CITY OF RIVERBANK
WATER SUPPLY STUDY AND
WATER MASTER PLAN

VOLUME ONE

NOVEMBER 2007

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BEYOND ENGINEERING

CITY OF RIVERBANK

WATER SUPPLY STUDY AND WATER MASTER PLAN

Volume One

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LIST OF ABBREVIATIONS

The following abbreviations are used in this report:

ac	Acres
ac-ft	Acre Feet
ADD	Average Day Demand
bgs	Below Ground Surface
CIP	Capital Improvements Program
du	Dwelling Unit
EA	Each
FAR	Floor Area Ratio
FCV	Flow Control Valve
ft/sec	Feet per Second
gpd/acre	Gallons per Day per Acre
gpd/du	Gallons per Day per Dwelling Unit
gpm	Gallons per Minute
LF	Linear Foot
MG	Million Gallons
MID	Modesto Irrigation District
mgd	Million Gallons per Day
OID	Oakdale Irrigation District
PF	Peaking Factor (diurnal)
psi	Pounds per Square Inch
SF	Square Feet
SR	State Route
TMP	Transmission Main Project
VFD	Variable Frequency Drive
yr	Year

1 Introduction

In support of a new General Plan a water supply and water distribution system master plan is required. Background information and intended master planning tasks are presented in this chapter.

1.1 Background and Purpose

In 2007, the City of Riverbank (City) will adopt the General Plan Policy Document (General Plan) [1] which identifies areas to be developed within the City to the year 2025. Previous infrastructure studies have identified deficiencies within the existing supply system that will require correction prior to significant development. Considering the need to ensure that water supply systems can support infill development within existing City limits and in General Plan areas, a master plan is warranted.

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

1. Projected water demands for various land uses from the General Plan.
2. Design of supply and distribution system to accommodate expanded service areas.
3. Capacity and condition of the existing distribution system.
4. Phased Capital Improvements 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 water supply system information.
2. Catalog existing water supply system deficiencies based on interviews with City staff and a review of historical records.

3. Compare the existing water demands/storage requirements to available water system facilities.

4. Develop water demand factors for residential service based on historical data.

5. Project future water demands using General Plan land use information and water demand factors.

6. Simulate the operation of the existing supply and distribution system through a steady-state computer model to identify capacity being utilized and possible locations of delivery system deficiencies.

7. Recommend piping improvements within the distribution system to correct operational deficiencies.

8. Identify water supply and distribution system expansions to serve new General Plan areas.

9. Develop a CIP which identifies specific water-related infrastructure projects required to support the new General Plan.

Each of these tasks is summarized in the following chapters.

2 Existing Conditions

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

2.1 Characteristics of the Existing Water System

The City supplies potable water through a pressurized distribution system. The City water supply and distribution system is comprised of eight wells with pumps, two 1 MG storage tanks with booster stations, and over 44 miles of pipeline 8 inch to 12 inch in diameter. There are also several miles of 4-inch and 6-inch diameter pipelines. The City existing water system is shown in Plate 2-A.

2.2 Existing Water Supply Wells

The City has eight water wells which supply all water used in the City system. The inventory includes new Well No. 9 (Prospector) constructed by the Crossroads residential development. The City is in the process of constructing a ninth well, Well No. 10, which will be located on City property north of the Crossroads commercial development near Oakdale Road and just south of the Modesto Irrigation District Lateral #6 Canal. A tenth well, Well No. 11, has been designed and is planned for the south side of Santa Fe Street, east of Central Avenue in rural northeastern Riverbank. Both Well No. 10 and Well No. 11 will have a pumping capacity of approximately 1,500 gpm (depending on groundwater levels). The locations of existing and planned water supply wells and tanks are shown in Figure 2-1.

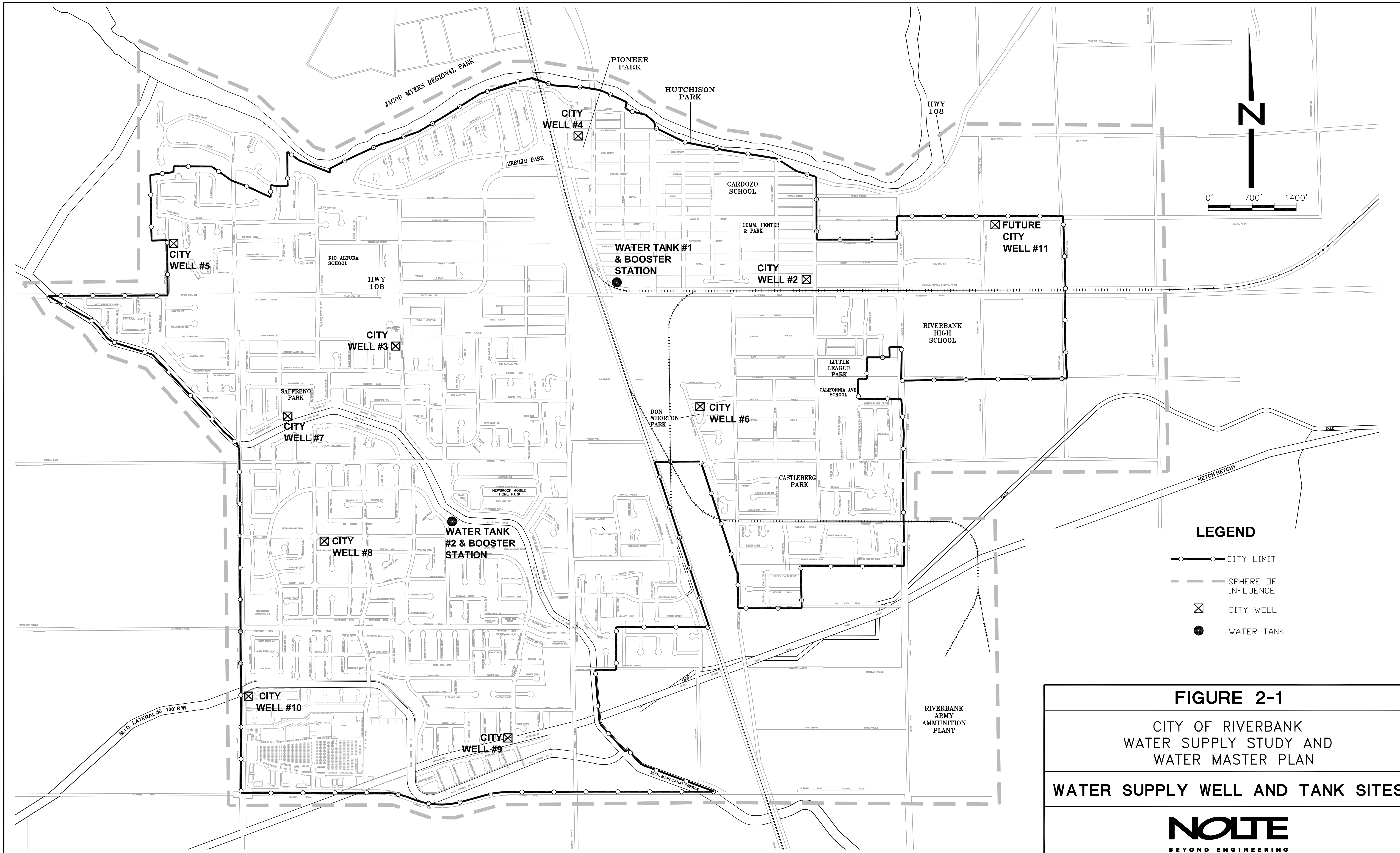

FIGURE 2-1

CITY OF RIVERBANK
WATER SUPPLY STUDY AND
WATER MASTER PLAN

WATER SUPPLY WELL AND TANK SITES

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A summary of the production capacity and other information for the existing groundwater wells is presented in Table 2-1.

TABLE 2-1
CITY OF RIVERBANK
WATER SUPPLY STUDY AND WATER MASTER PLAN
EXISTING GROUNDWATER WELLS

Well Number	Location	Year Drilled	Casing Depth (ft)	Pump Capacity (gpm)	Motor Size (hp)	Notes
1	2nd Street	1949	--	--	--	Abandoned
2	8th Street	1956	240	660	40	Operates with VFD[a]
3	Jackson	1965	420	625	60	Operates with VFD[a]
4	Pioneer	1972	436	900	100	Operates with VFD[a]
5	River Heights	1978	385	900	75	--
6	Whorton	1981	560	1,000	100	Operates with VFD[a]
7	Crossroads	1990	Unknown	1,200	100	--
8	Novi	2001	260	1,200	100	--
9	Prospector	2004	392	1,300	100	Operates with VFD[a]

[a] VFD = Variable Frequency Drive.

The 2006 monthly production and annual totals for each well are summarized in Table 2-2. The total well field production for 2006 was approximately 1,593,307,000 gallons or 4,890 acre feet (ac-ft). The average day use for 2006 was 4,366,000 gallons. The historic maximum water usage month occurred in July 2006 and is summarized in Table 2-3 with daily totals for each well. The peak day usage was July 19, 2006 at 8,823,000 gallons. This peak day usage was met by all eight wells operating 18.9 of the 24 hours that day.

TABLE 2-2
CITY OF RIVERBANK
WATER SUPPLY STUDY AND WATER MASTER PLAN
2006 WELL PRODUCTION (GALLONS)

Month	8th Street (Well No. 2)	Jackson (Well No. 3)	Pioneer (Well No. 4)	River Heights (Well No. 5)	Whorton (Well No. 6)	Crossroads (Well No. 7)	Novi (Well No. 8)	Prospector (Well No. 9)	Totals
January	7,232,200	25,432	135,388	2,000	0	0	80,000	66,946,000	74,421,020
February	10,073,400	2,410,056	25,898,752	0	12,000	24,761,000	1,160,000	8,389,000	72,704,208
March	9,543,900	44,880	19,481,660	65,000	12,000	94,000	5,100,000	40,960,000	75,301,440
April	17,318,200	655,248	13,622,576	545,000	14,000	1,147,000	14,260,000	24,168,000	71,730,024
May	18,042,500	7,361,816	38,348,464	15,271,000	12,000	59,000	19,350,000	73,621,000	172,065,780
June	12,293,675	16,028,144	38,528,919	26,931,500	13,051,250	2,172,250	30,622,500	64,483,500	204,111,738
July	23,564,225	0	19,625,089	34,073,500	24,124,750	19,261,750	39,537,500	73,177,500	233,364,314
August	21,635,300	1,660,560	27,658,796	28,898,000	32,475,000	7,606,000	22,200,000	73,785,000	215,918,656
September	11,783,800	2,182,664	29,396,400	4,161,000	24,906,000	3,053,000	26,950,000	65,602,000	168,034,864
October	13,422,000	1,065,152	27,821,112	3,530,000	0	1,472,000	24,600,000	56,931,000	128,841,264
November	8,417,600	0	20,843,020	1,030,000	9,978,000	183,000	12,900,000	45,156,000	98,507,620
December	11,157,100	50,116	30,220,696	307,000	0	149,000	6,030,000	30,392,000	78,305,912
Totals	**164,483,900**	**31,484,068**	**291,580,872**	**114,814,000**	**104,585,000**	**59,958,000**	**202,790,000**	**623,611,000**	**1,593,306,840**

TABLE 2-3
CITY OF RIVERBANK
WATER SUPPLY STUDY AND WATER MASTER PLAN
DAILY WELL PRODUCTION FOR MAXIMUM MONTH OF JULY 2006 (GALLONS)

Date	8th Street (Well No. 2)	Jackson (Well No. 3)	Pioneer (Well No. 4)	River Heights (Well No. 5)	Whorton (Well No. 6)	Crossroads (Well No. 7)	Novi (Well No. 8)	Prospector (Well No. 9)	Totals
07/01/06	725,475	0	1,179,035	1,082,500	361,250	359,250	972,500	2,419,500	7,099,510
07/02/06	725,475	0	1,179,035	1,082,500	361,250	359,250	972,500	2,419,500	7,099,510
07/03/06	725,475	0	1,179,035	1,082,500	361,250	359,250	972,500	2,419,500	7,099,510
07/04/06	798,050	0	0	1,206,000	498,000	788,500	1,390,000	2,624,000	7,304,550
07/05/06	798,050	0	0	1,206,000	498,000	788,500	1,390,000	2,624,000	7,304,550
07/06/06	760,100	0	11,220	1,171,000	469,000	590,000	1,325,000	2,468,500	6,794,820
07/07/06	777,200	0	0	1,154,000	444,000	590,000	1,325,000	2,468,500	6,758,700
07/08/06	792,633	0	0	1,182,667	513,667	579,333	1,470,000	2,547,000	7,085,300
07/09/06	792,633	0	0	1,182,667	513,667	579,333	1,470,000	2,547,000	7,085,300
07/10/06	792,633	0	0	1,182,667	513,667	579,333	1,470,000	2,547,000	7,085,300
07/11/06	777,700	0	0	1,180,000	521,000	941,000	1,540,000	2,547,000	7,506,700
07/12/06	854,600	0	0	1,116,000	475,000	793,667	1,500,000	2,948,000	7,687,267
07/13/06	704,300	0	6,732	1,131,000	475,000	793,667	1,100,000	2,098,000	6,308,699
07/14/06	809,700	0	0	1,201,000	564,000	793,667	1,790,000	2,758,000	7,916,367
07/15/06	784,700	0	0	1,151,667	511,667	870,333	1,406,667	2,463,333	7,188,367
07/16/06	784,700	0	0	1,151,667	511,667	870,333	1,406,667	2,463,333	7,188,367
07/17/06	784,700	0	0	1,151,667	511,667	870,333	1,406,667	2,463,333	7,188,367
07/18/06	794,000	0	0	1,117,000	909,000	1,006,000	1,470,000	2,581,000	7,877,000
07/19/06	849,600	0	1,346,400	1,033,000	1,326,000	414,000	1,150,000	2,704,000	8,823,000

TABLE 2-3 (CONTINUED)
CITY OF RIVERBANK
WATER SUPPLY STUDY AND WATER MASTER PLAN
DAILY WELL PRODUCTION FOR MAXIMUM MONTH OF JULY 2006 (GALLONS)

Date	8th Street (Well No. 2)	Jackson (Well No. 3)	Pioneer (Well No. 4)	River Heights (Well No. 5)	Whorton (Well No. 6)	Crossroads (Well No. 7)	Novi (Well No. 8)	Prospector (Well No. 9)	Total Day Volume
07/20/06	622,000	0	950,708	970,000	976,000	383,000	870,000	2,267,000	7,038,708
07/21/06	742,200	0	1,270,104	1,033,000	1,170,000	663,000	1,220,000	2,489,000	8,587,304
07/22/06	736,830	0	1,250,282	1,045,143	1,164,000	645,857	1,268,571	1,841,857	7,952,541
07/23/06	736,830	0	1,250,282	1,045,143	1,164,000	645,857	1,268,571	1,841,857	7,952,541
07/24/06	736,830	0	1,250,282	1,045,143	1,164,000	645,857	1,268,571	1,841,857	7,952,541
07/25/06	736,830	0	1,250,282	1,045,143	1,164,000	645,857	1,268,571	1,841,857	7,952,541
07/26/06	736,830	0	1,250,282	1,045,143	1,164,000	645,857	1,268,571	1,841,857	7,952,541
07/27/06	736,830	0	1,250,282	1,045,143	1,164,000	645,857	1,268,571	1,841,857	7,952,541
07/28/06	736,830	0	1,250,282	1,045,143	1,164,000	645,857	1,268,571	1,841,857	7,952,541
07/29/06	736,830	0	1,250,282	996,333	1,164,000	256,333	1,013,333	2,472,667	7,889,779
07/30/06	736,830	0	1,250,282	996,333	1,164,000	256,333	1,013,333	2,472,667	7,889,779
07/31/06	736,830	0	1,250,282	996,333	1,164,000	256,333	1,013,333	2,472,667	7,889,779
Totals	**23,564,225**	**0**	**19,625,089**	**34,073,500**	**24,124,750**	**19,261,750**	**39,537,500**	**73,177,500**	**233,364,314**
Peak Gallons/ Day (7/19/06)									**8,823,000**

The 2006 City billing information divided into five categories is presented in Table 2-4. The water billing information accounted for approximately 92% of the water produced for the same period. The balance would be City uses including parks, landscaping, possible flat rate agreements, and system water losses.

TABLE 2-4
CITY OF RIVERBANK
WATER SUPPLY STUDY AND WATER MASTER PLAN
CITY-WIDE WATER BILLING INFORMATION FOR 2006

Category	Number of Connections	Water Usage (gallons)
Residential	6,168	1,321,563,009
Commercial	214	94,960,040
Industrial	6	21,050,183
Government	19	9,164,759
Other	24	24,929,207
Totals	**6,431**	**1,471,667,200**

For the year of 2005, there were a total of 6,180 water connections. The number of water connections increased by 251 or 4.1% from October 2005 to October 2006. This follows an increase of 784 water connections in the period October 2004 to October 2005. The well production records showed an increase of 4.8% in water consumed from 2005 to 2006.

2.3 Existing Potable Water Storage and Distribution System Facilities

The existing potable water storage facilities consist of two above-ground storage tanks. One above-ground storage tank is located on Second Street just north of Patterson Road. The other above-ground storage tank is located on Saxon Way near the Modesto Irrigation District Main Canal. Each of the storage tanks has a capacity of approximately 1 MG (million gallons). Each tank includes a booster pump station equipped with three pumps. Each pump has a capacity of approximately 1,000 gpm. Table 2-5 summarizes existing potable water storage facilities for the City.

TABLE 2-5
CITY OF RIVERBANK
WATER SUPPLY STUDY AND WATER MASTER PLAN
WATER STORAGE AND BOOSTER STATION FACILITIES

	Tank #1	Tank #2
Storage Capacity, MG	1.0	1.0
Tank Diameter, ft	80	77
Tank Height, ft	28	32
Tank Elevation, ft	138	127
Number of Booster Pumps	3	3
Pump Capacity, Each	1,000 gpm	1,000 gpm
Location	Second Street	Saxon Way

3 Background Information - Design Criteria

Design criteria for the Master Plan is based on the technical memorandum *Summary of Proposed Design Criteria* (April 2007) [2]. The technical memorandum includes a discussion of the study area boundaries, land use assumptions, waste demand factors, groundwater supply, storage, and operational performance. Each is discussed in this chapter below.

3.1 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 3-1.

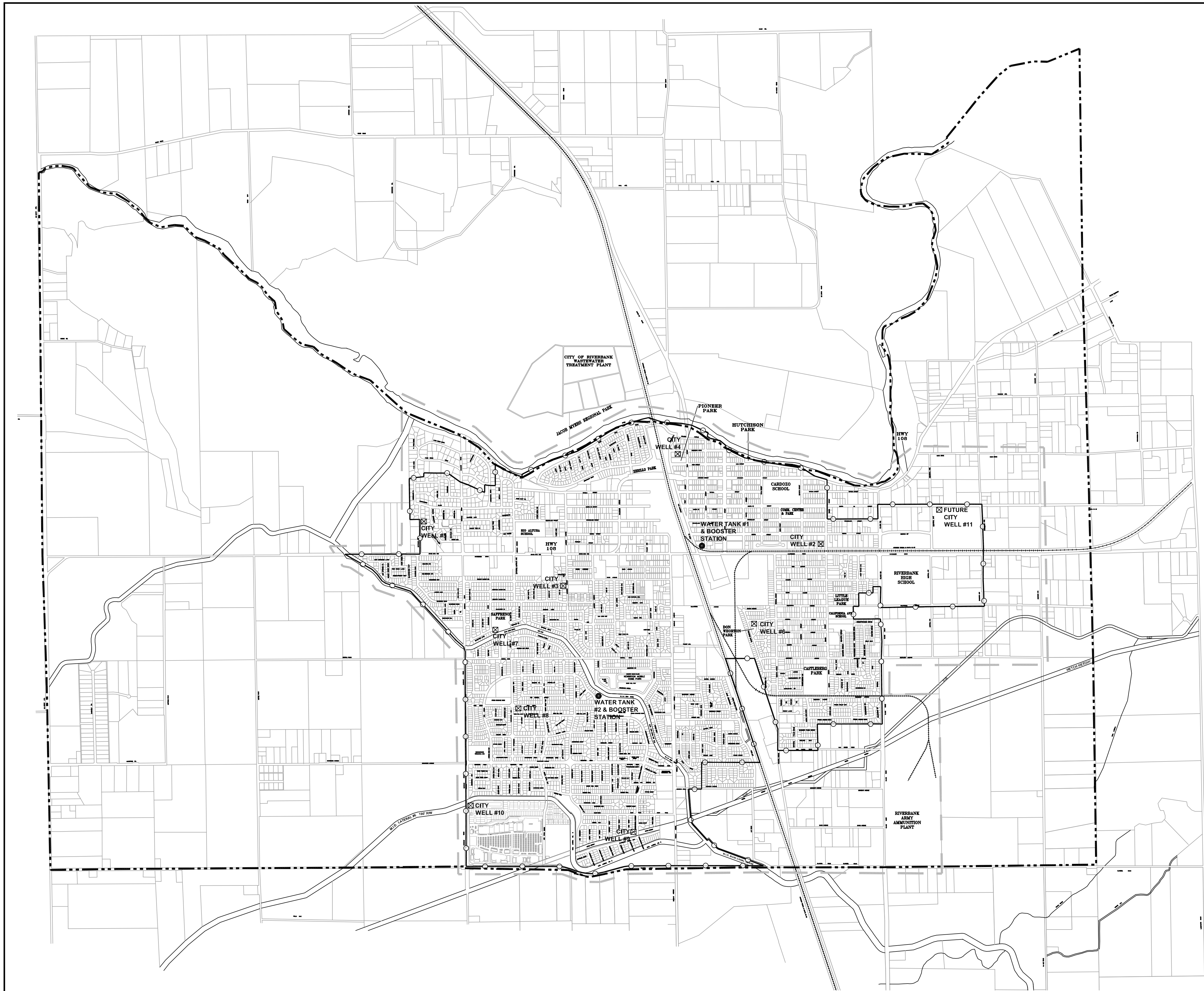

FIGURE 3-1

CITY OF RIVERBANK
WATER SUPPLY STUDY AND
WATER MASTER PLAN

GENERAL PLAN STUDY AREA

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3.2 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 for percentages of roadways for each land use category within City limits and densities for residential areas are presented in Table 3-1.

TABLE 3-1
CITY OF RIVERBANK
WATER SUPPLY STUDY AND WATER MASTER PLAN
ASSUMPTIONS FOR LAND USE AREAS WITHIN CITY LIMITS

Type of Land Use	Major/ Minor 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)[b]	-	-
Commercial	30	-
Industrial	30	-
School	-	-
Park	-	-
Open Space (Future Parks)	-	-

[a] All Infill areas within City limits are assumed Medium Density Residential.
[b] Demand factor unit is gpd/ac.

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 percentages 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 3-2.

TABLE 3-2
CITY OF RIVERBANK
WATER SUPPLY STUDY AND WATER MASTER PLAN
GENERAL PLAN LAND USE ASSUMPTIONS

Type of Land Use	Major/ Minor Roads (%)	Density (du/ac)	Household Size[a]	FAR[b]	Non-Residential Development Per Acre (SF)	Notes
Agricultural Resource Conservation Area	-	-	-	-	-	
Buffer Greenway Open Space	-	-	-	-	-	
Clustered Rural Residential	-	0.2	3.11	-	-	
High Density Residential	30	18.0	2.18	-	-	
Industrial-Business Park	30	-	-	0.25	-	
Infill Opportunity Area Downtown	-	0.9	2.18	0.51	997	
Infill Opportunity Area West Riverbank	-	1.6	2.18	0.26	217	
Low Density Residential	30	5.0	3.11	-	-	
Medium Density Residential	30	10.0	3.00	-	-	
Mixed Use Office Retail Residential	30	18.0	2.18	0.25	-	80% Non-Residential, 20% Residential (MUORR5 & MUORR9 100% Non-Residential)
Multi Use Recreation	-	-	-	-	-	
Park	-	-	-	-	-	
School-Civic	-	-	-	-	-	

[a] Population/dwelling unit.
[b] Floor area ratio.

3.3 Water Demand Factors

Proposed water demand factors for existing and future development areas are summarized in Table 3-3. Existing water demand factors were developed based on an analysis of historical water billings and well production data. Future water demand factors were based on existing demand factors as well as previous water supply studies prepared for the City [3, 4, 5]. Future water demands assume greater water usage considering higher residential occupancies and more extensive non-potable water use.

TABLE 3-3
CITY OF RIVERBANK
WATER SUPPLY STUDY AND WATER MASTER PLAN
PROPOSED WATER DEMAND FACTORS FOR
EXISTING AND FUTURE DEVELOPMENT AREAS

Land Use	Annual Average Day (ADD) Demand Factor	
	Existing	Future
Agricultural Resource Conservation Area	-	0 gpd/ac
Buffer Greenway Open Space (Open Space)	0 gpd/acre	0 gpd/ac
Clustered Rural Residential	-	1,200 gpd/du
High Density Residential	-	435 gpd/du
Industrial-Business Park (Industrial)	430 gpd/ac	2,000 gpd/ac
Low Density Residential	1,000 gpd/du, gpd/ac	625 gpd/du
Medium Density Residential	600 gpd/du	600 gpd/du
Infill Opportunity Area – Downtown, Non-Residential	-	2,000 gpd/ac
Infill Opportunity Area – Downtown, Residential	-	435 gpd/du
Infill Opportunity Area – West Riverbank, Non-Residential	-	2,000 gpd/ac
Infill Opportunity Area – West Riverbank, Residential	-	435 gpd/du
Mixed Use Office Retail Residential, Non-Residential (Commercial)	1,900 gpd/ac	2,000 gpd/ac
Mixed Use Office Retail Residential, Residential	-	435 gpd/ac
Multi Use Recreation	-	2,000 gpd/ac
Park	1,900 gpd/ac	2,500 gpd/ac
School-Civic	400 gpd/ac	2,000 gpd/ac

Based on 2006 City billing data and well production records, the average daily demand for residential land use was found to be 600 gpd per equivalent dwelling unit (EDU). This demand factor was used as a base for all medium density residential lots in both existing areas and future areas within City limits and in the General Plan. The water demands for other types of residential land uses (high density residential, low density residential, and mixed use office retail residential) were determined based on a comparison of the density and household size assumptions listed in Table 3-2.

Typical peaking factors are:

1. Maximum day demand = Average day demand x 2.3
2. Peak hour demand = Average day demand x 3.5

3.4 Groundwater Supply

Groundwater serves currently as the principle source of potable water. Design criteria for the groundwater supply network are presented in Table 3-4.

TABLE 3-4
CITY OF RIVERBANK
WATER SUPPLY STUDY AND WATER MASTER PLAN
PROPOSED DESIGN CRITERIA FOR
GROUNDWATER SUPPLY NETWORK

Criteria	Value
Demand requirement	Satisfy maximum day demand
Reserve capacity	20%
Emergency provisions	Standby power

3.5 Storage

Proposed requirements for water storage are summarized in Table 3-5. Storage should be provided for equalization, emergency, and firefighting purposes. It is recommended that as a minimum, tankage be provided for equalization and fire storage volumes. Booster pumping should be provided with storage tanks to meet peak hour demand. The minimum capacity of booster pumping should be equal to the difference in peak hour demands versus the maximum day demand or the volume of equalization storage delivered over a 24-hour period, whichever is greater. Emergency storage can be furnished through the operation of groundwater wells. The emergency capacity of the groundwater wells is based on well capacity greater than the maximum day demand and 20% reserve capacity while pumping for a 24-hour period.

TABLE 3-5
CITY OF RIVERBANK
WATER SUPPLY STUDY AND WATER MASTER PLAN
PROPOSED DESIGN REQUIREMENTS FOR STORAGE

Criteria	Value
Equalization storage	25% of maximum day demand
Emergency storage	1 times average day demand
Fire storage, school	3,500 gpm for three hours
Fire storage, commercial/industrial	4,000 gpm for three hours
Minimum water storage tank size	1 million gallons

3.6 Distribution System Operational Performance

Key design criteria for the water distribution system are as follows:

1. Standard water line sizing at 10 ft/sec for fire flows and 6 ft/sec for distribution flows.
2. Maximum pipeline velocity of 10 ft/sec during fire flow deliveries.
3. Minimum size for distribution water lines with residential fire hydrants at 8-inches.
4. Minimum of 12-inch water lines to be provided at no more than ½ mile grids.
5. System design will be based on the Hazen-Williams formula with C=130.
6. Minimum system pressure of 35 psi under maximum day demand plus fire flow will be maintained.
7. Minimum residual pressure of 35 psi at peak hour demand will be maintained.
8. Maximum head loss of 15 ft per 1,000 ft of pipe will be used as secondary design parameter.

4 Existing and Projected Water Demands

Existing and projected water demands for the Master Plan are based on the technical memorandum *Buildout Projections of Water Demands* (April 2007) [6]. To analyze the impacts of the General Plan on future infrastructure, projections of water demands are necessary. This chapter presents: 1) existing water demands within City limits, 2) future water demands within City limits considering infill and future development, and 3) water demands for General Plan areas.

4.1 Description of Methodology

Variables required to determine water demand projections are presented in Table 4-1.

TABLE 4-1
CITY OF RIVERBANK
WATER SUPPLY STUDY AND WATER MASTER PLAN
VARIABLES REQUIRED FOR WATER DEMAND PROJECTIONS

Variable	Unit
Type of Land Use	unitless
Water Demand Factor	gpd/du, gpd/ac
Density (lot sizes < 1 acre)	du/ac
Household Size	number of persons/du

Using the information from Table 4-1, the following step-by-step methodology was employed:

1. A summary of existing land use within the City was developed. The summary was divided into specific land use areas based on a review of historical information augmented by windshield surveys.

2. Existing land use was quantified through AutoCAD measurement of electronic files furnished by the City.

3. Anticipated areas within the City boundary for future development (infill) were identified and quantified similar to steps 1 and 2 above.

4. For development beyond the current City boundary, as envisioned in the updated General Plan, a land use summary was obtained from the General Plan consultants (EDAW).

5. Existing water demand factors were confirmed based on an analysis of historical water usage. Future water demand factors were based on previous water supply studies prepared for the City [3, 4, 5].

6. A water demand factor was selected based on type of land use.

7. The water demand factor was multiplied by the land area to determine an average daily demand (ADD) in units of gallons per day (gpd).

8. The ADDs for each type of land use were then combined to summarize the total ADD for existing land use, infill and future development within City limits, and the General Plan.

4.2 Land Use Areas within City Limits

Existing land use within City limits is illustrated in Plate 4-A. A breakdown of land use by geographic area within City limits is included in Table A-1 in Appendix A. A summary of existing land use development within City limits is presented in Table 4-2.

TABLE 4-2
CITY OF RIVERBANK
WATER SUPPLY STUDY AND WATER MASTER PLAN
EXISTING LAND USE WITHIN CITY LIMITS

Type of Land Use	Area (ac)
Medium Density Residential (MDR)	1,426.5
Low Density Residential (LDR)	249.6
Commercial (C)	211.5
Industrial (I)	208.9
School (SC)	69.4
Park (PK)	39.0
Open Space (OS)	29.8
Total	**2,235**

Additional development within City limits is anticipated in the future. Potential future development within existing land use areas are illustrated in Plate 4-B. Areas anticipated to contain future growth are summarized in Table 4-3.

TABLE 4-3
CITY OF RIVERBANK
WATER SUPPLY STUDY AND WATER MASTER PLAN
AREAS ASSUMED FOR FUTURE DEVELOPMENT
WITHIN CITY LIMITS

Infill Designation[a]	Area (ac)	Infill Land Use
IN #1	3.0	MDR #1
IN #2	14.5	MDR #1
IN #3	2.1	MDR #2
IN #4	3.8	MDR #2
IN #5	2.4	MDR #3
IN #6	8.2	MDR #2
IN #7	2.4	MDR #2
IN #8	4.7	MDR #2
IN #9	4.7	MDR #2
IN #10	15.5	MDR #3
IN #11	2.0	MDR #6
IN #12	1.3	MDR #4
IN #13	3.2	MDR #4
IN #14	5.1	MDR #4
IN #16	1.9	MDR #4
IN #17	2.0	MDR #4
IN #18	1.6	MDR #4
IN #19	4.8	MDR #4
IN #20	5.4	MDR #4
-	14.3	MDR #5
-	21.7	MDR #7
-	6.3	MDR #8
-	6.3	C #4
-	1.1	C #5
-	35.0	I #2
-	10.8	SC #2
Total	**184**	

[a] See Plate 4-B.

4.3 Additional Land Use Areas for General Plan

The updated General Plan presents planned land usage for areas currently outside of the City limits. The areas outside the existing City water system are shown on Plate 4-C. A summary of additional land use envisioned under the General Plan is included as Table 4-4.

TABLE 4-4
CITY OF RIVERBANK
WATER SUPPLY STUDY AND WATER MASTER PLAN
ADDITIONAL LAND USE PLANNED FOR
GENERAL PLAN AREAS

Type of Land Use	Area (ac)
Agricultural Resource Conservation Area	1,221
Buffer Greenway Open Space	400
Clustered Rural Residential	1,266
High Density Residential	73
Industrial-Business Park	263
Infill Opportunity Area – Downtown[a]	-
Infill Opportunity Area – West Riverbank[a]	-
Low Density Residential	1,232
Medium Density Residential	656
Mixed Use Office Retail Residential (MUORR)	158
Multi Use Recreation	139
Park	135
School-Civic	164
Total	**5,707**

[a] Infill Opportunity Areas are areas of new growth in addition to areas already within City limits. Acreages are included in Tables 4-2 and 4-3.

4.4 Projections of Existing Water Demands within City Limits

Combining land use summaries with water demand factors allows for the development of water demand projections. For existing development, the water demand projections are summarized in Table 4-5. A more detailed breakdown of existing water demands is included in Table A-2 in Appendix A (Volume Two).

TABLE 4-5
CITY OF RIVERBANK
WATER SUPPLY STUDY AND WATER MASTER PLAN
PROJECTIONS OF EXISTING WATER DEMANDS WITHIN CITY LIMITS

Type of Land Use	Density (du/ac)	Area (ac)	Water Demand Factor	ADD (gpd)
Medium Density Residential	5.5	234.7	600 gpd/du	542,177
Medium Density Residential	6.0	832.5	600 gpd/du	2,097,908
Medium Density Residential	6.5	359.3	600 gpd/du	980,780
Low Density Residential (lot size ≤1 ac)	1.5	51.3	1,000 gpd/du	76,892
Low Density Residential (lot size ≤1 ac)	2.3	21.1	1,000 gpd/du	48,482
Low Density Residential (lot size >1 ac)	-	177.2	1,000 gpd/ac	177,225
Commercial	-	211.5	1,900 gpd/ac	281,250
Industrial	-	208.9	430 gpd/ac	62,893
School	-	69.4	400 gpd/ac	27,772
Park	-	39.0	1,900 gpd/ac	74,167
Open Space	-	29.8	0 gpd/ac	0
Total		**2,235**		**4,369,546**
Total, ac-ft/yr				**4,890**

City water well production data from January-December 2006 indicates an average day demand of 4,366,000 gpd, within 0.1% of the projected value (4,369,546 gpd). Total annual water well production data from 2003-2006 is included as Table 4-6.

TABLE 4-6
CITY OF RIVERBANK
WATER SUPPLY STUDY AND WATER MASTER PLAN
2002-2006 CITY WATER WELL PRODUCTION

Year	Annual Water Well Production (gallons)	Annual Water Well Production (acre-feet)	Average Day Demand (gpd)
2002	1,230,633,000	3,777	3,372,000
2003	1,251,814,000	3,842	3,430,000
2004	1,357,357,000	4,166	3,719,000
2005	1,519,920,000	4,664	4,165,000
2006	1,593,307,000	4,890	4,366,000

4.5 Projections of Buildout Water Demands within City Limits

For future development within City limits, water demand projections are summarized in Table 4-7. A detailed summary of future water demands within City limits is shown in Table A-3 (Volume Two).

TABLE 4-7
CITY OF RIVERBANK
WATER SUPPLY STUDY AND WATER MASTER PLAN
PROJECTIONS OF FUTURE WATER
DEMANDS WITHIN CITY LIMITS

Type of Land Use	Density (du/ac)	Area (ac)	Water Demand Factor	ADD (gpd)
Medium Density Residential	5.5	234.7	600 gpd/du	542,177
Medium Density Residential	6.0	963.5	600 gpd/du	2,428,103
Medium Density Residential	6.5	359.3	600 gpd/du	980,780
Low Density Residential (lot size ≤ 1 ac)	1.5	27.8	1,000 gpd/du	41,687
Low Density Residential (lot size ≤ 1 ac)	2.3	21.1	1,000 gpd/du	48,482
Low Density Residential (lot size > 1 ac)	-	99.2	1,000 gpd/ac	99,210
Commercial	-	218.8	2,000 gpd/ac	299,489
Industrial	-	243.9	2,000 gpd/ac	303,065
School	-	80.2	2,000 gpd/ac	123,304
Park	-	39.0	2,500 gpd/ac	93,480
Open Space (Future Parks)	-	29.8	2,500 gpd/ac	74,470
Total				**5,034,247**
Total, ac-ft/yr				**5,640**

4.6 Projections of Total Future Water Demands for General Plan

Future water demand projections for the General Plan areas are presented in Table 4-8. A detailed summary of future water demands for the General Plan is presented in Table A-4 (Volume Two).

TABLE 4-8
CITY OF RIVERBANK
WATER SUPPLY STUDY AND WATER MASTER PLAN
PROJECTIONS OF TOTAL FUTURE WATER
DEMANDS FOR GENERAL PLAN

Type of Land Use	Density (du/ac)	Area (ac)[a]	Water Demand Factor	ADD (gpd)
Existing City Water System at Buildout	-		-	5,034,247[b]
Agricultural Resource Conservation Area	-	1,220.6	0 gpd/ac	0
Buffer Greenway Open Space	-	399.6	0 gpd/ac	0
Clustered Rural Residential	0.2	1,266.5	1,200 gpd/du	303,953
High Density Residential	18.0	72.8	435 gpd/du	398,789
Industrial-Business Park	-	263.4	2,000 gpd/ac	368,717
Infill Opportunity Area – Downtown, Non-Residential	-	-	2,000 gpd/ac	19,224
Infill Opportunity Area – Downtown, Residential	0.9	-	435 gpd/du	81,724
Infill Opportunity Area – West Riverbank, Non-Residential	-	-	2,000 gpd/ac	8,710
Infill Opportunity Area – West Riverbank, Residential	1.6	-	435 gpd/ac	157,568
Low Density Residential	5.0	1,232.1	625 gpd/du	2,695,171
Medium Density Residential	10.0	655.9	600 gpd/du	2,754,791
Mixed Use Office Retail Residential, Non-Residential	-	144.2	2,000 gpd/ac	201,862
Mixed Use Office Retail Residential, Residential	18.0	13.7	435 gpd/du	74,876
Multi Use Recreation	-	139.3	2,000 gpd/ac	278,513
Park	-	134.7	2,500 gpd/ac	336,767
School-Civic	-	164.0	2,000 gpd/ac	327,981
Total				**13,042,893**
Total, ac-ft/yr				**14,610**

[a] From Table 4-4.
[b] From Table 4-7.

4.7 Summary of Water Demand Projections

A summary of existing and future water demands is included as Table 4-9.

TABLE 4-9
CITY OF RIVERBANK
WATER SUPPLY STUDY AND WATER MASTER PLAN
SUMMARY OF WATER DEMAND PROJECTIONS

Condition	ADD (gpd)	Annual Demand (ac-ft/year)
Existing Demand within City Limits[a]	4,369,546	4,890
Future Demand within City Limits[b]	5,034,247	5,640
Future Demand within City Limits and General Plan[c]	13,042,893	14,610

[a] See Table 4-5.
[b] See Table 4-7.
[c] See Table 4-8.

5 Hydraulic Evaluation of Existing Distribution System

Certain deficiencies in the existing water supply system were identified from interviews with City maintenance staff and a review of historical maintenance records. The water distribution system model was created with the intention to serve as a tool in defining system improvements required to serve the City at near term and buildout General Plan conditions. This chapter will describe the methodology used to create the computer model, the software used, and the results of the hydraulic evaluation of the existing distribution system. Development and analysis of the Model is based on the technical memorandum *Water Distribution System Model for Existing Conditions* (August 2006) [7].

5.1 Objectives

A model of the existing distribution system was created to achieve the following objectives:

1. Identify potentially problematic areas in the existing distribution system.

2. Evaluate the capacity of the existing distribution system.

5.2 Model of Existing Collection System

A computer model was generated to determine reaches of the existing distribution system which may have hydraulic deficiencies. The following sections will describe the methodology used to generate the model and the subsequent results.

a. Description of WaterCAD

The modeling software selected for this task is WaterCAD version 7.0, developed and supported by Haestad Methods Solution Center of Bentley Systems, Inc. The program includes a graphical interface to layout complex network of pipes, tanks, pumps, and other water distribution system features. WaterCAD can be used to:

1. Conduct steady state simulations of water distribution systems with pumps, tanks, and control valves.

2. Conduct extended period simulations to analyze the system response to varying supply and demand conditions.

3. Perform water quality simulations to determine the water source and age, or track the growth or decay of a chemical constituent throughout the network.
4. Conduct fire flow analyses to understand the behavior of the system during emergency flow conditions.

b. Physical Components of Model

An electronic copy of the City base map was provided by the City to aid in the formulation of the water distribution system model. The base map included all streets, parcel boundaries, as well as existing water main locations and sizes. The base map was subsequently updated in March 2006 to reflect recent water system improvements. The base map is subdivided into a grid system which the City has currently adopted. A copy of the City base map with the grid system is included as Plate 5-A.

The Model will include all 8-inch and greater diameter pipelines. Some smaller pipelines, 6-inch and 4-inch, will be included as needed to completed existing water main loops. The Model will also include the existing groundwater wells, storage tanks, and booster pump stations. A summary of the model input data gathered and entered to formulate the City existing conditions water model is described as follows:

1. *Junction Nodes*: Junction nodes in the Model are typically representations of locations where water mains are connected, at changes in pipe size, and/or locations where a specific water demand is known. The most common labeling technique for junction nodes is sequential (1, 2, 3, …) however, this form of labeling presents problems when adding elements (junction nodes or pipes) to existing areas of the model. Rather than labeling the existing junction nodes sequentially, the water model was prepared with a labeling system for the junction nodes that correlates to the City grid system. A schematic of the City grid system and base map is presented in Plate 5-A.

The junction nodes in the Model will include the following labeling system:

Junction node label example: J-B4-35

where: J = junction node identifier
B = grid index letter (A – K)
4 = grid index number (1 – 12)
35 = junction node number

The junction node number will be sequential within the assigned grid index area. This labeling system allows the modeler to include additional junction nodes within the grid index area without affecting the overall model junction node numbering.

One of the most important input parameters in the development of a computer water model is the elevation of the junction nodes, reservoirs, and other sources of supply. A topographic map of the City was used to determine the elevation of the existing junction nodes. The same map was used to determine the elevation of wells, booster pump stations, and reservoirs.

2. *Pipes*: The pipe network for the Model was created from a review of the City base map. Pipe connectivity at certain areas of the distribution system was verified and critical existing 6-inch and 4-inch water main loops were added. The existing water distribution system map for the City is included as Plate 5-B. The City does not have multiple pressure zones. The entire City water distribution system is part of one main zone.

A schematic of the main zone water model network layout is presented as Plate 5-C. The main zone water model includes: 1) all existing 8-inch and larger water mains; 2) all the existing reservoirs (Tank 1 and Tank 2) and booster pump stations; 3) some critical 6-inch and 4-inch water mains loops; and 4) the groundwater supply wells (Well Nos. 2, 3, 4, 5, 6, 7, 8, and 9).

Pipe labeling for the Model as depicted in Plate 5-C is similar to the junction node labeling, i.e. based on the City grid system. The pipes in the Model include the following labeling system:

Pipe label example: P-B5-5

where: P = pipe identifier
B = grid index letter (A – K)
5 = grid index number (1 – 12)
5 = junction node number

For modeling purposes, the Hazen-Williams "C" value was initially set at 130 for all pipelines included with this Model. During the calibration phase of the model, the friction headloss coefficient can be modified as needed for each pipeline to obtain a more accurate representation of the existing distribution system performance.

3. *Groundwater Supply Wells*: Water supply to the City is entirely from groundwater wells. The City owns and maintains a total of eight wells, which supply potable water to the main zone distribution system. For the Model, each groundwater well is included as a junction node with a base elevation and a defined inflow (production) into the system, i.e. a negative demand. All wells are labeled in the Model as "Well X" where X is the well number. A summary of the production capacity included in the Model for each groundwater well is presented in Table 5-1.

TABLE 5-1
CITY OF RIVERBANK
WATER SUPPLY STUDY AND WATER MASTER PLAN
PRODUCTION CAPACITY OF GROUNDWATER WELLS USED IN MODEL

Well Number	Well Name	Capacity, gpm	Notes
2	8th Street	660	Operates with VFD[a]
3	Jackson	625	Operates with VFD[a]
4	Pioneer	900	Operates with VFD[a]
5	River Heights	900	--
6	Whorton	1,000	Operates with VFD[a]
7	Crossroads	1,200	--
8	Novi	1,200	--
9	Prospector	1,300	Operates with VFD[a]
Total		**7,785**	

[a] VFD = Variable frequency drive

4. *Storage Tanks and Booster Pump Stations*: During low water demand periods, water is stored in two existing storage tanks. The tanks are above grade and each have a capacity of approximately 1 MG. Each tank includes a booster pump station equipped with three pumps. Each pump has a capacity of approximately 1,000 gpm. The Model incorporates these existing facilities as described below.

The tanks are included in the Model as fixed head reservoirs (R-1 and R-2) with a hydraulic grade of 285 ft (approximately 60 psi above base elevation). The booster pumps at each pump station are included in the Model as Flow Control Valves (FVC). FCV-1, FCV-2, and FCV-3 are connected to the existing R-1 reservoir (storage tank) at Second Street. Similarly, FCV-4, FCV-5, and FCV-6 are connected to the existing R-2 reservoir (storage tank) at Saxon Way near Green Valley Court. A flow control valve was selected for simulation purposes to ensure that each pump supplies only 1,000 gpm.

5. *Demand Allocations*: The total existing conditions water demand estimated for the Model was allocated to the various junction nodes based on proximity to a junction node. For most of the residential areas, the total number of dwelling units was allocated among the existing junction nodes based on an approximate number of dwelling units surrounding the existing junction node. A summary of the junction node water demand allocation in relation to the land use areas is presented in Appendix B (Volume Two).

c. Calibration of the Existing Model

The input data described above was included with the Model for calibration purposes. A summary of the calibration methodology and model simulations is presented below.

1. *Methodology*: Calibration is a means of comparing the model results to the field observations or actual conditions. During calibration, it is sometimes necessary to adjust the input data so that the model results are in agreement with the measured (actual) system performance. This can include revising water demand peaking factors, fine-tuning the roughness coefficient of the pipes, changing pump operating characteristics, or adjusting other model attributes. This process is essential to gain confidence in the Model as well as understanding the behavior and performance of the hydraulic system. The process also serves as a troubleshooting tool to reveal missing or incorrect input data.

The City intends to use the Model to conduct steady state simulations only (a snapshot of the system at a specific time). When a water model is used for this type of simulations the model should be in agreement with the current (or field) conditions within 10%. To achieve this level of accuracy the model is calibrated with regard to flow and pressure.

Calibration in relation to the residual pressure within the system is accomplished by reviewing fire hydrant flow tests at different locations. For the size of the existing City water distribution system, between 3-4 fire flow test at various locations are recommended. The Stanislaus Consolidated Fire Protection District (Fire District) conducted a series of fire hydrant flow tests in January 2005 and July 2005 at various locations throughout the City. A schematic representation of the fire hydrant flow locations is presented in Plate 5-D and the test flows/pressures are summarized in Table 5-2.

TABLE 5-2
CITY OF RIVERBANK
WATER SUPPLY STUDY AND WATER MASTER PLAN
FIRE HYDRANT FLOW TEST DATA FOR CITY OF RIVERBANK

Location	Date and Time	Model Junction Node	Static Pressure (psi)	Test Flow (gpm)	Residual Pressure (psi)	Predicted Flow at 20 psi
Santa Fe/Claus	1/25/05; 8:30 a.m.	J-B4-55	60	1,748	32	2,119
Santa Fe/Snedigar	1/25/05; 10:30 a.m.	J-B6-1	62	1,627	21	1,648
Claus/California	7/1/04; 2:00 p.m.	J-C5-15	68	1,967	43	2,797
California/Kentucky (mid-block)	7/1/04; 2:15 p.m.	J-C5-20	65	1,688	45	2,616
Claus/Kentucky	7/1/04; 2:30 p.m.	J-D5-1	70	1,688	45	2,455

2. *Comparison of Model Simulations Versus Fire Hydrant Flow Tests*: Because some of the fire hydrant flow test data was gathered during the month of July, typically a hot summer month, it was assumed that the Model should simulate the maximum day demand to match the fire flow tests. To mimic the assumed conditions, the Model was populated with a maximum day demand of 2.3 times the average day demand. A fire flow simulation was executed for each junction node (fire flow location) with the test flow indicated in Table 5-2 to estimate the residual pressure at the junction node. A summary of the results predicted by the Model when compared to the fire hydrant flow test results is presented in Table 5-3.

TABLE 5-3
CITY OF RIVERBANK
WATER SUPPLY STUDY AND WATER MASTER PLAN
FIRE HYDRANT FLOW TEST DATA COMPARED TO MODEL SIMULATION RESULTS
ASSUMING MAXIMUM DAY DEMAND CONDITIONS

Location	Model Junction Node	Test Flow (gpm)	Test Flow Residual Pressure (psi)	Model Predicted Residual Pressure at Test Flow (psi)	Percent Difference (%)
Santa Fe/Claus	J-B4-55	1,748	32	26	18
Santa Fe/Snedigar	J-B6-1	1,627	21	0	100
Claus/California	J-C5-15	1,967	43	34	22
California/Kentucky (mid-block)	J-C5-20	1,688	45	39	14
Claus/Kentucky	J-D5-1	1,688	45	38	16

Because the Model predicts lower residual pressures than those observed during the actual fire hydrant flow tests, the simulation either is loaded with a higher water demand through the system or the static hydraulic grade line for the City is higher than currently included in the Model. Because the static pressures observed during the actual fire hydrant flow tests are in good correlation with the static hydraulic grade line of the Model, it was assumed that the water demand peaking factor should be revised for calibration purposes.

The fire flow simulations were executed again; however, the total water demand was revised to include only the average day demand. Simulations for each fire flow location were executed with this revised water demand. A summary of the results predicted by the Model when compared to the fire hydrant flow test results is presented in Table 5-4.

TABLE 5-4
CITY OF RIVERBANK
WATER SUPPLY STUDY AND WATER MASTER PLAN
FIRE HYDRANT FLOW TEST DATA COMPARED TO MODEL SIMULATION RESULTS
ASSUMING AVERAGE DAY DEMAND CONDITIONS

Location	Model Junction Node	Test Flow (gpm)	Test Flow Residual Pressure (psi)	Model Predicted Residual Pressure at Test Flow (psi)	Percent Difference (%)
Santa Fe/Claus	J-B4-55	1,748	32	28	12
Santa Fe/Snedigar	J-B6-1	1,627	21	3	86
Claus/California	J-C5-15	1,967	43	38	12
California/Kentucky (mid-block)	J-C5-20	1,688	45	42	5
Claus/Kentucky	J-D5-1	1,688	45	42	6

The change in water demand provides a better correlation between the values observed during the fire hydrant flow tests and those predicted by the Model. The only area that does not correlate well is the existing dead-end on Santa Fe/Snedigar (J-B6-1). This is a very long dead-end water main that extends from Eight Street to Snedigar Avenue along Santa Fe Street.

Because of the good correlation presented in Table 5-4, it is recommended to use the Model as created without changes to the demand and/or pipe headloss characteristics to analyze the existing conditions.

d. <u>Performance Criteria</u>

The criteria listed in Section 3.6 of Chapter 3 were used to aid in the evaluation of the Model performance.

The fire flows used in this analysis are as follows for each land use:

1. Residential (LDR and MDR) – 1,500 gpm.
2. Commercial – 3,000 gpm.
3. Industrial – 3,500 gpm.

e. Modeling Results

The following steady state simulations were executed for the existing conditions Model:

1. Average Day Demand: This simulation assumes the model is subjected to the total average day water demand and the existing wells provide sufficient flow to meet the demand (i.e. water from the storage tanks is not included in this simulation).

2. Max Day Demand: This simulation assumes the model is subjected to the total maximum day water demand and the existing wells provide sufficient flow to meet the demand (i.e. water from the storage tanks is not included in this simulation).

3. Peak Hour Demand: This simulation assumes the model is subjected to the total peak hour demand. The existing wells cannot provide sufficient flow to meet the demand thus water from the storage tanks is included in this simulation.

Complete results of these Model simulations are presented in Appendix C. A pressure contour map depicting the modeling results for each simulation is presented in Plate 5-E, 5-F, and 5-G. In general, the Model predicts acceptable pressures (greater than 35 psi), velocities (less than 10 ft/sec), and headloss (less than 15 ft/1,000 ft).

1. *Residential Land Use Fire Flow Simulations*: In addition to the steady state simulations listed above, the Model was executed for the following maximum day plus residential fire flow (1,500 gpm) steady state simulations:

a. Max Day and Fire Flow at J-A3-15 (River Cove Drive and Prestwick Drive)

b. Max Day and Fire Flow at J-B1-95 (dead-end of Cedarwood Circle)

c. Max Day and Fire Flow at J-B1-130 (Patterson Road and Hot Springs Lane)

d. Max Day and Fire Flow at J-B4-55 (Eight Street and Santa Fe Street)

e. Max Day and Fire Flow at J-C2-60 (dead-end of Willow Song Court)

f. Max Day and Fire Flow at J-D2-60 (Newbrook Circle and Lindbrook Drive)

g. Max Day and Fire Flow at J-D2-140 (dead-end of Westminster Court)

h. Max Day and Fire Flow at J-D5-85 (dead-end of Celestino Court)

i. Max Day and Fire Flow at J-E2-125 (dead-end of Blazer Court)

j. Max Day and Fire Flow at J-E2-245 (dead-end of Blessing Court)

k. Max Day and Fire Flow at J-F5-1 (Davis Avenue and Claus Road)

In these fire flow simulations, sufficient groundwater wells are turned ON with the capacity to meet the max day demand, however the fire flow is assumed to be provided from the storage tanks. Therefore, these fire flow simulations include at least two FCVs opened to supply the fire flow requirement.

The selected residential fire flow locations are arbitrary but are a good representation of the residential land use areas in the City. A summary of the fire flow analysis for these residential junction nodes is presented in Table 5-5. The Model predicts the existing distribution system can meet the performance criteria during residential fire flow simulations provided the existing distribution system near the fire flow location is a minimum of 8-inch diameter. The following junction nodes cannot provide 1,500 gpm of available fire flow during the maximum day demand and maintain acceptable residual pressures, velocities, and/or headloss:

1. J-B4-55 (Eight Street and Santa Fe Street): For this junction node, the existing 8-inch water main on Eight Street is a dead-end, resulting in high headloss and low residual pressures. Additional 12-inch water mains and water wells suggested in Chapter 7 for East Riverbank will help remedy this deficiency.

2. J-D5-85 (dead-end of Celestino Court): For this junction node, the existing 8-inch water main is a dead-end of approximately 500 ft in length. The maximum allowable fire flow at a residual of 35 psi is approximately 1,300 gpm. The residual pressure at this junction node when subjected to the total 1,500 gpm fire flow is approximately 28 psi. Although modeling results are evaluated with a minimum pressure requirement of 35 psi, City Water Standards [8] require a minimum residual pressure of 20 psi at the service point or fire hydrant for maximum day flows plus fire flow. By City Water Standards, the pressure of 28 psi is acceptable for existing water lines at J-D5-85.

3. J-F5-1 (Davis Avenue and Claus Road): For this junction node the existing 6-inch water main on Davis Avenue is the bottle neck in allowing the system to meet the

proposed fire flow. The maximum available fire flow at this junction node is approximately 1,435 gpm. The residual pressure at this junction node when subjected to the total 1,500 gpm fire flow is approximately 33 psi. Additional looping in the system with 12-inch water mains as suggested in Chapter 7 will help alleviate this deficiency.

TABLE 5-5
CITY OF RIVERBANK
WATER SUPPLY STUDY AND WATER MASTER PLAN
EXISTING CONDITIONS MODELING RESULTS RESIDENTIAL FIRE FLOW ANALYSIS

Junction Node	Needed Fire Flow (gpm)	Junction Node Demand (gpm)	Calculated Residual Pressure (psi)	Meets Minimum Pressure (35 psi)? (Yes/No)	Minimum Pressure Junction Node	Pressure (psi)
J-A3-15	1,500	1,532	75.73	Yes	J-B6-1	56.61
J-B1-130	1,500	1,509	61.40	Yes	J-B6-1	56.74
J-B1-95	1,500	1,512	57.39	Yes	J-B6-1	56.74
J-B4-55	1,500	1,540	34.08	No	J-B6-1	29.71
J-C2-60	1,500	1,511	37.26	Yes	J-C2-60	37.26
J-D2-140	1,500	1,508	54.54	Yes	J-D2-140	54.57
J-D2-60	1,500	1,523	52.00	Yes	J-D2-60	52.00
J-D5-85	1,500	1,516	28.78	No	J-D5-85	28.78
J-E2-125	1,500	1,509	57.46	Yes	J-B6-1	56.75
J-E2-245	1,500	1,510	56.96	Yes	J-B6-1	56.75
J-F5-1	1,500	1,532	33.12	No	J-F5-1	33.12

For all the residential land use fire flows listed above, the Model predicts high headloss (greater than 15 ft/1,000 ft) and high velocities (greater than 10 ft/sec) during the fire flow analyses in water mains less than 8-inch diameter near the fire flow location.

2. *Commercial Land Use Fire Flow Simulations*: In addition to the steady state simulations listed above, the Model was also executed for the following maximum day plus commercial fire flow (3,000 gpm) steady state simulations:

a. Max Day and Fire Flow at J-B2-75 (Estelle Avenue and Patterson Road)

b. Max Day and Fire Flow at J-D3-45 (Morrill Road and Roselle Avenue)

c. Max Day and Fire Flow at J-F2-85 (Squire Wells Way)

In these fire flow simulations, sufficient groundwater wells are turned ON with the capacity to meet the max day demand, however the fire flow is assumed to be provided from the storage tanks. Therefore, these fire flow simulations include at least three FCVs opened to supply the fire flow requirement.

The selected commercial fire flow locations are arbitrary but are a good representation of the commercial land use areas in the City. A summary of the fire flow analysis for these commercial junction nodes is presented in Table 5-6. The Model predicts the existing distribution system can meet the pressure performance criteria during commercial fire flow simulations, however a few existing 6-inch and 8-inch water mains fail to meet the maximum velocity (10 ft/sec) criteria.

TABLE 5-6
CITY OF RIVERBANK
WATER SUPPLY STUDY AND WATER MASTER PLAN
EXISTING CONDITIONS MODELING RESULTS COMMERCIAL FIRE FLOW ANALYSES

Junction Node	Needed Fire Flow (gpm)	Junction Node Demand (gpm)	Calculated Residual Pressure (psi)	Meets Minimum Pressure (35 psi)? (Yes/No)	Minimum Pressure Junction Node	Pressure (psi)
J-B2-75	3,000	3,000	46.93	Yes	J-B6-1	39.19
J-D3-45	3,000	3,000	51.31	Yes	J-B6-1	47.10
J-F2-85	3,000	3,000	47.57	Yes	J-B6-1	43.68

3. Industrial Land Use Fire Flow Simulations: In addition to the steady state simulations listed above, the Model was also executed for the following maximum day plus industrial fire flow (3,500 gpm) steady state simulations:

a. Max Day and Fire Flow at J-B3-10 (dead-end of Stanislaus Street)

b. Max Day and Fire Flow at J-B3-35 (Patterson Road and Third Street)

c. Max Day and Fire Flow at J-D3-40 (dead-end of Talbot Avenue)

In these fire flow simulations, sufficient groundwater wells are turned ON with the capacity to meet the max day demand, however the fire flow is assumed to be provided from the storage tanks. Therefore, these fire flow simulations include at least four FCVs opened to supply the fire flow requirement.

The selected industrial fire flow locations are arbitrary but are a good representation of the industrial land use areas in the City. A summary of the fire flow analysis for these industrial junction nodes is presented in Table 5-7. The Model predicts the existing distribution system cannot meet the performance criteria (minimum residual pressures, maximum velocity, and maximum headloss) during these industrial fire flow simulations.

TABLE 5-7
CITY OF RIVERBANK
WATER SUPPLY STUDY AND WATER MASTER PLAN
EXISTING CONDITIONS MODELING RESULTS INDUSTRIAL FIRE FLOW ANALYSES

Junction Node	Needed Fire Flow (gpm)	Junction Node Demand (gpm)	Calculated Residual Pressure (psi)	Meets Minimum Pressure (35 psi)? (Yes/No)	Minimum Pressure Junction Node	Pressure (psi)
J-B3-10	3,500	1,433	35.02	No	J-B3-10	35.00
J-B3-35	3,500	2,056	39.80	No	J-E5-1	35.00
J-D3-40	3,500	2,503	35.01	No	J-D3-40	35.00

At J-B3-10, the existing water main is an 8-inch pipe which can only supply a maximum fire flow of approximately 1,400 gpm and still maintain the required 35 psi minimum residual pressure. When J-B3-10 is subjected to the total 3,500 gpm fire flow there is no practical residual pressure. At J-B3-35, the existing 10-inch water mains are inadequate to maintain the minimum 35 psi residual pressure. The maximum available fire flow at J-B3-35 is approximately 2,040 gpm. When subjected to the total 3,500 fire flow the residual pressure at J-B3-35 is approximately 31 psi. At J-D3-40, the existing dead-end 10-inch water main is inadequate to provide the required 3,500 gpm fire flow and still maintain the minimum residual pressure of 35 psi. The maximum available fire flow at J-D3-40 is approximately 2,460 gpm. When subjected to the total 3,500 gpm fire flow the residual pressure at J-D3-40 is approximately 16 psi.

For all the industrial land use fire flows listed above, the Model predicts high headloss (greater than 15 ft/1,000 ft), high velocities (greater than 10 ft/sec), and unacceptable residual pressures (less than 35 psi) during the fire flow analyses. The primary reasons for this deficiency are undersized pipes and the lack of water main looping near the existing industrial land use areas. The deficiencies at these three junction nodes for industrial fire flows are addressed in Chapter 7.

6 Assessment of Future Water Supply

This chapter presents an assessment of future water supply based on the *Source Sufficiency Report for the City of Riverbank General Plan Update* prepared by Dunn Environmental (June 2007) [9]. Phased investigations for SB610 requirements include an analysis of: 1) surface hydrology; 2) municipal and private well installation details; 3) pump tests and other well specific information; and 4) hydrogeology for the General Plan area.

6.1 SB610 Requirements and Approach

In support of the proposed developments near the City, state regulations require the City to complete a SB610 groundwater source sufficiency study for the General Plan area for a projection of 20 years. Groundwater is the primary resource of potable water for the City and is critical to development. To meet these requirements, a conceptual hydrogeologic model was developed, regional and plan area water quality was reviewed, municipal well pump tests were performed, historic water level changes in response to historical pumping and recharge conditions were analyzed, and a General Plan area water balance analysis was performed.

6.2 Basin and Local Hydrogeology

The near surface geology beneath the General Plan area consists of a Pleistocene Age semi-confined aquifer composed of permeable sand, gravel, and silt deposits deposited by present day rivers. The deep, semi-confined to confined aquifer is Pliocene and older in age and consists of alluvial sands, gravels and silts. Regionally, the confining Corcoran Clay delineates the boundary between the two. Due to river erosion and reworking, the Corcoran Clay within the General Plan area is less distinct. The unconsolidated shallow sediments within the General Plan area are called the Forebay aquifer. Saline water may lie at depths greater than 800 below ground surface (bgs).

Based on Forebay Aquifer potential storage within the extensive sand and gravel deposits alone, the storage volume could exceed 120,000 ac-ft for 150 feet of sand and gravel. Deep aquifer storage capacity is significant, but sediment connectivity may be limited.

6.3 Well Capacity and General Storage

Based on the short term pump tests completed for several City wells, specific capacity in gallons per minute per foot of drawdown ranges from 24 to 121 gpm/ft. Constant rate tests and recovery tests indicated a transmissivity and hydraulic conductivity typical for aquifer sands and gravels.

Long term pump tests confirmed these aquifer parameters. Minimal influences were observed between the City wells and domestic observation wells during pump testing.

Groundwater levels have declined from 1969 to 1995, increased from 1995 to 1999, and stabilized recently with local influences. Groundwater levels have been locally depressed due to overdraft in Modesto area in the past. Regional groundwater flow is from the east to the southwest. Rainfall data from 1980 onward from MID and CIMIS Modesto and Manteca stations correlated with depth to water measurements for DWR General Plan area wells. Above average rainfall corresponds to increased water levels at DWR wells.

6.4 Water Quality Summary

Regional water quality is generally very good, with TDS, nitrate, and DBCP being concerns. Several possible contaminating activities are present in the General Plan area, most notable Thunderbolt Wood Processing and the Riverbank Army Ammunitions Plan. Neither of these sources has required mitigation at City water wells to date. Water quality at existing City wells has been excellent.

6.5 Groundwater Supply Assessment

Groundwater supply balance numeric models were developed for project buildout during a single normal year, a single dry year, and a multiple dry year for a 20 year assessment period. Groundwater recharge occurs due to rainfall, irrigation, and infiltration from Stanislaus River, storm water facilities, and local canals, and discharge relates to the municipal and irrigation water demands in the General Plan area. For buildout scenarios, the available supplies from recharge range up to 78,982 ac-ft/yr, project demands range up to 21,091 ac-ft/yr with a groundwater reserve up to 57,891 ac-ft/yr. The reserve does not account for the sustained well yields and relatively low overdraft observed during extensive drought periods.

The projected demand can be met by the groundwater source; and the General Plan area is SB610 compliant. Comprehensive best management and groundwater monitoring plans will have to be implemented to reduce the potential groundwater overdraft and maintain a groundwater balance.

6.6 Recommended Plans and Studies

As per the Integrated Regional Groundwater Management Plan for the Modesto Groundwater Basin (IRGMP), ongoing modeling and planning efforts should be pursued to limit the potential impacts from over utilization of groundwater outside the General Plan area [10]. Plan implementation will have to be a part of the Stanislaus – Tuolumne River Ground Water Basin Association efforts. The Best Management Operations identified in the IRGMP should continue as part of the efforts by USGS.

Groundwater monitoring networks should be used to monitor the success of management efforts. Water level monitoring programs will need to be used to identify potential overdraft concerns. Pumping rates and water level control devices will be critical to the success of the City water well system as overdraft potential is high.

Additional confirmation activities should be completed regarding the accuracy of transducer readings for each water well during daily routine pump operation for the City. This is critical to the long term success of the City groundwater management program. In addition, City Well No. 6 should be tested to assess the catchment area due to potential water quality concerns. Future aquifer parameter determination will support groundwater source sufficiency revisions.

7 Recommended Supply and Distribution System Improvements

This chapter presents recommended water supply and distribution system improvements designed to: 1) remedy deficiencies identified in the existing distribution system under current and buildout conditions; 2) satisfy design criteria for water supply facilities; and 3) expand the delivery system to meet General Plan conditions and requirements.

7.1 Identification of Deficiencies in Existing Distribution System

To identify system deficiencies for buildout conditions, the existing conditions Model was updated to include anticipated demands at buildout as well as suggested water mains, groundwater wells, and storage tanks to be constructed in the future. The buildout water Model includes the addition of a 2 MG storage tank with a booster pump station. FCV-7, FCV-8, and FCV-9 are connected to the future R-3 reservoir (storage tank) between Claribel Road and the MID Lateral #6. Planned Wells No. 10 and No. 11 were included in the buildout water model along with additional 12-inch water mains.

The buildout water model suggested performance criteria less than acceptable during the following modeling scenarios:

1. Industrial – Max Day and Fire Flow at J-B3-10 (dead-end of Stanislaus Street): For this junction node, the residual pressure is less than 0 psi (minimum pressure criteria of 35 psi) and the pipeline velocity is 22.5 ft/sec. The existing 8-inch pipeline, P-B3-10, is not sufficient to convey 3,500 gpm during fire flow requirements. The maximum available fire flow at J-B3-10 is approximately 1,400 gpm. P-B3-10 serves the old cannery area to be redeveloped in the future. To achieve sufficient fire flows, it is recommended that future developers loop the existing 8-inch pipeline in Stanislaus Street and connect to the existing 6-inch pipeline (P-B3-50) at the end of Sierra Street. Previously the cannery operated from its own well. It is recommended that future developers be required to make the upgrades necessary to achieve adequate pressures and fire flows from the City system.

2. Industrial – Max Day & Fire Flow at J-D3-40 (dead-end of Talbot Avenue). At this junction node, the residual pressure is 23.0 psi and the pipeline velocity is 14.5 ft/sec. The existing 10-inch pipeline, P-D3-25, is not sufficient to convey 3,500 gpm during fire flow requirements which would be needed with the development of surrounding

industrial areas. The maximum available fire flow at J-D3-40 is approximately 2,460 gpm. A new 12-inch pipeline connecting the end of P-D3-25 in Talbot Avenue to the existing dead-end in Kentucky Avenue is recommended as part of the Transmission Main Projects (TMP #3).

Aside from the two scenarios listed above, the buildout water Model predicts acceptable results for the other average day, max day, and peak hour scenarios. A schematic of the buildout water model network is presented as Plate 7-A. Complete results of the buildout water model simulations are presented in Appendix D (Volume Two).

For the existing conditions model, the 10-inch Patterson Road water main at J-B3-35 was inadequate to maintain the minimum 35 psi residual pressure. To ensure adequate fire protection, additional 12-inch and 16-inch water mains at J-B3-35 are recommended as part of the Transmission Main Projects (TMP #4). The existing 10-inch water lines would remain for redundancy in the system.

7.2 Water Supply Requirements at Buildout for General Plan

To develop recommended system improvements, a comparison of buildout water supply demands versus current City facilities is necessary. For planning purposes, the General Plan areas and existing City areas are divided into West Riverbank, Central Riverbank, and East Riverbank as depicted in Figure 7-1.

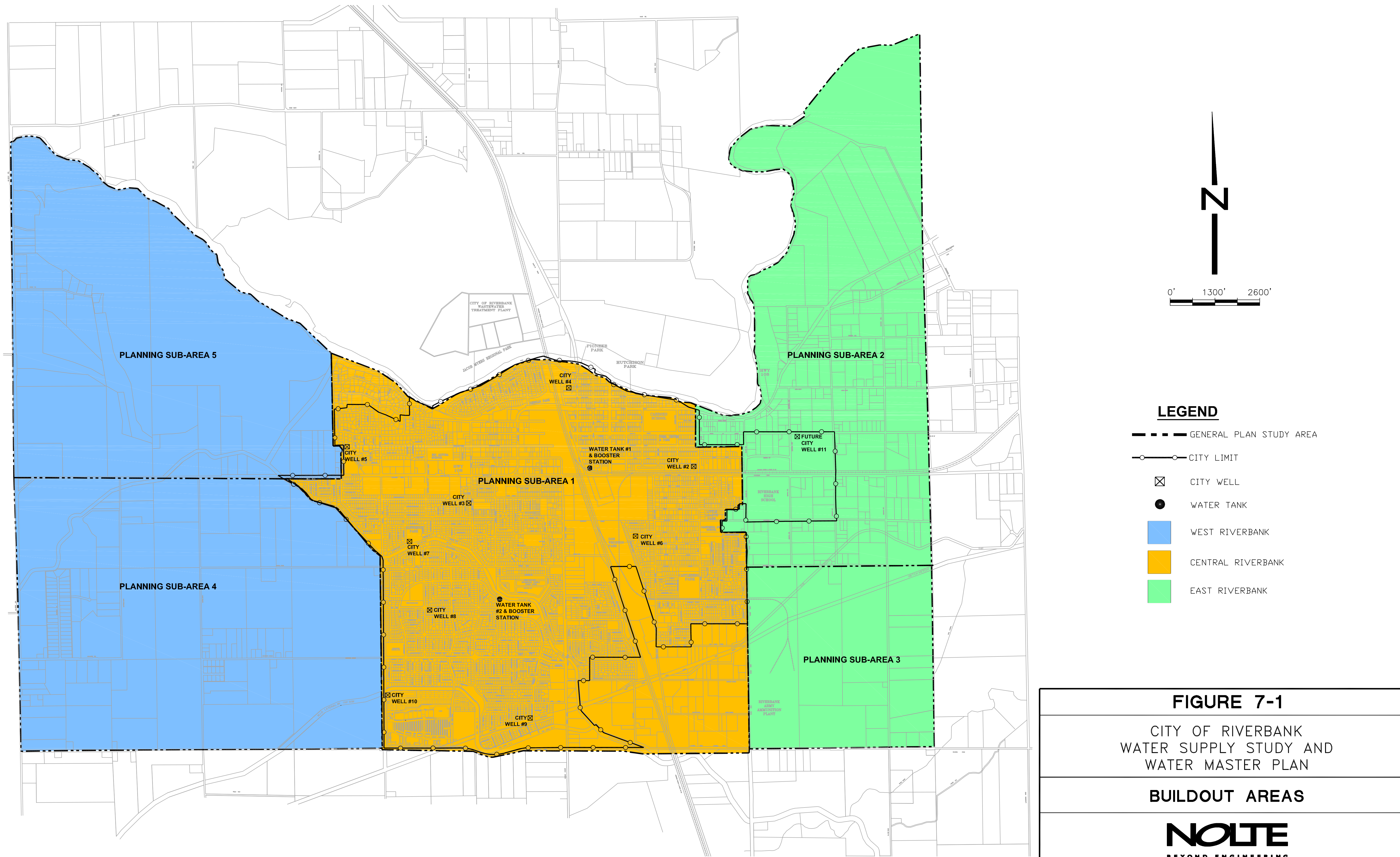

FIGURE 7-1

CITY OF RIVERBANK
WATER SUPPLY STUDY AND
WATER MASTER PLAN

BUILDOUT AREAS

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Buildout water demands separated into West Riverbank, Central Riverbank, and East Riverbank are presented in Table 7-1.

TABLE 7-1
CITY OF RIVERBANK
WATER SUPPLY STUDY AND WATER MASTER PLAN
BUILDOUT WATER DEMANDS (ADD)

Buildout Area		Average Day Demand (gpd)
West Riverbank		
Planning Sub-Area 4		3,117,932
Planning Sub-Area 5		1,475,912
	Subtotal	4,593,844
Central Riverbank		
Planning Sub-Area 1		613,103
Existing City at Buildout		5,034,247
	Subtotal	5,647,350
East Riverbank		
Planning Sub-Area 2		1,749,955
Planning Sub-Area 3		1,051,743
	Subtotal	2,801,699
Total		**13,042,893**

Maximum day and peak hour demands for each buildout area are shown in Table 7-2.

TABLE 7-2
CITY OF RIVERBANK
WATER SUPPLY STUDY AND WATER MASTER PLAN
MAXIMUM DAY AND PEAK HOUR DEMANDS AT BUILDOUT

Buildout Area	Average Day Demand (gpd)	Maximum Day Demand (gpd)	Peak Hour Demand (gpd)
West Riverbank	4,593,844	10,565,842	16,078,455
Central Riverbank	5,647,349	12,988,902	19,765,721
East Riverbank	2,801,699	6,443,907	9,805,945
Total	**13,042,892**	**29,998,651**	**45,650,121**

The number of wells required to meet maximum day demand and 20 percent reserve capacity for each buildout area is summarized in Table 7-3. For Central Riverbank, the existing wells (including Well No. 10) have capacities ranging from 625 gpm to 1,500 gpm (Table 2-1) providing a total existing capacity of 13,658,400 gpd. One additional well will be required for Central Riverbank to meet reserve capacity requirements and maximum day demand at buildout. East Riverbank and West Riverbank are primarily undeveloped and will require additional wells to meet the demands of future development. Well No. 11 was designed to provide water service to East Riverbank but has not yet been constructed. A total of ten new water wells (including Well No. 11) will be necessary at buildout conditions for East Riverbank and West Riverbank to meet maximum day demand and provide the recommended reserve capacity. Specific requirements for new wells are summarized in Appendix E (Volume Two).

TABLE 7-3
CITY OF RIVERBANK
WATER SUPPLY STUDY AND WATER MASTER PLAN
WELLS REQUIRED TO MEET MAXIMUM DAY DEMAND

Buildout Area	Required Capacity of Wells[a] (gpd)	Wells Required[b]	Existing Wells	Capacity of Existing Wells (gpd)	New Wells Needed	Total Capacity (gpd)[c]
West Riverbank	12,679,010	6	0	0	6	12,960,000
Central Riverbank	15,586,683	8	9[d]	13,370,400	1	15,818,400
East Riverbank	7,732,688	4	0	0	4	8,928,000
Total	**35,998,381**	**18**	**9**	**13,370,400**	**11**	**37,706,400**

[a] Maximum Day Demand plus 20% reserve capacity.
[b] Number of wells required with assumed capacity of 1,500 gpm to meet maximum day demand.
[c] Existing and new wells.
[d] For Central Riverbank, existing capacity includes Well No. 10.

7.3 Storage Requirements at Buildout for General Plan

Currently, the City has two above-ground storage tanks totaling 2.0 MG. Each of these above-ground storage tanks has a pumping station consisting of three booster pumps, each capable of delivering 1,000 gpm. In accordance with the Master Plan criteria (Chapter 3), the minimum capacity of booster pumping should be equal to the difference in peak hour demands versus the maximum day demand. Booster pumping requirements for each buildout area are shown in Table 7-4. The number of booster pump stations required for each buildout area is based on the assumption that one booster pump is out of service for each station. As shown, a total of four new booster pump stations will be necessary at buildout conditions.

TABLE 7-4
CITY OF RIVERBANK
WATER SUPPLY STUDY AND WATER MASTER PLAN
BOOSTER PUMP STATIONS REQUIRED

Buildout Area	Min. Capacity of Booster Pumping (gpd)[a]	Booster Pump Stations Required	Existing Booster Pumps Stations	New Booster Pump Stations Needed	Total Capacity (gpd)
West Riverbank	5,512,613	1.9	0	2	5,760,000
Central Riverbank	6,776,819	2.4	2	1	8,640,000
East Riverbank	3,362,038	1.2	0	1	2,880,000
Total	**15,651,470**	**5.4**	**2**	**4**	**17,280,000**

[a] Difference in peak hour demands versus the maximum day demand.

Tank storage is necessary to meet equalization, emergency, and fire storage requirements. Storage requirements at buildout conditions are shown for each buildout area in Table 7-5. A total of approximately 22.5 MG of storage is required to meet storage requirements at buildout.

TABLE 7-5
CITY OF RIVERBANK
WATER SUPPLY STUDY AND WATER MASTER PLAN
STORAGE REQUIREMENTS AT BUILDOUT

Storage Requirements	West Riverbank	Central Riverbank	East Riverbank	Total
Equalization Storage (gallons)[a]	2,641,460	3,247,226	1,610,977	7,499,663
Emergency Storage (gallons)[b]	4,593,844	5,647,349	2,801,699	13,042,892
Fire Storage (gallons)	630,000	630,000	630,000	1,890,000
Total (gallons)	**7,865,305**	**9,524,575**	**5,042,675**	**22,432,554**

[a] 25% of maximum day demand
[b] Average day demand

A summary of proposed facilities to meet storage requirements at buildout conditions is presented in Table 7-6. According to Master Plan criteria (Chapter 3), emergency storage can be furnished through the operation of groundwater wells. With an assumed well capacity of 1,500 gpm, each additional well can provide approximately 2.16 MG of storage based on 24 hours of operation. As shown, storage requirements can be met with the addition of five 2.0 MG storage tanks and five 1,500 gpm wells. Each of the five new storage tanks would have a new booster pump station which meets the requirements in Table 7-4.

TABLE 7-6
CITY OF RIVERBANK
WATER SUPPLY STUDY AND WATER MASTER PLAN
FACILITIES NEEDED TO MEET STORAGE REQUIREMENTS

Storage Requirements	Total Storage Required (MG)	Existing Tank Capacity (MG)	New Tanks Needed	New Tank Capacity (MG)[a]	New Wells Needed[b]	New Well Capacity (MG)[c]	Total Capacity (MG)[d]
West Riverbank	7.87	0.0	2	4.0	2	4.32	8.32
Central Riverbank	9.52	2.0	1	2.0	1	2.16	6.16
East Riverbank	5.04	0.0	2	4.0	2	4.32	8.32
Total	**22.43**	**2.0**	**5**	**10.0**	**5**	**10.80**	**22.80**

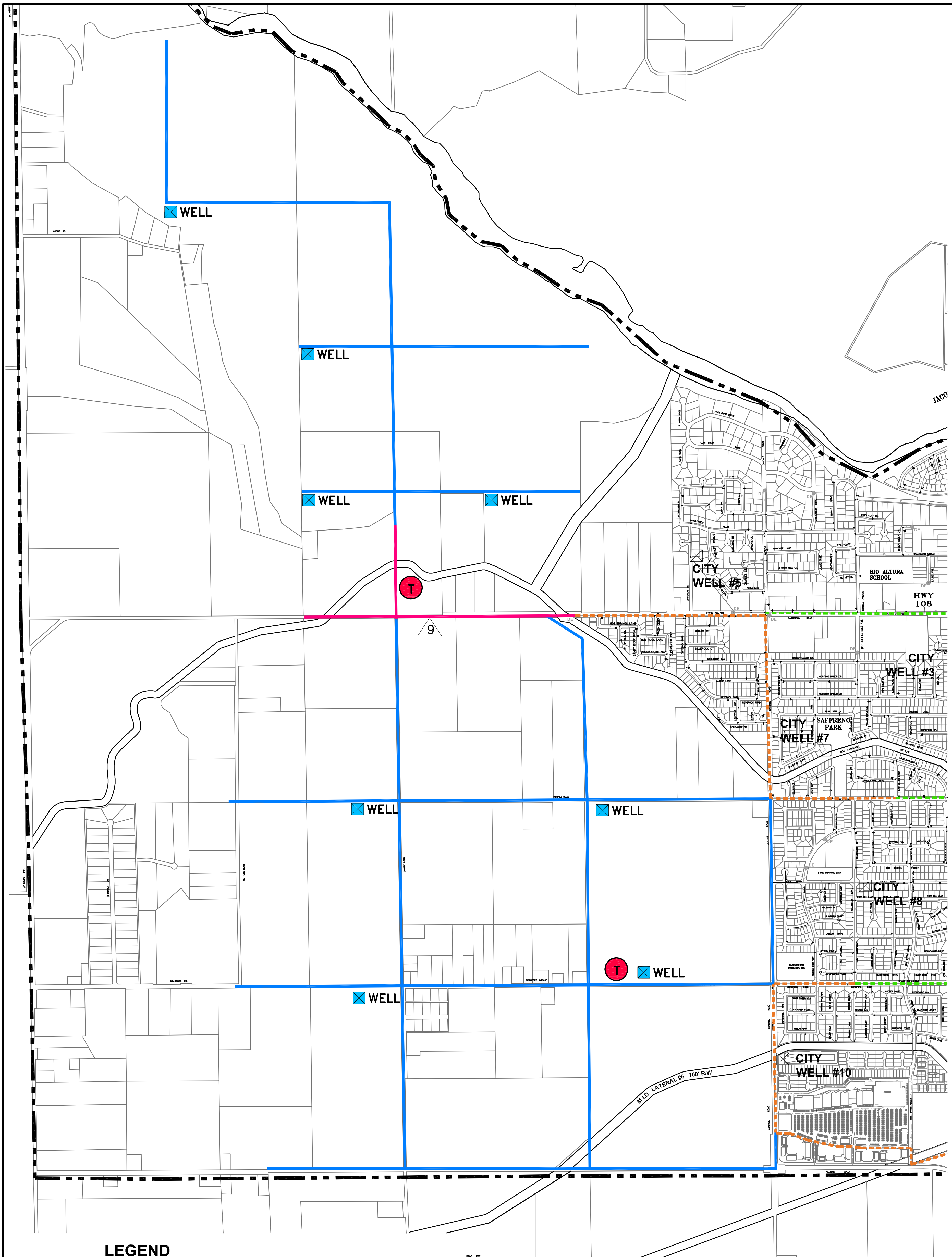
[a] Each tank has a capacity of 2.0 MG.
[b] Wells needed in addition to those required for maximum day demand and 20% reserve capacity (Table 7-3).
[c] New well capacity of 1,500 gpm each.
[d] Existing tanks and new facilities.

7.4 Recommended Supply and Distribution System Strategy

To address water supply and storage requirements at buildout for the City, conceptual facilities were identified for the West, Central, and East areas. The facilities include suggested groundwater wells, water storage tanks, and a grid system of 12-inch water mains. Suggested improvements for each area are as follows:

1. For West Riverbank the suggested facilities include eight groundwater wells with a minimum capacity of 1,500 gpm each and two 2.0 MG storage tanks. A minimum of six new groundwater wells are required to meet reserve capacity requirements and maximum day demands at buildout conditions as presented in Table 7-3. The two additional wells are recommended to meet storage requirements and to furnish additional supply in emergency conditions (wells out of service). Conceptual facilities for West Riverbank are shown in Figure 7-2.

2. For Central Riverbank the suggested facilities include two groundwater wells (in addition to Well No. 10) with a minimum capacity of 1,500 gpm each and one 2.0 MG storage tank. A minimum of one new groundwater well is required to meet reserve capacity requirements and maximum day demands at buildout conditions as shown in Table 7-3. The one additional well is recommended to meet storage requirements and to furnish additional supply in emergency conditions. Conceptual facilities for Central Riverbank are shown in Figure 7-3.



LEGEND

	PLANNING AREA BOUNDARY
	TRANSMISSION MAIN PROJECT 12" WATER MAIN (UNLESS NOTED OTHERWISE)
	POTENTIAL 12" WATER MAIN (MINIMUM)
	EXISTING 12" WATER MAIN
	EXISTING 10" WATER MAIN
WELL	POTENTIAL WELL
T	POTENTIAL WATER STORAGE TANK
WELL	EXISTING WELL
	EXISTING WATER STORAGE TANK
1	TRANSMISSION MAIN PROJECT NUMBER

N

0' 700' 1400'

FIGURE 7-2

CITY OF RIVERBANK
WATER SUPPLY STUDY AND
WATER MASTER PLAN

CONCEPTUAL WATER FACILITIES FOR WEST RIVERBANK SERVICE AREAS

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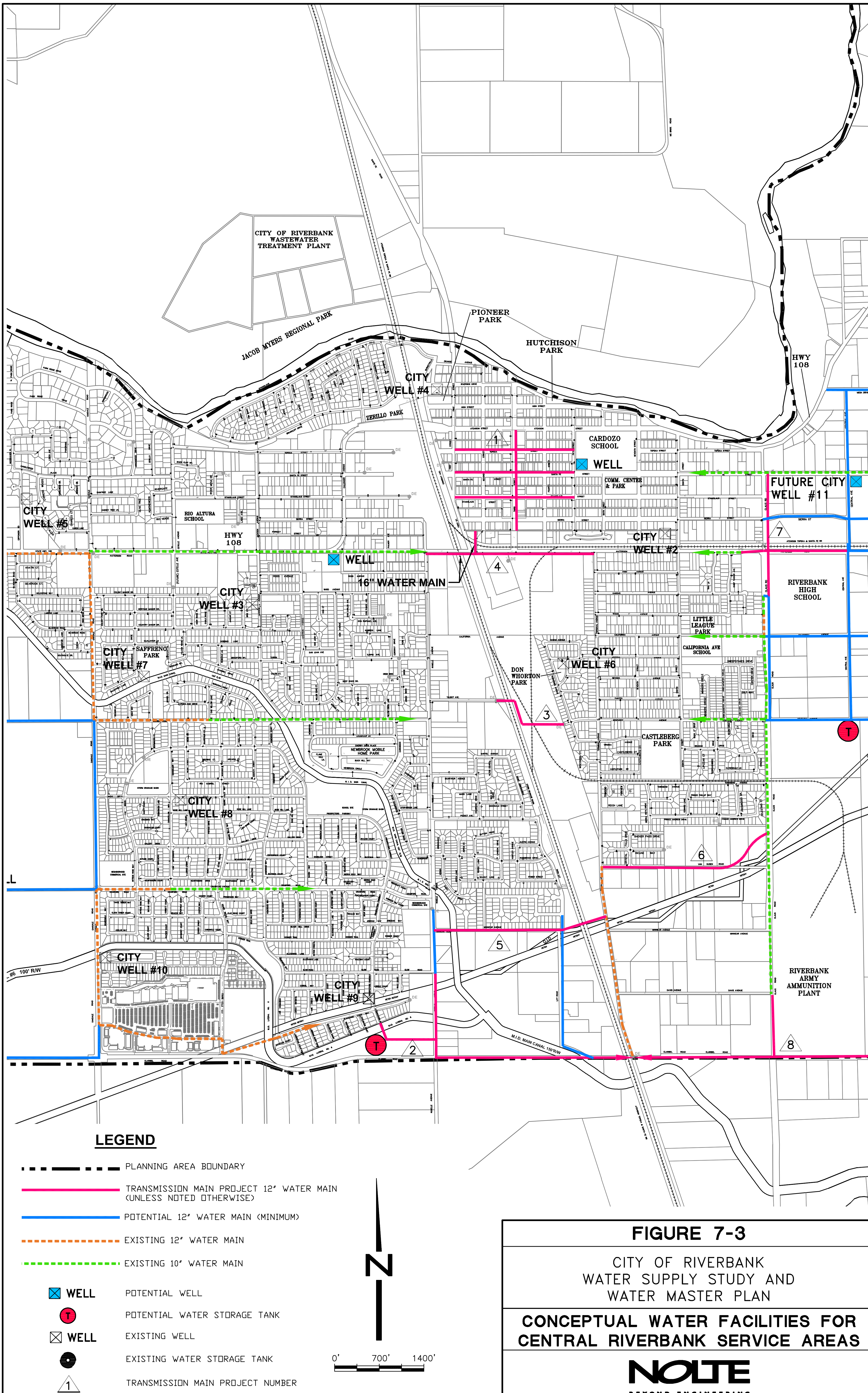

FIGURE 7-3

CITY OF RIVERBANK
WATER SUPPLY STUDY AND
WATER MASTER PLAN

CONCEPTUAL WATER FACILITIES FOR CENTRAL RIVERBANK SERVICE AREAS

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3. For East Riverbank the suggested facilities include six groundwater wells (including Well No. 11) with a minimum capacity of 1,500 gpm each and two 2.0 MG storage tanks. A minimum of four new groundwater wells are required to meet reserve capacity requirements and maximum day demands at buildout conditions as shown in Table 7-3. The two additional wells are suggested to furnish additional supply in emergency conditions. Conceptual facilities for East Riverbank are shown in Figure 7-4.

   Well No. 11 has been planned and designed for a location near Santa Fe Street and Central Avenue that is very compatible with water system needs and water supply strategy. The northern part of East Riverbank is a good area for water supply capacity, with expected good water quality, shallower depth wells, and higher volume as the groundwater travels from the northeast to the southwest.

7.5 Transmission Main Projects (TMP)

The City water system is one continuous pressure zone. To avoid pressure drops at times of high water demands, it is imperative that sub-areas of the water system separated by physical obstacles, such as canals and railroad tracks, be connected with high capacity transmission pipelines that can shunt large quantities of water to areas of demand. Specific transmission main projects (TMPs) are described below for areas where significant interconnection capacity is needed to meet existing and projected water demands.

Water mains recommended as part of the TMPs are shown in Figures 7-2, 7-3, and 7-4. Recommended water mains for the TMPs have been separated by buildout area and are prioritized as follows:

a. <u>Central Riverbank</u>

1. TMP #1 – Downtown Riverbank: Addition of 7,210 feet of 12-inch pipeline in Third Street, between Patterson Road and Atchison Street, and Stanislaus Street, Santa Fe Street, and Topeka Street, between First Street and Fifth Street. The downtown Riverbank Project would involve eight connection points to the existing distribution system.

2. TMP #2 –Prospectors/Claribel/Roselle: Addition of 5,590 feet of 12-inch pipeline from the dead-end in Prospectors Parkway to Roselle Avenue, and from the intersection of Roselle Avenue and Glow Road to the dead-end at the intersection of Terminal Avenue and Claribel Road. This project includes three canal crossings, one railroad crossing, one major pipeline crossing, and three connections to the existing system.

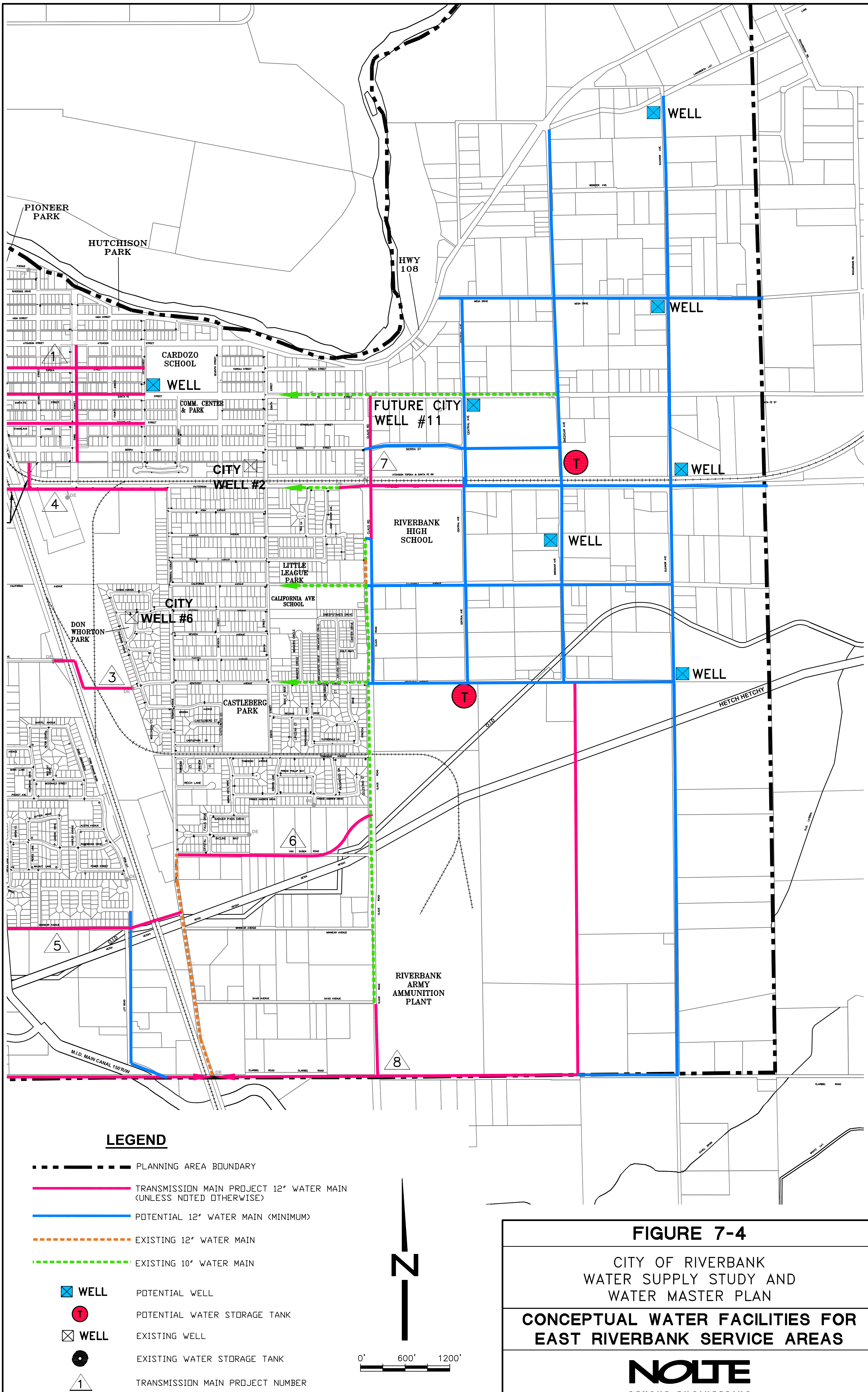

FIGURE 7-4

CITY OF RIVERBANK
WATER SUPPLY STUDY AND
WATER MASTER PLAN

CONCEPTUAL WATER FACILITIES FOR EAST RIVERBANK SERVICE AREAS

3. TMP #3 –Talbot/Kentucky Connection: Addition of 1,330 feet of 12-inch pipeline from the dead-end in Terminal Avenue to the dead-end in Kentucky Avenue just west of Tennessee Avenue. This project includes three railroad crossings and two connection points to the existing system.

4. TMP #4 – Patterson Road: Addition of 1,170 feet of 16-inch pipeline in Patterson Road from Roselle Avenue to First Street (including a segment of pipe just east of the existing storage tank) and 1,840 feet of 12-inch pipeline in Patterson Road from First Street to Terminal Avenue. This project includes three railroad crossings and three connection points to the existing system. The existing 10-inch water lines are to remain for redundancy and additional capacity during fire flows.

5. TMP #5 –Roselle/Terminal Connection: Addition of 2,740 feet of 12-inch pipeline from the Roselle Avenue to Terminal Avenue along Minniear Avenue. This project includes one railroad crossing, one canal crossing, and two connections to the existing system.

6. TMP #6 –Van Dusen Road: Addition of 2,840 feet of 12-inch pipeline from the Terminal Avenue to Claus Road along Van Dusen Road. This project includes two connections to the existing system.

b. <u>East Riverbank</u>

1. TMP #7 –Patterson/Claus: Addition of 3,610 feet of 12-inch pipeline from dead-end in Patterson Road just west of Claus Road to Central Avenue and from Claus Road near Riverbank High School to Santa Fe Street. This project includes one railroad crossing and three connections to the existing system.

2. TMP #8 –Claribel/Snedigar: Addition of 11,060 feet of 12-inch pipeline from the intersection of Claribel Road and Terminal Road to the intersection of Claus Road and Davis Avenue. Also included is a pipeline continuation in Claribel Road to the intersection of Snedigar Avenue and Kentucky Avenue. This project includes one major pipeline crossing and one connection to the existing system.

c. <u>West Riverbank</u>

1. TMP #9 – State Route (SR) -108: Involves 5,260 feet of 12-inch pipeline with three bore and jack crossings and one connection point to the existing water distribution system.

8 Probable Construction Costs

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

8.1 Unit Costs

Unit costs were developed for water lines, valves, wells, tanks, booster pump stations, and other elements identified as recommended improvements in Chapter 7. Table 8-1 summarizes the unit cost information. The unit pipe costs reflect installation, including dewatering, and assumes conventional pipe installation by means of open cut. A unit cost for trenchless pipeline installation by bore and jack construction under canals, railroads, major roads, and major pipelines is included as a separate unit cost. Unit costs were used to develop opinions of probable construction costs for the recommended system improvements.

TABLE 8-1
CITY OF RIVERBANK
WATER SUPPLY STUDY AND WATER MASTER PLAN
UNIT COSTS FOR SUGGESTED IMPROVEMENTS

Item	Unit Cost, $	Unit
Purchased Land[a]	$130,000	AC
Water Well (1,500 gpm)[b]	$1,450,000	EA
Storage Tank (2.0 MG) and Booster Pump Station	$2,210,000	EA
PVC Water Main		
12-inch	$50	LF
PVC Water Main (Under Paving)		
12-inch	$60	LF
16-inch	$90	LF
Gate Valves		
12-inch	$2,400	EA
16-inch	$3,100	EA
6-inch Fire Hydrant Assembly	$4,000	EA
Bore and Jack (Includes Casing and Carrier Pipe)	$740	LF

[a] Well land assumed at 0.25 acres per well site. Tank land assumed at 0.5 acres per well site.
[b] Includes test well/monitoring well installation, production well drilling, development and testing, and well equipping, (pump, motor, housing, and all associated equipment).

8.2 Probable Construction Costs for Suggested Improvements

Cost summaries for suggested improvements in Central, East, and West Riverbank are provided in Tables 8-2, 8-3, and 8-4, respectively. For each buildout area, probable construction costs are separated into water supply projects and distribution system projects. Distribution system projects are further categorized as TMPs or development driven. Conceptual water supply and distribution facilities are shown in Figure 8-1. Transmission Main Project (TMP) descriptions are presented in Chapter 7.

TABLE 8-2
CITY OF RIVERBANK
WATER SUPPLY STUDY AND WATER MASTER PLAN
SUMMARY OF PROBABLE SYSTEM COSTS FOR CENTRAL RIVERBANK

Buildout Area/Item	Quantity	Unit Cost, $	Unit	Total Cost, $
Water Supply Projects				
Water Well	2	$1,450,000	EA	$2,900,000
Well Land	0.5	$130,000	AC	$65,000
2.0 MG Storage Tank/Booster Pump Station	1	$2,210,000	EA	$2,210,000
Tank Land	0.5	$130,000	AC	$65,000
Subtotal				$5,240,000
Distribution System Projects				
TMP #1 – Downtown Riverbank				
12-inch PVC Water Main (in paving)	7,210	$60	LF	$432,600
12-inch Gate Valves	26	$2,400	EA	$62,400
6-inch Fire Hydrant Assembly	16	$4,000	EA	$64,000
Relocate Existing Fire Hydrants	3	$1,200	EA	$3,600
Subtotal				$559,000
TMP #2 –Prospectors/Claribel/Roselle				
12-inch PVC Water Main (in paving)	4,750	$60	LF	$285,000
Bore and Jack	840	$740	LF	$621,600
12-inch Gate Valves	15	$2,400	EA	$36,000
6-inch Fire Hydrant Assembly	19	$4,000	EA	$74,500
Subtotal				$1,017,100
TMP #3 –Talbot/Kentucky Connection				
12-inch PVC Water Main (in paving)	1,010	$60	LF	$60,600
Bore and Jack	320	$740	LF	$236,800
12-inch Gate Valves	6	$2,400	EA	$14,400
6-inch Fire Hydrant Assembly	4	$4,000	EA	$17,700
Subtotal				$329,500

TABLE 8-2 (CONTINUED)
CITY OF RIVERBANK
WATER SUPPLY STUDY AND WATER MASTER PLAN
SUMMARY OF PROBABLE SYSTEM COSTS FOR CENTRAL RIVERBANK

Buildout Area/Item	Quantity	Unit Cost, $	Unit	Total Cost, $
TMP #4 – Patterson Road				
12-inch PVC Water Main (in paving)	1,730	$60	LF	$103,800
16-inch PVC Water Main (in paving)	960	$90	LF	$86,400
Bore and Jack 12"	110	$740	LF	$81,400
Bore and Jack 14"	210	$740	LF	$155,400
12-inch Gate Valves	4	$2,400	EA	$9,600
16-inch Gate Valves	5	$3,100	EA	$15,500
6-inch Fire Hydrant Assembly	10	$4,000	EA	$40,100
Subtotal				$492,200
TMP #5 –Roselle/Terminal Connection				
12-inch PVC Water Main	2,510	$50	LF	$125,500
Bore and Jack	230	$740	LF	$170,200
12-inch Gate Valves	8	$2,400	EA	$19,200
6-inch Fire Hydrant Assembly	10	$4,000	EA	$38,800
Subtotal				$351,400
TMP #6 –Van Dusen Road				
12-inch PVC Water Main (in paving)	2,840	$60	LF	$170,400
12-inch Gate Valves	7	$2,400	EA	$16,800
6-inch Fire Hydrant Assembly	9	$4,000	EA	$37,900
Subtotal				$225,100
Water Distribution Mains (Development)				
12-inch PVC Water Main (in paving)	3,310	$60	LF	$198,600
Bore and Jack	270	$740	LF	$199,800
12-inch Gate Valves	12	$2,400	EA	$28,800
6-inch Fire Hydrant Assembly	12	$4,000	EA	$48,000
Subtotal				$475,200
Total				$8,690,000
Contingency, 25%				$2,170,000
Subtotal				$10,860,000
Design, 10%				$1,086,000
Construction Management, 15%				$1,629,000
Probable Cost				**$13,580,000**

TABLE 8-3
CITY OF RIVERBANK
WATER SUPPLY STUDY AND WATER MASTER PLAN
SUMMARY OF PROBABLE SYSTEM COSTS FOR EAST RIVERBANK

Buildout Area/Item	Quantity	Unit Cost, $	Unit	Total Cost, $
Water Supply Projects				
Water Well	6	$1,450,000	EA	$8,700,000
Well Land	1.50	$130,000	AC	$195,000
2.0 MG Storage Tank/Booster Pump Station	2	$2,210,000	EA	$4,420,000
Tank Land	1	$130,000	AC	$130,000
Subtotal				$13,445,000
Distribution System Projects				
TMP #7 –Patterson/Claus				
12-inch PVC Water Main (in paving)	3,500	$60	LF	$210,000
Bore and Jack	110	$740	LF	$81,400
12-inch Gate Valves	13	$2,400	EA	$31,200
6-inch Fire Hydrant Assembly	8	$4,000	EA	$32,000
Subtotal				$354,600
TMP #8 –Claribel/Snedigar				
12-inch PVC Water Main	5,190	$50	LF	$259,500
12-inch PVC Water Main (in paving)	5,750	$60	LF	$345,000
Bore and Jack	120	$740	LF	$88,800
12-inch Gate Valves	30	$2,400	EA	$72,000
6-inch Fire Hydrant Assembly	37	$4,000	EA	$147,500
Subtotal				$912,800
Water Distribution Mains (Development)				
12-inch PVC Water Main (in paving)	48,380	$60	LF	$2,902,800
Bore and Jack	1,300	$740	LF	$962,000
12-inch Gate Valves	130	$2,400	EA	$312,000
6-inch Fire Hydrant Assembly	166	$4,000	EA	$662,400
				$4,839,200
Total				$19,550,000
Contingency, 25%				$4,890,000
Subtotal				$24,440,000
Design, 10%				$2,444,000
Construction Management, 15%				$3,666,000
Probable Cost				**$30,550,000**

TABLE 8-4
CITY OF RIVERBANK
WATER SUPPLY STUDY AND WATER MASTER PLAN
SUMMARY OF PROBABLE SYSTEM COSTS FOR WEST RIVERBANK

Buildout Area/Item	Quantity	Unit Cost, $	Unit	Total Cost, $
Water Supply Projects				
Water Well	8	$1,450,000	EA	$11,600,000
Well Land	2	$130,000	AC	$260,000
2.0 MG Storage Tank/Booster Pump Station	2	$2,210,000	EA	$4,420,000
Tank Land	1	$130,000	AC	$130,000
Subtotal				$16,410,000
Distribution System Projects				
TMP #9 – SR-108				
12-inch PVC Water Main	1,140	$50	LF	$57,000
12-inch PVC Water Main (in paving)	3,500	$60	LF	$210,000
Bore and Jack	620	$740	LF	$458,800
12-inch Gate Valves	14	$2,400	EA	$33,600
6-inch Fire Hydrant Assembly	15	$4,000	EA	$60,000
Subtotal				$819,400
Water Distribution Mains (Development)				
12-inch PVC Water Main	31,030	$50	LF	$1,551,500
12-inch PVC Water Main (in paving)	28,800	$60	LF	$1,728,000
Bore and Jack	420	$740	LF	$310,800
12-inch Gate Valves	150	$2,400	EA	$360,000
6-inch Fire Hydrant Assembly	200	$4,000	EA	$800,000
Subtotal				$4,750,300
Total				$21,980,000
Contingency, 25%				$5,500,000
				$27,480,000
Subtotal				
Design, 10%				$2,748,000
Construction Management, 15%				$4,122,000
Probable Cost				**$34,350,000**

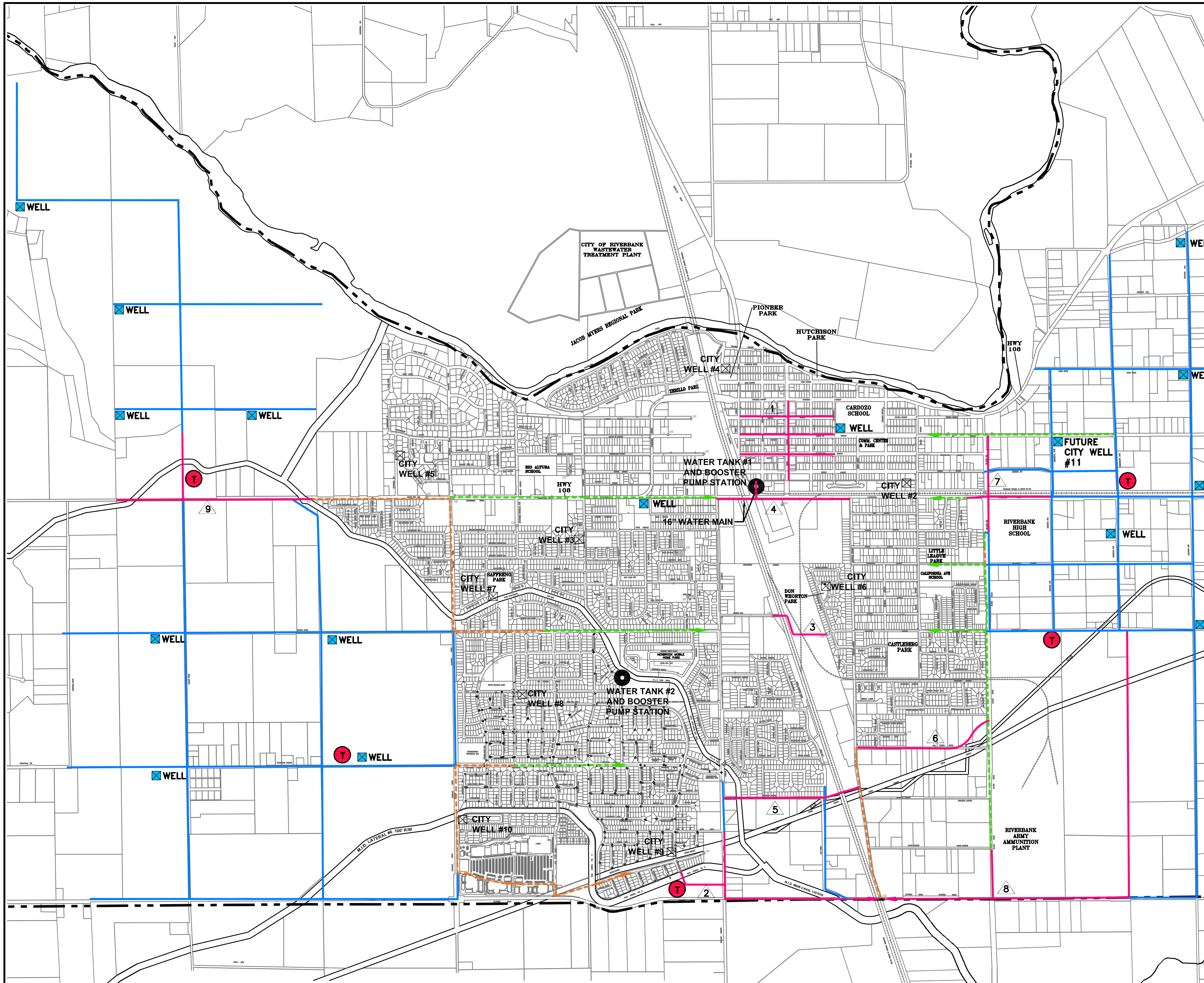

FIGURE 8-1

CITY OF RIVERBANK
WATER SUPPLY STUDY AND
WATER MASTER PLAN

CONCEPTUAL WATER FACILITIES
FOR RIVERBANK

NOLTE
BEYOND ENGINEERING

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A summary of probable system costs is provided in Table 8-5.

TABLE 8-5
CITY OF RIVERBANK
WATER SUPPLY STUDY AND WATER MASTER PLAN
SUMMARY OF PROBABLE SYSTEM COSTS FOR SUGGESTED FACILITIES

Buildout Area	Total Cost, $
Central Riverbank	13,580,000
East Riverbank	30,550,000
West Riverbank	34,350,000
Total Probable Cost	78,480,000

9 Capital Improvements Program

This chapter presents the recommend Capital Improvements Program (CIP) to address existing deficiencies and future growth for the City of Riverbank. For reference, not all projects and improvements described in Chapter 8 are described in the initial recommended CIP

9.1 Assumptions Used in Developing CIP

The water system CIP was based on the following assumptions:

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

2. Pipelines will be located in dedicated public right-of-way, and land for storage tanks and well sites will be purchased. The cost for purchased land is assumed to be $130,000/ac.

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 all pipeline appurtenances except gate valves and fire hydrants, which have been cataloged separately.

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

7. The water storage facilities cost includes tanks, pumps, motors, valves, and appurtenances.

8. The well costs include test well/monitoring well installation, well drilling and development, well housing, pumps, motors, valves, emergency generator and appurtenances.

9. The availability of 14-inch and 20-inch diameter pipe is limited and replacement is problematic. Therefore, projected water demands that necessitate pipelines exceeding 12-inch diameter will be served by 16-inch pipelines.

9.2 Discussion of CIP Facilities and Priorities

The City water system is a single pressure zone. Significant growth is expected in East and West Riverbank that will more than double the existing water demands. The existing City water service areas are separated by obstructions including railroad tracks and canals. As such, it is critical to have adequate transmission main capacity to shunt water throughout the existing and expanded system to areas of demand. It is also important to provide operational redundancy and eliminate system bottlenecks so the water supply and pressures will equalize.

West Riverbank is approximately 25 feet lower than East Riverbank and will have approximately 10 psi more static pressure. Therefore, it would be more efficient with less pressure drop from line losses if water moved through the system from east to west. Also, from hydrogeologic assessments, it is a good strategy to site wells on the northern portion of East Riverbank where wells are expected to have higher capacity at shallower depths and good water quality. The City should implement a program of constructing new wells to provide adequate capacity for on-going growth and for operational reserves.

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. <u>Current Needs</u>

1. East Riverbank Well – A new well in East Riverbank represents the single most important water system improvement. Well No. 11 has been designed and planned for a location on Santa Fe Street just east of Central Avenue. A monitoring well/test well has been drilled on the planned Well No. 11 site. This site is a good location for a high capacity City well according to the hydrogeologic assessment.

2. Downtown Fire Protection – A water system evaluation was performed on the downtown Riverbank area and determined that additional infrastructure is needed to meet new fire protection standards. The central portions of the recommended upgrades are being included in the Downtown Beautification and Infrastructure Project (TMP #1).

3. Claus Road and Patterson Road Connections – The railroad tracks parallel to Patterson Road have separated the existing eastside water system into two areas and created several dead end lines. There are no water lines crossing Patterson Road and the railroad tracks east of Eighth Street. New development is being proposed east of Claus Road and north of Patterson Road. This emphasizes the need for the following

improvements (TMP #7): 1) a 12-inch water line connection across Patterson Road and the railroad tracks; 2) a connection between the existing water line in Claus near Riverbank High School to the dead end line in Patterson; and 3) a 12-inch water line in north Claus Road to the existing 10-inch water line in Santa Fe Street. This would facilitate water movement from a new well in East Riverbank to water uses in both the north and south Bruinville areas.

4. Claribel Transmission Main – The existing City water system is divided by the railroad into eastside and westside sectors with only two connecting water lines. The main connecting water line is only a 10-inch line in Patterson Road. There is a 12-inch water line through the Public Works yard and under the railroad tracks, but the line functions mainly to convey water from Well No. 4 to River Cove and adjacent areas. There is a dead end 12-inch water line in Terminal Avenue at Claribel Road. A connecting loop water main under the railroad at Claribel should be constructed to provide water service from the Roselle area water lines to the eastside (TMP #2).

b. Near-term Needs

1. Additional Well: Downtown or East Riverbank – Wells No. 2 and No. 4 are both older wells with limited capacity. A new well is needed to serve the downtown and surrounding areas and to meet the growing demands, including fire protection for public buildings. A first and important step would be to identify a good well location and obtain the well site. It would be advisable to implement an aggressive program of identifying and evaluating well locations, obtaining future well sites, and completing production wells in advance of development to avoid water supply issues and system delivery restrictions.

2. New Water Storage Tank – Currently, the City only has two 1.0 MG tanks, which is less storage than is required for fire protection and equalization storage to meet peak hour needs. A 2.0 MG tank is recommended for the south end of Central Riverbank with 12-inch water lines connecting the tank to pipelines in Terminal Avenue, Roselle Avenue, and Well No. 9.

   It is not recommended that wells be drilled in the southeastern area because of groundwater quality issues from the Riverbank Army Ammunition Plant; therefore, a 2.0 MG tank in the south and southeastern areas would provide vital water supply facilities that could fill at night and meet the daytime needs.

3. Additional Water Main Crossings at Railroad Tracks – For increased capacity, east-west water movement, and operational and maintenance flexibility, additional water mains are needed across the central railroad tracks.

a. Talbot/Kentucky connection – Existing dead end water lines in Talbot and Kentucky should be connected with bore and jack crossings under the railroad tracks. This will provide needed capacity for water transmission between the City areas and a more efficient local water distribution system (TMP #3).

b. Patterson Road/Railroad Crossing Upgrade – The main water connection between the eastside and westside of the existing water system is a 10-inch water line in Patterson Road. The nearby Tank #1 is used to meet demands exceeding the eastside water system well capacities and therefore may provide less storage than desired for peak demand and fire protection. The water lines in Patterson Road should be a major transmission route. Therefore, the crossing under the railroad tracks at Patterson Road should be upsized to 16-inch to provide for significant east-west water shunting when needed (TMP #4)

c. Terminal/Minniear/Roselle connection – A water main connection from Roselle through Minniear to Terminal (TMP #5) appears feasible and would parallel the Hetch Hetchy and OID rights of way for the portion crossing the railroad tracks. This would be a valuable connection to increase capacity and provide operational redundancy for the Claribel main line.

c. <u>Development Driven</u>

As detailed in the Master Plan, a significant number of new wells and water storage tanks will be needed to meet the development demands of the projected planning area. A reasonable amount of water supply infrastructure should be constructed prior to new development occupancy to serve the new areas and avoid detrimental impacts on the existing system.

In addition to new water lines and water supplies for new developments, adequate inter-connecting water mains must also be constructed to integrate the new areas into the existing system and provide operational redundancy. Many of these key inter-connecting water mains are important to an effective water system and should be managed as City projects. The projects described under Near-Term Needs should be constructed before significant development to assure adequate infrastructure is in place. The projects listed below would be development-driven and their timing would likely be in the first phase of the proposed development.

1. Claus/Terminal Inter-tie at Van Dusen – As development occurs south of the existing City limits in the Van Dusen Avenue area, it is important that a 12-inch inter-tie water line be constructed between Claus Road and Terminal Avenue to create a system loop (TMP #6).

2. Claribel/Snedigar Inter-tie – When the proposed industrial area in southeastern Riverbank is developed, a 12-inch inter-tie water line should be constructed from Claribel to Snedigar to connect the existing water system areas with a looped water transmission main (TMP #8).

3. West Riverbank SR-108/Main Inter-tie – As development begins in West Riverbank adjacent to SR-108, a main water transmission line at least 12-inches in diameter should be constructed along the highway corridor from the existing system, across the canals, to the new wells in West Riverbank (TMP #9).

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
WATER SUPPLY STUDY AND WATER MASTER PLAN
PROBABLE PROJECT COSTS FOR RECOMMENDED CIP

CIP Phase/Project	Total Cost [a], $
Current Needs	
Water Well – East Riverbank	$2,320,000
TMP #1	$880,000
TMP #7	$560,000
TMP #2	$1,590,000
Subtotal	$5,350,000
Near-Term Needs	
Water Well – Downtown or East Riverbank	$2,320,000
Tank – Central Riverbank	$3,560,000
TMP #3	$520,000
TMP #4	$770,000
TMP #5	$560,000
Subtotal	$7,730,000
Development Driven	
TMP #6	$360,000
TMP #8	$1,430,000
TMP #9	$1,280,000
Subtotal	$3,070,000
Total Probable Costs	**$16,150,000**

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

References

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

[2] *City of Riverbank, Summary of Proposed Design Criteria, Technical Memorandum,* prepared by Nolte Associates, April 2007.

[3] *City of Riverbank, Initial Water Distribution System Study for East Side Area, Technical Memorandum*, prepared by Nolte Associates, March 2005.

[4] *Bruinville Area Master Facilities Plan, Conceptual Water System and Preliminary Water Supply Analysis, Draft,* prepared by Nolte Associates, August 2005.

[5] *City of Riverbank, Morrison Homes Water Supply Study for Southwest Side Area, Technical Memorandum*, prepared by Nolte Associates, September 2005.

[6] *City of Riverbank, Buildout Projections of Water Demands, Technical Memorandum,* prepared by Nolte Associates, April 2007.

[7] *City of Riverbank, Water Distribution System Model for Existing Conditions, Technical Memorandum,* prepared by Nolte Associates, August 2006.

[8] *City of Riverbank, Design Standards – Water*, prepared by Giuliani & Kull, Inc., 2007.

[9] *Source Sufficiency Report for the City of Riverbank General Plan Update,* prepared by Dunn Environmental, June 2007.

[10] *Stanislaus and Tuolumne Rivers Groundwater Basin Association, Integrated Regional Groundwater Management Plan (IRGMP) for the Modesto Subbasin*, prepared by Bookman-Edmonston, June 2005.