City Of Redding
WASTEWATER
Utility Master Plan

Final Draft
August 2012

Prepared by
City of Redding Public Works Department
Engineering Division

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City of Redding

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Executive Summary

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1.0 INTRODUCTION

The Wastewater Utility Master Plan 2012 addresses the City's sewer collection and wastewater treatment system needs for existing conditions, as well as for the planning periods of years 2015, 2020, 2030 and Ultimate Buildout (UBO). The evaluations of these systems and preparation of this report was conducted by the City of Redding Public Works Department Engineering Division. This master plan is an update of master plans previously prepared for the two service areas of Redding's collection and treatment system. These previous studies are:

- Wastewater Utility Master Plan (2003 by Carollo Engineers),
- Master Sewer Plan (1987 by Pace Engineering) which addressed the Clear Creek Basin and Treatment Plant, and
- Stillwater Service Area Master Sewer Plan (1992 by Pace Engineering) which addressed the Stillwater Basin.

This Master Plan addresses both the collection system and the wastewater treatment facilities for the Clear Creek and Stillwater service areas. The Wastewater Treatment Plant (WWTP) evaluation portion utilizes the most recent facilities plans for each treatment plant as follows:

- Clear Creek Wastewater Treatment Plant Facilities Plan (2005 by Brown and Caldwell), and
- Stillwater Wastewater Treatment Plant Facilities Plan (2008 by Waterworks Enginerers).

This report is organized with general background material presented first, followed by a chapter for evaluating each service area collection system and treatment facilities. Once the evaluations were complete and a list of recommended projects had been generated, cost estimates were obtained in preparation for the Capital Improvement Plan (CIP) and Financial Impact chapters. The aging pipe replacement program evaluation and inflow and infiltration reduction programs are presented in chapters preceding the CIP and Financial impacts.

The general background material includes:

- Description of the Utility,
- Regulatory Considerations,
- Wastewater Demand and forecasting methodology,
- Methodology used for developing the ten-year design storm, and
- Hydraulic analysis methodologies and assumptions.

Individual chapters covering the two collection systems include:

- Description of the existing facilities,
- Documentation of calibration of the hydraulic models,
- Evaluation of collection system and treatment capacities at each planning horizon, and
- The recommended facilities for conveying and treating existing and projected future flows.

The CIP chapter lists, ranks, and schedules the project recommendations. In addition it contains information regarding potential service to the Stillwater Creek Drainage Area.

The final chapter provides a general look at the financial impacts of the new Capital Improvement Plan. However, it does not make recommendations. Recommendations will follow as the product of a cost of service , impact fee and rate studies that will be prepared under contract by a consultant based on the findings of this Master Plan.

2.0 SCOPE AND PURPOSE OF WASTEWATER MASTER PLAN

The 2003 Wastewater Master Plan provided an evaluation and assessment of the utility requirements for operations, capital improvements, and funding during a period of time where the Redding area was experiencing rapid growth which was projected to continue. The current, 2012, effort has scaled back the growth expectation to account for economic changes that have occurred in the last four or five years.

The City of Redding Wastewater Utility Master Plan 2012 presents an updated evaluation and assessment of the current state of the City's wastewater system, and provides a framework for addressing wastewater system operations, capital improvements, funding and City management policy related to the wastewater system. The scope of work for the Wastewater Master Plan 2012 included the following primary tasks:

- Data Collection and Review
- Computer Model Development
- Household Equivalent Analysis
- Demand Forecasting
- Computer Modeling of Hydraulic Capacity
- System Evaluation and Recommendations for Improvements
- Capital Improvement Plan (CIP)
- Financial Analysis of the Impacts of the CIP

3.0 CLEAR CREEK BASIN FACILITIES

The Clear Creek Basin encompasses areas west of the Sacramento River, the western portion of the Enterprise area, and areas served upstream of the North Market Street Lift Station. A schematic of the Clear Creek sanitary service area and existing collection system is shown on Figure ES-1.

The Clear Creek Basin collection system includes 11 lift stations for pumping wastewater across the Sacramento River or over ridges. The collection system terminates at the Clear Creek Wastewater Treatment Plant (WWTP), and treated effluent is discharged to the Sacramento River.

Collection System

Major improvement recommendations resulting from the system evaluation under existing conditions include:

- Increase capacity in Westside Interceptor
- Increase capacity in the Lake Redding Interceptor
- Increase capacity in the Buenaventura Canyon Interceptor
- Increase capacity in Westside Lift Station
- Increase capacity at North Market Street Lift Station
- Replace outdated lift stations at Locust Street and Layton Ave

Locations of the recommended projects are indicated on Figure ES-2. Also indicated on this figure are other smaller sewer pipeline improvements.

Potential future system expansion projects included in the analysis are shown on Figure ES-3. A brief, planning level evaluation was performed to determine if the approximate project locations shown would function as gravity sewers. No further detailed investigation was performed. Locations are approximate for planning purposes only. Final pipe alignments and locations will be determined if and when any of the projects reaches preliminary design.

Treatment Facilities

Clear Creek WWTP (Wastewater Treatment Plant) is currently nearing completion of a significant capacity upgrade. Future projects within this planning document time frame are:

- Improvements to the levee between the ponds and the Sacramento River
- Upgrades to two of the existing holding ponds to preserve their use

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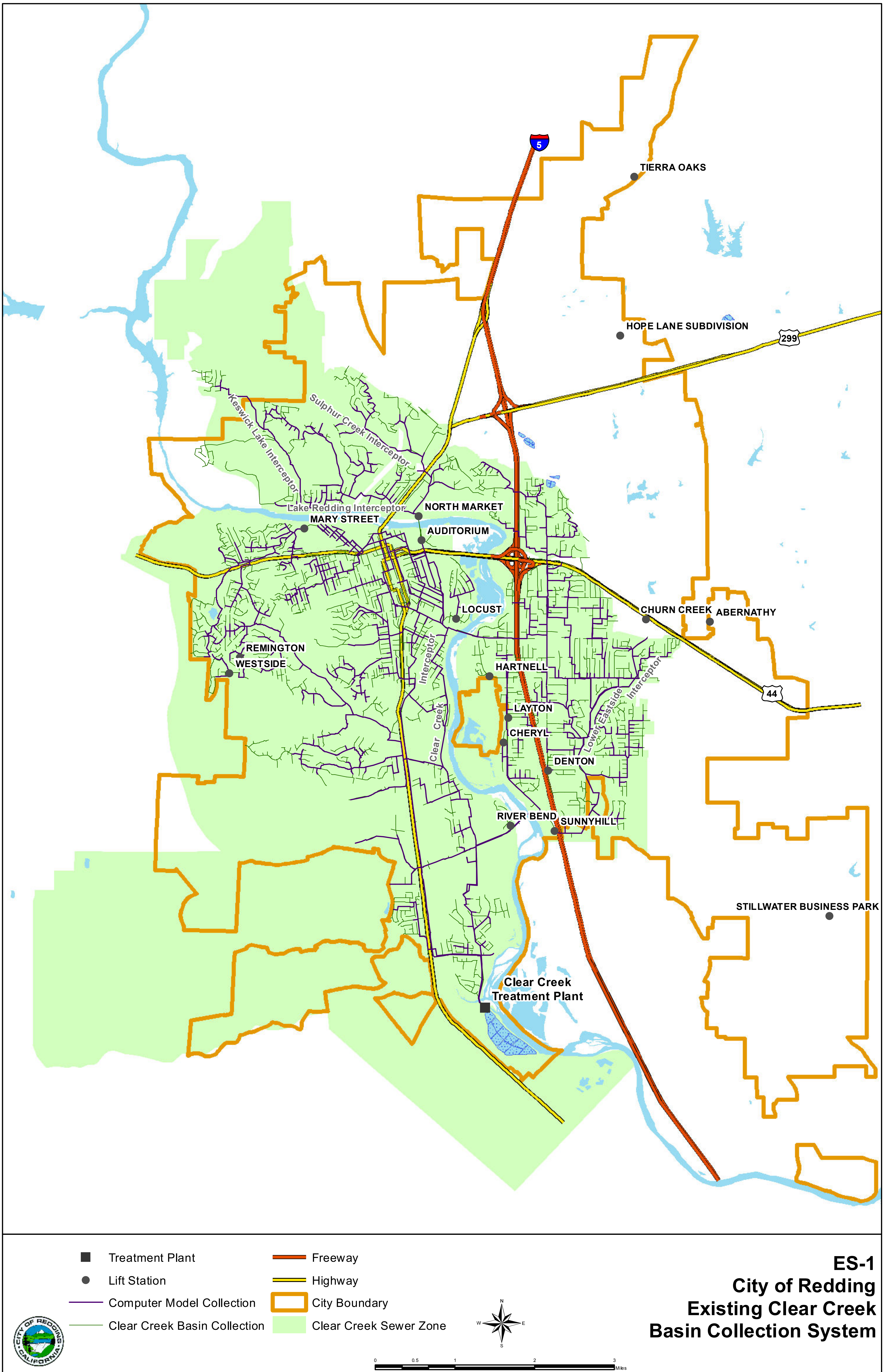

ES-1
City of Redding
Existing Clear Creek Basin Collection System

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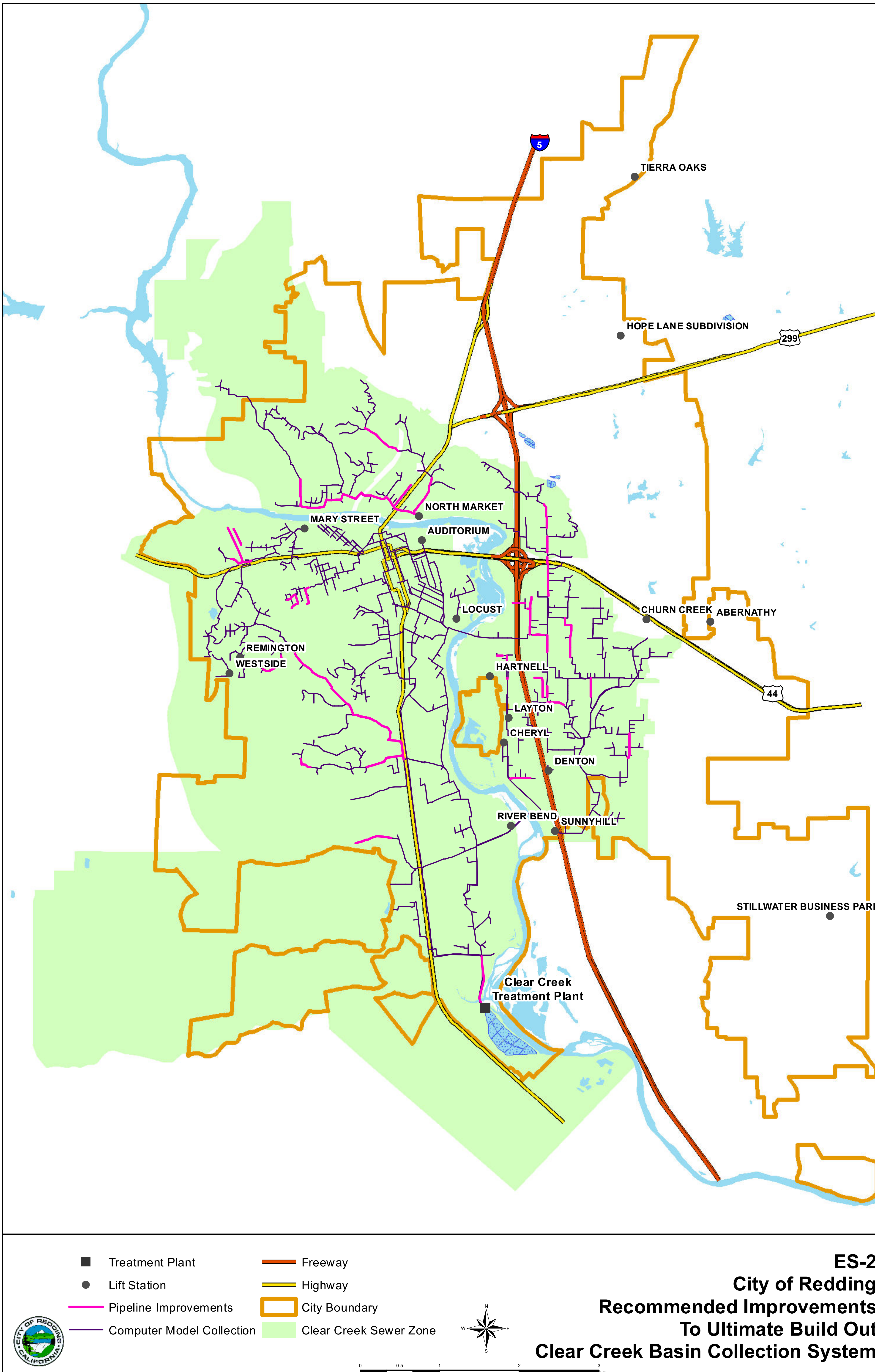
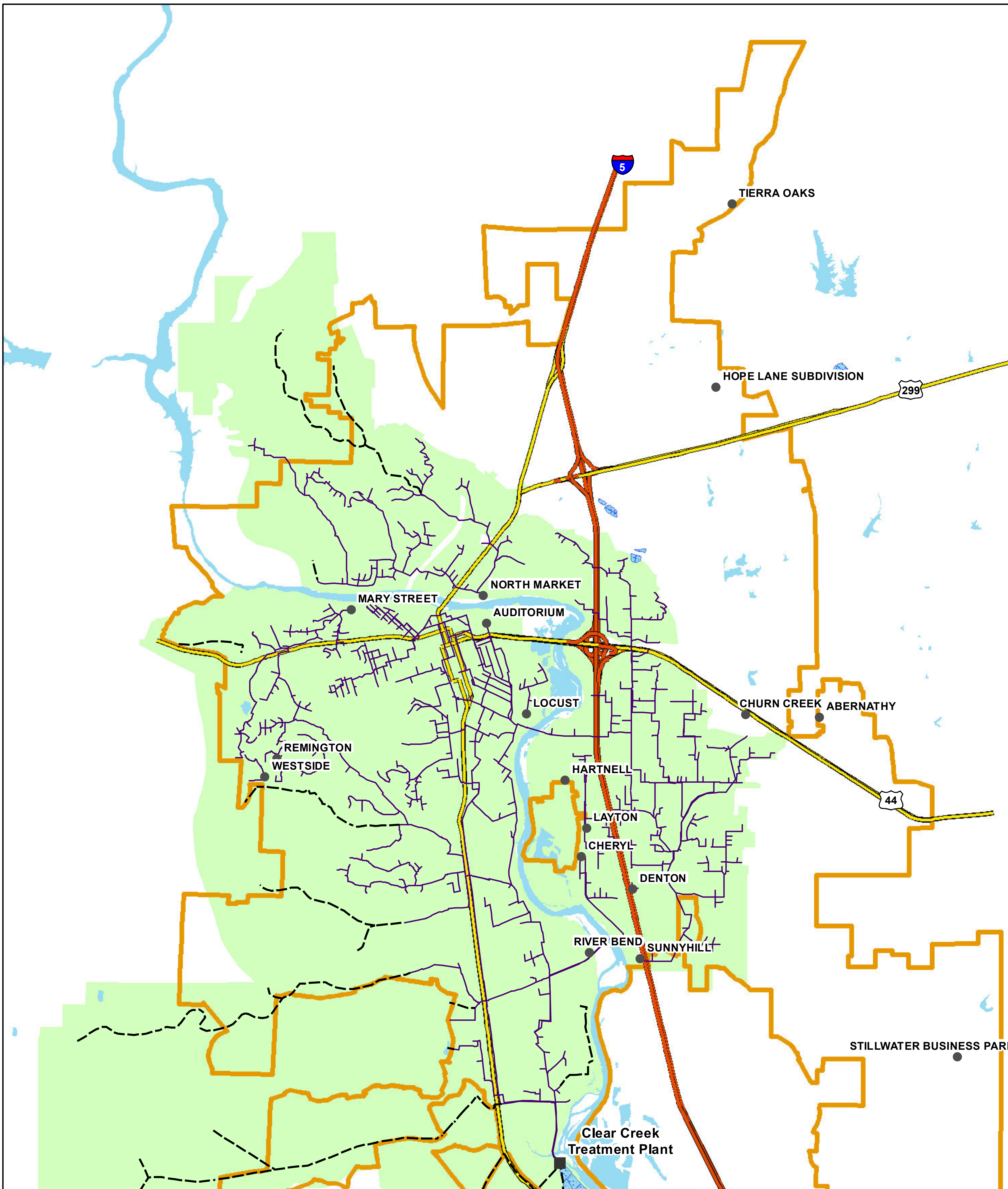
Aug. 28, 2012



ES-2
City of Redding
Recommended Improvements
To Ultimate Build Out
Clear Creek Basin Collection System



* Future Pipe alignments are approximate, schematic locations intended for planning level analysis only. If constructed, final alignment will be determined during the project development alternatives analysis.

■ Treatment Plant	Freeway
● Lift Station	Highway
Model Collection System	City Boundary
Potential Future Expansion	Clear Creek Sewer Zone

0 0.5 1 2 3 Miles

ES-3
City of Redding
Potential Future Expansion Projects
Clear Creek Basin Collection System

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Sept. 18, 2012

4.0 STILLWATER BASIN FACILITIES

The Stillwater Basin encompasses areas east of the Sacremanto River, including: Boulder Creek and Churn Creek drainage basins upstream of the Churn Creek Lift Station, and the Clover Creek Interceptor which terminates at the Stillwater WWTP. The Stillwater Basin collection system includes three lift stations, including the Churn Creek Lift Station. The Stillwater service area covers approximately one third of the current population of the City. This portion of the City is expected to experience a higher growth rate than the Clear Creek Collection System side and at UBO expected to serve approximately half of the population. The area serves the eastern and northern portions of the City in regions referred to in prior planning efforts and engineers reports as Twin View, Eastern Enterprise, and Stillwater Creek Service Areas. The service area contains approximately 20% commercial and industrial connections and serves the Stillwater Business Park. A schematic of the existing Stillwater Basin collection system is indicated on Figure ES-4.

Collection System

The entire planning time frame of this Master Plan (2012 to 2030) only called for two pipe projects in the Stillwater Collection System:

- Oasis Road
- Boulder Creek Interceptor Phase III

Treatment Facilities

The Stillwater Wastewater Treatment Plant Facilities Plan called for significant improvements in 2023 and between 2030 and UBO.

- Stillwater WWTP Phase 1C	- New Grit Chamber
	- Two Aeration Basins
	- Additional Clarifier
	- New Waste Activated Sludge (WAS)Holding Tank
	- New WAS Pumping Station
	- New WAS Force Main
- Stillwater WWTP Phase 1D	- New Outfall

Considerable analysis was also dedicated with this plan to evaluate alternative strategies for expanding sewer service east of the existing collection system to cover Stillwater Creek Drainage Area. Three different strategies were evaluated:

- Construction of the entire Stillwater Interceptor and Major lift station as a single effort
- Construction of the Stillwater Interceptor in three phases with interim lift stations
- Abandon Stillwater Interceptor and invest in improvements in our existing east side interceptors to allow lifting to our existing system as development occurs.

The cost comparison between the three strategies revealed that improving the existing system is far less expensive than the other two alternatives. However, it requires that a much larger portion of the necessary infrastructure be constructed and funded by project proponents. The analysis of Stillwater Creek Drainage Area is found in Appendix B: Community Outreach, Chapter 6 - Stillwater - Hydraulic Capacity and Treatment Evaluation and Chapter 9 - Capital Improvement Plan. Because of existing policy limiting annexation no recommendations are made regarding expanding service to this area. It is recommended that the subject of whether to allow expansion into this area, and how be further investigated with the next revision to this plan.

Locations of the recommended projects are indicated on Figure ES-5. Also indicated on this figure are other smaller sewer pipeline improvements.

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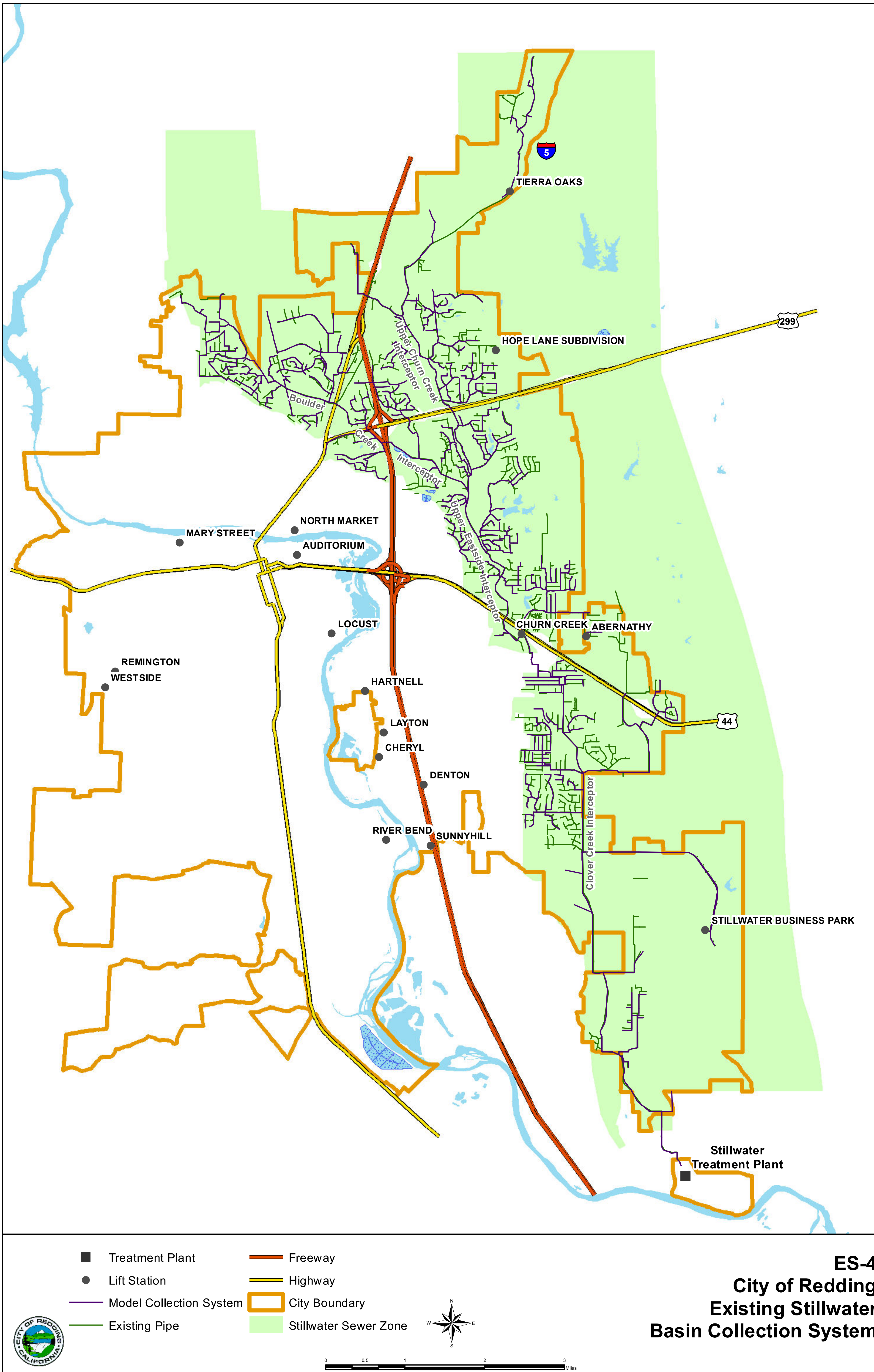

ES-4
City of Redding
Existing Stillwater
Basin Collection System

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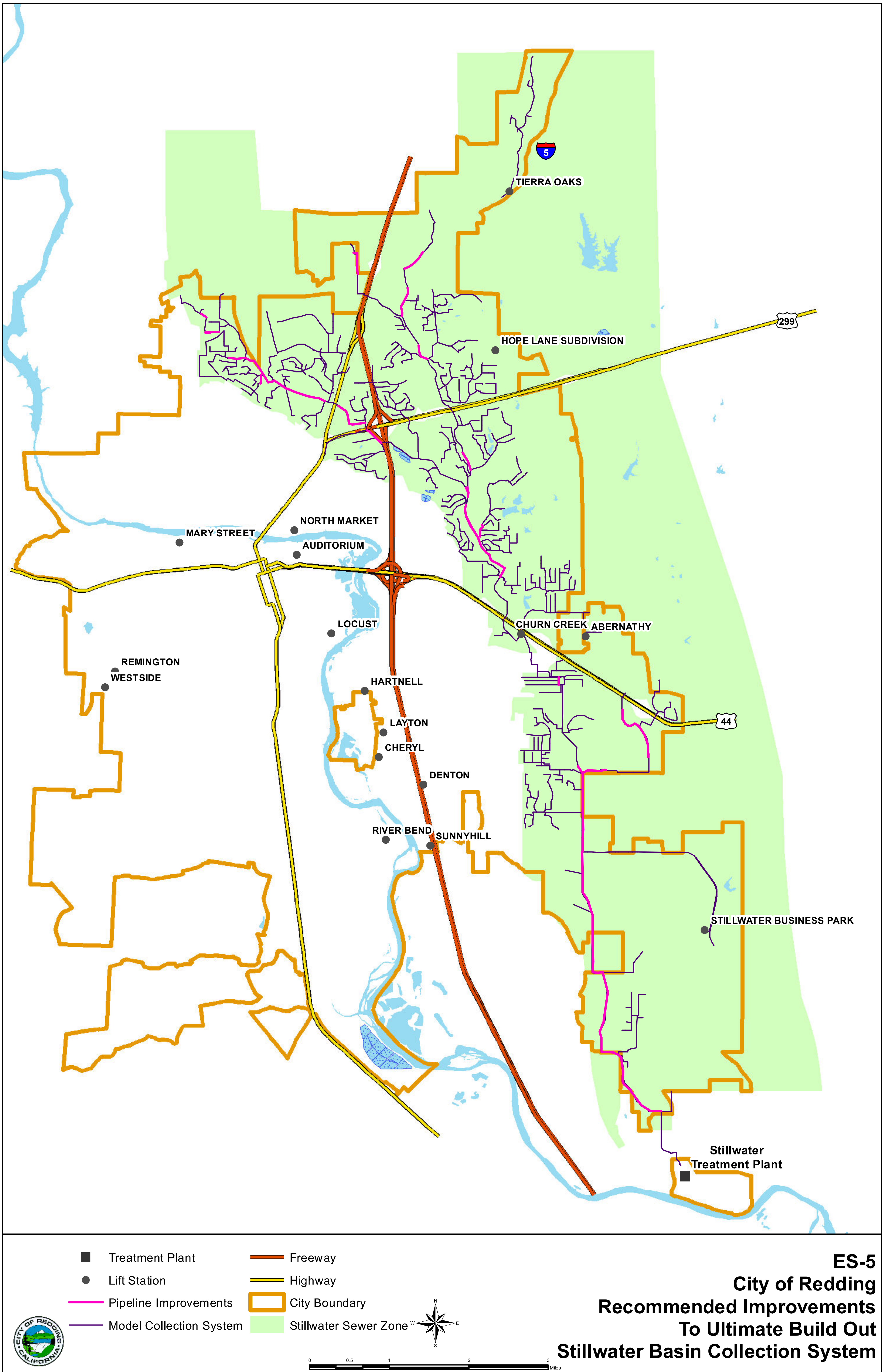
Sept. 19, 2012



ES-5
City of Redding
Recommended Improvements To Ultimate Build Out Stillwater Basin Collection System

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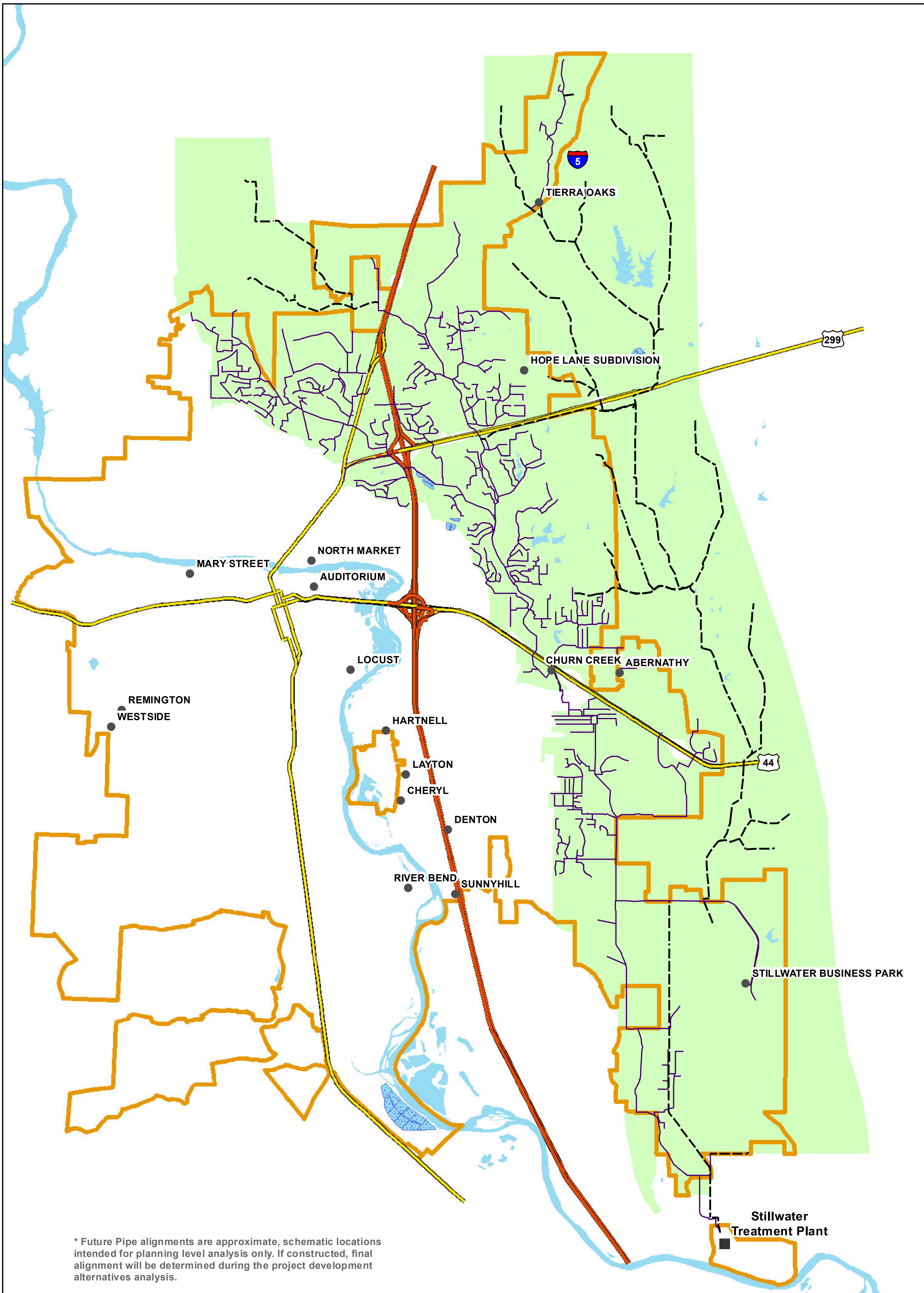

Treatment Plant
Lift Station
Model Collection System
Potential Future Expansion
Freeway
Highway
City Boundary
Stillwater Sewer Zone

0 0.5 1 2 3 Miles

ES-6
City of Redding
Potential Future Expansion Projects
Stillwater Basin Collection System

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Sept. 18, 2012

Potential future system expansion projects included in the analysis are shown on Figure ES-6. A brief, planning level evaluation was performed to determine if the approximate project locations shown would function as gravity sewers. No further detail investigation was performed. Locations are approximate for planning purposes only. Final pipe alignments and locations will be determined if and when any of the projects reaches preliminary design.

5.0 REGULATORY CONSIDERATIONS

Regulatory limitation of the available options for wastewater collection and treatment, effluent discharge, and biosolids disposal will continue to determine much of what the utility does. Regulatory enforcement actions including penalties, the potential effect on public relations, and the risk of litigation arising from inaction or improper handling of the regulatory requirements can impose significant costs to the utility. These costs are difficult to predict and budget for, and are more properly avoided through a systematic effort that identifies the impact those regulations have on utility actions and implements utility plans with these regulations in mind. These considerations will be an increasingly primary factor in the utility's capital improvement program and staffing levels, and will therefore be a determining factor in rate increases and resource allocation. As with other aspects of long-term planning, a constant, and clear focus on the regulatory sphere will be required to ensure an appropriate direction for the utilities future.

Regulatory considerations are incorporated into and serve as primary criteria used in development of the Wastewater Treatment Plant Facility Plans. Details of those considerations and criteria can be found in each treatment plant's Facility Plan.

Additional regulatory interest focuses on reduction of Inflow and Infiltration (I/I) entering the collection system. Excessive I/I can be a primary cause of overflows and difficulties for the treatment plant in handling the higher flows during storm events.

6.0 INFLOW AND INFILTRATION REDUCTION

The primary purpose of a sanitary sewer system is to collect and convey wastewater from the source to a wastewater treatment facility or to its point of discharge. Physical integrity of a sewer system may deteriorate with time due to such factors as deficient construction, physical defects, illicit connections, root penetration, poorly adjusted manholes, corrosion due to biochemical reactions, soil conditions and aggressive ground water. The result may be an increase in flows to be conveyed and treated through the entry of groundwater and rainwater into the sanitary sewer system. Increasing the hydraulic load on the sewer system can have numerous detrimental consequences: reduced available capacity of the system to convey and treat wastewater, increased operating costs, and the potential for sewer backups and overflows.

The most recent I/I reduction study was performed as part of an alternatives analysis for the Westside Interceptor Project in 1999. The study concluded that conveying and treating the I/I was more cost effective than attempting to reduce the I/I. Since that study, and construction of two phases of the Westside Interceptor, efforts have been instigated to reduce I/I from the highest contributing areas identified in the 1999 study.

The first step in development of a comprehensive I/I reduction plan is to identify as precisely as possible where the high I/I areas are located. To accomplish this the City has increased the number of flow monitors and the effectiveness of the monitoring program in the last two years. Chapter 8 of this plan details a robust monitoring program to identify and prioritize areas of the collection system that contribute the highest I/I. Subsequent updates or independent reports will detail the results of the monitoring program and specify actions to eliminate I/I from the worst portions of the collection system.

7.0 COLLECTION SYSTEM CONDITION ASSESSMENT

Collection system assessment typically includes characterization and cataloging of pipe defects, identifying deficiencies in capacity, evaluation of pipe age, obtaining O&M staff input then utilizing that data to prioritize rehabilitation and replacement needs. Capacity and reported maintenance issues are addressed in Chapters 5 and 6 for Clear Creek and Stillwater collection systems respectively. During the data collection phase of this study it was discovered that the existing pipe defect database had been discarded due to systematic and frequent erroneous data collection. Thus the rehabilitation and replacement portion of the plan focuses on pipe age and material.

The City wastewater collection system consists primarily of six and eight inch diameter pipe (77%) and either ABS, PVC or VCP pipes (88%). Table ES.1 presents the breakdown of pipes by size and material.

Table ES.1 - Breakdown of Gravity Pipe diameter and material, ft

Diameter, in	Pipe Type									
	ABS	AC	CIP	DI	PVC	RCP	STL	VCP	Totals	Percent
3					422				422	0.0
4				26				124	150	0.0
6	45181	81275	238	225	17951	2703	40	328976	476590	21.7
8	560990	27624	736	1121	333770	1237	183	279955	121561	55.3
10	27412	8285		88	30025			53305	119115	5.4
12	46957	7028	230		392	263		40233	95104	4.3
15	5261	7965	147		1232		385	45744	60734	2.8
16				3773	3357				7130	0.3
18	1664	2258			529			34168	38619	1.8
20					802				802	0.0
21					660	1693		19478	21831	1.0
22							544		544	0.0
24					2773			16811	19583	0.9
27						3646		10874	14521	0.7
30				696		2044		14279	17019	0.8
33								7358	7358	0.3
36				327	83	445		11339	12194	0.6
39						7527		3156	10683	0.5
42						38803		191	38994	1.8
45						6693			6693	0.3
48						24425			24425	1.1
54						8650			8650	0.4
Total, ft	687466	144434	1351	6256	391996	98130	1152	865991	219677	
Percent	31.3	6.6	0.1	0.3	17.8	4.5	0.1	39.4		
										Total: 416 Miles

The collection system pipe age was determined by correlating pipe segments with dates of record drawings. This process left approximately 25% of the pipe network with unknown age. It is likely that much of the pipe lacking record drawing information falls into the older pipe categories. Figure ES.7 shows the pipe age exceedance for the City collection system. An example of what the graph shows is that there is approximately 12% (vertical axis) of the identified system age that is older than 50-years.

Figure ES.7 - Pipe Age Exceedance

Sewer pipe service life varies greatly with pipe material, quality of construction, and type of soils. Both plastic and VCP pipes may have lifespans of up to 100 years. AC pipe appears to be the most vulnerable from an age perspective. Recommendations of this effort are based on an average pipe lifespan of 70 years. Given the age breakdown of pipes and a replacement age threshold, a replacement schedule can be projected. Figure ES.8 shows the rate of expiring and recommended replacement for wastewater collection system pipes broken down into five-year increments. Note that the early years of the plan recommends replacing pipe at a higher rate than expiring pipe to avoid excessive construction needs at the peak expiration periods. Table ES.2 shows the recommended schedule of aging pipe replacement.

Figure ES.8 - Expiring and Recommended Pipe Replacement Rates

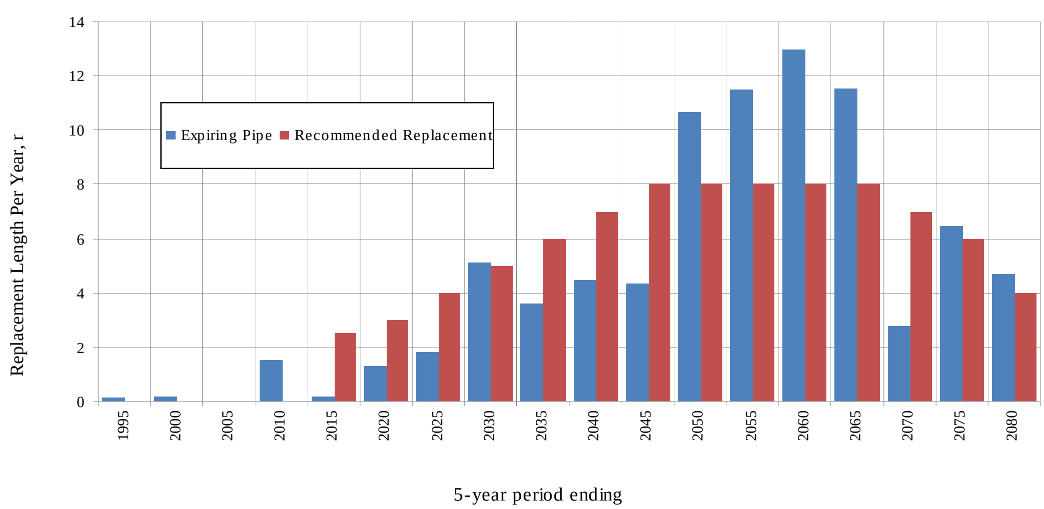


Table ES.2 - Recommended Aging Pipe Replacement Schedule

Time Period	Length of Replacement, miles per year
2012-2014	2.5
2015-2019	3
2020-2024	4
2025-2029	5

8.0 CAPITAL IMPROVEMENT PLAN

Numerous wastewater system improvements are required over the next 10 years, primarily to repair and replace the City's many aging sewer collection system components and attempt to reduce inflow and infiltration. The capital improvements have been determined using the full range of information and analysis from the facilities inspections, collection system and facility performance criteria, population and sewer demand projections, and detailed hydraulic modeling.

The Capital Improvement Plan consists of listing, prioritizing, scheduling and obtaining cost estimates for the projects called for in the evaluation sections (Chapters 5, 6 and 7). Details of the project listing and prioritizing and discussion of decisions made regarding specific projects or delay of specific projects can be found in Chapter 9 - Capital Improvement Plan. The results of the plan are two tables, one for projects and the second for programmatic pipe replacement plans. Table ES.3 reflects the projects results of the prioritizing, scheduling and cost estimating efforts. All costs are shown in 2012 dollars. Table ES.4 shows the cost estimates for the pipe replacement program as recommended.

Table ES-3 - Capital Improvement Plan

		Cost Split		Cost		
Year	Improvement	Rates	Fees	Rates	Fees	Total
2012-2013	Programmatic Pipe Replacement Elements	100%		$2,756,100		$2,481,737
	Minor Extensions and Oversizing		100%		$839,710	$839,710
	Lift Station Improvements	100%		$828,800		$828,800
	Sunnyhill Lift Station	100%		$1,100,000		$1,100,000
	Boulder Creek Interceptor - Phase III	75%	25%	$572,288	$190,763	$763,050
	CC Lift Station Improvements	87%	13%	$472,227	$70,563	$542,790
	Treatment Plant Structures and Improvements	100%		$200,390		$200,390
	CCWWTP BP5	77%	23%	$4,620,000	$1,380,000	$6,000,000
	CCWWTP BP6	77%	23%	$77,000	$23,000	$100,000
	CCWWTP BP7	77%	23%	$3,080,000	$920,000	$4,000,000
	Stillwater WWTP- Expansion 1A/B	75%	25%	$6,000,000	$2,000,000	$8,000,000
	Stillwater WWTP - Plant Expansion 1C	75%	25%	$225,000	$75,000	$300,000
	Oasis Road	34%	66%	$136,492	$264,956	$401,448
	Westside Lift Station	100%		$463,368		$463,368
	Mesa Alley	100%		$567,600		$567,600
			Totals:	$21,099,265	$5,763,991	$26,588,893
2013-2014	Programmatic Pipe Replacement Elements	100%		$1,459,000		$3,626,098
	I/I Reduction	100%		$1,000,000		$1,000,000
	Minor Extensions and Oversizing		100%		$500,000	$500,000
	Lift Station Improvements	100%		$200,000		$200,000
	Westside Interceptor - Phase III	0%	100%		$1,250,000	$1,250,000
	Treatment Plant Structures and Improvements	100%		$107,516		$107,516
	Clear Creek WWTP BP5	77%	23%	$361,502	$107,981	$469,484
	Clear Creek WWTP BP7	77%	23%	$1,446,009	$431,925	$1,877,934
	Stillwater WWTP- Expansion 1A/B	75%	25%	$4,225,352	$1,408,451	$5,633,803
	Solids Handling Facilities	75%	25%	$2,625,000	$875,000	$3,500,000
	Boneset Street	100%		$157,000		$157,000
	Mistletoe	100%		$234,000		$234,000
			Totals:	$11,815,380	$4,573,357	$18,555,835
2014-2015	Programmatic Pipe Replacement Elements	100%		$1,459,000		$3,760,215
	I/I Reduction	100%		$1,000,000		$1,000,000
	Minor Extensions and Oversizing		100%		$500,000	$500,000
	Lift Station Improvements	100%		$200,000		$200,000
	Westside Interceptor - Phase III		100%		$1,250,000	$1,250,000
	Treatment Plant Structures and Improvements	100%		$107,516		$107,516
	Solids Handling Facilities	75%	25%	$2,625,000	$875,000	$3,500,000
	Lake Redding Interceptor I	39%	61%	$955,500	$1,494,500	$2,450,000
	Manzanita Drive	100%		$113,000		$113,000
	San Francisco Drive South	100%		$165,000		$165,000
	San Francisco Drive West	100%		$289,000		$289,000
			Totals:	$6,914,016	$4,119,500	$13,334,731
2015-2016	Programmatic Pipe Replacement Elements	100%		$1,523,300		$4,399,707
	I/I Reduction	100%		$1,000,000		$1,000,000
	Minor Extensions and Oversizing		100%		$500,000	$500,000
	Lift Station Improvements	100%		$200,000		$200,000
	Treatment Plant Structures and Improvements	100%		$107,516		$107,516
	Hartnell Lift Station	100%		$117,000		$117,000
	Lake Redding Interceptor II	39%	61%	$955,500	$1,494,500	$2,450,000
	Hilltop Sewer	100%		$685,000		$685,000
			Totals:	$4,588,316	$1,994,500	$9,459,223

		Cost Split		Cost		
Year	Improvement	Rates	Fees	Rates	Fees	Total
2016-2017	Programmatic Pipe Replacement Elements	100%		$1,523,300		$4,399,707
	I/I Reduction	100%		$1,000,000		$1,000,000
	Minor Extensions and Oversizing		100%		$500,000	$500,000
	Lift Station Improvements	100%		$200,000		$200,000
	Treatment Plant Structures and Improvements	100%		$107,516		$107,516
	Clear Creek WWTP Levee	100%		$1,810,000		$1,810,000
	East Cypress Sewer	100%		$230,000		$230,000
	Canby Bypass Phase 1	100%		$440,000		$440,000
	Loma Street Alley	100%		$481,000		$481,000
	Churn Creek Road	100%		$173,000		$173,000
			Totals:	$5,964,816	$500,000	$9,341,223
2017-2018	Programmatic Pipe Replacement Elements	100%		$1,523,200		$4,399,707
	I/I Reduction	100%		$1,000,000		$1,000,000
	Minor Extensions and Oversizing		100%		$500,000	$500,000
	Lift Station Improvements	100%		$200,000		$200,000
	Treatment Plant Structures and Improvements	100%		$107,516		$107,516
	Cumberland Sewer	100%		$551,000		$551,000
	Hartnell LS		100%		$117,000	$117,000
	North Market LS	6%	94%	$7,080	$110,920	$118,000
	Hallmark Alley	100%		$612,000		$612,000
	Redbud Alley	100%		$299,000		$299,000
			Totals:	$4,299,796	$727,920	$7,904,223
2018-2019	Programmatic Pipe Replacement Elements	100%		$3,507,000		$4,399,707
	I/I Reduction	100%		$1,000,000		$1,000,000
	Minor Extensions and Oversizing		100%		$500,000	$500,000
	Lift Station Improvements	100%		$200,000		$200,000
	CC Lift Station Improvements	87%	13%	$293,284	$43,824	$337,108
	Treatment Plant Structures and Improvements	100%		$107,516		$107,516
	Bechelli South	100%		$126,000		$126,000
	Woodacre Drive	100%		$411,000		$411,000
	Patterson Ct	100%		$212,000		$212,000
			Totals:	$5,856,800	$543,824	$7,293,331
2019-2020	Programmatic Pipe Replacement Elements	100%		$4,556,200		$4,399,707
	I/I Reduction	100%		$1,000,000		$1,000,000
	Minor Extensions and Oversizing		100%		$500,000	$500,000
	Lift Station Improvements	100%		$200,000		$200,000
	Layton Lift Station	100%		$423,000		$423,000
	Locust Lift Station	100%		$495,000		$495,000
	CC Lift Station Improvements	87%	13%	$1,205,985	$180,205	$1,386,190
	Treatment Plant Structures and Improvements	100%		$107,516		$107,516
	Mercury Drive Sewer	100%		$515,000		$515,000
	Azailia I-5 Crossing	100%		$566,000		$566,000
			Totals:	$9,068,701	$680,205	$9,592,413
2020-2021	Programmatic Pipe Replacement Elements	100%		$5,835,100		$5,678,690
	I/I Reduction	100%		$1,000,000		$1,000,000
	Minor Extensions and Oversizing		100%		$500,000	$500,000
	Lift Station Improvements	100%		$200,000		$200,000
	Treatment Plant Structures and Improvements	100%		$107,516		$107,516
	Buenaventura Sewer	33%	67%	$627,990	$1,275,010	$1,903,000
	School Street	100%		$473,000		$473,000
			Totals:	$8,243,606	$1,775,010	$9,862,206

		Cost Split		Cost		
Year	Improvement	Rates	Fees	Rates	Fees	Total
2021-2022	Programmatic Pipe Replacement Elements	100%		$5,868,800		$5,678,690
	I/I Reduction	100%		$1,000,000		$1,000,000
	Minor Extensions and Oversizing		100%		$500,000	$500,000
	Lift Station Improvements	100%		$200,000		$200,000
	Treatment Plant Structures and Improvements	100%		$107,516		$107,516
	Cheryl Lift Station		100%		$139,000	$139,000
	Buenaventura Sewer	33%	67%	$627,990	$1,275,010	$1,903,000
			Totals:	$7,804,306	$1,914,010	$9,528,206
2022-2023	Programmatic Pipe Replacement Elements	100%		$5,939,100		$5,678,690
	I/I Reduction	100%		$1,000,000		$1,000,000
	Minor Extensions and Oversizing		100%		$500,000	$500,000
	Lift Station Improvements	100%		$200,000		$200,000
	Treatment Plant Structures and Improvements	100%		$107,516		$107,516
	Sulphur Creek	75%	25%	$1,554,750	$518,250	$2,073,000
			Totals:	$8,801,366	$1,018,250	$9,559,206
2023-2024	Programmatic Pipe Replacement Elements	100%		$6,053,500		$5,678,691
	I/I Reduction	100%		$1,000,000		$1,000,000
	Minor Extensions and Oversizing		100%		$500,000	$500,000
	Lift Station Improvements	100%		$200,000		$200,000
	Stillwater WWTP- Expansion 1C	75%	25%	$3,357,375	$1,119,125	$4,476,500
	Clear Creek WWTP Pond Upgrades	75%	25%	$862,500	$287,500	$1,150,000
			Totals:	$11,473,375	$1,906,625	$13,005,191
2024-2025	Programmatic Pipe Replacement Elements	100%		$6,223,700		$5,678,692
	I/I Reduction	100%		$1,000,000		$1,000,000
	Minor Extensions and Oversizing		100%		$500,000	$500,000
	Lift Station Improvements	100%		$200,000		$200,000
	Stillwater WWTP- Expansion 1C	75%	25%	$3,357,375	$1,119,125	$4,476,500
	Clear Creek WWTP Pond Upgrades	75%	25%	$862,500	$287,500	$1,150,000
			Totals:	$11,643,575	$1,906,625	$13,005,192
2025-2026	Programmatic Pipe Replacement Elements	100%		$6,157,100		$6,957,676
	I/I Reduction	100%		$1,000,000		$1,000,000
	Minor Extensions and Oversizing		100%		$500,000	$500,000
	Lift Station Improvements	100%		$200,000		$200,000
	Stillwater WWTP- Expansion 1C	75%	25%	$3,357,375	$1,119,125	$4,476,500
	Clear Creek WWTP Pond Upgrades	75%	25%	$862,500	$287,500	$1,150,000
			Totals:	$11,576,975	$1,906,625	$14,284,176
2026-2027	Programmatic Pipe Replacement Elements	100%		$6,064,900		$6,957,676
	I/I Reduction	100%		$1,000,000		$1,000,000
	Minor Extensions and Oversizing		100%		$500,000	$500,000
	Lift Station Improvements	100%		$200,000		$200,000
	Stillwater WWTP- Expansion 1C	75%	25%	$3,357,375	$1,119,125	$4,476,500
	Clear Creek WWTP Pond Upgrades	75%	25%	$862,500	$287,500	$1,150,000
			Totals:	$11,484,775	$1,906,625	$14,284,176
2027-2028	Programmatic Pipe Replacement Elements	100%		$6,064,900		$6,957,676
	I/I Reduction	100%		$1,000,000		$1,000,000
	Minor Extensions and Oversizing		100%		$500,000	$500,000
	Lift Station Improvements	100%		$200,000		$200,000
	Clear Creek WWTP Pond Upgrades	75%	25%	$862,500	$287,500	$1,150,000
			Totals:	$8,127,400	$787,500	$9,807,676

		Cost Split		Cost		
Year	Improvement	Rates	Fees	Rates	Fees	Total
2028-2029	Programmatic Pipe Replacement Elements	100%		$6,064,900		$6,957,679
	I/I Reduction	100%		$1,000,000		$1,000,000
	Minor Extensions and Oversizing		100%		$500,000	$500,000
	Lift Station Improvements	100%		$200,000		$200,000
	Boulder Creek Interceptor - Phase III	75%	25%	$1,089,000	$363,000	$1,452,000
			Totals:	$8,353,900	$863,000	$10,109,679
2029-2030	Programmatic Pipe Replacement Elements	100%		$6,064,900		$6,957,679
	I/I Reduction	100%		$1,000,000		$1,000,000
	Minor Extensions and Oversizing		100%		$500,000	$500,000
	Lift Station Improvements	100%		$200,000		$200,000
	Boulder Creek Interceptor - Phase III	75%	25%	$1,089,000	$363,000	$1,452,000
			Totals:	$8,353,900	$863,000	$10,109,679

Table ES.4 - Estimated Pipe Replacement Cost

Time Period	Length of Replacement, miles per year	Cost, $-million per year
2012-2014	2.5	3.2
2015-2019	3	3.8
2020-2024	4	5.1
2025-2029	5	6.4

9.0 FINANCIAL IMPACTS OF THE CAPITAL IMPROVEMENT PLAN

A high level analysis of the recommended CIP to projected wastewater utility rate in impact fee revenue was performed. It is noted that a more detailed analysis will be provided in a pending 2012 development impact fee and utility rate program update. The 2012 Master Plan analysis included the following assumptions:

- Master Plan Growth Rate Projections. Details of the growth projections can be found in Chapter 3 - Sewer Demand Development and Appendix F - Population Forecasting Reference Material.

- CCI escalation of cost of all projects. Cost estimates were prepared in 2012 dollars then escalated by an annual increase of 3.20% (20-year average CCI) to the year the project is scheduled for construction.

- Impact fees increasing at an annual rate of 3.20% starting in 2012-13 to match the CCI.

- Rates increased by the blended CCI/CPI index of 2.99% per year starting in 2012-13.

A short summary of the findings of the financial analysis prepared with this Master Plan are as follows:

1. Under the current fee schedule, the Utility account remains in good standing for the projected planning time frame. The account appears to start accumulating end of year balance in approximately 2024 as debt service payments drop to zero.

2. Under the current service rates, including annual CCI/CPI increases, the rate account will drop below zero in 2014-15.

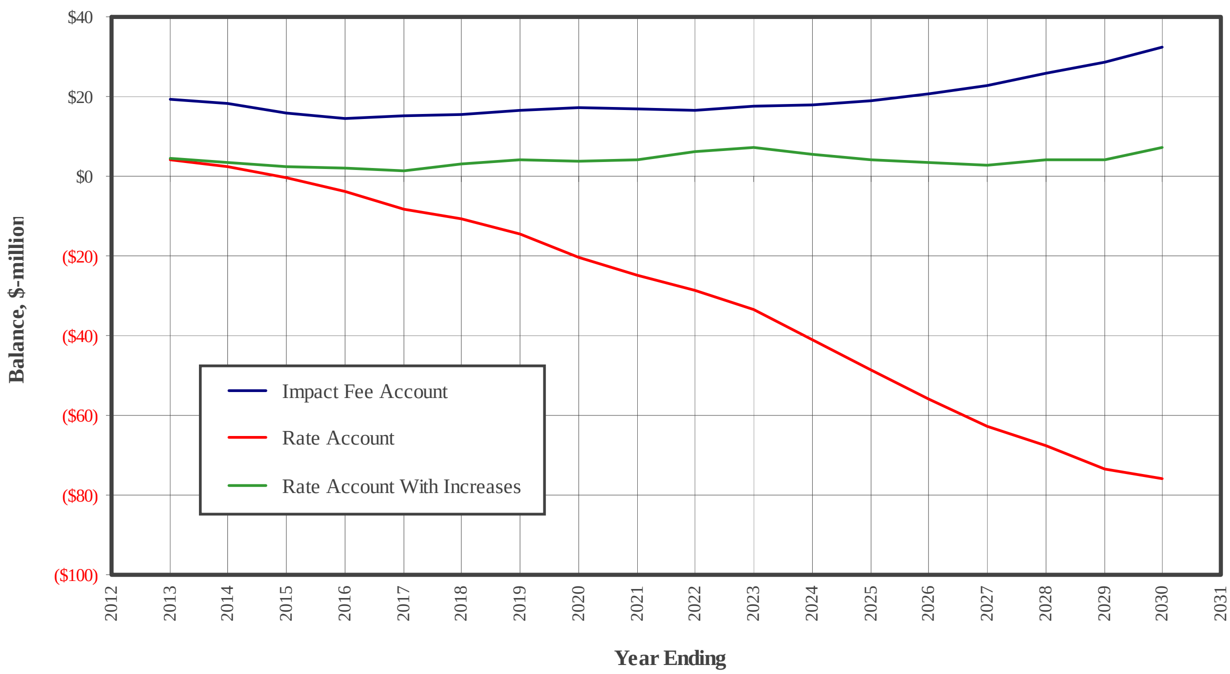
3. Risks associated with maintaining the current fee and rate schedule are:

    - Pipe replacement schedule will not keep up with expiring pipe resulting in an increase in sewer pipe failure
    - Treatment plant improvements may not keep up with the regulatory requirements resulting in regulatory actions potentially including fines.
    - Delay in construction of facilities necessary to prevent potential SSOs thereby increasing risk of additional regulatory actions.

4. The high level analysis revealed that if rates alone are used to keep the Utility balance from dropping

below zero, annual increases will need to be implemented ranging from approximately 7% to 2% starting with 7% in 2013-14. Figure ES.9 provides a graphical representation of the end of year balance for both accounts.

Figure ES.9 - Utility Account End of Year Balance



Tables

Figures

Appendices

ABS	Acrylonitrile-Butadine-Styrene pipe
AC	Asbestos Cement pipe
ADWF	Average Dry Weather Flow
C/I/Pf	Commercial/Industrial/Public Facility
CCTV	Closed Circuit Television
CCWWTP	Clear Creek Wastewater Treatment Plant
CI	cast iron pipe
CIP	capital improvement plan
DWF	Dry Weather Flow
DWI	Dry Weather Infiltration
EPA	United States Environmental Protection Agency
ESC	Economic Sciences Corporation
GIS	Geographical Information System
GP	General Plan
GPD	Gallon Per Day
HE	Household Equivalent
I/I	Inflow and Infiltration
IDF	Intensity Duration Frequency
IMS	Information Management System
InfoSWMM	The name of the Computer Model for Hydraulic Analysis
MF	
MGD	Million Gallons Per Day
NASSCO	National Association of Sewer Service Companies
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
ODBC	Open Database Connectivity
PACP	Pipe Assessment and Certification Program
PDR	Project Design Report
PDWF	Peak Dry Weather Flow
POTW	Publicly Owned Treatment Works
PVC	Poly-vinyl-chloride
RCP	Reinforced Concrete Pipe
RDI/I	Rain Driven Inflow and Infiltration
RTPA	Shasta County Regional Transportation Planning Agency
RWQCB	Regional Water Quality Control Board
SCADA	Supervisory Control And Data Acquisition
SFR	Single Family Residence
SSA	Sanitary Service Area
SSO	Sanitary Sewer Overflow

SWRCB	State Water Resources Control Board
SWWTP	Stillwater Wastewater Treatment Plant
TAZ	Traffic Analysis Zone
UBO	Ultimate Build-Out
USBR	United States Bureau of Reclamation
USGS	United States Geological Survey
VCP	Vitrified Clay Pipe
WWF	Wastewater Flow
WWMP	Wastewater Master Plan
WWTP	Wastewater Treatment Plant

CHAPTER 1
Introduction

1.1 PURPOSE

The purpose of the 2012 Wastewater Utility Master Plan (WWMP) is to create a stable long-range plan to support an orderly and efficient program of expansions, improvements, and rehabilitation of wastewater facilities associated with the two City of Redding publicly owned treatment works (POTWs). The treatment plant portions of the plan are supported by the Stillwater Wastewater Treatment Plant and the Clear Creek Wastewater Treatment Plant Facilities Plans. The plan addresses the wastewater collection system through development of a master plan that evaluates the capacity of the collection system, operations and maintenance, and capital replacement of aging components of the system. It is the intent of this document to provide guidance for decisions regarding priority of projects and utilization of available funds. The document is a planning-level tool. As such the recommended sizes of major improvements are approximate and should be re-studied at a design level of detail as part of each individual project during the design process. However, it is also the intent of this effort to provide the platform and tools necessary to expedite any such design level analysis.

1.2 GEOGRAPHIC EXTENT

The City of Redding (City) is located approximately 180 miles northeast of the San Francisco Bay, 140 miles north of the City of Sacramento, and 100 miles inland of the Pacific Coast. The City is located at the most northern end of the Sacramento Valley with surrounding ridges on three sides. Figure 1.1 presents a location map for the general vicinity of the City. The City currently operates and maintains approximately 426 miles of sanitary sewer pipeline, spanning 6 to 48 inches in diameter, 17 raw sewage lift stations, and two wastewater treatment plants (WWTP). The City is divided into two major collection systems, Clear Creek and Stillwater, with wastewater from each basin flowing into each WWTP. In general, the Clear Creek collection system occupies the western half of the City, and the Stillwater collection system occupies the eastern half. Both basins are divided further into smaller sanitary service areas (SSAs). The Clear Creek collection system serves the Redding, North Redding, Cascade, and Enterprise Service Areas. The Twin View, Eastern Enterprise, and Stillwater Creek Service Areas comprise the Stillwater Collection System. Figures 1.2 and 1.3 present the complete collection system for the City by each major drainage area.

Wastewater flows during the wet weather months indicate that large volumes of rainfall dependent inflow and infiltration (RDI/I) are entering the collection system as a result of aging, defective sewers, and illegal storm drain and roof connections. These increased flows limit the amount of additional flow entering the system and result in a system operating at and above its peak capacity.

1.3 OBJECTIVE

The primary goals of the 2012 WWMP are to identify capacity problems within the collection and treatment systems and develop a prioritized list of recommended capital projects to resolve capacity limitations and meet treatment needs. These goals were met through the following tasks:

- Develop sewer demand projections within the Wastewater Utility Service Area
- Develop a computer model of the sewer collection system starting with prior modeling databases updated based on the city's Geographic Information System (GIS) data
- Analyze the existing collection system under existing and future land use conditions
- Identify capacity problems within the collection system

- Identify recommended improvement projects
- Prioritize the recommended improvements and develop planning level estimates of capital construction cost
- Integrate the project recommendations and cost projections from both WWTP facility plans
- Develop a Capital Improvement Budget
- Prepare Financial comparison between existing income streams and utility budget needs

1.4 BACKGROUND

The City has evaluated their sewage collection and treatment systems numerous times in the past. The latest of these efforts was the 2003 WWMP conducted by Carollo Engineers. In addition to the 2003 WWMP both wastewater treatment plants have developed facility plans to guide their expansion.

The City has also evaluated improvements needed to accommodate growth in the Stillwater Creek Drainag Area, with two studies conducted in the 1990s by Pace Engineering. These studies are entitled Stillwater Service Area Master Plan (September 1992) and Stillwater Service Area Interim Sewer Study (January 1998). The 1992 Master Plan developed by Pace Engineering indicated that the Boulder Creek and Upper Eastside interceptors were at or near their capacity and parallel relief sewers were recommended to be implemented within two or three years of the study. To accommodate ultimate future growth, the 1992 Plan recommended a major trunk sewer (Stillwater Creek Interceptor) be constructed in the Stillwater Creek Service Area. The 1992 Master Plan indicated that excessive I/I were occurring in the Eastern Enterprise and Twin View Service Areas and recommended working on controlling these extraneous flows.

The purpose of the l998 Stillwater Service Area Interim Sewer Study was to reevaluate projected flows and sewer alternatives for the areas of the Stillwater Basin within the City's limits. The previous 1992 Master Plan included areas outside of the City's limits, which by 1998 had not been annexed, and it appeared that future annexation of these areas might be put on hold for an unknown period of time or not occur. In the 1998 Interim Study, the Eastern Enterprise and Stillwater Creek Service Areas were both reduced in size and flows. Instead of constructing a major trunk line in the Stillwater Creek Service Area (Stillwater Creek Interceptor), the 1998 Interim Study recommended constructing four lift stations to divert flows from newly developed areas over to existing sewer lines. With the addition of flows from newly developed areas, the existing sewer would need to be upsized or paralleled in some areas. The 1998 Interim Study acknowledged that if substantial development to the east of the City's limits continued in the future, the Stillwater Creek Interceptor, recommended in the 1992 Master Plan, would be warranted and the proposed interim lift station alternative would need to be modified.

The 2003 Carollo Wastewater Utility Master Plan effort addressed projected demands and developed a capital improvement plan to guide the utility decisions through 2010. Beyond 2010 the plan estimates growth at ultimate development (or build-out) conditions of the City’s sphere of influence. The plan acknowledges the development potential of the Stillwater Creek drainage area projecting that ultimate contribution could be as much as 17.3 mgd but indicating that development of the area would not occur until after 2010 thus no attempt was made to include the facility in the capital improvement list and schedule.

Figure 1.1
City of Redding
General Location Map

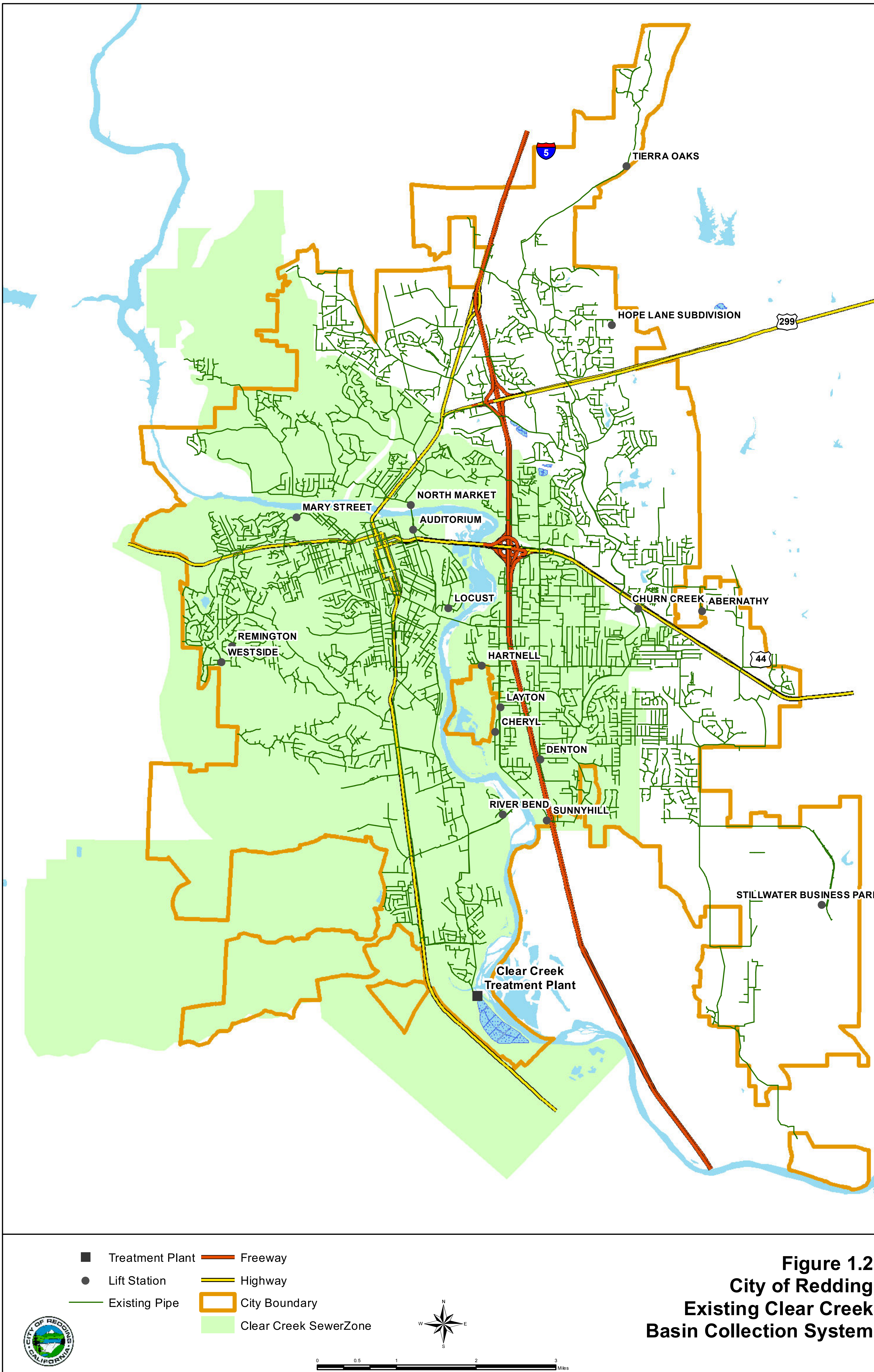


Figure 1.2
City of Redding
Existing Clear Creek
Basin Collection System

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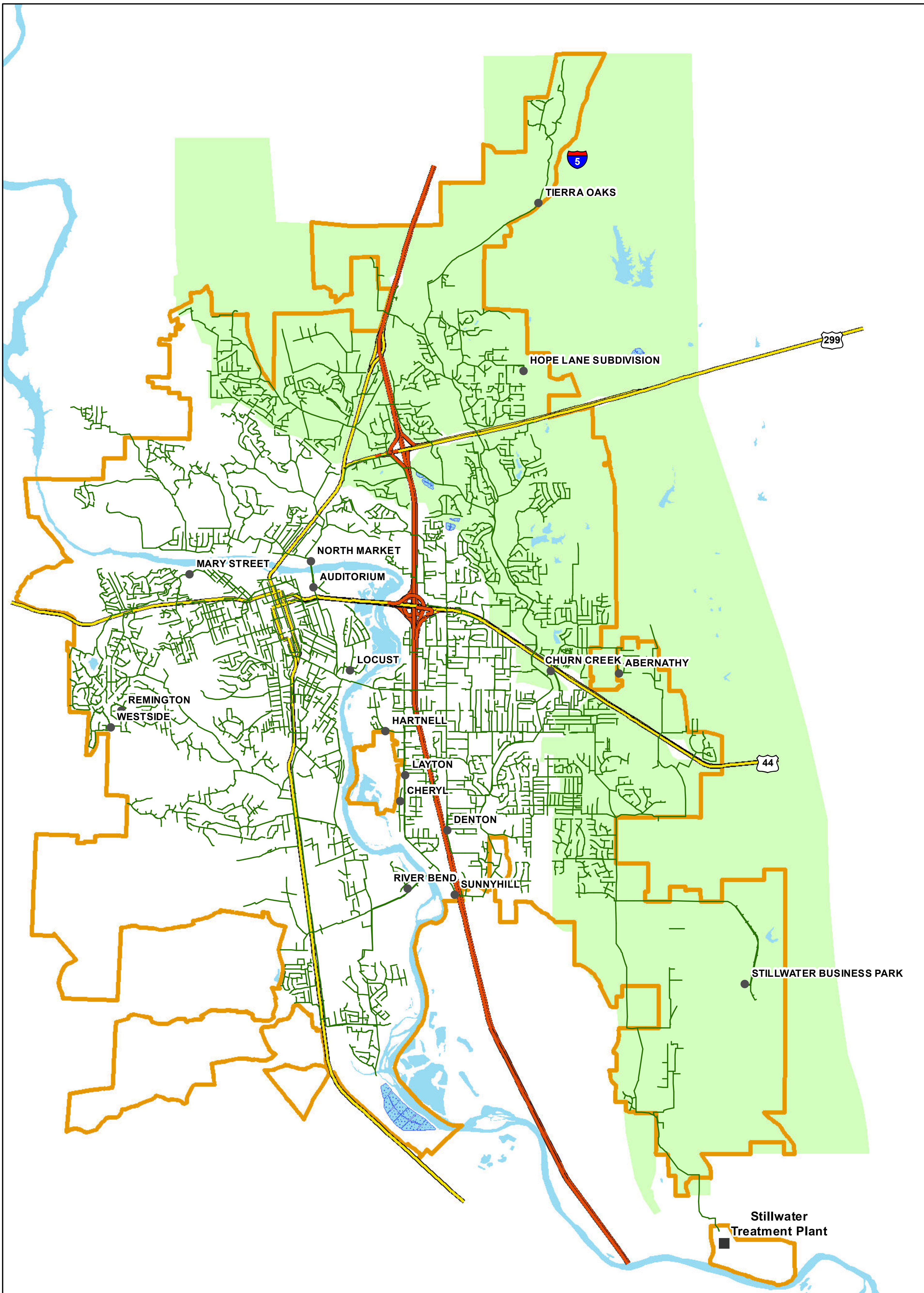
Aug. 3, 2012



Treatment Plant
Lift Station
Existing Pipe
Freeway
Highway
City Boundary
Stillwater Sewer Zone

0 0.5 1 2 3 Miles

Figure 1.3
City of Redding
Existing Stillwater
Basin Collection System

P:\RMU\ESRI\MasterPlan\WW_StillwaterExistingFig.mxd

Aug. 3, 2012

1.5 PROJECT SCOPE

The scope of work for this 2012 Wastewater Utility Master Plan report was divided into seven general tasks. The major tasks completed during this study were as follows:

Task 1 - Data Collection and Review. The collection system data was obtained from City of Redding GIS files, the computer model provided by Carollo Engineers with the 2003 WWMP, aerial photo-topo obtained by the City in 2004, and record drawings. Flow data was obtained from the City for lift stations, treatment plants, and monitoring stations as well as precipitation records for numerous rain gages located throughout the community. Demand data was collected from Customer Service records which include geographic location of all utility accounts along with the associated gpd demand.

Task 2 - Computer Model Development. After purchase of a license for the new GIS platform computer model tools the collection system model developed with the 2003 WWMP was sent to MWH-Soft (now Innovyze, the software company for the computer model environment) for conversion necessary for use in the new model environment. Following conversion GIS files and record drawings were used to verify and update all pipe sizes, slopes and network configurations in the collection systems. The model network was also updated with significant new pipe networks and interceptors constructed following the 2003 WWMP effort.

Task 3 - Household Equivalent (HE) Analysis. A review and comparison of the City's HE schedule to other agency schedules was performed. The HE rate of 300 gallons per day (gpd) per HE was utilized for developing dry weather flow demands. Different land uses are assigned varying numbers of HEs according to the winter water use study performed with the 1987 Master Sewer Plan.

Task 4 - Demand forecasting. The demand forecasting task included projection of the dry weather flows resulting from future development at specific planning horizons as well as attempting to project I&I quantities for newly developed areas. New demands were then added to the appropriate flow component of the hydraulic analysis prior to evaluating the utility needs for each planning horizon.

Task 5 - Computer Modeling. The computer modeling effort included calibration and analysis. Calibration involved extensive data review and analysis to isolate records that can be used to develop reliable and accurate average dry weather flows, average wet wether flows and storm records where RDI&I can be evaluated. Model output was then compared to recorded data for each category of flow. Discrepancies were examined and adjustments made to the computer modeling assumptions accordingly.

Once both models were calibrated, existing and future land use flows along with peak wet weather flows (PWWF) were projected through both models. Both the Clear Creek and Stillwater sewer basins were further divided into subbasins based on the geometric layout of the collection system. The Year 2010 sanitary flows were calculated from household equivalent (HE) data assigned to each parcel by the City. 2010 Flows were then adjusted to account for expected growth in each sub-basin for 2015, 2020, and 2030 planning horizon. The sanitary flow for Ultimate Buildout (UBO) generated from the each subbasins was determined from the general plan land use maps from the City and County. Peak wet weather flow was based on a 10-year, 24-hour design storm developed with the meteorology section of the 1993 City-Wide Storm Drain Master Plan and its subsequent revisions.

Task 6 - System Evaluation and Recommendations on Improvements. This task included examination and evaluation of monitoring data to identify specific locations or “hot spots” for focused RDI/I reduction efforts. Evaluation of the City's collection system was performed by running existing and future sanitary flows along with the design storm through both models. Existing and future improvements to the collection system, lift stations, and WWTPs were then indentified in phases: Year 2010, Year 2015, Year 2020, Year 2030, UBO.

Task 7- Capital Improvement Plan (CIP). A Capital Improvement Plan (CIP) was developed for the four planning phases previously mentioned. The CIP provides a cost estimate for recommended improvements to the collection system, lift stations, and WWTPs.

Task 8 - Financial Analysis. A brief financial overview through 2030 is provided as an order of magnitude evaluation of potential budget deficit or excess. A cost of service study prepared by an independent consultant will follow the Master Plan effort to provide detailed recommendations on utility funding.

CHAPTER 2
Regulatory Considerations and Impacts

2.1 INTRODUCTION

Wastewater treatment is heavily impacted and directed by regulations, which arise at both the state and federal level and address areas such as air and water quality, biosolids disposal, and response to sanitary sewer overflows. These regulations and their enforcement have a direct impact on both the need for construction or modification of collection and treatment facilities and the design of these facilities. Regulatory considerations can also have significant implications for wastewater rates. Due to this potential rate impact, as well as the effect that penalties and other regulatory liability can have on the utility's planning and operation, it is necessary to consider the regulatory context over the time period considered in this Master Plan.

In recent years, both the pace of new regulations being adopted and the level of enforcement of these regulations have increased substantially. Whereas this region has not historically been impacted by many of the regulations facing wastewater utilities in Southern California and the San Joaquin Valley, much of this regulatory body is beginning to be imposed in the area due to the growing perception of environmental problems in the Central Valley and the Sacramento-San Joaquin River Delta. Air quality concerns are increasing in the Redding area, and since City of Redding (City) wastewater treatment facilities discharge to the Sacramento River the utility is impacted by water quality efforts throughout the Central Valley. The regulatory considerations addressed in this chapter are reclaimed water reuse, regionalization, inflow and infiltration(I/I) reduction, new and increasingly stringent effluent limitations, biosolids production and disposal, and air quality. While this is by no means an exhaustive review of regulatory issues facing the utility, the specific areas discussed pose the most immediate and direct impact on the utility during this planning period.

2.2 RECLAIMED WATER

Throughout much of California, the shortage and cost of potable water has made the provision of reclaimed wastewater to commercial and industrial clients a profitable venture. Many wastewater treatment plants in Southern California are reaching almost 100% reuse, allowing them to avoid the cost and complication of discharging treated effluent to land or surface water. While in areas of water shortage financial considerations alone drive much of this reuse, the State Water Resources Control Board (SWRCB) has also put in place policies[1] that express a regulatory preference for reuse and direct the various Regional Water Quality Control Boards to induce the provision of reclaimed water through regulatory pressure.

Although there are advantages associated with wastewater reuse, the regional low cost of irrigation water and limited demand from commerce or industry in the Redding area combine with the cost of the necessary additional facilities and treatment to impose fiscal constraints on the provision of reclaimed water. Moreover, Central Valley Regional Water Quality Control Board (RWQCB) staff has stated that sending treated effluent south may be potentially considered as equivalent to reuse, with this water utilized in numerous ways by downstream users. At this time, and for the foreseeable future, it is unlikely that there will be a regulatory mandate for the City to provide reclaimed water, but reclaimed water is an option that should be considered periodically due to its increasing regulatory and potentially fiscal benefits.

As effluent limitations continue to become more stringent, and the cost to achieve this level of treatment continues to increase, options that move away from discharge to the Sacramento River become more useful.

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[1] *Recycled Water Policy (See State Water Resources Control Board Resolution 2009-0011).*

Much of the recent improvements to the City's wastewater treatment plants, including the installation of a new effluent diffuser at the Clear Creek Wastewater Treatment Plant (CCWWTP), are driven by regulatory considerations, and this will only increase as time goes on. Once the initial capital outlay is made for the equipment and processes necessary to meet reclaimed water requirements and deliver it to users, effluent diverted reduces the potential liability associated with river discharge. The Stillwater Wastewater Treatment Plant (SWWTP) already provides a small amount of reclaimed water to one nearby user, and the CCWWTP could be modified to treat reclaimed water relatively inexpensively although the pumping and distribution system would be costly.

2.3 REGIONALIZATION

The RWQCB has adopted policies that encourage dischargers to consider the regionalization of wastewater collection and treatment options, and which also direct RWQCB staff to consider innovative permitting options to promote regionalization programs[2]. This regionalization can consist of a variety of joint actions between public and/or private entities ranging from mutual aid agreements to actual centralization of wastewater treatment. At this time, the regulatory impetus in the region has been towards the latter. Because the City is the largest municipal entity in the area, any such focus by regulators will necessarily include existing and planned City facilities.

An example of this policy was the requirement by the RWQCB for the City of Shasta Lake to consider moving away from discharge to Churn Creek and connecting that city's wastewater collection system into the City's. A variety of legal mechanisms could be used to facilitate an agreement wherein the City collects and treats wastewater from other cities, but up-front capital costs often limit this application. For the City of Shasta Lake, it was determined that installing collection facilities south to a point connecting to the City's existing system would have been cost-prohibitive at that time. This does not mean that such options will not need to be considered in the future, and shows that there is an active regulatory impetus for regionalization in the area.

Another potential regionalization scenario is that of the City of Anderson's Water Pollution Control Plant, which is situated barely one mile south of the SWWTP across the Sacramento River. While there is currently no plan to consider the treatment of the City of Anderson's wastewater at SWWTP, the installation of a force main under the river could conceivably be a cost-effective way for the City of Anderson to avoid future facility expansions at its own treatment plant. In such a scenario, this treatment would be paid for based on the volume and load of the wastewater pumped under the river.

The City is not currently considering regionalization plans, and there appears to be no fiscal benefit to doing so at this time. That being said, utility managers will need to keep abreast of efforts by regulators to drive regionalization, and consider the potential effects this could have on the utility's future projects. Also, regionalization options should be kept in mind as development in the City expands, with a goal of identifying cost-effective and innovative regionalization solutions that would help the City work with its regional municipal partners.

2.4 INFLOW AND INFILTRATION REDUCTION

Throughout this master plan the subject of I/I is discussed, in both the magnitude of wet weather effects on the collection and treatment system as well as efforts to identify and reduce sources. In this context it is also important to note the increasing regulatory pressure on this subject. The RWQCB has long been interested in peak wet weather flows caused by I/I, due to the potential for increased sanitary sewer overflows (SSOs) and the need for expanded treatment facilities sufficient to handle these increased flows. Staff at the

[2] Central Valley Regional Water Quality Control Board Resolution R5-2009-0028

CCWWTP is now required to submit an annual report detailing the measures taken to reduce I/I, and the issue is going to become more heavily monitored by regulatory agencies.

The impacts from I/I are numerous, but the most important to regulators are the increased risk of SSOs, hydraulic overloading of treatment plants and treatment plant expansions that are needed to handle I/I related wet weather peaks. Violations associated with these SSOs can pose significant liability in the form of monetary penalties and expose the City to third-party lawsuits.

Collection systems are designed based on the system capacity needed to serve area homes and businesses. Large influxes of storm water can overwhelm the hydraulic capacity of the system, potentially leading to increases in both the number of SSOs and the volume spilled. California Water Code sections 13300 et seq. allow for penalties of up to $25,000 per day and $25 per gallon spilled for SSOs, and substantial penalties are often assessed. Due to the potential magnitude of these penalties, combined with the public health and public relations impacts of SSOs, it is important and cost-effective to allocate significant resources to the identification and reduction of I/I sources.

Storm season I/I can pose issues with treatment capacity as well. For example, the CCWWTP experiences wet weather influent peaks of over 40 million gallons per day, exceeding the capacity of the facility for treatment and necessitating temporary storage in emergency retention basins. Whenever dealing with peaks of this magnitude, the treatment process is impacted by the potential for solids flow-through, disinfection complications, and filtration overload. In the worst case scenario, this can lead to discharge of effluent that does not meet effluent limits, and while this is a rare occurrence, the associated penalties can be significant. The potential penalties are similar to those discussed above for SSOs, but since treatment plants involve millions of gallons, the penalties could be even more substantial. To avoid these problems, facilities must be expanded at significant cost to handle these peaks. This can range from the expansion of secondary systems to the installation of additional filtration, but any such projects are capital-intensive, and further study is needed to determine whether cost-effective solutions can be found to correct I/I in the collection system and reduce these wet weather impacts.

An example for future action on I/I is the issue of private sewer laterals. Many municipalities have determined that as much as a third of I/I may be entering collection systems through private laterals. Most wastewater utilities however have determined laterals are appropriately private and have not allocated resources to help landowners with their upkeep. The City is implementing a program to provide loans for private lateral repair, and could also require lateral inspection and repair when a home is sold. As another means of reducing I/I, the City has been allocating an increasing amount of capital to the repair and replacement of collection pipes in high I/I areas. This should provide significant I/I reduction, especially in the older areas of town with cracked and/or failing clay pipes.

2.5 EFFLUENT LIMITATIONS

Each treatment plant is regulated by separate National Pollution Discharge Elimination System (NPDES) permits, which details treatment and reporting requirements and imposes effluent limitations. These effluent limits constitute a threshold for pollutant removal above which discharge is considered a violation, with associated penalties and other consequences. As industry-wide treatment capabilities increase, and as new water quality goals are adopted throughout the state, these effluent limits are continuously reduced, and this increases the cost and complexity of treatment. Limits for new pollutants not previously required are also periodically imposed due to new water quality efforts being undertaken.

Each effluent limit that is made more stringent reduces the operational flexibility of the treatment process and imposes costs from increased staff time, chemical usage, installation of new processes or equipment, and impacts on the levels and therefore removal efficiency of other pollutants. Effluent limits at both of the City's wastewater treatment plants have reached a level where any further reduction may require the installation of extremely expensive equipment or processes such as ultra-violet disinfection or deionization. The vast majority of cost-effective solutions have been implemented, and it is now a situation of diminishing returns where each facility upgrade achieves an increasingly minuscule reduction in pollutant load while costing an increasingly large amount of capital. This has a direct and substantial impact on wastewater rates, and as these limits drive the treatment process this issue is one of the most important regulatory considerations for utility managers.

The imposition of new limits further complicates treatment and can lead to the use of additional chemicals or the addition of new processes or equipment. The monitoring of new pollutants also increases laboratory costs. Most significant, the addition of another pollutant limit raises the potential for effluent violations and therefore increases the amount of time and materials needed to avoid these penalties.

Since 2008, utility staff has seen a significant reduction in effluent limits and an increase in the frequency of new limits being imposed. Whereas limits have historically been lowered in a modest step-wise manner, regulators have begun to lower them much more quickly. The CCWWTP, for example, went through the permit renewal process in 2010, and the limits for disinfection byproducts were reduced by 70%. Also, the increasing focus on water quality in the state, the emergence of more accurate laboratory methods that can detect the presence of additional pollutants, and the escalating pressure on regulators from non-profit groups have lead to the pace of new limits increasing as well. The speed with which these changes occur, and the repercussions they have on treatment processes and facility upgrades, ensure that the issue of new and more stringent effluent limits will continue to be one of the more consequential regulatory areas for utility managers to monitor.

2.6 BIOSOLIDS PRODUCTION AND DISPOSAL

The wastewater treatment process results in a large amount of biosolids that require disposal. Throughout the state, and indeed the country, the issue of biosolids production and disposal is increasingly coming into focus due to public health perceptions, and significant interest for the potential of energy production. Counties in southern California and the San Joaquin Valley have been banning or restricting the land application of biosolids due to perceived air quality and public health concerns such as the contribution of airborne particulate matter and degradation of groundwater. Regulators at the state level are also beginning to provide incentives for the use of biosolids and solids digestion for the production of energy. Considering these and other emerging topics surrounding the production and disposal of biosolids, this is one of the more important regulatory areas related to wastewater treatment.

The City currently produces biosolids at both wastewater treatment plants, with biosolids from the SWWTP historically being sent to the CCWWTP for air drying after initial dewatering at the SWWTP. The solids are then either hauled to the Redding Municipal Airport for incorporation into agricultural fields, or hauled to one of the local landfills for disposal. Due to odor concerns solids from the SWWTP are hauled directly to the landfill for disposal. Ultimately these SWWTP solids will be pumped through a pipeline to the CCWWTP, where both solids streams will be co-mingled and digested. This process of biosolids handling and production, followed by disposal, presents both regulatory benefits and complications.

When biosolids are anaerobically digested, methane gas is produced. This occurs at the CCWWTP, and currently the methane is used to power a boiler that is then used to heat the digester. The remaining gas is flared, presenting a lost potential for energy production. As regulators begin to look at alternative means for energy production, use of methane for the cogeneration of heat and electricity is becoming the focus of much attention. In the Redding area, electricity rates are relatively low compared to state-wide averages, and this has complicated the cost feasibility of a cogeneration project at the CCWWTP. Also, methane gas production and quality are often inconsistent, and the methane must be supplemented with natural gas if used for energy production. Multiple incentive programs are developing to promote these types of projects, ranging from low-interest loans to credits towards greenhouse gas offsets described below in Section 2.7. Utility managers should periodically review the status of incentive programs to determine at which point the capital investment for a cogeneration project at the CCWWTP becomes feasible. In addition, future analyses should review the feasibility of adding facilities at the CCWWTP to receive material from commercial grease interceptors as well as commercial and large scale residential food waste. Utilizing these materials has been shown elsewhere to boost the quantity and quality of digester gas production, but the lack of large industrial sources of organic waste could inhibit such a program. Waste-acceptance facilities of this type would however provide additional disposal for local grease hauling companies while also helping the Solid Waste Utility meet existing waste diversion requirements.

Disposal options for biosolids are also becoming increasingly limited. In California, biosolids can be incinerated, land applied, placed in landfills, pelletized for fuels, or composted. The City has identified land application as a preference, with landfilling reserved for solids that don't meet land application regulations or for times of the year when land application is prohibited. Land application is cheaper than disposal at a landfill, and presents agricultural benefits from the nutrients available. Whereas biosolids have long been seen as a waste product, land application allows these solids to be used as a resource. However, when biosolids are applied, very small amounts of metals begin to accumulate in the soil. As regulations limit the maximum concentration of these metals for public health reasons, this places an ultimate temporal limit on each disposal field. While ample agricultural lands exist near the Redding Municipal Airport, the estimated time remaining before these fields reach their metals limit ranges from seven to twenty years. If the City continues to see land application as the preferred disposal option, utility managers will need to identify and acquire additional land suitable for this disposal, while carefully monitoring regulatory trends in case this option becomes too restrictive or even banned.

2.7 AIR QUALITY

Air quality control regulations are undergoing significant modification throughout the state, both in response to declining air quality as well as larger scale policy changes such as those surrounding the topic of climate change. The increased regulation of air quality standards could impact the utility significantly, and while the climate change policies are still evolving, and ultimately may not be implemented, the push to reduce greenhouse gases could have impacts unprecedented in both type and scale.

The California Air Resources Board is currently adopting more stringent air quality standards for stationary equipment. The utility has emergency generators at both wastewater treatment plants and at many of the lift stations throughout the collection system. While these new standards should not require the acquisition of new equipment at this time, it will increase the future cost of replacement equipment. At the CCWWTP, methane generated by the digestion of solids is currently flared, and a project being considered during this planning phase would make modifications to utilize this gas for the cogeneration of heat and energy. More stringent regulations will increase the cost of this project, potentially alter the type of equipment used, and in the worst case scenario could even make the project infeasible from a financial standpoint. Finally, many regulatory bodies throughout California are banning or restricting the land application of biosolids due to potential air quality concerns, as previously described in Section 2.6.

Regulations being considered to reduce generation of greenhouse gases would require certain producers of these gases to quantify the amount generated, reduce this generation through the installation of new processes or equipment, and purchase credits to cover the generation remaining. Various wastewater industry groups are lobbying state agencies to exempt "biogenic" gases expelled or produced during wastewater treatment, but if this effort fails, the high level of gases produced will result in significant costs for the purchase of credits, and/or require the installation of more efficient equipment and processes.

2.8 CONCLUSION

Regulatory limitation of the available options for wastewater collection and treatment, effluent discharge, and biosolids disposal will continue to determine much of what the utility does. Regulatory enforcement actions including penalties, the potential effect on public relations, and the risk of lawsuits arising from inaction or improper handling of these regulatory requirements can impose significant costs to the utility. These costs are difficult to predict and budget for, and are more properly avoided through a systematic effort that identifies the impact regulations have on utility actions and implements utility plans with these regulations in mind. These considerations will be an increasingly primary factor in the utility's capital improvement program and staffing levels, and will therefore be a determining factor in rate increases and resource allocation. As with other aspects of long-term utility planning, a constant and clear focus on the regulatory sphere will be required to ensure an appropriate direction for the utility's future.

CHAPTER 3
Sewer Demand Development

3.1 INTRODUCTION

This chapter describes the different flow components of sanitary sewer flows and the methods used for quantification of those components. It discusses the methodologies and assumptions used in deriving the flows for use in the subsequent hydraulic capacity analysis for each planning horizon.

3.2 COMPONENTS OF FLOW

A sanitary sewer collection system receives two flow components: dry weather flow (DWF) and wet weather flow (WWF). The dry weather flow component is flow generated by routine water usage in the residential, commercial, business and industrial sectors of the City. The other component of dry weather flow is the contribution of dry weather groundwater infiltration into the collection system. Dry weather groundwater infiltration will enter the collection system when the relative depth of the local groundwater table is higher than the depth of the pipeline, and if the pipe allows infiltration through defects such as cracks, misaligned joints and broken pipelines.

The groundwater infiltration component of sanitary sewer flow increases as the groundwater table rises during wet months. The increase in groundwater infiltration in the wet season is caused by the depth of the groundwater table rising above pipe invert elevations thus pipes located within close proximity to a water body may be significantly influenced by this component. The increase in groundwater infiltration during wet weather but not directly correlated with specific storm events it is still deemed a portion of dry weather flow.

The wet weather flow component includes stormwater inflow through illegal roof drain leaders or storm drain system cross connections, trench infiltration (percolation of stormwater through the soil and into the pipeline trench) and groundwater infiltration. The stormwater inflow and trench infiltration comprise the wet weather flow component termed rainfall dependent inflow and infiltration (RDI/I). This impact of inflow to the collection system occurs immediatly after rainfall while infiltration is seen hours after a rainfall event.

At different times during the wet weather season, groundwater infiltration has a more significant impact to the available collection system capacity. It is important in the modeling process to calibrate to the highest groundwater effect seen in the flow data to ensure that the model is being calibrated to the worst-case scenario and that the potential impact of groundwater infiltration is not underestimated.

The various wastewater flow components are illustrated in Figures 3.1 through 3.3.

COMMON WASTEWATER ACRONYMS			
Type of flow		**Quantity of flow**	
DWF	Dry Weather Flow	GPM	Gallons Per Minute
ADWF	Average Dry Weather Flow	GPD	Gallons Per Day
WWF	Wet Weather Flow	MGD	Million Gallons Per Day
PWWF	Peak Wet Weather Flow	**Storage Volume**	
I/I	Infiltration and Inflow	MG	Million Gallons
RDI/I	Rain Driven Infiltration and Inflow		
HE	Household Equivalent		
WWF	Wastewater Flow		
PDWF	Peak Dry Weather Flow		

Figure 3.1 Seasonal Sewer Flows

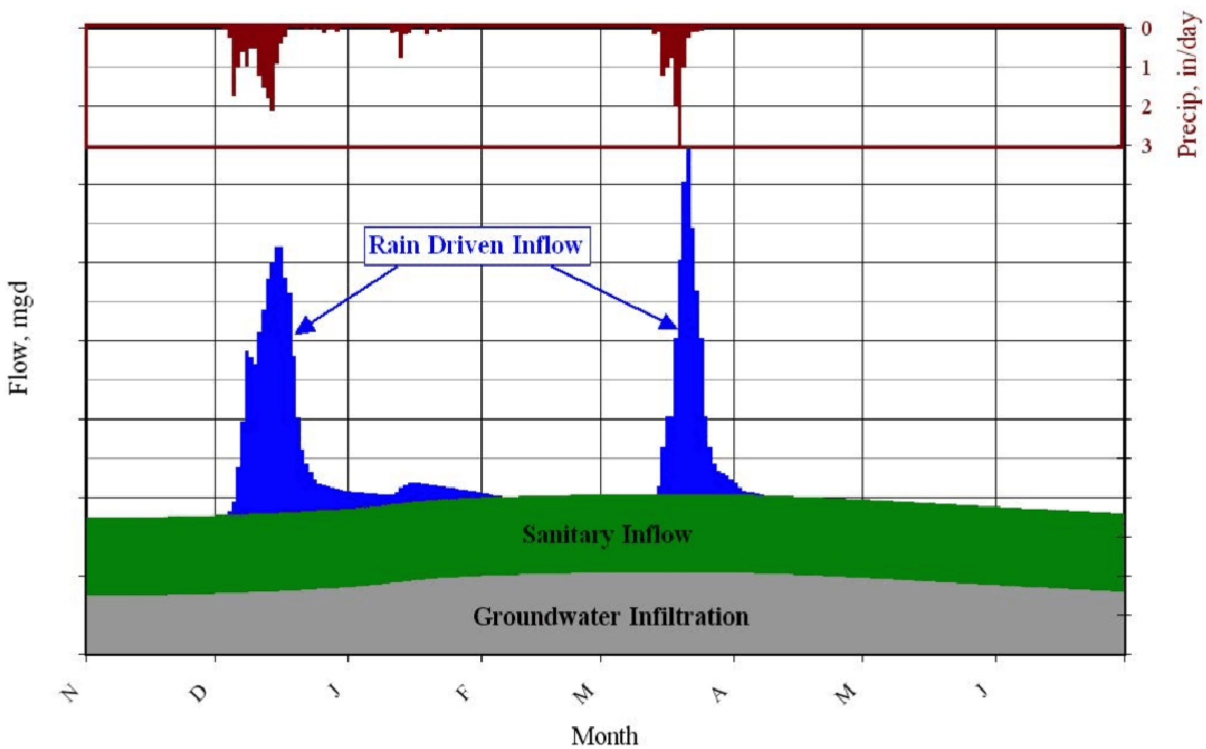


Figure 3.2 Rain Driven I & I Detail

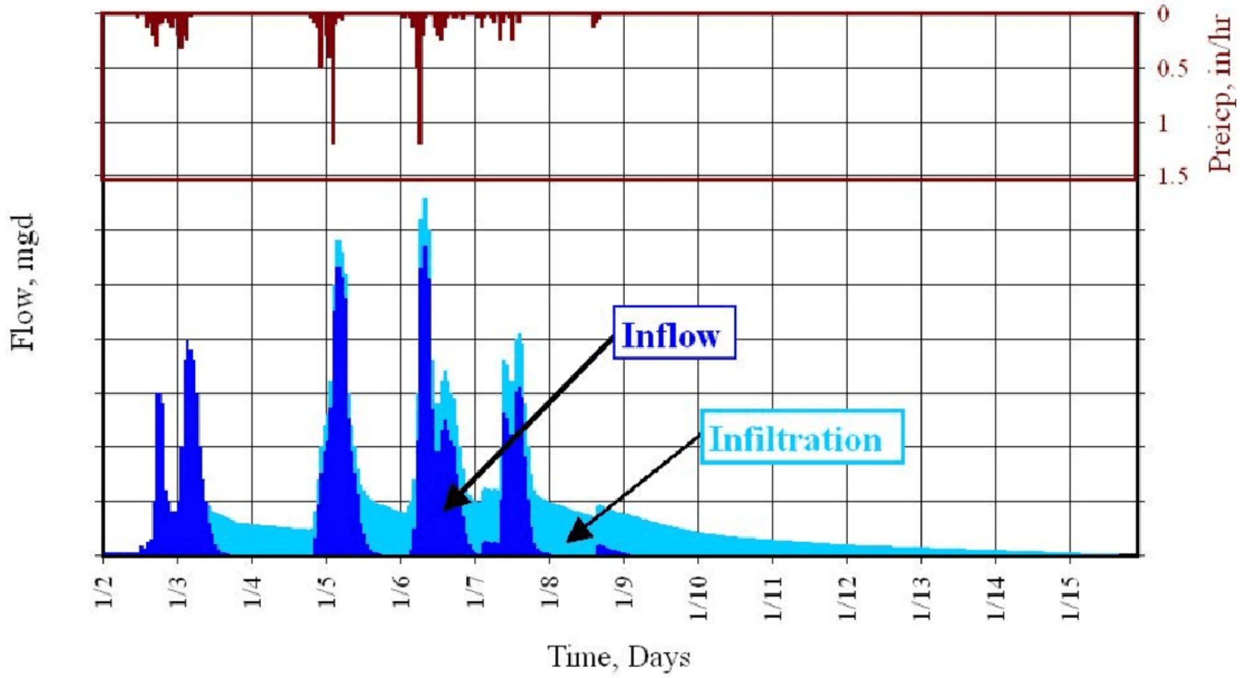
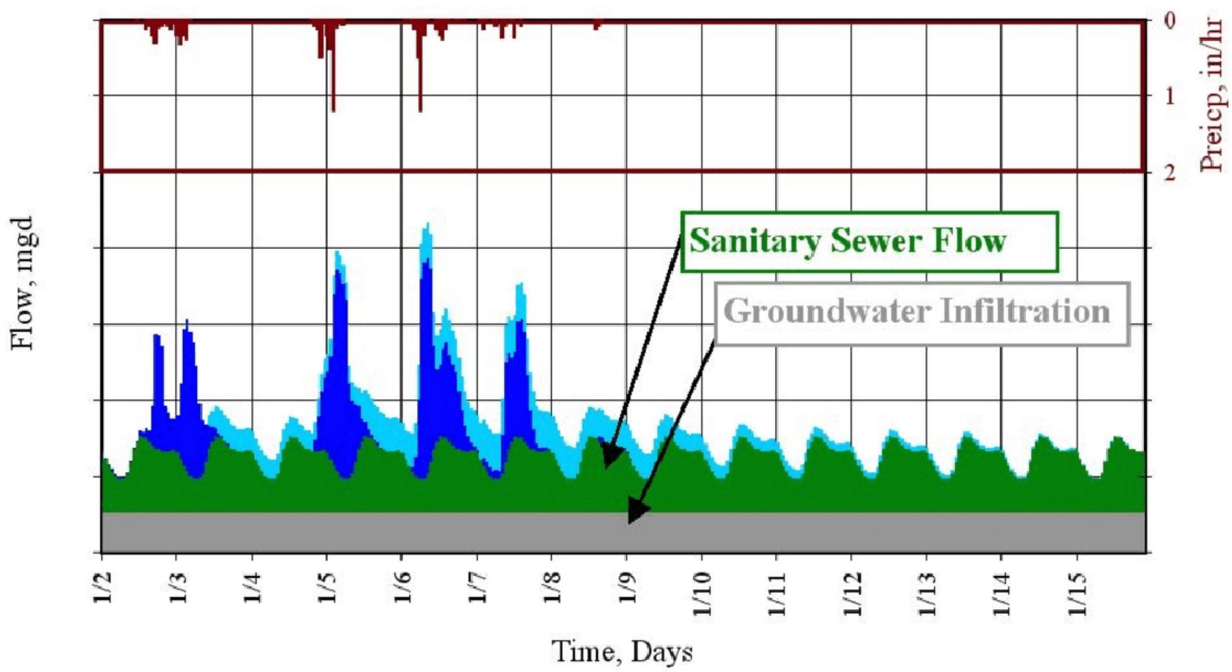


Figure 3.3 Total Sewer Flows



3.3 DRY WEATHER DEMAND DEVELOPMENT

Analysis and evaluation of the sanitary sewer collection system consists of development of demands based upon Land Use and Household Equivalent (HE) information, which are integral components in determining the amount of wastewater generated within the City's service area. The existing condition (Year 2010) HE information was obtained from customer service records and assigned to each sanitary service sub-basin by geographic location identified with each service account. Dry weather flows were then adjusted to account for projected growth for Year 2015, 2020, and 2030 time frames utilizing data from Shasta County Regional Transportation Planning Authority (RTPA) data which was adjusted downward to account for decrease in expected growth due to the current economic recession. Ultimate buildout (UBO) demands were developed using general plan densities from both City and County General Plan maps.

3.3.1 Assignment of Household Equivalents

In the 1979 Master Sewer Plan, household equivalent values for the existing multi-family, mobile homes, and most of the commercial/industrial establishments were estimated using typical values from studies and references. In 1987 a review of these values was conducted in association with the 1987 Master Sewer Plan which consisted of a study of the winter water usage of the typical use groups. In 1993 through 1997 another winter water use study was performed assumeing the potable water used during the winter months of December, January, and February approximated sewer flows, since it generally excludes irrigation water use dduring those months. The three years of water records of a sample of users in each group were averaged and converted to units of gallons per day (gpd). The flows were then compared to other measurable parameters such as type of establishment, square feet, bed, chair, etc. For each group, the parameter giving the most consistent results was used.

In the winter use study 2,501 residential 5/8-inch meter records were reviewed to determine winter water usage of a typical single-family household. The three-year average winter water usage for the data sample was 233 gpd per household. This flow was then rounded up to 240 to be used in determining HE factors for the typical use groups listed in Table 3.1. The 240 gpd/HE is not intended to represent a design value for sewer construction but only for determination of HE factors for typical use groups. If the actual sewage flows to the treatment plant are measured throughout the dry portion of the year (June, July, and August), the estimated average sewer flow is somewhere between 250 and 300 gpd/HE. The 240 gpd/HE metered winter water flow is lower than the expected average dry weather flow to the plant due to the following reasons:

- Winter water usage measured by water meters includes sime inaccuracies at low flows. Small amounts of water pass through each meter without being measured.
- Interior house usage in the winter is probably lower than the other seasons (i.e., more showers are taken and more washing is done in the summer.)
- There is some small amount of I/I during the summer months from irrigation and groundwater.

For analysis and design purposes it is deemed appropriate to use 300 gpd per HE for dry weather flow calculations. The 2010 Wastewater Master Plan effort will use 300 gpd per HE for all analysis.

Table 3.1 Household Equivalent Factors for Typical Use Groups

No	Use Group	Typical Flows	HEs	Source
1	Residential - single family	240	1.0	2006 WWUS
2	Residential - multiple family	178	0.74	2006 WWUS
3	Residential - mobile homes	178	0.74	2006 WWUS
4	Bakery - wholesale	170 gpd/1000 sq ft	0.6/1000 sq ft	1979 MSP
5	Bars without dining facilities	700 gpd/estabilishment	2.0/establishment	1979 MSP
6	Hair Care Facilities			
	A. Beauty Salon	120 gpd/chair	0.5/chair	1987 WWUS
	B. Barber Shops - Quick Service		0.8/1,000 sq ft	2006 WWUS
7	Car Wash - self service			
	A. Self-service		1.0/bay	1994 Interim
	B. Automatic		case by case	1994 Interim
	C. Small (1-car size)		1.0/pad	1994 Interim
	D. Large (Truck size)		2.0/pad	1994 Interim
8	Intermittent Use Facilities			
	A. Churches (without schools)	56 gpd/1,000 sq ft	0.2/1000 sq ft	1987 WWUS
	B. Convention/Meeting Rooms		0.2/1,000 sq ft	1991 Interim
9	City, County, Federal Bldgs	25 gpd/employee	0.08/employee	Reference
10	Department and Retail Stores	46 gpd/1,000 sq ft	0.2/1000 sq ft	1987 WWUS
11	Convalescent Homes	100 gpd/bed	0.4/bed	1987 WWUS
12	Medical Facilities			
	A. Hospitals	238 gpd/bed	1.0/bed	1987 WWUS
	B. Dental and Medical Offices		0.8/1,000 sq ft	1994 WWUS
	C. Health Clubs		0.8/1,000 sq ft	1995 WWUS
13	Industry, light (dry)	30 gpd/employee	0.1/employee	1979 MSP
14	Cleaners			
	A. Self-service Laundromat		0.5/machine	1986 WUS
	B. Dry Cleaners		2.0/1,000 sf	
15	Laundry (Industrial)		17.5/establishment	1979 MSP
16	Motels without dining facilities		0.50/room	1987 WWUS
17	Mortuaries	300gpd/slumber room	1.0/slumber room	1979 MSP
18	Professional Office	184 gpd/1,000 sq ft	0.8/1,000 sq ft	1979 MSP
19	Restaraunts			
	A. Large 24-hour chain	1291 gpd/1,000 sq ft	5.5/1,000 sq ft	1987 WWUS
	B. Large (> 2500 sq ft)	823 gpd/1,000 sq ft	3.5/1,000 sq ft	1987 WWUS
	C. Small (< 2500 sq ft)	498 gpd/1,000 sq ft	2.0/1,000 sq ft	1987 WWUS
	D. Pizza Parlors	1,569 gpd/establishment	6.5/establishment	1987 WWUS
	E. Fast food establishments:			
	i. Major Chain	2347 gpd/establishment	10.0/establishment	1987 WWUS
	ii. Local	494 gpd/establishment	2.0/establishment	1987 WWUS
	iii. Deli w/o OGI requir.		0.6/1,000 sq ft	1996 Interim
20	Schools			
	A. Elementary	4.6 gpd/student	0.02/student	1987 WWUS
	B. Secondary	9.3 gpd/student	0.04/student	1987 WWUS
21	Service Stations			
	A. w/mini-mart @ 500 ft no OGI		5.7/establishment	1997 Interim
	B. w/mini-mart other no OGI		1.6/establishment	1997 Interim
	C. w/mini-mart & fast food OGI		10.0/establishment	
	D. Service station only, any location		1.6/establishment	1997 Interim
	E. RV Dump Station		1.0/establishment	1997 Interim
22	Theaters	5-10 gpd/seat	0.02/seat	1979 MSP
23	Markets			
	A. Supermarkets (chain store)	242 gpd/1,000 sq ft	1.0/1,000 sq ft	1987 WWUS
	B. Small convenience (no gas)	238 gpd/establishment	1.0/establishment	1987 WWUS
24	Warehouse and Storage			
	A. w/ minimial office <1250 sq ft		1.0/establishment	1991 Interim
	B. Within other uses		0.0 if other paid	1991 Interim
	C. Building with Residence		1.0+0.8/1000 sq ft	1991 Interim

WWUS - Winter Water Use Study
MSP - Master Sewer Plan
WUS - Water Usage Study

3.3.2 - 2010 Allocation Methodology

Since 1979, the City of Redding has maintined the household equivalent and sewered area values by tabulating the building permits that have been issued in each sub-area and applying the appropriate household equivalent factor to the type of development. As part of the 1979 Master Sewer Plan study the entire collection system area was divided into a large number of sub-area (sub-basins) based on topography, pipe network configuration and other pertinent factors. Initially, the sub-areas for the Clear Creek Collection system numbered approximately 235 sub-basins ranging in size from 50 to 400 acres each. These sub-basins were refined with each subsequent planning effort resulting in 490 sub-basins ranging in size from 3 to 515 acres for the Clear Creek collection system and 313 sub-basins ranging in size from 5 to 710 acres for the Stillwater collection system. The collection of sub-basins also includes areas that could be reasonably sewered outside the existing collection system to the City's General Plan sphere of influence boundary. Sanitary service area (SSA) delineation is provided on Figures 3.4 and 3.5. More precise detail of boundary locations for the sanitary service areas are being included in the Wastewater Utility Atlas.

Sewer allocation methodology in this study followed that of the previous large scale sewer planning studies in assigning Household Equivalents to all connections throughout the City. The City of Redding customer service database contains record of the number of HEs associated with each connection and the connection's geographic coordinates. This data can then be used to associate the number of HEs assigned to each sewer sub-basin or potentially associated with each manhole or pipe in the collection system network. For this effort, HEs were assigned to sewer sub-basins delineated in the prior master plan efforts.

Table 3.2 contains a summary of the average dry weather flows (ADWFs) and HEs for both basins during each planning period. Appendix A- Sanitary Service Area Demand Tables contains the breakdown of HEs allotted to each subbasin and mini-subbasin for all planning horizons.

Table 3.2 Average Dry Weather Demand and Household Equivalent Summary (1)

	Existing (2010)				2015				2020				2030			
Basin	SFR	MF	C/I/Pf	ADWF	SFR	MF	C/I/Pf	ADWF	SFR	MF	C/I/Pf	ADWF	SFR	MF	C/I/Pf	ADWF
Clear Cr	15628	6710	10187	9.8	16034	6782	10304	9.9	16149	6785	10340	10.0	16526	6979	10485	10.2
Stillwater	7901	1969	2157	3.6	8851	2001	2468	4.0	10600	2066	3156	4.7	15156	2259	10600	6.8
Total	23529	8679	12344	13.4	24885	8783	12772	13.9	26749	8851	13496	14.7	31682	9238	21085	18.6

SFR - Single Family Residence, HEs
MF - Multiple Family Residences, HEs
C/I/Pf - Commercial/Industrial/Public Facility, HEs
ADWF - Average Dry Weather Flow, MGD

(1) Note: This table reflects total demand volume draining into the collection system. Total ADWF from the hydraulic analyisis is likely to be significantly different for two reasons; 1) Sewer demands are applied to the collection system utilizing an hourly diurnal pattern and; 2) Sewer collection pipe networks will have significant dampening or routing effects.

It is important to note that the Average Dry Weather Demand data is based on water usage studies that do not include water conservation efforts mandated by the State of California. The actual impact of any conservation effort will be revealed in future water usage studies potentially prompting an update of this effort. Because the current water usage information is at least 10-years old it is recommended that the City initiate a new study to verify or determine new usage values.

3.3.3 Allocation Methodology - 2015, 2020 and 2030

The 2010 model was used as the baseline for applying growth as an additional percentage for each SSA for each planning period. Growth for each planning period was determined from two sources, Shasta County Regional Transportation Planning Authority (RTPA) demand model and City-wide growth forecast by Economic Sciences Corporation, a consultant for Redding Electric Utility.

The RTPA data exists as population assigned to areas referred to as Traffic Analysis Zones (TAZ) for each planning horizon. The TAZ population data can be converted to percent growth for each TAZ for each planning period. Using GIS tools the percent growth for each TAZ (or appropriate portion thereof) can then be assigned to each SSA for each planning period. Areas where no development is allowed under the general plan such as greenways, floodplains, and areas exceeding 20% slopes were excluded from the analysis. Thus if a TAZ was covering two SSAs but the area in one SSA is excluded due to one of the above mentioned classifications, 100% of the HEs, or growth was assigned to the other SSA.

Growth for each SSA was then converted to percent of the City-wide growth occurring in each SSA for each planning period. The City-wide growth for each planning period was obtained from the consultant's forecast data and distributed to each SSA accoring to its portion of City-wide growth.

Growth was assumed to be consistant between the different types of demands. For example if population increase was indicated to be 5% for a specific SSA for a specific planning period all types of demands present in the SSA (residential, multi-family or commercial) were increased by 5%. Demands for areas where no service exists in 2010 were generated based on population increase projected by the RTPA model divided by 2.39 persons per household then allocated to the use category (commercial, multi-family, single-family) based on land use zoning maps.

3.3.4 - Ultimate Buildout Planning Horizon

Ultimate build-out condition population forecast for wastewater flow was obtained utilizing general plan development density maps to perform the same type of demand assignment process to each SSA. Following this effort and comparing the 2030 scenario projections with the UBO projections it was discovered that some of the SSAs had higher population in 2030 than indicated by the General Plan density information. Investigation of the reason this occurred found that the General Plan density population values were generated based on mid-range density values whereas the RTPA data may have, in some cases, assumed development at the highest available density value. It was deemed conservative to use the higher of the two values.

To determine sanitary flows for the UBO planning period, the GIS databases were used to determine the potential number of Household Equivalents within each SSA based on development density. For each land use range the value used was the middle of the range. For instance, if the land use was single family 3 to 5 per acre Household Equivalents were assigned at a rate of 4 per acre. However, due to more specific analysis conducted by the Shasta County RTPA effort, even when reduced for current economic conditions, some SSA Household Equivalent totals were higher in the 2030 analysis than the independently forecast UBO effort. In such cases it was assumed that the RTPA numbers were not based on average allowable density under General Plan guidelines but may have been nearer the maximum allowable density. For all SSAs where this occurred, the higher of the two (2030 or UBO according to GP density) was used to calculate demand.

This analysis utilized a general plan land use map formatted in ArcView's GIS. The general plan indicates what types of land use will occupy the City when the City is fully developed. The general plan land use map is divided into four main categories and 26 sub-categories. The four main categories are residential, commercial, industrial, and other classification. Flow rates for residential sources were given in HEs per acre, with one HE equaling 300 gpd. Sanitary flows from non-residential sources were given in gpd per acre (gpad). Figure 3.6 depicts the general plan land use map along with a growth boundary provided by the City indicating the limits of the City's future growth by UBO. The area outside of the growth boundary was not considered in the determination of sanitary flows for UBO. The distribution of land use in terms of area, percentage area, and flow rates in gallons per day (gpd) is presented in Tables 3.3 and 3.4 for the Clear Creek and Stillwater Basins, respectively. Growth to the East of the existing Stillwater Collection System was considered in a separate, additional analysis to determine preliminary feasibility of providing service to the remaining undeveloped City Limit area and General Plan primary and secondary growth areas and the General Plan sphere of influence. Details and results of that analysis are presented in Chapter 6 - Stillwater Hydraulic Capacity and Treatment Evaluation.

Within each subbasin and/or mini-subbasin, the area of each land use designation was multiplied by the corresponding HE or flow rate to obtain the amount of sanitary flow contributed by that particular area.

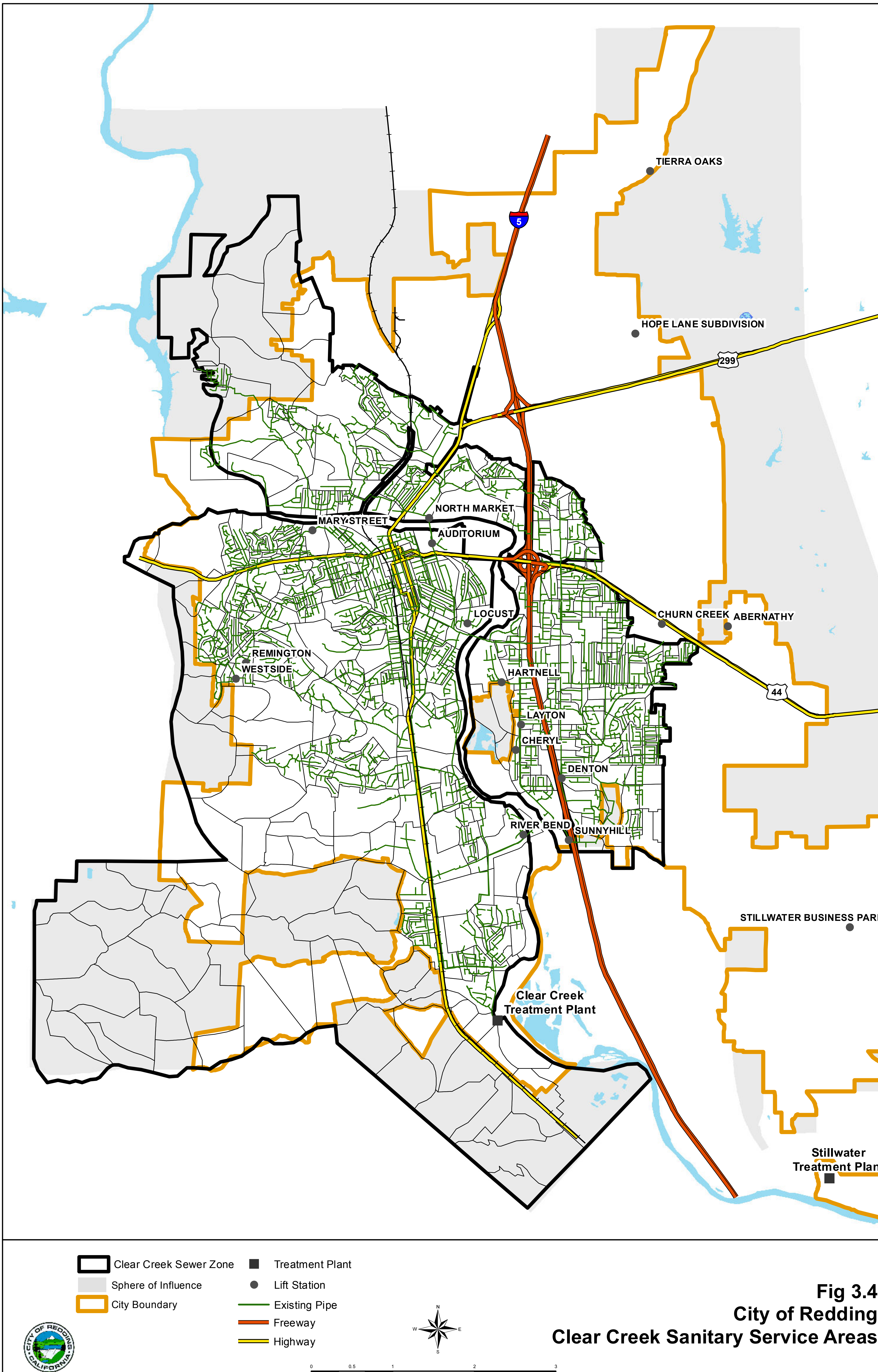


Fig 3.4
City of Redding
Clear Creek Sanitary Service Areas

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Sept. 4, 2012

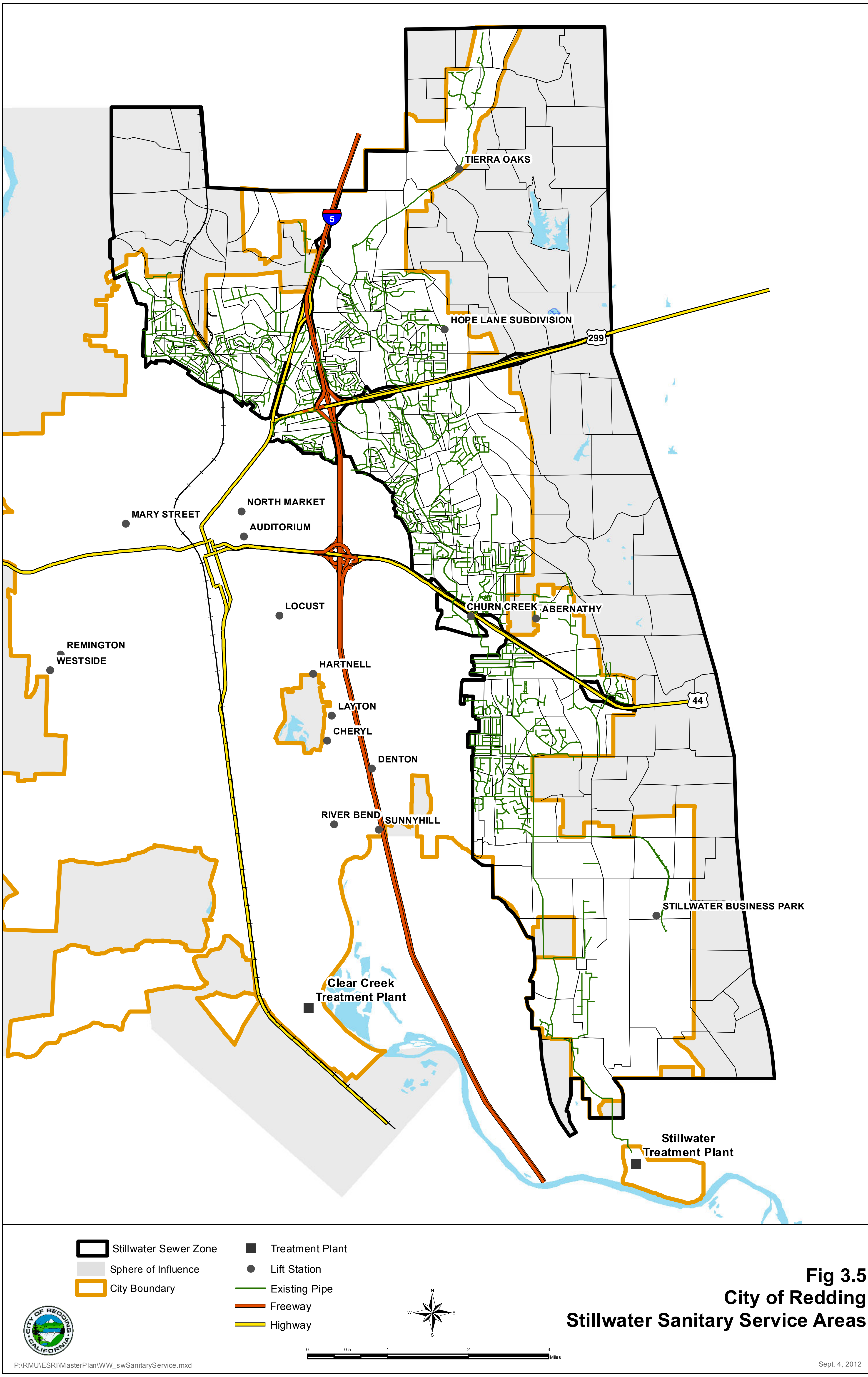

Fig 3.5
City of Redding
Stillwater Sanitary Service Areas

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Sept. 4, 2012

3.3.5 Diurnal Variation

Sanitary sewer flows from domestic sources exhibit a diurnal pattern characterized by higher sewer demands in the early morning and mid-evening as people are taking showers, running laundry and dishwashers. Diurnal patterns are obtained by averaging hourly flow monitoring records for multiple 24-hour periods during dry weather. Some small seasonal fluctuation in both magnitude and diurnal pattern of the domestic sewer demand is expected due to higher frequency of showering during the summer months. The changes due to this effect are not expected to be significant and are not accounted for in this plan.

Table 3.3 General Plan Land Use for Clear Creek WWTP Collection System

Land Use Designation	Area, ac	Percent of System Area	HEs	ADWF, mgd (1)
Single Family Residential	14,678	47.7	35744	10.7
Multi-Family Residential	567	1.8	10033	3.0
Commercial/Industrial/PF	6,983	22.7	14057	4.2
Green Space/Parks	8,552	27.8	0	0
Total	30,780	100	59834	18.0

(1) Calculated from HEs

Table 3.4 General Plan Land Use for Stillwater WWTP Collection System

Land Use Designation	Area, ac	Percent of System Area	HEs	ADWF, mgd (1)
Single Family Residential	13,534	53.5	28054	8.4
Multi-Family Residential	414	1.6	5274	1.6
Commercial/Industrial/PF	5,863	23.1	6789	2.0
Green Space/Parks	5,176	20.5	0	0
Total	25,312	100	40117	12.0

(1) Calculated from HEs

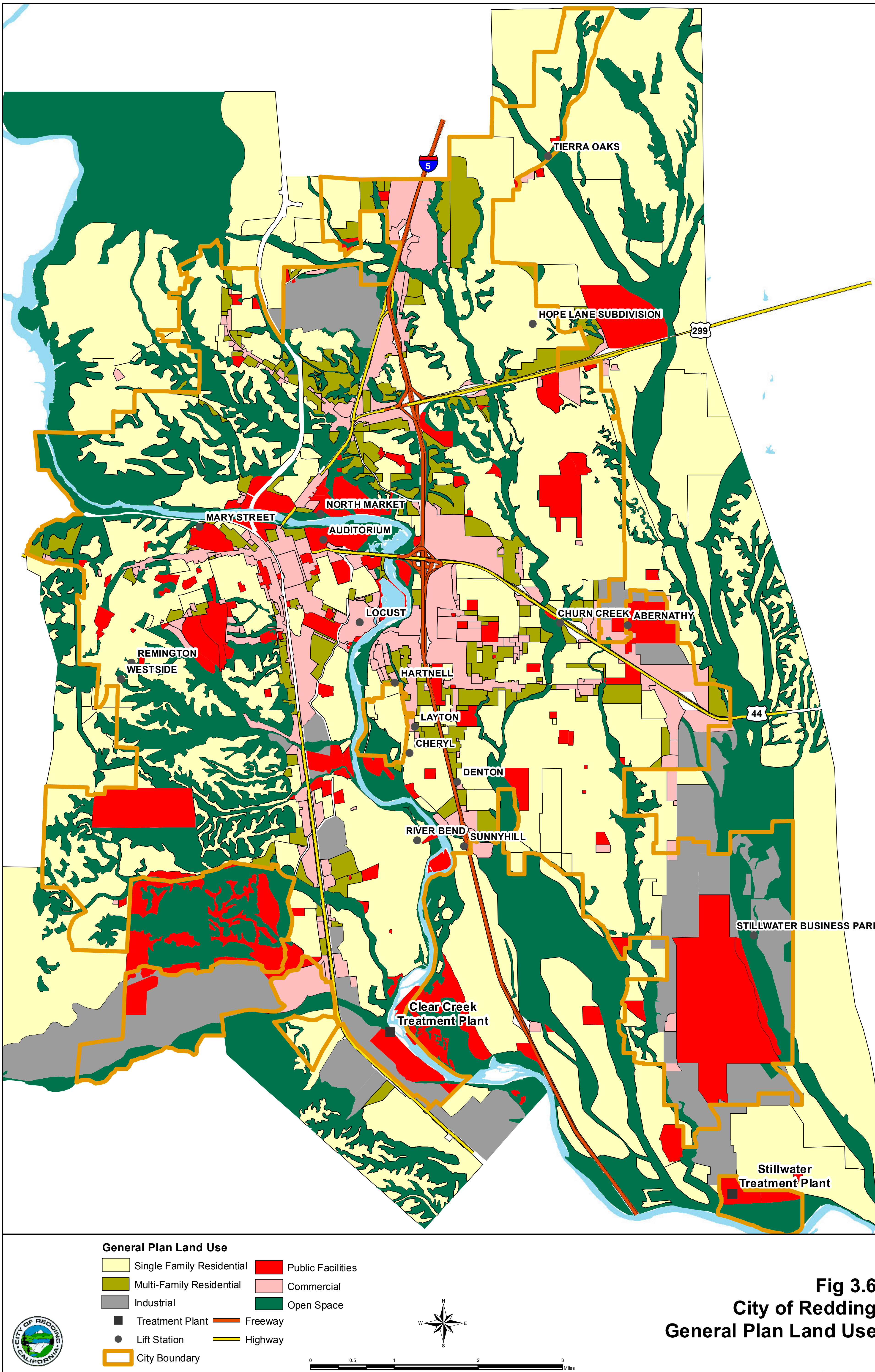


Fig 3.6
City of Redding
General Plan Land Use

3.3.6 New Service Areas and Extension of Service

Following extensive dialog with City planning staff, the local engineering community and other entities involved in land development, and in consideration of the current economic environment, additional growth in terms of expanding the collection system to new service areas was implemented selectively. Each SSA was considered relative to the following criteria:

- City of Redding General Plan growth area (primary, secondary or sphere of influence)
- Presence or absence of other infrastructure that might support or burden new development, such as water supply or transportation corridors.
- Current development level
- Natural barriers such as major creek corridors or topography
- Current annexation policies
- Availability to serve with pipes instead of lift stations

A narrative and discussion of the details of decisions for analysis of new service or extension of service are included in Appendix B - Community Outreach

New pipes reflected on maps associated with potential extension of service to new areas are shown in general locations for planning purposes only. The locations are approximate and only analyzed to determine if it is likely that slope is available to function adequately. No alternatives were analyzed for specific alignments or right-of-way or environmental investigations were performed. Thus any location shown for any future pipe is for planning purposes only and does not in any sense promise or commit that location. Should such pipes enter a design process the appropriate detailed studies including alternatives analysis, feasibility studies, environmental documentation and potential right-of-way studies will occur at that time and determine detailed alignment of the any new pipes.

Over 3,300 residential homes within the City sewer service area are served by private onsite wastewater treatment systems (septic systems) instead of the City sewer collection system. Between 10 and 20 of these homes per year have septic system failures and apply for repair permits with Shasta County Environmental Health. Repairs of existing septic systems may become more costly due to the new "Water Quality Control Policy for Siting, Design, Operation, and Maintenance of Onsite Wastewater Treatment Systems" drafted on March 20, 2012 by the SWRCB.

If a septic system within the City sewer service area is failing and a public sewer is located within 200 feet of the property line, the property owner is required to connect to the public sewer. Shasta County Environmental Health refers to the City of Redding Municipal Code Section 14.16.300 to deny the septic system repair permit and requires the connection to the public sewer.

Unfortunately, public sewers are not always available within 200 feet of a property line and some neighborhoods that are not served by public systems do not have good soil properties for supporting independent septic systems. As the cost of maintaining and replacing these independent systems increases there may be some consideration of forming special benefit districts to extend the public sewer system thereby providing service. Until that happens the cost of district fees to each property owner is estimated to exceed the cost of continued maintenance of their existing sanitary systems. In addition, projecting when and where this might occur would be very difficult therefore no recommendations are made at this time other than to be aware that the issue may increase in importance as costs of maintaining these systems increase.

3.4 WET WEATHER FLOWS

3.4.1 Groundwater Infiltration

Infiltration is the component of sanitary sewer flow that enters the collection system through defects in the pipes and manholes due to goundwater levels exceeding the elevation of the pipes. This component of sanitary sewer flow increases during the wet season (November through March) due to higher creek and groundwater levels but does not change significantly on a daily or even weekly basis.

Determination of infiltration flows is typically done using flow monitors to measure winter flows in the collection system during periods of time between storms. The difference between the non-storm wet weather monitoring data and dry weather monitoring data collected at the same location then represents the amount of infiltration entering the system upstream of the monitoring location.

Analysis of the infiltration component of sanitary sewer flows determined that the winter levels are approximately 3.0 Million Gallons Per Day (MGD) for Stillwater Collection System. The Clear Creek Collection system returns to dry weather flow conditions after about a week even in the winter season so although there is a long duration storm related inflow, the infiltration component does not appear to be significant. Due to the limited amount of data available at the time the computer models were calibrated the infiltration component was distributed evenly between all manholes in each collection system. Although this is not an ideal method and it is acknowledged that not all manholes or pipes contribute the same amount of infiltration the modeling effort still yeilded a high level of correlation with actual data during the calibration process, see Chapter 4 sections on Sewer Modeling and Model Calibration.

3.4.2 Rain Driven Inflow and Infiltration

The magnitude of Rain Driven Inflow and Infiltration (RDI/I) component of sanitary sewer analysis is determined using the same method as used for determination of the infiltration component performed during a storm event. To obtain the magnitude of RDI/I, groundwater infiltration and dry weather flow quantities are subtracted from flow monitoring records during a storm event. This yields the RDI/I for that specific storm event upstream of the flow monitoring location. However, it is very difficult, if not impossible, to capture and record a storm that precisely matches the required design storm and thereby the level of RDI/I and total sanitary flow to use for design purposes. Details of how RDI/I is analyzed are discussed in Chapter 4 - Hydraulic Analysis of the Collection System.

CHAPTER 4
Hydraulic Analysis of the Collection System

4.1 INTRODUCTION

The City of Redding wastewater collection system evaluation includes analysis of all major aspects of providing sewer collection services for the customer. The effort starts with evaluation of collection pipe and lift station capacity. This chapter presents the framework for the city-wide evaluation. The following two chapters cover details of each of the two individual collection systems and treatment plants.

The evaluation and analysis contained herein assumes development follows the projections described in Appendix F - Population Forecasting from a combination of Economic Sciences Corporation and Shasta County RTPA efforts. The effort is considered the best available projection of growth potential for different areas within the overall planning boundary. This document outlines the City of Redding intent, based on that best available projection, to locate projects that will provide service for those projected demands. However, since all such planning efforts carry some amount of uncertainty, should development occur earlier than projected or in areas where growth is not projected, improvements necessary to obtain service from the City of Redding collection system shall be constructed and paid for by the developer of the project and may or may not be eligible for reimbursement from the City of Redding or future land development projects that may benefit from said improvements. Such improvements may include not only those necessary to extend the collection system to the project but also improvements required within and to the existing collection system and/or treatment plants. To mitigate this uncertainty it is recommended that the Master Plan be updated on relatively frequent intervals.

4.2 HYDRAULIC MODEL DEVELOPMENT

The City conducted master plans for Clear Creek wastewater system in 1979 and 1987, using an early version of Pizer's HYDRA modeling computer program in the 1987 study to evaluate the Clear Creek collection system. For the 2003 WWMP Pizer's HYDRA model was selected as the platform for performing the model analysis. After extensive evaluation of the different modeling tools available, the 2010 effort determined that the MWH-Soft (now Innovyze) InfoSWMM model was a preferred platform for modeling the sewer collection system. InfoSWMM is a fully dynamic, geospatial wastewater and stormwater modeling and management software application. The platform offers direct ArcGIS integration enabling engineers and GIS professionals to work simultaniously on the same integrated platform. InfoSWMM utilizes an enhanced version of the SWMM5 analysis engine ad developed and distributed by the Water Supply and Water Resources Division of the U.S. Environmental Protection Agency's National Risk Management Research Laboratory (SWMM Version 5.0.018). It is a physically-based, discrete-time simulation model. It employs principles of conservation of mass, energy, and momentum wherever possible. The routing portion of InfoSWMM transports flow using either uniform routing, kinematic wave routing or dynamic wave routing through a conveyance system of pipes, channels, storage/treatment units, pumps, and hydraulic regulators such as weirs and orifices.

To migrate from the 2003 Hydra platform to the new InfoSWMM platform the City contracted with MWH-Soft to convert the model. Once the model was converted and running in the new modeling software, staff performed extensive quality assurance to verify all existing pipe diameters were accurate and that the collection system network geometry was correct. After the quality assurance check of the existing system was complete, all projects since 2003 (constructed, in design, or under construction) were added to the analysis to generate a 2010 (existing condition) model.

In previous studies approximately half of the pipelines and manholes were intentionally omitted from the collection system analysis to increase the speed and efficiency of the original Hydra model. Most of these pipes were 6-, and 8-inch diameter pipes serving very small areas. Hydraulic evaluation of these pipes was not considered necessary since flows were not anticipated to be significant due to the limited size of the areas served. The 2010 effort determined that adding these pipes would not serve any purpose in the Master Plan evaluation. Due to increased computational efficiency of more recent computer hardware there may be a time in the future when adding these pipes to the model would be appropriate. Flows that would have been analyzed in the omitted pipes were added to the collection system at the first modeled manhole downstream.

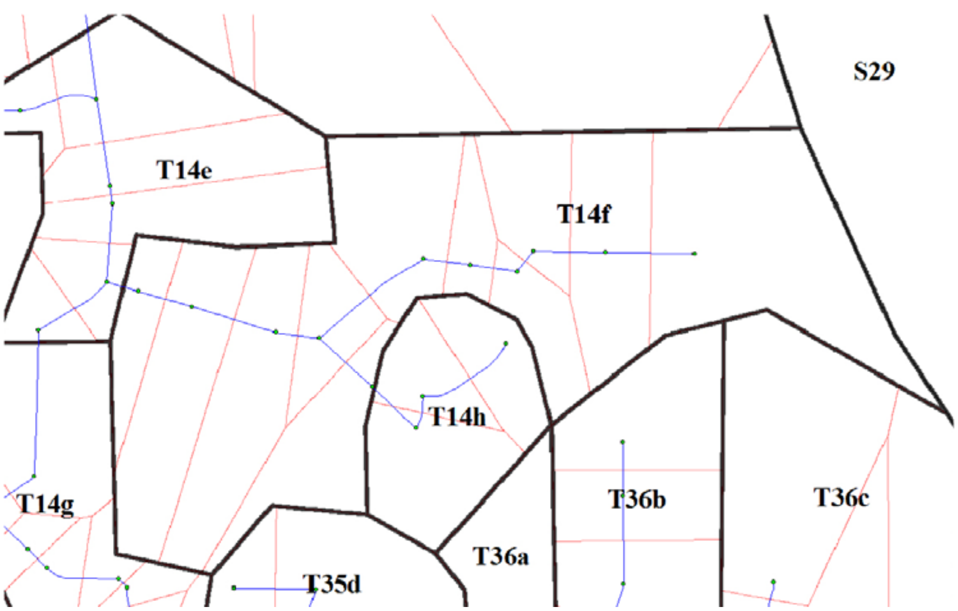
4.3 DRY WEATHER FLOW LOADING

The sanitary portion of the dry weather flows, as discussed in the previous chapter, are applied to the model by distribution to each manhole. The model platform divides each SSA into smaller polygons associated with each manhole utilizing a standard thiessen network methodology. It then divides the average daily dry weather flow for the SSA between each manhole in proportion to its specific thiessen polygon's area. Figure 4.1 shows an example of the Thiessen network delineation. SSA T14f is assigned a dry weather flow which is then divided amongst eleven smaller polygons associated with each manhole within that specific service area.

Dry weather flows are also added to the collection system utilizing a diurnal pattern to simulate the hourly changes in demand resulting from typical domestic water usage. The diurnal patterns are generated by analyzing historic flow monitoring records from dry weather periods. Diurnal patterns were generated for each geographic area where model calibration was performed. Details of the diurnal patterns are presented in chapters relative to each collection system, Stillwater and Clear Creek.

The second component of Dry Weather flow, groundwater infiltration, is not included as a separate inflow to the model. As noted in Chapter 3, dry weather groundwater infiltration is one of the factors creating the difference between the 240 gallon per day (GPD) and 300 GPD definitions of a household equivalent. However, because the seasonal groundwater elevation during winter months creates the critical period for peak flow determination, separate analysis for dry weather groundwater infiltration is not necessary.

Figure 4.1 Thiessen Network Example



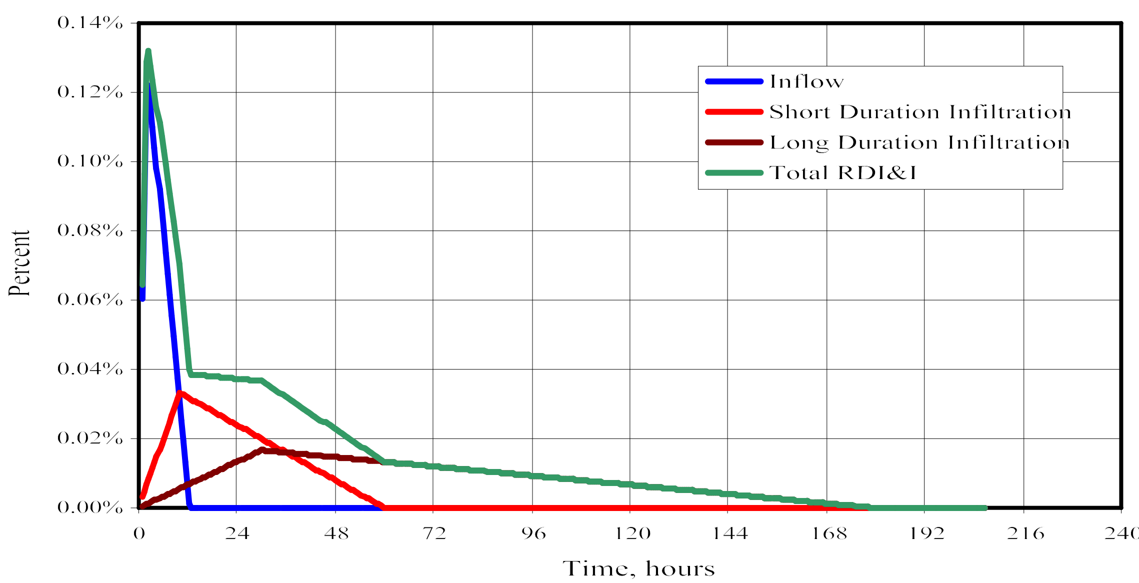
4.4 WET WEATHER FLOW LOADING

Wet weather flow loading in the hydraulic model involves two different elements, groundwater infiltration and rain driven inflow and infiltration. In the previous appendix the rain driven elements were differentiated into inflow and infiltration. However, for modeling purposes they are entered into the model simultaniously through a series of unit hydrographs.

Wet weather groundwater infiltration is determined by analysis of flow monitoring data during non-storm winter periods. The difference between the monitoring data and the calculated flow using city-wide customer service data for household equivalents represents the groundwater infiltration component. For the 2012 WWMP this component was entered into the computer model as a constant inflow relative to the area served by each manhole using the same Thiessen network described in the prior paragraph.

RDI/I is determined through the calibration process which will be covered in detail for each collection system evaluation in Chapters 5 and 6. Recorded precipitation amounts are used in combination with a series of three unit hydrographs to enter flow into the collection system at each manhole. The amount entering the collection system is determined based on the service area associated with that manhole and a factor representing a percent of the total recorded precipitation falling in each model time increment. The combination of unit hydrographs provides temporal distribution of the rain driven components entering the collection system. Figure 4.2 shows an example of the three unit hydrographs used to deliver rain driven flow components to the collection system.

Figure 4.2 Example Aggregate Unit Hydrograph



In future efforts the City might consider revising the inflow processing methodology for both groundwater inflow and rain driven components to correlate with length of pipe and or number of manholes rather than area. This would avoid the potential of overestimating the amount of non-sanitary sewer components from large undeveloped areas. For instance, sanitary service areas for an airport have very limited infrastructure density and therefore little opportunity for inflow and infiltration yet the area served is very large.

4.5 DESIGN STORM

After the calibration process is finished, a design storm is selected and run through the hydraulic model. The purpose of a design storm is to evaluate the capacity of the collection system based on peak wet weather flows. The results of this evaluation will determine where capacity deficiencies exist in the collection system. Design storms are synthetic rainfall events used to analyze the performance of a collection system under peak flows and volumes. Design storms have specific recurrence interval and rainfall duration and are typically developed from Intensity-Duration-Frequency (IDF) curves. These IDF curves are based on a statistical analysis of long-term rainfall gauges for a specific geographic area.

The temporal distribution of precipitation applied to a SSA or multiple SSAs to obtain the rain driven components of sewer flows requires the development of a design storm rainfall time series. The design storm accounts for variability of precipitation intensity over time utilizing the 10-year, 24-hour duration depth. The following are elements of a design storm:

- Precipitation Depth: The amount of precipitation occurring during a specified storm duration and recurrence interval. The depths of rainfall are statistical depths obtained by detailed study of historical precipitation data to find the maximum depth for each duration for a particular return period.

- Duration: The specified length of storm time under study. Duration of a design storm event should be at least four times the reaction time of the basin. The reaction time is the time required for the peak to reach the point of interest, typically a pipe, manhole or treatment plant.

- Frequency: The frequency of occurrence of events with the specified precipitation depth and duration. This is expressed in terms of the return period. In order to provide a reasonable level of flood protection, the statistical concept of return period or recurrence interval is utilized to assign a probabilistic meaning to a precipitation event. Frequency is typically expressed in years. For example the WWMP analyisis uses a 10-year event. The term recurrence interval is somewhat misleading in that the statistics used to generate the magnitude of the event indicate that there is a 10% chance in any given year which only translates to a once every ten year average if considering a long duration (decades) time frame. It is possible that multiple 10-year events may occur in sequential years or even within the same year.

The time distribution of rainfall within storms is important in estimating the rain driven sewer components. Distributions vary with storm type (orographic, convective), intensity and duration. There is no typical distribution that is applicable to all situations. A balanced symmetrical distribution was chosen to represent the design storms for Redding. A symmetrical precipitation distribution is constructed such that the depths specified for the greatest intensities occur during the central part of the storm. The design storm pattern consists of incremental precipitation depths nested within the storm duration in an alternating pattern with maximum value in the center and the second highest value to the right of center. One advantage of this type of storm pattern is that the critical storm depth for all durations less than the total duration of the storm are nested within the storm. Time increments of 5 minutes were utilized for distribution of the storm pattern.

Rainfall analysis for the City of Redding includes a significant orographic component. Analysis of the historic precipitation records reveals a significant elevation based difference in the amount of rainfall occurring in the region. To account for this effect, design storms were generated utilizing depths of precipitation for the specified duration and frequency obtained by interpolating between analysis of records at Shasta Dam (Elevation 1075) and the Redding Airport (Elevation 425).

Additional detail and discussion of the stocastic process utilized for obtaining precipitation depths, frequencies, durations and construction methodology for the design storms can be found in the 1993 City-Wide Storm Drain Study and its subsequent revisions$_{(1)}$.

The design storm used for both collection system analysis and evaluation was the ten- year, 24-hour recurrence interval storm. The depth of rainfall used for the design storm was obtained from IDF data obtained by the City of Redding in 2006 for revision to the 1993 City-Wide Master Storm Drain Study. Interpolation of the 2006 IDF information for elevation in 50 ft increments allowed development of a set of design storms for each 50 ft elevation band throughout the study area. The appropriate design storm was then assigned to each manhole in the collection system according to its rim elevation. Depth of precipitation used in the analysis for the 10-year, 24-hour storm ranged from 4.30 inches less than 500 feet to 6.14 inches for the highest areas of the City. The current National Oceanic and Atmospheric Administration (NOAA)-Atlas 14, Volume 6, Version 2.0: California, released in 2011, shows the 10-year, 24-hour depth at approximately 750 feet of 6.19 inches with 90% confidence level boundaries of 5.40 to 7.24 inches. It also shows 4.41 inches (with 3.84 to 5.16 90% confidence level boundaries) at the 500 ft elevation. The latest NOAA data is very close to and confirms the 2006 City of Redding IDF information.

4.6 SEWER DESIGN CRITERIA

The City of Redding sewer design criteria is implemented through publication of the City of Redding Construction standards. The Standards dictate allowable materials, minimum cover, maximum depth, construction, construction quality assurance, size and slope criteria. Minimum slopes specified in order to maintain minimum flow velocities. Flows are to be calculated utilizing 300 gpd per HE plus 1,500 gpd per acre developed with peaking factors obtained from the latest WWMPlan.

It is recommended that future updates to the Construction Standards include the following:

1) A specification of how full the pipe is to be under design flows. Many communities use 50% full but it is not uncommon to see design at 75% full. It is recommended that the City use the 50% full criteria.

2) Scale the level of effort, detail and geographic extent of analysis required based on the size and type of the new development. The Master Plan attempts to account for large scale development on a regional basis and implement projects to support such development. However, it is not uncommon for a property owner to bring a project forward in an area that was not expected to develop for ten or twenty years. There is no criteria in the standards for extent of analysis required by the developer's engineer. In addition, it is almost impossible to forecast demand for industrial areas. A large demand industrial project could potentially require significant off site improvements downstream in the collection system.

4.7 COLLECTION SYSTEM EVALUATION

4.7.1 Introduction

The City of Redding sewer system consists of two separate collection systems and treatment plants. The Clear Creek and Stillwater collection systems were evaluated based on routing the ten-year design storm event through the collection system using the calibrated InfoSWMM model. Assumptions and criteria used in the modeling effort are presented below. Improvements based on model results to provide adequate capacity in the collection systems are described in Chapters 5 and 6 and included in the Capital Improvement Program (CIP) and Financial Evaluation Chapters 9 and 10. Evaluation of the collection system includes an exhaustive analysis of available flow and rainfall monitoring records, calibration of the computer models

[1] *Montgomery Watson Engineers, City of Redding City-Wide Master Storm Drain Study (October 1993), 4-3.*

and identification of projects to alleviate potential restrictions. In addition future demands are incorporated for each planning horizon (2015, 2020, 2030 and UBO) and evaluation of the system occurs for each projected demand scenario.

4.7.2 Background

The City currently operates and maintains approximately 416 miles of sanitary sewer pipeline, spanning from 4 to 54 inches in diameter, 17 raw sewage lift stations, and two wastewater treatment plants (WWTP). Construction of the sewer collection system started in 1887 and has continually expanded through the years. The City sewer collection system is divided into two major drainage basins:

- Clear Creek Basin - Encompassing areas west of the Sacramento River, as well as the Enterprise area and areas upstream of the North Market Lift Station, and

- Stillwater Basin - Encompassing areas east of the river which are upstream of the Churn Creek Lift Station and along the Clover Creek Interceptor.

Sewer collection system pipelines for each major drainage basin terminates at one of the City's two WWTPs: the Clear Creek WWTP or the Stillwater WWTP. The existing collection systems for the Clear Creek and Stillwater Basins are indicated on Figures 3.5 and 3.6, respectively. These figures also show the service areas and portions of the collection systems that were hydraulically modeled.

4.7.3 Hydraulic Model Calibration

Both dry and wet weather flow monitoring data was used to calibrate the InfoSWMM model to recorded flow conditions in both the Clear Creek and Stillwater collection systems. Dry weather calibration was based on flows measured in the collection system during dry months between 2006 and 2010. The dry weather calibration assumed that unit flow was based on 300 gallons per household equivalent-day.

Analysis of the wet weather flow component consists of modeling the dynamics of RDI/I entering the collection system. The age and condition of the collection system facilities affects the quantity of inflow and infiltration into the system. Typically, older portions of collection systems allows more RDI/I to enter the collection system than newer portions, due to the pipelines being older and not manufactured or constructed to modern standards.

The model was calibrated for wet weather conditions based on flow monitoring and rainfall data recorded at lift stations, treatment plants and rain gauges located throughout the City. Several storm events were evaluated for use in calibrating the computer models. Selection of the calibration storm events was based the following factors:

1. Events occurring that most closely approximated the design storm (10-year, 24-hour)

2. Events providing dependable data for both rainfall and flow monitoring

Further details of the demands, model calibrations, and collection system evaluation are documented in following chapters covering each of the collection systems.

CHAPTER 5
Clear Creek - Hydraulic Capacity and Treatment Evaluation

5.1 DESCRIPTION OF EXISTING FACILITIES

The Clear Creek Basin encompasses areas west of the Sacramento River, the Enterprise area, and areas served upstream of the North Market Street Lift Station. A map of the existing Clear Creek Basin and collection system pipe network is presented on Figure 1.2.

5.1.1 Collection System

The Clear Creek Basin collection system includes 13 lift stations for pumping wastewater across the Sacramento River or over ridges. The collection system terminates at the Clear Creek Wastewater Treatment Plant (CCWWTP), and treated effluent is discharged to the Sacramento River. The collection system consists of approximately 268 miles of pipe ranging in size from 4 to 54-inches in diameter. Approximately 46 percent of the system is VCP, 25 percent ABS, 14 percent PVC, 9 percent asbestos cement, 5 percent RCP and 1 percent miscellaneous other pipe materials. Approximately 78 percent of the system consists of 4, 6 and 8-inch diameter pipes, 12 percent is pipes 10-, 12- or 15-inches in diameter, and 10 percent is 16-inch in diameter or larger. Data for pipe age was derived from plan drawings which resulted in approximately 67 miles (25 percent) of pipe with undetermined age. Of the pipes that age could be identified, the oldest pipes are approximately 75 years old with 50% of the system being 35-years or older. It is likely that the 25 percent of pipe without age information are some of the older pipes. Detailed analysis of pipe age and replacement needs is included in Chapter 7 - Collection System and Special Facility Preservation.

PIPE MATERIALS	
ABS	Acrylonitrile-Butadiene-Styrene
AC	Asbestos Concrete
CI	Cast Iron
PVC	Poly-vinyl-chloride
RCP	Reinforced Concrete Pipe
VCP	Vitrified Clay Pipe

5.1.2 Lift Stations

The Clear Creek Collection system has twelve lift stations. Eleven of the lift stations are included in the computer hydraulic analysis. Auditorium lift station was not considered to be large enough to include in construction of the computer model. Six of the lift stations are considered major facilities. Table 5.1 summarizes the historic flows recorded at each lift station. Table 5.2 shows Clear Creek Lift station characteristics.

Table 5.1 Clear Creek Collection System Lift Station Flows, gpm

Lift Station	Type	PWWF	AWWF	PDWF	ADWF
Auditorium	Minor	n/a	n/a	n/a	6.2
Cheryl	Minor	n/a	n/a	n/a	64
Denton	Major	411	75	411	74
Hartnell	Minor	n/a	n/a	n/a	44.3
Layton	Major	1821	926	374	275
Locust	Major	805	502	565	339
North Market	Major	2968	1470	806	402
Mary Street	Major	1766	726	511	316
Remington	Minor	n/a	n/a	n/a	1.4
Riverbend	Minor	n/a	n/a	n/a	11.1
Sunnyhill	Major	7975	5550	2075	1514
Westside	Minor	n/a	n/a	n/a	1.7

n/a - data not available

5.1.3 Treatment Plant

The City of Redding's Clear Creek WWTP was first constructed in 1966, and upgraded in 1977 to a design capacity of 8.8 million gallons per day (mgd) of average dry weather flow and 16.2 mgd of peak hour wet weather flow. After treatment and disinfection, the plant's effluent discharges to the Sacramento River downstream of the confluence of Clear Creek. In 2000 the City commissioned Carollo Engineers to develop a Wastewater Utilities Master Plan. Completed in 2003 the Master Plan primarily concentrated on collection system issues however did include a cursory review of the Clear Creek WWTP expansion requirements based on near-term (2010) peak hour wet weather flow projections. The Master Plan estimated the cost to meet 2010 requirements to be approximately $45 million, followed by an additional $20 million sometime after 2020 but did not include detailed analysis of any of the existing Clear Creek WWTP, process requirements, process options or ultimate treatment requirements. The Master Plan recommended that the City prepare a facilities plan to include detailed evaluation of needs and guide expansion of the treatment plant. In 2004 the City commissioned Brown and Caldwell to prepare the Clear Creek WWTP Facilities Plan. Recommendations of the Facilities Plan are included in this document as the evaluation for that facility. The Plan recommended approximately $66 million in improvements resulting in increased treatment capacity to 9.4 mgd ADWF and 40 mgd peak hour WWF. Most of the recommended improvements have been completed leaving only the laboratory building remaining to construct. . Figure 6.1 shows a schematic of the treatment plant operations. The cover photo of the Master Plan is an aerial photo of the WWTP facilities. Figure 6.2 is an aerial photo showing the ponds.

Figure 5.1 - Clear Creek WWTP Process Diagram

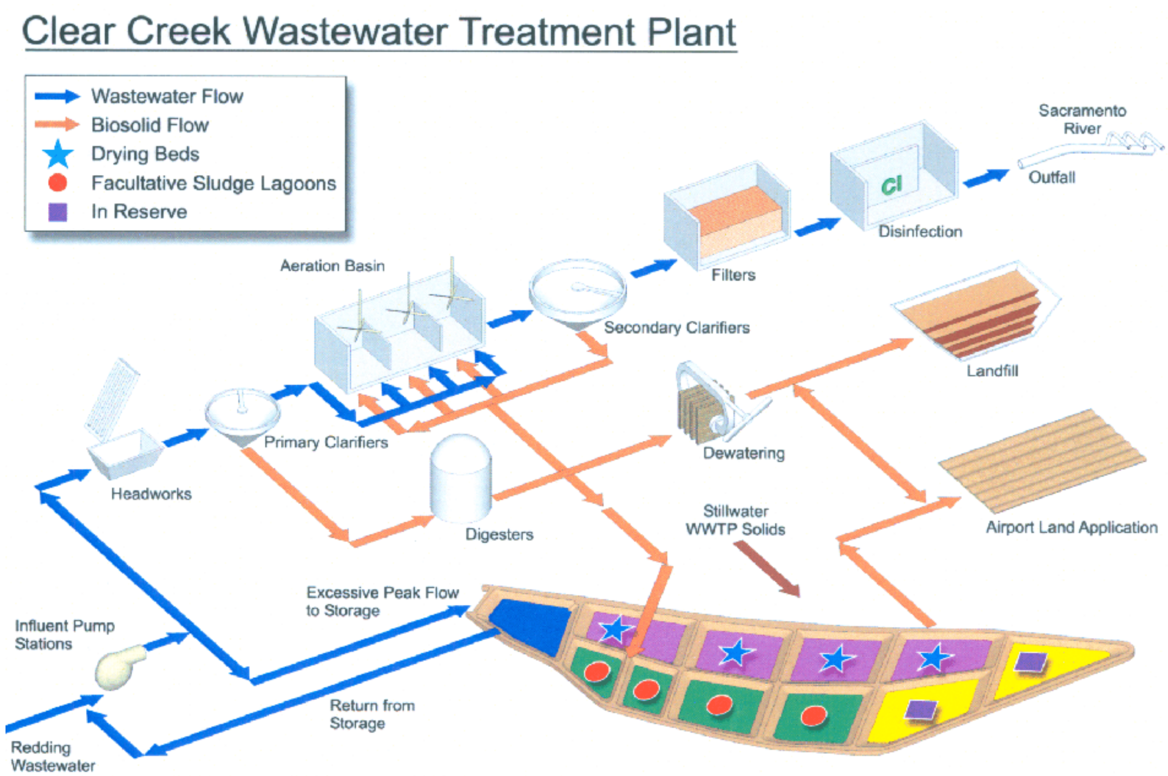


Figure 5.2 - Clear Creek Ponds

Photograph Courtesy of Eric Marshall

Table 5.2 Clear Creek Collection System Lift Station Data										
				Pumps			Force Main			
Lift Station	Address	Type	Date	No.	Capacity, gpm	Emergency Bypass	Diameter, in	Length, ft	Material	Lift height, ft
Auditorium	725 Auditorium Dr	Air Bladder	1962	2	100 total	Yes	4	23	AC	14
Cheryl	3797 Cheryl Dr	S&L	2004	2	450 total	Yes	6	250	CI	19.5
Denton	1025 Denton Way	S&L	1986	2	P1 = 185 P2 = 170 P1+P2 = 185	Yes	4	1200	AC	14.5
Hartnell	420 Hartnell Ave	S&L	1982	2	250 total	Yes	6	1100	PVC	39
Layton	3505 Bechelli Lane	Dry pit	1962	2	P1 = 1340 P2 = 1300 P1+P2 = 1700	Yes	10	1650	PVC	11
Locust	207 Locust Street	Dry pit	1961	2	P1 = 500 P2 = 500 P1+P2 = 580		10	2687	AC	14
North Market	975 North Market	Vert Turb	2008	3	P1 = 2100 P2 = 2100 P3 = 2100 P1+P2 = 5700	Yes	FM1 = 12 FM2 = 12	1670 1710	Steel	30
Mary Street	410 Overhill Drive	Dry Pit	2011	3	P1 = 2600 P2 = 2600 P3 = 1500 P4 = 1500 P1+P3+P4 = 4100		FM1 = 12 FM2 = 10	4964 989	CI	40
Remington	4099 Remington	S&L	1972	2	100 total	Yes	4	200	VCP	24
Riverbend	5650 Indianwood Dr	S&L	1990	2	100 total	Yes	4	300	C900	2
Sunnyhill	5100 Sunnyhill Dr	Dry Pit	1979	4	P1 = 950 P2 = 5500 P3 = 5500 P4 (off line) Total = 11,950	No (1)	30	890	CCS	42
Westside	4164 Boston Ave	S&L	1992	2	100 total	Yes	4	685	PVC	35

(1) Plan on file with contractor for emergency support.
S&L - Smith and Lovelace package lift station

5.2 DRY WEATHER FLOWS

Dry weather flow loading to the Clear Creek Collection system included area specific diurnal patterns generated by analysis of monitoring and lift station data. The period of time used for analysis of dry weather flow quantity and diurnal pattern at Clear Creek WWTP was the entire month of August 2009. Minimum ADWF was found to be 4.2 mgd occurring between 5:00 and 6:00 am. Maximum ADWF was 9.9 mgd between 11:00am and 12:00 noon. Figure 5.3 shows the diurnal pattern of the ADWF at Clear Creek WWTP.

Eight additional ADWF diurnal patterns developed based on monitoring data were used to simulate dry weather flows for collection systems upstream of the respective monitoring location. Details of the time frames and development of the diurnal patterns can be found in Appendix C - Supporting Data and Model Calibration. Results of the additional eight monitoring station DWF diurnal pattern analysis results are shown in Figure 5.4.

As a result of insufficient monitoring data, dry weather flow calibration was only accomplished at the WWTP. Figure 5.5 shows the correlation between recorded average dry weather flow and model output.

Figure 5.3 Clear Creek WWTP ADWF Diurnal Pattern

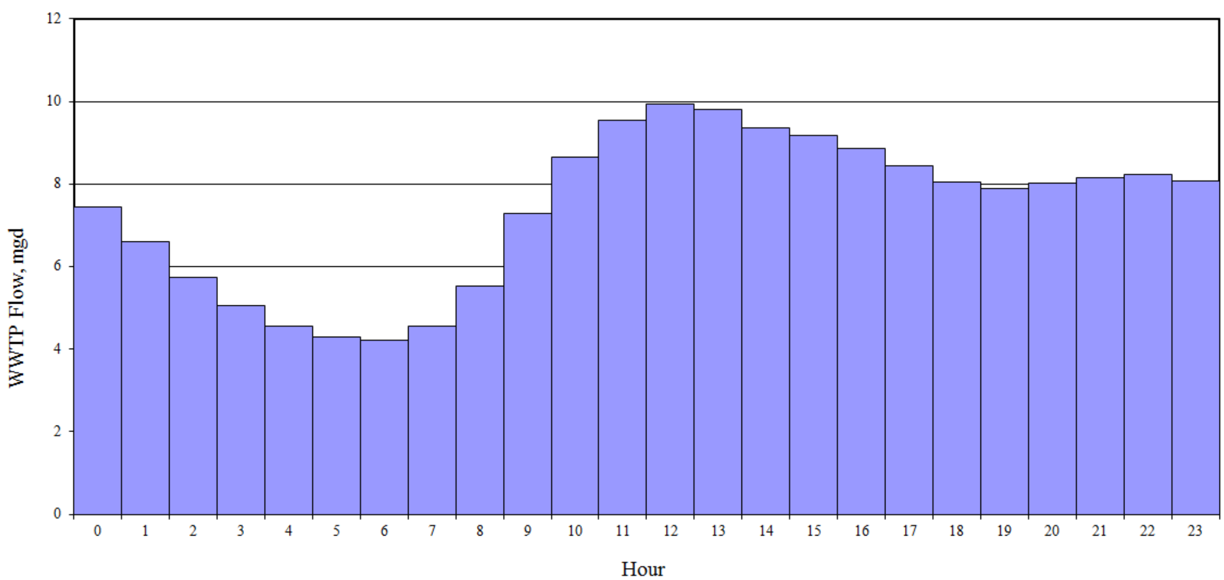


Figure 5.4 Clear Creek Collection System Diurnal Patterns

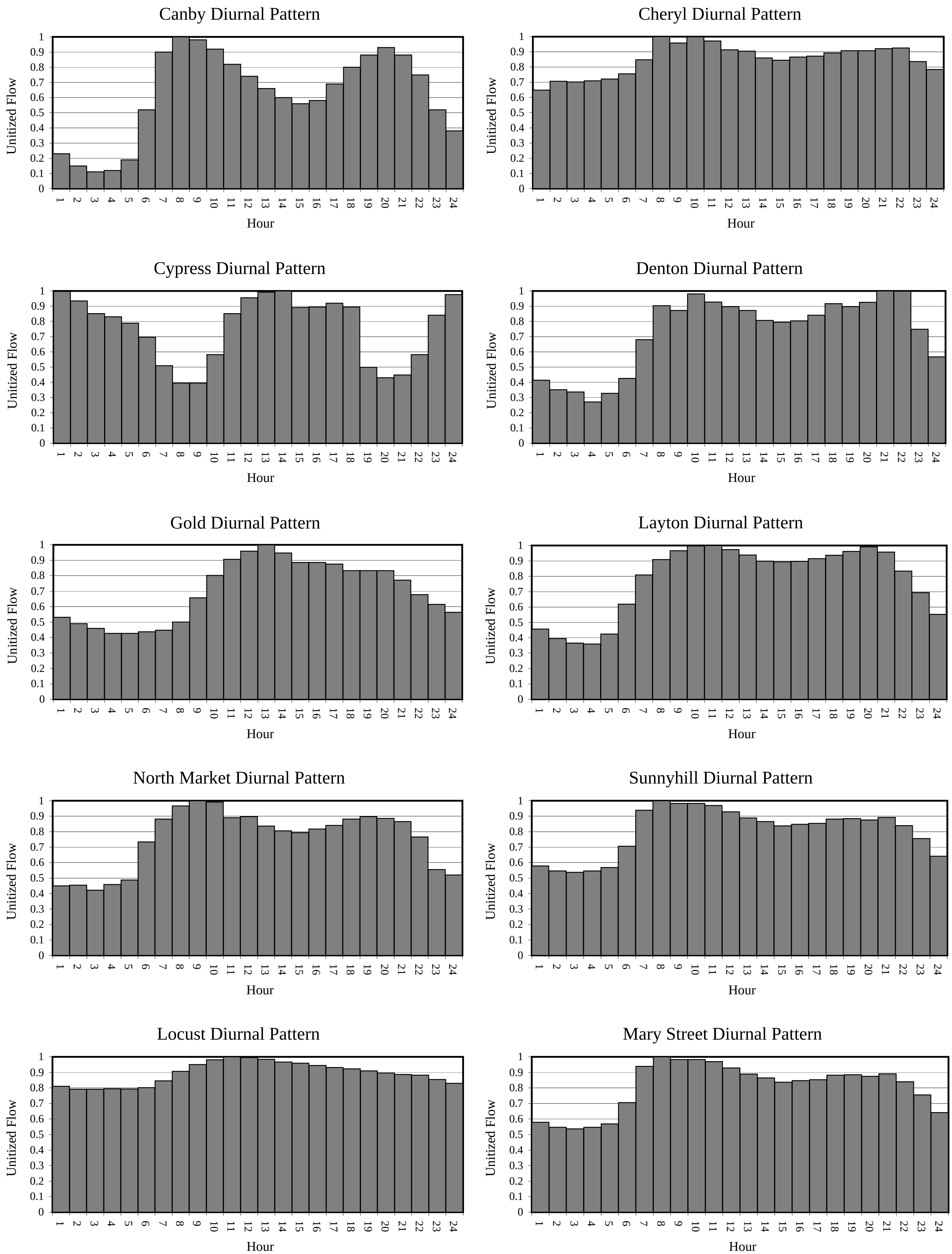
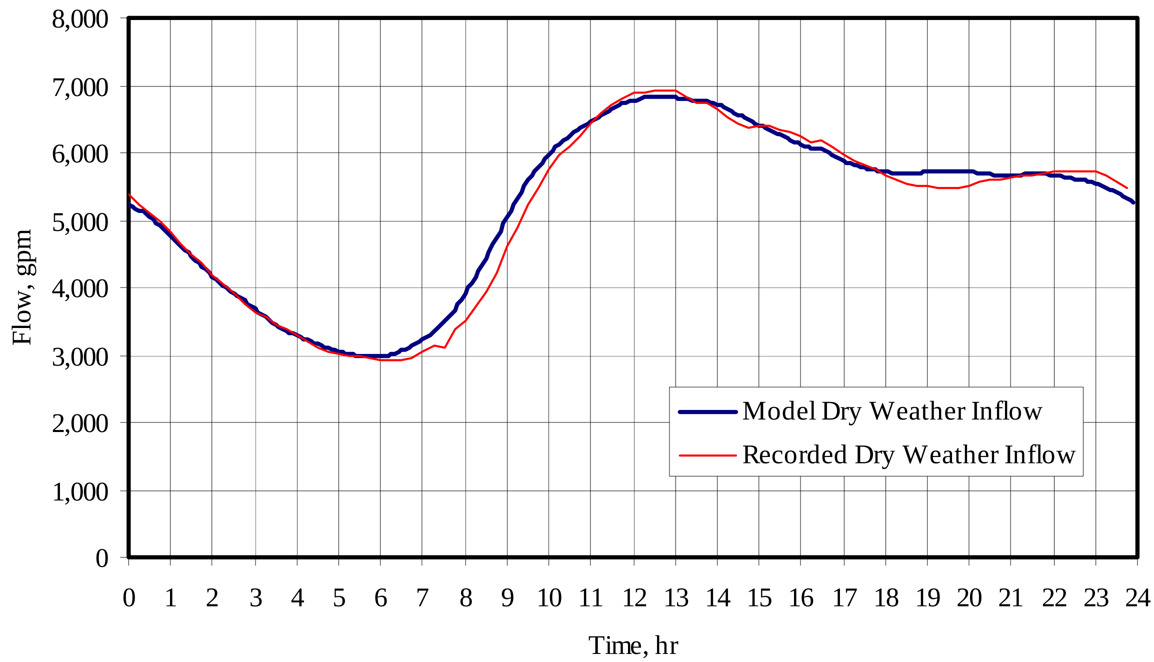


Figure 5.5 Clear Creek WWTP DWF Model Calibration

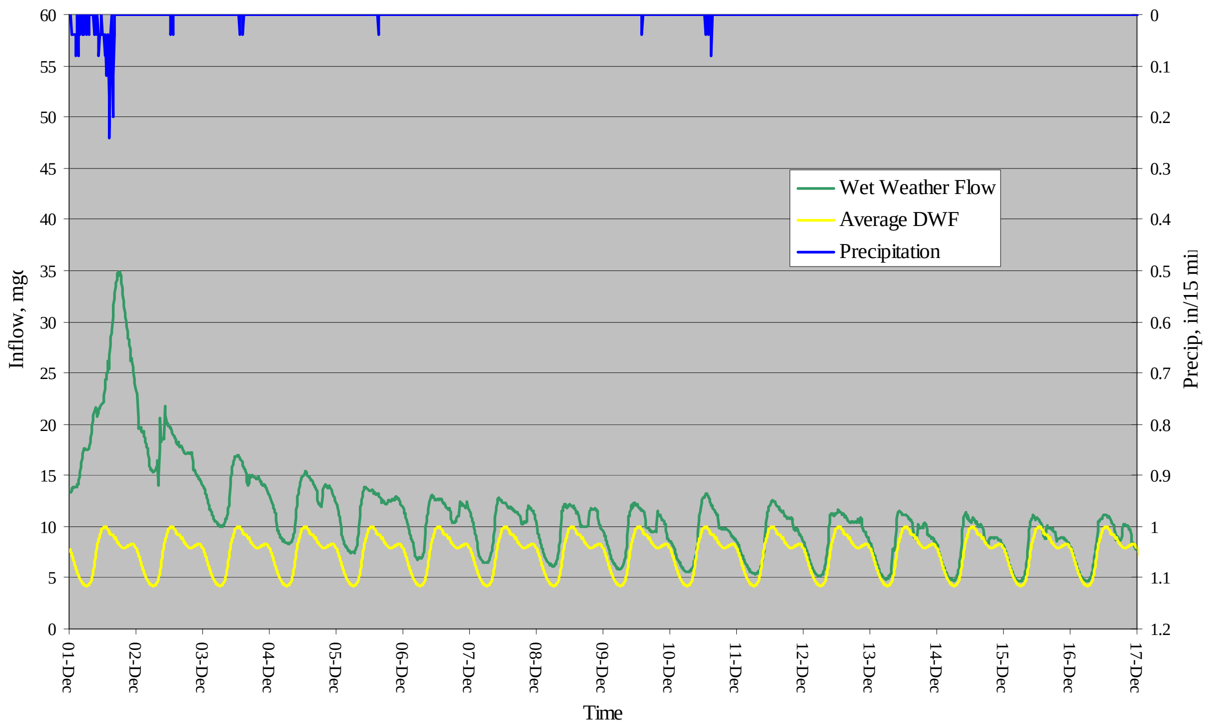


5.3 WET WEATHER FLOWS

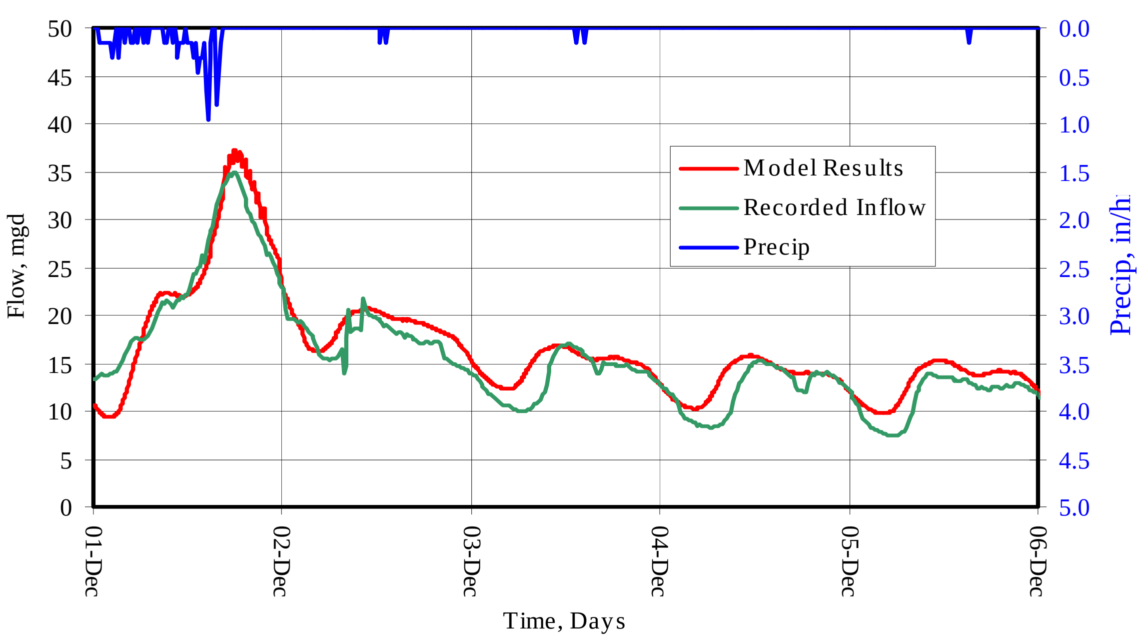
Wet weather data analysis for the Clear Creek collection system calibration included reviewing data from seven monitoring stations, North Market Street Lift Station, Mary Street Lift Station and the WWTP for the winter months of 2008-09 and 2009-10. Unfortunately, evaluation of the data from winter 2008-09 found that there was not enough data recorded to utilize in the Master Plan effort. Additional effort was put towards monitoring for winter 2009-10. However, although more data was captured, the quality of data and lack of coincident recording of precipitation and flow resulted in none of the data from seven City flow monitors or numerous precipitation gauges being usable for calibraton purposes. In order not to delay the planning effort, data from lift stations and the WWTP were used for analysis and calibration of the computer model. Time lines of available data and graphs of the monitoring and precipitation data are included in Appendix C - Supporting Data and Model Calibration.

During the process of evaluating the Clear Creek WWTP winter infiltration and sanitary flow components it was discovered that the system does not appear to have a significantly different groundwater infiltration rate for the winter months. However, it does appear to have an extended Rain Driven Infiltration period extending to approximately ten days following a rainfall event. Figure 5.6 shows a relatively discrete rain storm and the corresponding treatment plant inflows being elevated for the extended duration prior to returning to dry weather flow levels. The dry weather flow levels are used to generate the WWTP diurnal pattern averaged over the entire month of August 2008. Appendix C - Supporting Data and Model Calibration contains results from the extended period calibration. In order for the system to have a seasonal elevated groundwater inflow storms would need to occur approximately every week which is not a common phenomenon in the semi-arid Redding climate. Figure 5.7 shows the wet weather flow model calibration.

Figure 5.6 - Wet Weather Flow Data Figure

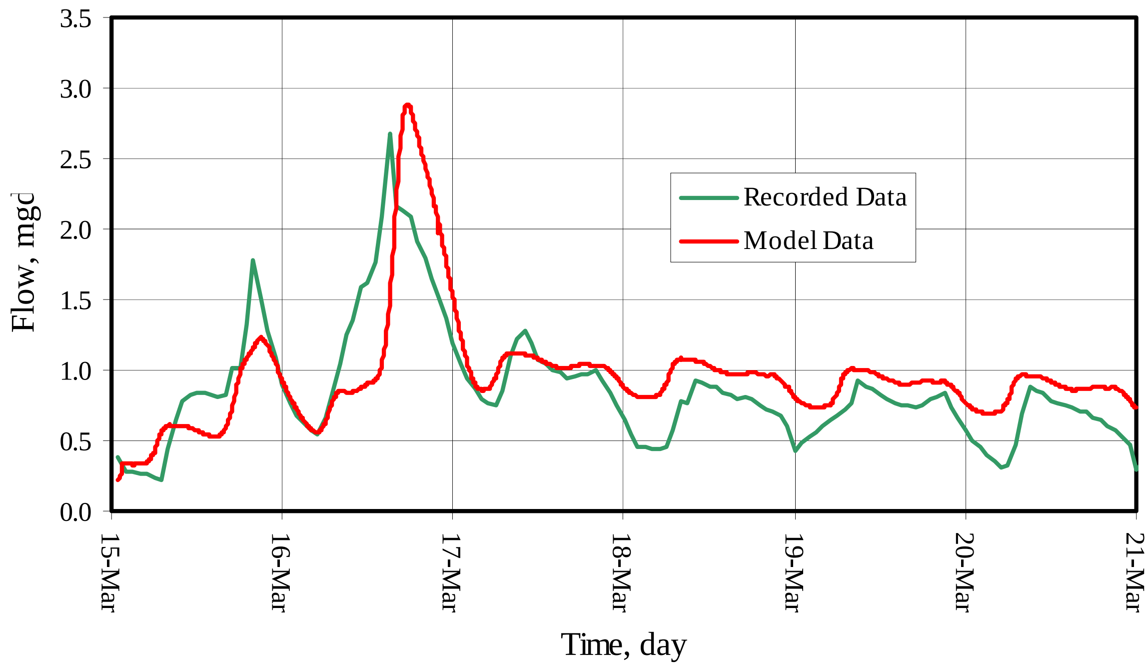


5.7 - WWTP Wet Weather Model Calibration



Adequate data from North Market Street Lift Station data was not available for preforming calibration of the model at that location. It is acknowledged that a calibration at this point is of utmost importance since the current flows and flow projections exceed those used for the recent Lift Station upgrade. Subsequent sections will cover recommendations regarding improved monitoring and periodic calibration of the computer models. Figure 5.8 shows the results of calibration effort performed at Mary Street Lift Station.

Figure 5.8 - Mary Street LS Wet Weather Calibration



5.4 COLLECTION SYSTEM HYDRAULIC EVALUATION

The Clear Creek Collection System hydraulic analysis evaluated pipe capacity under two levels of criteria. The highest priority was set for projects that resolved potential overflows and the second level of priority was assigned to pipes that were substantially surcharged (the ration of depth in the manhole to diameter of pipe exceeded 5:1).

The collection system adjacent to problem areas was then evaluated in an iterative process to determine the minimum length of pipe necessary to resolve the restriction. Recommended pipe sizes were obtained for each planning horizon through UBO model scenario.

Pipes were analyzed using a Manning's roughness coefficient ranging from 0.012 for recently constructed plastic pipe to 0.015 for old vitrified clay pipe. The majority of pipes were analyzed using a roughness of 0.013 in accordance with City of Redding Construction Standards.

Table 5.3 - Clear Creek Hydraulic Capacity Improvements

	Project Name	Tag No.	Manhole Number Upstream	Manhole Number Downstream	Length, ft	Diameter, in Existing	Diameter, in Recommended	Cost Share, % Rates	Cost Share, % Fees	Total Lengths of each Diameter, ft 8"	10"	12"	15"	18"	21"	24"	27"	48"
2010 (Existing)	**Lake Redding**	P-CC-1	G4-5	H4-36	1820	12	21	39	61						1820	4790	950	
			H4-36	H5-26	3600	15	21											
			H5-26	H6-22	2770	15	24											
			H6-22	H6-42	2020	18	24											
			H6-42	NMSLS	950	18	27											
	Cumberland	P-CC-2	N3-2	N4-19	1820	8	12	100	0			1820						
	East Cypress	P-CC-3	M9-52	M9-16	730	8	12	100	0			730						
	Buenaventura	P-CC-4	N4-7	O5-38	4400	10	12	33	67			4400	3560	2970				
			O5-38	P5-3	1450	10	15											
			P5-3	P5-4	210	12	15											
			P5-4	P6-1	870	12	18											
			P6-1	R6-24	1900	12	15											
			R6-24	R6-8	2100	15	18											
	Mercury	P-CC-5	R11-4	R11-26	1670	8	12	100	0			1670						
	Canby Bypass Phase I	P-CC-6	O11-3	O11-52	1210	15	18	100	0					1210				
	Westside Interceptor Phase III	P-CC-7	Z8-55	SB8-1	3162	N/A	48	0	100									3162
2015	**Bechelli South**	P-CC-17	O9-48	O9-58	100	8	15						100					
2020	**Sulphur Creek Phase 1 (Downstream)**	P-CC-8	G7-12	G7-22	630	15	18							630	2110			
			G7-22	H7-5	910	15	21											
			H7-10	H7-5	1200	15	21											
	Sulphur Creek Phase 2 (Upstream)	P-CC-9	E6-5	F6-2	440	10	12					440	2250					
			F6-2	F6-7	2250	10	15											
2030	**Bechelli North**	P-CC-11	N9-12	N9-16	380	6	8			380								
UBO	**Jenny Creek**	P-CC-10	K3-35	K3-37	610	8	12					610	900					
			K3-37	K3-15	760	12	15											
	Canby Bypass Phase II	P-CC-12	H9-8	J10-20	1580	10	12					1580	1040	2580	3070			
			J10-3	J10-1	750	10	15											
			J10-1	K10-8	290	12	15											
			K10-7	L10-69	2580	15	18											
			M10-26	N10-20	3070	18	21											
	Branstetter	P-CC-13	V5-1	V6-15	750	10	15						2510					
			V6-15	V6-10	1760	12	15											
	El Reno	P-CC-14	R4-13	S4-3	1190	8	12					3830						
			S6-3	R6-6	2640	10	12											
	Enterprise High School	P-CC-15	P10-5	P10-10	1121	6	8			1121								
	Park Marina	P-CC-16	L8-16	L8-18	740	6	10				740							

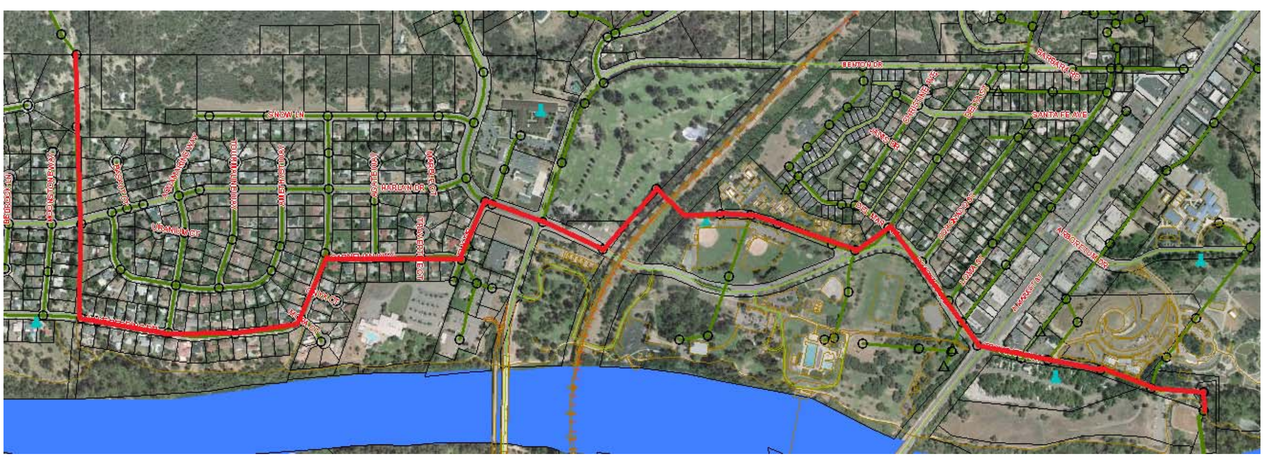
5.4.1 Collection System Capacity Projects

Projects identified by the hydraulic analysis are presented in this section at a planning level and tabluated on Table 5.3. Tabulated results reflect manholes and pipes from the hydraulic model. The model does not contain every manhole in the collection system so the actual design project may reflect more segments of pipe than are tabulated, however the size and lengths of pipes should be relatively accurate. Pipe replacement projects in this plan are recommended in the existing easements. Any deviation from the existing easements to realign or reroute a pipe may be studied as part of a alternatives analysis or feasibility study during preliminary engineering of the project. Prior master plan recommendations are mentioned for context and may differ from the recommendations in this report. All recommendations in this report are based on new, more detailed analysis which includes different rainfall amounts, different assumptions and more detailed quality assurance of the collection system representation.

2010 - Existing Conditions

Lake Redding Interceptor (P-CC-1) - Constructed in the late 1970s the pipeline ranges from 10 to 15-inches in diameter. The system has two problem areas, one in Lake Redding Drive from Moonstone Way to Carnelian Way and the second in Quartz Hill Road at Benton Drive. Sections of the pipe do not meet minimum slope requirements according to current Construction Standards. Grade appears to be constrained by the crossing under Harlan Drain/Carter Creek at Lake Redding Drive. The capacity of this pipe was identified as problematic in the 1987 and 2003 Utility Master Plans. The 1987 plan indicated that it should be replaced or improved by 2007. The 2010 plan called it out as an existing deficiency. Analysis showed that replacing problem sections of pipe merely shifted the problem to the next segment thus the minimum recommended improvement is the entire length of pipe from North Market Street Lift Station to the North boundary of Lake Redding Estates as shown in Figure 5.9. The project consists of construction of a total length of approximately 11,150 feet of pipe ranging from 21- to 27-inches in diameter.

Figure 5.9 - Lake Redding Interceptor



Cumberland (P-CC-2) - Constructed in approximately 1990 the pipe in Cumberland drive appears to be undersized for the slope and existing peak flows from manhole N3-2 to N4-19. The existing pipe is 8-inch diameter ABS pipe constructed in the early 1990s. The pipe has not been identified as a problem in prior master plans. However, the 2003 Utility Master Plan has the Westside Lift Station, which is upstream of this segment, redirected to a pipe planned for construction with Westridge Subdivision by 2005. Westridge Subdivision plans do not reflect accommodation for the redirection of Westside Lift Station flows. Figure 5.10 shows the extent of the recommended project.

Figure 5.10 - Cumberland Drive Sewer Pipe

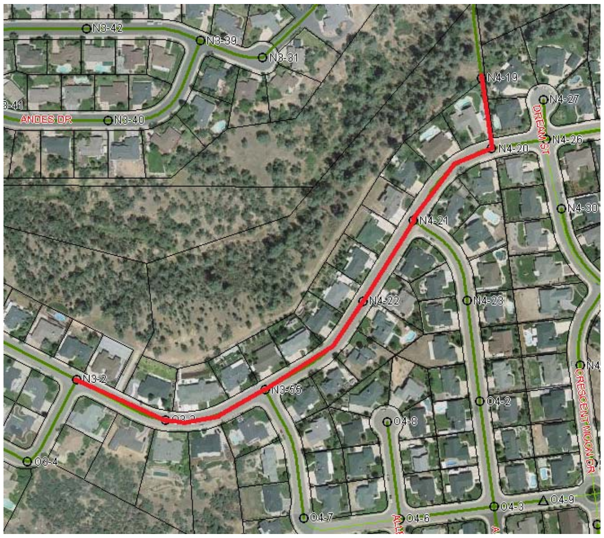


Figure 5.11 - East Cypress Sewer

East Cypress (P-CC-3) - The existing East Cypress sewer pipe is an 8-inch diameter vitrified clay pipe connecting a 15-inch diameter pipe upstream at manhole M9-52 to a 12-inch diameter pipe downstream at manhole M9-16. The upstream collection system was previously connected to a pipe draining south in Churn Creek Road but has been diverted to the current system draining west between buildings, crossing Larkspur Road and a recently reconstructed parking lot. The age of the existing pipe is not know. The recommended project is to investigate the possibility of returning at least a portion of the flow to the original pipe in Churn Creek Road. Project P-CC-20 includes more detail on the challenges at this location. If diverting some of the flow to the original pipe turns out to be infeasible the project would be to construct approximately 750 feet of 12-inch diameter replacement pipe. Figure 5.11 shows the location and extent of the project.

Buenaventura Offsite Sewer (P-CC-4) - The existing Buenaventura offsite sewer pipeline was constructed in the late 1970s with vitrified clay pipe ranging in size from 10- to 15-inches in diameter. The single length of 8-inch diameter pipe at the north-western terminus of the project is ABS. Most of the pipeline was constructed with bolt-down manhole lids as is common with cross country pipelines. The 2003 WWMP indicated that by the year 2005 an adjacent pipeline would be constructed with future development diverting flow from the Westside Lift Station south to a new pipeline thereby reducing some of the loading to the upper portion of the Buenaventura pipeline. The 2003 plan also identified the existing pipeline as inadequate between 2010 and UBO. The project consists of construction of approximately 11,200 feet of sewer pipe ranging in size from 12- to 18-inches in diameter. Figure 5.12 shows the location and extent of the recommended improvements.

The Buenaventura Offsite Sewer (P-CC-4) and Cumberland Drive (P-CC-2) are scheduled as existing needs projects to eliminate sanitary sewer overflows identified in the hydraulic analysis. The Westridge Subdivision is conditioned to construct part of the infrastructure necessary to take Westside Lift Station off line. However, the timing of construction of those improvements has not been identified and, under the current economic environment, may not happen for many years. Therefore the recommended list of projects provides a solution that is independent of private development schedules.

Figure 5.12a - Buenaventura Sewer North

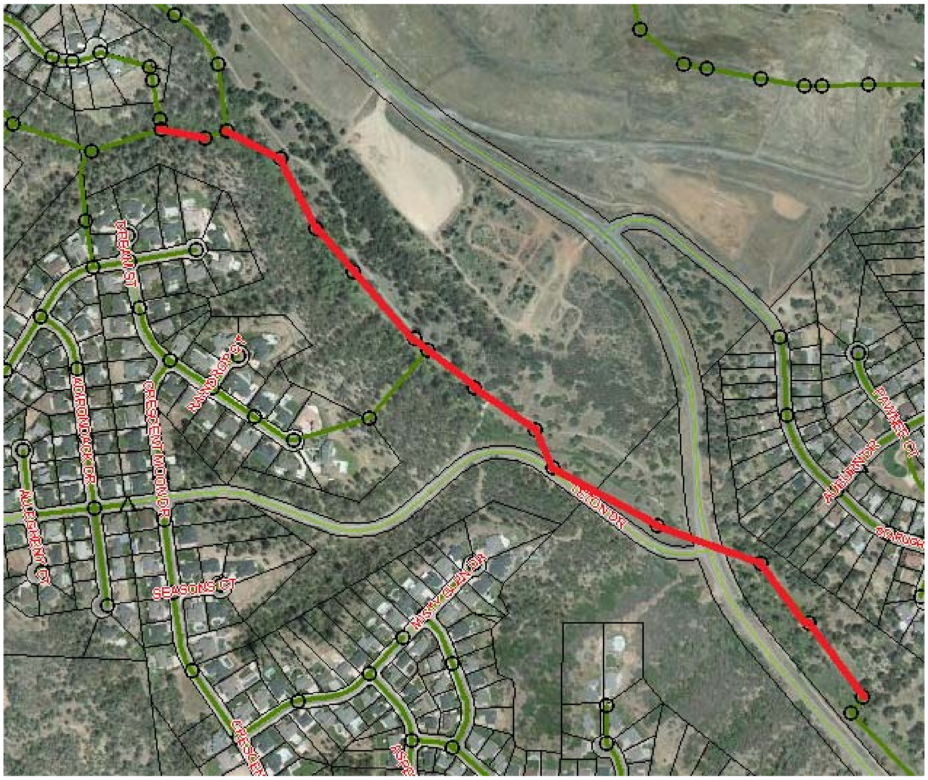
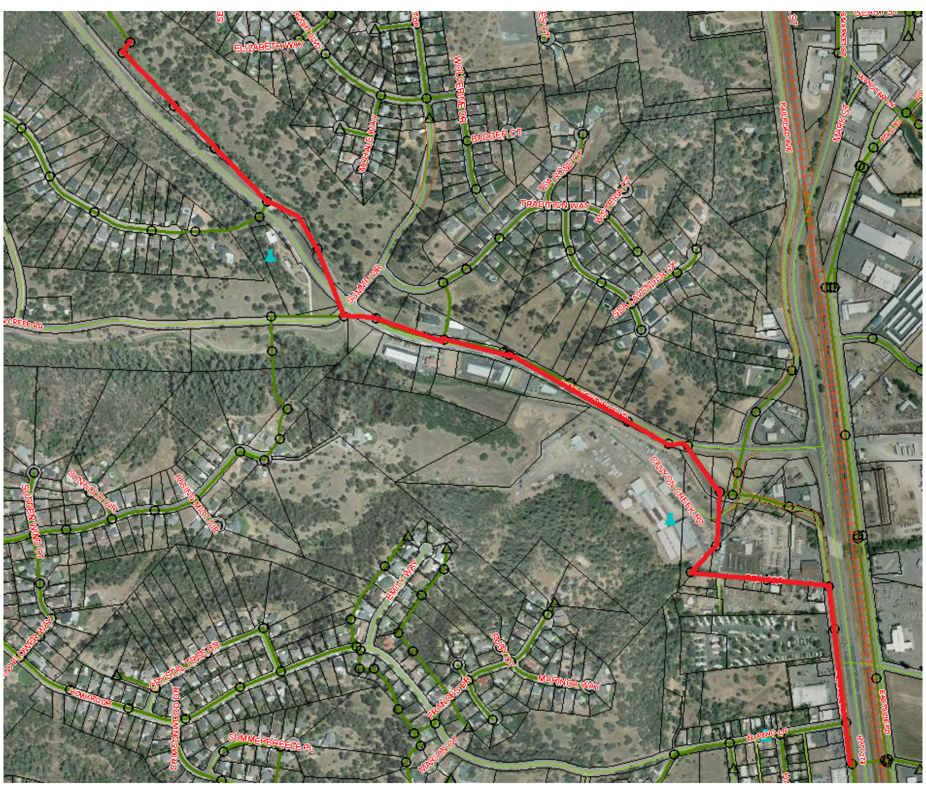


Figure 5.12b - Buenaventura Sewer South



Mercury Drive (P-CC-5) - Constructed in approximately 1983 the 8-inch diameter AC pipeline does not have capacity to meet existing demands. The pipe was identified in the 2003 WWMP as needing replacement under existing conditions. The minimum recommended project is approximately 1,650 feet of 12-inch diameter replacement pipe from manhole R11-4 to manhole R11-26 as depicted in Figure 5.13.

Canby Bypass Phase 1 (P-CC-6) - The Canby Bypass pipeline extends from near the north end of Canby Road at manhole H9-8 all the way to manhole O11-52 south of Hartnell. The entire pipeline was identified in the 2003 WWMP as inadequate at various planning horizons, most of it inadequate under existing conditions. In the current effort not all pipes in the system are inadequate and some are called for in latter planning horizons so the project will need to be phased. The location and extent of Canby Bypass Phase 1 is shown in Figure 5.14.

Westside Interceptor Phase III (P-CC-7) - The Westside Interceptor Phase III was identified in the 1999 Project Development Report as being scheduled for construction in 2007. The 2003 WWMP treated it as a project that was already studied and programmed. The project consists of construction of approximately 3,200 ft of parallel 48-inch diameter pipe from manhole Z8-55 at Girvan Road to the WWTP is depicted in Figure 5.15.

Figure 5.13 - Mercury Drive

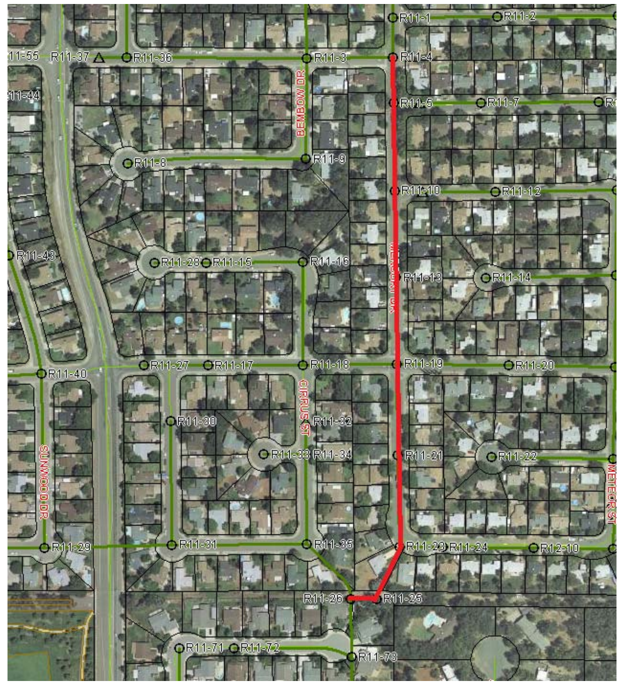


Figure 5.14 - Canby Bypass Phase 1

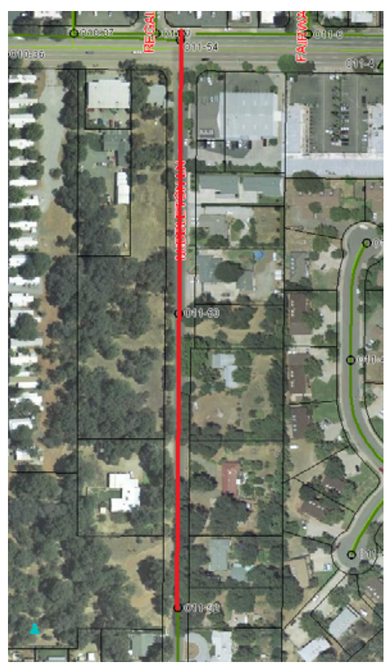
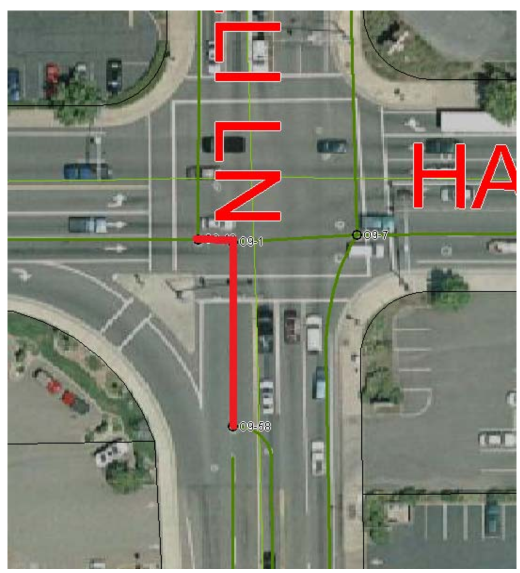


Figure 5.15 - Westside Interceptor PIII (North is left)

2015 Planning Horizon

Bechelli South (P-CC-17) - Downstream of the confluence of the Hartnell Lift Station force main and the upstream collection system North on Bechelli Lane. The existing pipes are approximately 15 feet of 8-inch AC pipe (O9-48 to O9-58) and approximately 80 feet of 8-inch VCP. Analysis reflects that the pipes need to be 10-inch by 2015 and 15-inch diameter at UBO. Figure 5.16 shows the location of the project.

Figure 5.16 - Bechelli South



2020 Planning Horizon

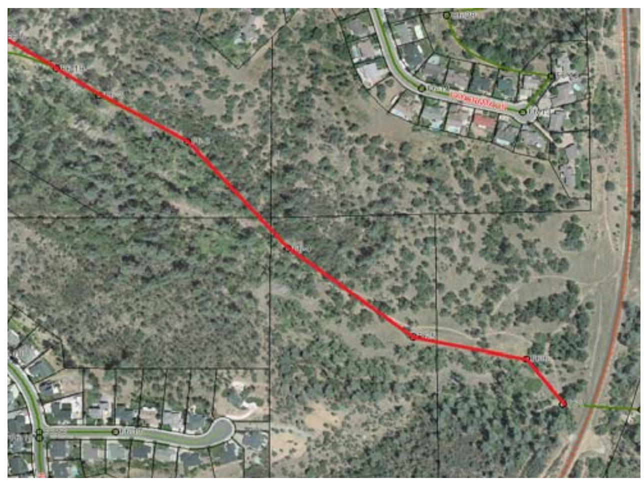
Lower Sulphur Creek Sewer (P-CC-8) - The existing 15-inch diameter VCP Sulphur Creek Sewer was constructed in the mid 1970s. The segment identified as needing replacement in this effort is immediately upstream of North Market Lift Station from manhole G7-12 to H7-5. The lowest two segments of pipe are called for improving by 2015. This segment was identified in the 2003 WWMP as needing improvement under existing conditions. The remainder was identified to need improving by UBO. The current recommended improvement is replacement of approximately 1,200 feet with 21-inch diameter pipe from manhole H7-10 to H7-5. The next four segments of pipe upstream to manhole G7-12 are recommended to be improved to either 21 or

18-inch diameter pipe between 2030 and UBO. Because they are contiguous pipes, it is further recommended that consideration be given to construction of the entire length, approximately 2,730 feet by 2015. Figure 5.17 shows the location and extent of the Lower Sulphur Creek Sewer project.

Upper Sulphur Creek Sewer (P-CC-9) - The existing Upper Sulphur Creek Sewer pipe was constructed in the mid 1960s to serve development on Lake Boulevard. The existing approximately 2,700 feet of pipe is 10-inch diameter AC pipe and was identified in the 2003 WWMP to need replacement by UBO. The current effort shows that two segments need replacement by 2020, one more by 2030 and the remainder by UBO. The recommended replacement size is approximately 440 feet of 12-inch diameter pipe from E6-5 to F6-2 and the remaining 2,260 feet from F6-2 to F6-7 should be 15-inch diameter. It is recommended that consideration be given to complete the project as a single project to be completed by 2020 rather than splitting it into multiple projects over multiple planning horizons. Figure 5.18 shows the location and extent of the Upper Sulphur Creek Sewer.

Figure 5.17 - Lower Sulphur Creek Sewer

Figure 5.18 - Upper Sulphur Creek Sewer



2030 Planning Horizon

Bechelli Lane (P-CC-11) - Bechelli Lane Sewer project includes two segments of pipe from manhole N9-12 to N9-16 as shown in Figure 5.19. The pipe is currently approximately 380 feet of 6-inch diameter VCP of unknown age. Analysis shows that the recommended pipe size is 8-inch diameter pipe needed by 2030.

Figure 5.19 - Bechelli Lane

UBO Planning Horizon

Upper Jenny Creek (P-CC-10) - The existing Upper Jenny Creek Sewer pipe was constructed in two different eras. The lower approximately 300 feet from manhole K3-7 to K3-11 is 12-inch diameter AC pipe constructed in the late 1950s. The remaining approximately 1,070 feet of 8- and 12-inch diameter ABS pipe was constructed in the mid 2000s based on plans drawn in the early 1980s. The lower pipe was identified in the 2003 WWMP as requiring imrpovement by UBO. The current analysis concurs with the addition of the next three segments upstream to manhole K3-35. Figure 5.20 shows the location and extent of Upper Jenny Creek improvements.

Figure 5.20 - Upper Jenny Creek Improvements

Canby Bypass (P-CC-12) - The remainder of the Canby Bypass Pipe consists of four different segments of pipe.

Segment	Upstream MH	Downstream MH	Length ft	Material	Age Years	Existing Diameter,	Recommended Diameter, in
1	H9-8	J10-20	1,580	ABS	35	10	12
2	J10-3	K10-8	1,040	VCP	Unknown	10 and 12	15
3	K10-7	L10-69	2,580	VCP	30	15	18
4a	M10-26	M10-22	1,730	SDR-35	10	18	21
4b	M10-22	N10-54	1,340	VCP	25	18	21

Figures 5.21a, b, c & d show the locations of the Canby Bypass pipe segments respectively. All segments of the Canby Bypass pipe were identfied in the 2003 WWMP as exceeding capacity under existing conditions. The 1987 WWMP recommended improvements to the pipes adjacent HWY 44 by 1992.

Figure 5.21a - Canby Bypass Segment 1

Figure 5.21b - Canby Bypass Segment 2

Figure 5.21c Canby Bypass Pipe Segment 3

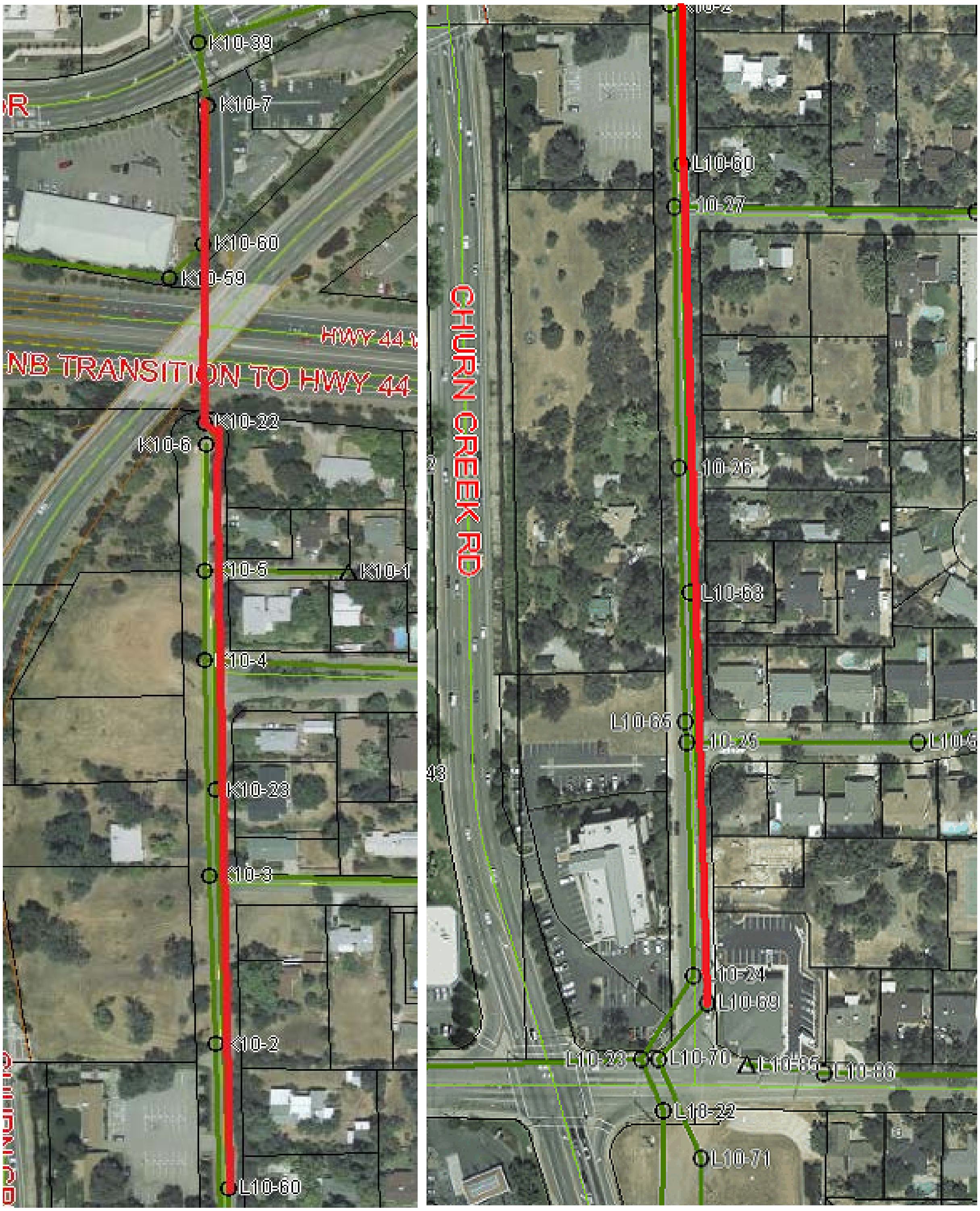
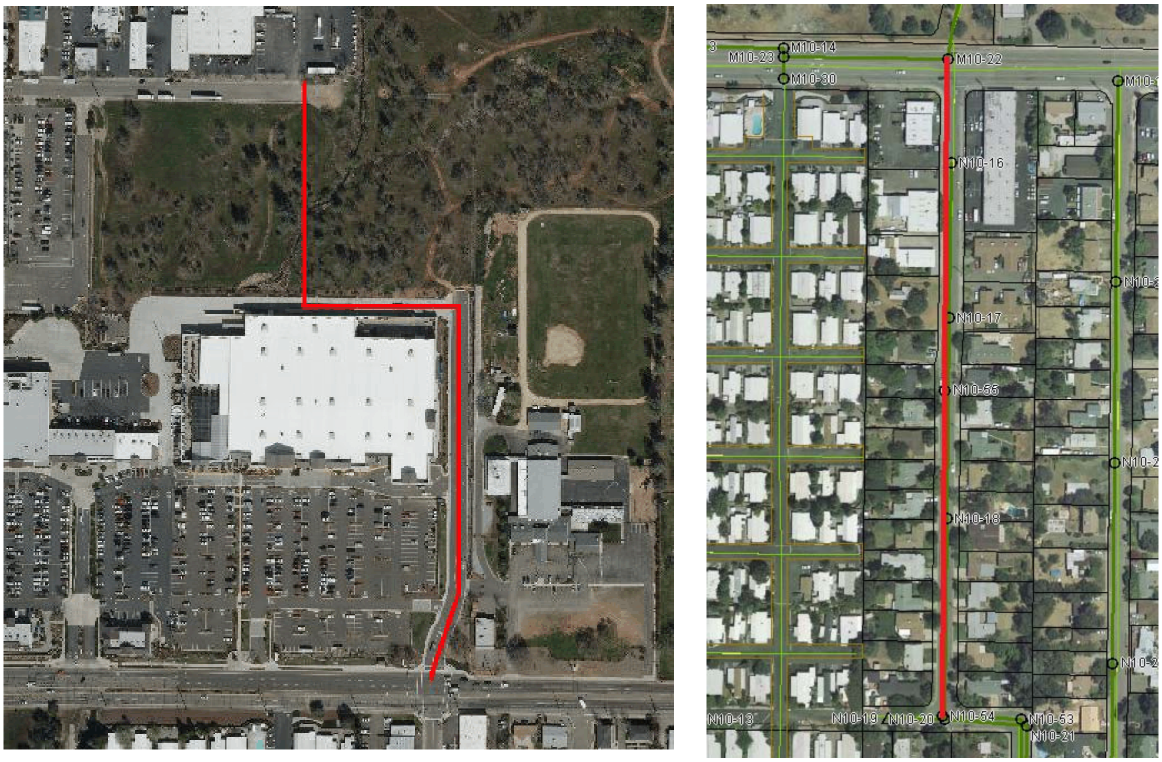


Figure 5.21d - Canby Bypass Pipe Segment 4



Branstetter (P-CC-13) - The Branstetter sewer pipe improvement is a recommendation for replacement of approximately 2,500 feet of 10- and 12-inch diameter ABS pipe constructed in the early 1980s from manhole V5-1 to V6-10. The 2003 WUMP concurred with the need to replace the lower segments by UBO. The current analysis indicates that the minimum diameter necessary at UBO is 15-inches. Figure 5.22 shows the location and extent of the Branstetter Sewer Pipe Project.

Figure 5.22 - Branstetter

El Reno (P-CC-14) - The El Reno sewer improvement include two segments, the first is replacing approximately 1,200 feet of 8-inch VCP from manhole R4-13 to S4-3 in Riviera Drive, constructed in the early 1970s with 12-inch diameter pipe. The second segment is replacing approximately 2,640 feet of 10-inch VCP of roughly the same vintage from manhole S6-3 to R6-6 with 12-inch diameter pipe. The second segment was identified in the 2003 WUMP as inadequate under existing conditions. Figures 5.23a and 5.23b show the location and extent of the El Reno sewer improvements.

Figure 5.23a - El Reno Segment 1

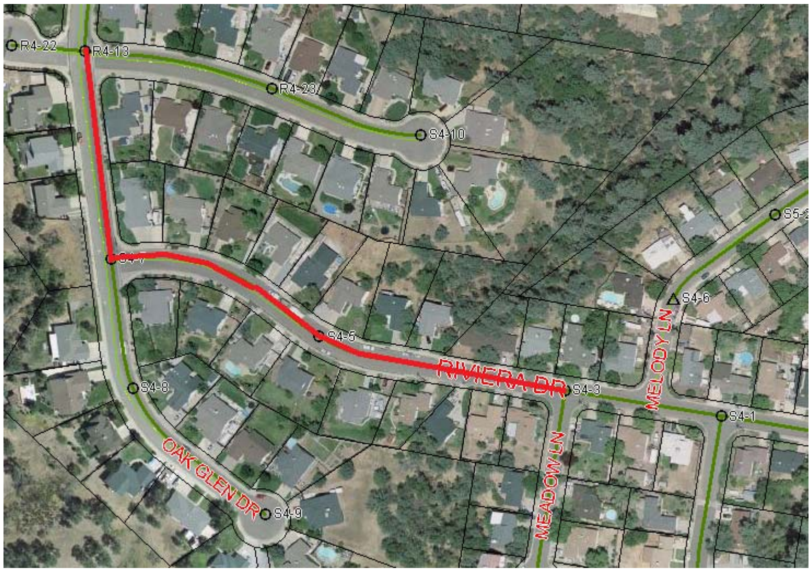
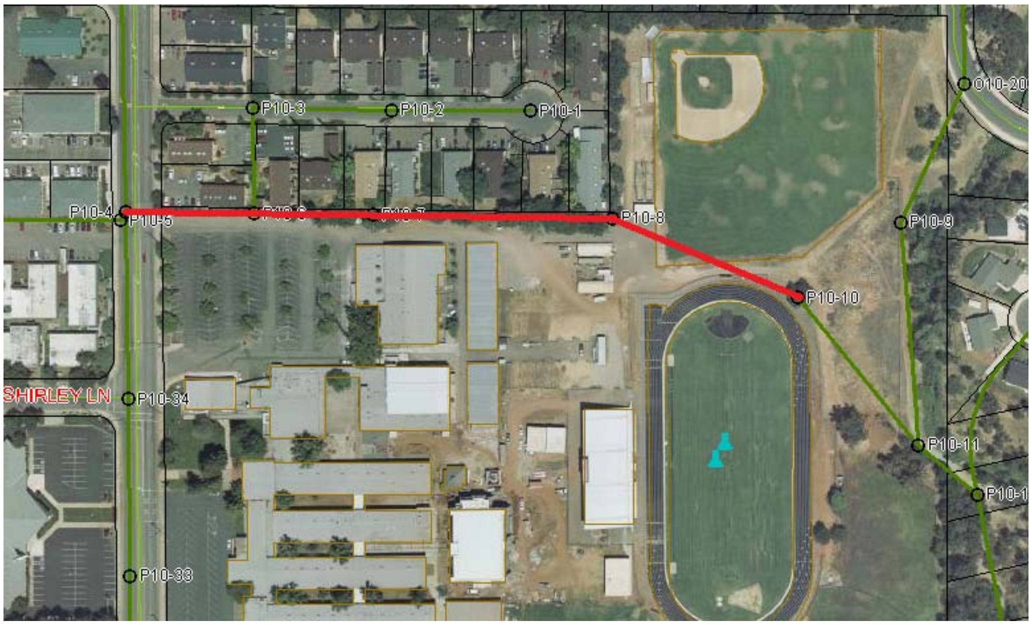


Figure 5.23b - El Reno Segment 2

Enterprise High School (P-CC-15) - The current UBO analysis reflects the need to increase pipe size in approximately 1,120 feet of 6-inch VCP pipe from manhole P10-5 to P10-10 on the north boundary of Enterprise High School to 8-inches in diameter. This project was identified in the 2003 WWMP and recommended for replacement under existing conditions. Figure 5.24 shows the location and extent of the project boundaries.

Figure 5.24 - Enterprise High School



5.4.2 - Lift Station Facility Evaluation

In addition to evaluation of the hydraulic capacity of the pipes in the collection system flow data was analyzed to determine potential improvements necessary at the Lift Stations and WWTPs. Table 5.4 summarizes the peak demands for each lift station and the WWTP for the Clear Creek Collection System.

Table 5.4 - Facility Flows for Clear Creek WW Collection System, mgd

Facility	Capacity	Planning Horizon				
		2010	2015	2020	2030	UBO
Remington	0.14	0.04	0.04	0.04	0.04	0.05
Westside	0.14	0.33	0.52	0.52	0.52	0.54
Mary Street	5.90	4.25	4.27	4.27	4.55	5.38
North Market	8.35	8.58	9.02	9.19	10.15	12.32
Locust	0.84	0.79	0.79	0.79	0.79	1.00
Hartnell	0.36	0.43	0.43	0.43	0.43	0.44
Layton	2.45	1.65	1.67	1.67	1.68	1.76
Cheryl	0.65	0.28	0.28	0.28	0.28	0.29
Denton	0.72	0.21	0.21	0.21	0.21	0.24
Sunnyhill	17.21	10.72	10.76	10.76	10.78	13.09
Riverbend	0.14	0.14	0.14	0.14	0.15	0.18
WWTP	(1)	52.23	52.50	53.52	54.57	69.27

(1) WWTP capacity includes equalization storage and will be discussed independently in a subsequent section.

The following list of lift station recommendations is based on the ***planning level*** analysis performed with this master plan. Prior to the design of any wastewater lift station facility it is imperative that a focused design level analysis be performed to verify flows and assure the design will accomplish the desired task.

2010 Planning Horizon (Existing)

Westside - Westside lift station capacity appears to be significantly below the calculated design flow under the existing condition.

Recommended Project

Tag No.	Item	Recommendation	Purpose
LS-CC-1	Westside LS	Increase capacity	Operation

Hartnell - This lift station also appears to have capacity below the calculated design flow under existing conditions.

Recommended Project

Tag No.	Item	Recommendation	Purpose
LS-CC-2	Hartnell LS	Increase capacity	Operation

North Market - Analysis reflects that design PWWF exceeds the lift station capacity under existing conditions. Because North Market Street LS is a new facility designed according to a focused analysis performed by Carollo Engineers it is recommended that further investigation be performed as soon as possible to refine and define the appropriate design flow for this facility. Such analysis needs to include recalibration of the computer model based on North Market Street specific monitoring data.

Recommended Project

Tag No.	Item	Recommendation	Purpose
LS-CC-4	North Market LS	Perform Analysis	CIP - Planning

2015 Planning Horizon

North Market - If the detailed analysis effort indicated in the Existing Planning Horizon for North Market Street Lift Station corroborates the findings of the planning level analysis performed with this effort then the lift station will need to improve capacity by 2015.

Recommended Project

Tag No.	Item	Recommendation	Purpose
LS-CC-5	North Market LS	Increase capacity	Operation

2030 Planning Horzon

Riverbend - Riverbend lift station analysis shows that it is operating at design capacity under existing conditions and that PWWFs will exceed design capacity in 2030.

Recommended Project

Tag No.	Item	Recommendation	Purpose
LS-CC-3	Riverbend LS	Increase capacity	Operation

UBO Planning Horizon

Locust - Analysis reflects that Locust Street Lift station will require additional pumping capacity between 2030 and UBO.

Recommended Project

Tag No.	Item	Recommendation	Purpose
LS-CC-6	Locust St. LS	Increase capacity	Operation

5.5 COLLECTION SYSTEM MAINTENANCE AND OPERATIONS EVALUATION

Evaluations for lift stations were performed by the Wastewater Utility staff. Their recommendations are summarized as follows:

5.5.1 - Lift Stations

Cheryl - This lift station, originally constructed in 1960, was rebuilt in 2004 with an upgrade to Smith & Lovelace package lift station. All electronics and pumps are above ground and need construction of a shade structure. The lift station needs AC drives to accommodate winter flows.

Recommended Projects

Tag No.	Item	Recommendation	Purpose	Time Frame
LS-CC-7	Shade Structure	Construct	Longevity	2020-2025
LS-CC-8	AC Drives	Construct	Capacity	2020-2025

Hartnell - The pump station needs new controls and enclosure and connection to SCADA. Consideration should be given to combining this project with LS-CC-2 which increases capacity of Hartnell LS.

Recommended Projects

Tag No.	Item	Recommendation	Purpose	Time Frame
LS-CC-11	New Controls	Replace	Dependability	2015-2020
LS-CC-12	Enclosure	Replace	Longevity	2015-2020
LS-CC-13	SCADA	Construct	Operation	2015-2020

Layton - Historic PWWF appears to exceed the existing design flow by a significant margin. Utility staff has indicated a belief that the facility does not have pumping capacity to handle design flows. Both motors have been rebuilt including new impellers in 2010. The access hatch to the wet well requires a security alarm. Replacement parts for the aging lift station are becoming difficult to obtain and there are confined space entry and safety issues for performing routine maintenance. The utility staff has requested replacement of the lift station.

Recommended Project

Tag No.	Item	Recommendation	Purpose
LS-CC-14	Layton Lift Station	Replace	Safety/Dependability

Locust - The Locust Street Lift Station has the two original drywell pumps located 16 feet below grade where the only access is a confined space entry via a vertical ladders and a horizontal hallway. In addition the dry pit is deteriorating. The hatch to the dry well needs a security alarm. Replacement parts for the aging lift station are becoming difficult to obtain. The utility staff believes that the station lacks capacity for wet weather flows. Analysis of the design flows shows that peak wet weather flows are near capacity for the lift station leaving little room for uncertainty. The utility staff has recommended replacing the lift station.

Recommended Project

Tag No.	Item	Recommendation	Purpose
LS-CC-15	Locust Lift Station	Replace	Safety/Dependability

North Market - A new North Market Street Lift station was constructed in 2010. Projects associated with rebuilding of the lift station are primarily to alleviate downstream restrictions. They include a new force main from the rodeo grounds to Butte Street under HWY 44 with a connection from the Auditorium Drive Lift Station and West Side Interceptor Phase II improvements. These projects are already in design and programmed for construction and therefore not included in this list. The one remaining project associated with the North Market Street Lift Station is removal of the old cable suspended sewer pipe across the Sacramento River.

Recommended Project

Tag No.	Item	Recommendation	Purpose
LS-CC-16	Remove suspended river crossing pipe	Demolition	Housekeeping

Remington - The lift station serves a very small demand and rarely runs. It needs a shade structure and water supply for maintenance. It also needs a fence, a new gate for security, rebuilt controls, enclosure and SCADA.

Recommended Projects

Tag No.	Item	Recommendation	Purpose
LS-CC-17	New Controls	Replace	Dependability
LS-CC-18	Enclosure	Replace	Longevity
LS-CC-19	Fence and Gate	Construct	Security
LS-CC-20	SCADA	Construct	Operation

Riverbend - The facility operates well for the limited demand. It needs a shade structure, new controls, enclosure, and SCADA.

Recommended Projects

Tag No.	Item	Recommendation	Purpose
LS-CC-21	New Controls	Replace	Dependability
LS-CC-22	Enclosure	Replace	Longevity
LS-CC-23	SCADA	Construct	Operation

Sunnyhill - The lift station needs hardware installed/constructed to accommodate a bypass pumping operation. The utility staff recommends evaluating the potential for combined use of the dry well as emergency overflow retention. The station needs an isolation valve for the force main.

Recommended Projects

Tag No.	Item	Recommendation	Purpose
LS-CC-24	Bypass Connection	Construct	Emergency Support
LS-CC-25	Force Main Valve	Construct	Operations

Westside - The lift station needs a shade structure, new controls, PLC processor with level probe, and SCADA.

Recommended Projects

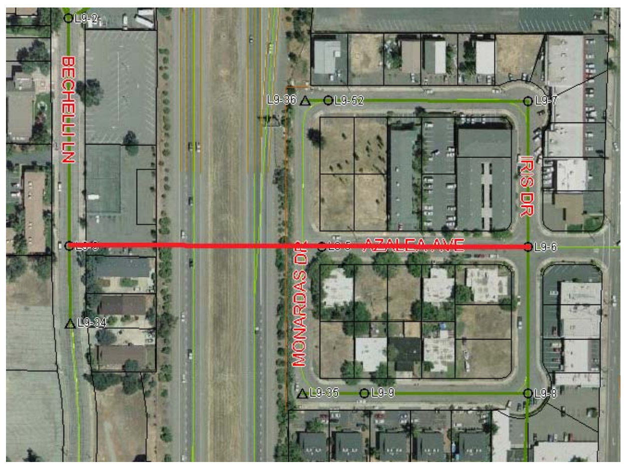
Tag No.	Item	Recommendation	Purpose
LS-CC-26	New Controls	Replace	Dependability
LS-CC-27	PLC Processor	Install	Operations
LS-CC-28	Shade Structure	Construct	Longevity
LS-CC-29	SCADA	Construct	Operations

5.5.2 - Pipe Projects

Azalea I-5 Crossing - P-CC-18

The sewer pipe under Interstate 5 at Azalea Avenue is currently a 6-inch diameter VCP sewer more than 50-years old and reported to be at a shallow depth. The pipe currently requires cleaning annually. The system downstream in Hilltop Drive also requires cleaning every year and shows up as having a capacity deficiency although not at the level that would instigate a project. The slope of the Azalia I-5 crossing is 0.008 to 0.018 depending on which pipe segment is being examined. Replacement of the pipes should be considered based on age and increased in size to 8-inches in diameter. However, the cost of a project to replace a pipe under Interstate 5 is likely to prohibit elevating the priority of this project over continued maintenance. Figure 5.26 shows the location and extent of the project.

Figure 5.26 - Azalea Ave I-5 Crossing



Hilltop - P-CC-19

The Hilltop sewer pipe was constructed behind the first row of buildings on the east side of Hilltop Drive. The existing facility is VCP, 1423 feet of 8-inch diameter and 500 feet of 10-inch diameter pipe. The facility is of unknown vintage other than it shows up in a 1962 Enterprise Public Utility District atlas which would make it older than 50 years. Segments of the pipe have very low slope. Most of the 8-inch pipe is at 0.004 ft/ft and the 10-inch pipe slope is lower than current design standards at 0.0026 ft/ft. The combination of low slope, age and presence of numerous restaurants upstream generates the need to clean the facility annually. It is recommended that the pipe be listed for replacement due to age. At the existing slope the lower 1213 feet of the 8-inch diameter pipe will need to be increased to 10-inch diameter pipe. Opportunity to increase slope should be investigated during the design process for replacement. Figure 5.27 shows the location and extent of the Hilltop Sewer pipe project.

Figure 5.27 Hilltop Drive Sewer

Churn Creek Road North - P-CC-20

The Churn Creek sewer pipe was originally constructed to convey sewer from north of Cypress south to manhole N10-8. At some point in time flow was diverted from that system west at M10-10 in a 15" diameter pipe to M9-52 where it drops to 8" diameter pipe. The 8" diameter pipe capacity is a problem under existing conditions creating project P-CC-3 previously documented in the hydraulic capacity section of this report. The diversion and abandonment of the pipe between M10-10 and M10-11 may also have created a maintenance problem in the 10" diameter pipe in Churn Creek Rd between M10-11 and N10-8 due to lack of adequate flow. It appears that there are no connections on the 238-feet of pipe from M10-11 to M10-12 then the first connections on the next segment of pipe are restaurants. It is recommended that the utility follow up on the use and maintenance of grease traps on these restaurants and to reconnect some kind of bypass pipe from M10-10 to M10-11. Figure 5.28 shows the location and extent of the recommended project. The pipes in Churn Creek road are 10-inch diameter VCP pipe of unknown age in excess of 50-years. Their slope ranges from 0.0027 to 0.003 which may also be causing some of the problems.

Figure 5.28 - Churn Creek Road North

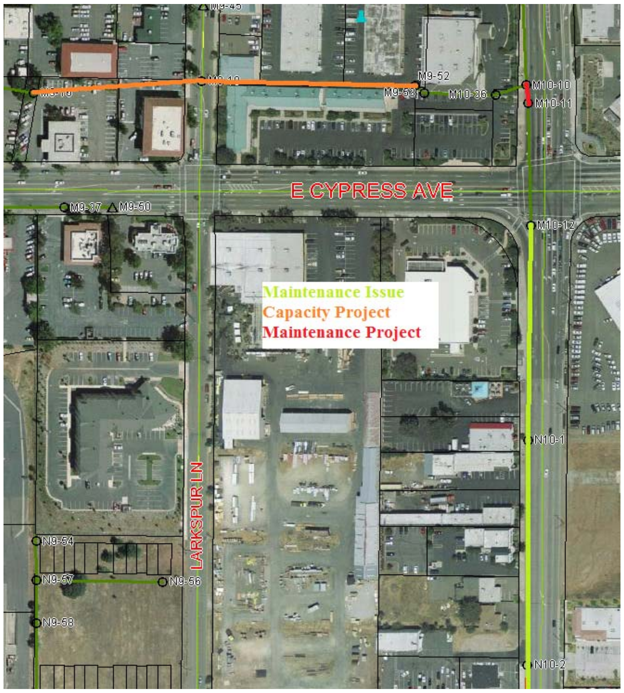


Figure 5.29 - San Francisco Drive West

San Francisco Drive West P-CC-21

The San Francisco Drive West sewer pipe project consists of approximately 791 feet of 53 year old 8-inch diameter VCP. The pipe appears to have adequate slope. It is recommended that the pipe be scheduled for replacement in the aging pipe replacement program. Figure 5.29 shows the location and extent of the project.

San Francisco Drive South P-CC-22

The San Francisco Drive South sewer pipe project considers 724 feet of 53 year old 8-inch diameter VCP and 310 feet of PVC pipe of unknown vintage. The top two segments of pipe from MH L4-14 to L4-23 are scheduled for replacement with the Placer Drive Widening Project already being designed. These segments of pipe and the one immediately upstream are all have significantly less slope than the minimum allowable under the current construction standards. The feasibility of increasing the slope is currently under investigation but it appears there may be opportunity to provide minimum slope. The lower two segments (419 feet from L4-23 to L4-20) are shown on the original plans as having vertical curves (sags) dropping slope in for the lower half of the first segment to 0.006 ft/ft. However, the plans lack any identification for vertical control of the pipe during construction. It is recommended that the upper portion (in Placer Drive) be increased in slope to the extent possible during the Placer Widening project and the lower two segments be replaced due to non-standard construction and age. Figure 5.30 shows the location and extent of the project.

Figure 5.30 - San Francisco Drive South

Figure 5.31 - Loma Street Alley

Loma Street Alley P-CC-23

The Loma Street Alley project considers approximately 1847 feet of 52 year old, 8-inch VCP pipe in the alley behind the businesses on the west side of Highway 273 north of the Sacramento River. The pipes are constructed at a slope less than the current minimum allowable slope. Although the location may not allow changing of the slope it is recommended that the pipe be elevated on the list of priorities for pipe replacement due to its age and location in the alley and exposure to heavy truck traffic. Figure 5.31 shows the location and extent of the project.

Figure 5.32 - Mesa Street Alley

Mesa Street Alley P-CC-24

The Mesa Street Alley sewer pipe is approximately 1314 feet of 53 year old 8-inch diameter VCP. The existing pipe appears to have adequate slope. It is recommended that the pipe be listed for replacement under the aging pipe replacement program. The last two segments of pipe from L4-39 to L4-45 are capacity limited under buildout conditions and will need to be 10-inches in diameter. Figure 5.32 shows the location and extent of the project.

Manzanita Drive P-CC-25

The Manzanita Drive Sewer is approximately 386 feet of 6-inch VCP of unknown vintage older than 50 years. The pipe appears to have adequate slope. It is recommended that the pipe be added to the list of pipes to be replaced under the aging pipe replacement program. Figure 5.33 shows the location and extent of the pipe.

Figure 5.33 - Manzanita Drive

Hallmark Alley P-CC-26

The Hallmark Alley project consists of replacement of approximately 2400 feet of 6-inch diameter VCP constructed in the 1960s. The pipe requires routine maintenance and is reaching the end of its service life. Figure 5.34 shows the location and extent of the project.

Redbud Alley P-CC-27

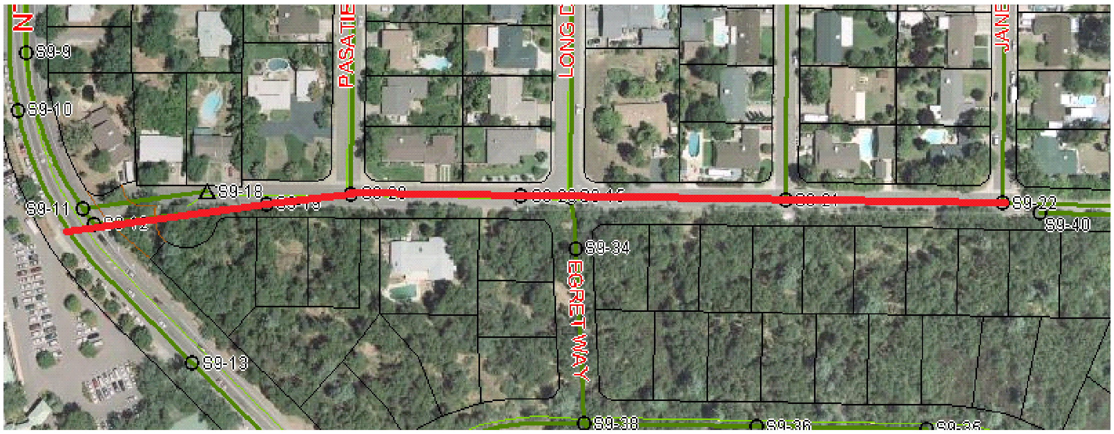
The Redbud Alley project consists of replacement of approximately 1170 feet of 6-inch diameter VCP constructed in the 1960s. The pipe requires routine cleaning and is reaching the end of its expected service life. Figure 5.34 shows the location and extent of the project.

Figure 5.34 - Hallmark and Redbud Alleys

Woodacre Drive   P-CC-28

All the sewer pipes in Woodacre appear to have been constructed at slopes that are considerably less than standard slopes. Investigation of the slopes and elevations of pipes in Bechelli revealed that if the Woodacre sewer were extended across Bechelli to the Bechelli interceptor and reconstructed to take advantage of approximately 3 more feet of drop available across Bechelli Ln, the maintenance burden may be alleviated as well as reducing demands on Cheryl Lift Station. The concept requires field verification of the depth of the Bechelli Interceptor at Woodacre Drive and invert in MH S9-12. Figure 5.35 shows the location and extent of the Woodacre sewer pipe project.

Figure 5.35 - Woodacre Drive



Mistletoe P-CC-29

The sewer pipe leading south from Mistletoe Lane was constructed behind the businesses on Hilltop Drive. The existing pipe is located under parking lots and landscape areas and experiences root intrusion problems. The existing facility is 8-inch VCP that is 53 years old. The available drawings show that it has adequate slope but is recommended to be replaced due to age. Figure 5.36 shows the location and extent of the project.

Figure 5.36 - Mistletoe

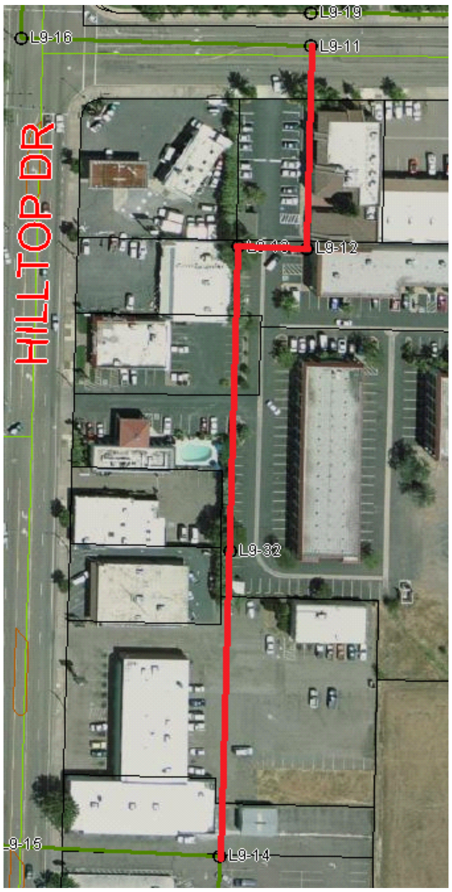
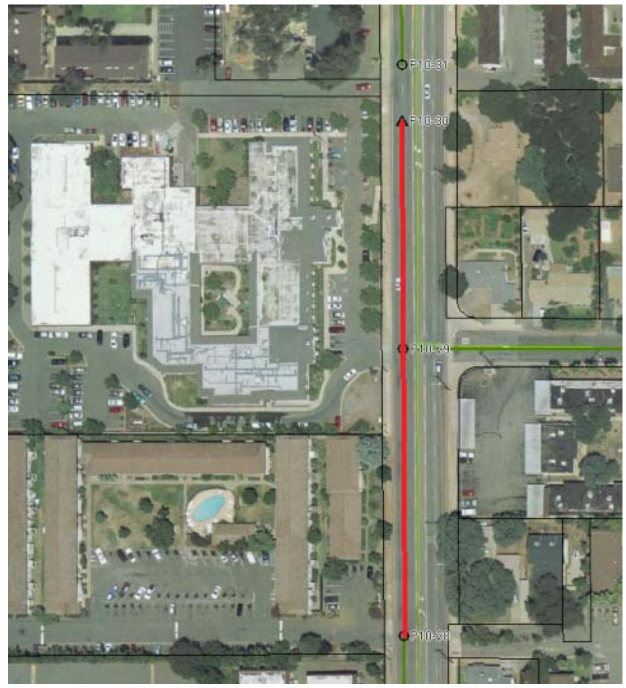


Figure 5.37 - Churn Creek



Churn Creek P-CC-31

The Churn Creek Sewer Pipe is approximately 566 feet of 6-inch diameter VCP of unknown age exceeding 48 years. The pipe appears to have adequate slope and may be problematic from a grease and oil perspective from the adjacent senior housing project. Regardless of the source of the problem the age of the pipe qualifies it for inclusion in the aging pipe replacement program. Figure 5.37 shows the location and extent of the project.

School Street P-CC-32

The existing School Street sewer pipe is approximately 1803 feet of 6-inch diameter VCP of unknown age exceeding 48 years. The pipes appear to have adequate slope. It is recommended that the pipe be listed for replacement due to age and maintenance issues. Figure 5.38 shows the location and extent of the project.

Figure 5.38 School Street

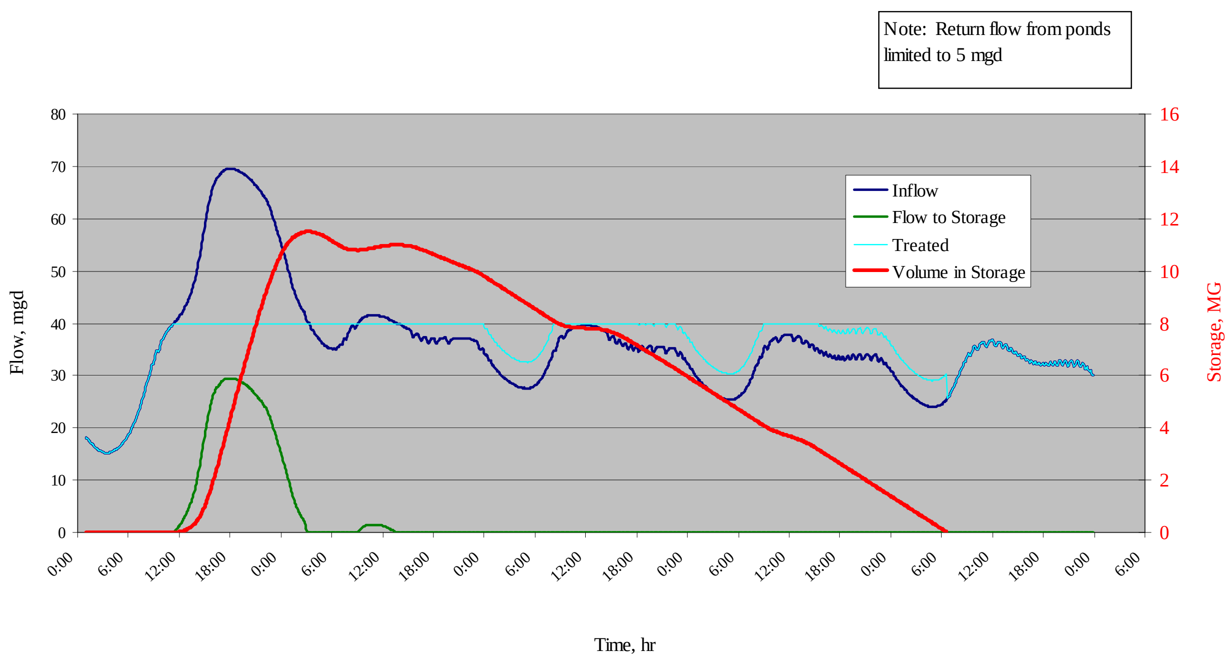
Table 5.5 - Clear Creek Maintenance Improvements

Project Name	Tag No.	Manhole Number		Length, ft	Diameter, in		Total Lengths of each Diameter, ft		
		Upstream	Downstream		Existing	Recommended	6"	8"	10"
Azalea I-5 Crossing	P-CC-18	L9-3	L9-6	817	6	6	817		
Hilltop Sewer Pipe	P-CC-19	L9-15	M9-7	1923	8 and 10	8 and 10		210	1713
Churn Creek Rd North	P-CC-20	M10-12	N10-8	1889	10	10			1889
San Francisco Drive West	P-CC-21	L4-6	L4-20	791	8	8			791
San Francisco Drive South	P-CC-22	L4-14	L4-20	419	8	8		419	
Loma Street Alley	P-CC-23	G7-6	H6-11	1847	8	8		1847	
Mesa Alley	P-CC-24	L4-43	L4-45	1314	8	8 and 10		975	339
Manzanita Drive	P-CC-25	N8-5	N9-13	386	6	6	386		
Woodacre Drive	P-CC-28	S9-22	S9-12	1375	6	8		1375	
Mistletoe Lane	P-CC-29	L9-11	L9-14	875	8	8		875	
Churn Creek Rd	P-CC-31	P10-30	P10-28	566	6	6	566		
School Street	P-CC-32	O9-37	O9-43	1803	6	6	1803		

5.6 WWTP FACILITIES PLAN

In 2004 the City contracted with Brown and Caldwell engineers to prepare a comprehensive facilities plan for Clear Creek WWTP. The plan utilized flow projections from the 2003 Wastewater Utility Master Plan which reflected 67.6 mgd peak wet weather flow (PWWF) in 2010 and 88.3 mgd PWWF at UBO. The facilities plan included two Phases, the first phase expanded the WWTP from 12 to 40 mgd peak flow capacity and is being completed this year (2012). The second phase was a recommended to start in 2010 with update to the flow projections. Flow projections are updated as part of the this Master Plan effort. The current projections are considerably lower than those provided in the 2003 WWMP at 52 mgd for existing conditions (2010) and 69 mgd at UBO. Analysis of forecast inflow, treatment capacity and storage determined that even at UBO the plant should be able to treat PWWF while only utilizing approximately 12 mg of storage. Figure 5.39 presents the results of that analysis.

Figure 5.39 - WWWTP Mass Balance Analysis



With this analysis, the updated flow predictions reflect that there is no need for additional expansion of CCWWTP for peak wet weather flows.

In 2010 the levee between the Clear Creek WWTP holding ponds and the Sacramento River was deemed inadequate to meet the latest FEMA requirements for accreditation. As a result the area behind the levee will be mapped in a new FEMA "Zone D" indicating that although the levee is adequate to protect the area for the 100-year peak flow event it does not provide the level of security FEMA desires in terms of freeboard (elevation over the 100-year water surface), erosion protection or ties to upstream and downstream high ground. Engineering consultants Pacific Hydrologic, Inc. and CGI Technical Services Inc. were contracted to evaluate the levee and make recommendations for attaining accreditation. Those recommendations include minor increases in elevation for limited areas of the levee. The amount and length of increase does not justify initiation of an independent project. However, the erosion protection recommendation includes approximately 760 feet of rock slope protection or other equally effective erosion protection method adjacent to Pond 8.

Currently only two of the Clear Creek WWTP holding ponds are lined. Utility staff is concerned that this does not provide adequate storage to account for future emergency and equalization needs. Therefore it is recommended that to additional ponds be lined.

Tag No.	Item	Recommendation	Purpose
TP-CC-1	Erosion Protection	Construct	Regulatory
TP-CC-2	Line Pond	Construction	Operations/Regulatory
TP-CC-3	Line Pond	Construction	Operations/Regulatory

CHAPTER 6

Stillwater - Hydraulic Capacity and Treatment Evaluation

6.1 DESCRIPTION OF EXISTING FACILITIES

The Stillwater Wastewater Treatment Plant (SWWTP) was put into operation in 1991. The Stillwater service area covers approximately one third of the current population of the City. This portion of the City is expected to experience a higher growth rate than the Clear Creek Collection System side and at UBO expected to serve approximately 50% of the population. The area serves the eastern and northern portions of the City in regions referred to in prior planning efforts and engineers reports as Twin View, Eastern Enterprise, and Stillwater Creek Service Areas. The service area contains approximately 20% commercial and industrial connections and serves the Stillwater Business Park. A map of the existing Stillwater service area and collection system pipe network is presented in Figure 1.3.

Stillwater Definitions	
WWTP	Wastewater Treatment Plant
Service Area	Total area served or planned to be served (Figure 1.3)
Collection System	Pipes, lift stations and force mains delivering sewer to the WWTP
Stillwater Creek Service Area	Portion of Stillwater Service Area gravity draining to Stillwater Creek. The majority of this area is located in planned growth areas and is currently not served.

6.1.1 Collection System

The Stillwater collection system includes 5 lift stations for pumping wastewater over ridges. Tierra Oaks Lift and Hope Lane Lift Stations pump from Stillwater Creek Service Area to Churn Creek collection system and Churn Creek Lift Station from Churn Creek to Clover Creek. Stillwater Business Park lift station pumps from Stillwater Creek Drainage Area to Clover Creek Interceptor. The collection system terminates at the SWWTP near the confluence of Clover Creek and the Sacramento River, and treated effluent is discharged to the Sacramento River. The existing collection system consists of approximately 150 miles of pipe ranging in size from 6 to 48-inches in diameter. Approximately 27 percent of the system is VCP, 40 percent ABS, 26 percent PVC and 7 percent miscellaneous other pipe materials. Approximately 74 percent of the system is 6 and 8-inch diameter pipes, 14 percent is 10-, 12-, and 15-inch diameter pipe, and 12 percent is larger than 15-inch diameter pipe. Data for pipe age was derived from plan drawings which left approximately 17 percent of the system with undetermined age. Of the pipes that age could be identified the oldest pipes are approximately 60 years old with approximately 50 percent of the system being older than 25 years. It is likely that the pipes with unknown age are part of the older portion of the collection system. Detailed analysis of pipe age and replacement needs is included in Chapter 7 - Collection System and Special Facility Preservation.

6.1.2 Lift Stations

Of the five lift station mentioned in the previous section only three are significant enough to consider in the hydraulic analysis, Tierra Oaks, Churn Creek and Stillwater Business Park. Stillwater Business Park lift station is not currently in use and has an ultimate capacity of 2 mgd. Hope Lane lift station is owned by the local homeowners association, maintained by the Wastewater Utility and serves a very small service area.

Flows from this area were added directly to the first available manhole in the gravity system. Abernathy lift station serves the City of Redding transfer station only and although is represented in the hydraulic analysis is considered part of the Solid Waste Utility facility inventory maintained by the Wastewater Utility. Table 6.1 summarizes the historic flows recorded at each lift station. Lift station and force main characteristics are presented in Table 6.2.

Table 6.1 - Historic Lift Station Flows, gpm

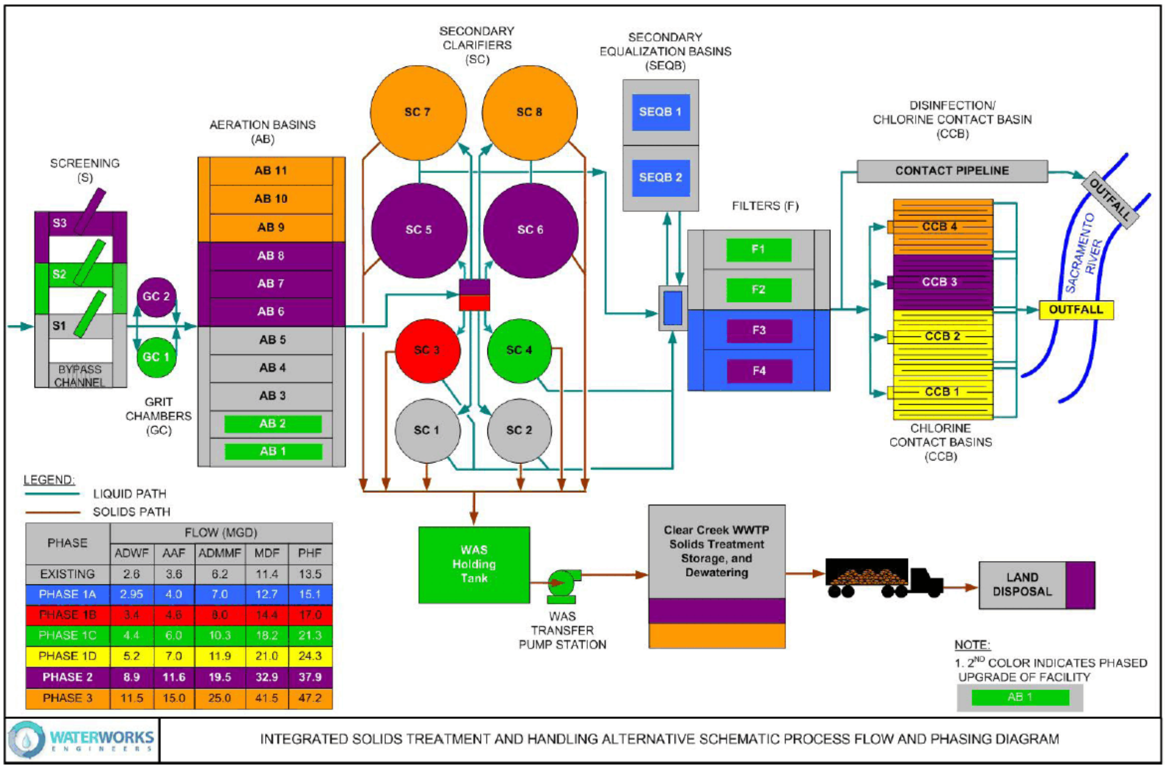
Lift Station	Type	PWWF	AWWF	PDWF	ADWF
Tierra Oaks	Minor	n/a	n/a	n/a	14
Churn Creek	Major	6,000	3,868	3,666	1,289
Hope Lane	Minor	n/a	n/a	n/a	n/a
Stillwater BP	Minor	n/a	n/a	n/a	n/a

n/a data not available
PWWF Peak Wet Weather Flow
AWWF Average Wet Weather Flow
PDWF Peak Dry Weather Flow
ADWF Average Dry Weather Flow

6.1.2 Treatment Plant

The Stillwater WWTP serves approximately one-third of the current population of the City of Redding. The Stillwater WWTP service area is, however, growing at a faster rate than the Clear Creek service area. By UBO the Stillwater service area is expected to be almost equivalent in size and population to the Clear Creek service area. The treatment plant was put into operation in 1991. The plant consists of a series of treatment processes which remove rags, solids, bacteria, nutrients, pathogens and other contaminants from the wastewater prior to discharge into the Sacramento River. Improvements under construction and planed for completion by the summer/fall of 2013 will provide treatment capacity of 14.4 mgd maximum day flow and 3.4 mgd average dry weather flow. Additional details and description of the treatment plant can be found in the City of Redding Stillwater WWTP Facilities Plan. Figure 6.1shows a process diagram for the treatment plant. Figure 6.2 is an areal photograph of the facility.

Figure 6.1 - Stillwater WWTP Process Diagram



PHASE	FLOW (MGD)				
	ADWF	AAF	ADMMF	MDF	PHF
EXISTING	2.6	3.6	6.2	11.4	13.5
PHASE 1A	2.95	4.0	7.0	12.7	15.1
PHASE 1B	3.4	4.6	8.0	14.4	17.0
PHASE 1C	4.4	6.0	10.3	18.2	21.3
PHASE 1D	5.2	7.0	11.9	21.0	24.3
PHASE 2	8.9	11.6	19.5	32.9	37.9
PHASE 3	11.5	15.0	25.0	41.5	47.2

Figure 6.2 - Stillwater WWTP Aerial Photograph

Table 6.2 - Stillwater Collection System Lift Station Data										
				Pumps			Force Main			
Lift Station	Address	Type	Date	No.	Capacity, gpm	Emergency Bypass	Diameter in	Length ft	Material	Lift Height, ft
Tierra Oaks	12660 Old Oregon Trail	Wet Well Submersible	1994	2	P1- 440 P2 - 380 P1+P2 - 496	None	16	1600	Ductile Iron	31
Churn Creek	2300 Goodwater Ave	Wet Well Submersible	1992 (1)	3	P1 - 5200 P2 - 5200 P3 - 5200 P4 - 2000 P5 - 2000 P1, P2 & P4 8,300	Yes	8	6280	C900	42
Hope Ln	19600 Carnegie Dr	S&L Package	2007	2	75	Yes	4	2200	C900	20
Stillwater BP	5990 Venture Pkwy	Wetwell Submersable	2009	2	1500	Yes	10	9690	HDPE	40

(1) Churn Creek Lift Station is currently being upgraded to 12 mgd firm capacity.

6.2 DRY WEATHER FLOWS

Dry weather flow (DWF) loading to the Stillwater Collection system included area specific diurnal patterns generated in the same manner that the Clear Creek DWF patterns were developed. One substantial difference was the number of data points used. In the Clear Creek Collection system there were ten data sources for developing diurnal patterns. In Stillwater there were only two viable data sources, Churn Creek Lift Station and the WWTP. Data used for Churn Creek Lift Station dry weather flows was averaged for every hour for every day in the month of August 2003, 2004, 2006 and 2007. Data recorded for 2005 and 2008 did not meet acceptable quality assurance for inclusion in the averaging because of calibration errors.

Hourly DWF for Stillwater WWTP was analyzed from August 28 through September 27, 2009 to obtain the diurnal pattern and for comparison to model output. Figures 6.3 and 6.4 show the two diurnal patterns developed from dry weather flow recordings. Appendix C- Supporting Data and Figures contains detailed figures reflecting data used in the analysis.

Figure 6.3 - Churn Creek Lift Station Diurnal Pattern

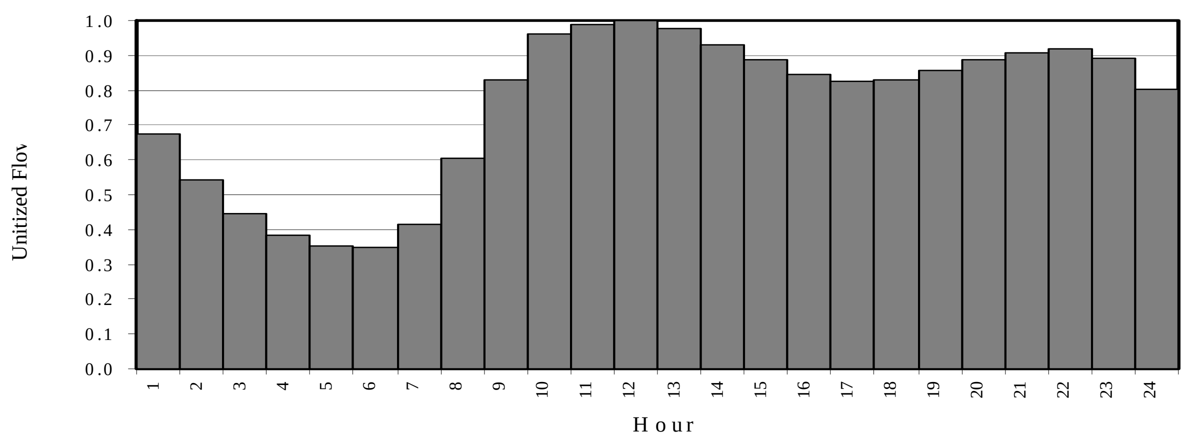


Figure 6.4 - Stillwater WWTP Diurnal Pattern

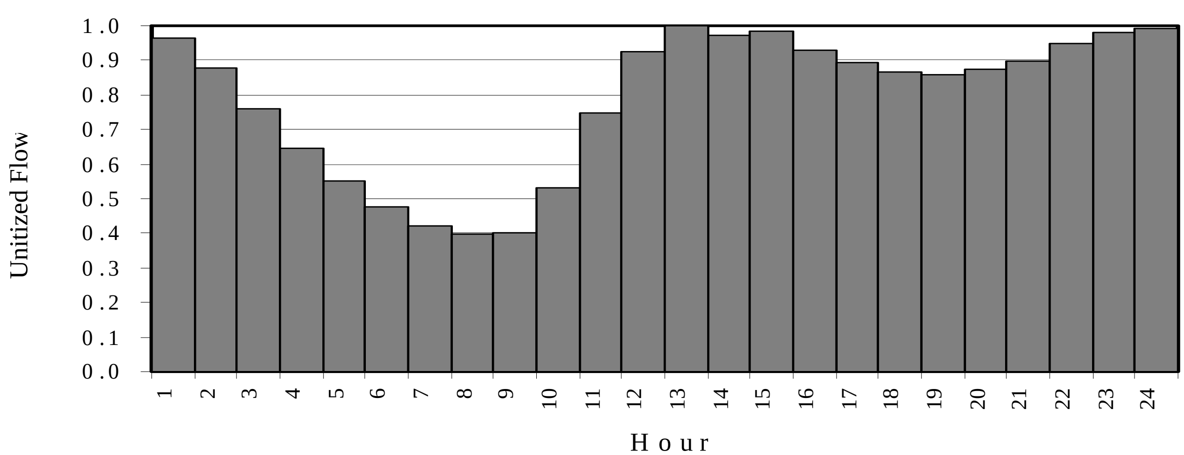


Figure 6.5 shows the results of DWF calibration at Churn Creek Lift Station. It is noted that there is a significant discrepancy between the recorded average dry weather flow and the model output at the lowest demand hours (4-7 am). However, the critical calibration point is the high demand hours between approximately 10 am and midnight. During that period the model results reflect the recorded average with a high degree of accuracy.

Calibration of the Stillwater Collection System DWF Model was achieved by adjusting timing of the Diurnal Pattern applied to the inflows. Because the collection system is long and narrow and the treatment plant data was used for development of the diurnal patterns it was necessary to simulate the application of diurnal patterns earlier in time to account for the lag time in the collection system. It was found that the average lag time in the collection system between Churn Creek Lift Station and the treatment plant was approximately 3-4 hours.

Figure 6.5 - Churn Creek Lift Station DWF Calibration

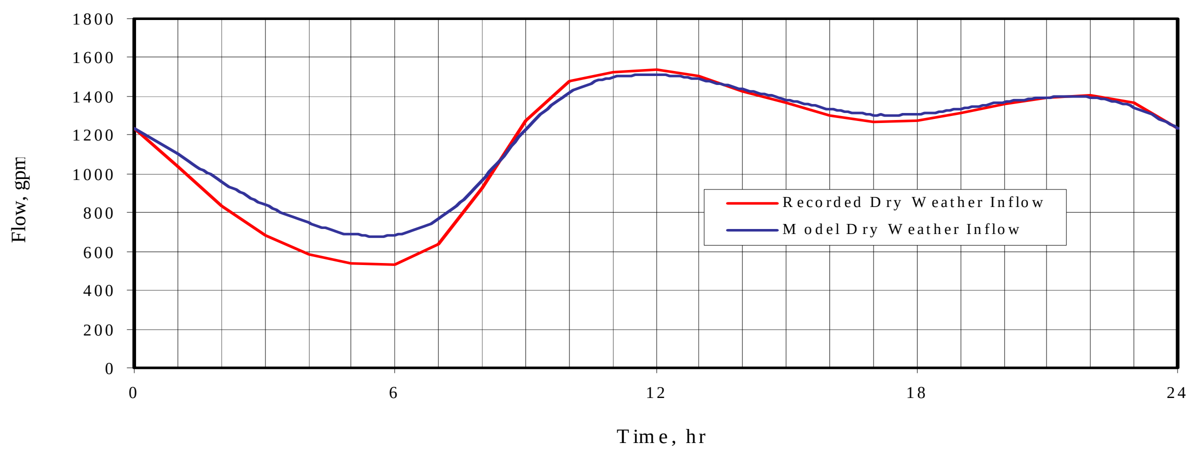
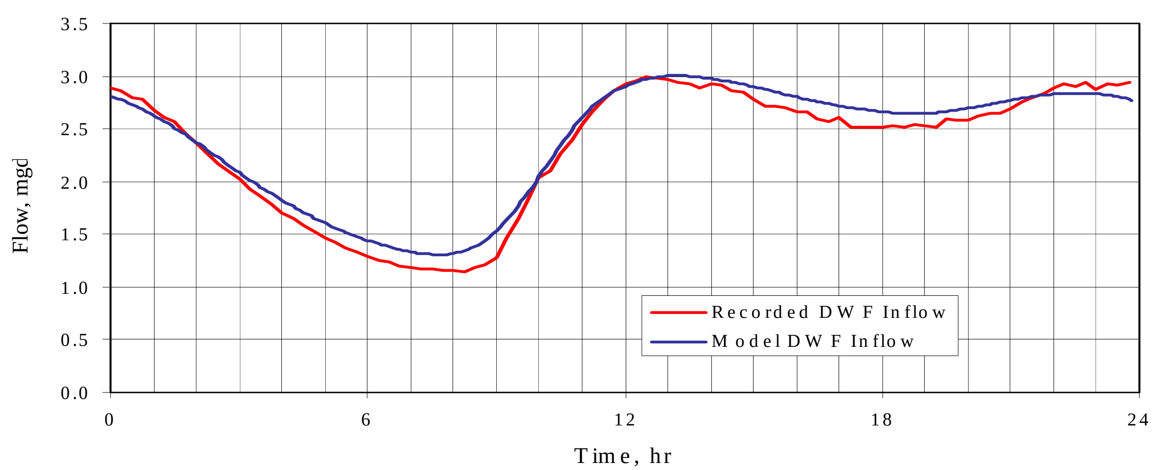


Figure 6.6 shows DWF calibration results at Stillwater WWTP. Calibration of DWF at the WWTP again reflects a difference bewteen average recorded data and model output at the low demand hours but a high degree of accuracy at the critical peak demand hours.

Figure 6.6 - Stillwater WWTP DWF Calibration



6.3 WET WEATHER FLOWS

Wet weather data analysis for the Stillwater collection system model calibration included review of data from seven monitoring stations, Churn Creek lift station and the WWTP for the winter months of 2008-9 and 2009-10. Evaluation of the data from the first winter season found that there was not enough data recorded to employ in the master plan effort. The winter 2009-2010 effort captured more data but again the data was not of high enough quality, did not capture a storm event or did not have both rainfall and precip data for the same time period. Precipitation data was collected and analyzed from twelve different sources throughout the City. The vast majority of the precipitation data was unusable due to technical difficulties with the recording equipment or scheduling difficulties. As a result the Stillwater collection system wet weather average flow calibration and rain driven flow calibrations were based on data collected from Churn Creek lift station and the WWTP. Appendix C - Supporting Data and Figures includes detailed data from the monitoring efforts.

Wet weather flow analysis utilized data from January and February 2010 during non-storm periods to establish the baseline winter flows for both Churn Creek lift station and the WWTP. Wet weather infiltration was loaded into the computer model by adding uniform direct inflow to each manhole in proportion to the area it serves until the ADWF increased in magnitude to match the recorded AWWF. Figure 6.7 and 6.8 show the results of the wet weather flow calibration effort for Churn Creek lift station and the WWTP respectively.

Figure 6.7 - Churn Creek Lift Station Wet Weather Calibration

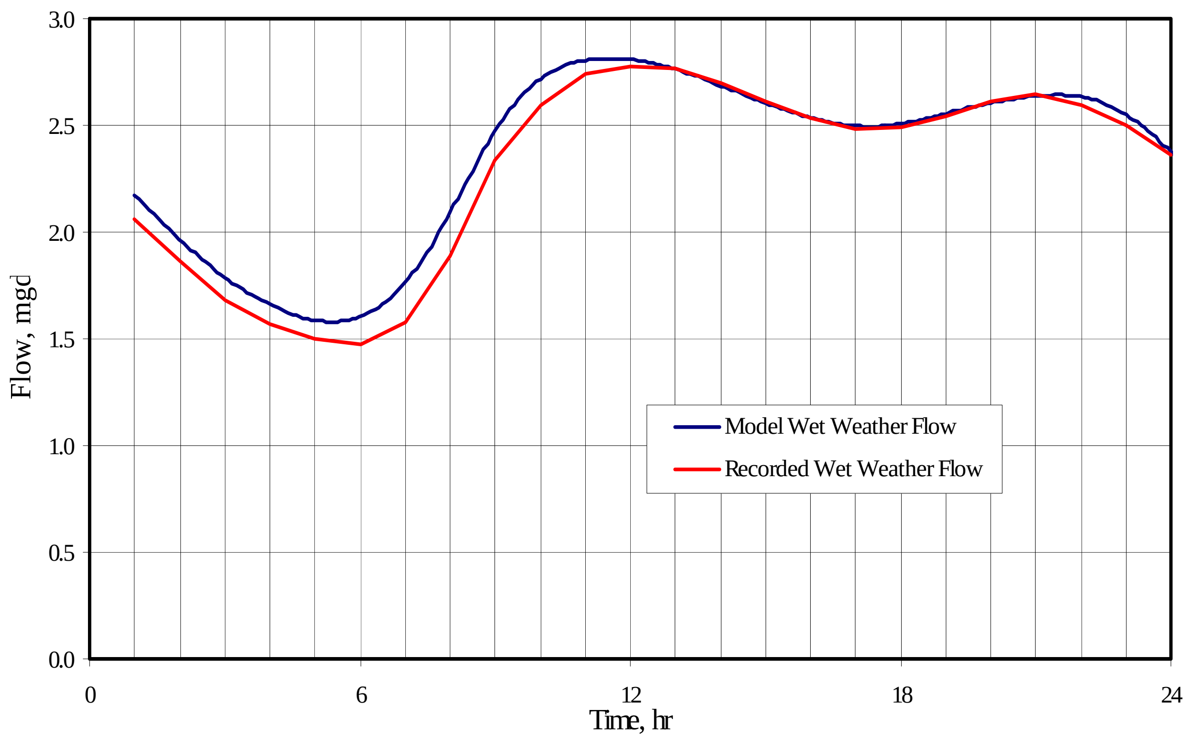
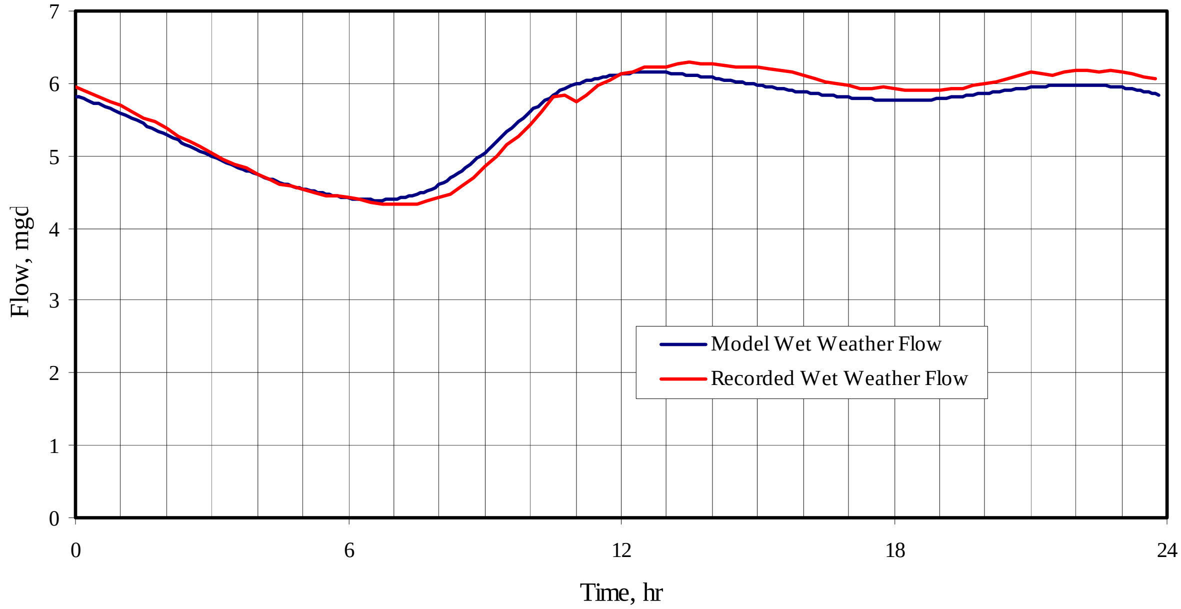


Figure 6.8 - Stillwater WWTP Wet Weather Calibration



Storm or rain driven components of collection system flows were calibrated using precipitation records from rain gauges located at Beltline Drive and Gold Hills Golf Course. Churn Creek Lift Station rain driven components were calibrated on a storm event occurring in January 2010. Results of that calibration are presented in Figure 6.9. Churn Creek Lift Station currently only has capacity to record approximately 5.6 mgd so the flow monitoring curve is truncated at that flow while model results simulate a much higher peak flow.

Figure 6.9 - Churn Creek Lift Station RDI/I Calibration

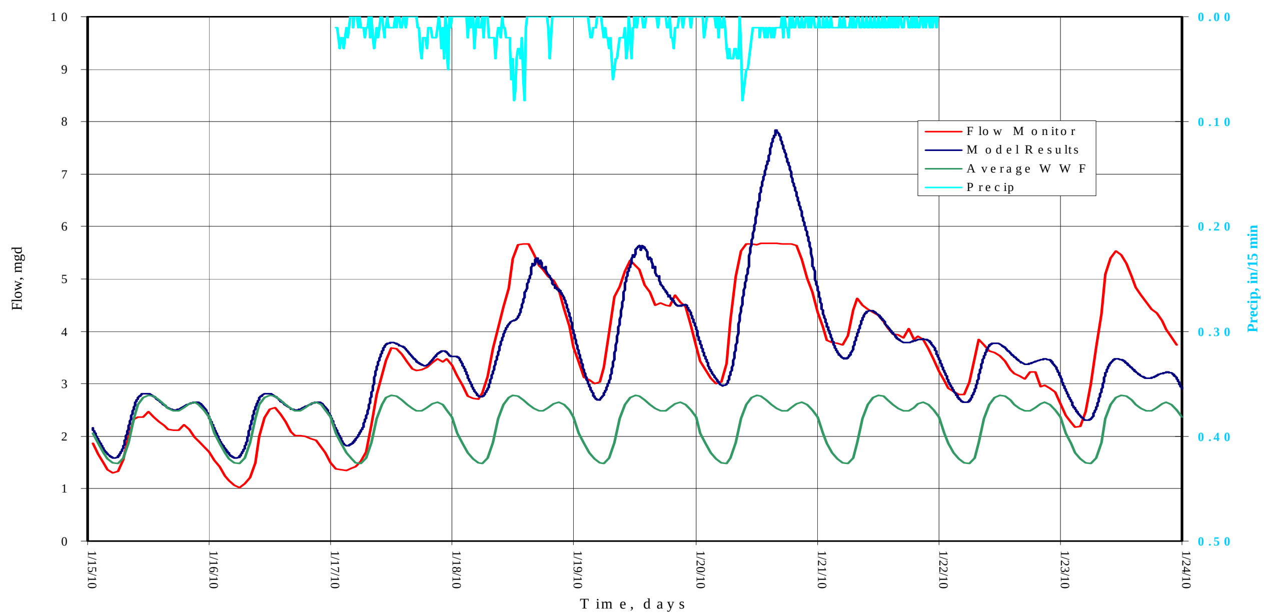
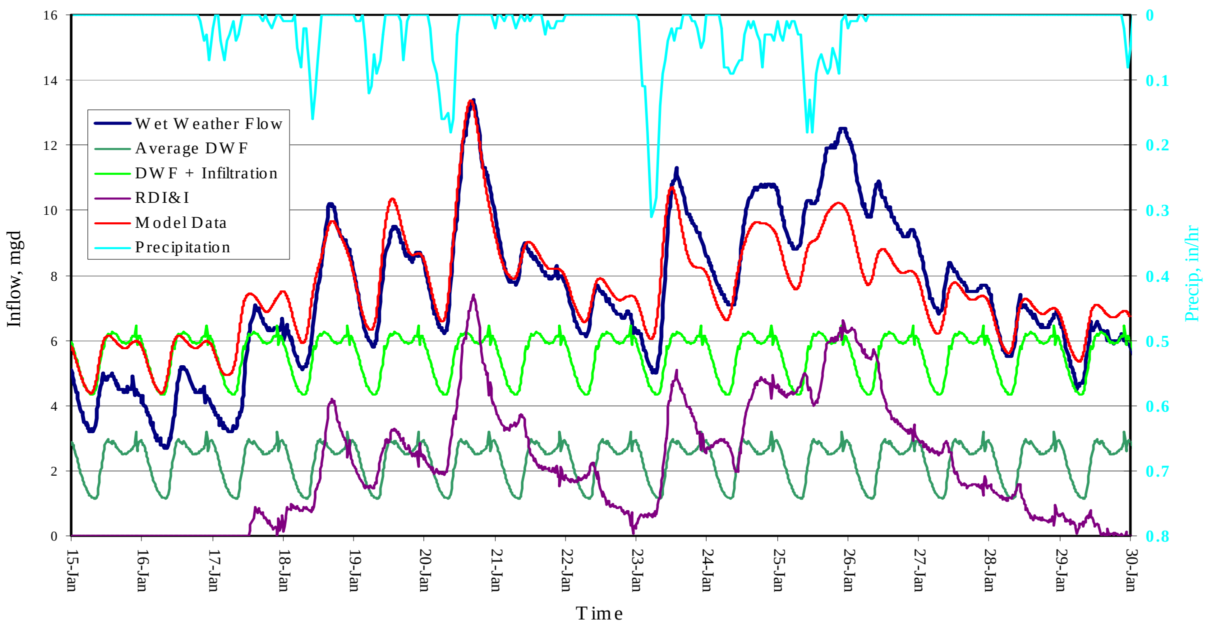


Figure 6.10 - Stillwater WWTP RDI/I Calibration



6.4 COLLECTION SYSTEM HYDRAULIC EVALUATION

Evaluation of the Stillwater Collection system found only a few projects needed to serve the existing and forecast growth through 2030 west of the Stillwater Creek Drainage Area. A summary of the projects can be found on Table 6.3. Potential future service to the Stillwater Creek Drainage Area is covered independently later in this chapter.

6.4.1 Collection System Capacity Projects

2010 Planning Horizon (Existing)

Oasis Road (P-S-1)-The Oasis Road improvements consist of two different segments of pipe called for in two different planning horizons. The first improvement recommended is replacement of approximately 1180 feet of 8-inch diameter VCP constructed in the late 1980s with 12-inch diameter pipe from manhole NY9-2 to NZ9-10 in Oasis Road. Analysis reflects that the second segment requires improvement along Salt Creek by UBO. Figure 6.11 shows the location and extent of the Oasis Road sewer improvements.

2015 and 2020 Planning Horizons

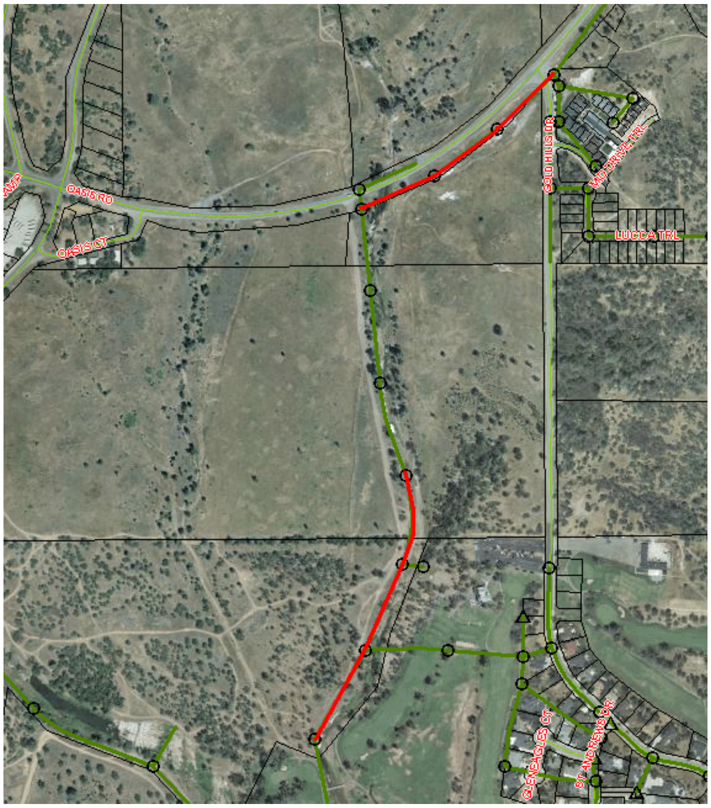
Analysis of the Stillwater Collection system for the 2015 and 2020 Planning Horizons did not reveal a need for improvements for hydraulic capacity. This may be the result of scaled back expected growth as a result of the last five year economic downturn and also because the collection system is relatively new.

Table 6.3 - Stillwater Hydraulic Capacity Improvements

	Project Name	Tag No.	Manhole Number		Length, ft	Diameter, in		Cost Share, %		Total Lengths of each Diameter, ft								
			Upstream	Downstream		Existing	Recommended	Rates	Fees	8"	10"	12"	15"	18"	21"	24"	27"	48"
2010	**Oasis Road**	P-S-1	NY9-2	NZ9-11	780	8	12	34	66			780	400					
			NZ9-11	NZ9-10	400	8	15											
2030	**Boulder Creek PIII**	P-S-5	C5-2	C6-31	1160	6	10				2460	2360	2760					
			C6-31	C6-28	1300	8	10											
			C6-28	D7-22	2360	10	12											
			D7-22	D7-5	790	10	15											
			D7-5	D7-2	1970	12	15											
UBO	**Boulder Creek PII**	P-S-4	D8-3	E8-22	2550	15	18							2550	1230			
			E8-6	E9-13	1230	18	21											
	Oasis Road	P-S-6	NZ9-1	A9-2	1440	15	18							1440				
	Edgewood Drive	P-S-3	G11-11	H11-20	730	8	12					2850						
			H11-18	J11-28	2120	8	12											
	Baer Road	P-S-2	NY8-3	NZ8-3	1210	12	15						1640					
			NZ8-3	NZ8-2	430	10	15											
	Quartz Hill	P-S-7	A5-17	A5-14	415	8	10				1368							
			B5-15	B5-11	433	6	10											
			B5-11	B5-10	520	8	10											

(1) Projects not called for under existing conditions are 100% growth related projects thus are 100% impact fee projects

Figure 6.11 - Oasis Road Improvements



2030 Planning Horizon

Boulder Creek Interceptor PII and PIII - The 2003 WWMP recommended replacement of the entire Boulder Creek Interceptor under existing conditions. Subsequent design and project development reports were predicated on the flows determined by that plan. The current analysis did not reflect the urgent necessity for these improvements. Extensive investigation was performed to determine why there was such a signficant difference in flows observed between the two plans. The results of that investigation found that there were two factors contributing to the high numbers found in the 2003 Plan; excessive RDI/I rate and excessive design storm depth assumptions.

The first observation was that an area miscalculation led to the application of RDI/I at a much higher rate. A recorded volume of RDI&I was divided amongst 521 acres generating an RDI/I rate of 3,474 gallons per acre day. This 3,474 gpad was then applied to 1,256 acres resulting in excess RDI/I entering the system by a factor of approximately 2.4. The second factor was the design storm used for that part of the City. The 2003 Plan calls out 8.61 inches of precipitation as the 10-year, 24-hour depth of precipitation to be used, according to the 1993 City-Wide Master Storm Drain Plan hydrology, for the Beltline Rain gauge area. The correct depth should have been 6.14 inches. This results in approximately 1.4 times as much RDI/I as would be expected to enter the collection system if the appropriate storm depth had been used. Combined, these two factors would result in nearly 4 times the volume of RDI/I than would be necessary to analyze. Therefore the current analysis recommends the latter two phases of Boulder Creek after more development with more demands applied to the system. It is also recommended that a high priority be placed on obtaining monitoring data in this area for a more detailed investigation of peak design flows.

data in this area for a more detailed investigation of peak design flows.

Evaluation of the collection system indicates that Boulder Creek Interceptor Phase III is recommended for construction by 2030 while Boulder Creek Interceptor Phase II falls between 2030 and UBO.

Boulder Creek Interceptor Phase III (P-S-5)

This project consists of replacing approximately 7,600 feet of 6- to 12-inch diameter VCP pipe from manhole C5-2 to D7-2 constructed in the mid to late 1960s. Recommended pipe sizes range from 10- to 15-inches in diameter and are detailed in Table 6.1. Figure 6.12 and 6.13 show the location and extent of the recommended improvements.

Figure 6.12 - Upper Segment of Boulder Creek Interceptor Phase III

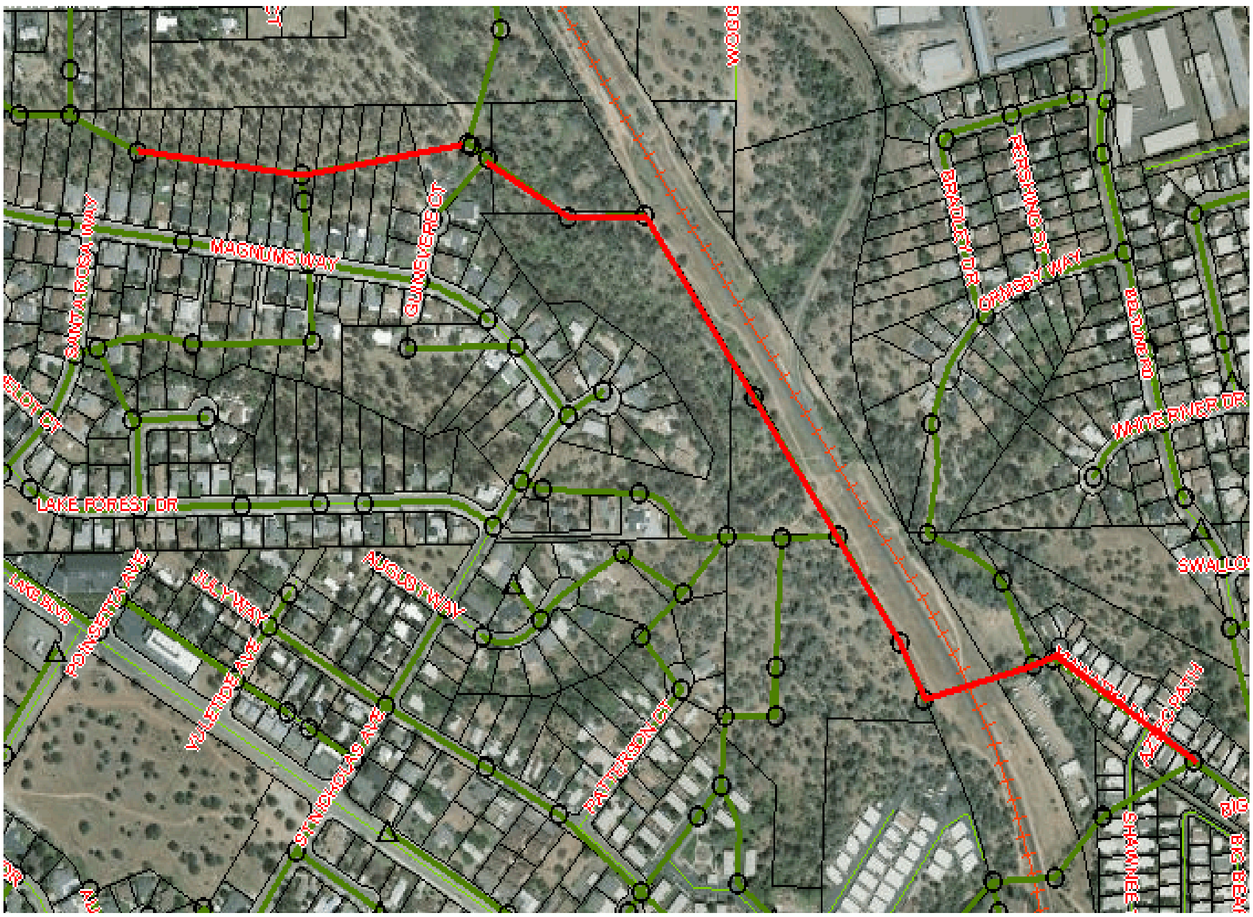
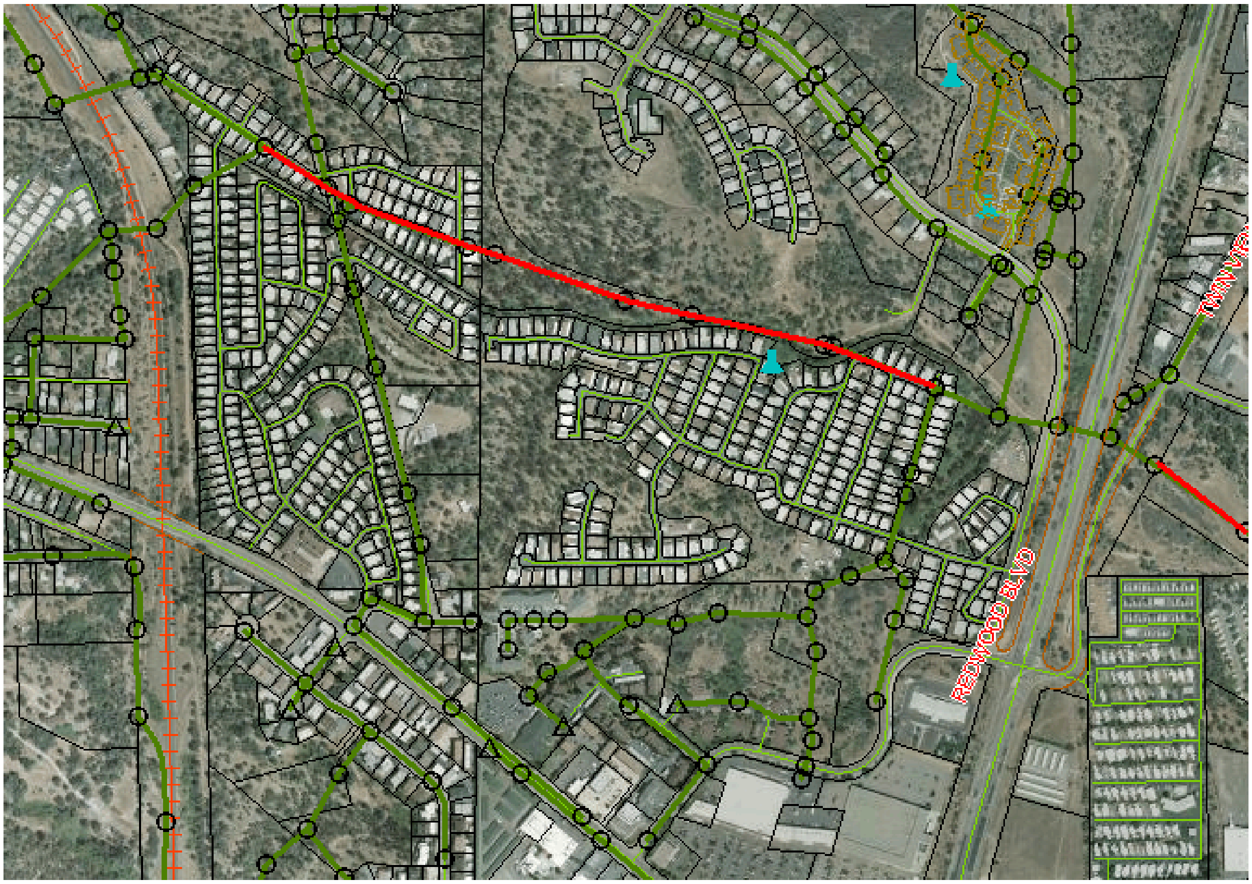


Figure 6.13 - Lower Segment of Boulder Creek Interceptor Phase III



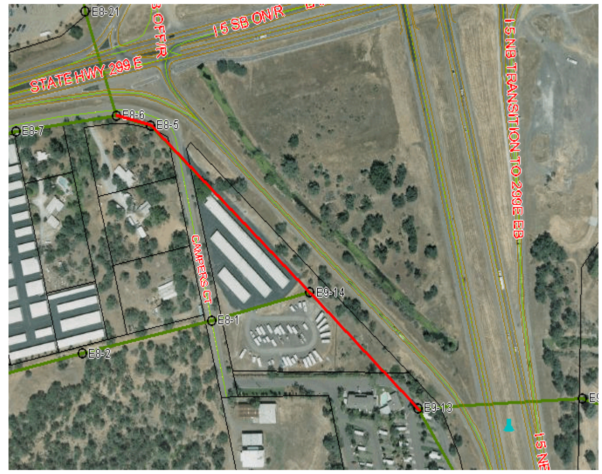
6.4.4 UBO Planning Horizon

Evaluation of the collection system capacity at UBO found that the additional demands at General Plan density requires the following capacity related projects.

Boulder Creek Interceptor Phase II (P-S-4) - Boulder Creek Interceptor Phase II was discussed at the end of the 2030 Planning Horizon section. Figure 6.14 and 6.15 show the location and extent of Boulder Creek Interceptor Phase II.

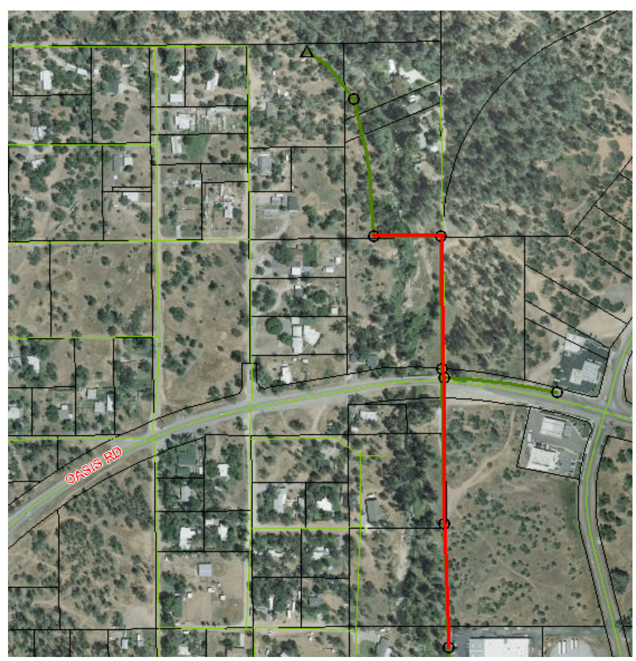
Figure 6.14 - Segment 1 of Boulder Creek Interceptor Phase II

Figure 6.15 - Segment 2 of Boulder Creek Interceptor Phase II



Oasis Road (P-S-6) - This segment consists of replacement of approximately 1440 feet of 15-inch ABS constructed in the early 1980s from manhole NZ9-1 to A9-2 with 18-inch diameter pipe along Salt Creek. The 2003 WWUMP recommended improvement of the first segment by 2010 and the entire Upper Churn Creek Interceptor by UBO. Figure 6.11 shows the location and extent of the current recommended Oasis Road sewer improvements.

Figure 6.16 - Baer Road



Baer Road (P-S-2) - Improvements on Baer Road are required as a result of development expected to occur within the Oasis Specific Plan area west of Interstate 5. The recommended improvement is replacement of approximately 1,650 feet of 10- and 12- inch diameter ABS pipe from manhole NY8-3 to NZ8-2 constructed in the early 1980s with 15-inch diameter pipe. Figure 6.16 shows the location and extent of the recommended improvements.

Edgewood Drive (P-S-3) - Edgewood Drive sewer improvements consist of replacement of approximately 1210 feet of 8-inch diameter ABS pipe from manhole H11-16 to J11-28 constructed in the late 1980s with 10-inch diameter pipe. Figure 6.17 shows the location and extent of the recommended projects.

Figure 6.17 - Edgewood Drive

Quartz Hill (P-S-7) - Improvements on Quartz Hill and south of Buckeye Elementary School east of Lake Boulevard, replacing 1368 feet of 6 and 8-inch diameter aging VCP with 10-inch diameter pipe. Figure 6.18 shows the location and extent of the recommended improvements.

Figure 6.18 Quartz Hill Improvements

6.5 LIFT STATION CAPACITY EVALUATION

In addition to evaluation of the hydraulic capacity of the pipes in the collection sysstem, flow data was analyzed to determine potential improvements necessary at the lift stations and WWTPs. Table 6.4 summarizes the peak demands for each lift station and the WWTP for the Stillwater collection system.

Table 6.4 - Facility Flows for Stillwater WW Collection System, mgd

Facility	Capacity	Planning Horizon							
		2010	2015	2020	2030	UBO(1)	UBO(2)	UBO(3)	UBO(4)
Tierra Oaks	0.72	0.55	0.78	0.78	0.79	0.93	0.93	0.93	0.93
Churn Creek	12.0	8.41	8.89	10.18	11.5	21.04	23.20	24.17	24.94
WWTP	(5)	16.08	17.45	18.80	21.14	35.48	37.00	37.66	38.39

(1) Does not include any development of the Stillwater Creek Drainage Area
(2) Includes development of Stillwater Creek Drainage Area within City Limits
(3) Includes development of Stillwater Creek Drainage Area within City Limits and Primary General Plan growth boundary.
(4) Includes development of Stillwater Creek Drainage Area within City Limits, Primary and Secondary General Plan growth boundaries.
(5) WWTP capacity includes equalization storage and is discussed in the Stillwater WWTP Facilities Plan.

6.5 LIFT STATION RECOMMENDATIONS

The following is a discussion of lift station recommendations based on the ***planning level*** analysis performed with this master plan. Prior to design of any lift station facility it is imperative that a focused design level analysis be performed to verify flows and assure the design will accomplish the desired task.

Tierra Oaks LS - Tierra Oaks Lift Station capacity appears to be exceeded by 2015 as a result of forecast development west of Tierra Oaks to the City Limit.

Recommended Project

Tag No.	Item	Recommendation	Purpose
LS-S-1	Tierra Oaks LS	Replace Pump and force main	Capacity

6.7 COLLECTION SYSTEM MAINTENANCE PROJECTS

The list of maintenance projects was derived by reviewing the maintenance activities and logs of the collection system staff and performing a preliminary investigation of potential reasons for high levels of maintenance at specific locations. The investigation consisted of research of plans and age of facilities to determine whether age, slope, size or other factors may justify initiation of a project to reduce maintenance activities. In most cases the pipes requiring excessive maintenance are old enough to justify including a pipe replacement program. Input from maintenance staff was also considered in the evaluation, potentially resulting in recommendation of replacing a pipe that may have excessive root intrusion with a different material less likely to have that type of difficulty. Table 6.5 summarizes the collection system maintenance projects.

Table 6.5 - Maintenance Projects

Project	Tag No.	Manhole No.		Length, ft	Diameter, in		Cost Split		Total Length	
		Up	Down		Existing	Recommended	Rates	Fees	6"	12"
Patterson Court	P-S-8	D6-17	D6-34	524	6	6	100		524	
Boneset Street	P-S-9	N13-13	N13-7	255	12	12	100			255
		N13-7	O13-1	262	6	8	100		262	

Patterson Court - P-S-9

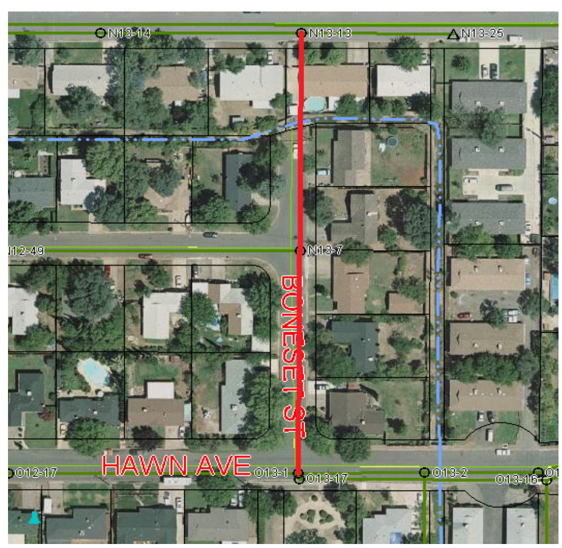
Sewer pipes downstream of Patterson Court appear to have adequate slope but serve a very small area so buildup of solids may be an issue causing excessive maintenance. There are two alternatives suggested for resolving the problem as depicted in Figure 6.19. Alternative 1 is to replace the lower section of pipe. Alternative 2 is construction of a new pipe to a location further downstream on the Boulder Creek Interceptor.

Figure 6.19 - Patterson Court

Boneset Street - P-S-10

The sewer pipe in Boneset Street is 255 feet of 12-inch diameter AC pipe and 262 feet of 6-inch diameter AC-pipe at low slope. The pipes are at least 49 years old as depicted in the Enterprise PUD atlas from 1962. Maintenance staff reports that there is a significant root intrusion problem in the facility. It is recommended that the pipes be given a relatively high priority in the aging pipe replacement program and that the 6-inch segment be replaced with 8-inch pipe. Figure 6.20 shows the location and extent of the project.

Figure 6.20 - Bonset Street



Clover Creek Interceptor Rehabilitation P-S-11

Clover Creek Interceptor Rehabilitation project is recommended to reduce wet weather I&I in the lower portion of the Stillwater WW Collection system. Investigation of the wet weather peak flows at Churn Creek Lift Station and corresponding flows at Stillwater WWTP showed that wet weather flows at the treatment plant are approximately twice those at Churn Creek Lift Station. Doubling of the wet weather flows between the two facilities is deemed excessive due to the limited amount of additional area served adjacent to and connecting to the Clover Creek Interceptor.

Information has also become available indicating that quality of construction of the facility was the source of significant problems. It is therefore recommended that a project be undertaken to rehabilitate the facility. Such rehabilitation should initially focus on detailed investigation of potential defects in the system and include evaluation of flows arriving from adjacent collectors and potentially lining of most of the facility. The total length of facility is approximately 32,700 feet with the majority of it being 42- and 48-inch diameter pipe. Approximately 48-percent of the pipes are either crossing or located in Clover Creek. Another approximately 23-percent is parallel to Clover Creek within floodplain boundaries. The location and extent of the project can be seen on the large scale map in Appendix E.

6.6 WWTP FACILITIES PLAN RECOMMENDATIONS

In 2007 the City of Redding contracted with Water Works Engineers to prepare a facilities plan to provide project definition and schedule for improvements necessary at the Stillwater WWTP to meet regulatory and capacity needs, including forecasting future needs for that facility. The plan outlined three Phases of improvement based on forecast growth and demand in terms of household equivalents. The first phase of the plan was then divided into four sub-phases 1A through 1D and scheduled for construction to provide the necessary capacity and treatment facilities. The City of Redding Stillwater Wastewater Treatment Plant Facilities Plan, November 2008 contains all the detail for this plan.

In summary Phase 1A and 1B are scheduled for completion in Fall 2013 and already included in the Utility CIP/Financial Plan. This phase will increase treatment capacity to 14 mgd with 12 mg storage available for equalization. Phase 1C and 1D timing is dependent on demand associated with growth projections made prior to the current economic recession. Growth projections used in the facilities plan appear to be higher than what has actually occurred since the plan was developed, and used future forecasts that were higher than the current projections. Fortunately, the project timing in the plan was determined by HE thresholds which can be correlated to time frames in this plan to place the various phases at new times, at least from a capacity perspective. Phase 1C is in the Utilities Financial Plan and scheduled for 2018 with Phase 1D at 2027.

Stillwater WWTP facilities plan shows the following schedule for improvements in terms of HEs:

Phase 1A - increases 11,800 to 13,525
Phase 1B - 15,495
Phase 1C - 20,305
Phase 1D - 23,952
Phase 2 - 40,219
Phase 3 - 52,667

Current projections for H-Es are:

Planning Horizon	Without SCDA	With SCDA
2010	12028	12028
2015	13320	13371
2020	15822	16525
2030	22863	26150

SCDA - Stillwater Creek Drainage Area, detailed in Section 6.8

Interpolation of the projected HE schedule can be performed to find the exact month and year each phase might be needed utilizing current demand forecasting with and without SCDA. However, the activity of doing so includes significant uncertainty.

Improvement Phase	Without SCDA	With SCDA
1A	2010	2010
1B	2019	2018
1C	2026	2024
1D	Beyond 2030	2028
2	Beyond 2030	Beyond 2030

From this summary it appears that the Stillwater WWTP Facilities Plan time frames were not unreasonable. It called for each phase in roughly the same time frame that the current analysis does. Therefore no recommendations are being made to alter the project or timing schedule.

Stillwater WWTP Diffuser

In 2005 City WWTP staff determined that the Stillwater WWTP discharge diffuser in the Sacramento River was not functioning adequately. Investigation of the facility determined that a gravel bar had migrated downstream and covered the diffuser. In addition to covering the diffuser it had filled with alluvial material from the river bottom. CH2M-Hill engineers was hired to study the situation and make a recommendation for repair or replacement and to perform preliminary design for the recommended solution. The result of that effort was to recommend advancement of replacing the diffuser, a task included in Phase 1D of the facilities plan, to 2008-9 and relocate it to a more stable section of the river. After considering the fiscal ramifications of that recommendation the City decided to pursue rehabilitation of the facility in its current location. Completion of the rehabilitation project occurred in early 2009. However, the existing location remains downstream of the problematic gravel bar in a section of river with a historic migration of approximately three feet per year away from the diffuser. As such, it is important to perform routine inspection of the facility and potentially budget for periodic maintenance until Phase 1D relocates the diffuser.

Therefore the recommended projects associated with Stillwater WWTP are:

Tag No.	Item	Recommendation	Purpose
TP-S-1	Stillwater FP Phase 1C	Construct by 2026	Capacity
TP-S-3	Diffuser Maintenance	Every 5 years or following Keswick releases greater than 60,000 cfs	Operations

6.7 STILLWATER CREEK SERVICE AREA DEVELOPMENT

6.7.1 History

Providing sewer service to the east side of the City of Redding, and further to the City General Plan Sphere of influence, has been considered for decades. The concept of a major interceptor along Stillwater Creek was introduced in a report titled A Regional Sewage Study of the Central Shasta County Area by Ott Water Engineers and Bartle Wells Associates dated April 1983. The study divided the Stillwater Drainage area into three sub-areas Upper, Middle and South roughly corresponding to the areas delineated on Figures B-7a, B-7b and B-7c in Appendix B of this report. Recommendations found in the report led to the development of the new Stillwater WWTP. The treatment plant started operation in 1992 and was intended to serve large areas without sewers farther to the east including a major part of Stillwater Creek basin.

In 1987 a Master Sewer Plan prepared by PACE Engineering and the City of Redding Public Works and Planning divisions addressed diversion of an area known as the Twin View Service Area from the Clear Creek WWTP to a new system, Clover Creek Interceptor, ultimately draining to the Stillwater WWTP. The diversion occurs at a new lift station located near Churn Creek south of HWY 44 now referred to as the Churn Creek Lift Station. The Clover Creek Interceptor was constructed in the early 1990s and appears to have been oversized to accommodate future development including an oversized crossing under HWY 44 at Crossroads in preparation for an interim lift station at Old HWY 44 at Stillwater Creek.

Stillwater Service Area was again studied in 1992 by PACE Engineering in a Master Plan titled "Stillwater Service Area Master Sewer Plan" which covered all areas potentially draining to Stillwater WWTP as far north as Bear Mountain Road and East to the Redding Sphere of Influence. The study recommended improvements to Boulder Creek Interceptor and Upper East Side interceptor. The parallel Upper East Side improvements have been constructed as has Phase I of a three phase project to improve Boulder Creek interceptor capacity. Although the Stillwater Creek Drainage Area was considered in this report all improvements associated with the area were labeled "AD" for As Developed which was defined as improvements to be constructed by and paid for by the developers of projects as the come forward in the future. The estimated cost of the total improvement list was $24,300,000 in 1992.

The next planning effort recognized that construction of such a large amount of infrastructure as suggested in the Stillwater Area Master Sewer Plan all at once, or leaving to be constructed over time by developments, to serve the entire Stillwater Creek Area would be nearly impossible. As a result City of Redding contracted with PACE Engineering to have a plan prepared specifically to cover implementation of a phased approach to development of the Stillwater Creek Service Area. The final report is titled Stillwater Service Area Interim Sewer Study dated January 1998. The study adheres to City Council Policy 1401 - City Services Outside City Limits which specifically discourages extending City infrastructure by limiting area served to City Limits. The plan recommended four interim lift stations pumping to the existing Upper Churn Creek and Churn Creek Interceptors. It also did not address development of areas south of Old Alturas so it covered development in the north half of Stillwater Creek Drainage Area.

The City of Redding 2003 Wastewater Utility Master Plan discussed and evaluated service to the Stillwater Creek Drainage Area but projected that development would not reach levels necessary to require the projects until after 2010, the limit of the financial planning period for that effort. As such, and as typical with such plans projects between the last planning horizon and UBO do not get listed in the Capital Improvement Plan or Financial Plan. Unfortunately this is problematic from two perspectives; first it is unrealistic to believe that such a large project as the main interceptor and lift station could or would be accomplished by a single development at its own expense even with the potential of reimbursement. The second problem is that the magnitude of funds to construct such a project may require collection of impact fees start many years ahead of construction.

Between 2003 and 2010, plans for a Stillwater interceptor project have been considered on numerous occasions. However, no projects or plans to schedule projects associated with its construction have risen above the level of discussion.

6.9.2 Evaluation

The initial effort to investigate what is reasonable to expect in terms of magnitude, location and timing of development included a series of workshops to with parties that may have significant influence, history, or experience in land development. An overview of and conclusions from that effort can be found in Appendix B - Community Outreach.

In the discussions with the local development engineering representatives it became evident that no effort had been made to identify how much development could be allowed to pump over to the existing system before projects are necessary on the existing interceptors. The second part of that question is how much infrastructure would be necessary to support pumping all of it and would that be less expensive than construction of the conceptual Stillwater Interceptor. To answer the question the Stillwater Drainage Area was divided into four development zones using the City of Redding limits and general plan boundaries. They correspond to the area within City Limits, area between City Limits and the General Plan primary growth boundary, area between primary growth boundary and secondary growth boundary and area between the secondary growth boundary and the General Plan Sphere of Influence. For simplicity these areas will henceforth be referred to as City Limits, Primary Growth Area, Secondary Growth Area and Sphere.

Demand Development

Growth density within these areas was determined by General Plan densities from the City of Redding and Shasta County adjusted to comply with the consensus of opinion reached in the Community Outreach effort presented in Appendix B. The analysis that followed did not include timing of when development would occur. Because of Council Policy 1401 it is reasonable to assume that areas within the City Limits would develop first and given the expense of construction of infrastructure necessary for “leapfrog” development it is also reasonable to assume that development generally follows the primary and secondary areas in order. It was further assumed that development would fund and construct improvements necessary to pump and convey sewer to the existing large diameter interceptors adjacent to Churn and Clover Creeks.

The goal of the analysis that followed was to identify projects that would permit approval of projects pumping sewer from the Stillwater Creek Drainage Area to the existing sewer system. It added the sewer volumes to locations of existing infrastructure that may be convenient or obvious. However, these locations are somewhat arbitrary and will likely require increase in size of facilities between the point of connection and the large diameter sewer interceptors being evaluated in this effort. Due to the uncertainty of location of connection and in forecasting development demand no effort was made to catalog the necessary improvements between such points of connection and the large diameter interceptors. Such effort is more detailed than the scope of this document and is best left to a time when a project is being investigated and enough information is available to undertake a feasibility analysis of different potential alignments or connection points. Analysis of pipes between the points of connection and the interceptors included arbitrary increases in size or allowable head on the manhole to assure that no sewer is lost to overflows thus all forecast flow reaches the large interceptors.

Development of City Limits

Serving the City Limits by pumping sewer over from Stillwater Drainage Area to Churn Creek and Clover Creek Interceptors adds an additional approximately 1698 acres of area which includes an additional approximately 2723 HEs. Additional HE allocation for new area served within City Limits that would have been sewered by the conceptual Stillwater Interceptor are listed in Table 6.5 Because some SSAs cross political boundaries the table includes a column indicating the percent of the SSA applicable to this category. These percent values are approximate. HE values in the table are not divided between the land use classifications. The “type” of HE within each SSA can be determined from General Plan Maps. Specific SSA boundary locations can be found in the City of Redding Wastewater Utility Atlas.

When applied to the hydraulic analysis the increased demands on the wastewater system, both domestic and I&I relative to the new service area, numerous new pipe capacity projects were found to be necessary to convey the additional sewer volumes. Table 6.6 reflects the necessary improvements to the large diameter interceptors parallel to Churn Creek to accept the additional demands. Improvements are of two types, increasing the diameter of existing pipes and reconnecting and rehabilitating the old parallel East Side Interceptor. No alternatives analysis was performed to determine if replacement was more cost efficient than rehabilitation. Also no analysis has been performed to determine if construction of a smaller diameter parallel pipe might be more cost effective than increasing the size of a current facility. Approximately 50% of the rehabilitated existing parallel interceptor was marginally adequate from a hydraulic capacity perspective. Depending on the condition of the pipe the facility may need lining which will reduce its conveyance capacity. A more detailed analysis, including re-calibration of the computer model should be performed prior to initiating a project for rehabilitation/reactivation of these pipes.

In addition to the pipe improvements the additional flow arriving at Churn Creek Lift Station results in the need for increased capacity at that facility. The increment of flow between UBO and UBO(1) which includes City Limits, is an additional 2.16 mgd peak flow. UBO peak flow arriving at the lift station at 2030 is 11.5. If the City Limits are allowed to develop and pump to systems draining to Churn Creek lift station are added, the resulting peak flow would be 13.66 mgd to a facility with a capacity of 12.0 mgd.

Recommended Replacement Projects

Oasis Road Phase II (P-S-12)

The Oasis Road Phase II project recommends increasing the size of two additional pipes in Oasis Road. It is important to note with this project that one of the two segments of pipe is already called for to increase in size under existing conditions. It would be logical to consider combining P-S-12 and P-S-1 by adding one more pipe size for the lower pipe and including the upstream pipe in that project. Figure 6.21 shows the location and extent of the project.

Figure 6.21 - Oasis Road Phase II

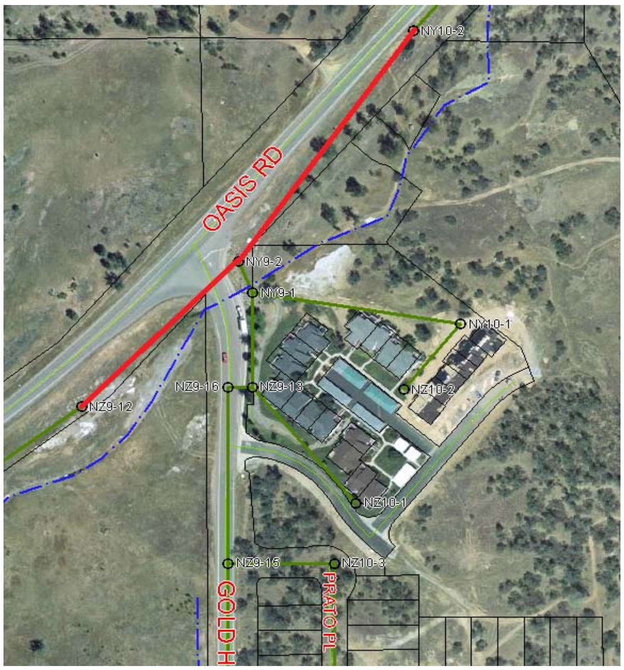
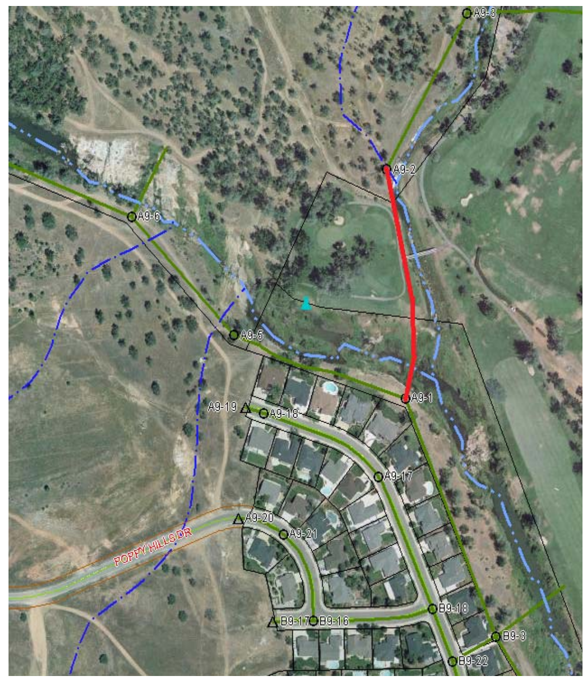


Figure 6.22 - Salt Creek



Salt Creek (P-S-13)

Salt Creek Sewer Pipe project consists of increasing the existing 632 feet of 15" diameter pipe to 21" diameter. The project is immediately adjacent to Salt Creek between a golf fairway and the creek. It then crosses under Churn Creek just upstream of the confluence with Salt Creek. The project will likely have constructablity and environmental challenges. The Salt Creek Project location and extent are depicted in Figure 6.22.

Hawley Road (P-S-14)

The Hawley Road project consists of increasing 732 feet of 21 and 582 feet of 18 inch diameter pipes one size to 24 and 21 inches diameter respectively. Replacing the pipe appears to involve significant environmental challenges and a crossing of Churn Creek. Figure 6.23 shows the location and extent of the project.

Palacio (P-S-15)

The Palacio Sewer Pipe project involves replacing approximately 714 feet of 27-inch and 645 feet of 24-inch diameter sewer pipe with 36-inch diameter pipe. Figure 6.24 shows the location and extent of the project.

Figure 6.23 - Hawley Road

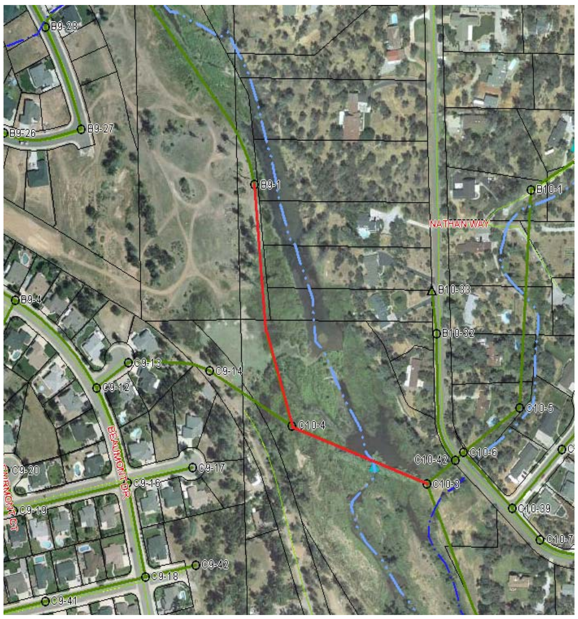


Figure 6.24 - Palacio

Boulder Elementary (P-S-16)

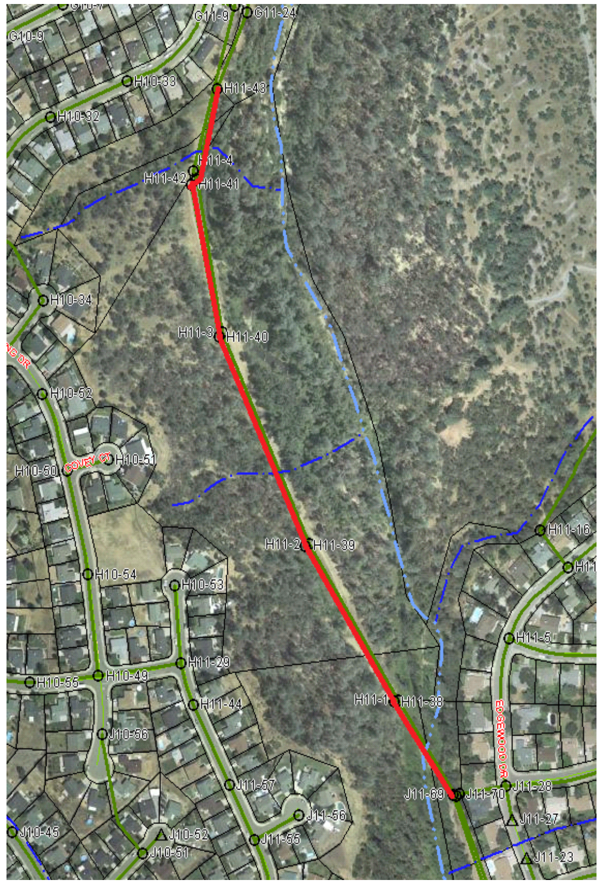
The Boulder Elementary Sewer Pipe crosses the playground at Boulder Creek Elementary School and includes replacement of approximately 483 feet of 24-inch diameter pipe with 30-inch diameter pipe. Because the project is primarily underneath a paved parking lot environmental challenges are expected to be limited, however construction will need to occur during periods of time when students are not present. Figure 6.25 shows the location and extent of the project.

Edgewood - (P-S-17)

The Edgewood Sewer Pipe project consists of replacing approximately 1762 feet of 27-inch and 36 feet of 30-inch diameter pipe with a mix of 30-inch and 36-inch diameter pipe. Table 6.5 shows which of the pipe lengths are recommended to be 30-inch diameter and which are recommended at 36-inch diameter. The project appears to be on an alignment beneath an existing access road until crossing Churn Creek near the southern terminus. Figure 6.26 shows the location and extent of the project.

Figure 6.25 - Boulder Elementary

Figure 6.26 - Edgewood



Recommended Rehabilitation Projects

Upper East Side Rehabilitation Project (P-S-18)

Rehabilitation of the original Upper East Side consists of modification of the upstream manhole to divert a portion of the flow to the old interceptor, construction of approximately 35 feet of new 18-inch diameter pipe to connect the upstream end of the old interceptor and rehabilitation of approximately 304 feet of 18-inch, 335 feet of 15-inch and 569 feet of 27-inch pipe and four manholes. The project also includes construction of approximately 30 feet of 27-inch diameter pipe at the downstream end to reconnect to the new interceptor. Figure 6.27 shows the location and extent of the Upper East Side Rehabilitation Project. The project needs to include re-connection to the new interceptor at the downstream terminus or continuation of the old interceptor downstream to a location where it joins the new interceptor. These alternatives were not explored as part of this study. The projects are described as ending at the location where the need for improved capacity ended. Cost estimates for the projects were prepared only for connection and rehabilitation of that length of existing original interceptor.

Upper East Side Rehabilitation Project II (P-S-19)

Hydraulic evaluation of the capacity of the combined Upper East Side Interceptors found that rehabilitation of only part of the parallel pipe was required to meet capacity needs. To accept City Limits flow the increased capacity of the parallel pipe ended at manhole J11-5, for Secondary Growth Area flow the increased capacity required ended at manhole K11-4. At the downstream locations the options would be to continue rehabilitation of the old interceptor downstream or construct a pipe to reconnect with the new interceptor. The project may be split or reduced in magnitude if the decision is made to defer or not construct the lower portion (that associated with the Secondary Growth Area). The project consists of modification of the upstream manhole creating a diversion for flow to the old interceptor, construction of approximately 30 feet of 18-inch pipe to make the connection to the old interceptor, and rehabilitation of approximately 1700 feet of 15-inch, 3560 feet of 18-inch, and 475 feet of 21-inch diameter pipe along with 16 manholes. It also includes construction of approximately 30 feet of 21-inch diameter pipe to reconnect at the downstream end. Figure 6.28 shows the location and extent of the project.

Figure 6.27 - Upper East Side Rehab

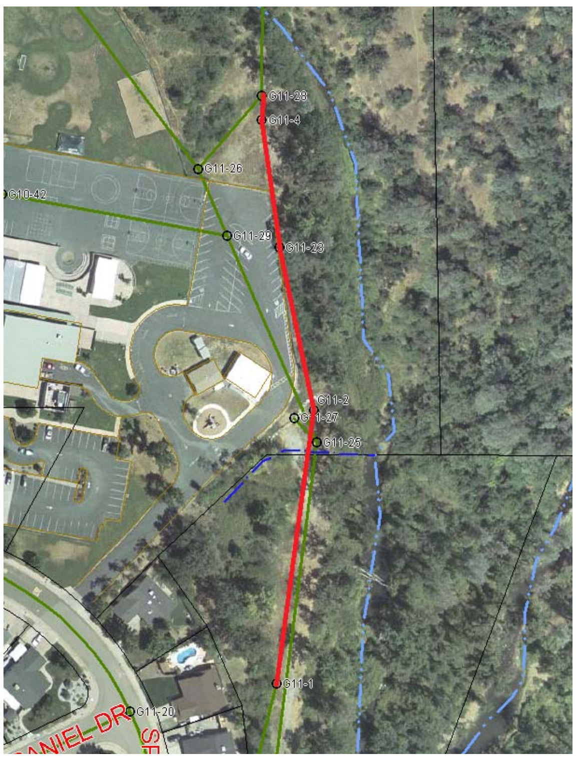
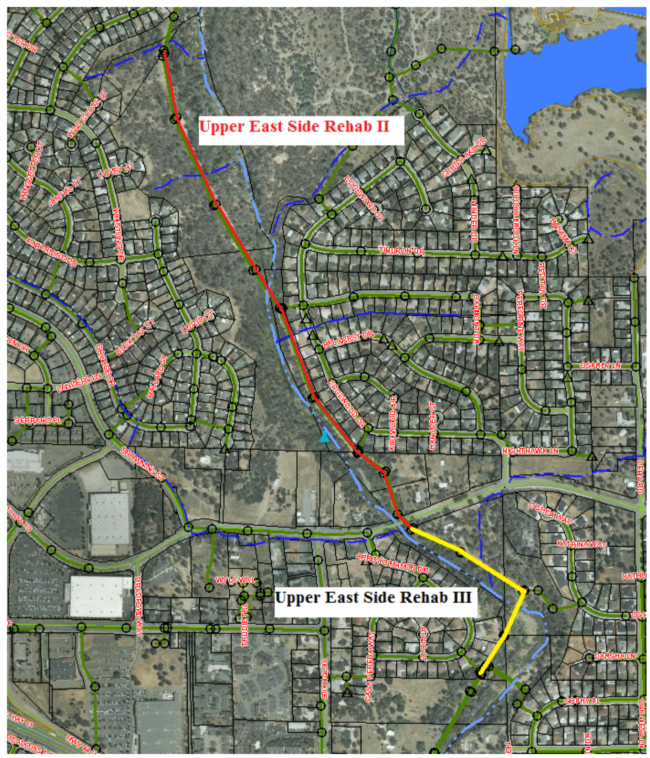


Figure 6.28 - Upper Ease Side Rehab Phase II and III



Primary Growth Area

To serve the portion of Stillwater Drainage Area within the City of Redding General Plan Primary Growth Area additional demands ,both domestic and I&I, were added to the hydraulic analysis in the same manner as the City Limits analysis discussed in the previous section. The additional SSA and demand information is provided in Table 6.7. Following the analysis and evaluation of the results it was determined that improvements required to serve the City Limits were adequate to also serve the primary growth area, that no additional projects would be necessary on the large diameter interceptors adjacent to Churn and Clover Creeks.

Secondary Growth Area

The City of Redding General Plan Secondary Growth area in the Stillwater Drainage Area does not have nearly the density of the other two areas being considered. This means that the domestic demand will be expected to be fairly low, while the wet weather peaking factor will likely be higher as there is more length of pipe required per service connection. Additional demands were added to the analysis as previously discussed representing projected development in the Secondary Growth Area. Additional SSAs and associated demands are listed in Table 6.8.

Following evaluation of the results of the hydraulic analysis it was determined that additional length of rehabilitated parallel East Side Interceptor will need to be put back into service. The length and man holes associated with that additional rehabilitation project are identified on Table 6.6 with the footnote (c) in the first column.

Upper East Side Rehabilitation III (P-S-19)

Upper East Side Rehabilitation III is included in the description of Upper East Side Rehabilitation II and is depicted on Figure 6.28.

Churn Creek Lift Station

In addition to improvements to the pipes conveying sewer, increased capacity is required at Churn Creek Lift Station in order to accommodate increased demands associated with Stillwater Creek Drainage Area. Churn Creek Lift Station is currently being upgraded from a capacity of 8.4 mgd to 12.0 mgd through a combination of upgrades to controls and pumps. Ultimate flows from serving City Limits, primary and secondary general plan areas east of the existing collection system will require an additional 3.5 mgd capacity. At 12 mgd peak flow rate the existing force main is at capacity so any future expansion will also include construction of a new parallel force main. The project would include increased pump, wet well and force main capacity.

Churn Creek LS - Churn Creek Lift Station appears to be adequate through the 2030 planning horizon without consideration of pumping from the Stillwater Creek Drainage Area. However should pumping be allowed to convey sewer from that area, additional capacity will be needed. The increment of additional peak flow expected by adding service to the additional planning zones is 2.16 mgd for City Limits, 0.97 mgd more for Primary Growth Area and 0.77 more for Secondary growth area. Table 6.5 shows the impact of adding the different development areas to forecast peak flows at the different planning horizons. Grey areas of the table reflect scenarios where increased capacity is required. The first result that is important to mention is that in 2030 the lift station is almost at capacity (12 mgd) without pumping anything from the Stillwater Creek Drainage Area. Therefore any plan to allow pumping sewer from the Stillwater Creek Drainage Area would need to include a component for increasing capacity at the Churn Creek Lift Station. If such a plan is not implemented development elsewhere in the existing collection system may not be able to occur without improving the lift station capacity.

Churn Creek Lift Station is currently being upgraded from a capacity of 8.4 mgd to 12.0 mgd through a combination of upgrades to controls and pumps. Ultimate flows from serving City Limits, primary and secondary general plan areas east of the existing collection system will require an additional 3.5 mgd capacity. At 12 mgd peak flow rate the existing force main is at capacity so any future expansion will also include construction of a new parallel force main. The project would include increased pump, wet well and force main capacity.

Table 6.6 - Churn Creek LS Demands, mgd

	Development Scenario			
Planning Horizon	Existing	With City Limits	With CL & Primary	With CL, Primary & Secondary
2010	8.41	10.57	11.54	12.31
2015	8.89	11.05	12.02	12.79
2020	10.18	12.34	13.31	14.08
2030	11.50	13.66	14.63	15.40

CL - City Limits

Table 6.7 - City Limit Sewer Allocation in Stillwater Creek Drainage Area

SSA Designation	Percent of SSA	Additional HEs	Additional Area, ac
S9	50	97.6	121.1
215	100	297.4	153.6
S14	50	83.0	61.6
S25	20	40.7	46.9
S29	90	122.4	145.4
S30	40	1.6	97.2
S31	40	105.4	35.4
S33	80	142.6	131.8
S32	100	198.6	102.7
S39A	100	273.6	137.3
S39B	100	649.0	148.1
S42A	100	346.0	65.6
S43	30	19.6	40.7
S42B	60	232.9	141.1
S64	100	95.6	151.3
S73	50	16.9	148.0
	Total	2722.9	1697.8

Table 6.8 - New Service Area Projects

		Manhole Number			Recommended Diameter, in			Cost Split, % (a)		Total Lengths of each Diameter, ft							
Project Name	Tag No.	Upstream	Downstream	Length, ft	Existing	UBO	UBO(2)	Rates	Fees	12"	15"	18"	21"	24"	27"	30"	36"
Oasis Road Phase II	P-S-12	NY10-2	NY9-2	508	10	10	12		100	508							
		NY9-2	NZ9-12	407	10	15	15				407						
Salt Creek	P-S-13	A9-2	A9-1	632	15	15	21		100				632				
Hawley Road	P-S-14	B9-1	C10-4	732	21	21	24		100					732			
		C10-4	C10-3	582	18	18	21						582				
Palacio	P-S-15	F10-9	F11-4	714	27	27	36		100								714
		F11-4	F11-3	645	24	24	36										645
Boulder Elementary	P-S-16	G11-26	G11-29	206	24	24	30		100							206	
		G11-29	G11-25	277	24	24	30									277	
Edgewood	P-S-17	H11-43	H11-42	539	27	27	36		100								539
		H11-42	H11-41	35	27	27	36										35
		H11-41	H11-40	443	27	27	30									443	
		H11-40	H11-39	709	27	27	30									709	
		H11-39	H11-38	559	27	27	36										559
		H11-38	J11-69	301	30	30	36										301
The following pipe segments are associated with reactivation and rehabilitation of the old East Side Interceptor which is still in place as a collector																	
Upper East Side Rehab	P-S-18	G11-28	G11-4	35	New Pipe		18		100			35					
		G11-4	G11-2	304		Rehab						304					
		G11-2	G11-1	335		Rehab					335						
		G11-1	G11-9	569		Rehab									569		
Upper East Side Rehab II	P-S-19	H11-42	H11-45	30	New Pipe		18		100			30					
		H11-45	H11-3	446		Rehab					446						
		H11-3	H11-2	699		Rehab					699						
		H11-2	H11-1	554		Rehab					554						
		H11-1	J11-1	344		Rehab						344					
		J11-1	J11-2	687		Rehab						687					
		J11-2	J11-3	511		Rehab						511					
		J11-3	J11-4	246		Rehab						246					
		J11-4	J11-4B	323		Rehab						323					
		J11-4B	J11-5	150		Rehab						150					
Upper East Side Rehab III (c)	P-S-20	J11-5	K11-62	391		Rehab						391					
(c)		K11-62	K11-2	544		Rehab						544					
(c)		K11-2	K11-3	362		Rehab						362					
(c)		K11-3	K11-40	245		Rehab							245				
(c)		K11-40	K11-7	80		Rehab							80				
(c)		K11-7	K11-4 (b)	150		Rehab							150				
							Total Replacement Length, ft:			508	407	65	1214	732		1635	2793
							Total Rehab Length, ft:				2034	3927	475		569		

(a) Projects are recommended for development of new service east of the existing collection system, cost is impact fee and potentially Special Benefit District.
(b) Hydraulic analysis reflects that the collection/conveyance system downstream of this point is adequate in the single upgrade pipe to the East Side Interceptor. However, it may be desirable to continue rehabilitation effort for the remainder of the downstream original parallel interceptor to provide both redundancy and to build in additional capacity.
(c) These sections of pipe are called for to accommodate development of the secondary growth area.
n/a not applicable

Table 6.9 - Service Areas and Demands for Primary Growth Area

SSA Designation	Percent of SSA	Additional HEs	Additional Area, ac
S14	50	83.0	61.5
S19	100	5.9	101.2
S18	100	24.1	184.0
S25	80	162.9	187.0
S30	70	2.9	118.0
S31	50	131.8	44.0
S33	25	44.5	33.0
S43	60	39.2	82.0
S42B	40	155.2	94.0
S46	30	3.8	63.9
E39	80	40.9	126.0
S61	75	0.6	82.0
	Total:	694.8	1176.6

Table 6.10 - Service areas and demands for Secondary Growth Area

SSA Designation	Percent of SSA	Additional HEs	Additional Area, ac
S24	100	6.4	227.0
S26	100	34.0	227.0
S27	100	22.3	197.0
S40	100	5.2	230.0
S43	40	6.5	54.4
S42B	10	38.8	23.5
S46	70	8.8	148.0
S50	50	44.3	117.5
	Total:	166.3	1224.4

CHAPTER 7
Collection System Condition Assessment

7.1 INTRODUCTION

This Chapter presents the results from the condition assessment conducted as part of this study. A typical comprehensive condition assessment of the collection system would include characterization of defects, identifying deficiencies, evaluating pipe age, evaluating capacity, obtaining City O&M staff input and prioritizing the rehabilitation and replacement needs.

Hydraulic capacity and maintenance issues were evaluated in the previous two chapters and prioritizing the rehabilitation needs will be covered in Chapter 9 - Capital Improvement Plan. During the data collection phase of this study it was discovered that the existing pipe defect database had been discarded due to systematic and frequent erroneous data collection. The only remaining information for which to base condition assessment on is pipe age and material.

7.2 COLLECTION SYSTEM SIZE AND MATERIAL

The City Wastewater Collection System consists primarily of six and eight inch diameter pipe (77%) and either ABS, PVC or VCP pipes (88%). Table 7.1 presents the breakdown of pipe diameters and materials. Figures 7.1 and 7.2 are graphical representations of the primary pipe sizes and materials.

Table 7.1 - Breakdown of Gravity Pipe diameter and material, ft

Diameter, in	Pipe Type									
	ABS	AC	CIP	DI	PVC	RCP	STL	VCP	Totals	Percent
3					422				422	0.0
4				26				124	150	0.0
6	45181	81275	238	225	17951	2703	40	328976	476590	21.7
8	560990	27624	736	1121	333770	1237	183	279955	121561	55.3
10	27412	8285		88	30025			53305	119115	5.4
12	46957	7028	230		392	263		40233	95104	4.3
15	5261	7965	147		1232		385	45744	60734	2.8
16				3773	3357				7130	0.3
18	1664	2258			529			34168	38619	1.8
20					802				802	0.0
21					660	1693		19478	21831	1.0
22							544		544	0.0
24					2773			16811	19583	0.9
27						3646		10874	14521	0.7
30				696		2044		14279	17019	0.8
33								7358	7358	0.3
36				327	83	445		11339	12194	0.6
39						7527		3156	10683	0.5
42						38803		191	38994	1.8
45						6693			6693	0.3
48						24425			24425	1.1
54						8650			8650	0.4
Total, ft	687466	144434	1351	6256	391996	98130	1152	865991	219677	
Percent	31.3	6.6	0.1	0.3	17.8	4.5	0.1	39.4		
										Total: 416 Miles

Figure 7.1 - Pipe Size Distribution

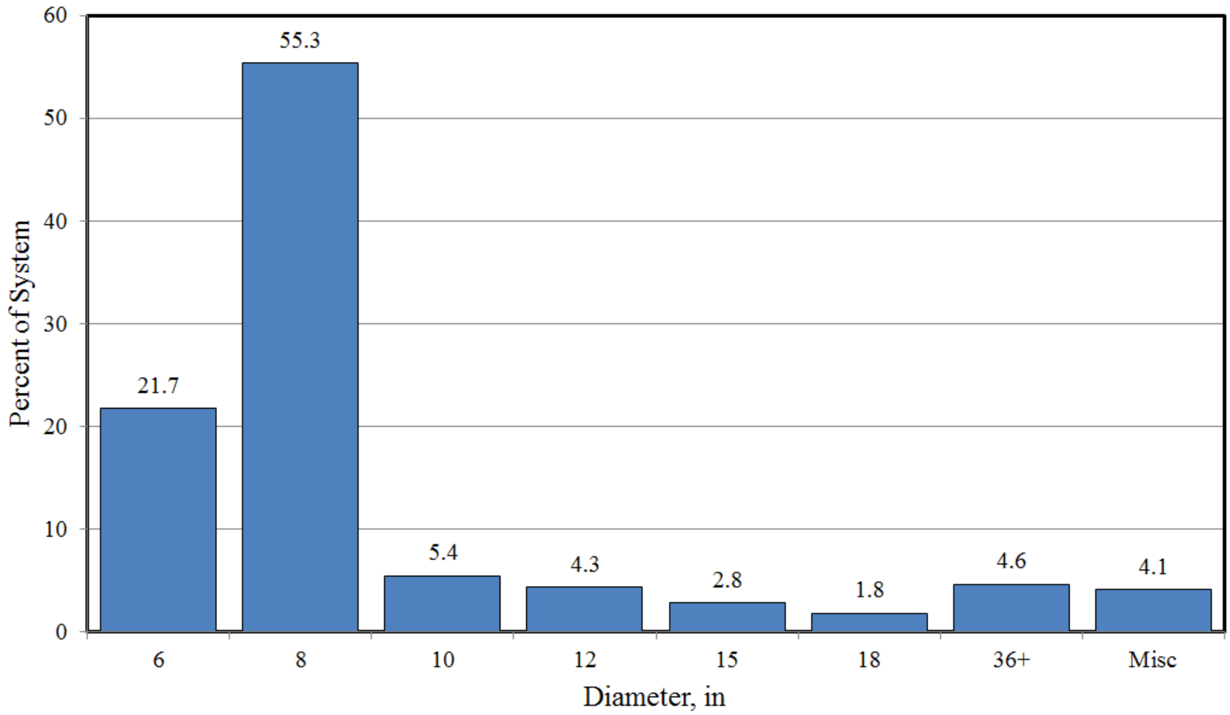
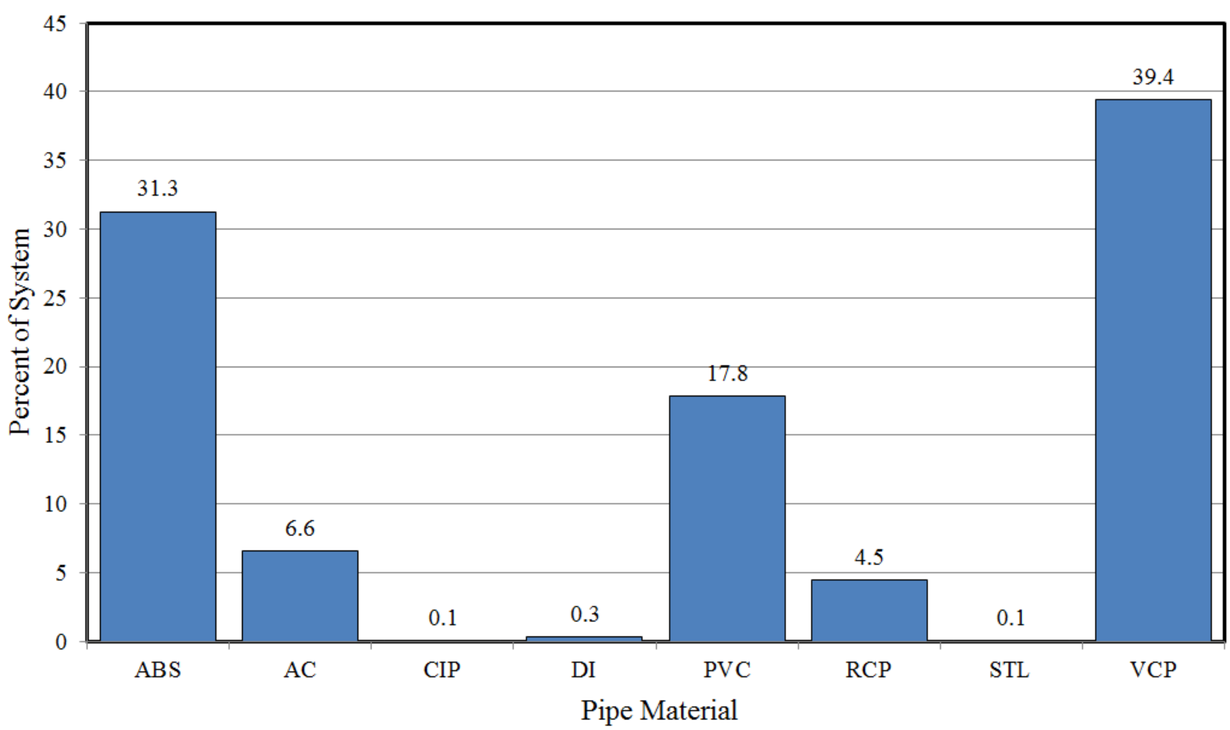


Figure 7.2 - Pipe Material Distribution



7.3 COLLECTION SYSTEM AGE

Collection system pipe age was determined by correlating pipe segments with dates of record drawings. This process left approximately 25% of the pipe network with unknown age. It is likely that much of the pipe without an identified date is older pipe. Figure 7.3 shows the city wide pipe age exceedance curve of the pipes with known age. Table 7.2 presents the breakdown of major pipe materials and age.

Figure 7.1 - Pipe Age Exceedance

Table 7.2 - Pipe age by material, feet

Material	Age, Years		
	0 to 30	30 to 60	Older than 60
ABS	598095	89371	
AC	5777	134324	4333
DI	4629	1627	
PVC	372396	19600	
RCP	29439	62803	5888
VCP	17398	62634	6959

7.4 LIFT STATIONS

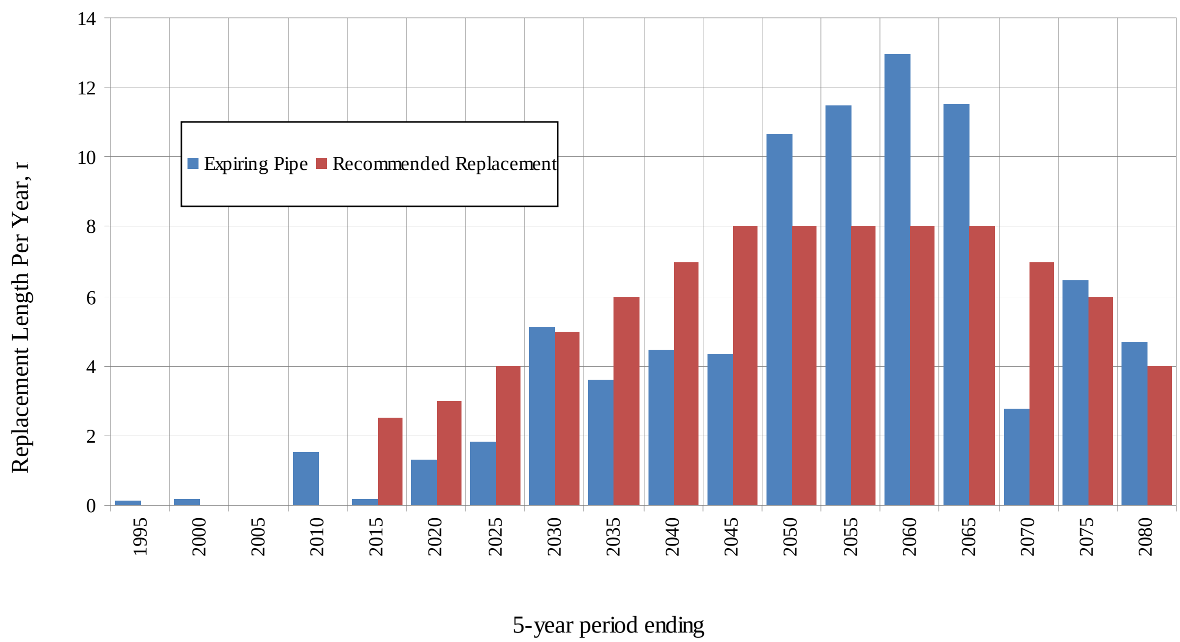
The City operates 15 wastewater lift stations constructed between 1961 and 2009. Many of the lift stations have had substantial upgrades or reconstruction projects in the last several years. Lift stations considered new because of recent or pending construction include Mary Street, Auditorium, Stillwater BP, Churn Creek, Layton, and North Market Street. The oldest lift station is Locust Street Lift Station which was constructed in 1961. Tables 5.2 - Clear Creek Collection System Lift Station Data and Table 6.2 Stillwater Collection System Lift Station Data present characteristics of each lift station.

Rebuilding or replacing of pumps is part of routine maintenance on lift stations and occurs on a periodic basis.

7.5 EVALUATION AND RECOMMENDATIONS

Sewer pipe service life varies greatly with pipe material, quality of construction, and type of soils. Both plastic and VCP pipes have reported lifespan of up to 100 years. AC pipe appears to be the most vulnerable from an age perspective. Recommendations of this effort are based on an average pipe lifespan of 70 years. Given the age breakdown of pipes and a replacement age threshold, a replacement schedule can be projected. Figure 7.4 shows the rate of expiring and recommended replacement for wastewater collection system pipes broken down into five year increments. Table 7.3 shows the recommended schedule of aging pipe replacement.

Figure 7.4 - Expiring and Recommended Pipe Replacement Rates



It is also recommended that the process of developing a pipe defect database be continued and that a procedure be defined for prioritizing pipe replacement projects based, at a minimum, on both condition and age.

Table 7.3 - Recommended Aging Pipe Replacement Schedule

Time Period	Length of Replacement, miles per year
2012-2014	2.5
2015-2019	3
2020-2024	4
2025-2029	5

CHAPTER 8
Inflow and Infiltration Reduction

8.1 INTRODUCTION

The primary purpose of a sanitary sewer system is to collect and convey wastewater from the source to a wastewater treatment facility or to its point of discharge. Physical integrity of a sewer system may deteriorate with time due to such factors as deficient construction, physical defects, illicit connections, root penetration, poorly adjusted manholes, corrosion due to biochemical reactions, soil conditions and aggressive ground waters. The result may be an increase in flows to be conveyed and treated through the entry of groundwater and rainwater into the sanitary sewer system. Increasing the hydraulic load on the sewer system can have numerous detrimental consequences: reduced available capacity of the system to convey and treat wastewater, increased operating costs, and the potential for sewer backups and overflows.

8.2 BACKGROUND

Inflow and Infiltration portions of the sewer flows have been studied by the City of Redding in prior Master Plan efforts and as an alternative to construction of the West Side Interceptor. The 1987 Master Sewer Plan indicates that in the early 1980's I/I reduction efforts resulted in substantial reductions in the I/I received at the Clear Creek WWTP. The reduction was from a peaking factor (PWWF/ADWF) of approximately 10:1 to 6:1 with an expectation that the ultimate condition ratio would be 4:1. The report also concluded that utilizing standard sewer pipe I/I reduction methods in attempt to attain a peaking factor lower than 4:1 would not be as productive as a program to eliminate I/I associated with private laterals.

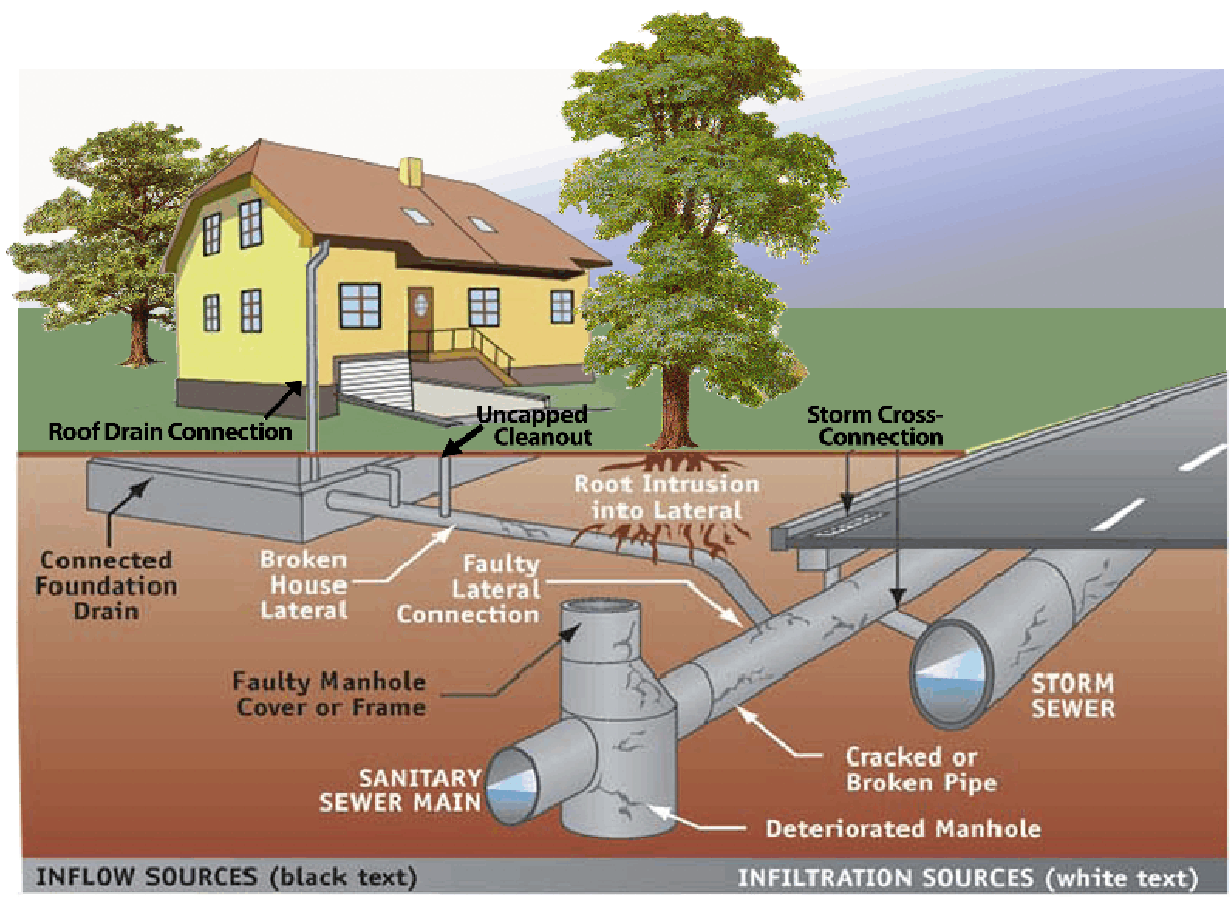
In 1999 the City received the Westside Interceptor Project Development Report (PDR) which studied RDI/I reduction as an alternative to construction of the Westside Interceptor. In that effort, data from eighteen monitoring stations was tabulated for inflow recorded during events between 1992 and 1995. Table VI-2 of that report indicates that portions of the downtown Redding area and two areas in east Redding have RDI/I rates ranging from 3699 to 27297 gpad. The report lacks specific detail on how the data was collected but it is likely that the readings were instantaneous readings taken near peak flows of each event. With this in mind the unit infiltration rates listed, which are up to an order of magnitude higher than any prior study, must represent peak instantaneous unit flow rates not daily wet weather inflow and should not be interpreted literally as the volume entering the system per acre per day. In fact further investigation of the amount of precipitation recorded on the days of the monitoring discovered that if interpreted as daily wet weather inflow an average of 28% of the entire storm precipitation falling would need to enter the collection system to reach the tabulated values. If interpreted literally, one monitoring station listed would have received over 200% of the recorded rainfall volume for that entire day over the entire sewershed. No information was provided in the study regarding intensity of rainfall during the various monitoring events. In addition, summing of the I/I recorded to 16.3 MGD is not meaningful because the monitoring events were from months where the maximum daily rainfall ranged from 0.43 inched to 4.88 inches. The summation also implies that the instantaneous readings reflect a total volume of inflow or that the contribution to the treatment plant would be 16.3 mgd which would not be the case simply because of timing of entering the system and routing of flows in over five miles of interceptor. With all this in mind, the information may still be useful in a comparative manner to evaluate which areas are more problematic than others with the exception of areas collecting to MS 18 and 22 where the maximum daily rainfall in the month identified was only 0.43inches.

The 2003 Wastewater Utility Master Plan utilized data from the 1999 Westside Interceptor Project Design Report (PDR) and reduced the effort, changed some of the collection area boundaries and made recommendations based on the prioritization of that plan. No additional monitoring or analysis appears to have been performed.

Since the 2003 Wastewater Utility Master Plan over $14 million has been spent on improvements to the collection system addressing various I/I aspects. Many of the projects were replacement of aging and deteriorating pipes deemed to be I/I problems. Over the past decade, many of the obvious problem pipes have been addressed leaving the areas or pipe networks that are more area wide in nature and more difficult to address with a focused effort.

It is the intent of the following sections to outline an organized approach to systematically address I/I. Figure 8.1 shows potential sources of both Inflow and Infiltration.

Figure 8.1 - I/I source Diagram



8.3 FLOW MONITORING PLAN

The wastewater utility currently operates 16 mobile monitoring stations in addition to flow monitors at 9 of the lift stations. The budget for the next two years also includes purchase of 2 more monitoring stations to expand the monitoring network. Manual monitoring using dippers is no longer performed in the City of Redding.

Unfortunately the data from prior monitoring efforts is not available and many of the technical documents derived from the data lacked significant information regarding quality of or quality control on the data. This leaves the City in the position of initiating an organized monitoring plan to identify areas of high I/I and prioritize efforts to eliminate excessive quantities. While the plan is being implemented, the areas identified in prior studies with the highest I/I rates should be the focus of reduction efforts. To provide an organized, focused effort for monitoring the following program is recommend.

8.3.1 Objectives

The objectives of the flow-monitoring program are as follows:

- Collect representative dry and wet weather flow data for the targeted sewer basins(s)
- Observe and quantify dry weather flow
- Observe and quantify dry weather infiltration
- Quantify rainfall derived inflow and infiltration (RDI/I) volumes
- Correlate RDI/I with rainfall volumes and intensities
- Determine and assist in prioritizing basins
- Observe and quantify potential wet-weather, non-storm related inflow (e.g. manholes located in low-lying areas which may be inundated during average creek flows)

The scope of the flow-monitoring program should be developed to ensure data collection is adequate to meet the program objectives.

8.3.2 Site Selection and Basin Delineation

Selection of flow monitor location sites is critical to defining sewer basins. Flow meter sites need to be selected so that the entire flow for the area of interest can be characterized. This may require multiple meters for areas with parallel sewers or complex connectivity. Metering sites should also be considered at boundary points for calibration and validation of hydraulic model(s). Meter sites need to be compatible with the minimum requirements of the flow monitoring equipment manufacturer relative to physical site constraints.

Sewer basin delineation can be accomplished through the use of sewer mapping. It is important that the monitor locations are strategically selected to provide an adequate delineation of sanitary sewer system basins.

8.3.3 Acceptable Flow Measures and Recording

Equipment may consist of one or more of the following: Supervisory Control And Data Acquisition (SCADA) data (pump run times, discharge pressure and volumetric data) capable of computing flow, or monitoring flow in force mains. Flow monitoring equipment needs to include a data logger, communication device and sensing unit. Where pressure pipe flow monitoring is to be performed for pump discharge flow measurements, magnetic flow meters or ultrasonic meters should be used. Where flow is measured in force mains, pressure measurements need to be recorded. All gravity sewer metering equipment needs to be capable of recording in both low flow and surcharged conditions for wet weather monitoring. The City must utilize engineering judgement in the selection of flow monitoring methods and the application of the resulting data.

Strengths and limitations for each flow monitoring method will be evaluated considering characteristics of the flow to be measured and the location to be monitored. Note that the pump station volumetric method of determining flow rate is not reliable for conditions where wet well levels surcharge into the incoming sewer lines, or where variable frequency drive units are in place, unless other metering is used to account for flows being discharged from or entering the pump station. Pump curves and system curves need to be verified when using this methodology to estimate flow rates. Caution should be exercised in application of this methodology. It is most appropriate for pump or lift stations with constant speed pumps that discharge to gravity sewers.

8.3.4 Duration of Flow Monitoring

For the purpose of defining the various dry weather flow components, the minimum recording period will include the months of July, August and September at all recording locations. This data will also be important for hydraulic model calibration and verification.

Wet weather flow monitoring will be conducted for a duration that satisfies the following minimum criteria:

Flow Monitoring for Model Calibration and Verification:

- Flow monitoring will provide data that characterizes seasonal variations and captures the peak seasonal sanitary sewer flows
- Flow monitoring will record three (3) individual wet-weather flow events of greater than one (1) inch of precipitation, including at least one (1) event with at least a two-year recurrence interval. These events will capture system response under a variety of antecedent rainfall and groundwater conditions
- Flow monitoring will continue for sufficient time between rain events for the flow to return to dry weather conditions

Flow Monitoring for Identification of Basins with Excessive RDI/I:

- Flow monitoring period will be of sufficient length to capture typical diurnal variations in dry-weather flow, including weekends and weekdays.
- Flow monitoring will capture three individual wet-weather events, each of which provide a system flow response, including a rainfall event representative of those with a two-year rainfall recurrence interval, or at least six months if the two-year recurrence interval is not achieved provided that there is at least one event where the total 24-hour rainfall exceeds 1.5 inches.
- Flow monitoring will be conducted during a period that provides the highest probability of wet conditions.

Flow monitoring for identification of basins with excessive RDI/I and hydraulic model calibration and verification will be conducted at a minimum of 20 percent of the pump station service areas within City's sanitary sewer system. Selection of locations for flow monitoring will consider the following:

- The average age of the gravity sewers in the sewer basin
- Pipe material and joint type
- Soil-type and porosity

- Maximum, minimum and yearly groundwater elevations
- Proximity to surface water bodies
- Ratio of pervious to non-pervious surface area
- Service area size
- Land use
- Historic I/I data
- Seasonal population patterns.

Additional flow monitoring beyond the 20 percent will be conducted as necessary to accurately characterize flows.

Flow monitoring data will be reviewed for conformance with the criteria for model calibration and verification, as well as for identification of excessive RDI/I basins. If the review of the monitoring data indicates the criteria have been satisfied, temporary metering can be discontinued. Otherwise flow monitoring will continue until adequate data are obtained.

8.3.5 Data Accuracy Specifications

Flow monitoring accuracies will be based on typical accuracies for the type of equipment used. Flow meters will monitor flow between sample periods and provide maximum and minimum values at 15-minute intervals.

Prior to installation of any meter and/or gauge, the device shall be calibrated according to manufacturer's recommendations. At least once every monitoring season thereafter, prior to the wet weather season, the device calibrations will be verified and the device re-calibrated if the recording has drifted in excess of ten percent (10%) above or below the expected outcome.

Calibration records will be included in the flow evaluation report to demonstrate that the equipment was properly calibrated. Any re-calibration required during the monitoring period shall be noted and also included in the report. The meters should be maintained in a manner that shall provide for a minimum:

- Seventy-five (75%) data reliability for each individual meter during a monthly monitoring program.
- Ninety percent (90%) for all meter data should be maintained during qualifying rain events.

Following completion of any flow monitoring period, the calibration of each flow meter will be verified. Data from meters that show variation in excess of ten percent (10%) above or below calibration levels shall be disqualified and the monitoring effort repeated.

Data reliability means the percentage of flow data that has been collected and is not obviously incorrect (i.e., float lines, drifting from known calibration levels, incorrect time or date stamps, low voltage indications, etc.).

8.3.6 Rainfall Monitoring

Rainfall monitoring will be done to obtain the data needed to compare wet weather sewer flow to corresponding rainfall volume, duration and intensity. The relationship between peak sewer flow and rainfall will be used during the evaluation of the sewer system's performance and the prediction of rainfall derived inflow/infiltration (RDI/I). Rainfall gauges will be of the continuous recording type, and store data in 15-minute increments. Rain gauges will be distributed throughout the area covered by the sanitary sewer system at a minimum of every 10 square miles. The density should provide reasonable coverage and representation of variations in rainfall intensity, duration and accumulation throughout the sewer system. Rainfall gauges will be capable of recording rainfall at 0.1-inch intervals or less.

Rain gauge data can be supplemented by data from gauges maintained by other entities such as National Oceanic and Atmospheric Administration (NOAA), United States Bureau of Reclamation (USBR), or Unitied States Geologic Survey (USGS).

8.3.7 Ground Water Monitoring

Ground water level data will be used, where available, to establish the potential for ground water infiltration to the sewer system. Groundwater data can be used in conjunction with flow data to analyze infiltration based on the relationship between the groundwater table level and the elevation of the sewers.

8.4 FLOW MONITORING IMPLEMENTATION

Sewer flow monitoring information will be used to characterize the performance of the sanitary sewer system during dry and wet weather flow conditions and to characterize the flow conditions that cause surcharging and/or overflows within the system.

8.4.1 Data Collection

Sewer flow, force main pressure, and rainfall information will be collected (downloaded) at periodic intervals for the duration of the monitoring period. In cases where area-velocity meters are used to monitor flow in gravity sewers, a site visit after each major storm event is advisable to confirm meter conditions and to download the meter data. Duration of recording prior to downloading the data will not exceed fifty percent (50%) of the manufacturer's recommended maximum battery life expectation.

Electronic collection and transmission of the data for both flow monitoring and rainfall records is required.

8.4.2 Data Summaries

Flow data summaries to be included in the flow evaluation report will present the flow data and observed flow conditions supported by graphical and tabular presentations of flow in the context of the rain events. Each summary will include the following information:

- A graphical time-series plot (hydrograph) of flow rate vs. time data, as well as associated recorded rainfall data, will be presented for each specific flow monitoring method below.
- A tabulation of daily average, maximum, minimum, and peak hour flow rate recorded during the flow-monitoring period will be presented. Tabulation will include all necessary parameters to verify results regardless of whether the meter is a velocity/area device or a volumetric flow calculation from wet well levels.
- Calibration and verification data for each device.
- Maintenance records for each device.
- Installation report including a summary of the installation details associated with each meter location, including a sketch of the manhole, wet well and/or force main configuration details and identifying related installation information.
- A rainfall analysis that estimates the rainfall recurrence interval for significant rainfall events.

8.4.3 Storage Format

The metered data will be stored in an open data format that can easily be accessed in an ODBC (Open data base connectivity) compliant format. Data for each meter should be uniquely identified and will be distinguishable from the data from other meters. Further, the data will be labeled and stored in a manner that will allow ease of site location identification and determination of the dates on which the data were collected.

8.4.4 Instrument Maintenance

Instrument operation will be checked periodically at or exceeding manufacturer's recommendations. Problems with any instrument will be corrected as soon as possible to sustain data collection at the highest level. Any corrective action for any instrument will be documented and included in that instruments maintenance record and subsequently in the data summary.

8.5 SEWER FLOW EVALUATION

The primary objectives of the flow evaluation are to characterize sewer flow under a range of hydrologic conditions, quantify peak flow for the purposes of identifying basins with RDI/I problem, and to develop the hydrographs needed to calibrate a hydraulic model. The sewer flow evaluation will include quantification of base sewage flow, dry weather infiltration (DWI) and rainfall-derived inflow/infiltration (RDI/I). Details of the procedures for sewer flow evaluation are included in section 8.7.

8.6 BASIN PRIORITIZATION

In development of a plan to address excessive RDI/I results from sewer flow monitoring and other relevant information, including SSO characterization need to be considered. The plan will identify basins; the activities to be performed in those basins; and a schedule for conducting the work. Basins will be selected based on the criteria presented in the following sections in conjunction with utility personnel knowledge of the system.

8.6.1 Basin Criteria

Sewer basins that are known or suspected of meeting the following criteria will be included in the RDI/I reduction plan:

- Basins with unresolved wet-weather SSOs, except where SSOs have only resulted during rainfall conditions in excess of a 10-year, 24-hour rainfall recurrence interval.
- Basins with unresolved SSOs caused by infrastructure defects (pipe sags, offset joints, broken pipe, etc.)
- Basins exceeding an actual peak flow of 755 gallons per day per HE plus 3 times commercial water consumption plus actual major industrial flows, where this peak flow is estimated to occur during rainfall conditions up to a 10-year, 24-hour rainfall recurrence interval.
- Basins served by pump stations exhibiting excessive pump run time.

8.6.2 RDI/I Plan Development

A RDI/I reduction plan will be developed to meet the following objectives:

- Identify and prioritize basins for investigation
- Establish baseline estimates of I/I
- Select the detailed approach to provide sufficient information for condition assessment activities including hydraulic, corrosion and structural investigation
- Coordinate improvements to records and mapping that may be needed

- Establish a schedule of activities

Prioritization of basins for investigation will be based on the following:

- An initial estimate of potential volume of I/I reduction in each basing (i.e., gallons per day)
- The number and severity of SSOs that occur within the basins
- Historical information about the system such as number of repairs and operation and maintenance history (including pump stations and force mains).

The typical approach to detailed investigations is to perform preliminary evaluations as a basis for ascertaining the need for further detailed field investigations. For example, when the case can be clearly identified for replacement of certain reaches of sewer mains based on initial field reconnaissance, supplemental field investigations may not be cost effective or necessary. Conversely, there may be cases where the cost of further detailed investigations can potentially result in project cost savings through better defining the required scope of upgrade work.

Information from the field investigations is used to evaluate sanitary sewer system conditions. Field investigations of gravity sanitary sewer systems may include:

- Manhole Inspections
- CCTV Inspections
- Smoke Testing
- Dye Testing
- Night Flow Isolation

Manhole Inspections: One of the most useful methods to determine sanitary sewer system condition is to perform and document inspections of manholes. Manholes have the potential to allow significant quantities of I/I into the sanitary sewer system (such as when manhole lids are lower than the surrounding surface and drain storm water from streets during wet weather). Manhole inspections can also provide indication of surcharged conditions in mainline sewers. Manhole inspections should be conducted to obtain information on manhole conditions and to observe sewer flow conditions, including indications of unacceptable surcharging. Manhole inspections will be conducted in all suspect excessive RDI/I basins. Manhole inspections will be conducted in accordance with National Association of Sewer Service Companies (NASSCO) standards.

In conjunction with manhole inspection activities, manholes and cleanouts in areas subject to flooding, ponding, or submerged conditions should be observed and noted. It should be noted if the cleanout is broken or if the manhole cover allows ponded water to enter the manhole.

A topside (or non-entry) manhole inspection should be conducted to determine overall structural condition of the manhole. The surrounding area should be observed and noted if the manhole is located in an area that is conducive to flooding over the top of the manhole. Manholes found to be surcharged may need to be re-inspected during a lower flow period. If a topside manhole observation provides evidence of the manhole being a significant I/I source, an internal manhole observation (i.e., pole camera or manhole entry) should be made to specifically determine what defects exist in the manhole and its connecting pipes. This information should be used to determine what corrective measures will be needed to correct the observed deficiencies.

CCTV Inspections: Closed Circuit Television (CCTV) inspection should be used to assess the condition of sewer lines by identifying structural problems, points of inflow and infiltration, capacity issues, and system blockages. The data collected should be compatible with and easily integrated by the Utilities' Information

Management System (IMS). The CCTV inspection will be conducted and recorded in accordance with the NASSCO Pipeline Assessement And Certification Program (PACP) standards.

Smoke Testing: Smoke and/or dye testing should be conducted as part of the evaluations in areas that are supsected to have inflow problems. Limited CCTV inspections should be used in conjunction with smoke testing to verify the location of cross connections and inflow sources that are identified.

Smoke testing will be carried out in conformance with widely used industry guidance such as EPA Handbook 625/6-01-030 "*Sewer System Infrastructure Analysis and Rehabilitation*" Section 4.3.6, and WEF Manual of Practice FD-6 "*Existing Sewer Evaluation and Rehabilitation*".

The entire section being tested should be visually inspected by walking along the route of the sewer line watching for smoke leaks. The location of smoke leaks should be marked, noted, numbered and photographed. The photograph number corresponding to each leak should be noted. Cleanouts and failures that are observed to produce smoke should also be noted if they are in an area subject to flooding.

Dye Testing: Dyed water testing may be used to verify connectivity, direction of flow, sources of I/I, as well as illicit connections to the system. Dye testing may be used to complement smoke testing to verify these sources.

Prior to dye testing the line to be tested should be cleaned. The downstream manhole should be monitored to observe if dyed water passes throughout the system and the estimated quantity noted. If sufficient dye water passes through the downstream manhole, a CCTV inspection may be performed to identify the location and magnitude of the source flow.

Night Flow Isolation: Nighttime flow isolations may be used to trace sources of infiltration. Night flow isolations may be used to locate and quantify the amount of infiltration entering a sewer system. Night flow isolations are typically performed to narrow down and identify reaches that have excessive infiltration that can be pinpointed for further investigations.

Night flow isolations typically are performed during low flow periods, between the hours of midnight and 6 AM. The flow measurement should be conducted with a weir structure that is suitable for the size pipe being isolated. The upstream reaches should be plugged, whenever flow conditions warrant, to provide a quantification of infiltration in each reach of line. When flow conditions do not allow for plugging, differential measurements should be used upstream and downstream for the section of pipe being investigated. Any known sewage flows that contribute flow normally under nighttime conditions in the line under investigation should be noted for the section of line under investigation.

A minimum investigative program in all basins with excessive I/I will include pump station evaluation, manhole inspections, and determination of critical inspection areas. At a minimum, basins that exhibit wet weather flows in excess of the peak flow threshold will be evaluated using smoke testing, and all gravity sewer locations that have identified unresolved dry weather overflows will be investigated with CCTV.

8.6.3 Identification of Areas for Inspection

Basins with excessive I/I will be selected based on the criteria established in Section 8.6.1 and best available information about the system. These areas need to be uniquely identifiable to track effort activities and for ease of reference. Each basin will be inventoried to identify the specific facilities that will be investigated and scope of the investigation. Verification of the system connectivity will also be necessary to trace sources of I/I. This will include mapping of:

- Pipelines
- Manholes
- Pump Stations
- Force Mains
- Valves
- Flow Control Strucutres
- Stream or Aerial Crossings
- Siphons

Once the areas are identified for I/I reduction activities, priority should be given to basins on at least five (5) criteria. The criteria may be weighted based on relative factors of importance and criticality. Each criterion should have an established weighting and ranking system. SSOs and conditions leading to environmental, public health, or safety risks will be given the highest priority, regardless of the weighting factors that may be applied. The minimum criteria to be considered will include:

- Number and severity of preventable SSOs
- I/I volume
- Peak one hour flow
- Operations and maintenance history
- Sewer basin criticality factors

8.6.4 Implementation Schedule

Implementation of the Flow Monitoring Plan will begin in Fall of 2012 and become a permanent program to pursue reduction of I/I on a continual basis.

In general, the sequence of activities is as follows:

- Review of Existing Information to Characterize SSOs and Identify Data Gaps
- Flow Monitoring Program Development and Implementation
- Assessment of the Monitoring data and formulation of a I/I reduction plan
- Execution of the Plan
- Prompt attention to Severe Defects
- Rehabilitation Planning

8.7 SEWER FLOW EVALUATION

The primary objectives fo the flow evaluation are to characterize sewer flow under a range of hydrologic conditions, quantify peak flow for the purposes of identifying basins with excessive I/I, and to develop the hydrographs needed to calibrate a hydraulic model. The sewer flow evaluation will include quantification of base sewage flow, dry weather infiltration (DWI) and rainfall-derived inflow/infiltration (RDI/I) using the following procedure:

- Separate periods of dry and wet-weather flow with respect to rainfall data
- Establish a typical 24-hour, dry-weather sewer hydrograph
- Estimate DWI by determining average flow rate during off peak hours
- Extract RDI/I by subtracting the dry-weather flow hydrograph from the wet-weather hydrograph for the event or events of interest

8.7.1 Data Analysis

The first step in determining the I/I reduction potential is to quantify the base sewage flow, the DWI and the RDI/I. This is done by compiling and reviewing of historical water consumption records and then comparing the results to the actual wastewater flow meter data collected as previously described. The following sections describe the process for determining each component of the total wastewater flow.

8.7.2 Base Sewage Flow

Water consumption data for the previous two (2) year period will be used for the base sewer flow determination by assuming 100 percent of the metered water consumption is returned to the sanitary sewer system as sewage flow. To minimize the uncertainty and potential overestimation of sewer flow, data should be analyzed for a time frame that would minimize the influence of water consumption for irrigation.

8.7.3 Average Dry Weather Flow (ADWF)

The flow at each flow-monitoring site will be used as the basis for determining dry weather average daily flow (ADWF) for the metered areas and for estimating the dry weather infiltration entering the sewers. In determining the ADWF, days with rainfall (and the following 3 days) are normally to be excluded from the analysis. Dry day flows will be recorded at each monitoring site and averaged to determine the shape fo the average diurnal curve for each metered area. A comparison of average daily flows is suggested to identify anomalies in flow patterns. The diurnal curve for each metered area represents the dry weather ADF and will be used as input to the hydraulic analysis.

8.7.4 Dry Weather Infiltration (DWI)

Dry weather infiltration for each metered area will be estimated by subtracting the base sewage flow from the ADWF. Engineering judgment will be applied in the estimation of DWI.

8.7.5 Rainfall Derived Infiltration/Inflow (RDI/I) Evaluation

Flows occurring during and after rainfall events that are higher than the dry weather diurnal curve represent potential RDI/I. The extraneous flow quantity is estimated by subtracting the measured average daily flow pattern from the wet weather flow quantity (in gallons) for each monitoring site can be divided by the total rainfall accumulation (in gallons) over the metered area to calculate an RDI/I factor, expressed as a percentage of the total accumulated rainfall that entered the sanitary sewer system. This evaluation will be carried out to characterize the volumetric contribution of rainfall to the system for each significant rainfall event captured by flow monitoring.

In addition to estimating the volumetric contribution of rainfall to the sanitary sewer system flow, peak one (1) hour flow will be observed in conjunction with each rainfall event. The peak one (1) hour flow is critical for identifying basins that will require I/I reduction efforts.

The rainfall-derived infiltration can be graphically observed in the receding portion fo the wet weather hydrograph. After the rainfall event has passed and the peak flow response has passed, the slower decline of flow back to normal dry weather conditions may be an indicator of the wet weather infiltration.

8.7.6 Flow Evaluation Report

A summary report will be prepared documenting the: 1) flow monitoring activities performed; 2) flow monitoring data collected; 3) flow analysis conducted; 4) findings; and 5) conclusions. These flow evaluation reports will be used to prioritize basins for I/I reduction efforts.

The evaluation report will include the following information:

TITLE PAGE
- Project Title
- Locality Contact Information

EXECUTIVE SUMMARY

INTRODUCTION

FLOW AND RAINFALL MONITORING METHODOLOGY AND APPROACH
- Use of Existing Data
- Monitoring Site Selection
- Monitoring Equipment Used
- Data Collection Activities
- QA/QC Procedures

MONITORED FLOW CHARACTERIZATION AND ASSESSMENT
- Data Analysis Overview
- Water Usage for Base Flow development
- Dry Weather Flow Analysis
- Dry Weather Infiltration Analysis
- RDI/I and Rainfall Analysis

FINDINGS AND CONCLUSIONS
- Discussion of Findings
- Areas Meeting criteria for I/I reduction efforts

APPENDICES
- Field Data
- System Monitoring location maps
- QA report
- Instrument Calibration Records

8.8 PRIVATE LATERAL I/I REDUCTION

8.8.1 Background

The City’s wastewater system is made up of approximately 416 miles of sewer collection mains that range in size from 6” to 48”. Throughout the City there are approximately 37,500 private sewer laterals that are connected to these sewer mains. Over 90% of these connections come from single family or multi family residential units while the remaining connections are either commercial or industrial sites.

In Redding, as in many cities in the United States, maintenance of sewer laterals is the responsibility of private property owners. The Redding Municipal Code (RMC), Section 14.16.020: Definitions, defines "sewer connection" or "private sewer lateral" as a privately owned and maintained conduit that conveys wastewater from a single premises to a public sewer. The RMC also states that maintenance of sewer connections, whether on public or private property, is the responsibility of the owner of the premises (RMC 14.16.340). Lastly, per Section 14.16.582: Prohibited Discharges, specific pollutants, such as petroleum oil, non-biodegradable cutting oil, dye wastes, radioactive wastes, etc., will not be introduced to the system by any user and this also includes storm water, uncontaminated groundwater, or surface water (Section 14.16.582 B.9.), which is better known as inflow and infiltration (I/I).

Poorly constructed and maintained sewer laterals contribute to the I/I of storm water or groundwater into the City's dedicated sewer system, which can lead to system overflows. The discharge of sewer overflow into private basements and surrounding waterways negatively impacts the environment and public health, and it also violates state and federal regulations. There are several potential sources that contribute to I/I through a private sewer lateral, which include illegally connected foundation drains, roof drains and down spouts, sump pumps, yard drains and clean outs, and bad connections to the sewer main. Private sewer laterals are certainly not the only source of I/I; however, studies have shown that efforts to reduce I/I significantly cannot be effective unless private sewer laterals are addressed. The 2003 Wastewater Utility Master Plan also stated that the replacement of private laterals is considered the most important project to reduce I/I. Unfortunately, property owners have little incentive to maintain leak-free laterals for reasons such as limited financial assistance to cover the costs of lateral maintenance, a lack of education regarding owner responsibilities, and in the absence of a sewer backup, difficulty identifying direct benefits of investing in maintenance.

In many prior wastewater plans the City has been advised that addressing or reducing I/I may be advantageous as a means to minimize SSO's and reduce infrastructure cost. However, arriving with the best solution to address the problem has been challenging and in some cases decisions were made to accept, convey and treat the I/I rather than attempting reduction or elimination programs. Many cities nationwide have also been dealing with the I/I issue and have already completed the first steps in researching and developing long-term programs that will encourage and force private property owners to maintain their sewer connections.

8.8.2 Potential Options for Implementation

Some cities across the United States have already completed the research for potential programs to implement, while others have completed case studies to test different repair methods, and several cities have put into practice a new city ordinance to address private lateral maintenance.

In May 2010, a residential sewer lateral maintenance program analysis was prepared for the City of Milwaukee. This report analyzed three programs: the status quo, an insurance program, and a loan program. The insurance program would require that property owners pay a flat monthly fee and a deductible, if their lateral had to be replaced. The funds generated from the fee increase would serve as a premium to run this program. The mandatory increase of the fee to pay for the program may encourage property owners to participate in the program and take advantage of money they have already invested. The option for a loan program includes a revolving, low interest loan to assist property owners. As loans are repaid, the money would be returned to the revolving loan fund to make additional loans, thus generating capital for administering the program in the future. It is difficult to assess whether the availability of a low interest loan would provide enough incentive for property owners to initiate sewer lateral repairs.

The ultimate recommendation was to implement an insurance program because based on their research it is the most affordable, politically feasible, and effective long term solution to encourage maintenance of the sewer laterals and to ensure the reduction of I/I in the City. As of November 2010 Milwaukee has yet to implement the insurance program, so a evaluation of its effectiveness is not yet available.

The study also looked at different funding mechanisms that could be used to start a private lateral maintenance program. Funding for a new program could be obtained through self generating means, such as fees or rate increases, or from outside resources. Some of these outside resources include Bonds or Notes, Community Development Block Grant Funds, Federal Environmental Grants, or Property Taxes and Assessments.

While there are many alternatives for financial assistance that a city can offer a property owner there is also eligibility and assistance criteria that to consider. This criteria includes a determination of what type of maintenance is eligible for assistance; the type of assistance available; and, who is eligible to receive assistance. A number of factors affect the maintenance eligible for assistance, including the following: the definition of the sewer lateral, the type of maintenance, and the portion of the lateral eligible for maintenance. The two main types of assistance offered to property owners are grants and loans. Eligibility to receive assistance offered by a lateral maintenance program can be income based, target neighborhoods (potentially related to age of the system), or specific property types.

In the City of Colfax (Placer County), as well as in several cities in the San Francisco Bay Area (Burlingame, Berkeley, Richmond, Alameda, Albany, Rohnert Park, Susalito and San Mateo) , an ordinance was developed and implemented to address private sewer lateral maintenance. The City of Colfax has titled the ordinance, "Ordinance Requiring Testing, Inspection, Repair and Replacement of Building Sewer Laterals", while the Bay Area Citys ordinance is identified as "Private Sewer Lateral Compliance Plan." These ordinances cover items such as testing of new and existing sewer laterals, sewer lateral certification, correcting violations, and right of entry onto private property.

In addition Colfax has prepared two other documents in conjunction with this ordinance titled, "Requirements and Standards for Closed Circuit Television Sewer Lateral Inspections" and "Standards for Obtaining a Sewer Lateral Certificate of Compliance Based on Repair or Replacement of Building Sewer Laterals." These provide additional details and guidance for implementing this type of ordinance.
The Bay Area Cities adopted the Private Sewer Lateral Compliance Plan as early as the mid 1990's in the City of Albany and most recently the City of Berkley in 2006. These ordinances require that all home owners certify their private sewer laterals every 20 years. They enforce this ordinance by requiring homeowners to provide verification of certification when trying to sell their home or when adding on additional square footage to the home. After speaking to staff in multiple cities it is clear that this approach is a sound preliminary step towards enforcing private sewer lateral maintenance. But, it is also a long term program that may take decades to truly show a decrease in I/I.

8.8.3 Recommendations for the City

As previously mentioned, there are approximately 37,500 private sewer laterals in the City of Redding, and it is known that private laterals have a significant contribution to the wastewater collection systems I/I. It is recommended that the City move forward with a plan to reduce I/I from private sewer laterals. If a program is not put into action now it will not be long before the City will be forced to implement something to comply with State or Federal regulations. The implementation of an Ordinance similar to those mentioned above within the City of Redding is the preferred alternative in starting the task of I/I reduction in private laterals.

Cost estimates for replacing a private sewer lateral may range between $3,000 and $12,000 depending on the type of repair method, the length of pipe, and the obstacles in the pipe pathway. Because a homeowner will be looking at spending thousands of dollars that is not necessarily readily available to them, certifying a lateral at the time of a home sale or home remodel is an opportunity to replace it, if necessary, when there is a loan in progress that could easily accommodate this cost.

In 2010, approximately 2,100 homes were sold in all of Shasta County. Home sales have been in a slump for the last few years and will most likely continue this way for several years. Assuming that about 1,100 of those homes were sold specifically in the City of Redding, then 3 % of private sewer laterals would have been either certified as being in good condition or would have been replaced for not meeting the City Standards for a private sewer lateral. This is not a large percent but it is a starting point with the opportunity to grow into a larger program, or that could be combined with an additional program to more quickly address the problem of private sewer lateral I/I.

Additionally, as the City moves ahead with this type of ordinance a public outreach campaign will be necessary to inform property owners of their responsibilities regarding sewer lateral maintenance, to raise awareness of public health and environmental risks associated with faulty laterals, and to communicate with them about the availability of financial assistance. Documentation and brochures, as well as a link on the City's webpage, should be developed and distributed to residents, local plumbers and contractors, and real estate and title company professionals.


16.2F

CHAPTER 9
Capital Improvement Plan

9.1 INTRODUCTION

Numerous wastewater system improvements are required over the next 10 years, primarily to repair and replace the City's many aging sewer collection system components and attempt to reduce inflow and infiltration. The capital improvements have been determined using the full range of information and analysis from the facilities inspections, collection system and facility performance criteria, population and sewer demand projections, and detailed hydraulic modeling.

9.2 PROJECT CLASSIFICATION AND COST ESTIMATES

Cost estimates were prepared for each collection system capital project. The cost estimates presented were made without the benefit of detailed engineering data and do not include alternatives analysis. The estimates are based on cost curves, bid tabs for recent City projects, and preliminary estimated quantities for major facility components. The final cost of each project and the resulting budget impacts will depend on actual labor and material costs, competitive market conditions, actual site conditions, final projects scope, implementation schedules, and other variables. Therefore the final project costs will vary from those presented herein, aad each project must be evaluated in greater detail prior to making specific financing decisions or establishing project budgets. A cost estimate report is included in Appendix G, which was prepared by the engineering consulting firm CH2M Hill Engineers.

To prioritize the recommended modifications and improvements, each facility is ranked to assess the relative value of improvements with respect to overall performance, compliance with regulatory requirements, cost of operation, ease of operation, and other various factors. Specifically, improvements were evaluated against the following criteria: process, reliability, operability, constructability, regulatory considerations, relative cost, and risk. Issues considered under each criteria are summarized in Table 9.1.

Once the projects were ranked for each criteria a value was assigned to each category from 1 to 6 representing the Utility priority for each criteria. This provides a mechanism for projects that are required for regulatory complance or with high potential risk to attain a higher score. Project criteria ranking scores were then multiplied by the criteria values and summed for each project to attain a project score. Projects were then sorted by overall score for each planning time frame to attain a prioritized list. The ranking scale and criteria values are presented in Table 9.2.

Tables 9.3, 9.4, and 9.5 identify the capital improvements, ranking, scoring, and reason for the projects and recommended improvements.

Table 9.1 - Ranking Criteria

Criteria	Issues Considered
Reliability	- Is it Dependable? - Level of redundancy
Operability	- Complexity of operation - Maintenance requirements - Staffing requirements - History of technology - Does it work?
Constructability	- Complexity/ease of construction - Space requirements - Environmental constraints - Political considerations
Regulatory	- Current or pending regulatory requirements dictate undertaking the project
Relative Cost	- Less than \$100k - \$100k to 500k - Greater than \$500k
Risk	- Risk of significant fiscal repercussions if project is deferred or not completed

Table 9.2 Ranking Scale

		Points		
Criteria	**Value**	0	1	2
Process	2	Insignificant	Limited	Significant
Reliability	3	Insignificant	Limited	Significant
Operability	3	Insignificant	Limited	Significant
Constructability	2	Difficult	Limited	Easy
Regulatory	6	Not	Limited	Required
Relative Cost	4	High	Intermediate	Low
Risk	5	Low	Intermediate	High

Table 9.3 - Facility Improvements 2011-2015

Tag No.	Facility Type	Facility Name	Identified Projects	Recommendation	Reason	Project Property Category: Process	Reliability	Operability	Constructability	Regulatory	Relative Cost	Risk	Value Score Product: Process	Reliability	Operability	Constructability	Regulatory	Relative Cost	Risk	Total Score
P-S-1	Sewer Pipe	Oasis Road	Construct 780 feet of 12-inch and 400 feet of 15-inch diameter pipe	Construct/Replace	Capacity	0	1	0	1	2	2	2	0	3	0	2	12	8	10	35
LS-CC-1	Lift Station	Westside Lift Station	Construct larger lift station	Construct larger	Capacity	1	2	0	2	2	0	2	2	6	0	4	12	0	10	34
P-CC-1	Interceptor	Lake Redding Interceptor	Construct 1820 feet of 21-inch, 4790 feet of 24-inch and 950 feet of 27-inch diameter pipe	Construct/Replace	Capacity	0	1	1	2	2	0	2	0	3	3	4	12	0	10	32
P-CC-3	Sewer Pipe	East Cypress Sewer	Construct 730 feet of 12-inch diameter pipe	Construct/Replace	Capacity	0	1	0	1	2	2	1	0	3	0	2	12	8	5	30
P-CC-6	Sewer Bypass	Canby Bypass Phase 1	Construct 1210 feet of 18-inch diameter pipe	Construct/Replace	Capacity	0	0	0	1	2	1	2	0	0	0	2	12	4	10	28
P-CC-7	Interceptor	Westside Interceptor Phase III	Construct 3162 feet of 48-inch diameter pipe	Construct/Replace	Capacity	1	0	1	0	2	0	2	2	0	3	0	12	0	10	27
P-S-11 (4)	Sewer Pipe	Clover Creek Interceptor Rehab	Rehabilitate/line 3-6 miles of large diameter interceptor	Rehab	Operations/Regulatory	0	0	1	1	2	0	2	0	0	3	2	12	0	10	27
P-CC-2	Sewer Pipe	Cumberland Sewer	Construct 1820 feet of 12-inch diameter pipe	Construct/Replace	Capacity	0	1	0	1	2	1	1	0	3	0	2	12	4	5	26
LS-CC-2	Lift Station	Hartnell LS	Increase Capacity	Improve	Capacity	1	1	0	2	1	0	2	2	3	0	4	6	0	10	25
LS-CC-4	Lift Station	North Market LS	Focused Study on Capacity and Projected Flows	Study	Capacity	1	1	1	2	0	2	1	2	3	3	4	0	8	5	25
LS-S-1 (1)	Lift Station	Tierra Oaks	Upgrade or replace pump and force main	Construct	Capacity	1	1	0	2	1	0	2	2	3	0	4	6	0	10	25
LS-CC-17 (2)	Lift Station	Remington LS	Replace controls	Replace	Dependability	1	1	2	2	0	2	0	2	3	6	4	0	8	0	23
LS-CC-20 (2)	Lift Station	Remington LS	Construct SCADA	Construct	Operations	1	1	2	2	0	2	0	2	3	6	4	0	8	0	23
LS-CC-21 (2)	Lift Station	Riverbend LS	New Controls	Replace	Dependability	1	1	2	2	0	2	0	2	3	6	4	0	8	0	23
LS-CC-23 (2)	Lift Station	Riverbend LS	Construct SCADA	Construct	Operations	1	1	2	2	0	2	0	2	3	6	4	0	8	0	23
P-CC-17	Sewer Pipe	Bechelli South	Construct 100 feet of 15-inch diameter pipe	Construct/Replace	Capacity	0	0	0	1	2	2	0	0	0	0	2	12	8	0	22
P-CC-24	Sewer Pipe	Mesa Alley	Replace 1814 feet of 8- and 10-inch diameter pipe	Construct/Replace	Maintenance	0	1	2	2	0	1	1	0	3	6	4	0	4	5	22
LS-CC-24	Lift Station	Sunnyhill LS	Add bypass pumping facility	Construct	Emergency Support	2	1	1	2	0	2	0	4	3	3	4	0	8	0	22
P-CC-5	Sewer Pipe	Mercury Drive Sewer	Construct 1670 feet of 12-inch diameter pipe	Construct/Replace	Capacity	0	1	0	1	2	1	0	0	3	0	2	12	4	0	21
P-CC-25	Sewer Pipe	Manzanita Drive	Replace 386 feet of 6-inch diameter pipe	Construct/Replace	Maintenance	0	1	2	2	0	2	0	0	3	6	4	0	8	0	21
P-S-8	Sewer Pipe	Patterson Ct	Construct 524 feet of 6-inch diameter pipe	Construct/Replace	Maintenance	0	1	2	2	0	2	0	0	3	6	4	0	8	0	21
LS-CC-25	Lift Station	Sunnyhill LS	Add Force Main valve	Construct	Operations	1	1	1	2	0	2	0	2	3	3	4	0	8	0	20
P-CC-22	Sewer Pipe	San Francisco Drive South	Replace 419 feet of 8-inch diameter pipe	Construct/Replace	Maintenance	0	1	2	1	0	2	0	0	3	6	2	0	8	0	19
P-CC-32	Sewer Pipe	School Street	Replace 1803 feet of 6-inch diameter pipe	Construct/Replace	Maintenance	0	1	2	1	0	2	0	0	3	6	2	0	8	0	19
P-S-9	Sewer Pipe	Boneset Street	Construct 262 feet of 6-inch and 255 feet of 12-inch diameter pipe	Construct/Replace	Maintenance	0	1	2	1	0	2	0	0	3	6	2	0	8	0	19
LS-CC-14	Lift Station	Layton LS	Replace LS	Construct	Safety/Dependability	1	1	1	1	0	1	1	2	3	3	2	0	4	5	19
P-CC-19	Sewer Pipe	Hilltop Sewer	Replace 1923 feet of 8- and 10-inch diameter pipe	Construct/Replace	Maintenance	0	2	2	1	0	1	0	0	6	6	2	0	4	0	18
P-CC-23	Sewer Pipe	Loma Street Alley	Replace 1847 feet of 8-inch diameter pipe	Construct/Replace	Maintenance	0	1	2	2	0	1	0	0	3	6	4	0	4	0	17
P-CC-31	Sewer Pipe	Churn Creek Road	Replace 566 feet of 6-inch diameter pipe	Construct/Replace	Maintenance	0	1	2	2	0	1	0	0	3	6	4	0	4	0	17
P-CC-21	Sewer Pipe	San Francisco Drive West	Replace 791 feet of 8-inch diameter pipe	Construct/Replace	Maintenance	0	1	2	1	0	1	0	0	3	6	2	0	4	0	15
P-CC-29	Sewer Pipe	Mistletoe	Replace 875 feet of 8-inch diameter pipe	Construct/Replace	Maintenance	0	1	2	1	0	1	0	0	3	6	2	0	4	0	15
LS-CC-18 (2)	Lift Station	Remington LS	Construct Enclosure	Replace	Longevity	0	1	0	2	0	2	0	0	3	0	4	0	8	0	15
LS-CC-19 (2)	Lift Station	Remington LS	Construct Fence and Gate	Construct	Security	0	1	0	2	0	2	0	0	3	0	4	0	8	0	15
LS-CC-22 (2)	Lift Station	Riverbend LS	Enclosure	Replace	Longevity	0	1	0	2	0	2	0	0	3	0	4	0	8	0	15
P-CC-26	Sewer Pipe	Hallmark Alley	Replace 2403 feet of 6" diameter pipe	Replace	Maintenance	0	1	2	1	0	1	0	0	3	6	2	0	4	0	15
P-CC-27	Sewer Pipe	Redbud Alley	Replace 1174 feet of 6" diameter pipe	Replace	Maintenance	0	1	2	1	0	1	0	0	3	6	2	0	4	0	15
P-CC-20	Sewer Pipe	Churn Creek Road North	Replace 1889 feet of 10-inch diameter pipe	Construct/Replace	Maintenance	0	1	2	0	0	1	0	0	3	6	0	0	4	0	13
LS-CC-15	Lift Station	Locust LS	Replace LS	Construct	Safety/Dependability	1	1	1	0	0	0	1	2	3	3	0	0	0	5	13
P-CC-4	Interceptor	Buenaventura Sewer	Construct 4400 feet of 12-inch, 3560 feet of 15-inch and 2970 feet of 18-inch diameter pipe	Construct/Replace	Capacity	0	0	0	0	2	0	0	0	0	0	0	12	0	0	12
P-CC-28	Sewer Pipe	Woodacre Drive	Replace 1375 feet of 8-inch diameter pipe	Construct/Replace	Maintenance	0	0	2	1	0	1	0	0	0	6	2	0	4	0	12
LS-CC-16 (3)	Demo Existing	North Market Suspended Pipe	Remove abandoned pipe across Sacramento River	Demolition	Housekeeping	0	0	0	0	1	0	1	0	0	0	0	6	0	5	11
P-CC-18	Sewer Pipe	Azailia I-5 Crossing	Replace 817 Feet of 6-inch diameter pipe	Construct/Replace	Maintenance	0	1	2	0	0	0	0	0	3	6	0	0	0	0	9

(1) Tierra Oaks Lift Station Upgrade was deemed to be related to development of a specific limited area and to be funded by that development as it is needed and therefore will not be reflected in any subsequent tables or analyis.
(2) Projects were deemed Lift Station Maintenance Projects and transfered to a budget line item Lift Station Improvements and therefore will not be reflected in any subsequent tables or analysis.
(3) Project deemed maintenance and included in misc repair and replace budget line item and therefore will not be reflected in any subsequent tables or analysis.
(4) Clover Creek Interceptor Rehabilitation project was determined to be inadequately scoped. Additional monitoring efforts will need to be performed to narrow the scope to more precisely locate the problem areas. Therefore the project will be discussed but not included in subsequent tables or analysis.

Table 9.4 - Facility Improvements 2016-2020

						Project Property Category							Value Score Product							
Tag No.	**Facility Type**	**Facility Name**	**Identified Projects**	**Recommendation**	**Reason**	**Process**	**Reliability**	**Operability**	**Constructability**	**Regulatory**	**Relative Cost**	**Risk**	**Process**	**Reliability**	**Operability**	**Constructability**	**Regulatory**	**Relative Cost**	**Risk**	**Total Score**
P-CC-17	Sewer Pipe	Bechelli South	Construct 100 feet of 15-inch diameter pipe	Construct	Capacity	0	1	0	1	2	2	1	0	3	0	2	12	8	5	30
TP-CC-1	Treatment Plant	Clear Creek WWTP	Levee Improvements	Construct	Reliability/Regulatory	0	2	1	0	2	1	1	0	6	3	0	12	4	5	30
LS-CC-10 (1)	Lift Station	Denton Lift Station	Rebuild Pumps	Rebuild	Dependability	1	1	0	2	1	0	2	2	3	0	4	6	0	10	25
LS-CC-11	Lift Station	Hartnell Lift Station	Replace Controls	Replace	Dependability	1	1	2	2	0	2	0	2	3	6	4	0	8	0	23
LS-CC-13	Lift Station	Hartnell Lift Station	Add SCADA Control	Construct	Operation	1	1	2	2	0	2	0	2	3	6	4	0	8	0	23
LS-CC-9 (1)	Lift Station	Denton Lift Station	Enclosure	Construct	Longevity	0	1	0	2	0	2	0	0	3	0	4	0	8	0	15
LS-CC-12	Lift Station	Hartnell Lift Station	Enclosure	Construct	Longevity	0	1	0	2	0	2	0	0	3	0	4	0	8	0	15

(1) Project completed in 2012 therefore not included in subsequent tables or analysis.

Table 9.5 - Facility Improvements 2021-2030

						Project Property Category							Value Score Product							
Tag No.	**Facility Type**	**Facility Name**	**Identified Projects**	**Recommendation**	**Reason**	**Process**	**Reliability**	**Operability**	**Constructability**	**Regulatory**	**Relative Cost**	**Risk**	**Process**	**Reliability**	**Operability**	**Constructability**	**Regulatory**	**Relative Cost**	**Risk**	**Total Score**
P-CC-8	Sewer Pipe	Sulphur Creek P1	630 feet of 18-inch and 2110 feet of 21-inch diameter pipe	Construct	Capacity	0	1	0	1	2	2	2	0	3	0	2	12	8	10	35
P-CC-9	Sewer Pipe	Sulphur Creek P2	440 feet of 12-inch and 2250 feet of 15-inch diameter pipe	Construct	Capacity	0	1	0	1	2	2	2	0	3	0	2	12	8	10	35
TP-S-1	Treatment Plant	Stillwater WWTP	Numerous improvements contained in Facilities Plan	Construct	Capacity/Operation	2	1	2	1	2	0	1	4	3	6	2	12	0	5	32
TP-CC-3	Treatment Plant	Clear Creek WWTP	Holding Pond Upgrades	Construct	Reliability/Regulatory	1	1	1	0	2	1	1	2	3	3	0	12	4	5	29
P-S-5	Sewer Pipe	Boulder Creek PIII	2460 feet of 10-inch, 2360 feet of 12-inch and 2760 feet of 15-inch diameter pipe	Construct	Capacity	0	1	0	0	2	0	2	0	3	0	0	12	0	10	25
LS-CC-7	Lift Station	Cheryl Lift Station	Shade Structure	Construct	Longevity	0	2	0	2	0	2	0	0	6	0	4	0	8	0	18
LS-CC-8	Lift Station	Cheryl Lift Station	AC Drives	Construct	Capacity	0	1	1	2	0	2	0	0	3	3	4	0	8	0	18
LS-CC-3 (1)	Lift Station	Riverbend LS	Increase Capacity	Improve	Capacity	0	0	0	2	0	0	1	0	0	0	4	0	0	5	9

(1) Projects were deemed Lift Station Maintenance Projects and transfered to a budget line item Lift Station Improvements and therefore will not be reflected in any subsequent tables. Cost and timing of the improvements are reflected in the specific line item in subsequent tables and analysis.

9.3 PROJECT SUMMARY

The Capital Improvement plan project listing is limited to planning horizons between 2010 and 2030. Projects recommended to meet demands or conditions beyond 2030 will be considered in more detail in subsequent studies. Attempting to refine or delineate projects 20 or more years in the future was deemed to be unproductive due to the level of uncertainty regarding growth and regulatory requirements. However, the exception to this is in the pipe replacement program element where the City needs to plan for replacement of pipes that were constructed during the growth boom of the 60's and 70's which will peak at approximately 11 miles of pipe per year reaching the end of its service life in 2055-2060.

9.3.1 Treatment Capacity

Following completion of Phase 1a/1b at the Stillwater WWTP in the year 2013 the City will meet treatment capacity requirements with an adequate margin of safety. The design storm analysis reflects utilization of equalization storage for peak hour flows at both treatment facilities and adequate storage is available to accommodate the required volume.

Stillwater WWTP Facility plan calls for construction of Phase 1C in 2018 at an estimated cost of $18.5 million in 2012 dollars. However, because of lower growth forecasting used in this Master Plan effort Phase 1C is not called for until 2023.

9.3.2 Lift Stations

Numerous lift station improvements are called for to resolve capacity, operations, and maintenance issues. The largest potential lift station improvement is at North Market Street LS pending detailed investigation of why there is such a large difference between flow projections attained for the recent facility upgrade and the current master plan projections. Other lift station replacement projects are small enough to accomplish with package lift stations. Details of lift station recommendations are found in the Clear Creek and Stillwater Evaluation chapters.

9.3.3 Pipes

Analysis of aging pipe reflects a need for increasing the pipe replacement program. Historic record reflects that the City has been replacing approximately 2 miles of pipe per year. This will need to increase significantly to keep up with pipe reaching the end of its expected service life.

It is recommended that pipe replacement be prioritized according to a standardized process including consideration of age, maintenance issues, defects, pipe material, and excessive I&I areas. Currently the City does not have a procedure in place to document the process or activity of prioritizing pipe replacement projects. It is recommended that the City pursue establishing a pipe ranking procedure for this determination. Without such a program/procedure the following recommendations are bulk replacement recommendations based solely on service life of pipes.

Time frame	Miles per year replacement
2012-2014	2.5
2015-2019	3.0
2020-2024	4.0
2025-2029	5.0

9.3.4 Stillwater Creek Drainage Area

The Stillwater Creek Drainage Area, described in Chapter 6, consists of area within the City of Redding General Plan sphere of influence that sewer service can only be provided for by either a large interceptor adjacent to Stillwater Creek or by pumping sewer over to the existing collection system. An interceptor adjacent to Stillwater Creek would extend the whole length of the City in a north/south direction from Tierra Oaks LS to Rancho Road (approximately 13 miles) and include a major lift station to convey flow to either the Clover Creek interceptor or a new interceptor in Airport Road.

The concept of pumping sewer to the existing system requires an unknown number of lift stations to convey flow from Stillwater Creek Drainage to either Churn Creek or Clover Creek basins. Previous studies have suggested multiple locations for interim lift stations to handle the demand until the Stillwater Interceptor was completed.

Analysis of this system was performed to compare relative costs of the various strategies to provide sewer service east of the drainage divide between the existing system and Stillwater Creek. To investigate the different alternatives, potential pipe routes were identified using aerial photos and 2 ft contour topography from 2004.

Potential pipe routes were identified with the following considerations:

- Efficient routing to minimize length
- Maintain gravity flow
- Minimize creek crossings
- Minimize environmental challenges
- Maximize potential area served
- Utilize existing right-of-way to extent possible
- Utilize bridge crossings where possible
- Maintain minimum slopes per COR construction standards

Cost estimates were prepared utilizing the most recent costs for large scale sewer projects to determine an average cost per foot of pipe construction including engineering, environmental concerns, construction contingency, construction management and inspection. The estimates are planning level estimates based on limited information and should be considered approximate with as much as 50% uncertainty. Dollar amounts are calculated in 2012 dollars.

Stillwater Interceptor and Single Major Lift Station

The Stillwater Interceptor alternative includes development of the entire area east of the topographic divide between Churn Creek or Clover Creek and the City General Plan sphere of influence boundary. For the purpose of this investigation areas were assumed to be completely developed at General Plan density. This alternative includes a major interceptor adjacent to Stillwater Creek starting at Tierra Oaks LS utilizing gravity flow south to Rancho Road. At Rancho Road a lift station would pump to Airport Road where another interceptor would be constructed to convey sewer to Stillwater WWTP. A brief investigation determined that the existing Clover Creek interceptor would not be adequate to convey the sewer from development of the entire sphere of influence. The decision to place the interceptor in Airport Road instead of increasing the size of the Clover Creek interceptor was made to avoid potential environmental challenges associated with construction activity on the existing interceptor located in the creek corridor.

The additional area served by this alternative was calculated to be approximately 12,630 acres and included the following infrastructure and approximate costs:

▸	~14.2 miles Stillwater Interceptor (18" to 42" diameter)	$39.8-million
▸	Major Lift Station and force main	$7.3-million
▸	~20 miles large diameter lateral interceptors (12" to 18" diameter)	$57.3-million

The total estimated cost for construction of this alternative is $104.4-million.

Phased Stillwater Interceptor

The phased approach considered three separate interim lift stations with service areas as described in Appendix B and shown on Figures B-7a, B-7b and B-7c. Analysis of the three phases of Stillwater Creek Drainage area did not consider or evaluate impacts on the existing system. The infrastructure and cost estimates listed below are for improvements necessary to collect and convey sewer to the existing system. Prior to construction of any of these phases a detailed evaluation of the impacts to the existing collection system should be performed to determine if any improvements are necessary for the existing system.

The area north of HWY 299 within the sphere of influence amounts to an additional approximately 5380 acres of area served. Cost estimates for the infrastructure necessary to construct this phase are:

▸	~3.3 miles of Stillwater Interceptor	$9.2-million
▸	~11.2 miles of large diameter lateral interceptors	$31.4-million
▸	Temporary Lift Station	$1.0-million
▸	6,800 ft force main	$1.3-million

The total estimated cost is projected to be $42.9-million

The middle area of Stillwater, between HWY 299 and HWY 44 serves approximately 3420 acres requiring the following infrastructure:

▸	~2.5 miles of Stillwater Interceptor	$7.1-million
▸	~5.4 miles of large diameter lateral interceptors	$15.1-million
▸	Temporary Lift Station	$1.0-million
▸	5,900 feet of force main	$1.2-million

The total estimated cost is projected to be $24.4-million

The south area of Stillwater consists of all unserved area in the Stillwater Creek Drainage area south of HWY 44 totaling approximately 3850 acres and requires the following:

▸	~3.3 miles of Stillwater Interceptor	$9.2-million
▸	~3.9 miles of large diameter lateral interceptors	$11.0-million
▸	Temporary Lift Station	$1.0-million
▸	2,500 ft force main	$0.5-million

The total estimated cost is projected to be $21.7-million

The total cost associated with all three phases is $89.0-million with approximately $6-million in temporary infrastructure. The strategy would still require approximately 5.1 miles of the ultimate Stillwater Interceptor to be constructed along with a major lift station at Rancho Road. The cost estimate for construction of the remaining infrastructure for the ultimate Stillwater Interceptor is $21.3-million. The present worth cost estimate of the entire collection of phases and remaining interceptor is approximately $110.3-million

Stillwater Service Impacts to Existing Collection System

Following evaluation of the costs of serving the Stillwater Creek Drainage Area (SCDA) through a major interceptor project, either as a whole or in phases, an analysis was performed to determine how much of the area could be pumped to the existing system. Details of that evaluation are presented in Chapter 6 - Stillwater Hydraulic Capacity and Treatment Evaluation.

Improvements necessary to serve the new area are listed in Table 6.6. The total cost of the list is estimated to be $5.7-million in pipe improvements and rehabilitation and another $3.2-million for upgrades to Churn Creek Lift Station and force main, for a total of $8.9-million.

The decision regarding whether to allow pumping of SCDA over to the existing collection system and how to fund the necessary improvements (impact fees, special benefit district, assessment district, etc.) will be analyzed as part of future Master Plan efforts.

9.4 PROJECT FUNDING

Project funding arises from two primary sources. The first is comprised of monthly sewer service charge for the cost of maintaining the collection system and operating the treatment plants. The second is impact fees related to connection to the system which include a connection charge for system improvement and treatment plant expansion, front footage charge, and line tap charge.

Rate Funded Improvements Improvements funded by rates are those arising from deterioration of the system, age of the system and those associated with code or regulatory changes. For instance, regulations may require more restrictive limits on the City's discharge to the Sacramento River. If this occurs and new facilities are necessary to achieve those goals then the funding source would be rates.

Impact Fee Improvements Improvements funded by impact fees are those supporting new development or extending service to new areas in support of future development. Other fee related categories of projects are oversizing of replacement pipes for future demands, and increasing the capacity of lift stations or treatment plants. New infrastructure associated with increasing the capacity of the existing system to accommodate Stillwater Creek Drainage Area development would be an example of an impact fee related project.

Hybrid Funded Projects Many projects fall into a hybrid funding category where multiple reasons exist that generate a need for the project. For example a deteriorating, aging lift station may be replaced with a larger facility to accommodate projected increase in demand or an old pipe may be replaced with a larger one for the same reason. Numerous different methodologies are available for dividing the cost between such projects. The strategy used in this plan for pipe construction was to minimize adding excessive amounts of new pipe to the system to the extent possible by replacing existing pipes with new larger pipes rather than constructing new parallel pipes. This serves to assist with pipe replacement, avoids additional maintenance burden and avoids the possibility of increasing the amount of I&I entering the system. Therefore parallel pipes are not recommended. If a pipe is not adequate in capacity, it is replaced and the rate/fee split determined by the cost of replacement in kind being borne by the rates and the difference in cost to attain UBO capacity is borne by impact fees.

Tables 9.6, 9.7 and 9.8 show the projects in their original planning time frames along with cost estimates in 2012 dollars and the cost splits.

Table 9.6 - Facility Improvements 2011-2015

								Funding Split		Amounts	
Tag No.	Facility Type	Facility Name	Identified Projects	Recommendation	Reason	Cost Estimate (1)	Total Score	Rates, %	Fees, %	Rates	Fees
P-S-1	Sewer Pipe	Oasis Road	Construct 780 feet of 12-inch and 400 feet of 15-inch diameter pipe	Construct/Replace	Capacity	$389,000	35	34	66	$132,260	$256,740
LS-CC-1	Lift Station	Westside Lift Station	Construct larger lift station	Construct larger	Capacity	$449,000	34	100	0	$449,000	$0
P-CC-1	Interceptor	Lake Redding Interceptor	Construct 1820 feet of 21-inch, 4790 feet of 24-inch and 950 feet of 27-inch diameter pipe	Construct/Replace	Capacity	$4,900,000	32	39	61	$1,911,000	$2,989,000
P-CC-3	Sewer Pipe	East Cypress Sewer	Construct 730 feet of 12-inch diameter pipe	Construct/Replace	Capacity	$230,000	30	100	0	$230,000	$0
TP-CC-1	Treatment Plant	Clear Creek WWTP	Levee Improvements	Construct	Reliability/Regulatory	$1,810,000	30	100	0	$1,810,000	$0
P-CC-6	Sewer Bypass	Canby Bypass Phase 1	Construct 1210 feet of 18-inch diameter pipe	Construct/Replace	Capacity	$440,000	28	100	0	$440,000	$0
P-CC-7	Interceptor	Westside Interceptor Phase III	Construct 3162 feet of 48-inch diameter pipe	Construct/Replace	Capacity	$2,500,000	27	0	100	$0	$2,500,000
P-CC-2	Sewer Pipe	Cumberland Sewer	Construct 1820 feet of 12-inch diameter pipe	Construct/Replace	Capacity	$551,000	26	100	0	$551,000	$0
LS-CC-2	Lift Station	Hartnell LS	Increase Capacity	Improve	Capacity	$117,000	25	0	100	$0	$117,000
LS-CC-4	Lift Station	North Market LS	Focused Study on Capacity and Projected Flows	Study	Capacity	$118,000	25	6	94	$7,080	$110,920
P-CC-11,17	Sewer Pipe	Bechelli South	Construct 100 feet of 15-inch diameter pipe	Construct/Replace	Capacity	$126,000	22	100	0	$126,000	$0
P-CC-24	Sewer Pipe	Mesa Alley	Replace 1814 feet of 8- and 10-inch diameter pipe	Construct/Replace	Maintenance	$550,000	22	100	0	$550,000	$0
LS-CC-24,25	Lift Station	Sunnyhill LS	Add bypass pumping facility	Construct	Emergency Support	$145,000	22	100	0	$145,000	$0
P-CC-5	Sewer Pipe	Mercury Drive Sewer	Construct 1670 feet of 12-inch diameter pipe	Construct/Replace	Capacity	$515,000	21	100	0	$515,000	$0
P-CC-25	Sewer Pipe	Manzanita Drive	Replace 386 feet of 6-inch diameter pipe	Construct/Replace	Maintenance	$113,000	21	100	0	$113,000	$0
P-S-8	Sewer Pipe	Patterson Ct	Construct 524 feet of 6-inch diameter pipe	Construct/Replace	Maintenance	$212,000	21	100	0	$212,000	$0
P-CC-22	Sewer Pipe	San Francisco Drive South	Replace 419 feet of 8-inch diameter pipe	Construct/Replace	Maintenance	$165,000	19	100	0	$165,000	$0
P-CC-32	Sewer Pipe	School Street	Replace 1803 feet of 6-inch diameter pipe	Construct/Replace	Maintenance	$473,000	19	100	0	$473,000	$0
P-S-9	Sewer Pipe	Boneset Street	Construct 262 feet of 6-inch and 255 feet of 12-inch diameter pipe	Construct/Replace	Maintenance	$157,000	19	100	0	$157,000	$0
LS-CC-14	Lift Station	Layton LS	Replace LS	Construct	Safety/Dependability	$423,000	19	100	0	$423,000	$0
P-CC-19	Sewer Pipe	Hilltop Sewer	Replace 1923 feet of 8- and 10-inch diameter pipe	Construct/Replace	Maintenance	$685,000	18	100	0	$685,000	$0
P-CC-23	Sewer Pipe	Loma Street Alley	Replace 1847 feet of 8-inch diameter pipe	Construct/Replace	Maintenance	$481,000	17	100	0	$481,000	$0
P-CC-31	Sewer Pipe	Churn Creek Road	Replace 566 feet of 6-inch diameter pipe	Construct/Replace	Maintenance	$173,000	17	100	0	$173,000	$0
P-CC-21	Sewer Pipe	San Francisco Drive West	Replace 791 feet of 8-inch diameter pipe	Construct/Replace	Maintenance	$289,000	15	100	0	$289,000	$0
P-CC-29	Sewer Pipe	Mistletoe	Replace 875 feet of 8-inch diameter pipe	Construct/Replace	Maintenance	$234,000	15	100	0	$234,000	$0
P-CC-26	Sewer Pipe	Hallmark Alley	Replace 2403 feet of 6" diameter pipe	Replace	Maintenance	$612,000	15	100	0	$612,000	$0
P-CC-27	Sewer Pipe	Redbud Alley	Replace 1174 feet of 6" diameter pipe	Replace	Maintenance	$299,000	15	100	0	$299,000	$0
LS-CC-15	Lift Station	Locust LS	Replace LS	Construct	Safety/Dependability	$495,000	13	100	0	$495,000	$0
P-CC-4	Interceptor	Buenaventura Sewer	Construct 4400 feet of 12-inch, 3560 feet of 15-inch and 2970 feet of 18-inch diameter pipe	Construct/Replace	Capacity	$3,806,000	12	33	67	$1,255,980	$2,550,020
P-CC-28	Sewer Pipe	Woodacre Drive	Replace 1375 feet of 8-inch diameter pipe	Construct/Replace	Maintenance	$411,000	12	100	0	$411,000	$0
LS-CC-16	Demo Existing	North Market Suspended Pipe	Remove abandoned pipe across Sacramento River	Demolition	Housekeeping	$160,000	11	100	0	$160,000	$0
P-CC-18	Sewer Pipe	Azailia I-5 Crossing	Replace 817 Feet of 6-inch diameter pipe	Construct/Replace	Maintenance	$566,000	9	100	0	$566,000	$0
					Total:	$22,594,000				$14,070,320	$8,523,680

(1) 2012 dollars at CCI 9280

Table 9.7 - Facility Improvements 2016-2020

								Funding Split		Amounts	
Tag No.	Facility Type	Facility Name	Identified Projects	Recommendation	Reason	Cost Estimate (1)	Total Score	Rates, %	Fees, %	Rates	Fees
LS-CC-9,10	Lift Station	Denton Lift Station	Rebuild Pumps, Enclosure	Rebuild	Dependability	$117,000	25	100	0	$117,000	$0
TP-CC-1	Treatment Plant	Clear Creek WWTP Levee	Add Erosion Protection	Cosntruct	Regulatory	$1,810,000	23	100	0	$1,810,000	$0
TP-CC-2	Treatment Plant	Clear Creek WWTP Pond	Line Pond 2	Construct	Capacity/Regulatory	$2,361,000	23	75	25	$1,770,750	$590,250
LS-CC-11, 12, 13	Lift Station	Hartnell Lift Station	Replace Controls, add SCADA, add enclosure	Replace	Dependability	$117,000	23	100	0	$117,000	$0
					Total:	$4,405,000				$3,814,750	$590,250

(1) 2012 dollars at CCI 9280

Table 9.8 - Facility Improvements 2021-2030

								Funding Split		Amounts	
Tag No.	Facility Type	Facility Name	Identified Projects	Recommendation	Reason	Cost Estimate (1)	Total Score	Rates, %	Fees, %	Rates	Fees
P-CC-8, 9	Sewer Pipe	Sulphur Creek	630 feet of 18-inch and 2110 feet of 21-inch diameter pipe 440 feet of 12-inch and 2250 feet of 15-inch diameter pipe	Construct	Capacity	$2,073,000	35	75	25	$1,554,750	$518,250
TP-S-1	Treatment Plant	Stillwater WWTP	Numerous improvements contained in Facilities Plan	Construct	Capacity/Operation	$17,906,000	32	75	25	$13,429,500	$4,476,500
TP-CC-3	Treatment Plant	Clear Creek WWTP	Holding Pond Upgrades	Construct	Reliability/Regulatory	$4,647,000	29	75	25	$3,485,250	$1,161,750
P-S-5	Sewer Pipe	Boulder Creek PIII	2460 feet of 10-inch, 2360 feet of 12-inch and 2760 feet of 15-inch diameter pipe	Construct	Capacity	$2,904,000	25	75	25	$2,178,000	$726,000
TP-C-3	Treatment Plant	Clear Creek WWTP Pond	Line Pond 4	Construct	Capacity/Regulatory	$2,286,000	23	75	25	$1,714,500	$571,500
LS-CC-7, 8	Lift Station	Cheryl Lift Station	Shade Structure, add AC Drives	Construct	Longevity	$139,000	18	0	100	$0	$139,000
					Total:	$29,955,000				$22,362,000	$7,593,000

(1) 2012 dollars at CCI 9280

9.5 PROJECT TIMING

All capacity related projects (pipes, lift stations, and treatment plants) are scheduled to be completed prior to the planning horizon where they were deemed necessary. Maintenance related projects such as leaking roofs, shade structures, fence repairs, etc. are scheduled according to their ranking and as budget allows. Wastewater Treatment Plant improvements are scheduled according to the recommendations of their treatment plant Facility plans. The first two planning periods are five year increments. Projects to resolve existing conditions and needed by 2015 were placed in the first 5-year time frame and prioritized according to their rank. Subsequent projects were scheduled in their respective time frames in a similar manner.

There are several larger projects that fell into time frames that created excessive budget problems. Some of these projects were advanced or delayed in order to better match budget and construction constraints. Each of these projects and the potential ramifications of the schedule change are discussed below.

The criteria for identifying a pipe project in this Master Plan is that the hydraulic analysis utilizing a 10-year, 24-hour storm resulted in an SSO. When the analysis reflects an SSO further quality assurance was performed to assure that the analysis accurately reflects the pipe sizes, system configuration and other assumptions that may affect that result. Results were also compared to analysis from prior master planning efforts for confirmation. Most of the pipe projects called for in the current plan were also identified in prior efforts. To determine the scope of each project, an iterative process of finding the critical, or most restrictive pipe, and replacing it with a larger pipe. If the SSO moved downstream as a result of freeing the restriction then the project was expanded by replacing the downstream pipes with larger pipes until the SSO no longer occurs in the analysis. If the SSO was resolved but upstream pipes remained problematic the project was expanded to include more pipes upstream.

The risk of delaying a project is that a SSO may occur during the period of delay. The definition of a 10-year storm event is that there is a 10-percent chance each year of the event occurring. Thus **on average** one would observe such an event once every ten years. This means that the risk of delaying a capacity related project is that there is a one in ten chance each year of delay of having an SSO at that location.

Table 9.9 shows the projects that were delayed in this CIP and the duration of delay beyond the planning horizon when they were initially recommended. It is important to mention that in the 2003 Wastewater Master Plan almost all the pipe projects recommended for the first 10-years were delayed to the next decade. Therefore many of the projects we are considering with this plan have already been delayed. The list of "Existing" needs projects must incur some delay due to the sheer number of projects, duration to instigate and execute the project, and budget realities. It is also important to know that the analysis is performed at periodic intervals (2010, 2015, 2020, and 2030) and that a project that shows an SSO in 2020 means that it could occur earlier so some risk may already be occurring.

Table 9.10 reflects the CIP projects in 2012 dollar values in the years scheduled following project leveling to avoid construction and budget constraints. The table includes four recurring items that are large enough to included in the list and identified in the budget spreadsheet but are not evaluated in this report. They are Minor Extensions and Oversizing, Lift Station Improvements, Treatment Plant Structures and Improvements, and Programmatic Pipe Replacement Elements. Programmatic Pipe Replacement Elements consists of Structures and Improvements, Misc Repair and Replacement, System Maintenance, 6-8" Line Repair/Replacement, and Redding Relief Sewers.

Tables 9.11 and 9.12 show the distribution of project type and cost for the entire plan.

Table 9.9 - Deferred Projects

Tag #	Project Title	Date Needed	Date Scheduled	Deferral Period (1)
P-CC-1	Lake Redding Interceptor I	Existing (2010)	2014-15	2
P-CC-1	Lake Redding Interceptor II	Existing (2010)	2015-16	3
P-CC-2	Cumberland Sewer	Existing (2010)	2017-18	5
P-CC-3	East Cypress Sewer	Existing (2010)	2016-17	4
P-CC-4	Buenaventura	Existing (2010)	2020-22	8 (2)
P-CC-5	Mercury	Existing (2010)	2019-20	7
P-CC-6	Canby Bypass Phase I	Existing (2010)	2016-17	4
P-CC-7	West Side Interceptor Phase	Existing (2010)	2014-15	2
P-CC-17	Bechelli South	2015	2018-19	3
P-CC-8,9	Sulphur Creek	2020	2022-23	3
LS-CC-2	Hartnell Lift Station	Existing (2010)	2017-18	5

(1) Deferral Period was reduced by two years because the "Existing" analysis was performed at 2010 demand levels and the report is currently being generated in 2012.
(2) Deferral of the Buenaventura project is likely to have less risk associated due to the policy of requiring bolt down manhole covers on all pipes in open space. This may result in the pipe operating under pressure instead of simply gravity flow and reduce the risk of SSO. The magnitude of risk is extremely difficult to evaluate in such instances. The majority of the project is in open space.

Table 9.10 - Capital Improvement Plan

		Cost Split		Cost		
Year	Improvement	Rates	Fees	Rates	Fees	Total
2012-2013	Programmatic Pipe Replacement Elements	100%		$2,756,100		$2,481,737
	Minor Extensions and Oversizing		100%		$839,710	$839,710
	Lift Station Improvements	100%		$828,800		$828,800
	Sunnyhill Lift Station	100%		$1,100,000		$1,100,000
	Boulder Creek Interceptor - Phase III	75%	25%	$572,288	$190,763	$763,050
	CC Lift Station Improvements	87%	13%	$472,227	$70,563	$542,790
	Treatment Plant Structures and Improvements	100%		$200,390		$200,390
	CCWWTP BP5	77%	23%	$4,620,000	$1,380,000	$6,000,000
	CCWWTP BP6	77%	23%	$77,000	$23,000	$100,000
	CCWWTP BP7	77%	23%	$3,080,000	$920,000	$4,000,000
	Stillwater WWTP- Expansion 1A/B	75%	25%	$6,000,000	$2,000,000	$8,000,000
	Stillwater WWTP - Plant Expansion 1C	75%	25%	$225,000	$75,000	$300,000
	Oasis Road	34%	66%	$136,492	$264,956	$401,448
	Westside Lift Station	100%		$463,368		$463,368
	Mesa Alley	100%		$567,600		$567,600
			Totals:	$21,099,265	$5,763,991	$26,588,893
2013-2014	Programmatic Pipe Replacement Elements	100%		$1,459,000		$3,626,098
	I/I Reduction	100%		$1,000,000		$1,000,000
	Minor Extensions and Oversizing		100%		$500,000	$500,000
	Lift Station Improvements	100%		$200,000		$200,000
	Westside Interceptor - Phase III	0%	100%		$1,250,000	$1,250,000
	Treatment Plant Structures and Improvements	100%		$107,516		$107,516
	Clear Creek WWTP BP5	77%	23%	$361,502	$107,981	$469,484
	Clear Creek WWTP BP7	77%	23%	$1,446,009	$431,925	$1,877,934
	Stillwater WWTP- Expansion 1A/B	75%	25%	$4,225,352	$1,408,451	$5,633,803
	Solids Handling Facilities	75%	25%	$2,625,000	$875,000	$3,500,000
	Boneset Street	100%		$157,000		$157,000
	Mistletoe	100%		$234,000		$234,000
			Totals:	$11,815,380	$4,573,357	$18,555,835
2014-2015	Programmatic Pipe Replacement Elements	100%		$1,459,000		$3,760,215
	I/I Reduction	100%		$1,000,000		$1,000,000
	Minor Extensions and Oversizing		100%		$500,000	$500,000
	Lift Station Improvements	100%		$200,000		$200,000
	Westside Interceptor - Phase III		100%		$1,250,000	$1,250,000
	Treatment Plant Structures and Improvements	100%		$107,516		$107,516
	Solids Handling Facilities	75%	25%	$2,625,000	$875,000	$3,500,000
	Lake Redding Interceptor I	39%	61%	$955,500	$1,494,500	$2,450,000
	Manzanita Drive	100%		$113,000		$113,000
	San Francisco Drive South	100%		$165,000		$165,000
	San Francisco Drive West	100%		$289,000		$289,000
			Totals:	$6,914,016	$4,119,500	$13,334,731
2015-2016	Programmatic Pipe Replacement Elements	100%		$1,523,300		$4,399,707
	I/I Reduction	100%		$1,000,000		$1,000,000
	Minor Extensions and Oversizing		100%		$500,000	$500,000
	Lift Station Improvements	100%		$200,000		$200,000
	Treatment Plant Structures and Improvements	100%		$107,516		$107,516
	Hartnell Lift Station	100%		$117,000		$117,000
	Lake Redding Interceptor II	39%	61%	$955,500	$1,494,500	$2,450,000
	Hilltop Sewer	100%		$685,000		$685,000
			Totals:	$4,588,316	$1,994,500	$9,459,223

Year	Improvement	Cost Split		Cost		
		Rates	Fees	Rates	Fees	Total
2016-2017	Programmatic Pipe Replacement Elements	100%		$1,523,300		$4,399,707
	I/I Reduction	100%		$1,000,000		$1,000,000
	Minor Extensions and Oversizing		100%		$500,000	$500,000
	Lift Station Improvements	100%		$200,000		$200,000
	Treatment Plant Structures and Improvements	100%		$107,516		$107,516
	Clear Creek WWTP Levee	100%		$1,810,000		$1,810,000
	East Cypress Sewer	100%		$230,000		$230,000
	Canby Bypass Phase 1	100%		$440,000		$440,000
	Loma Street Alley	100%		$481,000		$481,000
	Churn Creek Road	100%		$173,000		$173,000
			Totals:	$5,964,816	$500,000	$9,341,223
2017-2018	Programmatic Pipe Replacement Elements	100%		$1,523,200		$4,399,707
	I/I Reduction	100%		$1,000,000		$1,000,000
	Minor Extensions and Oversizing		100%		$500,000	$500,000
	Lift Station Improvements	100%		$200,000		$200,000
	Treatment Plant Structures and Improvements	100%		$107,516		$107,516
	Cumberland Sewer	100%		$551,000		$551,000
	Hartnell LS		100%		$117,000	$117,000
	North Market LS	6%	94%	$7,080	$110,920	$118,000
	Hallmark Alley	100%		$612,000		$612,000
	Redbud Alley	100%		$299,000		$299,000
			Totals:	$4,299,796	$727,920	$7,904,223
2018-2019	Programmatic Pipe Replacement Elements	100%		$3,507,000		$4,399,707
	I/I Reduction	100%		$1,000,000		$1,000,000
	Minor Extensions and Oversizing		100%		$500,000	$500,000
	Lift Station Improvements	100%		$200,000		$200,000
	CC Lift Station Improvements	87%	13%	$293,284	$43,824	$337,108
	Treatment Plant Structures and Improvements	100%		$107,516		$107,516
	Bechelli South	100%		$126,000		$126,000
	Woodacre Drive	100%		$411,000		$411,000
	Patterson Ct	100%		$212,000		$212,000
			Totals:	$5,856,800	$543,824	$7,293,331
2019-2020	Programmatic Pipe Replacement Elements	100%		$4,556,200		$4,399,707
	I/I Reduction	100%		$1,000,000		$1,000,000
	Minor Extensions and Oversizing		100%		$500,000	$500,000
	Lift Station Improvements	100%		$200,000		$200,000
	Layton Lift Station	100%		$423,000		$423,000
	Locust Lift Station	100%		$495,000		$495,000
	CC Lift Station Improvements	87%	13%	$1,205,985	$180,205	$1,386,190
	Treatment Plant Structures and Improvements	100%		$107,516		$107,516
	Mercury Drive Sewer	100%		$515,000		$515,000
	Azailia I-5 Crossing	100%		$566,000		$566,000
			Totals:	$9,068,701	$680,205	$9,592,413
2020-2021	Programmatic Pipe Replacement Elements	100%		$5,835,100		$5,678,690
	I/I Reduction	100%		$1,000,000		$1,000,000
	Minor Extensions and Oversizing		100%		$500,000	$500,000
	Lift Station Improvements	100%		$200,000		$200,000
	Treatment Plant Structures and Improvements	100%		$107,516		$107,516
	Buenaventura Sewer	33%	67%	$627,990	$1,275,010	$1,903,000
	School Street	100%		$473,000		$473,000
			Totals:	$8,243,606	$1,775,010	$9,862,206

Year	Improvement	Cost Split		Cost		
		Rates	Fees	Rates	Fees	Total
2021-2022	Programmatic Pipe Replacement Elements	100%		$5,868,800		$5,678,690
	I/I Reduction	100%		$1,000,000		$1,000,000
	Minor Extensions and Oversizing		100%		$500,000	$500,000
	Lift Station Improvements	100%		$200,000		$200,000
	Treatment Plant Structures and Improvements	100%		$107,516		$107,516
	Cheryl Lift Station		100%		$139,000	$139,000
	Buenaventura Sewer	33%	67%	$627,990	$1,275,010	$1,903,000
			Totals:	$7,804,306	$1,914,010	$9,528,206
2022-2023	Programmatic Pipe Replacement Elements	100%		$5,939,100		$5,678,690
	I/I Reduction	100%		$1,000,000		$1,000,000
	Minor Extensions and Oversizing		100%		$500,000	$500,000
	Lift Station Improvements	100%		$200,000		$200,000
	Treatment Plant Structures and Improvements	100%		$107,516		$107,516
	Sulphur Creek	75%	25%	$1,554,750	$518,250	$2,073,000
			Totals:	$8,801,366	$1,018,250	$9,559,206
2023-2024	Programmatic Pipe Replacement Elements	100%		$6,053,500		$5,678,691
	I/I Reduction	100%		$1,000,000		$1,000,000
	Minor Extensions and Oversizing		100%		$500,000	$500,000
	Lift Station Improvements	100%		$200,000		$200,000
	Stillwater WWTP- Expansion 1C	75%	25%	$3,357,375	$1,119,125	$4,476,500
	Clear Creek WWTP Pond Upgrades	75%	25%	$862,500	$287,500	$1,150,000
			Totals:	$11,473,375	$1,906,625	$13,005,191
2024-2025	Programmatic Pipe Replacement Elements	100%		$6,223,700		$5,678,692
	I/I Reduction	100%		$1,000,000		$1,000,000
	Minor Extensions and Oversizing		100%		$500,000	$500,000
	Lift Station Improvements	100%		$200,000		$200,000
	Stillwater WWTP- Expansion 1C	75%	25%	$3,357,375	$1,119,125	$4,476,500
	Clear Creek WWTP Pond Upgrades	75%	25%	$862,500	$287,500	$1,150,000
			Totals:	$11,643,575	$1,906,625	$13,005,192
2025-2026	Programmatic Pipe Replacement Elements	100%		$6,157,100		$6,957,676
	I/I Reduction	100%		$1,000,000		$1,000,000
	Minor Extensions and Oversizing		100%		$500,000	$500,000
	Lift Station Improvements	100%		$200,000		$200,000
	Stillwater WWTP- Expansion 1C	75%	25%	$3,357,375	$1,119,125	$4,476,500
	Clear Creek WWTP Pond Upgrades	75%	25%	$862,500	$287,500	$1,150,000
			Totals:	$11,576,975	$1,906,625	$14,284,176
2026-2027	Programmatic Pipe Replacement Elements	100%		$6,064,900		$6,957,676
	I/I Reduction	100%		$1,000,000		$1,000,000
	Minor Extensions and Oversizing		100%		$500,000	$500,000
	Lift Station Improvements	100%		$200,000		$200,000
	Stillwater WWTP- Expansion 1C	75%	25%	$3,357,375	$1,119,125	$4,476,500
	Clear Creek WWTP Pond Upgrades	75%	25%	$862,500	$287,500	$1,150,000
			Totals:	$11,484,775	$1,906,625	$14,284,176
2027-2028	Programmatic Pipe Replacement Elements	100%		$6,064,900		$6,957,676
	I/I Reduction	100%		$1,000,000		$1,000,000
	Minor Extensions and Oversizing		100%		$500,000	$500,000
	Lift Station Improvements	100%		$200,000		$200,000
	Clear Creek WWTP Pond Upgrades	75%	25%	$862,500	$287,500	$1,150,000
			Totals:	$8,127,400	$787,500	$9,807,676

Year	Improvement	Cost Split		Cost		
		Rates	Fees	Rates	Fees	Total
2028-2029	Programmatic Pipe Replacement Elements	100%		$6,064,900		$6,957,679
	I/I Reduction	100%		$1,000,000		$1,000,000
	Minor Extensions and Oversizing		100%		$500,000	$500,000
	Lift Station Improvements	100%		$200,000		$200,000
	Boulder Creek Interceptor - Phase III	75%	25%	$1,089,000	$363,000	$1,452,000
			Totals:	$8,353,900	$863,000	$10,109,679
2029-2030	Programmatic Pipe Replacement Elements	100%		$6,064,900		$6,957,679
	I/I Reduction	100%		$1,000,000		$1,000,000
	Minor Extensions and Oversizing		100%		$500,000	$500,000
	Lift Station Improvements	100%		$200,000		$200,000
	Boulder Creek Interceptor - Phase III	75%	25%	$1,089,000	$363,000	$1,452,000
			Totals:	$8,353,900	$863,000	$10,109,679

Table 9.11 - Distribution of Project Type

Project Type	Rates	Fees	Total	Percent
Pipelines	$127,073,535	$19,078,698	$146,152,233	68%
Lift Stations	$8,688,745	$661,511	$9,350,256	4%
Treatment Plants	$46,112,415	$14,010,357	$60,122,772	28%
Total	$181,874,695	$33,750,566	$215,625,261	
Percent	84%	16%		

Table 9.12 - Percent Breakdown Within Each Project Type

Project Type	Rates	Fees
Pipelines	87%	13%
Lift Stations	93%	7%
Treatment Plants	77%	23%

CHAPTER 10
Financial Impact of the Capital Improvement Plan

10.1 BACKGROUND

The impacts of this new 10- and 20-year CIP on the existing wastewater rates and impact fee accounts was evaluated to determine what changes may be required to adequately fund the utility. The following discussion summarizes the impacts of the CIP on utility finances and reviews the methodology and details for service charge and connection fee evaluations. Recommendations will follow as the product of a cost of service study that will be prepared under contract by a consultant based on the findings of this Master Plan.

The current fee and rate schedules are the result of a report generated by the Keese Company, titled Water and Wastewater Cost of Service Study and Rate Study dated January 11, 1999, the Muni-Financial report dated May 19, 2000, the 2003 Wastewater Master Plan and the Report of the Underground Infrastructure Development Impact Fee Citizen's Ad-Hoc Committee completed July 25, 2003. New cost of service, rate and fee studies are being prepared concurrent with this effort. In consideration of the pending cost of service study, this report will examine the fiscal needs of the utility, including the new capital improvement plan, relative to the utility revenue but will not explore funding alternatives or make recommendations regarding funding mechanisms.

10.2 GENERAL ANALYSIS

The following general financial evaluation provides a framework for integrating the CIP projects into the financial analysis.

Analysis of the finances includes the following assumptions:

- Master Plan growth rate projections. Details of the Master Plan growth rate projections can be found in Chapter 3 and Appendix F. Annual growth rates range from 0.72 to 1.56% per year

- CCI escalation of cost of all projects. Cost estimates were prepared in 2012 dollars then escalated by an annual increase of 3.20% to the year the project is scheduled for completion.

- Impact fees increasing at an annual rate of 3.20% starting in 2013-14 to match the CCI

- Rates increased by the blended CCI/CPI index of 2.99% per year starting in 2013-14.

- There are additional Utility budget divisions that set aside various components of the budget for specific purposes if examined at a high enough level of detail. For instance there is an account for rolling stock with interest on the balance that is a line item on revenue. In this document all such accounts were re-combined into either fee or rate accounts for the purpose of identifying potential overall budget challenges.

Tables 10.1a and 10.1b show the impact fee budget for near (2012/13 to 2020/21) and long (2012/22 to 2029/30) term projects respectively. Tables 10-2a and 10-2b show the rate budget for near and long term projects.

10.3 SUMMARY OF FINDINGS

Tables 10.1 and 10.2 show the basic balance accounting for the Utility through 2029-30. The analysis included an assumption that rates would be increased annually by a blended CCI/CPI index of 2.99% starting in 2013-14 and Impact Fees would be increased at the 20-year average CCI rate of 3.20% per year.

A short summary of the findings of the financial analysis prepared with this Master Plan are as follows:

1. Under the current fee schedule, the Utility account remains in good standing for the projected planning time frame. The account appears to start accumulating end of year balance in approximately 2024 as debt service payments drop to zero.

2. Under the current service rates, including annual CCI/CPI increases, the rate account will drop below zero in 2014-15.

3. Risks associated with maintaining the current fee and rate schedule are:

- Pipe replacement schedule will not keep up with expiring pipe resulting in an increase in sewer pipe failure
- Treatment plant improvements may not keep up with the regulatory requirements resulting in regulatory actions potentially including fines.
- Delay in construction of facilities necessary to prevent potential SSOs thereby increasing risk of additional regulatory actions.

4. The high level analysis revealed that if rates alone are used to keep the Utility balance from dropping below zero, annual increases will need to be implemented ranging from approximately 6.5% to 2% starting with 6.5% in 2013-14.

Figure 10.1 provides a graphical representation of the end of year balance for both accounts.

Although the Cost of Service Study will ultimately make recommendations to resolve the deficit issue, for the purpose of gaining an order of magnitude understanding of the budget gap, a high level analysis was performed to determine what increases in rates would be necessary to fund the utility. Two approaches were applied in this effort to attempt to help mitigate and understand the magnitude of the budget gap, eliminating or delaying projects, and raising the rates.

Unfortunately, the analysis to determine the required projects to maintain the existing level of service and prevent potential SSOs was performed with budget constraint as a criteria so if a project is not necessary it was not listed. After evaluation of the risks associated, numerous projects were delayed beyond the recommended planning horizon. Details and discussion of the risks of delay for each project are discussed in Chapter 9 - Capital Improvement Plan. However, the delay of a project does not necessarily alter the budget deficit other than to help prevent unusually large demands on revenue in a few years.

A second analysis was performed to determine the additional increases in rates necessary to fund the utility. Results of the rate increase analysis are presented in Tables 10.3a, 10.3b and summarized in Table 10.4.

Table 10.1a - CIP Impact on Connection Fee Account

	Year								
	12-13	13-14	14-15	15-16	16-17	17-18	18-19	19-20	20-21
Beginning Balance	$20,946,293	$18,524,106	$17,002,835	$13,998,305	$12,230,177	$12,509,821	$12,693,798	$13,275,356	$13,922,505
Revenue									
Connection Fees	$1,218,926	$2,384,493	$2,570,078	$2,616,720	$3,071,954	$3,256,330	$3,463,333	$3,716,968	$3,993,317
SRF Proceeds	$4,006,850	$2,828,125	$961,713						
Total Revenue	$5,225,776	$5,212,618	$3,531,791	$2,616,720	$3,071,954	$3,256,330	$3,463,333	$3,716,968	$3,993,317
Expenditures									
Capital Improvements	$6,426,040	$4,884,500	$4,549,147	$2,284,438	$608,082	$902,865	$702,257	$900,197	$2,382,692
Debt Service	$1,543,225	$2,093,614	$2,214,631	$2,214,631	$2,214,631	$2,214,631	$2,214,631	$2,214,631	$2,214,631
Total Expenditures	$7,969,265	$6,978,114	$6,763,779	$4,499,069	$2,822,714	$3,117,497	$2,916,888	$3,114,828	$4,597,324
Expected Savings @ 5% Capital	$321,302	$244,225	$227,457	$114,222	$30,404	$45,143	$35,113	$45,010	$119,135
Ending Balance	$18,524,106	$17,002,835	$13,998,305	$12,230,177	$12,509,821	$12,693,798	$13,275,356	$13,922,505	$13,437,634
Assumptions									
Increase in HE	274	282	286	294	349	360	373	389	406
Connection Fee (effective Jan 1)	$6,920	$7,142	$7,370	$7,606	$7,850	$8,101	$8,360	$8,628	$8,904
Construction Cost Index Increase, %	3.2%	3.2%	3.2%	3.2%	3.2%	3.2%	3.2%	3.2%	3.2%
Fee Increases, %	3.2%	3.2%	3.2%	3.2%	3.2%	3.2%	3.2%	3.2%	3.2%

Table 10.1b - CIP Impact on Connection Fee Account

	Year								
	21-22	22-23	23-24	24-25	25-26	26-27	27-28	28-29	29-30
Beginning Balance	$13,437,634	$12,976,588	$13,949,858	$14,449,892	$15,268,912	$16,943,759	$19,053,916	$22,211,829	$25,416,368
Revenue									
Connection Fees	$4,270,399	$4,581,969	$4,968,839	$5,371,682	$6,314,107	$6,838,811	$7,433,274	$8,084,059	$8,788,831
SRF Proceeds									
Total Revenue	$4,270,399	$4,581,969	$4,968,839	$5,371,682	$6,314,107	$6,838,811	$7,433,274	$8,084,059	$8,788,831
Expenditures									
Capital Improvements	$2,649,278	$1,467,439	$2,760,189	$2,848,458	$2,939,615	$3,033,713	$2,556,563	$3,258,519	$3,318,625
Debt Service	$2,214,631	$2,214,631	$1,846,626	$1,846,626	$1,846,626	$1,846,626	$1,846,626	$1,783,927	$1,710,401
Total Expenditures	$4,863,909	$3,682,070	$4,606,815	$4,695,085	$4,786,241	$4,880,339	$4,403,189	$5,042,446	$5,029,026
Expected Savings @ 5% Capital	$132,464	$73,372	$138,009	$142,423	$146,981	$151,686	$127,828	$162,926	$165,931
Ending Balance	$12,976,588	$13,949,858	$14,449,892	$15,268,912	$16,943,759	$19,053,916	$22,211,829	$25,416,368	$29,342,104
Assumptions									
Increase in HE	425	446	469	493	566	593	623	653	685
Connection Fee (effective Jan 1)	$9,189	$9,483	$9,786	$10,099	$10,422	$10,756	$11,100	$11,455	$11,822
Construction Cost Index Increase, %	3.2%	3.2%	3.2%	3.2%	3.2%	3.2%	3.2%	3.2%	3.2%
Fee Increases	3.2%	3.2%	3.2%	3.2%	3.2%	3.2%	3.2%	3.2%	3.2%

Table 10.2a - CIP Impact on Rate Account

	Year								
	12-13	13-14	14-15	15-16	16-17	17-18	18-19	19-20	20-21
Beginning Balance	$13,832,529	$5,608,149	$3,698,943	$930,998	($2,060,026)	($6,373,830)	($8,604,988)	($12,164,121)	($17,526,464)
Revenue									
Rate Revenue	$20,883,259	$21,465,810	$22,237,284	$22,976,454	$23,796,089	$24,702,381	$25,649,345	$26,638,783	$27,674,489
SRF Loan Proceeds	$12,788,150	$8,674,375	$2,885,138						
Rolling Stock Asset/Sales & Acct Interest	$361,731	$53,250	$56,714	$127,559	$64,331	$68,510	$160,237	$77,713	$175,714
Expected Savings @ 1% Pers & O&M	$89,203	$94,682	$98,416	$102,277	$106,157	$110,173	$111,659	$115,999	$120,469
Expected Savings @ 5% Capital	$657,333	$208,207	$250,340	$279,122	$365,614	$277,217	$388,030	$603,124	$572,897
Total Revenue	$34,779,676	$30,496,324	$25,527,891	$23,485,412	$24,332,191	$25,158,282	$26,309,271	$27,435,619	$28,543,569
Expenses									
O&M *	$12,300,546	$13,017,925	$13,491,720	$13,981,252	$14,475,753	$14,987,060	$15,248,658	$15,799,044	$16,365,910
Debt Service	$4,618,695	$6,399,081	$6,762,178	$6,762,748	$6,757,955	$6,758,043	$6,759,143	$4,836,443	$4,836,443
Capital Expenses (Rates)	$25,934,816	$12,838,524	$7,891,938	$5,582,437	$7,312,286	$5,544,337	$7,760,603	$12,062,475	$11,457,946
Rolling Stock	$150,000	$150,000	$150,000	$150,000	$100,000	$100,000	$100,000	$100,000	$100,000
Total Expenditures	$43,004,057	$32,405,530	$28,295,836	$26,476,437	$28,645,995	$27,389,440	$29,868,404	$32,797,962	$32,760,298
Ending Balance	$5,608,149	$3,698,943	$930,998	($2,060,026)	($6,373,830)	($8,604,988)	($12,164,121)	($17,526,464)	($21,743,193)
Assumptions									
Increase in HE	274	282	286	294	349	360	373	389	406
Blended CCI/CPI Cost Index Increase, %	0.00%	2.99%	2.99%	2.99%	2.99%	2.99%	2.99%	2.99%	2.99%
Total Increase	0.00%	2.99%	2.99%	2.99%	2.99%	2.99%	2.99%	2.99%	2.99%

Table 10.2b - CIP Impact on Rate Account

	Year								
	21-22	22-23	23-24	24-25	25-26	26-27	27-28	28-29	29-30
Beginning Balance	($21,743,193)	($25,139,338)	($29,668,008)	($36,868,358)	($44,119,028)	($51,049,753)	($57,540,602)	($62,061,557)	($67,703,910)
Revenue									
Rate Revenue	$28,759,284	$29,806,819	$31,001,015	$32,256,067	$33,575,750	$34,999,686	$36,499,392	$38,081,104	$39,749,092
SRF Loan Proceeds									
Rolling Stock Asset/Sales & Acct Interest	$88,144	$93,879	$202,131	$106,481	$113,405	$233,064	$128,636	$137,003	$145,906
Expected Savings @ 1% Pers & O&M	$124,073	$127,785	$131,607	$135,545	$139,599	$143,775	$148,076	$152,506	$129,545
Expected Savings @ 5% Capital	$556,919	$645,928	$867,606	$903,662	$928,204	$957,003	$896,592	$1,019,278	$1,050,675
Total Revenue	$29,528,419	$30,674,411	$32,202,359	$33,401,755	$34,756,959	$36,333,529	$37,672,696	$39,389,891	$41,075,218
Expenses									
O&M *	$16,849,748	$17,348,068	$17,861,304	$18,389,901	$18,934,319	$19,495,032	$20,072,526	$20,667,306	$18,527,509
Debt Service	$4,836,443	$4,836,443	$4,089,281	$4,089,281	$4,089,281	$4,089,281	$4,089,281	$3,879,375	$3,633,224
Capital Expenses (Rates)	$11,138,373	$12,918,570	$17,352,123	$18,073,242	$18,564,083	$19,140,066	$17,931,843	$20,385,564	$21,013,502
Rolling Stock	$100,000	$100,000	$100,000	$100,000	$100,000	$100,000	$100,000	$100,000	$100,000
Total Expenditures	$32,924,565	$35,203,081	$39,402,709	$40,652,425	$41,687,684	$42,824,379	$42,193,651	$45,032,245	$43,274,235
Ending Balance	($25,139,338)	($29,668,008)	($36,868,358)	($44,119,028)	($51,049,753)	($57,540,602)	($62,061,557)	($67,703,910)	($69,902,928)
Assumptions									
Increase in HE	425	446	469	493	566	593	623	653	685
Blended CCI/CPI Cost Index Increase, %	2.99%	2.99%	2.99%	2.99%	2.99%	2.99%	2.99%	2.99%	2.99%
Rate Increases, %	2.99%	2.99%	2.99%	2.99%	2.99%	2.99%	2.99%	2.99%	2.99%

* O&M includes Personnel, O&M Expenses, and Interdepartmental Expenses

Table 10.3a - CIP Impact on Rate Account with Rate Increases

	Year								
	12-13	13-14	14-15	15-16	16-17	17-18	18-19	19-20	20-21
Beginning Balance	$13,832,529	$5,608,149	$4,423,089	$3,201,956	$2,569,819	$1,470,611	$3,089,226	$3,860,729	$3,316,312
Revenue									
Rate Revenue	$20,883,259	$22,189,956	$23,784,096	$25,335,341	$27,010,684	$28,552,155	$29,979,981	$31,456,710	$32,662,329
SRF Loan Proceeds	$12,788,150	$8,674,375	$2,885,138						
Rolling Stock Asset/Sales & Acct Interest	$361,731	$53,250	$56,714	$127,559	$64,331	$68,510	$160,237	$77,713	$175,714
Expected Savings @ 1% Pers & O&M	$89,203	$94,682	$98,416	$102,277	$106,157	$110,173	$111,659	$115,999	$120,469
Expected Savings @ 5% Capital	$657,333	$208,207	$250,340	$279,122	$365,614	$277,217	$388,030	$603,124	$572,897
Total Revenue	$34,779,676	$31,220,470	$27,074,703	$25,844,299	$27,546,786	$29,008,055	$30,639,907	$32,253,545	$33,531,409
Expenses									
O&M *	$12,300,546	$13,017,925	$13,491,720	$13,981,252	$14,475,753	$14,987,060	$15,248,658	$15,799,044	$16,365,910
Debt Service	$4,618,695	$6,399,081	$6,762,178	$6,762,748	$6,757,955	$6,758,043	$6,759,143	$4,836,443	$4,836,443
Capital Expenses (Rates)	$25,934,816	$12,838,524	$7,891,938	$5,582,437	$7,312,286	$5,544,337	$7,760,603	$12,062,475	$11,457,946
Rolling Stock	$150,000	$150,000	$150,000	$150,000	$100,000	$100,000	$100,000	$100,000	$100,000
Total Expenditures	$43,004,057	$32,405,530	$28,295,836	$26,476,437	$28,645,995	$27,389,440	$29,868,404	$32,797,962	$32,760,298
Ending Balance	$5,608,149	$4,423,089	$3,201,956	$2,569,819	$1,470,611	$3,089,226	$3,860,729	$3,316,312	$4,087,423
Assumptions									
Increase in HE	274	282	286	294	349	360	373	389	406
Blended CCI/CPI Cost Index Increase, %	0.00%	2.99%	2.99%	2.99%	2.99%	2.99%	2.99%	2.99%	2.99%
Additional Increase, %	0.00%	3.51%	3.51%	3.01%	3.01%	2.01%	1.01%	1.01%	
Total Rate Increase, %	0.00%	6.50%	6.50%	6.00%	6.00%	5.00%	4.00%	4.00%	2.99%

Table 10.3b - CIP Impact on Rate Account with Rate Increases

	Year								
	21-22	22-23	23-24	24-25	25-26	26-27	27-28	28-29	29-30
Beginning Balance	$4,087,423	$5,914,021	$6,854,488	$5,252,987	$3,873,563	$3,003,950	$2,683,526	$4,278,707	$4,623,128
Revenue									
Rate Revenue	$33,958,868	$35,257,903	$36,689,572	$38,123,810	$39,640,188	$41,293,187	$42,637,519	$44,098,836	$45,593,675
SRF Loan Proceeds									
Rolling Stock Asset/Sales & Acct Interest	$111,302	$111,932	$112,423	$109,984	$110,080	$109,989	$106,644	$106,046	$105,205
Expected Savings @ 1% Pers & O&M	$124,073	$127,785	$131,607	$135,545	$139,599	$143,775	$148,076	$152,506	$129,545
Expected Savings @ 5% Capital	$556,919	$645,928	$867,606	$903,662	$928,204	$957,003	$896,592	$1,019,278	$1,050,675
Total Revenue	$34,751,163	$36,143,548	$37,801,208	$39,273,001	$40,818,071	$42,503,954	$43,788,832	$45,376,666	$46,879,099
Expenses									
O&M *	$16,849,748	$17,348,068	$17,861,304	$18,389,901	$18,934,319	$19,495,032	$20,072,526	$20,667,306	$18,527,509
Debt Service	$4,836,443	$4,836,443	$4,089,281	$4,089,281	$4,089,281	$4,089,281	$4,089,281	$3,879,375	$3,633,224
Capital Expenses (Rates)	$11,138,373	$12,918,570	$17,352,123	$18,073,242	$18,564,083	$19,140,066	$17,931,843	$20,385,564	$21,013,502
Rolling Stock	$100,000	$100,000	$100,000	$100,000	$100,000	$100,000	$100,000	$100,000	$100,000
Total Expenditures	$32,924,565	$35,203,081	$39,402,709	$40,652,425	$41,687,684	$42,824,379	$42,193,651	$45,032,245	$43,274,235
Ending Balance	$5,914,021	$6,854,488	$5,252,987	$3,873,563	$3,003,950	$2,683,526	$4,278,707	$4,623,128	$8,227,992
Assumptions									
Increase in HE	425	446	469	493	566	593	623	653	685
Construction Cost Index Increase, %	2.99%	2.99%	2.99%	2.99%	2.99%	2.99%	2.00%	2.00%	2.00%
Additional Increase, %									
Total Rate Increase, %	2.99%	2.99%	2.99%	2.99%	2.99%	2.99%	2.00%	2.00%	2.00%

* O&M includes Personnel, O&M Expenses, and Interdepartmental Expenses

Figure 10.1 - Utility Account End of Year Balance

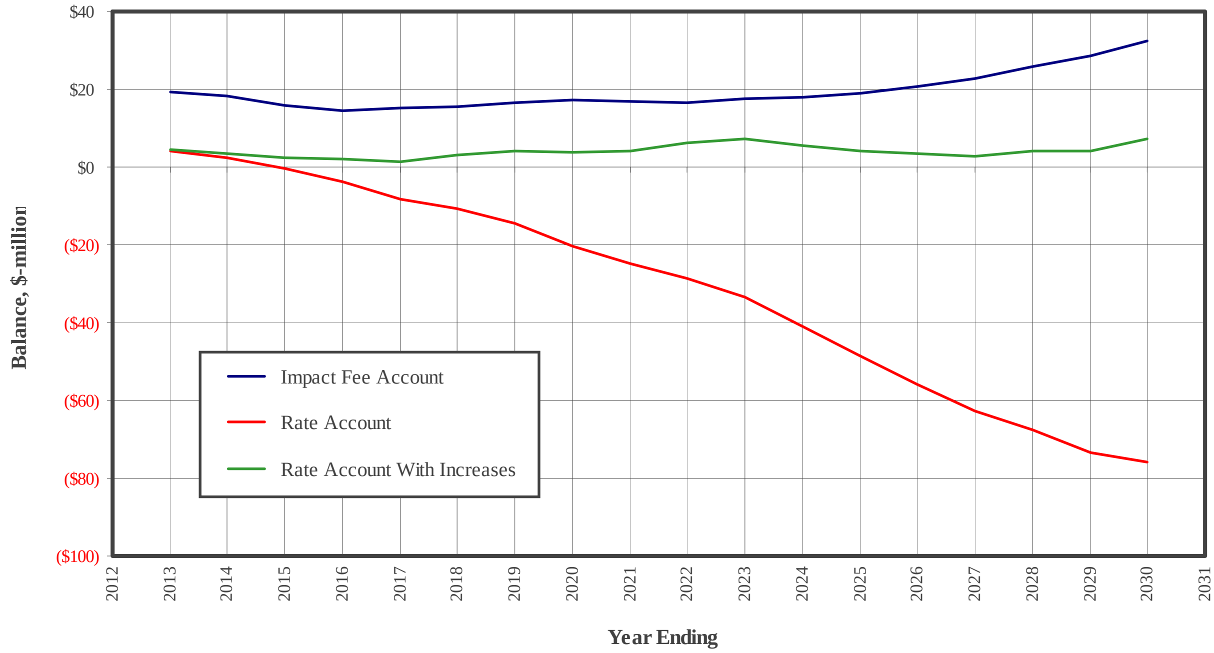


Table 10.4 - Rate Increase Analysis Schedule

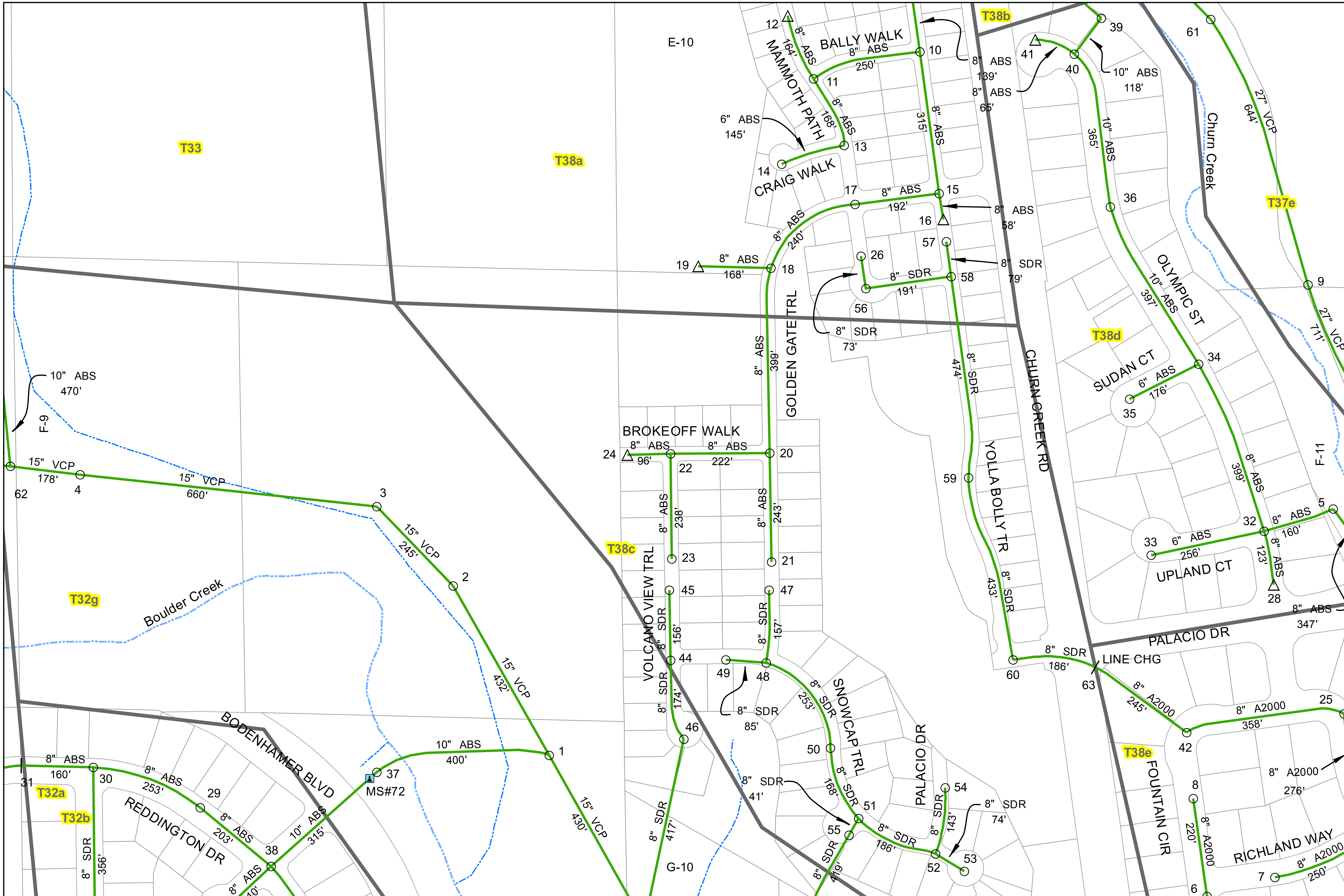
Year	CCI/CPI %	Additional Increase %	Total %	Cumulative %
2012-13	0	0	0	0
2013-14	3	3.5	6.5	6.5
2014-15	3	3.5	6.5	13.4
2015-16	3	3	6	20.2
2016-17	3	3	6	27.4
2017-18	3	2	5	33.8
2018-19	3	1	4	39.2
2019-20	3	1	4	44.7
2020-21	3	0	3	49.1

Year	CCI/CPI %	Additional Increase %	Total %	Cumulative %
2021-22	3	0	3	53.5
2022-23	3	0	3	58.2
2023-24	3	0	3	62.9
2024-25	3	0	3	67.8
2025-26	3	0	3	72.8
2026-27	2	0	3	78.0
2027-28	2	0	2	81.6
2028-29	2	0	2	85.2
2029-30	2	0	2	88.9

APPENDIX A

Sewer Demand Allocation

This appendix contains detailed information regarding allocation of sewer demands to each sanitary service area (SSA) in the computer analysis. Detailed delineation of SSA boundaries can be found in the City of Redding Wastewater Utility Atlas which is included as part of this plan by reference. An example page from the Atlas is included followed by tables indicating the number of household equivalents of each user type assigned to each SSA for each planning horizon.



CITY OF REDDING WASTEWATER MAPBOOK

LAST UPDATE FEBRUARY 9, 2010

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Table A.1: Clear Creek Collection System Sewer Allocation

SSA	Area, ac	2010 HE allocation			2015 HE allocation			2020 HE allocation			2030 HE allocation			UBO HE allocation		
		Commercial	Multiple Family	Single Family	Commercial	Multiple Family	Single Family	Commercial	Multiple Family	Single Family	Commercial	Multiple Family	Single Family	Commercial	Multiple Family	Single Family
C2	119.9	124.0	38.4	38.4	128.3	39.8	39.8	128.3	39.8	39.8	128.3	39.8	39.8	206.0	63.8	63.8
C11	256.6			14.0			44.9			45.0			73.4			536.0
C12	86.8	70.8	42.2	1.0	71.2	42.4	1.0	71.3	42.4	1.0	77.0	45.9	1.1	112.2	66.8	1.6
C14a	89.1			23.0			25.6			25.6			33.9			528.0
C14b	147.5			15.0			17.9			17.9			21.7			412.9
C15	81.8	10.0	8.0	6.0	10.3	8.2	6.2	10.3	8.2	6.2	10.5	8.4	6.3	40.6	32.5	24.3
C16a	14.8	66.0	71.8		66.0	71.8		66.0	71.8		66.0	71.8		66.0	71.8	
C16b	61.0		59.2	29.6		59.2	29.6		59.2	29.6		59.3	29.6		59.7	29.8
C17	41.8	14.9			15.8			15.8			17.3			27.7		
C18a	20.3			70.1			70.3			70.4			71.1			76.7
C18b	13.8			53.0			53.1			53.1			53.7			57.8
C19	36.3	76.1	26.6	77.0	76.3	26.7	77.1	76.3	26.7	77.2	76.8	26.9	77.7	80.5	28.2	81.4
C20a	28.1	1.7		32.0	1.7		32.4	1.7		32.4	1.7		32.5	3.1		57.9
C20b	28.3			8.0			8.6			8.6			8.7			19.7
C21	96.4			23.0			23.1			23.1			23.1			23.4
C22	141.6			44.0			44.0			45.0			46.6			873.2
C23	72.9			14.0			14.0			14.0			14.0			155.0
C24	204.6		28.9	11.0		29.4	11.2		30.0	11.4		31.2	11.9		583.6	222.4
C25a	14.4			30.0			30.1			30.1			30.2			63.5
C25b	21.8			103.0			103.4			103.4			103.5			132.8
C25c	19.6			41.0			41.3			41.3			41.3			79.5
C25d	6.3	3.0		56.0	3.0		56.1	3.0		56.1	3.0		56.1	3.5		64.1
C26	39.7			46.0			46.4			46.6			47.8			69.9
C27	70.7			24.0			25.2			25.2			25.5			113.2
C28	156.1			40.0			41.1			41.4			44.6			326.2
C29B	27.8		2.0	24.0		2.0	24.0		2.0	24.3		2.1	24.9		7.7	92.2
C30a	75.5		81.0	12.0		81.0	12.0		81.0	12.0		81.3	12.1		83.5	12.4
C30b	22.6	12.0		3.0	12.0		3.0	12.0		3.0	12.0		3.0	28.6		7.1
C30c	13.6	28.0	237.8	6.0	28.0	237.8	6.0	28.0	237.8	6.0	28.0	237.8	6.0	28.1	238.5	6.0
C31	48.0			15.0			15.0			15.0			15.4			117.7
C32	119.5	10.9	32.6	63.0	11.0	33.0	63.8	11.0	33.0	63.8	11.0	33.0	63.8	18.6	55.8	108.0
C33a	91.4			49.0			50.1			50.1			50.1			52.3
C33b	22.5			22.0			22.1			22.1			22.1			75.4
C34a	41.2	80.0		40.0	80.0		40.0	80.0		40.0	80.0		40.0	171.2		85.6
C34b	32.2	84.7		59.0	84.7		59.0	84.7		59.0	84.7		59.0	102.2		71.3
C34c	35.6	10.0		109.0	10.0		109.0	10.0		109.0	10.0		109.0	16.7		182.2
C34d	55.7	9.8		110.0	9.8		110.0	9.8		110.0	9.8		110.0	9.8		110.0
C36	75.3	170.0	35.5		170.0	35.5		170.0	35.5		170.0	35.5		170.0	35.5	
C37B	69.9	31.2		3.0	32.5		3.1	32.5		3.1	34.0		3.3	45.2		4.3
C38A	51.3	1.0			7.8			7.8			11.9			50.5		
C39	145.3			37.0			37.4			37.4			37.4			270.1
C40a	24.2	28.0	1.0	31.0	28.0	1.0	31.0	28.0	1.0	31.0	28.0	1.0	31.0	66.5	2.4	73.6
C40b	36.2			35.0			35.1			35.1			35.1			143.5
C41A	13.2		82.9	43.0		82.9	43.0		82.9	43.0		82.9	43.0		94.3	48.9
C41B	10.3			24.0			24.0			24.0			24.0			24.0
C42a	34.2	7.1	13.3	40.5	7.1	13.3	40.5	7.1	13.3	40.5	7.1	13.3	40.5	12.3	23.0	70.0
C42b	14.8			142.0			142.0			142.0			142.0			175.9
C43	37.0	1.1	98.9	56.4	1.1	98.9	56.4	1.1	98.9	56.4	1.1	98.9	56.4	1.1	98.9	56.4
C44A	10.2		27.6	10.0		27.6	10.0		27.7	10.0		27.7	10.0		32.8	11.9
C44B	61.5		2.0	36.5		2.0	36.5		2.0	36.5		2.0	36.5		2.4	43.8
C56	237.7		45.5	35.0		45.5	35.0		45.5	35.0		45.5	35.0		45.5	35.0
E1a	16.9			3.0			3.0			3.0			3.0			3.0
E1b	14.5	52.3	20.0	1.0	52.3	20.0	1.0	52.3	20.0	1.0	52.3	20.0	1.0	52.3	20.0	1.0
E1c	10.6	93.3			93.3			93.3			93.3			93.3		
E1d	31.5	226.2	137.6		226.2	137.6		226.2	137.6		226.2	137.6		226.2	137.6	

Table A.1: Clear Creek Collection System Sewer Allocation

SSA	Area, ac	2010 HE allocation			2015 HE allocation			2020 HE allocation			2030 HE allocation			UBO HE allocation		
		Commercial	Multiple Family	Single Family	Commercial	Multiple Family	Single Family	Commercial	Multiple Family	Single Family	Commercial	Multiple Family	Single Family	Commercial	Multiple Family	Single Family
E1e	94.8		262.7	3.0		262.9	3.0		262.9	3.0		263.1	3.0		937.3	10.7
E2a	10.2			18.0			19.1			19.1			19.1			41.6
E2b	37.1			58.5			62.4			62.5			64.0			230.3
E2c	31.2	22.9		12.0	23.1		12.1	23.1		12.1	24.3		12.7	251.6		131.8
E2d	32.1			14.0			16.5			16.5			16.5			301.4
E2e	15.5			16.0			16.0			16.0			16.0			190.5
E2f	12.7			26.0			26.1			26.1			26.1			142.5
E3	57.0			32.0			33.1			33.1			33.1			202.1
E4a	21.6			27.0			29.0			29.1			29.6			45.2
E4b	64.0			32.0			39.3			39.6			39.6			72.6
E5a	12.1			42.0			42.0			42.0			42.0			45.0
E5b	21.3			19.0			19.0			19.0			19.0			19.0
E5c	74.9	40.5		2.0	42.1		2.1	42.4		2.1	43.7		2.2	77.1		3.8
E5d	39.1			55.0			55.0			55.0			55.0			275.8
E5f	25.1			37.0			37.0			37.0			37.0			79.3
E5g	30.3			12.0			12.0			12.0			12.0			12.0
E5h	20.8			24.0			24.0			24.0			24.0			24.1
E5i	11.9			93.0			93.0			93.0			93.0			93.0
E5j	14.6			23.0			23.0			23.0			23.0			23.0
E14Aa	18.1			49.0			49.0			49.0			49.0			65.0
E14Ab	11.9		107.0	82.2		107.0	82.2		107.0	82.2		107.0	82.2		110.4	84.8
E14Ac	16.4			21.0			21.0			21.0			21.0			21.0
E14Ad	17.9			115.0			115.0			115.0			115.0			115.0
E15a	13.8		3.7	37.5		3.7	37.5		3.8	37.7		4.0	40.5		85.5	856.6
E15b	44.0	5.4		10.0	5.4		10.0	5.5		10.1	5.9		10.9	50.3		93.4
E15c	24.8	121.3		75.0	121.3		75.0	121.3		75.0	121.3		75.0	136.3		84.3
E15d	17.9	15.9		36.0	15.9		36.0	15.9		36.0	15.9		36.0	19.5		44.2
E15e	11.3	1.0		55.0	1.0		55.3	1.0		55.3	1.0		55.3	1.0		55.9
E16a	13.6		2.0	48.0		2.0	48.0		2.0	48.0		2.0	48.2		2.2	52.1
E16b	46.6	39.1		49.0	39.1		49.0	39.1		49.0	39.1		49.0	39.1		49.0
E16c	18.3	559.3		36.0	559.3		36.0	559.4		36.0	559.4		36.0	560.4		36.1
E17a	19.0			38.0			39.1			39.1			39.1			41.8
E17b	16.7	9.9	26.5	29.5	9.9	26.5	29.5	9.9	26.5	29.5	9.9	26.6	29.5	10.1	27.1	30.1
E17c	9.4			40.0			40.0			40.0			40.0			40.0
E17d	17.7	15.8		37.0	15.8		37.0	15.8		37.0	15.8		37.2	17.5		41.1
E18a	30.2			19.0			19.7			19.7			19.7			26.9
E18b	19.6			31.0			32.1			32.1			32.1			62.1
E18c	12.2			22.0			22.0			22.0			22.0			29.2
E18d	10.5			42.0			42.0			42.0			42.5			93.0
E18e	18.4			51.0			53.2			53.2			53.2			72.7
E18f	11.0			42.0			42.0			42.0			42.5			63.1
E18g	23.0			58.0			59.9			59.9			60.0			109.4
E19a	19.5			60.0			60.6			60.6			60.6			65.4
E19b	16.7	2.7	1.2	62.1	2.8	1.2	62.6	2.8	1.2	62.6	2.8	1.2	62.6	3.1	1.4	69.5
E19c	28.6			65.0			65.2			65.2			65.2			78.9
E19d	18.0			45.0			45.1			45.1			45.1			64.2
E20a	9.9	2.2	5.9	45.5	2.3	5.9	45.7	2.3	5.9	45.7	2.3	5.9	45.7	2.3	6.2	47.6
E20b	21.1			84.0			84.6			84.6			84.6			108.6
E20c	9.2			38.0			38.3			38.3			38.3			52.5
E20d	15.8			28.0			28.4			28.4			28.4			29.3
E21a	39.3			33.0			33.0			33.0			33.0			33.1
E21b	22.2			23.0			23.6			23.6			23.6			24.9
E21c	33.3			36.0			37.3			37.3			37.3			40.0
E21d	18.7		40.7	134.2		40.7	134.3		40.7	134.3		40.7	134.3		44.7	147.3
E22a	40.2			96.7			97.5			97.5			97.5			327.0

Table A.1: Clear Creek Collection System Sewer Allocation

SSA	Area, ac	2010 HE allocation			2015 HE allocation			2020 HE allocation			2030 HE allocation			UBO HE allocation		
		Commercial	Multiple Family	Single Family	Commercial	Multiple Family	Single Family	Commercial	Multiple Family	Single Family	Commercial	Multiple Family	Single Family	Commercial	Multiple Family	Single Family
E22b	28.6	1.2		81.0	1.2		81.2	1.2		81.2	1.2		81.5	1.3		83.7
E22c	55.4	9.0	14.9	31.0	9.2	15.2	31.6	9.2	15.2	31.6	9.2	15.2	31.6	9.5	15.7	32.8
E22d	20.0			38.0			38.1			38.1			38.1			38.3
E24a	47.6	6.8		32.0	7.4		35.3	7.4		35.3	7.4		35.3	8.8		41.9
E24b	23.5			77.0			78.1			78.1			78.1			80.4
E25	138.6			16.0			21.7			21.7			28.5			78.1
E26a	38.1			104.0			104.6			104.6			104.7			106.3
E26b	39.2			26.0			26.0			26.0			26.8			31.1
E26c	31.8			42.0			42.6			42.6			42.6			43.9
E27a	20.1			34.0			34.3			34.3			34.3			34.8
E27b	33.0			17.0			17.5			17.5			17.5			94.6
E27c	108.6			11.0			11.0			11.0			11.0			11.5
E28a	40.9			39.0			39.0			39.0			39.0			39.0
E28b	55.6			35.0			35.0			35.0			37.7			52.9
E29a	112.7		14.4	73.7		17.4	89.3		17.5	89.4		17.5	89.4		24.7	126.4
E29b	45.8			55.0			55.1			55.1			55.1			55.4
E29c	45.1			61.0			61.0			61.0			61.0			61.0
E30a	16.9			21.5			21.5			21.5			21.5			21.5
E30b	12.2		6.5	21.0		6.5	21.0		6.5	21.0		6.5	21.0		6.5	21.0
E30c	13.1			24.0			24.0			24.0			24.0			24.0
E30d	12.5	7.2		7.0	7.2		7.0	7.2		7.0	7.2		7.0	7.2		7.0
E31a	9.8			28.0			28.2			28.2			28.2			35.9
E31b	7.8			29.0			29.2			29.2			29.2			38.9
E31c	12.4			13.0			13.3			13.3			13.3			22.9
E31d	21.8	35.2		6.0	35.6		6.1	35.6		6.1	35.6		6.1	46.9		8.0
E31e	26.6	448.9		29.0	448.9		29.0	448.9		29.0	448.9		29.0	448.9		29.0
E31f	9.2			56.0			56.0			56.0			56.0			56.0
E31g	9.5			68.0			68.0			68.0			68.0			68.0
E32a	40.0	7.4		44.5	7.5		45.3	7.5		45.3	7.5		45.3	9.0		54.6
E32b	15.3	82.9	53.5	31.0	82.9	53.5	31.0	82.9	53.5	31.0	82.9	53.5	31.0	82.9	53.5	31.0
E32c	18.5			40.0			40.6			40.6			40.6			41.8
E32d	6.6	5.6		41.0	5.6		41.0	5.6		41.0	5.6		41.0	5.6		41.0
E32e	17.1			59.0			59.0			59.0			59.0			59.0
E32f	9.5			39.0			39.0			39.0			39.0			39.0
E42A	30.9		7.0	19.0		7.6	20.5		7.6	20.5		7.6	20.6		9.2	24.9
E43a	17.0			27.0			27.0			27.0			27.0			51.8
E43b	49.5	19.0		26.0	19.0		26.0	19.0		26.0	19.0		26.0	33.8		46.2
E43c	44.5			64.0			64.0			64.0			64.0			92.9
E43d	58.9			44.0			44.0			44.0			44.0			60.7
E44	16.0			82.0			82.2			82.2			82.2			82.7
E45	148.5	39.8	18.6	51.0	39.8	18.6	51.0	39.8	18.6	51.0	39.8	18.6	51.0	40.0	18.7	51.2
E46a	14.5	30.4	7.4	5.0	30.4	7.4	5.0	30.4	7.4	5.0	30.4	7.4	5.0	34.8	8.5	5.7
E46b	11.9			22.0			22.3			22.3			22.3			33.4
E46c	12.5	25.6		89.0	25.7		89.2	25.7		89.2	25.7		89.2	28.3		98.4
E46d	43.1			40.0			40.0			40.0			40.0			100.8
E46e	6.9			13.0			13.2			13.2			13.2			19.9
E47a	80.1	1.0	101.9	15.4	1.1	109.5	16.6	1.1	109.5	16.6	1.1	110.0	16.7	1.5	148.9	22.6
E48	48.1			31.0			31.0			31.0			31.0			101.1
E51a	20.9			22.0			22.0			22.0			22.3			23.9
E51b	31.6			69.5			69.5			69.5			69.9			272.1
E52	106.2			36.0			36.0			36.0			37.5			409.9
E53	107.8			26.7			28.2			28.2			42.5			211.2
E54a	48.3	35.9		3.0	36.0		3.0	36.3		3.0	41.9		3.5	96.7		8.1
E54b	43.4			43.0			43.0			43.1			43.1			71.8
E55a	19.6			31.0			31.1			31.2			31.2			161.1

Table A.1: Clear Creek Collection System Sewer Allocation

SSA	Area, ac	2010 HE allocation			2015 HE allocation			2020 HE allocation			2030 HE allocation			UBO HE allocation		
		Commercial	Multiple Family	Single Family	Commercial	Multiple Family	Single Family	Commercial	Multiple Family	Single Family	Commercial	Multiple Family	Single Family	Commercial	Multiple Family	Single Family
E55b	14.4	8.4	76.6	55.6	8.4	76.7	55.6	8.4	76.7	55.7	8.4	76.7	55.7	17.8	162.8	118.2
E55c	27.0			46.0			46.1			46.2			46.2			135.7
E55d	29.8			54.0			54.1			54.3			54.3			99.7
E55e	13.1			67.0			67.0			67.1			67.1			71.9
E55f	11.9			48.0			48.0			48.0			48.0			128.1
E55g	13.2			37.0			37.0			37.0			37.0			58.4
E56	41.2			25.0			25.5			25.6			27.5			42.5
E57Aa	34.6	71.8		24.0	71.8		24.0	71.8		24.0	71.8		24.0	71.8		24.0
E57Ab	15.6	71.8	29.6	104.3	71.9	29.6	104.5	71.9	29.6	104.5	72.2	29.8	104.9	74.6	30.8	108.5
E57Ba	22.7		89.7	1.0		90.0	1.0		90.0	1.0		92.9	1.0		109.5	1.2
E57Bb	7.7			65.5			65.7			65.7			67.4			77.2
E57Bc	16.3			16.0			16.4			16.4			19.7			39.5
E57Bd	5.4			77.7			77.9			77.9			78.6			83.5
E58a	26.3			48.0			48.0			48.0			48.0			48.0
E58b	22.8			45.0			45.0			45.0			45.0			45.0
E58c	21.4		273.6	60.0		273.8	60.1		273.8	60.1		274.5	60.2		280.4	61.5
E59a	30.0			55.0			55.5			55.5			55.5			56.4
E59b	32.6			53.0			53.3			53.3			53.3			90.9
E59c	39.5			100.0			100.3			100.3			100.3			100.9
E59d	31.1		246.4	1.0		246.4	1.0		246.4	1.0		246.4	1.0		322.0	1.3
E60	86.1		3.0	50.0		3.0	50.2		3.0	50.2		3.0	50.2		3.0	50.6
E61	98.1		168.2	31.8		168.2	31.8		168.2	31.8		168.5	31.9		184.7	34.9
E62	218.5	16.6			16.6			16.6			16.6			41.0		
E63	41.3		17.8	57.5		17.8	57.5		17.8	57.5		17.8	57.5		25.2	81.8
E64a	6.8	8.9	106.6		8.9	106.6		8.9	106.6		8.9	106.6		8.9	106.6	
E64b	10.9	1.5	4.5	34.0	1.5	4.5	34.0	1.5	4.5	34.0	1.5	4.5	34.0	2.9	8.8	67.0
E64c	21.1			50.0			50.0			50.0			50.0			50.0
E64d	13.7			85.0			85.0			85.0			85.0			85.0
E64e	10.3			85.0			85.0			85.0			85.0			85.0
E64f	49.0			51.0			52.3			52.4			56.0			88.0
E65	33.1			149.0			149.0			149.0			149.1			254.2
E66a	9.2			11.0			11.1			11.2			11.2			19.8
E66b	9.0			45.0			45.0			45.1			45.1			52.1
E66c	17.6			38.0			38.3			38.4			38.5			42.2
E67a	75.4			50.0			50.0			50.0			50.0			466.4
E67b	21.3			27.0			27.0			27.0			27.0			53.2
E67c	45.0			73.0			73.4			73.4			73.4			189.0
E67d	47.4			31.0			31.1			31.1			31.1			31.4
E67e	47.5			57.0			57.0			57.0			57.0			57.0
E67f	38.7			19.0			19.4			19.4			19.4			58.5
E67g	53.4			28.0			28.2			28.2			28.2			130.6
N5	298.8			34.0			34.4			34.4			34.5			39.7
N7a	44.3			37.0			37.0			37.0			37.0			37.0
N7b	11.7	1.0	2.0	10.0	1.0	2.0	10.0	1.0	2.0	10.0	1.0	2.0	10.0	1.0	2.0	10.0
N7c	21.6			124.0			124.0			124.0			124.0			124.0
N7d	156.6	45.6	10.2	7.0	46.2	10.4	7.1	46.2	10.4	7.1	46.5	10.4	7.1	52.3	11.7	8.0
N8a	375.3			90.0			106.4			107.8			114.2			710.8
N8b	13.0			64.0			64.1			64.1			64.2			99.2
N8c	11.0			27.0			27.0			27.1			27.1			58.7
N9a	3.2	75.0			75.0			75.0			75.1			84.2		
N9b	46.0			136.0			136.1			136.1			136.3			229.3
N9c	33.1	19.0	28.4	94.0	19.0	28.4	94.1	19.0	28.4	94.1	19.0	28.5	94.3	29.0	43.3	143.5
N9d	194.1	14.8	15.5	78.0	14.9	15.7	78.6	14.9	15.7	78.6	15.2	16.0	80.3	66.1	69.5	349.1
N10	254.4			41.0			48.7			49.0			50.6			368.1
N11a	34.6	6.2	6.0	29.0	6.9	6.6	32.2	6.9	6.6	32.3	7.1	6.8	33.1	14.3	13.8	66.9

Table A.1: Clear Creek Collection System Sewer Allocation

		2010 HE allocation			2015 HE allocation			2020 HE allocation			2030 HE allocation			UBO HE allocation		
SSA	Area, ac	Commercial	Multiple Family	Single Family	Commercial	Multiple Family	Single Family	Commercial	Multiple Family	Single Family	Commercial	Multiple Family	Single Family	Commercial	Multiple Family	Single Family
N11b	27.8	21.4	3.0	16.0	24.0	3.3	17.9	24.1	3.3	18.0	24.8	3.4	18.5	112.8	15.6	84.2
N11c	20.8		1.5	14.0		1.8	16.6		1.8	16.7		1.8	17.4		4.7	44.9
N11d	17.6	43.2	148.3	1.0	43.7	149.8	1.0	43.7	149.8	1.0	43.8	150.2	1.0	46.9	160.9	1.1
N11e	11.7	163.5		18.0	164.3		18.1	164.4		18.1	164.6		18.1	180.8		19.9
N11f	21.3	90.1		44.0	90.6		44.3	90.6		44.3	90.8		44.3	106.1		51.8
N12a	67.7	13.1	69.1	75.4	13.2	69.3	75.6	13.2	69.3	75.7	13.2	69.5	75.8	13.6	71.5	78.0
N12b	98.8	19.8	20.0	8.0	22.2	22.5	9.0	22.4	22.6	9.0	25.7	26.0	10.4	77.6	78.4	31.4
N13	66.3	3.2	15.3	29.0	3.4	16.4	31.1	3.4	16.5	31.2	3.5	16.7	31.7	7.8	37.5	71.0
N14	151.1			33.0			38.9			39.4			41.7			138.8
N15	161.1	15.7		19.0	16.5		20.1	16.6		20.2	17.0		20.6	66.4		80.6
N16a	119.6			60.0			60.9			60.9			64.8			245.7
N16b	91.8	2.2		39.0	2.3		40.6	2.3		40.6	2.7		47.6	5.1		90.0
N16c	37.2			57.0			58.2			58.2			63.2			94.0
N16d	14.1	2.9		32.0	2.9		32.4	2.9		32.4	3.1		34.4	4.1		46.3
N16e	15.9	1.0		62.0	1.0		62.5	1.0		62.5	1.0		64.9	1.3		79.0
N16f	24.8		1.5	33.0		1.5	33.9		1.5	33.9		1.7	37.6		2.7	60.4
N16g	5.7	44.2	4.4	9.0	44.4	4.5	9.0	44.4	4.5	9.0	45.2	4.5	9.2	49.9	5.0	10.2
N16h	7.8	46.6		107.0	46.6		107.2	46.6		107.2	46.9		107.8	48.7		111.9
N16i	36.0			103.0			103.5			103.5			105.8			119.4
N17a	14.1			26.0			26.0			26.0			26.0			37.9
N17b	44.0			15.0			15.0			15.0			15.0			53.4
N17c	18.9	10.0	18.5	86.0	10.0	18.5	86.0	10.0	18.5	86.0	10.0	18.5	86.0	11.9	22.0	102.4
N17d	17.5			6.0			6.0			6.0			6.0			19.2
N17e	12.2			1.0			1.0			1.0			1.0			16.0
N18a	43.6		32.6	17.0		32.6	17.0		32.6	17.0		32.6	17.0		54.3	28.4
N18b	38.6			44.0			44.0			44.0			44.0			87.3
N19a	26.5			51.0			51.0			51.0			51.0			104.2
N19b	11.8		3.0	45.0		3.0	45.0		3.0	45.0		3.0	45.0		5.4	81.1
N19c	17.9	2.2		11.0	2.2		11.0	2.2		11.0	2.2		11.0	18.7		95.9
N19d	21.6			12.0			12.0			12.0			12.0			12.0
N19e	42.6		6.0	31.0		6.0	31.0		6.0	31.0		6.0	31.0		7.8	40.3
N20	155.5	8.0	18.8	31.5	15.9	37.3	62.7	16.0	37.5	62.9	16.9	39.6	66.4	47.3	110.9	186.0
N21a	14.3			34.1			34.1			34.1			34.1			40.7
N21b	47.1			9.0			9.0			9.0			9.0			9.0
N21c	90.7	15.0	26.6	52.7	15.0	26.6	52.7	15.0	26.6	52.7	15.0	26.6	52.7	15.0	26.6	52.7
N21d	19.1	3.8	7.5	14.0	3.8	7.5	14.0	3.8	7.5	14.0	3.8	7.5	14.0	3.8	7.5	14.0
N22a	41.9	9.0	8.1	31.0	9.0	8.2	31.1	9.0	8.2	31.1	9.1	8.2	31.3	91.0	82.5	314.2
N22b	74.1	2.0	8.1	14.0	2.0	8.2	14.2	2.0	8.2	14.2	2.2	8.9	15.2	20.2	82.3	141.5
N22c	33.3			77.0			77.0			77.0			77.0			77.0
N23a	182.9	20.9	13.1	6.7	20.9	13.2	6.7	20.9	13.2	6.7	29.0	18.3	9.4	74.6	46.9	24.0
N23b	36.5	7.3	87.3		7.4	87.8		7.4	87.8		7.4	87.8		19.0	226.1	
R1a	34.3			15.0			15.1			15.1			16.5			67.9
R1b	47.9	1.3		73.0	1.3		73.1	1.3		73.1	1.3		73.1	1.6		90.7
R1c	45.0			16.0			16.3			16.3			17.0			86.1
R1d	20.1			9.0			9.0			9.0			9.0			9.0
R2a	49.0			19.0			19.0			19.0			19.0			28.0
R2b	56.7			11.0			11.0			11.0			11.0			11.0
R2c	7.3			34.0			34.0			34.0			34.0			34.0
R2e	10.8			17.0			17.0			17.0			17.0			17.0
R2f	7.2			32.0			32.0			32.0			32.0			32.0
R3a	12.7	10.8		28.0	10.8		28.0	10.8		28.0	10.8		28.0	10.8		28.0
R3b	18.4	22.2		11.0	22.2		11.0	22.2		11.0	22.2		11.0	22.2		11.0
R3c	11.9	9.7	36.3	7.0	9.7	36.3	7.0	9.7	36.3	7.0	9.7	36.3	7.0	10.0	37.5	7.2
R3d	25.3		38.5	12.0		38.5	12.0		38.7	12.1		38.7	12.1		50.9	15.9
R3e	12.8	156.6		8.0	156.6		8.0	156.7		8.0	156.7		8.0	162.5		8.3

Table A.1: Clear Creek Collection System Sewer Allocation

SSA	Area, ac	2010 HE allocation			2015 HE allocation			2020 HE allocation			2030 HE allocation			UBO HE allocation		
		Commercial	Multiple Family	Single Family	Commercial	Multiple Family	Single Family	Commercial	Multiple Family	Single Family	Commercial	Multiple Family	Single Family	Commercial	Multiple Family	Single Family
R4a	6.5			22.0			22.0			22.1			22.1			28.2
R4b	9.0	1.0	28.4	24.8	1.0	28.5	25.0	1.0	28.7	25.1	1.0	28.7	25.1	1.4	40.0	35.0
R4c	12.5		56.6	22.2		58.0	22.8		58.8	23.1		59.5	23.3		117.0	45.9
R4d	72.3	24.9	50.5	30.5	25.5	51.6	31.2	25.7	52.0	31.4	26.5	53.8	32.5	45.3	91.8	55.4
R5a	40.1		50.0	25.0		50.0	25.0		50.0	25.0		50.0	25.0		50.0	25.0
R5b	9.6	21.0	50.0	20.0	21.0	50.0	20.0	21.0	50.0	20.0	21.0	50.0	20.0	36.0	85.7	34.3
R5c	6.5			40.0			40.0			40.0			40.1			47.5
R5d	34.4	31.0	20.0	58.0	31.0	20.0	58.0	31.0	20.0	58.0	31.3	20.2	58.6	33.1	21.3	61.8
R6a	68.5	99.0	100.0	50.0	101.5	102.6	51.3	101.7	102.7	51.4	105.1	106.2	53.1	139.0	140.5	70.2
R6b	51.1	99.0	200.0		99.2	200.3		99.2	200.3		99.2	200.3		99.5	201.0	
R8a	35.8	1.6	38.7	104.7	1.6	38.7	104.7	1.6	38.7	104.7	1.6	39.0	105.3	1.7	40.5	109.4
R8c	19.1	57.8			57.8			57.8			57.8			93.2		
R8d	17.5	81.0			81.0			81.0			81.0			81.0		
R8e	69.5	57.2			69.3			69.5			89.1			237.4		
R8f	75.5	102.0			102.0			102.1			117.4			213.1		
R9a	16.0	466.6			466.6			466.6			467.0			469.4		
R9b	57.9	72.0			72.0			72.1			75.8			103.9		
R10c	27.2	169.8	3.0	7.0	189.8	3.3	7.8	190.8	3.3	7.9	210.6	3.7	8.7	423.4	7.4	17.5
R10d	25.8	75.7			75.7			75.7			75.7			75.7		
R11a	15.5			32.0			33.0			33.0			33.5			39.5
R11b	49.6	2.7	179.1	4.5	2.7	179.1	4.5	2.7	179.1	4.5	2.7	179.4	4.5	2.7	181.1	4.5
R12a	48.9	41.0	52.2		42.5	54.1		42.5	54.1		42.5	54.1		45.5	58.0	
R12b	23.1			39.0			39.0			39.0			39.0			39.0
R12c	15.7	28.8			28.8			28.8			28.8			105.0		
R12d	14.0		27.0	67.1		27.0	67.1		27.0	67.1		27.0	67.1		41.7	103.6
R13	48.0	244.0	31.0		245.1	31.1		245.1	31.1		245.1	31.1		247.3	31.4	
R14a	19.2	33.6	46.1	16.0	33.8	46.3	16.0	33.8	46.4	16.0	33.9	46.5	16.1	34.9	47.9	16.6
R14b	28.2	37.1	138.2	17.5	37.1	138.2	17.5	37.1	138.2	17.5	37.1	138.2	17.5	37.1	138.2	17.5
R14c	18.9		2.5	13.0		2.6	13.8		2.6	13.9		3.0	15.5		5.7	30.0
R14d	35.6	141.6		1.0	144.3		1.0	144.5		1.0	149.4		1.1	194.3		1.4
R14e	13.2			70.9			70.9			70.9			70.9			70.9
R15a	27.9			51.0			56.4			56.4			56.4			68.8
R15b	9.0	14.7	83.1	66.0	14.7	83.1	66.0	14.7	83.1	66.0	14.7	83.1	66.0	14.7	83.1	66.0
R15c	7.3	16.3	3.0	99.7	16.3	3.0	99.7	16.3	3.0	99.7	16.3	3.0	99.7	16.7	3.1	102.6
R15d	18.4	9.3	1.0	2.0	9.3	1.0	2.0	9.3	1.0	2.0	9.3	1.0	2.0	17.2	1.9	3.7
R15e	11.6	1.0	106.5	47.7	1.0	106.5	47.7	1.0	106.5	47.7	1.0	106.5	47.7	1.0	106.5	47.7
R15f	5.9	21.7		32.9	21.7		32.9	21.7		32.9	21.7		32.9	23.4		35.5
R15g	31.5	171.5			171.5			171.5			171.6			172.1		
R16a	19.1	2.4	12.6	20.0	3.2	17.3	27.5	3.2	17.4	27.6	3.3	17.6	27.9	6.3	33.7	53.5
R16b	14.7	12.2	28.1	36.0	14.0	32.3	41.3	14.0	32.3	41.4	14.0	32.3	41.4	18.2	42.0	53.8
R16c	8.8	6.9	65.9	1.0	6.9	65.9	1.0	6.9	65.9	1.0	6.9	65.9	1.0	6.9	65.9	1.0
R16d	13.0	73.6	80.7	5.0	73.6	80.7	5.0	73.6	80.7	5.0	73.6	80.7	5.0	73.6	80.7	5.0
R17a	10.1		50.0	25.0		50.0	25.0		50.0	25.0		50.2	25.1		80.7	40.4
R17b	10.7	22.5	30.0	8.0	22.5	30.0	8.0	22.5	30.0	8.0	22.5	30.0	8.0	22.5	30.0	8.0
R17c	38.6	75.0	161.6	20.9	75.1	161.8	20.9	75.2	161.9	21.0	75.5	162.6	21.1	81.2	174.9	22.6
R18a	24.2	295.3		13.6	295.3		13.6	295.3		13.6	295.3		13.6	295.3		13.6
R18b	26.0	194.3	28.1	13.0	202.8	29.3	13.6	202.8	29.3	13.6	202.8	29.3	13.6	222.4	32.2	14.9
R18c	16.2	12.7	49.1	26.0	12.7	49.1	26.0	12.7	49.1	26.0	12.7	49.1	26.0	12.7	49.1	26.0
R18d	28.6	18.3		34.2	18.9		35.3	18.9		35.4	19.9		37.3	29.6		55.5
R19a	41.3	114.3	1.0	2.0	117.5	1.0	2.1	118.7	1.0	2.1	122.4	1.1	2.1	230.0	2.0	4.0
R19b	30.2	9.8		88.0	9.8		88.4	9.8		88.4	9.8		88.4	9.9		89.3
R20a	14.3	5.7	4.4	75.5	6.0	4.6	79.0	6.0	4.6	79.0	6.0	4.6	79.0	7.7	5.9	100.9
R20b	17.8		18.5	85.5		18.5	85.5		18.5	85.5		18.5	85.5		19.1	88.0
R20c	33.4	76.9	4.0	18.8	84.2	4.4	20.6	84.2	4.4	20.6	84.2	4.4	20.6	137.4	7.1	33.7
R20d	20.8	70.6	20.6	9.2	70.6	20.6	9.2	70.6	20.6	9.2	70.6	20.6	9.2	74.8	21.8	9.8

Table A.1: Clear Creek Collection System Sewer Allocation

		2010 HE allocation			2015 HE allocation			2020 HE allocation			2030 HE allocation			UBO HE allocation		
SSA	Area, ac	Commercial	Multiple Family	Single Family	Commercial	Multiple Family	Single Family	Commercial	Multiple Family	Single Family	Commercial	Multiple Family	Single Family	Commercial	Multiple Family	Single Family
R20e	18.7	18.5	109.2	115.1	18.8	110.8	116.7	18.8	110.8	116.7	18.8	110.8	116.7	21.6	127.0	133.8
R20f	97.3		10.7	11.0		14.5	14.9		14.5	14.9		14.5	14.9		46.4	47.7
R21Aa	11.4			41.0			43.3			43.3			43.3			72.2
R21Ab	38.1			36.0			43.7			43.8			44.1			202.7
R21Ba	10.1			55.0			55.0			55.0			55.0			69.7
R21Bb	16.7			37.0			37.1			37.1			37.1			59.8
R21Bc	7.2	61.8	77.7	65.2	61.8	77.7	65.2	61.8	77.7	65.2	61.8	77.7	65.2	66.0	83.1	69.7
R21Bd	5.8	112.5			112.5			112.5			112.5			123.0		
R21Be	11.1	2.0	29.6	44.0	2.0	29.7	44.2	2.0	29.7	44.2	2.0	30.0	44.6	2.2	32.2	47.9
R22a	81.0	34.7	2.8	7.0	43.6	3.5	8.8	43.6	3.5	8.8	43.6	3.5	8.8	72.4	5.9	14.6
R22b	142.7	40.9	34.5	36.4	41.6	35.1	37.1	41.6	35.1	37.1	41.6	35.1	37.1	62.5	52.7	55.8
R22c	19.9	87.3	34.0	8.0	87.6	34.1	8.0	87.6	34.1	8.0	87.6	34.1	8.0	99.5	38.8	9.1
R22d	17.4	291.1	4.0	5.5	291.5	4.0	5.5	291.5	4.0	5.5	291.5	4.0	5.5	303.1	4.1	5.7
R22e	16.7	28.9	3.7		29.2	3.7		29.2	3.7		29.2	3.7		45.8	5.9	
R22f	7.9	276.7			276.9			276.9			276.9			286.0		
R25Aa	22.0		37.8	66.7		37.9	67.0		37.9	67.0		37.9	67.0		47.2	83.3
R25Ab	17.7			53.0			53.2			53.2			53.2			65.5
R25Ac	10.5			20.0			20.0			20.0			20.0			20.0
R25Ad	9.2	1.5		27.0	1.5		27.0	1.5		27.0	1.5		27.0	1.5		27.0
R25Ae	5.2	45.4	5.4	2.0	45.4	5.4	2.0	45.4	5.4	2.0	45.4	5.4	2.0	45.5	5.5	2.0
R25Af	43.6	29.0	27.3	19.0	29.0	27.3	19.0	29.0	27.3	19.0	29.0	27.3	19.0	46.1	43.4	30.2
R25	92.6	11.1	14.1	29.4	11.2	14.2	29.8	11.2	14.2	29.8	11.2	14.2	29.8	17.7	22.4	47.0
R26a	19.0	73.1	71.6	82.0	73.1	71.6	82.0	73.1	71.6	82.0	73.1	71.6	82.0	75.4	73.9	84.6
R26b	17.8	62.4	81.4	49.6	62.4	81.4	49.6	62.4	81.4	49.6	62.4	81.4	49.6	64.8	84.5	51.5
R26c	16.9	25.3	36.3	44.8	25.6	36.7	45.4	25.6	36.8	45.4	25.8	37.0	45.7	29.6	42.4	52.3
R26d	29.7	1.0		45.0	1.0		46.3	1.0		46.3	1.0		47.0	1.5		69.4
R26e	18.1		88.8	45.0		89.9	45.5		89.9	45.6		90.5	45.8		104.0	52.7
R27a	31.0		44.6	76.0		44.6	76.0		44.6	76.0		44.6	76.0		50.5	86.1
R27b	28.2		7.4	90.5		7.4	90.5		7.4	90.5		7.4	90.5		10.6	129.3
R27c	48.8	33.1	32.7	30.7	33.1	32.7	30.7	33.1	32.7	30.7	33.1	32.7	30.7	45.2	44.6	41.9
R27d	34.3	203.1			203.2			203.2			203.5			225.7		
R27e	23.4	33.5	63.6	57.0	33.5	63.6	57.0	33.5	63.6	57.0	33.7	64.0	57.3	39.6	75.3	67.4
R27f	50.5	254.0	31.0	5.0	254.0	31.0	5.0	254.0	31.0	5.0	254.9	31.1	5.0	280.4	34.2	5.5
R28	90.1	8.9	37.8	36.4	8.9	37.8	36.4	8.9	37.8	36.4	9.8	41.3	39.8	14.4	60.7	58.6
R29	184.3	4.5	8.9	7.0	4.5	8.9	7.0	4.5	8.9	7.0	4.5	8.9	7.0	4.5	8.9	7.0
R30a	88.3	6.2		58.0	6.6		62.5	6.7		62.8	7.4		69.6	14.2		134.1
R30b	22.1	2.0		43.0	2.1		44.3	2.1		44.3	2.1		45.7	2.7		58.0
R31	53.9			46.0			49.2			49.4			54.1			98.4
R32a	10.2			38.0			38.0			38.0			38.0			49.4
R32b	13.3	5.3		28.0	5.3		28.0	5.3		28.0	5.3		28.0	9.3		49.3
R33a	32.8	37.7		33.0	37.9		33.1	37.9		33.2	37.9		33.2	96.3		84.3
R34a	22.7	1.0	3.0	74.0	1.0	3.0	74.0	1.0	3.0	74.0	1.0	3.0	74.0	1.4	4.2	104.2
R34b	16.4	3.4		64.3	3.4		64.3	3.4		64.3	3.4		64.3	3.4		64.3
R35Aa	58.9	2.5		93.0	2.5		93.2	2.5		93.2	2.5		93.2	2.5		93.8
R35Ab	55.2	14.9		3.0	16.0		3.2	16.0		3.2	16.9		3.4	26.6		5.4
R35Ba	20.9	1.0		21.7	1.0		21.7	1.0		21.7	1.0		21.7	1.1		23.8
R35Bb	25.2			35.0			35.0			35.0			35.0			35.0
R36	31.1			21.0			27.7			28.2			41.0			156.6
R37a	30.5	102.5			102.5			102.5			102.5			102.5		
R37b	39.6			39.0			39.1			39.1			39.1			104.1
R38a	32.5	1.0		49.0	1.0		49.0	1.0		49.0	1.0		49.0	1.0		49.0
R38b	35.1			41.0			41.0			41.0			41.0			41.0
R39a	22.6	19.4	47.7	49.9	19.4	47.7	49.9	19.4	47.7	49.9	19.4	47.7	49.9	23.7	58.4	61.2
R39b	41.0			109.0			109.3			109.3			109.3			179.6
R40a	18.0			22.0			22.2			22.2			22.2			40.8

Table A.1: Clear Creek Collection System Sewer Allocation

SSA	Area, ac	2010 HE allocation			2015 HE allocation			2020 HE allocation			2030 HE allocation			UBO HE allocation		
		Commercial	Multiple Family	Single Family	Commercial	Multiple Family	Single Family	Commercial	Multiple Family	Single Family	Commercial	Multiple Family	Single Family	Commercial	Multiple Family	Single Family
R40b	56.5			25.0			25.0			25.1			26.1			208.5
R40c	96.5			63.0			63.0			63.1			64.1			74.0
R41a	18.9			17.0			17.8			17.8			17.8			26.2
R41b	20.8			49.0			49.9			50.0			50.0			60.9
R41c	35.5			64.0			65.9			66.1			66.1			82.7
R41d	20.4	111.4		14.0	112.4		14.1	112.5		14.1	112.5		14.1	122.3		15.4
R41e	31.4	21.7			22.5			22.6			23.6			39.2		
R41f	32.2			16.0			16.6			16.6			16.8			95.4
R42a	26.5	18.9	39.2	63.0	18.9	39.2	63.0	18.9	39.2	63.0	19.0	39.4	63.2	21.6	44.7	71.8
R42b	118.5	2.0	6.5	89.0	2.0	6.5	89.0	2.0	6.5	89.0	2.0	6.6	90.7	3.6	11.8	162.2
R43	154.4	72.3	19.3	24.0	72.9	19.5	24.2	73.0	19.5	24.2	73.8	19.7	24.5	282.9	75.6	93.9
R45	160.4	5.0	51.0	21.5	5.1	51.9	21.9	5.1	51.9	21.9	5.1	52.1	22.0	5.5	55.3	23.3
R47a	18.5	1.0	7.0	34.5	1.0	7.0	34.5	1.0	7.0	34.5	1.0	7.0	34.6	2.2	15.1	74.8
R47b	19.9		27.2	39.0		27.3	39.1		27.3	39.1		27.8	39.8		45.5	65.1
R47c	28.2	19.5			20.1			20.1			22.9			55.0		
R48a	55.9	67.1			67.1			67.1			67.3			160.9		
R48b	65.6	235.2	17.1	8.4	235.2	17.1	8.4	235.2	17.1	8.4	235.3	17.1	8.4	278.4	20.2	10.0
R49a	30.8	1.5	19.9	39.0	1.5	19.9	39.0	1.5	19.9	39.0	1.5	19.9	39.0	3.3	42.2	82.8
R49b	36.5			41.0			41.0			41.0			41.0			41.0
R49c	26.5			54.0			54.0			54.0			54.0			54.0
R50a	38.1	69.9	1.2		70.5	1.2		70.5	1.2		73.7	1.3		125.6	2.2	
R50b	60.9	215.9	13.3	21.1	216.6	13.4	21.2	216.6	13.4	21.2	219.7	13.6	21.5	324.5	20.0	31.7
R51	25.1			50.0			50.4			50.4			52.5			93.9
R52a	42.8			68.0			68.1			68.1			68.1			81.1
R52b	20.4			55.0			55.0			55.0			55.0			55.0
R53a	15.5			82.6			82.6			82.6			83.4			102.5
R53b	174.9	255.6	196.3	29.1	255.6	196.3	29.1	255.6	196.3	29.1	256.2	196.8	29.2	362.9	278.7	41.4
R54	42.7			77.0			77.0			77.0			77.1			81.0
R55a	53.4			34.0			34.3			34.3			35.7			193.1
R55b	35.1			39.0			39.2			39.2			40.5			214.5
R56	18.8			62.0			62.0			62.0			62.0			98.5
R57	116.2		133.2	31.1		133.9	31.2		134.0	31.3		138.2	32.2		171.0	39.9
R58	193.8			9.0			10.1			10.2			16.0			56.1
R59a	27.9			32.0			32.4			32.4			34.0			73.5
R59b	21.2			50.0			50.4			50.4			52.0			92.2
R59c	24.7			37.9			38.2			38.2			39.9			94.6
R60	63.0	133.8		49.0	133.9		49.0	133.9		49.0	134.4		49.2	148.6		54.4
R61	74.0	16.0		32.0	16.2		32.3	16.2		32.4	16.2		32.5	71.6		143.4
R62	34.3			37.0			37.0			37.0			37.0			37.0

Table A.2: Clear Creek Collection System Sewer Allocation for New Service Areas

		2010 HE allocation			2015 HE allocation			2020 HE allocation			2030 HE allocation			UBO HE allocation		
SSA	Area, ac	Commercial	Multiple Family	Single Family	Commercial	Multiple Family	Single Family	Commercial	Multiple Family	Single Family	Commercial	Multiple Family	Single Family	Commercial	Multiple Family	Single Family
C1	386.4						0.5			0.5			0.5			2.1
C3	376.3						1.7			1.7			5.9			120.9
C4	181.8						0.4			0.4			0.4			309.7
C5	123.0						0.1			0.1			3.6			155.9
C6	72.1												3.3			103.9
C7	87.9									0.0			1.9			77.4
C8	159.8						0.3			0.3			3.8			88.6
C9	109.2						0.0			0.0			2.3			111.0
C10	452.3												2.0			79.7
C13	163.3															20.3
C29A	127.5									1.8			5.3			358.5
C35	110.7															
C37A	286.7															
C38B	57.0				8.5			8.5			13.6			61.8		
C45	492.3						4.6			4.6			7.4			33.7
C46	226.7				4.9			4.9			10.7			55.8		
C47	106.8															
C48	353.3															
C49	130.6															
C50	160.4															
C51	244.2															
C52	187.1						0.3			0.3			0.4			2.0
C53A	71.2				10.5			10.6			14.2			58.0		
C53B	128.5															
C54	222.6															
C55	296.0															6.6
C57	275.0															
C58	514.1															16.7
C59	484.2															90.7
C60A	300.7															
C60B	134.8															
C61A	153.4															
C61B	141.3															
C62A	308.3															
C62B	224.5															
C63	111.3															
C64	141.6															
C65	301.4															
C66	360.2															
C67	337.2															
C68	174.8															
C69	288.8															
C70	334.4															49.7
C71	51.7															
C72	160.8						0.1			0.1			0.1			59.4
C73	182.3						0.1			0.1			0.1			217.2
C74	243.7						0.6			0.6			0.6			411.2
C75	339.2															
C76	166.5															
E23	47.2															

Table A.2: Clear Creek Collection System Sewer Allocation for New Service Areas

		2010 HE allocation			2015 HE allocation			2020 HE allocation			2030 HE allocation			UBO HE allocation		
SSA	Area, ac	Commercial	Multiple Family	Single Family	Commercial	Multiple Family	Single Family	Commercial	Multiple Family	Single Family	Commercial	Multiple Family	Single Family	Commercial	Multiple Family	Single Family
E49	43.1															
E50	32.5													27.8		
N1	307.3						0.0			0.0			0.0			0.0
N2	290.6						0.2			0.2			4.4			92.5
N3a	445.2															
N3	362.9						0.0			0.0			0.0			0.0
N4	198.6						2.2			2.3			16.7			319.4
N5a	44.4															
N6	133.6						5.8			6.1			7.6			194.4
N7e	9.1															
R7	123.6				6.1			6.4			7.7			44.2		
R8b	29.7						12.2			12.4			14.1			58.6
R23	104.4						6.2			6.2			6.2			86.6
R24	398.7						65.0			165.0		150.0	250.0		150.0	350.0
R44	143.6						21.5			22.5			34.1			205.5
R46	248.9						4.3			4.5			6.8			587.2
R63	81.2						0.1			0.1			12.1			79.7

Table A3: Stillwater Collection System Sewer Allocation

SSA	Area, ac	2010 HE allocation			2015 HE allocation			2020 HE allocation			2030 HE allocation			UBO HE allocation		
		Commercial	Multiple Family	Single Family	Commercial	Multiple Family	Single Family	Commercial	Multiple Family	Single Family	Commercial	Multiple Family	Single Family	Commercial	Multiple Family	Single Family
E6a	12.2			44.0			44.0			44.0			44.0			44.5
E6b	15.6			59.0			59.0			59.0			59.0			59.0
E6c	7.5			31.0			31.0			31.0			31.0			31.0
E6d	5.6			18.0			18.0			18.0			18.0			18.0
E6e	8.3			34.0			34.0			34.0			34.0			34.0
E6f	9.6			26.0			26.0			26.0			26.0			26.0
E6g	37.5	4.5	25.2	12.7	4.5	25.7	13.0	4.5	25.7	13.0	4.5	25.7	13.0	24.5	138.3	70.0
E79a	90.3	18.3			18.7			18.7			23.9			23.9		
E79b	674.7	47.0			48.0			78.1			83.2			83.2		
E7a	51.6	18.9		53.0	18.9		53.0	18.9		53.0	20.2		56.6	28.3		79.4
E7b	40.2			125.0			125.0			125.0			125.0			133.7
E7c	23.7			21.0			21.0			21.0			21.0			21.0
E7e	135.7			190.0			199.9			228.2			648.1			648.1
E8a	14.5			12.0			12.0			12.0			12.0			12.0
E8b	62.1	18.7		1.0	19.5		1.0	22.3		1.2	25.4		1.4	25.4		1.4
E8c	31.1			72.0			72.0			72.0			72.0			103.0
E8d	7.2			21.0			21.0			21.0			21.0			32.3
E8e	29.5			25.0			25.3			26.3			26.3			28.7
E8f	15.0			28.0			28.0			28.0			28.0			41.6
E8g	19.3			48.0			48.0			48.0			48.0			69.6
E8h	30.2			53.0			53.0			53.0			53.0			111.4
E8i	48.6	9.0		74.0	9.1		74.4	9.2		75.6	9.2		75.6	16.0		131.4
E8k	22.2			11.0			11.3			12.2			12.2			61.9
E8l	17.6			16.0			16.1			16.3			16.3			70.8
E9	199.7			2.0			20.9			144.2			211.0			368.0
E10a	35.9	16.5	129.5	12.6	16.6	130.2	12.6	16.6	130.2	12.6	16.6	130.2	12.6	24.2	189.8	18.4
E10b	32.1	2.6		62.0	2.6		62.0	2.6		62.0	2.6		62.0	3.5		81.1
E10c	19.1			39.0			39.0			39.0			39.0			99.3
E10d	27.2	2.1	177.6	21.4	2.1	177.9	21.4	2.1	177.9	21.4	2.1	177.9	21.4	3.1	260.8	31.4
E10e	88.9	15.4		39.0	15.7		39.6	15.7		39.6	15.7		39.6	34.0		86.0
E10f	44.4			93.0			93.0			93.0			93.0			234.7
E11a	22.2			28.0			28.0			28.0			28.0			88.9
E11b	15.5			25.0			25.0			25.1			25.1			70.9
E11c	17.7			60.0			60.0			60.0			60.0			110.2
E11d	13.2			29.0			29.0			29.1			29.2			34.2
E11e	23.8			81.0			81.1			81.4			81.5			90.2
E11f	9.3			18.0			18.0			18.3			18.4			22.0
E11g	4.5			13.0			13.1			13.6			13.8			15.8
E11h	12.0			36.0			36.0			36.0			36.0			72.8
E11i	17.6			63.0			63.0			63.0			63.0			71.2
E11j	73.3			141.0			141.9			141.9			141.9			586.5
E12a	18.4			44.0			44.0			44.0			44.0			50.2
E12b	23.2			80.0			80.0			80.0			80.0			88.1
E12c	52.9			23.0			23.0			23.7			31.2			31.2
E12d	52.0	16.0	56.2	101.0	16.5	58.0	104.1	16.8	58.9	105.7	16.8	58.9	105.7	31.4	110.3	198.0
E12e	39.8	2.1		40.1	2.1		40.1	2.1		40.1	2.1		40.1	2.1		40.1
E12f	144.5	28.0			28.0			28.1			28.6			28.6		
E13	440.0	177.7			179.1			180.0			180.0			180.0		
E14a	43.3		111.0	80.0		111.0	80.0		111.0	80.0		111.0	80.0		198.5	143.1
E14b	14.9			36.0			36.0			36.0			36.0			36.0
E14c	17.6			38.0			38.0			38.0			38.0			38.0

Table A3: Stillwater Collection System Sewer Allocation

SSA	Area, ac	2010 HE allocation			2015 HE allocation			2020 HE allocation			2030 HE allocation			UBO HE allocation		
		Commercial	Multiple Family	Single Family	Commercial	Multiple Family	Single Family	Commercial	Multiple Family	Single Family	Commercial	Multiple Family	Single Family	Commercial	Multiple Family	Single Family
E14d	19.3		8.9	77.0		8.9	77.0		8.9	77.0		8.9	77.0		11.4	98.7
E14e	14.6			41.0			41.0			41.0			41.0			44.1
E14f	29.5	31.9	20.7	13.0	31.9	20.7	13.0	31.9	20.7	13.0	31.9	20.7	13.0	34.1	22.2	13.9
E14g	80.1	19.8		31.0	21.5		33.8	22.7		35.6	23.0		36.2	55.7		87.4
E15A	106.4	7.0	27.4	19.0	7.0	27.4	19.0	8.7	33.8	23.4	13.4	52.3	36.3	125.8	489.1	339.4
E33	61.5			55.0			57.3			57.3			57.3			57.3
E34Aa	38.3	5.0		66.0	5.1		67.4	5.1		67.4	5.1		67.4	5.1		67.4
E34Ab	54.6			78.0			78.1			78.1			78.1			227.2
E34Ac	211.5	1.0	27.0	196.7	1.2	32.1	233.7	1.3	35.6	259.6	1.4	36.7	267.8	4.4	119.0	867.6
E34B	85.4	1.0		22.0	2.0		44.2	2.7		58.6	2.9		63.1	3.5		78.0
E35A	73.5			8.0			26.0			37.6			41.3			318.2
E35B	97.4			5.0			42.6			67.0			74.7			374.4
E36	196.9	61.5			61.5			61.5			61.5			61.5		
E37Aa	30.4	6.0	65.9		6.0	65.9		6.0	65.9		6.0	65.9		16.8	183.4	
E37Ab	22.0	4.5	99.2		4.5	99.2		4.5	99.2		4.5	99.2		12.1	265.1	
E37	158.7			4.6			16.5			24.3			49.0			161.1
E38	50.4	2.8			21.8			21.8			21.9			21.9		
E40a	60.3			127.0			127.0			127.0			146.4			193.5
E40b	259.1	21.2		102.0	21.8		105.0	22.1		106.3	22.1		106.3	22.1		106.3
E41a	151.6			204.0			216.1			221.1			221.1			364.4
E41b	130.8			52.0			60.8			66.4			105.4			290.6
E42a	38.0			5.0			7.2			8.0			9.6			9.6
E42b	62.3			4.0			8.8			10.8			14.7			54.4
E43a	34.4			78.0			78.0			78.0			78.0			102.8
E43b	48.5			59.0			59.0			59.0			59.0			93.9
E43c	26.2			50.0			50.0			50.0			50.0			78.9
E43d	15.6			28.0			28.0			28.0			28.0			44.7
E44Aa	16.1			45.0			45.7			45.7			45.7			45.7
E44Ab	8.8			40.0			40.4			40.4			40.4			40.4
E44Ac	22.4			108.0			108.9			108.9			108.9			108.9
E44Ae	9.8			51.0			51.4			51.4			51.4			51.4
E44Af	17.5			73.0			73.7			73.7			73.7			73.7
E44Ag	12.8			51.0			51.5			51.5			51.5			51.5
E44Ah	15.7			87.0			87.7			87.7			87.7			87.7
E44Ai	10.7			41.0			41.5			41.5			41.5			41.5
E72	120.7	4.6			6.0			12.4			145.7			145.7		
E73	213.6	1.6			8.3			11.4			550.0			550.0		
E75	181.4	4.5		31.0	6.3		43.8	12.3		85.3	61.5		424.9	61.5		424.9
E76	200.9	1.0			1.0			1.1			1.3			2.9		
E77	276.5	12.8	131.0		12.8	131.0		12.9	131.8		12.9	131.9		12.9	131.9	
S2a	136.6			28.0			28.0			28.0			29.9			97.0
S4	165.2			30.0			30.0			30.0			33.3			142.2
S5	76.3	13.4		24.0	13.4		24.0	13.4		24.0	13.9		24.9	40.3		72.3
S10	270.6			2.0			2.0			2.0			5.9			133.2
S31	88.6		11.1			12.5			13.0			15.1			263.6	
S32	102.7	79.8			79.8			126.0			157.7			198.6		
S39B	148.1			53.0			140.0			390.0			556.7			556.7
S42A	65.6	10.4		35.0	24.1		81.3	61.3		207.1	88.1		297.9	88.1		297.9
S46	211.9			3.0			3.0			4.4			18.7			18.7
S57	291.7		8.9			11.0			12.5			46.9			46.9	
T3a	170.0	9.6	27.4	43.7	9.6	27.5	44.0	9.6	27.5	44.0	18.3	52.4	83.8	42.6	122.0	194.9

Table A3: Stillwater Collection System Sewer Allocation

SSA	Area, ac	2010 HE allocation			2015 HE allocation			2020 HE allocation			2030 HE allocation			UBO HE allocation		
		Commercial	Multiple Family	Single Family	Commercial	Multiple Family	Single Family	Commercial	Multiple Family	Single Family	Commercial	Multiple Family	Single Family	Commercial	Multiple Family	Single Family
T3b	28.1	17.5	4.4	15.0	17.5	4.4	15.0	17.5	4.4	15.0	17.5	4.4	15.0	36.8	9.3	31.5
T4	111.1		38.5	7.0		38.6	7.0		38.6	7.0		38.6	7.0		57.9	10.5
T10	271.9	7.6		1.0	10.3		1.3	48.8		6.4	49.1		6.4	49.1		6.4
T11	277.9	7.1			154.3			319.0			934.4			934.4		
T12	442.0	10.3	3.8	32.0	44.0	16.3	136.4	135.4	50.1	419.3	329.6	121.9	1021.2	329.6	121.9	1021.2
T13b	51.2			66.0			66.2			66.3			79.7			234.4
T13c	11.2			8.0			8.0			8.0			8.9			45.8
T14a	5.5			3.0			3.0			3.0			3.5			21.0
T14b	14.0			18.0			18.0			18.0			19.2			61.5
T14c	32.3			54.0			54.0			54.0			56.8			154.1
T14d	114.9			64.0			64.0			67.1			91.9			382.1
T14e	31.2			15.0			15.0			16.1			22.7			78.4
T14f	84.0			86.0			86.0			94.5			140.2			150.4
T14g	26.1			19.0			19.0			21.5			34.9			40.4
T14h	15.6			15.0			15.0			16.7			25.6			25.6
T15a	110.7	10.2			15.1			16.5			42.9			738.7		
T15b	49.5	2.0		41.0	2.0		41.0	2.0		41.0	2.2		44.0	9.0		181.2
T15c	30.7			11.0			11.0			11.0			11.0			110.1
T15d	9.0			17.0			17.0			17.0			17.0			56.9
T15e	8.0			7.0			7.0			7.0			7.0			56.9
T15f	9.6			17.0			17.0			17.0			17.5			57.9
T15g	49.8			5.0			5.0			5.3			44.3			44.8
T15h	25.4			36.0			36.0			36.2			57.9			101.1
T15i	9.3			24.0			24.0			24.1			34.7			38.4
T15j	13.6			32.0			32.0			32.1			47.6			52.4
T15k	56.9			28.0			28.0			29.2			36.6			168.6
T16	51.1	34.5			35.2			41.8			41.8			41.8		
T17a	105.8	181.8			183.8			201.1			201.1			201.1		
T17b	86.3	22.6			23.7			32.9			32.9			32.9		
T18a	130.3	82.0			83.9			86.8			86.8			86.8		
T18b	76.9	37.3			37.7			41.4			41.4			41.4		
T19	62.8			42.0			42.1			42.1			42.1			42.1
T20	119.6	3.6			3.6			3.6			3.6			49.6		
T21a	43.8	21.9	52.5	42.5	23.0	55.1	44.5	25.7	61.6	49.8	31.3	74.8	60.5	37.1	88.8	71.8
T21b	49.4	1.0	14.8	69.7	1.0	14.8	69.7	1.0	14.8	69.7	1.0	14.8	69.7	1.9	28.4	134.0
T21c	13.4			17.0			17.0			17.0			17.0			41.4
T21d	16.8	17.8	29.6		18.2	30.2		19.1	31.9		20.2	33.7		54.1	90.0	
T22a	10.2		7.4	27.0		7.4	27.0		7.4	27.0		7.4	27.0		7.5	27.3
T22b	23.2		17.8	39.5		17.8	39.5		17.8	39.5		17.8	39.5		21.6	47.9
T22c	8.0			8.0			8.0			8.0			8.0			8.6
T22d	11.7			35.0			35.0			35.0			35.0			35.0
T23a	11.6			15.0			15.0			15.0			15.0			18.8
T23b	14.4			18.0			18.0			18.0			18.0			18.0
T23c	27.1	18.9	40.7	41.0	18.9	40.8	41.1	19.0	41.0	41.3	19.2	41.3	41.6	26.5	57.0	57.5
T23d	11.8			24.0			24.0			24.0			24.0			24.0
T23e	9.2		44.8	1.0		44.8	1.0		44.8	1.0		44.8	1.0		53.7	1.2
T23f	9.9	2.4	16.3	11.0	2.4	16.3	11.0	2.4	16.4	11.1	2.4	16.5	11.1	4.4	29.8	20.1
T23g	8.6	11.4	11.8	11.0	11.4	11.8	11.0	11.4	11.8	11.0	11.4	11.8	11.0	11.4	11.8	11.0
T23h	15.5	2.2	26.6	12.0	2.3	28.5	12.8	2.7	33.3	15.0	3.2	38.7	17.4	6.9	84.7	38.2
T24a	21.4			11.8			11.9			11.9			11.9			63.5
T24b	25.4			76.4			76.6			76.6			76.6			195.5

Table A3: Stillwater Collection System Sewer Allocation

SSA	Area, ac	2010 HE allocation			2015 HE allocation			2020 HE allocation			2030 HE allocation			UBO HE allocation		
		Commercial	Multiple Family	Single Family	Commercial	Multiple Family	Single Family	Commercial	Multiple Family	Single Family	Commercial	Multiple Family	Single Family	Commercial	Multiple Family	Single Family
T24c	36.0	1.7	32.2	35.5	1.7	32.2	35.5	1.7	32.2	35.5	1.7	32.3	35.6	5.1	94.0	103.7
T24d	59.3	27.7	48.4	180.4	27.7	48.4	180.4	27.8	48.5	181.0	28.8	50.4	187.8	65.0	113.6	423.6
T25a	15.1			53.0			53.0			53.0			53.0			91.7
T25b	10.0			44.0			44.1			44.1			44.1			75.1
T25c	19.0			61.0			61.2			61.2			61.2			105.8
T25d	33.0			108.0			108.1			108.1			108.4			168.0
T25e	40.0	3.0		47.0	3.0		47.0	3.0		47.0	3.0		47.5	10.3		163.6
T25f	11.6	3.1			3.1			3.1			4.3			4.3		
T26a	75.1		47.6			47.8			47.8			47.8			571.9	
T26b	46.5		58.0	54.8		58.0	54.8		58.0	54.8		58.0	54.8		204.3	193.0
T26c	22.5	52.5	38.5	26.4	52.5	38.5	26.4	52.5	38.5	26.4	52.5	38.5	26.4	52.5	38.5	26.4
T26d	53.4	270.0	40.0		270.0	40.0		270.0	40.0		270.0	40.0		291.1	43.1	
T27	75.2	50.7	91.9	6.5	50.7	91.9	6.5	50.7	91.9	6.5	50.7	91.9	6.5	125.7	228.0	16.1
T28	82.5	56.1	15.5	1.0	56.7	15.7	1.0	60.5	16.8	1.1	61.2	16.9	1.1	61.2	16.9	1.1
T29a	39.3	84.2	8.9	1.0	84.3	8.9	1.0	84.5	8.9	1.0	92.2	9.7	1.1	92.2	9.7	1.1
T29b	15.2	4.8	11.8	27.0	4.8	11.8	27.0	4.8	11.8	27.0	4.8	11.8	27.0	4.8	11.8	27.0
T29c	15.7		3.7	33.0		3.7	33.0		3.7	33.0		4.6	41.3		4.6	41.3
T30a	24.7	1.0	39.2	29.0	1.0	39.2	29.0	1.0	39.2	29.0	1.0	39.2	29.0	1.5	59.0	43.7
T30b	34.2		3.0	65.0		3.0	65.0		3.0	65.0		3.0	65.0		4.2	91.9
T30c	29.0	14.5	173.2		14.5	173.2		14.5	173.2		14.5	173.2		27.3	326.6	
T31a	56.0	62.2		6.3	63.0		6.3	63.0		6.3	63.0		6.3	88.3		8.9
T31b	37.1	22.2	34.8		22.9	35.8		22.9	35.8		22.9	35.8		57.9	90.6	
T31c	61.9	6.4		67.0	6.5		67.5	6.5		67.5	6.5		67.5	10.0		104.2
T31d	21.6			65.0			65.0			65.0			65.0			65.0
T31e	9.2			23.0			23.0			23.0			23.0			23.0
T31f	33.0			35.0			35.0			35.0			35.0			35.0
T32a	106.1			10.0			29.4			47.0			48.7			260.8
T32b	8.9			28.0			31.1			33.9			33.9			41.8
T32c	10.6			34.0			38.1			41.8			41.8			47.4
T32d	12.9			34.0			38.7			43.0			43.0			52.7
T32e	16.4	1.4			5.3			8.7			8.7			8.7		
T32f	5.1			19.0			19.0			19.0			19.0			20.2
T32g	68.2			14.0			21.3			27.9			30.6			218.5
T32h	10.6			8.0			9.6			11.1			11.1			15.3
T33	109.5	28.8			29.2			29.6			58.0			168.2		
T34a	15.0			35.0			35.0			35.0			46.9			47.2
T34b	14.5			21.0			21.0			21.0			25.0			56.7
T34c	13.5			33.0			33.0			33.0			43.7			44.6
T34d	22.8			45.0			45.0			45.0			62.8			63.7
T34e	17.5			45.0			45.0			45.0			57.7			63.6
T34f	13.6			35.0			35.0			35.0			45.4			47.5
T34g	17.7			39.0			39.0			39.0			53.6			53.6
T34h	10.4			20.0			20.0			20.0			29.8			31.5
T35a	50.5			51.0			51.0			51.0			80.4			129.6
T35b	35.9			50.0			50.0			50.3			85.3			100.8
T35c	114.9			11.0			11.0			11.0			30.4			156.4
T35d	24.2			26.0			26.0			28.3			40.5			46.5
T35e	19.8			29.0			29.0			30.8			40.5			46.5
T35f	48.0			43.0			43.0			45.5			58.9			77.5
T36a	13.3			19.0			19.0			20.5			28.3			28.3
T36b	30.7			28.0			28.0			31.3			48.7			48.7

Table A3: Stillwater Collection System Sewer Allocation

SSA	Area, ac	2010 HE allocation Commercial	2010 HE allocation Multiple Family	2010 HE allocation Single Family	2015 HE allocation Commercial	2015 HE allocation Multiple Family	2015 HE allocation Single Family	2020 HE allocation Commercial	2020 HE allocation Multiple Family	2020 HE allocation Single Family	2030 HE allocation Commercial	2030 HE allocation Multiple Family	2030 HE allocation Single Family	UBO HE allocation Commercial	UBO HE allocation Multiple Family	UBO HE allocation Single Family
T36c	41.8			41.7			41.7			46.3			71.0			71.0
T36d	12.3			12.0			12.0			12.6			16.0			26.4
T36e	18.5			16.0			16.0			17.8			27.5			33.2
T36f	42.2	40.7		24.0	40.7		24.0	42.4		25.0	51.2		30.2	89.1		52.6
T36g	23.5		10.8	35.2		10.8	35.2		11.2	36.7		13.4	43.8		27.4	89.5
T36h	30.0	2.0	52.5	12.5	2.0	52.5	12.5	2.1	55.0	13.1	2.6	67.3	16.0	6.0	158.0	37.5
T37a	39.3			18.0			18.0			18.4			19.2			90.2
T37b	27.7			61.0			61.0			62.5			65.1			135.1
T37c	68.9			68.0			68.0			74.4			85.2			255.3
T37d	65.4	230.0		9.0	230.0		9.0	257.4		10.1	284.9		11.1	284.9		11.1
T37e	84.3			54.0			54.0			54.4			97.6			229.4
T37f	27.7	2.5		86.0	2.5		86.0	2.5		86.5	3.5		122.0	4.4		151.4
T37g	28.2			54.0			54.0			54.5			96.7			112.0
T37h	49.1			95.0			95.0			96.0			175.6			202.8
T38a	56.5			117.5			117.8			118.2			141.4			321.6
T38b	37.9	23.4	23.7	8.8	23.4	23.7	8.8	23.5	23.7	8.8	25.2	25.5	9.5	74.8	75.6	28.1
T38c	33.9			79.0			79.1			79.2			87.6			195.8
T38d	18.6			42.0			42.0			42.0			42.0			99.6
T38e	27.9			48.0			48.0			48.0			48.0			120.8

Table A4: Stillwater Collection System Sewer Allocation for New Service Areas

		2010 HE allocation			2015 HE allocation			2020 HE allocation			2030 HE allocation			UBO HE allocation		
SSA	Area, ac	Commercial	Multiple Family	Single Family	Commercial	Multiple Family	Single Family	Commercial	Multiple Family	Single Family	Commercial	Multiple Family	Single Family	Commercial	Multiple Family	Single Family
E7d	93.1												69.7			69.7
E8j	5.7															17.8
E37B	65.3				1.1			2.0			19.2			19.2		
E39	158.6				1.0		2.2	2.1		4.9	22.4		52.3	22.4		52.3
E47	15.7						7.7			10.9			17.4			17.4
E68	110.8						52.0			73.5			118.0			278.7
E69	238.9				5.3		3.6	19.7		13.2	279.6		186.4	279.6		186.4
E70	174.5						76.9			108.7			174.5			511.1
E71	159.0						15.9			35.8			315.5			315.5
E74	172.1				49.9			104.1			155.7			155.7		
E78	161.9															
S9	242.3						16.1			20.8			32.3			195.1
S14	123.3						16.6			31.9			48.2			166.1
S29	161.6						1.8			9.3			39.8			136.0
S33	130.1									56.0			94.2			178.3
S39A	137.3						24.0			130.2			201.6			273.6
S42B	235.3						19.8			155.9			202.5			388.1
S62	228.2						0.0			0.6			2.7			2.7
S63	315.8						0.2			1.3			10.5			10.5
S64	151.3						1.6			1.8			163.1			163.1
S67	249.0							51.5			156.2			156.2		
S69	709.6							51.9			157.5			157.5		
S73	296.1									15.6			47.3			47.3
T8	214.1						30.0			61.5			142.5			142.5
T9	246.6						103.5			217.7			503.6			654.7
T12A	155.3						43.2			58.9			89.7			696.8
T13a	194.3						34.0			121.5			498.6			498.6

Table A5: Stillwater Collection System outside City Limits

		2010 HE allocation			2015 HE allocation			2020 HE allocation			2030 HE allocation			UBO HE allocation		
SSA	Area, ac	Commercial	Multiple Family	Single Family	Commercial	Multiple Family	Single Family	Commercial	Multiple Family	Single Family	Commercial	Multiple Family	Single Family	Commercial	Multiple Family	Single Family
S1	233.0															
S2b	83.9												1.2			64.5
S3	272.7												0.2			7.4
S6	186.9												0.1			0.1
S7	96.8															
S8	292.3															
S11	124.9												0.0			0.0
S12	257.7															
S13	226.4															
S15	153.6						22.7			29.3			45.5			297.4
S16	112.7															
S17	228.3															
S18	184.0						7.5			10.5			10.5			10.5
S19	202.5						1.8			2.6			2.6			2.6
S20	314.9												0.1			0.1
S21	217.5															
S22	209.4															
S23	226.9						0.1			1.7			9.7			9.7
S24	200.6															
S25	234.5						1.2			1.9			5.8			203.6
S26	226.7						0.6			8.8			51.3			51.3
S27	196.7						0.4			5.8			33.6			33.6
S28	184.3						0.0			0.0			0.0			0.0
S30	167.9						1.4			1.4			1.4			1.4
S34	204.4															
S35	202.9															
S36	186.2															
S37	169.4															
S38	102.1															
S40	229.5						0.8			2.9			4.3			4.3
S41	214.4															
S43	135.6						2.5			19.5			25.2			65.3
S44	184.2												0.1			0.1
S45	286.0												1.6			1.6
S47	306.9												370.3			370.3
S48	162.4												239.7			239.7
S49	209.0												209.5			209.5
S50	235.3												157.2			157.2
S51	193.5												76.9			76.9
S52	193.3												55.8			55.8
S53	276.7												114.7			114.7
S54	272.9						0.1			0.1			4.7			4.7
S56	224.0						0.1			0.1			10.4			10.4
S58	73.6				0.0			0.0			0.2			0.2		
S59	176.7				0.0			0.0			0.0			0.0		
S60	276.0						0.1			0.1			3.8			3.8
S61	109.1				0.0			0.0			1.6			1.6		
S65	162.1				0.0			31.6			95.8			95.8		
S66	145.1							33.4		33.4	101.4		101.4	101.4		101.4
S68	227.3									91.0			276.2			276.2

Table A5: Stillwater Collection System outside City Limits

		2010 HE allocation			2015 HE allocation			2020 HE allocation			2030 HE allocation			UBO HE allocation		
SSA	Area, ac	Commercial	Multiple Family	Single Family	Commercial	Multiple Family	Single Family	Commercial	Multiple Family	Single Family	Commercial	Multiple Family	Single Family	Commercial	Multiple Family	Single Family
S70	268.2									108.4			329.2			329.2
S71	234.9									97.5			296.0			296.0
S72	131.0									51.9			157.6			157.6
S74	268.7									111.9			339.7			339.7
S75	104.0									43.4			131.6			131.6
T1A	377.5															
T1	326.8															
T2	105.9															
T5	132.5						0.1			0.5			0.5			72.4
T6	125.2															
T7	70.4															
T8A	183.7						6.0			9.2			13.0			13.0
T8B	216.9						5.0			6.7			6.7			6.7
XXX	165.6															

APPENDIX B
Community Outreach

B.1 INTRODUCTION

In order for the City to develop a strategy for evaluation of where additional service may be necessary to support future demands for both water and sewer service several meetings were held with potential stakeholders. Meetings were held with Shasta County officials, local engineers, and major landholders to obtain their opinions and perspective on where and when growth might call for new service. The consensus was that under the current economic conditions of the community, state and country any new development that may occur within the next 5-10 years will likely happen on parcels that are already developed. The approximate current inventory of parcels with entitlements is:

Single Family Residential:	3,070 parcels
Multiple Family Residential:	2 parcels, 152 units
Commercial/Industrial:	~30 parcels

The current estimated inventory of parcels with entitlement and physical improvements already constructed but not fully developed (infrastructure but no building) is:

Single Family Residential:	375 parcels
Multiple Family Residential:	45 units
Commercial/Industrial:	~20 parcels

The vacancy rate in the City is a difficult value to obtain due to the recent rapid changes in the housing market. Obtaining an exact number of abandoned houses or foreclosure residences is not possible.

It is the consensus of the community outreach program that initial growth will probably occur within the existing vacant parcels and already developed parcels until the current inventory is significantly reduced. Once the inventory is reduced to the point where it becomes attractive to develop additional parcels, the question can be asked where will that most likely happen. In attempt to provide focus to that discussion, the assumption was made that infill development doesn't require large scale new utility projects, and the peripheral areas were divided into seven areas to be discussed individually. Figures B-1 through B-7 show the approximate boundaries of the areas discussed. They are Southwest Hills, Sulphur Creek, Lake Boulevard Extension, Oasis Road, Shasta View, South Rancho, and Stillwater Creek. Stillwater Creek was further divided into North, Middle and South Stillwater as shown in Figures B-7.1, B-7.2, and B-7.3. Discussion included both Water and Sewer Service. However, because water service is confined to contract boundaries, and no adjustments or additions to the contract boundary are being considered, most of the discussions focused around sewer service.

B.2 SOUTHWEST HILLS

The Southwest Hills area is shown on Figure B-1. Gore Ranch may develop when the market supports the effort of subdividing. However, most of the developable part of the property is on the east side of the property and can be sewered in a southeast direction to Clear Creek Road. Infrastructure necessary to complete this is primarily within the Ranch property itself. The majority of the property consists of steep hills with limited development potential. Some development may occur on the tops of the hills similar to hilltop developments elsewhere in the community. However, sewer service for such development can also be directed to the southeast direction and subsequently to Clear Creek Road. Development of the eastern portion of the ranch was accounted for in the 2030 analysis. The north portion of Gore Ranch might be sewered to the existing sewer in Branstetter, but due to the steep hillsides limiting the amount of development and the need to cross Olney Creek to reach the existing sewer line, it is deemed unlikely that this area would present significant development potential.

Development west of Gore Ranch is not likely to ever occur in a density necessary to require or support construction of the necessary infrastructure. The Texas Springs road area is large lot residential and not expected to ever subdivide to a density requiring or supporting construction of the additional sewer infrastructure.

Area north of Branstetter with potential to drain to a future pipe in Branstetter Lane is already subdivided at a parcel size that is not expected to change. Area further west along the north branch of Olney Creek, just inside the west City Limits, consists of two large parcels totalling approximately 336 acres. The parcels appear to have limited hilltop development potential but not likely at a density or quantity that would justify construction of approximately 2.2 miles of pipe necessary to provide sewer service.

The Kenyon Drive/Oregon Gulch Creek corridor may have some limited development potential on hilltops, but the vast majority of the area is steep slopes with low development density.

Development in the Power Line Road/Chaparral Drive area is in the secondary growth area and is already developed at high enough density that further significant subdividing and need for services is not expected to justify extending sewer service all the way up the canyon. The consensus was to remove the area from public infrastructure planning at this time and assume that annexation and incorporation of this area is not going to occur.

Clear Creek Road area is zoned heavy industrial. The consensus was that sewer demands from these uses are extremely varied and unpredictable. In addition, there is already an excess of developed commercial and industrial properties in the region. The consensus was to put the develpment of this area in UBO. Any necessary infrastructure would be constructed as development occurred by the developer. There is substantial secondary growth area to the west of the industrial zone that is already large lot development. The consensus was that this area has a high demand for parcels too large to achieve density necessary to fund or call for major infrastructure improvements. The sphere of influence is very large west of this area but this was also determined to be high demand large lot development area. Additionally the corridors for gravity sewer beyond the City Limits are located in narrow, steep creek canyons where construction would be nearly impossible. The consensus was to dismiss areas further west than City Limits and the Gore Ranch from consideration in public infrastructure planning at this time.

B.3 SULPHUR CREEK

The Sulphur Creek area is shown on Figure B-2. Sewer service to the potential upper Sulphur Creek collection system would necessitate extending a sewer interceptor approximately 5,000 feet north and west up the canyon from its existing terminus near Terra Nova Drive through at least three large undeveloped parcels. Development potential within these three parcels is limited to some small hilltop areas. Although these areas may offer limited cul-de-sac type residential development the total amount would not be significant enough to justify construction of the interceptor. Therefore the only time the interceptor would be called for is upon significant development further up the canyon.

The RTPA demand model indicates a relatively high level of development occurring in 2015 and 2020 in this area. It is believed that the geology of this area is such that if development were to occur sewer would need to be provided, that development of septic tank services is not particularly feasible. Areas in the canyon below Keswick Dam Road and for the first Sanitary Service Area north of Keswick Dam Road (SSA-N4) were added to the 2020 analysis. Pipe construction will be designated “as developed”. Areas further north and west were added to the UBO analysis and pipe construction will be designated “as developed.” A limited area further west immediately adjacent to Keswick Reservoir requires lifting over a hill to attain sewer service. Development potential is limited in these areas by steep slopes and accessability challenges. These areas were dismissed from public infrastructure analysis at this time. They are SSA N3a, N5a, and N7e.

B.4 LAKE BOULEVARD EXTENSION

The Lake Boulevard Extension is shown on Figure B-3. This area is referred to as Lake Boulevard Extension because the system necessary to provide sewer service would need to be extended from Old Oasis Road near Interstate 5 west and north to Lake Boulevard.. The area between City Limits and the Railroad is primary growth area. Area west of the Railroad drops to sphere of influence. The RTPA demand model calls for development in this area along Oasis Road in 2015. SSA T10 was added to that analysis. Construction of pipes will be labeled “as developed.” SSA T9 was added to the 2020 analysis. The remainder of the area was added to the UBO analysis.

B.5 OASIS ROAD AREA

The Oasis Road Area is shown on Figure B-4. The northern most area of this region (north of Palermo) is already developed large lot residential. The area between City Limits and Palermo is in the Sphere of influence but not identified as a primary or secondary growth area. All area north of Oasis Road within City Limits was added to the 2015 analysis. Area south of Oasis within the City Limits was also added to the 2015 analysis. Area east of City Limits and south of Oasis Road actually drains to the upper end of Stillwater Creek Area and will be discussed in that section. Pipe construction will be labeled “as developed”. Area north of Oasis Road draining east was added to the Tierra Oaks Lift Station. It is recommended that the proliferation of lift stations be avoided by requiring construction of a gravity sewer to reach the existing lift station even if a inverted siphon is necessary to get under Moody Creek. It is believed that there is sufficient head available on the west side of the creek to avoid this becoming a problem.

B.6 SHASTA VIEW AREA

The Shasta View Area is shown on Figure B-5. It is mostly within City Limits bounded by HWY 299 on the north, Old Alturas on the South, and Shasta View and Old Oregon Trails on the West and East Respectively. The majority of the area is owned by the McConnell Foundation and is the preferred location for potential future State College campus efforts. Topography in the area would have gravity sewers draining to the east to the conceptual Stillwater Interceptor. The area will be covered in subsequent sections regarding Stillwater Drainage Basin alternatives.

B.7 SOUTH RANCHO AREA

The South Rancho Area includes area between Rancho Road and Knighton Road from approximately Airport Road on the East to the bluff above Churn Creek on the West. The area is depicted in Figure B-6. It includes areas that are part of Clover Creek Sewer Assessment District and Airport Road Sewer Assessment District. The Clover Creek Interceptor traverses the length of the area from North to South. Most of the area is within City Limits. It is expected that most of the area can be served via the Clover Creek Interceptor and that as development occurs conveyance and connection to the interceptor will be accomplished by the developer of the specific project when it is constructed. No impact fee related projects are identified in this plan to extend service beyond the existing interceptor.

B.8 STILLWATER CREEK DRAINAGE AREA

The strategy to sewer the Stillwater Creek Drainage Area has been considered in numerous prior plans and efforts. The concept was to construct a large scale interceptor near Stillwater Creek to convey sewer south from the Terria Oaks area to a location near the south City Limits and then lift it from Stillwater Creek area over to Airport Road and Stillwater WWTP. In one effort the concept was carried forward to the point of attempting to form an assessment district to fund the projects. The assessment district was rejected by the stakeholders. Another effort included interim lift stations at multiple locations to pump sewer to the existing collection system but still considered the ultimate solution to be construction of the Stillwater Interceptor. The assessment district concept for funding the Stillwater Interceptor was abandoned when the City adopted Council Policy 1401 - City Services Outside City Limits on September 20th, 1988. The policy reads as follows:

Generally, it is the policy of the City to eliminate incentives for urban development to occur outside the City by the following measures:

a. The withholding of City services unless it can be shown that there is an equal or near equal return to the City based on the cost of such service or that the provision of such service outside the City benefits directly the health and safety of residents of the City and that provision of such service does not induce additional development outside the City nor make annexation of the area served more difficult.
b. By controlling the location extension, and timing of sewer, water, and electric lines.
c. By using the Redding General Plan to determine the intensity of use of a property.
d. by operating services outside the City at a profit so that existing residents do not subsidize development outside the City.
e. By supporting or requiring development standards equal to or better than those of the City.
f. By retaining a majority control of all regional-sewage systems that provide service within the Plan Area.
g. By generally opposing development of community septic system, sewer-lift stations, or temporary sewage disposal facilities.
h. By requiring annexation before provision of service.
i. By entering into reimbursement agreements only within the City limits.
j. By requiring utility lines to be developed in accordance with various master utility plans.
k. By maintaining adequate capacity in existing City facilities for property owners already in the City.
l. Through key open-space acquisitions such as public lands to the north and northwest.
m. By opposition to the creation of new or the expansion of existing special districts within the City's sphere of influence, except in the case of an existing district's providing a single service and that that district and the City have already entered into a contract to permit overlapping annexations.

Although Council Policy 1401 may effectively discourage expansion of utility service outside existing City Limits it does not appear to actually prohibit such growth. In addition the City's General Plan 2000-2020 still reflects primary, secondary and ultimate growth boundaries outside City Limits. With that in mind, the topic of where and when development might occur in the Stillwater Creek drainage area is still open for discussion and appropriate to address within the context of this Master Plan. Because the area is so large, and addressing it a single project or single system would be too cumbersome, the area was divided into North, Middle and South Sections as reflected in Figures B-7a through B-7c respectively.

Stillwater North: Discussions with the community determined that:
- no significant development would likely occur prior to 2030 and even at that time most of it would not likely need sewer service due to the existing large lot development that exists today. Such development would need to be further subdivided at a density that would support the need for regional sewer collection.

- The Ross Ranch is being considered as an alternative location for any potential State College should one be constructed. In any case such would not likely happen prior to 2030.
- Shasta College may need to be annexed and served eventually. At that time some development may piggyback on whatever sewer system is constructed to serve the College.
- Areas closer to City Limits, within the primary General Plan boundary may want to develop prior to 2030.

Recommendations: Areas within City Limits should be allowed to pump over to the existing collection system and improve local pipes to convey to Churn Creek Interceptor or Clover Creek Interceptor at developers expense.

Areas north of Tierra Oaks LS and force main shall drain to Tierra Oaks LS and such development shall provide analysis of their fair share of TOLS improvements. Such development should not be allowed to occur prior to necessary Tierra Oaks Lift Station improvements being constructed.

Stillwater Middle: Four locations for temporary lift stations have been suggested within the Stillwater Middle Area: Old Alturas, Old HWY 44, and South of HWY 44. Analysis would be required to determine the PWWF for pipe and lift station size approximation which is beyond the scope of this discussion.

Old Alturas: This location requires a very long force main from the east side of Stillwater Creek to the crest of the hill at Lema Rd. It does have a bridge to utilize for the creek crossing. The area sewered could include both sides of Stillwater Creek north of Old Alturas as the bridge may also be used for gravity sewer service. The project would be approximately 9,300 feet force main and approximately 1,800 feet of gravity sewer plus the lift station.

Viking Way: The Viking Way location is closer, at approximately 5,900 feet of force main and unknown improvements to the collection system between Abernathy and Churn Creek Lift Station. Both of the Viking Way and Old Alturas locations require that the sewer be lifted twice before reaching the Clover Creek Interceptor and gravity flowing to the WWTP.

Old HWY 44: The Old HWY 44 location has been discussed in some of the earlier planning documents and studies for the Stillwater Interceptor. The facility would require approximately 3,000 feet of force main utilizing the Old HWY 44 bridge to cross Stillwater Creek then approximately 1,500 feet of gravity pipe before reaching a 24" diameter sewer pipe already installed under HWY 44 at Crossroads Drive, the upstream end of the Clover Creek Interceptor.

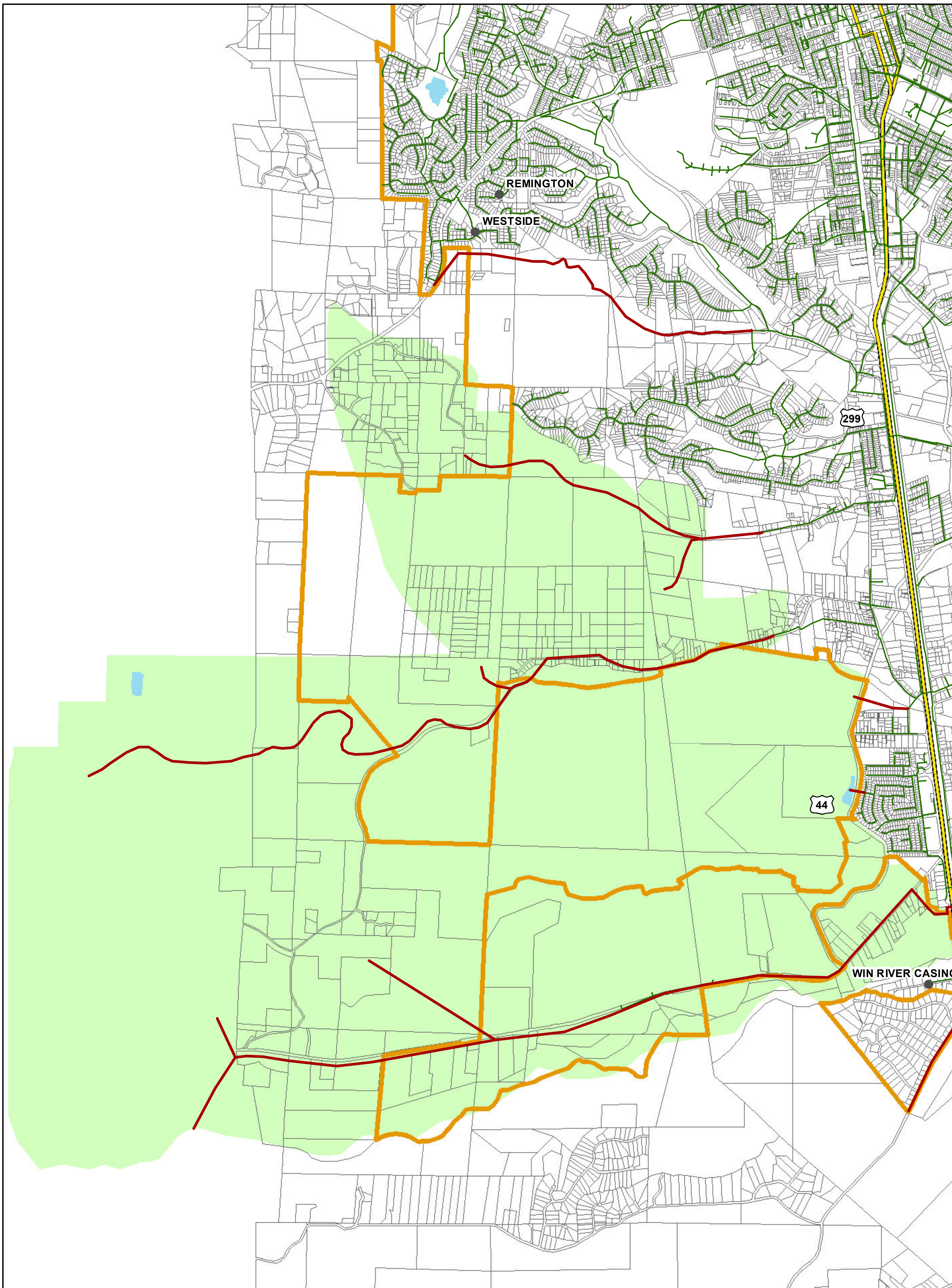
South of HWY 44: This location would place the lift station on the east side of Stillwater Creek utilizing a diagonal bore and jack or directional drill to cross both HWY 44 and Stillwater Creek surfacing at the top the bank on the West side of the Creek. From there the project would be approximately 1,300 feet of Force Main on “Private Road” and approximately 2,300 feet of gravity sewer to the Clover Creek Interceptor at Manhole P14-1.

Development in Stillwater Middle:

- Area within City Limits consists primarily of McConnell Foundation properties around Lema Ranch. This is property being reserved by the foundation in hopes of a future university. If such were to develop it would be a fairly lengthy process not likely to result in significant demand for many years, probably beyond 2030.
- Area within City limits could be pumped to Churn Creek interceptor with improvements to the existing system.
- Area between City limits and Primary growth boundary (between Shasta View and Old Oregon Trail would require a lift station to serve.
- The area between the primary and secondary General Plan growth boundaries includes the Nash Ranch and a lot of floodplain.
- The Nash Ranch was recently purchased by a local developer. Consensus on when further development of that property may occur resulted placing it in the 2020-2030 time frame.

<u>Stillwater South:</u>

- Discussions with Shasta County officials indicated they believe that development east of Stillwater Creek in this area will not happen at high enough density to call for sewer due to transportation limitations. Stillwater BP conservation easement prohibits extension of the road through the Business Park beyond the park boundaries. Stillwater Road from the north is undeveloped and may even be a private road. It is believed that property owners would not cooperate with expansion of the road to promote higher density development of nearby properties.
- The remaining area includes primary growth area between Stillwater Creek and the drainage divide to the Clover Creek Interceptor. Part of this area is already within the Aiport Road Sewer Assessment district. The remainder is not enough area to consider feasible for construction of a public lift station.



* Future Pipe alignments are approximate, schematic locations intended for planning level analysis only. If constructed, final alignment will be determined during the project development alternatives analysis.

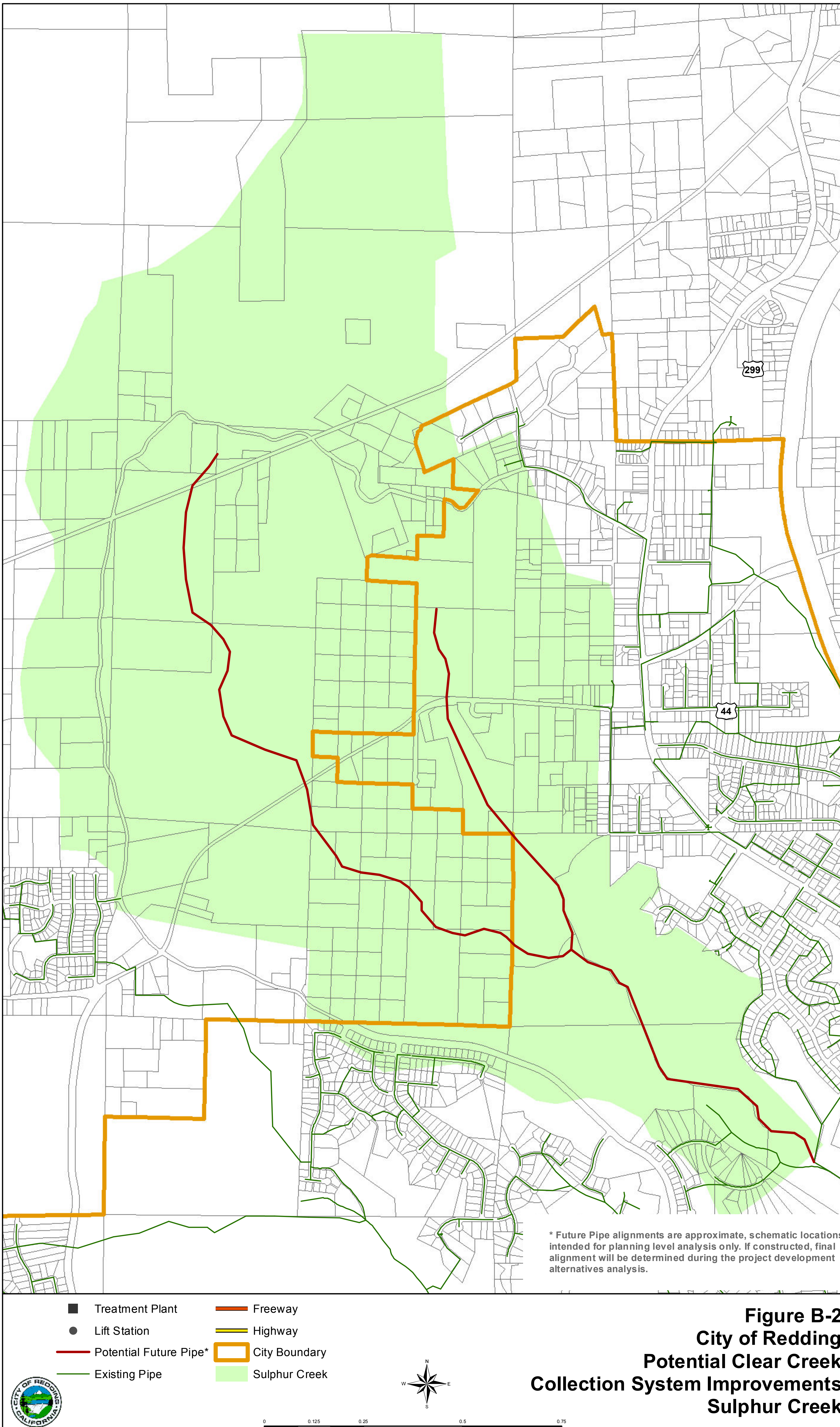
Potential Future Pipe*
Existing Pipe
Treatment Plant
Lift Station
Freeway
Highway
City Boundary
Southwest Area

0 0.25 0.5 1 1.5 Miles

Figure B-1
City of Redding
Potential Clear Creek
Collection System Improvements
Southwest Hills

P:\RMU\ESRI\MasterPlan\WW_CC_SouthwestHills.mxd

Aug. 1, 2012



* Future Pipe alignments are approximate, schematic locations intended for planning level analysis only. If constructed, final alignment will be determined during the project development alternatives analysis.

Figure B-2
City of Redding
Potential Clear Creek Collection System Improvements
Sulphur Creek

P:\RMU\ESRI\MasterPlan\WW_CC_SulphurCreek.mxd

Aug. 1, 2012

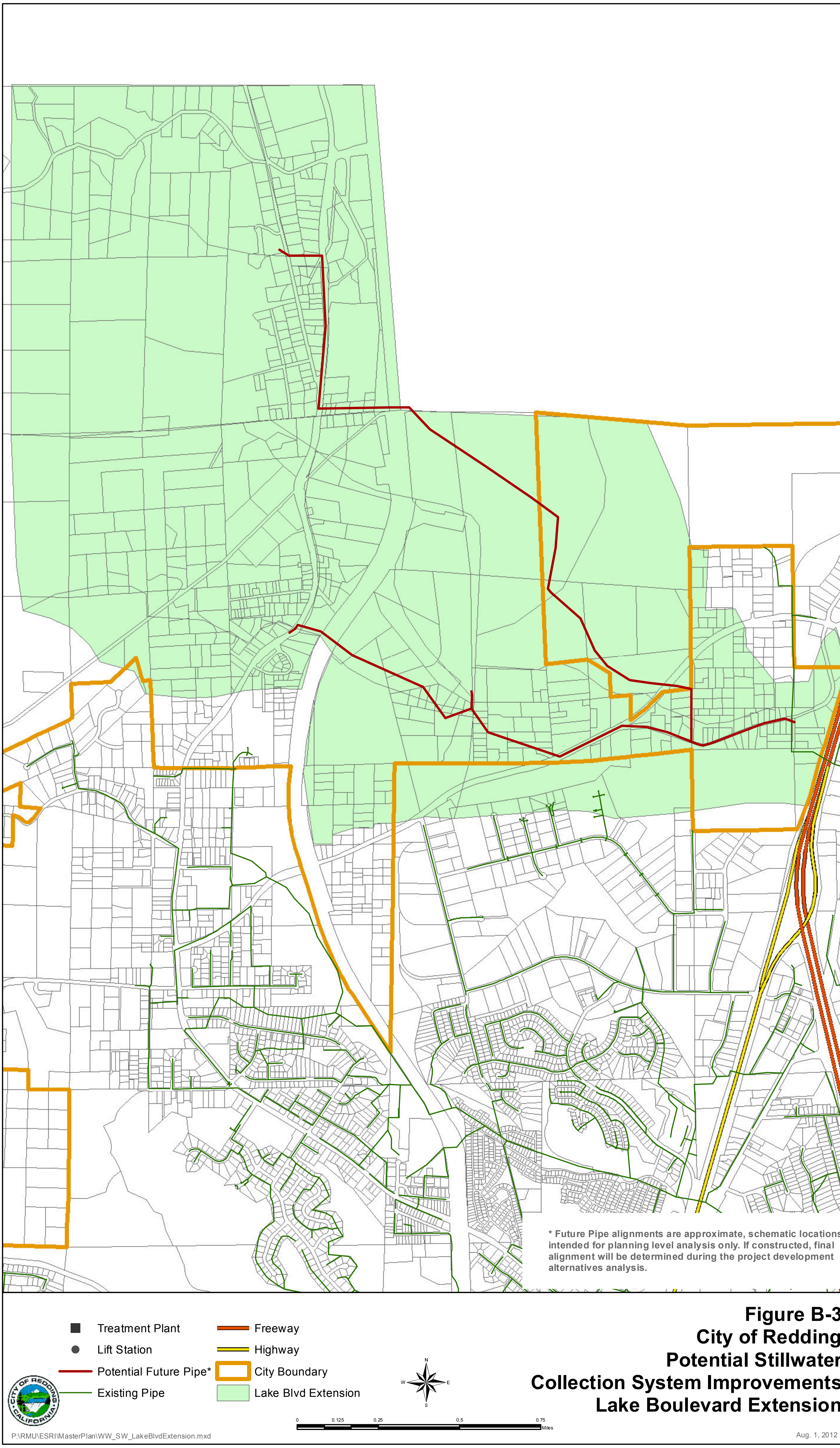
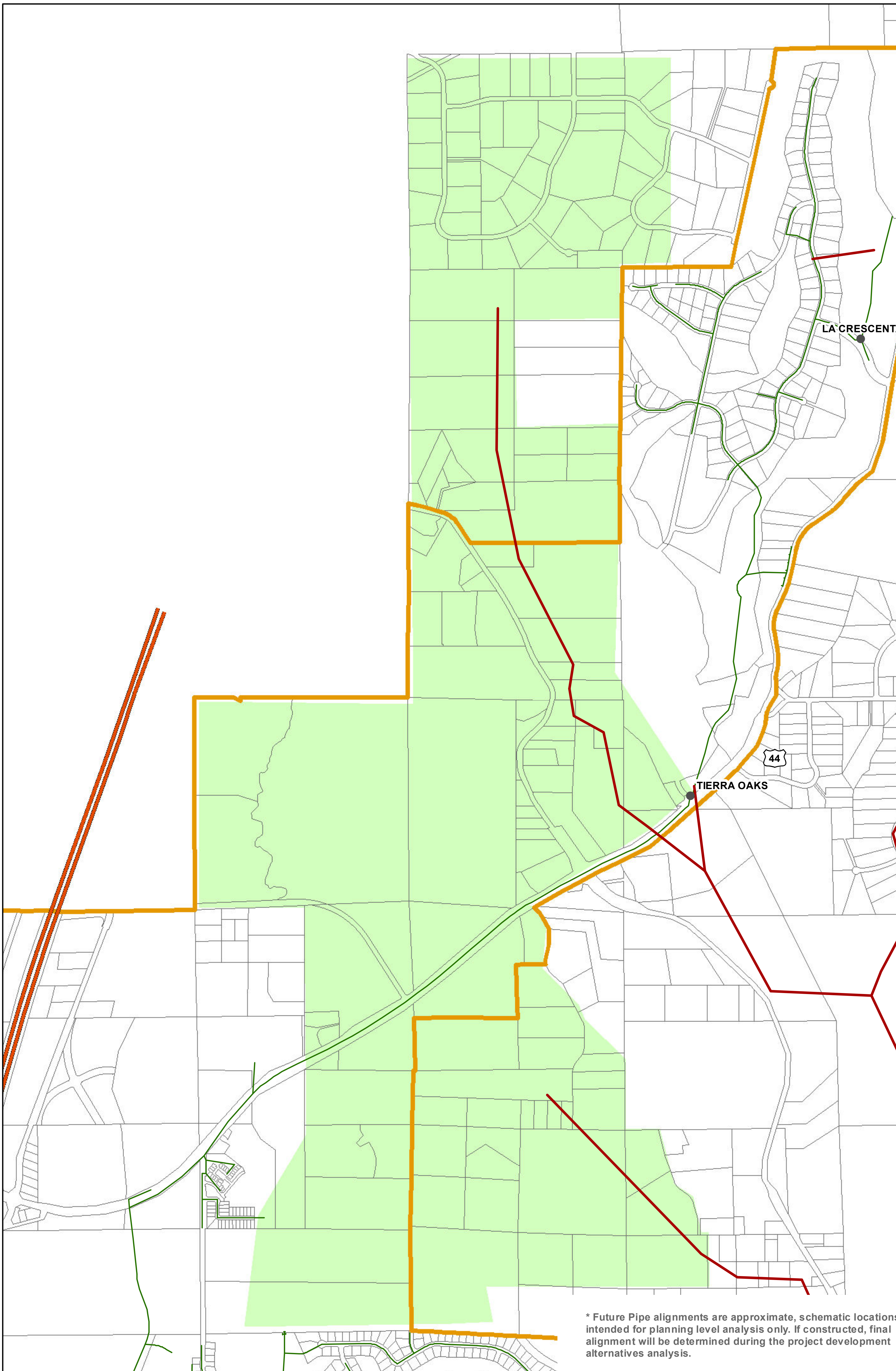


Figure B-3
City of Redding
Potential Stillwater
Collection System Improvements
Lake Boulevard Extension

P:\RMU\ESRI\MasterPlan\WW_SW_LakeBlvdExtension.mxd

Aug. 1, 2012



Treatment Plant
Lift Station
Potential Future Pipe*
Existing Pipe
Freeway
Highway
City Boundary
Oasis Road Area

0 0.125 0.25 0.5 0.75 Miles

Figure B-4
City of Redding
Potential Stillwater
Collection System Improvements
Oasis Road Area

P:\RMU\ESRI\MasterPlan\WW_SW_OasisRdArea.mxd

Aug. 1, 2012

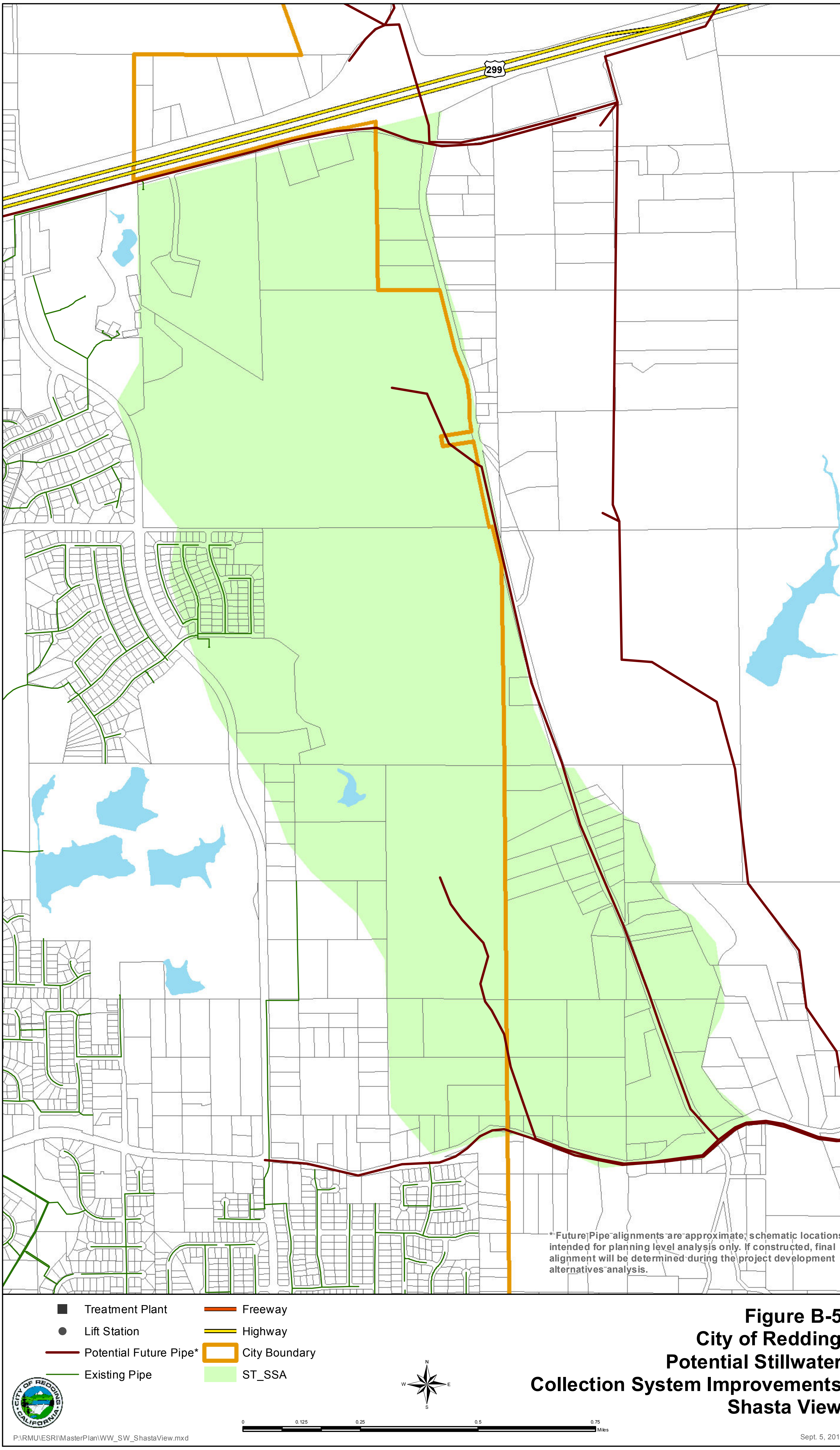


Figure B-5
City of Redding
Potential Stillwater
Collection System Improvements
Shasta View

P:\RMU\ESRI\MasterPlan\WW_SW_ShastaView.mxd

Sept. 5, 2012

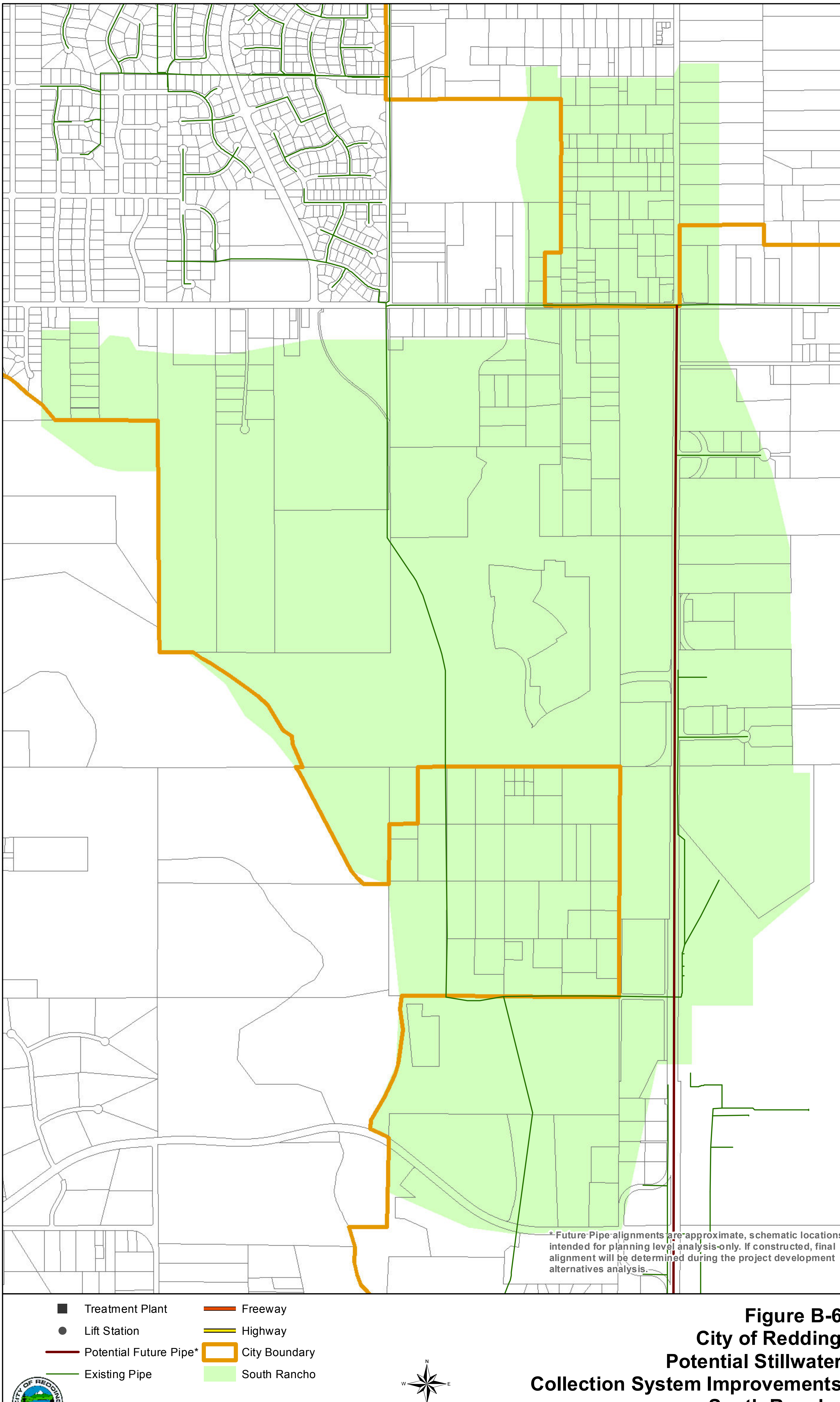
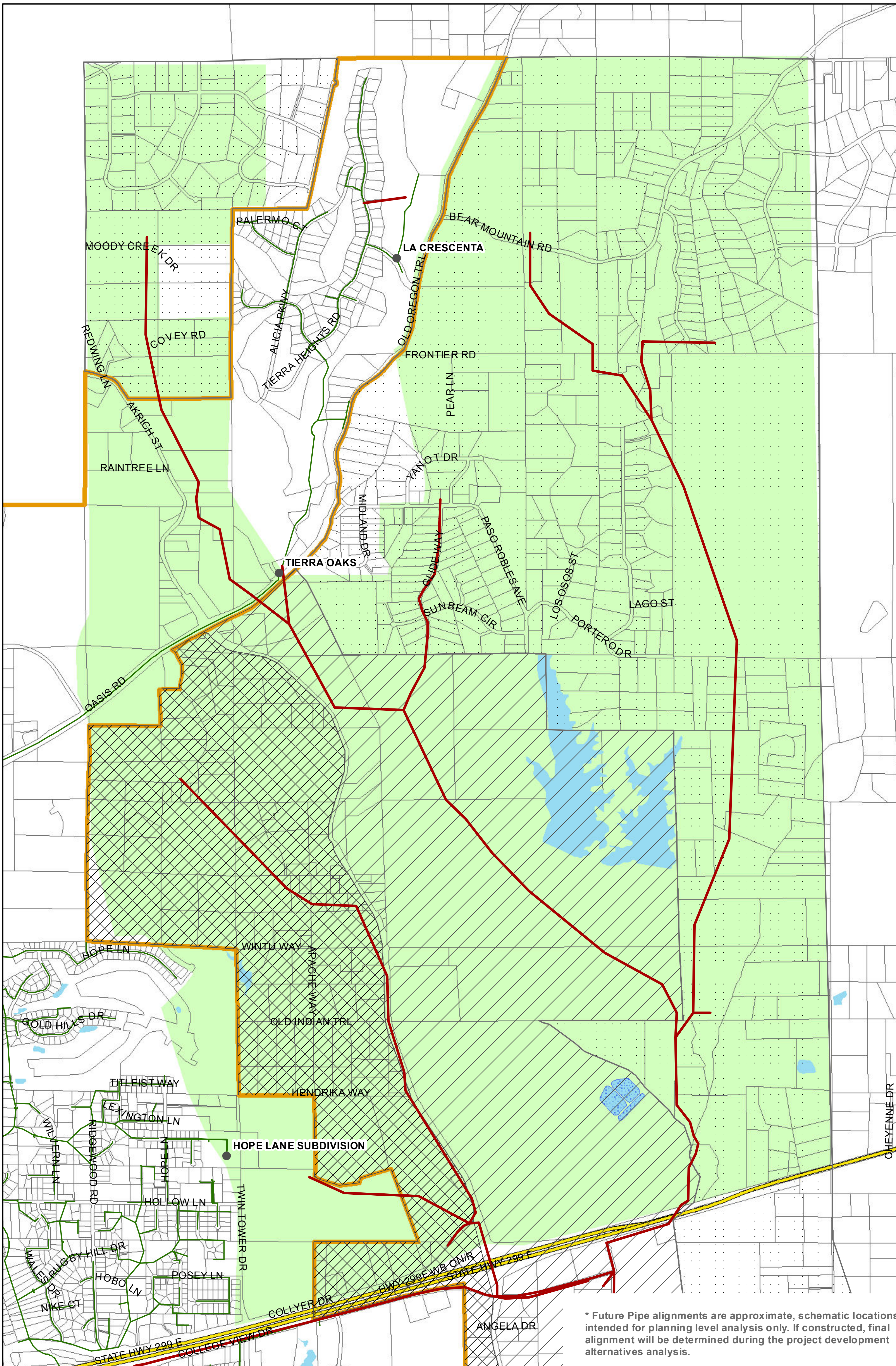


Figure B-6
City of Redding
Potential Stillwater
Collection System Improvements
South Rancho

P:\RMU\ESRI\MasterPlan\WW_SW_SouthRancho.mxd

Sept. 5, 2012



* Future Pipe alignments are approximate, schematic locations intended for planning level analysis only. If constructed, final alignment will be determined during the project development alternatives analysis.

Treatment Plant
Lift Station
Potential Future Pipe*
Existing Pipe
General Plan Primary Growth
General Plan Secondary Growth
General Plan Sphere of Influence
Freeway
Highway
City Boundary
Stillwater North

0 0.125 0.25 0.5 0.75 Miles

Figure B-7a
City of Redding
Potential Stillwater Collection System Improvements
Stillwater North

P:\RMU\ESRI\MasterPlan\WW_SW_StillwaterNorth.mxd

Sept. 5, 2012

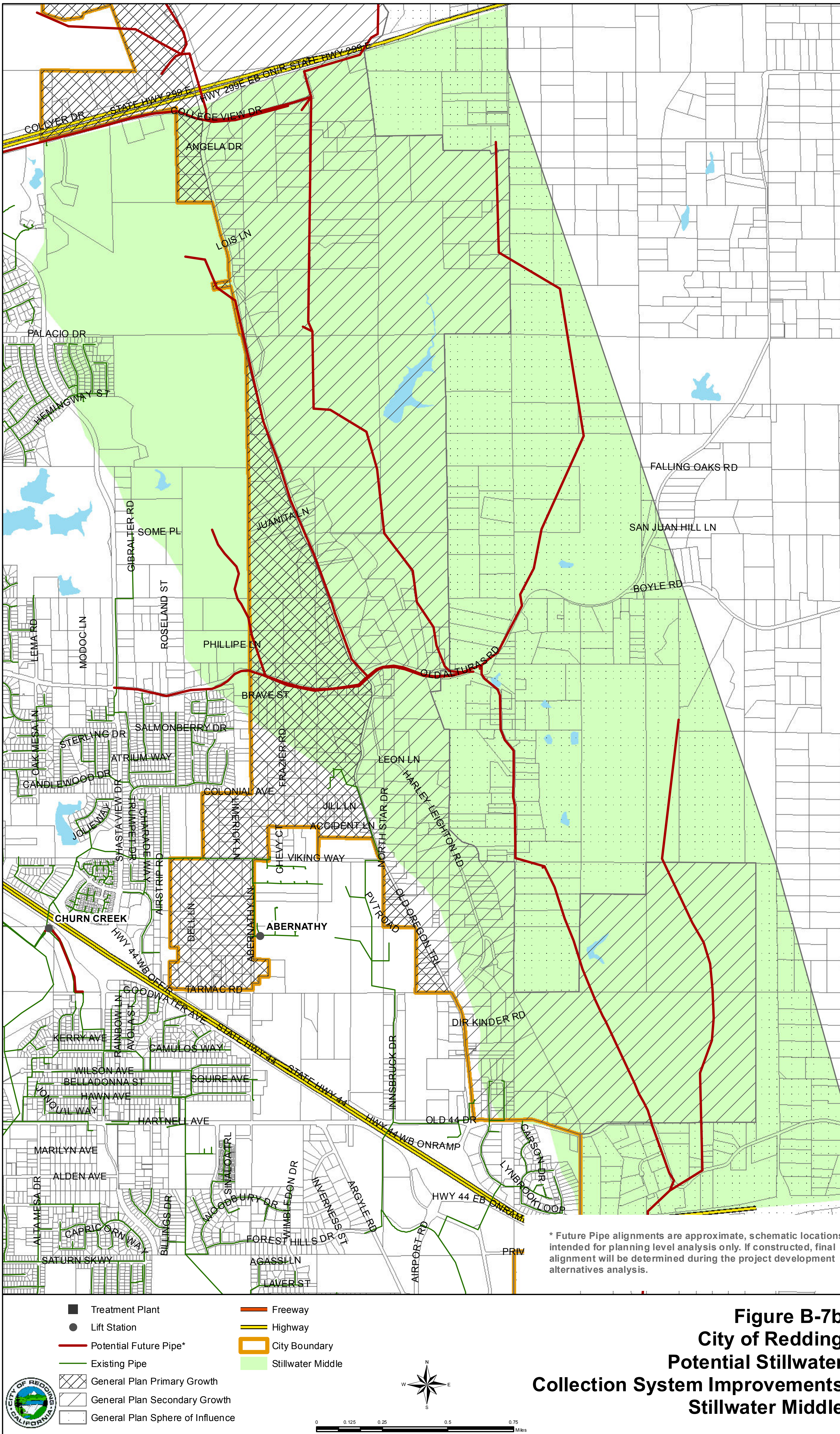


Figure B-7b
City of Redding
Potential Stillwater
Collection System Improvements
Stillwater Middle

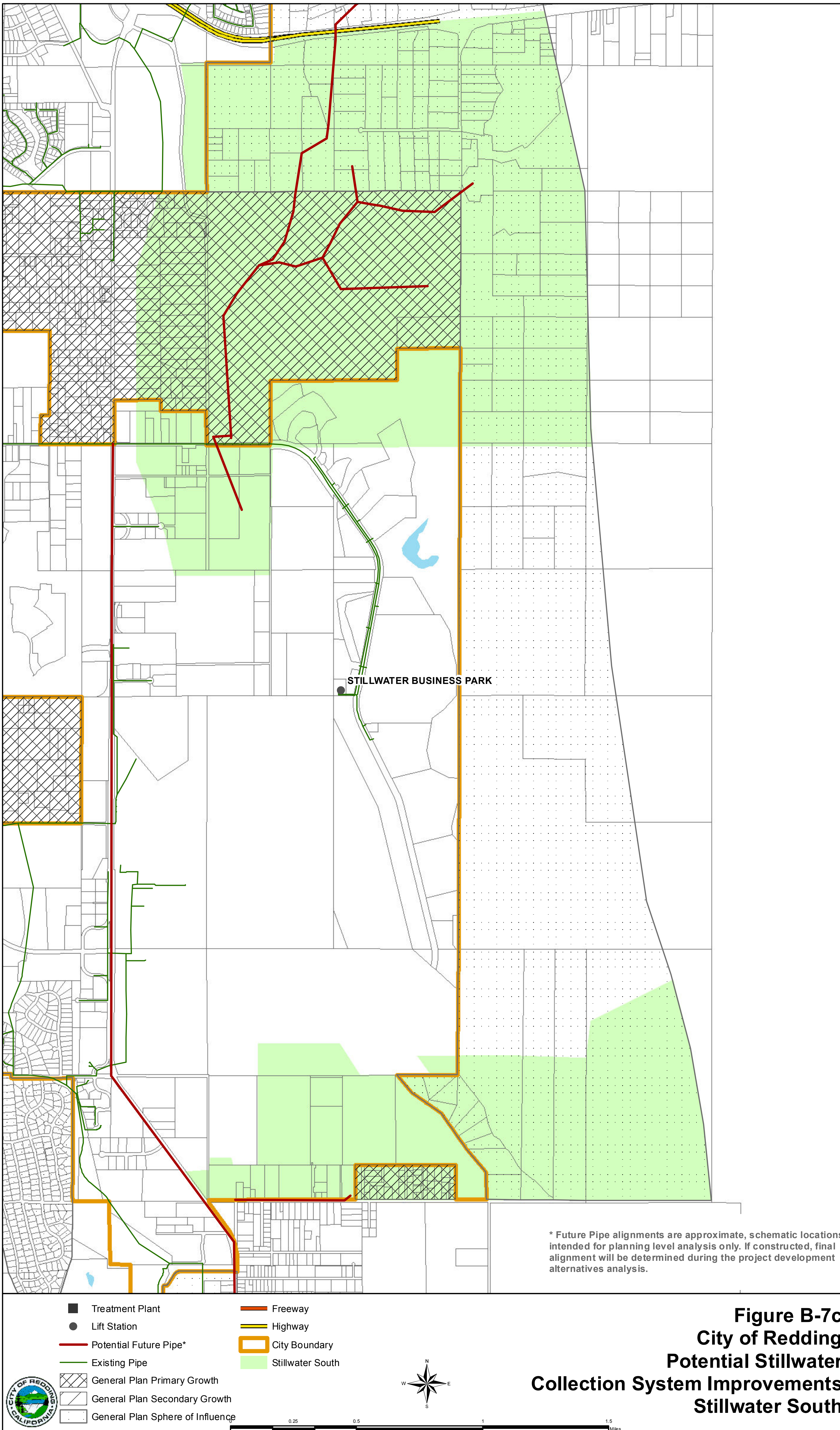


Figure B-7c
City of Redding
Potential Stillwater
Collection System Improvements
Stillwater South

P:\RMU\ESRI\MasterPlan\WW_SW_StillwaterSouth.mxd

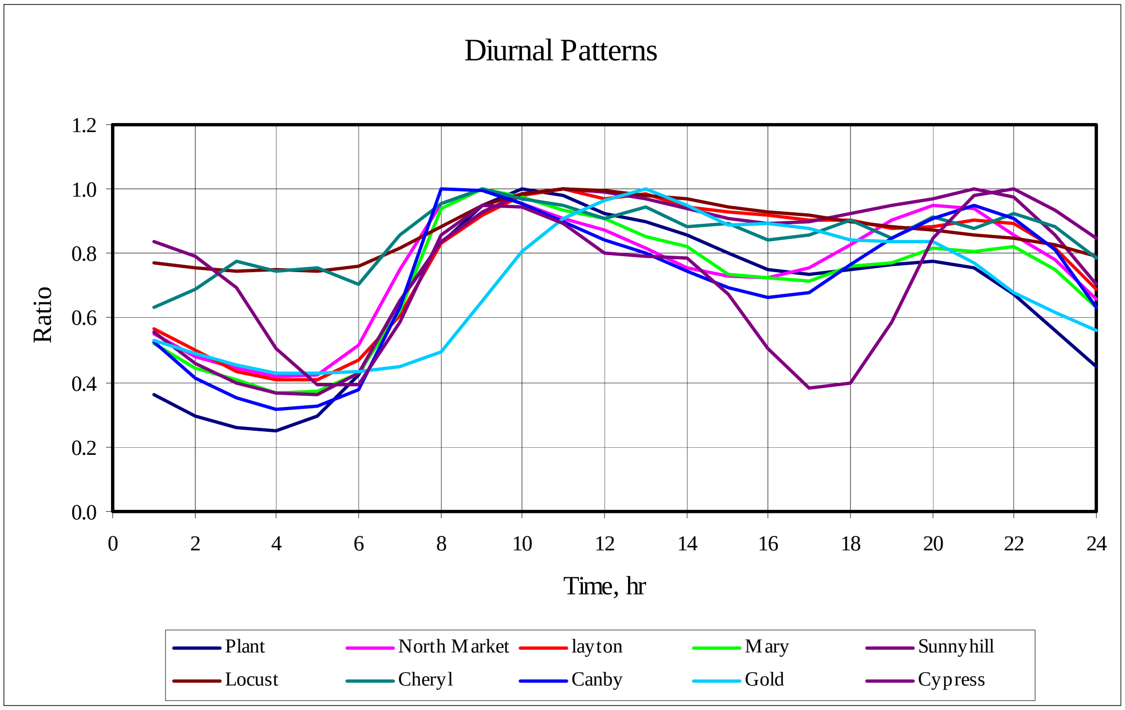
Sept. 5, 2012

APPENDIX C

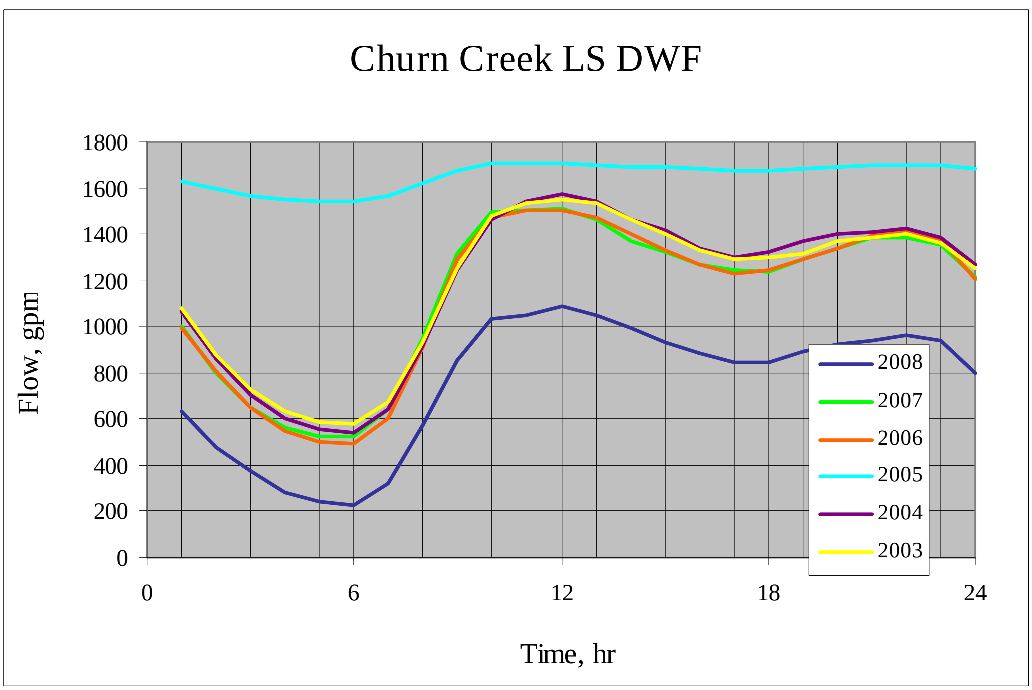
Supporting Figures and Data

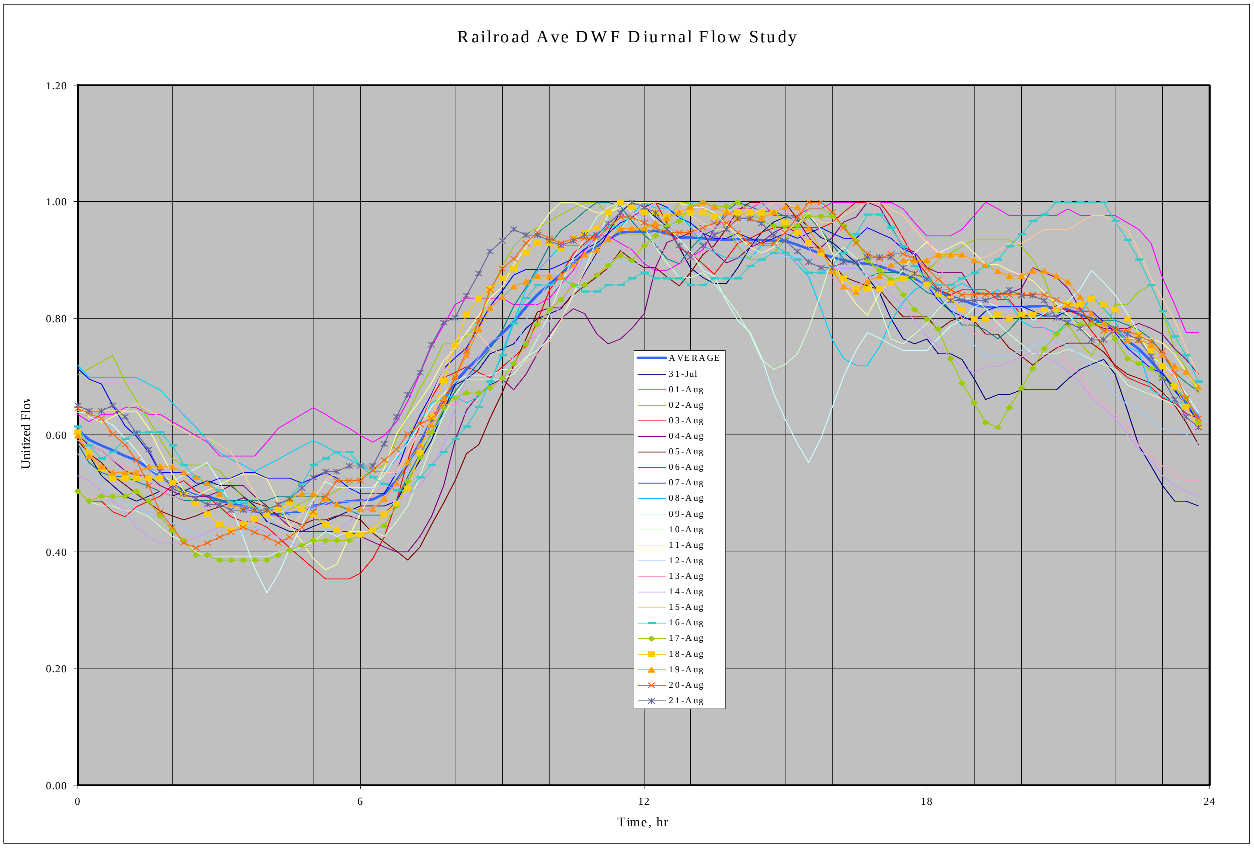
Diurnal Patterns

Initial investigation and graphing of multiple diurnal patterns in the Clear Creek Collection System. Each hour magnitude was calculated as a ratio of that hour to maximum hour thus maximum at each station is 1.0.



Diurnal Pattern and DWF study for Churn Creek Lift Station showing flow meter failure and calibration problems in 2005 and 2008. Data was averaged for each hour for 31 days of August for each year.




Railroad Ave DWF Diurnal Flow Study
Unitized Flow
Time, hr
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0
6
12
18
24
AVERAGE
31-Jul
01-Aug
02-Aug
03-Aug
04-Aug
05-Aug
06-Aug
07-Aug
08-Aug
09-Aug
10-Aug
11-Aug
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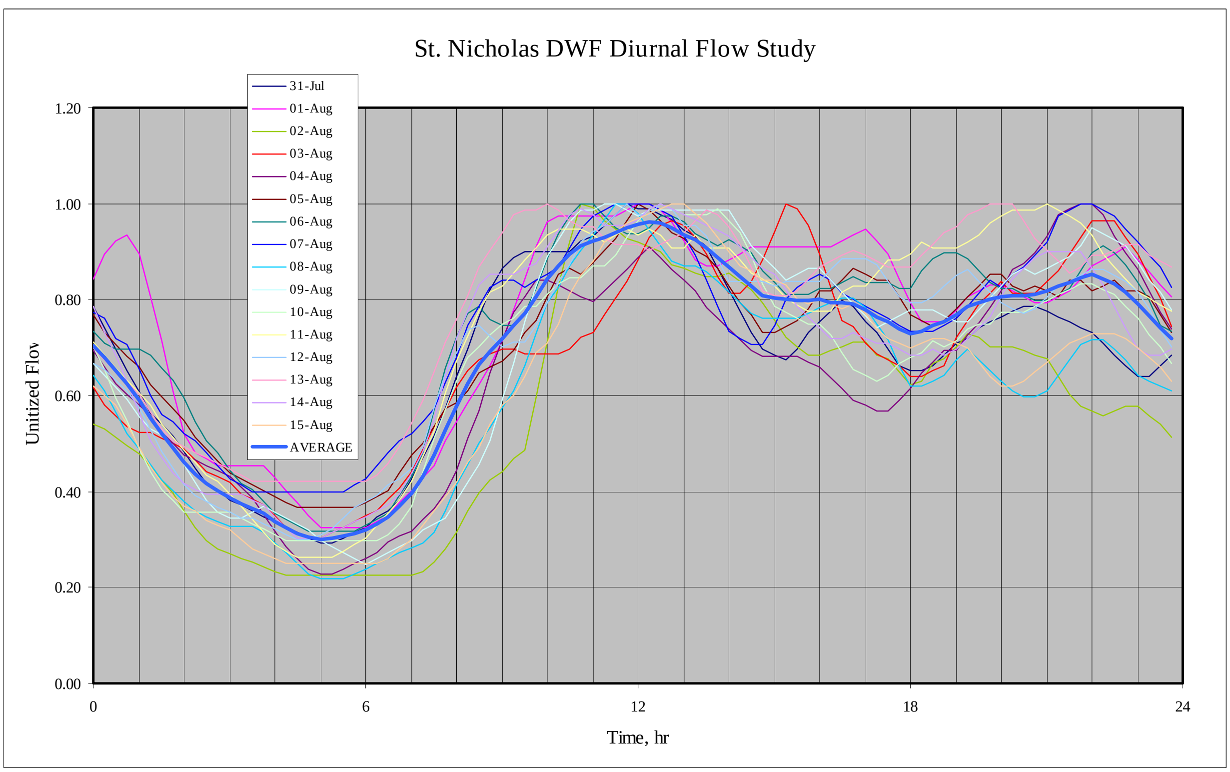
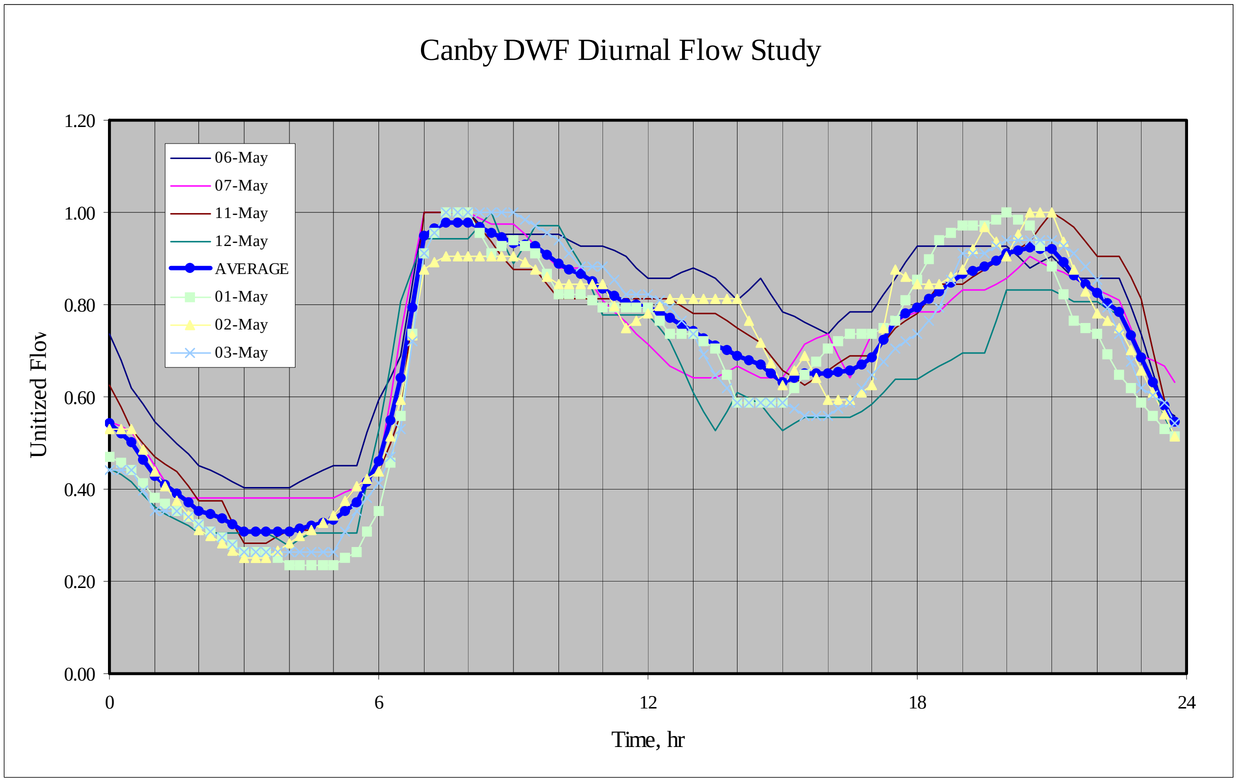
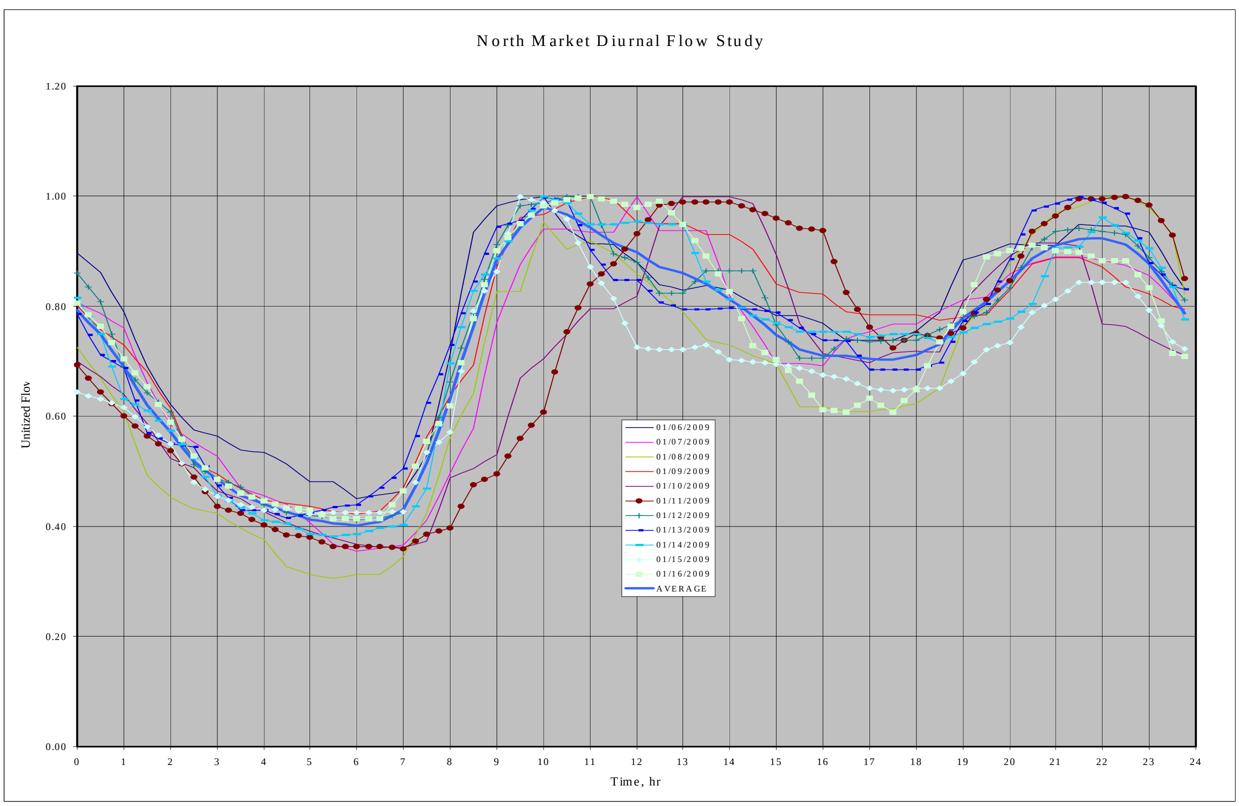
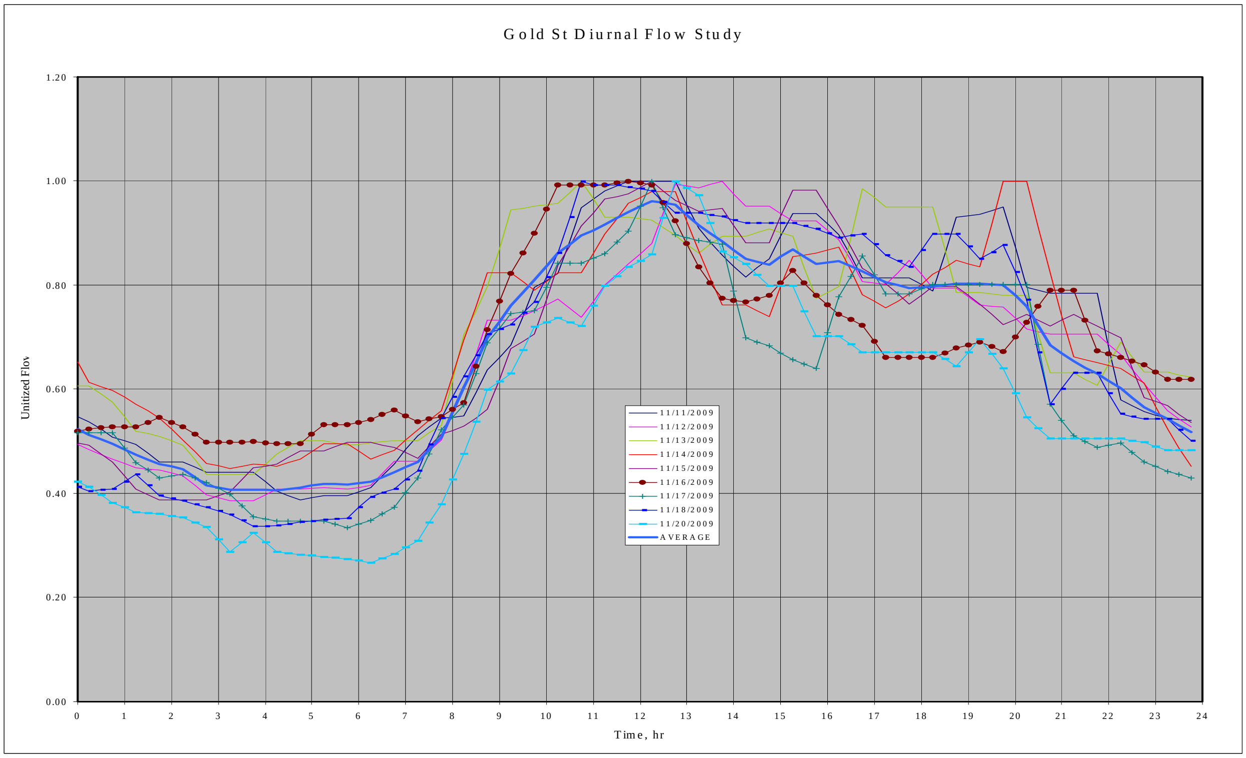
16-Aug
17-Aug
18-Aug
19-Aug
20-Aug
21-Aug


St. Nicholas DWF Diurnal Flow Study
Unitized Flow
Time, hr
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0
6
12
18
24
31-Jul
01-Aug
02-Aug
03-Aug
04-Aug
05-Aug
06-Aug
07-Aug
08-Aug
09-Aug
10-Aug
11-Aug
12-Aug
13-Aug
14-Aug
15-Aug
AVERAGE

Limited usable data resulted in Canby monitor being analyzed during a dry period in May.







Gold St Diurnal Flow Study
Unitized Flow
Time, hr
0.00
0.20
0.40
0.60
0.80
1.00
1.20
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
11/11/2009
11/12/2009
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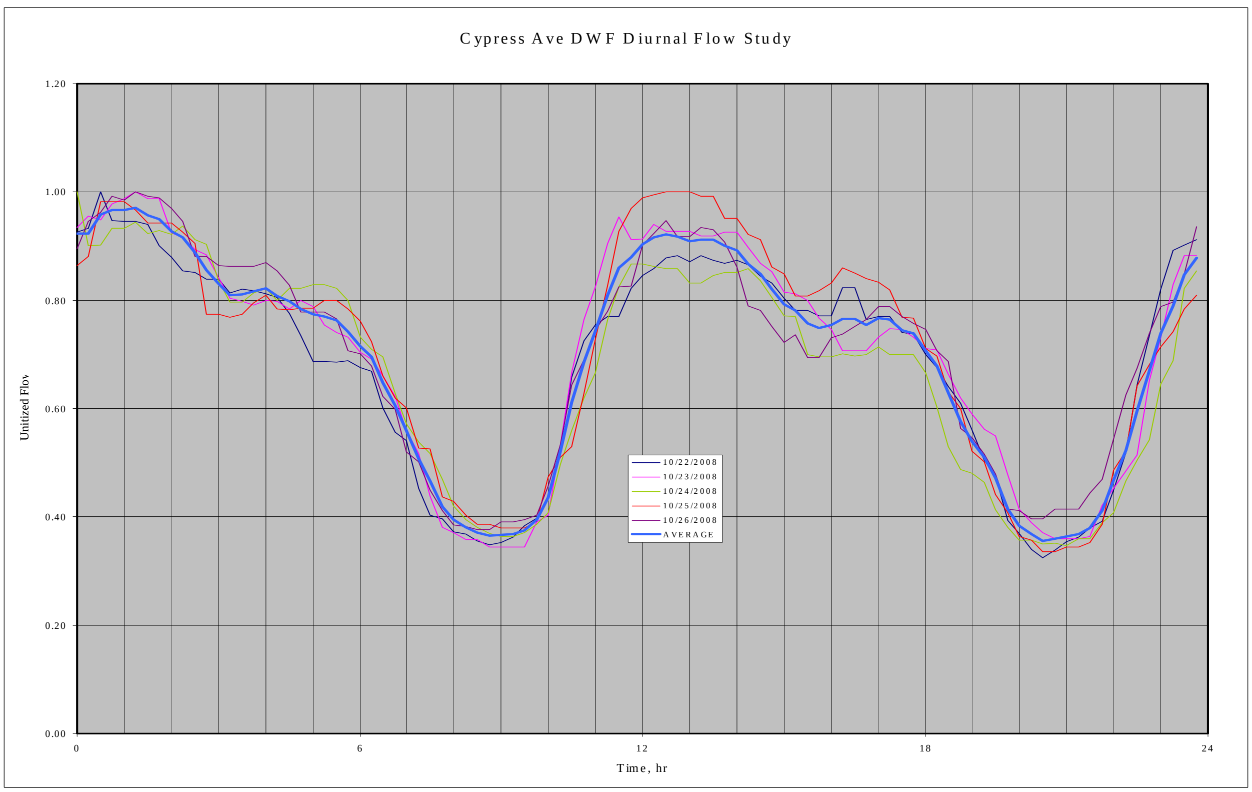
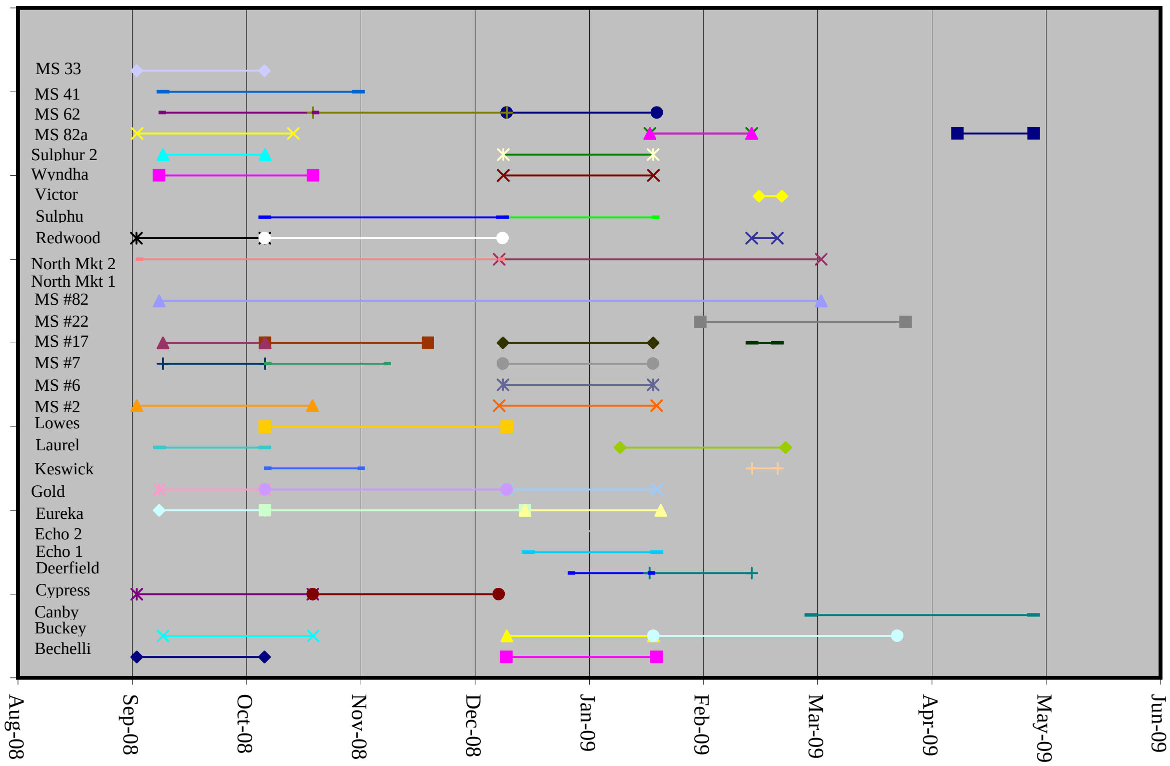
11/17/2009
11/18/2009
11/20/2009
AVERAGE

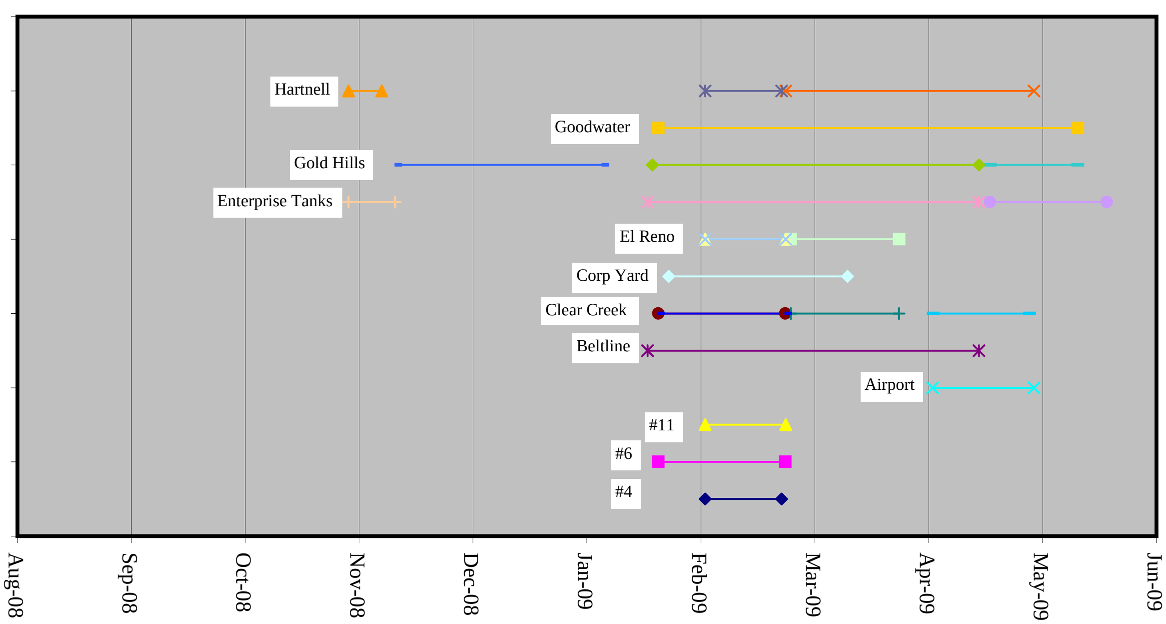


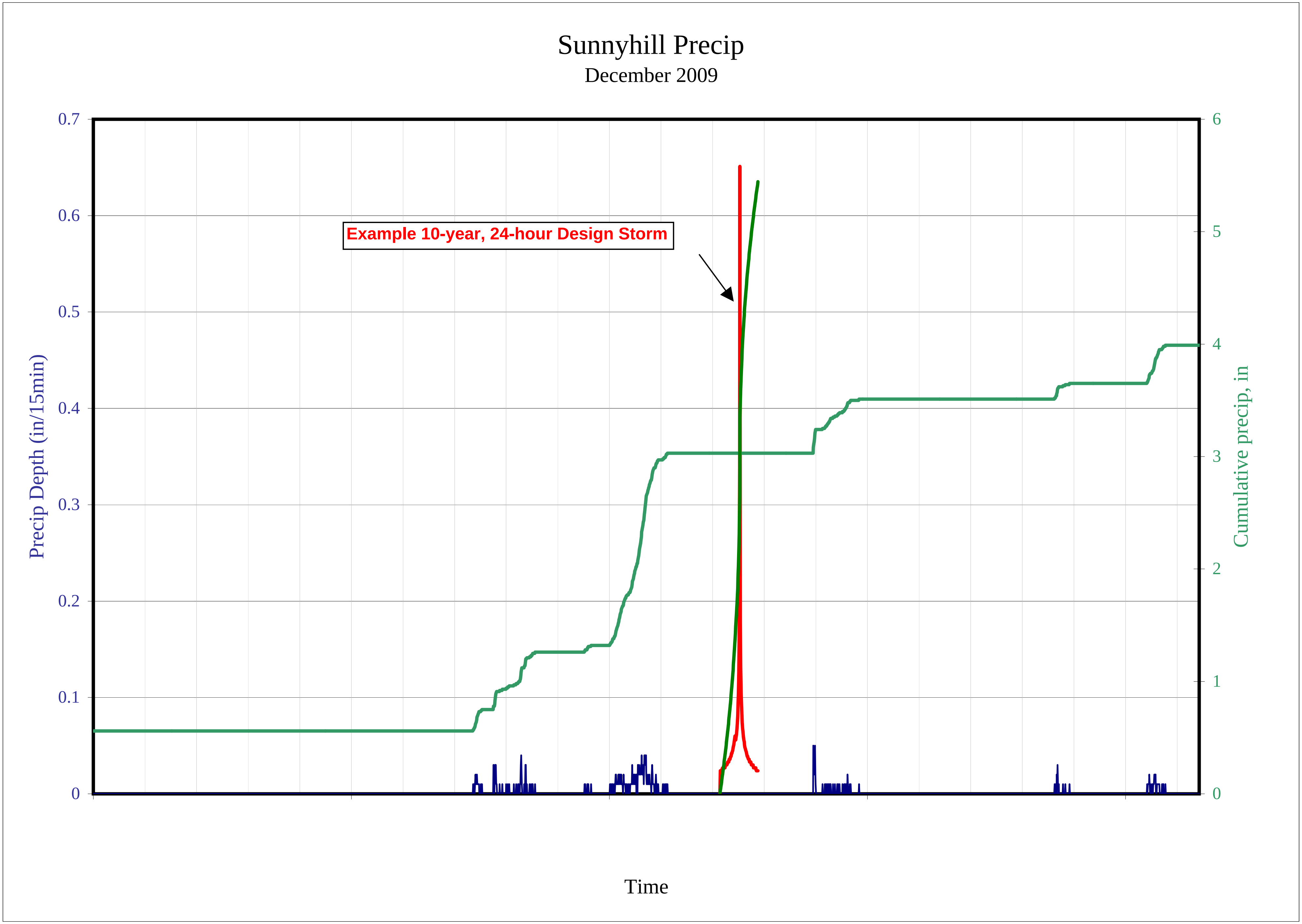
Cypress Ave DWF Diurnal Flow Study
Unitized Flow
Time, hr
0.00
0.20
0.40
0.60
0.80
1.00
1.20
0
6
12
18
24
10/22/2008
10/23/2008
10/24/2008
10/25/2008
10/26/2008
AVERAGE

2008-09 Flow Monitoring Data

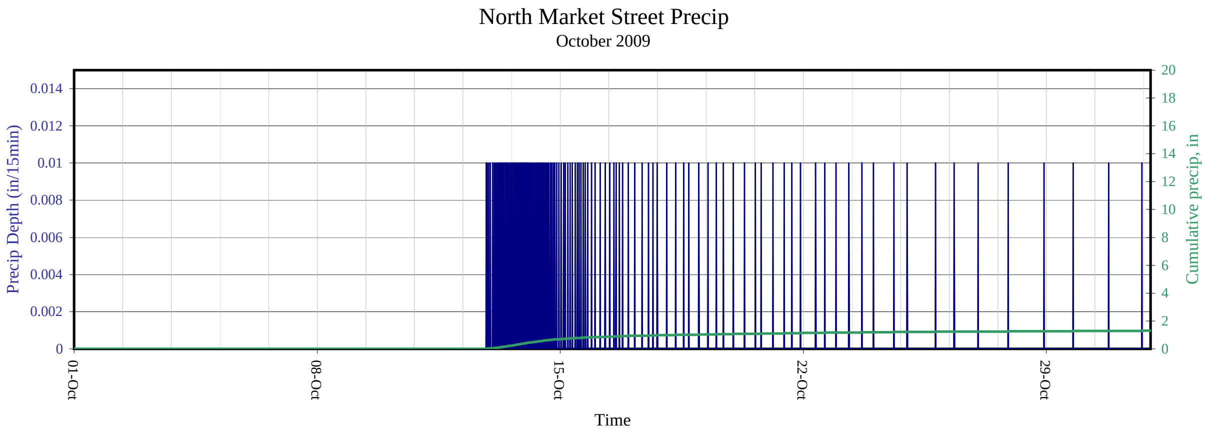


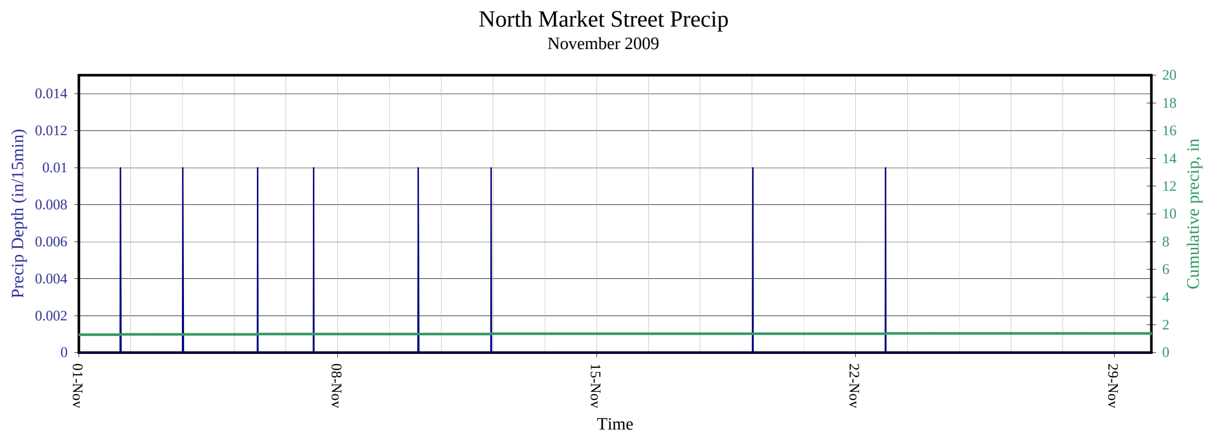
2008-09 Precipitation Data

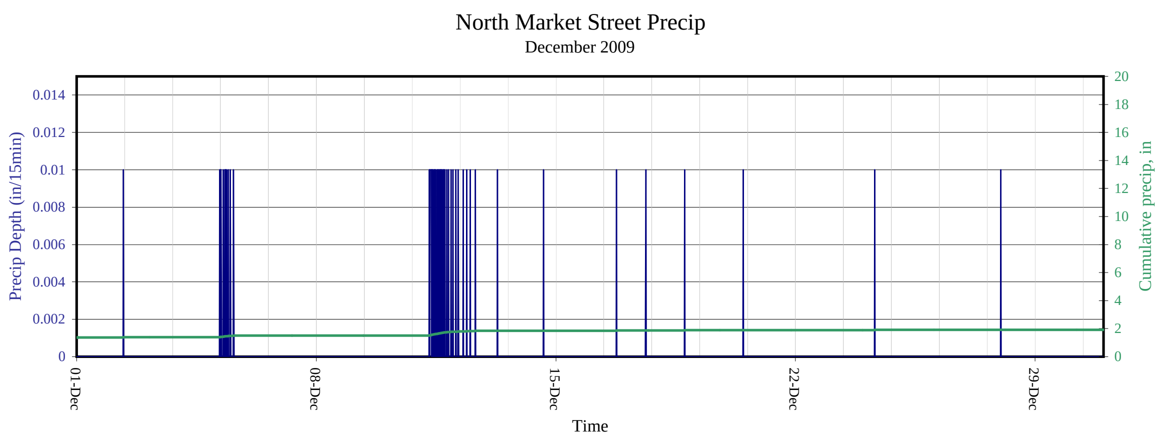


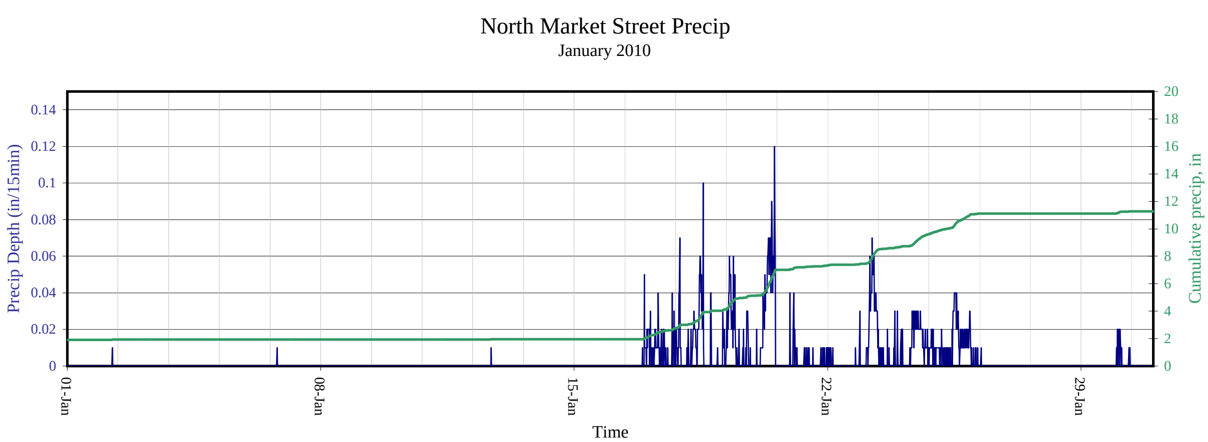


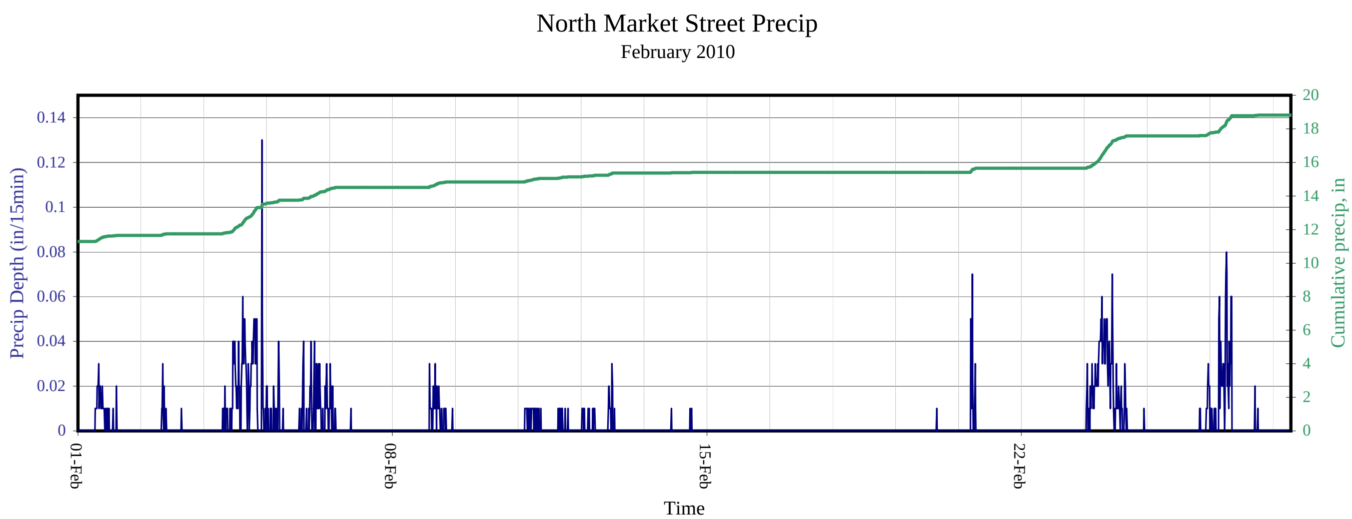
Sunnyhill Precip
December 2009
Example 10-year, 24-hour Design Storm
Precip Depth (in/15min)
Cumulative precip, in
Time
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
6
5
4
3
2
1
0

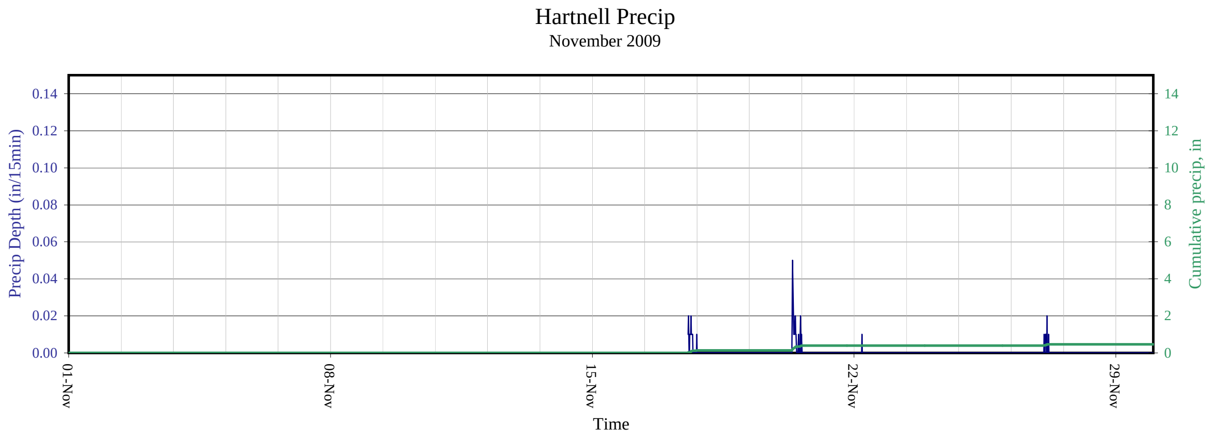

North Market Street Precip
October 2009
Precip Depth (in/15min)
Cumulative precip, in
Time
01-Oct
08-Oct
15-Oct
22-Oct
29-Oct


North Market Street Precip
November 2009
Precip Depth (in/15min)
Cumulative precip, in
Time
01-Nov
08-Nov
15-Nov
22-Nov
29-Nov

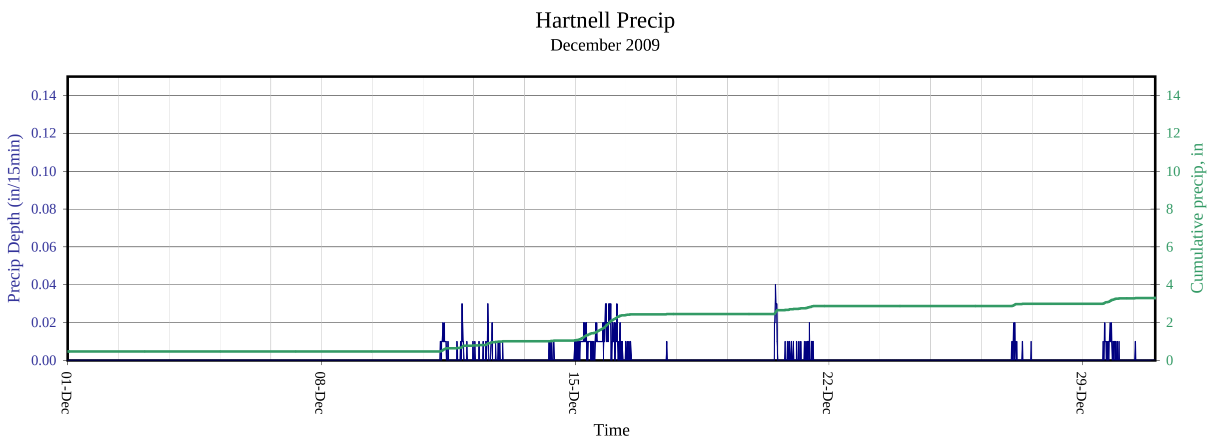

North Market Street Precip
December 2009
Precip Depth (in/15min)
Cumulative precip, in
Time
01-Dec
08-Dec
15-Dec
22-Dec
29-Dec


North Market Street Precip
January 2010
Precip Depth (in/15min)
Cumulative precip, in
Time
01-Jan
08-Jan
15-Jan
22-Jan
29-Jan

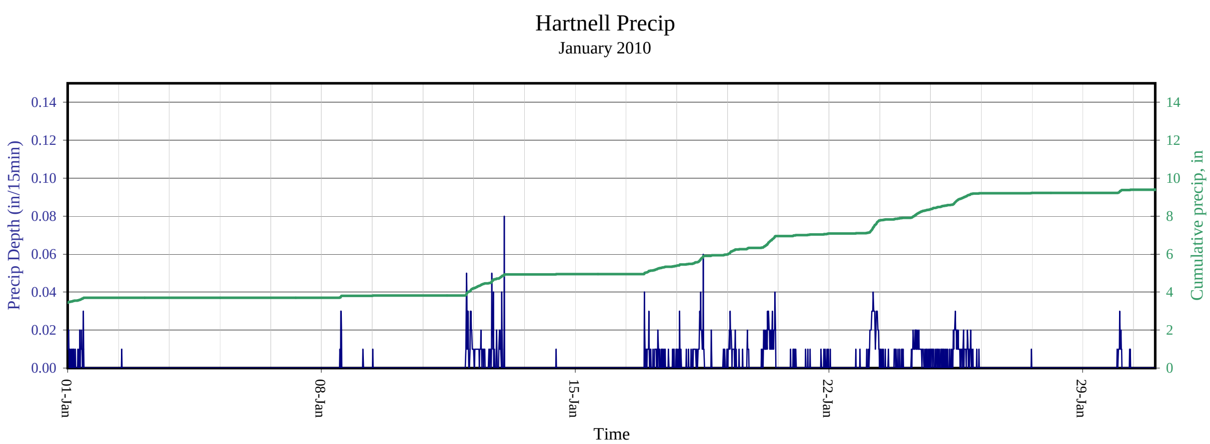

North Market Street Precip
February 2010
Precip Depth (in/15min)
Cumulative precip, in
Time
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
20
18
16
14
12
10
8
6
4
2
0
01-Feb
08-Feb
15-Feb
22-Feb



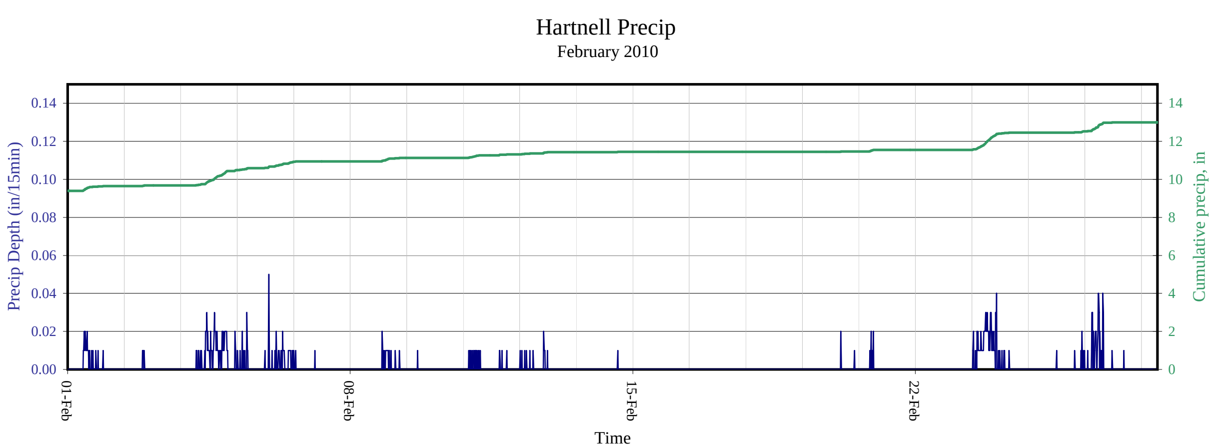
Hartnell Precip
November 2009
Precip Depth (in/15min)
Cumulative precip, in
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
14
12
10
8
6
4
2
0
01-Nov
08-Nov
15-Nov
22-Nov
29-Nov
Time



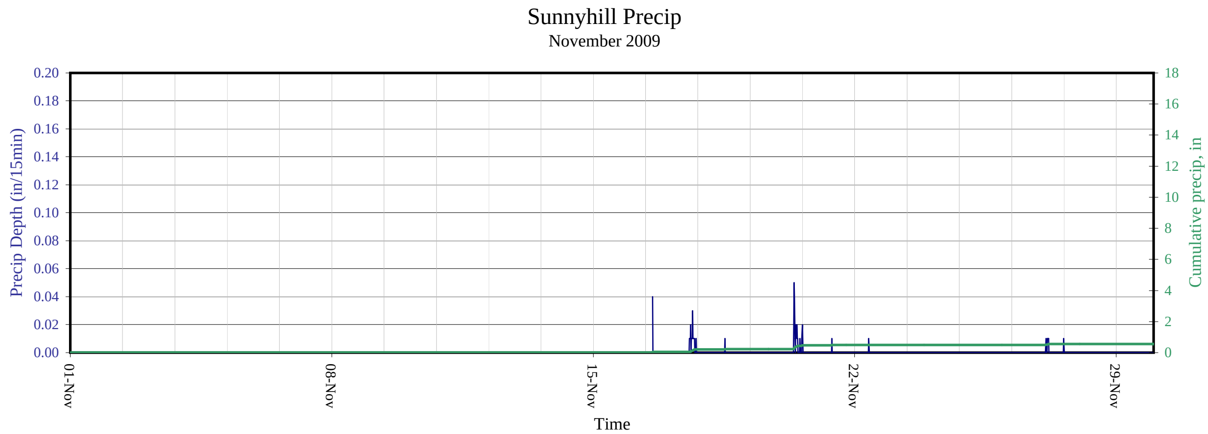
Hartnell Precip
December 2009
Precip Depth (in/15min)
Cumulative precip, in
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
14
12
10
8
6
4
2
0
01-Dec
08-Dec
15-Dec
22-Dec
29-Dec
Time

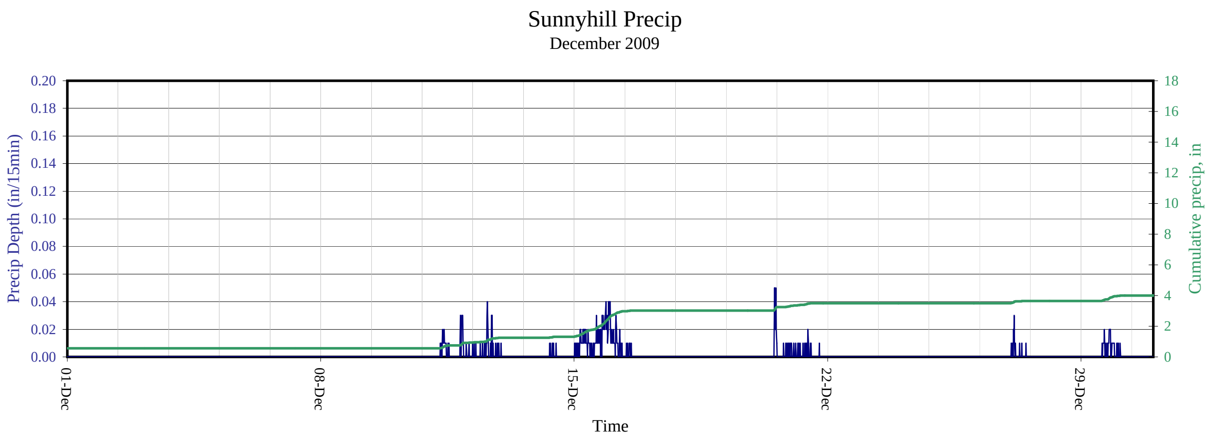


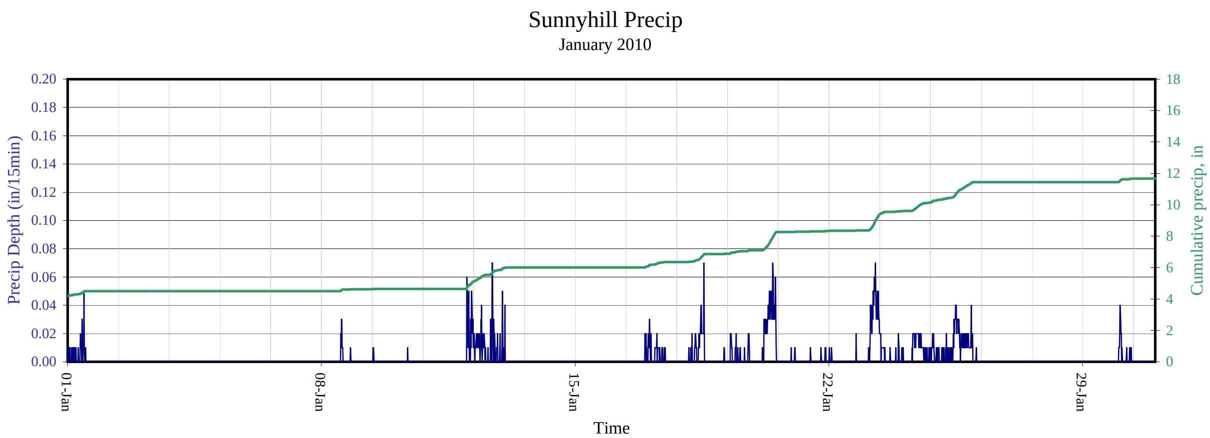
Hartnell Precip
January 2010
Precip Depth (in/15min)
Cumulative precip, in
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
14
12
10
8
6
4
2
0
01-Jan
08-Jan
15-Jan
22-Jan
29-Jan
Time

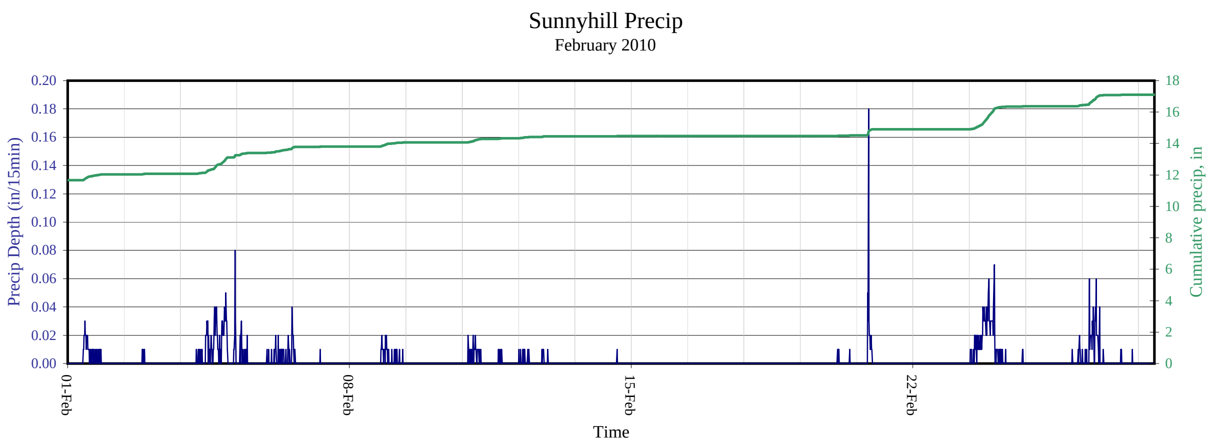


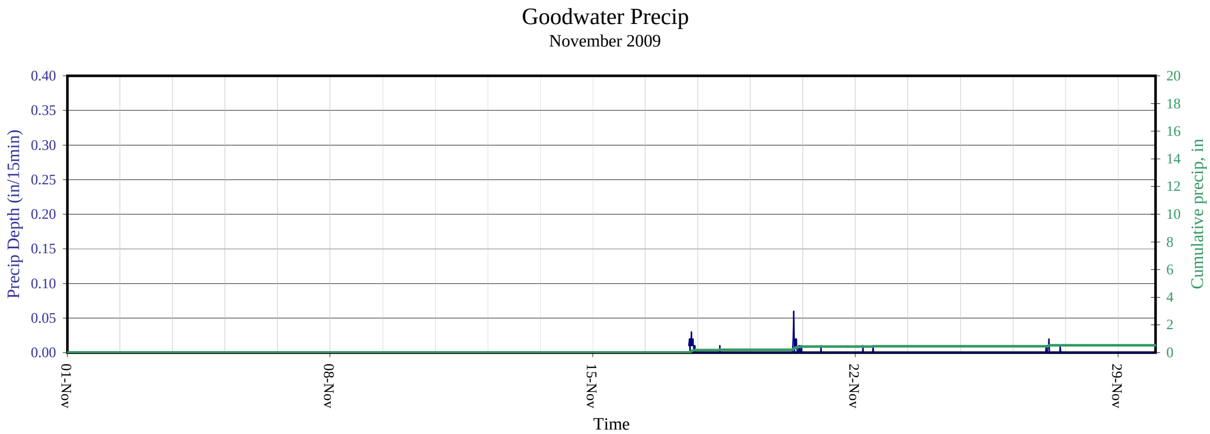
Hartnell Precip
February 2010
Precip Depth (in/15min)
Cumulative precip, in
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
14
12
10
8
6
4
2
0
01-Feb
08-Feb
15-Feb
22-Feb
Time

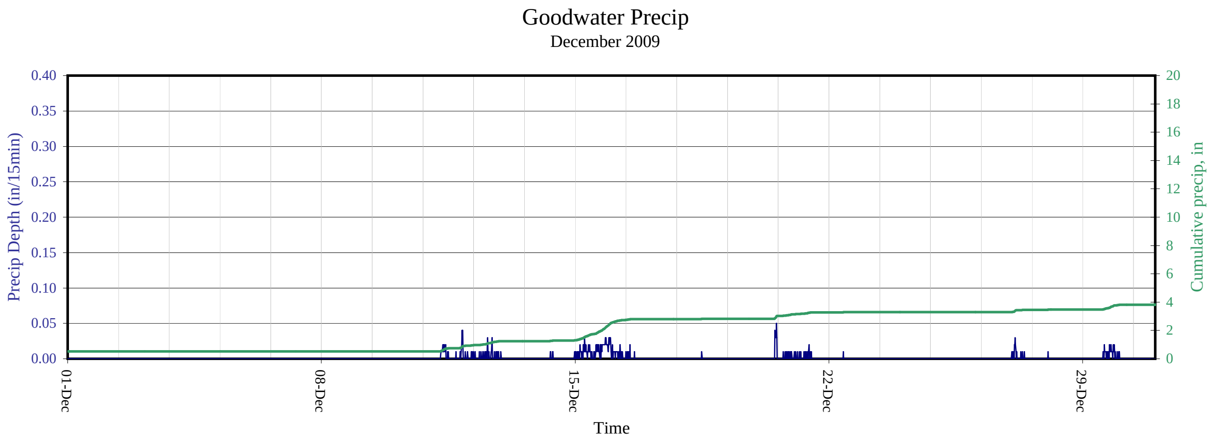

Sunnyhill Precip
November 2009
Precip Depth (in/15min)
Cumulative precip, in
01-Nov
08-Nov
15-Nov
22-Nov
29-Nov
Time

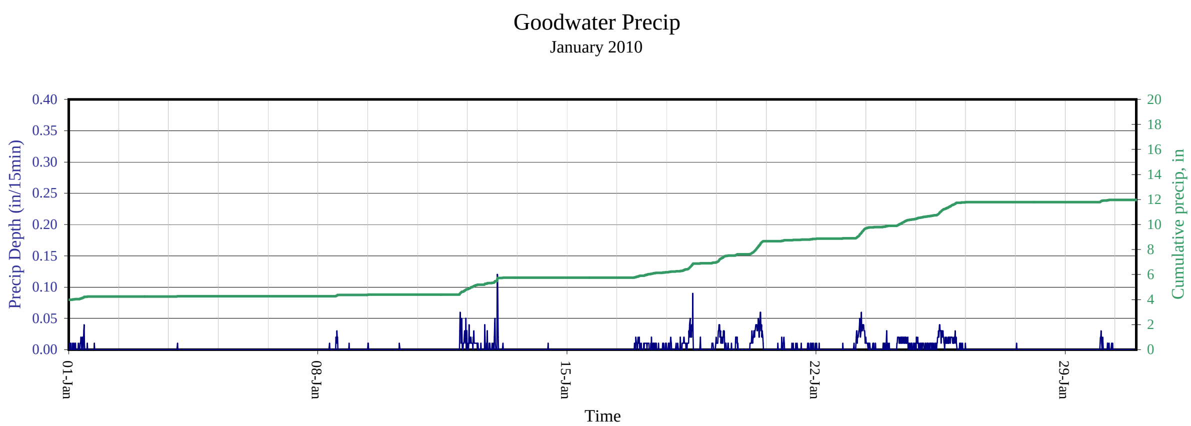

Sunnyhill Precip
December 2009
Precip Depth (in/15min)
Cumulative precip, in
01-Dec
08-Dec
15-Dec
22-Dec
29-Dec
Time

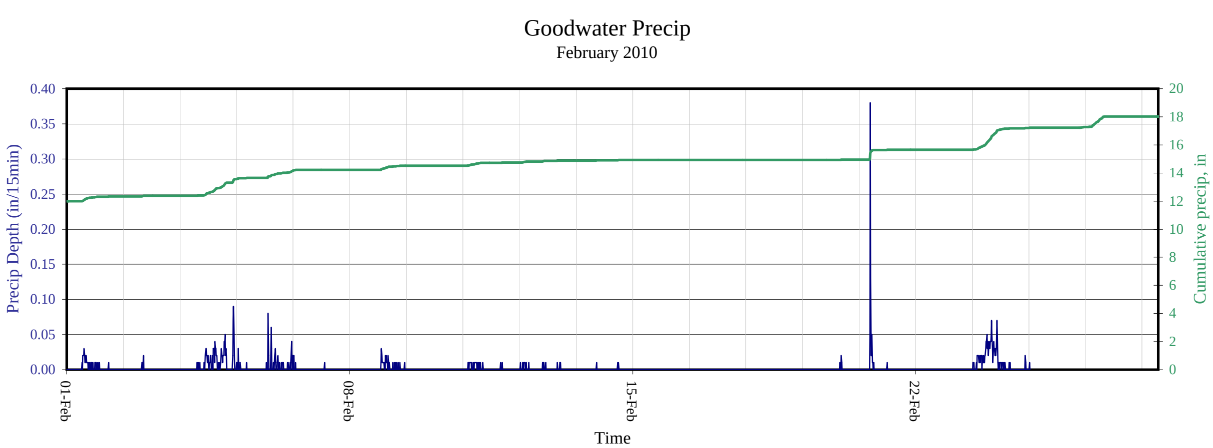

Sunnyhill Precip
January 2010
Precip Depth (in/15min)
Cumulative precip, in
01-Jan
08-Jan
15-Jan
22-Jan
29-Jan
Time

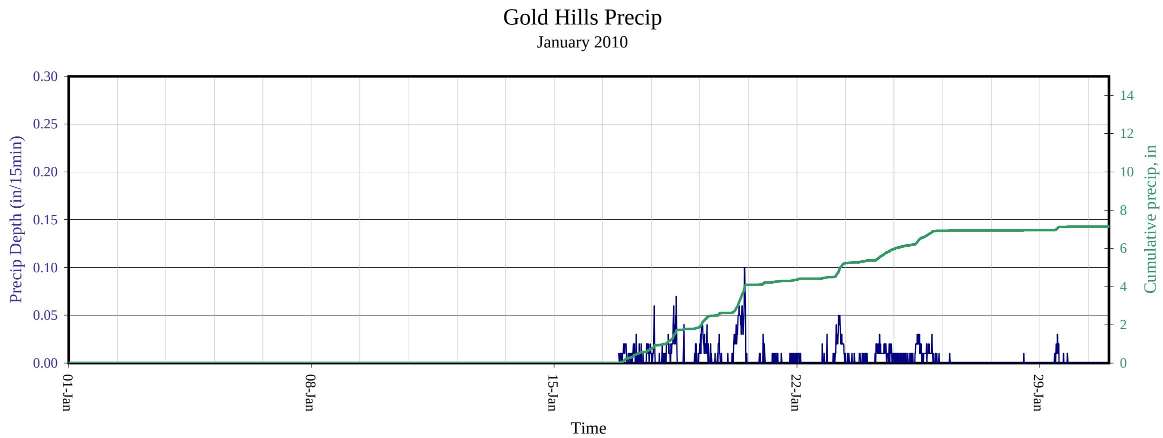

Sunnyhill Precip
February 2010
Precip Depth (in/15min)
Cumulative precip, in
01-Feb
08-Feb
15-Feb
22-Feb
Time

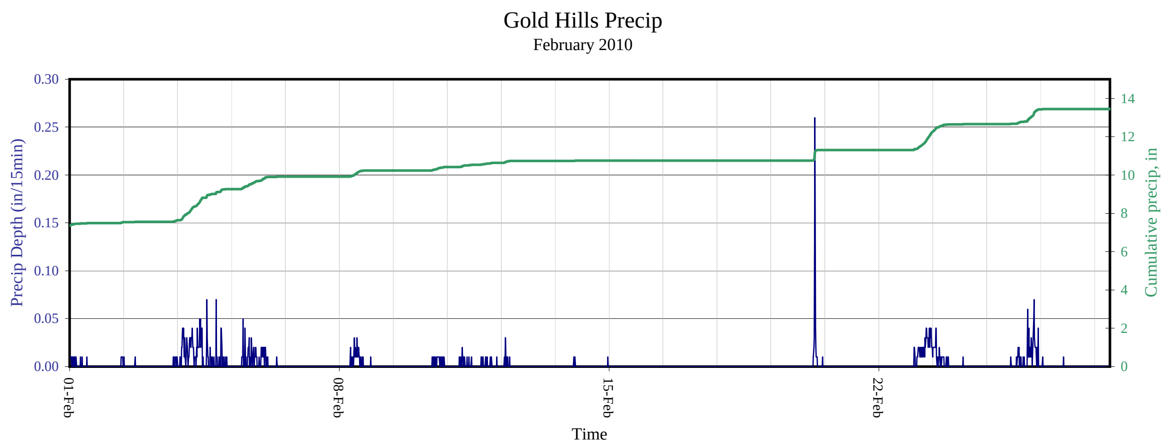

Goodwater Precip
November 2009
Precip Depth (in/15min)
Cumulative precip, in
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
20
18
16
14
12
10
8
6
4
2
0
01-Nov
08-Nov
15-Nov
22-Nov
29-Nov
Time


Goodwater Precip
December 2009
Precip Depth (in/15min)
Cumulative precip, in
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
20
18
16
14
12
10
8
6
4
2
0
01-Dec
08-Dec
15-Dec
22-Dec
29-Dec
Time

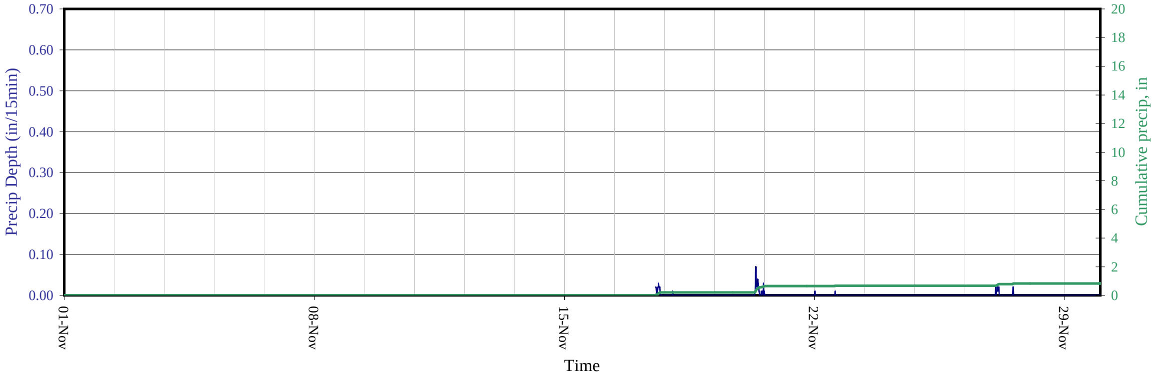

Goodwater Precip
January 2010
Precip Depth (in/15min)
Cumulative precip, in
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
20
18
16
14
12
10
8
6
4
2
0
01-Jan
08-Jan
15-Jan
22-Jan
29-Jan
Time


Goodwater Precip
February 2010
Precip Depth (in/15min)
Cumulative precip, in
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
20
18
16
14
12
10
8
6
4
2
0
01-Feb
08-Feb
15-Feb
22-Feb
Time

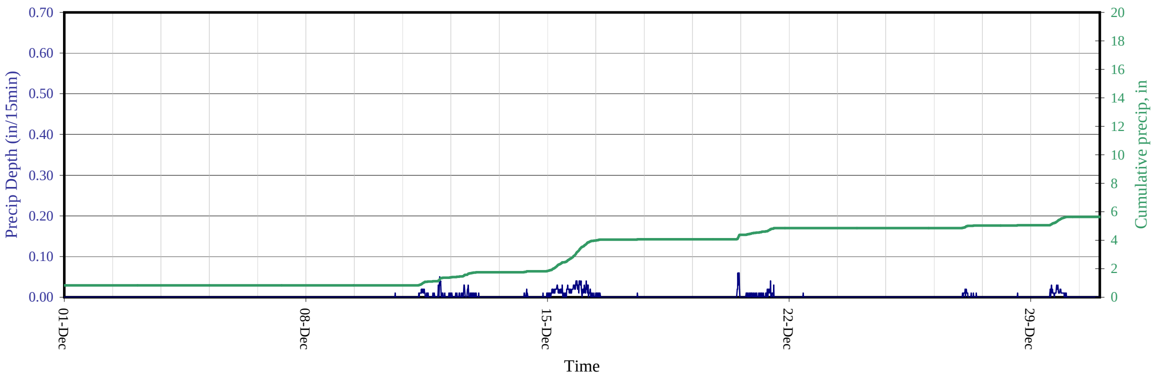

Gold Hills Precip
January 2010
Precip Depth (in/15min)
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Cumulative precip, in
14
12
10
8
6
4
2
0
01-Jan
08-Jan
15-Jan
22-Jan
29-Jan
Time


Gold Hills Precip
February 2010
Precip Depth (in/15min)
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Cumulative precip, in
14
12
10
8
6
4
2
0
01-Feb
08-Feb
15-Feb
22-Feb
Time

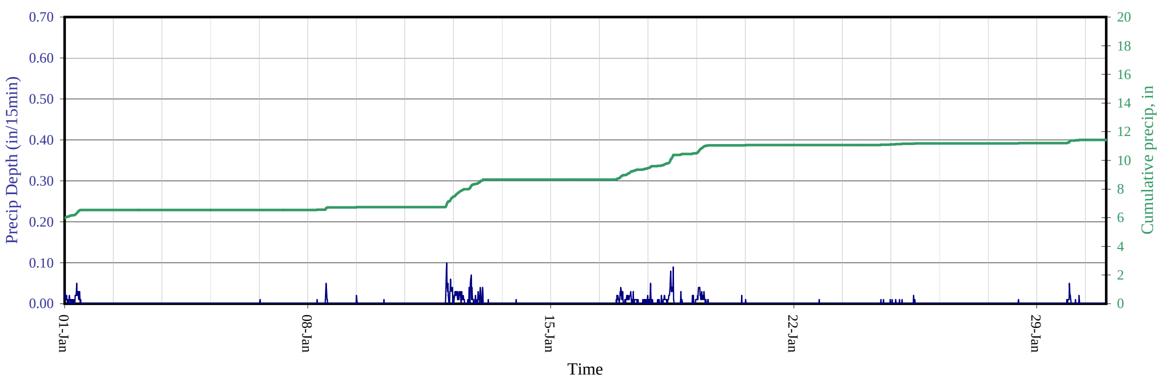
Enterprise Well Precip
November 2009



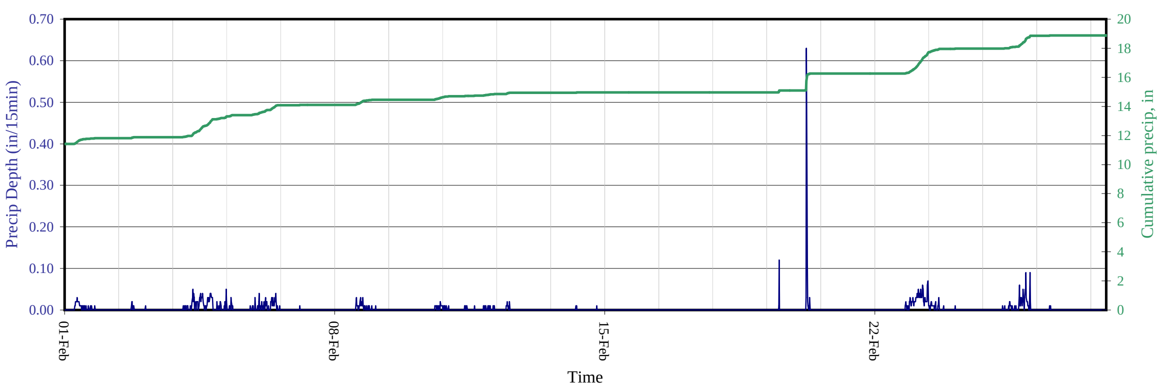
Enterprise Well Precip
December 2009

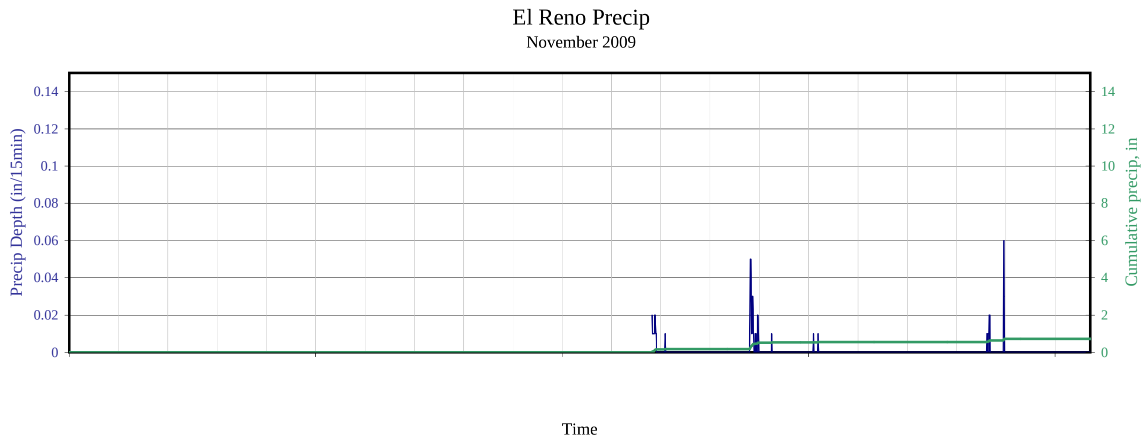


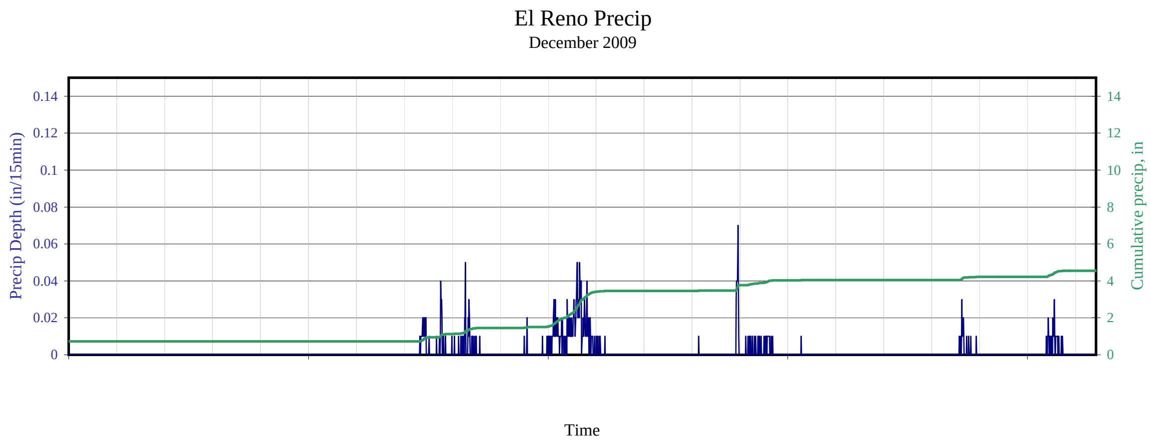
Enterprise Well Precip
January 2010

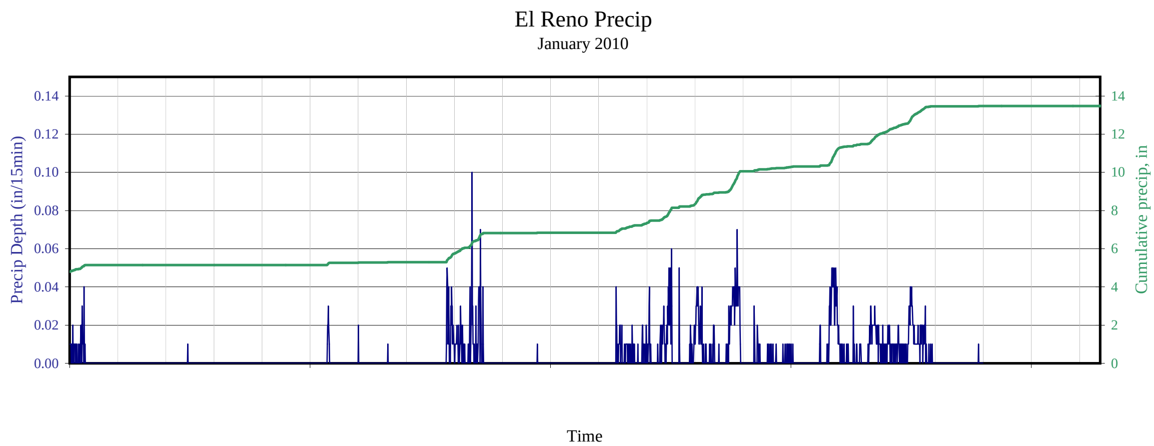


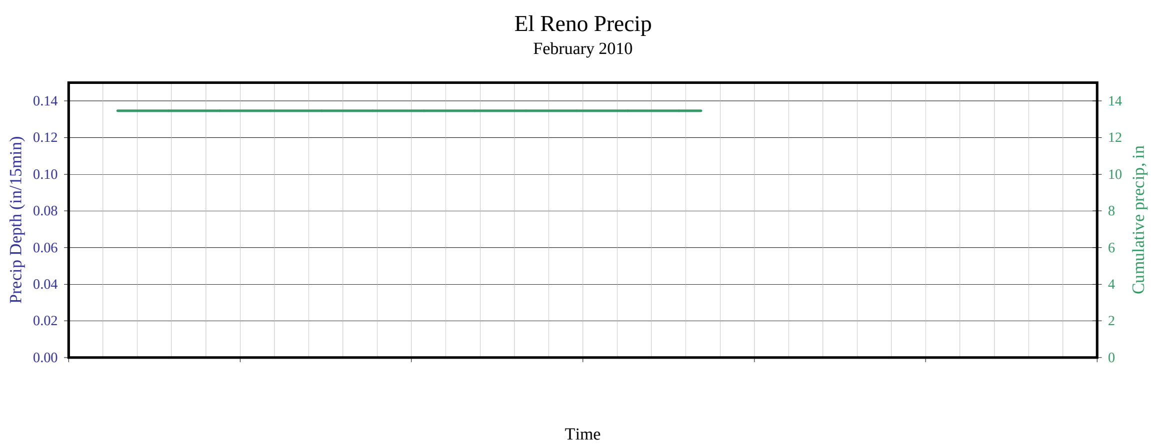
Enterprise Well Precip
February 2010

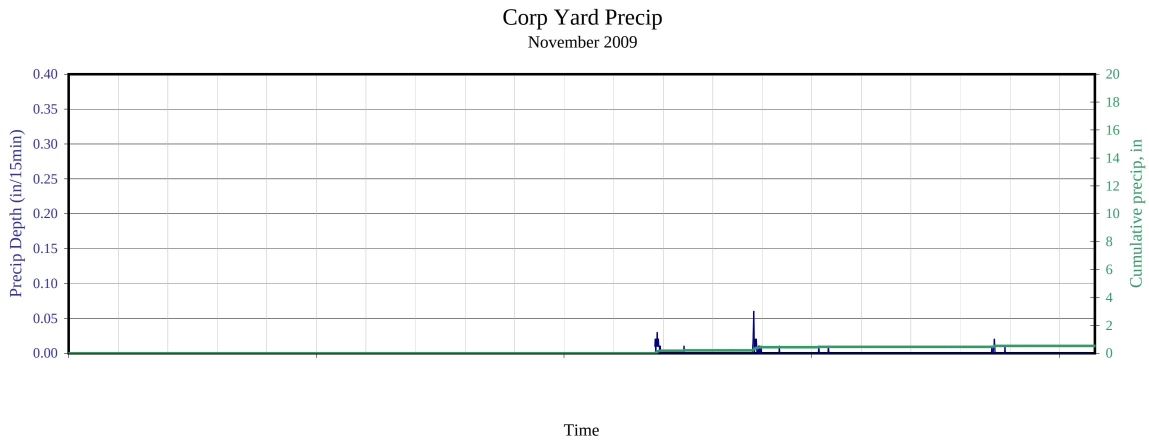


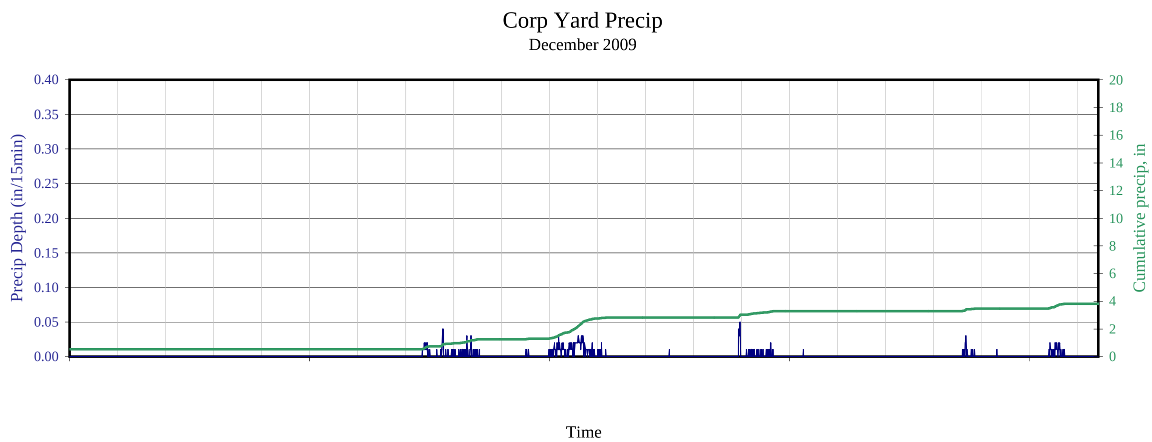

El Reno Precip
November 2009
Precip Depth (in/15min)
Cumulative precip, in
Time

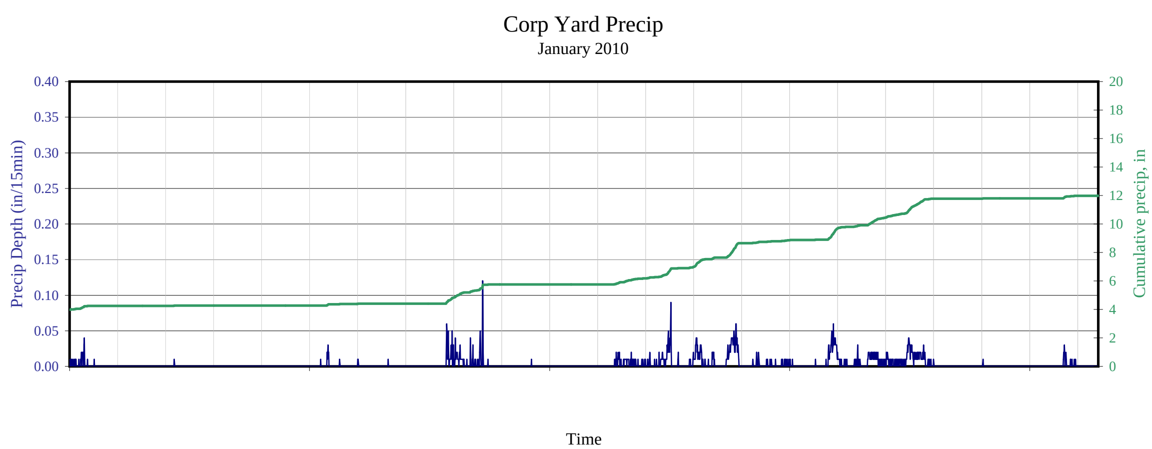

El Reno Precip
December 2009
Precip Depth (in/15min)
Cumulative precip, in
Time

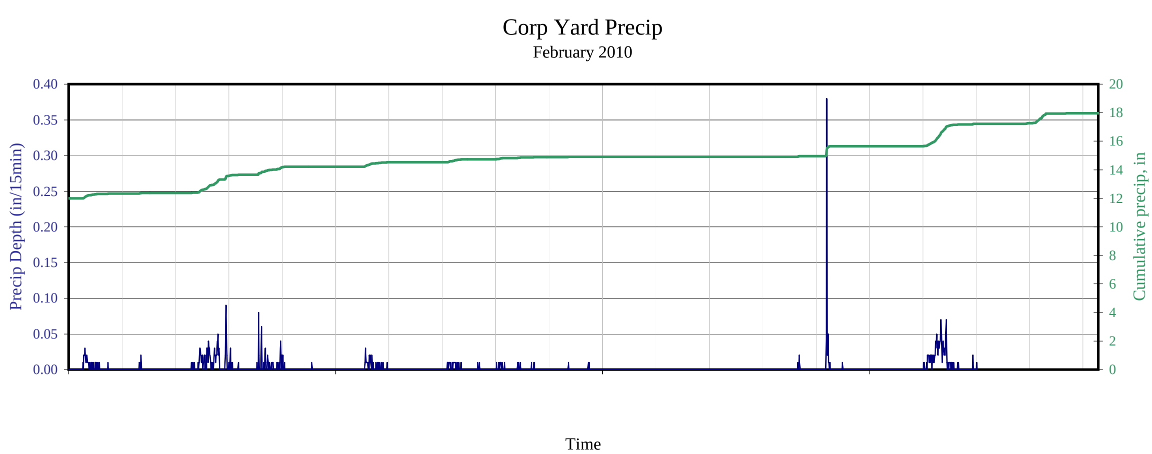

El Reno Precip
January 2010
Precip Depth (in/15min)
Cumulative precip, in
Time


El Reno Precip
February 2010
Precip Depth (in/15min)
Cumulative precip, in
Time

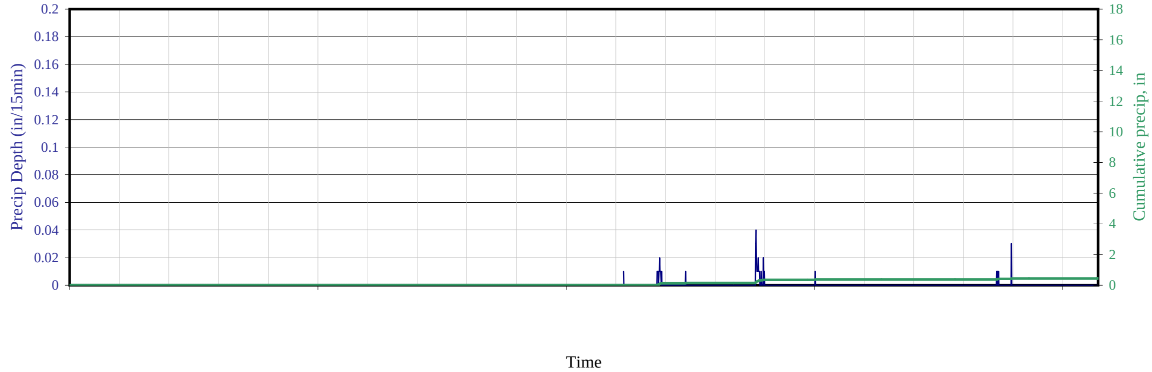

Corp Yard Precip
November 2009
Precip Depth (in/15min)
Cumulative precip, in
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
20
18
16
14
12
10
8
6
4
2
0
Time


Corp Yard Precip
December 2009
Precip Depth (in/15min)
Cumulative precip, in
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
20
18
16
14
12
10
8
6
4
2
0
Time

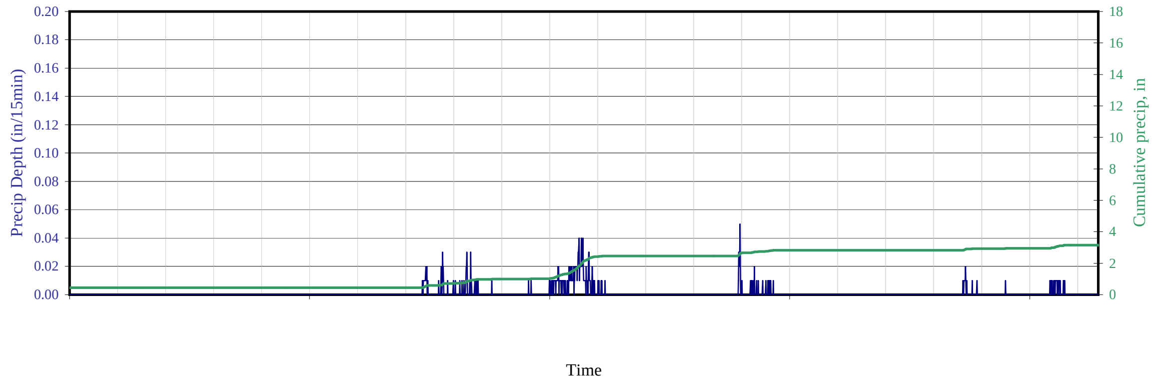

Corp Yard Precip
January 2010
Precip Depth (in/15min)
Cumulative precip, in
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
20
18
16
14
12
10
8
6
4
2
0
Time


Corp Yard Precip
February 2010
Precip Depth (in/15min)
Cumulative precip, in
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
20
18
16
14
12
10
8
6
4
2
0
Time

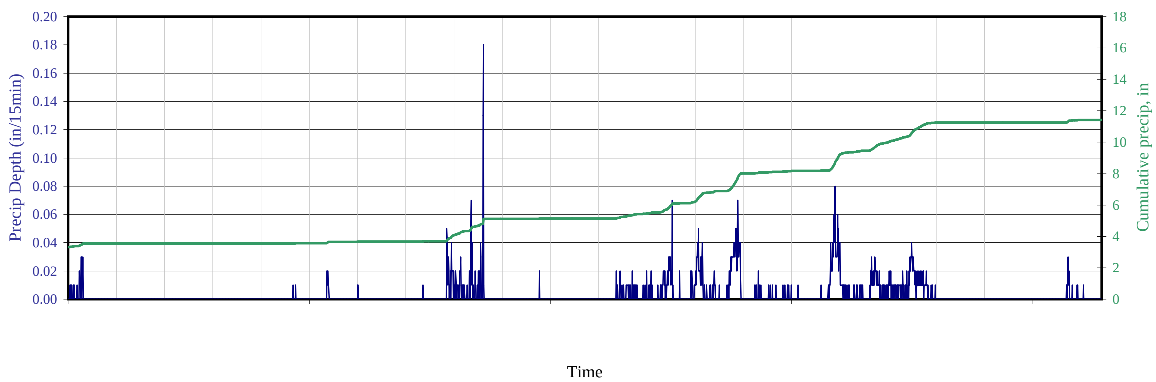
Clear Creek Precip
November 2009



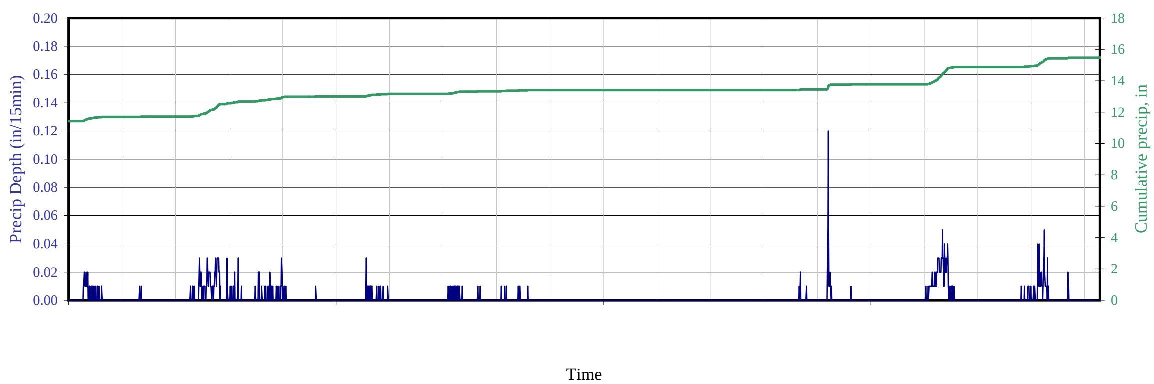
Clear Creek Precip
December 2009

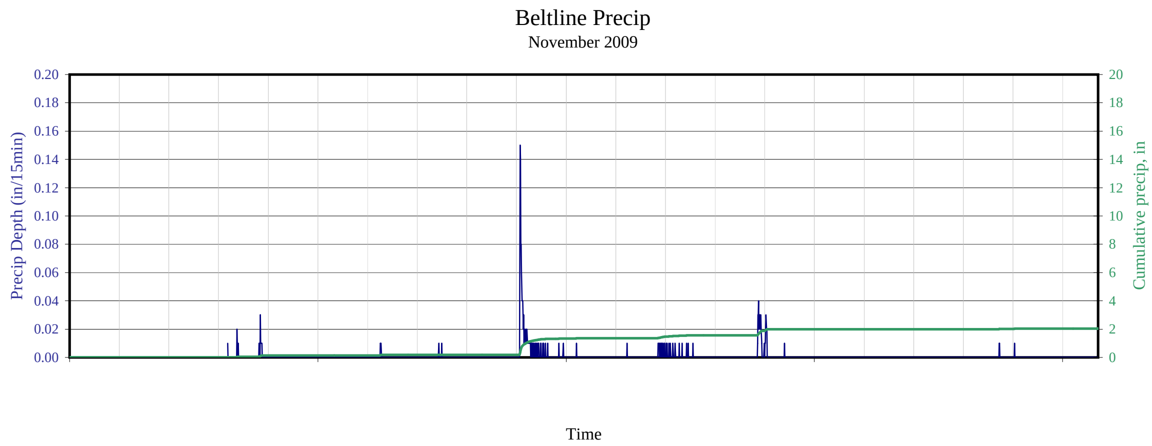


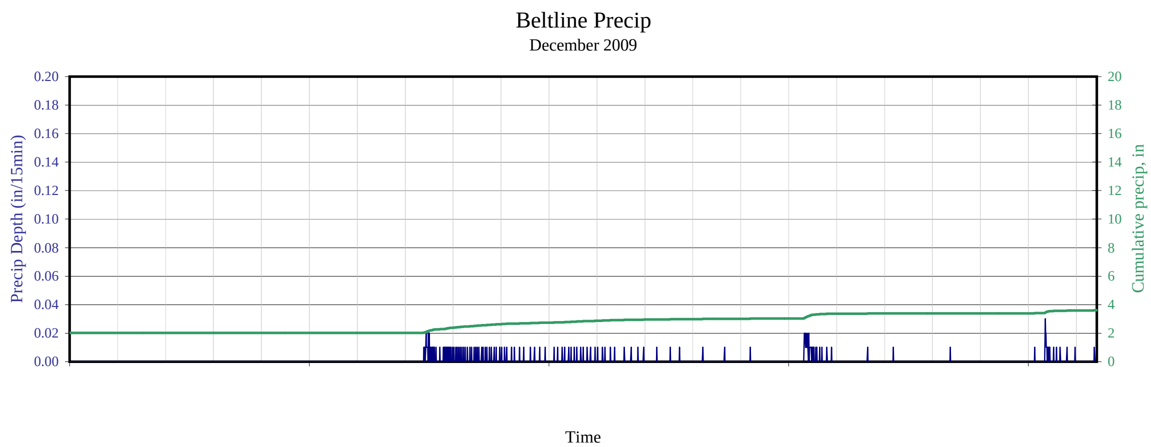
Clear Creek Precip
January 2010

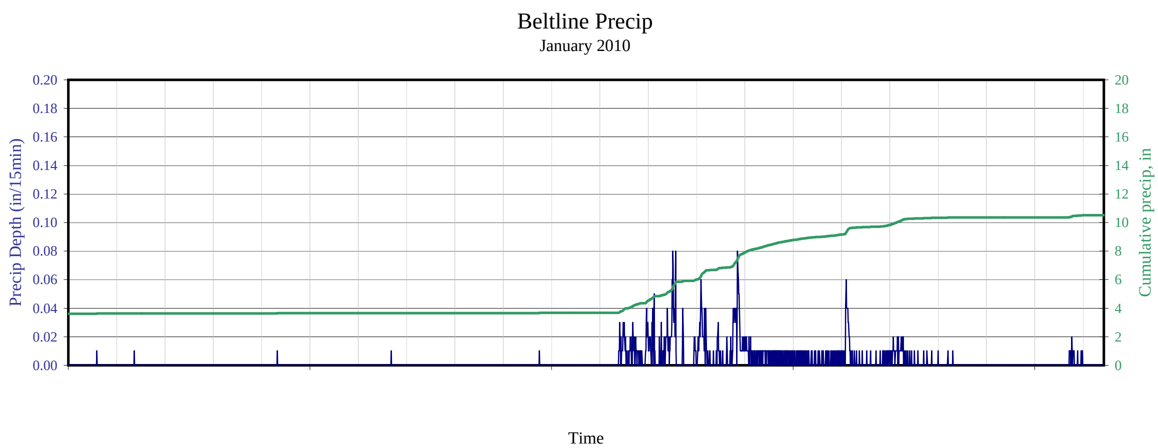


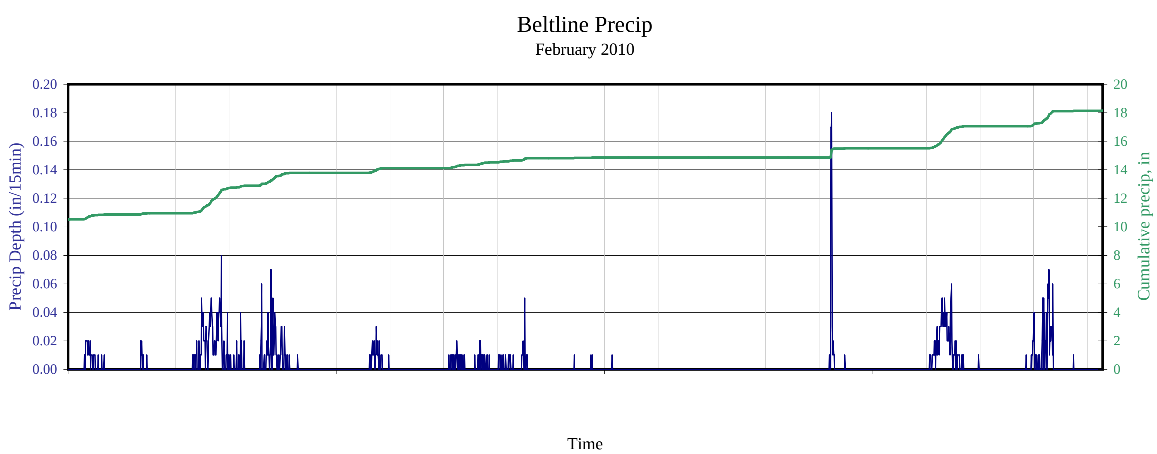
Clear Creek Precip
February 2010



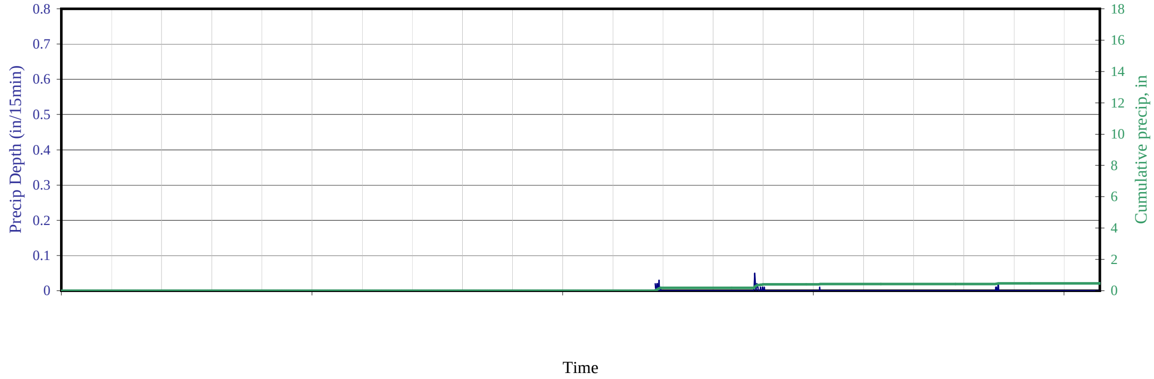

Beltline Precip
November 2009
Precip Depth (in/15min)
0.00
0.02
0.04
0.06
0.08
0.10
0.12
0.14
0.16
0.18
0.20
Cumulative precip, in
0
2
4
6
8
10
12
14
16
18
20
Time


Beltline Precip
December 2009
Precip Depth (in/15min)
0.00
0.02
0.04
0.06
0.08
0.10
0.12
0.14
0.16
0.18
0.20
Cumulative precip, in
0
2
4
6
8
10
12
14
16
18
20
Time

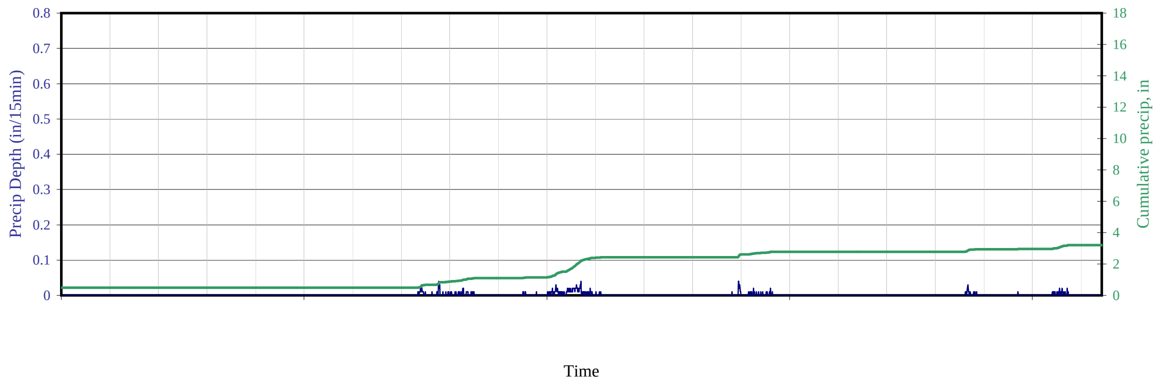

Beltline Precip
January 2010
Precip Depth (in/15min)
0.00
0.02
0.04
0.06
0.08
0.10
0.12
0.14
0.16
0.18
0.20
Cumulative precip, in
0
2
4
6
8
10
12
14
16
18
20
Time


Beltline Precip
February 2010
Precip Depth (in/15min)
0.00
0.02
0.04
0.06
0.08
0.10
0.12
0.14
0.16
0.18
0.20
Cumulative precip, in
0
2
4
6
8
10
12
14
16
18
20
Time

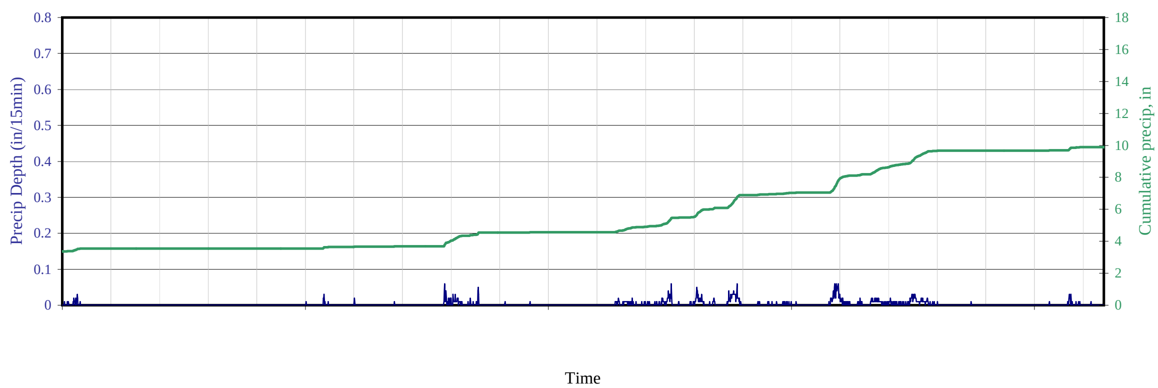
Airport Precip
November 2009



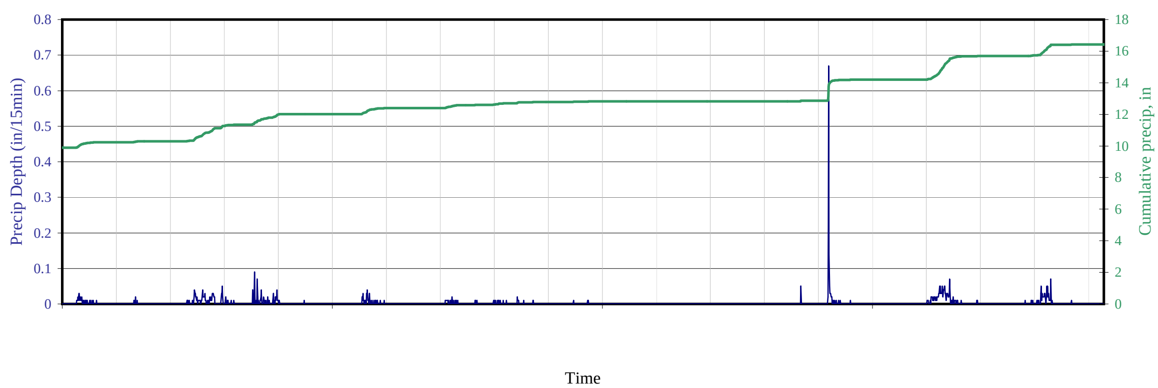
Airport Precip
December 2009



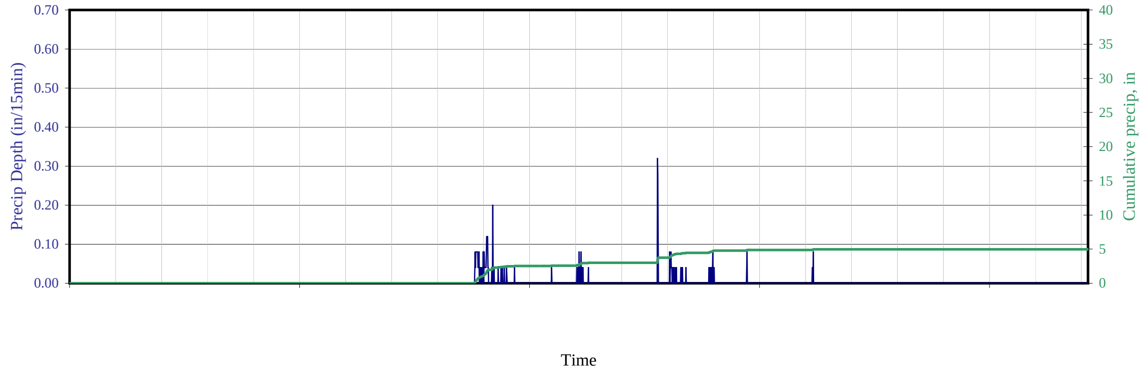
Airport Precip
January 2010



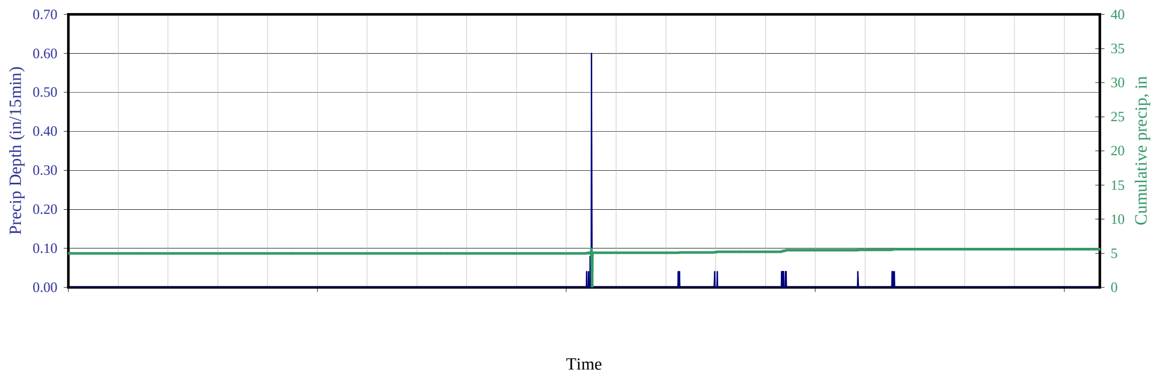
Airport Precip
February 2010



Redding Fire Station Precip
October 2009

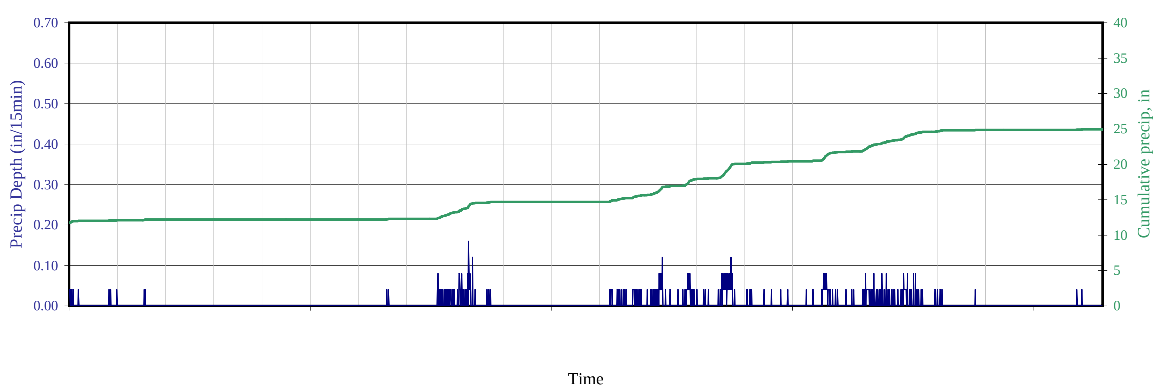


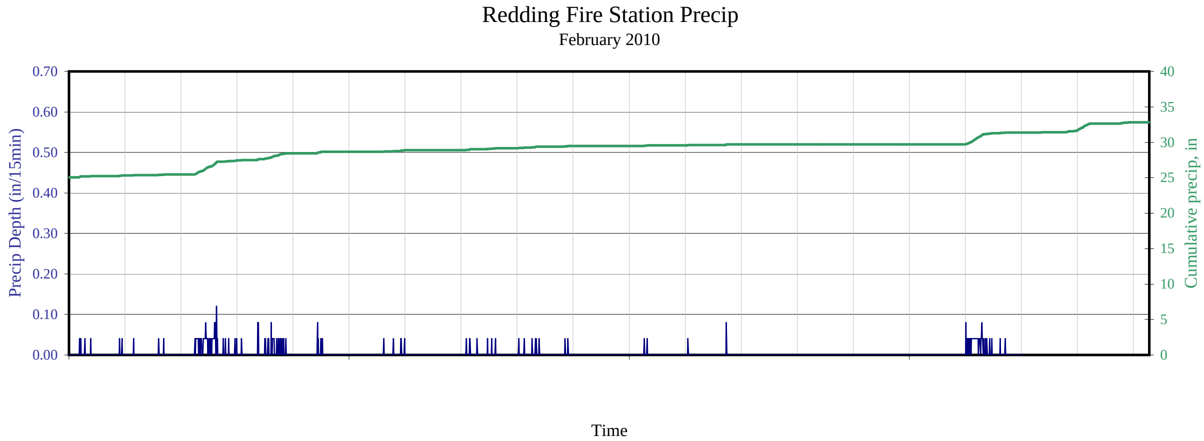
Redding Fire Station Precip
November 2009



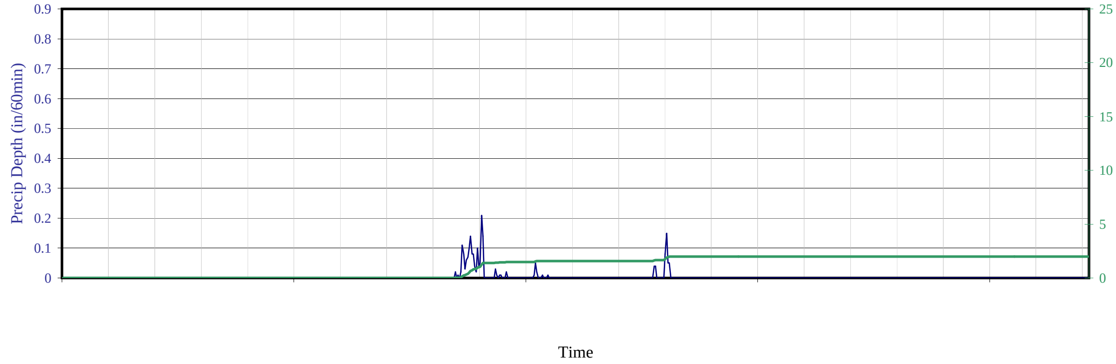
Redding Fire Station Precip
December 2009

Redding Fire Station Precip
January 2010

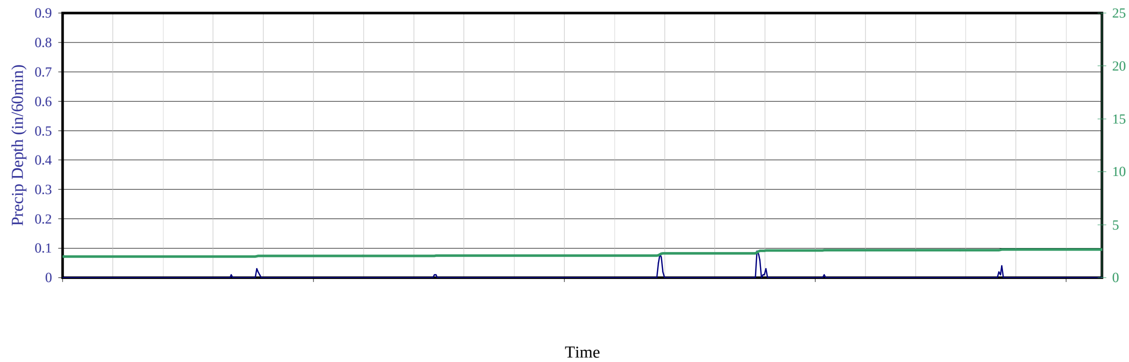



Redding Fire Station Precip
February 2010
Precip Depth (in/15min)
Cumulative precip, in
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
40
35
30
25
20
15
10
5
0
Time

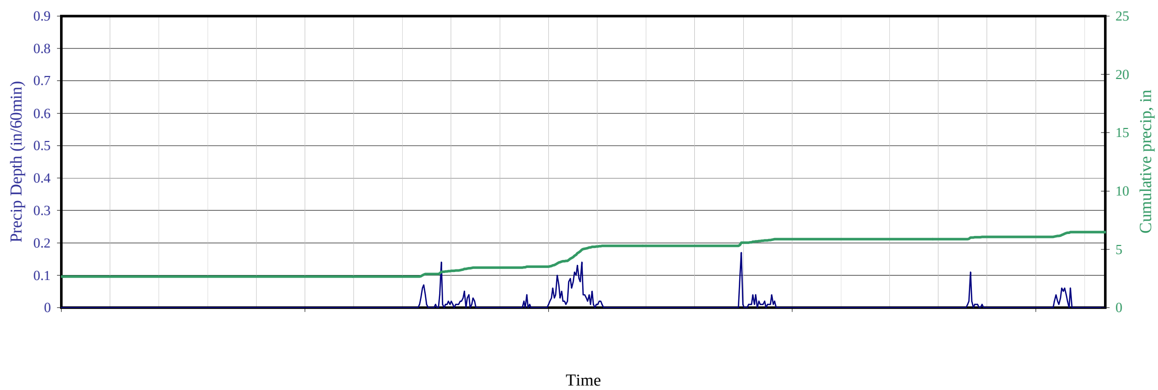
Redding Municipal Airport
October 2009



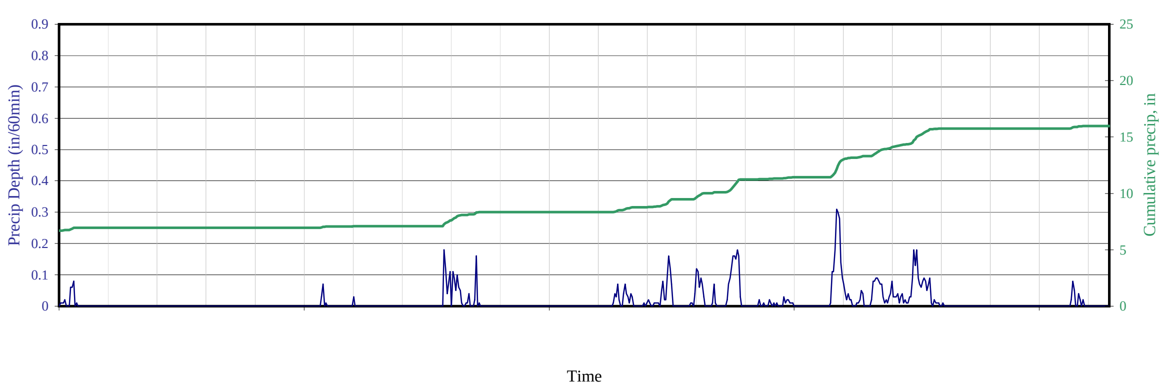
Redding Municipal Airport
November 2009



Redding Municipal Airport
December 2009

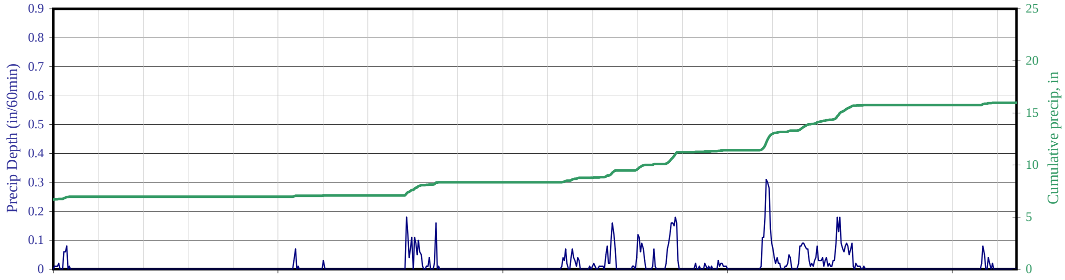


Redding Municipal Airport
January 2010



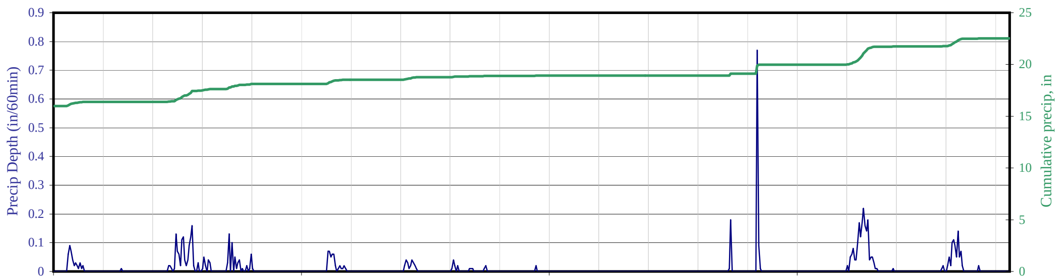
Time

Redding Municipal Airport
January 2010

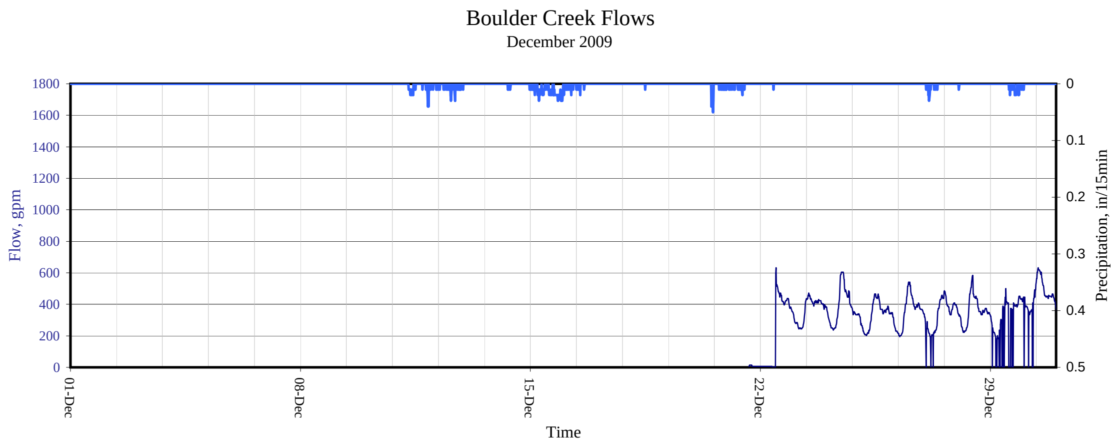


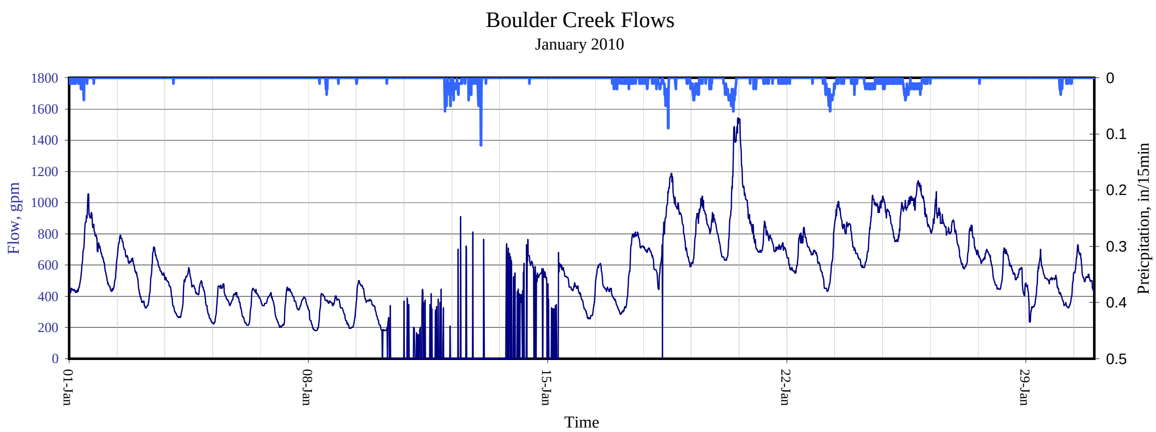
Time

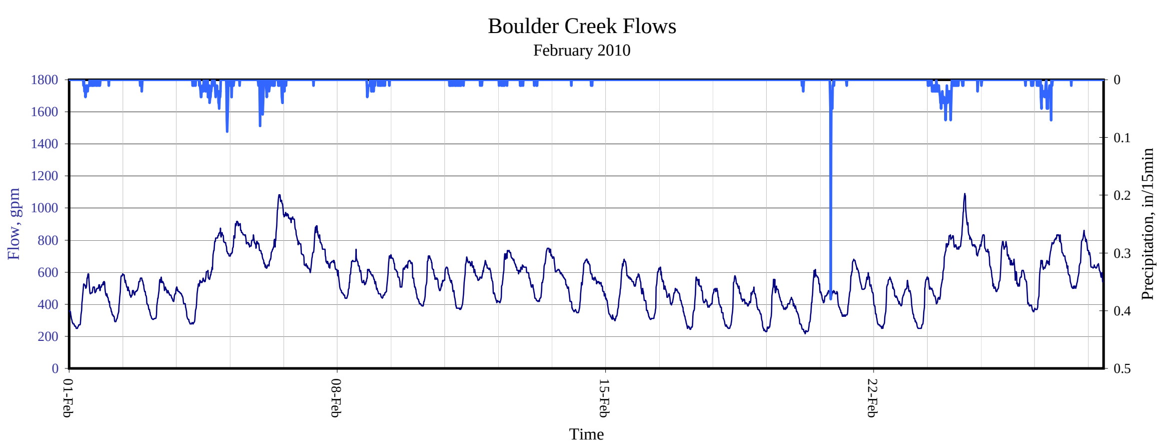
Redding Municipal Airport
February 2010

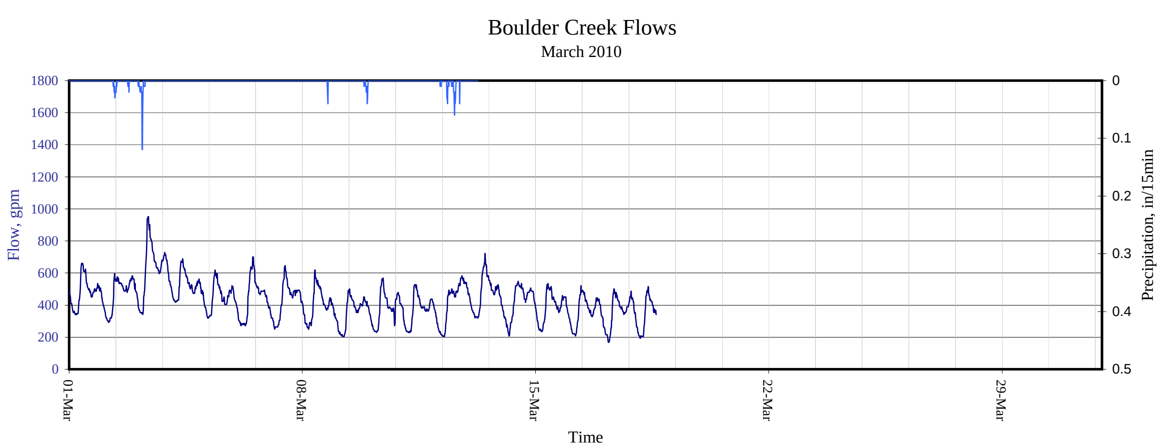


Time

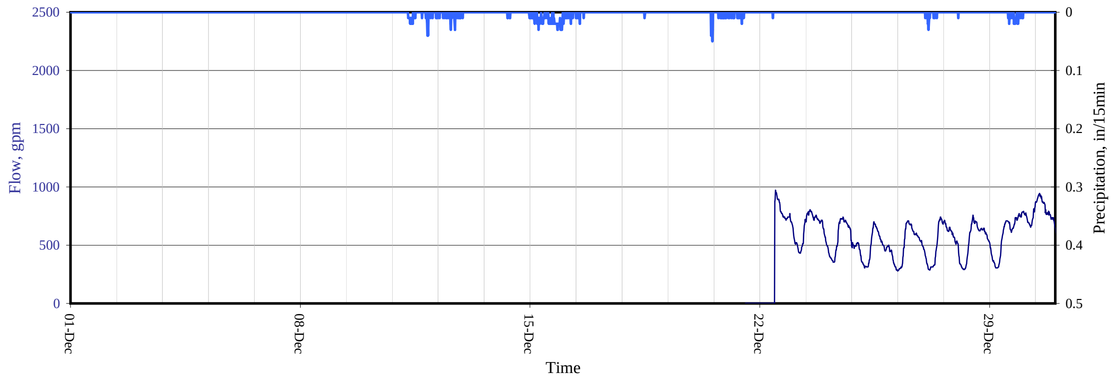

Boulder Creek Flows
December 2009
Flow, gpm
Precipitation, in/15min
Time
1800
1600
1400
1200
1000
800
600
400
200
0
0
0.1
0.2
0.3
0.4
0.5
01-Dec
08-Dec
15-Dec
22-Dec
29-Dec


Boulder Creek Flows
January 2010
Flow, gpm
Preicpitation, in/15min
Time
1800
1600
1400
1200
1000
800
600
400
200
0
0
0.1
0.2
0.3
0.4
0.5
01-Jan
08-Jan
15-Jan
22-Jan
29-Jan

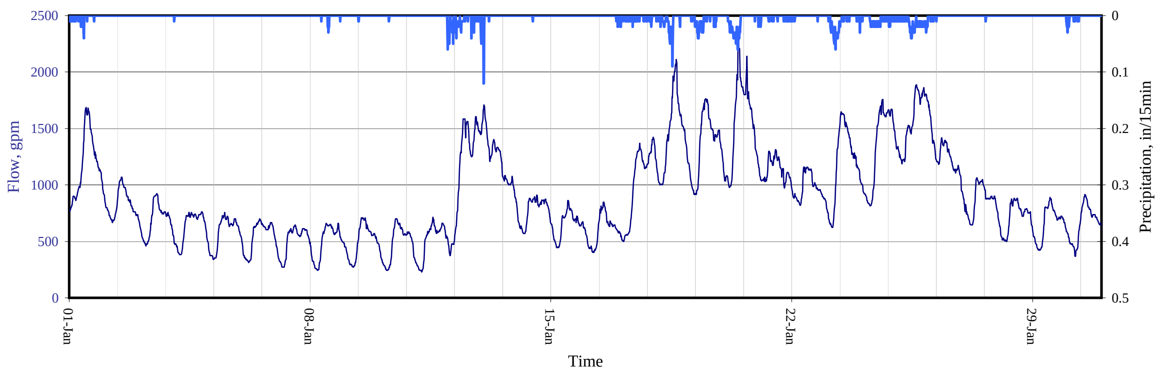

Boulder Creek Flows
February 2010
Flow, gpm
Precipitation, in/15min
Time
1800
1600
1400
1200
1000
800
600
400
200
0
0
0.1
0.2
0.3
0.4
0.5
01-Feb
08-Feb
15-Feb
22-Feb


Boulder Creek Flows
March 2010
Flow, gpm
Precipitation, in/15min
Time
1800
1600
1400
1200
1000
800
600
400
200
0
0
0.1
0.2
0.3
0.4
0.5
01-Mar
08-Mar
15-Mar
22-Mar
29-Mar

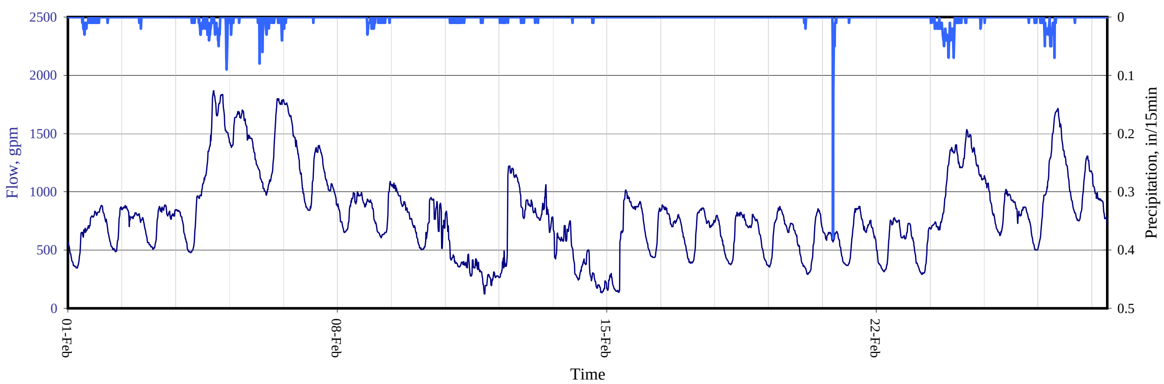
Churn @ Boulder
December 2009



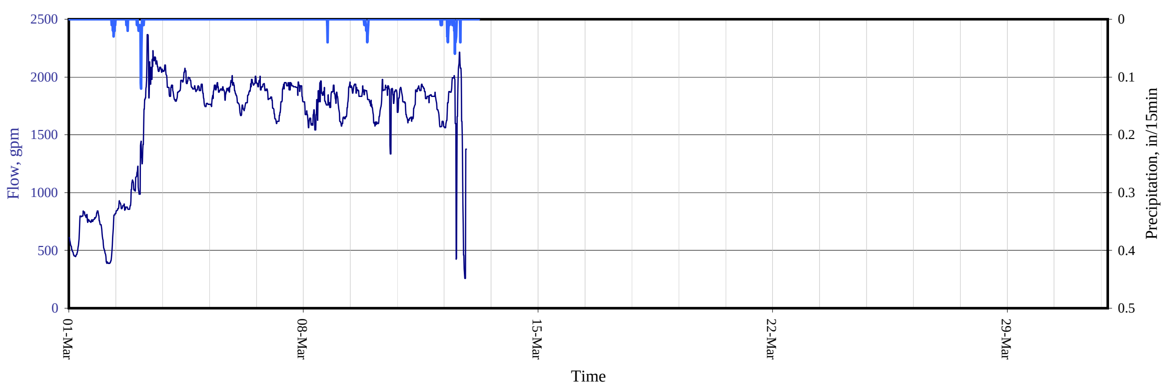
Churn Creek @ Boulder
January 2010



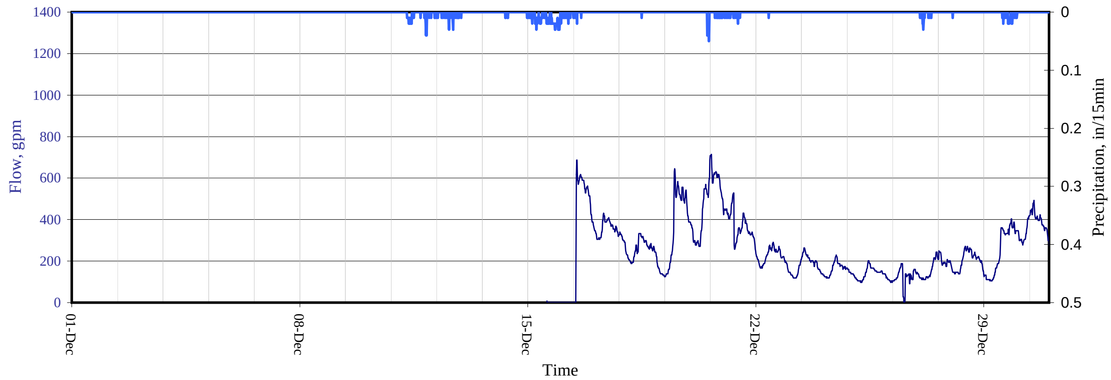
Churn Creek @ Boulder
February 2010



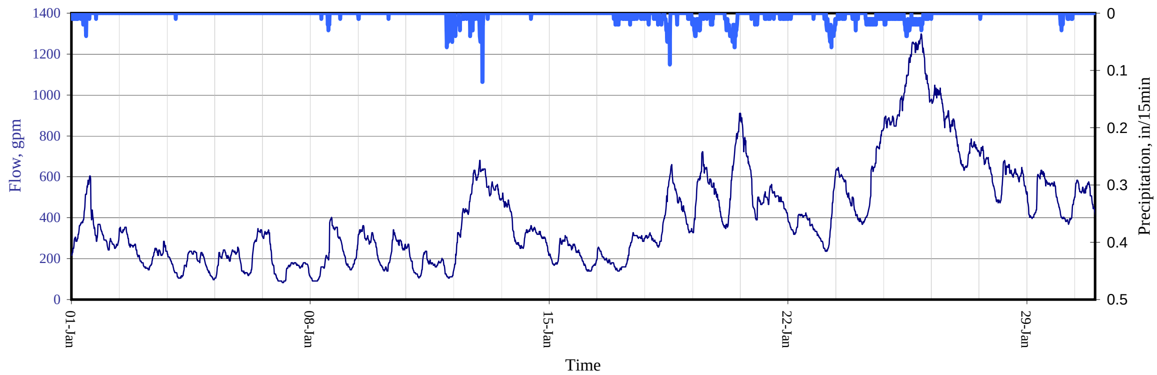
Churn Creek @ Boulder
March 2010



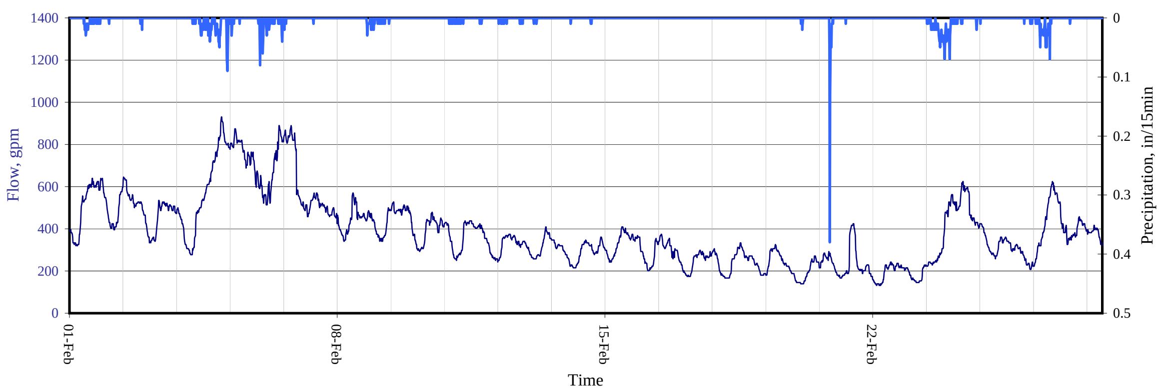
California @ 273
December 2009



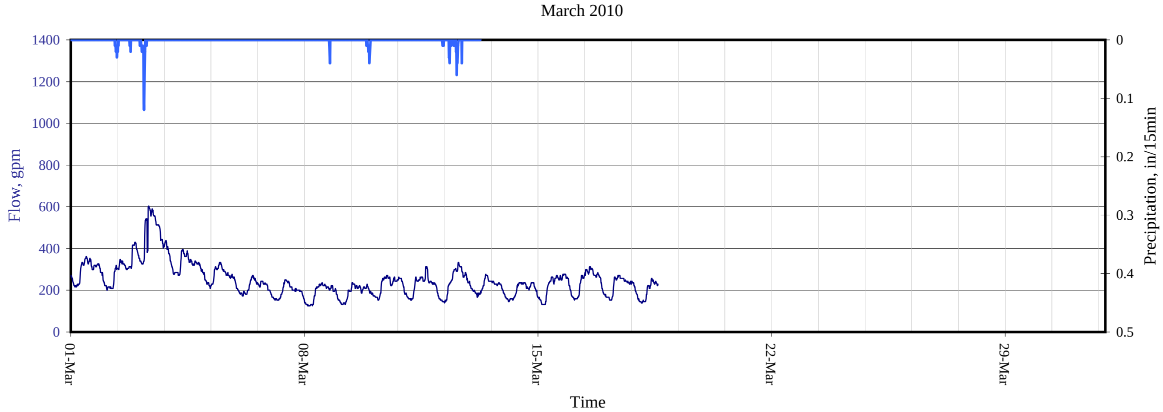
California @ 273
January 2010



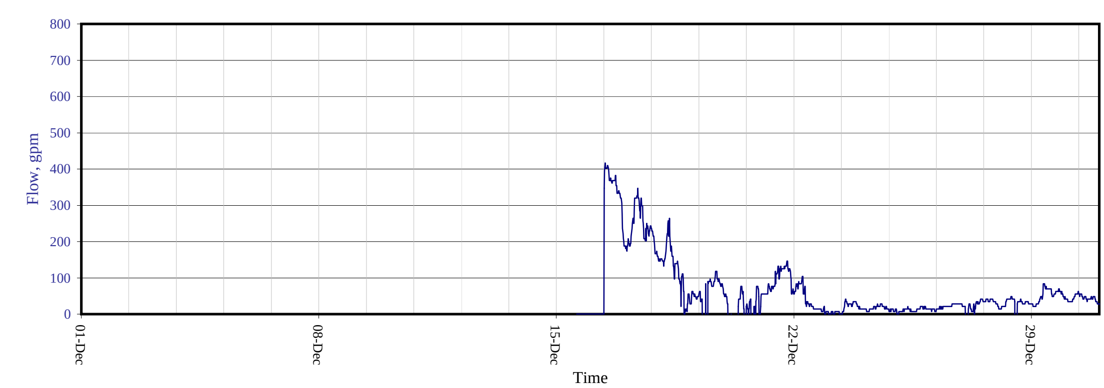
California @ 273
February 2010



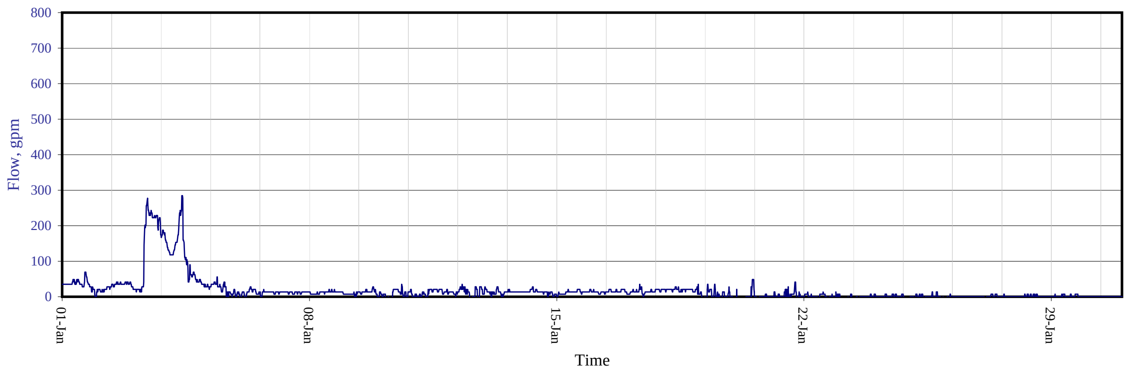
California @ 273
March 2010



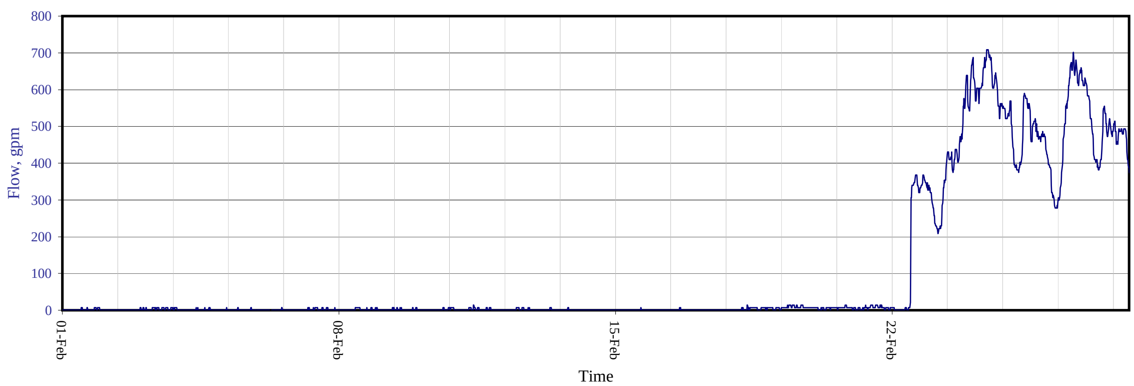
Cypress
December 2009



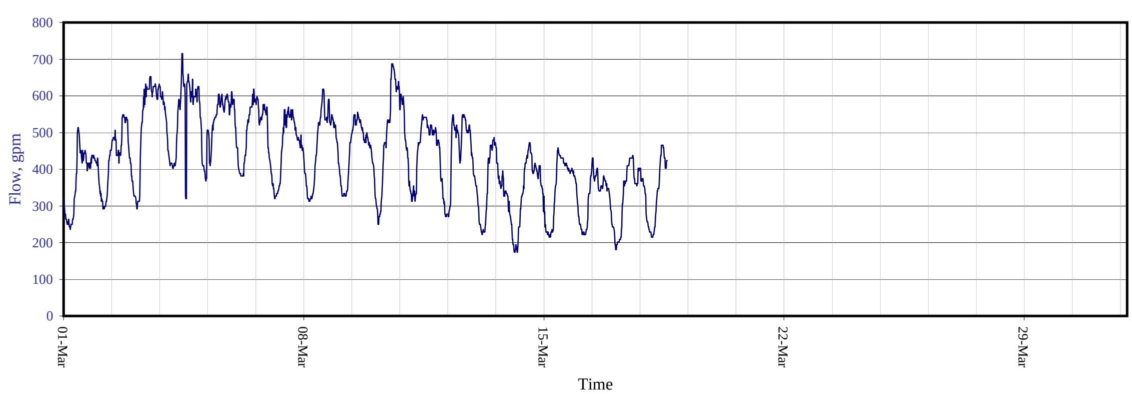
Cypress
January 2010



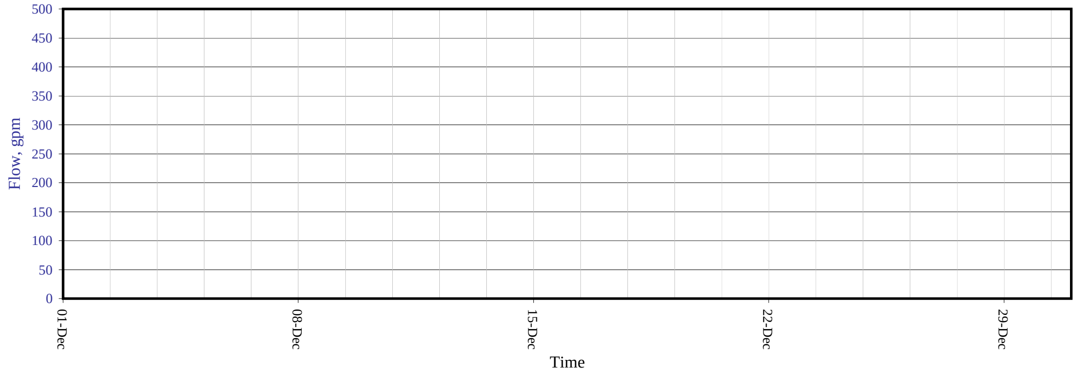
Cypress
February 2010



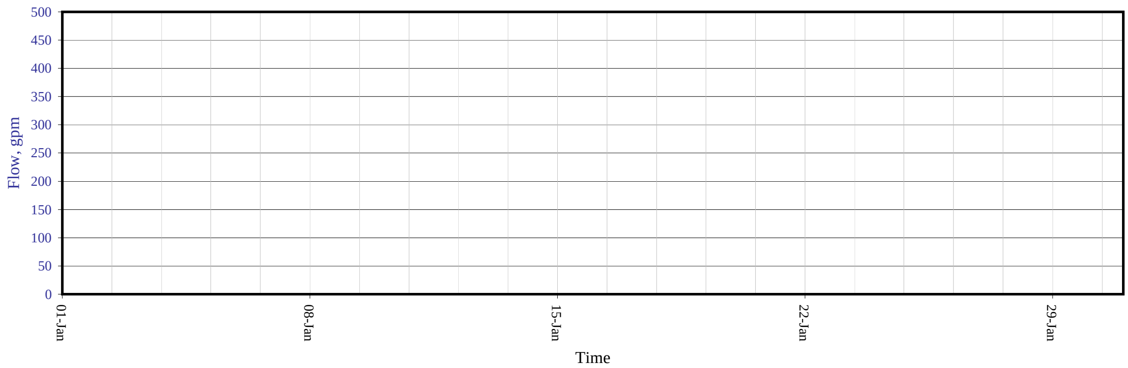
Cypress
March 2010



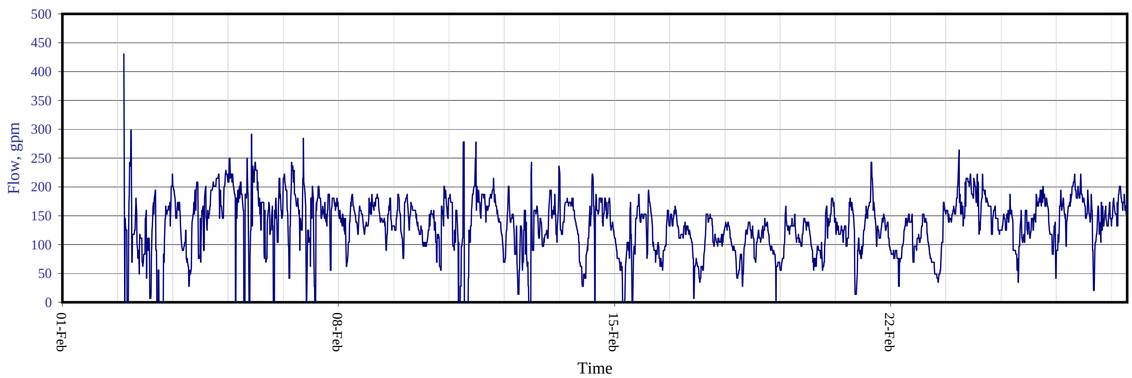
College View
December 2009



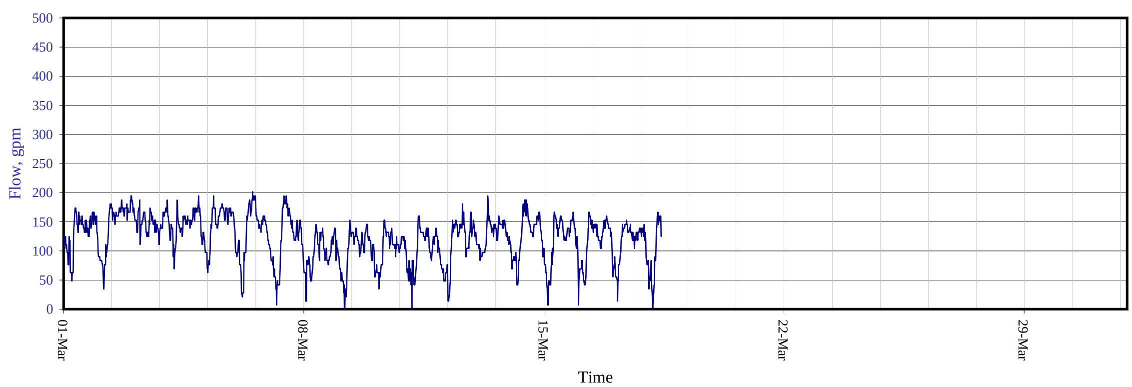
College View
January 2010



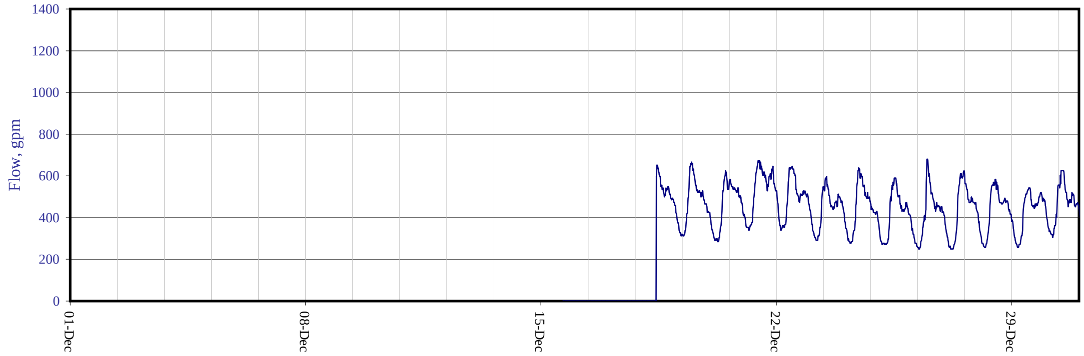
College View
February 2010



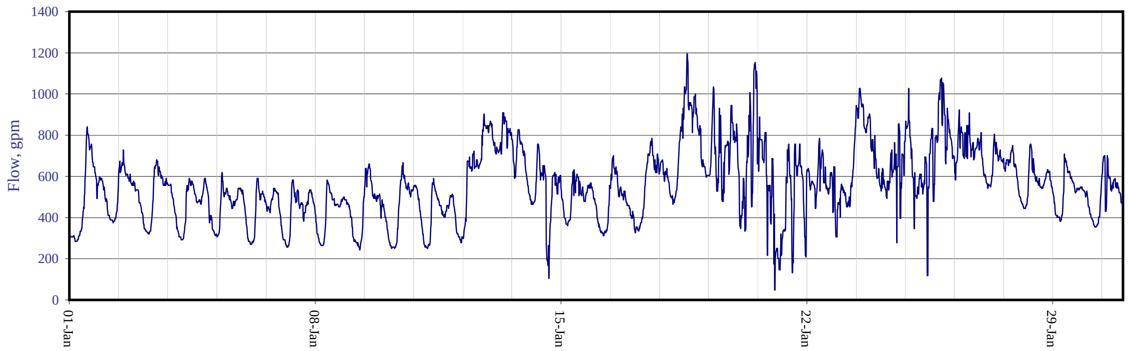
College View
March 2010



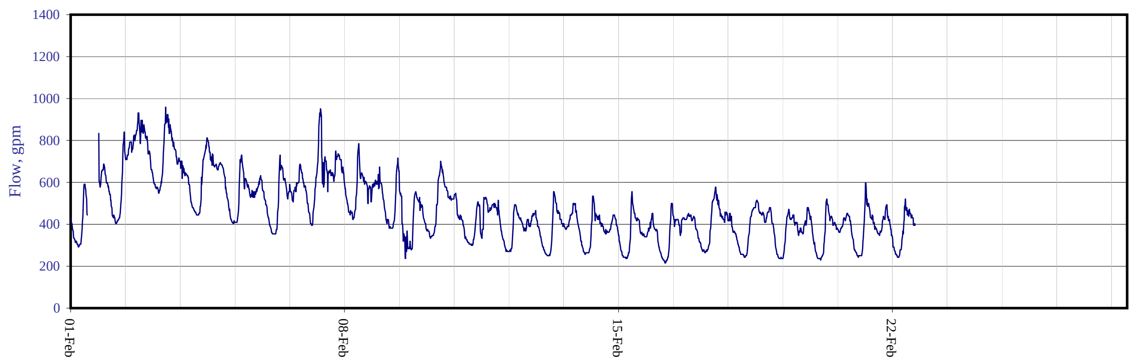
East Side Road
December 2009



East Side Road
January 2010

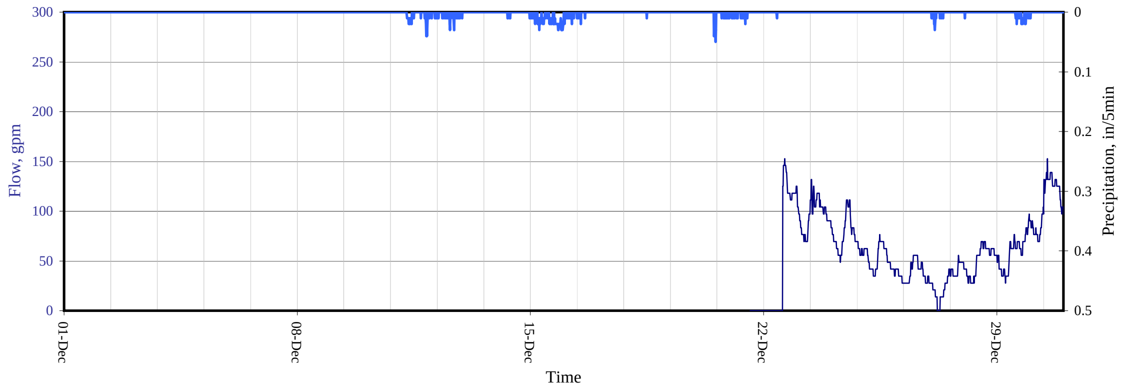


East Side Road
February 2010

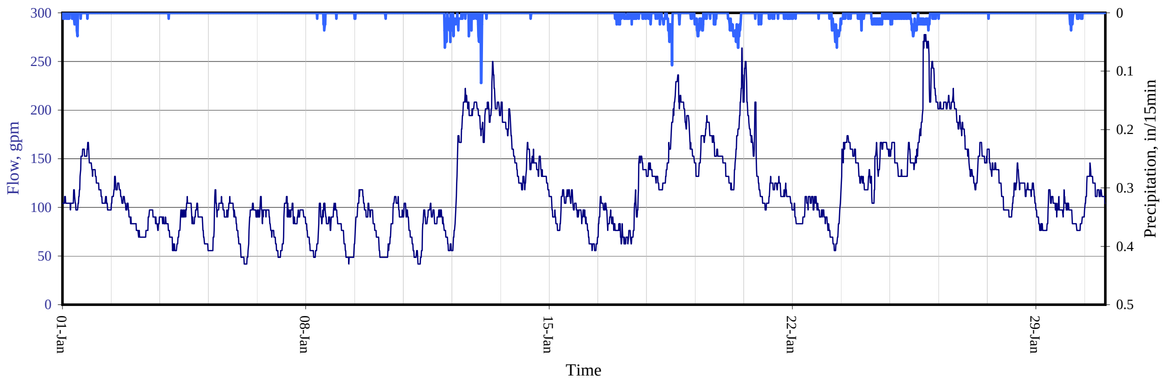


East Side Road
March 2010

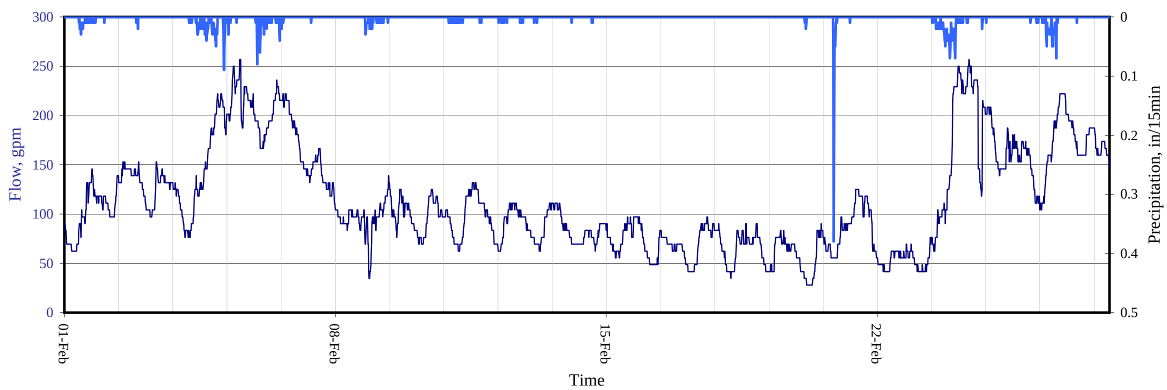
Goodwater East
December 2009



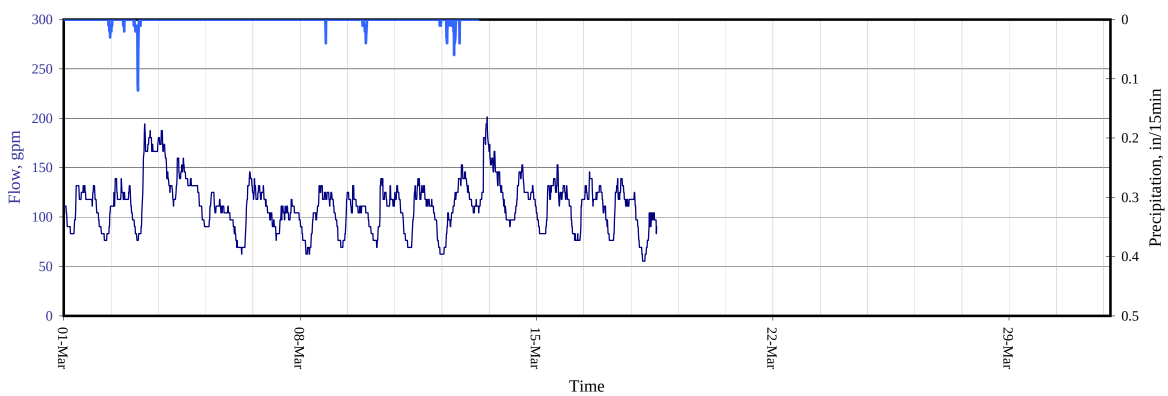
Goodwater East
January 2010



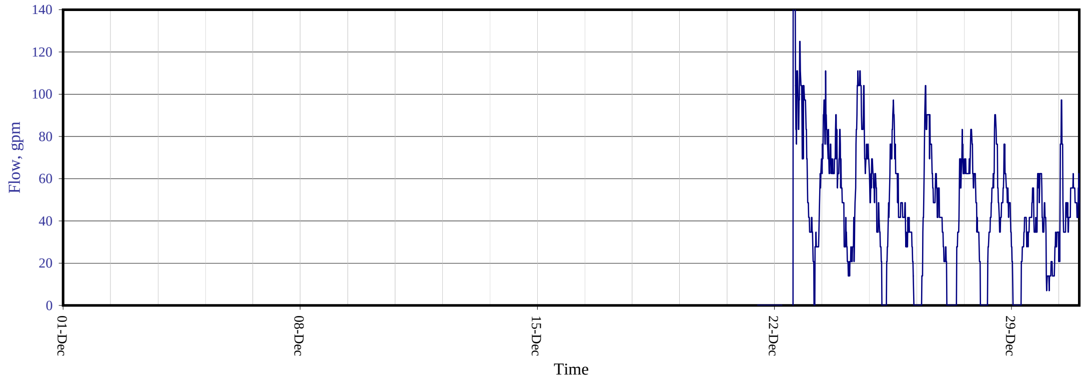
Goodwater East
February 2010



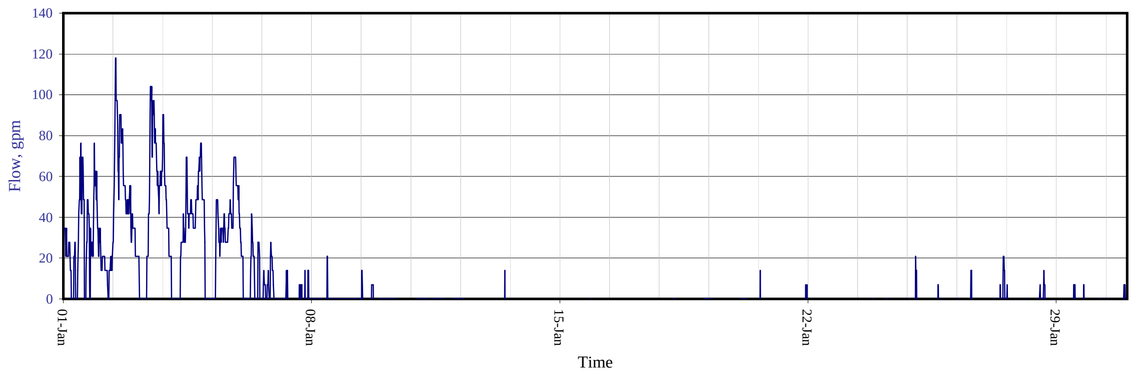
Goodwater East
March 2010



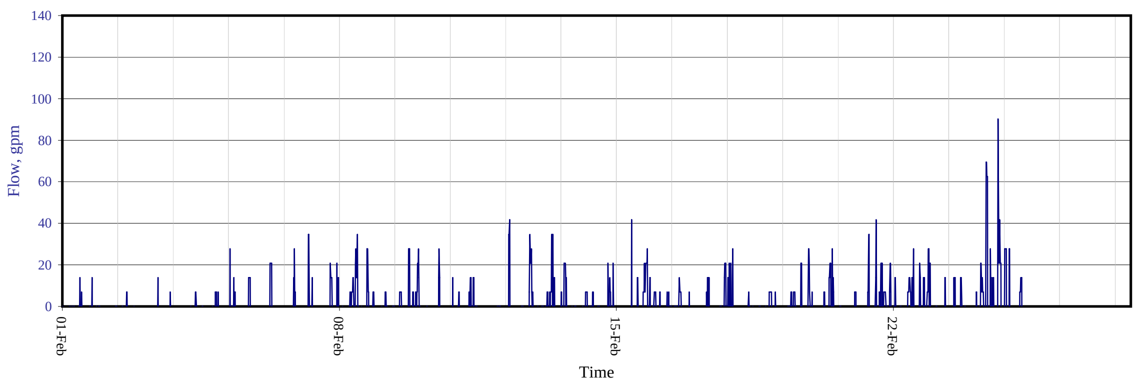
Goodwater West
December 2009



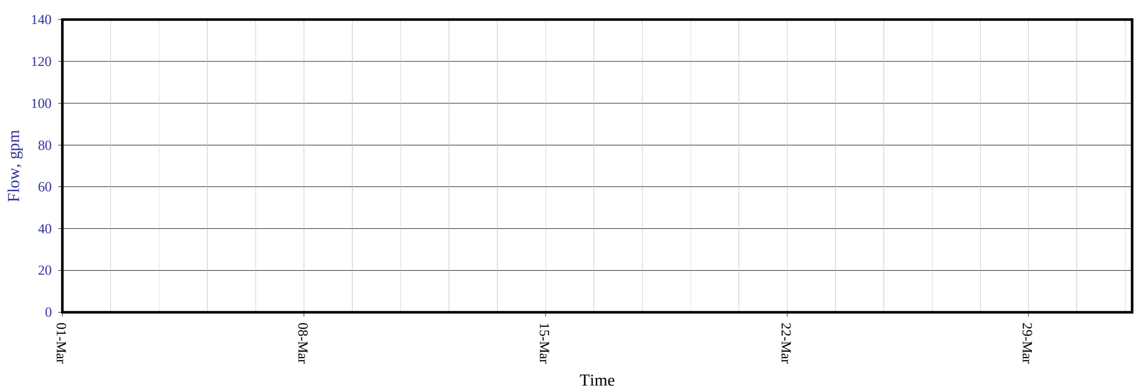
Goodwater West
January 2010

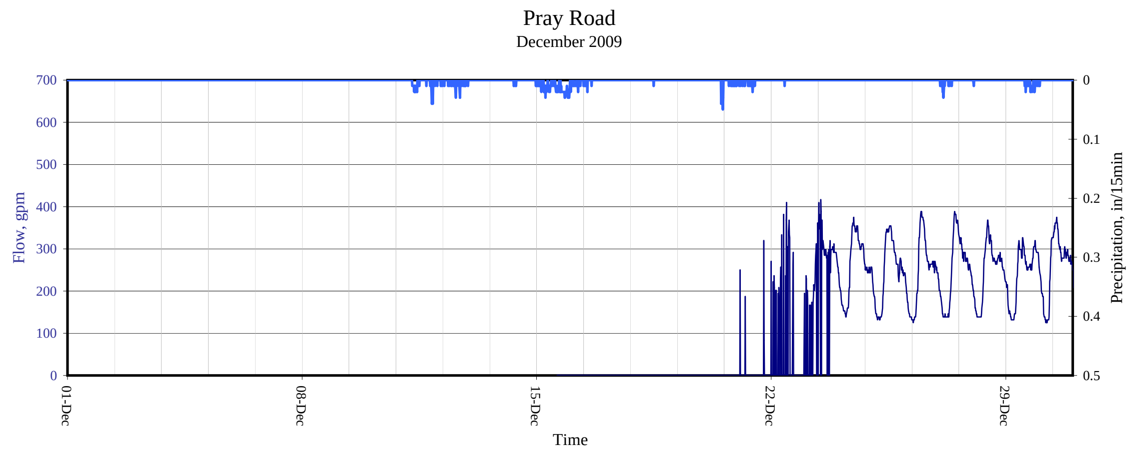


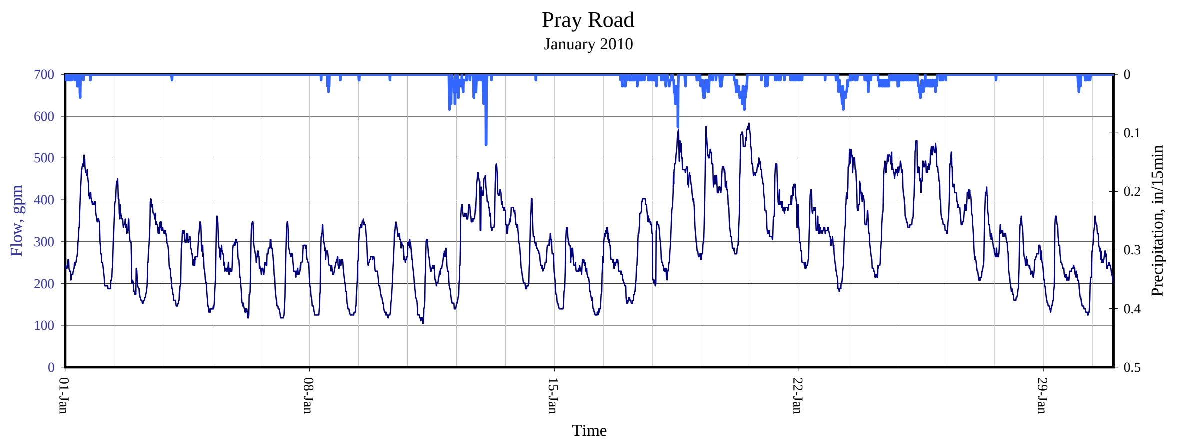
Goodwater West
February 2010

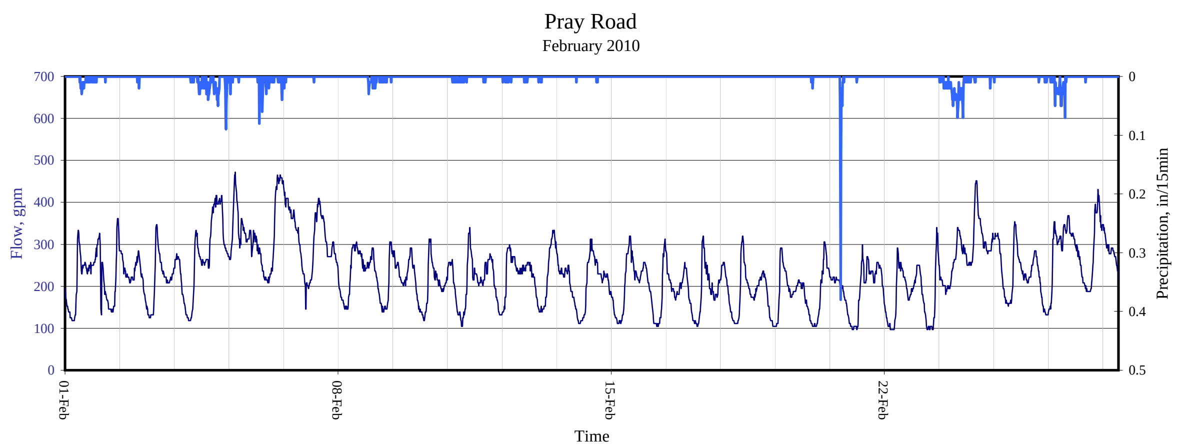


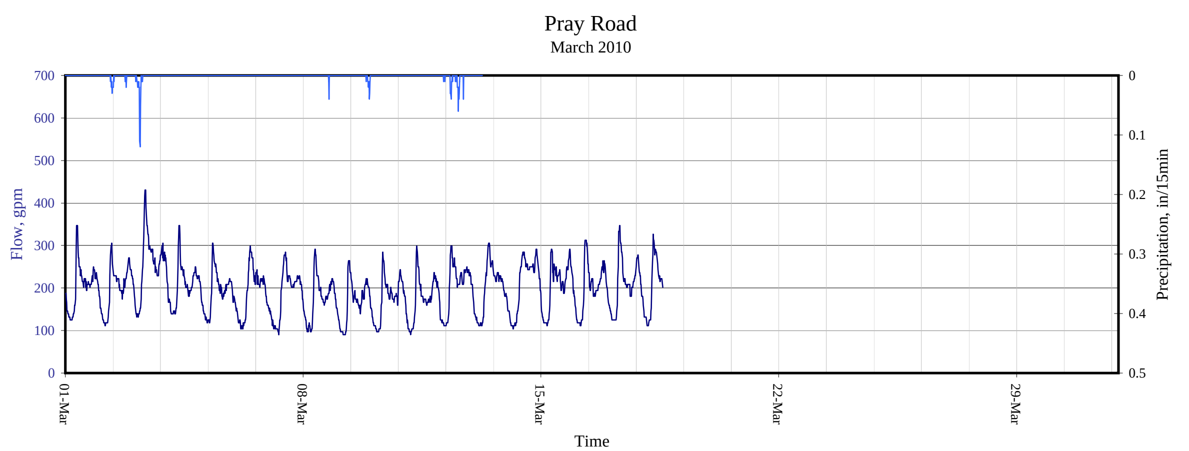
Goodwater West
March 2010

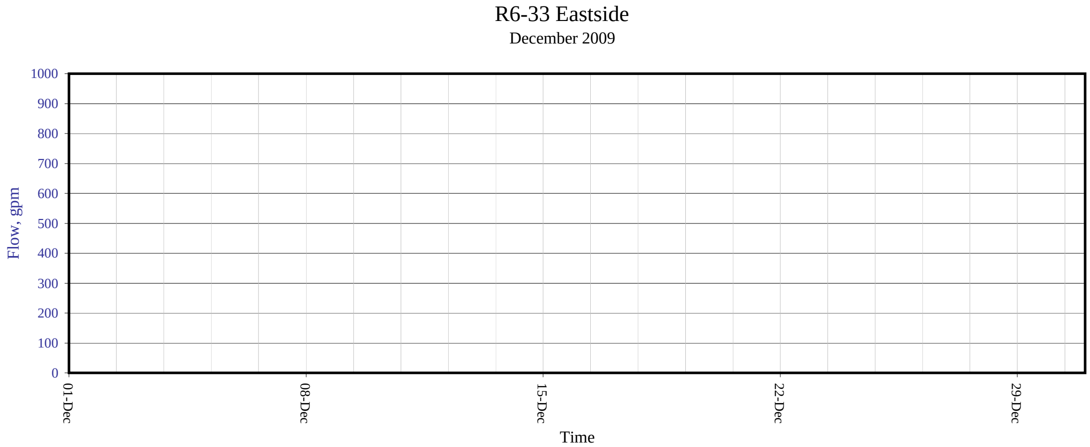


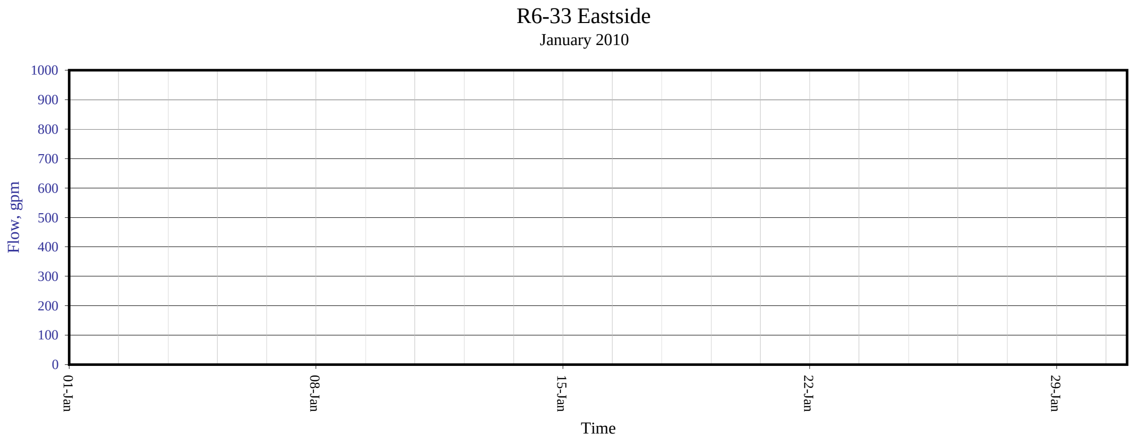

Pray Road
December 2009
Flow, gpm
Precipitation, in/15min
Time
01-Dec
08-Dec
15-Dec
22-Dec
29-Dec

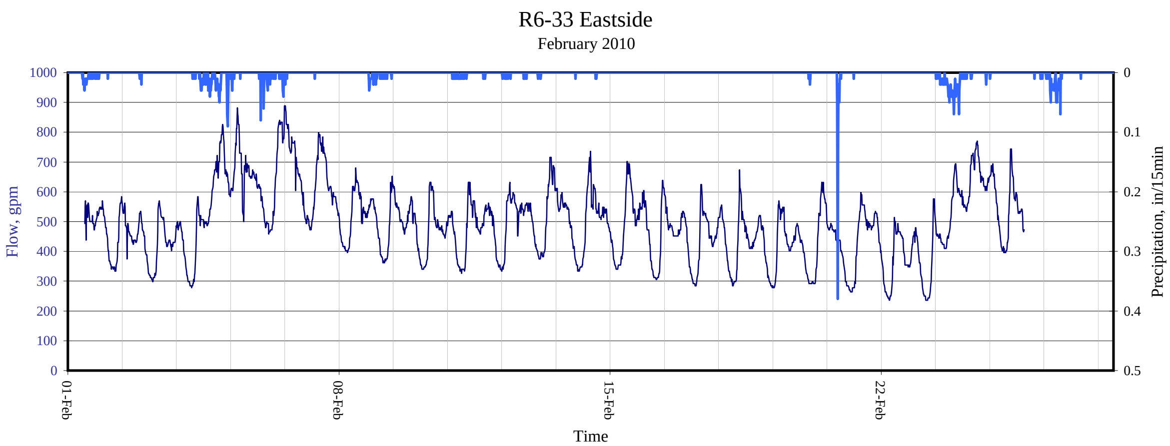

Pray Road
January 2010
Flow, gpm
Precipitation, in/15min
Time
01-Jan
08-Jan
15-Jan
22-Jan
29-Jan

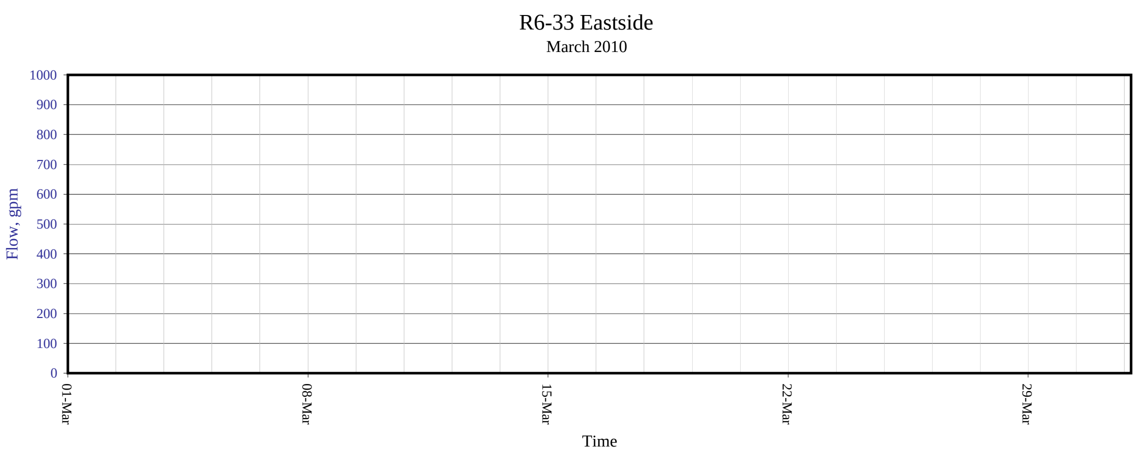

Pray Road
February 2010
Flow, gpm
Precipitation, in/15min
Time
01-Feb
08-Feb
15-Feb
22-Feb

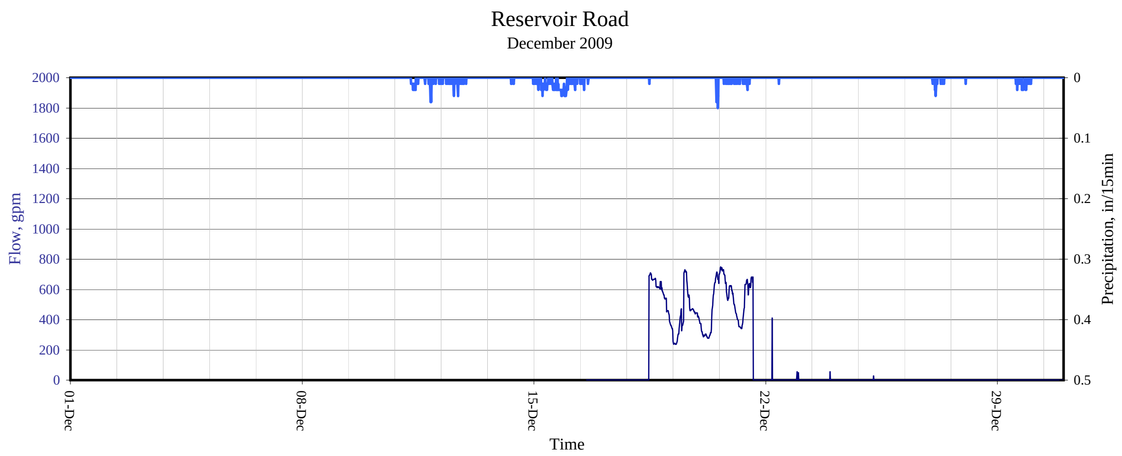

Pray Road
March 2010
Flow, gpm
Precipitation, in/15min
Time
01-Mar
08-Mar
15-Mar
22-Mar
29-Mar

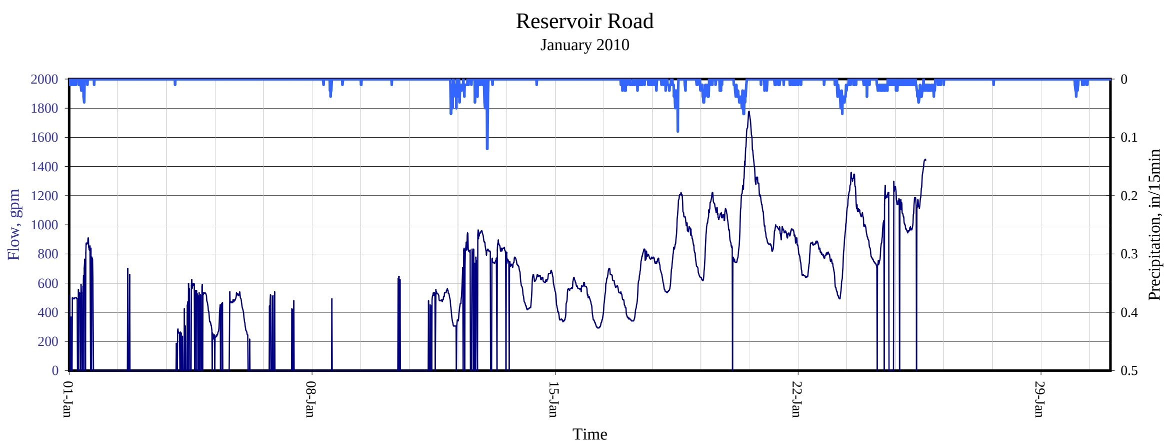

R6-33 Eastside
December 2009
Flow, gpm
1000
900
800
700
600
500
400
300
200
100
0
01-Dec
08-Dec
15-Dec
22-Dec
29-Dec
Time

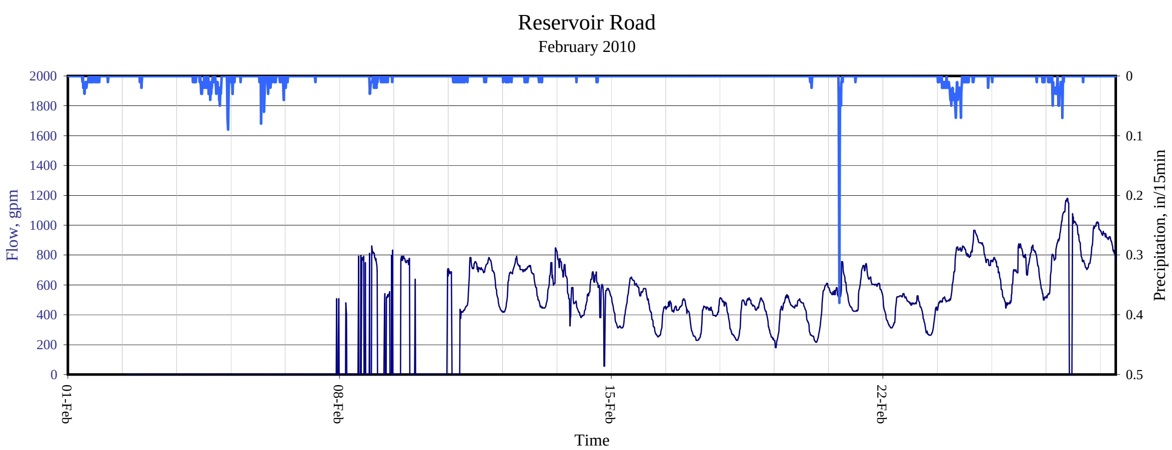

R6-33 Eastside
January 2010
Flow, gpm
1000
900
800
700
600
500
400
300
200
100
0
01-Jan
08-Jan
15-Jan
22-Jan
29-Jan
Time

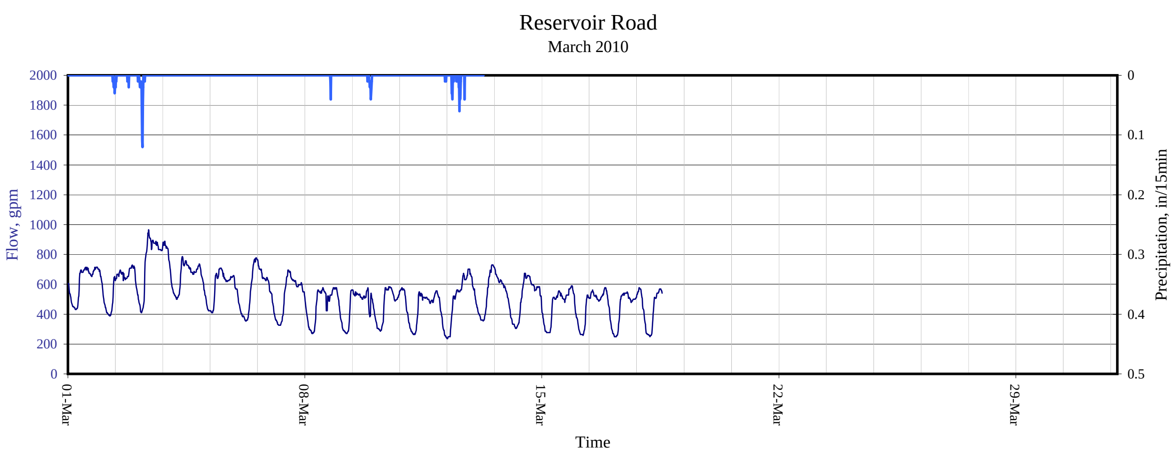

R6-33 Eastside
February 2010
Flow, gpm
Precipitation, in/15min
1000
900
800
700
600
500
400
300
200
100
0
0
0.1
0.2
0.3
0.4
0.5
01-Feb
08-Feb
15-Feb
22-Feb
Time


R6-33 Eastside
March 2010
Flow, gpm
1000
900
800
700
600
500
400
300
200
100
0
01-Mar
08-Mar
15-Mar
22-Mar
29-Mar
Time

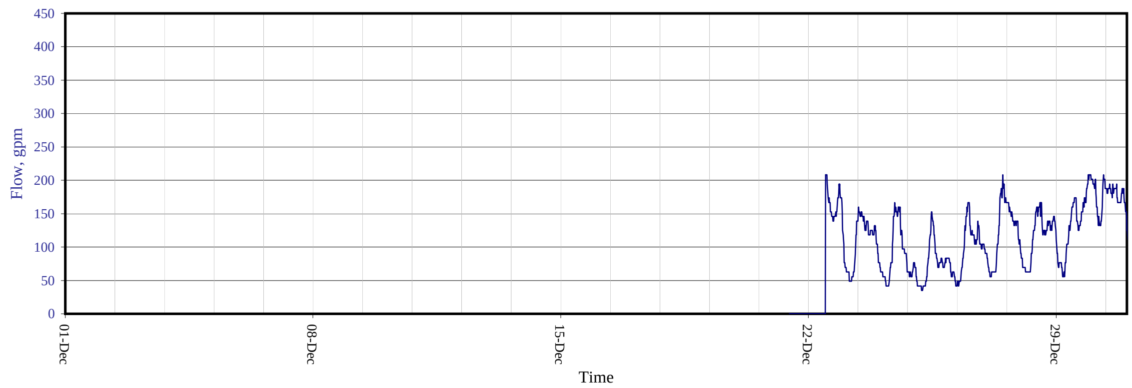

Reservoir Road
December 2009
Flow, gpm
Precipitation, in/15min
Time
01-Dec
08-Dec
15-Dec
22-Dec
29-Dec


Reservoir Road
January 2010
Flow, gpm
Precipitation, in/15min
Time
01-Jan
08-Jan
15-Jan
22-Jan
29-Jan

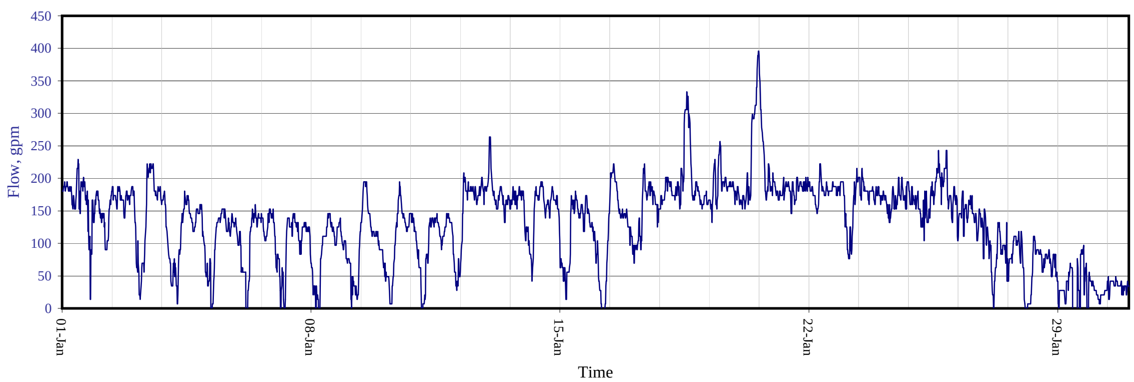

Reservoir Road
February 2010
Flow, gpm
Precipitation, in/15min
Time
01-Feb
08-Feb
15-Feb
22-Feb


Reservoir Road
March 2010
Flow, gpm
Precipitation, in/15min
Time
01-Mar
08-Mar
15-Mar
22-Mar
29-Mar

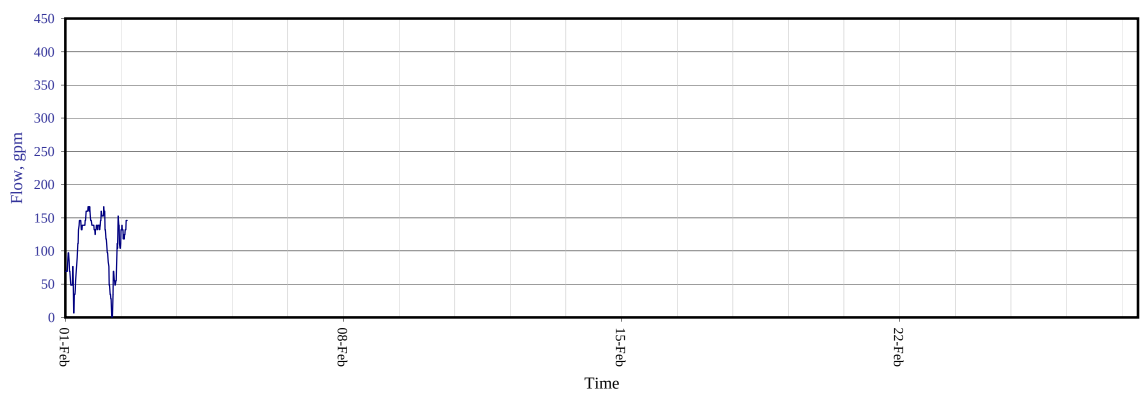
South College
December 2009



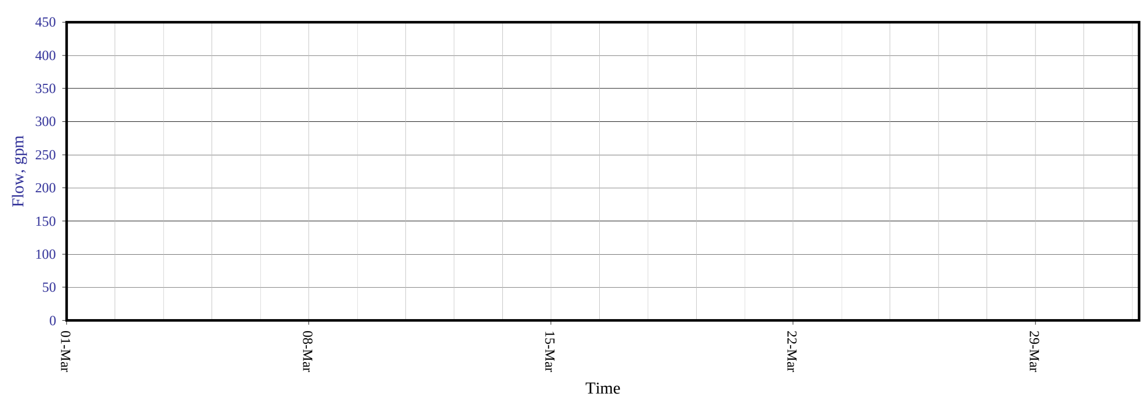
South College
January 2010



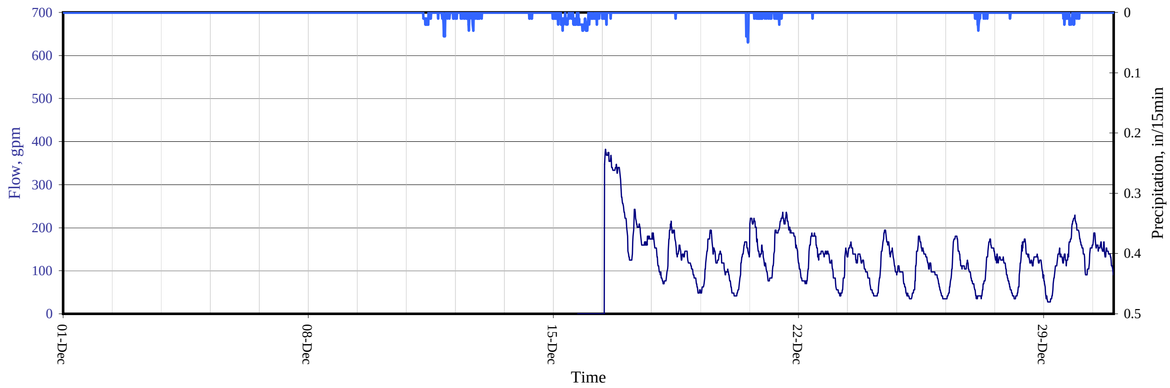
South College
February 2010



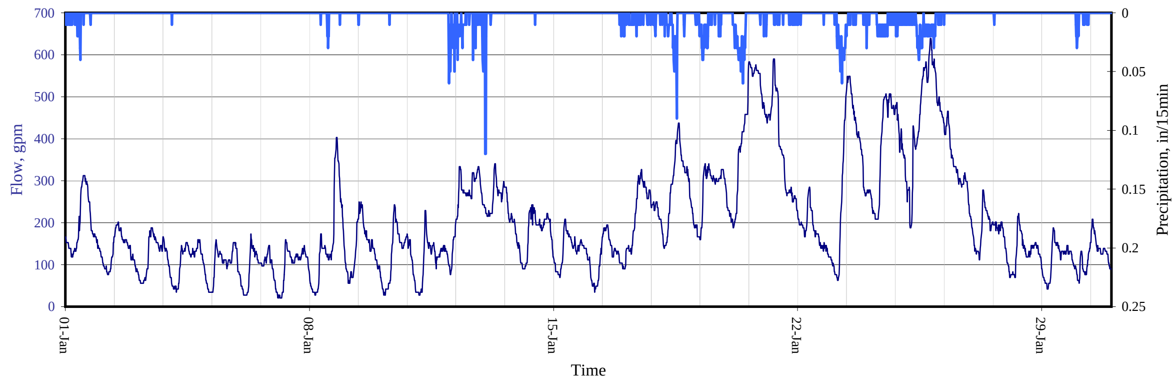
South College
March 2010



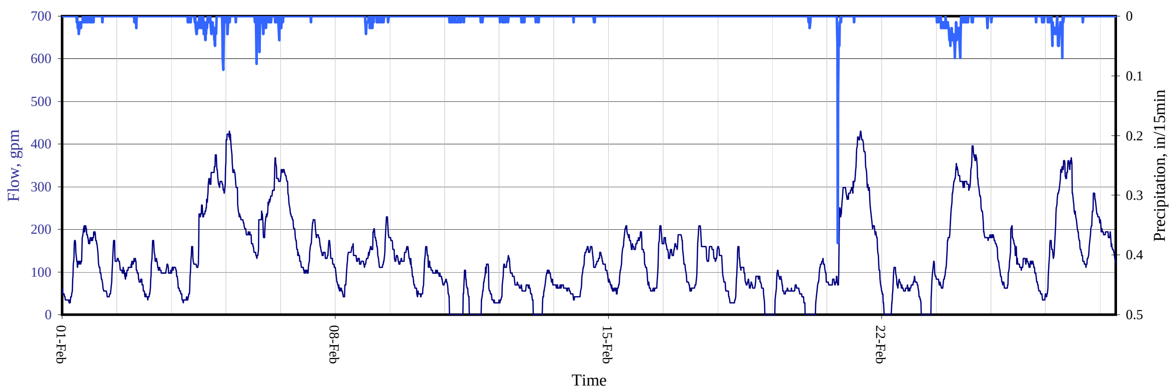
Tarmac
December 2009



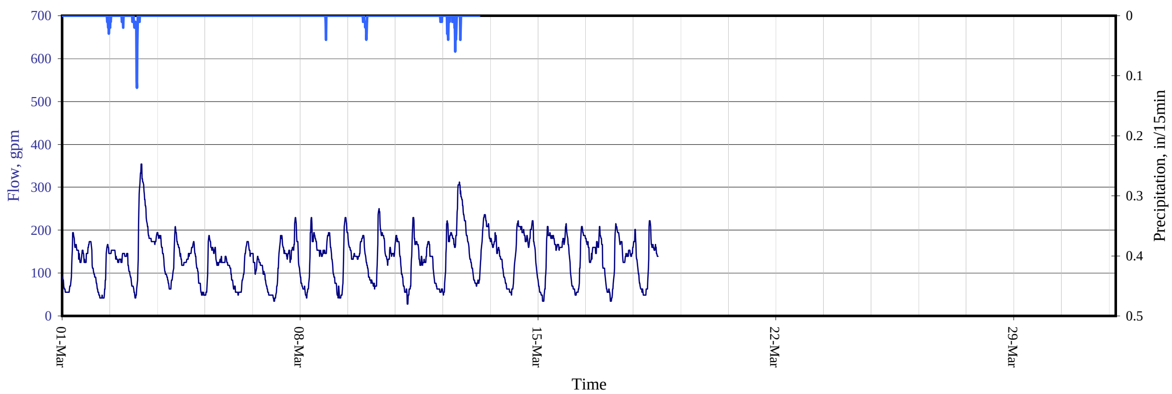
Tarmac
January 2010

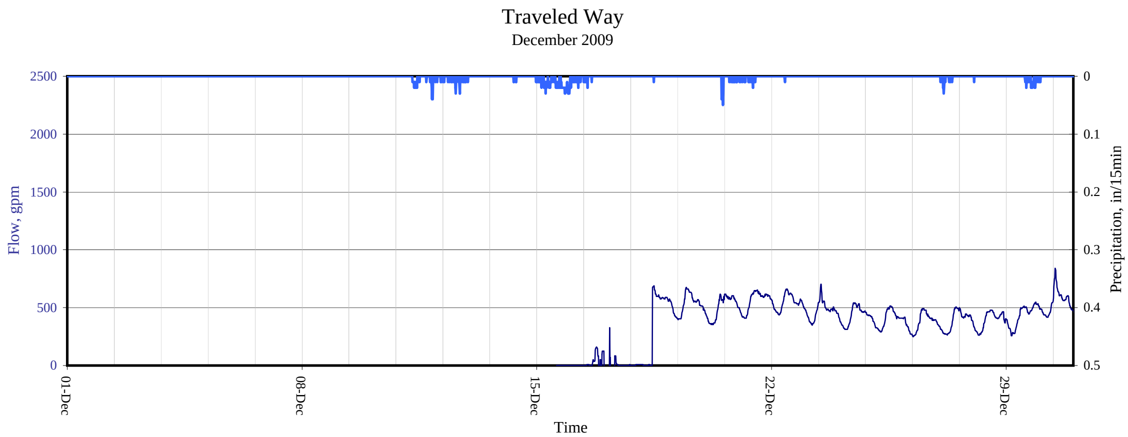


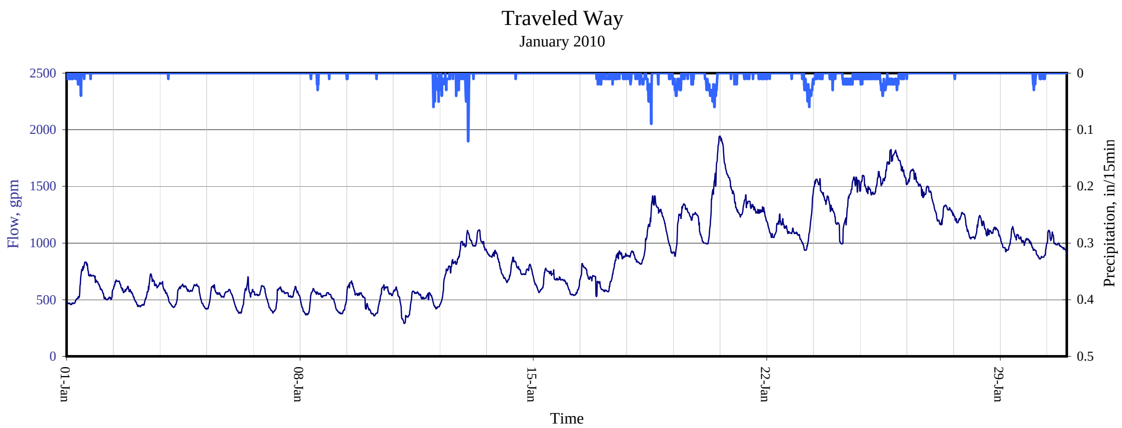
Tarmac
February 2010

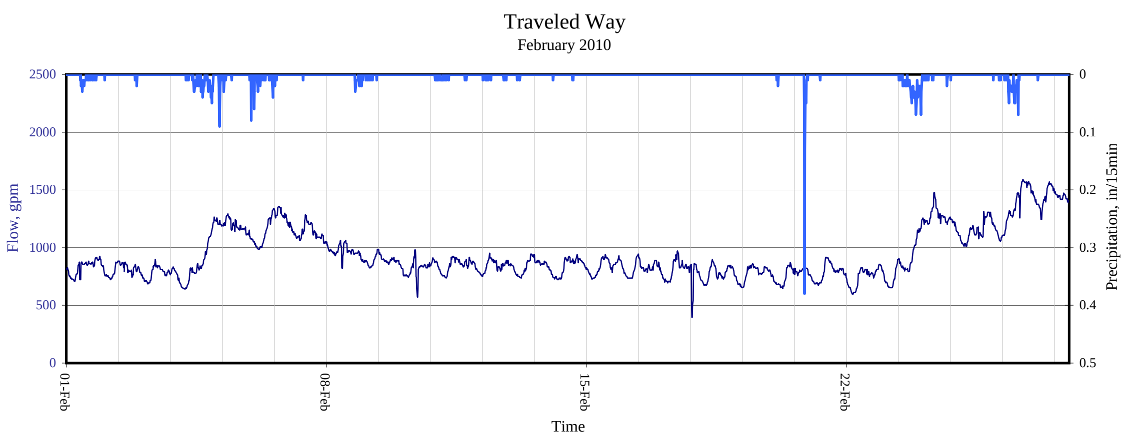


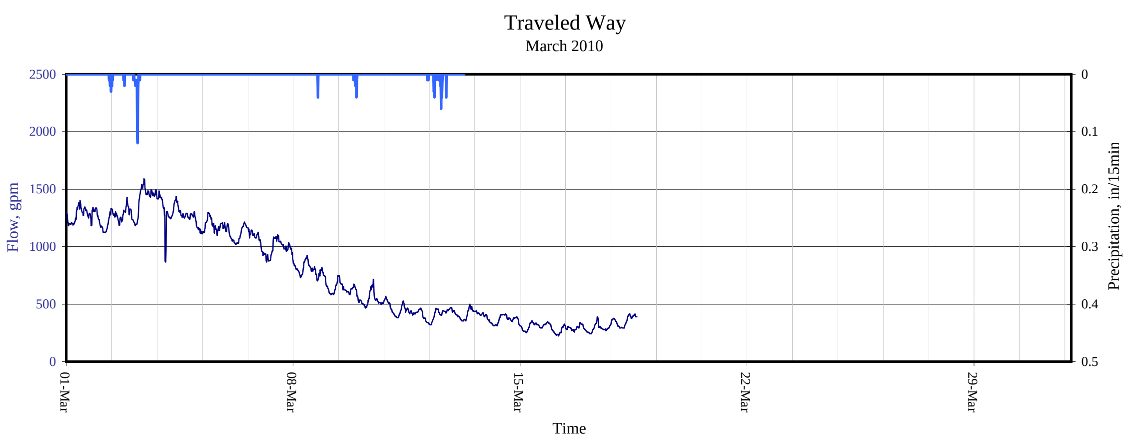
Tarmac
March 2010



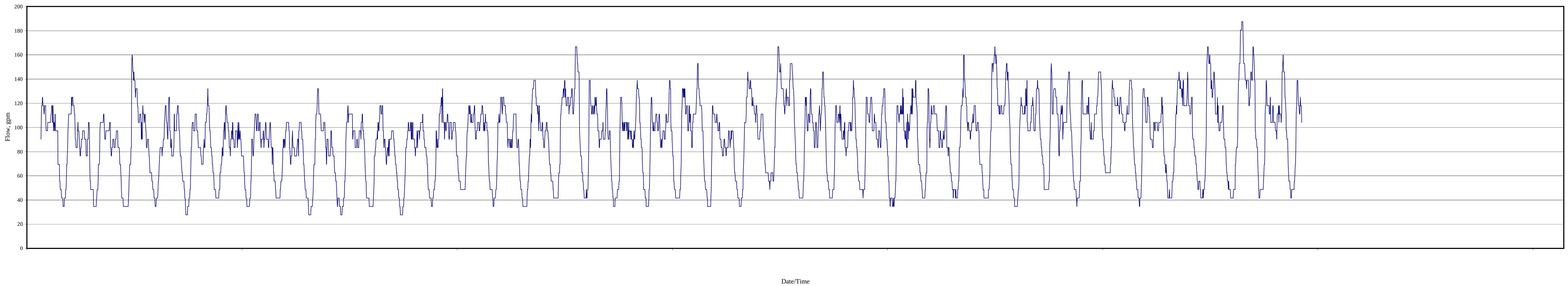

Traveled Way
December 2009
Flow, gpm
Precipitation, in/15min
Time
01-Dec
08-Dec
15-Dec
22-Dec
29-Dec


Traveled Way
January 2010
Flow, gpm
Precipitation, in/15min
Time
01-Jan
08-Jan
15-Jan
22-Jan
29-Jan

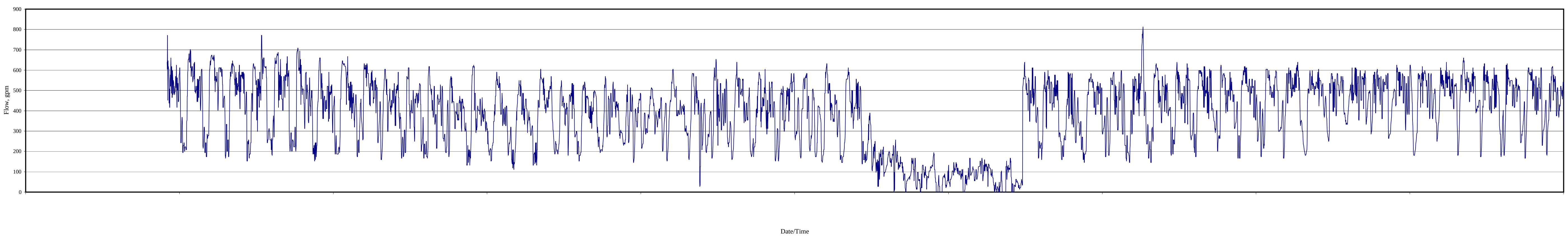

Traveled Way
February 2010
Flow, gpm
Precipitation, in/15min
Time
01-Feb
08-Feb
15-Feb
22-Feb


Traveled Way
March 2010
Flow, gpm
Precipitation, in/15min
Time
01-Mar
08-Mar
15-Mar
22-Mar
29-Mar

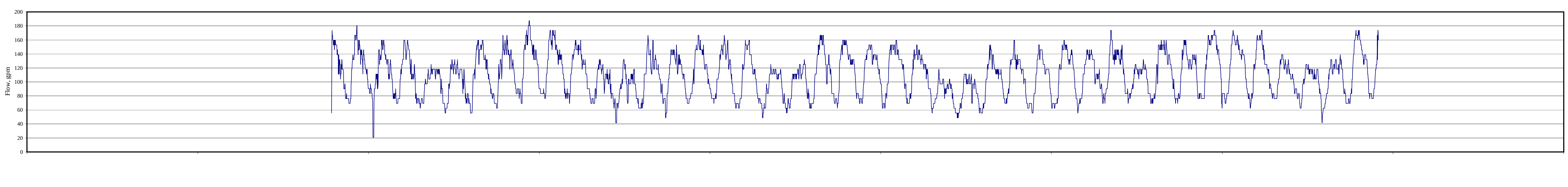
St.Nicholas



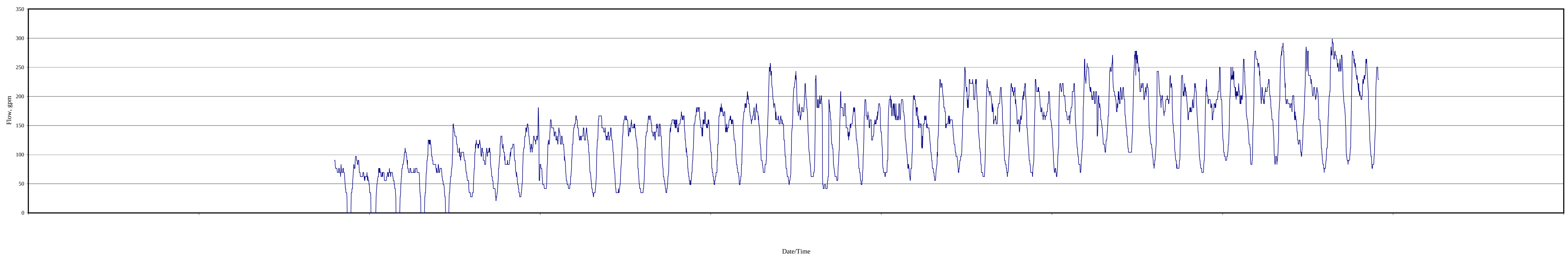
North Court Street



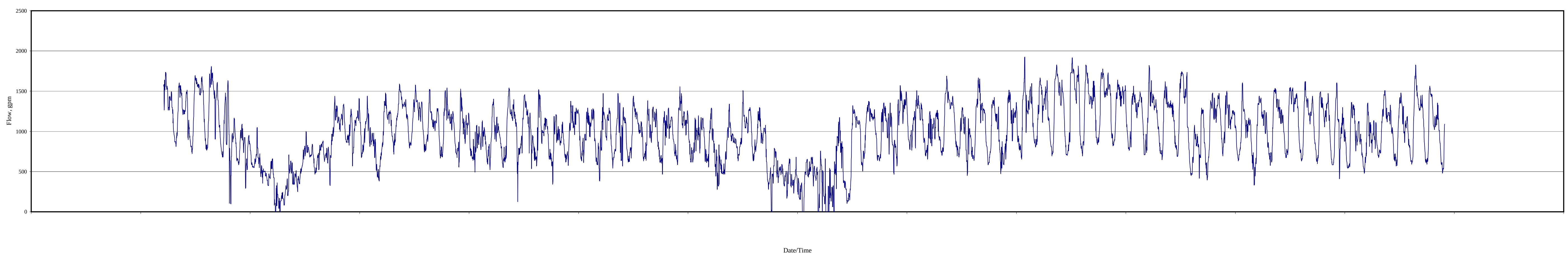
Railroad Ave

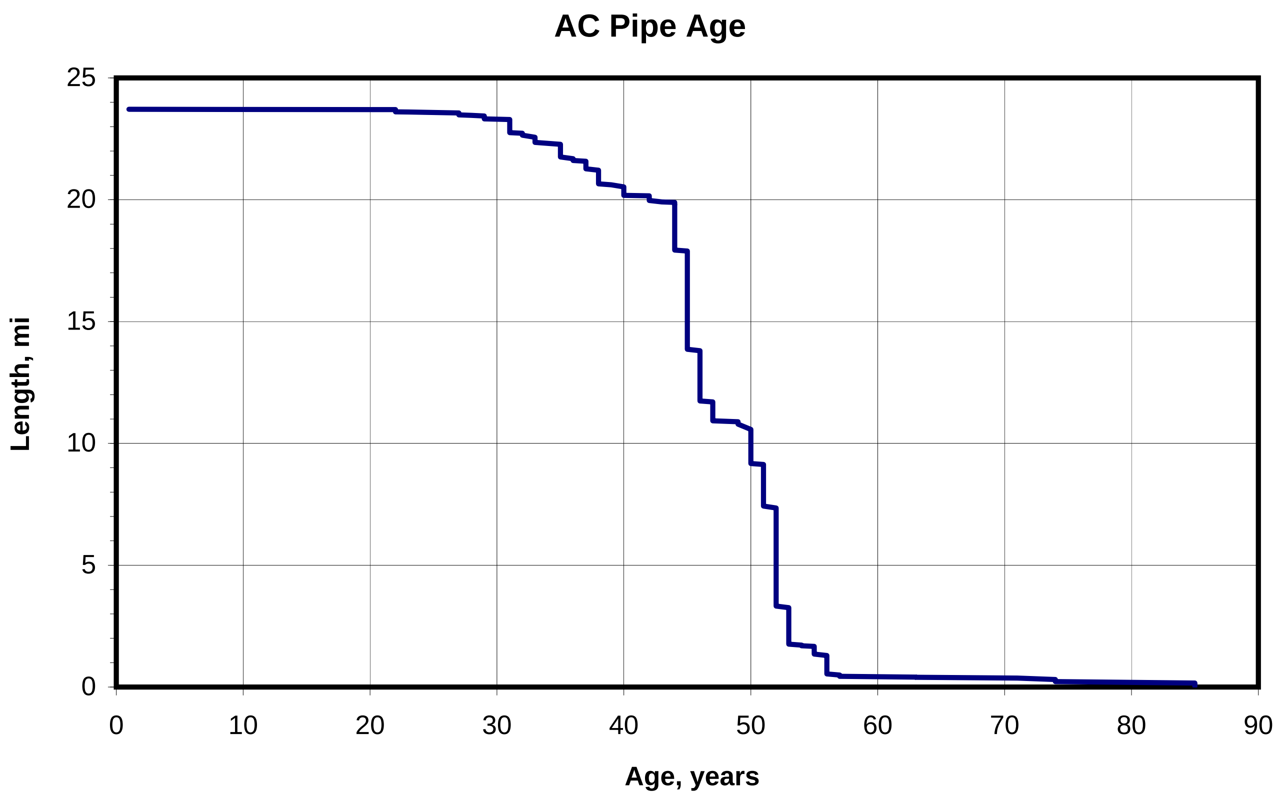


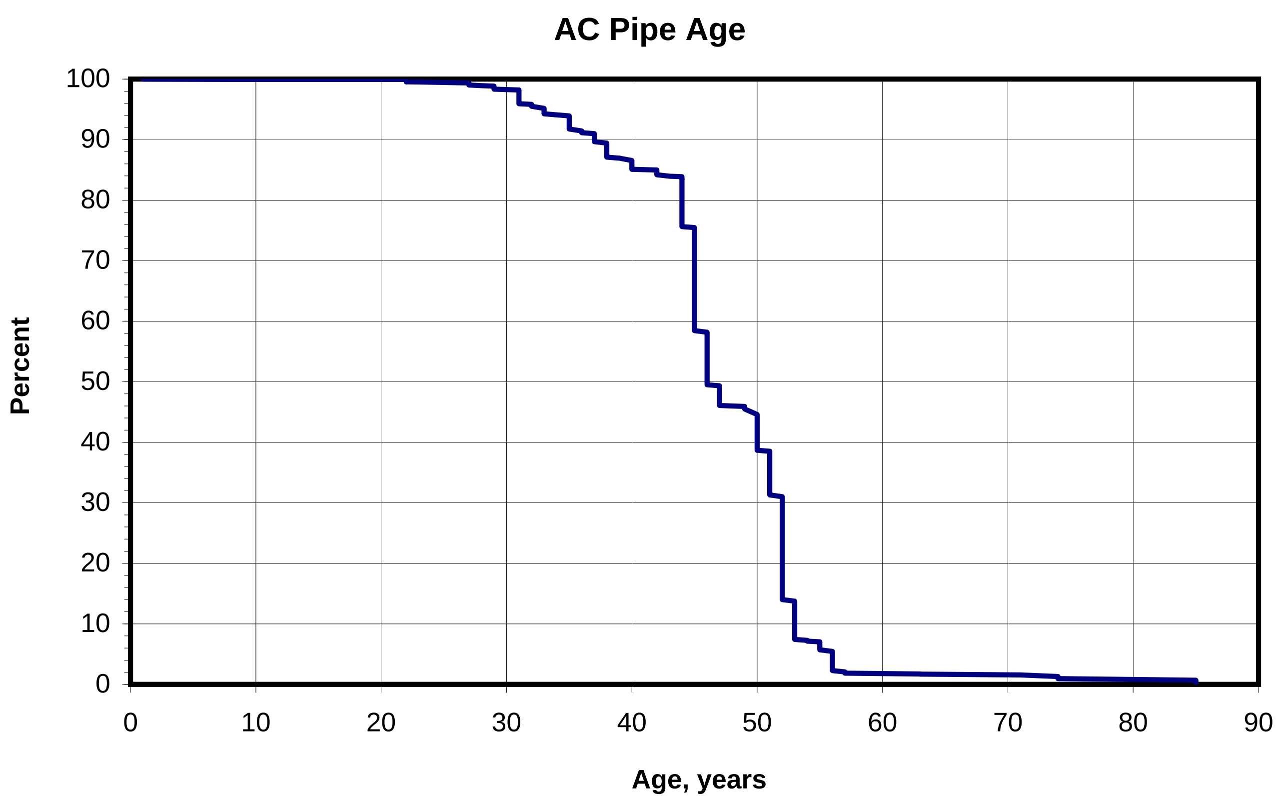
Redwood Trailer Park

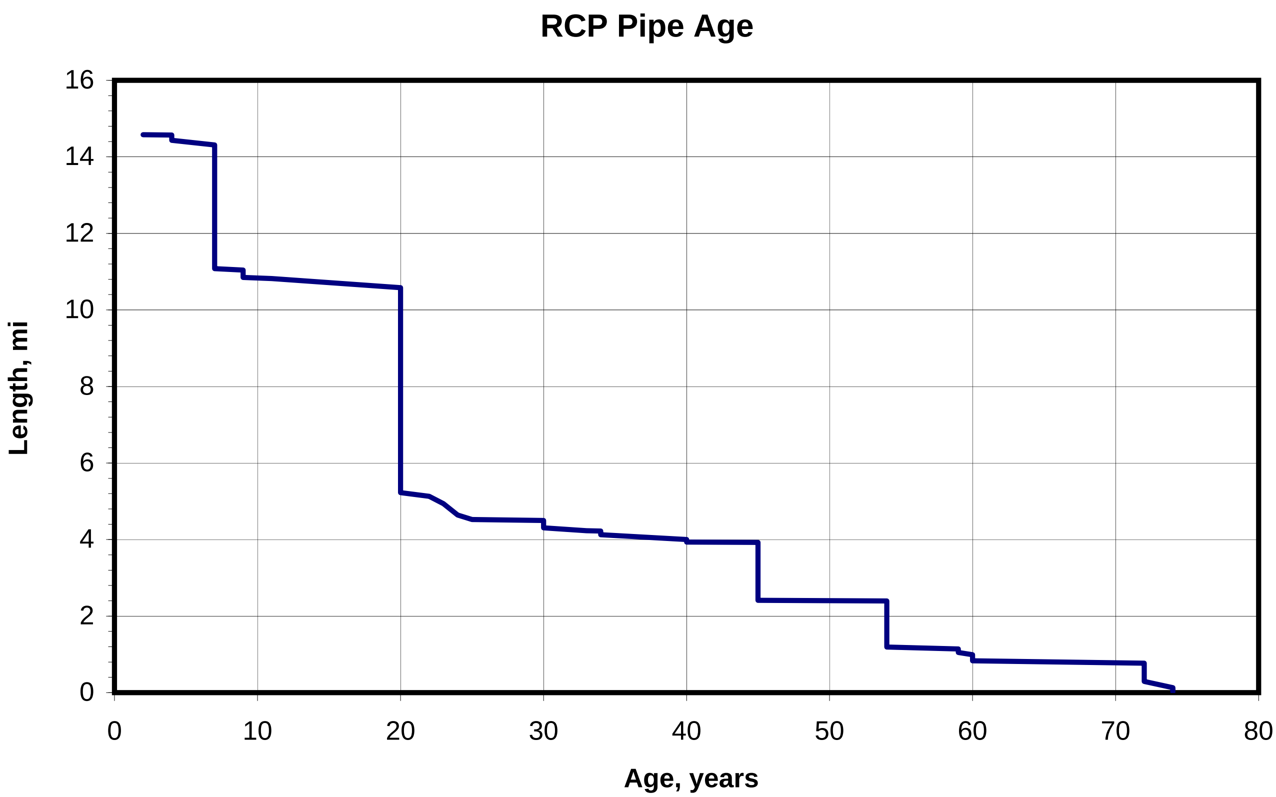


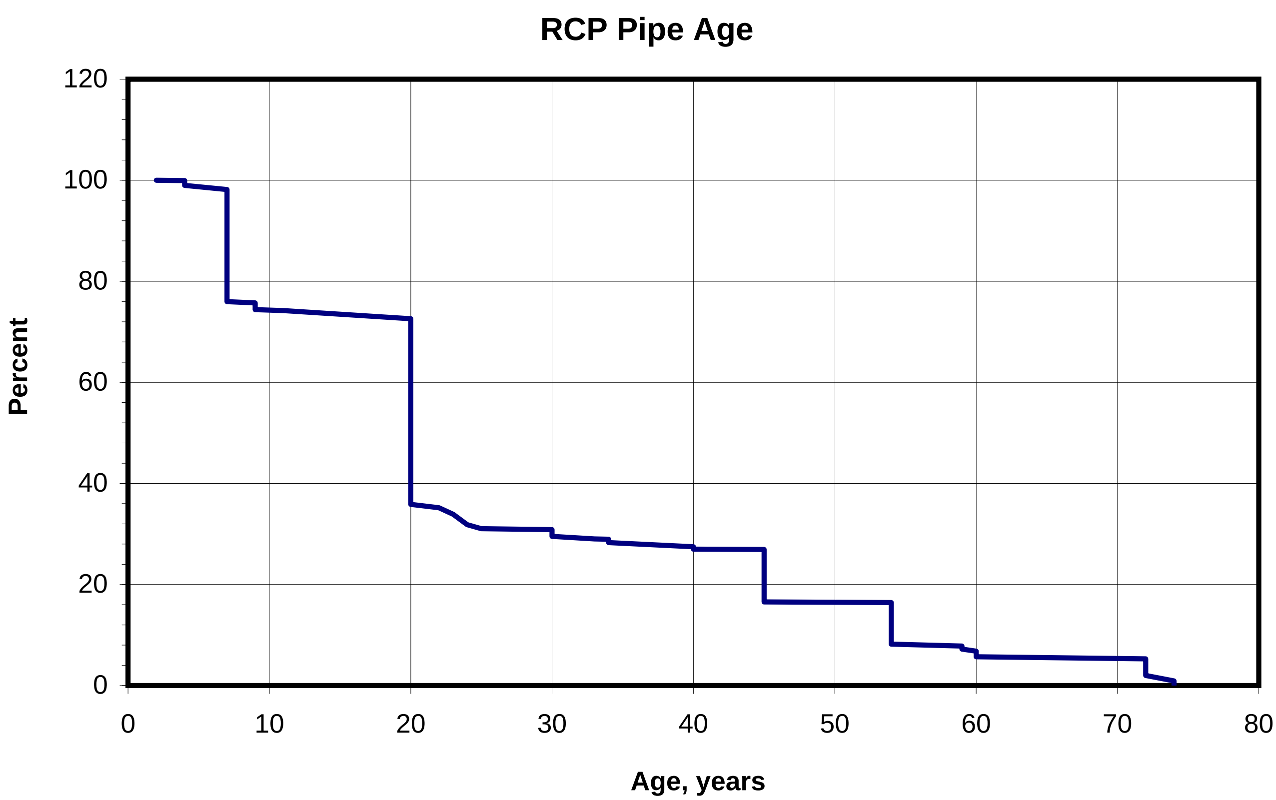
Rivella Vista

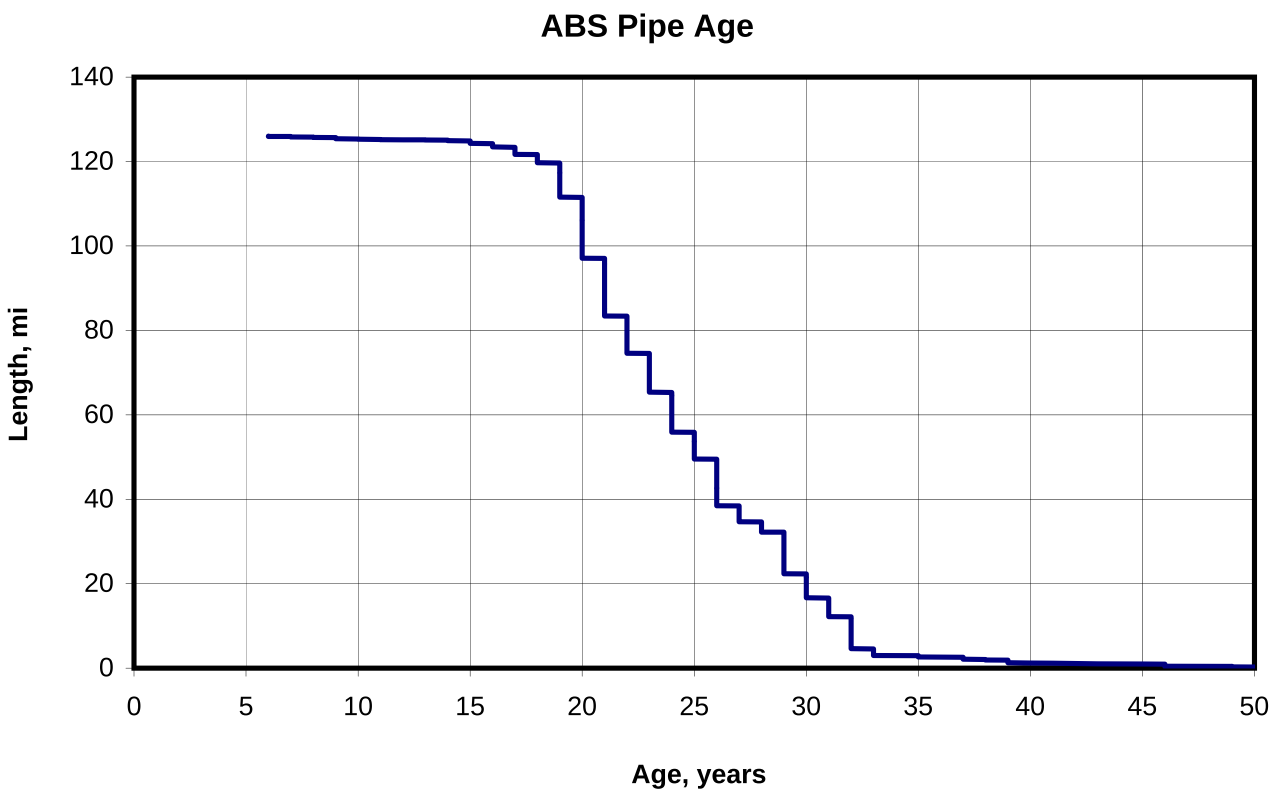


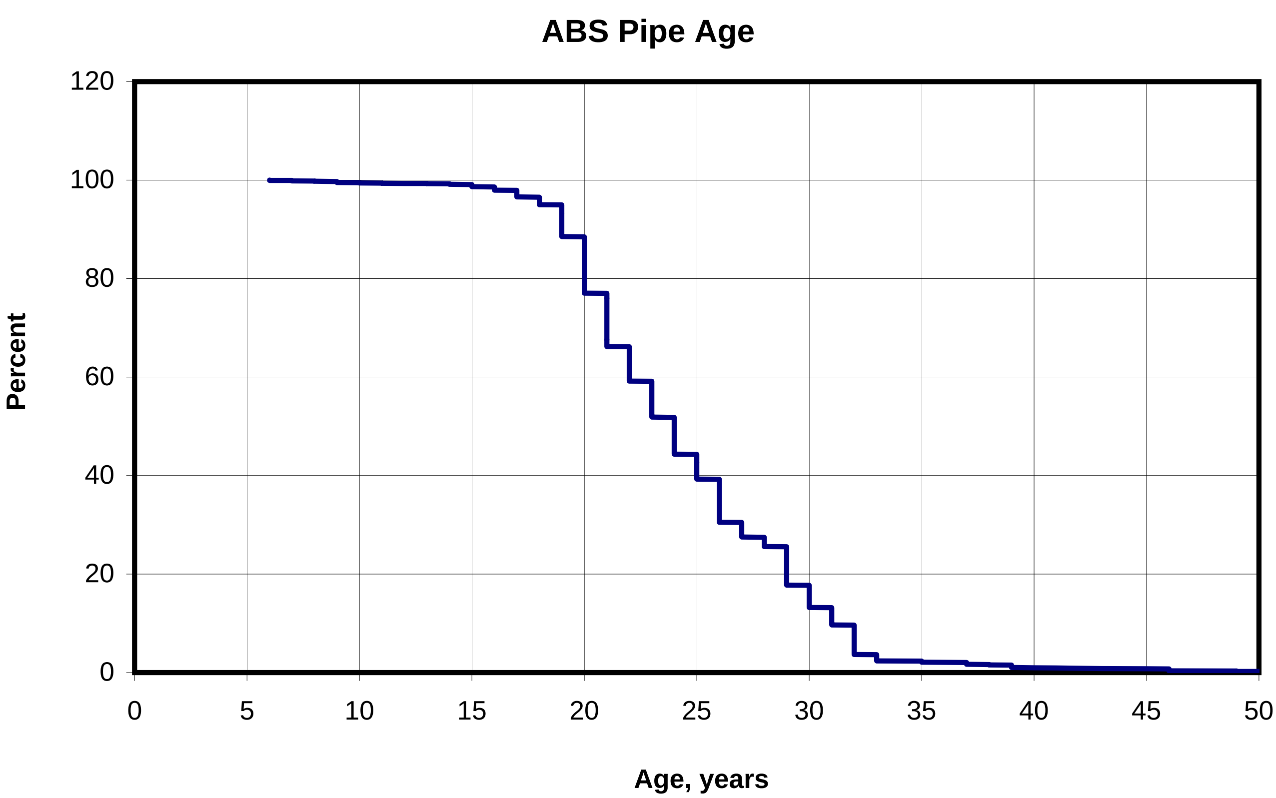

AC Pipe Age
Length, mi
0
5
10
15
20
25
0
10
20
30
40
50
60
70
80
90
Age, years

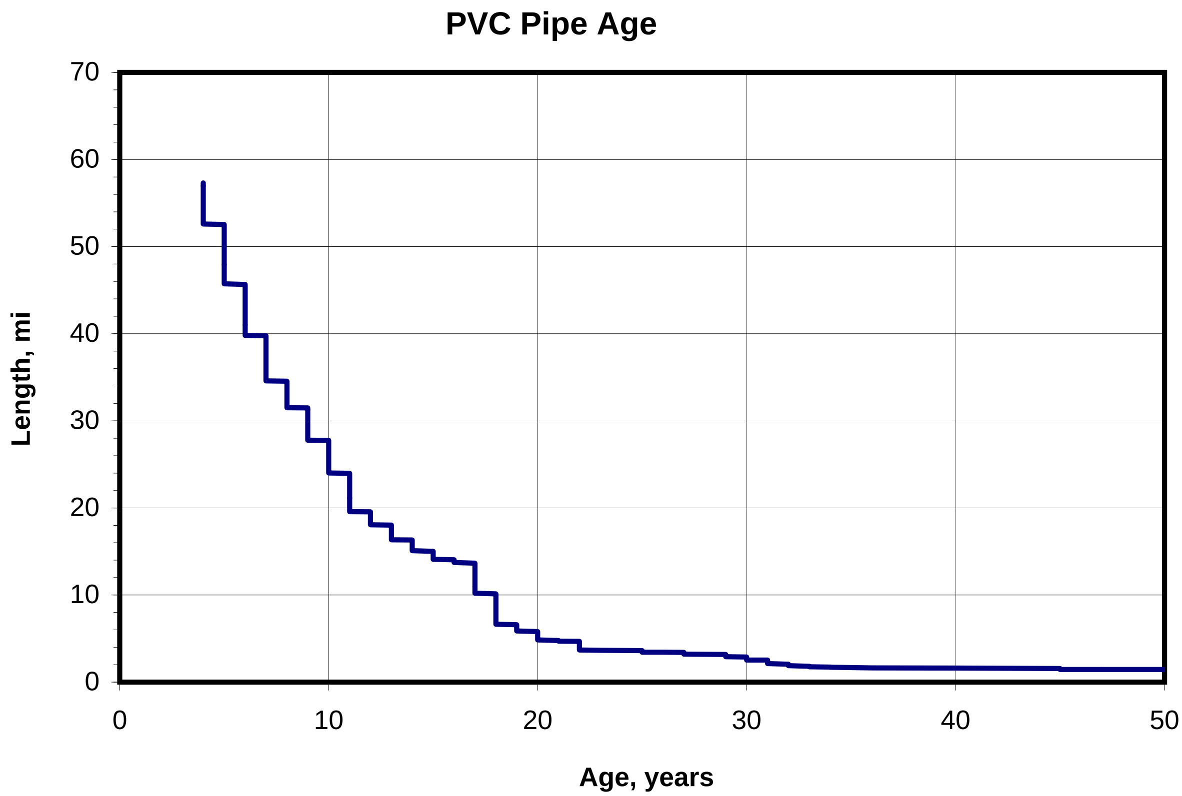

AC Pipe Age
Percent
0
10
20
30
40
50
60
70
80
90
100
0
10
20
30
40
50
60
70
80
90
Age, years

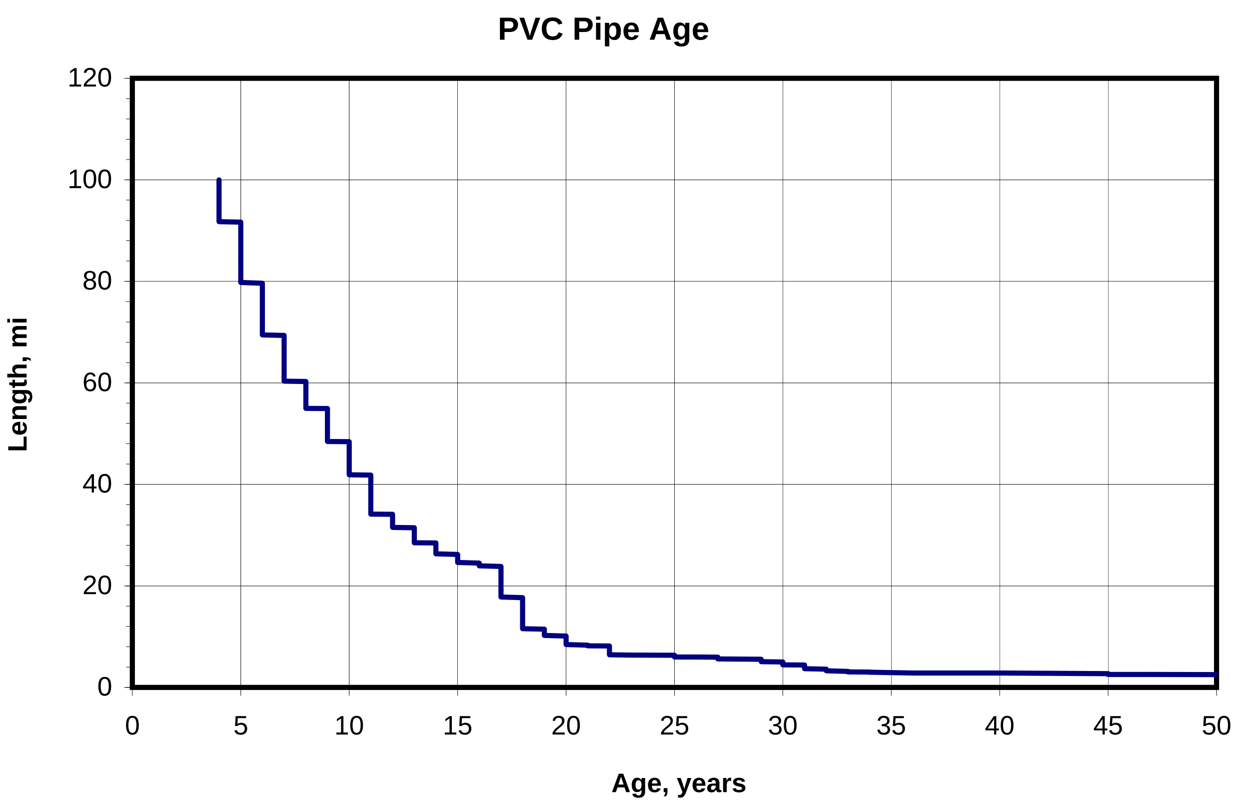

RCP Pipe Age
Length, mi
Age, years
0
2
4
6
8
10
12
14
16
0
10
20
30
40
50
60
70
80

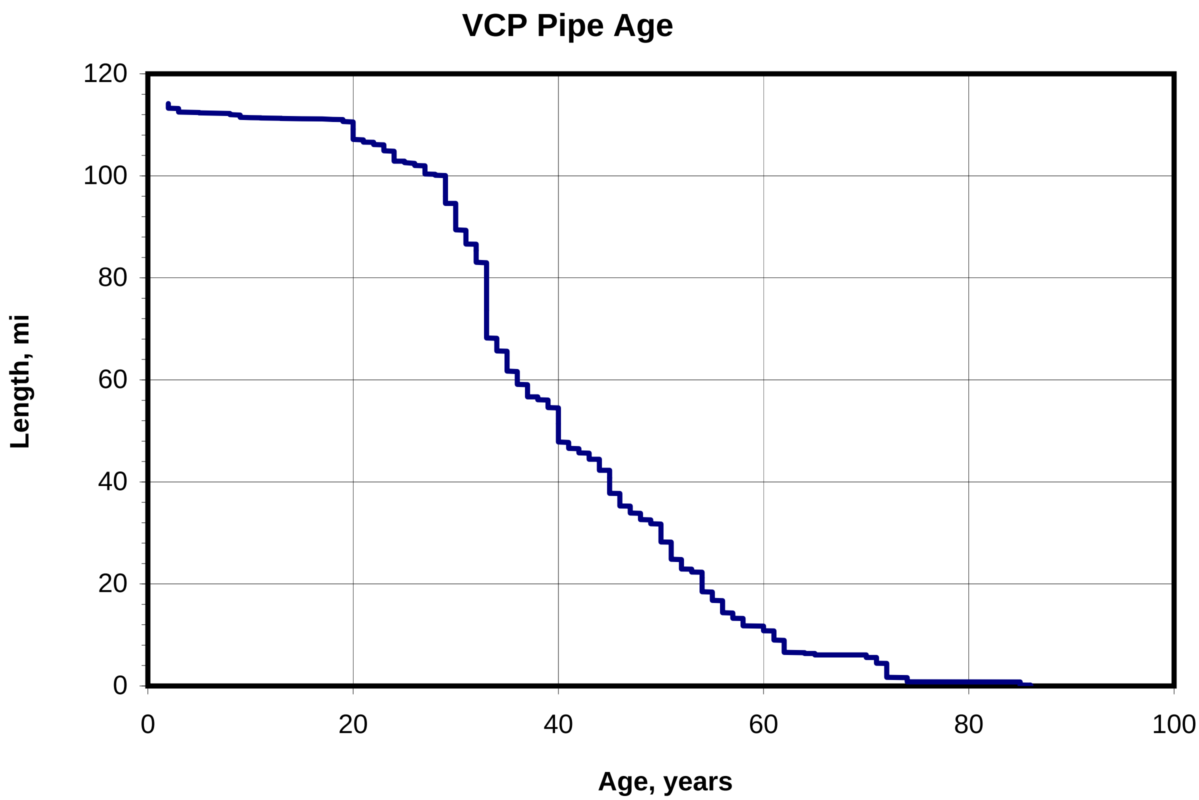

RCP Pipe Age
Percent
Age, years
0
20
40
60
80
100
120
0
10
20
30
40
50
60
70
80

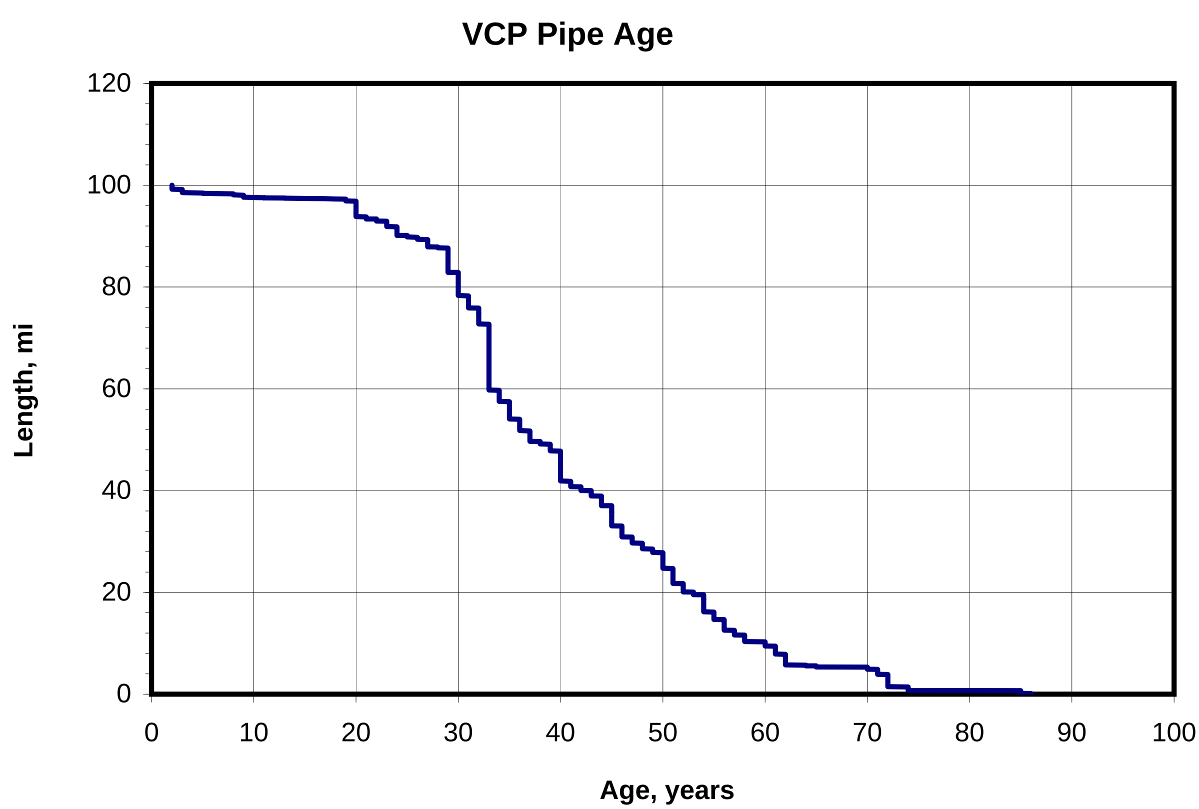

ABS Pipe Age
Length, mi
140
120
100
80
60
40
20
0
0
5
10
15
20
25
30
35
40
45
50
Age, years


ABS Pipe Age
Percent
120
100
80
60
40
20
0
0
5
10
15
20
25
30
35
40
45
50
Age, years


PVC Pipe Age
Length, mi
Age, years
0
10
20
30
40
50
60
70
0
10
20
30
40
50

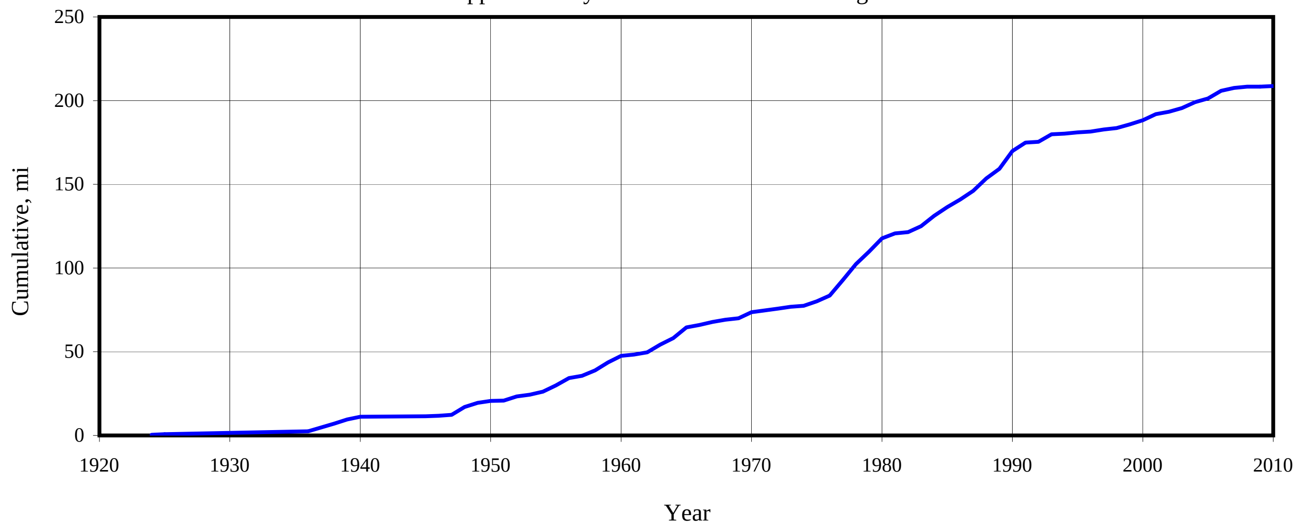

PVC Pipe Age
Length, mi
Age, years
0
20
40
60
80
100
120
0
5
10
15
20
25
30
35
40
45
50


VCP Pipe Age
Length, mi
Age, years
0
20
40
60
80
100
120
0
20
40
60
80
100


VCP Pipe Age
Length, mi
Age, years
0
20
40
60
80
100
120
0
10
20
30
40
50
60
70
80
90
100

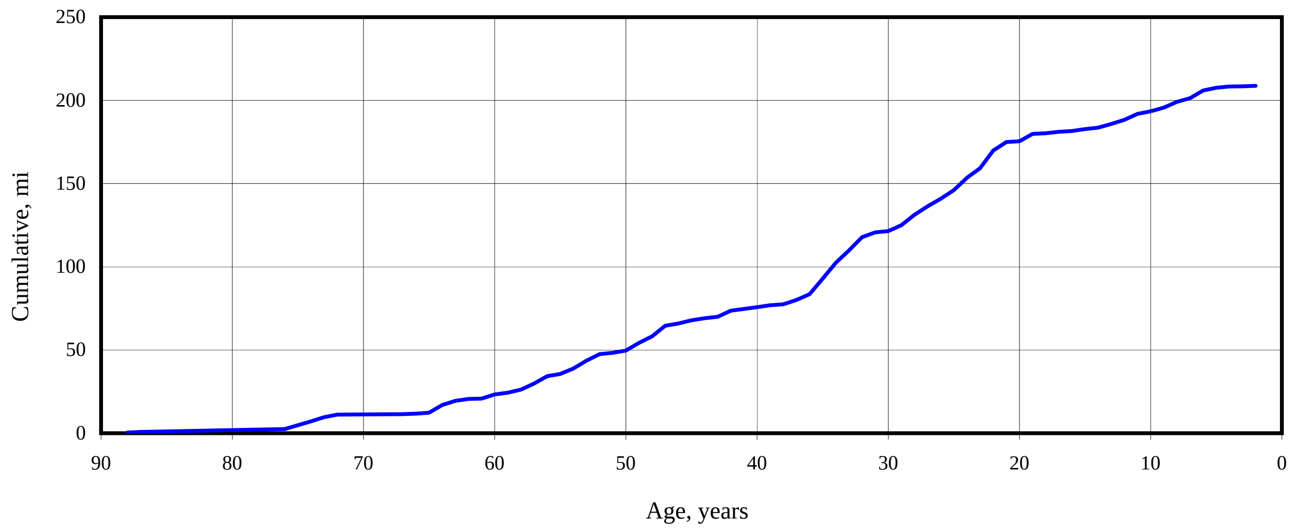
Clear Creek Collection System Pipe Construction

Approximately 67 miles are of unknown age



Clear Creek Collection System Pipe Age

Approximately 67 miles are of unknown age



Stillwater Collection System Pipe Construction

Approximately 26 miles are of unknown age

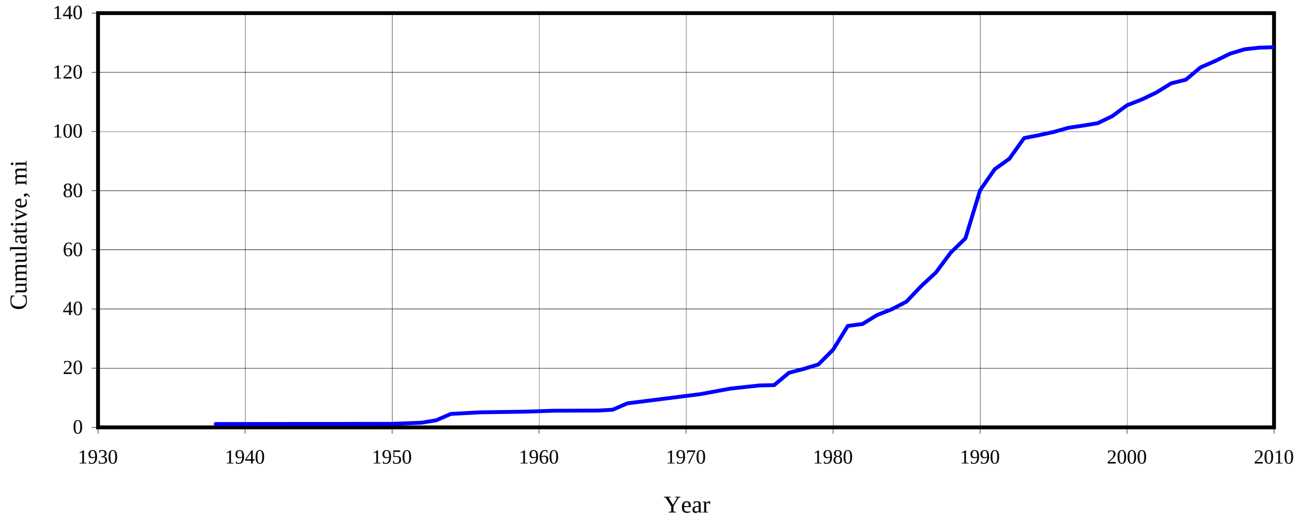
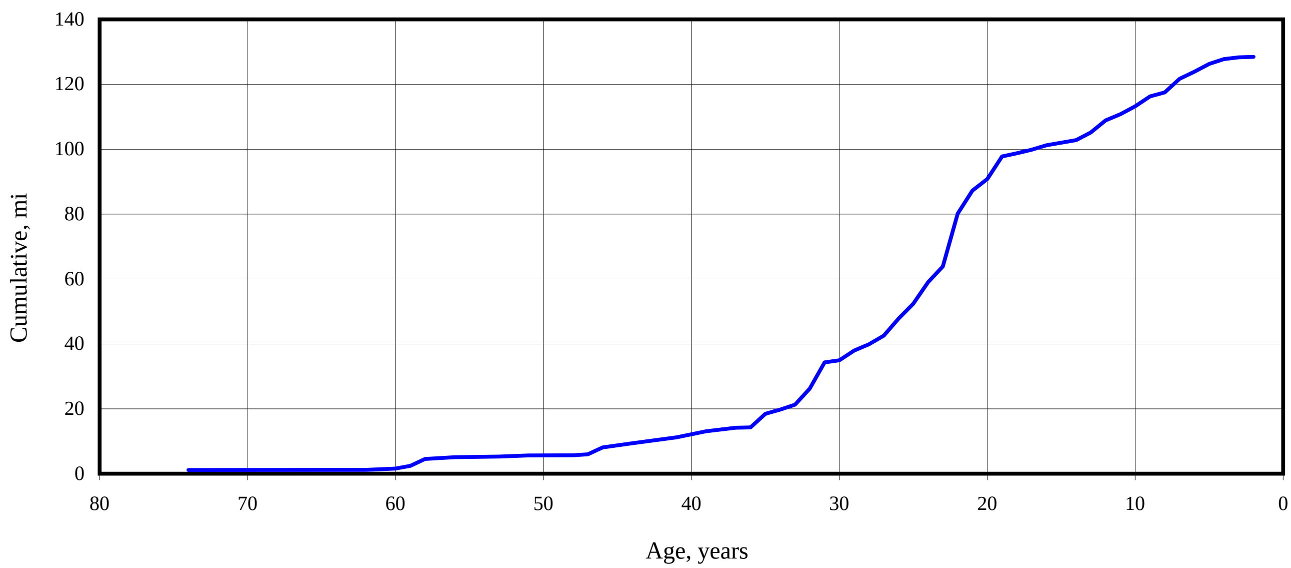
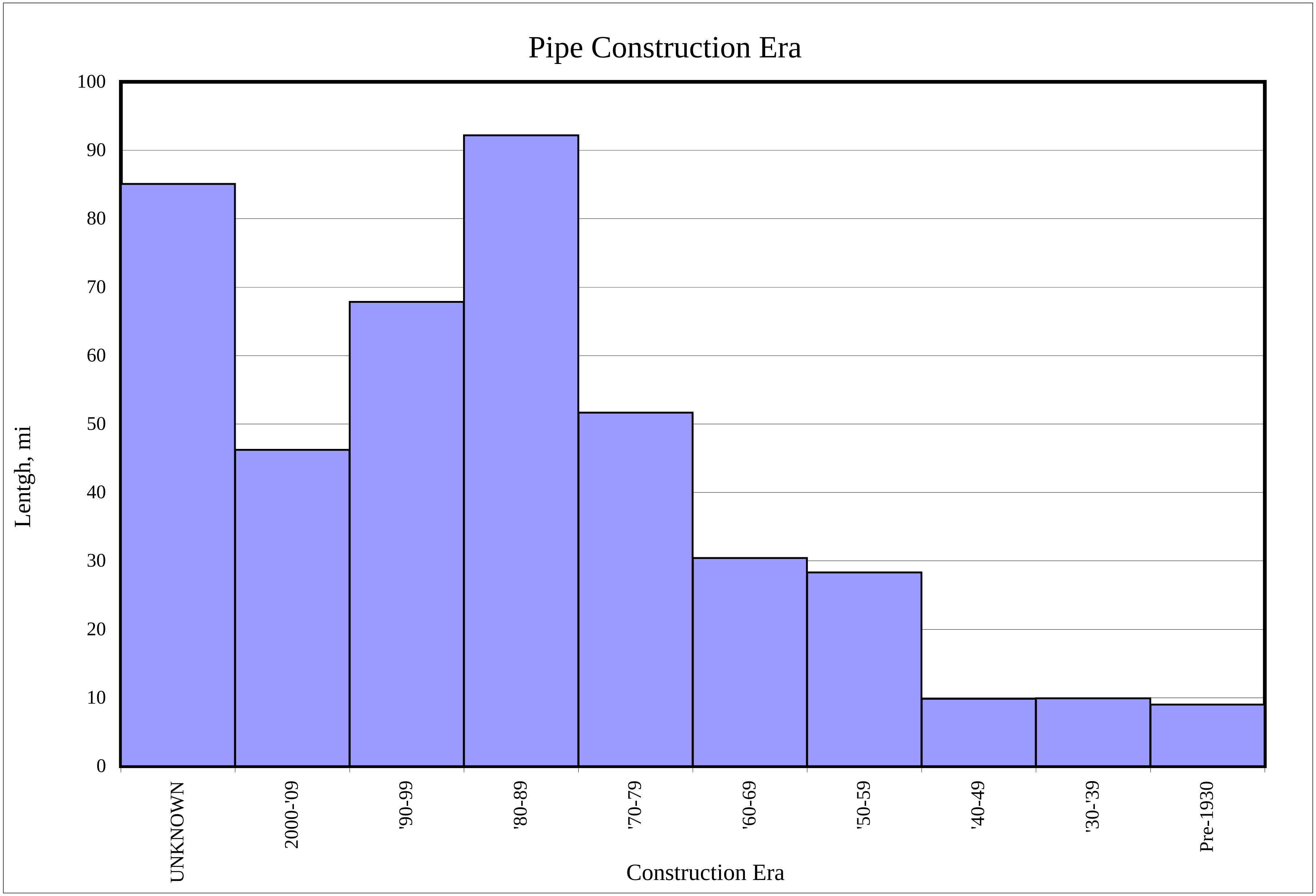
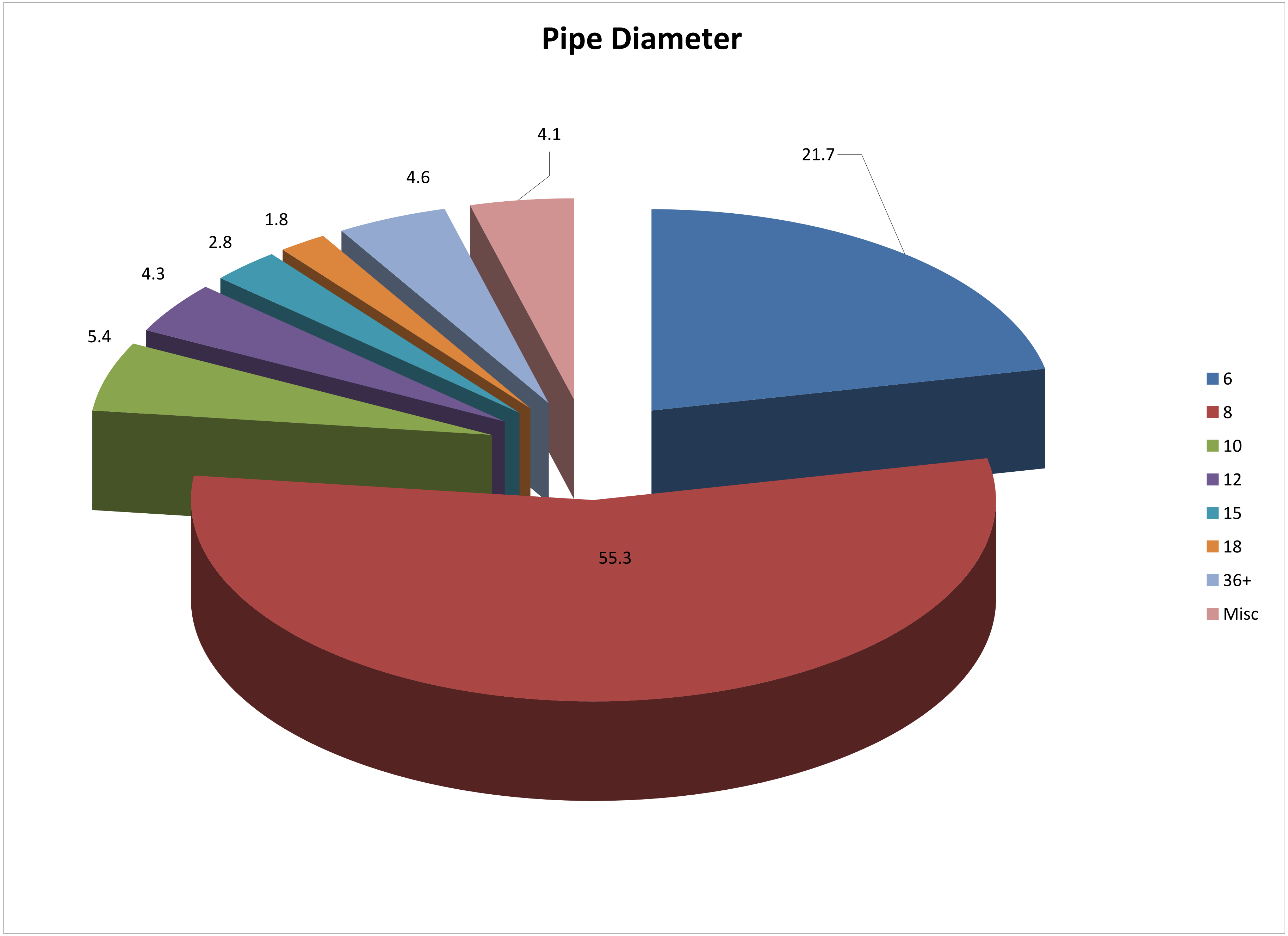


Figure 5.2 - Stillwater Collection System Pipe Age

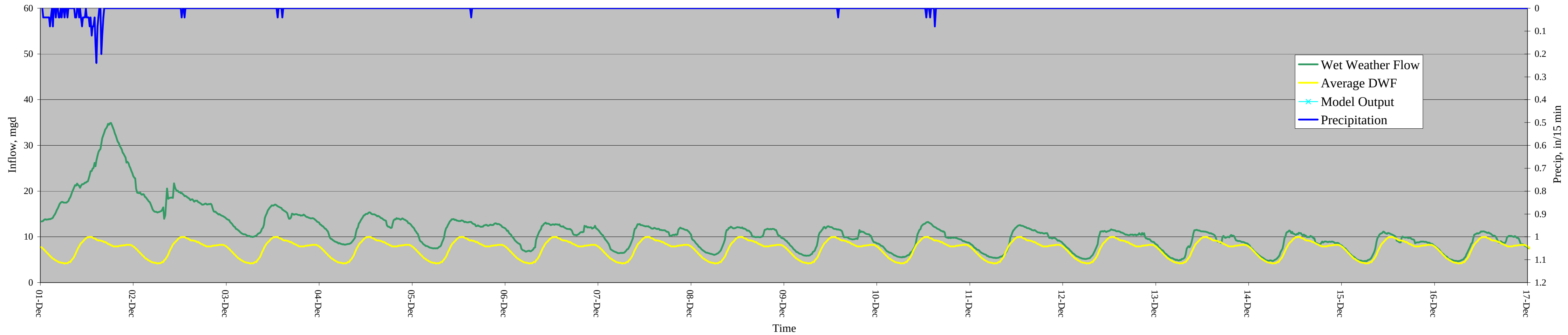
Approximately 26 miles are of unknown age



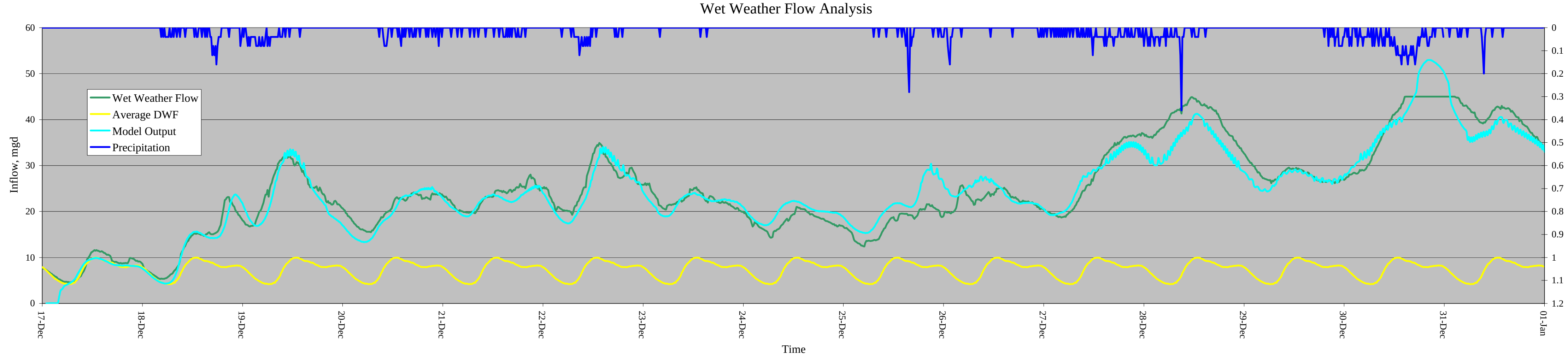

Pipe Construction Era
100
90
80
70
60
50
40
30
20
10
0
Lentgh, mi
UNKNOWN
2000-'09
'90-99
'80-89
'70-79
'60-69
'50-59
'40-49
'30-'39
Pre-1930
Construction Era


Pipe Diameter
21.7
55.3
5.4
4.3
2.8
1.8
4.6
4.1
6
8
10
12
15
18
36+
Misc

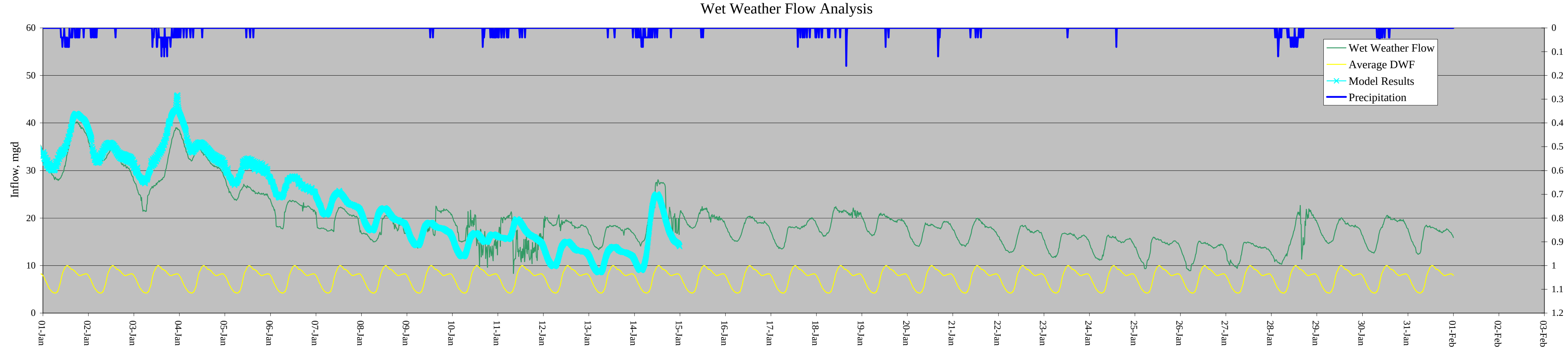
Clear Creek WWTP
Wet Weather Flow Analysis

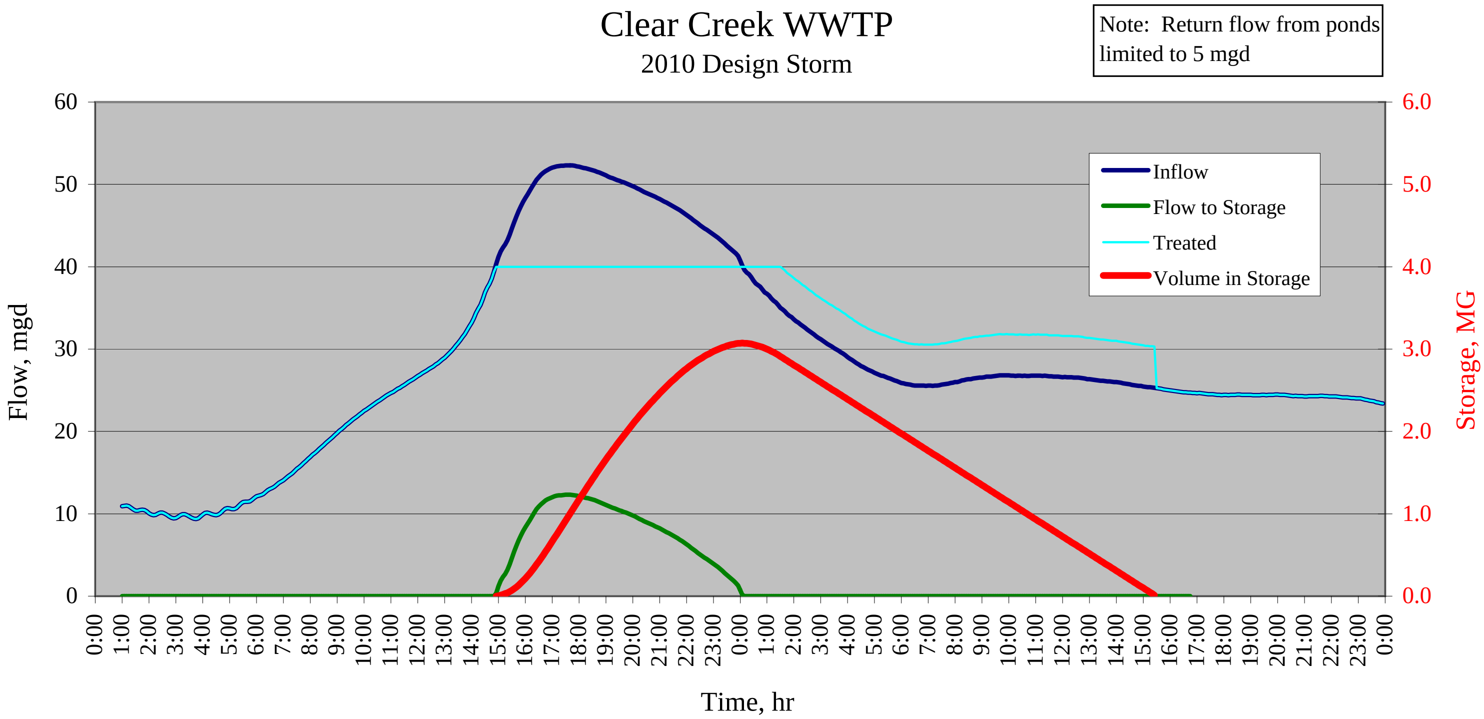


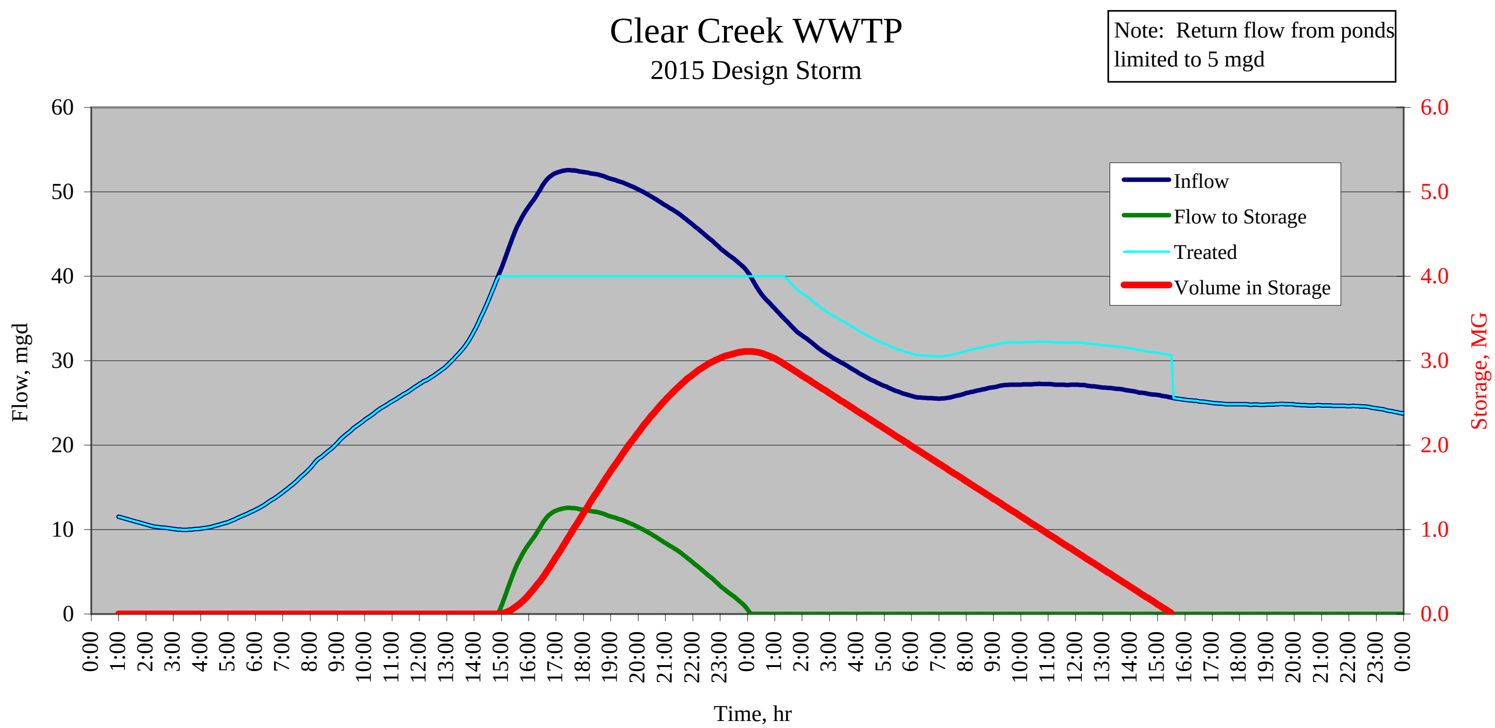
Clear Creek WWTP
Wet Weather Flow Analysis

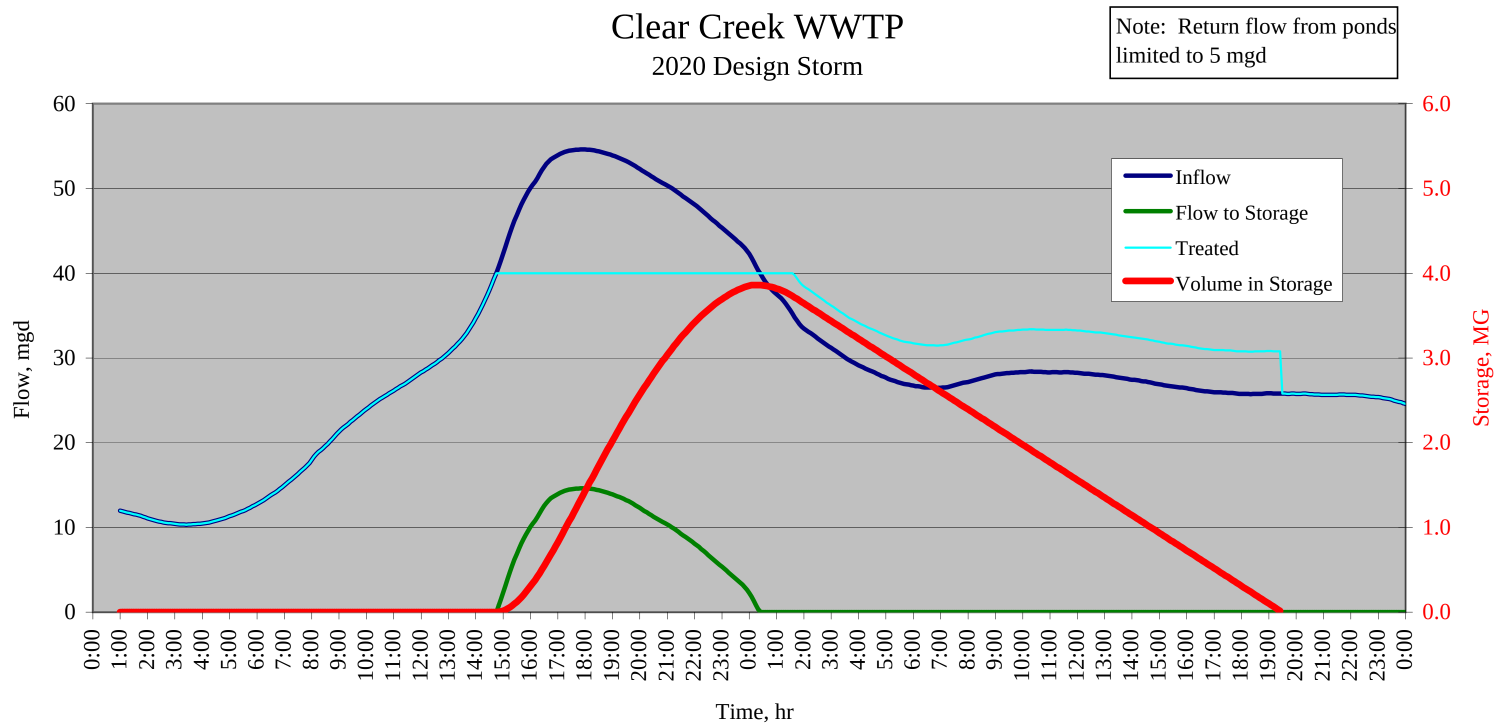


Clear Creek WWTP
Wet Weather Flow Analysis

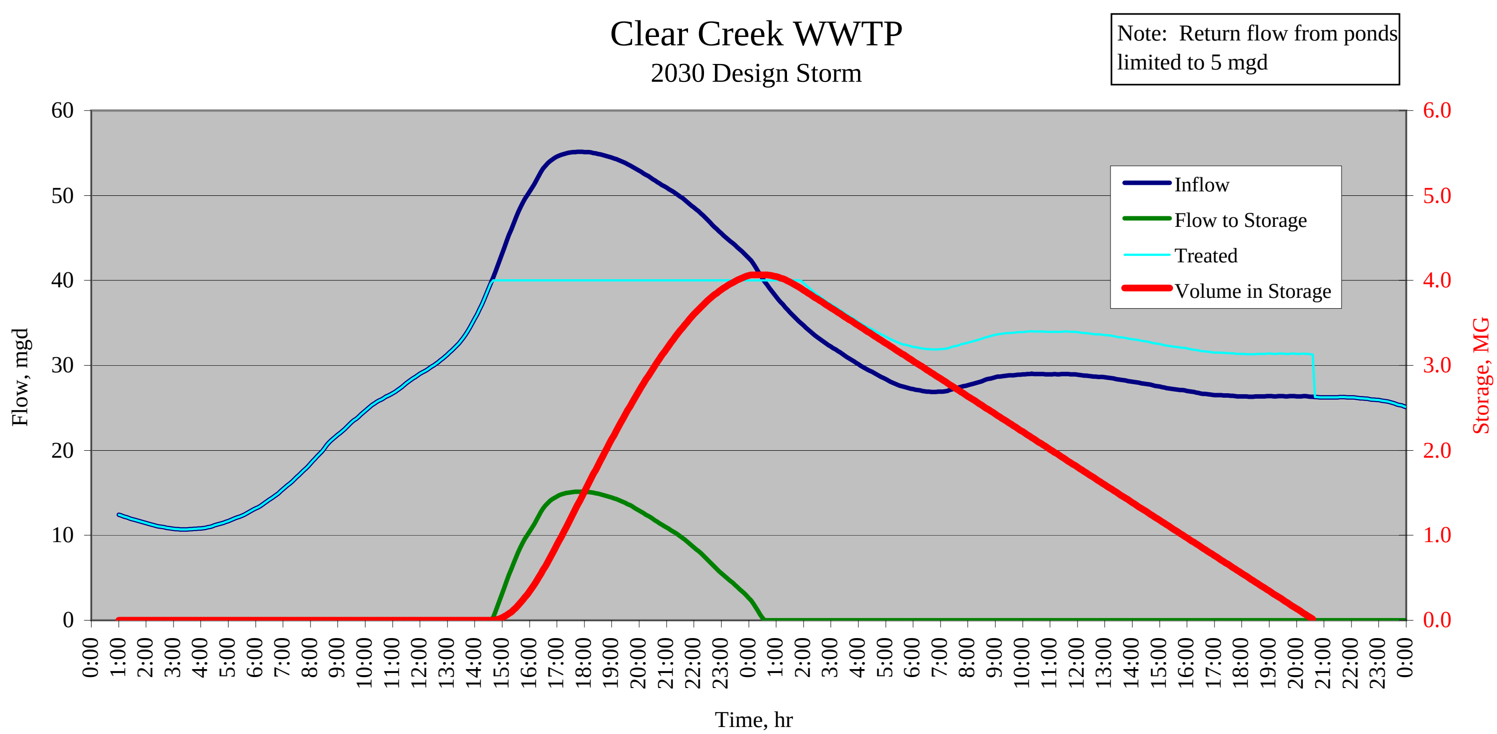



Clear Creek WWTP
2010 Design Storm
Note: Return flow from ponds limited to 5 mgd
Inflow
Flow to Storage
Treated
Volume in Storage
Flow, mgd
Storage, MG
Time, hr


Clear Creek WWTP
2015 Design Storm
Note: Return flow from ponds limited to 5 mgd
Inflow
Flow to Storage
Treated
Volume in Storage
Flow, mgd
Storage, MG
Time, hr



Clear Creek WWTP
2020 Design Storm
Note: Return flow from ponds limited to 5 mgd
Inflow
Flow to Storage
Treated
Volume in Storage
Flow, mgd
Storage, MG
Time, hr



Clear Creek WWTP
2030 Design Storm
Note: Return flow from ponds limited to 5 mgd
Inflow
Flow to Storage
Treated
Volume in Storage
Flow, mgd
Storage, MG
Time, hr

APPENDIX D
Pipe Inventory

2010 Master Plan Clear Creek Collection System Pipe Analysis Results

LENGTH (ft)	Manning's N	Diameter (in)	Material	Slope	Maximum Flow, gpm	Upstream MH Name	Upstream Invert (ft)	Upstream MH Rim	Maximum Upstream HGL	Upstream Flow Depth, ft	Class	Downstream MH Name	Downstream Invert (ft)	Downstream MH Rim	Maximum Downstream HGL	Downstream Flow Depth, ft	Class
121	0.015	10		0.005	233	D2-1	720.70	730.70	721.06	0.4		D3-5	720.07	739.97	720.46	0.4	
300	0.015	10		0.009	219	D2-2	723.33	738.89	723.63	0.3		D2-1	720.70	730.70	721.06	0.4	
155	0.015	10		0.005	219	D2-3	724.14	740.86	724.50	0.4		D2-2	723.33	738.89	723.63	0.3	
188	0.015	8		0.068	54	D2-4	736.90	740.40	737.00	0.1		D2-3	724.14	740.86	724.50	0.4	
117	0.015	10		0.004	147	D2-6	724.62	742.62	724.92	0.3		D2-3	724.14	740.86	724.50	0.4	
340	0.015	8		0.005	117	D2-7	726.19	738.19	726.47	0.3		D2-6	724.62	742.62	724.92	0.3	
409	0.015	10		0.044	24	D2-8	742.47	759.47	742.54	0.1		D2-6	724.62	742.62	724.92	0.3	
402	0.015	10		0.013	558	D3-1	706.31	716.31	706.76	0.5		E3-5	701.00	711.20	701.54	0.5	
446	0.015	10		0.013	494	D3-2	712.00	719.80	712.42	0.4		D3-1	706.31	716.31	706.76	0.5	
438	0.015	10		0.005	444	D3-3	714.15	720.05	714.74	0.6		D3-2	712.00	719.80	712.42	0.4	
378	0.015	10		0.011	415	D3-4	718.25	734.05	718.65	0.4		D3-3	714.15	720.05	714.74	0.6	
377	0.015	10		0.005	269	D3-5	720.07	739.97	720.46	0.4		D3-4	718.25	734.05	718.65	0.4	
456	0.015	8		0.005	76	D5-15	724.98	734.98	725.19	0.2		D6-1	722.58	732.58	722.81	0.2	
339	0.015	8		0.005	88	D6-1	722.58	732.58	722.81	0.2		D6-2	720.73	730.73	720.97	0.2	
358	0.015	8		0.006	94	D6-2	720.73	730.73	720.97	0.2		D6-56	718.73	728.73	718.99	0.3	
194	0.015	6		0.057	7	D6-3	726.50	729.50	726.54	0.0		D6-5	715.55	720.55	715.82	0.3	
207	0.015	8		0.006	119	D6-4	716.82	726.82	717.08	0.3		D6-5	715.55	720.55	715.82	0.3	
160	0.015	8		0.006	129	D6-5	715.55	720.55	715.82	0.3		D6-6	714.52	724.52	714.82	0.3	
252	0.015	8		0.005	130	D6-6	714.52	724.52	714.82	0.3		E6-1	713.28	723.28	713.55	0.3	
334	0.015	8		0.006	115	D6-56	718.73	728.73	718.99	0.3		D6-4	716.82	726.82	717.08	0.3	
215	0.015	12		0.008	1297	E3-1	660.00	670.00	665.89	5.9	SUR	F3-6	658.30	664.00	664.00	5.7	SUR
539	0.015	10		0.011	1097	E3-2	666.00	676.00	674.80	8.8	SUR	E3-1	660.00	670.00	665.89	5.9	SUR
743	0.015	10		0.031	661	E3-3	689.00	696.00	689.39	0.4		E3-2	666.00	676.00	674.80	8.8	SUR
369	0.015	10		0.024	619	E3-4	697.73	703.03	698.14	0.4		E3-3	689.00	696.00	689.39	0.4	
325	0.015	10		0.010	594	E3-5	701.00	711.20	701.54	0.5		E3-4	697.73	703.03	698.14	0.4	
436	0.015	8		0.015	445	E3-6	665.15	672.05	667.91	2.8	SUR	F3-6	658.50	664.00	664.00	5.5	SUR
73	0.015	10		0.164	438	E3-7	677.00	684.00	677.20	0.2		E3-6	665.15	672.05	667.91	2.8	SUR
511	0.015	10		0.032	424	E3-8	693.20	705.80	693.53	0.3		E3-7	677.00	684.00	677.20	0.2	
234	0.015	10		0.003	381	E3-9	693.98	704.38	694.61	0.6		E3-8	693.20	705.80	693.53	0.3	
401	0.015	8		0.111	198	E3-10	738.25	744.65	738.41	0.2		E3-9	693.98	704.38	694.61	0.6	
250	0.015	8		0.035	30	E3-12	702.04	710.44	702.12	0.1		E3-8	693.20	705.80	693.53	0.3	
446	0.015	10		0.076	165	E4-2	729.28	741.98	729.43	0.1		E4-28	695.54	701.54	695.88	0.3	
135	0.015	8		0.005	162	E4-3	730.00	745.00	730.36	0.4		E4-2	729.28	741.98	729.43	0.1	
159	0.015	8		0.006	151	E4-6	730.89	741.69	731.19	0.3		E4-3	730.00	745.00	730.36	0.4	
284	0.015	8		0.005	190	E4-9	739.64	752.54	740.06	0.4		E3-10	738.25	744.65	738.41	0.2	
381	0.015	8		0.021	21	E4-10	747.80	753.70	747.88	0.1		E4-9	739.64	752.54	740.06	0.4	
272	0.015	8		0.022	165	E4-11	745.55	755.05	745.77	0.2		E4-9	739.64	752.54	740.06	0.4	
368	0.015	8		0.005	103	E4-13	732.60	739.40	732.86	0.3		E4-6	730.89	741.69	731.19	0.3	
233	0.010	8		0.054	9	E4-14	745.12	750.94	745.16	0.0		E4-13	732.60	739.40	732.86	0.3	
295	0.010	8		0.003	50	E4-15	733.62	741.41	733.78	0.2		E4-13	732.60	739.40	732.86	0.3	
305	0.010	8		0.003	35	E4-16	734.67	740.61	734.80	0.1		E4-15	733.62	741.41	733.78	0.2	
129	0.015	8		0.001	42	E4-17	731.07	734.07	731.29	0.2		E4-6	730.89	741.69	731.19	0.3	
451	0.015	10		0.003	176	E4-28	695.54	701.54	695.88	0.3		E3-9	693.98	704.38	694.61	0.6	
306	0.013	8		0.017	27	E4-29	666.95	680.41	667.04	0.1		E4-32	661.62	668.36	661.71	0.1	
306	0.013	8		0.033	16	E4-31	671.84	678.54	671.90	0.1		E4-32	661.62	668.36	661.71	0.1	
307	0.013	8		0.072	59	E4-32	661.62	668.36	661.71	0.1		F4-26	639.55	646.19	639.67	0.1	
412	0.015	8		0.035	92	E5-2	713.00	715.00	713.15	0.2		E5-5	698.60	703.00	698.72	0.1	
318	0.015	6		0.043	30	E5-4	712.40	722.40	712.49	0.1		E5-5	698.60	703.00	698.72	0.1	
284	0.015	8		0.174	130	E5-5	698.60	703.00	698.72	0.1		E5-7	649.92	659.92	650.08	0.2	
671	0.015	8		0.058	147	E5-7	649.92	659.92	650.08	0.2		E6-4	611.07	620.87	611.18	0.1	
680	0.012	15		0.018	28	E5-17	610.54	622.60	610.61	0.1		E5-18	598.20	606.40	598.27	0.1	
137	0.012	15		0.018	28	E5-18	598.20	606.40	598.27	0.1		E5-19	595.73	603.00	595.88	0.1	
689	0.012	15		0.012	103	E5-19	595.73	603.00	595.88	0.1		F6-19	587.30	591.00	587.66	0.4	

2010 Master Plan Clear Creek Collection System Pipe Analysis Results

LENGTH (ft)	Manning's N	Diameter (in)	Material	Slope	Maximum Flow, gpm	Upstream MH Name	Upstream Invert (ft)	Upstream MH Rim	Maximum Upstream HGL	Upstream Flow Depth, ft	Class	Downstream MH Name	Downstream Invert (ft)	Downstream MH Rim	Maximum Downstream HGL	Downstream Flow Depth, ft	Class
121	0.013	8		0.105	35	E5-21	707.06	715.23	707.13	0.1		E5-22	694.45	707.77	694.54	0.1	
315	0.013	8		0.091	6	E5-21	711.04	718.60	711.07	0.0		E5-22	682.45	688.90	682.51	0.1	
301	0.013	8		0.039	43	E5-22	694.45	707.77	694.54	0.1		E5-23	682.87	688.86	682.95	0.1	
402	0.013	8		0.053	17	E5-22	682.45	688.90	682.51	0.1		E5-23	661.00	666.50	661.05	0.1	
500	0.013	8		0.109	59	E5-23	682.87	688.86	682.95	0.1		F4-27	628.88	642.94	629.07	0.2	
277	0.013	8		0.185	28	E5-23	661.00	666.50	661.05	0.1		E5-17	610.54	622.60	610.61	0.1	
669	0.013	8		0.100	17	E5-24	727.73	735.10	727.78	0.0		F5-25	661.21	666.05	661.28	0.1	
199	0.015	8		0.007	138	E6-1	713.28	723.28	713.55	0.3		E6-2	711.87	721.87	712.24	0.4	
206	0.015	8		0.004	147	E6-2	711.87	721.87	712.24	0.4		E6-42	711.10	721.10	711.38	0.3	
506	0.015	8		0.179	253	E6-3	699.90	709.90	700.06	0.2		E6-4	610.87	620.87	611.18	0.3	
505	0.015	8		0.039	418	E6-4	610.87	620.87	611.18	0.3		E6-5	591.00	601.00	591.38	0.4	
249	0.015	10		0.015	433	E6-5	591.00	601.00	591.38	0.4		F6-19	587.30	591.00	587.66	0.4	
222	0.015	8		0.006	159	E6-7	710.13	720.13	710.44	0.3		E6-8	708.80	718.80	709.12	0.3	
256	0.015	8		0.006	166	E6-8	708.80	718.80	709.12	0.3		E6-9	707.37	717.37	707.70	0.3	
205	0.015	8		0.006	174	E6-9	707.37	717.37	707.70	0.3		E6-10	706.08	716.08	706.35	0.3	
324	0.015	8		0.019	194	E6-10	706.08	716.08	706.35	0.3		E6-3	699.90	709.90	700.06	0.2	
290	0.015	8		0.056	38	E6-11	716.10	726.10	716.18	0.1		E6-3	699.90	709.90	700.06	0.2	
429	0.015	8		0.109	149	E6-19	634.00	638.00	634.14	0.1		E6-20	587.39	592.39	587.70	0.3	
349	0.015	8		0.023	319	E6-20	587.39	592.39	587.70	0.3		E6-21	579.51	589.51	579.87	0.4	
471	0.015	8		0.025	417	E6-21	579.51	589.51	579.87	0.4		F6-10	567.47	572.97	567.85	0.4	
447	0.015	8		0.057	83	E6-23	604.91	614.91	605.03	0.1		E6-21	579.51	589.51	579.87	0.4	
344	0.015	8		0.229	156	E6-27	664.94	674.94	665.06	0.1		E6-39	588.10	598.10	588.33	0.2	
36	0.015	8		0.020	168	E6-39	588.10	598.10	588.33	0.2		E6-20	587.39	592.39	587.70	0.3	
121	0.015	8		0.008	152	E6-42	711.10	721.10	711.38	0.3		E6-7	710.13	720.13	710.44	0.3	
464	0.015	12		0.142	1413	F3-1	655.34	660.04	655.70	0.4		F4-4	590.00	598.00	596.30	6.3	SUR
401	0.015	12		0.005	1361	F3-5	657.34	668.74	661.67	4.3	SUR	F3-1	655.34	660.04	655.70	0.4	
249	0.015	12		0.004	1344	F3-6	658.30	664.00	664.00	5.7	SUR	F3-5	657.34	668.74	661.67	4.3	SUR
175	0.015	12		0.003	124	F4-1	484.74	491.24	485.00	0.3		L7-37	484.14	490.84	484.55	0.4	
515	0.015	12		0.008	1353	F4-2	564.00	570.00	570.00	6.0	SUR	T9-3	560.10	570.10	565.24	5.1	SUR
208	0.015	12		0.113	1526	F4-3	587.49	597.99	587.88	0.4		F4-2	564.00	570.00	570.00	6.0	SUR
510	0.015	12		0.005	1478	F4-4	590.00	598.00	596.30	6.3	SUR	F4-3	587.49	597.99	587.88	0.4	
338	0.010	8		0.040	7	F4-5	746.99	757.81	747.02	0.0		E4-15	733.62	741.41	733.78	0.2	
218	0.010	8		0.071	9	F4-6	750.03	755.88	750.06	0.0		E4-16	734.67	740.61	734.80	0.1	
386	0.010	8		0.026	17	F4-7	744.75	752.49	744.81	0.1		E4-16	734.67	740.61	734.80	0.1	
413	0.010	8		0.004	9	F4-8	746.41	752.33	746.48	0.1		F4-7	744.75	752.49	744.81	0.1	
205	0.013	8		0.099	9	F4-16	744.53	753.29	744.56	0.0		F6-19	724.30	737.73	724.36	0.1	
274	0.013	8		0.039	75	F4-26	639.55	646.19	639.67	0.1		F4-27	628.88	642.94	629.07	0.2	
515	0.013	8		0.023	150	F4-27	628.88	642.94	629.07	0.2		F5-27	617.18	624.74	617.41	0.2	
400	0.015	8		0.057	100	F5-10	709.53	719.53	709.66	0.1		F5-11	686.61	696.61	686.79	0.2	
383	0.015	8		0.028	120	F5-11	686.61	696.61	686.79	0.2		G5-20	675.71	685.71	675.91	0.2	
228	0.013	8		0.026	50	F5-15	709.74	720.80	709.86	0.1		F5-16	703.72	710.30	703.79	0.1	
345	0.013	8		0.148	50	F5-16	703.72	710.30	703.79	0.1		F5-17	653.33	659.10	653.54	0.2	
203	0.013	8		0.004	62	F5-17	653.33	659.10	653.54	0.2		F5-19	652.51	662.60	652.64	0.1	
280	0.012	8		0.031	74	F5-19	652.51	662.60	652.64	0.1		F5-20	643.86	652.40	643.94	0.1	
337	0.012	8		0.144	75	F5-20	643.86	652.40	643.94	0.1		E5-19	595.73	603.00	595.88	0.1	
412	0.013	8		0.017	245	F5-21	596.49	604.28	596.77	0.3		F5-23	589.51	598.99	589.74	0.2	
521	0.013	8		0.038	260	F5-23	589.51	598.99	589.74	0.2		F5-24	569.71	577.21	569.97	0.3	
521	0.013	8		0.027	274	F5-24	569.71	577.21	569.97	0.3		G5-24	555.65	561.99	555.90	0.2	
306	0.013	8		0.090	33	F5-25	661.21	666.05	661.28	0.1		F5-26	633.85	658.00	633.92	0.1	
128	0.013	8		0.132	49	F5-26	633.85	658.00	633.92	0.1		F5-27	617.18	624.74	617.41	0.2	
259	0.013	8		0.024	215	F5-27	617.18	624.74	617.41	0.2		F5-31	611.02	619.31	611.24	0.2	
417	0.013	8		0.035	230	F5-31	611.02	619.31	611.24	0.2		F5-21	596.49	604.28	596.77	0.3	
309	0.015	8		0.025	130	F6-1	670.86	678.16	671.05	0.2		G6-28	663.26	669.46	663.56	0.3	

2010 Master Plan Clear Creek Collection System Pipe Analysis Results

LENGTH (ft)	Manning's N	Diameter (in)	Material	Slope	Maximum Flow, gpm	Upstream MH Name	Upstream Invert (ft)	Upstream MH Rim	Maximum Upstream HGL	Upstream Flow Depth, ft	Class	Downstream MH Name	Downstream Invert (ft)	Downstream MH Rim	Maximum Downstream HGL	Downstream Flow Depth, ft	Class
388	0.015	10		0.012	553	F6-2	581.90	586.90	582.36	0.5		F6-3	577.19	587.19	577.64	0.5	
583	0.015	10		0.013	567	F6-3	577.19	587.19	577.64	0.5		F6-4	569.34	579.34	569.79	0.4	
613	0.015	10		0.015	587	F6-4	569.34	579.34	569.79	0.4		F6-5	560.01	570.01	560.47	0.5	
432	0.015	10		0.015	605	F6-5	560.01	570.01	560.47	0.5		F6-6	553.60	563.60	554.17	0.6	
233	0.015	10		0.010	616	F6-6	553.60	563.60	554.17	0.6		F6-7	551.16	561.16	551.52	0.4	
299	0.015	12		0.026	616	F6-7	551.16	561.16	551.52	0.4		F6-8	543.50	549.50	543.90	0.4	
329	0.015	12		0.018	627	F6-8	543.50	549.50	543.90	0.4		F6-9	537.50	543.50	537.96	0.5	
324	0.015	12		0.012	635	F6-9	537.50	543.50	537.96	0.5		F7-3	533.75	537.75	534.29	0.5	
346	0.015	8		0.024	462	F6-10	567.47	572.97	567.85	0.4		F6-11	559.05	564.97	559.47	0.4	
407	0.015	8		0.022	487	F6-11	559.05	564.97	559.47	0.4		F7-1	550.25	585.25	550.66	0.4	
35	0.015	8		0.007	106	F6-15	672.65	678.65	672.88	0.2		V6-1	672.39	680.99	672.72	0.3	
134	0.014	16		0.025	1776	F6-15	587.57	597.57	588.12	0.5		K4-8	584.25	594.25	584.83	0.6	
291	0.015	8		0.005	94	F6-17	673.98	676.48	674.24	0.3		F6-15	672.65	678.65	672.88	0.2	
433	0.013	8		0.040	17	F6-19	724.30	737.73	724.36	0.1		E5-21	707.06	715.23	707.13	0.1	
195	0.015	10		0.028	536	F6-19	587.30	591.00	587.66	0.4		F6-2	581.90	586.90	582.36	0.5	
251	0.015	8		0.025	510	F7-1	550.25	585.25	550.66	0.4		W7-8	543.98	553.98	544.49	0.5	
397	0.015	8		0.022	531	F7-2	542.55	552.55	542.98	0.4		F7-3	533.75	537.75	534.29	0.5	
443	0.014	15		0.013	1180	F7-3	533.75	537.75	534.29	0.5		F7-4	528.00	533.00	528.63	0.6	
397	0.014	15		0.008	1195	F7-4	528.00	533.00	528.63	0.6		F7-5	524.83	528.83	525.43	0.6	
327	0.014	15		0.013	1428	F7-5	524.83	528.83	525.43	0.6		G7-8	520.48	529.78	520.60	0.1	
108	0.014	27		0.005	9948	F7-7	480.81	490.81	485.52	4.7	SUR	L7-57	480.25	490.25	484.87	4.6	SUR
305	0.015	6		0.137	224	F7-19	566.08	576.08	566.26	0.2		F7-5	524.83	528.83	525.43	0.6	SUR
519	0.014	12		0.012	1110	G4-5	510.76	515.86	515.86	5.1	SUR	X8-30	504.46	512.96	512.96	8.5	SUR
168	0.015	12		0.079	1515	G4-6	524.00	529.00	524.43	0.4		G4-5	510.76	515.86	515.86	5.1	SUR
399	0.015	12		0.040	1506	G4-7	540.00	547.00	540.56	0.6		G4-6	524.00	529.00	524.43	0.4	
404	0.015	12		0.034	1474	G4-8	553.62	560.02	554.17	0.5		G4-7	540.00	547.00	540.56	0.6	
239	0.015	12		0.005	1451	G4-9	554.87	561.97	557.68	2.8	SUR	G4-8	553.62	560.02	554.17	0.5	
245	0.015	12		0.005	1416	G4-10	556.10	565.10	560.24	4.1	SUR	G4-9	554.87	561.97	557.68	2.8	SUR
416	0.015	8		0.007	115	G5-1	506.85	516.85	507.10	0.2		G5-2	504.00	514.00	506.20	2.2	SUR
244	0.015	8		0.007	138	G5-2	504.00	514.00	506.20	2.2	SUR	H5-5	502.23	512.23	506.01	3.8	SUR
398	0.015	8		0.005	5	G5-3	508.60	518.60	508.66	0.1		G5-4	506.60	516.60	507.11	0.5	
369	0.015	8		0.012	8	G5-3	508.60	518.60	508.66	0.1		G5-2	504.00	514.00	506.20	2.2	SUR
255	0.015	8		0.006	22	G5-4	506.60	516.60	507.11	0.5		G5-5	505.07	512.77	507.12	2.1	SUR
408	0.015	8		0.021	362	G5-5	505.07	512.77	507.12	2.1	SUR	H5-22	496.50	506.70	504.72	8.2	SUR
361	0.013	8		0.039	331	G5-6	519.00	535.00	519.26	0.3		G5-5	505.07	512.77	507.12	2.1	SUR
443	0.015	10		0.020	485	G5-8	510.75	517.15	511.12	0.4		H5-31	501.75	508.05	503.90	2.1	SUR
199	0.015	10		0.016	473	G5-9	514.00	522.50	514.39	0.4		G5-8	510.75	517.15	511.12	0.4	
340	0.015	10		0.072	452	G5-10	538.37	548.37	538.62	0.3		G5-9	514.00	522.50	514.39	0.4	
269	0.015	10		0.055	395	G5-11	555.83	565.83	556.08	0.3		G5-14	541.18	551.18	541.52	0.3	
264	0.015	8		0.053	169	G5-12	596.10	602.10	596.28	0.2		G6-48	582.10	588.00	582.27	0.2	
356	0.015	8		0.062	22	G5-13	617.98	627.98	618.04	0.1		G5-12	596.10	602.10	596.28	0.2	
59	0.015	8		0.048	449	G5-14	541.18	551.18	541.52	0.3		G5-10	538.37	548.37	538.62	0.3	
358	0.015	8		0.229	51	G5-15	621.00	626.00	621.07	0.1		G5-14	541.18	551.18	541.52	0.3	
303	0.015	8		0.018	127	G5-20	675.71	685.71	675.91	0.2		G5-21	670.37	680.37	670.60	0.2	
291	0.015	8		0.019	133	G5-21	670.37	680.37	670.60	0.2		W7-5	664.70	671.70	664.81	0.1	
63	0.015	12		0.008	68	G5-22	490.22	500.22	490.38	0.2		L7-3	489.72	499.72	489.92	0.2	
395	0.013	8		0.034	331	G5-23	532.59	538.65	532.86	0.3		G5-6	519.00	535.00	519.26	0.3	
238	0.013	8		0.033	289	G5-24	555.65	561.99	555.90	0.2		G5-25	547.81	554.21	548.07	0.3	
401	0.013	8		0.030	303	G5-25	547.81	554.21	548.07	0.3		G5-26	535.90	542.44	536.24	0.3	
209	0.013	8		0.016	317	G5-26	535.90	542.44	536.24	0.3		G5-23	532.59	538.65	532.86	0.3	
188	0.015	6		0.165	68	G6-5	655.27	665.27	655.37	0.1		G6-51	624.80	634.80	624.88	0.1	
191	0.015	8		0.024	100	G6-6	501.16	506.16	501.33	0.2		G6-7	496.57	502.57	496.87	0.3	
585	0.015	8		0.004	110	G6-7	496.57	502.57	496.87	0.3		H6-23	493.99	500.99	494.21	0.2	

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438	0.015	8		0.012	26	G6-8	667.54	674.24	667.64	0.1		G6-24	662.27	671.27	662.68	0.4	
218	0.015	6		0.093	14	G6-13	559.10	569.10	559.15	0.0		G6-14	538.95	548.95	539.07	0.1	
284	0.015	6		0.124	93	G6-14	538.95	548.95	539.07	0.1		G6-15	504.00	510.00	504.17	0.2	
151	0.015	8		0.019	94	G6-15	504.00	510.00	504.17	0.2		G6-6	501.16	506.16	501.33	0.2	
360	0.015	10		0.031	383	G6-20	566.85	573.05	567.15	0.3		G5-11	555.83	565.83	556.08	0.3	
461	0.015	8		0.177	197	G6-21	647.30	664.70	647.44	0.1		G6-20	566.85	573.05	567.15	0.3	
222	0.015	8		0.005	17	G6-22	648.37	653.97	648.47	0.1		G6-21	647.30	664.70	647.44	0.1	
289	0.015	8		0.048	175	G6-23	661.25	674.85	661.45	0.2		G6-21	647.30	664.70	647.44	0.1	
257	0.015	8		0.004	170	G6-24	662.27	671.27	662.68	0.4		G6-23	661.25	674.85	661.45	0.2	
207	0.015	8		0.005	136	G6-28	663.26	669.46	663.56	0.3		G6-24	662.27	671.27	662.68	0.4	
238	0.015	8		0.064	173	G6-48	582.10	588.00	582.27	0.2		G6-20	566.85	573.05	567.15	0.3	
229	0.015	6		0.405	76	G6-51	624.80	634.80	624.88	0.1		G6-14	538.95	548.95	539.07	0.1	
262	0.014	15		0.005	1440	G7-8	519.78	529.78	520.60	0.8		G7-9	518.48	527.50	519.35	0.9	
425	0.014	15		0.005	1453	G7-9	518.48	527.50	519.35	0.9		G7-10	516.25	526.25	516.79	0.5	
406	0.014	15		0.020	1462	G7-10	516.25	526.25	516.79	0.5		G7-11	508.00	514.00	508.70	0.7	
248	0.014	15		0.009	1469	G7-11	508.00	514.00	508.70	0.7		G7-12	505.69	515.69	506.28	0.6	
231	0.014	15		0.017	1619	G7-12	505.69	515.69	506.28	0.6		G7-13	501.66	511.66	502.25	0.6	
397	0.014	15		0.018	1624	G7-13	501.66	511.66	502.25	0.6		G7-22	494.71	499.71	498.90	4.2	SUR
206	0.015	8		0.021	147	G7-18	510.00	520.00	510.21	0.2		G7-12	505.69	515.69	506.28	0.6	
312	0.015	8		0.149	143	G7-19	555.98	565.98	556.11	0.1		G7-18	510.00	520.00	510.21	0.2	
424	0.015	8		0.017	133	G7-20	563.03	573.03	563.26	0.2		G7-19	555.98	565.98	556.11	0.1	
287	0.015	8		0.273	65	G7-21	638.75	648.75	638.83	0.1		G7-20	563.03	573.03	563.26	0.2	
313	0.014	15		0.018	2133	G7-22	494.71	499.71	498.90	4.2	SUR	H7-9	489.05	499.05	497.11	8.1	SUR
458	0.015	6		0.261	8	G7-37	631.86	641.86	631.89	0.0		G7-10	516.25	526.25	516.79	0.5	SUR
238	0.015	8		0.020	63	G7-38	567.73	577.73	567.87	0.1		G7-20	563.03	573.03	563.26	0.2	
293	0.015	8		0.018	483	G7-46	500.09	505.59	500.69	0.6		G7-22	494.71	499.71	498.90	4.2	SUR
360	0.015	8		0.034	433	G7-47	512.34	516.84	512.67	0.3		G7-46	500.09	505.59	500.69	0.6	
416	0.015	8		0.015	420	G7-48	518.62	526.62	519.07	0.4		G7-47	512.34	516.84	512.67	0.3	
431	0.015	8		0.007	402	G7-49	521.51	527.51	522.30	0.8	SUR	G7-48	518.62	526.62	519.07	0.4	
178	0.015	8		0.004	156	G8-29	640.02	646.02	640.35	0.3		G9-9	639.22	645.52	639.63	0.4	
318	0.015	8		0.013	142	G8-30	644.01	652.01	644.25	0.2		G8-29	640.02	646.02	640.35	0.3	
156	0.015	8		0.022	121	G8-31	647.44	654.04	647.63	0.2		G8-30	644.01	652.01	644.25	0.2	
334	0.015	8		0.013	81	G8-32	651.92	658.02	652.09	0.2		G8-31	647.44	654.04	647.63	0.2	
267	0.015	8		0.011	38	G8-33	654.80	663.00	654.93	0.1		G8-32	651.92	658.02	652.09	0.2	
103	0.015	8		0.152	35	G8-34	670.30	676.70	670.36	0.1		G8-33	654.80	663.00	654.93	0.1	
206	0.015	8		0.108	33	G8-35	674.00	681.00	674.07	0.1		G8-32	651.92	658.02	652.09	0.2	
359	0.015	8		0.055	16	G8-55	667.12	672.92	667.18	0.1		G8-31	647.44	654.04	647.63	0.2	
190	0.015	8		0.035	24	G8-60	646.01	654.20	646.09	0.1		G9-9	639.39	645.52	639.63	0.2	
397	0.015	8		0.004	442	G9-3	632.72	638.12	634.81	2.1	SUR	H9-53	630.95	636.65	631.45	0.5	
80	0.015	8		0.004	270	G9-6	633.52	638.02	635.07	1.5	SUR	G9-3	633.23	638.12	634.81	1.6	SUR
499	0.015	8		0.004	263	G9-7	635.49	639.49	636.61	1.1	SUR	G9-6	633.52	638.02	635.07	1.5	SUR
426	0.015	8		0.004	244	G9-8	637.19	644.99	637.66	0.5		G9-7	635.49	639.49	636.61	1.1	SUR
512	0.015	8		0.004	207	G9-9	639.22	645.52	639.63	0.4		G9-8	637.19	644.99	637.66	0.5	
185	0.015	8		0.012	106	G9-15	626.91	638.91	627.11	0.2		H9-29	624.67	634.67	624.88	0.2	
192	0.015	8		0.097	102	G9-16	645.50	655.50	645.62	0.1		G9-15	626.91	638.91	627.11	0.2	
36	0.015	8		0.039	83	G9-17	646.90	656.90	647.04	0.1		G9-16	645.50	655.50	645.62	0.1	
244	0.015	8		0.009	15	G9-19	647.60	657.60	647.68	0.1		G9-16	645.50	655.50	645.62	0.1	
296	0.015	8		0.008	82	G9-25	649.33	659.33	649.54	0.2		G9-17	646.90	656.90	647.04	0.1	
172	0.015	8		0.010	175	G9-30	634.40	644.40	635.00	0.6		G9-3	632.72	638.12	634.81	2.1	SUR
1012	0.015	10		0.002	100	H4-1	501.29	512.00	507.63	6.3	SUR	H4-11	499.07	510.37	507.52	8.5	SUR
503	0.015	10		0.002	150	H4-11	499.07	510.37	507.52	8.5	SUR	H4-12	498.22	507.82	507.35	9.1	SUR
266	0.015	10		0.004	171	H4-12	498.22	507.82	507.35	9.1	SUR	H4-36	497.28	508.58	507.27	10.0	SUR
310	0.015	8		0.011	22	H4-13	501.59	508.79	507.35	5.8	SUR	H4-12	498.22	507.82	507.35	9.1	SUR

2010 Master Plan Clear Creek Collection System Pipe Analysis Results

LENGTH (ft)	Manning's N	Diameter (in)	Material	Slope	Maximum Flow, gpm	Upstream MH Name	Upstream Invert (ft)	Upstream MH Rim	Maximum Upstream HGL	Upstream Flow Depth, ft	Class	Downstream MH Name	Downstream Invert (ft)	Downstream MH Rim	Maximum Downstream HGL	Downstream Flow Depth, ft	Class
410	0.015	8		0.005	78	H4-21	500.10	507.00	506.22	6.1	SUR	H4-22	498.01	507.31	506.21	8.2	SUR
331	0.015	8		0.006	106	H4-22	498.01	507.31	506.21	8.2	SUR	H4-24	496.06	506.16	506.16	10.1	SUR
499	0.014	15		0.002	1128	H4-23	497.13	507.13	507.08	10.0	SUR	H4-24	496.06	506.16	506.16	10.1	SUR
474	0.014	15		0.001	1110	H4-24	496.06	506.16	506.16	10.1	SUR	H4-34	495.44	508.34	505.85	10.4	SUR
363	0.015	8		0.014	61	H4-26	503.12	511.22	506.22	3.1	SUR	H4-22	498.01	507.31	506.21	8.2	SUR
350	0.015	8		0.006	41	H4-32	502.86	509.86	506.24	3.4	SUR	H4-33	500.86	508.26	506.23	5.4	SUR
303	0.015	8		0.009	67	H4-33	500.86	508.26	506.23	5.4	SUR	H4-22	498.01	507.31	506.21	8.2	SUR
488	0.014	15		0.001	1119	H4-34	495.44	508.34	505.85	10.4	SUR	H5-10	494.82	506.62	505.51	10.7	SUR
649	0.015	12		0.004	1048	H4-35	499.58	511.88	510.21	10.6	SUR	H4-36	497.28	508.58	507.27	10.0	SUR
114	0.014	15		0.001	1116	H4-36	497.28	508.58	507.27	10.0	SUR	H4-23	497.13	507.13	507.08	10.0	SUR
417	0.015	8		0.010	40	H5-1	505.00	510.50	506.38	1.4	SUR	H4-33	500.86	508.26	506.23	5.4	SUR
404	0.015	8		0.018	35	H5-2	505.00	515.00	505.80	0.8	SUR	H5-3	497.71	509.61	505.81	8.1	SUR
173	0.015	6		0.006	27	H5-2	505.99	515.00	505.80	-0.2		H5-1	505.00	510.50	506.38	1.4	SUR
321	0.015	8		0.005	78	H5-3	497.71	509.61	505.81	8.1	SUR	H5-6	496.23	507.53	505.79	9.6	SUR
172	0.015	6		0.026	15	H5-4	502.20	510.00	505.81	3.6	SUR	H5-3	497.71	509.61	505.81	8.1	SUR
241	0.015	8		0.025	140	H5-5	502.23	512.23	506.01	3.8	SUR	H5-6	496.23	507.53	505.79	9.6	SUR
449	0.015	8		0.005	183	H5-6	496.23	507.53	505.79	9.6	SUR	H5-7	494.10	509.00	505.11	11.0	SUR
355	0.014	15		0.001	1192	H5-7	494.10	509.00	505.11	11.0	SUR	H5-11	493.65	509.65	504.68	11.0	SUR
284	0.014	15		0.002	1131	H5-8	494.57	507.67	505.35	10.8	SUR	H5-7	494.10	509.00	505.11	11.0	SUR
191	0.014	15		0.001	1128	H5-10	494.82	506.62	505.51	10.7	SUR	H5-8	494.57	507.67	505.35	10.8	SUR
320	0.014	15		0.001	1206	H5-11	493.65	509.65	504.68	11.0	SUR	H5-18	493.23	508.13	504.27	11.0	SUR
399	0.015	8		0.011	32	H5-12	498.23	507.13	504.67	6.4	SUR	H5-11	493.65	509.65	504.68	11.0	SUR
286	0.014	15		0.002	1222	H5-18	493.23	508.13	504.27	11.0	SUR	H5-20	492.76	507.06	503.88	11.1	SUR
433	0.014	15		0.000	1246	H5-20	492.76	507.06	503.88	11.1	SUR	H5-21	492.55	506.05	503.26	10.7	SUR
56	0.014	15		0.001	1472	H5-21	492.55	506.05	503.26	10.7	SUR	H5-26	492.50	505.57	503.11	10.6	SUR
217	0.015	8		0.018	389	H5-22	496.50	506.70	504.72	8.2	SUR	H5-21	492.05	506.05	503.26	11.2	SUR
462	0.014	15		0.002	1780	H5-23	491.37	502.00	502.00	10.6	SUR	H5-24	490.45	501.05	500.38	9.9	SUR
566	0.014	15		0.001	1788	H5-24	490.45	501.05	500.38	9.9	SUR	H5-25	489.62	503.02	498.38	8.8	SUR
531	0.014	15		0.001	1803	H5-25	489.62	503.02	498.38	8.8	SUR	H6-21	488.85	498.85	496.44	7.6	SUR
370	0.014	15		0.003	1476	H5-26	492.50	505.57	503.11	10.6	SUR	H5-23	491.37	502.00	502.00	10.6	SUR
201	0.015	8		0.021	40	H5-28	496.96	505.26	503.88	6.9	SUR	H5-20	492.76	507.06	503.88	11.1	SUR
428	0.015	10		0.024	504	H5-31	501.75	508.05	503.90	2.1	SUR	H5-23	491.37	502.00	502.00	10.6	SUR
141	0.015	8		0.030	11	H6-1	491.16	496.66	491.22	0.1		H6-2	486.94	496.94	491.29	4.4	SUR
279	0.014	15		0.003	169	H6-2	486.94	496.94	491.29	4.4	SUR	H6-22	486.24	493.96	491.26	5.0	SUR
499	0.015	8		0.010	25	H6-4	490.69	498.19	490.79	0.1		H6-5	485.79	495.35	490.64	4.8	SUR
327	0.014	18		0.003	2131	H6-5	485.21	495.35	490.64	5.4	SUR	H6-8	484.35	495.35	490.00	5.6	SUR
507	0.015	8		0.004	140	H6-7	487.24	497.24	494.43	7.2	SUR	H6-8	485.19	495.35	490.00	4.8	SUR
174	0.014	18		0.004	2194	H6-8	484.35	495.35	490.00	5.6	SUR	H6-11	483.73	498.98	489.64	5.9	SUR
197	0.014	18		0.002	2234	H6-11	483.73	498.98	489.64	5.9	SUR	H6-15	483.25	501.85	489.24	6.0	SUR
337	0.015	8		0.003	55	H6-14	484.00	497.40	488.19	4.2	SUR	H6-17	483.00	492.64	488.16	5.2	SUR
318	0.014	18		0.002	2239	H6-15	483.25	501.85	489.24	6.0	SUR	H6-16	482.55	496.05	488.58	6.0	SUR
188	0.014	18		0.005	2254	H6-16	482.55	496.05	488.58	6.0	SUR	H6-17	481.64	492.64	488.16	6.5	SUR
371	0.014	18		0.004	2291	H6-17	481.64	492.64	488.16	6.5	SUR	H6-42	480.23	495.03	487.34	7.1	SUR
468	0.014	15		0.002	1872	H6-19	487.23	497.23	493.18	5.9	SUR	H6-22	486.30	493.96	491.26	5.0	SUR
402	0.014	15		0.002	1857	H6-20	488.03	498.03	494.82	6.8	SUR	H6-19	487.23	497.23	493.18	5.9	SUR
209	0.014	15		0.002	1809	H6-21	488.85	498.85	496.44	7.6	SUR	H6-31	488.43	499.43	495.65	7.2	SUR
330	0.014	18		0.003	2105	H6-22	486.24	493.96	491.26	5.0	SUR	H6-5	485.21	495.35	490.64	5.4	SUR
578	0.015	8		0.012	124	H6-23	493.99	500.99	494.21	0.2		H6-22	486.89	493.96	491.26	4.4	SUR
97	0.014	15		0.002	176	H6-25	487.12	497.12	491.31	4.2	SUR	H6-2	486.94	496.94	491.29	4.4	SUR
448	0.015	6		0.004	52	H6-28	490.33	500.33	495.88	5.6	SUR	H6-31	488.43	499.43	495.65	7.2	SUR
204	0.014	15		0.002	1852	H6-31	488.43	499.43	495.65	7.2	SUR	H6-20	488.03	498.03	494.82	6.8	SUR
21	0.015	6		0.004	35	H6-35	489.41	497.68	489.61	0.2		H6-37	489.33	497.68	489.59	0.3	
191	0.015	6		0.025	79	H6-37	489.33	497.68	489.59	0.3		H6-11	484.60	498.98	489.64	5.0	SUR

2010 Master Plan Clear Creek Collection System Pipe Analysis Results

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375	0.015	10		0.006	175	H6-39	489.27	494.27	494.27	5.0	SUR	H6-25	487.12	497.12	491.31	4.2	SUR
379	0.014	18		0.001	2304	H6-42	480.23	495.03	487.34	7.1	SUR	H7-5	480.03	495.33	486.57	6.5	SUR
404	0.014	18		0.002	4517	H7-5	480.03	495.33	486.57	6.5	SUR	SA8-2	479.20	489.20	483.13	3.9	SUR
577	0.014	15		0.007	2197	H7-7	484.24	494.24	494.24	10.0	SUR	H7-5	479.97	495.33	486.57	6.6	SUR
593	0.014	15		0.005	2142	H7-9	489.05	499.05	497.11	8.1	SUR	H7-10	486.04	496.04	493.68	7.6	SUR
616	0.014	15		0.003	2174	H7-10	486.04	496.04	493.68	7.6	SUR	H7-7	484.24	494.24	494.24	10.0	SUR
436	0.015	8		0.024	362	H8-15	531.99	535.99	532.32	0.3		G7-49	521.51	527.51	522.30	0.8	SUR
330	0.015	8		0.010	51	H9-1	612.62	622.62	612.77	0.2		J9-19	609.35	619.35	609.48	0.1	
240	0.015	10		0.003	710	H9-8	599.84	609.84	606.49	6.7	SUR	H10-1	599.13	609.13	604.85	5.7	SUR
413	0.015	10		0.007	694	H9-9	602.90	612.90	609.23	6.3	SUR	H9-8	599.84	609.84	606.49	6.7	SUR
330	0.015	10		0.008	676	H9-10	605.68	615.68	611.30	5.6	SUR	H9-9	602.90	612.90	609.23	6.3	SUR
279	0.015	10		0.008	526	H9-11	608.05	618.05	612.36	4.3	SUR	H9-10	605.68	615.68	611.30	5.6	SUR
306	0.015	10		0.008	517	H9-12	610.42	620.42	613.46	3.0	SUR	H9-11	608.05	618.05	612.36	4.3	SUR
152	0.015	10		0.007	499	H9-13	611.48	621.48	613.98	2.5	SUR	H9-12	610.42	620.42	613.46	3.0	SUR
278	0.015	10		0.044	15	H9-14	622.75	632.75	622.80	0.1		H9-12	610.42	620.42	613.46	3.0	SUR
171	0.015	8		0.037	151	H9-19	612.00	622.00	612.19	0.2		H9-10	605.68	615.68	611.30	5.6	SUR
119	0.015	8		0.040	36	H9-20	616.75	626.75	616.84	0.1		H9-19	612.00	622.00	612.19	0.2	
26	0.015	8		0.079	111	H9-27	620.25	630.25	620.38	0.1		H9-28	618.22	628.22	618.37	0.1	
136	0.015	8		0.046	113	H9-28	618.22	628.22	618.37	0.1		H9-19	612.00	622.00	612.19	0.2	
75	0.015	8		0.012	107	H9-29	624.67	634.67	624.88	0.2		H9-30	623.75	633.75	623.94	0.2	
145	0.015	8		0.024	110	H9-30	623.75	633.75	623.94	0.2		H9-27	620.25	630.25	620.38	0.1	
97	0.015	8		0.008	56	H9-40	603.65	613.65	609.23	5.6	SUR	H9-9	602.90	612.90	609.23	6.3	SUR
32	0.015	10		0.007	482	H9-49	611.71	621.71	614.08	2.4	SUR	H9-13	611.48	621.48	613.98	2.5	SUR
78	0.015	8		0.007	478	H9-50	612.30	620.50	614.88	2.6	SUR	H9-49	611.71	621.71	614.08	2.4	SUR
413	0.015	10		0.008	475	H9-51	615.53	622.03	616.08	0.5		H9-50	612.30	620.50	614.88	2.6	SUR
445	0.015	8		0.029	461	H9-52	628.56	637.96	628.92	0.4		H9-51	615.53	622.03	616.08	0.5	
172	0.015	8		0.014	461	H9-53	630.95	636.65	631.45	0.5		H9-52	628.56	637.96	628.92	0.4	
344	0.015	10		0.003	743	H10-1	599.13	609.13	604.85	5.7	SUR	H10-2	597.97	607.97	602.22	4.3	SUR
21	0.015	8		0.004	40	H10-1	600.47	610.47	604.84	4.4	SUR	H10-1	600.38	609.13	604.85	4.5	SUR
239	0.015	10		0.004	753	H10-2	597.97	607.97	602.22	4.3	SUR	H10-3	597.10	607.10	600.34	3.2	SUR
98	0.015	10		0.004	772	H10-3	597.10	607.10	600.34	3.2	SUR	H10-62	596.69	606.69	599.54	2.9	SUR
322	0.015	8		0.002	24	H10-4	597.84	604.24	600.55	2.7	SUR	H10-3	597.10	607.10	600.34	3.2	SUR
365	0.015	8		0.039	49	H10-20	634.25	639.65	634.35	0.1		H10-22	619.89	625.59	620.06	0.2	
230	0.015	8		0.005	51	H10-22	619.89	625.59	620.06	0.2		J10-22	618.67	633.27	618.91	0.2	
160	0.015	10		0.003	774	H10-62	596.69	606.69	599.54	2.9	SUR	J10-21	596.27	604.78	598.23	2.0	SUR
426	0.015	8		0.004	76	J2-14	664.42	669.42	664.65	0.2		K2-2	662.70	670.70	662.94	0.2	
371	0.015	6		0.005	119	J3-4	712.74	722.74	713.07	0.3		J3-5	710.95	720.95	711.29	0.3	
174	0.015	6		0.007	126	J3-5	710.95	720.95	711.29	0.3		K3-1	709.80	719.80	710.00	0.2	
334	0.015	8		0.100	22	J3-14	692.28	702.28	692.34	0.1		J3-21	659.07	669.07	659.25	0.2	
400	0.015	8		0.022	95	J3-20	667.83	677.83	668.00	0.2		J3-21	650.07	669.07	659.25	9.2	SUR
269	0.015	8		0.037	144	J3-21	659.07	669.07	659.25	0.2		J3-26	649.02	659.02	649.19	0.2	
376	0.015	8		0.053	152	J3-26	649.02	659.02	649.19	0.2		J3-29	629.09	639.09	629.29	0.2	
363	0.015	8		0.033	169	J3-29	629.09	639.09	629.29	0.2		J3-33	617.11	627.11	617.30	0.2	
250	0.015	8		0.113	283	J3-33	617.11	627.11	617.30	0.2		J3-35	589.12	592.12	589.39	0.3	
303	0.015	8		0.030	285	J3-35	589.12	592.12	589.39	0.3		J4-1	580.00	590.00	580.62	0.6	
119	0.015	6		0.155	13	J3-36	647.38	657.38	647.42	0.0		J3-29	629.09	639.09	629.29	0.2	
250	0.015	6		0.048	98	J3-38	629.08	639.08	629.23	0.2		J3-33	617.11	627.11	617.30	0.2	
292	0.015	6		0.005	7	J3-40	627.00	635.00	627.08	0.1		J4-37	625.48	632.00	625.53	0.1	
92	0.015	6		0.076	5	J3-50	633.95	643.96	633.98	0.0		J3-40	627.00	635.00	627.08	0.1	
380	0.014	16		0.023	2077	J4-1	580.00	590.00	580.62	0.6		J4-7	571.22	574.66	571.81	0.6	
137	0.014	16		0.004	1786	J4-2	580.50	589.57	581.54	1.0		J4-1	580.00	590.00	580.62	0.6	
151	0.014	16		0.023	2097	J4-4	552.00	565.00	552.61	0.6		J4-63	548.50	565.00	549.32	0.8	
140	0.014	16		0.050	2095	J4-5	559.00	570.00	559.50	0.5		J4-4	552.00	565.00	552.61	0.6	

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LENGTH (ft)	Manning's N	Diameter (in)	Material	Slope	Maximum Flow, gpm	Upstream MH Name	Upstream Invert (ft)	Upstream MH Rim	Maximum Upstream HGL	Upstream Flow Depth, ft	Class	Downstream MH Name	Downstream Invert (ft)	Downstream MH Rim	Maximum Downstream HGL	Downstream Flow Depth, ft	Class
111	0.014	16		0.036	2091	J4-6	566.00	575.00	566.54	0.5		J4-64	562.00	575.00	562.55	0.5	
179	0.014	16		0.029	2087	J4-7	571.22	574.66	571.81	0.6		J4-6	566.00	575.00	566.54	0.5	
209	0.014	16		0.031	2100	J4-11	547.00	560.00	547.57	0.6		J4-71	540.59	552.00	541.21	0.6	
210	0.015	8		0.127	6	J4-13	567.03	571.50	567.06	0.0		J4-71	540.59	552.00	541.21	0.6	
239	0.015	6		0.083	10	J4-16	598.67	608.67	598.71	0.0		J4-19	578.89	588.89	579.11	0.2	
84	0.013	16		0.008	2217	J4-17	529.34	536.00	530.18	0.8		J4-67	528.37	540.08	529.56	1.2	
155	0.015	6		0.246	4	J4-18	597.04	607.04	597.06	0.0		J4-24	560.04	570.04	560.41	0.4	
241	0.015	8		0.049	238	J4-19	578.89	588.89	579.11	0.2		J4-62	567.12	577.12	567.60	0.5	
88	0.014	21		0.008	2555	J4-20	528.37	538.77	529.19	0.8		J4-21	527.70	533.70	528.63	0.9	
367	0.014	20		0.006	2617	J4-21	527.70	533.70	528.63	0.9		J4-31	525.60	530.80	526.89	1.3	
315	0.015	8		0.053	332	J4-22	499.73	555.18	545.43	45.7	SUR	J4-20	528.37	538.77	529.19	0.8	SUR
102	0.015	8		0.112	328	J4-23	556.61	566.61	556.82	0.2		J4-22	545.18	555.18	545.43	0.3	
175	0.015	8		0.020	325	J4-24	560.04	570.04	560.41	0.4		J4-23	556.61	566.61	556.82	0.2	
48	0.015	8		0.131	317	J4-25	566.25	576.25	566.45	0.2		J4-24	560.04	570.04	560.41	0.4	
145	0.015	6		0.012	76	J4-26	567.95	577.95	568.15	0.2		J4-25	566.25	576.25	566.45	0.2	
144	0.015	6		0.005	74	J4-27	568.65	578.65	568.92	0.3		J4-26	567.95	577.95	568.15	0.2	
40	0.015	6		0.010	72	J4-28	569.05	579.05	569.25	0.2		J4-27	568.65	578.65	568.92	0.3	
111	0.015	6		0.127	70	J4-29	593.15	603.15	593.25	0.1		J4-60	579.20	589.20	579.31	0.1	
229	0.015	6		0.026	68	J4-30	599.00	609.00	599.16	0.2		J4-29	593.15	603.15	593.25	0.1	
357	0.013	20		0.006	3526	J4-31	525.60	530.80	526.89	1.3		J4-68	523.32	531.59	527.70	4.4	SUR
222	0.015	6		0.056	39	J4-33	535.70	548.70	535.79	0.1		J4-68	523.32	531.59	527.70	4.4	SUR
197	0.015	8		0.149	102	J4-34	558.26	565.00	558.37	0.1		J4-17	529.34	536.00	530.18	0.8	SUR
424	0.015	6		0.051	24	J4-35	579.91	584.47	579.98	0.1		J4-34	558.26	565.00	558.37	0.1	
311	0.015	6		0.068	18	J4-36	601.06	605.57	601.12	0.1		J4-35	579.91	584.47	579.98	0.1	
349	0.015	6		0.070	13	J4-37	625.48	632.00	625.53	0.1		J4-36	601.06	605.57	601.12	0.1	
451	0.015	6		0.003	23	J4-42	565.00	575.00	565.15	0.1		J4-43	563.50	574.63	563.68	0.2	
392	0.015	8		0.013	73	J4-43	563.50	574.63	563.68	0.2		J4-34	558.26	565.00	558.37	0.1	
246	0.015	6		0.024	65	J4-46	604.84	614.84	604.99	0.1		J4-30	599.00	609.00	599.16	0.2	
236	0.015	8		0.004	31	J4-49	564.56	572.00	564.70	0.1		J4-43	563.50	574.63	563.68	0.2	
103	0.015	6		0.099	71	J4-60	579.20	589.20	579.31	0.1		J4-28	569.05	579.05	569.25	0.2	
188	0.015	8		0.005	240	J4-62	567.12	577.12	567.60	0.5		J4-25	566.25	576.25	566.45	0.2	
116	0.014	16		0.013	2098	J4-63	548.50	565.00	549.32	0.8		J4-11	547.00	560.00	547.57	0.6	
65	0.015	16		0.046	2092	J4-64	562.00	575.00	562.55	0.5		J4-5	559.00	570.00	559.50	0.5	
41	0.013	16		0.007	2217	J4-67	528.67	540.08	529.56	0.9		J4-20	528.37	538.77	529.19	0.8	
68	0.014	18		0.131	3738	J4-68	523.32	531.59	527.70	4.4	SUR	MSLSWW	514.25				
113	0.014	16		0.009	2112	J4-70	530.39	533.21	531.20	0.8		J4-17	529.34	536.00	530.18	0.8	
402	0.014	15		0.025	2112	J4-71	540.59	552.00	541.21	0.6		J4-70	530.39	533.21	531.20	0.8	
149	0.014	15		0.001	1850	J5-1	568.26	578.26	578.26	10.0	SUR	J5-2	568.10	578.10	576.90	8.8	SUR
343	0.014	15		0.001	1669	J5-2	568.10	578.10	576.90	8.8	SUR	J5-37	567.75	577.75	575.22	7.5	SUR
430	0.015	6		0.016	11	J5-4	579.00	589.00	579.07	0.1		J5-37	572.00	582.00	572.13	0.1	
194	0.015	6		0.031	41	J5-5	580.00	590.00	580.11	0.1		J5-9	574.00	584.00	574.13	0.1	
448	0.015	6		0.006	5	J5-6	574.00	584.00	574.06	0.1		J5-7	571.50	581.50	571.70	0.2	
198	0.015	6		0.003	30	J5-7	571.50	581.50	571.70	0.2		J5-14	571.00	581.00	571.15	0.2	
397	0.015	6		0.006	5	J5-8	574.00	584.00	574.06	0.1		J5-7	571.50	581.50	571.70	0.2	
198	0.015	6		0.027	53	J5-9	574.00	584.00	574.13	0.1		J5-16	568.70	578.70	568.96	0.3	
337	0.015	6		0.010	7	J5-10	577.50	587.50	577.56	0.1		J5-9	574.00	584.00	574.13	0.1	
282	0.015	6		0.039	9	J5-11	578.00	583.70	578.05	0.0		J5-17	567.00	577.00	567.26	0.3	
189	0.015	6		0.010	32	J5-13	580.64	585.14	580.77	0.1		J5-20	578.77	579.81	578.91	0.1	
530	0.014	15		0.001	1598	J5-14	567.34	577.34	577.34	10.0	SUR	J5-15	566.82	576.82	569.96	3.1	SUR
588	0.015	8		0.004	34	J5-14	571.00	581.00	571.15	0.2		J5-16	568.70	578.70	568.96	0.3	
534	0.014	15		0.002	1488	J5-15	566.82	576.82	569.96	3.1	SUR	J5-18	566.00	576.00	567.24	1.2	
473	0.015	8		0.004	90	J5-16	568.70	578.70	568.96	0.3		J5-17	567.00	577.00	567.26	0.3	
203	0.015	8		0.005	107	J5-17	567.00	577.00	567.26	0.3		J5-24	566.00	576.00	566.62	0.6	

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LENGTH (ft)	Manning's N	Diameter (in)	Material	Slope	Maximum Flow, gpm	Upstream MH Name	Upstream Invert (ft)	Upstream MH Rim	Maximum Upstream HGL	Upstream Flow Depth, ft	Class	Downstream MH Name	Downstream Invert (ft)	Downstream MH Rim	Maximum Downstream HGL	Downstream Flow Depth, ft	Class
201	0.014	15		0.001	1477	J5-18	566.00	576.00	567.24	1.2		J5-24	565.71	575.71	566.60	0.9	
298	0.015	6		0.027	5	J5-19	575.00	571.50	575.04	0.0		J5-17	567.00	577.00	567.26	0.3	
199	0.015	6		0.012	37	J5-20	578.77	579.81	578.91	0.1		J5-26	576.32	586.32	576.41	0.1	
361	0.015	6		0.004	22	J5-21	576.40	586.40	576.55	0.2		J5-31	575.00	585.00	575.11	0.1	
474	0.015	8		0.013	36	J5-22	572.00	582.00	572.12	0.1		J5-24	566.00	576.00	566.62	0.6	
24	0.014	18		0.002	1635	J5-24	565.71	575.71	566.60	0.9		J5-49	565.67	575.67	566.46	0.8	
19	0.015	8		0.015	162	J5-24	566.00	576.00	566.62	0.6		J5-24	565.71	575.71	566.60	0.9	SUR
363	0.014	18		0.003	1650	J5-25	564.01	574.01	564.89	0.9		J5-27	562.80	572.80	563.87	1.1	
269	0.015	10		0.041	38	J5-26	576.32	586.32	576.41	0.1		J5-28	565.30	574.60	565.46	0.2	
248	0.014	18		0.002	1653	J5-27	562.80	572.80	563.87	1.1		J5-35	562.32	572.32	563.41	1.1	
306	0.015	10		0.003	42	J5-28	565.30	574.60	565.46	0.2		J5-29	564.25	573.25	564.63	0.4	
256	0.015	12		0.002	175	J5-29	564.25	573.25	564.63	0.4		K5-70	563.71	571.31	564.02	0.3	
157	0.015	6		0.004	3	J5-30	571.64	581.64	571.69	0.0		J5-14	571.00	581.00	571.15	0.2	
183	0.015	8		0.016	33	J5-31	575.00	585.00	575.11	0.1		J5-22	572.00	582.00	572.12	0.1	
297	0.015	6		0.009	6	J5-32	577.73	587.73	577.79	0.1		J5-31	575.00	585.00	575.11	0.1	
99	0.015	8		0.001	5	J5-34	435.66	445.66	442.32	6.7	SUR	X8-5	435.55	445.55	442.33	6.8	SUR
480	0.014	18		0.002	1678	J5-35	562.32	572.32	563.41	1.1		J5-36	561.36	571.36	562.37	1.0	
426	0.014	18		0.003	1776	J5-36	561.36	571.36	562.37	1.0		K5-81	560.07	566.75	560.94	0.9	
426	0.014	15		0.001	1647	J5-37	567.75	577.75	575.22	7.5	SUR	J5-14	567.34	577.34	577.34	10.0	SUR
192	0.015	6		0.003	17	J5-37	572.00	582.00	572.13	0.1		J5-7	571.50	581.50	571.70	0.2	
237	0.015	8		0.002	10	J5-38	564.75	574.75	564.84	0.1		J5-29	564.25	573.25	564.63	0.4	
261	0.015	8		0.002	6	J5-39	565.30	575.30	565.38	0.1		J5-38	564.75	574.75	564.84	0.1	
251	0.015	6		0.012	3	J5-40	581.82	591.82	581.86	0.0		J5-20	578.77	579.81	578.91	0.1	
125	0.015	6		0.037	1	J5-41	583.41	593.41	583.43	0.0		J5-20	578.77	579.81	578.91	0.1	
82	0.015	6		0.031	1	J5-42	577.54	587.54	577.56	0.0		J5-19	575.00	571.50	575.04	0.0	
186	0.015	6		0.051	8	J5-44	575.67	585.67	575.71	0.0		J5-44-1	566.20	576.20	566.46	0.3	
14	0.015	6		0.039	25	J5-44-1	566.20	576.20	566.46	0.3		J5-49	565.67	575.67	566.46	0.8	SUR
274	0.015	6		0.030	3	J5-45	584.01	584.00	584.04	0.0		J5-44	575.67	585.67	575.71	0.0	
184	0.015	6		0.004	1	J5-47	574.00	584.00	574.04	0.0		J5-48	573.22	583.22	573.28	0.1	
333	0.015	6		0.004	3	J5-48	573.22	583.22	573.28	0.1		J5-37	572.00	582.00	572.13	0.1	
353	0.014	18		0.005	1646	J5-49	565.67	575.67	566.46	0.8		J5-25	564.01	574.01	564.89	0.9	
97	0.015	6		0.017	1	J5-51	573.65	583.65	573.68	0.0		J5-22	572.00	582.00	572.12	0.1	
91	0.015	12		0.020	897	J6-1	551.22	561.22	561.22	10.0	SUR	L4-82	549.37	559.37	559.37	10.0	SUR
251	0.015	12		0.011	69	J6-4	551.45	557.45	551.60	0.1		Y8-7	548.75	554.10	548.95	0.2	
447	0.014	24		0.001	5927	J6-5	548.76	563.00	558.30	9.5	SUR	J6-11	548.14	563.50	560.07	11.9	SUR
407	0.015	12		0.010	168	J6-8	546.24	553.24	546.47	0.2		Y7-3	542.05	550.05	542.31	0.3	
353	0.015	6		0.007	15	J6-11	555.85	563.50	555.95	0.1		J6-12	553.51	562.21	553.68	0.2	
558	0.014	24		0.002	5968	J6-11	548.24	563.50	560.07	11.8	SUR	J6-19	547.35	557.35	548.13	0.8	
514	0.015	6		0.007	47	J6-12	553.51	562.21	553.68	0.2		K6-24	549.87	559.87	550.10	0.2	
75	0.015	6		0.005	5	J6-14	558.47	563.47	558.53	0.1		L4-67	558.07	564.57	558.15	0.1	
61	0.013	8		0.004	131	J6-15	737.11	742.35	737.39	0.3		L7-73	736.86	741.26	737.17	0.3	
516	0.015	6		0.010	26	J6-16	554.95	563.05	555.07	0.1		K6-35	549.62	560.32	549.77	0.2	
245	0.015	12		0.008	197	J6-17	539.00	546.60	539.27	0.3		Y7-4	536.93	543.83	537.20	0.3	
303	0.014	21		0.044	5606	J6-19	547.35	557.35	548.13	0.8		J6-25	534.10	544.10	535.98	1.9	SUR
222	0.015	12		0.005	588	J6-22	533.57	541.47	541.47	7.9	SUR	J6-27	532.57	538.77	538.77	6.2	SUR
254	0.014	21		0.010	5545	J6-25	534.10	544.10	535.98	1.9	SUR	J6-28	531.69	538.79	538.79	7.1	SUR
41	0.015	12		0.022	978	J6-27	532.57	538.77	538.77	6.2	SUR	J6-28	531.69	538.79	538.79	7.1	SUR
403	0.014	21		0.006	4919	J6-28	531.69	538.79	538.79	7.1	SUR	J6-32	529.42	539.42	534.79	5.4	SUR
186	0.015	8		0.004	75	J6-30	547.19	557.59	547.44	0.3		J6-35	546.45	553.65	546.56	0.1	
185	0.014	21		0.003	4810	J6-32	529.42	539.42	534.79	5.4	SUR	J6-36	528.84	538.84	533.91	5.1	SUR
134	0.015	8		0.014	13	J6-34	525.13	535.30	525.20	0.1		J6-45	523.28	530.58	523.41	0.1	
244	0.015	8		0.102	88	J6-35	546.45	553.65	546.56	0.1		J6-38	521.71	527.41	521.88	0.2	
382	0.014	21		0.003	4838	J6-36	528.84	538.84	533.91	5.1	SUR	J6-37	527.70	537.70	528.52	0.8	

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LENGTH (ft)	Manning's N	Diameter (in)	Material	Slope	Maximum Flow, gpm	Upstream MH Name	Upstream Invert (ft)	Upstream MH Rim	Maximum Upstream HGL	Upstream Flow Depth, ft	Class	Downstream MH Name	Downstream Invert (ft)	Downstream MH Rim	Maximum Downstream HGL	Downstream Flow Depth, ft	Class
252	0.014	21		0.026	4805	J6-37	527.70	537.70	528.52	0.8		J6-47	521.06	535.04	522.02	1.0	
95	0.015	8		0.029	92	J6-38	521.71	527.41	521.88	0.2		J6-39	518.95	528.95	519.06	0.1	
31	0.015	12		0.065	94	J6-39	518.95	528.95	519.06	0.1		J6-40	516.92	526.92	517.84	0.9	
404	0.014	24		0.015	4909	J6-40	516.92	526.92	517.84	0.9		K7-1	511.02	521.02	512.00	1.0	
489	0.015	12		0.013	7	J6-44	531.69	541.69	531.74	0.0		J6-34	525.13	535.30	525.20	0.1	
186	0.015	8		0.004	17	J6-45	523.28	530.58	523.41	0.1		J6-46	522.61	533.00	522.68	0.1	
44	0.015	8		0.035	19	J6-46	522.61	533.00	522.68	0.1		J6-47	521.06	535.04	522.02	1.0	SUR
253	0.014	21		0.016	4822	J6-47	521.06	535.04	522.02	1.0		J6-40	516.92	526.92	517.84	0.9	
258	0.014	24		0.007	5678	J7-2	494.19	504.19	504.19	10.0	SUR	J7-4	492.41	502.41	502.41	10.0	SUR
127	0.014	24		0.003	5713	J7-4	492.41	502.41	502.41	10.0	SUR	J7-5	492.04	502.04	502.04	10.0	SUR
136	0.014	24		0.002	6032	J7-5	492.04	502.04	502.04	10.0	SUR	J7-6	491.77	501.77	501.77	10.0	SUR
324	0.014	24		0.001	6249	J7-6	491.77	501.77	501.77	10.0	SUR	K7-29	491.45	500.88	500.88	9.4	SUR
275	0.015	8		0.005	86	J8-1	596.69	605.49	596.95	0.3		J9-27	595.41	605.51	595.58	0.2	
191	0.015	10		0.005	368	J9-1	569.33	579.33	569.79	0.5		J9-2	568.29	578.29	568.88	0.6	
103	0.015	10		0.003	373	J9-2	568.29	578.29	568.88	0.6		J9-31	568.01	578.01	568.60	0.6	
369	0.015	10		0.003	21	J9-4	565.88	575.88	567.34	1.5	SUR	J10-1	564.84	574.84	567.34	2.5	SUR
343	0.015	8		0.014	356	J9-5	573.97	583.97	574.36	0.4		J9-1	569.33	579.33	569.79	0.5	
337	0.015	8		0.014	344	J9-6	578.60	588.60	578.98	0.4		J9-5	573.97	583.97	574.36	0.4	
477	0.015	8		0.004	220	J9-7	580.43	590.43	580.90	0.5		J9-6	578.60	588.60	578.98	0.4	
276	0.015	8		0.029	110	J9-9	586.62	596.62	586.79	0.2		J9-6	578.60	588.60	578.98	0.4	
168	0.015	8		0.028	99	J9-10	591.30	601.30	591.46	0.2		J9-9	586.62	596.62	586.79	0.2	
204	0.015	8		0.025	89	J9-18	596.39	606.39	596.55	0.2		J9-10	591.30	601.30	591.46	0.2	
318	0.015	8		0.041	75	J9-19	609.35	619.35	609.48	0.1		J9-18	596.39	606.39	596.55	0.2	
415	0.015	8		0.018	17	J9-20	600.37	610.37	600.45	0.1		J10-20	592.71	602.71	593.21	0.5	
341	0.015	8		0.006	214	J9-21	582.62	592.12	582.98	0.4		J9-7	580.43	590.43	580.90	0.5	
340	0.015	8		0.005	208	J9-22	584.16	589.46	584.57	0.4		J9-21	582.62	592.12	582.98	0.4	
205	0.015	8		0.005	208	J9-23	585.17	597.47	585.55	0.4		J9-22	584.16	589.46	584.57	0.4	
502	0.015	8		0.004	208	J9-24	587.37	590.67	587.78	0.4		J9-23	585.17	597.47	585.55	0.4	
303	0.015	8		0.005	143	J9-25	588.76	596.36	589.07	0.3		J9-24	587.37	590.67	587.78	0.4	
287	0.015	8		0.023	107	J9-27	595.41	605.51	595.58	0.2		J9-25	588.76	596.36	589.07	0.3	
343	0.015	10		0.003	378	J9-31	568.01	578.01	568.60	0.6		J9-32	567.08	582.35	567.79	0.7	
224	0.015	10		0.003	390	J9-32	567.24	582.35	567.79	0.6		K9-10	566.46	579.04	567.15	0.7	
289	0.015	12		0.002	1086	J10-1	564.84	574.84	567.34	2.5	SUR	K10-8	564.22	577.52	565.56	1.3	SUR
401	0.015	10		0.024	1069	J10-2	574.57	583.87	575.14	0.6		J10-1	564.84	574.84	567.34	2.5	SUR
348	0.015	10		0.006	1059	J10-3	576.61	588.01	581.22	4.6	SUR	J10-2	574.57	583.87	575.14	0.6	
215	0.015	10		0.034	840	J10-4	583.90	593.90	584.36	0.5		J10-3	576.61	588.01	581.22	4.6	SUR
313	0.015	10		0.010	217	J10-5	579.85	589.85	582.38	2.5	SUR	J10-3	576.61	588.01	581.22	4.6	SUR
316	0.015	10		0.050	200	J10-6	595.56	605.56	595.74	0.2		J10-5	579.85	589.85	582.38	2.5	SUR
149	0.015	8		0.008	19	J10-7	596.75	606.75	596.85	0.1		J10-6	595.56	605.56	595.74	0.2	
216	0.015	8		0.026	13	J10-16	603.04	613.04	603.10	0.1		J10-17	597.32	607.32	597.73	0.4	
413	0.015	8		0.004	176	J10-17	597.32	607.32	597.73	0.4		J10-6	595.56	605.56	595.74	0.2	
504	0.015	8		0.004	157	J10-18	599.32	609.32	599.67	0.3		J10-17	597.32	607.32	597.73	0.4	
310	0.015	8		0.029	9	J10-19	608.35	618.35	608.40	0.1		J10-18	599.32	609.32	599.67	0.3	
402	0.015	10		0.022	830	J10-20	592.71	602.71	593.21	0.5		J10-4	583.90	593.90	584.36	0.5	
500	0.015	10		0.007	798	J10-21	596.27	604.78	598.23	2.0	SUR	J10-20	592.71	602.71	593.21	0.5	
306	0.015	8		0.004	82	J10-22	618.67	633.27	618.91	0.2		J10-23	617.44	630.44	617.68	0.2	
308	0.015	8		0.004	85	J10-23	617.44	630.44	617.68	0.2		J10-24	616.07	626.97	616.30	0.2	
82	0.015	8		0.005	86	J10-24	616.07	626.97	616.30	0.2		J10-47	615.66	625.66	615.92	0.3	
252	0.015	8		0.004	108	J10-25	601.74	611.74	602.02	0.3		J10-58	600.74	610.74	601.31	0.6	
187	0.015	8		0.008	142	J10-26	600.74	610.74	601.01	0.3		J10-18	599.32	609.32	599.67	0.3	
187	0.015	8		0.005	88	J10-47	615.66	625.66	615.92	0.3		J10-48	614.81	624.81	614.96	0.1	
270	0.015	8		0.035	94	J10-48	614.81	624.81	614.96	0.1		J10-50	605.44	615.44	605.61	0.2	
249	0.015	8		0.108	3	J10-49	641.66	651.66	641.68	0.0		J10-48	614.81	624.81	614.96	0.1	

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LENGTH (ft)	Manning's N	Diameter (in)	Material	Slope	Maximum Flow, gpm	Upstream MH Name	Upstream Invert (ft)	Upstream MH Rim	Maximum Upstream HGL	Upstream Flow Depth, ft	Class	Downstream MH Name	Downstream Invert (ft)	Downstream MH Rim	Maximum Downstream HGL	Downstream Flow Depth, ft	Class
155	0.015	8		0.024	103	J10-50	605.44	615.44	605.61	0.2		J10-25	601.74	611.74	602.02	0.3	
185	0.015	8		0.000	126	J10-58	600.74	610.74	601.31	0.6		J10-26	599.96	610.74	601.01	1.0	SUR
365	0.015	8		0.004	118	K2-1	660.90	672.40	661.19	0.3		K3-35	659.33	669.33	659.63	0.3	
394	0.015	8		0.005	90	K2-2	662.70	670.70	662.94	0.2		K2-1	660.90	672.40	661.19	0.3	
250	0.015	8		0.066	19	K2-3	677.40	682.90	677.46	0.1		K2-1	660.90	672.40	661.19	0.3	
497	0.015	10		0.027	657	K2-5	679.28	683.28	679.68	0.4		K3-40	665.78	671.78	666.24	0.5	
479	0.015	6		0.034	138	K3-1	709.80	719.80	710.00	0.2		K3-2	693.54	703.54	693.78	0.2	
277	0.015	6		0.030	147	K3-2	693.54	703.54	693.78	0.2		K3-3	685.12	695.12	685.24	0.1	
171	0.015	8		0.197	149	K3-3	685.12	695.12	685.24	0.1		K3-7	651.97	661.97	652.57	0.6	
277	0.015	10		0.021	613	K3-4	662.33	672.33	662.75	0.4		K3-51	656.54	666.54	656.95	0.4	
145	0.015	8		0.005	601	K3-5	664.86	675.15	669.06	4.2	SUR	K3-50	664.10	670.29	666.69	2.6	SUR
370	0.015	12		0.019	589	K3-6	672.03	679.62	672.41	0.4		K3-5	664.86	675.15	669.06	4.2	SUR
301	0.015	12		0.011	979	K3-7	651.97	661.97	652.57	0.6		K3-11	648.55	658.55	650.66	2.1	SUR
207	0.015	8		0.072	9	K3-10	662.60	672.60	662.64	0.0		K3-15	647.67	657.67	648.42	0.8	SUR
137	0.015	12		0.006	1689	K3-11	648.55	658.55	650.66	2.1	SUR	K3-15	647.67	657.67	648.42	0.8	
167	0.015	10		0.005	708	K3-12	649.59	659.59	651.82	2.2	SUR	K3-11	648.75	658.55	650.66	1.9	SUR
272	0.015	6		0.013	21	K3-13	662.58	672.58	662.68	0.1		J3-21	659.07	669.07	659.25	0.2	
221	0.014	15		0.011	1701	K3-15	647.67	657.67	648.42	0.8		M11-37	645.31	655.31	645.89	0.6	
300	0.015	12		0.015	1711	K3-18	643.87	653.87	644.81	0.9		K3-21	639.37	649.37	640.03	0.7	
331	0.015	12		0.026	1719	K3-21	639.37	649.37	640.03	0.7		K3-24	630.72	640.72	631.37	0.6	
104	0.015	12		0.028	1724	K3-24	630.72	640.72	631.37	0.6		K3-25	627.84	637.84	628.48	0.6	
280	0.015	12		0.028	1732	K3-25	627.84	637.84	628.48	0.6		K3-27	619.92	629.92	621.67	1.7	SUR
147	0.015	6		0.114	12	K3-26	633.71	643.71	633.75	0.0		J3-33	617.11	627.11	617.30	0.2	
213	0.015	12		0.020	1744	K3-27	619.92	629.92	621.67	1.7	SUR	K3-28	615.70	625.70	616.12	0.4	
126	0.015	12		0.151	1754	K3-28	615.70	625.70	616.12	0.4		K4-10	596.95	606.95	597.29	0.3	
179	0.015	6		0.097	5	K3-34	680.00	690.00	680.03	0.0		K3-10	662.60	672.60	662.64	0.0	
330	0.015	8		0.005	131	K3-35	659.33	669.33	659.63	0.3		K3-36	657.80	667.80	658.17	0.4	
281	0.015	8		0.002	139	K3-36	657.80	667.80	658.17	0.4		K3-37	657.10	667.10	657.64	0.5	
459	0.015	12		0.011	828	K3-37	657.10	667.10	657.64	0.5		K3-7	651.97	661.97	652.57	0.6	
155	0.015	12		0.015	684	K3-38	659.41	671.31	659.85	0.4		K3-37	657.10	667.10	657.64	0.5	
530	0.015	12		0.005	683	K3-39	661.90	669.90	662.60	0.7		K3-38	659.41	671.31	659.85	0.4	
314	0.015	12		0.012	669	K3-40	665.78	671.78	666.24	0.5		K3-39	661.90	669.90	662.60	0.7	
104	0.015	8		0.004	92	K3-41	650.53	665.33	651.86	1.3	SUR	K3-12	650.09	659.59	651.82	1.7	SUR
32	0.015	8		0.008	611	K3-48	662.79	672.80	663.67	0.9	SUR	K3-4	662.53	672.33	662.75	0.2	
133	0.015	8		0.007	608	K3-49	663.75	670.34	665.88	2.1	SUR	K3-48	662.79	672.80	663.67	0.9	SUR
49	0.015	8		0.007	604	K3-50	664.10	670.29	666.69	2.6	SUR	K3-49	663.75	670.34	665.88	2.1	SUR
319	0.015	10		0.022	614	K3-51	656.54	666.54	656.95	0.4		K3-12	649.59	659.59	651.82	2.2	SUR
343	0.015	6		0.029	12	K4-1	665.00	675.00	665.06	0.1		K4-2	655.00	665.00	655.11	0.1	
559	0.015	6		0.034	42	K4-2	655.00	665.00	655.11	0.1		K4-7	636.00	639.60	636.19	0.2	
101	0.015	6		0.006	2	K4-5	636.61	646.61	636.65	0.0		K4-7	636.00	639.60	636.19	0.2	
225	0.015	6		0.094	33	K4-6	654.43	662.00	654.51	0.1		K5-4	633.50	640.20	633.92	0.4	
454	0.015	6		0.006	49	K4-7	636.00	639.60	636.19	0.2		K5-4	633.50	640.20	633.92	0.4	
189	0.014	16		0.020	1782	K4-8	584.25	594.25	584.83	0.6		J4-2	580.50	589.57	581.54	1.0	
63	0.014	16		0.151	1757	K4-10	596.95	606.95	597.29	0.3		F6-15	587.57	597.57	588.12	0.5	
300	0.015	8		0.051	12	K4-16	615.00	625.00	615.05	0.0		K4-17	599.80	609.80	600.03	0.2	
124	0.015	8		0.044	226	K4-17	599.80	609.80	600.03	0.2		K4-18	594.29	604.29	594.46	0.2	
145	0.015	8		0.107	227	K4-18	594.29	604.29	594.46	0.2		J4-19	578.89	588.89	579.11	0.2	
288	0.015	8		0.030	32	K4-36	674.20	684.20	674.29	0.1		K4-37	665.70	675.70	665.79	0.1	
228	0.015	8		0.058	42	K4-37	665.70	675.70	665.79	0.1		K4-38	652.40	662.40	652.65	0.3	
401	0.015	8		0.020	170	K4-38	652.40	662.40	652.65	0.3		K4-39	644.30	654.30	644.44	0.1	
193	0.015	8		0.188	203	K4-39	644.30	654.30	644.44	0.1		K4-40	608.70	618.70	608.91	0.2	
193	0.015	8		0.046	208	K4-40	608.70	618.70	608.91	0.2		K4-17	599.80	609.80	600.03	0.2	
21	0.015	8		0.209	126	K4-46	656.60	665.45	656.71	0.1		K4-38	652.40	662.40	652.65	0.3	

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LENGTH (ft)	Manning's N	Diameter (in)	Material	Slope	Maximum Flow, gpm	Upstream MH Name	Upstream Invert (ft)	Upstream MH Rim	Maximum Upstream HGL	Upstream Flow Depth, ft	Class	Downstream MH Name	Downstream Invert (ft)	Downstream MH Rim	Maximum Downstream HGL	Downstream Flow Depth, ft	Class
46	0.015	8		0.173	125	K4-47	664.43	669.50	664.55	0.1		K4-46	656.60	665.45	656.71	0.1	
33	0.015	8		0.079	119	K4-48	680.77	689.00	680.91	0.1		M11-31	678.16	688.00	678.28	0.1	
76	0.015	8		0.003	116	K4-50	683.18	692.50	683.51	0.3		K4-48	680.77	689.00	680.91	0.1	
184	0.015	8		0.087	113	K4-52	699.17	705.00	699.30	0.1		K4-50	683.18	692.50	683.51	0.3	
316	0.015	8		0.014	110	K4-53	703.63	713.63	703.85	0.2		K4-52	699.17	705.00	699.30	0.1	
377	0.015	8		0.009	29	K4-54	647.78	650.78	647.90	0.1		K4-39	644.30	654.30	644.44	0.1	
206	0.015	8		0.042	22	K4-55	656.50	661.60	656.57	0.1		K4-54	647.78	650.78	647.90	0.1	
215	0.015	8		0.082	99	K4-58	721.14	729.00	721.26	0.1		K4-53	703.63	713.63	703.85	0.2	
377	0.015	8		0.014	59	K4-60	726.56	733.96	726.71	0.2		K4-58	721.14	729.00	721.26	0.1	
89	0.015	8		0.016	56	K4-61	728.00	738.60	728.14	0.1		K4-60	726.56	733.96	726.71	0.2	
256	0.015	8		0.023	51	K4-69	733.92	738.92	734.04	0.1		K4-61	728.00	738.60	728.14	0.1	
574	0.015	6		0.007	13	K4-71	659.00	669.00	659.09	0.1		K4-2	655.00	665.00	655.11	0.1	
215	0.015	6		0.002	90	K5-4	633.50	640.20	633.92	0.4		K5-10	633.00	637.80	633.22	0.2	
105	0.015	6		0.052	1	K5-5	653.80	661.00	653.82	0.0		K5-98	648.38	658.38	648.42	0.0	
216	0.015	6		0.036	6	K5-6	660.70	664.50	660.74	0.0		K5-8	653.00	658.00	653.04	0.0	
290	0.015	6		0.116	4	K5-7	661.50	671.50	661.53	0.0		L5-3	628.00	632.00	628.04	0.0	
318	0.015	6		0.003	1	K5-7	661.50	671.50	661.53	0.0		K5-6	660.70	664.50	660.74	0.0	
200	0.015	6		0.105	10	K5-8	653.00	658.00	653.04	0.0		K5-21	632.00	636.00	632.06	0.1	
209	0.015	6		0.014	97	K5-10	633.00	637.80	633.22	0.2		K5-19	630.00	634.40	630.18	0.2	
234	0.015	6		0.012	1	K5-12	660.80	670.80	660.83	0.0		K5-8	653.00	658.00	653.04	0.0	
175	0.015	6		0.091	4	K5-12	660.80	670.80	660.83	0.0		K5-13	645.00	649.00	645.03	0.0	
201	0.015	6		0.172	6	K5-13	645.00	649.00	645.03	0.0		L5-11	611.00	621.00	611.06	0.1	
204	0.015	10		0.015	101	K5-19	630.00	634.40	630.18	0.2		K5-26	627.00	631.90	627.23	0.2	
208	0.015	6		0.053	16	K5-21	632.00	636.00	632.06	0.1		K5-27	621.00	627.00	621.30	0.3	
416	0.015	6		0.014	109	K5-26	627.00	631.90	627.23	0.2		K5-27	621.00	627.00	621.30	0.3	
416	0.015	6		0.012	142	K5-27	621.00	627.00	621.30	0.3		K5-38	616.00	621.00	616.20	0.2	
212	0.015	10		0.010	771	K5-29	599.74	609.74	600.36	0.6		K5-34	597.63	607.63	598.26	0.6	
198	0.015	10		0.010	777	K5-33	595.81	605.81	596.43	0.6		K5-39	593.79	603.79	594.42	0.6	
186	0.015	10		0.010	775	K5-34	597.63	607.63	598.26	0.6		K5-33	595.81	605.81	596.43	0.6	
426	0.015	6		0.052	170	K5-38	616.00	621.00	616.20	0.2		K5-39	593.79	603.79	594.42	0.6	SUR
424	0.015	10		0.016	982	K5-39	593.79	603.79	594.42	0.6		K5-47	587.12	597.12	587.79	0.7	
386	0.015	6		0.053	28	K5-41	614.14	621.00	614.22	0.1		K5-39	593.79	603.79	594.42	0.6	SUR
423	0.015	6		0.068	47	K5-45	615.65	618.65	615.75	0.1		K5-47	587.12	597.12	587.79	0.7	SUR
257	0.015	10		0.015	1033	K5-47	587.12	597.12	587.79	0.7		K5-55	583.18	593.18	583.85	0.7	
239	0.015	10		0.016	1048	K5-55	583.18	593.18	583.85	0.7		K5-58	579.32	589.32	579.95	0.6	
228	0.015	10		0.018	1051	K5-58	579.32	589.32	579.95	0.6		K5-67	575.20	585.20	576.41	1.2	SUR
459	0.015	6		0.028	117	K5-60	576.94	585.14	577.14	0.2		J5-29	564.25	573.25	564.63	0.4	
444	0.015	12		0.006	1101	K5-64	573.02	583.02	573.95	0.9		K5-73	570.20	580.20	570.82	0.6	
226	0.015	12		0.006	1087	K5-65	574.31	584.31	575.17	0.9		K5-64	573.02	583.02	573.95	0.9	
109	0.015	12		0.002	1082	K5-66	574.86	584.86	576.06	1.2	SUR	K5-65	574.61	584.31	575.17	0.6	
22	0.015	8		0.217	2	K5-66	579.42	589.42	579.44	0.0		K5-66	574.86	584.86	576.06	1.2	SUR
57	0.015	12		0.015	1078	K5-67	575.20	585.20	576.41	1.2	SUR	K5-66	574.31	584.86	576.06	1.8	SUR
266	0.015	12		0.004	182	K5-70	563.71	571.31	564.02	0.3		K5-80	562.64	570.65	563.20	0.6	
213	0.015	12		0.016	18	K5-71	566.13	573.13	566.20	0.1		K5-80	562.64	570.65	563.20	0.6	
379	0.014	15		0.005	1124	K5-72	566.34	575.79	567.08	0.7		K5-84	562.47	572.47	563.03	0.6	
484	0.014	15		0.007	1118	K5-73	570.20	580.20	570.82	0.6		K5-72	566.85	575.79	567.08	0.2	
132	0.015	8		0.010	13	K5-74	571.82	575.42	571.90	0.1		K5-73	570.50	580.20	570.82	0.3	
455	0.015	6		0.028	19	K5-79	586.19	590.79	586.27	0.1		L5-48	573.54	579.04	573.73	0.2	
256	0.015	12		0.001	203	K5-80	562.64	570.65	563.20	0.6		K5-81	560.07	566.75	560.94	0.9	
469	0.014	24		0.023	5616	K5-81	560.07	566.75	560.94	0.9		L4-82	549.37	559.37	559.37	10.0	SUR
29	0.015	12		0.082	5	K5-82	562.44	566.75	562.47	0.0		K5-81	560.07	566.75	560.94	0.9	
225	0.014	15		0.011	1129	K5-84	562.47	572.47	563.03	0.6		K5-81	560.07	566.75	560.94	0.9	
157	0.015	6		0.107	10	K5-86	600.00	610.00	600.04	0.0		K5-55	583.18	593.18	583.85	0.7	SUR

2010 Master Plan Clear Creek Collection System Pipe Analysis Results

LENGTH (ft)	Manning's N	Diameter (in)	Material	Slope	Maximum Flow, gpm	Upstream MH Name	Upstream Invert (ft)	Upstream MH Rim	Maximum Upstream HGL	Upstream Flow Depth, ft	Class	Downstream MH Name	Downstream Invert (ft)	Downstream MH Rim	Maximum Downstream HGL	Downstream Flow Depth, ft	Class
295	0.015	6		0.020	12	K5-87	621.50	631.50	621.57	0.1		K5-45	615.65	618.65	615.75	0.1	
478	0.015	10		0.009	9	K5-97	570.20	580.20	570.26	0.1		K5-71	566.13	573.13	566.20	0.1	
265	0.015	6		0.056	5	K5-98	648.38	658.38	648.42	0.0		K5-4	633.50	640.20	633.92	0.4	
379	0.015	6		0.005	69	K6-13	549.53	556.53	549.76	0.2		L6-24	547.54	553.94	547.77	0.2	
105	0.015	6		0.007	101	K6-14	546.89	557.09	547.15	0.3		K6-15	546.14	558.14	546.42	0.3	
188	0.015	6		0.007	107	K6-15	546.14	558.14	546.42	0.3		K6-26	544.88	559.18	545.29	0.4	
381	0.015	10		0.009	184	K6-21	538.98	553.78	539.25	0.3		K6-22	535.58	545.58	535.87	0.3	
381	0.015	10		0.008	197	K6-22	535.58	545.58	535.87	0.3		L6-32	532.41	542.41	532.83	0.4	
188	0.015	6		0.006	75	K6-24	549.87	559.87	550.10	0.2		K6-34	548.72	558.22	548.97	0.2	
82	0.015	6		0.008	95	K6-25	547.51	557.21	547.76	0.2		K6-14	546.85	557.09	547.15	0.3	
385	0.015	6		0.004	115	K6-26	544.88	559.18	545.29	0.4		K6-27	543.19	554.19	543.42	0.2	
381	0.015	12		0.011	163	K6-27	543.19	554.19	543.42	0.2		K6-21	538.98	553.78	539.25	0.3	
100	0.015	6		0.005	3	K6-33	550.23	560.23	550.28	0.1		K6-36	549.74	557.44	549.82	0.1	
193	0.015	6		0.006	85	K6-34	548.72	558.22	548.97	0.2		K6-25	547.51	557.21	547.76	0.2	
189	0.015	8		0.004	36	K6-35	549.62	560.32	549.77	0.2		L4-40	548.77	559.54	548.97	0.2	
381	0.015	6		0.005	8	K6-36	549.74	557.44	549.82	0.1		K6-37	547.86	556.86	547.96	0.1	
387	0.015	6		0.007	15	K6-37	547.86	556.86	547.96	0.1		K6-38	545.25	555.65	545.38	0.1	
186	0.015	8		0.006	30	K6-38	545.25	555.65	545.38	0.1		K6-51	544.22	554.22	544.37	0.2	
380	0.015	8		0.003	56	K6-41	548.34	559.54	548.55	0.2		J6-30	547.19	557.59	547.44	0.3	
379	0.015	6		0.005	9	K6-42	552.10	558.60	552.18	0.1		K6-43	550.10	557.60	550.22	0.1	
382	0.015	6		0.005	18	K6-43	550.10	557.60	550.22	0.1		K6-44	548.27	556.57	548.40	0.1	
376	0.015	6		0.006	26	K6-44	548.27	556.57	548.40	0.1		K6-45	546.00	553.40	546.18	0.2	
390	0.015	6		0.005	40	K6-45	546.00	553.40	546.18	0.2		K6-46	543.96	552.86	544.10	0.1	
224	0.015	6		0.020	42	K6-46	543.96	552.86	544.10	0.1		L6-58	539.50	545.40	539.58	0.1	
140	0.015	6		0.003	1	K6-47	550.68	560.68	550.72	0.0		K6-33	550.23	560.23	550.28	0.1	
138	0.015	6		0.008	3	K6-47	550.68	560.68	550.72	0.0		K6-35	549.62	560.32	549.77	0.2	
193	0.015	8		0.005	39	K6-51	544.22	554.22	544.37	0.2		K6-27	543.19	554.19	543.42	0.2	
244	0.013	8		0.052	131	K6-55	749.65	759.00	749.80	0.1		J6-15	737.11	742.35	737.39	0.3	
212	0.015	12		0.012	265	K6-56	538.03	550.70	538.31	0.3		L6-71	535.43	545.43	535.72	0.3	
201	0.015	6		0.004	1	K6-57	553.00	563.00	553.03	0.0		K6-42	552.10	558.60	552.18	0.1	
174	0.015	6		0.027	2	K6-57	553.00	563.00	553.03	0.0		K6-41	548.34	559.54	548.55	0.2	
340	0.014	21		0.015	4926	K7-1	511.02	521.02	512.00	1.0		K7-3	505.82	515.82	506.81	1.0	
493	0.014	21		0.015	4924	K7-3	505.82	515.82	506.81	1.0		K7-22	498.20	508.20	508.20	10.0	SUR
92	0.015	6		0.004	53	K7-5	499.08	505.90	499.31	0.2		K7-17	498.73	504.30	498.91	0.2	
209	0.015	6		0.043	51	K7-8	508.03	512.42	508.14	0.1		K7-5	499.08	505.90	499.31	0.2	
363	0.015	8		0.003	39	K7-14	491.22	496.22	491.40	0.2		K7-20	490.14	496.80	490.36	0.2	
303	0.015	6		0.010	56	K7-17	498.73	504.30	498.91	0.2		K7-18	495.85	500.40	496.03	0.2	
380	0.015	6		0.010	61	K7-18	495.85	500.40	496.03	0.2		K7-19	491.94	498.44	492.13	0.2	
173	0.015	6		0.010	65	K7-19	491.94	498.44	492.13	0.2		K7-20	490.14	496.80	490.36	0.2	
200	0.015	8		0.010	108	K7-20	490.14	496.80	490.36	0.2		K7-21	488.20	495.20	488.55	0.4	
358	0.015	8		0.003	114	K7-21	488.20	495.20	488.55	0.4		K7-28	487.30	494.90	487.59	0.3	
457	0.014	21		0.016	6351	K7-22	498.20	508.20	508.20	10.0	SUR	K7-29	490.88	500.88	500.88	10.0	SUR
389	0.015	6		0.014	26	K7-23	498.97	503.97	499.08	0.1		K7-30	493.72	497.82	493.88	0.2	
391	0.015	6		0.006	34	K7-24	494.92	500.12	495.07	0.1		K7-31	492.49	495.49	492.75	0.3	
377	0.015	6		0.006	5	K7-25	493.90	503.90	493.96	0.1		K7-26	491.68	500.68	491.77	0.1	
376	0.015	6		0.006	13	K7-26	491.68	500.68	491.77	0.1		K7-27	489.48	497.18	489.60	0.1	
368	0.015	6		0.006	20	K7-27	489.48	497.18	489.60	0.1		K7-28	487.30	494.90	487.59	0.3	
347	0.015	12		0.003	141	K7-28	487.30	494.90	487.59	0.3		L7-26	486.26	492.96	486.56	0.3	
404	0.014	27		0.003	9912	K7-29	490.88	500.88	500.88	10.0	SUR	K7-32	489.55	499.55	498.66	9.1	SUR
208	0.015	6		0.006	35	K7-30	493.72	497.82	493.88	0.2		K7-31	492.49	495.49	492.75	0.3	
343	0.015	8		0.004	92	K7-31	492.49	495.49	492.75	0.3		K7-33	491.22	498.22	491.50	0.3	
382	0.014	27		0.003	9928	K7-32	489.55	499.55	498.66	9.1	SUR	K7-34	488.23	498.23	498.23	10.0	SUR
351	0.015	8		0.004	94	K7-33	491.22	498.22	491.50	0.3		K7-36	489.95	498.95	490.20	0.2	

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385	0.014	27		0.003	9930	K7-34	488.23	498.23	498.23	10.0	SUR	K7-35	487.01	497.01	496.79	9.8	SUR
420	0.014	27		0.001	9967	K7-35	487.01	497.01	496.79	9.8	SUR	K7-40	486.59	496.23	493.24	6.7	SUR
349	0.015	10		0.004	98	K7-36	489.95	498.95	490.20	0.2		K7-37	488.68	496.78	488.94	0.3	
359	0.015	10		0.004	105	K7-37	488.68	496.78	488.94	0.3		K7-38	487.41	494.01	487.67	0.3	
341	0.015	10		0.004	112	K7-38	487.41	494.01	487.67	0.3		L7-35	486.14	492.24	486.42	0.3	
400	0.015	6		0.020	13	K7-39	503.00	510.20	503.07	0.1		K7-24	494.92	500.12	495.07	0.1	
524	0.014	30		0.003	9841	K7-40	486.23	496.23	493.24	7.0	SUR	K7-41	484.76	494.76	490.69	5.9	SUR
497	0.014	30		0.003	9859	K7-41	484.76	494.76	490.69	5.9	SUR	L7-43	483.36	493.36	488.52	5.2	SUR
350	0.015	12		0.028	12	K7-50	518.00	525.00	518.05	0.1		K7-8	508.03	512.42	508.14	0.1	
4	0.014	15		0.263	1	K7-5b	499.25	508.00	500.01	0.8		K7-5	499.08	505.90	499.31	0.2	
381	0.015	6		0.006	88	K8-8	473.26	478.76	473.52	0.3		L8-16	471.15	477.15	472.05	0.9	SUR
335	0.015	10		0.003	394	K9-10	566.46	579.04	567.15	0.7		K9-11	565.53	580.21	566.54	1.0	SUR
414	0.015	10		0.003	414	K9-11	565.53	580.21	566.54	1.0	SUR	K10-8	564.39	577.52	565.56	1.2	SUR
254	0.015	12		0.008	144	K10-2	554.56	565.96	554.79	0.2		L10-27	552.64	564.04	553.14	0.5	
237	0.015	12		0.008	140	K10-3	556.48	565.98	556.71	0.2		K10-2	554.56	565.96	554.79	0.2	
299	0.015	12		0.008	65	K10-4	558.88	568.98	559.04	0.2		K10-3	556.48	565.98	556.71	0.2	
127	0.015	12		0.008	8	K10-5	559.89	570.79	559.95	0.1		K10-4	558.88	568.98	559.04	0.2	
49	0.014	15		0.001	1624	K10-7	563.55	575.05	564.69	1.1		W8-2	563.50	573.50	564.48	1.0	
214	0.014	15		0.002	1507	K10-8	564.22	577.52	565.56	1.3	SUR	K10-39	563.84	576.54	564.97	1.1	
427	0.015	8		0.005	47	K10-9	560.96	570.96	561.14	0.2		K10-4	558.88	568.98	559.04	0.2	
191	0.015	8		0.004	40	K10-11	561.74	571.74	561.90	0.2		K10-9	560.96	570.96	561.14	0.2	
332	0.015	8		0.004	33	K10-12	563.05	573.05	563.20	0.1		K10-11	561.74	571.74	561.90	0.2	
224	0.015	8		0.003	35	K10-16	557.15	562.05	557.31	0.2		L10-49	556.43	561.43	556.61	0.2	
207	0.015	8		0.003	34	K10-17	557.78	561.98	557.94	0.2		K10-16	557.15	562.05	557.31	0.2	
518	0.014	15		0.003	1632	K10-22	561.94	571.94	563.15	1.2		K10-23	560.39	570.39	561.46	1.1	
557	0.014	15		0.003	1634	K10-23	560.39	570.39	561.46	1.1		L10-60	558.48	568.48	559.55	1.1	
228	0.015	8		0.004	30	K10-24	564.22	570.40	564.37	0.2		K10-12	563.05	573.05	563.20	0.1	
373	0.015	6		0.006	64	K10-25	558.70	566.00	558.91	0.2		K10-3	556.48	565.98	556.71	0.2	
233	0.015	8		0.004	22	K10-32	559.60	565.30	559.72	0.1		K10-33	558.59	562.59	558.73	0.1	
151	0.015	8		0.005	32	K10-33	558.59	562.59	558.73	0.1		K10-17	557.78	561.98	557.94	0.2	
88	0.014	15		0.003	1621	K10-39	563.84	576.54	564.97	1.1		K10-7	563.55	575.05	564.69	1.1	
502	0.015	8		0.004	110	K10-40	566.00	574.80	566.28	0.3		K10-39	563.84	576.54	564.97	1.1	SUR
411	0.015	8		0.004	101	K10-41	567.50	574.00	567.78	0.3		K10-40	566.00	574.80	566.28	0.3	
393	0.015	8		0.004	47	K10-42	574.86	584.36	575.05	0.2		K10-47	573.13	581.53	573.27	0.1	
416	0.015	8		0.012	42	K10-44	572.65	584.85	572.78	0.1		K10-41	567.50	574.00	567.78	0.3	
384	0.015	8		0.015	56	K10-47	573.13	581.53	573.27	0.1		K10-41	567.50	574.00	567.78	0.3	
510	0.015	10		0.002	45	K10-49	474.65	484.65	474.86	0.2		M11-18	473.57	483.57	473.73	0.2	
382	0.015	6		0.014	30	L2-4	748.63	758.63	748.75	0.1		L3-11	743.30	747.30	743.40	0.1	
500	0.015	10		0.009	635	L2-5	683.69	690.29	684.30	0.6		K2-5	679.28	683.28	679.68	0.4	
503	0.012	8		0.021	614	L2-6	694.04	700.04	694.46	0.4		L2-5	683.69	690.29	684.30	0.6	
407	0.012	8		0.017	581	L2-7	700.87	711.57	701.31	0.4		L2-6	694.04	700.04	694.46	0.4	
291	0.012	8		0.026	556	L2-8	708.37	714.37	708.74	0.4		L2-7	700.87	711.57	701.31	0.4	
375	0.012	8		0.033	542	L2-9	720.83	727.83	721.17	0.3		L2-8	708.37	714.37	708.74	0.4	
295	0.012	8		0.009	538	L2-10	723.47	733.47	724.72	1.3	SUR	L2-9	720.83	727.83	721.17	0.3	
439	0.015	6		0.032	26	L3-5	701.07	711.07	701.16	0.1		L3-7	681.67	691.87	682.36	0.7	SUR
477	0.015	8		0.021	560	L3-7	681.87	691.87	682.36	0.5		K3-6	672.03	679.62	672.41	0.4	
63	0.015	8		0.011	223	L3-8	690.67	700.67	690.99	0.3		L3-22	687.69	700.00	688.08	0.4	
289	0.015	8		0.034	143	L3-9	709.19	719.19	709.37	0.2		L3-24	699.22	707.11	699.45	0.2	
114	0.015	8		0.059	63	L3-10	727.91	734.91	728.02	0.1		L3-38	721.22	731.22	721.37	0.1	
402	0.015	8		0.038	49	L3-11	743.30	747.30	743.40	0.1		L3-10	727.91	734.91	728.02	0.1	
447	0.015	8		0.014	235	L3-14	693.14	703.14	693.44	0.3		L3-49	684.38	696.95	685.83	1.4	SUR
102	0.014	30		0.003	9902	L3-15	481.78	489.20	486.74	5.0	SUR	L7-49	481.48	491.48	486.40	4.9	SUR
208	0.015	8		0.006	226	L3-22	687.69	700.00	688.08	0.4		L3-49	684.38	696.95	685.83	1.4	SUR

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245	0.015	8		0.035	218	L3-24	699.22	707.11	699.45	0.2		L3-8	690.67	700.67	690.99	0.3	
353	0.015	8		0.035	61	L3-25	711.65	717.95	711.77	0.1		L3-24	699.22	707.11	699.45	0.2	
444	0.015	8		0.038	203	L3-28	719.42	729.42	719.63	0.2		T9-4	702.74	712.74	702.99	0.2	
286	0.015	8		0.056	35	L3-29	744.17	749.57	744.25	0.1		M3-54	728.13	735.30	728.49	0.4	
441	0.015	8		0.070	101	L3-32	760.59	766.83	760.72	0.1		M3-20	729.50	733.30	729.92	0.4	
123	0.015	8		0.036	55	L3-37	725.65	735.65	725.76	0.1		L3-38	721.22	731.22	721.37	0.1	
177	0.015	8		0.068	126	L3-38	721.22	731.22	721.37	0.1		L3-9	709.19	719.19	709.37	0.2	
198	0.015	8		0.005	465	L3-49	684.38	696.95	685.83	1.4	SUR	L3-7	681.67	691.87	682.36	0.7	SUR
164	0.015	8		0.031	26	L3-50	730.64	740.64	730.72	0.1		L3-62	725.59	735.59	725.80	0.2	
18	0.015	8		0.248	23	L3-53	735.02	740.52	735.07	0.0		L3-50	730.64	740.64	730.72	0.1	
167	0.015	8		0.037	194	L3-62	725.59	735.59	725.80	0.2		L3-28	719.42	729.42	719.63	0.2	
363	0.015	8		0.003	165	L3-63	726.83	736.83	727.28	0.4		L3-62	725.59	735.59	725.80	0.2	
40	0.015	6		0.031	22	L3-64	702.34	712.34	702.42	0.1		L3-5	701.07	711.07	701.16	0.1	
387	0.015	6		0.032	37	L4-4	733.05	743.05	733.15	0.1		L4-6	720.80	783.20	720.95	0.1	
157	0.015	8		0.006	210	L4-5	699.68	703.50	700.04	0.4		L4-81	698.70	701.77	699.04	0.3	
283	0.015	8		0.035	87	L4-6	720.80	783.20	720.95	0.1		L4-10	711.00	721.00	711.24	0.2	
374	0.015	12		0.013	4	L4-7	556.34	561.94	556.38	0.0		J6-4	551.45	557.45	551.60	0.1	
248	0.015	6		0.020	14	L4-8	714.99	724.99	715.06	0.1		L4-9	710.00	720.00	710.16	0.2	
143	0.015	8		0.046	128	L4-9	710.00	720.00	710.16	0.2		L4-13	703.50	713.50	703.72	0.2	
116	0.015	8		0.009	108	L4-10	711.00	721.00	711.24	0.2		L4-9	710.00	720.00	710.16	0.2	
188	0.015	8		0.012	138	L4-12	702.50	712.50	702.73	0.2		L4-20	700.20	704.98	700.39	0.2	
69	0.015	8		0.014	132	L4-13	703.50	713.50	703.72	0.2		L4-12	702.50	712.50	702.73	0.2	
130	0.015	8		0.015	126	L4-18	698.90	708.90	699.11	0.2		L4-19	696.90	706.90	697.15	0.2	
194	0.015	8		0.062	346	L4-19	696.90	706.90	697.15	0.2		L4-28	684.91	694.91	685.25	0.3	
69	0.015	8		0.005	202	L4-20	700.00	704.98	700.39	0.4		L4-5	699.68	703.50	700.04	0.4	
69	0.015	8		0.004	6	L4-21	699.00	704.00	699.06	0.1		L4-81	698.49	701.77	699.04	0.6	
330	0.015	8		0.023	62	L4-22	707.68	710.68	707.81	0.1		L4-20	700.20	704.98	700.39	0.2	
301	0.015	8		0.025	41	L4-23	715.20	725.20	715.31	0.1		L4-22	707.68	710.68	707.81	0.1	
153	0.015	8		0.039	47	L4-27	690.80	700.80	690.90	0.1		L4-28	684.91	694.91	685.25	0.3	
362	0.015	8		0.029	422	L4-28	684.91	694.91	685.25	0.3		L4-36	674.30	684.30	674.79	0.5	
126	0.015	6		0.007	24	L4-29	685.80	695.80	685.92	0.1		L4-28	684.91	694.91	685.25	0.3	
309	0.015	6		0.074	19	L4-30	708.50	718.50	708.56	0.1		L4-29	685.80	695.80	685.92	0.1	
345	0.015	6		0.013	10	L4-31	712.99	722.99	713.06	0.1		L4-30	708.50	718.50	708.56	0.1	
102	0.015	8		0.016	449	L4-36	674.30	684.30	674.79	0.5		L4-37	672.65	682.65	674.04	1.4	SUR
203	0.015	8		0.013	560	L4-37	672.65	682.65	674.04	1.4	SUR	L4-45	669.96	679.96	670.35	0.4	
164	0.015	8		0.015	108	L4-39	675.07	685.07	675.27	0.2		L4-37	672.65	682.65	674.04	1.4	SUR
193	0.015	8		0.002	42	L4-40	548.77	559.54	548.97	0.2		K6-41	548.34	559.54	548.55	0.2	
303	0.015	8		0.053	83	L4-42	694.09	701.09	694.22	0.1		V11-2	678.04	688.04	678.25	0.2	
230	0.015	8		0.008	76	L4-44	695.95	699.95	696.16	0.2		L4-42	694.09	701.09	694.22	0.1	
138	0.015	8		0.036	565	L4-45	669.96	679.96	670.35	0.4		L4-46	665.00	675.00	665.39	0.4	
148	0.015	8		0.037	569	L4-46	665.00	675.00	665.39	0.4		L4-47	659.48	669.48	659.86	0.4	
149	0.015	8		0.044	580	L4-47	659.48	669.48	659.86	0.4		L4-48	652.93	662.93	653.28	0.3	
205	0.015	8		0.059	597	L4-48	652.93	662.93	653.28	0.3		L4-49	640.90	650.90	641.23	0.3	
371	0.015	10		0.046	613	L4-49	640.90	650.90	641.23	0.3		L5-1	623.92	633.92	624.32	0.4	
126	0.015	8		0.033	39	L4-53	725.00	735.00	725.10	0.1		L4-6	720.80	783.20	720.95	0.1	
143	0.015	6		0.072	4	L4-64	725.27	735.27	725.30	0.0		L4-8	714.99	724.99	715.06	0.1	
323	0.015	6		0.010	11	L4-67	558.07	564.57	558.15	0.1		J6-16	554.95	563.05	555.07	0.1	
102	0.015	6		0.072	4	L4-70	720.34	730.34	720.37	0.0		L4-31	712.99	722.99	713.06	0.1	
189	0.015	8		0.010	217	L4-81	698.70	701.77	699.04	0.3		L4-19	696.90	706.90	697.15	0.2	
377	0.014	24		0.002	5871	L4-82	549.37	559.37	559.37	10.0	SUR	J6-5	548.76	563.00	558.30	9.5	SUR
187	0.015	8		0.039	619	L5-1	623.92	633.92	624.32	0.4		L5-4	616.65	628.00	617.15	0.5	
120	0.015	6		0.095	8	L5-3	628.00	632.00	628.04	0.0		L5-4	616.65	628.00	617.15	0.5	SUR
159	0.015	8		0.024	653	L5-4	616.65	628.00	617.15	0.5		L5-5	612.90	622.90	613.38	0.5	

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LENGTH (ft)	Manning's N	Diameter (in)	Material	Slope	Maximum Flow, gpm	Upstream MH Name	Upstream Invert (ft)	Upstream MH Rim	Maximum Upstream HGL	Upstream Flow Depth, ft	Class	Downstream MH Name	Downstream Invert (ft)	Downstream MH Rim	Maximum Downstream HGL	Downstream Flow Depth, ft	Class
92	0.015	8		0.027	657	L5-5	612.90	622.90	613.38	0.5		L5-11	610.45	620.45	610.96	0.5	
251	0.015	6		0.200	24	L5-6	666.00	674.00	666.05	0.1		L5-4	616.65	628.00	617.15	0.5	SUR
318	0.015	6		0.072	19	L5-7	689.00	693.00	689.06	0.1		L5-6	666.00	674.00	666.05	0.1	
315	0.015	6		0.044	8	L5-8	703.00	706.00	703.05	0.0		L5-7	689.00	693.00	689.06	0.1	
417	0.015	8		0.026	704	L5-11	610.45	620.45	610.96	0.5		K5-29	599.74	609.74	600.36	0.6	
12	0.015	6		0.046	13	L5-11	611.00	621.00	611.06	0.1		L5-11	610.45	620.45	610.96	0.5	SUR
282	0.015	6		0.087	31	L5-12	634.96	643.00	635.03	0.1		L5-11	610.45	620.45	610.96	0.5	SUR
282	0.015	6		0.056	26	L5-18	647.28	657.28	647.35	0.1		L5-44	631.60	641.60	631.70	0.1	
235	0.015	8		0.060	43	L5-28	618.60	625.60	618.69	0.1		L5-34	604.43	611.43	604.54	0.1	
244	0.015	8		0.051	60	L5-34	604.43	611.43	604.54	0.1		L5-37	592.08	605.18	592.24	0.2	
477	0.015	8		0.039	119	L5-37	592.08	605.18	592.24	0.2		L5-48	573.54	579.04	573.73	0.2	
345	0.015	6		0.011	41	L5-38	595.78	599.98	595.92	0.1		L5-37	592.08	605.18	592.24	0.2	
130	0.015	8		0.039	194	L5-42	589.56	594.56	589.77	0.2		L5-53	584.49	594.49	584.71	0.2	
188	0.015	8		0.043	238	L5-43	581.52	585.52	581.74	0.2		L6-6	573.40	578.40	573.66	0.3	
317	0.015	6		0.056	46	L5-44	631.60	641.60	631.70	0.1		L5-51	614.00	624.00	614.11	0.1	
275	0.015	8		0.032	150	L5-48	573.54	579.04	573.73	0.2		L6-8	564.85	571.85	565.04	0.2	
223	0.015	6		0.064	56	L5-51	614.00	624.00	614.11	0.1		K5-29	599.74	609.74	600.36	0.6	SUR
65	0.015	8		0.046	236	L5-53	584.49	594.49	584.71	0.2		L5-43	581.52	585.52	581.74	0.2	
309	0.015	8		0.024	241	L6-6	573.40	578.40	573.66	0.3		M6-88	565.93	571.93	566.20	0.3	
216	0.015	8		0.037	160	L6-8	564.85	571.85	565.04	0.2		L6-12	556.95	566.45	557.15	0.2	
220	0.015	12		0.022	170	L6-12	556.95	566.45	557.15	0.2		L6-16	552.11	559.41	552.31	0.2	
191	0.015	12		0.024	178	L6-16	552.11	559.41	552.31	0.2		L6-24	547.54	553.94	547.77	0.2	
285	0.015	8		0.025	138	L6-19	547.25	553.45	547.45	0.2		L6-66	540.27	550.27	540.48	0.2	
270	0.015	8		0.005	121	L6-20	548.53	553.03	548.84	0.3		L6-19	547.25	553.45	547.45	0.2	
430	0.015	8		0.004	99	L6-21	550.46	556.33	550.72	0.3		L6-20	548.53	553.03	548.84	0.3	
279	0.015	8		0.017	33	L6-21	537.07	547.07	537.18	0.1		L6-32	532.41	542.41	532.83	0.4	
190	0.015	12		0.024	256	L6-24	547.54	553.94	547.77	0.2		L6-25	542.50	551.50	542.76	0.3	
265	0.015	12		0.017	263	L6-25	542.50	551.50	542.76	0.3		K6-56	538.03	550.70	538.31	0.3	
95	0.015	8		0.015	144	L6-28	538.67	544.37	538.90	0.2		MH-31	537.20	543.00	537.40	0.2	
422	0.015	8		0.028	145	L6-31	537.20	543.00	537.40	0.2		L6-33	525.52	537.22	526.01	0.5	
191	0.015	12		0.011	506	L6-32	532.41	542.41	532.83	0.4		L6-77	530.27	540.27	530.61	0.3	
387	0.015	12		0.011	685	L6-33	525.52	537.22	526.01	0.5		L6-34	521.13	529.43	521.55	0.4	
491	0.014	15		0.011	698	L6-34	521.13	529.43	521.55	0.4		L6-38	515.70	525.50	515.86	0.2	
155	0.015	6		0.001	15	L6-35	515.70	520.20	515.88	0.2		L6-38	515.50	525.50	515.86	0.4	
119	0.015	12		0.012	1	L6-38	515.70	521.70	515.71	0.0		L6-40	514.27	522.75	514.40	0.1	
88	0.014	15		0.021	716	L6-38	515.50	525.50	515.86	0.4		L6-92	513.67	523.67	514.13	0.5	
18	0.015	6		0.354	54	L6-40	520.31	524.81	520.38	0.1		L6-40	514.27	522.75	514.40	0.1	
176	0.015	12		0.012	56	L6-40	514.27	522.75	514.40	0.1		L6-76	512.09	522.09	512.38	0.3	
108	0.014	15		0.020	778	L6-43	507.13	517.13	507.54	0.4		L6-54	505.00	515.00	505.34	0.3	
460	0.015	6		0.026	8	L6-46	551.25	556.82	551.30	0.1		L6-58	539.50	545.40	539.58	0.1	
218	0.014	15		0.044	778	L6-54	505.00	515.00	505.34	0.3		L6-55	495.42	501.42	495.66	0.2	
24	0.014	15		0.132	790	L6-55	495.42	501.42	495.66	0.2		L6-56	492.26	502.26	492.58	0.3	
273	0.014	30		0.020	851	L6-56	492.26	502.26	492.58	0.3		L7-71	486.76	496.76	487.45	0.7	
17	0.014	15		0.042	56	L6-56	492.98	502.98	493.07	0.1		L6-56	492.26	502.26	492.58	0.3	
180	0.015	6		0.210	55	L6-58	539.50	545.40	539.58	0.1		L6-65	502.65	512.65	502.80	0.2	
323	0.015	8		0.011	57	L6-65	502.65	512.65	502.80	0.2		L7-70	496.91	506.91	497.05	0.1	
77	0.015	8		0.021	142	L6-66	540.27	550.27	540.48	0.2		L6-28	538.67	544.37	538.90	0.2	
114	0.015	12		0.011	270	L6-71	535.43	545.43	535.72	0.3		L6-72	534.14	544.14	534.62	0.5	
160	0.015	12		0.002	272	L6-72	534.14	544.14	534.62	0.5		L6-32	532.41	542.41	532.83	0.4	
285	0.014	15		0.017	776	L6-75	511.95	521.95	512.35	0.4		L6-43	507.13	517.13	507.54	0.4	
34	0.015	6		0.004	58	L6-76	512.09	522.09	512.38	0.3		L6-75	511.95	521.95	512.35	0.4	
36	0.015	12		0.021	510	L6-77	530.27	540.27	530.61	0.3		L6-78	529.50	539.50	529.92	0.4	
384	0.015	12		0.010	522	L6-78	529.50	539.50	529.92	0.4		L6-33	525.52	537.22	526.01	0.5	

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88	0.014	15		0.008	717	L6-91	512.68	522.68	513.17	0.5		L6-75	511.95	521.95	512.35	0.4	
117	0.014	15		0.008	717	L6-92	513.67	523.67	514.13	0.5		L6-91	512.68	522.68	513.17	0.5	
282	0.015	8		0.004	63	L7-1	491.31	501.31	491.54	0.2		G5-22	490.22	500.22	490.38	0.2	
53	0.014	14		0.033	3	L7-2	491.95	501.95	491.98	0.0		G5-22	490.22	500.22	490.38	0.2	
80	0.015	8		0.006	69	L7-3	489.72	499.72	489.92	0.2		L7-10	489.21	493.41	489.41	0.2	
204	0.015	8		0.031	4	L7-8	494.00	498.60	494.03	0.0		L7-13	487.79	491.60	487.87	0.1	
124	0.015	8		0.006	72	L7-10	489.21	493.41	489.41	0.2		L7-15	488.46	493.46	488.70	0.2	
287	0.015	8		0.004	9	L7-13	487.79	491.60	487.87	0.1		L7-18	486.72	491.30	486.82	0.1	
417	0.015	8		0.004	80	L7-15	488.46	493.46	488.70	0.2		L7-23	486.80	492.50	487.02	0.2	
441	0.015	8		0.004	17	L7-17	482.30	493.90	488.04	5.7	SUR	L7-21	481.94	490.20	486.41	4.5	SUR
299	0.015	8		0.004	15	L7-18	486.72	491.30	486.82	0.1		L7-22	485.63	490.20	485.76	0.1	
343	0.015	8		0.004	23	L7-21	481.53	490.20	486.41	4.9	SUR	L7-28	481.15	490.60	485.04	3.9	SUR
373	0.015	8		0.004	22	L7-22	485.63	490.20	485.76	0.1		L7-29	484.32	489.20	484.46	0.1	
364	0.015	8		0.006	87	L7-23	486.80	492.50	487.02	0.2		L7-30	484.66	489.66	484.89	0.2	
339	0.015	12		0.003	150	L7-26	486.26	492.96	486.56	0.3		L7-27	485.23	491.63	485.54	0.3	
379	0.015	12		0.003	154	L7-27	485.23	491.63	485.54	0.3		L7-37	484.14	490.84	484.55	0.4	
366	0.014	42		0.004	28	L7-28	481.15	490.60	485.04	3.9	SUR	L7-38	480.75	491.00	483.85	3.1	
362	0.015	8		0.004	28	L7-29	484.32	489.20	484.46	0.1		L7-39	483.10	489.80	483.18	0.1	
361	0.015	8		0.006	95	L7-30	484.66	489.66	484.89	0.2		L7-40	482.52	487.52	482.77	0.3	
390	0.015	10		0.004	119	L7-35	486.14	492.24	486.42	0.3		F4-1	484.74	491.24	485.00	0.3	
507	0.015	12		0.004	281	L7-37	484.14	490.84	484.55	0.4		L7-51	482.05	489.05	482.37	0.3	
368	0.014	45		0.000	34	L7-38	480.75	491.00	483.85	3.1		L7-52	480.66	491.00	483.75	3.1	
373	0.015	8		0.004	36	L7-39	483.10	489.80	483.18	0.1		L7-53	481.70	489.00	481.85	0.1	
366	0.015	8		0.006	108	L7-40	482.52	487.52	482.77	0.3		L7-54	480.38	488.38	480.65	0.3	
83	0.014	30		0.003	9876	L7-43	483.36	493.36	488.52	5.2	SUR	L7-44	483.13	493.13	488.24	5.1	SUR
345	0.014	30		0.003	9877	L7-44	483.13	493.13	488.24	5.1	SUR	L7-46	482.08	492.08	487.08	5.0	SUR
101	0.014	30		0.003	9910	L7-46	482.08	492.08	487.08	5.0	SUR	L3-15	481.78	489.20	486.74	5.0	SUR
64	0.014	30		0.003	9922	L7-49	481.48	491.48	486.40	4.9	SUR	L7-50	481.28	491.28	486.18	4.9	SUR
190	0.014	30		0.002	9938	L7-50	481.28	491.28	486.18	4.9	SUR	F7-7	480.81	490.81	485.52	4.7	SUR
278	0.014	15		0.006	281	L7-51	482.05	489.05	482.37	0.3		L7-58	480.49	485.99	480.82	0.3	
306	0.015	8		0.010	39	L7-52	482.30	491.00	483.75	1.4	SUR	L7-58	480.49	485.99	480.82	0.3	
255	0.015	8		0.008	43	L7-53	481.70	489.00	481.85	0.1		L7-79	479.70	489.70	479.85	0.2	
524	0.015	8		0.005	122	L7-54	480.38	488.38	480.65	0.3		L7-81	477.58	486.93	477.86	0.3	
478	0.014	27		0.001	9958	L7-57	480.25	490.25	484.87	4.6	SUR	L7-59	479.89	489.89	481.38	1.5	
454	0.014	15		0.006	322	L7-58	480.49	485.99	480.82	0.3		L7-60	477.82	482.82	478.19	0.4	
399	0.014	27		0.010	9882	L7-59	479.89	489.89	481.38	1.5		L7-61	475.97	485.97	478.12	2.1	
397	0.014	18		0.004	374	L7-60	477.82	482.82	478.19	0.4		L7-62	476.20	481.20	476.64	0.4	
574	0.014	27		0.005	9876	L7-61	475.97	485.97	478.12	2.1		M7-30	473.12	483.12	474.92	1.8	
311	0.014	18		0.004	503	L7-62	476.20	481.20	476.64	0.4		M7-33	475.00	479.50	475.42	0.4	
264	0.014	14		0.027	1	L7-68	499.00	509.00	499.02	0.0		L7-2	491.95	501.95	491.98	0.0	
54	0.015	6		0.151	1	L7-68	500.02	510.02	500.04	0.0		L7-1	491.31	501.31	491.54	0.2	
221	0.015	8		0.027	91	L7-69	472.00	482.00	472.16	0.2		L8-3	466.00	473.00	466.35	0.4	
287	0.015	8		0.020	60	L7-70	496.91	506.91	497.05	0.1		L7-1	491.31	501.31	491.54	0.2	
212	0.014	30		0.001	867	L7-71	486.76	496.76	487.45	0.7		L9-38	486.54	496.54	486.89	0.3	
130	0.015	8		0.005	137	L7-73	736.86	741.26	737.17	0.3		O2-5	736.20	745.00	736.38	0.2	
214	0.015	8		0.009	49	L7-79	479.70	489.70	479.85	0.2		L7-60	477.82	482.82	478.19	0.4	
88	0.015	8		0.006	129	L7-81	477.58	486.93	477.86	0.3		L7-62	477.03	481.20	476.64	-0.4	
292	0.014	42		0.001	21	L7-84	480.18	490.18	480.62	0.4		M7-71	479.92	489.92	480.62	0.7	
82	0.014	42		0.001	17	L7-85	480.25	490.25	480.62	0.4		L7-84	480.18	490.18	480.62	0.4	
254	0.014	42		0.001	13	L7-86	480.46	490.46	480.62	0.2		L7-85	480.25	490.25	480.62	0.4	
512	0.015	6		0.017	27	L8-2	474.54	483.54	474.65	0.1		L8-3	466.00	473.00	466.35	0.4	
259	0.015	6		0.005	131	L8-3	466.00	473.00	466.35	0.4		L8-6	464.69	474.69	465.25	0.6	SUR
413	0.015	10		0.003	381	L8-6	464.69	474.69	465.25	0.6		L8-7	463.40	473.40	464.04	0.6	

2010 Master Plan Clear Creek Collection System Pipe Analysis Results

LENGTH (ft)	Manning's N	Diameter (in)	Material	Slope	Maximum Flow, gpm	Upstream MH Name	Upstream Invert (ft)	Upstream MH Rim	Maximum Upstream HGL	Upstream Flow Depth, ft	Class	Downstream MH Name	Downstream Invert (ft)	Downstream MH Rim	Maximum Downstream HGL	Downstream Flow Depth, ft	Class
383	0.015	10		0.002	387	L8-7	463.40	473.40	464.04	0.6		L8-8	462.46	472.46	463.37	0.9	SUR
356	0.015	10		0.003	460	L8-8	462.46	472.46	463.37	0.9	SUR	M8-1	461.52	471.52	462.35	0.8	
223	0.015	8		0.003	246	L8-10	465.40	470.40	465.91	0.5		L8-6	464.69	474.69	465.25	0.6	
358	0.015	6		0.022	22	L8-11	474.40	477.40	474.49	0.1		L8-12	466.43	476.51	466.91	0.5	
321	0.015	8		0.003	230	L8-12	466.43	476.51	466.91	0.5		L8-10	465.40	470.40	465.91	0.5	
322	0.015	6		0.005	28	L8-13	472.75	476.75	472.90	0.1		L8-16	471.15	477.15	472.05	0.9	SUR
319	0.015	8		0.003	196	L8-14	467.46	478.00	467.89	0.4		L8-12	466.43	476.51	466.91	0.5	
347	0.015	6		0.004	136	L8-16	471.15	477.15	472.05	0.9	SUR	L8-17	469.76	475.76	470.65	0.9	SUR
396	0.015	6		0.003	150	L8-17	469.76	475.76	470.65	0.9	SUR	L8-18	468.50	474.50	468.88	0.4	
307	0.015	8		0.003	172	L8-18	468.50	474.50	468.88	0.4		L8-14	467.46	478.00	467.89	0.4	
121	0.015	6		0.009	97	L9-3	566.70	576.70	566.94	0.2		L9-4	565.60	575.60	565.85	0.3	
325	0.015	6		0.018	147	L9-4	565.60	575.60	565.85	0.3		L9-5	559.70	569.70	559.98	0.3	
369	0.015	6		0.018	172	L9-5	559.70	569.70	559.98	0.3		L9-6	553.00	563.00	555.78	2.8	SUR
251	0.015	6		0.006	186	L9-6	553.00	563.00	555.78	2.8	SUR	L9-8	551.60	561.60	553.96	2.4	SUR
263	0.015	6		0.015	8	L9-7	557.00	567.00	557.06	0.1		L9-6	553.00	563.00	555.78	2.8	SUR
138	0.015	6		0.003	192	L9-8	551.60	561.60	553.96	2.4	SUR	L9-10	551.17	561.17	552.89	1.7	SUR
139	0.015	6		0.003	232	L9-10	551.17	561.17	552.89	1.7	SUR	L9-15	550.70	556.70	551.00	0.3	
339	0.015	8		0.004	381	L9-14	547.30	556.00	549.95	2.7	SUR	M9-10	545.99	560.29	547.72	1.7	SUR
215	0.015	8		0.016	240	L9-15	550.70	556.70	551.00	0.3		L9-14	547.30	556.00	549.95	2.7	SUR
592	0.014	30		0.012	4	L9-26	480.52	490.52	480.55	0.0		M11-18	473.57	483.57	473.73	0.2	
298	0.015	8		0.019	133	L9-32	553.00	560.00	553.20	0.2		L9-14	547.30	556.00	549.95	2.7	SUR
397	0.015	8		0.007	147	L9-33	550.99	560.99	553.06	2.1	SUR	L10-23	548.20	558.60	552.83	4.6	SUR
257	0.014	15		0.023	55	L9-37	499.00	509.00	499.10	0.1		L6-56	492.98	502.98	493.07	0.1	
209	0.014	30		0.015	878	L9-38	486.54	496.54	486.89	0.3		M7-71	479.92	489.92	480.62	0.7	
126	0.015	6		0.007	47	L10-4	547.74	557.74	552.09	4.4	SUR	L10-6	546.80	556.22	552.06	5.3	SUR
466	0.015	8		0.003	75	L10-6	546.80	556.22	552.06	5.3	SUR	L10-20	545.39	566.19	551.99	6.6	SUR
354	0.015	10		0.005	172	L10-7	549.60	557.00	549.90	0.3		M10-35	547.67	554.67	548.96	1.3	SUR
459	0.015	8		0.008	3	L10-7	552.00	557.00	549.90	-2.1		L10-8	548.30	553.61	552.06	3.8	SUR
435	0.015	8		0.003	40	L10-8	548.30	553.61	552.06	3.8	SUR	L10-6	546.80	556.22	552.06	5.3	SUR
330	0.015	8		0.005	151	L10-9	551.40	556.60	551.74	0.3		L10-7	549.85	557.00	549.90	0.0	
319	0.015	8		0.003	138	L10-10	552.25	557.65	552.62	0.4		L10-9	551.40	556.60	551.74	0.3	
62	0.015	8		0.003	135	L10-11	552.45	557.95	552.79	0.3		L10-10	552.25	557.65	552.62	0.4	
273	0.015	8		0.007	14	L10-12	554.28	564.28	554.36	0.1		L10-11	552.45	557.95	552.79	0.3	
114	0.015	6		0.007	39	L10-13	553.19	558.99	553.35	0.2		L10-11	552.45	557.95	552.79	0.3	
331	0.015	6		0.022	32	L10-14	560.45	567.05	560.56	0.1		L10-13	553.19	558.99	553.35	0.2	
190	0.015	6		0.028	24	L10-15	565.80	577.40	565.89	0.1		L10-14	560.45	567.05	560.56	0.1	
350	0.015	12		0.003	460	L10-20	545.39	566.19	551.99	6.6	SUR	M10-1	544.24	552.24	551.63	7.4	SUR
268	0.015	12		0.004	403	L10-21	546.63	555.10	552.53	5.9	SUR	L10-67	545.56	555.56	552.32	6.8	SUR
320	0.015	12		0.004	395	L10-22	547.92	559.22	552.78	4.9	SUR	L10-21	546.63	555.10	552.53	5.9	SUR
67	0.015	12		0.004	394	L10-23	548.20	558.60	552.83	4.6	SUR	L10-22	547.92	559.22	552.78	4.9	SUR
128	0.015	12		0.004	276	L10-24	548.72	560.02	552.87	4.1	SUR	L10-23	548.20	558.60	552.83	4.6	SUR
295	0.015	12		0.004	272	L10-25	550.00	561.00	552.98	3.0	SUR	L10-24	548.72	560.02	552.87	4.1	SUR
347	0.015	12		0.004	237	L10-26	551.28	563.28	553.07	1.8	SUR	L10-25	550.00	561.00	552.98	3.0	SUR
329	0.015	12		0.004	233	L10-27	552.64	564.04	553.14	0.5		L10-26	551.28	563.28	553.07	1.8	SUR
60	0.015	8		0.003	28	L10-32	554.28	559.78	554.43	0.1		L10-33	554.10	559.80	554.34	0.2	
183	0.015	8		0.003	74	L10-33	554.10	559.80	554.34	0.2		L10-35	553.55	563.55	553.80	0.3	
48	0.015	8		0.004	45	L10-34	554.29	559.79	554.47	0.2		L10-33	554.10	559.80	554.34	0.2	
364	0.015	8		0.003	79	L10-35	553.55	563.55	553.80	0.3		L10-11	552.45	557.95	552.79	0.3	
327	0.015	8		0.003	22	L10-46	556.20	562.80	556.33	0.1		L10-47	555.15	560.15	555.32	0.2	
229	0.015	8		0.004	41	L10-47	555.15	560.15	555.32	0.2		L10-34	554.29	559.79	554.47	0.2	
331	0.015	8		0.003	41	L10-49	556.43	561.43	556.61	0.2		L10-50	555.50	563.00	555.72	0.2	
416	0.015	8		0.003	58	L10-50	555.50	563.00	555.72	0.2		X8-2	554.30	563.60	554.52	0.2	
528	0.014	18		0.003	31	L10-51	473.10	488.00	473.22	0.1		Z7-7	471.49	481.49	471.61	0.1	

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LENGTH (ft)	Manning's N	Diameter (in)	Material	Slope	Maximum Flow, gpm	Upstream MH Name	Upstream Invert (ft)	Upstream MH Rim	Maximum Upstream HGL	Upstream Flow Depth, ft	Class	Downstream MH Name	Downstream Invert (ft)	Downstream MH Rim	Maximum Downstream HGL	Downstream Flow Depth, ft	Class
298	0.015	8		0.004	53	L10-54	551.15	557.15	553.00	1.8	SUR	L10-25	550.00	561.00	552.98	3.0	SUR
542	0.014	15		0.004	1638	L10-60	558.48	568.48	559.55	1.1		L10-68	556.57	566.57	557.58	1.0	
30	0.015	8		0.004	16	L10-66	545.69	555.69	552.32	6.6	SUR	L10-67	545.56	555.56	552.32	6.8	SUR
45	0.015	8		0.004	405	L10-67	545.56	555.56	552.32	6.8	SUR	L10-20	545.39	566.19	551.99	6.6	SUR
516	0.014	15		0.004	1641	L10-68	556.57	566.57	557.58	1.0		L10-69	554.60	564.60	555.68	1.1	
97	0.014	15		0.003	1653	L10-69	554.60	564.60	555.68	1.1		L10-70	554.32	564.32	555.29	1.0	
138	0.014	15		0.025	1661	L10-70	554.32	564.32	555.29	1.0		L10-71	550.83	560.83	554.89	4.1	SUR
611	0.014	15		0.003	1673	L10-71	550.83	560.83	554.89	4.1	SUR	T9-1	548.77	557.71	552.60	3.8	SUR
370	0.015	6		0.049	4	L10-72	651.00	655.30	651.03	0.0		K5-10	633.00	637.80	633.22	0.2	
293	0.015	6		0.074	18	L10-73	597.66	603.66	597.72	0.1		S9-14	575.98	581.48	576.10	0.1	
330	0.015	8		0.017	78	L10-74	477.75	487.75	477.91	0.2		L7-69	472.00	482.00	472.16	0.2	
399	0.015	6		0.005	40	L10-75	575.10	583.10	575.27	0.2		L11-18	573.13	578.63	573.33	0.2	
349	0.015	6		0.016	66	L11-11	581.89	587.89	582.06	0.2		L11-12	576.25	583.25	576.43	0.2	
345	0.015	6		0.017	78	L11-12	576.25	583.25	576.43	0.2		L11-13	570.55	577.55	570.82	0.3	
353	0.015	8		0.010	160	L11-13	570.55	577.55	570.82	0.3		M11-15	567.10	573.10	567.43	0.3	
217	0.015	6		0.005	68	L11-14	571.62	577.62	571.85	0.2		L11-13	570.55	577.55	570.82	0.3	
268	0.015	6		0.005	65	L11-17	572.93	577.93	573.16	0.2		L11-14	571.62	577.62	571.85	0.2	
38	0.015	6		0.005	51	L11-18	573.13	578.63	573.33	0.2		L11-17	572.93	577.93	573.16	0.2	
170	0.015	6		0.032	8	L11-19	575.92	581.02	575.97	0.0		L11-13	570.55	577.55	570.82	0.3	
314	0.015	8		0.010	32	M2-4	761.66	769.26	761.78	0.1		M2-5	758.45	764.15	758.56	0.1	
284	0.015	8		0.030	51	M2-5	758.45	764.15	758.56	0.1		M3-3	750.06	758.00	750.21	0.2	
467	0.015	8		0.015	10	M2-6	765.38	771.68	765.44	0.1		M2-5	758.45	764.15	758.56	0.1	
295	0.015	8		0.025	74	M2-8	750.20	755.77	750.34	0.1		M2-10	742.86	748.98	746.27	3.4	SUR
245	0.015	8		0.010	88	M2-10	742.86	748.98	746.27	3.4	SUR	M2-12	740.35	746.18	746.18	5.8	SUR
165	0.012	8		0.016	774	M2-12	739.45	746.18	746.18	6.7	SUR	M2-13	736.76	743.32	743.32	6.6	SUR
367	0.012	8		0.004	583	M2-13	736.76	743.32	743.32	6.6	SUR	M2-14	735.25	742.95	739.75	4.5	SUR
362	0.012	8		0.014	606	M2-14	735.25	742.95	739.75	4.5	SUR	M2-15	730.30	735.90	735.90	5.6	SUR
167	0.012	8		0.005	535	M2-15	730.30	735.90	735.90	5.6	SUR	M2-16	729.54	737.74	734.64	5.1	SUR
455	0.012	8		0.004	540	M2-16	729.54	737.74	734.64	5.1	SUR	M2-17	727.54	738.24	731.07	3.5	SUR
131	0.012	8		0.005	541	M2-17	727.54	738.24	731.07	3.5	SUR	M2-19	726.86	733.46	730.03	3.2	SUR
274	0.012	8		0.004	544	M2-19	726.86	733.46	730.03	3.2	SUR	M2-20	725.77	733.27	727.81	2.0	SUR
399	0.012	8		0.006	549	M2-20	725.77	733.27	727.81	2.0	SUR	L2-10	723.47	733.47	724.72	1.3	SUR
333	0.012	8		0.016	40	M2-21	735.52	741.72	735.95	0.4		M2-15	730.30	735.90	735.90	5.6	SUR
86	0.015	8		0.002	401	M2-28	739.65	749.65	746.81	7.2	SUR	M2-12	739.45	746.18	746.18	6.7	SUR
235	0.015	8		0.034	26	M2-29	747.67	756.75	747.75	0.1		M2-28	739.65	749.65	746.81	7.2	SUR
365	0.015	8		0.005	371	M2-31	741.58	750.75	749.09	7.5	SUR	M2-28	739.65	749.65	746.81	7.2	SUR
346	0.015	8		0.015	21	M2-55	761.80	767.60	761.89	0.1		N2-5	756.46	766.56	756.68	0.2	
442	0.015	6		0.005	19	M3-2	752.17	761.00	752.29	0.1		M3-3	750.06	758.00	750.21	0.2	
324	0.015	8		0.040	108	M3-3	750.06	758.00	750.21	0.2		M3-5	736.97	742.00	737.17	0.2	
365	0.015	8		0.022	138	M3-5	736.97	742.00	737.17	0.2		M3-9	728.83	734.00	729.06	0.2	
285	0.015	6		0.058	20	M3-6	753.60	760.10	753.67	0.1		M3-5	736.97	742.00	737.17	0.2	
379	0.015	8		0.023	168	M3-9	728.83	734.00	729.06	0.2		M3-10	720.00	729.00	720.20	0.2	
164	0.015	8		0.056	215	M3-10	720.00	729.00	720.20	0.2		M3-11	710.85	715.50	711.21	0.4	
219	0.015	8		0.033	483	M3-11	710.85	715.50	711.21	0.4		M3-15	703.63	709.00	704.98	1.3	SUR
328	0.015	8		0.004	253	M3-12	747.21	757.00	747.77	0.6		M3-13	745.80	754.00	746.06	0.3	
259	0.015	8		0.039	260	M3-13	745.80	754.00	746.06	0.3		M3-14	735.66	743.00	735.85	0.2	
232	0.015	8		0.101	261	M3-14	735.66	743.00	735.85	0.2		M3-53	712.41	719.00	712.70	0.3	
312	0.015	8		0.009	491	M3-15	703.62	709.00	704.98	1.4	SUR	M3-18	700.90	709.24	701.45	0.5	
363	0.015	6		0.072	12	M3-16	732.78	738.29	732.83	0.0		M3-17	706.90	712.38	707.02	0.1	
411	0.015	6		0.015	33	M3-17	706.90	712.38	707.02	0.1		M3-18	700.90	709.24	701.45	0.5	SUR
127	0.015	8		0.014	528	M3-18	700.90	709.24	701.45	0.5		M3-19	699.11	709.11	699.54	0.4	
93	0.015	8		0.023	531	M3-19	699.11	709.11	699.54	0.4		M3-35	697.00	707.00	697.43	0.4	
382	0.015	8		0.004	126	M3-20	729.61	733.30	729.92	0.3		M3-54	728.13	735.30	728.49	0.4	

2010 Master Plan Clear Creek Collection System Pipe Analysis Results

LENGTH (ft)	Manning's N	Diameter (in)	Material	Slope	Maximum Flow, gpm	Upstream MH Name	Upstream Invert (ft)	Upstream MH Rim	Maximum Upstream HGL	Upstream Flow Depth, ft	Class	Downstream MH Name	Downstream Invert (ft)	Downstream MH Rim	Maximum Downstream HGL	Downstream Flow Depth, ft	Class
320	0.015	8		0.050	24	M3-21	735.96	746.76	736.03	0.1		M3-10	720.00	729.00	720.20	0.2	
299	0.015	8		0.046	52	M3-30	719.79	740.18	719.89	0.1		M3-32	706.04	738.00	706.15	0.1	
399	0.015	8		0.046	63	M3-32	706.04	738.00	706.15	0.1		N4-1	687.59	733.59	687.72	0.1	
418	0.015	8		0.046	40	M3-33	739.02	744.76	739.11	0.1		M3-30	719.79	740.18	719.89	0.1	
460	0.015	8		0.025	542	M3-35	697.00	707.00	697.43	0.4		M3-36	685.66	693.66	686.12	0.5	
420	0.015	8		0.021	552	M3-36	685.66	693.66	686.12	0.5		M3-37	676.83	684.83	680.68	3.9	SUR
324	0.015	8		0.012	568	M3-37	676.83	684.83	680.68	3.9	SUR	M4-11	672.84	679.84	673.21	0.4	
389	0.015	8		0.029	24	M3-44	740.00	746.97	740.08	0.1		M3-9	728.83	734.00	729.06	0.2	
375	0.015	8		0.058	17	M3-46	741.78	747.00	741.84	0.1		M3-10	720.00	729.00	720.20	0.2	
378	0.015	6		0.015	28	M3-48	755.76	760.00	755.87	0.1		M3-3	750.06	758.00	750.21	0.2	
80	0.015	8		0.019	263	M3-53	712.41	719.00	712.70	0.3		M3-11	710.85	715.50	711.21	0.4	
346	0.015	8		0.004	163	M3-54	728.13	735.30	728.49	0.4		L3-63	726.83	736.83	727.28	0.4	
73	0.015	6		0.084	2	M3-54	738.89	748.89	738.91	0.0		M3-16	732.78	738.29	732.83	0.0	
376	0.015	6		0.007	17	M3-56	732.38	735.30	732.48	0.1		M3-20	729.51	733.30	729.92	0.4	
250	0.015	8		0.017	618	M4-8	663.99	670.99	664.55	0.6		M4-9	659.78	668.28	661.52	1.7	SUR
255	0.015	8		0.017	619	M4-9	659.78	668.28	661.52	1.7	SUR	M4-10	655.52	662.52	655.98	0.5	
425	0.015	8		0.037	637	M4-10	655.52	662.52	655.98	0.5		N4-16	639.88	646.88	646.88	7.0	SUR
430	0.015	12		0.021	590	M4-11	672.84	679.84	673.21	0.4		M4-8	663.99	670.99	664.55	0.6	
307	0.015	6		0.049	38	M5-12	637.13	641.13	637.23	0.1		M5-44	621.94	631.94	622.04	0.1	
275	0.015	6		0.006	33	M5-13	638.87	645.87	639.03	0.2		M5-12	637.13	641.13	637.23	0.1	
327	0.015	6		0.007	30	M5-14	641.22	645.42	641.36	0.1		M5-13	638.87	645.87	639.03	0.2	
313	0.015	6		0.140	9	M5-19	662.29	667.69	662.33	0.0		M6-2	618.83	627.83	618.87	0.0	
304	0.015	8		0.018	41	M5-35	589.90	594.00	590.02	0.1		L5-53	584.49	594.49	584.71	0.2	
214	0.015	6		0.053	43	M5-44	621.94	631.94	622.04	0.1		M6-4	610.64	620.64	610.73	0.1	
58	0.015	6		0.144	12	M6-2	618.83	627.83	618.87	0.0		M6-4	610.64	620.64	610.73	0.1	
321	0.015	6		0.141	61	M6-4	610.64	620.64	610.73	0.1		M6-5	565.84	572.94	565.99	0.1	
333	0.015	6		0.026	66	M6-5	565.84	572.94	565.99	0.1		M6-8	557.07	568.07	557.26	0.2	
320	0.015	8		0.016	119	M6-7	580.00	590.00	580.22	0.2		M6-12	575.00	585.20	575.13	0.1	
436	0.015	6		0.010	68	M6-8	557.07	568.07	557.26	0.2		M6-17	552.55	557.55	552.77	0.2	
594	0.015	12		0.030	261	M6-9	551.97	556.57	552.19	0.2		M6-20	534.00	545.30	534.30	0.3	
228	0.015	8		0.102	125	M6-12	575.00	585.20	575.13	0.1		M6-13	551.72	559.72	551.91	0.2	
406	0.015	10		0.024	130	M6-13	551.72	559.72	551.91	0.2		M6-26	542.00	545.60	542.14	0.1	
116	0.015	6		0.078	3	M6-14	555.10	565.10	555.12	0.0		M6-28	546.00	552.00	546.04	0.0	
182	0.015	6		0.005	2	M6-15	556.00	566.00	556.05	0.0		M6-14	555.10	565.10	555.12	0.0	
426	0.015	8		0.005	76	M6-17	552.55	557.55	552.77	0.2		L6-21	550.46	556.33	550.72	0.3	
411	0.015	12		0.012	280	M6-20	534.00	545.30	534.30	0.3		M6-32	529.00	534.40	529.25	0.2	
347	0.015	6		0.002	5	M6-23	534.84	539.74	534.91	0.1		M6-20	534.00	545.30	534.30	0.3	
303	0.015	10		0.063	136	M6-26	542.00	545.60	542.14	0.1		M6-33	523.00	531.00	523.52	0.5	
292	0.015	6		0.042	6	M6-28	546.00	552.00	546.04	0.0		M6-78	533.64	543.65	533.70	0.1	
172	0.015	6		0.023	3	M6-31	533.00	544.60	533.04	0.0		M6-32	529.00	534.40	529.25	0.2	
248	0.015	12		0.024	285	M6-32	529.00	534.40	529.25	0.2		M6-33	523.00	531.00	523.52	0.5	
346	0.015	12		0.003	424	M6-33	523.00	531.00	523.52	0.5		M6-34	521.80	530.80	522.30	0.5	
182	0.015	12		0.004	427	M6-34	521.80	530.80	522.30	0.5		M6-35	521.09	527.09	521.58	0.5	
107	0.015	12		0.004	440	M6-35	521.09	527.09	521.58	0.5		M6-36	520.62	525.62	521.17	0.5	
186	0.015	12		0.036	1528	M6-36	520.62	525.62	521.17	0.5		M6-42	514.00	519.00	514.66	0.7	
179	0.015	12		0.003	1087	M6-37	521.20	525.20	522.64	1.4	SUR	M6-36	520.62	525.62	521.17	0.5	
530	0.015	12		0.025	1546	M6-42	514.00	519.00	514.66	0.7		Z7-36	501.00	507.00	501.51	0.5	
264	0.015	8		0.025	247	M6-43	558.61	563.61	558.89	0.3		M6-9	551.97	556.57	552.19	0.2	
35	0.015	10		0.011	1	M6-44	552.12	562.12	552.14	0.0		M6-13	551.72	559.72	551.91	0.2	
108	0.015	6		0.010	1	M6-45	557.10	567.10	557.12	0.0		M6-15	556.00	566.00	556.05	0.0	
219	0.015	6		0.025	1	M6-45	557.10	567.10	557.12	0.0		M6-13	551.72	559.72	551.91	0.2	
107	0.015	12		0.001	358	M6-47	456.22	466.22	456.98	0.8		O7-29	456.13	466.13	456.90	0.8	
144	0.015	6		0.036	29	M6-48	506.21	512.71	506.30	0.1		Z7-36	501.00	507.00	501.51	0.5	SUR

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366	0.015	6		0.012	51	M6-53	524.76	532.66	524.94	0.2		L6-40	520.31	524.81	520.38	0.1	
92	0.014	15		0.005	1579	M6-59	488.94	499.54	489.81	0.9		M6-61	488.48	498.94	489.37	0.9	
19	0.015	12		0.037	1578	M6-59	489.65	499.65	490.20	0.6		M6-59	488.94	499.54	489.81	0.9	
162	0.014	15		0.005	1587	M6-61	488.48	498.94	489.37	0.9		M6-63	487.71	497.71	488.70	1.0	
358	0.014	15		0.004	1597	M6-63	487.71	497.71	488.70	1.0		M7-2	486.35	496.35	487.43	1.1	
295	0.015	6		0.043	11	M6-78	533.65	543.65	533.70	0.1		M6-35	521.09	527.09	521.58	0.5	
404	0.015	8		0.012	555	M6-83	526.25	536.25	528.52	2.3	SUR	M6-37	521.20	525.20	522.64	1.4	SUR
302	0.015	8		0.024	244	M6-88	565.93	571.93	566.20	0.3		M6-43	558.61	563.61	558.89	0.3	
363	0.015	6		0.011	44	M6-90	528.91	534.51	529.06	0.1		M6-53	524.76	532.66	524.94	0.2	
348	0.014	15		0.004	1610	M7-2	486.35	496.35	487.43	1.1		M7-62	478.20	491.66	479.11	0.9	
332	0.014	15		0.022	115	M7-15	484.52	488.12	484.67	0.1		M7-22	477.08	482.18	477.26	0.2	
524	0.014	30		0.002	72	M7-17	472.78	484.42	472.95	0.2		M7-23	471.80	481.80	472.12	0.3	
48	0.014	39		0.004	16199	M7-19	462.60	472.60	464.85	2.3		M7-36	462.39	480.60	465.17	2.8	
434	0.014	15		0.002	126	M7-20	475.37	484.37	475.64	0.3		M7-32	474.37	484.37	474.63	0.3	
286	0.015	10		0.004	335	M7-21	457.95	467.95	458.47	0.5		Y7-4	456.75	466.75	457.04	0.3	
173	0.014	15		0.010	122	M7-22	477.08	482.18	477.26	0.2		M7-20	475.37	484.37	475.64	0.3	
146	0.014	30		0.010	592	M7-23	471.80	481.80	472.12	0.3		M7-28	470.30	480.30	471.88	1.6	
233	0.014	15		0.003	138	M7-24	473.24	480.24	473.53	0.3		M7-25	472.58	476.58	472.77	0.2	
253	0.014	15		0.011	146	M7-25	472.58	476.58	472.77	0.2		M7-26	469.68	479.68	469.88	0.2	
261	0.014	15		0.012	152	M7-26	469.68	479.68	469.88	0.2		M7-19	462.60	472.60	464.85	2.3	SUR
182	0.014	30		0.009	11117	M7-27	467.97	477.97	469.79	1.8		M7-46	466.41	476.41	467.50	1.1	
289	0.014	30		0.008	11117	M7-28	470.30	480.30	471.88	1.6		M7-27	467.97	477.97	469.79	1.8	
195	0.014	27		0.006	10527	M7-29	471.44	481.44	473.47	2.0		M7-28	470.30	480.30	471.88	1.6	
272	0.014	27		0.006	9885	M7-30	473.12	483.12	474.92	1.8		M7-29	471.44	481.44	473.47	2.0	
131	0.014	15		0.003	133	M7-32	474.37	484.37	474.63	0.3		M7-35	474.01	482.01	474.27	0.3	
448	0.014	18		0.004	510	M7-33	475.00	479.50	475.42	0.4		M11-17	473.00	478.00	473.43	0.4	
281	0.014	15		0.003	136	M7-35	474.01	482.01	474.27	0.3		M7-24	473.24	480.24	473.53	0.3	
103	0.014	39		0.008	17103	M7-36	462.39	480.60	465.17	2.8		M7-37	461.59	477.59	464.93	3.3	SUR
414	0.014	39		0.001	13269	M7-37	461.59	477.59	464.93	3.3	SUR	N7-36	461.13	471.13	464.22	3.1	
289	0.015	8		0.004	107	M7-39	485.67	495.67	485.98	0.3		M7-15	484.52	488.12	484.67	0.1	
353	0.014	39		0.001	12851	M7-45	463.00	473.00	465.50	2.5		M7-19	462.60	472.60	464.85	2.3	
148	0.014	39		0.023	12627	M7-46	466.41	476.41	467.50	1.1		M7-45	463.00	473.00	465.50	2.5	
43	0.014	18		0.100	1533	M7-47	470.71	480.71	471.05	0.3		M7-46	466.41	476.41	467.50	1.1	
252	0.014	18		0.003	1531	M7-48	471.45	481.45	472.42	1.0		M7-47	470.71	480.71	471.05	0.3	
46	0.014	18		0.003	1528	M7-49	471.59	481.59	472.51	0.9		M7-48	471.45	481.45	472.42	1.0	
1168	0.013	8		0.161	9	M7-51	693.00	708.00	693.03	0.0		H4-1	507.00	512.00	507.63	0.6	
529	0.014	42		0.002	2556	M7-59	477.80	488.80	478.71	0.9		N7-70	476.91	487.91	477.82	0.9	
105	0.014	42		0.002	2553	M7-60	477.98	487.98	478.89	0.9		M7-59	477.80	488.80	478.71	0.9	
340	0.014	15		0.002	4	M7-62	485.06	491.66	485.12	0.1		M7-15	484.52	488.12	484.67	0.1	
131	0.014	42		0.002	2551	M7-62	478.20	491.66	479.11	0.9		M7-60	477.98	487.98	478.89	0.9	
221	0.014	42		0.001	933	M7-64	478.77	488.77	479.40	0.6		M7-67	478.55	488.55	479.17	0.6	
120	0.014	42		0.003	926	M7-66	479.13	489.13	479.61	0.5		M7-64	478.77	488.77	479.40	0.6	
196	0.014	45		0.002	943	M7-67	478.55	488.55	479.17	0.6		M7-62	478.20	491.66	479.11	0.9	
930	0.014	42		0.001	924	M7-68	479.69	489.69	480.50	0.8		M7-66	479.13	489.13	479.61	0.5	
164	0.014	42		0.001	917	M7-69	479.89	489.89	480.57	0.7		M7-68	479.69	489.69	480.50	0.8	
207	0.014	30		0.014	1	M7-70	483.40	489.92	483.41	0.0		L9-26	480.52	490.52	480.55	0.0	
83	0.014	42		0.000	899	M7-71	479.92	489.92	480.62	0.7		M7-69	479.89	489.89	480.57	0.7	
379	0.015	10		0.003	482	M8-1	461.52	471.52	462.35	0.8		M8-2	460.55	470.55	461.29	0.7	
24	0.015	10		0.001	498	M8-2	460.55	470.55	461.29	0.7		M8-3	460.53	470.53	461.21	0.7	
24	0.015	10		0.001	546	M8-3	460.53	470.53	461.21	0.7		LLSWW	460.50				
176	0.015	8		0.005	92	M8-4	487.69	497.69	487.93	0.2		M8-21	486.83	496.83	487.44	0.6	
276	0.014	18		0.003	1525	M8-5	472.40	482.40	473.28	0.9		M7-49	471.59	481.59	472.51	0.9	
31	0.014	15		0.229	1519	M8-6	479.20	489.20	479.49	0.3		M8-5	472.40	482.40	473.28	0.9	

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1130	0.014	15		0.005	1517	M8-7	484.89	494.89	485.93	1.0		M8-6	479.20	489.20	479.49	0.3	
175	0.014	15		0.011	1335	M8-8	488.81	498.81	489.41	0.6		M8-21	486.83	496.83	487.44	0.6	
384	0.014	15		0.040	1289	M8-9	504.18	514.18	504.60	0.4		M8-8	488.81	498.81	489.41	0.6	
379	0.014	15		0.039	1281	M8-10	518.83	528.83	519.25	0.4		M8-9	504.18	514.18	504.60	0.4	
264	0.014	15		0.003	1264	M8-11	519.62	529.62	520.59	1.0		M8-10	518.83	528.83	519.25	0.4	
228	0.014	15		0.003	1255	M8-12	520.30	530.30	521.19	0.9		M8-11	519.62	529.62	520.59	1.0	
337	0.015	8		0.005	90	M8-14	489.47	499.47	489.70	0.2		M8-4	487.69	497.69	487.93	0.2	
94	0.014	15		0.006	1253	M8-17	520.90	530.90	521.59	0.7		M8-12	520.30	530.30	521.19	0.9	
50	0.015	6		0.085	78	M8-18	525.15	539.95	525.27	0.1		M8-17	520.90	530.90	521.59	0.7	SUR
349	0.015	6		0.004	78	M8-19	526.52	532.52	526.84	0.3		M8-18	525.15	539.95	525.27	0.1	
155	0.014	15		0.013	1441	M8-21	486.83	496.83	487.44	0.6		M8-7	484.89	494.89	485.93	1.0	
257	0.014	15		0.002	1174	M9-1	521.35	531.35	522.39	1.0		M8-17	520.90	530.90	521.59	0.7	
349	0.014	15		0.003	1165	M9-2	522.40	532.40	523.24	0.8		M9-1	521.35	531.35	522.39	1.0	
175	0.014	15		0.002	1151	M9-3	529.38	539.38	530.34	1.0		M9-23	529.02	539.02	529.48	0.5	
423	0.014	15		0.002	1126	M9-4	530.40	540.40	531.29	0.9		M9-3	529.38	539.38	530.34	1.0	
427	0.015	12		0.010	1095	M9-5	534.48	544.48	535.16	0.7		M9-4	530.40	540.40	531.29	0.9	
270	0.015	12		0.009	1082	M9-6	536.88	546.88	537.58	0.7		M9-5	534.48	544.48	535.16	0.7	
170	0.015	12		0.007	1064	M9-7	538.37	552.37	539.16	0.8		M9-6	537.19	546.88	537.58	0.4	
250	0.015	10		0.003	478	M9-8	542.97	554.77	543.84	0.9	SUR	M9-24	542.30	552.30	542.67	0.4	
451	0.015	10		0.003	427	M9-9	544.14	559.44	544.82	0.7		M9-8	542.97	554.77	543.84	0.9	SUR
409	0.015	8		0.005	397	M9-10	545.99	560.29	547.72	1.7	SUR	M9-9	544.14	559.44	544.82	0.7	SUR
533	0.015	6		0.006	19	M9-14	547.73	557.73	547.85	0.1		M9-9	544.55	559.44	544.82	0.3	
445	0.015	6		0.007	17	M9-15	548.00	558.00	548.11	0.1		M9-8	542.97	554.77	543.84	0.9	SUR
50	0.015	12		0.009	560	M9-16	538.98	553.98	539.45	0.5		M9-38	538.52	552.00	539.42	0.9	
506	0.015	6		0.011	38	M9-17	548.11	553.31	550.57	2.5	SUR	M10-7	542.34	550.54	550.54	8.2	SUR
324	0.015	8		0.003	549	M9-19	539.89	554.89	544.23	4.3	SUR	M9-16	538.98	553.98	539.45	0.5	
300	0.014	15		0.022	1156	M9-23	529.02	539.02	529.48	0.5		M9-2	522.40	532.40	523.24	0.8	
249	0.015	12		0.016	495	M9-24	542.30	552.30	542.67	0.4		M9-7	538.37	552.37	539.16	0.8	
159	0.015	12		0.001	567	M9-38	538.52	552.00	539.42	0.9		M9-7	538.37	552.37	539.16	0.8	
409	0.015	8		0.002	540	M9-52	540.72	551.72	549.62	8.9	SUR	M9-19	539.89	554.89	544.23	4.3	SUR
23	0.014	15		0.003	556	M9-53	540.78	551.78	549.62	8.8	SUR	M9-52	540.72	551.72	549.62	8.9	SUR
108	0.015	12		0.007	494	M10-1	544.24	552.24	551.63	7.4	SUR	M10-5	543.46	553.26	551.50	8.0	SUR
223	0.015	12		0.002	498	M10-5	543.46	553.26	551.50	8.0	SUR	M10-6	543.06	551.36	551.20	8.1	SUR
474	0.015	12		0.002	503	M10-6	543.06	551.36	551.20	8.1	SUR	M10-7	542.34	550.54	550.54	8.2	SUR
223	0.015	12		0.000	506	M10-7	542.34	550.54	550.54	8.2	SUR	M10-8	542.23	551.13	550.28	8.0	SUR
229	0.015	12		0.002	511	M10-8	542.23	551.13	550.28	8.0	SUR	M10-9	541.80	550.80	549.98	8.2	SUR
224	0.015	12		0.003	524	M10-9	541.80	550.80	549.98	8.2	SUR	M10-10	541.10	551.26	549.67	8.6	SUR
62	0.014	15		0.002	534	M10-10	541.26	551.26	549.67	8.4	SUR	M10-36	541.11	551.11	549.64	8.5	SUR
233	0.015	10		0.003	10	M10-11	541.52	550.12	541.60	0.1		M10-12	540.80	552.00	540.92	0.1	
441	0.015	10		0.003	19	M10-12	540.80	552.00	540.92	0.1		N10-1	539.52	553.02	539.70	0.2	
369	0.015	6		0.017	19	M10-19	560.60	565.60	560.69	0.1		M11-10	554.41	558.91	554.66	0.2	
642	0.014	18		0.002	2064	M10-22	540.40	555.00	545.21	4.8	SUR	N10-55	539.21	548.01	543.78	4.6	SUR
325	0.014	18		0.003	103	M10-23	541.38	550.48	545.21	3.8	SUR	M10-22	540.40	555.00	545.21	4.8	SUR
135	0.014	18		0.005	1674	M10-25	546.76	552.46	550.21	3.4	SUR	M10-28	546.10	550.64	550.01	3.9	SUR
468	0.014	18		0.002	1892	M10-26	543.84	549.70	548.61	4.8	SUR	M10-46	542.99	553.50	547.73	4.7	SUR
496	0.014	18		0.002	1708	M10-27	544.94	551.04	549.32	4.4	SUR	M10-26	543.84	549.70	548.61	4.8	SUR
471	0.014	18		0.002	1691	M10-28	546.10	550.64	550.01	3.9	SUR	M10-27	544.94	551.04	549.32	4.4	SUR
44	0.015	8		0.060	92	M10-30	544.01	552.21	545.20	1.2	SUR	M10-23	541.38	550.48	545.21	3.8	SUR
270	0.015	8		0.008	19	M10-31	546.42	552.42	551.61	5.2	SUR	M10-1	544.24	552.24	551.63	7.4	SUR
195	0.015	10		0.006	208	M10-34	545.58	551.58	548.72	3.1	SUR	M10-26	544.47	549.70	548.61	4.1	SUR
335	0.015	10		0.006	185	M10-35	547.67	554.67	548.96	1.3	SUR	M10-34	545.58	551.58	548.72	3.1	SUR
137	0.014	15		0.002	533	M10-36	541.11	551.11	549.64	8.5	SUR	M9-53	540.78	551.78	549.62	8.8	SUR
399	0.014	18		0.002	1959	M10-42	542.15	557.50	546.92	4.8	SUR	M10-43	541.34	553.90	546.13	4.8	SUR

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LENGTH (ft)	Manning's N	Diameter (in)	Material	Slope	Maximum Flow, gpm	Upstream MH Name	Upstream Invert (ft)	Upstream MH Rim	Maximum Upstream HGL	Upstream Flow Depth, ft	Class	Downstream MH Name	Downstream Invert (ft)	Downstream MH Rim	Maximum Downstream HGL	Downstream Flow Depth, ft	Class
448	0.014	18		0.002	1993	M10-43	541.34	553.90	546.13	4.8	SUR	M10-22	540.40	555.00	545.21	4.8	SUR
418	0.014	18		0.002	1913	M10-46	542.99	553.50	547.73	4.7	SUR	M10-42	542.15	557.50	546.92	4.8	SUR
319	0.015	8		0.004	122	M11-7	559.06	565.56	559.39	0.3		M11-45	557.91	566.91	558.17	0.3	
323	0.015	10		0.004	148	M11-7	559.06	565.56	559.39	0.3		M11-45	557.91	566.91	558.17	0.3	
301	0.015	8		0.006	253	M11-9	555.55	565.55	555.96	0.4		M11-10	553.72	563.72	554.15	0.4	
329	0.015	8		0.007	80	M11-9	556.67	566.67	556.88	0.2		M11-10	554.41	558.91	554.66	0.2	
401	0.015	8		0.007	117	M11-10	554.41	558.91	554.66	0.2		M11-11	551.61	555.61	551.90	0.3	
393	0.015	8		0.005	258	M11-10	553.72	563.72	554.15	0.4		M11-48	551.63	561.63	552.13	0.5	
265	0.015	8		0.004	120	M11-11	551.61	555.61	551.90	0.3		M11-20	550.53	559.53	550.85	0.3	
449	0.015	8		0.001	63	M11-13	463.00	473.00	463.44	0.4		L8-8	462.46	472.46	463.37	0.9	SUR
488	0.015	10		0.003	125	M11-14	563.35	571.50	563.66	0.3		M11-53	561.69	577.50	561.94	0.2	
349	0.015	8		0.007	165	M11-15	567.10	573.10	567.43	0.3		T9-2	564.55	570.05	564.72	0.2	
174	0.015	6		0.003	4	M11-16	655.00	656.00	655.06	0.1		K4-6	654.43	662.00	654.51	0.1	
223	0.014	18		0.005	515	M11-17	473.00	478.00	473.43	0.4		M7-23	471.80	481.80	472.12	0.3	
420	0.014	30		0.002	63	M11-18	473.57	483.57	473.73	0.2		M7-17	472.78	484.42	472.95	0.2	
274	0.015	12		0.018	406	M11-20	550.53	559.53	550.85	0.3		N11-13	545.60	552.60	546.22	0.6	
318	0.015	6		0.052	14	M11-21	570.63	574.63	570.69	0.1		M11-20	550.53	559.53	550.85	0.3	
91	0.015	8		0.153	121	M11-31	678.16	688.00	678.28	0.1		K4-47	664.43	669.50	664.55	0.1	
544	0.015	6		0.009	22	M11-32	659.05	669.05	659.17	0.1		K4-6	654.43	662.00	654.51	0.1	
399	0.015	6		0.114	33	M11-33	663.85	670.85	663.92	0.1		L5-28	618.60	625.60	618.69	0.1	
280	0.015	6		0.138	17	M11-36	626.97	635.71	627.02	0.0		F6-15	587.57	597.57	588.12	0.5	SUR
70	0.014	15		0.021	1706	M11-37	645.31	655.31	645.89	0.6		K3-18	643.87	653.87	644.81	0.9	
320	0.015	8		0.005	250	M11-45	557.28	567.28	557.71	0.4		M11-9	555.55	565.55	555.96	0.4	
350	0.015	8		0.004	78	M11-45	557.91	566.91	558.17	0.3		M11-9	556.67	566.67	556.88	0.2	
35	0.015	10		0.013	206	M11-45	557.50	566.91	558.17	0.7		M11-45	557.45	567.28	557.71	0.3	
265	0.015	8		0.004	263	M11-48	551.63	561.63	552.13	0.5		M11-49	550.61	560.61	551.11	0.5	
28	0.015	8		0.003	269	M11-49	550.61	560.61	551.11	0.5		M11-20	550.53	559.53	550.85	0.3	
335	0.015	10		0.008	142	M11-53	561.69	577.50	561.94	0.2		M11-7	559.06	565.56	559.39	0.3	
241	0.014	21		0.005	0	M12-3	511.91	518.91	511.91	0.0		N12-75	510.67	519.47	510.74	0.1	
392	0.015	8		0.003	40	N2-5	756.46	766.56	756.68	0.2		N2-6	755.44	766.81	755.57	0.1	
292	0.015	8		0.018	52	N2-6	755.44	766.81	755.57	0.1		M2-8	750.20	755.77	750.34	0.1	
404	0.015	8		0.019	287	N2-8	747.11	752.71	747.57	0.5		M2-12	739.45	746.18	746.18	6.7	SUR
409	0.015	8		0.016	276	N2-9	753.84	761.94	754.16	0.3		N2-8	747.11	752.71	747.57	0.5	
339	0.015	8		0.021	258	N2-10	761.03	766.53	761.31	0.3		N2-9	753.84	761.94	754.16	0.3	
114	0.015	8		0.005	23	N2-11	761.56	766.56	761.68	0.1		N2-10	761.03	766.53	761.31	0.3	
93	0.015	8		0.004	232	N2-19	761.44	768.44	761.90	0.5		N2-10	761.03	766.53	761.31	0.3	
273	0.015	8		0.004	222	N2-22	762.48	767.98	762.92	0.4		N2-19	761.44	768.44	761.90	0.5	
406	0.015	8		0.047	213	N2-23	781.50	791.50	781.71	0.2		N2-22	762.48	767.98	762.92	0.4	
67	0.015	8		0.009	109	N2-30	740.06	750.06	740.29	0.2		N2-35	739.43	746.00	739.62	0.2	
196	0.015	8		0.004	109	N2-31	740.82	750.82	741.13	0.3		N2-30	740.06	750.06	740.29	0.2	
287	0.015	8		0.034	84	N2-32	750.60	760.60	750.74	0.1		N2-31	740.82	750.82	741.13	0.3	
335	0.015	8		0.019	11	N2-33	756.85	766.85	756.91	0.1		N2-32	750.60	760.60	750.74	0.1	
399	0.015	8		0.018	117	N2-35	739.43	746.00	739.62	0.2		N2-42	732.03	742.03	732.20	0.2	
401	0.015	8		0.043	138	N2-42	732.03	742.03	732.20	0.2		N3-54	714.77	724.57	714.97	0.2	
291	0.015	8		0.004	515	N3-2	723.52	733.52	731.68	8.2	SUR	O3-2	722.37	728.17	728.17	5.8	SUR
332	0.015	8		0.004	247	N3-6	748.70	758.70	749.14	0.4		M3-12	747.21	757.00	747.77	0.6	
383	0.015	8		0.004	209	N3-7	750.41	760.41	750.81	0.4		N3-6	748.70	758.70	749.14	0.4	
233	0.015	8		0.053	28	N3-8	761.02	771.02	761.09	0.1		N3-6	748.70	758.70	749.14	0.4	
422	0.015	8		0.001	65	N3-11	755.27	765.27	755.69	0.4		N3-21	754.96	764.96	755.14	0.2	
126	0.015	8		0.001	54	N3-12	755.43	765.43	755.73	0.3		N3-11	755.27	765.27	755.69	0.4	
271	0.015	8		0.001	38	N3-14	755.77	765.77	755.99	0.2		N3-12	755.43	765.43	755.73	0.3	
407	0.015	8		0.003	13	N3-15	756.84	766.84	756.94	0.1		N3-14	755.77	765.77	755.99	0.2	
206	0.015	6		0.132	15	N3-17	747.10	757.01	747.06	0.0		RLSWW	436.23				

2010 Master Plan Clear Creek Collection System Pipe Analysis Results

LENGTH (ft)	Manning's N	Diameter (in)	Material	Slope	Maximum Flow, gpm	Upstream MH Name	Upstream Invert (ft)	Upstream MH Rim	Maximum Upstream HGL	Upstream Flow Depth, ft	Class	Downstream MH Name	Downstream Invert (ft)	Downstream MH Rim	Maximum Downstream HGL	Downstream Flow Depth, ft	Class
328	0.015	6		0.051	15	N3-18	746.85	756.85	746.91	0.1		RLSWW	730.00				
304	0.015	8		0.004	187	N3-20	753.47	763.47	753.86	0.4		N3-22	752.27	762.27	752.66	0.4	
26	0.015	8		0.057	177	N3-21	754.96	764.96	755.14	0.2		N3-20	753.47	763.47	753.86	0.4	
379	0.015	10		0.003	200	N3-22	752.27	762.27	752.66	0.4		N3-23	751.15	761.15	751.53	0.4	
226	0.015	10		0.003	206	N3-23	751.15	761.15	751.53	0.4		N3-7	750.41	760.41	750.81	0.4	
490	0.015	8		0.125	55	N3-31	713.55	723.55	713.63	0.1		N4-17	652.90	657.90	653.15	0.2	
321	0.015	8		0.169	92	N3-36	726.10	730.10	726.20	0.1		N3-37	672.50	676.50	672.70	0.2	
288	0.015	8		0.022	133	N3-37	672.50	676.50	672.70	0.2		N3-38	666.07	670.07	666.25	0.2	
389	0.015	8		0.034	139	N3-38	666.07	670.07	666.25	0.2		N4-17	652.90	657.90	653.15	0.2	
360	0.015	8		0.018	479	N3-45	730.01	736.01	735.43	5.4	SUR	N3-2	723.52	733.52	731.68	8.2	SUR
379	0.015	8		0.009	458	N3-46	733.42	739.02	739.02	5.6	SUR	N3-45	730.01	736.01	735.43	5.4	SUR
320	0.015	8		0.024	445	N3-47	741.12	747.52	741.62	0.5		N3-46	733.42	739.02	739.02	5.6	SUR
286	0.015	8		0.004	416	N3-48	742.34	750.64	745.68	3.3	SUR	N3-47	741.12	747.52	741.62	0.5	
141	0.015	8		0.005	78	N3-49	743.07	749.97	744.32	1.2	SUR	N3-48	742.34	750.64	745.68	3.3	SUR
275	0.015	8		0.003	158	N3-54	714.57	724.57	714.97	0.4		WSLSWW	713.61				
400	0.015	8		0.004	388	N3-55	721.11	728.44	726.39	5.3	SUR	N4-22	719.51	726.81	723.88	4.4	SUR
393	0.015	8		0.046	75	N4-1	687.59	733.59	687.72	0.1		N4-2	669.42	679.42	669.52	0.1	
88	0.015	8		0.131	81	N4-2	669.42	679.42	669.52	0.1		N4-3	657.89	724.46	658.02	0.1	
134	0.015	8		0.046	85	N4-3	657.89	724.46	658.02	0.1		N4-24	651.75	661.75	651.89	0.1	
188	0.015	8		0.000	223	N4-4	638.56	642.56	642.56	4.0	SUR	N4-37	638.56	644.00	643.22	4.7	SUR
198	0.015	8		0.008	582	N4-5	637.90	657.00	643.26	5.4	SUR	N4-6	636.33	656.00	641.20	4.9	SUR
98	0.015	8		0.090	576	N4-6	636.13	656.00	641.20	5.1	SUR	N4-7	627.33	647.00	640.28	12.9	SUR
264	0.015	10		0.006	938	N4-7	627.13	647.00	640.28	13.2	SUR	N4-8	625.55	645.00	637.91	12.4	SUR
345	0.015	10		0.006	955	N4-8	625.55	645.00	637.91	12.4	SUR	N4-9	623.45	643.00	634.64	11.2	SUR
252	0.015	10		0.008	979	N4-9	623.45	643.00	634.64	11.2	SUR	N4-10	621.45	651.00	632.02	10.6	SUR
400	0.015	10		0.023	991	N4-10	621.45	651.00	632.02	10.6	SUR	N4-11	612.34	632.00	627.68	15.3	SUR
73	0.015	10		0.016	998	N4-11	612.34	632.00	627.68	15.3	SUR	N4-36	611.19	631.00	626.88	15.7	SUR
177	0.015	10		0.006	1062	N4-12	598.11	628.00	618.76	20.7	SUR	O4-1	597.00	617.00	616.15	19.2	SUR
330	0.015	10		0.029	1044	N4-14	608.03	628.00	623.44	15.4	SUR	N4-12	598.30	628.00	618.76	20.5	SUR
298	0.015	8		0.018	428	N4-15	633.85	641.85	641.85	8.0	SUR	N4-7	628.53	647.00	640.28	11.8	SUR
290	0.015	8		0.021	619	N4-16	639.88	646.88	646.88	7.0	SUR	N4-15	633.85	641.85	641.85	8.0	SUR
363	0.015	8		0.021	203	N4-17	652.90	657.90	653.15	0.2		N4-18	645.10	655.10	649.70	4.6	SUR
325	0.015	8		0.022	673	N4-18	645.10	655.10	649.70	4.6	SUR	N4-5	637.90	657.00	643.26	5.4	SUR
319	0.015	8		0.226	460	N4-19	715.33	725.33	715.54	0.2		N4-18	645.10	655.10	649.70	4.6	SUR
209	0.015	8		0.004	457	N4-20	716.09	730.99	718.80	2.7	SUR	N4-19	715.33	725.33	715.54	0.2	
323	0.015	8		0.005	451	N4-21	717.59	727.49	721.79	4.2	SUR	N4-20	716.09	730.99	718.80	2.7	SUR
280	0.015	8		0.007	407	N4-22	719.51	726.81	723.88	4.4	SUR	N4-21	717.59	727.49	721.79	4.2	SUR
299	0.015	8		0.005	36	N4-23	719.00	727.40	721.80	2.8	SUR	N4-21	717.59	727.49	721.79	4.2	SUR
223	0.015	8		0.046	90	N4-24	651.75	661.75	651.89	0.1		N4-25	641.47	651.47	643.08	1.6	SUR
63	0.015	8		0.046	92	N4-25	641.47	651.47	643.08	1.6	SUR	N4-4	638.56	642.56	642.56	4.0	SUR
397	0.015	8		0.138	77	N4-35	665.44	675.44	665.54	0.1		N4-36	611.19	631.00	626.88	15.7	SUR
261	0.015	10		0.012	1051	N4-36	611.19	631.00	626.88	15.7	SUR	N4-14	608.03	628.00	623.44	15.4	SUR
27	0.015	8		0.024	224	N4-37	638.56	644.00	643.22	4.7	SUR	N4-5	637.90	657.00	643.26	5.4	SUR
396	0.015	8		0.021	380	N5-1	578.83	588.83	579.19	0.4		N5-2	570.50	580.50	570.85	0.4	
327	0.015	8		0.026	419	N5-2	570.50	580.50	570.85	0.4		N5-3	561.99	569.99	562.40	0.4	
354	0.015	8		0.020	447	N5-3	561.99	569.99	562.40	0.4		N6-1	554.99	564.99	555.37	0.4	
368	0.015	8		0.005	103	N5-4	685.79	695.79	686.04	0.3		N5-12	683.94	693.94	684.21	0.3	
162	0.015	8		0.006	133	N5-10	680.77	684.77	681.07	0.3		N5-33	679.60	685.00	679.96	0.4	
325	0.015	8		0.005	124	N5-11	682.41	692.41	682.69	0.3		N5-10	680.77	684.77	681.07	0.3	
307	0.015	8		0.005	114	N5-12	683.94	693.94	684.21	0.3		N5-11	682.41	692.41	682.69	0.3	
100	0.014	42		0.004	30267	N5-13	410.40	420.40	413.39	3.0		SB8-1	410.00	420.00	412.40	2.4	
326	0.015	8		0.070	185	N5-23	673.81	679.81	673.98	0.2		O5-31	650.98	660.98	651.15	0.2	
375	0.015	8		0.004	42	N5-25	675.49	685.99	675.65	0.2		N5-23	673.81	679.81	673.98	0.2	

2010 Master Plan Clear Creek Collection System Pipe Analysis Results

LENGTH (ft)	Manning's N	Diameter (in)	Material	Slope	Maximum Flow, gpm	Upstream MH Name	Upstream Invert (ft)	Upstream MH Rim	Maximum Upstream HGL	Upstream Flow Depth, ft	Class	Downstream MH Name	Downstream Invert (ft)	Downstream MH Rim	Maximum Downstream HGL	Downstream Flow Depth, ft	Class
363	0.015	8		0.012	33	N5-26	679.71	691.71	679.82	0.1		N5-25	675.49	685.99	675.65	0.2	
88	0.015	6		0.023	3	N5-27	681.74	692.04	681.77	0.0		N5-26	679.71	691.71	679.82	0.1	
265	0.015	8		0.005	24	N5-28	680.94	692.44	681.07	0.1		N5-26	679.71	691.71	679.82	0.1	
190	0.015	8		0.031	138	N5-33	679.77	685.00	679.96	0.2		N5-23	673.81	679.81	673.98	0.2	
362	0.015	8		0.026	477	N6-1	554.99	564.99	555.37	0.4		N6-2	545.50	555.50	545.91	0.4	
371	0.015	8		0.023	506	N6-2	545.50	555.50	545.91	0.4		N6-3	536.89	546.89	538.33	1.4	SUR
334	0.015	8		0.013	540	N6-3	536.89	546.89	538.33	1.4	SUR	N6-4	532.64	541.00	533.09	0.4	
298	0.015	8		0.021	546	N6-4	532.64	541.00	533.09	0.4		M6-83	526.25	536.25	528.52	2.3	SUR
181	0.015	6		0.000	1	N6-4	555.10	541.00	555.19	0.1		M6-87	532.64	565.10	533.09	0.4	
308	0.015	15		0.003	537	N6-10	522.20	537.20	522.78	0.6		M6-37	521.20	525.20	522.64	1.4	SUR
311	0.015	15		0.003	522	N6-12	523.20	531.20	523.72	0.5		N6-10	522.20	537.20	522.78	0.6	
309	0.015	15		0.004	515	N6-14	524.47	528.20	524.96	0.5		N6-12	523.20	531.20	523.72	0.5	
310	0.015	15		0.004	498	N6-15	525.58	530.00	526.08	0.5		N6-14	524.47	528.20	524.96	0.5	
281	0.015	8		0.004	491	N6-16	526.60	536.60	529.11	2.5	SUR	N6-15	525.58	530.00	526.08	0.5	
377	0.015	8		0.036	479	N6-17	540.16	546.16	540.51	0.3		N6-16	526.60	536.60	529.11	2.5	SUR
373	0.015	8		0.032	471	N6-18	552.11	557.11	552.47	0.4		N6-17	540.16	546.16	540.51	0.3	
359	0.015	8		0.021	459	N6-19	559.81	566.81	560.22	0.4		N6-18	552.11	557.11	552.47	0.4	
180	0.015	8		0.043	453	N6-20	567.61	573.61	567.93	0.3		N6-19	559.81	566.81	560.22	0.4	
284	0.015	8		0.056	448	N6-21	583.54	589.54	583.83	0.3		N6-20	567.61	573.61	567.93	0.3	
376	0.015	6		0.039	18	N6-27	538.13	548.13	538.20	0.1		N6-28	523.31	533.31	523.54	0.2	
408	0.015	6		0.002	40	N6-28	523.31	533.31	523.54	0.2		O6-2	522.50	532.50	522.71	0.2	
175	0.015	8		0.004	78	N6-36	489.10	495.80	489.35	0.3		N7-2	488.37	498.37	488.56	0.2	
403	0.015	8		0.010	17	N6-46	524.00	530.00	524.09	0.1		N6-47	520.00	527.00	520.09	0.1	
398	0.015	8		0.022	26	N6-47	520.00	527.00	520.09	0.1		O6-13	511.10	520.50	511.29	0.2	
199	0.015	6		0.002	5	N6-52	584.12	594.12	584.24	0.1		N6-53	583.74	593.74	583.77	0.0	
111	0.015	6		0.305	9	N6-53	583.74	593.74	583.77	0.0		N6-61	551.23	561.20	551.25	0.0	
163	0.015	6		0.012	10	N6-55	526.00	532.00	526.07	0.1		N6-46	524.00	530.00	524.09	0.1	
125	0.015	6		0.105	12	N6-61	551.20	561.20	551.25	0.0		N6-27	538.13	548.13	538.20	0.1	
286	0.015	6		0.031	14	N6-64	533.30	536.00	533.37	0.1		N6-14	524.47	528.20	524.96	0.5	
168	0.015	8		0.004	86	N7-2	488.25	498.25	488.50	0.2		N7-6	487.57	488.95	487.82	0.3	
11	0.015	8		0.011	83	N7-2	488.37	498.37	488.56	0.2		N7-2	488.25	498.25	488.50	0.2	
210	0.015	8		0.004	90	N7-6	487.57	488.95	487.82	0.3		N7-9	486.72	496.72	486.99	0.3	
260	0.015	8		0.004	100	N7-9	486.72	496.72	486.99	0.3		M7-39	485.67	495.67	485.98	0.3	
320	0.015	8		0.016	71	N7-19	467.77	471.77	467.93	0.2		N7-20	459.62	469.62	462.66	3.0	SUR
48	0.014	39		0.001	12528	N7-20	459.62	469.62	462.66	3.0		N7-35	459.57	474.80	462.61	3.0	
358	0.014	39		0.001	12483	N7-26	459.01	469.01	462.05	3.0		N7-34	458.63	474.33	461.65	3.0	
256	0.015	8		0.021	26	N7-29	468.32	477.32	468.41	0.1		N7-31	463.00	470.21	463.28	0.3	
546	0.014	39		0.001	12498	N7-31	460.21	470.21	463.28	3.1		N7-20	459.62	469.62	462.66	3.0	
349	0.014	39		0.001	12442	N7-34	458.63	474.33	461.65	3.0		O7-5	458.19	473.89	461.26	3.1	
505	0.014	39		0.001	12508	N7-35	459.57	474.80	462.61	3.0		N7-26	459.01	469.01	462.05	3.0	
827	0.014	39		0.001	12569	N7-36	461.13	471.13	464.22	3.1		N7-31	460.21	470.21	463.28	3.1	
726	0.014	45		0.001	2644	N7-64	472.50	482.50	473.59	1.1		O7-47	471.77	482.37	472.64	0.9	
16	0.014	36		0.082	2281	N7-64	471.20	483.00	473.63	2.4		N7-64	472.50	482.50	473.59	1.1	
55	0.014	36		0.001	2276	N7-65	471.26	483.76	473.63	2.4		N7-64	471.20	483.00	473.63	2.4	
13	0.014	36		0.200	2272	N7-65	473.76	483.76	474.04	0.3		N7-65	471.26	483.76	473.63	2.4	
83	0.014	14		0.015	351	N7-65	473.76	483.76	474.04	0.3		N7-64	472.50	482.50	473.59	1.1	
476	0.014	42		0.002	2610	N7-66	474.67	484.67	475.68	1.0		N7-65	473.76	483.76	474.04	0.3	
51	0.014	42		0.002	2588	N7-67	474.77	485.73	475.73	1.0		N7-66	474.67	484.67	475.68	1.0	
211	0.014	42		0.001	2586	N7-68	475.01	486.01	475.99	1.0		N7-67	474.73	485.73	475.73	1.0	
393	0.014	42		0.002	2582	N7-69	475.66	486.66	476.58	0.9		N7-68	475.01	486.01	475.99	1.0	
738	0.014	42		0.002	2563	N7-70	476.91	487.91	477.82	0.9		N7-69	475.66	486.66	476.58	0.9	
343	0.015	8		0.004	38	N7-83	463.17	471.17	463.34	0.2		N7-26	461.80	469.01	462.05	0.2	
165	0.015	6		0.004	48	N8-4	520.06	526.06	520.26	0.2		N8-5	519.39	523.99	519.59	0.2	

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398	0.015	6		0.009	69	N8-5	519.39	523.99	519.59	0.2		N9-13	515.92	521.02	518.10	2.2	SUR
66	0.015	6		0.076	216	N9-9	519.82	529.02	520.03	0.2		N9-12	514.81	526.61	517.74	2.9	SUR
30	0.015	8		0.013	215	N9-11	520.85	531.05	521.14	0.3		N9-11	520.46	530.16	520.80	0.3	
57	0.015	8		0.011	215	N9-11	520.46	530.16	520.80	0.3		N9-9	519.82	529.02	520.03	0.2	
168	0.013	6		0.008	292	N9-12	514.81	526.61	517.74	2.9	SUR	N9-15	513.46	521.96	515.47	2.0	SUR
284	0.015	6		0.004	74	N9-13	515.92	521.02	518.10	2.2	SUR	N9-12	514.81	526.61	517.74	2.9	SUR
326	0.013	6		0.005	38	N9-14	515.09	520.19	515.30	0.2		N9-15	513.46	521.96	515.47	2.0	SUR
209	0.013	6		0.012	327	N9-15	513.46	521.96	515.47	2.0	SUR	N9-16	510.86	516.75	512.56	1.7	SUR
513	0.013	8		0.003	331	N9-16	510.86	516.75	512.56	1.7	SUR	N9-46	509.36	512.70	511.10	1.7	SUR
106	0.013	8		0.006	1	N9-16	510.00	520.00	510.03	0.0		N9-45	509.35	514.85	509.42	0.1	
42	0.013	6		0.004	101	N9-17	508.16	510.96	508.55	0.4		N9-19	507.97	511.97	508.55	0.6	SUR
280	0.013	6		0.004	120	N9-19	507.97	511.97	508.55	0.6	SUR	O9-3	506.86	513.16	508.62	1.8	SUR
302	0.015	8		0.013	214	N9-20	524.87	534.00	525.16	0.3		N9-11	520.85	531.05	521.14	0.3	
298	0.013	6		0.004	6	N9-45	509.35	514.85	509.42	0.1		N9-17	508.16	510.96	508.55	0.4	
361	0.013	8		0.003	363	N9-46	509.20	512.70	511.10	1.9	SUR	O9-47	508.00	512.40	510.48	2.5	SUR
438	0.015	10		0.003	42	N10-1	539.52	553.02	539.70	0.2		N10-2	538.18	543.18	538.33	0.2	
393	0.015	10		0.009	58	N10-2	538.18	543.18	538.33	0.2		N10-3	534.81	539.81	535.07	0.3	
311	0.015	10		0.003	70	N10-3	534.81	539.81	535.07	0.3		N10-7	533.98	546.18	534.14	0.2	
313	0.015	10		0.013	76	N10-7	533.98	546.18	534.14	0.2		N10-8	529.78	541.58	530.16	0.4	
277	0.015	10		0.003	192	N10-8	529.78	541.58	530.16	0.4		N10-9	528.97	540.97	529.37	0.4	
273	0.015	10		0.002	199	N10-9	528.97	540.97	529.37	0.4		N10-10	528.30	538.50	528.72	0.4	
351	0.015	10		0.002	208	N10-10	528.30	538.50	528.72	0.4		O10-13	527.50	539.20	527.92	0.4	
154	0.014	18		0.002	2097	N10-20	537.44	551.44	542.28	4.8	SUR	N10-21	537.16	544.36	541.93	4.8	SUR
351	0.014	18		0.003	2101	N10-21	536.66	544.36	541.93	5.3	SUR	N10-52	535.59	544.39	541.11	5.5	SUR
619	0.014	18		0.002	2110	N10-50	534.11	542.01	540.46	6.4	SUR	O10-47	533.01	539.00	539.00	6.0	SUR
178	0.014	18		0.005	2108	N10-51	535.00	544.50	540.88	5.9	SUR	N10-50	534.11	542.01	540.46	6.4	SUR
103	0.014	18		0.006	2106	N10-52	535.59	544.39	541.11	5.5	SUR	N10-51	535.00	544.50	540.88	5.9	SUR
668	0.014	18		0.002	2083	N10-55	539.21	548.01	543.78	4.6	SUR	N10-20	538.04	551.44	542.28	4.2	SUR
370	0.015	10		0.003	419	N11-13	545.60	552.60	546.22	0.6		N11-15	544.48	551.48	545.22	0.7	
401	0.015	10		0.003	428	N11-15	544.48	551.48	545.22	0.7		N11-18	543.34	553.34	543.79	0.5	
355	0.015	6		0.019	10	N11-17	549.92	558.92	549.99	0.1		N11-18	543.34	553.34	543.79	0.5	
261	0.015	10		0.011	447	N11-18	543.34	553.34	543.79	0.5		N11-19	540.54	550.54	540.85	0.3	
159	0.015	10		0.034	460	N11-19	540.54	550.54	540.85	0.3		N11-23	535.21	541.21	535.61	0.4	
423	0.015	6		0.004	16	N11-22	537.03	545.43	537.14	0.1		N11-23	535.21	541.21	535.61	0.4	
301	0.015	10		0.015	481	N11-23	535.21	541.21	535.61	0.4		N11-24	530.78	535.78	531.18	0.4	
308	0.015	10		0.015	488	N11-24	530.78	535.78	531.18	0.4		N11-25	526.21	530.21	526.71	0.5	
395	0.015	10		0.008	494	N11-25	526.21	530.21	526.71	0.5		O11-12	523.17	529.87	523.80	0.6	
478	0.014	21		0.004	224	N11-44	503.18	516.68	503.46	0.3		N11-45	501.27	513.17	501.60	0.3	
664	0.014	21		0.003	263	N11-45	501.27	513.17	501.60	0.3		N12-54	499.38	513.58	499.69	0.3	
106	0.015	8		0.188	186	N11-49	522.85	530.55	522.99	0.1		N11-44	503.18	516.68	503.46	0.3	
324	0.015	8		0.020	163	N11-50	529.24	539.44	529.49	0.3		N11-49	522.85	530.55	522.99	0.1	
206	0.015	8		0.012	4	N11-51	525.30	531.40	525.34	0.0		N11-49	522.85	530.55	522.99	0.1	
226	0.015	8		0.039	136	N11-54	538.00	544.00	538.17	0.2		N11-50	529.24	539.44	529.49	0.3	
372	0.015	8		0.029	119	N11-55	548.73	555.23	548.90	0.2		N11-54	538.00	544.00	538.17	0.2	
283	0.015	8		0.032	99	N11-56	557.66	562.06	557.82	0.2		N11-55	548.73	555.23	548.90	0.2	
130	0.015	8		0.017	37	N11-57	559.85	567.55	559.96	0.1		N11-56	557.66	562.06	557.82	0.2	
147	0.015	8		0.009	18	N11-63	524.15	529.25	524.24	0.1		N11-49	522.85	530.55	522.99	0.1	
75	0.015	10		0.003	227	N12-1	525.19	535.19	525.58	0.4		N12-56	524.93	534.93	525.40	0.5	
102	0.015	10		0.003	226	N12-2	525.48	535.48	525.90	0.4		N12-1	525.19	535.19	525.58	0.4	
214	0.015	10		0.003	222	N12-3	526.17	536.17	526.57	0.4		N12-2	525.48	535.48	525.90	0.4	
77	0.015	10		0.002	216	N12-4	526.36	536.36	526.78	0.4		N12-3	526.17	536.17	526.57	0.4	
158	0.015	10		0.003	198	N12-5	527.44	537.44	527.82	0.4		N12-57	526.98	536.98	527.37	0.4	
205	0.015	8		0.003	191	N12-6	527.98	537.98	528.45	0.5		N12-5	527.44	537.44	527.82	0.4	

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119	0.015	8		0.078	123	N12-7	537.21	549.21	537.35	0.1		N12-6	527.98	537.98	528.45	0.5	
387	0.015	8		0.004	116	N12-8	538.75	550.75	539.08	0.3		N12-7	537.21	549.21	537.35	0.1	
267	0.015	8		0.044	10	N12-12	540.52	544.52	540.57	0.0		N12-13	528.91	531.91	529.13	0.2	
270	0.015	8		0.003	63	N12-13	528.91	531.91	529.13	0.2		N12-6	527.98	537.98	528.45	0.5	
266	0.015	8		0.003	85	N12-18	541.87	546.87	542.17	0.3		N12-52	541.11	543.61	541.32	0.2	
250	0.015	8		0.003	60	N12-21	542.63	545.13	542.85	0.2		N12-18	541.87	546.87	542.17	0.3	
371	0.015	8		0.001	92	N12-31	539.17	545.97	539.55	0.4		N12-8	538.75	550.75	539.08	0.3	
162	0.015	6		0.005	91	N12-32	539.90	541.90	540.19	0.3		N12-31	539.17	545.97	539.55	0.4	
463	0.014	21		0.013	33	N12-51	509.07	519.17	509.15	0.1		N11-44	503.18	516.68	503.46	0.3	
148	0.015	8		0.008	88	N12-52	541.11	543.61	541.32	0.2		N12-32	539.90	541.90	540.19	0.3	
638	0.014	21		0.004	274	N12-54	499.38	513.58	499.69	0.3		O12-4	497.07	507.57	497.44	0.4	
405	0.015	10		0.002	231	N12-56	524.93	534.93	525.40	0.5		O12-34	524.13	534.13	524.65	0.5	
208	0.015	10		0.003	211	N12-57	526.98	536.98	527.37	0.4		N12-4	526.36	536.36	526.78	0.4	
372	0.015	8		0.032	24	N12-61	513.11	523.11	513.19	0.1		N11-45	501.27	513.17	501.60	0.3	
312	0.015	8		0.003	46	N12-66	529.85	531.85	530.04	0.2		N12-13	528.91	531.91	529.13	0.2	
500	0.014	21		0.003	12	N12-75	510.67	519.47	510.74	0.1		N12-51	509.07	519.17	509.15	0.1	
349	0.015	8		0.037	175	O2-1	725.74	731.94	725.94	0.2		O3-13	712.90	723.90	713.27	0.4	
268	0.015	8		0.035	164	O2-4	735.20	741.10	735.39	0.2		O2-1	725.74	731.94	725.94	0.2	
212	0.015	8		0.004	148	O2-5	736.00	745.00	736.38	0.4		O2-4	735.20	741.10	735.39	0.2	
314	0.015	8		0.004	376	O3-2	722.37	728.17	728.17	5.8	SUR	N3-55	721.11	728.44	726.39	5.3	SUR
283	0.015	8		0.016	24	O3-4	728.05	733.75	731.68	3.6	SUR	N3-2	723.52	733.52	731.68	8.2	SUR
413	0.015	8		0.004	398	O3-7	744.15	753.25	752.65	8.5	SUR	N3-48	742.34	750.64	745.68	3.3	SUR
414	0.015	8		0.004	383	O3-8	745.82	755.92	753.65	7.8	SUR	O3-7	744.15	753.25	752.65	8.5	SUR
350	0.015	8		0.019	372	O3-10	752.62	758.22	752.98	0.4		O3-8	745.82	755.92	753.65	7.8	SUR
325	0.015	8		0.006	362	O3-11	754.60	760.60	755.32	0.7	SUR	O3-10	752.62	758.22	752.98	0.4	
88	0.015	8		0.059	201	O3-13	712.90	723.90	713.27	0.4		WSLSWW	705.38				
524	0.015	10		0.019	1114	O4-1	597.00	617.00	616.15	19.2	SUR	O5-32	586.98	611.00	607.20	20.2	SUR
382	0.015	8		0.070	308	O4-10	702.28	708.28	702.51	0.2		O5-45	675.60	685.60	675.83	0.2	
177	0.015	8		0.005	292	O4-12	703.16	711.16	703.72	0.6		O4-10	702.28	708.28	702.51	0.2	
263	0.015	8		0.005	232	O4-13	704.46	711.46	704.87	0.4		O4-12	703.16	711.16	703.72	0.6	
283	0.015	8		0.005	49	O4-15	704.46	710.46	704.64	0.2		O4-12	703.16	711.16	703.72	0.6	
360	0.015	8		0.005	222	O4-16	706.22	716.22	706.62	0.4		O4-13	704.46	711.46	704.87	0.4	
189	0.015	8		0.005	201	O4-19	707.09	717.09	707.47	0.4		O4-16	706.22	716.22	706.62	0.4	
400	0.015	8		0.005	176	O4-21	708.91	718.91	709.27	0.4		O4-19	707.09	717.09	707.47	0.4	
184	0.015	6		0.003	51	O5-2	636.20	646.20	636.43	0.2		O5-4	635.66	645.66	635.90	0.2	
209	0.015	8		0.074	244	O5-3	635.39	645.39	635.59	0.2		O5-10	620.02	630.02	620.23	0.2	
83	0.015	6		0.003	53	O5-4	635.66	645.66	635.90	0.2		O5-3	635.39	645.39	635.59	0.2	
186	0.015	6		0.145	47	O5-5	662.90	672.90	662.98	0.1		O5-2	636.20	646.20	636.43	0.2	
326	0.015	6		0.056	35	O5-6	681.11	691.11	681.20	0.1		O5-5	662.90	672.90	662.98	0.1	
464	0.015	6		0.027	28	O5-7	688.61	698.61	688.70	0.1		O5-8	675.98	685.98	676.10	0.1	
306	0.015	6		0.040	53	O5-8	675.98	685.98	676.10	0.1		O5-16	663.80	673.80	663.98	0.2	
271	0.015	6		0.025	18	O5-9	682.87	692.87	682.95	0.1		O5-8	675.98	685.98	676.10	0.1	
446	0.015	8		0.072	251	O5-10	620.02	630.02	620.23	0.2		O5-11	587.84	597.84	588.37	0.5	
357	0.015	8		0.012	438	O5-11	587.84	597.84	588.37	0.5		N6-21	583.54	589.54	583.83	0.3	
391	0.015	6		0.039	169	O5-12	602.89	612.89	603.11	0.2		O5-11	587.84	597.84	588.37	0.5	SUR
136	0.015	6		0.037	165	O5-13	607.96	617.96	608.18	0.2		O5-12	602.89	612.89	603.11	0.2	
249	0.015	6		0.092	156	O5-14	630.88	635.00	631.05	0.2		O5-13	607.96	617.96	608.18	0.2	
274	0.015	6		0.032	145	O5-15	639.70	649.70	639.92	0.2		O5-14	630.88	635.00	631.05	0.2	
497	0.015	6		0.049	128	O5-16	663.80	673.80	663.98	0.2		O5-15	639.70	649.70	639.92	0.2	
136	0.015	8		0.003	9	O5-17	664.26	670.96	664.34	0.1		O5-16	663.80	673.80	663.98	0.2	
208	0.015	6		0.030	9	O5-18	689.16	699.16	689.21	0.1		O5-9	682.87	692.87	682.95	0.1	
224	0.015	6		0.005	5	O5-19	683.95	693.95	684.01	0.1		O5-9	682.87	692.87	682.95	0.1	
163	0.015	8		0.003	85	O5-27	688.29	698.29	688.55	0.3		O5-30	687.75	697.75	688.00	0.2	

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LENGTH (ft)	Manning's N	Diameter (in)	Material	Slope	Maximum Flow, gpm	Upstream MH Name	Upstream Invert (ft)	Upstream MH Rim	Maximum Upstream HGL	Upstream Flow Depth, ft	Class	Downstream MH Name	Downstream Invert (ft)	Downstream MH Rim	Maximum Downstream HGL	Downstream Flow Depth, ft	Class
428	0.015	8		0.005	94	O5-30	687.75	697.75	688.00	0.2		N5-4	685.79	695.79	686.04	0.3	
222	0.015	8		0.070	188	O5-31	650.98	660.98	651.15	0.2		O5-3	635.39	645.39	635.59	0.2	
486	0.015	10		0.012	1149	O5-32	586.98	611.00	607.20	20.2	SUR	O5-33	581.13	601.00	598.37	17.2	SUR
337	0.015	10		0.012	1156	O5-33	581.13	601.00	598.37	17.2	SUR	O5-34	577.08	597.00	592.17	15.1	SUR
400	0.015	10		0.020	1172	O5-34	577.08	597.00	592.17	15.1	SUR	O5-35	569.08	589.00	584.61	15.5	SUR
86	0.015	10		0.021	1179	O5-35	569.08	589.00	584.61	15.5	SUR	O5-36	567.27	587.00	582.96	15.7	SUR
481	0.015	10		0.017	1191	O5-36	567.27	587.00	582.96	15.7	SUR	O5-37	559.28	579.00	573.56	14.3	SUR
391	0.015	10		0.019	1210	O5-37	559.28	579.00	573.56	14.3	SUR	O5-38	551.89	571.00	565.69	13.8	SUR
494	0.015	10		0.015	1234	O5-38	551.89	571.00	565.69	13.8	SUR	P5-1	544.50	564.00	555.33	10.8	SUR
215	0.015	8		0.042	72	O5-39	697.33	707.33	697.45	0.1		O5-27	688.29	698.29	688.55	0.3	
302	0.015	8		0.008	60	O5-40	699.73	709.73	699.91	0.2		O5-39	697.33	707.33	697.45	0.1	
281	0.015	6		0.108	8	O5-41	669.90	679.90	669.94	0.0		O5-15	639.70	649.70	639.92	0.2	
370	0.015	8		0.069	326	O5-45	675.60	685.60	675.83	0.2		P5-12	649.96	659.96	650.20	0.2	
284	0.015	8		0.003	165	O6-1	512.06	522.06	512.50	0.4		O6-13	511.10	520.50	511.29	0.2	
290	0.015	6		0.036	157	O6-2	522.50	532.50	522.71	0.2		O6-1	512.06	522.06	512.50	0.4	
376	0.015	6		0.063	95	O6-3	545.94	555.94	546.08	0.1		O6-2	522.50	532.50	522.71	0.2	
184	0.015	6		0.215	8	O6-11	626.68	636.68	626.71	0.0		O5-11	587.84	597.84	588.37	0.5	SUR
351	0.015	10		0.049	199	O6-13	511.10	520.50	511.29	0.2		O6-14	493.85	498.85	494.02	0.2	
196	0.015	10		0.086	229	O6-14	493.85	498.85	494.02	0.2		O6-17	477.06	484.06	477.52	0.5	
499	0.015	10		0.003	242	O6-17	477.06	484.06	477.52	0.5		O7-47	471.77	482.37	472.64	0.9	SUR
271	0.015	12		0.004	385	O6-24	455.88	465.88	456.33	0.5		Y7-1	454.70	464.70	455.21	0.5	
202	0.015	6		0.037	6	O6-27	615.43	625.43	615.47	0.0		O5-13	607.96	617.96	608.18	0.2	
225	0.015	8		0.004	61	O6-33	664.64	670.24	664.87	0.2		O5-16	663.80	673.80	663.98	0.2	
308	0.015	8		0.005	36	O6-34	666.06	671.56	666.21	0.2		O6-33	664.64	670.24	664.87	0.2	
277	0.015	8		0.005	19	O6-35	667.43	672.23	667.54	0.1		O6-34	666.06	671.56	666.21	0.2	
777	0.014	45		0.001	2968	O6-44	469.30	479.30	470.39	1.1		P6-27	468.50	478.50	469.62	1.1	
152	0.014	45		0.001	2951	O6-46	469.48	479.48	470.54	1.1		O6-44	469.30	479.30	470.39	1.1	
319	0.014	39		0.001	12449	O7-5	458.19	473.89	461.26	3.1		O7-30	457.74	471.94	460.91	3.2	
360	0.015	10		0.003	13	O7-14	473.96	479.96	474.05	0.1		O7-15	472.70	479.20	472.86	0.2	
265	0.015	10		0.004	45	O7-15	472.70	479.20	472.86	0.2		O7-16	471.60	476.60	471.78	0.2	
578	0.015	10		0.004	58	O7-16	471.60	476.60	471.78	0.2		O7-17	469.20	485.20	469.39	0.2	
113	0.015	12		0.003	60	O7-17	469.20	485.20	469.39	0.2		O7-18	468.83	483.83	469.03	0.2	
525	0.015	12		0.003	68	O7-18	468.83	483.83	469.03	0.2		P7-1	467.17	479.17	467.63	0.5	
411	0.015	8		0.003	52	O7-25	461.95	471.95	462.16	0.2		O7-5	460.67	473.89	461.26	0.6	
404	0.015	8		0.018	17	O7-26	465.75	475.75	465.83	0.1		O7-27	458.50	470.94	459.44	0.9	SUR
457	0.014	39		0.001	12451	O7-27	456.46	470.94	459.44	3.0		P7-22	455.92	470.00	458.93	3.0	
322	0.015	12		0.001	382	O7-29	456.13	466.13	456.90	0.8		O6-24	455.88	465.88	456.33	0.5	
1098	0.014	39		0.001	12423	O7-30	457.74	471.94	460.91	3.2		Z7-4	456.61	466.61	459.66	3.1	
102	0.015	8		0.004	4	O7-35	467.70	474.00	467.76	0.1		O7-5	458.19	473.89	461.26	3.1	SUR
876	0.014	45		0.001	2948	O7-42	470.33	476.60	471.44	1.1		O6-46	469.48	479.48	470.54	1.1	
239	0.014	45		0.001	2946	O7-43	470.58	479.20	471.67	1.1		O7-42	470.33	476.60	471.44	1.1	
25	0.014	45		0.001	2945	O7-44	470.61	479.20	471.69	1.1		O7-43	470.58	479.20	471.67	1.1	
298	0.014	45		0.001	2942	O7-45	470.89	481.00	471.99	1.1		O7-44	470.61	479.20	471.69	1.1	
36	0.014	45		0.003	2915	O7-46	470.98	481.00	472.01	1.0		O7-45	470.89	481.00	471.99	1.1	
333	0.014	45		0.002	2890	O7-47	471.77	482.37	472.64	0.9		O7-46	470.98	481.00	472.01	1.0	
393	0.015	10		0.004	6	O7-48	475.37	482.37	475.43	0.1		O7-14	473.96	479.96	474.05	0.1	
83	0.015	8		0.006	136	O8-3	465.16	475.16	465.45	0.3		O8-5	464.69	474.69	465.27	0.6	
35	0.015	8		0.001	295	O8-5	464.69	474.69	465.27	0.6		HLSWW	464.64				
15	0.015	8		0.043	703	O9-1	505.30	515.30	510.04	4.7	SUR	O9-1	504.63	514.63	508.47	3.8	SUR
81	0.015	8		0.005	753	O9-1	504.63	514.63	508.47	3.8	SUR	O9-58	504.24	514.24	507.59	3.3	SUR
47	0.013	6		0.004	119	O9-3	506.86	513.16	508.62	1.8	SUR	O9-4	506.67	513.97	508.63	2.0	SUR
33	0.013	6		0.004	124	O9-4	506.67	513.97	508.63	2.0	SUR	O9-5	506.53	514.13	508.62	2.1	SUR
40	0.013	6		0.003	135	O9-5	506.53	514.13	508.62	2.1	SUR	O9-6	506.39	513.29	508.57	2.2	SUR

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LENGTH (ft)	Manning's N	Diameter (in)	Material	Slope	Maximum Flow, gpm	Upstream MH Name	Upstream Invert (ft)	Upstream MH Rim	Maximum Upstream HGL	Upstream Flow Depth, ft	Class	Downstream MH Name	Downstream Invert (ft)	Downstream MH Rim	Maximum Downstream HGL	Downstream Flow Depth, ft	Class
363	0.013	6		0.004	134	O9-6	506.39	513.29	508.57	2.2	SUR	O9-7	504.79	514.79	509.30	4.5	SUR
55	0.015	8		0.003	166	O9-7	504.79	514.79	509.30	4.5	SUR	O9-1	504.63	514.63	508.47	3.8	SUR
318	0.015	8		0.003	15	O9-9	503.64	514.54	503.75	0.1		O9-12	502.69	513.79	502.85	0.2	
441	0.015	8		0.003	31	O9-12	502.69	513.79	502.85	0.2		O9-15	501.38	512.78	501.54	0.2	
27	0.015	8		0.003	35	O9-15	501.38	512.78	501.54	0.2		O9-16	501.29	510.79	501.48	0.2	
207	0.015	8		0.003	46	O9-16	501.29	510.79	501.48	0.2		O9-18	500.67	510.77	500.89	0.2	
434	0.015	8		0.003	59	O9-18	500.67	510.77	500.89	0.2		P9-4	499.41	513.01	499.65	0.2	
58	0.015	6		0.010	7	O9-19	505.72	515.72	505.78	0.1		O9-18	500.67	510.77	500.89	0.2	
350	0.015	6		0.004	88	O9-36	533.15	539.45	533.44	0.3		O10-1	531.78	539.98	532.07	0.3	
353	0.015	6		0.004	26	O9-40	536.49	547.99	536.63	0.1		O9-41	534.91	546.01	535.08	0.2	
352	0.015	6		0.004	38	O9-41	534.91	546.01	535.08	0.2		O9-42	533.34	543.44	533.53	0.2	
358	0.015	6		0.005	45	O9-42	533.34	543.44	533.53	0.2		O9-43	531.72	541.02	532.13	0.4	
330	0.015	6		0.004	56	O9-43	531.72	541.02	532.13	0.4		O10-9	530.32	542.02	531.98	1.7	SUR
268	0.015	6		0.012	38	O9-45	529.86	536.96	531.62	1.8	SUR	P9-53	526.65	533.25	531.62	5.0	SUR
259	0.013	8		0.010	485	O9-47	508.00	512.40	510.48	2.5	SUR	O9-1	505.30	515.30	510.04	4.7	SUR
195	0.015	8		0.004	8	O9-55	533.15	543.15	533.22	0.1		O9-56	532.34	542.34	532.43	0.1	
147	0.015	8		0.004	11	O9-56	532.34	542.34	532.43	0.1		O9-57	531.72	541.72	531.81	0.1	
303	0.015	8		0.006	15	O9-57	531.72	541.72	531.81	0.1		O9-45	529.86	536.96	531.62	1.8	SUR
437	0.015	12		0.002	684	O9-58	504.24	514.24	507.59	3.3	SUR	O9-59	503.40	513.40	505.73	2.3	SUR
244	0.015	8		0.004	4	O9-58	504.66	514.66	504.72	0.1		O9-9	503.64	514.54	503.75	0.1	
504	0.015	12		0.002	704	O9-59	503.40	513.40	505.73	2.3	SUR	O9-60	502.40	512.40	504.48	2.1	SUR
497	0.015	12		0.002	728	O9-60	502.40	512.40	504.48	2.1	SUR	P9-59	501.40	511.40	503.14	1.7	SUR
318	0.015	6		0.006	112	O10-1	531.78	539.98	532.07	0.3		N10-8	529.78	541.58	530.16	0.4	
377	0.015	6		0.011	18	O10-2	535.78	545.18	535.88	0.1		O10-1	531.78	539.98	532.07	0.3	
473	0.015	6		0.007	6	O10-4	539.27	546.37	539.33	0.1		O10-2	535.78	545.18	535.88	0.1	
383	0.015	6		0.005	5	O10-6	538.25	544.45	538.31	0.1		O10-7	536.33	543.03	536.42	0.1	
134	0.015	6		0.006	13	O10-7	536.33	543.03	536.42	0.1		O10-8	535.54	543.44	535.65	0.1	
224	0.015	6		0.023	38	O10-8	535.54	543.44	535.65	0.1		O10-9	530.32	542.02	531.98	1.7	SUR
366	0.015	6		0.020	97	O10-9	530.32	542.02	531.98	1.7	SUR	P10-5	522.87	534.50	531.35	8.5	SUR
392	0.015	6		0.003	20	O10-10	536.84	542.64	536.99	0.1		O10-8	535.54	543.44	535.65	0.1	
328	0.015	10		0.003	215	O10-13	527.50	539.20	527.92	0.4		O10-14	526.67	537.37	527.08	0.4	
227	0.015	10		0.003	224	O10-14	526.67	537.37	527.08	0.4		O10-17	525.99	533.99	526.45	0.5	
258	0.015	8		0.003	40	O10-15	527.69	534.19	527.87	0.2		O10-16	526.92	534.42	527.10	0.2	
253	0.015	8		0.004	44	O10-16	526.92	534.42	527.10	0.2		O10-17	525.99	533.99	526.45	0.5	
240	0.015	10		0.003	272	O10-17	525.99	533.99	526.45	0.5		O10-25	525.27	531.97	525.74	0.5	
246	0.015	12		0.004	442	O10-20	518.06	524.00	518.75	0.7		P10-9	517.23	525.23	517.54	0.3	
380	0.015	12		0.007	436	O10-21	520.88	535.98	521.30	0.4		O10-20	518.20	524.00	518.75	0.6	
398	0.015	12		0.002	400	O10-22	522.39	537.99	522.95	0.6		O10-44	521.40	538.00	521.93	0.5	
74	0.015	10		0.003	276	O10-25	525.27	531.97	525.74	0.5		O10-26	525.06	531.96	525.49	0.4	
117	0.015	10		0.004	278	O10-26	525.06	531.96	525.49	0.4		O10-48	524.57	532.00	524.96	0.4	
414	0.015	12		0.002	357	O10-27	523.36	532.36	523.88	0.5		O10-22	522.39	537.99	522.95	0.6	
15	0.015	12		0.003	355	O10-28	523.40	532.00	523.91	0.5		O10-27	523.36	532.36	523.88	0.5	
60	0.015	12		0.003	353	O10-29	523.56	530.26	524.06	0.5		O10-28	523.40	532.00	523.91	0.5	
280	0.015	6		0.007	64	O10-30	525.40	530.00	525.61	0.2		O10-29	523.56	530.26	524.06	0.5	
175	0.015	6		0.005	58	O10-33	526.25	531.55	526.47	0.2		O10-30	525.40	530.00	525.61	0.2	
501	0.014	42		0.002	18141	O10-34	436.44	446.44	442.85	6.4	SUR	X8-5	435.65	445.55	442.33	6.7	SUR
750	0.014	15		0.005	2001	O10-34	530.23	541.03	535.71	5.5	SUR	O11-54	526.36	539.86	531.60	5.2	SUR
415	0.015	6		0.004	44	O10-35	530.66	537.96	530.87	0.2		Z7-9	529.07	541.47	529.25	0.2	
380	0.015	6		0.009	5	O10-36	532.63	542.63	532.68	0.1		Z7-9	529.07	541.47	529.25	0.2	
191	0.015	6		0.006	43	O10-37	529.42	539.80	531.64	2.2	SUR	O11-2	528.35	540.50	531.62	3.3	SUR
308	0.015	6		0.004	24	O10-38	530.62	535.82	531.68	1.1	SUR	O10-37	529.42	539.80	531.64	2.2	SUR
60	0.015	6		0.008	56	O10-39	526.71	529.42	526.90	0.2		O10-33	526.25	531.55	526.47	0.2	
148	0.015	12		0.004	419	O10-44	521.40	538.00	521.93	0.5		O10-21	520.88	535.98	521.30	0.4	

2010 Master Plan Clear Creek Collection System Pipe Analysis Results

LENGTH (ft)	Manning's N	Diameter (in)	Material	Slope	Maximum Flow, gpm	Upstream MH Name	Upstream Invert (ft)	Upstream MH Rim	Maximum Upstream HGL	Upstream Flow Depth, ft	Class	Downstream MH Name	Downstream Invert (ft)	Downstream MH Rim	Maximum Downstream HGL	Downstream Flow Depth, ft	Class
281	0.014	15		0.003	1999	O10-46	531.39	538.99	537.25	5.9	SUR	O10-34	530.43	541.03	535.71	5.3	SUR
325	0.014	15		0.003	1994	O10-47	532.70	539.00	539.00	6.3	SUR	O10-46	531.59	538.99	537.25	5.7	SUR
176	0.015	10		0.006	285	O10-48	524.57	532.00	524.96	0.4		O10-29	523.56	530.26	524.06	0.5	
327	0.015	6		0.005	35	O11-1	529.97	534.97	533.71	3.7	SUR	O11-2	528.35	540.50	531.62	3.3	SUR
63	0.015	6		0.007	59	O11-2	528.35	540.50	531.62	3.3	SUR	O11-3	527.91	540.00	531.61	3.7	SUR
19	0.015	8		0.080	61	O11-3	527.91	540.00	531.61	3.7	SUR	O11-54	526.36	539.86	531.60	5.2	SUR
269	0.015	6		0.006	26	O11-5	527.73	534.03	527.87	0.1		O11-6	526.21	539.01	526.34	0.1	
326	0.015	10		0.006	32	O11-6	526.21	539.01	526.34	0.1		O11-8	524.40	534.40	524.54	0.1	
324	0.015	10		0.008	49	O11-8	524.40	534.40	524.54	0.1		O11-13	521.70	532.00	522.17	0.5	
210	0.015	10		0.008	1	O11-11	527.91	537.91	527.94	0.0		O11-6	526.21	539.01	526.34	0.1	
297	0.015	10		0.005	501	O11-12	523.17	529.87	523.80	0.6		O11-13	521.70	532.00	522.17	0.5	
329	0.015	10		0.011	554	O11-13	521.70	532.00	522.17	0.5		O11-15	518.07	524.57	519.46	1.4	SUR
323	0.015	6		0.027	84	O11-14	526.80	532.80	526.97	0.2		O11-15	518.07	524.57	519.46	1.4	SUR
320	0.015	10		0.005	656	O11-15	518.07	524.57	519.46	1.4	SUR	O11-17	516.41	521.01	516.78	0.4	
319	0.015	10		0.039	678	O11-17	516.41	521.01	516.78	0.4		O11-20	504.03	512.03	507.38	3.3	SUR
59	0.014	18		0.004	1074	O11-20	504.03	512.03	507.38	3.3	SUR	O11-22	503.81	512.01	507.35	3.5	SUR
513	0.015	12		0.004	1068	O11-22	503.81	512.01	507.35	3.5	SUR	O11-33	501.98	508.00	502.26	0.3	
23	0.015	10		0.002	363	O11-25	505.07	512.17	507.97	2.9	SUR	O11-25	505.03	512.03	507.93	2.9	SUR
307	0.015	10		0.003	365	O11-25	505.03	512.03	507.93	2.9	SUR	O11-20	504.03	512.03	507.38	3.3	SUR
176	0.015	10		0.002	355	O11-26	505.49	513.49	508.25	2.8	SUR	O11-25	505.07	512.17	507.97	2.9	SUR
230	0.015	8		0.007	40	O11-28	508.38	514.98	508.75	0.4		O11-29	506.83	513.83	508.77	1.9	SUR
52	0.015	8		0.006	46	O11-29	506.83	513.83	508.77	1.9	SUR	O11-30	506.54	513.54	508.76	2.2	SUR
321	0.015	10		0.003	348	O11-30	506.54	513.54	508.76	2.2	SUR	O11-26	505.49	513.49	508.25	2.8	SUR
415	0.014	24		0.002	305	O11-31	495.61	503.80	495.99	0.4		O11-57	494.92	504.92	495.61	0.7	
454	0.014	24		0.001	1392	O11-32	494.70	507.00	495.58	0.9		O11-34	494.02	515.42	494.79	0.8	
35	0.015	12		0.216	1071	O11-33	501.98	508.00	502.26	0.3		O11-32	494.70	507.00	495.58	0.9	
445	0.014	24		0.002	1397	O11-34	494.02	515.42	494.79	0.8		O11-36	492.98	508.88	493.71	0.7	
336	0.015	12		0.004	17	O11-35	500.03	515.42	500.13	0.1		O11-48	498.57	510.00	498.67	0.1	
536	0.014	21		0.004	1399	O11-36	492.98	508.88	493.71	0.7		O11-39	491.00	500.20	491.68	0.7	
534	0.015	12		0.009	44	O11-36	497.03	508.57	497.15	0.1		O11-39	492.20	500.20	492.34	0.1	
476	0.015	12		0.006	49	O11-39	492.20	500.20	492.34	0.1		P11-1	489.20	498.00	489.35	0.1	
625	0.014	21		0.005	1421	O11-39	491.00	500.20	491.68	0.7		P11-2	488.11	495.21	488.78	0.7	
134	0.015	12		0.012	28	O11-48	498.57	510.00	498.67	0.1		O11-36	497.03	508.57	497.15	0.1	
608	0.014	15		0.050	2115	O11-52	522.13	534.83	522.64	0.5		P11-67	492.00	500.00	492.67	0.7	
606	0.014	15		0.003	2106	O11-53	524.25	535.25	528.08	3.8	SUR	O11-52	522.13	534.83	522.64	0.5	
607	0.014	15		0.003	2047	O11-54	526.36	539.86	531.60	5.2	SUR	O11-53	524.25	535.25	528.08	3.8	SUR
141	0.014	24		0.002	296	O11-55	495.91	506.51	496.26	0.4		O11-31	495.61	503.80	495.99	0.4	
387	0.014	24		0.001	288	O11-56	496.43	507.33	496.84	0.4		O11-55	495.91	506.51	496.26	0.4	
278	0.014	24		0.001	317	O11-57	494.92	504.92	495.61	0.7		O11-32	494.70	507.00	495.58	0.9	
357	0.015	12		0.005	6	O11-66	501.98	512.50	502.04	0.1		O11-35	500.03	515.42	500.13	0.1	
166	0.015	8		0.011	306	O12-2	508.35	515.45	509.43	1.1	SUR	O11-30	506.54	513.54	508.76	2.2	SUR
187	0.015	8		0.039	303	O12-3	520.24	522.54	520.50	0.3		O12-2	508.35	515.45	509.43	1.1	SUR
406	0.014	24		0.002	279	O12-4	497.07	507.57	497.44	0.4		O11-56	496.43	507.33	496.84	0.4	
115	0.015	8		0.004	302	O12-5	520.65	528.95	521.30	0.7		O12-3	520.24	522.54	520.50	0.3	
393	0.015	8		0.003	269	O12-6	521.98	526.98	522.52	0.5		O12-5	520.65	528.95	521.30	0.7	
128	0.015	8		0.013	265	O12-7	523.58	526.98	523.92	0.3		O12-6	521.98	526.98	522.52	0.5	
86	0.015	8		0.045	22	O12-8	528.00	538.00	528.07	0.1		O12-34	524.13	534.13	524.65	0.5	
320	0.015	8		0.003	27	O12-30	521.76	541.04	521.90	0.1		O12-5	520.65	528.95	521.30	0.7	
138	0.015	8		0.004	256	O12-34	524.13	534.13	524.65	0.5		O12-7	523.58	526.98	523.92	0.3	
347	0.015	8		0.004	34	P4-2	706.00	710.00	706.15	0.1		O4-15	704.46	710.46	704.64	0.2	
304	0.015	8		0.005	167	P4-4	710.36	720.36	710.70	0.3		O4-21	708.91	718.91	709.27	0.4	
474	0.015	10		0.020	1310	P5-1	544.50	564.00	555.33	10.8	SUR	P5-2	534.96	554.00	546.18	11.2	SUR
477	0.015	10		0.015	1325	P5-2	534.96	554.00	546.18	11.2	SUR	P5-3	528.00	548.00	536.54	8.5	SUR

2010 Master Plan Clear Creek Collection System Pipe Analysis Results

LENGTH (ft)	Manning's N	Diameter (in)	Material	Slope	Maximum Flow, gpm	Upstream MH Name	Upstream Invert (ft)	Upstream MH Rim	Maximum Upstream HGL	Upstream Flow Depth, ft	Class	Downstream MH Name	Downstream Invert (ft)	Downstream MH Rim	Maximum Downstream HGL	Downstream Flow Depth, ft	Class
205	0.015	12		0.023	1516	P5-3	528.00	548.00	536.54	8.5	SUR	P5-4	523.34	553.00	534.30	11.0	SUR
472	0.015	12		0.007	1528	P5-4	523.34	553.00	534.30	11.0	SUR	P6-30	519.89	539.00	529.00	9.1	SUR
474	0.015	10		0.001	222	P5-5	528.70	536.70	536.70	8.0	SUR	P5-3	528.00	548.00	536.54	8.5	SUR
224	0.015	8		0.005	213	P5-6	529.86	539.86	537.16	7.3	SUR	P5-5	528.70	536.70	536.70	8.0	SUR
416	0.015	8		0.304	183	P5-7	650.87	659.37	650.99	0.1		P5-6	529.86	539.86	537.16	7.3	SUR
215	0.015	8		0.022	156	P5-8	655.50	665.50	655.74	0.2		P5-7	650.87	659.37	650.99	0.1	
175	0.015	8		0.029	147	P5-9	660.57	671.57	660.76	0.2		P5-8	655.50	665.50	655.74	0.2	
162	0.015	8		0.058	142	P5-10	670.00	682.00	670.16	0.2		P5-9	660.57	671.57	660.76	0.2	
379	0.015	8		0.069	344	P5-12	649.96	659.96	650.20	0.2		P5-13	623.85	633.85	624.09	0.2	
397	0.015	8		0.070	352	P5-13	623.85	633.85	624.09	0.2		P5-14	596.29	606.29	596.54	0.2	
292	0.015	8		0.068	361	P5-14	596.29	606.29	596.54	0.2		P5-15	576.31	586.31	576.56	0.3	
440	0.015	8		0.071	373	P5-15	576.31	586.31	576.56	0.3		P5-16	545.30	555.30	555.30	10.0	SUR
115	0.015	8		0.007	168	P5-16	545.30	555.30	555.30	10.0	SUR	P5-1	544.50	564.00	555.33	10.8	SUR
38	0.015	12		0.007	1597	P6-1	516.25	536.00	524.16	7.9	SUR	P6-2	516.00	536.00	523.68	7.7	SUR
448	0.015	12		0.017	1622	P6-2	516.00	536.00	523.68	7.7	SUR	P6-3	508.58	528.00	517.76	9.2	SUR
448	0.015	12		0.017	1677	P6-3	508.58	528.00	517.76	9.2	SUR	P6-4	500.88	520.00	511.33	10.5	SUR
307	0.015	12		0.008	1716	P6-4	500.88	520.00	511.33	10.5	SUR	P6-5	498.40	518.00	506.68	8.3	SUR
128	0.015	12		0.009	1757	P6-5	497.91	518.00	506.68	8.8	SUR	P6-6	496.69	516.00	504.62	7.9	SUR
370	0.015	12		0.006	1768	P6-6	496.69	516.00	504.62	7.9	SUR	R6-26	494.35	505.00	498.65	4.3	SUR
328	0.015	8		0.004	9	P6-7	667.37	672.57	667.45	0.1		O6-34	666.06	671.56	666.21	0.2	
719	0.014	45		0.001	3069	P6-26	467.49	477.49	468.63	1.1		R6-30	466.82	476.82	468.07	1.2	
1059	0.014	45		0.001	3013	P6-27	468.50	478.50	469.62	1.1		P6-26	467.49	477.49	468.63	1.1	
400	0.015	12		0.008	1569	P6-30	519.49	539.00	529.00	9.5	SUR	P6-1	516.25	536.00	524.16	7.9	SUR
461	0.015	12		0.000	87	P7-1	467.17	479.17	467.63	0.5		P7-29	467.00	478.00	467.14	0.1	
141	0.015	12		0.003	97	P7-2	465.57	476.57	465.81	0.2		P7-23	465.12	475.12	465.41	0.3	
268	0.015	12		0.005	108	P7-3	464.20	476.20	464.42	0.2		P7-4	462.83	467.83	463.15	0.3	
176	0.015	12		0.002	113	P7-4	462.83	467.83	463.15	0.3		P7-32	462.53	465.03	462.79	0.3	
444	0.015	12		0.002	162	P7-5	460.44	470.44	460.77	0.3		P7-21	459.34	469.34	459.71	0.4	
1452	0.014	39		0.001	12635	P7-6	455.75	465.75	458.70	3.0		P7-12	454.28	464.28	456.46	2.2	
122	0.014	39		0.001	12709	P7-12	454.28	464.28	456.46	2.2		P7-24	454.16	464.16	455.90	1.7	
426	0.015	8		0.004	78	P7-13	459.79	464.79	460.04	0.3		P7-12	454.28	464.28	456.46	2.2	SUR
142	0.015	12		0.002	167	P7-21	459.34	469.34	459.71	0.4		P7-6	455.75	465.75	458.70	3.0	SUR
192	0.014	39		0.001	12457	P7-22	455.92	470.00	458.93	3.0		P7-6	455.75	465.75	458.70	3.0	
391	0.015	12		0.002	101	P7-23	465.12	475.12	465.41	0.3		P7-3	464.20	476.20	464.42	0.2	
213	0.014	30		0.010	12712	P7-24	454.16	464.16	455.90	1.7		R7-3	452.03	462.03	455.07	3.0	SUR
236	0.015	12		0.009	0	P7-24	456.66	464.16	455.90	-0.8		R7-3	454.53	462.03	455.07	0.5	
57	0.015	12		0.025	94	P7-29	467.00	478.00	467.14	0.1		P7-2	465.57	476.57	465.81	0.2	
320	0.015	8		0.004	35	P7-31	463.85	468.85	464.01	0.2		P7-32	462.53	465.03	462.79	0.3	
397	0.015	12		0.005	150	P7-32	462.53	465.03	462.79	0.3		P7-5	460.44	470.44	460.77	0.3	
332	0.015	8		0.003	73	P9-4	499.41	513.01	499.65	0.2		P9-5	498.35	513.15	498.68	0.3	
274	0.015	10		0.003	143	P9-5	498.35	513.15	498.68	0.3		P9-6	497.66	504.66	498.03	0.4	
292	0.015	10		0.002	157	P9-6	497.66	504.66	498.03	0.4		P9-62	497.08	507.08	497.54	0.5	
20	0.015	8		0.007	217	P9-9	497.86	511.46	498.22	0.4		P9-9	497.73	507.73	498.09	0.4	
99	0.015	8		0.007	221	P9-9	497.73	507.73	498.09	0.4		P9-62	497.08	507.08	497.54	0.5	
231	0.015	8		0.006	211	P9-10	499.36	512.96	499.72	0.4		P9-9	497.86	511.46	498.22	0.4	
458	0.015	8		0.005	195	P9-11	501.82	515.02	502.18	0.4		P9-10	499.36	512.96	499.72	0.4	
63	0.015	8		0.062	189	P9-12	505.72	515.52	505.90	0.2		P9-11	501.82	515.02	502.18	0.4	
377	0.015	6		0.071	63	P9-17	525.26	530.96	525.37	0.1		P9-5	498.35	513.15	498.68	0.3	
204	0.015	6		0.031	56	P9-18	531.66	536.56	531.79	0.1		P9-17	525.26	530.96	525.37	0.1	
246	0.015	6		0.011	27	P9-23	535.56	541.56	535.68	0.1		P9-24	532.94	538.94	533.18	0.2	
315	0.015	6		0.004	49	P9-24	532.94	538.94	533.18	0.2		P9-18	531.66	536.56	531.79	0.1	
365	0.015	10		0.005	22	P9-29	539.36	544.56	539.48	0.1		P9-35	537.50	545.00	537.58	0.1	
85	0.015	8		0.007	17	P9-31	527.98	537.98	528.08	0.1		P9-32	527.40	533.70	527.60	0.2	

2010 Master Plan Clear Creek Collection System Pipe Analysis Results

LENGTH (ft)	Manning's N	Diameter (in)	Material	Slope	Maximum Flow, gpm	Upstream MH Name	Upstream Invert (ft)	Upstream MH Rim	Maximum Upstream HGL	Upstream Flow Depth, ft	Class	Downstream MH Name	Downstream Invert (ft)	Downstream MH Rim	Maximum Downstream HGL	Downstream Flow Depth, ft	Class
258	0.015	10		0.003	57	P9-32	527.40	533.70	527.60	0.2		P9-33	526.60	536.60	526.80	0.2	
198	0.015	10		0.004	62	P9-33	526.60	536.60	526.80	0.2		P9-66	525.90	535.50	526.10	0.2	
183	0.015	10		0.008	38	P9-34	528.86	534.96	528.99	0.1		P9-32	527.40	533.70	527.60	0.2	
322	0.015	10		0.027	24	P9-35	537.50	545.00	537.58	0.1		P9-34	528.86	534.96	528.99	0.1	
135	0.015	6		0.009	3	P9-36	538.69	542.99	538.73	0.0		P9-37	537.45	542.55	537.52	0.1	
262	0.015	6		0.011	10	P9-37	537.45	542.55	537.52	0.1		P9-38	534.64	541.04	534.76	0.1	
335	0.015	6		0.005	18	P9-38	534.64	541.04	534.76	0.1		P9-24	532.94	538.94	533.18	0.2	
358	0.015	6		0.010	18	P9-43	530.29	537.79	531.63	1.3	SUR	P9-53	526.65	533.25	531.62	5.0	SUR
283	0.015	6		0.008	18	P9-49	533.48	539.98	533.58	0.1		P9-67	531.09	536.99	531.86	0.8	SUR
308	0.015	6		0.008	58	P9-51	528.70	535.00	531.75	3.1	SUR	P9-52	526.29	533.39	531.61	5.3	SUR
313	0.015	8		0.005	92	P9-52	526.29	533.39	531.61	5.3	SUR	P9-54	524.75	533.45	531.50	6.8	SUR
34	0.015	6		0.011	53	P9-53	526.65	533.25	531.62	5.0	SUR	P9-52	526.29	533.39	531.61	5.3	SUR
34	0.015	8		0.005	101	P9-54	524.75	533.45	531.50	6.8	SUR	P9-55	524.57	533.47	531.49	6.9	SUR
333	0.015	8		0.004	101	P9-55	524.57	533.47	531.49	6.9	SUR	P10-5	523.23	533.50	531.36	8.1	SUR
258	0.015	8		0.006	29	P9-58	526.01	536.01	526.14	0.1		R9-48	524.50	541.70	524.82	0.3	
491	0.015	12		0.002	739	P9-59	501.40	511.40	503.14	1.7	SUR	P9-60	500.40	510.40	501.65	1.3	SUR
505	0.015	12		0.003	747	P9-60	500.40	510.40	501.65	1.3	SUR	P9-61	499.12	509.12	499.58	0.5	
150	0.015	12		0.016	752	P9-61	499.12	509.12	499.58	0.5		P9-62	496.77	506.77	497.52	0.8	
31	0.015	10		0.010	391	P9-62	497.08	507.08	497.54	0.5		P9-62	496.77	506.77	497.52	0.8	
49	0.014	21		0.001	1136	P9-62	496.77	506.77	497.52	0.8		LLSWW	496.72				
301	0.015	10		0.004	69	P9-66	525.90	535.50	526.10	0.2		R9-47	524.59	537.79	524.98	0.4	
285	0.015	6		0.008	51	P9-67	531.09	536.99	531.86	0.8	SUR	P9-51	528.70	535.00	531.75	3.1	SUR
171	0.015	6		0.051	6	P10-3	531.15	537.90	531.19	0.0		P10-6	522.40	531.50	529.53	7.1	SUR
16	0.015	8		0.005	115	P10-5	522.95	533.50	531.36	8.4	SUR	P10-5	522.87	534.50	531.35	8.5	SUR
207	0.015	6		0.001	204	P10-5	523.10	534.50	531.35	8.3	SUR	P10-6	522.87	531.50	529.53	6.7	SUR
202	0.015	6		0.005	219	P10-6	522.40	531.50	529.53	7.1	SUR	P10-7	521.48	535.58	527.52	6.0	SUR
403	0.015	6		0.004	236	P10-7	521.48	535.58	527.52	6.0	SUR	P10-8	519.92	538.52	522.80	2.9	SUR
309	0.015	6		0.004	253	P10-8	519.92	538.52	522.80	2.9	SUR	P10-10	518.64	534.04	519.08	0.4	
343	0.015	12		0.024	447	P10-9	517.23	525.23	517.54	0.3		P10-39	509.07	519.00	509.44	0.4	
284	0.015	6		0.020	261	P10-10	518.64	534.04	519.08	0.4		P10-38	513.02	523.00	513.18	0.2	
118	0.015	12		0.011	719	P10-11	508.47	516.47	508.97	0.5		P10-12	507.22	514.22	507.76	0.5	
496	0.015	12		0.010	788	P10-12	507.22	514.22	507.76	0.5		P10-13	502.22	514.22	502.84	0.6	
160	0.015	12		0.007	800	P10-13	502.22	514.22	502.84	0.6		P10-14	501.07	511.68	501.18	0.1	
88	0.015	12		0.009	869	P10-14	500.59	511.68	501.18	0.6		P10-42	499.76	508.00	500.33	0.6	
217	0.015	12		0.015	929	P10-15	496.00	505.00	496.53	0.5		P10-16	492.74	500.74	493.29	0.5	
420	0.015	12		0.013	931	P10-16	492.74	500.74	493.29	0.5		R10-20	487.19	496.19	487.92	0.7	
156	0.015	6		0.005	31	P10-17	498.11	506.11	498.26	0.1		P10-38	497.29	507.24	497.47	0.2	
208	0.015	6		0.135	26	P10-18	525.87	533.97	525.93	0.1		P10-17	498.11	506.11	498.26	0.1	
279	0.015	6		0.020	20	P10-19	531.40	539.00	531.49	0.1		P10-18	525.87	533.97	525.93	0.1	
273	0.015	6		0.008	50	P10-28	525.30	531.00	525.47	0.2		R10-1	523.20	531.00	523.61	0.4	
143	0.015	6		0.006	41	P10-38	497.29	507.24	497.47	0.2		P10-15	496.50	505.00	496.53	0.0	
17	0.015	6		0.270	262	P10-38	513.02	523.00	513.18	0.2		P10-11	508.47	516.47	508.97	0.5	SUR
49	0.015	12		0.012	449	P10-39	509.07	519.00	509.44	0.4		P10-11	508.47	516.47	508.97	0.5	
252	0.015	8		0.013	8	P10-40	500.78	509.80	500.84	0.1		P10-38	497.29	507.24	497.47	0.2	
19	0.015	12		0.006	888	P10-41	496.12	508.08	496.80	0.7		P10-15	496.00	505.00	496.53	0.5	
338	0.015	12		0.011	886	P10-42	499.76	508.00	500.33	0.6		P10-41	496.12	508.08	496.80	0.7	
386	0.015	8		0.049	69	P10-44	520.10	532.30	520.22	0.1		P10-14	501.07	511.68	501.18	0.1	
153	0.015	8		0.004	62	P10-48	517.56	521.56	517.78	0.2		P10-50	516.75	524.21	516.88	0.1	
335	0.015	8		0.028	65	P10-50	516.75	524.21	516.88	0.1		P10-12	507.22	514.22	507.76	0.5	
292	0.015	8		0.005	46	P10-51	519.07	525.79	519.24	0.2		P10-48	517.56	521.56	517.78	0.2	
175	0.015	8		0.026	40	P10-52	523.58	528.58	523.68	0.1		P10-51	519.07	525.79	519.24	0.2	
475	0.015	12		0.008	57	P11-1	489.20	498.00	489.35	0.1		P11-3	485.64	495.44	485.84	0.2	
348	0.014	21		0.005	1429	P11-2	488.11	495.21	488.78	0.7		P11-50	486.46	495.00	487.55	1.1	

2010 Master Plan Clear Creek Collection System Pipe Analysis Results

LENGTH (ft)	Manning's N	Diameter (in)	Material	Slope	Maximum Flow, gpm	Upstream MH Name	Upstream Invert (ft)	Upstream MH Rim	Maximum Upstream HGL	Upstream Flow Depth, ft	Class	Downstream MH Name	Downstream Invert (ft)	Downstream MH Rim	Maximum Downstream HGL	Downstream Flow Depth, ft	Class
391	0.015	12		0.003	58	P11-3	485.64	495.44	485.84	0.2		P11-4	484.66	494.66	484.86	0.2	
392	0.015	12		0.003	60	P11-4	484.66	494.66	484.86	0.2		P11-6	483.63	490.63	483.82	0.2	
487	0.014	21		0.009	3551	P11-4	484.47	494.37	485.42	1.0		P11-7	480.20	492.80	481.70	1.5	
401	0.015	12		0.004	63	P11-6	483.63	490.63	483.82	0.2		P11-9	482.18	489.50	482.37	0.2	
38	0.014	21		0.002	3553	P11-7	480.20	492.80	481.70	1.5		P11-8	480.13	491.90	481.58	1.4	
539	0.014	24		0.002	3553	P11-8	480.13	491.90	481.58	1.4		P11-10	479.12	492.52	480.57	1.5	
414	0.015	12		0.004	65	P11-9	482.18	489.50	482.37	0.2		R11-74	480.66	489.00	480.84	0.2	
624	0.014	24		0.002	3806	P11-10	479.12	492.52	480.57	1.5		R10-37	477.80	486.90	479.28	1.5	
240	0.015	6		0.004	153	P11-11	524.15	532.75	531.94	7.8	SUR	P11-12	523.15	532.15	530.91	7.8	SUR
255	0.015	6		0.002	162	P11-12	523.15	532.15	530.91	7.8	SUR	P11-13	522.73	531.43	529.72	7.0	SUR
248	0.015	6		0.004	172	P11-13	522.73	531.43	529.72	7.0	SUR	P11-15	521.73	530.90	528.28	6.6	SUR
326	0.015	6		0.006	19	P11-14	526.84	532.34	529.73	2.9	SUR	P11-13	524.73	531.43	529.72	5.0	SUR
242	0.015	8		0.003	190	P11-15	520.40	530.90	528.28	7.9	SUR	R11-1	519.65	530.25	527.89	8.2	SUR
305	0.015	6		0.005	22	P11-16	521.88	531.68	528.29	6.4	SUR	P11-15	520.40	530.90	528.28	7.9	SUR
460	0.015	8		0.004	85	P11-20	524.83	534.83	528.22	3.4	SUR	R11-36	522.83	528.83	528.04	5.2	SUR
236	0.015	6		0.003	81	P11-26	481.45	490.50	481.80	0.3		P11-10	479.12	492.52	480.57	1.5	SUR
250	0.015	8		0.002	173	P11-26	481.29	490.50	481.80	0.5		P11-10	479.12	492.52	480.57	1.5	SUR
156	0.015	10		0.004	251	P11-27	481.96	487.96	482.37	0.4		P11-26	481.39	490.50	481.80	0.4	
283	0.015	10		0.003	178	P11-28	482.75	489.75	483.11	0.4		P11-27	481.96	487.96	482.37	0.4	
356	0.015	10		0.003	173	P11-29	483.99	491.69	484.33	0.3		P11-28	482.75	489.75	483.11	0.4	
374	0.015	10		0.009	164	P11-30	488.10	494.60	488.36	0.3		P11-56	484.78	492.48	485.03	0.2	
271	0.015	10		0.011	148	P11-31	491.19	499.09	491.42	0.2		P11-30	488.10	494.60	488.36	0.3	
413	0.015	10		0.037	120	P11-32	506.30	514.10	506.45	0.2		P11-31	491.19	499.09	491.42	0.2	
471	0.015	8		0.016	99	P11-33	513.99	522.69	514.18	0.2		P11-32	506.30	514.10	506.45	0.2	
342	0.015	8		0.005	23	P11-34	492.88	503.98	493.00	0.1		P11-31	491.19	499.09	491.42	0.2	
397	0.015	8		0.005	9	P11-37	489.93	495.93	490.01	0.1		P11-30	488.10	494.60	488.36	0.3	
321	0.014	21		0.006	3548	P11-50	486.46	495.00	487.55	1.1		P11-4	484.47	494.37	485.42	1.0	
71	0.015	10		0.011	169	P11-56	484.78	492.48	485.03	0.2		P11-29	483.99	491.69	484.33	0.3	
455	0.015	8		0.017	25	P11-58	524.06	530.06	524.16	0.1		R11-55	516.40	525.00	516.47	0.1	
266	0.015	10		0.003	69	P11-64	482.77	489.17	482.99	0.2		P11-27	481.96	487.96	482.37	0.4	
52	0.015	8		0.004	66	P11-65	483.14	488.84	483.37	0.2		P11-64	482.94	489.17	482.99	0.0	
305	0.015	8		0.005	63	P11-66	484.54	491.24	484.74	0.2		P11-65	483.14	488.84	483.37	0.2	
275	0.014	15		0.020	2116	P11-67	492.00	500.00	492.67	0.7		P11-50	486.45	495.00	487.55	1.1	
341	0.015	6		0.004	132	P12-15	527.47	534.47	534.38	6.9	SUR	P12-20	526.11	534.47	533.25	7.1	SUR
336	0.015	6		0.006	144	P12-20	526.11	534.47	533.25	7.1	SUR	P11-11	524.15	532.75	531.94	7.8	SUR
398	0.015	6		0.004	88	P12-23	529.02	534.92	534.92	5.9	SUR	P12-15	527.47	534.47	534.38	6.9	SUR
345	0.015	8		0.004	98	R4-4	705.48	712.68	705.74	0.3		R5-45	703.93	713.33	704.22	0.3	
355	0.015	8		0.004	20	R4-5	707.01	712.01	707.13	0.1		R4-4	705.48	712.68	705.74	0.3	
354	0.015	8		0.004	67	R4-6	706.93	711.13	707.14	0.2		R4-4	705.48	712.68	705.74	0.3	
324	0.015	8		0.004	54	R4-7	708.21	712.41	708.40	0.2		R4-6	706.93	711.13	707.14	0.2	
345	0.015	8		0.005	412	R4-13	702.49	711.49	709.42	6.9	SUR	S4-7	700.86	710.86	706.78	5.9	SUR
297	0.015	8		0.005	398	R4-14	704.03	714.03	711.51	7.5	SUR	R4-13	702.49	711.49	709.42	6.9	SUR
369	0.015	8		0.002	42	R4-15	705.73	715.73	711.52	5.8	SUR	R4-14	704.83	714.03	711.51	6.7	SUR
400	0.015	8		0.004	345	R4-20	705.63	716.00	713.66	8.0	SUR	R4-14	704.03	714.03	711.51	7.5	SUR
247	0.015	8		0.004	337	R4-21	706.63	717.82	714.91	8.3	SUR	R4-20	705.63	716.00	713.66	8.0	SUR
121	0.015	8		0.006	31	R4-22	703.16	713.16	709.41	6.2	SUR	R4-13	702.49	711.49	709.42	6.9	SUR
135	0.015	8		0.009	243	R5-3	653.88	665.88	654.23	0.4		R5-4	652.64	659.64	652.84	0.2	
87	0.015	8		0.007	250	R5-4	652.44	659.64	652.84	0.4		R5-5	651.85	656.70	652.11	0.3	
318	0.015	8		0.007	253	R5-5	651.70	656.70	652.11	0.4		R5-6	649.37	654.37	649.65	0.3	
192	0.015	8		0.023	260	R5-6	649.37	654.37	649.65	0.3		R5-7	644.94	660.94	645.71	0.8	SUR
103	0.015	8		0.005	360	R5-7	644.94	660.94	645.71	0.8	SUR	R5-8	644.47	661.47	644.77	0.3	
153	0.015	8		0.036	364	R5-8	644.47	661.47	644.77	0.3		R5-9	638.92	643.92	639.20	0.3	
254	0.015	8		0.067	378	R5-9	638.92	643.92	639.20	0.3		Z7-9	622.02	628.02	622.21	0.2	

2010 Master Plan Clear Creek Collection System Pipe Analysis Results

LENGTH (ft)	Manning's N	Diameter (in)	Material	Slope	Maximum Flow, gpm	Upstream MH Name	Upstream Invert (ft)	Upstream MH Rim	Maximum Upstream HGL	Upstream Flow Depth, ft	Class	Downstream MH Name	Downstream Invert (ft)	Downstream MH Rim	Maximum Downstream HGL	Downstream Flow Depth, ft	Class
135	0.015	8		0.006	97	R5-10	645.80	665.80	646.03	0.2		R5-7	644.94	660.94	645.71	0.8	SUR
134	0.015	8		0.009	3	R5-12	700.20	704.00	700.24	0.0		L4-21	699.00	704.00	699.06	0.1	
561	0.015	8		0.014	229	R5-18	662.00	669.20	662.30	0.3		R5-3	653.88	665.88	654.23	0.4	
310	0.015	8		0.003	25	R5-19	662.93	670.83	663.07	0.1		R5-18	662.00	669.20	662.30	0.3	
276	0.015	8		0.076	189	R5-20	683.01	688.01	683.18	0.2		R5-18	662.00	669.20	662.30	0.3	
412	0.015	8		0.030	179	R5-21	695.18	701.78	695.40	0.2		R5-20	683.01	688.01	683.18	0.2	
440	0.015	8		0.010	163	R5-22	699.52	705.82	699.80	0.3		R5-21	695.18	701.78	695.40	0.2	
368	0.015	8		0.005	151	R5-27	701.34	708.04	701.67	0.3		R5-22	699.52	705.82	699.80	0.3	
397	0.015	8		0.004	147	R5-28	702.94	710.64	703.27	0.3		R5-27	701.34	708.04	701.67	0.3	
273	0.015	8		0.037	65	R5-29	691.57	699.57	691.69	0.1		R5-39	681.45	690.95	681.61	0.2	
210	0.015	8		0.011	33	R5-36	697.13	707.13	697.25	0.1		R5-37	694.78	704.78	694.93	0.2	
306	0.015	8		0.011	51	R5-37	694.78	704.78	694.93	0.2		R5-29	691.57	699.57	691.69	0.1	
286	0.015	8		0.033	104	R5-39	681.45	690.95	681.61	0.2		R5-40	671.92	685.92	672.23	0.3	
441	0.015	8		0.004	116	R5-40	671.92	685.92	672.23	0.3		P5-10	670.00	682.00	670.16	0.2	
331	0.015	8		0.004	23	R5-43	698.55	704.35	698.68	0.1		R5-36	697.13	707.13	697.25	0.1	
252	0.015	8		0.004	119	R5-45	703.93	713.33	704.22	0.3		R5-28	702.94	710.64	703.27	0.3	
365	0.015	10		0.027	1316	R6-3	503.82	510.32	508.64	4.8	SUR	R6-4	493.94	500.94	500.00	6.1	SUR
337	0.015	10		0.009	1333	R6-4	493.94	500.94	500.00	6.1	SUR	R6-5	490.81	499.19	491.83	1.0	SUR
444	0.015	10		0.014	1415	R6-5	482.19	499.19	491.83	9.6	SUR	R6-6	475.79	491.79	479.60	3.8	SUR
278	0.014	15		0.007	3303	R6-6	475.79	491.79	479.60	3.8	SUR	R6-8	473.73	492.00	474.59	0.9	
622	0.014	15		0.002	1886	R6-7	477.23	492.23	482.65	5.4	SUR	R6-6	475.79	491.79	479.60	3.8	SUR
226	0.014	18		0.021	3975	R6-8	473.73	492.00	474.59	0.9		R6-27	464.65	488.00	466.15	1.5	SUR
208	0.015	8		0.006	92	R6-11	647.10	665.10	647.33	0.2		R5-10	645.80	665.80	646.03	0.2	
164	0.015	8		0.032	58	R6-18	652.37	662.37	652.49	0.1		R6-11	647.10	665.10	647.33	0.2	
283	0.014	15		0.014	1866	R6-22	481.11	490.11	484.00	2.9	SUR	R6-7	477.23	492.23	482.65	5.4	SUR
411	0.014	15		0.002	1863	R6-23	481.91	493.91	485.95	4.0	SUR	R6-22	481.11	490.11	484.00	2.9	SUR
500	0.014	15		0.002	1844	R6-24	482.89	502.00	488.29	5.4	SUR	R6-23	481.91	493.91	485.95	4.0	SUR
235	0.015	12		0.006	1839	R6-25	484.56	504.00	492.40	7.8	SUR	R6-24	483.09	502.00	488.29	5.2	SUR
360	0.015	12		0.002	1832	R6-26	485.25	505.00	498.65	13.4	SUR	R6-25	484.56	504.00	492.40	7.8	SUR
997	0.014	54		0.001	7097	R6-27	464.55	488.00	466.15	1.6		S7-42	463.54	473.54	465.19	1.6	
1453	0.014	45		0.001	3116	R6-30	466.82	476.82	468.07	1.2		R6-27	465.30	488.00	466.15	0.9	
879	0.014	42		0.001	12803	R7-1	450.89	460.89	453.58	2.7		S7-7	449.96	459.96	452.65	2.7	
175	0.015	8		0.008	13	R7-2	480.93	490.93	481.01	0.1		R7-4	479.59	489.59	479.70	0.1	
1564	0.014	42		0.001	12768	R7-3	452.03	462.03	455.07	3.0		R7-1	450.89	460.89	453.58	2.7	
334	0.015	8		0.006	22	R7-4	479.59	489.59	479.70	0.1		S7-4	477.59	487.59	477.75	0.2	
12	0.015	6		0.017	194	R9-4	493.78	506.00	494.09	0.3		CLSWW	493.57				
351	0.015	6		0.004	163	R9-5	495.18	506.18	496.20	1.0	SUR	R9-4	493.78	506.00	494.09	0.3	
328	0.015	6		0.004	151	R9-6	496.53	509.53	497.77	1.2	SUR	R9-5	495.18	506.18	496.20	1.0	SUR
205	0.015	6		0.007	140	R9-8	504.50	512.50	504.86	0.4		R9-6	496.53	509.53	497.77	1.2	SUR
351	0.015	8		0.004	175	R9-9	507.16	520.86	507.58	0.4		P9-12	505.72	515.52	505.90	0.2	
438	0.014	15		0.004	1668	R9-10	518.00	528.64	519.07	1.1		R9-13	516.25	526.25	517.20	1.0	
448	0.014	18		0.002	1374	R9-13	516.25	526.25	517.20	1.0		R9-15	515.31	525.31	516.12	0.8	
490	0.014	15		0.004	1360	R9-15	515.31	525.31	516.12	0.8		S9-4	513.12	522.96	513.99	0.9	
351	0.015	6		0.015	106	R9-16	509.68	521.98	509.90	0.2		R9-8	504.50	512.50	504.86	0.4	
60	0.015	6		0.005	100	R9-17	509.99	522.99	510.30	0.3		R9-16	509.68	521.98	509.90	0.2	
251	0.015	8		0.003	171	R9-19	507.92	518.42	508.32	0.4		R9-9	507.16	520.86	507.58	0.4	
444	0.015	8		0.003	161	R9-30	509.24	519.24	509.62	0.4		R9-19	507.92	518.42	508.32	0.4	
289	0.015	8		0.003	132	R9-31	510.06	517.96	510.40	0.3		R9-30	509.24	519.24	509.62	0.4	
291	0.015	6		0.006	119	R9-32	511.67	521.67	511.99	0.3		R9-31	510.06	517.96	510.40	0.3	
287	0.015	6		0.005	108	R9-33	513.00	522.00	513.32	0.3		R9-32	511.67	521.67	511.99	0.3	
295	0.015	6		0.005	93	R9-34	514.50	523.10	514.78	0.3		R9-33	513.00	522.00	513.32	0.3	
344	0.015	6		0.040	13	R9-38	523.00	533.00	523.06	0.1		R9-30	509.24	519.24	509.62	0.4	
317	0.015	6		0.005	7	R9-39	511.69	518.99	511.76	0.1		R9-31	510.06	517.96	510.40	0.3	

2010 Master Plan Clear Creek Collection System Pipe Analysis Results

LENGTH (ft)	Manning's N	Diameter (in)	Material	Slope	Maximum Flow, gpm	Upstream MH Name	Upstream Invert (ft)	Upstream MH Rim	Maximum Upstream HGL	Upstream Flow Depth, ft	Class	Downstream MH Name	Downstream Invert (ft)	Downstream MH Rim	Maximum Downstream HGL	Downstream Flow Depth, ft	Class
271	0.015	12		0.000	90	R9-47	524.59	537.79	524.98	0.4		R9-48	524.50	541.70	524.82	0.3	
661	0.015	12		0.002	135	R9-48	524.50	541.70	524.82	0.3		R10-1	523.20	531.00	523.61	0.4	
363	0.015	8		0.003	13	R9-50	534.44	544.44	534.57	0.1		R9-47	524.59	537.79	524.98	0.4	
186	0.015	12		0.002	219	R10-1	523.20	531.00	523.61	0.4		R10-2	522.82	532.82	523.24	0.4	
131	0.015	12		0.002	222	R10-2	522.82	532.82	523.24	0.4		R10-3	522.57	534.97	523.03	0.5	
409	0.015	12		0.002	247	R10-3	522.57	534.97	523.03	0.5		R10-4	521.81	534.61	522.23	0.4	
397	0.015	12		0.002	257	R10-4	521.81	534.61	522.23	0.4		R10-5	520.84	529.44	521.42	0.6	
329	0.014	15		0.002	461	R10-5	520.84	529.44	521.42	0.6		R10-7	520.34	526.44	520.92	0.6	
150	0.015	8		0.007	313	R10-6	521.93	529.83	522.38	0.4		R10-5	520.84	529.44	521.42	0.6	
378	0.014	15		0.002	461	R10-7	520.34	526.44	520.92	0.6		R10-14	519.76	531.56	520.35	0.6	
272	0.015	6		0.011	31	R10-9	526.26	531.46	526.38	0.1		R10-1	523.20	531.00	523.61	0.4	
291	0.015	6		0.010	6	R10-13	535.49	540.79	535.55	0.1		R10-19	532.69	538.44	532.76	0.1	
408	0.014	15		0.002	472	R10-14	519.76	531.56	520.35	0.6		R10-15	519.14	533.74	519.74	0.6	
384	0.014	15		0.001	478	R10-15	519.14	533.74	519.74	0.6		R10-17	518.58	533.98	519.18	0.6	
282	0.014	15		0.002	484	R10-17	518.58	533.98	519.18	0.6		R10-26	518.14	530.54	518.71	0.6	
409	0.015	6		0.013	17	R10-18	531.01	539.01	531.10	0.1		R10-21	525.62	530.69	525.70	0.1	
356	0.015	6		0.005	7	R10-19	532.69	538.44	532.76	0.1		R10-18	531.01	539.01	531.10	0.1	
347	0.015	8		0.005	8	R10-19	532.69	538.44	532.76	0.1		R10-40	531.01	534.57	531.07	0.1	
524	0.015	12		0.007	935	R10-20	487.19	496.19	487.92	0.7		R10-34	483.42	489.42	483.89	0.5	
85	0.015	6		0.031	20	R10-21	525.62	530.69	525.70	0.1		R10-41	522.99	528.96	523.08	0.1	
185	0.015	6		0.045	25	R10-23	526.27	531.27	526.35	0.1		R10-24	518.00	528.00	518.49	0.5	
67	0.015	12		0.014	533	R10-24	518.00	528.00	518.49	0.5		R10-25	517.09	525.99	517.29	0.2	
199	0.015	12		0.204	536	R10-25	517.09	525.99	517.29	0.2		R10-29	477.31	482.01	477.70	0.4	
83	0.014	15		0.002	497	R10-26	518.14	530.54	518.71	0.6		R10-24	518.00	528.00	518.49	0.5	
358	0.015	6		0.033	9	R10-27	530.00	538.00	530.05	0.1		R10-26	518.14	530.54	518.71	0.6	SUR
408	0.014	24		0.004	5468	R10-28	472.20	481.70	473.74	1.5		S10-8	470.41	479.41	471.47	1.1	
189	0.014	15		0.009	540	R10-29	477.31	482.01	477.70	0.4		R10-47	475.56	483.44	476.39	0.8	
520	0.014	24		0.005	5457	R10-30	474.80	482.70	476.18	1.4		R10-28	472.20	481.70	473.74	1.5	
368	0.014	15		0.004	1099	R10-31	476.38	483.98	477.10	0.7		R10-47	474.84	483.44	476.39	1.6	SUR
339	0.014	24		0.004	3814	R10-32	476.20	485.00	477.36	1.2		R10-47	474.84	483.44	476.39	1.6	
142	0.015	6		0.167	43	R10-33	506.72	512.02	506.80	0.1		R10-34	483.42	489.42	483.89	0.5	
215	0.015	12		0.024	983	R10-34	483.42	489.42	483.89	0.5		R10-36	478.16	485.26	478.88	0.7	
431	0.014	24		0.002	3810	R10-35	477.20	487.00	478.64	1.4		R10-32	476.20	485.00	477.36	1.2	
436	0.014	15		0.004	1084	R10-36	478.16	485.26	478.88	0.7		R10-31	476.38	483.98	477.10	0.7	
228	0.014	24		0.002	3807	R10-37	477.80	486.90	479.28	1.5		R10-35	477.40	487.00	478.64	1.2	
204	0.015	12		0.003	99	R10-38	478.81	486.57	479.05	0.2		R10-36	478.16	485.26	478.88	0.7	
331	0.015	8		0.024	15	R10-40	531.01	534.57	531.07	0.1		R10-41	522.99	528.96	523.08	0.1	
249	0.015	6		0.066	38	R10-41	522.99	528.96	523.08	0.1		R10-33	506.72	512.02	506.80	0.1	
61	0.015	8		0.005	34	R10-46	522.26	532.26	522.40	0.1		R10-6	521.93	529.83	522.38	0.4	
30	0.014	24		0.001	5450	R10-47	474.84	483.44	476.39	1.6		R10-30	474.80	482.70	476.18	1.4	
19	0.015	12		0.002	96	R10-49	478.85	488.85	479.10	0.3		R10-38	478.81	486.57	479.05	0.2	
126	0.015	8		0.003	205	R11-1	519.65	530.25	527.89	8.2	SUR	R11-4	519.31	530.00	527.67	8.4	SUR
301	0.015	6		0.019	37	R11-2	525.48	530.98	527.90	2.4	SUR	R11-1	519.65	530.25	527.89	8.2	SUR
250	0.015	8		0.006	158	R11-3	520.80	530.80	527.86	7.1	SUR	R11-4	519.31	530.00	527.67	8.4	SUR
140	0.015	8		0.003	347	R11-4	519.31	530.00	527.67	8.4	SUR	R11-5	518.90	529.60	526.96	8.1	SUR
255	0.015	8		0.003	351	R11-5	518.90	529.60	526.96	8.1	SUR	R11-10	518.15	528.95	525.64	7.5	SUR
252	0.015	8		0.003	358	R11-10	518.15	528.95	525.64	7.5	SUR	R11-13	517.38	528.38	524.29	6.9	SUR
240	0.015	8		0.003	364	R11-13	517.38	528.38	524.29	6.9	SUR	R11-19	516.62	527.82	522.95	6.3	SUR
269	0.015	8		0.008	31	R11-18	518.73	529.00	522.96	4.2	SUR	R11-19	516.62	527.82	522.95	6.3	SUR
259	0.015	8		0.003	473	R11-19	516.62	527.82	522.95	6.3	SUR	R11-21	515.82	527.02	520.46	4.6	SUR
322	0.015	8		0.003	74	R11-20	517.61	526.61	523.03	5.4	SUR	R11-19	516.62	527.82	522.95	6.3	SUR
273	0.015	8		0.003	477	R11-21	515.82	527.02	520.46	4.6	SUR	R11-23	515.02	526.05	517.78	2.8	SUR
157	0.015	8		0.003	494	R11-23	515.02	526.05	517.78	2.8	SUR	R11-25	514.60	529.00	516.11	1.5	SUR

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LENGTH (ft)	Manning's N	Diameter (in)	Material	Slope	Maximum Flow, gpm	Upstream MH Name	Upstream Invert (ft)	Upstream MH Rim	Maximum Upstream HGL	Upstream Flow Depth, ft	Class	Downstream MH Name	Downstream Invert (ft)	Downstream MH Rim	Maximum Downstream HGL	Downstream Flow Depth, ft	Class
133	0.015	6		0.015	21	R11-24	516.97	524.27	517.78	0.8	SUR	R11-23	515.02	526.05	517.78	2.8	SUR
71	0.015	8		0.008	495	R11-25	514.60	529.00	516.11	1.5	SUR	R11-26	514.04	528.24	515.34	1.3	SUR
174	0.015	12		0.003	619	R11-26	514.04	528.24	515.34	1.3	SUR	R11-73	513.58	522.69	515.00	1.4	SUR
371	0.015	10		0.004	90	R11-29	517.59	527.66	517.83	0.2		R11-31	516.29	526.29	516.56	0.3	
395	0.015	10		0.003	106	R11-31	516.29	526.29	516.56	0.3		R11-35	515.02	525.02	515.36	0.3	
258	0.015	8		0.027	11	R11-34	521.87	531.87	521.93	0.1		R11-35	515.02	525.02	515.36	0.3	
204	0.015	10		0.005	125	R11-35	515.02	525.02	515.36	0.3		R11-26	514.04	528.24	515.34	1.3	SUR
520	0.015	8		0.004	119	R11-36	522.83	528.83	528.04	5.2	SUR	R11-3	520.80	530.80	527.86	7.1	SUR
86	0.015	6		0.009	19	R11-37	523.82	528.01	528.01	4.2	SUR	R11-36	523.03	528.83	528.04	5.0	SUR
255	0.015	8		0.014	38	R11-38	521.15	527.95	521.27	0.1		R11-29	517.59	527.66	517.83	0.2	
502	0.015	10		0.003	41	R11-40	519.11	528.81	519.28	0.2		R11-29	517.59	527.66	517.83	0.2	
369	0.015	8		0.005	24	R11-41	520.78	530.28	520.91	0.1		R11-40	519.11	528.81	519.28	0.2	
357	0.015	8		0.003	11	R11-43	520.28	528.28	520.37	0.1		R11-40	519.11	528.81	519.28	0.2	
237	0.015	8		0.005	22	R11-45	521.92	529.22	522.04	0.1		R11-41	520.78	530.28	520.91	0.1	
410	0.015	8		0.073	33	R11-55	516.40	525.00	516.47	0.1		R11-57	486.70	492.80	486.89	0.2	
515	0.015	8		0.004	53	R11-57	486.70	492.80	486.89	0.2		P11-66	484.54	491.24	484.74	0.2	
392	0.014	36		0.002	9417	R11-59	438.82	448.82	442.96	4.1	SUR	X8-6	438.20	446.59	442.50	4.3	SUR
287	0.015	12		0.003	647	R11-73	513.58	522.69	515.00	1.4	SUR	S11-1	512.69	522.69	514.40	1.7	SUR
417	0.015	12		0.004	67	R11-74	480.66	489.00	480.84	0.2		R10-49	478.85	488.85	479.10	0.3	
267	0.015	6		0.004	21	R12-4	521.01	526.01	523.09	2.1	SUR	R12-5	519.95	525.50	523.09	3.1	SUR
305	0.015	8		0.003	67	R12-5	518.50	525.50	523.09	4.6	SUR	R11-20	517.61	526.61	523.03	5.4	SUR
266	0.015	8		0.003	49	R12-14	519.22	525.52	523.11	3.9	SUR	R12-5	518.50	525.50	523.09	4.6	SUR
205	0.015	8		0.019	545	S4-1	692.33	710.33	695.97	3.6	SUR	S5-20	688.46	706.46	693.20	4.7	SUR
398	0.015	8		0.018	47	S4-2	699.69	705.80	699.81	0.1		S4-1	692.33	710.33	695.97	3.6	SUR
268	0.015	8		0.019	490	S4-3	697.50	709.50	698.88	1.4	SUR	S4-1	692.33	710.33	695.97	3.6	SUR
472	0.015	8		0.004	472	S4-5	699.30	709.30	703.61	4.3	SUR	S4-3	697.50	709.50	698.88	1.4	SUR
369	0.015	8		0.004	438	S4-7	700.86	710.86	706.78	5.9	SUR	S4-5	699.30	709.30	703.61	4.3	SUR
353	0.015	8		0.014	108	S5-1	704.00	714.00	704.20	0.2		L4-18	698.90	708.90	699.11	0.2	
441	0.015	10		0.018	1178	S5-3	548.93	556.43	549.66	0.7		S6-3	540.95	545.95	541.62	0.7	
549	0.015	10		0.031	775	S5-4	565.99	572.49	566.42	0.4		S5-3	548.93	556.43	549.66	0.7	
561	0.015	10		0.023	708	S5-5	578.71	584.71	579.16	0.4		S5-4	565.99	572.49	566.42	0.4	
456	0.015	10		0.025	676	S5-6	589.93	596.93	590.35	0.4		S5-5	578.71	584.71	579.16	0.4	
540	0.015	8		0.168	637	S5-7	679.46	687.26	679.72	0.3		S5-6	589.93	596.93	590.35	0.4	
371	0.015	8		0.012	579	S5-8	683.79	705.96	687.77	4.0	SUR	S5-7	679.46	687.26	679.72	0.3	
396	0.015	8		0.012	551	S5-20	688.46	706.46	693.20	4.7	SUR	S5-8	683.79	705.96	687.77	4.0	SUR
394	0.015	8		0.231	37	S5-21	654.80	662.80	654.86	0.1		S5-4	565.99	572.49	566.42	0.4	
189	0.015	8		0.207	22	S5-27	604.35	661.05	604.39	0.0		S5-4	565.99	572.49	566.42	0.4	
442	0.015	8		0.112	16	S5-28	653.66	668.96	653.71	0.0		S5-27	604.35	661.05	604.39	0.0	
482	0.015	10		0.026	1299	S6-1	516.55	521.55	519.76	3.2	SUR	R6-3	503.82	510.32	508.64	4.8	SUR
685	0.014	45		0.003	23541	S6-2	425.01	435.01	433.44	8.4	SUR	Z8-39	422.77	432.77	431.93	9.2	SUR
498	0.015	10		0.022	1235	S6-3	540.95	545.95	541.62	0.7		Z7-8	529.86	534.86	530.52	0.7	
421	0.015	8		0.249	49	S6-4	642.66	648.66	642.73	0.1		S6-3	540.95	545.95	541.62	0.7	SUR
332	0.015	8		0.085	29	S6-12	524.19	529.19	524.26	0.1		S6-16	496.01	502.01	496.13	0.1	
507	0.015	8		0.015	41	S6-16	496.01	502.01	496.13	0.1		S6-17	488.25	495.25	492.13	3.9	SUR
341	0.015	8		0.003	78	S6-17	488.25	495.25	492.13	3.9	SUR	S6-20	487.25	493.50	492.09	4.8	SUR
354	0.015	8		0.005	122	S6-18	483.79	500.79	491.94	8.1	SUR	R6-5	482.19	499.19	491.83	9.6	SUR
352	0.015	8		0.004	113	S6-19	485.19	494.79	492.03	6.8	SUR	S6-18	483.79	500.79	491.94	8.1	SUR
384	0.015	8		0.005	92	S6-20	487.25	493.50	492.09	4.8	SUR	S6-19	485.19	494.79	492.03	6.8	SUR
777	0.014	15		0.002	665	S6-22	476.81	488.81	477.57	0.8		R6-8	473.73	492.00	474.59	0.9	
28	0.014	15		0.017	658	S6-23	477.29	488.29	477.66	0.4		S6-22	476.81	488.81	477.57	0.8	
239	0.014	15		0.004	657	S6-24	478.18	488.18	478.77	0.6		S6-23	477.29	488.29	477.66	0.4	
28	0.014	15		0.009	656	S6-25	478.43	489.43	478.86	0.4		S6-24	478.18	488.18	478.77	0.6	
204	0.014	15		0.007	645	S6-28	480.12	489.12	480.57	0.4		S6-38	478.60	490.00	479.52	0.9	

2010 Master Plan Clear Creek Collection System Pipe Analysis Results

LENGTH (ft)	Manning's N	Diameter (in)	Material	Slope	Maximum Flow, gpm	Upstream MH Name	Upstream Invert (ft)	Upstream MH Rim	Maximum Upstream HGL	Upstream Flow Depth, ft	Class	Downstream MH Name	Downstream Invert (ft)	Downstream MH Rim	Maximum Downstream HGL	Downstream Flow Depth, ft	Class
234	0.014	15		0.004	642	S6-29	480.99	489.99	481.56	0.6		S6-28	480.12	489.12	480.57	0.4	
365	0.014	15		0.004	612	S6-30	482.27	492.27	482.81	0.5		S6-29	480.99	489.99	481.56	0.6	
375	0.014	15		0.003	572	S6-31	483.37	495.37	483.92	0.5		S6-30	482.27	492.27	482.81	0.5	
414	0.015	12		0.019	502	S6-32	491.09	501.09	491.44	0.4		S6-31	483.37	495.37	483.92	0.5	
213	0.015	12		0.005	494	S6-33	492.22	502.22	492.75	0.5		S6-32	491.09	501.09	491.44	0.4	
304	0.014	15		0.001	650	S6-38	478.60	490.00	479.52	0.9		S6-25	478.43	489.43	478.86	0.4	
23	0.015	8		0.348	68	S7-1	474.60	484.60	474.67	0.1		S7-2	467.10	477.10	467.49	0.4	
765	0.014	18		0.002	147	S7-2	467.10	477.10	467.49	0.4		S7-3	465.95	475.95	466.12	0.2	
593	0.014	18		0.020	168	S7-3	465.95	475.95	466.12	0.2		S7-7	454.00	459.96	452.65	-1.3	
408	0.015	8		0.007	41	S7-4	477.59	487.59	477.75	0.2		S7-1	474.60	484.60	474.67	0.1	
355	0.014	42		0.003	23373	S7-5	426.24	436.24	434.53	8.3	SUR	S6-2	425.01	435.01	433.44	8.4	SUR
37	0.015	8		0.166	31	S7-6	460.30	470.30	460.36	0.1		S7-7	449.96	459.96	452.65	2.7	SUR
1143	0.014	42		0.001	13008	S7-7	449.96	459.96	452.65	2.7		S7-17	448.73	458.73	451.36	2.6	
182	0.015	8		0.004	16	S7-8	466.43	471.43	466.54	0.1		S7-6	460.30	470.30	460.36	0.1	
90	0.015	8		0.136	76	S7-16	463.75	473.75	463.85	0.1		S7-17	448.73	458.73	451.36	2.6	SUR
306	0.014	42		0.001	13073	S7-17	448.73	458.73	451.36	2.6		S7-19	448.33	458.33	451.03	2.7	
351	0.014	42		0.001	13088	S7-19	448.33	458.33	451.03	2.7		S8-3	447.84	457.84	450.70	2.9	
565	0.015	8		0.005	59	S7-22	466.53	476.53	466.74	0.2		S7-16	463.75	473.75	463.85	0.1	
421	0.015	8		0.003	74	S7-26	474.05	481.05	474.29	0.2		T7-24	472.68	480.68	472.95	0.3	
292	0.015	8		0.004	63	S7-27	475.19	482.19	475.40	0.2		S7-26	474.05	481.05	474.29	0.2	
197	0.015	8		0.004	53	S7-29	476.00	481.20	476.19	0.2		S7-27	475.19	482.19	475.40	0.2	
310	0.015	8		0.003	49	S7-32	477.01	482.01	477.21	0.2		S7-29	476.00	481.20	476.19	0.2	
967	0.014	54		0.001	7144	S7-41	462.49	472.49	464.09	1.6		T7-20	461.49	471.49	463.17	1.7	
1115	0.014	54		0.001	7122	S7-42	463.54	473.54	465.19	1.6		S7-41	462.49	472.49	464.09	1.6	
452	0.014	42		0.001	13115	S8-3	447.84	457.84	450.70	2.9		Z8-38	447.53	457.53	450.24	2.7	
320	0.015	8		0.005	114	S8-5	563.90	570.40	564.17	0.3		T8-8	562.29	571.19	562.57	0.3	
362	0.015	6		0.007	26	S9-1	507.00	514.00	507.13	0.1		R9-8	504.50	512.50	504.86	0.4	
427	0.014	18		0.002	1361	S9-4	512.96	522.96	513.99	1.0		S9-7	512.19	521.85	512.85	0.7	
436	0.015	6		0.004	87	S9-5	511.59	518.59	511.89	0.3		R9-17	509.99	522.99	510.30	0.3	
112	0.015	6		0.004	82	S9-6	512.00	519.00	512.29	0.3		S9-5	511.59	518.59	511.89	0.3	
448	0.014	18		0.002	1452	S9-7	511.85	521.85	512.85	1.0		S9-10	511.05	521.05	512.07	1.0	
50	0.015	6		0.019	90	S9-8	513.13	518.00	513.32	0.2		S9-7	512.19	521.85	512.85	0.7	SUR
291	0.015	6		0.004	41	S9-8	513.13	518.00	513.32	0.2		S9-6	512.00	519.00	512.29	0.3	
370	0.015	6		0.006	127	S9-9	515.29	521.00	515.67	0.4		S9-8	513.13	518.00	513.32	0.2	
485	0.014	18		0.002	1459	S9-10	511.05	521.05	512.07	1.0		S9-13	510.20	520.20	511.20	1.0	
247	0.015	6		0.003	119	S9-11	516.11	521.01	516.50	0.4		S9-9	515.29	521.00	515.67	0.4	
26	0.015	6		0.002	116	S9-12	516.16	526.16	516.58	0.4		S9-11	516.11	521.01	516.50	0.4	
465	0.014	18		0.002	1465	S9-13	510.20	520.20	511.20	1.0		Z8-40	509.34	519.34	510.38	1.0	
78	0.015	6		0.011	29	S9-14	575.98	581.48	576.10	0.1		L10-75	575.10	583.10	575.27	0.2	
62	0.015	6		0.002	87	S9-15	517.18	527.18	518.09	0.9	SUR	S9-20	517.06	527.06	517.99	0.9	SUR
552	0.015	8		0.001	15	S9-16	517.84	521.34	518.06	0.2		S9-15	517.18	527.18	518.09	0.9	SUR
262	0.015	6		0.002	112	S9-19	516.56	526.56	517.19	0.6	SUR	S9-12	516.16	526.16	516.58	0.4	
266	0.015	6		0.001	93	S9-20	517.06	527.06	517.99	0.9	SUR	S9-28	516.73	526.73	517.48	0.7	SUR
344	0.015	6		0.001	63	S9-21	517.63	527.63	518.35	0.7	SUR	S9-15	517.18	527.18	518.09	0.9	SUR
327	0.015	6		0.001	42	S9-22	518.09	528.09	518.45	0.4		S9-21	517.63	527.63	518.35	0.7	SUR
289	0.015	6		0.003	16	S9-27	518.52	520.00	518.64	0.1		S9-21	517.63	527.63	518.35	0.7	SUR
117	0.015	6		0.001	109	S9-28	516.73	526.73	517.48	0.7	SUR	S9-19	516.56	526.56	517.19	0.6	SUR
283	0.015	8		0.004	11	S9-29	517.98	527.98	518.07	0.1		S9-28	516.73	526.73	517.48	0.7	SUR
279	0.015	6		0.005	30	S9-31	513.35	519.35	513.50	0.1		S9-6	512.00	519.00	512.29	0.3	
315	0.015	8		0.002	29	S9-41	518.74	526.67	518.91	0.2		S9-22	518.09	528.09	518.45	0.4	
399	0.014	24		0.011	5479	S10-8	470.41	479.41	471.47	1.1		S10-21	466.01	478.01	467.59	1.6	
302	0.015	6		0.022	59	S10-14	511.72	519.22	511.86	0.1		S10-15	504.97	522.97	505.21	0.2	
63	0.015	6		0.020	147	S10-15	504.97	522.97	505.21	0.2		DLSWW	503.68				

2010 Master Plan Clear Creek Collection System Pipe Analysis Results

LENGTH (ft)	Manning's N	Diameter (in)	Material	Slope	Maximum Flow, gpm	Upstream MH Name	Upstream Invert (ft)	Upstream MH Rim	Maximum Upstream HGL	Upstream Flow Depth, ft	Class	Downstream MH Name	Downstream Invert (ft)	Downstream MH Rim	Maximum Downstream HGL	Downstream Flow Depth, ft	Class
354	0.015	6		0.004	81	S10-16	506.37	517.37	506.67	0.3		S10-15	504.97	522.97	505.21	0.2	
529	0.014	30		0.002	5499	S10-21	466.01	478.01	467.59	1.6		S10-28	464.91	475.51	466.32	1.4	
317	0.014	30		0.004	6579	S10-28	464.91	475.51	466.32	1.4		S10-29	463.65	474.65	465.42	1.8	
492	0.014	30		0.002	6588	S10-29	463.65	474.65	465.42	1.8		S11-10	462.63	473.03	464.42	1.8	
286	0.015	12		0.004	660	S11-1	512.69	522.69	514.40	1.7	SUR	S11-2	511.41	521.41	513.75	2.3	SUR
289	0.015	12		0.004	686	S11-2	511.41	521.41	513.75	2.3	SUR	S11-22	510.15	521.15	513.05	2.9	SUR
425	0.015	12		0.002	737	S11-3	509.79	521.29	512.29	2.5	SUR	S11-4	508.64	519.34	511.11	2.5	SUR
59	0.015	12		0.004	743	S11-4	508.74	519.34	511.11	2.4	SUR	S11-18	508.50	515.50	510.94	2.4	SUR
172	0.015	12		0.003	957	S11-5	507.70	517.70	509.29	1.6	SUR	S11-25	507.11	517.11	508.48	1.4	SUR
531	0.015	12		0.037	969	S11-6	506.44	522.44	506.89	0.4		S11-7	487.00	495.00	487.33	0.3	
170	0.015	12		0.106	1031	S11-7	487.00	495.00	487.33	0.3		S11-8	469.08	476.88	472.38	3.3	SUR
367	0.015	12		0.004	1047	S11-8	469.08	476.88	472.38	3.3	SUR	S11-9	467.77	473.97	470.29	2.5	SUR
499	0.015	12		0.003	1069	S11-9	467.77	473.97	470.29	2.5	SUR	S10-28	464.91	475.51	466.32	1.4	SUR
511	0.014	30		0.002	6600	S11-10	462.63	473.03	464.42	1.8		T11-1	461.61	469.51	463.39	1.8	
223	0.015	8		0.003	96	S11-13	511.48	517.48	511.75	0.3		S11-14	510.73	519.73	511.41	0.7	SUR
226	0.015	8		0.004	99	S11-14	510.73	519.73	511.41	0.7	SUR	S11-15	509.86	516.86	511.32	1.5	SUR
318	0.015	8		0.003	169	S11-15	509.86	516.86	511.32	1.5	SUR	S11-18	509.00	515.50	510.94	1.9	SUR
279	0.015	8		0.011	65	S11-16	512.80	519.80	512.97	0.2		S11-15	509.86	516.86	511.32	1.5	SUR
347	0.015	12		0.002	950	S11-18	508.50	515.50	510.94	2.4	SUR	S11-5	507.70	517.70	509.29	1.6	SUR
289	0.015	12		0.001	714	S11-22	510.15	521.15	513.05	2.9	SUR	S11-3	509.79	521.29	512.29	2.5	SUR
386	0.015	8		0.009	39	S11-24	512.00	517.00	512.13	0.1		S11-18	508.50	515.50	510.94	2.4	SUR
213	0.015	12		0.003	961	S11-25	507.11	517.11	508.48	1.4	SUR	S11-6	506.44	522.44	506.89	0.4	
231	0.014	42		0.002	30264	SA8-1	411.40	421.40	415.04	3.6	SUR	N5-13	410.90	420.40	413.39	2.5	
137	0.014	24		0.009	4907	SA8-2	479.20	489.20	483.13	3.9	SUR	NMSLS	478.00				
1245	0.014	42		0.002	30258	SA8-3	414.01	424.01	421.53	7.5	SUR	SA8-1	411.40	421.40	415.04	3.6	SUR
19	0.014	72		0.001	30272	SB8-1	410.00	420.00	412.40	2.4		Outfall	409.99				
386	0.015	12		0.010	348	T5-1	506.89	516.89	507.23	0.3		T6-3	502.89	512.72	503.08	0.2	
391	0.015	12		0.007	303	T5-2	509.79	519.79	510.14	0.4		T5-1	507.06	516.89	507.23	0.2	
409	0.015	12		0.010	256	T5-3	514.00	524.00	514.29	0.3		T5-2	509.79	519.79	510.14	0.4	
360	0.015	12		0.008	475	T6-1	495.33	505.33	495.76	0.4		S6-33	492.39	502.22	492.75	0.4	
521	0.015	12		0.006	440	T6-2	498.45	508.45	498.92	0.5		T6-1	495.50	505.33	495.76	0.3	
406	0.015	12		0.010	394	T6-3	502.72	512.72	503.08	0.4		T6-2	498.62	508.45	498.92	0.3	
408	0.015	8		0.007	38	T7-4	458.15	471.15	458.29	0.1		T8-3	455.34	470.34	455.53	0.2	
432	0.015	8		0.003	159	T7-6	460.37	472.37	460.74	0.4		T8-10	458.98	473.98	459.35	0.4	
386	0.015	8		0.004	145	T7-7	461.99	473.19	462.31	0.3		T7-6	460.37	472.37	460.74	0.4	
401	0.015	8		0.004	134	T7-9	463.55	478.55	463.87	0.3		T7-7	461.99	473.19	462.31	0.3	
270	0.015	8		0.004	124	T7-10	464.64	475.64	464.94	0.3		T7-9	463.55	478.55	463.87	0.3	
339	0.015	8		0.012	117	T7-11	468.79	477.79	469.01	0.2		T7-10	464.64	475.64	464.94	0.3	
239	0.015	8		0.004	113	T7-12	469.76	477.76	470.07	0.3		T7-11	468.79	477.79	469.01	0.2	
426	0.015	8		0.004	104	T7-14	471.32	479.32	471.60	0.3		T7-12	469.76	477.76	470.07	0.3	
880	0.014	48		0.002	7187	T7-19	460.59	470.59	462.04	1.5		V7-5	458.99	468.99	460.52	1.5	
941	0.014	54		0.001	7176	T7-20	461.49	471.49	463.17	1.7		T7-19	460.59	470.59	462.04	1.5	
439	0.015	8		0.003	88	T7-24	472.68	480.68	472.95	0.3		T7-14	471.32	479.32	471.60	0.3	
123	0.015	6		0.020	33	T8-1	574.06	582.96	574.17	0.1		W8-4	571.63	581.63	571.76	0.1	
503	0.014	42		0.001	13357	T8-2	446.89	456.89	449.74	2.8		T8-4	446.34	456.34	449.27	2.9	
214	0.015	8		0.006	60	T8-3	455.34	470.34	455.53	0.2		T8-2	446.89	456.89	449.74	2.8	SUR
550	0.014	42		0.001	13372	T8-4	446.34	456.34	449.27	2.9		T8-5	445.79	451.79	448.78	3.0	
73	0.014	42		0.003	13368	T8-5	445.79	451.79	448.78	3.0		T8-6	445.60	455.60	448.73	3.1	
564	0.014	42		0.002	13355	T8-6	445.60	455.60	448.73	3.1		Z8-52	444.69	454.69	448.28	3.6	SUR
343	0.015	8		0.005	122	T8-7	560.81	568.01	561.09	0.3		M11-7	559.06	565.56	559.39	0.3	
301	0.015	8		0.005	117	T8-8	562.29	571.19	562.57	0.3		T8-7	560.81	568.01	561.09	0.3	
219	0.015	8		0.005	169	T8-10	458.98	473.98	459.35	0.4		Z8-5	457.80	470.50	457.96	0.2	
636	0.014	15		0.002	1676	T9-1	548.71	557.71	552.60	3.9	SUR	M10-25	547.22	552.46	550.21	3.0	SUR

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132	0.015	8		0.005	47	T9-2	564.55	570.05	564.72	0.2		S8-5	563.90	570.40	564.17	0.3	
37	0.015	8		0.032	120	T9-2	564.55	570.05	564.72	0.2		M11-14	563.35	571.50	563.66	0.3	
499	0.015	12		0.008	1388	T9-3	560.10	570.10	565.24	5.1	SUR	G4-10	556.10	565.10	560.24	4.1	SUR
369	0.015	8		0.026	224	T9-4	702.74	712.74	702.99	0.2		L3-14	693.14	703.14	693.44	0.3	
269	0.014	18		0.004	1638	T9-5	498.94	508.94	499.75	0.8		T9-6	497.75	514.85	499.01	1.3	
610	0.014	24		0.026	10390	T9-6	497.75	514.85	499.01	1.3		T9-8	481.71	489.61	482.79	1.1	
183	0.014	30		0.004	8788	T9-7	498.46	518.36	500.23	1.8		T9-6	497.75	514.85	499.01	1.3	
548	0.014	22		0.045	10399	T9-8	481.71	489.61	482.79	1.1		T9-11	457.00	464.00	459.07	2.1	SUR
4	0.014	24		0.002	10401	T9-11	457.00	464.00	459.07	2.1	SUR	T9-28	456.99	466.00	458.24	1.2	
505	0.014	24		0.013	7438	T9-28	457.00	466.00	458.24	1.2		V9-3	450.42	456.12	456.12	5.7	SUR
45	0.014	18		0.003	2972	T9-28	456.99	466.00	458.24	1.2		T9-29	456.86	465.00	457.72	0.9	
218	0.014	18		0.014	2976	T9-29	456.86	465.00	457.72	0.9		T9-30	453.83	460.00	454.55	0.7	
270	0.014	21		0.016	2986	T9-30	453.83	460.00	454.55	0.7		V9-9	449.50	457.00	450.56	1.1	
507	0.014	30		0.003	8776	T10-1	499.77	509.17	501.84	2.1		T9-7	498.46	518.36	500.23	1.8	
407	0.015	8		0.005	43	T10-2	456.39	466.39	456.55	0.2		V10-16	454.33	464.33	456.98	2.6	SUR
343	0.014	30		0.010	7111	T10-25	456.62	463.82	457.74	1.1		V10-12	453.16	462.36	457.22	4.1	SUR
97	0.015	8		0.146	73	T10-26	470.00	481.00	470.09	0.1		V10-12	455.91	462.36	457.22	1.3	SUR
394	0.014	30		0.002	6608	T11-1	461.61	469.51	463.39	1.8		T11-2	460.80	470.00	462.59	1.8	
775	0.014	30		0.002	6638	T11-2	460.80	470.00	462.59	1.8		T11-3	459.18	468.38	460.85	1.7	
25	0.014	30		0.003	6655	T11-3	459.18	468.38	460.85	1.7		T11-29	459.10	469.10	460.80	1.7	
117	0.014	30		0.005	6861	T11-4	458.26	468.16	459.72	1.5		T11-5	457.66	466.96	459.59	1.9	
492	0.014	30		0.002	7105	T11-5	457.66	466.96	459.59	1.9		T10-25	456.62	463.82	457.74	1.1	
257	0.015	8		0.004	246	T11-6	461.43	471.43	461.94	0.5		T11-5	457.66	466.96	459.59	1.9	SUR
249	0.015	8		0.005	239	T11-7	462.68	472.68	463.10	0.4		T11-6	461.43	471.43	461.94	0.5	
465	0.015	4		0.023	119	T11-8	473.83	489.93	475.07	1.2	SUR	T11-7	462.68	472.68	463.10	0.4	SUR
467	0.015	4		0.025	100	T11-8	474.83	489.93	475.07	0.2		T11-7	462.68	472.68	463.10	0.4	SUR
376	0.015	8		0.022	129	T11-9	500.31	510.31	500.51	0.2		V11-1	491.86	501.86	492.04	0.2	
358	0.015	8		0.019	24	T11-10	506.98	516.98	507.07	0.1		T11-9	500.31	510.31	500.51	0.2	
225	0.015	8		0.012	97	T11-11	503.12	513.12	503.31	0.2		T11-9	500.31	510.31	500.51	0.2	
298	0.015	8		0.012	93	T11-13	506.84	515.99	507.03	0.2		T11-11	503.12	513.12	503.31	0.2	
230	0.015	8		0.023	15	T11-14	518.10	522.60	518.17	0.1		Z8-11	512.90	522.90	512.97	0.1	
447	0.015	8		0.012	49	T11-16	512.30	523.00	512.44	0.1		T11-13	506.84	515.99	507.03	0.2	
327	0.015	6		0.045	18	T11-25	725.53	735.53	725.60	0.1		L4-10	711.00	721.00	711.24	0.2	
299	0.015	10		0.015	203	T11-27	464.01	473.41	464.26	0.2		T11-28	459.44	468.94	460.81	1.4	SUR
20	0.015	10		0.007	207	T11-28	459.44	468.94	460.81	1.4	SUR	T11-29	459.30	469.10	460.80	1.5	SUR
334	0.014	30		0.003	6858	T11-29	459.10	469.10	460.80	1.7		T11-4	458.26	468.16	459.72	1.5	
454	0.015	10		0.003	180	V5-1	487.12	493.72	487.47	0.3		V5-2	485.59	494.29	486.02	0.4	
293	0.015	10		0.003	199	V5-2	485.59	494.29	486.02	0.4		V6-15	484.65	500.25	484.89	0.2	
362	0.015	8		0.004	119	V6-1	672.39	680.99	672.72	0.3		F6-1	670.86	678.16	671.05	0.2	
90	0.014	15		0.002	503	V6-2	469.07	482.07	469.61	0.5		Z8-22	468.86	481.96	469.45	0.6	
238	0.014	15		0.003	494	V6-3	469.69	480.99	470.21	0.5		V6-2	469.07	482.07	469.61	0.5	
304	0.015	8		0.006	85	V6-4	471.63	481.63	471.85	0.2		V6-3	469.69	480.99	470.21	0.5	
504	0.015	12		0.011	392	V6-10	475.02	482.52	475.38	0.4		V6-3	469.69	480.99	470.21	0.5	
497	0.015	12		0.005	349	V6-11	477.39	485.99	477.83	0.4		V6-10	475.02	482.52	475.38	0.4	
496	0.015	12		0.005	318	V6-12	479.94	488.94	480.33	0.4		V6-11	477.39	485.99	477.83	0.4	
344	0.015	12		0.005	263	V6-13	481.81	492.51	482.16	0.3		V6-12	479.94	488.94	480.33	0.4	
346	0.015	12		0.005	235	V6-14	483.38	495.98	483.72	0.3		V6-13	481.81	492.51	482.16	0.3	
80	0.015	12		0.016	217	V6-15	484.65	500.25	484.89	0.2		V6-14	483.38	495.98	483.72	0.3	
1096	0.014	48		0.002	7220	V7-5	458.99	468.99	460.52	1.5		V7-7	457.19	467.19	458.60	1.4	
50	0.014	48		0.001	7235	V7-7	457.19	467.19	458.60	1.4		V7-8	457.12	467.12	458.45	1.3	
1243	0.014	48		0.003	7271	V7-8	457.12	467.12	458.45	1.3		W7-17	453.85	474.67	455.21	1.4	
904	0.014	36		0.001	8224	V8-1	443.01	457.41	446.89	3.9	SUR	V8-2	442.11	453.80	446.24	4.1	SUR
28	0.014	36		0.004	7738	V8-2	443.71	453.80	446.24	2.5		V8-28	442.06	462.00	446.23	4.2	SUR

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LENGTH (ft)	Manning's N	Diameter (in)	Material	Slope	Maximum Flow, gpm	Upstream MH Name	Upstream Invert (ft)	Upstream MH Rim	Maximum Upstream HGL	Upstream Flow Depth, ft	Class	Downstream MH Name	Downstream Invert (ft)	Downstream MH Rim	Maximum Downstream HGL	Downstream Flow Depth, ft	Class
65	0.014	42		0.002	17786	V8-2	441.43	453.80	446.24	4.8	SUR	V8-3	441.33	451.33	446.17	4.8	SUR
969	0.014	42		0.001	18046	V8-3	441.33	451.33	446.17	4.8	SUR	Z8-29	439.94	449.94	445.17	5.2	SUR
305	0.015	6		0.017	31	V8-4	579.16	588.56	579.27	0.1		T8-1	574.06	582.96	574.17	0.1	
315	0.014	42		0.001	13543	V8-5	441.94	457.00	446.54	4.6	SUR	V8-2	441.43	453.80	446.24	4.8	SUR
473	0.014	42		0.002	13534	V8-6	442.74	457.00	446.99	4.2	SUR	V8-5	441.94	457.00	446.54	4.6	SUR
178	0.015	6		0.005	9	V8-7	447.07	453.02	447.16	0.1		V8-6	446.24	457.00	446.99	0.7	SUR
547	0.014	42		0.001	13481	V8-8	443.45	458.81	447.51	4.1	SUR	V8-6	442.74	457.00	446.99	4.2	SUR
331	0.015	8		0.031	128	V8-9	457.21	467.21	457.39	0.2		V8-8	447.00	458.81	447.51	0.5	
335	0.015	8		0.003	110	V8-10	458.08	468.27	458.47	0.4		V8-9	457.21	467.21	457.39	0.2	
72	0.015	8		0.003	85	V8-11	458.27	472.57	458.55	0.3		V8-10	458.08	468.27	458.47	0.4	
437	0.015	8		0.008	45	V8-12	461.99	467.69	462.14	0.1		V8-11	458.53	472.57	458.55	0.0	
406	0.015	8		0.003	33	V8-14	460.00	468.00	460.18	0.2		V8-11	458.27	472.57	458.55	0.3	
398	0.015	8		0.005	23	V8-15	461.80	469.80	461.92	0.1		V8-14	460.00	468.00	460.18	0.2	
224	0.015	8		0.015	55	V8-17	455.86	462.96	456.00	0.1		Z8-54	452.50	460.20	452.72	0.2	
316	0.015	8		0.004	45	V8-18	457.06	465.56	457.26	0.2		V8-17	455.86	462.96	456.00	0.1	
458	0.015	8		0.006	15	V8-23	460.98	466.98	461.07	0.1		V8-10	458.27	468.27	458.47	0.2	
895	0.014	24		0.002	2531	V8-27	445.08	460.00	446.78	1.7		V8-28	443.60	462.00	446.23	2.6	SUR
1030	0.014	36		0.001	9967	V8-28	443.60	462.00	446.23	2.6		Z8-56	442.06	452.06	445.25	3.2	SUR
943	0.014	36		0.001	8198	V9-1	443.94	454.84	447.60	3.7	SUR	V8-1	443.01	457.41	446.89	3.9	SUR
3	0.014	24		0.003	8831	V9-2	444.47	454.59	450.97	6.5	SUR	V9-11	444.69	454.59	448.18	3.5	SUR
630	0.014	24		0.008	7445	V9-3	450.42	456.12	456.12	5.7	SUR	V9-2	445.69	454.59	450.97	5.3	SUR
230	0.015	8		0.004	100	V9-6	443.16	453.16	443.45	0.3		SBLSWW	442.23				
34	0.015	8		0.005	292	V9-7	447.86	454.40	451.81	4.0	SUR	V9-2	447.69	454.59	450.97	3.3	SUR
629	0.014	21		0.005	3033	V9-9	449.50	457.00	450.56	1.1		V9-10	446.62	457.00	448.18	1.6	
791	0.014	24		0.001	2701	V9-10	446.62	457.00	448.18	1.6		V9-12	445.91	456.00	447.48	1.6	
768	0.014	36		0.001	8235	V9-11	444.69	454.59	448.18	3.5	SUR	V9-1	443.94	454.84	447.60	3.7	SUR
23	0.014	24		0.006	1290	V9-11	446.76	454.59	448.18	1.4		V9-10	446.62	457.00	448.18	1.6	
928	0.014	24		0.001	2636	V9-12	445.91	456.00	447.48	1.6		V8-27	445.08	460.00	446.78	1.7	
443	0.014	33		0.002	8008	V10-2	451.11	461.41	456.75	5.6	SUR	V10-3	450.33	463.03	456.30	6.0	SUR
673	0.014	33		0.001	8169	V10-3	450.33	463.03	456.30	6.0	SUR	V10-4	449.33	458.03	455.61	6.3	SUR
417	0.014	33		0.001	8389	V10-4	449.33	458.03	455.61	6.3	SUR	V10-14	448.87	458.87	455.18	6.3	SUR
350	0.014	30		0.009	8627	V10-5	448.36	460.96	454.89	6.5	SUR	V10-6	445.07	455.07	454.27	9.2	SUR
122	0.014	30		0.006	8632	V10-6	445.07	455.07	454.27	9.2	SUR	SLSWW	444.34				
448	0.014	33		0.005	7990	V10-12	453.16	462.36	457.22	4.1	SUR	V10-2	451.11	461.41	456.75	5.6	SUR
259	0.014	33		0.001	8556	V10-14	448.87	458.87	455.18	6.3	SUR	V10-5	448.56	460.96	454.89	6.3	SUR
461	0.015	8		0.005	209	V10-15	453.92	463.92	456.80	2.9	SUR	V10-14	451.62	458.87	455.18	3.6	SUR
79	0.015	8		0.005	160	V10-16	454.33	464.33	456.98	2.6	SUR	V10-15	453.92	463.92	456.80	2.9	SUR
269	0.015	8		0.063	181	V11-1	491.86	501.86	492.04	0.2		T11-8	474.93	489.93	475.07	0.1	
268	0.015	8		0.011	101	V11-2	678.04	688.04	678.25	0.2		L4-39	675.07	685.07	675.27	0.2	
369	0.015	8		0.034	16	V11-3	519.39	529.00	519.45	0.1		T11-13	506.84	515.99	507.03	0.2	
586	0.014	15		0.002	592	W6-1	467.20	479.50	467.92	0.7		W7-14	466.03	474.63	466.44	0.4	
346	0.015	6		0.010	62	W6-2	567.46	574.46	567.64	0.2		S8-5	563.90	570.40	564.17	0.3	
575	0.014	18		0.002	164	W7-1	454.78	465.78	455.08	0.3		W8-3	453.65	465.65	453.95	0.3	
290	0.014	18		0.003	113	W7-2	455.92	466.12	456.14	0.2		W7-15	455.06	465.56	455.33	0.3	
93	0.014	18		0.004	101	W7-3	456.26	466.56	456.46	0.2		W7-2	455.92	466.12	456.14	0.2	
513	0.014	18		0.002	67	W7-4	457.15	468.25	457.35	0.2		W7-3	456.26	466.56	456.46	0.2	
303	0.015	8		0.233	141	W7-5	664.70	671.70	664.81	0.1		G5-12	596.10	602.10	596.28	0.2	
259	0.014	18		0.004	761	W7-7	460.20	474.20	460.75	0.6		W7-17	453.85	474.67	455.21	1.4	
93	0.015	8		0.015	521	W7-8	543.98	553.98	544.49	0.5		F7-2	542.55	552.55	542.98	0.4	
111	0.015	6		0.025	13	W7-9	680.82	690.82	680.89	0.1		V11-2	678.04	688.04	678.25	0.2	
305	0.015	8		0.005	104	W7-10	464.27	474.27	464.53	0.3		Z8-8	462.87	472.87	463.16	0.3	
562	0.014	15		0.010	611	W7-14	466.03	474.63	466.44	0.4		Z8-2	460.43	472.73	461.12	0.7	
165	0.014	18		0.002	128	W7-15	455.06	465.56	455.33	0.3		W7-1	454.78	465.78	455.08	0.3	

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LENGTH (ft)	Manning's N	Diameter (in)	Material	Slope	Maximum Flow, gpm	Upstream MH Name	Upstream Invert (ft)	Upstream MH Rim	Maximum Upstream HGL	Upstream Flow Depth, ft	Class	Downstream MH Name	Downstream Invert (ft)	Downstream MH Rim	Maximum Downstream HGL	Downstream Flow Depth, ft	Class
453	0.014	18		0.002	10	W7-17	459.17	474.67	459.25	0.1		Z8-21	458.37	471.17	458.51	0.1	
376	0.014	48		0.003	8028	W7-17	453.85	474.67	455.21	1.4		W7-18	452.76	462.76	454.14	1.4	
57	0.014	48		0.003	8034	W7-18	452.76	462.76	454.14	1.4		W7-19	452.61	462.61	453.97	1.4	
361	0.014	48		0.003	8034	W7-19	452.61	462.61	453.97	1.4		W7-20	451.50	461.00	452.73	1.2	
57	0.014	54		0.001	8041	W7-20	451.00	461.00	452.73	1.7		W7-21	450.95	460.95	452.67	1.7	
1123	0.014	54		0.001	8104	W7-21	450.95	460.95	452.67	1.7		X7-25	449.82	459.82	451.56	1.7	
393	0.014	15		0.004	1628	W8-2	563.50	573.50	564.48	1.0		K10-22	561.94	571.94	563.15	1.2	
385	0.014	18		0.003	174	W8-3	453.65	465.65	453.95	0.3		Z8-54	452.50	460.20	452.72	0.2	
179	0.015	6		0.023	51	W8-4	571.63	581.63	571.76	0.1		W6-2	567.46	574.46	567.64	0.2	
565	0.015	8		0.018	69	W8-5	452.90	462.90	453.05	0.1		Z8-29	442.77	449.94	445.17	2.4	SUR
32	0.015	8		0.009	112	W8-6	552.56	560.00	553.14	0.6		X8-1	552.28	559.38	553.13	0.9	SUR
328	0.015	8		0.004	101	W8-7	553.90	563.90	554.18	0.3		W8-6	552.56	560.00	553.14	0.6	
420	0.015	8		0.006	67	X6-1	467.76	477.76	467.96	0.2		X7-2	465.35	474.15	465.64	0.3	
359	0.015	8		0.005	54	X6-2	469.44	476.84	469.63	0.2		X6-1	467.76	477.76	467.96	0.2	
334	0.015	8		0.005	38	X6-3	471.12	478.92	471.27	0.2		X6-2	469.44	476.84	469.63	0.2	
343	0.015	8		0.005	15	X6-4	472.80	479.00	472.90	0.1		X6-3	471.12	478.92	471.27	0.2	
372	0.015	8		0.005	67	X6-14	466.90	476.90	467.11	0.2		X7-18	465.11	475.11	465.33	0.2	
416	0.015	8		0.005	59	X6-15	468.82	478.82	469.02	0.2		X6-14	466.90	476.90	467.11	0.2	
265	0.015	8		0.005	49	X6-16	470.08	480.08	470.26	0.2		X6-15	468.82	478.82	469.02	0.2	
272	0.015	8		0.003	28	X6-17	471.00	480.00	471.14	0.1		X6-16	470.08	480.08	470.26	0.2	
393	0.015	8		0.003	89	X7-2	465.35	474.15	465.64	0.3		W7-10	464.27	474.27	464.53	0.3	
391	0.015	10		0.002	192	X7-3	461.21	471.21	461.60	0.4		Y7-21	460.24	470.19	460.63	0.4	
187	0.015	10		0.002	185	X7-4	461.67	471.67	462.06	0.4		X7-3	461.21	471.21	461.60	0.4	
170	0.015	10		0.002	180	X7-6	462.02	472.02	462.42	0.4		X7-4	461.67	471.67	462.06	0.4	
287	0.015	8		0.005	78	X7-17	463.79	473.79	464.01	0.2		X7-20	462.45	472.45	462.79	0.3	
283	0.015	8		0.005	74	X7-18	465.11	475.11	465.33	0.2		X7-17	463.79	473.79	464.01	0.2	
146	0.015	10		0.003	158	X7-20	462.45	472.45	462.79	0.3		X7-6	462.02	472.02	462.42	0.4	
258	0.015	8		0.004	72	X7-21	463.45	473.45	463.68	0.2		X7-20	462.45	472.45	462.79	0.3	
799	0.014	54		0.001	8181	X7-25	449.82	459.82	451.56	1.7		X7-26	449.02	459.02	450.78	1.8	
389	0.014	54		0.001	8200	X7-26	449.02	459.02	450.78	1.8		Y7-34	448.64	458.64	450.43	1.8	
210	0.015	8		0.006	132	X8-1	552.28	559.38	553.13	0.9	SUR	L9-33	550.99	560.99	553.06	2.1	SUR
376	0.015	8		0.004	70	X8-2	554.30	563.60	554.52	0.2		L10-27	552.64	564.04	553.14	0.5	
179	0.015	8		0.049	18	X8-3	620.19	630.19	620.25	0.1		H9-13	611.48	621.48	613.98	2.5	SUR
259	0.015	8		0.010	24	X8-4	499.11	507.31	504.74	5.6	SUR	H5-22	496.50	506.70	504.72	8.2	SUR
295	0.014	42		0.002	18163	X8-5	435.55	445.55	442.33	6.8	SUR	X8-7	435.09	444.99	442.02	6.9	SUR
460	0.014	36		0.003	9430	X8-6	438.00	446.59	442.50	4.5	SUR	X8-8	436.59	444.96	441.99	5.4	SUR
20	0.014	42		0.001	18489	X8-7	434.99	444.99	442.02	7.0	SUR	X8-8	434.97	444.96	441.99	7.0	SUR
309	0.014	42		0.004	23142	X8-8	434.97	444.96	441.99	7.0	SUR	Z8-30	433.77	444.37	441.03	7.3	SUR
287	0.015	8		0.007	31	X8-10	439.86	449.86	441.05	1.2	SUR	Z8-30	437.87	444.37	441.03	3.2	SUR
126	0.014	42		0.004	23208	X8-12	432.58	442.58	439.89	7.3	SUR	X8-14	432.06	442.06	439.51	7.5	SUR
648	0.014	42		0.004	23163	X8-14	432.06	442.06	439.51	7.5	SUR	Y8-8	429.65	439.65	437.52	7.9	SUR
308	0.015	8		0.021	15	X8-29	578.20	588.20	578.27	0.1		W8-4	571.63	581.63	571.76	0.1	
648	0.015	12		0.008	1033	X8-30	504.46	512.96	512.96	8.5	SUR	H4-35	499.58	511.88	510.21	10.6	SUR
297	0.015	12		0.003	390	Y7-1	454.70	464.70	455.21	0.5		Z7-13	453.79	463.79	454.33	0.5	
429	0.015	6		0.021	15	Y7-2	507.94	512.94	508.01	0.1		K7-23	498.97	503.97	499.08	0.1	
410	0.015	12		0.007	178	Y7-3	542.05	550.05	542.31	0.3		J6-17	539.00	546.60	539.27	0.3	
31	0.015	12		0.017	338	Y7-4	456.75	466.75	457.04	0.3		M6-47	456.22	466.22	456.98	0.8	
253	0.015	12		0.008	201	Y7-4	536.93	543.83	537.20	0.3		Y7-15	534.96	542.06	535.28	0.3	
51	0.015	12		0.072	19	Y7-6	459.91	469.91	459.96	0.1		M6-47	456.22	466.22	456.98	0.8	
203	0.015	12		0.007	251	Y7-15	534.96	542.06	535.28	0.3		J6-22	533.57	541.47	541.47	7.9	SUR
364	0.015	10		0.003	313	Y7-16	459.20	469.20	459.68	0.5		M7-21	457.95	467.95	458.47	0.5	
345	0.015	10		0.000	283	Y7-17	459.33	469.33	460.14	0.8		Y7-16	459.20	469.20	459.68	0.5	
39	0.015	10		0.001	226	Y7-18	459.38	469.38	460.16	0.8		Y7-17	459.33	469.33	460.14	0.8	

2010 Master Plan Clear Creek Collection System Pipe Analysis Results

LENGTH (ft)	Manning's N	Diameter (in)	Material	Slope	Maximum Flow, gpm	Upstream MH Name	Upstream Invert (ft)	Upstream MH Rim	Maximum Upstream HGL	Upstream Flow Depth, ft	Class	Downstream MH Name	Downstream Invert (ft)	Downstream MH Rim	Maximum Downstream HGL	Downstream Flow Depth, ft	Class
378	0.015	10		0.002	219	Y7-21	460.19	470.19	460.63	0.4		Y7-18	459.38	469.38	460.16	0.8	
317	0.015	6		0.023	51	Y7-25	466.57	476.57	466.70	0.1		Y7-17	459.33	469.33	460.14	0.8	SUR
825	0.014	54		0.001	8255	Y7-32	447.08	457.08	448.89	1.8		Z7-9	446.29	461.64	447.73	1.4	
460	0.014	54		0.001	8213	Y7-34	448.64	458.64	450.43	1.8		Y7-35	448.26	458.26	449.92	1.7	
554	0.014	54		0.001	8227	Y7-35	448.26	458.26	449.92	1.7		Y7-36	447.59	457.59	449.36	1.8	
233	0.014	54		0.001	8238	Y7-36	447.59	457.59	449.36	1.8		Y7-37	447.39	457.39	449.12	1.7	
261	0.014	54		0.001	8245	Y7-37	447.39	457.39	449.12	1.7		Y7-32	447.08	457.08	448.89	1.8	
340	0.015	6		0.011	5	Y8-6	552.49	562.49	552.54	0.0		Y8-7	548.75	554.10	548.95	0.2	
229	0.015	12		0.011	124	Y8-7	548.75	554.10	548.95	0.2		J6-8	546.24	553.24	546.47	0.2	
975	0.014	42		0.003	23188	Y8-8	429.65	439.65	437.52	7.9	SUR	S7-5	426.24	436.24	434.53	8.3	SUR
303	0.015	8		0.005	44	Y8-9	434.68	443.81	437.52	2.8	SUR	Y8-8	433.15	439.65	437.52	4.4	SUR
424	0.015	10		0.001	215	Y8-11	428.96	443.48	433.59	4.6	SUR	S6-2	428.51	435.01	433.44	4.9	SUR
375	0.015	10		0.001	199	Y8-14	429.35	439.35	433.72	4.4	SUR	Y8-11	428.96	443.48	433.59	4.6	SUR
278	0.015	10		0.001	192	Y8-16	429.65	442.85	433.80	4.2	SUR	Y8-14	429.35	439.35	433.72	4.4	SUR
285	0.015	10		0.002	177	Y8-17	430.22	441.92	433.89	3.7	SUR	Y8-16	429.65	442.85	433.80	4.2	SUR
203	0.015	8		0.010	60	Y8-25	432.33	440.93	433.91	1.6	SUR	Y8-17	430.22	441.92	433.89	3.7	SUR
356	0.015	8		0.005	198	Y8-26	431.56	441.29	435.01	3.4	SUR	S7-5	429.74	436.24	434.53	4.8	SUR
311	0.015	8		0.004	47	Y8-33	433.56	440.46	433.90	0.3		Y8-25	432.33	440.93	433.91	1.6	SUR
383	0.015	10		0.005	111	Y8-42	432.24	442.24	433.95	1.7	SUR	Y8-17	430.22	441.92	433.89	3.7	SUR
507	0.014	15		0.003	69	Z7-1	444.61	454.61	444.79	0.2		Z8-8	442.94	452.94	443.14	0.2	
26	0.014	15		0.003	64	Z7-2	444.70	452.70	444.87	0.2		Z7-1	444.61	454.61	444.79	0.2	
334	0.014	15		0.003	55	Z7-3	445.72	455.02	445.88	0.2		Z7-2	444.70	452.70	444.87	0.2	
280	0.015	8		0.004	24	Z7-3	480.45	487.55	480.60	0.1		R10-49	478.85	488.85	479.10	0.3	
189	0.014	39		0.001	12439	Z7-4	456.61	466.61	459.66	3.1		O7-27	456.46	470.94	459.44	3.0	
358	0.014	15		0.006	41	Z7-4	447.78	457.78	447.91	0.1		Z7-3	445.72	455.02	445.88	0.2	
587	0.014	18		0.007	49	Z7-7	471.49	481.49	471.61	0.1		S7-2	467.10	477.10	467.49	0.4	
377	0.014	15		0.006	33	Z7-7	449.93	459.93	450.04	0.1		Z7-4	447.78	457.78	447.91	0.1	
513	0.015	10		0.026	1278	Z7-8	529.86	534.86	530.52	0.7		S6-1	516.55	521.55	519.76	3.2	SUR
491	0.014	15		0.002	24	Z7-8	450.72	460.72	450.87	0.1		Z7-7	449.93	459.93	450.04	0.1	
330	0.015	8		0.226	394	Z7-9	622.02	628.02	622.21	0.2		S5-3	549.13	556.43	549.66	0.5	
461	0.014	48		0.003	8665	Z7-9	446.29	461.64	447.73	1.4		Z7-31	445.02	455.02	446.47	1.5	
261	0.015	6		0.009	53	Z7-9	529.07	541.47	529.25	0.2		O10-39	526.79	529.42	526.90	0.1	
266	0.014	15		0.004	417	Z7-11	452.58	462.58	453.04	0.5		Z7-9	446.29	461.64	447.73	1.4	SUR
380	0.015	12		0.003	402	Z7-13	453.79	463.79	454.33	0.5		Z7-11	452.58	462.58	453.04	0.5	
207	0.014	15		0.004	3	Z7-29	451.64	461.64	451.68	0.0		Z7-8	450.72	460.72	450.87	0.1	
80	0.014	48		0.003	8672	Z7-31	445.02	455.02	446.47	1.5		Z7-32	444.77	454.77	446.36	1.6	
314	0.015	6		0.022	11	Z7-31	573.00	583.00	573.06	0.1		J5-24	566.00	576.00	566.62	0.6	SUR
429	0.015	8		0.005	51	Z7-32	701.73	711.73	701.91	0.2		O5-40	699.73	709.73	699.91	0.2	
596	0.014	48		0.002	8683	Z7-32	444.77	454.77	446.36	1.6		Z7-33	443.64	457.78	445.24	1.6	
173	0.015	8		0.004	16	Z7-33	665.36	670.86	665.46	0.1		O6-33	664.64	670.24	664.87	0.2	
451	0.014	48		0.002	8697	Z7-33	443.64	457.78	445.24	1.6		Z7-35	442.80	455.00	444.36	1.6	
180	0.014	48		0.002	8708	Z7-35	442.80	455.00	444.36	1.6		Z7-36	442.44	452.70	443.92	1.5	
30	0.015	8		0.010	2	Z7-35	477.38	487.38	477.41	0.0		M7-22	477.08	482.18	477.26	0.2	
190	0.015	12		0.049	1578	Z7-36	501.00	507.00	501.51	0.5		M6-59	489.65	499.65	490.20	0.6	
1488	0.014	42		0.005	8727	Z7-36	442.44	452.70	443.92	1.5		Z8-52	434.74	449.00	435.38	0.6	
391	0.015	8		0.006	31	Z8-1	649.26	654.26	649.40	0.1		R6-11	647.10	665.10	647.33	0.2	
66	0.014	42		0.005	23209	Z8-1	420.55	430.55	430.55	10.0	SUR	Z8-56	420.20	430.49	430.37	10.2	SUR
144	0.014	18		0.002	755	Z8-2	460.43	472.73	461.12	0.7		W7-7	460.20	474.20	460.75	0.6	
186	0.015	8		0.034	117	Z8-2	428.54	438.54	431.32	2.8	SUR	Z8-1	422.13	430.55	430.55	8.4	SUR
751	0.014	18		0.001	1556	Z8-4	507.95	517.95	509.40	1.5		Z8-18	507.30	516.54	507.74	0.4	
392	0.015	8		0.016	20	Z8-4	434.95	444.95	435.03	0.1		Z8-2	428.54	438.54	431.32	2.8	SUR
42	0.015	8		0.103	183	Z8-5	457.80	470.50	457.96	0.2		Z8-38	447.53	457.53	450.24	2.7	SUR
385	0.014	14		0.050	182	Z8-5	439.84	449.84	439.99	0.2		Z8-1	420.55	430.55	430.55	10.0	SUR

2010 Master Plan Clear Creek Collection System Pipe Analysis Results

LENGTH (ft)	Manning's N	Diameter (in)	Material	Slope	Maximum Flow, gpm	Upstream MH Name	Upstream Invert (ft)	Upstream MH Rim	Maximum Upstream HGL	Upstream Flow Depth, ft	Class	Downstream MH Name	Downstream Invert (ft)	Downstream MH Rim	Maximum Downstream HGL	Downstream Flow Depth, ft	Class
631	0.014	42		0.002	18088	Z8-6	437.49	447.49	443.53	6.0	SUR	O10-34	436.54	446.44	442.85	6.3	SUR
232	0.014	15		0.002	178	Z8-6	440.40	448.40	440.74	0.3		Z8-5	439.84	449.84	439.99	0.2	
508	0.014	36		0.001	9407	Z8-7	439.60	449.60	443.49	3.9	SUR	R11-59	439.02	448.82	442.96	3.9	SUR
253	0.014	15		0.002	171	Z8-7	440.94	450.44	441.25	0.3		Z8-6	440.40	448.40	440.74	0.3	
418	0.015	8		0.006	138	Z8-8	462.87	472.87	463.16	0.3		Z8-2	460.43	472.73	461.12	0.7	SUR
496	0.014	15		0.004	92	Z8-8	442.94	452.94	443.14	0.2		Z8-7	440.94	450.44	441.25	0.3	
179	0.015	8		0.034	20	Z8-11	512.90	522.90	512.97	0.1		T11-13	506.84	515.99	507.03	0.2	
402	0.015	8		0.005	67	Z8-11	442.98	450.28	443.18	0.2		Z8-7	440.94	450.44	441.25	0.3	
399	0.015	8		0.036	36	Z8-14	506.00	516.00	506.09	0.1		V11-1	491.86	501.86	492.04	0.2	
286	0.015	8		0.005	19	Z8-14	444.30	450.30	444.41	0.1		Z8-11	442.98	450.28	443.18	0.2	
178	0.014	15		0.038	1624	Z8-17	505.74	515.74	506.22	0.5		T9-5	498.94	508.94	499.75	0.8	
280	0.015	8		0.004	38	Z8-17	444.20	451.20	444.36	0.2		Z8-11	442.98	450.28	443.18	0.2	
441	0.014	18		0.002	1603	Z8-18	506.54	516.54	507.74	1.2		Z8-17	505.74	515.74	506.22	0.5	
82	0.015	8		0.006	36	Z8-18	444.67	450.67	444.81	0.1		Z8-17	444.20	451.20	444.36	0.2	
566	0.014	18		0.002	34	Z8-21	458.37	471.17	458.51	0.1		W7-4	457.15	468.25	457.35	0.2	
252	0.015	8		0.005	33	Z8-21	446.02	451.02	446.16	0.1		Z8-18	444.67	450.67	444.81	0.1	
546	0.014	15		0.002	525	Z8-22	468.86	481.96	469.45	0.6		Z8-23	467.86	480.76	468.49	0.6	
287	0.015	8		0.003	18	Z8-22	446.92	452.62	447.04	0.1		Z8-21	446.02	451.02	446.16	0.1	
392	0.014	15		0.002	564	Z8-23	467.86	480.76	468.49	0.6		W6-1	467.20	479.50	467.92	0.7	
146	0.015	6		0.008	6	Z8-23	448.02	454.12	448.08	0.1		Z8-22	446.92	452.62	447.04	0.1	
1565	0.014	42		0.002	18085	Z8-29	439.94	449.94	445.17	5.2	SUR	Z8-6	437.59	447.49	443.53	5.9	SUR
632	0.014	54		0.001	23642	Z8-29	421.41	431.41	431.10	9.7	SUR	Z8-1	420.55	430.55	430.55	10.0	SUR
379	0.014	42		0.003	23172	Z8-30	433.77	444.37	441.03	7.3	SUR	X8-12	432.58	442.58	439.89	7.3	SUR
146	0.015	8		0.008	250	Z8-30	425.46	435.46	431.72	6.3	SUR	Z8-29	424.24	431.41	431.10	6.9	SUR
347	0.015	8		0.003	59	Z8-32	426.64	438.00	431.19	4.5	SUR	Z8-30	425.46	435.46	431.72	6.3	SUR
625	0.014	18		0.007	260	Z8-33	449.87	460.20	450.14	0.3		V8-3	445.72	451.33	446.17	0.5	
295	0.015	8		0.006	76	Z8-33	427.26	437.26	431.19	3.9	SUR	Z8-30	425.46	435.46	431.72	6.3	SUR
516	0.014	42		0.001	13291	Z8-38	447.53	457.53	450.24	2.7		T8-2	446.89	456.89	449.74	2.8	
1034	0.014	42		0.003	30250	Z8-38	416.90	426.90	426.90	10.0	SUR	SA8-3	414.01	424.01	421.53	7.5	SUR
354	0.014	18		0.002	1513	Z8-39	508.63	518.63	509.77	1.1		Z8-4	507.95	517.95	509.40	1.5	
381	0.014	45		0.004	23549	Z8-39	422.77	432.77	431.93	9.2	SUR	Z8-29	421.41	431.41	431.10	9.7	SUR
420	0.014	18		0.002	1490	Z8-40	509.34	519.34	510.38	1.0		Z8-39	508.63	518.63	509.77	1.1	
293	0.015	8		0.007	10	Z8-40	436.95	441.85	437.03	0.1		Z8-4	434.95	444.95	435.03	0.1	
150	0.014	42		0.002	13417	Z8-52	444.69	454.69	448.28	3.6	SUR	Z8-53	444.46	454.46	448.14	3.7	SUR
180	0.014	42		0.080	8731	Z8-52	434.74	449.00	435.38	0.6		Z8-53	420.35	444.50	430.49	10.1	SUR
662	0.014	42		0.002	13378	Z8-53	444.46	454.46	448.14	3.7	SUR	V8-8	443.45	458.81	447.51	4.1	SUR
59	0.014	42		0.046	8762	Z8-53	420.35	444.50	430.49	10.1	SUR	Z8-54	417.64	435.50	430.47	12.8	SUR
207	0.014	18		0.013	232	Z8-54	452.50	460.20	452.72	0.2		Z8-33	449.87	460.20	450.14	0.3	
174	0.014	42		0.008	8767	Z8-54	417.64	435.50	430.47	12.8	SUR	Z8-55	417.47	435.50	430.38	12.9	SUR
387	0.015	8		0.014	24	Z8-55	458.35	468.35	458.44	0.1		W8-5	452.90	462.90	453.05	0.1	
30	0.014	42		0.011	8792	Z8-55	420.55	435.50	430.38	9.8	SUR	Z8-56	419.01	430.49	430.37	11.4	SUR
1564	0.014	36		0.001	9393	Z8-56	442.06	452.06	445.25	3.2	SUR	Z8-7	439.80	449.60	443.49	3.7	SUR
621	0.014	42		0.006	31292	Z8-56	420.55	430.49	430.37	9.8	SUR	Z8-38	416.90	426.90	426.90	10.0	SUR

2010 Master Plan Stillwater Collection System Pipe Analysis Results

LENGTH (ft)	Manning's N (Double)	Diameter (in)	Material	Slope	Maximum Flow, gpm	Upstream MH Name	Upstream Invert (ft)	Upstream MH Rim	Maximum Upstream HGL	Flow Depth, ft	Class	Downstream MH Name	Downstream Invert (ft)	Downstream MH Rim	Maximum Downstream HGL	Flow Depth, ft	Class
196	0.013	6	VCP	0.0181	92.4	A4-2	746.4	756.0	746.5	0.2		A5-31	742.8	753.0	743.0	0.2	
373	0.013	6	VCP	0.0176	81.3	A4-3	752.9	763.0	753.1	0.2		A4-2	746.4	756.0	746.5	0.2	
234	0.013	6	VCP	0.0246	72.9	A4-4	758.7	771.0	758.8	0.1		A4-3	752.9	763.0	753.1	0.2	
386	0.013	8	ABS	0.0068	68.8	A4-5	761.3	772.0	761.5	0.2		A4-4	758.7	771.0	758.8	0.1	
115	0.013	8	ABS	0.0040	59.7	A4-6	761.8	771.0	761.9	0.2		A4-5	761.3	772.0	761.5	0.2	
314	0.013	8	ABS	0.0214	53.5	A5-1	733.7	743.0	733.8	0.1		A5-10	727.0	733.0	727.1	0.1	
341	0.013	8	ABS	0.0045	43.8	A5-2	735.2	741.0	735.4	0.2		A5-1	733.7	743.0	733.8	0.1	
105	0.013	8	ABS	0.0040	39.6	A5-3	735.6	741.0	735.8	0.2		A5-2	735.2	741.0	735.4	0.2	
297	0.013	8	ABS	0.0156	20.1	A5-4	740.3	748.0	740.3	0.1		A5-3	735.6	741.0	735.8	0.2	
305	0.013	8	DIP	0.0046	68.1	A5-7	709.6	715.0	709.7	0.2		B5-6	708.2	712.0	708.4	0.2	
356	0.013	8	ABS	0.0044	67.4	A5-8	711.1	719.0	711.3	0.2		A5-7	709.6	715.0	709.7	0.2	
417	0.013	8	ABS	0.0152	63.9	A5-9	717.5	724.0	717.6	0.1		A5-8	711.1	719.0	711.3	0.2	
304	0.013	8	ABS	0.0312	59.0	A5-10	727.0	733.0	727.1	0.1		A5-9	717.5	724.0	717.6	0.1	
209	0.013	6		0.0308	7.6	A5-11	717.9	728.0	717.9	0.0		B5-8A	711.4	721.0	711.5	0.1	
503	0.013	6	VCP	0.0063	5.6	A5-12	721.1	731.0	721.1	0.1		A5-11	717.9	728.0	717.9	0.0	
202	0.013	6	VCP	0.0198	2.1	A5-13	725.1	735.0	725.1	0.0		A5-12	721.1	731.0	721.1	0.1	
824	0.013	8	VCP	0.0031	142.4	A5-14	724.4	734.0	724.7	0.3		B5-16	721.8	732.0	722.1	0.3	
389	0.013	6	VCP	0.0135	121.5	A5-15	735.7	743.0	736.0	0.2		A5-18	730.5	738.0	730.7	0.2	
116	0.013	6	VCP	0.0229	112.5	A5-16	738.4	748.0	738.6	0.2		A5-15	735.7	743.0	736.0	0.2	
415	0.013	6	VCP	0.0135	138.9	A5-17	730.0	739.0	730.2	0.2		A5-14	724.4	734.0	724.7	0.3	
40	0.013	6	VCP	0.0132	134.7	A5-18	730.5	738.0	730.7	0.2		A5-17	730.0	739.0	730.2	0.2	
155	0.013	8	ABS	0.0051	10.4	A5-19	731.3	739.0	731.3	0.1		A5-18	730.5	738.0	730.7	0.2	
138	0.013	8	ABS	0.0051	4.9	A5-20	732.0	740.0	732.0	0.1		A5-19	731.3	739.0	731.3	0.1	
98	0.013	6	ABS	0.0043	1.4	A5-21	732.4	741.0	732.4	0.0		A5-20	732.0	740.0	732.0	0.1	
185	0.013	6	VCP	0.0239	104.9	A5-31	742.8	753.0	743.0	0.2		A5-16	738.4	748.0	738.6	0.2	
380	0.013	8	VCP	0.0035	10.4	A6-1	722.4	727.0	722.5	0.1		B6-6	721.1	726.0	721.2	0.1	
403	0.013	8	VCP	0.0033	4.2	A6-2	723.7	726.0	723.8	0.1		A6-1	722.4	727.0	722.5	0.1	
280	0.013	8	ABS	0.0043	4.9	A6-3	711.4	716.0	711.5	0.1		A6-4	710.2	717.0	710.3	0.1	
407	0.013	8	ABS	0.0039	10.4	A6-4	710.2	717.0	710.3	0.1		A7-12	708.6	719.0	708.7	0.1	
423	0.013	8	ABS	0.0045	59.7	A7-1	699.2	707.0	699.4	0.2		B7-6	697.3	710.0	697.5	0.2	
423	0.013	8	ABS	0.0045	45.1	A7-2	701.1	711.0	701.3	0.2		A7-1	699.2	707.0	699.4	0.2	
417	0.013	8	ABS	0.0046	40.3	A7-3	703.0	713.0	703.1	0.1		A7-2	701.1	711.0	701.3	0.2	
38	0.013	8	ABS	0.0042	32.6	A7-4	704.9	710.0	705.0	0.1		A7-7	704.7	710.0	704.9	0.1	
419	0.013	8	ABS	0.0045	28.5	A7-5	706.8	714.0	706.9	0.1		A7-4	704.9	710.0	705.0	0.1	
368	0.013	8	ABS	0.0047	35.4	A7-7	704.7	710.0	704.9	0.1		A7-3	703.0	713.0	703.1	0.1	
399	0.013	8	ABS	0.0045	16.7	A7-12	708.6	719.0	708.7	0.1		A7-5	706.8	714.0	706.9	0.1	
649	0.012	18	VCP	0.0059	219.4	A8-1	616.4	623.0	616.6	0.2		A9-7	612.6	622.0	612.9	0.3	
435	0.012	18	VCP	0.0064	204.9	A8-2	619.2	625.0	619.4	0.2		A8-1	616.4	623.0	616.6	0.2	
361	0.012	18	VCP	0.0053	204.9	A8-3	621.1	629.0	621.3	0.2		A8-2	619.2	625.0	619.4	0.2	
361	0.012	18	VCP	0.0029	201.4	A8-4	622.1	630.0	622.4	0.3		A8-3	621.1	629.0	621.3	0.2	
132	0.013	8	ABS	0.0043	12.5	A8-6	700.4	708.0	700.4	0.1		A8-7	699.8	705.0	699.9	0.1	
420	0.013	8	ABS	0.0038	19.4	A8-7	699.8	705.0	699.9	0.1		A8-8	698.2	704.0	698.3	0.1	
399	0.013	8	ABS	0.0040	29.2	A8-8	698.2	704.0	698.3	0.1		B8-2	696.6	706.0	696.7	0.1	
739	0.012	21	VCP	0.0050	902.8	A9-1	603.7	616.0	604.1	0.5		B9-3	599.9	610.0	600.5	0.6	
632	0.012	15	ABS	0.0085	634.7	A9-2	609.0	620.0	609.4	0.4		A9-1	603.7	616.0	604.1	0.5	
441	0.012	15	ABS	0.0044	631.9	A9-3	611.0	621.0	611.5	0.5		A9-2	609.0	620.0	609.4	0.4	
481	0.012	15	ABS	0.0037	597.9	A9-4	612.8	622.0	613.3	0.5		A9-3	611.0	621.0	611.5	0.5	
554	0.012	18	ABS	0.0107	263.2	A9-5	609.6	619.0	609.8	0.2		A9-1	603.7	616.0	604.1	0.5	
428	0.012	18	ABS	0.0029	261.1	A9-6	610.8	622.0	611.2	0.3		A9-5	609.6	619.0	609.8	0.2	
645	0.012	18	ABS	0.0027	244.4	A9-7	612.6	622.0	612.9	0.3		A9-6	610.8	622.0	611.2	0.3	
415	0.013	8	ABS	0.0516	22.9	A9-9	632.4	637.0	632.5	0.1		A9-3	611.0	621.0	611.5	0.5	
376	0.013	8	ABS	0.0298	17.4	A9-10	643.6	651.0	643.7	0.1		A9-9	632.4	637.0	632.5	0.1	

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LENGTH (ft)	Manning's N (Double)	Diameter (in)	Material	Slope	Maximum Flow, gpm	Upstream MH Name	Upstream Invert (ft)	Upstream MH Rim	Maximum Upstream HGL	Flow Depth, ft	Class	Downstream MH Name	Downstream Invert (ft)	Downstream MH Rim	Maximum Downstream HGL	Flow Depth, ft	Class
193	0.013	8	ABS	0.0849	1.4	A9-13	660.0	664.0	660.0	0.0		A9-10	643.6	651.0	643.7	0.1	
149	0.013	8	ABS	0.0590	11.8	A9-14	652.4	658.0	652.4	0.0		A9-10	643.6	651.0	643.7	0.1	
373	0.013	8	ABS	0.0484	9.7	A9-15	670.4	675.0	670.5	0.0		A9-14	652.4	658.0	652.4	0.0	
389	0.013	8	SDR-35	0.0066	8.3	A9-17	606.5	613.0	606.6	0.1		B9-18	604.0	612.0	604.0	0.1	
399	0.013	8	SDR-35	0.0095	5.6	A9-18	610.3	616.0	610.3	0.0		A9-17	606.5	613.0	606.6	0.1	
65	0.013	8	SDR-35	0.0118	3.5	A9-19	611.1	617.0	611.1	0.0		A9-18	610.3	616.0	610.3	0.0	
550	0.013	12	ABS	0.0064	171.5	A10-1	619.7	626.0	620.0	0.2		B10-5	616.2	624.0	616.5	0.3	
349	0.013	12	ABS	0.0074	59.7	A10-2	623.5	632.0	623.8	0.3		A10-5	621.1	631.0	621.3	0.2	
349	0.013	12	ABS	0.0104	41.7	A10-3	628.3	636.0	628.4	0.1		A10-20	624.7	638.0	624.8	0.1	
208	0.013	12	ABS	0.0065	4.2	A10-4	631.0	639.0	631.0	0.0		A10-28	629.6	637.0	629.8	0.1	
194	0.013	12	ABS	0.0072	168.8	A10-5	621.1	631.0	621.3	0.2		A10-1	619.7	626.0	620.0	0.2	
151	0.013	8	ABS	0.0186	31.9	A10-6	623.9	630.0	624.0	0.1		A10-5	621.1	631.0	621.3	0.2	
179	0.013	8	ABS	0.0062	25.0	A10-7	625.0	630.0	625.2	0.1		A10-6	623.9	630.0	624.0	0.1	
405	0.013	8	ABS	0.0796	22.9	A10-8	657.3	663.0	657.4	0.1		A10-7	625.0	630.0	625.2	0.1	
266	0.013	8	ABS	0.0652	11.8	A10-9	674.7	681.0	674.7	0.0		A10-8	657.3	663.0	657.4	0.1	
280	0.013	8	ABS	0.0222	6.3	A10-10	630.2	636.0	630.2	0.0		A10-6	623.9	630.0	624.0	0.1	
295	0.013	8	ABS	0.1041	4.2	A10-11	660.8	667.0	660.9	0.0		A10-10	630.2	636.0	630.2	0.0	
140	0.013	8	ABS	0.1939	3.5	A10-11	670.8	667.0	670.9	0.0		A9-10	643.6	651.0	643.7	0.1	
172	0.013	6	ABS	0.0892	1.4	A10-12	676.1	684.0	676.2	0.0		A10-11	660.8	667.0	660.9	0.0	
385	0.013	8	ABS	0.0215	2.1	A10-12	679.1	684.0	679.2	0.0		A9-11	670.8	685.0	670.9	0.0	
245	0.013	6	ABS	0.0793	1.4	A10-13	680.3	686.0	680.3	0.0		A10-11	660.8	667.0	660.9	0.0	
398	0.013	8	ABS	0.0124	3.5	A10-17	675.4	685.0	675.4	0.0		A9-15	670.4	675.0	670.5	0.0	
149	0.013	12	ABS	0.0077	59.0	A10-20	624.7	638.0	624.8	0.1		A10-2	623.5	632.0	623.8	0.3	
90	0.013	8	ABS	0.0957	14.6	A10-21	633.3	639.0	633.3	0.0		A10-20	624.7	638.0	624.8	0.1	
244	0.013	8	ABS	0.0403	13.9	A10-22	643.1	646.0	643.1	0.1		A10-21	633.3	639.0	633.3	0.0	
189	0.013	8	ABS	0.0825	12.5	A10-23	658.7	666.0	658.7	0.0		A10-22	643.1	646.0	643.1	0.1	
409	0.013	8	ABS	0.0235	9.7	A10-25	668.3	674.0	668.3	0.1		A10-23	658.7	666.0	658.7	0.0	
394	0.013	8	ABS	0.0126	3.5	A10-26	673.3	679.0	673.3	0.0		A10-25	668.3	674.0	668.3	0.1	
193	0.013	6	ABS	0.0075	2.1	A10-27	674.7	680.0	674.7	0.0		A10-26	673.3	679.0	673.3	0.0	
241	0.013	12	ABS	0.0057	36.8	A10-28	629.6	637.0	629.8	0.1		A10-3	628.3	636.0	628.4	0.1	
522	0.013	8	ABS	0.0617	29.2	A10-29	661.9	671.0	661.9	0.1		A10-28	629.6	637.0	629.8	0.1	
445	0.013	8	ABS	0.0164	25.7	A10-30	669.2	676.0	669.3	0.1		A10-29	661.9	671.0	661.9	0.1	
399	0.013	8	ABS	0.0054	22.9	A10-31	671.3	682.0	671.4	0.1		A10-30	669.2	676.0	669.3	0.1	
174	0.013	8	ABS	0.0043	20.8	A10-32	672.1	679.0	672.2	0.1		A10-31	671.3	682.0	671.4	0.1	
248	0.013	8	ABS	0.0008	19.4	A10-33	672.3	684.9	672.5	0.2		A10-32	672.1	679.0	672.2	0.1	
209	0.013	8	ABS	0.0497	76.4	A10-35	631.5	636.0	631.6	0.1		A10-5	621.1	631.0	621.3	0.2	
188	0.013	8	ABS	0.0885	74.3	A10-37	648.1	652.0	648.2	0.1		A10-35	631.5	636.0	631.6	0.1	
319	0.013	8	ABS	0.0530	68.1	A10-39	665.0	670.0	665.1	0.1		A10-37	648.1	652.0	648.2	0.1	
199	0.013	8	ABS	0.0051	63.9	A10-40	666.0	676.0	666.2	0.2		A10-39	665.0	670.0	665.1	0.1	
165	0.013	8	ABS	0.0051	51.4	A10-41	666.9	673.0	667.0	0.2		A10-40	666.0	676.0	666.2	0.2	
239	0.013	8	ABS	0.0048	49.3	A10-42	668.0	678.0	668.2	0.2		A10-41	666.9	673.0	667.0	0.2	
452	0.013	8	ABS	0.0059	16.0	A10-46	674.9	687.8	675.0	0.1		A10-33	672.3	684.9	672.5	0.2	
348	0.013	8	ABS	0.0046	11.8	A11-2	676.5	687.3	676.6	0.1		A10-46	674.9	687.8	675.0	0.1	
406	0.013	8	ABS	0.0039	8.3	A11-3	678.1	685.0	678.2	0.1		A11-2	676.5	687.3	676.6	0.1	
463	0.013	8	ABS	0.0031	4.9	A11-4	679.6	685.0	679.6	0.1		A11-3	678.1	685.0	678.2	0.1	
170	0.013	8	ABS	0.0035	2.8	A11-5	680.2	685.0	680.2	0.0		A11-4	679.6	685.0	679.6	0.1	
353	0.013	10	ABS	0.0033	279.9	B5-3	705.9	712.0	706.3	0.4		B6-14	704.7	713.0	704.9	0.2	
216	0.013	10	ABS	0.0032	274.3	B5-4	706.6	720.0	707.0	0.4		B5-3	705.9	712.0	706.3	0.4	
349	0.013	10	ABS	0.0031	266.7	B5-5	707.6	712.0	708.0	0.4		B5-4	706.6	720.0	707.0	0.4	
84	0.013	8	ABS	0.0064	91.0	B5-6	708.2	712.0	708.4	0.2		B5-5	707.6	712.0	708.0	0.4	
228	0.013	10	ABS	0.0027	174.3	B5-7	708.2	712.0	708.6	0.3		B5-5	707.6	712.0	708.0	0.4	
367	0.013	10	ABS	0.0032	172.2	B5-8	709.4	716.7	709.7	0.3		B5-7	708.2	712.0	708.6	0.3	

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104	0.013	6	VCP	0.0197	9.0	B5-8A	711.4	721.0	711.5	0.1		B5-8	709.4	716.7	709.7	0.3	
53	0.013	6	VCP	0.0120	162.5	B5-9	710.0	720.0	710.3	0.3		B5-8	709.4	716.7	709.7	0.3	
329	0.013	6	VCP	0.0172	161.1	B5-10	715.7	726.0	715.9	0.2		B5-9	710.0	720.0	710.3	0.3	
520	0.013	8	VCP	0.0022	159.0	B5-11	716.9	727.0	717.3	0.5		B5-10	715.7	726.0	715.9	0.2	
72	0.013	6	VCP	0.0157	155.6	B5-12	718.0	721.0	718.2	0.2		B5-11	716.9	727.0	717.3	0.5	
92	0.013	6	VCP	0.0079	153.5	B5-13	718.7	722.0	719.0	0.3		B5-12	718.0	721.0	718.2	0.2	
269	0.013	6	VCP	0.0087	152.1	B5-15	721.1	731.0	721.4	0.3		B5-13	718.7	722.0	719.0	0.3	
241	0.013	8	VCP	0.0030	147.2	B5-16	721.8	732.0	722.1	0.3		B5-15	721.1	731.0	721.4	0.3	
268	0.013	8	VCP	0.0154	116.0	B5-19	720.1	730.0	720.3	0.2		C5-4	715.9	726.0	716.0	0.1	
385	0.013	8	VCP	0.0051	10.4	B5-20	722.0	730.0	722.1	0.1		B5-19	720.1	730.0	720.3	0.2	
317	0.013	8	VCP	0.0011	7.6	B5-22	722.4	729.0	722.5	0.1		B5-20	722.0	730.0	722.1	0.1	
287	0.013	8	VCP	0.0173	5.6	B5-25	727.3	734.0	727.4	0.0		B5-22	722.4	729.0	722.5	0.1	
317	0.013	6	VCP	0.0069	4.2	B5-26	729.5	734.0	729.6	0.0		B5-25	727.3	734.0	727.4	0.0	
250	0.013	8	VCP	0.0162	102.8	B5-27	724.1	734.0	724.3	0.2		B5-19	720.1	730.0	720.3	0.2	
425	0.013	8	ABS	0.0037	11.8	B5-28	725.7	733.0	725.7	0.1		B5-27	724.1	734.0	724.3	0.2	
343	0.013	8	VCP	0.0065	89.6	B5-29	726.3	736.0	726.5	0.2		B5-27	724.1	734.0	724.3	0.2	
313	0.013	10	VCP	0.0023	87.5	B5-30	727.0	737.0	727.3	0.3		B5-29	726.3	736.0	726.5	0.2	
280	0.013	10	VCP	0.0020	84.7	B5-31	727.6	738.0	727.8	0.2		B5-30	727.0	737.0	727.3	0.3	
720	0.013	10	VCP	0.0020	80.6	B5-32	729.0	739.0	729.2	0.2		B5-31	727.6	738.0	727.8	0.2	
453	0.013	10	VCP	0.0019	77.1	B5-33	729.9	735.0	730.1	0.2		B5-32	729.0	739.0	729.2	0.2	
174	0.013	10	VCP	0.0022	72.2	B5-35	730.3	740.0	730.5	0.2		B5-33	729.9	735.0	730.1	0.2	
388	0.013	10	VCP	0.0020	65.3	B5-36	731.0	741.0	731.2	0.2		B5-35	730.3	740.0	730.5	0.2	
455	0.013	10	VCP	0.0019	57.6	B5-37	731.9	742.0	732.1	0.2		B5-36	731.0	741.0	731.2	0.2	
642	0.013	10	VCP	0.0024	43.8	B5-37A	733.4	743.0	733.6	0.2		B5-37	731.9	742.0	732.1	0.2	
197	0.013	8	ABS	0.0047	8.3	B5-39	726.6	732.0	726.7	0.1		B5-28	725.7	733.0	725.7	0.1	
104	0.013	8	ABS	0.0054	0.7	B5-40	727.2	731.0	727.2	0.0		B5-39	726.6	732.0	726.7	0.1	
391	0.013	8	VCP	0.0041	411.1	B6-1	714.0	725.7	716.7	2.7	SUR	B6-9	712.4	726.0	712.6	0.2	
405	0.013	8	VCP	0.0036	405.6	B6-2	715.5	724.0	719.0	3.5	SUR	B6-1	714.0	725.7	714.2	0.2	
404	0.013	8	VCP	0.0035	396.5	B6-3	716.9	725.0	721.1	4.3	SUR	B6-2	715.5	724.0	715.7	0.2	
398	0.013	8	VCP	0.0035	322.9	B6-4	718.3	724.0	721.2	2.9	SUR	B6-3	716.9	725.0	717.0	0.2	
401	0.013	8	VCP	0.0035	304.9	B6-5	719.7	727.0	721.2	1.5	SUR	B6-4	718.3	724.0	718.4	0.2	
395	0.013	8	VCP	0.0035	17.4	B6-6	721.1	726.0	721.2	0.1		B6-5	719.7	727.0	719.8	0.1	
405	0.013	8	VCP	0.0040	415.3	B6-9	712.4	726.0	714.5	2.1	SUR	B7-16	710.8	725.0	711.0	0.2	
354	0.013	8	ABS	0.0082	306.3	B6-10	675.9	684.0	676.3	0.4		C6-32	673.0	681.2	673.4	0.5	
371	0.013	8	ABS	0.0189	302.8	B6-11	682.9	688.0	683.2	0.3		B6-10	675.9	684.0	676.3	0.4	
275	0.013	8	ABS	0.0202	298.6	B6-12	688.5	698.0	688.8	0.3		B6-11	682.9	688.0	683.2	0.3	
352	0.013	8	ABS	0.0041	295.1	B6-13	689.9	698.0	690.4	0.5		B6-12	688.5	698.0	688.8	0.3	
421	0.013	10	ABS	0.0351	290.3	B6-14	704.7	713.0	704.9	0.2		B6-13	689.9	698.0	690.4	0.5	
513	0.013	8	VCP	0.0692	155.6	B7-1	681.5	692.0	681.6	0.1		B7-7	646.0	662.0	646.3	0.3	
420	0.013	8	ABS	0.0197	124.3	B7-2	689.8	706.0	690.0	0.2		B7-1	681.5	692.0	681.6	0.1	
435	0.013	8	ABS	0.0039	119.4	B7-3	691.5	705.0	691.8	0.3		B7-2	689.8	706.0	690.0	0.2	
431	0.013	8	ABS	0.0039	114.6	B7-4	693.2	707.0	693.4	0.3		B7-3	691.5	705.0	691.8	0.3	
416	0.013	8	ABS	0.0054	74.3	B7-5	695.4	705.0	695.6	0.2		B7-4	693.2	707.0	693.4	0.3	
414	0.013	8	ABS	0.0046	67.4	B7-6	697.3	710.0	697.5	0.2		B7-5	695.4	705.0	695.6	0.2	
194	0.013	10	VCP	0.0171	624.3	B7-7	646.0	662.0	646.4	0.4		C7-56	642.7	652.0	642.9	0.2	
252	0.013	10	ABS	0.0181	2.8	B7-8	650.6	657.0	650.6	0.0		B7-7	646.0	662.0	646.3	0.3	
392	0.013	8	VCP	0.0778	472.2	B7-10	676.5	683.0	676.8	0.3		B7-7	646.0	662.0	646.3	0.3	
98	0.013	8	ABS	0.0526	3.5	B7-11	681.7	692.0	681.7	0.0		B7-10	676.5	683.0	676.6	0.1	
403	0.013	8	VCP	0.0477	466.7	B7-12	695.8	705.0	696.0	0.3		B7-10	676.5	683.0	676.6	0.1	
397	0.013	8	VCP	0.0040	458.3	B7-13	697.4	708.0	699.9	2.5	SUR	B7-12	695.8	705.0	695.9	0.1	
409	0.013	8	VCP	0.0244	441.0	B7-14	707.4	715.0	707.7	0.3		B7-13	697.4	708.0	697.6	0.3	
298	0.013	8	VCP	0.0062	434.0	B7-15	709.2	721.0	709.9	0.6		B7-14	707.4	715.0	707.5	0.2	

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LENGTH (ft)	Manning's N (Double)	Diameter (in)	Material	Slope	Maximum Flow, gpm	Upstream MH Name	Upstream Invert (ft)	Upstream MH Rim	Maximum Upstream HGL	Flow Depth, ft	Class	Downstream MH Name	Downstream Invert (ft)	Downstream MH Rim	Maximum Downstream HGL	Flow Depth, ft	Class
403	0.013	8	VCP	0.0040	422.9	B7-16	710.8	725.0	712.1	1.3	SUR	B7-15	709.2	721.0	709.4	0.2	
330	0.013	8	ABS	0.0048	37.5	B8-1	694.8	707.0	694.9	0.1		B7-4	693.2	707.0	693.4	0.3	
407	0.013	8	ABS	0.0045	35.4	B8-2	696.6	706.0	696.7	0.1		B8-1	694.8	707.0	694.9	0.1	
386	0.013	8	ABS	0.0046	20.8	B8-3	694.9	707.0	695.0	0.1		C8-3	693.1	701.0	693.3	0.1	
403	0.013	8	ABS	0.0040	18.1	B8-4	696.5	706.0	696.6	0.1		B8-3	694.9	707.0	695.0	0.1	
395	0.013	8	ABS	0.0040	12.5	B8-5	698.1	705.0	698.2	0.1		B8-4	696.5	706.0	696.6	0.1	
385	0.013	8	ABS	0.0280	27.8	B8-9	692.3	700.0	692.4	0.1		B7-1	681.5	692.0	681.6	0.1	
732	0.012	21	VCP	0.0054	965.3	B9-1	595.4	601.0	595.9	0.5		C10-4	591.5	599.0	592.0	0.5	
672	0.012	21	VCP	0.0034	948.6	B9-2	597.7	604.0	598.2	0.6		B9-1	595.4	601.0	595.9	0.5	
804	0.012	21	VCP	0.0028	934.0	B9-3	599.9	610.0	600.5	0.6		B9-2	597.7	604.0	598.2	0.6	
381	0.013	8	ABS	0.0159	103.5	B9-4	601.9	606.0	602.1	0.2		C9-12	595.9	606.0	596.1	0.2	
312	0.013	8	ABS	0.0048	95.1	B9-5	603.4	607.0	603.6	0.2		B9-4	601.9	606.0	602.1	0.2	
348	0.013	8	ABS	0.0037	48.6	B9-6	604.7	609.0	604.9	0.2		B9-5	603.4	607.0	603.6	0.2	
316	0.013	8	ABS	0.0050	26.4	B9-7	606.3	611.0	606.4	0.1		B9-6	604.7	609.0	604.9	0.2	
224	0.013	8	ABS	0.0245	23.6	B9-8	611.7	619.0	611.8	0.1		B9-7	606.3	611.0	606.4	0.1	
318	0.013	8	ABS	0.0097	19.4	B9-9	607.8	612.0	607.8	0.1		B9-6	604.7	609.0	604.9	0.2	
354	0.013	8	ABS	0.0205	16.7	B9-10	615.0	619.0	615.1	0.1		B9-9	607.8	612.0	607.8	0.1	
118	0.013	8	ABS	0.0361	21.5	B9-12	616.0	622.0	616.1	0.1		B9-8	611.7	619.0	611.8	0.1	
363	0.013	8	ABS	0.0045	6.3	B9-16	605.6	612.0	605.7	0.1		B9-18	604.0	612.0	604.0	0.1	
136	0.013	8	SDR-35	0.0047	4.9	B9-17	606.2	615.0	606.3	0.1		B9-16	605.6	612.0	605.7	0.1	
167	0.013	8	SDR-35	0.0101	16.0	B9-18	604.0	612.0	604.0	0.1		B9-22	602.3	611.0	602.4	0.1	
250	0.013	8	SDR-35	0.0047	5.6	B9-19	606.3	613.0	606.4	0.1		B9-20	605.2	611.0	605.2	0.1	
266	0.013	8	SDR-35	0.0062	6.9	B9-20	605.2	611.0	605.2	0.1		B9-21	603.5	612.0	603.6	0.1	
139	0.013	8	SDR-35	0.0087	8.3	B9-22	603.5	611.0	603.6	0.1		B9-21	602.3	612.0	603.6	1.3	SUR
161	0.013	8	SDR-35	0.0147	25.0	B9-22	602.3	611.0	602.4	0.1		B9-3	599.9	610.0	600.5	0.6	
662	0.013	12	ABS	0.0038	259.7	B10-1	600.8	610.0	601.2	0.4		C10-5	598.3	606.0	598.6	0.3	
379	0.013	12	ABS	0.0167	258.3	B10-2	607.1	613.0	607.4	0.2		B10-1	600.8	610.0	601.2	0.4	
149	0.013	8	VCP	0.0123	63.9	B10-2B	609.0	616.0	609.1	0.1		B10-2	607.1	613.0	607.4	0.2	
354	0.013	12	ABS	0.0097	193.1	B10-3	610.6	618.0	610.8	0.2		B10-2	607.1	613.0	607.4	0.2	
395	0.013	12	ABS	0.0062	184.0	B10-4	613.7	620.0	614.0	0.3		B10-23	611.3	620.0	611.5	0.2	
445	0.013	12	ABS	0.0056	174.3	B10-5	616.2	624.0	616.5	0.3		B10-4	613.7	620.0	614.0	0.3	
249	0.013	8		0.0142	61.1	B10-6	612.5	621.0	612.6	0.1		B10-2B	609.0	616.0	609.1	0.1	
392	0.013	8	ABS	0.0242	54.9	B10-7	622.0	629.0	622.1	0.1		B10-6	612.5	621.0	612.6	0.1	
197	0.013	8	ABS	0.0127	48.6	B10-9	624.5	633.0	624.6	0.1		B10-7	622.0	629.0	622.1	0.1	
326	0.013	8	ABS	0.0327	13.9	B10-10	635.2	641.0	635.2	0.1		B10-9	624.5	633.0	624.6	0.1	
267	0.013	8	ABS	0.0686	9.7	B10-11	653.5	670.0	653.5	0.0		B10-10	635.2	641.0	635.2	0.1	
591	0.013	8	ABS	0.0237	32.6	B10-12	638.5	645.0	638.6	0.1		B10-9	624.5	633.0	624.6	0.1	
357	0.013	8	ABS	0.1853	3.5	B10-15	679.8	686.0	679.8	0.0		B10-4	613.7	620.0	614.0	0.3	
371	0.013	8	ABS	0.0099	2.1	B10-16	683.5	689.0	683.5	0.0		B10-15	679.8	686.0	679.8	0.0	
317	0.013	8	ABS	0.0096	1.4	B10-17	683.1	689.0	683.1	0.0		B10-18	680.0	690.0	680.0	0.0	
306	0.013	8	ABS	0.0598	2.8	B10-18	680.0	690.0	680.0	0.0		B10-22	661.7	672.0	661.7	0.1	
478	0.013	8	ABS	0.0091	7.6	B10-22	661.7	672.0	661.7	0.1		A10-8	657.3	663.0	657.4	0.1	
84	0.013	12	ABS	0.0084	187.5	B10-23	611.3	620.0	611.5	0.2		B10-3	610.6	618.0	610.8	0.2	
211	0.013	8	ABS	0.0420	27.1	B10-26	647.4	657.0	647.5	0.1		B10-12	638.5	645.0	638.6	0.1	
147	0.013	8	ABS	0.0323	5.6	B10-28	658.3	661.0	658.3	0.0		B10-11	653.5	670.0	653.5	0.0	
465	0.013	8	ABS	0.0205	2.8	B10-29	667.8	673.0	667.8	0.0		B10-28	658.3	661.0	658.3	0.0	
212	0.013	8	ABS	0.0360	25.0	B11-1	655.0	665.0	655.1	0.1		B10-26	647.4	657.0	647.5	0.1	
119	0.013	8	ABS	0.0698	22.2	B11-3	663.3	672.0	663.4	0.1		B11-1	655.0	665.0	655.1	0.1	
322	0.013	8	ABS	0.0289	18.1	B11-6	672.6	681.0	672.7	0.1		B11-3	663.3	672.0	663.4	0.1	
400	0.013	8	ABS	0.0055	12.5	B11-7	674.8	683.0	674.9	0.1		B11-6	672.6	681.0	672.7	0.1	
579	0.013	6	VCP	0.0058	188.9	C5-1	676.5	683.5	676.9	0.4		C6-32	673.2	681.2	673.4	0.3	
565	0.013	6	VCP	0.0140	145.8	C5-2	684.4	694.0	684.6	0.2		C5-1	676.5	683.5	677.1	0.6	SUR

2010 Master Plan Stillwater Collection System Pipe Analysis Results

LENGTH (ft)	Manning's N (Double)	Diameter (in)	Material	Slope	Maximum Flow, gpm	Upstream MH Name	Upstream Invert (ft)	Upstream MH Rim	Maximum Upstream HGL	Flow Depth, ft	Class	Downstream MH Name	Downstream Invert (ft)	Downstream MH Rim	Maximum Downstream HGL	Flow Depth, ft	Class
235	0.013	6	VCP	0.0406	143.8	C5-3	693.9	704.0	694.1	0.2		C5-2	684.4	694.0	684.6	0.2	
87	0.013	6	VCP	0.2533	118.1	C5-4	715.9	726.0	716.0	0.1		C5-3	693.9	704.0	694.1	0.2	
166	0.013	6	VCP	0.0067	25.7	C5-5	695.1	705.0	695.2	0.1		C5-3	693.9	704.0	694.1	0.2	
307	0.013	6	VCP	0.0194	24.3	C5-6	701.0	711.0	701.1	0.1		C5-5	695.1	705.0	695.2	0.1	
157	0.013	6	VCP	0.0206	23.6	C5-7	704.3	714.0	704.3	0.1		C5-6	701.0	711.0	701.1	0.1	
219	0.013	6	VCP	0.0361	22.2	C5-8	712.1	722.0	712.2	0.1		C5-7	704.3	714.0	704.3	0.1	
105	0.013	6	VCP	0.0515	20.1	C5-9	717.6	728.0	717.6	0.1		C5-8	712.1	722.0	712.2	0.1	
195	0.013	6	VCP	0.0611	17.4	C5-12	729.5	739.0	729.5	0.1		C5-9	717.6	728.0	717.6	0.1	
296	0.013	8	VCP	0.0040	15.3	C5-13	730.7	741.0	730.8	0.1		C5-12	729.5	739.0	729.5	0.1	
50	0.013	8	VCP	0.0040	12.5	C5-14	730.9	741.0	730.9	0.1		C5-13	730.7	741.0	730.8	0.1	
453	0.013	8	VCP	0.0032	11.1	C5-15	732.3	742.0	732.4	0.1		C5-14	730.9	741.0	730.9	0.1	
633	0.013	8	VCP	0.0065	0.7	C5-16	736.4	746.0	736.5	0.0		C5-15	732.3	742.0	732.4	0.1	
180	0.013	10		0.0017	38.9	C5-17	733.8	743.0	733.9	0.2		B5-37A	733.4	743.0	733.6	0.2	
58	0.013	8	VCP	0.0073	37.5	C5-19	734.2	744.0	734.3	0.1		C5-17	733.8	743.0	733.9	0.2	
477	0.013	8	VCP	0.0033	34.0	C5-21	735.7	743.0	735.9	0.2		C5-19	734.2	744.0	734.3	0.1	
364	0.013	6	VCP	0.0034	27.1	C5-22	738.1	748.0	738.3	0.1		C5-61	736.9	743.0	737.1	0.2	
334	0.013	6	VCP	0.0044	13.9	C5-23	741.1	751.0	741.2	0.1		C5-60	739.7	750.0	739.8	0.1	
293	0.013	6	VCP	0.0063	5.6	C5-24	743.0	753.0	743.0	0.1		C5-23	741.1	751.0	741.2	0.1	
469	0.013	6	VCP	0.0126	26.4	C5-25	725.2	732.0	725.3	0.1		D6-58	719.3	726.0	719.4	0.2	
335	0.013	8	ABS	0.0168	1.4	C5-27	726.4	732.0	726.5	0.0		C5-56	720.8	727.0	720.8	0.0	
191	0.013	6	VCP	0.0044	23.6	C5-28	726.0	740.0	726.1	0.1		C5-25	725.2	732.0	725.3	0.1	
465	0.013	6	VCP	0.0075	20.1	C5-30	729.5	738.0	729.6	0.1		C5-28	726.0	740.0	726.1	0.1	
132	0.013	6	VCP	0.0062	18.1	C5-32	730.3	740.0	730.4	0.1		C5-30	729.5	738.0	729.6	0.1	
433	0.013	6	VCP	0.0066	16.7	C5-33	733.2	743.0	733.3	0.1		C5-32	730.3	740.0	730.4	0.1	
471	0.013	6	VCP	0.0056	9.0	C5-34	735.8	744.0	735.9	0.1		C5-33	733.2	743.0	733.3	0.1	
310	0.013	6	VCP	0.0035	2.1	C5-35	738.3	744.0	738.4	0.0		C5-52	737.2	744.0	737.3	0.1	
262	0.013	8	ABS	0.0050	12.5	C5-38	717.5	732.0	717.6	0.1		C5-41	716.2	729.0	716.3	0.1	
338	0.013	8	ABS	0.0048	9.0	C5-39	719.2	725.0	719.2	0.1		C5-38	717.5	732.0	717.6	0.1	
261	0.013	8	ABS	0.0040	4.2	C5-40	720.2	726.0	720.3	0.1		C5-39	719.2	725.0	719.2	0.1	
253	0.013	8	ABS	0.0049	16.0	C5-41	716.2	729.0	716.3	0.1		C5-43	715.0	722.0	715.1	0.1	
292	0.013	8	ABS	0.0043	25.7	C5-43	715.0	722.0	715.1	0.1		C5-44	713.7	721.0	713.8	0.1	
408	0.013	8	ABS	0.0045	27.8	C5-44	713.7	721.0	713.8	0.1		C5-45	711.9	721.0	712.0	0.1	
100	0.013	8	ABS	0.2786	41.0	C5-46	704.3	725.0	704.4	0.1		C5-1	676.5	683.5	677.1	0.6	
65	0.013	8	ABS	0.0581	8.3	C5-47	718.8	727.0	718.8	0.0		C5-43	715.0	722.0	715.1	0.1	
220	0.013	8	ABS	0.0245	4.9	C5-48	724.2	732.0	724.2	0.0		C5-47	718.8	727.0	718.8	0.0	
149	0.013	6	SDR-35	0.0258	2.8	C5-49	728.0	735.0	728.0	0.0		C5-48	724.2	732.0	724.2	0.0	
165	0.013	8	ABS	0.0407	39.6	C5-51	711.0	717.0	711.1	0.1		C5-46	704.3	725.0	704.4	0.1	
268	0.013	6	VCP	0.0052	6.3	C5-52	737.2	744.0	737.3	0.1		C5-34	735.8	744.0	735.9	0.1	
421	0.013	8	ABS	0.0191	6.9	C5-55	719.0	724.0	719.1	0.0		C5-51	711.0	717.0	711.1	0.1	
233	0.013	8	ABS	0.0037	29.9	C5-55	711.9	724.0	712.0	0.1		C5-51	711.0	717.0	711.1	0.1	
403	0.013	8	ABS	0.0044	3.5	C5-56	720.8	727.0	720.8	0.0		C5-55	719.0	724.0	719.1	0.0	
342	0.013	6	VCP	0.0044	20.1	C5-60	739.7	750.0	739.8	0.1		C5-22	738.1	748.0	738.3	0.1	
364	0.013	6	VCP	0.0032	30.6	C5-61	736.9	743.0	737.1	0.2		C5-21	735.7	743.0	735.9	0.2	
556	0.013	10	VCP	0.0085	678.5	C6-1	650.5	658.0	651.0	0.5		D6-32	645.8	656.0	646.3	0.5	
61	0.013	10	VCP	0.0094	675.7	C6-2	651.0	660.0	651.6	0.5		C6-1	650.5	658.0	651.0	0.5	
232	0.013	8	VCP	0.0054	46.5	C6-3	652.3	659.0	652.4	0.2		C6-2	651.0	660.0	651.6	0.5	
306	0.013	8	VCP	0.0158	45.1	C6-4	657.1	664.0	657.2	0.1		C6-3	652.3	659.0	652.4	0.2	
355	0.013	8	VCP	0.1389	44.4	C6-5	706.4	711.0	706.4	0.1		C6-4	657.1	664.0	657.2	0.1	
375	0.013	8	ABS	0.0198	40.3	C6-6	713.8	722.0	713.9	0.1		C6-5	706.4	711.0	706.4	0.1	
282	0.013	8	ABS	0.0041	38.2	C6-8	714.9	722.0	715.1	0.2		C6-6	713.8	722.0	713.9	0.1	
252	0.013	8	ABS	0.0048	34.7	C6-9	716.1	722.0	716.2	0.1		C6-8	714.9	722.0	715.1	0.2	
234	0.013	8	ABS	0.0063	2.8	C6-10	717.6	727.0	717.6	0.0		C6-9	716.1	722.0	716.2	0.1	

2010 Master Plan Stillwater Collection System Pipe Analysis Results

LENGTH (ft)	Manning's N (Double)	Diameter (in)	Material	Slope	Maximum Flow, gpm	Upstream MH Name	Upstream Invert (ft)	Upstream MH Rim	Maximum Upstream HGL	Flow Depth, ft	Class	Downstream MH Name	Downstream Invert (ft)	Downstream MH Rim	Maximum Downstream HGL	Flow Depth, ft	Class
232	0.013	8	ABS	0.0061	0.7	C6-11	719.0	725.0	719.0	0.0		C6-10	717.6	727.0	717.6	0.0	
68	0.013	8	VCP	0.0040	51.4	C6-12	714.3	726.0	716.7	2.4	SUR	B6-1	714.0	725.7	714.2	0.2	
257	0.013	8	ABS	0.0050	8.3	C6-13	715.4	725.0	715.5	0.1		C7-40	714.1	724.0	714.2	0.1	
384	0.013	8	ABS	0.0052	5.6	C6-14	717.4	727.0	717.4	0.1		C6-13	715.4	725.0	715.5	0.1	
132	0.013	8	ABS	0.0046	18.1	C6-16	714.6	723.8	714.7	0.1		C6-58	713.9	725.9	714.1	0.1	
286	0.013	8	ABS	0.0048	4.9	C6-18	715.9	721.0	716.0	0.1		C6-16	714.6	723.8	714.7	0.1	
386	0.013	10	VCP	0.0093	628.5	C6-25	654.6	669.0	655.1	0.5		C6-2	651.0	660.0	651.6	0.5	
187	0.013	10	VCP	0.0034	626.4	C6-26	655.3	664.0	656.0	0.8		C6-25	654.6	669.0	655.1	0.5	
367	0.013	10	VCP	0.0033	625.0	C6-27	656.5	665.0	657.3	0.9	SUR	C6-26	655.3	664.0	656.0	0.8	
510	0.013	10	VCP	0.0032	506.3	C6-28	658.1	667.0	658.7	0.6		C6-27	656.5	665.0	657.3	0.9	SUR
657	0.013	8	VCP	0.0122	504.9	C6-29	666.1	677.0	666.6	0.5		C6-28	658.1	667.0	658.7	0.6	
242	0.013	8	VCP	0.0117	503.5	C6-30	669.0	675.0	669.4	0.5		C6-29	666.1	677.0	666.6	0.5	
63	0.013	8	VCP	0.0125	496.5	C6-31	673.0	681.0	673.4	0.5		C6-59	672.2	683.0	672.7	0.5	
20	0.013	10	VCP	0.0084	190.3	C6-32	673.2	681.2	673.5	0.4		C6-31	673.0	681.0	673.4	0.5	
187	0.013	8	VCP	0.0076	113.9	C6-33	657.9	668.0	658.1	0.2		C6-27	656.5	665.0	657.3	0.9	SUR
368	0.013	6	VCP	0.0545	84.7	C6-34	678.0	686.0	678.1	0.1		C6-33	657.9	668.0	658.1	0.2	
192	0.013	8	ABS	0.0197	27.8	C6-35	661.7	672.0	661.8	0.1		C6-33	657.9	668.0	658.1	0.2	
197	0.013	8	ABS	0.0209	12.5	C6-36	665.8	676.0	665.9	0.1		C6-35	661.7	672.0	661.8	0.1	
195	0.013	8	ABS	0.0240	10.4	C6-37	670.5	681.0	670.6	0.1		C6-36	665.8	676.0	665.9	0.1	
196	0.013	8	ABS	0.1746	3.5	C6-38	704.8	715.0	704.8	0.0		C6-37	670.5	681.0	670.6	0.1	
447	0.013	8	ABS	0.0336	2.8	C6-46	719.4	724.0	719.4	0.0		C6-47	704.4	713.0	704.4	0.0	
159	0.013	8	ABS	0.0530	3.5	C6-47	704.4	713.0	704.4	0.0		C6-48	696.0	703.0	696.0	0.0	
84	0.013	8	ABS	0.2833	10.4	C6-48	696.0	703.0	696.0	0.0		C6-49	672.2	679.0	672.2	0.1	
338	0.013	8	ABS	0.0143	11.8	C6-49	672.2	679.0	672.2	0.1		C6-50	667.3	673.0	667.4	0.1	
318	0.013	8	ABS	0.0177	13.9	C6-50	667.3	673.0	667.4	0.1		C6-35	661.7	672.0	661.8	0.1	
267	0.013	8	ABS	0.0236	4.9	C6-51	702.3	707.0	702.4	0.0		C6-48	696.0	703.0	696.0	0.0	
275	0.013	8	ABS	0.0401	2.8	C6-53	713.4	719.0	713.4	0.0		C6-51	702.3	707.0	702.4	0.0	
373	0.013	6	ABS	0.0063	0.7	C6-54	715.7	718.0	715.7	0.0		C6-53	713.4	719.0	713.4	0.0	
137	0.013	6	ABS	0.0070	2.1	C6-55	719.3	725.0	719.4	0.0		C6-56	718.4	724.0	718.4	0.0	
166	0.013	8	ABS	0.0832	2.8	C6-56	718.4	724.0	718.4	0.0		C7-51	704.5	715.0	704.6	0.0	
407	0.013	8	ABS	0.1016	20.8	C6-57	699.0	718.0	699.1	0.1		D7-23	657.6	663.0	657.7	0.1	
384	0.013	8	ABS	0.0040	20.1	C6-58	713.9	725.9	714.1	0.1		C7-28	712.4	726.0	712.5	0.1	
342	0.013	8	VCP	0.0094	501.4	C6-59	672.2	683.0	672.7	0.5		C6-30	669.0	675.0	669.4	0.5	
272	0.013	8	ABS	0.1171	2.1	C6-60	704.0	714.0	704.0	0.0		C6-59	672.2	683.0	672.7	0.5	
512	0.013	10	VCP	0.0058	747.2	C7-2	629.2	635.0	634.7	5.5	SUR	C8-7	626.2	636.0	626.7	0.5	
492	0.013	10	VCP	0.0060	741.0	C7-3	632.1	641.0	637.5	5.4	SUR	C7-2	629.2	635.0	629.6	0.4	
192	0.013	10	VCP	0.0344	736.1	C7-4	638.8	648.0	639.2	0.4		C7-3	632.1	641.0	632.6	0.4	
262	0.013	10	VCP	0.0006	723.6	C7-5	638.9	646.0	641.0	2.0	SUR	C7-4	638.8	648.0	639.0	0.3	
303	0.013	10	VCP	0.0065	720.1	C7-6	640.9	648.0	642.6	1.7	SUR	C7-5	638.9	646.0	639.8	0.9	SUR
176	0.013	10	VCP	0.0024	625.0	C7-7	641.3	649.0	643.3	2.0	SUR	C7-6	640.9	648.0	641.3	0.4	
118	0.013	8	ABS	0.0529	13.2	C7-8	645.0	652.0	645.0	0.0		C7-4	638.8	648.0	639.0	0.3	
268	0.013	8	VCP	0.0338	2.8	C7-9	654.0	660.0	654.1	0.0		C7-8	645.0	652.0	645.0	0.0	
79	0.013	8	VCP	0.0495	1.4	C7-10	657.9	665.0	657.9	0.0		C7-9	654.0	660.0	654.1	0.0	
337	0.013	8	VCP	0.0079	9.0	C7-12	647.7	654.0	647.7	0.1		C7-8	645.0	652.0	645.0	0.0	
126	0.013	8	VCP	0.0093	6.9	C7-13	648.8	656.0	648.9	0.1		C7-12	647.7	654.0	647.7	0.1	
129	0.013	8	VCP	0.0773	96.5	C7-16	650.9	661.0	651.0	0.1		C7-6	640.9	648.0	641.3	0.4	
79	0.013	8	VCP	0.0453	0.7	C7-17	654.4	664.0	654.4	0.0		C7-16	650.9	661.0	651.0	0.1	
292	0.013	8	VCP	0.0091	94.4	C7-18	653.5	662.0	653.7	0.2		C7-16	650.9	661.0	651.0	0.1	
395	0.013	8	VCP	0.1061	90.3	C7-19	695.4	699.0	695.5	0.1		C7-18	653.5	662.0	653.7	0.2	
230	0.013	8	VCP	0.0253	86.1	C7-20	701.2	707.0	701.4	0.2		C7-19	695.4	699.0	695.5	0.1	
429	0.013	8	VCP	0.0043	81.9	C7-21	703.1	715.0	703.3	0.2		C7-20	701.2	707.0	701.4	0.2	
330	0.013	8	VCP	0.0039	2.8	C7-23	704.4	709.0	704.4	0.0		C7-21	703.1	715.0	703.3	0.2	

2010 Master Plan Stillwater Collection System Pipe Analysis Results

LENGTH (ft)	Manning's N (Double)	Diameter (in)	Material	Slope	Maximum Flow, gpm	Upstream MH Name	Upstream Invert (ft)	Upstream MH Rim	Maximum Upstream HGL	Flow Depth, ft	Class	Downstream MH Name	Downstream Invert (ft)	Downstream MH Rim	Maximum Downstream HGL	Flow Depth, ft	Class
280	0.013	8	VCP	0.0039	75.7	C7-24	704.2	716.0	704.4	0.2		C7-21	703.1	715.0	703.3	0.2	
267	0.013	6	VCP	0.0263	0.7	C7-25	711.2	721.0	711.2	0.0		C7-24	704.2	716.0	704.4	0.2	
421	0.013	8	VCP	0.0137	34.0	C7-26	709.9	718.0	710.0	0.1		C7-24	704.2	716.0	704.4	0.2	
398	0.013	8	VCP	0.0040	31.3	C7-27	711.5	718.0	711.7	0.1		C7-26	709.9	718.0	710.0	0.1	
206	0.013	8	ABS	0.0043	25.0	C7-28	712.4	726.0	712.5	0.1		C7-27	711.5	718.0	711.7	0.1	
217	0.013	8	VCP	0.0041	38.9	C7-30	705.1	715.0	705.2	0.2		C7-24	704.2	716.0	704.4	0.2	
399	0.013	8	VCP	0.0245	8.3	C7-31	714.8	719.0	714.9	0.0		C7-30	705.1	715.0	705.2	0.2	
413	0.013	8	VCP	0.0045	6.3	C7-33	716.7	721.0	716.8	0.1		C7-31	714.8	719.0	714.9	0.0	
270	0.013	8	VCP	0.0041	2.1	C7-34	717.8	723.0	717.8	0.0		C7-33	716.7	721.0	716.8	0.1	
243	0.013	8	VCP	0.0038	29.2	C7-35	706.0	716.0	706.1	0.1		C7-30	705.1	715.0	705.2	0.2	
406	0.013	8	VCP	0.0044	22.2	C7-37	707.8	718.0	707.9	0.1		C7-35	706.0	716.0	706.1	0.1	
320	0.013	8	VCP	0.0101	18.1	C7-38	711.0	721.0	711.1	0.1		C7-37	707.8	718.0	707.9	0.1	
246	0.013	8	VCP	0.0050	15.3	C7-39	712.3	722.0	712.3	0.1		C7-38	711.0	721.0	711.1	0.1	
376	0.013	8	VCP	0.0050	13.2	C7-40	714.1	724.0	714.2	0.1		C7-39	712.3	722.0	712.3	0.1	
252	0.013	8	VCP	0.0395	6.9	C7-45	699.0	709.0	699.0	0.0		D7-21	689.0	699.0	689.1	0.0	
372	0.013	8	VCP	0.0081	4.9	C7-46	702.0	712.0	702.0	0.0		C7-45	699.0	709.0	699.0	0.0	
282	0.013	8	VCP	0.0234	2.1	C7-47	708.6	719.0	708.6	0.0		C7-46	702.0	712.0	702.0	0.0	
149	0.013	8	ABS	0.0290	9.7	C7-51	704.5	715.0	704.6	0.0		C7-52	700.2	720.0	700.3	0.1	
164	0.013	8	ABS	0.0072	19.4	C7-52	700.2	720.0	700.3	0.1		C6-57	699.0	718.0	699.1	0.1	
358	0.013	8	ABS	0.0050	8.3	C7-53	702.0	713.0	702.1	0.1		C7-52	700.2	720.0	700.3	0.1	
233	0.013	8	ABS	0.0063	5.6	C7-54	706.0	716.0	706.1	0.1		C7-51	704.5	715.0	704.6	0.0	
29	0.013	10	VCP	0.0466	622.9	C7-56	642.7	652.0	643.4	0.7		C7-7	641.3	649.0	641.8	0.5	
104	0.013	8	ABS	0.0055	2.8	C7-59	718.0	728.0	718.0	0.0		C6-14	717.4	727.0	717.4	0.1	
481	0.013	8	VCP	0.0033	28.5	C8-1	687.6	695.0	687.7	0.1		C8-32	686.0	697.0	686.1	0.1	
201	0.013	8	ABS	0.0042	27.1	C8-3	693.1	701.0	693.3	0.1		B8-9	692.3	700.0	692.4	0.1	
237	0.013	8	ABS	0.0033	4.9	C8-4	693.9	704.0	694.0	0.1		C8-3	693.1	701.0	693.3	0.1	
347	0.013	8	ABS	0.0045	3.5	C8-5	695.5	705.0	695.5	0.0		C8-4	693.9	704.0	694.0	0.1	
246	0.013	10	VCP	0.0043	806.3	C8-6	625.2	631.0	630.3	5.0	SUR	D8-11	624.4	632.0	625.0	0.6	
27	0.013	10	VCP	0.0048	747.9	C8-7	626.2	636.0	631.8	5.6	SUR	C8-7A	626.1	636.0	626.6	0.5	
231	0.013	10	VCP	0.0035	749.3	C8-7A	626.1	636.0	631.6	5.6	SUR	C8-6	625.2	631.0	626.0	0.7	
224	0.013	6	VCP	0.0663	56.3	C8-8	640.1	649.0	640.2	0.1		C8-6	625.2	631.0	626.0	0.7	SUR
235	0.013	8	VCP	0.0032	54.2	C8-9	640.8	649.0	641.0	0.2		C8-8	640.1	649.0	640.2	0.1	
295	0.013	6	VCP	0.0106	52.1	C8-10	644.0	650.0	644.1	0.2		C8-9	640.8	649.0	641.0	0.2	
40	0.013	8	VCP	0.0074	48.6	C8-11	644.3	649.0	644.4	0.1		C8-10	644.0	650.0	644.1	0.2	
91	0.013	6	VCP	0.1095	48.6	C8-12	654.2	660.0	654.3	0.1		C8-11	644.3	649.0	644.4	0.1	
192	0.013	8	VCP	0.0067	38.9	C8-13	655.5	666.0	655.6	0.1		C8-12	654.2	660.0	654.3	0.1	
88	0.013	6	VCP	0.0967	37.5	C8-14	664.0	674.0	664.1	0.1		C8-13	655.5	666.0	655.6	0.1	
225	0.013	6	VCP	0.0189	35.4	C8-15	668.3	678.0	668.4	0.1		C8-14	664.0	674.0	664.1	0.1	
116	0.013	8	VCP	0.0055	31.9	C8-16	668.9	689.0	669.0	0.1		C8-15	668.3	678.0	668.4	0.1	
355	0.013	8	VCP	0.0113	56.3	C8-23	672.1	687.0	672.3	0.1		D9-59	668.1	679.0	668.4	0.3	
252	0.013	8	AC	0.0112	13.9	C8-24	674.9	684.0	675.0	0.1		C8-23	672.1	687.0	672.3	0.1	
129	0.013	8	VCP	0.0956	39.6	C8-30	684.4	691.0	684.5	0.1		C8-23	672.1	687.0	672.3	0.1	
139	0.013	8	VCP	0.0031	38.9	C8-31	684.8	694.0	685.0	0.2		C8-30	684.4	691.0	684.5	0.1	
363	0.013	8	VCP	0.0032	33.3	C8-32	686.0	697.0	686.1	0.1		C8-31	684.8	694.0	685.0	0.2	
395	0.013	8	ABS	0.0540	23.6	C8-35	690.2	696.0	690.3	0.1		C8-16	668.9	689.0	669.0	0.1	
124	0.013	8	ABS	0.0598	9.0	C8-40	661.6	665.0	661.7	0.0		C8-12	654.2	660.0	654.3	0.1	
405	0.013	8	ABS	0.0211	7.6	C8-41	670.2	674.0	670.2	0.0		C8-40	661.6	665.0	661.7	0.0	
402	0.013	8	ABS	0.0294	6.3	C8-42	682.0	686.0	682.0	0.0		C8-41	670.2	674.0	670.2	0.0	
356	0.013	8	ABS	0.0208	2.1	C8-43	689.4	691.0	689.4	0.0		C8-42	682.0	686.0	682.0	0.0	
366	0.013	8	VCP	0.0021	6.3	C9-1	673.5	686.0	673.6	0.1		D9-34	672.8	691.0	672.9	0.1	
233	0.013	8	VCP	0.0020	1.4	C9-2	674.0	685.0	674.0	0.0		C9-1	673.5	686.0	673.6	0.1	
196	0.013	8	VCP	0.0024	11.8	C9-3	688.8	694.0	688.9	0.1		D9-36	688.3	692.0	688.4	0.1	

2010 Master Plan Stillwater Collection System Pipe Analysis Results

LENGTH (ft)	Manning's N (Double)	Diameter (in)	Material	Slope	Maximum Flow, gpm	Upstream MH Name	Upstream Invert (ft)	Upstream MH Rim	Maximum Upstream HGL	Flow Depth, ft	Class	Downstream MH Name	Downstream Invert (ft)	Downstream MH Rim	Maximum Downstream HGL	Flow Depth, ft	Class
617	0.013	8	VCP	0.0019	3.5	C9-5	690.0	700.0	690.1	0.1		C9-3	688.8	694.0	688.9	0.1	
258	0.013	6	VCP	0.0733	1.4	C9-6	691.0	696.0	691.0	0.0		C8-23	672.1	687.0	672.3	0.1	
450	0.013	8	ABS	0.0175	41.0	C9-7	611.3	616.0	611.4	0.1		B9-5	603.4	607.0	603.6	0.2	
393	0.013	8	ABS	0.0375	36.8	C9-8	626.0	631.0	626.1	0.1		C9-7	611.3	616.0	611.4	0.1	
194	0.013	8	ABS	0.0728	32.6	C9-9	640.1	655.0	640.2	0.1		C9-8	626.0	631.0	626.1	0.1	
422	0.013	8	ABS	0.0311	11.8	C9-10	628.2	634.0	628.2	0.1		B9-10	615.0	619.0	615.1	0.1	
343	0.013	8	ABS	0.0245	6.9	C9-11	636.6	642.0	636.6	0.0		C9-10	628.2	634.0	628.2	0.1	
118	0.013	8	ABS	0.0062	125.0	C9-12	595.9	606.0	596.1	0.2		C9-13	595.1	607.0	595.4	0.3	
234	0.013	8	ABS	0.0039	126.4	C9-13	595.1	607.0	595.4	0.3		C9-14	594.2	604.0	594.4	0.2	
307	0.013	8	ABS	0.0089	127.8	C9-14	594.2	604.0	594.4	0.2		C10-4	591.5	599.0	592.0	0.5	
312	0.013	8	ABS	0.0044	20.1	C9-16	597.2	607.0	597.3	0.1		C9-12	595.9	606.0	596.1	0.2	
395	0.013	8	ABS	0.0061	11.8	C9-19	599.6	610.0	599.7	0.1		C9-16	597.2	607.0	597.3	0.1	
130	0.013	6	ABS	0.0195	6.3	C9-21	606.4	616.0	606.4	0.0		C9-22	603.8	614.0	603.9	0.1	
324	0.013	8	ABS	0.0129	8.3	C9-22	603.8	614.0	603.9	0.1		C9-19	599.6	610.0	599.7	0.1	
85	0.013	6	ABS	0.0085	3.5	C9-25	606.3	613.0	606.3	0.0		C9-26	605.6	611.0	605.6	0.0	
374	0.013	8	ABS	0.0098	5.6	C9-26	605.6	611.0	605.6	0.0		B9-4	601.9	606.0	602.1	0.2	
127	0.013	8	PVC	0.0057	29.9	C9-27	673.7	682.0	673.8	0.1		C9-37	673.0	688.0	673.0	0.1	
339	0.013	8	PVC	0.0044	27.1	C9-31	675.2	692.0	675.3	0.1		C9-27	673.7	682.0	673.8	0.1	
352	0.013	8	PVC	0.0258	10.4	C9-33	684.2	692.0	684.3	0.1		C9-31	675.2	692.0	675.3	0.1	
406	0.013	8	PVC	0.0045	6.9	C9-34	686.1	692.0	686.1	0.1		C9-33	684.2	692.0	684.3	0.1	
125	0.013	8	PVC	0.0076	4.9	C9-36	687.0	697.0	687.0	0.0		C9-34	686.1	692.0	686.1	0.1	
212	0.013	8	PVC	0.1551	31.3	C9-37	673.0	688.0	673.0	0.1		C9-9	640.1	655.0	640.2	0.1	
748	0.012	27	VCP	0.0012	1434.7	C10-1	582.8	596.0	583.6	0.8		D10-3	581.9	594.0	582.8	0.8	
751	0.012	27	VCP	0.0014	1393.8	C10-2	583.9	596.0	584.6	0.8		C10-1	582.8	596.0	583.6	0.8	
752	0.012	24	VCP	0.0027	1386.1	C10-3	585.9	601.0	586.6	0.7		C10-2	583.9	596.0	584.6	0.8	
582	0.012	18	VCP	0.0096	1098.6	C10-4	591.5	599.0	592.0	0.5		C10-3	585.9	601.0	586.6	0.7	
262	0.013	12	ABS	0.0140	266.7	C10-5	598.3	606.0	598.6	0.3		C10-6	594.6	606.0	594.8	0.2	
33	0.013	12	ABS	0.0824	280.6	C10-6	594.6	606.0	594.8	0.2		C10-42	591.9	608.0	592.1	0.2	
119	0.013	8	ABS	0.0748	11.8	C10-7	618.0	625.0	618.0	0.0		C10-39	609.1	614.0	609.2	0.0	
337	0.013	8	ABS	0.0608	9.7	C10-8	638.5	650.0	638.5	0.0		C10-7	618.0	625.0	618.0	0.0	
378	0.013	8	ABS	0.0198	17.4	C10-11	620.8	633.0	620.9	0.1		C10-12	613.4	623.0	613.5	0.1	
125	0.013	8	ABS	0.0199	18.1	C10-12	613.4	623.0	613.5	0.1		C10-31	610.9	621.0	611.0	0.1	
401	0.013	8	ABS	0.0112	26.4	C10-13	603.5	614.0	603.6	0.1		D10-5	599.0	609.0	599.1	0.1	
333	0.013	8	ABS	0.0177	10.4	C10-19	626.8	636.0	626.8	0.1		C10-11	620.8	633.0	620.9	0.1	
366	0.013	8	ABS	0.1214	2.1	C10-20	671.2	678.0	671.2	0.0		C10-19	626.8	636.0	626.8	0.1	
52	0.013	8	ABS	0.0384	8.3	C10-21	640.5	654.0	640.5	0.0		C10-8	638.5	650.0	638.5	0.0	
170	0.013	8	ABS	0.0039	7.6	C10-23	641.2	647.0	641.2	0.1		C10-21	640.5	654.0	640.5	0.0	
293	0.013	8	ABS	0.0046	4.9	C10-24	642.5	658.0	642.6	0.1		C10-23	641.2	647.0	641.2	0.1	
72	0.013	6	ABS	0.2186	0.7	C10-25	658.3	667.0	658.3	0.0		C10-24	642.5	658.0	642.6	0.1	
291	0.013	8	ABS	0.0042	1.4	C10-29	661.3	671.0	661.3	0.0		D10-17	660.1	675.0	660.1	0.0	
149	0.013	8	ABS	0.0413	22.9	C10-30	609.7	622.0	609.7	0.1		C10-13	603.5	614.0	603.6	0.1	
212	0.013	8	ABS	0.0058	19.4	C10-31	610.9	621.0	611.0	0.1		C10-30	609.7	622.0	609.7	0.1	
359	0.013	8	ABS	0.1459	1.4	C10-32	662.1	666.0	662.1	0.0		C10-30	609.7	622.0	609.7	0.1	
347	0.013	8	ABS	0.0041	4.9	C10-33	600.7	606.0	600.8	0.1		C10-51	599.3	605.0	599.4	0.1	
138	0.013	8	ABS	0.0264	3.5	C10-34	604.4	609.0	604.4	0.0		C10-33	600.7	606.0	600.8	0.1	
386	0.013	8	ABS	0.1108	2.1	C10-35	647.2	653.0	647.2	0.0		C10-34	604.4	609.0	604.4	0.0	
146	0.013	8	ABS	0.0733	0.7	C10-36	657.9	668.0	657.9	0.0		C10-35	647.2	653.0	647.2	0.0	
312	0.013	8	ABS	0.0046	3.5	C10-37	668.5	672.0	668.5	0.0		C11-10	667.0	673.0	667.0	0.0	
247	0.013	8	ABS	0.0050	1.4	C10-38	669.7	673.0	669.7	0.0		C10-37	668.5	672.0	668.5	0.0	
254	0.013	8	ABS	0.0572	12.5	C10-39	609.1	614.0	609.2	0.0		C10-42	594.6	608.0	594.6	0.0	
94	0.013	12	ABS	0.0639	281.3	C10-42	591.9	608.0	592.1	0.2		C10-3	585.9	601.0	586.6	0.7	
319	0.013	8	PVC	0.0128	1.4	C10-43	661.6	668.0	661.6	0.0		C11-31	657.5	667.0	657.5	0.0	

2010 Master Plan Stillwater Collection System Pipe Analysis Results

LENGTH (ft)	Manning's N (Double)	Diameter (in)	Material	Slope	Maximum Flow, gpm	Upstream MH Name	Upstream Invert (ft)	Upstream MH Rim	Maximum Upstream HGL	Flow Depth, ft	Class	Downstream MH Name	Downstream Invert (ft)	Downstream MH Rim	Maximum Downstream HGL	Flow Depth, ft	Class
252	0.013	8		0.0047	7.6	C10-51	599.3	605.0	599.4	0.1		D10-19	598.1	608.0	598.2	0.1	
381	0.013	10	ABS	0.0135	86.8	C11-1	619.0	629.0	619.2	0.2		D11-10	613.9	621.0	614.0	0.2	
214	0.013	8	ABS	0.0421	35.4	C11-2	628.0	635.0	628.1	0.1		C11-1	619.0	629.0	619.2	0.2	
322	0.013	8	ABS	0.0497	34.7	C11-3	644.0	648.0	644.1	0.1		C11-2	628.0	635.0	628.1	0.1	
218	0.013	8	ABS	0.0115	30.6	C11-4	646.5	654.0	646.6	0.1		C11-3	644.0	648.0	644.1	0.1	
371	0.013	8	ABS	0.0363	17.4	C11-5	660.0	671.0	660.1	0.1		C11-4	646.5	654.0	646.6	0.1	
400	0.013	8	ABS	0.0263	11.1	C11-6	670.5	676.0	670.6	0.1		C11-5	660.0	671.0	660.1	0.1	
245	0.013	8	ABS	0.0170	6.9	C11-7	674.7	686.0	674.7	0.0		C11-6	670.5	676.0	670.6	0.1	
280	0.013	8	ABS	0.0731	11.8	C11-10	667.0	673.0	667.0	0.0		C11-4	646.5	654.0	646.6	0.1	
182	0.013	8	PVC	0.1605	5.6	C11-11	648.2	658.0	648.2	0.0		C11-1	619.0	629.0	619.2	0.2	
242	0.013	8	ABS	0.0413	44.4	C11-12	629.0	636.0	629.1	0.1		C11-1	619.0	629.0	619.2	0.2	
385	0.013	8	ABS	0.0351	42.4	C11-13	642.5	649.0	642.6	0.1		C11-12	629.0	636.0	629.1	0.1	
224	0.013	8	ABS	0.0559	40.3	C11-14	655.0	664.0	655.1	0.1		C11-13	642.5	649.0	642.6	0.1	
422	0.013	8	ABS	0.0240	9.7	C11-15	665.1	682.0	665.2	0.1		C11-14	655.0	664.0	655.1	0.1	
403	0.013	8	ABS	0.0040	5.6	C11-16	666.7	680.0	666.8	0.1		C11-15	665.1	682.0	665.2	0.1	
347	0.013	6	ABS	0.0065	3.5	C11-17	669.0	675.0	669.0	0.0		C11-16	666.7	680.0	666.8	0.1	
54	0.013	8	ABS	0.0587	6.9	C11-21	670.2	677.0	670.2	0.0		C11-10	667.0	673.0	667.0	0.0	
153	0.013	8	ABS	0.0392	29.2	C11-22	661.0	670.0	661.1	0.1		C11-14	655.0	664.0	655.1	0.1	
379	0.013	8	ABS	0.0039	28.5	C11-23	662.5	675.0	662.6	0.1		C11-22	661.0	670.0	661.1	0.1	
154	0.013	8	ABS	0.0060	11.1	C11-24	663.4	675.0	663.5	0.1		C11-23	662.5	675.0	662.6	0.1	
356	0.013	8	ABS	0.0046	14.6	C11-25	664.1	671.0	664.2	0.1		C11-23	662.5	675.0	662.6	0.1	
364	0.013	8	ABS	0.0040	9.0	C11-27	665.6	675.0	665.7	0.1		C11-25	664.1	671.0	664.2	0.1	
230	0.013	8	ABS	0.0041	3.5	C11-29	666.5	676.0	666.6	0.0		C11-27	665.6	675.0	665.7	0.1	
233	0.013	8	PVC	0.0347	4.2	C11-30	656.3	662.0	656.4	0.0		C11-11	648.2	658.0	648.2	0.0	
198	0.013	8	PVC	0.0060	2.8	C11-31	657.5	667.0	657.5	0.0		C11-30	656.3	662.0	656.4	0.0	
146	0.013	6	VCP	0.0103	37.5	D6-15	679.5	685.0	679.6	0.1		C6-34	678.0	686.0	678.1	0.1	
163	0.013	8	SDR	0.0092	42.4	D6-15	679.5	685.0	679.6	0.1		C6-34	678.0	686.0	678.1	0.1	
176	0.013	6	VCP	0.1431	77.8	D6-16	704.7	715.0	704.8	0.1		D6-15	679.5	685.0	679.6	0.1	
229	0.013	6	VCP	0.0093	76.4	D6-17	706.8	717.0	707.0	0.2		D6-16	704.7	715.0	704.8	0.1	
115	0.013	6	VCP	0.0819	75.0	D6-18	716.3	721.0	716.4	0.1		D6-17	706.8	717.0	707.0	0.2	
286	0.013	8	VCP	0.0032	73.6	D6-19	717.2	722.0	717.4	0.2		D6-18	716.3	721.0	716.4	0.1	
261	0.013	6	VCP	0.0051	9.7	D6-20	722.7	729.0	722.8	0.1		D6-54	721.3	727.0	721.4	0.0	
303	0.013	6	VCP	0.0070	4.9	D6-22	724.8	731.0	724.9	0.1		D6-20	722.7	729.0	722.8	0.1	
469	0.013	6	VCP	0.0062	1.4	D6-23	727.7	734.0	727.7	0.0		D6-22	724.8	731.0	724.9	0.1	
317	0.013	6	VCP	0.0059	13.2	D6-24	719.1	724.0	719.1	0.1		D6-19	717.2	722.0	717.4	0.2	
395	0.013	6	VCP	0.0055	8.3	D6-25	721.2	726.0	721.3	0.1		D6-24	719.1	724.0	719.1	0.1	
175	0.013	6	VCP	0.0057	2.1	D6-26	722.2	727.0	722.3	0.0		D6-25	721.2	726.0	721.3	0.1	
358	0.013	8	VCP	0.0021	45.8	D6-28	717.9	723.0	718.1	0.2		D6-19	717.2	722.0	717.4	0.2	
284	0.013	8	VCP	0.0020	41.7	D6-29	718.5	724.0	718.7	0.2		D6-28	717.9	723.0	718.1	0.2	
299	0.013	10	VCP	0.0102	722.9	D6-32	645.8	656.0	646.3	0.5		D7-22	642.7	654.0	643.5	0.8	
359	0.013	6	VCP	0.0164	43.1	D6-33	651.7	662.0	651.8	0.1		D6-32	645.8	656.0	646.3	0.5	SUR
236	0.013	6	VCP	0.0183	38.2	D6-34	656.0	666.0	656.1	0.1		D6-33	651.7	662.0	651.8	0.1	
225	0.013	6	VCP	0.0248	31.9	D6-35	661.6	672.0	661.6	0.1		D6-34	656.0	666.0	656.1	0.1	
86	0.013	6	VCP	0.2723	24.3	D6-36	685.0	695.0	685.0	0.0		D6-35	661.6	672.0	661.6	0.1	
81	0.013	8	VCP	0.0032	23.6	D6-37	685.2	701.0	685.3	0.1		D6-36	685.0	695.0	685.0	0.0	
187	0.013	6	VCP	0.1192	22.2	D6-38	707.5	717.0	707.5	0.1		D6-37	685.2	701.0	685.3	0.1	
112	0.013	8	VCP	0.0054	20.8	D6-39	708.1	718.0	708.2	0.1		D6-38	707.5	717.0	707.5	0.1	
365	0.013	8	VCP	0.0058	18.1	D6-40	710.2	720.0	710.3	0.1		D6-39	708.1	718.0	708.2	0.1	
340	0.013	8	VCP	0.0022	12.5	D6-41	710.9	721.0	711.0	0.1		D6-40	710.2	720.0	710.3	0.1	
86	0.013	8	VCP	0.0028	11.1	D6-43	711.2	726.0	711.2	0.1		D6-41	710.9	721.0	711.0	0.1	
147	0.013	8	VCP	0.0100	9.0	D6-45	712.6	721.0	712.7	0.1		D6-43	711.2	726.0	711.2	0.1	
61	0.013	8	VCP	0.0013	8.3	D6-46	712.7	723.0	712.8	0.1		D6-45	712.6	721.0	712.7	0.1	

2010 Master Plan Stillwater Collection System Pipe Analysis Results

LENGTH (ft)	Manning's N (Double)	Diameter (in)	Material	Slope	Maximum Flow, gpm	Upstream MH Name	Upstream Invert (ft)	Upstream MH Rim	Maximum Upstream HGL	Flow Depth, ft	Class	Downstream MH Name	Downstream Invert (ft)	Downstream MH Rim	Maximum Downstream HGL	Flow Depth, ft	Class
457	0.013	8	VCP	0.0011	6.3	D6-47	713.2	723.0	713.3	0.1		D6-46	712.7	723.0	712.8	0.1	
343	0.013	8	ABS	0.0420	2.1	D6-50	719.2	729.0	719.2	0.0		C6-38	704.8	715.0	704.8	0.0	
59	0.013	6	VCP	0.0705	11.1	D6-54	721.3	727.0	721.4	0.0		D6-19	717.2	722.0	717.4	0.2	
383	0.013	8	VCP	0.0020	36.1	D6-58	719.3	726.0	719.4	0.2		D6-29	718.5	724.0	718.7	0.2	
45	0.013	12	VCP	0.0085	835.4	D7-1	625.4	635.0	626.0	0.5		D7-3	625.1	633.0	625.6	0.6	
282	0.012	15	AC	0.0057	916.7	D7-2	621.7	631.0	622.2	0.5		D7-29	620.0	627.0	620.6	0.6	
428	0.013	12	VCP	0.0079	838.2	D7-3	625.1	633.0	625.6	0.6		D7-2	621.7	631.0	622.2	0.5	
868	0.013	12		0.0082	827.1	D7-4	632.5	643.0	633.1	0.5		D7-1	625.4	635.0	626.0	0.5	
626	0.013	12	VCP	0.0082	808.3	D7-5	637.7	646.0	638.2	0.5		D7-4	632.5	643.0	633.1	0.5	
133	0.013	10	VCP	0.0070	797.2	D7-6	638.6	644.0	639.3	0.7		D7-5	637.7	646.0	638.2	0.5	
527	0.013	10	VCP	0.0067	794.4	D7-7	642.1	649.0	642.8	0.7		D7-6	638.6	644.0	639.3	0.7	
92	0.013	6	VCP	0.0382	45.1	D7-8	645.7	654.0	645.8	0.1		D7-7	642.1	649.0	642.8	0.7	SUR
296	0.013	6	VCP	0.0249	41.7	D7-9	653.0	660.0	653.2	0.1		D7-8	645.7	654.0	645.8	0.1	
348	0.013	6	VCP	0.0924	36.1	D7-10	685.2	693.0	685.3	0.1		D7-9	653.0	660.0	653.2	0.1	
553	0.013	8	VCP	0.0016	24.3	D7-11	686.1	696.0	686.3	0.2		D7-10	685.2	693.0	685.3	0.1	
227	0.013	6	VCP	0.0426	14.6	D7-12	695.8	705.0	695.9	0.1		D7-11	686.1	696.0	686.3	0.2	
376	0.013	8	VCP	0.0079	73.6	D7-13	624.6	635.0	624.8	0.2		D7-2	621.7	631.0	622.2	0.5	
96	0.013	6	VCP	0.0538	65.3	D7-14	629.8	640.0	629.9	0.1		D7-13	624.6	635.0	624.8	0.2	
283	0.013	8	VCP	0.0042	62.5	D7-15	631.0	641.0	631.2	0.2		D7-14	629.8	640.0	629.9	0.1	
200	0.013	8	SDR-35	0.0937	21.5	D7-16	641.0	651.0	641.1	0.1		D8-7	622.2	632.0	622.8	0.6	
294	0.013	8	VCP	0.0754	18.8	D7-17	663.3	673.0	663.4	0.1		D7-16	641.0	651.0	641.1	0.1	
337	0.013	8	VCP	0.0505	14.6	D7-18	680.3	690.0	680.4	0.1		D7-17	663.3	673.0	663.4	0.1	
96	0.013	8	VCP	0.0073	11.1	D7-20	681.0	691.0	681.1	0.1		D7-18	680.3	690.0	680.4	0.1	
192	0.013	8	VCP	0.0418	9.0	D7-21	689.0	699.0	689.1	0.0		D7-20	681.0	691.0	681.1	0.1	
133	0.013	10	VCP	0.0043	746.5	D7-22	642.7	654.0	643.5	0.8		D7-7	642.1	649.0	642.8	0.7	
163	0.013	8	ABS	0.0913	22.2	D7-23	657.6	663.0	657.7	0.1		D7-22	642.7	654.0	643.5	0.8	SUR
266	0.012	15	AC	0.0126	1713.2	D7-29	620.0	627.0	620.7	0.6		D8-5	616.7	626.0	617.3	0.6	
144	0.013	10	VCP	0.0023	813.2	D8-1	622.6	633.0	625.3	2.7	SUR	D8-7	622.2	632.0	622.8	0.6	
204	0.012	15	AC	0.0032	1736.8	D8-2	611.8	626.0	612.8	1.0		E8-34	611.1	625.0	612.0	0.9	
548	0.012	15	AC	0.0034	1731.3	D8-3	613.6	625.0	614.6	1.0		D8-2	611.8	626.0	612.6	0.9	
224	0.012	15	AC	0.0034	1719.4	D8-4	614.4	628.0	615.4	1.0		D8-3	613.6	625.0	614.5	0.8	
235	0.012	15	AC	0.0098	1713.9	D8-5	616.7	626.0	617.4	0.7		D8-4	614.4	628.0	615.2	0.8	
508	0.013	10	VCP	0.0043	836.8	D8-7	622.2	632.0	624.3	2.0	SUR	D7-29	620.0	627.0	620.6	0.6	
48	0.013	10	VCP	0.0073	812.5	D8-8	622.9	633.0	625.6	2.7	SUR	D8-1	622.6	633.0	623.2	0.7	
246	0.013	10	VCP	0.0047	810.4	D8-9	623.7	632.0	627.3	3.5	SUR	D8-8	622.9	633.0	623.4	0.5	
60	0.013	6	VCP	0.0108	18.1	D8-10	624.4	629.0	627.3	2.9	SUR	D8-9	623.7	632.0	624.6	0.9	SUR
202	0.013	10	VCP	0.0033	808.3	D8-11	624.4	632.0	628.6	4.2	SUR	D8-9	623.7	632.0	624.6	0.9	SUR
134	0.013	6	VCP	0.0079	36.1	D8-20	624.0	631.0	625.6	1.6	SUR	D8-8	622.9	633.0	623.4	0.5	
197	0.013	6	VCP	0.0240	53.5	D8-21	617.7	638.0	617.8	0.1		E8-25	613.0	623.0	613.1	0.1	
49	0.013	6	VCP	0.0247	26.4	D8-22	618.9	629.0	619.0	0.1		D8-21	617.7	638.0	617.8	0.1	
243	0.013	6	VCP	0.0178	23.6	D8-23	623.2	633.0	623.3	0.1		D8-22	618.9	629.0	619.0	0.1	
300	0.013	6	VCP	0.0128	20.8	D8-25	627.1	637.0	627.2	0.1		D8-23	623.2	633.0	623.3	0.1	
192	0.013	8	SDR-35	0.0516	18.1	D8-26	637.0	647.0	637.0	0.1		D8-25	627.1	637.0	627.2	0.1	
75	0.013	8		0.2268	9.0	D8-27	675.1	685.0	675.1	0.0		D8-27B	658.1	668.0	658.1	0.0	
152	0.013	8	VCP	0.1387	11.1	D8-27B	658.1	668.0	658.1	0.0		D8-26	637.0	647.0	637.0	0.1	
186	0.013	6	VCP	0.0465	8.3	D8-28	683.7	694.0	683.8	0.0		D8-27	675.1	685.0	675.1	0.0	
359	0.013	6	VCP	0.0221	4.9	D8-29	691.7	702.0	691.7	0.0		D8-28	683.7	694.0	683.8	0.0	
409	0.013	8	ABS	0.0956	22.9	D8-35	670.1	680.0	670.1	0.1		D8-43	631.0	636.0	631.1	0.1	
433	0.013	8	ABS	0.0039	17.4	D8-36	671.8	680.0	671.9	0.1		D8-35	670.1	680.0	670.1	0.1	
315	0.013	8	ABS	0.0046	11.8	D8-37	673.2	678.0	673.3	0.1		D8-36	671.8	680.0	671.9	0.1	
207	0.013	8	ABS	0.0371	9.0	D8-38	680.9	698.0	680.9	0.0		D8-37	673.2	678.0	673.3	0.1	
331	0.013	8	ABS	0.0043	5.6	D8-39	682.3	692.0	682.3	0.1		D8-38	680.9	698.0	680.9	0.0	

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LENGTH (ft)	Manning's N (Double)	Diameter (in)	Material	Slope	Maximum Flow, gpm	Upstream MH Name	Upstream Invert (ft)	Upstream MH Rim	Maximum Upstream HGL	Flow Depth, ft	Class	Downstream MH Name	Downstream Invert (ft)	Downstream MH Rim	Maximum Downstream HGL	Flow Depth, ft	Class
180	0.013	8	ABS	0.0046	3.5	D8-40	683.1	693.0	683.1	0.0		D8-39	682.3	692.0	682.3	0.1	
172	0.013	8	ABS	0.0775	23.6	D8-43	631.0	636.0	631.1	0.1		D8-21	617.7	638.0	617.8	0.1	
277	0.013	6	VCP	0.0498	11.8	D8-50	688.7	699.0	688.8	0.0		C8-24	674.9	684.0	675.0	0.1	
404	0.013	6	VCP	0.0119	4.9	D8-50A	693.6	702.0	693.6	0.0		D8-50	688.7	699.0	688.8	0.0	
43	0.013	6		0.0142	2.1	D8-51	694.2	702.0	694.2	0.0		D8-50A	693.6	702.0	693.6	0.0	
257	0.013	6	VCP	0.0153	0.7	D8-52	698.1	708.0	698.1	0.0		D8-51	694.2	702.0	694.2	0.0	
275	0.013	10	VCP	0.0035	173.6	D9-1	613.8	626.0	614.1	0.3		E9-9	612.9	623.0	613.3	0.4	
411	0.013	8	VCP	0.0162	23.6	D9-3	620.5	626.0	620.6	0.1		D9-1	613.8	626.0	614.1	0.3	
401	0.013	8	VCP	0.0192	9.0	D9-4	628.2	634.0	628.2	0.1		D9-3	620.5	626.0	620.6	0.1	
180	0.013	8	VCP	0.1218	5.6	D9-5	650.0	654.0	650.1	0.0		D9-4	628.2	634.0	628.2	0.1	
279	0.013	8	VCP	0.0718	13.2	D9-6	640.5	647.0	640.6	0.0		D9-3	620.5	626.0	620.6	0.1	
342	0.013	8	VCP	0.0864	9.7	D9-8	670.1	679.0	670.1	0.0		D9-6	640.5	647.0	640.6	0.0	
216	0.013	8	VCP	0.0164	7.6	D9-9	673.6	684.0	673.7	0.0		D9-8	670.1	679.0	670.1	0.0	
336	0.013	8	VCP	0.0171	4.2	D9-10	679.4	689.0	679.4	0.0		D9-9	673.6	684.0	673.7	0.0	
228	0.013	6	VCP	0.0071	0.7	D9-11	681.0	691.0	681.0	0.0		D9-10	679.4	689.0	679.4	0.0	
191	0.013	6	VCP	0.0007	147.9	D9-12	613.9	622.0	614.8	0.9	SUR	D9-1	613.8	626.0	614.1	0.3	
135	0.013	6	VCP	0.0005	147.2	D9-13	614.0	620.0	615.3	1.3	SUR	D9-12	613.9	622.0	614.8	0.9	SUR
164	0.013	8	VCP	0.0356	59.0	D9-14	619.9	625.0	620.0	0.1		D9-13	614.0	620.0	615.3	1.3	SUR
224	0.013	6	VCP	0.0202	57.6	D9-15	624.4	630.0	624.5	0.1		D9-14	619.9	625.0	620.0	0.1	
242	0.013	8	VCP	0.0159	9.7	D9-16	628.2	637.0	628.3	0.1		D9-15	624.4	630.0	624.5	0.1	
480	0.013	8	VCP	0.0821	6.9	D9-18	667.6	671.0	667.6	0.0		D9-16	628.2	637.0	628.3	0.1	
240	0.013	6	VCP	0.0193	45.8	D9-19	629.0	636.0	629.1	0.1		D9-15	624.4	630.0	624.5	0.1	
148	0.013	6	VCP	0.0206	43.8	D9-21	632.1	638.0	632.2	0.1		D9-19	629.0	636.0	629.1	0.1	
228	0.013	6	VCP	0.0437	41.7	D9-22	642.0	648.0	642.1	0.1		D9-21	632.1	638.0	632.2	0.1	
219	0.013	8	VCP	0.0168	39.6	D9-23	645.7	657.0	645.8	0.1		D9-22	642.0	648.0	642.1	0.1	
71	0.013	8	VCP	0.1012	34.7	D9-24	652.9	669.0	653.0	0.1		D9-23	645.7	657.0	645.8	0.1	
92	0.013	8	VCP	0.0749	33.3	D9-25	659.8	671.0	659.9	0.1		D9-24	652.9	669.0	653.0	0.1	
148	0.013	8	VCP	0.0778	32.6	D9-26	671.3	679.0	671.4	0.1		D9-25	659.8	671.0	659.9	0.1	
34	0.013	8	VCP	0.0021	31.3	D9-30	671.4	691.0	671.5	0.1		D9-26	671.3	679.0	671.4	0.1	
149	0.013	8	VCP	0.0019	29.2	D9-32	671.6	690.0	671.8	0.2		D9-30	671.4	691.0	671.5	0.1	
385	0.013	8	VCP	0.0023	26.4	D9-33	672.5	691.0	672.6	0.1		D9-32	671.6	690.0	671.8	0.2	
150	0.013	8	VCP	0.0019	22.9	D9-34	672.8	691.0	672.9	0.1		D9-33	672.5	691.0	672.6	0.1	
145	0.013	8	VCP	0.0000	16.0	D9-35	673.2	691.0	673.3	0.1		D9-34	672.8	691.0	672.9	0.1	
441	0.013	8	VCP	0.0353	14.6	D9-36	688.3	692.0	688.4	0.1		D9-35	673.2	691.0	673.2	0.0	
396	0.013	8	ABS	0.0978	2.8	D9-37	684.4	690.0	684.4	0.0		D9-23	645.7	657.0	645.8	0.1	
154	0.013	6	ABS	0.0062	1.4	D9-38	685.4	691.0	685.4	0.0		D9-37	684.4	690.0	684.4	0.0	
336	0.013	6	VCP	0.0281	86.8	D9-39	623.5	630.0	623.6	0.2		D9-13	614.0	620.0	615.3	1.3	SUR
63	0.013	6	VCP	0.0157	85.4	D9-41	624.5	630.0	624.7	0.2		D9-39	623.5	630.0	623.6	0.2	
117	0.013	6	VCP	0.0087	84.0	D9-42	625.5	632.0	625.7	0.2		D9-41	624.5	630.0	624.7	0.2	
419	0.013	8	VCP	0.1000	5.6	D9-44	667.4	671.0	667.4	0.0		D9-42	625.5	632.0	625.7	0.2	
394	0.013	8	VCP	0.0442	2.1	D9-45	684.8	695.0	684.8	0.0		D9-44	667.4	671.0	667.4	0.0	
99	0.013	6	VCP	0.0081	75.7	D9-46	626.3	631.0	626.5	0.2		D9-42	625.5	632.0	625.7	0.2	
152	0.013	6	VCP	0.0083	72.9	D9-47	627.6	638.0	627.8	0.2		D9-46	626.3	631.0	626.5	0.2	
328	0.013	6	VCP	0.0114	70.1	D9-48	631.3	637.0	631.5	0.2		D9-47	627.6	638.0	627.8	0.2	
103	0.013	6	VCP	0.0112	68.8	D9-50	632.5	637.0	632.6	0.2		D9-48	631.3	637.0	631.5	0.2	
184	0.013	6	VCP	0.0278	68.1	D9-51	637.6	646.0	637.7	0.1		D9-50	632.5	637.0	632.6	0.2	
201	0.013	8	VCP	0.0040	67.4	D9-52	638.4	655.0	638.6	0.2		D9-51	637.6	646.0	637.7	0.1	
168	0.013	6	VCP	0.0748	66.0	D9-54	650.9	661.0	651.0	0.1		D9-52	638.4	655.0	638.6	0.2	
94	0.013	6	VCP	0.0062	66.0	D9-55	651.5	662.0	651.7	0.2		D9-54	650.9	661.0	651.0	0.1	
91	0.013	8	VCP	0.0686	64.6	D9-57	657.8	662.0	657.9	0.1		D9-55	651.5	662.0	651.7	0.2	
87	0.013	6	VCP	0.1148	63.9	D9-58	667.8	673.0	667.9	0.1		D9-57	657.8	662.0	657.9	0.1	
197	0.013	8	VCP	0.0018	63.9	D9-59	668.1	679.0	668.4	0.3		D9-58	667.8	673.0	667.9	0.1	

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LENGTH (ft)	Manning's N (Double)	Diameter (in)	Material	Slope	Maximum Flow, gpm	Upstream MH Name	Upstream Invert (ft)	Upstream MH Rim	Maximum Upstream HGL	Flow Depth, ft	Class	Downstream MH Name	Downstream Invert (ft)	Downstream MH Rim	Maximum Downstream HGL	Flow Depth, ft	Class
158	0.013	6	VCP	0.0425	5.6	D9-60	674.8	688.0	674.9	0.0		D9-59	668.1	679.0	668.4	0.3	
362	0.013	6	VCP	0.0195	3.5	D9-61	681.9	691.0	682.0	0.0		D9-60	674.8	688.0	674.9	0.0	
477	0.013	6	VCP	0.0148	1.4	D9-62	689.0	693.0	689.0	0.0		D9-61	681.9	691.0	682.0	0.0	
329	0.013	8	ABS	0.0435	1.4	D9-63	664.4	670.0	664.4	0.0		D9-5	650.0	654.0	650.1	0.0	
734	0.012	27	VCP	0.0016	1661.1	D10-1	580.1	587.0	580.9	0.8		E10-5	578.9	584.0	579.7	0.8	
587	0.012	27	VCP	0.0017	1659.7	D10-2	581.0	590.0	581.8	0.8		D10-1	580.1	587.0	580.9	0.8	
756	0.012	27	VCP	0.0012	1474.3	D10-3	581.9	594.0	582.8	0.8		D10-2	581.0	590.0	581.8	0.8	
340	0.013	8	ABS	0.0400	37.5	D10-4	595.5	606.0	595.6	0.1		D10-3	581.9	594.0	582.8	0.8	SUR
100	0.013	8	ABS	0.0088	27.8	D10-5	599.0	609.0	599.1	0.1		D10-19	598.1	608.0	598.2	0.1	
402	0.013	10	ABS	0.0235	180.6	D10-6	590.5	600.0	590.7	0.2		D10-2	581.0	590.0	581.8	0.8	
210	0.013	10	ABS	0.0049	159.0	D10-7	592.4	600.0	592.7	0.3		D10-21	591.4	596.0	591.7	0.3	
401	0.013	10	ABS	0.0050	154.2	D10-8	594.4	605.0	594.7	0.3		D10-7	592.4	600.0	592.7	0.3	
121	0.013	10	ABS	0.0091	144.4	D10-9	596.3	603.0	596.5	0.2		D10-12	595.2	602.0	595.4	0.2	
106	0.013	10	ABS	0.0073	153.5	D10-12	595.2	602.0	595.4	0.2		D10-8	594.4	605.0	594.7	0.3	
238	0.013	8	ABS	0.1083	9.0	D10-13	621.0	628.0	621.0	0.0		D10-12	595.2	602.0	595.4	0.2	
306	0.013	8	ABS	0.1014	7.6	D10-14	652.1	658.0	652.1	0.0		D10-13	621.0	628.0	621.0	0.0	
309	0.013	8	ABS	0.0201	4.9	D10-16	658.3	670.0	658.3	0.0		D10-14	652.1	658.0	652.1	0.0	
436	0.013	8	ABS	0.0042	3.5	D10-17	660.1	675.0	660.1	0.0		D10-16	658.3	670.0	658.3	0.0	
223	0.013	8	ABS	0.0118	36.1	D10-19	598.1	608.0	598.2	0.1		D10-4	595.5	606.0	595.6	0.1	
155	0.013	10	ABS	0.0057	179.2	D10-21	591.4	596.0	591.7	0.3		D10-6	590.5	600.0	590.7	0.2	
375	0.013	8	ABS	0.0045	15.3	D10-22	593.1	598.0	593.2	0.1		D10-21	591.4	596.0	591.7	0.3	
302	0.013	8	ABS	0.0042	11.8	D10-23	594.3	599.0	594.4	0.1		D10-22	593.1	598.0	593.2	0.1	
367	0.013	8	ABS	0.0040	4.9	D10-24	595.8	600.0	595.8	0.1		D10-23	594.3	599.0	594.4	0.1	
253	0.013	10	ABS	0.0028	143.1	D11-1	597.0	604.0	597.3	0.3		D10-9	596.3	603.0	596.5	0.2	
500	0.013	10	ABS	0.0133	138.9	D11-2	603.6	611.0	603.8	0.2		D11-1	597.0	604.0	597.3	0.3	
356	0.013	8	ABS	0.0376	41.0	D11-3	617.0	624.0	617.1	0.1		D11-2	603.6	611.0	603.8	0.2	
258	0.013	8	ABS	0.0387	37.5	D11-4	627.0	634.0	627.1	0.1		D11-3	617.0	624.0	617.1	0.1	
80	0.013	8	WABS	0.0056	18.1	D11-5	658.5	669.0	658.6	0.1		D11-28	658.1	674.0	658.1	0.1	
401	0.013	8	ABS	0.0045	15.3	D11-6	660.3	673.0	660.4	0.1		D11-5	658.5	669.0	658.6	0.1	
384	0.013	8	ABS	0.0045	11.1	D11-7	662.0	673.0	662.1	0.1		D11-6	660.3	673.0	660.4	0.1	
354	0.013	10	ABS	0.0135	94.4	D11-9	608.4	617.0	608.6	0.2		D11-2	603.6	611.0	603.8	0.2	
412	0.013	10	ABS	0.0132	91.7	D11-10	613.9	621.0	614.0	0.2		D11-9	608.4	617.0	608.6	0.2	
399	0.013	8	ABS	0.0040	18.1	D11-12	650.8	665.0	650.9	0.1		E11-14	649.2	659.0	649.4	0.1	
345	0.013	8	ABS	0.0045	20.1	D11-13	653.2	664.0	653.3	0.1		E11-27	651.6	660.0	651.7	0.1	
226	0.013	8	ABS	0.0046	15.3	D11-14	654.2	668.0	654.3	0.1		D11-13	653.2	664.0	653.3	0.1	
369	0.013	8	ABS	0.0041	12.5	D11-16	655.7	666.0	655.8	0.1		D11-14	654.2	668.0	654.3	0.1	
174	0.013	8	ABS	0.0039	4.2	D11-17	656.4	666.0	656.4	0.1		D11-16	655.7	666.0	655.8	0.1	
64	0.013	8	ABS	0.0034	13.2	D11-19	651.1	665.0	651.2	0.1		D11-12	650.8	665.0	650.9	0.1	
163	0.013	8	ABS	0.0010	9.7	D11-21	662.2	669.0	662.3	0.1		D11-7	662.0	673.0	662.1	0.1	
234	0.013	8	ABS	0.0046	8.3	D11-22	663.2	667.0	663.3	0.1		D11-21	662.2	669.0	662.3	0.1	
428	0.013	8	ABS	0.0044	6.9	D11-25	665.1	669.0	665.2	0.1		D11-22	663.2	667.0	663.3	0.1	
289	0.013	8	ABS	0.0181	4.9	D11-26	670.4	677.0	670.4	0.0		D11-25	665.1	669.0	665.2	0.1	
395	0.013	8	ABS	0.0045	2.1	D11-27	672.1	675.0	672.2	0.0		D11-26	670.4	677.0	670.4	0.0	
143	0.013	8	WABS	0.0253	23.6	D11-28	658.1	674.0	658.1	0.1		D11-29	654.4	662.0	654.5	0.1	
236	0.013	8	SDR-35	0.1163	28.5	D11-29	654.4	662.0	654.5	0.1		D11-4	627.0	634.0	627.1	0.1	
154	0.013	8	WABS	0.1689	7.6	D11-32	653.1	661.0	653.1	0.0		D11-4	627.0	634.0	627.1	0.1	
385	0.013	8	SDR-35	0.0200	6.9	D11-33	660.8	665.0	660.8	0.0		D11-32	653.1	661.0	653.1	0.0	
251	0.013	8	SDR-35	0.0223	5.6	D11-34	666.4	671.0	666.4	0.0		D11-33	660.8	665.0	660.8	0.0	
239	0.013	8	SDR-35	0.0085	3.5	D11-35	668.4	674.0	668.5	0.0		D11-34	666.4	671.0	666.4	0.0	
60	0.013	8	SDR-35	0.0093	2.1	D11-36	669.0	679.0	669.0	0.0		D11-35	668.4	674.0	668.5	0.0	
124	0.013	8	ABS	0.0685	12.5	E7-15	704.0	712.0	704.0	0.0		E7-22	695.5	703.0	695.5	0.0	
265	0.013	8	ABS	0.0362	22.9	E7-18	668.0	678.0	668.0	0.1		E7-32	658.4	668.0	658.5	0.1	

2010 Master Plan Stillwater Collection System Pipe Analysis Results

LENGTH (ft)	Manning's N (Double)	Diameter (in)	Material	Slope	Maximum Flow, gpm	Upstream MH Name	Upstream Invert (ft)	Upstream MH Rim	Maximum Upstream HGL	Flow Depth, ft	Class	Downstream MH Name	Downstream Invert (ft)	Downstream MH Rim	Maximum Downstream HGL	Flow Depth, ft	Class
346	0.013	8	ABS	0.0942	16.7	E7-19	700.5	711.0	700.6	0.0		E7-18	668.0	678.0	668.0	0.1	
422	0.013	8	ABS	0.0205	11.8	E7-20	709.2	719.0	709.2	0.1		E7-19	700.5	711.0	700.6	0.0	
409	0.013	8	ABS	0.0040	8.3	E7-21	710.8	721.0	710.9	0.1		E7-20	709.2	719.0	709.2	0.1	
95	0.013	8	ABS	0.0861	15.3	E7-22	695.5	703.0	695.5	0.0		E7-43	687.3	697.0	687.4	0.1	
156	0.013	8	ABS	0.1566	22.9	E7-23	664.0	674.0	664.1	0.0		E7-29	639.6	650.0	639.7	0.1	
165	0.013	6	VCP	0.0203	58.3	E7-27	634.3	644.0	634.5	0.1		D7-15	631.0	641.0	631.2	0.2	
164	0.013	6	VCP	0.0191	56.3	E7-28	637.5	647.0	637.6	0.1		E7-27	634.3	644.0	634.5	0.1	
108	0.013	6	VCP	0.0198	55.6	E7-29	639.6	650.0	639.7	0.1		E7-28	637.5	647.0	637.6	0.1	
373	0.013	6	VCP	0.0241	30.6	E7-30	648.6	659.0	648.7	0.1		E7-29	639.6	650.0	639.7	0.1	
199	0.013	6	VCP	0.0270	27.1	E7-31	654.0	664.0	654.0	0.1		E7-30	648.6	659.0	648.7	0.1	
166	0.013	6	VCP	0.0267	25.0	E7-32	658.4	668.0	658.5	0.1		E7-31	654.0	664.0	654.0	0.1	
315	0.013	6	VCP	0.0130	9.7	E7-35	699.9	714.0	700.0	0.1		D7-12	695.8	705.0	695.9	0.1	
190	0.013	6	VCP	0.0051	4.2	E7-36	700.9	711.0	700.9	0.1		E7-35	699.9	714.0	700.0	0.1	
321	0.013	8	ABS	0.0727	19.4	E7-43	687.3	697.0	687.4	0.1		E7-23	664.0	674.0	664.1	0.0	
62	0.013	8	ABS	0.0676	10.4	E7-46	708.2	712.0	708.2	0.0		E7-15	704.0	712.0	704.0	0.0	
316	0.013	6	VCP	0.0412	18.1	E8-1	615.0	625.0	615.1	0.1		E9-14	602.0	612.0	602.9	0.9	SUR
399	0.013	6	VCP	0.0152	15.3	E8-2	621.1	631.0	621.2	0.1		E8-1	615.0	625.0	615.1	0.1	
467	0.013	6	VCP	0.0439	11.1	E8-3	641.6	652.0	641.6	0.1		E8-2	621.1	631.0	621.2	0.1	
676	0.012	18	AC	0.0020	1882.6	E8-5	603.3	609.0	604.3	1.0		E9-14	602.0	612.0	602.9	0.9	
102	0.012	18	AC	0.0021	1880.6	E8-6	603.5	611.0	604.5	1.0		E8-5	603.3	609.0	604.2	0.9	
304	0.013	6	VCP	0.0487	35.4	E8-7	618.3	628.0	618.4	0.1		E8-6	603.5	611.0	604.4	0.9	SUR
303	0.013	6	VCP	0.0081	31.9	E8-8	620.8	631.0	620.9	0.1		E8-7	618.3	628.0	618.4	0.1	
90	0.013	6	VCP	0.0098	29.9	E8-11	621.7	632.0	621.8	0.1		E8-8	620.8	631.0	620.9	0.1	
270	0.013	8	VCP	0.0032	28.5	E8-12	622.5	633.0	622.7	0.1		E8-11	621.7	632.0	621.8	0.1	
84	0.013	6	VCP	0.0295	25.7	E8-15	625.0	635.0	625.1	0.1		E8-12	622.5	633.0	622.7	0.1	
571	0.013	6	VCP	0.0192	22.9	E8-16	636.0	646.0	636.1	0.1		E8-15	625.0	635.0	625.1	0.1	
269	0.013	6	VCP	0.0877	19.4	E8-17	659.6	670.0	659.6	0.1		E8-16	636.0	646.0	636.1	0.1	
229	0.013	6	VCP	0.0146	16.7	E8-18	662.9	673.0	663.0	0.1		E8-17	659.6	670.0	659.6	0.1	
174	0.013	8	VCP	0.0346	14.6	E8-19	669.0	679.0	669.0	0.1		E8-18	662.9	673.0	663.0	0.1	
254	0.013	6	VCP	0.0946	12.5	E8-20	693.0	702.0	693.0	0.0		E8-19	669.0	679.0	669.0	0.1	
287	0.012	18	AC	0.0023	1845.1	E8-21	604.2	614.0	605.1	1.0		E8-6	603.5	611.0	604.4	0.9	
232	0.012	18	AC	0.0021	1844.4	E8-22	604.6	609.0	605.6	1.0		E8-21	604.2	614.0	605.0	0.9	
211	0.013	8	AC	0.0007	69.4	E8-23	604.8	615.0	605.7	0.9	SUR	E8-22	604.6	609.0	605.5	0.9	SUR
254	0.013	8	VCP	0.0092	59.0	E8-24	607.1	617.0	607.3	0.2		E8-23	604.8	615.0	605.6	0.8	SUR
226	0.013	6	VCP	0.0258	56.3	E8-25	613.0	623.0	613.1	0.1		E8-24	607.1	617.0	607.3	0.2	
281	0.013	8	VCP	0.0061	7.6	E8-27	606.5	617.0	606.6	0.1		E8-23	604.8	615.0	605.6	0.8	SUR
294	0.013	8	VCP	0.0038	4.9	E8-28	607.6	618.0	607.7	0.1		E8-27	606.5	617.0	606.6	0.1	
129	0.013	8	VCP	0.0183	3.5	E8-29	610.0	620.0	610.0	0.0		E8-28	607.6	618.0	607.7	0.1	
230	0.012	15	AC	0.0050	1765.3	E8-31	607.8	621.0	608.7	0.8		E8-37	606.7	615.0	607.6	0.9	
221	0.012	15	AC	0.0035	1761.8	E8-32	608.6	618.0	609.6	1.0		E8-31	607.8	621.0	608.6	0.7	
98	0.012	15	AC	0.0043	1750.0	E8-33	609.0	619.0	609.9	0.9		E8-32	608.6	618.0	609.5	0.8	
597	0.012	15	AC	0.0035	1741.0	E8-34	611.1	625.0	612.1	1.0		E8-33	609.0	619.0	609.8	0.8	
650	0.012	15	AC	0.0032	1771.5	E8-37	606.7	615.0	607.7	1.0		E8-22	604.6	609.0	605.5	0.9	
189	0.013	10	ABS	0.0202	218.1	E9-1	598.2	607.0	598.4	0.2		E9-19	594.4	601.0	594.7	0.3	
130	0.013	10	VCP	0.0022	202.1	E9-4	609.6	613.0	610.0	0.4		E9-20	609.4	614.0	609.5	0.2	
339	0.013	10	VCP	0.0020	198.6	E9-5	610.3	615.0	610.7	0.4		E9-4	609.6	613.0	610.0	0.4	
460	0.013	10	VCP	0.0021	183.3	E9-6	611.3	621.0	611.7	0.4		E9-5	610.3	615.0	610.7	0.4	
283	0.013	10	VCP	0.0025	183.3	E9-7	612.0	622.0	612.3	0.4		E9-6	611.3	621.0	611.7	0.4	
137	0.013	10	VCP	0.0020	183.3	E9-8	612.3	622.0	612.6	0.4		E9-7	612.0	622.0	612.3	0.4	
311	0.013	10	VCP	0.0019	183.3	E9-9	612.9	623.0	613.3	0.4		E9-8	612.3	622.0	612.6	0.4	
208	0.012	15	ABS	0.0130	2005.6	E9-12	600.0	606.0	600.7	0.7		F9-19	597.3	604.0	597.8	0.5	
492	0.012	18	AC	0.0021	2004.9	E9-13	601.0	615.0	602.1	1.1		E9-12	600.0	606.0	600.6	0.6	

2010 Master Plan Stillwater Collection System Pipe Analysis Results

LENGTH (ft)	Manning's N (Double)	Diameter (in)	Material	Slope	Maximum Flow, gpm	Upstream MH Name	Upstream Invert (ft)	Upstream MH Rim	Maximum Upstream HGL	Flow Depth, ft	Class	Downstream MH Name	Downstream Invert (ft)	Downstream MH Rim	Maximum Downstream HGL	Flow Depth, ft	Class
452	0.012	18	AC	0.0021	1902.1	E9-14	602.0	612.0	603.0	1.0		E9-13	601.0	615.0	602.0	1.0	
151	0.013	8	ABS	0.0909	6.3	E9-15	626.6	637.0	626.6	0.0		E9-9	612.9	623.0	613.3	0.4	
197	0.013	8	ABS	0.0357	4.2	E9-16	633.6	644.0	633.7	0.0		E9-15	626.6	637.0	626.6	0.0	
347	0.013	8	ABS	0.0472	2.8	E9-17	650.0	660.0	650.0	0.0		E9-16	633.6	644.0	633.7	0.0	
860	0.013	10	ABS	0.0058	240.3	E9-18	592.6	599.0	593.0	0.3		F9-12	587.6	593.0	587.9	0.3	
316	0.013	10	ABS	0.0056	222.2	E9-19	594.4	601.0	594.7	0.3		E9-18	592.6	599.0	593.0	0.3	
289	0.013	10	ABS	0.0385	211.1	E9-20	609.4	614.0	609.5	0.2		E9-1	598.2	607.0	598.4	0.2	
487	0.012	27	VCP	0.0024	1761.1	E10-2	575.9	593.0	576.6	0.8		F10-61	574.7	589.0	575.5	0.8	
434	0.012	27	VCP	0.0024	1759.0	E10-3	576.9	595.0	577.7	0.7		E10-2	575.9	593.0	576.6	0.8	
107	0.012	27	VCP	0.0021	1663.2	E10-4	577.9	588.0	578.7	0.8		E10-11	577.7	586.0	578.5	0.8	
598	0.012	27	VCP	0.0017	1662.5	E10-5	578.9	584.0	579.7	0.8		E10-4	577.9	588.0	578.7	0.8	
128	0.013	8	ABS	0.0074	105.6	E10-6	582.8	588.0	583.0	0.2		F10-39	581.8	591.0	582.0	0.2	
318	0.013	8	ABS	0.0043	29.9	E10-7	584.2	593.0	584.3	0.1		E10-6	582.8	588.0	583.0	0.2	
323	0.013	8	ABS	0.0040	27.8	E10-8	585.5	593.0	585.6	0.1		E10-7	584.2	593.0	584.3	0.1	
354	0.013	8	ABS	0.0037	25.7	E10-9	586.8	593.0	586.9	0.1		E10-8	585.5	593.0	585.6	0.1	
192	0.013	8	ABS	0.0045	19.4	E10-10	587.6	593.0	587.7	0.1		E10-9	586.8	593.0	586.9	0.1	
397	0.012	27	VCP	0.0019	1756.3	E10-11	577.7	586.0	578.5	0.8		E10-3	576.9	595.0	577.7	0.7	
320	0.013	8	ABS	0.0283	92.4	E10-12	586.7	594.0	586.9	0.1		E10-11	577.7	586.0	578.5	0.8	SUR
468	0.013	8	ABS	0.0041	10.4	E10-13	588.7	595.0	588.7	0.1		E10-12	586.7	594.0	586.9	0.1	
246	0.013	8	ABS	0.0421	5.6	E10-14	599.0	605.0	599.0	0.0		E10-13	588.7	595.0	588.7	0.1	
422	0.013	8	ABS	0.0081	14.6	E10-15	591.1	593.0	591.1	0.1		E10-10	587.6	593.0	587.7	0.1	
160	0.013	8	ABS	0.0041	10.4	E10-16	591.7	595.0	591.8	0.1		E10-15	591.1	593.0	591.1	0.1	
327	0.013	8	ABS	0.0024	75.0	E10-17	583.6	588.0	583.8	0.3		E10-6	582.8	588.0	583.0	0.2	
78	0.013	8	ABS	0.0077	25.0	E10-18	584.2	588.0	584.3	0.1		E10-17	583.6	588.0	583.8	0.3	
274	0.013	8	ABS	0.0034	23.6	E10-21	585.1	589.0	585.3	0.1		E10-18	584.2	588.0	584.3	0.1	
200	0.013	8	ABS	0.0028	22.2	E10-23	585.7	590.0	585.8	0.1		E10-21	585.1	589.0	585.3	0.1	
388	0.013	8	ABS	0.0042	18.8	E10-25	587.3	592.0	587.4	0.1		E10-23	585.7	590.0	585.8	0.1	
107	0.013	8	ABS	0.0037	17.4	E10-26	587.7	593.0	587.8	0.1		E10-25	587.3	592.0	587.4	0.1	
567	0.013	8	ABS	0.0860	75.7	E11-1	635.5	642.0	635.6	0.1		E10-12	586.7	594.0	586.9	0.1	
259	0.013	8	ABS	0.0881	16.7	E11-2	658.4	663.0	658.4	0.0		E11-1	635.5	642.0	635.6	0.1	
393	0.013	8	ABS	0.0039	7.6	E11-3	659.9	668.0	660.0	0.1		E11-2	658.4	663.0	658.4	0.0	
625	0.013	8	ABS	0.0137	56.9	E11-4	644.1	659.0	644.2	0.1		E11-1	635.5	642.0	635.6	0.1	
268	0.013	8	ABS	0.0050	54.2	E11-5	645.4	654.0	645.6	0.2		E11-4	644.1	659.0	644.2	0.1	
303	0.013	8	ABS	0.0013	50.0	E11-9	645.8	652.0	646.0	0.3		E11-5	645.4	654.0	645.6	0.2	
165	0.013	8	ABS	0.0167	63.9	E11-10	634.3	641.0	634.5	0.1		F11-11	631.6	637.0	631.8	0.3	
409	0.013	8	ABS	0.0111	51.4	E11-11	638.9	651.0	639.0	0.1		E11-10	634.3	641.0	634.5	0.1	
380	0.013	8	ABS	0.0099	48.6	E11-12	642.6	656.0	642.8	0.1		E11-11	638.9	651.0	639.0	0.1	
494	0.013	8	ABS	0.0035	26.4	E11-13	647.9	659.0	648.0	0.1		E12-3	646.2	653.0	646.3	0.1	
303	0.013	8	ABS	0.0045	22.9	E11-14	649.2	659.0	649.4	0.1		E11-13	647.9	659.0	648.0	0.1	
345	0.013	8	ABS	0.0045	43.1	E11-16	647.3	662.0	647.5	0.2		E11-9	645.8	652.0	646.0	0.3	
344	0.013	8	ABS	0.0040	37.5	E11-17	648.7	661.0	648.9	0.1		E11-16	647.3	662.0	647.5	0.2	
311	0.013	8	ABS	0.0045	34.7	E11-19	650.1	664.0	650.2	0.1		E11-17	648.7	661.0	648.9	0.1	
386	0.013	8	ABS	0.0158	6.9	E11-20	640.4	647.0	640.5	0.0		E11-10	634.3	641.0	634.5	0.1	
172	0.013	8	ABS	0.0155	1.4	E11-22	643.1	651.0	643.1	0.0		E11-20	640.4	647.0	640.5	0.0	
369	0.013	8	ABS	0.0453	36.1	E11-24	648.3	654.0	648.4	0.1		F11-11	631.6	637.0	631.8	0.3	
413	0.013	8	ABS	0.0067	19.4	E11-25	651.1	661.0	651.2	0.1		E11-24	648.3	654.0	648.4	0.1	
393	0.013	8	ABS	0.0038	31.9	E11-27	651.6	660.0	651.7	0.1		E11-19	650.1	664.0	650.2	0.1	
56	0.013	8	ABS	0.0027	1.4	E11-29	645.6	654.0	645.6	0.0		E11-5	645.4	654.0	645.6	0.2	
254	0.013	8	SDR-35	0.0091	11.1	E11-30	639.6	651.0	639.7	0.1		F11-18	637.3	644.0	637.4	0.1	
315	0.013	8	SDR-35	0.0154	9.0	E11-31	651.4	655.0	651.7	0.3		F11-20	646.8	653.0	646.9	0.1	
197	0.013	8	SDR-35	0.0063	1.4	E11-32	654.7	660.0	654.7	0.0		E11-33	653.4	659.0	653.7	0.3	
291	0.013	8	SDR-35	0.0075	6.3	E11-33	653.4	659.0	653.7	0.3		E11-31	651.4	655.0	651.7	0.3	

2010 Master Plan Stillwater Collection System Pipe Analysis Results

LENGTH (ft)	Manning's N (Double)	Diameter (in)	Material	Slope	Maximum Flow, gpm	Upstream MH Name	Upstream Invert (ft)	Upstream MH Rim	Maximum Upstream HGL	Flow Depth, ft	Class	Downstream MH Name	Downstream Invert (ft)	Downstream MH Rim	Maximum Downstream HGL	Flow Depth, ft	Class
322	0.013	8	SDR-35	0.0144	2.1	E11-34	652.9	659.0	652.9	0.0		E11-35	648.2	655.0	648.5	0.2	
261	0.013	8	SDR-35	0.0108	4.2	E11-35	648.2	655.0	648.5	0.2		E11-36	645.6	652.0	645.9	0.2	
254	0.013	8	SDR-35	0.0246	7.6	E11-36	645.6	652.0	645.9	0.2		E11-30	639.6	651.0	639.7	0.1	
55	0.013	8	SDR-35	0.0093	1.4	E11-37	646.1	652.0	646.2	0.0		E11-36	645.6	652.0	645.9	0.2	
310	0.013	8	ABS	0.0035	43.8	E12-1	643.7	656.0	643.9	0.2		E11-12	642.6	656.0	642.8	0.1	
330	0.013	8	ABS	0.0044	39.6	E12-2	645.2	653.0	645.3	0.2		E12-1	643.7	656.0	643.9	0.2	
206	0.013	8	ABS	0.0049	36.1	E12-3	646.2	653.0	646.3	0.1		E12-2	645.2	653.0	645.3	0.2	
426	0.013	8	ABS	0.0039	9.7	E12-4	652.7	659.0	652.8	0.1		E11-25	651.1	661.0	651.2	0.1	
412	0.013	8	VCP	0.0170	8.3	F7-12	700.0	710.0	700.1	0.1		E8-20	693.0	702.0	693.0	0.0	
395	0.013	8	VCP	0.0041	6.3	F7-13	701.6	712.0	701.7	0.1		F7-12	700.0	710.0	700.1	0.1	
202	0.013	8	VCP	0.0044	2.8	F7-14	702.5	713.0	702.5	0.0		F7-13	701.6	712.0	701.7	0.1	
144	0.013	8	VCP	0.0061	8.3	F8-10	705.0	715.0	705.1	0.1		F8-11	704.1	708.0	704.2	0.1	
392	0.013	8	VCP	0.0147	10.4	F8-11	704.1	708.0	704.2	0.1		F8-12	698.4	703.0	698.5	0.1	
396	0.013	8	VCP	0.0053	14.6	F8-12	698.4	703.0	698.5	0.1		F8-13	696.3	701.0	696.4	0.1	
380	0.013	8	VCP	0.0039	19.4	F8-13	696.3	701.0	696.4	0.1		F8-14	694.8	701.0	694.9	0.1	
397	0.013	8	VCP	0.0040	21.5	F8-14	694.8	701.0	694.9	0.1		F8-15	693.2	699.0	693.3	0.1	
398	0.013	8	VCP	0.0080	27.8	F8-15	693.2	699.0	693.3	0.1		F8-16	690.1	697.0	690.1	0.1	
393	0.013	8	VCP	0.0280	31.3	F8-16	690.1	697.0	690.1	0.1		F8-17	679.1	686.0	679.1	0.1	
413	0.013	8	VCP	0.0399	34.0	F8-17	679.1	686.0	679.1	0.1		F9-4	662.6	673.0	662.7	0.2	
419	0.013	8	VCP	0.0072	59.0	F8-18	665.6	676.0	665.7	0.2		F9-4	662.6	673.0	662.7	0.2	
328	0.013	8	VCP	0.0039	56.3	F8-19	666.9	677.0	667.1	0.2		F8-18	665.6	676.0	665.7	0.2	
241	0.013	8	VCP	0.0039	54.9	F8-20	667.8	678.0	668.0	0.2		F8-19	666.9	677.0	667.1	0.2	
275	0.013	8	VCP	0.0413	52.8	F8-21	679.1	689.0	679.2	0.1		F8-20	667.8	678.0	668.0	0.2	
404	0.013	8	VCP	0.0040	51.4	F8-23	680.8	691.0	680.9	0.2		F8-21	679.1	689.0	679.2	0.1	
384	0.013	8	ABS	0.0278	5.6	F8-24	691.4	701.0	691.5	0.0		F8-23	680.8	691.0	680.9	0.2	
407	0.013	8	ABS	0.0089	2.1	F8-25	695.1	705.0	695.1	0.0		F8-24	691.4	701.0	691.5	0.0	
458	0.013	8	VCP	0.0169	10.4	F8-26	692.5	702.0	692.5	0.1		F8-35	684.7	695.0	684.8	0.1	
419	0.013	8	ABS	0.0045	6.9	F8-27	694.3	704.0	694.4	0.1		F8-26	692.5	702.0	692.5	0.1	
403	0.013	8	ABS	0.0122	4.2	F8-28	699.2	705.0	699.3	0.0		F8-27	694.3	704.0	694.4	0.1	
399	0.013	8	ABS	0.0040	2.1	F8-29	700.8	706.0	700.9	0.0		F8-28	699.2	705.0	699.3	0.0	
227	0.013	6	ABS	0.0048	0.7	F8-30	701.9	712.0	701.9	0.0		F8-29	700.8	706.0	700.9	0.0	
329	0.013	8	ABS	0.0055	23.6	F8-31	683.7	694.0	683.8	0.1		F8-32	681.8	692.0	682.0	0.2	
272	0.013	8	VCP	0.0040	41.0	F8-32	681.8	692.0	682.0	0.2		F8-23	680.8	691.0	680.9	0.2	
403	0.013	8	VCP	0.0042	14.6	F8-33	683.5	694.0	683.6	0.1		F8-32	681.8	692.0	682.0	0.2	
249	0.013	8	VCP	0.0048	12.5	F8-35	684.7	695.0	684.8	0.1		F8-33	683.5	694.0	683.6	0.1	
392	0.013	6	VCP	0.0202	7.6	F8-44	649.5	660.0	649.6	0.0		E8-3	641.6	652.0	641.6	0.1	
270	0.013	8	VCP	0.0982	102.8	F9-1	627.5	638.0	627.6	0.1		E9-13	601.0	615.0	602.0	1.0	SUR
388	0.013	8	VCP	0.0451	101.4	F9-2	645.0	655.0	645.1	0.1		F9-1	627.5	638.0	627.6	0.1	
297	0.013	8	VCP	0.0455	101.4	F9-3	658.5	668.0	658.6	0.1		F9-2	645.0	655.0	645.1	0.1	
240	0.013	8	VCP	0.0170	97.2	F9-4	662.6	673.0	662.7	0.2		F9-3	658.5	668.0	658.6	0.1	
363	0.013	8	ABS	0.0040	20.8	F9-6	685.1	695.0	685.2	0.1		F8-31	683.7	694.0	683.8	0.1	
462	0.012	15	VCP	0.0077	2031.3	F9-8	587.7	593.0	588.5	0.8		F10-62	584.2	592.0	584.9	0.7	
467	0.012	15	VCP	0.0053	2021.5	F9-9	590.2	600.0	591.1	0.9		F9-8	587.7	593.0	588.5	0.7	
436	0.012	15	VCP	0.0055	2014.6	F9-10	592.6	601.0	593.5	0.9		F9-9	590.2	600.0	591.0	0.8	
518	0.012	15	VCP	0.0049	2010.4	F9-11	595.2	602.0	596.1	0.9		F9-10	592.6	601.0	593.4	0.8	
450	0.013	10	ABS	0.0076	241.7	F9-12	587.6	593.0	587.9	0.3		F10-62	584.2	592.0	584.9	0.7	
248	0.012	15	VCP	0.0064	2006.9	F9-18	596.8	602.0	597.6	0.8		F9-11	595.2	602.0	596.0	0.8	
23	0.012	21	ABS	0.0226	2006.3	F9-19	597.3	604.0	597.9	0.6		F9-18	596.8	602.0	597.5	0.8	
428	0.012	15	VCP	0.0055	2311.8	F10-1	576.8	585.0	577.9	1.1		G10-5	574.4	582.0	575.4	1.0	
388	0.012	15	VCP	0.0060	2248.6	F10-2	579.2	585.0	580.1	0.9		F10-1	576.8	585.0	577.7	0.9	
241	0.012	15	VCP	0.0039	2248.6	F10-3	580.1	590.0	581.3	1.3	SUR	F10-2	579.2	585.0	580.0	0.9	
717	0.012	15	VCP	0.0036	2252.8	F10-4	582.7	588.0	585.0	2.3	SUR	F10-3	580.1	590.0	581.1	1.0	

2010 Master Plan Stillwater Collection System Pipe Analysis Results

LENGTH (ft)	Manning's N (Double)	Diameter (in)	Material	Slope	Maximum Flow, gpm	Upstream MH Name	Upstream Invert (ft)	Upstream MH Rim	Maximum Upstream HGL	Flow Depth, ft	Class	Downstream MH Name	Downstream Invert (ft)	Downstream MH Rim	Maximum Downstream HGL	Flow Depth, ft	Class
367	0.013	8	ABS	0.0038	125.7	F10-5	575.8	583.0	576.1	0.3		F11-2	574.4	583.0	574.7	0.3	
714	0.012	27	VCP	0.0022	1772.2	F10-9	573.2	588.0	574.0	0.8		F11-4	571.6	584.0	572.3	0.7	
124	0.013	8	ABS	0.0068	48.6	F10-10	584.4	588.0	584.6	0.1		E10-17	583.6	588.0	583.8	0.3	
318	0.013	8	ABS	0.0033	45.8	F10-15	585.5	589.0	585.7	0.2		F10-10	584.4	588.0	584.6	0.1	
189	0.013	8	ABS	0.0046	44.4	F10-17	586.3	590.0	586.5	0.2		F10-15	585.5	589.0	585.7	0.2	
242	0.013	8	ABS	0.0268	41.0	F10-18	592.8	600.0	592.9	0.1		F10-17	586.3	590.0	586.5	0.2	
426	0.013	8	ABS	0.1165	33.3	F10-20	642.5	648.0	642.5	0.1		F10-18	592.8	600.0	592.9	0.1	
209	0.013	8	ABS	0.0447	21.5	F10-22	651.8	657.0	651.8	0.1		F10-20	642.5	648.0	642.5	0.1	
228	0.013	8	ABS	0.0466	16.7	F10-23	662.4	669.0	662.5	0.1		F10-22	651.8	657.0	651.8	0.1	
252	0.013	8	A2000	0.0056	4.9	F10-25	572.9	577.0	573.0	0.1		F11-41	571.5	580.0	571.6	0.1	
186	0.013	8	ABS	0.0053	27.8	F10-29	592.7	600.0	592.8	0.1		F10-38	591.7	598.0	591.8	0.1	
256	0.013	8	ABS	0.0046	23.6	F10-30	593.9	603.0	594.0	0.1		F10-29	592.7	600.0	592.8	0.1	
161	0.013	8	ABS	0.0071	21.5	F10-31	595.0	605.0	595.1	0.1		F10-30	593.9	603.0	594.0	0.1	
181	0.013	8	ABS	0.0035	124.3	F10-32	576.5	583.0	576.7	0.3		F10-5	575.8	583.0	576.1	0.3	
400	0.013	8	ABS	0.0044	119.4	F10-34	578.2	583.0	578.5	0.3		F10-32	576.5	583.0	576.7	0.3	
337	0.013	10	ABS	0.0050	113.9	F10-36	579.9	584.0	580.1	0.2		F10-34	578.2	583.0	578.5	0.3	
422	0.013	10	ABS	0.0031	65.3	F10-37	578.1	588.0	578.3	0.2		F10-1	576.8	585.0	577.7	0.9	SUR
284	0.013	10	ABS	0.0478	62.5	F10-38	591.7	598.0	591.8	0.1		F10-37	578.1	588.0	578.3	0.2	
115	0.013	10	ABS	0.0071	106.3	F10-39	581.8	591.0	582.0	0.2		F10-40	581.0	587.0	581.3	0.3	
413	0.013	10	ABS	0.0026	109.0	F10-40	581.0	587.0	581.3	0.3		F10-36	579.9	584.0	580.1	0.2	
74	0.013	8	ABS	0.0058	0.7	F10-41	581.4	588.0	581.5	0.0		F10-40	581.0	587.0	581.3	0.3	
208	0.013	8	ABS	0.0120	0.7	F10-42A	577.0	587.0	577.0	0.0		F10-42	574.5	579.0	574.5	0.0	
375	0.013	8	A2000	0.0043	3.5	F10-42	574.5	579.0	574.5	0.0		F10-25	572.9	577.0	573.0	0.1	
658	0.012	27	VCP	0.0024	1764.6	F10-61	574.7	589.0	575.5	0.8		F10-9	573.2	588.0	574.0	0.8	
157	0.012	15	VCP	0.0096	2249.3	F10-62	584.2	592.0	585.8	1.6	SUR	F10-4	582.7	588.0	583.8	1.1	
404	0.013	8	ABS	0.0107	129.2	F11-1	572.8	583.0	573.0	0.2		G11-7	568.5	580.0	569.2	0.7	SUR
361	0.013	8	ABS	0.0044	127.8	F11-2	574.4	583.0	574.7	0.3		F11-1	572.8	583.0	573.0	0.2	
320	0.012	27	VCP	0.0024	1972.2	F11-3	569.3	580.0	570.1	0.8		G11-7	568.5	580.0	569.2	0.7	
645	0.012	24	VCP	0.0036	1772.9	F11-4	571.6	584.0	572.3	0.7		F11-3	569.3	580.0	570.1	0.8	
548	0.013	12	ABS	0.0065	197.2	F11-6	572.8	584.0	573.1	0.3		F11-3	569.3	580.0	570.1	0.8	
606	0.013	12	ABS	0.0085	186.8	F11-7	578.0	598.0	578.2	0.2		F11-6	572.8	584.0	573.1	0.3	
159	0.013	12	ABS	0.0134	155.6	F11-8	586.5	598.0	586.7	0.2		F11-24	584.4	598.0	584.5	0.2	
399	0.013	10	ABS	0.0921	118.8	F11-9	626.8	633.0	626.9	0.1		F11-13	590.0	595.0	590.2	0.2	
179	0.013	10	ABS	0.0154	106.9	F11-10	629.5	639.0	629.7	0.2		F11-9	626.8	633.0	626.9	0.1	
458	0.013	8	ABS	0.0045	102.8	F11-11	631.6	637.0	631.8	0.3		F11-10	629.5	639.0	629.7	0.2	
176	0.013	10	ABS	0.0199	147.9	F11-13	590.0	598.0	590.2	0.2		F11-8	586.5	595.0	586.7	0.2	
199	0.013	8	ABS	0.1432	27.1	F11-14	618.5	624.0	618.6	0.1		F11-13	590.0	595.0	590.2	0.2	
106	0.013	8	ABS	0.1033	23.6	F11-15	629.5	632.0	629.6	0.1		F11-14	618.5	624.0	618.6	0.1	
386	0.013	8	ABS	0.0098	22.9	F11-16	633.3	643.0	633.4	0.1		F11-15	629.5	632.0	629.6	0.1	
386	0.013	8	ABS	0.0086	17.4	F11-17	636.6	649.0	636.7	0.1		F11-16	633.3	643.0	633.4	0.1	
118	0.013	8	SDR-35	0.0058	14.6	F11-18	637.3	644.0	637.4	0.1		F11-17	636.6	649.0	636.7	0.1	
293	0.013	8	ABS	0.0223	12.5	F11-20	646.8	653.0	646.9	0.1		F11-21	640.3	646.0	640.3	0.1	
385	0.013	8	ABS	0.0077	16.7	F11-21	640.3	646.0	640.3	0.1		F11-22	637.3	644.0	637.4	0.1	
405	0.013	8	ABS	0.0159	20.8	F11-22	637.3	644.0	637.4	0.1		F11-23	630.9	641.0	630.9	0.0	
275	0.013	8	ABS	0.1690	25.0	F11-23	630.9	641.0	630.9	0.0		F11-24	584.4	598.0	584.5	0.2	
168	0.013	12	ABS	0.0378	181.9	F11-24	584.4	598.0	584.5	0.2		F11-7	578.0	598.0	578.2	0.2	
281	0.013	8	A2000	0.0037	6.9	F11-41	571.5	580.0	571.6	0.1		G11-22	570.5	580.0	570.7	0.2	
300	0.013	8	ABS	0.0035	25.7	F12-2	647.0	655.0	647.1	0.1		G12-4	646.0	656.0	646.1	0.1	
382	0.013	8	ABS	0.0046	21.5	F12-3	648.8	652.0	648.9	0.1		F12-2	647.0	655.0	647.1	0.1	
388	0.013	8	ABS	0.0041	9.0	F12-4	651.5	658.0	651.6	0.1		F12-9	649.9	652.0	650.0	0.1	
302	0.013	8	ABS	0.0038	16.7	F12-9	649.9	652.0	650.0	0.1		F12-3	648.8	652.0	648.9	0.1	
137	0.013	8	ABS	0.0045	2.1	F12-10	640.6	650.0	640.7	0.0		G12-7	640.0	658.0	640.1	0.1	

2010 Master Plan Stillwater Collection System Pipe Analysis Results

LENGTH (ft)	Manning's N (Double)	Diameter (in)	Material	Slope	Maximum Flow, gpm	Upstream MH Name	Upstream Invert (ft)	Upstream MH Rim	Maximum Upstream HGL	Flow Depth, ft	Class	Downstream MH Name	Downstream Invert (ft)	Downstream MH Rim	Maximum Downstream HGL	Flow Depth, ft	Class
349	0.013	8	VCP	0.0043	9.7	G9-1	686.6	697.0	686.7	0.1		F9-6	685.1	695.0	685.2	0.1	
337	0.013	8	ABS	0.0045	6.9	G9-2	688.1	698.0	688.2	0.1		G9-1	686.6	697.0	686.7	0.1	
281	0.013	8	ABS	0.0032	6.3	G9-10	689.0	694.0	689.1	0.1		G9-2	688.1	698.0	688.2	0.1	
255	0.013	8	ABS	0.0032	4.2	G9-11	689.9	694.0	689.9	0.1		G9-10	689.0	694.0	689.1	0.1	
185	0.012	15	VCP	0.0200	2303.5	G10-2	566.5	577.0	567.1	0.6		G10-41	562.8	575.0	564.0	1.2	
713	0.012	15	VCP	0.0039	2302.1	G10-3	569.3	579.0	572.0	2.7	SUR	G10-2	566.5	577.0	567.1	0.6	
372	0.012	15	VCP	0.0084	2295.1	G10-4	572.4	580.0	573.8	1.4	SUR	G10-3	569.3	579.0	571.7	2.4	SUR
411	0.012	15	VCP	0.0050	2311.1	G10-5	574.4	582.0	576.0	1.5	SUR	G10-4	572.4	580.0	573.2	0.8	
250	0.013	8	ABS	0.0321	20.8	G10-6	571.5	578.0	571.6	0.1		G11-20	563.5	573.0	563.6	0.1	
491	0.013	8	ABS	0.0357	23.6	G10-7	581.1	586.0	581.1	0.1		G11-20	563.5	573.0	563.6	0.1	
225	0.013	8	ABS	0.0393	19.4	G10-9	589.9	595.0	589.9	0.1		G10-7	581.1	586.0	581.1	0.1	
404	0.013	8	ABS	0.0307	29.9	G10-13	604.1	614.0	604.2	0.1		F10-38	591.7	598.0	591.8	0.1	
231	0.013	8	ABS	0.0428	7.6	G10-14	614.0	624.0	614.0	0.0		G10-13	604.1	614.0	604.2	0.1	
196	0.013	8	ABS	0.1764	2.8	G10-16	648.6	659.0	648.6	0.0		G10-14	614.0	624.0	614.0	0.0	
316	0.013	8	ABS	0.0040	20.1	G10-17	605.3	615.0	605.4	0.1		G10-13	604.1	614.0	604.2	0.1	
217	0.013	8	ABS	0.0695	18.1	G10-19	620.4	630.0	620.5	0.1		G10-17	605.3	615.0	605.4	0.1	
273	0.013	8	ABS	0.0171	7.6	G10-20	625.1	635.0	625.1	0.0		G10-19	620.4	630.0	620.5	0.1	
151	0.013	8	ABS	0.0046	0.7	G10-21	625.8	636.0	625.8	0.0		G10-20	625.1	635.0	625.1	0.0	
420	0.013	8	ABS	0.0105	4.2	G10-25	635.1	650.0	635.1	0.0		G10-27	630.6	637.0	630.7	0.0	
175	0.013	8	ABS	0.0073	1.4	G10-26	636.3	648.0	636.4	0.0		G10-25	635.1	650.0	635.1	0.0	
388	0.013	8	ABS	0.0438	6.9	G10-27	630.6	637.0	630.7	0.0		G10-28	613.6	620.0	613.7	0.1	
385	0.013	8	ABS	0.0564	15.3	G10-28	613.6	620.0	613.7	0.1		G10-31	591.9	599.0	592.0	0.1	
224	0.013	8	ABS	0.0139	6.3	G10-29	616.7	622.0	616.8	0.0		G10-28	613.6	620.0	613.7	0.1	
185	0.013	8	ABS	0.0182	1.4	G10-30	620.1	626.0	620.1	0.0		G10-29	616.7	622.0	616.8	0.0	
375	0.013	8	ABS	0.0545	18.8	G10-31	591.9	599.0	592.0	0.1		G10-6	571.5	578.0	571.6	0.1	
343	0.012	21	VCP	0.0020	2385.4	G10-41	562.8	575.0	563.9	1.2		G11-26	562.1	571.0	563.8	1.7	
113	0.012	27	VCP	0.0093	7.6	G11-1	558.8	568.0	558.9	0.0		G11-9	557.8	566.0	557.9	0.2	
335	0.012	15	VCP	0.0073	4.2	G11-2	561.2	570.0	561.3	0.0		G11-1	558.8	568.0	558.9	0.0	
304	0.012	18	VCP	0.0016	1.4	G11-4	561.7	571.0	561.8	0.0		G11-2	561.2	570.0	561.3	0.0	
625	0.012	24	VCP	0.0080	2118.1	G11-5	567.3	575.5	568.0	0.6		G11-28	562.6	572.0	563.7	1.1	
33	0.012	24	VCP	0.0000	2116.0	G11-6	567.6	577.5	568.2	0.6		G11-5	567.3	575.5	568.2	0.9	
234	0.012	27	VCP	0.0038	2104.9	G11-7	568.5	580.0	569.2	0.7		G11-6	567.6	577.5	568.4	0.8	
82	0.013	10	ABS	0.0061	67.4	G11-8	558.3	569.0	558.4	0.2		G11-9	557.8	566.0	557.9	0.2	
569	0.012	18	VCP	0.0049	75.7	G11-9	557.8	566.0	557.9	0.2		H11-41	551.9	563.0	552.9	1.0	
374	0.013	8	ABS	0.0057	131.3	G11-10	576.5	580.0	576.7	0.3		H11-20	574.4	580.0	574.6	0.2	
383	0.013	8	ABS	0.0061	126.4	G11-11	578.8	584.0	579.0	0.3		G11-10	576.5	580.0	576.7	0.3	
376	0.013	8	ABS	0.0120	118.1	G11-12	583.3	589.0	583.5	0.2		G11-11	578.8	584.0	579.0	0.3	
292	0.013	8	ABS	0.0181	115.3	G11-13	588.6	594.0	588.8	0.2		G11-12	583.3	589.0	583.5	0.2	
419	0.013	8	ABS	0.0183	110.4	G11-14	596.3	603.0	596.4	0.2		G11-13	588.6	594.0	588.8	0.2	
430	0.013	8	ABS	0.0140	88.9	G11-15	602.3	612.0	602.4	0.2		G11-14	596.3	603.0	596.4	0.2	
451	0.013	8	ABS	0.0651	79.2	G11-16	631.6	636.0	631.7	0.1		G11-15	602.3	612.0	602.4	0.2	
198	0.013	8	ABS	0.0265	47.2	G11-20	563.5	573.0	563.6	0.1		G11-8	558.3	569.0	558.4	0.2	
152	0.013	8	ABS	0.0160	9.7	G11-21	570.0	577.0	570.1	0.1		G11-6	567.6	577.5	568.4	0.8	SUR
65	0.013	8	ABS	0.0091	7.6	G11-22	570.5	580.0	570.7	0.2		G11-21	570.0	577.0	570.1	0.1	
124	0.012	27	VCP	0.0099	4443.1	G11-24	554.7	566.0	555.5	0.9		H11-43	553.4	563.2	554.6	1.2	
396	0.012	27	VCP	0.0063	4438.2	G11-25	557.2	569.5	558.1	1.0		G11-24	554.7	566.0	555.5	0.8	
206	0.012	24	VCP	0.0000	4609.0	G11-26	562.1	571.0	563.7	1.6		G11-29	562.0	574.0	563.1	1.1	
15	0.012	21	VCP	0.0352	2562.5	G11-28	562.6	572.0	563.6	1.0		G11-26	562.1	571.0	563.8	1.7	
277	0.012	24	VCP	0.0190	4507.6	G11-29	562.0	574.0	562.8	0.8		G11-25	557.2	569.5	558.1	0.9	
298	0.013	8	ABS	0.0046	38.9	G12-1	635.0	649.0	635.2	0.1		G12-13	633.7	649.0	633.9	0.2	
174	0.013	8	ABS	0.0412	33.3	G12-2	640.8	651.0	640.9	0.1		G12-13	633.7	649.0	633.9	0.2	
169	0.013	8	ABS	0.0199	31.9	G12-3	644.2	656.0	644.3	0.1		G12-2	640.8	651.0	640.9	0.1	

2010 Master Plan Stillwater Collection System Pipe Analysis Results

LENGTH (ft)	Manning's N (Double)	Diameter (in)	Material	Slope	Maximum Flow, gpm	Upstream MH Name	Upstream Invert (ft)	Upstream MH Rim	Maximum Upstream HGL	Flow Depth, ft	Class	Downstream MH Name	Downstream Invert (ft)	Downstream MH Rim	Maximum Downstream HGL	Flow Depth, ft	Class
389	0.013	8	ABS	0.0045	29.2	G12-4	646.0	656.0	646.1	0.1		G12-3	644.2	656.0	644.3	0.1	
349	0.013	8	ABS	0.0044	14.6	G12-6	638.4	655.0	638.5	0.1		G12-8	636.8	647.0	636.9	0.1	
429	0.013	8	ABS	0.0038	6.9	G12-7	640.0	658.0	640.1	0.1		G12-6	638.4	655.0	638.5	0.1	
418	0.013	8	ABS	0.0043	20.1	G12-8	636.8	647.0	636.9	0.1		G12-1	635.0	649.0	635.2	0.1	
188	0.013	8	ABS	0.0111	74.3	G12-13	633.7	649.0	633.9	0.2		G11-16	631.6	636.0	631.7	0.1	
449	0.013	8	ABS	0.0124	2.8	H10-29	657.7	663.0	657.8	0.0		H10-30	652.2	658.0	652.2	0.0	
332	0.013	8	ABS	0.0564	11.8	H10-30	652.2	658.0	652.2	0.0		H10-31	633.4	638.0	633.5	0.0	
403	0.013	8	ABS	0.0771	15.3	H10-31	633.4	638.0	633.5	0.0		H10-32	602.4	607.0	602.4	0.0	
268	0.013	8	ABS	0.0913	17.4	H10-32	602.4	607.0	602.4	0.0		H10-33	577.9	583.0	578.0	0.1	
366	0.013	8	ABS	0.0538	19.4	H10-33	577.9	583.0	578.0	0.1		G11-8	558.3	569.0	558.4	0.2	
303	0.013	8	ABS	0.0301	15.3	H10-36	599.0	604.0	599.1	0.1		G10-9	589.9	595.0	589.9	0.1	
218	0.013	8	ABS	0.0528	11.1	H10-37	610.5	616.0	610.5	0.0		H10-36	599.0	604.0	599.1	0.1	
284	0.013	8	ABS	0.0408	6.3	H10-39	622.1	626.0	622.1	0.0		H10-37	610.5	616.0	610.5	0.0	
293	0.013	8	ABS	0.0404	1.4	H10-40	650.3	655.0	650.3	0.0		H10-41	638.4	642.0	638.5	0.0	
225	0.013	8	ABS	0.0353	4.2	H10-41	638.4	642.0	638.5	0.0		H10-42	630.5	635.0	630.5	0.0	
260	0.013	8	ABS	0.0366	6.3	H10-42	630.5	635.0	630.5	0.0		H10-45	621.0	631.0	621.0	0.1	
456	0.013	8	ABS	0.0150	11.1	H10-45	621.0	631.0	621.0	0.1		H10-46	614.1	622.0	614.2	0.1	
262	0.013	8	ABS	0.0080	8.3	H10-49	630.8	638.0	630.8	0.1		H11-29	628.7	638.0	628.7	0.1	
301	0.013	8	ABS	0.0049	4.9	H10-50	641.1	651.0	641.1	0.1		H10-54	639.6	650.0	639.6	0.0	
265	0.013	8	ABS	0.0353	1.4	H10-52	650.4	660.0	650.5	0.0		H10-50	641.1	651.0	641.1	0.1	
336	0.013	8	ABS	0.0262	6.9	H10-54	639.6	650.0	639.6	0.0		H10-49	630.8	638.0	630.8	0.1	
328	0.013	8	ABS	0.0399	3.5	H10-57	635.2	639.0	635.2	0.0		H10-39	622.1	626.0	622.1	0.0	
335	0.013	8	PVC	0.0188	6.3	H10-65	614.3	619.0	614.4	0.0		J10-46	608.0	618.0	608.1	0.1	
444	0.013	8	ABS	0.0090	232.6	H11-5	552.0	560.0	552.4	0.3		J11-28	548.1	556.0	548.3	0.2	
434	0.013	8	ABS	0.0119	18.8	H11-6	557.2	564.0	557.3	0.1		H11-5	552.0	560.0	552.4	0.3	
415	0.013	8	ABS	0.0161	13.2	H11-7	563.9	571.0	564.0	0.1		H11-6	557.2	564.0	557.3	0.1	
415	0.013	8	ABS	0.0240	7.6	H11-8	573.8	580.0	573.9	0.0		H11-7	563.9	571.0	564.0	0.1	
291	0.013	8	ABS	0.0041	207.6	H11-9	553.2	567.0	553.6	0.4		H11-5	552.0	560.0	552.4	0.3	
394	0.013	8	ABS	0.0377	4.9	H11-10	588.7	595.0	588.8	0.0		H11-8	573.8	580.0	573.9	0.0	
179	0.013	8	ABS	0.0050	2.1	H11-12	586.0	592.0	586.0	0.0		H11-13	585.1	595.0	585.2	0.1	
282	0.013	8	ABS	0.0196	18.8	H11-13	585.1	595.0	585.2	0.1		J11-35	579.6	586.0	579.7	0.1	
131	0.013	8	ABS	0.0049	200.7	H11-16	553.9	559.0	554.2	0.3		H11-9	553.2	567.0	553.6	0.4	
434	0.013	8	ABS	0.0085	200.0	H11-17	557.6	564.0	557.9	0.3		H11-16	553.9	559.0	554.2	0.3	
467	0.013	8	ABS	0.0079	190.3	H11-18	561.2	567.0	561.5	0.3		H11-17	557.6	564.0	557.9	0.3	
163	0.013	8	ABS	0.0188	141.0	H11-19	569.2	580.0	569.4	0.2		H11-33	566.2	574.0	566.4	0.2	
331	0.013	8	ABS	0.0154	137.5	H11-20	574.4	580.0	574.6	0.2		H11-19	569.2	580.0	569.4	0.2	
245	0.013	8	ABS	0.0442	6.3	H11-22	564.0	570.0	564.1	0.0		H11-9	553.2	567.0	553.6	0.4	
391	0.013	8	ABS	0.0197	4.2	H11-23	571.8	578.0	571.8	0.0		H11-22	564.0	570.0	564.1	0.0	
398	0.013	8	ABS	0.0045	2.1	H11-24	573.6	578.0	573.6	0.0		H11-23	571.8	578.0	571.8	0.0	
147	0.013	6	ABS	0.0281	1.4	H11-25	592.9	599.0	592.9	0.0		H11-10	588.7	595.0	588.8	0.0	
237	0.013	8	ABS	0.0233	8.3	H11-26	566.8	573.0	566.8	0.0		H11-18	561.2	567.0	561.5	0.3	
444	0.013	8	ABS	0.0702	2.8	H11-27	597.9	602.0	598.0	0.0		H11-26	566.8	573.0	566.8	0.0	
182	0.013	6	ABS	0.0668	1.4	H11-28	610.1	618.0	610.1	0.0		H11-27	597.9	602.0	598.0	0.0	
200	0.013	8	ABS	0.0125	16.0	H11-29	626.1	638.0	626.2	0.1		H11-57	623.6	644.0	623.7	0.1	
210	0.013	8	ABS	0.0123	9.7	H11-29	628.7	638.0	628.7	0.1		H11-44	626.1	642.0	626.2	0.1	
198	0.013	6	ABS	0.0545	10.4	H11-32	599.0	609.0	599.1	0.0		H12-31	588.3	594.0	588.3	0.1	
181	0.013	8	ABS	0.0272	181.3	H11-33	566.2	574.0	566.4	0.2		H11-18	561.2	567.0	561.5	0.3	
185	0.013	8	ABS	0.0101	37.5	H11-34	568.0	574.0	568.2	0.1		H11-33	566.2	574.0	566.4	0.2	
260	0.013	8	ABS	0.0045	36.8	H11-35	569.2	575.0	569.4	0.1		H11-34	568.0	574.0	568.2	0.1	
356	0.013	8	ABS	0.0055	33.3	H11-36	571.2	577.0	571.3	0.1		H11-35	569.2	575.0	569.4	0.1	
182	0.013	8	SDR-35	0.0045	31.3	H11-37	572.0	578.0	572.1	0.1		H11-36	571.2	577.0	571.3	0.1	
301	0.012	30	DI	0.0122	4537.5	H11-38	543.9	551.0	544.7	0.8		J11-69	540.2	553.0	541.3	1.1	

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559	0.012	27	VCP	0.0048	4531.9	H11-39	546.6	557.0	547.7	1.1		H11-38	543.9	551.0	544.7	0.8	
709	0.012	27	VCP	0.0045	4527.1	H11-40	549.8	560.0	550.9	1.1		H11-39	546.6	557.0	547.6	1.0	
443	0.012	27	VCP	0.0047	4521.5	H11-41	551.9	563.0	552.9	1.0		H11-40	549.8	560.0	550.8	1.0	
34	0.012	27	VCP	0.0000	4444.4	H11-42	552.0	563.0	553.1	1.1		H11-41	551.9	563.0	552.9	1.0	
539	0.012	27	VCP	0.0028	4444.4	H11-43	553.4	563.2	554.6	1.2		H11-42	552.0	563.0	553.0	1.1	
179	0.013	8	SDR-35	0.0095	17.4	H11-57	623.6	644.0	623.7	0.1		J11-65	621.9	627.0	622.0	0.1	
235	0.013	8	ABS	0.0135	16.0	H12-31	588.3	594.0	588.3	0.1		H11-13	585.1	595.0	585.2	0.1	
471	0.013	8	ABS	0.0308	84.0	J10-41	578.5	589.0	578.7	0.1		J11-74	564.0	576.0	564.2	0.2	
191	0.013	8	ABS	0.0092	84.0	J10-42	580.3	583.0	580.5	0.2		J10-41	578.5	589.0	578.7	0.1	
62	0.013	8	ABS	0.0243	49.3	J10-43	581.8	592.0	581.9	0.1		J10-42	580.3	583.0	580.5	0.2	
395	0.013	8	ABS	0.0132	39.6	J10-44	587.0	597.0	587.1	0.1		J10-43	581.8	592.0	581.9	0.1	
309	0.013	8	ABS	0.0381	28.5	J10-45	598.8	609.0	598.9	0.1		J10-44	587.0	597.0	587.1	0.1	
299	0.013	8	ABS	0.0204	17.4	J10-46	614.1	618.0	614.2	0.1		J10-45	608.0	609.0	608.0	0.0	
332	0.013	8	ABS	0.0279	26.4	J10-46	608.0	618.0	608.1	0.1		J10-45	598.8	609.0	598.9	0.1	
340	0.013	8	PVC	0.0644	8.3	J10-51	608.9	619.0	608.9	0.0		J10-44	587.0	597.0	587.1	0.1	
308	0.013	8	SDR-35	0.0977	6.3	J10-54	611.9	617.0	611.9	0.0		J10-43	581.8	592.0	581.9	0.1	
438	0.013	8	SDR-35	0.0436	4.9	J10-56	628.0	638.0	628.0	0.0		J10-51	608.9	619.0	608.9	0.0	
511	0.012	30	VCP	0.0033	4792.4	J11-2	537.9	549.0	539.0	1.1		J11-67	536.2	550.0	537.1	0.9	
221	0.012	30		0.0027	4918.1	J11-4B	534.1	543.3	535.3	1.2		J11-5	533.5	543.0	534.6	1.1	
356	0.012	30	VCP	0.0037	4920.1	J11-5	533.5	543.0	534.6	1.1		K11-62	532.2	544.0	533.3	1.1	
173	0.013	8	ABS	0.0027	25.7	J11-6	543.3	549.0	543.4	0.1		J11-7	542.8	549.0	543.1	0.3	
328	0.013	10	ABS	0.0025	97.2	J11-7	542.8	549.0	543.1	0.3		J11-9	542.0	552.0	542.3	0.3	
417	0.013	8	ABS	0.0042	66.0	J11-8	544.6	550.0	544.8	0.2		J11-7	542.8	549.0	543.1	0.3	
301	0.013	10	ABS	0.0023	101.4	J11-9	542.0	552.0	542.3	0.3		J11-11	541.3	551.0	541.6	0.3	
198	0.013	10	ABS	0.0025	112.5	J11-11	541.3	551.0	541.6	0.3		J11-13	540.8	551.0	541.0	0.2	
226	0.013	8	ABS	0.0063	8.3	J11-12	542.8	553.0	542.8	0.1		J11-11	541.3	551.0	541.6	0.3	
26	0.013	10		0.0222	119.4	J11-13	540.8	551.0	541.0	0.2		J11-13A	540.2	551.0	540.5	0.3	
173	0.013	10	VCP	0.0029	121.5	J11-13A	540.2	551.0	540.5	0.3		J11-67	536.2	550.0	539.7	3.5	SUR
273	0.013	8	ABS	0.0084	6.3	J11-14	545.0	554.0	545.1	0.1		J11-12	542.8	553.0	542.8	0.1	
238	0.013	8	ABS	0.0044	2.8	J11-15	546.1	554.0	546.1	0.0		J11-14	545.0	554.0	545.1	0.1	
387	0.013	8	ABS	0.0135	4.9	J11-15	546.1	554.0	546.1	0.0		J11-13	540.8	551.0	541.0	0.2	
471	0.013	8	ABS	0.0072	60.4	J11-17	548.0	554.0	548.2	0.2		J11-8	544.6	550.0	544.8	0.2	
217	0.013	8	ABS	0.0635	57.6	J11-18	561.8	572.0	561.9	0.1		J11-17	548.0	554.0	548.2	0.2	
139	0.013	8	ABS	0.0143	0.7	J11-19	550.0	556.0	550.0	0.0		J11-17	548.0	554.0	548.2	0.2	
135	0.013	8	ABS	0.0054	1.4	J11-20	549.9	556.0	549.9	0.0		J11-21	549.1	555.0	549.2	0.0	
349	0.013	8	ABS	0.0056	2.8	J11-21	549.1	555.0	549.2	0.0		J11-22	547.2	554.0	547.2	0.1	
295	0.013	8	ABS	0.0037	6.9	J11-22	547.2	554.0	547.2	0.1		J11-15	546.1	554.0	546.1	0.0	
367	0.013	8	ABS	0.0134	56.3	J11-24	566.7	577.0	566.9	0.1		J11-18	561.8	572.0	561.9	0.1	
166	0.013	8	ABS	0.0665	1.4	J11-25	577.8	588.0	577.8	0.0		J11-24	566.7	577.0	566.9	0.1	
182	0.013	8	ABS	0.0281	243.1	J11-28	548.1	556.0	548.3	0.2		J11-69	540.2	553.0	542.9	2.7	SUR
380	0.013	8	ABS	0.0110	7.6	J11-29	552.2	558.0	552.3	0.1		J11-28	548.1	556.0	548.3	0.2	
365	0.013	8	ABS	0.0183	4.9	J11-30	558.9	565.0	558.9	0.0		J11-29	552.2	558.0	552.3	0.1	
367	0.013	8	ABS	0.0200	2.8	J11-31	566.3	572.0	566.3	0.0		J11-30	558.9	565.0	558.9	0.0	
106	0.013	8	ABS	0.0048	54.2	J11-32	567.2	577.0	567.4	0.2		J11-24	566.7	577.0	566.9	0.1	
320	0.013	8	ABS	0.0219	52.1	J11-33	574.2	584.0	574.3	0.1		J11-32	567.2	577.0	567.4	0.2	
196	0.013	8	ABS	0.0073	50.0	J11-34	575.7	586.0	575.8	0.2		J11-33	574.2	584.0	574.3	0.1	
158	0.013	8	ABS	0.0247	49.3	J11-35	579.6	586.0	579.7	0.1		J11-34	575.7	586.0	575.8	0.2	
219	0.013	8	ABS	0.0307	29.9	J11-36	586.3	593.0	586.4	0.1		J11-35	579.6	586.0	579.7	0.1	
229	0.013	8	ABS	0.0054	25.7	J11-37	587.5	594.0	587.6	0.1		J11-36	586.3	593.0	586.4	0.1	
249	0.013	8	ABS	0.0394	24.3	J11-39	597.3	602.0	597.4	0.1		J11-37	587.5	594.0	587.6	0.1	
214	0.013	6	ABS	0.0298	0.7	J11-40	598.6	605.0	598.6	0.0		J12-11	592.3	597.0	592.3	0.0	
142	0.013	10	ABS	0.0248	18.8	J11-43	546.8	552.0	546.9	0.1		J11-6	543.3	549.0	543.4	0.1	

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LENGTH (ft)	Manning's N (Double)	Diameter (in)	Material	Slope	Maximum Flow, gpm	Upstream MH Name	Upstream Invert (ft)	Upstream MH Rim	Maximum Upstream HGL	Flow Depth, ft	Class	Downstream MH Name	Downstream Invert (ft)	Downstream MH Rim	Maximum Downstream HGL	Flow Depth, ft	Class
171	0.013	8	ABS	0.0359	113.2	J11-45	545.7	549.0	545.8	0.1		K11-17	539.6	550.0	539.8	0.3	
402	0.013	8	ABS	0.0127	110.4	J11-46	550.8	557.0	551.0	0.2		J11-45	545.7	549.0	545.8	0.1	
470	0.013	8	ABS	0.0081	109.0	J11-47	554.6	561.0	554.8	0.2		J11-46	550.8	557.0	551.0	0.2	
467	0.013	8	ABS	0.0135	94.4	J11-48	560.9	567.0	561.1	0.2		J11-46	554.6	557.0	554.6	0.0	
311	0.013	8	ABS	0.0226	1.4	J11-49	618.9	623.0	619.0	0.0		J10-54	611.9	617.0	611.9	0.0	
213	0.013	8	SDR-35	0.0267	29.9	J11-50	593.2	597.0	593.2	0.1		J11-75	587.5	591.0	587.6	0.1	
64	0.013	8	SDR-35	0.0427	29.2	J11-51	595.9	600.0	596.0	0.1		J11-50	593.2	597.0	593.2	0.1	
229	0.013	8	SDR-35	0.0593	20.8	J11-52	609.5	613.0	609.5	0.1		J11-51	595.9	600.0	596.0	0.1	
258	0.013	8	SDR-35	0.0443	19.4	J11-53	620.9	626.0	621.0	0.1		J11-52	609.5	613.0	609.5	0.1	
287	0.013	8	SDR-35	0.0536	6.9	J11-58	611.3	618.0	611.3	0.0		J11-51	595.9	600.0	596.0	0.1	
161	0.013	8	SDR-35	0.0353	4.9	J11-59	616.9	620.0	617.0	0.0		J11-58	611.3	618.0	611.3	0.0	
386	0.013	8	SDR-35	0.0190	2.1	J11-60	624.3	627.0	624.3	0.0		J11-59	616.9	620.0	617.0	0.0	
191	0.013	8	SDR-35	0.0052	18.1	J11-65	621.9	627.0	622.0	0.1		J11-53	620.9	626.0	621.0	0.1	
330	0.012	30	VCP	0.0002	4918.1	J11-66	534.2	549.0	535.9	1.7		J11-4B	534.1	543.3	535.3	1.1	
231	0.012	30	VCP	0.0087	4914.6	J11-67	536.2	550.0	537.1	0.9		J11-66	534.2	549.0	535.9	1.7	
698	0.012	30	VCP	0.0033	4784.7	J11-69	540.2	553.0	541.4	1.1		J11-2	537.9	549.0	539.0	1.1	
429	0.013	8	ABS	0.0072	88.2	J11-74	564.0	576.0	564.2	0.2		J11-48	560.9	567.0	561.1	0.2	
279	0.013	8	SDR-35	0.0257	32.6	J11-75	587.5	591.0	587.6	0.1		J10-42	580.3	583.0	580.5	0.2	
252	0.013	8	ABS	0.0457	20.8	J12-2	608.8	614.0	608.9	0.1		J11-39	597.3	602.0	597.4	0.1	
258	0.013	8	ABS	0.0101	18.8	J12-3	611.4	619.0	611.5	0.1		J12-2	608.8	614.0	608.9	0.1	
327	0.013	8	ABS	0.0443	14.6	J12-4	625.9	632.0	626.0	0.1		J12-3	611.4	619.0	611.5	0.1	
306	0.013	8	ABS	0.0134	9.0	J12-5	630.0	639.0	630.1	0.1		J12-4	625.9	632.0	626.0	0.1	
150	0.013	10	ABS	0.0053	8.3	J12-6	569.8	580.0	569.8	0.1		J12-12	569.0	574.0	569.0	0.0	
258	0.013	8	ABS	0.0070	9.7	J12-7	581.2	588.0	581.2	0.1		K12-45	579.4	586.0	579.5	0.1	
348	0.013	8	ABS	0.0669	4.2	J12-11	592.3	597.0	592.3	0.0		J12-12	569.0	574.0	569.0	0.0	
435	0.013	10	ABS	0.0509	13.9	J12-12	569.0	574.0	569.0	0.0		J11-43	546.8	552.0	546.9	0.1	
318	0.013	8		0.0094	63.2	J12-17	585.0	596.0	585.2	0.2		J12-18	582.0	592.0	582.2	0.2	
191	0.013	8	SDR	0.0078	68.1	J12-18	582.0	592.0	582.2	0.2		K12-56	580.5	585.0	580.8	0.3	
268	0.013	8	SDR-35	0.0145	0.7	J13-1	623.7	634.0	623.8	0.0		K13-19	619.9	627.0	619.9	0.0	
362	0.012	30	DI	0.0006	4931.9	K11-2	530.4	544.0	532.0	1.6		K11-3	530.2	539.0	531.4	1.2	
268	0.012	33	VCP	0.0023	4936.8	K11-3	530.2	539.0	531.4	1.2		K11-47	529.6	540.0	530.7	1.2	
522	0.012	33	VCP	0.0024	5227.1	K11-4	528.9	539.0	530.1	1.2		K11-18	527.6	539.0	528.8	1.2	
122	0.013	10	ABS	0.0062	73.6	K11-8	543.1	553.0	543.2	0.2		K11-9	542.3	552.0	542.4	0.1	
385	0.013	10	ABS	0.0147	78.5	K11-9	542.3	552.0	542.5	0.1		K11-10	536.7	547.0	536.8	0.1	
292	0.013	10	ABS	0.0079	82.6	K11-10	536.7	547.0	536.8	0.2		K11-11	534.4	544.0	534.6	0.2	
224	0.013	10	ABS	0.0218	214.6	K11-11	534.4	544.0	534.6	0.2		K11-50	529.5	540.0	530.5	1.1	SUR
349	0.013	8	ABS	0.0063	130.6	K11-12	536.6	547.0	536.8	0.3		K11-11	534.4	544.0	534.6	0.2	
383	0.013	8	ABS	0.0040	126.4	K11-16	538.1	548.0	538.4	0.3		K11-12	536.6	547.0	536.8	0.3	
402	0.013	8	ABS	0.0037	120.1	K11-17	539.6	550.0	539.8	0.3		K11-16	538.1	548.0	538.4	0.3	
319	0.012	33	VCP	0.0025	5239.6	K11-18	527.6	539.0	528.9	1.2		K11-19	526.8	536.0	528.1	1.3	
642	0.012	33	VCP	0.0022	5257.6	K11-19	526.8	536.0	528.1	1.3		L11-29	525.4	535.0	526.6	1.1	
186	0.013	10	ABS	0.0041	72.2	K11-20	543.8	554.0	544.0	0.2		K11-8	543.1	553.0	543.2	0.1	
173	0.013	10	ABS	0.0028	71.5	K11-23	544.3	554.0	544.5	0.2		K11-20	543.8	554.0	544.0	0.1	
340	0.013	8	ABS	0.0036	14.6	K11-24	545.5	555.0	545.6	0.1		K11-23	544.3	554.0	544.5	0.2	
181	0.013	8	ABS	0.0029	7.6	K11-25	546.1	556.0	546.1	0.1		K11-24	545.5	555.0	545.6	0.1	
245	0.013	8	ABS	0.0030	1.4	K11-26	547.1	557.0	547.1	0.0		K11-34	546.4	556.0	546.4	0.1	
72	0.013	8	ABS	0.0039	4.2	K11-34	546.4	556.0	546.4	0.1		K11-25	546.1	556.0	546.1	0.1	
307	0.013	6	ABS	0.0145	34.7	K11-36	534.0	550.0	534.1	0.1		K11-47	529.6	540.0	530.7	1.2	SUR
310	0.013	6	ABS	0.0143	34.7	K11-36	534.0	550.0	534.1	0.1		K11-47	529.6	540.0	530.7	1.2	SUR
119	0.013	8	ABS	0.0906	65.3	K11-37	544.8	550.0	544.9	0.1		K11-36	534.0	550.0	534.1	0.1	
171	0.013	8	ABS	0.1054	63.2	K11-38	562.8	575.0	562.9	0.1		K11-37	544.8	550.0	544.9	0.1	
267	0.013	8	ABS	0.0037	60.4	K11-39	563.8	572.0	564.0	0.2		K11-38	562.8	575.0	562.9	0.1	

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67	0.012	33	VCP	0.0012	5006.9	K11-47	529.6	540.0	530.8	1.2		K11-50	529.5	540.0	530.5	1.1	
135	0.012	33	VCP	0.0044	5222.2	K11-50	529.5	540.0	530.6	1.1		K11-4	528.9	539.0	530.1	1.2	
544	0.012	30	VCP	0.0033	4927.8	K11-62	532.2	544.0	533.3	1.1		K11-2	530.4	544.0	532.0	1.6	
156	0.013	10	ABS	0.0051	178.5	K12-1	564.0	574.0	564.3	0.3		K12-12	563.2	578.0	563.6	0.4	
435	0.013	8	ABS	0.0040	48.6	K12-2	565.8	573.0	565.9	0.2		K12-1	564.0	574.0	564.3	0.3	
413	0.013	8	ABS	0.0166	11.1	K12-3	572.6	579.0	572.7	0.1		K12-2	565.8	573.0	565.9	0.2	
305	0.013	8	ABS	0.0078	9.0	K12-4	575.0	582.0	575.1	0.1		K12-3	572.6	579.0	572.7	0.1	
278	0.013	8	ABS	0.0047	34.7	K12-5	567.1	573.0	567.2	0.1		K12-2	565.8	573.0	565.9	0.2	
297	0.013	8	ABS	0.0048	14.6	K12-6	568.5	578.0	568.6	0.1		K12-5	567.1	573.0	567.2	0.1	
361	0.013	8	ABS	0.0048	14.6	K12-11	568.8	575.0	568.9	0.1		K12-5	567.1	573.0	567.2	0.1	
409	0.013	10	ABS	0.0029	277.1	K12-12	563.2	578.0	563.6	0.4		L12-11	562.0	576.0	562.5	0.5	
199	0.013	8	ABS	0.0403	125.7	K12-13	572.0	580.0	572.2	0.2		K12-1	564.0	574.0	564.3	0.3	
269	0.013	8	ABS	0.0046	120.1	K12-14	573.3	579.0	573.5	0.3		K12-13	572.0	580.0	572.2	0.2	
398	0.013	8	ABS	0.0061	91.0	K12-15	575.7	581.0	575.9	0.2		K12-14	573.3	579.0	573.5	0.3	
349	0.013	8	ABS	0.0046	12.5	K12-18	570.4	576.0	570.5	0.1		K12-11	568.8	575.0	568.9	0.1	
409	0.013	8	ABS	0.0047	7.6	K12-20	572.3	578.0	572.4	0.1		K12-18	570.4	576.0	570.5	0.1	
355	0.013	8	ABS	0.0051	2.1	K12-21	574.1	580.0	574.2	0.0		K12-20	572.3	578.0	572.4	0.1	
237	0.013	8	ABS	0.0040	9.0	K12-24	572.2	580.0	572.2	0.1		K12-26	571.2	577.0	571.3	0.1	
108	0.013	8	ABS	0.0337	0.7	K12-25	575.8	582.0	575.8	0.0		K12-24	572.2	580.0	572.2	0.1	
298	0.013	8	ABS	0.0047	10.4	K12-26	571.2	577.0	571.3	0.1		K12-27	569.8	576.0	569.9	0.1	
274	0.013	8	ABS	0.0048	12.5	K12-27	569.8	576.0	569.9	0.1		K12-6	568.5	578.0	568.6	0.1	
424	0.013	8	ABS	0.0042	34.0	K12-29	573.2	578.0	573.3	0.1		K12-31	571.4	583.0	571.5	0.1	
176	0.013	6	ABS	0.0053	1.4	K12-30	574.1	580.0	574.2	0.0		K12-29	573.2	578.0	573.3	0.1	
422	0.013	8	ABS	0.0180	54.9	K12-31	571.4	583.0	571.5	0.1		K11-39	563.8	572.0	564.0	0.2	
344	0.013	8	ABS	0.0048	30.6	K12-32	574.8	581.0	575.0	0.1		K12-29	573.2	578.0	573.3	0.1	
178	0.013	8	ABS	0.0056	18.8	K12-36	572.4	581.0	572.5	0.1		K12-31	571.4	583.0	571.5	0.1	
356	0.013	8	ABS	0.0042	16.7	K12-37	573.9	579.0	574.0	0.1		K12-36	572.4	581.0	572.5	0.1	
307	0.013	8	ABS	0.0044	25.0	K12-39	576.2	582.0	576.3	0.1		K12-32	574.8	581.0	575.0	0.1	
305	0.013	8	ABS	0.0040	21.5	K12-42	577.4	584.0	577.5	0.1		K12-39	576.2	582.0	576.3	0.1	
298	0.013	8	ABS	0.0038	16.7	K12-44	578.5	587.0	578.6	0.1		K12-42	577.4	584.0	577.5	0.1	
169	0.013	8	ABS	0.0050	11.8	K12-45	579.4	586.0	579.5	0.1		K12-44	578.5	587.0	578.6	0.1	
347	0.013	8	ABS	0.0167	27.8	K12-47	579.1	589.0	579.2	0.1		K12-14	573.3	579.0	573.5	0.3	
416	0.013	8	ABS	0.0055	6.9	K12-48	581.3	591.0	581.4	0.1		K12-47	579.1	589.0	579.2	0.1	
384	0.013	8	ABS	0.0054	4.9	K12-49	583.4	593.0	583.5	0.1		K12-48	581.3	591.0	581.4	0.1	
416	0.013	8	ABS	0.0056	86.1	K12-50	578.0	588.0	578.2	0.2		K12-15	575.7	581.0	575.9	0.2	
139	0.013	8	ABS	0.0061	83.3	K12-51	578.8	589.0	579.0	0.2		K12-50	578.0	588.0	578.2	0.2	
127	0.013	8	ABS	0.0058	3.5	K12-52	584.2	594.0	584.2	0.0		K12-49	583.4	593.0	583.5	0.1	
231	0.013	8	ABS	0.0043	78.5	K12-53	579.8	583.0	580.0	0.2		K12-51	578.8	589.0	579.0	0.2	
391	0.013	8	ABS	0.0366	94.4	K12-54	577.5	583.0	577.6	0.1		K12-12	563.2	578.0	563.6	0.4	
305	0.013	8	SDR-35	0.0022	72.9	K12-56	580.5	585.0	580.8	0.3		K12-53	579.8	583.0	580.0	0.2	
235	0.013	8	ABS	0.0051	90.3	K13-1	578.7	585.0	578.9	0.2		K12-54	577.5	583.0	577.6	0.1	
233	0.013	8	ABS	0.0042	89.6	K13-2	579.7	584.0	579.9	0.2		K13-1	578.7	585.0	578.9	0.2	
405	0.013	8	ABS	0.0131	34.0	K13-4	585.0	595.0	585.1	0.1		K13-2	579.7	584.0	579.9	0.2	
461	0.013	8	ABS	0.0110	31.3	K13-5	590.1	600.0	590.2	0.1		K13-4	585.0	595.0	585.1	0.1	
46	0.013	8	ABS	0.0830	4.9	K13-6	594.8	605.0	594.8	0.0		K13-11	590.9	597.0	591.1	0.2	
267	0.013	8	ABS	0.0291	3.5	K13-7	602.6	613.0	602.6	0.0		K13-6	594.8	605.0	594.8	0.0	
216	0.013	8	SDR-35	0.0082	21.5	K13-9	600.8	607.0	600.9	0.1		K13-10	599.0	605.0	599.1	0.1	
307	0.013	8	SDR-35	0.0263	22.9	K13-10	599.0	605.0	599.1	0.1		K13-11	590.9	597.0	591.1	0.2	
298	0.013	8	ABS	0.0030	28.5	K13-11	590.9	597.0	591.1	0.2		K13-5	590.1	600.0	590.2	0.1	
289	0.013	8	SDR-35	0.0118	17.4	K13-16	604.2	613.0	604.3	0.1		K13-9	600.8	607.0	600.9	0.1	
305	0.013	8	SDR-35	0.0056	4.2	K13-17	609.8	616.0	609.8	0.0		K13-18	608.1	615.0	608.1	0.0	
46	0.013	8	SDR-35	0.0849	10.4	K13-18	608.1	615.0	608.1	0.0		K13-16	604.2	613.0	604.3	0.1	

2010 Master Plan Stillwater Collection System Pipe Analysis Results

LENGTH (ft)	Manning's N (Double)	Diameter (in)	Material	Slope	Maximum Flow, gpm	Upstream MH Name	Upstream Invert (ft)	Upstream MH Rim	Maximum Upstream HGL	Flow Depth, ft	Class	Downstream MH Name	Downstream Invert (ft)	Downstream MH Rim	Maximum Downstream HGL	Flow Depth, ft	Class
258	0.013	8	SDR-35	0.0455	4.2	K13-19	619.9	627.0	619.9	0.0		K13-18	608.1	615.0	608.1	0.0	
226	0.013	8	SDR-35	0.0048	2.1	K13-21	610.9	616.0	610.9	0.0		K13-17	609.8	616.0	609.8	0.0	
179	0.013	8	SDR-35	0.0180	1.4	K13-22	614.1	619.0	614.1	0.0		K13-21	610.9	616.0	610.9	0.0	
271	0.013	8	SDR-35	0.0046	49.3	K13-23	584.6	595.0	584.7	0.2		K13-31	583.3	590.0	583.5	0.1	
267	0.013	8	SDR-35	0.0333	17.4	K13-24	593.5	603.0	593.5	0.1		K13-23	584.6	595.0	584.7	0.2	
288	0.013	8	SDR-35	0.0590	11.8	K13-25	610.5	615.0	610.5	0.0		K13-24	593.5	603.0	593.5	0.1	
357	0.013	8	SDR-35	0.0106	4.2	K13-26	614.2	618.0	614.3	0.0		K13-25	610.5	615.0	610.5	0.0	
279	0.013	8	SDR-35	0.0047	29.9	K13-27	585.9	596.0	586.0	0.1		K13-23	584.6	595.0	584.7	0.2	
396	0.013	8	SDR-35	0.0376	26.4	K13-28	600.8	604.0	600.8	0.1		K13-27	585.9	596.0	586.0	0.1	
289	0.013	8	SDR-35	0.0090	9.0	K13-29	603.4	605.0	603.4	0.1		K13-28	600.8	604.0	600.8	0.1	
376	0.013	8	SDR-35	0.0097	51.4	K13-31	583.3	590.0	583.5	0.1		K13-2	579.7	584.0	579.9	0.2	
293	0.013	8	SDR-35	0.0056	18.8	K13-34	580.7	586.0	580.8	0.1		K12-47	579.1	589.0	579.2	0.1	
400	0.013	8	SDR-35	0.0100	16.0	K13-36	584.7	589.0	584.8	0.1		K13-34	580.7	586.0	580.8	0.1	
395	0.013	8	SDR-35	0.0106	10.4	K13-37	588.9	592.0	588.9	0.1		K13-36	584.7	589.0	584.8	0.1	
115	0.013	8	SDR-35	0.0138	6.9	K13-38	590.4	600.0	590.5	0.0		K13-37	588.9	592.0	588.9	0.1	
46	0.013	8	SDR-35	0.0499	1.4	K13-39	576.8	587.0	576.8	0.0		L13-20	574.5	580.0	574.5	0.0	
178	0.012	33	VCP	0.0028	5300.0	L11-27	521.9	532.0	523.1	1.2		L11-41	521.4	528.2	522.5	1.1	
490	0.012	33	VCP	0.0031	5270.8	L11-29	525.4	535.0	526.6	1.2		L11-45	523.9	532.0	525.1	1.2	
340	0.012	36	DIP	0.0032	5329.2	L11-41	521.4	528.2	522.5	1.1		L11-47	520.3	528.0	521.3	1.0	
294	0.012	33	VCP	0.0022	5292.4	L11-43	522.6	531.0	523.9	1.3		L11-27	521.9	532.0	523.1	1.1	
535	0.012	33	VCP	0.0025	5277.8	L11-45	523.9	532.0	525.2	1.2		L11-43	522.6	531.0	523.8	1.2	
360	0.013	12		0.0138	741.0	L12-1	525.0	531.0	525.5	0.4		M12-9	520.1	526.0	520.7	0.6	
356	0.013	12	ABS	0.0055	716.7	L12-2	527.0	533.0	527.6	0.6		L12-1	525.0	531.0	525.5	0.4	
324	0.013	12	ABS	0.0086	708.3	L12-3	529.8	536.0	530.3	0.5		L12-2	527.0	533.0	527.6	0.6	
313	0.013	12	ABS	0.0181	689.6	L12-4	535.5	541.0	535.9	0.4		L12-3	529.8	536.0	530.3	0.5	
321	0.013	12	ABS	0.0202	663.2	L12-5	542.0	548.0	542.3	0.4		L12-4	535.5	541.0	535.9	0.4	
334	0.013	12	ABS	0.0091	642.4	L12-6	545.0	552.0	545.5	0.5		L12-5	542.0	548.0	542.3	0.4	
323	0.013	12	ABS	0.0272	630.6	L12-7	553.8	574.0	554.1	0.3		L12-6	545.0	552.0	545.5	0.5	
296	0.013	12	ABS	0.0118	322.9	L12-8	557.3	571.0	557.6	0.3		L12-7	553.8	574.0	554.1	0.3	
275	0.013	10	ABS	0.0236	283.3	L12-10	560.6	579.0	560.9	0.2		L12-17	554.1	572.0	554.7	0.6	
509	0.013	10	ABS	0.0028	279.9	L12-11	562.0	576.0	562.5	0.5		L12-10	560.6	579.0	560.9	0.2	
203	0.013	10	ABS	0.0015	284.7	L12-17	554.1	572.0	554.7	0.6		L12-7	553.8	574.0	554.1	0.3	
375	0.013	8	ABS	0.0285	8.3	L12-19	568.0	574.0	568.0	0.0		L12-8	557.3	571.0	557.6	0.3	
413	0.013	8	ABS	0.0051	6.3	L12-20	570.1	576.0	570.1	0.1		L12-19	568.0	574.0	568.0	0.0	
385	0.013	8	ABS	0.0046	2.1	L12-21	571.8	578.0	571.9	0.0		L12-20	570.1	576.0	570.1	0.1	
300	0.013	8	ABS	0.0044	4.2	L12-38	575.2	578.0	575.3	0.0		K12-37	573.9	579.0	574.0	0.1	
471	0.013	12	ABS	0.0032	277.8	L13-1	566.7	577.0	567.1	0.4		L13-17	565.2	574.0	565.5	0.3	
379	0.013	12	ABS	0.0032	272.9	L13-2	567.9	578.0	568.3	0.4		L13-1	566.7	577.0	567.1	0.4	
108	0.013	8	ABS	0.0045	31.3	L13-3	575.1	585.0	575.3	0.1		L13-4	574.7	585.0	574.8	0.1	
303	0.013	8	ABS	0.0158	35.4	L13-4	574.7	585.0	574.8	0.1		L13-5	569.9	582.0	570.3	0.4	
334	0.013	12	ABS	0.0023	258.3	L13-5	569.9	582.0	570.3	0.4		L13-6	569.1	582.0	569.5	0.4	
401	0.013	12	ABS	0.0025	263.9	L13-6	569.1	582.0	569.5	0.4		L13-7	568.1	578.0	568.7	0.6	
270	0.013	12	ABS	0.0006	266.0	L13-7	568.1	578.0	568.7	0.6		L13-2	567.9	578.0	568.3	0.4	
486	0.013	8	ABS	0.0040	218.1	L13-8	571.8	577.1	572.2	0.4		L13-5	569.9	582.0	570.3	0.4	
32	0.013	12	ABS	0.0029	297.2	L13-17	565.2	574.0	565.5	0.3		L13-22	565.1	574.0	565.3	0.2	
398	0.013	8	SDR-35	0.0080	13.9	L13-18	568.4	577.0	568.5	0.1		L13-17	565.2	574.0	565.5	0.3	
392	0.013	8	SDR-35	0.0081	10.4	L13-19	571.6	577.0	571.6	0.1		L13-18	568.4	577.0	568.5	0.1	
420	0.013	8	SDR-35	0.0070	4.9	L13-20	574.5	580.0	574.5	0.0		L13-19	571.6	577.0	571.6	0.1	
275	0.013	12	ABS	0.0284	298.6	L13-22	565.1	574.0	565.3	0.2		L12-8	557.3	571.0	557.6	0.3	
248	0.013	6	VCP	0.1012	7.6	M11-30	574.3	580.0	574.3	0.0		M11-40	549.2	559.0	549.2	0.0	
162	0.013	8	ABS	0.0156	19.4	M11-39	521.2	531.0	521.3	0.1		M11-52	518.0	528.0	521.3	3.3	SUR
591	0.012	33	ABS	0.0059	5344.4	M11-39	520.3	531.0	521.3	1.0		M11-51	516.9	525.5	517.8	1.0	

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278	0.013	8	ABS	0.1010	11.8	M11-40	549.2	559.0	549.2	0.0		M11-39	521.2	531.0	521.3	0.1	
685	0.012	33	VCP	-0.0006	5395.1	M11-50	515.1	524.8	517.7	2.6		M12-1	515.5	528.0	516.6	1.1	
301	0.012	33	VCP	0.0058	5351.4	M11-51	516.9	525.5	517.9	1.0		M11-50	515.1	524.8	517.4	2.3	
337	0.013	10	SDR-35	0.0075	41.7	M11-52	518.0	528.0	521.3	3.3	SUR	M11-50	515.1	524.8	517.4	2.3	SUR
125	0.012	33	VCP	0.0046	5370.1	M12-1	515.5	528.0	517.4	1.9		M12-4	514.9	524.0	516.5	1.6	
492	0.012	27	ABS	0.0216	5343.8	M12-4	514.9	524.0	517.4	2.4	SUR	CCWW					
58	0.013	12	VCP	0.0208	4.2	M12-6	518.5	529.0	518.5	0.0		M12-17	517.3	529.0	517.6	0.3	
528	0.013	12	ABS	0.0053	747.9	M12-9	520.1	526.0	520.7	0.6		M12-17	517.3	529.0	517.6	0.3	
85	0.013	12	VCP	0.0644	755.6	M12-17	517.3	529.0	517.6	0.3		M12-18			CCWW		
1532	0.012	21	DIP	0.0000	5887.5	M12-19-1	499.5		564.8			M12-22 Sipho	547.0		FM		
1535	0.012	16	DIP	0.0000		M12-19-2						M12-22			FM		
512	0.013	8	PVC	0.0050	104.2	M13-1	574.8	584.8	575.0	0.2		M13-3	572.2	578.5	572.4	0.2	
499	0.013	8		0.0050	86.1	M13-2	577.3	587.3	577.5	0.2		M13-1	574.8	584.8	575.0	0.2	
40	0.013	8		0.0300	182.6	M13-3	572.2	578.5	572.4	0.2		SHWW					
782	0.012	30	VCP	0.0068	5896.5	N12-22	547.0	556.0	548.0	1.0		N12-77	541.7	551.0	542.9	1.2	
403	0.013	10	ABS	0.0170	52.1	N12-29	534.4	544.0	534.5	0.1		N12-30	527.6	538.0	530.9	3.4	SUR
215	0.013	12	AC	0.0031	30.6	N12-30	530.8	538.0	530.9	0.1		N13-14	530.1	540.0	530.3	0.1	
236	0.013	6	AC	0.0071	29.2	N12-33	532.5	540.0	532.6	0.1		N12-30	530.8	538.0	530.9	0.1	
354	0.013	6	AC	0.0082	26.4	N12-34	535.4	542.0	535.5	0.1		N12-33	532.5	540.0	532.6	0.1	
361	0.013	6	AC	0.0048	20.1	N12-35	537.1	543.0	537.2	0.1		N12-34	535.4	542.0	535.5	0.1	
389	0.013	6	AC	0.0051	13.9	N12-36	539.1	547.0	539.2	0.1		N12-35	537.1	543.0	537.2	0.1	
403	0.013	6	AC	0.0050	6.9	N12-37	541.1	548.0	541.2	0.1		N12-36	539.1	547.0	539.2	0.1	
242	0.013	6	VCP	0.0048	0.0	N12-38	542.3	545.0	542.3	0.0		N12-37	541.1	548.0	541.2	0.1	
197	0.013	6	VCP	0.0048	3.5	N12-43	542.2	547.0	542.2	0.0		N12-44	541.2	546.0	541.3	0.1	
327	0.013	6	VCP	0.0062	9.7	N12-44	541.2	546.0	541.3	0.1		N12-45	539.2	544.0	539.3	0.1	
320	0.013	6	VCP	0.0060	16.7	N12-45	539.2	544.0	539.3	0.1		N12-46	537.3	543.0	537.4	0.1	
347	0.013	6	VCP	0.0057	24.3	N12-46	537.3	543.0	537.4	0.1		N12-47	535.3	541.0	535.4	0.1	
354	0.013	6	VCP	0.0049	32.6	N12-47	535.3	541.0	535.4	0.1		N12-48	533.5	539.0	533.7	0.2	
341	0.013	6	VCP	0.0051	39.6	N12-48	533.5	539.0	533.7	0.2		N12-49	531.8	538.0	531.9	0.2	
354	0.013	6	VCP	0.0093	47.2	N12-49	531.8	538.0	531.9	0.2		N13-7	528.5	536.0	528.7	0.3	
818	0.012	36	VCP	0.0029	5954.2	N12-68	527.6	539.0	528.8	1.2		N13-15	525.2	544.0	526.4	1.2	
146	0.012	36	VCP	0.0028	5901.4	N12-69	528.0	539.0	529.2	1.2		N12-68	527.6	539.0	528.8	1.2	
236	0.012	30	VCP	0.0087	5900.0	N12-70	530.0	542.0	531.0	1.0		N12-69	528.0	539.0	529.2	1.2	
177	0.012	30	VCP	0.0089	5896.5	N12-71	531.6	541.0	532.6	1.0		N12-70	530.0	542.0	531.0	1.0	
667	0.012	30	VCP	0.0075	5896.5	N12-72	536.6	548.0	537.6	1.0		N12-71	531.6	541.0	532.6	1.0	
451	0.012	30	VCP	0.0077	5896.5	N12-73	540.1	549.0	541.1	1.0		N12-72	536.6	548.0	537.6	1.0	
387	0.013	6	AC	0.0053	0.0	N12-76	539.2	548.0	539.2	0.0		N12-35	537.1	543.0	537.2	0.1	
389	0.012	30	VCP	0.0041	5896.5	N12-77	541.7	551.0	542.9	1.2		N12-73	540.1	549.0	541.1	1.0	
83	0.013	6	AC	0.0283	50.7	N13-2	562.7	567.0	562.8	0.1		N13-26	560.3	568.0	560.4	0.1	
396	0.013	6	AC	0.0050	54.9	N13-3	554.2	560.0	554.4	0.2		N13-4	552.2	560.0	552.3	0.1	
285	0.013	6	AC	0.0379	59.0	N13-4	552.2	560.0	552.3	0.1		N13-5	541.4	546.0	541.5	0.1	
216	0.013	6	AC	0.0349	61.8	N13-5	541.4	546.0	541.5	0.1		N13-6	533.8	541.0	534.1	0.2	
292	0.013	6	AC	0.0091	90.3	N13-6	533.8	541.0	534.1	0.2		O13-4	531.2	537.0	531.4	0.2	
247	0.013	6	AC	0.0053	94.4	N13-7	528.5	536.0	528.7	0.3		O13-1	527.2	537.0	527.5	0.3	
203	0.013	6	AC	0.0342	10.4	N13-8	564.8	570.0	564.9	0.1		N13-9	557.9	562.0	558.0	0.1	
389	0.013	6	AC	0.0051	14.6	N13-9	557.9	562.0	558.0	0.1		N13-10	555.9	565.0	556.0	0.1	
327	0.013	6	AC	0.0200	20.8	N13-10	555.9	565.0	556.0	0.1		N13-11	549.4	554.0	549.4	0.1	
186	0.013	6	AC	0.0509	25.0	N13-11	549.4	554.0	549.4	0.1		N13-12	539.9	545.0	540.0	0.1	
201	0.013	6	AC	0.0301	27.1	N13-12	539.9	545.0	540.0	0.1		N13-6	533.8	541.0	534.1	0.2	
250	0.013	12	AC	0.0039	38.9	N13-13	529.5	537.0	529.6	0.1		N13-7	528.5	536.0	528.7	0.3	
236	0.013	12	AC	0.0028	33.3	N13-14	530.1	540.0	530.3	0.1		N13-13	529.5	537.0	529.6	0.1	
505	0.012	36	VCP	0.0029	5956.3	N13-15	525.2	544.0	526.4	1.2		O13-13	523.7	537.0	524.8	1.2	

2010 Master Plan Stillwater Collection System Pipe Analysis Results

LENGTH (ft)	Manning's N (Double)	Diameter (in)	Material	Slope	Maximum Flow, gpm	Upstream MH Name	Upstream Invert (ft)	Upstream MH Rim	Maximum Upstream HGL	Flow Depth, ft	Class	Downstream MH Name	Downstream Invert (ft)	Downstream MH Rim	Maximum Downstream HGL	Flow Depth, ft	Class
294	0.013	8	ABS	0.0295	26.4	N13-16	546.2	556.0	546.3	0.1		N13-17	537.5	548.0	537.6	0.1	
283	0.013	10	ABS	0.0110	45.8	N13-17	537.5	548.0	537.6	0.1		N12-29	534.4	544.0	534.5	0.1	
276	0.013	10	ABS	0.0084	15.3	N13-19	539.9	550.0	539.9	0.1		N13-17	537.5	548.0	537.6	0.1	
217	0.013	10	ABS	0.0113	10.4	N13-20	542.3	552.0	542.3	0.1		N13-19	539.9	550.0	539.9	0.1	
92	0.013	12	ABS	0.0034	8.3	N13-22	542.6	553.0	542.7	0.1		N13-20	542.3	552.0	542.3	0.1	
317	0.013	12	ABS	0.0035	5.6	N13-23	543.7	554.0	543.8	0.1		N13-22	542.6	553.0	542.7	0.1	
126	0.013	12	ABS	0.0029	1.4	N13-24	544.1	554.0	544.1	0.0		N13-23	543.7	554.0	543.8	0.1	
159	0.013	12	AC	0.0026	2.1	N13-25	529.9	537.0	529.9	0.0		N13-13	529.5	537.0	529.6	0.1	
209	0.013	6	AC	0.0293	51.4	N13-26	560.3	568.0	560.4	0.1		N13-3	554.2	560.0	554.4	0.2	
320	0.013	8	ABS	0.0334	22.2	N13-27	556.9	567.0	556.9	0.1		N13-16	546.2	556.0	546.3	0.1	
408	0.013	8	ABS	0.0044	10.4	N13-28	558.7	568.0	558.7	0.1		N13-27	556.9	567.0	556.9	0.1	
169	0.013	8	ABS	0.0048	5.6	N13-32	559.5	565.0	559.5	0.1		N13-28	558.7	568.0	558.7	0.1	
167	0.013	8	ABS	0.0051	3.5	N13-34	560.3	565.0	560.4	0.0		N13-32	559.5	565.0	559.5	0.1	
82	0.013	6	AC	0.0210	7.6	N13-35	566.6	570.0	566.6	0.1		N13-8	564.8	570.0	564.9	0.1	
28	0.013	8	SDR-35	0.0120	20.8	N15-3	590.3	596.0	590.3	0.1		N15-4	589.9	596.0	590.3	0.4	
392	0.013	8	SDR-35	0.0049	86.8	N15-4	589.9	596.0	590.3	0.4		O15-25	588.2	598.0	588.5	0.4	
154	0.013	8	SDR-35	0.0051	6.3	NS12-1	745.4	753.0	745.5	0.1		NS12-2	744.6	750.0	744.7	0.1	
357	0.013	8	SDR-35	0.0323	38.9	NS12-2	744.6	750.0	744.7	0.1		NS12-3	733.1	738.0	733.3	0.2	
410	0.013	8	SDR-35	0.0043	51.4	NS12-3	733.1	738.0	733.3	0.2		NS12-4	731.3	739.0	731.5	0.2	
392	0.013	8	SDR-35	0.0045	64.6	NS12-4	731.3	739.0	731.5	0.2		NS12-5	729.6	736.0	729.7	0.1	
388	0.013	8	SDR-35	0.0150	69.4	NS12-5	729.6	736.0	729.7	0.1		NT12-23	723.7	730.0	723.9	0.1	
376	0.013	8	SDR-35	0.0043	7.6	NS12-7	721.0	727.0	721.1	0.1		NT12-1	719.4	725.0	719.5	0.1	
307	0.013	8	SDR-35	0.0046	22.9	NT12-1	719.4	725.0	719.5	0.1		NT12-2	718.0	733.0	718.3	0.2	
237	0.013	8	SDR-35	0.0046	100.0	NT12-2	718.0	733.0	718.3	0.2		NT12-3	716.9	728.0	717.1	0.2	
404	0.013	8	SDR-35	0.0179	102.8	NT12-3	716.9	728.0	717.1	0.2		NT12-4	709.7	715.0	709.9	0.3	
359	0.013	8	SDR-35	0.0047	113.9	NT12-4	709.7	715.0	709.9	0.3		NT12-5	708.0	718.0	708.3	0.3	
276	0.013	8	SDR-35	0.0046	119.4	NT12-5	708.0	718.0	708.3	0.3		NT12-6	706.8	717.0	707.0	0.2	
403	0.013	8	SDR-35	0.0078	125.0	NT12-6	706.8	717.0	707.0	0.2		NT12-7	703.6	710.0	703.8	0.2	
378	0.013	8	SDR-35	0.0209	128.5	NT12-7	703.6	710.0	703.8	0.2		NU12-2	695.7	704.0	695.9	0.2	
364	0.013	8	SDR-35	0.0157	74.3	NT12-23	723.7	730.0	723.9	0.1		NT12-2	718.0	733.0	718.3	0.2	
323	0.013	8	SDR-35	0.0039	13.2	NU12-1	697.0	702.0	697.1	0.1		NU12-2	695.7	704.0	695.9	0.2	
388	0.013	8	SDR-35	0.0247	156.9	NU12-2	695.7	704.0	695.9	0.2		NU12-12	686.2	666.0	686.2	0.0	
409	0.013	8	SDR-35	0.0233	162.5	NU12-3	686.2	692.0	686.4	0.2		NU12-4	676.6	682.0	677.0	0.3	
340	0.013	8	SDR-35	0.0043	166.0	NU12-4	676.6	682.0	677.0	0.3		NU12-6	675.2	684.0	675.4	0.2	
210	0.013	8	SDR-35	0.0403	12.5	NU12-5	683.7	691.0	683.7	0.1		NU12-6	675.2	684.0	675.4	0.2	
379	0.013	10	SDR-35	0.0330	250.7	NU12-6	675.2	684.0	675.4	0.2		NU12-12	662.7	666.0	663.1	0.4	
412	0.013	8	SDR-35	0.0519	17.4	NU12-7	702.6	708.0	702.7	0.1		NU12-9	681.3	699.0	681.5	0.2	
137	0.013	8	SDR-35	0.0060	40.3	NU12-8	682.1	693.0	682.2	0.1		NU12-9	681.3	699.0	681.5	0.2	
349	0.013	8	SDR-35	0.0046	66.0	NU12-9	681.3	699.0	681.5	0.2		NU12-10	679.7	694.0	679.9	0.2	
258	0.013	8	SDR-35	0.0047	68.8	NU12-10	679.7	694.0	679.9	0.2		NU12-11	678.5	692.0	678.6	0.2	
406	0.013	8	SDR-35	0.0081	70.8	NU12-11	678.5	692.0	678.6	0.2		NU12-6	675.2	684.0	675.4	0.2	
163	0.013	10	SDR-35	0.0027	252.8	NU12-12	662.7	666.0	663.1	0.4		NU12-13	662.2	669.0	662.6	0.4	
210	0.013	10	SDR-35	0.0054	262.5	NU12-13	662.2	669.0	662.6	0.4		NU12-14	661.1	669.0	661.4	0.3	
462	0.013	10	SDR-35	0.0101	266.7	NU12-14	661.1	669.0	661.4	0.3		NV12-1	656.5	660.0	656.7	0.2	
295	0.013	10	SDR-35	0.0256	282.6	NV12-1	656.5	660.0	656.7	0.2		NV12-2	648.9	654.0	649.3	0.4	
425	0.013	10	SDR-35	0.0036	293.1	NV12-2	648.9	654.0	649.3	0.4		NV12-3	647.4	654.0	647.8	0.4	
481	0.013	10	SDR-35	0.0057	309.7	NV12-3	647.4	654.0	647.8	0.4		NV12-4	644.6	650.0	645.0	0.4	
293	0.013	10	SDR-35	0.0053	322.9	NV12-4	644.6	650.0	645.0	0.4		NV12-5	643.1	650.0	643.5	0.4	
173	0.013	10	SDR-35	0.0061	331.3	NV12-5	643.1	650.0	643.5	0.4		NV12-6	642.0	655.0	642.5	0.4	
320	0.013	10	SDR-35	0.0042	344.4	NV12-6	642.0	655.0	642.5	0.4		NW12-1	640.7	655.0	641.1	0.4	
504	0.013	10	SDR-35	0.0048	359.7	NW12-1	640.7	655.0	641.1	0.4		NW12-2	638.3	653.0	638.7	0.4	
231	0.013	10	SDR-35	0.0051	369.4	NW12-2	638.3	653.0	638.7	0.4		NW12-3	637.1	642.0	637.5	0.3	

2010 Master Plan Stillwater Collection System Pipe Analysis Results

LENGTH (ft)	Manning's N (Double)	Diameter (in)	Material	Slope	Maximum Flow, gpm	Upstream MH Name	Upstream Invert (ft)	Upstream MH Rim	Maximum Upstream HGL	Flow Depth, ft	Class	Downstream MH Name	Downstream Invert (ft)	Downstream MH Rim	Maximum Downstream HGL	Flow Depth, ft	Class
433	0.013	10	SDR-35	0.0151	376.4	NW12-3	637.1	642.0	637.5	0.3		NW12-4	630.6	635.0	630.8	0.2	
136	0.013	10	SDR-35	0.0410	380.6	NW12-4	630.6	635.0	630.8	0.2		NY10-5			TOWW		
408	0.013	12	ABS	0.0040	120.1	NY8-2	632.8	646.0	633.0	0.2		NY8-6	631.1	644.0	631.4	0.3	
245	0.013	12	ABS	0.0035	103.5	NY8-3	633.6	644.0	633.8	0.2		NY8-2	632.8	646.0	633.0	0.2	
475	0.013	12	ABS	0.0100	95.8	NY8-4	638.4	644.0	638.5	0.2		NY8-3	633.6	644.0	633.8	0.2	
244	0.013	12	ABS	0.0035	71.5	NY8-5	639.2	644.0	639.4	0.2		NY8-4	638.4	644.0	638.5	0.2	
556	0.013	12	ABS	0.0027	127.8	NY8-6	631.1	644.0	631.4	0.3		NZ8-3	629.7	636.0	629.9	0.2	
407	0.013	8	ABS	0.0095	488.2	NY9-2	631.8	638.0	632.3	0.5		NZ9-12	628.0	636.0	628.4	0.4	
508	0.013	10	SDR-35	0.0248	470.8	NY10-2	644.5	656.0	644.8	0.3		NY9-2	631.8	638.0	632.3	0.5	
486	0.013	10	SDR-35	0.0556	454.9	NY10-3	671.5	679.0	671.7	0.3		NY10-2	644.5	656.0	644.8	0.3	
492	0.012	15	ABS	0.0024	163.2	NZ8-1	623.3	630.0	623.6	0.3		A8-4	622.1	630.0	622.4	0.3	
755	0.012	15	ABS	0.0022	138.2	NZ8-2	625.0	637.0	625.2	0.3		NZ8-1	623.3	630.0	623.6	0.3	
433	0.013	10	ABS	0.0108	134.7	NZ8-3	629.7	636.0	629.9	0.2		NZ8-2	625.0	637.0	625.2	0.3	
522	0.012	15	ABS	0.0030	588.9	NZ9-1	614.4	624.0	614.9	0.5		A9-4	612.8	622.0	613.3	0.5	
392	0.012	15	ABS	0.0042	575.0	NZ9-2	616.0	623.0	616.5	0.5		NZ9-1	614.4	624.0	614.9	0.5	
424	0.012	15	ABS	0.0055	557.6	NZ9-3	618.4	626.0	618.8	0.4		NZ9-2	616.0	623.0	616.5	0.5	
396	0.012	15	ABS	0.0048	545.8	NZ9-10	620.3	625.0	620.7	0.4		NZ9-3	618.4	626.0	618.8	0.4	
397	0.013	8	ABS	0.0064	506.9	NZ9-11	622.8	629.0	624.9	2.1	SUR	NZ9-10	620.3	625.0	620.7	0.4	
369	0.013	8	ABS	0.0139	500.0	NZ9-12	628.0	636.0	628.4	0.4		NZ9-11	622.8	629.0	625.3	2.5	SUR
112	0.013	6	AC	0.0207	7.6	O12-11	541.3	545.0	541.4	0.0		O12-12	539.0	545.0	539.1	0.1	
403	0.013	6	VCP	0.0129	14.6	O12-12	539.0	545.0	539.1	0.1		O12-13	533.8	541.0	533.9	0.1	
278	0.013	6	VCP	0.0040	22.9	O12-13	533.8	541.0	533.9	0.1		O12-14	532.7	543.0	532.8	0.1	
368	0.013	6	VCP	0.0040	29.9	O12-14	532.7	543.0	532.8	0.1		O12-15	531.2	542.0	531.4	0.2	
341	0.013	6	VCP	0.0041	34.0	O12-15	531.2	542.0	531.4	0.2		O12-16	529.8	541.0	530.0	0.2	
347	0.013	6	VCP	0.0039	38.9	O12-16	529.8	541.0	530.0	0.2		O12-17	528.5	541.0	528.6	0.2	
332	0.013	6	AC	0.0038	43.8	O12-17	528.5	541.0	528.6	0.2		O13-1	527.2	537.0	527.5	0.3	
354	0.013	6	AC	0.0040	18.1	O12-18	532.6	541.0	532.7	0.1		O12-11	531.2	545.0	541.4	10.2	SUR
327	0.013	6	AC	0.0103	6.3	O12-21	537.1	543.0	537.2	0.1		O12-19	533.8	538.0	533.9	0.1	
327	0.013	6	AC	0.0037	11.8	O12-21	533.8	543.0	533.9	0.1		O12-18	532.6	541.0	532.7	0.1	
192	0.013	8	PVC	0.0053	43.1	O12-35	523.2	533.0	523.4	0.1		P12-49	522.2	528.0	522.4	0.2	
30	0.013	6	AC	0.0174	261.1	O13-1	527.2	537.0	527.5	0.3		O13-17	526.7	537.0	527.0	0.3	
155	0.013	8	AC	0.0069	122.9	O13-2	528.3	536.0	528.5	0.2		O13-1	527.2	537.0	527.5	0.3	
125	0.013	8	AC	0.0067	91.7	O13-3	529.1	536.0	529.3	0.2		O13-2	528.3	536.0	528.5	0.2	
125	0.013	6	AC	0.0168	91.0	O13-4	531.2	537.0	531.4	0.2		O13-3	529.1	536.0	529.3	0.2	
268	0.013	6	AC	0.0019	30.6	O13-9	528.8	535.0	528.9	0.2		O13-2	528.3	536.0	528.5	0.2	
260	0.013	6	AC	0.0039	27.8	O13-10	529.8	538.0	529.9	0.1		O13-9	528.8	535.0	528.9	0.2	
412	0.013	6	AC	0.0034	24.3	O13-11	531.2	538.0	531.3	0.1		O13-10	529.8	538.0	529.9	0.1	
425	0.013	6	AC	0.0081	43.8	O13-12	566.1	545.0	566.3	0.2		N13-2	562.7	536.0	562.8	0.1	
134	0.012	36	VCP	0.0035	5961.8	O13-13	523.7	537.0	524.9	1.2		O13-16	523.2	534.0	524.5	1.2	
1311	0.012	36	VCP	0.0040	6231.3	O13-14	521.7	535.0	522.9	1.1		O13-15	516.5	530.0	517.8	1.3	
1031	0.012	36	VCP	0.0024	6311.1	O13-15	516.5	530.0	517.8	1.3		P13-17	513.9	521.0	514.8	0.9	
542	0.012	36	VCP	0.0028	6220.8	O13-16	523.2	534.0	524.5	1.3		O13-14	521.7	535.0	522.8	1.1	
294	0.013	10	ABS	0.0118	263.2	O13-17	526.7	537.0	527.0	0.3		O13-16	523.2	534.0	524.5	1.2	SUR
682	0.013	12	VCP	0.0027	118.1	O14-1	552.8	549.0	553.0	0.3		P14-6	550.9	563.0	551.2	0.3	
815	0.013	12	ABS	0.0024	101.4	O14-2	554.7	570.0	554.9	0.2		O14-1	552.8	563.0	553.0	0.3	
398	0.013	12	ABS	0.0038	82.6	O14-3	556.2	568.0	556.4	0.2		O14-2	554.7	570.0	554.9	0.2	
214	0.013	8	ABS	0.0119	213.9	O15-1	560.6	571.0	560.8	0.3		O15-6	558.0	570.0	558.4	0.3	
316	0.013	8	ABS	0.0128	153.5	O15-2	564.6	574.0	564.8	0.2		O15-1	560.6	571.0	560.8	0.3	
395	0.013	8	ABS	0.0140	150.7	O15-3	570.1	580.0	570.3	0.2		O15-2	564.6	574.0	564.8	0.2	
389	0.013	8	ABS	0.0142	146.5	O15-4	575.6	586.0	575.9	0.2		O15-3	570.1	580.0	570.3	0.2	
171	0.013	8	ABS	0.0149	134.7	O15-5	580.5	590.0	580.7	0.2		O15-22	578.0	588.0	578.2	0.2	
808	0.013	12	ABS	0.0027	213.9	O15-6	558.0	570.0	558.4	0.3		P15-2	555.8	569.0	556.2	0.4	

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404	0.013	8	ABS	0.0119	59.0	O15-7	565.4	571.0	565.5	0.1		O15-1	560.6	572.0	560.8	0.3	
315	0.013	8	ABS	0.0242	29.9	O15-9	573.0	579.0	573.1	0.1		O15-7	565.4	572.0	565.5	0.1	
294	0.013	8	ABS	0.0318	20.1	O15-10	582.3	587.0	582.4	0.1		O15-9	573.0	579.0	573.1	0.1	
362	0.013	8	ABS	0.0270	16.7	O15-12	592.1	596.0	592.1	0.1		O15-10	582.3	587.0	582.4	0.1	
378	0.013	8	SDR-35	0.0109	2.1	O15-17	588.0	593.0	588.0	0.0		O15-24	583.8	590.0	583.9	0.1	
157	0.013	8	ABS	0.0147	136.8	O15-22	578.0	588.0	578.2	0.2		O15-4	575.6	586.0	575.9	0.2	
396	0.013	8	SDR-35	0.0082	9.7	O15-24	583.8	590.0	583.9	0.1		P15-6	580.6	585.0	580.6	0.1	
395	0.013	8	SDR-35	0.0049	96.5	O15-25	588.2	598.0	588.5	0.4		O15-29	586.4	590.0	586.7	0.4	
310	0.013	8	SDR-35	0.0019	101.4	O15-29	586.4	590.0	586.7	0.4		O15-30	585.8	591.0	585.9	0.1	
82	0.013	8	SDR-35	0.0642	133.3	O15-30	585.8	591.0	585.9	0.1		O15-5	580.5	590.0	580.7	0.2	
300	0.013	6	AC	0.0050	2.8	P12-1	521.8	527.0	521.8	0.0		P12-2	520.3	526.0	520.4	0.1	
298	0.013	6	AC	0.0050	8.3	P12-2	520.3	526.0	520.4	0.1		R12-33	518.8	525.0	518.9	0.1	
295	0.013	6	AC	0.0102	4.2	P12-3	520.5	525.0	520.5	0.0		P12-4	517.5	524.0	517.6	0.1	
296	0.013	6	AC	0.0017	11.1	P12-4	517.5	524.0	517.6	0.1		R12-37	517.0	524.0	517.1	0.1	
343	0.013	10	VCP	0.0029	92.4	P12-5	517.4	523.0	517.6	0.2		P12-6	516.3	523.0	516.6	0.2	
333	0.013	10	VCP	0.0031	100.7	P12-6	516.3	523.0	516.6	0.2		R12-44	515.3	523.0	515.6	0.3	
411	0.013	10	VCP	0.0044	76.4	P12-7	519.1	524.0	519.3	0.2		P12-5	517.4	523.0	517.6	0.2	
403	0.013	10	ABS	0.0032	68.8	P12-8	521.9	526.0	522.1	0.3		P12-12	521.0	525.0	520.7	-0.3	
195	0.013	6	AC	0.0038	1.4	P12-9	520.5	525.0	520.5	0.0		P12-10	519.8	525.0	519.8	0.1	
310	0.013	8	VCP	0.0050	6.3	P12-10	519.8	525.0	519.8	0.1		P12-11	518.2	523.0	518.3	0.1	
490	0.013	8	AC	0.0037	13.9	P12-11	518.2	523.0	518.3	0.1		R12-54	516.4	522.0	516.5	0.1	
125	0.013	10	VCP	0.0115	70.1	P12-12	521.0	525.0	521.1	0.1		P12-7	519.1	524.0	519.3	0.2	
263	0.013	6	AC	0.0162	11.8	P12-13	521.6	527.0	521.7	0.1		P12-5	517.4	523.0	517.6	0.2	
259	0.013	6	AC	0.0051	9.0	P12-14	522.9	528.0	523.0	0.1		P12-13	521.6	527.0	521.7	0.1	
159	0.013	6	AC	0.0317	1.4	P12-18	529.6	534.0	529.6	0.0		P12-19	524.5	532.0	524.6	0.1	
325	0.013	6	AC	0.0050	5.6	P12-19	524.5	532.0	524.6	0.1		P12-14	522.9	528.0	523.0	0.1	
319	0.013	10	ABS	0.0038	62.5	P12-37	523.2	527.0	523.4	0.2		P12-8	521.9	526.0	522.1	0.2	
299	0.013	10	ABS	0.0032	56.3	P12-39	524.0	528.0	524.2	0.2		P12-37	523.2	527.0	523.3	0.0	
329	0.013	10	ABS	0.0026	49.3	P12-40	524.9	530.0	525.1	0.2		P12-39	524.0	528.0	524.2	0.2	
184	0.013	8	ABS	0.0025	9.7	P12-41	525.3	531.0	525.4	0.1		P12-40	524.9	530.0	525.1	0.2	
453	0.013	8	ABS	0.0025	34.7	P12-46	526.0	530.0	526.2	0.2		P12-40	524.9	530.0	525.1	0.2	
388	0.013	8	PVC	0.0044	50.0	P12-49	522.2	528.0	522.4	0.2		P12-50	520.5	525.0	520.8	0.3	
1833	0.013	8	PVC	0.0019	100.0	P12-49	524.0	528.0	524.3	0.3		P12-50	520.5	525.0	520.8	0.3	
294	0.013	8	PVC	0.0050	162.5	P12-50	520.5	525.0	520.8	0.3		P12-51	519.0	524.0	519.3	0.3	
271	0.013	8	PVC	0.0045	170.8	P12-51	519.0	524.0	519.3	0.3		P13-14	517.8	528.0	518.0	0.3	
127	0.013	8	ABS	0.0041	5.6	P12-70	526.5	532.0	526.6	0.1		P12-46	526.0	530.0	526.2	0.2	
93	0.013	8	ABS	0.0025	2.8	P12-71	525.6	532.0	525.6	0.0		P12-41	525.3	531.0	525.4	0.1	
1367	0.012	39	VCP	0.0030	6734.0	P13-1	510.9	524.0	512.1	1.2		R13-4	506.8	515.0	508.0	1.2	
454	0.013	12	ABS	0.0064	214.6	P13-2	513.8	523.0	514.1	0.3		P13-1	510.9	524.0	512.1	1.2	SUR
115	0.013	8	PVC	0.0454	202.1	P13-3	519.0	529.0	519.2	0.2		P13-2	513.8	523.0	514.0	0.2	
308	0.013	8	PVC	0.0272	77.1	P13-5	527.4	534.0	527.5	0.1		P13-3	519.0	529.0	519.1	0.1	
263	0.013	8	PVC	0.0350	65.3	P13-7	536.6	539.0	536.7	0.1		P13-5	527.4	534.0	527.5	0.1	
328	0.013	8	PVC	0.0202	50.7	P13-8	543.2	550.0	543.3	0.1		P13-7	536.6	539.0	536.7	0.1	
260	0.013	8	PVC	0.0090	180.6	P13-14	517.8	528.0	518.0	0.3		P13-15	515.4	521.0	515.8	0.3	
342	0.013	8	PVC	0.0044	191.0	P13-15	515.4	521.0	515.8	0.3		P13-17	513.9	521.0	514.8	0.9	SUR
260	0.012	36	VCP	0.0119	6499.3	P13-17	513.9	521.0	514.8	0.9		P13-1	510.9	524.0	512.1	1.2	
487	0.012	24	VCP	0.0032	478.5	P14-1	536.4	549.0	536.8	0.4		P15-1	534.9	540.0	535.3	0.4	
617	0.012	24	VCP	0.0020	435.4	P14-2	537.6	551.0	538.0	0.4		P14-1	536.4	549.0	536.8	0.4	
447	0.012	18	VCP	0.0343	247.9	P14-3	552.9	565.0	553.1	0.2		P14-2	537.6	551.0	538.0	0.4	
388	0.013	12	ABS	0.0272	179.9	P14-4	548.2	559.0	548.3	0.2		P14-2	537.6	551.0	538.0	0.4	
444	0.013	12	ABS	0.0031	170.8	P14-5	549.5	564.0	549.9	0.3		P14-4	548.2	559.0	548.3	0.2	
561	0.013	12	ABS	0.0025	144.4	P14-6	550.9	563.0	551.2	0.3		P14-5	549.5	564.0	549.9	0.3	

2010 Master Plan Stillwater Collection System Pipe Analysis Results

LENGTH (ft)	Manning's N (Double)	Diameter (in)	Material	Slope	Maximum Flow, gpm	Upstream MH Name	Upstream Invert (ft)	Upstream MH Rim	Maximum Upstream HGL	Flow Depth, ft	Class	Downstream MH Name	Downstream Invert (ft)	Downstream MH Rim	Maximum Downstream HGL	Flow Depth, ft	Class
919	0.012	24	VCP	0.0019	497.2	P15-1	534.9	540.0	535.3	0.4		R15-2	533.1	539.0	533.6	0.4	
627	0.013	12	ABS	0.0046	238.9	P15-2	555.8	569.0	556.2	0.4		P14-3	552.9	565.0	553.1	0.2	
342	0.013	8	ABS	0.0045	24.3	P15-3	566.9	571.0	567.0	0.1		O15-7	565.4	572.0	565.5	0.1	
300	0.013	8	ABS	0.0046	20.8	P15-4	568.3	573.0	568.4	0.1		P15-3	566.9	571.0	567.0	0.1	
308	0.013	8	ABS	0.0089	16.7	P15-5	571.0	576.0	571.1	0.1		P15-4	568.3	573.0	568.4	0.1	
261	0.013	8	ABS	0.0366	13.9	P15-6	580.6	585.0	580.6	0.1		P15-5	571.0	576.0	571.1	0.1	
315	0.013	6	VCP	0.0063	1.4	R12-18	523.0	528.0	523.0	0.0		R12-20	521.0	527.0	521.1	0.0	
318	0.013	6	VCP	0.0062	3.5	R12-20	521.0	527.0	521.1	0.0		R12-26	519.0	526.0	519.1	0.1	
183	0.013	6	VCP	0.0033	24.3	R12-21	516.4	523.0	516.6	0.1		R12-61	515.8	523.0	515.9	0.1	
269	0.013	6	VCP	0.0080	6.9	R12-26	519.0	526.0	519.1	0.1		R12-34	516.9	525.0	517.0	0.1	
401	0.013	6	AC	0.0083	11.8	R12-27	518.9	525.0	519.0	0.1		R12-28	515.6	523.0	515.7	0.1	
251	0.013	8	VCP	0.0047	20.1	R12-28	515.6	523.0	515.7	0.1		R12-30	514.4	522.0	514.6	0.2	
233	0.013	6	VCP	0.0040	29.9	R12-29	515.3	523.0	515.5	0.1		R12-30	514.4	522.0	514.6	0.2	
271	0.013	6	VCP	0.0040	52.8	R12-30	514.4	522.0	514.6	0.2		R12-41	513.3	521.3	513.5	0.2	
311	0.013	6	VCP	0.0062	13.2	R12-33	518.8	525.0	518.9	0.1		R12-34	516.9	525.0	517.0	0.1	
257	0.013	8	VCP	0.0050	21.5	R12-34	516.9	525.0	517.0	0.1		R12-38	515.6	524.0	515.8	0.2	
316	0.013	6	VCP	0.0044	17.4	R12-37	517.0	524.0	517.1	0.1		R12-38	515.6	524.0	515.8	0.2	
256	0.013	8	VCP	0.0046	42.4	R12-38	515.6	524.0	515.8	0.2		R12-45	514.4	523.0	514.7	0.3	
358	0.013	6	VCP	0.0054	63.9	R12-41	513.3	521.3	513.5	0.2		R12-48	511.4	520.3	511.8	0.4	
363	0.013	10	VCP	0.0024	109.0	R12-44	515.3	523.0	515.6	0.3		R12-45	514.4	523.0	514.7	0.3	
248	0.013	10	VCP	0.0045	177.1	R12-45	514.4	523.0	514.7	0.3		R12-46	513.3	521.0	513.7	0.4	
266	0.013	10	VCP	0.0029	189.6	R12-46	513.3	521.0	513.7	0.4		R12-47	512.6	521.0	512.9	0.3	
254	0.013	10	VCP	0.0046	204.9	R12-47	512.6	521.0	512.9	0.3		R12-48	511.4	520.3	511.8	0.4	
260	0.013	10	VCP	0.0030	277.8	R12-48	511.4	520.3	511.8	0.4		R12-49	510.6	520.9	511.0	0.4	
345	0.013	10	VCP	0.0030	343.1	R12-49	510.6	520.9	511.1	0.5		R12-52	509.6	521.1	510.5	0.9	SUR
192	0.013	12	ABS	-0.0016	346.5	R12-52	509.6	521.1	510.5	0.9		R12-76	509.9	519.6	510.3	0.4	
263	0.013	8	VCP	0.0034	22.9	R12-53	515.3	523.0	515.4	0.1		R12-45	514.4	523.0	514.7	0.3	
274	0.013	8	VCP	0.0039	18.8	R12-54	516.4	522.0	516.5	0.1		R12-53	515.3	523.0	515.4	0.1	
300	0.013	6	VCP	0.0071	7.6	R12-58	521.0	527.0	521.1	0.1		R12-59	518.9	525.0	519.0	0.1	
383	0.013	6	VCP	0.0056	16.0	R12-59	518.9	525.0	519.0	0.1		R12-60	516.8	524.0	516.9	0.1	
77	0.013	8	VCP	0.0048	22.9	R12-60	516.8	524.0	516.9	0.1		R12-21	516.4	523.0	516.6	0.1	
59	0.013	6	VCP	0.0085	27.8	R12-61	515.8	523.0	515.9	0.1		R12-29	515.3	523.0	515.5	0.1	
323	0.013	8	ABS	0.0033	25.7	R12-64	516.3	522.0	516.4	0.1		S12-22	515.2	520.0	515.4	0.1	
133	0.013	8	ABS	0.0039	7.6	R12-65	515.4	524.0	515.5	0.1		R12-74	514.9	521.0	515.0	0.1	
295	0.013	8	ABS	0.0050	4.9	R12-66	517.0	521.0	517.1	0.1		R12-65	515.4	524.0	515.4	0.0	
420	0.013	6	ABS	0.0072	11.1	R12-69	515.6	526.0	515.6	0.1		R12-47	512.6	521.0	512.9	0.3	
128	0.013	8	ABS	0.0048	4.2	R12-71	513.5	521.0	513.5	0.0		R12-73	512.8	518.0	512.9	0.1	
364	0.013	8	ABS	0.0043	2.1	R12-72	515.0	519.0	515.1	0.0		R12-71	513.5	521.0	513.5	0.0	
164	0.013	8	ABS	0.0089	8.3	R12-73	512.8	518.0	512.9	0.1		R12-48	511.4	520.3	511.8	0.4	
238	0.013	6	ABS	0.0066	10.4	R12-74	514.9	521.0	515.0	0.1		R12-46	513.3	521.0	513.7	0.4	
411	0.013	12	ABS	0.0034	354.2	R12-75	509.3	519.6	509.7	0.4		R13-11	507.9	516.4	508.3	0.4	
228	0.013	12	ABS	0.0026	348.6	R12-76	509.9	519.6	510.4	0.5		R12-75	509.3	519.6	509.7	0.4	
132	0.013	8	ABS	0.0047	21.5	R12-82	516.9	521.0	517.0	0.1		R12-64	516.3	522.0	516.4	0.1	
1090	0.012	42	RCP	0.0024	8161.1	R13-1	500.3	514.0	501.7	1.4		S13-15	497.7	514.0	499.1	1.4	
523	0.012	39	VCP	0.0040	6836.1	R13-2	502.4	513.0	503.6	1.1		R13-1	500.3	514.0	501.7	1.4	
538	0.012	39	VCP	0.0034	6825.7	R13-3	504.2	514.0	505.4	1.2		R13-2	502.4	513.0	503.5	1.1	
766	0.012	39	VCP	0.0033	6775.0	R13-4	506.8	515.0	508.0	1.2		R13-3	504.2	514.0	505.4	1.2	
376	0.012	21	VCP	0.0094	874.3	R13-5	503.9	516.0	504.3	0.4		R13-1	500.3	514.0	501.7	1.4	
305	0.012	21	VCP	0.0054	863.9	R13-6	505.5	517.0	506.0	0.5		R13-5	503.9	516.0	504.3	0.4	
610	0.013	12	ABS	0.0070	445.8	R13-7	504.6	517.0	505.0	0.4		R13-1	500.3	514.0	501.7	1.4	SUR
261	0.013	12	ABS	0.0028	440.3	R13-8	505.3	517.0	505.9	0.5		R13-7	504.6	517.0	505.0	0.4	
370	0.013	12	ABS	0.0027	436.1	R13-9	506.3	517.0	506.8	0.5		R13-8	505.3	517.0	505.8	0.5	

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LENGTH (ft)	Manning's N (Double)	Diameter (in)	Material	Slope	Maximum Flow, gpm	Upstream MH Name	Upstream Invert (ft)	Upstream MH Rim	Maximum Upstream HGL	Flow Depth, ft	Class	Downstream MH Name	Downstream Invert (ft)	Downstream MH Rim	Maximum Downstream HGL	Flow Depth, ft	Class
311	0.013	12	ABS	0.0026	418.1	R13-10	507.1	517.0	507.6	0.5		R13-9	506.3	517.0	506.8	0.5	
290	0.013	12	ABS	0.0028	375.0	R13-11	507.9	516.4	508.4	0.5		R13-10	507.1	517.0	507.6	0.5	
769	0.012	18	VCP	0.0138	572.9	R14-1	528.7	536.0	529.1	0.3		R14-5	518.1	527.0	518.5	0.3	
132	0.012	21	VCP	0.0075	702.8	R14-2	514.9	526.0	515.2	0.4		R14-3	513.9	527.0	514.3	0.4	
861	0.012	21	VCP	0.0049	771.5	R14-3	513.9	527.0	514.3	0.4		R14-4	509.7	522.0	510.1	0.5	
794	0.012	21	VCP	0.0052	831.9	R14-4	509.7	522.0	510.1	0.5		R13-6	505.5	517.0	506.0	0.5	
252	0.012	18	VCP	0.0130	628.5	R14-5	518.1	527.0	518.5	0.3		R14-2	514.9	526.0	515.2	0.4	
1034	0.012	24	VCP	0.0021	527.1	R15-1	530.9	541.0	531.4	0.5		R14-1	528.7	536.0	529.1	0.3	
1152	0.012	24	VCP	0.0019	516.0	R15-2	533.1	539.0	533.6	0.4		R15-1	530.9	541.0	531.4	0.5	
365	0.013	8	ABS	0.0037	4.9	S12-2	511.7	519.0	511.7	0.1		S12-5	510.3	520.0	510.4	0.1	
202	0.013	8	ABS	0.0133	10.4	S12-5	510.3	520.0	510.4	0.1		S12-6	507.6	518.0	507.9	0.3	
371	0.013	8	ABS	0.0037	122.9	S12-6	507.6	518.0	507.9	0.3		S12-8	506.2	516.0	506.5	0.3	
411	0.013	8	ABS	0.0031	130.6	S12-8	506.2	516.0	506.5	0.3		T12-2	504.9	515.0	505.2	0.3	
437	0.013	8	ABS	0.0040	106.3	S12-9	509.4	517.0	509.6	0.3		S12-6	507.6	518.0	507.9	0.3	
317	0.013	8	ABS	0.0044	77.8	S12-10	510.8	517.0	511.0	0.2		S12-9	509.4	517.0	509.6	0.3	
208	0.013	8	ABS	0.0041	23.6	S12-12	510.2	516.0	510.3	0.1		S12-9	509.4	517.0	509.6	0.3	
323	0.013	8	ABS	0.0032	18.1	S12-14	511.3	517.0	511.4	0.1		S12-12	510.2	516.0	510.3	0.1	
220	0.013	8	ABS	0.0099	72.2	S12-15	512.9	517.0	513.1	0.2		S12-10	510.8	517.0	511.0	0.2	
387	0.013	8	ABS	0.0003	63.9	S12-16	513.0	519.0	513.5	0.4		S12-15	512.9	517.0	513.1	0.2	
235	0.013	8	ABS	0.0043	35.4	S12-21	514.1	517.0	514.2	0.1		S12-16	513.0	519.0	513.5	0.4	
305	0.013	8	ABS	0.0038	31.3	S12-22	515.2	520.0	515.4	0.1		S12-21	514.1	517.0	514.2	0.1	
377	0.013	8	ABS	0.0176	7.6	S12-30	510.9	516.0	510.9	0.0		T12-22	504.2	516.0	504.5	0.3	
385	0.013	8	ABS	0.0046	102.8	S12-33	507.6	517.0	507.9	0.2		T12-23	505.9	516.0	506.2	0.3	
389	0.013	8	ABS	0.0041	87.5	S12-34	509.2	518.0	509.5	0.2		S12-33	507.6	517.0	507.9	0.2	
382	0.013	8	ABS	0.0039	45.1	S12-36	510.7	517.0	510.9	0.2		S12-34	509.2	518.0	509.5	0.2	
420	0.013	8	ABS	0.0035	31.3	S12-37	512.2	519.0	512.3	0.1		S12-36	510.7	517.0	510.9	0.2	
324	0.013	8	ABS	0.0035	21.5	S12-38	513.3	518.0	513.4	0.1		S12-37	512.2	519.0	512.3	0.1	
172	0.013	8	ABS	0.0036	13.9	S12-42	513.9	517.0	514.0	0.1		S12-38	513.3	518.0	513.4	0.1	
365	0.013	8	ABS	0.0036	9.0	S12-43	515.2	519.0	515.3	0.1		S12-42	513.9	517.0	514.0	0.1	
417	0.013	8	ABS	0.0035	4.2	S12-44	516.7	521.0	516.7	0.1		S12-43	515.2	519.0	515.3	0.1	
400	0.013	8	ABS	0.0119	4.2	S12-45	513.1	521.0	513.1	0.0		S13-5	508.3	517.0	508.4	0.1	
1337	0.012	42	RCP	0.0024	8287.5	S13-1	497.2	514.0	498.7	1.4		T13-9	494.1	509.0	495.6	1.6	
462	0.013	8	ABS	0.0044	13.2	S13-2	512.7	517.0	512.8	0.1		S13-3	510.6	516.0	510.7	0.1	
292	0.013	8	ABS	0.0047	19.4	S13-3	510.6	516.0	510.7	0.1		S13-4	509.3	515.0	509.4	0.1	
186	0.013	8	ABS	0.0053	22.9	S13-4	509.3	515.0	509.4	0.1		S13-5	508.3	517.0	508.4	0.1	
324	0.013	8	WABS	0.0037	31.3	S13-5	508.3	517.0	508.4	0.1		R13-10	507.1	517.0	507.6	0.5	
185	0.013	8	ABS	0.0046	3.5	S13-6	511.5	522.0	511.5	0.0		S13-3	510.6	516.0	510.7	0.1	
318	0.013	8	SDR-35	0.0050	18.1	S13-7	509.9	520.0	510.0	0.1		S13-10	508.3	518.0	508.4	0.1	
268	0.013	8	SDR-35	0.0117	8.3	S13-9	513.0	523.0	513.1	0.1		S13-7	509.9	520.0	510.0	0.1	
210	0.013	8	SDR-35	0.0057	25.0	S13-10	508.3	518.0	508.4	0.1		S13-12	507.1	517.0	507.2	0.1	
285	0.013	8	SDR-35	0.0042	31.3	S13-12	507.1	517.0	507.2	0.1		S13-13	505.9	516.0	506.1	0.2	
278	0.013	8	SDR-35	0.0051	45.8	S13-13	505.9	516.0	506.1	0.2		S13-14	504.5	514.0	504.6	0.1	
278	0.013	8	SDR-35	0.0243	51.4	S13-14	504.5	514.0	504.6	0.1		S13-15	497.7	514.0	499.1	1.4	SUR
186	0.012	42	VCP	0.0026	8238.9	S13-15	497.7	514.0	499.1	1.4		S13-13	497.2	516.0	506.1	8.8	SUR
412	0.013	10	ABS	0.0086	8.3	SA14-2	483.4	487.0	483.4	0.1		SB14-3	479.8	485.0	487.4	7.6	SSO
544	0.013	10	ABS	0.0038	179.2	SA14-2	479.8	487.0	480.1	0.3		SB14-3	477.8	485.0	487.4	9.7	SSO
1382	0.012	48	RCP	0.0012	10225.0	SA14-3	470.4	486.0	472.2	1.8		SB13-10	468.7	483.0	470.5	1.8	
1315	0.012	48	RCP	0.0012	10179.9	SA14-4	472.0	488.0	473.8	1.8		SA14-3	470.4	486.0	472.2	1.8	
437	0.013	10	PVC	0.0035	25.0	SA14-6	485.7	492.0	485.8	0.1		SA14-9	484.2	492.0	492.5	8.3	SSO
100	0.013	10	PVC	0.0005	42.4	SA14-7	480.5	488.0	480.8	0.3		SA14-8	480.5	485.0	490.0	9.6	SSO
145	0.013	10	PVC	0.0043	167.4	SA14-8	480.5	485.0	480.7	0.3		SB14-2	479.8	489.0	485.5	5.7	SUR
501	0.013	10	PVC	0.0035	31.3	SA14-9	484.2	492.0	484.3	0.1		SA14-10	482.5	488.0	491.4	8.9	SSO

2010 Master Plan Stillwater Collection System Pipe Analysis Results

LENGTH (ft)	Manning's N (Double)	Diameter (in)	Material	Slope	Maximum Flow, gpm	Upstream MH Name	Upstream Invert (ft)	Upstream MH Rim	Maximum Upstream HGL	Flow Depth, ft	Class	Downstream MH Name	Downstream Invert (ft)	Downstream MH Rim	Maximum Downstream HGL	Flow Depth, ft	Class
479	0.013	10	PVC	0.0035	39.6	SA14-10	482.5	488.0	482.6	0.2		SA14-7	480.5	488.0	490.3	9.8	SSO
381	0.013	10	PVC	0.0029	122.2	SA14-11	481.6	488.0	481.8	0.3		SA14-8	480.5	485.0	490.0	9.6	SSO
327	0.013	8	PVC	0.0068	6.3	SA14-12	485.3	491.0	485.4	0.1		SA14-13	483.1	489.0	490.3	7.2	SSO
546	0.013	10	PVC	0.0028	37.5	SA14-13	483.1	489.0	483.3	0.2		SA14-11	481.6	488.0	490.2	8.6	SSO
522	0.013	10	PVC	0.0020	24.3	SA14-14	484.2	489.0	484.3	0.1		SA14-13	483.1	489.0	490.3	7.2	SSO
465	0.013	10	PVC	0.0030	16.7	SA14-15	485.6	490.0	485.7	0.1		SA14-14	484.2	489.0	490.3	6.2	SSO
450	0.013	10	PVC	0.0035	9.0	SA15-1	487.3	494.0	487.4	0.1		SA14-6	485.7	492.0	493.4	7.7	SSO
1340	0.012	48	RCP	0.0013	10338.9	SB13-10	468.7	483.0	470.5	1.8		SC14-3	467.0	481.0	468.9	1.9	
416	0.013	10	ABS	0.0039	220.8	SB14-1	474.6	487.3	475.0	0.5		SC14-6	473.0	484.0	480.5	7.5	SUR
594	0.013	10	ABS	0.0027	202.1	SB14-2	476.3	489.0	476.6	0.4		SB14-1	474.6	487.3	482.7	8.2	SUR
457	0.013	10	ABS	0.0033	186.8	SB14-3	477.8	485.0	478.1	0.3		SB14-2	476.3	489.0	485.5	9.2	SUR
298	0.013	8	PVC	0.0078	7.6	SB14-5	485.2	492.0	485.3	0.1		SB14-6	482.9	490.0	490.2	7.3	SSO
449	0.013	10	PVC	0.0030	77.1	SB14-6	482.9	490.0	483.1	0.2		SA14-11	481.6	488.0	490.2	8.6	SSO
518	0.013	10	PVC	0.0025	64.6	SB14-7	484.2	491.0	484.4	0.2		SB14-6	482.9	490.0	490.2	7.3	SSO
364	0.013	8	PVC	0.0027	57.6	SB14-8	485.0	487.0	485.4	0.4		SB14-7	484.2	491.0	490.3	6.1	SUR
244	0.013	8	PVC	0.0048	50.7	SB14-9	486.2	487.0	486.3	0.2		SB14-8	485.0	487.0	490.4	5.4	SSO
1350	0.012	48	RCP	0.0012	10966.0	SC14-1	465.0	474.0	466.9	1.9		SD14-3	463.5	478.0	465.4	1.9	
249	0.012	48	RCP	0.0013	10888.9	SC14-2	465.3	479.0	467.2	1.9		SC14-1	465.0	478.0	467.0	1.9	
349	0.012	48	RCP	0.0012	10356.9	SC14-3	467.0	481.0	468.9	1.9		SC14-7	466.7	487.0	468.4	1.6	
168	0.013	10	ABS	0.0191	313.9	SC14-4	468.6	484.5	468.8	0.3		SC14-2	465.3	479.0	467.2	1.9	SUR
607	0.013	10	ABS	0.0032	309.0	SC14-5	470.5	488.5	471.0	0.5		SC14-4	468.6	484.5	469.1	0.5	
626	0.013	10	ABS	0.0037	266.0	SC14-6	473.0	484.0	473.4	0.4		SC14-13	470.7	491.0	475.8	5.1	SUR
832	0.012	48	RCP	0.0016	10374.3	SC14-7	466.7	487.0	468.4	1.7		SC14-2	465.3	479.0	467.2	1.9	
51	0.013	12	ABS	0.0913	83.3	SC14-8	469.7	479.0	469.8	0.1		SC14-1	465.0	478.0	467.0	1.9	SUR
109	0.013	8	ABS	0.1128	2.8	SC14-9	482.0	492.0	482.0	0.0		SC14-8	469.7	479.0	469.8	0.1	
348	0.013	8	SDR-35	0.0082	79.2	SC14-10	472.6	482.0	472.8	0.2		SC14-8	469.7	479.0	469.8	0.1	
268	0.013	8	SDR-35	0.0078	74.3	SC14-11	474.7	483.0	474.8	0.2		SC14-10	472.6	482.0	472.8	0.2	
370	0.013	8	SDR-35	0.0103	46.5	SC14-12	478.5	482.0	478.6	0.1		SC14-11	474.7	483.0	474.8	0.2	
118	0.013	10	ABS	0.0017	288.9	SC14-13	470.7	491.0	471.2	0.5		SC14-5	470.5	488.5	474.9	4.4	SUR
622	0.012	48	RCP	0.0015	11091.7	SD14-1	460.7	474.0	462.5	1.8		SE15-3	459.8	471.0	461.6	1.8	
1212	0.012	48	RCP	0.0011	11045.1	SD14-2	462.0	477.0	464.0	2.0		SD14-1	460.7	474.0	462.5	1.8	
1189	0.012	48	RCP	0.0012	10987.5	SD14-3	463.5	478.0	465.3	1.9		SD14-2	462.0	477.0	464.0	2.0	
656	0.012	48	RCP	0.0012	11334.7	SE15-1	457.6	476.0	459.5	1.9		SE15-4	456.8	476.0	458.8	1.9	
1060	0.012	48	RCP	0.0011	11302.1	SE15-2	458.8	480.0	460.8	2.0		SE15-1	457.6	476.0	459.6	1.9	
2083	0.013	8	RCP	0.0049	148.6	SE15-2	469.0	480.0	469.3	0.3		SE15-1	458.8	476.0	459.6	0.7	SUR
682	0.012	48	RCP	0.0014	11127.1	SE15-3	459.8	471.0	461.6	1.8		SE15-2	458.8	480.0	460.8	2.0	
918	0.012	48	RCP	0.0013	11334.7	SE15-4	456.8	476.0	458.7	1.9		SF15-5	455.7	471.0	457.4	1.8	
65	0.012	36		0.0029	11334.7	SF15-1	433.9	443.9	435.4	1.5		SF15-2	433.7	465.0	435.1	1.4	
452	0.012	36	RCP	0.0427	11334.7	SF15-2	453.2	465.0	454.1	0.8		SF15-1	433.9	443.9	435.5	1.5	
100	0.012	102		0.0000	11334.7	SF15-2	433.7	465.0	435.1	1.4		Outfall					
426	0.012	48	RCP	0.0024	11334.7	SF15-3	454.3	474.0	455.8	1.5		SF15-2	453.2	465.0	453.2	0.0	
394	0.012	48	RCP	0.0014	11334.7	SF15-4	454.8	469.0	456.6	1.8		SF15-3	454.3	474.0	455.8	1.5	
500	0.012	48	RCP	0.0017	11334.7	SF15-5	455.7	471.0	457.4	1.7		SF15-4	454.8	469.0	456.6	1.8	
153	0.013	8	ABS	0.0047	140.3	T12-2	504.9	515.0	505.2	0.3		T12-3	504.2	514.0	504.7	0.5	
455	0.013	10	ABS	0.0023	268.1	T12-3	504.2	514.0	504.7	0.5		T12-5	503.2	519.0	503.6	0.4	
211	0.013	10	ABS	0.0025	125.0	T12-4	504.7	515.0	505.0	0.3		T12-3	504.2	514.0	504.7	0.5	
116	0.013	10	ABS	0.0049	268.8	T12-5	503.2	519.0	503.6	0.4		T12-21	502.6	513.0	503.5	0.9	SUR
94	0.013	8	ABS	0.0017	36.8	T12-6	511.5	515.0	511.7	0.2		T12-7	511.3	516.0	511.5	0.2	
371	0.013	8	ABS	0.0034	38.9	T12-7	511.3	516.0	511.5	0.2		T12-9	510.1	517.0	510.2	0.2	
425	0.013	8	ABS	0.0035	43.8	T12-9	510.1	517.0	510.2	0.2		T12-19	508.6	515.0	508.8	0.2	
330	0.013	8	ABS	0.0044	72.2	T12-12	507.6	514.0	507.8	0.2		T12-15	506.1	516.0	506.4	0.2	
269	0.013	8	ABS	0.0048	65.3	T12-13	508.9	515.0	509.1	0.2		T12-12	507.6	514.0	507.8	0.2	

2010 Master Plan Stillwater Collection System Pipe Analysis Results

LENGTH (ft)	Manning's N (Double)	Diameter (in)	Material	Slope	Maximum Flow, gpm	Upstream MH Name	Upstream Invert (ft)	Upstream MH Rim	Maximum Upstream HGL	Flow Depth, ft	Class	Downstream MH Name	Downstream Invert (ft)	Downstream MH Rim	Maximum Downstream HGL	Flow Depth, ft	Class
186	0.013	8	ABS	0.0040	48.6	T12-14	509.6	514.0	509.8	0.2		T12-13	508.9	515.0	509.1	0.2	
208	0.013	8	ABS	0.0067	124.3	T12-15	506.1	516.0	506.4	0.2		T12-4	504.7	515.0	505.0	0.3	
125	0.013	8	ABS	0.0042	4.2	T12-16	510.2	514.0	510.2	0.1		T12-14	509.6	514.0	509.8	0.2	
399	0.013	8	ABS	0.0032	11.1	T12-17	512.5	517.0	512.6	0.1		S12-14	511.3	517.0	511.4	0.1	
317	0.013	8	ABS	0.0042	47.9	T12-18	507.5	514.0	507.6	0.2		T12-15	506.1	516.0	506.4	0.2	
211	0.013	8	ABS	0.0054	45.8	T12-19	508.6	515.0	508.8	0.2		T12-18	507.5	514.0	507.6	0.2	
231	0.013	12	ABS	0.0044	661.8	T12-21	502.6	513.0	503.5	0.9		T12-36	501.9	522.0	502.6	0.7	
197	0.013	8	ABS	0.0082	152.8	T12-22	504.2	516.0	504.5	0.3		T12-21	502.6	513.0	503.5	0.9	SUR
385	0.013	8	ABS	0.0043	140.3	T12-23	505.9	516.0	506.2	0.3		T12-22	504.2	516.0	504.5	0.3	
61	0.013	10	ABS	0.0072	236.8	T12-24	503.7	516.0	504.0	0.3		T12-28	503.2	513.0	503.6	0.3	
205	0.013	8	ABS	0.0053	230.6	T12-25	504.8	515.0	505.2	0.4		T12-24	503.7	516.0	504.0	0.3	
176	0.013	8	ABS	0.0037	225.7	T12-26	505.4	515.0	505.8	0.4		T12-25	504.8	515.0	505.2	0.4	
151	0.013	10	SDR-35	0.0044	238.9	T12-28	503.2	513.0	503.6	0.3		T12-21	502.6	513.0	503.5	0.9	SUR
280	0.013	8	ABS	0.0035	222.2	T12-29	506.4	516.0	506.8	0.4		T12-26	505.4	515.0	505.8	0.4	
250	0.013	8	ABS	0.0036	213.2	T12-31	507.3	517.0	507.7	0.4		T12-29	506.4	516.0	506.8	0.4	
499	0.013	12	ABS	0.0024	663.2	T12-36	501.9	522.0	502.6	0.7		T13-5	500.7	520.0	501.6	0.9	
303	0.013	8	ABS	0.0127	177.8	T13-1	512.1	522.0	512.4	0.2		T13-3	508.3	518.0	508.7	0.4	
282	0.013	8	ABS	0.0035	198.6	T13-3	508.3	518.0	508.7	0.4		T12-31	507.3	517.0	507.7	0.4	
761	0.013	12	SDR-35	0.0015	670.8	T13-5	500.7	520.0	501.6	0.9		T13-7	499.5	516.0	500.3	0.8	
500	0.013	12	SDR-35	0.0024	686.1	T13-7	499.5	516.0	500.3	0.8		T13-8	498.3	514.0	498.8	0.5	
503	0.013	12	SDR-35	0.0085	700.7	T13-8	498.3	514.0	498.8	0.5		T13-9	494.1	509.0	495.6	1.6	SUR
1156	0.012	42	RCP	0.0018	9032.6	T13-9	494.1	509.0	495.7	1.6		T13-10	492.0	509.0	493.5	1.6	
506	0.012	42	RCP	0.0020	9109.0	T13-10	492.0	509.0	493.6	1.6		V13-5	491.0	512.0	492.6	1.6	
60	0.012	42	RCP	0.0037	9191.0	V13-4	489.3	512.0	490.8	1.4		V13-25	489.1	510.0	490.6	1.5	
912	0.012	42	RCP	0.0018	9150.0	V13-5	491.0	512.0	492.6	1.6		V13-4	489.3	512.0	490.7	1.4	
1419	0.012	42	RCP	0.0025	9204.2	V13-25	489.1	510.0	490.6	1.5		W13-2	485.6	504.0	487.2	1.6	
1417	0.012	42	RCP	0.0020	9471.5	W13-1	483.2	507.0	484.8	1.6		X13-1	480.4	500.0	481.9	1.5	
1281	0.012	42	RCP	0.0019	9395.8	W13-2	485.6	504.0	487.2	1.6		W13-1	483.2	507.0	484.8	1.6	
1325	0.012	42	RCP	0.0024	9609.0	X13-1	480.4	500.0	481.9	1.5		Y13-2	477.2	494.0	479.1	2.0	
1318	0.012	48	RCP	0.0010	9800.0	Y13-1	476.5	492.0	478.4	1.9		Z13-3	475.2	493.0	476.9	1.8	
686	0.012	42	RCP	0.0010	9663.9	Y13-2	477.2	494.0	479.1	2.0		Y13-1	476.5	492.0	478.3	1.8	
695	0.012	48	RCP	0.0011	9943.1	Z13-2	474.4	493.0	476.2	1.8		Z14-1	473.6	489.0	475.4	1.8	
671	0.012	48	RCP	0.0011	9913.9	Z13-3	475.2	493.0	477.0	1.8		Z13-2	474.4	493.0	476.2	1.8	
1354	0.012	48	RCP	0.0012	10097.9	Z14-1	473.6	489.0	475.4	1.8		SA14-4	472.0	488.0	473.7	1.8	
514	0.013	12	SDR-35	0.0083	154.2	Z14-2	477.9	490.0	478.1	0.2		Z14-1	473.6	489.0	475.4	1.8	SUR
514	0.013	12	SDR-35	0.0025	143.8	Z14-3	479.2	495.0	479.5	0.3		Z14-2	477.9	490.0	478.1	0.2	
514	0.013	12	SDR-35	0.0025	119.4	Z14-4	480.5	496.0	480.7	0.3		Z14-3	479.2	495.0	479.5	0.3	
486	0.013	12	SDR-35	0.0032	113.2	Z14-5	482.0	499.0	482.3	0.2		Z14-4	480.5	496.0	480.7	0.3	
707	0.013	10	SDR-35	0.0030	94.4	Z14-6	484.1	498.0	484.4	0.2		Z14-5	482.0	499.0	482.3	0.2	
397	0.013	8	SDR-35	0.0036	83.3	Z14-7	485.6	500.0	485.8	0.2		Z14-6	484.1	498.0	484.4	0.2	
494	0.013	8	SDR-35	0.0053	66.7	Z14-8	488.2	496.0	488.4	0.2		Z14-7	485.6	500.0	485.8	0.2	

APPENDIX E
Large Scale Maps

Map of City of Redding Wastewater Collection System and Service Area

Map of parcels with independent sewer systems

APPENDIX F

Population Forecasting Reference Materials

Technical Memorandum for Shasta County RTPA Demand Model Assumptions

Table of population forecasting from Economic Sciences Corporation

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Oakland, CA 94612
www.dowlinginc.com

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maronson@dowlinginc.com

Dowling Associates, Inc.

Date: June 4, 2007

Memorandum

To: Thomas Hays, Shasta RTPA

cc: Shasta Model Users Group

From: Mike Aronson

Reference: Shasta RTPA Model Update P01114

Subject: Land Use Forecast Assumptions

This memorandum summarizes the land use assumptions for the Shasta County travel model.

Summary

Forecast Process

The land use forecasts for the Shasta County travel model were developed using a combination of:

- Detailed information on individual planned development in each jurisdiction
- Overall growth forecasts for Shasta County from several sources
- Growth forecasts prepared by economists for specific areas (Redding and South County)

The overall forecasts for all of Shasta County and for individual jurisdictions were compiled for each five-year increment between 2005 and 2030.

The actual inputs to the travel modeling process were developed on a parcel basis, starting with the known pipeline development and adding assumed development in other likely areas to match the control totals as closely as possible. In some cases, pipeline development alone would exceed the growth totals, and therefore a slower phasing of development and occupancy would be assumed for certain development areas.

Pipeline Development

The economic consulting firm of Strategic Economics met with planning staff from Shasta County and the cities of Anderson, Redding and Shasta Lake. They prepared comprehensive lists and maps of known "pipeline" development projects in each jurisdiction.

Population Forecasts

Population and housing forecasts to the year 2030 were compiled from the following sources:

- Overall County: California Department of Finance population projections
- Redding: Economic Science Corporation (ESC) projection for the Redding Electric Utility, adjusted for available residential land supply
- Anderson, Cottonwood and South County: Forecasts prepared by Pacific Municipal Consultants (PMC) for South County transportation studies
- Other areas: Historic growth rates from 1990 and 2000 Census, adjusted upwards for areas with known development proposals

The forecasts result in an increase of 48 percent in housing units between 2005 and 2030,

Employment Forecasts

There are no official State of California forecasts of employment by jurisdiction or county. Overall employment forecasts by economic sector were initially based on commercial forecasts prepared by Woods and Poole. These were adjusted upwards to be consistent with the assumed Shasta County population forecasts, which were higher than those assumed by Woods and Poole.

The forecasts result in an increase of 49 percent in total employment between 2005 and 2030.

Residential Projections

Projections for residential growth were documented by Strategic Economics in a memorandum dated November 10, 2005 (Figure 1 and Table 1). These projections were used as the control total targets for residential growth during the parcel-based allocation process. The individual assumptions by jurisdiction and subarea were also noted (Table 2).

Previous Residential Projection

For the 2000 Transportation Model, Economic and Planning Systems (EPS) developed a projection of growth in Shasta County. As is done in this current analysis, EPS compared the historic performance of multiple projections sources before developing the preferred projection for the County. Ultimately, it was determined that the high-migration Economic Sciences Corporation projection for the City of Redding would be the appropriate base for a countywide projection. The projection demonstrated an accurate history of projecting population growth in the City, and was the basis for the City's General Plan update being completed concurrently with the transportation model.

Figure 1: Shasta County Subareas for Residential Projections

Table 1: Shasta County Residential Projection Targets

PROJECTION OF OCCUPIED RESIDENTIAL UNITS BY SUBAREA, SHASTA COUNTY 2005-2030

			2005 base year (DOF occupied housing units)	2010	2015	2020	2025	2030	Estimated Incremental Household Growth	Estimated Percent Household Growth	Net Remaining	Land Capacity (Est. Units)[1]
Projected Units Countywide			68,220	75,158	81,656	88,154	94,652	101,150	32,930	48.3%	32,930	43,962
	Redding at Midpoint Densities, Assume 75% Buildout		34,612	39,109	43,115	46,603	49,587	52,044	17,432	50.4%	15,497	17,432
	Anderson (OmniMeans/PMC)		3,847	5,191	6,531	7,765	8,553	9,193	5,346	139.0%	10,151	5,346
	Shasta Lake		3,786	4,286	4,786	5,286	5,786	6,286	2,500	66.0%	7,651	3,917
	Total Unincorporated County		25,975	26,572	27,224	28,499	30,726	33,626	7,651	29.5%	7,651	17,503
	Urban:	Cottonwood (OmniMeans/PMC)	1,160	1,368	1,614	1,904	2,247	2,651	1,491	128.5%	6,160	1,492
		Other South County (OmniMeans/PMC)	932	1,020	1,104	1,188	1,830	2,482	1,550	166.3%	4,610	444
		Palo Cedro and Southeast of Redding, 70% Buildout	1,562	1,592	1,624	1,715	1,839	2,024	462	29.6%	4,149	924
		Happy Valley (Incl. North Fork)	845	919	998	1,219	1,524	1,977	1,132	134.0%	3,017	2,724
	Rural:	North Central Shasta County (Big Bend, Montgomery	1,240	1,253	1,268	1,308	1,363	1,444	204	16.5%	2,812	----
		East Shasta County (Burney, Fall River, McArthur, C	3,365	3,399	3,436	3,538	3,680	3,889	524	15.6%	2,288	
		Shingletown and Highway 44 Dersch Road Corridor	1,811	1,890	1,974	2,211	2,536	3,020	1,209	66.8%	1,079	5,770
		Other	10,856	10,881	10,908	10,984	11,088	11,242	386	3.6%	693	
		Bella Vista Water/Northeast of Redding	4,204	4,249	4,298	4,433	4,620	4,897	693	16.5%	0	1,095

PROJECTION OF OCCUPIED RESIDENTIAL UNITS BY SUBAREA, SHASTA COUNTY, 5-YEAR INCREMENTS

			2005 base year (DOF occupied housing units)	2005 to 2010	2010 to 2015	2015 to 2020	2020 to 2025	2025 to 2030
Projected Units Countywide			68,220	6,938	6,498	6,498	6,498	6,498
	Redding at Midpoint Densities, Assume 75% Buildout		34,612	4,497	4,006	3,488	2,983	2,458
	Anderson (OmniMeans/PMC)		3,847	1,344	1,340	1,234	788	640
	Shasta Lake		3,786	500	500	500	500	500
	Total Unincorporated County		25,975	597	652	1,276	2,227	2,900
	Urban:	Cottonwood (OmniMeans/PMC)	1,160	208	246	290	343	404
		Other South County (OmniMeans/PMC)	932	88	84	84	642	652
		Palo Cedro and Southeast of Redding, 70% Buildout	1,562	30	32	90	124	185
		Happy Valley (Incl. North Fork)	845	74	79	221	305	453
	Rural:	North Central Shasta County (Big Bend, Montgomery	1,240	13	14	40	55	82
		East Shasta County (Burney, Fall River, McArthur, C	3,365	34	37	103	141	210
		Shingletown and Highway 44 Dersch Road Corridor	1,811	79	84	236	326	484
		Other	10,856	25	27	76	104	155
		Bella Vista Water/Northeast of Redding	4,204	45	48	135	187	277

Source: Strategic Economics, November, 2005

Table 1: Shasta County Residential Projection Targets

PROJECTION OF OCCUPIED RESIDENTIAL UNITS BY SUBAREA, SHASTA COUNTY 2005-2030

			2005 base year (DOF occupied housing units)	2010	2015	2020	2025	2030	Estimated Incremental Household Growth	Estimated Percent Household Growth	Net Remaining	Land Capacity (Est. Units)[1]
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	Redding at Midpoint Densities, Assume 75% Buildout		34,612	39,109	43,115	46,603	49,587	52,044	17,432	50.4%	15,497	17,432
	Anderson (OmniMeans/PMC)		3,847	5,191	6,531	7,765	8,553	9,193	5,346	139.0%	10,151	5,346
	Shasta Lake		3,786	4,286	4,786	5,286	5,786	6,286	2,500	66.0%	7,651	3,917
	Total Unincorporated County		25,975	26,572	27,224	28,499	30,726	33,626	7,651	29.5%	7,651	17,503
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		Happy Valley (Incl. North Fork)	845	919	998	1,219	1,524	1,977	1,132	134.0%	3,017	2,724
	Rural:	North Central Shasta County (Big Bend, Montgomery	1,240	1,253	1,268	1,308	1,363	1,444	204	16.5%	2,812	----
		East Shasta County (Burney, Fall River, McArthur, C	3,365	3,399	3,436	3,538	3,680	3,889	524	15.6%	2,288	
		Shingletown and Highway 44 Dersch Road Corridor	1,811	1,890	1,974	2,211	2,536	3,020	1,209	66.8%	1,079	5,770
		Other	10,856	10,881	10,908	10,984	11,088	11,242	386	3.6%	693	
		Bella Vista Water/Northeast of Redding	4,204	4,249	4,298	4,433	4,620	4,897	693	16.5%	0	1,095

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			2005 base year (DOF occupied housing units)	2005 to 2010	2010 to 2015	2015 to 2020	2020 to 2025	2025 to 2030
Projected Units Countywide			68,220	6,938	6,498	6,498	6,498	6,498
	Redding at Midpoint Densities, Assume 75% Buildout		34,612	4,497	4,006	3,488	2,983	2,458
	Anderson (OmniMeans/PMC)		3,847	1,344	1,340	1,234	788	640
	Shasta Lake		3,786	500	500	500	500	500
	Total Unincorporated County		25,975	597	652	1,276	2,227	2,900
	Urban:	Cottonwood (OmniMeans/PMC)	1,160	208	246	290	343	404
		Other South County (OmniMeans/PMC)	932	88	84	84	642	652
		Palo Cedro and Southeast of Redding, 70% Buildout	1,562	30	32	90	124	185
		Happy Valley (Incl. North Fork)	845	74	79	221	305	453
	Rural:	North Central Shasta County (Big Bend, Montgomery	1,240	13	14	40	55	82
		East Shasta County (Burney, Fall River, McArthur, C	3,365	34	37	103	141	210
		Shingletown and Highway 44 Dersch Road Corridor	1,811	79	84	236	326	484
		Other	10,856	25	27	76	104	155
		Bella Vista Water/Northeast of Redding	4,204	45	48	135	187	277

Source: Strategic Economics, November, 2005

Table 2: Residential Projections Assumptions

			2005 Base Year Assumptions	Projection Assumptions
Projected Units Countywide			Occupied housing units as reported by the CA Department of Finance	From DoF population projections by age group, worked into households using household formation rates from 2000 U.S. Census
	Redding at Midpoint Densities, Assume 75% Buildout TOTAL HOUSEHOLDS		Occupied housing units as reported by the CA Department of Finance	Years 2005-2015 correspond to growth rates from ESC Projection. Growth rate gradually decreases over time from 2015 to 2030, and total estimated incremental growth reflects 75 percent of Redding's land capacity estimate. This number falls short of the E
	Anderson (OmniMeans/PMC)		Occupied housing units as reported by the CA Department of Finance	OmniMeans/PMC Memorandum
	Shasta Lake		Occupied housing units as reported by the CA Department of Finance	Assumed absorption rate of 100 units/year. This is higher than historic rate of 78 units/year in last 5 years but reflects strong showings in pipeline development, including estimated 1500 units Mountain Gate Meadows
	Total Unincorporated County		Occupied housing units as reported by the CA Department of Finance	County net of Cities
	Urban:	Cottonwood (OmniMeans/PMC)	From PMC/OmniMeans Projection for South County	From PMC/OmniMeans Projection for South County
		Other South County (OmniMeans/PMC)	From PMC/OmniMeans Projection for South County	From PMC/OmniMeans Projection for South County
		Palo Cedro and Southeast of Redding, 70% Buildout	Applied constant growth rate from 1990 and 2000 Census for Households. Census Tracts:	From 2005-2030, change at double its historic 10 year average annual growth rate from 1990-2000 Census.
		Happy Valley (Incl. North Fork)	Applied constant growth rate from 1990 and 2000 Census for Households. Census Tracts:	Control total for 2030 accommodates major pipeline development + 20 percent additional development
	Rural:	North Central Shasta County (Big Bend, Montgomery Creek, Round Mountain)	Applied constant growth rate from 1990 and 2000 Census for Households. Census Tracts:	Assumed to develop at 25 year average annual growth rate for the total unincorporated county of 0.61%
		East Shasta County (Burney, Fall River, McArthur, Cassel)	Applied constant growth rate from 1990 and 2000 Census for Households. Census Tracts:	Assumed to develop at tract 10 year average annual growth rate from 1990-2000, or 0.58%
		Shingletown and Highway 44 Dersch Road Corridor	Applied constant growth rate from 1990 and 2000 Census for Households. Census Tracts:	Assumed to develop at tract10 year average annual growth rate from 1990-2000, or 2.07%
		Other	Total DOF for Uninc county minus all other unincorporated areas	Assumed to develop at tract's 10 year average annual growth rate for the total unincorporated county of 0.14%. Assume this rate because growth in these areas will be the slowest, and more likely to reflect unincorporated rate
		Bella Vista Water/Northeast of Redding	Applied constant growth rate from 1990 and 2000 Census for Households. Census Tracts:	Assumed to develop at 25 year average annual growth rate for the total unincorporated county of 0.61%

Source: Strategic Economics, November, 2005

EPS extrapolated the Redding projection to Shasta County by assuming that the City of Redding would continue to capture the same share of the County's population over time. Incorporated areas would continue to grow faster than the unincorporated areas and Redding would continue to grow faster than Anderson and Shasta Lake. The final county projection was adjusted to conform to current and projected population estimates from the State of California. Ultimately there was some concern that this projection did not accurately project growth in other cities and the unincorporated areas of Shasta County; in fact, the EPS projection overestimated the county population and households in the year 2000 when compared with the U.S. Census.

Residential Projections Sources

Several projection series were evaluated and compared based on projected residential growth through 2030. The modeling techniques, historic accuracy, and applicability to the 2000-2030 time frame were considered. Reviews of these projection series follow.

Woods & Poole 2004

Woods & Poole is a national private projection of population by age group and/or housing units. This projection is only available at the countywide level. Woods & Poole is developed through modeling efforts tracking birth, death, and migration rates over time for the entire United States. County population projections are then developed based on sub-county analysis areas "economic areas" as the reference area. Growth in one county is linked to growth in other counties in order to maintain the national projected population. Total population is primarily informed by employment and earnings projections in the Woods & Poole model.

Based on our research, a fairly sizeable portion of the population in Shasta County is not working or is not working in Shasta County, therefore Woods & Poole, which is driven primarily by employment may not be an accurate source of population projections for Shasta County. When compared to the US Census, Woods & Poole underestimated total population growth from 1990 to 2000

Economic Sciences Corporation

Economic Sciences Corporation (ESC) completes a projection of Redding households and population for Redding Electric Utility each year. This projection is not available at the countywide level, and is only available for the City of Redding. Because this projection is based on actual customer records from the Redding Electric Utility, it appears to be the most accurate projection of Redding's population and household trends, at least in the short term.

While this population projection has historically been very accurate and appears accurate in the short term (5-10 years), the model does not take into account the available supply of land when determining its projections. Data from the City of Redding Planning Department indicates that the barring any further annexation, the City of Redding will exhaust its residential land supply by approximately 2015. At this point, much of the additional growth projected for the City of Redding in the ESC projection will likely be diverted into nearby unincorporated areas of the County as well as the City of Anderson.

Economic and Planning Systems

Economic and Planning Systems' (EPS) projection for the previous regional transportation model is based on Economic Sciences Corporation's projection for the City of Redding, and extrapolated to the Countywide level on a proportional population growth basis.

Since EPS used the ESC Redding projection as its base, this projection series has the same limited land supply issue that the ESC Redding projection has. Additionally, the EPS projections also assumed that Redding would continue to attract the largest share of the growth in the County through 2025. For this forecast update, this projection was considered to be a very aggressive estimate as it also fails to take Redding's land supply constraints into consideration.

California Department of Finance

The California Department of Finance (DOF) is the state projection of population by age group, available through the year 2050. There has been some concern that the DOF projection places an emphasis on its projections for major metropolitan areas, resulting in less accurate projections for non-urban areas such as Shasta County. The largest inaccuracies are likely in the method with which the DOF calculates net migration.

Historically, the DOF projections have been the most accurate for the County when compared to the Census. The DOF projections also represent a mid-range scenario; its population projections are higher than Woods & Poole, but lower than the EPS projections.

Preferred Residential Projection

Based on the information available regarding the historical accuracy of the various projection sources, the methodology with which these projections are calculated and information regarding the availability of land in the City of Redding, the following projection sources have been used in the residential projections.

Economic Sciences Corporation

While these projections were deemed to be overly aggressive in the long term, they are very accurate for the City of Redding in the short-term. Therefore, Redding's long-term projections were adjusted downward based on information regarding the availability of land.

Department of Finance

Given the historical accuracy and the DOF's position as a mid-range scenario among all available population projections, the Department of Finance projections for the County were used as the base for the population projections. However, the total county population was adjusted with input from the stakeholders.

Additional Adjustments

The basic residential projections were modified based on input from stakeholders in late 2005, particularly in the following ways:

- Growth rates for Anderson, Cottonwood and South County were made consistent with other land use forecasts prepared for transportation studies in those areas
- Pipeline activity was assumed to phase in over time;

- Historic growth rates were reflected in areas where constant growth is expected to occur;
- Projections were adjusted to accommodate both large scale development projects, such as North Fork, the Vineyards, and Mountain Gate Meadows, as well as some increment of additional development where appropriate.

Employment Projections

The overall employment projection targets are based on growth rates by sector developed by Woods & Poole, adjusted to correspond to the higher rate of population growth assumed for Shasta County (Table 3).

Employment Projections Sources

Several projection series were analyzed for the projection of jobs in Shasta County through 2030. Whereas the residential projection focuses generally on housing unit growth, the employment projection also divides the projected jobs into separate sectors. Generally, jobs are grouped in the following sectoral categories: Manufacturing, Retail, Services, Construction, and Agriculture. Some of the projection series described below provide a general jobs projection, while others provide a sectoral breakdown.

Sources of employment data were compared on a decade-by-decade basis. Unlike the population projections, no one source can be considered a comprehensive, Census-type base for employment projections. Employment projections use varying sectoral categories and collect a variety of data that frequently omits employment in the government sector, or the self-employed. Strategic Economics evaluated each projection series with the following criteria:

- The projection series must include all categories of workers including self-employed and unpaid family members
- The projection series must allow the employment to be spatially located

The sources are compared below.

Woods & Poole

Woods & Poole (W&P) 2004 is a national private projection of jobs by sector. The W&P projection is based on a modified "export base" model incorporating national trends in sectoral growth and decline, and accounting for the effect of employment trends of adjacent areas on each other.

Woods & Poole is considered an excellent source of employment projections, in that it includes employment information for categories of workers not included in other projection series including the self-employed, proprietors, domestic workers, unpaid family workers, railroad workers, and members of the armed forces.

Table 3: Shasta County Employment Projection Targets

Total County	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**
Retail	14,719	15,943	17,121	18,403	19,790	21,300
Service	29,669	33,229	36,798	40,706	44,950	49,531
Government	11,147	11,892	12,588	13,331	14,112	14,924
Other	14,094	14,947	15,673	16,442	17,249	18,087
Total Employment	**69,629**	**76,011**	**82,180**	**88,882**	**96,101**	**103,843**

Anderson + Anderson SOI	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**
Retail	1,183	1,281	1,376	1,479	1,591	1,712
Service	1,403	1,571	1,740	1,925	2,126	2,342
Government	483	515	545	578	611	647
Other	1,713	1,817	1,905	1,998	2,096	2,198
Total Employment	**4,782**	**5,185**	**5,567**	**5,980**	**6,424**	**6,899**

Redding + Redding SOI	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**
Retail	11,417	12,366	13,280	14,275	15,350	16,522
Service	23,748	26,598	29,454	32,582	35,979	39,647
Government	8,069	8,609	9,112	9,650	10,215	10,803
Other	9,156	9,710	10,182	10,681	11,205	11,750
Total Employment	**52,390**	**57,282**	**62,028**	**67,188**	**72,750**	**78,722**

Shasta Lake	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**
Retail	493	534	573	616	663	713
Service	678	759	841	930	1,027	1,132
Government	576	615	651	689	729	771
Other	577	612	641	673	706	740
Total Employment	**2,324**	**2,520**	**2,706**	**2,909**	**3,125**	**3,357**

Cottonwood	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**
Retail	278	301	323	347	373	402
Service	297	333	369	408	451	496
Government	341	364	386	408	432	457
Other	302	321	336	353	370	388
Total Employment	**1,219**	**1,319**	**1,414**	**1,516**	**1,626**	**1,744**

Rural East (Burney, Fall River, McArthur, Cassel)	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**
Retail	484	524	563	605	650	700
Service	977	1,094	1,212	1,341	1,480	1,631
Government	387	413	437	462	490	518
Other	443	470	493	517	543	569
Total Employment	**2,291**	**2,501**	**2,704**	**2,925**	**3,163**	**3,418**

Shasta County Other	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**
Retail	864	936	1,005	1,080	1,162	1,250
Service	2,567	2,875	3,184	3,522	3,889	4,286
Government	1,290	1,376	1,457	1,543	1,633	1,727
Other	1,902	2,017	2,115	2,219	2,328	2,441
Total Employment	**6,623**	**7,204**	**7,761**	**8,364**	**9,012**	**9,704**

Based on Woods & Poole, growth rates adjusted in proportion to population projections

California Employment Development Department

The California Employment Development Department (EDD) provides a projection of employment by industry for Shasta County through 2008, as well as current data. Its projection is based on unemployment and tax data reported to the State. This data is analyzed and projected by a local branch of the EDD, ensuring the greatest projection accuracy of local conditions. The Shasta County Economic Development Corporation (Shasta EDC) uses this local projection for its analysis and policy development.

While the EDD is a considered a fairly reliable projection of employment, it does not include employment information for categories of workers including the self-employed. In addition, current employment data from EDD is available spatially to local governments through a confidentiality agreement, but does not always have accurate place information for its currently reported jobs, making it difficult to accurately locate employment within the county.

InfoUSA

Info USA is a private source of employment data estimated by gathering data from the Yellow Pages, Business White Pages Directory, phone calls, county courthouse, Secretary of State data, business magazines and newspapers, annual reports, 10K's and other SEC filings, new business registrations and incorporations and postal service information.

InfoUSA does not provide a projection of employment, but is a reasonably accurate spatial picture of current employment in Shasta County. For this travel model update, InfoUSA was used as the initial source for 2004 base year employment, with considerable additional consultant effort to fill in and correct the employment information.

Selected Projection Source

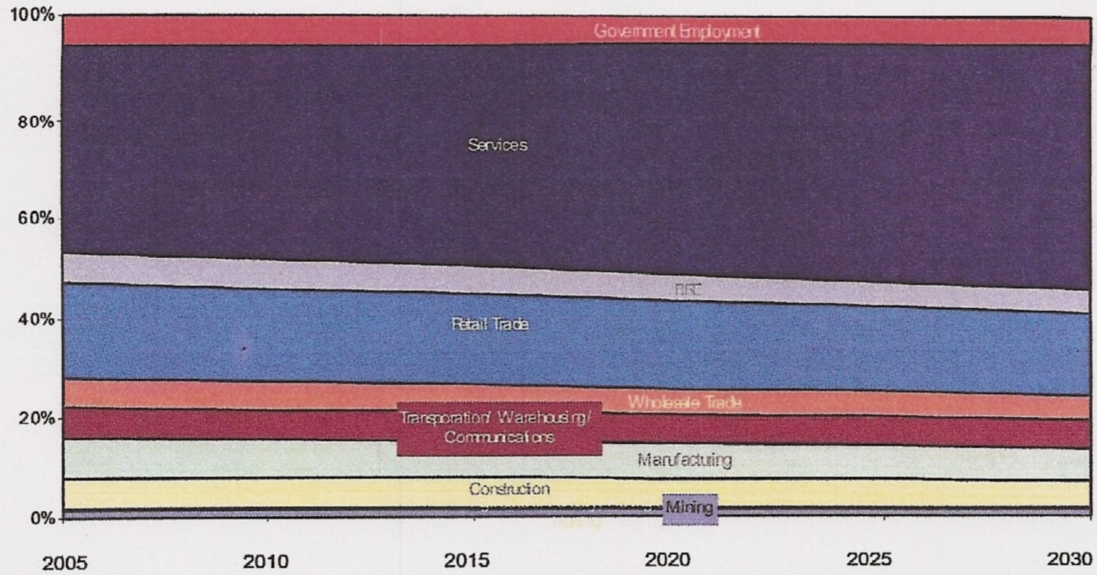
Woods & Poole was used as the projection source because it provides five year increments of employment by sector at the County level, and was determined to be the most comprehensive source of job estimates for the governmental sector and for domestic workers.

Employment Sectors

Figure 2 shows how the employment sectors are projected to shift over time within Shasta County. As anticipated in the previous 2000 EPS Projection, the Services sector is anticipated to become a larger share of total jobs in the County, while Manufacturing and Wholesale Trade become a declining share of total jobs. All sectors are anticipated to increase their total absolute number of jobs.

The 2000 EPS projection anticipated that retail jobs would increase proportionally with residential population growth. This assumption was retained for this employment forecast. The Woods & Poole projections had retail employment increasing by 21 percent between 2005 and 2030, while overall employment would grow by 37 percent. This compares to an assumed housing growth of 48 percent during the same period. For this forecast, retail employment was adjusted to increase by 45 percent, with an overall employment increase of 49 percent between 2005 and 2030.

Figure 2: Shift in Sectors as a Percent of Total Employment, Shasta County 2005-2030



Subarea Allocation

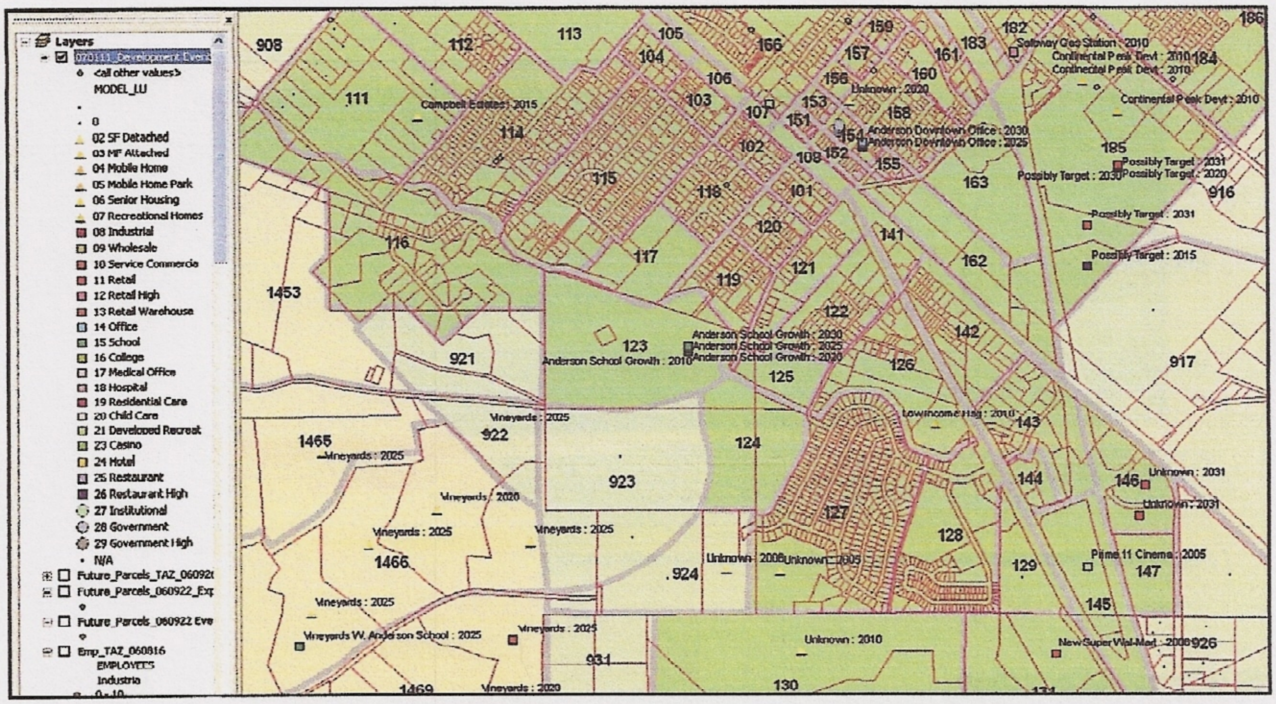
Employment growth was allocated to the Cities and unincorporated county using a proportional formula. In this estimate, Cities maintain their current share of jobs in each of the given sectors. It is expected that land capacity limitations in Anderson and Cottonwood, as well as anticipated large scale development projects such as Oasis Road and Stillwater Business Park will shift a larger share of the projected job growth to Redding, and possibly to Shasta Lake, while Anderson's share of growth decreases. This shift would be most likely to occur in the Manufacturing, Warehousing, and Transportation/ Communications sectors.

Geographic Allocation

Future land uses were allocated to individual parcels and aggregated to the transportation analysis zones (TAZs) used in the Shasta County travel model. A geographic information systems (GIS) process was used to track the various development assumptions (Figure 3).

The initial geographic allocations were based on the pipeline development projects and expected development years provided by each of the jurisdictions. Several major projects, such as Vineyards, provided detailed phasing expectations for residential and non-residential land uses.

Figure 3: Example GIS Land Use Allocation



Locations for additional development beyond pipeline development were assumed based primarily on proximity to other similar development. The City of Redding provided extensive information on zoning and expected likelihood of development for each vacant parcel. In other areas, residential development was assumed to occur near recent development activity (based on 2000 to 2004 building permit data), while non-residential development was assumed to occur near similar existing non-residential uses.

Employment in health services, education and government was projected to grow, but specific development areas were not identified for these uses (with the exception of several new school sites). Therefore, most of the growth in these sectors were assumed to occur in the vicinity of existing concentrations of employment, such as existing medical centers, government offices and school administration sites.

Phased Development Projects

The development years for major projects provided by jurisidictions were adjusted in order to fit within the overall Shasta County growth projections (Table 4). In particular, several development areas are not projected to be fully built out by 2030.

Model Land Use Inputs

Summaries of the final land use totals used in the Shasta County travel model for each five year increment are attached (Table 5) These totals may not exactly match the residential and employment projections targets, as they are based on specific developments and parcels, and were not "smoothed out" to precisely match the control totals.

Table 4: Shasta County Development Phasing Assumptions

Development	Land Use	Units	2005	2010	2015	2020	2025	2030	After 2030	TOTAL	Percent by 2030
Anderson Potential Target Site	Retail	SF	0	0	0	130,000	0	130,000	66,000	326,000	80%
	Fast Food	SF	0	0	2,500	0	0	2,500	0	5,000	100%
City of Redding (7251 Eastside)	Industrial	SF	0	0	0	198,000	0	298,000	496,000	992,000	50%
Clover Creek (3901 Airport)	Office	SF	0	0	72,700	0	0	0	0	72,700	100%
	Retail	SF	0	0	0	72,700	0	0	0	72,700	100%
Cobblestone Business Park	Office	SF	0	187,000	0	0	0	0	0	187,000	100%
Lasata	MF Attached	DU	0	0	150	151	0	0	0	301	100%
Manor Crest (Cottonwood Hills)	SF Detached	DU	0	64	64	0	0	0	0	128	100%
McConnell Land (350 Old Oregon)	SF Detached	DU	0	0	223	1,165	0	0	0	1,388	100%
Mountain Gate Meadows	SF Detached	DU	0	0	0	0	250	500	250	1,000	75%
	MF Attached	DU	0	0	0	250	250	0	0	500	100%
	Service Commercial	SF	0	0	0	100,000	0	0	0	100,000	100%
North Fork	SF Detached	DU	0	47	47	460	314	532	0	1,400	100%
	Retail	SF	0	0	0	0	180,000	290,000	472,000	942,000	50%
	Office	SF	0	0	0	145,000	0	0	0	145,000	100%
	Equestrian Center	Emps	0	0	0	0	10	0	0	10	100%
Oak Ranch Estates	SF Detached	DU	0	66	66	0	0	0	0	132	100%
Oasis Road Specific Plan	SF 1-5 DU/Acre	DU	0	0	6	3	3	0	0	12	100%
	SF 2-3.5 DU/Acre	DU	0	0	16	0	16	0	0	32	100%
	SF 6-10 DU/Acre	DU	0	0	30	30	0	0	0	60	100%
	MF 15 DU/Acre	DU	0	0	593	296	296	0	0	1,185	100%
	MF 18 DU/Acre	DU	0	0	448	280	168	0	0	896	100%
	Regional Commercial	SF	0	188,500	188,500	188,500	377,000	0	1,342,222	2,284,722	41%
	General Commercial	SF	0	0	143,500	143,500	0	143,500	143,500	574,000	75%
	Shopping Center	SF	0	0	0	0	0	113,500	113,500	227,000	50%
	General Office	SF	0	0	0	0	19,800	0	0	19,800	100%
	Limited Office	SF	0	0	13,100	0	0	0	0	13,100	100%
Palo Cedro Silverbridge Oaks	SF Detached	DU	0	0	0	100	200	0	0	300	100%
Palomar Davis Ridge	SF Detached	DU	0	197	197	0	0	0	0	394	100%
	MF Attached	DU	0	56	0	0	0	0	0	56	100%
Park Marina Drive Specific Plan	SF Detached	DU	0	22	0	0	0	0	0	22	100%
	MF Attached	DU	0	0	99	14	10	0	0	123	100%
	Retail	SF	0	0	50,000	39,200	42,500	55,500	0	187,200	100%
	Office	SF	0	0	0	0	42,500	0	0	42,500	100%
	Hotel	SF	0	0	0	55,500	42,500	0	0	98,000	100%
Shasta Gateway Industrial Park	Industrial	SF	0	49,000	49,000	94,000	94,000	94,000	1,590,000	1,970,000	19%
	Office	SF	0	24,500	24,500	24,500	24,500	0	0	98,000	100%
Shastina Ranch	SF Detached	DU	0	328	0	94	0	0	0	422	100%
	School	Emps	0	0	50	0	0	0	0	50	100%
Shingletown Sierra Pacific	SF Detached	DU	0	66	66	0	0	0	0	132	100%

Table 4 (continued): Shasta County Development Phasing Assumptions

Development	Land Use	Units	2005	2010	2015	2020	2025	2030	After 2030	TOTAL	Percent by 2030
Stillwater Business Park	Industrial	SF	0	0	0	224,000	224,000	199,000	3,554,000	4,201,000	15%
	Office	SF	0	0	205,200	563,900	223,600	593,900	510,900	2,097,500	76%
VA Home Property (Knighton)	Industrial	SF	0	365,000	138,000	0	0	132,000	0	635,000	100%
	Office	SF	0	191,800	127,900	0	179,100	0	0	498,800	100%
Vineyards	SF Detached	DU	0	682	422	1,166	1,029	666	330	4,295	92%
	MF Attached	DU	0	0	640	0	287	287	0	1,214	100%
	Retail	SF	0	20,000	0	50,000	20,000	50,000	0	140,000	100%
	Office	SF	0	0	50,000	50,000	0	0	0	100,000	100%
	School	Emps	0	0	0	50	50	0	0	100	100%
Woodridge Lake	Retail	SF	0	0	30,000	30,000	0	0	0	60,000	100%

Table 5: Shasta Model Land Use Inputs

2004 Land Use Summary

Area	Population	Housing Units	Occupied Units	Employment				
				Retail	Service	Government	Other	TOTAL
Incorporated								
Anderson	9,065	3,738	3,737	886	1,220	410	846	3,363
Redding	81,136	33,886	33,848	10,862	22,065	7,492	7,718	48,138
Shasta Lake	9,016	3,711	3,706	493	678	576	577	2,324
Subtotal Incorporated	**99,217**	**41,335**	**41,290**	**12,242**	**23,963**	**8,479**	**9,141**	**53,825**
Unincorporated								
Anderson Sphere	1,841	759	758	297	173	73	867	1,410
Redding Sphere	10,120	3,994	3,987	287	1,640	577	1,438	3,941
Cottonwood	3,479	1,323	1,322	278	297	341	302	1,219
Rural North Central (Big Bend, Montgomery Creek)	293	143	141	12	5	20	0	37
Rural East (Burney, Fall River, McArthur, Cassel)	5,240	2,183	2,166	484	977	387	443	2,291
Rural Shingletown	1,263	628	607	87	88	53	34	262
Rural Vineyards	39	15	15	0	0	0	0	0
Rural Other	41,760	17,371	17,101	765	2,474	1,217	1,868	6,323
Subtotal Unincorporated	**64,035**	**26,416**	**26,097**	**2,209**	**5,653**	**2,668**	**4,953**	**15,483**
TOTAL	163,252	67,751	67,388	14,451	29,616	11,147	14,094	69,308

Table 5 (continued): Shasta Model Land Use Inputs

Increment 2004 to 2005

Area	Population	Housing Units	Occupied Units	Employment: Retail	Service	Government	Other	TOTAL
Incorporated								
Anderson	262	125	125	0	10	0	0	10
Redding	1,602	583	583	268	43	0	0	311
Shasta Lake	131	69	69	0	0	0	0	0
Subtotal Incorporated	**1,996**	**777**	**777**	**268**	**53**	**0**	**0**	**321**
Unincorporated								
Anderson Sphere	0	0	0	0	0	0	0	0
Redding Sphere	27	0	0	0	0	0	0	0
Cottonwood	10	0	0	0	0	0	0	0
Rural North Central (Big Bend, Montgomery Creek)	0	0	0	0	0	0	0	0
Rural East (Burney, Fall River, McArthur, Cassel)	0	0	0	0	0	0	0	0
Rural Shingletown	0	0	0	0	0	0	0	0
Rural Vineyards	0	0	0	0	0	0	0	0
Rural Other	146	60	60	0	0	0	0	0
Subtotal Unincorporated	**182**	**60**	**60**	**0**	**0**	**0**	**0**	**0**
TOTAL	**2,178**	**837**	**837**	**268**	**53**	**0**	**0**	**321**

2005 Land Use Summary

Area	Population	Housing Units	Occupied Units	Employment: Retail	Service	Government	Other	TOTAL
Incorporated								
Anderson	9,327	3,863	3,862	886	1,230	410	846	3,373
Redding	82,738	34,469	34,430	11,130	22,108	7,492	7,718	48,449
Shasta Lake	9,147	3,780	3,775	493	678	576	577	2,324
Subtotal Incorporated	**101,213**	**42,112**	**42,067**	**12,510**	**24,016**	**8,479**	**9,141**	**54,146**
Unincorporated								
Anderson Sphere	1,841	759	758	297	173	73	867	1,410
Redding Sphere	10,147	3,994	3,987	287	1,640	577	1,438	3,941
Cottonwood	3,489	1,323	1,322	278	297	341	302	1,219
Rural North Central (Big Bend, Montgomery Creek)	293	143	141	12	5	20	0	37
Rural East (Burney, Fall River, McArthur, Cassel)	5,240	2,183	2,166	484	977	387	443	2,291
Rural Shingletown	1,263	628	607	87	88	53	34	262
Rural Vineyards	39	15	15	0	0	0	0	0
Rural Other	41,906	17,431	17,161	765	2,474	1,217	1,868	6,323
Subtotal Unincorporated	**64,217**	**26,476**	**26,157**	**2,209**	**5,653**	**2,668**	**4,953**	**15,483**
TOTAL	**165,430**	**68,588**	**68,224**	**14,719**	**29,669**	**11,147**	**14,094**	**69,629**

Table 5 (continued): Shasta Model Land Use Inputs

Increment 2005 to 2010

Area	Population	Housing Units	Occupied Units	Employment				
				Retail	Service	Government	Other	TOTAL
Incorporated								
Anderson	2,701	1,328	1,328	354	160	37	103	655
Redding	11,713	4,701	4,701	617	2,954	477	629	4,677
Shasta Lake	1,210	504	504	80	80	37	53	250
Subtotal Incorporated	**15,624**	**6,534**	**6,534**	**1,051**	**3,194**	**551**	**786**	**5,582**
Unincorporated								
Anderson Sphere	28	14	14	0	0	0	0	0
Redding Sphere	49	22	22	0	29	61	0	90
Cottonwood	367	130	130	20	7	43	0	70
Rural North Central (Big Bend, Montgomery Creek)	29	13	13	0	0	0	0	0
Rural East (Burney, Fall River, McArthur, Cassel)	52	32	32	28	202	27	23	280
Rural Shingletown	143	66	66	9	22	0	9	40
Rural Vineyards	0	0	0	0	0	0	0	0
Rural Other	350	142	142	119	84	79	45	326
Subtotal Unincorporated	**1,017**	**419**	**419**	**177**	**343**	**210**	**76**	**806**
TOTAL	16,641	6,953	6,953	1,228	3,537	761	862	6,388

2010 Land Use Summary

Area	Population	Housing Units	Occupied Units	Employment				
				Retail	Service	Government	Other	TOTAL
Incorporated								
Anderson	12,028	5,192	5,191	1,241	1,390	448	950	4,028
Redding	94,451	39,170	39,132	11,747	25,062	7,969	8,348	53,126
Shasta Lake	10,358	4,284	4,279	573	758	613	630	2,574
Subtotal Incorporated	**116,837**	**48,646**	**48,601**	**13,561**	**27,210**	**9,030**	**9,927**	**59,728**
Unincorporated								
Anderson Sphere	1,869	773	772	297	173	73	867	1,410
Redding Sphere	10,196	4,016	4,009	287	1,668	638	1,438	4,031
Cottonwood	3,856	1,453	1,452	298	304	384	302	1,289
Rural North Central (Big Bend, Montgomery Creek)	322	156	154	12	5	20	0	37
Rural East (Burney, Fall River, McArthur, Cassel)	5,292	2,215	2,198	512	1,179	414	466	2,571
Rural Shingletown	1,406	694	673	97	109	53	43	302
Rural Vineyards	39	15	15	0	0	0	0	0
Rural Other	42,256	17,573	17,303	884	2,557	1,296	1,912	6,649
Subtotal Unincorporated	**65,235**	**26,895**	**26,576**	**2,385**	**5,996**	**2,879**	**5,029**	**16,289**
TOTAL	182,071	75,541	75,177	15,946	33,206	11,908	14,956	76,017

Table 5 (continued): Shasta Model Land Use Inputs

Increment 2010 to 2015

Area	Population	Housing Units	Occupied Units	Employment Retail	Employment Service	Employment Government	Employment Other	TOTAL
Incorporated								
Anderson	983	472	472	120	114	37	57	328
Redding	10,645	3,994	3,994	952	1,966	449	467	3,834
Shasta Lake	1,372	500	500	0	104	37	53	194
Subtotal Incorporated	**13,000**	**4,966**	**4,966**	**1,072**	**2,184**	**523**	**577**	**4,356**
Unincorporated								
Anderson Sphere	238	89	89	0	0	0	0	0
Redding Sphere	138	56	56	0	711	53	36	800
Cottonwood	608	230	230	0	191	27	10	228
Rural North Central (Big Bend, Montgomery Creek)	0	0	0	0	0	0	0	0
Rural East (Burney, Fall River, McArthur, Cassel)	0	0	0	28	162	27	23	240
Rural Shingletown	143	66	66	63	78	0	9	150
Rural Vineyards	2,151	842	842	0	157	0	8	165
Rural Other	525	232	232	3	102	53	71	230
Subtotal Unincorporated	**3,804**	**1,515**	**1,515**	**95**	**1,400**	**160**	**157**	**1,813**
TOTAL	**16,804**	**6,481**	**6,481**	**1,167**	**3,584**	**684**	**734**	**6,169**

2015 Land Use Summary

Area	Population	Housing Units	Occupied Units	Employment Retail	Employment Service	Employment Government	Employment Other	TOTAL
Incorporated								
Anderson	13,012	5,664	5,663	1,360	1,504	485	1,007	4,356
Redding	105,095	43,164	43,125	12,699	27,029	8,418	8,814	56,960
Shasta Lake	11,730	4,784	4,779	573	861	651	683	2,768
Subtotal Incorporated	**129,837**	**53,612**	**53,567**	**14,633**	**29,394**	**9,553**	**10,504**	**64,084**
Unincorporated								
Anderson Sphere	2,107	862	861	297	173	73	867	1,410
Redding Sphere	10,334	4,072	4,065	287	2,380	691	1,474	4,831
Cottonwood	4,464	1,683	1,682	298	495	412	312	1,517
Rural North Central (Big Bend, Montgomery Creek)	322	156	154	12	5	20	0	37
Rural East (Burney, Fall River, McArthur, Cassel)	5,292	2,215	2,198	540	1,341	441	489	2,811
Rural Shingletown	1,549	760	739	160	187	53	52	452
Rural Vineyards	2,190	857	857	0	157	0	8	165
Rural Other	42,781	17,805	17,534	887	2,659	1,349	1,983	6,879
Subtotal Unincorporated	**69,038**	**28,410**	**28,091**	**2,480**	**7,397**	**3,039**	**5,186**	**18,102**
TOTAL	**198,875**	**82,022**	**81,658**	**17,113**	**36,790**	**12,592**	**15,690**	**82,185**

Table 5 (continued): Shasta Model Land Use Inputs

Increment 2015 to 2020

Area	Population	Housing Units	Occupied Units	Employment				
				Retail	Service	Government	Other	TOTAL
Incorporated								
Anderson	164	80	80	265	118	20	69	472
Redding	8,339	3,480	3,480	827	887	449	24	2,187
Shasta Lake	1,266	490	490	12	136	37	140	324
Subtotal Incorporated	**9,768**	**4,050**	**4,050**	**1,104**	**1,141**	**506**	**232**	**2,983**
Unincorporated								
Anderson Sphere	55	28	28	0	456	0	24	480
Redding Sphere	486	211	211	0	1,797	61	317	2,175
Cottonwood	878	300	300	0	3	27	0	30
Rural North Central (Big Bend, Montgomery Creek)	107	50	50	0	0	0	0	0
Rural East (Burney, Fall River, McArthur, Cassel)	241	100	100	28	162	27	23	240
Rural Shingletown	462	240	240	54	27	0	9	90
Rural Vineyards	2,916	1,166	1,166	90	174	43	8	315
Rural Other	945	352	352	6	173	70	122	371
Subtotal Unincorporated	**6,090**	**2,447**	**2,447**	**178**	**2,790**	**229**	**503**	**3,701**
TOTAL	**15,859**	**6,497**	**6,497**	**1,282**	**3,931**	**735**	**735**	**6,684**

2020 Land Use Summary

Area	Population	Housing Units	Occupied Units	Employment				
				Retail	Service	Government	Other	TOTAL
Incorporated								
Anderson	13,176	5,744	5,743	1,625	1,622	505	1,076	4,828
Redding	113,434	46,644	46,605	13,526	27,916	8,867	8,838	59,147
Shasta Lake	12,995	5,274	5,269	585	997	688	822	3,092
Subtotal Incorporated	**139,605**	**57,662**	**57,617**	**15,737**	**30,535**	**10,059**	**10,736**	**67,067**
Unincorporated								
Anderson Sphere	2,162	890	889	297	629	73	891	1,890
Redding Sphere	10,820	4,283	4,277	287	4,176	752	1,791	7,006
Cottonwood	5,342	1,983	1,982	298	498	439	312	1,547
Rural North Central (Big Bend, Montgomery Creek)	429	206	204	12	5	20	0	37
Rural East (Burney, Fall River, McArthur, Cassel)	5,533	2,315	2,298	568	1,502	468	512	3,051
Rural Shingletown	2,011	1,000	979	215	214	53	61	542
Rural Vineyards	5,106	2,023	2,023	90	331	43	17	480
Rural Other	43,726	18,156	17,886	893	2,832	1,419	2,106	7,250
Subtotal Unincorporated	**75,129**	**30,857**	**30,538**	**2,658**	**10,187**	**3,268**	**5,689**	**21,802**
TOTAL	**214,734**	**88,518**	**88,155**	**18,395**	**40,722**	**13,327**	**16,425**	**88,869**

Table 5 (continued): Shasta Model Land Use Inputs

Increment 2020 to 2025

Area	Population	Housing Units	Occupied Units	Employment				
				Retail	Service	Government	Other	TOTAL
Incorporated								
Anderson	0	0	0	176	21	37	3	236
Redding	6,293	3,006	3,006	1,059	3,170	459	427	5,114
Shasta Lake	1,302	500	500	0	80	37	98	214
Subtotal Incorporated	**7,595**	**3,506**	**3,506**	**1,235**	**3,270**	**533**	**527**	**5,565**
Unincorporated								
Anderson Sphere	359	140	140	0	0	0	0	0
Redding Sphere	616	249	249	0	730	61	261	1,052
Cottonwood	819	340	340	0	3	27	0	30
Rural North Central (Big Bend, Montgomery Creek)	76	50	50	0	0	0	0	0
Rural East (Burney, Fall River, McArthur, Cassel)	298	140	140	28	162	27	23	240
Rural Shingletown	530	240	240	9	22	0	9	40
Rural Vineyards	2,023	778	778	36	4	0	0	40
Rural Other	3,180	1,072	1,072	81	37	122	0	240
Subtotal Unincorporated	**7,902**	**3,009**	**3,009**	**155**	**958**	**238**	**293**	**1,642**
TOTAL	**15,497**	**6,515**	**6,515**	**1,390**	**4,227**	**771**	**819**	**7,208**

2025 Land Use Summary

Area	Population	Housing Units	Occupied Units	Employment				
				Retail	Service	Government	Other	TOTAL
Incorporated								
Anderson	13,176	5,744	5,743	1,801	1,643	542	1,078	5,064
Redding	119,727	49,650	49,611	14,586	31,085	9,326	9,264	64,261
Shasta Lake	14,298	5,774	5,769	585	1,077	725	920	3,307
Subtotal Incorporated	**147,200**	**61,167**	**61,123**	**16,972**	**33,805**	**10,593**	**11,263**	**72,632**
Unincorporated								
Anderson Sphere	2,522	1,030	1,029	297	629	73	891	1,890
Redding Sphere	11,436	4,533	4,526	287	4,907	813	2,051	8,058
Cottonwood	6,161	2,323	2,322	298	501	466	312	1,577
Rural North Central (Big Bend, Montgomery Creek)	505	256	254	12	5	20	0	37
Rural East (Burney, Fall River, McArthur, Cassel)	5,831	2,455	2,438	596	1,664	495	535	3,291
Rural Shingletown	2,541	1,240	1,219	224	235	53	70	582
Rural Vineyards	7,129	2,801	2,801	126	335	43	17	520
Rural Other	46,905	19,228	18,958	974	2,869	1,541	2,106	7,490
Subtotal Unincorporated	**83,031**	**33,866**	**33,547**	**2,813**	**11,145**	**3,505**	**5,982**	**23,445**
TOTAL	**230,231**	**95,033**	**94,670**	**19,785**	**44,949**	**14,098**	**17,245**	**96,077**

Table 5 (continued): Shasta Model Land Use Inputs

Increment 2025 to 2030

Area	Population	Housing Units	Occupied Units	Employment				
				Retail	Service	Government	Other	TOTAL
Incorporated								
Anderson	0	0	0	658	72	37	2	769
Redding	5,946	2,461	2,461	594	2,399	555	412	3,961
Shasta Lake	1,205	500	500	0	3	37	94	134
Subtotal Incorporated	**7,151**	**2,961**	**2,961**	**1,252**	**2,474**	**629**	**507**	**4,863**
Unincorporated								
Anderson Sphere	1,047	467	467	131	15	0	0	145
Redding Sphere	1,524	606	606	0	1,890	61	297	2,249
Cottonwood	1,021	400	400	0	3	27	0	30
Rural North Central (Big Bend, Montgomery Creek)	165	80	80	0	0	0	0	0
Rural East (Burney, Fall River, McArthur, Cassel)	506	210	210	28	162	27	23	240
Rural Shingletown	684	360	360	9	22	0	9	40
Rural Vineyards	2,477	953	953	90	10	0	0	100
Rural Other	1,098	439	439	0	11	79	0	90
Subtotal Unincorporated	**8,522**	**3,514**	**3,514**	**258**	**2,112**	**195**	**329**	**2,894**
TOTAL	**15,673**	**6,475**	**6,475**	**1,511**	**4,586**	**824**	**836**	**7,757**

2030 Land Use Summary

Area	Population	Housing Units	Occupied Units	Employment				
				Retail	Service	Government	Other	TOTAL
Incorporated								
Anderson	13,176	5,744	5,743	2,459	1,715	579	1,080	5,833
Redding	125,673	52,111	52,072	15,180	33,485	9,881	9,677	68,222
Shasta Lake	15,502	6,274	6,269	585	1,079	762	1,014	3,440
Subtotal Incorporated	**154,351**	**64,129**	**64,084**	**18,224**	**36,279**	**11,222**	**11,770**	**77,495**
Unincorporated								
Anderson Sphere	3,569	1,498	1,496	427	644	73	891	2,035
Redding Sphere	12,960	5,138	5,132	287	6,797	875	2,348	10,307
Cottonwood	7,181	2,723	2,722	298	504	493	312	1,607
Rural North Central (Big Bend, Montgomery Creek)	670	336	334	12	5	20	0	37
Rural East (Burney, Fall River, McArthur, Cassel)	6,337	2,665	2,648	624	1,826	523	558	3,531
Rural Shingletown	3,225	1,600	1,579	233	257	53	78	622
Rural Vineyards	9,606	3,754	3,754	216	345	43	17	620
Rural Other	48,004	19,666	19,396	974	2,881	1,620	2,106	7,580
Subtotal Unincorporated	**91,553**	**37,380**	**37,061**	**3,071**	**13,257**	**3,700**	**6,311**	**26,339**
TOTAL	**245,904**	**101,508**	**101,145**	**21,296**	**49,536**	**14,922**	**18,081**	**103,834**

Table 5 (continued): Shasta Model Land Use Inputs

Increment 2005 to 2030

Area	Population	Housing Units	Occupied Units	Employment				
				Retail	Service	Government	Other	TOTAL
Incorporated								
Anderson	3,848	1,880	1,880	1,573	485	169	233	2,460
Redding	42,936	17,642	17,642	4,050	11,377	2,388	1,958	19,774
Shasta Lake	6,355	2,494	2,494	92	401	186	437	1,116
Subtotal Incorporated	**53,139**	**22,017**	**22,017**	**5,714**	**12,263**	**2,743**	**2,629**	**23,349**
Unincorporated								
Anderson Sphere	1,728	739	739	131	470	0	24	625
Redding Sphere	2,814	1,144	1,144	0	5,157	298	910	6,366
Cottonwood	3,693	1,400	1,400	20	206	152	10	388
Rural North Central (Big Bend, Montgomery Creek)	377	193	193	0	0	0	0	0
Rural East (Burney, Fall River, McArthur, Cassel)	1,097	482	482	140	849	136	115	1,240
Rural Shingletown	1,962	972	972	146	170	0	45	360
Rural Vineyards	9,567	3,739	3,739	216	345	43	17	620
Rural Other	6,098	2,235	2,235	210	407	403	238	1,257
Subtotal Unincorporated	**27,335**	**10,904**	**10,904**	**863**	**7,604**	**1,031**	**1,358**	**10,856**
TOTAL	**80,474**	**32,920**	**32,920**	**6,577**	**19,867**	**3,775**	**3,987**	**34,205**

Attachment 3

SHASTA COUNTY TRAVEL DEMAND FORECASTING MODEL MEETINGS:

NUMBER	MEETING	DATE
1.	Steering Committee Model Update Kickoff Meeting	October 8, 2003
2.	Steering Committee Winter Meeting - Initial Requirements	January 9, 2004
3.	SMUG - RFQ coordination and requirements document	March 29, 2004
4.	Travel Model Kickoff Meeting - Schedule/data collection	January 12, 2005
5.	SMUG - Road Network Classification and TAZ revisions	March 29, 2005
6.	SMUG Preliminary Projections and Land Use Allocation Meeting	June 22, 2005
7.	SMUG Preliminary Projections and Land Use Allocation Meeting	June 23, 2005
8.	SMUG - Data Inventory Pipeline Project ID	August 18, 2005
9.	SMUG Projection and Land Use Allocation Meeting #2	September 14, 2005
10.	SMUG Projection and Land Use Allocation Meeting #3&4	September 15, 2005
11.	SMUG Projection and Land Use Allocation Meeting #3	October 20, 2005
12.	SMUG - Base Year validation review	November 10, 2005
13.	SMUG - Project Status - Base Year and data verifications	March 21, 2006
14.	SMUG - Calibration phase one	July 12, 2006
15.	SMUG - Calibration phase two	August 21, 2006
16.	Training - Model Documentation review	September 25/26, 2006
17.	Traffic Model - Output Review, validation and calibration results	November 21, 2006
18.	Forecast Assumptions Agreement by SMUG	January 23, 2007

Attachment 3-1 Shasta Model User Group (SMUG)		
Name	**Agency**	**Position**
Thomas Hays *	RTPA	Senior Planner
Scott White *	Caltrans	Chief Office of District Planning
Kim Hanagan *	Caltrans	PE System Planning
John Stokes *	City of Anderson	Planning Director
John Abshier *	City of Redding	Traffic Engineer
Kent Manuel	City of Redding	Senior Planner
Jim Coats	City of Redding	GIS Manager
Carla Thompson *	City of Shasta Lake	Development Service Director
Zack Bonnin	County of Shasta	Senior Planner
Dan Little	RTPA	Executive Director
Doug DeMallie	City of Redding	Planning Manager
Al Cathey	County of Shasta	Traffic Engineer
Dennis Daily	City of Shasta Lake	Traffic Engineer
Wayne Gungl	City of Redding	Permit Center Manager
Rich Barchus	City of Anderson	Public Works Director
Kevin Kidd	City of Anderson	Deputy Public Works Director
Dan Kovacich	RTPA	Executive Director
Consultant Support		
Mike Aronson	Dowling Associates Inc	Project Manager
Dena Blazer	Strategic Economics	Project Manger – Land Use
Abby Thorne-Lyman	Strategic Economics	Associate – Land Use
Mark Teague	Pacific Municipal Corp	Planner
Kamesh Vedula	Omni-Means	Traffic Modeler/Engineer
Marcella Nankervis	WILLDAN	Traffic Engineer – City of Shasta Lake

* = Core Group Member

In addition to the 18 consultant lead meetings, approximately 30 meetings were held one on one with jurisdictional subject matter experts to confirm the accuracy and appropriateness of the information provided to the project team.

Economic Sciences Raw Data for Population Forecasting

CITY OF REDDING
POPULATION FORECAST
2012 FORECAST

	Base Case	High Growth	Low Growth
1982	45,059	45,059	45,059
1983	46,758	46,758	46,758
1984	48,502	48,502	48,502
1985	50,385	50,385	50,385
1986	52,641	52,641	52,641
1987	55,307	55,307	55,307
1988	58,650	58,650	58,650
1989	62,555	62,555	62,555
1990	66,950	66,950	66,950
1991	70,700	70,700	70,700
1992	73,350	73,350	73,350
1993	75,300	75,300	75,300
1994	76,450	76,450	76,450
1995	77,350	77,350	77,350
1996	78,150	78,150	78,150
1997	78,950	78,950	78,950
1998	79,650	79,650	79,650
1999	80,383	80,383	80,383
2000	81,742	81,742	81,742
2001	83,525	83,525	83,525
2002	84,990	84,990	84,990
2003	86,010	86,010	86,010
2004	86,811	86,811	86,811
2005	87,407	87,407	87,407
2006	88,003	88,003	88,003
2007	88,621	88,621	88,621
2008	89,121	89,121	89,121
2009	89,583	89,583	89,583
2010*	89,861	89,861	89,861
2011	90,662	90,971	90,351
2012	91,317	91,869	90,744
2013	91,990	92,794	91,143
2014	92,674	93,736	91,548
2015	93,376	94,814	91,963
2016	94,209	95,925	92,501
2017	95,069	97,077	93,056
2018	95,961	98,278	93,631
2019	96,890	99,533	94,229
2020	97,860	100,850	94,853
2021	98,876	102,237	95,507
2022	99,942	103,698	96,193
2023	101,063	105,350	96,914
2024	102,242	107,091	97,783
2025	103,594	108,925	98,693
2026	105,012	110,859	99,646
2027	106,500	112,898	100,645
2028	108,061	115,047	101,693
2029	109,698	117,311	102,790
2030	111,413	119,693	103,939

* Benchmark by Census 2010 Survey 4/1/2010

APPENDIX G

Cost Estimates

Draft Basis of Estimate

City of Redding Master Plan Support

Prepared for

City of Redding, California

August, 2012

CH2MHILL

CH2M HILL Engineers, Inc.
2525 Airpark Drive
Redding, California 96001

Contents

Basis of Estimate

Purpose of Estimate

The purpose of this Cost Estimate is to establish an Engineer's opinion of probable cost, including Construction Costs, Design Costs, and Construction Management Costs, at planning-level design development.

General Project Description

The City of Redding is in the process of updating its Water and Wastewater Master Plans. The City has requested that CH2M HILL Engineers, Inc. provide the City with assistance in cost estimating for wastewater collection system improvements, including sewer conveyance systems, pump station improvements, pond lining and Levee improvements at the Clear Creek Wastewater Treatment Plant.

- Sewer conveyance system improvements include the following:
  - Maintenance Projects
  - Clear Creek Collection System
  - Stillwater Collection System
  - Stillwater Drainage Pumping Projects
  - Clover Creek Interceptor Rehabilitation
- Pump Station Improvements include the following:
  - Six locations in the Churn Creek Drainage Area: Westside and Layton (demolish and replace), North Market, Riverbend, Locust, and Hartnell (upgrade pumps and controls)
  - One location in the Stillwater Drainage Area: Tierra Oaks (minor capacity increase)
  - Four locations requiring Miscellaneous Sitework and Security Upgrades
  - Removal of abandoned sewer piping suspended under the North Market Street Bridge over the Sacramento River
- Pond lining and Levee improvements at the Clear Creek Wastewater Treatment Plant include the following:
  - Lining Ponds 2 and 4 with a double layer of a membrane liner with a leak detection system, requiring import native fill and compaction of approximately three foot thick over the pond area
  - Installation of Riprap Rock Slope Protection to the river side of the levee at Pond 8 at the Clear Creek Wastewater Treatment Plant

Overall Costs

See Cost Estimate Summary, Appendix A, for the cost summary breakdown by project. See Cost Estimate Details, Appendix B, for the cost estimate details.

Scope of Work

This project consists of the following key components:

- Open-cut excavation sewer pipe replacement as follows:
  - Trench width excavation determined by replacement pipe diameter, and an assumed trench depth of 10 feet below existing surface
  - Demolition of existing pipe, including hauling for offsite disposal
  - Installation of replacement sewer piping, including 0.5 foot of imported bedding material, imported pipe zone material to 1 foot above piping, and native backfill for the remaining trench

- Open-cut surface restoration includes the following:
  - Trenching in existing roads, including asphalt pavement T-Patch 2 feet wider than pipe trenching, 1 foot on each side of trench
  - Trenching in landscaped area including landscaping replacement, 10 feet wide. For San Francisco Drive West and South, the estimate assumes trenching and pipe replacement will be done with small equipment between existing houses on easements
  - Trenching in open zone landscaped areas includes site clearing and surface restoration to 25 feet wide
- Horizontal directional drilling pipe replacement, where assumed required, as follows:
  - Excavation and backfilling jacking and receiving pits
  - New manholes where existing pipe and casings exist, abandonment of existing piping, and new pipe and casing placed parallel
  - New piping is assumed to be high-density polyethylene (HDPE) fusion weld joints in 0.5-inch-thick wall steel casing, and pressure grouted between casing and pipe wall
- Pipe Rehabilitation, where assumed required, as follows:
  - Pipe lining and grouting of existing sewer piping
- Existing Pump Station Improvements includes the following:
  - Complete demolition and replacement of the Westside and Layton lift stations
  - Capacity upgrades to North Market, Hartnell, Riverbend, Locust, and Tierra Oaks lift stations including pump and control upgrades
  - Four locations requiring Miscellaneous Sitework and Security Upgrades
  - Removal of abandoned sewer piping suspended under the North Market Street Bridge over the Sacramento River
- Pond lining and Levee improvements at the Clear Creek Wastewater Treatment Plant include the following:
  - Lining Ponds 2 and 4 with a double layer of a membrane liner with a leak detection system, requiring import native fill and compaction of approximately three foot thick over the pond area
  - Installation of Riprap Rock Slope Protection to the river side of the levee at Pond 8 at the Clear Creek Wastewater Treatment Plant

Markups

These markups are based on general assumptions about how the project will be contracted. Actual markup percentages may vary from those shown in Table 1, and are the responsibility of the bidding contractor.

TABLE 1
Contractor Markups
City of Redding, Master Plan Support

Component	Markup on Direct Costs (%)
Contractor General Conditions	8.00
Sales Tax on Material	7.25
Contractor Overhead	12.00

TABLE 1
Contractor Markups
City of Redding, Master Plan Support

Contractor Profit	8.00
Bonds/Insurance	3.50
Contingency	30.00

Escalation Rate

This estimate is presented in current 2012 Dollars. No escalation is included.

Estimate Classification

This Class 5 cost estimate was prepared in accordance with the guidelines of the Association for the Advancement of Cost Engineering International (AACEI). According to AACEI, the Class 5 Estimate is defined as follows:

> This estimate is prepared based on limited information, where little more than proposed improvement type, its location, and the capacity are known, where preliminary engineering is from 0% to 2% complete. Strategic planning purposes include but are not limited to, market studies, assessment of viability, evaluation of alternate schemes, project screening, location and evaluation of resource needs and budgeting, and long-range capital planning. Examples of estimating methods used would include cost/capacity curves and factors, scale-up factors, and parametric and modeling techniques. The expected accuracy ranges for this class of estimate are –20% to –50% for the low range side and +30% to +100% on the high range side.

Estimate Methodology

This cost estimate is considered a bottom rolled-up type estimate with cost items and breakdown of labor, materials, and equipment. Some quotations were obtained for various items. The estimate includes allowance cost and costs for certain components of the estimate.

Cost Resources

The following are the various cost resources used to develop the cost estimate:

- R.S. Means
- CH2M HILL Historical Data
- Vendor Quotes on Equipment and Materials where appropriate
- Estimator Judgment

Labor Costs

The estimate has been adjusted for local area labor rates, based on RS Means City Cost Index for Redding, California.

Labor unit prices reflect a burdened rate, including workers compensation, unemployment taxes, fringe benefits, and medical insurance. Labor rates are based on National Average Union Rates and Prevailing Wages, adjusted to a City Cost Index for Redding, California. Both the National Average Rates and City Cost Index are from the RS Means Cost Data 2012.

Taxes

A California state sales tax rate of 7.25 percent was added to all material costs.

Major Assumptions

The estimate is based on the assumption that the work will be done on a competitive bid basis and the contractor will have a reasonable amount of time to complete the work. We assume that the contractor will have a reasonable project schedule, no overtime, and is under a single contract.

This estimate should be evaluated for market changes after 90 days from the issue date. It is assumed that much of the following fabricated equipment will be shipped from the mainland United States:

- Pipe material, open cut, assumed polyvinyl chloride (PVC)
- Pipe material, horizontal directional drilling, assumed HDPE fusion weld joints
- Trench depth assumed 10 feet below existing ground surface
- Asphalt paving replacement is assumed to be T-patch only; full lane or full street overlay is not included

Allowances

The estimate includes allowances for the following work that is not sufficiently detailed at this time:

- Mobilization/demobilization allowance
- Pre- and post-construction survey allowance
- Pre- and post-construction closed-circuit television (CCTV) inspection of sewer pipelines allowance
- Sewer bypass allowance
- Erosion control allowance
- Traffic control allowance
- Pipe Rehabilitation lining and grouting allowance
- Design and engineering allowance
- Construction management allowance

Excluded Costs

The cost estimate excludes the following costs:

- Permits
- Land acquisition and easements
- Hazardous waste remediation or mitigation costs
- Owner’s costs such as legal and administration

Reference Documents

- Excel files provided to CH2M HILL by the City of Redding
  - Clear_Creek_Collection_System_Summary
  - Clover_Creek_Interceptor_Rehab
  - Maintenance_Projects_List
  - Stillwater_Collection_System_Projects
  - Stillwater_Drainage_Pumping_Projects

Appendix A
Cost Estimate Summary

Maintenance Projects

Project Number	Project Description	Const Cost with 30% Contingency	Year of Estimate	Design Cost	CM Cost	2012 Total Cost	2012 Total Cost Rounded (K)
P-CC-18	Azailia I-5 Crossing	$434,878	2012	$65,232	$65,232	$565,341	**$566,000**
P-CC-19	Hiltop	$526,539	2012	$78,981	$78,981	$684,501	**$685,000**
P-CC-21	San Francisco West	$222,180	2012	$33,327	$33,327	$288,834	**$289,000**
P-CC-22	San Francisco South	$126,839	2012	$19,026	$19,026	$164,891	**$165,000**
P-CC-23	Loma Street Alley	$369,544	2012	$55,432	$55,432	$480,407	**$481,000**
P-CC-24	Mesa Alley	$422,931	2012	$63,440	$63,440	$549,810	**$550,000**
P-CC-25	Manzanita Drive	$86,407	2012	$12,961	$12,961	$112,329	**$113,000**
P-CC-26	Hallmark Alley	$470,438	2012	$70,566	$70,566	$611,569	**$612,000**
P-CC-27	Redbud Alley	$229,647	2012	$34,447	$34,447	$298,541	**$299,000**
P-CC-28	Woodacre Drive	$315,569	2012	$47,335	$47,335	$410,240	**$411,000**
P-CC-29	Mistletoe	$179,710	2012	$26,957	$26,957	$233,623	**$234,000**
P-CC-31	Churn Creek	$132,844	2012	$19,927	$19,927	$172,697	**$173,000**
P-CC-32	School Street	$363,493	2012	$54,524	$54,524	$472,541	**$473,000**
P-S-10	Boneset	$120,358	2012	$18,054	$18,054	$156,465	**$157,000**
P-S-9	Patterson Court	$162,451	2012	$24,368	$24,368	$211,186	**$212,000**

Clear Creek Collection System

Project Number	Project Description	Const Cost with 30% Contingency	Year of Estimate	Design Cost	CM Cost	2012 Total Cost	2012 Total Cost Rounded (K)
P-CC-1, YR 2010	Lake Redding, Planning Year 2010	$1,472,822	2012	$220,923	$220,923	$1,914,669	**$1,915,000**
P-CC-1, UBO	Lake Redding, Ultimate Buildout	$3,768,793	2012	$565,319	$565,319	$4,899,431	**$4,900,000**
P-CC-2, UBO	Cumberland, Ultimate Buildout	$423,737	2012	$63,561	$63,561	$550,858	**$551,000**
P-CC-3, UBO	East Cypress, Ultimate Buildout	$176,837	2012	$26,526	$26,526	$229,888	**$230,000**
P-CC-4, YR 2010	Buenaventura, Planning Year 2010	$967,702	2012	$145,155	$145,155	$1,258,013	**$1,259,000**
P-CC-4, UBO	Buenaventura, Ultimate Buildout	$2,926,941	2012	$439,041	$439,041	$3,805,023	**$3,806,000**
P-CC-5, UBO	Mercury, Ultimate Buildout	$396,068	2012	$59,410	$59,410	$514,888	**$515,000**
P-CC-6, UBO	Canby Bypass Phase 1, Ultimate Buildout	$338,446	2012	$50,767	$50,767	$439,980	**$440,000**
P-CC-7, UBO	Westside PIII, Ultimate Buildout	$1,922,337	2012	$288,351	$288,351	$2,499,038	**$2,500,000**
P-CC-8 & P-CC-9, UBO	Sulphur Creek, Ultimate Buildout	$1,594,280	2012	$239,142	$239,142	$2,072,564	**$2,073,000**
P-CC-11 & P-CC-17, UBO	Bechelli North & South, Ultimate Buildout	$96,399	2012	$14,460	$14,460	$125,319	**$126,000**

Stillwater Collection System

Project Number	Project Description	Const Cost with 30% Contingency	Year of Estimate	Design Cost	CM Cost	2012 Total Cost	2012 Total Cost Rounded (K)
P-S-1, YR 2010	Oasis Road, Year 2010	$102,350	2012	$15,353	$15,353	$133,055	**$134,000**
P-S-1, UBO	Oasis Road, Ultimate Buildout	$298,578	2012	$44,787	$44,787	$388,151	**$389,000**
P-S-5, UBO	Boulder Creek Interceptor PIII, Ultimate Buildout	$2,233,104	2012	$334,966	$334,966	$2,903,035	**$2,904,000**

Stillwater Drainage Pumping Projects

Project Number	Project Description	Const Cost with 30% Contingency	Year of Estimate	Design Cost	CM Cost	2012 Total Cost	2012 Total Cost Rounded (K)
UBO	Serving all expected growth except Stillwater Creek Drainage Area	$107,322	2012	$16,098	$16,098	$139,519	**$140,000**
UBO (2)	UBO plus City Limits portion of Stillwater Creek Drainage Area	$3,522,237	2012	$528,336	$528,336	$4,578,908	**$4,579,000**
	Pipe Rehabilitation	$536,810	2012	$80,522	$80,522	$697,853	**$698,000**
	Pipe Rehabilitation UBO (4)	$205,963	2012	$30,894	$30,894	$267,752	**$268,000**

Clover Creek Interceptor Rehabilitation

Project Number	Project Description	Const Cost with 30% Contingency	Year of Estimate	Design Cost	CM Cost	2012 Total Cost	2012 Total Cost Rounded (K)
P-S-11, Priority 1	Clover Creek Interceptor Rehab, Priority 1	$6,825,608	2012	$1,023,841	$1,023,841	$8,873,290	**$8,874,000**
P-S-11, Priority 2	Clover Creek Interceptor Rehab, Priority 2	$2,388,314	2012	$358,247	$358,247	$3,104,808	**$3,105,000**
P-S-11, Priority 3	Clover Creek Interceptor Rehab, Priority 3	$5,056,866	2012	$758,530	$758,530	$6,573,926	**$6,574,000**

Priority 1: 15,804 LF In or Crossing Creek, Assumed Pipe Relining
Priority 2: 7,539 LF Parallel Creek, but not in Creek, Assumed Open Cut
Priority 3: 9,390 LF In Roadway Parallel to Creek, Assumed Open Cut including Asphalt Paving T-Patch

Pump Station Upgrades

Project Number	Project Description	Const Cost with 30% Contingency	Year of Estimate	Design Cost	CM Cost	2012 Total Cost	2012 Total Cost Rounded (K)
LS-CC-1 & 26 - 29	Westside Lift Station	$345,259	2012	$51,789	$51,789	$448,837	**$449,000**
LS-CC-5	North Market Lift Station	$90,725	2012	$13,609	$13,609	$117,943	**$118,000**
LS-CC-2 & 11 - 13	Hartnell Lift Station	$89,778	2012	$13,467	$13,467	$116,711	**$117,000**
	Tierra Oaks Lift Station	$76,650	2012	$11,498	$11,498	$99,645	**$100,000**
LS-CC-14	Layton Lift Station	$325,163	2012	$48,774	$48,774	$422,712	**$423,000**
LS-CC-15	Locust Lift Station	$380,005	2012	$57,001	$57,001	$494,007	**$495,000**
LS-CC-16	Remove Suspended River Crossing Pipe	$123,026	2012	$18,454	$18,454	$159,934	**$160,000**
LS-CC-17	Remington Lift Station	$88,828	2012	$13,324	$13,324	$115,476	**$116,000**
LS-CC-24 - 25	Sunnyhill Lift Station	$110,861	2012	$16,629	$16,629	$144,119	**$145,000**
LS-CC-3 & 21 - 23	Riverbend Lift Station	$120,380	2012	$18,057	$18,057	$156,494	**$157,000**
LS-CC-7 & 8	Cheryl Lift Station	$106,877	2012	$16,032	$16,032	$138,940	**$139,000**
LS-CC-9 & 10	Denton Lift Station	$89,778	2012	$13,467	$13,467	$116,711	**$117,000**

Clear Creek WWTP Pond Lining

Project Number	Project Description	Const Cost with 30% Contingency	Year of Estimate	Design Cost	CM Cost	2012 Total Cost	2012 Total Cost Rounded (K)
	Pond 2	$1,815,926	2012	$272,389	$272,389	$2,360,704	**$2,361,000**
	Pond 4	$1,758,111	2012	$263,717	$263,717	$2,285,544	**$2,286,000**

Clear Creek WWTP Levee

Project Number	Project Description	Const Cost with 30% Contingency	Year of Estimate	Design Cost	CM Cost	2012 Total Cost	2012 Total Cost Rounded (K)
	Clear Creek WWTP Levee	$1,391,944	2012	$208,792	$208,792	$1,809,527	**$1,810,000**