CITY OF RIVERBANK
STORM DRAIN SYSTEM
MASTER PLAN

VOLUME ONE

JUNE 2008

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BEYOND ENGINEERING

CITY OF RIVERBANK

STORM DRAIN SYSTEM MASTER PLAN

Volume One

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Submitted to:

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LIST OF ABBREVIATIONS

The following abbreviations are used in this report:

ac	acre(s)
ac-ft	acre-feet
BMP	best management practice
cfs	cubic feet per second
CIP	capital improvement program
d/D	ratio of depth of flow within pipe to pipe diameter
du	dwelling unit
FAR	floor area ratio
ft	feet
ft/sec	feet per second
GIS	geographical information system
gpd/acre	gallons per day per acre
I/I	infiltration and inflow
lf	linear feet/foot
MID	Modesto Irrigation District
MS4	Municipal Separate Storm Sewer System
NPDES	National Pollution Discharge Elimination System
OD	outside diameter
OID	Oakdale Irrigation District
PVC	polyvinylchloride
RCP	reinforced concrete pipe
RBAAP	Riverbank Army Ammunition Plant
SCADA	supervisory control and data acquisition
sf	square feet
SR	state route

1 Introduction

In support of a new General Plan, a storm drain system master plan is required. This Storm Drain Master Plan (Master Plan) will serve as a basis for storm drain infrastructure and as an aide to assessing the impact of new and future development. An existing storm drain system model was prepared to assess the capacity of specific existing storm drain elements and to identify and size required system improvements. These tools will allow the City of Riverbank (City) to plan, coordinate, and phase required system upgrades with multiple developments. Background information and intended master planning tasks are presented in this chapter.

1.1 Background and Purpose

In 2008, the City will adopt the General Plan Policy Document (General Plan) [1], which identifies areas to be developed within the City to the year 2025. The General Plan will extend the areas to be served by the City storm drain system in comparison to those areas identified in the previous draft Storm Drainage Study and Master Plan (2002 Draft Master Plan), dated February 2002 [2].

The City is experiencing an increasing population which is currently about 22,000 people (March 2007). The existing City limits encompass approximately 2,400 acres (ac), with the City sphere of influence incorporating an additional 1,200 ac. The existing storm drain system currently conveys storm runoff to various points of discharge along the Stanislaus River and the Modesto Irrigation District (MID) canal.

The primary objective of the Master Plan is to ensure that the City storm drain system can adequately meet the development goals adopted in the General Plan. In particular, the Master Plan will address the following:

1. Conceptual conveyance systems to accommodate General Plan expanded service areas.

2. Identify upgrades to existing components of the storm drainage system.

3. Phased capital improvement program (CIP) that provides appropriate infrastructure to support growth while remedying existing system deficiencies.

1.2 Scope of Master Plan

The following tasks were completed as part of the Master Plan:

1. Update existing storm drain system information and prepare a storm sewer system map.

2. Catalog existing collection system deficiencies based on interviews with City staff and a review of records data.

3. Conduct topographic surveys to analyze problem areas.

4. Model the existing drainage system to identify system deficiencies.

5. Recommend improvements within the drainage system to correct operational deficiencies.

6. Recommend improvements related to National Pollution Discharge Elimination System (NPDES) compliance and water quality.

7. Develop a CIP which identifies specific storm drainage and water quality infrastructure to support the new General Plan.

Each of these tasks is summarized in the following chapters.

2 Summary of Previous Storm Drain Master Plan

The Master Plan was developed based partly on information provided in a previous storm drain master plan and prior studies accomplished in select areas of the City. The latest storm drain master plan (2002 Draft Master Plan) is summarized in this chapter.

2.1 2002 Storm Drainage Study and Master Plan

Prior to the 2002 Draft Master Plan, no overall master plan existed. The City addressed upgrading and expanding any existing infrastructure on an as-needed basis. For reference, the 2001 Sewer System Master Plan addressed the wastewater collection and treatment needs to serve approximately 30,000 people. The service area evaluated by the 2001 Sewer System Master Plan is presented in Figure 2-1. The study area for the 2002 Draft Master Plan generally coincided with that area; however, the 2002 Draft Master Plan included general guidelines for developing storm drainage systems for a potential population of approximately 50,000 persons. The information collected for the 2002 Draft Master Plan was used to estimate the size of "downstream" lines and major lift stations that could ultimately serve a population beyond 30,000. In addition, the 2002 Draft Master Plan outlined a general concept and possible system improvements for routing storm runoff from existing City rights-of-way through master storm water detention basins.

2.2 Summary of Proposed Improvements

The 2002 Draft Master Plan proposed improvements were categorized as either: 1) existing system upgrading or 2) system expansion. The following summarizes the recommendations.

a. <u>Existing System Upgrading</u>

Several issues were identified within the existing City limits:

1. Eliminate storm drainage cross connections to the sanitary sewer system. This would affect approximately 70 ac.

    a. Parsley Street between Jackson Avenue and Callender Avenue

    b. Patterson Road at Callender Avenue

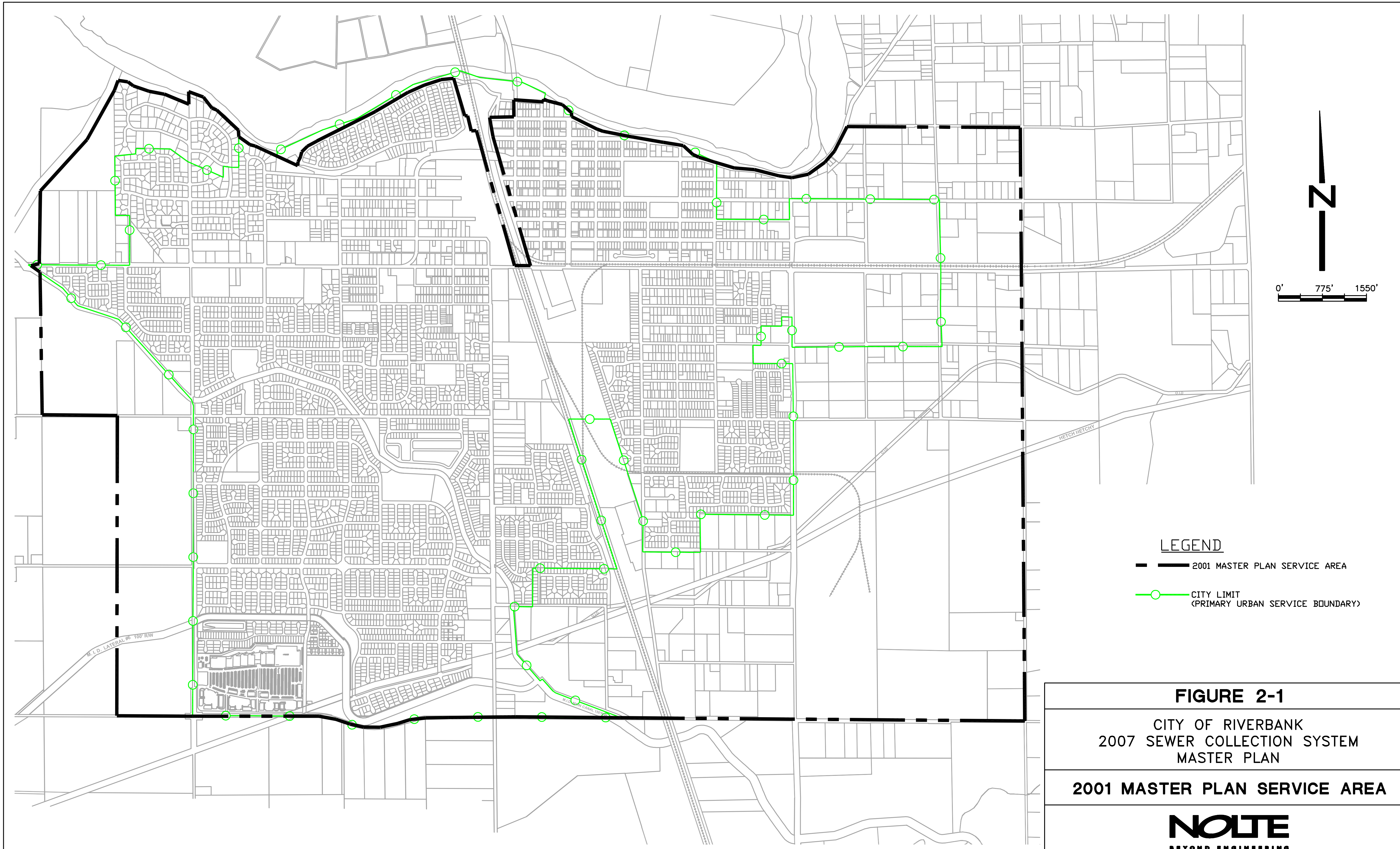

FIGURE 2-1

CITY OF RIVERBANK
2007 SEWER COLLECTION SYSTEM
MASTER PLAN

2001 MASTER PLAN SERVICE AREA

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c. Topeka Street and Santa Fe Street east of Callender Avenue

d. Sierra Street at Palmer Avenue (only north side of Sierra Street has interconnections)

e. Santa Fe Street between Third and Fourth Streets

f. High Street between City Corporation Yard and First Street

2. Cross connections with the sanitary sewer also need to be eliminated at the tomato cannery. Facilities should be installed to contain and dispose of all on-site runoff from the cannery property.

3. A CIP is needed to mitigate the potential flooding at the following streets and intersections:

c. Patterson Road between Roselle Avenue and First Street

d. Patterson Road at Palmer Avenue

e. Patterson Road between Terminal Avenue and Eighth Street

f. Claus Road at Santa Fe Street

g. Kentucky Avenue between Terminal Avenue and Eighth Street

h. Van Dusen Road at Terminal Avenue (to be mitigated by future development)

i. Roselle Avenue, north of Talbot Avenue

j. Patterson Road west of Terminal Avenue – The storm drain should be upsized from this location to the outfall on Seventh Street to prevent flooding and also provide additional capacity for the First Street Basin force main which connects at Fifth Street and Stanislaus Street.

b. <u>System Expansion</u>

Based on the anticipated growth of the City, several areas were identified for expansion projects. The general improvements mentioned are as follows:

1. Construct new drainage lines in:
    a. Santa Fe Street between Eighth Street and Claus Road
    b. Patterson Road between Eighth Street and Claus Road
    c. Van Dusen Avenue
2. Per City Standard Specifications, construct two new storm drainage detention facilities, to detain approximately 19 acre-feet (ac-ft) of storm runoff each, in the East Riverbank area.
3. Construct new pumping stations with the capacity to pump detained storm water in a 40-48 hour period.
4. Evaluate capacity of Castleberg Park and upgrade, if necessary.
5. Begin discussions with Oakdale Irrigation District (OID) and MID in developing additional storm runoff disposal points.
6. Upgrade supervisory control and data acquisition (SCADA) system.

2.3 Completed Projects from 2002 Master Plan

The following improvements proposed in the 2002 Draft Master Plan have been completed by the City:

1. Eliminate Storm Drainage cross connections to the Sanitary Sewer System
    a. Patterson Road at Callender Avenue (City disconnected storm drain and installed a dry well)
    b. Santa Fe Street between Third and Fourth Streets
2. Potential flooding area
    a. In Patterson Road at Palmer Avenue, a catch basin has been installed at mid-block to convey the storm water east on Patterson Road
    b. In Patterson Road between Terminal Avenue and Eighth Street, a catch basin has been installed at mid-block on north and south sides of Patterson Road

2.4 Oakdale Irrigation District Drainage

The OID service area is adjacent to and up gradient of East Riverbank. OID maintains irrigation and drainage facilities that pass through the City. A significant portion of the eastside planning area is within the OID service area.

The 2002 Draft Master Plan identified OID facilities and associated issues from excess runoff from OID. The 2002 Draft Master Plan also indicated that the existing drainage systems were not large enough to pass upstream storm runoff during higher intensity or longer duration storms and that flooding occurs at various locations. Four areas were identified as follows: The vicinity of Central Avenue and California Avenue (which is near the Riverbank Drain), the area east of Rosebrook Drive, (which is near the Snedigar Drain), along Claribel Road between Claus Road and Terminal Avenue, and the vicinity of Claribel Road and Litt Road.

The City and OID are discussing the drainage conditions on the eastside and strategies to resolve historical drainage issues. Included in Appendix A is a technical memorandum dated February 2, 2006 summarizing a City and OID meeting to 1) discuss drainage issues; 2) develop solutions, and; 3) identify needed studies. This memorandum also noted the idea of intercepting irrigation drainage for diversion to the OID Riverbank Lateral. City consulting engineer Bill Kull was tasked with determining the feasibility of this idea and produced a study on July 18, 2006. The idea of intercepting and redirecting irrigation drainage was proposed to eliminate the use of the Crane Drain, Riverbank Drain, and the Snedigar Pipeline within the City, and to establish a dialogue between OID and Riverbank regarding the potential use of OID facilities for storm drainage management by the City.

The East Riverbank Drainage Feasibility Study by Giuliani & Kull Inc. dated July 18, 2006 [3] is included in Appendix B.

OID has indicated they are interested in transferring the Crane Pipeline, Snedigar Pipeline, and the Snedigar Pond and pump station to the City if they can be utilized for storm drainage purposes.

3 Existing Conditions

As an initial step in developing the Master Plan, information regarding the existing storm drain system was compiled. This chapter reviews the characteristics of the existing system and problematic areas.

3.1 Characteristics of the Existing Storm Drainage System

The City storm drain system consists of 12-inch to 54-inch diameter collection piping, four storm drainage park/detention basins, six storm water pump stations, seven gravity storm water outfalls to the Stanislaus River, and one outfall to a MID Canal. Typically, storm water is collected into detention basins and then pumped out within 24-48 hours following the storm. A map of the existing collection system is provided as Plate 3-A.

Storm drainage from industrial areas within the City was typically disposed of on-site with the exception of the closed cannery which may have drained into the sanitary sewer. Storm drainage from the newer commercial/industrial areas is either detained on site or released to the City system after the peak discharge has passed or is disposed of on site.

3.2 Problematic Areas

Storm drainage from specific problem areas is reportedly connected into the sanitary sewer collection system. It appears that there is still approximately 60 ac of development draining into the sanitary sewer system.

Existing areas of potential flooding and areas of suspected storm water inflow into the sanitary sewer system were identified in the 2002 Draft Master Plan. As listed in Chapter 2, the City has corrected some of these problem areas. Table 3-1 summarizes the remaining areas (see Figure 3-1).

TABLE 3-1
CITY OF RIVERBANK
STORM DRAIN SYSTEM MASTER PLAN
POTENTIAL FLOODING LOCATIONS AND INTERCONNECTIONS
FROM 2002 DRAFT MASTER PLAN [2]

Street / Area	Description
Parsley Street between Jackson and Callender	Sanitary sewer cross connection
Topeka and Santa Fe east of Callender	Sanitary sewer cross connection
Sierra Street at Palmer	Sanitary sewer cross connection
Patterson Road between Roselle Avenue and First Street	Under-sized 12-inch line
High Street between City Corporation Yard and First Street	Sanitary sewer cross connection
Kentucky Avenue between Terminal Avenue and Eighth Street	Storm drain line leakage
Van Dusen Road at Terminal Avenue	Inadequate inlets
Roselle Avenue immediately north of Talbot Avenue	Inadequate inlets
Claus Road at Santa Fe Street	Only drywell drainage
California Avenue at Central Avenue	Inadequate drainage system (future development)
South of Pocket Avenue between Roselle Avenue and the BNSF Railroad	Offsite runoff
Claribel Road between Terminal Avenue and Claus Road	Non-existent drainage system (future development)
Claribel Road in the vicinity of Litt Road	Non-existent drainage system (future development)
Patterson Road west of Terminal Avenue	Area prone to flooding due to insufficient sized storm drain to the Seventh Street outfall

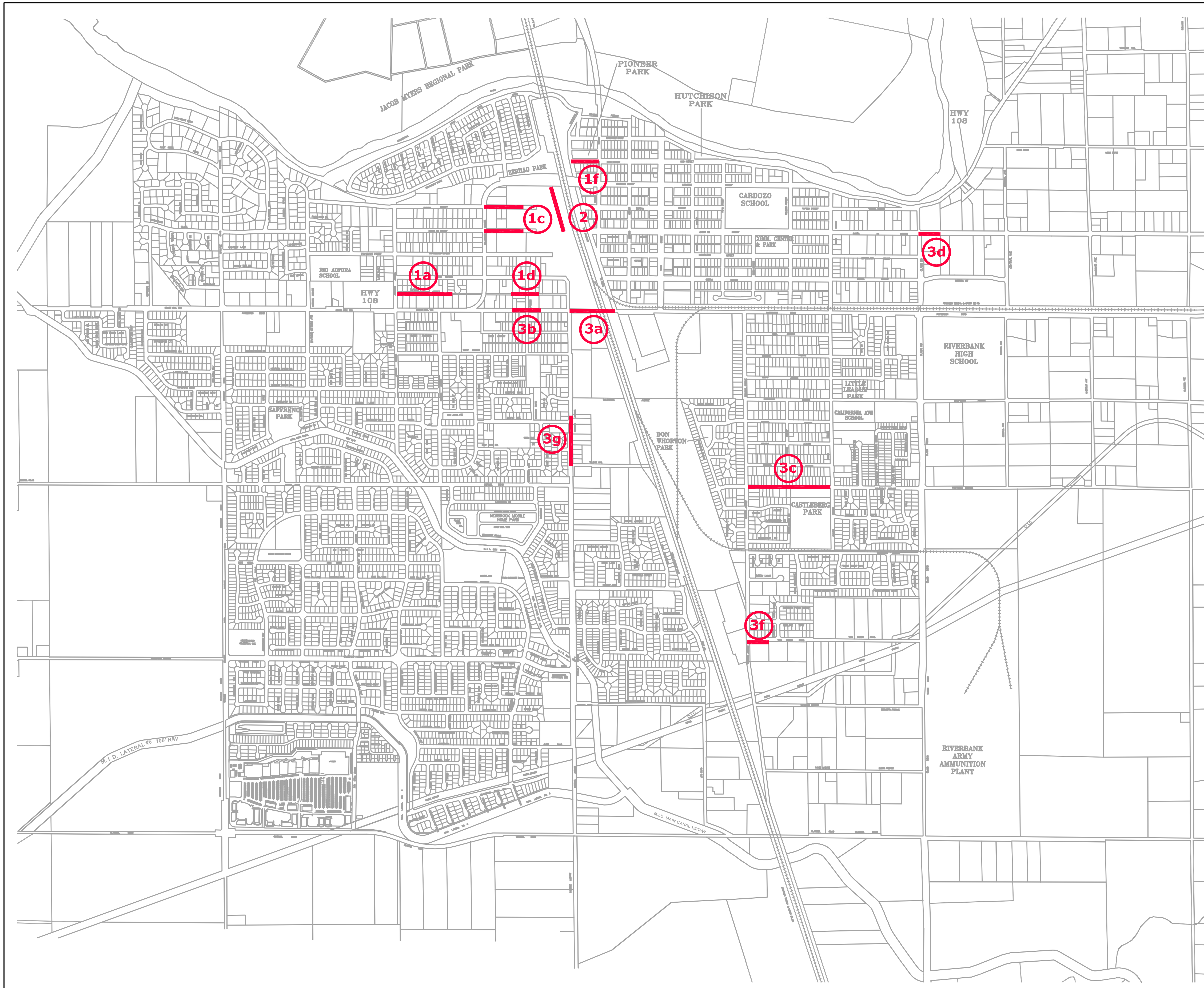

FIGURE 3-1

CITY OF RIVERBANK
2007 STORM DRAIN SYSTEM
MASTER PLAN

2002 DRAFT MASTER PLAN
PROPOSED IMPROVEMENTS

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4 Background Information - Design Criteria

Design criteria for the Master Plan is based on the technical memorandum, *Summary of Proposed Design Criteria* (June 2007) [4]. This technical memorandum includes a discussion of the study area boundaries, land use, storm drain standards, and storm water quality criteria. With the exception of storm water quality, each is discussed in this chapter.

4.1 Study Area

The study area for the Master Plan is based on the secondary urban service boundary, the total planning area presented in the General Plan land use diagram. For master planning purposes, the study area extends beyond the current City limits and primary urban service boundary. The limits of the study area used in the Master Plan are shown in Figure 4-1.

4.2 Land Use Assumptions

Existing and future land uses within City limits are divided into seven categories:

1. Medium Density Residential (MDR)
2. Low Density Residential (LDR)
3. Commercial (C)
4. Industrial (I)
5. School (SC)
6. Park (P)
7. Open Space (OS)

Assumptions pertaining to roadways and densities for residential areas are presented in Table 4-1.

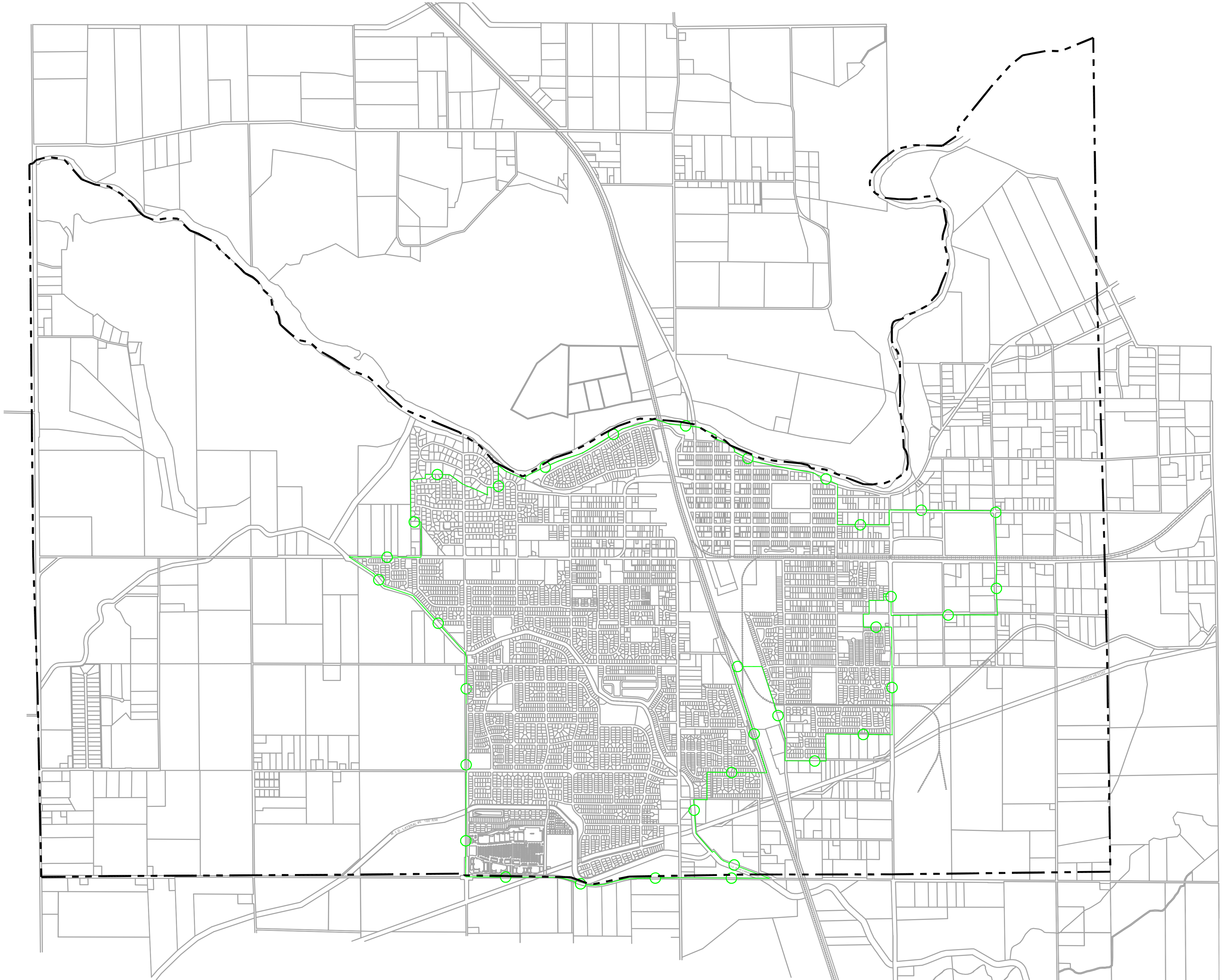

FIGURE 4-1

CITY OF RIVERBANK
2007 STORM DRAIN SYSTEM
MASTER PLAN

2007 MASTER PLAN STUDY AREA

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TABLE 4-1
CITY OF RIVERBANK
STORM DRAIN SYSTEM MASTER PLAN
ASSUMPTIONS FOR LAND USE AREAS WITHIN CITY LIMITS

Land Use	Roads (%)	Density (du/ac)
Medium Density Residential	30	5.5-6.5
Infill Development [a]	30	6.0
Low Density Residential (lot size ≤ 1 ac)	-	1.5-2.3
Low Density Residential (lot size >1 ac)	-	-
Commercial	30	-
Industrial	30	-
School	-	-
Park	-	-
Open Space (Future Parks)	-	-

[a] All Infill areas within City limits are assumed Medium Density Residential.

As noted earlier, an updated General Plan will be approved by the City. The updated General Plan presents planned land usage for areas currently outside of the City limits. These land uses are divided into twelve categories:

1. Agricultural Resource Conservation Area (ARCA)
2. Buffer Greenway Open Space (BGOS)
3. Clustered Rural Residential (CRR)
4. High Density Residential (HDR)
5. Industrial-Business Park (IBP)
6. Infill Opportunity Area (IOA)
7. Low Density Residential (LDR)
8. Medium Density Residential (MDR)
9. Mixed Use Office Retail Residential (MUORR)
10. Multi Use Recreation (MUR)
11. Park (P)
12. School-Civic (SC)

Assumptions for percentage of roadways for each land use category, densities, and household sizes were obtained from the General Plan consultants (EDAW). The assumptions for General Plan areas are presented in Table 4-2. The runoff coefficient for each General Plan land use is also presented. This coefficient has been calculated based on the criteria presented subsequently in the Hydrology and Design Storm Criteria section.

TABLE 4-2
CITY OF RIVERBANK
STORM DRAIN SYSTEM MASTER PLAN
GENERAL PLAN LAND USE ASSUMPTIONS

Type of Land Use	Major/ Minor Roads (%)	Density (du/ac)	FAR[a]	Non-Residential Development Per Acre (SF)	Runoff Coefficient[b]
Agricultural Resource Conservation Area	-	-	-	-	0.20
Buffer Greenway Open Space	-	-	-	-	0.20
Clustered Rural Residential	-	0.2	-	-	0.30
High Density Residential	30	18.0	-	-	0.85
Industrial-Business Park	30	-	0.25	-	0.90
Infill Opportunity Area-Downtown	-	0.9	0.51	997	0.70
Infill Opportunity Area-West Riverbank	-	1.6	0.26	217	0.85
Low Density Residential	30	5.0	-	-	0.70
Medium Density Residential	30	10.0	-	-	0.55
Mixed Use Office Retail Residential[c,d]	30	18.0	0.25	-	0.90
Multi Use Recreation	-	-	-	-	0.35
Park	-	-	-	-	0.20
School-Civic	-	-	-	-	0.55

[a] Floor area ratio.
[b] See Hydrology and Design Storm section
[c] 80% Non-Residential, 20% Residential
[d] MUORR5 & MUORR9 100% Non-Residential

4.3 Storm Drain System Standards

The existing City and Stanislaus County (County) storm drainage standards dictate the design of the storm drainage systems within the City [5, 6]. These are discussed below.

a. Hydrology and Design Storm Criteria

The new City design standards for storm drains to be adopted in 2008 utilize a 10-year storm event for conveyance facilities. The return interval for storm drain basins is a 100-year, 24-hour event.

A return frequency of ten years is recommended for storm drain systems. This level is consistent with current engineering practice throughout the state. Typically, piped storm drain systems are designed to collect and convey the 10-year storm event to an outfall location, such as a detention basin, authorized irrigation canal, or a natural waterway. In addition, each site should have an overland release path defined so that flow in excess of the design event can leave the area without causing damage to buildings.

Drainage Areas. Drainage areas are defined based on the interpretation of the existing topographic information data. The best available topographic information should be used in performing any hydraulic analysis. Typically, data accurate enough for design purposes is excellent hydraulic analysis. For drainage areas outside the project limits, contributing flow must be defined by the best available data. Ground or aerial surveys may be necessary to develop an accurate analysis. For this Master Plan, the data utilized includes USGS data from the Riverbank, CA Quadrangle dated 1987; limited field data for specified areas; and limited 2-foot contour data from Figure 6, Service Area Topography of the Sewer System Master Plan, November 2001 [7]. The drainage areas contributing to each of the modeled systems were delineated based on piped storm drainage systems and the topography draining to those systems. Chapter 6 further describes the modeled systems.

Runoff Coefficient. The runoff coefficient is a factor used to assess the amount of rainfall that leaves (runs off) of an area after it has fallen on the area. The steepness of the area, the amount of surface ponding that may occur, vegetative cover, and the ability of the surface to absorb water affect this factor. While the runoff coefficient is used as a constant in the calculation, this value will vary throughout the year, reflecting the ability of the soil to absorb moisture and the state of the vegetative cover that exists. The maximum runoff occurs when the soil has become saturated and is no longer capable of absorbing water. The City design standards for runoff coefficients are presented in Table 4-3.

TABLE 4-3
CITY OF RIVERBANK
STORM DRAIN SYSTEM MASTER PLAN
RUNOFF COEFFICIENTS – DESIGN STANDARD [5]

Type of Area	Runoff Coefficient
Standard Composite Runoff Coefficients:	
Park	0.20
Low Density Residential (greater than 2 and less than 6 du/ac)	0.55
Medium Density Residential (“cluster” housing, condominium, town homes)	0.70
High Density Residential (Apartments)	0.85
Commercial	0.90
Industrial	0.90
Basic Runoff Coefficients	
Pavements and Roofs	0.95
Compacted Earth Without Pavement	0.70
Lawn, Pasture, Crops, Open Space	0.20

The runoff coefficients used for existing areas in the existing system models are presented in Chapter 6.

Time of Concentration. The time of concentration for the rainfall is the time for the rainfall to flow across the area and through the gutters or pipes to the lowest point in the area for which the flow is being calculated. The initial time of concentration, also called the roof to gutter time, represents an approximation of time for a drop of water to land on a surface and make its way to the gutter in the street. The City design standards are presented in Table 4-4.

TABLE 4-4
CITY OF RIVERBANK
STORM DRAIN SYSTEM MASTER PLAN
TIME OF CONCENTRATION – DESIGN STANDARD [5]

Parameter	Criteria
Roof to Gutter	
Low Density Residential	20 minutes
Medium and High Density Residential	10 minutes
Gutter Flow Time	2.5 ft/sec high point to inlet
Pipe Flow Time	Calculated based on actual or design conditions

The time of concentrations used in the existing system models are discussed in Chapter 6.

Rainfall Intensity. Intensity of the rainfall is calculated based on the Rainfall Intensity Duration Frequency Curve presented in City Standard Detail 301. The values for these parameters are derived from average annual rainfall. The average rainfall in the City varies from approximately 11.5 to 13.5 inches per year (based on Stanislaus County Mean Annual Precipitation Map, Plate 4-B). The Tc used for the rainfall intensity calculation should be based on the Time of Concentration discussion in the City Standards.

b. Pipeline Design

Pipeline design and calculations will follow the City standards which are briefly summarized in this paragraph. The City standards allow the use of reinforced concrete pipe (RCP) and polyvinylchloride (PVC) pipe with a minimum diameter of 12 inches. The piped system is to be designed to carry the 10-year storm event with a minimum velocity of 2.0 ft/sec.

c. Percolation of Storm Water

Percolation of storm water can be a significant source of discharge of storm water, a supplemental discharge method, part of a water quality treatment system, or simply an active part of a composite of the above possibilities. The City prefers that percolation not be the only method of storm water disposal. However, the City does encourage including percolation of storm water to maintain the stability of the underlying groundwater aquifers. The City standards include detailed criteria for design of percolation facilities.

d. Storm Water Basin Criteria

Several options for storm water basins exist. Two different types of basins exist: detention basins and retention basins. Each type of basin typically has its own design criteria.

Detention Basins. This type of basin receives surface runoff and then releases the flow through a controlled outlet, such as an orifice or a pump station, at a lower flow rate. Typically, a detention basin reduces the peak flow and extends the duration of the runoff at a lower flow rate. Historically, the major purpose for detention basins is to minimize or reduce the hydraulic overloading of downstream facilities. Detention basins are now being used and recommended for water quality and hydromodification management purposes. Detention basins can move flow in the hydrograph to prevent channel erosion in unlined channels and can be configured to remove sediment and other pollutants from surface runoff.

Retention Basins. This type of basin typically receives surface runoff and holds water. The runoff is prevented from entering typical drainage features like creeks, rivers, or channels. The accumulated water leaves the basin by infiltration or evaporation.

Existing Design Criteria. The latest City design criteria for drainage basins do not distinguish between detention and retention, but rather by dual-use or non-dual use. Detention and retention basins are both to be designed to contain the same volume – the runoff from the 100-year, 24-hour storm event. The calculation for this volume is derived from the County standards for retention facilities. The following calculation is utilized within the City:

V = CAR / 12, where:
V = Design volume (ac-ft)
C = Runoff coefficient of the contributing area
A = Tributary area (ac)
R = Rainfall depth for the design storm (inches)
For the 100-year, 24-hour event, R = 3.4 inches

The latest design criteria also state that each basin "shall be considered unique, with the layout and design evaluated on a case-by-case basis – subject to minimum requirements…" These minimum criteria are as follows:

1. Maximum water surface elevation: 6 inches (minimum) below the lowest upstream inlet

2. Freeboard: 2 ft

3. Volume: per above, assuming no outlet, percolation or evaporation; however, underground pipes may be considered in volume calculation

4. If Non-Dual Use:

    a. 2H:1V maximum side slopes
    b. 4 inch minimum lining of gunnite or shotcrete
    c. 1% basin bottom slope to outlet or percolation facility
    d. Maximum basin depth of 10 ft (therefore, maximum water depth of 8 ft)

5. If Dual Use:

    a. 5H:1V maximum side slopes
    b. Provide landscaping
    c. 2% basin bottom slope to outlet or percolation facility

d. Maximum depth of 6 ft (lowest adjacent top of curb to lowest point in basin, therefore maximum water depth of 4 ft)

All basins, whether detention or retention, must be empty within 48 hours. The definition of "empty" includes only the basin surface; it does not include the underground facilities, such as pipes or horizontal rock drains.

The standards address the percolation facilities for retention basins via the use of horizontal rock wells. Design criteria such as pipe material, drain rock type, horizontal well layout, and percolation criteria are addressed in the standards. Horizontal drains within basins shall be capable of draining the 10-year, 24-hour storm within 72 hours, provided that the basin is empty within the 48-hour period.

5 Storm Water Quality

Storm water quality is an increasingly important aspect of storm water management. This is an area with significant emerging and changing regulations. The guidance in this chapter is based on the technical memorandum *Storm Water Quality* (August 2007) [8]. This chapter relates to permanent storm water treatment best management practices (BMPs) and is based on the regulations in place as of Spring 2007.

5.1 Regulations

Storm water quality management is specifically addressed by the Storm Water Management Plan for the Cities of Ceres, Oakdale, Patterson and Riverbank dated March 2003 with an addendum dated October 2003 (Management Plan) [10]. The Management Plan was prepared as required by State Water Resources Control Board Water Quality Order No. 2003-0005-DWQ, NPDES General Permit No. CAS000004. The permit defines requirements for small Municipal Separate Storm Sewer System (MS4) communities and additional requirements in Attachment 4 of the permit that are applicable to areas with high growth or high growth potential. The City has chosen to be a co-permittee with the other cities that share the Management Plan.

This permit designates the City as the operator of a MS4. This designation automatically applies to any urbanized area under the General Permit.

The permit defines an area with High Growth Potential as follows:

> *If an area anticipates a growth rate of more that 25% over a ten year period ending prior to the end of the first permit term, it has high growth potential.*

The City is currently approaching or passing the growth threshold and therefore the design standards in Attachment 4 of the permit would be applicable. (See Appendix C for the full text of the design standards from the NPDES permit.)

These standards apply to the following categories of development:

1. 100,000 sf commercial development
2. Automotive repair shops
3. Retail gasoline outlets
4. Restaurants
5. Home subdivisions with 10 or more housing units

6. Parking lots 5,000 square feet (sf) or more with 25 or more parking places and potentially exposed to storm water runoff

The standards define:

1. Design standards applicable to all categories
2. Provisions applicable to individual priority project categories
3. Waivers
4. Limitations on use of infiltration best management practices
5. Alternative certification for storm water treatment mitigation
6. Conflicts with local practices

The City has currently implemented the standards applicable to small MS4 communities through City Ordinance 2006-002 which is added to Title 5 Public Works - Chapter 52 Stormwater Management and Discharge Control. This ordinance may be revised to incorporate the additional standards associated with potential high growth.

The following presents a methodology for managing storm water required for an area with high growth potential.

5.2 Implementation Concept

The implementation of storm water quality improvements incorporates two features: 1) those items which are integrated into the required project features such as site layout, material choices, and good site housekeeping items; and 2) treatment facilities, such as biofiltration swales and underground vortex separator units.

Storm water quality is more than just added life cycle cost related to designing and maintaining landscaped or structural permanent best management practices. Storm water quality management is:

1. Started at the source
2. Low impact
3. An improvement to the community
4. A benefit to downstream habitats
5. Sustainable

a. <u>Start at the Source</u>

Start at the source is a concept that incorporates site design and maintenance features that provide storm water quality benefits inherent to their use and implementation. These features provide a water quality benefit through the reduction of impervious surface, enhanced infiltration, reduced runoff, reduced or eliminated non-storm water pollution, and reduced use of substances that can negatively impact water quality. When the impervious surface is reduced and more infiltration is allowed, the flow is reduced. Increasing pervious areas allows infiltration and replenishes groundwater.

Some examples of start at the source features include:

1. A higher ratio of pervious surfaces
2. Utilizing non-traditional materials, such as pervious pavement
3. Clustering development to reduce required capacity of storm water treatment facilities
4. Directing roof runoff to pervious areas or rain gardens
5. Providing positive containment for waste materials
6. Directing (post-construction) wash water to the sanitary sewer

Storm water control measures cited in the regulations also address the quantity of water a site contributes to the downstream storm drain system. Within the City, the downstream system mainly consists of the City storm drain infrastructure and other facilities, such as channels and rivers. A site will not contribute more runoff to the downstream system than it does in its current condition. Ideally, a site would contribute less runoff than its current condition; however, this is not necessary under current regulations.

The regulations capping the amount of runoff at the existing condition has other benefits to the City. First, as new developments are constructed, the storm drain infrastructure in place, which currently operates satisfactorily, should continue to operate satisfactorily with regular maintenance. This means additional piping, upsizing, or new facilities to accommodate higher runoff will not be required. This reduces the cost of replacement for infrastructure in the normal life cycle cost. Second, the impacts to downstream facilities, such as the Stanislaus River, would be minimized.

b. Permanent Best Management Practices

When one references storm water quality in new development as defined by the regulations, permanent BMPs are expected to be incorporated. These BMPs can be natural, as in the case of biofiltration swales or constructed wetlands, or structural, as in the case of vortex separators and media filtration units. The BMPs used at a site depend upon the pollutants of concern to be removed and the general site constraints, such as topography or contributing drainage area.

Appendix D contains a listing of various permanent storm water treatment BMPs along with descriptions, design criteria, environmental considerations (such as groundwater levels), and maintenance requirements [9]. Unfortunately, some of the BMPs available and listed are relatively new systems. The performance and appropriateness of all the systems are still being analyzed and reviewed by the regulatory agencies. Therefore, the listed BMPs that are acceptable to the regulatory agencies may change with additions and deletions at any time.

5.3 Development Issues

Storm water quality requirements affect two main types of development within the City: 1) new development and 2) infill development. New developments typically incorporate storm water quality measures through good site planning. These sites are often large enough to incorporate appropriate measures. Infill developments are often smaller and the incorporation of storm water quality control measures may be constrained by the existing site. While the ideal position is that storm water quality control should start at the source and be part of the site improvements for each site, this may not always be feasible with infill development.

a. New Development

Typically, new development begins with undeveloped or completely cleared land, allowing storm water quality elements to be planned during the design process. These elements can then be incorporated into the development.

As discussed in the previous section, the new development design plan related to storm water quality should follow the regulations set forth in the City NPDES permit. These regulations can also be implemented by incorporating sustainable elements into the project to help reduce impervious area and to utilize a “Start at the Source” mentality. Examples of methods of incorporating sustainable design include providing pervious pavement, clustering development, and providing open space.

For new developments, the City should determine which types of BMPs fit into the desired outcome and could be placed on a preferred list. While there are many options available, limiting factors include available open space, whether runoff is piped or at-grade, and overall topography. Based upon the topography of the City, the City’s goals of replenishing the groundwater supplies, and reducing pollutants of concern for downstream water bodies, suggested types of BMPs are presented in Table 5-1. Appendix D provides a general description, the design criteria, and maintenance requirements of these BMPs.

TABLE 5-1
CITY OF RIVERBANK
STORM DRAIN SYSTEM MASTER PLAN
SUGGESTED BMPS

At Grade BMP Options	Underground BMP Options
Biofiltration Swale (a.k.a. grassy swale)	Vortex Separator Unit (ex: CDS Unit)
Biofiltration Strip	Media Filtration Unit
Detention Basin	
Rain Garden	
Bioretention	
Retention Basin	

Regardless of who performs maintenance on the BMPs, the City may want to consider creating a method of tracking the types and schedule of maintenance for the BMPs within the City. This will help the City ensure that the BMPs are effective for their useful lives as well as provide documentation for compliance with NPDES requirements.

b. Infill Development

Infill development refers to areas surrounded by existing developed properties, typically medium density or high density development. The City has areas such as this within the downtown area, the cannery, and property adjacent to the railroad tracks.

Permanent BMPs or flow reduction for an infill development should be based upon the development size and opportunities available at each site. The size and location of the site should be considered. For example, the cannery site may be large enough and configured to accommodate start at the source measures and permanent BMPs on site. Topography is often another opportunity. The City is relatively flat, which is a favorable condition for many of the "at grade" permanent BMPs.

5.4 Regional Storm Water Treatment

Regional storm water treatment is a concept that allows the runoff from multiple sites to be treated using one facility. Treatment facilities with adequate capacity are designed and used to treat storm water flow from the increased or redeveloped impervious surfaces of individual projects. These regional treatment facilities are intended to provide for the needs of small infill projects or for the needs of larger projects that have storm water flows that exceed the capabilities of on-site systems. The treatment of equivalent storm water runoff would occur within the same watershed. A methodology for banking and trading of treatment needs is proposed.

a. Banking and Trading of Treatment Needs

The areas that will be used for storm water treatment mitigation for the developments are areas of varying runoff coefficients. Direct trade of acreage is not an equivalent trade of storm water runoff when runoff coefficients are unequal. Therefore, to have a direct trade of treatment, trade of equivalent flows is required.

b. Opportunities

The first objective in utilizing regional storm water treatment is to determine opportunities for this type of treatment.

The City runoff flows mainly to the Stanislaus River via piped systems. Ideally, runoff would be treated by a biofiltration swale or detention basin prior to discharging into a piped system. However, these options would require runoff to remain above grade and out of the street to achieve treatment. The use of a pump station to place runoff into a treatment facility would be cost prohibitive and maintenance intensive. Therefore, these types of options would be better suited to newer developments, where open space and vegetated areas can be designed to accommodate this type of BMP.

Runoff can also be treated by underground options, which is better suited for the existing piped systems within the City. One option is a vortex separator, of which a CDS Unit is one product. These units can be in-line, where all runoff flows through the unit, or off-line, where a weir directs runoff through a flume to the unit. These units typically remove large solids, trash, and sediment through a vortex swirl action. Sorbent material can also be added to the unit to remove oil and grease. Material is removed from the unit via a vacuum truck. These units can treat 25 cubic feet per second (cfs) or more, which for a commercial area (runoff coefficient of 0.85) is the equivalent of approximately 150 ac. The main drawback agencies have with this unit is that the unit typically removes only particles. Other pollutants, such as heavy metals, are not specifically targeted. Often, these pollutants are better removed by landscaped options which allow infiltration and adsorption by the soil.

6 Hydraulic Analysis of Existing Storm Drain System

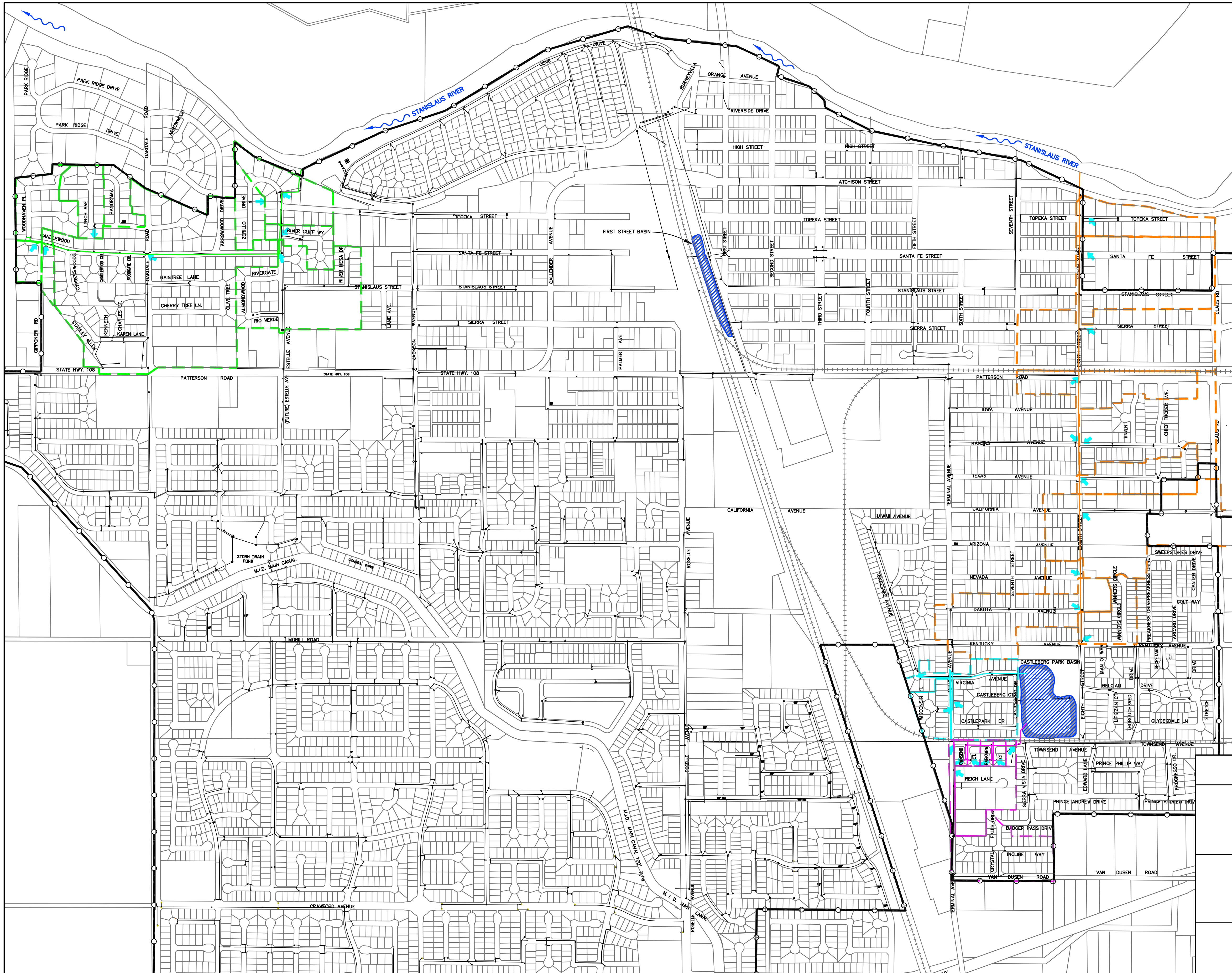
Certain deficiencies in the existing storm drain system were identified by City maintenance staff as part of a field review of existing conditions. A computer model of the major systems was created to further evaluate the hydraulic performance of certain problematic areas. Specifically, there are four pipe systems with problems the City either has identified or that the City anticipates being impacted in the near future. These areas are: 1) Townsend Road, 2) the Virginia Avenue/Terminal Avenue area, 3) Eighth Street from the Castleberg Basin pump discharge to the Stanislaus River outfall, and 4) Candlewood Drive to the Stanislaus River outfall. The City also requested that two of the existing storm drain basins be modeled: Castleberg Basin and the First Street Basin. This chapter will describe the methodology used to create the computer model and the results of the hydraulic evaluations. The systems modeled and their contributing drainage areas are presented in Figure 6-1. Recommendations for corrective actions are addressed in Chapter 7.

6.1 Model Methodology

Two types of software were used to model the performance of the drainage systems identified previously. Haestad Methods StormCAD was utilized for calculations related to piped systems (see Appendix E) and Haestad Methods PondPack (see Appendix F) was used to calculate the performance of the drainage basins. Both programs perform calculations using the Rational Method and Modified Rational Method.

a. <u>Drainage Areas</u>

Drainage areas are defined based on an interpretation of the existing topographic information data. For the Master Plan, the data utilized includes USGS data from the Riverbank, CA Quadrangle dated 1987; limited field data for specified areas; and limited 2-foot contour data from Figure 6, Service Area Topography of the Sewer System Master Plan, November 2001 [7]. The drainage areas contributing to each of the modeled systems were delineated based on the piped storm drainage system and the topography draining to those systems. The piped storm drain systems discharging to the basins and ground topography as stated above were used to delineate the areas contributing to the Castleberg and First Street basins.



LEGEND

SYMBOL	DESCRIPTION
	DRAINAGE AREA BOUNDARIES
	CITY LIMIT
	DISCHARGE POINT OF DRAINAGE AREA
	STRUCTURE ACCEPTING INFLOW
	STORM DRAIN PIPE
	MODELED SYSTEM – 8TH STREET
	MODELED SYSTEM – TOWNSEND AVENUE
	MODELED SYSTEM – CANDLEWOOD PLACE
	MODELED SYSTEM – VIRGINIA AVENUE
	DRAINAGE AREA BOUNDARY – CASTLEBERG BASIN, FIRST STREET BASIN
	STORM DRAINAGE STRUCTURES WHERE HGL IS ABOVE GRADE IN MODEL (MODEL FLOODING)

NOTE: DRAINAGE AREA BOUNDARIES MATCH THE COLOR OF THE MODELED SYSTEM CITED ABOVE.

N

0 500' 1000' 1500'

GRAPHIC SCALE: 1" = 1000'

FIGURE 6-1

CITY OF RIVERBANK
2007 STORM DRAIN SYSTEM
MASTER PLAN

MODELED SYSTEMS

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b. Runoff Coefficient

The values for runoff coefficients presented in Table 6-1 are based upon the City design standards dated 1994 [10]. The runoff coefficients are used only for the analysis of existing areas of the Master Plan. These values will not be used for future development. The current City design standards are more detailed and utilize runoff coefficients based on current design conditions. These standards should be followed for runoff coefficients of various surface types and land uses [5].

TABLE 6-1
CITY OF RIVERBANK
STORM DRAIN SYSTEM MASTER PLAN
RUNOFF COEFFICIENTS (MODELED SYSTEMS)

Type of Area	Runoff Coefficient[a]
Residential (>0.5 ac)	0.30
Park	0.35
Residential (<0.5 ac)	0.50
Commercial / Industrial	0.90
Roadway	0.95

[a] See Appendix G

c. Time of Concentration

The time of concentration for the rainfall is the time for the rainfall to flow across the area and through the gutters or pipes to the lowest point in the area for which the flow is being calculated. The initial time of concentration, also called the roof to gutter time, represents an approximation of time for a drop of water to land on a surface and make its way to the gutter in the street. The roof to gutter times used for this Master Plan are presented in Table 6-2. This criteria is based upon the City design standards dated 1994. These values will not be used for future development.

TABLE 6-2
CITY OF RIVERBANK
STORM DRAIN SYSTEM MASTER PLAN
TIME OF CONCENTRATION (MODELED SYSTEMS)

Parameter	Criteria
Roof to Gutter	
Residential (>1 ac)	30 minutes
Residential (<1 ac)	20 minutes
Commercial	10 minutes
Gutter Flow Time	Calculated based on actual or design conditions
Pipe Flow Time	Calculated based on actual or design conditions

The gutter flow time typically is calculated for the longest reach of gutter and is based on standard gutter flow equations. In the modeling for the Master Plan, an assumed value of 1 ft/sec velocity has been used based on the 1994 City design criteria.

Pipe flow time is based upon the calculated travel time in the piped system. In the Master Plan, average pipe size and an assumed pipe slope were used for pipes that are not incorporated into the model. Pipe travel time is then added to the initial time of concentration and gutter flow time. The combination of these three items provides the time of concentration at various connection points within the modeled systems.

d. Rainfall Intensity

Intensity of the rainfall is calculated based on the Rainfall Intensity Curve presented in City Design Standards Drawing No. 7-A. The curves for the 10-year event were used for initial models of any system and for the drainage basin models. To test sensitivity, StormCAD models for the 5-year event and the 2-year event were also created using the appropriate frequency curves.

e. Variations to the Storm Drain Block Maps

The Storm Drain Block Maps and the field survey data of manhole and inlet locations [11,12] were used to determine the pipe systems contributing to the modeled system. In the base mapping, some looped connections were shown. However, extensive field data was not available to verify the flow path of these interconnections. Field verification occurred in May 2007 and modifications to the modeled systems were made to reflect the findings.

6.2 Townsend Road Area

The system from Townsend Avenue conveys runoff to the Castleberg Basin within Castleberg Park. The areas contributing to this system include the areas bounded by the railroad to the north, Van Dusen Road to the south, Terminal Avenue on the west, and Sierra Vista Drive on the east. This system was analyzed to determine the system performance relative to the Castleberg Basin.

a. Model Setup

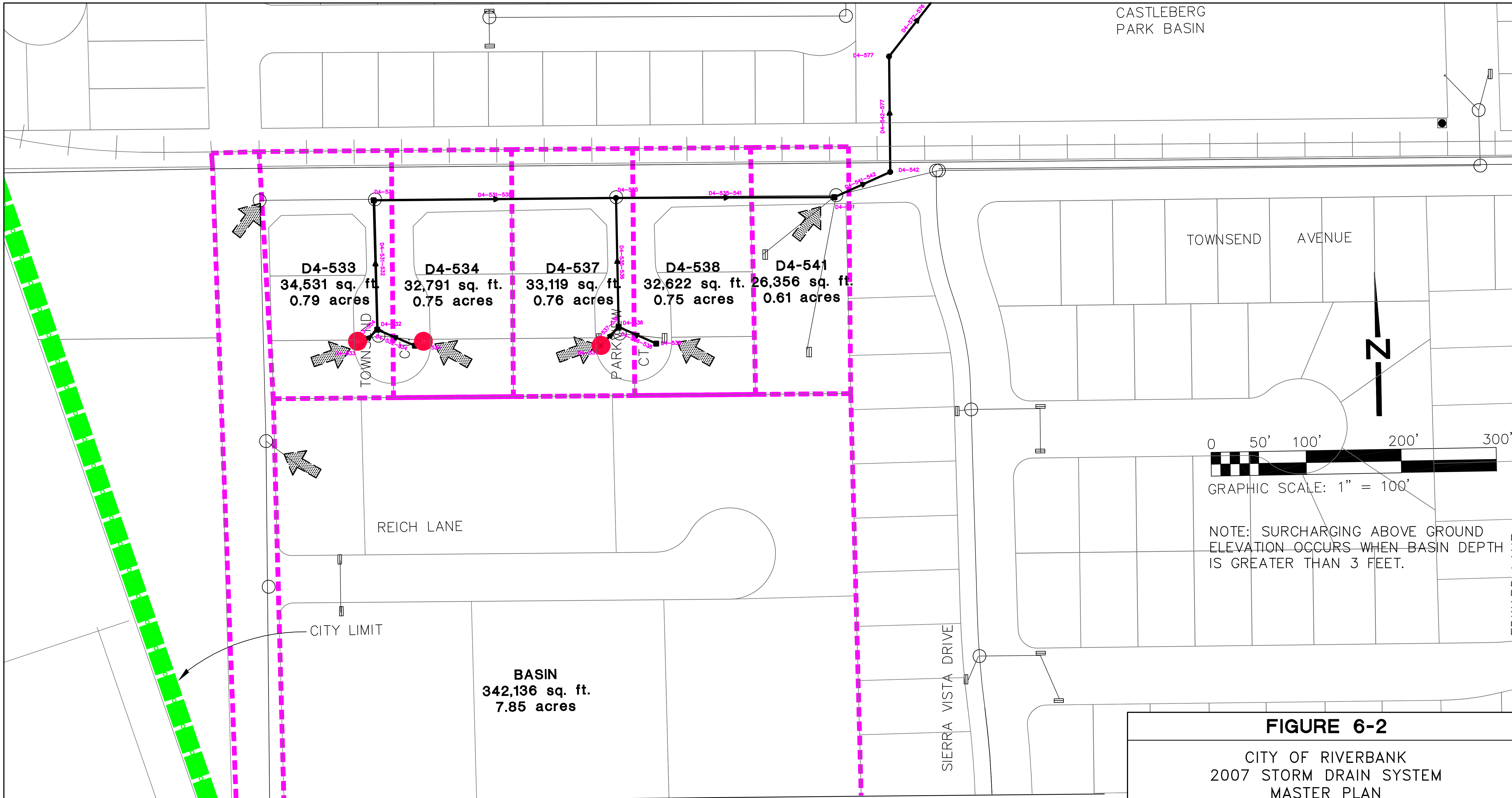
The system was created as described in model methodology for the pipes from the intersection of Terminal and Townsend Avenues to the Castleberg Basin for the 10-year storm event (see Figures 6-2 and 6-3 for the modeled system and the contributing drainage areas).

Within this system, there are two unknowns that could impact the analysis. The first is the influence of the basin which may exist at the northeast corner of the intersection of Terminal Avenue and Reich Lane. The base mapping shows a basin at this location and an outflow to the system within Terminal Avenue (which conveys runoff to Townsend Avenue). The modeling currently assumes that the basin is neither detaining nor retaining runoff. The second unknown is the influence of the cross connection between the storm drain systems contributing to the Castleberg Basin. The model assumes manhole D4-542 is accepting flow from or overflowing to a manhole to the east from the Sierra Vista Drive area. The Sierra Vista Drive system is believed to primarily discharge to the Castleberg Basin via an outfall from Eighth Street. This interaction is ignored in the analysis of the Townsend system.

The model was executed with alternatives varying from free outflow to the pump station in Castleberg Park (with the pump removing all runoff) to a maximum depth of 5 ft of water within the basin.

b. 10-Year Flow Analysis

The model was executed using the 10-year event. Table 6-3 summarizes the outcome of the different configurations with varying depths of water in the Castleberg Basin.



MATCH LINE SEE FIGURE 6-3

FIGURE 6-2

CITY OF RIVERBANK
2007 STORM DRAIN SYSTEM
MASTER PLAN

TOWNSEND AVENUE

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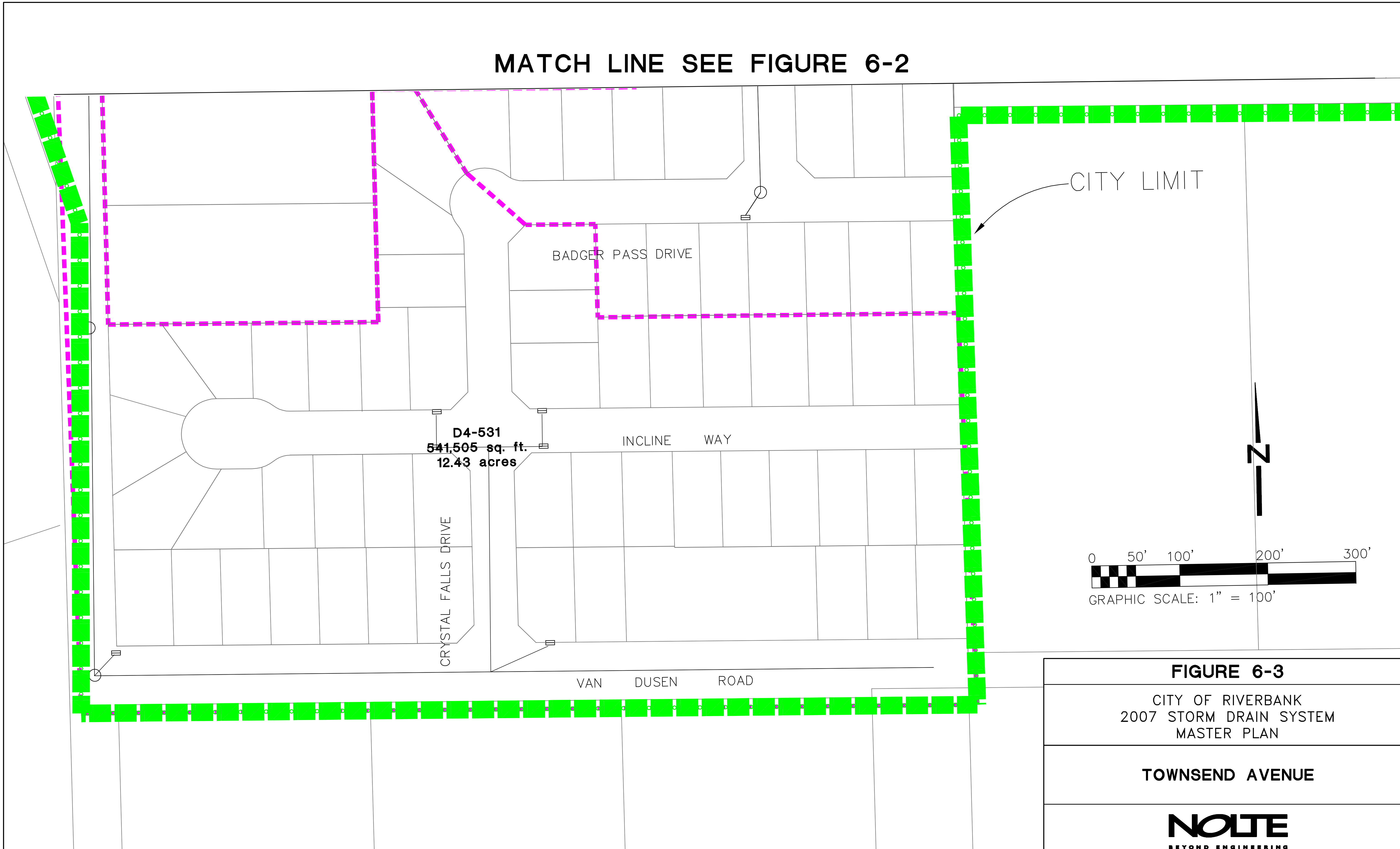

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TABLE 6-3
CITY OF RIVERBANK
STORM DRAIN SYSTEM MASTER PLAN
RESULTS OF HYDRAULIC ANALYSIS OF TOWNSEND AVENUE SYSTEM

Basin Depth	Pipe Surcharge	Manhole Surcharge (Surface Flow)
Free outfall	X	
1 ft	X	
2 ft	X	
3 ft	X	
4 ft	X	X

The model results indicate the system operates well. The basin can fill with approximately 3 ft of water before the Townsend Avenue system overflows to the surface. The drainage structure at which the system first overflows to the surface is located at the southeast inlet on Townsend Court. Routing additional runoff to this piped storm drain system could have negative effects on the Townsend Avenue system.

6.3 Virginia Avenue and Terminal Avenue Area

The system on Virginia Avenue and Terminal Avenue conveys runoff to the Castleberg Basin within Castleberg Park. The areas contributing to this system include the areas bounded by Virginia Avenue, Castleberg Park, the railroad to the south, and the parcels along Wisconsin Court to the east. Within the area of Terminal Avenue and Virginia Avenue, existing homes were constructed prior to construction of curb and gutter. The roadway was improved to include curb and gutter, and the curbs were installed at an elevation higher than the finished floors of the homes. When runoff depth exceeds the curb height or the driveway grade break, runoff may inundate these homes. This phenomenon can also occur when the Castleberg Basin exceeds a set elevation and the system hydraulic grade line exceeds the ground elevation.

a. Model Setup

The system was created as described in model methodology for the pipes from the intersection of Tennessee Avenue and Virginia Avenue to the Castleberg Basin and modeled for the 10-year storm event. Figure 6-4 depicts the modeled system and contributing drainage areas.

This system was modeled with two configurations. Figure 6-4 shows the difference between these two configurations. Configuration A is per the City block maps. Runoff from the area bounded by Terminal Avenue, Virginia Avenue, Castleberg Drive, and Castlepark Drive is collected by a piped system and discharges to the 15-inch pipe in Terminal Avenue, south of

Virginia Avenue. Configuration B, based upon the configuration of existing manholes in Virginia Avenue, assumes that the same neighborhood discharges to the 21-inch pipe system in Virginia Avenue, east of Terminal.

The model was executed with alternatives varying from free outflow to the pump station in Castleberg Park (with the pump removing all runoff) to a maximum depth of 5 ft of water within the basin.

b. 10-Year Flow Analysis

The model was executed using the 10-year event for both Configuration A and Configuration B. Table 6-4 summarizes the outcome of the different configurations with varying depths of water in the Castleberg Basin.

TABLE 6-4
CITY OF RIVERBANK
STORM DRAIN SYSTEM MASTER PLAN
RESULTS OF HYDRAULIC ANALYSIS OF VIRGINIA AVENUE/TERMINAL AVENUE SYSTEM

	Configuration A		Configuration B	
Basin Depth	Pipe Surcharge	Manhole Surcharge (Surface Flow)	Pipe Surcharge	Manhole Surcharge (Surface Flow)
Free outfall	X	X		
1 ft	X	X	X	
2 ft	X	X	X	
3 ft	X	X	X	X

The model results indicate that if system Configuration A exists, the point of connection may be the main issue, causing surcharge on Terminal Avenue. When the system utilizes Configuration B, the system has adequate capacity. However, the depth of water within the Castleberg Basin influences the system. Per the model, the basin can fill with approximately 3 ft of water before the Virginia Avenue system overflows to the surface. Routing additional runoff to this piped storm drain system could have negative effects on the Virginia Avenue system.

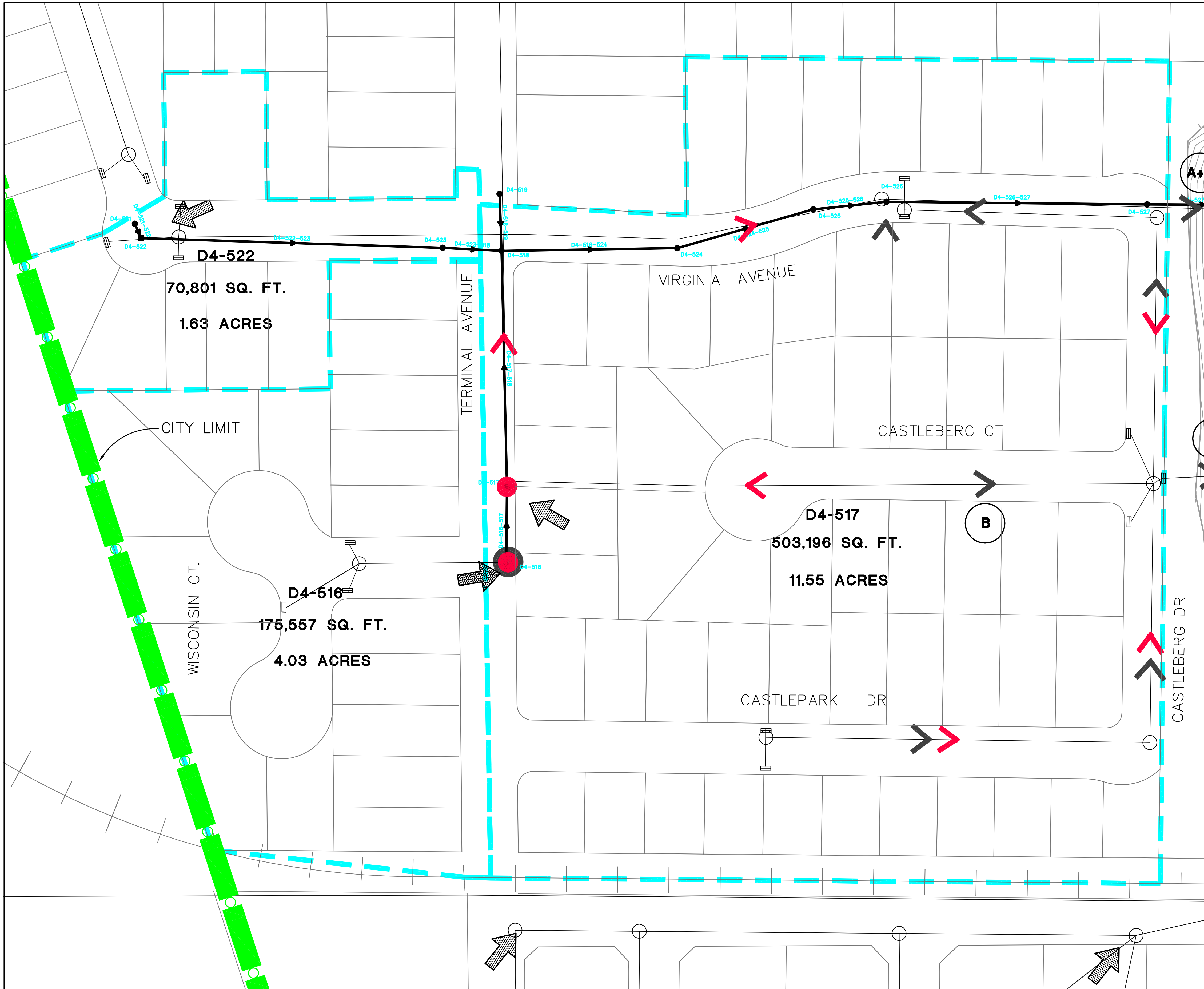

FIGURE 6-4

CITY OF RIVERBANK
2007 STORM DRAIN SYSTEM
MASTER PLAN

VIRGINIA AVENUE

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6.4 Castleberg Basin

The Castleberg Basin is a dual-use basin located within Castleberg Park. The predominantly residential areas contributing to the basin are presented in Figure 6-5. New developments are being planned to the south of Townsend Road and infill projects may replace pervious areas currently being used for agriculture. The new developments will need an outfall for storm drainage. Because the basin is relatively deep from its bottom to the curbs on the adjacent streets, it may be perceived that this basin has significant additional capacity beyond that which is being utilized currently. The purpose of the analysis of the Castleberg Basin is to determine if there is excess capacity for these new developments and to determine the effects to the upstream systems analyzed (see the previous Townsend system and Virginia/Terminal system discussions).

a. <u>Model Setup</u>

The basin model was run using the assumption that there is a constant outfall from the beginning of the storm event until the basin is completely empty. This analysis was conducted to determine the ideal operating condition of the basin. However, it is known that the pump station removing runoff from the basin will turn off when the Eighth Street system surcharges to the elevation of the pump outfall. In addition, calculations to assess the volume of the basin relative to the new storm basin standards were also accomplished.

Various storm durations were checked to determine the duration contributing the maximum volume to the basin. For the Castleberg Basin, this maximum storm duration is 14 hours, which contributes 14.5 ac-ft of storm runoff.

Information concerning the number of pumps and horsepower were provided by the City. The approximate pumping head was estimated from the field survey data available. Based on this information, the pumps were estimated to remove approximately 6.75 cfs.

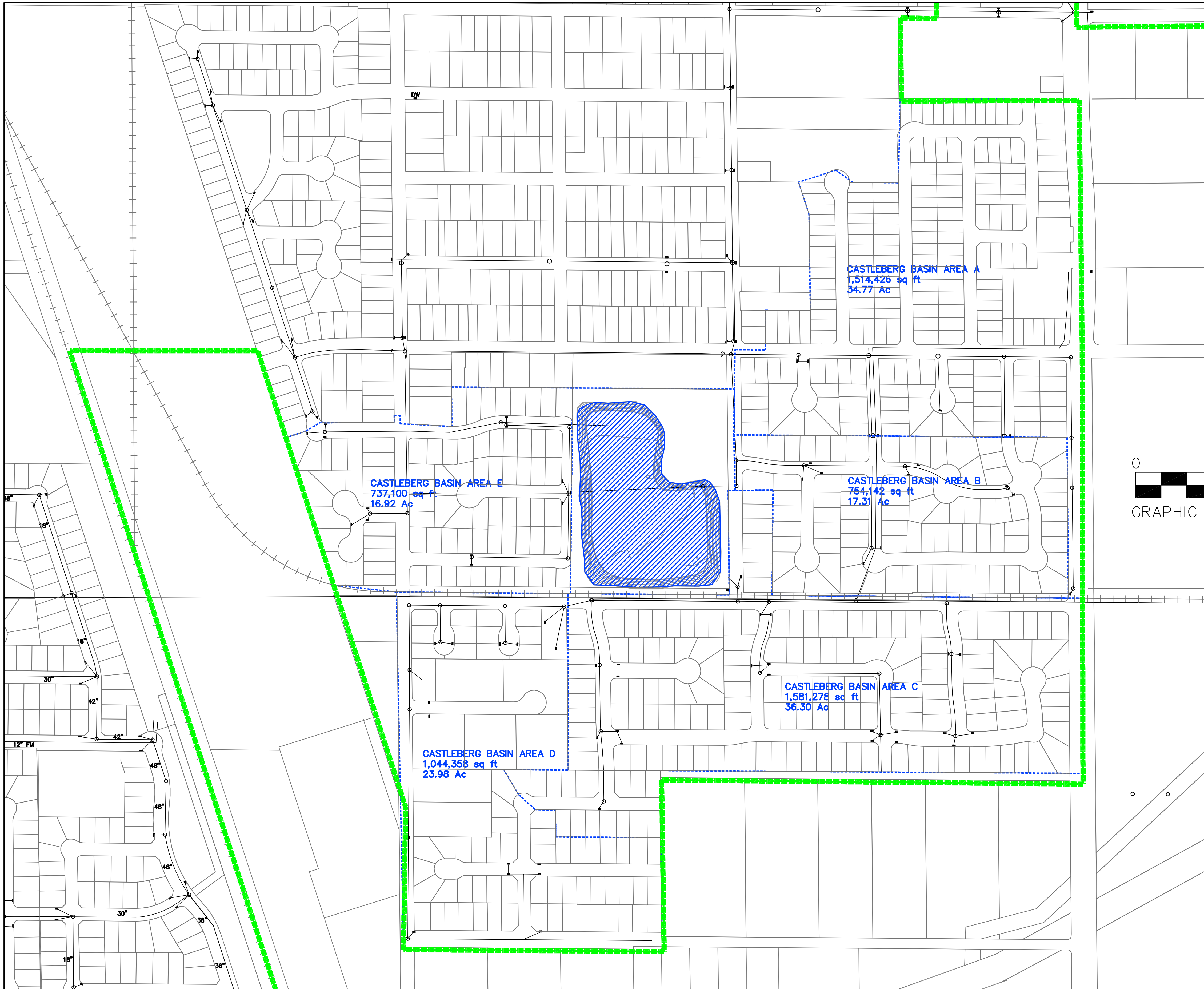

FIGURE 6-5

CITY OF RIVERBANK
2007 STORM DRAIN SYSTEM
MASTER PLAN

CASTLEBERG DRAINAGE BASIN

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b. Results of Analysis

The effective basin volume was compared to the volume required based upon the City design standards. The effective volume is defined as the volume which can be utilized prior to creating issues in the upstream drainage systems. Based upon the models created for the Virginia Avenue system, the basin can reach a maximum depth of approximately 3 ft before the upstream system overflows to ground elevations. This correlates to a volume of approximately 10.8 ac-ft within the basin.

Based on the equation from the 1994 standards:

$$V = A*0.6 \text{ (inches)}/12$$

The required volume for the upstream residential areas is approximately 7.1 ac-ft.

Based on the proposed design standards for drainage basins and the following equation:

$V = CAR / 12$, where:
$C = 0.55$
$A = 141$ ac (including Castleberg Park)
$R = 3.4$ inches (100-year, 24-hour event)

The basin volume required using the new standards is 21 ac-ft. This is significantly higher than the 1994 standards and significantly larger than the volume of Castleberg Basin.

The basin performance was also analyzed. The maximum inflow volume was determined based upon an analysis of varying storm durations for the 10-year event intensity. The storm duration creating the maximum inflow volume to the Castleberg Basin is 14 hours. This storm accumulates approximately 8.5 ac-ft in the basin with a water depth of approximately 2.73 ft above the lowest inlet in the basin. The basin analysis was performed with the Castleberg Park Pump Station on and removing approximately 6.75 cfs for the entire storm duration. If the pump is turned off at any time, the basin operations are adversely affected and additional storage is required.

A total of 14.6 ac-ft of basin volume would be required if the basin pumps were not operational for the entire event. This volume would create a water depth of 3.6 ft which would impair the operation of both the Virginia and the Townsend storm drain systems.

6.5 Eighth Street System

The system on Eighth Street conveys runoff to the Stanislaus River, near the northerly limit of the City. The areas contributing to this system include the pump outfall from the Castleberg Basin and the neighborhoods generally to the east of Eighth Street (see Figures 6-6, 6-7, and 6-8 for the contributing drainage areas). New developments are being planned to the east of Eighth Street and infill projects are replacing pervious areas. No observed failures of the Eighth Street system have been noted by the City. The purpose of the analysis of Eighth Street is to determine if there is excess capacity for the infill and new developments.

a. Model Setup

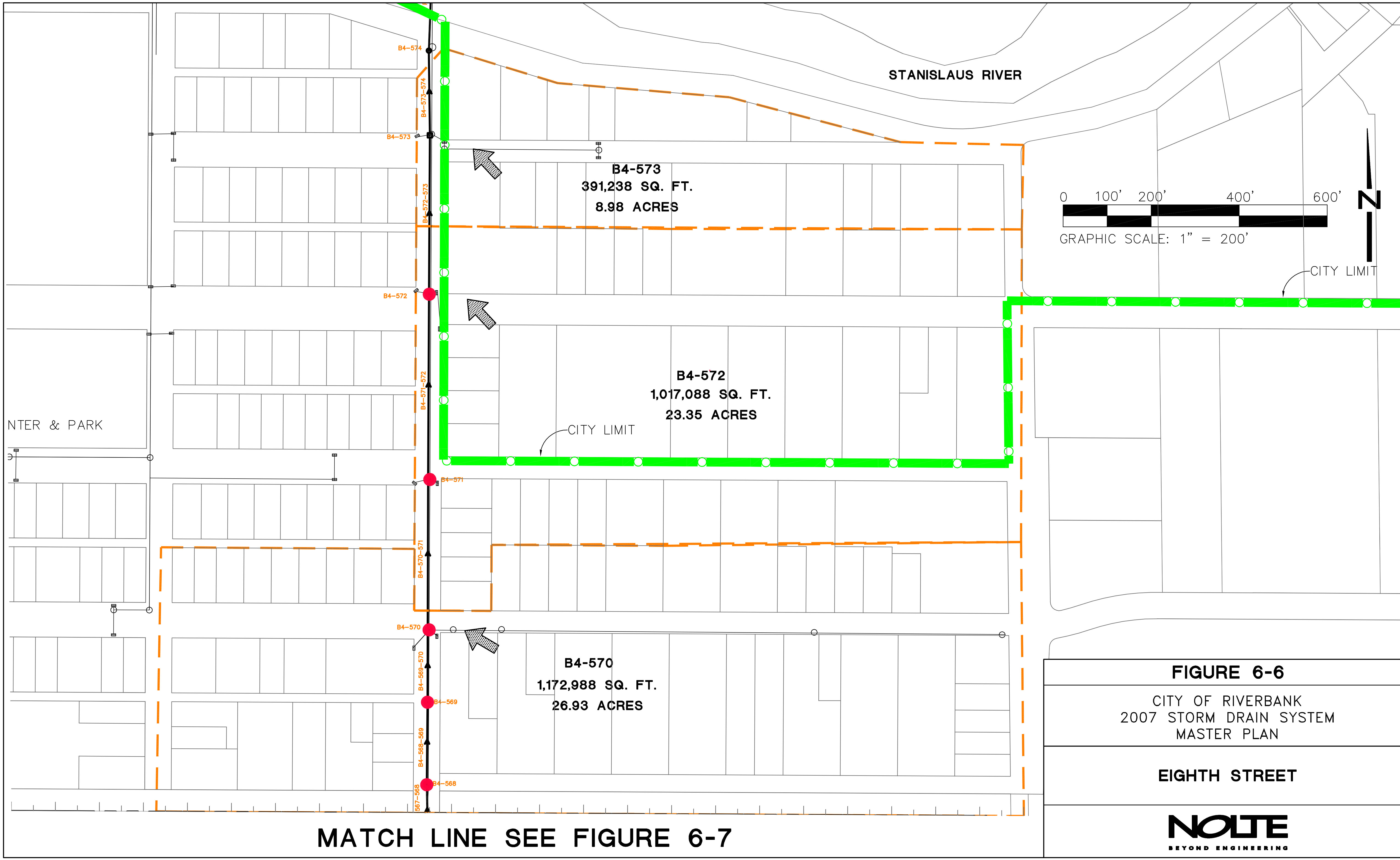
This system was generally set up per the City storm drain system base maps. The principal deviation from the base map is the exclusion of the storm drain system from Kansas Avenue. The base map indicated that the Kansas Avenue pipe system was connected to both the Eighth Street system and to the system discharging to the Stanislaus River at Seventh Street. Based upon the overall topography of the City, it was assumed that Eighth Street is not the primary outfall for storm drains in Kansas Avenue.

The Castleberg Park Pump Station can contribute approximately 6.75 cfs to the system. When the Eighth Street system surcharges at the pump station outfall, the Castleberg Park pump station switches off. Alternative scenarios were created to model the system with the pump on and with the pump off.

The system within Eighth Street was modeled to determine the system performance at the 10-year storm event, per proposed City design standards. In addition, the system was modeled utilizing the 5-year event, per the City 1994 standards, and the 2-year event. The 2-year and 5-year event analyses were created to determine the sensitivity of the system performance. All analyses assumed a free outfall to the Stanislaus River.

b. Results of Analysis

Six alternative scenarios were identified and analyzed. These alternatives include each of the three storm events with the Castleberg Basin pumps either on or off. All scenarios experienced pipe surcharge and conditions wherein the hydraulic grade line exceeded the ground elevation.



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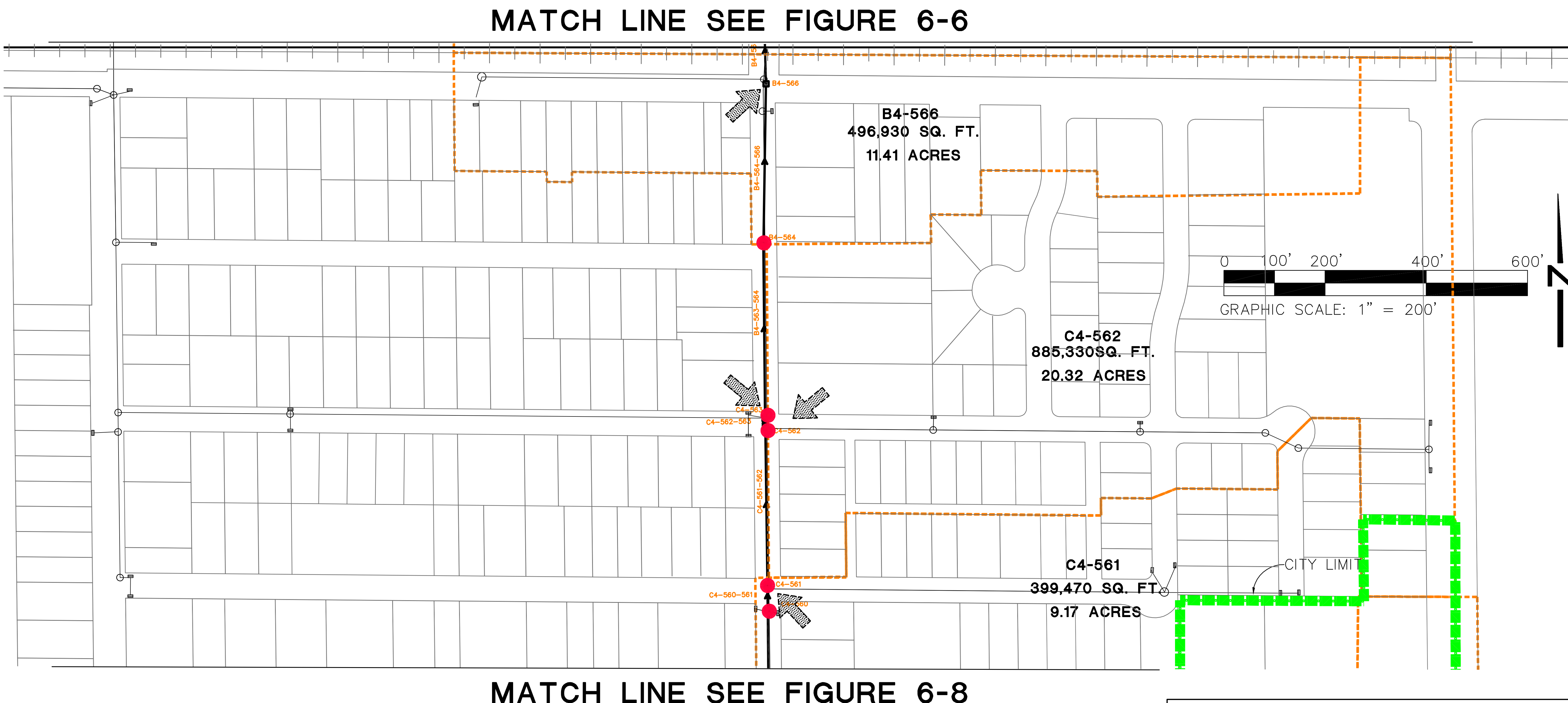
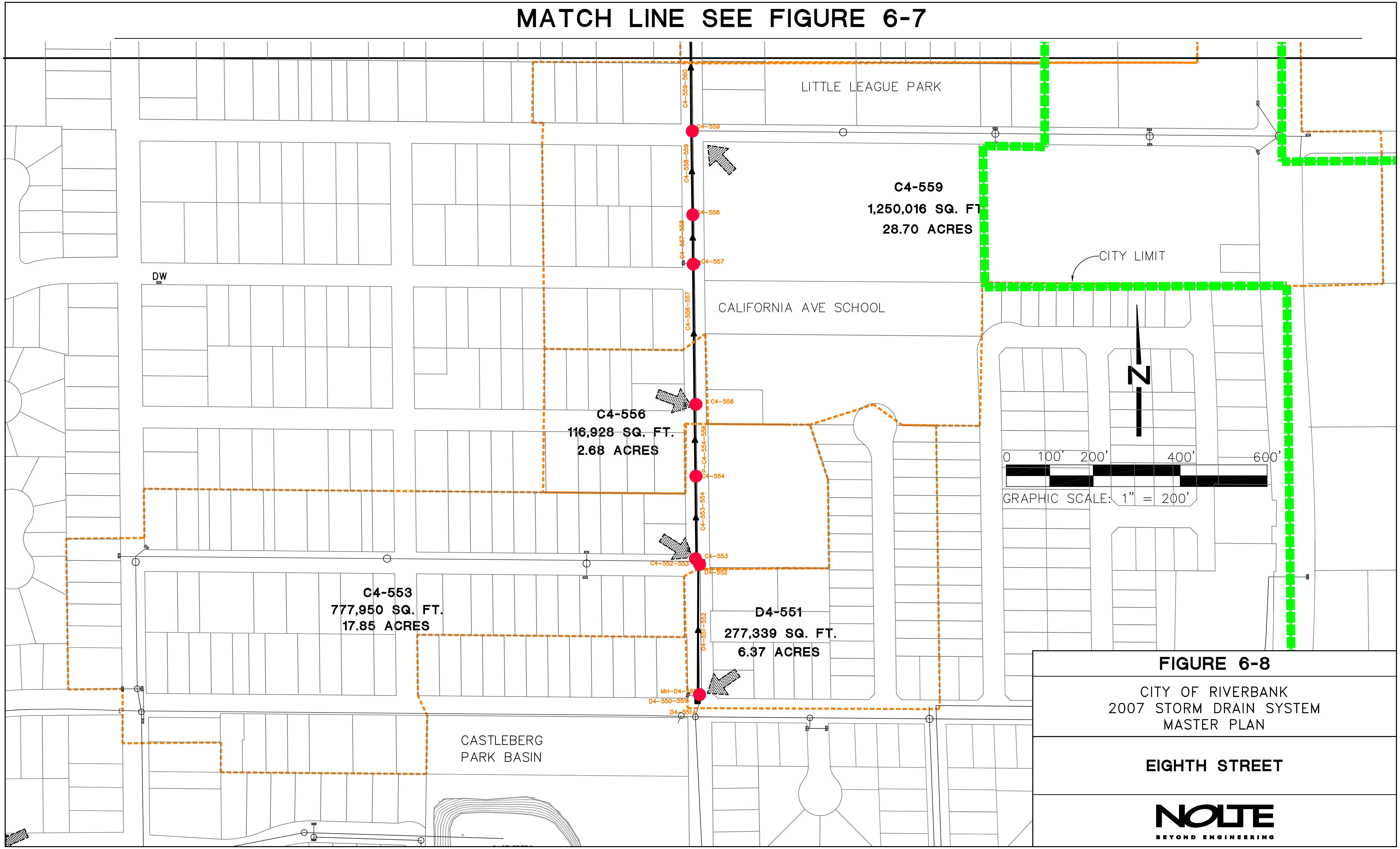


FIGURE 6-7

CITY OF RIVERBANK
2007 STORM DRAIN SYSTEM
MASTER PLAN

EIGHTH STREET

NOLTE
BEYOND ENGINEERING



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City staff has not witnessed this outcome in the field. One possible reason is that the overall topography of the City may influence the perception of the problem. In general, the City drains from east to west. Flows not captured by the storm drain inlets on Eighth Street would generally flow to the west, away from Eighth Street. Flows into the area south of Patterson Road and west of Eighth Street are blocked by the railroad to the west of Terminal Avenue. Excess flow in this area aggravates the local flooding at Terminal Avenue and Patterson Road. The Terminal Avenue system was not specifically analyzed. Flows into the area north of Patterson Road and west of Eighth Street enters the depression within the downtown area of the City and aggravates an existing flooding problem. This discussion not only applies to the direction of flows that are not captured by the Eighth Street storm drain but also describes the overland release path that would exist even if the Eighth Street system were conforming to the design standards.

6.6 Candlewood Area System

The system on Candlewood Avenue conveys runoff to the Stanislaus River, near the northerly limit of the City. The areas contributing to this system include the neighborhood bounded by Patterson Road, Woodhaven Place, and Estelle Avenue. This system has a free outfall to the Stanislaus River (see Figures 6-9 and 6-10 for the contributing drainage areas and the modeled system). The City has observed failure of the Candlewood Avenue system at its westerly end, near Woodhaven Place. The purpose of the analysis of the Candlewood Avenue system is to determine the probable cause and possible solution to this flooding**.**

a. Model Setup

This system was generally set up per the City storm drain system base maps. The model was analyzed using a 10-year storm event with a free outfall to the Stanislaus River. In addition, models for the 2-year and 5-year storm events were also executed to measure the sensitivity of the system.

A capacity calculation was performed for the 15-inch diameter outfall to the river. The capacity was so much less than the immediately upstream 36-inch pipe that the outfall was modeled as a 36-inch pipe.

b. Results of Analysis

Three alternative scenarios were identified and analyzed: the 10-year, 5-year, and 2-year events. All scenarios experienced pipe surcharge and conditions wherein the hydraulic grade line exceeded the ground elevation. City staff has witnessed this outcome in the field near the intersection of Candlewood Avenue and Woodhaven Place.

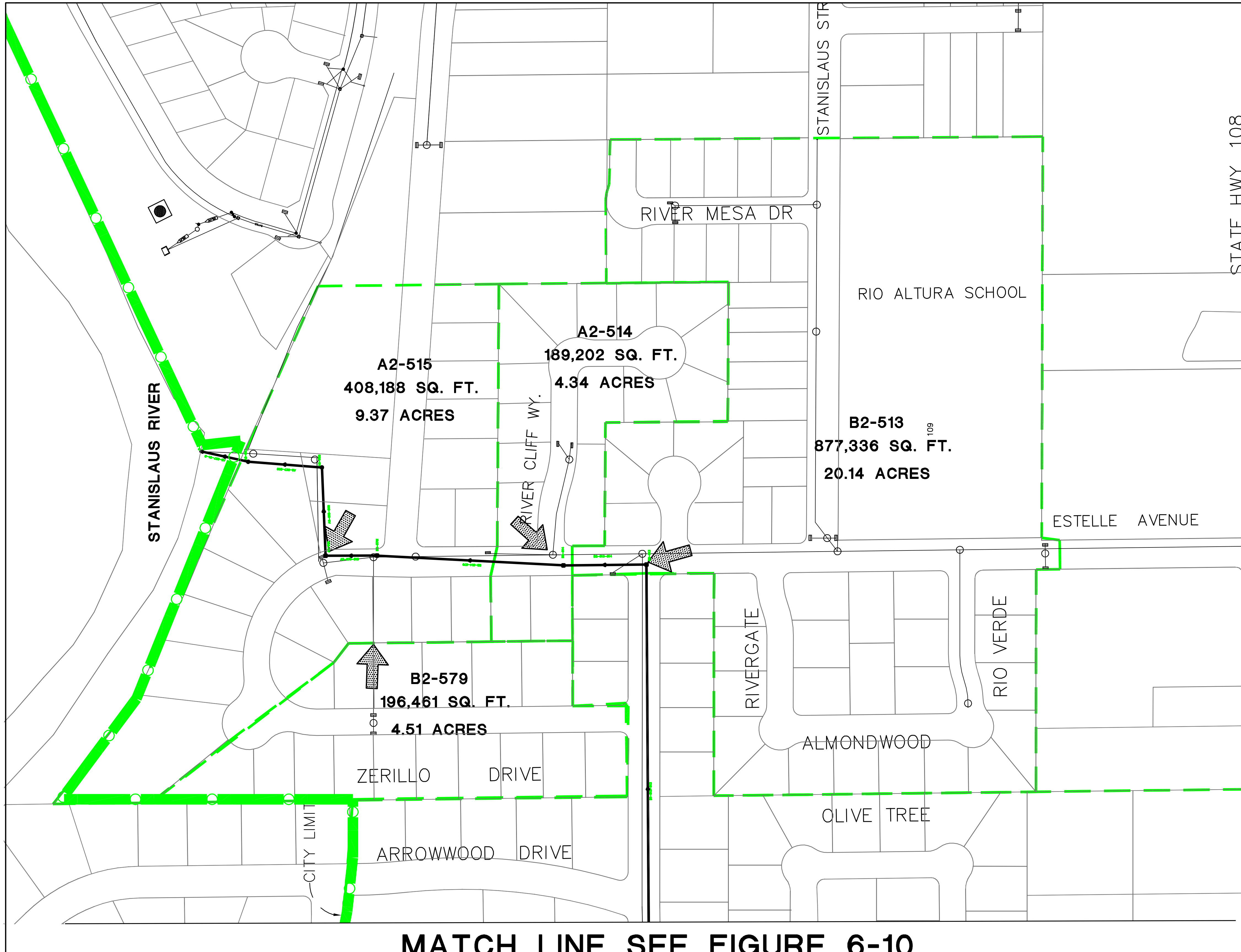

FIGURE 6-9

CITY OF RIVERBANK
2007 STORM DRAIN SYSTEM
MASTER PLAN

CANDLEWOOD PLACE

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BEYOND ENGINEERING

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MATCH LINE SEE FIGURE 6-9

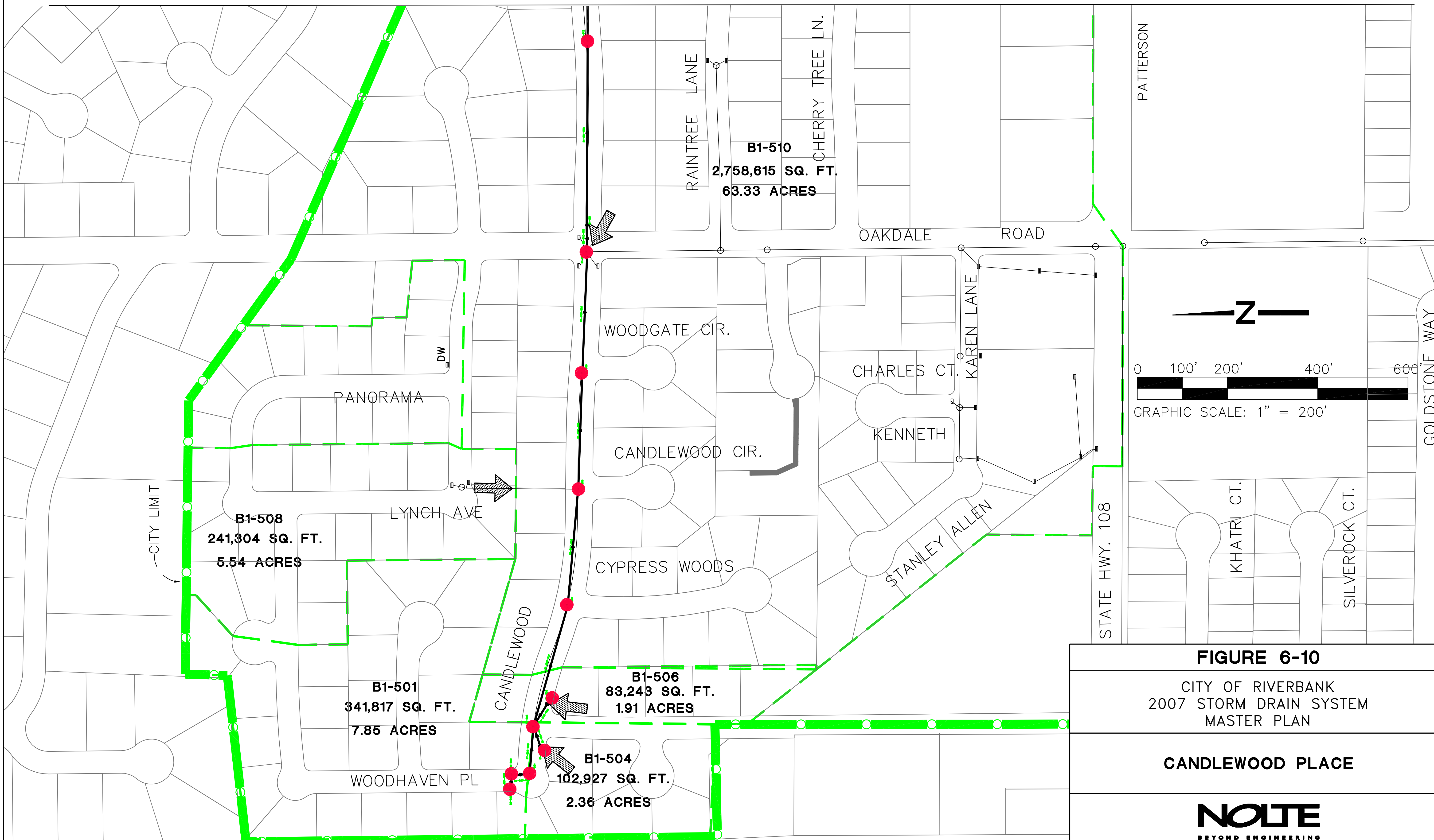

FIGURE 6-10

CITY OF RIVERBANK
2007 STORM DRAIN SYSTEM
MASTER PLAN

CANDLEWOOD PLACE

NOLTE
BEYOND ENGINEERING

The first condition of this system which should be noted is that the grate and manhole rim elevations at the upstream end of the system are approximately 15 ft lower than the manhole rim elevations in Estelle Avenue. In addition, the overall ground slope along Candlewood slopes from Estelle Avenue toward Woodhaven Place. Any runoff not collected by inlets or that is surcharged from inlets will flow in the street toward Woodhaven Place. The ground and the hydraulic grade line are sloping opposite to each other, which allows the hydraulic grade line to quickly converge with the ground elevation. This counter slope condition can create issues when a surcharge condition occurs within the downstream portions of the system. These two conditions and the analysis cited below contribute to the local flooding experienced at the intersection of Candlewood Avenue and Woodhaven Place.

c. Related Storm Drain Configuration Issues

Three main issues related to interconnections within the storm drain system were noted that could potentially impact flooding and surcharging of the Candlewood storm drains. While the following items were not incorporated into the model due to inadequate information, these issues may influence detrimentally the operation of the Candlewood system. These items were identified based upon the City storm drain mapping and a field review which was performed in May 2007.

The first location of concern is an overflow manhole at the intersection of Patterson Road and Silverock Road. The system in Silverock Road conveys drainage to the south, eventually discharging to the basin and pump station at Saffreno Park. While this system was not analyzed, the field check indicated that if this system backs up, it will overflow into the system in Patterson Road and contribute to the Candlewood system via Oakdale Road.

The second location is at Estelle Avenue. The pipe system downstream of the pump at Saffreno Park conveys runoff to a manhole at the intersection of Estelle Avenue and Patterson Road. This runoff then has the option of flowing north on Estelle Avenue or east on Patterson Road. The contribution from this pump station was not included in the initial analysis of the Candlewood system. Any flow that moves north on Estelle would further exacerbate the conditions in Candlewood.

The third location is at Jackson Avenue and Patterson Road. At this point, the flows from the Saffreno Park pump and the flows from the lift station at Jackson Avenue and Country Manor Drive may mix and may flow north along Jackson to the lift station at River Cove and Briarcliff or west toward Estelle and the Candlewood system.

These interconnections may also offer some relief to the Candlewood system during low to medium flow conditions. The influence of these interconnections and pump stations were not analyzed; however, they have the potential for negative impact on the Candlewood system performance.

6.7 First Street Basin

The First Street Basin is a non-dual use basin located adjacent to First Street between Topeka Street and Sierra Street. The primarily residential areas contributing to the basin are presented in Figure 6-11. The purpose of this analysis is to determine the performance of the First Street Basin and to determine if there is existing additional capacity within this basin.

a. Model Setup

The basin model was executed using the assumption that there is a constant outfall from the beginning of the storm event until the basin is completely empty. This analysis was accomplished to determine the ideal operating condition of the basin. However, it is known that the pump station removing runoff from the basin is manually turned on when the flow in the downstream systems have receded to prevent flooding in the downtown area. In addition, the volume of the basin relative to the 1994 and 2007 storm basin standards was also calculated.

Various storm durations were checked to determine the duration contributing the maximum volume to the basin. For the First Street Basin, this maximum storm duration is 17.5 hours, which contributes 8.2 ac-ft of storm runoff.

Information concerning the number of pumps and horsepower were provided by the City. The approximate pumping head was estimated from the field survey data available. Based on this information, the pumps were estimated to remove approximately 2.85 cfs.

FIGURE 6-11

CITY OF RIVERBANK
2007 STORM DRAIN SYSTEM
MASTER PLAN

FIRST STREET DRAINAGE BASIN

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b. Results of Analysis

The effective basin volume was compared to the volume required based upon the City design standards. The effective volume is defined as the volume which can be utilized prior to creating issues in the upstream drainage systems. However, systems upstream of the First Street Basin were not analyzed. The effective volume was calculated as the volume of the basin to the point at which the basin would overtop. Based upon the basin topography, the basin can reach a maximum elevation of approximately 136.0 ft. This correlates to a volume of approximately 11.1 ac-ft within the basin.

Based on the equation from the 1994 standards:

$$V = A*0.6 \text{ (inches)}/12$$

The contributing volume of the upstream residential areas is approximately 3.7 ac-ft.

The new basin size requirements use the following equation:

$$V = C\ A\ R\ /\ 12, \text{ where:}$$

C = 0.6 (weighted for all contributing areas)
A = 74.7 ac
R = 3.4 inches (100-year, 24-hour event)

Based on the above calculation, the basin volume required using the new standards is 12.7 ac-ft. This is significantly larger than the 1994 standards and larger than the volume of First Street Basin.

The basin performance was also analyzed. The maximum inflow volume was determined based upon varying storm durations and a calculated peak flow. The storm duration creating the maximum inflow volume to the First Street Basin is 17.5 hours. Because this storm contributes approximately 8.2 ac-ft of volume, the basin can completely contain the 10-year design event without pumping which corresponds to the existing operations. If the pumps are used continuously throughout the storm event, a basin volume of approximately 5.4 ac-ft is utilized. This basin volume creates a water depth of approximately 4.8 ft above the lowest inlet in the basin.

7 Recommended System Improvements

This chapter presents specific projects or follow-on tasks recommended to alleviate existing deficiencies developed in Chapter 6. These projects are prioritized to facilitate implementation. A brief summary of the supporting analysis is presented in this section to assist in understanding the recommended priorities.

For the purposes of these recommendations and because of the inter connectivity and dependency of the various systems on each other, the existing systems that were analyzed will be presented in groups as follows:

1. Group A: Castleberg Basin system

   a. Townsend Road area
   b. Virginia Avenue/Terminal Avenue area
   c. Additional areas discharging to the basin (individual storm drains in these area were not modeled as part of the Master Plan)
   d. Castleberg Basin
   e. Eighth Street from the Castleberg Basin pump discharge to the Stanislaus River outfall

2. Group B: Candlewood System

   a. Candlewood Place
   b. Connecting storm drains
   c. Contributing adjacent areas
   d. Stanislaus River outfall

3. Group C: First Street Basin

   a. Areas discharging to the basin (individual storm drains in these area were not modeled as part of the Master Plan)
   b. First Street Basin
   c. First Street Basin discharge system

7.1 Project Priority for Existing System

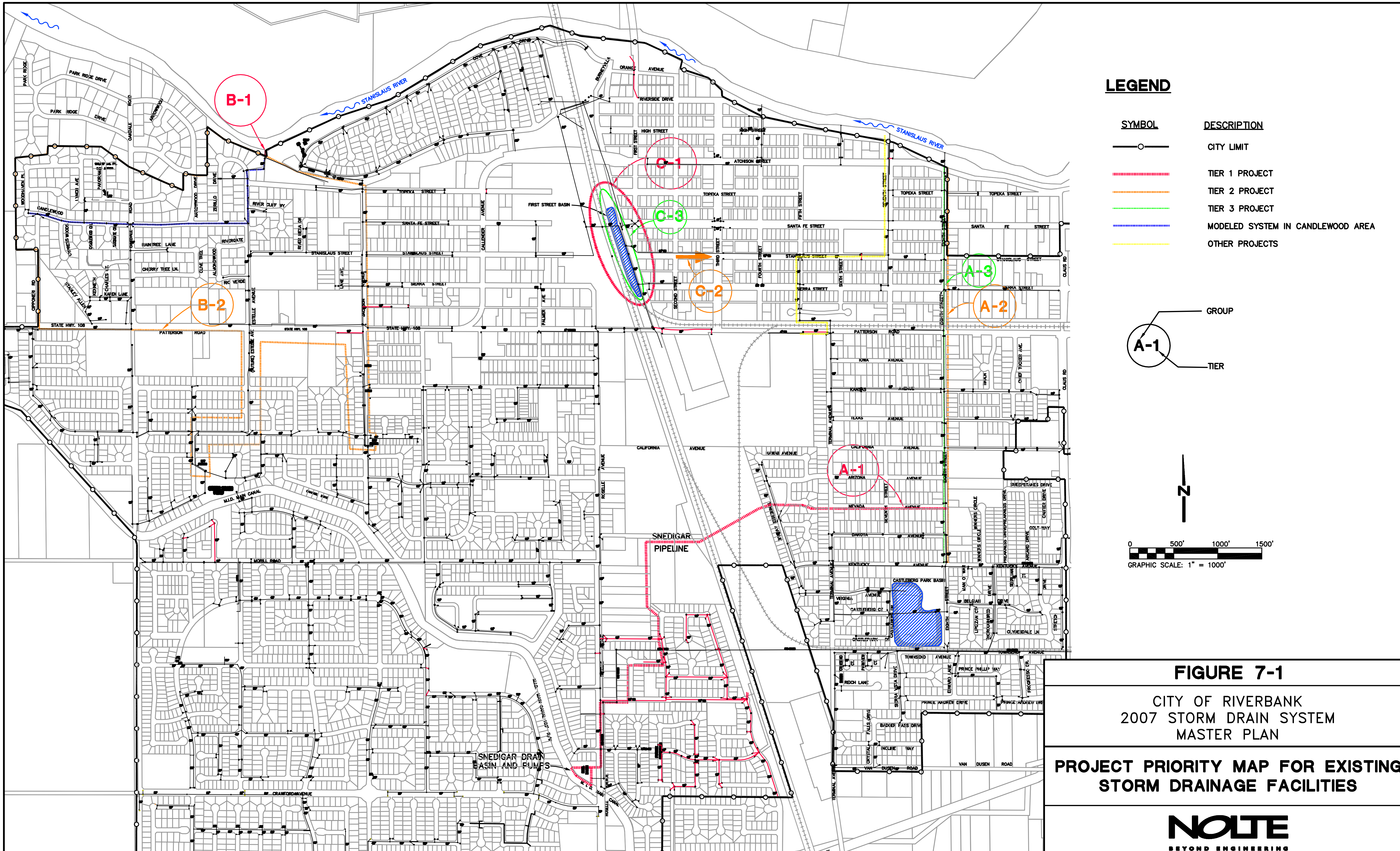
Based upon the model outcomes, the City-observed system issues, and the need for additional study, the system deficiencies have been divided into Tier 1, Tier 2, and Tier 3 projects. Tier 1 projects are the most critical to providing immediate relief and to providing a better understanding of the storm drain system operations and should be completed prior to continuing on to Tier 2 and Tier 3 projects. Project priorities have been established separately for each system group of projects, discussed above. In Table 7-1, a listing of the projects by Group and Tier are presented. In Figure 7-1 the locations of the projects are presented. Descriptions of the recommendations and the proposed projects for each are described below by Group and Tier.

TABLE 7-1
CITY OF RIVERBANK
STORM DRAIN SYSTEM MASTER PLAN
PROJECT PRIORITIES – RECOMMENDED IMPROVEMENTS FOR EXISTING FACILITIES

	Tier 1	Tier 2	Tier 3
Group A – Castleberg Basin System			
A-1 Interim Capacity Increase	X		
A-2 Further Study – Eighth Street operations and overland release patterns		X	
A-3 Design Eighth Street			X
A-4 Construct Eighth Street			X
Group B – Candlewood System			
B-1 Replace 15-inch River Outfall Pipe with Appropriately Sized Pipe	X		
B-2 Further Study – effects of cross connections		X	
Group C – First Street Basin			
C-1 Basin Maintenance	X		
C-2 Further Study – downstream system operations		X	
C-3 Further Study – basin operations			X

a. Group A – Castleberg System

The hydraulic analysis of the Castleberg system indicated that no additional drainage areas should be connected to the Castleberg Basin because it is only able to operate effectively with the current basin configuration and pump capacity. Pumps at the Castleberg Park Pump Station must remain operational at all times to maintain the water basin operating depth below 3.0 ft to maintain the operation of the Virginia Avenue and Townsend Road area storm drains. The pipes upstream of the basin operate at design capacities when the basin depth does not exceed 3.0 ft.



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The system influencing the operation of the Castleberg basin, impacting the operations of the systems upstream of the basin, and affecting overland flow to downstream areas most significantly is the Eighth Street system, which does not currently have capacity to receive any additional flows. However, tract maps have been approved and storm drainage pipelines stubbed-out to expand the Castleberg Basin service to include the adjoining Van Dusen area to the south. This accelerates the need for improvements to the Eighth Street storm drainage system.

The following projects are recommended for the Group A, Castleberg Basin area to implement the above recommendations. The priority indicated below is intended to allow the projects that provide the most benefit to occur first.

Tier 1 – Interim capacity increase. OID has discontinued irrigation deliveries to the East Riverbank area. Additionally there has been a proposal to intercept the irrigation drainage water at Eleanor Avenue and divert to the OID Riverbank Lateral. After construction of the drainage basins and pipelines proposed in the feasibility study, certain OID facilities would not be needed by OID including the Snedigar pipeline, Riverbank Drain, and the Snedigar Drain. OID is interested in turning certain facilities over to the City, when agreeable solutions are developed and implemented. However, these facilities remain an operational necessity for OID for conveying irrigation drainage to the Snedigar Pond, where the drainage is pumped into the MID main canal.

The Snedigar pipeline crosses Eighth Street and could be connected to the storm drain pipeline to provide additional discharge capacity to the Castleberg system because the pumps shut down when the Eighth Street storm water line is surcharged. The available capacity in the Snedigar pipeline for additional storm water is not known at this time, but it could provide some interim discharge benefit to the Castleberg/Eighth Street system. This project is labeled A-1 on Figure 7-1.

Tier 2 – Further study of Eighth Street system. The Eighth Street system is a critical backbone system for the City. This system provides conveyance for a large portion of the City and an outfall for the Castleberg Park Basin. Surcharging of this system occurs even in small storm events, such as the 2-year storm event, which may force runoff into an overland release pattern. This system should be further studied to provide a better understanding of the piped system; the effects of surcharging, such as the over land release patterns in the City; and feasible alternatives for improving this system to provide an acceptable level of storm conveyance and protection. An analysis of the Eighth Street storm drain system may include investigating the existing flooding conditions in the downtown and Terminal areas to establish a possible solution that can benefit several areas. Possible alternatives may include upsizing the Eighth Street system, providing a parallel pipe, providing additional detention, or providing a dedicated outfall pipe for the Castleberg Basin. Alternatives for this project should accommodate the discharge from the Castleberg Pump Station through the 10-year storm event to provide protection for the systems and properties upstream of the Basin. This project is labeled A-2 on Figure 7-1.

Tier 3 – Eighth Street system design and construction. The design shall utilize the most effective and feasible option identified in the recommended Eighth Street Study. This project is labeled A-3 on Figure 7-1.

b. <u>Group B – Candlewood Place</u>

The system on Candlewood Place conveys runoff to the Stanislaus River, via storm drains in the northerly Patterson Road, Woodhaven Place, and Estelle Avenue. This system has a free outfall to the limit of the City. The hydraulic analysis indicated that the hydraulic grade line exceeds the ground elevation; and City staff have witnessed this outcome in the field, specifically near the intersection of Candlewood Avenue and Woodhaven Place.

There are two main issues contributing to this system's operations. First, the overall ground slope along Candlewood Place slopes from Estelle Avenue toward Woodhaven Place. Any runoff not collected by inlets or that is surcharged from inlets will flow in the street toward Woodhaven Place. The ground and the hydraulic grade line are sloping opposite to each other, which allows the hydraulic grade line to quickly converge with the ground elevation. Second, there are multiple storm drain system interconnections from areas outside the modeled portion of the system which may detrimentally influence the operations of the Candlewood system.

The following projects are recommended for the Group B, Candlewood Place area. The order designated below is intended to allow the projects that provide the most benefit to occur first.

Tier 1 – Replace the existing 15-inch outfall. The hydraulic analysis indicated that the existing 15-inch outfall to the Stanislaus River is undersized for the runoff flow, contributing to the surcharge conditions in the Candlewood system. This pipe should be resized to provide outfall conditions with no surcharge in this pipe. This project is labeled B-1 on Figure 7-1.

Tier 2 – Further detailed analysis of the storm drain system. There are multiple systems which may be contributing flow to the Candlewood Place storm drain. Analysis should include a review of the overland release paths for the Candlewood neighborhood, the influence of the Saffreno Park pump discharge to Estelle Avenue, the influence of the pump discharge from Country Drive, and the storm drain connection between Estelle Avenue and Jackson Drive at Patterson Road. This analysis should identify possible alternatives which will be most effective for relieving the flooding on Candlewood Place while maintaining effective operation of the interconnected systems. In addition, alternatives should be developed which will allow the 10-year storm event to be conveyed out of the Candlewood Place neighborhood. This project is labeled B-2 on Figure 7-1.

c. <u>Group C – First Street Basin</u>

The First Street Basin is a non-dual use basin located adjacent to First Street between Topeka Street and Sierra Street. Residential areas primarily contribute to the basin. The basin model was executed using the assumption that there is a constant outfall from the beginning of the storm event until the basin is completely empty. This analysis was accomplished to determine the ideal operating condition of the basin. However, it is known that the pump station removing runoff from the basin is manually turned on when the flow in the downstream systems has receded to prevent flooding in the downtown area.

The First Street Basin requires a discharge which operates at all times during a storm without constraints. This means that capacity in a downstream system is needed to drain the First Street Basin, while downstream areas remain unaffected.

The following projects are recommended for the Group C, First Street Basin area. The order designated below is intended to allow the projects that provide the most benefit to occur first.

Tier 1 – Basin maintenance. Maintenance of the basin is intended to prevent undesirable erosive conditions, while maintaining the basin volume and extending the life of the basin. Maintenance of the side slopes would include either paving or providing other means of erosion control, such as seed impregnated jute mat. The bottom of the basin should remain unpaved to encourage some infiltration. The bottom of the basin should also be vegetated with flow paths protected using turf reinforcement mat or other erosion protection. The bottom should be graded to drain toward the pump station outfall and undesirable vegetation should be removed. This project is labeled C-1 on Figure 7-1.

Tier 2 – Downstream system analysis. The system downstream of the First Street Basin pump station does not have adequate capacity to convey the pump discharge from the basin throughout a storm event. At this time, the First Street Basin pump station remains off until manually switched on after the flow in the downstream pipe has receded to a level which would allow the pump station discharge to flow within the pipe without causing downstream issues. The main task of this project is to determine alternatives for providing a positive, consistent outflow system for the First Street Basin. Alternatives may include providing more capacity in the downstream system or providing a dedicated outfall for the First Street Basin. This project is labeled C-2 on Figure 7-1.

Tier 3 – Further analysis of basin operations. Analyze the potential to more efficiently and fully utilize the capacity of the basin. The entire area draining to the basin should be verified, mapped, and calculated to verify the basin operates adequately when the pump station is draining the basin, without constraints, during and immediately following a storm event. Finally, the existing inflow and pump outflow configuration should be examined to determine if there are more efficient means of filling and draining the basin, such as providing a separate pump station outflow structure. This project is labeled C-3 on Figure 7-1.

d. Conclusion

The City has existing storm drain systems that will operate more effectively with some relatively minor improvements. However, there are also systems that require further study and a more complete understanding before specific improvements can be recommended and implemented. To provide the most impact and most efficient use of the City's resources, the projects presented in Table 7-1 should be implemented in the order shown.

7.2 Strategy for Central Riverbank Storm Drain System

Key components of the Central Riverbank storm drainage strategy include a new storm drain pipeline in the railroad track corridor connecting new storm water basins to a new river outfall. The new storm drainage system would serve the old cannery area, undeveloped industrial area along the railroad tracks, and the south central area of future development. The system could also supplement the existing system and solve several existing problem areas. A discussion of the existing problem areas is included in Section 7.1 and includes utilizing an existing OID pipeline and outfall to the MID Main Canal. Each of the remaining areas are discussed below and illustrated in Figure 7-2.

a. Old Cannery Area

The old cannery area is shown in the 2002 Draft Master Plant as a significant area of storm water inflows to the sewer systems and is the subject of current redevelopment studies. Also as shown in Figure 3-1, several of the problem areas in the existing system are adjacent to the cannery area, including Patterson Road, and could be solved with a new central storm drain system. Further study could confirm that a new dual use storm water basin could be constructed north of State Route (SR) 108 with an outfall to the Stanislaus River. Constructing a new storm drain system to serve the cannery area could also be a significant benefit to the wastewater collection system.

b. Central Industrial Corridor

The new central storm drainage system should be extended through the industrial corridor along the railroad tracks to the south end of the City. Several areas in the industrial corridor could be further developed and would need storm drainage infrastructure. There are areas prone to flooding on Roselle Avenue and Patterson Road that could benefit from a new storm drain line. Additionally, overflow storm drain lines could be constructed from Terminal Avenue and Eighth Street to mitigate problems in those systems during extreme storm events. New storm water basins could be constructed within the industrial and railroad corridor to meet the storm water system needs.

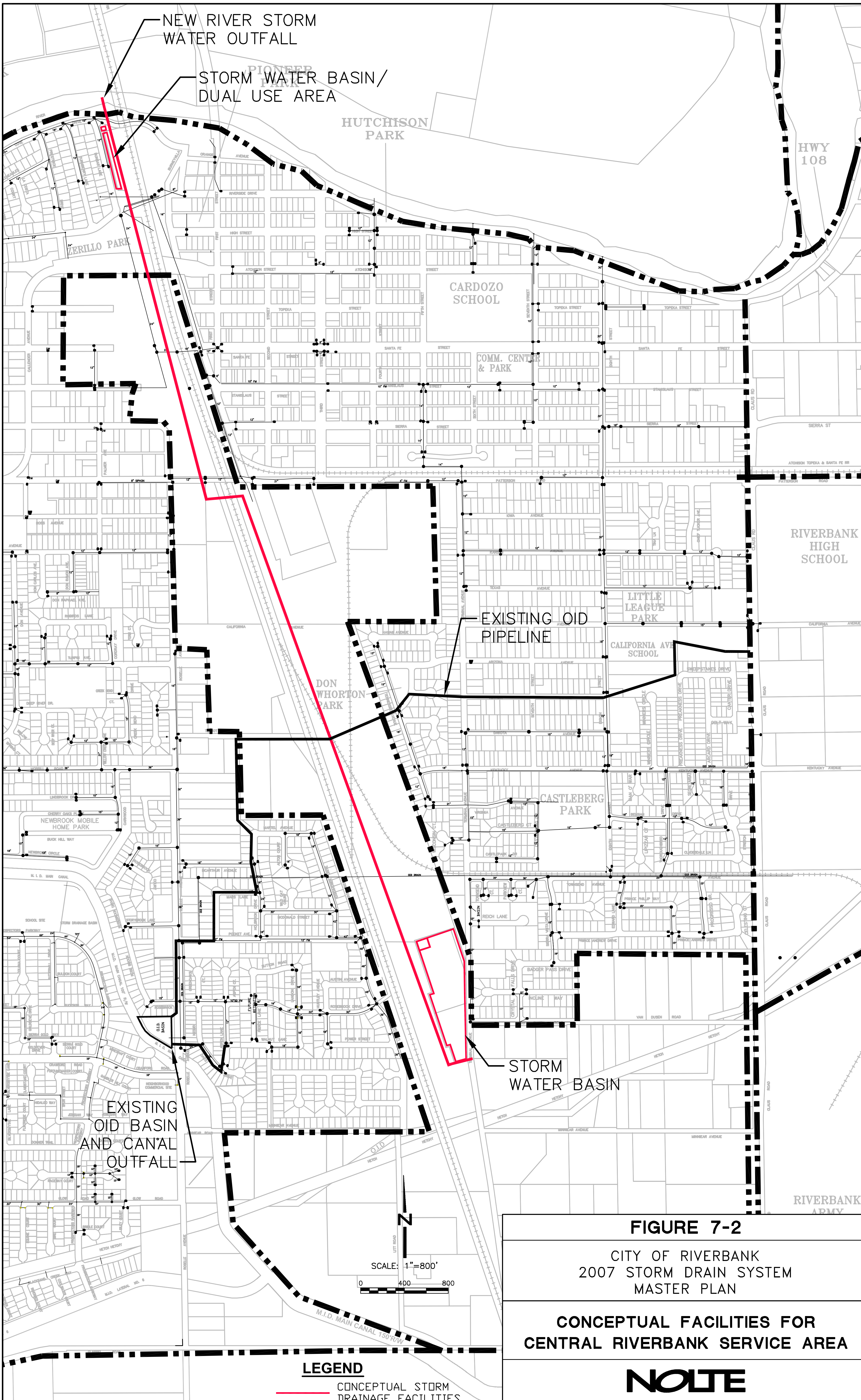

FIGURE 7-2

CITY OF RIVERBANK
2007 STORM DRAIN SYSTEM
MASTER PLAN

CONCEPTUAL FACILITIES FOR CENTRAL RIVERBANK SERVICE AREA

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LEGEND

CONCEPTUAL STORM DRAINAGE FACILITIES

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c. South Central Riverbank Area

There is a large area between Van Dusen Road and Claribel Road between Claus Road and the MID Main Canal that does not have an existing storm drainage system and could have significant growth and development under the new General Plan. New storm drainage outfalls to the MID canals are not considered a good long range plan; therefore, storm water would need to be retained within the area in storm water basins or conveyed to the river through a new central storm water drainage system, sized to serve the future needs of the adjoining areas.

7.3 Strategy for East Riverbank Storm Drain System

The area east of Claus Road is designated as East Riverbank and currently has low density development intermixed with many small pastures and open areas. As shown in the General Plan, the East Riverbank area will have new higher-density development which will provide the needed storm drainage infrastructure. The strategy is to provide new storm water basins and future storm drainage pumps and outfalls to the river. The East Riverbank area has four subareas, which are illustrated on Figure 7-3 and are discussed below.

a. North Bruinville

The North Bruinville area extends from Patterson Road to north of Mesa Drive where the elevation drops to the low area. Several developers have completed planning work in this area and a storm water basin is proposed on the north side of Patterson Road between Central Avenue and Snedigar Avenue. A future storm drain outfall has been planned to go north on Snedigar Avenue. At least one more storm water basin will be needed to serve that area.

b. South Bruinville

The South Bruinville area extends from Patterson Road south to the Hetch Hetchy right-of-way. The developers in this area have proposed a storm water basin between Central Avenue and Snedigar Avenue north of Kentucky Avenue, with a future pump station and outfall pipeline routed north on Snedigar Avenue to join the North Bruinville outfall storm drain. Additional storm water basins will be needed to serve this area.

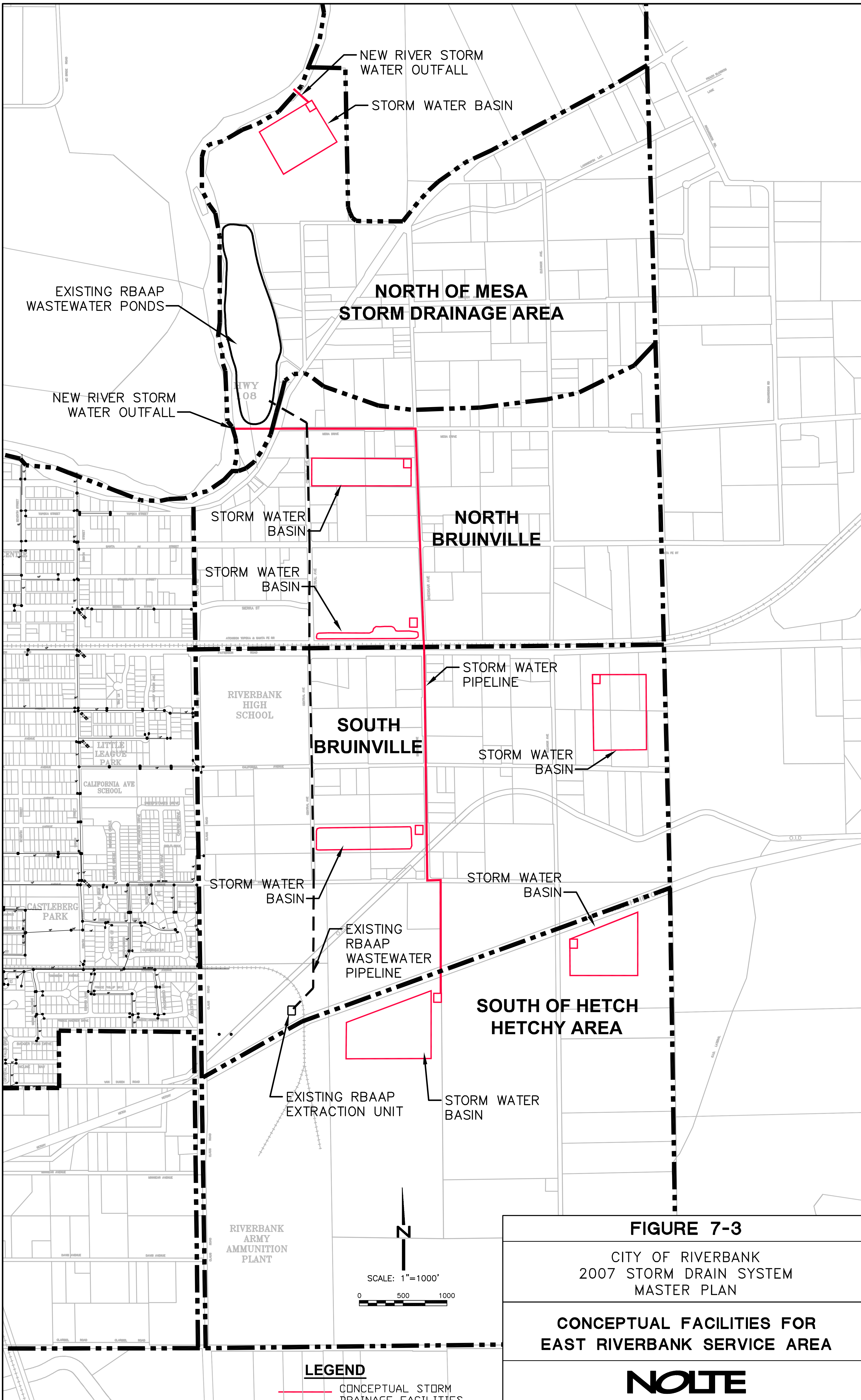

FIGURE 7-3

CITY OF RIVERBANK
2007 STORM DRAIN SYSTEM
MASTER PLAN

CONCEPTUAL FACILITIES FOR EAST RIVERBANK SERVICE AREA

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c. South of Hetch Hetchy

The Hetch Hetchy right-of-way and pipelines create a subarea which is the furthest from the river and is also south of the OID Riverbank Lateral. Although the Riverbank Lateral is still an active irrigation facility, the urban expansion of Riverbank in an easterly direction will diminish the acreage of irrigated parcels that utilize the Riverbank Lateral. This facility may eventually be utilized under a permit with MID, as the Snedigar Pipeline is currently utilized, as a drainage facility that could be potentially be converted to a municipal storm drainage facility. However, because the future available capacity in the OID Riverbank Lateral is unknown, the Master Plan includes storm water disposal on site, in basins, or by discharge to the river through a common outfall pipeline through the South and North Bruinville areas.

The Riverbank Army Ammunition Plan (RBAAP) has an existing storm water collection system for its area, a pumped wastewater pipeline routed north on Central Avenue, and existing wastewater disposal ponds adjacent to the Stanislaus River north of SR108. The RBAAP is being turned over to the City for future reuse. Due to the environmental necessity of the existing RBAAP storm water system, it has not been considered for service to any adjacent areas.

7.4 Strategy for the West Riverbank Storm Drain System

The area west of Oakdale Road is designated as the West Riverbank planning area and is currently mainly agricultural with some low density development. The area slopes to the west with low points in the southwest and the northwest at the Stanislaus River. The General Plan has a multi-use recreation and resource management area (MUR) corridor in the West Riverbank planning area. The storm drain strategy is to construct a series of storm water basins/multiple use areas in this corridor connected with pipelines to collect, distribute, and dispose of the storm water. If needed, the collected storm water could be conveyed northward to a new river outfall. The West Riverbank area and conceptual storm water pipelines are illustrated on Figure 7-4.

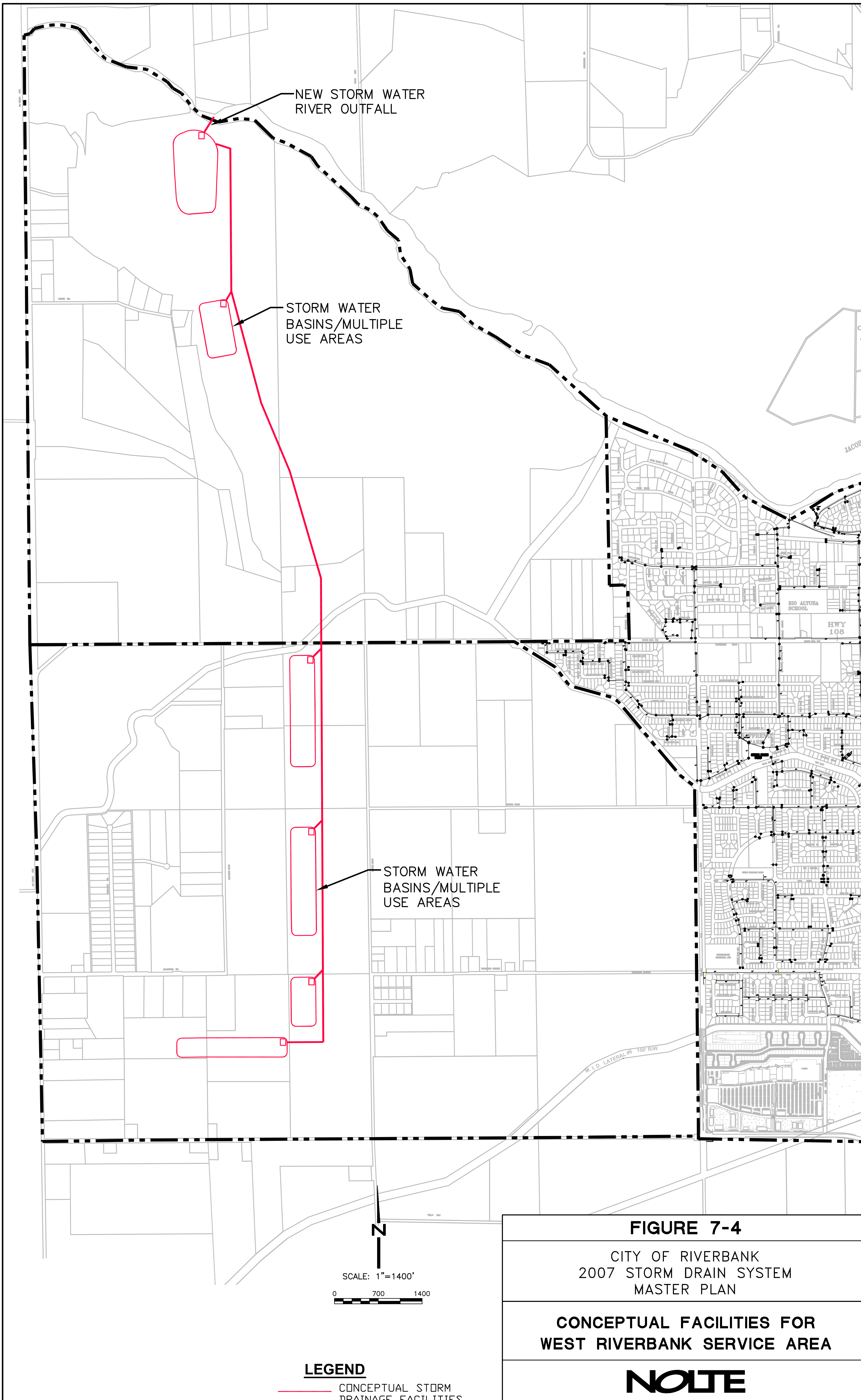

FIGURE 7-4

CITY OF RIVERBANK
2007 STORM DRAIN SYSTEM
MASTER PLAN

CONCEPTUAL FACILITIES FOR WEST RIVERBANK SERVICE AREA

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8 Probable Construction Costs

This chapter summarizes the probable construction costs for the recommended storm drain system improvements.

8.1 Unit Costs

Unit costs were developed for gravity storm drain pipelines, manholes, dual-use basins, lift stations/pumping stations, and other elements identified as recommended improvements in Chapter 7. Tables 8-1 and 8-2 summarize the unit cost information. The unit pipe costs reflect installation, including dewatering, and assume conventional pipe installation by means of open cut, unless otherwise noted. Capital costs may be higher if trenchless technology construction methods are employed. Reinforced concrete pipe was assumed for pipe material for pipelines greater than 10-inches in diameter. A manhole diameter of 48-inches was assumed appropriate for all gravity storm water pipelines. Manholes are assumed to be spaced no more than 500 ft apart. Unit costs were used to estimate probable construction costs for the recommended system improvements.

TABLE 8-1
CITY OF RIVERBANK
STORM DRAIN SYSTEM MASTER PLAN
UNIT COSTS FOR STORM DRAIN PIPELINES

Pipe Diameter, inches	Pipe Cost, $/lf	
	0-10 ft depth	10-20 ft depth
18	158	378
21	144	364
24	148	368
27	165	385
30	186	406
33	214	434
36	240	460
42	266	486
48	292	512

TABLE 8-2
CITY OF RIVERBANK
STORM DRAIN SYSTEM MASTER PLAN
UNIT COSTS FOR SYSTEM COMPONENTS

Item	Unit Cost, $/ea
Connection to Existing Manhole	2,000
Adding a Flow Line to an Existing Manhole	2,000
48-inch Manhole	10,000

8.2 Probable Construction Costs for Recommended Improvements to Existing System

Probable construction costs for the suggested improvements to the existing collection system are presented in Table 8-3. Probable costs are organized by group and tier as discussed in Section 7.1. Also included for improvements to the existing system is upsizing the pipeline along Patterson Road, Fifth Street, Stanislaus Street, and Seventh Street to mitigate flooding as discussed in Section 2.2. For cost estimating purposes, it was assumed that this pipeline would be upsized to 24-inches in diameter, although the required size would be confirmed during final design. Existing areas requiring improvements are designated on Figure 7-1.

TABLE 8-3
CITY OF RIVERBANK
STORM DRAIN SYSTEM MASTER PLAN
SUMMARY OF PROBABLE CONSTRUCTION COSTS FOR
EXISTING SYSTEM IMPROVEMENTS

Group/Tier	Quantity	Unit Cost, $	Unit	Total Cost, $
Group A-Castleberg Basin System				
Tier 1				
Connection to Existing Storm Drain Pipeline at Eighth Street for Conversion of Existing Snedigar Pipeline (OID) to Storm Drain Pipeline	1	27,000	LS	27,000
Tier 2				
Further Study of Eighth Street System	1	25,000	LS	25,000
Tier 3				
Design and Construction of Eighth Street System Improvements				
Parallel Existing 12-inch Pipeline	310	83	LF	25,730
Parallel Existing 15-inch Pipeline	365	89	LF	32,485
Parallel Existing 18-inch Pipeline	630	378	LF	238,140
Parallel Existing 24-inch Pipeline	650	368	LF	239,200
Parallel Existing 30-inch Pipeline	2,705	406	LF	1,098,230
Manholes	15	20,000	EA	300,000
Subtotal				*1,985,785*
Group B-Candlewood System				
Tier 1				
Replace Existing 15-inch Storm Drain Outfall with 36-inch Pipeline	90	460	LF	41,400
Tier 2				
Further Analysis of the Candlewood Place Storm Drain System	1	25,000	LS	25,000
Subtotal				*66,400*
Group C-First Street Basin				
Tier 1				
Maintenance on First Street Basin				
Clearing and Grubbing	1	5,000	LS	5,000

TABLE 8-3 (CONTINUED)
CITY OF RIVERBANK
STORM DRAIN SYSTEM MASTER PLAN
SUMMARY OF PROBABLE CONSTRUCTION COSTS FOR
EXISTING SYSTEM IMPROVEMENTS

Group/Tier	Quantity	Unit Cost, $	Unit	Total Cost, $
Group C-First Street Basin				
Tier 1 (continued)				
Grading of Basin Bottom	1	18,000	LS	18,000
Plant Vegetation at Basin Bottom	1	15,000	LS	15,000
Pave Side Slopes of Basin	740	750	CY	555,000
Tier 2				
Further Analysis of Downstream System	1	25,000	LS	25,000
Tier 3				
Further Analysis Efficiency of Basin Capacity	1	25,000	LS	25,000
Subtotal				*643,000*
Other Projects				
Upsize Pipeline Along Patterson Road, Fifth Street, Stanislaus Street, and Seventh Street	4,000	148	LF	592,000
Subtotal				*592,000*
Total				3,288,000
Contingency, 25%				822,000
Subtotal				4,110,000
Design [a], 10%				399,000
Construction Management [a], 15%				598,000
Probable Cost				**5,200,000**

[a] Design and construction management fees apply to projects under Group A-Tier 1, Group A-Tier 3, Group B-Tier 1, Group C-Tier 1, and Other Projects.

8.3 Probable Construction Costs for Recommended Storm Drain System Strategy

Probable construction costs for suggested improvements to each buildout area for General Plan growth are presented in the following sections. The recommended improvements for each area are designated on Figure 8-1.

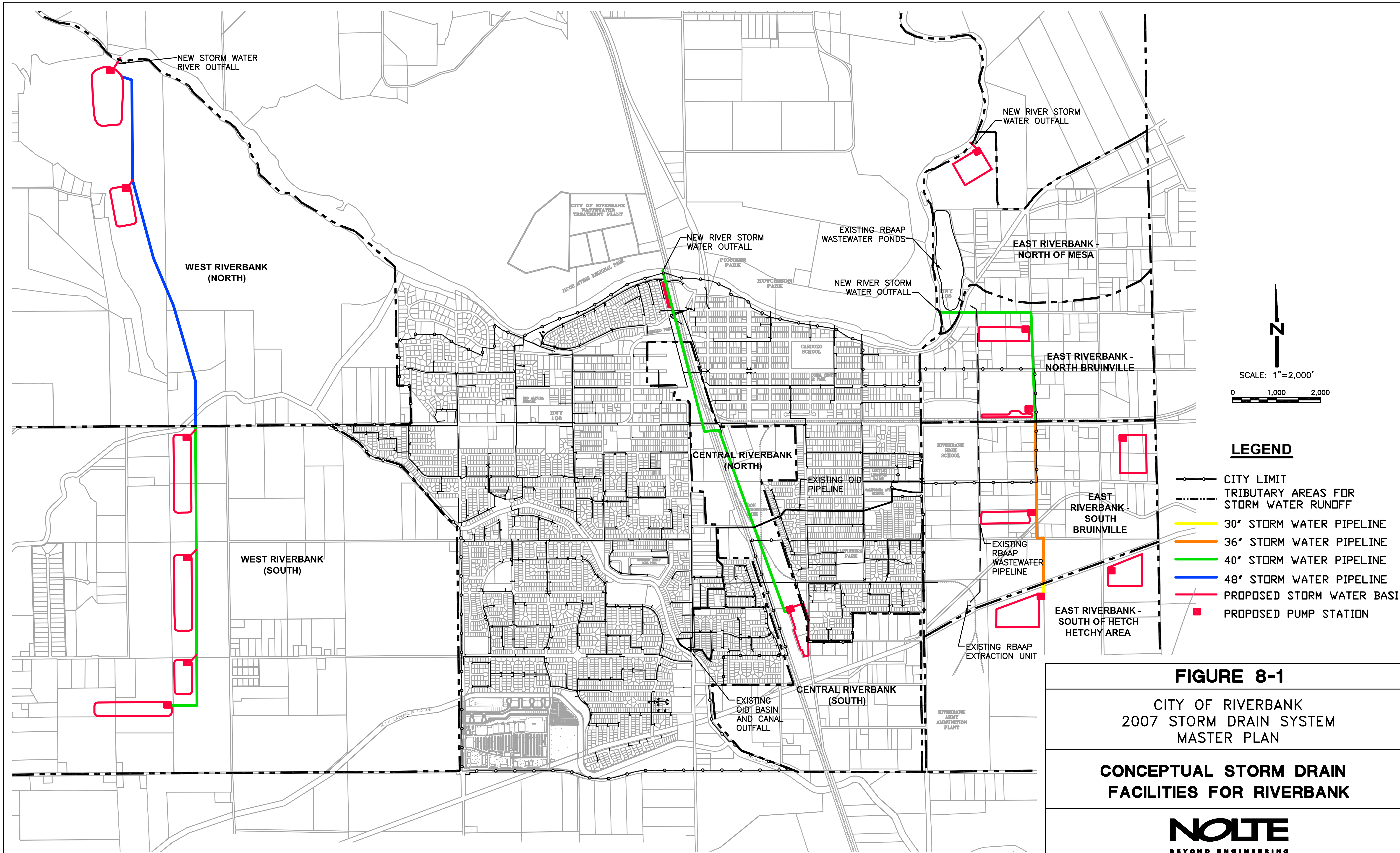

FIGURE 8-1

CITY OF RIVERBANK
2007 STORM DRAIN SYSTEM
MASTER PLAN

CONCEPTUAL STORM DRAIN FACILITIES FOR RIVERBANK

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a. Central Riverbank

Total probable construction cost for the recommended drainage system for Central Riverbank is summarized in Table 8-4. An infrastructure discussion is presented below.

TABLE 8-4
CITY OF RIVERBANK
STORM DRAIN SYSTEM MASTER PLAN
SUMMARY OF PROBABLE CONSTRUCTION COSTS FOR
CENTRAL RIVERBANK SYSTEM IMPROVEMENTS

Item	Quantity	Unit Cost, $	Unit	Total Cost, $
Central Riverbank				
Storm Drain Pipeline				
North				
42-inch Pipeline (0-10 ft cover)	8,070	266	LF	2,146,620
Manholes	17	10,000	EA	169,000
Bore and Jack across Railroad (42-inch Pipeline)	240	600	LF	144,000
Bore and Jack across Railroad at Patterson (42-inch Pipeline)	140	600	LF	84,000
Bore and Jack across SR 108/Atchison (42-inch Pipeline)	200	600	LF	120,000
Storm Water Basin				
South (1 Basin)	18,000	20	CY	360,000
North (1 Basin)	2,000	20	CY	40,000
Pump/Lift Stations				
South Pump Station	1	620,000	EA	620,000
North Pump Station	1	940,000	EA	940,000
Total				4,624,000
Contingency, 25%				1,156,000
Subtotal				5,780,000
Design, 10%				578,000
Construction Management, 15%				867,000
Probable Cost				**7,300,000**

Suggested facilities for Central Riverbank include approximately 8,700 ft of 42-inch gravity storm drain pipe with an outfall to the Stanislaus River near Dunbar Lane. Construction of the storm drain pipeline in Central Riverbank would require 18 manholes and multiple bore and jack crossings under railroads and major roadways. Two dual-use storm water basins with individual lift/pumping stations are proposed as shown on Figure 8-1. There is insufficient land available to completely contain runoff from the 100-year, 24-hour storm event for the areas tributary to the proposed infrastructure. The 42-inch storm drain pipeline has been sized larger than necessary to provide excess capacity not available in the proposed basins.

b. East Riverbank

The total probable construction cost for the recommended drainage system for East Riverbank is summarized in Table 8-5. An infrastructure discussion is presented below.

TABLE 8-5
CITY OF RIVERBANK
STORM DRAIN SYSTEM MASTER PLAN
SUMMARY OF PROBABLE CONSTRUCTION COSTS FOR
EAST RIVERBANK SYSTEM IMPROVEMENTS

Item	Quantity	Unit Cost, $	Unit	Total Cost, $
East Riverbank				
Storm Drain Pipeline				
South of Hetch Hetchy				
30-inch Pipeline (0-10 ft cover)	260	186	LF	48,360
South Bruinville				
36-inch Pipeline (0-10 ft cover)	3,610	240	LF	866,400
North Bruinville				
42-inch Pipeline (0-10 ft cover)	4,490	266	LF	1,194,340
Manholes	18	10,000	EA	175,200
Bore and Jack Across Hetch Hetchy (36-inch Pipeline)	150	600	LF	90,000
Bore and Jack Across R.R. at Patterson (36-inch Pipeline)	140	600	LF	84,000
Bore and Jack Across SR 108 (42-inch Pipeline)	110	600	LF	66,000
Storm Water Basin				
South of Hetch Hetchy (2 Basins)	57,000	20	CY	1,140,000
South Bruinville (2 Basins)	45,000	20	CY	900,000
North Bruinville (2 Basins)	26,000	20	CY	520,000
North of Mesa (1 Basin)	22,000	20	CY	440,000

TABLE 8-5 (CONTINUED)
CITY OF RIVERBANK
STORM DRAIN SYSTEM MASTER PLAN
SUMMARY OF PROBABLE CONSTRUCTION COSTS FOR
EAST RIVERBANK SYSTEM IMPROVEMENTS

Item	Quantity	Unit Cost, $	Unit	Total Cost, $
Pump/Lift Stations				
South of Hetch Hetchy	2	940,000	EA	1,880,000
South Bruinville	2	1,400,000	EA	2,800,000
North Bruinville	2	1,690,000	EA	3,380,000
North of Mesa	1	680,000	EA	680,000
Total				14,265,000
Contingency, 25%				3,567,000
Subtotal				17,832,000
Design, 10%				1,784,000
Construction Management, 15%				2,675,000
Probable Cost				**22,300,000**

Suggested facilities for East Riverbank include approximately 8,800 ft of 30-inch, 36-inch, and 42-inch gravity storm drain pipe with an outfall extending from Mesa Drive to the Stanislaus River just south of the RBAAP wastewater ponds. Construction of the storm drain pipeline in East Riverbank would require 18 manholes and three bore and jack crossings under a railroad, major roadway, and the Hetch Hetchy right-of-way. Seven dual-use storm water basins with individual lift/pumping stations are proposed as shown on Figure 8-1.

c. West Riverbank

The total probable construction cost for the recommended drainage system for West Riverbank is summarized in Table 8-6. An infrastructure discussion is summarized below.

TABLE 8-6
CITY OF RIVERBANK
STORM DRAIN SYSTEM MASTER PLAN
SUMMARY OF PROBABLE CONSTRUCTION COSTS FOR
WEST RIVERBANK SYSTEM IMPROVEMENTS

Item	Quantity	Unit Cost, $	Unit	Total Cost, $
West Riverbank				
Storm Drain Pipeline				
South				
42-inch Pipeline (0-10 ft cover)	6,910	266	LF	1,838,060
North				
48-inch Pipeline (0-10 ft cover)	8,220	292	LF	2,400,240
Manholes	31	10,000	EA	308,000
Bore and Jack Across SR 108 (42-inch Pipeline)	90	600	LF	54,000
Bore and Jack Across Canal (48-inch Pipeline)	180	600	LF	108,000
Storm Water Basin				
South (4 Basins)	82,400	20	CY	1,648,000
North (2 Basins)	41,200	20	CY	824,000
Pump/Lift Stations				
South	4	1,600,000	EA	6,400,000
North	2	2,230,000	EA	4,460,000
Total				18,041,000
Contingency, 25%				4,511,000
Subtotal				22,552,000
Design, 10%				2,256,000
Construction Management, 15%				3,383,000
Probable Cost				**28,200,000**

Suggested facilities for East Riverbank include approximately 15,500 ft of 42-inch and 48-inch gravity storm drain pipe with an outfall to the Stanislaus River at the northwest region of Riverbank. Construction of the storm drain pipeline in West Riverbank would require 31 manholes and two bore and jack crossings under a major roadway and canal. Six dual-use storm water basins with individual lift/pumping stations are proposed as shown on Figure 8-1.

d. Summary

A summary of probable system costs for the proposed storm drain systems in Central, East, and West Riverbank is provided in Table 8-7.

TABLE 8-7
CITY OF RIVERBANK
STORM DRAIN SYSTEM MASTER PLAN
SUMMARY OF PROBABLE SYSTEM COSTS FOR SUGGESTED FACILITIES

Buildout Area	Total Cost, $
Existing System	5,200,000
Central Riverbank	7,300,000
East Riverbank	22,300,000
West Riverbank	28,200,000
Total Probable Cost	**63,000,000**

9 Capital Improvements Program

This chapter presents the recommended Capital Improvements Program (CIP) to address existing deficiencies and future growth for the City of Riverbank.

9.1 Assumptions Used in Developing CIP

The storm drain system CIP was based on the following assumptions:

1. Phasing of the facilities is based upon City growth projections.

2. Storm drain pipelines will be located in dedicated public right-of-way.

3. A contingency of 25% has been applied to all unit costs of construction. The contingency has been added before design and construction management fees are added.

4. Design costs have been estimated at 10% and construction management costs have been estimated at 15%, each as a percentage of the projected construction cost.

5. The pipeline unit cost includes street restoration and appurtenances. Manholes and connections have been cataloged separately.

6. The bore and jack costs include the cost for both the casing and the carrier pipe material.

7. The pump station costs are for a complete facility including wet well, electrical components, and backup power supply.

9.2 Discussion of CIP Facilities and Priorities

The City storm drainage system conveys runoff to multiple points along the Stanislaus River and MID Canal. Major growth is expected in East, West, and Central Riverbank that will significantly increase storm water runoff. Because storm water is collected in gravity systems that seldom have redundant pipelines or alternate routes, pipelines must be designed and constructed with the full capacity needed at buildout. Critical components of the system must be in place prior to extensions and connections to collection lines that would increase the flow beyond the existing capacity.

The following summarizes the recommended improvements described in previous chapters, and prioritizes the CIP into the following phases of current needs, near term, and development driven.

a. Current Needs

1. Improvements to Existing System, Tier 1 – As discussed in Section 7.1, Tier 1 needs are the top priority improvements for providing immediate relief to existing storm drainage systems. From the Group A improvements, the first priority is to increase capacity of the Castleberg/Eighth Street system by connecting the abandoned OID facilities to the existing storm drain system. The priority project under the Group B improvements is to replace the storm drain outfall at Candlewood Place. Further analysis would be required to determine the required pipe size. However, for cost estimating purposes, the replacement pipe size is assumed at 36-inch diameter. From the Group C improvements, the top priority project is maintenance on the First Street Basin. Potential improvements for erosion control used in the cost estimate include grading the basin bottom, planting vegetation for flow paths, and paving the side slopes.

2. Improvements to Existing System, Tier 2 – Projects designated at Tier 2 require further analysis of the existing system. The Tier 2 improvements for Group A involve further study of the Eighth Street system to investigate the effects of surcharging and possible solutions to prevent flooding conditions. Under Group B, the Tier 2 project is further analysis of the Candlewood Place storm drain system to identify possible alternatives for relieving flooding. The Group C Tier 2 project involves a downstream system analysis to determine alternatives for providing consistent outflow from the First Street Basin.

3. Improvements to the Existing System, Tier 3 – The Tier 3 project for Group A includes the design and construction of Eight Street Improvements. A possible solution of paralleling the existing storm drain pipeline to provide additional capacity was used for cost estimating purposes. The Tier 3 project for Group C is further analysis of the efficiency of the First Street Basin capacity.

4. Other Projects – Other high priority projects include upsizing the pipeline from Patterson Road, west of Terminal Avenue, to the outfall on Seventh Street. Upsizing the existing pipeline will mitigate flooding and provide additional capacity for the First Street Basin. Further analysis would be required to determine the required pipe size. However, for cost estimating purposes, the replacement pipe size is assumed at 24-inch diameter.

b. Near-term Needs

1. Central Riverbank Storm Drain Improvements – Storm drain improvements to Central Riverbank are a near-term need to supplement the existing system as well as prepare for

new growth in the existing City and General Plan buildout areas. As described in Section 8.3, suggested facilities for Central Riverbank include approximately 8,700 ft of storm drain pipeline and associated facilities as well as two dual use storm water basins with individual pumping stations.

c. Development Driven

1. East Riverbank Storm Drain Improvements – As development begins in East Riverbank, a backbone system will need to be constructed to collect, distribute, and dispose of storm water. As described in Section 8.3, suggested facilities for East Riverbank include approximately 8,800 ft of storm drain pipeline and associated facilities as well as seven dual use storm water basins with individual pumping stations.

2. West Riverbank Storm Drain Improvements – As development begins in West Riverbank, a backbone system will need to be constructed to collect, distribute, and dispose of storm water. As described in Section 8.3, suggested facilities for West Riverbank include approximately 15,500 ft of storm drain pipeline and associated facilities as well as six dual use storm water basins with individual pumping stations.

9.3 Probable Costs for Recommended CIP

A summary of probable costs for current needs, near-term needs, and development driven projects is provided in Table 9-1.

TABLE 9-1
CITY OF RIVERBANK
STORM DRAIN SYSTEM MASTER PLAN
PROBABLE PROJECT COSTS FOR RECOMMENDED CIP

CIP Phase/Project	Total Cost[a], $
Current Needs	
Tier 1	
Connect OID Snedigar Pipeline to Storm Drain System	42,200
Replace Storm Drain Outfall for Candlewood System	64,700
Repair First Street Basin	926,000
Tier 2	
Further Analysis of Eighth Street System	31,300
Further Analysis of Candlewood Place System	31,300
Further Analysis of System Downstream of First Street Basin	31,300
Tier 3	
Design and Construction of Eighth Street System Improvements	3,022,000
Further Analysis of Efficiency of First Street Basin Capacity	31,300
Other Projects	
Upsize pipeline along Patterson Road Fifth Street, Stanislaus Street, and Seventh Street	925,000
Subtotal	*5,106,000*
Near-Term Needs	
Central Riverbank	
Storm Water Basins	625,000
Storm Water Pump Stations	2,438,000
Storm Water Pipelines	4,170,000
Subtotal	*7,233,000*
Development Driven	
East Riverbank	
Storm Water Basins	4,688,000
Storm Water Pump Stations	13,657,000
Storm Water Pipelines	3,947,000
West Riverbank	
Storm Water Basins	3,863,000
Storm Water Pump Stations	16,968,000
Storm Water Pipelines	7,359,000
Subtotal	*50,482,000*
Total Probable Costs	**63,000,000**

[a] Includes contingency, design, and construction management allowances

References

[1] *City of Riverbank General Plan,* to be adopted 2007.

[2] *City of Riverbank, Storm Drain System Master Plan*, *Draft,* prepared by GDR Engineering, February 2002.

[3] *East Riverbank Drainage Feasibility Study*, prepared by Giuliani & Kull, Inc., July 18, 2006.

[4] *City of Riverbank, Summary of Proposed Design Criteria Technical Memorandum*, prepared by Nolte Associates, Inc., June 2007.

[5] City of Riverbank Standard Specifications, Storm Drain Systems Section, 2007.

[6] Stanislaus County Standards, July 1998.

[7] *City of Riverbank, Sewer System Master Plan,* prepared by Garcia-Davis-Ringler Engineering, November 2001.

[8] Storm Water Management Program for the Cities of Ceres, Oakdale, Patterson, Riverbank, Report of Waste Discharge, March 10, 2003.

[9] Storm Water Quality Handbook – Project Planning and Design Guide, California Department of Transportation, May 2007.

[10] City of Riverbank Standard Specifications, Section 7, July 1994.

[11] City of Riverbank Storm System Maps, February 17, 2006.

[12] Field Topography, April 2007.