City Of Lodi

Storm Drainage Master Plan

August 2012

City of Lodi

Storm Drainage Master Plan

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1. INTRODUCTION

1.1 Background

Expansion of the City of Lodi storm drainage service area is required to serve planned development areas. In 1963 the City of Lodi (City) adopted the Lodi Master Plan for the Development of Storm Water Collection and Disposal Facilities for drainage areas A through H, as shown on Figure 1, Storm Drainage Planning Areas. Facilities required to serve areas A through E, G and H have been constructed. The 2012 Storm Drain Master Plan will address planning areas F, I, K and L. Drainage master planning for J, M and N, as presented in Figure 1, will be addressed in a future analysis.

On April 7, 2010, the City adopted the General Plan Policy document that identifies areas to be developed within the City through the year 2030. The General Plan specifies in Section 3 – Growth Management and Infrastructure, GM-P11, that the City "prepare master plan documents as necessary during the planning period to address the infrastructure needs of existing and projected growth, and to determine appropriate infrastructure provisions for each phase."

The 2012 Storm Drainage Master Plan will present design criteria, define level of service standards, analyze service demands, consider alternative facilities plans and present the recommended plan for providing storm drainage service to the community.

Regulatory requirements governing the discharge of storm water runoff to receiving water bodies are a significant factor to be considered in the development of this Storm Drainage Master Plan.

1.2 Existing City of Lodi Storm Drainage Master Plan

"A Master Plan for the Development of Storm Water Collection and Disposal Facilities" was prepared by Blair-Westfall Associates Consulting Engineers in 1963. The planning area boundary encompassed the area approximately defined by the Central California Traction Company (C.C.T.C) Railroad tracks on the east, Harney Lane on the south, one-half mile west of Lower Sacramento Road on the west and the Mokelumne River on the north.

Under this plan, storm drainage facilities included a network of conveyance pipelines and storm pump stations with storage basins located around the City. The basins were planned to be interconnected with adjacent drainage areas so that the disposal of nuisance waters and moderate storm water runoff could be accomplished by gravity flow to storm pump stations with ultimate disposal to the Mokelumne River or the Woodbridge Irrigation District (WID) canal. By diverting lower flows directly to terminal drainage facilities, the basins could be utilized for multiple uses including recreation, recharge, and storm water detention.

In 1990, the planning area was expanded to include Drainage Area I that extends from

Kettleman Lane to Harney Lane and from Lower Sacramento Road to the one-half mile west of Lower Sacramento Road or the southerly extension of the WID canal. The same conceptual facilities plan was adopted for Area I as for the remainder of the master plan. At the same time, Area G was expanded southerly to include the area bounded by the WID canal, Lower Sacramento Road and Harney Lane.

1.3 Study Area

The 2012 Storm Drainage Master Plan has been expanded to coincide with the General Plan limits adding Areas J, K, L, M and N; as presented in Figure 1. This Storm Drainage Master Plan will only address Areas F, I, K and L for the following reasons. First, facilities required to serve Areas F, I, K, and L are independent of those facilities serving J, M, and N. Second, the planning horizon for this Storm Drainage Master Plan is 2035 and development is not expected to occur in Areas J, M, and N before that time. Should development occur in these areas, this Storm Drainage Master Plan will need to be amended.

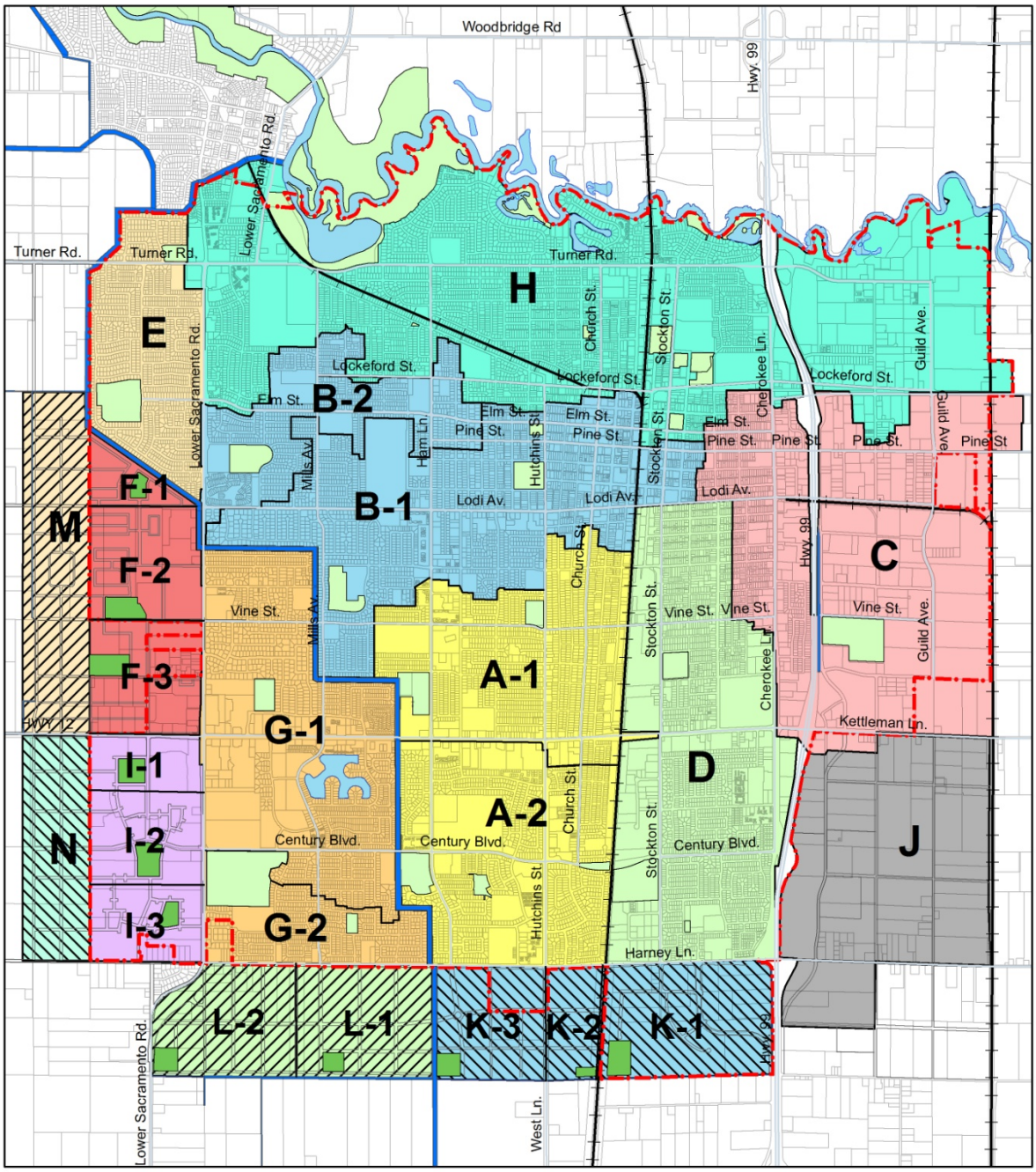


Figure 1
Storm Drain Planning Areas

Legend

- Future Basins
- City Limits
- Parcels
- Canal
- Parks
- Railroad
- General Plan - Streets
- River
- A-Basin Drainage Area
- B-Basin Drainage Area
- C-Basin Drainage Area
- D-Basin Drainage Area
- E-Basin Drainage Area
- F-Basin Drainage Area
- G-Basin Drainage Area
- H-Basin Drainage Area
- I-Basin Drainage Area
- J-Basin Drainage Area
- K-Basin Drainage Area
- L-Basin Drainage Area
- M-Basin Drainage Area
- N-Basin Drainage Area

N W E S

1 in = 3,000 ft

2.1 Basin Area Descriptions

The 2012 Storm Drainage Master Plan has been divided into planning areas A-N, as shown in Figure 1. The General Plan land uses and acreages used in the analysis for the design of pipes and detention basins for Areas F, I, K and L are provided in Table 1. No additional master planning was required for Areas A through E, G and H because the facilities have been fully constructed and the areas are nearly fully developed. Areas J, M and N will be analyzed in the future.

Table 1: Basin Areas

Land Use	F-1 (Ac)	F-2 (Ac)	F-3 (Ac)	TOTAL F-BASIN (Ac)	I-1 (Ac)	I-2 (Ac)	I-3 (Ac)	TOTAL I-BASIN (Ac)
LDR	46.0	37.8	49.7	**133.0**	6.4	74.5	91.5	**172.0**
MDR		26.4	18.7	**45.0**	8.2	21.1	9.2	**38.6**
HDR		9.8		**10.0**	12.2	13.7		**26.0**
COM		27.1	41.8	**69.0**	36.8			**37.0**
MIX								
IND								
PUB		44.4	9.7	**54.0**	5.2	16.4		**22.0**
OPEN	4.3	14.1	10.4	**28.8**	8.1	12.3	7.3	**27.0**
HWY								
Total	50.3	159.6	130.2	**339.8**	76.9	138.0	108.0	**322.6**

Land Use	K-1 (Ac)	K-2 (Ac)	K-3 (Ac)	TOTAL K- BASIN (Ac)	L-1 (Ac)	L-2 (Ac)	TOTAL L-BASIN (Ac)
LDR	6.9	20.7	29.5	**57.0**	107.7	203.9	**312.0**
MDR	72.0	16.9	38.4	**127.0**	4.7	33.2	**38.0**
HDR	10.0		10.0	**20.0**			
COM	109.9	18.9	41.7	**170.5**			
MIX					35.2		**35.0**
IND							
PUB			18.1	**18.0**		9.8	**10.0**
OPEN	12.1	18.0	16.0	**46.0**	27.8	20.5	**48.0**
HWY	23.9			**24.0**			
Total	234.7	74.6	153.8	**462.5**	175.5	267.4	**443.0**

2.1.1 Area A

This area is generally bounded by Tokay Street on the north, Union Pacific Railroad (UPRR) on the east, Harney Lane on the south, and the WID canal on the west. Area A is divided into two subareas: A-1 and A-2. Subarea A-1 extends from Tokay Street to Kettleman Lane. The detention basin serving

subarea A-1 (Kofu Park) is located immediately north of the City of Lodi Municipal Services Center at Ham Lane and Kettleman Lane. The detention basin serving subarea A-1 disposes storm water through natural recharge and by a pump station. Flows from the pump station are sent to the A-2 pump station for discharge into the WID canal.

Subarea A-2 lies between Kettleman Lane and Harney Lane. The detention basin serving subarea A-2 (Beckman Park) is located on Century Boulevard next to the WID canal. The A-2 pump station has an outfall connection into the WID canal. The A-2 pump station is one of two existing outfall connections into the WID canal. The areas within subareas A-1 and A-2 are fully developed and most storm drainage facilities have been constructed. Area A is shown in Figure 1.

2.1.2 Area B

This area is generally bounded by Lockeford Street on the north, Washington Street on the east, Tokay Street on the south, and Lower Sacramento Road on the west. Area B is divided into two subareas; B-1 and B-2. Subarea B-1 extends northerly from Tokay Street to Elm Street. The detention basin serving subarea B-1 (Vinewood Park) is located on Tokay Street just east of Mills Avenue. This detention basin disposes storm water through natural recharge and by a pump station.

Subarea B-2 lies between Elm Street and Lockeford Street. The detention basin serving subarea B-2 (Henry Glaves Park) is located on Oxford Way, 500 feet east of Lower Sacramento Road. This detention basin disposes storm water through natural recharge and by a pump station. Flows from both the B-1 and B-2 pump stations are sent to the Shady Acres pump station for discharge into the WID canal. The areas within subareas B-1 and B-2 are fully developed and most storm drainage facilities have been constructed. Area B is shown in Figure 1.

2.1.3 Area C

This area is generally bounded by Lockeford Street on the north, Central California Traction Company Railroad (CCT) on the east, Kettleman Lane on the south, and 500 feet west of Washington Street on the west. The detention basin serving area C (Pixley Park) is partially constructed at this time and is located on Vine Street, 600 feet east of Beckman Road. Once fully constructed, the detention Basin C will dispose storm water through natural recharge and by a pump station that will be constructed in the future. Flows from the pump station will be diverted to the Cluff Avenue pump station and pumped to the Mokelumne River. Area C is shown in Figure 1.

2.1.4 Area D

This area is generally bounded by Lodi Avenue on the north, Cherokee Lane on the east, Harney Lane on the south, and the UPRR on the west. The detention basin serving area D (Salas Park) is located at Stockton Street and Century Boulevard. The detention basin disposes storm water through natural recharge

and by a pump station. Flows from the pump station are pumped to the A-2 pump station and then discharged to the WID canal. Area D is shown in Figure 1.

2.1.5 Area E

This area is bounded by the WID canal on the north, west and south and Lower Sacramento Road on the east. The detention basin serving area E (Peterson Park) is located on Elm Street, ¼ mile west of Lower Sacramento Road. This detention basin disposes storm water through natural recharge and by a pump station. Flows from the pump station are sent to the Lodi Lake pump station located at Turner Road and Mills Avenue where it is pumped into the Mokelumne River. The areas within area E are near fully developed and the storm drainage facilities have been fully constructed. Area E is shown in Figure 1.

2.1.6 Area F

This area is bounded by the WID canal on the north, Lower Sacramento Road on the east, Kettleman Lane on the south, and ½ mile west of Lower Sacramento Road. Area F is divided into three subareas, F-1, F-2, and F-3 as shown in Figure 1. Subarea F-1 is that portion lying between the WID canal and Lodi Avenue. Subarea F-2 is that portion lying between Lodi Avenue and Vine Street. Subarea F-3 is that portion lying between Vine Street and Kettleman Lane. Justifications for dividing Area F in this manner are: 1) property ownerships align with the subarea boundary, 2) planning subareas are approximately equal-sized, 3) subareas are configured in a fashion consisted with the expected phasing of development and 4) subarea topography is conducive to the design of gravity flow facilities. Area F is shown in Figure 1.

2.1.7 Area G

This area is bounded by WID canal on the north, WID canal on the east, Harney Lane on the south, and the Lower Sacramento Road on the west. Area G is divided into two subareas, G-1 and G-2. Subarea G-1 lies between the WID canal to Century Boulevard. The detention basin serving subareas G-1 and G-2 is located at De Benedetti Park (G-Basin) located at Lower Sacramento Road and Century Boulevard. Storm water runoff from subarea G-1 and most of subarea G-2 can bypass G Basin and flow directly to A-2 pump station if needed. The areas within subarea G-2 are between Century Boulevard and Harney Lane. The areas within Area G are almost fully developed and the storm drainage facilities serving this area have been constructed. Flows from the pump station will be diverted to the A-2 pump station for release into the WID canal. Area G is shown in Figure 1.

2.1.8 Area H

This area is generally bounded by the limits of the urban development bordering the Mokelumne River on the north, the CCT on the east, Lockeford Street on the south, and Lower Sacramento Road on the west as shown in Figure 1. Area H

discharges storm water by gravity flow and four pump stations located at Lodi Lake, Lincoln Avenue, Turner Road, and Cluff Avenue directly into the Mokelumne River. Area H has 17 outfall connections into the Mokelumne River. Area H, with the exception of east of State Route 99, is fully developed. Area H is shown in Figure 1.

2.1.9 Area I

Boundaries for this area include Kettleman Lane on the north, Lower Sacramento Road on the east, Harney Lane on the south, and one-half mile west of Lower Sacramento Road on the west. Area I is divided up into three subareas: I-1, I-2, and I-3 as shown in Figure 1. Subarea I-1 is that portion lying between Kettleman Lane and ¼ mile south of Kettleman Lane. Subarea I-2 is that portion lying between ¼ mile south of Kettleman Lane and 600 feet south of Century Boulevard. Subarea I-3 is that portion lying between 600 feet south of Century Boulevard and Harney Lane. Justifications for dividing Area I in this manner are: 1) planning subareas are approximately equal-sized, 2) property ownerships align with subarea boundaries and 3) subarea topography is conducive to the design of gravity flow facilities. Area I is shown in Figure 1.

2.1.10 Area K

This area is bounded by Harney Lane on the north, State Route 99 on the east, one-half mile south of Harney Lane on the south, and the WID canal on the west. Area K is divided into three subareas: K-1, K-2, and K-3 as shown in Figure 1. Subarea K-1 extends westerly from Highway 99 to the Union Pacific Railroad (UPRR) tracks. Subarea K-2 lies between the UPRR tracks and West Lane. Subarea K-3 is located between West Lane and the WID Canal. Each subarea is distinct because of ownership characteristics, physical barriers (i.e., railroad, street, canal), and the phasing of development. Area K is shown in Figure 1.

2.1.11 Area L

Boundaries for this area include Harney Lane on the north, the WID canal on the east, one-half mile south of Harney Lane on the south, and Lower Sacramento Road on the west. Area L is divided into two subareas, L-1 and L-2, as shown in Figure 1. Subarea L-1 is that portion lying between the WID canal and the extension of Mills Avenue. Subarea L-2 is that portion lying between the extension of Mills Avenue and Lower Sacramento Road. Justifications for dividing Area L in this manner are: 1) property ownerships align with the subarea boundary and 2) subarea sizes are conducive to the design of gravity flow facilities. Area L is shown in Figure 1.

2.2 Woodbridge Irrigation District Agreement

The City has a 40-year Storm Drainage and Discharge Agreement with the WID, dated October 20, 1993, allowing storm water discharges into the WID canal. The agreement covers the area defined as the City's corporate boundaries, with an ultimate coverage area of 16,800 acres. Under the terms of the agreement, the discharges from the City's pump stations must be regulated. The City discharges, at any one time, shall not exceed the

combined flow rate of 160 cubic feet per second (cfs) and shall not exceed 60 cfs from any one discharge location to avoid exceeding the capacity of the canal. The Agreement allows three points of discharge into the WID canal. The first is an existing connection located on Shady Acres Drive. The Shady Acres Pump Station is located in a residential neighborhood. The second is an existing discharge located adjacent to Kofu Park on Century Boulevard. The third connection has not been installed. The third connection will be located in Area K one-half mile south of Harney Lane.

2.3 Regulatory Requirements

Phase II of the National Pollutant Discharge Elimination System (NPDES) requires the City of Lodi, and all other small municipal separate storm sewer systems (MS4) to operate under a permit for storm water discharges to the Mokelumne River and the Sacramento-San Joaquin Delta. Pursuant to the NPDES requirements, the City adopted its Storm Water Management Program in 2003.

As a regulated MS4 in the State, the City adopted its Storm Water Development Design Standard Plan (DSP) in 2008 with the following objectives:

1. Assist the City in the development of a Master Plan for the storm water conveyance and the management.
2. Provide well defined storm water development standards.
3. Protect the quality of storm water runoff and of the receiving waters.

As a result of regulatory requirements, new development and redevelopment projects are required to implement Best Management Practices (BMPs) consistent with the City's NPDES permit and the DSP to achieve and implement the above-listed objectives. BMP selection is purposely left open in the DSP, allowing the development to choose from a variety of BMPs. BMPs will affect both the flow rate and the volume of storm water runoff with the combined effect of multiple developments having to be considered in the sizing of conveyance and detention facilities. All new development and redevelopment projects are required to comply with any future changes to the NPDES permit requirements or changes within the DSP.

2.4 Design Criteria

Design criteria for the storm drainage system are outlined in the City of Lodi Public Improvement Design Standards. Criteria include storm water runoff coefficients, minimum pipe size, design depth, minimum and maximum velocity, minimum cover, manhole placement and spacing, catch basins, and detention basins.

For estimating runoff flow, the Rational Method (Q = CiA) must be used for areas less than 160 acres. For projects with an area larger than 160 acres, coordination with the City Engineer is required to estimate design flow. Design Standards Section 3.200 Design Flow summarizes the runoff coefficients (C) and time of concentration values (t_c) included in the Design Standards. If applicable, a composite runoff coefficient may be used in the calculation based on the weighted average of the surface C factors defined in Table 5-6 of the Design Standards are presented in Table 2. Rainfall intensity (i) values for corresponding time of concentration determined using City of Lodi Standard Plan

606. Area (A) is the tributary drainage area in acres.

The DSP was prepared in May 2008 and was prepared in response to the requirements contained in the NPDES Permit. The DSP will protect the quality of the storm water runoff and the receiving waters that surround Lodi and, as a result, could reduce the peak flow and flow volume of storm water runoff. The DSP will affect the level of service for storm conveyance in the future.

The assignment of the runoff coefficient is somewhat subjective. At the time the rainfall producing runoff occurs, the coefficient varies with topography, land use, vegetal cover, soil type, and moisture content of the soil. The DSP increases the amount of vegetal cover on soils thus resulting in a decrease in the C-factor. Changes to the runoff coefficients resulting from implementation of the DSP and incorporated herein as changes to the City of Lodi Design Standards are as follows:

a. C-factor for commercial land use is changed from 0.8 to 0.7.
b. C-factor for industrial land use is changed from 0.9 to 0.75.
c. C-factor for residential land use has not changed. Recently residential development practices have constructed homes on smaller lots resulting in less permeable surfaces (ie. landscaping) around the home resulting in potentially increased runoff. The current State storm water design standards, however, require residential development to reduce the amount of runoff from individual lots. These changes offset each other and, therefore, the C-factor has not been changed.

Table 2: Storm Drainage System Design Standards

Land Use, Surface Type	Coefficient of Runoff, C	Time of Concentration, T_c (min.)
Parks	0.2	30
Residential (low density)	0.4	25
Apartments	0.5	20
Schools and Churches	0.5	20
Commercial	0.7	10
Industrial	0.75	10
Pavement	0.95	-
Roof	0.8	-
Compacted earth (no gravel)	0.75	-
Lawn and Open Area	0.2	-

[a] Section 3.2 "Design Flow" from 1991 Design Standards

2.4.1 Basins

All areas and subareas within the Storm Drainage Master Plan (F, I, K and L) will be served by a detention basin(s). The basins are planned to be approximately four to ten feet deep and generally should have one inlet and one outlet. Side slopes for a passive use basin shall be no steeper than three to one and a joint use basin shall be no steeper that six to one. The actual detention basins are determined by the storm water runoff volume calculations prepared at the time of development. For design of detention basins, a 100-year 48-hour storm with 0.4 ft of rain shall be used. The volume shall be calculated as V (acre-feet) = 0.4CA. City of Lodi Design Standards require 200 percent of the required detention volume to be available to serve a project if no outlet is available. Temporary basins are discussed further in the following section, Interim Facilities. The basins located in Areas F and I will be joint use, serving both as parks, upland open space and detention basins. Basins located in Areas K and L will be passive

use basins with open space uses but no park uses. Conceptual drawings of F, I, K and L basins are provided in Appendix A, B, C and D respectively.

Operation of the passive use pass-through type basins K and L will have all runoff flows pass through the basin where it is stored prior to scheduled release into the WID canal. Passive use basins will have permanent low flow marshland areas and the basins will be landscaped with drought-tolerant, low-maintenance grasses, shrubs and trees. This is contrasted to existing basins and basins F and I wherein low flows bypass the basin until sufficiently higher flow rates are realized in the piping system resulting in water backing up into the basins.

There is a preference for a single inlet pipe into the basins equipped with trash screening and low flow diversion to a wetted marsh area. The outlet structure will have automatic, remote-operated gated flow control and level indicator. All storm water pipe inlets to basins shall have personnel exclusion gates and shall be hinged to open automatically and remotely.

2.4.2 Collection and Conveyance Facilities

The collection system is a gravity flow system that meets the hydraulic grade line criteria set forth in Section 3.300 of the City of Lodi Design Standards. The actual collection system that is constructed will be different in that the alignments will follow the street patterns, and the slopes and lengths may vary. At the time of development, preparation of detailed Storm Drainage Master Plans will be a requirement.

Other storm drainage system criteria include:

1) Minimum storm drain pipe diameter, 12-inch
2) Manning's equation, pipe friction coefficient of n = 0.013 for all pipe materials
3) Design depth of flow (Hydraulic Grade Line) minimum, 1 ft of freeboard between the top of curb and hydraulic grade line
4) Minimum pipe flow velocity, 2 ft/sec when flowing half full
5) Maximum pipe flow velocity, 10 ft/sec
6) Minimum pipe cover shall be 2 ft in residential streets and 2.5 ft in other streets
7) Storm drain manholes are required at storm drain intersections, changes in pipe diameter, and changes in horizontal or vertical alignment
8) Minimum manhole spacing shall be as follows:
9) For 12-inch to 30-inch diameter, 500 ft
10) For 33-inch to 54-inch diameter, 750 ft
11) For 60-inch or larger, 1000 ft
12) Catch basins shall be placed at all gutter low points and shall consider that the design storm flow shall not exceed curb height or encroach into travel lanes. Gutter run lengths contributing flow to catch basins shall not exceed 1,000 lineal feet.

2.4.3 Overland Release

An overland flood release pathway shall be incorporated into the streets and circulation design plan for each subarea. For example, when any particular catch basin is obstructed or overwhelmed with water, the street drainage design (high points and low points) for that subarea shall be calculated so that no water shall pond higher than the lowest right of way elevation without releasing the excess water toward the planned flood release point of the subarea.

2.4.4 Pump Stations

Pump stations are required in area storm basins that are not able to release storm water by gravity flow. Areas F, I, K, and L collection systems and basins have different hydraulic grade line considerations and some basins will require either a gate valve or pump station to control flows leaving the basins. The gate valves and pump stations must be connected to a SCADA remote control system to allow the coordination between each gate valve and pump station. Pump stations in Areas K and L will require the third point of discharge into the WID canal as provided for in the WID Agreement. The point of discharge shall be located in Area K adjacent to the WID canal and water shall be discharged south of the Wilkerson Canal check structures. The pump station will serve Area K and possibly Area L. Interdependent control facilities will be installed at each subarea basin pump station modulating the release rate from each basin.

All pump stations shall have mechanical trash screening capabilities (1/2 inch sphere size), oil skimming capabilities, automatic controls, flow and level measuring gauges, SCADA remote control and all weather access. SCADA communication facilities are required that connect the Control Center and each pump station to permit flow pacing between the pump stations.

2.5 Hydrology and Modeling

2.5.1 General

This section presents the methodology used to create the City's Storm Drainage Master Plan model along with the 5-year rainfall intensity design criteria used in the model. Previously, the City used 2-year storm events for master plan designs. The change to a 5-year storm design criteria will provide greater protection against localized flooding events.

2.5.2 Storm Drainage Subareas

Analysis was performed for each subarea for the purpose of establishing a conceptual size and alignment design for the storm drainage facilities required to serve each subarea. In addition, the results of the analysis established a conceptual storage volume requirement for each subarea detention basin. The location of the various subareas discussed below is provided in Figure 1.

The analysis is based upon the City of Lodi Storm Drainage Design Standards,

2010 General Plan land uses and the facilities design criteria described in the previous sections of this report. Results of the analyses for subarea F, I, K and L are summarized in Table 3 below and details are presented in Appendices A, B, C and D respectively including land use area, detention basin volume, pipe alignment and pipe size. Vertical information contained in the appendices is conceptual and preliminary and is subject to change during the final design analysis.

The vertical and horizontal alignment of infrastructure facilities must consider other utilities, including wastewater pipes, water pipes, recycled water pipes, and dry utilities. In addition, the alignment of the pipes will be modified as road alignments are determined. Utility crossing considerations have been made only at a conceptual design level.

2.5.2.1 Subarea F-1

Detention basin storage requirements are approximately 9.1 acre-feet to serve the 50-acre subarea F-1. The F-1 basin will be located between the WID canal and Lodi Avenue within the planned neighborhood park. The detention basin serving subarea F-1 may require a pump station to remove water from the basin and discharge into the existing City storm system located 200 feet north of Kettleman Lane on Westgate Drive. Further analysis will be provided prior to development of the area. At the time of development, the planned or a temporary terminal drainage outlet for the F-1 basin may be constructed or, if not, retention basin design requirements would have to be satisfied. Pipe diameters range from 18 inches to 30 inches. The land use information is provided in Table 1.

2.5.2.2 Subarea F-2

Detention basin storage requirements are approximately 34.0 acre-feet to serve the 160-acre subarea F-2. The detention basin serving subarea F-2 is planned to be located 900-feet west of Lower Sacramento Road and along the extension of Tokay Street within the planned community park. The detention basin serving subarea F-2 may require a pump station to remove water from the basin into the existing City storm system located 200 feet north of Kettleman Lane on Westgate Drive. Further analysis will be provided prior to development of the area. SCADA controlled gate valves will be required at both the inflow pipeline to the basin and outflow pipeline leaving the basin. At the time of development, the planned or a temporary terminal drainage outlet for the detention basin serving subarea F-2 may be constructed or, if not, retention basin design requirements would have to be satisfied. Pipe diameters range from 15 inches to 54 inches. The land use information is provided in Table 1.

2.5.2.3 Subarea F-3

Detention basin storage requirements are approximately 29.5 acre-feet to serve the 130-acre subarea F-3. The detention basin serving subarea F-3 is planned to be located 1,600-feet west of Lower Sacramento Road along Taylor Road within the planned community park. The detention basin serving subarea F-3 will require a pump station to remove water from the basin. At the time of development, flows from the pump station are sent to the existing storm drainage facilities located 200 feet north of intersection of Kettleman Lane and Lower Sacramento Road. Pipe diameters range from 15 inches to 54 inches. The land use assumptions are presented in Table 1.

2.5.2.4 Subarea I-1

Detention basin storage requirements are approximately 17.5 acre-feet to serve the 72-acre subarea I-1. The detention basin serving subarea I-1 is planned to be located along Westgate Drive approximately 400-feet south of Kettleman Lane. The detention basin serving subarea I-1 will require a pump station to remove water from the basin. Flows from the pump station are sent to the nearest discharge point at the intersection of Lower Sacramento Road and Century Boulevard. At the time of development, planned or a temporary terminal drainage outlet for the I-1 basin may be constructed or, if not, retention basin design requirements would have to be satisfied. Pipe diameters range from 15 inches to 48 inches. The land use information for the approved project is provided in Table 1.

2.5.2.5 Subarea I-2

Detention basin storage requirements are approximately 26.2 acre-feet to serve the 138-acre subarea I-2. The detention basin serving subarea I-2 is planned to be located near the intersection of Westgate Drive and Century Boulevard. The detention basin serving subarea I-2 will require a pump station to remove water from the basin. Further analysis will be required prior to development of the area. At the time of development, flows from the pump station are sent to the existing storm drainage facilities at the intersection of Lower Sacramento Road and Century Boulevard. Pipe diameters range from 15 inches to 48 inches. The land use information for the approved project is provided in Table 1.

2.5.2.6 Subarea I-3

Detention basin storage requirements are approximately 18.7 acre-feet to serve the 108-acre subarea I-3. The detention basin serving subarea I-3 is planned to be located approximately 700-feet north of Harney Lane and 500-feet west of Lower Sacramento Road. The detention basin serving subarea I-3 will require a pump station to remove water

from the basin. At the time of development, planned or a temporary terminal drainage outlet for the I-3 basin may be constructed or, if not, retention basin design requirements would have to be satisfied. Pipe diameters range from 15 inches to 54 inches. The land use information for the approved project is provided in Table 1.

2.5.2.7 Subarea K-1

Subarea K-1 is comprised of the Reynolds Ranch Development project. The Reynolds Ranch Development project is entitled and has approved Master Plans, improvement plans for the initial two phases, and construction phasing for the project infrastructure. The land uses and areas for the 235 acre project are presented in Table 1. The approved Reynolds Ranch Master Plans design calculations assumed a 2-year storm event rather than the 5-year storm event used in the 2012 Lodi Storm Drainage Master Plans. A portion of the storm drainage infrastructure has been installed based on the approved Storm Drainage Master Plans for that project. As the Reynolds Ranch Development expands into the next phases of the project, the remaining storm water pipelines will be sized using the 5-year storm event design standards specified in the 2012 Lodi Storm Drainage Master Plans.

The existing retention basin serving subarea K-1 is located one-half mile south of Harney Lane and east of the UPRR tracks. The storage capacity of the retention basin is 61.4 acre-feet and is designed to provide storage for 200% of the design run-off volume for a 48-hour, 100 year storm. The retention basin serving subarea K-1 will remain a retention basin until development in the K-1 area exceeds the existing storage capacity of the retention basin. At that time, the retention basin serving subarea K-1 will have to be expanded if it is to continue operating as a retention basin.

Alternatively, the basin could be converted to a detention basin (100% of the design volume) by constructing a pipeline and pumping facilities to the third discharge point to the WID canal. The point of discharge is approximately 4,000 feet east of the basin and one-half mile south of Harney Lane.

2.5.2.8 Subarea K-2

The K-2 subarea comprises approximately 75 acres and the land use details are provided in Table 1. The detention basin storage requirements are approximately 14.2 acre-feet. The detention basin serving subarea K-2 is planned to be located on the west side of the UPRR and one-half mile south of Harney Lane. The UPRR area is not included in the detention basin calculations. A pump station is required to convey discharges from the basin to the third point of discharge in the WID canal. Pipe diameters with the subarea range from 18 inches

to 42 inches.

2.5.2.9 Subarea K-3

Detention basin storage requirements are approximately 33.1 acre-feet to serve the 154-acre Subarea K-3. The detention basin is planned to be located adjacent to the WID canal and one-half mile south of Harney Lane. The K-3 basin will require a pump station to discharge into the WID canal. Pipe diameters range from 18 inches to 54 inches. The land use assumptions are provided in Table 1.

2.5.2.10 Subarea L-1

Detention basin storage requirements are approximately 31.8 acre-feet to serve the 176-acre Subarea L-1. The land use information for this subarea is presented in Table 1. The detention basin serving subarea L-1 is planned to be located along the extension of South Mills Avenue and one-half mile south of Harney Lane. The detention basin serving subarea L-1 will require a pump station to convey discharges easterly to the WID canal point of discharge. Further study is required to determine the sizing of the pump station and whether flows will discharge directly into the WID canal or to the pump station at the detention basin serving subarea K-3. Pipe diameters range from 12 inches to 48 inches.

2.5.2.11 Subarea L-2

Detention basin storage requirements are approximately 45.0 acre-feet to serve the 267-acre Subarea L-2. The land use information for this subarea is presented in Table 1. The detention basin serving subarea L-2 is planned to be located along the Lower Sacramento Road and one-half mile south of Harney Lane. The detention basin serving subarea L-2 is required to convey discharges easterly to the WID canal point of discharge. Further study is required to determine the sizing of the pump station and whether flows will discharge directly into the WID canal or to the pump station at the detention basin serving subarea K-3. Pipe diameters range from 15 inches to 54 inches.

Table 3: Subarea Details

Subarea	Detention Basin Storage (acft)	Subarea Size (acres)	Pipe Size Range (inches)
F-1	8.5	50.3	18 - 30
F-2	33.4	160	15 - 54
F-3	27.4	130	15 - 54
I-1	18.7	76.9	15 - 48
I-2	24.4	138	15 - 48
I-3	18.3	108	15 - 54
K-1	61.4	234.7	24 - 66
K-2	14.2	74.6	18 - 42
K-3	33.1	153.8	18 - 54
L-1	31.8	175.5	12 - 48
L-2	45.0	276.4	15 - 54

2.5.3 Watershed Modeling and Analysis

A stormwater model was developed for the F, I, K and L basin areas to model stormwater generation and determine pipe sizing. All the design criteria mentioned in section 2.4.2 were used in the model.

2.5.4 Model Selection

The City selected Bentley's StormCAD V8i software for the stormwater model. Bentley's WaterCAD and SewerCAD software are used for modeling the City's water and wastewater systems. To be consistent, the City used the same stormwater modeling software from the same company.

StormCAD provides comprehensive modeling for the design and analysis of storm sewer systems using a peak flow (Rational Method) approach. The software has the ability to import GIS layers, output files into AutoCAD and ESRI shape files.

2.5.5 Rainfall Intensity

Rainfall intensity is used in calculating the design flow. Values for the rainfall intensity for corresponding time of concentration shall be taken from City of Lodi Standard Plan 606.

3. FACILITIES

3.1 Interim Facilities

In the event a property develops prior to the construction of the master facilities, it will be necessary to construct interim facilities that provide the same level of service as the master plan facilities. In most cases, the interim facilities would include collection piping and a retention basin storage facility. The design requirement is 200 percent of the storm water runoff volume for interim retention basin sizing. Allowances for percolation are not presently permitted in the sizing of interim retention basins.

3.2 Finance and Implementation Plan

Construction of the Master Plan Facilities will be dependent upon the rate and pattern of development in the study area. The cost and financing of the improvements shall be determined as part of the Impact Mitigation Fee Program that is being adopted concurrently with this report. Financing alternatives include, but are not limited to, developer financing on a pay-as-you-go basis or through a new City-wide development impact fee program.

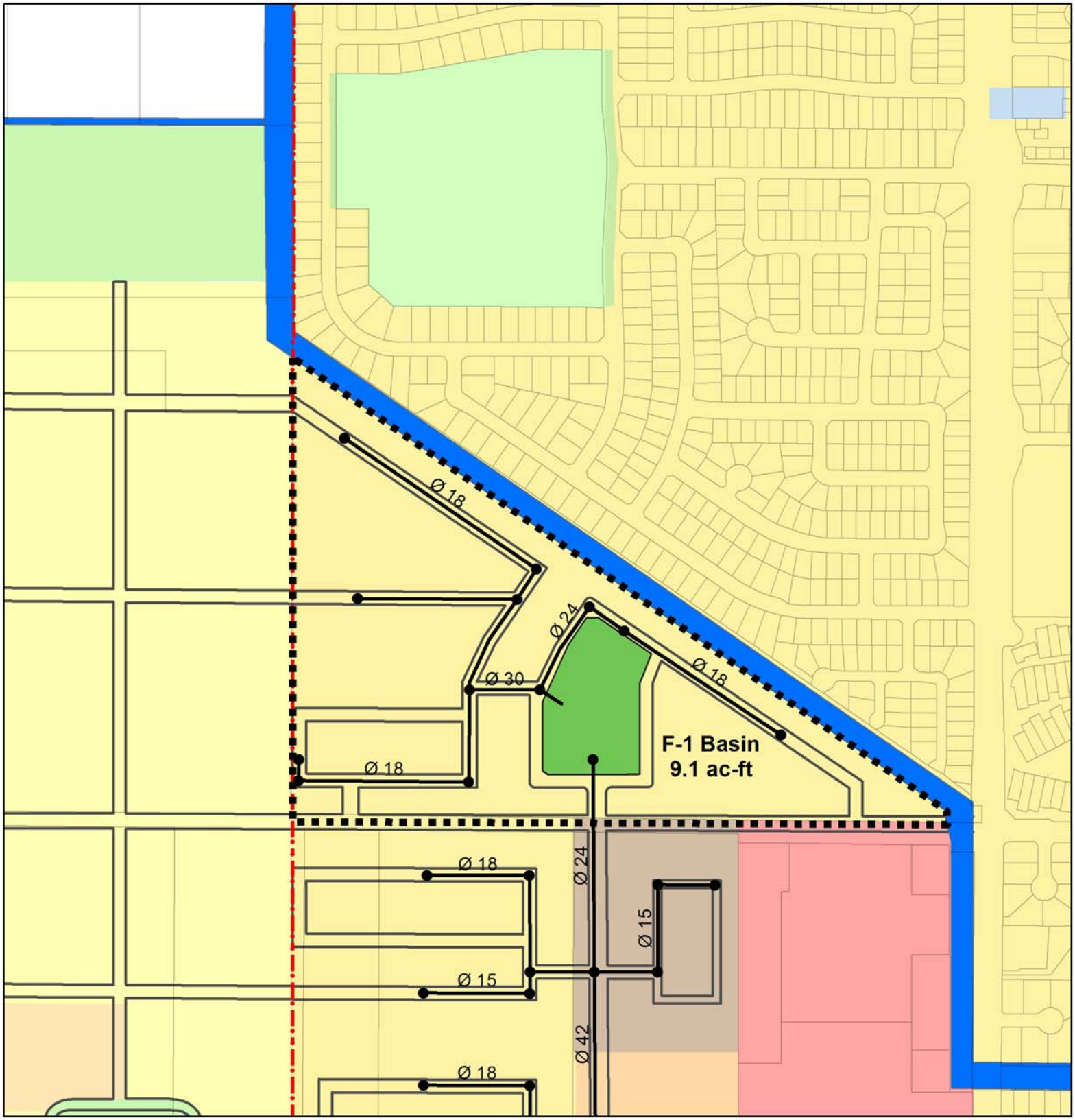
Appendix A

F Basin

F - Basin Modeling Assumptions

The F-Basin area covers the northwest section of Lodi. Several assumptions were made throughout the modeling process:

1. The pipes were sized using a 5-year storm event. Our current standards dictate the use of a 2-year storm event to size the storm water mainlines. The change to a 5-year storm event will provide greater protection.
2. The C-factor for commercial and industrial land uses was changed due to the 2008 Storm Water Design Standards. The commercial C-factor changed from 0.8 to 0.7. The industrial C-factor changed from 0.9 to 0.75. C-factor for residential land use has not changed. Recently residential development practices have constructed homes on smaller lots resulting in less permeable surfaces (i.e. landscaping) around the home resulting in potentially increased runoff. The current State storm water design standards, however, require residential development to reduce the amount of runoff from individual lots. These changes offset each other and, therefore, the C-factor has not been changed.
3. The C-factor for Vintner's Square and the Westgate Shopping Center are assumed to be 0.8 because they are already built and was designed using a 0.8 C-factor.
4. The detention basin serving subareas F-1, F-2 and F-3 connect to an existing 48-inch pipe that has been installed in Westgate Drive and through the Vintners Square Shopping Center. The existing 48-inch pipe ultimately drains to the G-Basin then to the Beckman Park Pump Station.
5. The storm water pipes in the F-Basin area are sized and located based on the 2006 Lodi Westside Project preliminary master plans. Inverts were adjusted due to some locations not having the standard cover required and new C-factors.
6. Subarea F-3 did not have the same details that subarea F-1 and F-2 had made known in the 2006 Lodi Westside Project preliminary master plans. The storm water pipes in this area have changed from the preliminary master plans submitted.
7. The Raley's shopping center's temporary retention basin has a design HGL at 32-ft. The HGL for F-2 Basin in the model is 32.46-ft. The invert for the Raley's storm drainage is at 28.13 and the future invert will be 27.88-ft.
8. Subarea F-1 may need to pump from 27.5 feet to 28.0 feet (0.5 feet) to enter into the outfall pipe.
9. Subarea F-3 will need to pump from 18.0 feet to 23.7 feet (5.7 feet) to enter into the outfall pipe.



F-1
Storm Drainage Area

N
W E
S

1 in = 500 ft

Legend

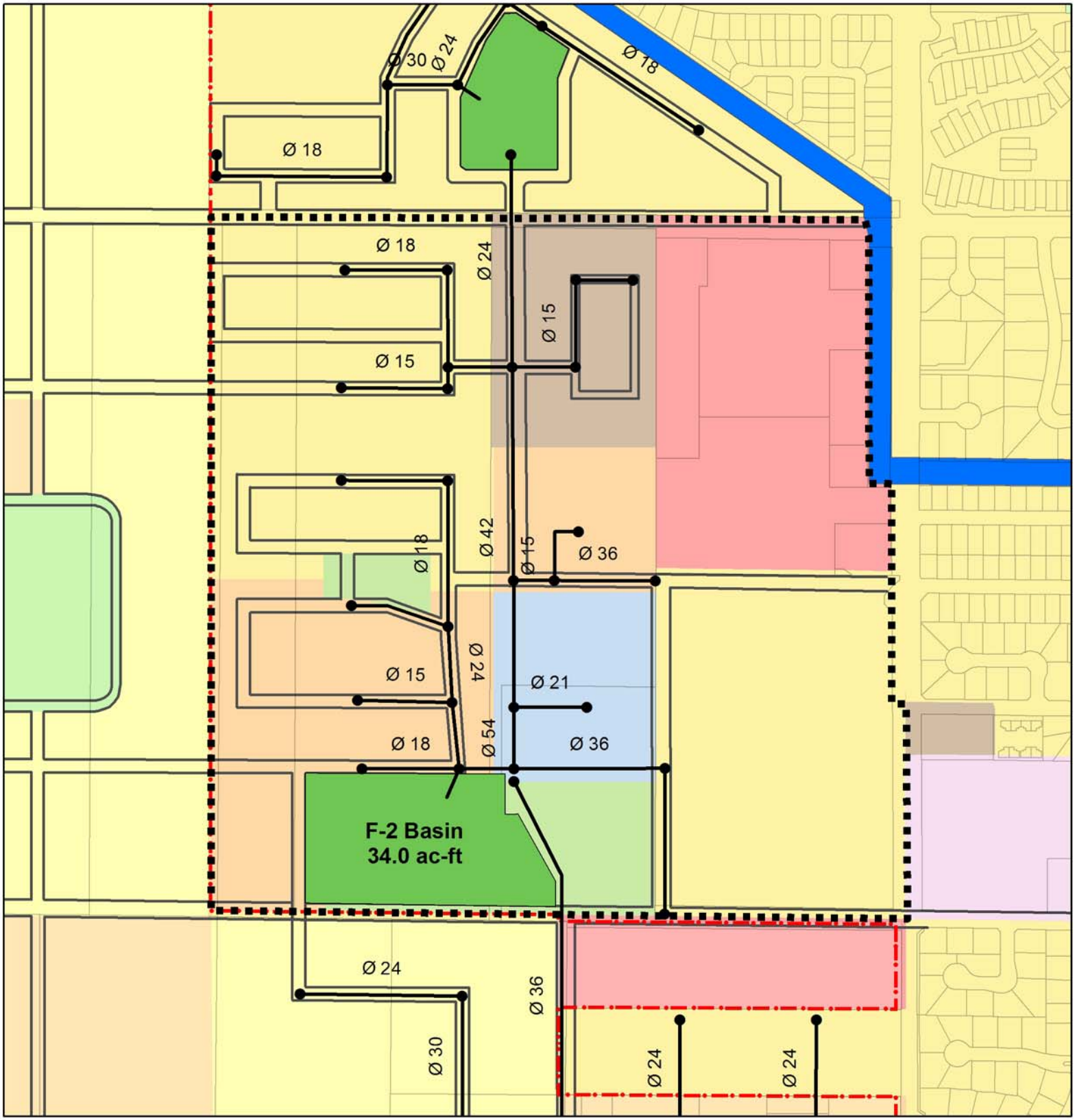
- Storm Drainage Pipes
- Junction
- F-1 Area
- Future Basins
- City Limits
- Parcels
- Canal
- Parks
- Railroad
- River

General Plan - Land Use

- Business Park
- Commercial
- Downtown Mixed Use
- High Density Residential
- Industrial
- Low Density Residential
- Medium Density Residential
- Mixed Use Center
- Mixed Use Corridor
- Office
- Open Space
- Public/Quasi-Public
- Right of Way
- Urban Reserve
- Water

F-1 Stormwater Basin Sizing Calculation

Land Use	Area (Sqft)	Area (Acres)	C-Factor	Rainfall Intensity	Detention Volume (Ac-Ft)	
LDR	2,002,889	46.0	0.4	0.4	7.4	
Park	81,903	1.9	0.2	0.4	0.2	
Basin	106,276	2.4	1.0	0.4	1.0	
Total	2,084,792	50.3			**8.5**	
Depth (ft)	Volume (cf)	Area (ac)	Area (sf)	Width (ft)	Length (ft)	
4.0	369,525	2.1	91,922	326	326	106,276
				278	278	77,151
Lowest T.C. =	33.5	2.4	Water Surface Area =		106,276	sf
Design H.G.L. =	31.5		Bottom Surface Area =		77,151	sf*
Basin Bottom Elev. =	27.5		Average Area =		91,713	sf
Water Depth =	4.0	ft				
Volume of Storage Provided:			8.5	ac-ft	368,688	cf
*Assumed 6:1 side slopes						



F-2
Storm Drainage Area

N
W E
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1 in = 500 ft

Legend

- Storm Drainage Pipes
- Junction
- F-2 Area
- Future Basins
- City Limits
- Parcels
- Canal
- Parks
- Railroad
- River

General Plan - Land Use

- Business Park
- Commercial
- Downtown Mixed Use
- High Density Residential
- Industrial
- Low Density Residential
- Medium Density Residential
- Mixed Use Center
- Mixed Use Corridor
- Office
- Open Space
- Public/Quasi-Public
- Right of Way
- Urban Reserve
- Water

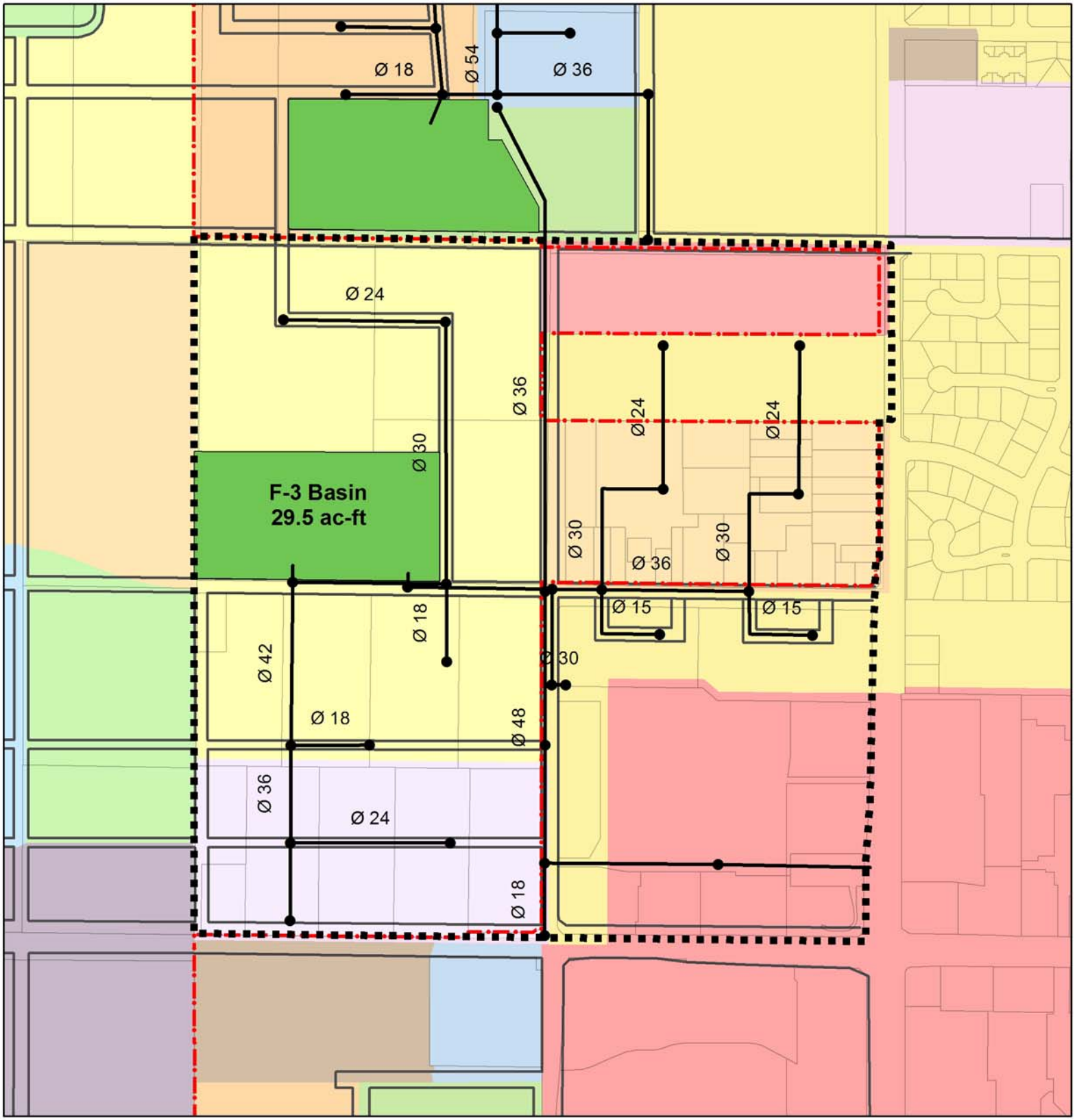
F-2 Stormwater Basin Sizing Calculation

Land Use	Area (Sqft)	Area (Acres)	C-Factor	Rainfall Intensity	Detention Volume (Ac-Ft)
LDR	1,644,826	37.8	0.4	0.4	6.0
MDR	1,149,548	26.4	0.5	0.4	5.3
HDR	425,146	9.8	0.5	0.4	2.0
Park/Open Space	267,050	6.1	0.2	0.4	0.5
Basin	348,540	8.0	1.0	0.4	3.2
Public/Quasi-Public	1,934,064	44.4	0.5	0.4	8.9
Commercial	1,180,912	27.1	0.7	0.4	7.6
Total	6,950,085	159.6			**33.4**

Depth (ft)	Volume (cf)	Area (ac)	Area (sf)	Width (ft)	Length (ft)	
4.6	1,456,359	7.3	316,600	740	471	348,540
				685	416	284,740

Lowest T.C. =	33.1	8.0	Water Surface Area =		348,540	sf
Design H.G.L. =	31.1		Bottom Surface Area =		284,740	sf*
Basin Bottom Elev. =	26.5		Average Area =		316,640	sf
Water Depth =	4.6	ft				
Volume of Storage Provided:			33.4	ac-ft	1,456,544	cf

*Assumed 6:1 side slopes



F-3
Storm Drainage Area

N
W E
S

1 in = 500 ft

Legend

- Storm Drainage Pipes
- Junction
- F-3 Area
- Future Basins
- City Limits
- Parcels
- Canal
- Parks
- Railroad
- River

General Plan - Land Use

- Business Park
- Commercial
- Downtown Mixed Use
- High Density Residential
- Industrial
- Low Density Residential
- Medium Density Residential
- Mixed Use Center
- Mixed Use Corridor
- Office
- Open Space
- Public/Quasi-Public
- Right of Way
- Urban Reserve
- Water

F-3 Stormwater Basin Sizing Calculation

Land Use	Area (Sqft)	Area (Acres)	C-Factor	Rainfall Intensity	Detention Volume (Ac-Ft)
LDR	2,163,190	49.7	0.4	0.4	7.9
MDR	814,572	18.7	0.5	0.4	3.7
Park	278,633	6.4	0.2	0.4	0.5
Basin	173,520	4.0	1.0	0.4	1.6
Public/Quasi-Public	421,661	9.7	0.5	0.4	1.9
Commercial	1,820,372	41.8	0.7	0.4	11.7
Total		130.2			**27.4**

Depth (ft)	Volume (cf)	Area (ac)	Area (sf)	Width (ft)	Length (ft)	
8.9	1,194,760	3.1	134,243	360	482	173,520
				253	375	95,001

Lowest T.C. =	29.5	4.0	Water Surface Area =		173,520	sf
Design H.G.L. =	27.0		Bottom Surface Area =		95,001	sf*
Basin Bottom Elev. =	18.1		Average Area =		134,260	sf
Water Depth =	8.9	ft				
Volume of Storage Provided:			27.4	ac-ft	1,194,917	cf

*Assumed 6:1 side slopes

F-Basin Stormwater Overall Calculations					
Land Use	Area (Sqft)	Area (Acres)	C-Factor	Rainfall Intensity	Detention Volume (Ac-Ft)
LDR	5,810,904	133.4	0.4	0.4	21.3
MDR	1,964,120	45.1	0.5	0.4	9.0
HDR	425,146	9.8	0.5	0.4	2.0
Commercial	3,001,284	68.9	0.7	0.4	19.3
Public/Quasi-Public	2,355,725	54.1	0.5	0.4	10.8
Basin	628,336	14.4	1.0	0.4	5.8
Park/Open Space	627,586	14.4	0.2	0.4	1.2
Total		340.1			**69.3**

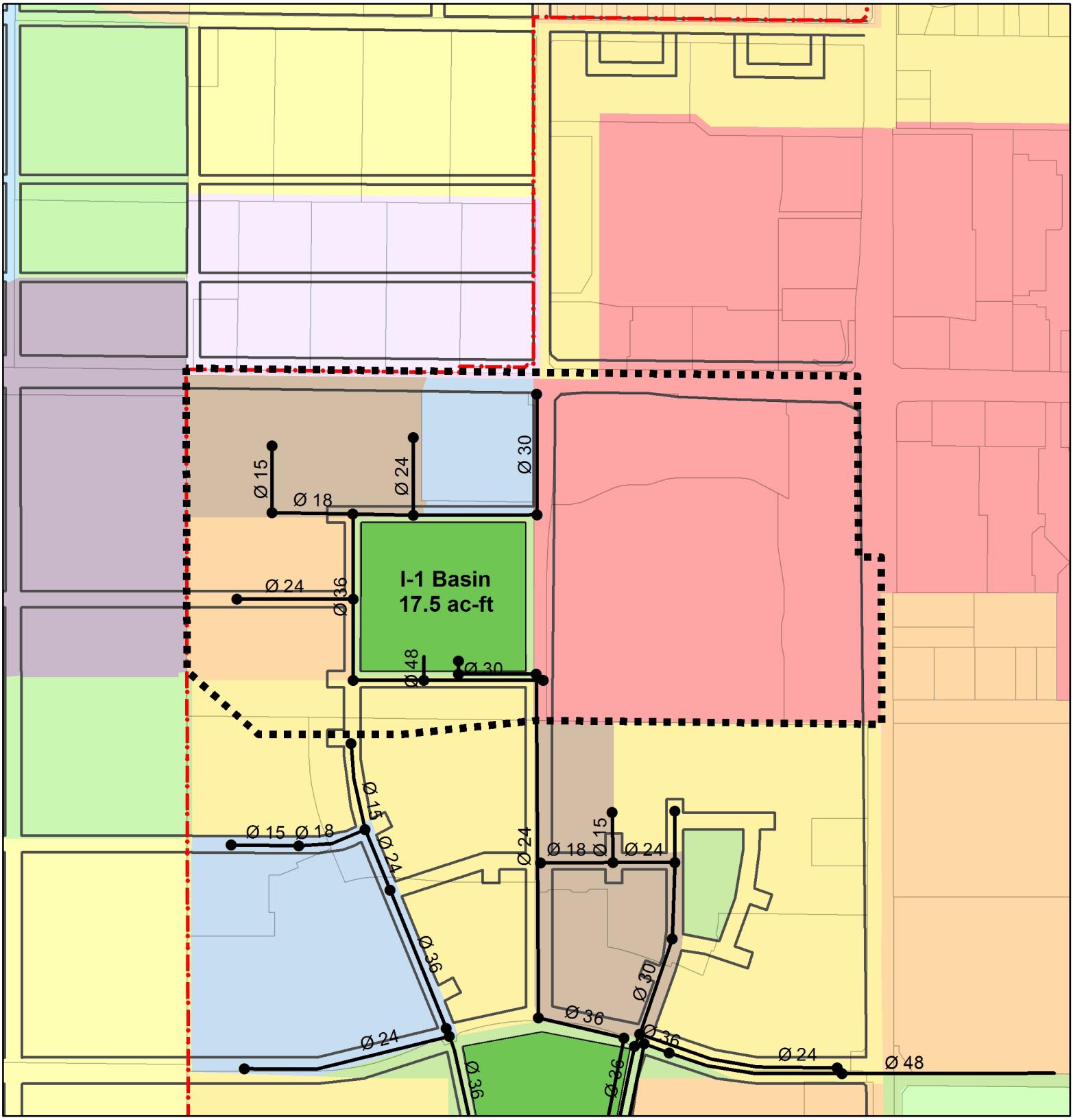
Appendix B

I Basin

I - Basin Modeling Assumptions

The I-Basin area covers the southeast section of Lodi. Several assumptions were made throughout the modeling process:

1. The pipes were sized using a 5-year storm event. Our current standards dictate the use of a 2-year storm event to size the storm water mainlines. The change to a 5-year storm event will provide greater protection.
2. The C-factor for commercial and industrial land uses was changed due to the 2008 Storm Water Design Standards. The commercial C-factor changed from 0.8 to 0.7. The industrial C-factor changed from 0.9 to 0.75. C-factor for residential land use has not changed. Recently residential development practices have constructed homes on smaller lots resulting in less permeable surfaces (i.e. landscaping) around the home resulting in potentially increased runoff. The current State storm water design standards, however, require residential development to reduce the amount of runoff from individual lots. These changes offset each other and, therefore, the C-factor has not been changed.
3. The 42-inch wastewater outfall pipeline will be rerouted through Area I. The outfall pipeline will run along the south end of the Walmart property, west to Westgate Dr., south to Century Blvd and west to the existing pipeline. Conflicts with this 42-inch pipeline may require the need for two smaller storm drainage pipelines to cross under the 42-inch pipeline.
4. The configuration and pipe sizes are based off the Southwest Gateway Project. However, many of inverts and pipe sizes have changed due to C-factor changes.
5. Subarea I-1 will need to pump from 21.5 feet to 24.3 feet (2.8 feet) to enter into the outfall pipe.
6. Subarea I-2 will need to pump from 18.0 feet to 23.1 feet (5.1 feet) to enter into the outfall pipe.
7. Subarea I-3 will need to pump from 17.8 feet to 20.9 feet (3.1 feet) to enter into the outfall pipe.



I-1
Storm Drainage Area

N
W E
S

1 in = 500 ft

Legend

- Storm Drainage Pipes
- Junction
- I-1 Area
- Future Basins
- City Limits
- Parcels
- Canal
- Parks
- Railroad
- River

General Plan - Land Use

- Business Park
- Commercial
- Downtown Mixed Use
- High Density Residential
- Industrial
- Low Density Residential
- Medium Density Residential
- Mixed Use Center
- Mixed Use Corridor
- Office
- Open Space
- Public/Quasi-Public
- Right of Way
- Urban Reserve
- Water

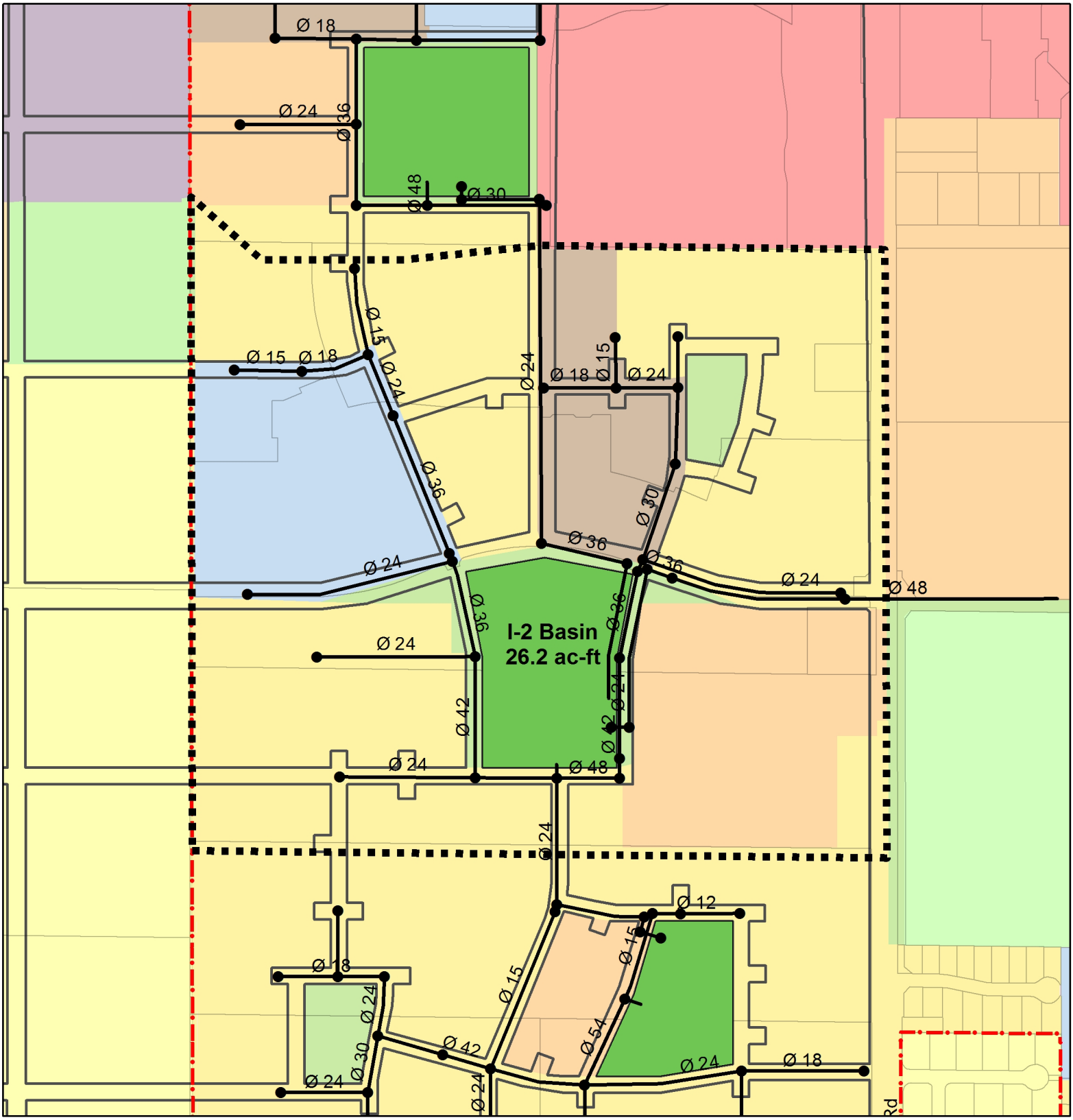
I-1 Stormwater Basin Sizing Calculation

Land Use	Area (Sqft)	Area (Acres)	C-Factor	Rainfall Intensity	Detention Volume (Ac-Ft)
LDR	278,348	6.4	0.4	0.4	1.0
MDR	358,934	8.2	0.5	0.4	1.6
HDR	530,996	12.2	0.5	0.4	2.4
Park	128,953	3.0	0.2	0.4	0.2
Basin	225,625	5.2	1.0	0.4	2.1
Public/Quasi-Public	225,641	5.2	0.5	0.4	1.0
Commercial	1,600,830	36.8	0.7	0.4	10.3
Total		76.9			**18.7**

Depth (ft)	Volume (cf)	Area (ac)	Area (sf)	Width (ft)	Length (ft)	
4.0	816,449	4.7	204,112	475	475	225,625
				427	427	182,329

Lowest T.C. =	28	5.2	Water Surface Area =	225,625	sf
Design H.G.L. =	26		Bottom Surface Area =	182,329	sf*
Basin Bottom Elev. =	22		Average Area =	203,977	sf
Water Depth =	4.0	ft			
Volume of Storage Provided:			18.7 ac-ft	815,908	cf

*Assumed 6:1 side slopes



I-2
Storm Drainage Area

N
W E
S

1 in = 500 ft

Legend

- Storm Drainage Pipes
- Junction
- I-2 Area
- Future Basins
- City Limits
- Parcels
- Canal
- Parks
- Railroad
- River

General Plan - Land Use

- Business Park
- Commercial
- Downtown Mixed Use
- High Density Residential
- Industrial
- Low Density Residential
- Medium Density Residential
- Mixed Use Center
- Mixed Use Corridor
- Office
- Open Space
- Public/Quasi-Public
- Right of Way
- Urban Reserve
- Water

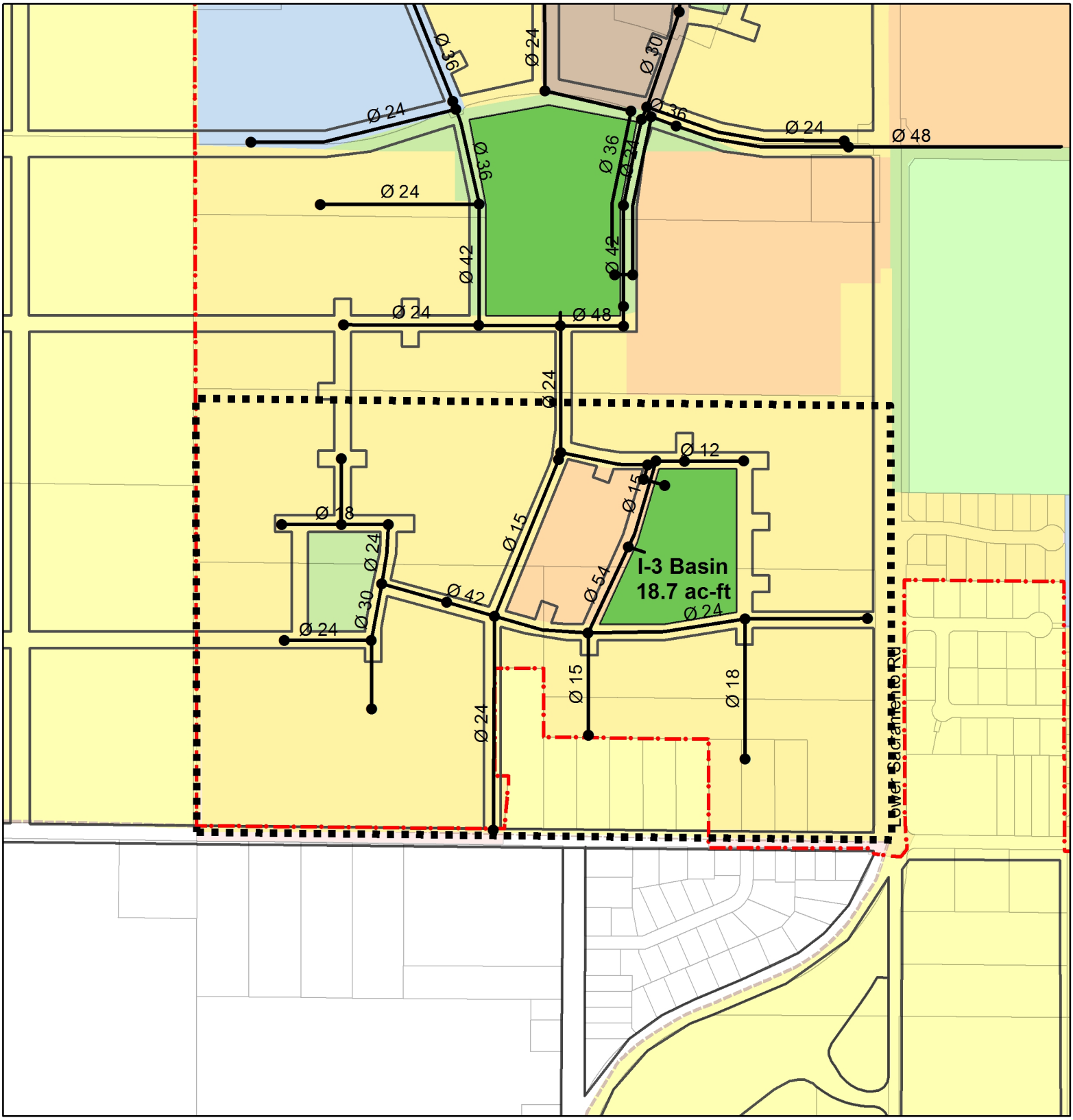
I-2 Stormwater Basin Sizing Calculation

Land Use	Area (Sqft)	Area (Acres)	C-Factor	Rainfall Intensity	Detention Volume (Ac-Ft)
LDR	3,243,913	74.5	0.4	0.4	11.9
MDR	920,858	21.1	0.5	0.4	4.2
HDR	596,336	13.7	0.5	0.4	2.7
Park/Open Space	359,721	8.3	0.2	0.4	0.7
Public/Quasi-Public	715,691	16.4	0.5	0.4	3.3
Basin	173,889	4.0	1.0	0.4	1.6
Total		138.0			**24.4**

Depth (ft)	Volume (cf)	Area (ac)	Area (sf)	Width (ft)	Length (ft)	
7.6	1,063,937	3.2	139,992	417	417	173,889
				326	326	106,146

Lowest T.C. =	27.6	4.0	Water Surface Area =	173,889	sf
Design H.G.L. =	25.6		Bottom Surface Area =	106,146	sf*
Basin Bottom Elev. =	18.0		Average Area =	140,017	sf
Water Depth =	7.6	ft			
Volume of Storage Provided:			24.4	ac-ft	1,064,132	cf

*Assumed 6:1 side slopes



I-3
Storm Drainage Area

N
W E
S

1 in = 500 ft

Legend

- Storm Drainage Pipes
- Junction
- I-3 Area
- Future Basins
- City Limits
- Parcels
- Canal
- Parks
- Railroad
- River

General Plan - Land Use

- Business Park
- Commercial
- Downtown Mixed Use
- High Density Residential
- Industrial
- Low Density Residential
- Medium Density Residential
- Mixed Use Center
- Mixed Use Corridor
- Office
- Open Space
- Public/Quasi-Public
- Right of Way
- Urban Reserve
- Water

I-3 Stormwater Basin Sizing Calculation

Land Use	Area (Sqft)	Area (Acres)	C-Factor	Rainfall Intensity	Detention Volume (Ac-Ft)
LDR	3,983,998	91.5	0.4	0.4	14.6
MDR	402,059	9.2	0.5	0.4	1.8
Park/Open Space	157,295	3.6	0.2	0.4	0.3
Basin	162,000	3.7	1.0	0.4	1.5
Total		108.0			**18.3**

Depth (ft)	Volume (cf)	Area (ac)	Area (sf)	Width (ft)	Length (ft)	
5.9	795,235	3.1	135,938	405	400	162,000
				335	330	110,417

Lowest T.C. =	25.6	3.7	Water Surface Area =	162,000	sf
Design H.G.L. =	23.6		Bottom Surface Area =	110,417	sf*
Basin Bottom Elev. =	17.8		Average Area =	136,209	sf
Water Depth =	5.9	ft			
Volume of Storage Provided:			18.3	ac-ft	796,820	cf

*Assumed 6:1 side slopes

I-Basin Stormwater Overall Calculations

Land Use	Area (Sqft)	Area (Acres)	C-Factor	Rainfall Intensity	Detention Volume (Ac-Ft)
LDR	7,506,259	172.3	0.4	0.4	27.6
MDR	1,681,852	38.6	0.5	0.4	7.7
HDR	1,127,333	25.9	0.5	0.4	5.2
Commercial	1,600,830	36.8	0.7	0.4	10.3
Public/Quasi-Public	941,332	21.6	0.5	0.4	4.3
Park/Open Space	645,969	14.8	0.2	0.4	1.2
Basin	561,514	12.9	1.0	0.4	5.2
Total		322.9			**61.4**

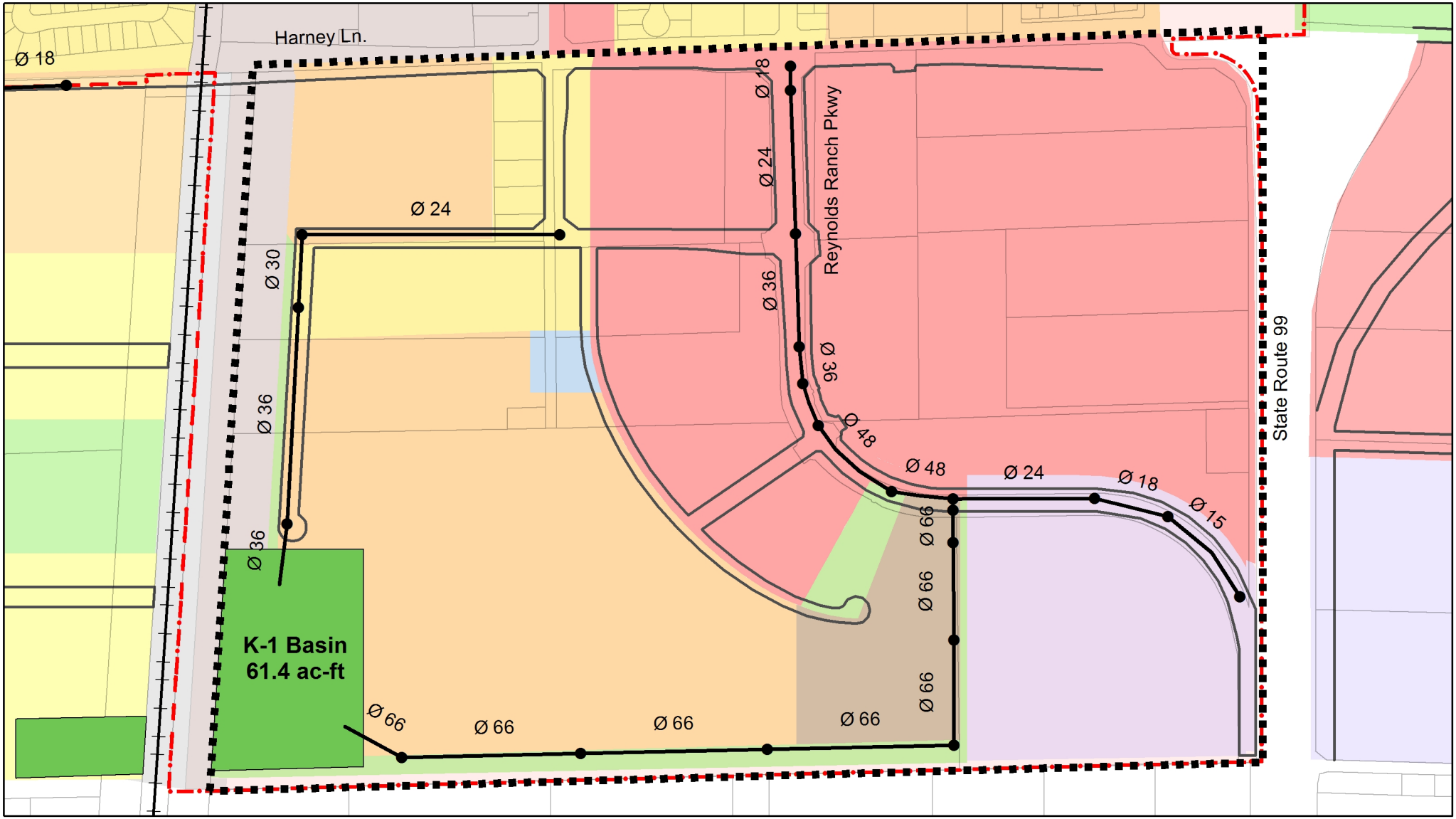
Appendix C

K Basin

K - Basin Modeling Assumptions

The K-Basin area covers the southerly section of Lodi along Harney Lane between the State Route 99 and the WID. Several assumptions were made throughout the modeling process:

1. The pipes were sized using a 5-year storm event. Our current standards dictate the use of a 2-year storm event to size the storm water mainlines. The change to a 5-year storm event will provide greater protection.
2. The C-factor for commercial and industrial land uses was changed due to the 2008 Storm Water Design Standards. The commercial C-factor changed from 0.8 to 0.7. The industrial C-factor changed from 0.9 to 0.75. C-factor for residential land use has not changed. Recently residential development practices have constructed homes on smaller lots resulting in less permeable surfaces (i.e. landscaping) around the home resulting in potentially increased runoff. The current State storm water design standards, however, require residential development to reduce the amount of runoff from individual lots. These changes offset each other and, therefore, the C-factor has not been changed.
3. Subarea K-1 – Sections of the master storm water pipes in the K-1 drainage subarea have been installed. The area used the South Lodi Storm Drainage Master Plan as a template for the pipe locations and sizes.
4. The retention basin serving subarea K-1 was designed and constructed with the Reynolds Ranch Phase I Development Project. The bottom of the basin is at an elevation of 32.0 feet.
5. Subarea K-1 – This area was designed by the Reynolds Ranch Project. The design calculations assumed a 2-year storm event; however, the model is using a 5-year storm event for all future calculations. Because of this change, the computer model anticipates flooding will occur at the most upstream manholes on Reynolds Ranch Parkway.
6. Subarea K-1 – The UPRR property area is not included in analysis. The UPRR property is not anticipated to have the land develop and drain into the retention basin serving subarea K-1.
7. Subarea K-2 - The area used the South Lodi Storm Drainage Master Plan as a template for the pipe locations and sizes. Sizes and locations have changed due to changes to the C-factors and updated road alignments from the South Hutchins Annexation Project.
8. Subarea K-2 – Area includes west of the UPRR to Hutchins St/West Ln.
9. The retention basin serving subarea K-2 basin will need to pump from 27.5 feet to 30.0 feet (2.5 feet) to enter into the outfall pipe.
10. Subarea K-3 - The area used the South Lodi Storm Drainage Master Plan as a guide for the pipe locations and sizes. Slight changes in the alignment were made to reflect the street layout from the South Hutchins Traffic Circulation Plan. The pipe sizes have changed due to the use of a 5-year storm event.
11. The retention/detention basin serving subareas K-1 and K-2 will discharge the retained storm water to the future pump station at the detention basin serving subarea K-3 into the WID canal.



K-1
Storm Drainage Area

Legend

- KBasin_5yrHGL
- Storm Water Pipes
- K-1 Area
- Future Basins
- City Limits
- Parcels
- Canal
- Parks
- Railroad
- River

General Plan - Land Use

- Business Park
- Commercial
- Downtown Mixed Use
- High Density Residential
- Industrial
- Low Density Residential
- Medium Density Residential
- Mixed Use Center
- Mixed Use Corridor
- Office
- Open Space
- Public/Quasi-Public
- Right of Way
- Urban Reserve
- Water

N W E S

1 in = 500 ft

K-1 Stormwater Basin Sizing Calculation

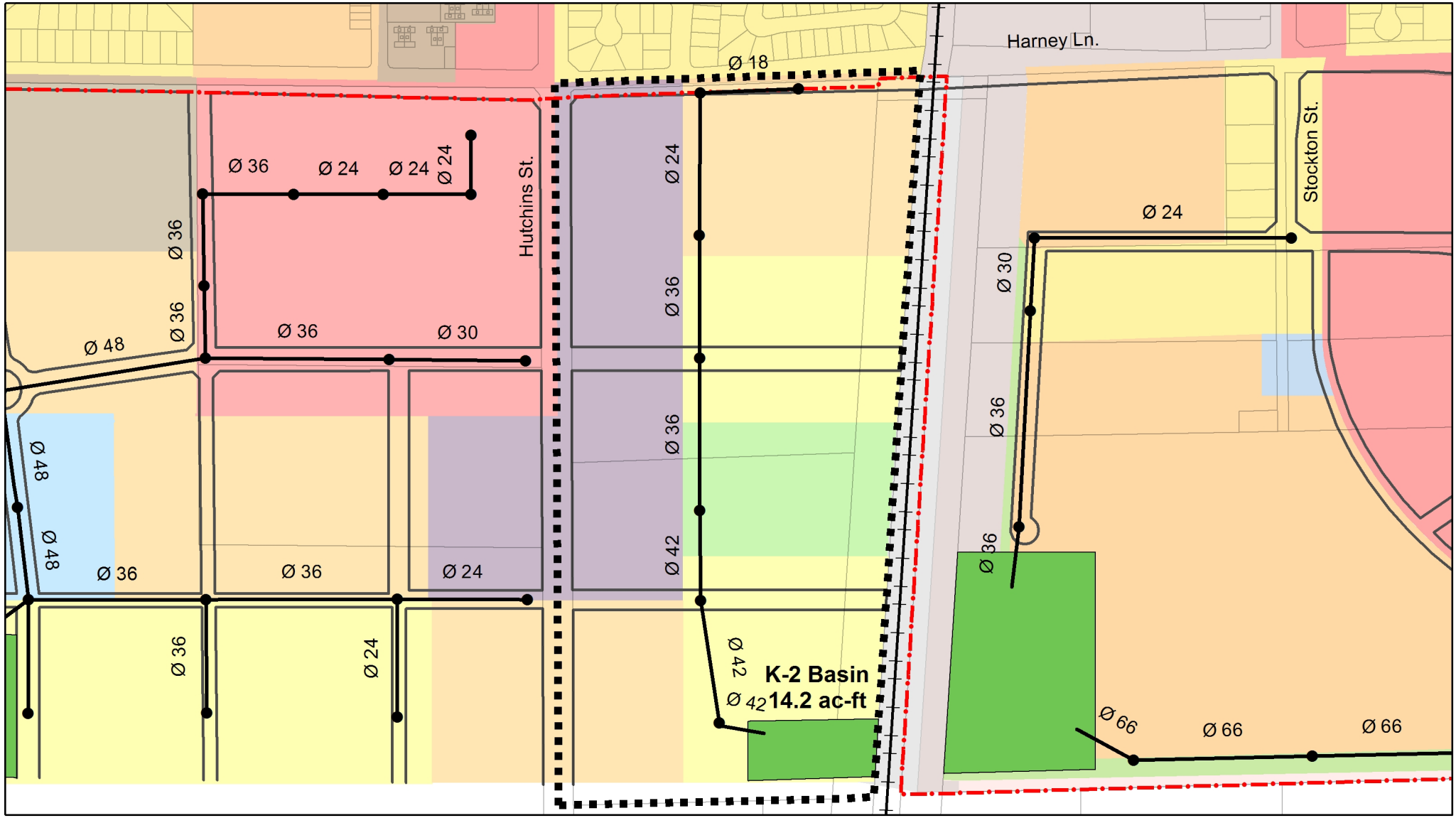
Land Use	Area (sf)	Area (ac)	C-Factor	Rainfall Intensity	Detention Volume (ac-ft)	
LDR	302,659	6.9	0.4	0.4	1.1	
MDR	3,135,052	72.0	0.5	0.4	14.4	
HDR	433,729	10.0	0.5	0.4	2.0	
Park/Open Space	99,055	2.3	0.2	0.4	0.2	
Commercial	4,786,374	109.9	0.7	0.4	30.8	
Streets/Interchange	1,041,084	23.9	1.0	0.4	9.1	
Basin	427,095	9.8	1.0	0.4	3.9	
Total	10,225,048	234.7			**61.4**	*

Depth (ft)	Volume (cf)	Area (ac)	Area (sf)	Width (ft)	Length (ft)	
6.8	2,676,741	9.0	393,638	532	741	393,638

Lowest T.C. =	40.0		Water Surface Area =	-	sf
Design H.G.L. =	38.8		Bottom Surface Area =	-	sf*
Basin Bottom Elev. =	32.0		Average Area =	393,638	sf
Water Depth =	6.8	ft			
Volume of Storage Provided:			61.4	ac-ft	2,676,741	cf

* Reynolds Ranch Master Plans used a Detention Volume of 61.7

*Assumed 4:1 side slopes



K-2
Storm Drainage Area

Legend

- KBasin_5yrHGL
- Storm Water Pipes
- K-2 Area
- Future Basins
- City Limits
- Parcels
- Canal
- Parks
- Railroad
- River

General Plan - Land Use

- Business Park
- Commercial
- Downtown Mixed Use
- High Density Residential
- Industrial
- Low Density Residential
- Medium Density Residential
- Mixed Use Center
- Mixed Use Corridor
- Office
- Open Space
- Public/Quasi-Public
- Right of Way
- Urban Reserve
- Water

N W E S

1 in = 500 ft

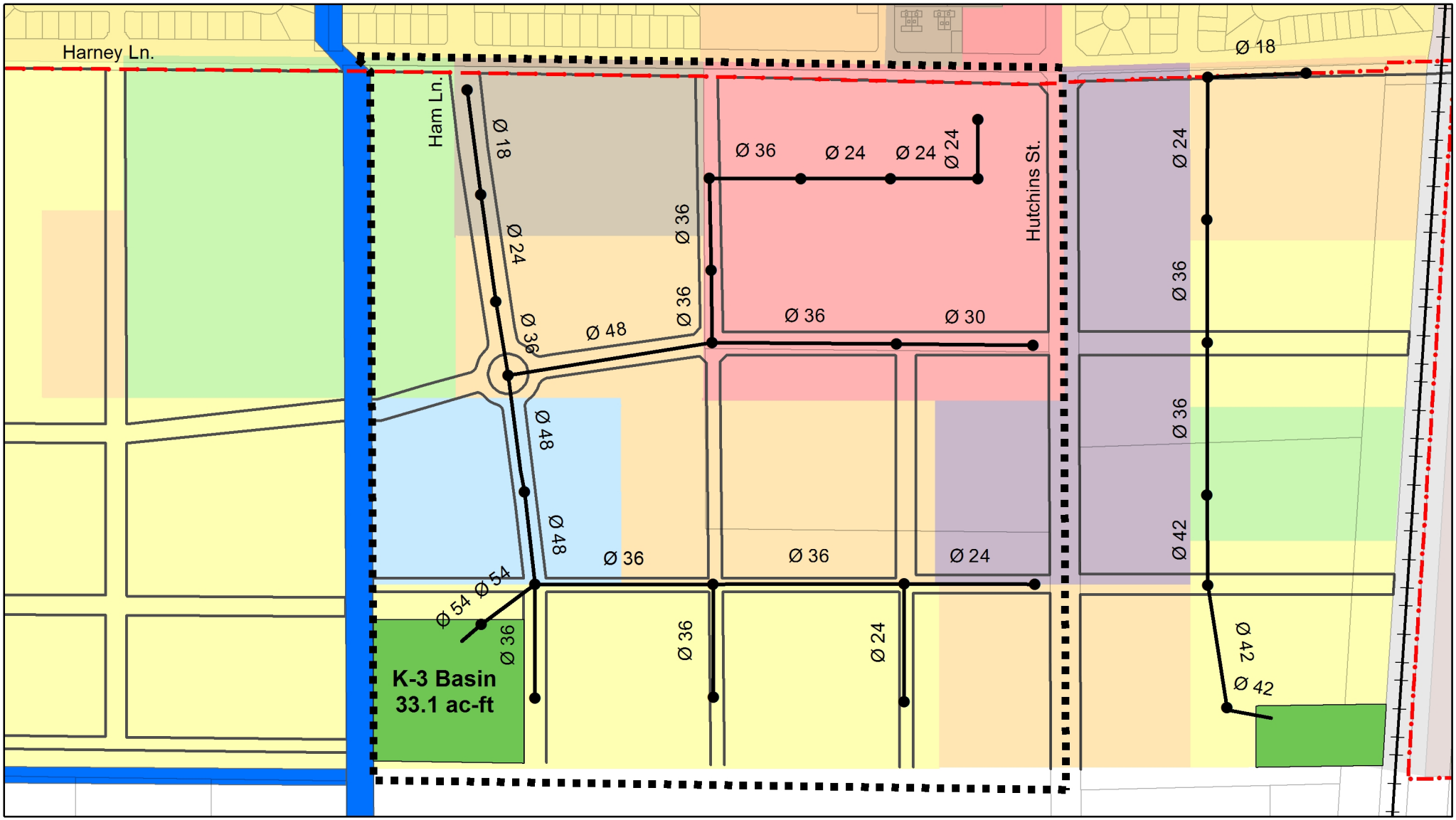
K-2 Stormwater Basin Sizing Calculation

Land Use	Area (sf)	Area (ac)	C-Factor	Rainfall Intensity	Detention Volume (ac-ft)
LDR	903,002	20.7	0.4	0.4	3.3
MDR	736,742	16.9	0.5	0.4	3.4
Park/Open Space	683,674	15.7	0.2	0.4	1.3
Commercial	823,284	18.9	0.7	0.4	5.3
Basin	101,247	2.3	1.0	0.4	0.9
Total	3,247,949	74.6			**14.2**

Depth (ft)	Volume (cf)	Area (ac)	Area (sf)	Width (ft)	Length (ft)	
8.0	617,541	1.8	77,193	443	218	96,574
				379	154	58,366

Lowest T.C. =	37.5		Water Surface Area =	96,574	sf
Design H.G.L. =	35.5		Bottom Surface Area =	58,366	sf*
Basin Bottom Elev. =	27.5		Average Area =	77,470	sf
Water Depth =	8.0	ft			
Volume of Storage Provided:			14.2 ac-ft	619,760	cf

*Assumed 4:1 side slopes



K-3
Storm Drainage Area

Legend

- KBasin_5yrHGL
- Storm Water Pipes
- K-3 Area
- Future Basins
- City Limits
- Parcels
- Canal
- Parks
- Railroad
- River

General Plan - Land Use

- Business Park
- Commercial
- Downtown Mixed Use
- High Density Residential
- Industrial
- Low Density Residential
- Medium Density Residential
- Mixed Use Center
- Mixed Use Corridor
- Office
- Open Space
- Public/Quasi-Public
- Right of Way
- Urban Reserve
- Water

N W E S

1 in = 500 ft

K-3 Stormwater Basin Sizing Calculation

Land Use	Area (sf)	Area (ac)	C-Factor	Rainfall Intensity	Detention Volume (ac-ft)
LDR	1,284,898	29.5	0.4	0.4	4.7
MDR	1,674,766	38.4	0.5	0.4	7.7
HDR	435,251	10.0	0.5	0.4	2.0
Public/Quasi-Public	788,886	18.1	0.5	0.4	3.6
Park/Open Space	411,551	9.4	0.2	0.4	0.8
Commercial	1,815,893	41.7	0.7	0.4	11.7
Basin	287,404	6.6	1.0	0.4	2.6
Total	6,698,649	153.8			**33.1**

Depth (ft)	Volume (cf)	Area (ac)	Area (sf)	Width (ft)	Length (ft)	
5.5	1,441,700	6.0	262,127	550	517	284,350
				506	473	239,338

Lowest T.C. =	33.0		Water Surface Area =	284,350	sf
Design H.G.L. =	31.0		Bottom Surface Area =	239,338	sf*
Basin Bottom Elev. =	25.5		Average Area =	261,844	sf
Water Depth =	5.5	ft			
Volume of Storage Provided:			33.1	ac-ft	1,440,142	cf

*Assumed 4:1 side slopes

K-Basin Stormwater Overall Calculations

Land Use	Area (sf)	Area (ac)	C-Factor	Rainfall Intensity	Detention Volume (ac-ft)
LDR	2,490,559	57.2	0.4	0.4	9.1
MDR	5,546,560	127.3	0.5	0.4	25.5
HDR	868,980	19.9	0.5	0.4	4.0
Commercial	7,425,551	170.5	0.7	0.4	47.7
Public/Quasi-Public	788,886	18.1	0.5	0.4	3.6
Park/Open Space	1,194,280	27.4	0.2	0.4	2.2
Streets/Interchange	1,041,084	23.9	1.0	0.4	9.1
Basin	815,746	18.7	1.0	0.4	7.5
Total	20,171,646	463.1			**108.7**

Appendix D

L Basin

L - Basin Modeling Assumptions

The L-Basin area covers the southern section of Lodi. Several assumptions were made throughout the modeling process:

1. The pipes were sized using a 5-year storm event. Our current standards dictate the use of a 2-year storm event to size the storm water mainlines. The change to a 5-year storm event will provide greater protection.
2. The C-factor for commercial and industrial land uses was changed due to the 2008 Storm Water Design Standards. The commercial C-factor changed from 0.8 to 0.7. The industrial C-factor changed from 0.9 to 0.75. C-factor for residential land use has not changed. Recently residential development practices have constructed homes on smaller lots resulting in less permeable surfaces (i.e. landscaping) around the home resulting in potentially increased runoff. The current State storm water design standards, however, require residential development to reduce the amount of runoff from individual lots. These changes offset each other and, therefore, the C-factor has not been changed.
3. The detention basin serving subarea L-1 basin will need to pump from 20.5 feet to 22.7 feet (2.2 feet) to enter into the 48-inch storm water outfall pipe.
4. The detention basin serving subarea L-2 basin will need to pump from 18.0 feet to 22.6 feet (4.6 feet) to enter into the 48-inch storm water outfall pipe.
5. Subareas L-1 and L-2 used the South Lodi Storm Drainage Master Plan as a template for the pipe locations and sizes.
6. The detention basin serving subareas L-1 and L-2 will drain to the WID canal. There are two options for discharging the storm drainage into the WID canal. The first option would be the outfall storm pipeline may be tunneled under the WID canal to the east side of the canal to a lift station that will release the storm water into the canal at a controlled rate. The second option would be a connection to the WID canal on the west side of the canal and have the pump stations release at a controlled rate not to exceed 60 cfs.

L-1
Storm Drainage Area

Legend

- Storm Drainage Pipes
- Junction
- L-1 Area
- Future Basins
- City Limits
- Parcels
- Canal
- Parks
- Railroad
- River

General Plan - Land Use

- Business Park
- Commercial
- Downtown Mixed Use
- High Density Residential
- Industrial
- Low Density Residential
- Medium Density Residential
- Mixed Use Center
- Mixed Use Corridor
- Office
- Open Space
- Public/Quasi-Public
- Right of Way
- Urban Reserve
- Water

N
W E
S

1 in = 500 ft

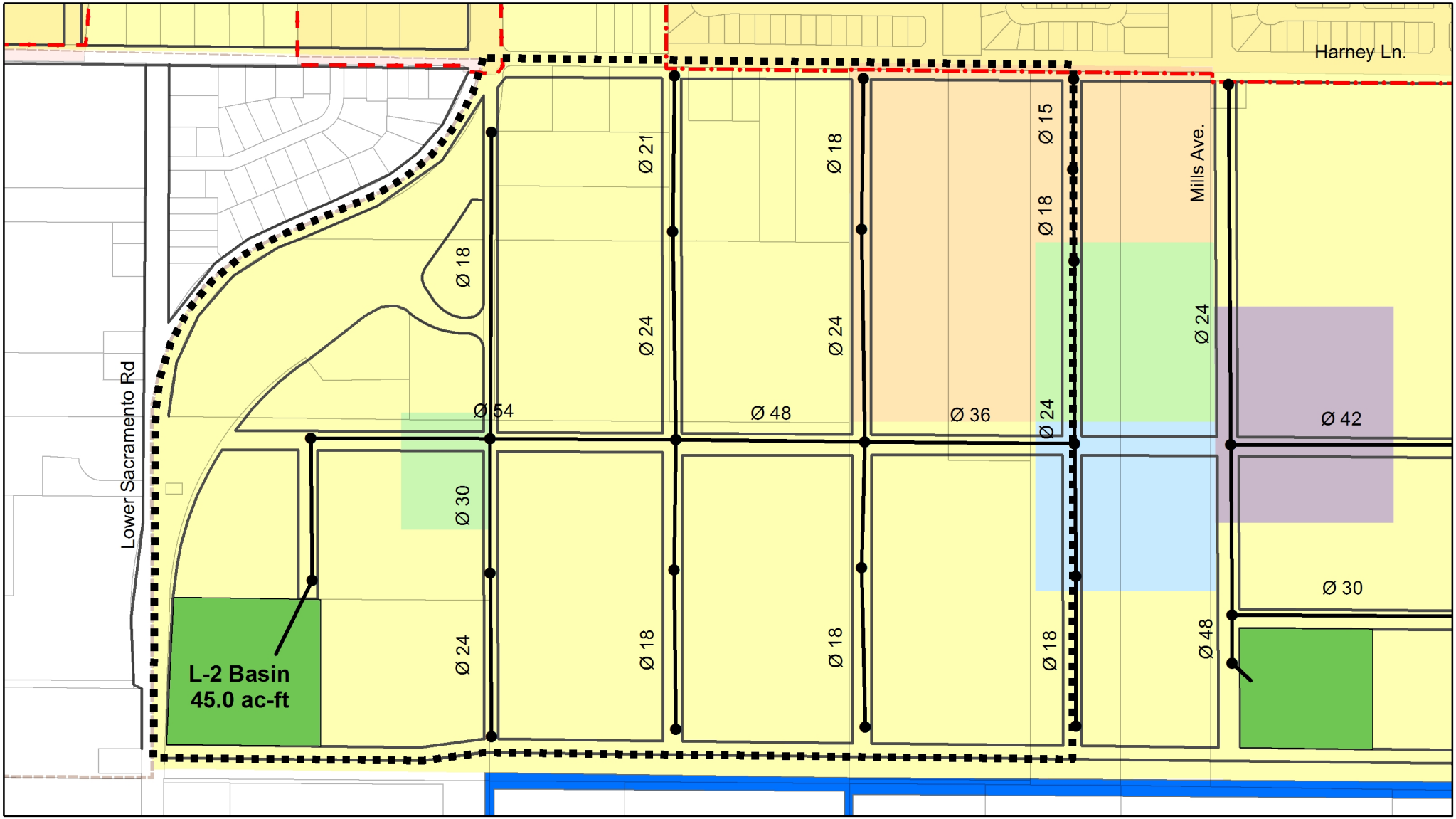
L-1 Stormwater Basin Sizing Calculation

Land Use	Area (sf)	Area (ac)	C-Factor	Rainfall Intensity	Detention Volume (ac-ft)
LDR	4,692,613	107.7	0.4	0.4	17.2
MDR	205,799	4.7	0.5	0.4	0.9
Mixed Use	1,534,801	35.2	0.7	0.4	9.9
Park/Open Space	999,521	22.9	0.2	0.4	1.8
Basin	212,258	4.9	1.0	0.4	1.9
Total	7,644,992	175.5			**31.8**

Depth (ft)	Volume (cf)	Area (ac)	Area (sf)	Width (ft)	Length (ft)	
7.5	1,386,587	4.2	184,878	481	438	210,678
				421	378	159,138

Lowest T.C. =	30.0		Water Surface Area =	210,678	sf
Design H.G.L. =	28.0		Bottom Surface Area =	159,138	sf*
Basin Bottom Elev. =	20.5		Average Area =	184,908	sf
Water Depth =	7.5	ft			
Volume of Storage Provided:			31.8	ac-ft	1,386,810	cf

*Assumed 4:1 side slopes



L-2
Storm Drainage Area

Legend

- Storm Drainage Pipes
- Junction
- L-2 Area
- Future Basins
- City Limits
- Parcels
- Canal
- Parks
- Railroad
- River

General Plan - Land Use

- Business Park
- Commercial
- Downtown Mixed Use
- High Density Residential
- Industrial
- Low Density Residential
- Medium Density Residential
- Mixed Use Center
- Mixed Use Corridor
- Office
- Open Space
- Public/Quasi-Public
- Right of Way
- Urban Reserve
- Water

N
W E
S

1 in = 500 ft

L-2 Stormwater Basin Sizing Calculation

Land Use	Area (sf)	Area (ac)	C-Factor	Rainfall Intensity	Detention Volume (ac-ft)
LDR	8,882,205	203.9	0.4	0.4	32.6
MDR	1,444,105	33.2	0.5	0.4	6.6
Public	427,108	9.8	0.5	0.4	2.0
Park/Open Space	597,316	13.7	0.2	0.4	1.1
Basin	296,134	6.8	1.0	0.4	2.7
Total	11,646,868	267.4			**45.0**

Depth (ft)	Volume (cf)	Area (ac)	Area (sf)	Width (ft)	Length (ft)	
9.0	1,961,634	5.0	217,959	510	493	251,430
				438	421	184,398

Lowest T.C. =	29.0		Water Surface Area =	251,430	sf
Design H.G.L. =	27.0		Bottom Surface Area =	184,398	sf*
Basin Bottom Elev. =	18.0		Average Area =	217,914	sf
Water Depth =	9.0	ft			
Volume of Storage Provided:			45.0 ac-ft	1,961,226	cf

*Assumed 4:1 side slopes

L-Basin Stormwater Overall Calculations					
Land Use	Area (sf)	Area (ac)	C-Factor	Rainfall Intensity	Detention Volume (ac-ft)
LDR	13,574,818	311.6	0.4	0.4	49.9
MDR	1,649,904	37.9	0.5	0.4	7.6
Mixed Use	1,534,801	35.2	0.7	0.4	9.9
Park/Open Space	1,596,837	36.7	0.2	0.4	2.9
Public	427,108	9.8	0.5	0.4	2.0
Basin	508,393	11.7	1.0	0.4	4.7
Total	19,291,861	442.9			**76.9**