



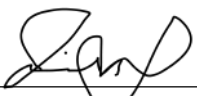
Wastewater Collection System Master Plan

Prepared for:
City of El Monte
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December 31, 2018

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Executive Summary

The City of El Monte (City) is comprised of an area of approximately 10 square miles in Los Angeles County (County), California. It is a major metropolis located in the hub of San Gabriel Valley with a racially and ethnically diverse population. The City has a population of 115,807 in 2016 with 66% Hispanic, 29% Asian, and 4% Whites (United States Census Bureau). The City has convenient transportation choices with easy access to freeways, roadways and public transit opportunities, and quality infrastructure. Figure 2-1 shows a vicinity map of the study area.

The City's Public Works Department owns, operates, and maintains the City's wastewater collection system with approximately 130 miles of sewer main lines and 7 active lift stations. The City is a member city of one of the seventeen jurisdictions that are signatory to Joint Outfall Agreement that provides for a shared regional interconnected sewer conveyance and treatment system, also referred to as the Joint Outfall System (JOS). The system includes the main Joint Water Pollution Control Plant (JWPCP) and six satellite Water Reclamation Plants (WRPs), and over 1,230 miles of trunk sewers and 50 pumping plants that collect wastewater from the local sewers that are owned, operated, and maintained by its member cities and the County. The City's collection system conveys wastewater generated within the City to connections to the County sewer lines, and the collected wastewater flows are ultimately treated by the Whittier Narrows Water Reclamation Plant (WRP).

This comprehensive Wastewater Collection System Master Plan Update (Plan Update) updates the Wastewater Collection System Master Plan completed in 2005 (2005 WWMP) and evaluates the condition and capacity of the City's wastewater collection system under existing (2016) conditions, near-term future (2021) conditions, and long-term future (2035) conditions to recommend a Capital Improvement Program (CIP). The 2005 WWMP was not developed as a report, but instead included a map of surcharged pipelines and a table of model results.

Chapter 9 of this this Plan Update includes an asset management plan (AMP) to recommend repair/replacement plans for the City's manholes and gravity mains based on the pipeline inspection data and manhole inspection data and risk analysis.

ES-1. System Mapping

As part of this Plan Update, a Geographic Information System (GIS) database of the City's existing wastewater collection system was developed by DCSE, a sub-consultant of this Plan Update, based on the City's sewer atlas and record drawings. New facility IDs were assigned to the sewer assets based on the grid numbers of the sewer atlas. Record drawings were scanned and linked to the GIS mapping system for reference. GIS conversion standards were developed and provided to the City for their continued update and maintenance of the GIS database in the future. With regular updates to the sewer geodatabase, it will become a critical tool for the City's engineering, operations, maintenance and planning departments. Figure 2-2 illustrates the resulting sewer GIS database.

ES-2. Flow Projections

Approximately 94% of the wastewater generated within the City is collected by City-owned facilities and conveyed to connections to the County sewer lines. The remainder of the wastewater generated within the City is collected either by septic systems or directly by the county sewer lines. Wastewater generation factors were developed by utilizing historical water usage records provided by the San Gabriel Valley Water Company (SGVWC) for the past 6 years and flow monitoring data collected for this Plan Update. Table ES 2-1 shows the wastewater generation factors that were used for developing wastewater flow projections.

The existing wastewater flows were then estimated using the wastewater generation factors developed for the corresponding land use types. Near-term future wastewater flows were projected based on the specific future developments known at the time of preparing this Plan Update. The long-term future wastewater flows were projected based on population growth projections. Table ES 2-2 summarizes the average daily flows estimated for each planning time frame.

Table ES 2-1: Wastewater Generation Factors

Land Use		GPD/DU or GPD/room	GPD/Acre	GPD/1000 sq. ft.
Residential	Low-density residential/ Low to medium density residential	-	1,170	-
	Medium density residential	-	1,890	-
	High-density residential	-	3,360	-
	Medium density and Neighbor Commercial	-	1,890	-
	Single Family	170	-	-
	Multi-Family	140	-	-
Commercial ¹		-	1,785	115
Industrial ²		-	600	100
Public Facilities ³		-	1,785	115
Open Space/Recreation		-	300	-
Transportation ⁴		-	300	-
Hotel		100	-	-

1. Excluding commercial storage
2. Excluding open storage
3. Excluding non-attended public parking facilities
4. Only applicable to airport and bus terminal and yards.

Table ES 2-2: Base Wastewater Flow Projections

Sewer Flow Condition	Existing (mgd)	Near-term Future (mgd)	Long-term Future (mgd)
BWF	6.3	6.89	8.81

Wastewater flows in the above table were projected for the entire city. Approximately 94% of the wastewater flows are collected by the City's wastewater collection system, that is, 5.9 mgd, 6.5 mgd and 8.3 mgd of wastewater flows are collected by the City's wastewater collection system for existing, near-term future, and long-term future conditions, respectively.

ES-3. Hydraulic Development and Analysis

Utilizing the wastewater collection system GIS database developed in the early phase of this Plan Update, a hydraulic model was developed using InfoSWMM. A well calibrated hydraulic model can represent the collection system facilities and reflect the flow characteristics under various flow conditions. It is the primary tool for evaluating the capacity of pipelines in a wastewater collection system. A set of dynamic simulations were developed, and were used to evaluate wastewater system requirements during peak flow conditions, and to develop a recommended set of existing and future system improvements.

To effectively evaluate a wastewater system, it is necessary to derive standards regarding the amount of flow that may be efficiently conveyed by a pipeline to provide reliable gravity sewer service. **Technical Memorandum No.3 – Draft Sewer System Design Criteria** was prepared to establish a set of planning criteria for the City's sewer system based on the planning criteria used for other similar sewer municipalities and was reviewed by the City staff. Recommended planning criteria for gravity mains are listed below:

- Existing pipelines 12-inch and smaller in diameter, maximum d/D shall not exceed 0.7,
- Existing pipelines larger than 12-inch in diameter, maximum d/D shall not exceed 0.85,
- New pipelines 12-inch and smaller in diameter, maximum d/D shall not exceed 0.5,
- New pipeline larger than 12-inch in diameter, maximum d/D shall not exceed 0.75.

The City's wastewater collection system was analyzed for three time frames: existing (2016), near-term future (2021), and long-term future (2035). The system was also analyzed under three flow conditions: average dry weather flow (ADWF), peak dry weather flow (PDWF), and peak wet weather flow (PWWF). Deficient pipelines were identified based on the model results under PWWF conditions, which accounts for a 10-year, 24-hour design storm. Based on model results, approximately 3.2 miles of the existing pipelines do not meet the planning criteria, and about 61% of the deficient pipelines were identified to be undersized to accommodate existing PWWF.

Based on the hydraulic analysis presented in Chapter 6, all deficient gravity mains were grouped and prioritized into 13 projects that consist almost entirely of pipeline upsizing with one new pipeline recommended. The recommended upsizing includes approximately 3% of the City's total collection system. A new pipeline was recommended between Santa Anita Ave and Brockway St within the Gateway Specific Plan Area to allow for flow diversion from the existing 15-inch pipeline into the existing 12-inch according to the sewer improvement plan proposed in the Gateway Specific Plan. The new pipeline can avoid pipeline replacements downstream within easements and reduce the number of pipelines needed to be replaced within the area.

ES-4. Capital Improvement Program (CIP)

Pipeline improvements were recommended based on the hydraulic capacity of the pipelines under PWWF conditions. Cost estimates for the CIP projects were developed based upon the unit costs presented in Chapter 8. A summary of the costs by phase are provided in Table ES 4-1.

Table ES 4-1: Cost Estimates for Pipeline Improvement Projects

Project	Capital Improvement Costs (\$)
<i>Existing</i>	
1	928,733
2	467,744
3	1,257,072
4	835,206
5	422,921
6	832,102
7	535,629
Existing Total	5,279,408
<i>Near-term Future</i>	
8	228,071
Near-term Future Total	228,071
<i>Long-term Future</i>	
9	2,824,783
10	287,343
11	103,713
12	119,966
13	539,848
Long-term Future Total	3,875,652
Total	9,383,132

ES-5. Asset Management Plan

Approximately 50% of the City's gravity mains and manholes were inspected for this Plan Update. Inspected data were used together with the hydraulic model results to develop an asset management plan for the City's gravity mains and manholes. InfoMaster, the asset management software developed by Innovyze, was utilized for the development of the gravity main and manhole asset management plans. InfoMaster combines asset information from GIS database, CCTV records, and other sources to perform survey data analysis, risk analysis, and rehabilitation planning to ultimately develop a rehabilitation and repair plan for the aging infrastructure.

Survey analysis were performed on the inspected facilities to evaluate their structural, operational, and service conditions. The inspected facilities were scored based on the defects identified and a rehabilitation action was assigned to the corresponding defect. Risk analysis evaluated the facilities' likelihood of failure and consequence of failure. A decision tree was developed separately for gravity mains and manholes including multi-steps to consider the rehabilitation costs, risk grading, and physical conditions of the asset to determine the adequate rehabilitation action. The final rehabilitation plans for gravity mains and manholes are presented in Chapter 9.

1. Introduction

1.1. General

The City of El Monte (City) is located west of the interchange of Interstate 605 and 10, approximately 12 miles east of Downtown Los Angeles. It is a residential, industrial, and commercial city in the heart of the San Gabriel Valley within the Los Angeles County of California. The wastewater collection facilities that serve the City are owned, maintained, and operated by the City Sewer Division under the City's Public Works Department. The City's most recent sewer master plan was performed by George G. Boghossian & Associates, Inc. and completed in December 2005. There was no report prepared for the 2005 Wastewater System Master Plan (WWMP) but only model results data and a map identifying the surcharged sewer mains.

This comprehensive Wastewater Collection System Master Plan Update (Plan Update) was developed as an update to the 2005 WWMP to review and evaluate the capacity and condition of the wastewater collection system based on future growth projections through year 2035. A Capital Improvement Program (CIP) is recommended for the City based on the evaluation to plan for its aging infrastructure and continued growth of the City's General Plan.

The Master Plan Update is presented in nine chapters:

- Chapter 1 – Introduction
- Chapter 2 – Background
- Chapter 3 – System Mapping
- Chapter 4 – Existing Sanitary Sewer System
- Chapter 5 – Wastewater Generation Analysis
- Chapter 6 – Hydraulic Model Development
- Chapter 7 – Hydraulic Analysis and Results
- Chapter 8 – Recommended Capital Improvement Projects
- Chapter 9 – Asset Management Plan

1.2. Authorization

The Wastewater Master Plan Update was performed under a Professional Services Agreement (PSA) entered into between Infrastructure Engineering Corporation (IEC) and the City of El Monte, dated January 19th, 2016.

1.3. Purpose

The purpose of this Plan Update is to develop a sewer system model with geographic information system (GIS) integration to re-evaluate the system capacity in existing, near-term future, and long-term future conditions, and develop a capital improvement program (CIP) to accommodate the sewer flow increase due to City growth. Specific recommendations for pipeline improvements will be made in time frames of existing (2016), near-term future (2021), and long-term future (2035) to address existing and projected capacity constraints. This recommended CIP forms the basis for the updated capacity fee and capital facilities financing plan and will be used in wastewater rate evaluations to be completed in separate financial studies.

1.4. Asset Management

The asset management plan (AMP) was developed by utilizing Innovyze's InfoMaster, identifying and scoring City assets. InfoMaster works in conjunction with the hydraulic model and its results, as well as the condition assessment from pipeline and manhole inspections, ultimately developing a rehabilitation and replacement plan for the aging infrastructure. The AMP also

prioritizes the rehabilitation/replacement projects based on the associated risks of asset failure throughout the City. Cost estimates of the rehabilitation/replacement projects are included.

2. Background

2.1. History of the City

The City of El Monte (City) was incorporated in 1912 and has undergone significant changes over the course of time. In the early 20th century, the City grew and prospered by agricultural industries including fruit orchards, farms, and dairy. The City gradually began to transform into a residential community after the experimental subsistence program called the “Rurban Homesteads” that was established by the federal government during the Depression. The economy began to shift from agriculture base to a modern industrial and commercial base during and after World War II. The City experienced growth in population following the war and became known as a major industrial area manufacturing plastic, glass, and electronic equipment. The population was estimated to be 113,481 by April 2010, and 115,807 by July 2016 according to the United States Census Bureau. Currently, the City has the 10th largest population in Los Angeles County.

2.2. Study Area

The City of El Monte encompasses a land area of approximately 10 square miles, 12 miles east of Downtown Los Angeles. It lies between two rivers: The San Gabriel River borders the city on the east, and the Rio Hondo begins in Irwindale, the neighboring city to the north, and flows southwesterly through the City. Other neighboring cities include the cities of Baldwin Park, Arcadia, Temple City, Rosemead, South El Monte, and unincorporated Los Angeles County. The vicinity map of the City is shown in Figure 2-1.

The City is a highly urbanized residential, industrial, and commercial community, and has become a transportation hub of the San Gabriel Valley with its excellent access to two freeways, Interstate 605 and Interstate 10, railroads, airport, and bus. The City is also a racially and ethnically diverse community with 66% Hispanic, 29% Asian, and 4% White.

2.2.1. Sanitary Sewer Service Area

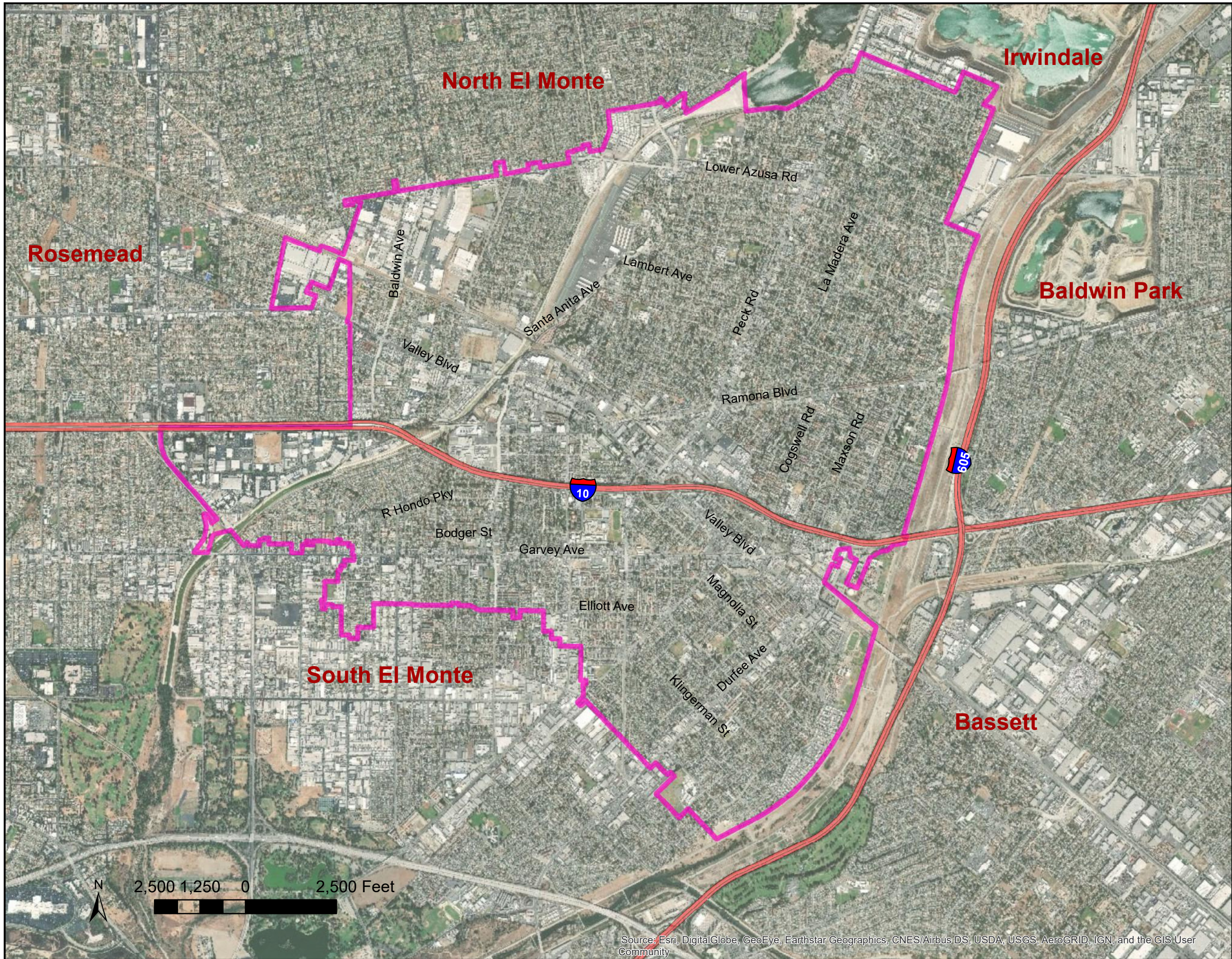
The study area for the wastewater collection system focuses on the City-owned facilities within the City boundary. The City Sewer Division of the Public Works Department is responsible for operating and maintaining the City’s wastewater collection system, which includes 130 miles of gravity mains, 2,687 manholes, and 7 sewage lift stations. The City is one of the jurisdictions under District No. 15 of the Los Angeles County Sanitation Districts (LACSD), which is responsible for treating and disposing wastewater collected from the City. Wastewater from the City is conveyed to and treated at the Whittier Narrows Water Reclamation Plant (WRP). District No. 15 is one of the 17 Districts that are signatory to the Joint Outfall Agreement (JOA). This agreement provides for the shared collective ownership and operation of the regional interconnected system of facilities called the Joint Outfall System (JOS). This Plan Update only evaluates the City-owned facilities, and Figure 2-2 shows the studied facilities of this Plan Update.

2.2.2. Previous Planning Studies

Previous planning studies utilized herein include the following:


- 2005 Wastewater System Master Plan, George G. Boghossian & Associates, Inc. – this master plan only provided model output data and addressed the surcharged pipelines in a map. No report was prepared for this master plan.
- 2006 General Plan/Zoning Code Update & Environmental Impact Report – provides existing/future land use information and the basis for future development and sewer flow projections.
- 2011 General Plan – provides existing/future land use information and the basis for future development and sewer flow projections.
- 2006 Gateway Specific Plan – provides future/ build-out land use information and development plans for the Specific Plan area.
- 2016 Downtown Main Street Transit-Oriented District Specific Plan and Master Plan – provides existing/future land use information and development plans of the Specific Plan area.

- 2015 Flair Spectrum Specific Plan – provides existing/future land use information and development plans for the Specific Plan area.
- 2012 Mountain View Specific Plan – provides existing/future land use information and development plans for the Specific Plan area.



Legend

 City of El Monte Boundary

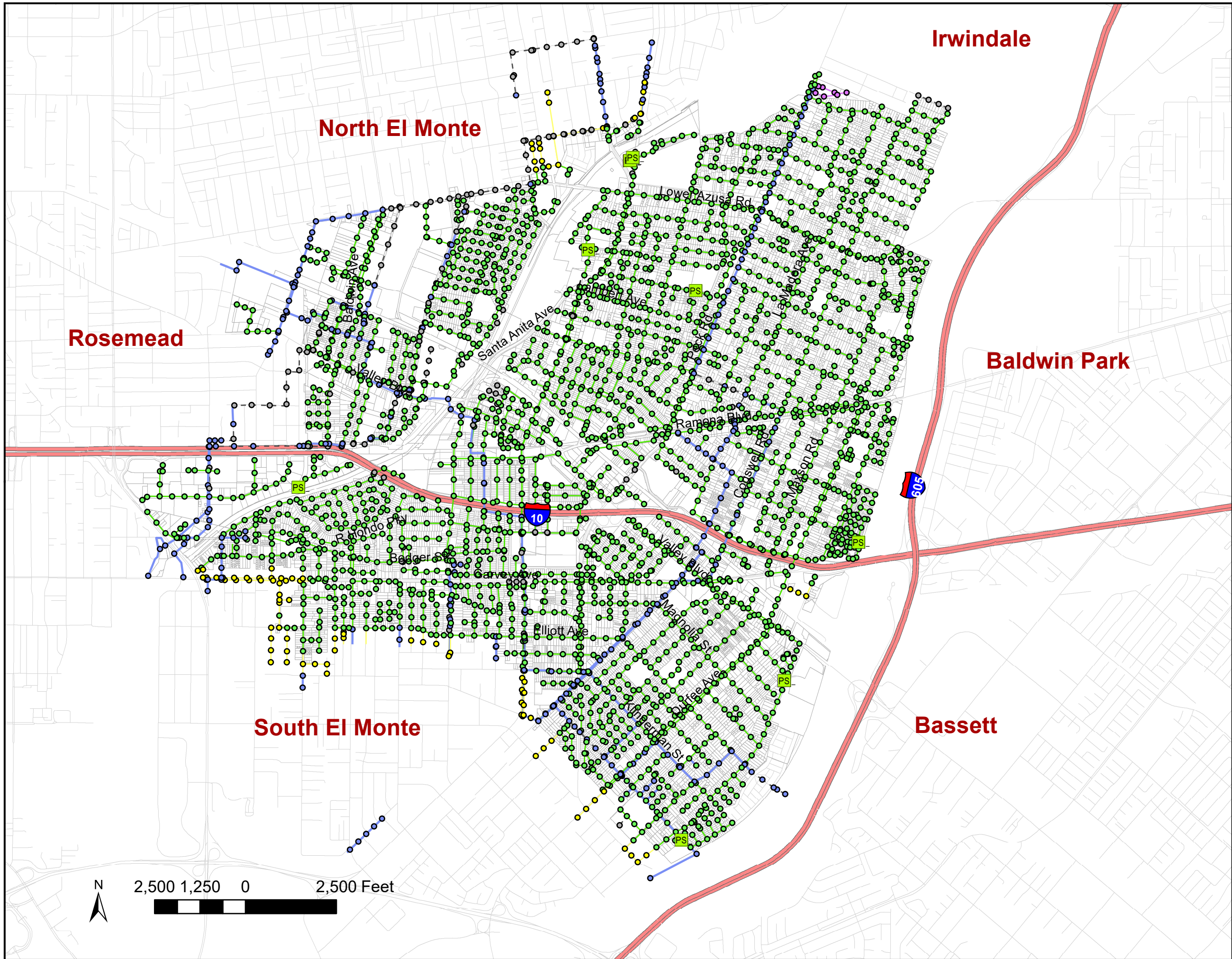


City of El Monte
Wastewater Collection System Master Plan

Study Area Vicinity Map

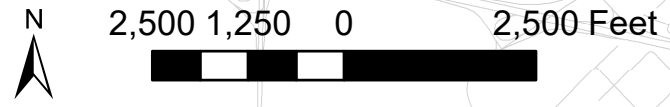
Figure 2-1


Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



Legend

- City Owned Lift Station
- Other Lift Station
- City Manhole
- County Manhole
- Private Manhole
- Other Manhole
- Abandoned Manhole
- City Sewer Line
- County Sewer Line
- Private Sewer Line
- Other Sewer Line
- Abandoned Sewer Line
- City Parcels





City of El Monte
Wastewater Collection System Master Plan
Existing Wastewater Collection System
Figure 2-2

3. System Mapping

The City's sewer asset records and maps were kept mostly in a hard copy filing system and the last sewer atlas maps were prepared in 2000. It is important to know the locations and design information of the sewer assets for effective and efficient management, so a critical component of this Plan Update is to consolidate all record drawing to construct a fully comprehensive sewer Geographic Information System (GIS) database for the City. This reduces discrepancies from conflicting maps using different datums, allow easier update to the City's sewer asset records, and provides more accurate and readable electronic maps available to all staff both in the office and in the field, provided the system is updated regularly.

The sewer system geodatabase was prepared by DCSE, a subconsultant to IEC for this Plan Update, and completed in the early phase of this project. The completed sewer GIS database was used as the basis of the hydraulic model and linked to CCTV inspection software for the Asset Management Program. The work performed is briefly summarized below.

3.1. Sewer Atlas

The City's last sewer atlas was prepared in 2000 and hasn't been updated since then. The sewer atlas maps were updated for this Plan Update and used as a basis of the convention system of facility identifiers for the City's sewer geodatabase. The updated sewer atlas is broken down into new atlas grids with a grid scale size of 1:2400 in 11x17" sheets. Old atlas map numbers were retained for future reference.

3.2. Pilot Project

The pilot project was done at the earlier phase of the GIS conversion task. Four grids of sewer atlas maps including G5, G6, H5, and H6 were selected for GIS conversion to execute and validate the conversion procedures. Anomalies were found and verified with City staff. The pilot project also allowed the City to evaluate and choose among the GIS data formats and the alternative techniques for data conversion, and was used as the foundation to complete the final geodatabase design.

3.3. GIS Mapping

GIS conversion of the City's sewer system was developed at the beginning of the Plan Update as the geodatabase was used as the basis for the hydraulic model development and asset management program. This effort included conversion of the City's existing wastewater collection system data into ESRI's spatial database engine (SDE) format, and an extensive review of available record drawings. Information on record drawings such as pipe diameter, slope, rim/invert elevations, material, and age was extracted to the sewer geodatabase. Record drawings were also scanned and linked to the GIS mapping system, which allows for a view of scans by clicking on the selected features. Errors and discrepancies found on record drawing were verified with City staff. Deliverables for this task included inventory lists of source data, assessment reports of missing data, database design documents, and a finalized wastewater geodatabase with atlas page layout.

Each asset in the GIS database has a unique identifier, which is the facility identification number (Facility ID). The convention system for the sewer assets were based on the Updated Sewer Atlas Book. The naming of Facility IDs is broken down into three parts. For example, Facility ID GM-G6-049 is a gravity main noted by a short abbreviation of "GM" located in atlas sheet number "G6" with an asset number of "049".

GIS conversion standards were developed and provided to the City for their continued update and maintenance of the GIS database. A parcel level GIS layer was also created to include the existing and build-out land use information collected as part of this project that will allow the City to easily modify and update land use in the future as changes occur or as future updates of the master plan occur.

3.4. Manhole Inspections and CCTV Pipeline Inspections

As part of this Plan Update, manhole inspections and CCTV pipeline inspections were performed by Pro-Pipe®, a subconsultant to IEC for this Plan Update, on approximately 50% of the system. The inspection data supplement the GIS data on sewer manholes and pipelines that were missing as-builts or had contradictory record drawing data and was used to develop the AMP. The manhole inspections were performed using 360-High Definition Manhole Inspections utilizing the IBAK

Panoramo Si which can capture 100% of the entire manhole cavity and measure inverts, defects, etc. The CCTV pipeline inspections were performed using Digital Pipeline Scanning utilizing the IBAK Panoramio 3D Optoscanner which captures 100% of the entire pipeline interior and measure the diameters, offsets, etc.

Details of the selection techniques on the sewer facilities were discussed in **Technical Memorandum NO. 2 – Manhole Inspections and CCTV Inspections**, dated April 12, 2017 prepared by IEC.

4. Existing Sanitary Sewer System

The City of El Monte is a member agency under District 15 of the Sanitation Districts of Los Angeles County (LACSD). The LACSD are a confederation of 24 independent special districts that provide wastewater and solid waste management service for approximately 5.6 million people over 78 cities in the Los Angeles County. Seventeen of the jurisdictions, including District 15, are signatory to the Joint Outfall Agreement, an interjurisdiction agreement that addresses the collective ownership and operation of the regional, interconnected system of wastewater conveyance, treatment and disposal facilities, known as the Joint Outfall System (JOS). The JOS includes seven wastewater treatment plants, over 1,230 miles of trunk sewers, and 50 pumping plants that conveys sewerage from member cities' and the County's local sewers to the LACSD's treatment plants. The City's existing sanitary sewer system includes a total of approximately 130 miles of pipelines and 7 lift stations. Currently, most wastewater flows generated within the City are conveyed by City facilities to connections to the County sewer lines, and are ultimately treated at the Whittier Narrows Water Reclamation Plant (WRP), located south of the City, for Primary, secondary, and tertiary treatment. Nearly all treated effluent is reused for irrigation and groundwater recharge. A limited number of City residences are on septic tanks.

4.1. Summary of Wastewater Assets

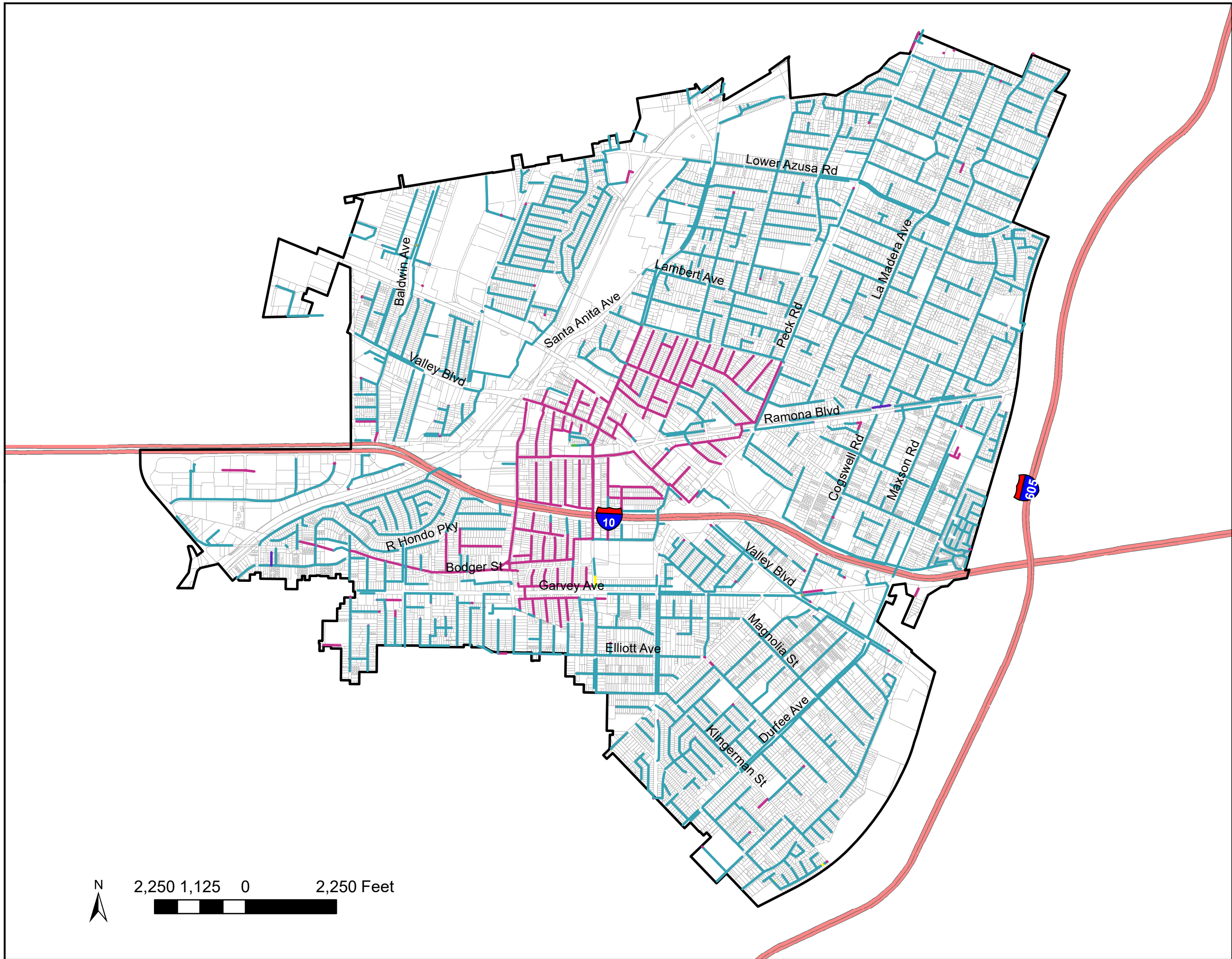
4.1.1. Gravity Mains

The City owns and operates approximately 129.7 miles of pipelines in the sewer collection system. Material information for gravity mains were obtained from record drawings and included in the facilities attributes of the sewer geodatabase. The majority of existing pipelines are Vitrified Clay Pipe (VCP) as shown in Table 4-1. Figure 4-1 shows locations of the pipelines by material type.

Table 4-1: Gravity Mains by Material

Material Abbreviation	Material Name	Total Length (ft)	Total Length (miles)	Percent of City Gravity Mains by Length
ABS	Acrylonitrile Butadiene Styrene	763	0.145	0.11%
CAS	Cast Iron	440	0.083	0.06%
CIPP	Cured In Place	410	0.078	0.06%
DIP	Ductile Iron	136	0.026	0.02%
PVC	Polyvinyl Chloride	12	0.002	0.00%
VCP	Vitrified Clay	583,787	110.6	85.2%
UNK	Unknown	99,338	18.8	14.5%
Total		684,886	129.7	100%

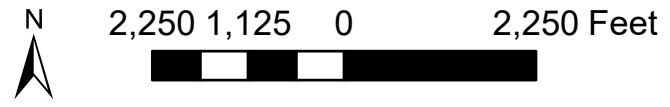
About 14.5% of the total length of gravity mains were categorized with Unknown material due to the lack of information in the record drawings or the lack of record drawings. The City may revisit this and update the geodatabase when better information is available.



Legend

Gravity Main by Material

- Acrylonitrile Butadiene Styrene (ABS)
- Cast Iron (CAS)
- Cured In Place (CIPP)
- Ductile Iron (DIP)
- Polyvinyl Chloride (PVC)
- Vitrified Clay (VCP)
- Unknown (UNK)
- City Parcels
- City of El Monte Boundary



City of El Monte
Wastewater Collection System Master Plan
Gravity Mains by Material
Figure 4-1

The City's gravity mains range from 6-in to 21-in in diameter with 8-inch gravity main predominating, as shown in Table 4-2. Gravity mains displayed by diameter are shown in Figure 4-2.

Table 4-2. Gravity Mains by Diameter

Diameter	Total Length (ft)	Total Length (miles)	Percent of City Gravity Mains by Length
6	1,841	0.35	0.27%
8	590,378	111.8	86.2%
10	35,851	6.8	5.2%
12	29,401	5.6	4.3%
15	12,646	2.4	1.8%
18	4,153	0.79	0.6%
21	321	0.06	0.05%
UNK	10,295	1.95	1.5%
Total	684,886	129.71	100.0%

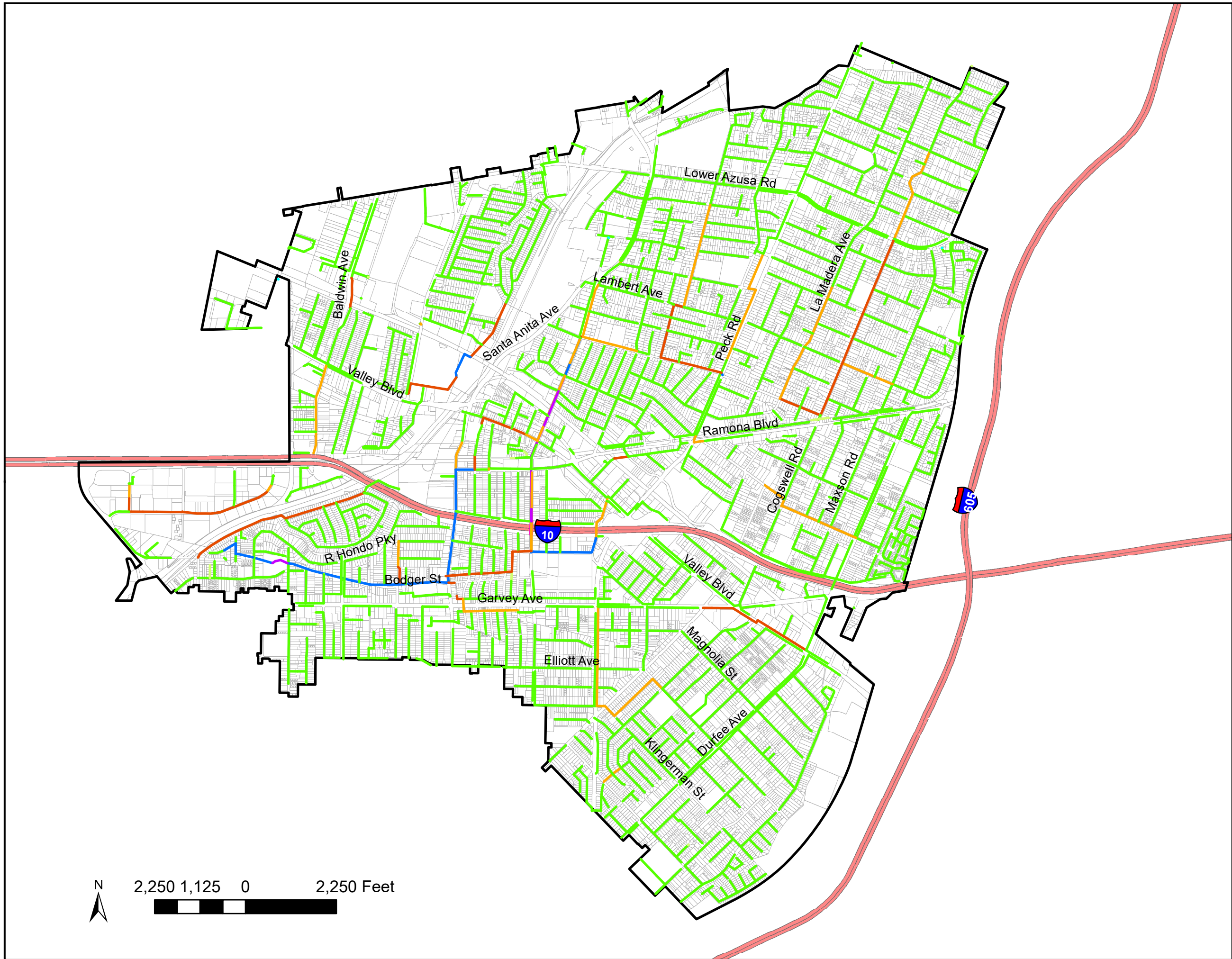
4.1.2. Lift Stations

There are currently 7 sewer lift stations that are owned, operated, and maintained by the City. Detailed design and operation information was not available for all the sewer lift stations at the time of preparing this Plan Update, so assumptions were made when developing the hydraulic model. Table 4-3 lists the locations of the 7 lift stations. Served areas of the lift stations are identified in Figure 4-3.

Table 4-3. Existing Sewer Lift Stations

Number	Lift Station	Number of Pumps	Serving Area
1	Lambert	2	Lambert Park (Park Restrooms)
2	Mountain View High School	2	Mountain View High School
3	Flair	2	Surrounding Area
4	Fine View	2	Surrounding Area
5	Kings Row	3	Shield of Faith Christian School and the surrounding area
6	Tyler	2	Surrounding Area
7	Lewis Home	2	3 connected developments

Two of the lift stations, Lambert and Mountain View High School, were not modeled in the hydraulic model as they are used only for individual lots and can be analyzed as point loads. Similarly, two pumps of the Kings Row Lift Station that serve the individual lots were also not modeled.

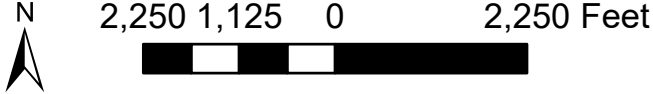


Legend

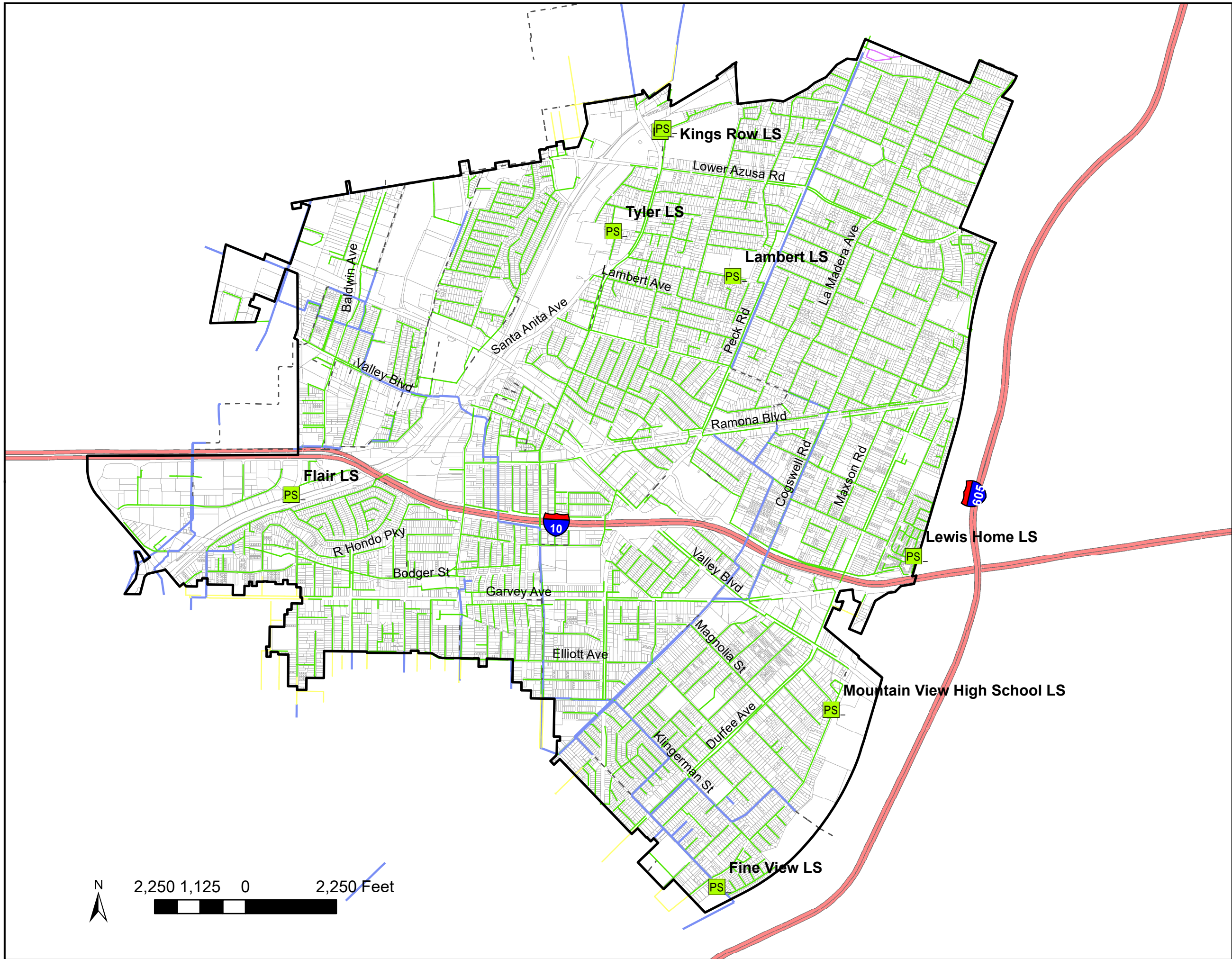
Pipeline by Diameter

- 4-inch
- 6-inch
- 8-inch
- 10-inch
- 12-inch
- 15-inch
- 18-inch
- 21-inch

- City Parcels
- City of El Monte Boundary

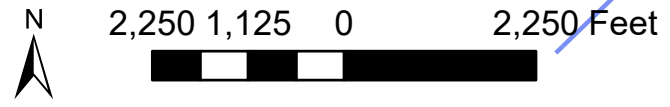



City of El Monte
 Wastewater Collection System Master Plan
Gravity Mains by Diameter
Figure 4-2



Legend

- PS Lift Station
- City Sewer Line
- County Sewer Line
- Private Sewer Line
- Other Sewer Line
- Abandoned Sewer Line
- City Parcels
- City of El Monte Boundary





City of El Monte
Wastewater Collection System Master Plan

City Lift Stations

Figure 4-3

5. Wastewater Generation Analysis

5.1. Background

Approximately 94% of wastewater generated within the City is collected by the City-owned facilities and then conveyed to the County-owned sewer lines. A few residences are on septic tanks, and the remaining wastewater generated within the City is either collected directly by County-owned facilities or collected by the neighboring City-owned facilities and then conveyed to the County-owned facilities. The collected wastewater flows are ultimately treated at the Whittier Narrows WRP.

This Plan Update only focuses on wastewater flows collected by the City-owned facilities as they are used for capacity assessment for the City's wastewater collection system. Figure 5-1 shows the parcels served by the City's sewer system. This chapter presents the estimation of wastewater flows for existing conditions and future conditions that are used as the basis for the hydraulic analysis. The wastewater flows were estimated for the existing (2016), near-term future (2021), and long-term future (2035) conditions.

5.2. Flow Monitoring Program

In order to quantify the existing wastewater flow collected by the City's sewer system and project the future wastewater flow, it is necessary to know the return-to-sewer (RTS) ratios by land use types in addition to that of the City's historical water usage records. A flow monitoring program was included as an early task of this Plan Update to characterize the wastewater flows entering the City's sewer system, and the collected flow monitoring data was used to develop and validate the sewer generation factors.

The flow monitoring program was conducted over a six-week period from 4/7/2016 through 5/23/2016 at five flow monitoring sites, which were selected to be representative areas of various land use types throughout the collection system. The flow monitoring sites and monitor basins are illustrated in Figure 5-2. **Technical Memorandum No. 1 – Flow Monitor Plan (TM-1)**, provided in Appendix A, documents the methodology used to select the flow monitoring sites and characterizes the primary land use types of the tributary flow areas. Detailed results of the flow monitoring data for each monitoring site were presented in a separate **Flow Monitoring Plan**.

5.3. Wastewater Flow Projections

5.3.1. Land Use and Wastewater Unit Generation Rates




There are nine water agencies that provide water services to businesses and residences within the City with three being the major water providers: The City serves approximately 20% of the City's land area, the San Gabriel Valley Water Company (SGVWC) serves approximately 58% of the City's land area, and California American Water serves approximately 10% of the City's land area. Figure 5-2 identifies the service area by water provider. Only the 2010 to 2015 historical water billing data from SGVWC was available at the time of this Plan Update and was used as a base to estimate the City's existing wastewater generation.

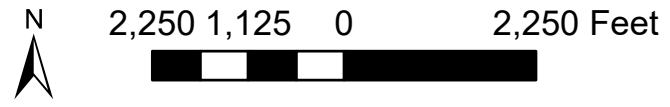
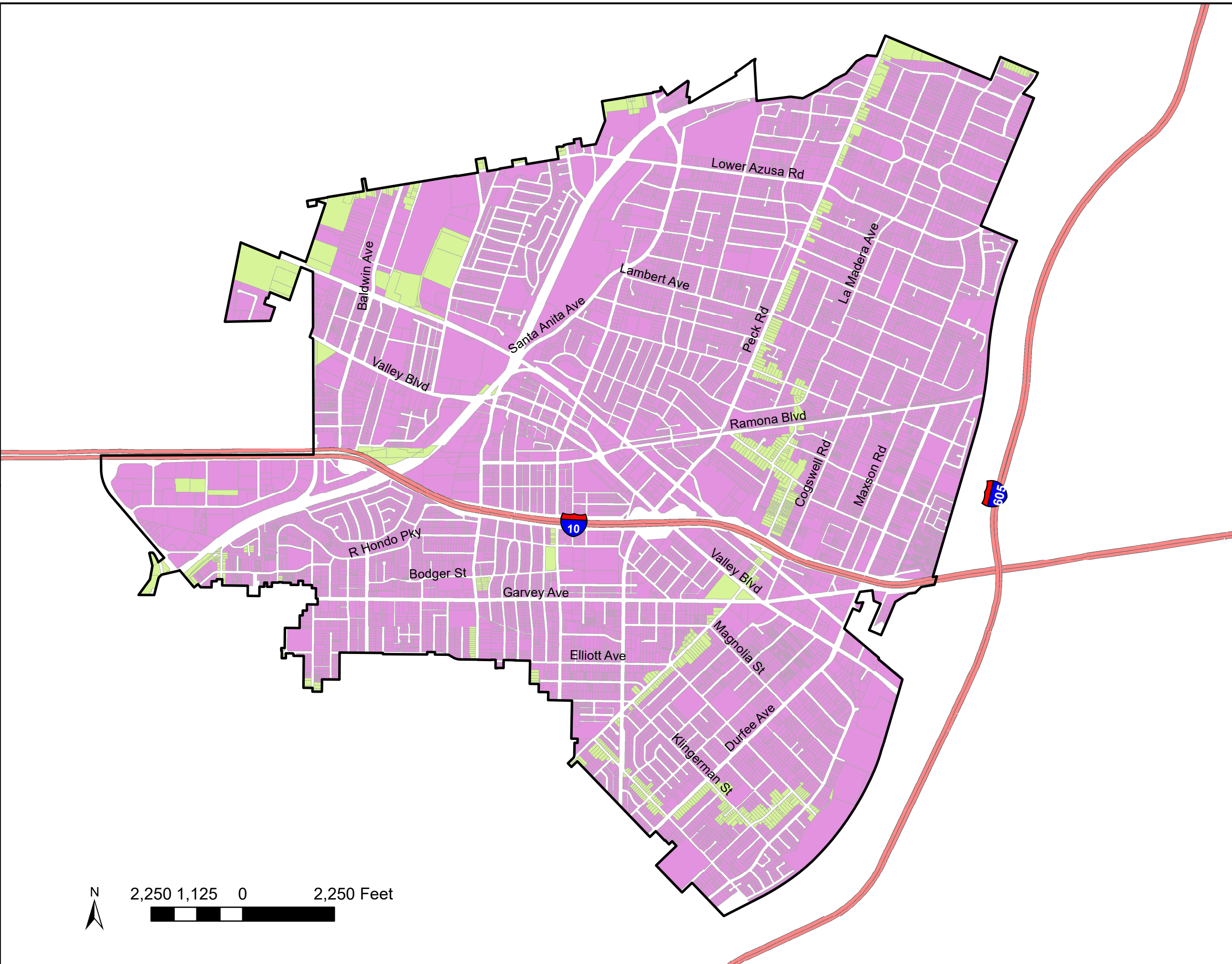
Existing wastewater flow rate was estimated using the water billing data provided by SGVWC for the period 2010 to 2015. Existing wastewater discharge for each billing account was calculated based upon the average usage over the previous 6 years. Water billing accounts were matched to Assessor's Parcel Numbers (APNs) through geo-coding using GIS. The geo-coding process matched approximately 87% of the water user accounts. Matched accounts from the City accounted for approximately 50% of the City land area. Water demand unit factors were then calculated by land use type based on the corresponding gross acreage and water usage. The existing water demand of the overall city was then calculated with the water demand unit factors with an assumption made that the remaining 50% of the land area had similar water usage characteristics and wastewater generation characteristics.


RTS ratios were calculated and calibrated based on sewer flows captured at the flow monitoring sites and the estimated water demands from the corresponding sewer tributary area. For land use types that were not covered in the flow monitoring program, RTS ratios were recommended based on a review of planning studies from neighboring agencies.

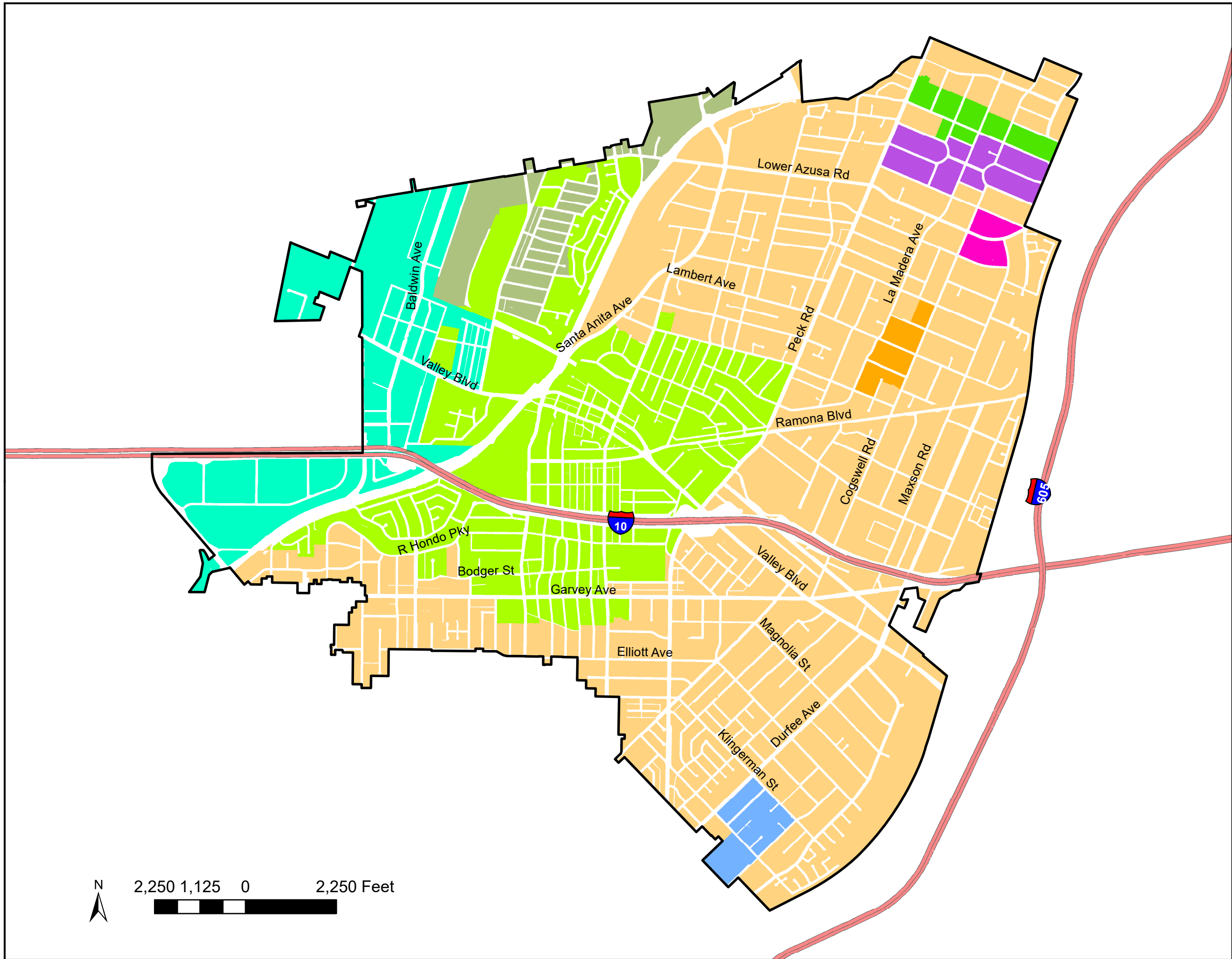
Wastewater unit generation rates for residential parcels were categorized into low-density/low-to-medium density residential (LDR/MLDR), medium-density residential (MDR), high-density residential (HDR), and medium density residential/neighbor commercial (MDNC). According to the City's **2015 Urban Water Management Plan**, the water demand duty factor for residential households is approximately 60 gallons per capita per day (GPCD). Based on the City's **2014-2021 Housing Element**, the average household size is at 4.04 persons. Table 2 of the **General Plan and Zoning Codes Update and EIR Existing Conditions Report** lists the allowed density and intensity of use for each residential use type. Maximum densities for LDR/MLDR, MDR, HDR, and MDNC are 8 du/ac, 14 du/ac, 25 du/ac, and 14 du/ac, respectively.

Legend

-  Parcels Connected to County Lines
-  Parcels Connected to City Sewer
-  City of El Monte




 City of El Monte
 Wastewater Collection System Master Plan
Parcels Connected to the City's Sewer System
 Figure 5-1



Legend

- California American
- Champion
- City of El Monte
- Del Rio
- Golden State Water
- Hemlock
- Ruban Homes
- San Gabriel Valley
- Sterling Mutual
- City of El Monte Boundary



 City of El Monte
 Wastewater Collection System Master Plan
Water Service Providers
Figure 5-2

Table 5-1 presents the estimated water demand unit factors, the RTS ratios, and the recommended wastewater unit generation rates by land use type for existing conditions. Approximately 63.4% of the City’s calculated average sewer flow can be attributed to residential land use types, and the remainder can be attributed to commercial, industrial, public facilities, open space/recreation, and transportation.

Table 5-1: Wastewater Unit Generation Factors for Existing Conditions

Land Use		Water Demand Unit Factor (gpd/acre)	RTS Ratio	Wastewater Generation Unit Factor (gpd/acre)
Residential	Low Density Residential/ Medium to Low Density Residential	1,800	0.65	1,170
	Medium density Residential	2,700	0.7	1,890
	High Density Residential	4,800	0.7	3,360
	Medium Density/Neighbor Commercial	2,700	0.7	1,890
Commercial ¹		2,100	0.85	1,785
Industrial ²		1,000	0.6	600
Public Facilities ³		2,100	0.85	1,785
Open Space/Recreation		1,000	0.3	300
Transportation ⁴		1,000	0.3	300

1. Excluding commercial storage
2. Excluding open storage
3. Excluding non-attended public parking facilities
4. only applicable to airport and bus terminal and yards.

Wastewater unit generation factors listed in Table 5-1 were estimated per gross acreage. For known future developments with development details on building square feet and/or residential units, wastewater unit generation factors, developed by IEC from recently completed projects of a similar nature, were used and are listed in Table 5-2.

Table 5-2: Wastewater Unit Generation Factors

Land Use	Unit	Wastewater Generation Unit Factor (gpd/unit)
Single-family Residential	unit	170
Multi-family Residential	unit	140
Commercial	sq. ft.	115/1,000
Office	sq. ft.	115/1,000
Industrial	sq. ft.	100/1,000
Hotel	Room (rm)	100

5.3.2. Existing Baseflow Development

Three flow components are considered for the City’s wastewater system hydraulic analysis: Base Wastewater Flow (BWF), Ground Water Infiltration (GWI), and Rainfall Dependent Infiltration/Inflow (RDI/I). BWF is domestic (or sanitary) wastewater flow from residential, commercial, and institutional (schools, churches, hospitals, etc.) sources, plus industrial wastewater. The existing BWF was estimated by applying the wastewater generation unit factors to the corresponding land use categories. Average Dry Weather Flow (ADWF) combines the BWF and GWI.

5.3.3. Future Wastewater Flows Projection

Future BWF projections were calculated for two time frames: near-term future (2021) and long-term future (2035). A list of known future developments was considered for the future wastewater flow projections, as outlined in Table 5-3. Most of these future developments are anticipated to be completed in near-term future, and a few projects will be developed in phases from existing throughout 2035. Near-term future BWF were projected by adding the specific near-term future development flows to the existing BWF. Project sites of the future developments are identified in Figure 5-3.

The specific future developments were assumed to remain unchanged in long-term future projections. Long-term future flows from the remainder areas were projected based on the Proposed General Plan (GP) zone designations. Wastewater flows from areas with changes to GP zone designation were re-calculated with the Proposed General Plan zone designations while area with unchanged GP zone designation were increased linearly consistent with the population projections from 2016 to 2035. Based on the U.S. Census Bureau, the City’s population in 2016 is 115,807. The City of El Monte is projected to increase population to 140,000 by 2035, approximately 20.9% increase from 2016.

Table 5-3: Known Future Developments

Project #	Address	Description	Proposed Land Use	Sewer Generation Factor	Existing			Near-term			Long-term			Total Development Flows (gpd)
					Unit	Proposed Development	Sewer Flow (gpd)	Unit	Proposed Development	Sewer Flow (gpd)	Unit	Proposed Development	Sewer Flow (gpd)	
1	4304 Temple City Blvd	New 28,655 sf warehouse building, within 150 ft of residential zoned or use property	Industrial	100 gpd/1000 sf	-	-	-	sf	28,655	2,866	-	-	-	2,866
2	4200 Baldwin Ave	Unknow development, assumed 0.5 of the lot area for building area	Industrial	100 gpd/1000 sf	-	-	-	sf	21,780	2,178	-	-	-	2,178
3	4123-4143 Rowland Ave	72-unit multi-family development in two phases	Multi-family	140 gpd/unit	-	-	-	units	72	10,080	-	-	-	10,080
4	4144 Arden Dr	New 63,450 sf industrial building	Industrial	100 gpd/1000 sf	-	-	-	sf	63,450	6,345	-	-	-	6,345
5	10620 Hickson St	2 new industrial buildings with 67,000 sf of total space	Industrial	100 gpd/1000 sf	-	-	-	sf	67,000	6,700	-	-	-	6,700
6	4102-4156 Baldwin Ave & 9960 Bessie Ave	55 family units on two lots totaling 3.71 acres	Multi-family	140 gpd/unit	-	-	-	units	55	7,700	-	-	-	7,700
7	9933 Valley Blvd	New 16,900 sf s-story commercial building	Commercial	115 gpd/1000 sf	-	-	-	sf	16,900	1,944	-	-	-	1,944
8	9920 Valley Blvd	A new 4-story Hilton Gardens hotel	Hotel	100 gpd/rm	-	-	-	rm	133	13,300	-	-	-	13,300
9	4000 Arden Dr	A new Walmart Superstore in 15.4 acres lot	Commercial	115 gpd/1000 sf	-	-	-	sf	186,782	21,480	-	-	-	21,480
10	3527 Santa Anita Ave	Part of the Gateway Master Plan. residential and commercial developments in 4 lots	Multi-family	140 gpd/unit	units	132	18,480	units	620	86,800	-	-	-	105,280
10	3527 Santa Anita Ave	Part of the Gateway Master Plan. residential and commercial developments in 4 lots	Commercial	115 gpd/1000 sf	-	-	-	sf	75,000	8,625	-	-	-	8,625
11	3335 Santa Anita Ave	Part of the Gateway Master Plan. Parcel 5 of Gateway Project: 12-story 200 room hotel, 100,000 sf of office, 35,000 sf of theater space, 100,000 sf of dining/retail, total space of 430,000 gross sf	Commercial	115 gpd/1000 sf	-	-	-	sf	235,000	27,025	-	-	-	27,025

Table 5-3: Known Future Developments

Project #	Address	Description	Proposed Land Use	Sewer Generation Factor	Existing			Near-term			Long-term			Total Development Flows (gpd)
					Unit	Proposed Development	Sewer Flow (gpd)	Unit	Proposed Development	Sewer Flow (gpd)	Unit	Proposed Development	Sewer Flow (gpd)	
11	3335 Santa Anita Ave	Part of the Gateway Master Plan. Parcel 5 of Gateway Project: 12-story 200 room hotel, 100,000 sf of office, theater space and dining/retail, total space of 430,000 gross sf	Hotel	100 gpd/rm	-	-	-	rm	200	20,000	-	-	-	20,000
12	9400 Flair Dr	Flair Spectrum Specific Plan. 14.6 ac. Mixed-use project for an outlet center w/ 690,000 sf of retail and restaurants, a 250 room hotel and 600 residential units	Commercial	115 gpd/1000 sf	-	-	-	sf	690,000	79,350	-	-	-	79,350
12	9400 Flair Dr	Flair Spectrum Specific Plan. 14.6 ac. Mixed-use project for an outlet center w/ 690,000 sf of retail and restaurants, a 250 room hotel and 600 residential units	Hotel	100 gpd/rm	-	-	-	rm	250	25,000	-	-	-	25,000
12	9400 Flair Dr	Flair Spectrum Specific Plan. 14.6 ac. Mixed-use project for an outlet center w/ 690,000 sf of retail and restaurants, a 250 room hotel and 600 residential units	Multi-family	140 gpd/unit	-	-	-	unit	600	84,000	-	-	-	84,000
13	3268 Rosemead Blvd	New two-story office/showroom building	Office	115 gpd/1000 sf	-	-	-	sf	20,000	2,300	-	-	-	2,300
14	9133 Garvey Ave	New 5-story, 61.7k office building, remodel 26.7k for warehouse and remodel 9.6k for print shop. Demo remaining buildings	Commercial	115 gpd/1000 sf	-	-	-	sf	98,000	11,270	-	-	-	11,270
15	11234 Montecito Dr	New 5 residential lot division	Single-family	170 gpd/unit	-	-	-	units	5	850	-	-	-	850
16	3708 Cypress Ave	12 unit detached multi-family development	Multi-family	140 gpd/unit	-	-	-	units	12	1,680	-	-	-	1,680
17	11127 Ramona Blvd	Part of Downtown Main St. 62 units including 4 live-work units	Multi-family	140 gpd/unit	-	-	-	units	62	8,680	-	-	-	8,680
18	11712 Lansdale St	A 4-unit PUD	Multi-family	140 gpd/unit	-	-	-	units	4	560	-	-	-	560
19	11640-11710 Valley Blvd	4-story 76-unit residential condo	Multi-family	140 gpd/unit	-	-	-	units	76	10,640	-	-	-	10,640

Table 5-3: Known Future Developments

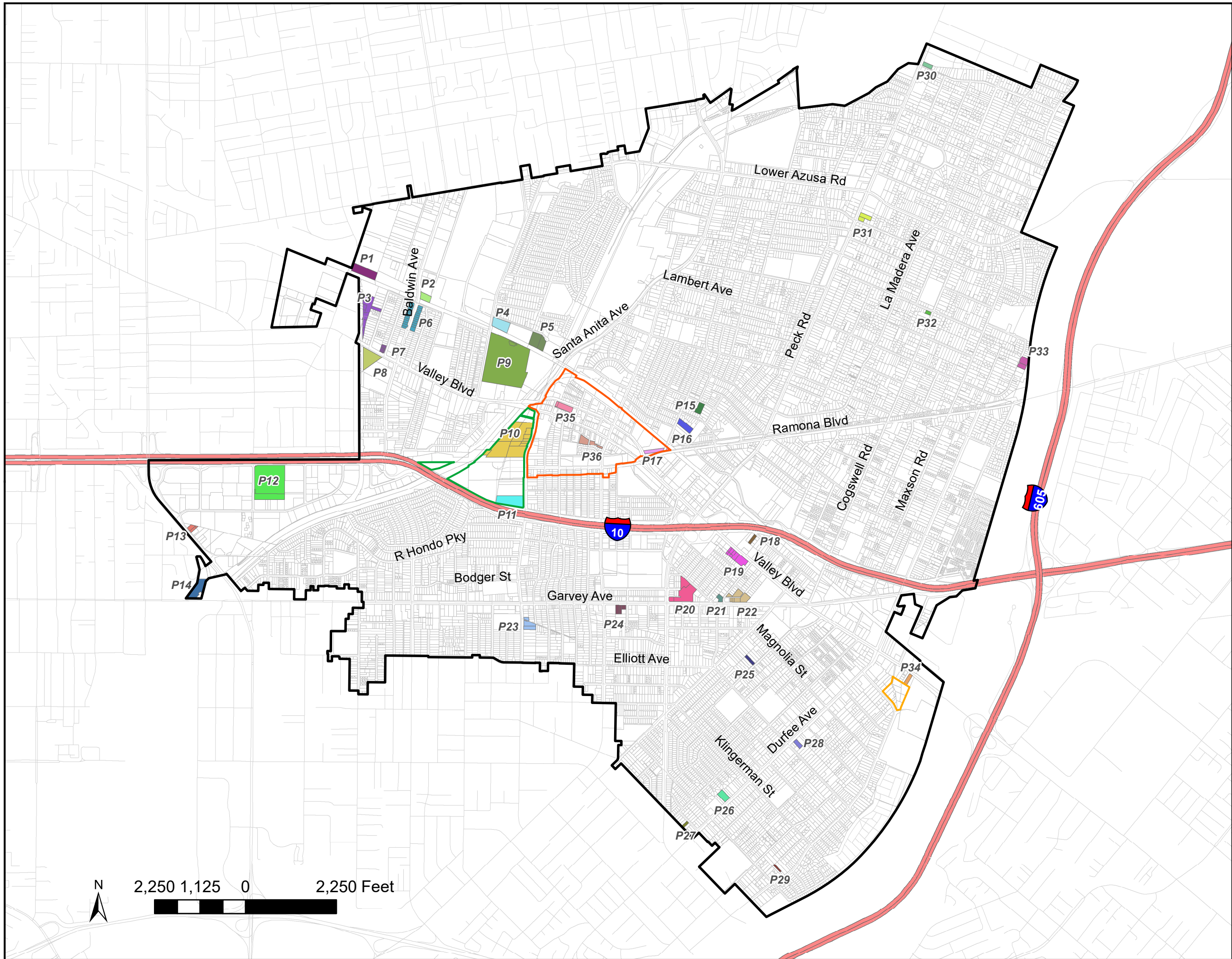
Project #	Address	Description	Proposed Land Use	Sewer Generation Factor	Existing			Near-term			Long-term			Total Development Flows (gpd)
					Unit	Proposed Development	Sewer Flow (gpd)	Unit	Proposed Development	Sewer Flow (gpd)	Unit	Proposed Development	Sewer Flow (gpd)	
20	11301-11401 Garvey Ave	Demo existing auto dealership and construct new mixed-use project including 2,800 sf of retail and 114 residential units	Multi-family	140 gpd/unit	-	-	-	units	114	15,960	-	-	-	15,960
20	11301-11401 Garvey Ave	Demo existing auto dealership and construct new mixed-use project including 2,800 sf of retail and 114 residential units	commercial	115 gpd/1000 sf	-	-	-	sf	2,800	322	-	-	-	322
21	11605 Garvey Ave	30 senior residential units and 5,500 sq.ft of retail uses	Multi-family	140 gpd/unit	-	-	-	units	30	4,200	-	-	-	4,200
21	11605 Garvey Ave	30 senior residential units and 5,500 sq.ft of retail uses	commercial	115 gpd/1000 sf	-	-	-	sf	5,500	633	-	-	-	633
22	11619-11707 Garvey Ave & 11726-28 Asher and 3024 La Madera	Mixed-use complex with ground floor retail and upper floor housing. Two buildings	Multi-family	140 gpd/unit	-	-	-	units	106	14,840	-	-	-	14,840
22	11619-11707 Garvey Ave & 11726-28 Asher and 3024 La Madera	Mixed-use complex with ground floor retail and upper floor housing. Two buildings	Commercial	115 gpd/1000 sf	-	-	-	sf	58,213	6,694	-	-	-	6,694
23	2704, 2710, 2728 Santa Anita Ave	38 new townhouse units and 2 new detached SFR	Multi-family	140 gpd/unit	-	-	-	units	38	5,320	-	-	-	5,320
23	2704, 2710, 2728 Santa Anita Ave	38 new townhouse units and 2 new detached SFR	Single-family	170 gpd/unit	-	-	-	units	2	340	-	-	-	340
24	11022-11048 Garvey Ave	Mixed-use development include 70 townhomes, and free-standing 2,154 sf retail building	Multi-family	140 gpd/unit	-	-	-	units	70	9,800	-	-	-	9,800
24	11022-11048 Garvey Ave	Mixed-use development includes 70 townhomes, and free-standing 2,154 sf retail building	Commercial	115 gpd/1000 sf	-	-	-	sf	2,154	248	-	-	-	248
25	2709 Cogswell Rd	4- unit PUD	Multi-family	140 gpd/unit	-	-	-	units	4	560	-	-	-	560
26	2253 Durfee Ave	Mixed-use project: 36 residential units, 4 retail stores on the first floor	Multi-family	140 gpd/unit	-	-	-	units	36	5,040	-	-	-	5,040

Table 5-3: Known Future Developments

Project #	Address	Description	Proposed Land Use	Sewer Generation Factor	Existing			Near-term			Long-term			Total Development Flows (gpd)
					Unit	Proposed Development	Sewer Flow (gpd)	Unit	Proposed Development	Sewer Flow (gpd)	Unit	Proposed Development	Sewer Flow (gpd)	
26	2253 Durfee Ave	Mixed-use project: 36 residential units, 4 retail stores on the first floor. Lack of details of the building sf of the commercial area, use gross acreage for flow calculation	Commercial	1785 gpd/ac	-	-	-	ac	1.03	1,942	-	-	-	1,942
27	12228 Chosen St	GPA from MLR to MMU and ZC from R2 to MMU and P overlay for a new 29,365 manufacturing/office building and parking	Commercial	115 gpd/1000 sf	-	-	-	sf	29,365	3,377	-	-	-	3,377
28	2616 Durfee Ave	Mixed use 2,500 sf commercial and 13 residential units	Commercial	115 gpd/1000 sf	-	-	-	sf	2,500	288	-	-	-	288
28	2616 Durfee Ave	Mixed use 2,500 sf commercial and 13 residential units	Multi-family	140 gpd/unit	-	-	-	units	13	1,820	-	-	-	1,820
29	2231 Parkway Dr	9-unit residential subdivision	Multi-family	140 gpd/unit	-	-	-	units	9	1,260	-	-	-	1,260
30	11613 Rio Hondo Pkwy	5 new detached 2-story units. Lot area of 23,274 sf	Multi-family	140 gpd/unit	-	-	-	units	5	700	-	-	-	700
31	4704-4716 Peck Rd	Demo existing buildings and construction of a 4-story 49 unit affordable housing complex	Multi-family	140 gpd/unit	-	-	-	units	49	6,860	-	-	-	6,860
32	4455 Cogswell	Lot split 1 to 2	Single-family	170 gpd/unit	-	-	-	units	2	340	-	-	-	340
33	4422-4436 Bannister St	23 residential lots and 1 common lot to establish 3+ residential units	Single-family	170 gpd/unit	-	-	-	units	23	3,910	-	-	-	3,910
33	4422-4436 Bannister St	23 residential lots and 1 common lot to establish 3+ residential units	Multi-family	140 gpd/unit	-	-	-	units	3	420	-	-	-	420
34	12432 Valley Blvd	New 60521 sf hotel construction with 96 guest rooms	Hotel	100 gpd/rm	-	-	-	rams	96	9,600	-	-	-	9,600
35		Downtown Main Street SP Site 1. New Mixed-Use Development	Multi-family	140 gpd/unit	-	-	-	units	60	8,400	-	-	-	8,400
35		Downtown Main Street SP Site 1. New Mixed-Use Development	Commercial	115 gpd/1000 sf	-	-	-	sf	18,000	2,070	-	-	-	2,070

Table 5-3: Known Future Developments

Project #	Address	Description	Proposed Land Use	Sewer Generation Factor	Existing			Near-term			Long-term			Total Development Flows (gpd)
					Unit	Proposed Development	Sewer Flow (gpd)	Unit	Proposed Development	Sewer Flow (gpd)	Unit	Proposed Development	Sewer Flow (gpd)	
36		Downtown Main Street SP Site 2. New Mixed-Use Development	Multi-family	140 gpd/unit	-	-	-	units	95	13,300	-	-	-	13,300
36		Downtown Main Street SP Site 2. New Mixed-Use Development	Commercial	115 gpd/1000 sf	-	-	-	sf	2,500	288	-	-	-	288
Gateway Specific Plan		Excluding P10 and P11	Multi-family	140 gpd/unit	-	-	-	-	-	-	units	1,098	153,720	153,720
Gateway Specific Plan		Excluding P10 and P12	Commercial	115 gpd/1000 sf	-	-	-	-	-	-	sf	993,000	114,195	114,195
Gateway Specific Plan		Excluding P10 and P13	Public Facilities	115 gpd/1000 sf	-	-	-	-	-	-	sf	20,000	2,300	2,300
Downtown Main Street		Excluding P17, P35, P36	Multi-family	140 gpd/unit	-	-	-	-	-	-	units	2,173	304,220	304,220
Downtown Main Street		Excluding P17, P35, P36	Commercial	115 gpd/1000 sf	-	-	-	-	-	-	sf	1,429,500	164,393	164,393
Mountain View			Single-family	170 gpd/unit	-	-	-	unit	62	10,540	-	-	-	10,540
Total							18,480			568,442			738,828	1,325,750

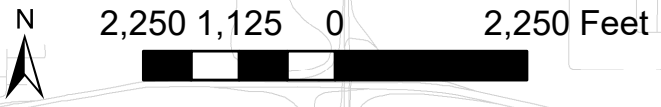


Legend

Future Developments

P1	P19
P2	P20
P3	P21
P4	P22
P5	P23
P6	P24
P7	P25
P8	P26
P9	P27
P10	P28
P11	P29
P12	P30
P13	P31
P14	P32
P15	P33
P16	P34
P17	P35
P18	P36

- Downtown Main Street
- Gateway Specific Plan
- Mountain View Specific Plan
- City of El Monte Boundary



City of El Monte
Wastewater Collection System Master Plan

Known Future Developments

Figure 5-3

BWF projections for existing, near-term future, and long-term future are summarized in Table 5-4.

Table 5-4: Base Wastewater Flow Projections

Sewer Flow Condition	Existing (mgd)	Near-term Future (mgd)	Long-term Future (mgd)
BWF	6.3	6.89	8.81
GWl	0.71	0.71	0.71
ADWF	7.01	7.6	9.52

5.3.4. Inflow and Infiltration Analysis

Existing inflow and infiltration rates were analyzed and quantified from the collected flow monitoring data. The inflow and infiltration analysis included an estimate of Groundwater Infiltration (GWI), or the Base Infiltration (BI), which cannot be directly measured. GWI is defined as groundwater entering the collection system through pipe joints and manhole walls due to an aging system or improper construction. GWI tends to be lowest during the summer and fall months and while it is affected by rainfall, it responds gradually and is not directly related to any one individual rainfall event. GWI rates were estimated for the flow monitor basins and overall collection system using the Stevens/Schutzbach method. This empirical method utilizes a curve fitting technique to calculate a rough estimate of GWI from the relationship between the Average Dry Weather Flow (ADWF) and the Maximum Daily Flow (MDF). The GWI entering the City’s wastewater collection system is estimated to be approximately 0.7 mgd.

Several storm events occurred during the flow monitoring period, and the largest storm occurred on 5/6/2016 with a peak rain intensity of 0.51 in./hr and can be heavier than a 1-year 3-hour storm and less than a 2-year 3 hour storm based on the National Oceanic and Atmospheric Administration (NOAA) frequency contour map for the City of El Monte. Figure 5-4 shows the histogram of the rainfall event on 5/6/2016. Rain dependent Inflow/Infiltration, or RDI/I, is defined as storm water that enters the wastewater collection system in direct response to the intensity and duration of the storm event. The capacity of downstream pipes and transport facilities must be sufficient to carry these peak instantaneous flows. The peak RDI/I rates were calculated to be the difference between the peak flows (captured in 15-minute time intervals) on peak wet weather day and peak dry weather day. RDI/I rates were estimated for the five flow monitoring sites and then the average RDI/I per inch per linear foot was calculated by dividing RDI/I rate by the sum of the products between pipeline diameter and pipeline length. An assumption was made that RDI/I entering the pipeline is proportionate to pipe sizes and pipe length.

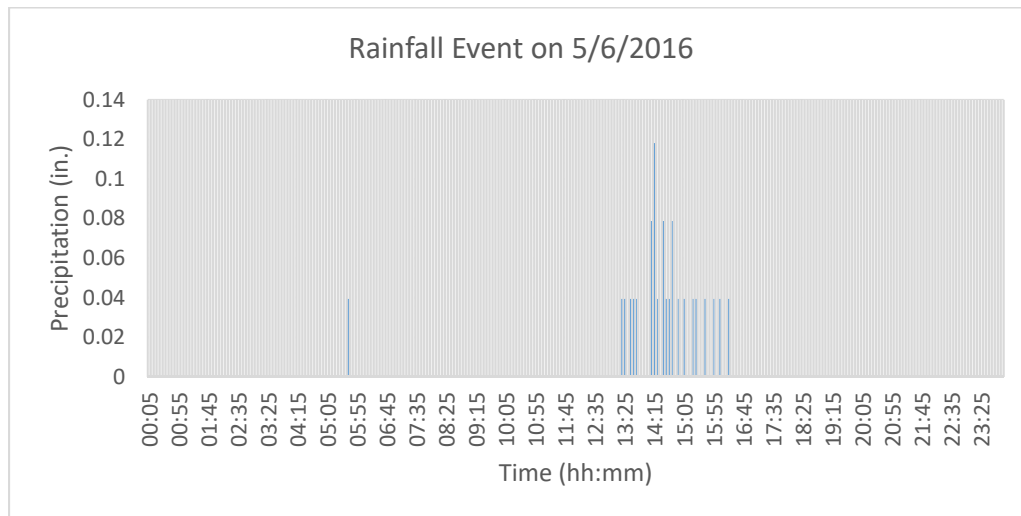
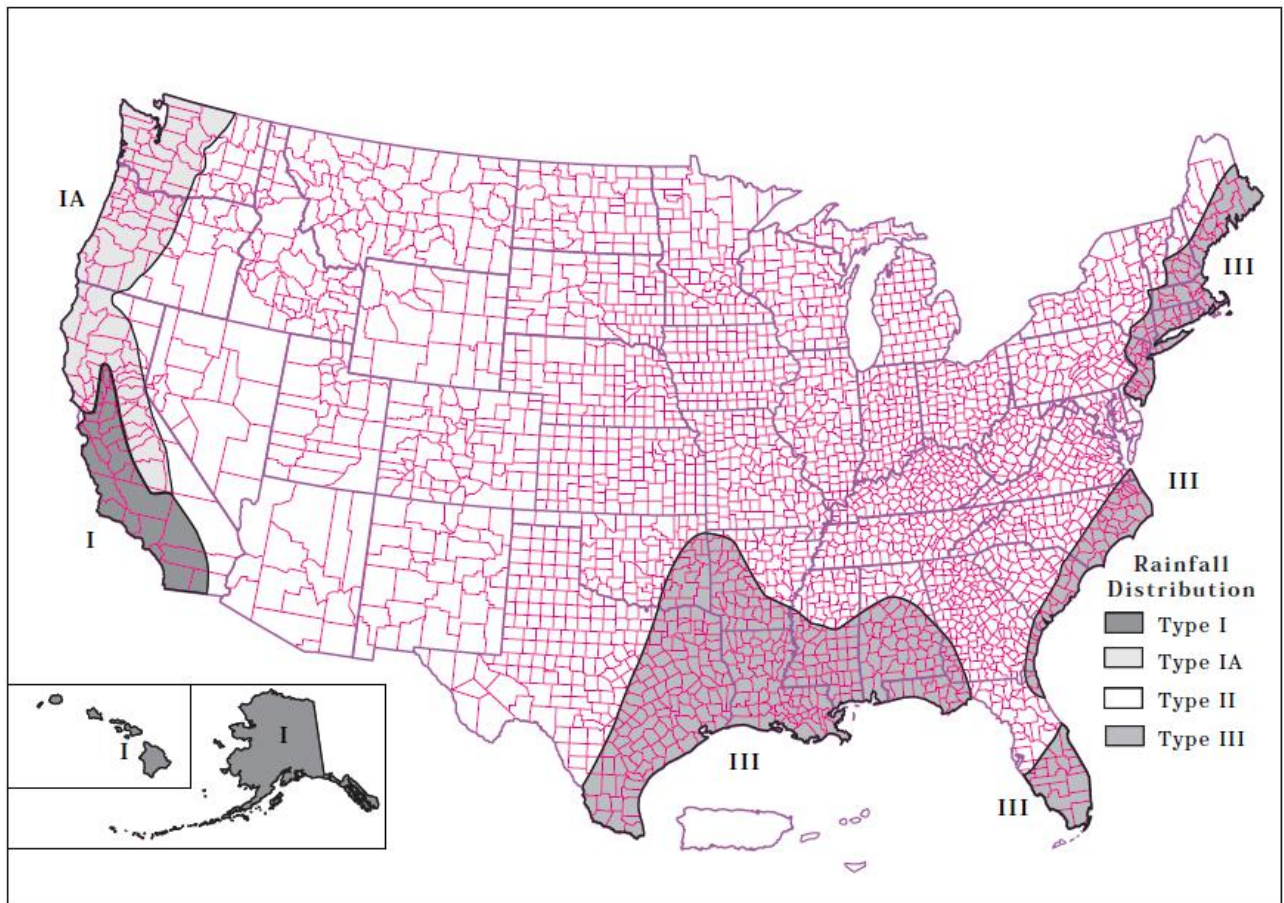


Figure 5-4: Rainfall Event on 5/6/2016

Even though the Los Angeles Regional Water Quality Control Board does not specify a design storm for capacity assessment of collection systems, a design storm must be accounted for in the hydraulic analysis as required by the State Waste Discharge Requirement (WDR) 2006-003, with which the City must comply. The selection of a design storm is a decision that balances risk of capacity deficiency during a particularly heavy rainfall event versus economic consequences of over-designing the collection system to handle flow that is seen only occasionally. Based on a review of neighboring agencies' planning studies and management plans from 2007 through 2014 and discussion with City staff, a 10-year 24-hour design storm is recommended for the wet weather analysis.

Based on the NOAA's Precipitation Frequency Estimates for the City of El Monte area, the precipitation of a 10-year 24 hour storm was estimated to be 5.17 inch. A synthetic rainfall distribution was developed on an hourly basis based on the Type I synthetic 24-hour rainfall distribution developed by the Natural Resources Conservation Service (NRCS) as Type I represents the Pacific maritime climate with wet winters and dry summers¹. Figure 5-5 presents the approximate geographic boundaries of the four synthetic 24-hour rainfall distributions that NRCS developed. Figure 5-6 shows the design event rainfall intensity based on the NRCS Type I rainfall distribution.

Figure 5-5. Approximate Geographic Boundaries for NRCS Rainfall Distributions (USDA 1986)



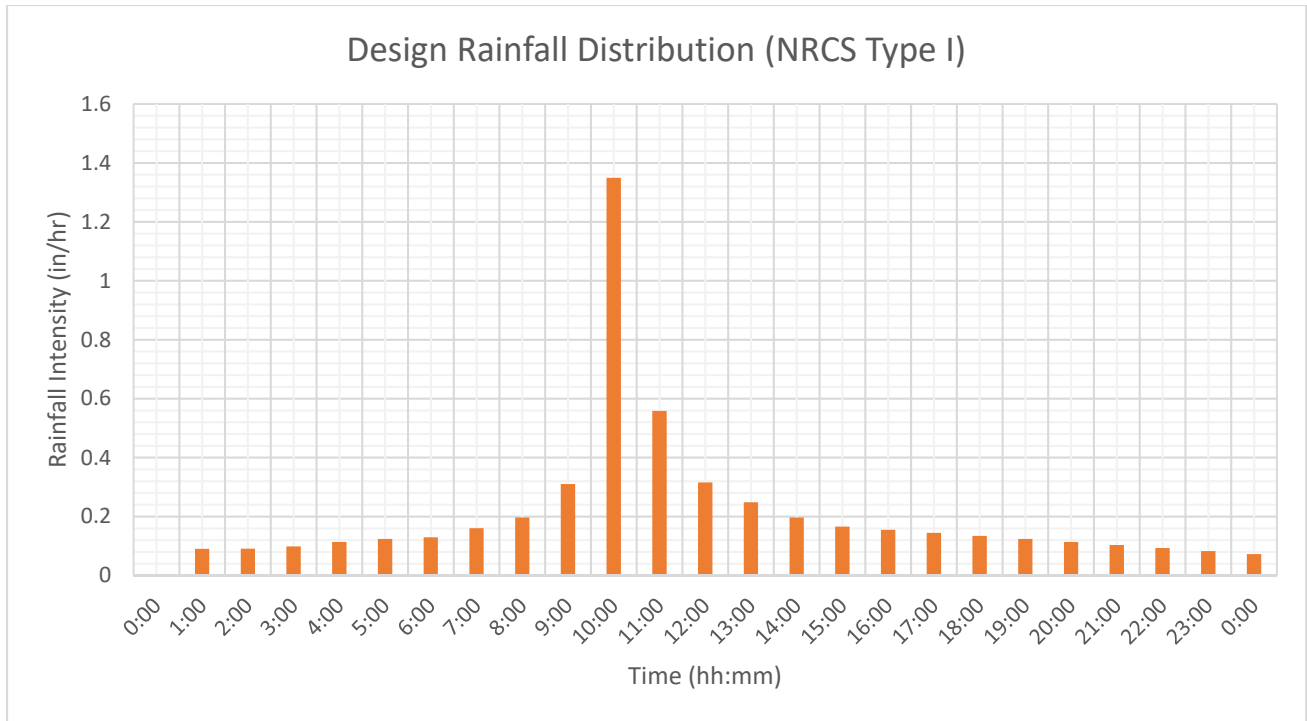


Figure 5-6: Design Rainfall Distribution (NRCS Type I)

5.3.5. Peak Dry Weather Flow (PDWF)

Wastewater flow rates vary by time as different customer types have different daily use patterns, which are referred to as diurnal curves. Because the wastewater generation patterns vary for residential and non-residential sources, two separate diurnal curves were used. Typical residential and non-residential diurnal curves were extracted from flow monitoring data. The normalized diurnal curves for residential and non-residential wastewater flows can be seen in Figure 5-7 and Figure 5-8, respectively. The diurnal curves were not applied to GWI and RDI/I.

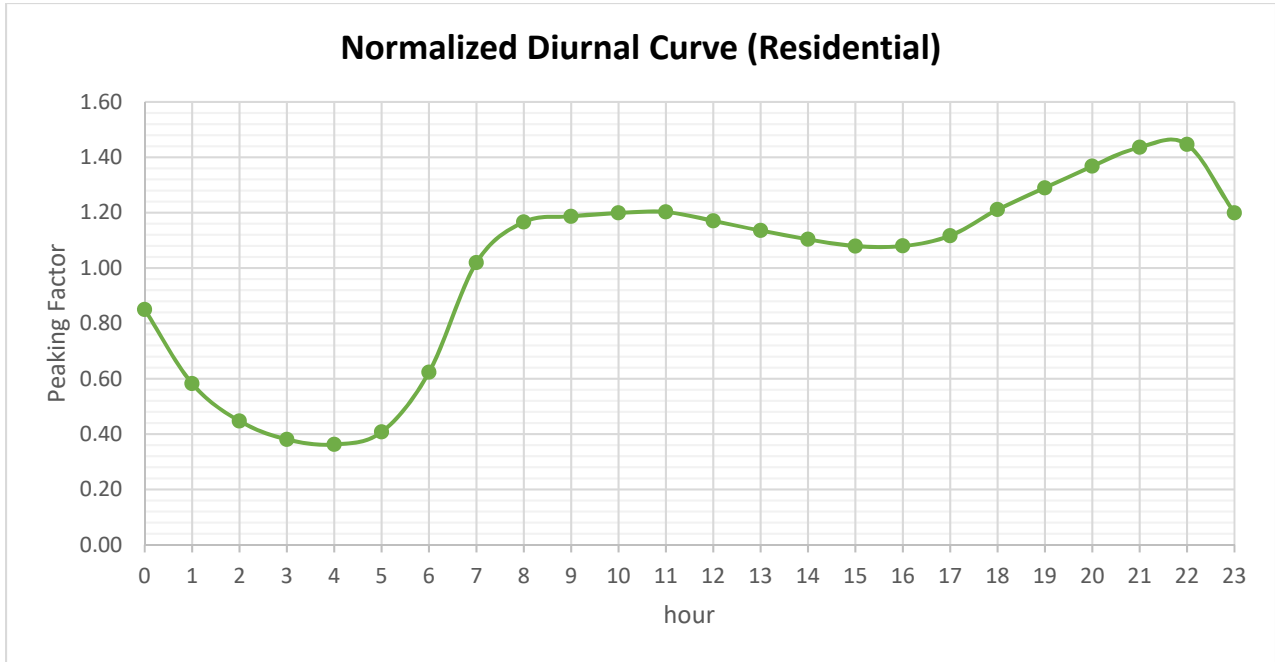


Figure 5-7: Residential Diurnal Curve

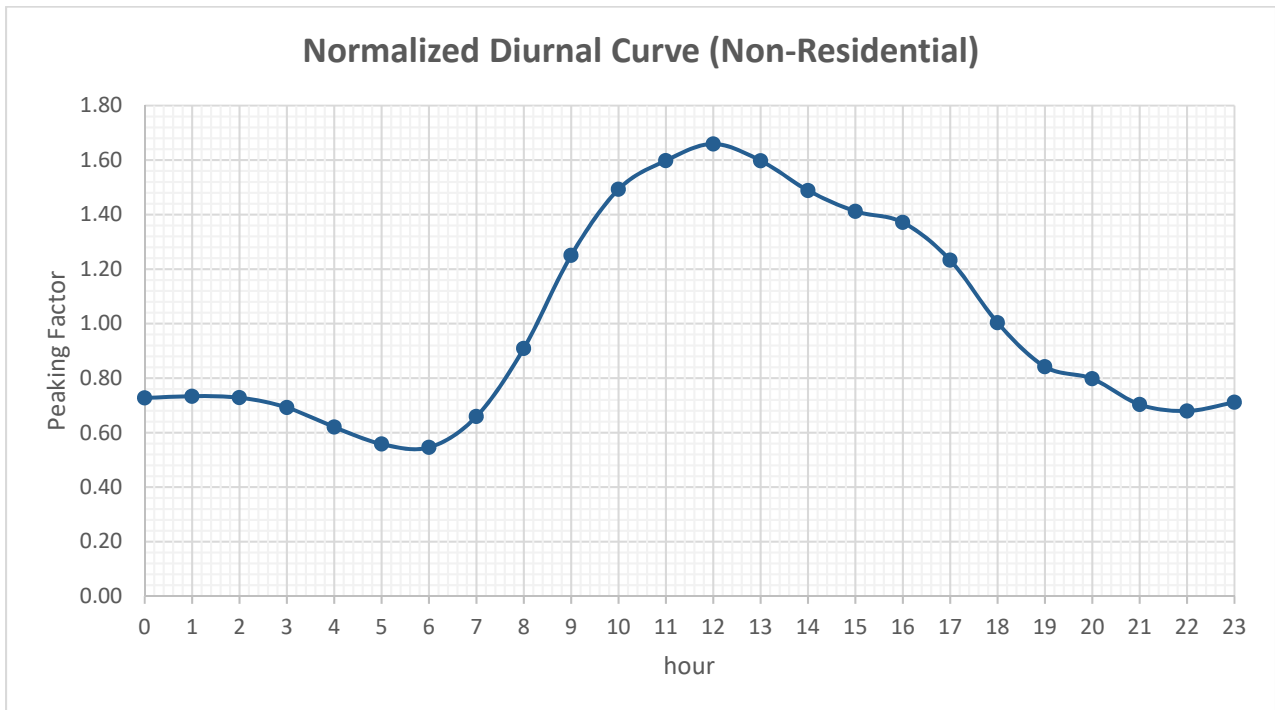


Figure 5-8: Non-Residential Diurnal Curve

5.3.6. Peak Wet Weather Flow (PWWF)

Peak Wet Weather Flow is estimated as Peak Dry Weather Flow (PDWF) plus the 10-year design storm Rainfall Dependent Infiltration/Inflow (RDI/I). The 10-year design storm RDI/I was calculated by extrapolating the estimated RDI/I rates analyzed from the recent storm event assuming that RDI/I is proportional with rainfall intensity. More than 60% of the City’s wastewater flows were generated from residential areas, and residential flows were characterized to be peaked at 10:00 pm. To be conservative, the design storm was timed such that the peak RDI/I coincides with the peak dry flow, which is at 10:00 pm in this case. Figure 5-9 shows the design storm RDI/I pattern used in the model. This design storm RDI/I pattern was developed by modifying the design rainfall distribution shown in Figure 5-6 such that the peak RDI/I occurs at 10:00 pm.

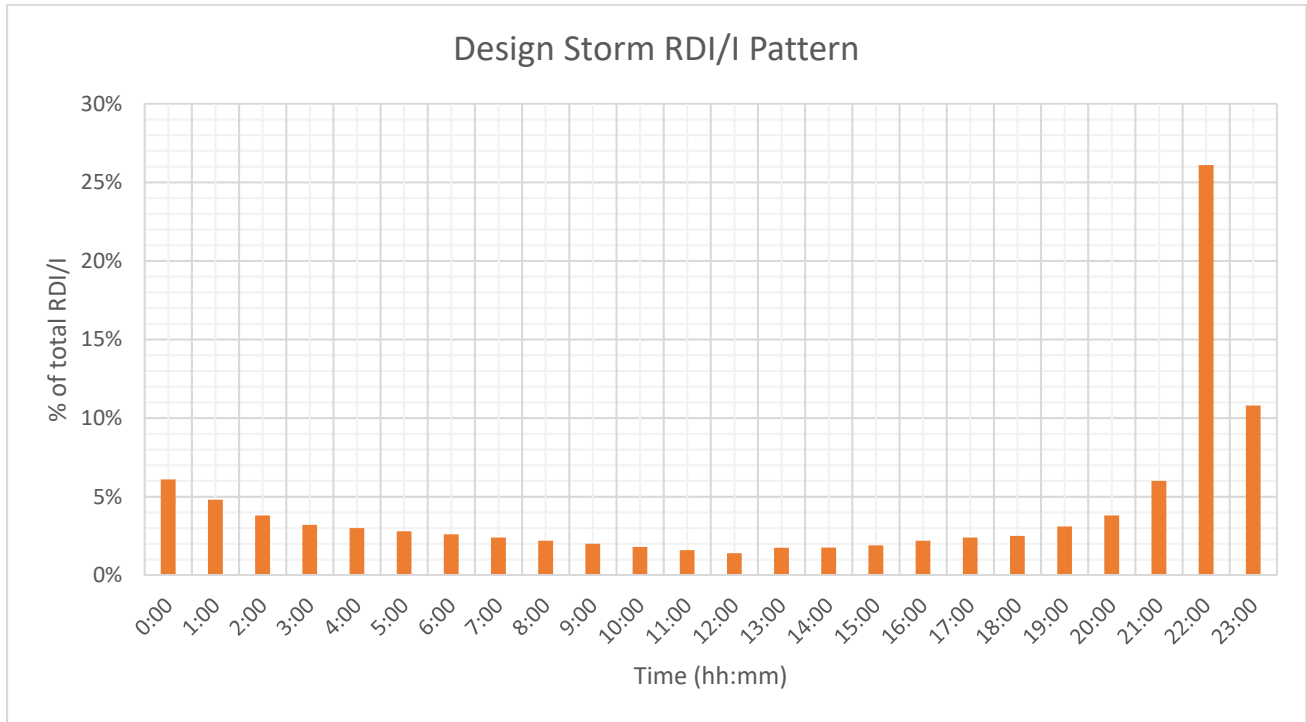


Figure 5-9. Design Storm RDI/I Pattern

6. Hydraulic Model Development

In support of the wastewater master plan, a wastewater collection system hydraulic model was developed to conduct a capacity analysis for the system. InfoSWMM 14.6 Update 2 was selected to build the hydraulic model for the City of El Monte. This platform combines a fully dynamic hydraulic modeling engine developed and approved by the Environmental Protection Agency (EPA) with the GIS integration that can take advantage of the data that the City has built into its sewer system GIS database.

6.1. Physical Data Input

The sewer system GIS database completed at the beginning of the Plan Update was utilized as the basis for the pipeline and manhole model infrastructure. All City owned wastewater facilities, excluding laterals and a few pump stations that serve individual lots, were combined into one completed model. This includes invert elevations, lengths, locations and diameters for approximately 130 miles of gravity mains and five active lift stations. Connections of the City sewer system to the County sewer lines were modeled as outfalls. For sewer assets that are missing hydraulic data, assumptions were made with additional research. Figure 6-1 illustrates the InfoSWMM model of the City’s wastewater collection system. Since design data were not available for all lift stations when preparing this master plan, lift stations missing design and operational data were modeled as “ideal pumps”, meaning inflows equal outflows. A peaking factor of 4 is applied to the base wastewater flows of the areas that were served by the “ideal pumps”. Table 6-1 lists the methods used to model the lift stations.

Table 6-1. Lift Station Model Methods

Lift Station	Serving Area	Lift Station in Model
Lambert	Lambert Park (Park Restrooms)	Point Load
Mountain View High School	Mountain View High School	Point Load
Flair	Surrounding Area	Homa Model AVX446-200/2.8 TV-VM Volts 208 2.8hp
Fine View	Surrounding Area	Homa submersible Pump Model AMX446-240/6.2N FM
Kings Row	Shield of Faith Christian School and the surrounding area	Ideal Pump
Tyler	Surrounding Area	Homa Model AMX446-220/6.2 TU/CFM
Lewis Home	3 connected developments	Ideal Pump

It is recommended that the model be updated with the missing data as it becomes available in the future

Three scenarios were created for the existing, near-term future, and long-term future time frames, and each scenario was analyzed under three flow conditions: Average Dry Weather Flow (ADWF), Peak Dry Weather Flow (PDWF), and Peak Wet Weather Flow (PWWF). These scenarios were loaded with the wastewater flow projections developed on a parcel-level basis as described in Section 5.

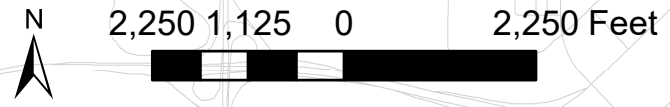
6.2. Flow Loading


Wastewater flows from the City were loaded to the model apportioned on a manhole-by-manhole basis. Each parcel was assigned to a tributary manhole in the collection system. The tributary manhole of a parcel would be the upstream manhole of the sewer main that its sewer lateral is connecting to. Sewer flows to each tributary manhole were summed and loaded in the model. It is worth noting that not all city parcels are served by the City’s sewer system as discussed in the previous chapter. Figure 6-1 illustrates the parcels that are served by the City’s sewer system.



Legend

- Modeled Lift Station
- Modeled Outfall
- Modeled Manhole
- Modeled Gravity Main
- Modeled Force Main
- City Parcels
- City of El Monte Boundary





City of El Monte
Wastewater Collection System Master Plan

**Modeled Sewer Facilities
in InfoSWMM**

Figure 6-1

7. Hydraulic Analysis and Results

7.1. Design Criteria

A hydraulic model is the primary tool for evaluating the capacity of the pipes in a sewer collection system. An effective hydraulic model represents collection system facilities and collection system flows for capacity analysis. This chapter describes the selection of system criteria, the development of collection system facilities, and the calculation of flows in the collection system model for the City.

In analyzing a wastewater system, it is necessary to derive standards regarding the amount of flow that may be efficiently conveyed by a given wastewater pipeline. In addition, reliable sewer service should be provided while minimizing excessive wear or energy usage through force mains and lift stations, *Technical Memorandum No. 3 – Draft Sewer System Design Criteria* was prepared to discuss the recommended design criteria in detail, which was reviewed and agreed upon by the City staff.

7.1.1. Pipeline Design Criteria

Sizing a new pipeline is based on the Manning's equation and the following design criteria shown in Table 7-1.

Table 7-1: Design Criteria for Pipelines

Gravity Main Requirement	Design Criteria
New Pipeline 12-inch or Smaller in diameter	Peak flow d/D shall not exceed 50%
New Pipeline greater than 12-inch in diameter	Peak flow d/D shall not exceed 75%
Manning's n	0.013
Force Main Requirement	Design Criteria
Maximum Allowable Velocity	10 feet per second
Maximum Allowable Headloss	10 feet per 1,000 feet of pipeline
Hazen-Williams C Factor	120

In evaluating the City's existing gravity mains, it is unnecessary to allow an excessive factor of safety as the City's sewer basin is largely built out, and future development patterns are relatively certain. Evaluation should be made on a case-by-case basis including estimated flow rates and impacts to the City's sewer facilities when new wastewater users apply for wastewater service. Existing City-owned sewer gravity mains may be flowing at levels above a d/D of 50% and still be operating satisfactorily. Remaining pipeline capacity, d/D above 75%, has been reserved to handle emergency flows and provide for ventilation within the pipe. To account for the City being mostly built-out and ensure that gravity mains are replaced due to capacity and flow constraints, the following replacement criteria were used:

- For existing gravity main 12-inch in diameter or smaller, maximum d/D under PWWF conditions shall not exceed 70%.
- For existing gravity main greater than 12-inch in diameter, maximum d/D under PWWF conditions shall not exceed 85%.

All pipelines requiring replacement shall be designed in accordance with the City's design criteria. If a gravity main requires upsizing but its immediately downstream pipeline is sufficient in capacity, this downstream pipeline may also be proposed for upsizing for continuity/consistency purposes, that is, to ensure that pipe-reaches increase in diameter as they progress downstream, and prevent, wherever possible, pipe-reaches from fluctuating up and down in diameters as well as to provide design flexibility in the future.

7.1.2. Lift Station Design Criteria

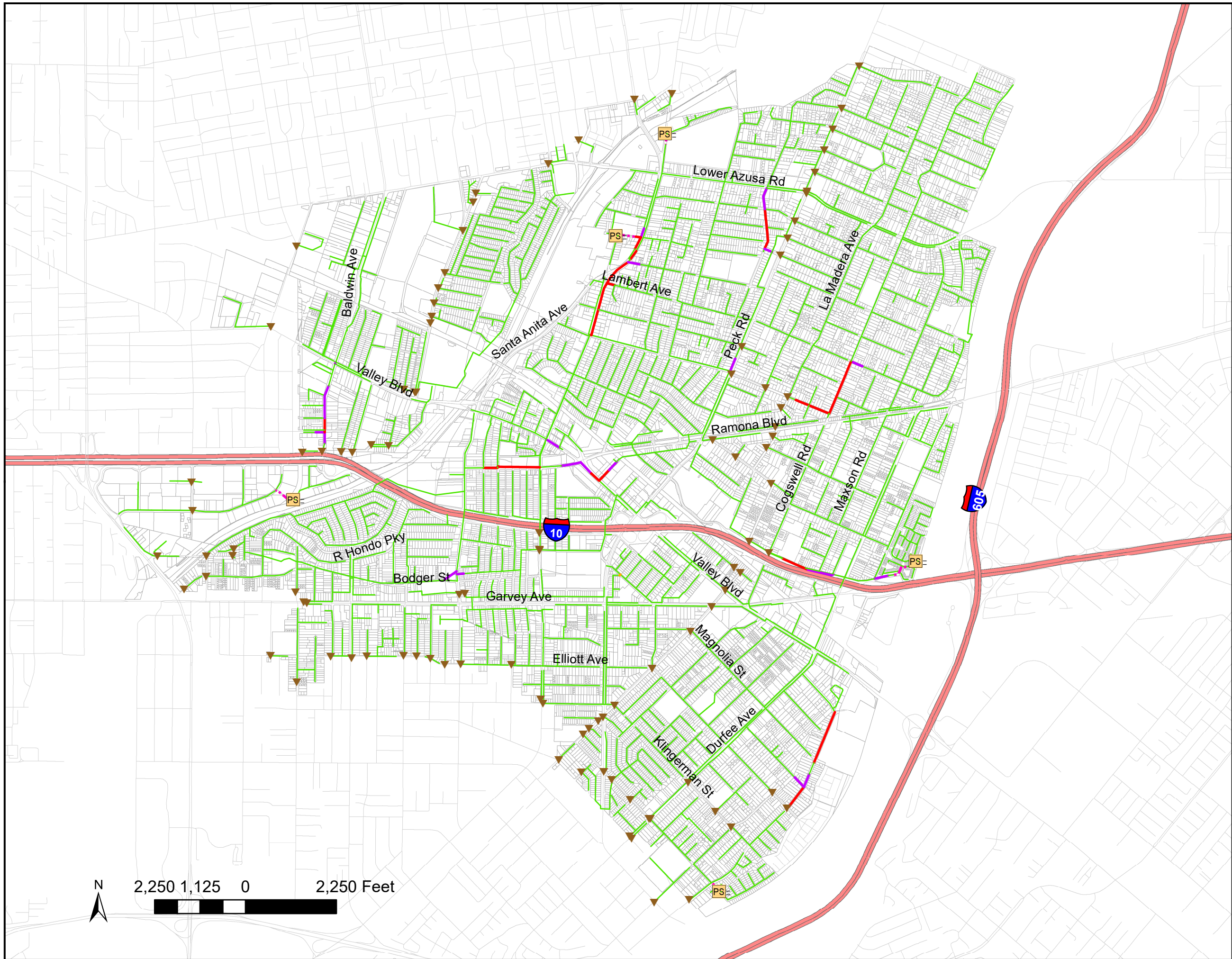
Since not all design and operation data of the City's active lift stations were available when preparing this master plan, evaluation of the City's lift stations is not included in this Plan Update. However, lift station design criteria is recommended herein to provide reference and support for future sewer utility impact studies:

- Lift stations should be sized for the PWWF plus an additional 20% capacity to account for wear, miscellaneous debris, etc. that may reduce pumping performance.
- With the largest capacity pump serving as standby, lift stations should be capable of meeting the following criteria:
 - Maintain the pump manufacturers recommended cycling times for pumping equipment.
 - All lift stations shall incorporate dual force mains beginning from pumps and ending at gravity flows
 - 60% pump efficiency should be assumed, except where other information is available.
 - 90% motor efficiency should be assumed, except where other information is available.
 - Wet well shall be sized to minimize retention time such that maximum pump cycling time (usually at $\frac{1}{2}$ design inflow) is within manufacturer's recommendations.
 - Separate from wet well operating volume, emergency storage volume shall be sufficient to accommodate storage of 6-hour pumping volume at average ultimate flow.

7.2. Results Summary

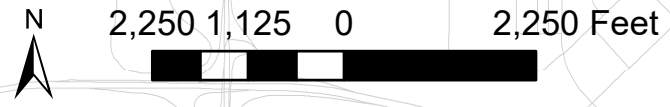
The hydraulic model was performed under 24-hour simulations with the combined flow components and diurnal curves. Capacity analysis of gravity mains is generally based on the depth of flow to the diameter of the pipe (d/D) under PWWF conditions. Model results for existing, near-term future, and long-term futures under PDWF and PWWF conditions were evaluated to identify the deficient pipelines for each time frame. Figure 7-1 illustrates the locations of the deficient pipelines by planning time frame. Some of the deficient pipelines were affected by their downstream deficient pipelines and will meet the replacement criteria once the downstream deficient pipelines are upsized.


Based on model results, approximately 3.7 miles of gravity main do not satisfy the replacement criteria from existing throughout 2035: 42 gravity main segments do not meet the replacement criteria under PWWF conditions for existing time frame; one additional gravity main segment does not meet the replacement criteria under PWWF conditions for near-term future; and 24 additional gravity main segments fail to meet the replacement criteria under PWWF conditions for long-term future. Table 7-2 lists the maximum flows and maximum d/D ratios of these deficient pipelines.



Legend

- PS- Modeled Lift Station
- Modeled Outfall
- Deficient under Existing PWWF
- Deficient under Near-term Future PWWF
- Deficient under Long-term Future PWWF
- Modeled Force Main
- Modeled Gravity Main
- City Parcels
- City of El Monte Boundary





City of El Monte
Wastewater Collection System Master Plan

Capacity Deficient Pipelines by Planning Period
Figure 7-1

Table 7-2. Model Results for Deficient Pipelines under PWWF Conditions

ID	Length	Existing Diameter	Slope (%)	Existing PWWF			Near-term Future PWWF			Long-term Future PWWF		
				Max. Flow (mgd)	Max. d/D	Flow Class	Max. Flow (mgd)	Max. d/D	Flow Class	Max. Flow	Max. d/D	Flow Class
GM-D5-046	313.4	8	0.147	0.361	1.000	Exceeds Capacity	0.361	1.000	Exceeds Capacity	0.357	1.000	Exceeds Capacity
GM-D5-070	162.1	8	0.45	0.642	1.000	Exceeds Capacity	0.641	1.000	Exceeds Capacity	0.648	1.000	Exceeds Capacity
GM-D5-071	182.5	8	0.433	0.638	1.000	Exceeds Capacity	0.638	1.000	Exceeds Capacity	0.648	1.000	Exceeds Capacity
GM-E5-001	249.6	8	0.589	0.635	1.000	Exceeds Capacity	0.635	1.000	Exceeds Capacity	0.654	1.000	Exceeds Capacity
GM-E5-011	152.1	10	0.197	0.679	1.000	Exceeds Capacity	0.677	1.000	Exceeds Capacity	0.683	1.000	Exceeds Capacity
GM-E5-012	152.9	8	0.589	0.621	1.000	Exceeds Capacity	0.622	1.000	Exceeds Capacity	0.651	1.000	Exceeds Capacity
GM-E5-022	188.6	10	0.201	0.680	1.000	Exceeds Capacity	0.680	1.000	Exceeds Capacity	0.680	1.000	Exceeds Capacity
GM-E5-046	349.5	10	0.197	0.682	1.000	Exceeds Capacity	0.683	1.000	Exceeds Capacity	0.679	1.000	Exceeds Capacity
GM-G4-049	544.6	8	0.053	0.557	1.000	Exceeds Capacity	0.552	1.000	Exceeds Capacity	0.540	1.000	Exceeds Capacity
GM-G5-038	482.0	8	0.156	0.298	1.000	Backwater	0.298	1.000	Backwater	0.316	1.000	Exceeds Capacity
GM-G5-039	379.0	8	0.156	0.309	1.000	Backwater	0.309	1.000	Backwater	0.313	1.000	Exceeds Capacity
GM-G5-042	264.0	8	0.106	0.304	0.998	Free Surface	0.304	0.995	Free Surface	0.304	1.000	Exceeds Capacity
GM-J7-019	325.0	8	0.2	0.360	0.908	Free Surface	0.372	0.964	Free Surface	0.443	1.000	Exceeds Capacity
GM-J7-018	350.0	8	0.2	0.350	0.846	Free Surface	0.362	0.919	Free Surface	0.431	1.000	Exceeds Capacity
GM-J7-016	346.0	8	0.199	0.344	0.815	Free Surface	0.356	0.860	Free Surface	0.428	1.000	Exceeds Capacity
GM-K6-028	335.6	8	0.396	0.465	0.763	Free Surface	0.476	0.782	Free Surface	0.576	1.000	Exceeds Capacity
GM-G4-067	350.0	8	0.231	0.612	0.911	Free Surface	0.627	0.919	Free Surface	0.674	0.985	Free Surface
GM-E5-050	329.5	10	0.2	0.720	0.982	Free Surface	0.719	0.982	Free Surface	0.705	0.975	Free Surface
GM-F7-036	270.8	12	0.281	1.181	0.834	Free Surface	1.185	0.836	Free Surface	1.297	0.961	Free Surface
GM-F7-051	269.1	12	0.279	1.176	0.792	Free Surface	1.180	0.795	Free Surface	1.293	0.943	Free Surface
GM-D5-065	257.0	8	0.393	0.265	0.762	Free Surface	0.265	0.762	Free Surface	0.305	0.935	Free Surface
GM-F7-054	203.5	12	0.28	1.171	0.789	Free Surface	1.174	0.791	Free Surface	1.291	0.921	Free Surface
GM-G5-043	364.0	8	0.299	0.297	0.804	Free Surface	0.296	0.803	Free Surface	0.319	0.921	Free Surface
GM-H6-038	331.7	8	0.238	0.369	0.785	Free Surface	0.369	0.785	Free Surface	0.411	0.903	Free Surface
GM-G4-070	518.5	8	0.984	0.550	0.882	Free Surface	0.547	0.885	Free Surface	0.531	0.902	Free Surface
GM-F7-030	238.5	12	0.281	1.168	0.785	Free Surface	1.171	0.787	Free Surface	1.291	0.901	Free Surface
GM-G2-005	23.3	10	0.215	0.554	0.798	Free Surface	0.566	0.811	Free Surface	0.642	0.897	Free Surface
GM-D5-042	236.0	8	0.364	0.104	0.664	Free Surface	0.104	0.663	Free Surface	0.235	0.892	Free Surface
GM-G2-001	31.1	10	0.193	0.554	0.783	Free Surface	0.566	0.796	Free Surface	0.642	0.890	Free Surface
GM-F7-023	338.1	12	0.278	1.123	0.771	Free Surface	1.127	0.774	Free Surface	1.246	0.870	Free Surface
GM-F7-016	325.0	12	0.277	1.117	0.758	Free Surface	1.120	0.760	Free Surface	1.240	0.844	Free Surface
GM-K6-037	290.0	8	0.393	0.473	0.741	Free Surface	0.484	0.757	Free Surface	0.584	0.838	Free Surface
GM-F7-004	291.3	12	0.278	1.109	0.754	Free Surface	1.113	0.756	Free Surface	1.231	0.838	Free Surface
GM-G2-009	296.3	10	0.226	0.546	0.730	Free Surface	0.559	0.743	Free Surface	0.634	0.830	Free Surface
GM-K6-023	329.6	8	0.234	0.035	0.352	Free Surface	0.035	0.359	Free Surface	0.064	0.829	Free Surface
GM-K7-002	330.7	8	0.203	0.365	0.751	Free Surface	0.376	0.768	Free Surface	0.448	0.820	Free Surface
GM-E5-065	324.5	10	0.197	0.723	0.861	Free Surface	0.723	0.862	Free Surface	0.707	0.814	Free Surface

Table 7-2. Model Results for Deficient Pipelines under PWWF Conditions

ID	Length	Existing Diameter	Slope (%)	Existing PWWF			Near-term Future PWWF			Long-term Future PWWF		
				Max. Flow (mgd)	Max. d/D	Flow Class	Max. Flow (mgd)	Max. d/D	Flow Class	Max. Flow	Max. d/D	Flow Class
GM-G5-040	269.3	8	0.171	0.288	0.691	Free Surface	0.288	0.691	Free Surface	0.317	0.795	Free Surface
GM-D6-045	340.6	8	0.238	0.336	0.739	Free Surface	0.336	0.739	Free Surface	0.367	0.795	Free Surface
GM-K6-018	339.4	8	1.108	0.420	0.578	Free Surface	0.431	0.589	Free Surface	0.532	0.793	Free Surface
GM-F6-052	353.1	12	0.28	1.199	0.728	Free Surface	1.203	0.729	Free Surface	1.318	0.789	Free Surface
GM-E5-013	194.9	8	0.251	0.065	0.826	Free Surface	0.065	0.826	Free Surface	0.071	0.785	Free Surface
GM-H6-029	350.0	8	0.237	0.373	0.727	Free Surface	0.373	0.727	Free Surface	0.413	0.782	Free Surface
GM-H4-058	170.4	12	0.235	0.149	0.574	Free Surface	0.150	0.634	Free Surface	0.161	0.773	Free Surface
GM-D6-050	210.8	8	0.237	0.338	0.718	Free Surface	0.338	0.718	Free Surface	0.369	0.772	Free Surface
GM-D5-072	283.7	8	0.388	0.026	0.589	Free Surface	0.026	0.587	Free Surface	0.058	0.771	Free Surface
GM-D6-034	208.7	8	0.244	0.324	0.716	Free Surface	0.324	0.716	Free Surface	0.354	0.771	Free Surface
GM-H7-090	318.2	8	0.346	0.365	0.683	Free Surface	0.365	0.683	Free Surface	0.408	0.762	Free Surface
GM-D6-021	245.2	8	0.237	0.322	0.705	Free Surface	0.322	0.705	Free Surface	0.351	0.757	Free Surface
GM-H7-070	350.0	8	0.24	0.282	0.695	Free Surface	0.282	0.695	Free Surface	0.317	0.753	Free Surface
GM-F2-028	243.9	10	0.201	0.505	0.667	Free Surface	0.517	0.678	Free Surface	0.589	0.748	Free Surface
GM-H5-042	27.7	8	0.216	0.245	0.627	Free Surface	0.302	0.721	Free Surface	0.318	0.747	Free Surface
GM-F2-032	310.7	10	0.238	0.527	0.657	Free Surface	0.539	0.668	Free Surface	0.613	0.740	Free Surface
GM-D6-014	318.4	8	0.242	0.304	0.690	Free Surface	0.304	0.690	Free Surface	0.332	0.739	Free Surface
GM-H7-064	45.5	8	0.242	0.358	0.667	Free Surface	0.358	0.667	Free Surface	0.400	0.737	Free Surface
GM-F7-005	304.9	10	0.2	0.452	0.661	Free Surface	0.456	0.664	Free Surface	0.502	0.733	Free Surface
GM-G2-004	224.0	8	0.201	0.012	0.667	Free Surface	0.013	0.675	Free Surface	0.015	0.727	Free Surface
GM-G2-013	276.7	10	0.199	0.565	0.649	Free Surface	0.577	0.658	Free Surface	0.655	0.719	Free Surface
GM-F3-038	257.1	10	0.241	0.471	0.641	Free Surface	0.483	0.652	Free Surface	0.550	0.718	Free Surface
GM-D6-003	214.3	8	0.238	0.300	0.670	Free Surface	0.300	0.670	Free Surface	0.327	0.716	Free Surface
GM-F3-029	49.8	8	0.341	0.407	0.642	Free Surface	0.419	0.654	Free Surface	0.481	0.713	Free Surface
GM-E5-069	44.1	10	0.272	0.953	0.766	Free Surface	0.953	0.766	Free Surface	0.848	0.712	Free Surface
GM-F6-012	331.1	8	2.961	0.434	0.695	Free Surface	0.434	0.695	Free Surface	0.463	0.703	Free Surface
GM-G4-011	383.0	8	0.222	0.043	0.614	Free Surface	0.054	0.630	Free Surface	0.125	0.701	Free Surface
GM-H4-055	390.2	12	0.297	0.403	0.526	Free Surface	0.471	0.574	Free Surface	0.656	0.701	Free Surface
GM-H7-062	283.6	8	0.314	0.361	0.646	Free Surface	0.361	0.646	Free Surface	0.404	0.701	Free Surface
GM-D6-060	200.0	8	0.26	0.341	0.658	Free Surface	0.341	0.658	Free Surface	0.372	0.700	Free Surface

8. Recommended Capital Improvement Projects (CIP)

8.1. Summary

Results of the hydraulic analysis presented in Chapter 7 were utilized to develop a phased and prioritized hydraulic capacity based Capital Improvement Program (CIP). There are two main elements of the CIP: analysis and cost estimation. The analysis phase consists of evaluating the wastewater collections system at different time frames and under various operational scenarios. Construction costs were estimated for the proposed facilities in terms of dollar value in 2017. The cost estimates are provided for planning purposes and represent “Class 4 for Studies or Feasibility Report” Level costs as established by the American Association of Cost Engineers (AACE), with an accuracy of +50% to -30%.

8.2. Unit Costs

Unit costs used to develop capital cost estimates for proposed facilities were developed using the Engineering News Record Construction Cost Index (ENR-CCI) and recent bid results for projects of a similar nature. These estimates are based on the best available data at the time of this report; however, since prices of materials and labor fluctuate with time, new estimates should be obtained during the preliminary design of proposed facilities to confirm budget amounts. Recent market trends have indicated substantial volatility in the price of construction materials such as steel and concrete. These factors, coupled with the high level of similar work currently being performed, have on occasion resulted in a generally unpredictable bidding environment.

The Engineering News Record Construction Cost Index for the Los Angeles, California area (ENR-CCI-LA) was 11,935.8 of December 2017. Table 8-1 listed the updated unit construction costs for the wastewater pipeline improvements by size.

Table 8-1: Gravity Main Unit Costs

Diameter (in.)	Construction Unit Cost (\$/LF)
10	179
12	189
15	203
18	219

Baseline construction costs for the proposed sewer improvements were calculated directly using the unit costs listed in Table 8-1. A 30% construction contingency was applied to the baseline construction cost to account for unknown site conditions and other unforeseen events. Adding to the baseline construction cost results in the Estimated Construction Costs for the proposed sewer pipeline improvements.

Engineering, construction phase professional, and administration services contingencies were included as a percentage of the Estimated Construction Cost. A 10% contingency was applied to the Estimated Construction Cost to account for the costs associated with engineering services such as planning and design reports, Right of Way (ROW) acquisition, design, permits, surveying, geotechnical investigation, etc. Another 10% contingency was applied to the Estimated Construction Costs to account for the costs associated with construction phase professional services such as construction management, materials testing, inspection, engineering services (submittal reviews, as-built), etc. A 7.5% contingency was applied to the Estimated Construction Cost to account for costs associated with the project administration services such as legal fees, CEQA compliance/Environmental Approval Process, financing expenses, administrative costs, etc.

8.3. Proposed Wastewater Collection System Improvements and Cost Estimates

Proposed wastewater pipeline improvements were prioritized with phases and were assigned with project numbers, as shown in Figure 8-1. The pipeline improvements were separated into 13 projects, comprising approximately 4.1% of the City's total gravity mains. Figures 8-1A to 8-1J show the individual pipeline improvement projects in detail. A majority of the pipeline improvements are upsizing existing gravity mains to provide sufficient capacity for future growth. Two alternatives were proposed with Project 9, that is, either Project 9 plus Project 9a or Project 9 plus Project 9b, as shown in Figure 8-1. Project 9a includes one new pipeline added near the Amador Street and Santa Anita Avenue to divert flows from the existing 15-inch lines westerly into sewers in Brockway Street and upsizing the existing gravity mains in Brockway St. Project 9b includes upsizing gravity mains in Santa Anita Avenue and gravity mains downstream flowing northwesterly to the county line. Since Project 9b requires longer pipeline improvements, situates in busier streets, and is within more easements, it is not recommended as the primary alternative. The primary alternative for Project 9 is Project 9 plus Project 9a, and is used to estimate the costs.

Project 1 to Project 7 are recommended for the existing phase (to meet existing PWWF), Project 8 is recommended for the near-term future phase, and Project 9 to Project 13 are recommended for the long-term future phase. Table 8-2 presents the improvement projects and their associated cost estimates. Cost estimates provided herein are in planning level and should be verified and updated during the preliminary design phase of each project

Table 8-2: Proposed Pipeline Improvements and Cost Estimates

ID	Exist. Diameter (in.)	Proposed Diameter (in.)	Length (ft)	CIP Project	Phase	Unit Construction Cost (\$/LF)	Baseline Construction Cost (\$)	Construction Contingency [30%] (\$)	Estimated Construction Cost (\$)	Engineering Cost [10%] (\$)	Construction Management [10%] (\$)	Project Administration [7.5%] (\$)	Capital Improvement Cost (\$)
GM-E5-001	8	12	249.6	1	Existing	189	47,178	14,153	61,332	6,133	6,133	4,600	78,198
GM-E5-012	8	12	152.9	1	Existing	189	28,902	8,671	37,572	3,757	3,757	2,818	47,905
GM-E5-011	10	15	152.1	1	Existing	203	30,883	9,265	40,148	4,015	4,015	3,011	51,189
GM-E5-022	10	15	188.6	1	Existing	203	38,286	11,486	49,772	4,977	4,977	3,733	63,459
GM-E5-046	10	15	349.5	1	Existing	203	70,940	21,282	92,223	9,222	9,222	6,917	117,584
GM-E5-050	10	15	329.5	1	Existing	203	66,884	20,065	86,949	8,695	8,695	6,521	110,860
GM-E5-069	10	15	44.1	1	Existing	203	8,949	2,685	11,634	1,163	1,163	873	14,833
GM-E5-065	10	15	324.5	1	Existing	203	65,876	19,763	85,638	8,564	8,564	6,423	109,189
GM-D5-071	8	12	182.5	1	Existing	189	34,502	10,351	44,852	4,485	4,485	3,364	57,187
GM-D5-070	8	12	162.1	1	Existing	189	30,640	9,192	39,832	3,983	3,983	2,987	50,785
GM-D5-063	10	12	83.3	1	Existing	189	15,741	4,722	20,463	2,046	2,046	1,535	26,090
GM-D5-046	8	12	313.4	1	Existing	189	59,229	17,769	76,998	7,700	7,700	5,775	98,172
GM-D5-058	8	12	286.1	1	Existing	189	54,078	16,224	70,302	7,030	7,030	5,273	89,635
GM-D5-064	8	12	43.6	1	Existing	189	8,235	2,470	10,705	1,071	1,071	803	13,649
Project 1 Subtotal												\$ 928,733	
GM-G2-001	10	15	31.1	2	Existing	203	6,322	1,897	8,219	822	822	616	10,479
GM-G2-009	10	15	296.3	2	Existing	203	60,156	18,047	78,203	7,820	7,820	5,865	99,709
GM-F2-028	10	15	243.9	2	Existing	203	49,519	14,856	64,375	6,438	6,438	4,828	82,079
GM-F2-032	10	15	310.7	2	Existing	203	63,072	18,922	81,994	8,199	8,199	6,150	104,542
GM-G2-013	10	15	276.7	2	Existing	203	56,179	16,854	73,033	7,303	7,303	5,477	93,117
GM-G2-005	10	15	23.3	2	Existing	203	4,721	1,416	6,137	614	614	460	7,825
GM-G2-024	10	15	208.0	2	Existing	203	42,229	12,669	54,897	5,490	5,490	4,117	69,994
Project 2 Subtotal												\$ 467,744	
GM-G5-038	8	15	482.0	3	Existing	203	97,846	29,354	127,200	12,720	12,720	9,540	162,180
GM-G5-039	8	15	379.0	3	Existing	203	76,937	23,081	100,018	10,002	10,002	7,501	127,523
GM-G4-073	8	15	6.7	3	Existing	203	1,363	409	1,772	177	177	133	2,260
GM-G4-063	8	15	531.9	3	Existing	203	107,980	32,394	140,374	14,037	14,037	10,528	178,977



Table 8-2: Proposed Pipeline Improvements and Cost Estimates

ID	Exist. Diameter (in.)	Proposed Diameter (in.)	Length (ft)	CIP Project	Phase	Unit Construction Cost (\$/LF)	Baseline Construction Cost (\$)	Construction Contingency [30%] (\$)	Estimated Construction Cost (\$)	Engineering Cost [10%] (\$)	Construction Management [10%] (\$)	Project Administration [7.5%] (\$)	Capital Improvement Cost (\$)
GM-G4-067	8	15	350.0	3	Existing	203	71,050	21,315	92,365	9,237	9,237	6,927	117,765
GM-G4-070	8	15	518.5	3	Existing	203	105,256	31,577	136,832	13,683	13,683	10,262	174,461
GM-G4-049	8	15	544.6	3	Existing	203	110,548	33,164	143,712	14,371	14,371	10,778	183,233
GM-G4-046	10	15	26.0	3	Existing	203	5,278	1,583	6,861	686	686	515	8,748
GM-G5-042	8	15	264.0	3	Existing	203	53,599	16,080	69,679	6,968	6,968	5,226	88,841
GM-G5-043	8	15	364.0	3	Existing	203	73,892	22,168	96,060	9,606	9,606	7,204	122,476
GM-G5-040	8	15	269.3	3	Existing	203	54,665	16,399	71,064	7,106	7,106	5,330	90,607
Project 3 Subtotal												\$ 1,257,072	
GM-F7-036	12	15	270.8	4	Existing	203	54,963	16,489	71,451	7,145	7,145	5,359	91,100
GM-F6-045	12	15	193.0	4	Existing	203	39,170	11,751	50,921	5,092	5,092	3,819	64,924
GM-F6-052	12	15	353.1	4	Existing	203	71,669	21,501	93,170	9,317	9,317	6,988	118,792
GM-F7-004	12	15	291.3	4	Existing	203	59,126	17,738	76,864	7,686	7,686	5,765	98,002
GM-F7-016	12	15	325.0	4	Existing	203	65,975	19,792	85,767	8,577	8,577	6,433	109,354
GM-F7-054	12	15	203.5	4	Existing	203	41,313	12,394	53,707	5,371	5,371	4,028	68,476
GM-F7-030	12	15	238.5	4	Existing	203	48,424	14,527	62,951	6,295	6,295	4,721	80,262
GM-F7-023	12	15	338.1	4	Existing	203	68,626	20,588	89,214	8,921	8,921	6,691	113,748
GM-F7-051	12	15	269.1	4	Existing	203	54,629	16,389	71,018	7,102	7,102	5,326	90,548
Project 4 Subtotal												\$ 835,206	
GM-H6-029	8	12	350.0	5	Existing	189	66,150	19,845	85,995	8,600	8,600	6,450	109,644
GM-H6-038	8	12	331.7	5	Existing	189	62,701	18,810	81,511	8,151	8,151	6,113	103,926
GM-H7-090	8	12	318.2	5	Existing	189	60,149	18,045	78,194	7,819	7,819	5,865	99,697
GM-H6-020	8	12	30.0	5	Existing	189	5,676	1,703	7,379	738	738	553	9,408
GM-H6-027	8	12	320.0	5	Existing	189	60,480	18,144	78,624	7,862	7,862	5,897	100,246
Project 5 Subtotal												\$ 422,921	
GM-K7-002	8	12	330.7	6	Existing	189	62,502	18,751	81,253	8,125	8,125	6,094	103,598
GM-J7-019	8	12	325.0	6	Existing	189	61,425	18,427	79,852	7,985	7,985	5,989	101,812
GM-J7-018	8	12	350.0	6	Existing	189	66,150	19,845	85,995	8,599	8,599	6,450	109,644
GM-J7-016	8	12	346.0	6	Existing	189	65,394	19,618	85,012	8,501	8,501	6,376	108,391



Table 8-2: Proposed Pipeline Improvements and Cost Estimates

ID	Exist. Diameter (in.)	Proposed Diameter (in)	Length (ft)	CIP Project	Phase	Unit Construction Cost (\$/LF)	Baseline Construction Cost (\$)	Construction Contingency [30%] (\$)	Estimated Construction Cost (\$)	Engineering Cost [10%] (\$)	Construction Management [10%] (\$)	Project Administration [7.5%] (\$)	Capital Improvement Cost (\$)
GM-K6-037	8	12	290.0	6	Existing	189	54,810	16,443	71,253	7,125	7,125	5,344	90,848
GM-K6-041	8	12	29.9	6	Existing	189	5,658	1,697	7,356	736	736	552	9,378
GM-K6-028	8	12	335.6	6	Existing	189	63,434	19,030	82,464	8,246	8,246	6,185	105,142
GM-K6-018	8	12	339.4	6	Existing	189	64,141	19,242	83,383	8,338	8,338	6,254	106,314
GM-K6-043	8	12	309.6	6	Existing	189	58,508	17,552	76,060	7,606	7,606	5,705	96,977
Project 6 Subtotal												\$ 832,102	
GM-D6-003	8	10	214.3	7	Existing	179	38,364	11,509	49,873	4,987	4,987	3,740	63,588
GM-D6-014	8	10	318.4	7	Existing	179	56,998	17,099	74,097	7,410	7,410	5,557	94,474
GM-D6-034	8	12	208.7	7	Existing	189	39,439	11,832	51,271	5,127	5,127	3,845	65,371
GM-D6-021	8	12	245.2	7	Existing	189	46,342	13,903	60,245	6,024	6,024	4,518	76,812
GM-D6-045	8	12	340.6	7	Existing	189	64,367	19,310	83,677	8,368	8,368	6,276	106,688
GM-D6-050	8	12	210.8	7	Existing	189	39,845	11,953	51,798	5,180	5,180	3,885	66,043
GM-D6-060	8	12	200.0	7	Existing	189	37,800	11,340	49,140	4,914	4,914	3,685	62,653
Project 7 Subtotal												\$ 535,629	
EXISTING PHASE SUBTOTAL												\$ 5,279,408	
GM-H5-057	8	12	195.6	8	Near-term	189	36,973	11,092	48,065	4,806	4,806	3,605	61,282
GM-H5-049	8	12	342.0	8	Near-term	189	64,634	19,390	84,024	8,402	8,402	6,302	107,130
GM-H5-040	8	12	162.7	8	Near-term	189	30,751	9,225	39,976	3,998	3,998	2,998	50,970
GM-H5-042	8	12	27.7	8	Near-term	189	5,242	1,573	6,815	681	681	511	8,689
Project 8 Subtotal												\$ 228,071	
NEAR-TERM FUTURE PHASE SUBTOTAL												\$ 228,071	
GM-G4-039	15	18	410.1	9	Long-term	219	89,802	26,941	116,743	11,674	11,674	8,756	148,847
GM-G4-072	15	18	168.3	9	Long-term	219	36,863	11,059	47,922	4,792	4,792	3,594	61,100
GM-H2-009	8	15	209.0	9a	Long-term	203	42,418	12,725	55,143	5,514	5,514	4,136	70,308
GM-G3-001	12	18	334.9	9a	Long-term	219	73,350	22,005	95,355	9,536	9,536	7,152	121,578
GM-G3-051	8	18	327.6	9a	Long-term	219	71,753	21,526	93,278	9,328	9,328	6,996	118,930
GM-G3-057	8	18	242.4	9a	Long-term	219	53,095	15,928	69,023	6,902	6,902	5,177	88,004
GM-G3-052	8	18	300.0	9a	Long-term	219	65,700	19,710	85,410	8,541	8,541	6,406	108,898

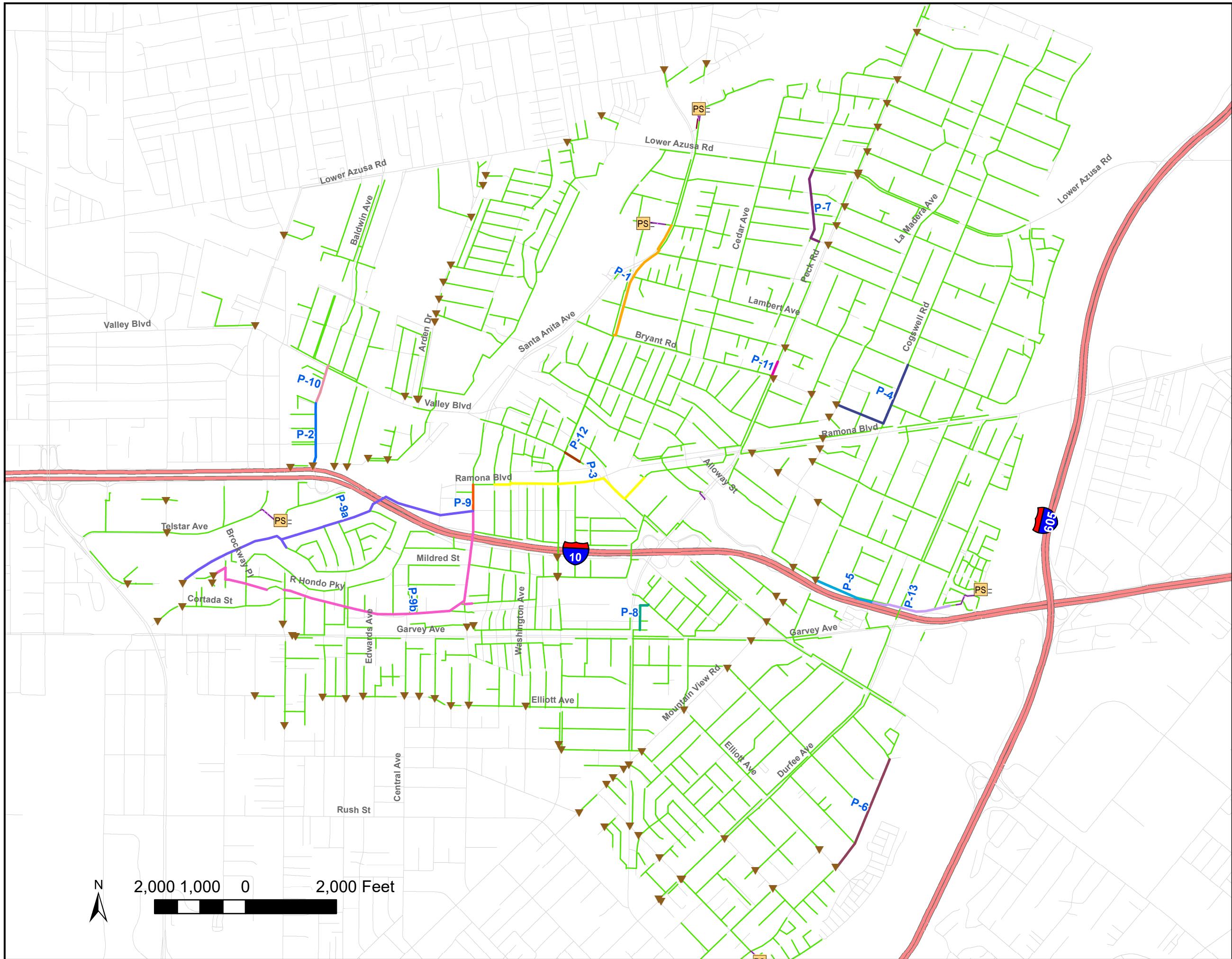


Table 8-2: Proposed Pipeline Improvements and Cost Estimates

ID	Exist. Diameter (in.)	Proposed Diameter (in)	Length (ft)	CIP Project	Phase	Unit Construction Cost (\$/LF)	Baseline Construction Cost (\$)	Construction Contingency [30%] (\$)	Estimated Construction Cost (\$)	Engineering Cost [10%] (\$)	Construction Management [10%] (\$)	Project Administration [7.5%] (\$)	Capital Improvement Cost (\$)
GM-G3-058	8	18	168.1	9a	Long-term	219	36,803	11,041	47,844	4,784	4,784	3,588	61,001
GM-G3-023	12	18	365.6	9a	Long-term	219	80,066	24,020	104,086	10,409	10,409	7,806	132,710
GM-G3-013	12	18	365.2	9a	Long-term	219	79,988	23,996	103,984	10,398	10,398	7,799	132,579
GM-H2-005	12	18	123.4	9a	Long-term	219	27,017	8,105	35,122	3,512	3,512	2,634	44,781
GM-H2-004	12	18	191.0	9a	Long-term	219	41,829	12,549	54,378	5,438	5,438	4,078	69,332
GM-H2-007	12	18	324.9	9a	Long-term	219	71,160	21,348	92,508	9,251	9,251	6,938	117,947
GM-H2-014	12	18	131.7	9a	Long-term	219	28,850	8,655	37,505	3,751	3,751	2,813	47,819
GM-H2-016	12	18	218.9	9a	Long-term	219	47,931	14,379	62,310	6,231	6,231	4,673	79,446
GM-H2-003	12	18	301.3	9a	Long-term	219	65,985	19,795	85,780	8,578	8,578	6,434	109,370
GM-H2-008	12	18	347.1	9a	Long-term	219	76,008	22,803	98,811	9,881	9,881	7,411	125,984
GM-H2-006	12	18	332.1	9a	Long-term	219	72,721	21,816	94,537	9,454	9,454	7,090	120,535
GM-H2-013	12	18	355.2	9a	Long-term	219	77,778	23,333	101,111	10,111	10,111	7,583	128,917
GM-H2-027	12	18	349.8	9a	Long-term	219	76,614	22,984	99,599	9,960	9,960	7,470	126,988
GM-H2-022	12	18	348.3	9a	Long-term	219	76,289	22,887	99,175	9,918	9,918	7,438	126,448
GM-H2-033	12	18	108.6	9a	Long-term	219	23,785	7,135	30,920	3,092	3,092	2,319	39,423
IEC-GM61	12	18	324.3	9a	Long-term	219	71,018	21,305	92,323	9,232	9,232	6,924	117,712
IEC-GM58405048	-	18	1449.4	9a	Long-term	219	317,421	95,226	412,647	41,265	41,265	30,949	526,125
Project 9 Subtotal												\$ 2,824,783	
GM-F3-029	8	12	49.8	10	Long-term	189	9,414	2,824	12,238	1,224	1,224	918	15,603
GM-F3-055	10	12	104.7	10	Long-term	189	19,783	5,935	25,718	2,572	2,572	1,929	32,791
GM-F3-045	10	12	163.9	10	Long-term	189	30,985	9,296	40,281	4,028	4,028	3,021	51,358
GM-F3-038	10	15	257.1	10	Long-term	203	52,192	15,658	67,850	6,785	6,785	5,089	86,509
GM-F3-034	10	15	300.4	10	Long-term	203	60,985	18,295	79,280	7,928	7,928	5,946	101,082
Project 10 Subtotal												\$ 287,343	
GM-F6-012	8	12	331.1	11	Long-term	189	62,572	18,772	81,344	8,134	8,134	6,101	103,713
Project 11 Subtotal												\$ 103,713	
GM-G4-011	8	12	383.0	12	Long-term	189	72,378	21,713	94,091	9,409	9,409	7,057	119,966
Project 12 Subtotal												\$ 119,966	

Table 8-2: Proposed Pipeline Improvements and Cost Estimates

ID	Exist. Diameter (in.)	Proposed Diameter (in.)	Length (ft)	CIP Project	Phase	Unit Construction Cost (\$/LF)	Baseline Construction Cost (\$)	Construction Contingency [30%] (\$)	Estimated Construction Cost (\$)	Engineering Cost [10%] (\$)	Construction Management [10%] (\$)	Project Administration [7.5%] (\$)	Capital Improvement Cost (\$)
GM-H7-066	8	12	292.2	13	Long-term	189	55,224	16,567	71,791	7,179	7,179	5,384	91,533
GM-H7-064	8	12	45.5	13	Long-term	189	8,599	2,580	11,179	1,118	1,118	838	14,253
GM-H7-070	8	12	350.0	13	Long-term	189	66,150	19,845	85,995	8,599	8,599	6,450	109,644
GM-H7-068	8	12	199.8	13	Long-term	189	37,763	11,329	49,092	4,909	4,909	3,682	62,593
GM-H7-079	8	12	204.3	13	Long-term	189	38,607	11,582	50,189	5,019	5,019	3,764	63,991
GM-H7-067	8	12	347.9	13	Long-term	189	65,755	19,726	85,481	8,548	8,548	6,411	108,989
GM-H7-062	8	12	283.6	13	Long-term	189	53,602	16,081	69,683	6,968	6,968	5,226	88,845
Project 13 Subtotal												\$ 539,848	
LONG-TERM FUTURE PHASE SUBTOTAL												\$ 3,875,652	
TOTAL IMPROVEMENT COSTS												\$ 9,383,132	



Legend

- PS Modeled Lift Station
- ▼ Modeled Outfall
- City Gravity Mains
- Sewer Pressurized Main

Proposed CIP Project

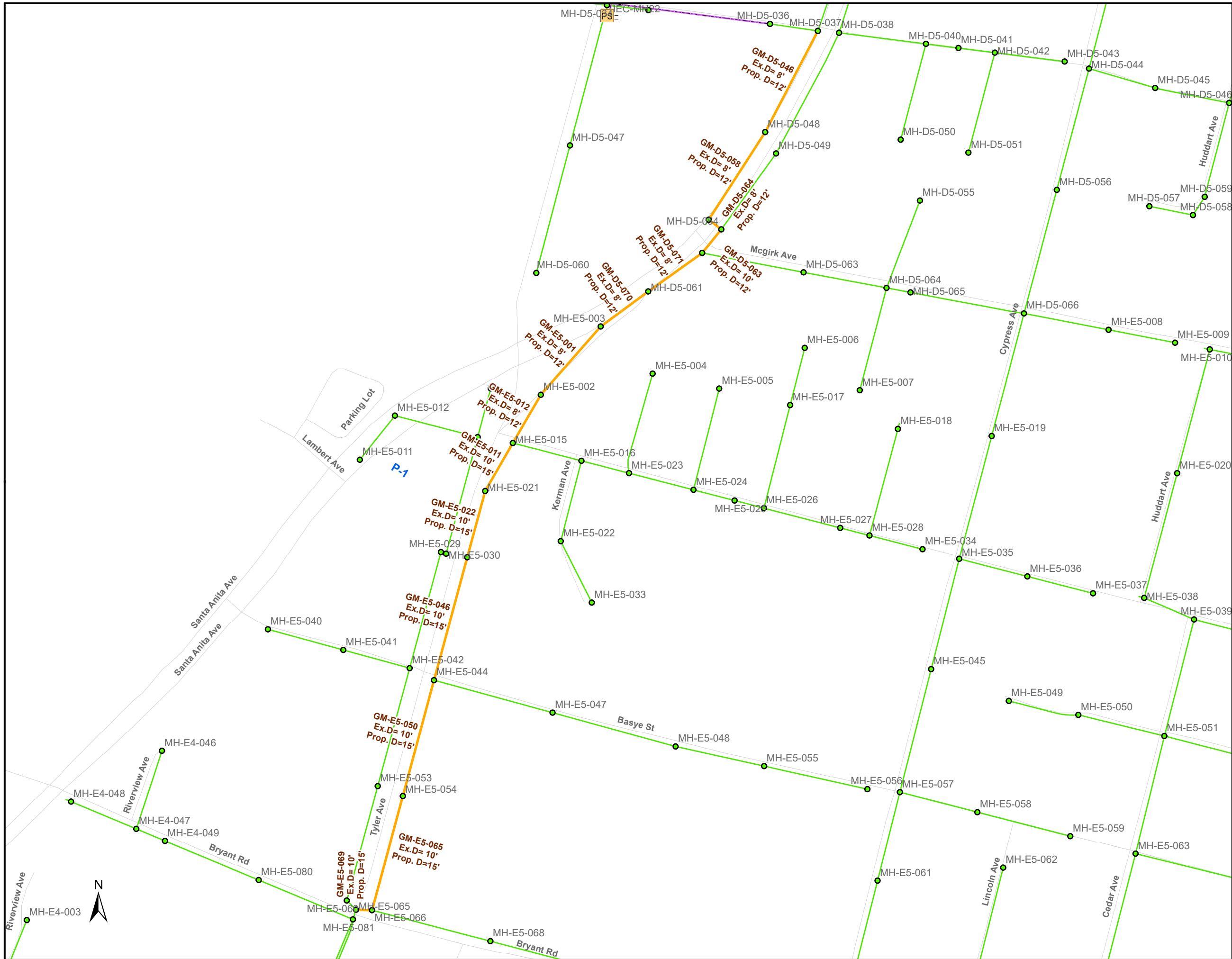
- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 9a
- 9b
- 10
- 11
- 12
- 13



City of El Monte
Sewer Master Plan

Proposed CIP Projects

Figure 8-1




Legend

- PS Modeled Lift Station
- ▼ Modeled Outfall
- City Gravity Mains
- Modeled Manhole
- Sewer Force Main

Proposed CIP Project

- 1







City of El Monte
Wastewater Collection System Master Plan



**Proposed CIP Projects
Detail Map
Figure 8-1A**



Legend

-  Modeled Outfall
-  City Gravity Mains
-  Modeled Manhole
-  Sewer Force Main

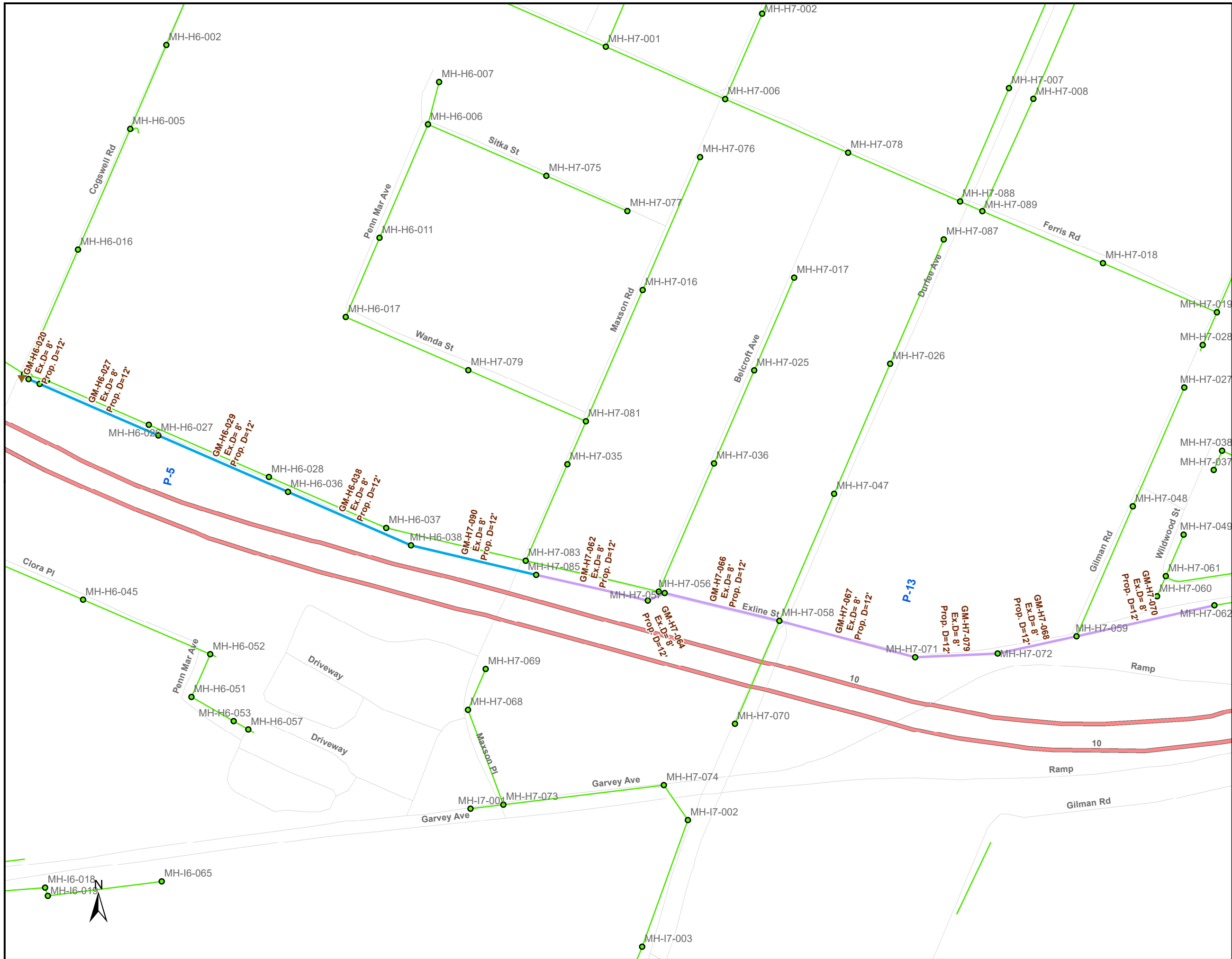
Proposed CIP Project

-  4
-  11







City of El Monte
Wastewater Collection System Master Plan



**Proposed CIP Projects
Detail Map
Figure 8-1D**



Legend

-  Modeled Outfall
-  City Gravity Mains
-  Modeled Manhole
-  Sewer Force Main

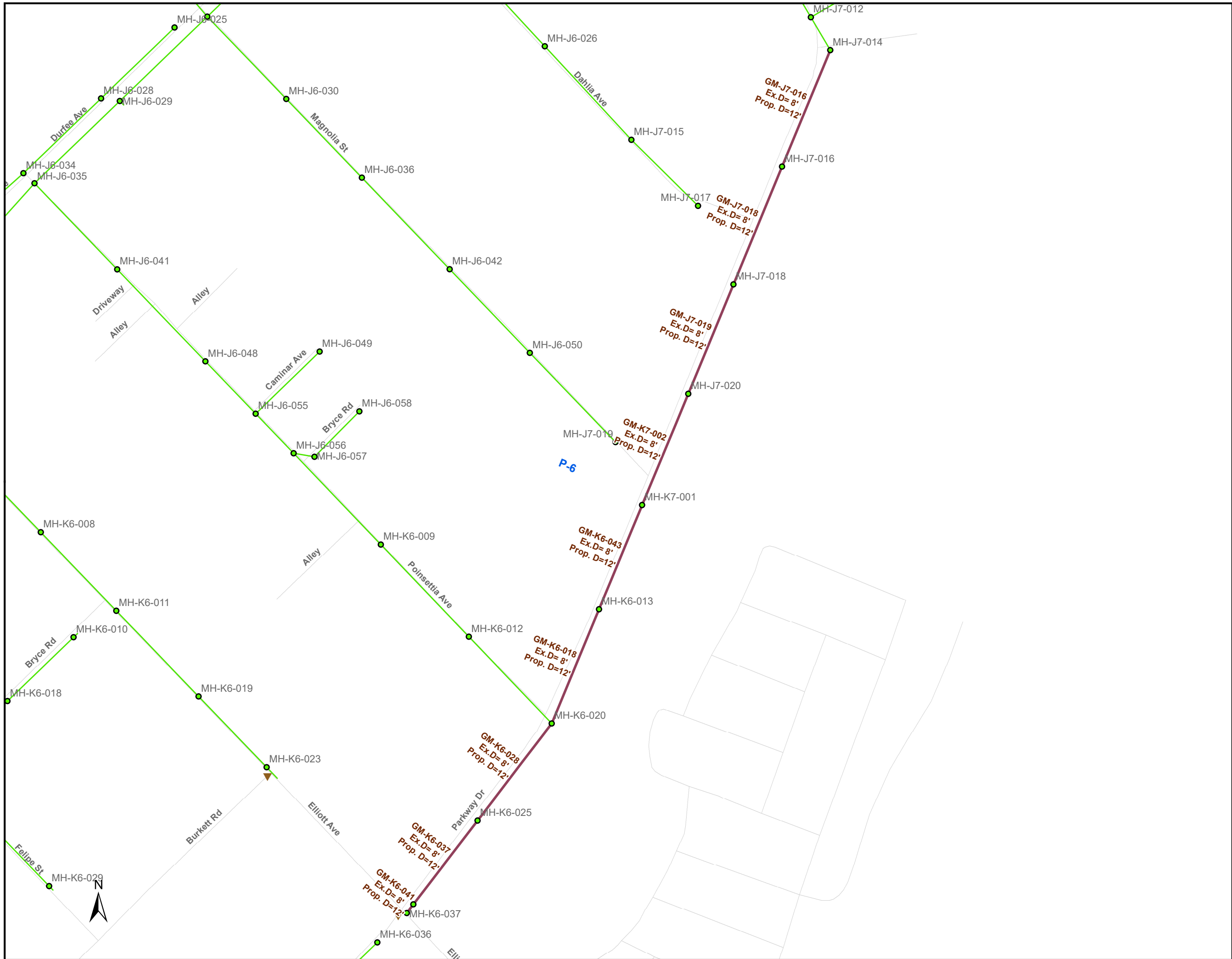
Proposed CIP Project

-  5
-  13







City of El Monte
Wastewater Collection System Master Plan


Proposed CIP Projects Detail Map Figure 8-1E



Legend

-  Modeled Outfall
-  City Gravity Mains
-  Modeled Manhole
-  Sewer Force Main

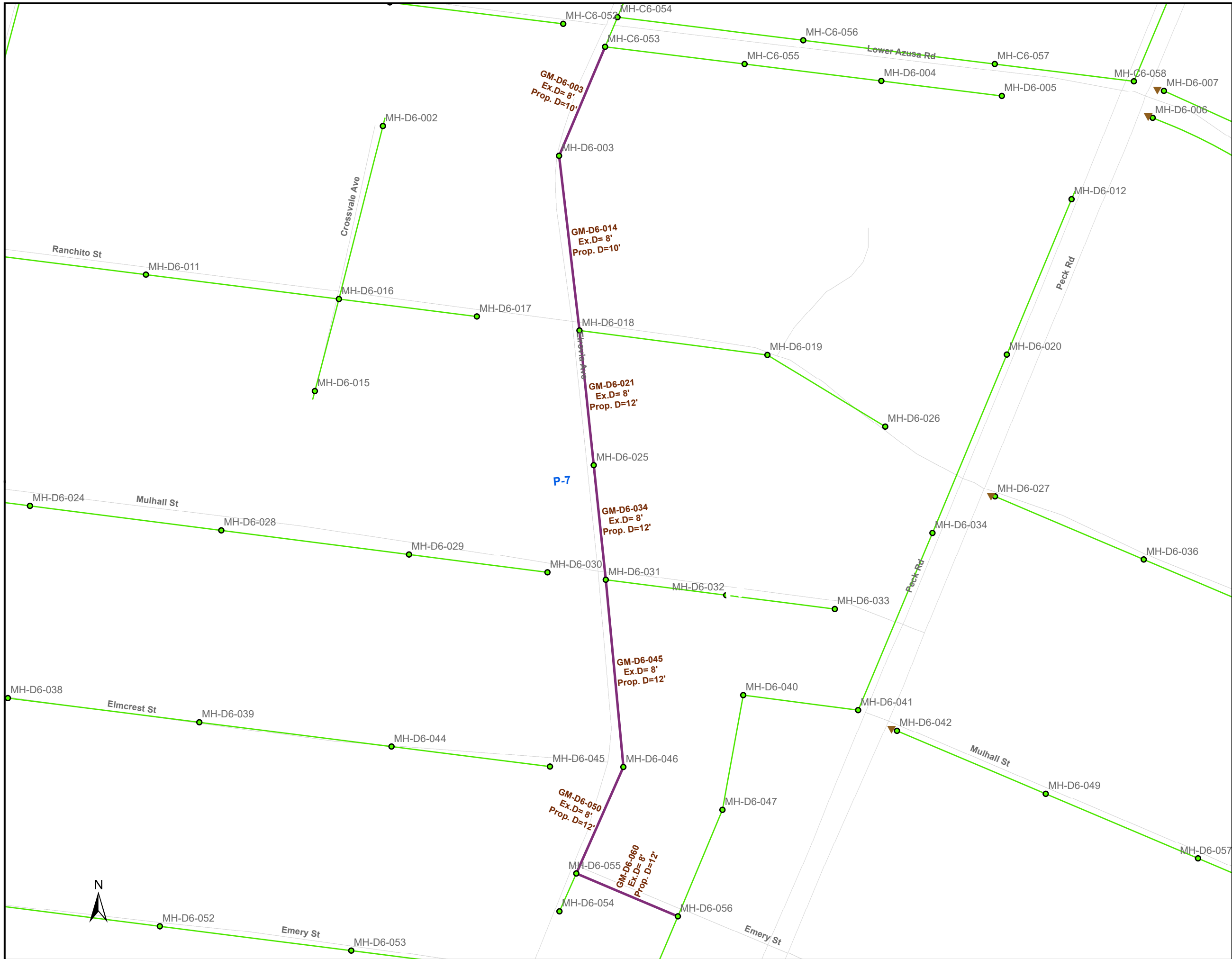
Proposed CIP Project

-  6







City of El Monte
Wastewater Collection System Master Plan


**Proposed CIP Projects
Detail Map
Figure 8-1F**



Legend

-  Modeled Outfall
-  City Gravity Mains
-  Modeled Manhole
-  Sewer Force Main

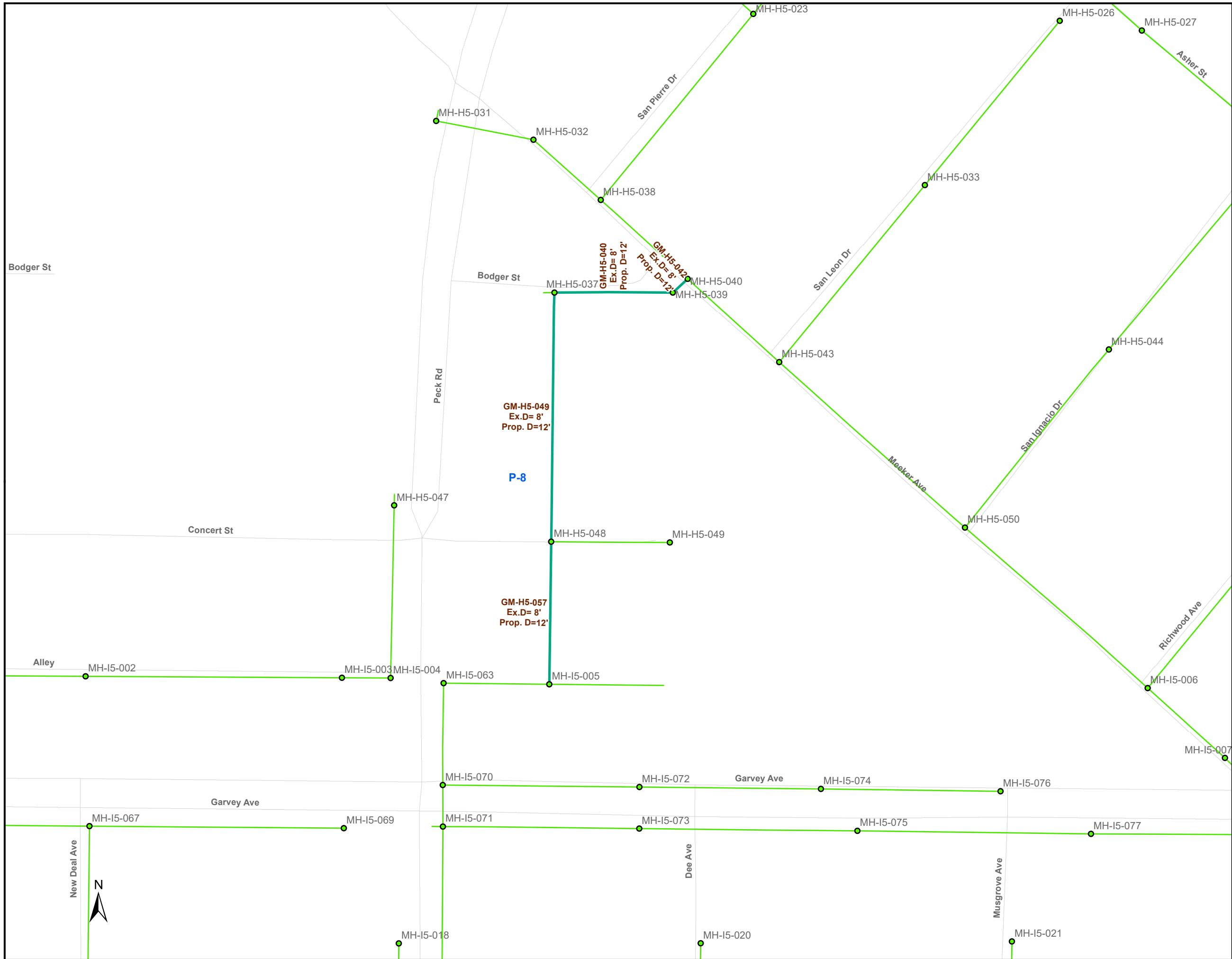
Proposed CIP Project

-  7



City of El Monte
Wastewater Collection System Master Plan

**Proposed CIP Projects
Detail Map
Figure 8-1G**



Legend

- City Gravity Mains
- Modeled Manhole
- Sewer Force Main

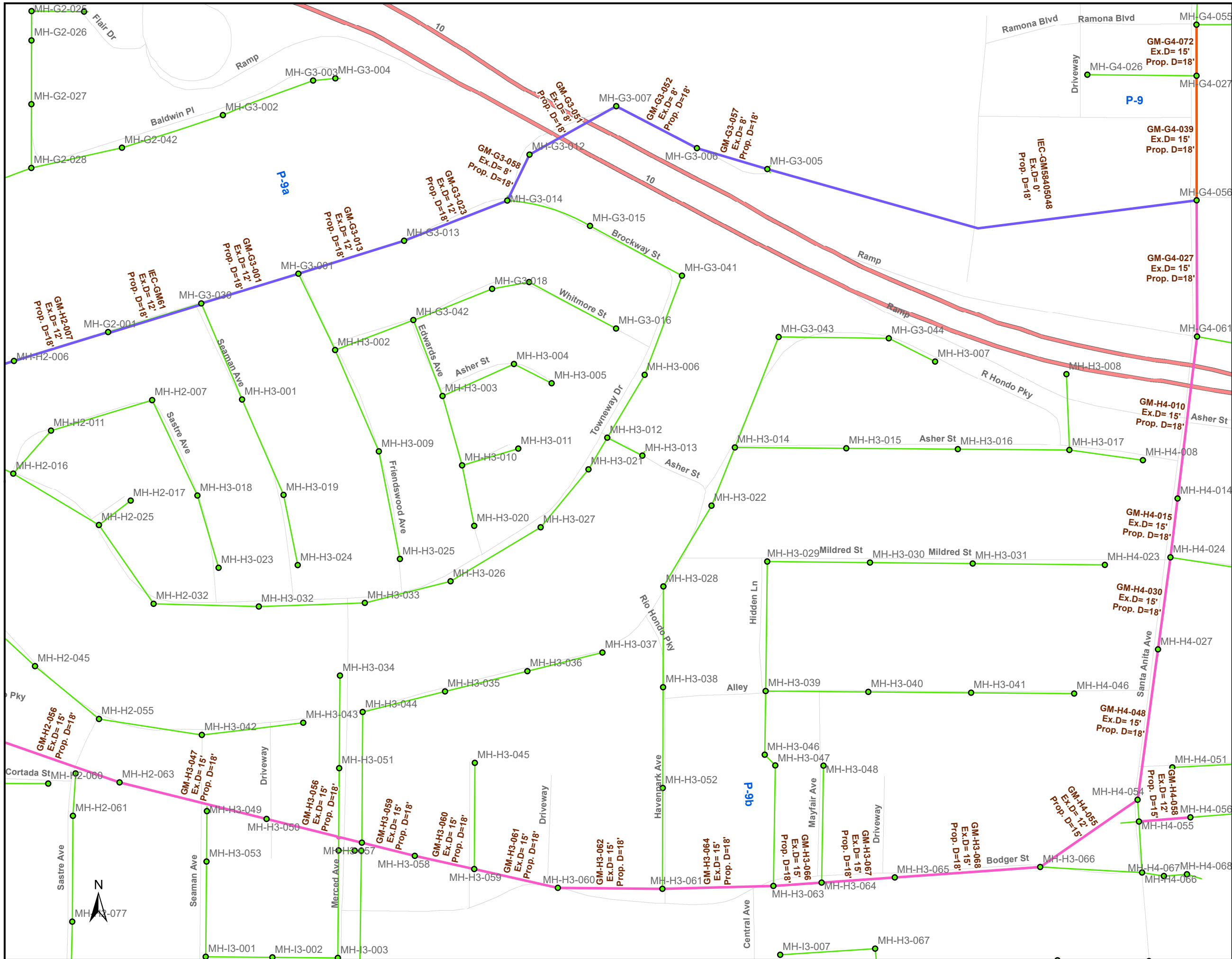
Proposed CIP Project

- 8



City of El Monte
Wastewater Collection System Master Plan

**Proposed CIP Projects
Detail Map
Figure 8-1H**



Legend

- City Gravity Mains
- Modeled Manhole
- Sewer Force Main

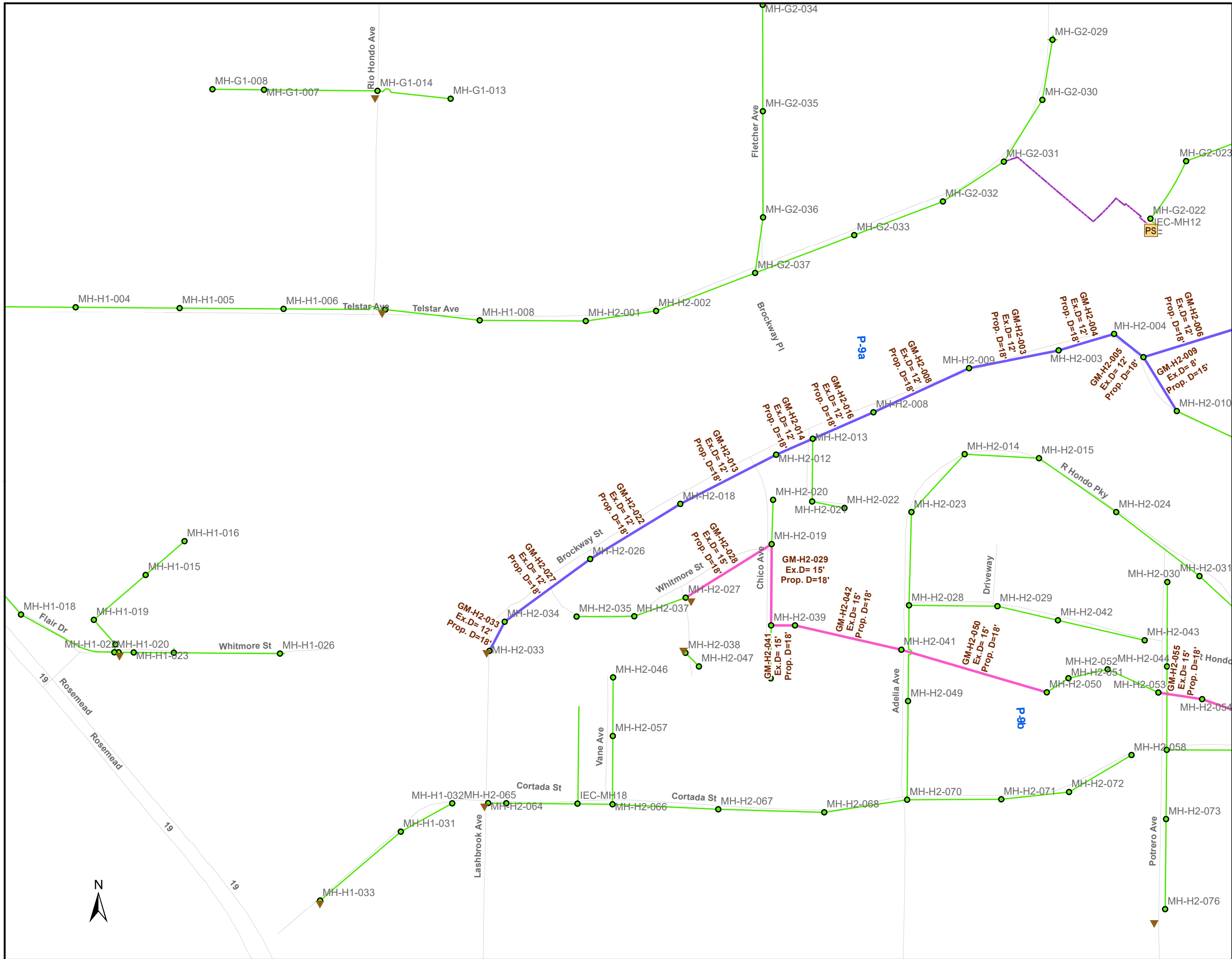
Proposed CIP Project

- 9
- 9a
- 9b



City of El Monte
Wastewater Collection System Master Plan

Proposed CIP Projects Detail Map Figure 8-11




Legend

- Modeled Lift Station
- Modeled Outfall
- City Gravity Mains
- Modeled Manhole
- Sewer Force Main

Proposed CIP Project

- 9a
- 9b





City of El Monte
Wastewater Collection System Master Plan

Proposed CIP Projects Detail Map Figure 8-1J

9. Asset Management Plan

9.1. Background

Like many towns and cities in the U.S, the City of El Monte (City) is experiencing wastewater collection system challenges, with infrastructure that's approaching or at the end of its design life. Maintenance costs are rising, and regulations are increasingly stringent to protect water quality and, ultimately, public health. Therefore, as part of the City's Wastewater Collection System Master Plan (WWMP) effort, Infrastructure Engineering Corporation (IEC) has also been tasked to develop an Asset Management Plan (AMP) for the City's sewer system infrastructure. Results from pipeline and manhole inspections conducted in the field formed the basis of the structural condition assessment for the AMP. The capacity analysis completed in Chapter 8 along with the condition assessment will further refine prioritization and execution of the City's Capital Improvement Program in the coming years. The following resources were used to develop the City's Asset Management Plan:

1. Data from Closed-Circuit Television (CCTV) inspections of existing pipelines conducted by Pro-Pipe ® Professional Pipe Services in 2018
2. Data from Manhole inspections conducted by Pro-Pipe ® Professional Pipe Services in 2018 using IBAK Panorama SI methods
3. Design criteria presented in Chapter 7
4. Sewer system capacity results derived from InfoSWMM hydraulic model for existing, near-term future, and long-term future flows
5. The decision support software used for this AMP was InfoMaster Sewer, Version 8.5, Update 5

The purpose of this AMP is to develop a sound and cost-effective rehabilitation/replacement plan based on the condition assessment results. This chapter summarizes the analytical method used, the computational software and tools applied, and results obtained to develop the City's AMP.

One main component of this AMP is the risk-based rehabilitation plan developed according to the system structural condition assessment and the risk assessment of the probability and consequence of failure for each asset.

9.2. Asset Management Overview

The existing condition and integrity of sewer collections are increasingly becoming a concern in cities and utility districts nationwide. The City has gravity mains that are currently over 113 years old. As the existing aging sewer systems continue to support expanding growth and land uses continually change, the sewer system may begin to experience more and more surcharging, blockages, and backups which could directly impact public health and the environment.

In the past, improvements to the systems have been based more on a reactive approach versus a proactive approach. The reactive approach to improving a system may not be the most cost-effective or reliable, and in many cases has not shown to actually improve overall system performance. As a result, the City's decision to develop an Asset Management Plan to proactively evaluate the existing sewer collection system will ultimately provide the groundwork for keeping its sewer system up-to-date in the most efficient and cost-effective manner.

9.3. InfoMaster Overview

InfoMaster Sewer is an ArcGIS-based asset integrity management and capital planning tool for sewer networks that was developed by Innovyze. It leverages existing GIS data and seamlessly links voluminous CCTV data for capital planning analysis including condition assessment, risk analysis, and rehabilitation planning.

InfoMaster can import CCTV data in NASSCO PACP, MACP and LACP, WRc, or other defect standards. PACP is the Pipeline Assessment Certification Program developed by the National Association of Sewer System Companies (NASSCO), while the MACP is the Manhole Assessment Certification Program and LACP is the sewer Lateral Assessment Certification Program. The Water Research Centre (WRc) developed sewer defect codes used in the U.K. prior to the development of NASSCO standards, which can also be imported into InfoMaster.

With the imported CCTV data, InfoMaster can perform condition assessment using geocoding of defects, scoring of the CCTV defects, and generating a draft rehabilitation plan solely based on condition assessment. Users can also perform risk-based analysis using InfoMaster to estimate the likelihood of failure (probability of failure based on age, materials, hydraulic capacity, etc.) and consequence of failure (impact of failure in terms disruption to the public and economy, public health and safety,

damages to the environment, etc.) of an asset. A rehabilitation plan can be developed through multi-step decision algorithm with consideration of both condition and risk-based assessments to determine recommendations of structure repairs/replacements for the asset.

Figure 9-1 from the InfoMaster Users Guide below shows the InfoMaster data and decision management process.

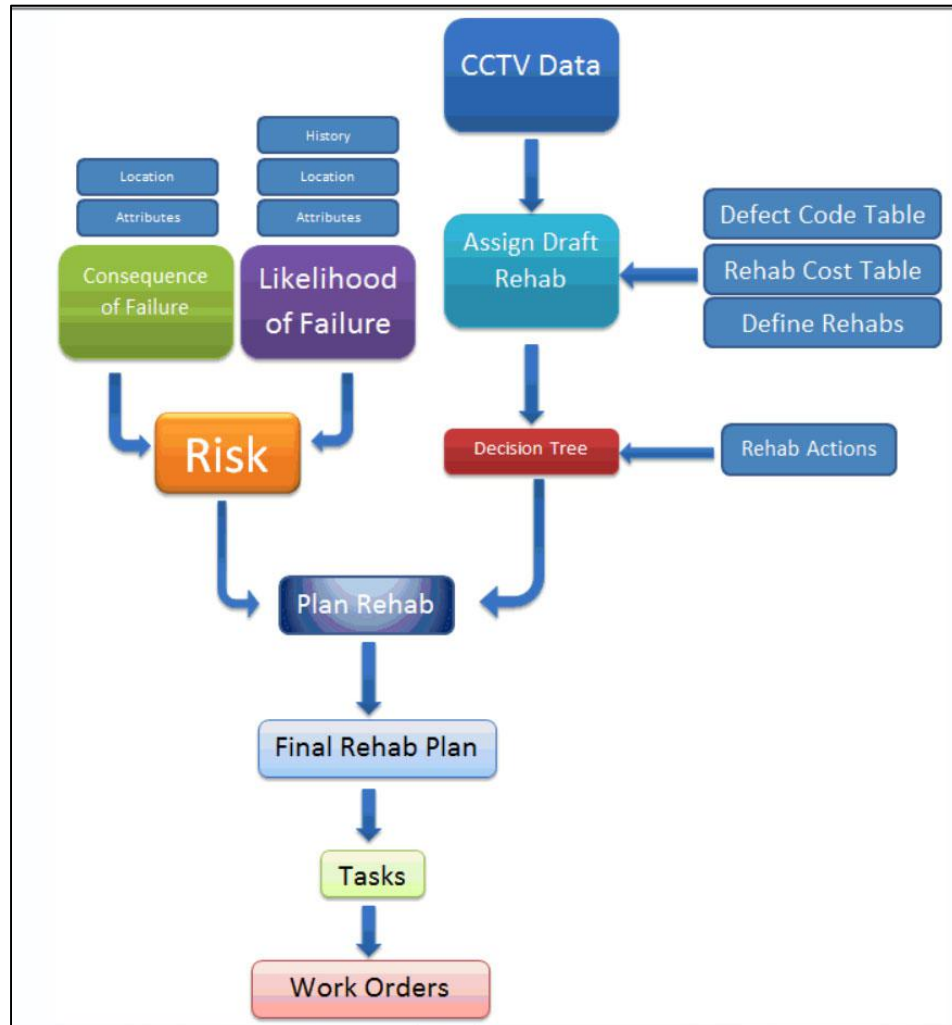


Figure 9-1. InfoMaster Data and Decision Management Process

9.4. Gravity Main Asset Management Plan

9.4.1. GIS Database

As part of the City's WWMP, the City's sewer system had been digitized into a GIS database. Information such as date of installation, material, slope, length, pipe size, etc. stored in as-builts, atlas maps or other paper formats were transferred into a GIS database. Due to missing as-builts or poor conditions of the as-builts, some pipes were missing all or part of this record information.

Table 9-1 summarizes the length of existing gravity pipelines by their installation year/decade.

Table 9-1. Length of Pipelines per Decade

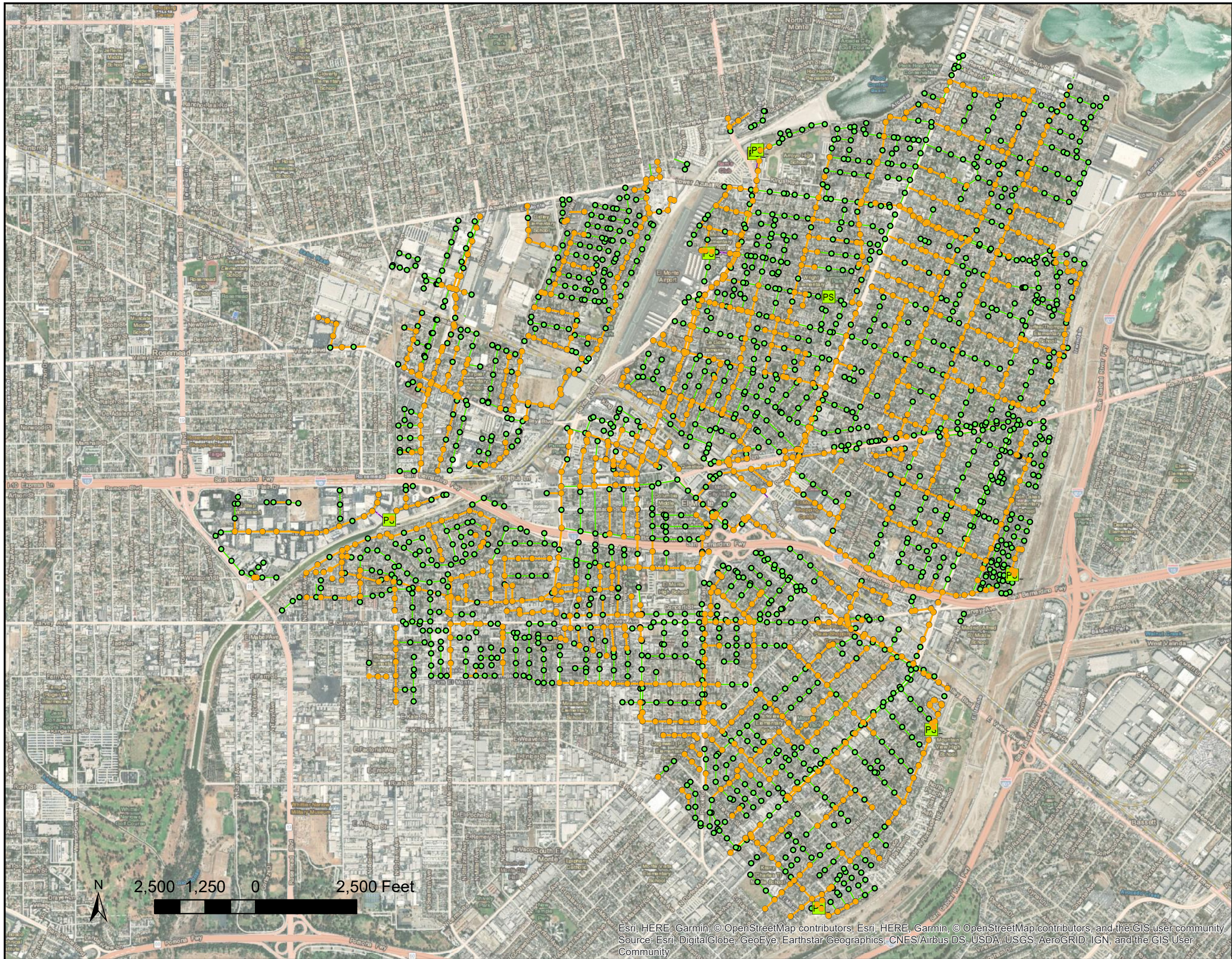
Year, by Decade	Total Length (ft)	Percent of Total
1900 - 1910	506	0.07%
1910 - 1920	0	0.00%
1920 - 1930	0	0.00%
1930 - 1940	63,282	9.24%
1940 - 1950	6,620	0.97%
1950 - 1960	99,885	14.58%
1960 - 1970	46,664	6.81%
1970 - 1980	21,785	3.18%
1980 - 1990	19,880	2.90%
1990 - 2000	2,820	0.41%
2000 - 2010	2,301	0.34%
2010 - 2015	2,884	0.42%
UNK	418,578	61.09%
Total	685,205	100.00%

The City's oldest pipelines were installed in 1905. More than half of the pipelines do not have records of their installation dates. Of the pipelines with records of installation dates, approximately one third were installed more than 75 years ago. Per industry standards, pipelines installed in the late 19th century have an average service life of about 120 years, pipelines installed in early 20th century have an average service life of about 100 years, and pipes installed after 1945 have shorter service life of about 75 years. Without proper records or known installation dates, it is not possible to estimate the remaining service life of the majority of the City's sewer pipelines.

9.4.2. Filed Evaluations and CCTV Data

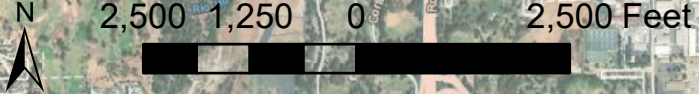
As part of the AMP, approximately 50% (~330,000 LF) of the City's gravity sewer main were inspected by Pro-Pipe® starting in December 2017. Pro-Pipe® integrated the high-definition scans and conventional closed-circuit television (CCTV) inspection data into a GIS database by referencing the City's GIS sewer gravity main IDs. The final deliveries of the inspection data include computer generated schematics of each inspected pipeline, visual documentation (i.e. video clips), and pipeline assessment data using PACP pipeline defect standard certified by NASSCO.

Inspected gravity mains are shown in Figure 9- 2.




Legend

- Inspected Manhole
- City Manhole
- Inspected Gravity Main
- City Sewer Line
- Sewer Force Main
- PS City Owned Lift Station
- PS Other Lift Station



Esri, HERE, Garmin, © OpenStreetMap contributors, Esri, HERE, Garmin, © OpenStreetMap contributors, and the GIS user community, Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



City of El Monte
Wastewater Collection System Master Plan
Inspected Sewer Facilities
Figure 9-2

9.4.3. CCTV Inspection and Rehabilitation Plan

The gravity main CCTV inspection data was imported into InfoMaster and a survey analysis was performed to geocode the defects, score the pipe condition, and assign preliminary rehabilitation methods for the corresponding pipes using the built-in survey analysis wizard tool.

The survey analysis wizard includes four steps:

1. Validate survey data: imported inspections are matched to the GIS data. Imported defect code data is validated against InfoMaster's internal defect codes. Inspections are classified as either active or not. Active inspections are inspections that a user wants to be scored.
2. Geocode survey data: the defects are geocoded to the map and placed on the applicable facility based on the related fields (Distance, Continuous, and DistanceToGo) in the Conditions table of the inspection data
3. Score pipes: defect codes on the facility are analyzed to generate an overall score for the facility.
4. Generate Draft Rehabilitation Plan: a draft rehabilitation plan is generated for each facility based on the defects read and the rehab methods specified in the Defect Codes table.

Figure 9-3 shows the defects identified through CCTV inspection.

A draft pipe rehabilitation plan was developed during the survey analysis solely based on the gravity mains' condition assessment. InfoMaster has default rehabilitation methods assigned to the defect codes that can be modified. The rehabilitation methods are listed below:

- No Action
- Cleaning
- Point Repair
- Lining
- Replace

The NASSCO's PACP defects reference table is included in Appendix B. Appendix C contains a table with defect codes and their associated rehabilitation methods.

The condition assessment and the draft rehabilitation plan were only developed for the CCTV inspected gravity mains. In addition to the draft rehabilitation plan, InfoMaster allows users to perform risk-based assessment based on pipe's material, age, hydraulic capacity, size, depth, etc. The risk assessment results can be used to evaluate the gravity mains without CCTV inspection data and used to prioritize the rehabilitation/replacement projects. The risk assessment results and the condition assessment based on CCTV data can then be incorporated into one final pipe rehabilitation plan for the whole system.

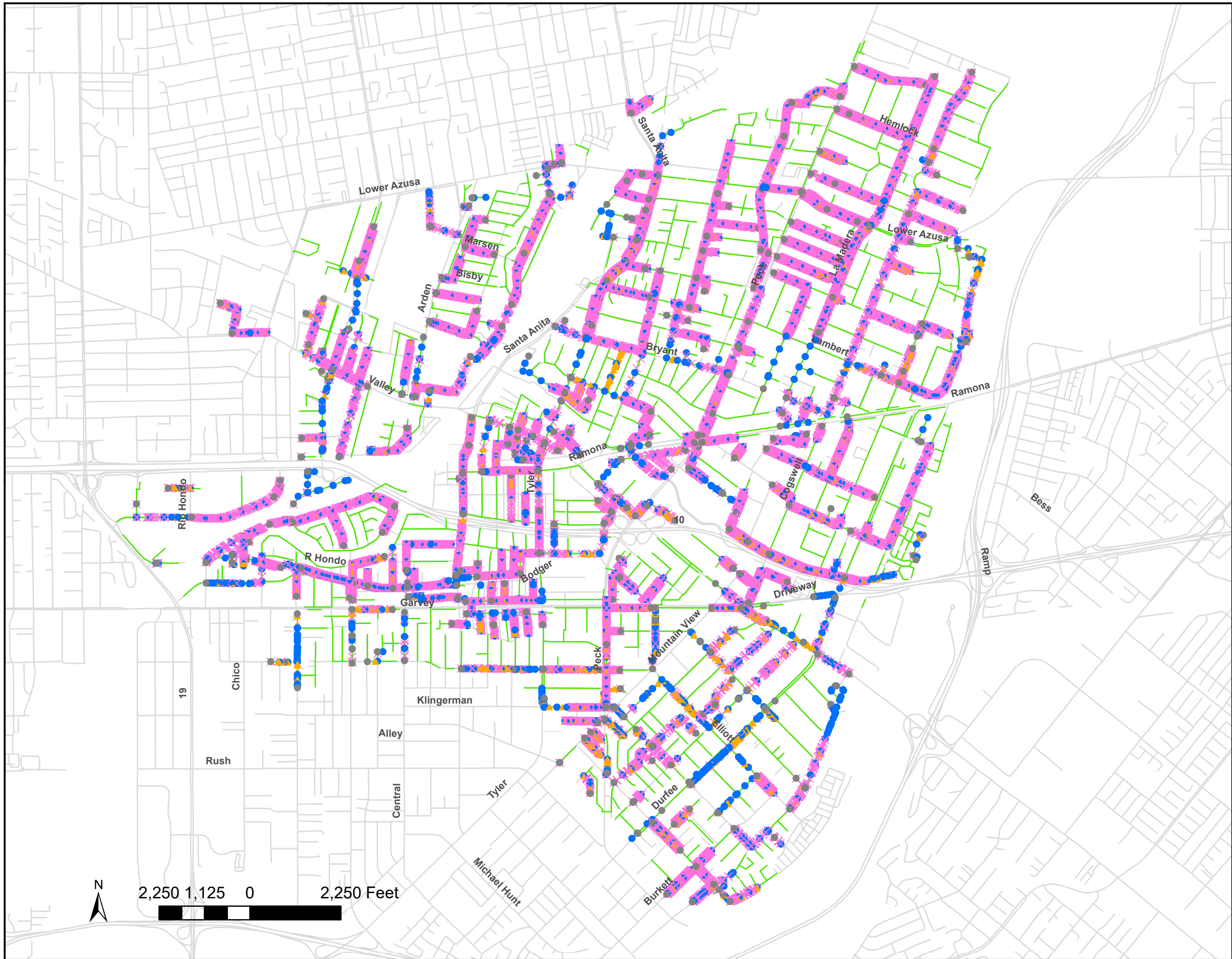
9.4.4. Risk Assessment

The risk-based assessment includes evaluation of the pipelines' likelihood of failure and consequence of failure. A pipeline's likelihood of failure was scored based on five criteria:

- Age
- Material
- Depth
- Length
- Capacity

A pipeline's consequence of failure was scored based on four criteria:


- Size
- Critical Facilities
- Water Bodies
- Street Type



Legend

Def_Type

- CONSTRUCTION
- ▲ SERVICE
- MISCELLANEOUS
- ✕ STRUCTURAL
- Gravity Main



City of El Monte
Wastewater Master Plan

Gravity Main Defects

Figure 9-3

Details of each criterion will be discussed below.

9.4.4.1. Likelihood of Failure (LOF)

AGE

LOF evaluates the probability of a pipe failure or structural deterioration. A pipeline’s installation date was used to determine the age of the pipe. The older the pipe is, a higher score the pipe was assigned. Since over half of the City’s pipelines are missing installation date records, the CCTV inspection data was utilized to determine the score for pipes with unknown installation years. Figure 9-4 presents the average structure score of a pipeline by age in 20-year increment. A higher structure score presents more severe defects.

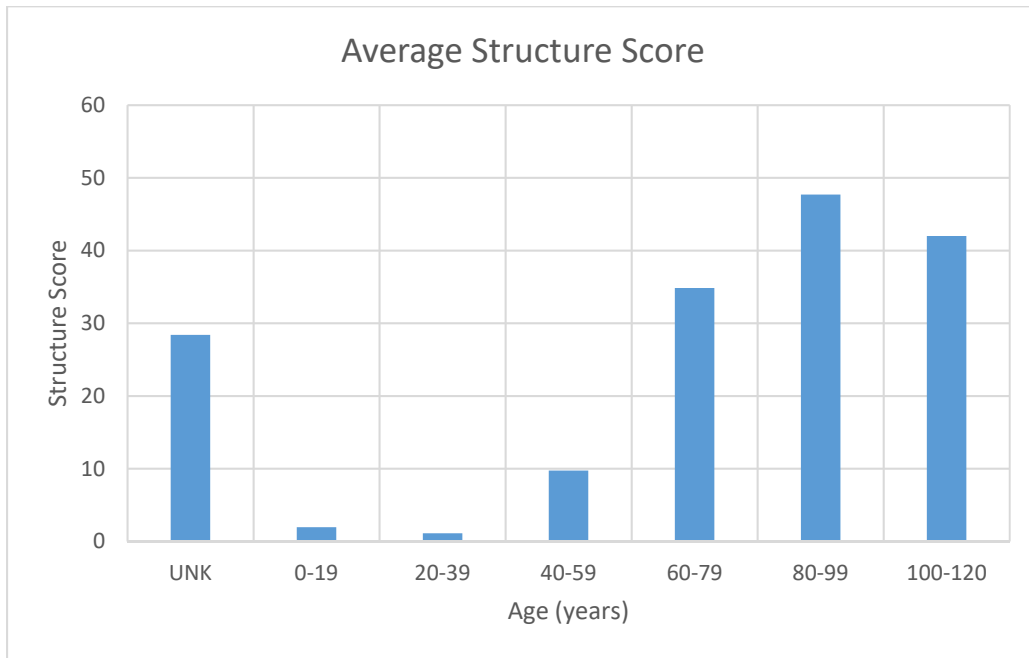


Figure 9-4. Average Structure Score for Inspected Gravity Mains

As shown in Figure 9-4, the average structure score for pipelines with unknown installation years is close to the average structure score of pipelines with age year of 60 -79. It is reasonable to assume that the majority of pipelines with unknown installation years were installed around 60 – 80 years ago and scored the same.

Table 9-2 shows the LOF Scores by Pipe Age.

Table 9-2. LOF Score by Age

Installation Year	Age (Years)	Score	Length (miles)
<= 1918	100	5	0.29
1918 - 1943	75 - 100	4	12.26
1943 - 1968	50 - 75	3	28.28
1968 - 1993	25 - 50	2	8.48
1993 - 2016	2 - 25	1	1.3
UNK		3	79.08

MATERIAL

A pipeline’s estimated useful life varies based on the pipe materials. The strength and corrosion resistance varies based on the material of the pipe. Table 9-3 shows the LOF score by pipe materials. The scores were determined based on similar studies available and the CCTV inspection data.

Table 9-3. LOF Score by Material

Material	Estimated Service Life	Score
Cast Iron (CAS)	75 - 100	1
Unknown (UNK)	-	3
Acrylonitrile Butadiene Styrene (ABS)	70	3
Polyvinyl Chloride (PVC)	70	3
Vitrified Clay Pipe (VCP)	100	3
Cured-in-Place Pipe (CIPP)	50	5
Ductile Iron Pipe (DIP)	60	5

* Estimated service life sourced from²⁻⁴

In order to score the pipelines with unknown material, the average structure score by material was analyzed based on the inspected pipelines, as shown in Figure 9-5 below. As shown in Table 4-1 and Figure 4-1 of the WWMP, approximately 85% of the system’s gravity mains are VCP pipes. The average structure score of pipelines with unknown material is close to the average structure score of VCP pipes and the LOF score by material should be similar. No inspected gravity mains were made of PVC or ABS, therefore, the figure below shows zero score for the two materials. In addition, total length of CAS, DIP, and CIPP gravity mains accounts for only 0.25% of the total inspected gravity mains, and did not provide a good sample size. Therefore, the average structure scores for these materials were not used to score the likelihood of failure of these materials.

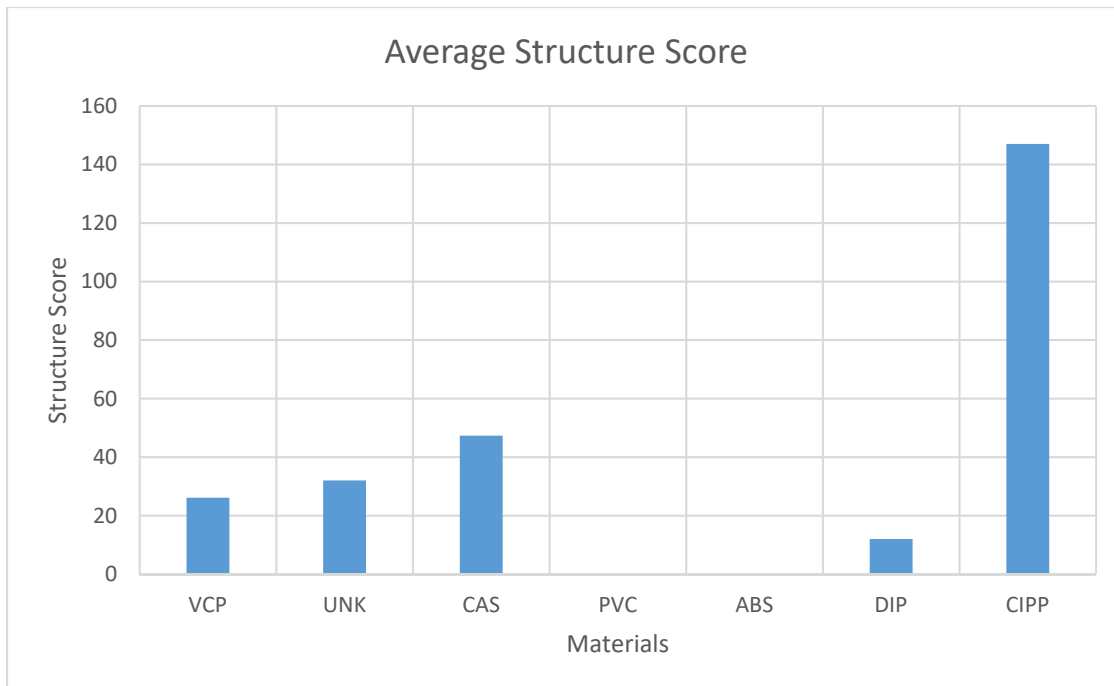


Figure 9-5. Average Structure Score by Gravity Main Material

DEPTH

Pipes located closer to the surface are assumed to be more likely to fail due to the traffic volume from the street and pipes located deeper from the surface are assumed to be more likely to fail due to the increased soil pressure.⁴ Table 9-4 lists the LOF score by pipe depth.

Table 9-4. LOF Score by Depth

Depth (ft)	Score
<=5	5
5- 7.5	3
7.5 - 15	1
> 15	5
UNK	3

LENGTH

Longer pipes are assumed to be more likely to fail due to bending stresses from external loading.⁴⁻⁶

Table 9-5. LOF Score by Pipe Length

Pipe Length (ft)	Score
< 200	1
200 - 300	2
300 - 400	3
400 - 500	4
500 - 700	5

CAPACITY

In addition to the criteria identified above, hydraulic capacity results were also utilized to determine the likelihood of failure of a pipe. Pipe with less remaining hydraulic capacity is more likely to fail operationally. For this criterion, two factors need to be considered: one is whether the pipe is hydraulically deficient and if so, the maximum d/D under long-term PWWF condition is considered. For pipes that are deficient under existing, near-term future, and long-term future, scores of 3, 2, and 1 were given, respectively. Table 9-6 listed the LOF score by the pipe's maximum d/D under long-term Peak Wet Weather condition.

Table 9-6. LOF Score by Max. d/D

Max. d/D under LT PWWF	Score
<= 0.5	1
0.5 - 0.65	2
0.65 - 0.75	3
0.75 - 0.85	4
0.9 - 1	5

Total capacity score of a pipeline is 2 times the sum of the pipe's deficient score plus the maximum d/D score. For example, if a pipeline becomes deficient under existing PWWF condition and has a maximum d/D of 0.8 under long-term PWWF condition, its total capacity score is $2 \times (3+2+1) + 4 = 16$. Total capacity scores of the pipelines range from 1 to 17. Table 9-7 lists the LOF score by the pipeline's total capacity score.

Table 9-7. LOF Score by Capacity Score

Capacity Score	Score
1-2	1
2-4	2
4-7	3
7-10	4
10-17	5

9.4.4.2. Consequence of Failure (COF)

SIZE

As part of the risk assessment, the COF evaluates the criticality of an asset. Larger pipes usually carry more flows, are backbones of the system, and typically serve a larger area of people. Failures of larger pipes can result in high cost of replacement, higher adverse impacts to the environment and the community, thus, are assumed to have a higher consequence of failure. Table 9-8 lists the COF score by pipe size.

Table 9-8. COF Score by Size

Pipe Size (in.)	Score
<= 6	1
8-10	2
12	3
15	4
18-21	5

CRITICAL FACILITIES

Pipes located near critical facilities including fire departments, police departments, schools, hospitals, and power facilities in this study have higher community impacts throughout the City. The City's GIS database was utilized to determine the distance between pipes and the critical facilities listed above. Pipes within 1,000 feet of the critical facilities were scored from 1-5, and pipes more than 1,000 feet away from the critical facilities were scored zero.

Table 9-9 lists the COF score by distance between the pipe and critical facilities.

Table 9-9. COF Score by Distance to Critical Facilities

Distance (ft)	Score
< 50	5
50 - 200	4
200 - 500	3
500 - 700	2
700 - 1000	1
> 1000	0

WATER BODIES

Failure of a pipe in close proximity to an above-ground water body can result in Sanitary Sewer Overflows (SSOs) into the water bodies, leading to environmental and public health concerns. Table 9-10 lists the COF score by distance from the nearest water body, which is The Rio Hondo. Pipes within 1,000 feet of the Rio Hondo were scored from 1-5, and pipes more than 1,000 feet away were given a score of zero.

Table 9-10. COF Score by Distance to Water Body

Distance (ft)	Score
<= 100	5
100 - 250	4
250 - 350	3
350 - 450	2
450 - 1000	1
> 1000	0

STREET TYPE

Pipes located in busy streets have a higher consequence of failure as pipe repair or replacement will aggravate higher volumes of traffic and impact more people. Busy streets are assumed to be street segments with speed limits of 45 mph (miles

per hour) and above, such as freeways, highways, and parkways. Pipes are scored based on the streets they are located in. Table 9-11 lists the COF score based on pipeline proximity to street type.

Table 9-11. COF Score by Pipeline Proximity to Street Type

Speed Limit (mph)	Score
55	5
45	4
35	3
25	2
15	1

After scoring pipelines based on the above criteria, a risk analysis was performed in InfoMaster to combine the LOF scores and the COF scores to develop a total score for the pipes. There are three different methods for calculating risk level based on LOF and COF, including Linear Normalization Classification, Bi-Directional Distribution, Multi-Criterion Classification and Asset Grading Classification.

Linear normalization classification is the simplest method. This method calculates the summation/product of the LOF and COF risk scores as the total risk score, and the total risk score will be normalized and divided into the user specified boundaries.

Figure 9-6 is an example of results using Linear normalization classification from the InfoMaster User Guide.

Linear Normalization Classification Example Table

ID	Total COF	Total LOF	Total Risk	Normalized Value	Value compared to Boundaries	Risk by Grading
P1	6	6	12	100	60% < P1	Extreme
P2	3.1	4	7.1	59.17	50% < P2 < 60%	High
P3	2.1	3.4	5.5	45.83	40% < P3 < 50%	Medium
P4	1.9	2.0	3.9	32.50	30% < P4 < 40%	Low
P5	1.7	1.8	3.5	29.17	P5 < 30%	Negligible

*Assuming user is normalizing to 100

Figure 9-6. Risk Analysis Results Table by Linear Normalization Classification

Bi-Directional Distribution is the most commonly used method by InfoMaster users and is the selected risk analysis method for this AMP. This method allows users to create a matrix of either 3x3 (3 levels of LOF scores and 3 levels of COF scores) or 5x5 to compare the consequence of failure and likelihood of failure results independently before grading the risk of an asset.

Figure 9-7 is a screenshot of the risk analysis for this AMP.

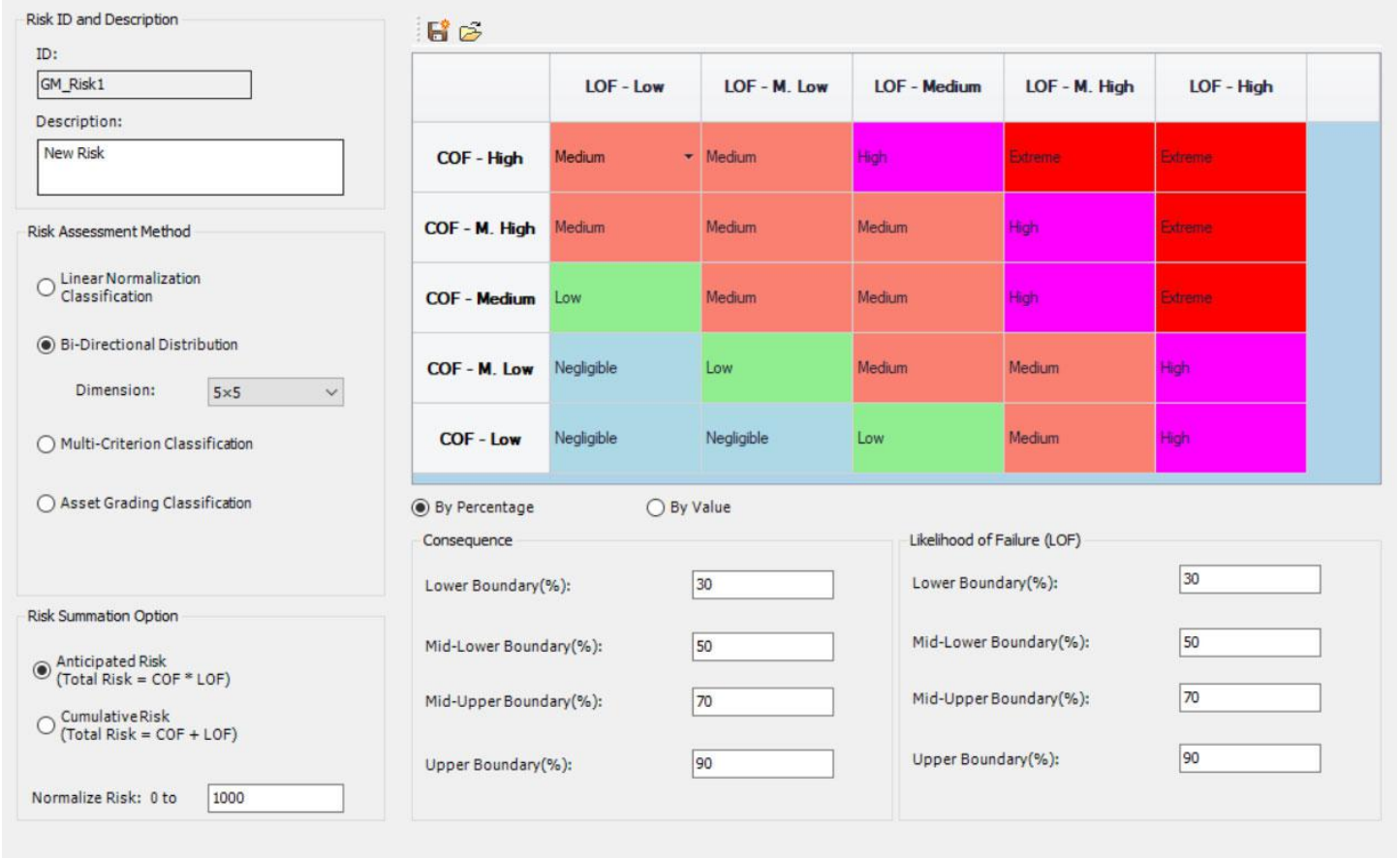


Figure 9-7. Bi-Directional Distribution Method

Multi-criterion classification is similar to the Bi-Directional method but allows additional control over how individual calculated consequences relate to the prioritization of rehabilitation. Asset Grading Classification maps the total COF scores on a scale of 1-5 and compares that to the asset grade to assess risk for each pipe. These two methods are rarely applied by InfoMaster Users.

Table 9-12 summarizes the weights associated with each LOF criterion and COF criterion for the risk analysis.

Table 9-12. Summary of Weights Associated with Each Criterion

LOF Criteria	Weight	COF Criteria	Weight
Age	2	Size	2
Material	1	Critical Facilities	1
Depth	1	Water Bodies	1
Length	1	Street Type	2
Capacity	2		

Table 9-13 presents a summary of the risk analysis results.

Table 9-13. Risk Analysis Results Summary

Risk	Length (Miles)	% of Total Length	Number of Facilities
1- Negligible	0.24	0.18	12
2-Low	8.72	6.72	325
3-Medium	111.32	85.83	2,358
4-High	8.60	6.63	145
5-Extreme	0.82	0.63	11

A small percentage of pipelines were assigned to extreme and high risk, and approximately 86% of the pipelines were assigned as medium risk. Figure 9-8 and Figure 9-9 provide the contribution of each criterion for the LOF and COF scores.

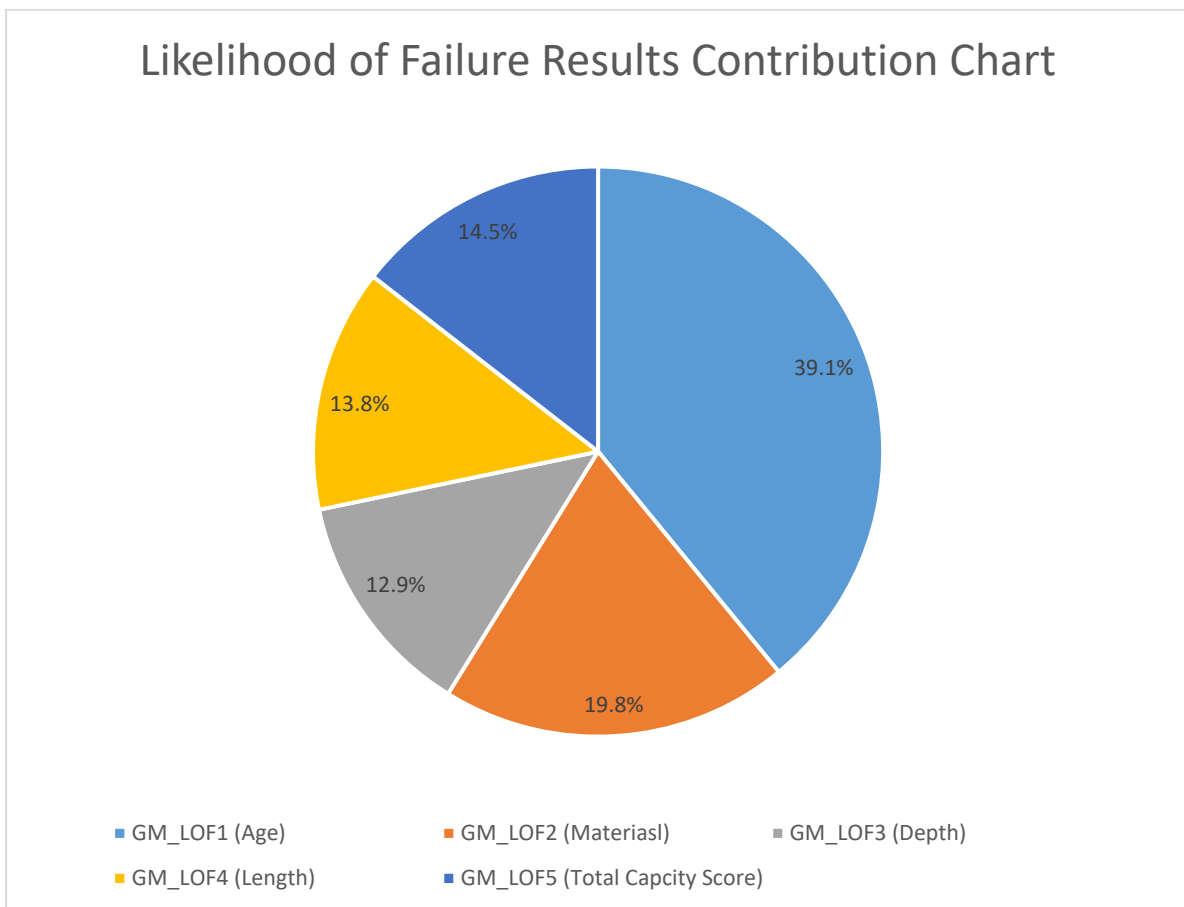


Figure 9-8. Likelihood of Failure Results Contribution Chart

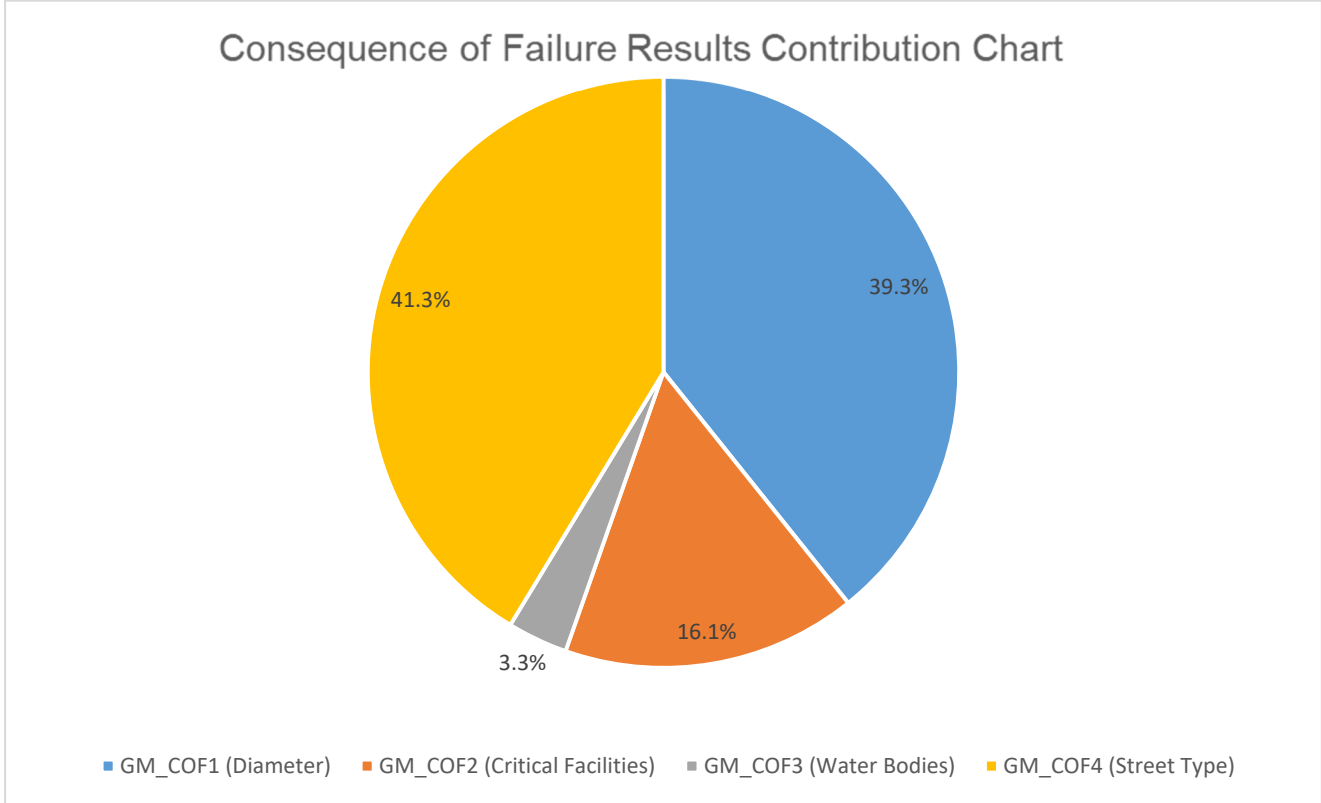


Figure 9-9. Consequence of Failure Results Contribution Chart

Figure 9-10 and Figure 9-11 shows how the sewer system was scored by LOF and COF. Figure 9-12 shows the combined risks results on the map of the City showing where the highest risk pipes are located.

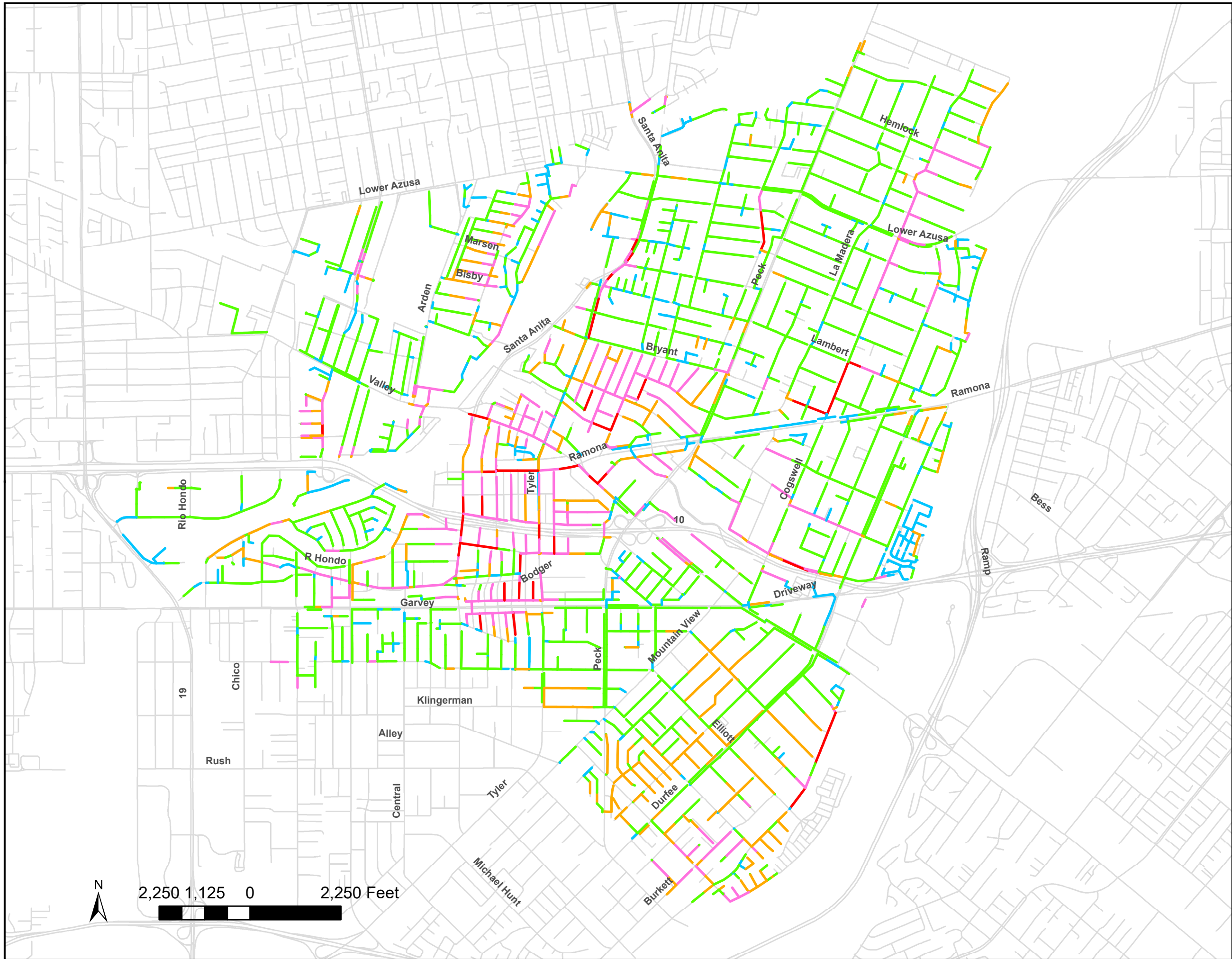
9.4.5. Gravity Main Rehabilitation Plan

9.4.5.1. Draft Rehabilitation Plan

As mentioned previously, InfoMaster provides a draft rehabilitation plan solely based on CCTV inspection data. Table 9-14 summarizes the results from the Draft Rehabilitation Plan. Figure 9-13 shows the Draft Rehabilitation Plan as a map.

Table 9-14. Summary of Draft Rehabilitation Action Recommendations

Rehabilitation Action	Number of Rehabilitation Action Results
Cleaning	293
Investigation	60
Lining	2,683
Point Repair	2,645
Grand Total	5,681



Legend

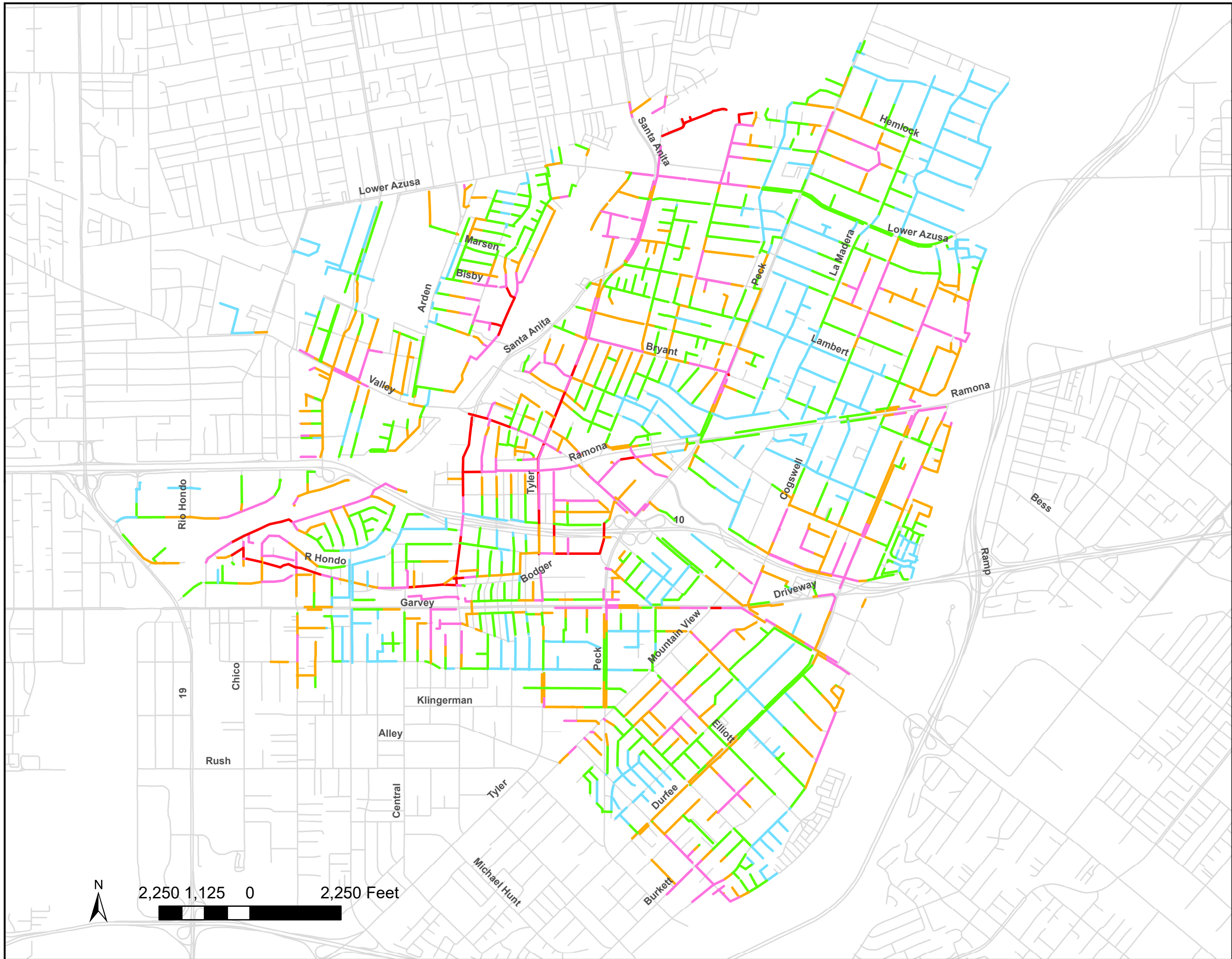
Gravity Main Likelihood of Failure Score

- less than or equal to 13
- 13 - 15
- 15 - 17
- 17 - 21
- larger than 21



City of El Monte
Wastewater Master Plan

Gravity Main Likelihood of Failure Score
Figure 9-10



Legend

Gravity Main Consequence of Failure Score

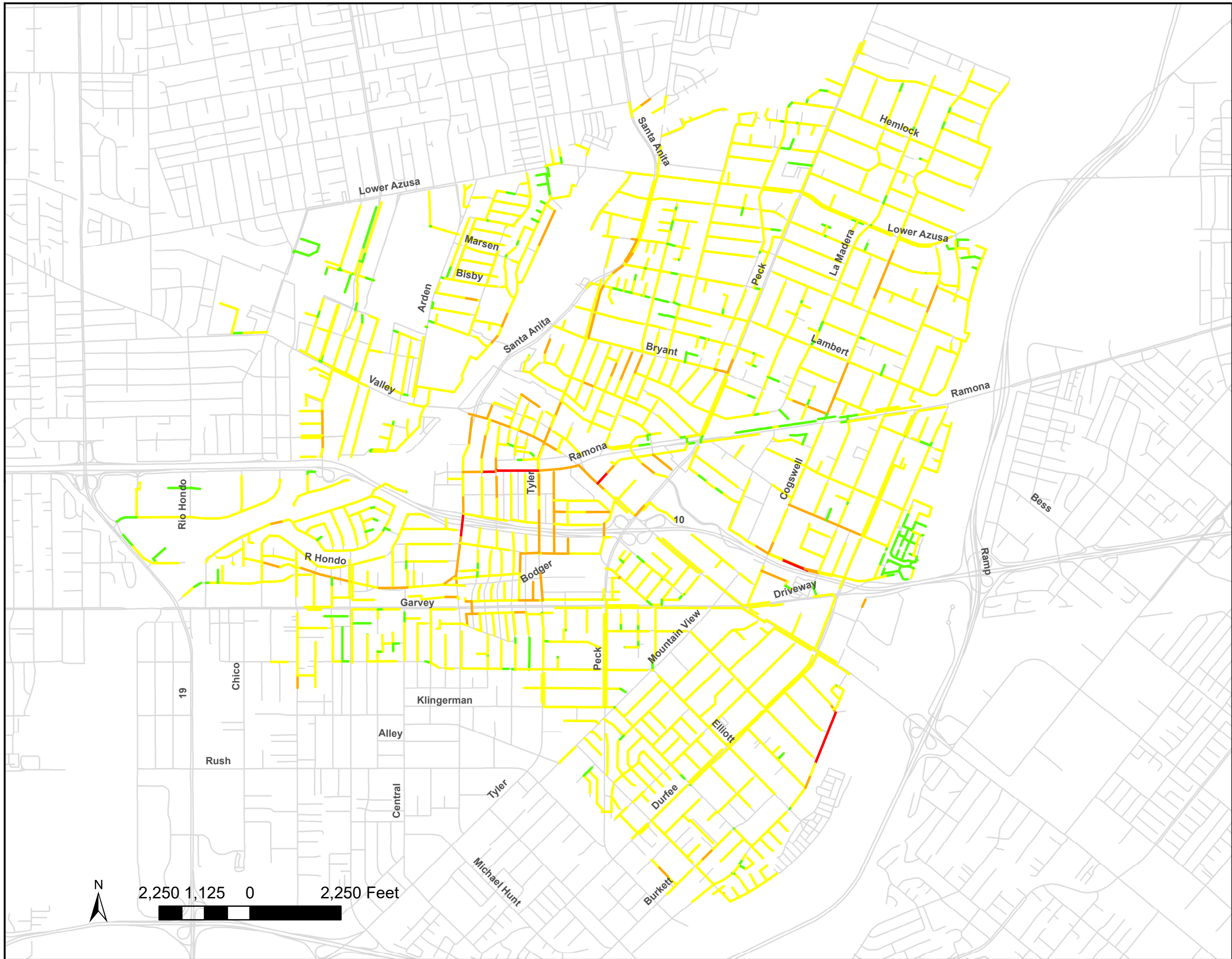
- less than or equal to 8
- 8 - 10
- 10 - 12
- 12 - 15
- larger than 15



City of El Monte
Wastewater Master Plan

Gravity Main Consequence of Failure Score


Figure 9-11



Legend

**Gravity Main
Total Risk Score**

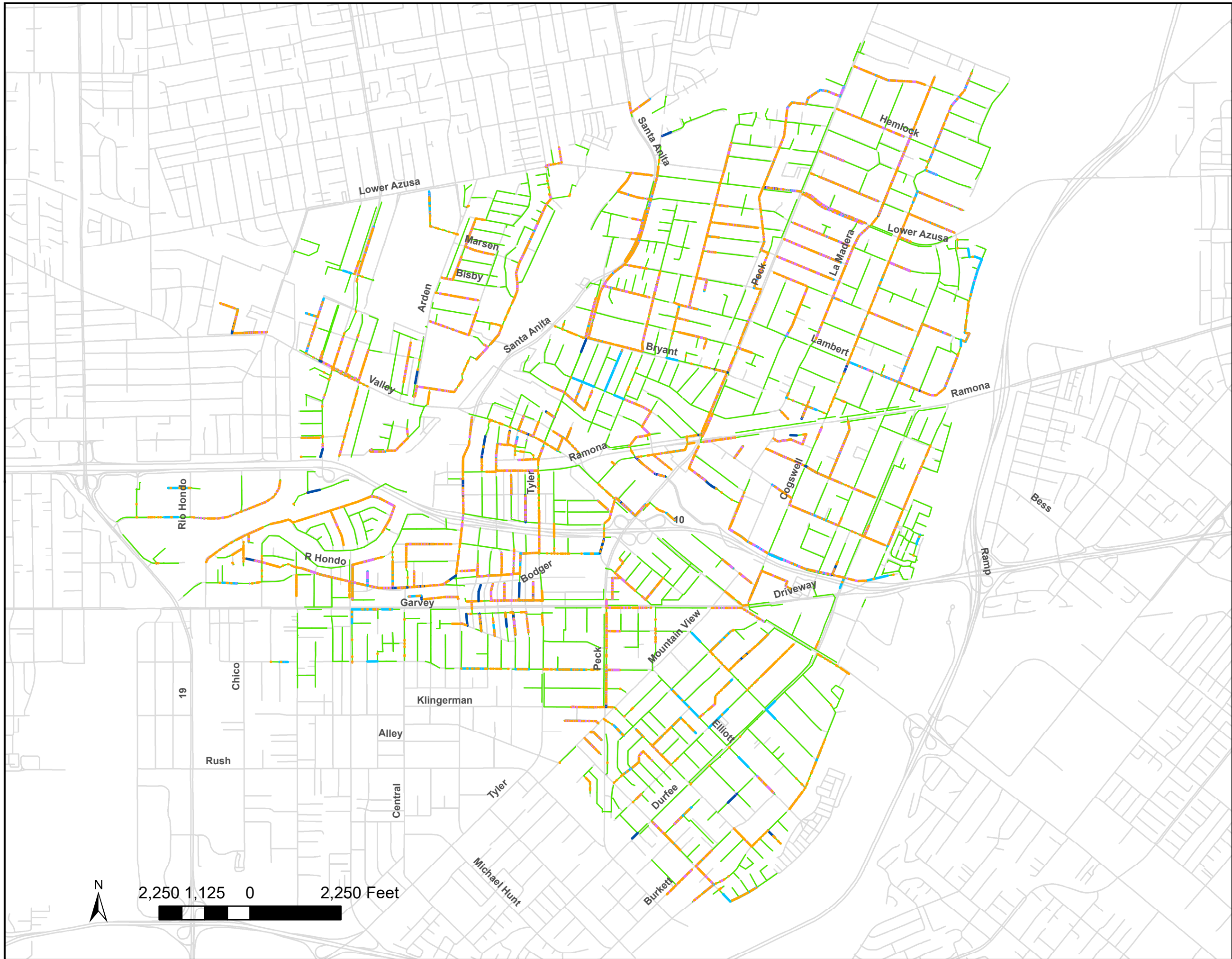
- less than or equal to 2
- 3
- 4
- 5



City of El Monte
Wastewater Master Plan

**Gravity Main Risk Analysis
Combined Risk Results Map**

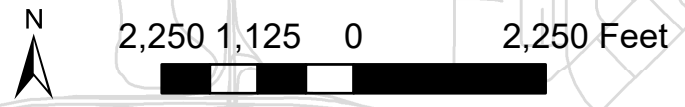
Figure 9-12




Legend

Draft Rehab. Plan

- CLEANING
- LINING
- - - POINT REPAIR
- INVESTIGATION
- City Gravity Main





City of El Monte
Wastewater Master Plan
**Gravity Main Draft
Rehabilitation Plan**
Figure 9-13

9.4.5.2. Final Pipe Rehabilitation/Replacement Plan

With consideration of both the condition assessment results and risk assessment results, a decision tree was created to make the final recommendations on pipe rehabilitation/replacement. Costs associated with each rehabilitation method was also added. The decision tree is fully customizable to allow users the ability to specify conditions as thresholds for the corresponding rehabilitation method. The decision tree of the Final Pipe Rehabilitation/Replacement Plan is shown in Figure 9-14. Tables 9-15, 9-16, 9-17, and 9-18 shows the planning-level costs that were used to develop the Final Pipe Rehabilitation/Replacement Plan. Unit costs shown in the tables include an additional 30% for contingency and 27.5% for engineering, legal, admin, etc. costs.

Table 9-15. Unit Costs for Lining

Diameter (in.)	Cost (\$/LF)
8	80
10	100
12	120
15	150
18	180
21	210

Costs for lining a shorter segment of pipeline is a lot higher than costs for a longer segment. Partial lining was assumed to have a setup cost of \$10,000.

Table 9-16. Unit Costs for Replacement

Diameter (in.)	Cost (\$/LF)
8	310
10	325
12	345
15	375
18	400
21	510

Table 9-17. Unit Costs for Cleaning/Heavy Cleaning

Diameter (in.)	Cost (\$/LF)
8-10	1.1
12-15	1.3
18	1.9
21	2.7

Figure 9-14. Gravity Main Rehabilitation Plan Decision Tree

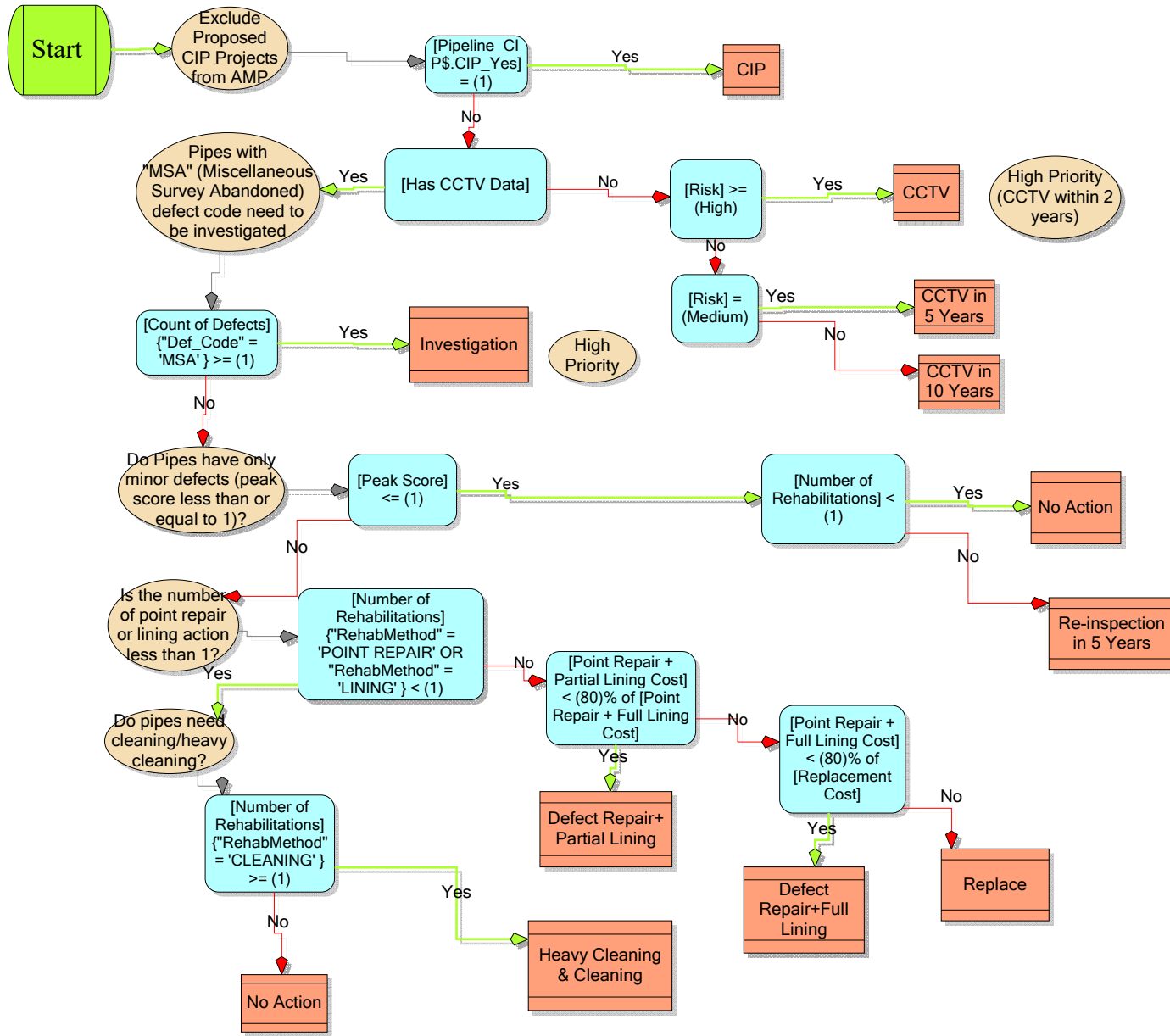


Table 9-18. Unit Costs for Other Rehabilitation Methods

Rehabilitation Method	Unit Cost
Point Repair	\$31,00/ in (dia)
CCTV	\$ 1.5/ LF

Unit costs for Cleaning were based on heavy cleaning costs in order to be conservative. Cleaning costs are based on actual costs incurred during CCTV and cleaning operations completed this year by Pro-Pipe.

Facilities proposed for upsizing in Chapter 8 were excluded from the rehabilitation plan. Results from the Final Rehabilitation/Replacement Plan were reflective of the rehabilitation plan decision tree. Details of the results are included in Appendix D. Rehabilitation/replacement of the gravity mains were recommended to start from high-risk to low-risk pipelines. Inspection of some gravity mains could not be completed due to various reasons with a defect code "Miscellaneous Survey Abandoned (MSA)" assigned. These "MSA" gravity mains would require the City's immediate attention. Table 9-19 lists the "MSA" gravity mains and the corresponding survey notes. Figure 9-15 shows the final rehabilitation/replacement actions for the gravity mains by risk grading. Rehabilitation/replacement projects should be field validated and evaluated on a project-to-project basis. Lower-risk pipelines may be repaired in an early phase based on its location and project nature.

Table 9-19. "MSA" Gravity Mains

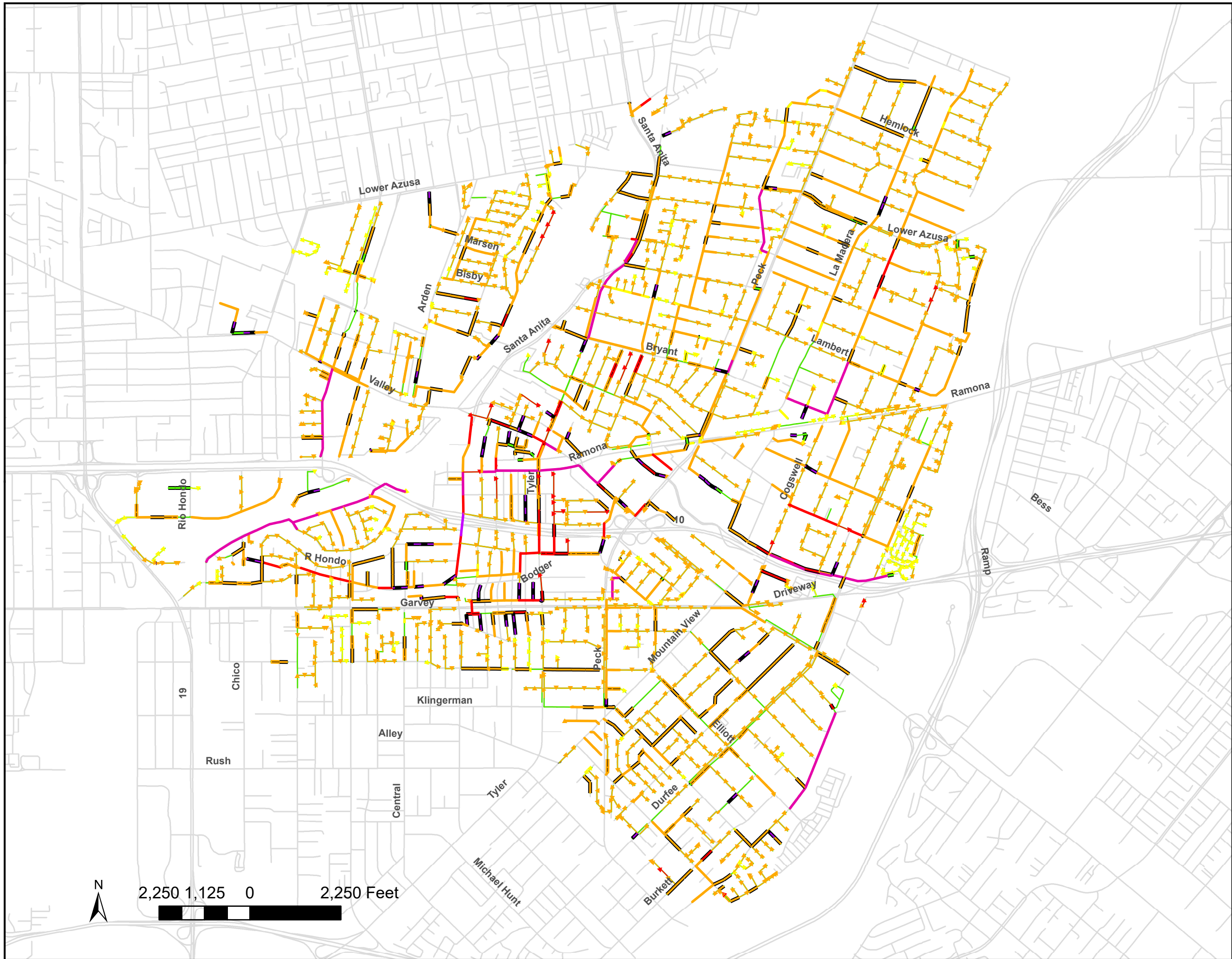
Gravity Main ID	Notes
GM-E5-031	DEBREE IN MAIN; FLIPS CAMERA TO ITS SIDE
GM-E5-031	MATCHED FOOTAGE; COMPLETE
GM-C5-014	AT LIFT STATION
GM-D7-011	POTRUDING LATERAL
GM-D7-011	MATCHED FOOTAGE; COMPLETE
GM-D7-017	DEBREE IN MAIN
GM-D7-017	MATCHED FOOTAGE COMPLETE
GM-C6-060	SCREW DRIVER STUCK IN JOINT
GM-C6-060	MATCHED FOOTAGE; REVERSAL COMPLETE
GM-F3-059	INTRUDING LATERAL
GM-F3-059	INTRUDING LATERAL
GM-F7-027	WEDGED STICK IN LINE
GM-F7-027	WEDGED STICK IN LINE
GM-D3-020	INTRUDING LATERAL
GM-D3-020	INTRUDING LATERAL
GM-G2-056	ATTACHED DEBRIS
GM-G2-056	ATTACHED DEBRIS
GM-E2-039	UNABLE TO CONTINUE DUE TO INTRUSION
GM-E2-035	UNABLE TO CONTINUE DUE TO OBSTRUCTION
GM-G6-015	SIZE REDUCTION
GM-G7-065	UNMAPPED MH MH-G7-066; UNABLE TO MAKE TURN
GM-G7-065	MATCHED FOOTAGE; REVERSAL COMPLETE
GM-F7-004	ROOTS
GM-F7-004	MATCHED FOOTAGE; REVERSAL COMPLETE
GM-E5-076	POSSIBLE ROCKS OR COMPACTED MUD
GM-F4-048	BUILD UP
GM-F6-065	OFFSET
GM-F6-065	OFFSET

Table 9-19. "MSA" Gravity Mains

Gravity Main ID	Notes
GM-E2-035	MATCHED FOOTAGE; COMPLETE
GM-F2-007	MAIN DROPS; LOOKS LIKE A SIPHON
GM-F2-007	REVERSAL INCOMPLETE; MAIN DROPS; LOOKS LIKE A SIPHON
GM-G4-078	INTRUDING LATERAL
GM-G4-078	INTRUDING LATERAL
GM-G4-039	UNKOWN INTRUSION IN MAIN
GM-G5-044	INTRUDING LATERAL
GM-G5-044	INTRUDING PIPE FROM LATERAL
GM-G5-036	INTRUDING LATERAL
GM-G5-036	INTRUDING LATERAL
GM-G4-039	REVERSAL COMPLETE; MATCHED FOOTAGE
GM-G6-044	TURN IN PIPE
GM-G6-066	MAIN LINE TURNS; TRACTOR UNABLE TO MAKE TURN
GM-G4-004	SEWER MAIN BROKEN
GM-G4-004	REVERSAL COMPLETE; MATCHED FOOTAGE
GM-H7-053	INTRUDING LATERAL
GM-H7-053	INTRUDING LATERAL
GM-G4-040	INTRUDING LATERAL
GM-G4-040	UNKNOWN OBSTACLE
GM-G4-057	UNABLE TO CONTINUE DUE TO TURN IN CHANLE
GM-G4-057	MATCHED FOOTAGE; ENDED AT UNMAPPED MH; MH-G4-013A
GM-I4-029	INTRUDING SPIKE
GM-H3-029	INTRUSION
GM-H4-084	INTRUDING LATERAL
GM-H4-084	INTRUDING LATERAL
GM-I4-013	UNKNOWN OBSTACLE
GM-H4-083	INTRUDING LATERAL
GM-F6-020	UNDERWATER
GM-G4-007	POTRUDING LATERAL
GM-G4-007	MATCHED FOOTAGE; REVERSAL COMPLETE
GM-F4-010	ROOTBALL
GM-H3-029	INTRUSION
GM-H3-028	UNKNOWN OBSTACLE
GM-H3-028	UNKNOWN OBSTACLE
GM-H3-064	AT EXTRA MANHOLE
GM-H3-064	INTRUDING LATERAL
GM-H3-067	INTRUDING LATERAL
GM-H3-067	INTRUDING LATERAL
GM-H4-055	UNKOWN OBSTRUCTION
GM-G2-024	CAMERA GOES UNDER WATER; DEBREE
GM-K5-081	METEL BAR IN CENTER OF MAIN
GM-K5-081	REVERSAL COMPLETE; MATCHED FOOTAGE
GM-I3-006	INTRUDING LATERAL


















Table 9-19. "MSA" Gravity Mains

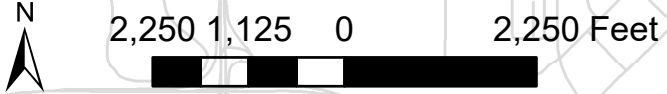

Gravity Main ID	Notes
GM-I3-006	intruding lateral
GM-K6-025	SCREWDRIVER
GM-K6-025	SCREWDRIVER
GM-G5-060	POTRUDING LATERAL
GM-G5-060	MATCHED FOOTAGE; REVERSAL COMPLETE
GM-H5-009	PIPE SIZE CHANGE
GM-H5-009	PIPE SIZE CHANGE
GM-I4-049	ROOTS
GM-I4-048	INTRUDING LATERAL
GM-I4-048	INTRUDING LATERAL
GM-I4-049	ROOTS
GM-E4-045	WEDGED STICK
GM-E4-045	WEDGED STICK
GM-H4-080	INTRUSION
GM-H4-073	ATTACHED DEBRIS
GM-H1-024	TRACTOR UNABLE TO MAKE RIGHT TURN IN MAIN
GM-H6-050	WEDGED ROD
GM-H6-050	WEDGED ROD
GM-I4-035	OFFSET
GM-I6-059	WEDGED PIPE
GM-I6-059	WEDGED PIPE
GM-J5-028	METAL BAR ACROSS MAIN
GM-H2-042	INTRUDING LATERAL
GM-G2-024	GREASE
GM-F4-001	CORROSION IN CAST IRON PIPE IS CAUSING TRACTOR TO FLIP TO ITS SIDE
GM-K6-056	TRACTOR UNABLE TO PROCEED DUE TO OFFSET AT JOINT
GM-K6-056	REVERSAL COMPLETE; MATCHED FOOTAGE
GM-G3-021	SEWER MAIN TURNS INTO A Y
GM-G3-021	UNABLE TO MAKE TURN
GM-F4-001	TRACTOR UNABLE TO PROCEED DUE TO CORROSION IN MAIN UNABLE TO COMPLETE REVERSAL



Legend

Gravity Main Final Rehabilitation Plan

-  Investigation
-  CCTV in 2 Years
-  CCTV/Re-inspection in 5 Years
-  CCTV in 10 Years
-  CIP
-  Defect Repair+ Partial Lining, Risk 2
-  Defect Repair+ Partial Lining, Risk 3
-  Defect Repair+ Partial Lining, Risk 4
-  Defect Repair+ Full Lining, Risk 1-2
-  Defect Repair+ Full Lining, Risk 3
-  Defect Repair+ Full Lining, Risk 4
-  Heavy Cleaning/Cleaning
-  Replace, Risk 2
-  Replace, Risk 3
-  Replace, Risk 4
-  Replace, Risk 5
-  Gravity Main

City of El Monte
Wastewater Master Plan
Gravity Main Final Rehabilitation Plan
Figure 9-15

9.5. Manhole Asset Management Plan

A manhole is the most accessible component of the sewer system. Common failures of manholes include infiltration, surrounding ground settlements, corrosion, and structural problems.⁷ This Manhole Asset Management Plan was developed using a similar process as the Gravity Main Asset Management Plan.

9.5.1. GIS Database

As part of the City's WWMP, the City's sewer system has been digitized into GIS database. Only a small portion of manholes were identified with a known installation date in the GIS database due to poor or missing records. Manholes with unknown installation dates were assumed to be the same as their downstream pipes. Manhole materials were not available from the as-builts. Based on the manhole inspection data and information provided by City staff, the vast majority of the manholes were constructed of brick or precast concrete. Table 9-20 summarizes the number of manhole by installation year/decade.

Table 9-20. Number of Manholes per Decade

Installation Year, by Decade	# of Manhole	Percent of Total
1900 - 1910	9	0.34%
1910 - 1920	0	0.00%
1920 - 1930	0	0.00%
1930 - 1940	186	6.95%
1940 - 1950	26	0.97%
1950 - 1960	379	14.16%
1960 - 1970	211	7.88%
1970 - 1980	106	3.96%
1980 - 1990	104	3.89%
1990 - 2000	17	0.64%
2000 - 2010	15	0.56%
2010 - 2015	20	0.75%
UNK	1,603	59.90%
Total	2,676	100.00%

As shown, about 60% of the City's existing manholes do not have a record of installation dates. Of the manholes with a known installation year, more than half were installed 60 or more years ago.

9.5.2. Field Evaluation and CCTV Inspection

As part of the asset management plan, approximately 50% (1,250) of the City's manhole were inspected by Pro-Pipe®. Pro-Pipe® uses MACP (Manhole Assessment Certification Program) certified personnel to perform manhole inspections using IBAK Panoramo SI equipment and software. The IBAK Panoramo SI has the ability to scan a manhole within a 20 second period and provide 360-degree pan, zoom, and tilt optical inspection of any section within the manhole for analysis.

The manholes inspected for this AMP are shown in Figure 9-2.

9.5.3. Manhole Inspection and Rehabilitation Plan

The manhole inspection data was imported into InfoMaster and a survey analysis was performed to geocode the defects, score the manhole structural and operational conditions, and assign preliminary rehabilitation methods for the corresponding manholes using the built-in survey analysis wizard tool. Figure 9-16 shows the defects identified through manhole inspection.

InfoMaster has default rehabilitation methods assigned to the certain defect codes. The rehabilitation methods are listed below:

- No Action
- Cleaning
- Point Repair
- Lining
- Remove Roots

The NASSCO's MACP defects reference table and the default rehabilitation action assigned to the defect code in InfoMaster is included as Appendix E.

A Draft Manhole Rehabilitation Plan was developed based on the manhole inspection data. Therefore, only the inspected manholes were assessed and recommended for rehabilitation actions. In addition to the Draft Rehabilitation Plan, InfoMaster allows users to perform risk-based assessment based on manhole's age, location to critical facilities, connected pipes, etc. The risk assessment results can be used to evaluate the manholes without inspection data. The risk assessment results and the survey analysis results can then be incorporated into one Final Manhole Rehabilitation Plan for the whole system.

9.5.4. Risk Assessment

The risk-based assessment includes evaluation of the manholes' likelihood of failure and consequence of failure. The manhole's likelihood of failure was scored based on two criteria:

- Age
- Manhole Depth

The manhole's consequence of failure was scored based on four criteria:

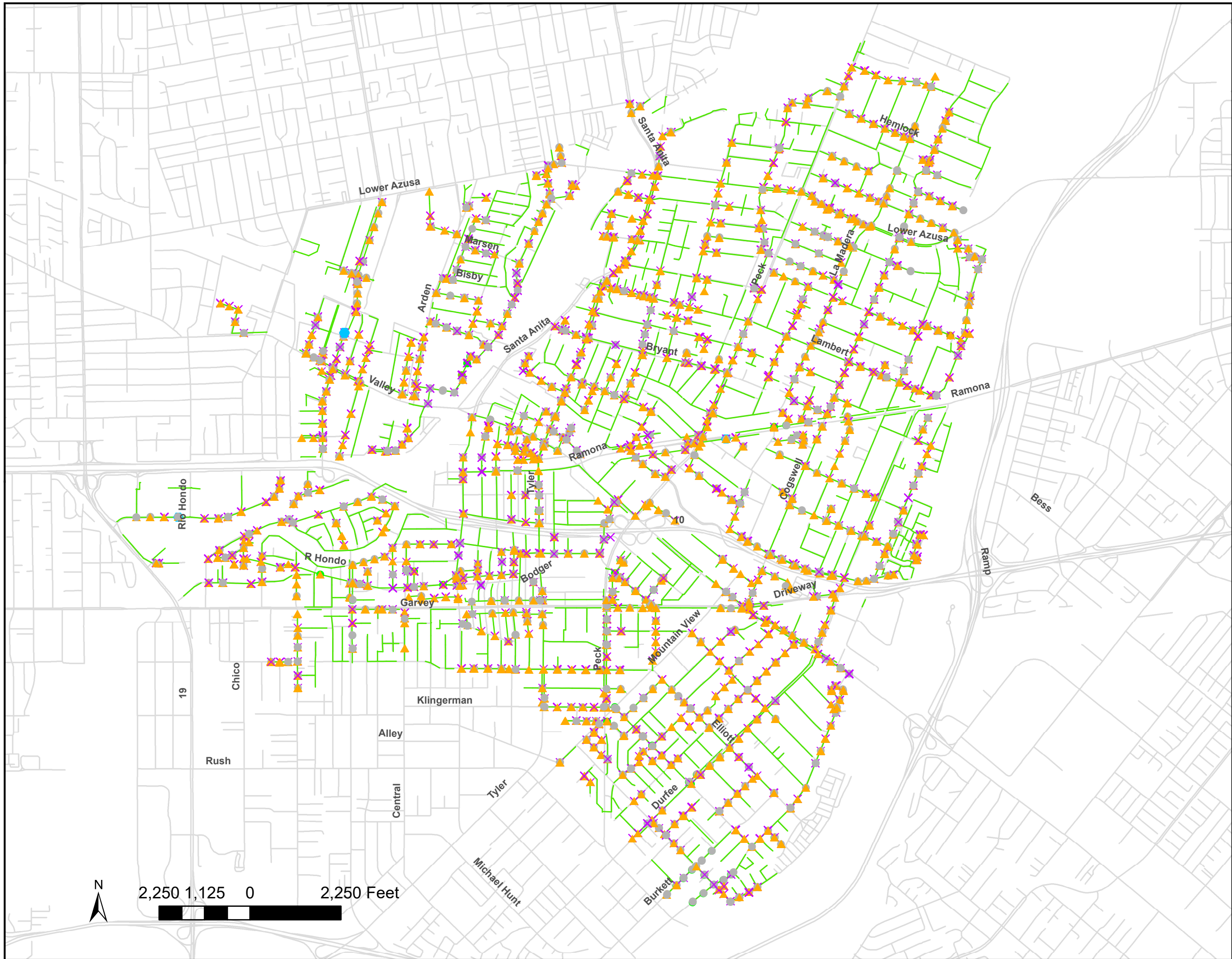
- Connections
- Connected Inlet Size
- Critical Facilities
- Water Bodies
- Street Type

Details of each criterion will be discussed below.

9.5.4.1. Likelihood of Failure (LOF)

AGE


LOF evaluates the probability of a manhole structural and operational failure. The older the manhole is, a higher score the manhole was assigned. Since over half of the City's manholes are missing installation date records, the inspection data was utilized to determine the score for manholes with an unknown installation year. Figure 17 presents the manholes' average structure score by age in 20 year increments. A higher structure score presents more severe defects.



Legend

Manhole Defect Type

- ✕ STRUCTURAL
- CONSTRUCTION
- ▲ SERVICE
- MISCELLANEOUS
- Gravity Main


 City of El Monte
 Wastewater Master Plan
Manhole Defects
Figure 9-16

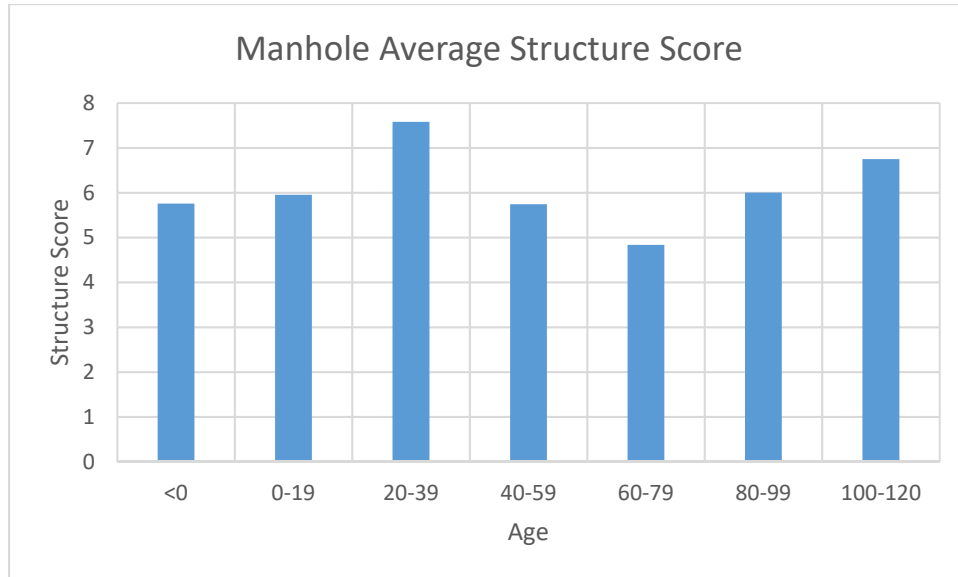


Figure 9-17. Average Manhole Structure Score by Age

Based on Figure 9-17, there is no clear correlation between the structure condition and manhole age. Table 9-21 shows the wall materials identified during manhole inspection.

Table 9-21. Inspected Manhole Material

Wall Material	# of Inspected Manholes
Brick	905
Cast In Place Concrete	4
Precast Concrete	265
Unknown	1
Total	1,175

Older manholes constructed prior to 1950s tend to be brick manholes as bricks and mortar were the common materials used to construct manholes. During the mid-20th century, there was a shift from brick manholes to precast concrete manholes. The life span of brick manholes varies depending on the craftsmanship of the builders.⁸ Precast concrete can have a service life of in excess of 100 years, but precast concrete manholes may be subject to corrosion due to hydrogen sulfide and other chemicals and solvents released in wastewater.^{7,9}

Pipes with unknown installation years are close to the average structure score of pipelines with age year of 60-79. For this analysis, they were assigned a medium risk score. Table 9-22 shows the LOF Scores by manhole age.

Table 9-22. LOF Score by Manhole Age

Installation Year	Age (Years)	Score	# of Manhole
<= 1918	100	5	9
1918 - 1943	75 - 100	4	191
1943 - 1968	50 - 75	3	602
1968 - 1993	25 - 50	2	226
1993 - 2016	2 - 25	1	45
UNK		3	1597

Manhole Depth

Similar to gravity main, shallow manholes are assumed more likely to fail due to the traffic volume from the street and deeper manholes assumed more likely to fail due to the increased soil pressure and allow more infiltration. Table 9-23 lists the LOF score by manhole depth.

Table 9-23. LOF Score by Manhole Depth

Manhole Depth (ft)	Score
Less than 4'	5
4-7	1
7-12	3
Greater than 12'	5
UNK	3

9.5.4.2. Consequence of Failure (COF)

CONNECTIONS

As part of the risk assessment, the COF evaluates the criticality of an asset. Manholes with more connections have higher consequence of failure as they usually transfer more flows and have larger sewer basin. Table 9-24 lists the COF score by manhole connections.

Table 9-24. COF Score by Manhole Connections

Connections	Score
<= 1	1
2	2
3	3
4	4
> 4	5

CONNECTED INLET SIZES

Manholes connected to larger pipes, which usually carry more flows and are backbones of the system, are assumed to higher consequence of failure. Table 9-25 lists the COF score by connected pipe size.

Table 9-25. COF Score by Connected Inlet Size

Pipe Size (in.)	Score
<= 8	1
8 - 10	2
10 - 12	3
12 - 15	4
15 - 21	5

CRITICAL FACILITIES

Manholes located near critical facilities including fire departments, police departments, schools, hospitals, and power facilities in this study have higher community impacts throughout the City. The City’s GIS database was utilized to determine the distance between manholes and the critical facilities listed above. Manholes within 500 ft of the critical facilities were scored from 1-5, and manholes more than 500 ft away from the critical facilities were given a score of zero.

Table 9-26 lists the COF score by distance between manholes and critical facilities.

Table 9-26. COF Score by Distance to Critical Facilities

Distance (ft)	Score
< 50	5
50 -100	4
100 - 200	3
200 - 300	2
300 - 500	1
> 500	0

WATER BODIES

Failure of a manhole in close proximity to an above-ground water body can result in contamination to the nearest water body and lead to environmental and public health concerns. Table 9-27 lists the COF score by distance to a nearby water body, which is The Rio Hondo. Manholes within 1000 feet of the Rio Hondo were scored from 1-5, and pipes beyond 1000 feet from a water body were given a score of zero.

Table 9-27. COF Score by Distance to Water Body

Distance (ft)	Score
<= 50	5
50- 150	4
150 - 300	3
300 - 450	2
450 - 1000	1
> 1000	0

STREET TYPE

Manholes located in busy streets have a higher consequence of failure as repair or replacement work will aggravate higher volumes of traffic and impact more people. Busy streets are assumed to be street segments with speed limits of 45 mph (miles per hour) and above, such as freeways, highways, and parkways. Manholes are scored based on the streets they are located in. Table 9-28 lists the COF score based on manhole proximity to street type.

Table 9-28. COF Score by Manhole Proximity to Street Type

Speed Limit (mph)	Score
55	5
45	4
35	3
25	2
15	1

After scoring manholes based on the above criteria, a risk analysis was performed to combine the LOF scores and the COF scores to develop a total score for the manholes. Bi-Directional Distribution is also selected for manhole risk analysis, as discussed in the pipeline risk analysis.

Table 9-29 summarizes the weights associated with each LOF criterion and COF criterion for the risk analysis.

Table 9-29. Summary of Weights for Each Manhole Criterion

LOF Criteria	Weight	COF Criteria	Weight
Age	1.00	Connections	2
Manhole Depth	1.00	Connected Pipe Size	2
		Critical Facilities	1
		Water Bodies	1
		Street Type	2

Table 9-30 presents the risk analysis results summary.

Table 9-30. Manhole Risk Analysis Results Summary

Risk	% of Total Number	Number of Facilities
1- Negligible	0.30	8
2-Low	10.04	268
3-Medium	71.84	1,918
4-High	15.54	415
5-Extreme	2.28	61

A small percentage of manholes were assigned to extreme and high risk, and approximately 72% of the manholes were assigned as medium risk. Figure 9-18 and Figure 9-19 provide the breakdown of contribution for the LOF and COF scores.

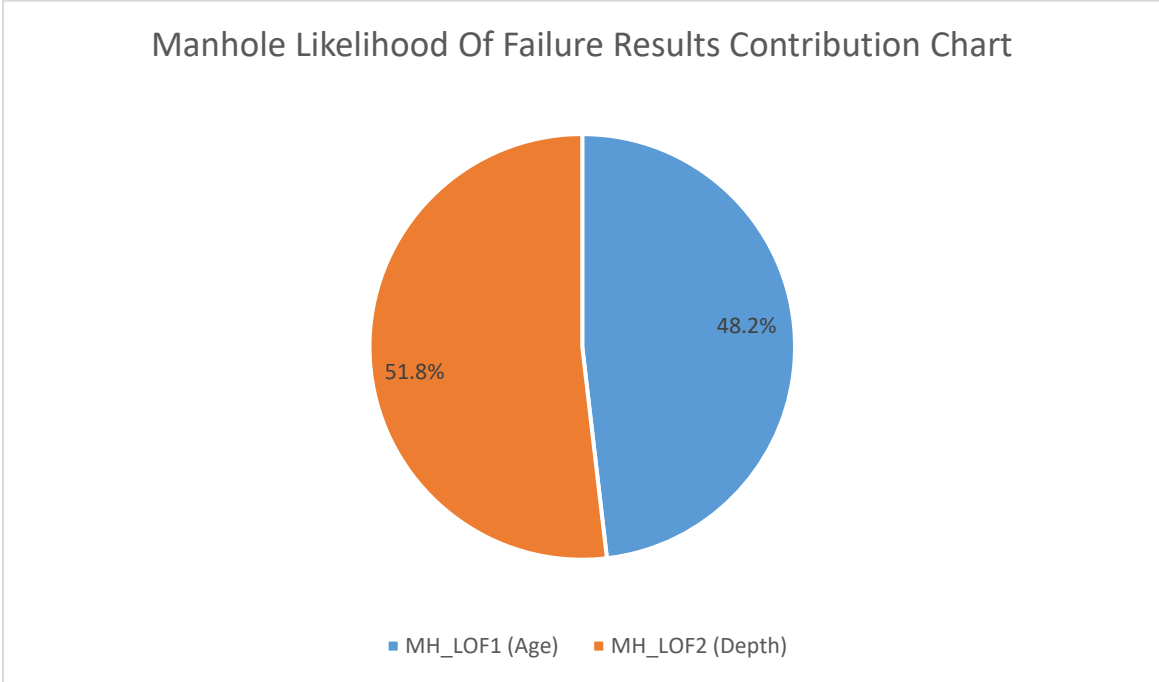


Figure 9-18. Manhole Likelihood of Failure Results Contribution Chart

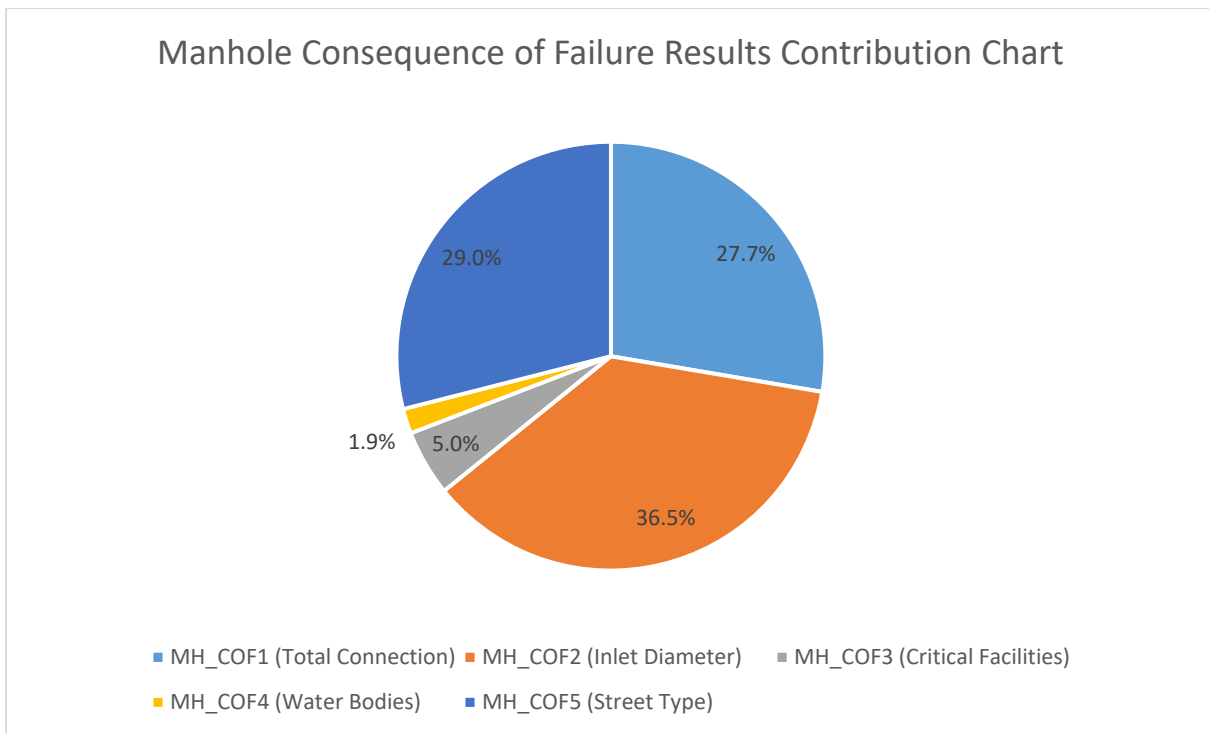
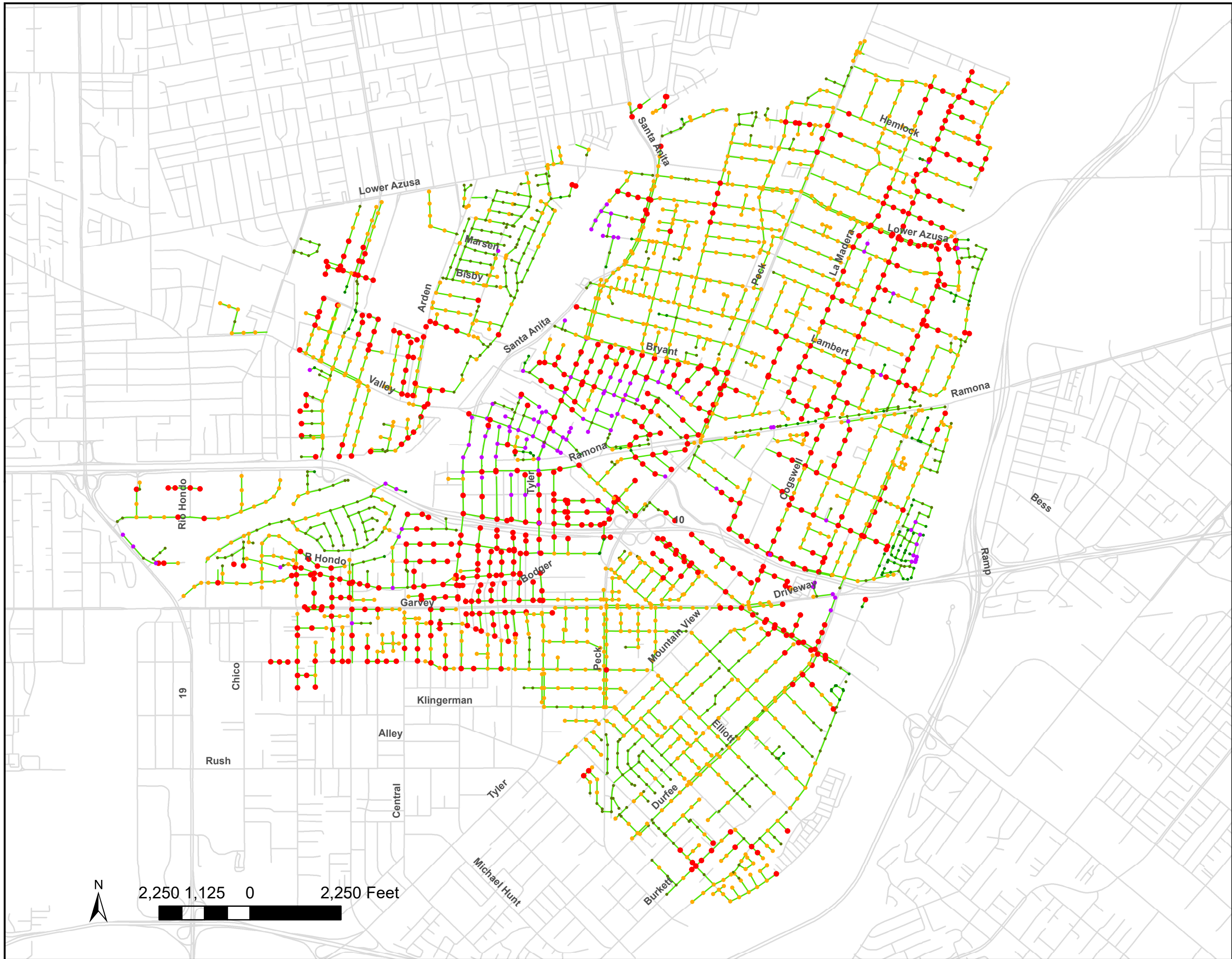


Figure 9-19. Manhole Consequence of Failure Results Contribution Chart

Figure 9-20 and Figure 9-21 show how the manholes of the overall sewer system were scored by LOF and COF. Figure 9-22 shows the combined risks results on the map of the City showing where the highest risk manholes are located.




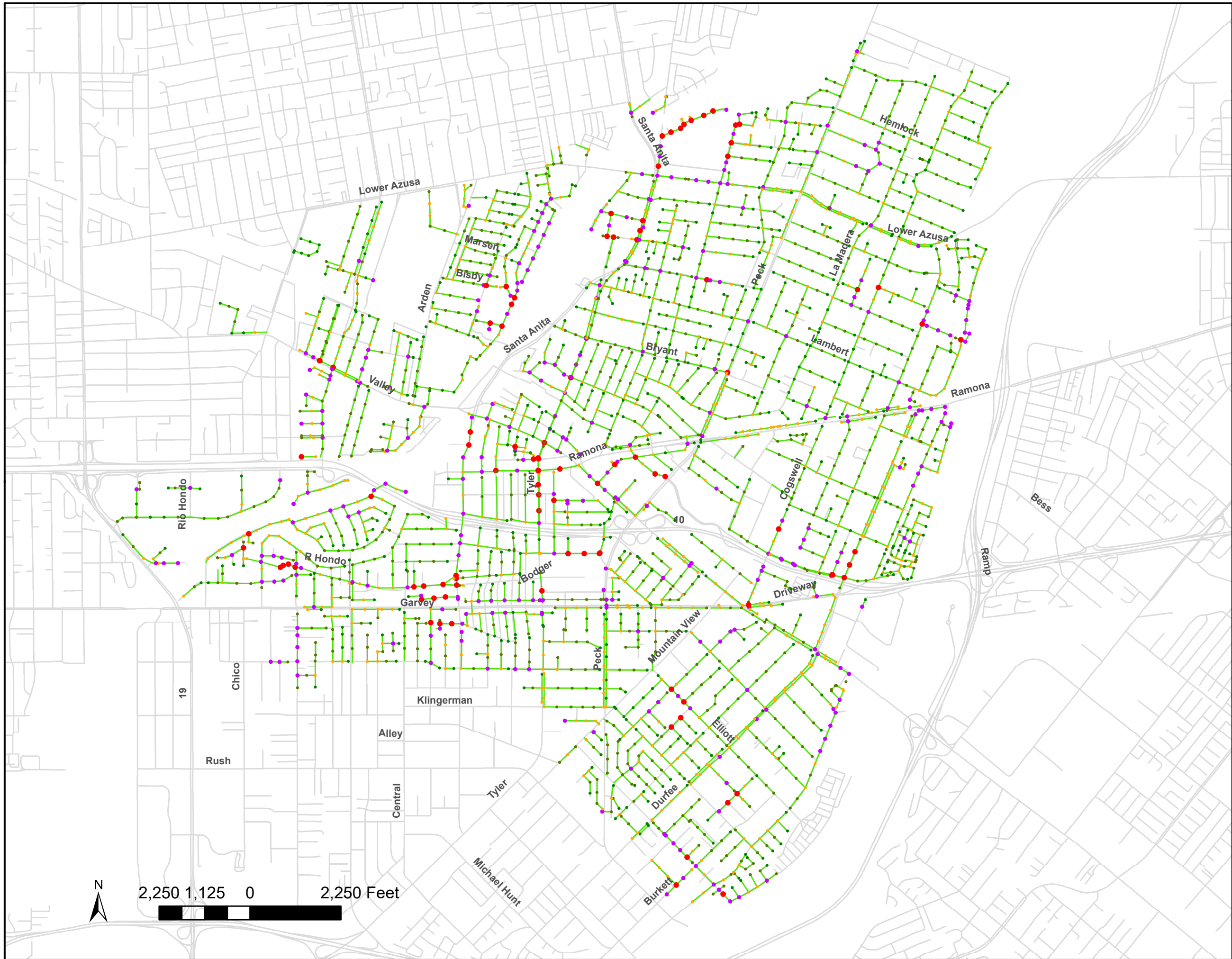
Legend

Manhole LOF Score Range

- less than or equal to 3
- 3 - 5
- 5 - 6
- 6 - 7
- larger than 7

— Gravity Main

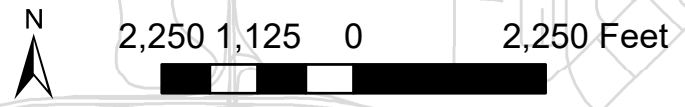

 City of El Monte
 Wastewater Master Plan
**Manhole Likelihood of Failure
 Results Map**
Figure 9-20



Legend

Manhole COF Score Range

- less than or equal to 12
- 12 - 15
- 15 - 17
- 17 - 20
- larger than 20
- Gravity Main

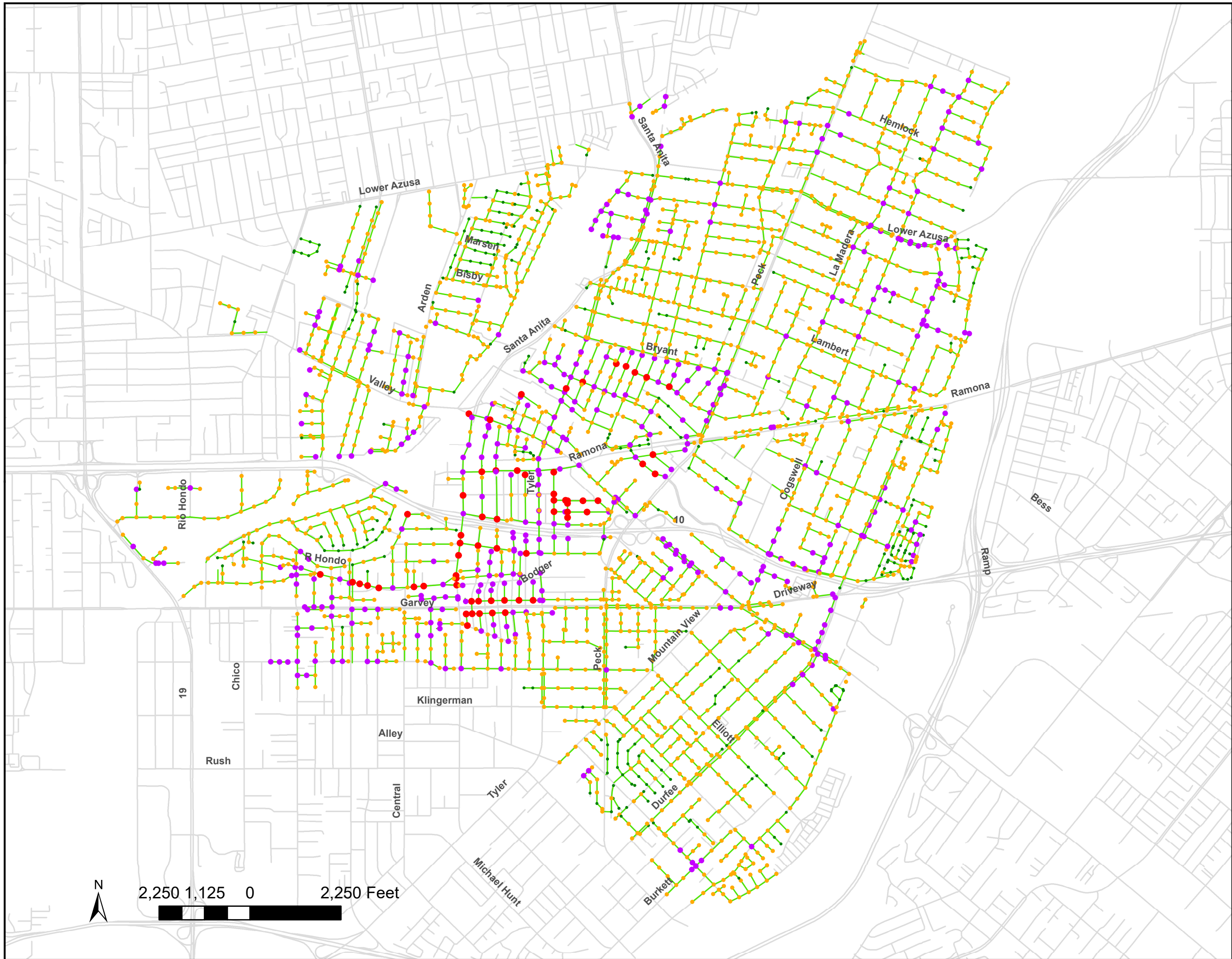


Infrastructure
ENGINEERING CORPORATION

City of El Monte
Wastewater Master Plan

**Manhole Consequence of Failure
Results Map**

Figure 9-21




Legend

Manhole Total Risk Score

- less than or equal to 2
- 2 - 3
- 3 - 4
- larger than 4

— Gravity Main

 Infrastructure
ENGINEERING CORPORATION

City of El Monte
Wastewater Master Plan

**Manhole Risk Analysis
Combined Risk Results Map**

Figure 9-22

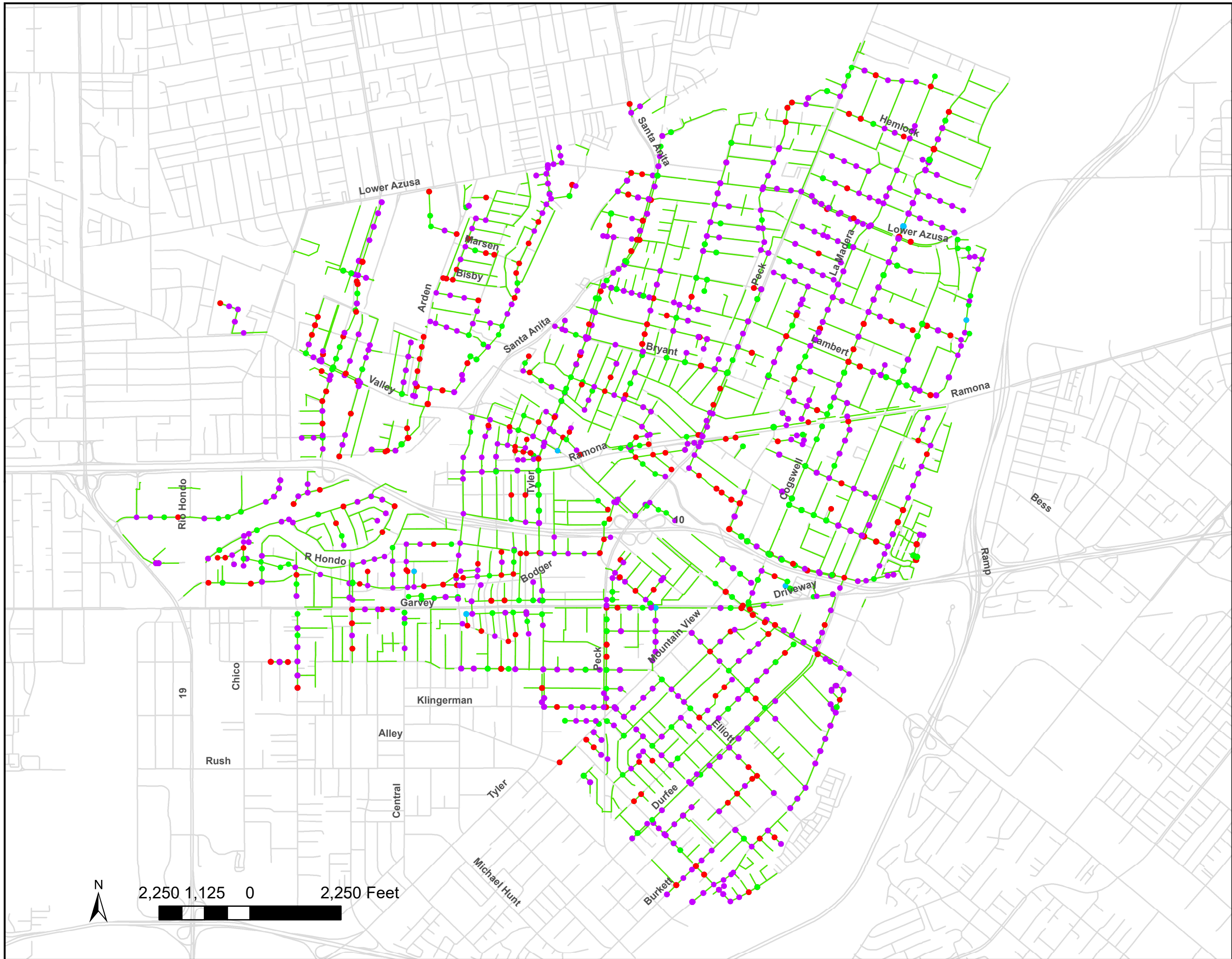
9.5.5. Manhole Rehabilitation Plan

9.5.5.1. Draft Manhole Rehabilitation Plan

As discussed previously, InfoMaster provides a draft rehabilitation plan solely based on manhole inspection data. Table 9-31 summarizes the results from the Draft Manhole Rehabilitation Plan. Figure 9-23 shows the Draft Rehabilitation Plan as a map.


Table 9-31. Summary of Manhole Draft Rehabilitation Action Recommendations

Rehabilitation Action	Number of Rehabilitation Action Results
CLEANING	736
LINING	1,067
POINT REPAIR	530
REMOVE ROOTS	11
Grand Total	2,344



Legend

- CLEANING
- POINT REPAIR
- LINING
- REMOVE ROOTS
- Gravity Main


 City of El Monte
 Wastewater Master Plan
Manhole Draft Rehabilitation Plan
Figure 9-23

9.5.5.2. Final Manhole Rehabilitation/Replacement Plan

With consideration of both the condition assessment results and risk assessment results, a decision tree was created to make the final recommendations on manhole rehabilitation/replacement. Costs associated with each rehabilitation method were also added. The decision tree is customizable to allow users to specify threshold conditions for the corresponding rehabilitation method. The decision tree of the Final Manhole Rehabilitation Plan is shown in Figure 9-24. Based on research of similar studies completed in the past 10 years¹⁰⁻¹³, Tables 9-32 shows the planning-level unit costs that were used to develop the Manhole Final Rehabilitation Plan. Unit costs shown in the tables include an additional 30% for contingency and 27.5% for costs for engineering, legal, admin, etc.

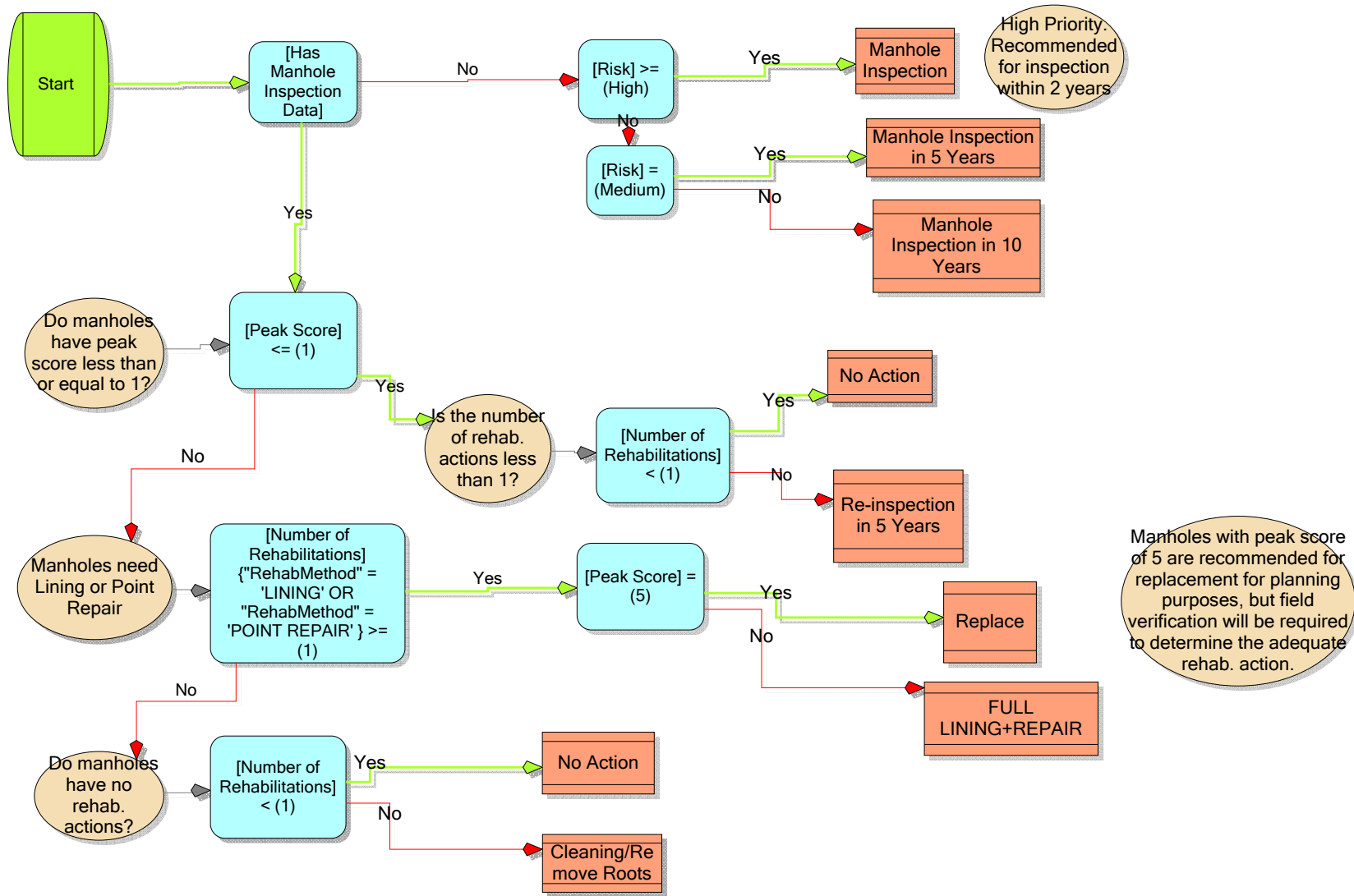
Table 9-32. Unit Costs for Manhole Rehabilitation Methods

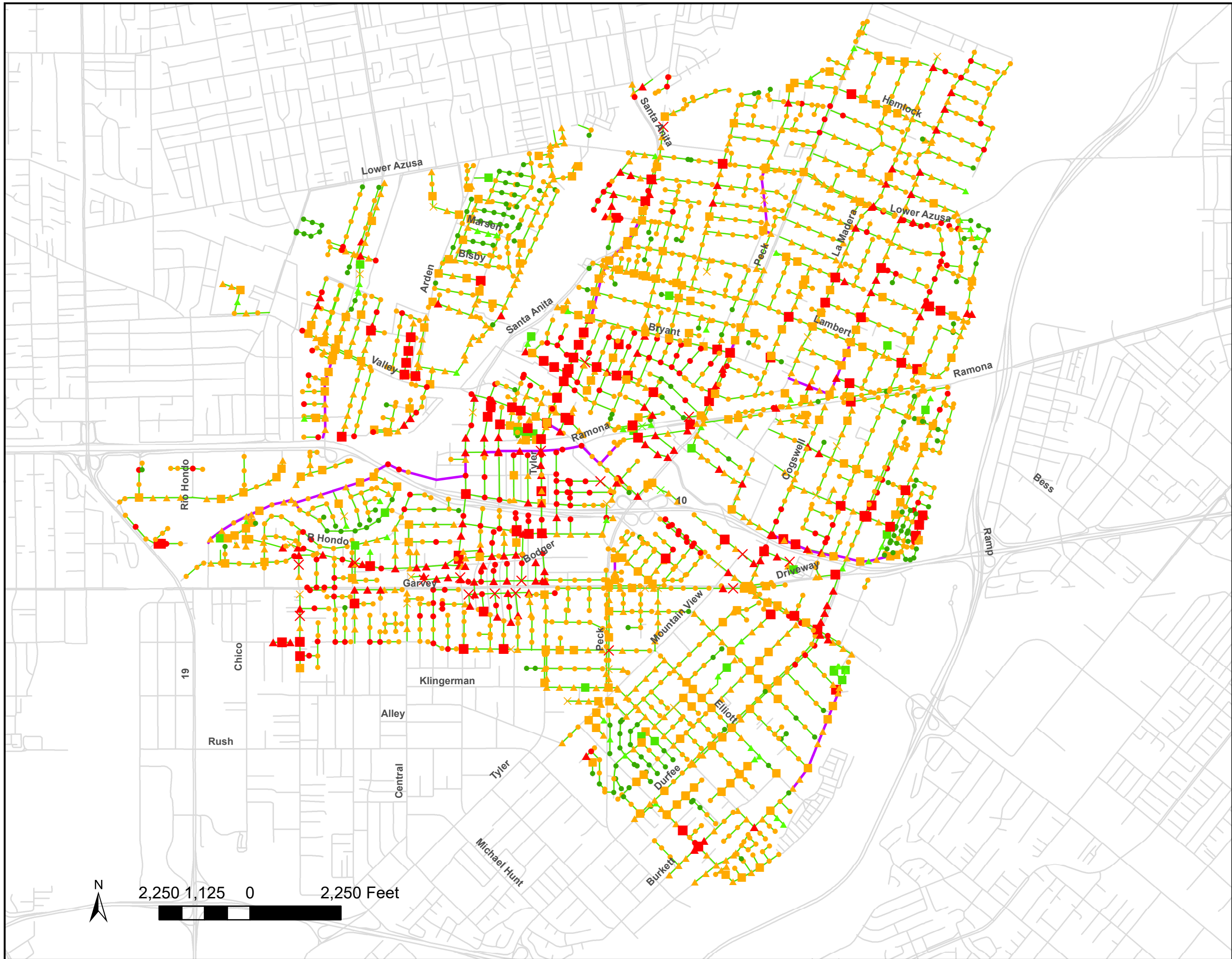
Rehabilitation Method	Unit Cost
Point Repair/Lining	\$11,000 ea.
Replacement	\$19,000 ea.
CCTV	\$110 ea.
Cleaning/Remove Root	\$600 ea.

Point repair and lining is assumed to include cleaning and removing roots if necessary.

Results from the Final Manhole Rehabilitation/Replacement Plan are reflective of the rehabilitation plan decision tree. Details of the results are shown in Appendix F. Figure 9-25 presents the final manhole rehabilitation plan by risk grading. Rehabilitation/replacement of the manholes is recommended to start from high-risk manholes to low-risk manholes. Rehabilitation/replacement projects should be field validated and evaluated on a project-to-project basis. Low-risk manholes may be repaired in an early phase based on its location and project nature. Manhole repair/replacement, gravity main repair/replacement, and gravity main upsizing can be combined into one improvement project based on asset location, project nature, and available budget.

Figure 9-24. Manhole Rehabilitation Plan Decision Tree






Legend

Rehab. Action by Risk

- ✕ Cleaning/Remove Roots, 2
- ✕ Cleaning/Remove Roots, 3
- ✕ Cleaning/Remove Roots, 4-5
- Manhole Inspection in 10 Years
- Manhole Inspection in 5 Years
- Manhole Inspection in 2 Years
- ▲ FULL LINING+REPAIR, 1-2
- ▲ FULL LINING+REPAIR, 3
- ▲ FULL LINING+REPAIR, 4-5
- Replace, 2
- Replace, 3
- Replace, 4-5
- Gravity Main CIP
- Gravity Main



City of El Monte
Wastewater Master Plan
**Manhole Final
Rehabilitation Plan**
Figure 9-25

Following the completion of this Gravity Sewer Asset Management Plan, it is recommended that the City continue to proactively evaluate and manage sewer facilities, including the following:

1. Continue conducting CCTV inspections, assessing the condition of the gravity sewer system using NASSCO standards, and obtaining data that can be uploaded into the City's GIS database. Approximately 50-percent of gravity mains were inspected via CCTV by Pro-Pipe® during the preparation of this Asset Management Plan. The City also utilizes Cues CCTV technology for City crews to inspect pipelines and has the equipment and software to continue this effort. Whether this task is performed by the City or a contractor, it is recommended that the City review current inspection and condition assessment procedures to confirm any data obtained in the future is consistent with NASSCO standards and can be incorporated into the City's database. The City should also develop a clear plan for inspection data so that it is properly transferred from field crews, to supervisors, and if deemed necessary, to engineering and administrative staff for identification of replacement or repair needs. The City should identify a phased approach for future CCTV inspections to ensure all gravity mains are inspected.
2. Continue cleaning gravity mains, which can be done during inspections.
3. Continue conducting manhole inspections. Approximately 50-percent of the City's manholes were inspected by Pro-Pipe® during the preparation of this Asset Management Plan. The City should identify a phased approach for future manhole inspections to ensure all manholes in the system are inspected, defects are identified according to NASSCO standards, and manhole rehabilitation or replacement projects are prioritized.
4. The City should define and implement a manhole rehabilitation program, identifying the City's desired rehabilitation methods, which may include sealing techniques to reduce infiltration, restoration of manhole surfaces, installation of coatings/liners for corrosion protection, installation of bench and channel inserts, removal or replacement of deteriorated steps, replacement of frames and covers, and frame adjustments if needed.
5. Refine or improve the Decision Trees for pipeline and manhole rehabilitations. The flow chart should be refined or updated to improve rehabilitation and replacement decisions and to allow for programmatic decisions to be made consistently.
6. It is recommended that the City also begin the development of an Asset Management Plan for lift stations and force mains, which may entail the following initial steps:
 - a. Consider the preparation of a detailed inventory list to document assets at each lift station.
 - b. Conduct condition assessments at each station using detailed checklists. This should be performed by a multi-discipline team of mechanical, structural, and electrical engineers assisted by operations staff who are familiar with the details, deficiencies, and maintenance history of the stations. These assessments should document conditions and include condition rankings, an estimate of the remaining useful life, criticality, vulnerability, and overall risk for each asset.
 - c. Conduct condition assessments of existing force mains. There are various non-invasive and invasive techniques available to identify corrosion, deterioration, leaks, or defects in existing force mains. The appropriate technique will need to be selected based on the pipeline material, ability to take the pipeline out of service, location, and other factors. Once the condition of each force main is reviewed, force main risk assessments can be performed, and repairs or replacements can be prioritized.

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Appendices