development Timeline
City of Selma

Selma-Kingsburg-Fowler CSD
Wastewater Collection System
2016 Master Plan Update



Symbology

- WWTP Wastewater Treatment Plant
- LS Existing Lift Station
- Existing Force Main
- Existing Gravity Main
- 2016 Master Plan Study Area
- City SOIs
- City Limits

Planned Development Type

- Industrial
- Residential

Planned Development Year

- 2015
- 2020
- 2025
- 2035

Note:
Growth projections based on discussions with District and Kingsburg staff between 8/14/2015 and 12/17/2015.

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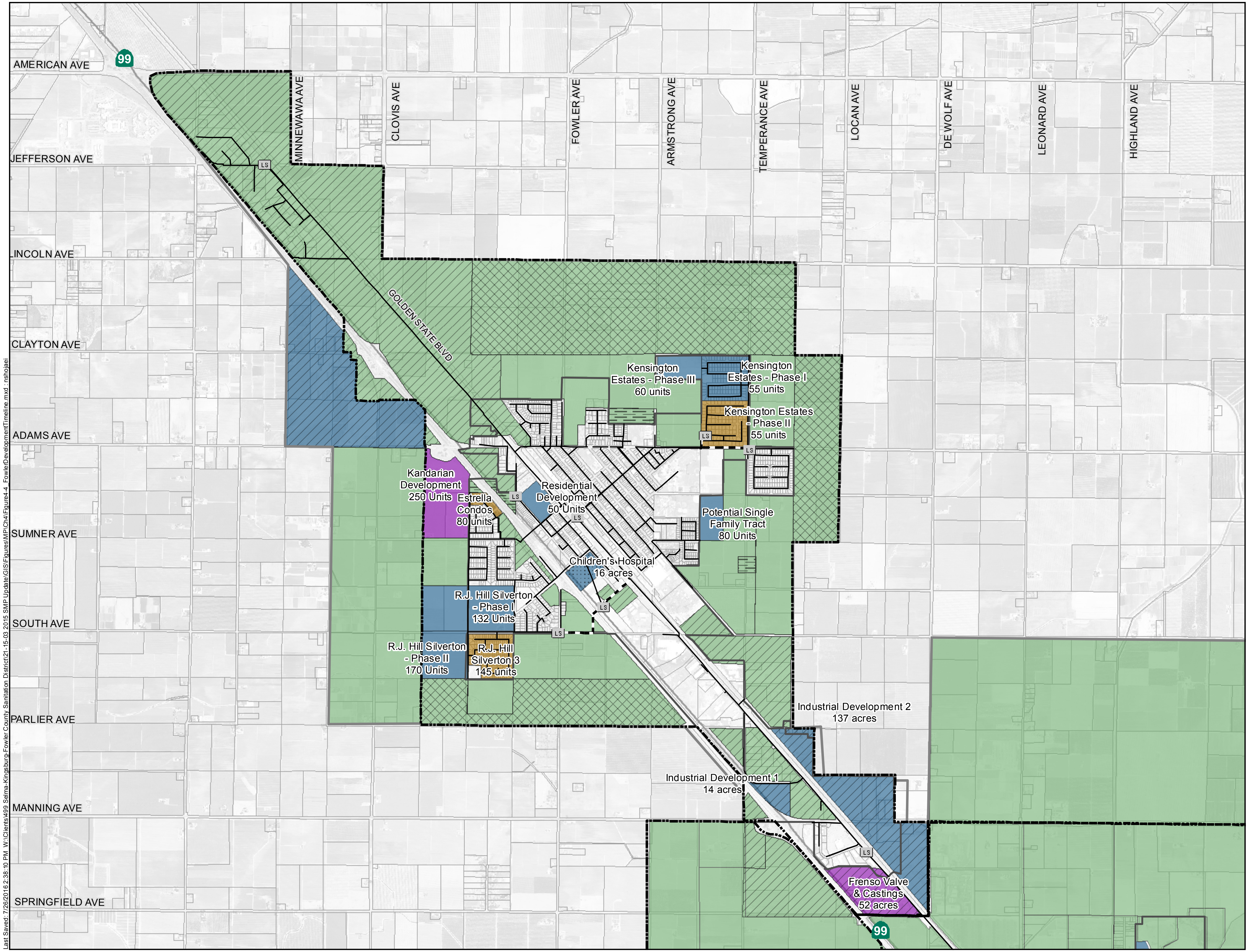
Figure 4-3

Development Timeline City of Kingsburg

Selma-Kingsburg-Fowler CSD
Wastewater Collection System
2016 Master Plan Update



N
0 0.25 0.5
Miles

Symbology

- WWTP Wastewater Treatment Plant
- LS Existing Lift Station
- Existing Gravity Main
- Existing Force Main
- 2016 Master Plan Study Area
- City SOIs
- City Limits

Planned Development Type

- Agricultural
- Commercial/Industrial
- Medical
- Park/Open Space
- Residential

Planned Development Year

- 2015
- 2020
- 2025
- 2035

Note:
1. Development timeline based on discussions with District and Fowler staff between 8/14/2015 and 12/17/2015.

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Figure 4-4

Development Timeline
City of Fowler

Selma-Kingsburg-Fowler CSD
Wastewater Collection System
2016 Master Plan Update

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4.2.2 PDWF Projections

ADWF projections for each parcel were multiplied by diurnal peaking curves to create PDWF projections. The peaking curves used in this calculation were the residential or non-residential design diurnal curve described in Chapter 3, as appropriate. The design diurnal patterns are independent of location or flow monitoring basin within the collection system, and provide all new development and growth with consistent peak factors.

4.2.3 PWWF Projections

PWWF projections were calculated from the PDWF projections by applying RDII values for the development areas at each development timeframe. RDII was calculated using the design storm described in Chapter 3, and incorporating inflow and infiltration factors that are appropriate for new development. The inflow and infiltration factors are independent of location or flow monitoring basin within the collection system, and provide all new development and growth with consistent RDII generation.

4.2.4 Maximum Industrial Discharge for Design Flow

The maximum industrial discharge for each Significant Industrial Discharger was calculated by using the recorded average hourly flow for the maximum month (where available) or the baseline discharge entitlement, whichever was greater. These values are provided in Chapter 3.

4.3 EXISTING AND FUTURE DESIGN FLOW VALUES

The design flows used to evaluate the capacity of the collection system using the hydraulic model (described in more detail in Chapter 5) are presented in Table 4-4.

Table 4-4. Summary of Design Flow Projections by Development Timeframe

Description	Existing (2015), mgd	5-Year (2020), mgd	10-Year (2025), mgd	20-Year (2035), mgd
ADWF	4.30	5.53	5.64	23.45
PDWF	7.87	9.93	10.09	38.85
PWWF (Design Flow)	15.91	17.54	17.75	44.85

CHAPTER 5
Hydraulic Model Update and Capacity Evaluation

As part of the 2016 Master Plan Update, an updated hydraulic model of the City's sanitary sewer system has been developed and utilized for the collection system hydraulic analysis. Chapter 5 contains a summary overview of the model software, the modeled system network, future design flow allocation, and hydraulic capacity evaluation using the design flows described in Chapter 4.

5.1 MODEL DESCRIPTION

As part of the 2006 Master Plan, a hydraulic model was developed utilizing H2O Map Sewer Pro software (H2O Map Sewer), a product of Innovyze, Inc. as the modeling program. H2O Map Sewer was developed specifically for collection system capacity analysis and is widely used in California. The H2O Map Sewer hydraulic model, updated appropriately, is used to identify hydraulic deficiencies under existing and future timeframe conditions, and to evaluate potential relief sewers or other infrastructure improvements to address the possible hydraulic deficiencies.

There are two types of hydraulic models used to simulate a sewer collection system: 1) a steady state/static simulation; and 2) an extended period/dynamic simulation. Simulations from a steady state model represent a snapshot of the system performance at a given point in time under specific sewage generation conditions (typically a peak flow condition). An extended period/dynamic model employs a continuous simulation of the changes in system flow rates, and is typically used to analyze the operational performance of the system over a 24-hour or longer period. Extended period/dynamic modeling requires more extensive data input than a steady-state model, including various 24-hour diurnal patterns for various land use categories within the sewer collection system and a representation of time-varying RDII response to rainfall. For the purposes of the 2016 Master Plan, as with the 2006 Master Plan, an extended period/dynamic simulation has been used in system analyses to analyze the operational performance of the District's collection system over a 48-hour period.

5.2 EXISTING SYSTEM HYDRAULIC MODEL UPDATE

This section describes the collection system hydraulic model, describes the additional facilities added into the hydraulic model as part of the 2016 Master Plan Update, and provides a summary of the existing and future timeframe flow allocation of the hydraulic model.

5.2.1 Model Network Revisions

The hydraulic model simulates a skeletonized system with about 78.5 total miles of modeled pipelines and 22 lift stations. The skeletonized system includes all the major trunk sewers 10-inch diameter and larger. Additional smaller diameter pipelines were added to the model as needed to keep tributary areas at a reasonable size and to provide for hydraulic conductivity.

The hydraulic model as developed for the 2006 was compared against the District's collection system Geographic Information Systems (GIS) to determine if additional existing sewers needed to be added to the model system. The comparison yielded the following general classes of updates to the hydraulic model:

- Structural improvements or developments that have occurred since the time of the 2006 Master Plan were updated into the model.

- Instances of inconsistent gravity main diameters between the hydraulic model and the GIS were identified and investigated. In some instances, field investigation by District staff was utilized to determine the correct diameter. The hydraulic model was updated as the investigations indicated was appropriate.
- Infrastructure that appeared in the hydraulic model, but not in the District's GIS was investigated to determine which source correctly represented field conditions. The hydraulic model was updated as appropriate.

In addition to the comparisons described above, basic data checks were conducted of the updated model for missing data and physical inconsistencies (e.g., reverse pipe slopes or diameter changing from larger to smaller rather than vice versa). Figure 5-1 presents the updated model network for the 2016 Master Plan Update hydraulic evaluation.

5.2.2 Existing System Dry Weather Flow Updates

Extensive flow monitoring and hydraulic model calibration was performed as part of the hydraulic model development for the 2006 Master Plan. Because flow monitoring was not conducted for the for the 2016 Master Plan, recalibration of model dry weather flows was not conducted. Rather, the previous calibration was reviewed and found to be acceptable. The following updates were then made to the dry weather flows in the hydraulic model:

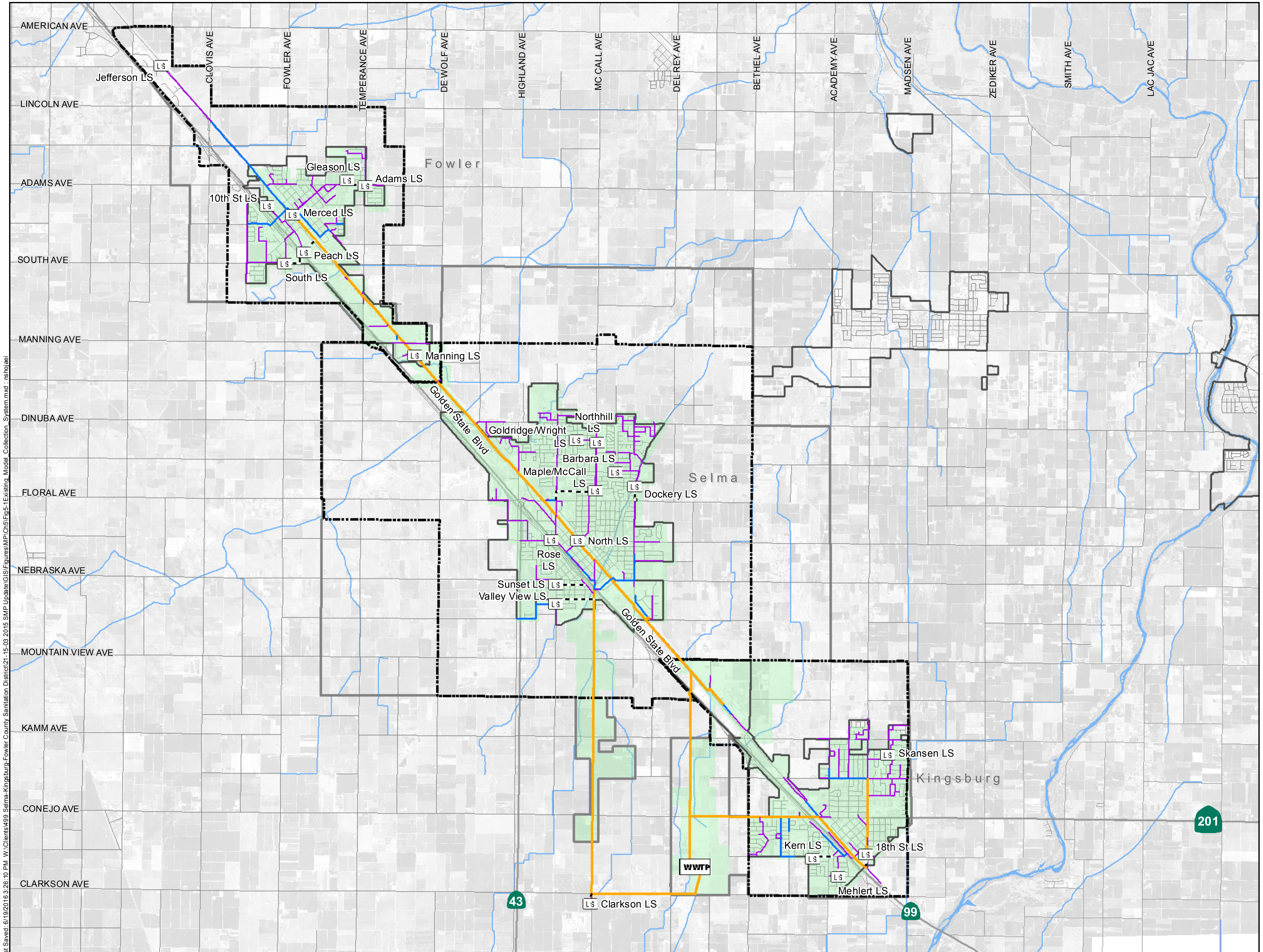
- Significant Industrial Discharger flow was updated to the values shown in Chapter 3.
- ADWF from development projects identified for the 2015 timeframe, indicating that these developments are recently completed or close to completion, as described in Chapter 4, were added to the hydraulic model. These flows became part of the existing design flows.

5.2.3 Existing System Wet Weather Flow Updates

As with the existing dry weather flows in the hydraulic model, the existing wet weather flows were not recalibrated as part of the 2016 Master Plan Update. For the majority of the collection system, RDII factors were not adjusted and remain identical to those used in the 2006 Master Plan. The RDII factors used in the District's hydraulic model are described as R-T-K factors, which are utilized in the hydraulic model to generate hydrographs from each tributary area that represent estimated flows during and immediately after rainfall events caused by potential seepage of precipitation into the collection system. The R-T-K factors generates a series of three triangular hydrographs that represent short-term, medium-term, and long-term rainfall response. The R-T-K factors include:

1. **R-factor**: The percentage of rainfall that enters the system in the form of RDII.
2. **T-factor**: The time from the storm onset to the runoff peak.
3. **K-factor**: A constant used in defining the ratio of the "time to recession" to the "time to peak" of the hydrograph.

Components of the R-T-K hydrograph are provided courtesy of the EPA Office of Research and Development, and are presented on Figure 5-2.



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0 0.6 1.2
Miles

Symbology

- WWTP Wastewater Treatment Plant
- LS Lift Station
- Force Main

Gravity Main - by Diameter

- 6-inch - 12-inch
- 14-inch - 18-inch
- 21-inch - 60-inch
- 2016 Master Plan Study Area
- City SOIs
- City Limits
- Existing District Service Area

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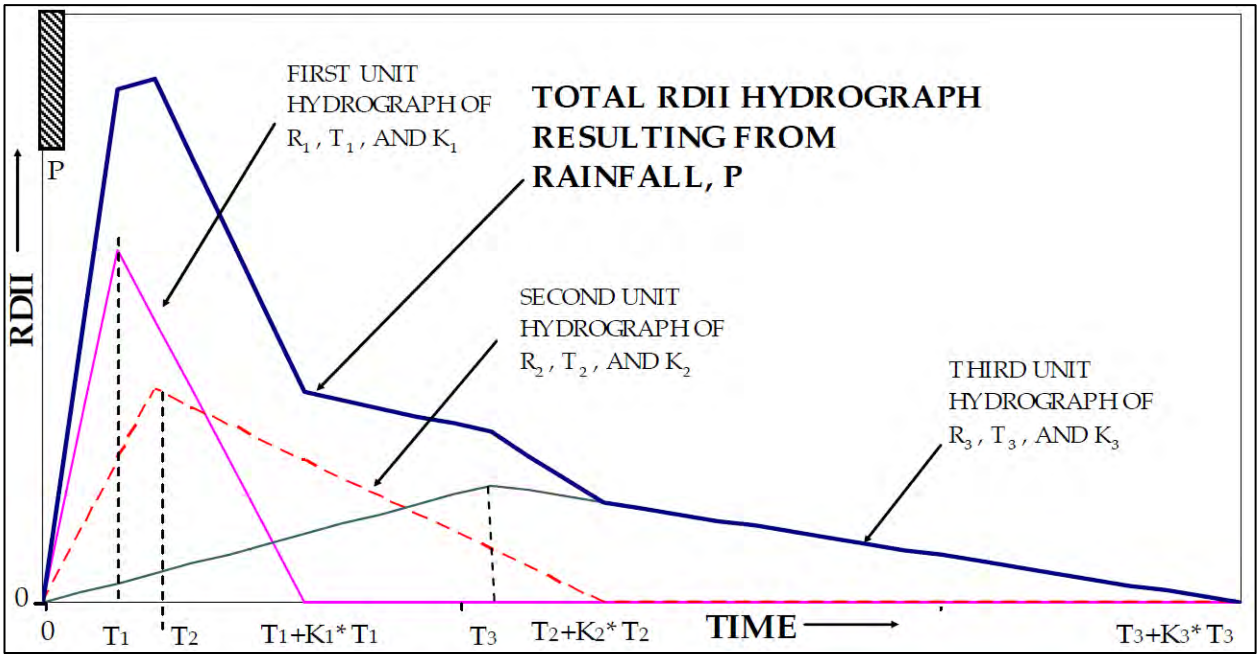
Figure 5-1

Modeled Existing Collection System

Selma-Kingsburg-Fowler CSD
Wastewater Collection System
2016 Master Plan Update

Figure 5-2. Components of RTK Hydrograph



When a wet weather flow simulation is run in the model, the R-T-K factors are applied to represent a specific rainfall event. These parameters generate a wet weather flow hydrograph for each tributary area. Of the three factors, the R-factor has the clearest intuitive meaning, and also has the largest influence on the magnitude of the PWWF of any of the R-T-K factors.

The R-T-K factors used in the 2016 Master Plan Update were largely retained from the 2006 Master Plan and are shown in Table 5-1. The R-T-K factors calibrated for Flow Monitoring Basin FM-06 indicate a large amount of RDII entering the collection system rapidly as is typical where cross connections to the storm sewer system are found, or where other direct inflow connections exist. As a result of these high calibrated R-T-K factors, District staff performed field investigations in the vicinity of Young Street and McCall Avenue, during which they found and removed several cross connections with the storm sewer system. Because of this investigation and correction effort, the R-T-K factors were lowered in the Young Street and McCall Avenue vicinity. The revision to the R-T-K factors in this vicinity is the same revision that was performed for the hydraulic studies performed for the McCall Sewer design studies and option evaluations.

Table 5-1. R-T-K Factors for RDII Generation in Hydraulic Model by Flow Monitor Basin

Description	FM-01	FM-02	FM-03	FM-04	FM-05	FM-06	FM-07	FM-08	FM-09	Rose Lift Station
R: Effective Rainfall Volume (%)	0.65	0.75	0.75	0.9	6.8	9.5	1.95	0.5	0.85	0.5
R1: Triangle1 Rainfall Volume (% of R)	80	90	90	90	20	90	90	90	90	95
R2: Triangle2 Rainfall Volume (% of R)	10	10	10	10	10	10	10	10	10	5
T1: Time to Peak 1 (hr)	0.8	1.5	0.9	0.9	0.5	1.5	0.9	2.0	2.0	0.9
T2: Time to Peak 2 (hr)	0.9	1.6	1.0	1.0	1.0	1.6	1.0	2.1	2.1	1.0
T3: Time to Peak 3 (hr)	1.0	1.7	1.1	1.1	4.0	1.7	1.1	2.2	2.2	1.1
K1: Recession Constant 1	1.0	2.0	2.0	2.0	2.0	0.5	0.5	1.0	1.0	0.5
K2: Recession Constant 2	1.1	2.5	2.5	2.5	3.0	0.5	1.0	0.5	0.5	1.0
K3: Recession Constant 3	1.2	3.0	3.0	3.0	3.0	0.50	1.5	0.25	0.25	1.5

5.3 EXISTING CAPACITY EVALUATION

This section presents the results of the hydraulic evaluation of the District's collection system under existing conditions. Collection system capacity for gravity mains, wet wells, pump stations, and force mains is assessed with respect to the system's performance under the existing PWWF design flow condition described in Chapter 4 using the criteria described in Chapter 3.

5.3.1 Existing Gravity Main Hydraulic Evaluation

Existing gravity mains exceed the performance criteria under existing design flows in a number of locations. The specific reason that the gravity main or group of gravity mains fails to meet the performance criteria can vary from being undersized to lacking sufficient slope at a particular location. These specific reasons, and the remedies to address them, are discussed more in Chapter 7. The gravity mains that fail to meet performance criteria are displayed on Figure 5-2. These gravity mains are summarized by member City below.

5.3.1.1 Selma

The gravity mains within Selma that fail to meet performance criteria under existing design flows can be found in Table 5-2.

Table 5-2. Gravity Mains Within Selma Not Meeting Performance Criteria Under Existing Conditions

Location	Diameter	Extent	Cause
Thompson Avenue	12-inch	Dinuba Avenue to Oak Street	Undersized
McCall Avenue	8-inch	Maple Street to north of Barbara Street	Undersized
McCall Avenue	10-inch	Barbara Street to Hillcrest Street	Undersized
Dockery Avenue	12/15-inch	Gaither Street to Nebraska Avenue	Undersized
Nebraska Avenue	12-inch	Mitchell Avenue to South Thompson Avenue / Knowles Street	Undersized
Highway CA-99	12-inch	McCall Avenue and Knowles Street	Undersized
Floral Avenue	12/15-inch	South Thompson Avenue to West Front Street	Undersized
Huntsman Avenue	8-inch	Olive Street to Mulberry Street	Undersized
Barbara Street	10-inch	Olive Street to Orange Avenue	Undersized
Orange Avenue	10/12-inch	Lewis Street to Aspen Street	Insufficient Slope
North Street	12-inch	Arrants Street to West Front Street	Undersized
Young Street	12-inch	Rose Avenue to Sherman Street	Insufficient Slope
McCall Avenue	10-inch	Nebraska Avenue to Highway CA-99	Undersized
Nebraska Avenue	15-inch	Dockery Avenue to west of Olive Street	Undersized

5.3.1.2 Kingsburg

The gravity mains within Kingsburg that fail to meet performance criteria under existing design flows can be found in Table 5-3.

Table 5-3. Gravity Mains Within Kingsburg Not Meeting Performance Criteria Under Existing Conditions

Location	Diameter	Extent	Cause
Stroud Avenue	10-inch	18th Avenue to 22nd Avenue	Undersized
Rafer Johnson Drive	15-inch	Sunset Street to Meadow Lane	Insufficient Slope
Highway CA-99	18-inch	North of West Kern Street	Insufficient Slope
Highway CA-99	12-inch	Intersection with West Kern Street	Insufficient Slope
Gilroy Street	14-inch	Intersection of Smith Avenue	Insufficient Slope
18th Avenue	21-inch	South of Riverside Street	Insufficient Slope
Stroud Avenue	10-inch	West of 24th Avenue	Insufficient Slope
Stroud Avenue	10-inch	18th Avenue to 22nd Avenue	Insufficient Slope
Stroud Avenue	18-inch	East of 12th Avenue	Insufficient Slope
Ally	12-inch	South of Silverbrooke Street	Insufficient Slope
Morgan Drive	15-inch	Lake Street and Mariposa Street	Insufficient Slope
15th Avenue	10-inch	Kamm Avenue to Hemma Street	Insufficient Slope
Academy Avenue	12-inch	North of Harold Street	Insufficient Slope
Road 12	24-inch	North of Simpson Street	Insufficient Slope

5.3.1.3 Fowler

The gravity mains within Fowler that fail to meet performance criteria under existing design flows can be found in Table 5-4.

Table 5-4. Gravity Mains Within Fowler Not Meeting Performance Criteria Under Existing Conditions

Location	Diameter	Extent	Cause
North 10th Street	8-inch	Tuolumne Street to West Merced Street	Undersized
West Fresno Street	6-inch	South Fowler Avenue to South 10th Avenue	Undersized
East Merced Street	8-inch	Northeast of 5th Street	Undersized
South De Wolf Avenue	12-inch	Intersection of South Golden State Boulevard	Undersized

5.3.2 Existing Lift Station Hydraulic Evaluation

As described in Chapter 3, the District's performance standards require that all collection system lift stations have sufficient capacity to convey design flows with the largest pump out of service, defined as the "firm capacity" of the lift station. Each existing lift station's firm capacity was compared to the existing design flow conveyed to the lift station. If the designed flow was greater than the lift station's firm capacity, then the lift station was considered to have insufficient capacity. The majority of the collection system lift stations currently have sufficient firm capacity to convey existing design flows; however, the hydraulic model indicates that there are several lift stations that lack this capacity under existing conditions. The lift stations that have insufficient firm capacity to convey existing design flows can be seen in Table 5-5. These lift stations are also presented on Figure 5-3.

Table 5-5. Lift Stations Not Meeting Performance Criteria Under Existing Conditions

Lift Station Name	Lift Station ID	Location	Notes
Merced Street	D-1	Fowler	District facility.
Manning	D-2	Fowler	District facility.
North Street	D-3	Selma	District facility.
Clarkson & Mc Call	S-11	Selma	

5.3.3 Existing Force Main Hydraulic Evaluation

There are no force mains that fail to meet the District's performance criteria under existing conditions.

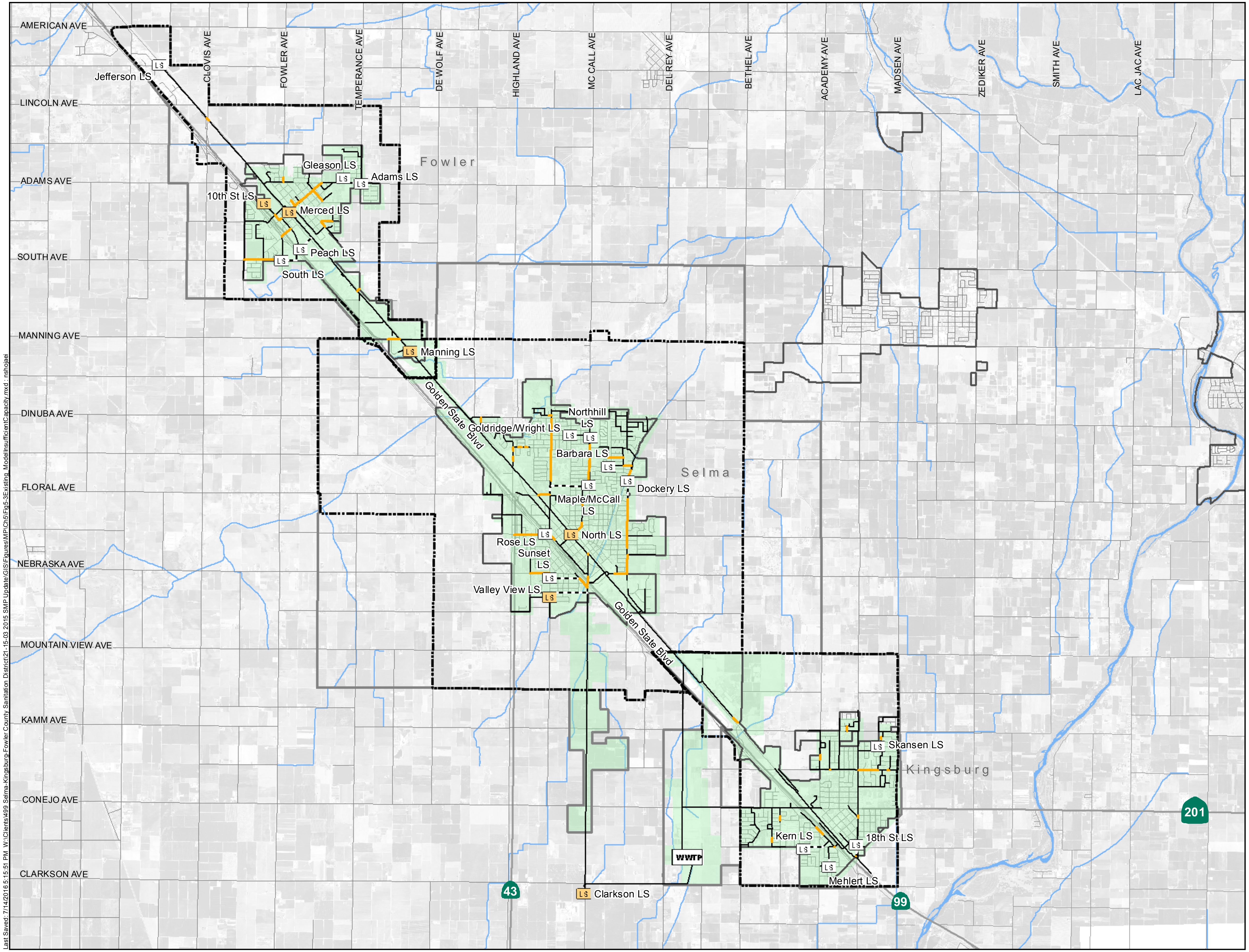


Figure 5-3

Infrastructure with Insufficient Capacity - Existing Design Flow

Selma-Kingsburg-Fowler CSD
Wastewater Collection System
2016 Master Plan Update

5.4 FUTURE CAPACITY EVALUATION

The infrastructure required to convey the future (2020, 2025, and 2035) design flows as described in Chapter 4, including both upgrades to existing infrastructure and new infrastructure, is described in the sections below. A discussion of the methodologies used to assign future flows and to develop new infrastructure is included.

5.4.1 Development Methodology for New Collection System Infrastructure

In general, development of the new collection system infrastructure for future flows was governed by the limits and criteria presented in Chapter 3. It is the District's, as well as the member Cities' preference to avoid the construction of pump stations where possible, and to utilize gravity mains to the extent practicable. The topographic data used during the development of the new infrastructure was obtained from 2-foot contour interval data in GIS format from Fresno County.

Overall development of the proposed alignments for the new infrastructure was intended to reflect the following major considerations:

- The alignment should respect, to the degree practicable, the barriers presented by parcel boundaries, existing roads, canals, and other land features.
- Regional topography and minimum slope considerations should allow the remote future connections to be served by the proposed trunk sewer.
- Construction, operation, and maintenance costs associated with the proposed alignment should be manageable.

The required collection system infrastructure for future design flows can be seen on Figure 5-4.

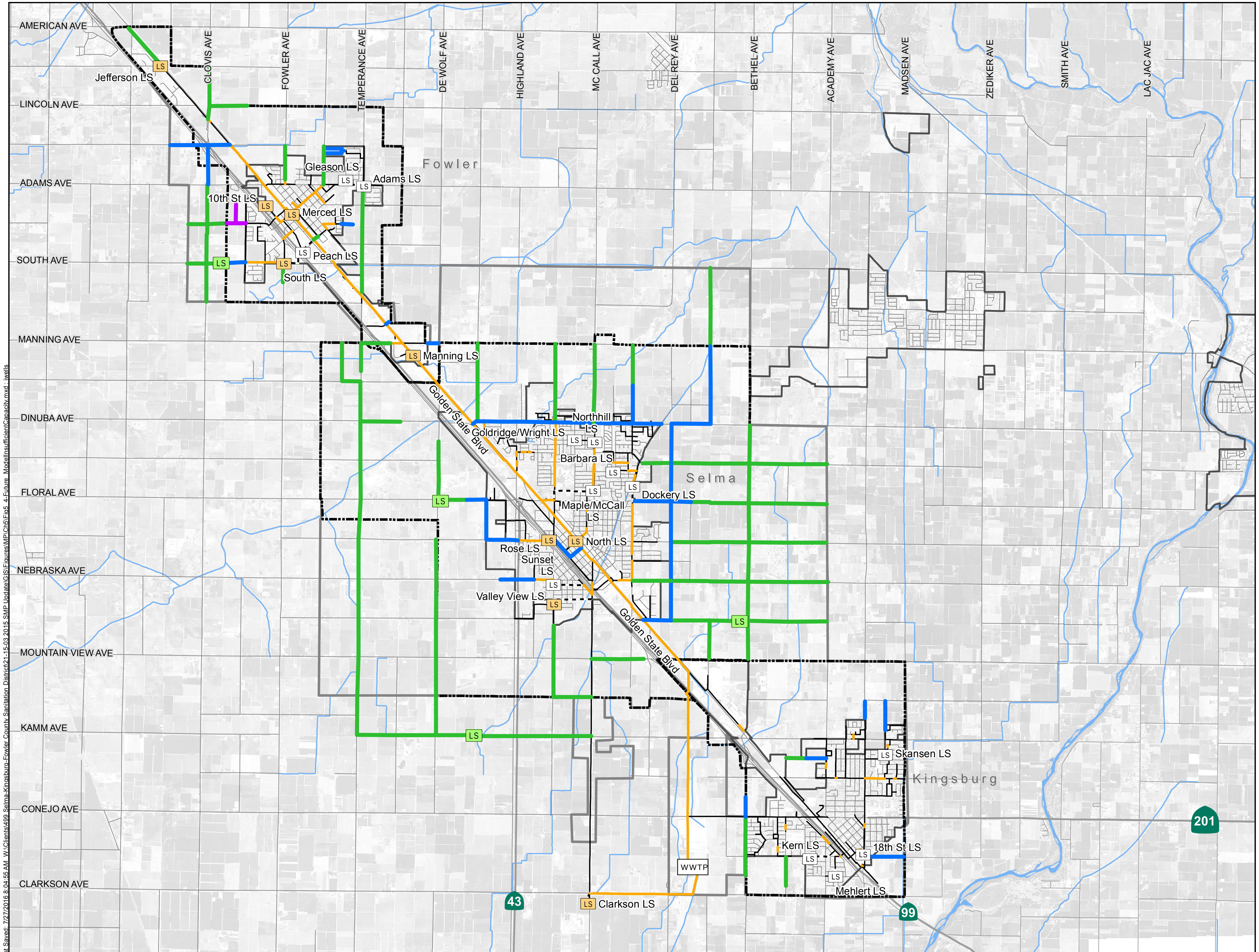
5.4.2 Load Allocation for Future Design Flows

Tributary areas were identified for allocating wastewater flows to the appropriate modeled gravity main, either existing or new. Each tributary area has at least one connection node in the hydraulic model. Current and future land uses for each tributary area were tabulated using the land use information in Chapter 2 and the development information presented in Chapter 4 as applicable.

The tributary area to load allocation shown on Figure 5-5, Figure 5-6, and Figure 5-7 for the three member Cities represent the locations where projected flows from study area tributary areas were loaded into the modeled collection system network. The load allocation is based upon the local topography. Certain larger tributary areas were loaded to more than one manhole, with each link representing an equal percentage of the total projected flows from a given parcel. The intent of this methodology was to load wastewater flows as realistically as possible in the hydraulic model.

5.4.3 Future Gravity Main Hydraulic Evaluation

The existing infrastructure that does not meet the District's performance criteria with future design flows, as well as the new gravity mains required to convey future design flow, are described below.



Symbology

- WWTP Wastewater Treatment Plant
- LS Existing Lift Station
- LS Existing Lift Station - Insufficient Capacity
- LS Proposed Lift Station
- Existing Force Main
- Existing Gravity Main
- Existing Gravity Main - Insufficient Capacity
- New Gravity Main - 2020
- New Gravity Main - 2025
- New Gravity Main - 2035
- 2016 Master Plan Study Area
- City SOIs
- City Limits

Figure 5-4

Infrastructure with Insufficient Capacity - Future Design Flow

Selma-Kingsburg-Fowler CSD
Wastewater Collection System
2016 Master Plan Update

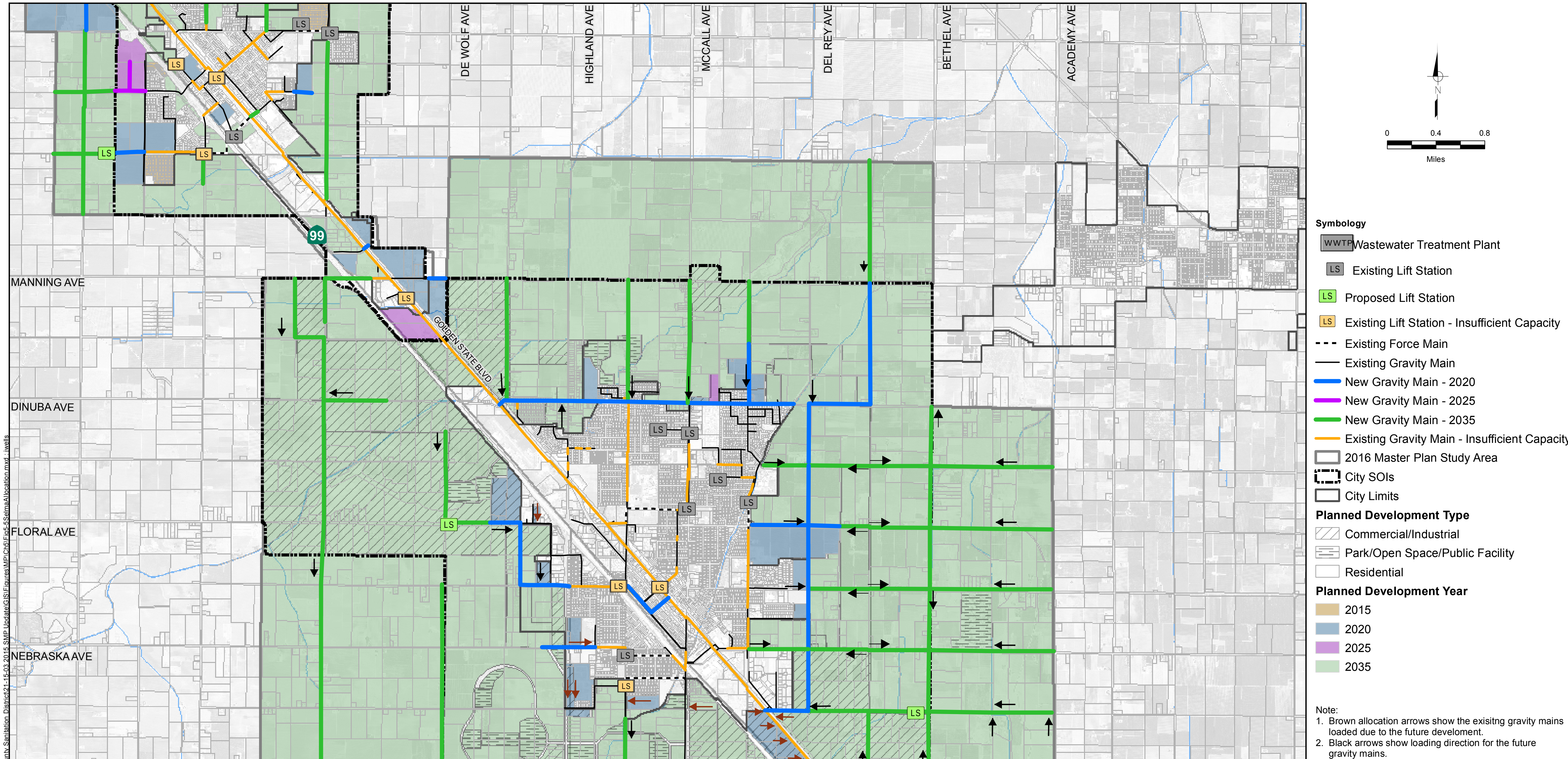


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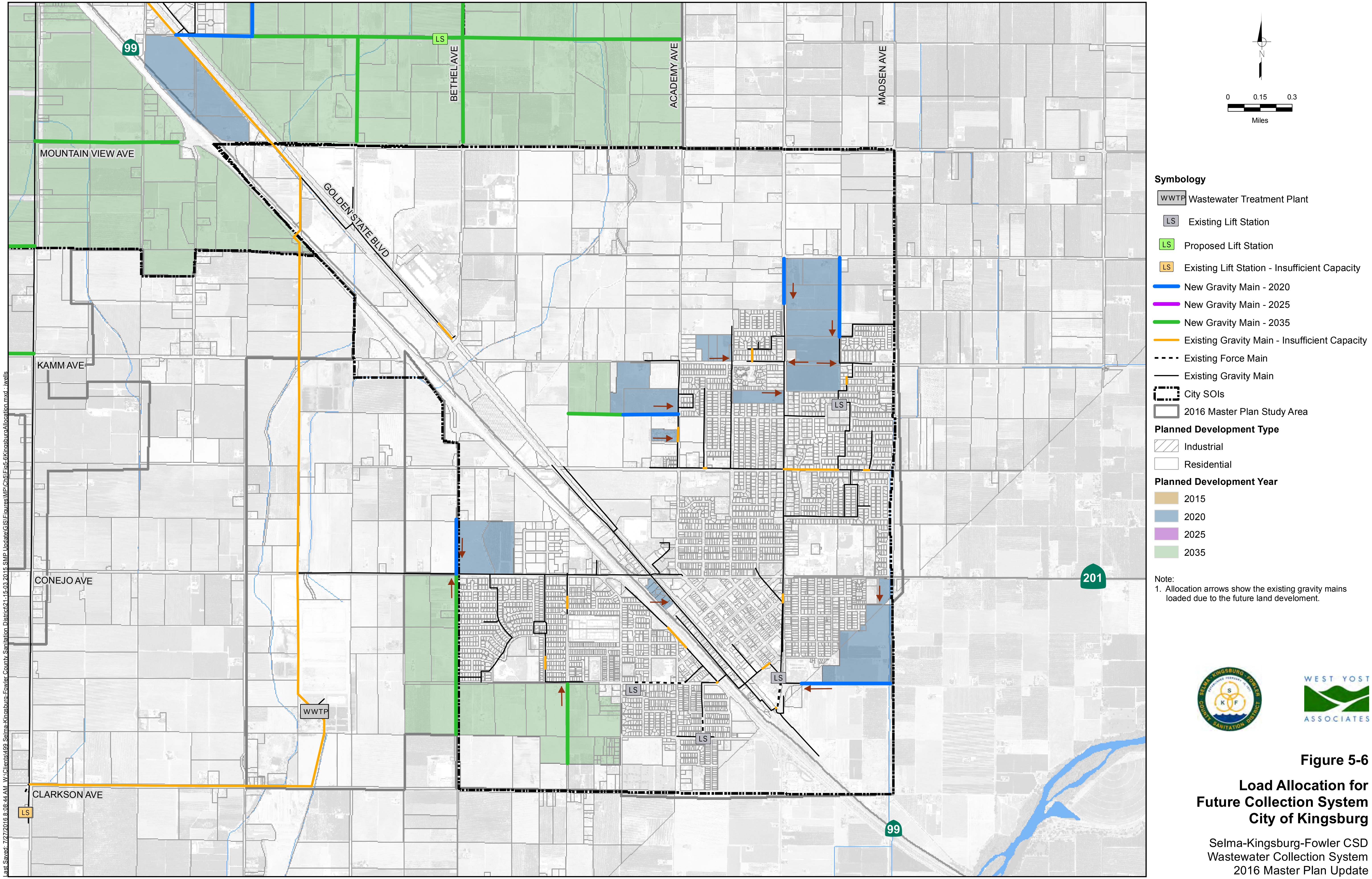
Figure 5-5

Load Allocation for Future Collection System City of Selma

Selma-Kingsburg-Fowler CSD
Wastewater Collection System
2016 Master Plan Update



Symbology

- WWTP Wastewater Treatment Plant
- LS Existing Lift Station
- LS Proposed Lift Station
- LS Existing Lift Station - Insufficient Capacity
- New Gravity Main - 2020
- New Gravity Main - 2025
- New Gravity Main - 2035
- Existing Gravity Main - Insufficient Capacity
- Existing Force Main
- Existing Gravity Main
- City SOIs
- 2016 Master Plan Study Area

Planned Development Type

- Industrial
- Residential

Planned Development Year

- 2015
- 2020
- 2025
- 2035

Note:
1. Allocation arrows show the existing gravity mains loaded due to the future land develoment.

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Figure 5-6

Load Allocation for Future Collection System City of Kingsburg

Selma-Kingsburg-Fowler CSD
Wastewater Collection System
2016 Master Plan Update

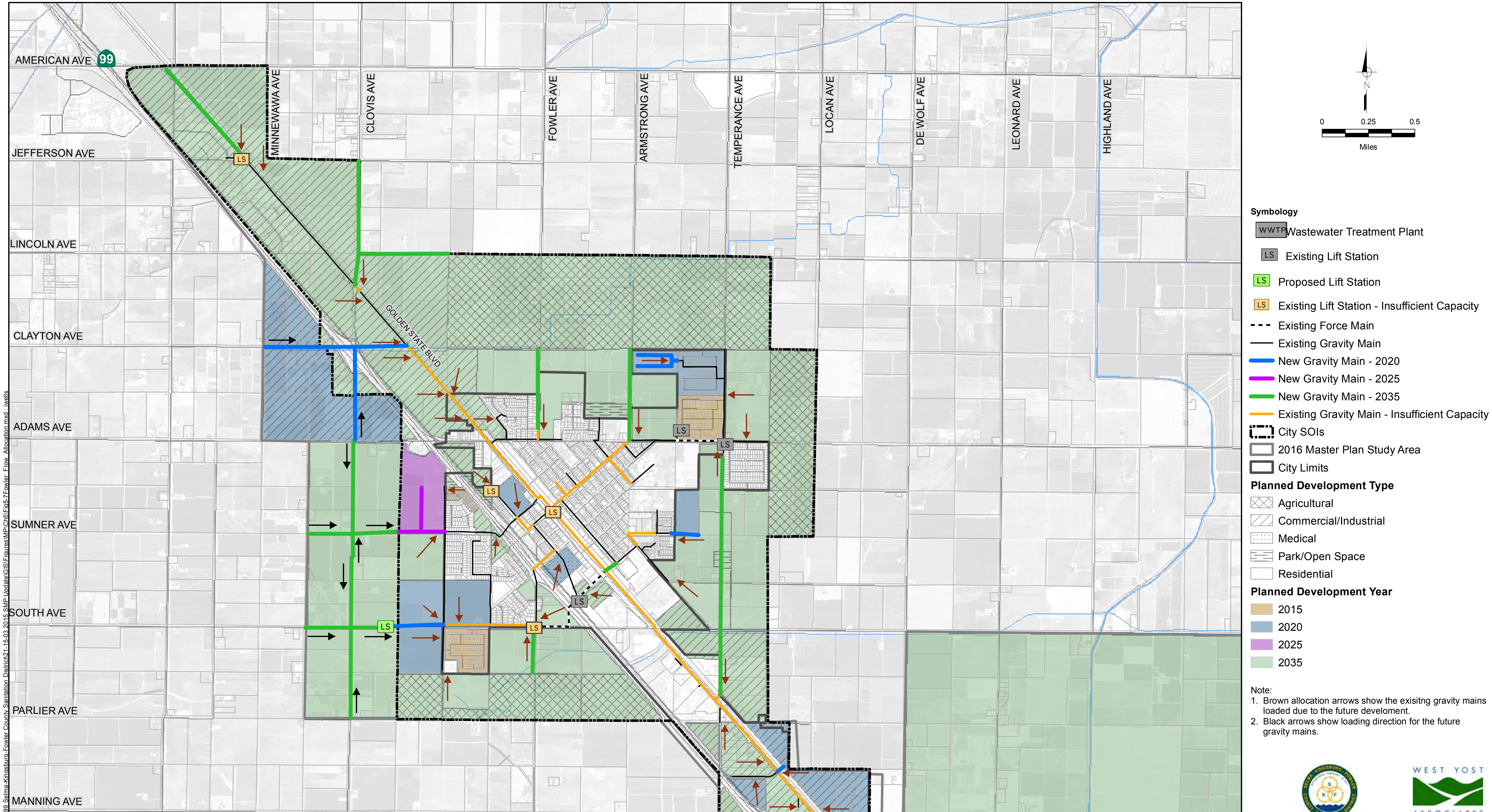

Figure 5-7
Load Allocation for Future Collection System City of Fowler

Selma-Kingsburg-Fowler CSD
Wastewater Collection System
2016 Master Plan Update

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5.4.3.1 Selma

The existing gravity mains within Selma that do not meet the District's performance criteria under future conditions according to the hydraulic modeling evaluation are presented in Table 5-6.

Table 5-6. Existing Gravity Mains Within Selma Not Meeting Performance Criteria Under Future Conditions

Location	Diameter	Extent	Cause	Development Timeline
Rose Avenue	24-inch	Shaft Street and Rose Avenue LS	Undersized	2035
Thompson Avenue	18-inch	South of Blaine Avenue	Undersized	2035

A general description of the new gravity mains required to serve the future development timelines within Selma is provided below. These gravity mains can be seen on Figure 5-4.

Area North of Selma for 2020 Timeline

- New gravity main in East Dinuba Avenue between Ditch Road and Golden State Boulevard

Amberwood and Other Residential Developments in the Northeast and East of Selma for 2020 Timeline

- New gravity main in South Indianola Avenue between East South Avenue and East Manning Avenue
- New gravity main in East Manning Avenue extending west from South Indianola Avenue
- New gravity main in South Indianola Avenue between East Manning Avenue and East Dinuba Avenue
- New gravity main in East Dinuba Avenue extending east from South Del Rey Avenue
- New gravity main in South Del Rey Avenue between East Dinuba Avenue and East Saginaw Avenue
- New gravity main in East Floral Avenue between Dockery Avenue and South Amber Avenue

Relief for Young Street for 2020 Timeline

- New gravity main in Young Street from Rose Avenue to 1st Street

Commercial and Industrial Developments in the Northwest of Selma for 2020 Timeline

- New gravity main in East Rose Avenue between South Highland Avenue and east of South Leonard Avenue
- New gravity main in South Leonard Avenue between East Rose Avenue and East Floral Avenue
- New gravity main in East Floral Avenue between East of South Leonard Avenue and South De Wolf Street
- New gravity main in South De Wolf Street extending north from East Floral Avenue

Industrial and Residential Developments to the West of Selma for 2035 Timeline

- New gravity main in East Dinuba Avenue extending east from South Temperance Avenue
- New gravity main in South Temperance Avenue between East Springfield and East Kamm Avenue
- New gravity main in South De Wolf Avenue between East Rose Avenue and East Kamm Avenue
- New gravity main in East Kamm Avenue between South Temperance Avenue and South Mc Call Avenue
- New gravity main in Thompson Avenue extending south from Saginaw Avenue
- New gravity main in South Mc Call Avenue between East Kamm Avenue and East Clarkson Avenue
- New gravity main in East Clarkson Avenue between South Mc Call Avenue and Wastewater Treatment Plant

Industrial and Residential Developments to the North of East Dinuba Avenue for 2035 Timeline

- New gravity main in South Leonard Avenue between East South Dinuba Avenue and East South Avenue
- New gravity main in South Thompson Avenue between Dinuba Avenue and East South Avenue
- New gravity main in Dockery Avenue extending north from Dinuba Avenue to East South Avenue

Industrial and Residential Developments to the East of Selma for 2035 Timeline

- New gravity main in South Bethel Avenue between East Dinuba Avenue and East Mountain View Avenue
- New gravity mains in East Huntsman Avenue, Floral Avenue, Rose Avenue, and Nebraska Avenue between South Academy Avenue and South Bethel Avenue

- New gravity mains in East Huntsman Avenue, Floral Avenue, Rose Avenue, and Nebraska Avenue extending west from South Bethel Avenue
- New gravity mains in East Huntsman Avenue, Rose Avenue, and Nebraska Avenue extending east from South Del Rey Avenue
- New gravity mains in East Huntsman Avenue and Nebraska Avenue extending west from South Del Rey Avenue
- New gravity main in East Saginaw Avenue between South Academy Avenue and South Del Rey Avenue
- New gravity main in South Bethel Avenue between East Mountain View Avenue and East Saginaw Avenue

Selma Crossing Developments to the South of Selma

- New gravity main in East Mountain View Avenue between Mc Call Avenue and South Van Horn Avenue

5.4.3.2 Kingsburg

There are no existing gravity mains within Kingsburg that fail to meet the District's performance criteria under future conditions according to the hydraulic modeling evaluation. A general description of the new gravity mains required to serve the future development timelines within Kingsburg is provided below. These gravity mains can be seen on Figure 5-4.

Kingsburg Development for 2020 Timeline

- New gravity main in South Bethel Avenue extending north from East Conejo Avenue
- New gravity main in 36th Avenue between Road 16 and Kern Street
- New gravity main in Stroud Avenue between 18th Avenue and 22nd Avenue
- New gravity main in South Mendocino Avenue between 17th Avenue and East Caruthers Avenue

Kingsburg Development for 2035 Timeline

- New gravity main in South Bethel Avenue extending south from East Conejo Avenue
- New gravity main in Rafer Johnson Drive extending south from East Magnolia Avenue

5.4.3.3 Fowler

The existing gravity mains within Fowler that do not meet the District's performance criteria under future conditions according to the hydraulic modeling evaluation are presented in Table 5-7.

Table 5-7. Existing Gravity Mains Within Fowler Not Meeting Performance Criteria Under Future Conditions

Location	Diameter	Extent	Cause	Development Timeline
East Sumner Street	8/10-inch	Laker Lane to South 5th Street	Undersized	2020
South 5th Street	10-inch	East Sumner Avenue to South 7th Street	Undersized	2020
South 7th Street	15-inch	East Merced Street to Peach Street	Undersized	2035
Peach Street	15-inch	6th Street to 7th Street	Undersized	2035
South 5th Street	10-inch	Harris Court to East Mott Avenue	Undersized	2035
South Fowler Avenue	10-inch	East La Crosse Avenue to East Adams Avenue	Undersized	2035
East Manning Avenue	8/10-inch	Golden State Boulevard to Vineyard Place	Undersized	2035
East South Avenue	12-inch	South Fowler Avenue to South Sunnyside Avenue	Undersized	2035
East Merced Street	12-inch	Adam Avenue to Golden State Boulevard	Undersized	2035

A general description of the new gravity mains required to serve the future development timelines within Fowler is provided below. These gravity mains can be seen on Figure 5-4.

Fowler Development for 2020 Timeline

- New gravity main in South Armstrong Avenue to South Temperance Avenue
- New gravity main in East Sumner Avenue extending east from Christopher Court
- New gravity main in East Valley Derive extending east from Golden State Boulevard
- New gravity main in East Manning Avenue between South De Wolf Avenue and South Golden State Boulevard
- New gravity main in East South Avenue extending West from South Sunnyside Avenue

Fowler Development for 2025 Timeline

- New gravity main in East Sumner Avenue extending West from South Sunnyside Avenue
- New gravity main north of East Sumner Avenue

Fowler Development for 2035 Timeline

- New gravity main in South Clovis Avenue between East Adams Avenue and South of East Sumner Avenue
- New gravity main in Golden State Boulevard between American Avenue and Jefferson Avenue
- New gravity main in Clovis Avenue between East Jefferson Avenue and South Golden State Boulevard
- New gravity main in Lincoln Avenue between Clovis Avenue and South Sunnyside Avenue
- New gravity main in South Fowler Avenue between East La Crosse Avenue and East Clayton Avenue
- New gravity main in South Armstrong Avenue between East Clayton Avenue and East Adams Avenue
- New gravity main in South Harris Avenue at East South Avenue
- New gravity main in South Temperance Avenue extending north from South Golden State Boulevard
- New gravity main in East Manning Avenue at South Temperance Avenue
- New gravity main in South Fowler Avenue extending south from East South Avenue
- New gravity main in East South Avenue extending east from South Kenneth Avenue
- New gravity main in South Clovis Avenue extending north from East Parlier Avenue
- New gravity main in East Sumner Avenue extending East from South Kenneth Avenue

5.4.3.4 District Gravity Mains

In addition to the gravity mains that are described above, the existing gravity main in the Golden State Boulevard fails to meet performance criteria for the 2035 timeline.

5.4.4 Future Lift Station Hydraulic Evaluation

The hydraulic model indicates that there are several existing lift stations that lack firm capacity under future conditions. The lift stations that have insufficient firm capacity to convey future design flows can be seen in Table 5-8. These lift stations are also presented on Figure 5-4.

Table 5-8. Existing Lift Stations Not Meeting Performance Criteria Under Future Conditions			
Lift Station Name	Lift Station ID	Location	Development Timeline
South Avenue	F-5	Fowler	2035
Rose Street	S-3	Selma	2035

Additionally, four new lift stations are required to serve future timeline development because minimum slope and minimum cover criteria do not allow service entirely by gravity mains. These proposed future lift stations can be seen in Table 5-9.

Table 5-9. Proposed Future Lift Stations Required to Convey Design Flows Under Future Conditions		
Proposed Future Lift Station Name	Location	Development Timeline
Proposed East Kamm Avenue	Selma	2035
Proposed East Floral Avenue	Selma	2035
Proposed East Saginaw Avenue	Selma	2035
Proposed East South Avenue	Fowler	2035

5.4.5 Future Force Main Hydraulic Evaluation

A single existing force main, the 10-inch force main at the North Street Lift Station, was identified by the hydraulic model as being insufficient for future design flows.

Operational Analysis

Whereas previous chapters have focused on the hydraulic capacity of the collection system and the need for future capacity to meet development needs, Chapter 6 summarizes the evaluation of the condition and day-to-day operation of the District's collection system. Maintaining the condition of the collection system and providing effective operation of the collection system are equally important to providing adequate hydraulic capacity in meeting the needs of the member cities and their customers.

6.1 GRAVITY MAIN RISK ASSESSMENT

This section describes the methodology and results of the risk assessment of the gravity sewer mains. For the gravity mains in the collection system, a risk model was developed in InfoMaster™ Sewer, an advanced ArcGIS-based analytical asset management and capital planning software for wastewater networks. A rating for both likelihood and consequence of failure was assigned by the model to each gravity main. For this analysis, a failure is considered to be a deficiency that results in a sanitary sewer overflow (SSO). SSOs are violations of state and federal laws, and can adversely impact the environment and public health. SSOs can also require costly emergency repairs which are disruptive to the community.

The risk assessment model then combines the likelihood of failure ratings with the consequence of failure ratings to develop a comprehensive risk rating. This section summarizes the District-specific analysis that uses available information to assign a risk level for each gravity main in the District's collection system.

6.1.1 Likelihood of Failure Analysis

The likelihood of failure analysis considers the probability that a failure will occur in a given gravity main. Gravity mains have the following principal failure modes: structural failure, maintenance failure, and hydraulic capacity failure. For each failure mode, one or more factors are considered in determining the likelihood of a failure, as discussed below.

6.1.1.1 Failure Modes

Hydraulic Capacity Failure. Hydraulic restrictions or bottlenecks cause surcharging, which can lead to SSOs at, or upstream of, the location of the restriction. A sewer main with inadequate hydraulic capacity is defined as a segment for which the maximum flow (q) exceeds the full flow capacity (Q) in the gravity sewer main, as estimated by the District's hydraulic model. The hydraulic model is a skeletonized version of the system, with trunk lines included, but neighborhood collector mains omitted. It is not expected that these small-diameter neighborhood mains have hydraulic capacity issues, as these gravity mains are typically a minimum of 6 or 8 inches in diameter and sized larger than required to convey the flows in order to facilitate cleaning equipment. The results of the hydraulic capacity failure analysis are shown on Figure 6-1.

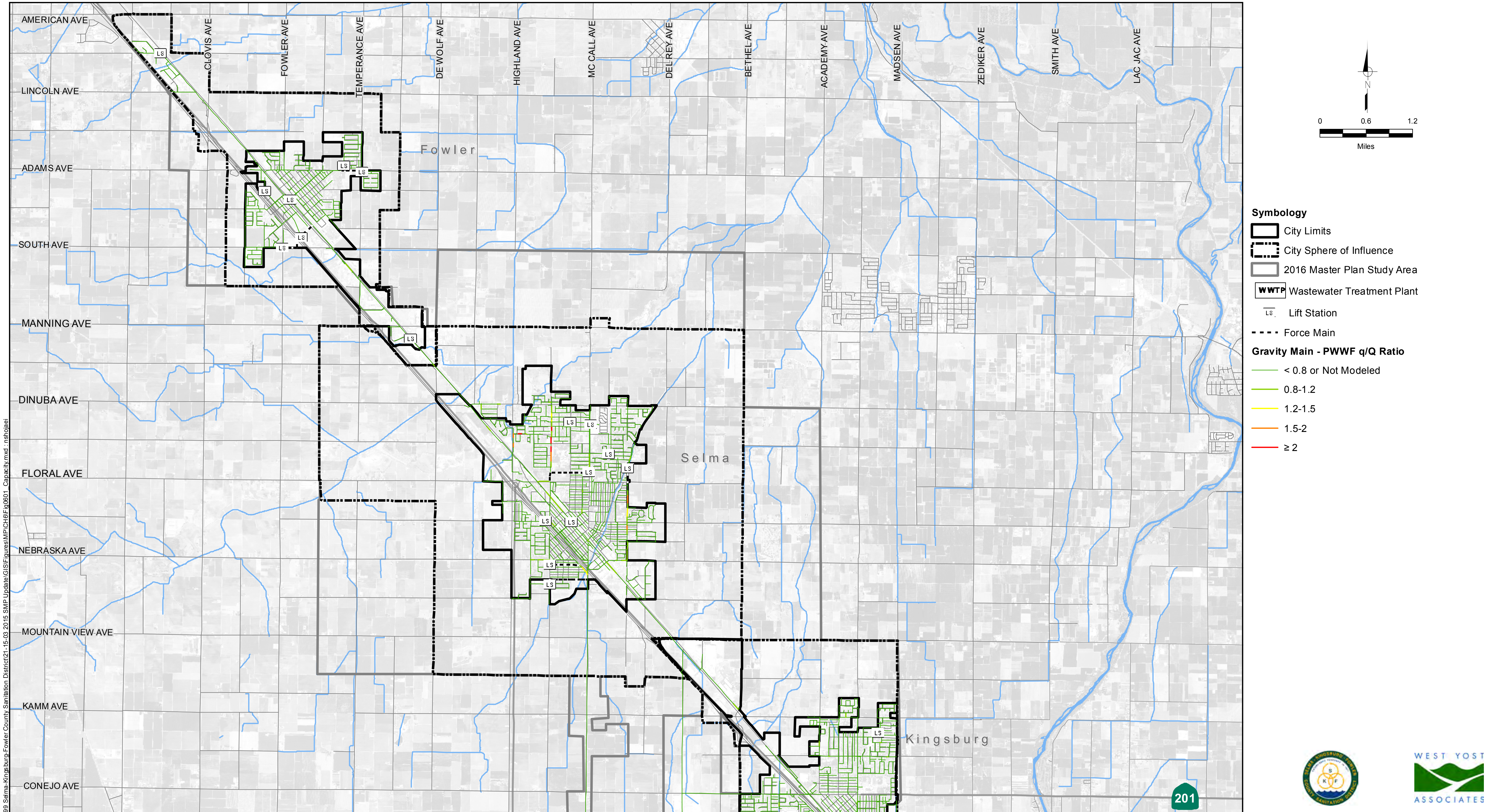


Figure 6-1

Likelihood of Failure Hydraulic Capacity Failure

Selma-Kingsburg-Fowler CSD
Wastewater Collection System
2016 Master Plan Update

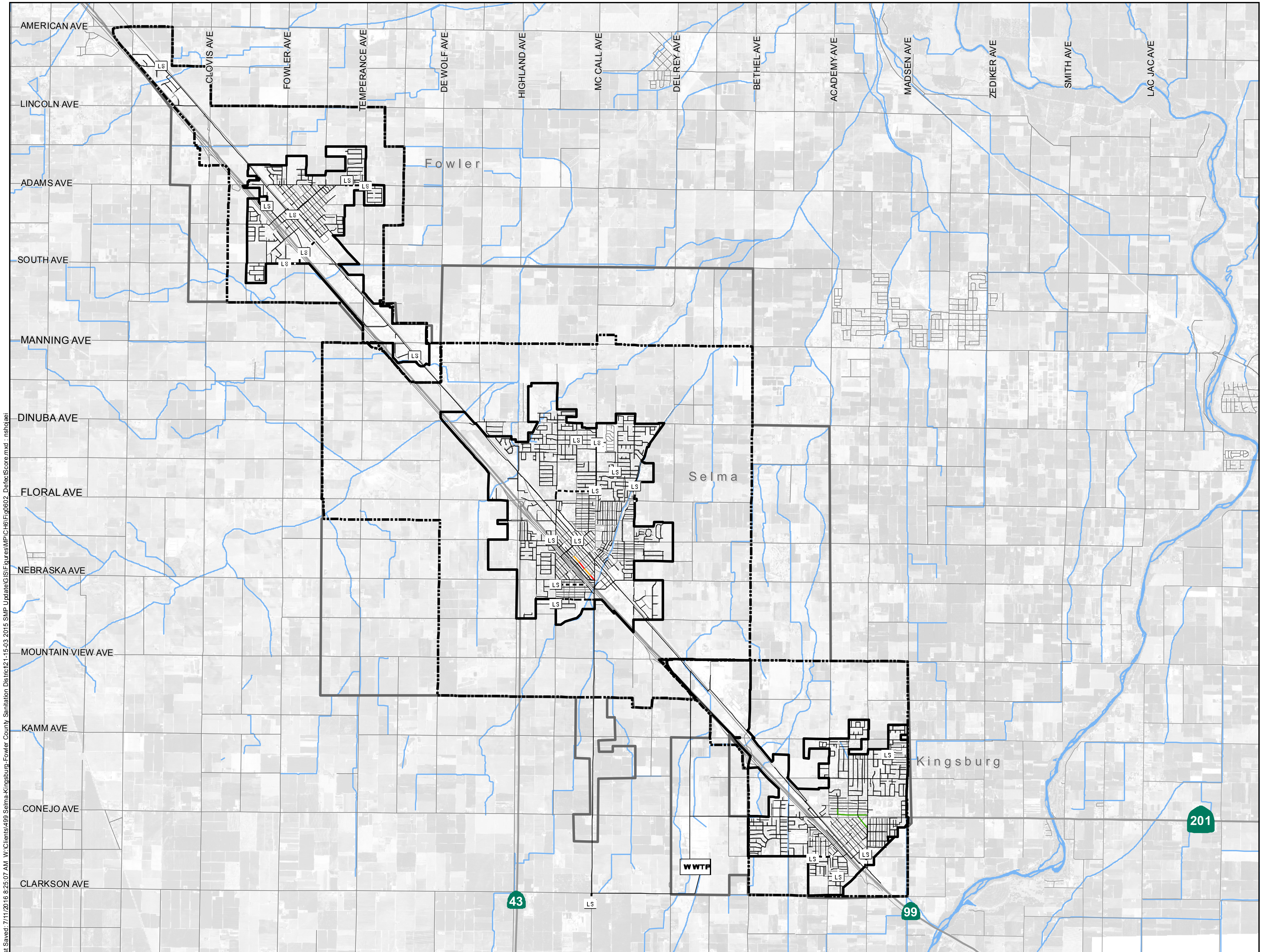
Structural Failure. Cracks and breaks can progress to pipeline collapse. The severity of structural defects is most accurately documented through Closed-Circuit Television (CCTV) inspection. However, there are only 10 gravity mains with CCTV inspections on record. Four gravity mains in Selma (6PC0-0100_6PO0-0400, 6PC0-0300_6PC0-0200, 6PC0-0200_6PC0-0100, and 6PC0-0400_6PC0-0300) and six gravity mains in Kingsburg (7ED0-0050_7EO0-0500, 7ED0-0100_7ED0-0050, 7EDA-0050_7ED0-0200, 7EDA-0100_7EDA-0050, 7EDA-0200_7EDA-0100, and 7EDB-1END_7ED0-0200) have been inspected. There are no records of inspection for gravity mains located in Fowler. The results of the structural failure analysis, as documented by the peak Pipe Assessment Certification Program (PACP) structural defect score, are shown on Figure 6-2.

For the remaining gravity mains in the system without CCTV inspection records, the likelihood of structural failure was estimated from the installation year of the gravity main, as older sewer mains are more likely to have cracks, breaks, and corrosion. The installation year was known for approximately 27 percent of the system (791 out of 2,912 pipes). This was due to inconsistencies between the District's Hansen computerized maintenance management system (CMMS) and the GIS. West Yost determined the approximate installation year for the remaining gravity mains using the county housing construction dates for the neighborhood, as recorded on Zillow.com. The results of the structural failure analysis by installation year are shown on Figure 6-3.

Maintenance Failure. Maintenance problems related to root intrusions, grease accumulations, and debris can cause blockages and result in SSOs. The District maintains records of all service calls and maintenance frequency. Records of previous blockages and/or SSOs, increased service calls and more frequent maintenance are indicators of a higher likelihood of maintenance failure.

Service calls are either recorded based on the affected pipe by Asset ID, or by the Assessor Parcel Number for the location of the caller. For this analysis, the number of service calls assigned to each parcel was spatially joined to the closest gravity main and added to the number of service calls directly recorded for each gravity main. Approximately 10 percent of the gravity mains (242 out of 2,912) have a past record of service calls. Figure 6-4 summarizes the results of the service call maintenance failure analysis.

The District also keeps a record of the higher maintenance "Trouble Spot" mains that require higher frequency (1-month, 3 months and 6 months) cleaning as a preventative measure against blockages. For those mains without any service call records, the "Trouble Spot" frequency was used to determine the likelihood of maintenance failure. Approximately 3 percent of the system is on the "Trouble Spot" list (87 pipes out of 2,912). Figure 6-5 summarizes the results of the trouble spot maintenance failure analysis.



N

0 0.6 1.2
Miles

Symbology

- City Limits
- City Sphere of Influence
- 2016 Master Plan Study Area
- WWTP Wastewater Treatment Plant
- LS Lift Station
- Force Main

Gravity Main - Structural Peak Defect Score

- Grade 5 Defect
- Grade 4 Defect
- Grade 3 Defect
- Grade 2 Defect
- Grade 1 Defect or No Defect
- No Inspection

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Figure 6-2

Likelihood of Failure Structural Failure by Defect Score

Selma-Kingsburg-Fowler CSD
Wastewater Collection System
2016 Master Plan Update

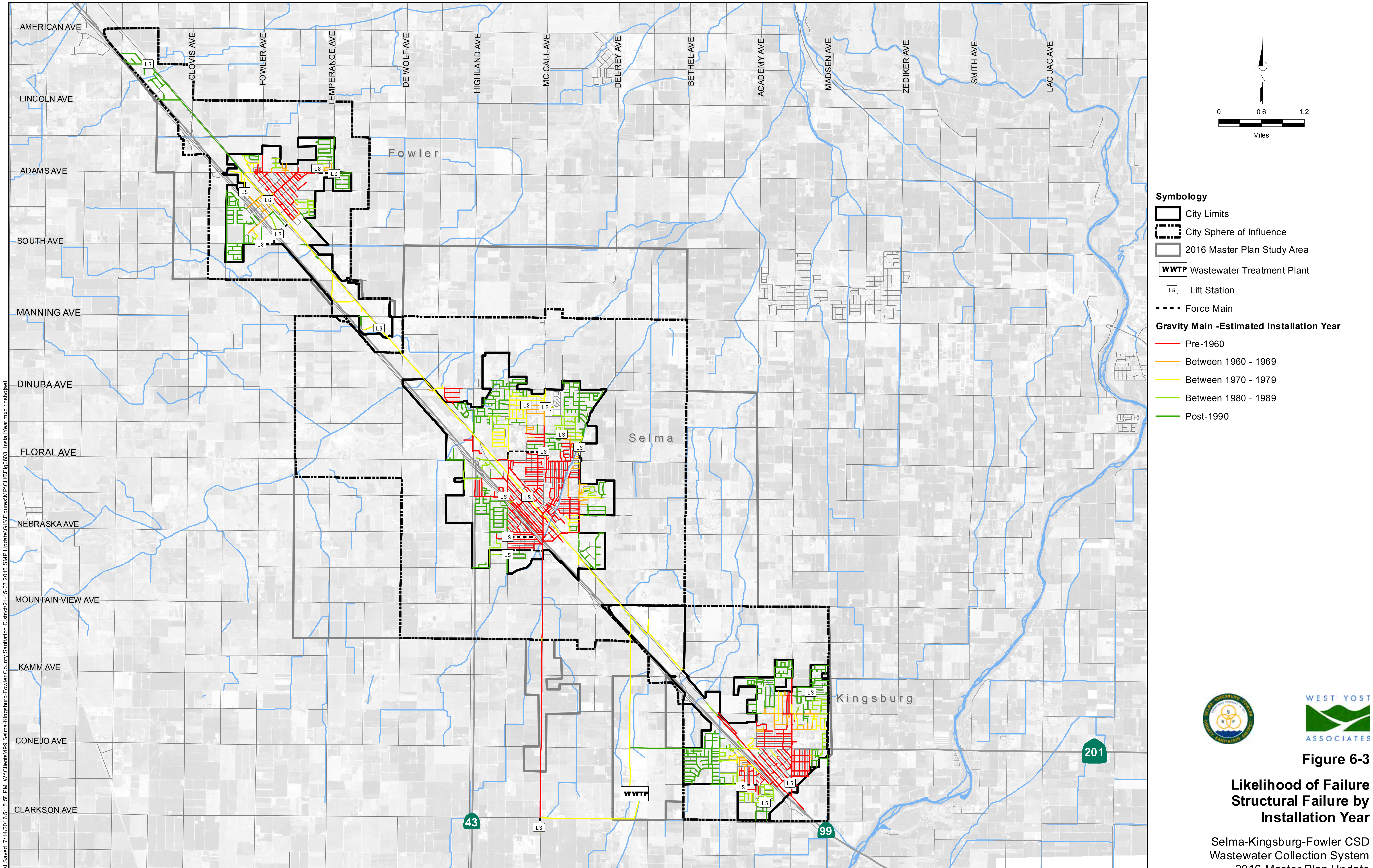

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Figure 6-3

Likelihood of Failure Structural Failure by Installation Year

Selma-Kingsburg-Fowler CSD
Wastewater Collection System
2016 Master Plan Update

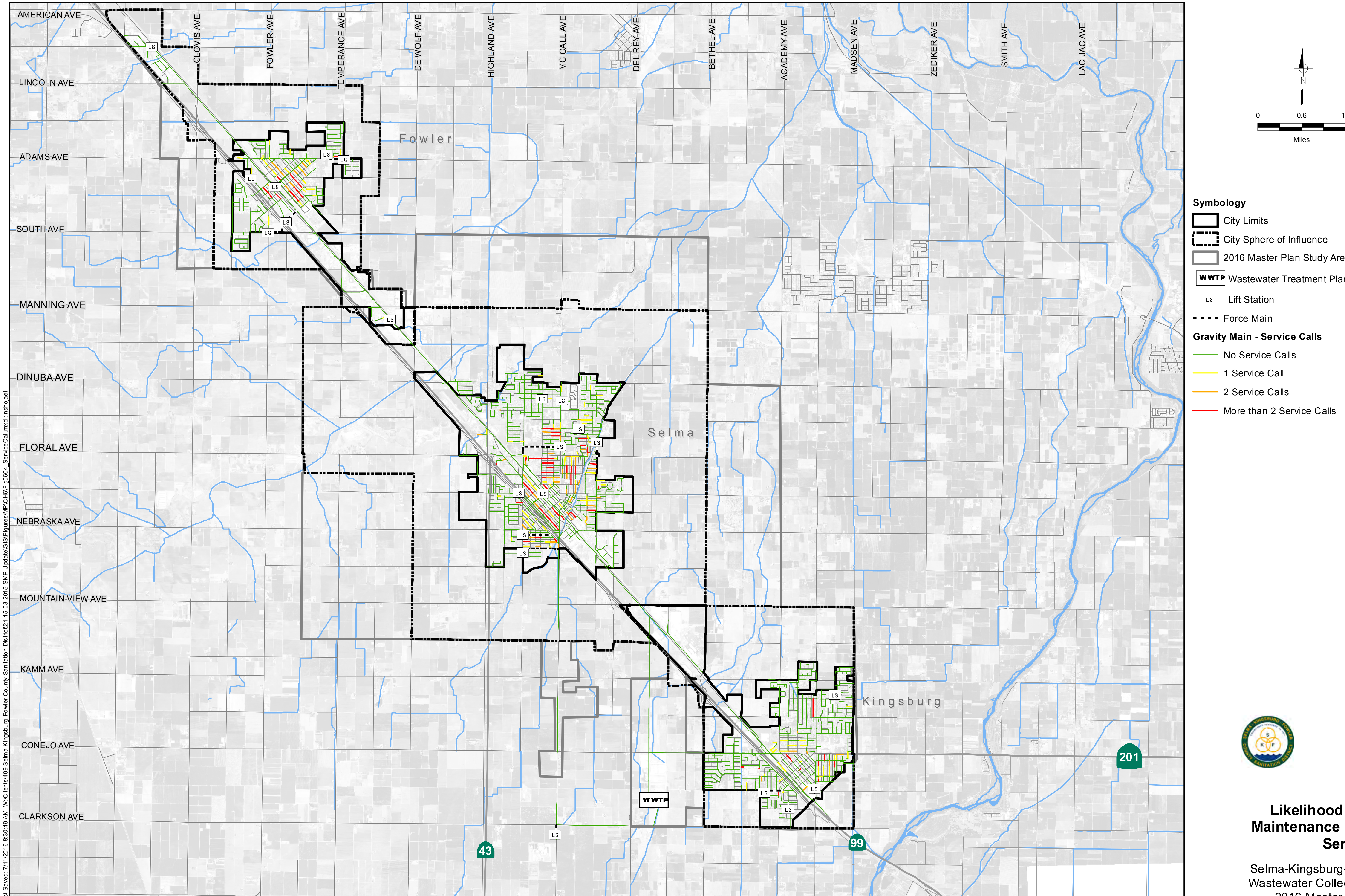

Figure 6-4

Likelihood of Failure Maintenance Failure by Service Calls

Selma-Kingsburg-Fowler CSD
Wastewater Collection System
2016 Master Plan Update

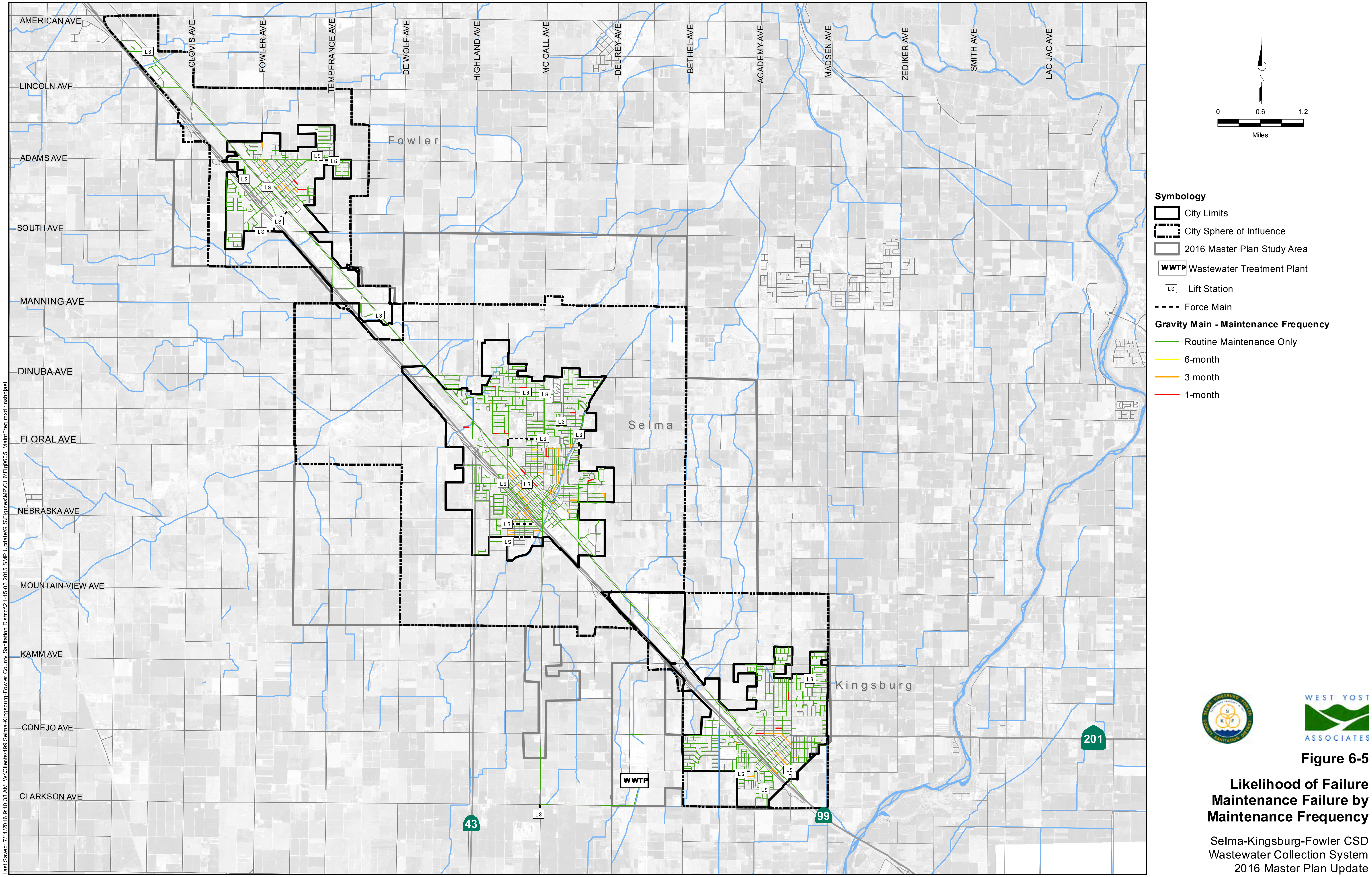

Figure 6-5

Likelihood of Failure
Maintenance Failure by Maintenance Frequency

Selma-Kingsburg-Fowler CSD
Wastewater Collection System
2016 Master Plan Update

6.1.1.2 Likelihood of Failure Methodology

The risk model described above is applied to each sewer main to produce a single rating for each likelihood failure category on a scale of one to five, with five being the highest possible rating. This rating is determined according to the Rating Logic shown in Table 6-1. Finally, the model calculates the weighted total of the three scores as the single Likelihood of Failure score with 23 and 115 being the lowest and highest possible scores, respectively. The weighting factors applied were developed through pairwise analysis as detailed in Appendix B.

6.1.2 Consequence of Failure Analysis

The consequence of failure considers the potential impacts from a SSO in each gravity main segment of the collection system. For each category, one or more factors are considered in determining the potential consequence of a failure, as discussed below. The consequence of failure analysis is divided into three categories: potential spill volume, environmental and public health, and emergency response and construction impact.

6.1.2.1 Consequence of Failure Factors

Potential Spill Volume. The State Water Resources Control Board requires collection system agencies to prevent SSOs and to mitigate SSOs when they occur. The higher the volume of the spill, the more difficult the spill mitigation and compliance requirements, and the higher fines become. The potential SSO volume was estimated from the peak wet weather flow, as estimated by the hydraulic model. The hydraulic model does not include the entire system, so pipe diameter and minimum slope were used to estimate the hydraulic capacity of un-modeled sewer mains. There is some inherent error in the SSO volume analysis; using pipe diameter and minimum slope is a conservative estimate, since this method assumes that each sewer main flows full. The results of the spill volume analysis are shown on Figure 6-6.

Emergency Response and Construction Impact. Emergency response and repair costs can increase substantially when the gravity main is difficult to access by SSO response crews. Repairs in arterial streets, highways, or railroad crossings require additional efforts to redirect traffic and are more difficult to respond to than spills on smaller collector streets. Sewer easements often add additional access constraints, as equipment mobilization, access to back yards, and work on private property limit spill mitigation and construction. The following facilities were used to identify increased emergency response impacts: gravity mains located adjacent to the Golden State freeway, railroad crossings, along arterial streets, or along collector streets. The results of the emergency response analysis are shown on Figure 6-7.

Environmental and Public Health Impact. An SSO will have an increased negative impact on public health and the environment as the proximity to public facilities (*e.g.,* schools and parks) and to environmentally sensitive areas (*e.g.,* waterways) and increases. Using GIS, an intersection of the sewer pipeline location with streams or lakes identified sewer mains located in close proximity to waterways. The distance from a pipe segment to a public facility, was estimated using GIS data of park and school locations. The consequence of failure increases as the proximity decreases, thus differing degrees of risk were assigned to pipes within 150 feet of and pipes intersecting waterways and public facilities. The results of the environmental impact analysis are shown on Figure 6-8. The results of the public health impact analysis are shown on Figure 6-9.

Table 6-1. Likelihood of Gravity Sewer Failure Rating Factors

Factor	Rating (1 being the lowest, 5 being the highest)					Rating Logic	Weighting Factor
	1	2	3	4	5		
Hydraulic Capacity Failure							
Hydraulic Capacity (q[PWWF]/Q)	< 0.8 or Not Modeled	0.8-1.2	1.2-1.5	1.5-2	≥ 2	Single Rating	1
Structural Failure							
Highest Severity Structural Defect Rating	Grade 1 Defect or No Defect	Grade 2 Defect	Grade 3 Defect	Grade 4 Defect	Grade 5 Defect	Defect Rating, if available. Otherwise, Installation Year	1
Pipe Age - Installation Decade	Post-1990	Between 1980-1989	Between 1970-1979	Between 1960-1969	Pre-1960		
Maintenance Failure							
Service Calls	No Service Calls	-	1 Service Call	2 Service Calls	More than 2 Service Calls	Highest of Two Factors	1
Maintenance Frequency - Trouble Spots	Routine Maintenance Only	-	6-month	3-month	1-month		

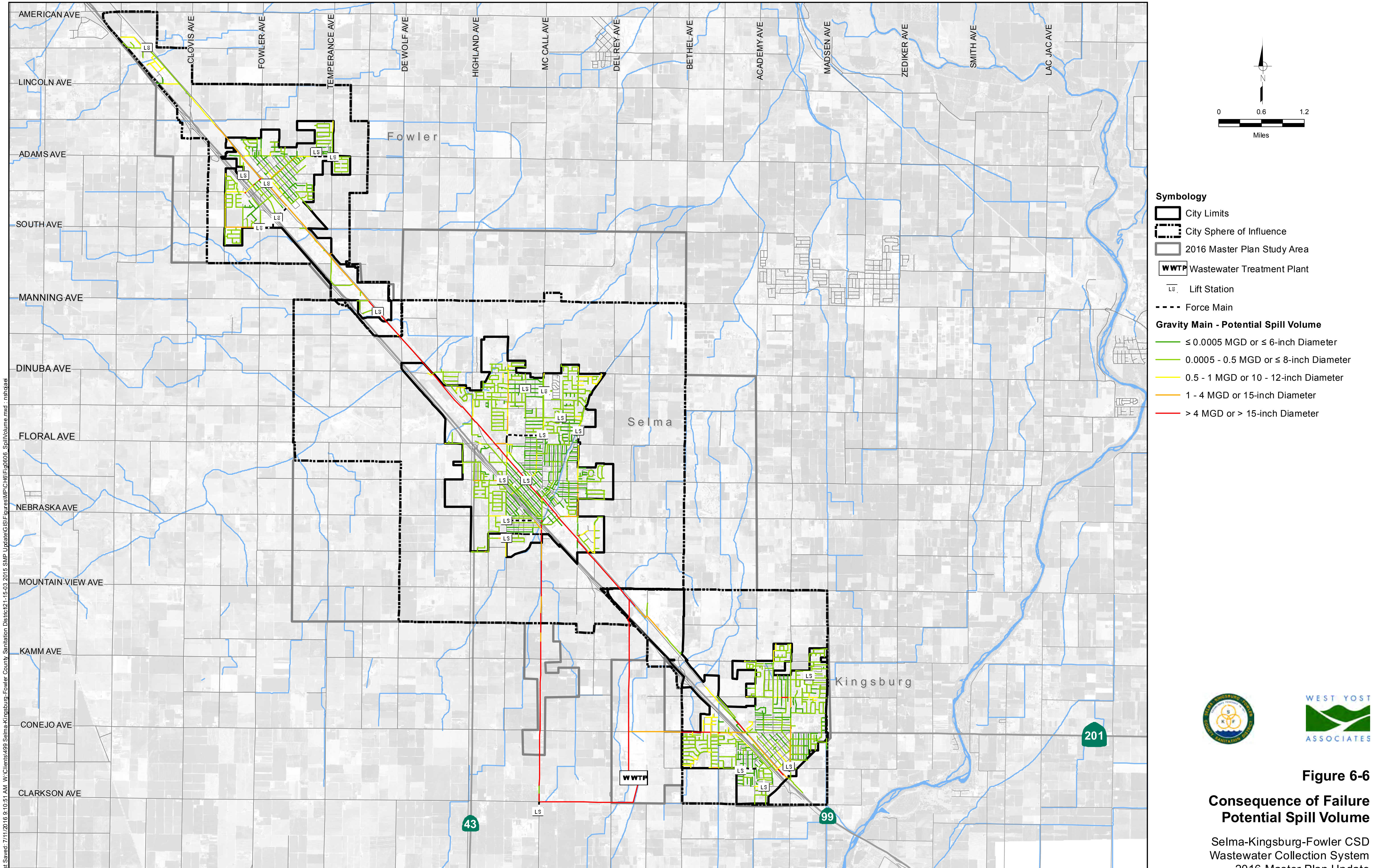

Figure 6-6

Consequence of Failure
Potential Spill Volume

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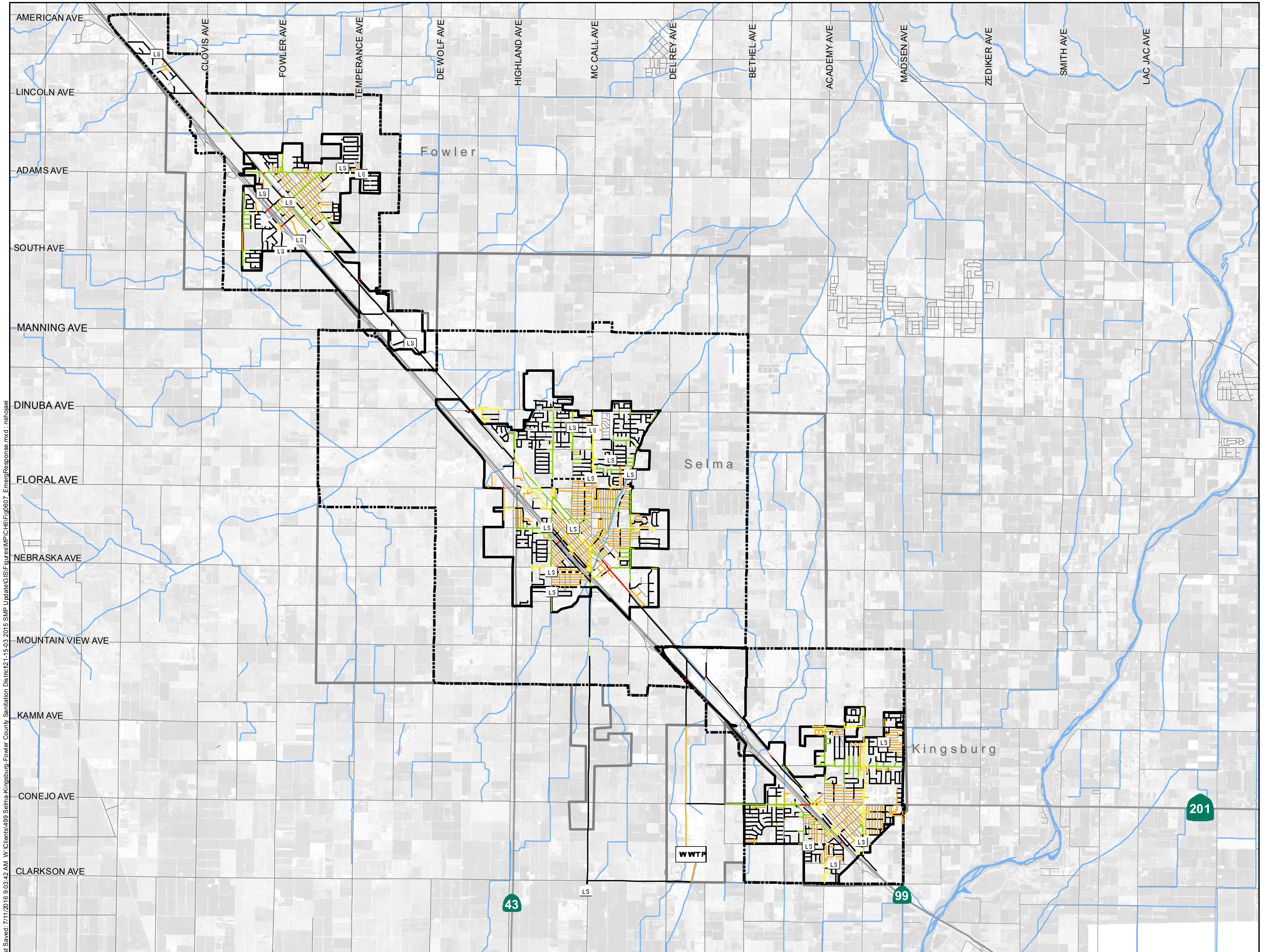
Wastewater Collection System
2016 Master Plan Update



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Miles

Symbology

City Limits

City Sphere of Influence

2016 Master Plan Study Area

WWTP Wastewater Treatment Plant

LS Lift Station

Force Main

Gravity Main - Location within Streets and Easements

Golden State Fwy or Railroad Crossing

Easement

Arterial Street

Collector

Other

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Figure 6-7

Consequence of Failure Emergency Response and Construction Impact

Selma-Kingsburg-Fowler CSD
Wastewater Collection System
2016 Master Plan Update

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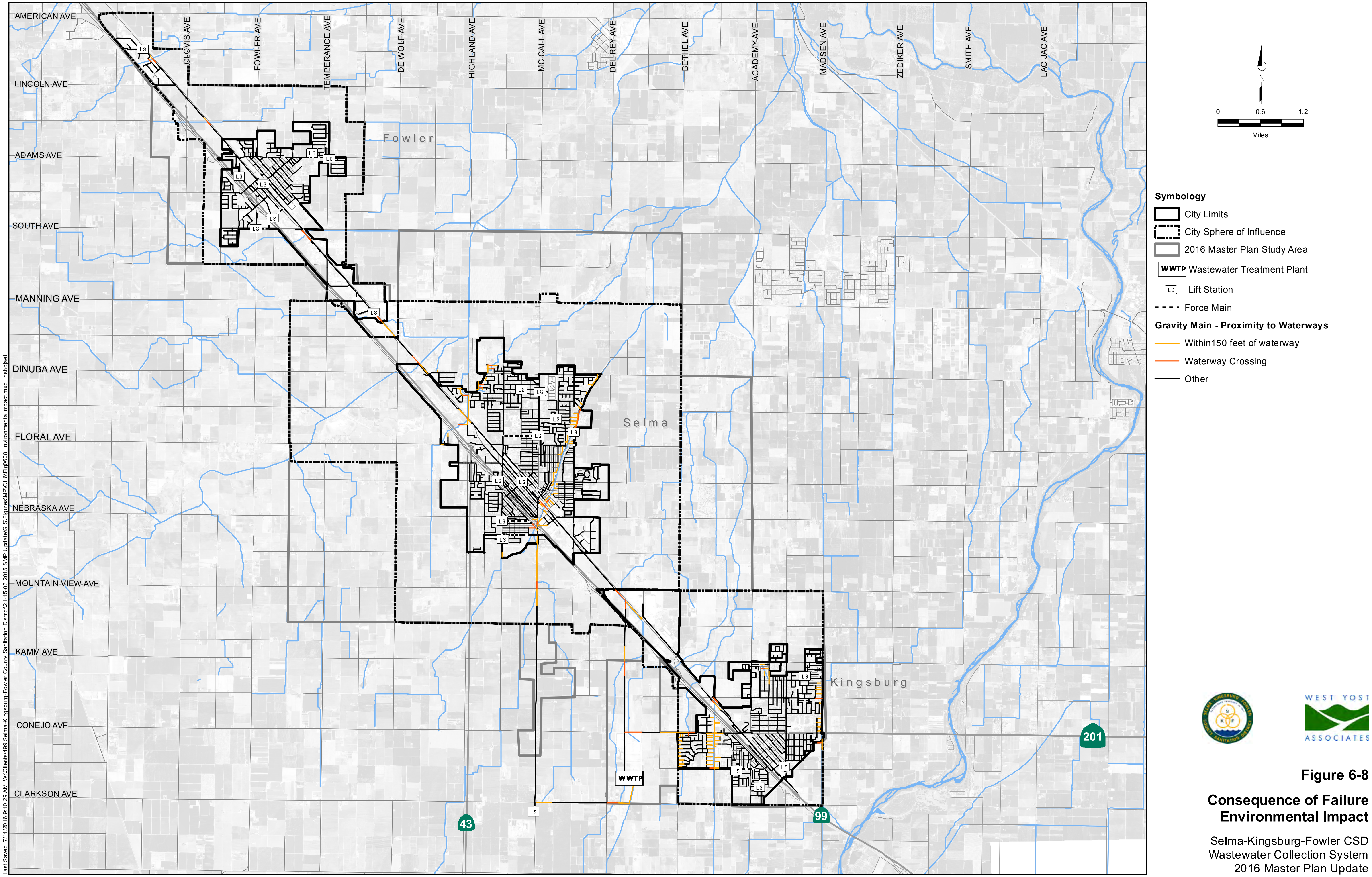
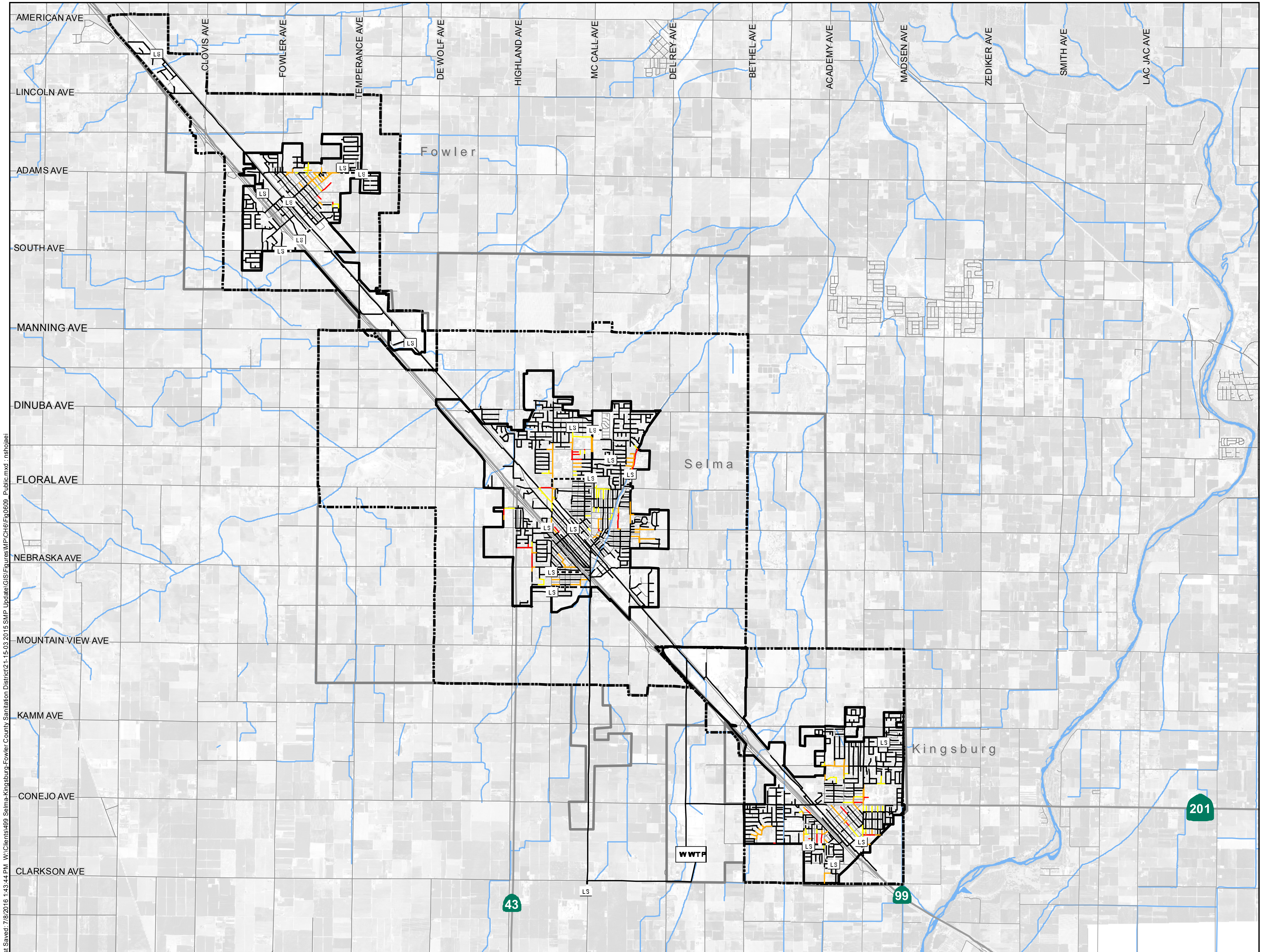


Figure 6-8

Consequence of Failure Environmental Impact

Selma-Kingsburg-Fowler CSD
Wastewater Collection System
2016 Master Plan Update



N

0 0.6 1.2
Miles

Symbology

City Limits
City Sphere of Influence
2016 Master Plan Study Area
WWTP Wastewater Treatment Plant
LS Lift Station
Force Main

Gravity Main - Proximity to High Pedestrian Traffic Areas

Within/Intersecting
Within 75 feet
Within 150 feet
Other

WEST YOST ASSOCIATES

Figure 6-9

Consequence of Failure
Public Health Impact

Selma-Kingsburg-Fowler CSD
Wastewater Collection System
2016 Master Plan Update

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6.1.2.2 Consequence of Failure Methodology

Each sewer main is rated by the model for each consequence of failure factor on a scale of one to five, with five indicating the highest adverse consequence of failure. The methodology for rating each sewer main is summarized in Table 6-2. The model calculates the weighted total of the ratings for each category as the single Consequence of Failure score with 18 and 90 being the lowest and highest possible scores, respectively. The weighting factors applied were developed through pairwise analysis as detailed in Appendix B.

6.1.3 Gravity Sewer Risk Levels

The InfoMaster™ sewer risk model was developed to perform the risk assessment calculations. InfoMaster™ applies a series of algorithms to generate the total likelihood and consequence of failure score for each asset, as described above. By plotting the consequence of failure and the likelihood of failure scores against each other, an overall risk level was assigned to each sewer main. Risk was prioritized into five levels: High Risk, Medium-High Risk, Medium Risk, Medium-Low Risk, and Low Risk, as shown in Table 6-3. These risk levels are assigned to the various ranges using best engineering judgement to determine which combinations of scores warrant the highest level of concern versus those that warrant lesser levels of concern. Table 6-3 shows the number of sewer mains out of a total of 2,912 that fall into each range.

Low Risk. Approximately one percent of the system by length (1.32 out of 165 miles) falls in the Low Risk Category, as shown in dark green in Table 6-3. Gravity mains in this category typically contain the following likelihood and consequence of failure characteristics:

- At the lower end of the scoring section, (and the majority of this risk category) these mains are 6-inch pipes in residential streets away from public and environmental areas. These mains do not have any structural, maintenance, or hydraulic capacity concerns.
- At the highest end of the scoring section, these mains are 8-inch pipes, away from public and environmental areas. These mains have defect rate of less than 2, installed from 1980 to1991, have no service call record, are under routine maintenance, and have no hydraulic capacity concerns.

Medium-Low Risk. Approximately 32 percent of the system by length (53 out of 165 miles) is Medium-Low Risk, as shown in light green in Table 6-3. Gravity mains in this category typically contain the following likelihood and consequence of failure characteristics:

- At the lower end of the scoring section, (and the majority of this risk category) these mains are 6-inch pipes located away from public and environmental areas. These mains do not have any structural, maintenance, or hydraulic capacity concerns, but have a higher peak wet weather flow than mains in low risk category.
- At the highest end of the scoring section, these mains are 8-inch pipes on collector streets, away from public and environmental areas. These mains have hydraulic deficiency with routine maintenance frequency.

Table 6-2. Consequence of Gravity Sewer Failure Rating Factors

Factor	Rating (1 being the lowest, 5 being the highest)					Rating Logic	Weighting Factor
	1	2	3	4	5		
Potential Spill Volume							
Modeled Peak Wet Weather Flow (PWWF)	≤ 0.0005 MGD	0.0005 – 0.5 MGD	0.5 - 1 MGD	1 - 4 MGD	> 4 MGD	Modeled PWWF (if not modeled, Pipe Diameter)	10
Pipe Diameter	≤ 6-inch	8-inch	10-12 inch	15 inch	> 15 inch		
Emergency Response and Construction Impact							
Location within Streets and Easements	Other	Collector	Arterial Street	Easement	CA-99 / Golden State Fwy or Railroad Crossing	Single Rating	3
Environmental and Public Health Impact							
Proximity to Waterways	Other	-	-	Within 150 feet of Waterway	Waterway Crossing	Highest of Two Factors	7
Proximity to High Pedestrian Traffic Areas	Other	Within 150' of High Pedestrian Traffic Area	Within 75' of High Pedestrian Traffic Area	Within/ Intersecting High Pedestrian Traffic Area	-		

Table 6-3. Gravity Sewer Risk Assessment Results

Miles of Gravity Sewer Mains		Likelihood of Failure A (3)	B (4)	C (5)	D (6 – 7)	E (8-13)	Total
Consequence of Failure	A (20-26)	1.32	1.77	2.37	5.96	1.36	12.78
	B (27-39)	41.46	9.88	7.56	27.06	12.73	98.69
	C (40-58)	11.23	2.10	5.30	12.66	3.60	34.88
	D (59-73)	1.38	0.62	9.06	3.39	0.85	15.30
	E (78-97)	0.25	0.00	2.42	0.95	0.12	3.73
	Total	55.63	14.37	26.70	50.02	18.66	165.38

Risk Levels: Dark Green = Low, Light Green = Medium-Low, Yellow = Medium, Orange = Medium-High, Red = High

Medium Risk. Approximately 17 percent of the system by length (29 out of 165 miles) is Medium Risk, as shown in yellow in Table 6-3. Gravity mains in this category typically contain the following likelihood and consequence of failure characteristics:

- At the lower end of the scoring spectrum, (and a large portion of this risk category) these mains are 8-inch pipes located away from public and environmental areas. These mains are in Grade 3 of defect rate category or installed between 1980 and 1990. These mains do not have any maintenance, or hydraulic capacity concerns.
- At the highest end of this category, these mains are 8-inch pipes in easement within 150 feet of a waterway and 75 feet of a high pedestrian area. These mains have no hydraulic capacity concerns, have Grade 2 of defect rate or were installed before 1960. There was no record of service call for them and they are under routine maintenance frequency.

Medium-High Risk. Approximately 36 percent of the system by length (60 out of 165 miles) is Medium-High Risk, as shown in orange in Table 6-3. Gravity mains in this category typically contain the following likelihood and consequence of failure characteristics:

- At the lower end of the scoring spectrum, these mains are 8-inch pipes located in collector streets but away from environmental areas. These mains have no maintenance concerns, but have structural and hydraulic capacity concerns. These mains are in Grade 3 of defect rate category or installed between 1980 and 1990. These mains do not have any maintenance, or hydraulic capacity concerns.
- At the highest end of the scoring spectrum, these mains are 10-inch to 12-inch pipes in easement and within 150 feet of a high-pedestrian traffic area. These mains have high hydraulic capacity concerns, have defects of Grade 5 or were installed before 1960. These pipes are surcharged during peak wet weather conditions but there was no record of service call for them and they are under routine maintenance frequency.

High Risk. Only approximately 14 percent of the system by length (22 out of 165 miles) is High Risk, as shown in red in Table 6-3. Gravity mains in this category typically contain the following likelihood and consequence of failure characteristics:

- At a minimum, these mains are 8-inch pipes in arterial streets within 150 feet of a waterway and 75 feet of a high pedestrian area. These mains have no hydraulic capacity and maintenance concerns, but have moderate structural concerns. The most severe pipe defects are Grade 3, and has routine maintenance.
- At the higher end of the scoring spectrum, these mains are larger than 15-inch within 150 feet of a waterway, within 75 feet of a high pedestrian traffic area, and located in CA-99 or railroad crossing. These mains have high structural, maintenance and capacity concerns. These pipes are surcharged during peak wet weather conditions and have more than 2 or more service call record and 3-month maintenance frequency.

The results of the risk assessment are shown on Figure 6-10 for the entire District, Figure 6-11 for Selma, Figure 6-12 for Kingsburg, and Figure 6-13 for Fowler.

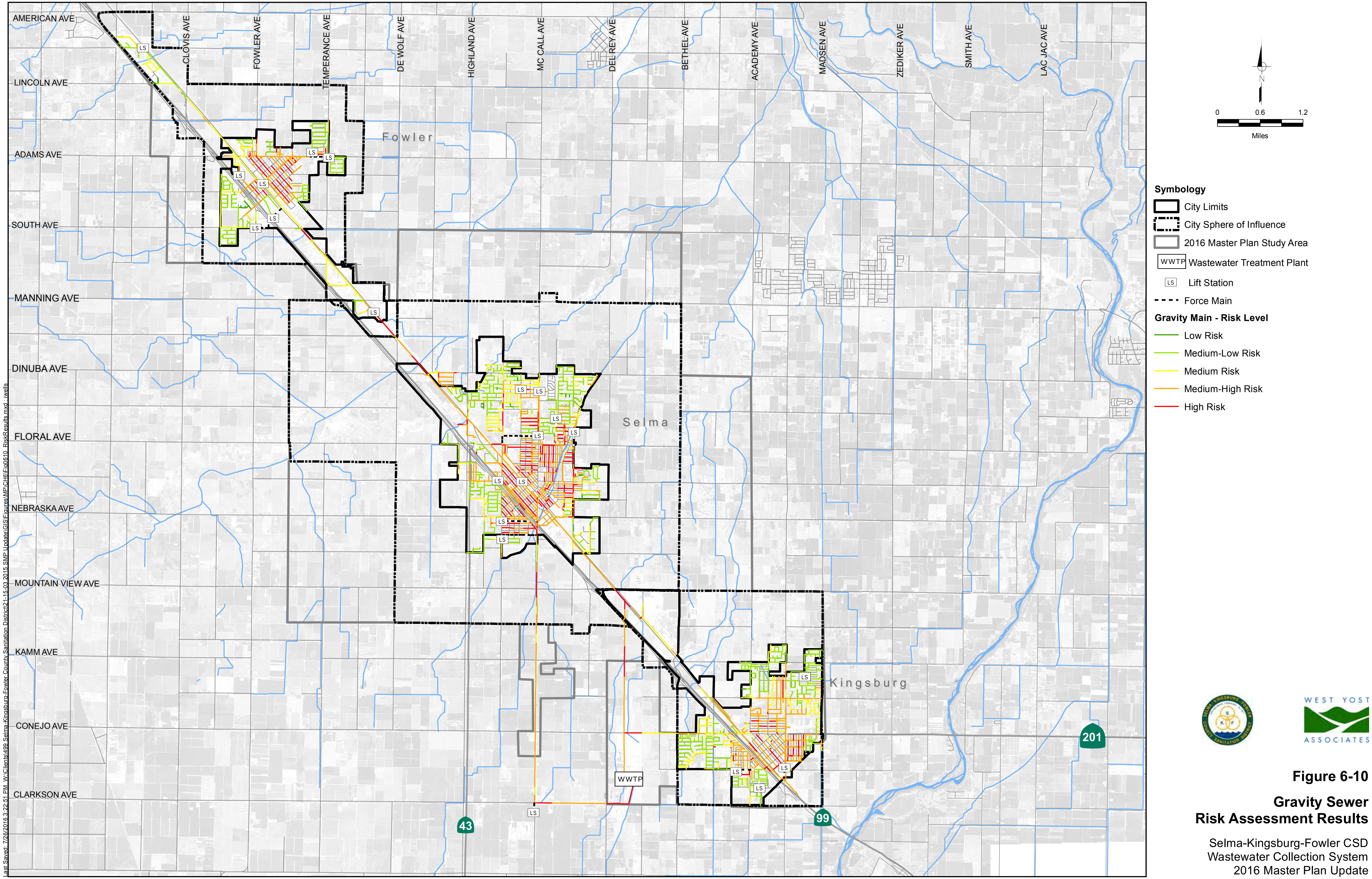

Figure 6-10

Gravity Sewer Risk Assessment Results

Selma-Kingsburg-Fowler CSD
Wastewater Collection System
2016 Master Plan Update

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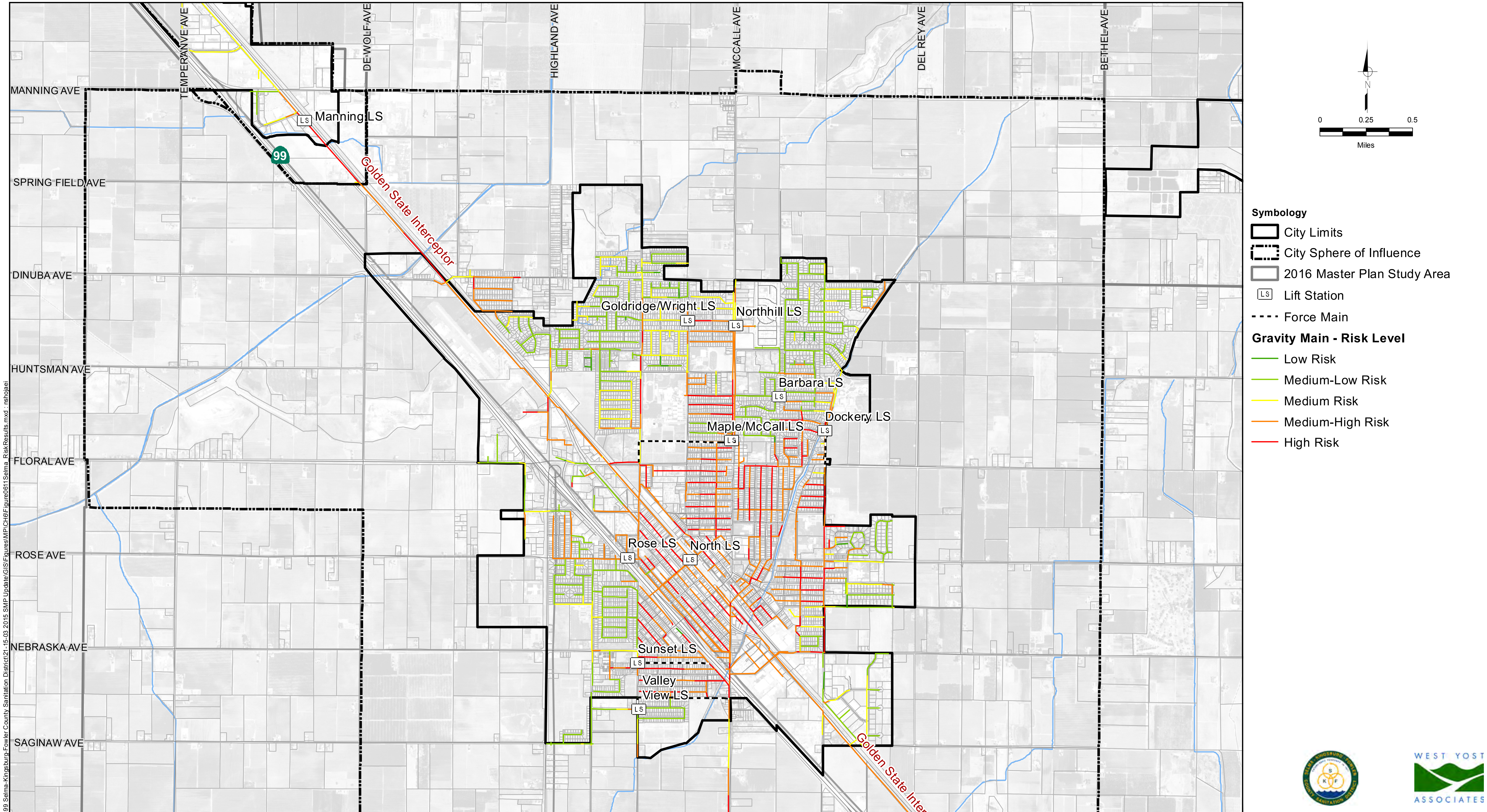
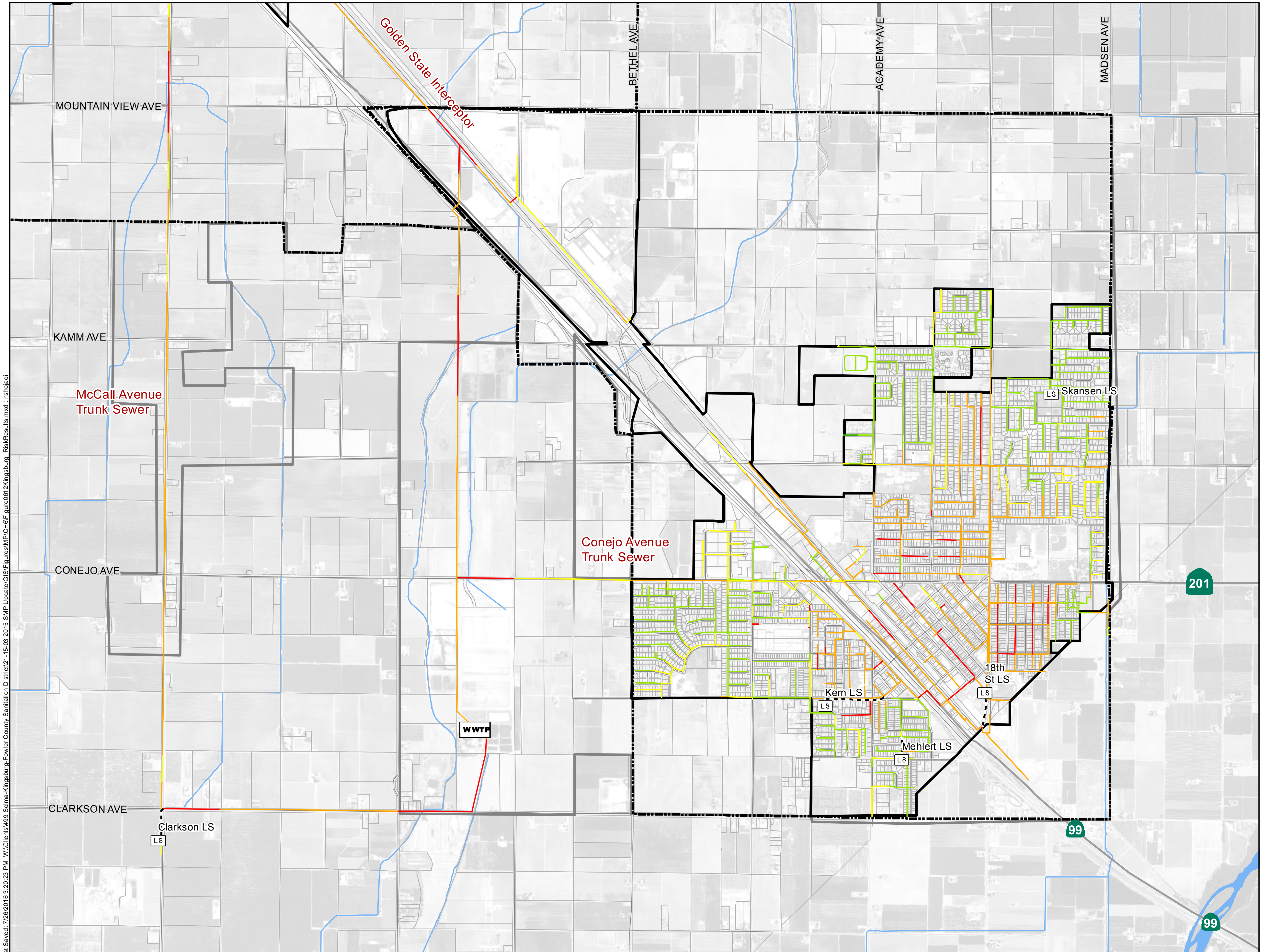


Figure 6-11

Gravity Sewer Risk Assessment Results City of Selma

Selma-Kingsburg-Fowler CSD
Wastewater Collection System
2016 Master Plan Update



0 0.2 0.4
Miles

Symbology

- City Limits
- City Sphere of Influence
- 2016 Master Plan Study Area
- WWTP Wastewater Treatment Plant
- LS Existing Lift Station
- Force Main

Gravity Main - Risk Level

- Low Risk
- Medium-Low Risk
- Medium Risk
- Medium-High Risk
- High Risk

WEST YOST ASSOCIATES

Figure 6-12

Gravity Sewer
Risk Assessment Results
City of Kingsburg

Selma-Kingsburg-Fowler CSD
Wastewater Collection System
2016 Master Plan Update

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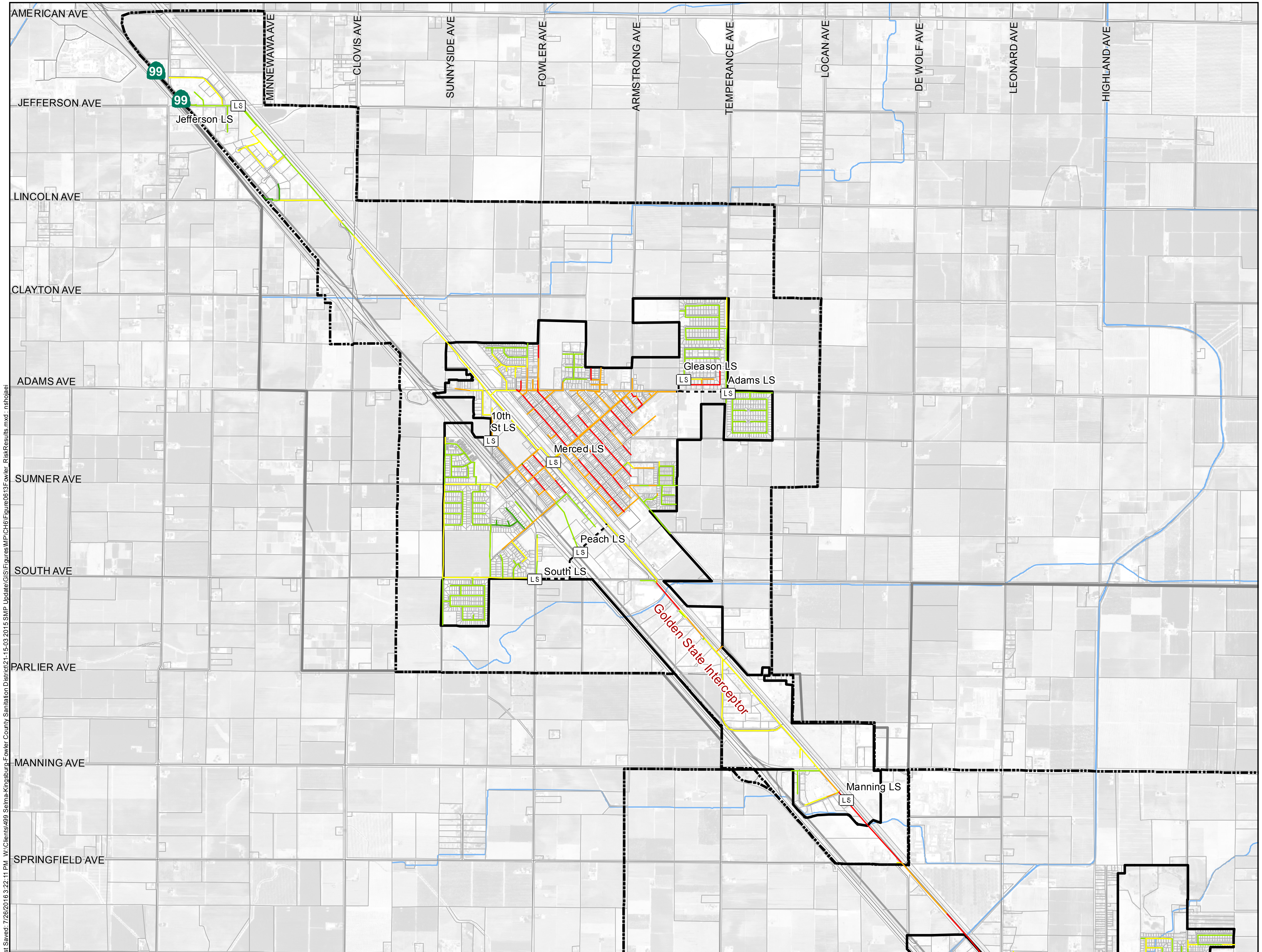


N

0 0.25 0.5
Miles

Symbology

- City Limits
- City Sphere of Influence
- 2016 Master Plan Study Area
- Lift Station
- Force Main
- Low Risk
- Medium-Low Risk
- Medium Risk
- Medium-High Risk
- High Risk

WEST YOST ASSOCIATES

Figure 6-13

Gravity Sewer Risk Assessment Results City of Fowler

Selma-Kingsburg-Fowler CSD
Wastewater Collection System
2016 Master Plan Update

6.2 LIFT STATION RISK ASSESSMENT

The District operates and maintains 22 lift stations. The District owns the four lift stations along the interceptor, while each City owns the lift stations within its own local sewer collection system.

District Facilities. Merced Street Lift Station (D-1), Manning Lift Station (D-2), North Street Lift Station (D-3), and 18th Street Lift Station (D-4).

City of Selma Facilities. Rose Street Lift Station (S-3), Goldridge/Wright Lift Station (S-4), North Hill Lift Station (S-5), Dockery Lift Station (S-6), Sunset Lift Station (S-7), Barbara Lift Station (S-8), Valley View Lift Station (S-9), Maple/McCall Lift Station (S-10), and Clarkson/McCall Lift Station (S-11).

City of Kingsburg Facilities. Mehlert Lift Station (K-1), Kern Lift Station (K-2), and Skansen Lift Station (K-3).

City of Fowler Facilities. North 10th Street Lift Station (F-2), Peach Street Lift Station (F-3), Gleason Lift Station (F-4), South Avenue Lift Station (F-5), Jefferson Avenue Lift Station (F-6), and Adams/Temperance Lift Station (F-7).

6.2.1 Likelihood of Failure Analysis

The likelihood of failure analysis considers the probability that a failure will occur in a given lift station. Lift stations have the following principal failure modes: maintenance failure, structural failure, and hydraulic capacity failure. For each failure mode, one or more factors are considered in determining the likelihood of a failure, as discussed below.

Maintenance Failure. Maintenance problems related to pump failure, electrical failure, or grease and odor issues can cause a decrease in the level of service provided by the Lift Station. West Yost worked with District Maintenance personnel to categorize the maintenance issues seen at each Lift Station into three tiers based on severity, with Tier 1 being most severe, Tier 2 being less severe, and Tier 3 being minor. Stations not included in Table 6-4 do not have maintenance concerns.

Mechanical Failure. Older lift stations are more likely to fail than newer ones due to the age of materials and wear from repeated use. The likelihood of mechanical failure was estimated from the installation year of the sewer main, as older stations mains are more likely to have cracks, breaks, corrosion, and equipment that is beyond its intended useful life. A major rehabilitation will extend the useful life of the asset. The date of major rehabilitations was used in place of the original installation date where applicable. The installation years can be seen in Table 6-5.

Capacity Failure. As part of the 2016 Master Plan Update, a hydraulic capacity evaluation was conducted on the collection system for current and 2035 buildout conditions under peak wet weather flow conditions, as documented in Chapter 5 of this report. Table 6-6 shows the lift stations that were determined to have an existing capacity deficiency. The extent of the capacity deficiency was quantified by the percent of the existing firm capacity. Lift stations not included in the table have sufficient firm capacity under both scenarios.

Table 6-4. Lift Station Maintenance Tier		
ID	Lift Station Name	Maintenance Issues
Tier 1 Stations		
D-1	Merced Street	Pump wear due to sand from raisin processing discharges, electrical is in need of upgrades, odor issues, and portable A/C unit required in hot weather to prevent overheating.
D-2	Manning	Pump wear due to sand from raisin processing discharges, severe corrosion issues at cast iron bend on discharge force main, and portable A/C unit required in hot weather to prevent overheating.
D-3	North Street	Odor issues, electrical is in need of upgrades, and portable A/C unit required in hot weather to prevent overheating.
D-4	18th Street	Age and wear issues.
Tier 2 Stations		
S-3	Rose Street	Severe corrosion issue at discharge elbow from hydrogen sulfide, wet well t-lock liner pulling away, and electrical and controls located on ground are difficult to access for maintenance.
S-6	Dockery	Grease buildup in wet well requires monthly wash-down.
S-10	Maple/McCall	Grease buildup in wet well.
S-11	Clarkson/McCall	Corroded discharge force main and no air valve on discharge piping.
F-3	Peach Street	Recurring cockroach and rat issues.
Tier 3 Stations		
K-1	Mehlert	Minor Issues
K-3	Skansen	Minor Issues
S-7	Sunset	Minor Issues

Table 6-5. Lift Station Installation Year		
ID	Lift Station Name	Estimated Installation Year[1]
F-2	N 10th Street	2011 – Major Rehabilitation 1965 – Original Installation
F-3	Peach Street	1961
F-4	Gleason	2015 – Major Rehabilitation 1973 – Original Installation
F-5	South Avenue	1991
F-6	Jefferson Avenue	1995
F-7	Adams and Temperance	2004
D-1	Merced Street	1971
D-2	Manning	1971
D-3	North Street	1971
D-4	18th Street	1998 – Major Rehabilitation pre-1971 – Original Installation
S-3	Rose Street	1994 – Full Replacement of Original Station
S-4	Goldridge/Wright	1972
S-5	North Hill	2013 – Major Rehabilitation 1964 – Original Installation
S-6	Dockery	2003 – Major Rehabilitation 1965 – Original Installation
S-7	Sunset	2011 – Major Rehabilitation 1991 – Original Installation
S-8	Barbara	2011 – Major Rehabilitation 1984 – Original Installation
S-9	Valley View	2006
S-10	Maple/McCall	1991
S-11	Clarkson/McCall	1994 – Full Replacement of Original Station
K-1	Mehlert	1993
K-2	Kern Street	2011 – Major Rehabilitation 1980 – Original Installation
K-3	Skansen	1999

[1] Pump station installation years were provided by District staff and reflect major rehabilitation projects.

Table 6-6. Lift Station Capacity Deficiencies					
ID	Lift Station Name	Firm Capacity, gpm	Existing Design Flow, gpm	Existing Pump Capacity Deficiency	
				Deficiency, gpm	Deficiency, q/Q
D-1	Merced Street	750	1,200	450	1.60
D-2	Manning	750	2,210	1,460	2.95
D-3	North Street	1,900	5,026	3,126	2.65
S-11	Clarkson/McCall	1,500	1,940	440	1.29

The risk model is applied to each lift station to produce a single rating for each likelihood failure category on a scale of one to five, with five being the highest possible rating. This rating is determined according to the Rating Logic shown in Table 6-7. Finally, the model calculates the weighted total of the three scores as the single Likelihood of Failure rating with 23 and 115 being the lowest and highest possible ratings, respectively. The weighting factors were developed through pairwise comparison as described in Appendix B.

6.2.2 Consequence of Failure Analysis

The consequence of failure considers the potential impacts from a SSO in each lift station. For each category, one or more factors are considered in determining the potential consequence of a failure, as discussed below. The consequence of failure analysis is divided into three categories: potential spill volume, environmental and public health, and emergency response and construction impact.

Potential Spill Volume. The State Water Resources Control Board requires collection system agencies to prevent SSOs and to mitigate SSOs when they occur. The higher the volume of the spill, the more difficult the spill mitigation and compliance requirements, and the higher fines become. The potential SSO volume was estimated from the modeled peak wet weather flow. The design flows are shown for each station in Table 6-8.

Table 6-7. Likelihood of Lift Station Failure Rating Factors

Factor	Rating (1 being the lowest, 5 being the highest)					Rating Logic	Weighting Factor
	1	2	3	4	5		
Maintenance Failure							
Maintenance Tier	No Maintenance Concerns	Tier 3 Facility	-	Tier 2 Facility	Tier 1 Facility	Single Rating	10
Mechanical Failure							
Station Age - Installation Decade	Post-2005	Between 1995-2005	Between 1985-1995	Between 1980-1985	Pre-1980	Single Rating	5
Hydraulic Capacity Failure							
Existing Capacity Deficiency, q/Q	< 1.00	1.00 - 1.35	1.36 - 1.65	1.66 - 2.00	≥ 2.00	Single Rating	8

Table 6-8. Lift Station Design Flows

ID	Lift Station Name	Existing Design Flow, gpm
F-2	N 10th Street	53
F-3	Peach Street	426
F-4	Gleason	88
F-5	South Avenue	218
F-6	Jefferson Avenue	44
F-7	Adams and Temperance	107
D-1	Merced Street	1,200
D-2	Manning	2,210
D-3	North Street	5,026
D-4	18th Street	1,492
S-3	Rose Street	330
S-4	Goldridge/Wright	28
S-5	North Hill	31
S-6	Dockery	557
S-7	Sunset	568
S-8	Barbara	14
S-9	Valley View	10
S-10	Maple/McCall	461
S-11	Clarkson/McCall	1,940
K-1	Mehlert	47
K-2	Kern Street	70
K-3	Skansen	143

Emergency Response and Construction Impact. Emergency response and repair costs can increase substantially when the lift station is difficult to access by SSO response crews. Repairs in or adjacent to major streets require additional efforts to redirect traffic and are more difficult to respond to than spills on smaller local streets. Limited Staging area makes getting the equipment to the site and installed more difficult for maintenance crews. The access constraints for each station are shown in Table 6-9.

Table 6-9. Lift Station Access Constraints

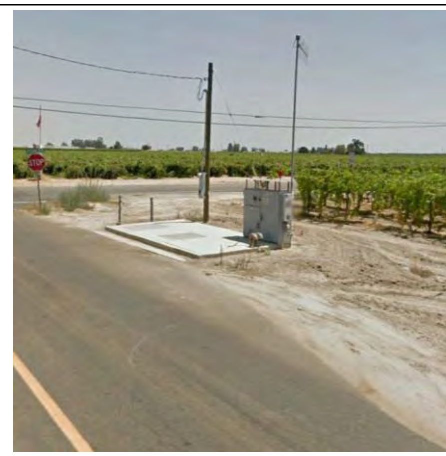
Lift Station Name (ID)	Access Description	Lift Station Name (ID)	Access Description
N 10th Street (F-2)	 No Access Constraints	Peach Street (F-3)	 No Access Constraints
Gleason (F-4)	 Limited Staging Area	South Avenue (F-5)	 Limited Staging Area/ Minor Traffic Control

Table 6-9. Lift Station Access Constraints

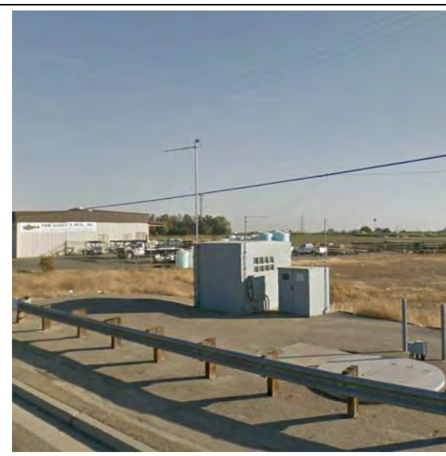
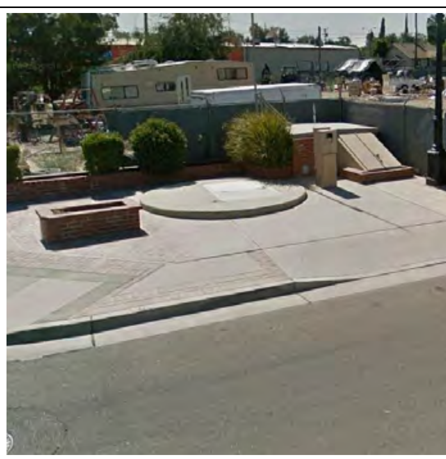
Lift Station Name (ID)	Access Description	Lift Station Name (ID)	Access Description
Jefferson Avenue (F-6)	 Minor Traffic Control Needed – Local Intersection	Adams and Temperance (F-7)	 Minor Traffic Control Needed – Collector Intersection
Merced Street (D-1)	 Significant Traffic Control Needed – Golden State 99 Intersection	Manning (D-2)	 No Access Constraints/ Minor Traffic Control
North Street (D-3)	 Limited Staging Area/ Minor Traffic Control	18th Street (D-4)	 No Access Constraints

Table 6-9. Lift Station Access Constraints

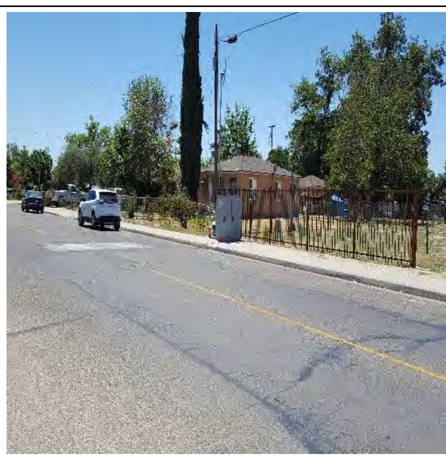
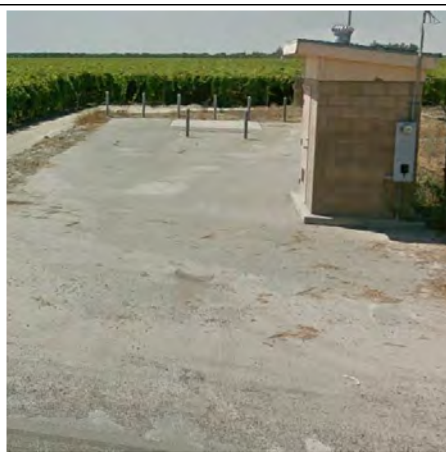
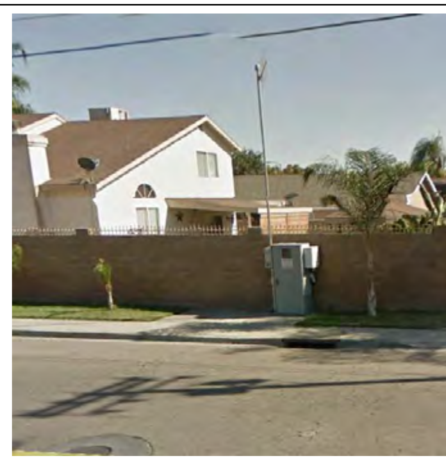
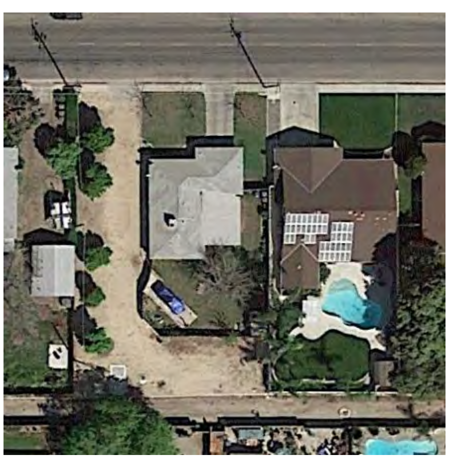
Lift Station Name (ID)	Access Description	Lift Station Name (ID)	Access Description
Rose Street (S-3)	 Limited Staging Area/ Minor Traffic Control	Goldridge/Wright (S-4)	 Major Traffic Control Needed – Collector Intersection w/schools
North Hill (S-5)	 Limited Staging Area/ Major Traffic Control	Dockery (S-6)	 No Access Constraints
Sunset (S-7)	 Major Traffic Control Needed – Collector Intersection	Barbara (S-8)	 Major Traffic Control Needed – Local Intersection

Table 6-9. Lift Station Access Constraints

Lift Station Name (ID)	Access Description	Lift Station Name (ID)	Access Description
Valley View (S-9)	 Limited Staging Area/Minor Traffic Control	Maple/McCall (S-10)	 Limited Staging Area/Major Traffic Control
Clarkson/McCall (S-11)	 No Access Constraints	Mehlert (K-1)	 Limited Staging Area/Minor Traffic Control
Kern Street (K-2)	 No Access Constraints	Skansen (K-3)	 No Access Constraints/Minor Traffic Control

Environmental and Public Health Impact. An SSO will have an increased negative impact on public health and the environment as the proximity to environmentally sensitive areas (*e.g.,* waterways) and public facilities (*e.g.,* schools and parks) increases. Using GIS, an intersection of the lift station location with streams or lakes identified pipes located in close proximity to waterways. The distance from a lift station to a public facility, was estimated using GIS data of park and school locations. The highest rate according to each of these two factors are considered as the consequence of environmental and public health failure rate. Skansen Lift Station (K-3) is within Erling Park and 18th Street Lift Station (D-4) is within 75 feet of Lincoln Elementary School. No other lift station is within 150 feet of a park or school. Dockery Lift Station (S-6) is within 150 of the Centerville and Kingsburg Canal and Manning Lift Station (D-2) is within 400 feet of Iowa Ditch. All other stations are further than 400 feet from a waterway.

Each lift station is rated by the model for each consequence of failure factor on a scale of one to five, with five indicating the highest adverse consequence of failure. The methodology for rating each lift station is summarized in Table 6-10. The model calculates the weighted total of the ratings for each category as the single Consequence of Failure score with 18 and 90 being the lowest and highest possible ratings, respectively.

Table 6-10. Consequence of Lift Station Failure Rating Factors							
Factor	Rating (1 being the lowest, 5 being the highest)					Rating Logic	Weighting Factor
	1	2	3	4	5		
Potential Spill Volume							
Modeled Peak Wet Weather Flow (PWWF)	≤ 0.0005 MGD	0.0005 – 0.5 MGD	0.5 - 1 MGD	1 - 4 MGD	> 4 MGD	Single Rating	10
Emergency Response and Construction Impact							
Access Constraints	No Access Constraints	Limited Staging Area	-	Minor Traffic Control Needed	Significant Traffic Control Needed	Single Rating	5
Environmental Impact							
Proximity to Waterways	Other	-	-	Within 400 feet of Waterway	Within 150 feet of Waterway	Highest of Two Factors	3
Proximity to High Pedestrian Traffic Areas	Other	-	Within 150' of High Pedestrian Traffic Area	Within 75' of High Pedestrian Traffic Area	Within/ Intersecting High Pedestrian Traffic Area		

6.2.3 Lift Station Risk Levels

A MS Access database model was developed to perform the risk assessment calculations. The model applies a series of algorithms to calculate total consequence and likelihood of failure scores for each station. By plotting the consequence of failure and the likelihood of failure scores against each other, an overall risk level was assigned to each station. Risk levels are prioritized into five risk levels: Low Risk, Medium-Low Risk, Medium Risk, Medium-High Risk, and High Risk, each of which is shown in Table 6-11. These risk levels are assigned to the various cells using best engineering judgment to determine which combinations of score warrant the highest levels of concern versus those that warrant lesser levels of concern.

Table 6-11. Lift Station Risk Assessment Results

Name of Lift Station		Likelihood of Failure				
		A (23 – 35)	B (36 – 45)	C (46 – 68)	D (69 – 91)	E (92-115)
Consequence of Failure	A (18 – 28)	K-2 F-2				
	B (29 – 35)	F-4, F-5 S-9	K-1	S-3, S-5		
	C (36 – 53)	F-6, F-7 S-7, S-8	K-3 S-4	S-6, S-10	F-3 S-11	
	D (54 – 71)			D-4	D-3	D-1, D-2
	E (72 – 90)					

Risk Levels: Dark Green = Low, Light Green = Medium-Low, Yellow = Medium, Orange = Medium-High, Red = High

The facilities are listed in order of risk from high to low in Table 6-12.

ID	Lift Station Name	Risk Level
D-1	Merced Street	High
D-2	Manning	High
D-3	North Street	High
D-4	18th Street	Medium-High
S-11	Clarkson/McCall	Medium-High
S-6	Dockery	Medium-High
F-3	Peach Street	Medium-High
S-10	Maple/McCall	Medium-High
S-3	Rose Street	Medium
S-5	Northhill	Medium
S-4	Goldridge/Wright	Medium
S-7	Sunset	Medium
K-3	Skansen	Medium
F-6	Jefferson Avenue	Medium
F-7	Adams and Temperance	Medium
S-8	Barbara	Medium
K-1	Mehlert	Medium-Low
F-5	South Avenue	Medium-Low
F-4	Gleason	Medium-Low
S-9	Valley View	Medium-Low
F-2	N 10th Street	Low
K-2	Kern Street	Low

Table 6-12. Lift Station Risk Levels

6.3 GRAVITY MAIN OPERATIONAL AND CONDITION-BASED RECOMMENDATIONS

The sections above identified and prioritized the collection system assets at the highest risk of operational and condition-based failure. The following section provides recommendations to alleviate this risk of failure, as well as some recommendations to alleviate other problems that were identified in the risk assessment, but were not significant enough to lead to failure of the collection system. Recommendations for gravity mains include replacement recommendations, inspection recommendations, and operational recommendations.

6.3.1 Gravity Main Replacement

It is recommended that the gravity main condition assessment described above be used to prioritize the gravity main replacements required to eliminate the capacity deficiencies that were identified in the hydraulic model as described in Chapter 5. In this manner, as capacity deficiencies are addressed, the gravity mains that pose highest risk of failure based on operational and condition criteria are addressed as well. The prioritized CIP based upon the risk assessment is described in detail in Chapter 7.

6.3.2 Gravity Main Inspection

For those gravity mains that are not recommended for replacement as part of the CIP, it is recommended that a CCTV inspection program that is prioritized by the risk assessment be implemented in a systematic manner. The inspection program will provide detailed condition and operational data that will be used to prioritize rehabilitation and repair plans in future years. This prioritized inspection program is provided in Chapter 7.

6.3.3 Gravity Main Operational Improvements

The District's gravity main operations and maintenance program is generally sufficient and effective, as evidenced by the low number of SSOs in the District. However, discussion with District staff indicated that odors from the collection system are an on-going nuisance. While odors do not rise to the level of collection system failure, do tend to reduce public and customer satisfaction. Causes of collection system odors and possible solutions are described below.

6.3.3.1 Collection System Odor Causes

The most common odor causes in sewer collection systems include:

- Friction drag, influenced by wastewater velocity
- Change in wastewater velocity, influenced by change in slopes
- Physical characteristics of the system which influence airflow
    - d/D and headspace constriction
    - Diameter changes in downstream direction
    - Inverted siphons
    - Confluence of major tributary sewers

Friction Drag and Air Movement in Conduits. The driving force which moves air within sewer pipes is friction between the sewer headspace air and the moving wastewater. For most of the sewer system, the only resistance to air movement in a sewer pipe is friction between the air and the walls of the pipe. Given these two principals, it is possible to generate a velocity gradient profile for air movement in sewers, as shown on Figure 6-14. As might be anticipated, the velocity of the air is at a maximum near the surface of the water and decreases rapidly with increasing distance from the sewage. It is important to note that there are no stagnant air zones and that virtually *all* air in a sewer is moving with the wastewater.

There are many minor factors which act to enhance or diminish this friction and therefore the velocity and pressure of air in sewers. The friction factor between the water and air increases when the surface of the water is "roughened" by the generation of waves and "whitecaps" through turbulence or water velocities in excess of 5 feet-per-second. This type of turbulence can be generated by steep slopes or drops.

Strong turbulence, such as that generated by large hydraulic jumps, long gravity drops, or a spraying force main, increases friction dramatically since the water is churned into individual droplets. The droplets have many times the surface area of smooth water flow and therefore generate increased friction with the air. This high friction added to the effects of increased sewage velocity can move high volumes of air down sewers. To make matters worse, turbulence in wastewater also increases the release of odors and corrosion-causing compounds from wastewater, such as H_2S gas.

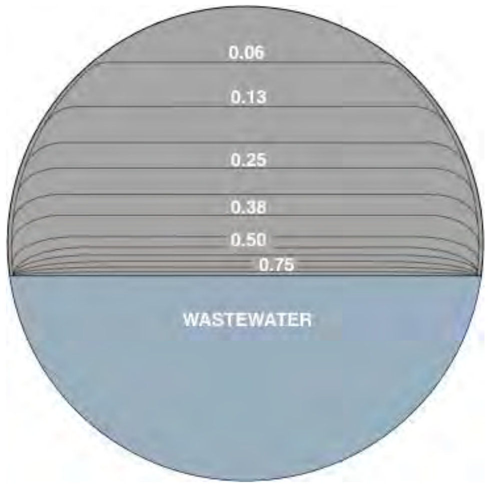


Figure 6-14. Idealized Air Velocity Contours in Percent of Wastewater Velocity

Odor Release Due to Slope Reduction. Just as fast-moving wastewater can accelerate air movement; conversely, a slow-moving, calm water surface will exert minimal drag on the air and move relatively small volumes of air. Additionally, if the wastewater flow decelerates, then the friction between the fast-moving air and the slow-moving sewage will slow the air movement. Therefore, when the velocity of wastewater decreases due to a flattening of sewer slopes, the fast-moving air from upstream collides into the slower air in the flatter segment, generating high gas pressure. This high pressure pushes sewer gasses through the nearest openings and into the atmosphere, causing complaints as shown on Figure 6-15.

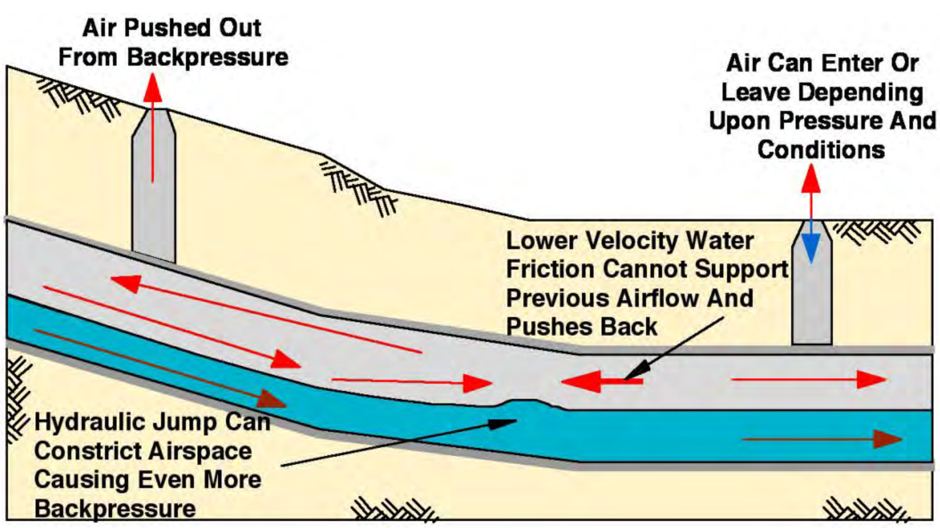


Figure 6-15. Pressurization Due to Slope Change

Odor Release Due to Air Headspace Constriction. The ratio of wastewater flow depth to the pipe diameter is expressed as d/D. When the pipe is half full, this ratio equals 0.5 and it equals 1 when the pipe is running full. Since the headspace above the wastewater conveys moving air, a constriction in this space will “squeeze” this air and it will become pressurized. Headspace constriction is one of the main causes of pressurization in the collection system. As the wastewater flow increases, it takes up more space in the pipe (the d/D increases) and the gasses are forced out and escape through any available routes such as house connections or vent holes.

Reducing Pipe Diameter in the Downstream Direction. A pipe’s diameter is sometimes reduced in the downstream direction in order to “squeeze” past an existing underground structure. This creates a choke point in the pipe. The surface of the flow approaching this bottleneck tends to rise, forcing the air above into wave fronts that are pushed backwards. When these air waves collide with the air traveling downstream, pressurization occurs, forcing the gasses out of the sewer system.

Inverted Siphons. The sewer collection system is usually designed with inverted siphons due to the abundance of interfering structures. Inverted siphons are pipes or other conduits that dips down in order to pass under a structure blocking the path of the pipe. Because they have to dip down, they are always full of water and have no headspace in the pipe available for the movement of air. They therefore block the flow of any air that is traveling down the pipe towards them. Alternate air pipes called “air jumpers” are built for the air movement past the siphon and they join with the sewer once the siphon ends. Some jumpers are undersized and have become a source of gas pressurization.

Confluence of Major Tributary Sewers. Turbulence in wastewater flow not only leads to higher gas pressures in the sewers, but also facilitates the release of H_2S gas from the sewage into the headspace. When gas vents from a sewer into the atmosphere, it is the H_2S gas that people smell and find so offensive. When one flow stream enters into another at a strong angle (i.e. perpendicular), it generates significant turbulence and leads to pressure and strong odor releases.

6.3.3.2 Collection System Odor Troubleshooting

Odor control is a complex and time consuming challenge, and requires a consistent and methodical response from District operations and maintenance staff. A Standard Operating Procedure (SOP) for odor control response from District staff has been developed for the 2016 Master Plan Update.

6.3.3.3 Collection System Odor Control Technology

In areas of the collection system for which odor control is found to be a persistent issue, improvements other than maintenance might be required. There are many technologies and strategies available to address odors in the collection system, as described below.

Sealing Maintenance Holes with Insert. Manhole inserts are a common method for mitigating odor problems originating from underground gravity pipelines. The basic manhole insert shown on Figure 6-16 utilizes a bowl-like device that is installed on the manhole frame just below the rim, and holds activated carbon that extracts H_2S gas as the air escapes from the top of the manhole to the atmosphere above. Other more advanced manhole inserts hold up to 20 pounds of activated carbon, that traps and stores unpleasant hydrogen sulfide odors. Purified air is then allowed to ventilate into the atmosphere through the canister lid. A one-way valve allows water to drain, but no air to pass through it. It can be used in a more concentrated area in order to more effectively treat the foul air while prolonging the amount of time required between carbon replacements. The more advanced insert is shown on Figure 6-17.

Figure 6-16. Manhole Insert

Figure 6-17. Parson Odoreater Manhole Insert

Manhole Odor Filter. Still more advanced is the Manhole Odor Eliminator (MOE) produced by Inventive Resources, Inc. (Inventive Resources) which utilizes a bladder that buffers the fluctuations of sewer gas, requiring the carbon to only treat the peak air flow as can be seen on Figure 6-18. The device weighs 20 pounds and holds 20 pounds of activated carbon, making the filled apparatus easily maneuverable for District maintenance crews. The activated carbon is contained within a replaceable cartridge that has been quoted by Inventive Resources to need replacement about once every year for this application.

Figure 6-18. Manhole Odor Eliminator (MOE™)

6.3.3.4 Hydraulic Design Improvements

In some cases, odors vent from the sewer due to poor or inadequate hydraulic design. Another strategy for reducing odors venting from the collection system is implementing the adequate sewer design criteria to avoid hydraulic and geometric characteristics that either increase the production of odors or constrict the flow of gas in the sewer headspace, forcing it out of the sewer.

Low Flow Velocity. If sewage flows too slowly, sediment within the sewage settles out and deposits within the pipe. These deposits provide an ideal environment for an anaerobic slime layer where H_2S is produced. Sewers should be designed to provide an adequate flow velocity to reduce the deposition of solids within the sewage and help eliminate the development of H_2S.

Inverted Siphons. Significant odor issues have been associated with air pressure build-up on the upstream side of inverted siphons. It lies with the fact that the sewer pipe in a siphon flows completely full with no headspace within the pipe to convey the gas. Therefore, air ducts or "air jumpers" are needed to transport the gases across the siphon. These air jumpers have historically been undersized. Air jumper should be designed to provide sufficient headspace to convey the air across.

6.4 LIFT STATION OPERATIONAL AND CONDITION-BASED RECOMMENDATIONS

The sections above identified and prioritized the collection system assets at the highest risk of operational and condition-based failure. The following section provides recommendations to alleviate this risk of failure, as well as some recommendations to alleviate other problems that were identified in the risk assessment, but were not significant enough to lead to failure of the collection system. Recommendations for lift stations include upgrade and replacement recommendations, as well as regular preventative maintenance recommendations.

6.4.1 Lift Station Upgrades and Replacement

It is recommended that the lift station condition assessment described above be used to prioritize the lift station replacements required to eliminate the capacity deficiencies that were identified in the hydraulic model as described in Chapter 5. In this manner, as capacity deficiencies are addressed, the lift stations that pose highest risk of failure based on operational and condition criteria are addressed as well. The prioritized CIP based upon the risk assessment is described in detail in Chapter 7.

6.4.2 Lift Station Inspection and Preventative Maintenance

All lift stations within the District regardless of age or condition require regular preventative maintenance. The Lift Station Preventative Maintenance and Inspection SOP has been updated as part of the 2016 Master Plan Update.

CHAPTER 7
Prioritized Capital Improvement Program

Chapter 7 provides an overview of the recommended CIP for the gravity main, lift stations, and force mains that have been identified for improvement in Chapter 5 and Chapter 6. This CIP has been prioritized based on the development timeline and risk assessment performed, and includes conceptual costs for the recommended projects.

7.1 BASIS FOR CAPITAL IMPROVEMENT COSTS

The following sections describe the methods and associated costs evaluated for completing rehabilitation, repair, and replacement projects in the District's collection system for both capacity enhancement and condition repair. Construction costs are presented in May 2016 dollars based on an Engineering News Record (ENR) Construction Cost Index (CCI) of 10337 (20-city average). Construction costs are to be used for conceptual-level cost estimating only. The cost estimates prepared for the 2016 Master Plan Update are in accordance with the guidelines of the Association for the Advancement of Cost Engineering (AACE) International for a Class 5 Estimate, suitable for long-range capital planning, with an accuracy range of -50 percent to +100 percent.

7.1.1 Pipeline Rehabilitation, Repair, and Replacement Methods and Conceptual Costs

The following rehabilitation, repair, and replacement methods are potential options for the District's gravity main and force main projects: open cut construction, pipe bursting, pipe reaming, and tunneling. For projects that require the installation of a new relief sewer to address wet weather flows, in-situ methods for the existing pipe, such as the use of cured-in-place pipe, may be considered in conjunction with construction of the new relief sewer pipeline. Specific to the District's projects, factors that determine the most cost effective rehabilitation method include geological and physical setting, existing pipeline material and condition, and available construction access.

7.1.1.1 Open Cut Construction

Description: Open cut or open trench construction, also known as cut and cover, has historically been the most widely used approach for sewer pipe replacements. A trench is excavated that is approximately 18 inches to two feet wider than the replacement pipe, and six to 12 inches deeper than the bottom of pipe. A new pipe is installed, backfill material placed and compacted, and pavement and surface facilities restored. Often, the new pipe is installed in a different location than the original pipe, and the original pipe abandoned in place. In this case, sewer flow continues through the original pipe, and a planned shutdown is scheduled during the "tie-in," when the new pipe is connected to the existing pipe. Alternatively, the existing pipe is removed to allow replacement of the new pipe in the same location. The existing flow is bypassed through a temporary pumped system during construction operations.

Advantages and Limitations: Historically, open cut construction has been more cost effective than trenchless technologies, and consequently, more widely used for pipe replacement. Open cut construction is appropriate in most soil conditions, and could be beneficial in locations where significant utility crossings are present, depending on the depths of existing utilities. An open trench can be adjusted in the field to avoid existing underground obstructions, or to otherwise relocate the new pipe. This method enables installation of a larger diameter pipeline where capacity issues are present, or improved materials when available or needed.

One limitation to open cut construction is in shoring and dewatering. Shoring of the trench walls is required for personnel safety and an engineered shoring system is required when a trench is greater than five feet in depth, in accordance with California Labor Code Section 6705. Excavation below the groundwater table, or in soils that permit infiltration of groundwater into the open trench necessitate aggressive dewatering methods. The added cost of these requirements can decrease the economic viability of open cut construction in specific situations. For pipeline installations in new alignments, a geotechnical investigation is recommended during the design phase to determine shoring requirements and whether groundwater is anticipated during construction.

Open cut construction is also difficult where construction access is limited, or on steep hillsides. Open cut construction also impacts surface features and traffic, may introduce safety concerns in highly used or highly traveled locations, and creates temporary noise and dust impacts. Historically, CalTrans has required trenchless construction methods to be used for the installation of new pipelines within their rights of way.

Probable Unit Costs: The unit cost of open cut construction varies depending on site conditions and construction access limitations. However, in paved roadways underlain by generally cohesive soils above the groundwater table, and in areas without significant utility or traffic issues, open cut pipeline installation costs range from $10 to $14 per inch diameter per foot of pipe installed.

These pipeline installation costs include excavation, shoring, pipe installation, backfill, and compaction. These costs do not include mobilization, paving, traffic control, or pipeline appurtenances, which are estimated as a separate item, and for planning purposes, are considered equal to the fifty percent of the cost of pipeline installation.

For the Districts projects, the following unit costs (rounded to the dollar) were applied. These unit costs were compared to the bid tabs for two recent projects completed in the District and found to be reasonable:

Normal construction conditions:	$15 per inch diameter per foot of pipe
Deep construction conditions (Depth greater than 12 feet):	$18

7.1.1.2 Pipe Bursting

Description: Pipe bursting is a trenchless construction method by which existing pipe is replaced with the same size or typically one size larger pipe in the same location. Pipe bursting is most effective in replacing pipes that are less than 24 inches in diameter and are at least 4 feet deep. This method is the most cost effective when there are few lateral connections, when the old pipe is structurally deteriorated or is easily fractured (e.g., vitrified clay pipe), and when additional capacity is needed and trenchless methods are desired or required.

A conical pipe bursting head is conveyed through the pipe, exerting outward forces that fracture the existing pipe and displace fragments outward into the soil. The head is driven by pneumatic pressure, hydraulic expansion, or static pull; the head is connected to and pulls in the new pipe. The pipe bursting head is inserted and also retrieved through new access pits that are located at approximately 400 to 500 foot intervals.

The optimal pull length is dependent upon the size of the host pipe, the degree of upsize required, and the type of soil in the surrounding subsurface. Additional pits, typically two feet wide by two feet long, are required at each service lateral connection and at crossing utilities. Pipes suitable for pipe bursting are those made of brittle materials, such as vitrified clay. Special bursting heads with cutting elements are required for more ductile pipe materials such as steel, polyvinyl chloride (PVC) and ductile iron. Typically, the replacement pipe material will be high-density polyethylene (HDPE) or fused PVC. Construction using PVC requires longer pit lengths than with HDPE because PVC requires a longer bending radius.

Advantages and Limitations: Pipe bursting is quickly gaining popularity as a replacement methodology for small diameter sewers. If HDPE pipe is used, a relatively small pit (as compared to open trench) is required for entry of the pipe bursting head, which can be extracted through an existing manhole. Pipe bursting replaces the existing pipe by up to two diameter sizes without significant open trenching, and therefore reduces surface impacts. The unit cost of pipe bursting is decreasing, and often comparable to open cut methods.

Existing conditions must be considered carefully when specifying pipe bursting. Flowing soils such as sand, highly incompressible soils such as rock, installations below the groundwater table, sensitive utilities located within two to three pipe diameters of the pipe to be burst, historical point repairs that are not conducive to bursting such as steel couplings, or significant sags or pipe collapses will limit the success of pipe bursting operations. Pipe bursting may also create ground vibrations and outward ground displacements adjacent to the pipe alignment; these displacements are exacerbated in shallow installations or when the pipe is significantly upsized. When the existing pipe is shallow, this ground displacement may be controlled by saw cutting pavement over the pipe in advance of the bursting operation. This approach localizes surface heave and provides for more simplified trench patch repair.

Pipe bursting is performed between pits spaced 400-500 feet apart. A manhole can be used in lieu of the receiving pit. During the pipe bursting process, the rehabilitated pipe segment must be taken out of service by rerouting or bypassing sewer flows. Laterals are reconnected through external pits after the pipe bursting activities are completed.

Probable Unit Costs: The unit cost of pipe bursting varies depending on site conditions and construction access limitations. However, in paved roadways underlain by generally cohesive soils above the groundwater table, and in areas without significant utility or traffic issues, pipe bursting costs range from $10 to $15 per inch diameter per foot of pipe installed. These pipeline installation costs include excavation and shoring of pits, pipe bursting and installation, backfill, and compaction. These costs do not include mobilization, paving, traffic control, or pipeline appurtenances/lateral restoration, which are estimated as separate item, and considered equal to the cost of pipeline installation.

In the prioritized CIP developed for the 2016 Master Plan Update, pipe bursting was specified for specific projects which called for a single increment diameter increase, and for which conditions were judged favorable for pipe bursting.

For the Districts projects, the following unit costs (rounded to the dollar) were applied:

Pipe Bursting Normal Conditions: $20 per inch diameter per foot of pipe

7.1.1.3 Cured in Place Pipe (CIPP)

Description: CIPP is a trenchless repair method that installs a resin-saturated felt liner into the host pipe through existing manholes. The liner is made of interwoven polyester and may be fiber-reinforced for additional strength. Commonly manufactured resins include unsaturated polyester, vinyl ester, and epoxy, each having distinct chemical resistance to domestic wastewater. The CIPP liner is installed by inversion using water or pressurized air; after the liner is in place, the resin-impregnated tube is cured using hot water, steam, or high-intensity ultraviolet light, creating a seamless pipe that fits tightly against the host pipe wall. Laterals are then connected to the mainline pipe using a remote controlled cutting device.

Advantages and Limitations: CIPP is a viable rehabilitation technology in 6-inch or larger gravity sewers where the existing pipe has sufficient capacity. Because laterals are connected from inside the lined pipe, little or no trenching is required. Therefore, CIPP may be a preferred alternative in pipelines where trenching would be cost prohibitive. The CIPP method can be used to address structural problems such as cracks and structurally deficient segments, as well as root intrusions because the liner forms itself generally to the shape of the host pipe, and can span gaps caused by roots up to one inch in diameter. Larger gaps and alignment deficiencies such as offset joints and sags would require a point repair prior to lining.

The flexibility of the resin tube allows installation through existing bends, further minimizing the need for excavation. The liner is resistant to chemical attack, eliminates groundwater from entering the sewer, and retards further corrosion and erosion of the pipeline.

The thickness of CIPP liner typically ranges from ½ inch to 1 inch and therefore, the final inside diameter is approximately 1 to 2 inches less than the inside diameter of the existing pipe. The liner typically has less flow friction compared to the host pipe, so the reduction in diameter does not result in a reduction in hydraulic capacity, particularly for pipe above 8 inches in diameter.

CIPP installation requires bypass pumping and groundwater dewatering, if in a high groundwater area. Installation length is generally limited to approximately 800 feet due to curing limitations. Therefore, if manholes are located further apart than 800 feet, intermediate trenched access locations are required. Another challenge associated with using CIPP is the procurement, treatment, and/or disposal of water used during the curing process; during the curing process of any resin system, volatile organic compounds are released and must be closely monitored.

CIPP is a viable alternative to pipeline replacement when pipeline replacement options are cost-prohibitive, and when existing pipe diameter can be reduced without compromising system performance. CIPP is not recommended when pipeline slopes or other constraints limit the use of hydroflushing as a cleaning method.

Probable Unit Costs: The cost of CIPP varies significantly depending on site access, pipeline configuration, liner specifications, curing method, ease of disposal of curing water, and bidding climate. However, for conceptual estimating purposes, CIPP installation costs range from $10 to $15 per inch diameter per foot of liner installed in normal conditions. These costs do not include mobilization, trenching if needed, special disposal costs, lateral connections, or traffic control, which are estimated as a separate item, and considered equal to the cost of CIPP pipeline installation.

For the 2016 Master Plan Update, it is assumed that all of the District's projects will require the installation of new, larger pipe to address capacity constraints. However, during preliminary design, the opportunity to provide smaller, parallel relief sewers in conjunction with repair of the existing pipe using CIPP liner should be considered.

7.1.1.4 Pipe Reaming

Description: Pipe reaming is very similar to pipe bursting in that an existing pipe is drilled out and a new pipe of equal or greater diameter inserted in its place. Because pipe reaming does not displace the broken pieces of the old pipe into the soil, this method is better suited to pipe rehabilitation where nearby pipes or utilities might be impacted by the displaced soil.

Pipe reaming employs a directional drill which pulverizes and grinds up the existing pipe while a new pipe is inserted behind it. The old pipe is accessed by an insertion trench, and the drill head is pulled through the pipe by a drill line which runs from an insertion trench where the pipe is accessed to the next manhole. The broken pipe is carried away through the old pipe by drill fluid and collected at the downstream manhole.

Pipe reaming can be used to remove brittle pipes such as those composed of vitrified clay, PVC, asbestos concrete, or ductile iron. Fused PVC or HDPE are typically used for the replacement pipe. Pipe reaming has been effective at replacing sections of sewer over 1,000 feet in length or more with little soil disruption.

Advantages and Limitations: Like other trenchless technologies, pipe reaming is advantageous when trying to minimize the impact of construction on traffic and business. When using pipe reaming as a rehabilitation technology, adequate space must be available for the insertion pit and the heavy machinery necessary for directional drilling and handling of the solids generated by the drilling process. Pipe reaming can become very expensive if there are a large number of laterals that must be reconnected to the replaced pipe.

Probable Unit Costs: Similar to pipe bursting, the unit cost of pipe reaming varies depending on site conditions and construction access limitations. However, in paved roadways underlain by generally cohesive soils above the groundwater table, and in areas without significant utility or traffic issues, pipe reaming costs range from $18 to $22 per inch diameter per foot of pipe installed. These pipeline installation costs include excavation and shoring of pits, pipe reaming and installation, backfill, and compaction. These costs do not include mobilization, paving, traffic control, or pipeline appurtenances, which are estimated as a separate item, and considered equal to the cost of pipeline installation.

For the 2016 Master Plan Update, it was assumed that pipelines would be installed using open cut methods or pipe bursting. The costs for pipe reaming are included for reference, in the event that preliminary design indicates that pipe reaming may be more feasible for a particular project.

7.1.1.5 Tunneling

Description: Where open cut construction is not feasible, practical, or cost effective, trenchless methods can be used to install the sewer pipe. Commonly used trenchless methods include jack-and-bore above the water table, micro tunneling below the water table, and horizontal direction drilling. These methods involve pre-drilling the pipeline alignment and then installing new pipe through the opening. When installed below Caltrans or railroad right of ways, an additional casing may be required by the governing jurisdiction.

Advantages and Limitations: Tunneling presents similar advantages to pipe bursting and pipe reaming related to minimized surface impacts when compared to open cut construction. Pipe size increase is not limited with tunneling methods and longer lengths of pipe can be replaced through a single bore.

Tunneling requires precise location of existing utilities and is not always appropriate where the new pipeline must maintain a precise slope or avoid numerous underground facilities. Additionally, tunneling requires an understanding of the materials to be tunneled through.

Tunneling requires experienced equipment operators that are skilled with the location and guidance of the necessary equipment. Tunneling is assumed to be required along and across Caltrans and railroad rights-of-way.

Probable Unit Costs: The unit cost of tunneling varies depending on site conditions and construction access limitations. However, in areas without significant utility or traffic issues, tunneling costs are generally 1.5 to 2 times the cost of open cut construction. These pipeline installation costs include excavation and shoring of pits, drilling, pipe installation, backfill, and compaction. These costs do not include mobilization, paving, traffic control, or pipeline appurtenances, which are estimated as a separate item, and considered as fifty percent of the cost of pipeline installation.

For the 2016 Master Plan Update, it was assumed that pipelines would be installed using open cut methods or pipe bursting. The costs for tunneling are included for reference, in the event that preliminary design indicates that tunneling may be required for a particular project.

7.1.2 Pipeline Inspection Methods and Conceptual Costs

Both the hydraulic analysis described in Chapter 5 and the risk analysis described in Chapter 6 identified gravity mains that require physical inspection to confirm condition, slope, and/or hydraulic capacity before the nature and extent of the required CIP project can be finalized. Further, the risk assessment has identified the need for regular inspection of gravity main assets to better quantify condition information for targeted preventative maintenance and rehabilitation.

For the 2016 Master Plan Update, inspection in most cases comprises CCTV inspection of the gravity main. However, in some cases inspection indicates that vertical surveying should be performed to establish the invert elevation and rim elevations of the upstream and downstream manholes so that a slope may be established.

Probable Unit Costs: CCTV inspection costs can vary depending on the amount of heavy cleaning/root cutting, flow diversion, pipe diameter, traffic control, and property owner coordination necessary. The District should attempt to establish large volume contracts in order to minimize costs. Assuming such contracts can be secured, $2.00 per linear foot is assumed for inspection costs.

7.1.3 Lift station Construction, Upgrade, and Rehabilitation Methods and Conceptual Costs

7.1.3.1 Lift Station Construction and Capacity Upgrades

The hydraulic capacity analysis presented in Chapter 5 identified both existing lift stations with insufficient capacity and new lift stations that will be required for development. Lift station new construction and capacity upgrade construction cost estimates are based upon pre-established West Yost costs curves for wastewater lift stations, which combine the costs curves presented in Shank's "Pumping Station Design" with cost data from actual projects completed in the last 10 years.

The lift station firm capacity (the capacity of the station with the largest pump in reserve) is the key value to input to the curves. From the capacity value, a line is drawn to where capacity intersects the cost curve lines. Two lines are provided to reflect difficult construction conditions and comparatively easy construction conditions.

7.1.3.2 Lift Station Rehabilitation

The risk assessment described in Chapter 6 identified several lift stations that do not require capacity increases for either existing or future design flows, but whose condition requires rehabilitation in order to maintain reliable service. Rehabilitation activities may include structural, electrical, or site improvements as required at each lift station location. Because the requirements for rehabilitation vary for specific lift stations, the costs will vary as well. However, discussion with District staff indicates that recent lift station rehabilitation projects have been consistently close to $205,000 in cost. This value will be used as the conceptual construction costs for lift station rehabilitation in the 2016 Master Plan Update. It should be noted that this value applies to City-owned lift stations. District-owned lift stations are larger and more complex, and costs will be developed on an individual basis.

7.1.4 Lateral Replacement Methods and Conceptual Costs

The analysis of service calls within the District performed for the risk assessment that is described in Chapter 6 found that District Operations and Maintenance crews regularly respond to collection system problems that originate in the laterals, rather than the gravity mains. As a means to reduce unplanned maintenance calls and to conserve and protect the integrity of the collection system, the 2016 Master Plan Update provides recommendations for regular lateral replacement. Replacement of lateral, including the installation of a clean-out and backflow prevention device, is assumed to cost $7,500 per replacement.

7.1.5 Contingency and Implementation Costs

Contingency cost and implementation mark-ups must be reviewed on a case-by-case basis because they will vary considerably with each construction project. However, to assist District staff with budgeting for these recommended collection system improvements, the following percentages were developed.

- Contingency: 30 percent
- Implementation Costs: 30 percent

Design:	10 percent
Construction Management and Inspection:	10 percent
Permitting, Regulatory and CEQA Compliance:	5 percent
District Administration, Public Outreach, and Legal:	5 percent
Total:	30 percent

The total contingency and implementation costs are compounded, so the total markup of the base construction cost is 69 percent. For the 2016 Master Plan, it is assumed that new facilities will be developed in public rights-of-way or on public property. Therefore, land acquisition costs have not been included. Proposed costs do not include costs for annual operation and maintenance.

7.2 PROPOSED CIP

Proposed CIP projects have been developed to meet the hydraulic capacity requirements presented in Chapter 5. The projects are categorized by the development timeline for which they are required. Projects identified for the 2015 timeframe are required under existing hydraulic conditions. Further, the proposed CIP projects have been prioritized according to the risk assessment that was performed as described in Chapter 6. Using the risk assessment, District and member City funds are being prioritized to projects that will most improve the overall condition of the collection system, as well as provide needed capacity.

7.2.1 Proposed Gravity Main CIP

The recommended gravity main projects for the existing and future collection system were developed based on the methodologies and criteria presented in previous chapters. Additionally, already-completed plans such as the Dinuba North Line have been integrated into the proposed CIP. The District's current project to line and improve the condition of the existing McCall Avenue Trunk sewer has been taken into account in all evaluations.

For gravity main capacity improvement projects identified as part of the 2016 Master Plan, replacement or new gravity mains were sized to convey design flows. Existing pipe slopes and depths were preserved when upsizing sewers in-place. Diameters were increased as minimally as possible in order to prevent oversizing and subsequent low velocities during dry weather conditions. Model runs with all capacity projects in place were made to determine the impact of increased capacity from upstream projects on peak flows in pipes downstream of those projects to verify that no additional collection system capacity deficiencies would result.

increased capacity from upstream projects on peak flows in pipes downstream of those projects to verify that no additional collection system capacity deficiencies would result.

In some cases, the hydraulic model identified short reaches of gravity main (often a single pipeline), which have insufficient capacity because of flat or even negative slopes. In these cases, a construction project to correct such a small lack of capacity may not be advisable. For such cases, the proposed CIP recommends inspection to confirm the slope, alignment, and capacity of the reach, rather than a replacement project. For these projects, inspection costs, rather than replacement costs are reflected in the prioritized CIP.

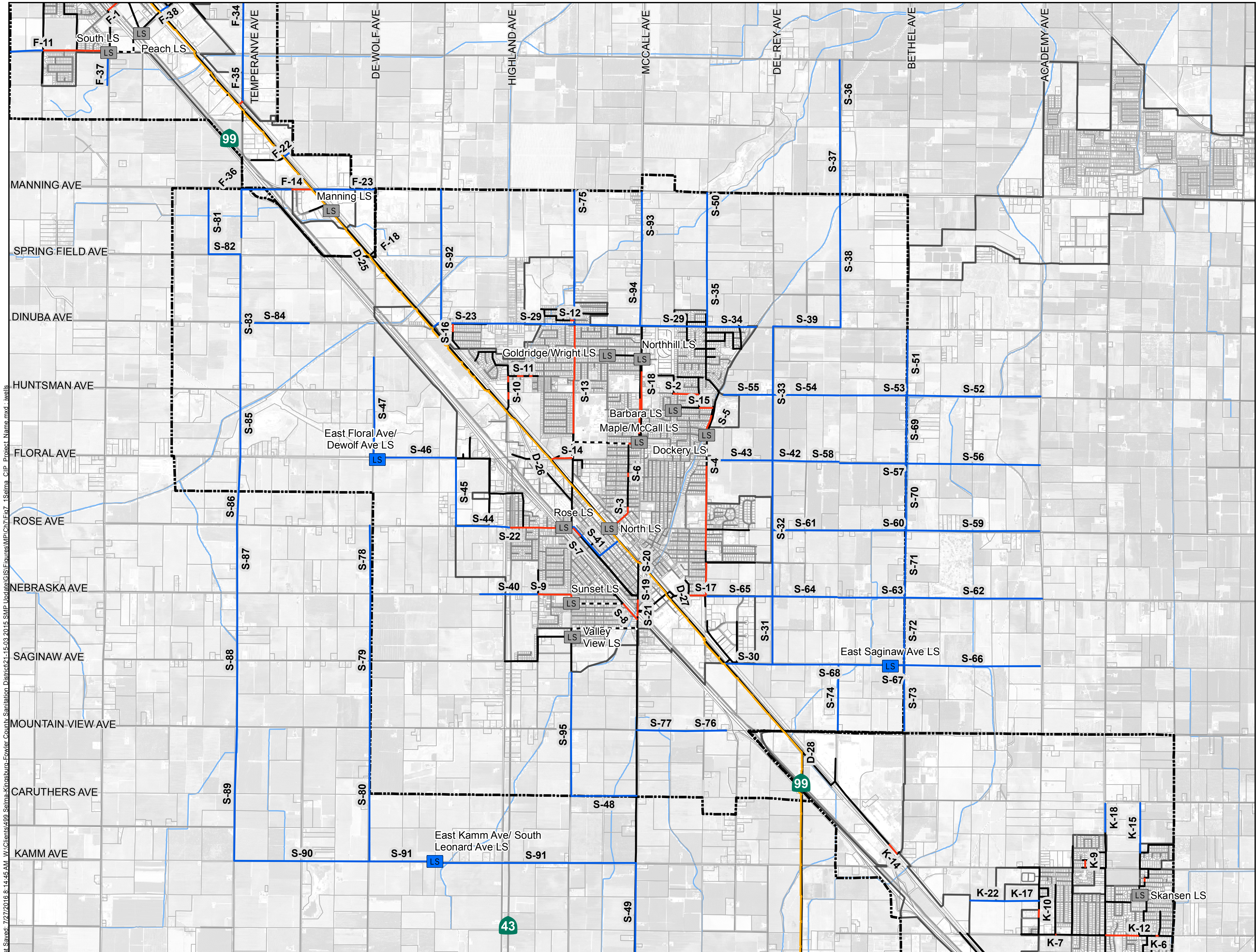
The proposed gravity main CIP for Selma can be seen on Figure 7-1, for Kingsburg on Figure 7-2, and for Fowler on Figure 7-3. The CIP projects are labeled on these figures. The projects are listed in detail for each City in Appendix C. The development timeline, prioritization, and estimated conceptual costs are included for each project in the Appendix.

The proposed CIP for gravity mains is summarized in Table 7-1. Estimated conceptual capital costs are summarized by development timeline and member City in the table. As shown in Table 7-1, approximately $228M in gravity main improvements are required to meet the collection system requirements of the development and design flows that are described in Chapter 4. Approximately four percent of the improvements, with an approximate estimate cost of $10M, are required for existing conditions. Another 20 percent of the gravity main improvements totaling approximately $46M are required for development that is projected to occur in the 2020 development timeframe. Seventy-five percent of the improvements are not required until the 2035 development timeframe at the end of the study period.

Table 7-1. Summary of Proposed Gravity Main CIP Conceptual Capital Costs

Development Timeframe	Selma, dollars	Kingsburg, dollars	Fowler, dollars	District, dollars	Entire 2016 Master Plan Update Study Area, dollars
2015	8,170,880	617,780	955,190	—	9,743,850
2020	38,076,340	2,361,260	5,488,060	—	45,925,660
2025	—	—	1,063,820	—	1,063,820
2035	99,757,470	2,955,460	19,166,530	49,561,270	171,440,730
Total	$146,004,690	$5,934,500	$26,673,600	$49,561,270	$228,174,060

Geographically, Selma requires the largest portion of the proposed gravity main CIP compared to the other member cities, with the majority of the projects being required for the 2035 development timeframe. Fowler's required portion of the CIP is significantly smaller, and Kingsburg's required portion is smaller still. The District's portion of the proposed gravity main CIP totals approximately $50M, all required for the 2035 timeframe. The projects in the District's proposed gravity main comprise parallel construction projects along the Golden State Interceptor to provide needed capacity in this interceptor for development in the 2035 timeframe.



Symbology

- LS Proposed Lift Station
- Proposed Gravity Main
- Parallel District Gravity Main
- Replace Existing Gravity Mian
- WWTP Wastewater Treatment Plant
- LS Existing Lift Station
- Modeled Gravity Main
- Modeled Force Main
- Unmodeled Gravity Main
- City Limits
- City SOIs

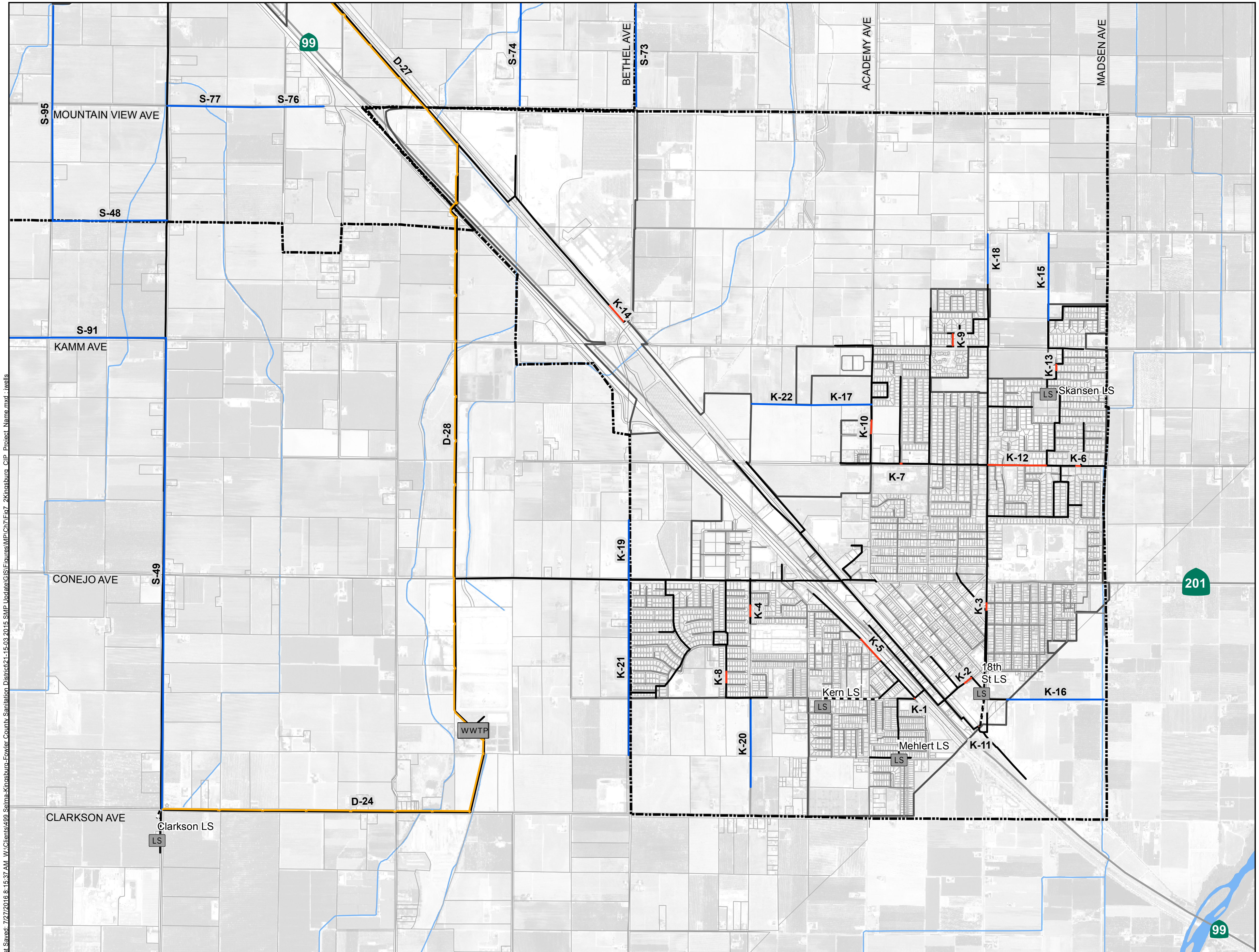
Note:
1. Labels indicate the name of the CIP project. Project details may be found in the detailed CIP tables.
2. Project name starting with S indicates Selma's collection system; D indicates the District's collection system.
3. Detailed CIP Project information can be found in Appendix C.

WEST YOST ASSOCIATES

Figure 7-1

Recommended CIP Projects
City of Selma

Selma-Kingsburg-Fowler CSD
Wastewater Collection System
2016 Master Plan Update



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Symbology

- LS Proposed Lift Station
- Proposed Gravity Main
- Parallel Existing District Gravity Main
- Replace Existing Gravity Mian
- WWTP Wastewater Treatment Plant
- LS Existing Lift Station
- Modeled Gravity Main
- Modeled Force Main
- Unmodeled Gravity Main
- City Limits
- City SOIs

Note:
1. Labels indicate the name of the CIP project. Project details may be found in the detailed CIP tables..
2. Project name starting with K indicates Kingsburg's collection system; D indicates the District's collection system.
3. Detailed CIP Project information can be found in Appendix C.

WEST YOST ASSOCIATES

Figure 7-2

Recommended CIP Projects
City of Kingsburg

Selma-Kingsburg-Fowler CSD
Wastewater Collection System
2016 Master Plan Update

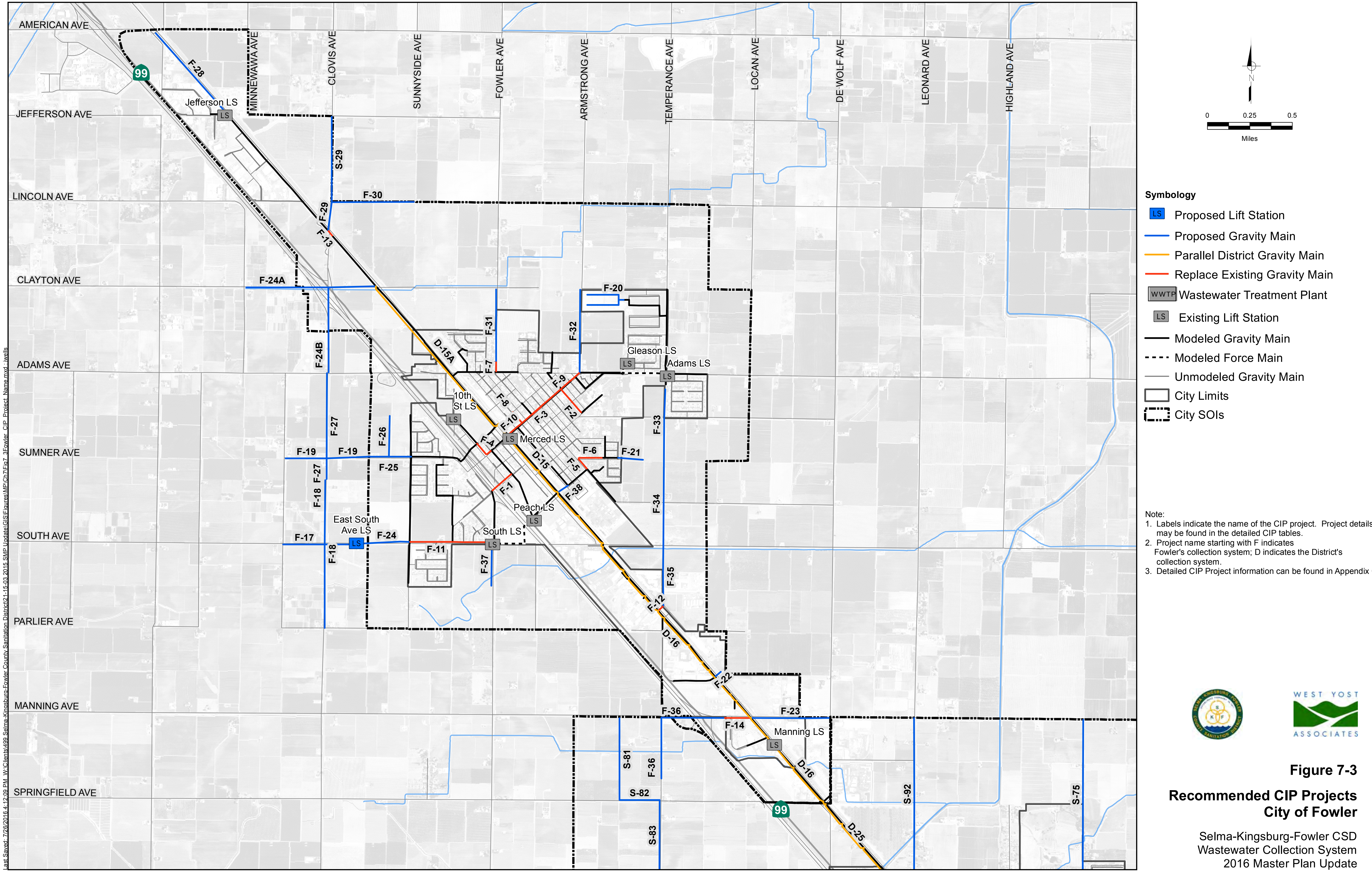


Figure 7-3

Recommended CIP Projects
City of Fowler

Selma-Kingsburg-Fowler CSD
Wastewater Collection System
2016 Master Plan Update

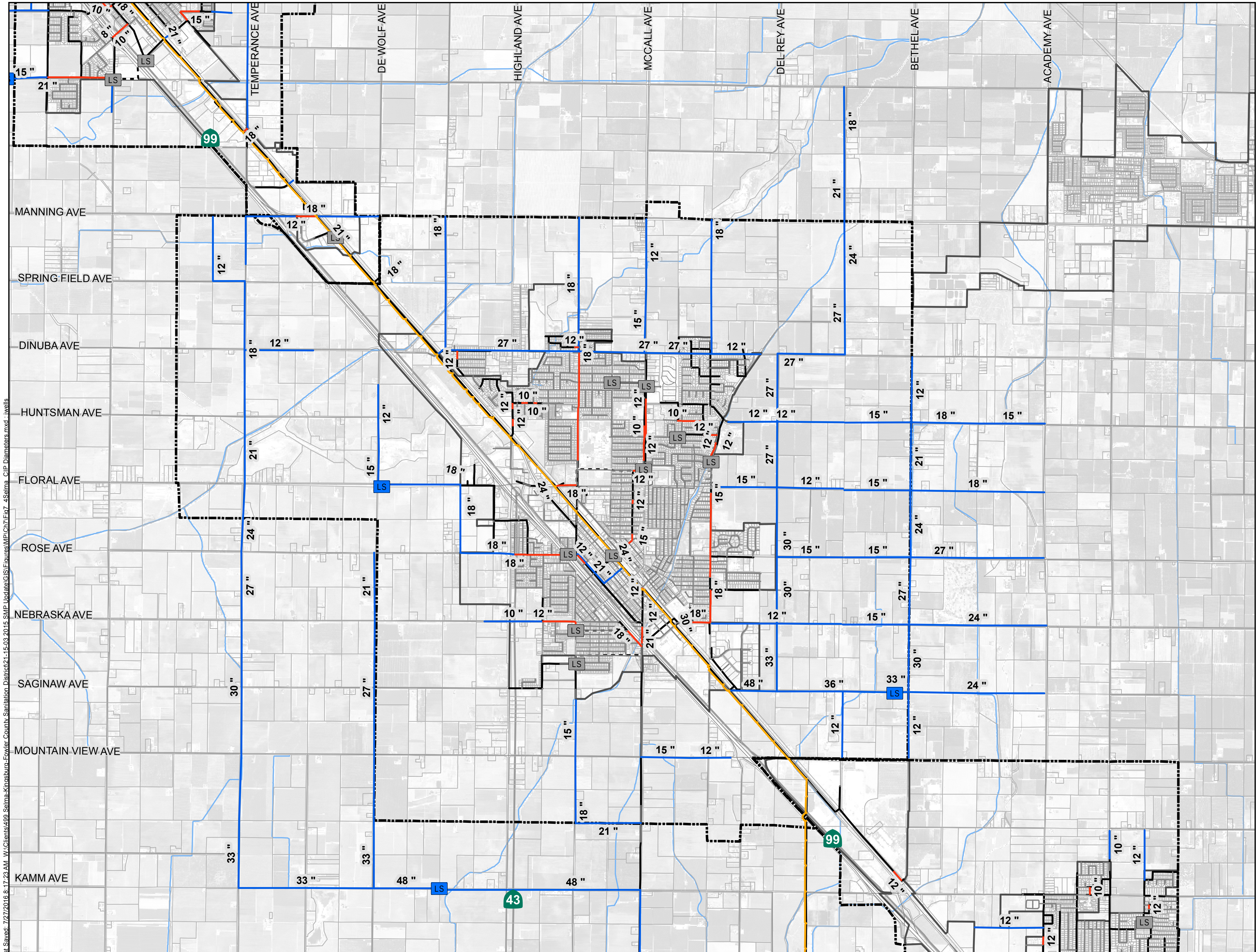
The gravity main diameter required for each project can be found in the detailed project descriptions in Appendix C. For easy reference, the required gravity main diameters can also be seen for Selma (and District projects within Selma) on Figure 7-4, for Kingsburg on Figure 7-5, and for Fowler (and District projects within Fowler) on Figure 7-6.

7.2.2 Proposed Lift Station CIP

As described in Chapter 5, the hydraulic model identified existing lift stations that have insufficient capacity under existing design flows. The model also identified existing lift stations that have insufficient capacity under future design flows. Finally, the hydraulic model was used to identify the capacity and location of proposed lift stations needed in the future to convey flow from development. The proposed lift station CIP has been developed from these results. The required lift station capacity increases with estimated conceptual capital costs are provided in Table 7-2. The location of these lift stations can be seen on Figure 1 through Figure 3.

Table 7-2. Proposed Lift Station Capacity CIP with Estimated Capital Costs

Lift Station Name	Lift Station ID	Location	Development Timeline	Action	Required Design Firm Capacity, gpm	Estimated Conceptual Capital Cost, dollars
Merced Street	D-1	Fowler	2015	Capacity Upgrade	1,200	605,000
Manning	D-2	Fowler	2015	Capacity Upgrade	2,200	803,000
North Street	D-3	Selma	2015	Capacity Upgrade	5,000	1,324,000
Clarkson & Mc Call	S-11	Selma	2015	Capacity Upgrade	3,000	957,000
South Avenue	F-5	Fowler	2035	Capacity Upgrade	1,250	615,000
Rose Street	S-3	Selma	2035	Capacity Upgrade	1,250	615,000
Proposed East Kamm Avenue	N/A	Selma	2035	New Construction	8,400	5,794,000
Proposed East Floral Avenue	N/A	Selma	2035	New Construction	650	1,499,000
Proposed East Saginaw Avenue	N/A	Selma	2035	New Construction	5,100	4,119,000
Proposed East South Avenue	N/A	Fowler	2035	New Construction	580	1,454,000
Total						17,785,000



0 0.35 0.7
Miles

Symbology

- Proposed Lift Station
- Proposed Gravity Main
- Parallel District Gravity Main
- Replace Existing Gravity Mian
- WWTP Wastewater Treatment Plant
- LS Existing Lift Station
- Modeled Gravity Main
- Modeled Force Main
- Unmodeled Gravity Main
- City Limits
- City SOIs

Note:
1. Labels indicate recommended diameter.
2. Detailed CIP Project information can be found in Appendix C.

WEST YOST ASSOCIATES

Figure 7-4

Recommended CIP Gravity Main Diameter City of Selma

Selma-Kingsburg-Fowler CSD
Wastewater Collection System
2016 Master Plan Update

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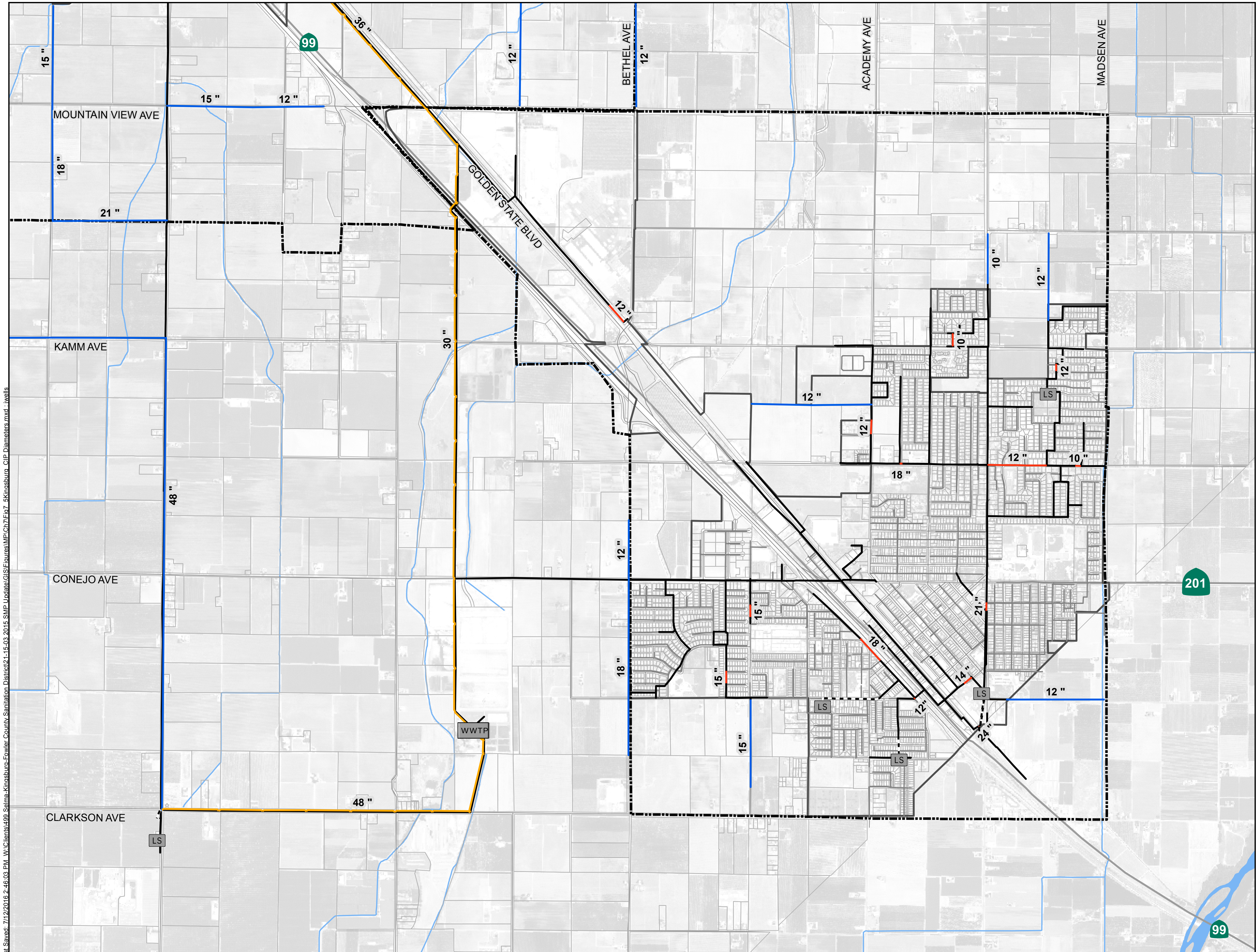


Symbology

- LS Proposed Lift Station
- Proposed Gravity Main
- Parallel District Gravity Main
- Replace Existing Gravity Mian
- WWTP Wastewater Treatment Plant
- LS Existing Lift Station
- Modeled Gravity Main
- Modeled Force Main
- Unmodeled Gravity Main
- City Limits
- City SOIs

0 0.2 0.4
Miles

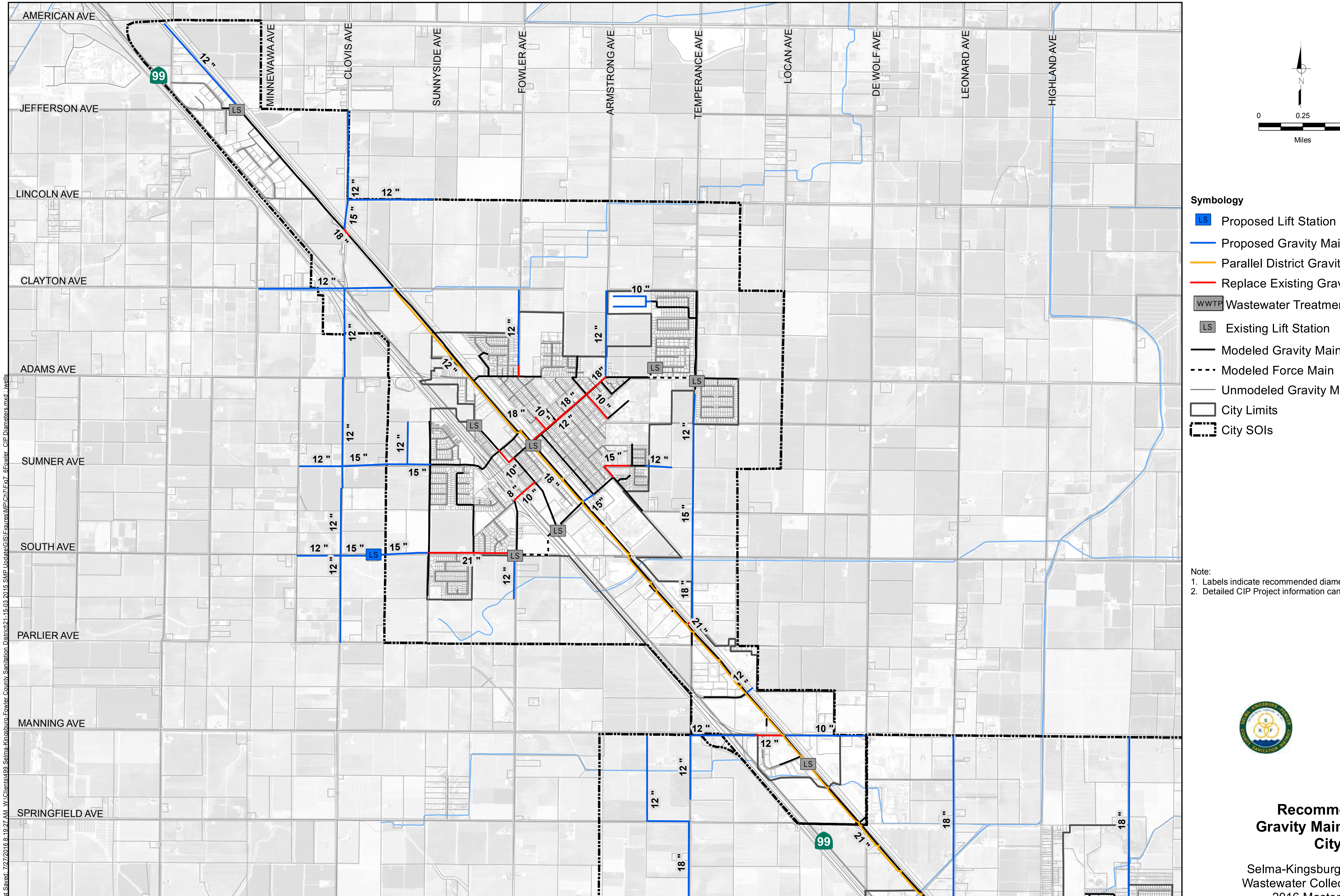
Note:
1. Labels indicate recommended diameter.
2. Detailed CIP Project information can be found in Appendix C.

WEST YOST ASSOCIATES

Figure 7-5

Recommended CIP Gravity Main Diameter City of Kingsburg

Selma-Kingsburg-Fowler CSD
Wastewater Collection System
2016 Master Plan Update



Symbology

- Proposed Lift Station
- Proposed Gravity Main
- Parallel District Gravity Main
- Replace Existing Gravity Main
- Wastewater Treatment Plant
- Existing Lift Station
- Modeled Gravity Main
- Modeled Force Main
- Unmodeled Gravity Main
- City Limits
- City SOIs

Note:
1. Labels indicate recommended diameter.
2. Detailed CIP Project information can be found in Appendix C.

WEST YOST ASSOCIATES

Figure 7-6

Recommended CIP Gravity Main Diameter City of Fowler

Selma-Kingsburg-Fowler CSD
Wastewater Collection System
2016 Master Plan Update

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As described in Chapter 6, the three District lift stations Merced Street, Manning, and North Street are most critical and highest priority for upgrade. Additionally, the 18th Street Lift Station, which is also a District lift station, does not require a capacity upgrade but requires rehabilitation with a high priority. A conceptual capital cost of $609,500 is estimated for this rehabilitation. This cost has been developed by District staff and is currently budgeted.

The capacity increases for the Merced Street Lift Station, Manning Lift Station, and North Street Lift Station are being phased as part of the 2016 Master Plan Update. The required firm design capacities presented in Table 7-2 will sufficient capacity for existing design flows, and will be sufficient to the 2035 development time frame. Further capacity upgrades will be required at this time. The full capacity analysis for each lift station is provided in Appendix D.

7.2.3 Proposed Force Main CIP

A single existing force main was determined to have insufficient capacity for future design flows. The North Street Lift Station will require a 12-inch diameter force main in the 2035 development timeframe. Because the capacity improvements to the North Street Lift Station are being phased as described above, the upgrade of this force main is not included as part of the proposed CIP for the 2016 Master Plan Update.

7.3 PROPOSED INSPECTION AND REFURBISHMENT/REPLACEMENT BUDGETS

In addition to the proposed CIP for the capacity improvements described above, the District's collection system will require regular investment in refurbishment/replacement (R/R) to maintain the working order of the collection system. In order to prioritize R/R projects for gravity mains, the condition of each main must be assessed in a systematic manner so that needed repairs can be located and planned for.

7.3.1 CCTV Inspection Program

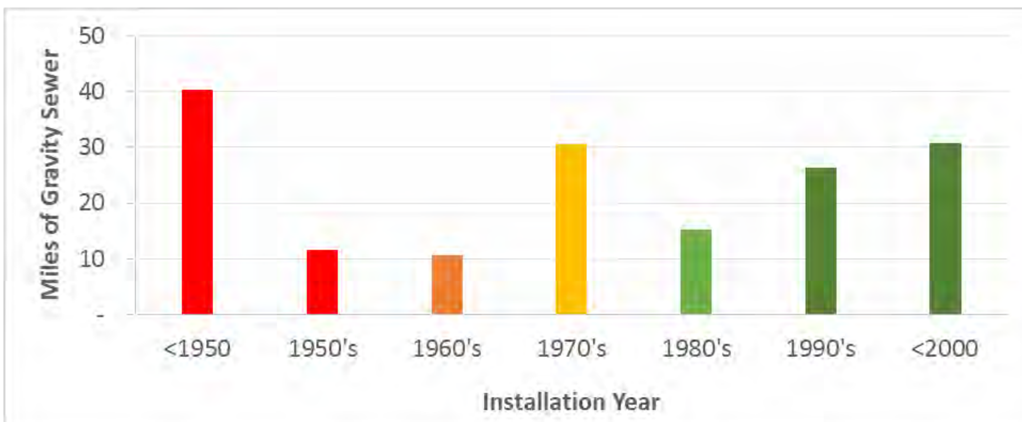
It is recommended that the District implement an ongoing CCTV Inspection Program in order to collect baseline information about the condition of the existing gravity mains for the development of a long-term gravity sewer R/R program. The inspection plan can be phased over the next seven years (at a maximum) and should use the standardized National Association of Sewer Service Companies (NASSCO) PACP defect coding system so that the condition of one pipe can be compared directly with another.

The risk assessment results in Chapter 6 should be used to prioritize gravity sewers for CCTV inspection so that higher risk pipes are inspected in the first few phases of the program. This inspection program will require that approximately 23.6 miles of gravity main be inspected each year over the seven-year program. At $2.00 per linear foot, the annual budgetary cost for this recommended CCTV inspection program is approximately $250,000 per year.

7.3.2 Refurbishment/Replacement Program

When developing an adequate gravity sewer R/R program without the benefit of CCTV data, it's important to look at the remaining useful lives of the assets in the system. In fairly newer communities, R/R funds can remain significantly lower than in communities where significant portions of the infrastructure are past its useful life and requires replacement. In order to approximate the remaining useful life of the District's gravity sewers, county housing construction dates were used to estimate the installation year of many of the District's assets in Chapter 6. Figure 7-7 shows the number of miles of pipe estimated to be installed in past decades. As a result of this analysis, it was found that as much as 24 percent of the gravity sewers in the District service area may be nearing or past the end of their useful lives (assuming a standard useful life of 70 years for VCP pipe). Given this potentially significant amount of replacement project backlog, it is recommended that the District consider developing a proactive program for funding the replacement of these sewers.

Figure 7-7. Approximate Gravity Sewer Installation Dates



One useful, albeit ideal, rule-of-thumb is to consider the cost of replacing 1/70 of the system each year to keep up with the average rate of assets passing the end of their useful life each year. Assuming an average of $15 per inch-diameter per linear foot of pipe for the District's service area, the replacement costs of the gravity sewers owned by each agency are shown in Table 7-3. As shown, the total replacement value of the gravity sewer system is approximately $147M, and a 70-year replacement plan would invest $2.1M per year to replace sewers that are past their useful lives.

Table 7-3. Gravity Sewer Replacement Values			
Owner	Replacement Cost, dollars	70-yr Replacement Plan, dollars	FY 2015-16 R/R Fund, dollars
District	26,051,445	372,164	—
Fowler	25,506,660	364,381	128,474
Kingsburg	41,971,290	599,590	214,568
Selma	53,832,579	769,037	282,784
Grand Total	$147,361,974	$2,105,172	$625,826

Currently, the District operates four separate R/R funds: one for District-owned facilities, and one for each of the three member cities. The member cities R/R funds are replenished at the rate of $34 per ESFR for gravity sewer and lift station improvements. As shown in Table 7-3, the fiscal year 2015-16 R/R funds for each member city are currently funded at the rate of approximately 36 percent of the ideal 70-year replacement plan. At this current funding rate, it would take approximately 195 years to replace the gravity sewer system.

Once additional CCTV data is collected, the District will be able to make more specific asset management decisions (such as employing rehabilitation methods such as spot repairs or CIPP lining, as discussed above) to help extend the useful life of the system and maximize R/R funds. For now, it is recommended that the District consider increasing R/R funding to 50 percent of the ideal 70-year replacement plan, which would result in an increase from $34 to $47 per ESFR for each city. This recommendation assumes that lift station improvements will be funded by the capital improvement budget, instead of the R/R budget.

Additionally, the District should budget for the replacement or major rehabilitation of approximately 25 laterals per year, as laterals are the cause of a significant number of emergency maintenance call-outs. The cost of such a program would be approximately $190,000 per year.

APPENDIX A

Detailed Land Use

Table A-1. Detailed Landuse Development Data

WY_ID	WY_Land_Use	Name	Type	Units	PlanDate	Acres	City	WY_Updated_Unite	Final Unit	Acres/Unit	acres
1	Res-Low	Hash Property	Residential	194	2020		Kingsburg		194	4.50	43.11
2	Ind-heavy	Frenso Valve & Castings	Industrial		2025	51	Fowler			1.00	51.12
3	Ind-light	Industrial Development 1	Industrial		2020	14	Fowler			1.00	14.00
4	Ind-heavy	Industrial Development 2	Industrial		2020	26	Fowler			1.00	26.00
5	Res-Low	Kensignton Estates - Phase I	Residential	40	2015		Fowler	55	55	1.80	30.56
6	Res-Low	Kensignton Estates - Phase II	Residential	100	2015		Fowler	55	55	1.80	30.56
7	Res-Low	Kensignton Estates - Phase III	Residential		2020		Fowler	60	60	1.80	33.33
8	Res-Med-Low	R.J. Hill Silverton 3	Residential	145	2015		Fowler	145	145	4.60	31.52
9	Res-Med	Estrella Condos	Residential	60	2015		Fowler	80	80	9.55	8.38
10	Res-Med-Low	R.J. Hill Silverton - Phase II	Residential		2020	37	Fowler				36.98
11	Res-Med	Residential Development 1	Residential		2025		Fowler	250	250	9.55	26.18
12	Community Facility	Children's Hospital	Medical		2020	16	Fowler			1.00	16.00
13	Res-Low	Residential Development 2	Residential		2020		Fowler	50	50	1.80	27.78
14	Ind-Heavy	Industrial Development 3	Industrial		2035	307	Fowler			1.00	306.72
15	Res-Low	Kings Crossings/Covington - Phase II	Residential	45	2020		Kingsburg		45	4.50	10.00
16	Res-Low	Gary Nelson	Residential	130	2020		Kingsburg		130	4.50	28.89
17	Res-Med	Potential Single Family Tract	Residential		2020		Fowler	80	80	9.55	8.38
18	Res-Med-Low	R.J. Hill Silverton 2	Residential		2020		Fowler	170	170	4.60	36.96
19	Res-Med-Low	R.J. Hill Silverton 1	Residential		2020		Fowler	132	132	4.60	28.70
20	Res-Low	Raven Tract	Residential	106	2020		Selma		106	2.75	38.55
21	Res-Low	Amberwood	Residential	2558	2020		Selma		2558	2.75	930.18
22	Commercial	Selma Crossing - Phase I	Commercial		2020	76	Selma			1.00	76.00
23	Res-Low	Vineyard Estates - Phase II & III	Residential	101	2020		Selma		101	2.75	36.73
24	Res-Low	Synergy Tract	Residential	66	2020		Selma		66	2.75	24.00
25	Res-Low	Valley View - Phase III	Residential	43	2020		Selma		43	2.75	15.64

APPENDIX B

Risk Assessment Pairwise Analysis

Risk Assessment Pairwise Analysis

A weighting factor was developed for each category in the likelihood of gravity main failure analysis using a pairwise comparison analysis, shown in Table B-1 The categories were compared to each other and received a score from 1 to 5 according to the following logic:

- If Factor A is much more important than Factor B: Factor A = 5, Factor B = 1
- If Factor A is more important than Factor B: Factor A = 4, Factor B = 2
- If Factor A is equal in importance to Factor B: Factor A = 3, Factor B = 3
- If Factor A is less important than Factor B: Factor A = 2, Factor B = 4
- If Factor A is much less important than Factor B: Factor A = 1, Factor B = 5

The scores were totaled for each category, then normalized to a scale of 1 to 10.

Table B-1. Likelihood of Gravity Sewer Failure Pairwise Analysis

Category vs. Category	Hydraulic Capacity Failure	Structural Failure	Maintenance Failure	Total	Normalized Weighting Factor
Hydraulic Capacity Failure	—	4	4	8	10
Structural Failure	2	—	4	6	8
Maintenance Failure	2	2	—	4	5

A weighting factor was developed for each category in the consequence of gravity main failure using a pairwise comparison, shown in Table B-2. The categories were compared to each other and received a score from 1 to 5 according to the following logic:

- If Factor A is much more important than Factor B: Factor A = 5, Factor B = 1
- If Factor A is more important than Factor B: Factor A = 4, Factor B = 2
- If Factor A is equal in importance to Factor B: Factor A = 3, Factor B = 3
- If Factor A is less important than Factor B: Factor A = 2, Factor B = 4
- If Factor A is much less important than Factor B: Factor A = 1, Factor B = 5

The scores were totaled for each category, then normalized to a scale of 1 to 10.

Table B-2. Consequence of Gravity Sewer Failure Pairwise Analysis

Category vs. Category	Potential Spill Volume	Emergency Response and Construction Impact	Environmental and Public Health Impact	Total	Normalized Weighting Factor
Potential Spill Volume	—	5	4	9	10
Emergency Response and Construction Impact	1	—	2	3	3
Environmental and Public Health Impact	2	4	—	6	7

A weighting factor was developed for each category in the likelihood of lift station failure analysis using a pairwise comparison analysis, shown in Table B-3. The categories were compared to each other and received a score from 1 to 5 according to the following logic:

- If Factor A is much more important than Factor B: Factor A = 5, Factor B = 1
- If Factor A is more important than Factor B: Factor A = 4, Factor B = 2
- If Factor A is equal in importance to Factor B: Factor A = 3, Factor B = 3
- If Factor A is less important than Factor B: Factor A = 2, Factor B = 4
- If Factor A is much less important than Factor B: Factor A = 1, Factor B = 5

The scores were totaled for each category, then normalized to a scale of 1 to 10.

Table B-3. Likelihood of Lift Station Failure Pairwise Analysis

Category vs. Category	Hydraulic Capacity Failure	Mechanical Failure	Maintenance Failure	Total	Normalized Weighting Factor
Hydraulic Capacity Failure	—	4	4	8	8
Mechanical Failure	2	—	4	6	5
Maintenance Failure	2	2	—	4	10

A weighting factor was developed for each category in the consequence of lift station failure analysis using a pairwise comparison, shown in Table B-4. The categories were compared to each other and received a score from 1 to 5 according to the logic described above in Chapter 6. The scores were totaled for each category, then normalized on a scale of 1 to 10.

Table B-4. Consequence of Lift Station Failure Pairwise Analysis					
Category vs. Category	Potential Spill Volume	Emergency Response and Construction Impact	Environmental and Public Health	Total	Normalized Weighting Factor
Potential Spill Volume	—	5	5	10	10
Emergency Response and Construction Impact	1	—	4	5	5
Environmental and Public Health Impact	1	2	—	3	3

APPENDIX C

Detailed CIP Project Tables

Table C-1. Capital Improvement Program Projects in Selma

Project Name	Project Type	Location	Description	Fiscal Year	Recommended Action	Estimated Construction Cost, 2016 Dollars	Estimated Capital Cost, 2016 Dollars
S-1	Replacement	McCall Avenue between Maple Street and North of Barbara Street	• Upsize 750 LF sewer to 10-inch diameter PVC • Upsize 643 LF sewer to 12-inch diameter PVC • Replace 422 LF sewer with 12-inch diameter PVC to remedy flat slope	2015	Pipe Bursting	$154,320	$260,800
S-2	Replacement	Huntsman Avenue between Olive Street and Mulberry Street	• Upsize 1,043 LF sewer to 10-inch diameter PVC	2015	Pipe Bursting	$101,280	$171,160
S-3	Replacement	North Street between Arrants Street and West Front Street	• Upsize 1,227 LF sewer to 15-inch diameter PVC	2015	Standard Open Cut	$208,600	$352,530
S-4	Replacement	Dockery Avenue between Gaither Street and Mill Street Dockery Avenue between Peach Street and Nebraska Avenue	• Upsize 3,817 LF sewer to 15-inch diameter PVC • Upsize 1,291 LF sewer to 18-inch diameter PVC	2015	Standard Open Cut	$1,207,400	$2,040,500
S-5	Replacement	Orange Avenue between Lewis Street and Aspen Street	• Replace 811 LF sewer to 12-inch diameter PVC to remedy negative slope	2015	Inspection	$1,620	$2,740
S-6	Replacement	Lee Street between Chestnut Street and Gaither Street	• Replace 165 LF sewer to 12-inch diameter PVC to remedy negative slope	2015	Inspection	$330	$560
S-7	Replacement	Young Street between Rose Avenue and Sherman Street	• Replace 298 LF sewer to 12-inch diameter PVC to remedy negative slope	2015	Inspection	$600	$1,010

Table C-1. Capital Improvement Program Projects in Selma							
Project Name	Project Type	Location	Description	Fiscal Year	Recommended Action	Estimated Construction Cost, 2016 Dollars	Estimated Capital Cost, 2016 Dollars
S-8	Replacement	Highway CA-99 South between McCall Avenue and Knowles Street	• Upsize 848 LF sewer to 18-inch diameter PVC	2015	Standard Open Cut	$228,960	$386,940
S-9	Replacement	Nebraska Avenue from Mitchell Avenue to intersection of South Thompson Avenue and Knowles Street	• Upsize 1,638 LF sewer to 12-inch diameter PVC	2015	Standard Open Cut	$294,840	$498,280
S-10	Replacement	Highland Avenue between Nelson Blvd and Golden State Blvd	• Replace 545 LF sewer to 12-inch diameter PVC to remedy flat slope	2015	Inspection	$1,090	$1,840
S-11	Replacement	Nelson Blvd	• Replace of 406 LF sewer to 10-inch diameter PVC to remedy flat and negative slope	2015	Inspection	$810	$1,370
S-12	Replacement	Sarah Street between Kelly Circle and South Thompson Avenue	• Upsize 171 LF sewer to 12-inch diameter PVC	2015	Standard Open Cut	$30,780	$52,020
S-13	Replacement	South Thompson Avenue between Dinuba Avenue and Oak Street	• Upsize 4,253 LF sewer to 18-inch diameter PVC	2015	Standard Open Cut	$1,148,310	$1,940,640
S-14	Replacement	Floral Avenue between South Thompson Avenue and West Front Street	• Upsize 836 LF sewer to 18-inch diameter PVC	2015	Standard Open Cut	$225,720	$381,470
S-15	Replacement	Barbara Street between Olive Street and Orange Avenue	• Upsize 548 LF sewer to 12-inch diameter PVC	2015	Standard Open Cut	$98,640	$166,700
S-16	Replacement	South Leonard Avenue between East Dinuba Avenue and East Ostler Street	• Replace 330 LF sewer to 12-inch diameter PVC due to negative slope	2015	Inspection	$660	$1,120

Table C-1. Capital Improvement Program Projects in Selma							
Project Name	Project Type	Location	Description	Fiscal Year	Recommended Action	Estimated Construction Cost, 2016 Dollars	Estimated Capital Cost, 2016 Dollars
S-17	Replacement	Nebraska Avenue between Dockery Avenue and West of Olive Street	• Upsize 891 LF sewer to 18-inch diameter PVC	2015	Standard Open Cut	$240,570	$406,560
S-18	Replacement	McCall Avenue between Barbara Street and Hillcrest Street	• Upsize 1,517 LF sewer to 12-inch diameter PVC	2015	Standard Open Cut	$273,060	$461,470
S-19	Replacement	McCall Avenue between Nebraska Avenue and Park Street	• Upsize 530 LF sewer to 12-inch diameter PVC	2015	Standard Open Cut	$95,400	$161,230
S-20	Replacement	McCall Avenue between East Front Street and Whitson Street	• Upsize 530 LF sewer to 12-inch diameter PVC	2015	Standard Open Cut	$95,400	$161,230
S-21	Replacement	McCall Avenue in South of Park Street	• Replace 184 LF sewer to 24-inch diameter PVC due to flat slope	2015	Inspection	$370	$630
S-22	Replacement	Rose Avenue between Shaft Street and Rose Avenue Lift Station	• Upsize 2,159 LF sewer to 18-inch diameter PVC	2020	Standard Open Cut	$582,930	$985,150
S-23	Parallel Construction	East Dinuba Avenue between Golden State Blvd and South Fancher Street	• Construct 2,140 LF of 27-inch diameter PVC parallel to existing 12-inch	2020	Standard Open Cut	$866,700	$1,464,720
D-24	Parallel Construction	East Clarkson Avenue between South McCall Avenue and Waste Water Treatment Plant	• Construct 9,212 LF sewer of 48-inch diameter PVC parallel to existing 21-inch	2035	Standard Open Cut	$6,632,640	$11,209,160
D-25	Parallel Construction	Golden State Blvd between South De Wolf Avenue and Floral Avenue	• Construct 10,800 LF sewer of 21-inch diameter PVC parallel to existing 30-inch	2035	Standard Open Cut	$3,402,000	$5,749,380

Table C-1. Capital Improvement Program Projects in Selma							
Project Name	Project Type	Location	Description	Fiscal Year	Recommended Action	Estimated Construction Cost, 2016 Dollars	Estimated Capital Cost, 2016 Dollars
D-26	Parallel Construction	Golden State Blvd between Park Street and Floral Avenue	• Construct 7,297 LF sewer to 24-inch diameter PVC parallel to existing 33-inch, 36-inch, 39-inch and 42-inch	2035	Standard Open Cut	$2,626,920	$4,439,490
D-27	Parallel Construction	Golden State Blvd between Park Street and South Amber Avenue	• Construct 8,000 LF sewer of 30-inch diameter PVC parallel to existing 42-inch	2035	Standard Open Cut	$3,600,000	$6,084,000
D-28	Parallel Construction	South Amber Avenue between South Golden State Avenue and Waste Water Treatment Plant	• Construct 13,413 LF sewer of 30-inch diameter PVC parallel to existing 42-inch	2035	Standard Open Cut	$6,035,850	$10,200,590
S-29	New Construction	East Dinuba Avenue between East Dockery Avenue and South Fancher Street	• Construct 8,735 LF sewer of 27-inch diameter PVC	2020	Standard Open Cut	$3,537,680	$5,978,680
S-30	New Construction	East Saginaw Avenue extending East from Golden Gate State Blvd	• Construct 1,885 LF sewer of 48-inch diameter PVC	2020	Standard Open Cut	$1,357,200	$2,293,670
S-31	New Construction	South Del Rey Avenue between East Nebraska Avenue and East Saginaw Avenue	• Construct 2,677 LF sewer of 33-inch diameter PVC	2020	Standard Open Cut	$1,325,120	$2,239,450
S-32	New Construction	South Del Rey Avenue between East Floral Avenue and East Nebraska Avenue	• Construct 5,352 LF sewer of 30-inch diameter PVC	2020	Standard Open Cut	$2,408,400	$4,070,200

Table C-1. Capital Improvement Program Projects in Selma							
Project Name	Project Type	Location	Description	Fiscal Year	Recommended Action	Estimated Construction Cost, 2016 Dollars	Estimated Capital Cost, 2016 Dollars
S-33	New Construction	South Del Rey Avenue between East Dinuba Avenue and East Floral Avenue	• Construct 5,266 LF sewer of 27-inch diameter PVC	2020	Standard Open Cut	$2,132,730	$3,604,310
S-34	New Construction	East Dinuba Avenue between Ditch Road and East Dockery Avenue	• Construct 1,934 LF sewer of 12-inch diameter PVC	2020	Standard Open Cut	$348,120	$588,320
S-35	New Construction	North of Dockery Avenue	• Construct 2,586 LF sewer of 18-inch diameter PVC	2020	Standard Open Cut	$698,220	$1,179,990
S-36	New Construction	South Indianola Avenue between East South Avenue and East Parlier Avenue	• Construct 2,682 LF sewer of 18-inch diameter PVC	2020	Standard Open Cut	$724,140	$1,223,800
S-37	New Construction	South Indianola Avenue between East Parlier Avenue and East Manning Avenue	• Construct 2,616 LF sewer of 21-inch diameter PVC	2020	Standard Open Cut	$824,040	$1,392,630
S-38	New Construction	South Indianola Avenue between East Manning Avenue and East Dinuba Avenue	• Construct 2,627 LF sewer of 24-inch diameter PVC • Construct 2,603 LF sewer of 27-inch diameter PVC	2020	Standard Open Cut	$1,781,240	$3,010,300
S-39	New Construction	East Dinuba Avenue between South Indianola Avenue and South Del Rey Avenue	• Construct 2,655 LF sewer of 27-inch diameter PVC	2020	Standard Open Cut	$1,075,280	$1,817,220

Table C-1. Capital Improvement Program Projects in Selma							
Project Name	Project Type	Location	Description	Fiscal Year	Recommended Action	Estimated Construction Cost, 2016 Dollars	Estimated Capital Cost, 2016 Dollars
S-40	New Construction	East Nebraska Avenue between Mitchel Avenue and South Highland Avenue	• Construct 2,245 LF sewer of 10-inch diameter PVC	2020	Standard Open Cut	$336,750	$569,110
S-41	New Construction	From Rose Avenue to Young Street and 1st Street	• Construct 2,858 LF sewer of 21-inch diameter PVC	2020	Standard Open Cut	$900,270	$1,521,460
S-42	New Construction	East Floral Avenue between South Del Ray Avenue and South Amber Avenue	• Construct 1,355 LF sewer of 12-inch diameter PVC	2020	Standard Open Cut	$243,900	$412,190
S-43	New Construction	East Floral Avenue between Dockery Avenue and South Del Ray Avenue	• Construct 2,455 LF sewer of 15-inch diameter PVC	2020	Standard Open Cut	$552,380	$933,520
S-44	New Construction	East Rose Avenue between South Highland Avenue and East of South Leonard Avenue	• Construct 2,131 LF sewer of 18-inch diameter PVC	2020	Standard Open Cut	$575,370	$972,380
S-45	New Construction	East of South Leonard Avenue between East Rose Avenue and East Floral Avenue	• Construct 2,701 LF sewer of 18-inch diameter PVC	2020	Standard Open Cut	$729,270	$1,232,470
S-46	New Construction	East Floral Avenue between East of South Leonard Avenue and South De Wolf Street	• Construct 2,765 LF sewer of 18-inch diameter PVC	2020	Standard Open Cut	$746,550	$1,261,670

Table C-1. Capital Improvement Program Projects in Selma							
Project Name	Project Type	Location	Description	Fiscal Year	Recommended Action	Estimated Construction Cost, 2016 Dollars	Estimated Capital Cost, 2016 Dollars
S-47	New Construction	South De Wolf Street extending North from East Floral Avenue	• Construct 2,626 LF sewer of 12-inch diameter PVC • Construct 1,384 LF sewer of 15-inch diameter PVC	2020	Standard Open Cut	$784,080	$1,325,100
S-48	New Construction	East Caruthers Avenue between South McCall Avenue and Thompson Avenue	• Construct 2,572 LF sewer of 21-inch diameter PVC	2035	Standard Open Cut	$810,180	$1,369,200
S-49	New Construction	South McCall Avenue between East Kamm Avenue and East Clarkson Avenue	• Construct 10,612 LF sewer of 48-inch diameter PVC	2035	Standard Open Cut	$7,640,640	$12,912,680
S-50	New Construction	Dockery Avenue extending north from Dinuba Avenue to East Manning Avenue	• Construct 2,696 LF sewer of 18-inch diameter PVC	2035	Standard Open Cut	$727,920	$1,230,180
S-51	New Construction	South Bethel Avenue between East Dinuba Avenue and East Huntsman Avenue	• Construct 2,561 LF sewer of 12-inch diameter PVC	2035	Standard Open Cut	$460,980	$779,060

Table C-1. Capital Improvement Program Projects in Selma

Project Name	Project Type	Location	Description	Fiscal Year	Recommended Action	Estimated Construction Cost, 2016 Dollars	Estimated Capital Cost, 2016 Dollars
S-52	New Construction	East Huntsman Avenue between South Academy Avenue and South Bethel Avenue	• Construct 2,603 LF sewer of 15-inch diameter PVC • Construct 2,676 LF sewer of 18-inch diameter PVC	2035	Standard Open Cut	$1,308,200	$2,210,860
S-53	New Construction	East Huntsman Avenue extending West from South Bethel Avenue	• Construct 2,614 LF sewer of 15-inch diameter PVC	2035	Standard Open Cut	$588,150	$993,970
S-54	New Construction	East Huntsman Avenue extending East from South Del Rey Avenue	• Construct 2,617 LF sewer of 12-inch diameter PVC	2035	Standard Open Cut	$471,060	$796,090
S-55	New Construction	East Huntsman Avenue extending West from South Del Rey Avenue	• Construct 1,953 LF sewer of 12-inch diameter PVC	2035	Standard Open Cut	$351,540	$594,100
S-56	New Construction	East Floral Avenue between South Academy Avenue and South Bethel Avenue	• Construct 5,289 LF sewer of 18-inch diameter PVC	2035	Standard Open Cut	$1,428,030	$2,413,370
S-57	New Construction	East Floral Avenue extending West from South Bethel Avenue	• Construct 2,600 LF sewer of 15-inch diameter PVC	2035	Standard Open Cut	$585,000	$988,650

Table C-1. Capital Improvement Program Projects in Selma							
Project Name	Project Type	Location	Description	Fiscal Year	Recommended Action	Estimated Construction Cost, 2016 Dollars	Estimated Capital Cost, 2016 Dollars
S-58	New Construction	East Floral Avenue extending East from South Amber Avenue	• Construct 1,263 LF sewer of 12-inch diameter PVC	2035	Standard Open Cut	$227,340	$384,200
S-59	New Construction	East Rose Avenue between South Academy Avenue and South Bethel Avenue	• Construct 5,250 LF sewer of 27-inch diameter PVC	2035	Standard Open Cut	$2,126,250	$3,593,360
S-60	New Construction	East Rose Avenue extending West from South Bethel Avenue	• Construct 2,600 LF sewer of 15-inch diameter PVC	2035	Standard Open Cut	$585,000	$988,650
S-61	New Construction	East Rose Avenue extending East from South Del Rey Avenue	• Construct 2,615 LF sewer of 15-inch diameter PVC	2035	Standard Open Cut	$588,380	$994,360
S-62	New Construction	East Nebraska Avenue between South Academy Avenue and South Bethel Avenue	• Construct 5,414 LF sewer of 24-inch diameter PVC	2035	Standard Open Cut	$1,949,040	$3,293,880
S-63	New Construction	East Nebraska Avenue extending West from South Bethel Avenue	• Construct 2,616 LF sewer of 15-inch diameter PVC	2035	Standard Open Cut	$588,600	$994,730
S-64	New Construction	East Nebraska Avenue extending East from South Del Rey Avenue	• Construct 2,539 LF sewer of 12-inch diameter PVC	2035	Standard Open Cut	$457,020	$772,360
S-65	New Construction	East Nebraska Avenue extending West from South Del Rey Avenue	• Construct 2,578 LF sewer of 12-inch diameter PVC	2035	Standard Open Cut	$464,040	$784,230

Table C-1. Capital Improvement Program Projects in Selma							
Project Name	Project Type	Location	Description	Fiscal Year	Recommended Action	Estimated Construction Cost, 2016 Dollars	Estimated Capital Cost, 2016 Dollars
S-66	New Construction	East Saginaw Avenue between South Academy Avenue and South Bethel Avenue	• Construct 5,360 LF sewer of 24-inch diameter PVC	2035	Standard Open Cut	$1,929,600	$3,261,020
S-67	New Construction	East Saginaw Avenue extending West from South Bethel Avenue	• Construct 525 LF sewer of 33-inch diameter PVC	2035	Standard Open Cut	$259,880	$439,200
S-68	New Construction	East Saginaw Avenue between Lift Station and South Del Rey Avenue	• Construct 4,500 LF sewer of 36-inch diameter PVC	2035	Standard Open Cut	$2,430,000	$4,106,700
S-69	New Construction	South Bethel Avenue between East Floral Avenue and East Huntsman Avenue	• Construct 2,681 LF sewer of 21-inch diameter PVC	2035	Standard Open Cut	$844,520	$1,427,240
S-70	New Construction	South Bethel Avenue between East Nebraska Avenue and East Rose Avenue	• Construct 2,639 LF sewer of 24-inch diameter PVC	2035	Standard Open Cut	$950,040	$1,605,570
S-71	New Construction	South Bethel Avenue between East Floral Avenue and East Rose Avenue	• Construct 2,640 LF sewer of 27-inch diameter PVC	2035	Standard Open Cut	$1,069,200	$1,806,950
S-72	New Construction	South Bethel Avenue between East Floral Avenue and East Saginaw Avenue	• Construct 2,660 LF sewer of 30-inch diameter PVC	2035	Standard Open Cut	$1,197,000	$2,022,930

Table C-1. Capital Improvement Program Projects in Selma							
Project Name	Project Type	Location	Description	Fiscal Year	Recommended Action	Estimated Construction Cost, 2016 Dollars	Estimated Capital Cost, 2016 Dollars
S-73	New Construction	South Bethel Avenue between East Mountain View Avenue and East Saginaw Avenue	• Construct 2,609 LF sewer of 12-inch diameter PVC	2035	Standard Open Cut	$469,620	$793,660
S-74	New Construction	South of East Saginaw Avenue	• Construct 2,679 LF sewer of 12inch diameter PVC	2035	Standard Open Cut	$482,220	$814,950
S-75	New Construction	South Thompson Avenue between Dinuba Avenue and East Manning Avenue	• Construct 5,260 LF sewer of 18-inch diameter PVC	2035	Standard Open Cut	$1,420,200	$2,400,140
S-76	New Construction	East Mountain View Avenue between McCall Avenue and South Dockery Avenue	• Construct 1,607 LF sewer of 12inch diameter PVC	2035	Standard Open Cut	$289,260	$488,850
S-77	New Construction	East Mountain View Avenue between South Dockery Avenue and South Van Horn Avenue	• Construct 1,902 LF sewer of 15inch diameter PVC	2035	Standard Open Cut	$427,950	$723,240
S-78	New Construction	South De Wolf Avenue between East Rose Avenue and East Nebraska Avenue	• Construct 2,640 LF sewer of 21inch diameter PVC	2035	Standard Open Cut	$831,600	$1,405,400
S-79	New Construction	South De Wolf Avenue between East Mountain View Avenue and East Nebraska Avenue	• Construct 5,313 LF sewer of 27inch diameter PVC	2035	Standard Open Cut	$2,151,770	$3,636,490

Table C-1. Capital Improvement Program Projects in Selma							
Project Name	Project Type	Location	Description	Fiscal Year	Recommended Action	Estimated Construction Cost, 2016 Dollars	Estimated Capital Cost, 2016 Dollars
S-80	New Construction	South De Wolf Avenue between East Mountain View Avenue and East Kamm Avenue	• Construct 5,260 LF sewer of 33inch diameter PVC	2035	Standard Open Cut	$2,603,700	$4,400,250
S-81	New Construction	North of East Springfield Avenue	• Construct 2,538 LF sewer of 12inch diameter PVC	2035	Standard Open Cut	$456,840	$772,060
S-82	New Construction	East Springfield Avenue extending West from South Temperance Avenue	• Construct 1,249 LF sewer of 12inch diameter PVC	2035	Standard Open Cut	$224,820	$379,950
S-83	New Construction	South Temperance Avenue between East Springfield and East Huntsman Avenue	• Construct 5,328 LF sewer of 18inch diameter PVC	2035	Standard Open Cut	$1,453,140	$2,455,810
S-84	New Construction	East Dinuba Avenue extending East from South Temperance Avenue	• Construct 2,707 LF sewer of 12inch diameter PVC	2035	Standard Open Cut	$487,260	$823,470
S-85	New Construction	South Temperance Avenue between East Floral and East Huntsman Avenue	• Construct 2,644 LF sewer of 21inch diameter PVC	2035	Standard Open Cut	$832,860	$1,407,530
S-86	New Construction	South Temperance Avenue between East Floral and East Rose Avenue	• Construct 2,655 LF sewer of 24inch diameter PVC	2035	Standard Open Cut	$955,800	$1,615,300

Table C-1. Capital Improvement Program Projects in Selma							
Project Name	Project Type	Location	Description	Fiscal Year	Recommended Action	Estimated Construction Cost, 2016 Dollars	Estimated Capital Cost, 2016 Dollars
S-87	New Construction	South Temperance Avenue between East Rose and East Nebraska Avenue	• Construct 2,720 LF sewer of 27inch diameter PVC	2035	Standard Open Cut	$1,101,600	$1,861,700
S-88	New Construction	South Temperance Avenue between East Mountain View Avenue and East Nebraska Avenue	• Construct 5,237 LF sewer of 30inch diameter PVC	2035	Standard Open Cut	$2,356,650	$ 3,982,740
S-89	New Construction	South Temperance Avenue between East Mountain View Avenue and East Kamm Avenue	• Construct 5,302 LF sewer of 33inch diameter PVC	2035	Standard Open Cut	$405,600	$685,460
S-90	New Construction	East Kamm Avenue between South Temperance Avenue and South De Wolf Avenue	• Construct 5,302 LF sewer of 33inch diameter PVC	2035	Standard Open Cut	$2,624,490	$4,435,390
S-91	New Construction	East Kamm Avenue between South De Wolf Avenue and South McCall Avenue	• Construct 5,302 LF sewer of 48inch diameter PVC	2035	Standard Open Cut	$3,817,440	$6,451,470
S-92	New Construction	South Leonard Avenue between East South Dinuba Avenue and East Manning Avenue	• Construct 5,344 LF sewer of 18-inch diameter PVC	2035	Standard Open Cut	$1,442,880	$2,438,470
S-93	New Construction	South McCall Avenue between East Springfield Avenue and East Manning Avenue	• Construct 2,626LF sewer of 12-inch diameter PVC	2035	Standard Open Cut	$472,680	$798,830

Table C-1. Capital Improvement Program Projects in Selma							
Project Name	Project Type	Location	Description	Fiscal Year	Recommended Action	Estimated Construction Cost, 2016 Dollars	Estimated Capital Cost, 2016 Dollars
S-94	New Construction	South McCall Avenue between East Dinuba Avenue and East Springfield Avenue	• Construct 2,640 LF sewer of 15-inch diameter PVC	2035	Standard Open Cut	$594,000	$1,003,860
S-95	New Construction	Thompson Avenue in north of East Caruthers Avenue	• Construct 1,656 LF sewer of 18inch diameter PVC • Construct 1,876 LF sewer of 15inch diameter PVC	2035	Standard Open Cut	$869,220	$1,468,980

Table C-2. Capital Improvement Program Projects in Kingsburg

Project Name	Project Type	Location	Description	Fiscal Year	Recommended Action	Estimated Construction Cost, 2016 Dollars	Estimated Capital Cost, 2016 Dollars
K-1	Replacement	Intersection of Highway CA-99 and West Kern Street	• Replace 28 LF of gravity main with 12-inch diameter PVC to remedy flat slope	2015	Inspection	$60	$100
K-2	Replacement	Gilroy Street	• Replace 220 LF of gravity main with 14-inch diameter PVC to remedy flat slope	2015	Inspection	$440	$740
K-3	Replacement	18th Avenue extending South from Riverside Street	• Replace 192 LF of gravity main with 21-inch diameter PVC to remedy flat slope	2015	Inspection	$380	$640
K-4	Replacement	Rafer Johnson Derive between Sunset Street and Meadow Line	• Replace 280 LF of gravity main of 15-inch diameter PVC to remedy flat slope	2015	Inspection	$560	$950
K-5	Replacement	Highway 99 South	• Replace 669 LF of gravity main with 18-inch diameter PVC to remedy flat slope	2015	Inspection	$1,340	$2,260

Table C-2. Capital Improvement Program Projects in Kingsburg

Project Name	Project Type	Location	Description	Fiscal Year	Recommended Action	Estimated Construction Cost, 2016 Dollars	Estimated Capital Cost, 2016 Dollars
K-6	Replacement	Stroud Avenue extending West from 24th Avenue	• Replace 125 LF of gravity main with 10-inch diameter PVC to remedy flat slope	2015	Inspection	$250	$420
K-7	Replacement	Stroud Avenue extending East from 12th Avenue	• Replace 60 LF of gravity main with 18-inch diameter PVC to remedy flat slope	2015	Inspection	$120	$200
K-8	Replacement	Morgan Derive between Lake Street and Mariposa Street	• Replace 288 LF of gravity main with 15-inch diameter PVC to remedy flat slope	2015	Inspection	$580	$980
K-9	Replacement	15th Avenue between Kamm Avenue and Hemma Street	• Replace 300 LF of gravity main with 10-inch diameter PVC to remedy flat slope	2015	Inspection	$600	$1,010
K-10	Replacement	South of Academy Avenue extending North from Harold Street	• Replace 329 LF of gravity main with 12-inch diameter PVC to remedy flat slope	2015	Inspection	$660	$1,120

Table C-2. Capital Improvement Program Projects in Kingsburg

Project Name	Project Type	Location	Description	Fiscal Year	Recommended Action	Estimated Construction Cost, 2016 Dollars	Estimated Capital Cost, 2016 Dollars
K-11	Replacement	Road 12	• Replace 13 LF of gravity main with 24-inch diameter PVC to remedy flat slope	2015	Inspection	$30	$50
K-12	Replacement	Stroud Avenue between 18th Avenue and 22th Avenue	• Upsize 1,336 LF of gravity main with 12-inch diameter PVC	2015	Standard Open Cut	$240,480	$406,410
K-13	Replacement	Easement at South of Silverbrooke Street	• Replace 165 LF of gravity main with 12-inch diameter PVC to remedy flat slope	2015	Standard Open Cut	$29,700	$50,190
K-14	Replacement	Golden State Blvd extending North from South Bethel Avenue	• Replace 502 LF of gravity main with 12-inch diameter PVC to remedy flat slope	2015	Standard Open Cut	$90,360	$152,710
K-15	New Construction	Between Solig Street and East Caruthers Avenue	• Construct 1,956 LF of 12-inch diameter PVC	2020	Standard Open Cut	$352,080	$595,020
K-16	New Construction	396th Avenue between Road 16 and Kern Street	• Construct 2,194 LF of 12-inch diameter PVC	2020	Standard Open Cut	$394,920	$667,410
K-17	New Construction	Klepper Street between South Academy Avenue and 6th Avenue	• Construct 1,356 LF of 12-inch diameter PVC	2020	Standard Open Cut	$244,080	$412,500

Table C-2. Capital Improvement Program Projects in Kingsburg							
Project Name	Project Type	Location	Description	Fiscal Year	Recommended Action	Estimated Construction Cost, 2016 Dollars	Estimated Capital Cost, 2016 Dollars
K-18	New Construction	South Mendocino Avenue between 17th Avenue and East Caruthers Avenue	• Construct 1,103 LF of 10-inch diameter PVC	2020	Standard Open Cut	$165,450	$279,610
K-19	New Construction	South Bethel Avenue extending North from East Conejo Avenue	• Construct 1,337 LF of 12-inch diameter PVC	2020	Standard Open Cut	$240,660	$406,720
K-20	New Construction	Rafer Johnson Derive Extending south from East Magnolia Avenue	• Construct 1,950 LF of 15-inch diameter PVC	2035	Standard Open Cut	$438,750	$741,490
K-21	New Construction	South Bethel Avenue Extending south from East Conejo Avenue	• Construct 3,950 LF of 18-inch diameter PVC	2035	Standard Open Cut	$1,066,500	$1,802,390
K-22	New Construction	Klepper Street between Rafer Johnson Derive and 6th Avenue	• Construct 1,353 LF of 12-inch diameter PVC	2035	Standard Open Cut	$243,540	$411,580

Table C-3. Capital Improvement Program Projects in Fowler							
Project Name	Project Type	Location	Description	Fiscal Year	Recommended Action	Estimated Construction Cost, 2016 Dollars	Estimated Capital Cost, 2016 Dollars
F-1	Replacement	West Fresno Street between South Fowler Avenue and South 10th Avenue	• Upsize 295 LF sewer to 8-inch diameter PVC • Upsize 523 LF sewer to 10-inch diameter PVC	2015	Pipe Bursting	$151,800	$256,540
F-2	Replacement	Easement	• Upsize 960 LF sewer to 10-inch diameter PVC	2015	Pipe Bursting	$104,600	$176,770
F-3	Replacement	East Merced Street between 4th Avenue and 5th Avenue	• Upsize 400 LF sewer to 12-inch diameter PVC	2015	Deep Open Cut	$192,000	$324,480
F-4	Replacement	North 10th Street between Tuolumne Street and West Merced Street	• Upsize 675 LF sewer to 10-inch diameter PVC	2015	Pipe Bursting	$86,400	$146,020
F-5	Replacement	South 5th Street between East Sumner Avenue and South 7th Street	• Upsize 423 LF sewer to 15-inch diameter PVC	2020	Deep Open Cut	$135,000	$228,150
F-6	Replacement	East Sumner Street between Laker Lane and South 5th Street	• Upsize 765 LF sewer to 15-inch diameter PVC	2020	Deep Open Cut	$114,210	$193,010
F-7	Replacement	South Fowler Avenue between East La Crosse Avenue and East Adams Avenue	• Upsize 325 LF sewer to 12-inch diameter PVC	2035	Deep Open Cut	$206,550	$349,070
F-8	Replacement	Easement	• Upsize 468 LF sewer to 10-inch diameter PVC	2035	Deep Open Cut	$70,200	$118,640

Table C-3. Capital Improvement Program Projects in Fowler							
Project Name	Project Type	Location	Description	Fiscal Year	Recommended Action	Estimated Construction Cost, 2016 Dollars	Estimated Capital Cost, 2016 Dollars
F-9	Replacement	East Merced Street between Adam Avenue and South 7th Street	• Upsize 2,585 LF sewer to 18-inch diameter PVC	2035	Deep Open Cut	$84,240	$142,370
F-10	Replacement	East Merced Street between South 7th Street and Golden State Blvd	• Upsize 328 LF sewer to 21-inch diameter PVC	2035	Deep Open Cut	$123,980	$209,530
F-11	Replacement	East South Avenue between South Fowler Avenue and South Sunnyside Avenue	• Upsize 2,503 LF sewer to 21-inch diameter PVC	2035	Deep Open Cut	$946,130	$1,598,960
F-12	Replacement	South Temperance Avenue and Golden State Blvd	• Upsize 214 LF sewer to 18-inch diameter PVC	2035	Deep Open Cut	$69,340	$117,180
F-13	Replacement	Golden State Blvd	• Upsize 222 LF sewer to 18-inch diameter PVC	2035	Deep Open Cut	$71,930	$121,560
F-14	Replacement	East Manning Avenue between Golden State Blvd and Vineyard Place	• Upsize 787 LF sewer to 12-inch diameter PVC • Upsize 48 LF sewer to 18-inch diameter PVC	2035	Deep Open Cut	$241,920	$408,840
D-15	Parallel Construction	Golden State Blvd between West Tuolumne Street and West Peach Street	• Construct 2,886 LF of 18-inch diameter PVC parallel to existing 24-inch	2035	Deep Open Cut	$935,060	$1,580,250

Table C-3. Capital Improvement Program Projects in Fowler							
Project Name	Project Type	Location	Description	Fiscal Year	Recommended Action	Estimated Construction Cost, 2016 Dollars	Estimated Capital Cost, 2016 Dollars
D-15A	Parallel Construction	Golden State Blvd between West Tuolumne Street and East Clayton Avenue	• Construct 5,754 LF of 12-inch diameter PVC parallel to existed 18-inch	2035	Deep Open Cut	$1,242,860	$2,100,430
D-16	Parallel Construction	Golden State Blvd between South De wolf Avenue and West Peach Street	• Construct 12,833 LF of 21-inch diameter PVC parallel to existing 24-inch	2035	Deep Open Cut	$4,850,870	$8,197,970
F-17	New Construction	East South Avenue extending East from South Kenneth Avenue	• Construct 1,291 LF of 12-inch diameter PVC • Construct 864 LF of 15-inch diameter PVC	2035	Deep Open Cut	$278,860	$471,270
F-18	New Construction	South Clovis Avenue extending North from East Parlier Avenue	• Construct 4,582 LF of 12-inch diameter PVC	2035	Deep Open Cut	$233,280	$394,240
F-19	New Construction	East Sumner Avenue extending East from South Kenneth Avenue	• Construct 1,275 LF of 12-inch diameter PVC • Construct 1,310 LF of 15-inch diameter PVC	2035	Deep Open Cut	$629,100	$1,063,180
F-20	New Construction	Between South Armstrong Avenue and South Temperance Avenue	• Construct 2,385 LF of 10-inch diameter PVC	2020	Deep Open Cut	$429,300	$725,520

Table C-3. Capital Improvement Program Projects in Fowler							
Project Name	Project Type	Location	Description	Fiscal Year	Recommended Action	Estimated Construction Cost, 2016 Dollars	Estimated Capital Cost, 2016 Dollars
F-21	New Construction	East Summer Avenue extending east from Christopher Court	•Construct 778 LF of 12-inch diameter PVC	2020	Deep Open Cut	$168,050	$284,000
F-22	New Construction	East Valley Derive extending east from Golden State Blvd	•Construct 226 LF of 12-inch diameter PVC	2020	Deep Open Cut	$48,820	$82,510
F-23	New Construction	East Manning Avenue between South De Wolf Avenue and South Golden State Blvd	•Construct 2,419 LF of 10-inch diameter PVC	2020	Deep Open Cut	$435,420	$735,860
F-24	New Construction	East South Avenue extending West from South Sunnyside Avenue South Sunnyside Avenue and	•Construct 1,503 LF of 15-inch diameter PVC	2020	Deep Open Cut	$405,810	$685,820
F-24A	New Construction	East Clayton Avenue between Golden State Avenue and South Minnewawa Avenue	•Construct 4,032 LF of 12-inch diameter PVC	2020	Deep Open Cut	$870,910	$1,471,840
F-24B	New Construction	South Clovis Avenue between East Adams Avenue and East Clayton Avenue	•Construct 2,631 LF of 12-inch diameter PVC	2020	Deep Open Cut	$568,300	$960,430
F-25	New Construction	East Summer Avenue extending West from South Sunnyside Avenue	•Construct 1,321 LF of 15-inch diameter PVC	2025	Deep Open Cut	$356,670	$602,770
F-26	New Construction	North of East Summer Avenue	•Construct 1,263 LF of 12-inch diameter PVC	2025	Deep Open Cut	$272,810	$461,050

Table C-3. Capital Improvement Program Projects in Fowler							
Project Name	Project Type	Location	Description	Fiscal Year	Recommended Action	Estimated Construction Cost, 2016 Dollars	Estimated Capital Cost, 2016 Dollars
F-27	New Construction	South Clovis Avenue between East Adams Avenue and South of East Sumner Avenue	• Construct 3,291 LF of 12-inch diameter PVC	2035	Deep Open Cut	$710,860	$1,201,350
F-28	New Construction	Golden State Blvd between American Avenue and Jefferson Avenue	• Construct 3,174 LF of 12-inch diameter PVC	2035	Deep Open Cut	$685,580	$1,158,630
F-29	New Construction	Clovis Avenue between East Jefferson Avenue and South Golden State Blvd	• Construct 2,645 LF of 12-inch diameter PVC • Construct 895 LF of 15-inch diameter PVC	2035	Deep Open Cut	$812,970	$1,373,920
F-30	New Construction	Lincoln Avenue between Clovis Avenue and South Sunnyside Avenue	• Construct 2,555 LF of 12-inch diameter PVC	2035	Deep Open Cut	$551,880	$932,680
F-31	New Construction	South Fowler Avenue between East La Crosse Avenue and East Clayton Avenue	• Construct 2,236 LF of 12-inch diameter PVC	2035	Deep Open Cut	$482,980	$816,240
F-32	New Construction	South Armstrong Avenue between East Clayton Avenue and East Adams Avenue	• Construct 2,573 LF of 12-inch diameter PVC	2035	Deep Open Cut	$555,770	$939,250
F-33	New Construction	South Temperance Avenue between East Adam Avenue and East Sumner Avenue	• Construct 2,200 LF of 12-inch diameter PVC	2035	Deep Open Cut	$475,200	$803,090

Table C-3. Capital Improvement Program Projects in Fowler							
Project Name	Project Type	Location	Description	Fiscal Year	Recommended Action	Estimated Construction Cost, 2016 Dollars	Estimated Capital Cost, 2016 Dollars
F-34	New Construction	South Temperance Avenue between East South Avenue and East Sumner Avenue	• Construct 2,703 LF of 15-inch diameter PVC	2035	Deep Open Cut	$729,810	$1,233,380
F-35	New Construction	South Temperance Avenue between East South Avenue and East Parlier Avenue	• Construct 1,825 LF of 18-inch diameter PVC	2035	Deep Open Cut	$591,300	$999,300
F-36	New Construction	East Manning Avenue and South Temperance Avenue	• Construct 3,858 LF of 12-inch diameter PVC	2035	Deep Open Cut	$833,330	$1,408,330
F-37	New Construction	South Fowler Avenue extending South from East South Avenue	• Construct 1,338 LF of 12-inch diameter PVC	2035	Deep Open Cut	$289,010	$488,430
F-38	New Construction	South 7th Street extending West to Golden Gate Blvd	• Construct 380 LF of 15-inch diameter PVC	2035	Deep Open Cut	$102,600	$173,390

APPENDIX D

Detailed Lift Station Capacity Assessment

Table D-1. Detailed Lift Station Capacity Requirements

Lift Station Name	Map I.D.	City	Lift Station Design Data						Pump Firm Capacity versus Existing Design Flows					Pump Firm Capacity versus Buildout Design Flows				
			Pump Number	Pump Capacity (gpm)	Firm Capacity (gpm)	Total Capacity (gpm)	TDH (feet)	Existing Force Main Diameter (inch)	Existing Design Flow (gpm)	Pump Capacity Deficiency Existing Condition (gpm)	Available Firm Capacity (gpm)	Remaining Capacity (ESFR)	Required Force Main Diameter (inch)	Buildout Design Flow (gpm)	Pump Capacity Deficiency at Buildout (gpm)	Available Firm Capacity at Buildout (gpm)	Remaining Capacity (ESFR)	Required Force Main Diameter (inch)
N 10th Street	F-2	Fowler	1 2	316 316	316	632	5	4	53	Sufficient Firm Capacity	263	468	2	78	Sufficient Firm Capacity	238	423	2
Peach Street	F-3	Fowler	1 2	800 800	800	1,600	14	6	426	Sufficient Firm Capacity	374	665	4	543	Sufficient Firm Capacity	257	457	4
Gleason	F-4	Fowler	1 2	224 224	224	448	13	4	88	Sufficient Firm Capacity	136	242	2	88	Sufficient Firm Capacity	136	242	2
South Avenue	F-5	Fowler	1 2	417 417	417	834	22	8	218	Sufficient Firm Capacity	199	354	2	1,252	835	0	0	4
Jefferson Avenue	F-6	Fowler	1 2	120 120	120	240	22	6	44	Sufficient Firm Capacity	76	135	2	146	26	0	0	2
Adams and Temperance	F-7	Fowler	1 2	478 478	478	956	50	8	107	Sufficient Firm Capacity	371	660	2	381	Sufficient Firm Capacity	97	172	4
Merced Street	D-1	District (Fowler)	1 2	750 750	750	1,500	20	8	1,200	450	0	0	4	2,895	2,145	0	0	8
Manning	D-2	District (Fowler)	1 2	750 750	750	1,500	21	30	2,210	1,460	0	0	6	5,394	4,644	0	0	10
North Street	D-3	District (Selma)	1 2	1900 1900	1,900	3,800	13	10	5,026	3,126	0	0	8	10,215	8,315	0	0	12
18th Street	D-4	District (Kingsburg)	1 2 3	1163 1163 1163	2,326	3,489	19	14	1,492	Sufficient Firm Capacity	834	1,483	6	1,680	Sufficient Firm Capacity	646	1,148	6
Rose Street	S-3	Selma	1 2	865 865	865	1,730	19	6	330	Sufficient Firm Capacity	535	951	2	1,243	378	0	0	4
Goldridge and Wright	S-4	Selma	1 2	100 100	100	200	15	4	28	Sufficient Firm Capacity	72	128	2	28	Sufficient Firm Capacity	72	128	2
North Hill	S-5	Selma	1 2	470 352	352	822	10	4	31	Sufficient Firm Capacity	321	571	2	31	Sufficient Firm Capacity	321	571	2
Dockery	S-6	Selma	1 2	865 865	865	1,730	19	6	557	Sufficient Firm Capacity	308	548	4	557	Sufficient Firm Capacity	308	548	4
Sunset	S-7	Selma	1 2	669 669	669	1,338	23	6	568	Sufficient Firm Capacity	101	180	4	590	Sufficient Firm Capacity	79	140	4
Barbara	S-8	Selma	1 2	265 170	170	435	12	12	14	Sufficient Firm Capacity	156	277	2	14	Sufficient Firm Capacity	156	277	2
Valley View	S-9	Selma	1 2	1100 1100	1,100	2,200	30	8	10	Sufficient Firm Capacity	1,090	1,938	6	90	Sufficient Firm Capacity	1,010	1,796	6
McCall & Maple	S-10	Selma	1 2	550 550	550	1,100	22	6	461	Sufficient Firm Capacity	89	158	4	461	Sufficient Firm Capacity	89	158	4
Clarkson & McCall	S-11	Selma	1 2	1500 1500	1,500	3,000	20	12	1,940	440	0	0	6	2,972	1,472	0	0	8
Mehlhert	K-1	Kingsburg	1 2	230 230	230	460	17	4	47	Sufficient Firm Capacity	183	325	2	47	Sufficient Firm Capacity	183	325	2
Kern Street	K-2	Kingsburg	1 2	787 787	787	1,574	14	4	70	Sufficient Firm Capacity	717	1,275	2	70	Sufficient Firm Capacity	717	1,275	2
Skansen	K-3	Kingsburg	1 2	500 500	500	1,000	17	6	143	Sufficient Firm Capacity	357	635	2	170	Sufficient Firm Capacity	330	587	2

Source:" District lift station and wet well information.
Notes:
1. Remaining capacity in ESFRs calculated by dividing day flow by 270 gallons per unit day.