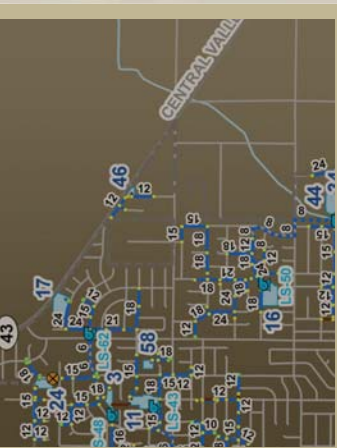
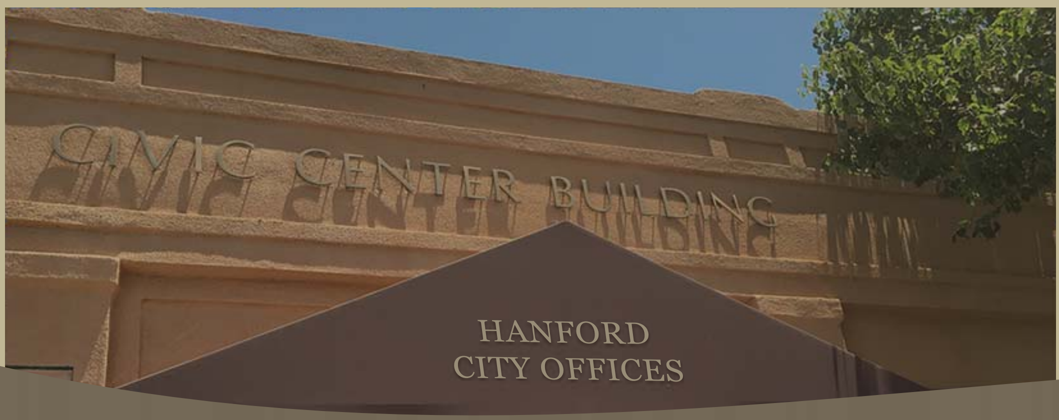
SEPTEMBER 2017

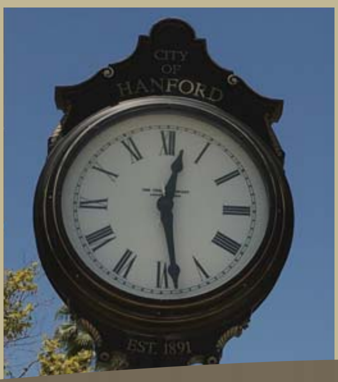
FINAL

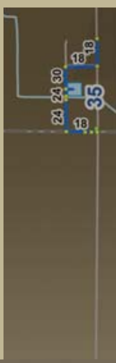
City of Hanford

Storm Drainage System Master Plan







AKEL
ENGINEERING GROUP, INC.

ADOPTION RESOLUTION

AKEL
ENGINEERING GROUP, INC.

RESOLUTION NO. 17-57-R

A RESOLUTION OF THE CITY COUNCIL OF THE CITY OF HANFORD ADOPTING THE HANFORD STORM DRAINAGE SYSTEM MASTER PLAN, DATED SEPTEMBER 2017

At a regular meeting of the City Council of the City of Hanford, duly called and held on November 7, 2017 at 7:00 P.M., it was moved by Council Member Sorensen, and seconded by Council Member Mendes, and duly carried that the following resolution be adopted:

WHEREAS, to ensure that storm drainage system facilities are properly planned and constructed, the City of Hanford contracted with the consulting firms of Quad Knopf, Inc. and Zumwalt-Hansen & Associates to develop a Storm Drainage System Master Plan to facilitate future urban growth; and

WHEREAS, the firms of Quad Knopf, Inc., and Zumwalt-Hansen & Associates, subcontracted with the firm of Akel Engineering Group, Inc., to prepare the Storm Drainage System Master Plan and related studies; and

WHEREAS, the Storm Drainage System Master Plan Report is organized in six sections (1) Introduction; (2) Planning Area Characteristics; (3) System Performance and Design; (4) Existing Facilities and Model Development; (5) Evaluation and Proposed Improvements; (6) Capital Improvement Program; and

WHEREAS, the Land Use Element, and the Public Facilities Element of the 2035 Hanford General Plan, adopted on April 24, 2017 by Resolution 17-21-R, provide specific statements supporting the development and implementation of a Storm Drainage System Master Plan for planned urban growth; and

WHEREAS, THE City Council of the City of Hanford has determined that the proposed Storm Drainage System Master Plan will incorporate and implement the new policies and concepts established in the adopted 2035 Hanford General Plan and is necessary for planned urban growth and development in the City consistent with the 2035 General Plan.

NOW, THEREFORE, BE IT RESOLVED that the City Council of the City of Hanford has determined that as a result of the proposed Master Plan, no new effects could occur, or new mitigation measures would be required that have not been addressed within the scope of the certified Environmental Impact Report (SCH No. 2015041024) prepared for the 2035 General Plan Update. The Environmental Impact Report prepared for the 2035 General Plan was certified by Resolution 17-20-R, adopted on April 24, 2017, which included a Statement of Overriding Considerations and a Mitigation and Monitoring Program, herein incorporated by reference. The Program Environmental Impact Report adequately analyzed and addressed the Storm Drainage System Master Plan.

NOW, THEREFORE, BE IT FURTHER RESOLVED that the City Council of the City of Hanford hereby adopts the Storm Drainage System Master Plan dated September 2017:

This resolution supercedes Resolution No. 95-41-R, adopted November 7, 1995.

PASSED, ADOPTED, and APPROVED this 7th day of November, 2017, by the following vote:

AYES: Sue Sorensen, Justin Mendes, Francisco Ramirez, Martin Devine, David Ayers

NOES: ——

ABSTAIN: ——

ABSENT: ——

DAVID G. AYERS,
MAYOR of the City of Hanford

ATTEST:

JENNIFER GOMEZ,
CITY CLERK

STATE OF CALIFORNIA)
COUNTY OF KINGS) ss
CITY OF HANFORD)

I, JENNIFER GOMEZ, City Clerk of the City of Hanford, do hereby certify the foregoing Resolution was duly passed and adopted by the City Council of the City of Hanford at a regular meeting thereof held on the 7th day of November, 2017.

Dated: November 8, 2017

JENNIFER GOMEZ,
CITY CLERK

CITY OF HANFORD

2017

STORM DRAINAGE SYSTEM MASTER PLAN

Final

September 2017

REGISTERED PROFESSIONAL ENGINEER
ANTOINE A AKEL
C 041682
CIVIL
STATE OF CALIFORNIA
9/29/17

AKEL
ENGINEERING GROUP, INC.

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Smart Planning Our Water Resources

September 29, 2017

City of Hanford
319 Douty Street
Hanford CA, 93230

Attention: Lou Camara, P.E.
Director of Public Works

Subject: 2017 Storm Drainage System Master Plan – Final Report

Dear Lou:

We are pleased to submit the final report for the City of Hanford Storm Drainage System Master Plan. This master plan is a standalone document, though it was prepared as part of the integrated infrastructure master plans for the water, sewer, and storm drainage master plans. The master plan documents the following:

- Existing system facilities, acceptable hydrologic and hydraulic performance criteria, and projected stormwater runoff consistent with the Planned Area Boundary.
- Development of the City's GIS-based hydrologic and hydraulic stormwater models.
- Capacity evaluation of the existing system with improvements to mitigate existing deficiencies and to accommodate policy updates and future growth.
- Capital Improvement Program (CIP) with an opinion of probable construction costs and suggestions for cost allocations to meet AB 1600.
- Hydrologic analysis and modeling completed by Hydmet.

We extend our thanks to you; John Doyel, Deputy Director of Public Utilities / City Engineer; Darlene Mata, Community Development Director; and other City staff whose courtesy and cooperation were valuable components in completing this study.

Sincerely,

AKEL ENGINEERING GROUP, INC.

Tony Akel, P.E.
Principal

Enclosure: Report

7433 N. FIRST STREET, SUITE 103 • FRESNO, CALIFORNIA 93720 • (559) 436-0600 • FAX (559) 436-0622
www.akeleng.com

Acknowledgements

City Council

David Ayers, Mayor

Sue Sorensen, Vice Mayor

Martin Devine

Francisco Ramirez

Justin Mendes

Management Personnel

Lou Camara, Director of Public Works

John Doyel, Deputy Director of Public Utilities / City Engineer

Darlene Mata, Community Development Director

Mike Cosenza, Utilities Superintendent

Other City Engineering, Planning, and Operations Staff

City of Hanford
Storm Drainage System Master Plan

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FIGURES

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APPENDICES

EXECUTIVE SUMMARY

This executive summary presents a brief background of the City's stormwater drainage system, the planning area characteristics, the hydrology and hydraulic criteria, and the hydrology and hydraulic model developments.

These hydrology and hydraulic models were used to evaluate the capacity adequacy of the existing stormwater drainage system, for recommending improvements to mitigate existing deficiencies and for servicing future growth. The prioritized capital improvement program accounts for growth throughout the Hanford Planning Area.

ES.1 STUDY OBJECTIVES

The City of Hanford recognizes the importance of planning, developing, and financing system facilities to provide sewer collection services to existing customers and for servicing anticipated growth within the Hanford Planning Area, the City initiated the preparation of the 2017 Sewer System Master Plan (SSMP).

City Council approved Akel Engineering Group Inc. to prepare this master plan in November of 2013. The plan included a capacity analysis of the City's stormwater drainage system using hydrology and hydraulic models, recommended prioritized capacity improvements, and water quality related improvements to meet the anticipated requirements from the Regional Water Quality Control Board.

The planning boundary and horizon for the master plan were developed in accordance with the City's recently adopted General Plan. Should planning conditions change, and depending on their magnitude, adjustments to the master plan recommendations might be necessary.

The City of Hanford authorized Akel Engineering Group Inc. to complete the following tasks:

- Summarize the City's existing stormwater system facilities.
- Document growth planning assumptions and known future developments.
- Update the Storm Drainage system performance criteria.
- Project future stormwater flows.
- Evaluate the storm drainage facilities to address hydraulic capacity requirements from existing and projected developments, and water quality requirements from recent regulations.
- Perform a capacity analysis for the existing collection system and recommending improvements.
- Recommend a Capital Improvement Program (CIP) with an opinion of probable costs.

- Perform a capacity allocation analysis for cost sharing purposes.
- Develop a Storm Drainage System Master Plan report.

ES.2 INTEGRATED APPROACH TO MASTER PLANNING

The City implemented an integrated master planning approach and contracted the services of Akel Engineering Group to prepare the following documents:

- Water System Master Plan
- Sewer System Master Plan
- Storm Drainage System Master Plan

While each of these reports is published as a standalone document, they have been coordinated for consistency with the City's General Plan document. Additionally, each report has been cross referenced to reflect relevant analysis results with the other reports.

ES.3 STUDY AREA DESCRIPTION

The City of Hanford is located in Kings County, approximately 30 miles southeast of the City of Fresno and 20 miles west of the City of Visalia (**Figure ES.1**). The City's closest neighbor, the City of Lemoore is located 8 miles to the west. Highway 198 bisects the southern boundary of the City in the east west direction, while Highway 43 is adjacent to the City's eastern boundary. In 2002, the City outlined the long-term Urban Growth Boundary (UGB), which was approved by City Council, and identified lands intended for future urbanization within the City Service area.

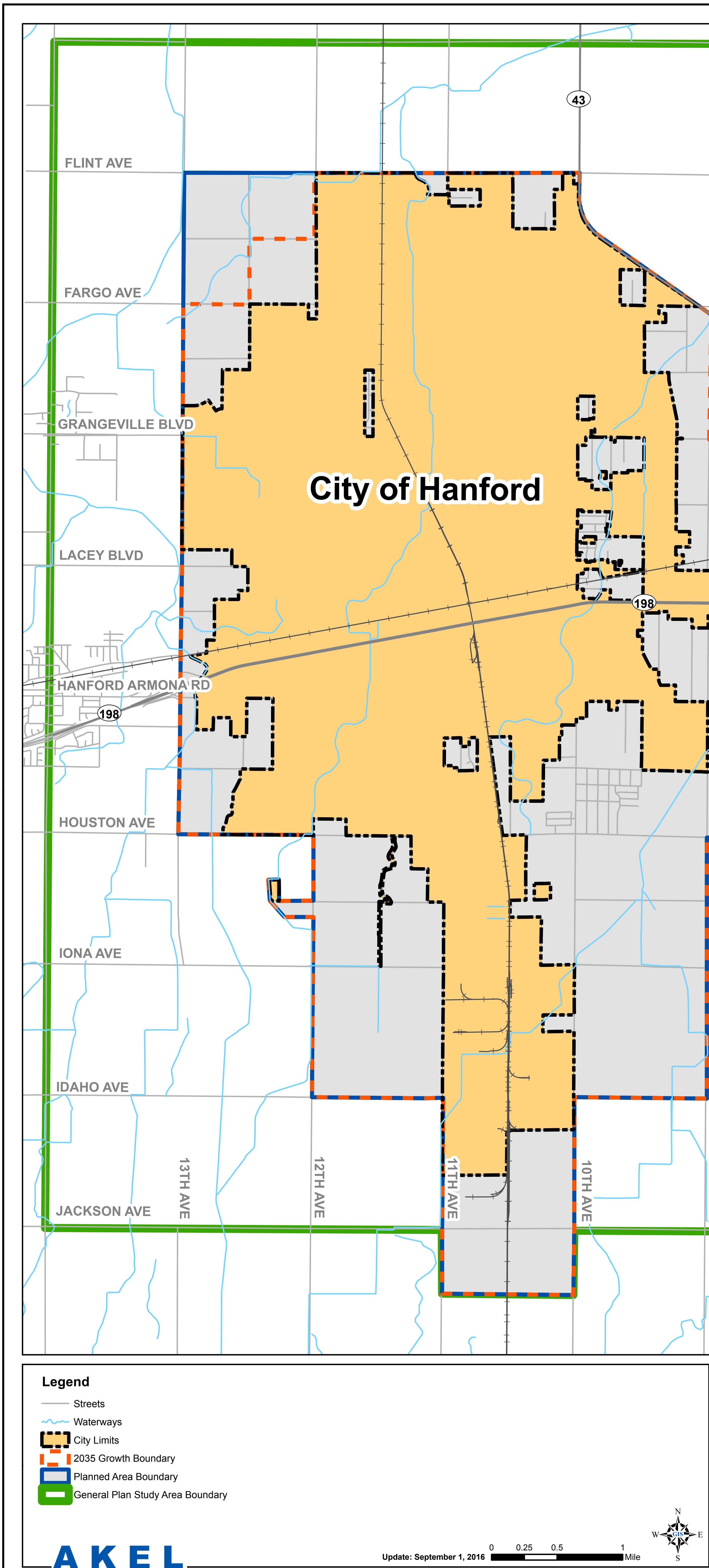
The City operates and maintains a storm drainage system that covers the majority of the area within the City limits. Currently, stormwater runoff discharges to detention basins and canals that are located throughout the City.

ES.4 SYSTEM PERFORMANCE AND DESIGN CRITERIA

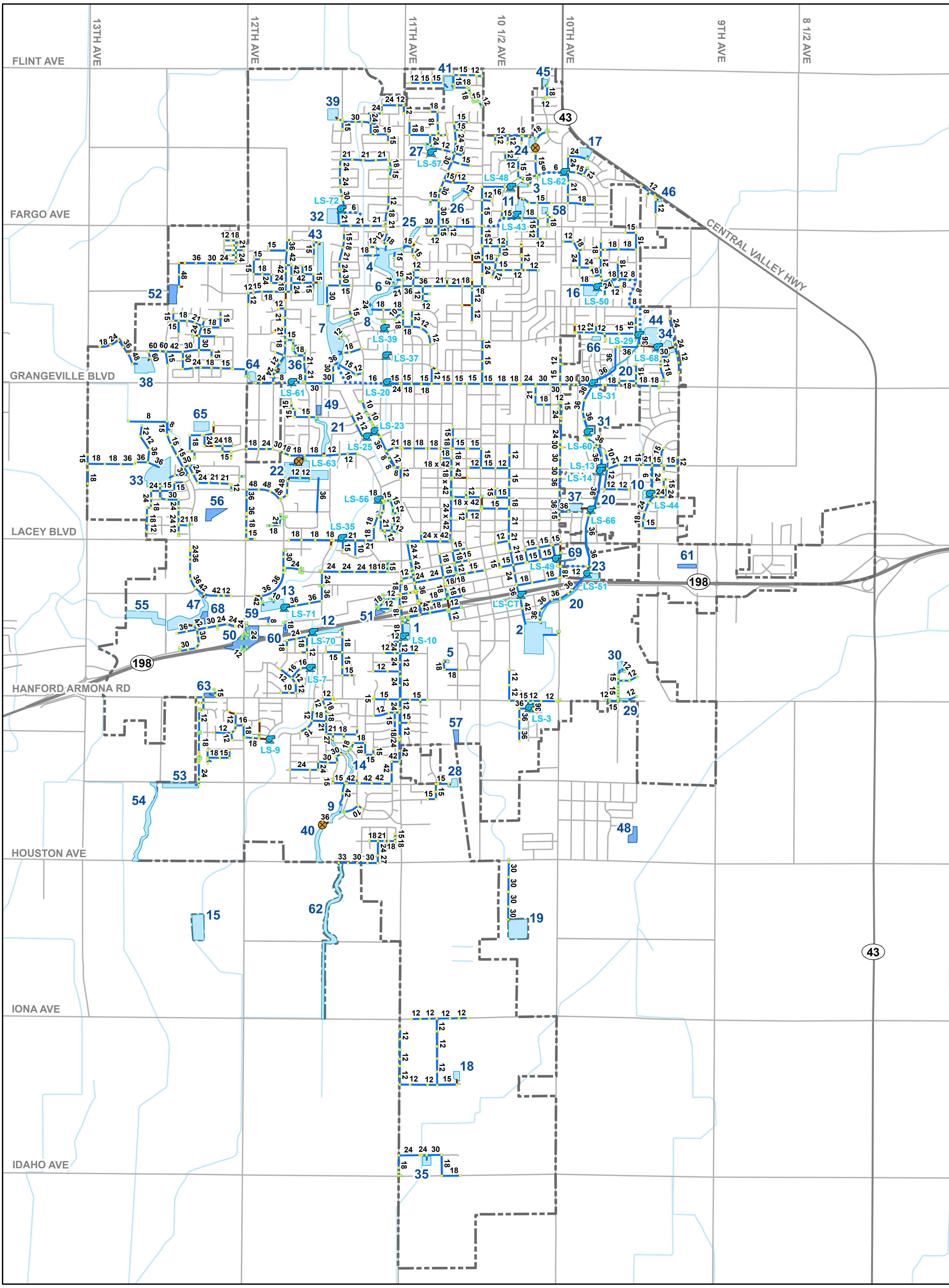
This report documents the City's performance and design criteria that were used for evaluating hydrologic and hydraulic systems within the City's drainage watershed (**Table ES.1**).Hydrologic criteria are developed to characterize the flood routing of rainfall runoff in a defined drainage system. Akel Engineering Group retained the services of Dr. Jack Humphrey of Hydmet Inc. to complete the hydrologic evaluation of this project. The hydraulic criteria for the storm drainage system were used to evaluate the capacity requirements of conveyance facilities, retention basins, and pump stations.

ES.5 HYDROLOGIC AND HYDRAULIC MODEL DEVELOPMENT

Factors critical to the hydrologic model development include watersheds, drainage basins within each watershed, overland flow routing within drainage subbasins, and conveyance that makes full use of pipes as well as streets for routing 100-year design storm events. A hydraulic model was developed for the City's existing storm drainage system (**Figure ES.2**), which includes facilities



ES. 1
Planning Area
Storm Drainage System Master Plan
City of Hanford



Legend

Existing System

- Lift Stations
- Valves
- Catch Basins
- Manholes
- Gravity Pipes
- Force Mains
- Unknown Pipe Size
- City Storm Basins
- Private Storm Basins
- City Limits
- Streets
- Waterways

AKEL ENGINEERING GROUP, INC.

Update: September 6, 2016

0 0.25 0.5 1 Mile

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ES. 2
Existing Storm Drainage System

Storm Drainage System Master Plan
City of Hanford

Table ES.1 Hydrologic and Hydraulic Design Criteria

Storm Drainage System Master Plan
City of Hanford

Hydrology and Hydraulics Design Criteria	
Ponding Basins (Existing and Future)	
Design Storm	
Detention	**100 year - 2 day**
Retention	**100 year - 10 day**
Flooding for Developments	All Basins: Development pad elevations shall be designed to mitigate flood damage from a **100 year - 30 day** event. Allowable flooding up to 1.5 feet above the gutter flowline.
Retention	Existing/Future: Responsible for full retention of design storm. No flooding of street during design storm.
Detention	Existing/Future: Responsible for full detention of design storm. No flooding in streets during design storm. Discharge to ditch or other drainage facility upon approval of City engineer.
Pipelines	
Design Storm	Residential: **2 year - 6 hour** Commercial: **5 year - 6 hour**
Street Flooding	Existing: Allowable flooding up to 1.5 feet above the gutter flowline Future: No flooding in streets during design storm
Minimum Pipe Size	12 inches
Pump Stations	
Detention Pumps	Sizing requirements based on emptying detention basin in 5 to 7 days for the design storm
Direct Discharge Pumps	Sizing requirements based on design flow, with allowable flooding of up to 1.5 feet above the gutter flowline at the lowest system elevation

such as conveyance facilities, outfalls, pump stations, and retention basins. This section discusses the existing watersheds, the delineation of drainage basins and subbasins, and the components of the storm drainage system.

ES.6 CAPACITY EVALUATION

The hydrologic and hydraulic models were used for evaluating the storm drainage system to identify capacity deficiencies and to recommend improvements required to serve future growth. The criteria used for evaluating the capacity adequacy of the storm drainage system (pipelines, stormwater collection basins, and pump stations) and used for sizing recommended improvements were discussed and summarized in the System Performance and Design Criteria chapter.

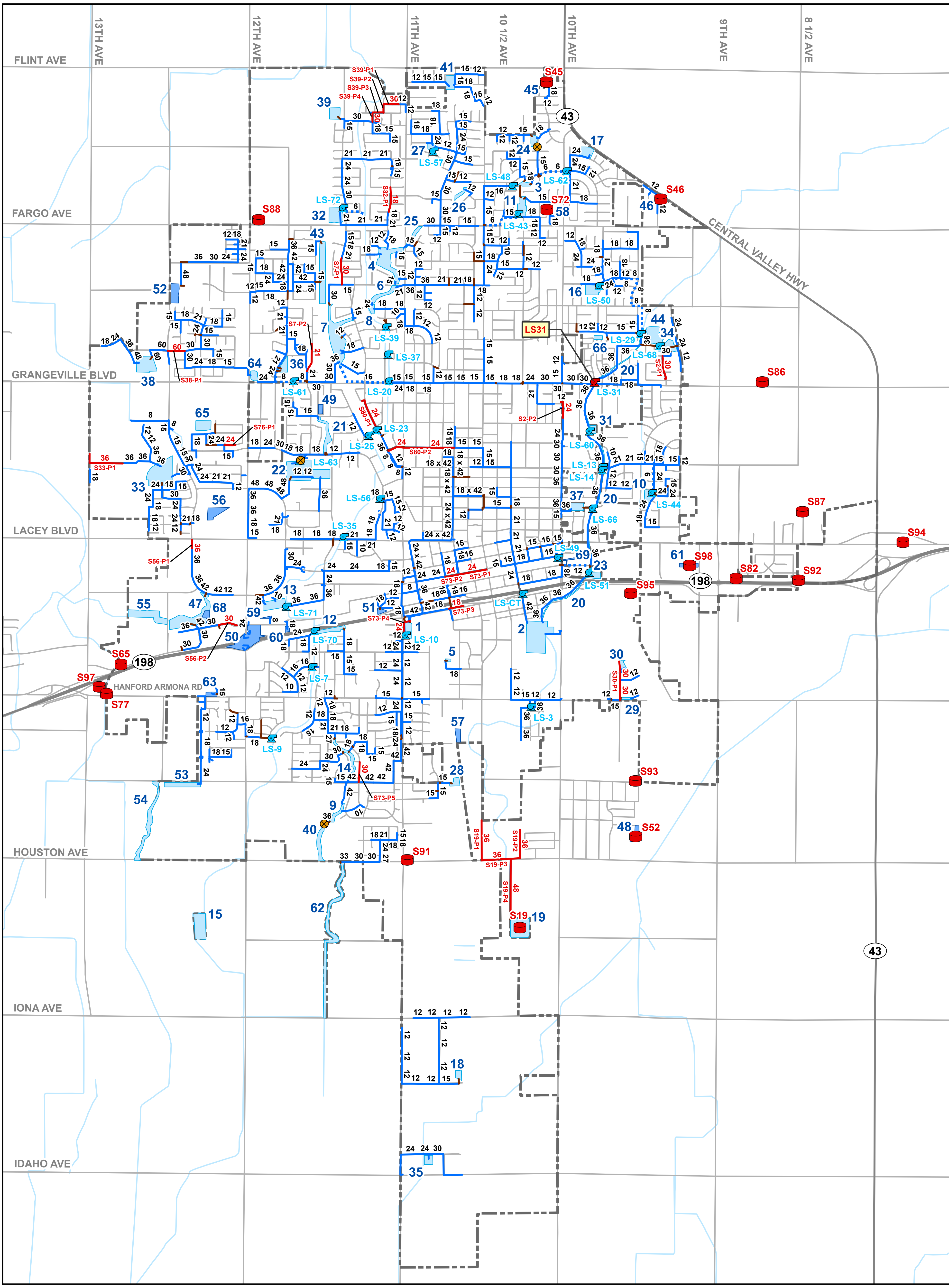
The evaluation of the City's existing storm drainage system was conducted by Dr. Jack Humphrey of Hydmet Inc. These sections summarize the evaluation of the existing system performed by Hydmet Inc. and the improvements recommended to mitigate exiting deficiencies and serve future growth.

ES.7 CAPITAL IMPROVEMENT PROGRAM

The Capital Improvement Program costs for the projects identified in this master plan for mitigating existing system deficiencies and for serving anticipated future growth throughout the City are summarized on **Table ES.2** and are graphically represented on **Figure ES.3**.

The estimated construction costs include the baseline costs plus **15 percent** contingency allowance to account for unforeseen events and unknown field conditions. Capital improvement costs include the estimated construction costs plus **15 percent** project-related costs (engineering design, project administration, construction management and inspection, and legal costs).

The costs in this sewer system master plan were benchmarked using a 20-City national average Engineering News Records (ENR) Construction Cost Index (CCI) of 10,532, reflecting a date of January 2017. In total, the CIP includes approximately 10 miles of pipeline improvements, and one lift station improvement, and 18 retention basin improvements, with a project cost totaling over 29 million dollars.



Legend

Future Improvements
- Basins
- Lift Stations
- Pipes

Existing System
- Lift Stations
- Valves
- Gravity Pipes
- Force Mains
- Unknown Pipe Size

- City Storm Basins
- Private Storm Basins
- City Limits
- Streets
- Waterways

AKEL ENGINEERING GROUP, INC.

Update: August 10, 2017

0 0.25 0.5 1 Mile

N W E S

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ES. 3
Proposed Improvements
Storm Drainage System Master Plan
City of Hanford

Table ES.2 Capital Improvement Program
Storm Drainage System Master Plan
City of Hanford

Improvements						Pipelines and Appurtenances Costs					Capital Improvement Program			Suggested Cost Allocation		Cost Sharing	
Improv. No.	Type of Improv	Alignment	Limits	Existing Diameter (in)	New/Parallel/ Replace	Diameter (in)	Length (ft)	Number of Casings	Unit Cost[1] ($/LF)	Pipe Cost ($)	Baseline Constr. Costs ($)	Estimated Constr. Cost[2] ($)	Capital Improvement Costs[3] ($)	Existing Users %	Future Users %	Existing Users ($)	Future Users ($)
Existing System Improvements																	
Existing Pipeline Improvements																	
Basin S2																	
S2-P1	Pipe	Brookhollow Dr	From Hoover Way to Waterview St	18	Replace	30	825	-	241	198,603	198,603	228,394	262,653	100%	0%	262,653	0
S2-P2	Pipe	10th Ave	From Bass St to approximately 190 ft n/o Malone St	15	Replace	24	600	-	196	117,357	117,357	134,960	155,204	0%	100%	0	155,204
												Subtotal - S2	417,857			262,653	155,204
Basin S7																	
S7-P1	Pipe	Glacier Way	From approximately 100 ft n/o Muir Way to Cortner St	24	Replace	30	900	-	241	216,658	216,658	249,157	286,531	90%	10%	257,878	28,653
S7-P2	Pipe	Kings Rd	From Crescent Way to Claridge Ln	-	New	21	975	-	166	161,365	161,365	185,570	213,406	80%	20%	170,724	42,681
												Subtotal - S7	499,936			428,602	71,334
Basin S19																	
S19-P1	Pipe	10 1/2 Ave	From 1,350 ft n/o Houston Ave to Houston Ave	-	New	36	1,350	-	286	385,923	385,923	443,811	510,383	0%	100%	0	510,383
S19-P2	Pipe	ROW	ROW between 10 1/2 Ave and 10 th Ave from 1,000 ft n/o Houston Ave to Houston Ave	-	New	36	1,275	-	286	364,482	364,482	419,155	482,028	0%	100%	0	482,028
S19-P3	Pipe	Houston Ave	From 10 1/2 Ave to 1,000 ft e/o 10 1/2 Ave	-	New	36	1,000	-	286	285,869	285,869	328,749	378,061	0%	100%	0	378,061
S19-P4	Pipe	ROW	ROW between 10 1/2 Ave and 10th Ave from Houston Ave to 2,000 ft s/o Houston Ave	30	Replace	48	2,025	-	391	792,157	792,157	910,980	1,047,627	0%	100%	0	1,047,627
												Subtotal - S19	2,418,099			0	2,418,099
Basin S30																	
S30-P1	Pipe	9 1/4 Ave	From Hanford Armona Rd to 1,350 ft n/o Hanford Armona Rd	15	Replace	30	1,300	-	241	312,951	312,951	359,893	413,878	100%	0%	413,878	0
												Subtotal - S30	413,878			413,878	0
Basin S32																	
S32-P1	Pipe	Fountain Plaza Dr	From West Pebble Dr to Willow St	12	Replace	18	850	-	135	115,100	115,100	132,365	152,219	100%	0%	152,219	0
												Subtotal - S32	152,219			152,219	0
Basin S33																	
S33-P1	Pipe	Learning Center Main Access	From 13th Ave to School	18	Replace	36	1,425	-	286	407,363	407,363	468,467	538,737	100%	0%	538,737	0
												Subtotal - S33	538,737			538,737	0
Basin S38																	
S38-P1	Pipe	Berkshire Ln	From Bordeaux St to Centennial Dr	42	Replace	60	575	-	451	259,539	259,539	298,469	343,240	100%	0%	343,240	0
												Subtotal - S38	343,240			343,240	0
Basin S39																	
S39-P1	Pipe	Imperial Way	From Plum Ln to Cajun Way	24	Replace	30	500	-	241	120,366	120,366	138,421	159,184	80%	20%	127,347	31,837
S39-P2	Pipe	Cajun Way	From Imperial Way to Millbrook St	24	Replace	30	275	-	241	66,201	66,201	76,131	87,551	80%	20%	70,041	17,510
S39-P3	Pipe	Milbrook St	From Cajun Way to Zion Way	24	Replace	30	375	-	241	90,274	90,274	103,815	119,388	80%	20%	95,510	23,878
S39-P4	Pipe	Zion Way	From Millbrook St to Saffron St	24	Replace	30	325	-	241	78,238	78,238	89,973	103,469	80%	20%	82,776	20,694
												Subtotal - S39	469,592			375,673	93,918
Basin S56																	
S56-P1	Pipe	Centennial Dr	From Lacey Blvd to 300 ft s/o Lacey Blvd	24	Replace	36	300	-	286	85,761	85,761	98,625	113,418	0%	100%	0	113,418
S56-P2	Pipe	Glendale Ave	From approximately 800 ft w/o 12th Ave to approximately 300 w/o 12th Ave	24	Replace	30	625	-	241	150,457	150,457	173,026	198,980	0%	100%	0	198,980
												Subtotal - S56	312,398			0	312,398
Basin S73																	
S73-P1	Pipe	Sixth St	From Douty St to Redington St	15	Replace	24	875	-	196	171,145	171,145	196,817	226,339	0%	100%	0	226,339
S73-P2	Pipe	Sixth St	From Redington St to Phillips St	18	Replace	24	535		196	104,643	104,643	120,339	138,390	0%	100%	0	138,390
S73-P3	Pipe	Third St	From approximately 80 ft w/o Redington St to Phillips St	12	Replace	18	500	-	135	67,706	67,706	77,862	89,541	0%	100%	0	89,541
S73-P4	Pipe	11th Ave	From approximately 70 ft n/o Silverado St to approximately 150 ft s/o Third St	18	Replace	24	550	-	196	107,577	107,577	123,713	142,270	0%	100%	0	142,270
S73-P5	Pipe	Echo Ln	From 100 ft n/o Echo Ct to Hume Ave	12	Replace	30	675	-	241	162,494	162,494	186,868	214,898	50%	50%	107,449	107,449

Table ES.2 Capital Improvement Program
Storm Drainage System Master Plan
City of Hanford

Improvements						Pipelines and Appurtenances Costs					Capital Improvement Program			Suggested Cost Allocation		Cost Sharing	
Improv. No.	Type of Improv	Alignment	Limits	Existing Diameter (in)	New/Parallel/ Replace	Diameter (in)	Length (ft)	Number of Casings	Unit Cost[1] ($/LF)	Pipe Cost ($)	Baseline Constr. Costs ($)	Estimated Constr. Cost[2] ($)	Capital Improvement Costs[3] ($)	Existing Users %	Future Users %	Existing Users ($)	Future Users ($)
												Subtotal - S73	811,439			107,449	703,990
Basin S76																	
S76-P1	Pipe	Hopkins Dr	From Cogswell Pl to Scripps Ct	18	Replace	24	375	-	196	73,348	73,348	84,350	97,003	100%	0%	97,003	0
												Subtotal - S76	97,003			97,003	0
Basin S80																	
S80-P1	Pipe	Rodgers Rd	From Neville Ave to Lift Station 23	10	Replace	24	1,175	-	196	229,823	229,823	264,297	303,941	100%	0%	303,941	0
S80-P2	Pipe	Cameron St	From Redington St to Rodgers Rd	18	Replace	24	2,225	-	196	435,197	435,197	500,477	575,548	100%	0%	575,548	0
												Subtotal - S80	879,490			879,490	0
Existing Retention Basin Improvements				**(AF)**		**(AF)**											
S-19	Existing Retention Basin		Approximately 2,600 ft se/o 10 1/2 Ave and Houston Ave	72.3	Capacity Expansion	23.7					89,345	102,747	118,159	87%	13%	102,798	15,361
S-45	Existing Retention Basin		Approximately 500 ft n/o Capistrano St and Mission Rd	3.8	Capacity Expansion	6.2					49,899	57,383	65,991	62%	38%	40,914	25,077
S-46	Existing Retention Basin		Approximately 900 ft n/o Meadow View and Fargo Ave	3.0	Capacity Expansion	1.0					36,240	41,676	47,928	0%	100%	0	47,928
S-52	Existing Retention Basin		Approximately 2,700 feet ne/o Houston Ave and 10th Ave	7.0	Capacity Expansion	29.0					100,386	115,443	132,760	82%	18%	108,863	23,897
Existing Lift Station Improvements				**Firm Capacity**		**Firm Capacity**											
Basin S2																	
LS-31	Lift Station		Lift Station 31 : Approximately 250 ft w/o intersection of Grangeville Blvd and Arroyo Rd	1 @ 2,500	Replace	3 @ 1,200 gpm					1,836,241	2,111,677	2,428,428	100%	0%	2,428,428	0
										Subtotal - Existing Pipeline Improvements	5,560,595	6,394,684	7,353,887			3,598,944	3,754,943
										Subtotal - Retention Basin Improvements	275,869	317,250	364,837			252,575	112,262
										Subtotal - Lift Station Improvements	1,836,241	2,111,677	2,428,428			2,428,428	0
Future System Improvements																	
Pipelines Servicing Future Retention Basins[5]																	
S65-P1	Pipe		2,000 ft upstream of Retention Basin S65	-	New	42	2,000	-	331	662,011	662,011	761,313	875,510	0%	100%	0	875,510
S72-P1	Pipe		2,000 ft upstream of Retention Basin S72	-	New	24	2,000	-	196	391,189	391,189	449,867	517,347	0%	100%	0	517,347
S77-P1	Pipe		2,000 ft upstream of Retention Basin S77	-	New	48	2,000	-	391	782,377	782,377	899,734	1,034,694	0%	100%	0	1,034,694
S82-P1	Pipe		2,000 ft upstream of Retention Basin S82	-	New	60	2,000	-	451	902,743	902,743	1,038,154	1,193,877	0%	100%	0	1,193,877
S86-P1	Pipe		2,000 ft upstream of Retention Basin S86	-	New	96	2,000	-	767	1,534,663	1,534,663	1,764,862	2,029,592	0%	100%	0	2,029,592
S87-P1	Pipe		2,000 ft upstream of Retention Basin S87	-	New	60	2,000	-	451	902,743	902,743	1,038,154	1,193,877	0%	100%	0	1,193,877
S88-P1	Pipe		2,000 ft upstream of Retention Basin S88	-	New	48	2,000	-	391	782,377	782,377	899,734	1,034,694	0%	100%	0	1,034,694
S91-P1	Pipe		2,000 ft upstream of Retention Basin S91	-	New	36	2,000	-	286	571,737	571,737	657,498	756,122	0%	100%	0	756,122
S92-P1	Pipe		2,000 ft upstream of Retention Basin S92	-	New	60	2,000	-	451	902,743	902,743	1,038,154	1,193,877	0%	100%	0	1,193,877
S93-P1	Pipe		2,000 ft upstream of Retention Basin S93	-	New	66	2,000	-	497	993,017	993,017	1,141,970	1,313,265	0%	100%	0	1,313,265
S94-P1	Pipe		2,000 ft upstream of Retention Basin S94	-	New	60	2,000	-	451	902,743	902,743	1,038,154	1,193,877	0%	100%	0	1,193,877
S95-P1	Pipe		2,000 ft upstream of Retention Basin S95	-	New	30	2,000	-	241	481,463	481,463	553,682	636,735	0%	100%	0	636,735
S97-P1	Pipe		2,000 ft upstream of Retention Basin S97	-	New	48	2,000	-	391	782,377	782,377	899,734	1,034,694	0%	100%	0	1,034,694
S98-P1	Pipe		2,000 ft upstream of Retention Basin S98	-	New	36	2,000	-	286	571,737	571,737	657,498	756,122	0%	100%	0	756,122

Table ES.2 Capital Improvement Program
Storm Drainage System Master Plan
City of Hanford

Improvements						Pipelines and Appurtenances Costs					Capital Improvement Program			Suggested Cost Allocation		Cost Sharing	
Improv. No.	Type of Improv	Alignment	Limits	Existing Diameter (in)	New/Parallel/ Replace	Diameter (in)	Length (ft)	Number of Casings	Unit Cost[1] ($/LF)	Pipe Cost ($)	Baseline Constr. Costs ($)	Estimated Constr. Cost[2] ($)	Capital Improvement Costs[3] ($)	Existing Users %	Future Users %	Existing Users ($)	Future Users ($)
Future Retention Basins						**(AF)**											
S-65	New Retention Basin		Approximately 1,500 ft w/o Aquifer Dr and Highway 198		Future	6.0					98,803	113,623	130,667	0%	100%	0	130,667
S-72	New Retention Basin		Approximately 600 ft ne/o Fargo Ave and Fairmont Ave		Future	6.0					98,803	113,623	130,667	0%	100%	0	130,667
S-77	New Retention Basin		Approximately 3,300 ft w/o Greenbrier Dr and Hanford Harmona Rd		Future	18.0					154,239	177,374	203,981	0%	100%	0	203,981
S-82	New Retention Basin		Approximately 600 ft ne/o Highway 198 and 9th Ave		Future	20.0					162,915	187,352	215,455	0%	100%	0	215,455
S-86	New Retention Basin		Approximately at intersection of 8 1/2 Ave and Grangeville Blvd		Future	64.0					337,665	388,314	446,561	0%	100%	0	446,561
S-87	New Retention Basin		Approximately 1,050 ft n/o intersection of Lacey Blvd and Vista Ave		Future	58.0					314,954	362,197	416,527	0%	100%	0	416,527
S-88	New Retention Basin		Approximately 300 ft ne/o 12th Ave and Fargo Ave		Future	20.0					162,915	187,352	215,455	0%	100%	0	215,455
S-91	New Retention Basin		Approximately at the intersection of Houston Ave and 11th Ave		Future	16.0					145,440	167,256	192,345	0%	100%	0	192,345
S-92	New Retention Basin		Approximately 300 ft se/o Curtis St and David St		Future	42.0					253,061	291,021	334,674	0%	100%	0	334,674
S-93	New Retention Basin		Approximately 4,000 ft nw/o Houston Ave and 9th Ave		Future	100.0					470,108	540,624	621,718	0%	100%	0	621,718
S-94	New Retention Basin		Approximately 850 ft e/o of Lacey Blvd and 8th Ave		Future	146.0					633,259	728,248	837,485	0%	100%	0	837,485
S-95	New Retention Basin		Approximately 1,000 ft sw/of Third St and 9 1/2 Ave		Future	3.0					83,409	95,920	110,309	0%	100%	0	110,309
S-97	New Retention Basin		Approximately at the intersection of Highway 198 and Hanford Armona Rd		Future	4.0					88,652	101,950	117,242	0%	100%	0	117,242
S-98	New Retention Basin		Approximately 1,500 ft nw/o at intersection of 9 1/8 Ave and Highway 198		Future	10.0					118,115	135,832	156,207	0%	100%	0	156,207
										Subtotal - Future Pipeline Improvements	11,163,920	12,838,508	14,764,284			0	14,764,284
										Subtotal - Future Retention Basins	3,122,338	3,590,688	4,129,292			0	4,129,292
										Total							
										Pipeline Improvements	16,724,515	19,233,192	**22,118,171**			**3,598,944**	**18,519,228**
										Retention Basin Improvements	3,398,207	3,907,938	**4,494,129**			**252,575**	**4,241,553**
										Lift Station Improvements	1,836,241	2,111,677	**2,428,428**			**2,428,428**	**0**
										Total Capital Improvement Costs	**21,958,963**	**25,252,807**	**29,040,728**			**6,279,947**	**22,760,781**

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7/19/2017

Notes:
1. Costs are based on ENR Construction Cost Index from January 2017.
2. Baseline construction costs plus 15% to account for unforeseen events and unknown conditions.
3. Estimated construction costs plus 15% to cover other costs including: engineering design, project administration (developer and City staff), construction management and inspection, and legal costs.
4. New retention basin depth assumed to be equal to 25 feet.
5. Pipelines servicing future retention basins are placeholders for future trunk systems of this basin
6. Casing price is estimated at $22/in/l-ft.

CHAPTER 1 - INTRODUCTION

This chapter provides a brief background of the City's Storm Drainage system, the need for this master plan, and the objectives of the study. Abbreviations and definitions are also provided in this chapter.

1.1 BACKGROUND

The City of Hanford (City) is located approximately 30 miles southeast of the city of Fresno and 20 miles west of the city of Visalia (**Figure 1.1**). The City provides storm drainage service to approximately 56,000 residents, as well as commercial, industrial, and institutional establishments. The City currently owns and operates more than 65 miles of storm drainage pipeline, 30 pump stations, and more than 60 storm drainage basins.

In 1995, the City developed a Storm Drainage System Master Plan that identified capacity deficiencies and flooding problem areas caused by stormwater runoff. Recognizing the importance of planning, developing, and financing system facilities to provide enhanced stormwater drainage to existing developed areas and for servicing anticipated growth within the City's future sphere of influence, the City initiated updating elements of the 1995 Storm Drainage Master Plan, to reflect current land use conditions.

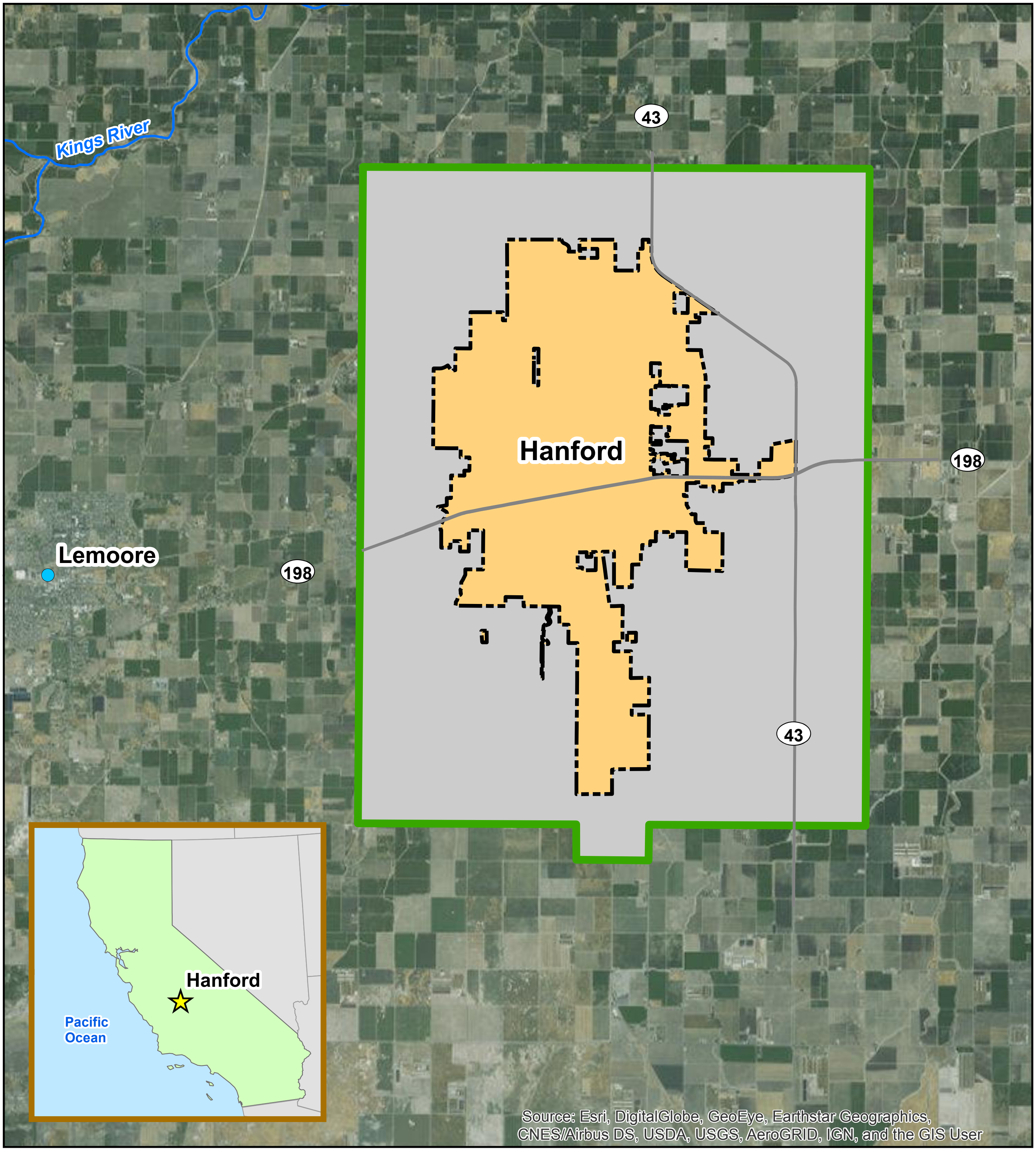
1.2 SCOPE OF WORK

City Council approved Akel Engineering Group Inc. to prepare this master plan in November of 2013. The plan included a capacity analysis of the City's stormwater drainage system using hydrology and hydraulic models, recommended prioritized capacity improvements, and water quality related improvements to meet the anticipated requirements from the Regional Water Quality Control Board.

The planning boundary and horizon for the master plan were developed in accordance with the City's recently adopted General Plan. Should planning conditions change, and depending on their magnitude, adjustments to the master plan recommendations might be necessary.

The City of Hanford authorized Akel Engineering Group Inc. to complete the following tasks:

- Summarize the City's existing stormwater system facilities.
- Document growth planning assumptions and known future developments.
- Update the Storm Drainage system performance criteria.
- Project future stormwater flows.



Legend

- Cities
- City Limits Area
- General Plan Area
- Highways
- River

Update: January 18, 2016

0 0.5 1 2 Miles

N W E S

Figure 1.1
Regional Location Map

Storm Drainage System Master Plan
City of Hanford

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- Evaluate the storm drainage facilities to address hydraulic capacity requirements from existing and projected developments, and water quality requirements from recent regulations.
- Perform a capacity analysis for the existing collection system and recommending improvements.
- Recommend a Capital Improvement Program (CIP) with an opinion of probable costs.
- Perform a capacity allocation analysis for cost sharing purposes.
- Develop a Storm Drainage System Master Plan report.

1.3 INTEGRATED APPROACH TO MASTER PLANNING

The City implemented an integrated master planning approach and contracted the services of Akel Engineering Group to prepare the following documents:

- Water System Master Plan
- Sewer System Master Plan
- Storm Drainage System Master Plan

While each of these reports is published as a standalone document, they have been coordinated for consistency with the City's General Plan document. Additionally, each report has been cross referenced to reflect relevant analysis results with the other reports.

1.4 PREVIOUS MASTER PLANS

The City's most recent storm drainage system master plan was completed in 1995. This master plan included evaluation of servicing growth to the Planned Area Boundary, evaluating the existing system, and identifying storm drainage improvements required to serve future growth. Additionally, the 1995 Master Plan included the development of hydrologic and hydraulic models which were used for evaluating the storm drainage system. Improvements were recommended for servicing existing and future growth areas, and a corresponding Capital Improvement Program was developed to quantify the corresponding costs.

1.5 RELEVANT REPORTS

The City's storm drainage requirements have undergone multiple transformations since the completion of the 1995 Storm Drainage System Master Plan. The following lists relevant reports that were used in the completion of this master plan, as well as a brief description of each document:

- **Storm Drainage System Master Plan, August 1995 (1995 SDMP).** This report documents the planning and performance criteria, evaluates the storm drainage system, recommends improvements and provides an estimate of costs.

- **City of Hanford 2017 General Plan Update (2017 General Plan).** The City's General Plan provides future land use planning, and growth assumptions for the Planning Area. Additionally, this report establishes the planning horizon for improvements in this master plan.

1.6 REPORT ORGANIZATION

This Storm Drainage System Master Plan report contains the following chapters:

Chapter 1 – Introduction. This chapter provides a brief background of the City's Storm Drainage system, the need for this master plan, and the objectives of the study. Abbreviations and definitions are also provided in this chapter.

Chapter 2 – Planning Area Characteristics. This chapter presents a discussion of the planning area characteristics affecting the hydrologic and hydraulic analysis of this master plan. These characteristics include soil, topography, floodplains, and land use.

Chapter 3 – System Performance and Design Criteria. This chapter presents the City's planning and design criteria that were used for evaluating hydrologic and hydraulic systems within the City's drainage watershed.

Chapter 4 – Existing Facilities Model Development. This chapter defines the hydrologic delineation of storm drainage basins, routing to their respective receiving facilities, and includes the hydrologic model development. Additionally, this chapter includes an overview of the storm drainage system, and the model development.

Chapter 5 –Evaluation and Proposed Improvements. This chapter presents a summary of the storm drainage system evaluation and identifies improvements needed to mitigate existing deficiencies as well as improvements needed to expand the system and service future growth.

Chapter 6 – Capital Improvement Program. This chapter provides a summary of the recommended storm drainage system improvements intended to mitigate existing capacity deficiencies and for accommodating anticipated future growth. The chapter also presents the cost criteria and methodologies for developing the Capital Improvement Program (CIP).

1.7 ACKNOWLEDGEMENTS

Obtaining the necessary information to successfully complete the analysis presented in this report, and developing the long term strategy for mitigating the existing system deficiencies and for accommodating future growth, was accomplished with the strong commitment and very active input from dedicated team members including:

- Lou Camara, Director of Public Works
- John Doyel, Director of Public Utilities / City Engineer
- Darlene Mata, Community Development Director

- Mike Cosenza, Utilities Superintendent
- QK Inc, General Plan Consultant
- John Zumwalt, City of Hanford Consultant

This report was prepared in conjunction with the General Plan Update, and included coordination with QK and John Zumwalt, who were the General Plan consultants.

As part of the preparation of this Storm Drainage System Master Plan, Hydmet provided hydrological and meteorological planning services to the City and Akel Engineering Group. Hydmet was a valuable partner in the development of this master plan.

1.8 UNIT CONVERSIONS AND ABBREVIATIONS

Engineering units were used in reporting flow rates and volumes pertaining to the design and operation of various components of the storm drainage system. Where it was necessary to report values in smaller or larger quantities, different sets of units were used to describe the same parameter.

Values reported in one set of units can be converted to another set of units by applying a multiplication factor. A list of multiplication factors for units used in this report is shown on **Table 1.1**.

Various abbreviations and acronyms were also used in this report to represent relevant stormwater system terminologies and engineering units. A list of abbreviations and acronyms is included in **Table 1.2**.

1.9 GEOGRAPHIC INFORMATION SYSTEMS

This master planning effort made use of Geographic Information Systems (GIS) technology, for completing the following tasks:

- Delineate stormwater tributary basins, and outlining watershed areas.
- Delineate critical pipeline and retention basin infrastructure
- Generate maps and exhibits used in this master plan.

Table 1.1 Unit Conversions

Storm Drainage System Master Plan
City of Hanford

Volume Unit Calculations		
To Convert From:	**To:**	**Multiply by:**
acre feet	gallons	325,851
acre feet	cubic feet	43,560
acre feet	million gallons	0.3259
cubic feet	gallons	7.481
cubic feet	acre feet	2.296×10^{-5}
cubic feet	million gallons	7.481×10^{-6}
gallons	cubic feet	0.1337
gallons	acre feet	3.069×10^{-6}
gallons	million gallons	1×10^{-6}
million gallons	gallons	1,000,000
million gallons	cubic feet	133,672
million gallons	acre feet	3.069

Flow Rate Calculations		
To Convert From:	**To:**	**Multiply By:**
ac-ft/yr	mgd	8.93×10^{-4}
ac-ft/yr	cfs	1.381×10^{-3}
ac-ft/yr	gpm	0.621
ac-ft/yr	gpd	892.7
cfs	mgd	0.646
cfs	gpm	448.8
cfs	ac-ft/yr	724
cfs	gpd	646,300
gpd	mgd	1×10^{-6}
gpd	cfs	1.547×10^{-6}
gpd	gpm	6.944×10^{-4}
gpd	ac-ft/yr	1.12×10^{-3}
gpm	mgd	1.44×10^{-3}
gpm	cfs	2.228×10^{-3}
gpm	ac-ft/yr	1.61
gpm	gpd	1,440
mgd	cfs	1.547
mgd	gpm	694.4
mgd	ac-ft/yr	1,120
mgd	gpd	1,000,000

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3/28/2016

Table 1.2 Abbreviations and Acronyms
Storm Drainage System Master Plan
City of Hanford

Abbreviation	Expansion	Abbreviation	Expansion
AACE International	Association for the Advancement of Cost Engineering	gpd	gallons per day
AC	acre	GPS	Global Positioning System
ACP	Asbestos Cement Pipe	HEC	Hydrologic Engineering Center
AF	Acre Feet	HEC-HMS	Hydrologic Engineering Center - Hydrologic Modeling System
Akel	Akel Engineering Group, Inc.	in	inch
City	City of Hanford	KCWD	Kings County Water District
CCI	Construction Cost Index	LF	linear feet
cfs	cubic feet per second	MG	million gallons
CIP	Capital Improvement Program	MGD	million gallons per day
County	County of Kings	mi	miles
CVRWQCB	Central Valley Regional Water Quality Control Board	NRCS	National Resource Conservation Service
DWR	Department of Water Resources	PAB	Planned Area Boundary
ENR	Engineering News Record	PDC	Peoples Ditch Company
EPA	Environmental Protection Agency	ROW	Right of Way
FEMA	Federal Emergency Management Agency	RWCQB	Regional Water Quality Contol Board
ft	feet	SCS	Soil Conservation Service
fps	feet per second	SWRCB	State Water Resources Control Board
GIS	Geographic Information Systems	TBD	to be determined
gpm	gallons per minute		

CHAPTER 2 – PLANNING AREA CHARACTERISTICS

This chapter presents a discussion of the planning area characteristics affecting the hydrologic and hydraulic analysis of this master plan. These characteristics include soil, topography, floodplains, and land use.

2.1 STUDY AREA DESCRIPTION

The City of Hanford is located in Kings County, approximately 30 miles southeast of the City of Fresno and 20 miles west of the City of Visalia (**Figure 2.1**). The City's closest neighbor, the City of Lemoore is located 8 miles to the west. Highway 198 bisects the southern boundary of the City in the east west direction, while Highway 43 is adjacent to the City's eastern boundary. In 2002, the City outlined the long-term Urban Growth Boundary (UGB), which was approved by City Council, and identified lands intended for future urbanization within the City Service area.

The City operates and maintains a storm drainage system that covers the majority of the area within the City limits. Currently, stormwater runoff discharges to detention basins and canals that are located throughout the City.

2.2 PLANNING AREA BOUNDARIES

The City's 2017 General Plan update designates two boundaries for defining urban expansion:

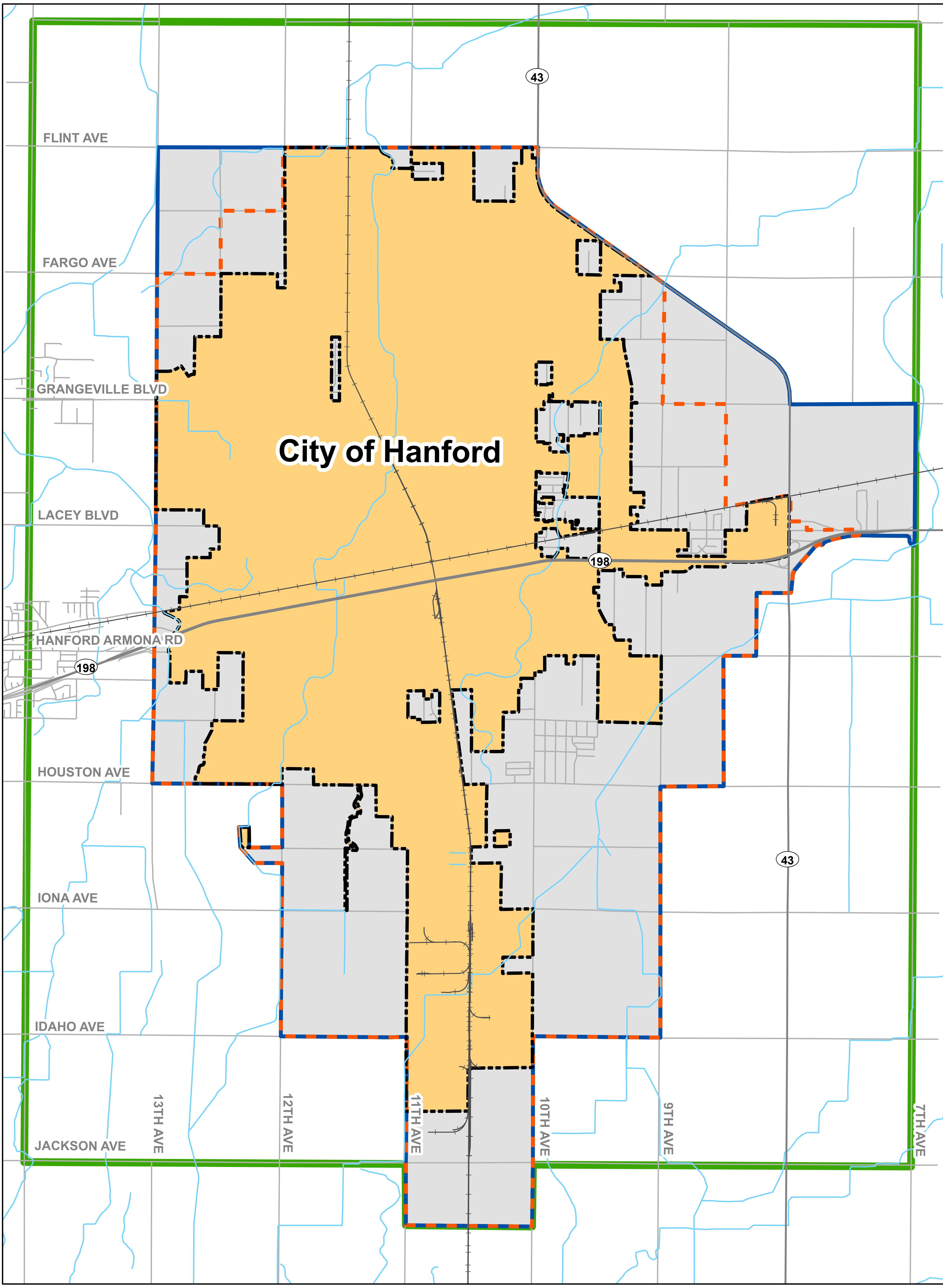
Planned Area Boundary: This boundary serves as the maximum extent of the area planned for urban development.

2035 Growth Boundary: This boundary serves as the extent of development with urban uses planned to occur during the 2015 to 2035 planning period.

It should be noted that for the purposes of this master plan, City Staff has requested improvements to be sized to account for the development of the Planned Area Boundary. Based on growth assumptions consistent with the 2017 General Plan Update, buildout of the Planned Area Boundary is not expected until approximately 2050.

2.3 WATERSHEDS AND DRAINAGE AREAS

The City of Hanford maintains a rich diversity of land use types, which contribute to a varying degree of stormwater runoff containment needs. Several creeks, a vast array of agricultural lands, small pockets of development, and the City itself comprises the wide array of runoff generation and conveyance within the Planned Area Boundary.



Legend

- Streets
- Waterways
- City Limits
- 2035 Growth Boundary
- Planned Area Boundary
- General Plan Study Area Boundary

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Update: September 1, 2016

0 0.25 0.5 1 Mile

N W E S

Figure 2.1
Planning Area

Storm Drainage System Master Plan
City of Hanford

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2.3.1 Watersheds

The City has four major watersheds within the Planned Area Boundary that collect and convey stormwater runoff within the City Planned Area Boundary. These watersheds were developed by the United States Department of Agriculture (USDA), and are as follows: Jacobs Slough, Sand Slough, Guernsey Slough, and Jacobs Ditch (**Figure 2.2**). The following are brief descriptions of the four watersheds:

- Jacobs Slough Watershed: The Jacob Slough Watershed is generally defined as the area between Last Chance Ditch to the west and Peoples Ditch to the east. The Jacob Slough watershed generally covers the western half of the City limits.
- Sand Slough Watershed: The Sand Slough Watershed is generally defined as the area between Peoples Ditch to the west and the Peoples Ditch East Branch to the east. The Sand Slough Watershed generally covers the eastern half of the City limits.
- Guernsey Slough Watershed: The Guernsey Slough Watershed is generally defined as the area between Peoples Ditch East Branch to the west and Lakeside Ditch East Branch to the east. The Guernsey Slough watershed covers outlying portions of the study area along the eastern boundary of the City limits.
- Jacobs Ditch Watershed: The Jacobs Ditch Watershed is generally defined as the area between the Lemoore Canal to the west and Lakeside Canal East Branch to the east. The Tulare Lake canal forms the southern boundary of this watershed. The Jacobs Ditch watershed covers outlying portions of the City along the southern boundary of the City limits.

2.3.2 Drainage Areas

While watersheds are typically comprised of smaller drainage basins defined by topographical features, the drainage areas in the City of Hanford, due to the generally flat topography, do not necessarily align with the NRCS defined watersheds. The City's storm drainage system consists of many complex systems, which divert, retain, and dispose of stormwater runoff through a series of conveyance networks. These networks have different means of disposing of stormwater runoff, such as outfalling to East Peoples Ditch, the Central Peoples Ditch, or diversion to detention facilities, which hold stormwater runoff during peak rainfall events before being conveyed to the canals and sloughs throughout the City. Drainage areas for the City are discussed in further detail in a later chapter.

2.4 FLOODPLAINS

Floodplains are important for delineating the extent of water-level rise during major floods. Typically, floodplains are estimated for the historic 100-Year and 500-Year flood. Most of the floodplains for the City are located along the Peoples Ditch and Central Peoples Ditch. The creeks and rivers in and around the City Planned Area Boundary are shown on **Figure 2.2**.

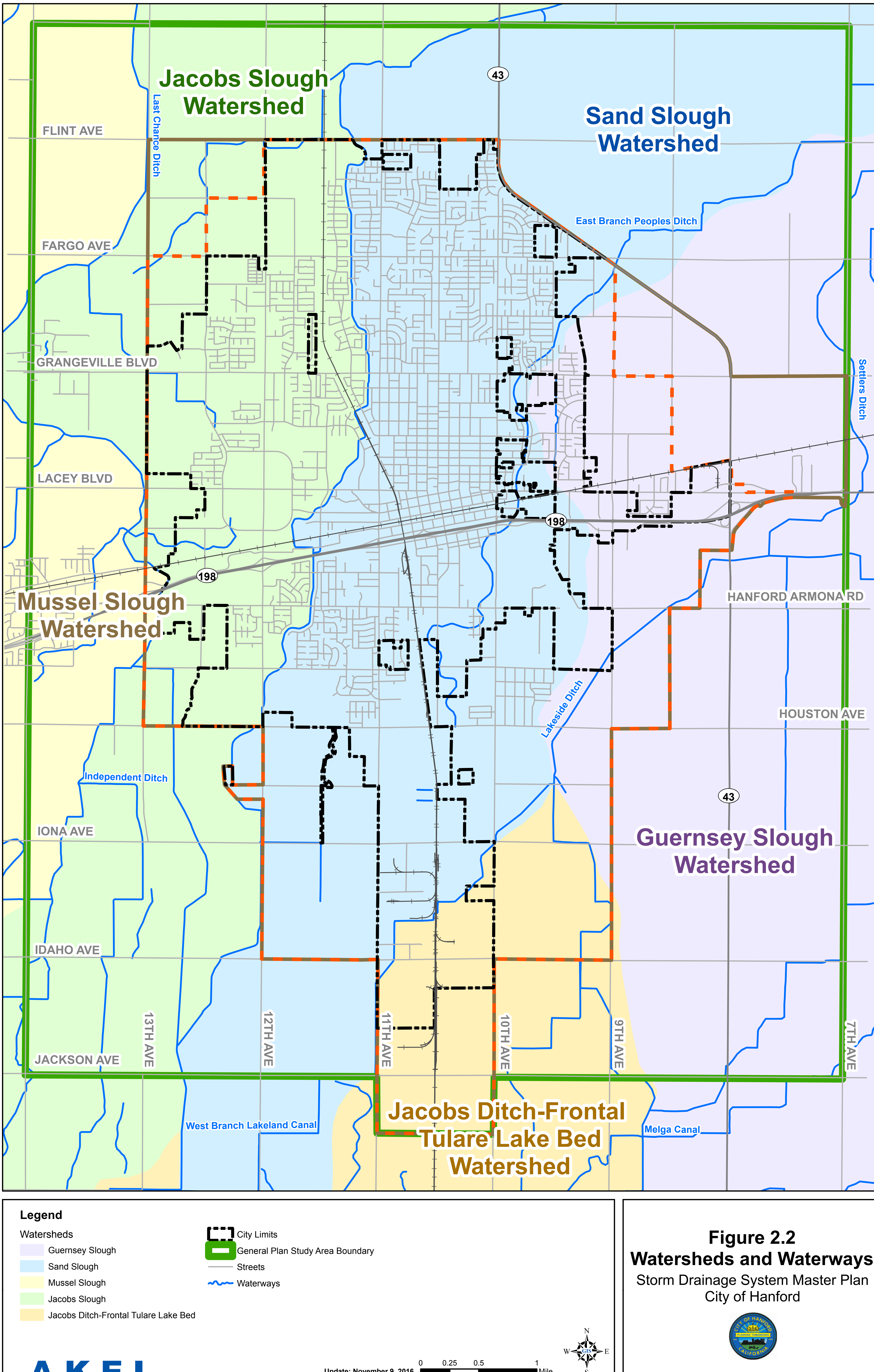


Figure 2.2
Watersheds and Waterways
Storm Drainage System Master Plan
City of Hanford

The Federal Emergency Management Agency (FEMA) produces Flood Insurance Rate Maps that show areas subject to flooding during major storm events. The flood risk information that is conveyed is based on historical data, including meteorological, hydrological, and hydraulic data for the specified area. The map creation is a result of the 1968 National Flood Insurance Program, aimed at reducing or preventing property owner losses due to flooding by allowing premiums to be paid for those in need of protection.

The flood boundaries for mapping purposes were not readily available in the development of this master plan; however, the National Flood Insurance Program has updated the flood mapping in June 2009, and mapping is available through FEMA.

2.5 EXISTING SERVICE AREA AND LAND USE

The City's water system services residential and non-residential lands within the City limits, as summarized on **Table 2.1**. This service area includes:

- 6,059 net acres of developed lands inside the City limits.
- 2,765 net acres of undeveloped lands inside the City limits.
- 265 net acres of underutilized lands inside the City limits that are expected to redevelop.

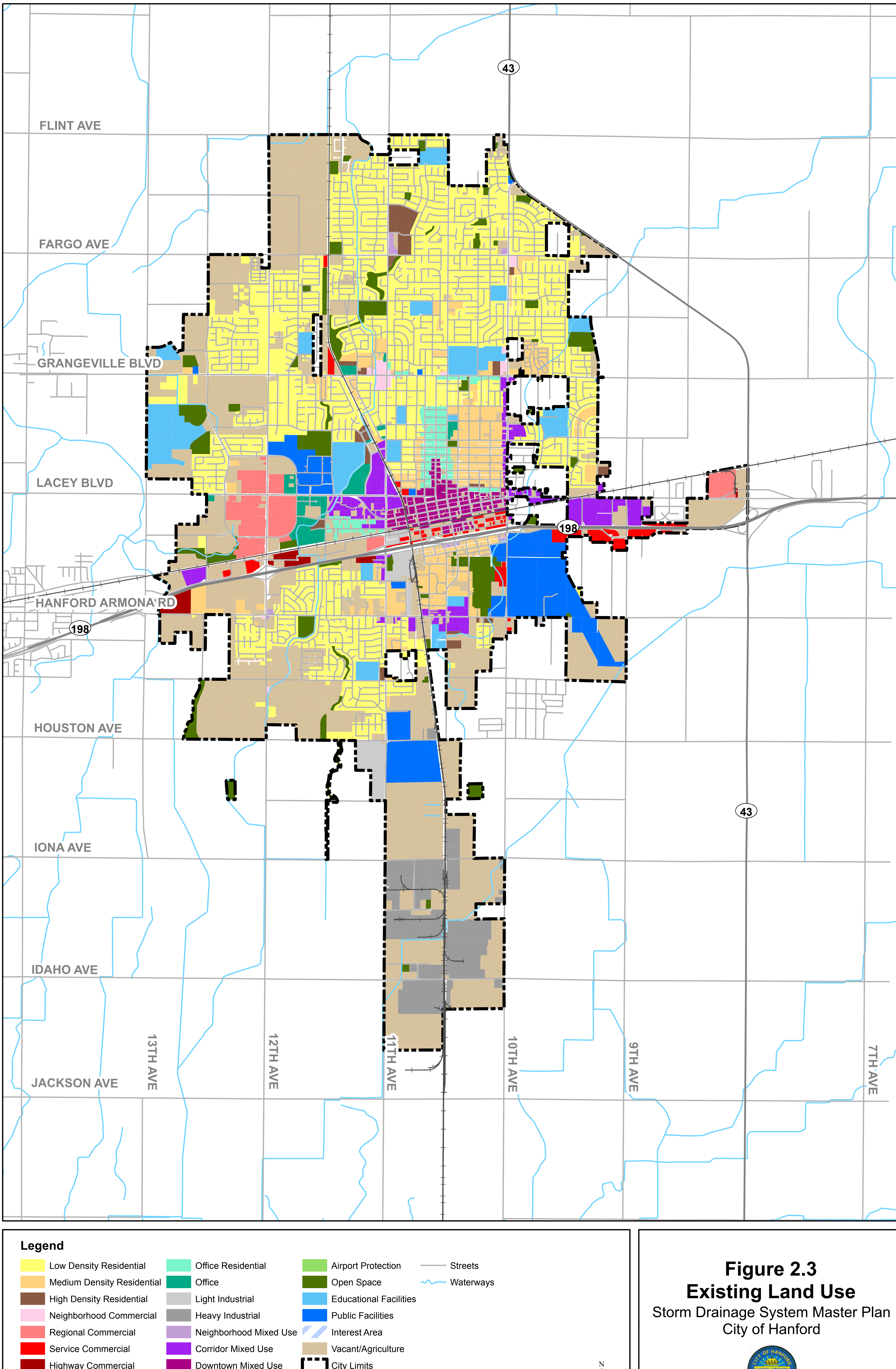
The existing land use statistics were based on the land use information provided by the consulting firm Quad Knopf (QK), which is summarized on **Figure 2.3**. The land use information provided included developed and undeveloped areas, which were classified into the following subtypes:

- Net Area. Net areas are typically fully developed, and exclude street and other associated right of ways.
- Gross Area. Gross areas are typically large undeveloped parcels, which may be subdivided in future developments. Part of these areas will include street and other right of ways.

For the purpose of this master plan, existing and future land use was consolidated into net acres. In order to convert the areas that were identified as gross areas to net areas, the following reduction factors were applied:

- Single Family Residential land use types: 1 gross acre = 0.80 net acre
- Multi-Family Residential / Mixed Use land use types: 1 gross acre = 0.85 net acre
- Commercial / Industrial land use types: 1 gross acre = 0.90 net acre

The City's General Plan anticipates approximately 16,900 net acres of residential and non-residential development at ultimate buildout of the Planned Area Boundary. The land use designations utilized in this master plan are consistent with the Land Use Element of the City's General Plan, as shown on **Figure 2.4**.



Update: July 1, 2016

AKEL ENGINEERING GROUP, INC.

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Figure 2.3
Existing Land Use
Storm Drainage System Master Plan
City of Hanford

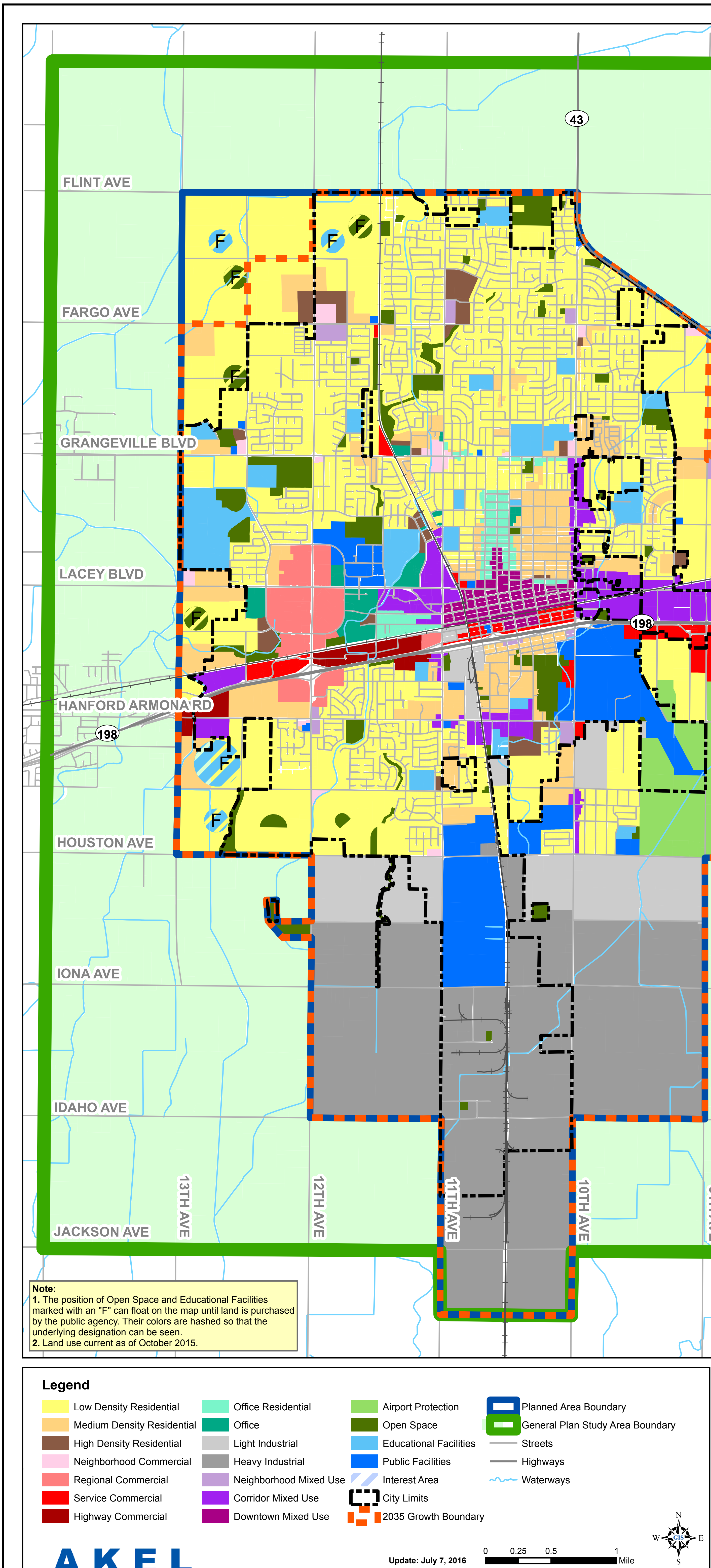

Figure 2.4
2035 General Plan Land Use
Storm Drainage System Master Plan
City of Hanford

Table 2.1 Existing and Future Development
Storm Drainage System Master Plan
City of Hanford

Land Use Classification	Existing Service Area				2035 Growth Boundary				Planned Area Boundary				Total in 2035 Growth Boundary	Total in Planned Area Boundary
	Developed (acres)	Undeveloped (acres)	Underutilized (acres)	*Subtotal* (acres)	Developed (acres)	Undeveloped (acres)	Underutilized (acres)	*Subtotal* (acres)	Developed (acres)	Undeveloped (acres)	Underutilized (acres)	*Subtotal* (acres)	(net acres)	(net acres)
Residential														
Low Density	2,837	991	35	3,863	476	790	82	1,348	63	529	0	592	5,211	5,804
Medium Density	498	220	5	723	35	215	21	271	0	72	4	76	994	1,070
High Density	84	65	8	158	0	38	0	38	0	26	0	26	196	222
Subtotal - Residential	3,419	1,276	48	4,744	511	1,043	103	1,657	63	627	4	694	6,401	7,095
Mixed Use														
Office Residential	89	20	5	114	0	0	0	0	0	0	0	0	114	114
Neighborhood Mixed Use	12	42	0	54	0	15	0	15	0	0	0	0	70	70
Corridor Mixed Use	250	139	86	476	10	3	0	13	0	0	0	0	489	489
Downtown Mixed Use	81	15	28	123	0	0	0	0	0	0	0	0	123	123
Subtotal - Mixed Use	432	216	119	767	10	18	0	29	0	0	0	0	795	795
Non-Residential														
Neighborhood Commercial	27	26	0	53	8	11	1	20	0	0	0	0	73	73
Regional Commercial	216	154	6	376	0	0	0	0	18	163	6	188	376	564
Service Commercial	103	47	7	156	56	63	0	119	0	0	0	0	275	275
Highway Commercial	48	68	0	115	16	4	12	32	0	0	0	0	147	147
Office	88	30	1	119	0	0	0	0	0	0	0	0	119	119
Light Industrial	105	20	40	166	83	520	36	640	0	0	0	0	806	806
Heavy Industrial	376	535	33	943	211	2,380	227	2,817	0	0	0	0	3,761	3,761
Airport Protection	0	125	0	125	111	501	63	674	0	0	0	0	799	799
Educational Facilities	445	110	7	562	11	17	0	28	0	80	0	80	590	669
Public Facliities	438	56	0	494	3	13	0	16	0	0	0	0	510	510
Open Space	362	105	4	471	41	159	0	200	0	17	0	17	671	688
Open Space with Irrigation	16	41	4		0	105	0		0	17	0			
Open Space without Irrigation	346	65	0		41	54	0		0	0	0			
Interest Area	0	0	0	0	0	0	0	0	49	509	43	601	0	601
Subtotal - Non-Residential	2,208	1,274	98	3,580	539	3,668	340	4,547	68	769	49	886	8,127	9,012
Total														
	6,059	2,765	265	9,090	1,060	4,729	443	6,233	131	1,396	53	1,580	**15,323**	**16,903**

CHAPTER 3 – SYSTEM PERFORMANCE AND DESIGN CRITERIA

This chapter presents the City's planning and design criteria that were used for evaluating hydrologic and hydraulic systems within the City's drainage watershed.

3.1 HYDROLOGIC CRITERIA

Hydrologic criteria are developed to characterize the flood routing of rainfall runoff in a defined drainage system. Akel Engineering Group retained the services of Hydmet Inc. to complete the hydrologic evaluation of this project. This section discusses the precipitation characteristics, the design storms used in this master plan, and soil imperviousness.

3.1.1 Precipitation Characteristics

A dominating factor in the generation of rainfall in California, including the Central California interior and the City, is the oscillation of the semi-permanent high pressure area of the north Pacific Ocean. This high pressure center moves north in the summer and south in the winter, adjusting the flow of moisture into California. In the winter, when the high pressure center is south, moisture can move south and bring widespread rainfall.

In certain instances when circulation patterns allow for subtropical moisture to enter California from a southwesterly direction, rainfall amounts can be quite heavy, and can result in widespread flooding. The City receives an average 8.3 inches of total precipitation per year. The City's wet weather season typically starts in November and ends in April.

3.1.2 Design Storms

Design storms are typically defined by three important features: depth, duration and frequency.

- **Depth.** The depth of the storm identifies the amount of precipitation occurring during a specific time interval.
- **Duration.** The duration of the storm identifies how long it lasted. The 1995 Storm Drainage System Master Plan recommended two different design storms for evaluation of conveyance facilities, a design storm for evaluation of detention basins, and additional storm duration for evaluation of retention facilities.

  Design storm durations for the City are listed as follows:

  - **24-Hour Storm**, which is used to represent a typical rainfall event for the City. This storm is used for evaluating conveyance facilities.

  - **2-Day Storm**, which is used as a means for evaluating the performance of detention facilities in the City, and the response to prolonged periods of precipitation.
  - **10-Day Storm**, which is used as a means for evaluating the performance of retention facilities in the City, and the response to prolonged periods of precipitation.
  - **30-Day Storm**, which is used as a means for evaluating the structural integrity of retention facilities in the City, and the response to prolonged periods of precipitation.
- **Frequency.** The frequency of the storm is the recurrence interval at which the storm may occur at a given area.

This master plan includes the precipitation depth-duration-frequency table as provided in NOAA Atlas 14 Volume 6 Version 2 (**Table 3.1**). The depth-duration-frequency values reflect rainfall events specific to the City and lists precipitations, in inches and inches per hour, for return intervals up to 100 years.

The design storms used in this evaluation, and which are specific to the City, are listed on **Table 3.2**. The values used in evaluating the storm drainage system are as follows:

- **2-year 6-hour.** This design storm is used to evaluate existing residential drainage facilities as well as to size future ones. This storm was quantified at 0.68 inches in the analysis specific to the City of Hanford.
- **5-year 6-hour.** This design storm is used to evaluate existing commercial drainage facilities, as well as size future ones. This storm was quantified at 0.86 inches in the analysis specific to the City of Hanford.
- **100-year 2-day.** This design storm is used to evaluate existing and future detention basins. This storm was quantified at 4.00 inches in the analysis specific to the City of Hanford.
- **100-year 10-day.** This design storm is used to evaluate existing retention basins and size future ones. This storm was quantified at 5.69 inches in the analysis specific to the City of Hanford.
- **100-year 30-day.** This design storm is used to evaluate the ability of existing and future retention and detention basins to mitigate development flooding. This storm was quantified at 8.48 inches in the analysis specific to the City of Hanford.

Table 3.1 Precipitation Depth-Duration-Frequency Data

Storm Drainage System Master Plan

City of Hanford

Duration	2-Year		5-Year		10-Year		100-Year	
	(in)	(in/hr)	(in)	(in/hr)	(in)	(in/hr)	(in)	(in/hr)
5 min	0.08	0.96	0.10	1.20	0.13	1.56	0.23	2.76
10 min	0.12	0.72	0.15	0.90	0.18	1.08	0.34	2.04
15 min	0.14	0.56	0.18	0.72	0.22	0.88	0.41	1.64
30 min	0.20	0.40	0.25	0.50	0.30	0.60	0.56	1.12
1 hr	0.27	0.27	0.34	0.34	0.42	0.42	0.78	0.78
2 hr	0.40	0.20	0.50	0.25	0.59	0.30	1.02	0.51
3 hr	0.49	0.16	0.62	0.21	0.73	0.24	1.22	0.41
6 hr	**0.68**	**0.11**	**0.86**	**0.14**	1.02	0.17	1.64	0.27
12 hr	0.92	0.08	1.21	0.10	1.45	0.12	2.29	0.19
24 hr	1.22	0.05	1.66	0.07	2.02	0.08	3.19	0.13
2 day	1.50	0.03	2.06	0.04	2.50	0.05	**4.00**	**0.08**
10 day	2.22	0.01	2.89	0.01	3.46	0.01	**5.69**	**0.02**
30 day	3.27	0.01	4.26	0.01	5.12	0.01	**8.48**	**0.01**

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3/28/2016

Note:

1. Source: NOAA Atlas 14 Volume 6 version 2 for station "HANFORD 1 S".

Table 3.2 Relevant Design Storms

Storm Drainage System Master Plan
City of Hanford

Design Criteria[1]	Design Storm
2 year - 6 hour	Used to evaluate existing and size future residential drainage facilities. Quantified at 0.68 inches.
5 year - 6 hour	Used to evaluate existing and size future commercial drainage facilities. Quantified at 0.86 inches.
100 year - 2 day	Used to evaulate existing and future detention basins. Quantified at 4.00 inches.
100 year - 10 day	Used to evaluate existing and future retention basins. Quantified at 5.69 inches.
100 year - 30 day	Used to evaluate potential structural damage to retention basins due to floodwater accumulation. Quantified at 8.48 inches.

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Note:

1. Source: City of Hanford 1995 Storm Drainage System Master Plan

3.1.3 Soil Imperviousness

In determining the quantity of rainfall runoff generated from a given land use type, three factors dictate the volume of water that enters the storm drainage system: effective imperviousness, ineffective imperviousness, and effective pervious area.

- **Effective Impervious.** An effective impervious area is the percentage of impervious area that generates stormwater runoff entering the storm drainage system. The effective impervious percentages are based on land uses identified in the General Plan, and are included in **Table 3.3** It should be noted that the effective percent-impervious values have been increased from the 1995 SDMP for consistency with current City landscaping practices.

- **Ineffective Impervious.** An ineffective impervious area is land that has no flow path, or the flow path results in delayed timing of the runoff, to the storm drainage system. These areas are typically noted as residential backyards, pools, or dense shrub landscaping.

- **Effective Pervious.** Effective pervious areas contribute to runoff based on the National Resource Conservation Service (NRCS) Soil Classification Group, and the subsequent SCS Curve Number.

3.2 HYDRAULIC CRITERIA

The hydraulic criteria for the storm drainage system were used to evaluate the capacity requirements of conveyance facilities, retention basins, and pump stations.

3.2.1 Gravity Conveyance Facilities

Gravity pipeline capacities depend on several factors including: material and roughness of the pipe, the limiting velocity and slope, and the maximum allowable depth of flow. The hydraulic modeling software used for evaluating the capacity adequacy of the City storm drainage system was based on the Hydrologic Engineering Center Flood Hydrograph Package (HEC-1). This software incorporates hydrologic routing tools for overland flow, precipitation, and Manning's Equation to simulate pipe flow.

Storm Hydraulic Design

The City's storm drainage system was evaluated using a 5-year 6-hour design storm for pipelines conveying runoff from non-residential land use, and using a 2-year 6-hour design storm for pipelines conveying only residential runoff (**Table 3.4**). In future development areas planned to contain both residential and non-residential land use types, the 5-year 6-hour design storm was used for evaluation and the sizing of improvements. During the hydraulic analysis of the 100-year 30-day design storm, City streets were sometimes allowed to flood to provide reasonable conveyance and storage capacity, thus reducing additional costly improvements.

Table 3.3 Effective Percent Imperviousness and Infiltration Losses

Storm Drainage System Master Plan
City of Hanford

Land Use Classification	Effective Imperviousness (%)	Const. Loss (in/hr)
Residential[1]		
Low Density	50	0.4
Medium Density	55	0.3
High Density	60	0.3
Mixed Use		
Office Residential	60	0.3
Neighborhood Mixed Use	60	0.3
Corridor Mixed Use	60	0.3
Downtown Mixed Use	70	0.3
Non-Residential		
Neighborhood Commercial	90	0.2
Regional Commercial	90	0.2
Service Commercial	90	0.2
Highway Commercial	90	0.2
Office	90	0.3
Light Industrial	80	0.2
Heavy Industrial	80	0.2
Airport Protection	10	0.5
Educational Facilities	70	0.3
Public Facliities	70	0.3
Open Space	10	0.5
Interest Area	90	0.2

Table 3.4 Hydrologic and Hydraulic Design Criteria

Storm Drainage System Master Plan
City of Hanford

Hydrology and Hydraulics Design Criteria	
Ponding Basins (Existing and Future)	
Design Storm	
Detention	**100 year - 2 day**
Retention	**100 year - 10 day**
Flooding for Developments	All Basins: Development pad elevations shall be designed to mitigate flood damage from a **100 year - 30 day** event. Allowable flooding up to 1.5 feet above the gutter flowline.
Retention	Existing/Future: Responsible for full retention of design storm. No flooding of street during design storm.
Detention	Existing/Future: Responsible for full detention of design storm. No flooding in streets during design storm. Discharge to ditch or other drainage facility upon approval of City engineer.
Pipelines	
Design Storm	Residential: **2 year - 6 hour** Commercial: **5 year - 6 hour**
Street Flooding	Existing: Allowable flooding up to 1.5 feet above the gutter flowline Future: No flooding in streets during design storm
Minimum Pipe Size	12 inches
Pump Stations	
Detention Pumps	Sizing requirements based on emptying detention basin in 5 to 7 days for the design storm
Direct Discharge Pumps	Sizing requirements based on design flow, with allowable flooding of up to 1.5 feet above the gutter flowline at the lowest system elevation

Manning's Equation for Pipe Capacity

The Continuity Equation and the Manning's Equation for steady-state flow are used for calculating pipe capacities in open channel flow. Open channel flow can consist of either open conduits or, in the case of gravity pipelines, partially full closed conduits. Gravity full flow occurs when the conduit is flowing full but has not reached a pressure condition.

- Continuity Equation: $Q = V A$

  Where:
  Q = peak flow, in cubic feet per second (cfs)
  V = velocity, in feet per second (fps)
  A = cross-sectional area of pipe, in square feet (sq. ft.)

- Manning Equation: $V = (1.486 R^{2/3} S^{1/2})/n$

  Where:
  V = velocity, in feet per second (fps)
  n = Manning's roughness coefficient
  R = hydraulic radius, area divided by wetted perimeter (ft)
  S = slope of pipe, in feet per foot (ft/ft)

Manning's Roughness Coefficient (n)

The Manning Roughness Coefficient 'n' is a friction coefficient that is used in the Manning formula for flow calculation in open channel flow. In conveyance systems, the coefficient can vary between 0.011 and 0.017 depending on pipe material, size of pipe, depth of flow, root intrusion, smoothness of joints, and other factors.

For the purpose of this evaluation, an "n" value of 0.013 was used for both existing and proposed gravity pipes.

3.2.2 Retention and Detention Basins

The capacities of existing detention basins were evaluated to meet the runoff requirements of a 100-year 2-day design storm, while the retention basins were evaluated to meet the requirements of the 100-year 10-day storm event. The 100-year 30-day storm was used to evaluate the potential for structural damage to homes and businesses. The criterion does not allow for percolation during these storm events.

3.2.3 Pump Stations

Pump stations were sized to empty basin volume in five to seven days following the 100-year 2-day design storm. Pump station sizing requirements may be reduced based on available sump storage at the pump station. It should be noted that under normal operating conditions, pump stations should include a contingency for having the equivalent of the largest capacity pump out of service as a standby. During the 100-year storm, the standby contingency is waived.

3.3 LAND DEVELOPMENT REVIEW

For the purposes of evaluating land development, and as the hydrological models may not be available for all developments, it is recommended that the following steps be taken to evaluate system impacts:

Step 1. Evaluate the land use for consistency with the General Plan land use incorporated in this Master Plan evaluation.

- If the Land Use is consistent. If the land use is consistent with the General Plan, see step 2.
- If the Land Use is different. As part of the General Plan Amendment, a hydrologic and hydraulic evaluation should be completed by the developer's engineer, and confirmed through the use of the City's hydrology models by City staff or preferred other.

Step 2. Confirm that development engineering evaluation has used Effective Percent Impervious and Rainfall values consistent with the Design Criteria of this Master Plan. If the Soil Conservation Service method is used for evaluation, also check the consistency of the Constant Loss values. It is preferred that, unless there is a site-specific soil study, a "D" soil should be used in evaluations.

Step 3. Complete the evaluation using a City-preferred hydrologic routing method. Please note that all evaluations are subject to the approval of the City Engineer.

CHAPTER 4 – EXISTING FACILITIES AND MODEL DEVELOPMENT

This chapter defines the hydrologic delineation of storm drainage basins, routing to their respective receiving facilities, and includes the hydrologic model development. Additionally, this chapter includes an overview of the storm drainage system, and the model development.

4.1 HYDROLOGIC SYSTEM OVERVIEW

Factors critical to the hydrologic model development include watersheds, drainage basins within each watershed, overland flow routing within drainage subbasins, and conveyance that makes full use of pipes as well as streets for routing 100-year design storm events. This section discusses the existing watersheds, and the delineation of drainage basins and subbasins.

4.1.1 Watersheds

Watersheds within the City Planned Area Boundary and outlying areas were defined based on the receiving tributary creek or river system, with topographical or physical barriers dictating the limits of the watershed. The City has four major watersheds within the Planned Area Boundary that collect and convey stormwater runoff. These watersheds were developed by the United States Department of Agriculture (USDA), and are as follows: Jacobs Slough, Sand Slough, Guernsey Slough, and Jacobs Ditch (**Figure 2.2**).

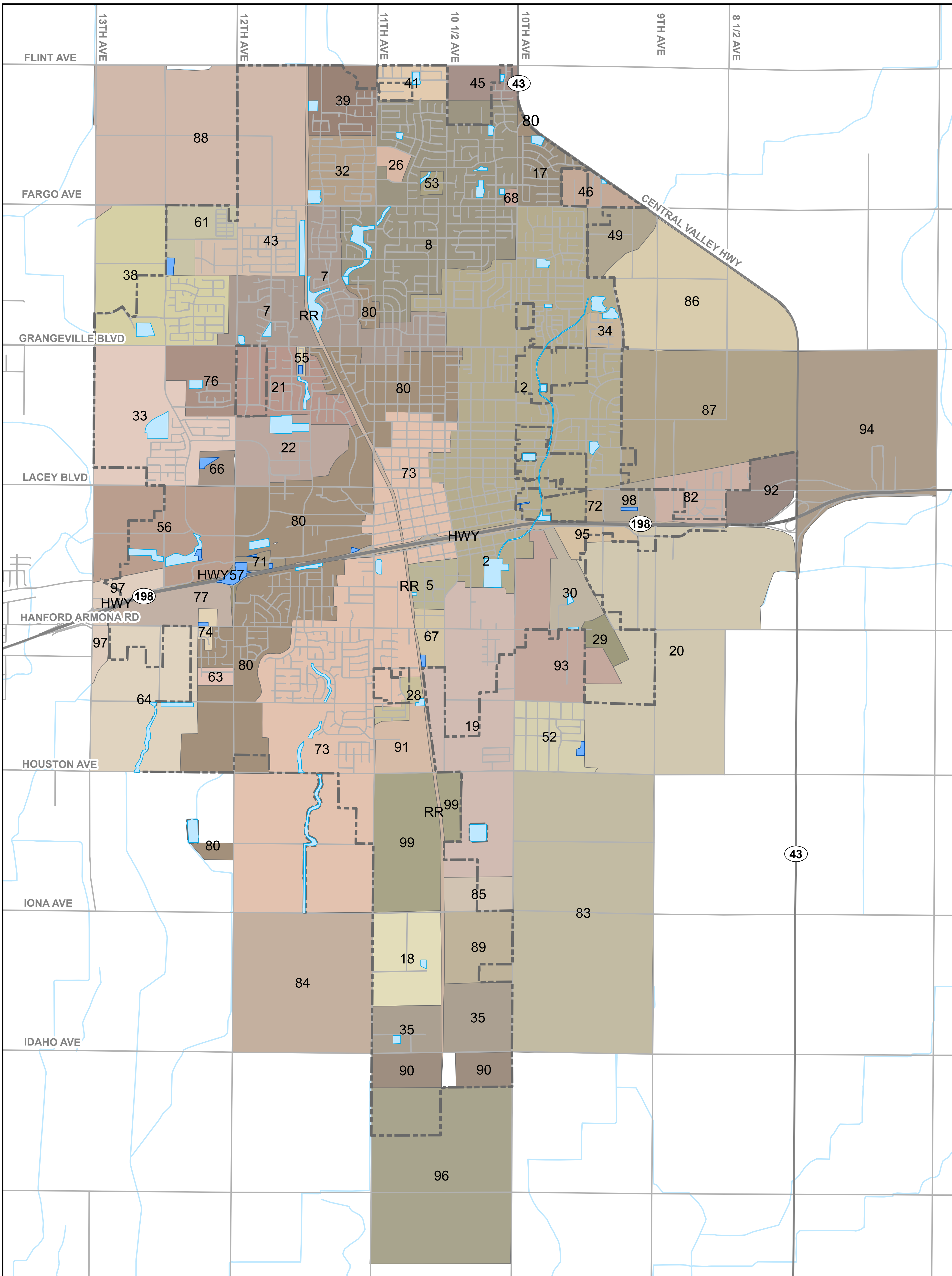
4.1.2 Drainage Basins

Drainage basins are typically defined by existing or natural conveyance systems within each watershed. As the City has a relatively flat topography, drainage basin boundaries are largely dictated by street drainage and existing facilities that convey stormwater to a set discharge, and may not coincide with the delineation of watershed boundaries. Drainage basins in the City may discharge to retention basins, pump stations, or direct outfalls to canals and sloughs located throughout the City.

Each drainage basin was assigned a uniquely coded identifier intended for cross referencing purposes. The coded identifier reflects the name of the receiving water body or storm drainage infrastructure that receives the stormwater. This project divided the City into approximately 60 drainage basins shown on **Figure 4.1**.

4.1.3 Drainage Subbasins

Each basin shown on **Figure 4.1** was further divided into smaller subbasins for the purpose of routing hydrologic stormwater flows as the connectivity within each drainage basin is very critical for accurate analysis. These individual subbasins are documented on **Figure 4.2**.



Legend

- Drainage Systems
- City Storm Basins
- Private Storm Basins
- City Limits
- Streets
- Waterways

Figure 4.1
Existing Storm Drainage Systems

Storm Drainage System Master Plan
City of Hanford

Update: September 6, 2016

0 0.25 0.5 1 Mile

N S E W

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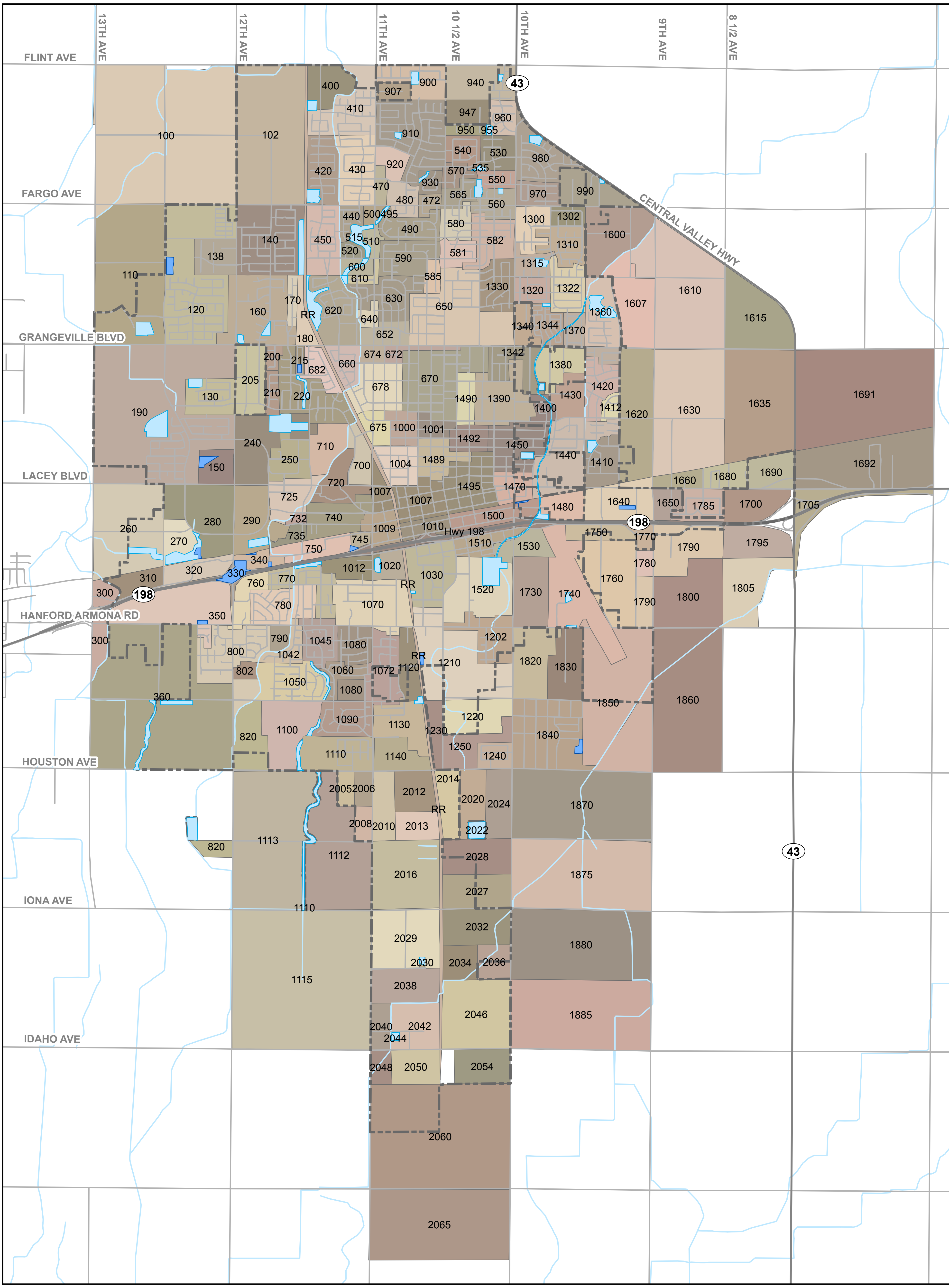

Legend

- Drainage Subbasins
- City Storm Basins
- Private Storm Basins
- City Limits
- Streets
- Waterways

0 0.25 0.5 1 Mile

Update: September 6, 2016

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Figure 4.2 Existing Storm Drainage Subbasins

Storm Drainage System Master Plan
City of Hanford

Each individual subbasin included hydrologic and hydraulic modeling information to address Overland Flow Routing and Combined Pipe Street Conveyance.

- **Overland Flow Routing.** This element consists of routing rainfall runoff to the stormwater conveyance system. Overland flow routing is dependent on land use and physical barriers blocking the flow paths within the drainage basins. In this analysis, the Kinematic Wave Equation was used to calculate overland flow, and was built into the developed hydrology model.

- **Combined Pipe Street Conveyance.** During typical storm events, streets are used to convey rainfall runoff from house gutters to nearest catchments where it enters the storm collection system.

4.2 HYDRAULIC SYSTEM OVERVIEW

The City's storm drainage system includes conveyance facilities, outfalls, pump stations, and retention basins. This section discusses the components of the storm drainage system.

4.2.1 Conveyance System

The modeled storm drainage system includes approximately 65 miles of stormwater conveyance to local retention systems or ditches (**Table 4.1**). Pipe sizes range from 8-inches to 60-inches in diameter, and are shown on **Figure 4.3**. The storm conveyance system is predominantly composed of 12-, 15-, and 18-inch pipelines.

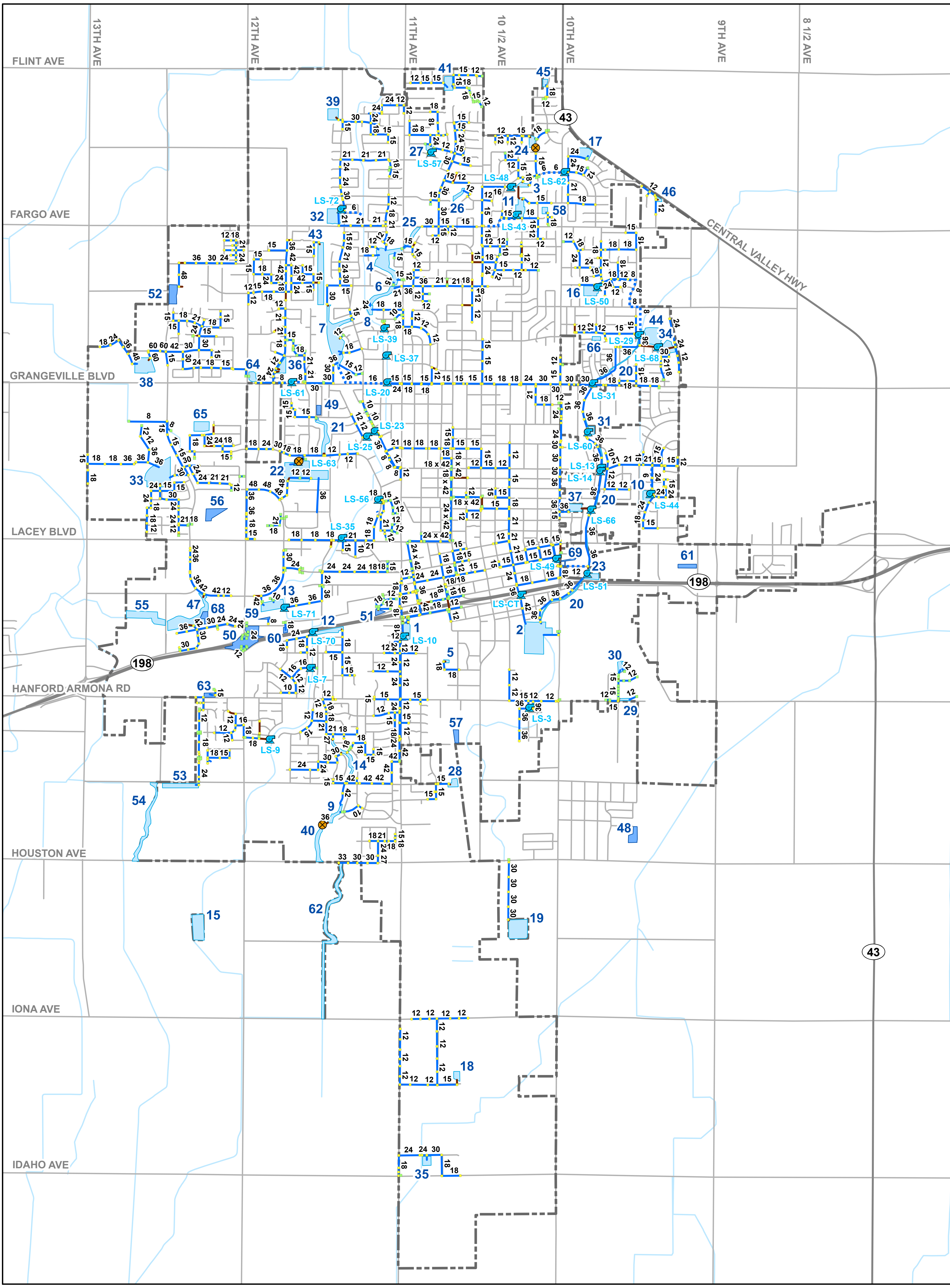
4.2.2 Detention and Retention Basins

The City currently operates approximately 60 detention and retention basins. These facilities include slough remnants, which are identified on **Figure 4.4**. The other basins located within the existing service area are man-made detention and retention facilities, and serve as dedicated stormwater receiving facilities, or dual-purpose park facilities, that are allowed to fill with excess stormwater runoff during the wet season. The stormwater receiving facilities are documented on **Figure 4.5**. These drainage basins range in size from approximately 3.5 acre-feet (AF) to 94 AF (**Table 4.2**).

4.2.3 Pump Stations

The City currently owns and operates 30 pump stations within the City limits (**Figure 4.3**). The pump stations vary in size and **Table 4.3** lists each individual pump station, including information regarding each pump station as provided by City staff.

The City's pump stations discharge to varying locations, which include canals, pipelines, and other conveyance facilities located throughout the City. **Figure 4.6** documents the existing storm drainage pump stations in the City's storm drainage system.



Legend

Existing System

- Lift Stations
- Valves
- Catch Basins
- Manholes
- Gravity Pipes
- Force Mains
- Unknown Pipe Size
- City Storm Basins
- Private Storm Basins
- City Limits
- Streets
- Waterways

Figure 4.3
Existing Storm Drainage System

Storm Drainage System Master Plan
City of Hanford

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0 0.25 0.5 1 Mile

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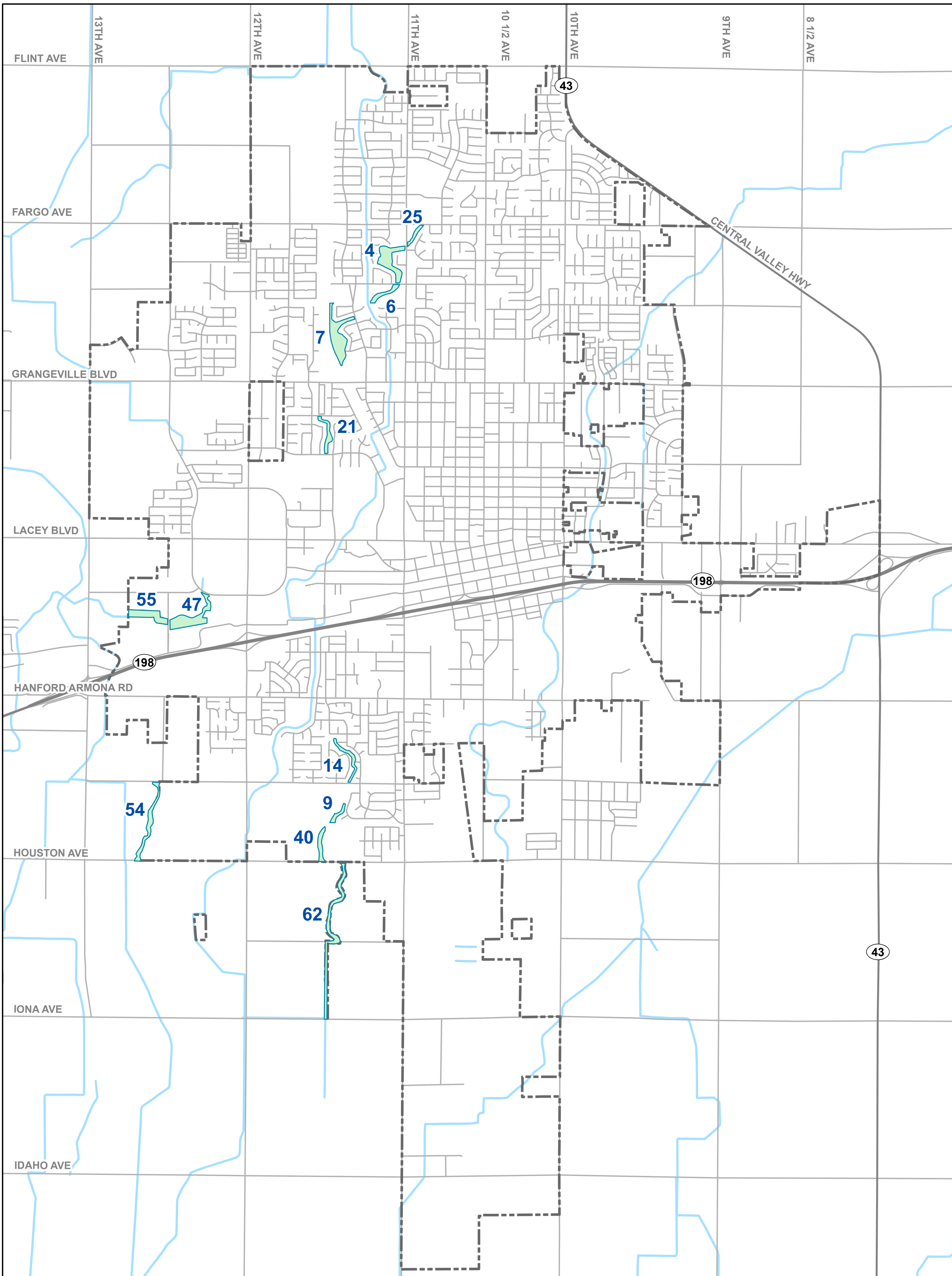

Legend

- Storm Sloughs
- Waterways
- Streets

Update: September 6, 2016

0 0.25 0.5 1 Mile

N W E S

Figure 4.4
Large Waterways

Storm Drainage System Master Plan
City of Hanford

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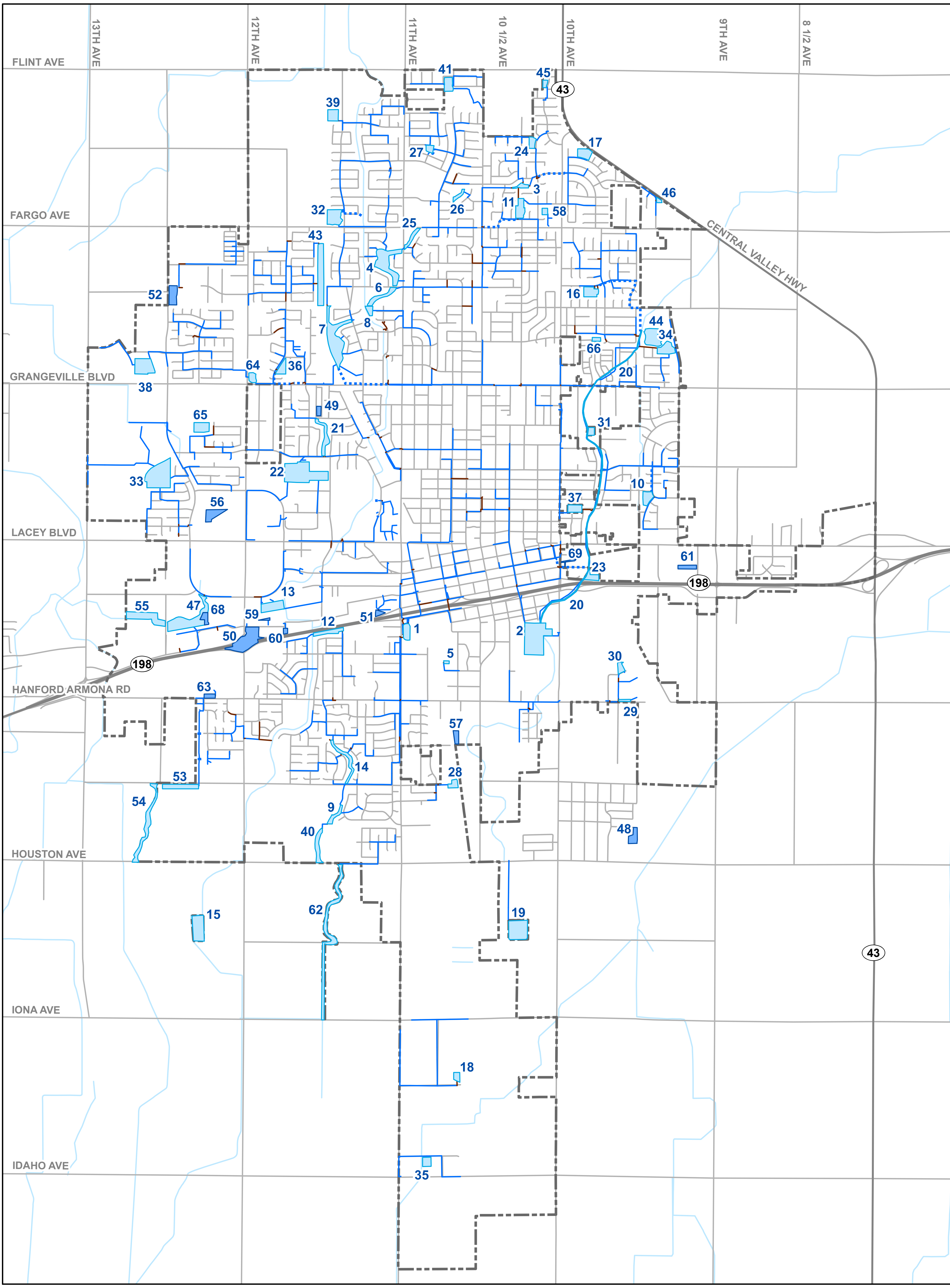

Legend

Gravity Pipes	City Storm Basins
Force Mains	Private Storm Basins
Unknown Pipe Size	City Limits
Streets	Waterways

Figure 4.5 Existing Storm Basins

Storm Drainage System Master Plan
City of Hanford

Update: September 6, 2016

0 0.25 0.5 1 Mile

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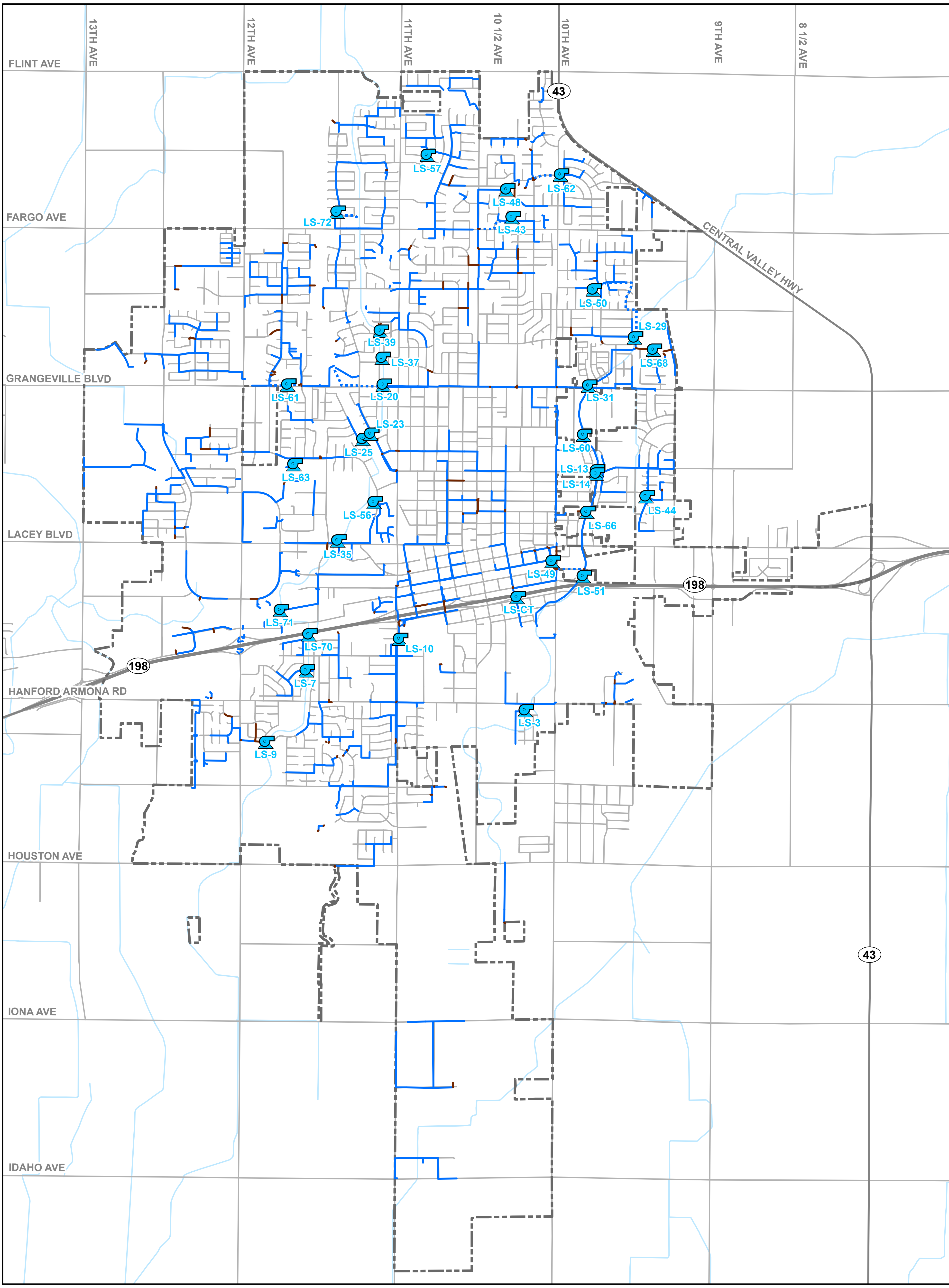

Legend

- Lift Stations
- Gravity Pipes
- Force Mains
- Unknown Pipe Size
- City Limits
- Streets
- Waterways

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Update: September 6, 2016

0 0.25 0.5 1 Mile

N W E S

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Figure 4.6
Existing Lift Stations

Storm Drainage System Master Plan
City of Hanford

Table 4.1 Existing Modeled Pipe Inventory

Storm Drainage System Master Plan

City of Hanford

Size	Length	
(in)	(in)	(mi)
8	3,796	0.7
10	4,444	0.8
12	70,376	13.3
15	68,842	13.0
16	2,622	0.5
18	63,302	12.0
21	19,541	3.7
24	37,008	7.0
27	415	0.1
30	23,997	4.5
33	313	0.1
36	30,073	5.7
42	10,717	2.0
48	3,414	0.6
60	1,165	0.2
Unknown	7,099	1.3
Total	347,126	**65.7**

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3/30/2016

Table 4.2 Existing Drainage Basin Inventory
Storm Drainage System Master Plan
City of Hanford

Basin No.	Const. Date	Name	Location	Type	Capacity (AF)	Area (AC)	Comments
1	1967	Beacon Basin	Third St. and 11th Ave.	Excavated	21.1	3.7	Detention basin
2	1963/91	Brown St. Basin	First St. and Brown St.	Excavated	55.4	8.3	Retention basin
3	1961/90	Encore Basin	Encore Dr. and Caronette Ln.	Natural/Excavated	4.3	1.1	Detention basin
4	1968	Mussel Slough	Between Cortner St. and 11th Ave.	Natural	22.7	8.0	Detention slough (Weir structure required for storage indicated)
5 [3]	1969	Scott St. Basin	West end of Scott St. and S.F.R.R.	Excavated	7.2	1.1	Retention basin
6		Hidden Valley Park Basin	Between Cortner St. and Laura Ln. Basin	Natural	18.6	3.2	Detention slough (Weir structure required for storage indicated)
7	1993	Mussel Slough Basin	West of Peoples Ditch - behind YMCA	Excavated	92.7	16.4	Peoples Ditch Co. reserves 35 AF - Retention basin
8	1960	Laura Lane Basin	Laura Ln. at People's Ditch - south of Hidden Valley	Excavated	5.1	0.9	Retention basin
9	1958	Bonney View Slough	West side of Fern Dr. north of Evergreen Dr.	Natural	6.7	2.0	Detention Slough (vol. per 1984 S.D. Master Plan)
10	1980	Hye Park Basin	Myrtle St. and Connie St.	Excavated	8.0	2.6	Detention basin
11	1981	Redwood basin	Redwood St. and Kensington St.	Excavated	14.9	3.7	Detention basin
12	1984/93	Carraway Village Basin	North end of Kimball at Hwy 198	Excavated	9.5	2.6	Retention slough
13	1992	Hanson Basin	Hanford Mall (Behind Sequoia Inn)	Excavated	41.7	5.6	Retention basin
14	1993	Sand Slough Basin	N. of Hume Ave. between Echo and Butternut	Excavated	27.7	5.0	Detention basin
15	1990	Sanchez Basin (New Deal)	Southwest of Houston and 12th Ave, along People's Ditch	Excavated	41.0	8.2	Retention basin
16	1980	Lakewood Basin	Lakewood and Neil Way	Excavated	19.5	4.5	Detention basin
17	1994	Sherwood Basin	Sherwood Dr. and Pinecastle Dr.	Excavated	13.6	3.0	Retention basin
18	1974	Kings Industrial Park	Industry Ave. and S.F.R.R.	Excavated	5.3	1.6	Retention basin
19	1998	Houston Basin	2,000' south of Houston Ave. between 10th & 10 1/2 Ave.	Excavated	72.3	9.5	Retention basin
20		East Branch Ditch	Between Leland Ave. and Houston Ave.	Natural	50.0	9.1	Piped and open channel ditch combined (4.01 +/- miles)
21	1977	South Mussel Slough	Greenfield and Campus	Natural	8.4	4.0	Retention Slough (vol. per 1984 S.D. Master Plan)
22	1977/99	County Complex/YAC Basin	Greenfield and Princeton Ave.	Excavated	94.0	22.3	Retention basin (East basin property owned by county)
23	1989	Fifth St. Basin	Fifth St. east of 10th Ave.	Excavated	13.3	2.0	Detention basin
24	1990/94	Lone Oak Basin	Fairmont Dr. north of Sherwood Dr.	Excavated	5.6	1.7	Retention basin
25	1983	Mussel Slough (Behind Oakbridge Condos)	Between Fargo and 11th Ave.	Natural	12.3	2.3	Retention basin (vol. per 1984 S.D. Master Plan)
26	1978	Solar Est. Basin (Mussel Slough) Private	Sun / Star Estates	Natural	5.0	1.7	Privately owned
27	1995	Quail Run Basin	Windsor St. and Fir St.	Excavated	4.6	1.3	Detention basin
28	1995	Topper Estates Basin	Hume Ave. east of Shepard Dr.	Excavated	7.0	1.4	Retention basin/County Basin (Shared) Not City maintained
29		Airport Basin No. 1 (South)	City Airport adjacent to Hanford Armona Rd.	Excavated	10.0	2.0	Retention basin
30	1984	Airport Basin No. 2 (North)	City Airport north of Hangers	Excavated	4.2	0.9	Retention basin
31	1997	Beulah Basin	Beulah and Cameron St.	Excavated	8.0	1.5	Detention basin
32	1999	Stonecrest Basin	Fargo Ave. and Glacier St.	Excavated	36.6	6.8	Retention basin
33	1999	Country Crossing Basin	Northwest of Country Crossing subdivision	Excavated	40.0	13.0	Retention basin (expanded to include Ashton Park)
34	2001	Crystal Springs (Part of Freedom Park Basin)	West side of 9 1/4 Ave. between Grangeville and Leland	Excavated	7.1	2.1	Retention basin
35	2002	Energy Basin	Energy St. east of 11th Ave.	Excavated	16.0	2.2	Retention basin
36	2002	Fitzgerald Basin	Fitzgerald Dr. north of Grangeville Blvd.	Excavated	9.6	1.8	Detention basin
37	2002	Whitney Basin	Whitney St. and Kruger St.	Excavated	19.0	2.6	Detention basin
38	2003	Silver Oaks Basin	North side of Grangeville Blvd. west of Centennial Dr.	Excavated	43.3	7.2	Retention basin

Table 4.2 Existing Drainage Basin Inventory
Storm Drainage System Master Plan
City of Hanford

Basin No.	Const. Date	Name	Location	Type	Capacity (AF)	Area (AC)	Comments
39	2003	Glacier Basin	Glacier Way south of Flint Ave.	Excavated	30.0	3.0	Retention basin
40	2004	Live Oak Basin	North side Houston Ave. between 11th and 12th Ave	Natural/Excavated	32.8	4.8	Piped to natural basin south side of Houston Ave.
41	2004	Pioneer Basin	Pioneer and Joshua St.	Excavated	14.8	2.7	Detention basin
43	2006	Vineyard Basin	West side of railroad tracks at Cortner St. south of Fargo Ave.	Excavated	46.5	9.2	Detention basin
44	2006	Freedom Park Basin	West side of 9 1/4 Ave. between Grangeville and Leland	Excavated	47.0	12.0	Detention basin volume includes the 7.1 acre ft at Crystal Springs
45	2006	Mission Park Basin	Mission Dr. and Adobe Ct. south of Flint Ave.	Excavated	3.8	1.0	Retention basin
46	2008	Meadow View	Meadow View Rd. 900 ft north of Fargo Ave.	Excavated	3.0	0.4	Retention basin
47	2008	Centennial Basin	Centennial Dr. at Mall Dr. (Behind Wal-Mart)	Natural/Excavated	46.5	6.0	Retention basin
48			East of Temple Dr.	Excavated	0.0	0.0	Private County
49		East Branch Ditch	300 ft northeast of Malone St. and University Ave.	Excavated	18.0	4.4	Private
50		State Highway	Glendale Ave. and 12th Ave.	Excavated	10.0	2.0	
51			Hwy 198 and 11th Ave.	Excavated	10.5	2.1	Private
52			500 ft of north Chateau Way	Excavated	7.0	2.4	Private
53	2013	Greenbrier Gardens	Hume Ave. east of 12th Ave.	Excavated	15.0	4.2	Temporary storage basin, per as-built 504.503 (Tract 876, Greenbrier Gardens) received from City staff 9/16/2015
54			East of Houston Ave. and 13th Ave.	Natural	0.0	0.0	Does not yet collect city runoff.
55			North of Aquifer Drive and Glendale Avenue	Excavated	6.0	1.2	
56			Northwest of Lacey Blvd and 12th Avenue	Excavated	50	9.4	Private
57			1,000 ft south of Harold St and Hanford Armona Rd	Excavated	40	8	Private
58			Intersection of Fairmont Dr. and Redwood St.	Excavated	3.5	0.5	Private
59			Glendale Ave. and South 12th Ave.	Excavated	2	0.5	Private
60			400 ft northwest of Gable Way and Lombard St	Excavated	0	0	Private
61			West of Lacey Blvd. and 9 1/8 Ave.	Excavated	22.5	4.5	Garlic Processing Facility
62			West of 11th Ave. and Iona Blvd.	Natural	33	6.6	Connected to 40 via possible 6-inch
63			North of Hanford Armona Rd. and Greenbrier Dr.	Excavated	6	1.2	Private
64			Intersection of 12th Ave. and Grangeville Blvd.	Excavated	35	7	
65			Northwest of Cerritos Ave. and Hayward St.	Excavated	5	1	
66			Intersection of Cedar St. and Poplar Rd.	Excavated	10	1.5	
68		Private Wal-Mart Basin	Between Centennial Dr. and Glendale Ave.	Excavated	4.5	0.9	Private Wal-Mart Basin
69			Intersection of 5th St. and 10th Ave.	Natural	4.5	0.2	County island

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4/26/2017

Notes:
1. Source: As-builts received from City of Hanford staff 9/16/2015.
2. Unless noted otherwise, information shown extracted from "Drainage Basin Facilities Record", City of Hanford Utility Division, received 04/22/2014
3. Per information provided by City Staff, received May 18, 2017.

Table 4.3 Existing Lift Station Inventory

Storm Drainage System Master Plan
City of Hanford

Pump No.	Inst. Date	Location	Pit Depth (ft)	Pump Make	Motor Make	Phase	Volts	Generator	Comments
3	1961	Kings Terrace-Jordan Wy & Hanford Armona Rd.	17.0	Prime 8" 2,100	Prime Axial Flow 15	3	230	No	Discharge at Houston Basin
7	1961/89	801 Holt Ave. & Ewell Wy.	17.3	Paco 6" 2,600	Reliance 50	3	480	No	Discharge to W. Branch Ditch
9	1962/89/14	Osprey at Peoples Ditch	21.5	HOMA AK 1058-330/19.7F/C (10")	HOMA 19.7	3	230	No	Discharge to W. Branch Ditch
10	1985	11th Ave. & Third St.	25.5	Peabody Barns	11.3	3	230	No	Discharge to Sand Slough via 24" in 11th.
13	1961	840 E. Florinda St. & Gladys Wy.	14.0	F.M. 6" 1100	F.M. 5	3	230	No	Discharge to E. Branch Ditch
14	1961/99	Florinda St. & Gladys Wy.	21.5, 17	F.M. 8" 2650	F.M. 15, 30	3	480	No	Discharge to E. Branch Ditch
20	1959/96	842 W. Grangeville Blvd.	19.5	Meyers 8VLX 3200	F.M. 50	3	480	Yes	Discharge to Mussel Slough Basin
23	1958/99	1248 Rodgers Rd.	18.1, 12	F.M. 8" 3300, Meyers 8VLX 2900	F.M. 25, 30	3	480	Yes	Discharge to W. Branch Ditch
25	1961	1229 Williams & Peoples Ditch	21.0	Meyers 8VLX 4", 1200	F.M. 15	3	230	No	Discharge to W. Branch Ditch
29	1962/14	1989 Harrison & E. Branch	18.8	HOMA AK 1058-330/19.7F/C (10")	HOMA 19.7	3	230	Yes	Discharge to E. Branch Ditch
31	1963	854 E. Grangeville Blvd. & Beulah St.	20.3	(2) Paco @ 5000 total	Reliance 20, 25	3	480	No	Discharge to E. Branch Ditch
35	1967	Lacey Blvd. east of Campus Dr. at the W. Branch Ditch	20.3	F.M. 8"- 2 @ 1800 ea.	U.S. 15, G.E. 15	3	480	Yes	Discharge to W. Branch Ditch
37	1973	Jana Wy. & Emma Lee Ln.	12.5	F.M. 150	G.E. 5	3	230	No	Discharge to W. Branch Ditch
39	1996	W. Mulberry & Peoples Ditch	9.1	Meyers	Reliance 5	3	230	No	Discharge to W. Branch Ditch
43	1981	Redwood St. in Douty Estates	14.6	Hydromatic 150	Hydromatic 1.5	Single	230	No	Discharge to Mussel Slough
44	1980	Myrtle St. & Connie Dr.	12.4	Hydromatic 4", 100	G.E. .75	Single	230	No	Discharge to E. Branch Ditch
48	1979/11	Encore Dr. & Fairmont Dr.	9.0	Gorman Rupp JS4F60-X18, (4")	18hp	3	230	No	Discharge to Mussel Slough
49	1989	Sixth St. West of 10th Ave.	14.4	(2) Paco #1=2300, #2=1200	Reliance 60, 30	3	480	Yes	(2) Discharge to E. Branch Ditch
50	1987/11	Lakewood Dr. & Neil Wy.	21.0	Gorman Rupp JS4F60-X13, (4")	15	3	480	No	Discharge to E. Branch Ditch
51	1988	Fifth St. East of 10th Ave.	14.5	Homa 335 (submersible)	5.5	3	230	No	Discharge to E. Branch Ditch
56	1995	Greenfield Ave. & Elm St.	13.3	(2) Meyers #1=2250, #2=4500	20, 40	3	480	No	Discharge to W. Branch Ditch
57	1997/14	Fir St. & Windsor Dr.	19.5	HOMA AMX434/1-193/6.7T/C (4")	HOMA 6.7	Single	230	No	Discharge to Mussel Slough via 30" in Aspen
60	1997	Beulah St. & Cameron St.	21.0	Paco 450	Reliance 10	3	230	No	Discharge to E. Branch Ditch
61	998	Grangeville Blvd. & Rosewood Ln.	20.0	Meyers (submersible) 215 g.p.m.	2, WGX20 - 3, 4RX	3	230	Yes	Discharge to Mussel Slough
62	1998	10th Ave. & Encore Dr.	16.5	Myers 4RX - 435 g.p.m.	10	3	230	No	Discharge to Encore Basin
63	1998	Greenfield Ave. & University Ave.	18'	Paco 450	10	3	230	No	Discharge sd in Greenfield (Malone Basin)
66	2003	875 E. Whitney Dr.& Jessie Ave.	24.4	Meyers - 900 g.p.m.	7.5	3	230	No	Discharge E. Branch Ditch
68	2006	Crystal Springs Basin	22.2	Meyers - 1550 g.p.m.	15.1	3	480	No	Discharge E. Branch Ditch
70	2007	Kimball & 198 Carraway Basin	22.6	Myers - 1250 g.p.m.	15.1	3	230	No	Discharge W. Brach Ditch
71	2007	Mall Dr. Mall Basin	22.4	(2) Myers - 1800 g.p.m.	2 - 7.5	3	230	No	Discharge W. Brach Ditch

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3/30/2016

Notes:

1. Source: "Storm Drain Facilities Record", City of Hanford Utility Division, received 04/22/14

4.3 HYDROLOGIC MODEL

The hydrologic model was used for calculating stormwater runoff volumes from each identified drainage subbasin. This section discusses the hydrologic modeling software and the model development.

4.3.1 Modeling Software

The hydraulic modeling software used for evaluating the capacity adequacy of the City storm drainage system was based on the Hydrologic Engineering Center Flood Hydrograph Package (HEC-1). This software incorporates hydrologic routing tools for overland flow, precipitation, and Manning's Equation to simulate pipe flow.

The selected modeling software that was used for the hydrology analysis on this project was developed by the U.S. Army Corps of Engineers' Hydrologic Engineering Center. The software package is called the Flood Hydrograph Package (HEC-1), and is capable of evaluating a wide array of flood hydrology systems, including large river watersheds, and small urban drainage runoff. The model package was largely chosen for consistency with the previous master plan.

4.3.2 Model Development

A hydrologic model was developed for each identified drainage basin. The characteristics for each subbasin were populated to account for land use types, flood routing, conveyance, and routing methodology.

Land Use. Land use was used to define impervious area and the SCS Curve Number for pervious runoff. Residential areas included soil classifications to define non-effective runoff mostly confined in backyards.

Flood Routing. Flood routing consists of determining the flow path and connectivity to the storm drainage collection system.

Conveyance. Muskingum-Cunge conveyance methodology for pipe connections, channelized systems, and stream routing.

Routing Methodology. Kinematic wave routing methodology for transforming precipitation into runoff for overland flow routing, street flow, and pipe conveyance

CHAPTER 5 – EVALUATION AND PROPOSED IMPROVEMENTS

This chapter presents a summary of the storm drainage system evaluation and identifies improvements needed to mitigate existing deficiencies as well as improvements needed to expand the system and service future growth.

5.1 OVERVIEW

The hydrologic and hydraulic models were used for evaluating the storm drainage system to identify capacity deficiencies and to recommend improvements required to serve future growth. The criteria used for evaluating the capacity adequacy of the storm drainage system (pipelines, stormwater collection basins, and pump stations) and used for sizing recommended improvements were discussed and summarized in the System Performance and Design Criteria chapter.

The evaluation of the City's existing storm drainage system was conducted by Dr. Jack Humphrey of Hydmet Inc. The following sections summarize the evaluation of the existing system performed by Hydmet Inc. and the improvements recommended to mitigate exiting deficiencies and serve future growth.

5.2 PIPELINE CONVEYANCE

The 2-year 6-hour design storm was used for evaluating the capacity adequacy of conveyance facilities for existing residential runoff, and the 5-year 6-hour storm for existing non-residential runoff. The existing capacity analysis indicates that the conveyance facilities are mostly adequate to accommodate the design storms.

The capacity evaluation indicated some pipelines do not meet the City's design criteria for conveyance capacity. As such, improvements are recommended to mitigate these capacity deficiencies. The recommended pipe improvements are shown on **Figure 5.1**, and tabulated and discussed in the following sections. Recommended improvements are also summarized on **Table 5.1**.

Basin S2

This section documents improvements within the Basin S2 storm drainage collection system service area.

- Improvement **S2-P1**: Replace the 18-inch pipeline with a new 30-inch pipeline on Brookhollow Drive from Hoover Way to Waterview Street. This improvement is intended to mitigate deficiencies of the storm drainage system at buildout.

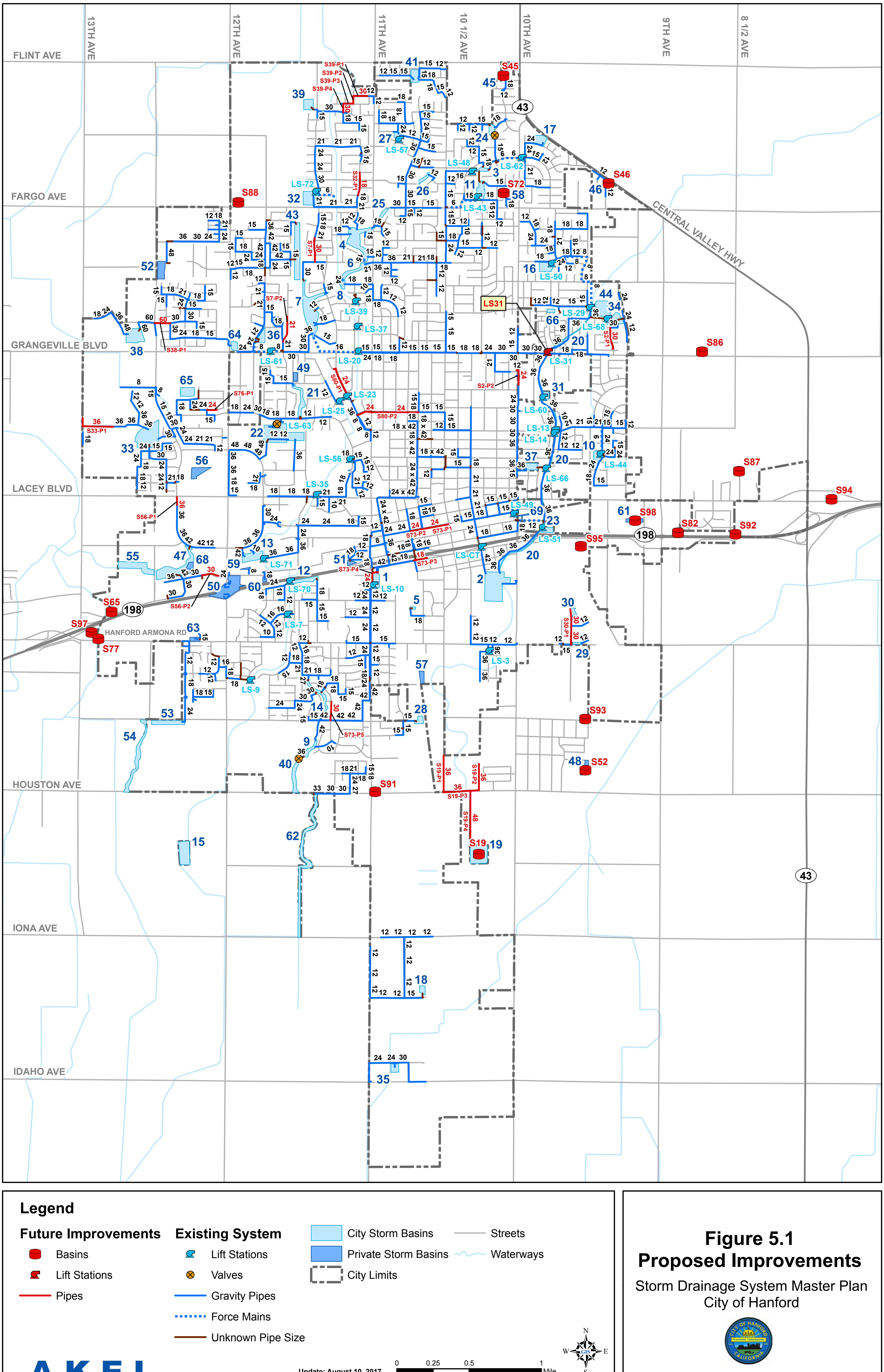

Figure 5.1
Proposed Improvements

Storm Drainage System Master Plan
City of Hanford

Table 5.1 Schedule of Improvements
Storm Drainage System Master Plan
City of Hanford

Improv. No.	Type of Improv	Alignment	Limits	Existing Diameter (in)	New/Parallel/ Replace	Infrastructure Improvements Diameter (in)	Infrastructure Improvements Length (ft)
Existing System Improvements							
Existing Pipeline Improvements							
Basin S2							
S2-P1	Pipe	Brookhollow Dr	From Hoover Way to Waterview St	18	Replace	30	825
S2-P2	Pipe	10th Ave	From Bass St to approximately 190 ft n/o Malone St	15	Replace	24	600
Basin S7							
S7-P1	Pipe	Glacier Way	From approximately 100 ft n/o Muir Way to Cortner St	24	Replace	30	900
S7-P2	Pipe	Kings Rd	From Crescent Way to Claridge Ln	-	New	21	975
Basin S19							
S19-P1	Pipe	10 1/2 Ave	From 1,350 ft n/o Houston Ave to Houston Ave	-	New	36	1,350
S19-P2	Pipe	ROW	ROW between 10 1/2 Ave and 10 th Ave from 1,000 ft n/o Houston Ave to Houston Ave	-	New	36	1,275
S19-P3	Pipe	Houston Ave	From 10 1/2 Ave to 1,000 ft e/o 10 1/2 Ave	-	New	36	1,000
S19-P4	Pipe	ROW	ROW between 10 1/2 Ave and 10th Ave from Houston Ave to 2,000 ft s/o Houston Ave	30	Replace	48	2,025
Basin S30							
S30-P1	Pipe	9 1/4 Ave	From Hanford Armona Rd to 1,350 ft n/o Hanford Armona Rd	15	Replace	30	1,300
Basin S32							
S32-P1	Pipe	Fountain Plaza Dr	From West Pebble Dr to Willow St	12	Replace	18	850
Basin S33							
S33-P1	Pipe	Learning Center Main Access	From 13th Ave to School	18	Replace	36	1,425
Basin S38							
S38-P1	Pipe	Berkshire Ln	From Bordeaux St to Centennial Dr	42	Replace	60	575
Basin S39							
S39-P1	Pipe	Imperial Way	From Plum Ln to Cajun Way	24	Replace	30	500
S39-P2	Pipe	Cajun Way	From Imperial Way to Millbrook St	24	Replace	30	275
S39-P3	Pipe	Milbrook St	From Cajun Way to Zion Way	24	Replace	30	375
S39-P4	Pipe	Zion Way	From Millbrook St to Saffron St	24	Replace	30	325
Basin S56							
S56-P1	Pipe	Centennial Dr	From Lacey Blvd to 300 ft s/o Lacey Blvd	24	Replace	36	300
S56-P2	Pipe	Glendale Ave	From approximately 800 ft w/o 12th Ave to approximately 300 w/o 12th Ave	24	Replace	30	625
Basin S73							
S73-P1	Pipe	Sixth St	From Douty St to Redington St	15	Replace	24	875
S73-P2	Pipe	Sixth St	From Redington St to Phillips St	18	Replace	24	535
S73-P3	Pipe	Third St	From approximately 80 ft w/o Redington St to Phillips St	12	Replace	18	500
S73-P4	Pipe	11th Ave	From approximately 70 ft n/o Silverado St to approximately 150 ft s/o Third St	18	Replace	24	550
S73-P5	Pipe	Echo Ln	From 100 ft n/o Echo Ct to Hume Ave	12	Replace	30	675

Table 5.1 Schedule of Improvements
Storm Drainage System Master Plan
City of Hanford

Improv. No.	Type of Improv	Alignment	Limits	Existing Diameter (in)	New/Parallel/ Replace	Infrastructure Improvements Diameter (in)	Infrastructure Improvements Length (ft)
Basin S76							
S76-P1	Pipe	Hopkins Dr	From Cogswell Pl to Scripps Ct	18	Replace	24	375
Basin S80							
S80-P1	Pipe	Rodgers Rd	From Neville Ave to Lift Station 23	10	Replace	24	1,175
S80-P2	Pipe	Cameron St	From Redington St to Rodgers Rd	18	Replace	24	2,225
Existing Retention Basin Improvements				(AF)		(AF)	
S-19	Existing Retention Basin	-	Approximately 2,600 ft se/o 10 1/2 Ave and Houston Ave	72.3	Capacity Expansion	23.7	-
S-45	Existing Retention Basin	-	Approximately 500 ft n/o Capistrano St and Mission Rd	3.8	Capacity Expansion	6.2	-
S-46	Existing Retention Basin	-	Approximately 900 ft n/o Meadow View and Fargo Ave	3	Capacity Expansion	1	-
S-52	Existing Retention Basin	-	Approximately 2,700 feet ne/o Houston Ave and 10th Ave	7	Capacity Expansion	29	-
Lift Station Improvements						Firm Capacity	
Basin S2							
LS-31	Lift Station	-	Lift Station 31 : Approximately 250 ft w/o intersection of Grangeville Blvd and Arroyo Rd	1 @ 2,500	Replace	3 @ 1,200 gpm	-
Future System Improvements							
Pipelines Servicing Future Retention Basins							
S65-P1	Pipe	-	2,000 ft upstream of Retention Basin S65	-	New	42	2,000
S72-P1	Pipe	-	2,000 ft upstream of Retention Basin S72	-	New	24	2,000
S77-P1	Pipe	-	2,000 ft upstream of Retention Basin S77	-	New	48	2,000
S82-P1	Pipe	-	2,000 ft upstream of Retention Basin S82	-	New	60	2,000
S86-P1	Pipe	-	2,000 ft upstream of Retention Basin S86	-	New	96	2,000
S87-P1	Pipe	-	2,000 ft upstream of Retention Basin S87	-	New	60	2,000
S88-P1	Pipe	-	2,000 ft upstream of Retention Basin S88	-	New	48	2,000
S91-P1	Pipe	-	2,000 ft upstream of Retention Basin S91	-	New	36	2,000
S92-P1	Pipe	-	2,000 ft upstream of Retention Basin S92	-	New	60	2,000
S93-P1	Pipe	-	2,000 ft upstream of Retention Basin S93	-	New	66	2,000
S94-P1	Pipe	-	2,000 ft upstream of Retention Basin S94	-	New	60	2,000
S95-P1	Pipe	-	2,000 ft upstream of Retention Basin S95	-	New	30	2,000
S97-P1	Pipe	-	2,000 ft upstream of Retention Basin S97	-	New	48	2,000
S98-P1	Pipe	-	2,000 ft upstream of Retention Basin S98	-	New	36	2,000
Future Retention Basins						(AF)	
S-65	New Retention Basin	-	Approximately 1,500 ft w/o Aquifer Dr and Highway 198	-	Future	6.0	-
S-72	New Retention Basin	-	Approximately 600 ft ne/o Fargo Ave and Fairmont Ave	-	Future	6.0	-
S-77	New Retention Basin	-	Approximately 3,300 ft w/o Greenbrier Dr and Hanford Harmona Rd	-	Future	18.0	-
S-82	New Retention Basin	-	Approximately 600 ft ne/o Highway 198 and 9th Ave	-	Future	20.0	-
S-86	New Retention Basin	-	Approximately at intersection of 8 1/2 Ave and Grangeville Blvd	-	Future	64.0	-
S-87	New Retention Basin	-	Approximately 1,050 ft n/o intersection of Lacey Blvd and Vista Ave	-	Future	58.0	-
S-88	New Retention Basin	-	Approximately 300 ft ne/o 12th Ave and Fargo Ave	-	Future	20.0	-
S-91	New Retention Basin	-	Approximately at the intersection of Houston Ave and 11th Ave	-	Future	16.0	-

Table 5.1 Schedule of Improvements
Storm Drainage System Master Plan
City of Hanford

Improv. No.	Type of Improv	Alignment	Limits	Existing Diameter (in)	New/Parallel/ Replace	Infrastructure Improvements Diameter (in)	Infrastructure Improvements Length (ft)
S-92	New Retention Basin	-	Approximately 300 ft se/o Curtis St and David St	-	Future	42.0	-
S-93	New Retention Basin	-	Approximately 4,000 ft nw/o Houston Ave and 9th Ave	-	Future	100.0	-
S-94	New Retention Basin	-	Approximately 850 ft e/o of Lacey Blvd and 8th Ave	-	Future	146.0	-
S-95	New Retention Basin	-	Approximately 1,000 ft sw/of Third St and 9 1/2 Ave	-	Future	3.0	-
S-97	New Retention Basin	-	Approximately at the intersection of Highway 198 and Hanford Armona Rd	-	Future	4.0	-
S-98	New Retention Basin	-	Approximately 1,500 ft nw/o at intersection of 9 1/8 Ave and Highway 198	-	Future	10.0	-

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5/18/2017

Note:
1. New retention basin depth assumed to be equal to 25 feet.

- Improvement **S2-P2**: Replace the existing 15-inch pipeline with a new 24-inch pipeline on 10th Avenue from Bass Street to approximately 190 feet north of Malone Street. This improvement is intended to mitigate deficiencies of the storm drainage system at buildout.

Basin S7

This section documents improvements within the Basin S7 storm drainage collection system service area.

- Improvement **S7-P1**: Replace the existing 24-inch pipeline with a new 30-inch pipeline on Glacier Way from 100 feet north of Muir Way to Cortner Street. This improvement is intended to mitigate deficiencies of the storm drainage system at buildout.

- Improvement **S7-P2**: Construct a new 21-inch pipeline on Kings Road from Crescent Way to Claridge Lane. This improvement is intended to mitigate deficiencies of the storm drainage system at buildout.

Basin S19

This section documents improvements within the Basin S19 storm drainage collection system service area.

- Improvement **S19-P1**: Construct a new 36-inch pipeline on 10 ½ Avenue from 1,350 feet north of Houston Avenue to Houston Avenue. This improvement is intended to mitigate deficiencies of the storm drainage system at buildout.

- Improvement **S19-P2**: Construct a new 36-inch pipeline on Right-of-Way between 10 1/2 Ave and 10th Ave from 1,000 feet north /of Houston Ave to Houston Ave. This improvement is intended to mitigate deficiencies of the storm drainage system at buildout.

- Improvement **S19-P3**: Construct a new 36-inch pipeline on Houston Avenue from 10 ½ Avenue to 1,000 feet east of Houston Avenue. This improvement is intended to mitigate deficiencies of the storm drainage system at buildout.

- Improvement **S19-P4**: Replace the existing 30-inch pipeline with a new 48-inch pipeline on Right-of-Way between 10 ½ Avenue and 10th Avenue from Houston Avenue to 2,000 feet south of Houston Avenue. This improvement is intended to mitigate deficiencies of the storm drainage system at buildout.

Basin S30

This section documents improvements within the Basin S30 storm drainage collection system service area.

- Improvement **S30-P1**: Replace the existing 15-inch pipeline with a new 30-inch pipeline on 9 ¾ Avenue from Hanford Armona Road to 1,350 feet north of Hanford Armona Road. This improvement is intended to mitigate deficiencies in the existing system.

Basin S32

This section documents improvements within the Basin S32 storm drainage collection system service area.

- Improvement **S32-P1**: Replace the existing 15-inch pipeline with a new 18-inch pipeline on Fountain Plaza Drive from West Pebble Drive to Willow Street. This improvement is intended to mitigate deficiencies in the existing system.

Basin S33

This section documents improvements within the Basin S33 storm drainage collection system service area.

- Improvement **S33-P1**: Replace the existing 18-inch pipeline with a new 36-inch pipeline in the Learning Main Center Access drive from 13th Avenue to the School. This improvement is intended to mitigate deficiencies in the existing system.

Basin S38

This section documents improvements within the Basin S38 storm drainage collection system service area.

- Improvement **S38-P1**: Replace the existing 42-inch pipeline with a new 60-inch pipeline on Berkshire Lane from Bordeaux Street to Centennial Drive. This improvement is intended to mitigate deficiencies of the storm drainage system at buildout.

Basin S39

This section documents improvements within the Basin S39 storm drainage collection system service area.

- Improvement **S39-P1**: Replace the existing 24-inch pipeline with a new 30-inch pipeline on Imperial Way from Plum Lane to Cajun Way. This improvement is intended to mitigate deficiencies of the storm drainage system at buildout.

- Improvement **S39-P2**: Replace the existing 24-inch pipeline with a new 30-inch pipeline on Cajun Way from Imperial Way to Millbrook Street. This improvement is intended to mitigate deficiencies of the storm drainage system at buildout.

- Improvement **S39-P3**: Replace the existing 24-inch pipeline with a new 30-inch pipeline on Millbrook Street from Cajun Way to Zion Way. This improvement is intended to mitigate deficiencies of the storm drainage system at buildout.

- Improvement **S39-P4**: Replace the existing 24-inch pipeline with a new 30-inch pipeline on Zion Way from Millbrook Street to Saffron Street. This improvement is intended to mitigate deficiencies of the storm drainage system at buildout.

Basin S56

This section documents improvements within the Basin S56 storm drainage collection system service area.

- Improvement **S56-P1**: Replace the existing 24-inch pipeline with a new 36-inch pipeline on Centennial Drive from Lacey Boulevard to 300 feet south of Lacey Boulevard. This improvement is intended to mitigate deficiencies of the storm drainage system at buildout.

- Improvement **S56-P2**: Replace the existing 24-inch pipeline with a new 30-inch pipeline on Glendale Avenue from approximately 800 feet west of 12th Avenue to approximately 300 feet west of 12th Avenue. This improvement is intended to mitigate deficiencies of the storm drainage system at buildout.

Basin 73

This section documents improvements within the Basin S73 storm drainage collection system service area.

- Improvement **S73-P1**: Replace the existing 15-inch pipeline with a new 24-inch pipeline on Sixth Street from Douty Street to Redington Street. This improvement is intended to mitigate deficiencies of the storm drainage system at buildout.

- Improvement **S73-P2**: Replace the existing 18-inch pipeline with a new 24-inch pipeline on Sixth Street from Redington Street to Philips Street. This improvement is intended to mitigate deficiencies of the storm drainage system at buildout.

- Improvement **S73-P3**: Replace the existing 12-inch pipeline with a new 18-inch pipeline on Third Street from approximately 80 feet west of Redington Street to Philips Street. This improvement is intended to mitigate deficiencies of the storm drainage system at buildout.

- Improvement **S73-P4**: Replace the existing 18-inch pipeline with a new 24-inch pipeline on 11th Avenue from approximately 70 feet north of Silverado Street to approximately 150 feet south of Third Street. This improvement is intended to mitigate deficiencies of the storm drainage system at buildout.

- Improvement **S73-P5**: Replace the existing 12-inch pipeline with a new 30-inch pipeline on Echo Lane from 100 feet north of Echo Lane to Hume Avenue. This improvement is intended to mitigate deficiencies of the storm drainage system at buildout.

Basin S76

This section documents improvements within the Basin S76 storm drainage collection system service area.

- Improvement **S76-P1**: Replace the existing 18-inch with a new 24-inch pipeline on Hopkins Drive from Kaplan Place to Cogswell Place. This improvement is intended to mitigate deficiencies of the storm drainage system at buildout.

Basin S80

This section documents improvements within the Basin S80 storm drainage collection system service area.

- Improvement **S80-P1**: Replace the 10-inch pipeline with a new 24-inch pipeline on Rodgers Road from Neville Avenue to Lift Station 23. This improvement is intended to mitigate deficiencies in the existing system.

- Improvement **S80-P2**: Replace the 18-inch pipeline with a new 24-inch pipeline on Cameron Street from Redington Street to Rodgers Road. This improvement is intended to mitigate deficiencies in the existing system.

5.3 DRAINAGE COLLECTION BASINS

Detention and retention basins were sized to meet the runoff requirements of the 100-year 2-day and 100-year 10-day design storms, respectively. Several existing basins required improvement to meet the design storm requirements. Basin improvements were attributed to existing deficiencies, anticipated future growth. To distinguish existing storm drainage basin deficiencies from future required storm drainage basins to meet design criteria, the following detention basins improvements categories were identified:

- **Basin Capacity Expansion (Existing Facility, Increase Capacity).** These facilities are existing, and currently used as runoff collection facilities. Expansion improvements are required to accommodate the runoff requirements of the design storm.

- **New Drainage Basin (New Facility, New Capacity).** New drainage basins for the buildout of the Planned Area Boundary were given an approximate site location based on existing topography, and where stormwater could not be economically routed to another existing drainage basin.

5.3.1 Recommended Basin Capacity Expansion

It should be noted that for planning purposes drainage basin capacity deficiencies in existing drainage basins are assumed to be mitigated with the construction of a new drainage basin. Based on site-specific conditions it may be feasible to expand an existing basin to create the additional required basin capacity. Drainage basin improvements are shown graphically on **Figure 5.1** highlighted in red, and documented on **Table 5.1**.

The basin capacity expansions recommended as part of this 2017 Storm Drainage System Master Plan are the following:

- Basin **S-19**: Upgrade the storage capacity of retention basin S-19, located 2,600 feet south east of 10 ½ Avenue and Houston Avenue with a new retention basin of capacity equal to 23.7 AF.

- Basin **S-45**: Upgrade the storage capacity of retention basin S-45, located 500 feet north of Capistrano Street and Mission Road with a new retention basin of capacity equal to 6.2 AF

- Basin **S-46**: Upgrade the storage capacity of retention basin S-46, located 900 feet north of Meadow View and Fargo Avenue with a new retention basin of capacity equal to 1.0 AF.

- Basin **S-52**: Upgrade the storage capacity of retention basin S-52, located 2,700 feet north east of Houston Avenue and 10th Avenue with a new retention basin of capacity equal to 29 AF.

5.3.2 Recommended Future Storage Basins

The analysis of the existing storm drainage system also led to the recommendation of new drainage basins that will need to be constructed to ensure proper runoff collection at buildout of the Planned Area Boundary.

The new drainage basins recommended at buildout of the Planned Area Boundary are the following:

- Basin **S-65**: Construct a new retention basin S-65, located 1,500 feet west of Aquifer Drive and Highway 198 for a capacity equal to 6.0 AF.

- Basin **S-72**: Construct a new retention basin S-72, located 600 feet north-east of Fargo Avenue and Fairmont Avenue for a capacity equal to 6.0 AF.

- Basin **S-77**: Construct a new retention basin S-77, located 3,300 feet west of Greenbrier Drive and Hanford Armona Road for a capacity equal to 18.0 AF.

- Basin **S-82**: Construct a new retention basin S-82, located 600 feet north-east of Highway 198 and 9th Avenue for a capacity equal to 20.0 AF.

- Basin **S-86**: Construct a new retention basin S-86 located at the intersection of 8 ½ Avenue and Grangeville Boulevard for a capacity equal to 64.0 AF.
- Basin **S-87**: Construct a new retention basin S-87, located 1,050 feet north of intersection of Lacey Boulevard and Vista Avenue for a capacity equal to 58.0 AF.
- Basin **S-88**: Construct a new retention basin S-88, located 300 feet north-east of the intersection of 12th Avenue and Fargo Avenue for a capacity equal to 20.0 AF.
- Basin **S-91**: Construct a new retention basin S-89, located at the intersection of Houston Avenue and 11th Avenue for a capacity equal to 16.0 AF.
- Basin **S-92**: Construct a new retention basin S-92, located 300 feet south-east of the intersection of Curtis Street and David Street for a capacity equal to 42.0 AF.
- Basin **S-93**: Construct a new retention basin S-93, located 4,000 feet north-west of Houston Avenue and 9th Avenue for a capacity equal to 100.0 AF.
- Basin **S-94**: Construct a new retention basin S-94, located 850 feet east of Lacey Boulevard and 8th Avenue for a capacity equal to 146.0 AF.
- Basin **S-95**: Construct a new retention basin S-95, located 1,000 feet south-west of Third Street and 9 ½ Avenue for a capacity equal to 3.0 AF.
- Basin **S-97**: Construct a new retention basin S-97, located at the intersection of Highway 198 and Hanford Armona Road for a capacity equal to 4.0 AF.
- Basin **S-98**: Construct a new retention basin S-98, located at the intersection of 9 ⅛ Avenue and Highway 198 for a capacity equal to 10.0 AF.

5.4 PUMP STATIONS

Pump station improvements to meet existing runoff requirements are summarized on **Table 5.1** and shown graphically on **Figure 5.1**. Areas of future development are assumed to be collected by gravity and conveyed to retention facilities, mitigating the need for additional pump stations. Improvement

- Improvement LS-31: Lift Station 31 is located approximately 250 west of intersection of Grangeville Boulevard and Arroyo Road and will need to be upgraded for a firm capacity of 3,600 gpm.

5.5 IMPROVEMENTS OUTSIDE THE EXISTING SERVICE AREA

Due to the uncertain timing and location of future developments outside of the existing service area, specific pipeline alignments and storage basin locations are not included in the master plan. However, placeholder capacities and pipe lengths are shown for cost estimating purposes. The storage basin capacity represents the total required retention for the drainage basin. The pipeline sizing is based on the total requirements of runoff from the drainage basin. Storage basin and pipelines for specific developments should be evaluated as the development occurs, and are subject to City Engineer approval.

Table 5.1 shows on a specific section the total length of pipeline necessary and the pipeline size required to serve each future retention basin. For each proposed future basin, **Table 5.1** proposes an associated future pipeline length equal to 2,000 feet and a proposed pipeline size. Each line item in this section of **Table 5.1** is shown as a placeholder purpose.

5.6 INDUSTRIAL PARK IMPROVEMENTS

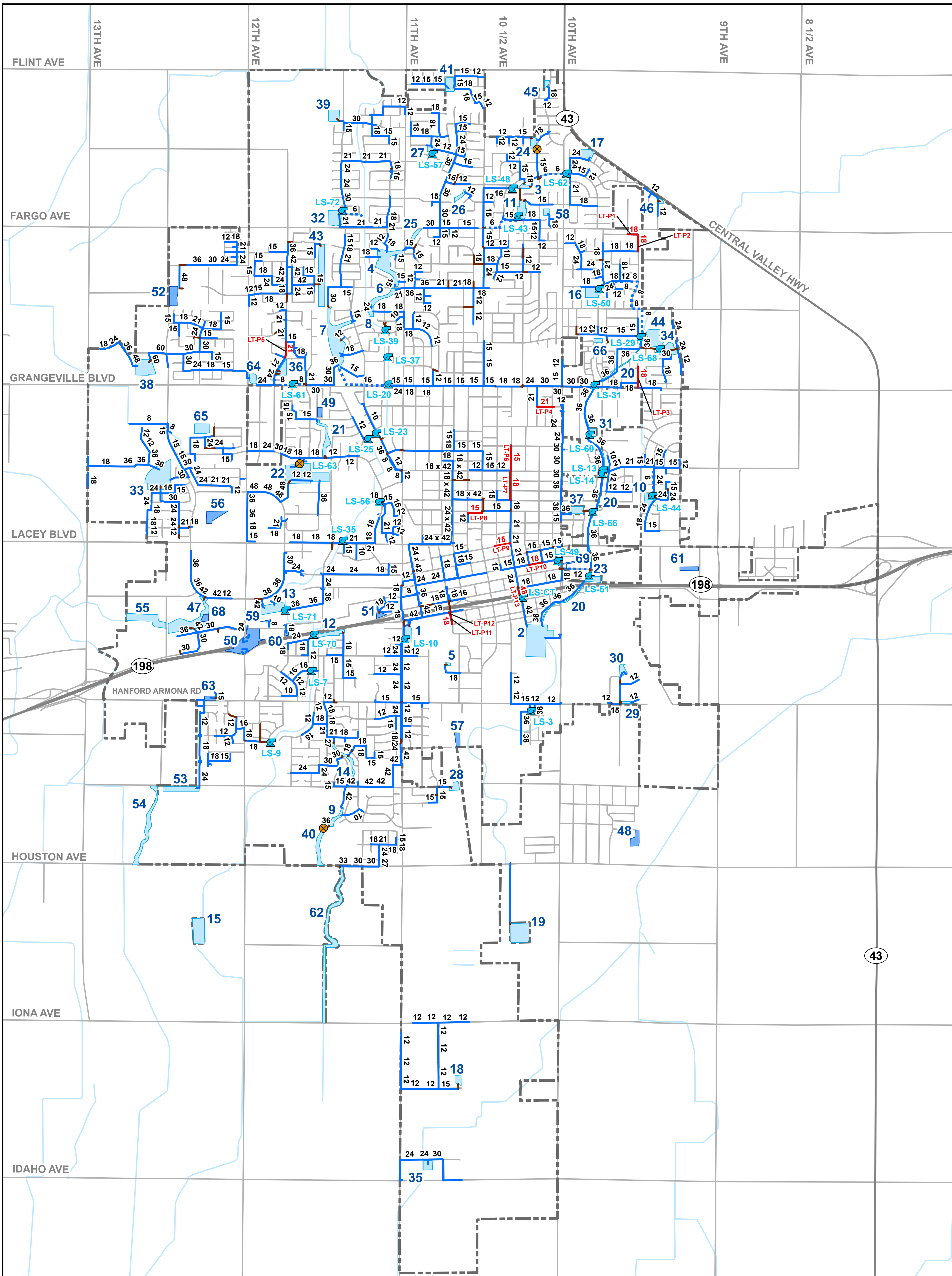
The City of Hanford requires new industrial users to provide on-site retention of all runoff from the individual development in an effort to reduce potential hazardous waste contamination. The City provides small retention storage to collect nuisance water from the streets. As such, the industrial area was not considered in this stormwater analysis. Runoff requirements will be specific to the size and nature of the developments that occur in the industrial park, and basins storage siting and requirements should be evaluated on a case-by-case basis, and subject the approval of the City Engineer.

5.7 LONG TERM REPLACEMENT RECOMMENDATIONS

The evaluation of the storm drainage system at buildout revealed pipelines with minor capacity deficiencies. As these pipelines near the end of their physical life, it is recommended that they be replaced with the sizing recommendations included in this section. As these improvements were minor capacity upgrades, City staff requested they not be shown in the capital improvement program. Therefore, these improvements are summarized separately below, and included on **Table 5.2** and shown on **Figure 5.2**.

The improvements recommended on the long term are listed below:

- Replacement **LT-P1**: Replace the existing 15-inch pipeline with a new 18-inch pipeline on Cedarwood Street from Fargo Place to Fernwood Drive.
- Replacement **LT-P2**: Replace the existing 15-inch pipeline with a new 18-inch pipeline on Fernwood Drive from Cedarwood Street to Burlwood Avenue.
- Replacement **LT-P3**: Replace the existing 15-inch pipeline with a new 18-inch pipeline on Harrison Avenue from Cleveland Way to Grangeville Boulevard.
- Replacement **LT-P4**: Replace the existing 18-inch pipeline with a new 21-inch pipeline on Bass Street from Normandie Street to East Street.



Legend

Future Improvements

Pipes

Existing System

Lift Stations

Valves

Gravity Pipes

Force Mains

Unknown Pipe Size

City Storm Basins

Private Storm Basins

City Limits

Streets

Waterways

Update: May 17, 2017

0 0.25 0.5 1 Mile

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Figure 5.2
Long Term Replacement Recommendations

Storm Drainage System Master Plan
City of Hanford

Table 5.2 Long Term Replacement Recommendations
Storm Drainage System Master Plan
City of Hanford

Improv. No.	Type of Improv	Alignment	Limits	Existing Diameter (in)	New/Parallel/ Replace	Diameter (in)	Length (ft)
LT-P1	Pipe	Cedarwood St	From Fargo Pl to Fernwood Dr	15	Replace	18	350
LT-P2	Pipe	Fernwood Dr	From Cedarwood St to Burlwood Ave	15	Replace	18	575
LT-P3	Pipe	Harrison Ave	From Cleveland Way to Grangeville Blvd	15	Replace	18	725
LT-P4	Pipe	Bass St	From Normandie St to East St	18	Replace	21	575
LT-P5	Pipe	Fitzgerald Ln	From approximately 200 ft n/o Crescent Way to Berkshire Way	18	Replace	21	550
LT-P6	Pipe	Brown St	From Cameron St to Florinda St	12	Replace	15	825
LT-P7	Pipe	Brown St	From approximately 180 ft n/o Elm St to Ivy St	15	Replace	18	1,025
LT-P8	Pipe	Irwin Ct	From Irwin St to Douty St	12	Replace	15	475
LT-P9	Pipe	Eight St	From Harris St to Brown St	12	Replace	15	550
LT-P10	Pipe	Sixth St	From White St to Green St	15	Replace	18	450
LT-P11	Pipe	Phillips St	From Second St to 100 ft s/o Third St	12	Replace	18	325
LT-P12	Pipe	Phillips St	From 100 ft s/o Third St to Third St	15	Replace	18	100
LT-P13	Pipe	Brown Street	From Fourth St to Third St	36	Replace	48	475
LT-C13	Casing [1]	Brown Street	Highway 198		New	72	600

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5/18/2017

Note:

1. Casing length when crossing a highway equal to 600 feet.

- Replacement **LT-P5**: Replace the existing 18-inch pipeline with a new 21-inch pipeline on Fitzgerald Lane from approximately 200 feet north of Crescent Way to Berkshire Way.

- Replacement **LT-P6**: Replace the existing 12-inch pipeline with a new 15-inch pipeline on Brown Street from Cameron Street to Florinda Street.

- Replacement **LT-P7**: Replace the existing 15-inch pipeline with a new 18-inch pipeline on Brown Street from approximately 180 feet north of Elm Street to Ivy Street.

- Replacement **LT-P8**: Replace the existing 12-inch pipeline with a new 15-inch pipeline on Irwin Street to Douty Street.

- Replacement **LT-P9**: Replace the existing 12-inch pipeline with a new 15-inch pipeline on Eight Street from Harris Street to Brown Street.

- Replacement **LT-P10**: Replace the existing 15-inch pipeline with a new 18-inch pipeline on Sixth Street from White Street to Green Street.

- Replacement **LT-P11**: Replace the existing 12-inch pipeline with a new 18-inch pipeline on Phillips Street from Second Street to 100 feet south of Third Street.

- Replacement **LT-P12**: Replace the existing 15-inch pipeline with a new 18-inch pipeline on Phillips Street from 100 feet south of Third Street to Third Street.

- Replacement **LT-P13**: Replace the existing 36-inch pipeline with a new 48-inch pipeline on Brown Street from Fourth Street to Third Street.

CHAPTER 6 – CAPITAL IMPROVEMENT PROGRAM

This chapter provides a summary of the recommended storm drainage system improvements intended to mitigate existing capacity deficiencies and for accommodating anticipated future growth. The chapter also presents the cost criteria and methodologies for developing the Capital Improvement Program (CIP).

6.1 COST ESTIMATE ACCURACY

Cost estimates presented in the CIP were prepared for general master planning purposes and, where relevant, for further project evaluation. Final costs of a project will depend on several factors including the final project scope, costs of labor and material, and market conditions during construction.

The Association for the Advancement of Cost Engineering (AACE International), formerly known as the American Association of Cost Engineers has defined three classifications of assessing project costs. These classifications are presented in order of increasing accuracy: Order of Magnitude, Budget, and Definitive.

- **Order of Magnitude Estimate.** This classification is also known as an “original estimate”, “study estimate”, or “preliminary estimate”, and is generally intended for master plans and studies.

  This estimate is not supported with detailed engineering data about the specific project, and its accuracy is dependent on historical data and cost indexes. It is generally expected that this estimate would be accurate within -30 percent to +50 percent.

- **Budget Estimate.** This classification is also known as an “official estimate” and generally intended for predesign studies. This estimate is prepared to include flow sheets and equipment layouts and details. It is generally expected that this estimate would be accurate within -15 percent to +30 percent.

- **Definitive Estimate.** This classification is also known as a “final estimate” and prepared during the time of contract bidding. The data includes complete plot plans and elevations, equipment data sheets, and complete specifications. It is generally expected that this estimate would be accurate within -5 percent to + 15 percent.

Costs developed in this study should be considered “Order of Magnitude” and have an expected accuracy range of **-30 percent** and **+50 percent**.

6.2 COST ESTIMATE METHODOLOGY

Cost estimates presented in this chapter are opinions of probable construction and other relevant costs developed from several sources including cost curves, Akel experience on other master planning projects, and input from City staff on the development of public and private cost sharing. Where appropriate, costs were escalated to reflect the more current Engineering News Record's (ENR) Construction Cost Index (CCI).

This section documents the unit costs used in developing the opinion of probable construction costs, the Construction Cost Index, the land acquisition costs, and markups to account for construction contingency and other project related costs.

6.2.1 Unit Costs

The unit cost estimates used in developing the Capital Improvement Program are summarized on **Table 6.1**. The unit costs are intended for developing the Order of Magnitude estimate, and do not account for site specific conditions, labor of material costs during the time of construction, final project scope, implementation schedule, detailed utility and topography surveys for retention basin sites, investigation of alternative routings for pipes, and other various factors. These factors are assumed included in the contingencies applied to the final capital improvement cost.

The unit costs include:

- **Pipeline Unit Costs.** Unit costs were escalated from the 1995 SDMP and compared to bid tabulations provided by City Staff to validate the cost assumptions.
- **Drainage Basin Unit Costs.** These costs are based on the proposed new or expanded capacities and, for new facilities, generally assume an average depth of 25 feet for cost estimating purposes. This master plan recommends special studies and geotechnical investigations be conducted to determine the feasible maximum depth at each site.
- **Pump Station Costs.** These costs are based on a lift station project equation as shown on **Table 6.1**.

6.2.2 Construction Cost Index

Costs estimated in this study are adjusted utilizing the Engineering News Record (ENR) Construction Cost Index (CCI), which is widely used in the engineering and construction industries.

The costs in this Storm Drainage System Master Plan were calculated using a 20-City national average ENR CCI of 10,532, reflecting a date of January 2017.

Table 6.1 Unit Costs

Storm Drainage System Master Plan
City of Hanford

Pipe Size (in)	($/Lineal Foot)
15	$120
18	$135
21	$166
24	$196
30	$241
36	$286
42	$331
48	$391
54	$436
60	$451
66	$497
72	$542
84	$692
96	$767
108	$858
120	$948
Detention Basin	**Capacity Cost (acre/$)**
New Retention Basin	73,156
Retention Basin Expansion	36,578
Pipeline Casings	
$22 per inch diameter per linear foot	
Lift Stations	
Estimated Lift Station Project Cost = $8,764*Q^2 + 244,811*Q + 331,618$, where Q is in mgd	

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Note: 4/6/2017

1. Costs based on ENR CCI of 10532 for January 2017.

6.2.3 Land Acquisition

Construction of pipelines is generally assumed to be within existing or future street right-of-ways. A land acquisition fee for the construction of retention basins was estimated and included to account for future land purchases.

Land acreages needed for drainage basins were calculated based on provisions for an assumed average depth of 25 feet.

6.2.4 Construction Contingency Allowance

Knowledge about site-specific conditions for each proposed project is limited at the master planning stage; therefore, construction contingencies were used. The estimated construction costs in this master plan include a **15 percent** contingency allowance to account for unforeseen events and unknown field conditions.

6.2.5 Project Related Costs

The capital improvement costs also account for project-related costs, comprised of engineering design, project administration (developer and City staff), construction management and inspection, and legal costs. The project related costs in this master plan were estimated by applying an additional **15 percent** to the estimated construction costs.

6.3 CAPITAL IMPROVEMENT PROGRAM

The Capital Improvement Program includes pipeline, retention basin, and pump stations projects recommended in this master plan, and phased for potential expenditure budgeting discussed in a later section. Each improvement was assigned a unique coded identifier associated with its associated drainage basin.

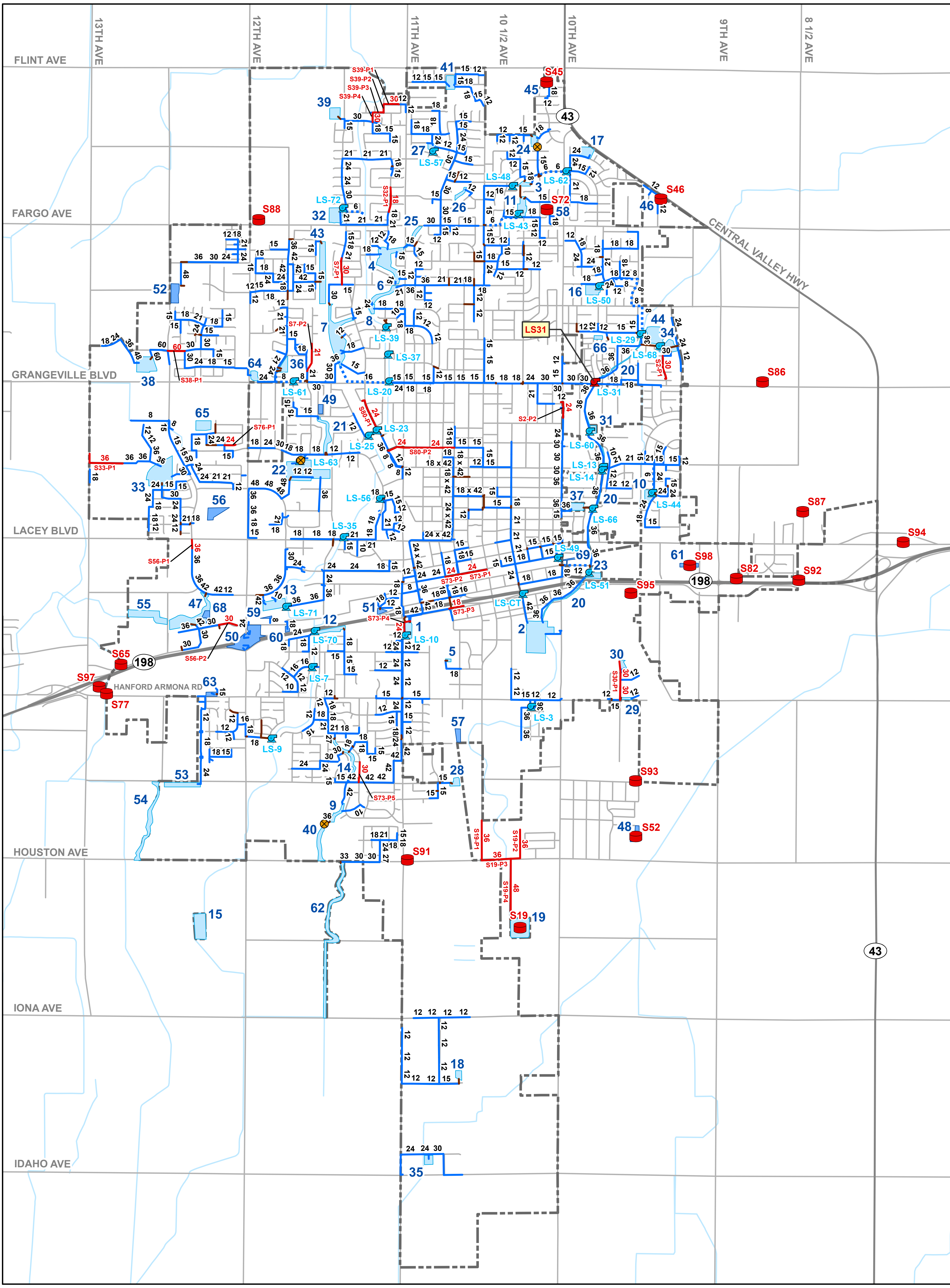
The estimated construction costs include the baseline costs plus **15 percent** contingency allowance to account for unforeseen events and unknown field conditions, as described in a previous section. Capital improvement costs include the estimated construction costs plus **15 percent** project-related costs (engineering design, project administration, construction management and inspection, and legal costs).

6.3.1 Pipelines

The recommended pipeline improvements are grouped by drainage basin and listed on **Table 6.2**. Each improvement includes a general description of the street alignment and limits, as well as existing pipe diameter and length. Improvements are shown on **Figure 6.1**.

The following pipeline improvements categories were identified:

- **New Pipeline.** A new pipeline is proposed where none exists.



Legend

Future Improvements
- Basins
- Lift Stations
- Pipes

Existing System
- Lift Stations
- Valves
- Gravity Pipes
- Force Mains
- Unknown Pipe Size

- City Storm Basins
- Private Storm Basins
- City Limits
- Streets
- Waterways

0 0.25 0.5 1 Mile

Update: August 10, 2017

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Figure 6.1
Proposed Improvements

Storm Drainage System Master Plan
City of Hanford

Table 6.2 Capital Improvement Program
Storm Drainage System Master Plan
City of Hanford

Improv. No.	Type of Improv	Alignment	Limits	Existing Diameter (in)	New/Parallel/ Replace	Diameter (in)	Length (ft)	Number of Casings	Unit Cost[1] (\$/LF)	Pipe Cost (\$)	Baseline Constr. Costs (\$)	Estimated Constr. Cost[2] (\$)	Capital Improvement Costs[3] (\$)	Suggested Cost Allocation: Existing Users (%)	Suggested Cost Allocation: Future Users (%)	Cost Sharing: Existing Users (\$)	Cost Sharing: Future Users (\$)
Existing System Improvements																	
Existing Pipeline Improvements																	
Basin S2																	
S2-P1	Pipe	Brookhollow Dr	From Hoover Way to Waterview St	18	Replace	30	825	-	241	198,603	198,603	228,394	262,653	100%	0%	262,653	0
S2-P2	Pipe	10th Ave	From Bass St to approximately 190 ft n/o Malone St	15	Replace	24	600	-	196	117,357	117,357	134,960	155,204	0%	100%	0	155,204
												Subtotal - S2	417,857			262,653	155,204
Basin S7																	
S7-P1	Pipe	Glacier Way	From approximately 100 ft n/o Muir Way to Cortner St	24	Replace	30	900	-	241	216,658	216,658	249,157	286,531	90%	10%	257,878	28,653
S7-P2	Pipe	Kings Rd	From Crescent Way to Claridge Ln	-	New	21	975	-	166	161,365	161,365	185,570	213,406	80%	20%	170,724	42,681
												Subtotal - S7	499,936			428,602	71,334
Basin S19																	
S19-P1	Pipe	10 1/2 Ave	From 1,350 ft n/o Houston Ave to Houston Ave	-	New	36	1,350	-	286	385,923	385,923	443,811	510,383	0%	100%	0	510,383
S19-P2	Pipe	ROW	ROW between 10 1/2 Ave and 10 th Ave from 1,000 ft n/o Houston Ave to Houston Ave	-	New	36	1,275	-	286	364,482	364,482	419,155	482,028	0%	100%	0	482,028
S19-P3	Pipe	Houston Ave	From 10 1/2 Ave to 1,000 ft e/o 10 1/2 Ave	-	New	36	1,000	-	286	285,869	285,869	328,749	378,061	0%	100%	0	378,061
S19-P4	Pipe	ROW	ROW between 10 1/2 Ave and 10th Ave from Houston Ave to 2,000 ft s/o Houston Ave	30	Replace	48	2,025	-	391	792,157	792,157	910,980	1,047,627	0%	100%	0	1,047,627
												Subtotal - S19	2,418,099			0	2,418,099
Basin S30																	
S30-P1	Pipe	9 1/4 Ave	From Hanford Armona Rd to 1,350 ft n/o Hanford Armona Rd	15	Replace	30	1,300	-	241	312,951	312,951	359,893	413,878	100%	0%	413,878	0
												Subtotal - S30	413,878			413,878	0
Basin S32																	
S32-P1	Pipe	Fountain Plaza Dr	From West Pebble Dr to Willow St	12	Replace	18	850	-	135	115,100	115,100	132,365	152,219	100%	0%	152,219	0
												Subtotal - S32	152,219			152,219	0
Basin S33																	
S33-P1	Pipe	Learning Center Main Access	From 13th Ave to School	18	Replace	36	1,425	-	286	407,363	407,363	468,467	538,737	100%	0%	538,737	0
												Subtotal - S33	538,737			538,737	0
Basin S38																	
S38-P1	Pipe	Berkshire Ln	From Bordeaux St to Centennial Dr	42	Replace	60	575	-	451	259,539	259,539	298,469	343,240	100%	0%	343,240	0
												Subtotal - S38	343,240			343,240	0
Basin S39																	
S39-P1	Pipe	Imperial Way	From Plum Ln to Cajun Way	24	Replace	30	500	-	241	120,366	120,366	138,421	159,184	80%	20%	127,347	31,837
S39-P2	Pipe	Cajun Way	From Imperial Way to Millbrook St	24	Replace	30	275	-	241	66,201	66,201	76,131	87,551	80%	20%	70,041	17,510
S39-P3	Pipe	Milbrook St	From Cajun Way to Zion Way	24	Replace	30	375	-	241	90,274	90,274	103,815	119,388	80%	20%	95,510	23,878
S39-P4	Pipe	Zion Way	From Millbrook St to Saffron St	24	Replace	30	325	-	241	78,238	78,238	89,973	103,469	80%	20%	82,776	20,694
												Subtotal - S39	469,592			375,673	93,918
Basin S56																	
S56-P1	Pipe	Centennial Dr	From Lacey Blvd to 300 ft s/o Lacey Blvd	24	Replace	36	300	-	286	85,761	85,761	98,625	113,418	0%	100%	0	113,418
S56-P2	Pipe	Glendale Ave	From approximately 800 ft w/o 12th Ave to approximately 300 w/o 12th Ave	24	Replace	30	625	-	241	150,457	150,457	173,026	198,980	0%	100%	0	198,980
												Subtotal - S56	312,398			0	312,398
Basin S73																	
S73-P1	Pipe	Sixth St	From Douty St to Redington St	15	Replace	24	875	-	196	171,145	171,145	196,817	226,339	0%	100%	0	226,339
S73-P2	Pipe	Sixth St	From Redington St to Phillips St	18	Replace	24	535		196	104,643	104,643	120,339	138,390	0%	100%	0	138,390
S73-P3	Pipe	Third St	From approximately 80 ft w/o Redington St to Phillips St	12	Replace	18	500	-	135	67,706	67,706	77,862	89,541	0%	100%	0	89,541
S73-P4	Pipe	11th Ave	From approximately 70 ft n/o Silverado St to approximately 150 ft s/o Third St	18	Replace	24	550	-	196	107,577	107,577	123,713	142,270	0%	100%	0	142,270
S73-P5	Pipe	Echo Ln	From 100 ft n/o Echo Ct to Hume Ave	12	Replace	30	675	-	241	162,494	162,494	186,868	214,898	50%	50%	107,449	107,449

Table 6.2 Capital Improvement Program
Storm Drainage System Master Plan
City of Hanford

Improv. No.	Type of Improv	Alignment	Limits	Existing Diameter (in)	New/Parallel/ Replace	Diameter (in)	Length (ft)	Number of Casings	Unit Cost[1] ($/LF)	Pipe Cost ($)	Baseline Constr. Costs ($)	Estimated Constr. Cost[2] ($)	Capital Improvement Costs[3] ($)	Suggested Cost Allocation: Existing Users (%)	Suggested Cost Allocation: Future Users (%)	Cost Sharing: Existing Users ($)	Cost Sharing: Future Users ($)
												Subtotal - S73	811,439			107,449	703,990
Basin S76																	
S76-P1	Pipe	Hopkins Dr	From Cogswell Pl to Scripps Ct	18	Replace	24	375	-	196	73,348	73,348	84,350	97,003	100%	0%	97,003	0
												Subtotal - S76	97,003			97,003	0
Basin S80																	
S80-P1	Pipe	Rodgers Rd	From Neville Ave to Lift Station 23	10	Replace	24	1,175	-	196	229,823	229,823	264,297	303,941	100%	0%	303,941	0
S80-P2	Pipe	Cameron St	From Redington St to Rodgers Rd	18	Replace	24	2,225	-	196	435,197	435,197	500,477	575,548	100%	0%	575,548	0
												Subtotal - S80	879,490			879,490	0
Existing Retention Basin Improvements				**(AF)**		**(AF)**											
S-19	Existing Retention Basin		Approximately 2,600 ft se/o 10 1/2 Ave and Houston Ave	72.3	Capacity Expansion	23.7					89,345	102,747	118,159	87%	13%	102,798	15,361
S-45	Existing Retention Basin		Approximately 500 ft n/o Capistrano St and Mission Rd	3.8	Capacity Expansion	6.2					49,899	57,383	65,991	62%	38%	40,914	25,077
S-46	Existing Retention Basin		Approximately 900 ft n/o Meadow View and Fargo Ave	3.0	Capacity Expansion	1.0					36,240	41,676	47,928	0%	100%	0	47,928
S-52	Existing Retention Basin		Approximately 2,700 feet ne/o Houston Ave and 10th Ave	7.0	Capacity Expansion	29.0					100,386	115,443	132,760	82%	18%	108,863	23,897
Existing Lift Station Improvements				**Firm Capacity**		**Firm Capacity**											
Basin S2																	
LS-31	Lift Station		Lift Station 31 : Approximately 250 ft w/o intersection of Grangeville Blvd and Arroyo Rd	1 @ 2,500	Replace	3 @ 1,200 gpm					1,836,241	2,111,677	2,428,428	100%	0%	2,428,428	0
										Subtotal - Existing Pipeline Improvements	5,560,595	6,394,684	7,353,887			3,598,944	3,754,943
										Subtotal - Retention Basin Improvements	275,869	317,250	364,837			252,575	112,262
										Subtotal - Lift Station Improvements	1,836,241	2,111,677	2,428,428			2,428,428	0
Future System Improvements																	
Pipelines Servicing Future Retention Basins[5]																	
S65-P1	Pipe		2,000 ft upstream of Retention Basin S65	-	New	42	2,000	-	331	662,011	662,011	761,313	875,510	0%	100%	0	875,510
S72-P1	Pipe		2,000 ft upstream of Retention Basin S72	-	New	24	2,000	-	196	391,189	391,189	449,867	517,347	0%	100%	0	517,347
S77-P1	Pipe		2,000 ft upstream of Retention Basin S77	-	New	48	2,000	-	391	782,377	782,377	899,734	1,034,694	0%	100%	0	1,034,694
S82-P1	Pipe		2,000 ft upstream of Retention Basin S82	-	New	60	2,000	-	451	902,743	902,743	1,038,154	1,193,877	0%	100%	0	1,193,877
S86-P1	Pipe		2,000 ft upstream of Retention Basin S86	-	New	96	2,000	-	767	1,534,663	1,534,663	1,764,862	2,029,592	0%	100%	0	2,029,592
S87-P1	Pipe		2,000 ft upstream of Retention Basin S87	-	New	60	2,000	-	451	902,743	902,743	1,038,154	1,193,877	0%	100%	0	1,193,877
S88-P1	Pipe		2,000 ft upstream of Retention Basin S88	-	New	48	2,000	-	391	782,377	782,377	899,734	1,034,694	0%	100%	0	1,034,694
S91-P1	Pipe		2,000 ft upstream of Retention Basin S91	-	New	36	2,000	-	286	571,737	571,737	657,498	756,122	0%	100%	0	756,122
S92-P1	Pipe		2,000 ft upstream of Retention Basin S92	-	New	60	2,000	-	451	902,743	902,743	1,038,154	1,193,877	0%	100%	0	1,193,877
S93-P1	Pipe		2,000 ft upstream of Retention Basin S93	-	New	66	2,000	-	497	993,017	993,017	1,141,970	1,313,265	0%	100%	0	1,313,265
S94-P1	Pipe		2,000 ft upstream of Retention Basin S94	-	New	60	2,000	-	451	902,743	902,743	1,038,154	1,193,877	0%	100%	0	1,193,877
S95-P1	Pipe		2,000 ft upstream of Retention Basin S95	-	New	30	2,000	-	241	481,463	481,463	553,682	636,735	0%	100%	0	636,735
S97-P1	Pipe		2,000 ft upstream of Retention Basin S97	-	New	48	2,000	-	391	782,377	782,377	899,734	1,034,694	0%	100%	0	1,034,694
S98-P1	Pipe		2,000 ft upstream of Retention Basin S98	-	New	36	2,000	-	286	571,737	571,737	657,498	756,122	0%	100%	0	756,122

Table 6.2 Capital Improvement Program
Storm Drainage System Master Plan
City of Hanford

Improvements						Pipelines and Appurtenances Costs					Capital Improvement Program			Suggested Cost Allocation		Cost Sharing	
Improv. No.	Type of Improv	Alignment	Limits	Existing Diameter (in)	New/Parallel/ Replace	Diameter (in)	Length (ft)	Number of Casings	Unit Cost[1] ($/LF)	Pipe Cost ($)	Baseline Constr. Costs ($)	Estimated Constr. Cost[2] ($)	Capital Improvement Costs[3] ($)	Existing Users %	Future Users %	Existing Users ($)	Future Users ($)
Future Retention Basins						**(AF)**											
S-65	New Retention Basin		Approximately 1,500 ft w/o Aquifer Dr and Highway 198		Future	6.0					98,803	113,623	130,667	0%	100%	0	130,667
S-72	New Retention Basin		Approximately 600 ft ne/o Fargo Ave and Fairmont Ave		Future	6.0					98,803	113,623	130,667	0%	100%	0	130,667
S-77	New Retention Basin		Approximately 3,300 ft w/o Greenbrier Dr and Hanford Harmona Rd		Future	18.0					154,239	177,374	203,981	0%	100%	0	203,981
S-82	New Retention Basin		Approximately 600 ft ne/o Highway 198 and 9th Ave		Future	20.0					162,915	187,352	215,455	0%	100%	0	215,455
S-86	New Retention Basin		Approximately at intersection of 8 1/2 Ave and Grangeville Blvd		Future	64.0					337,665	388,314	446,561	0%	100%	0	446,561
S-87	New Retention Basin		Approximately 1,050 ft n/o intersection of Lacey Blvd and Vista Ave		Future	58.0					314,954	362,197	416,527	0%	100%	0	416,527
S-88	New Retention Basin		Approximately 300 ft ne/o 12th Ave and Fargo Ave		Future	20.0					162,915	187,352	215,455	0%	100%	0	215,455
S-91	New Retention Basin		Approximately at the intersection of Houston Ave and 11th Ave		Future	16.0					145,440	167,256	192,345	0%	100%	0	192,345
S-92	New Retention Basin		Approximately 300 ft se/o Curtis St and David St		Future	42.0					253,061	291,021	334,674	0%	100%	0	334,674
S-93	New Retention Basin		Approximately 4,000 ft nw/o Houston Ave and 9th Ave		Future	100.0					470,108	540,624	621,718	0%	100%	0	621,718
S-94	New Retention Basin		Approximately 850 ft e/o of Lacey Blvd and 8th Ave		Future	146.0					633,259	728,248	837,485	0%	100%	0	837,485
S-95	New Retention Basin		Approximately 1,000 ft sw/of Third St and 9 1/2 Ave		Future	3.0					83,409	95,920	110,309	0%	100%	0	110,309
S-97	New Retention Basin		Approximately at the intersection of Highway 198 and Hanford Armona Rd		Future	4.0					88,652	101,950	117,242	0%	100%	0	117,242
S-98	New Retention Basin		Approximately 1,500 ft nw/o at intersection of 9 1/8 Ave and Highway 198		Future	10.0					118,115	135,832	156,207	0%	100%	0	156,207
										Subtotal - Future Pipeline Improvements	11,163,920	12,838,508	14,764,284			0	14,764,284
										Subtotal - Future Retention Basins	3,122,338	3,590,688	4,129,292			0	4,129,292
										Total							
										Pipeline Improvements	16,724,515	19,233,192	**22,118,171**			**3,598,944**	**18,519,228**
										Retention Basin Improvements	3,398,207	3,907,938	**4,494,129**			**252,575**	**4,241,553**
										Lift Station Improvements	1,836,241	2,111,677	**2,428,428**			**2,428,428**	**0**
										Total Capital Improvement Costs	**21,958,963**	**25,252,807**	**29,040,728**			**6,279,947**	**22,760,781**

AKEL ENGINEERING GROUP, INC.

7/19/2017

Notes:
1. Costs are based on ENR Construction Cost Index from January 2017.
2. Baseline construction costs plus 15% to account for unforeseen events and unknown conditions.
3. Estimated construction costs plus 15% to cover other costs including: engineering design, project administration (developer and City staff), construction management and inspection, and legal costs.
4. New retention basin depth assumed to be equal to 25 feet.
5. Pipelines servicing future retention basins are placeholders for future trunk systems of this basin
6. Casing price is estimated at $22/in/l-ft.

- **Replacement Pipeline.** This improvement is intended as a replacement to an existing pipeline, and along the same alignment. The existing pipeline should be abandoned when the replacement pipeline has been constructed.

The opinion of probable construction costs, for the projects included in this master plan, are based on the pipe unit costs summarized on **Table 6.1**.

6.3.2 Drainage Basins

Retention basin improvements included the following two categories:

- **Existing Retention Basin Capacity Expansion.** Existing retention basin improvements are shown on **Figure 6.1**, and listed on **Table 6.2**. Each retention basin includes the volume required to meet the design storm requirements in acre feet.

  It should be noted that infill development requiring capacity increases to the retention basins should excavate the retention basin and provide appurtenances to connect to the storm drainage system.

- **New Future Retention Basins.** New retention basins are also shown on **Figure 6.1**, listed on **Table 6.2.**

The opinion of probable construction costs for new or upgraded retention basins are based on the costs summarized on **Table 6.1**.

6.3.3 Pump Stations

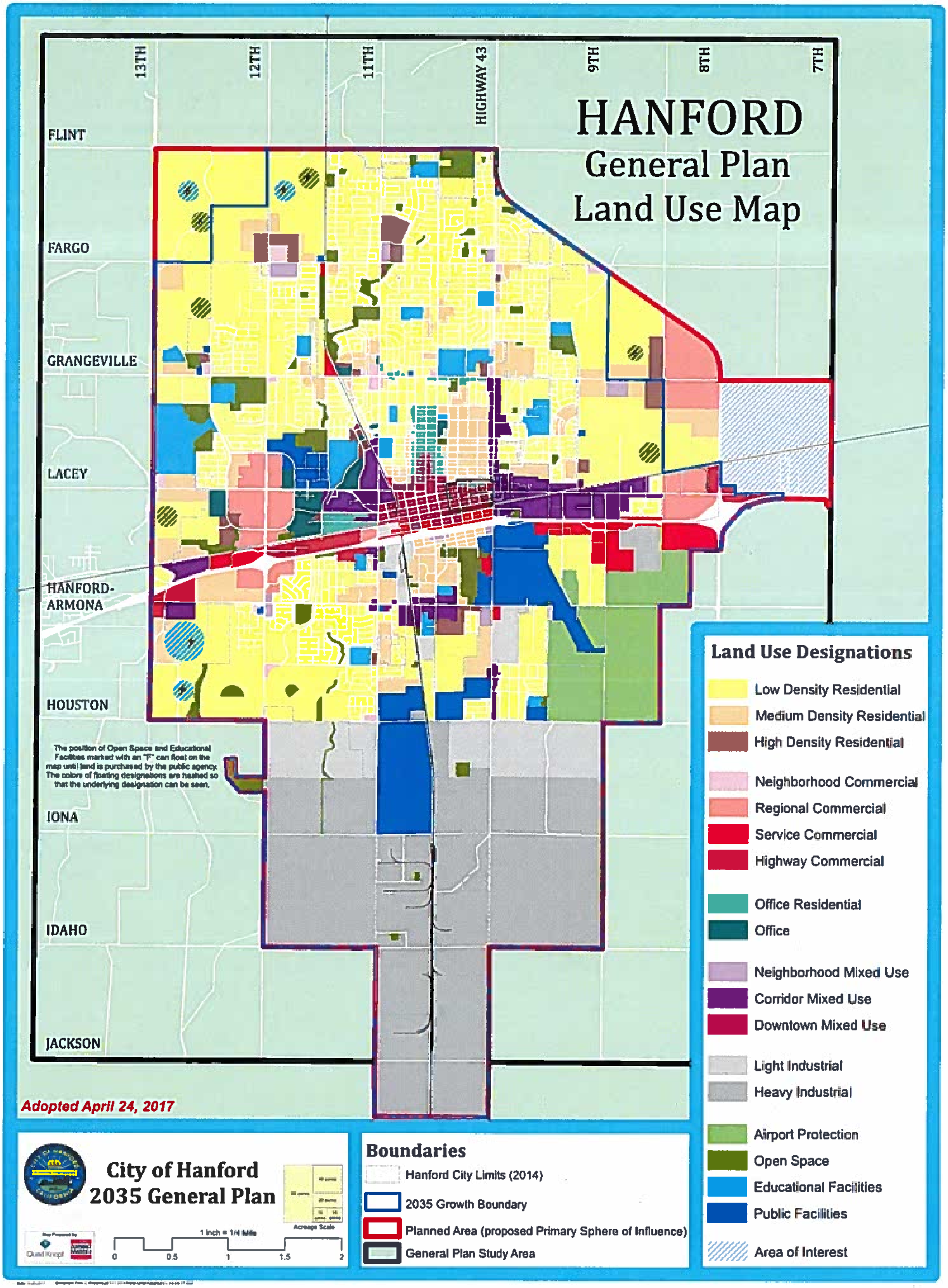
Several existing pump stations required capacity increases to meet the performance criteria listed in a previous chapter, as shown on **Figure 6.1**. The pump station and the recommended firm capacity is listed on **Table 6.2**.

6.3.4 Suggested Capacity Allocation Analysis

Capacity allocation analysis is needed to identify improvement funding sources, and to establish a nexus between development impact fees and improvements needed to service growth. In compliance with the provisions of Assembly Bill AB 1600, the analysis differentiates between the project needs of servicing existing users and for those required to service anticipated future developments. **Table 6.2** lists each improvement, and separates the cost by responsibility between existing and future users. The cost responsibility is based on model parameters for existing and future land use, and may change depending on the nature of development.

APPENDIX A

General Plan Land Use Map


HANFORD
General Plan
Land Use Map
13TH
12TH
11TH
HIGHWAY 43
9TH
8TH
7TH
FLINT
FARGO
GRANGEVILLE
LACEY
HANFORD-ARMONA
HOUSTON
IONA
IDAHO
JACKSON
The position of Open Space and Educational Facilities marked with an "F" can float on the map until land is purchased by the public agency. The colors of floating designations are hashed so that the underlying designation can be seen.
Adopted April 24, 2017
Land Use Designations
Low Density Residential
Medium Density Residential
High Density Residential
Neighborhood Commercial
Regional Commercial
Service Commercial
Highway Commercial
Office Residential
Office
Neighborhood Mixed Use
Corridor Mixed Use
Downtown Mixed Use
Light Industrial
Heavy Industrial
Airport Protection
Open Space
Educational Facilities
Public Facilities
Area of Interest
City of Hanford
2035 General Plan
1 inch = 1/4 Mile
0
0.5
1
1.5
2
Acreage Scale
Boundaries
Hanford City Limits (2014)
2035 Growth Boundary
Planned Area (proposed Primary Sphere of Influence)
General Plan Study Area