City of Galt

STORM DRAINAGE SYSTEM MASTER PLAN

FINAL

MAY 2010

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City of Galt

STORM DRAINAGE SYSTEM MASTER PLAN

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STORM DRAINAGE SYSTEM MASTER PLAN

ES.1 INTRODUCTION

The City of Galt (City) is located along State Highway 99 in northern California's Central Valley, between the cities of Sacramento and Stockton, and near the Delta Recreation Area[1].

The City collects and disposes stormwater runoff generated within the City service area. The storm drainage system is designed to manage the runoff of rainwater and minimize the impact of significant rainfall, which ultimately flows into local drainage channels. The City's storm drainage infrastructure includes over 70 miles of storm drainage lines spanning 4-inches to 84-inches in diameter, one detention pond, and two pump stations.

ES.2 STUDY AREA

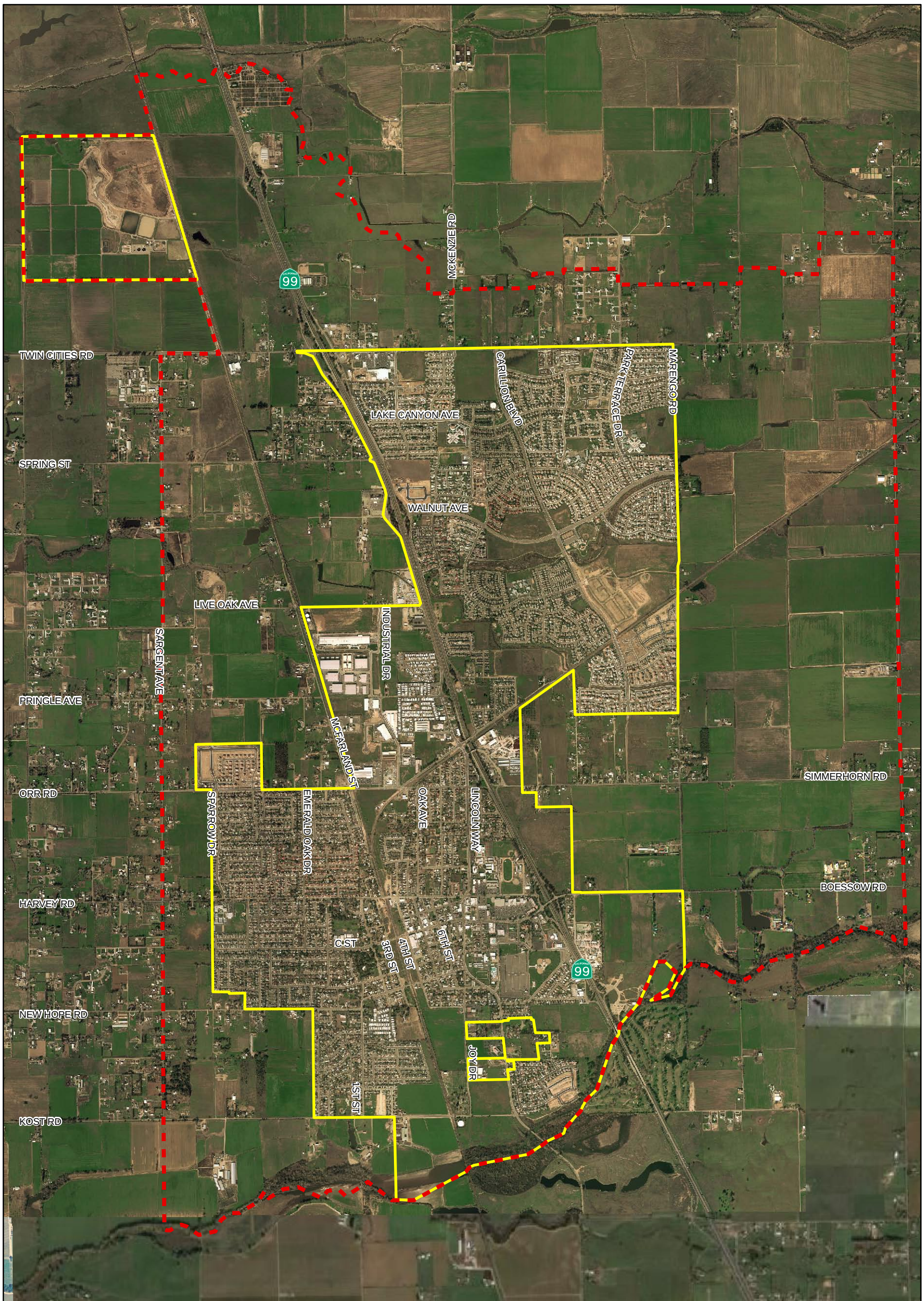
The City's 2030 General Plan Public Review Draft (General Plan) planning boundary is the study area boundary for this storm drainage system master plan (Master Plan). The Master Plan study boundary and the General Plan boundary are synonymous and will be used interchangeably throughout this report. The General Plan planning boundary extends beyond the current storm drainage system service area and is approximately 8,817 acres (13.8 square miles). The Master Plan contains a forecast of storm drainage system improvements in a large study area beyond the City's limits. Figure ES.1 shows the study area boundary and the current City limits.

Evaluating infrastructure needs beyond the current City limits is important because: there are pending conceptual development plans that are beyond the City limits; and historical cycles of rapid growth in the Sacramento metropolitan area indicates that significant development into the study area could occur within a short planning period.

ES.3 EXISTING AND FUTURE SERVICE AREA

The land use criteria used in this Master Plan (residential, commercial, etc.) are consistent with the 2030 General Plan Land Use. The type of land use in an area will affect the volume and peak flow of the storm water runoff. Adequately estimating the quantity of storm water runoff from various land use types is important in sizing and maintaining effective storm drainage system facilities.

[1] City of Galt 2030 General Plan, Existing Conditions Report, November 2005, Mintier & Associates et al.



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General Plan Boundary

City Limits

N

0 2,500 5,000 Feet

Figure ES.1
Study Area
Storm Drainage System Master Plan
City of Galt

The City currently provides storm drainage service to approximately 3,763 acres (includes developed and undeveloped land) or 5.9 square miles. The largest land use category is residential (rural, low density, medium density, medium-high density, and high density), which accounts for approximately 1,758 acres, or approximately 47 percent of the total current City limit acreage. Commercial, office professional, and light industrial make up approximately 566 acres, or 15 percent of the total. Other land uses such as public/quasi-public, parks, streets, and open space account for 1,440 acres, or 38 percent of the total service area.

At build-out of the General Plan boundary, the City will serve approximately 8,817 acres. Build-out is defined as complete development of all lands outside the 100-year floodplain. There are approximately 8,059 acres within the study area that are outside the 100-year floodplain. Residential will continue to represent the largest land use category in the City and will make up approximately 49 percent of the total acreage.

ES.4 HISTORICAL AND FUTURE POPULATION

In 1990, the City's population began to grow rapidly and that growth continued through year 2000. From 1990 through 2007, the population grew from approximately 8,800 to 23,500. Over these 17 years, the City grew at an annual rate of about six percent.

The General Plan forecasts that the City's population will grow at an annual rate of 3.4 percent from 2002 to 2025, and will reach a 2030 population of 50,094 people. Table ES.1 summarizes the existing and projected year 2030 population.

Table ES.1 Existing and Projected Year 2030 Population
Storm Drainage System Master Plan
City of Galt

Year	Population
2007	23,470
2030	50,094

Note:
1. Source: City of Galt 2030 General Plan, Existing Conditions Report, November 2005, Mintier & Associates et al. and City of Galt General Plan, Policy Document, Public Review Draft, July 2008, Mintier & Associates et al.

ES.5 HYDROLOGIC AND HYDRAULIC ANALYSIS

The existing storm drainage system collects and conveys surface water runoff throughout the City and ultimately discharges the runoff into local drainage channels. The majority of storm water runoff generated in the City is discharged directly into drainage channels, such as Deadman Gulch or Dry Creek, although the City does own and operate one detention basin that is capable of capturing storm water runoff.

The storm drainage system was evaluated using H_2OMAP SWMM modeling software. H_2OMAP SWMM is a commercial version of EPA SWMM 5.0 software. The SWMM Runoff Block, which is included in H_2OMAP SWMM, was used to perform the hydrologic analysis. This analysis conducted rainfall-runoff simulations that accounted for climate, soil, land use, and topographic conditions of the watershed. Once runoff quantity was simulated, and loads at receiving nodes were determined, the routing portion of the software transported the flow through the City's conveyance system of storm drains, detention basins, and pump stations to evaluate the capacity of these facilities.

ES.6 CAPACITY EVALUATION AND PROPOSED IMPROVEMENTS

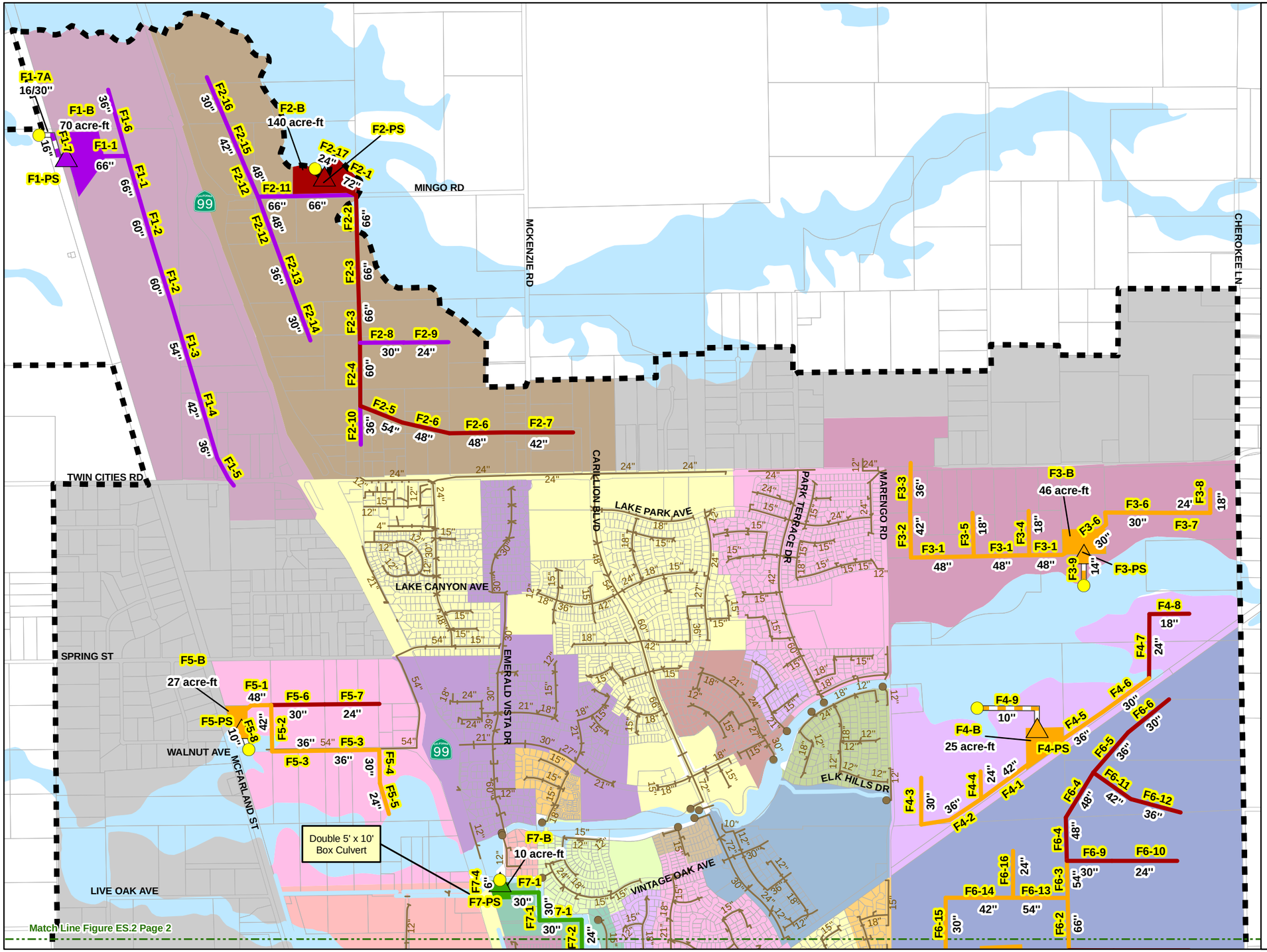
The capacity analysis entailed identifying areas in the storm drainage system where street flooding exceeded the one-foot maximum criteria. Storm drains that lack sufficient capacity to convey runoff generated from the design storm could produce backwater effects in the drainage system and potentially cause flooding.

When evaluating the adequacy of the storm drainage facilities serving existing and future developments, City streets were allowed to flood and provide additional storage capacity, thus reducing the number of storm drain improvements. When storm drains are located in City streets, the goal was to contain storm flows within the drainage pipelines, with minimal ponding in City streets during the 10-year design storm. The storm drainage criteria allowed City streets to flood up to one foot above the gutter flow line in the 100-year design storm. If flooding exceeded one foot, then an improvement was necessary to correct the problem. Pipe systems that are not within a street that act as an overland flow channel should have sufficient capacity to convey the 100-year design storm, while maintaining a hydraulic grade line below the manhole rim elevations.

In general, the existing storm drainage system has sufficient capacity to convey runoff generated during the 10-year design storm. In some locations, the existing storm drains lack sufficient capacity to convey the design runoff while meeting the one-foot criterion. These areas are generally located in 100-year City's southwest area and are susceptible to flooding.

The proposed improvements that will serve future users are sized for build-out conditions. As the City continues to grow beyond its current limits, it is recommended that the pipeline diameters, detention basin sizes, and pump station capacities proposed in this Master Plan be constructed so that the facilities have sufficient capacity for build-out conditions. Building a smaller interim project with the plans of upsizing in the future to account for further growth is not recommended. In this Master Plan, the proposed pipe diameter represents the ultimate diameter for build-out conditions.

Figure ES.2 illustrates the proposed storm drainage system improvements required to correct existing deficiencies and to serve future users. The proposed pipeline diameter is also shown on the figures. Figure ES.2 shows the proposed improvements in different



Legend

Storm Facilities

- Outfall
- Future Outfall
- Pump Station
- Gravity Pipeline
- Outfall Pipeline
- Storage Basin
- Surface Drainage/100-Year FEMA Floodplain

Facility Coloring

- Existing System

Existing System Improvements

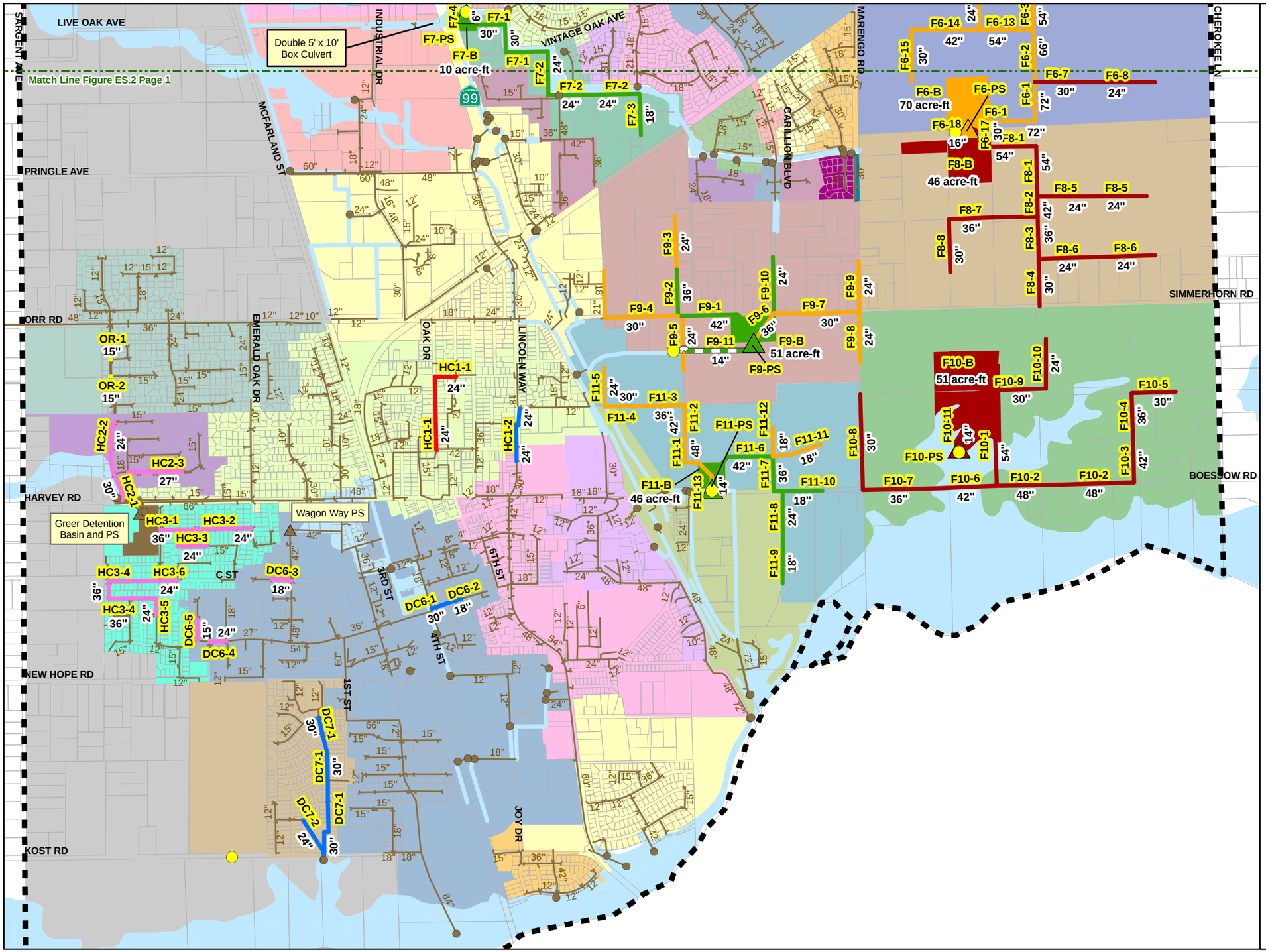
- Phase 1 (2009 - 2015): New
- Phase 1 (2009 - 2015): Replacement
- Phase 2 (2016 - 2020): New
- Phase 2 (2016 - 2020): Replacement

Future System Improvements

- Phase 1 (2009 - 2015)
- Phase 2 (2016 - 2020)
- Phase 3 (2021 - 2025)
- Phase 4 (2026 - 2030)
- Future Drainage Subbasins
- General Plan Boundary
- Parcels
- F1-2 Figure Number
- 12" Proposed Pipeline Diameter
- 12/24" Proposed Pipeline/ Casing Pipe Diameter
- 8" Existing Pipeline Diameter

Feet
0 1,500 3,000

Figure ES.2
Proposed Capital Improvements (1 of 2)
Storm Drainage
System Master Plan
City of Galt



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Storm Facilities

- Outfall
- Future Outfall
- Pump Station
- Gravity Pipeline
- Outfall Pipeline
- Storage Basin
- Surface Drainage/100-Year FEMA Floodplain

Facility Coloring

- Existing System

Existing System Improvements

- Phase 1 (2009 - 2015): New
- Phase 1 (2009 - 2015): Replacement
- Phase 2 (2016 - 2020): New
- Phase 2 (2016 - 2020): Replacement

Future System Improvements

- Phase 1 (2009 - 2015)
- Phase 2 (2016 - 2020)
- Phase 3 (2021 - 2025)
- Phase 4 (2026 - 2030)
- Future Drainage Subbasins
- General Plan Boundary
- Parcels
- F1-2 Figure Number
- 12" Proposed Pipeline Diameter
- 12/24" Proposed Pipeline/ Casing Pipe Diameter
- 8" Existing Pipeline Diameter

0 1,500 3,000 Feet

Figure ES.2
Proposed Capital Improvements (2 of 2)
Storm Drainage System Master Plan
City of Galt

GALT

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categories (colors). The different colors identify the implementation timeframe of the improvements and differentiate between near-term and long-term improvements.

A detailed inventory of the proposed improvements illustrated in Figure ES.2 is included in Table 6.2 of this report.

ES.6.1 Existing Versus Future Improvement

An existing deficiency is one where the existing facility's capacity is insufficient to meet the planning criteria (e.g. pipeline upgrades required to prevent flooding in excess of one foot above the curb line) for existing users. If a project was proposed to correct an existing deficiency, then existing users were assigned 100 percent of the project's benefit, and therefore, 100 percent of the costs.

The vast majority of the Master Plan improvements will serve future users, even when an improvement calls for the upgrade of an existing facility. In these cases, an existing storm drain may have sufficient capacity to convey current design runoff, but as growth continues and more users are added to the system, the increased runoff results in capacity deficiencies. These are labeled future improvements. Future users were assigned 100 percent of the future project's benefit and 100 percent of the costs. More information on the breakdown in cost split between existing and future users and whether a proposed improvement is intended to correct an existing deficiency, to serve a future user, or both is provided in Chapter 5 and Chapter 6.

ES.6.2 Proposed Existing System Improvements

For the majority of the City, the existing storm drainage system contains sufficient capacity to convey peak runoff without exceeding the planning criteria discussed in Chapter 3. There are a few exceptions where existing storm drains will need to be replaced by larger diameter storm drains, or parallel storm drains will need to be constructed to bypass flow around hydraulically deficient storm drain pipes. Detailed descriptions of the proposed existing system improvement projects are provided in Chapter 5.

ES.6.3 Proposed Future System Improvements

Chapter 5 summarizes the new storm drains, pump stations, and storm detention basins that will serve future users. Please note that the locations of the storm drains are preliminary and will likely change during the design phase. The locations shown are possible alignments based on available information and are intended to assist in the development of probable construction costs. No investigation into the feasibility of these alignments has been conducted. However, an attempt was made to place future pipeline alignments within existing streets or proposed future streets presented in the General Plan's Land Use and Circulation Diagram.

As part of this Master Plan, several options available to the City to convey storm water runoff generated in future development areas were analyzed, including the use of direct discharge of storm water runoff to creeks and drainage channels, regional detention basins, and privately maintained detention basins. A project memorandum that summarized the benefits and drawbacks of each alternative was prepared to assist the City in the selection of a preferred alternative. This memorandum is included in Appendix B.

It was determined that the best alternative for the City to pursue in the future is the use of regional storm water detention basins. This alternative is consistent with General Plan policies and future hydromodification and storm water quality regulations.

Therefore, the proposed improvements assume that regional detention basins will be constructed to service future growth within the General Plan boundary. It is also assumed that each detention basin will be equipped with a pump station and associated outfall pipelines to pump storm water from the detention basins into the creeks or drainage channels following the storm. In lieu of a pump station/outfall pipeline set up, the City may be able to construct a system of orifices and gravity storm drains to discharge storm water from the detention basins, assuming that the topography of the detention basin and the discharge point will accommodate such a system. The system should be designed to avoid hydromodification of the receiving channel.

In lieu of the basins, the City may have the opportunity to discharge directly into the creek systems. However, in order to do so, a detailed study would be required to quantify the impact of increased urban runoff on the downstream creek capacity if a detention basin is not installed. The study should also address future regulatory considerations (e.g., hydromodification) and the water quality impact to the stream associated with direct discharges.

ES.7 CAPITAL PROJECT PRIORITIZATION

The majority of the proposed improvements are driven by future development. Most of the improvements are new storm drains that serve future growth, but there are some improvements to existing facilities that are needed to serve existing users, or resulted from future growth.

Prioritizing the required capital improvements for the City's storm drainage system is an important aspect of the Master Plan. The improvement projects were prioritized based on the following factors:

- Upgrading storm drains to mitigate existing flooding conditions
- Building new storm drains, pump stations, and detention basins necessary to serve future users

The implementation of these improvements will depend on the City's pace of development and selection of areas to be served with urban infrastructure. The City provided guidance on future development and phasing of infrastructure to serve future users. Based on this input, the projects were grouped into the following timeframes:

- Years 2009 through 2015
- Years 2016 through 2020
- Years 2021 through 2025
- Years 2026 through 2030

ES.7.1 Existing System Improvement Prioritization

The highest priority projects are those that mitigate existing street flooding. Refer to Table 5.1 in the 2009–2015 column for all Phase I projects and the 2016-2020 column for all the Phase 2 projects. Figure ES.2 illustrates the locations of these improvements and the phasing by color code. The proposed Phase 1 (2009 – 2015) projects and the subbasins in which they are located include:

- Dry Creek 6 subbasin storm drain projects (DC6-1 and DC6-2)
- Dry Creek 7 subbasin storm drain projects (DC7-1 and DC7-2)
- Hen Creek 1 subbasin storm drain projects (HC1-1 and HC1-2)
- Hen Creek 2 subbasin storm drain projects (HC2-1)

The proposed Phase 2 (2016 – 2020) projects and the subbasins in which they are located include:

- Dry Creek 6 subbasin storm drain projects (DC6-3 through DC6-5)
- Hen Creek 2 subbasin storm drain projects (HC2-2 and HC2-3)
- Hen Creek 3 subbasin storm drain projects (HC3-1 and HC3-6)
- ORR Road subbasin storm drain projects (OR-1 and OR-2)

ES.7.2 Phase 1 Projects (2009-2015)

Projects serving new developments in growth areas targeted by the City are shown in Phase 1. The future system projects shown in Phase 1 are part of a larger network of capital projects. For example, the first reaches of the Future Subbasin 9 (F9-1, F9-2, F9-10, F9-11 F9-B, and F9-PS) and Future Subbasin 11 (F11-6 through F11-10, F11-13, F11-B, F11-PS) are targeted as the first segments in the network to be constructed. Future Subbasin 7, on the other hand, is targeted for implementation entirely in Phase 1.

In addition to these capital projects, the City will implement storm drain rehabilitation and replacement projects.

ES.7.3 Phase 2 Projects (2016-2020)

In general, the Phase 2 projects will serve future development beyond year 2015. These projects are within the 10-year window identified by the City. Some of the projects are extensions of storm drain conveyance facilities that were started in Phase 1. For example, F9-3 through F9-9 represents the second phase of the Future Subbasin 9 capital projects. The Phase 2 projects include the following:

- Future Subbasin 3 (F3-1 through F3-7, F3-B, F3-PS)
- Future Subbasin 4 (F4-1 through F4-5, F4-9, F4-B, F4-PS)
- Future Subbasin 5 (F5-1 through F5-5, F5-7, F5-8, F5-B, F5-PS)
- Future Subbasin 6 (F6-1 through F6-3, F6-12 through F6-16, F6-18, F6-B, F6-PS)
- Future Subbasin 9 (F9-3 through F9-9)
- Future Subassin 11 (F11-1 through F11-5, F11-11, F11-13)
- On going storm drain rehabilitation and replacement

ES.7.4 Phase 3 and 4 Projects (2021-2025 and 2026-2030)

Table 5.1 breaks the projects into Phase 3 and 4. For the purposes of prioritization, these are viewed as very long-term projects exclusively driven by development at the fringes of the planning area, and will be grouped together.

A majority of the northwestern and southeastern portion of the General Plan boundary is slated for development after 2020, as are certain areas in the northeastern portion of the General Plan boundary. These projects are categorized as Phase 4 and Phase 5.

ES.8 CAPITAL PROJECT COSTS

A summary of the capital project costs and the implementation timeframe is presented in Chapter 6. The breakdown in existing and future user cost share by phase is summarized in Table ES.2. Table ES.3 summarizes the breakdown in cost for the different facility categories (e.g. storm drains and detention basins).

Table ES.2 Existing Versus Future User Cost Share Storm Drainage System Master Plan City of Galt					
	Implementation Phase				
Reimbursement Category	**2009-15 ($, mill.)**	**2016-20 ($, mill.)**	**2021-25 ($, mill.)**	**2026 - 30 ($, mill.)**	**Total ($, mill.)**
Existing User (2)	3.1	4.0	0.9	0.9	**9.0**
Future User (3)	13.9	29.7	34.7	14.0	**92.3**
Total	**17.1**	**33.7**	**35.6**	**14.9**	**101.3**

Notes:
1. All costs are in March 2009 dollars. ENR CCI 20 City average = 8534
2. Projects are expected to be funded through user rates.
3. Projects are expected to be funded through storm development impact fees collected by the City or by developers.

Table ES.3 Existing Versus Future Cost by Facility Type Storm Drainage System Master Plan City of Galt				
Reimbursement Category	**Storm Drains ($, mill.)**	**Detention Basins ($, mill.)**	**Pump Stations ($, mill.)**	**Total ($, mill.)**
Existing Users(2)	9.0	0.0	0.0	**9.0**
Future Users(3)	41.3	31.0	20.0	**92.3**
Total	**50.3**	**31.0**	**20.0**	**101.3**

Notes:
1. All costs are in March 2009 dollars. ENR CCI 20 City average = 8534
2. Projects are expected to be funded through user rates.
3. Projects are expected to be funded through storm development impact fees collected by the City or by developers.

ES.9 COST OF SERVICE

The existing and future user capital costs discussed above were used to determine a cost of service to existing rate payers and future customer connections. The following is not a rate study, fee program, or development impact fee analysis. It is a simplified assessment of the costs that the City might need to recover from existing rate payers and future development to pay for the proposed Master Plan projects. This analysis serves only to assist the City in determining whether a rate or development impact fee increase might be needed to finance the proposed CIPs. This Master Plan analysis is simply a high level calculation that provides the potential order of magnitude assessment and brackets the possible costs. A more detailed rate/development impact study should be conducted to determine the magnitude of a possible increase to fund the proposed CIPs.

ES.9.1 Existing Users Fee for Service

The City collects storm drainage utility rates to pay for storm drainage operations. In 2003, the City established a tiered rate structure. All existing account holders prior to March 1, 2003 are grouped into the Tier 1 rate structure, whereas all new construction after March 1, 2003 is grouped into the Tier 2 rate structure. The capital costs to implement the proposed Master Plan projects fall under the capital replacement and improvement of existing system components. These costs are spread over approximately 7,200 existing service connections.

The total existing system Master Plan capital costs equal approximately $9.0 million. One possible scenario to finance these projects might include two phases of bond financing. One bond could cover the work for Phases 1 and 2 (2009 through 2020), and a second bond could finance projects for Phases 3 and 4 (2021 through 2030). For this simplified analysis, we assumed that the first bond would be for $7.3 million and the second for $1.7 million, both paid off over 30 years at an interest rate of five percent. The monthly increase necessary to finance the first bond to fund the proposed capital replacement projects could be approximately $2.50 per rate payer. In year 2020 when the second bond is secured, the rate could increase to about $3 dollars per rate payer.

This simplified analysis does not take into account any existing City bonds (if any) that are being paid, the type of bond that would be used, alternative payment schedules, or class of service. It is recommended that a comprehensive rate analysis be completed to quantify the impacts to existing rate payers and to the City's proposed storm drainage rates. The possible rate increase will likely vary depending on the class of service (e.g. single and multi-family residential, commercial, and industrial) and determining this level of detail for setting rates goes beyond the scope of this study.

ES.9.2 Future User Development Impact Fees

Historically, new storm drain pipelines are paid by developers and are not covered by storm drainage impact fees. However, it is anticipated that costs for future detention basins and pump stations needed to serve future users will be funded as an addition to any existing storm drainage development impact fees charged by the City. The total future system Master Plan capital costs equal approximately $92.3 million. Of this $92.3 million, $51 million would be needed for detention basins and pump stations, and $41.3 million for pipeline construction. Depending upon the City's future development plan, the pipelines could be funded either through development impact fees, or directly through the developers, with a separate reimbursement fund established for others who benefit from the improvement.

Based on the 2030 General Plan, the number of future water connections added to the City will likely increase above the projections summarized in Table 4-1 of the 2005 UWMP. Based on the projected build-out water demands, by year 2030 there could be between 18,000 to 20,000 connections within the General Plan boundaries. This represents an

increase of 10,800 to 12,800 in future rate payers that would pay impact fees to finance future detention basin and pump station capital projects. Therefore, the possible capital cost per future connection could range from $3,900 to $4,800.

The development impact fee is significantly influenced by the number of connections, and will likely vary based on the class of service. The City should complete a detailed development impact fee study to quantify the appropriate fee by class of service to finance increases in capacity for future users.

Chapter 1

BACKGROUND

1.1 INTRODUCTION

This chapter presents a brief summary of the storm drainage service area, the need for this storm drainage system master plan (Master Plan) and the objectives of the study. A list of abbreviations is also provided to assist the reader in understanding the information presented.

1.2 BACKGROUND

The City of Galt (City) is located along State Highway 99 in northern California's Central Valley, between the cities of Sacramento and Stockton, and near the Delta Recreation Area[1]. Figure 1.1 presents a location map of the City. The City collects and disposes stormwater runoff generated within the City service area. The storm drainage system is designed to manage the runoff of rainwater and minimize the impact of significant rainfall, which ultimately flows into local drainage channels.

1.3 STORM DRAINAGE SERVICE AREA

Figure 1.2 illustrates the City's current storm drainage system service area. The City owns, manages, and maintains over 70 miles of storm drainage lines spanning 4-inches to 84-inches in diameter, one detention pond, and two pump stations throughout the City.

The land use assumptions in this Master Plan were based on the City's 2030 General Plan Public Review Draft (General Plan) and projected future developments within the General Plan boundary. Should future planning conditions change from the assumptions stated in this Master Plan (i.e., accelerated growth, more intense developments, etc.), revisions and adjustments to the Master Plan recommendations would be necessary.

1.4 SCOPE AND AUTHORIZATION

The purpose of this Master Plan is to identify capacity deficiencies in the storm drainage system, develop feasible alternatives to correct these deficiencies, and plan the infrastructure that will serve future development. On August 15, 2008, the City approved a professional service agreement with Carollo Engineers, P.C. (Carollo) to prepare this Master Plan for the storm drainage system, which included the following main tasks:

- Model development

[1] City of Galt 2030 General Plan, Existing Conditions Report, November 2005, Mintier & Associates et al.

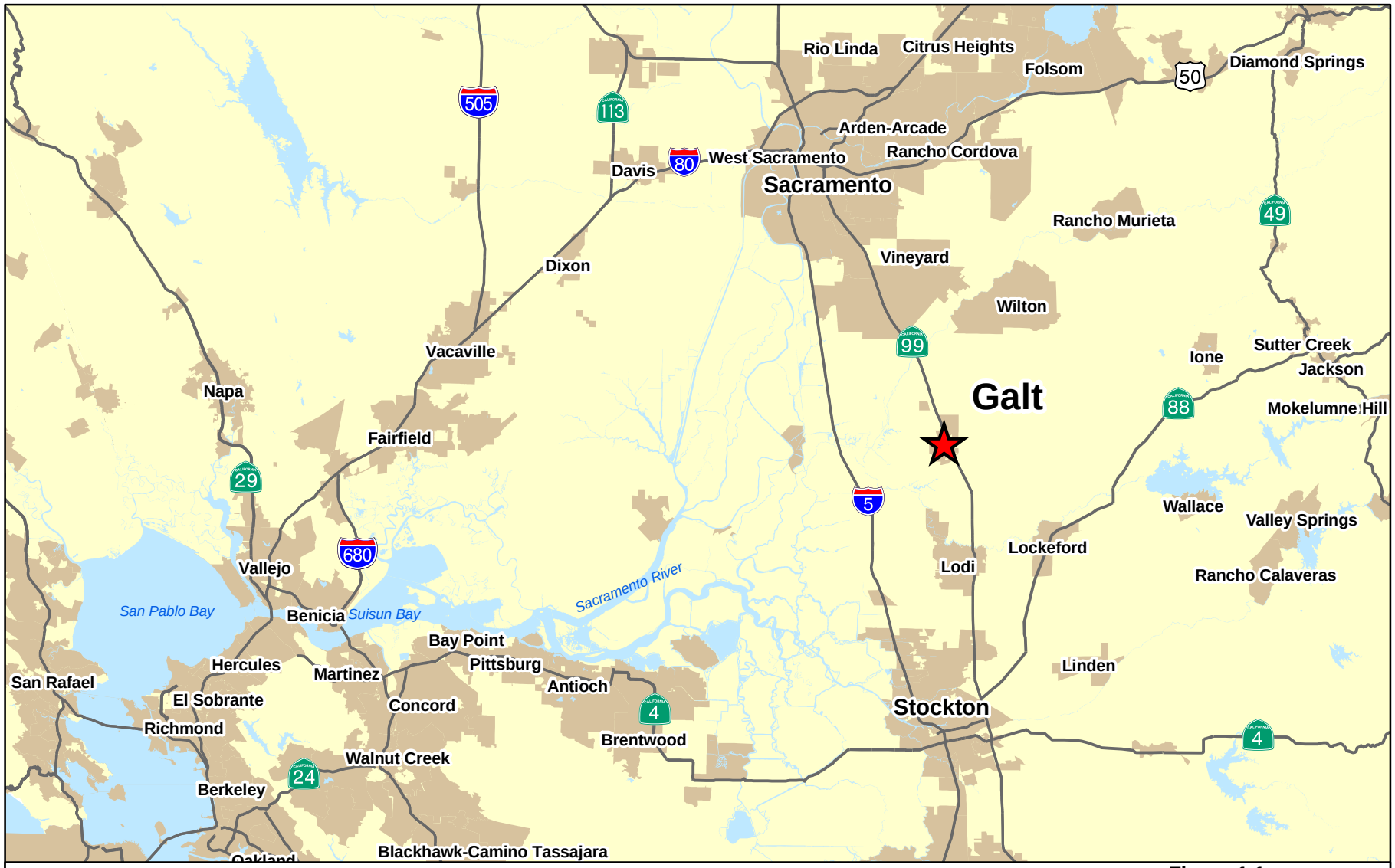
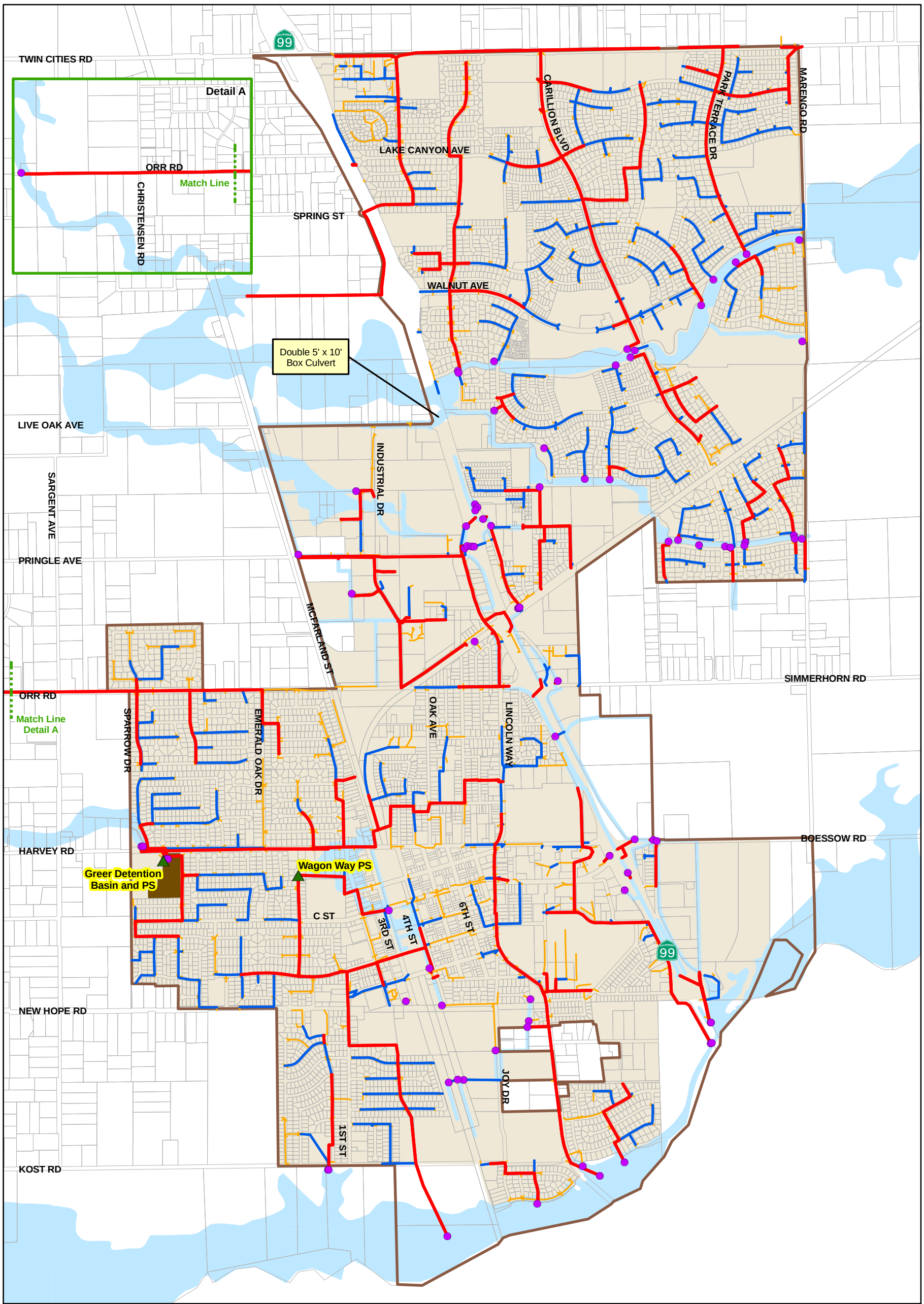


Figure 1.1
Location Map
Storm Drainage System Master Plan
City of Galt



Legend

Existing Storm Drainage System

- Outfall
- Pump Station
- Storage Basin

Storm Drain Diameter

- 12" and Less
- 14 - 21"
- 24" and Larger

- Parcels
- Surface Drainage/100-Year FEMA Floodplain
- City Limits
- Current Storm Drainage System Service Area

Feet
0 1,250 2,500

Figure 1.2
Current Storm Drainage System Service Area
Storm Drainage System Master Plan
City of Galt

- Storm drainage system analysis and capital project development
- Master Plan preparation

1.5 REPORT ORGANIZATION

The storm drainage system master plan report contains six chapters, followed by appendices that provide supporting documentation for the information presented in the report. The chapters are briefly described below:

Chapter 1 - Background. This chapter presents the need for this Master Plan and the objectives of the study. Lists of abbreviations and reference material is also provided to assist the reader in understanding the information presented.

Chapter 2 - Study Area Description. This chapter presents a description of the study area, defines the land use classifications, and summarizes the historical population trends.

Chapter 3 - Planning Criteria. This chapter presents the planning criteria for evaluating the storm drainage system. The planning criteria address the storm drainage system capacity, gravity storm pipe slopes, maximum flood depths, and storm runoff coefficients.

Chapter 4 - Storm Drainage System Facilities and Hydraulic Model. This chapter presents an overview of the City's storm drainage facilities. This chapter also describes the development of the City's storm drainage hydrologic and hydraulic models. These models were used for identifying existing system deficiencies and for recommending improvements.

Chapter 5 - Capacity Evaluation and Proposed Improvements. This chapter presents the results of the capacity evaluation of the storm drainage system and the proposed projects that correct capacity deficiencies and serve future users.

Chapter 6 - Capital Improvement Projects. This chapter presents the capital improvement projects, and summary of the capital costs, and is organized to assist the City in making finance decisions.

1.6 ACKNOWLEDGMENTS

Carollo Engineers wishes to acknowledge and thank Mr. Gregg Halladay, Director of Public Works; Mr. Paul Cavanaugh, City Engineer; Mr. Bill Forrest, Project Manager/Senior Civil Engineer; and Mr. Adin Selby, Streets Superintendent. Their cooperation and courtesy in obtaining a variety of necessary information were valuable components in completing and producing this report.

1.7 ABBREVIATIONS AND DEFINITIONS

To conserve space and to improve readability, the following abbreviations are used in this report.

AACE	Association for the Advancement of Cost Engineering
AF	acre feet
cfs	cubic feet per second
CIP	capital improvement project
City	City of Galt
DCIA	directly connected impervious area
DDF	depth duration frequency
DEM	digital elevation model
ENR CCI	Engineering News Record Cost Construction Index
FEMA	Federal Emergency Management Agency
ft	feet
GIS	geographic information system
in/hr	inches per hour
msl	mean sea level
NFIP	National Flood Insurance Program
NRCS	Natural Resources Conservation Service
ROW	right-of-way
RTC	real time controls
SWMM	Storm Water Management Model
UPRR	Union Pacific Railroad
USDA	United States Department of Agriculture
WWTP	wastewater treatment plant

1.8 REFERENCE MATERIAL

The following documents were referenced in the preparation of this master plan:

- City of Galt General Plan, Existing Conditions Report for the 2008 General Plan, Public Review Draft, November 2005, Mintier & Associates et al.
- City of Galt General Plan, Policy Document, Public Review Draft, July 2008, Mintier & Associates et al.
- City of Galt General Plan, Draft Environmental Impact Report, Draft, July 2008, Mintier & Associates et al.
- Sacramento County Department of Water Resources, West Galt Drainage Study, Final, January 2003, Dennis Huff - Consulting Engineer.
- Volume 2 of the Sacramento City/County Drainage Manual, Hydrology Standards, December 1996, Sacramento County Water Resources Division and the City of Sacramento Department of Utilities Division of Engineering Services.

STUDY AREA DESCRIPTION

This chapter presents a description of the study area, defines the land use classifications, and summarizes the historical population trends.

2.1 STUDY AREA

The 2030 General Plan Public Review Draft (General Plan) planning boundary is the study area boundary for this storm drainage system master plan (Master Plan). The Master Plan study boundary and the 2030 General Plan planning boundary are synonymous and will be used interchangeably throughout this report. The General Plan boundary extends beyond the current storm drainage system service area and is approximately 8,817 acres (13.8 square miles). The Master Plan contains a forecast of storm drainage system improvements in a large study area beyond the City of Galt's (City) limits. Figure 2.1 shows the study area boundary and the current City limits. The current City limits roughly extend from Dry Creek on the south to Twin Cities Road on the north; and from McFarland Street/Sparrow Drive on the west to Marengo Road on the east[1].

Evaluating infrastructure needs beyond the current City limits is important because:

- There are pending conceptual development plans that are beyond the City limits; and
- Historical rapid growth in the Sacramento metropolitan area indicates that significant development into the study area could occur within a short planning period, in the future.

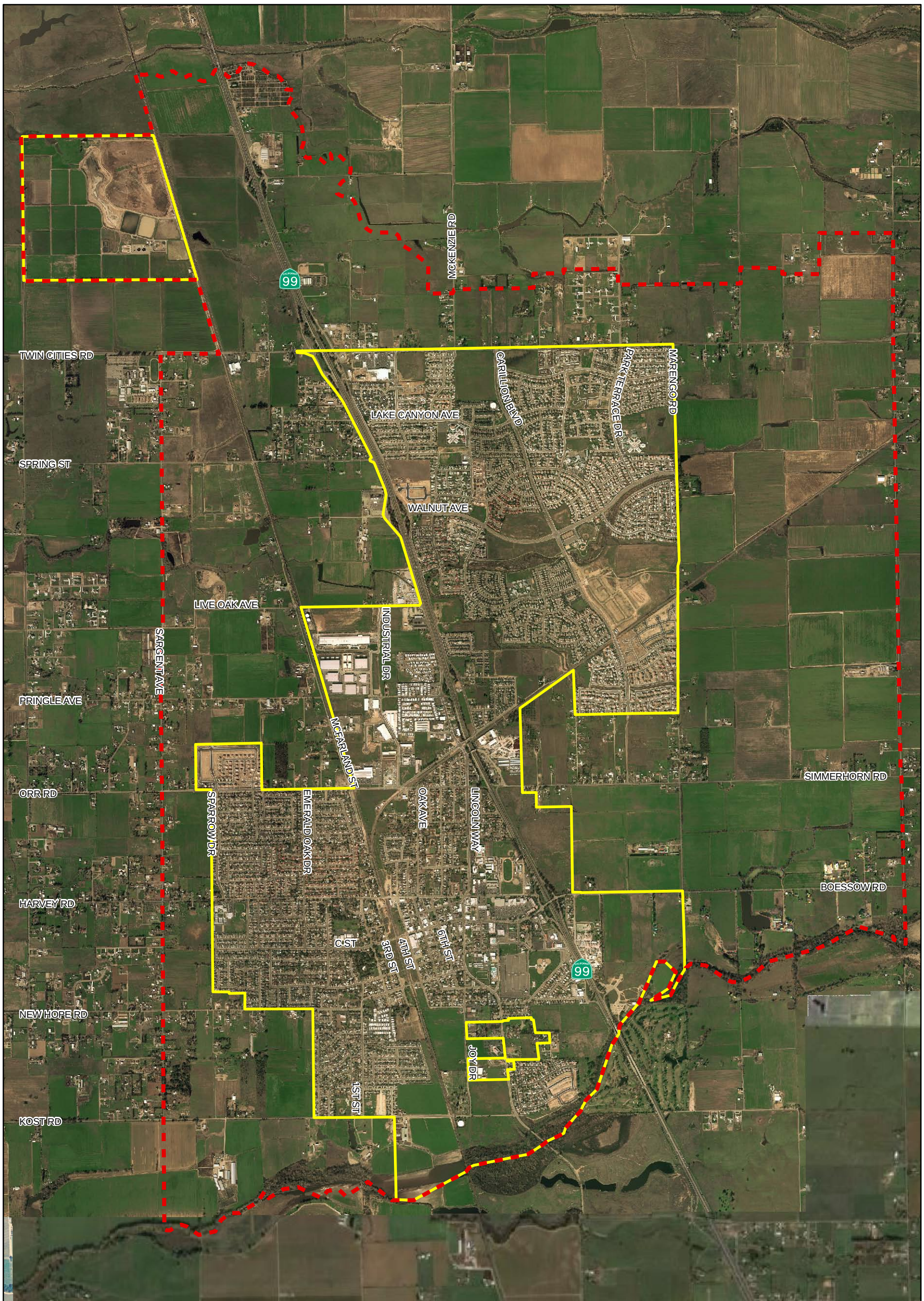
2.2 PLANNING PERIOD

The Master Plan study area is intended to include the existing City limits and development within the General Plan boundary that could occur through the year 2030. Existing and projected populations and land uses within the study area are discussed in this chapter.

2.3 SOIL TYPES

According to the Soil Survey of Sacramento County, California, from the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) (http://www.ca.nrcs.usda.gov/), the most dominant soil type within the Study Area is San Joaquin Silt Loam. Numerous additional soil types scattered throughout the Study Area include Bruella, Clear Lake, Columbia, Consumnes, Durixeralfs, Galt, Kimball, Liveoak, Madera, and Xerarents soils. Figure 2.2 shows the distribution of soil types throughout the City.

[1] City of Galt 2030 General Plan, Existing Conditions Report, November 2005, Mintier & Associates et al.



Legend

General Plan Boundary

City Limits

N

0 2,500 5,000 Feet

Figure 2.1
Study Area
Storm Drainage System Master Plan
City of Galt

GALT

carollo

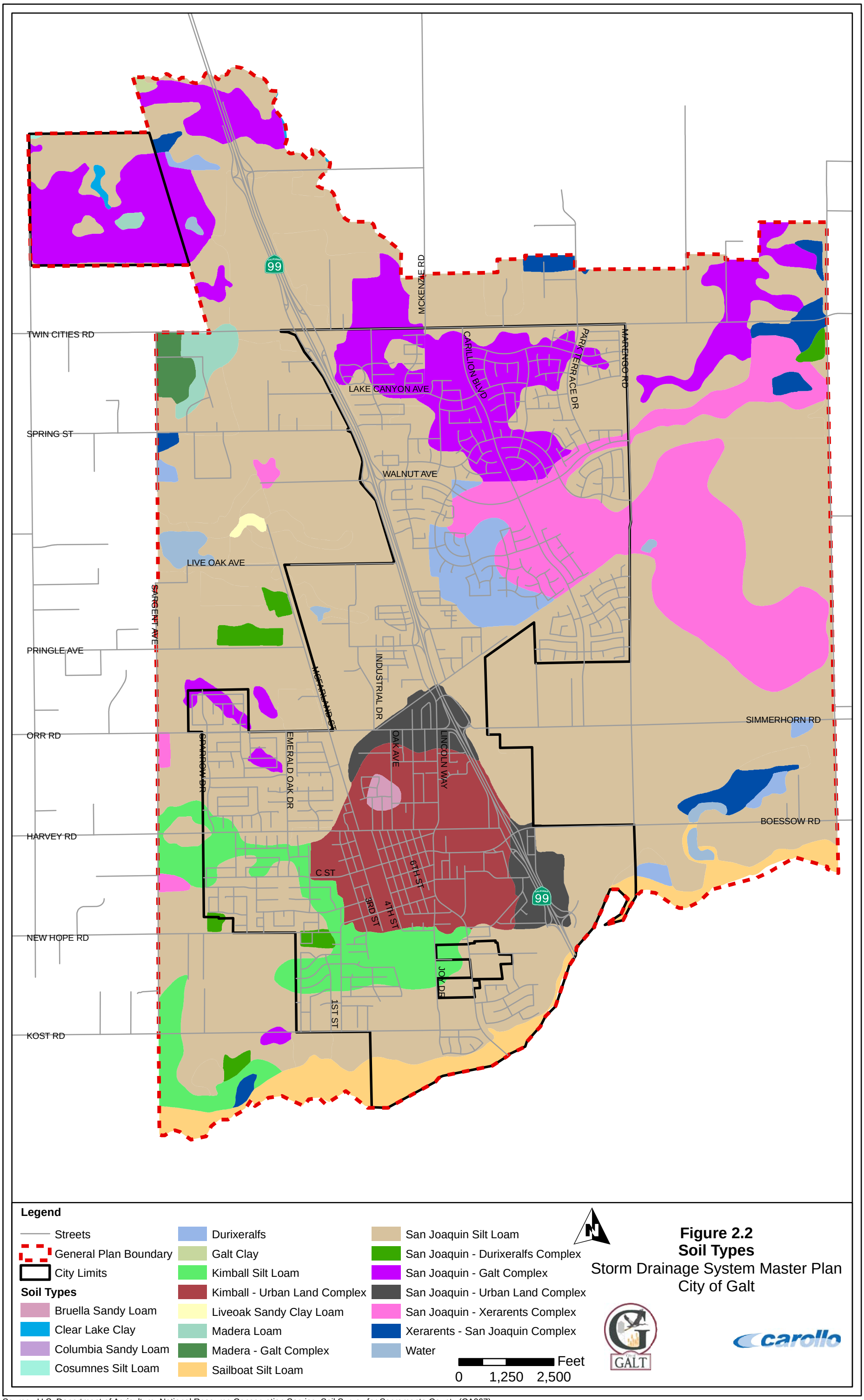


Figure 2.2
Soil Types
Storm Drainage System Master Plan
City of Galt

Source: U.S. Department of Agriculture, National Resource Conservation Service, Soil Survey for Sacramento County (CA067)

2.4 CLIMATE

The City's study area is characterized by a Mediterranean-type climate with wet, cold winters, and warm, dry summers. Most of the rainfall occurs between November and April with an average annual rainfall of 17.5 inches[1]. The Study Area's elevation ranges from about 34 feet above mean sea level (msl) on the west side of the City, to 68 feet msl on the east.

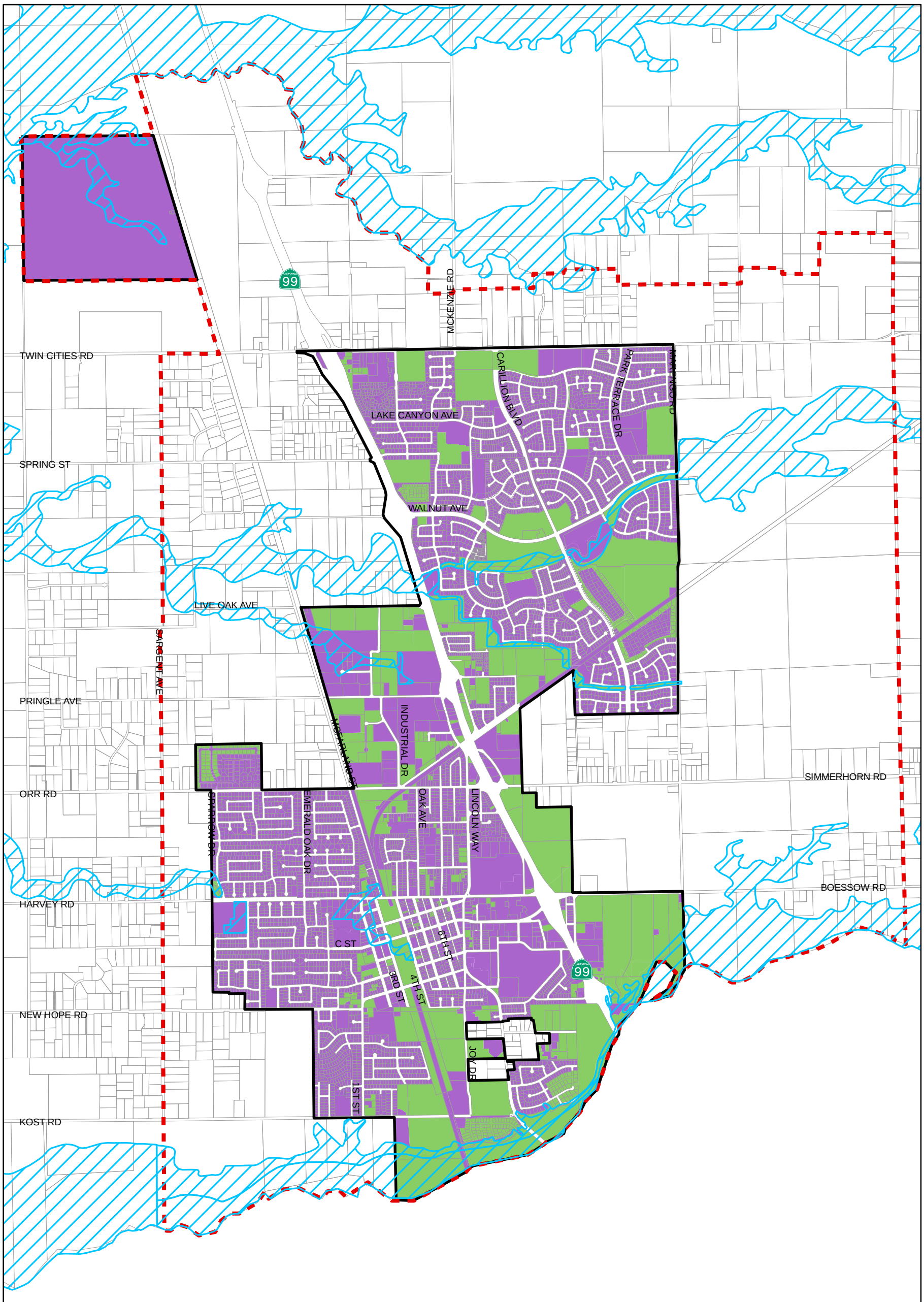
2.5 100-YEAR FLOODPLAIN

Maps indicating "special flood hazard areas" (i.e. floodplains) have been developed through the National Flood Insurance Program (NFIP), which is administered by the Federal Emergency Management Agency (FEMA). Areas of particular importance for insurance purposes are those that are subject to inundation by a 100-year flood event. Figure 2.3 shows the 100-year floodplain boundary for the current City limits and General Plan boundary.

This Master Plan assumes that existing undeveloped land within the 100-year floodplain will not be developed in the future. These areas, therefore, are assumed to generate no future urban storm water runoff through build-out. If any project is allowed to develop within the floodplain, the anticipated increase in stormwater runoff generated from these projects should have relatively little impact on the proposed storm drain projects in this Master Plan. If the floodplain area changes in size and results in more development, then the City should consider evaluating the impacts on downstream storm drains and detention basins as applicable.

2.6 LAND USE

At the time of writing this Master Plan, the General Plan Existing Conditions Report (November 2005), General Plan Policy Document Public Review Draft (July 2008), and General Plan Environmental Impact Report Draft (July 2008) were complete. The General Plan guides development within the planning boundary and establishes the long-range development policies. The General Plan also provides land use and population projections. Land use information is an integral component in determining the amount of storm water runoff generated within the City. The type of land use in an area will affect the volume and peak flow of the storm water runoff. Adequately estimating the quantity of storm water runoff from various land use types is important in sizing and maintaining effective storm drainage system facilities.



Legend

- 100-Year FEMA Floodplain
- Developed Land (November 2008)
- Vacant Land (November 2008)
- Parcels
- General Plan Boundary
- City Limits

N

0 2,500 5,000 Feet

Figure 2.3
100-Year Floodplain
Storm Drainage System Master Plan
City of Galt

Source: Mintier & Associates

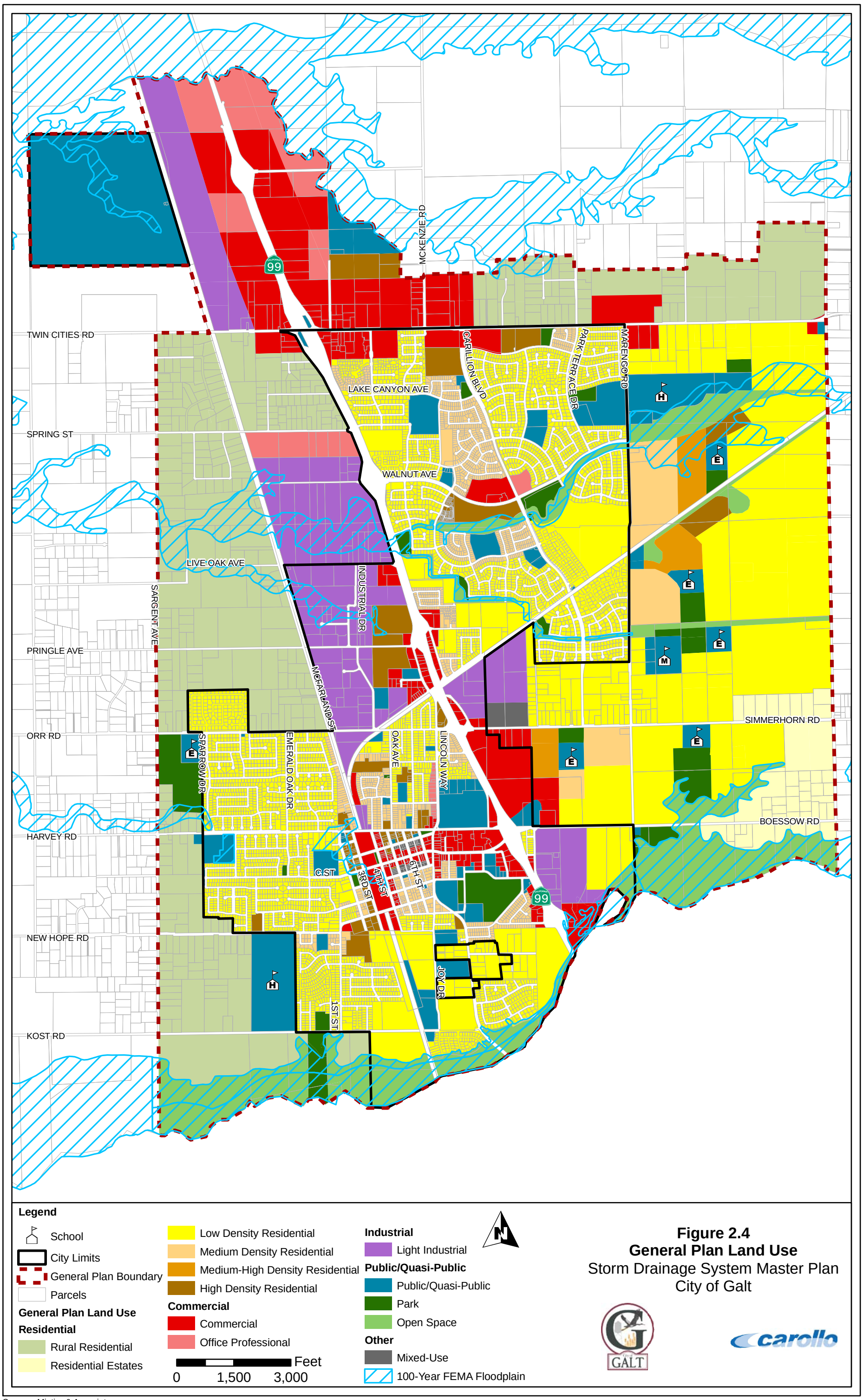


Figure 2.4
General Plan Land Use
Storm Drainage System Master Plan
City of Galt

Source: Mintier & Associates

Land use assumptions used in this study are consistent with the 2030 General Plan. Since the land use assumptions forecast the type of growth within the study area, this association to the Master Plan should ensure that the future storm water runoff and facilities required to serve future growth are consistent with the City's guiding document on development. Figure 2.4 illustrates the different land uses found in the General Plan. The study area's land use designation and respective acreage totals are summarized in Table 2.1. Appendix A provides a description of the different land uses. The descriptions are excerpts from the General Plan.

2.6.1 Storm Drainage Service Area by Land Use

2.6.1.1 Existing Service Area Land Use

The City provides storm drainage service to residents, businesses, and other institutions within its City limits. Table 2.1 provides the acreage totals by land use classification within the General Plan boundary. Also included in Table 2.1 are the land use totals for the 2007/08 storm drainage service area, and the breakdown between developed land, which generates runoff, and undeveloped land that will be developed in the future. The City currently provides storm drainage service to approximately 3,763 acres (includes developed and undeveloped land) or 5.9 square miles.

The largest land use category is residential (rural, low density, medium density, medium-high density, and high density), which accounts for approximately 1,758 acres, or approximately 47 percent of the total current City limit acreage. Commercial, office professional and light industrial make up approximately 566 acres, or 15 percent of the total. Other land uses such as public/quasi-public, parks, streets, and open space account for 1,440 acres, or 38 percent of the total service area.

2.6.1.2 Future Service Area Land Use

At build-out of the General Plan boundary, the City will encompass approximately 8,817 acres. Build-out is defined as complete development of all lands outside the 100-year floodplain. There are approximately 8,059 acres within the study area that are outside the 100-year floodplain. The breakdown of the different land use categories is provided in Table 2.1.

2.7 HISTORICAL AND FUTURE POPULATION

The City was historically an agriculture based community, and has become an important transportation hub for rail and trucking. It has also evolved into a bedroom community for the growing regional centers of Sacramento and San Joaquin Counties[2]. In 1990, the City's population began to grow rapidly and that growth continued through year 2000. From 1990

[2] City of Galt 2030 General Plan, Existing Conditions Report, November 2005, Mintier & Associates et al.

Table 2.1 Study Area Land Use Designations
Storm Drainage System Master Plan
City of Galt

Land Use Designation	General Plan Boundary [1] (ac)	2007/2008 City Limits		
		Total (ac)	Developed (ac)	Undeveloped (ac)
Residential				
Rural Residential (A-RR)	1,329	0.4	0.1	0.3
Residential Estates (K-RE)	172	0	0	0
Low Density Residential (B-LDR)	2,246	1,401	990	411
Medium Density Residential (C-MDR)	335	216	208	8
Medium High Density Residential (L-MHD)	77	0	0	0
High Density Residential (D-HDR)	181	140	101	39
Employment Related				
Commercial (E-C)	623	271	101	169
Office Professional (F-OP)	179	11	3	8
Light Industrial (G-LI)	599	284	120	164
Others				
Public/Quasi-Public (H-PQP)	437	218	162	56
Open Space (I-OS)	561	152	11	141
Park (I-PK)	191	70	70	0.2
Mixed Use (M-MU)	19	5	4	0.5
Roads/Railroads/Canals [2]	1,572	702	702	0
Wastewater Treatment Plant [3]	296	293	293	0
Total	**8,817**	**3,763**	**2,766**	**997**

Notes:
1. Galt General Plan boundary is the study area boundary. Land use totals exclude roads, canals, and railroads. Adjustments to land use totals were made in order to maintain a Roads/Railroads/Canals subtotal that is approximately 20 percent.
2. Roads not identified in the General Plan as a land use, but separated here for flow calculations.
3. Included with Public/Quasi-Public total land use in General Plan, but separated here for flow calculations.

through 2007, the population grew from approximately 8,800 to 23,500. Over these 17 years, the City grew at an annual rate of about six percent.

The General Plan forecasts that the City's population will grow at an annual rate of 3.4 percent from 2002 to 2025, and will reach a 2030 population of 50,094 people. Table 2.2 and Figure 2.5 summarize the City's historical and projected population to year 2030.

Table 2.2 Historical and Projected Population
Storm Drainage System Master Plan
City of Galt

Year	Population
1970	3,200
1980	5,514
1990	8,775
1995	14,800
2000	19,472
2007	23,470
2015	32,779
2020	38,000
2025	44,150
2030	50,094

Note:
1. City of Galt 2030 General Plan, Existing Conditions Report, November 2005, Mintier & Associates et al. and City of Galt General Plan, Policy Document, Public Review Draft, July 2008, Mintier & Associates et al.

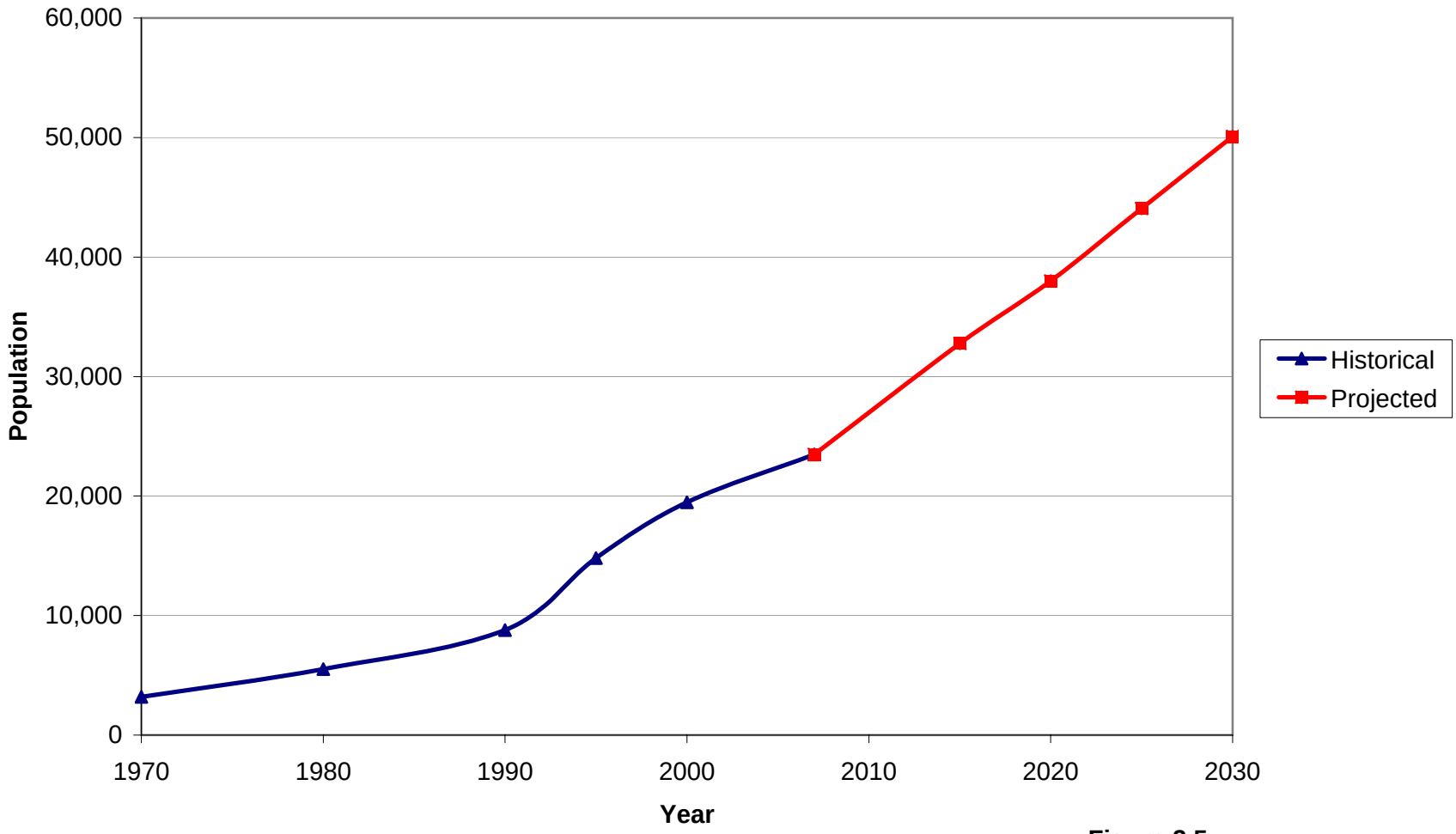


Figure 2.5
Historical and Projected Population
Storm Drainage System Master Plan
City of Galt

PLANNING CRITERIA

The capacity of the City of Galt's (City) storm drainage collection system was evaluated based on the planning criteria defined in this chapter. The criteria include standards from the City's Improvement Standards and Specifications (Improvement Standards), Sacramento County Standards, and other planning criteria developed by Carollo based on engineering judgment and past experience. Precipitation characteristics, design storm duration and frequency, and impervious versus pervious surfaces were reviewed to perform the hydrologic analysis on the system. The planning criteria address the storm drainage system capacity, roughness coefficients, and pump station capacity.

3.1 HYDRAULIC CRITERIA

The City's Improvement Standards stipulate general policies of the City and outline storm drain design criteria. Some of these criteria are discussed below. If not discussed in the storm drainage master plan (Master Plan), the reader should assume that the design criteria conform to the Improvement Standards.

3.1.1 Gravity Storm Drains

Conveyance facilities in the City consist mainly of storm drain pipes and some open channels. Capacity analysis of the storm drain system was performed in accordance with the criteria established in this chapter. Storm drain capacity is dependent on many factors, including roughness of the pipe, the minimum velocity, slope of pipe, and other assumptions and criteria defined below.

3.1.1.1 Manning Coefficient (n)

The Manning coefficient 'n' is a friction coefficient and varies with respect to pipe material, size of pipe, depth of flow, smoothness of pipe and joints, and build up of debris or other obstructions like root intrusion. For storm drain pipes, the Manning coefficient typically ranges between 0.012 and 0.015 depending o000n material type. The Manning's n value for all storm drains was assumed to be 0.015 for the hydraulic analysis. This is a conservative estimate for Manning's n value, but is reasonable considering the age of some pipes in the drainage system, and is consistent with Sacramento County design standards.

3.1.1.2 Surcharge Depth and Street Flooding

Storm drains are designed to surcharge under normal operation. It is common engineering practice in drainage to allow curb and gutter streets to act as storage and conveyance, similar to overland flow, for a given rainface intensity and duration in order to protect adjacent properties from flooding. When evaluating the adequacy of the exiting conveyance facilities serving existing developments, City streets were allowed to flood and provide flow attenuation and storage capacity, thus avoiding some cost-prohibitive improvements.

Floodwaters were permitted to accumulate in streets to one foot above the gutter flow line for the 100-year storm.

3.1.2 Pump Stations

Pump stations should be sized to efficiently handle the calculated runoff from a storm with a ten-year return period unless utilized in conjunction with a detention basin. Pumping stations utilized in conjunction with basins were sized to be capable of draining 100 percent of the basin's storage capacity within five days.

3.2 HYDROLOGIC CRITERIA

This section describes the hydrological characteristics of the City and the design storms that were used to estimate existing and future storm flows.

3.2.1 Precipitation Characteristics

The City's wet season occurs from November through April, although the majority of the City's rainfall occurs from December through February. Typically, storms that originate over the Pacific Ocean reach their maximum precipitation as they cross over the higher elevations of the coastal range, and decrease in precipitation as they reach lower elevations of the inland valleys. Mean annual precipitation in Galt is approximately 17.5-inches[1].

3.2.2 Elements of the Design Storms

The capacity of storm drainage facilities depends on the selection of a level of protection provided by those facilities. The level of protection is often expressed in terms of the frequency, or return period, of the storm for which the facilities are to prevent damage or for which the facilities will safely pass the stormwater flows. This storm is referred to as the design storm and is an idealized representation of a typical storm with a specified return period.

Selection of the design storm can have a significant impact on the size and cost of required drainage facilities. There are three elements of a design storm: precipitation depth, duration, and frequency.

3.2.2.1 <u>Precipitation Depth</u>

Precipitation depth is the amount of precipitation occurring during a specified storm duration. The depths of rainfall are statistical depths obtained by studying historical precipitation data to find the depth for each duration and for a particular frequency. Precipitation depth is usually expressed in inches.

[1] City of Galt 2030 General Plan, Existing Conditions Report, November 2005, Mintier & Associates et al.

3.2.2.2 Duration

Duration is the specified length of storm time considered. Duration of a design storm event should be at least four times the response time of the basin. The response time is the time required for the peak flow to reach the point of interest, such as a structure, outlet, or spillway. When the design of storage facilities is involved, the duration should be sufficiently long so that the runoff and storage volumes return to near their level at the beginning of the simulation. Duration may be expressed in any time unit such as minutes, hours, or days.

3.2.2.3 Frequency

Frequency is the number of occurrences of events with the specified precipitation depth and duration. It is expressed in terms of return period. In order to provide a reasonable level of flood protection, the statistical concept of return period or recurrence interval is utilized, which aids in assigning a probabilistic meaning to a precipitation event.

3.2.3 Design Storms

The City's design storms were developed using the methods and design charts presented in Volume 2 of the Sacramento City/County Drainage Manual (Sac County Drainage Manual). The depth-duration-frequency relationships derived in the Sac County Drainage Manual are based on the data obtained from the National Weather Services Downtown Sacramento Rain Gauge. This data only represents an area of a few hundred acres. Multiplication reduction factors are provided in the Sac County Drainage Manual for converting the point gage data to area data. These factors are shown on Table 3.1 as area multipliers. Two design storms were used for the evaluation of the City's existing storm drainage system and for sizing future storm drainage facilities. The 24-hour, 10-year event was used for evaluating storm conveyance facilities, while the 24-hour, 100-year event was used for evaluating the combined capacity of basins, streets, and pipes. The 10-year and 100-year recurrence intervals have become standard selections in most locations in California because they provide a balance between level of service and affordability, and provide reasonable standards of care.

Design storms for the City are provided in Table 3.1. Figure 3.1 presents a graphical representation of the design storms for the 24-hour, 10-year and 24-hour, 100-year recurrence intervals.

3.2.4 Soil Imperviousness

For stormwater modeling, the key factor relating land use to runoff is "effective percent imperviousness." Rainfall on impervious surfaces is not subject to losses by infiltration into the soil; the only losses in impervious areas are due to depression storage. All initial losses for impervious areas, typically 0.02 to 0.08 inches, are assumed to be satisfied by precipitation preceding the design storm.

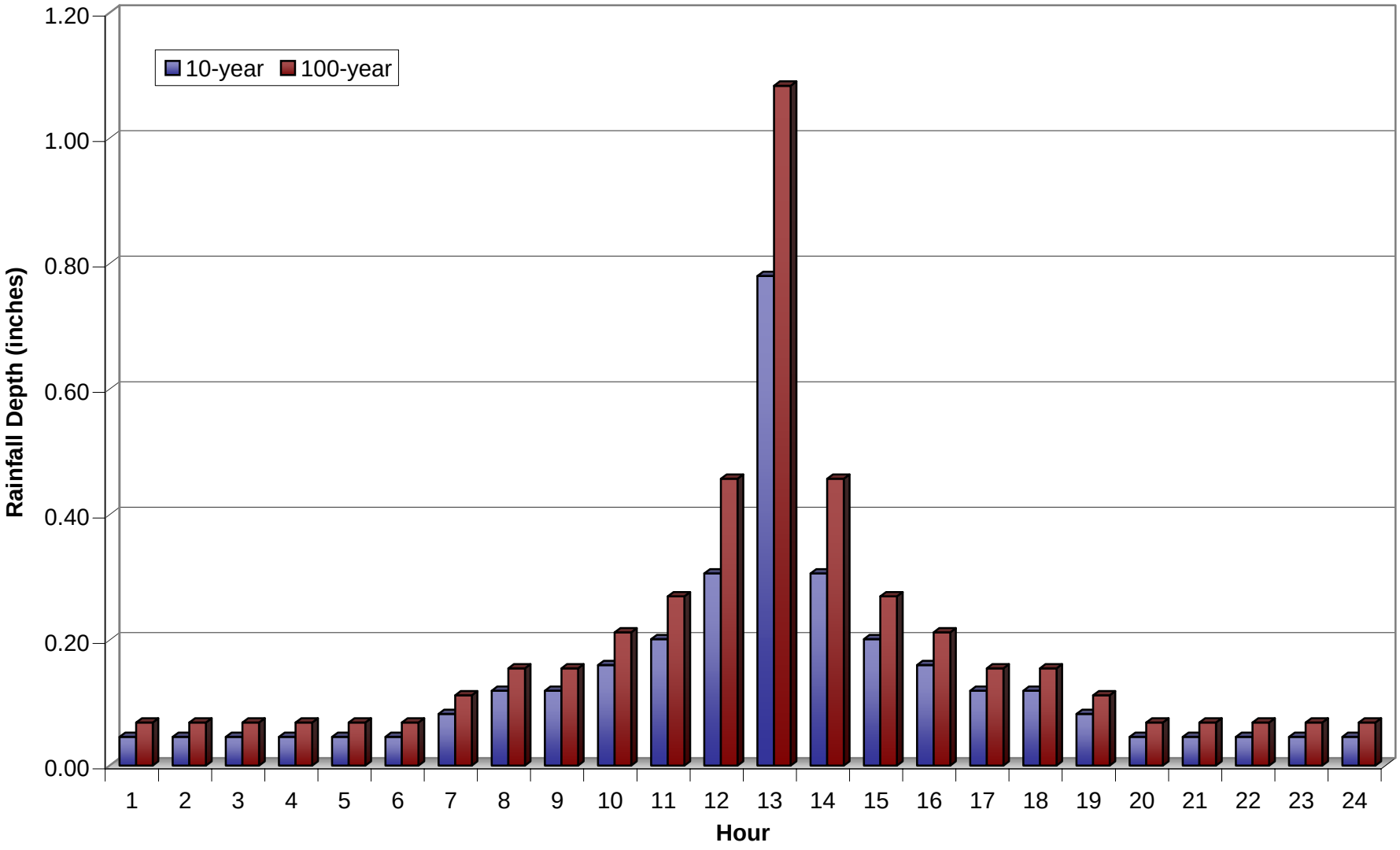


Figure 3.1
24-Hour Design Storms
Storm Drainage System Master Plan - Planning Criteria
City of Galt

carollo

Table 3.1	Precipitation Depth-Duration-Frequency Storm Drainage System Master Plan City of Galt					
Duration	**10-year[(2)]**			**100-year[(2)]**		
	Inches	**Area[(3)] Multiplier**	**Adjusted Inches**	**Inches**	**Area[(3)] Multiplier**	**Adjusted Inches**
5-min	0.25	0.83	0.21	0.44	0.97	0.43
10-min	0.36	0.83	0.30	0.62	0.97	0.60
15-min	0.43	0.83	0.36	0.73	0.97	0.71
30-min	0.57	0.83	0.47	0.94	0.97	0.91
1-hour	0.77	0.93	0.72	1.21	0.93	1.13
2-hours	1.04	0.95	0.99	1.59	0.95	1.51
3-hours	1.23	0.96	1.18	1.85	0.96	1.78
6-hours	1.65	0.97	1.60	2.5	0.97	2.43
12-hours	2.25	0.98	2.21	3.3	0.98	3.23
24-hours[(2)]	**2.98**	**0.98**	**2.92**	**4.25**	**0.98**	**4.17**

Notes:
1. Developed based on methods provided in Volume 2 of the Sacramento City/County Drainage Manual.
2. The 24-hour, 10-year and 100-year events were used for the evaluation of the City's storm drainage system.
3. Source: Tables 4-4 and 4-5 of the Sacramento City/County Drainage Manual. Factors for durations greater than one hour are based on NOAA Atlas2, Precipitation-Rrequency Atlas of the Western United States, Volume XI-California. Factors for durations less than one hour are based on NWS Technical Paper 40.

3.2.4.1 Effective Percent Imperviousness

Effective percent or connected impervious area is related to land use, storm water drainage system configuration, and recurrence interval. If runoff from an impervious area flows directly into a concentrated flow path, (i.e. into a gutter), it is considered directly connected. If it flows over a pervious area before becoming a concentrated flow, it is unconnected.

The existing impervious cover in small urban areas can be estimated by direct measurements of land use from aerial photography. The impervious area for future land use must be determined from maps contained in the General Plan. To make that determination, it is necessary to develop a table of effective percent impervious values for each land use code. Table 3.2 lists typical effective percent of impervious area for each of the Galt land use designations.

Table 3.2 Soil Percent Imperviousness Storm Drainage System Master Plan City of Galt		
Land Use Category	**Effective Percent Impervious**	**Non-Effective Percent Impervious**
Residential Designations		
Rural Residential (A-RR)	35%	15%
Rural Estate (K-RE)	35%	15%
Low Density Residential (B-LDR)	35%	15%
Medium Density Residential (C-MDR)	50%	5%
Medium High Density Residential (L-MHD)	60%	5%
High Density Residential (D-HDR)	70%	0%
Commercial Designations		
Commercial (E-C)	90%	0%
Office Professional (F-OP)	90%	0%
Industrial Designations		
Light Industrial, Existing (G-LI)	70%	0%
Light Industrial, Future (G-LI)	15%	0%
Other Designations		
Public/Quasi-Public (H-PQP)	Varies	0%
Open Space (I-OS)	1%	0%
Park (I-PK)	2%	0%
Meadowview Park	1%	0%
Mixed Use (M-MU)	90%	0%
Roads/Railroads/Canals	95%	0%

Future runoff from industrial land use designations were assumed to be contained through on site drainage facilities. Therefore, City storm drain facilities for future industrial land use areas are required to capture stormwater flows associated with street drainage only. To simulate this, an effective percent imperviousness of 15 percent was assumed for all future industrial areas.

3.2.4.2 Non-Effective Percent Imperviousness

In residential urban areas, either a portion of the pervious runoff area has no flow path to the drainage system, or the flow path is via groundwater drains, which effectively delays runoff until it does not contribute to the design hydrographs. These areas are typically backyards, swimming pools, dense shrub landscaping, and gardens. Table 3.2 lists the non-effective percent impervious areas.

3.2.4.3 Pervious Area Runoff and Infiltration Parameters

The remaining runoff originates from pervious areas. There are several ways to estimate the volume and/or the rate of infiltration of water into a soil. Three excellent estimation methods are Green-Ampt, SCS method, and Horton's method. All of these equations provide a relatively accurate assessment of the infiltration characteristics of the soil in question. Infiltration into the soil in pervious areas was estimated for each subbasin by the model using the Horton equation. Horton and Green- Ampt are widely used in SWMM, especially when using SWMM runoff module. The Green-Ampt method accounts for multiple variables that other methods, such as Horton, do not. If is a function of the soil solution head, porsity, hydraulic conductivity, and time. Some of these parameters are difficult to estimate.

On the other hand, Horton equation is an emperical formula that states that infiltration starts at some rate and decreases exponentially with time. After a period of time when the soil saturation level reaches a certain value, the rate of infiltration will become constant. Parameters for the Horton equation can be reasonably estimated from literature and USDA soil data.

Because the Horton parameters vary depending on soil type, soil maps were examined to determine the soil type within each drainage area. Weighted average soil properties were determined for each SWMM model subbasin based on the amount of each hydrologic soil group in the subbasin, and typical soil properties for each group.

Four hydrologic soil groups are used. The soils are classified based on water intake at the end of long duration storms after prior wetting, an opportunity for swelling, and without the proactive effects of vegetation. The hydrologic soil groups are:

A: Soils having high infiltration rates even when thoroughly wetted and consisting chiefly of deep, well to excessively drained sands or gravels. These soils have a high rate of water transmission.

B: Soils having moderate infiltration rates when thoroughly wetted and consisting of moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission.

C: Soils having slow infiltration rates when thoroughly wetted and consisting chiefly of soils with a layer that impedes the downward movement of water or soils with moderately fine to fine texture. These soils have a slow rate of water transmission.

D: Soils having very slow infiltration rates when thoroughly wetted and consisting chiefly of clay soils with high swelling potential, soils with permanent high water table, soils with claypan or clay layer at or near the surface, and shallow soils over nearly impervious material. These soils have a very slow rate of water transmission.

Each soil group is associated with the typical infiltration soil properties as listed in Table 3.3. By determining the percentages of each hydrologic soil group within a subbasin, maximum

and minimum infiltration rates were calculated. The constant decay rate for Horton infiltration analysis was set to 0.0015 per second. Figure 3.2 shows the hydrologic soil groups within the City, which are based on data provided by the Natural Resources Conservation Service (NRCS).

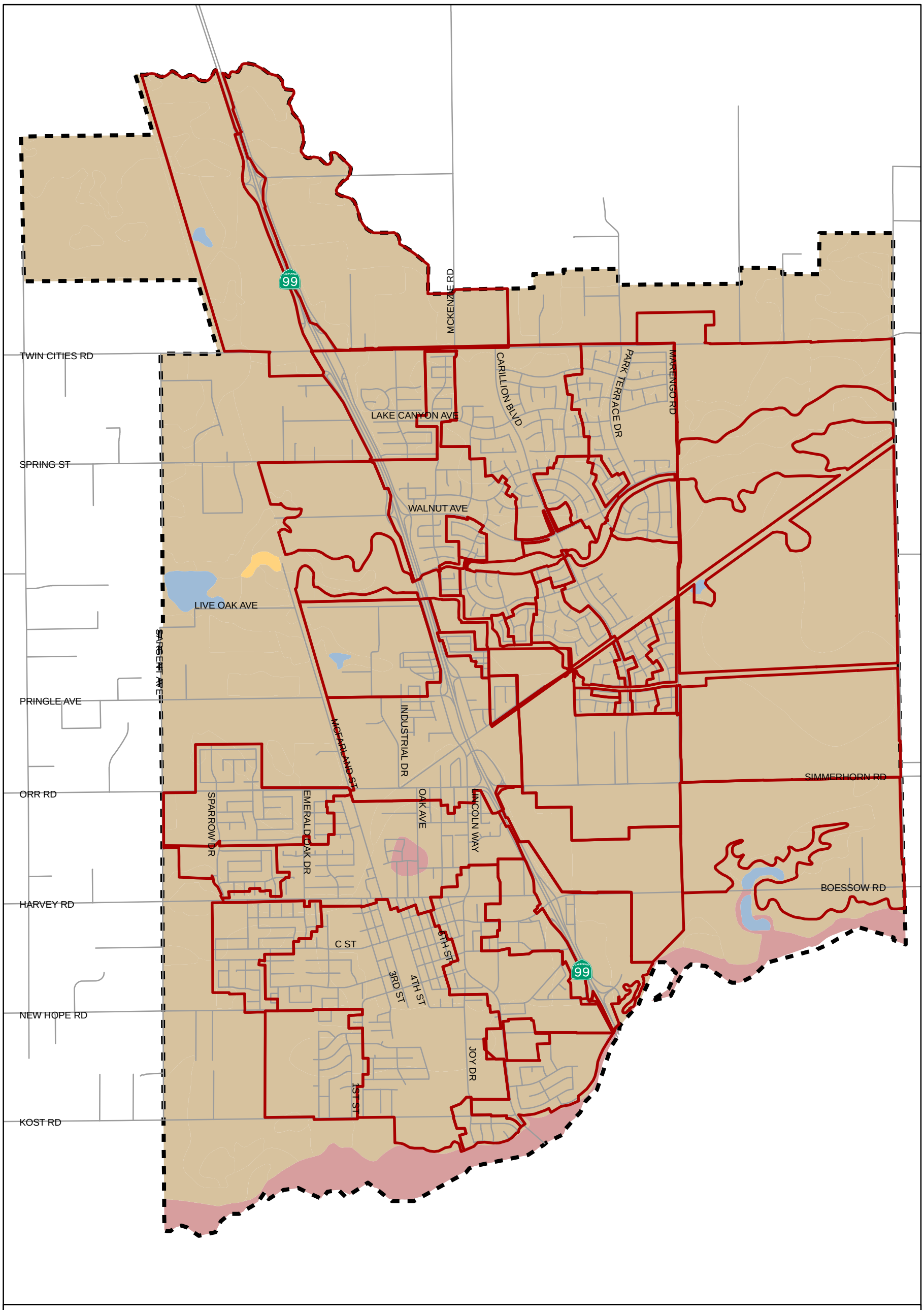


Figure 3.2
NRCS Hydrologic Soil Groups
Storm Drainage System Master Plan
City of Galt

Source: U.S. Department of Agriculture, National Resource Conservation Service, Soil Survey for Sacramento County (CA067)

Table 3.3 Infiltration Rates for NRCS Hydrologic Soil Groups Storm Drainage System Master Plan City of Galt		
Soil Group	**Maximum Infiltration Rate (in/hr)**	**Minimum Infiltration Rate (in/hr)**
A	2.0	0.065
B	1.5	0.050
C	1.0	0.035
D	0.5	0.020

3.2.5 Overland Flow

3.2.5.1 Manning Coefficient (n) for Overland Flow

The overland flow travel time is affected by the type of surface cover. For each SWMM unit, roughness coefficients were input into the model for both pervious and impervious surfaces. Typical roughness coefficients, based on the types of ground cover, are shown in Table 3.4.

Table 3.4 Parameters for Overland Flow Storm Drainage System Master Plan City of Galt		
Surface	**Overland Manning's n**	**Distance/Range (ft)**
Pavement - smooth	0.02	50-200
Pavement - rough/cracked	0.05	50-200
Bare soil - newly graded areas	0.10	100-300
Range - heavily grazed	0.15	100-300
Turf - 1-2 in/lawns/golf courses	0.20	100-300
Turf - 2-4 in/parks/medians/pasture	0.30	200-500
Turf - 2-6 in natural grassland	0.40	200-500
Residential Landscaping	0.60	100-300
Few trees - natural grass undergrowth	0.50	300-600
Scattered trees - weed/shrub undergrowth	0.60	300-600
Numerous trees - dense undergrowth	0.80	300-600

Note:
1. Manning's n for shallow flow depths is not the same as Manning's n for channels.

3.3 RELEVANT ASSUMPTIONS

Custom stage curves were developed to model the hydraulic grade line of the receiving waters at the City's outfall locations during the 100-year design event. Stage curves for the Deadman Gulch and Hen Creek outfalls were developed based on information derived from a HEC RAS model developed by Dennis Huff as part of the West Galt Drainage Study. Stage curves for the Dry Creek outfalls were estimated from an approximate model of the Dry Creek watershed developed in H_2OMAP SWMM.

3.4 PLANNING CRITERIA SUMMARY

The recommended planning criteria for this Master Plan are summarized in Table 3.5.

Table 3.5 Planning Criteria Summary
Storm Drainage System Master Plan
City of Galt

Design Storms

Design Storm	Facilities to be Evaluated	Maximum HGL Depth/Flooding Depth Criteria
10-year, 24-hour	Storm Sewer Conveyance Facilities	0.5' below Inlet Grates, 1.0' below Manhole Covers
100-year, 24-hour	Combined Capacity of Streets, Basins, and Pipes	Maximum 1.0' Allowable Flooding Depth in Streets

Precipitation Depth-Duration-Frequency

10-year

Duration	Inches	Area Multiplier	Adjusted Inches
5 min	0.25	0.83	0.21
10 min	0.36	0.83	0.30
15 min	0.43	0.83	0.36
30 min	0.57	0.83	0.47
1 hour	0.77	0.93	0.72
2 hours	1.04	0.95	0.99
3 hours	1.23	0.96	1.18
6 hours	1.65	0.97	1.60
12 hours	2.25	0.98	2.21
24 hours	2.98	0.98	2.92

100-year

Duration	Inches	Area Multiplier	Adjusted Inches
5 min	0.44	0.97	0.43
10 min	0.62	0.97	0.60
15 min	0.73	0.97	0.71
30 min	0.94	0.97	0.91
1 hour	1.21	0.93	1.13
2 hours	1.59	0.95	1.51
3 hours	1.85	0.96	1.78
6 hours	2.5	0.97	2.43
12 hours	3.3	0.98	3.23
24 hours	4.25	0.98	4.17

Soil Imperviousness

Land Use Category	Effective Percent Impervious	Non-Effective Percent Impervious
Rural Residential (A-RR)	35%	15%
Rural Estate (K-RE)	35%	15%
Low Density Residential (B-LDR)	35%	15%
Medium Density Residential (C-MDR)	50%	5%
High Density Residential (L-MHD)	60%	5%
High Density Residential (D-HDR)	70%	0%
Commercial (E-C)	90%	0%
Office Professional (F-OP)	90%	0%
Light Industrial (G-LI)	70%	0%
Public/Quasi-Public (H-PQP)	Varies	0%
Open Space (I-OS)	1%	0%
Park (I-PK)	2%	0%
Meadowview Park	1%	0%
Mixed Use (M-MU)	90%	0%
Roads/Railroads/Canals	95%	0%

Design Hydrographs

The Design Hydrographs were determined using the SWMM RUNOFF Block of H20MAP SWMM software for the 10-year and 100-year 24-hour storms with 5-minute time steps.

Lag Time

Lag time was calculated by the travel time component method:

Lag time = To + Tg + Tp + Tc
where:
To = Overland flow travel time
Tg = Gutter flow travel time
Tp = Pipe flow travel time
Tc = Channel flow travel time

Overland Flow

Surface	Overland Manning's n	Distance/Range
Pavement - smooth	0.02	50-200
Pavement - rough/cracked	0.05	50-200
Bare soil - newly graded areas	0.1	100-300
Range - heavily grazed	0.15	100-300
Turf - 1-2 in/lawn/golf courses	0.2	100-300
Turf - 2-4 in/park/medians/pasture	0.3	200-500
Turf - 2-6 in natural grassland	0.4	200-500
Residential Landscaping	0.6	100-300
Few trees - natural grass undergrowth	0.5	300-600
Scattered trees - weed/shrub undergrowth	0.6	300-600
Numerous trees - dense undergrowth	0.8	300-600

STORM DRAINAGE SYSTEM FACILITIES AND HYDRAULIC MODEL

This chapter presents an overview of the City of Galt's (City) storm drainage facilities. The chapter also describes the development of the City's storm drainage hydrologic and hydraulic models. These models were used for identifying existing system deficiencies and for recommending capital improvements.

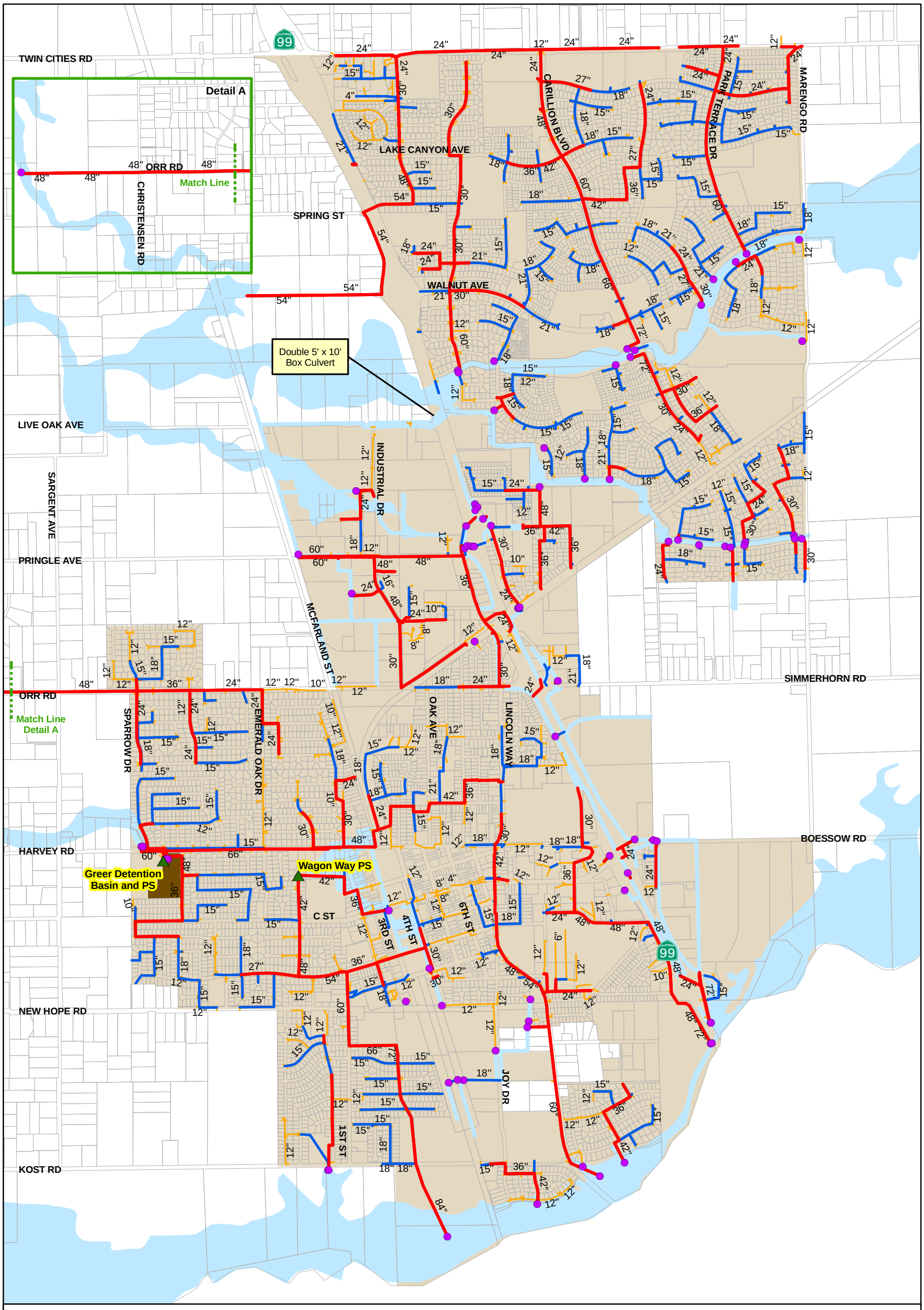
4.1 SYSTEM OVERVIEW

The existing storm drainage system collects and conveys surface water runoff throughout the City and discharges the runoff into local drainage channels. The majority of storm water runoff generated in the City is discharged directly into drainage channels, such as Deadman Gulch or Dry Creek, although the City does own and operate one detention basin that is capable of capturing storm water runoff. Figure 4.1 shows the existing storm drainage system, including storm drain diameters and detention basin, pump station, and outfall locations. More detail on the City's storm drainage system is provided below. Table 4.1 presents a summary by diameter of the known storm drains in the drainage system. In total, there are approximately 73 miles of storm drains.

Table 4.1 Storm Drainage System Pipeline Summary
Storm Drainage System Master Plan
City of Galt

Diameter (inch)	Length (feet)	Diameter (inch)	Length (feet)
4	914	30	20,415
6	881	33	507
8	2,175	36	15,739
10	6,392	39	267
12	110,929	42	6,250
14	29	48	21,568
15	79,427	54	6,311
16	149	60	12,547
18	37,030	66	5,293
21	7,205	72	5,340
24	37,152	83	490
		Total	**384,378**

Source: City provided AutoCAD data.



Legend

Existing Storm Drainage System

- Outfall
- Pump Station
- Storage Basin

Storm Drain Diameter

- 12" and Less
- 14 - 21"
- 24" and Larger
- Surface Drainage/ 100-Year FEMA Floodplain

- Parcels
- City Limits

N

0 1,250 2,500 Feet

Figure 4.1
Existing Storm Drainage System
Storm Drainage System Master Plan
City of Galt

4.2 EXISTING SYSTEM DRAINAGE AREAS

The City is currently divided into 38 hydraulically distinct subbasins, as shown on Figure 4.2. Table 4.2 summarizes the total area for each subbasin and the level of development in each. Each subbasin has a system of conveyance facilities to collect and dispose runoff. Depending on the subbasin, stormwater runoff is either conveyed to local drainage channels (e.g., Deadman Gulch, Dry Creek, etc.) or can be stored in a detention basin prior to disposal.

For the sake of clarity, the existing subbasins were grouped into six larger drainage areas based on their receiving waters. A brief description of each drainage area and the existing drainage facilities in each drainage area is provided below.

4.2.1 Deadman Gulch North Drainage Area

Deadman Gulch flows in a westerly direction through the northern part of the City. East of Highway 99, Deadman Gulch was designed and constructed to serve as a storm water detention facility in addition to a storm water conveyance facility. The culvert under Highway 99 meters the flow into Deadman Gulch west of Highway 99[1].

For the purposes of this Master Plan, the north-reach of Deadman Gulch refers to the main stem of Deadman Gulch, which extends through the northern part of the City limits in a general westerly direction, as shown in Figure 4.2. Two smaller tributaries combine with the main stem (or “north-reach”) of Deadman Gulch on the east side of Highway 99 and just east of Midway Avenue. These two smaller tributaries are referred to as the “south-reach” and “southwest-reach” of Deadman Gulch for the purposes of this report.

The Deadman Gulch North drainage area services primarily residential developments in the northeast part of the City limits with small pockets of commercial and public land use areas. Storm drain pipelines in this drainage area range in size from 4-inches to 72-inches in diameter. As shown in Figure 4.2 and Table 4.2, this area is further broken down into ten subbasins and unconnected pipeline networks (Deadman Gulch North 1 through Deadman Gulch North 10) that discharge into the north-reach of Deadman Gulch.

4.2.2 Deadman Gulch South Drainage Area

The south-reach of Deadman Gulch refers to the waterway that flows into Deadman Gulch near Highway 99 and extends upstream in a general southeasterly direction beyond the City limits, as shown in Figure 4.2.

[1] City of Galt General Plan, Environmental Impact Report, Draft, July 2008, Minter & Associates.

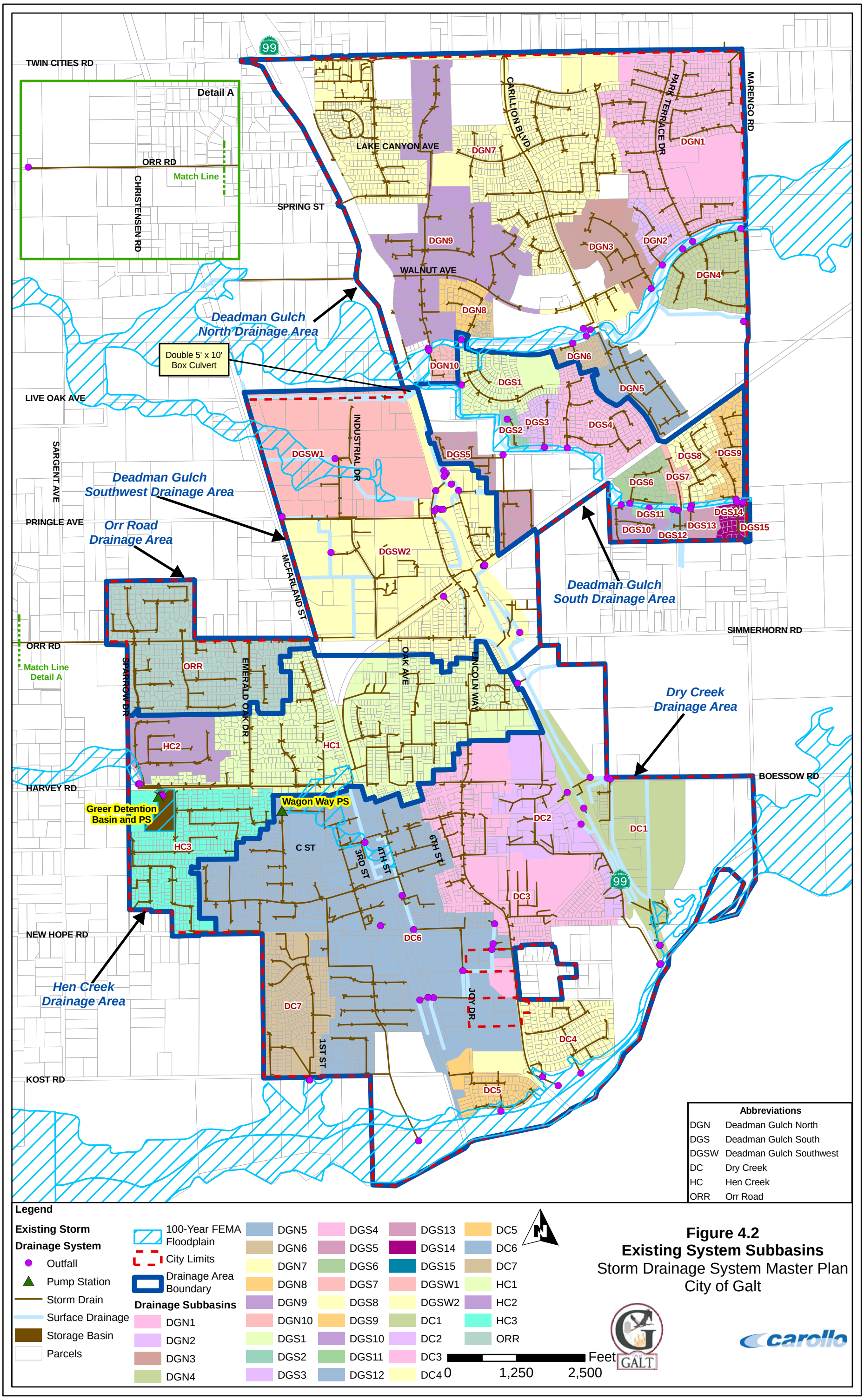


Figure 4.2
Existing System Subbasins
Storm Drainage System Master Plan
City of Galt

Table 4.2 Subbasin Area and Level of Development
Storm Drainage System Master Plan
City of Galt

Subbasin Name/ Abbreviation	Acres	Developed Area (Acres)	Developed Percent Developed	Undeveloped Area (Acres)	Undeveloped Percent Undeveloped
Deadman Gulch North (DGN) Drainage Area					
DGN 1	168.3	150.3	89%	17.9	11%
DGN 2	12.8	12.8	100%	0.0	0%
DGN 3	45.5	45.1	99%	0.4	1%
DGN 4	42.4	42.3	100%	0.1	0%
DGN 5	34.5	23.3	67%	11.3	33%
DGN 6	9.4	9.3	100%	0.0	0%
DGN 7	278.7	273.0	98%	5.8	2%
DGN 8	18.1	18.0	100%	0.1	0%
DGN 9	136.7	118.0	86%	18.7	14%
DGN 10	7.6	7.5	100%	0.0	0%
Deadman Gulch South (DGS) Drainage Area					
DGS 1	41.4	38.6	93%	2.9	7%
DGS 2	5.6	5.1	92%	0.5	8%
DGS 3	12.0	11.5	95%	0.6	5%
DGS 4	48.9	48.7	100%	0.2	0%
DGS 5	29.8	29.0	97%	0.8	3%
DGS 6	16.7	16.6	100%	0.1	0%
DGS 7	5.7	5.3	92%	0.5	8%
DGS 8	22.4	17.8	80%	4.6	20%
DGS 9	24.2	19.4	80%	4.8	20%
DGS 10	12.2	12.2	100%	0.0	0%
DGS 11	2.6	2.4	94%	0.1	6%
DGS 12	4.4	4.4	100%	0.0	0%
DGS 13	8.0	7.9	99%	0.0	1%
DGS 14	7.2	7.2	100%	0.0	0%
DGS 15	1.4	1.4	100%	0.0	0%
Deadman Gulch Southwest (DGSW) Drainage Area					
DGSW 1	152.3	93.3	61%	59.0	39%
DGSW 2	246.8	184.0	75%	62.8	25%
Dry Creek (DC) Drainage Area					
DC 1	105.9	52.9	50%	53.0	50%
DC 2	71.0	67.5	95%	3.5	5%
DC 3	151.2	146.1	97%	5.1	3%
DC 4	56.6	36.9	65%	19.6	35%
DC 5	24.7	8.6	35%	16.0	65%
DC 6	398.6	299.2	75%	99.4	25%

Table 4.2 Subbasin Area and Level of Development Storm Drainage System Master Plan City of Galt					
		Developed		Undeveloped	
Subbasin Name/ Abbreviation	Acres	Area (Acres)	Percent Developed	Area (Acres)	Percent Undeveloped
DC 7	68.5	68.4	100%	0.0	0%
Hen Creek (HC) Drainage Area					
HC 1	253.8	235.6	93%	18.2	7%
HC 2	41.9	41.6	99%	0.3	1%
HC 3	103.5	103.0	100%	0.5	0%
Orr Road Drainage Area					
ORR	132.8	118.7	89%	14.1	11%

The Deadman Gulch South drainage area, which is located just south of the Deadman Gulch North drainage area, is composed of residential and public land use areas. The drainage area consists of fifteen small subbasins that discharge into the south-reach of Deadman Gulch. Pipelines in the area range in size from 12-inches to 72-inches in diameter.

4.2.3 Deadman Gulch Southwest Drainage Area

The southwest-reach of Deadman Gulch refers to the waterway that flows into the north reach of Deadman Gulch east of Midway Avenue and extends upstream in a general southeasterly direction to the western end of the City limits.

The Deadman Gulch Southwest drainage area is composed predominantly of industrial land uses, although portions of the drainage area also service commercial and residential uses. Storm drain pipelines in this area range in size from 4-inches to 60-inches in diameter, which convey flow from two distinct subbasins that discharge into the southwest-reach of Deadman Gulch.

4.2.4 Dry Creek Drainage Area

Dry Creek is a natural channel, which forms the southern boundary of the City. Dry Creek flows in a westerly direction into the Mokelumne River. The creek extends east beyond the City limits. Seven separate subbasins (Dry Creek 1 through Dry Creek 7) comprise the Dry Creek drainage area, which consists of residential, commercial, public, and industrial land use areas in the southern end of the City.

Storm drain pipelines ranging in size from 4-inches to 83-inches in diameter convey stormwater runoff from the seven subbasins to discharge points at Dry Creek. In addition, a portion of the drainage area is served by a storm drainage pump station located on Wagon Way north of ‘C’ Street. Two subbasins in this drainage area are also interconnected with

the Hen Creek drainage area. The Dry Creek 2 subbasin is interconnected with the Hen Creek drainage area through an open channel near Highway 99. The Dry Creek 3 subbasin is interconnected with the Hen Creek drainage area through an 18-inch diameter storm drain on Lincoln Way near Myrtle Avenue.

4.2.5 Hen Creek Drainage Area

Hen Creek is a smaller waterway that generally runs parallel with Harvey Road west of the City limits. Storm runoff stored in the Greer Middle School joint use facility/park detention basin is pumped into Hen Creek for disposal. Three separate subbasins comprise the Hen Creek drainage area, which consists primarily of residential land use areas in southwestern end of the City.

Storm drain pipelines ranging in size from 4-inches to 66-inches convey stormwater runoff to a weir structure located near A Street, which regulates the amount of flow that can be discharged directly into Hen Creek from the three subbasins. Excess stormwater flows are directed to the 32 acre-ft (AF) Greer detention basin and stored before being discharged into Hen Creek by the A Street pump station.

As noted in Section 4.2.4, two subbasins in this drainage area are also interconnected with the Hen Creek drainage area through an open channel near Highway 99, and through an 18-inch diameter storm drain on Lincoln Way near Myrtle Avenue.

4.2.6 Orr Road Drainage Area

The Orr Road subbasin services a residential development area in the western part of the City. Storm water runoff is collected in a 36-inch and 48-inch storm drain on Elm Avenue. Storm water runoff in this subbasin is discharged in an open channel on Orr Road west of the City limits.

4.3 STORM DRAIN RETENTION/DETENTION BASINS

There is currently one detention basin operated by the City to store storm water runoff generated within the existing City limits. The Greer detention basin, which is located near the intersection of A Street and Fumasi Drive (Figure 4.1), has an estimated total storage capacity of roughly 32 AF.

4.4 STORM DRAIN PUMP STATIONS

There are currently two pump stations in the storm drainage system. The location of each pump station is shown on Figure 4.1.

4.5 EXISTING DISCHARGE LOCATIONS

The City currently discharges storm runoff into open channels at roughly 80 locations throughout the City. The majority of the storm water runoff is discharged into the open channels directly; however, the City does operate the Greer detention basin, which can store storm water runoff prior to being discharged.

4.6 MODELING SOFTWARE

The storm drainage system was evaluated using H_2OMAP SWMM modeling software. H_2OMAP SWMM is a commercial version of EPA SWMM 5.0 software. The SWMM RUNOFF Block, which is included in H_2OMAP SWMM, was used to perform the hydrologic analysis.

H_2OMAP SWMM is a fully dynamic wastewater and storm water modeling and management software application. H_2OMAP SWMM can be used to model the entire land phase of the hydrologic cycle as applied to urban storm water and wastewater collection systems. The model can perform single event or long-term (continuous) rainfall-runoff simulations accounting for climate, soil, land use, and topographic conditions of the watershed. Once runoff quantity is simulated, and wastewater loads at receiving nodes are determined (for wastewater collection system modeling), the routing portion of H_2OMAP SWMM transports, using either steady flow routing, kinematic wave routing or dynamic wave routing, the flow through a conveyance system of pipes, channels, storage/treatment devices, pumps, and hydraulic regulators such as weirs and orifices. The model offers advanced Real-Time Control (RTC) scheme for the operational management of hydraulic structures.

4.7 HYDROLOGIC MODEL

Hydrologic analysis of the City's storm drainage system was performed using the SWMM Runoff Block, which is included in the H_2OMAP SWMM modeling software. The SWMM Runoff Block was designed to simulate the surface water runoff response of a drainage basin to precipitation by representing the basin as an interconnected system of hydrologic and hydraulic components. The Runoff Block was used to simulate the quantity of storm water runoff that flows overland in each subbasin during a particular storm event.

In the SWMM Runoff Block, each model component represents a specific aspect of the rainfall-runoff processes occurring in a portion of the watershed. A component may represent the runoff occurring in a subbasin, the routing of flows down a stream channel, or the routing of flows through a detention basin. The model operates by reading an input data file that contains the parameters describing each component of the drainage basin, along with information describing how the various components work together to form the drainage basin. The result of the modeling process was a tabulation of stream flow hydrographs at desired locations within the study area.

The Runoff Block output data was generated by the model based on the input parameters detailed below.

4.7.1 Model Components

Description of the model components requires the estimation of a set of parameters describing the hydrologic characteristics of the component. Parameters describing the various components of the model are based on land use, soils, vegetation, stream channels, and topography. For example, the land use in a subbasin will determine the percent of that subbasin that is impervious and the average condition of the drainage channels. These values, along with others describing additional components of the subbasin, are placed in a computer input data file that is read by the SWMM Runoff computer model and used as a basis for computation of the rainfall-runoff processes in the subbasin.

4.7.1.1 SWMM Hydrologic Unit (Subcatchments)

Subcatchments are hydrologic units of land whose topography and drainage system elements direct surface runoff to a single discharge point. The City was divided up into roughly 1,800 individual subcatchments and the appropriate outlet point was defined. The area and boundary of each subcatchment was determined with the use of development plans, available topographic data, and field observations to determine the drainage path. Table 4.3 summarizes the number of subcatchments by subbasin and the minimum, maximum, and average subcatchment area within each subbasin.

Table 4.3 Subcatchment Summary
Storm Drainage System Master Plan
City of Galt

Subbasin	Subbasin Area (acres)	No. of Subcatchments	Subcatchment Area (Acres) Min	Max	Average
Deadman Gulch North (DGN) Drainage Area					
DGN 1	168.3	135	0.25	18.29	1.22
DGN 2	12.8	12	0.56	1.78	1.07
DGN 3	45.5	35	0.50	3.36	1.28
DGN 4	42.4	37	0.13	2.35	1.15
DGN 5	34.5	35	0.15	3.77	0.99
DGN 6	9.4	7	0.83	1.68	1.33
DGN 7	278.7	247	0.07	7.99	1.07
DGN 8	18.1	16	0.58	2.11	1.13
DGN 9	136.7	105	0.15	3.02	1.20
DGN 10	7.6	4	1.31	2.26	1.86

Table 4.3 Subcatchment Summary
Storm Drainage System Master Plan
City of Galt

Subbasin	Subbasin Area (acres)	No. of Subcatchments	Subcatchment Area (Acres) Min	Max	Average
Deadman Gulch South (DGS) Drainage Area					
DGS 1	41.4	23	0.71	10.34	1.80
DGS 2	5.6	4	0.74	2.26	1.38
DGS 3	12.0	8	1.07	2.01	1.52
DGS 4	48.9	38	0.47	2.63	1.28
DGS 5	29.8	32	0.10	2.94	0.92
DGS 6	16.7	15	0.05	1.90	0.97
DGS 7	5.7	7	0.63	1.64	0.85
DGS 8	22.4	23	0.66	1.53	0.96
DGS 9	24.2	31	0.30	2.17	0.88
DGS 10	12.2	12	0.25	1.56	1.02
DGS 11	2.6	4	0.22	1.16	0.63
DGS 12	4.4	7	0.14	1.64	0.63
DGS 13	8.0	9	0.51	1.44	0.90
DGS 14	7.2	8	0.24	1.28	0.91
DGS 15	1.4	3	0.20	1.00	0.47
Deadman Gulch Southwest (DGSW) Drainage Area					
DGSW 1	152.3	20	0.20	14.54	4.28
DGSW 2	246.8	90	0.09	27.06	1.79
Dry Creek (DC) Drainage Area					
DC 1	105.9	3	0.46	101.74	35.23
DC 2	71.0	43	0.16	12.30	1.87
DC 3	151.2	98	0.11	7.85	1.46
DC 4	56.6	32	0.31	9.27	2.05
DC 5	24.7	24	0.53	4.63	1.39
DC 6	398.6	217	0.15	9.91	1.36
DC 7	68.5	36	0.39	4.85	1.88
Hen Creek (HC) Drainage Area					
HC 1	253.8	154	0.20	9.12	1.63
HC 2	41.9	38	0.41	2.19	1.08
HC 3	103.5	78	0.11	14.78	1.32
Orr Road Drainage Area					
ORR	132.8	101	0.32	2.51	1.30

4.7.1.2 Design Hydrographs

Design hydrographs were determined using the SWMM Runoff Module of H_2OMAP SWMM, which is incorporated in the Galt Stormwater model. The 10-year and 100-year, 24-hour storms were used in the analysis. The hyetographs, which are graphical representations of the distribution of rainfall over time, were balanced so that 5, 10, 15, etc. minute intensities are nested symmetrically within the 24-hour storm. They were constructed (by the SWMM Runoff Module) from depth duration frequency (DDF) data shown in Table 3.1.

4.7.1.3 Width of SWMM Hydrologic Unit (SWMM Subbasin)

The width of each SWMM Hydrologic unit, or SWMM subbasin was used by the model to estimate the flow from the furthest point in the drainage area to the outlet. Determining this physical width of overland flow is a difficult process as it depends on storage and shape effects of the subbasin. Therefore, it is commonly used as a calibration parameter to account for the impact of the drainage system within each subbasin on flow travel time. However, due to inadequate data for calibrating the runoff from each subbasin, subbasin width was not considered as a calibration parameter in this analysis. Instead, the width was estimated first by determining the maximum length of overland flow and dividing the area by this length. This method is recommended in the SWMM User's Manual.

4.7.1.4 Ground Slope

Ground slopes were determined using the City's elevation data and ArcView GIS. An average overland flow path slope is required for each basin within SWMM Runoff. This value was automatically determined through intersection of subbasin areas with the Digital Elevation Model (DEM) derived from the City elevation data points and survey data. The elevation grid was intersected with the subbasins and the slope of each grid cell within the subbasin was calculated. Using the number of cells within each subbasin, the average basin slope was calculated. To verify this procedure, subbasin slopes for selected subbasins were manually estimated using available ground contour elevations and following SWMM guidelines.

4.7.1.5 Directly Connected Impervious Area

SWMM Runoff requires initial percent Directly Connected Impervious Area (DCIA) values to estimate the volume of runoff. GIS techniques were employed to calculate the percent DCIA values. DCIA refers to the impervious areas that are directly connected to stormwater conveyance systems, such as stream channels and storm sewers, with no opportunity for infiltration. For the existing conditions, transportation features (roads, bridges, and highways) were merged with building footprints to create DCIA coverage. These features typically contribute the highest amounts of direct stormwater runoff to a storm sewer system. Once the features were merged into a polygon coverage, the percentage of each subbasin's area represented by this coverage was calculated and defined as percent DCIA.

The transportation and building footprint features were extracted from the measured impervious coverage data obtained from the City.

For future land use conditions, DCIA values considered representative of each of the City's land use designations were determined based on a review of existing conditions. The Watershed DCIA-land use relationships were used in conjunction with future land use to determine future DCIA values for each SWMM model subbasin.

4.7.1.6 Depression Storage in Pervious and Impervious Areas

Depression storage is a volume that must be filled prior to the occurrence of runoff on pervious and impervious areas and is often used as a calibration parameter. Depression storage is input into the model as an average depth over the entire drainage area. Because this value is difficult to estimate, trial depression storage values were initially input for pervious and impervious portions of each SWMM hydrologic unit using values in the SWMM User's Manual and then adjusted, where necessary, during model comparison with other hydrologic models.

4.8 HYDRAULIC MODEL

The H_2OMAP SWMM hydraulic model was used to simulate the hydraulic conditions in the City's storm drainage system. The computer hydraulic model was used to analyze the storm drainage system, to identify deficiencies, and to propose system improvements.

4.8.1 Flow Routing

Flow routing within a conduit link in H_2OMAP SWMM is governed by the conservation of mass and momentum equations for gradually-varied unsteady flow (i.e., the St. Venant equations). The H_2OMAP SWMM user has a choice on the level of sophistication used to solve these equations:

- Steady Flow
- Kinematic Wave Routing
- Dynamic Wave Routing

The City's hydraulic model used Dynamic wave routing to analyze the storm drainage system. Dynamic wave routing solves the complete St. Venant flow equations and therefore produces the most accurate results. These equations consist of the continuity and momentum equations for conduits and a flow continuity equation at nodes.

Dynamic wave routing can account for channel storage, backwater, entrance/exit losses, flow reversal, and pressurized flow. Because it couples the solution for both water levels at nodes and flow in conduits it can be applied to any general network layout, even those containing multiple downstream diversions and loops. It is the method of choice for systems subjected to significant backwater effects due to downstream flow restrictions or flow

regulation via weirs and orifices. This generality comes at a price of having to use much smaller time steps, on the order of a minute or less.

4.8.2 Gutter Flow

The purpose of modeling gutter flow in the model is to account for the attenuation and storage of storm water. Storage in streets/gutters was first simulated in the model by allowing ponding at drop inlets. Based on the terrain and elevations around the inlets, estimations of ponded areas were developed for each inlet. These areas were allowed to flood or pond to a depth of one foot.

Areas with flooding or ponding greater than one foot were analyzed on an individual basis. To avoid unnecessary pipeline improvements in these areas, gutters were then modeled as open channels to represent actual gutter flow from one drop inlet to the next. A representative cross section was used to determine flow, velocity, and depth in the gutters. This allowed storm water to travel down the gutter to the next inlet where capacity in the pipe was available, which typically occurs in storm drainage systems. If modeling the system in this manner did not correct the capacity problem, then a storm drain improvement was necessary.

4.9 MODEL VERIFICATION

The reasonableness of the model results and the hydraulic grade line profiles were evaluated during the initial model runs. This was accomplished by comparing areas of flooding predicted by the model with observations offered by the City. Areas around the City that experience flooding were confirmed by the model results. Following the verification process, the model was used for the existing and future storm drainage system analysis.

CAPACITY EVALUATION AND PROPOSED IMPROVEMENTS

This chapter presents the results of the capacity evaluation of the storm drainage system and the proposed projects that correct capacity deficiencies and serve future users.

5.1 FUTURE SYSTEM DRAINAGE AREAS

As the City of Galt (City) expands to the General Plan boundary by the year 2030, additional hydrologically distinct subbasins will be added to the storm drainage system, as illustrated in Figure 5.1. Each subbasin will have a system of conveyance facilities to collect and store stormwater runoff.

5.2 CAPACITY EVALUATION

The capacity analysis entailed identifying areas in the storm drainage system where street flooding exceeded the maximum criteria. Storm drains that lack sufficient capacity to convey runoff generated from the design storm could produce backwater effects in the drainage system and potentially cause flooding. This chapter discusses the possible locations of existing and future flooding caused by these deficiencies. When an increase to capacity is required, it was assumed, unless otherwise noted, that storm drains would be replaced with a larger diameter pipeline.

When evaluating the adequacy of the storm drainage facilities serving existing and future developments, City streets were allowed to flood and provide additional storage capacity, thus reducing the number of storm drain improvements. When storm drains are located in City streets, the goal was to contain storm flows within the drainage pipelines, with minimal ponding in City streets during the 10-year design storm. The storm drainage criteria allowed City streets to flood up to one foot above the gutter flow line in the 100-year design storm. If flooding exceeded one foot, then an improvement was necessary to correct the problem. Pipe systems that are not within a street that acts as an overland flow channel, should have sufficient capacity to convey the 100-year design storm, while maintaining a hydraulic grade line below the manhole rim elevations.

In general, the existing storm drainage system has sufficient capacity to convey runoff generated during the 10-year design storm. In some locations, the existing storm drains lack sufficient capacity to convey the 100-year design runoff while meeting the one foot criterion. These areas are generally located in the southwest area and are susceptible to flooding.

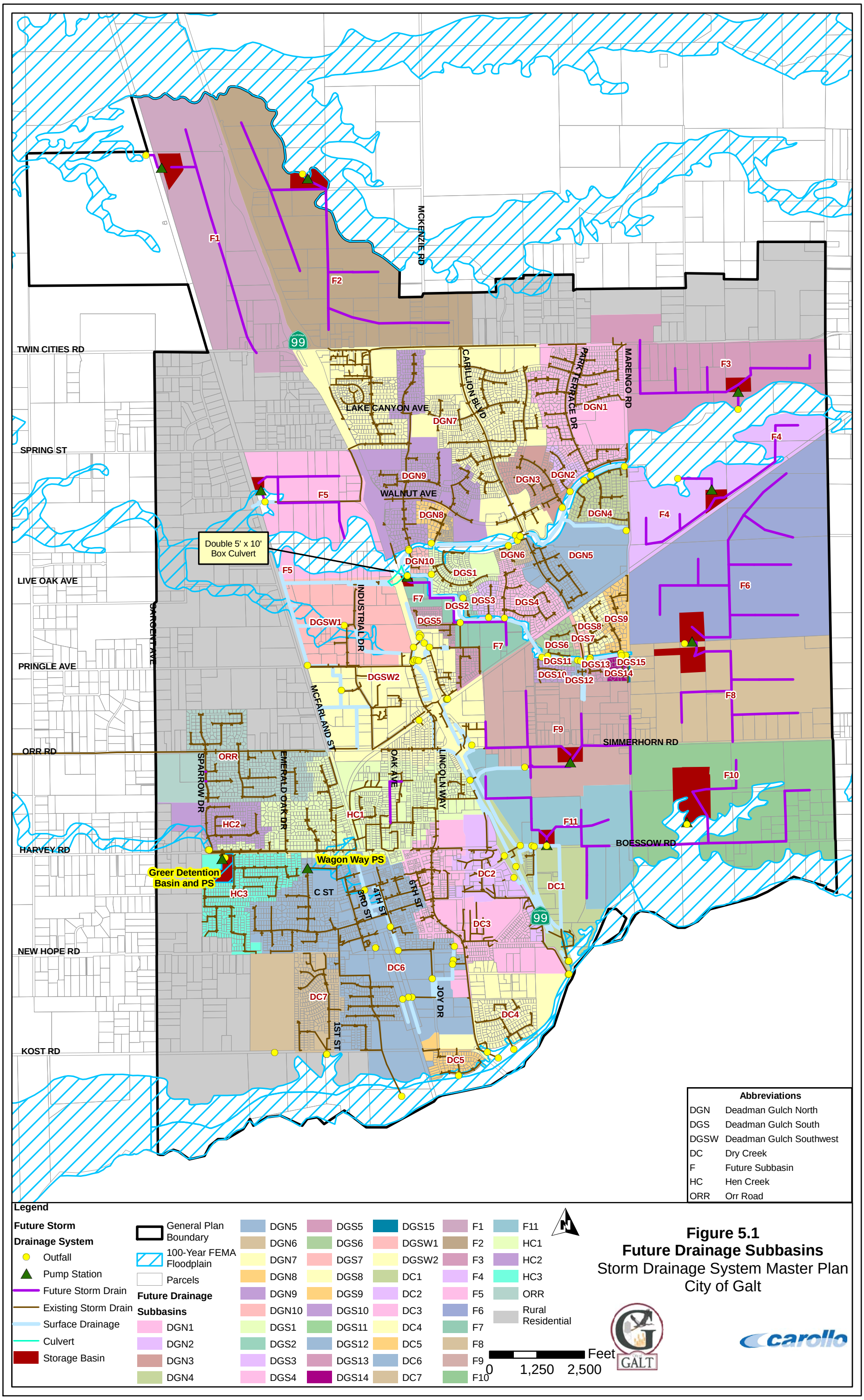


Figure 5.1
Future Drainage Subbasins
Storm Drainage System Master Plan
City of Galt

The proposed improvements that will serve future users are sized for build-out conditions. As the City continues to grow beyond its current limits, it is recommended that the pipeline diameters, detention basin sizes, and pump station capacities proposed in this storm drainage system master plan (Master Plan) be constructed so that the facilities have sufficient capacity for build-out conditions. Building a smaller interim project with the plans of upsizing in the future to account for further growth is not recommended. In this Master Plan, the proposed pipe diameter represents the ultimate diameter for build-out conditions.

5.3 STORM DRAINAGE SYSTEM IMPROVEMENTS

Figure 5.2 illustrates the proposed storm drainage system improvements required to correct existing deficiencies and to serve future users. The proposed pipeline diameter is also shown on the figures. Other projects that will benefit existing users include proposed storm drain rehabilitation projects discussed below.

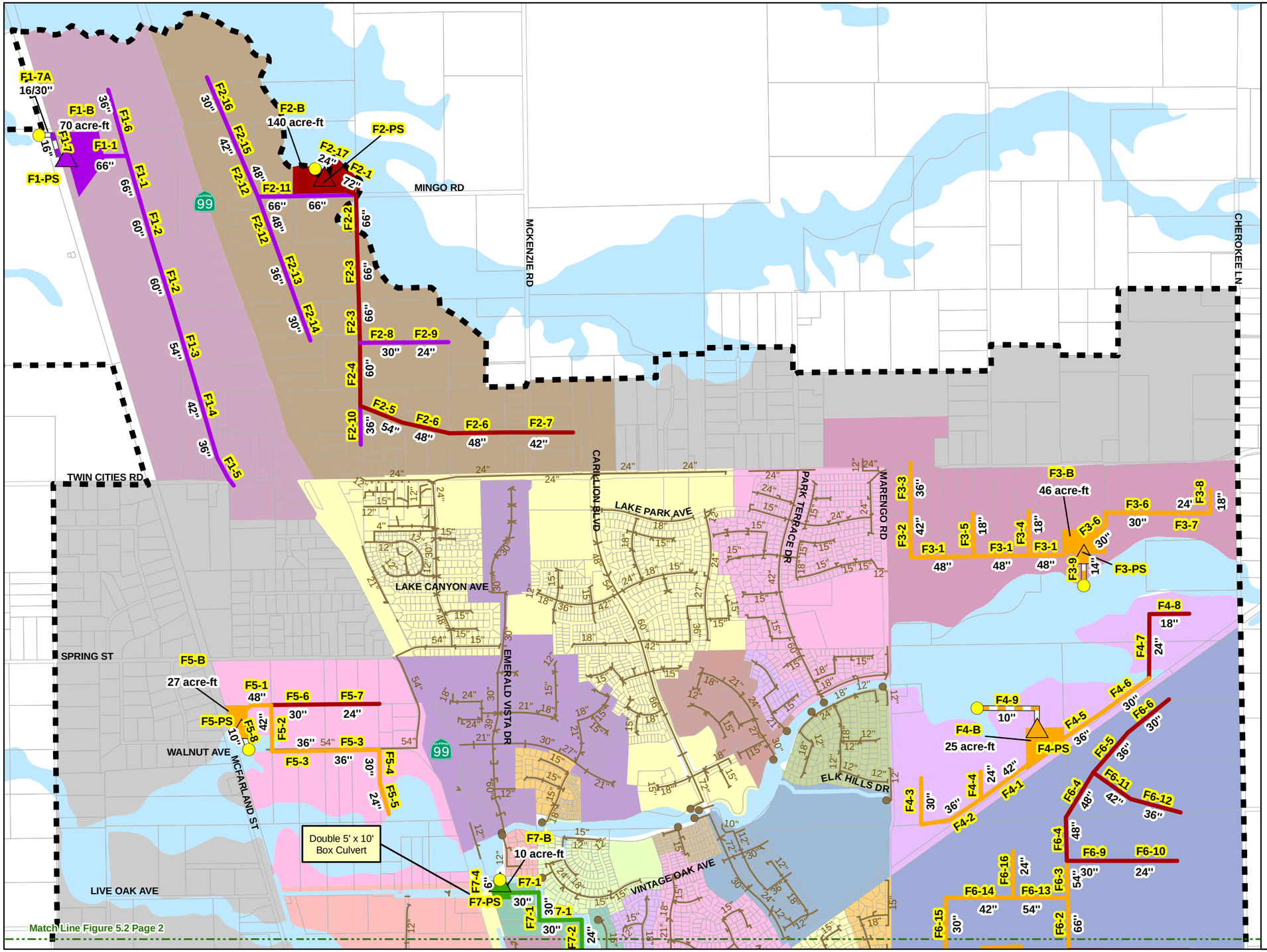
Table 5.1 shows details of each improvement. For future storm drains, the proposed diameter is shown along with the length of pipe. This table also shows the improvement figure number. Figure 5.2 and Table 5.1 should be used together to locate the proposed improvement on the map and to gain details of the improvement (length, diameter, street location, etc.). The improvement figure number links the figure and table. For example, HC-1 in Table 5.1 refers to the proposed relief storm drain sewer in the Hen Creek 1 Subbasin, which can be found in Figure 5.2 on Oak Avenue.

5.3.1 Storm Drain Rehabilitation and Replacement

In addition to the improvements recommended to mitigate capacity deficiencies, the City should implement a storm drain rehabilitation program. The storm drain rehabilitation program consists of removing older storm drains that are susceptible to failure. This program will extend the useful life of existing storm drains and maintain the operation of the storm drainage system. Rehabilitation projects are presented in the recommended capital improvement projects (CIP).

5.3.2 Existing Versus Future Improvement

An existing deficiency is one where the existing facility's capacity is insufficient to meet the planning criteria (e.g. pipeline upgrades required to prevent flooding in excess of one foot above the curb line) for existing users. If a project was proposed to correct an existing deficiency, then existing users were assigned 100 percent of the project's benefit, and therefore, 100 percent of the costs.



Legend

Storm Facilities

- Outfall
- Future Outfall
- Pump Station
- Gravity Pipeline
- Outfall Pipeline
- Storage Basin
- Surface Drainage/100-Year FEMA Floodplain

Facility Coloring

- Existing System

Existing System Improvements

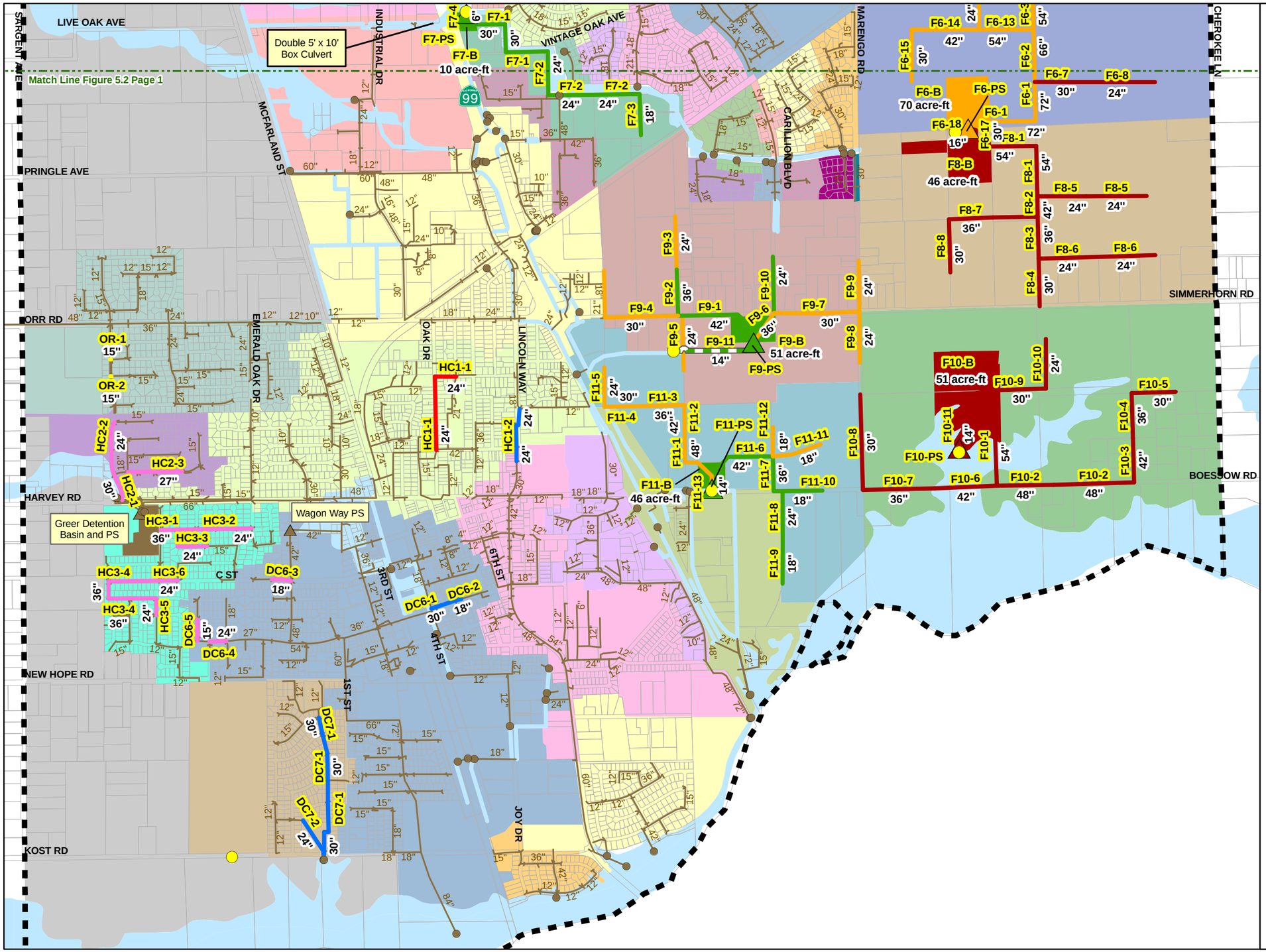
- Phase 1 (2009 - 2015): New
- Phase 1 (2009 - 2015): Replacement
- Phase 2 (2016 - 2020): New
- Phase 2 (2016 - 2020): Replacement

Future System Improvements

- Phase 1 (2009 - 2015)
- Phase 2 (2016 - 2020)
- Phase 3 (2021 - 2025)
- Phase 4 (2026 - 2030)
- Future Drainage Subbasins
- General Plan Boundary
- Parcels
- F1-2 Figure Number
- 12" Proposed Pipeline Diameter
- 12/24" Proposed Pipeline/ Casing Pipe Diameter
- 8" Existing Pipeline Diameter

Feet
0 1,500 3,000

Figure 5.2
Proposed Capital Improvements (1 of 2)
Storm Drainage
System Master Plan
City of Galt



Legend

Storm Facilities

- Outfall
- Future Outfall
- Pump Station
- Gravity Pipeline
- Outfall Pipeline
- Storage Basin
- Surface Drainage/100-Year FEMA Floodplain

Facility Coloring

- Existing System

Existing System Improvements

- Phase 1 (2009 - 2015): New
- Phase 1 (2009 - 2015): Replacement
- Phase 2 (2016 - 2020): New
- Phase 2 (2016 - 2020): Replacement

Future System Improvements

- Phase 1 (2009 - 2015)
- Phase 2 (2016 - 2020)
- Phase 3 (2021 - 2025)
- Phase 4 (2026 - 2030)
- Future Drainage Subbasins
- General Plan Boundary
- Parcels
- F1-2 Figure Number
- 12" Proposed Pipeline Diameter
- 12/24" Proposed Pipeline/ Casing Pipe Diameter
- 8" Existing Pipeline Diameter

N

0 1,500 3,000 Feet

Figure 5.2
Proposed Capital Improvements (2 of 2)
Storm Drainage System Master Plan
City of Galt

GALT

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Table 5.1 Proposed Storm Drainage System Improvements
Storm Drainage System Master Plan
City of Galt

Figure No.	Type of Improvement	Description/ Street	Description / Limits	Pipeline Cost Schedule (A or B)	Project Length/Size and Cost: Ex. Size/ Diam. (in)	New Size/ Diam. (in)	Replace/ New	Length (ft)	Capital Improvement Phasing: Phase 1 2009-2015	Phase 2 2016-2020	Phase 3 2021-2025	Phase 4 2026-2030
Existing System Improvements												
Dry Creek 6 Subbasin												
DC6-1	Pipe	E Street	4th Street crossing	A	15	30	Replace	70	Phase 1			
DC6-2	Pipe	E Street	4th Street to 5th Street	A	12	18	Replace	400	Phase 1			
DC6-3	Pipe	C Street	Wagon Way to Rowland Court	A	15	18	Replace	300	Phase 1			
DC6-4	Pipe	E Street	Retriever Way to Village Run Drive	A	18	24	Replace	250	Phase 1			
DC6-5	Pipe	Range Way	E Street to Plains Court	A	12	15	Replace	300	Phase 1			
Dry Creek 7 Subbasin												
DC7-1	Pipe	Meadowview Drive	Kost Road to Cindy Lane	A	18/24	30	Replace	2,100	Phase 1			
DC7-2	Pipe	Meadowview Park	Meadowview Drive to East of Creekside Way	A	15	24	Replace	700	Phase 1			
Hen Creek 1 Subbasin												
HC1-1	Pipe	Oak Avenue/Simon Street	Myrtle Avenue to Palin Avenue	A	-	24	New	1,400	Phase 1			
HC1-2	Pipe	Lincoln Way	North of A Street to Wendy Hope Drive	A	18/21	24	Replace	800	Phase 1			
Hen Creek 2 Subbasin												
HC2-1	Pipe	Sparrow Drive	A Street to Sterling Grove Drive	A	27	30	Replace	400	Phase 1			
HC2-2	Pipe	Sparrow Drive	Sterling Grove Drive to Cinnamon Drive	A	15	24	Replace	800	Phase 1			
HC2-3	Pipe	Sterling Grove Drive	Spoonbill Lane to Silver Pine Court	A	15/18	27	Replace	800	Phase 1			
Hen Creek 3 Subbasin												
HC3-1	Pipe	Oakwilde Street	Fumasi Drive to Toni Court	A	24	36	Replace	250	Phase 1			
HC3-2	Pipe	Oakwilde Street	Toni Court to Emerald Oak Drive	A	15/18	24	Replace	1,100	Phase 1			
HC3-3	Pipe	Danny Drive	Oakwilde Street to South of Oakwilde Street	A	15	24	Replace	700	Phase 1			
HC3-4	Pipe	C Street/Rio Mesa Way	Fumasi Drive to Wristen Way	A	24/27	36	Replace	1,800	Phase 1			
HC3-5	Pipe	Wristen Way	Rio Mesa Way to McTucker Drive	A	21	24	Replace	250	Phase 1			
HC3-6	Pipe	C Street	Fumasi Drive to Dawn Circle	A	15	24	Replace	250	Phase 1			
Orr Road Subbasin												
OR-1	Pipe	Sparrow Drive	Mallard Drive	A	-	15	New	30	Phase 1			
OR-2	Pipe	Sparrow Drive	Wren Drive	A	-	15	New	30	Phase 1			
Storm Drain Replacement Program												
-	Pipe	Various Locations	Storm Drain Replacement Program. Average Size is 24.	A	24	24	Replace	10,000	Phase 1	Phase 2	Phase 3	Phase 4
Future System Improvements												
Future Subbasin 1												
F1-1	Pipe	West of Highway 99	Future Basin (F1-B) to Mingo Road Extension	B	-	66	New	1,300				Phase 4
F1-2	Pipe	West of Highway 99	Mingo Road Extension to South of Mingo Road Extension	B	-	60	New	1,800				Phase 4
F1-3	Pipe	West of Highway 99	South of Mingo Road Extension to North of Twin Cities Road	B	-	54	New	1,000				Phase 4
F1-4	Pipe	West of Highway 99	North of Twin Cities Road	B	-	42	New	850				Phase 4
F1-5	Pipe	West of Highway 99	North of Twin Cities Road to Twin Cities Road	B	-	36	New	850				Phase 4
F1-6	Pipe	West of Highway 99	North of Mingo Road Extension to North of Mingo Road Extension	B	-	36	New	1,000				Phase 4
F1-7	Force Main	Near Union Pacific Railroad	Future Basin (F1-B) to Future Outfall	B	-	16	New	600				Phase 4
F1-7A	Pipe/Casing[1]	Near Union Pacific Railroad	Crossing Under UPRR	A	-	16/30	New	300				Phase 4
F1-B	Basin	Eastside of Union Pacific Railroad	Future Detention Basin	-	-	70 acre-ft	New	-				Phase 4
	Land Acquisition				-	8 acres	New	-				Phase 4
F1-PS	Pump Station	Eastside of Union Pacific Railroad	Pump Station at Future Basin (F1-B)	B		7 cfs	New	-				Phase 4

Table 5.1 Proposed Storm Drainage System Improvements
Storm Drainage System Master Plan
City of Galt

Figure No.	Type of Improvement	Description/ Street	Description / Limits	Pipeline Cost Schedule (A or B)	Project Length/Size and Cost: Ex. Size/ Diam. (in)	New Size/ Diam. (in)	Replace/ New	Length (ft)	Capital Improvement Phasing: Phase 1 2009-2015	Phase 2 2016-2020	Phase 3 2021-2025	Phase 4 2026-2030
Future Subbasin 2												
F2-1	Pipe	North of Mingo Road	Future Basin (F2-B) to Mingo Road	B	-	72	New	400			Phase 3	
F2-2	Pipe	Bergeron Road Extension	Mingo Road to South of Mingo Road	B	-	66	New	700			Phase 3	
F2-3	Pipe	Bergeron Road Extension	South of Mingo Road to South of Mingo Road	B	-	66	New	1,500			Phase 3	
F2-4	Pipe	Bergeron Road Extension	South of Mingo Road to North of Twin Cities Road	B	-	60	New	900			Phase 3	
F2-5	Pipe	North of Twin Cities Road	Bergeron Road to East of Bergeron Road	B	-	54	New	700			Phase 3	
F2-6	Pipe	North of Twin Cities Road	East of Bergeron Road to West of McKenzie Road	B	-	48	New	1,600			Phase 3	
F2-7	Pipe	North of Twin Cities Road	West of McKenzie Road to East of McKenzie Road	B	-	42	New	1,000			Phase 3	
F2-8	Pipe	South of Mingo Road	Bergeron Road Extension to East of Bergeron Road Extension	B	-	30	New	700				Phase 4
F2-9	Pipe	South of Mingo Road	East of Bergeron Road Extension to West of McKenzie Road	B	-	24	New	700				Phase 4
F2-10	Pipe	Bergeron Road	North of Twin Cities Road to North of Twin Cities Road	B	-	36	New	600				Phase 4
F2-11	Pipe	Mingo Road	East of Highway 99 to Bergeron Road Extension	B	-	66	New	1,500				Phase 4
F2-12	Pipe	East of Highway 99	South of Mingo Road to North of Mingo Road	B	-	48	New	1,300				Phase 4
F2-13	Pipe	East of Highway 99	South of Mingo Road to South of Mingo Road	B	-	36	New	900				Phase 4
F2-14	Pipe	East of Highway 99	South of Mingo Road to South of Mingo Road	B	-	30	New	600				Phase 4
F2-15	Pipe	East of Highway 99	North of Mingo Road to North of Mingo Road	B	-	42	New	600				Phase 4
F2-16	Pipe	East of Highway 99	North of Mingo Road to North of Mingo Road	B	-	30	New	700				Phase 4
F2-17	Force Main	Mingo Road	Future Basin (F2-B) to Future Outfall	B	-	24	New	200			Phase 3	
F2-B	Basin	Mingo Road	Future Detention Basin	B	-	140 acre-ft	New	-			Phase 3	
	Land Acquisition				-	16 acres	New	-			Phase 3	
F2-PS	Pump Station	Mingo Road	Pump Station at Future Basin (F2-B)	B	-	14 cfs	New	-			Phase 3	
Future Subbasin 3												
F3-1	Pipe	South of Twin Cities Road	Future Basin (F3-B) to East of Marengo Road	B	-	48	New	2,700		Phase 2		
F3-2	Pipe	East of Marengo Road	South of Twin Cities Road to South of Twin Cities Road	B	-	42	New	700		Phase 2		
F3-3	Pipe	East of Marengo Road	South of Twin Cities Road to Twin Cities Road	B	-	36	New	700		Phase 2		
F3-4	Pipe	East of Marengo Road	South of Twin Cities Road to South of Twin Cities Road	B	-	18	New	600		Phase 2		
F3-5	Pipe	East of Marengo Road	South of Twin Cities Road to South of Twin Cities Road	B	-	18	New	600		Phase 2		
F3-6	Pipe	South of Twin Cities Road	Future Basin (F3-B) to West of Cherokee Lane	B	-	30	New	1,600		Phase 2		
F3-7	Pipe	South of Twin Cities Road	West of Cherokee Lane to West of Cherokee Lane	B	-	24	New	600		Phase 2		
F3-8	Pipe	West of Cherokee Lane	South of Twin Cities Road to South of Twin Cities Road	B	-	18	New	300		Phase 2		
F3-9	Force Main	West of Cherokee Lane	Future Basin (F3-B) to Future Outfall	B	-	14	New	600		Phase 2		
F3-B	Basin	South of Twin Cities Road	Future Detention Basin	B	-	46 acre-ft	New	-		Phase 2		
	Land Acquisition				-	6 acres	New	-		Phase 2		
F3-PS	Pump Station	South of Twin Cities Road	Pump Station at Future Basin (F3-B)	B	-	5 cfs	New	-		Phase 2		
Future Subbasin 4												
F4-1	Pipe	Northside of Union Pacific Railroad	Future Basin (F4-B) to East of Marengo Road	B	-	42	New	1,200		Phase 2		
F4-2	Pipe	Northside of Union Pacific Railroad	East of Marengo Road to East of Marengo Road	B	-	36	New	1,000		Phase 2		
F4-3	Pipe	East of Marengo Road	Union Pacific Railroad to North of Union Pacific Railroad	B	-	30	New	700		Phase 2		
F4-4	Pipe	East of Marengo Road	Union Pacific Railroad to North of Union Pacific Railroad	B	-	24	New	400		Phase 2		
F4-5	Pipe	Northside of Union Pacific Railroad	East of Marengo Road to West of Cherokee Lane	B	-	36	New	900		Phase 2		
F4-6	Pipe	Northside of Union Pacific Railroad	West of Cherokee Lane to West of Cherokee Lane	B	-	30	New	900		Phase 2		
F4-7	Pipe	West of Cherokee Lane	Union Pacific Railroad to North of Union Pacific Railroad	B	-	24	New	900			Phase 3	
F4-8	Pipe	North of Union Pacific Railroad	West of Cherokee Lane to West of Cherokee Lane	B	-	18	New	600			Phase 3	
F4-9	Force Main	North of Union Pacific Railroad	Future Basin (F4-B) to Future Outfall	B	-	10	New	1,200		Phase 2		

Table 5.1 Proposed Storm Drainage System Improvements
Storm Drainage System Master Plan
City of Galt

Figure No.	Type of Improvement	Description/ Street	Description / Limits	Pipeline Cost Schedule (A or B)	Project Length/Size and Cost: Ex. Size/ Diam. (in)	New Size/ Diam. (in)	Replace/ New	Length (ft)	Capital Improvement Phasing: Phase 1 2009-2015	Phase 2 2016-2020	Phase 3 2021-2025	Phase 4 2026-2030
F4-B	Basin	North of Union Pacific Railroad	Future Detention Basin	B	-	25 acre-ft	New	-		Phase 2		
	Land Acquisition				-	3 acres	New	-		Phase 2		
F4-PS	Pump Station	North of Union Pacific Railroad	Pump Station at Future Basin (F4-B)	B	-	3 cfs	New	-		Phase 2		
Future Subbasin 5												
F5-1	Pipe	South of Spring Street	Future Basin (F5-B) to East of McFarland Street	B	-	48	New	500		Phase 2		
F5-2	Pipe	East of McFarland Street	North of Walnut Avenue to Walnut Avenue	B	-	42	New	700		Phase 2		
F5-3	Pipe	Walnut Avenue	East of McFarland Street to West of Highway 99	B	-	36	New	1,600		Phase 2		
F5-4	Pipe	West of Highway 99	Walnut Avenue to South of Walnut Avenue	B	-	30	New	500		Phase 2		
F5-5	Pipe	West of Highway 99	South of Walnut Avenue to North of Live Oak Avenue	B	-	24	New	500		Phase 2		
F5-6	Pipe	South of Spring Street	East of McFarland Street to West of Highway 99	B	-	30	New	800			Phase 3	
F5-7	Pipe	South of Spring Street	West of Highway 99 to West of Highway 99	B	-	24	New	800			Phase 3	
F5-8	Force Main	McFarland Street	Future Basin (F5-B) to Future Outfall	B	-	10	New	500		Phase 2		
F5-B	Basin	McFarland Street	Future Detention Basin	B	-	27 acre-ft	New	-		Phase 2		
	Land Acquisition				-	3 acres	New	-		Phase 2		
F5-PS	Pump Station	McFarland Street	Pump Station at Future Basin (F5-B)	B	-	3 cfs	New	-		Phase 2		
Future Subbasin 6												
F6-1	Pipe	East of Marengo Road	Future Basin (F6-B) to North of Deadman Gulch	B	-	72	New	1,400		Phase 2		
F6-2	Pipe	East of Marengo Road	North of Deadman Gulch to South of Union Pacific Railroad	B	-	66	New	800		Phase 2		
F6-3	Pipe	East of Marengo Road	North of Deadman Gulch to South of Union Pacific Railroad	B	-	54	New	600		Phase 2		
F6-4	Pipe	East of Marengo Road	South of Union Pacific Railroad to South of Union Pacific Railroad	B	-	48	New	1,400			Phase 3	
F6-5	Pipe	South of Union Pacific Railroad	West of Cherokee Lane to West of Cherokee Lane	B	-	36	New	800			Phase 3	
F6-6	Pipe	South of Union Pacific Railroad	West of Cherokee Lane to West of Cherokee Lane	B	-	30	New	800			Phase 3	
F6-7	Pipe	North of Marengo Road	East of Marengo Road to West of Cherokee Lane	B	-	30	New	700			Phase 3	
F6-8	Pipe	North of Marengo Road	West of Cherokee Lane to West of Cherokee Lane	B	-	24	New	1,100			Phase 3	
F6-9	Pipe	South of Union Pacific Railroad	East of Marengo Road to West of Cherokee Lane	B	-	30	New	700			Phase 3	
F6-10	Pipe	South of Union Pacific Railroad	West of Cherokee Lane to West of Cherokee Lane	B	-	24	New	1,000			Phase 3	
F6-11	Pipe	South of Union Pacific Railroad	South of Union Pacific Railroad to West of Cherokee Lane	B	-	42	New	700			Phase 3	
F6-12	Pipe	South of Union Pacific Railroad	West of Cherokee Lane to West of Cherokee Lane	B	-	36	New	800			Phase 3	
F6-13	Pipe	South of Union Pacific Railroad	East of Marengo Road to West of Cherokee Lane	B	-	54	New	800		Phase 2		
F6-14	Pipe	South of Union Pacific Railroad	East of Marengo Road to East of Marengo Road	B	-	42	New	1,000		Phase 2		
F6-15	Pipe	East of Marengo Road	North of Deadman Gulch to South of Union Pacific Railroad	B	-	30	New	800		Phase 2		
F6-16	Pipe	East of Marengo Road	North of Deadman Gulch to South of Union Pacific Railroad	B	-	24	New	700		Phase 2		
F6-17	Pipe	Near Deadman Gulch	Connects Future Basins F6-B and F8-B	B	-	30	New	700			Phase 3	
F6-18	Force Main	Near Deadman Gulch	Future Basin (F6-B) to Future Outfall	B	-	16	New	1,800		Phase 2		
F6-B	Basin	Near Deadman Gulch	Future Detention Basin	-	-	70 acre-ft	New	-		Phase 2		
	Land Acquisition				-	8 acres	New	-		Phase 2		
F6-PS	Pump Station	Near Deadman Gulch	Pump Station at Future Basin (F6-B)	-	-	7 cfs	New	-		Phase 2		
Future Subbasin 7												
F7-1	Pipe	Parallel to Deadman Gulch	Future Basin (F7-B) to South of Vintage Oak Avenue	B	-	30	New	1,600	Phase 1			
F7-2	Pipe	Parallel to Deadman Gulch	South of Vintage Oak Avenue to Cedar Flat Avenue	B	-	24	New	2,000	Phase 1			
F7-3	Pipe	Cedar Flat Avenue Extension	South of Colson Court to North of Union Pacific Railroad	B	-	18	New	600	Phase 1			
F7-4	Force Main	Deadman Gulch	Future Basin (F7-B) to Future Outfall	B	-	6	New	50	Phase 1			
F7-B	Basin	Deadman Gulch	Future Detention Basin	-	-	10 acre-ft	New	-	Phase 1			
	Land Acquisition				-	2 acres	New	-	Phase 1			

Table 5.1 Proposed Storm Drainage System Improvements
Storm Drainage System Master Plan
City of Galt

Figure No.	Type of Improvement	Description/ Street	Description / Limits	Pipeline Cost Schedule (A or B)	Project Length/Size and Cost: Ex. Size/ Diam. (in)	New Size/ Diam. (in)	Replace/ New	Length (ft)	Capital Improvement Phasing: Phase 1 2009-2015	Phase 2 2016-2020	Phase 3 2021-2025	Phase 4 2026-2030
F7-PS	Pump Station	Deadman Gulch	Pump Station at Future Basin (F7-B)	-	-	1 cfs	New	-	Phase 1			
Future Subbasin 8												
F8-1	Pipe	West of Cherokee Lane	Future Basin (F8-B) to South of Deadman Gulch	B	-	54	New	1,700			Phase 3	
F8-2	Pipe	West of Cherokee Lane	South of Deadman Gulch to South of Deadman Gulch	B	-	42	New	300			Phase 3	
F8-3	Pipe	West of Cherokee Lane	South of Deadman Gulch to North of Simmerhorn Road	B	-	36	New	600			Phase 3	
F8-4	Pipe	West of Cherokee Lane	North of Simmerhorn Road to Simmerhorn Road	B	-	30	New	700			Phase 3	
F8-5	Pipe	South of Deadman Gulch	West of Cherokee Lane to West of Cherokee Lane	B	-	24	New	1,600			Phase 3	
F8-6	Pipe	North of Simmerhorn Road	West of Cherokee Lane to West of Cherokee Lane	B	-	24	New	1,700			Phase 3	
F8-7	Pipe	North of Simmerhorn Road	East of Marengo Road to West of Cherokee Lane	B	-	36	New	1,300			Phase 3	
F8-8	Pipe	East of Marengo Road	South of Deadman Gulch to North of Simmerhorn Road	B	-	30	New	800			Phase 3	
F8-B	Basin	Deadman Gulch	Future Detention Basin	-	-	46 acre-ft	New	-			Phase 3	
	Land Acquisition				-	5 acres	New	-			Phase 3	
Future Subbasin 9												
F9-1	Pipe	Simmerhorn Road	Future Basin (F9-B) to West of Steiner Road	B	-	42	New	1,200	Phase 1			
F9-2	Pipe	West of Steiner Road	Simmerhorn Road to North of Simmerhorn Road	B	-	36	New	700	Phase 1			
F9-3	Pipe	West of Steiner Road	North of Simmerhorn Road to South of Union Pacific Railroad	B	-	24	New	800		Phase 2		
F9-4	Pipe	Simmerhorn Road	West of Steiner Road to North of Simmerhorn Road	B	-	30	New	1,800		Phase 2		
F9-5	Pipe	West of Steiner Road Extension	Simmerhorn Road to South of Simmerhorn Road	B	-	24	New	800		Phase 2		
F9-6	Pipe	Simmerhorn Road	Future Basin (F9-B) to Carillion Boulevard	B	-	36	New	200		Phase 2		
F9-7	Pipe	Simmerhorn Road	Carillion Boulevard to Marengo Road	B	-	30	New	1,300		Phase 2		
F9-8	Pipe	Marengo Road	Simmerhorn Road to North of Simmerhorn Road	B	-	24	New	800		Phase 2		
F9-9	Pipe	Marengo Road	Simmerhorn Road to South of Simmerhorn Road	B	-	24	New	800		Phase 2		
F9-10	Pipe	Carillion Boulevard	Simmerhorn Road to North of Simmerhorn Road	B	-	24	New	800	Phase 1			
F9-11	Force Main	Simmerhorn Road	Future Basin (F9-B) to Future Outfall	B	-	14	New	1,400	Phase 1			
F9-B	Basin	Simmerhorn Road	Future Detention Basin	-	-	51 acre-ft	New	-	Phase 1			
	Land Acquisition				-	6 acres	New	-	Phase 1			
F9-PS	Pump Station	Simmerhorn Road	Pump Station at Future Basin (F9-B)	-	-	5 cfs	New	-	Phase 1			
Future Subbasin 10												
F10-1	Pipe	East of Marengo Road	Future Basin (F10-B) to Boessow Road	B	-	54	New	800			Phase 3	
F10-2	Pipe	Boessow Road	East of Marengo Road to West of Cherokee Lane	B	-	48	New	2,100			Phase 3	
F10-3	Pipe	West of Cherokee Lane	Boessow Road to North of Boessow Road	B	-	42	New	700			Phase 3	
F10-4	Pipe	West of Cherokee Lane	North of Boessow Road to South of Simmerhorn Road	B	-	36	New	700			Phase 3	
F10-5	Pipe	North of Boessow Road	West of Cherokee Lane to West of Cherokee Lane	B	-	30	New	700			Phase 3	
F10-6	Pipe	Boessow Road	East of Marengo Road to East of Marengo Road	B	-	42	New	900			Phase 3	
F10-7	Pipe	Boessow Road	East of Marengo Road to Marengo Road	B	-	36	New	1,100			Phase 3	
F10-8	Pipe	Marengo Road	Boessow Road to North of Boessow Road	B	-	30	New	1,400			Phase 3	
F10-9	Pipe	North of Boessow Road	East of Marengo Road to West of Cherokee Lane	B	-	30	New	1,200			Phase 3	
F10-10	Pipe	East of Marengo Road	North of Boessow Road to South of Simmerhorn Road	B	-	24	New	700			Phase 3	
F10-11	Force Main	East of Marengo Road	Future Basin (F10-B) to Future Outfall	B	-	14	New	900			Phase 3	
F10-B	Basin	East of Marengo Road	Future Detention Basin	-	-	51 acre-ft	New	-			Phase 3	
	Land Acquisition				-	6 acres	New	-			Phase 3	
F10-PS	Pump Station	East of Marengo Road	Pump Station at Future Basin (F10-B)	-	-	5 cfs	New	-			Phase 3	

Table 5.1 Proposed Storm Drainage System Improvements
Storm Drainage System Master Plan
City of Galt

Figure No.	Type of Improvement	Description/ Street	Description / Limits	Pipeline Cost Schedule (A or B)	Project Length/Size and Cost: Ex. Size/ Diam. (in)	New Size/ Diam. (in)	Replace/ New	Length (ft)	Capital Improvement Phasing: Phase 1 2009-2015	Phase 2 2016-2020	Phase 3 2021-2025	Phase 4 2026-2030
Future Subbasin 11												
F11-1	Pipe	Crystal Way Extension	Future Basin (F11-B) to North of Boessow Road	B	-	48	New	600		Phase 2		
F11-2	Pipe	Crystal Way Extension	North of Boessow Road to South of Simmerhorn Road	B	-	42	New	500		Phase 2		
F11-3	Pipe	South of Simmerhorn Road	East of Highway 99 to East of Highway 99	B	-	36	New	600		Phase 2		
F11-4	Pipe	South of Simmerhorn Road	East of Highway 99 to Eastside of Highway 99	B	-	30	New	600		Phase 2		
F11-5	Pipe	Eastside of Highway 99	Eastside of Highway 99 to North of Highway 99	B	-	24	New	600		Phase 2		
F11-6	Pipe	North of Boessow Road	Future Basin (F11-B) to West of Marengo Road	B	-	42	New	800	Phase 1			
F11-7	Pipe	West of Marengo Road	North of Boessow Road to Boessow Road	B	-	36	New	600	Phase 1			
F11-8	Pipe	West of Marengo Road	Boessow Road to South of Boessow Road	B	-	24	New	800	Phase 1			
F11-9	Pipe	West of Marengo Road	South of Boessow Road to South of Boessow Road	B	-	18	New	600	Phase 1			
F11-10	Pipe	Boessow Road	West of Marengo Road to West of Marengo Road	B	-	18	New	600	Phase 1			
F11-11	Pipe	North of Boessow Road	West of Marengo Road to West of Marengo Road	B	-	18	New	700		Phase 2		
F11-12	Pipe	West of Marengo Road	North of Boessow Road to North of Boessow Road	B	-	18	New	400		Phase 2		
F11-13	Force Main	Boessow Road	Future Basin (F11-B) to Future Outfall	B	-	14	New	200	Phase 1			
F11-B	Basin	Boessow Road	Future Detention Basin	-	-	46 acre-ft	New	-	Phase 1			
	Land Acquisition				-	5 acres	New	-	Phase 1			
F11-PS	Pump Station	Boessow Road	Pump Station at Future Basin (F11-B)	-	-	5 cfs	New	-	Phase 1			

Notes:
1. Proposed casings size and carrier pipe size.
2. Pump station capacities refer to the total capacity unless noted otherwise.

The vast majority of the Master Plan improvements will serve future users, even when an improvement calls for the upgrade of an existing facility. In these cases, an existing storm drain may have sufficient capacity to convey current design runoff, but as growth continues and more users are added to the system, the increased runoff results in capacity deficiencies. These are labeled future improvements. Future users were assigned 100 percent of the future project's benefit and 100 percent of the costs. More information on the breakdown in cost split between existing and future users and whether a proposed improvement is intended to correct an existing deficiency, to serve a future user, or both is provided in Table 6.3.

5.3.3 Proposed Existing System Improvements

For the majority of the City, the existing storm drainage system contains sufficient capacity to convey peak runoff without exceeding the planning criteria discussed in Chapter 3. There are a few exceptions where existing storm drains will need to be replaced by larger diameter storm drains, or parallel storm drains will need to be constructed to bypass flow around hydraulically deficient storm drain pipes.

5.3.3.1 Dry Creek 6 Subbasin

The hydraulic model indicated that there are several areas within the existing Dry Creek 6 subbasin that experienced street flooding in excess of the maximum allowable criteria. Recommended improvements to mitigate the existing deficiencies and reduce localized flooding in the vicinity of the improvement include the following:

- Replace the existing 12-inch and 15-inch storm drain on E Street from 4th Street to 5th Street with an 18-inch and 30-inch storm drain (DC6-1 and DC6-2).
- Replace the existing 15-inch storm drain on 'C' Street from Wagon Way Roland Court (DC6-3).
- Replace two short stretches of existing 12-inch and 18-inch storm drains on 'E' Street and Range Way with 15-inch and 24-inch storm drains, respectively.

5.3.3.2 Dry Creek 7 Subbasin

Recommended improvements to mitigate existing deficiencies within the Dry Creek 7 subbasin include the following:

- Replace the existing 18-inch and 24-inch storm drain on Meadowview Drive from Kost Road to Cindy Lane with a 30-inch storm drain (DC7-1).
- Replace a short run of 15-inch storm drain located in Meadowview Park with a 24-inch storm drain.

5.3.3.3 Hen Creek 1 Subbasin

Recommended improvements to mitigate existing deficiencies within the Hen Creek 1 subbasin include the following:

- Install a 24-inch diameter relief storm drain sewer on Oak Avenue and Simon Street (HC1-1).
- Replace the existing 18-inch and 21-inch storm drain on Lincoln Way north of A Street to Wendy Hope Drive with a 24-inch storm drain (HC1-2).

5.3.3.4 Hen Creek 2 Subbasin

Recommended improvements to mitigate existing deficiencies within the Hen Creek 2 subbasin include the following:

- Replace the existing 15-inch and 27-inch diameter storm drains on Sparrow Drive north of A Street with a 24-inch and 30-inch storm drain (HC2-1 and HC2-2).
- Replace existing 15-inch and 18-inch storm drains on Sterling Grove Drive east of Sparrow drive with a 27-inch storm drain (HC2-3).

5.3.3.5 Hen Creek 3 Subbasin

Recommended improvements to mitigate existing deficiencies within the Hen Creek 3 subbasin include the following:

- Replace existing 15-inch, 18-inch, and 24-inch diameter storm drains on Oakwilde Street and Danny Drive with 24-inch and 36-inch storm drains (HC3-1, HC3-2, and HC3-3).
- Replace several existing storm drains on C Street and Wristen Way with 24-inch and 36-inch diameter storm drains (HC3-4, HC3-5, and HC3-6).

5.3.3.6 Orr Road Subbasin

While constructing the storm drainage system hydraulic model, it was discovered that an existing 15-inch diameter storm drain on Sparrow Drive in the Orr Road subbasin currently runs from north to south to Quail Hollow Drive, and then proceeds from south back to north on Sparrow Drive roughly 15-feet west of the pipeline running north to south.

The hydraulic model simulated street flooding in excess of one foot in the vicinity of this storm. For this reason, it is recommended that two, 15-inch diameter pipe segments (OR-1 and OR-2) be constructed to connect the two opposing pipe runs to alleviate the existing deficiency in the area.

5.3.4 Proposed Future System Improvements

The following discussion summarizes the new storm drains, pump stations, and storm detention basins that will serve future users. Please note that the location of the storm

drains are preliminary and will likely change during the design phase. The locations shown are possible alignments based on available information and are intended to assist in the development of probable construction costs. No investigation into the feasibility of these alignments has been conducted. However, an attempt was made to place future pipeline alignments within existing streets or proposed future streets presented in the General Plan's Land Use and Circulation Diagram.

As part of this Master Plan, several options available to the City to convey storm water runoff generated in future development areas were analyzed, including the use of direct discharge of storm water runoff to creeks and drainage channels, regional detention basins, and privately maintained detention basins. A project memorandum that summarized the benefits and drawbacks of each alternative was prepared to assist the City in the selection of a preferred alternative. This memorandum is included in Appendix B.

It was ultimately determined that the best alternative for the City to pursue in the future is the use of regional storm water detention basins. This alternative is consistent with General Plan policies and future hydromodification and storm water quality regulations.

Therefore, the proposed improvements presented in this report assume that regional detention basins will be constructed to service future growth within the General Plan boundary. It is also assumed that each detention basin will be equipped with a pump station and associated outfall pipelines to pump storm water from the detention basins into the creeks or drainage channels following the storm. In lieu of a pump station/outfall pipeline set up, the City may be able to construct a system of orifices and gravity storm drains to discharge storm water from the detention basins, assuming that the topography of the detention basin and the discharge point will accommodate such a system. The system should be designed to avoid hydromodification of the receiving channel.

In lieu of the basins, the City may have the opportunity to discharge directly into the creek systems. However, in order to do so, a detailed study would be required to quantify the impact of increased urban runoff on the downstream creek capacity if a detention basin is not installed. The study should also address future regulatory considerations (e.g., hydromodification) and the water quality impact to the stream associated with direct discharges.

5.3.4.1 Future Subbasin 1

Future Subbasin 1 will service the area north of Twin Cities Road and west of Highway 99 in the northern portion of the General Plan boundary. This area is slated for commercial and industrial development in the future. The proposed storm drainage system facilities consist of a network of 36-inch through 66-inch diameter storm drains (F1-1 through F1-6), which convey storm water runoff to a 70 acre-ft (AF) detention basin (F1-B) located near the City's wastewater treatment plant (WWTP) just east of the Union Pacific Railroad (UPRR) line. A proposed 7 cubic feet per second (cfs) pump station (F1-PS) and 16-inch diameter force main (F1-7) will discharge the storm water runoff into a tributary to Laguna Creek.

5.3.4.2 Future Subbasin 2

Future Subbasin 2 will service the area north of Twin Cities Road, east of Highway 99, and west of a block of rural residential land use areas in the northern portion of the General Plan boundary. This area is slated primarily for commercial development in the future, although there are small pockets of public and high-density residential land use areas. The proposed storm drainage system facilities consist of a network of 24-inch through 72-inch diameter storm drains (F2-1 through F2-16), which convey storm water runoff to a 140 AF detention basin (F2-B) located near Mingo Road and the General Plan boundary. A proposed 14 cfs pump station (F2-PS) and 24-inch diameter force main (F2-17) will discharge the storm water runoff into a tributary to Laguna Creek.

5.3.4.3 Future Subbasin 3

Future Subbasin 3 will service the area east of Marengo Road, south of Twin Cities Road, and north of Deadman Gulch. This area is slated for residential, commercial, and public development in the future. The proposed storm drainage system facilities consist of a network of 18-inch through 48-inch diameter storm drains (F3-1 through F3-8), which convey storm water runoff to a 46 AF detention basin (F3-B) located in a future park location identified in the General Plan. A proposed 5 cfs pump station (F3-PS) and 14-inch diameter force main (F3-9) will discharge the storm water runoff generated in this subbasin into the northern reach of Deadman Gulch.

5.3.4.4 Future Subbasin 4

Future Subbasin 4 will service the area east of Marengo Road, north of the UPRR, and south of Deadman Gulch. This area is slated for residential and public development in the future. The proposed storm drainage system facilities consist of a network of 21-inch through 42-inch diameter storm drains (F4-1 through F4-8), which convey storm water runoff to a 25 AF detention basin (F4-B) located in a future park site identified in the General Plan. A proposed 3 cfs pump station (F4-PS) and 10-inch diameter force main (F4-9) will discharge the storm water runoff generated in this subbasin into the northern reach of Deadman Gulch.

5.3.4.5 Future Subbasin 5

Future Subbasin 5 will service the area west of Highway 99, east of the UPRR, north of Deadman Gulch, and south of Spring Street. This area is slated for commercial and industrial development in the future. The proposed storm drainage system facilities consist of a network of 24-inch through 48-inch diameter storm drains (F5-1 through F5-7), which convey storm water runoff to a 27 AF detention basin (F5-B) located near the UPRR. A proposed 3 cfs pump station (F5-PS) and 10-inch diameter force main (F5-8) will discharge the storm water runoff generated in this subbasin into Deadman Gulch.

5.3.4.6 Future Subbasin 6

Future Subbasin 6 will service the area east of Marengo Road, south of the UPRR, and north of a strip of open space identified in the General Plan. This area is slated for primarily residential development in the future, with some public land use areas. The proposed storm drainage system facilities consist of a network of 24-inch through 72-inch diameter storm drains (F6-1 through F6-16), which convey storm water runoff to a 70 AF detention basin (F6-B) located in a future park site identified in the General Plan.

Due to the proximity of the detention basins in Future Subbasin 6 and 8 (F6-B and F8-B), it is desirable to interconnect the two to utilize a single pump station, which will discharge storm water from both subbasins. To accomplish this, a short 30-inch storm drain under the strip of open space is recommended to interconnect the two detention basins. In addition, a 12 cfs pump station (F6-PS) and 12-inch diameter force main (F6-18) is proposed to discharge the storm water into the southern reach of Deadman Gulch.

5.3.4.7 Future Subbasin 7

Future Subbasin 7 will service a small area to the south of the southern reach of Deadman Gulch, which is targeted for future residential development. To accomplish this, the proposed storm drainage system facilities consist of a series of 18-inch through 30-inch diameter storm drains (F7-1 through F7-3) constructed parallel to Deadman Gulch, which convey storm water runoff to a small, 10 AF detention basin (F7-B) located near Highway 99. A proposed 1 cfs pump station (F7-PS) and 6-inch diameter force main (F7-4) will discharge the storm water into the southern reach of Deadman Gulch.

5.3.4.8 Future Subbasin 8

Future Subbasin 8 will service the area east of Marengo Road, north of Simmerhorn Road, and south of a strip of open space identified in the General Plan. This area is slated primarily for residential development in the future, with some public land use areas. The proposed storm drainage system facilities consist of a network of 24-inch through 54-inch diameter storm drains (F8-1 through F8-8), which convey storm water runoff to a 46 AF detention basin (F8-B) located in a future park site identified in the General Plan.

As noted in Section 5.3.4.6, the detention basins in Future Subbasin 6 and 8 will be interconnected to utilize a single pump station, which will discharge storm water from both subbasins into the southern reach of Deadman Gulch. The recommended pump station and force main projects are discussed further in Section 5.3.4.6.

5.3.4.9 Future Subbasin 9

Future Subbasin 9 will service an area in the center portion of the General Plan boundary consisting of residential, commercial, industrial, mixed use, and public land use designations.

The proposed storm drainage system facilities consist of a network of 24-inch through 42-inch diameter storm drains (F9-1 through F9-10), which convey storm water runoff to a 51 AF detention basin (F9-B) located in a future park site identified in the General Plan. A proposed 5 cfs pump station (F9-PS) and 14-inch diameter force main (F9-11) will discharge the storm water runoff generated in this subbasin into a drainage channel tributary to Dry Creek.

5.3.4.10 Future Subbasin 10

Future Subbasin 10 will service the area east of Marengo Road and south of Simmerhorn Road. This area is slated for residential and public development in the future. The proposed storm drainage system facilities consist of a network of 24-inch through 54-inch diameter storm drains (F10-1 through F10-10), which convey storm water runoff to a 51 AF detention basin (F10-B) located in a future park site identified in the General Plan. A proposed 5 cfs pump station (F10-PS) and 14-inch diameter force main (F10-11) will discharge the storm water runoff generated in this subbasin into Dry Creek.

5.3.4.11 Future Subbasin 11

Future Subbasin 11 will service an area in the southern portion of the General Plan boundary consisting of residential, commercial, industrial, mixed use, and public land use designations.

The proposed storm drainage system facilities consist of a network of 18-inch through 48-inch diameter storm drains (F11-1 through F11-12), which convey storm water runoff to a 46 AF detention basin (F11-B) located in a future park site identified in the General Plan. A proposed 5 cfs pump station (F11-PS) and 14-inch diameter force main (F11-13) will discharge the storm water runoff generated in this subbasin into a drainage channel tributary to Dry Creek.

5.4 CAPITAL PROJECT PRIORITIZATION

The majority of improvements listed in Table 5.1 are driven by future development. Most of the improvements are new storm drains that serve future growth, but there are some improvements to existing facilities that are needed to serve existing users, or resulted from future growth. When fully implemented, the capital projects will facilitate the collection, conveyance, storage, and discharge of peak storm flows to limit street flooding to the maximum allowed.

Prioritizing the required capital improvements for the City's storm drainage system is an important aspect of the Master Plan. The improvement projects were prioritized based on the following factors:

- Upgrading storm drains to mitigate existing flooding conditions
- Building new storm drains, pump stations, and detention basins to serve future users

The implementation of these improvements will depend on the City's pace of development and selection of areas to be served with urban infrastructure. The City provided guidance on future development and phasing of infrastructure to serve future users. Based on this input, the projects were grouped into the following timeframes:

- Years 2009 through 2015
- Years 2016 through 2020
- Years 2021 through 2025
- Years 2026 through 2030

The projects shown in Figure 5.2 are color coded according to phase, which reflects their priority. Table 5.1 indicates the phasing timeframe for each capital project.

Proposed improvements within areas identified for early development were assigned a higher priority. Areas within an approved tentative map tract received the highest priority. The actual implementation of the improvements serving future users depends on the pace of development. The priorities presented below are estimates based on available information provided by the City. Changes in the City's planning assumptions or growth projections could increase or decrease the priority of each improvement.

5.4.1 Existing System Improvement Prioritization

The highest priority projects are those that mitigate existing street flooding. Refer to table 5.1 in the 2009 – 2015 column for all Phase 1 projects and the 2016-2020 column for all the Phase 2 projects. Figure ES.2 illustrates the locations of these improvements and the phasing by color code. The proposed Phase 1 (2009-2015) projects and the subbasins in which they are located include:

- Dry Creek 6 subbasin storm drain projects (DC6-1 through DC6-2)
- Dry Creek 7 subbasin storm drain projects (DC7-1 and DC7-2)
- Hen Creek 1 subbasin storm drain projects (HC1-1 and HC1-2)
- Hen Creek 2 subbasin storm drain projects (HC2-1)

The proposed Phase 2 (2016-2020) projects and the subbasins in which they are located include:

- Dry Creek 6 subbasin storm drain projects (DC6-3 and DC6-5)
- Hen Creek 2 subbasin storm drain projects (HC2-2 through HC2-3)
- Hen Creek 3 subbasin storm drain projects (HC3-1 through HC3-6)
- Orr Road subbasin storm drain projects (OR-1 and OR-2)

5.4.2 Phase 1 Projects (2009-2015)

Projects serving new developments in growth areas targeted by the City are shown in Phase 1. The future system projects shown in Phase 1 are part of a larger network of capital projects. For example, the first reaches of the Future Subbasin 9 (F9-1, F9-2, F9-10, F9-11 F9-B, and F9-PS) and Future Subbasin 11 (F11-6 through F11-10, F11-13, F11-B, F11-PS) are targeted as the first segments in the network to be constructed. Future Subbasin 7, on the other hand, is targeted for implementation entirely in Phase 1.

In addition to these capital projects, the City will implement storm drain rehabilitation and replacement projects.

5.4.3 Phase 2 Projects (2016-2020)

In general, the Phase 2 projects will serve future development beyond year 2015. These projects are within the 10-year window identified by the City. Some of the projects are extensions of storm drain conveyance facilities that were started in Phase 1. For example, F9-3 through F9-9 represents the second phase of the Future Subbasin 9 capital projects. The Phase 2 projects include the following:

- Future Subbasin 3 (F3-1 through F3-7, F3-B, F3-PS)
- Future Subbasin 4 (F4-1 through F4-5, F4-9, F4-B, F4-PS)
- Future Subbasin 5 (F5-1 through F5-5, F5-7, F5-8, F5-B, F5-PS)
- Future Subbasin 6 (F6-1 through F6-3, F6-12 through F6-16, F6-18, F6-B, F6-PS)
- Future Subbasin 9 (F9-3 through F9-9)
- Future Subassin 11 (F11-1 through F11-5, F11-11, F11-13)
- On going storm drain rehabilitation and replacement

5.4.4 Phase 3 and 4 Projects (2021-2025 and 2026-2030)

Table 5.1 breaks the projects into Phase 3 and 4. For the purposes of prioritization, these are viewed as very long-term projects exclusively driven by development at the fringes of the planning area, and will be grouped together.

A majority of the northwestern and southeastern portion of the General Plan boundary is slated for development after 2020, as are certain areas in the northeastern portion of the General Plan boundary. These projects are categorized as Phase 4 and Phase 5.

5.5 ADDITIONAL RECOMMENDATIONS

In addition to the improvements discussed above, the City should consider the following recommendations.

5.5.1 Storm Drain Replacement, Rehabilitation, and Maintenance

This Master Plan effort did not include a condition assessment to evaluate the structural integrity of existing storm drains, nor did it evaluate rehabilitation alternatives for existing storm drains. However, we are including rehabilitation of storm drains as capital projects. For the purposes of budgeting, we assumed that the City would implement various rehabilitation projects through the year 2030. A storm drain rehabilitation allowance was provided for Phases 1 through 4.

The capital improvements assumed that the City would replace roughly 500 feet of storm drains every year. The weighted average diameter of all storm drains in the storm drainage system is approximately 24-inches. Therefore, in order to develop the capital program impact, we assumed that 500 feet of 24-inch diameter storm drains would be replaced every year through 2030.

5.6 RURAL RESIDENTIAL DEVELOPMENT

Up to this point, one of the assumptions in the Master Plan is that Rural Residential designated lands are not anticipated to be annexed into the City limits during the timeframe of the 2030 General Plan. Therefore, storm water runoff imparted from existing and future customers within this land use were not accounted in the analysis. A question was raised about the impacts that extending service to rural customers would have on the proposed system. The following discussion addresses this question.

The 2003 West Galt Drainage Study, completed by Dennis Huff, addressed drainage improvements for the rural areas of Galt. We assumed that the drainage system that served Rural Residential designated lands would be similar to that described in the West Galt Drainage Study. According to this study, open channel drainage systems are currently the standard for new developments with two acres or more per residence in the unincorporated areas near the City. Due to the high capital cost of installing storm drain pipes when compared to open channels, construction of a pipe conveyance system to service Rural Residential developments would likely be costly and infeasible.

Therefore, it is assumed that future development in Rural Residential areas will be serviced by roadside open channels and swales, as is the current practice. For this reason, annexing future Rural Residential development will likely not impact the proposed storm drainage collection system identified in this report, because the runoff generated by these areas will not be conveyed through the proposed storm drainage collection system. As future developments come online, impacts to downstream channel capacity should be studied through a subdivision project drainage report, as discussed in the West Galt Drainage Study.

A different approach was considered for the Rural Residential land located outside of the West Galt Drainage Study area, for example land located north of Twin Cities Road and

east of Carillion Boulevard; and a second pocket of Rural Residential land south of Twin Cities Road between Highway 99 and the railroad tracks. If this land were developed, then additional storm drainage infrastructure would be needed because existing and proposed storm drains are not sized to serve the Rural Residential properties. These specific Rural Residential areas could be connected to the existing and/or future storm drainage systems, but the rural developments would be required to store their runoff with new detention basins. The stored runoff would then be pumped or gravity discharged into one of the storm drainage systems. It is important to note that the Rural Residential facilities would need to retain runoff until the existing and future storm drainage facilities had a chance to drain or discharge to one of the channels. This could take days due to possible channel discharge restrictions (e.g. no hydro modification).

CAPITAL IMPROVEMENT PROJECTS

This chapter presents the recommended capital improvement projects (CIP) for the City of Galt (City) storm drainage system, a summary of the capital costs, and a basic assessment of the possible financial impact on individual existing and future users. This chapter is organized to assist the City in making finance decisions, and to plan the storm drainage system improvements through build-out of the 2030 General Plan (General Plan). The CIP is based on the evaluation of the City's storm drainage system, planning area, and land use, as detailed in the recommended projects described in the previous chapters.

6.1 CAPITAL IMPROVEMENT PROJECT COSTS

The capacity upgrades and new service projects set the foundation for the City's storm drainage system CIP. The cost estimates presented in this study are opinions developed from bid tabulations, cost curves, information obtained from previous studies, and Carollo Engineers, P.C. (Carollo) experience on other projects. The costs are based on an Engineering News Record Construction Cost Index (ENR CCI) 20-city average of 8,534 (March 2009).

6.2 COST ESTIMATING ACCURACY

The cost estimates presented in the CIP have been prepared for general master planning purposes and for guidance in project evaluation and implementation. Final costs of a project will depend on actual labor and material costs, competitive market conditions, final project scope, implementation schedule, and other variable factors such as: preliminary alignment generation, investigation of alternative routings, and detailed utility and topography surveys.

The Association for the Advancement of Cost Engineering (AACE) defines an Order of Magnitude Estimate for master plan studies as an approximate estimate made without detailed engineering data. It is normally expected that an estimate of this type would be accurate within plus 50 percent to minus 30 percent. This section presents the assumptions used in developing order of magnitude cost estimates for recommended facilities.

6.3 CONSTRUCTION UNIT COSTS

The construction costs are representative of storm drainage system facilities under normal construction conditions and schedules. Costs have been estimated for public works construction, either as new construction is existing developed areas, or new construction in undeveloped areas.

6.3.1 Pipeline Unit Costs

Storm drainage system pipeline improvements range in size from 15-inches to 72-inches in diameter. Pipe casings up to 30-inches in diameter are included for major crossings (e.g. creeks, canals, highways, railroad). Pipeline unit costs are shown in Table 6.1. The construction cost estimates are based upon these unit costs. The unit costs are for "typical" field conditions with construction in stable soil at a depth ranging between 10 to 15 feet.

Table 6.1 Pipeline Construction Unit Costs
Storm Drainage System Master Plan
City of Galt

Pipe Size (inches)	Pipeline Unit Cost ($/Linear Foot)	
	Schedule A (Developed Areas)	**Schedule B (Undeveloped Areas)**
15	157	110
18	171	120
21	199	140
24	228	159
27	256	179
30	285	199
33	313	219
36	342	239
42	399	279
48	456	319
54	513	359
60	570	399
66	627	439
Pipeline Casing for Major Crossings		
16/30	1,108	--

Note:
1. ENR CCI 20 City average used for estimating (March 2009) = 8,534

Construction of pipelines in undeveloped areas is anticipated to cost less than those constructed in developed areas, such as downtown. The unit costs in Table 6.1 are discounted by 30 percent for pipelines that will be built in undeveloped areas. This discount is based on a review of bid tabulations that were constructed in developed and undeveloped areas. Pipelines built in undeveloped areas ranged from 30 to 50 percent less than pipelines built in developed areas.

6.3.2 Detention Basin Unit Costs

Costs associated with new detention basins include earthwork and piping. The unit costs do not include fencing, landscape, and land acquisition. Land acquisition costs are discussed below. The detention/retention basin cost versus capacity curve shown in Figure 6.1 was developed based on projects of similar size in California.

6.3.3 Pump Station Unit Cost

Pump station improvements include the construction of facilities or increasing the capacity of exiting pump stations to convey storm runoff. Cost estimates for pump stations were developed based on projects of similar size in California.

6.3.4 Land Acquisition

Acquisition of property, easements, and right-of-way (ROW) may be required for some of the recommended projects, but not all. Storm drain pipeline corridor or easements are assumed to be in public ROW, and therefore do not require land acquisition. However, land may be required for the detention basins recommended in this Master Plan and are noted in the CIP table. The land costs were assumed to equal $240,000 per acre.

6.4 PROJECT COSTS AND CONTINGENCIES

6.4.1 Baseline Construction Cost

This is the total estimated construction cost, in dollars, of the proposed improvement. Pipeline, detention basin, and pump station Baseline Construction Costs were developed using the following criteria:

- Pipeline: Calculated by multiplying the estimated length by the unit cost.
- Detention Basins: Calculated by using the required capacity in the cost curve equation.
- Pump Stations: Calculated by using the total capacity in the cost curve equation.

6.4.2 Estimated Construction Cost

Contingency costs must be reviewed on a case-by-case basis because they will vary considerably with each project. Consequently, it is appropriate to allow for uncertainties associated with the preliminary layout of a project. Such factors as unexpected construction conditions, the need for unforeseen mechanical items, and variations in final quantities are a few of the items that can increase project costs for which it is wise to make allowances in preliminary estimates. To assist the City in making financial decisions for these future construction projects, contingency costs will be added to the planning budget as percentages of the total construction cost, divided into two categories: Estimated Construction Cost and Capital Improvement Cost.

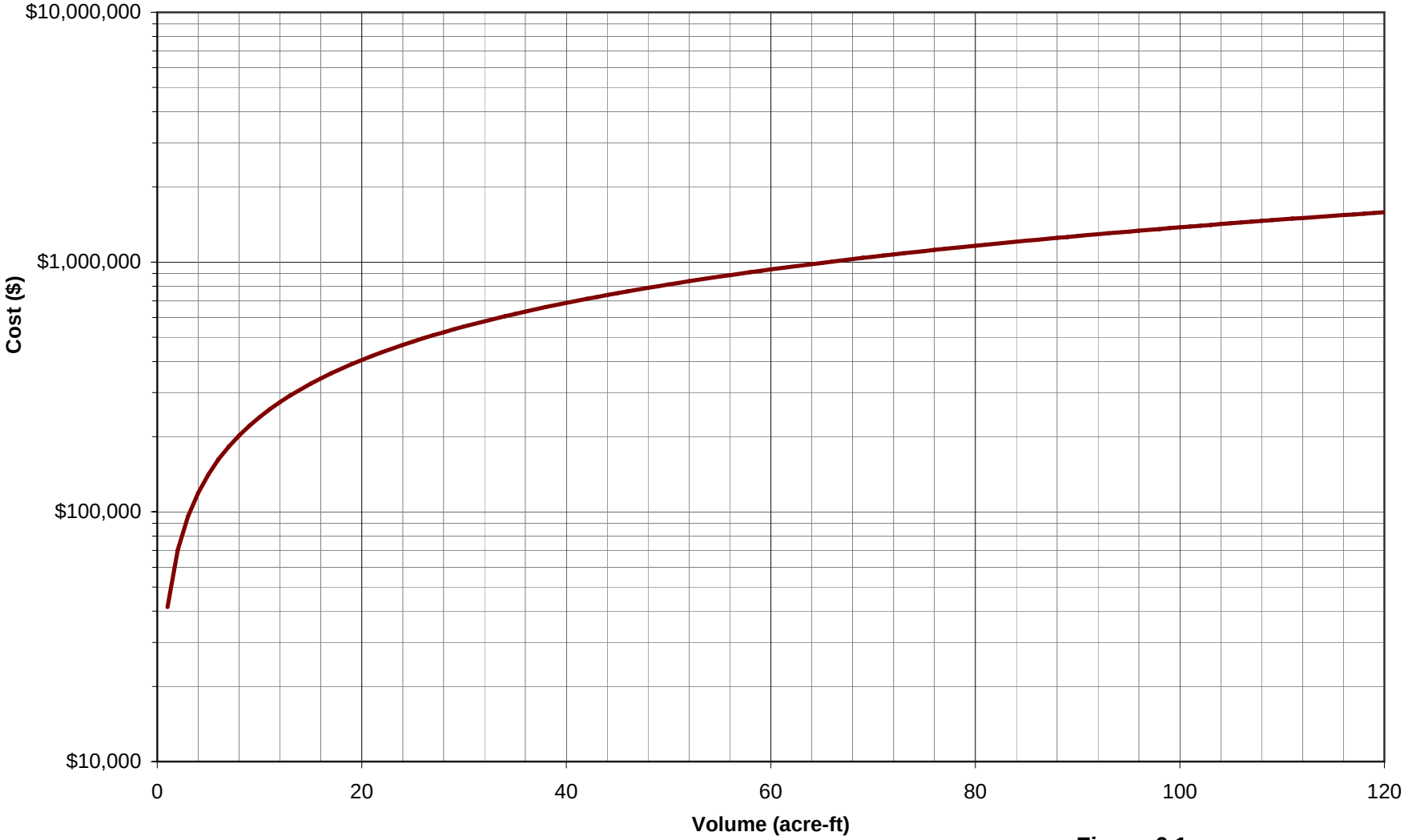


Figure 6.1
Detention Basin Cost Versus Volume Curve
Storm Drainage System Master Plan
City of Galt

Since knowledge about site-specific conditions of each proposed project is limited at the master planning stage, a 25 percent contingency was applied to the Baseline Construction Cost to account for unforeseen events and unknown conditions. A 25 percent contingency to account for unknown site conditions such as poor soils, unforeseen conditions, environmental mitigations, and other unknowns is typical for master planning projects. The Estimated Construction Cost for the proposed storm drainage system improvement consists of the Baseline Construction Cost plus the 25 percent construction contingency.

6.4.3 Capital Improvement Cost

Other project construction contingency costs are divided into three subcategories, totaling 30 percent: 10 percent engineering, 10 percent construction phase professional services, and 10 percent project administration. Engineering services associated with new facilities include preliminary investigations and reports, ROW acquisition, foundation explorations, preparation of drawings and specifications during construction, surveying and staking, sampling of testing material, and start-up services. For this study, engineering costs are assumed to equal 10 percent of the Estimated Construction Cost.

Construction phase professional services covers such items as construction management, engineering services, materials testing, and inspection during construction. The cost of these items can also vary, but for the purpose of this study, it is assumed that construction phase professional services expenses will equal approximately 10 percent of the Estimated Construction Cost.

Finally, there are project administration costs, which cover such items as legal fees, environmental/CEQA compliance requirements, financing expenses, administrative costs, and interest during construction. The cost of these items can also vary, but for the purpose of this Master Plan, it is assumed that project administration costs will equal 10 percent of the Estimated Construction Cost.

The Capital Improvement Cost is the total of the Estimated Construction Cost (including contingency) plus the other costs discussed in the previous paragraphs.

As shown in the following sample calculation of the Capital Improvement Cost, the total cost of all project construction contingencies (construction, engineering services, construction management, and project administration) is 62.5 percent of the Baseline Construction Cost. Note that contingencies were not applied to land acquisition costs. Calculation of the 62.5 percent is the overall mark-up on the baseline construction cost to arrive at the capital improvement cost. It is not an additional contingency.

Example:

Baseline Construction Cost	$1,000,000
Construction Contingency (25%)	250,000
Estimated Construction Cost	1,250,000
Engineering Cost (10%)	125,000
Construction Management (10%)	125,000
Project Administration (10%)	125,000
Capital Improvement Cost	$1,625,000

A summary of the capital project costs is presented in Table 6.2. This table identifies the projects, provides a brief description of the project, identifies facility size (e.g. pipe diameter and length), and the capital improvement cost. The table also shows the probable phase in which the project would be implemented. The implementation timeframe was based on the priority of each project to correct existing deficiencies or to serve future users.

6.5 CAPITAL IMPROVEMENT IMPLEMENTATION

As discussed in Chapter 5, the CIPs are prioritized based on their urgency to mitigate existing deficiencies and for servicing anticipated growth. It is recommended that improvements to mitigate existing deficiencies be constructed as soon as possible. The deficiencies in the future system have a significant total capital cost that is best distributed based on the order in which the City develops.

The implementation phases are separated into 5-year increments, except for the first phase, which runs from 2009 through 2015. Each project is itemized by phase in Table 6.2 and a summary by phase is provided in Table 6.3. The need for new storm drains was based on the City's projection for extending urban services to new developments.

6.6 EXISTING VERSUS FUTURE USER COST SHARE

The improvements proposed in this Master Plan either benefit existing users, or are required to service new development and future users. Some of the projects provide benefit to both existing and future users. An opinion of benefit to future users, based on preliminary project information, was included in Table 6.2. It was assumed that projects intended to correct existing deficiencies provide no benefit to future users, and would be required regardless of future development. It was also assumed that future users would benefit entirely from the construction of facilities necessary to serve future development.

A breakdown in existing and future user cost share of the proposed projects by phase is summarized in Table 6.3. Table 6.4 summarizes the breakdown in cost for the different facility categories (e.g. storm drains and detention basins).

Table 6.2 Capital Improvement Projects
Storm Drainage System Master Plan
City of Galt

Figure No.	Type of Improvement	Description/ Street	Description / Limits	Pipeline Cost Schedule (A or B)	Project Length/Size and Cost: Ex. Size/ Diam. (in)	New Size/ Diam. (in)	Replace/ New	Length (ft)	Capital Improvement Cost[(2),(3)] ($)	Capital Improvement Phasing: Phase 1 2009-2015 ($)	Phase 2 2016-2020 ($)	Phase 3 2021-2025 ($)	Phase 4 2026-2030 ($)	Future Users Benefit (%)	Reimbursement Category: Existing Improvements ($)	Future Improvements ($)
Existing System Improvements																
Dry Creek 6 Subbasin																
DC6-1	Pipe	E Street	4th Street crossing	A	15	30	Replace	70	$ 33,000	$ 33,000				0%	$ 33,000	$ -
DC6-2	Pipe	E Street	4th Street to 5th Street	A	12	18	Replace	400	$ 111,000	$ 111,000				0%	$ 111,000	$ -
DC6-3	Pipe	C Street	Wagon Way to Rowland Court	A	15	18	Replace	300	$ 83,000		$ 83,000			0%	$ 83,000	$ -
DC6-4	Pipe	E Street	Retriever Way to Village Run Drive	A	18	24	Replace	250	$ 93,000		$ 93,000			0%	$ 93,000	$ -
DC6-5	Pipe	Range Way	E Street to Plains Court	A	12	15	Replace	300	$ 76,000		$ 76,000			0%	$ 76,000	$ -
Dry Creek 7 Subbasin																
DC7-1	Pipe	Meadowview Drive	Kost Road to Cindy Lane	A	18/24	30	Replace	2,100	$ 972,000	$ 972,000				0%	$ 972,000	$ -
DC7-2	Pipe	Meadowview Park	Meadowview Drive to East of Creekside Way	A	15	24	Replace	700	$ 258,000	$ 258,000				0%	$ 258,000	$ -
Hen Creek 1 Subbasin																
HC1-1	Pipe	Oak Avenue/Simon Street	Myrtle Avenue to Palin Avenue	A	-	24	New	1,400	$ 518,000	$ 518,000				0%	$ 518,000	$ -
HC1-2	Pipe	Lincoln Way	North of A Street to Wendy Hope Drive	A	18/21	24	Replace	800	$ 296,000	$ 296,000				0%	$ 296,000	$ -
Hen Creek 2 Subbasin																
HC2-1	Pipe	Sparrow Drive	A Street to Sterling Grove Drive	A	27	30	Replace	400	$ 185,000		$ 185,000			0%	$ 185,000	$ -
HC2-2	Pipe	Sparrow Drive	Sterling Grove Drive to Cinnamon Drive	A	15	24	Replace	800	$ 296,000		$ 296,000			0%	$ 296,000	$ -
HC2-3	Pipe	Sterling Grove Drive	Spoonbill Lane to Silver Pine Court	A	15/18	27	Replace	800	$ 333,000		$ 333,000			0%	$ 333,000	$ -
Hen Creek 3 Subbasin																
HC3-1	Pipe	Oakwilde Street	Fumasi Drive to Toni Court	A	24	36	Replace	250	$ 138,000		$ 138,000			0%	$ 138,000	$ -
HC3-2	Pipe	Oakwilde Street	Toni Court to Emerald Oak Drive	A	15/18	24	Replace	1,100	$ 408,000		$ 408,000			0%	$ 408,000	$ -
HC3-3	Pipe	Danny Drive	Oakwilde Street to South of Oakwilde Street	A	15	24	Replace	700	$ 258,000		$ 258,000			0%	$ 258,000	$ -
HC3-4	Pipe	C Street/Rio Mesa Way	Fumasi Drive to Wristen Way	A	24/27	36	Replace	1,800	$ 999,000		$ 999,000			0%	$ 999,000	$ -
HC3-5	Pipe	Wristen Way	Rio Mesa Way to McTucker Drive	A	21	24	Replace	250	$ 93,000		$ 93,000			0%	$ 93,000	$ -
HC3-6	Pipe	C Street	Fumasi Drive to Dawn Circle	A	15	24	Replace	250	$ 93,000		$ 93,000			0%	$ 93,000	$ -
Orr Road Subbasin																
OR-1	Pipe	Sparrow Drive	Mallard Drive	A	-	15	New	50	$ 13,000		$ 13,000			0%	$ 13,000	$ -
OR-2	Pipe	Sparrow Drive	Wren Drive	A	-	15	New	50	$ 13,000		$ 13,000			0%	$ 13,000	$ -
Storm Drain Replacement Program																
-	Pipe	Various Locations	Storm Drain Replacement Program. Average Size is 24.	A	24	24	Replace	10,000	$ 3,703,000	$ 926,000	$ 926,000	$ 926,000	$ 926,000	0%	$ 3,704,000	$ -
								Existing Improvements Subtotal	**$ 8,972,000**	**$ 3,114,000**	**$ 4,007,000**	**$ 926,000**	**$ 926,000**		**$ 8,973,000**	**$ -**
Future System Improvements																
Future Subbasin 1																
F1-1	Pipe	West of Highway 99	Future Basin (F1-B) to Mingo Road Extension	B	-	66	New	1,300	$ 926,000				$ 926,000	100%	$ -	$ 926,000
F1-2	Pipe	West of Highway 99	Mingo Road Extension to South of Mingo Road Extension	B	-	60	New	1,800	$ 1,167,000				$ 1,167,000	100%	$ -	$ 1,167,000
F1-3	Pipe	West of Highway 99	South of Mingo Road Extension to North of Twin Cities Road	B	-	54	New	1,000	$ 583,000				$ 583,000	100%	$ -	$ 583,000
F1-4	Pipe	West of Highway 99	North of Twin Cities Road	B	-	42	New	850	$ 385,000				$ 385,000	100%	$ -	$ 385,000
F1-5	Pipe	West of Highway 99	North of Twin Cities Road to Twin Cities Road	B	-	36	New	850	$ 330,000				$ 330,000	100%	$ -	$ 330,000
F1-6	Pipe	West of Highway 99	North of Mingo Road Extension to North of Mingo Road Extension	B	-	36	New	1,000	$ 388,000				$ 388,000	100%	$ -	$ 388,000
F1-7	Force Main	Near Union Pacific Railroad	Future Basin (F1-B) to Future Outfall	B	-	16	New	600	$ 172,000				$ 172,000	100%	$ -	$ 172,000
F1-7A	Pipe/Casing[(1)]	Near Union Pacific Railroad	Crossing Under UPRR	A	-	16/30	New	300	$ 540,000				$ 540,000	100%	$ -	$ 540,000
F1-B	Basin	Eastside of Union Pacific Railroad	Future Detention Basin	-	-	70 acre-ft	New	-	$ 1,708,000				$ 1,708,000	100%	$ -	$ 1,708,000
	Land Acquisition				-	8 acres	New	-	$ 1,920,000				$ 1,920,000	100%	$ -	$ 1,920,000
F1-PS	Pump Station	Eastside of Union Pacific Railroad	Pump Station at Future Basin (F1-B)	B		7 cfs	New	-	$ 2,473,000				$ 2,473,000	100%	$ -	$ 2,473,000

Table 6.2 Capital Improvement Projects
Storm Drainage System Master Plan
City of Galt

Figure No.	Type of Improvement	Description/ Street	Description / Limits	Pipeline Cost Schedule (A or B)	Project Length/Size and Cost: Ex. Size/ Diam. (in)	New Size/ Diam. (in)	Replace/ New	Length (ft)	Capital Improvement Cost[(2),(3)] ($)	Capital Improvement Phasing: Phase 1 2009-2015 ($)	Phase 2 2016-2020 ($)	Phase 3 2021-2025 ($)	Phase 4 2026-2030 ($)	Future Users Benefit (%)	Reimbursement Category: Existing Improvements ($)	Future Improvements ($)
Future Subbasin 2																
F2-1	Pipe	North of Mingo Road	Future Basin (F2-B) to Mingo Road	B	-	72	New	400	$ 310,000			$ 310,000		100%	$ -	$ 310,000
F2-2	Pipe	Bergeron Road Extension	Mingo Road to South of Mingo Road	B	-	66	New	700	$ 499,000			$ 499,000		100%	$ -	$ 499,000
F2-3	Pipe	Bergeron Road Extension	South of Mingo Road to South of Mingo Road	B	-	66	New	1,500	$ 1,069,000			$ 1,069,000		100%	$ -	$ 1,069,000
F2-4	Pipe	Bergeron Road Extension	South of Mingo Road to North of Twin Cities Road	B	-	60	New	900	$ 583,000			$ 583,000		100%	$ -	$ 583,000
F2-5	Pipe	North of Twin Cities Road	Bergeron Road to East of Bergeron Road	B	-	54	New	700	$ 408,000			$ 408,000		100%	$ -	$ 408,000
F2-6	Pipe	North of Twin Cities Road	East of Bergeron Road to West of McKenzie Road	B	-	48	New	1,600	$ 829,000			$ 829,000		100%	$ -	$ 829,000
F2-7	Pipe	North of Twin Cities Road	West of McKenzie Road to East of McKenzie Road	B	-	42	New	1,000	$ 453,000			$ 453,000		100%	$ -	$ 453,000
F2-8	Pipe	South of Mingo Road	Bergeron Road Extension to East of Bergeron Road Extension	B	-	30	New	700	$ 228,000				$ 228,000	100%	$ -	$ 228,000
F2-9	Pipe	South of Mingo Road	East of Bergeron Road Extension to West of McKenzie Road	B	-	24	New	700	$ 182,000				$ 182,000	100%	$ -	$ 182,000
F2-10	Pipe	Bergeron Road	North of Twin Cities Road to North of Twin Cities Road	B	-	36	New	600	$ 234,000				$ 234,000	100%	$ -	$ 234,000
F2-11	Pipe	Mingo Road	East of Highway 99 to Bergeron Road Extension	B	-	66	New	1,500	$ 1,069,000				$ 1,069,000	100%	$ -	$ 1,069,000
F2-12	Pipe	East of Highway 99	South of Mingo Road to North of Mingo Road	B	-	48	New	1,300	$ 674,000				$ 674,000	100%	$ -	$ 674,000
F2-13	Pipe	East of Highway 99	South of Mingo Road to South of Mingo Road	B	-	36	New	900	$ 349,000				$ 349,000	100%	$ -	$ 349,000
F2-14	Pipe	East of Highway 99	South of Mingo Road to South of Mingo Road	B	-	30	New	600	$ 195,000				$ 195,000	100%	$ -	$ 195,000
F2-15	Pipe	East of Highway 99	North of Mingo Road to North of Mingo Road	B	-	42	New	600	$ 271,000				$ 271,000	100%	$ -	$ 271,000
F2-16	Pipe	East of Highway 99	North of Mingo Road to North of Mingo Road	B	-	30	New	700	$ 228,000				$ 228,000	100%	$ -	$ 228,000
F2-17	Force Main	Mingo Road	Future Basin (F2-B) to Future Outfall	B	-	24	New	200	$ 78,000			$ 78,000		100%	$ -	$ 78,000
F2-B	Basin	Mingo Road	Future Detention Basin	B	-	140 acre-ft	New	-	$ 2,891,000			$ 2,891,000		100%	$ -	$ 2,891,000
	Land Acquisition				-	16 acres	New	-	$ 3,840,000			$ 3,840,000		100%	$ -	$ 3,840,000
F2-PS	Pump Station	Mingo Road	Pump Station at Future Basin (F2-B)	B	-	14 cfs	New	-	$ 5,036,000			$ 5,036,000		100%	$ -	$ 5,036,000
Future Subbasin 3																
F3-1	Pipe	South of Twin Cities Road	Future Basin (F3-B) to East of Marengo Road	B	-	48	New	2,700	$ 1,399,000		$ 1,399,000			100%	$ -	$ 1,399,000
F3-2	Pipe	East of Marengo Road	South of Twin Cities Road to South of Twin Cities Road	B	-	42	New	700	$ 317,000		$ 317,000			100%	$ -	$ 317,000
F3-3	Pipe	East of Marengo Road	South of Twin Cities Road to Twin Cities Road	B	-	36	New	700	$ 271,000		$ 271,000			100%	$ -	$ 271,000
F3-4	Pipe	East of Marengo Road	South of Twin Cities Road to South of Twin Cities Road	B	-	18	New	600	$ 117,000		$ 117,000			100%	$ -	$ 117,000
F3-5	Pipe	East of Marengo Road	South of Twin Cities Road to South of Twin Cities Road	B	-	18	New	600	$ 117,000		$ 117,000			100%	$ -	$ 117,000
F3-6	Pipe	South of Twin Cities Road	Future Basin (F3-B) to West of Cherokee Lane	B	-	30	New	1,600	$ 518,000		$ 518,000			100%	$ -	$ 518,000
F3-7	Pipe	South of Twin Cities Road	West of Cherokee Lane to West of Cherokee Lane	B	-	24	New	600	$ 156,000		$ 156,000			100%	$ -	$ 156,000
F3-8	Pipe	West of Cherokee Lane	South of Twin Cities Road to South of Twin Cities Road	B	-	18	New	300	$ 59,000		$ 59,000			100%	$ -	$ 59,000
F3-9	Force Main	West of Cherokee Lane	Future Basin (F3-B) to Future Outfall	B	-	14	New	600	$ 151,000		$ 151,000			100%	$ -	$ 151,000
F3-B	Basin	South of Twin Cities Road	Future Detention Basin	B	-	46 acre-ft	New	-	$ 1,242,000		$ 1,242,000			100%	$ -	$ 1,242,000
	Land Acquisition				-	6 acres	New	-	$ 1,440,000		$ 1,440,000			100%	$ -	$ 1,440,000
F3-PS	Pump Station	South of Twin Cities Road	Pump Station at Future Basin (F3-B)	B	-	5 cfs	New	-	$ 1,692,000		$ 1,692,000			100%	$ -	$ 1,692,000
Future Subbasin 4																
F4-1	Pipe	Northside of Union Pacific Railroad	Future Basin (F4-B) to East of Marengo Road	B	-	42	New	1,200	$ 544,000		$ 544,000			100%	$ -	$ 544,000
F4-2	Pipe	Northside of Union Pacific Railroad	East of Marengo Road to East of Marengo Road	B	-	36	New	1,000	$ 388,000		$ 388,000			100%	$ -	$ 388,000
F4-3	Pipe	East of Marengo Road	Union Pacific Railroad to North of Union Pacific Railroad	B	-	30	New	700	$ 228,000		$ 228,000			100%	$ -	$ 228,000
F4-4	Pipe	East of Marengo Road	Union Pacific Railroad to North of Union Pacific Railroad	B	-	24	New	400	$ 104,000		$ 104,000			100%	$ -	$ 104,000
F4-5	Pipe	Northside of Union Pacific Railroad	East of Marengo Road to West of Cherokee Lane	B	-	36	New	900	$ 349,000		$ 349,000			100%	$ -	$ 349,000
F4-6	Pipe	Northside of Union Pacific Railroad	West of Cherokee Lane to West of Cherokee Lane	B	-	30	New	900	$ 291,000		$ 291,000			100%	$ -	$ 291,000
F4-7	Pipe	West of Cherokee Lane	Union Pacific Railroad to North of Union Pacific Railroad	B	-	24	New	900	$ 234,000			$ 234,000		100%	$ -	$ 234,000
F4-8	Pipe	North of Union Pacific Railroad	West of Cherokee Lane to West of Cherokee Lane	B	-	18	New	600	$ 117,000			$ 117,000		100%	$ -	$ 117,000
F4-9	Force Main	North of Union Pacific Railroad	Future Basin (F4-B) to Future Outfall	B	-	10	New	1,200	$ 215,000		$ 215,000			100%	$ -	$ 215,000

Table 6.2 Capital Improvement Projects
Storm Drainage System Master Plan
City of Galt

Figure No.	Type of Improvement	Description/ Street	Description / Limits	Pipeline Cost Schedule (A or B)	Project Length/Size and Cost: Ex. Size/ Diam. (in)	New Size/ Diam. (in)	Replace/ New	Length (ft)	Capital Improvement Cost[(2),(3)] ($)	Capital Improvement Phasing: Phase 1 2009-2015 ($)	Phase 2 2016-2020 ($)	Phase 3 2021-2025 ($)	Phase 4 2026-2030 ($)	Future Users Benefit (%)	Reimbursement Category: Existing Improvements ($)	Future Improvements ($)
F4-B	Basin	North of Union Pacific Railroad	Future Detention Basin	B	-	25 acre-ft	New	-	$ 780,000		$ 780,000			100%	$ -	$ 780,000
	Land Acquisition				-	3 acres	New	-	$ 720,000		$ 720,000			100%	$ -	$ 720,000
F4-PS	Pump Station	North of Union Pacific Railroad	Pump Station at Future Basin (F4-B)	B	-	3 cfs	New	-	$ 1,092,000		$ 1,092,000			100%	$ -	$ 1,092,000
Future Subbasin 5																
F5-1	Pipe	South of Spring Street	Future Basin (F5-B) to East of McFarland Street	B	-	48	New	500	$ 258,000		$ 258,000			100%	$ -	$ 258,000
F5-2	Pipe	East of McFarland Street	North of Walnut Avenue to Walnut Avenue	B	-	42	New	700	$ 317,000		$ 317,000			100%	$ -	$ 317,000
F5-3	Pipe	Walnut Avenue	East of McFarland Street to West of Highway 99	B	-	36	New	1,600	$ 622,000		$ 622,000			100%	$ -	$ 622,000
F5-4	Pipe	West of Highway 99	Walnut Avenue to South of Walnut Avenue	B	-	30	New	500	$ 163,000		$ 163,000			100%	$ -	$ 163,000
F5-5	Pipe	West of Highway 99	South of Walnut Avenue to North of Live Oak Avenue	B	-	24	New	500	$ 130,000		$ 130,000			100%	$ -	$ 130,000
F5-6	Pipe	South of Spring Street	East of McFarland Street to West of Highway 99	B	-	30	New	800	$ 258,000			$ 258,000		100%	$ -	$ 258,000
F5-7	Pipe	South of Spring Street	West of Highway 99 to West of Highway 99	B	-	24	New	800	$ 208,000			$ 208,000		100%	$ -	$ 208,000
F5-8	Force Main	McFarland Street	Future Basin (F5-B) to Future Outfall	B	-	10	New	500	$ 89,000		$ 89,000			100%	$ -	$ 89,000
F5-B	Basin	McFarland Street	Future Detention Basin	B	-	27 acre-ft	New	-	$ 827,000		$ 827,000			100%	$ -	$ 827,000
	Land Acquisition				-	3 acres	New	-	$ 720,000		$ 720,000			100%	$ -	$ 720,000
F5-PS	Pump Station	McFarland Street	Pump Station at Future Basin (F5-B)	B	-	3 cfs	New	-	$ 1,147,000		$ 1,147,000			100%	$ -	$ 1,147,000
Future Subbasin 6																
F6-1	Pipe	East of Marengo Road	Future Basin (F6-B) to North of Deadman Gulch	B	-	72	New	1,400	$ 1,089,000		$ 1,089,000			100%	$ -	$ 1,089,000
F6-2	Pipe	East of Marengo Road	North of Deadman Gulch to South of Union Pacific Railroad	B	-	66	New	800	$ 570,000		$ 570,000			100%	$ -	$ 570,000
F6-3	Pipe	East of Marengo Road	North of Deadman Gulch to South of Union Pacific Railroad	B	-	54	New	600	$ 349,000		$ 349,000			100%	$ -	$ 349,000
F6-4	Pipe	East of Marengo Road	South of Union Pacific Railroad to South of Union Pacific Railroad	B	-	48	New	1,400	$ 726,000			$ 726,000		100%	$ -	$ 726,000
F6-5	Pipe	South of Union Pacific Railroad	West of Cherokee Lane to West of Cherokee Lane	B	-	36	New	800	$ 310,000			$ 310,000		100%	$ -	$ 310,000
F6-6	Pipe	South of Union Pacific Railroad	West of Cherokee Lane to West of Cherokee Lane	B	-	30	New	800	$ 258,000			$ 258,000		100%	$ -	$ 258,000
F6-7	Pipe	North of Marengo Road	East of Marengo Road to West of Cherokee Lane	B	-	30	New	700	$ 228,000			$ 228,000		100%	$ -	$ 228,000
F6-8	Pipe	North of Marengo Road	West of Cherokee Lane to West of Cherokee Lane	B	-	24	New	1,100	$ 284,000			$ 284,000		100%	$ -	$ 284,000
F6-9	Pipe	South of Union Pacific Railroad	East of Marengo Road to West of Cherokee Lane	B	-	30	New	700	$ 228,000			$ 228,000		100%	$ -	$ 228,000
F6-10	Pipe	South of Union Pacific Railroad	West of Cherokee Lane to West of Cherokee Lane	B	-	24	New	1,000	$ 258,000			$ 258,000		100%	$ -	$ 258,000
F6-11	Pipe	South of Union Pacific Railroad	South of Union Pacific Railroad to West of Cherokee Lane	B	-	42	New	700	$ 317,000			$ 317,000		100%	$ -	$ 317,000
F6-12	Pipe	South of Union Pacific Railroad	West of Cherokee Lane to West of Cherokee Lane	B	-	36	New	800	$ 310,000			$ 310,000		100%	$ -	$ 310,000
F6-13	Pipe	South of Union Pacific Railroad	East of Marengo Road to West of Cherokee Lane	B	-	54	New	800	$ 466,000		$ 466,000			100%	$ -	$ 466,000
F6-14	Pipe	South of Union Pacific Railroad	East of Marengo Road to East of Marengo Road	B	-	42	New	1,000	$ 453,000		$ 453,000			100%	$ -	$ 453,000
F6-15	Pipe	East of Marengo Road	North of Deadman Gulch to South of Union Pacific Railroad	B	-	30	New	800	$ 258,000		$ 258,000			100%	$ -	$ 258,000
F6-16	Pipe	East of Marengo Road	North of Deadman Gulch to South of Union Pacific Railroad	B	-	24	New	700	$ 182,000		$ 182,000			100%	$ -	$ 182,000
F6-17	Pipe	Near Deadman Gulch	Connects Future Basins F6-B and F8-B	B	-	30	New	700	$ 228,000			$ 228,000		100%	$ -	$ 228,000
F6-18	Force Main	Near Deadman Gulch	Future Basin (F6-B) to Future Outfall	B	-	16	New	1,800	$ 515,000		$ 515,000			100%	$ -	$ 515,000
F6-B	Basin	Near Deadman Gulch	Future Detention Basin	-	-	70 acre-ft	New	-	$ 1,708,000		$ 1,708,000			100%	$ -	$ 1,708,000
	Land Acquisition				-	8 acres	New	-	$ 1,920,000		$ 1,920,000			100%	$ -	$ 1,920,000
F6-PS	Pump Station	Near Deadman Gulch	Pump Station at Future Basin (F6-B)	-	-	7 cfs	New	-	$ 2,473,000		$ 2,473,000			100%	$ -	$ 2,473,000
Future Subbasin 7																
F7-1	Pipe	Parallel to Deadman Gulch	Future Basin (F7-B) to South of Vintage Oak Avenue	B	-	30	New	1,600	$ 518,000	$ 518,000				100%	$ -	$ 518,000
F7-2	Pipe	Parallel to Deadman Gulch	South of Vintage Oak Avenue to Cedar Flat Avenue	B	-	24	New	2,000	$ 518,000	$ 518,000				100%	$ -	$ 518,000
F7-3	Pipe	Cedar Flat Avenue Extension	South of Colson Court to North of Union Pacific Railroad	B	-	18	New	600	$ 117,000	$ 117,000				100%	$ -	$ 117,000
F7-4	Force Main	Deadman Gulch	Future Basin (F7-B) to Future Outfall	B	-	6	New	50	$ 5,000	$ 5,000				100%	$ -	$ 5,000
F7-B	Basin	Deadman Gulch	Future Detention Basin	-	-	10 acre-ft	New	-	$ 388,000	$ 388,000				100%	$ -	$ 388,000
	Land Acquisition				-	2 acres	New	-	$ 480,000	$ 480,000				100%	$ -	$ 480,000

Table 6.2 Capital Improvement Projects
Storm Drainage System Master Plan
City of Galt

Figure No.	Type of Improvement	Description/ Street	Description / Limits	Pipeline Cost Schedule (A or B)	Project Length/Size and Cost: Ex. Size/ Diam. (in)	New Size/ Diam. (in)	Replace/ New	Length (ft)	Capital Improvement Cost[(2),(3)] ($)	Capital Improvement Phasing: Phase 1 2009-2015 ($)	Phase 2 2016-2020 ($)	Phase 3 2021-2025 ($)	Phase 4 2026-2030 ($)	Future Users Benefit (%)	Reimbursement Category: Existing Improvements ($)	Future Improvements ($)
F7-PS	Pump Station	Deadman Gulch	Pump Station at Future Basin (F7-B)	-	-	1 cfs	New	-	$ 692,000	$ 692,000				100%	$ -	$ 692,000
Future Subbasin 8																
F8-1	Pipe	West of Cherokee Lane	Future Basin (F8-B) to South of Deadman Gulch	B	-	54	New	1,700	$ 991,000			$ 991,000		100%	$ -	$ 991,000
F8-2	Pipe	West of Cherokee Lane	South of Deadman Gulch to South of Deadman Gulch	B	-	42	New	300	$ 137,000			$ 137,000		100%	$ -	$ 137,000
F8-3	Pipe	West of Cherokee Lane	South of Deadman Gulch to North of Simmerhorn Road	B	-	36	New	600	$ 234,000			$ 234,000		100%	$ -	$ 234,000
F8-4	Pipe	West of Cherokee Lane	North of Simmerhorn Road to Simmerhorn Road	B	-	30	New	700	$ 228,000			$ 228,000		100%	$ -	$ 228,000
F8-5	Pipe	South of Deadman Gulch	West of Cherokee Lane to West of Cherokee Lane	B	-	24	New	1,600	$ 414,000			$ 414,000		100%	$ -	$ 414,000
F8-6	Pipe	North of Simmerhorn Road	West of Cherokee Lane to West of Cherokee Lane	B	-	24	New	1,700	$ 440,000			$ 440,000		100%	$ -	$ 440,000
F8-7	Pipe	North of Simmerhorn Road	East of Marengo Road to West of Cherokee Lane	B	-	36	New	1,300	$ 505,000			$ 505,000		100%	$ -	$ 505,000
F8-8	Pipe	East of Marengo Road	South of Deadman Gulch to North of Simmerhorn Road	B	-	30	New	800	$ 258,000			$ 258,000		100%	$ -	$ 258,000
F8-B	Basin	Deadman Gulch	Future Detention Basin	-	-	46 acre-ft	New	-	$ 1,242,000			$ 1,242,000		100%	$ -	$ 1,242,000
	Land Acquisition				-	5 acres	New	-	$ 1,200,000			$ 1,200,000		100%	$ -	$ 1,200,000
Future Subbasin 9																
F9-1	Pipe	Simmerhorn Road	Future Basin (F9-B) to West of Steiner Road	B	-	42	New	1,200	$ 544,000	$ 544,000				100%	$ -	$ 544,000
F9-2	Pipe	West of Steiner Road	Simmerhorn Road to North of Simmerhorn Road	B	-	36	New	700	$ 271,000	$ 271,000				100%	$ -	$ 271,000
F9-3	Pipe	West of Steiner Road	North of Simmerhorn Road to South of Union Pacific Railroad	B	-	24	New	800	$ 208,000		$ 208,000			100%	$ -	$ 208,000
F9-4	Pipe	Simmerhorn Road	West of Steiner Road to North of Simmerhorn Road	B	-	30	New	1,800	$ 583,000		$ 583,000			100%	$ -	$ 583,000
F9-5	Pipe	West of Steiner Road Extension	Simmerhorn Road to South of Simmerhorn Road	B	-	24	New	800	$ 208,000		$ 208,000			100%	$ -	$ 208,000
F9-6	Pipe	Simmerhorn Road	Future Basin (F9-B) to Carillion Boulevard	B	-	36	New	200	$ 78,000		$ 78,000			100%	$ -	$ 78,000
F9-7	Pipe	Simmerhorn Road	Carillion Boulevard to Marengo Road	B	-	30	New	1,300	$ 421,000		$ 421,000			100%	$ -	$ 421,000
F9-8	Pipe	Marengo Road	Simmerhorn Road to North of Simmerhorn Road	B	-	24	New	800	$ 208,000		$ 208,000			100%	$ -	$ 208,000
F9-9	Pipe	Marengo Road	Simmerhorn Road to South of Simmerhorn Road	B	-	24	New	800	$ 208,000		$ 208,000			100%	$ -	$ 208,000
F9-10	Pipe	Carillion Boulevard	Simmerhorn Road to North of Simmerhorn Road	B	-	24	New	800	$ 208,000	$ 208,000				100%	$ -	$ 208,000
F9-11	Force Main	Simmerhorn Road	Future Basin (F9-B) to Future Outfall	B	-	14	New	1,400	$ 351,000	$ 351,000				100%	$ -	$ 351,000
F9-B	Basin	Simmerhorn Road	Future Detention Basin	-	-	51 acre-ft	New	-	$ 1,342,000	$ 1,342,000				100%	$ -	$ 1,342,000
	Land Acquisition				-	6 acres	New	-	$ 1,440,000	$ 1,440,000				100%	$ -	$ 1,440,000
F9-PS	Pump Station	Simmerhorn Road	Pump Station at Future Basin (F9-B)	-	-	5 cfs	New	-	$ 1,843,000	$ 1,843,000				100%	$ -	$ 1,843,000
Future Subbasin 10																
F10-1	Pipe	East of Marengo Road	Future Basin (F10-B) to Boessow Road	B	-	54	New	800	$ 466,000			$ 466,000		100%	$ -	$ 466,000
F10-2	Pipe	Boessow Road	East of Marengo Road to West of Cherokee Lane	B	-	48	New	2,100	$ 1,089,000			$ 1,089,000		100%	$ -	$ 1,089,000
F10-3	Pipe	West of Cherokee Lane	Boessow Road to North of Boessow Road	B	-	42	New	700	$ 317,000			$ 317,000		100%	$ -	$ 317,000
F10-4	Pipe	West of Cherokee Lane	North of Boessow Road to South of Simmerhorn Road	B	-	36	New	700	$ 271,000			$ 271,000		100%	$ -	$ 271,000
F10-5	Pipe	North of Boessow Road	West of Cherokee Lane to West of Cherokee Lane	B	-	30	New	700	$ 228,000			$ 228,000		100%	$ -	$ 228,000
F10-6	Pipe	Boessow Road	East of Marengo Road to East of Marengo Road	B	-	42	New	900	$ 408,000			$ 408,000		100%	$ -	$ 408,000
F10-7	Pipe	Boessow Road	East of Marengo Road to Marengo Road	B	-	36	New	1,100	$ 427,000			$ 427,000		100%	$ -	$ 427,000
F10-8	Pipe	Marengo Road	Boessow Road to North of Boessow Road	B	-	30	New	1,400	$ 453,000			$ 453,000		100%	$ -	$ 453,000
F10-9	Pipe	North of Boessow Road	East of Marengo Road to West of Cherokee Lane	B	-	30	New	1,200	$ 388,000			$ 388,000		100%	$ -	$ 388,000
F10-10	Pipe	East of Marengo Road	North of Boessow Road to South of Simmerhorn Road	B	-	24	New	700	$ 182,000			$ 182,000		100%	$ -	$ 182,000
F10-11	Force Main	East of Marengo Road	Future Basin (F10-B) to Future Outfall	B	-	14	New	900	$ 226,000			$ 226,000		100%	$ -	$ 226,000
F10-B	Basin	East of Marengo Road	Future Detention Basin	-	-	51 acre-ft	New	-	$ 1,342,000			$ 1,342,000		100%	$ -	$ 1,342,000
	Land Acquisition				-	6 acres	New	-	$ 1,440,000			$ 1,440,000		100%	$ -	$ 1,440,000
F10-PS	Pump Station	East of Marengo Road	Pump Station at Future Basin (F10-B)	-	-	5 cfs	New	-	$ 1,843,000			$ 1,843,000		100%	$ -	$ 1,843,000

Table 6.2 Capital Improvement Projects
Storm Drainage System Master Plan
City of Galt

Figure No.	Type of Improvement	Description/ Street	Description / Limits	Pipeline Cost Schedule (A or B)	Project Length/Size and Cost: Ex. Size/ Diam. (in)	New Size/ Diam. (in)	Replace/ New	Length (ft)	Capital Improvement Cost[(2),(3)] ($)	Capital Improvement Phasing: Phase 1 2009-2015 ($)	Phase 2 2016-2020 ($)	Phase 3 2021-2025 ($)	Phase 4 2026-2030 ($)	Future Users Benefit (%)	Reimbursement Category: Existing Improvements ($)	Future Improvements ($)
Future Subbasin 11																
F11-1	Pipe	Crystal Way Extension	Future Basin (F11-B) to North of Boessow Road	B	-	48	New	600	$ 310,000		$ 310,000			100%	$ -	$ 310,000
F11-2	Pipe	Crystal Way Extension	North of Boessow Road to South of Simmerhorn Road	B	-	42	New	500	$ 228,000		$ 228,000			100%	$ -	$ 228,000
F11-3	Pipe	South of Simmerhorn Road	East of Highway 99 to East of Highway 99	B	-	36	New	600	$ 234,000		$ 234,000			100%	$ -	$ 234,000
F11-4	Pipe	South of Simmerhorn Road	East of Highway 99 to Eastside of Highway 99	B	-	30	New	600	$ 195,000		$ 195,000			100%	$ -	$ 195,000
F11-5	Pipe	Eastside of Highway 99	Eastside of Highway 99 to North of Highway 99	B	-	24	New	600	$ 156,000		$ 156,000			100%	$ -	$ 156,000
F11-6	Pipe	North of Boessow Road	Future Basin (F11-B) to West of Marengo Road	B	-	42	New	800	$ 362,000	$ 362,000				100%	$ -	$ 362,000
F11-7	Pipe	West of Marengo Road	North of Boessow Road to Boessow Road	B	-	36	New	600	$ 234,000	$ 234,000				100%	$ -	$ 234,000
F11-8	Pipe	West of Marengo Road	Boessow Road to South of Boessow Road	B	-	24	New	800	$ 208,000	$ 208,000				100%	$ -	$ 208,000
F11-9	Pipe	West of Marengo Road	South of Boessow Road to South of Boessow Road	B	-	18	New	600	$ 117,000	$ 117,000				100%	$ -	$ 117,000
F11-10	Pipe	Boessow Road	West of Marengo Road to West of Marengo Road	B	-	18	New	600	$ 117,000	$ 117,000				100%	$ -	$ 117,000
F11-11	Pipe	North of Boessow Road	West of Marengo Road to West of Marengo Road	B	-	18	New	700	$ 137,000		$ 137,000			100%	$ -	$ 137,000
F11-12	Pipe	West of Marengo Road	North of Boessow Road to North of Boessow Road	B	-	18	New	400	$ 78,000		$ 78,000			100%	$ -	$ 78,000
F11-13	Force Main	Boessow Road	Future Basin (F11-B) to Future Outfall	B	-	14	New	200	$ 50,000	$ 50,000				100%	$ -	$ 50,000
F11-B	Basin	Boessow Road	Future Detention Basin	-	-	46 acre-ft	New	-	$ 1,242,000	$ 1,242,000				100%	$ -	$ 1,242,000
	Land Acquisition				-	5 acres	New	-	$ 1,200,000	$ 1,200,000				100%	$ -	$ 1,200,000
F11-PS	Pump Station	Boessow Road	Pump Station at Future Basin (F11-B)	-	-	5 cfs	New	-	$ 1,692,000	$ 1,692,000				100%	$ -	$ 1,692,000
								Future Improvements Subtotal	**$ 92,348,000**	**$ 13,939,000**	**$ 29,698,000**	**$ 34,689,000**	**$ 14,022,000**		**$ -**	**$ 92,348,000**
								CIP Total (Existing and Future)	**$ 101,320,000**	**$ 17,053,000**	**$ 33,705,000**	**$ 35,615,000**	**$ 14,948,000**		**$ 8,973,000**	**$ 92,348,000**

Notes:
1. Proposed casings size and carrier pipe size.
2. Baseline Construction Cost plus 25% to account for unforeseen events and unknown conditions.
3. Estimated Construction Cost plus 30% to cover other costs including Engineering, Construction Management, and Project Administration.
4. Pump station capacities refer to the total capacity unless noted otherwise.
5. Costs are based on the Engingeering News Record Construction Cost Index 20-city average of 8534 (March 2009).

Table 6.3	Existing Versus Future User Cost Share Storm Drainage System Master Plan City of Galt				
	Implementation Phase				
Reimbursement Category	2009-15 ($, mill.)	2016-20 ($, mill.)	2021-25 ($, mill.)	2026 - 30 ($, mill.)	Total ($, mill.)
Existing User [2]	3.1	4.0	0.9	0.9	**9.0**
Future User [3]	13.9	29.7	34.7	14.0	**92.3**
Total	**17.0**	**33.7**	**35.6**	**14.9**	**101.3**

Notes:
1. All costs are in March 2009 dollars. ENR CCI 20 City average = 8534
2. Projects are expected to be funded through user rates.
3. Projects are expected to be funded through storm development impact fees collected by the City or by developers.

Table 6.4	Existing Versus Future Cost by Facility Type Storm Drainage System Master Plan City of Galt			
Reimbursement Category	Storm Drains ($, mill.)	Detention Basins ($, mill.)	Pump Stations ($, mill.)	Total ($, mill.)
Existing Users[2]	9.0	0.0	0.0	**9.0**
Future Users[3]	41.3	31.0	20.0	**92.3**
Total	**50.3**	**31.0**	**20.0**	**101.3**

Notes:
1. All costs are in March 2009 dollars. ENR CCI 20 City average = 8534
2. Projects are expected to be funded through user rates.
3. Projects are expected to be funded through storm development impact fees collected by the City or by developers.

6.7 COST OF SERVICE

The existing and future user capital costs discussed above were used to determine a cost of service to existing rate payers and future customer connections. The following is not a rate study, fee program, or development impact fee analysis. It is a simplified assessment of the costs that the City might need to recover from existing rate payers and future development to pay for the proposed Master Plan projects. This analysis serves only to assist the City in determining whether a rate or development impact fee increase might be needed to finance the proposed CIPs. This Master Plan analysis is simply a high level calculation that provides the potential order of magnitude assessment and brackets the possible costs. A more detailed rate/development impact study should be conducted to determine the magnitude of a possible increase to fund the proposed CIPs.

6.7.1 Existing Users Fee for Service

The City collects storm drainage utility rates to pay for storm drainage operations. In 2003, the City established a tiered rate structure. All existing account holders prior to March 1, 2003 are grouped into the Tier 1 rate structure, whereas all new construction after March 1, 2003 are grouped into the Tier 2 rate structure. The capital costs to implement the proposed Master Plan projects fall under the capital replacement and improvement of existing system components. These costs are spread over approximately 7,200 existing service connections.

As the City implements the proposed Master Plan projects, an increase in the rates could be necessary to finance them if they are implemented per the phasing schedule assumed in this Master Plan.

The total existing system Master Plan capital costs equal approximately $9.0 million. One possible scenario to finance these projects might include two phases of bond financing. One bond could cover the work for Phases 1 and 2 (2009 through 2020), and a second bond could finance projects for Phases 3 and 4 (2021 through 2030). For this simplified analysis, we assumed that the first bond would be for $7.1 million and the second for $1.9 million, both paid off over 30 years at an interest rate of 5 percent. Although the number of current service connections is approximately 7,200, this number is expected to increase.

Since the 2005 Urban Water Management Plan (UWMP) forecasts the possible increase in future water service connections, we used this report to estimate the increase in storm drainage utility rate payers. We assumed that the number of future water connections was equal to the number of future storm drainage utility rate payers. Table 4-1 of the 2005 UWMP provides guidance for the increase in connections to 2030, and future growth was assumed at three percent after year 2030. However, we revised this information to reflect the anticipated growth reported in the 2030 General Plan, which based on population and commercial development, effectively increased the projections of future connections above those reported in the 2005 UWMP. In other words, using the 2030 General Plan guidance, we have estimated that there will be more rate payers available to pay for these two bonds than is anticipated in the UWMP, thereby reducing the increase on the individual rate payers to finance this debt. We assumed the mid-point of each repayment term to estimate the number of rate payers available to pay back the debt. Below is a summary of the assumptions regarding the number of future connections used to estimate the possible increase in rates necessary to finance the bond debt:

- 7,200 water service connections in Year 2008
- 13,540 water service connections in Year 2020 (Table 4.1 from 2005 UWMP reported 11,393 service connections)

- 18,385 water service connections in Year 2030 (Table 4.1 from 2005 UWMP reported 16,484 service connections)
- Three percent annual increase in water service connections after Year 2030
- Average number of storm drainage utility rate payers to pay Bond 1 was 15,950
- Average number of storm drainage utility rate payers to pay Bond 2 was 23,350

Based on these assumptions, the monthly increase necessary to finance the first bond to fund the proposed capital replacement projects could be approximately $2.50 per rate payer. In year 2020 when the second bond is secured, the rate could increase to about $3.00 per rate payer.

This simplified analysis does not take into account any existing City bonds (if any) that are being paid, the type of bond that would be used, alternative payment schedules, or class of service. It is recommended that a comprehensive rate analysis be completed to quantify the impacts to existing rate payers and to the City's proposed storm drainage rates. The possible rate increase will likely vary depending on the class of service (e.g. single and multi-family residential, commercial, and industrial), whether a rate payer is in Tier 1 or 2, and determining this level of detail for setting rates goes beyond the scope of this study.

6.7.2 Future Users Development Impact Fees

Historically, new storm drain pipelines are paid by developers and are not covered by storm drainage impact fees. However, it is anticipated that costs for future detention basins and pump stations needed to serve future users will be funded as an addition to any existing storm drainage development impact fees charged by the City. The total future system Master Plan capital costs equal approximately $92.3 million. Of this $92.3 million, $51 million would be needed for detention basins and pump stations, and $41.3 million for pipeline construction. Depending upon the City's future development plan, the pipelines could either be funded through development impact fees, or directly through the developers, with a separate reimbursement fund established for others who benefit from the improvement. We assumed that the storm drains are developer funded. Table 6.5 provides a breakdown of future user costs by facility and finance category (development impact fees or developer funded). The total cost of facilities financed through development impact fees was used to estimate the magnitude of a possible future impact fee.

As mentioned above, based on the 2030 General Plan, the number of future water connections added to the City will likely increase above the projections summarized in Table 4-1 of the 2005 UWMP. Based on the projected build-out water demands, by year 2030 there could be between 18,000 to 20,000 connections within the General Plan boundaries. This represents an increase of 10,800 to 12,800 in future rate payers that would pay impact fees to finance future detention basin and pump station capital projects. Therefore, the possible capital cost per future connection could range from $3,900 to $4,800.

Table 6.5 Impact Fee Versus Developer Financed Storm Drainage System Master Plan City of Galt				
Finance Category	**Storm Drains ($, mill.)**	**Detention Basins ($, mill.)**	**Pump Stations ($, mill.)**	**Total ($, mill.)**
Impact Fee	--	31.0	20.0	**51.0**
Developer Funded	41.3	--	--	**41.3**
Total	**41.3**	**31.0**	**20.0**	**92.3**

Notes:
1. All costs are in March 2009 dollars. ENR CCI 20 City average = 8534

The development impact fee is significantly influenced by the number of connections, and will likely vary based on the class of service. The City should complete a detailed development impact fee study to quantify the appropriate fee by class of service to finance increases in capacity for future users.

6.8 FUTURE USER BENEFIT ZONES

The City requested that Carollo evaluate the feasibility of establishing “benefit zones” for the storm drainage system where a development impact fee would be based on the development location. The rationale is that development located farthest from urban services should pay a greater impact fee since the costs to extend services out to these users is greater when compared to an infill development or development adjacent to existing services.

This approach could be applied to assessing impact fees for storm drainage collection systems. The reason is that the City’s storm drainage collection system varies in size and depth depending on where future development is proposed. In other words, large diameter storm drains may be necessary to serve future developments on the perimeter of the sphere of influence, whereas an infill development near existing infrastructure may only need a small storm drain to provide service. Some might argue that developments at the farthest reaches of study area should pay higher impact fees when compared to developments adjacent to or within City limits because the type of infrastructure required to extend urban service to undeveloped areas is not uniform for all future users and depends on location. This is a policy decision that will not be discussed in this Master Plan. However, basing development impact fees on future user benefit zones or on location is a possible approach for the City, in lieu of a uniform storm drainage connection fee for the entire City. The discussion below is not a recommendation for the City to pursue future user benefit zones when establishing impact fees, but simply a possible scenario for the City to investigate during a more detailed rate/development impact fee study.

6.8.1 Common Use Facilities

The proposed capital improvement projects recommended in this Master Plan are broken up into numerous hydraulically distinct subbasins. Therefore, none of the proposed storm drainage system facilities will benefit all future users, as would be the case for a large trunk sewer that conveys the entire City's wastewater flow to the treatment plant.

6.8.2 Future User Benefit Zones

One approach that could be utilized by the City would be to use the future storm drainage subbasins identified in this Master Plan as the basis for the future user benefit zones. As described in Section 5.3.4, the proposed future system improvements were broken up into eleven subbasins, each with a distinct pipeline network serviced by a detention basin and pump station. The future user benefit zones would be identified based on the number corresponding to the future subbasin (e.g., Future Subbasin 1, 2, etc.). Figure 5.1 delineates the future subbasin boundaries and can therefore be referenced to define the possible future user benefit zones. Future infill development could be grouped into a single benefit zone covering the existing subbasins, which would also be subjected to an impact fee.

APPENDIX A - DESCRIPTION OF DIFFERENT LAND USES (GENERAL PLAN EXCERPTS)

Land Use Designations and Standards

The Land Use and Circulation Diagram (Figure LU-1) shows 13 residential and non-residential land use designations. These 13 land use designations are described, with photo examples, in Table LU-1. State law mandates that general plans include standards of population density and building intensity for all of the territory covered by the plan. To satisfy this requirement, the General Plan includes such standards for each of the land use designations appearing on the Land Use and Circulation Diagram. These standards are stated differently for residential and non-residential development.

Residential Uses

Standards of population density for residential uses can be derived by multiplying the maximum allowable number of dwelling units per gross acre by the average number of persons per dwelling unit assumed for the applicable residential designation. Standards of building intensity for residential uses are stated as the allowable range of dwelling units per gross acre.

The assumed average number of persons per dwelling unit for each residential designation has been extrapolated from population and housing unit estimates prepared by the Sacramento Area Council of Governments (SACOG) and the State of California Department of Finance. These are summarized in Table LU-2.

Non-Residential Uses

Standards of building intensity for non-residential uses in the General Plan are stated as maximum floor-area ratios (FARs). A floor-area ratio is the ratio of the gross building square footage on a lot to the net square footage of the lot.

For example, on a lot with 10,000 net square feet of land area, a FAR of 1.00 will allow 10,000 square feet of gross building floor area to be built, regardless of the number of stories in the building (e.g., 5,000 square feet per floor on two floors or 10,000 square feet on one floor). On the same lot, a FAR of 0.50 would allow 5,000 square feet of floor area, and a FAR of 0.25 would allow 2,500 square feet. The diagram below illustrates conceptually how buildings of one, two, and four stories could be developed on a given lot with a FAR of 1.00.

Standards of population density for non-residential uses can be derived by multiplying one acre (43,560 square feet) by the applicable FAR and then dividing by the assumed average square footage of building area per employee. The assumed average square footage of nonresidential building floor area per employee is based on historic averages and market studies. These are summarized in Table LU-2.

Various Building Configurations Representing a Floor-Area Ratio of 1.00 on the Same Lot

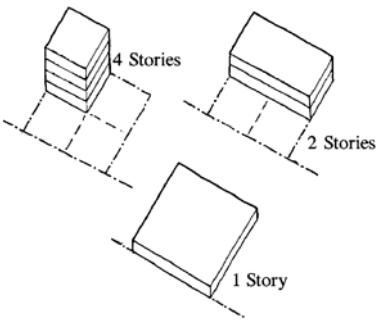
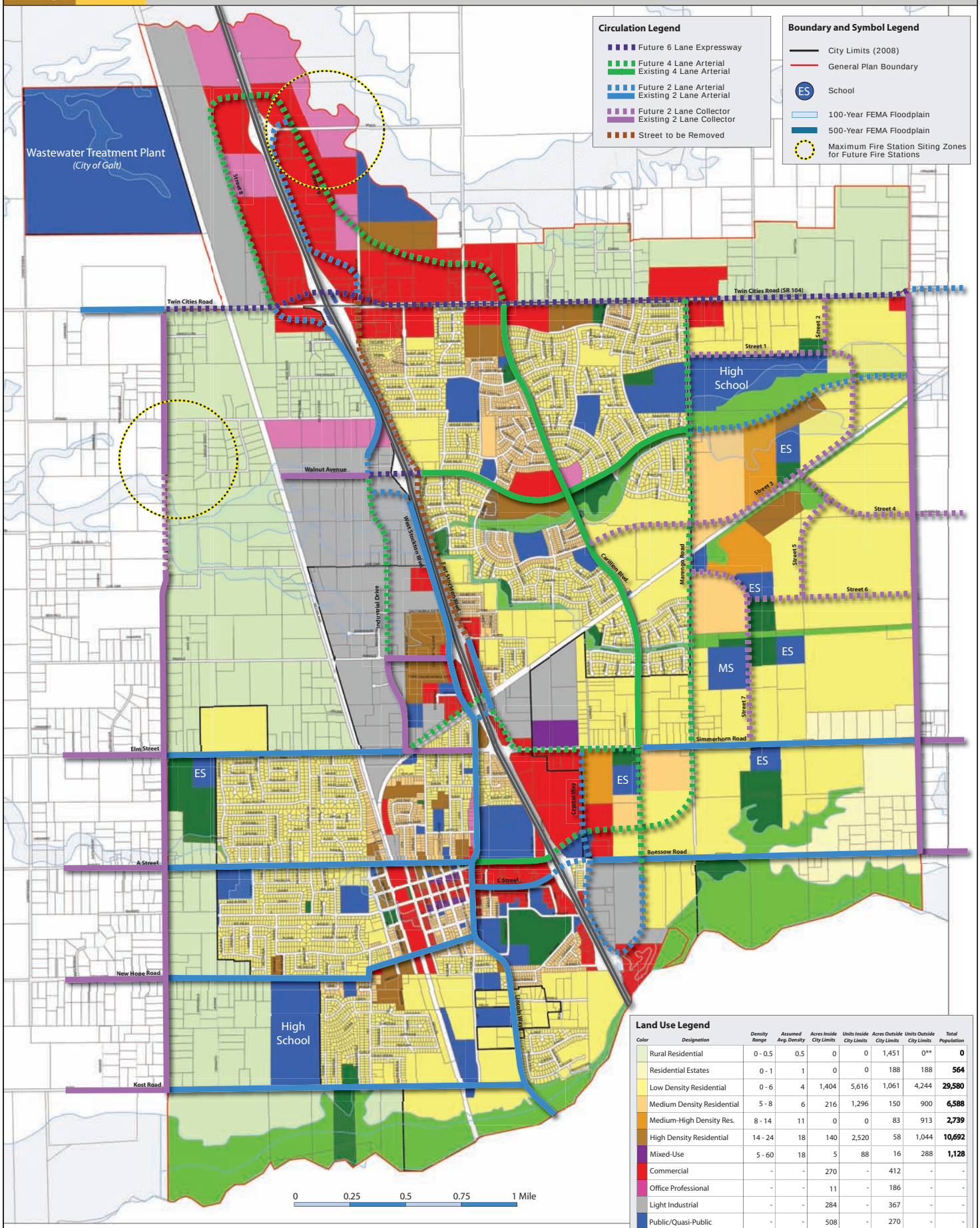


Table LU-1 Land Uses Categories	
	Rural Residential (RR) Provides for single family detached homes and secondary residential units on 2 acre minimum lots without full urban services and with limited agricultural uses. This use is in the Planning Area but outside of the 2007 city limits. This use is typically located on the far western and northern parts of the Planning Area to provide transition between urban and rural uses.
	Residential Estates (RE) Provides for single family detached executive housing opportunities, secondary residential units, and public and quasi-public uses on large lots with limited urban services.
	Low-Density Residential (LDR) Provides for single family detached homes, secondary residential units, public and quasi-public uses, and similar and compatible uses. This use is typically located in areas which include full urban services, and away from industrial, intensive commercial, and large-scale infrastructure (i.e., power substations, wastewater treatment plant).
	Medium-Density Residential (MDR) Provides for single family detached homes, secondary residential units, duplexes, public and quasi-public uses, and similar and compatible uses. Attached single- and multi-family homes are also allowed with a conditional use permit. This use is typically located adjacent to low-density residential areas and provides a transition between low-density and medium-high density residential.
	Medium-High Density Residential (MHDR) Provides for single family detached and attached homes, secondary residential units, public and quasi-public uses, and similar, compatible uses. This use provides a transition from lower density residential areas and is often close to commercial/office professional areas, and arterial streets.
	High-Density Residential (HDR) Provides for single-family attached homes, multi-family residential units, and similar and compatible uses. This use is typically located near medium-high density and/or near commercial/office professional uses or arterial streets and highways.

	Mixed-Use (MU) Provides for residential uses combined with compatible uses such as retail, service, restaurants, banks, entertainment uses, professional and administrative offices, and public and quasi-public uses. This use is typically located in the downtown and other parts of the city that serve as community centers with residential, commercial, and employment uses in the immediate vicinity.
	Commercial (C) Provides primarily for regional, neighborhood, and locally-oriented retail and service uses, restaurants, banks, entertainment uses, public and quasi-public uses, and similar and compatible uses. This use is typically located downtown and in areas of good visibility, such as arterials or major intersections.
	Office Professional (OP) Provides for office parks, office buildings, and quasi-public uses. This use is typically located on arterial and collector streets, and in downtown if it is in scale with existing buildings.
	Industrial (I) Provides for research and development, warehouses, and manufacturing, and quasi-public uses. This use is typically located away from residential uses and in the immediate vicinity of State Route 99 and/or the Union Pacific mainline railroad tracks.
	Public/Quasi-Public (PQ) Provides for public facilities such as schools, fire stations, hospitals, sanitariums, libraries, museums, government offices and courts, churches, meeting halls, cemeteries and mausoleums, public facilities, and similar and compatible uses. This use is typically located throughout the community.
	Parks (P) Provides for active and passive recreational uses, habitat protection, and public/quasi-public uses. This use is located throughout the community.
	Open Space (OS) Provides for passive outdoor recreational uses, habitat protection, watershed management, public and quasi-public uses, areas that contain public health and safety hazards such as floodways, and areas containing environmentally-sensitive features. This use is located throughout the community.

general plan 2030 a vision for the future galt, california

FIGURE LU-1: LAND USE AND CIRCULATION DIAGRAM



Land Use Legend

Color	Designation	Density Range	Assumed Avg. Density	Acres Inside City Limits	Units Inside City Limits	Acres Outside City Limits	Units Outside City Limits	Total Population
	Rural Residential	0 - 0.5	0.5	0	0	1,451	0**	**0**
	Residential Estates	0 - 1	1	0	0	188	188	**564**
	Low Density Residential	0 - 6	4	1,404	5,616	1,061	4,244	**29,580**
	Medium Density Residential	5 - 8	6	216	1,296	150	900	**6,588**
	Medium-High Density Res.	8 - 14	11	0	0	83	913	**2,739**
	High Density Residential	14 - 24	18	140	2,520	58	1,044	**10,692**
	Mixed-Use	5 - 60	18	5	88	16	288	**1,128**
	Commercial	-	-	270	-	412	-	-
	Office Professional	-	-	11	-	186	-	-
	Light Industrial	-	-	284	-	367	-	-
	Public/Quasi-Public	-	-	508	-	270	-	-
	Parks	-	-	65	-	140	-	-
	Open Space	-	-	152	-	420	-	-
	Total			*3,055*	*9,522*	*4,802*	*7,577*	***51,291***

Notes:
1) The population associated with this diagram is approximately 51,291 total.
2) This diagram includes minor changes from assumptions contained in the Final EIR, including removal of designations for three fire stations, resulting in de minimis increases in residential, park, and commercial land uses.
** Units per Gross Acre*
*** Rural Residential-designated lands are not anticipated to be annexed into the City limits during this General Plan*

Updated April 2009

APPENDIX B - FUTURE STORM DRAINAGE SYSTEM CONCEPT ANALYSIS MEMORANDUM

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PROJECT MEMORANDUM

Project Name:	Storm Drainage System Master Plan	**Date:**	October 15, 2009
Client:	City of Galt	**Project Number:**	8100A.00
Prepared By:	Tommy Greci		
Reviewed By:	Jose Gutierrez, Scott Parker		
Subject:	Future Storm Drainage System Concept Analysis		
Distribution:	Bill Forrest, Senior Civil Engineer		

1.0 INTRODUCTION

At the workshop conducted on October 1, 2009, Carollo Engineers, P.C. (Carollo) presented preliminary storm drainage improvements to service future users. The City of Galt (City) requested that Carollo analyze options available to the City to provide storm drainage service to future users.

This memorandum summarizes the analysis of the alternatives for the collection, conveyance, storage, and disposal of storm water runoff generated by future development within the current City General Plan boundary.

The City currently discharges storm water runoff generated within the City limits into three major waterways, including Dry Creek, Deadman Gulch, and Hen Creek. The City also operates one storm water detention basin, which regulates runoff discharged into Hen Creek.

The following describes specific policies and/or regulations related to storm water conveyance and disposal that we used as a guide in developing the proposed improvements and recommended approach.

1.1 General Plan Policies

The City's General Plan Policy Document identifies the following policies related to storm water drainage:

- **Policy PFS-4.7: Mitigating Stormwater Runoff.** The City should require projects that have significant impacts on the quantity and quality of surface water runoff to incorporate mitigation measures for impacts related to urban runoff.
- **Policy PFS-4.8: Joint Use of Detention Facilities.** The City should encourage stormwater detention facilities to be designed for multiple purposes, including recreational (e.g., parks, ball fields, etc.) stormwater quality improvement, and/or waterfowl habitat.

- **Policy PFS-4.9: Detention Requirements.** The City should require detention storage with measured release to ensure that the capacity of downstream creeks and sloughs will not be exceeded. To ensure downstream capacity is not exceeded, the following measures will be applied:
  a. Outflow to creeks and sloughs should be designed and constructed to avoid exceeding downstream channel capacities; and
  b. Storage facilities should be designed and constructed to prevent problems caused by timing of storage outflows.

1.2 Sacramento Areawide NPDES Municipal Stormwater Permit

The City, along with the Cities of Citrus Heights, Elk Grove, Folsom, Rancho Cordova, Sacramento, and the County of Sacramento, is a member of the Sacramento Stormwater Quality Partnership (Partnership). The Partnership's member agencies operate their storm drain collection systems under Waste Discharge Requirements (WDR) Order No. R5-2008-0142 (National Pollutant Discharge Elimination System (NPDES) Permit No. CAS082597) issued by the California Regional Water Quality Control Board (RWQCB). Through the WDR, the Partnership is required to modify its Storm Water Quality Improvement Plan (SQIP) to address several provisions. This section identifies those provisions applicable to the master planning process.

1.2.1 Provision H.15.a

Provision H.15.a, states, in part, the following:

"Each permittee shall incorporate water quality and watershed protection principles into planning procedures and policies or requirements to direct land-use decisions and require implementation of consistent water quality protection measures for priority development projects. These principles and policies shall be designed to protect natural water bodies and shall include, at a minimum, the following:

i. Minimize the amount of impervious surfaces and directly connected impervious surfaces in areas of new development and redevelopment to maximize on-site infiltration of runoff (low development practices).

viii. Implement source and/or treatment controls to protect downstream receiving water quality from increased pollutant loads in runoff flows from new development and significant redevelopment.

ix. Control the post-development peak storm water run-off discharge rates and velocities to prevent or reduce downstream erosion and to protect stream habitat (hydromodification concepts)."

1.2.2 Stormwater Quality Improvement Plan

Chapter 8 of the SQIP prepared by the Partnership provides information about the City's Stormwater Management Program. The "New Development Element" of the City's Stormwater Management Program presents strategies for the City to reduce pollutants in urban runoff discharges from newly developed and significantly redeveloped sites. One such strategy includes the development of a Hydromodification Management Plan (HMP). The City has not currently developed a HMP, but will be required to do so in the future.

2.0 ALTERNATIVES TO SERVE FUTURE DEVELOPMENT OUTSIDE THE CURRENT CITY LIMITS

Carollo formulated and evaluated several alternatives to effectively provide storm drainage service to future users. Some of the alternatives incorporate water quality and watershed protection principles. All the alternatives provide a variety of functions, from flood control and water quality, to recreation, and/or aesthetic benefits. The alternatives summarized below specifically address the following:

- The location and potential causes of flooding. By accurately assessing the potential causes, the project team developed solutions to remedy the specific drainage problems.
- The frequency and magnitude of flooding. The relative frequency of floods allows the potential risk to property in the area to be assessed. The magnitude of flooding determines how large the stormwater facility must be to control flooding.
- Developing a set of feasible solutions to control flooding. The descriptions of the flood control alternatives include the information needed to choose a preferred alternative.

2.1 Alternative 1 - Direct Discharge

Alternative 1 relies on several distinct networks of gravity storm drains to convey storm water runoff generated from future developments to creek discharge points. As a result, the flows conveyed in the creek systems during major storm events would rise substantially due to the increase in impervious surfaces in newly developed areas.

The advantages associated with this alternative include:

- Easy to implement and administer;
- Less maintenance on storm drainpipes, inlets and outfalls, when compared to detention basins.

Due to the increase in urban runoff, it would be necessary to study the impact of each development on the capacity of the creek, downstream of the discharge points. Care would also be needed to ensure that excessive erosion or damage to wildlife habitats is not caused by increased stormwater runoff rates.

There would also likely be an increase in urban pollution into the creek systems associated with this alternative. This could be minimized by requiring large developments to install stormwater quantity and quality facilities, as has been done for some developments in the City.

The disadvantage of this alternative in terms of stormwater quality can also be overcome by end of pipe treatment options such as baffle boxes.

2.2 Alternative 2 - Storm Water Detention

Alternative 2 relies on several distinct networks of gravity storm drains to convey storm water runoff generated from future developments to be stored in regional detention basins scattered throughout the City. The purpose of the detention basins would be to store peak runoff, which would otherwise be discharged directly into the major creeks. The City's existing Greer Detention Basin serves this function.

There are several advantages associated with utilizing storm drainage detention basins:

- Peak runoff is not discharged directly into major creeks.
- Discharge to creeks can be controlled to avoid exceeding the downstream creek capacity; thereby reducing the potential for flooding and creek erosion.
- Utilizing detention basins would aid in compliance with future hydromodification requirements.
- Detention basins help improve the water quality of storm water discharged to the creeks. The detention basins can be retrofitted to augment additional pond functions such as nutrient removal, and recreation.

Constructing detention basins throughout the City would require additional maintenance by City staff. However, this alternative was formulated with recreation and aesthetic benefits in mind. A goal of this alternative would be to place detention basins, where possible, at future park locations identified in the General Plan. By doing so, the detention basins would have "dual use," which is consistent with the City's General Plan Policy PFS-4.8 and would not require a significant increase in maintenance activities by the City, since the parks would need to be maintained by the City's Parks Department regardless of whether or not the park is "dual use."

2.3 Alternative 3 - Privately Maintained Detention

Alternative 3 relies on numerous small networks of gravity storm drains to collect and convey storm water runoff generated in individual developments or subdivisions to small, privately maintained detention basins. The purpose of the detention basins would be to store peak runoff from the small collection systems.

The advantages associated with utilizing this approach to service future customers include the following:

- Peak runoff is not discharged directly into major creeks.

- Discharge to creeks can be controlled to avoid exceeding the downstream creek capacity.
- Utilizing detention basins would aid in compliance with future hydromodification requirements.
- Can be integrated with “low impact development” design concepts.
- Storm drainage networks and detention basins would be exclusively developer funded.

For this alternative, City staff would need to devote time and resources to ensure that the detention basins are properly, designed, operated and maintained. This may be difficult, due to the large number of small basins needed to employ this strategy. Additionally, due to the large number of basins, it may be difficult to track discharges into the creeks to ensure that the downstream capacity is not exceeded.

3.0 ALTERNATIVE COMPARISON

Alternative 1 is the easiest to implement and administer for the City, and represents a continuation of existing practices. However, this alternative is not consistent with hydromodification concepts, which will likely be stressed by future regulatory actions. In addition, it would require a study of the impact of discharges from new development on the capacity of the major creeks and their existing floodplain. Such a study is beyond the scope of this Master Plan, and may be expensive.

Alternative 2 is desirable because peak runoff from new development would not discharge directly into the major creeks and because it would improve storm water quality. This is consistent with hydromodification principles and General Plan policies. There may be an issue with increased maintenance requirements. However, the amount of increased maintenance can be minimized by placing detention basins at future park locations, as has been done for the Greer Detention Basin.

Alternative 3 is desirable because it reduces the amount of maintenance required by the City and also includes a low capital cost to the City. This assumes that neighborhood storm drainage collection systems and detention basins would be exclusively developer funded and maintained appropriately by future homeowner associations. If the homeowner associations do not properly operate and maintain these facilities, then the responsibility could fall on the City. This alternative is also consistent with hydromodification principles. However, this alternative would be difficult to administer to ensure that the basins are properly maintained.

Table A provides a summary of the benefits of each alternative.

4.0 RECOMMENDATION

Alternative 1 is not recommended due to the significant increase in peak runoff rates to the creek systems caused by urban development, the potential impact to existing floodplains, and

future hydromodification regulations. This alternative would create water quality issues in the future. Alternative 3 is not recommended due to the difficulties associated with administering such a strategy and the potential maintenance issues associated with numerous small detention basins. Therefore, Carollo recommends Alternative 2 as the preferred alternative for this Master Plan. This alternative is the most consistent with General Plan policies and future hydromodification and storm water quality regulations. The increased maintenance requirements for the regional basins would be minimized by locating them in future park locations.

In the future, the City may have the opportunity to reduce the number of detention basins by utilizing direct discharge to the creek system. In order to do so, a detailed study would be required to quantify the impact of increased urban runoff on the downstream creek capacity if a detention basin is not installed. The study should also address future regulatory considerations (e.g., hydromodification) and the water quality impact to the stream associated with direct discharges.

Table A Summary of Alternatives Comparison

	Improves Storm Water Quality	Ability to Control Discharge to Channels	Provides Ability to Comply with Future Hydro Modification Requirements	Protects Against Channel Erosion	Provides Recreation/Park	Reduces Outfall Maintenance	Reduction in Pipe Sizes	Eliminates future Basin Maintenance and Operation	Aesthetically Pleasing
Alternative 1 Direct Discharge								X	X
Alternative 2 Storm Water Detention	X	X	X	X	X	X			X
Alternative 3 Privately Maintained Detention			X	X		X	X	X	