COUNTY OF SAN MATEO

Crystal Springs County Sanitation District

SEWER MASTER PLAN

Prepared by:
Brown and Caldwell
August 1999

CONTENTS

LIST OF TABLES

LIST OF FIGURES

*Foldout figure follows page number indicated.

EXECUTIVE SUMMARY

In December 1996, the County of San Mateo engaged Brown and Caldwell to prepare a sewer system master plan for the Crystal Springs County Sanitation District (CSCSD). This executive summary presents the findings, conclusion, and recommendations regarding this system. It also proposes a capital improvement plan (CIP) and summarizes recommended rates and a revenue plan to finance proposed improvements.

Background

The overall master planning process used for the sewer system master plan consisted of identifying capacity limitations along with structural deficiencies of the sewer system and developing an ongoing improvement program to correct the limitations. Part of the overall improvement program is the consideration for changing current maintenance activities to more appropriately match the needs of the sewer system. The improvement plan's goal is to develop a balance between capital projects and system maintenance to achieve a highly reliable collection system for the lowest overall cost.

A series of field inspections were performed to collect information on the collection system. Limited source detection methods (including smoke testing, manhole inspections, maintenance calls, television inspection and topographic surveying) were used to identify collection system structural deficiencies. Wet weather flow monitoring and hydraulic modeling were performed to develop a listing of hydraulic deficiencies. Projects were developed and prioritized based on the deficiencies and capital costs that were prepared. Methods for financing the recommended improvements are also included in the study.

Findings

Review of known problem areas and interviews with County maintenance crews was used to prioritize field inspections in the CSCSD. Flow monitoring was also performed to evaluate the amount of remaining capacity in the wastewater collection system. This section presents the results of the field inspection and capacity analysis.

A manhole inspection program was performed in the winter and spring of 1997. Field crews documented the condition of 257 manholes. No serious defects were noted during the inspection. Results of the inspections were used to prioritize the television inspection program.

The smoke testing program was conducted during the summer of 1998. Areas with suspected high Inflow/Infiltration (I/I) were scheduled for testing. Field crews tested approximately 50,800 linear feet of sewer lines. A total of 59 collection system defects were documented during the program. No serious defects were noted.

The television inspection program was conducted during the winter of 1999. A total of 9,271 feet of the collection system was inspected. Over 210 structural defects were documented during the inspection. Results of the television inspection program were used to develop the CIP.

Flow monitoring was performed during the winters of 1997 and 1998. The purpose of the flow monitoring was to develop peak wastewater flow rates for use in the hydraulic model of the collection system. The capacity of the major trunk sewer along Polhemus Road was evaluated for this study. Results of the analysis indicate that approximately 5,000 linear feet of the trunk sewer has inadequate capacity.

Recommendations

A CIP was developed based on the results of the field work and capacity analysis. A total of nine capital improvement projects were developed for the CSCSD. Eight of the projects are recommended to repair structural deficiencies. The remaining project is recommended to provide additional hydraulic capacity to the Polhemus Road trunk sewer. Estimated total construction costs for the projects range between $1,570,000 and 1,850,000 depending on the selected alternative improvement. The location of the improvement projects is listed below:

1. Timberlane Way
2. South Ascension Drive
3. Polhemus Road (north)
4. Polhemus Road (south)
5. Rainbow Drive
6. Enchanted Way
7. Parrot Drive
8. Lexington Avenue
9. Randall Road

SECTION 1

INTRODUCTION

This chapter introduces the sewer master planning process for the Crystal Springs County Sanitation District (CSCSD) of San Mateo County (County), including background, authorization, scope of work and report organization.

Background and Purpose of Work

The overall master planning process used for the sewer system master plan consisted of identifying capacity limitations along with structural deficiencies of the sewer system and developing an ongoing improvement program to correct the limitations. Part of the overall improvement program is the consideration for changing current maintenance activities to more appropriately match the needs of the sewer system. The improvement plan's goal is to develop a balance between capital projects and system maintenance to achieve a highly reliable collection system for the lowest overall cost.

A series of field inspections were performed to collect information on the collection system. Limited source detection methods (including smoke testing, manhole inspections, maintenance calls, television inspection and topographic surveying) were used to identify collection system structural deficiencies. Wet weather flow monitoring and hydraulic modeling were performed to develop a listing of hydraulic deficiencies. Projects were developed and prioritized based on the deficiencies and capital costs that were prepared. Methods for financing the recommended improvements are also included in the study.

The County maintains and operates nine noncontiguous sewer districts containing approximately 130 miles of sewer mains. The sewer districts are:

1. Burlingame Hills Sewer Maintenance District
2. Crystal Springs County Sanitation District
3. Devonshire County Sanitation District
4. Emerald Lake Heights Sewer Maintenance District
5. Fair Oaks Sewer Maintenance District
6. Harbor Industrial Sewer Maintenance District
7. Kensington Square Sewer Maintenance District
8. Oak Knoll Sewer Maintenance District
9. Scenic Heights County Sanitation District

The CSCSD is located on the San Francisco Peninsula in the area roughly bounded by the Arthur Younger Freeway (Highway 92) in the south, the Junipero Serra Freeway (I-280) in the west, Crystal Springs Road in the north and Parrot Drive in the east.

Though the County has maintained and upgraded the collection system in the past, this work has been done without the benefit of master planning. This report provides a prioritized capital improvement program along with recommended follow-up field investigations and potential funding mechanisms.

Authorization

The County authorized this work through an agreement with Brown and Caldwell dated December 17, 1996.

Scope of Work

The scope of work includes the following activities:

Assessment of Existing Sewer Systems. To develop a meaningful capital improvement program, it was necessary to determine the structural and hydraulic condition of the CSCSD collection system. Methods used to complete the evaluation included reviewing existing maps and records drawings, interviewing County maintenance workers and checking maintenance records, manhole inspections, wet weather flow monitoring, smoke testing and television inspection. Results from the flow monitoring program were used to develop wet weather hydrographs for use in the hydraulic model and determine which areas in the system had the highest infiltration/inflow rates.

Development of Sewer System Capital Improvement Plans. A listing of sewer system deficiencies were developed based on the sewer system assessment task. Capital projects were developed to correct each identified system deficiency. Capital projects were prioritized and estimated capital costs for each project were determined. Project priorities were reviewed with County staff and an annual schedule of required capital improvements were developed. A financial plan was developed to support the recommend projects. The financial plan includes financial alternatives and recommended sewer charges and revised connection fees, if any.

Data Management. Data generated during the study was entered into a series of Access databases for future use by the County. The databases will be submitted under separate cover to the County with the Master Plans.

Master Plan Report. Prepare a sewer system master plan report for the Crystal Springs District. The master plan report is supported by a series of technical memoranda prepared as part of the previous tasks. The master plan provides completed documentation of the recommended capital improvement projects as well as financing alternatives.

Report Format

This Master Plan report has been organized as a reference report, to the extent possible. Each section in the report consists of one to two pages of descriptive text followed by a data table, graphical figure, or both. This report has 15 sections roughly divided as follows:

- Sections 1 through 3 describe the current County system and operating procedures.
- Sections 4 through 9 describe the field work programs.
- Sections 10 and 11 summarize the hydraulic modeling work.
- Sections 12 through 15 describe the capital improvement program and funding mechanisms.

Technical memoranda and backup material are also provided in the appendices following the main body of the report as identified in the Table of Contents.

SECTION 2

EXISTING SEWERS

The general physical characteristics of the Crystal Springs County Sanitation District (CSCSD) sewer collection system are described in this section. These characteristics provide the basis for physical evaluation of the collection system and determine the system's ability to convey current and projected wastewater flows.

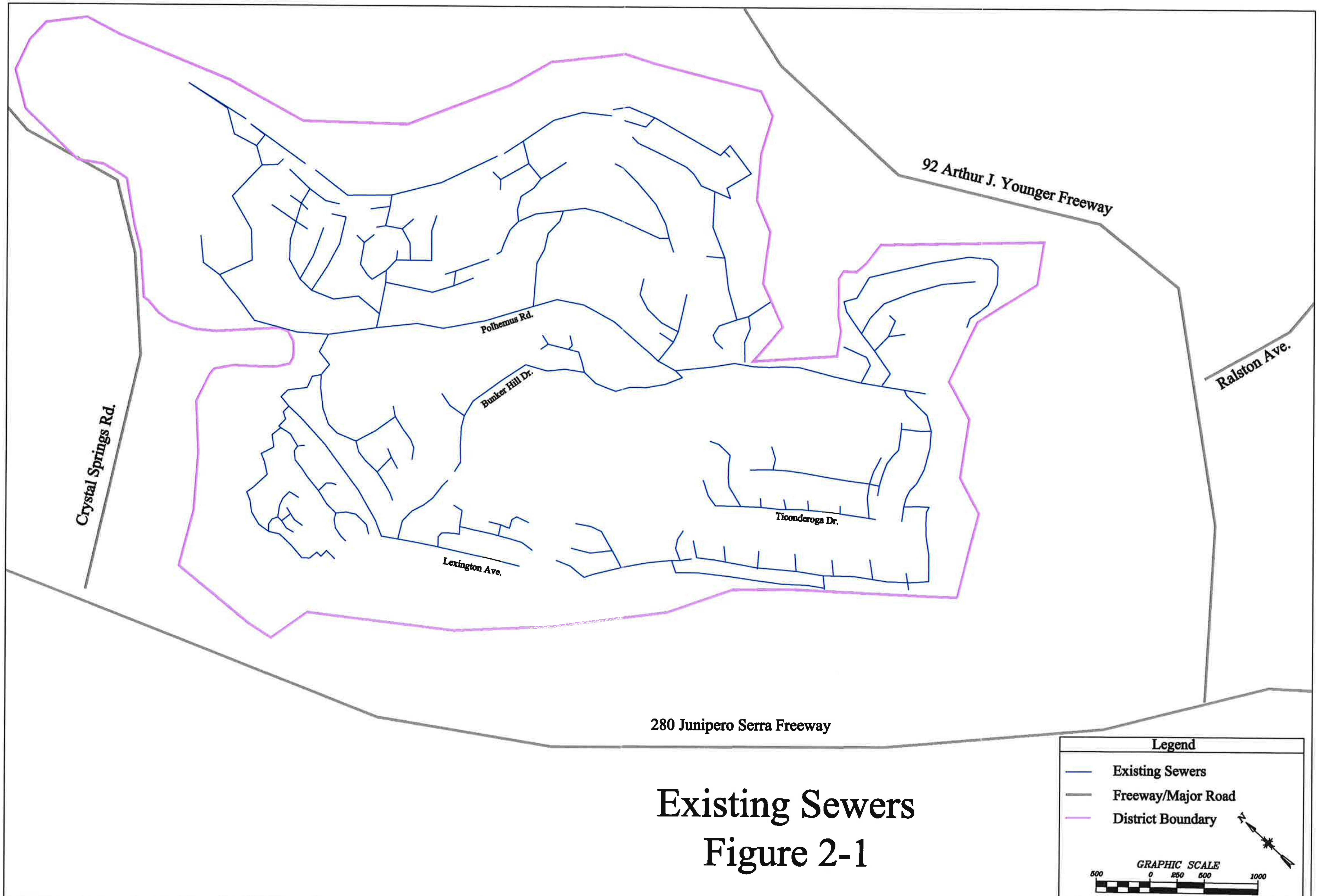
Description of Existing Facilities

The CSCSD's sewer collection system is characterized as a gravity system. Sewage pumping stations are not required due to the topography in the service area. The collection system consists of approximately 13 miles of 6-inch to 15-inch-diameter vitrified clay pipe. Most of the collection system has been constructed between the post World War II period and the present.

The main trunk sewer in the CSCSD is a 10-inch to 15-inch-diameter sewer located in the valley along Polhemus Road. This sewer roughly divides the CSCSD into two major drainage areas. The trunk sewer begins by collecting wastewater flows from County and State facilities located on Tower Road and Polhemus Road and then flows to the north and ultimately discharges wastewater flow to the Town of Hillsborough. The point of connection to the Town of Hillsborough is at the intersection of Polhemus Road and Crystal Springs Road. The CSCSD purchased capacity in the Town of Hillsborough and City of San Mateo sewer systems. Figure 2-1 depicts the CSCSD boundaries and collection system.

Manhole Number System

A manhole numbering scheme was developed to aid in data management. The manhole numbering system consists of an eight-digit alphanumeric code. The first letter identifies the District within the County (C for CSCSD). The next four numbers identify the manhole within the CSCSD. A single letter code follows and is used for manholes with duplicate numbers (typically infill manholes constructed by the County). The last two numbers in the code describe the County map number.



Existing Sewers
Figure 2-1

SECTION 3

SEWER OPERATION AND MAINTENANCE

Prior to beginning the physical inspection of the Crystal Springs County Sanitation District (CSCSD), the current operation and maintenance procedures were reviewed. This section documents the results of that review.

Known Problem Areas

Areas of known problems within the sewer collection system were identified through discussions with County personnel and review of the CSCSD maintenance records. Problem areas were identified by line blockages from roots and grease accumulations or sewer sags. The collection systems are on a cleaning frequency of once per year minimum and can range up to four times per year based on collection system call outs. Problems associated with flat sewers are not found in the CSCSD due to the relatively steep topography in the service area. There are no known manholes or pipelines with hydrogen sulfide corrosion problems.

Several approaches are available for addressing sewer maintenance problems. Grease problems are addressed by controlling grease discharges from commercial establishments by requiring grease traps and having an enforcement program to ensure that they function properly. Grease can accumulate at sags, areas with flat slopes, roots, and offset joints in sewers. Grease problems in residential areas are addressed by increased maintenance (hydroflushing of the sewer to flush the grease accumulation downstream).

Root problems are typically addressed by using an undersized root cutter, typically a 4-inch-diameter cutter for a 6-inch sewer. The County maintenance crews prefer to use an undersized cutter to prevent damage to the pipeline. Roots can also be addressed by chemical foam application to kill the roots. Application and reapplication is typically required on a 1- to 3-year cycle. The County has recently started using chemical root treatment in the Burlingame Hills Sewer Maintenance District.

Accumulations of rocks and gravel in the sewer line can be an indicator of broken pipe in the system. Television inspection should be performed in these areas to look for pipes in bad condition. A listing of the maintenance “hot-spots” for sewer laterals in the system requiring callouts more than twice a year is provided in Table 3-1. Sewer mains requiring two or more callouts per year are summarized in Table 3-2. A description of the problem is also provided. This listing was used to develop the collection system physical inspection programs described in the following sections.

Table 3-1. Callout Summary for Sewer Laterals

Street number	Street name	Year	Reason for callout				
			Roots	Grease	Paper	Inspection	Comment
2267	Allegheny Wy	1992	x				Lateral OK
2275	Allegheny Wy	1995					No cleanout, Permit 2539
1506	Ascension Dr	1996	x				
1542	Ascension Dr	1990	x				
1548	Ascension Dr	1987	x				
1624	Ascension Dr	1993					Bad spot; lateral needs repair
1630	Ascension Dr	1987		x			No cleanout
1312	Bel Aire Rd	1994					Permit 2477Lateral OK
1327	Bel Aire Rd	1978	x				"T"-Cleanout
1330	Bel Aire Rd	1995	x				
1366	Bel Aire Rd	1979				x	
1456	Bel Aire Rd	1978					No cleanout
1480	Bel Aire Rd	1985					No cleanout
20	Bennington Dr	1976					Lateral OK
1520	Brandywine Rd	1980	x				Lateral OK
1547	Brandywine Rd	1993					VOID Permit 2386. Owner taking responsibility of uninspected work.
2193	Bunker Hill Dr	1990	x				
2220	Bunker Hill Dr	1992			x		Permit 2219 & Lateral OK
5	Crown Ct	1986				x	Permit 0945
20	Crown Ct	1986					Permit 0946
45	Crown Ct	1987				x	Permit 1475
1341	Enchanted Wy	1986	x				Off-set
1354	Enchanted Wy	1993					No cleanout
1515	Forge Rd	1996	x		x		
2011	Kings Ln	1996	x				Off-set, Lateral OK
2034	Kings Ln	1979				x	Permit 0164
2041	Kings Ln	1984	x				Lateral OK
1261	Laurel Hill Dr	1993					No cleanout
1263	Laurel Hill Dr	1992	x				Permit 1549 (1987), Hair
1263	Laurel Hill Dr	1993	x		x		
1479	Laurel Hill Dr	1996					Permit 2706 Voided - Owner decided not to reconstruct cleanout. "T"-cleanout
1415	Lexington Ave	1992					No cleanout
1607	Lexington Ave	1980					No cleanout
1628	Lexington Ave	1992					No cleanout
1659	Lexington Ave	1987	x				
1660	Lexington Ave	1985					Cleanout OK

Street number	Street name	Year	Reason for callout				
			Roots	Grease	Paper	Inspection	Comment
1690	Lexington Ave	1979	x				No cleanout
1719	Lexington Ave	1977					Rocks in Cleanout
1723	Lexington Ave	1995			x		Dirt, Permit 2597
1784	Lexington Ave	1994					Lateral OK
1880	Lexington Ave	1978	x				Lateral OK
1912	Lexington Ave	1995					Permit 2552, Non-standard cleanout
2036	Lexington Ave	1995					No cleanout, Lateral OK
2136	Lexington Ave	1980					Lateral OK
1786	Los Altos Dr	1993					No cleanout
1805	Los Altos Dr	1979	x		x		No cleanout
1812	Los Altos Dr	1988	x				Off-set
1936	Los Altos Dr	1996					Lateral OK
1983	Los Altos Dr	1979	x				
15	Lundys Ln	1987	x				Improper cleanout
1707	Monticello Rd	1994	x				
1708	Monticello Rd	1987	x				
1759	Monticello Rd	1986					Repair lateral (Off-Set)
30	Mountain View Pl	1995					No cleanout
1136	Parrott Dr	1985				x	Repair Main
1151	Parrott Dr	1985	x				
1163	Parrott Dr	1991	x		x		
1203	Parrott Dr	1993					Lateral OK
1230	Parrott Dr	1979	x				Lateral OK
1311	Parrott Dr	1992					Mud & Needs Repair
1399	Parrott Dr	1991					Permit 2170 & Broken Pipe
1426	Parrott Dr	1980					Broken Lateral
1475	Parrott Dr	1993					Lateral OK
1499	Parrott Dr	1985		x			Combo & mud
1563	Parrott Dr	1977					Broken lateral
1615	Parrott Dr	1979	x				Lateral OK
1615	Parrott Dr	1980	x				Lateral OK
1616	Parrott Dr	1992	x				Grass
1636	Parrott Dr	1975				x	Lateral OK
1684	Parrott Dr	1975					No cleanout
1691	Parrott Dr	1996	x		x		
1699	Parrott Dr	1985	x				
1798	Parrott Dr	1975	x				No cleanout
1819	Parrott Dr	1978	x				Lateral OK
1835	Parrott Dr	1991	x				Lateral OK
1883	Parrott Dr	1993					No cleanout
15	Powhatan Pl	1993	x				Lateral OK
2024	Queens Ln	1990	x				
2029	Queens Ln	1996			x		

Street number	Street name	Year	Reason for callout				
			Roots	Grease	Paper	Inspection	Comment
2030	Queens Ln	1992	x				
2072	Queens Ln	1994	x		x		
2083	Queens Ln	1984	x				
2154	Queens Ln	1996	x				
2177	Queens Ln	1994	x				
2184	Queens Ln	1991					No cleanout; too far back of property line
1427	Rainbow Dr	1991					Permit 2143, No cleanout
1844	Randall Rd	1994	x				Lateral OK
1876	Randall Rd	1991	x				
1884	Randall Rd	1995					Permit 2207
30	Roxbury Ln	1994	x				
35	Roxbury Ln	1982					Permit 0407
1510	Seneca Ln	1995	x				"T"-cleanout connects to manhole. Letter sent.
25	Shelburne Pl	1993	x		x		
2224	Sheraton Pl	1985	x		x		
2230	Sheraton Pl	1992	x				Lateral OK
139	Starlite Dr	1985	x				Lateral OK
148	Starlite Dr	1993					No cleanout
163	Starlite Dr	1976			x		No cleanout
1456	Tarrytown Rd	1995					Rocks, Permit 2637
1911	Ticonderoga Dr	1978					No cleanout
1992	Ticonderoga Dr	1991			x		Lateral OK
2012	Ticonderoga Dr	1980					No cleanout
2043	Ticonderoga Dr	1980					No cleanout
2059	Ticonderoga Dr	1994					No cleanout
2096	Ticonderoga Dr	1990	x				
2124	Ticonderoga Dr	1987				x	Permit 1460
2062	Timberlane Wy	1980					Permit 0253
2083	Timberlane Wy	1986				x	Permit 1073
2087	Timberlane Wy	1986				x	Permit 1075
2095	Timberlane Wy	1986				x	Permit 1074
5	White Plains Ct	1980	x				Lateral OK
35	White Plains Ct	1977					Cleanout repair
1615	Yorktown Rd	1985	x				Off-set
1644	Yorktown Rd	1992		x			No cleanout
1712	Yorktown Rd	1978	x				Lateral OK

Table 3-2. Callout Summary for Sewer Mains

Street number	Street name	Year	Reason for callout				
			Roots	Grease	Paper	Inspection	Comment
10	Burgoyne Ct	1977	x				Main OK
1359	Enchanted Wy	1978	x				
1405	Enchanted Wy	1978					Main OK (3)
1835	Parrott Dr	1980	x				
1835	Randall Rd	1980		x	x		
1624	Ascension Dr	1985	x	x			
1136	Parrott Dr	1985				xx	
1835	Parrott Dr	1985	xxx				
1306	Bel Aire Rd	1986				xxxx	Main OK, Off-Set (Bel Aire Rd & Parrot Dr)
1405	Enchanted Wy	1986	x				Main OK (2)
1250	Parrott Dr	1986					Broken Main, Main Ok
2029	Queens Ln	1987	xxx				

SECTION 4

MANHOLE INSPECTION

The manhole inspection program was conducted during the winter and spring of 1997. Field crews documented the condition of 257 manholes in the Crystal Springs County Sanitation District (CSCSD). This section presents the results of the manhole inspection program.

Purpose and Objective

Manhole inspection was performed to evaluate manholes as potential infiltration/inflow (I/I) sources and document their physical condition. Additionally, the manhole inspection results were used to prioritize the smoke testing and television inspection programs. The manhole inspection program did not include all the manholes in the CSCSD. Manholes were selected for inspection to provide a representative sample of the manholes in the CSCSD.

During the inspection, the general condition of the manhole and incoming/outgoing pipelines was determined. Photographs of the incoming/outgoing pipelines were taken to determine their condition. The following conditions were documented during the inspection:

- Manhole bench/channel condition
- Roots in the manhole or pipeline
- Grease in the manhole or pipeline
- Manhole frame/cover condition
- Presence of I/I in the manhole or pipeline
- Major debris in the manhole or pipeline
- General physical condition of the pipeline.

Findings

The major manhole defects noted during the manhole inspection program are listed in Table 4-1. The major pipeline defects observed from the photographs are listed in Table 4-2. A technical memorandum, dated October 12, 1998, describing the manhole inspection in more detail is provided in Appendix A. Attachments A, B and C for the technical memorandum were provided in the original submittal. Manhole inspection forms and photographs are provided under separate cover in a series of three-ring binders.

Table 4-1. Manhole Defects

Defect type	Number
Bench/Channel Defects	10
Roots	5
Grease	23
Frame and Cover Problems	12
Active or signs of Infiltration/Inflow	7
Major Debris in Channel	12
Manholes Inspected	257

Table 4-2. Pipeline Defects Noted from Manhole Inspection Program

Pipes with separated joints greater than moderate and deflections greater than 1 inch	12
Pipes with greater than minor corrosion	0
Pipes with infiltration/inflow	0
Pipes with greater than light grease	25
Pipes with greater than light roots	38
Pipes with roots and grease	3
Pipes with cracks and fractures	22
Pipes with plugs and obstructions	0

SECTION 5

FLOW MONITORING PROGRAM

A flow monitoring program was implemented to measure flow rates during dry weather and discrete rainfall events. This section describes the flow monitoring program. Flows and flow rates developed from the flow monitoring efforts are described in Sections 8 and 9.

Wastewater flows were divided into base sanitary flow (BSF) and wet weather infiltration/inflow (I/I) components for this study. Base sanitary flow factors are based on dry weather flow monitoring performed during the winter of 1997. Due to limited rainfall during the winter of 1997, additional wet weather flow monitoring was performed during the following season. El Niño effects resulted in extensive rainfall during the months of January and February of 1998. Wet weather flow projections are based on flow monitoring results from the second flow monitoring program in 1998. Results of the 1997 flow monitoring program are provided in Appendix B. Results of the 1997-1998 flow monitoring program are provided in the County of San Mateo 1997 – 1998 flow monitoring program dated January 14, 1998, and March 4, 1998.

Purpose and Objective

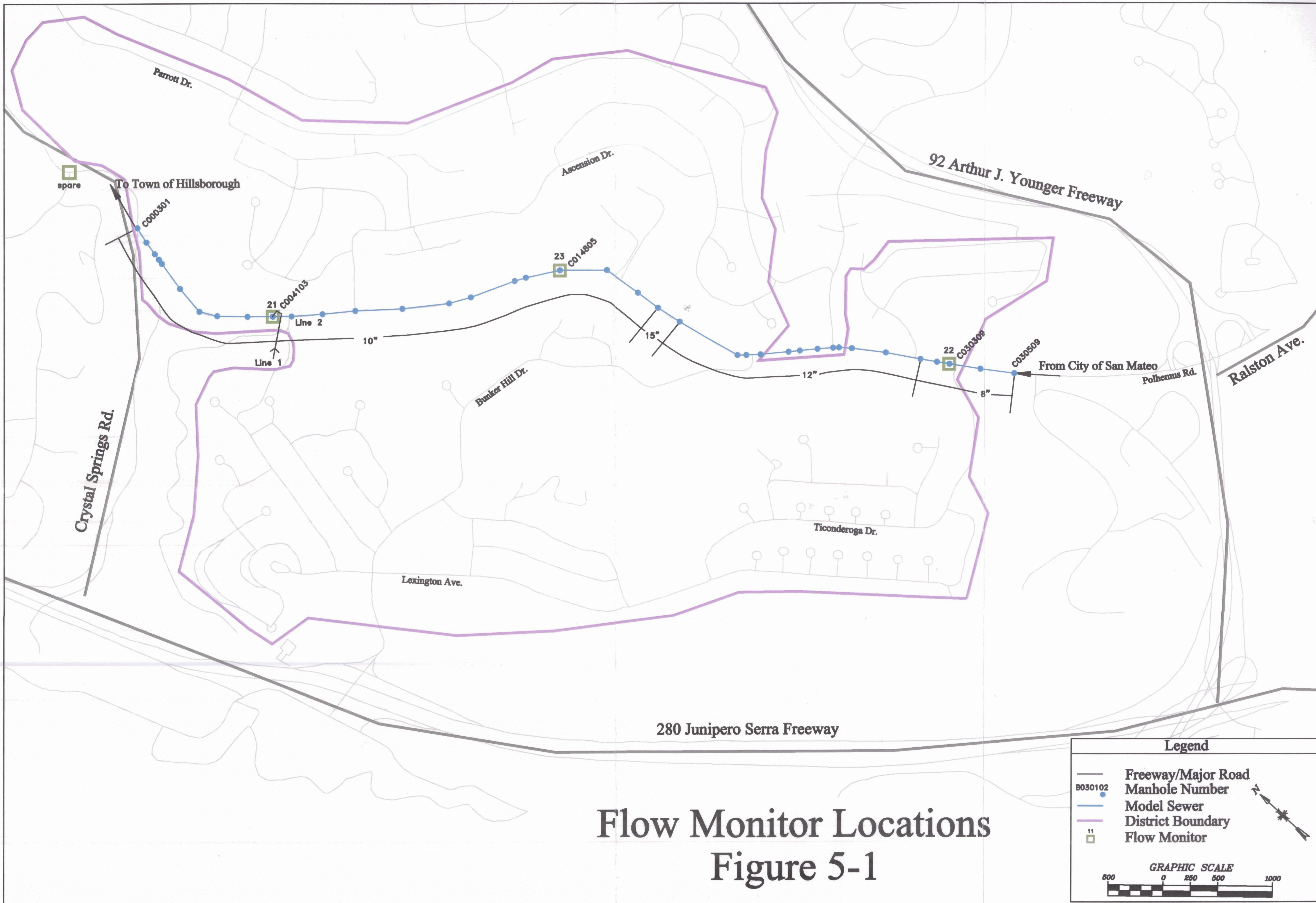
The purpose of the flow monitoring program was to measure the existing collection system flows at various locations in the Crystal Springs County Sanitation District (CSCSD). Wet weather and dry weather flow rates were measured to develop design flows for use in a hydraulic model of the collection system. Additionally, a rain gauge was installed at 2295 Cobblehill Place to determine how collection system flows reacted to various rainfall events. The rain gauge was moved to a County facility located at the 1551 Tartan Trail Road Pump House.

Table 5-1 summarizes the measured flow rates for each monitoring station in the CSCSD for the 1997/1998 flow monitoring period. The location of the flow monitors and rain gauges is shown on Figure 5-1. The technical memorandum describing the 1997 flow monitoring program is provided in Appendix B. Attachments A and B for the technical memorandum were provided in the original submittal. This memorandum describes the location of the flow monitors and rain gauges, and the complete results of the flow monitoring program.

Table 5-1. Flow Monitoring Results, million gallons per day 1997/1998

Flow monitoring site	Minimum dry weather flow	Average dry weather flow	Peak wet weather flow
21 Line 1*	0.07	0.11	0.89
21 Line 2*	0.01	0.61	4.60
22 Line 2	0.03	0.12	0.95
23	0.12	0.44	2.31

*Flow monitors located in same manhole measuring two lines.



Flow Monitor Locations
Figure 5-1

SECTION 6

SMOKE TESTING PROGRAM

The smoke testing program was conducted during the summer of 1998. Field crews tested approximately 50,800 linear feet of sewer lines in the Crystal Springs County Sanitation District (CSCSD). This section presents the results of the smoke testing program.

Purpose and Objective

Smoke testing is a quick and effective method for identifying many types of wastewater collection system deficiencies. Typical defects encountered during a smoke testing program include the following:

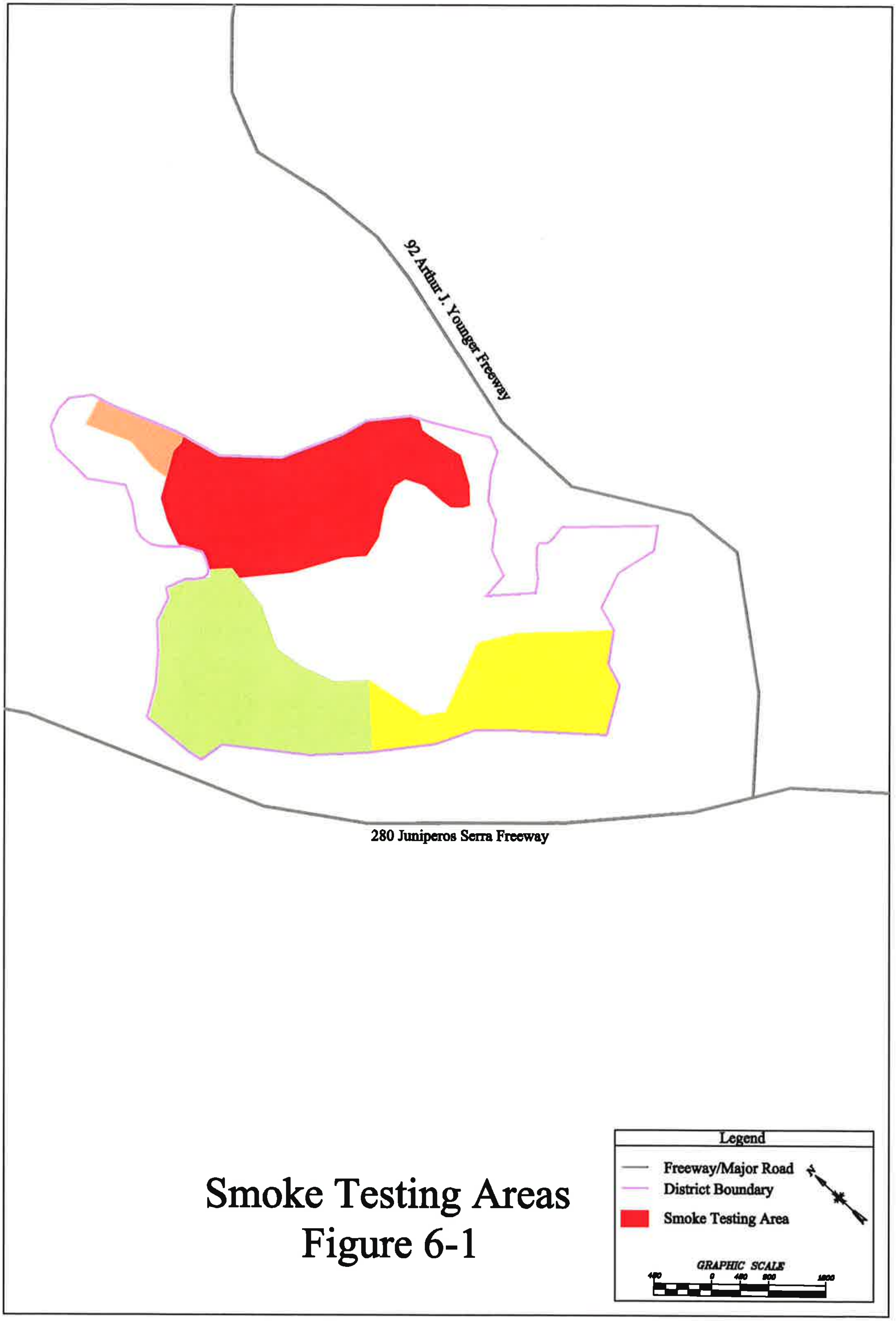
1. Broken or deteriorated building laterals.
2. Improperly capped cleanouts.
3. Broken or deteriorated sewer mains in unpaved areas.
4. Unsealed or damaged manholes.
5. Sags and/or obstructions in the mains.
6. Direct and indirect connections between storm and sanitary sewer systems.
7. Untrapped or improper building plumbing.
8. Illegal sewer connections from/to storm drain systems

Although smoke testing is an efficient method of identifying collection system inadequacies, certain conditions affect the interpretation and effectiveness of the test. One factor that affects smoke testing results is the extent and porosity of the cover over the sewer main or service lateral. For instance, pilot studies have indicated that only one-third or less of lateral defects are detected by smoke testing.

Smoke Testing Results

Smoke testing was performed during the dry months of August and September 1998 to ensure that smoke was not trapped in high groundwater. The areas tested in the CSCSD area are shown on Figure 6-1. Smoke testing areas were selected based on the results of the flow monitoring program. Areas with suspected high I/I rates were selected for smoke testing.

No major defects were noted during the smoke testing program. A total of 59 defects were located and documented during the program. The most prevalent defect was missing or damaged cleanout covers. The majority of these defects are located on the private side of the property line. A summary of the smoke testing defects is provided in Table 6-1. A technical memorandum, dated October 13, 1998, describing the smoke testing program in more detail is provided in Appendix C. Smoke testing reports and photographs are also provided in Appendix C.



Smoke Testing Areas
Figure 6-1

Table 6-1. Smoke Testing Defect Summary

Defect type	Number of defects
Cleanout	52
Lateral	2
Illegal drain	2
Storm drain cross connection	1
Manhole leaks	1
Pavement cracks	1
Other	0
Total footage tested:	50,794

SECTION 7

TELEVISION INSPECTION PROGRAM

The television inspection program was conducted during the winter of 1999. Field crews inspected approximately 9,271 linear feet of sewer lines in the Crystal Springs County Sanitation District (CSCSD). This section presents the results of the television inspection program.

Purpose and Objective

The purpose of the television inspection program of mainline sewers was to observe and document the internal condition of the pipeline in reference to infiltration/inflow (I/I) and structural deterioration. Results of the television inspection were then used to develop capital improvement programs described in Sections 13 and 14. The following conditions were observed and documented:

1. Structural Integrity—the number, type and extent of cracks and/or broken, crushed, shattered or collapsed pipe.
2. Root Intrusion—the amount and severity of the roots were documented.
3. I/I—the location of I/I sources were documented.
4. Protruding Laterals—a lateral's protrusion into the pipeline was estimated to judge if it will interfere with rehabilitation or routine maintenance.
5. Defective lateral connections—defective lateral connections such as broken pipe at the connections, broken saddles, cracks and the connections, pieces missing from the connection, and structural defects in the lateral were documented.
6. Offset or Open Joints—offset or open joints were visually estimated from the inspection to determine if they would require spot repairs prior to rehabilitation.
7. Pipe Sags—the extent of sags or misalignment was judged to help determine the structural integrity of the pipeline and their suitability for rehabilitation.
8. Corrosion—hydrogen sulfide corrosion of concrete sewers was identified and documented.

Television Inspection Results

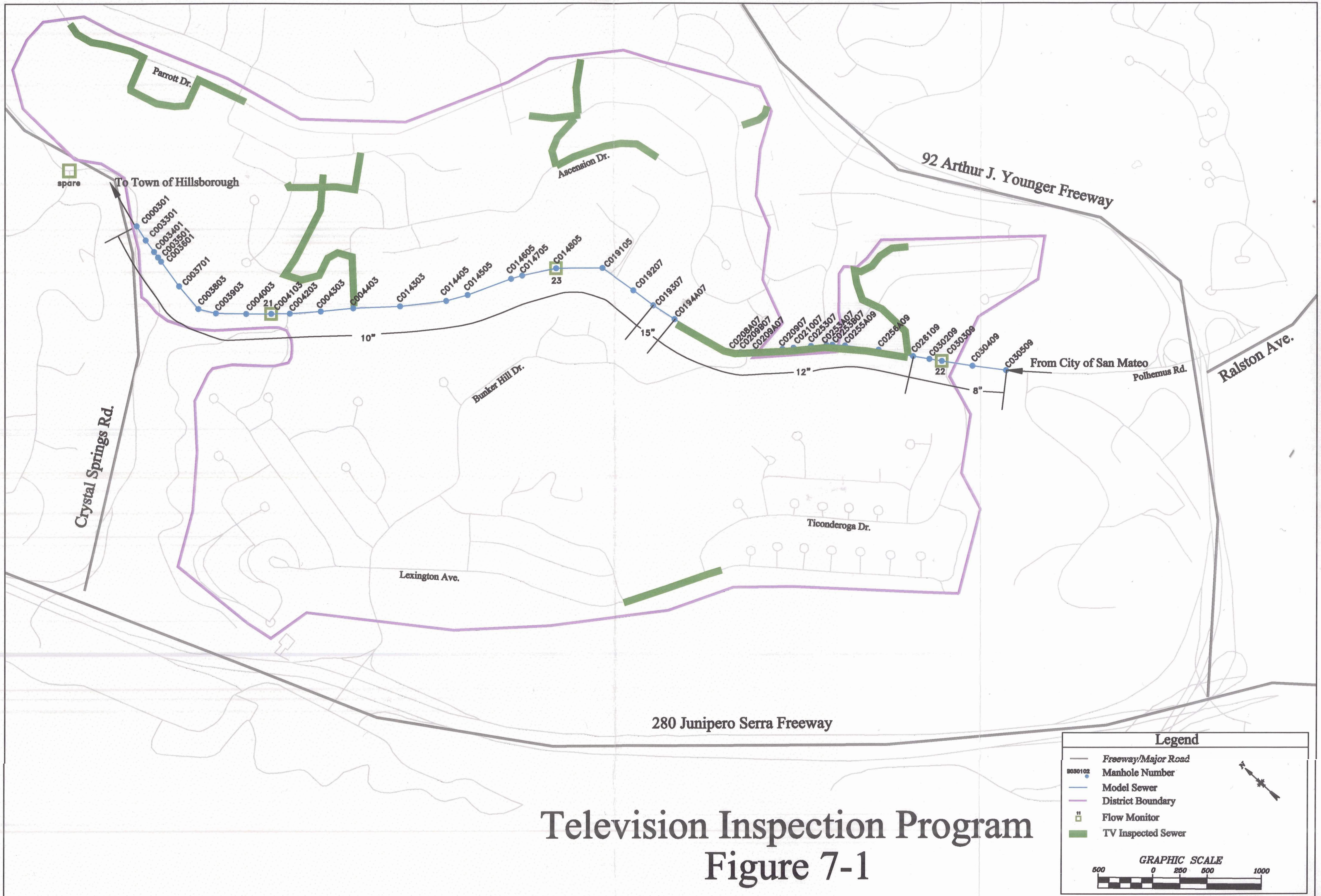
The areas scheduled for television inspection in the CSCSD area are shown on Figure 7-1. Sewers were selected for television inspection if they met one of the following four criteria:

- Excessive maintenance callouts
- Manhole inspection program noted a pipeline defect
- Special request from the County maintenance personnel
- A mainline defect was noted during the smoke testing program.

Sewers scheduled for television inspection were cleaned or flushed prior to inspection to allow for a better structural inspection. Approximately 2,000 linear feet of mainline sewer could not be inspected due to severe defects in the line, which blocked the path of the camera, or lack of access to the sewer. When a severe defect was encountered, the camera setup was reversed to attempt an inspection of the sewer whenever possible. Results of the television inspection program are summarized in Table 7-1. Complete results of the program are provided in Appendix D.

Table 7-1. Television Inspection Summary

Description	Total
Footage attempted	9,947
Footage completed	9,355
Cracks	
Radial	21
Longitudinal	2
Joints	
Minor offset joint	0
Major offset joint	5
Laterals	
Protruding lateral	4
Defect at connection	2
Dead connection	6
Roots	
Roots at joint	148
Roots at lateral	14
Infiltration/Inflow	
At joint	0
At crack	0
At roots	0
At inside lateral	0
At lateral connection	0
At inside lateral and at connection	0
Alignment	
Sag in line	5
Pipe out of round	0
Structural	
Piece missing	6
Shattered/broken	2
Crushed or collapsed	2
Mineral Stains	
At joint	0
At cracks	0
Sulfide Corrosion	
Minor	0



Television Inspection Program
Figure 7-1

SECTION 8

BASE SANITARY FLOWS

The results of the flow monitoring program described in Section 5 were used to establish base sanitary flow (BSF) rates. Base sanitary flow rates are used with wet weather flow rates and the hydraulic model to determine the amount of available capacity in the collection system. Wet weather flow rates and the hydraulic modeling are discussed in subsequent sections of the report. This section describes the methodology used to develop base sanitary flow rates for the Crystal Springs County Sanitation District (CSCSD).

Dry Weather Flow

BSF is wastewater contributed by residential, commercial, industrial and public users. Base flow is directly related to land use and varies throughout the day and between weekdays and weekends. BSF from residential areas has a typical diurnal pattern with peak flows occurring in the morning after 7:00 a.m. and a second smaller peak occurring in the evening. A typical dry weather hydrograph is shown on Figure 8-1.

BSF flow contributions to the hydraulic model are based on the flow monitoring data collected during dry weather periods. Actual dry weather flow hydrographs were extracted from the flow monitoring data and used in the model. Peaking factors normally estimated for subsequent use in the hydraulic analysis were not needed since the actual diurnal flow pattern from the flow monitoring could be used directly in the hydraulic model.

Dry weather periods were used to minimize the amount of groundwater infiltration (GWI) included in the calculation. GWI occurs when groundwater levels are above the sewer pipes and the pipes have defects that allow infiltration. Some groundwater infiltration is undoubtedly included in the BSF rates. However, extensive review of accurate water use data in each District would be needed to determine the amount of groundwater infiltration in each area. Based on our review of the flow monitoring, GWI is not a significant factor in the total wastewater flow in the CSCSD area.
BSF projections were not prepared for future land use conditions. Land use planners for the County and affected City agencies indicated that growth or significant infilling were not expected in the future.

BSF rates used for the service area for each of the flow monitoring sites are presented in Table 8-1. A complete description of the flow monitoring program is given in Appendix B. Additionally, the technical memorandum describing the flow projections and hydraulic modeling in more detail is provided in Appendix E.

Typical Dry Weather Hydrograph
Figure 8-1

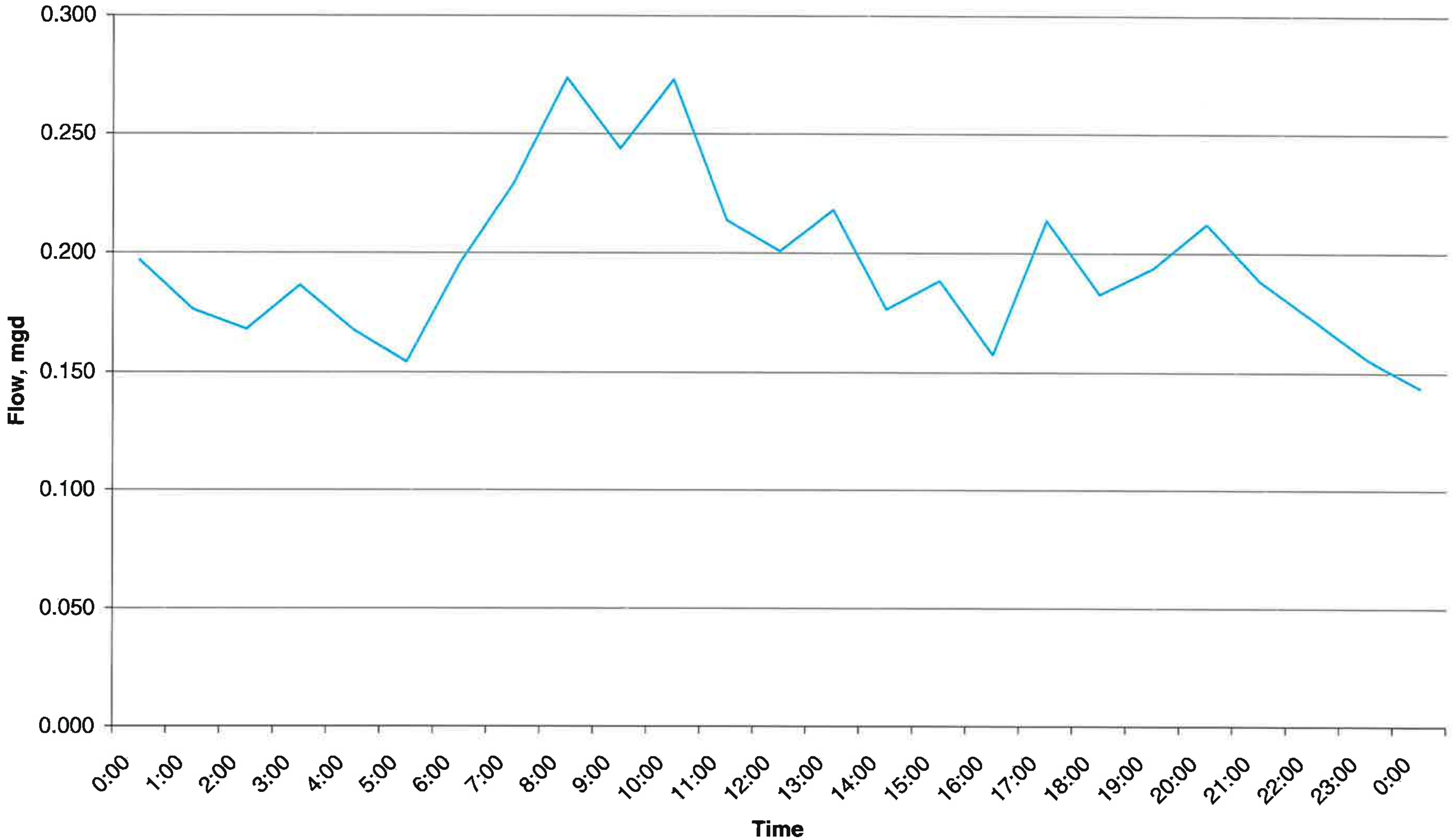


Table 8-1. Base Sanitary Flow Rates

Flow monitor	Base sanitary flow, mgd
21 Line 1*	0.195
21 Line 2*	0.286
22 Line 2	0.150
23	0.320

*Flow monitor located in same manhole measuring two lines.

SECTION 9

INFLOW/INFILTRATION RATES

The flow monitoring program described in Section 5 was performed to establish inflow/infiltration (I/I) rates. I/I rates are used in conjunction with base sanitary flow (BSF) rates (established in Section 8) and the hydraulic model to determine the amount of available capacity in the collection system. This section describes the methodology used to develop I/I rates for the Crystal Springs County Sanitation District (CSCSD).

Wet Weather Flow

I/I consists of direct inflow of stormwater runoff and rainfall-induced infiltration of stormwater percolating through the soil into the collection system. Inflow occurs when storm water enters the collection system through illegally connected catch basins, area drains or home roof gutter downspouts, or through manhole covers of cleanout lids. Inflow can become severe if surface flooding occurs and manholes and cleanouts are submerged or used to drain low-lying areas.

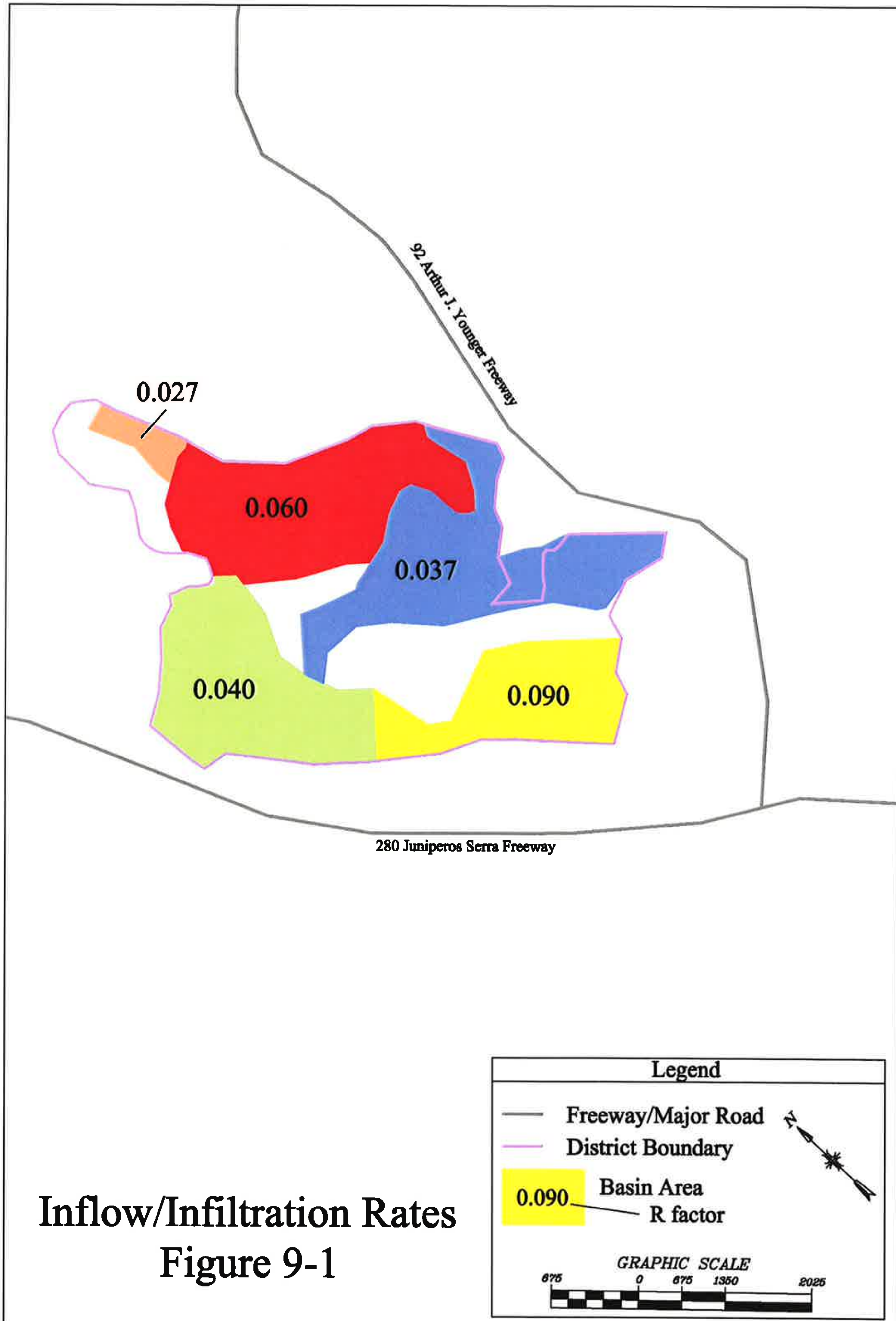
I/I accounts for the large increase in peak flows that occur during rainfall events. In areas with older sewers, I/I is typically the largest component of the total wastewater flow. I/I was evaluated by calculating the "R" factor for each of the monitored basins for each storm. An "R" factor is the percentage of rainfall volume falling on an area that enters the collection system as I/I. The composite minimum and maximum "R" factor, based on the flow monitoring data, for each flow monitoring location is listed in Table 9-1. The flow monitors service areas and R factor used for the wet weather flow projections are shown on Figure 9-1.

A wet weather design storm was developed to determine the effects of I/I on the capacity of the wastewater conveyance system. The January 18, 1998, rainfall event was very similar to a 5-year design storm in terms of intensity, duration, and volume. Therefore, this storm was selected as the design event. Minor adjustments were made to the rainfall hydrograph to account for differences in the volume between the actual storm and the 5-year design rainfall.

Unit hydrographs were developed for each basin to develop wet weather hydrographs for use in the model. Unit hydrographs are based on the "R" factor and the individual runoff characteristics for each basin. Synthetic hydrographs were added to the base flow hydrographs and the total flow hydrograph was then input to the hydraulic model. A typical wet weather synthetic hydrograph is shown on Figure 9-2. A complete description of the I/I flow projections is provided in the Technical Memorandum provided in Appendix E.

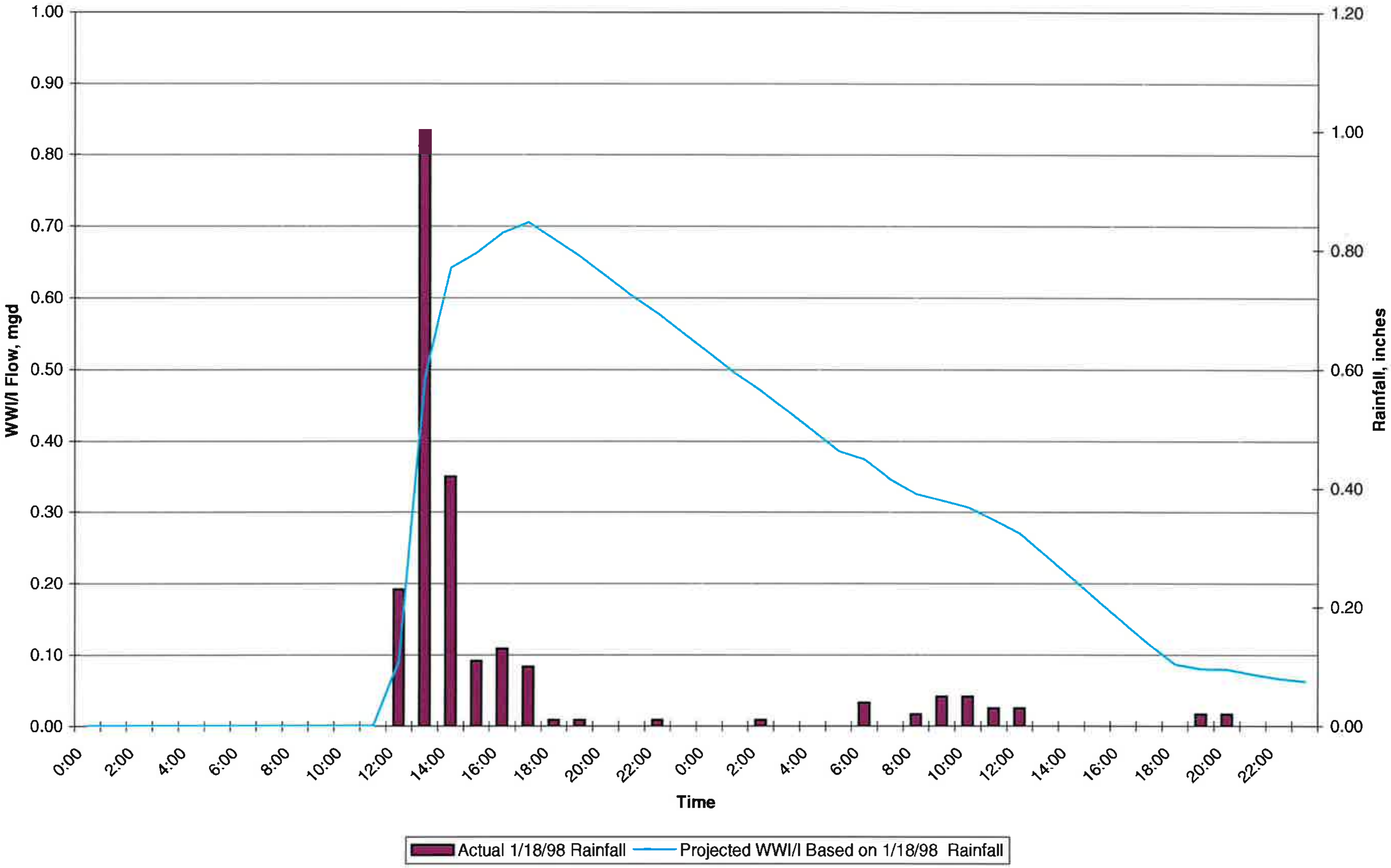
Table 9-1. R Factor

Flow Monitoring Site	Minimum	Maximum
21 Line 1	0.031	0.044
21 Line 2	0.054	0.091
22 Line 2	0.047	0.102
23	0.037	0.097



Inflow/Infiltration Rates
Figure 9-1

Typical Wet Weather Hydrograph
Figure 9-2



SECTION 10

HYDRAULIC MODEL DESCRIPTION

A hydraulic model was prepared of the Crystal Springs County Sanitation District's (CSCSD) wastewater collection system trunk sewer. The model was used to evaluate the capacity of the pipelines to carry existing peak wet weather flows. This section presents a description of the model and the model development.

Computer Model

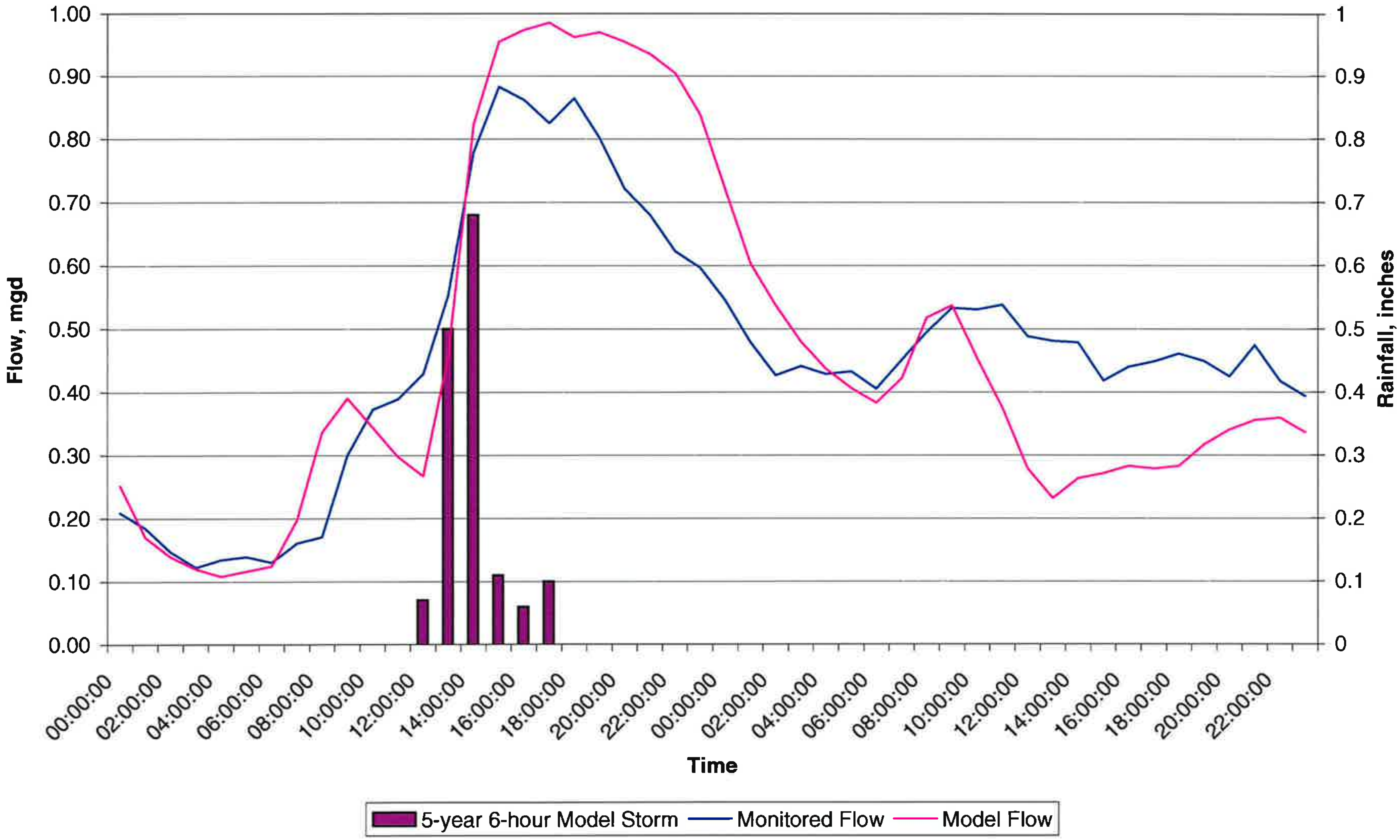
Major trunk sewers in each of the sewer Districts were modeled to determine where capacity deficiencies exist. The HYDRA model developed by PIZER, Inc., was used to simulate wastewater flows in the each of the Districts collection systems. HYDRA routes flow hydrographs (developed in Section 9) through the collection system and accounts for the time delays of peak flow from various tributary areas as the flows move downstream.

For the CSCSD, the Polhemus Road trunk sewer was modeled. This sewer includes nearly all the pipelines 8 inches in diameter or larger in the CSCSD. This trunk sewer is composed of 8-inch- and 15-inch-diameter gravity sewers in the upstream portion. Near the downstream end of the trunk sewer, the diameter decreases to 10 inches.

Most of the pipeline data used in the model was taken from the existing County collection system maps. Pipeline data required by the model includes upstream and downstream inverts and pipeline length and diameter. Surveying was completed to fill in gaps in the data or questionable data.

Modeled flow is compared to the theoretical capacity of each pipe segment. The capacity of each pipeline is a function of the pipeline slope and diameter. If capacity deficiencies were detected, then the program was used to size the appropriate relief and/or replacement sewer size. A typical example hydrograph comparing the model hydrograph to actual flow monitoring is shown on Figure 10-1. The technical memorandum describing the flow development and modeling is provided in Appendix E.

Typical Monitored to Model Flow Calibration
Figure 10-1



e:\4692 San Mateo\HYDRAmdl\EPipes\Figure 10-1.xls

8/25/99

SECTION 11

MODEL RESULTS

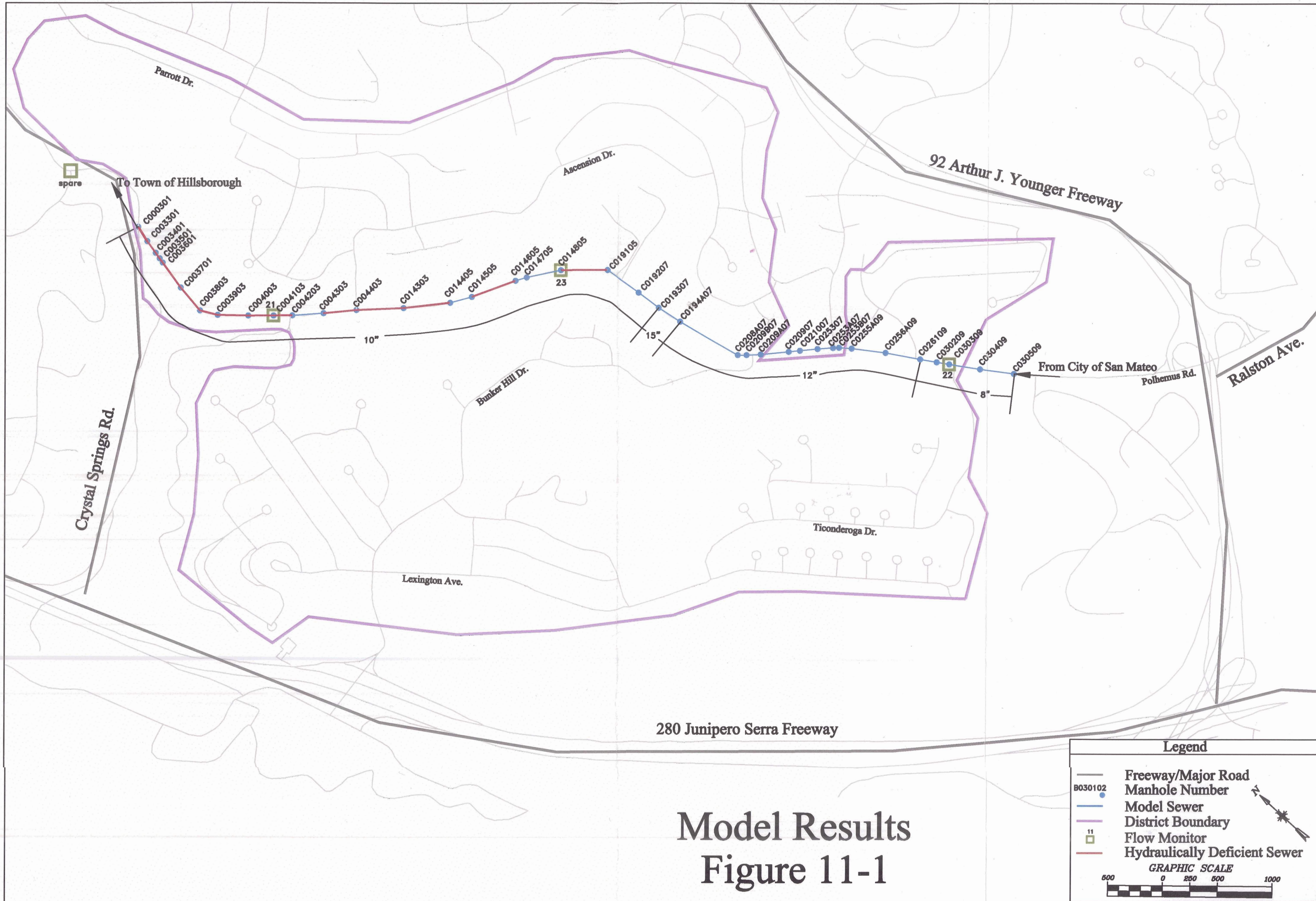
An evaluation of the pipeline capacities was performed using the flows developed in Sections 8 and 9 and the hydraulic model described in Section 10. This section describes the results of the capacity evaluation developed for the Crystal Springs County Sanitation District (CSCSD).

Capacity Analysis

The capacity of the existing system was evaluated using peak wet weather flows. This flow condition is generated by existing development in the service area (Section 8) under design storm conditions (Section 9).

The model routes the flow through the pipe network, calculates the capacities of the pipes, and compares the routed flows to the pipe capacities to identify inadequate pipes. The pipe capacity calculations are based on a Manning's roughness coefficient of 0.013. Pipes were defined to be hydraulically inadequate if the depth of flow is 100 percent or greater of the pipe diameter. The model sized relief and replacement sewer sizes for all inadequate sewers.

The results of the model indicate a severe bottleneck where the Polhemus Road trunk sewer changes to 10 inches in diameter. Nearly all the 10-inch-diameter sewer is unable to convey peak wet weather flow without surcharging. Model results are shown on Figure 11-1. The technical memorandum describing the flow development and modeling is provided in Appendix E. Additionally, the complete HYDRA modeling results are provided in Appendix E.



Model Results
Figure 11-1

SECTION 12

UNIT COSTS

This section presents the basis for the estimated unit costs that were developed for estimating the construction costs and the capital costs of recommended capital improvements. The cost index and the development of the capital costs of gravity sewer pipeline construction and rehabilitation are presented.

Capital Costs

The total capital investment necessary to complete a project consists of expenditures for construction, engineering services, contingencies, and such overhead items as legal and administrative services and financing. The various components of capital costs are described below. Unit construction costs were developed for the following construction and rehabilitation methods:

- Remove and Replace—recommended for pipelines with serious structural or hydraulic capacity deficiencies where trenchless construction is typically more expensive or not practical.
- Sliplining—recommended for pipelines with minor structural deficiencies or root intrusion and minimal sags.
- Pipe Bursting—recommended method for increasing capacity of structurally deficient 6-inch-diameter lines to 8-inch-diameter lines and provides minimal disruption to the community.
- Chemical Root Treatment—recommended for lines with root intrusion.
- Do Nothing—no capital project is recommended for lines with minor structural deficiencies and light root intrusion. For this option, television re-inspection in a maximum of 10 years is recommended.
- Increase O& M—recommended for lines with minor root intrusion and grease buildup.
- Spot Repair—recommended for lines with severe defects that create maintenance problems or where required prior to implementing other rehabilitation methods.

Cost Index. A good indicator of changes over time in construction costs is the Engineering News Record (ENR) 20-city Construction Cost Index (CCI), which is computed from prices of construction materials and labor, and based on a value of 100 in 1913. Cost data in this report are based on an ENR CCI of 6000, representing costs in March 1999.

Construction Costs. Construction costs presented in the master plan represent preliminary cost estimates of the materials, labor and services necessary to build the proposed projects. The cost estimates are prepared to be indicative of the cost of construction in the study area. In considering cost estimates, it is important to realize that changes during final design, as well as future changes in the cost of material, labor and equipment, will cause comparable changes in the estimated costs. Unit costs used in this study were obtained from a review of pertinent sources of reliable construction cost information. Construction cost data given in this report are not intended to represent the lowest prices that can be achieved for each type of work, but rather are intended to represent planning-level estimates for budgeting purposes. The following assumptions were made in the development of the unit costs:

- Remove and Replace—Costs include excavation, backfill, compaction, haul off and asphalt repair. Material costs for 8-inch- to 21-inch-diameter sewers are for PVC or VCP. Material costs for 24-inch-diameter or larger sewers are for RCP. Replacement costs for 6-inch-diameter lines include cost for 8-inch-diameter replacement materials. The costs have been developed based on average trench depth not exceeding 15 feet.
- Sliplining—Costs include the use of HDPE as the liner material, construction of access pits and an average service lateral reconnection fee. Sewage bypass pumping is only needed on a localized basis and, therefore, is not included in the costs.
- Pipe Bursting—Costs include the use of HDPE as the liner material, construction of access pits and an average service lateral reconnection fee. Costs include the bypassing of sewage.
- Chemical Root Treatment—Costs include application and removal with hydroflush equipment. Costs also include reapplication every 2 years.
- Do nothing—Costs for this option are for television re-inspection in 10 years at a rate of $1.50/foot for the data collection and data review.
- Spot Repair—A cost of $800 has been included in the estimates for each spot repair occurrence.

Table 12-1 presents the unit construction costs for construction and rehabilitation of gravity sewer pipelines.

Contingencies, Engineering, and Overhead

Construction contingencies, engineering and overhead are assumed to be 40 percent of the construction cost. It is appropriate to allow for the uncertainties unavoidably associated with planning-level layout of projects. Such factors as unexpected geotechnical conditions, extraordinary utility relocation and alignment changes are a few of the items that can increase project cost for which it is wise to make allowance in preliminary estimates.

Engineering services associated with projects include preliminary investigations and reports, site and route surveys, geotechnical explorations, preparation of drawings and specifications, construction services, surveying and staking, and sampling and testing of materials. Overhead charges cover such items as legal fees, financing expenses, administrative costs, and interest during construction.

Table 12-1. Gravity Sewer Pipe Unit Construction Costs

Pipe diameter, inches	Relief and replacement sewer cost, $/foot	Sliplining, $/foot	Root treatment, $/foot	Pipe bursting, l.f.
6	85	n/a	3	90
8	85	55	3	90
10	100	70	4	115
12	110	90	5	145
15	120	110	6	175
18	140	n/a	n/a	n/a
21	180	n/a	n/a	n/a
24	195	n/a	n/a	n/a
27	220	n/a	n/a	n/a
30	230	n/a	n/a	n/a
33	255	n/a	n/a	n/a
36	285	n/a	n/a	n/a
42	305	n/a	n/a	n/a
48	355	n/a	n/a	n/a

Other Costs:

$800/spot repair   Reinspect in 10 years = $1.50/foot

SECTION 13

RECOMMENDED COLLECTION SYSTEM IMPROVEMENTS

Improvements will be necessary to the Crystal Springs County Sanitation District (CSCSD) collection system to adequately convey peak wet weather flows (PWWF). This section presents the recommended improvements for accommodating the hydraulic capacity problems identified in Section 11. Capital improvement projects for correcting structural deficiencies as well as the hydraulic deficiencies are provided in Section 14.

Collection System Sewer Sizing

The improvements recommended for correcting the hydraulic capacity problems are based on the model results for peak wet weather flow. The model selects pipe sizes for parallel relief pipes and replacement pipes. The main drawback to relief sewers is the increased amount of sewer pipe in the ground for the maintenance crews. For this report, alternatives and costs have been developed assuming a larger sewer will replace the existing sewer. However, the County will have to decide on a case-by-case basis during the design of each project as to whether to construct replacement or parallel relief sewers.

Sewer sizes developed by the computer model were verified and modified where necessary to reduce potential maintenance problems. Maintenance problems can arise when a larger sewer discharges into a smaller sewer. The diameters of the smaller sewers are modified to be no smaller than the upstream pipe. In some cases, a sewer is extended for several reaches to connect two portions of the collection system with hydraulic problems.

Short lengths and isolated reaches of over-capacity pipe have, in some cases, not been included with the recommended relief/replacement sewer program. These reaches are not considered significant hydraulic problems because resulting backwater would be minor.

Nearly 5,000 linear feet of the Polhemus Road trunk sewer was identified as hydraulically deficient. A 10-inch and 12-inch relief sewer is recommended to relieve the existing trunk sewer. The location of the recommended relief sewer is shown on Figure 13-1. Table 13-1 summarizes the modeling results.

Table 13-1. Recommended Replacement Sewers

Upstream manhole	Downstream manhole	Existing diameter, inches	Length, ft	Recommended replacement sewer sizes, inches
C019105	C014405	10	1,714	8
C014405	C000301	10	3,280	12
Total			4,994	

Infiltration/Inflow Reduction

The use of collection system rehabilitation to reduce the overall PWWF within the basin was considered as an option prior to developing the recommendations listed in Table 13-1 for pipe replacement. Collection system rehabilitation is used to accomplish two main objectives:

1. Provide a continuing level of service with regard to the structural integrity of the collection system.

2. Reduce the overall level of I/I entering the collection system for either peak flow rates or for total I/I flow into the system.

I/I studies nationwide have demonstrated that effective removal of I/I from the collection system requires a comprehensive implementation of collection system rehabilitation of both the sanitary sewer and the private building lateral. Agencies, such as, East Bay Municipal utilities District, Vallejo Sanitation and Flood Control District, and the City and County of Honolulu have performed pilot rehabilitation programs documenting the need for comprehensive rehabilitation for effective I/I removal. The effective amount of I/I reduction possible, even with comprehensive rehabilitation, is a subject of some debate within the sewer industry. Claims range from over 90 percent removal to less than 40 percent removal of the I/I from the collection system. Many things impact the ability of the rehabilitation effectiveness in removing I/I for a long period of time (50 years is considered a reasonable time measure for effectiveness of rehabilitation program). An average long-term effectiveness of 75 percent was assumed for I/I removal from the collection system for this study, based on the results of similar work in the Bay Area.

This type of area-wide rehabilitation approach is critical for collection systems where field data from condition assessment programs show no one area of the collection system as having a significantly higher level of sewer defects that contribute to I/I in the collection system. The Crystal Springs County Sanitation District condition assessment data indicates that the entire district will require comprehensive rehabilitation to provide the required reduction in I/I related flows to avoid the capacity limitations within the existing collection system configuration.

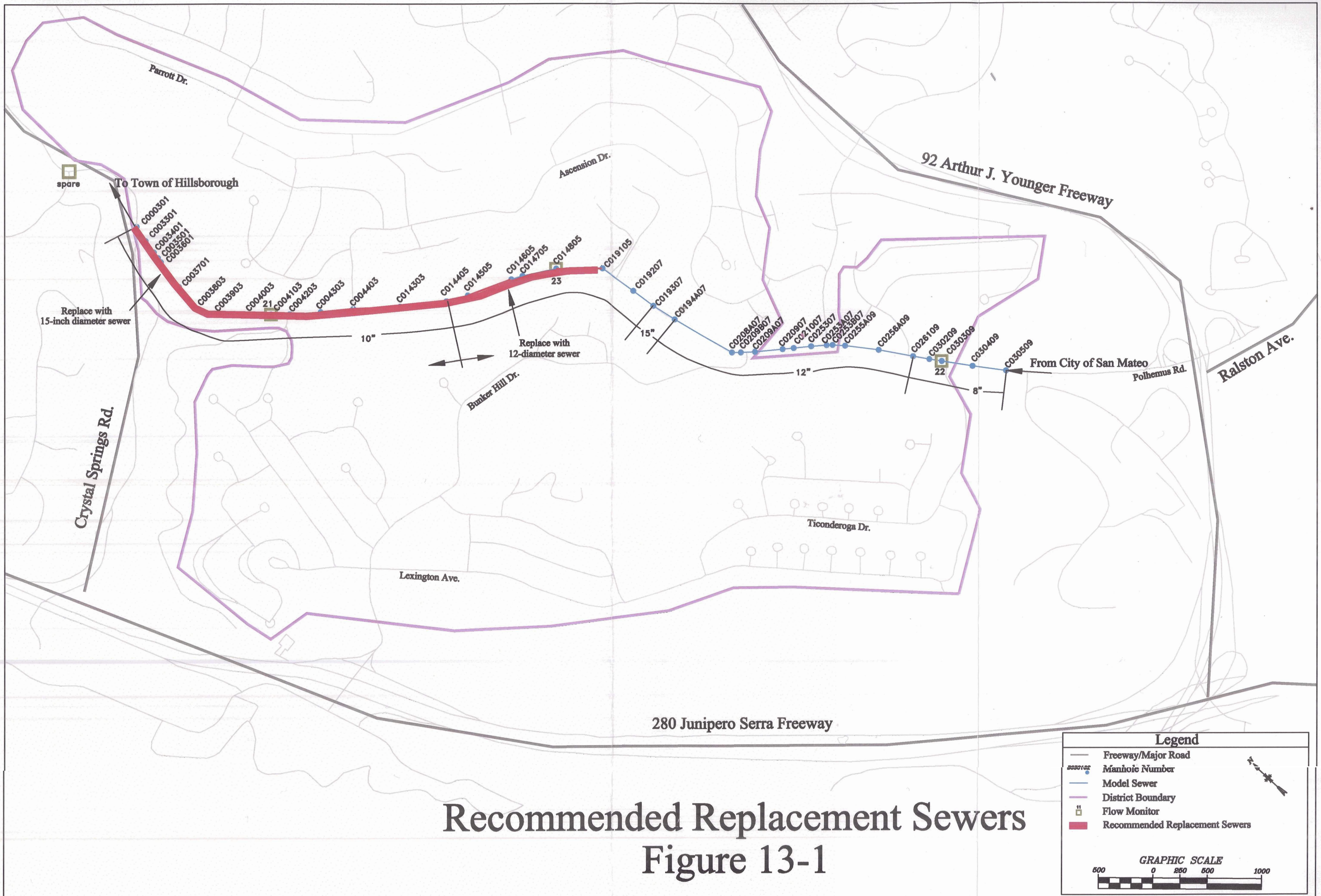
The capacity limitation of 1.74 mgd in the 10-inch sewer in Polhemus requires a 1.86 mgd reduction in the projected PWWF of 3.60 mgd as shown in Appendix E. Effectively, 52 percent of the PWWF will need to be eliminated from the system through a comprehensive rehabilitation program of the district. Using the 75 percent effectiveness criteria, which could be considered optimistic, then the entire collection system in the district will require comprehensive rehabilitation.

The cost associated with complete collection system rehabilitation, using the unit costs provided in Table 12-1, equals $5.15 million for the 13 miles of collection system approximated as 8-inch rehabilitated sewer at $75/lf (assumes approximately a 50/50 split between slip lining and pipe bursting of equivalent 8-inch-diameter pipe). The rehabilitation of the sewer laterals will cost approximately $50/ft when considering landscaping replacement or the use of trenchless construction methods. The estimated total length of sewer laterals in the district is about 10 miles. Therefore, the estimated construction cost for lateral rehabilitation is $2.64 million. The total estimated construction cost for a rehabilitation program that is effective enough to eliminate the requirement for a new larger capacity sewer is approximately $7.79 million. The estimated replacement construction cost for the increased capacity of sewer in Polhemus Road is $655,300 as shown for the two Polhemus Road projects listed in Table 14-1.

Wastewater Cost of Treatment

The cost of treating the increased PWWF will have to be borne by the rate payers of the district. The current cost of treatment charged by the City of San Mateo is approximately $0.00125/gallon treated. Using this rate the cost of treating the PWWF storm event total flow of approximately 10.5 million gallons, as shown in Figure 9-2 as the area under the projected wet weather flow line, equals $13,125 per peak flow event. Given that this is a once in five-year condition, the overall cost impact to eliminate the wet weather flows is not practical based on the cost analysis shown above. Planning and negotiation should begin with the Town of Hillsborough and the City of San Mateo regarding the need for collection system capacity down stream of the district.

The County needs to carefully review the terms of the operating agreements for accommodating wastewater flow with each of these agencies to determine who is responsible for the cost of any potential downstream improvements required as the result of construction of a new larger-capacity sewer for the district. The operating agreements should provide a basis of negotiation and planning for developing the recommended projects so that no agency is overly burdened with the cost of the new facilities and that the potential for overflows is prevented.



Recommended Replacement Sewers
Figure 13-1

SECTION 14

CAPITAL IMPROVEMENT PROGRAM

Capital improvement program (CIP) projects in the Crystal Springs County Sanitation District (CSCSD) are necessary to correct identified hydraulic and structural deficiencies. This section presents the recommended improvements for correction of the hydraulic deficiencies presented in Section 13 and the structural problems identified in Section 7.

Capital Projects

A total of nine capital improvement projects were developed for the Crystal Springs District. Eight of the projects are required to correct structural deficiencies that create increased maintenance costs or where the sewer is deteriorated to the point where failure may occur in the near future. One project was developed to provide increased hydraulic capacity to the Polhemus Road trunk sewer. Alternatives have been developed for the following projects in the Crystal Springs District:

1. Timberlane Way
2. South Ascension Drive
3. Polhemus Road (north)
4. Polhemus Road (south)
5. Rainbow Drive
6. Enchanted Way
7. Parrot Drive
8. Lexington Avenue
9. Randall Road

A priority ranking of 1 to 3 was applied to each of the projects to aid in the scheduling of the recommended CIP projects. The ranking was done according to the following:

- Priority 1—Required to correct hydraulic deficiencies. The only mitigation alternative available for this option is construction of relief or replacement sewers.
- Priority 2—Sewer lines with excessive maintenance requirements. Improvements to Priority 2 lines are required to prevent dry weather overflows that may be associated with blockages created by roots or other structural problems.
- Priority 3—Sewer lines with minor to major structural deficiencies. Corrective action may or may not be required on these lines depending on the severity of defects.

Table 14-1 presents the recommended projects, priority rating and minimum and maximum mitigation construction costs. Each of the recommended projects are shown on Figure 14-1. A project summary sheet is provided for each project in Appendix F. The summary sheet describes the project location, description of the deficiency, the three corrective alternatives, estimated construction costs for each alternative and any specific project concerns (i.e., easement work, coordination with neighboring cities, etc.).

Table 14-1. Recommended Capital Improvement Program

Project Description	Priority	Minimum construction cost, dollars	Maximum construction cost, dollars
Polhemus Road (north)	1	N/A	582,100
Randall Road	2	61,300	73,200
Timberlane Way	2	208,115	238,900
Parrot Drive	3	180,000	180,000
Lexington Avenue	3	2,500	127,000
Enchanted Way	3	30,100	35,900
Rainbow Drive	3	271,400	325,600
South Ascension Drive	3	233,200	279,700
Polhemus Road (south)	3	4,000	4,000
Totals		$1,572,700	$1,846,400

Estimated construction costs for the projects range from $1,572,700 to $1,846,400 depending on the selected alternative. The Polhemus Road replacement sewer project will require coordination with the Town of Hillsborough. The Town of Hillsborough trunk sewer that receives flow from the Polhemus Road trunk sewer also has capacity limitations. Correcting the capacity limitations on the Polhemus Road trunk sewer may aggravate the capacity problem in the Town of Hillsborough trunk sewer.

Operation and Maintenance Program

A crucial part of the successful ongoing performance of the collection system is the operation and maintenance (O&M) program used by the agency. Current maintenance guidelines for the collection system are to clean all sewers in easements annually, and all sewers in roadways every 6 months. In addition, some sewers are cleaned more frequently where they have been identified as being prone to blockages. The purpose of this section is to provide an overview of an O&M approach for the district. It is beyond the scope of work for this project to develop a reach by reach O&M program for the district.

County staff provided a long-term history of emergency call outs to respond to potential spills and blockages. Analysis of these data confirmed that some portions of the system require more frequent cleaning than other segments, which is typical of all collection systems. Also typical cleaning practice is to clean enough material from the pipe to keep the flow moving, rather than completely clean the pipe. An example of this practice is the use of a 4-inch root cutter head to open the flow on the 6-inch-diameter sewer. This cleaning method provides only 44 percent of the available pipe cross sectional area to convey sewer flows. Cleaning to the full diameter of the sewer (use of a 6-inch root cutter in a 6-inch sewer, etc.) and removing the debris from the immediate downstream manhole, while more time consuming, will provide the maximum available sewer system capacity without pipe replacement. The priority of the field crew should be placed on providing a clean sewer rather than the more typical production rate performance criteria.

Overall collection system maintenance should be on a regular schedule that balances the need to provide maximum available sewer capacity with the cost of maintenance. Typical cleaning frequencies in other agencies in the Bay Area range from once every 6 to 10 years, with segments of sewer cleaned more frequently (up to monthly) where needed. Adopting a program with a fixed cleaning frequency should be instituted for the district. The County has maintenance management software that is capable of establishing schedules for the maintenance crews. Initial cleaning frequencies should be extended to once every 2 years (except for known trouble spots) and then to longer return periods as the condition of the collection system relative to debris, grease, and roots build up is determined throughout the collection system. Known trouble spots that require more frequent maintenance should be placed on a 2-month cleaning schedule, or more frequent if warranted, and tracked to determine whether the cleaning frequency can be increased.

Establishing a cleaning program that relies on continuous schedule/frequency refinement will provide the district with an optimum cleaning program that provides a high level of service and reliability to the community. An added benefit to a responsive cleaning program is the ability of the maintenance crews to shift their focus to accommodate changes in the collection system as changes occur.

When the cleaning of the collection system is performed by a maintenance crew that has other assigned duties in addition to O&M on the collection system, it becomes very important to prioritize with justification, the time requirements of the maintenance crews. Other collection system activities, such as spot repairs, main line rehabilitation, manhole rehabilitation/reconstruction, and lateral rehabilitation could all be added to the duties of the maintenance crew. The impact of this type of increased work load would likely require the maintenance crews to become completely assigned to collection system O&M. This approach would allow the County to maintain the structural integrity of the collection system with a minimum amount of outside construction contracting. Larger projects where several sewers are rehabilitated at the same time should be constructed with a contractor that specializes in the rehabilitation method being used for that portion of the collection system.

The upcoming EPA regulations on sanitary sewer overflows (SSO) will likely require that each district within the County apply for and secure a National Pollutant Discharge Elimination System (NPDES) permit for the operation of the collection system. One of the key aspects proposed for the SSO regulations is the tracking and elimination of dry weather overflows. The SSO regulations will likely allow for limited overflows to occur that are related to acts of nature (severe wet weather events) and for acts of vandalism (illegal dumping of debris into a manhole). It will not allow for repeat overflow locations and will require a database/geographic information system to track the operation and maintenance and the performance of the collection system.

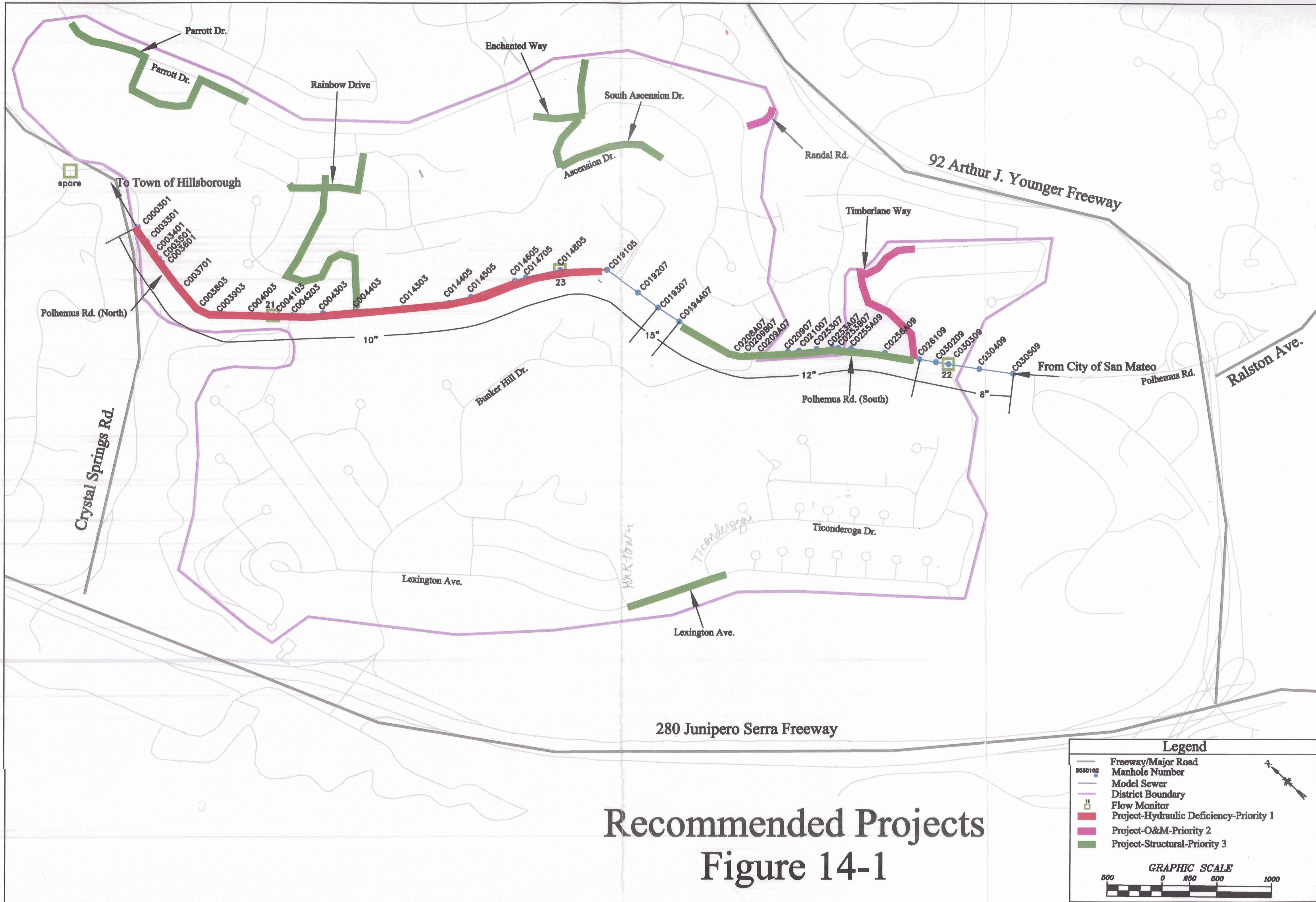
The mission of proactive collection system maintenance is to provide the longest possible life to the sewers without having to replace them with costly construction projects. The primary goal of providing the maximum capacity of the existing collection system network is what the maintenance program should achieve. Unfortunately, an aggressive O&M program will not have any effect on the amount of I/I that enters the collection system as the repairs that are completed by the maintenance crews are selective, structurally oriented, and spread over the entire collection system, rather than a comprehensive focused rehabilitation program.

Other Collection System Options

The County could consider the impacts/benefits of other collection system options, in addition to construction and modifications of the O&M program recommendations made from this study. Two main options are presented below:

1. Require lateral inspection testing and repair as a condition of ownership transfer of a sewered parcel. The benefit is that the new property owner will acquire the property with a sound sewer lateral and the County will, over a long time period, have the sewer lateral located on the private property rehabilitated at no direct cost to the County. Statistically, home ownership changes an average of every 7 to 10 years. A downside to this approach is that many properties do not change ownership in this time frame and consequently the County will end up with a mix of tested and untested laterals within a neighborhood, thereby limiting the effectiveness of the rehabilitation for reducing the I/I contribution to PWWF. This type of inspection has been implemented in several communities in California and in all cases meet with considerable political resistance for impacted jurisdictions and the local real estate organizations. Where implemented, the program is now considered a minor cost of doing business within the community.

2. Begin a long-term sewer replacement program of the collection system. At this time, the cost of a cyclic replacement program based on the design life of the collection system is both impractical and cost prohibitive. The cost comparison of providing system capacity versus total system rehabilitation (see Section 13) to reduce I/I contribution demonstrates the economic burden on the rate payer. A key benefit of a scheduled cyclic replacement program would be establishing a reasonable expected cap to I/I related flows by establishing a schedule of replacement combined with ongoing O&M to effectively limit the amount of I/I entering the collection system.



Recommended Projects
Figure 14-1

SECTION 15

SANITARY SEWER RATES

The implementation of the capital improvement programs (CIP) developed for Crystal Springs County Sanitation District (CSCSD) in Section 14 will require that the District invest considerably in its sanitary sewer collection system. As a consequence, the District will need to charge higher rates to its customers. The impact of the various alternative levels of CIP expenditures on District finances and a projection of this impact on the equivalent single-family residences (SFR) rate is presented in this section. SFRs currently make up approximately 98 percent of all CSCSD residential unit equivalents. The impact of various levels of CIP expenditures on the rates assessed SFRs was determined by (1) determining the various alternative levels of the CIP expenditures considered over a 5-year period, adjusted for inflation, and (2) determining current revenue requirements.

The sanitary sewer rates necessary to pay for the recommended improvements at each alternative level considered for the 5-year study period FY 1999/00 through 2003/04 were estimated. This section presents the methodology used to determine the likely impacts.

The rates derived assume no use of reserves to lower revenue requirements necessary to be recovered from rates. As such, this section contains guidelines for the County's use in determining an appropriate reserve level for the District. All supporting documentation of the development of revenue requirements and rates is contained in Appendix G.

RATE IMPACTS

Determining the impact of the CIP on the sanitary sewer rates requires that the cost of the CIP be combined with existing annual revenue requirements to estimate the increase in the rates required to meet the new level of revenue requirements. Essentially, revenue requirements are developed based on historical expenditures, offsetting revenues, and alternative levels of CIP-related expenditures for each fiscal year in the study period. This total net revenue requirement is divided by the total number of equivalent residential connections (ERC) in the District to obtain the rate per ERC.

Development of CIP

The three priority levels of capital improvements currently under consideration are discussed in detail in Section 14. The recommended financing alternative for the District for the CIP developed is pay-as-you-go financing. Although debt (e.g., Certificates of Participation [COPs] or revenue bonds) could possibly be issued by combining projects from several Districts to create a larger single issue, pay-as-you-go financing is the recommended alternative at this time.

Development of Annual Revenue Requirements

Revenue requirements for the CSCSD system were estimated from accounting information provided by County staff. For each alternative, historical and projected revenue requirements were developed. Projected expenses were developed by inflating the FY 1997/98 expenses by 3 percent per year. The capital projects expenditures (CIP) in any given year is the level of CIP divided by 5 years (assuming the projects will be paid evenly over the 5-year period) and inflated by 3 percent in each subsequent year. Offsetting revenue in the form of secure property taxes was also inflated by 3 percent per year. Other projected offsetting revenues were based on historical levels of receipts and were not inflated. It was assumed that the District does not plan to either add to or subtract from their existing reserve fund balance. This assumption may change if the County conducts a reserve study, the results of which may indicate that the reserve balance can either be used or added to. Tables 15-1, 15-2 and 15-3 contain a summary of the revenue requirements and rate development.

Impact of Revised Revenue Requirements

The impact on rates of the proposed CIP is significant regardless of what level of capital projects CSCSD choose to construct. Current rates are $352/residential unit equivalent. The Alternative 1 CIP necessitates a maximum rate increase of 104 percent to $718/residential unit equivalent in FY 2003/04. Alternatives 2 and 3 cause maximum rate increases of 101 percent and 96 percent to $708/residential unit equivalent and $690/residential unit equivalent in FY 2003/04, respectively. This analysis assumes that the increased costs, both as a result of the CIP and increases in general expenses, are absorbed equally by all customers. The tables provided in Appendix G summarize the revenue requirements including CIP levels for each alternative along with the calculated rates. As no significant growth is expected in CSCSD, the number of equivalent residential units used to calculate the rates is 1,499. The full development of the rates for the three alternatives and the average of the three alternatives is contained in Appendix G. Tables 15-1, 15-2 and 15-3 also contain a summary of the rate development.

Table 15-1. Crystal Springs Alternative 1 Summary Rate Development

Item	Projected, dollars				
	1999/00	2000/01	2001/02	2002/03	2003/04
Gross expenses	1,051,519	1,079,105	1,107,519	1,136,786	1,166,930
Total offsetting revenue	87,462	88,080	88,717	89,373	90,048
Use of fund balance	-	-	-	-	-
Net revenue requirements	964,056	991,025	1,018,802	1,047,413	1,076,882
Annual rate assuming 1,499 connections	643	661	680	699	718

Table 15-2. Crystal Springs Alternative 2 Summary Rate Development

Item	Projected, dollars				
	1999/00	2000/01	2001/02	2002/03	2003/04
Gross expenses	1,037,882	1,065,059	1,093,052	1,121,884	1,151,582
Total offsetting revenue	87,462	88,080	88,717	89,373	90,048
Use of fund balance	-	-	-	-	-
Net revenue requirements	950,419	976,979	1,004,335	1,032,512	1,061,534
Annual rate assuming 1,499 connections	634	652	670	689	708

Table 15-3. Crystal Springs Alternative 3 Summary Rate Development

Item	Projected, dollars				
	1999/00	2000/01	2001/02	2002/03	2003/04
Gross expenses	1,013,586	1,040,034	1,067,276	1,095,335	1,124,236
Total offsetting revenue	87,462	88,080	88,717	89,373	90,048
Use of fund balance	-	-	-	-	-
Net revenue requirements	926,123	951,954	978,559	1,005,963	1,034,188
Annual rate assuming 1,499 connections	618	635	653	671	690

RESERVE RECOMMENDATION

The following list of general recommendations are for the County's use in determining the appropriate amount of reserve funds to maintain for the District.

1. **Working Capital Reserve**—This generally constitutes 1/6 to 1/12 (as appropriate for a utility's billing cycle) of annual operations and maintenance expenses. This is intended to cover the gap created by the need to pay for expenses incurred prior to the receipt of fees for services rendered.

2. **Emergency Repair Reserve**—Between 1 percent and 3 percent of the current replacement value of a system's assets can be held in reserve for use in the case of main breaks or other necessary emergency repairs.

3. **Self Insurance Reserve**—Between 1 percent and 3 percent of the current replacement value of a system's assets can be held in reserve as self insurance in the case of damages a system might sustain from natural or other disaster.

4. **Debt Service Reserve**—Generally, debt holders require that a utility maintain a minimum reserve equal to 1 year's debt service payments.

It is recommended that at a minimum, the County maintain 10 percent of annual operations and maintenance expenses as working capital reserves, or about $100,000 in the case of Crystal Springs, along with emergency repair reserves. Assuming CSCSD has approximately 45,000 feet of equivalent 10-inch-diameter pipe (assuming 9,000 feet modeled length represents 20 percent of the system) and assuming $100/foot replacement cost yields an estimated minimum system replacement value of $4,500,000. Using the guideline stated above the County should thus maintain between $45,000 and $135,000 for emergency repair reserves. Thus the total minimum recommended reserves would be between $145,000 and $235,000 for CSCSD. It should be noted that this minimum level of reserves is based on the District's current O&M expenses, the above guidelines, and a rough estimate of the value of the District's assets and should be updated if better information becomes available. Current and projected fund balance levels are shown on the tables in Appendix G.

APPENDIX A

MANHOLE INSPECTION TECHNICAL MEMORANDUM

MEMORANDUM

To: Mark Welsh
County of San Mateo, DPW

From: Charlie Joyce
Brown & Caldwell

Date: October 12, 1998 File- 4692.01/10

Subject: Sanitary Sewer and Water System Evaluation Study
Manhole Inspection Memorandum of Field Work

INTRODUCTION

This memorandum presents a summary of the field investigations conducted during the winter and spring of 1997 on inspection of manholes in the nine sewer districts maintained by the San Mateo County Department of Public Works. A total of 873 manholes in the nine districts were inspected with the following in each district:

Table 1
Number of Manholes Inspected By District

District	Manholes Inspected
Burlingame Hills Sewer Maintenance District	90
Crystal Springs County Sanitation District	257
Devonshire County Sanitation District	37
Emerald Lake Heights Sewer Maintenance District	233
Fair Oaks Sewer Maintenance District	204
Harbor Industrial Sewer Maintenance District	22
Kensington Square Sewer Maintenance District	6
Oak Knoll Sewer Maintenance District	17
Scenic Heights County Sanitation District	7

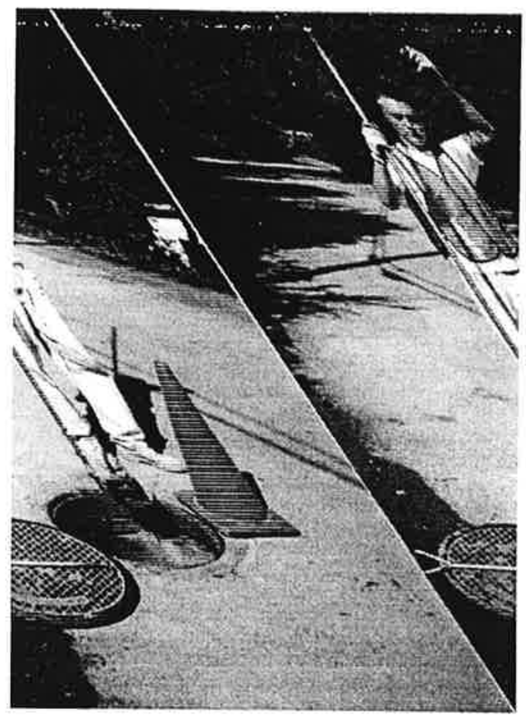
The purpose of this memorandum is to provide the background of how the manholes inspections were conducted, manhole numbering, interpretation of the manhole data, how the data will be used for other parts of the sanitary sewer collection system evaluation, and a summary of critical locations in the districts where repair work should take place. The memorandum also includes descriptions on how to locate photographs related to an inspected manhole in the 12 three ring binders provided at the completion of this project.

This memorandum does not provide the condition assessment of the sanitary collection system. That work effort will be completed as part of a later task in the project when the other parts of the field data, namely flow monitoring, television inspection, and smoke testing, are completed.

MANHOLE INSPECTION OVERVIEW

A key part of the data collection consisted of documenting the findings of the inspections for analysis. Two methods of documenting the manhole inspection were used for this project. The first was a field form set up to allow the field crew to collect data in an efficient manner on the condition of the manhole. The second method of documenting the manhole condition was to photograph defects found during the visual inspections. The manhole inspections were top side inspections where the condition of the manhole was observed from the surface.

In order to collect additional data on each manhole location a "Camera on a Stick" (Figure 1) was lowered into the manhole and a photograph of each pipe entering and leaving the manhole was taken. Where infiltration/inflow or other manholes conditions warranted a photograph was also taken from the "Camera on a Stick".



The view in the pipeline using the "Camera on a Stick" is dependent on the flow, debris, and channel benching in the manhole. Where the camera can be placed in the channel with a clear view of the pipeline the photograph typically shows approximately 20 feet of the sewer away from the manhole for an 8-inch diameter sewer. Larger sewer diameters typically show a longer distance and smaller sewer diameters show a shorter distance.

Pipes were photographed in a clockwise direction to avoid confusion and to allow for cataloging the photographs. Pipe A was always the first pipe in the clockwise direction from the primary outlet pipe(s). Drop manholes would have a photograph taken of both the top and bottom of the drop manhole and were noted as such in the comment field of that pipe. Each pipe in the drop manhole pipe was given a separate pipe identifier.

A copy of a blank field form used to document manhole conditions is included as Attachment A. Also in that attachment is a blank form for the pipe condition assessment that was completed for each pipe when the photographs were reviewed.

Manhole numbering modifications to the existing manholes numbering system for each basin were performed so that each manhole in the nine districts has a discrete unique label. The manhole number is an eight character alpha/numeric with the following definition:

B0001A04

B	Burlingame Hills, see Table 2.
0001	Manhole Number with zeros shown for place holders.
A	Several manholes were placed after initial numbering using a letter - A, B, etc. When not needed this part of field is left blank.
04	District Map Number as supplied by County.

Table 2
District Designators

District	Designator
Burlingame Hills Sewer Maintenance District	B
Crystal Springs County Sanitation District	C
Devonshire County Sanitation District	D
Emerald Lake Heights Sewer Maintenance District	E
Fair Oaks Sewer Maintenance District	F
Harbor Industrial Sewer Maintenance District	H
Kensington Square Sewer Maintenance District	K
Oak Knoll Sewer Maintenance District	O
Scenic Heights County Sanitation District	S

The manholes were numbered as the inspections were completed. Each completed form was then entered into a Microsoft Access v2.0 database that was programmed for manhole inspection analysis. Each item on the inspection form was input to the data base. The checks and boxes on the inspection form translate to a yes/no or numerical value in the database for future use in the condition assessment analysis. Data related to the pipe photographs were entered directly into the database after the photographs were developed and reviewed.

Manholes were selected for inspection to provide a representative random sample of the manholes in each of the nine districts. Manholes were identified for inspection from the collection system maps. The manholes selected normally met one of the following criteria:

- Connection of more than two sewers entering the manhole
- One of the sewers entered into or exited from an easement
- The sewer segment appeared typical to the area served
- A special flow connection or cross-connection was shown on the maps
- A manhole with many laterals entering, such as a cul-de-sac.

Manholes located in easements were also inspected, although access to many of these manholes was not possible due to obstructions, locked gates, or the occasional fence built over the manhole. Traffic control measures were used to route vehicles around the field crew and the crew followed safety precautions as outlined in the Field Health and Safety Plan required on all Brown and Caldwell field related projects.

MANHOLE INSPECTION BINDERS

A series of three-ring binders containing the print outs from the database with the accompanying photographs for each inspected manhole were assembled. The binders are numbered by an alpha/numeric format where the first letter corresponds to the district and the number corresponds to the binder number for that district. This format allows for future manhole inspections to be placed in successive binders. A field was added to the database so that the binder number could be attached to the manhole number.

A summary report is contained at the front of each binder to facilitate the location of a manhole. The summary report is provided in two orientations: 1) by film roll number, and 2) by manhole number. The contents of the binders area are arranged by film roll number for each District, rather than by manhole number.

The photographs for each manhole are arranged so the first photo (normally upper left) is the manhole number followed by the manhole cover, channel, or other defect photographs. The pipe photographs follow using the same convention as identified in the field inspection, beginning with Pipe A and proceeding through to Pipe X.

Locating a manhole in the binders is most easily accomplished by using the database query "BINDER/ROLL/MHID" to identify the binder number and the roll number of the associated photographs and then looking up the database print out and photographs in the appropriate binder.

Of the 873 manholes inspected a total of 2,480 pipes were photographed. The following tables provide summary information related to the manholes and pipes inspected. The tables are arranged by manhole number. Specific database reports for manholes and pipes, Attachments B and C, respectively, follow this memorandum.

Manholes
Manholes with Bench/Channel Defects Worse Than Moderate
Manholes with Roots
Manholes with Grease
Manholes with Frame and Cover Problems
Manholes with Infiltration/Inflow and Flow Caps
Manholes with Major Debris in Channel

Pipes

Pipes with Separated Joints Greater than Moderate and Deflections Greater than One Inch
Pipes with Greater than Minor Corrosion
Pipes with Infiltration/Inflow
Pipes with Greater than Light Grease
Pipes with Greater than Light Roots
Pipes with Roots and Grease
Pipes with Cracks and Fractures
Pipes with Plugs and Obstructions

APPENDIX B

1997 FLOW MONITORING PROGRAM TECHNICAL MEMORANDUM

MEMORANDUM 4692-02

November 19, 1997

TO: MARK WELCH, COUNTY OF SAN MATEO

FROM: BRIAN HAMMER, BROWN AND CALDWELL
CHARLIE JOYCE, BROWN AND CALDWELL

SUBJECT: COUNTY OF SAN MATEO MASTER PLAN
1997 FLOW MONITORING PROGRAM

This memorandum documents the flow monitoring program conducted for the County of San Mateo Master Plan during the winter of 1997. The purpose of the project was to measure the flow rate during dry weather and discrete rainfall events in the San Mateo County area. This memorandum discusses the flow monitoring program and subsequent data analysis. Results of the flow monitoring program are attached.

Flow Monitoring Locations

A flow monitoring plan was developed to determine dry weather flow rates and Inflow/Infiltration (I/I) rates in the County of San Mateo wastewater collection system. As part of the flow monitoring plan, specific locations within the County sanitary collection systems where temporary flow monitors and rain gauges could be installed were identified and evaluated. Potential monitoring site evaluations were conducted the week of January 16, 1997, by Brown and Caldwell staff.

During the field evaluation, manholes were inspected to determine their hydraulic suitability for flow monitoring and accessibility. Special safety considerations were also documented. Fifteen manholes were selected for temporary flow monitoring among the nine sewer district. Additionally, four rain gauge sites in the County collection system were also located and evaluated. The selected flow monitoring sites and rain gauge locations are listed in Table 1 and Table 2, respectively. Flow monitoring site reconnaissance forms for the selected manholes are included in Attachment A. Included in Attachment A are schematic diagrams of each sewer district showing the flow monitor locations.

Table 1 Flow Monitoring Locations

Flow monitor site	Location	Pipe diameter, in.
11	Burlingame Hills - 2815 Adeline near Alvarado	8
12	Burlingame Hills - 2872 Canyon Road	8
21	Crystal Springs - Polhemus Road near Ascension Street	10
22	Crystal Springs - Polhemus Road and Ticonderoga Road	8
31	Devonshire - Devonshire Road and Exeter Street	8
41	Emerald Lake - 1706 Cordilleras Road	8
42	Emerald Lake - Lake Boulevard and Oak Knoll Drive	8
43	Emerald Lake - Glenwood Drive at Garret Park	6
44	Emerald Lake - 1036 Lakeview Drive	6
51	Fair Oaks - Douglas Court. (end)	30
52	Fair Oaks - Bay Road at Willow Street.	30
53	Fair Oaks - 559 Oakside Drive	21
54	Fair Oaks - 343 Nimitz Avenue.	15
55	Fair Oaks - Woodside Road. near Churchhill	10

Table 2 Rain Gauge Locations

Rain gauge no.	Location
1	Burlingame Hills - Hillside at Newton, Fire Station #2
2	Crystal Springs - 2295 Cobble Hill at Ticonderoga Road (private residence)
3	Emerald Lake - California at Jefferson, Fire Station #19
4	Fair Oaks - Bay Road at 2nd Street., Fire Station #11

Flow Monitoring

Montedoro-Whitney WDFM-8 flow monitors were installed at the fifteen selected locations on January 22 and 23, 1997. These monitors are capable of measuring both depth and velocity of flow. The combined depth and velocity measurements make it possible to calculate flow rates for open channel conditions and during surcharge or backwater conditions.

Depth measurements were made by a differential pressure type strain gauge. One side of the sensing element is open to atmospheric pressure. This prevents errors due to changes in barometric pressure. Adjustments for temperature differences are made to further insure the accuracy of the measurements. The depth of flow sensing element is located on the bottom of the monitoring probe, which allows for depth measurements from zero to a maximum of 10 feet when the probe is centered exactly on the bottom of the pipe.

In field conditions, it is very difficult to center the probe exactly on the bottom of the pipe. The resultant difference between actual water surface level and monitored water surface level is called a depth offset. Corrections for the depth offset are discussed later in this memorandum. Depth measurements with these monitors are accurate to 0.01 of a foot under laboratory conditions. Accuracy of depth measurements in the field is dependent on the hydraulic characteristics of the flow stream at the monitoring site, proper installation techniques, and frequent maintenance procedures.

The monitors measure flow velocity using the ultrasonic Doppler shift method. The velocity sensor on the monitor sends an ultrasonic signal into the flow stream and measures velocities based on the Doppler shift. The flow monitoring velocity sensor is located approximately 1.5 inches from the bottom of the sensor and must be completely submerged to obtain accurate velocity measurements.

Velocity measurements are made at the bottom of the pipe near the wall and, therefore, are not actually measuring the average velocity of the flow stream. The difference between the monitored velocity and the average velocity is called a velocity offset and is also discussed later in this memorandum.

Precipitation intensity and duration were measured at four temporary locations in the County service area. The rain gauges were tipping bucket type gauges connected to portable electronic event recorders. The rain gauges are calibrated to tip after 0.01 inches of rainfall is received. The event recorder documents the time of each tip. Rain gauges 1 and 3 were installed on January 24, 1997. Rain gauges 2 and 4 were installed January 23, 1997. The flow monitors and rain gauges were removed on March 18, and March 24, 1997, respectively.

Flow Monitor Calibration

Calibration data was collected to verify both depth and velocity and to develop a depth-to-discharge relationship for the monitoring sites. Calibration data was obtained approximately once a week by manually measuring the depth and velocity of the flow stream with portable equipment. Field staff were responsible for maintaining the flow monitoring equipment and obtaining calibration information. The data was collected at various times in the diurnal cycle including early morning low flow periods and peak flow periods. Attachment B provides a listing of the calibration data for each flow monitoring location.

Data Analysis

Flow monitoring data analysis consisted of developing depth to discharge relationships for calculating flows, and determining depth and velocity offset values for the raw data. These tasks are described in the following paragraphs.

Depth-to-Discharge Relationship. The first step in the data analysis process was to develop a flow depth-to-discharge rating curve for each monitoring site. The rating curve was used to determine flows under open channel conditions. During the monitoring site calibration, the average velocity and corresponding depth of flow were measured approximately twice weekly at each of the flow monitoring sites. Average velocity measurements were made by field crews using portable velocity probes. The portable velocity probe is capable of continuously samples the velocity of the flow stream. Field crews move the portable velocity probe throughout the cross-sectional area of the flow stream for a period of 10 to 40 seconds and the average velocity was calculated automatically by the portable equipment.

These measurements were used to develop depth-to-discharge relationships. Calibration measurements were made at various times of the day and various days of the week to obtain information during the largest range of conditions experienced in the system during the monitoring period.

Actual flow rates were calculated from the calibration data using the continuity equation (flow = area x average velocity). The flow rate was then used to calculate the equivalent hydraulic slope at the site using Mannings equation. The average slope for all the manual measurements was then calculated and flow rates were plotted on a depth-versus-flow graph, and a Mannings curve was "fitted" to the data points. The curve utilizes the standard Mannings equation for open-channel flow, and use a depth-variable roughness coefficient or Mannings "n" value. The curves were then used to convert the flow monitoring depth measurements to flow rates during open channel flow conditions. When surcharging occurs, the depth and velocity measurements were used to calculate the flow rate using the continuity equation.

Offsets. The site calibration measurements were also used to develop depth and velocity offsets for the flow monitoring sites. Depths offsets occur when the flow monitoring probe was not installed exactly in the center of the pipe. Velocity offsets occur because the velocity sensor measures a point velocity near the pipe wall. In addition, each sensor has an inherent electronic offset. Manual calibration data was used to correct the monitored depth measurements and convert the point velocities to an average velocity. For this project, the combined electronic and physical offset remained constant at each of the flow monitoring sites during the flow monitoring period.

Results

Four storm events occurred during the flow monitoring program. The storm dates and their daily rainfall totals are summarized in Table 3.

Table 3 Rain Gauge Results, inches

Date	Rain Gauge 1 Burlingame Hills	Rain Gauge 2 Crystal Springs	Rain Gauge 3 Emerald Lake	Rain Gauge 4 Fair Oaks
01/24/97	0.63	0.56	0.71	0.59
01/25/97	1.20	1.15	1.64	1.02
01/26/97	0.53	0.43	0.52	0.25
02/17/97	0.21	0.13	0.13	0.07
03/02/97	0.23	0.11	0.21	0.02
03/16/97	0.34	0.13	0.40	0.10

The flow monitors at sites 12 and 44 either failed or became clogged with debris, for noted periods of time. For site 44, we do not recommend using the flow data from February 23, 1997, to March 16, 1997, as flow levels were too low to measure accurately. Also, flow monitoring at site 12 failed from February 20, 1997, to February 25, 1997. No additional monitoring problems were noted. Table 4 presents the dry weather and wet weather flow monitoring results of this analysis.

Table 4 Flow Monitoring Results, million gallons per day

Flow Monitoring Site	Minimum Flow	Average Flow	Peak Dry Weather Flow	Peak Wet Weather Flow
11	0.01	0.11	0.27	1.13
12	0.06	0.11	0.17	0.24
21	0.01	0.34	1.12	2.82
22	0.03	0.12	0.37	0.50
31	0.02	0.08	0.20	0.65
41	0.01	0.04	0.07	0.18
42	0.01	0.02	0.04	0.09
43	0.01	0.02	0.03	0.07
44	0.01	0.03	0.10	0.12
51	0.29	0.66	1.31	2.30
52	0.41	1.79	3.22	8.89
53	0.41	1.20	2.26	4.26
54	0.19	0.41	0.80	1.94
55	0.00	0.22	0.48	1.10

Listed below is a summary of the contents of the attachments:

Attachment A Flow Monitoring Site Reconnaissance Forms.

Attachment B. Flow Calibration Data

Attachment C Graphical Flow Summary. Graphical plots of minimum, daily, and peak flow rates.

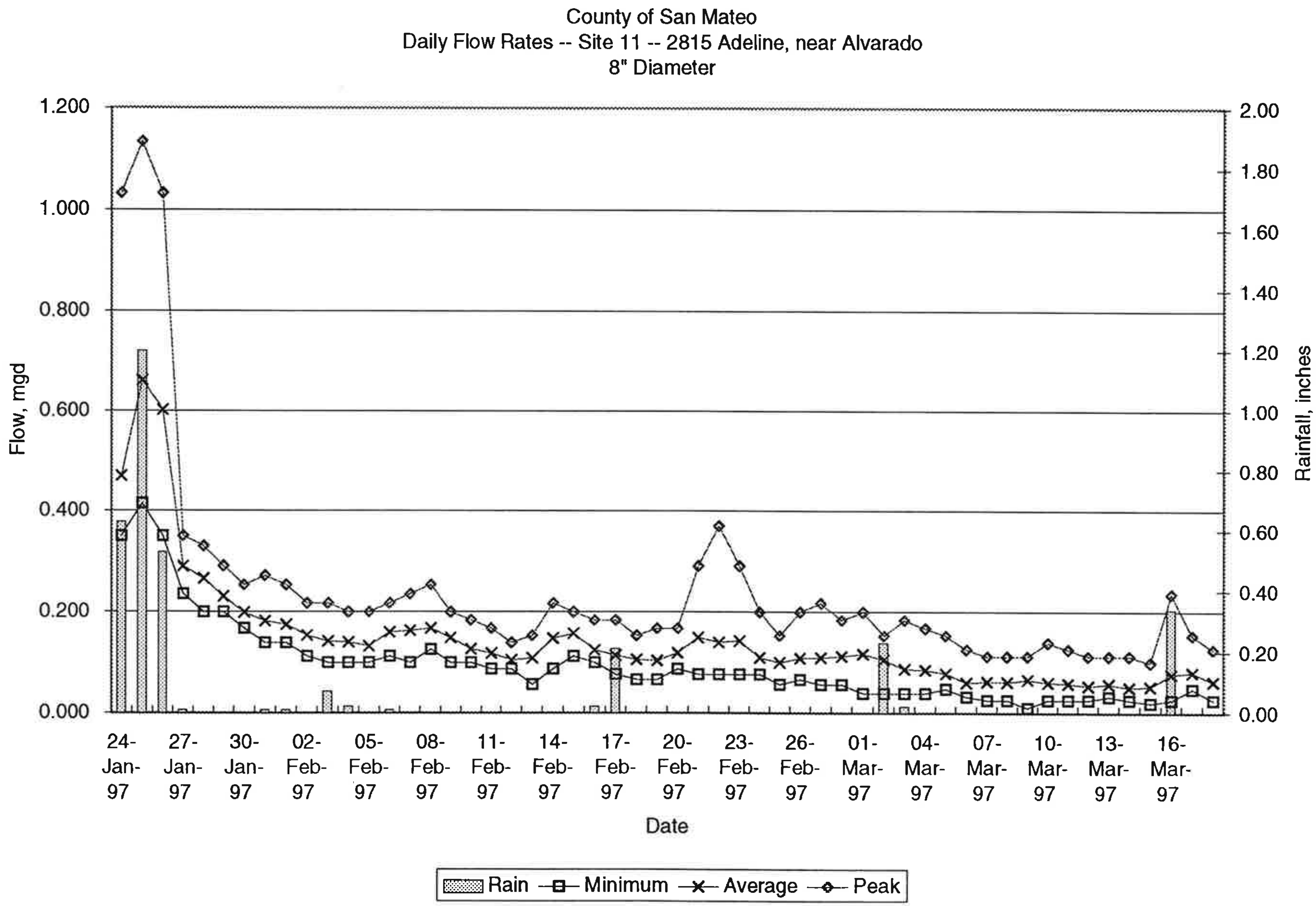
BH:CJ:jm
Attachments

ATTACHMENT A

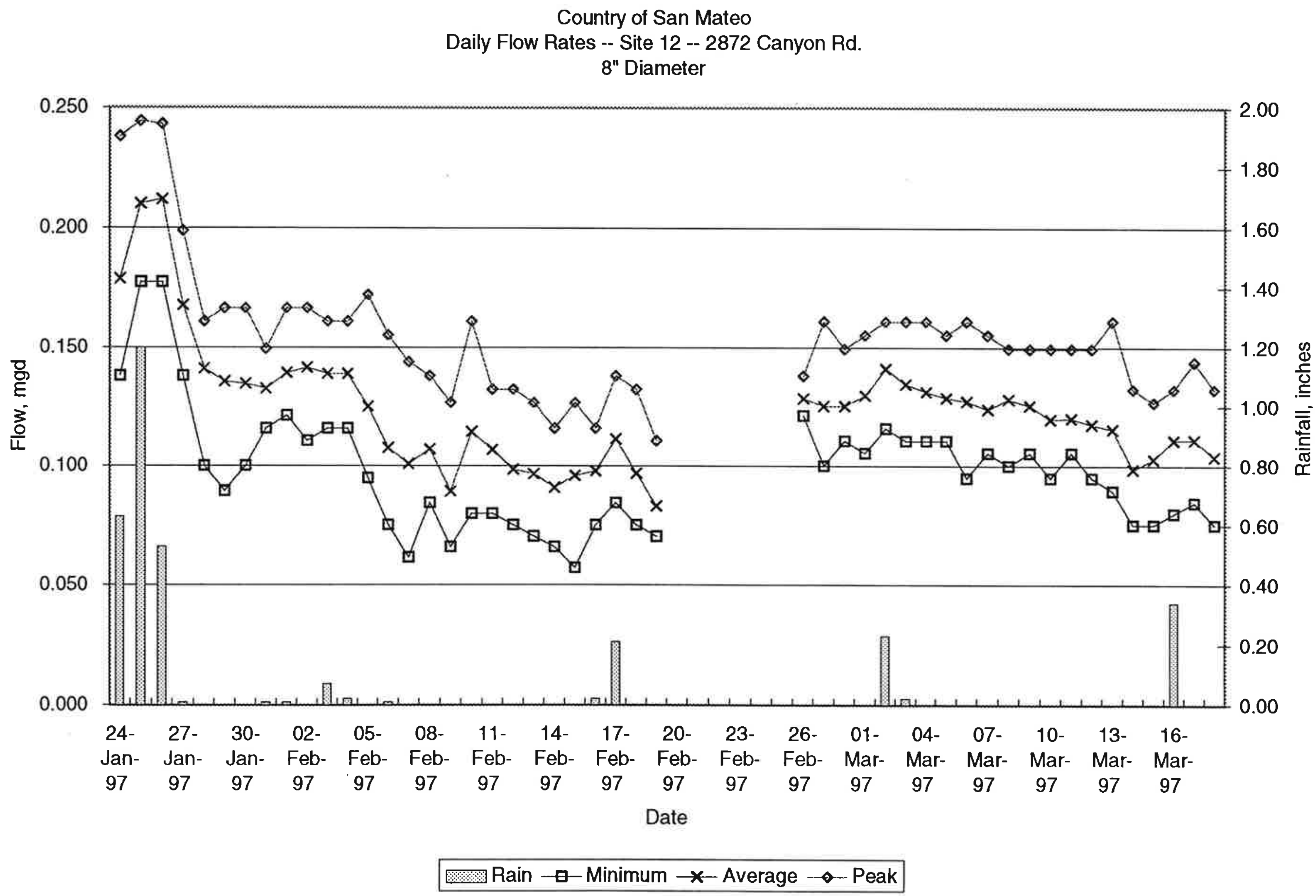
FLOW MONITORING SITE RECONNAISSANCE FORMS

ATTACHMENT C

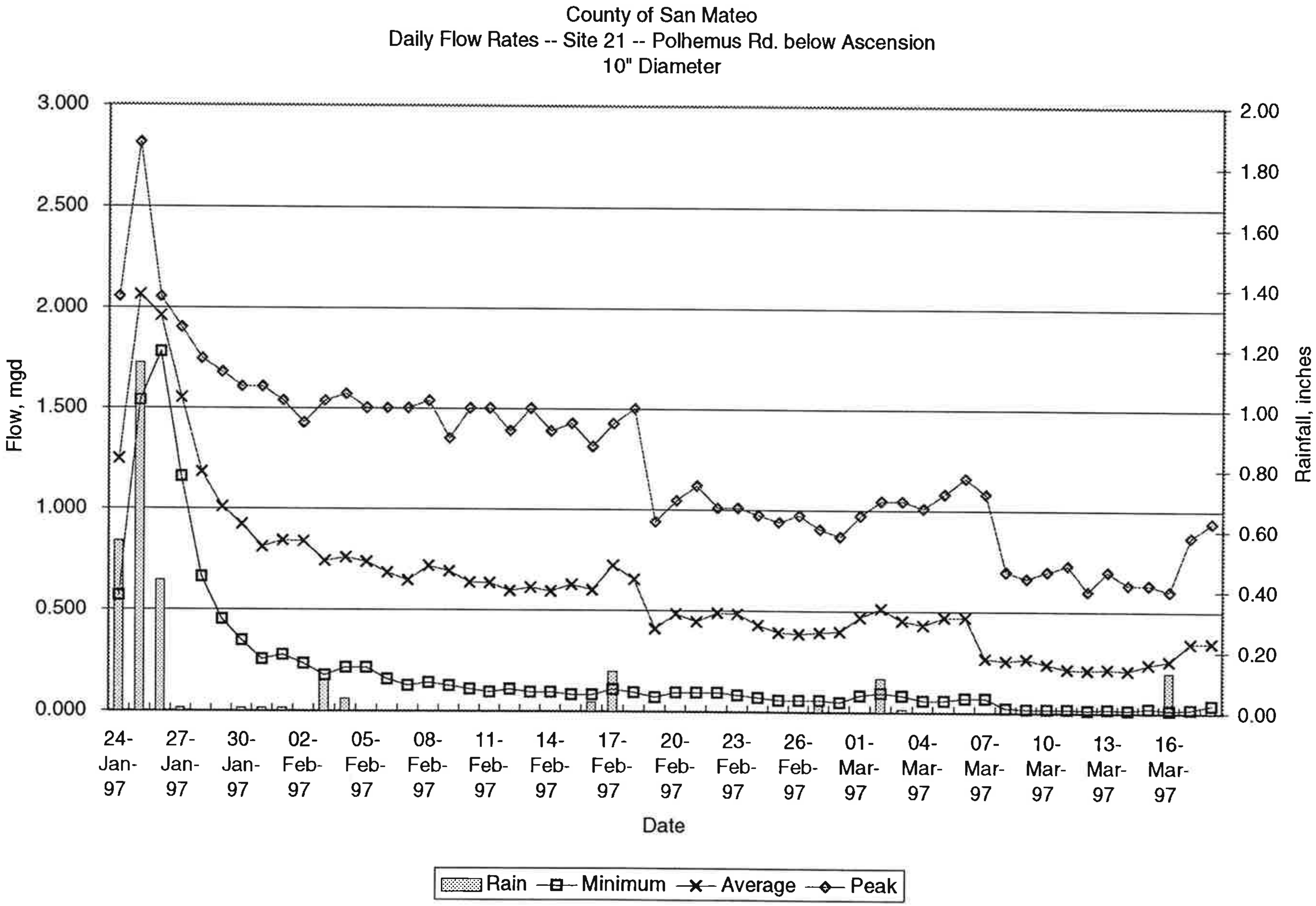
GRAPHICAL FLOW SUMMARY
GRAPHICAL PLOTS OF MINIMUM, DAILY, AND PEAK FLOW RATES



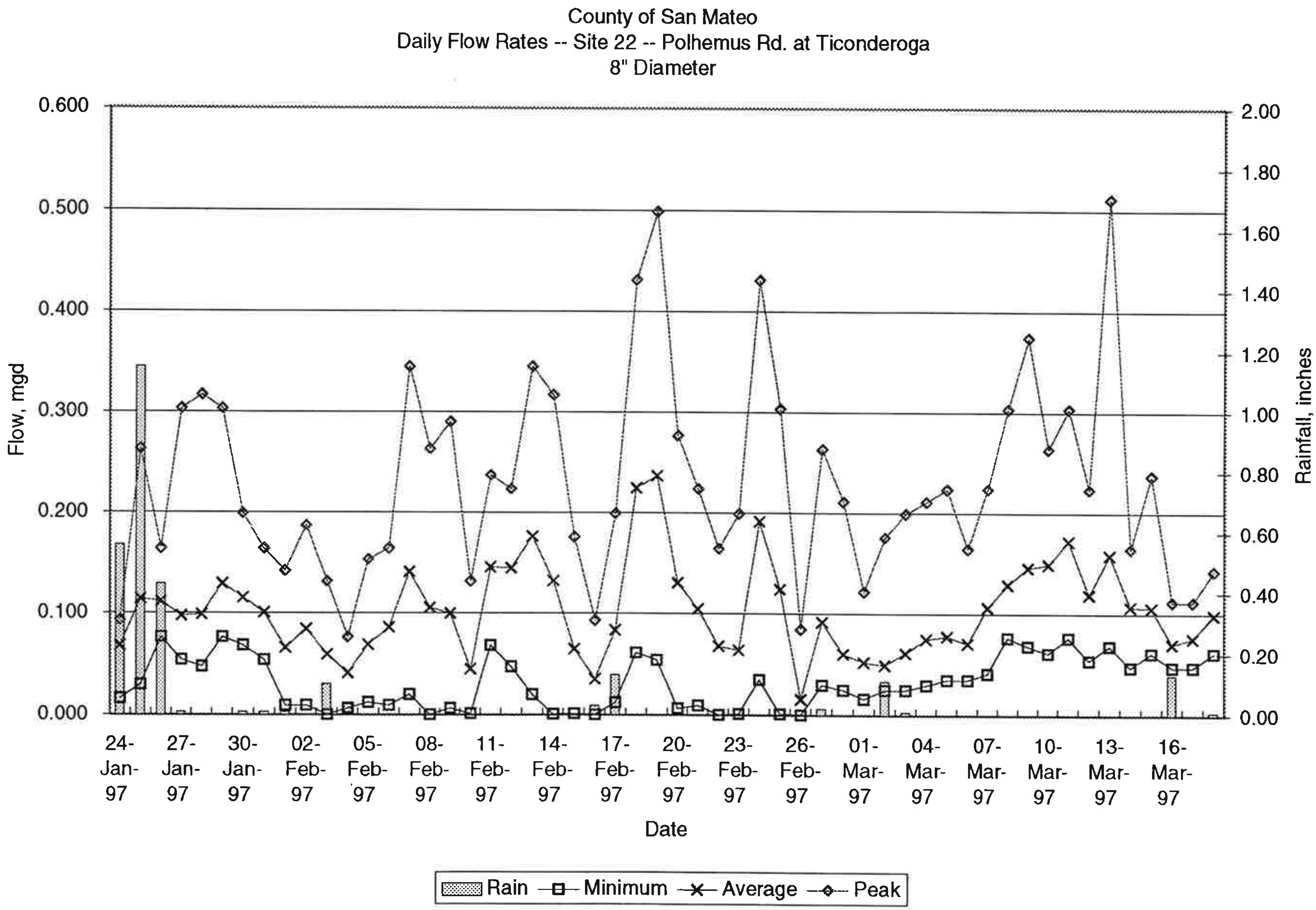
e:\4692\333\current:333_11.xls



e:\4692\333\Current:333_12.xls

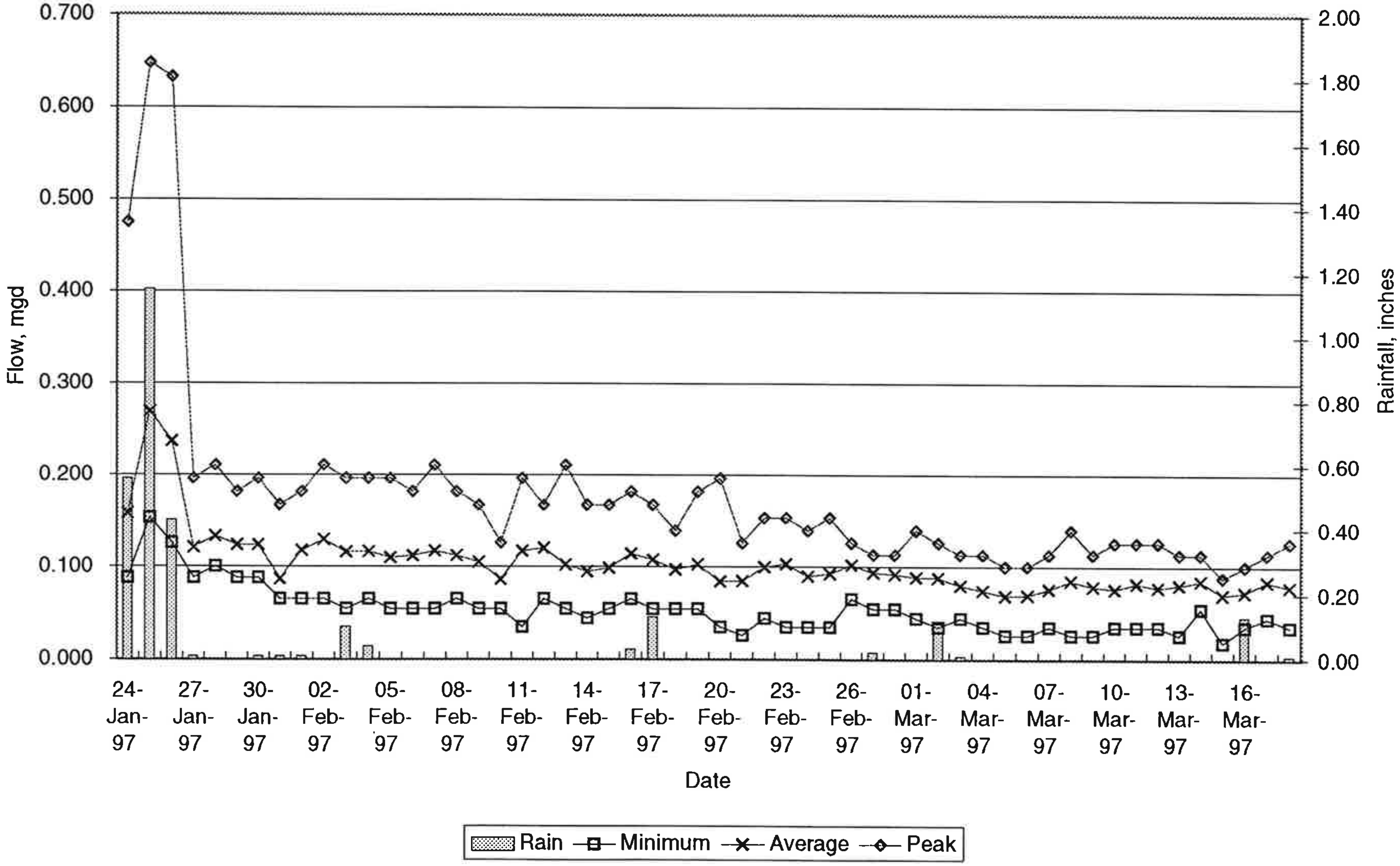


e:\4692\333\Current:333_21.xls

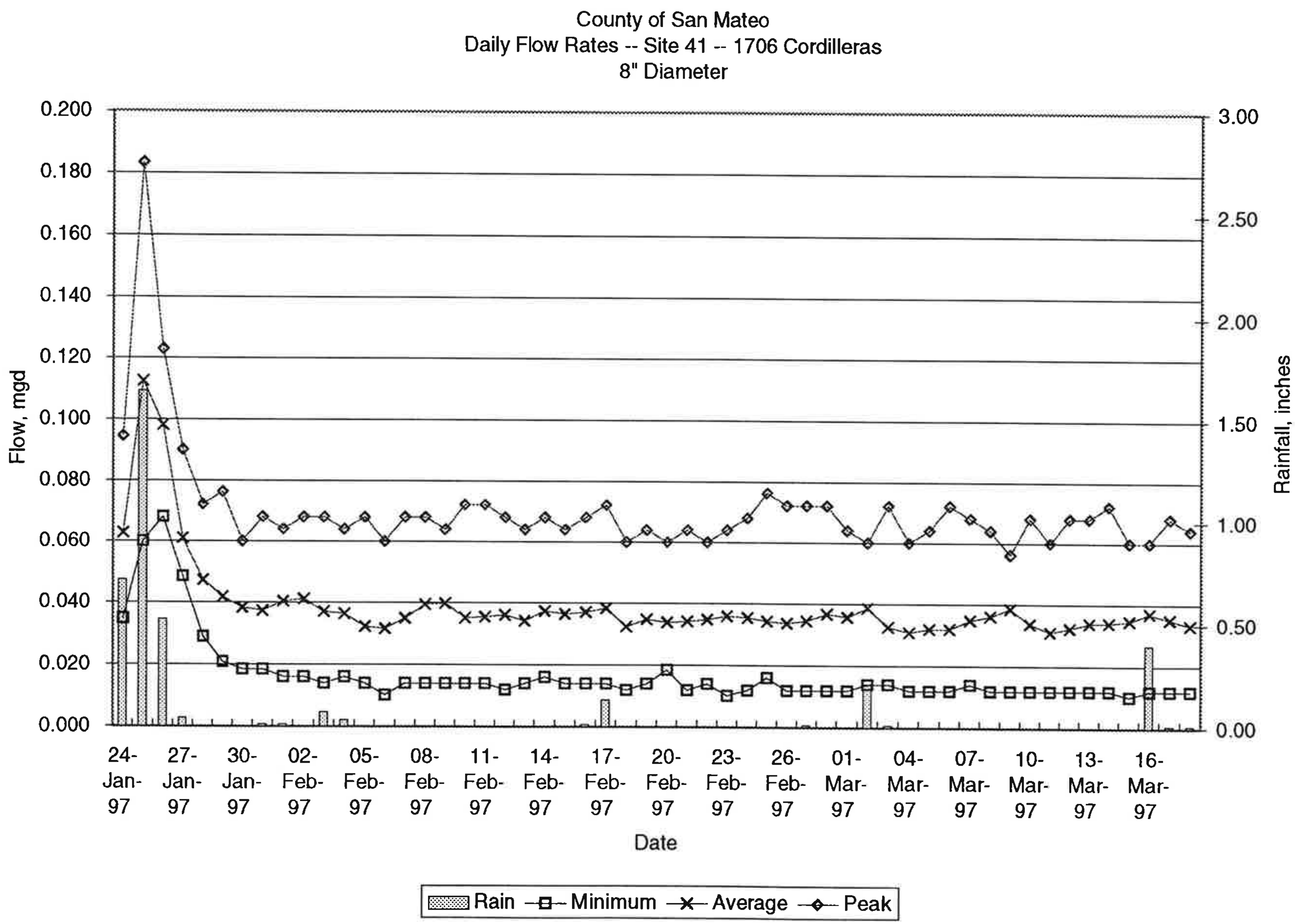


e:\4692\333\Current:333_22.xls

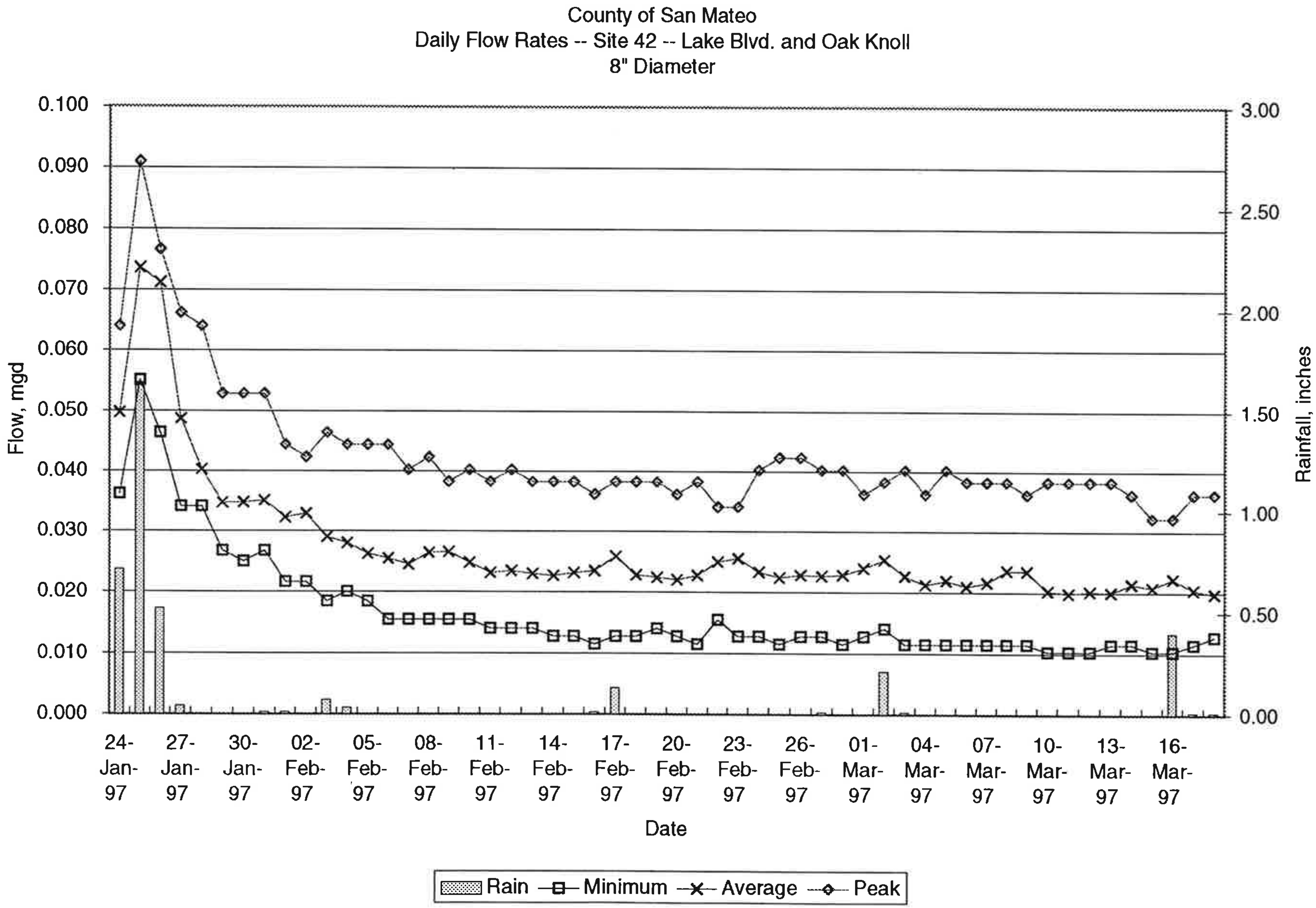
County of San Mateo
Daily Flow Rates -- Site 31 -- Devonshire and Exeter
8" Diameter



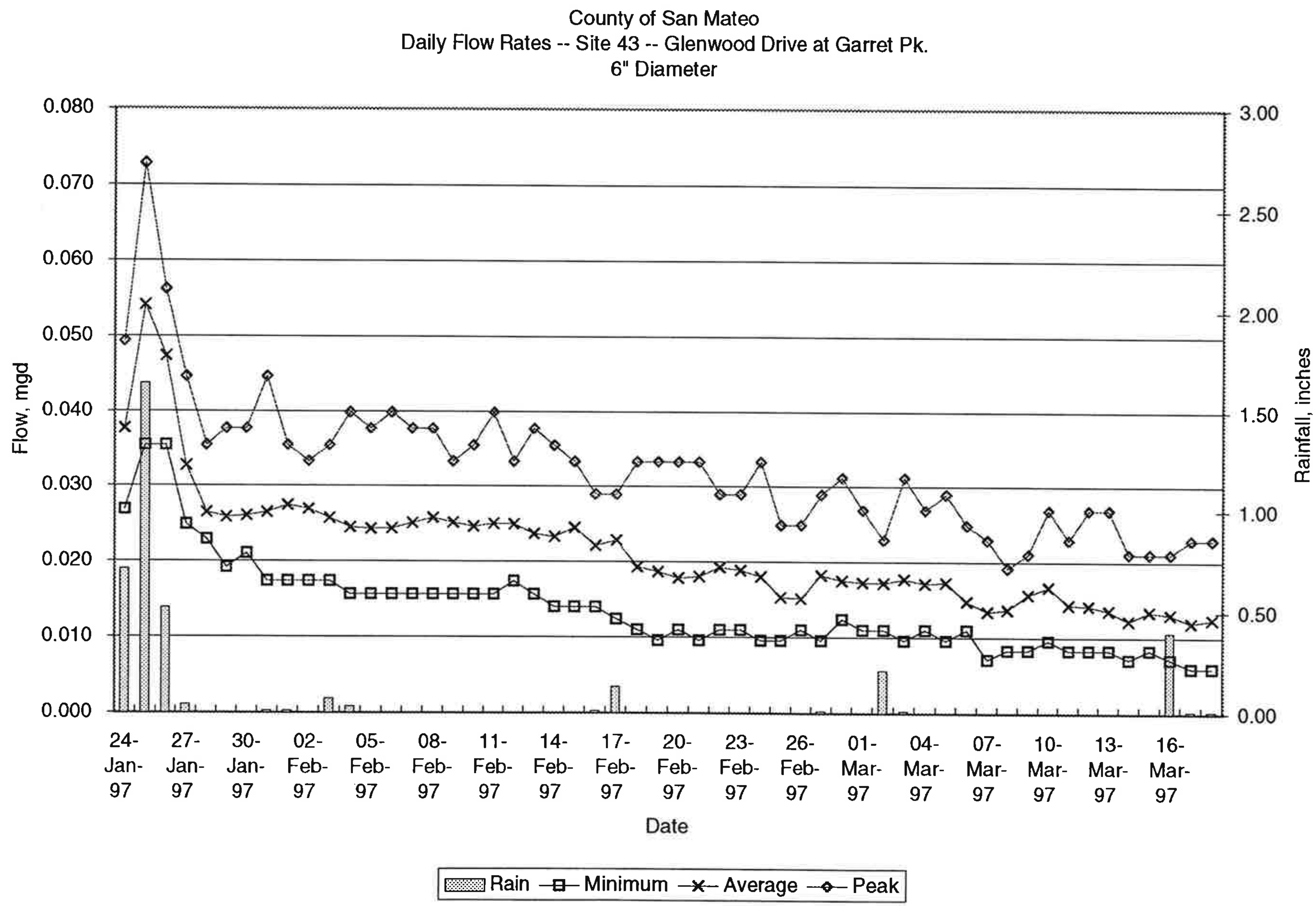
e:\4692\333\Current:333_31.xls



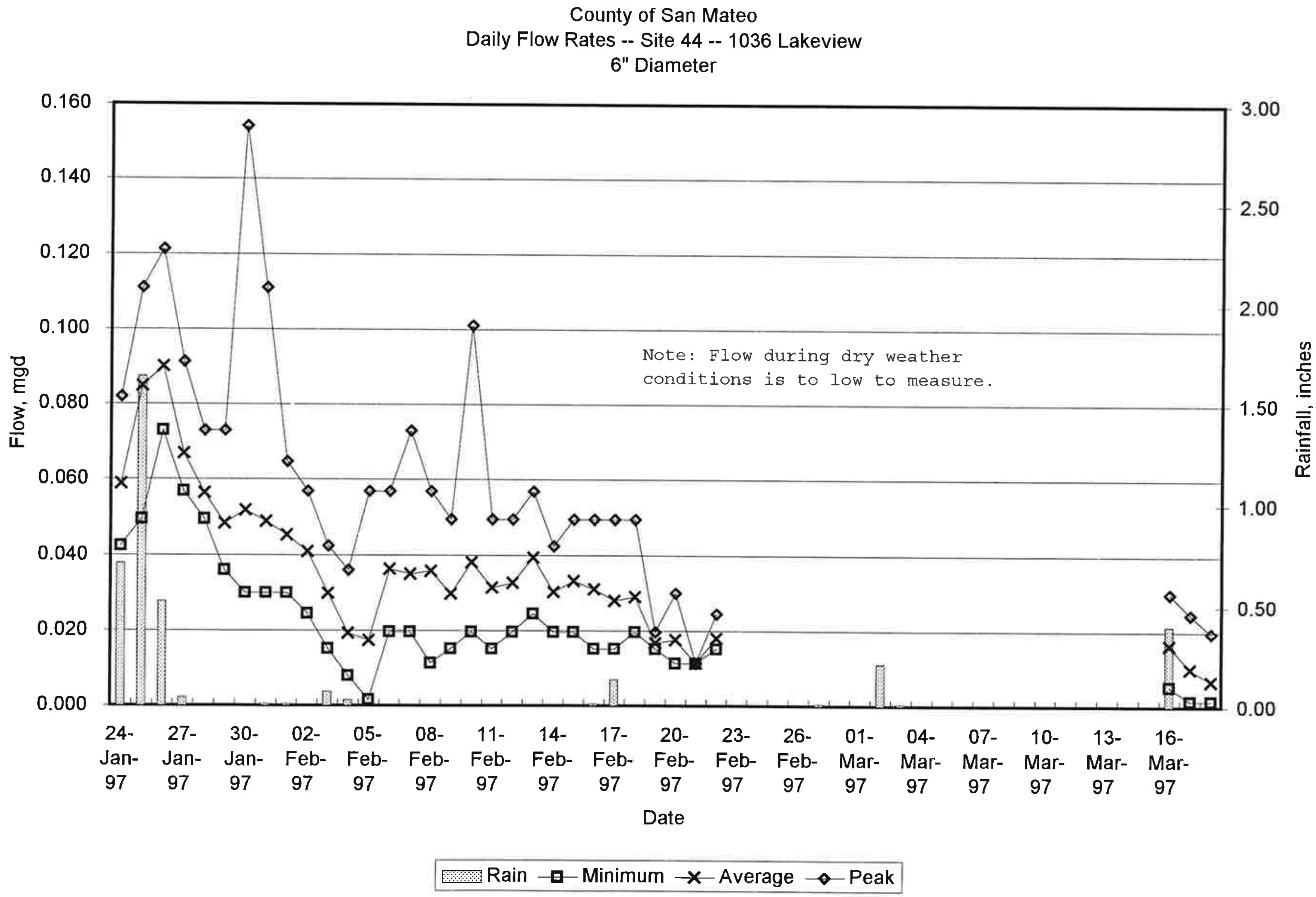
e:\4692\333\Current:333_41.xls



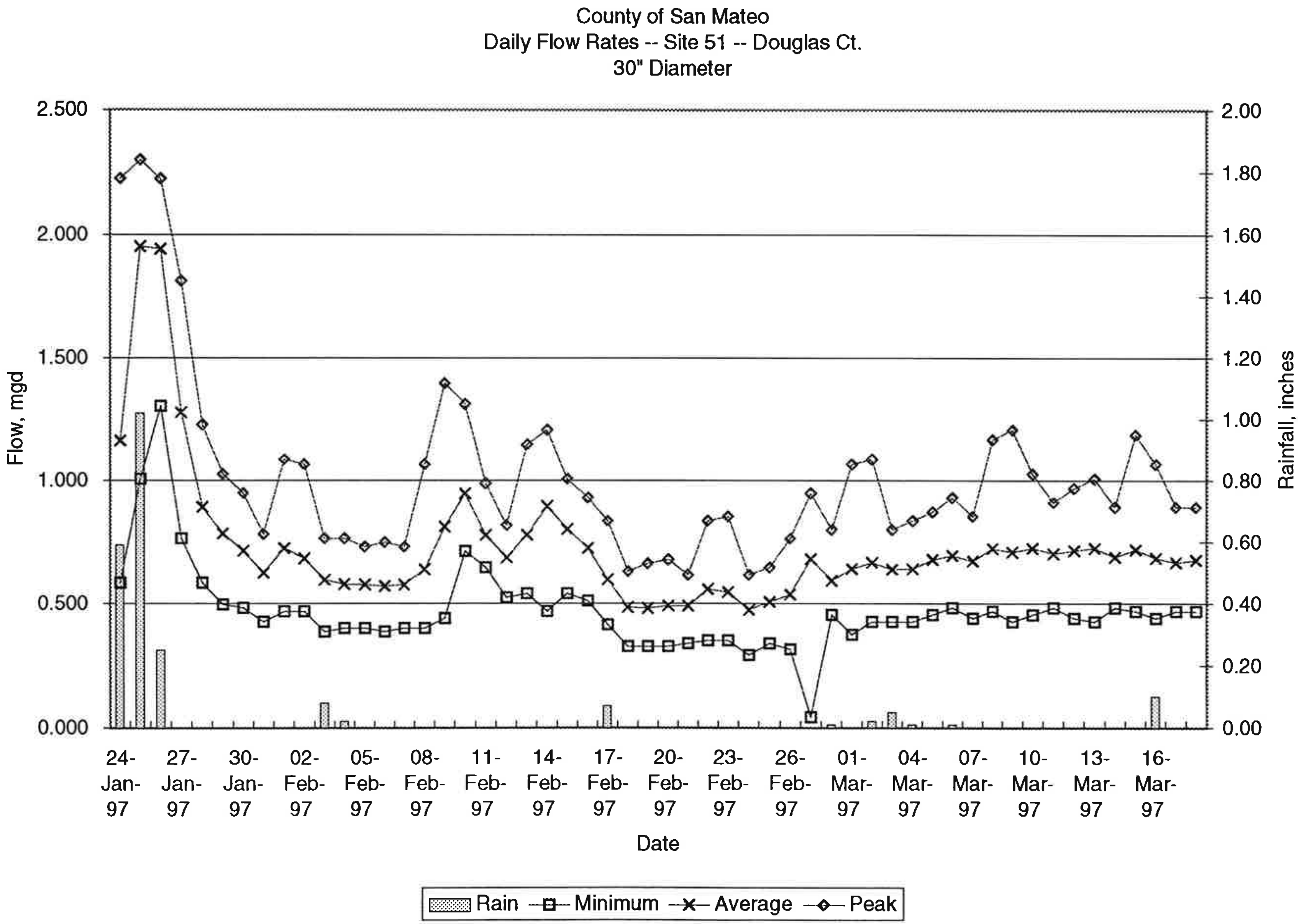
e:\4692\333\Current:333_42.xls



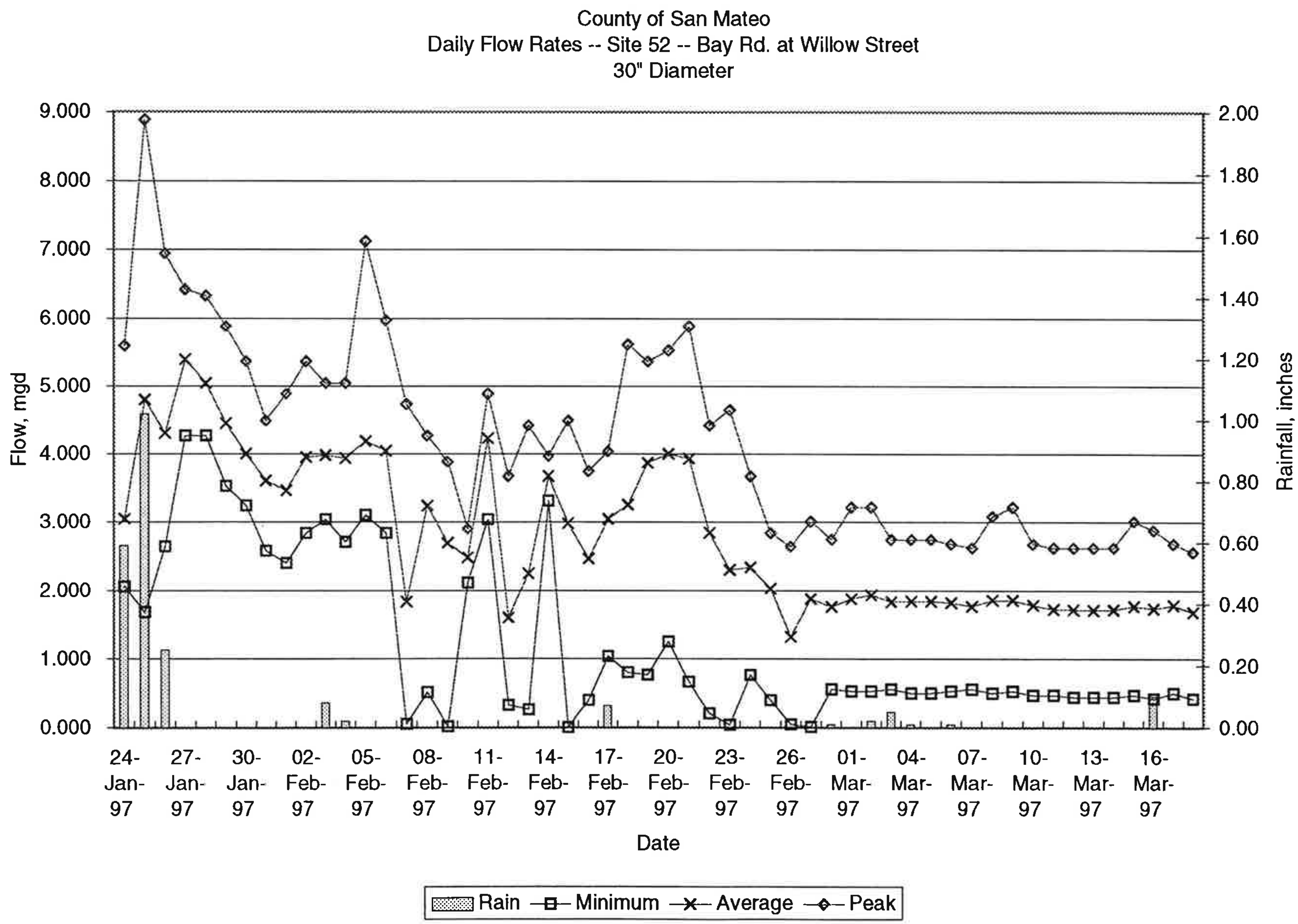
e:\4692\333\Current:333_43.xls



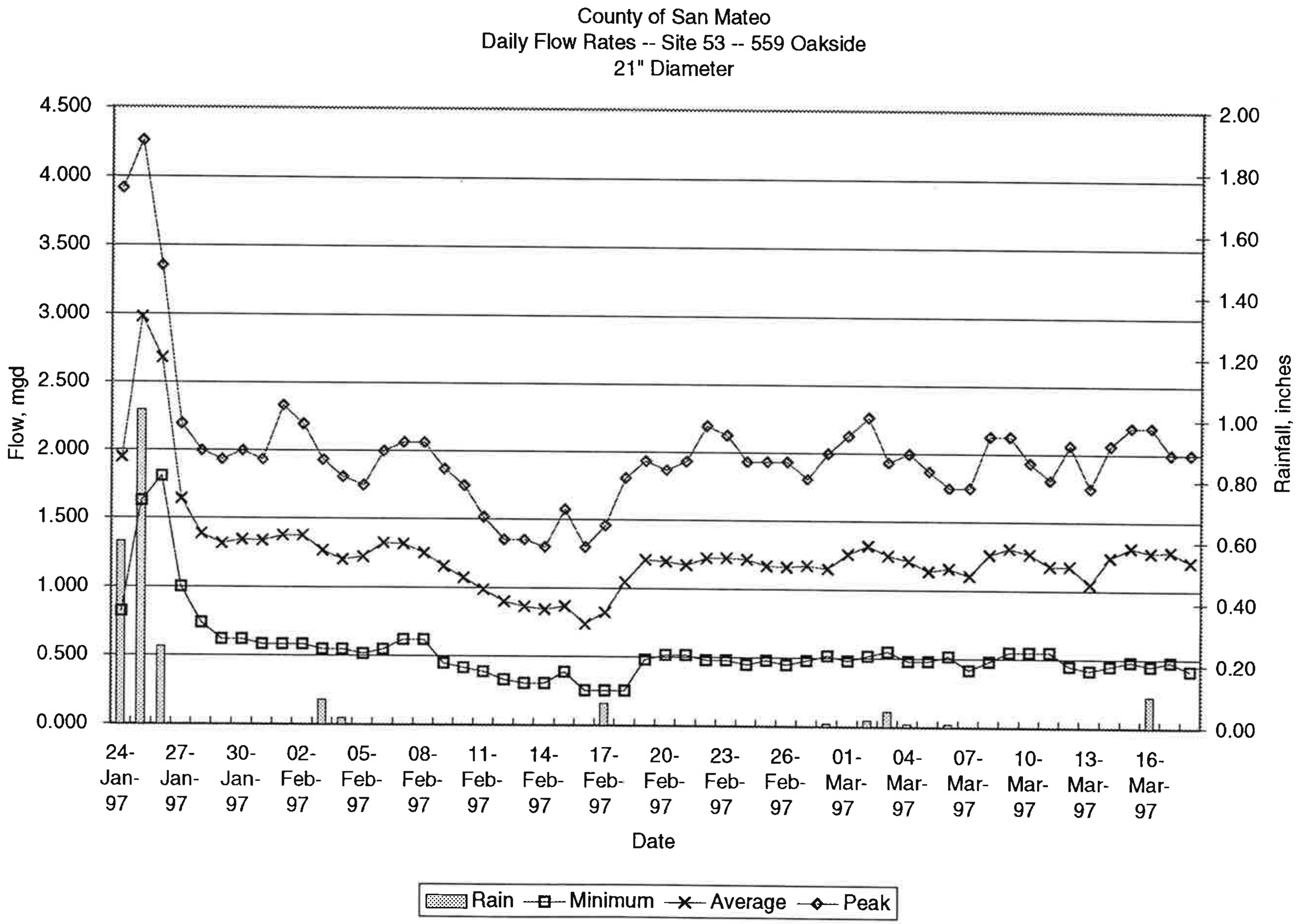
e:\4692\333\Current:333_44.xls



e:\4692\333\Current:333_51.xls

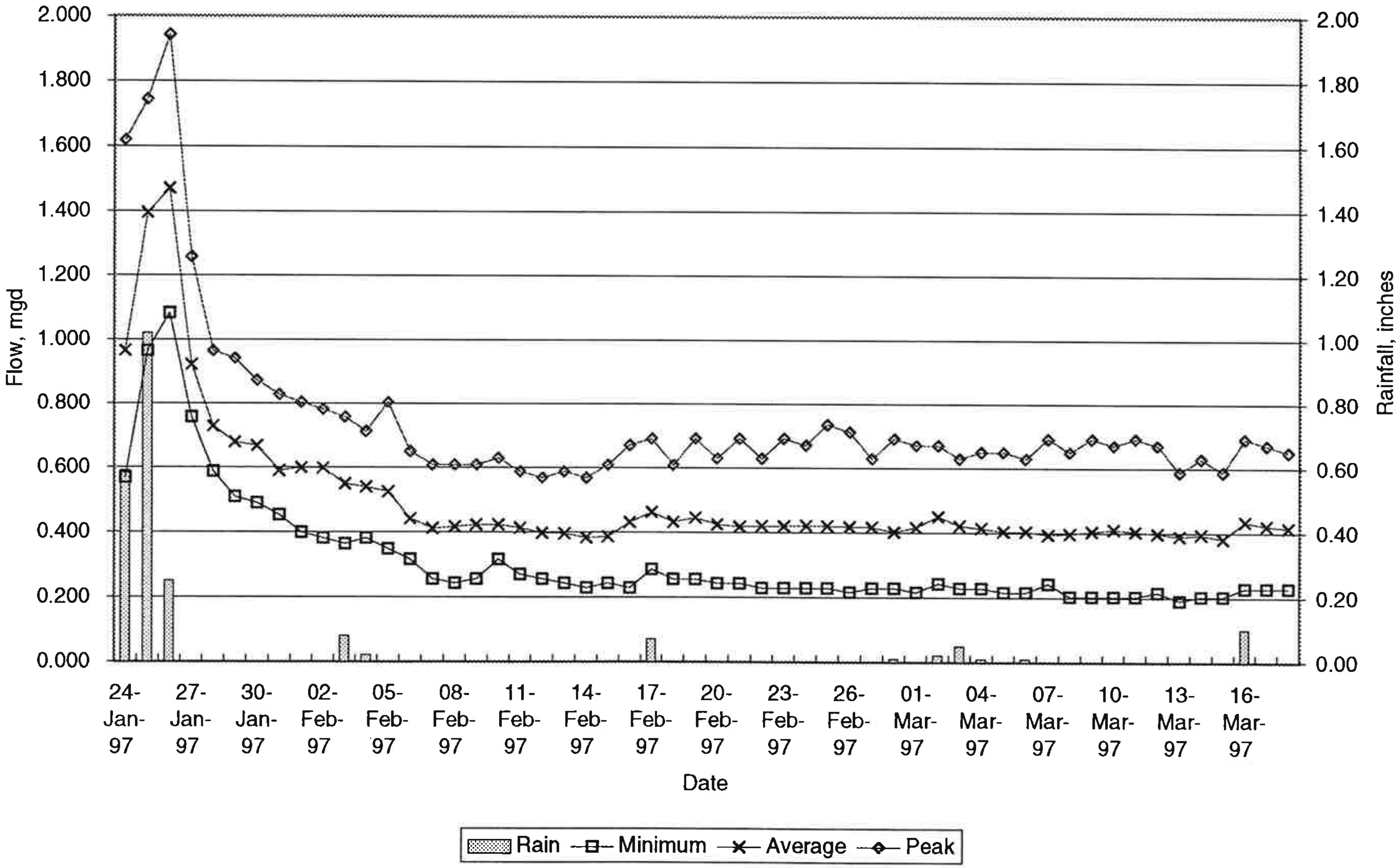


e:\4692\333\Current:333_52.xls

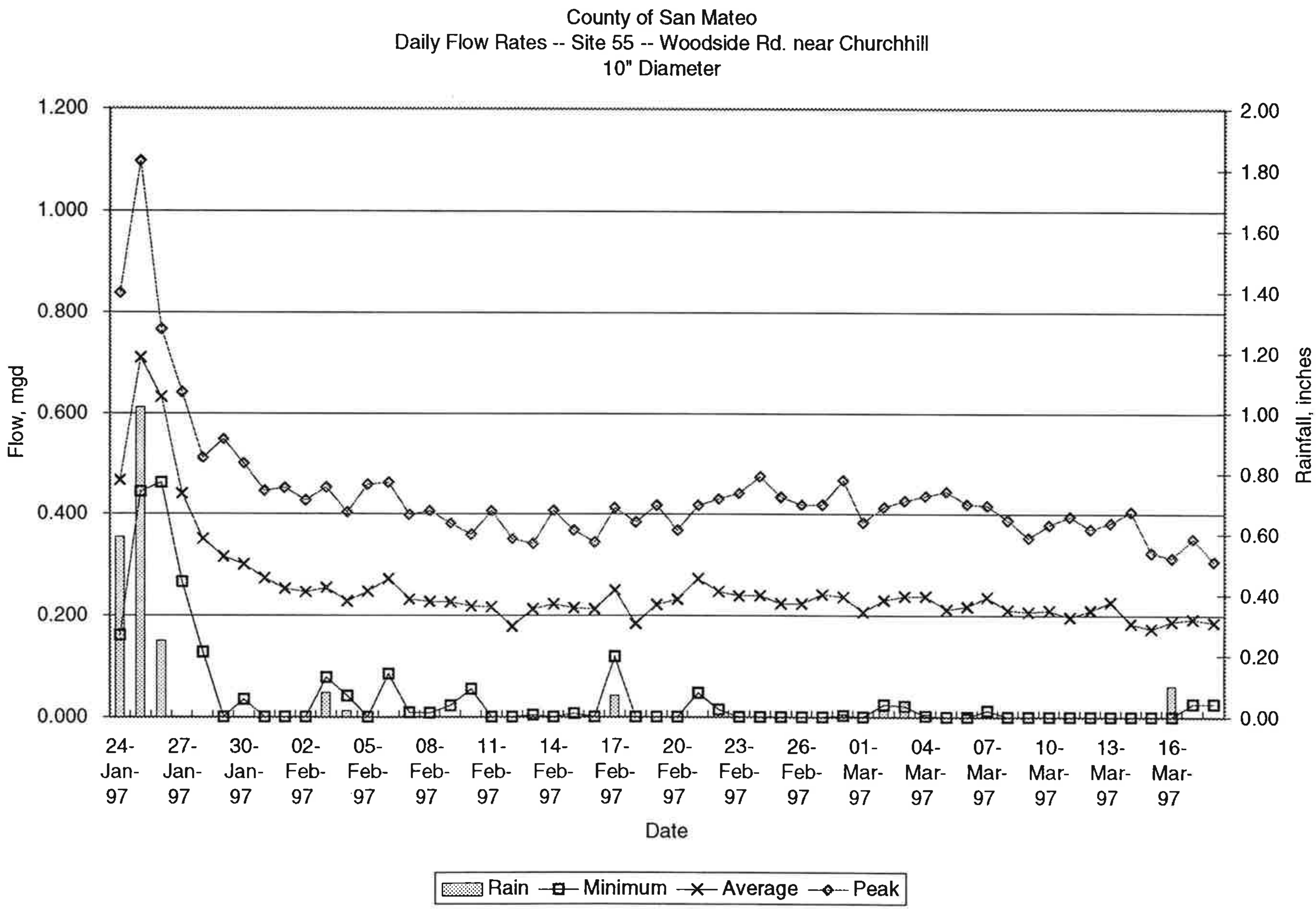


e:\4692\333\Current:333_53.xls

County of San Mateo
Daily Flow Rates -- Site 54 -- 343 Nimitz Ave.
15" Diameter



e:\4692\333\Current:333_54.xls



e:\4692\333\Current:333_55.xls

APPENDIX C

SMOKE TESTING TECHNICAL MEMORANDUM AND RESULTS

MEMORANDUM 14692-003

October 13, 1998

TO: MARK WELSH
COUNTY OF SAN MATEO, DPW

FROM: BRIAN HAMMER
BROWN AND CALDWELL

SUBJECT: WASTEWATER MASTER PLAN
SMOKE TESTING FIELD INSPECTION

This technical memorandum presents the results of the smoke testing program performed during the summer of 1998 as part of the Wastewater Master Plan. Smoke testing was performed in sections of the Burlingame Hills, Crystal Springs, Devonshire, Emerald Lake, and Fair Oaks Sewer Districts.

Smoke Testing

Smoke testing is a quick and effective method for identifying many types of wastewater collection system deficiencies. Typical defects encountered during a smoke testing program include the following:

1. Broken or deteriorated building laterals.
2. Improperly capped cleanouts.
3. Broken or deteriorated sewer mains.
4. Unsealed or damaged manholes.
5. Sags and/or obstructions in the mains.
6. Direct and indirect connections between storm and sanitary sewer systems.
7. Untrapped or improper building plumbing.
8. Illegal sewer connections.

Although smoke testing is an efficient method of identifying collection system inadequacies, certain conditions affect the interpretation and effectiveness of the test. One factor that affects smoke testing results is the extent and porosity of the cover over the sewer main or service lateral. For instance, pilot studies have indicated that only one-third or less of defective laterals are detected by smoke testing.

Another limitation is that smoke cannot emerge through highly impervious surfaces such as concrete or asphalt, unless they are cracked. Additionally, smoke will not travel through saturated soil. Therefore, this fieldwork is most effectively conducted only during dry weather, when the soil is at its driest condition.

Smoke Testing Field Procedures

The smoke testing program consisted of public notification and actual smoke testing. Public notification was accomplished by means of two separate public notices prior to smoke testing: one distributed approximately 1 week followed by another 24-48 hours in advance of testing, to individual residences and businesses. These notices, shown in Figure 1, explained the reason smoke testing was being performed and gave a brief description of the procedures to be used by the smoke testing crew. The notices also advised persons with respiratory ailments or similar problems to contact the County Department of Public Works office so field crews could provide these people with special attention during the smoke testing operation.

The smoke testing field program consisted of circulating a nontoxic and nonstaining "smoke" through the sewer system. A specialized blower was used to circulate smoke through the sewer system at a rate of approximately 1,500 cubic feet per minute. Smoke traveled through the connecting mainlines and service laterals until it came out of defects or roof vents. Each defect found was photographed using digital cameras to document the defect. The crew maintained field logs in which they recorded the address, relative location, and type of defect found. Information from the field logs was input to a specialized ACCESS database for documentation and analysis. Inspection forms were then printed directly from the program along with the digital image of the defect.

Smoke Testing Results

Smoke testing was performed during the dry months of August and September 1998 to prevent smoke from being trapped in high groundwater and saturated soils. Smoke testing was performed in all subbasins in the Districts of Burlingame Hills and Devonshire, with the exception of those areas where the crew did not have access, and in selected subbasins of the Crystal Springs, Emerald Lakes, and Fair Oaks Districts. Those selected subbasins were 21line1, 21line2, 22line2, and SP in the Crystal Springs District, 45 in the Emerald Lake District, and 54 in the Fair Oaks Sewer Maintenance District. These subbasins are shown in Figure 2. Some sewer lines in these areas could not be accessed. Approximately 140,000 lineal feet of sewer line was tested during the 3-week inspection period.

A total of 201 defects was located and documented by field crews during the smoke testing period. Table 1 provides a summary of the defects for each of the Districts. The most prevalent defect noted was faulty cleanouts. Cross-connections between the sanitary sewer and the storm drain system were not noted during the testing period. Summary tables of the smoke testing results are provided in Attachments A1 and A2. Smoke testing forms and photographs of the defects are provided in Attachment B.

Potential health concern defects exist where direct physical contact with sewage or sewer gas is possible through open pipes, uncapped cleanouts, or poor plumbing connections. Whenever a resident reported smoke inside a building, a crew member inspected the location of the smoke to determine the source of the smoke. The smoke sources commonly found inside a home or commercial building were dried out or defective sink/bathtub traps, faulty plumbing, untrapped connections to the sewer, and area or floor drains. Area and floor drains were documented where applicable. Residents were provided with practical information regarding what could be done about the other problems to protect against the possibility of sewer gas or sewage entering the residence or business.

Uncapped cleanouts at ground or below ground level are both a public health concern and potential inflow source. The majority of defects noted were uncapped cleanouts where either the cap was loose, broken or deteriorated, or missing from the cleanout. We recommend the county consider having these cleanouts capped tightly to prevent sewage form spilling out into public areas and to eliminate cleanouts as a source of inflow.

APPENDIX D

TELEVISION INSPECTION RESULTS

RUN No.	STREET OR PARCEL No.	UPSTREAM MANHOLE No.	DOWNSTREAM MANHOLE No.	DEPTH	LENGTH BETWEEN MANHOLES, ft	COMPLETE FOOTAGE TAPED, ft	PIPE SIZE, in	PIPE MATERIAL TYPE	DATE OF INSPECTION	VIDEO TAPE No.	MAINLINE SEWER DEFECTS: CRACK		JTS		LATERALS			ROOTS		I/I						ALIGN		STRUC.			M.S.		S.C.		T	TOTAL No. of DEFECTS TO REHABILITATE	Total Score	COMMENTS
											CP1	CP2	OJ1	OJ2	PT1	PT2	PT3	RJ	RT	I1	I2	I3	I4	I5	I6	A1	A2	S1	S2	S3	M1	M2	C1	C2				
62, 63	1827 Randall Rd	242	241	4.8	95	**42**	6	VCP	2/10/99	15-4																				1						1	238	No pipe top. Off set. Unable to get by.
61, 66	1867 Randall Rd	238	239		138	**65**	6	VCP	2/10/99	15-3				1		1		1																1	1	4	163	Pipe is gone. No TV
2	1139 Parrot Dr.	22	21	5	280	290	6	VCP	2/1/99	11-11							1	2	1									2		1					3	7	54	Poor grade of line.
31	1136 Parrot Drive	19A	19	10	45	**9**	6	VCP	2/9/99	13-8								3																		3	33	Unable to get by steep bend in line. Will try reverse setup.
56	1796 Lexington	475	474			246	6	VCP	2/10/99	14-18	5																		1						6	6	29	
49	2060 Timber Line	260	259	4.4	115	**8**	6	VCP	2/10/99	14-11				1																						1	25	Camera rolls over due to offset. Unable to get by.
3	1125 Parrot Dr.	21	20	5	218	240	6	VCP	2/2/99	11-12	1																		1						3	2	23	Poor grade of line.
20	1729 Los Altos Drive	166	165		80	**15**	6	VCP	2/3/99	12-14				1				1																		2	20	Offset unable to get by.
58	1840 Lexington	473	472			316	8	VCP	2/10/99	14-20	4	2																1							7	7	18	
12	11428 Rainbow Drive	48	47		130	156	6	VCP	2/3/99	12-7								3										1								4	18	Poor grade of line.
37	2018 Queens Lane	269	268	5.1	65	**13**	6	VCP	2/9/99	13-14				1																						1	15	End of line. Camera under water.. Camera will not get by. (roots/ off set joint?)
43	2069 Timber Line	263	262		208	225	8	VCP	2/9/99	14-5								3										1							4	4	14	MH#262 not as shown on map.
1	1103 Parrot Dr	23	22	5.4	275	289	6	VCP	2/1/99	11-10	3						2	3										1							4	9	14	Poor grade of line.
35	2035 Queens Lane	271	270		244	250	6	VCP	2/9/99	13-12	1							14	3																3	18	9	
4	1263 Parrot Dr.	27	26	5.3	130	141	6	VCP	2/2/99	11-13	2						1		1							2									3	6	9	Poor grade of line.
48	180 Kruston Crt	168	167	5	98	103	6	VCP	2/10/99	14-10								5																	2	5	7	
8, 10	1390 Rainbow Drive	51	50	12.6	300	303	6	VCP	2/2/99	12-5							1	14	1																5	16	7	Poor grade of line.
11	1424 Rainbow Drive	49	48	13	70	92	6	VCP	2/3/99	12-6								3																	3	3	7	
41	2072 Timber Line	265	264	6.6	252	263	8	VCP	2/9/99	14-3								12	1																4	13	6	
9	1418 Rainbow Drive	50	49	13	75	78	6	VCP	2/2/99	12-4								3	1																1	4	6	
36	2024 Queens Lane	270	269		139	174	6	VCP	2/9/99	13-13					1	1		5																	2	7	6	
28	2060 Queens Lane	272	271	4.1	432	451	6	VCP	2/4/99	13-5	1							14	1																10	16	6	
26	2096 Queens Line	274	273	5	176	184	6	VCP	2/4/99	13-3					1			6																	3	7	6	
39	2024 Timber Line	267	266	7.4	153	156	8	VCP	2/9/99	14-1								7																	2	7	6	
16	1417 Enchanted Way	112	109	6.8	80	103	6	VCP	2/3/99	12-11								5																		5	5	
64	1827 Randall Rd	241	240		104	**21**	6	VCP	2/10/99	15-6								1																		1	5	Rolls over and MH 240 is buried. Unable to TV.
17	1426 Belair Rd.	113	112		170	106	6	VCP	2/3/99	12-12								5																		5	5	
42	2079 Timber Line	264	263			87	8	VCP	2/9/99	14-4								2																	2	2	5	
38	2000 Timber Line	268	267	4	190	201	8	VCP	2/9/99	13-15								7	1																1	8	4	
23	1598 Ascension Drive	159	158	5.5	113	117	6	VCP	2/4/99	12-17								2																	3	2	4	
50	2060 Timber Line	259	258	4.4	167	**71**	6	VCP	2/10/99	14-12	1																									1	4	Bend in line unable to get by.
7	163 Starlight Dr.	82	51	6	320	333	6	VCP	2/2/99	12-2								6																	7	6	4	
6	113 Starlight Dr.	83	82	6	452	462	6	VCP	2/2/99	12-1								7	3																8	10	4	

RUN No.	STREET OR PARCEL No.	UPSTREAM MANHOLE No.	DOWNSTREAM MANHOLE No.	DEPTH	LENGTH BETWEEN MANHOLES, ft	COMPLETE FOOTAGE TAPED, ft	PIPE SIZE, in	PIPE MATERIAL TYPE	DATE OF INSPECTION	VIDEO TAPE No.	MAINLINE SEWER DEFECTS: CRACK		JTS		LATERALS			ROOTS		I/I						ALIGN		STRUC.			M.S.		S.C.		T	TOTAL No. of DEFECTS TO REHABILITATE	Total Score	COMMENTS
											CP1	CP2	OJ1	OJ2	PT1	PT2	PT3	RJ	RT	I1	I2	I3	I4	I5	I6	A1	A2	S1	S2	S3	M1	M2	C1	C2				
47	1299 Parrot Dr	28	29	4.3	106	54	6	VCP	2/10/99	14-9				1																						1	4	Camera rolls over due to offset. Unable to get by.
60	1876 Randall Rd	238	237		90	84	6	VCP	2/10/99	15-2								3																		3	4	Poor grade of line.
27	2089 Queens Lane	273	272	5	430	451	6	VCP	2/4/99	13-4					2			6																	6	8	4	
59	1876 Randall Rd	236	237	11.6	161	151	6	VCP	2/10/99	15-1							1		1																4	2	3	
25	1650 Ascension Drive	182	157	6.6	333	348	6	VCP	2/4/99	13-2								1																	10	1	3	
55	1896 Lexington	494	498			256	8	VCP	2/10/99	14-17																									8		3	
24	1610 Ascension Drive	158	157	5	323	339	6	VCP	2/4/99	13-1								1																	9	1	3	
21	1730 Los Altos Drive	164	163	6.6	362	380	6	VCP	2/4/99	12-15																1									10	1	3	
19	1729 Los Altos Drive	164	165	6..6	130	141	6	VCP	2/3/99	12-13	1							1																		2	3	Had problem which soap suds in line.
54	1888 Lexington	472	494	6.8		148	8	VCP	2/10/99	14-16	1																								1	1	3	
22	1709 Los Altos Drive	163	159	6	135	143	6	VCP	2/4/99	12-16																1									2	1	2	
44	Polhemus Rd	304	303	8.2		68	8	VCP	2/9/99	14-6																1										1	1	
45	Polhemus Rd	303	302		201	207	8	VCP	2/9/99	14-7	1																									1	1	
57	1824 Lexington	474	473			138	6	VCP	2/10/99	14-19																									2		1	
50, 51	2060 Timber Line	259	258		167	74	6	VCP	2/10/99	14-13								1																		1	1	Unable to get by. Roots heavy.
40	2036 Timber Line	266	265		79	83	8	VCP	2/9/99	14-2								1																		1	1	
5	1405 Enchanted Way	84	83	9	155	177	6	VCP	2/2/99	11-14																									1		1	
13	Ascension Drive	46	45	13	110	120	6	VCP	2/3/99	12-8																												No defects.
14	Ascension Drive	45	44	5		156	6	VCP	2/3/99	12-9																												No defects.
46	Polhemus Rd	302	261		136	143	8	VCP	2/9/99	14-8																												Heavy flow not able to see much.
TOTAL					8232	9271					21	2		5	4	2	6	148	14							5		6	2	2				1	140	218		

County of San Mateo - Wastewater Master Plan
Mainline Sewer Internal Inspection
District: Crystal Springs

RUN No.	STREET OR PARCEL No.	UPSTREAM MANHOLE No.	DOWNSTREAM MANHOLE No.	DEPTH	LENGTH BETWEEN MANHOLES, ft	COMPLETE FOOTAGE TAPED, ft	PIPE SIZE, in	PIPE MATERIAL TYPE	DATE OF INSPECTION	VIDEO TAPE No.	MAINLINE SEWER DEFECTS: CRACK		JTS		LATERALS			ROOTS		I/I						ALIGN		STRUC.			M.S.		S.C.		T	TOTAL No. of DEFECTS TO REHABILITATE	Total Score	COMMENTS
											CP1	CP2	OJ1	OJ2	PT1	PT2	PT3	RJ	RT	I1	I2	I3	I4	I5	I6	A1	A2	S1	S2	S3	M1	M2	C1	C2				
15	1426 Belair Rd.	114	113	11			6	VCP	2/3/99	12-10																												Unable to get camera in line. Will try reverse setup. Both MHs have bands.
18	1644 Parrot Drive	173	172				6	VCP	2/3/99	12-13																												Unable to get camera in line. Both MHs have bands.
29	1136 Parrot Drive	20	19A	11	45	8	6	VCP	2/9/99	13-6																												Drop in line. Unable to get by due to by pass.
30	1136 Parrot Drive	20	19		45	8	6	VCP	2/9/99	13-7																												Unable to get up grade - too steep by pass.
33	1136 Parrot Drive	18	19		83	5	6	VCP	2/9/99	13-10																												Camera will not go in a MH 19 had to start MH 18. Unable to get by due to by pass.
32	1136 Parrot Drive	19A	19		45	8	6	VCP	2/9/99	13-9																			1							1		Broken pipe. Unable to get by due to by pass. Poor grade of line.
31	1136 Parrot Drive	19A	19	10	45	9	6	VCP	2/9/99	13-8								3																		3		Unable to get by steep bend in line due to by pass. Will try reverse setup.
34	Parrot Drive	18	17		140	46	6	VCP	2/9/99	13-11								3																		3	7	End of line. Unable to get trough due to by pass. MH 17 has too much water unable to go.
52, 53	2060 Timber Line	258	257		65		6	VCP	2/10/99	14-14								2																	1	2		Unable to get by. Bent in line at both MHs.
65	1856 Randall Rd	239	240		208		6	VCP	2/10/99	15-7								1											1							2		Unable to get by due to cracked pipe with roots.
TOTAL					676	84												9											2						1	11		

APPENDIX E

HYDRAULIC MODELING TECHNICAL MEMORANDUM

MEMORANDUM 14692-006

December 22, 1998

TO: MARK WELSH
COUNTY OF SAN MATEO, DPW

FROM: CHARLIE JOYCE
BROWN AND CALDWELL

SUBJECT: WASTEWATER MASTER PLAN
FLOW PROJECTIONS AND HYDRAULIC MODELING

This technical memorandum presents the results of the hydraulic modeling performed to determine the amount of available capacity in the County of San Mateo (County) trunk sewers. Modeling was performed on the major trunk sewers in Burlingame Hills (BH), Crystal Springs (CS), Devonshire (DS), Emerald Lake (EL), and Fair Oaks (FO), Oak Knoll (OK) and Scenic Heights (SH) sewer districts.

Design Flow Projections

Wastewater flows were divided into base sanitary flow (BSF) and wet weather infiltration/inflow (I/I) components for this study. Base sanitary flow factors are based on dry weather flow monitoring performed during the winter of 1997. Due to limited rainfall during the winter of 1997, additional wet weather flow monitoring was performed during the following season. El Nino effects resulted in extensive rainfall during the January and February of 1998. Wet weather flow projections are based on flow monitoring results from second flow monitoring program.

BSF. BSF is wastewater contributed by residential, commercial, industrial, and public users. Base flow is directly related to land use and varies throughout the day and between weekdays and weekends. BSF from residential areas has a typical diurnal pattern with peak flows occurring in the morning after 7:00 a.m. and a second smaller peak occurring in the evening.

BSF flow contributions to the hydraulic model are based on the flow monitoring data collected during dry weather periods. Actual dry weather hydrographs were extracted from the flow monitoring data and used in the model. Dry weather periods were used to minimize the amount of groundwater infiltration included in the calculation. Groundwater infiltration occurs when groundwater levels are above the sewer pipes and the pipes have defects that allow infiltration. Some groundwater infiltration is undoubtedly included in the BSF rates, however, extensive review of accurate water use date in each District would be needed to determine the amount of groundwater infiltration in each area.

Dry weather flow projections were prepared for current land use conditions only. Land use planners for the County and affected City agencies indicated that growth or significant in-filling was not expected in the future.

Flow monitoring was not performed in the OK and SH Districts. BSF calculations for these Districts are based on the number of parcels in the District and a per parcel water use rate of 220 gallons per day. A conservative sanitary peaking factor of 3.5 was used to determine the peak dry weather flow.

Wet Weather I/I Flow

I/I consists of direct inflow of storm water runoff and rainfall-induced infiltration of storm water percolating into the collection system. Inflow occurs when storm water enters the collection system through illegally connected catch basins, area drains, or home roof gutter downspouts, or through manhole covers of cleanout lids. Inflow can become severe if surface flooding occurs and manholes and cleanouts are submerged or used to drain low-lying areas.

I/I accounts for the large increase in peak flows that occur during rainfall events. In areas with older sewers, I/I is typically the largest component of the total wastewater flow. I/I was evaluated by calculating the "R" factor for each of the monitored basins for each storm. An "R" factor is the percentage of rainfall that enters the collection system as I/I. The composite minimum and maximum "R" factor for each District is listed in Table 1.

Table 1, R Factors

District	Minimum R factor	Maximum R factor
Burlingame Hills	0.026	0.113
Crystal Springs	0.027	0.102
Devonshire	0.018	0.040
Emerald Lake	0.024	0.105
Fair Oaks	0.012	0.111

To determine the effects of I/I on the capacity of the wastewater conveyance system a wet weather design storm was developed. The January 18, 1998 rainfall event was very similar to a 5-year design storm in terms of intensity, duration, and volume. Therefore, this storm was selected as the design event. Minor adjustments were made to the rainfall hydrograph to account for differences in the volume between the actual storm and the 5-year design rainfall.

To develop wet weather hydrographs for use in the model, unit hydrographs were developed for each basin. Unit hydrographs are based on the "R" factor and the individual runoff characteristics for each basin. Synthetic hydrographs were added to the base flow hydrographs and the total hydrograph was input to the model.

Due to the lack of flow monitoring data for the OK and SH areas, a conservative I/I rate of 2,400 gallons per acre per day was used. This rate is used by the Central Contra Costa Sanitary District and is the most conservative rate in use in the Bay Area.

Capacity Analysis

Major trunk sewers in each of the sewer Districts were modeled to determine if any capacity deficiencies exist. The HYDRA model developed by PIZER, Inc. was used to simulate wastewater flows in the each of the Districts collection systems. HYDRA routes flow hydrographs through the collection system and accounts for the time delays of peak flow from various tributary areas as the flows move downstream. A standard Manning's friction coeffcient of 0.0135 was used for the analysis.

Modeled flow is compared to the theoretical capacity of each pipe segment. The capacity of each pipeline is a function of the pipeline slope and diameter. Surveying was required in various areas to verify the pipeline slope. If capacity deficiencies were detected, the program was used to size the appropriate relief and/or replacement sewer size.

Hydraulic models of the Harbor Industrial and Kensington Square districts were not prepared due to their small size. Both districts are much less than 50 acres in size. An 8-inch diameter sewer with a slope of 0.1 percent has enough capacity to serve a tributary area greater than 50 acres in size using conservative flow factors for BSF and I/I. Therefore, it was assumed that trunk sewers in the Harbor Industrial and Kensington Square districts have adequate capacity.

Hydrographs produced by the model were compared to the actual wet weather hydrographs from the flow monitoring to verify model calibration. An example of a model calibration hydrograph for the Burlingame Hills District is shown in Figure 1.

The modeled sewers for each District and the results of the modeling are shown on Figure 2 through Figure 8. Relief sewer sizes for each District are summarized in Tables 2 through Table 5. Hydraulic capacity deficiencies were not found in the DS, OK or SH Districts. Complete model results are given in Attachment A.

Table 2, Hydraulic Modeling Results, Burlingame Hills

Upstream Manhole	Downstream Manhole	Existing Diameter, inches	Length, ft	Recommended Relief Sewer Sizes, inches
B004603	B000204	6-8	2,610	8
B000204	B000104	8	216	12
Total			2,826	

Table 3, Hydraulic Modeling Results, Crystal Springs

Upstream Manhole	Downstream Manhole	Existing Diameter, inches	Length, ft	Recommended Relief Sewer Sizes, inches
C019105	C014405	10	1,714	8
C014405	C000301	10	3,280	12
Total			4,994	

Table 4, Hydraulic Modeling Results, Emerald Lake

Upstream Manhole	Downstream Manhole	Existing Diameter, inches	Length, ft	Recommended Relief Sewer Sizes, inches
E115601	E115201	6	455	8
E102322	E101634	8	1,163	8
E101634	E101134	8	342	12
Total			1,960	

Table 5, Hydraulic Modeling Results, Fair Oaks

Upstream Manhole	Downstream Manhole	Existing Diameter, inches	Length, ft	Recommended Relief Sewer Sizes, inches
F198636	F198227	10	1,170	8
F197727	F193228	10	1,327	10
F193228	F191828	8-10	1,743	15
F190528	F183828	15	1,253	15
F183828	F170419	18	2,911	30
F170419	F169919	15-18	870	27
F169919	F168014	15	1,642	15
F157414	F156914	10	1,049	10
F156914	F156714	10	176	15
F120311	F117211	8-10	921	18
F117211	F116211	10-12	1,883	12
F116211	F115610	12-18	1,489	24
F156614	F145009	15-21	2,979	24
F143709	F115510	10-21	3,251	15
F115510	F114904	30	2,857	45
TOTAL			25,521	

C:\HYDRA\SANMATEO\CPIPES.CMD 16:06 2-Oct-98

MGD

CRYSTAL SPRINGS SEWER DISTRICT 5-year 6-hour Storm

*** POLHEMUS MAIN Analysis of Existing Pipes

Link	Long	Slope	Invert	San	Sto	Qdes	Qmax	GrUp	GrDn	SrCh/Dlt
		Diam	Up/Dn	Inf	Mis	Vel	%Cap	HGLUp	HGLDn	Parallel
						d/D	QRem	DiffUp	DiffDn	Replace
1	609	0.0193	355.08	0.1	0.1	0.19	0.94	377.38	352.21	
		8	343.36	0.0	0.0	2.99	20.20	355.29	343.57	
C030509						0.32		22.09	8.64	
2	64	0.0231	343.36	0.1	0.1	0.19	1.03	352.21	351.29	
		8	341.89	0.0	0.0	3.19	18.43	343.56	342.09	
C030409						0.30		8.65	9.20	
3	201	0.0213	341.89	0.3	0.7	0.92	0.99	351.29	345.60	
		8	337.60	0.0	0.0	5.01	93.29	342.40	338.11	
C030309						0.76		8.89	7.49	
4	136	0.0199	337.60	0.3	0.7	0.92	0.95	345.60	342.10	
		8	334.90	0.0	0.0	4.88	96.71	338.12	335.42	
C030209						0.78		7.48	6.68	
5	269	0.0238	335.10	0.4	0.7	1.01	3.09	342.00	334.00	
		12	328.69	0.0	0.0	5.07	32.67	335.51	329.10	
C026109						0.41		6.49	4.90	
6	308	0.0233	328.69	0.4	0.7	1.01	3.05	335.00	326.00	
		12	321.50	0.0	0.0	5.03	33.02	329.11	321.92	
C0256A09						0.42		5.89	4.08	
7	135	0.0281	321.50	0.4	0.7	1.01	3.35	326.00	322.00	***
		12	317.70	0.0	0.0	1.99	30.07	322.26	320.87	
C0255A09						0.40		3.74	1.13	
8	60	0.0087	317.50	0.4	0.7	1.01	1.86	322.00	321.00	***
		12	316.98	0.0	0.0	1.99	54.19	320.87	320.73	
C0253B07						0.54		1.13	0.27	
9	100	0.0256	315.40	0.4	0.7	1.01	3.20	321.00	318.00	***/***
		12	312.84	0.0	0.0	1.99	31.53	320.73	320.51	
C0253A07						0.41		0.27	-2.51	
10	233	0.0266	312.84	0.4	0.7	1.01	3.26	318.00	312.00	***/***
		12	306.65	0.0	0.0	1.99	30.95	320.51	320.03	
C025307						0.40		-2.51	-8.03	
11	104	0.0194	306.65	0.4	0.7	1.01	2.79	312.00	309.00	***/***
		12	304.63	0.0	0.0	1.99	36.20	320.03	319.80	
C021007						0.44		-8.03	-10.80	
12	268	0.0154	304.63	0.4	0.7	1.01	2.48	309.00	306.00	***/***
		12	300.50	0.0	0.0	1.99	40.64	319.80	319.26	
C020907						0.46		-10.80	-13.26	

C:\HYDRA\SANMATEO\CPIPES.CMD 16:06 2-Oct-98
MGD

CRYSTAL SPRINGS SEWER DISTRICT 5-year 6-hour Storm

*** POLHEMUS MAIN — Analysis of Existing Pipes

Link	Long	Slope Diam	Invert Up/Dn	San Inf	Sto Mis	Qdes Vel d/D	Qmax %Cap QRem	GrUp HGLUp DiffUp	GrDn HGLDn DiffDn	SrCh/Dlt Parallel Replace
13	180	0.0055	300.50	0.4	0.7	1.01	1.48	306.00	305.00	***/***
		12	299.51	0.0	0.0	1.99	68.02	319.26	318.89	
C0209A07						0.62		-13.26	-13.89	
14	144	0.0054	299.51	0.4	0.7	1.01	1.47	305.00	304.00	***/***
		12	298.73	0.0	0.0	1.99	68.54	318.89	318.58	
C0209B07						0.63		-13.89	-14.58	
15	318	0.0054	298.73	0.4	0.7	1.01	1.47	304.50	301.00	***/***
		12	297.00	0.0	0.0	1.99	68.39	318.58	317.94	
C0208A07						0.62		-14.08	-16.94	
16	296	0.0044	293.40	0.7	0.7	1.21	2.40	301.70	298.35	***/***
		15	292.10	0.0	0.0	1.52	50.19	317.94	317.70	
C0194A07						0.52		-16.24	-19.35	
17	285	0.0551	292.10	0.7	0.7	1.20	2.88	298.35	286.70	***/***
		10	276.40	0.0	0.0	3.42	41.76	317.70	315.42	
C019307						0.47		-19.35	-28.72	
18	294	0.0386	276.40	0.7	0.7	1.20	2.41	286.70	274.30	***/***
		10	265.05	0.0	0.0	3.42	49.89	315.42	313.21	
C019207						0.52		-28.72	-38.91	
19	459	0.0067	265.05	0.7	0.7	1.20	1.00	274.30	266.59	***/***
		10	261.99	0.0	0.0	3.42	120.07	313.21	309.81	6
C019105						1.00	0.20	-38.91	-43.22	12
20	387	0.0377	261.99	0.7	0.7	1.22	2.39	266.59	258.26	***/***
		10	247.40	0.0	0.0	3.45	50.90	309.81	306.88	
C014805						0.53		-43.22	-48.62	
21	159	0.0202	247.40	0.8	1.3	1.93	1.75	258.26	252.65	***/***
		10	244.18	0.0	0.0	5.47	110.40	306.88	303.42	6
C014705						0.87	0.18	-48.62	-50.77	12
22	341	0.0108	244.18	0.8	1.3	1.93	1.28	252.65	250.28	***/***
		10	240.48	0.0	0.0	5.47	150.67	303.42	296.90	8
C014605						1.00	0.65	-50.77	-46.62	12
23	368	0.0265	240.48	0.8	1.3	1.93	2.00	250.28	241.73	***/***
		10	230.73	0.0	0.0	5.47	96.40	296.90	289.87	
C014505						0.78		-46.62	-48.14	
24	535	0.0074	230.73	0.8	1.3	1.93	1.06	241.73	235.76	***/***
		10	226.76	0.0	0.0	5.47	182.18	289.87	279.76	10
C014405						1.00	0.87	-48.14	-44.00	15

C:\HYDRA\SANMATEO\CPIPES.CMD 16:06 2-Oct-98

MGD

CRYSTAL SPRINGS SEWER DISTRICT 5-year 6-hour Storm

*** POLHEMUS MAIN

Analysis of Existing Pipes

Link	Long	Slope Diam	Invert Up/Dn	San Inf	Sto Mis	Qdes Vel d/D	Qmax %Cap QRem	GrUp HGLUp DiffUp	GrDn HGLDn DiffDn	SrCh/Dlt Parallel Replace
25	288	0.0061	226.76	0.8	1.3	1.93	0.96	235.76	231.77	***/***
		10	225.02	0.0	0.0	5.47	201.69	279.76	274.22	12
C014303						1.00	0.97	-44.00	-42.45	15
26	271	0.0170	225.02	1.1	2.2	3.02	1.60	231.77	227.41	***/***
		10	220.41	0.0	0.0	8.57	188.60	274.22	260.68	10
C004403						1.00	1.42	-42.45	-33.27	15
27	321	0.0672	220.41	1.1	2.2	3.02	3.19	227.41	220.27	***/***
		10	198.82	0.0	0.0	8.57	94.87	260.68	245.54	
C004303						0.77		-33.27	-25.27	
28	130	0.0200	198.82	1.1	2.2	3.02	1.74	220.27	207.22	***/***
		10	196.22	0.0	0.0	8.57	173.89	245.54	239.08	10
C004203						1.00	1.28	-25.27	-31.86	15
29	320	0.0200	196.22	1.4	2.5	3.60	1.74	207.22	194.17	***/***
		10	189.82	0.0	0.0	10.20	206.95	239.08	217.25	12
C004103						1.00	1.86	-31.86	-23.08	15
30	249	0.0554	189.82	1.4	2.5	3.60	2.89	194.17	180.61	***/***
		10	176.01	0.0	0.0	10.20	124.31	217.25	200.44	6
C004003						1.00	0.70	-23.08	-19.83	12
31	195	0.0599	176.01	1.4	2.5	3.60	3.01	180.61	172.95	***/***
		10	164.35	0.0	0.0	10.20	119.52	200.44	187.14	6
C003903						1.00	0.59	-19.83	-14.19	12
32	269	0.0553	164.35	1.4	2.5	3.60	2.89	172.95	154.63	***/***
		10	149.48	0.0	0.0	10.20	124.47	187.14	169.07	6
C003803						1.00	0.71	-14.19	-14.44	12
33	163	0.0480	149.48	1.4	2.5	3.60	2.69	154.63	148.15	***/***
		10	141.66	0.0	0.0	10.20	133.61	169.07	157.79	8
C003701						1.00	0.90	-14.44	-9.64	12
34	37	0.0478	141.66	1.4	2.5	3.60	2.69	148.15	146.22	***/***
		10	139.90	0.0	0.0	10.20	133.82	157.79	154.62	8
C003601						1.00	0.91	-9.64	-8.40	12
35	10	0.0480	139.90	1.4	2.5	3.60	2.69	146.22	145.89	***/***
		10	139.42	0.0	0.0	10.20	133.57	154.62	153.17	8
C003501						1.00	0.90	-8.40	-7.28	12
36	334	0.0478	139.42	1.4	2.5	3.60	2.69	145.89	130.56	***/***
		10	123.46	0.0	0.0	10.20	133.92	153.17	130.91	8
C003401						1.00	0.91	-7.28	-0.35	12

C:\HYDRA\SANMATEO\CPIPES.CMD 16:06 2-Oct-98
MGD

CRYSTAL SPRINGS SEWER DISTRICT 5-year 6-hour Storm

*** POLHEMUS MAIN

Analysis of Existing Pipes

Link	Long	Slope Diam	Invert Up/Dn	San Inf	Sto Mis	Qdes Vel d/D	Qmax %Cap QRem	GrUp HGLUp DiffUp	GrDn HGLDn DiffDn	SrCh/Dlt Parallel Replace
37	158	0.0277	123.46	1.4	2.5	3.60	2.05	130.56	126.24	***/***
		10	119.09	0.0	0.0	10.22	176.14	130.91	119.92	10
C003301						1.00	1.56	-0.35	6.32	15

Lateral length= 8997 Upstream length= 8997

APPENDIX F

CAPITAL IMPROVEMENT PROJECTS

District: Crystal Springs Priority: 1

Project: Polhemus Road (North)

Project Purpose: Hydraulics

Project Location: Northern section of Polhemus Road
MH 1-3, MH 3-44, MH 44-148, MH 148-193

Existing Conditions:

Pipeline: 36 feet of 8-inch diameter
5528 feet of 10-inch diameter
315 feet of 15-inch diameter
70 feet of 16-inch diameter

Television Inspection: Not inspected

Operation & Maintenance 3 callouts/year: Y / [N]

Manhole Inspection: Roots / Pipe / Grease

Hydraulics: Yes, needs 12-inch and 15-inch diameter replacement sewers

Alternative 1: Replace with 12-inch diameter sewer (1714 feet)
Replace with 15-inch diameter sewer (3280 feet)

Alternative 1 Cost: $582,100

Alternative 2: n/a

Alternative 2 Cost:

Alternative 3: n/a

Alternative 3 Cost:

Project Concerns: Increases capacity/flow may affect sewer downstream of Crystal Springs District in Town of Hillsborough. Need to coordinate.

Recommended Alternative: Replace existing line with 15-inch and 12- inch diameter sewers.

District: Crystal Springs Priority: 2

Project: Randall Road

Project Purpose: Operations & Maintenance

Project Location: Randall Road
MH 236-242

Existing Conditions:
- Pipeline: 796 feet of 6-inch diameter
- Television Inspection: 2 serious structure problems
- Operation & Maintenance 3 callouts/year: [Y] / N
- Manhole Inspection: [Roots] / Pipe / Grease
- Hydraulics: No

Alternative 1: Increase Operations & Maintenance (rc)
Spot repair (2)

Alternative 1 Cost: $61,300

Alternative 2: Pipe bursting
Spot repair (2)

Alternative 2 Cost: $73,200

Alternative 3: Remove and Replace

Alternative 3 Cost: $67,700

Project Concerns: Located in easement.

Recommended Alternative:

District: Crystal Springs Priority: 2
Project: Timberlane Way

Project Purpose: Operations & Maintanance

Project Location: Timberlane Way
MH 274-265, MH 265-263, MH 263-261, MH 261-303

Existing Conditions:
Pipeline: 1506 feet of 6-inch diameter
1305 feet of 8-inch diameter
Television Inspection: 3 minor structural problems (cracks)
1 severe offset
roots
Operation & Maintenance 3 callouts/year: [Y] / N
Manhole Inspection: [Roots] / Pipe / Grease
Hydraulics: No

Alternative 1: Increase Operations & Maintenance (rc)
Spot Repair (1)

Alternative 1 Cost: $211,700

Alternative 2: Pipe Bursting for 6-inch diameter
Sliplining for 8-inch diameter
Spot Repair (1)

Alternative 2 Cost: $208,115

Alternative 3: Remove and Replace

Alternative 3 Cost: $238,935

Project Concerns:

Recommended Alternative:

District: Crystal Springs Priority: 3

Project: North Parrott Drive

Project Purpose: Structural

Project Location: Northern section of Parrott Drive
MH 23-20, MH 20-15, MH 15-29

Existing Conditions:

Pipeline: 2118 feet of 6-inch diameter
Television Inspection: cracks, breaks, and roots
Operation & Maintenance 3 callouts/year: Y / [N]
Manhole Inspection: [Roots] / Pipe / Grease
Hydraulics: No
Includes temporary bypass. Does the District have any plans for this area.

Alternative 1: Remove and Replace

Alternative 1 Cost: $180,000

Alternative 2: None

Alternative 2 Cost:

Alternative 3: None

Alternative 3 Cost:

Project Concerns: Located in slide area.

Recommended Alternative:

District: Crystal Springs

Priority: 3

Project: Lexington Avenue

Project Purpose: Structural

Project Location: Lexington Avenue
MH 491-480, MH 480-475, MH 475-494, MH 494-498

Existing Conditions:
Pipeline: 980 feet of 6-inch diameter
690 of 8-inch diameter
Television Inspection: 7 minor structural problems
1 hole in pipe
Operation & Maintenance 3 callouts/year: Y / [N]
Manhole Inspection: [Roots] / [Pipe] / [Grease]
Hydraulics: No

Alternative 1: Increase Operations & Maintenance (rc)
Spot Repair (1)

Alternative 1 Cost: $126,000

Alternative 2: Pipe Bursting for 6-inch diameter
Sliplining for 8-inch diameter
Spot Repair (1)

Alternative 2 Cost: $127,000

Alternative 3: Do Nothing – Reinspect in 10 years

Alternative 3 Cost: $2,500

Project Concerns:

Recommended Alternative:

District: Crystal Springs Priority: 3

Project: Enchanted Way

Project Purpose: Structural

Project Location: Enchanted Way
MH 114-109

Existing Conditions:
Pipeline: 390 feet of 6-inch diameter
Television Inspection:
Operation & Maintenance 3 callouts/year: Y / N
Manhole Inspection: Roots / Pipe / Grease
Hydraulics: No

Alternative 1: Increase Operations & Maintenance (rc)
Spot Repair (1)

Alternative 1 Cost: $30,100

Alternative 2: Pipe Bursting
Spot Repair (1)

Alternative 2 Cost: $35,900

Alternative 3: Remove and Replace

Alternative 3 Cost: $33,200

Project Concerns: Located in easement.

Recommended Alternative:

District: Crystal Springs | Priority: 3

Project: Rainbow Drive

Project Purpose: Structural

Project Location: Rainbow Drive, Lakeshore Drive, Starlite Drive
MH 56-52, MH 81-52, MH 51-52, MH 87-51, MH 85-84, MH 51-44

Existing Conditions:
Pipeline: 3609 feet of 6-inch diameter
Television Inspection: roots and 1 hole in pipe (MH 48-47)
Operation & Maintenance 3 callouts/year: Y / [N]
Manhole Inspection: [Roots] / Pipe / Grease
Hydraulics: No

Alternative 1: Increase Operations & Maintenance (rc)
Spot Repair (1)

Alternative 1 Cost: $271,400

Alternative 2: Pipe Bursting
Spot Repair (1)

Alternative 2 Cost: $325,600

Alternative 3: Remove and Replace

Alternative 3 Cost: $306,800

Project Concerns: Located in easement.

Recommended Alternative:

District: Crystal Springs Priority: 3

Project: South Ascension Drive

Project Purpose: Structural

Project Location: Southern section of Ascension Drive
MH 170-166, MH 173-166, MH 166-164, MH 164-159, MH 159-185

Existing Conditions:
Pipeline: 3099 feet of 6-inch diameter
Television Inspection: 1 minor structural problem
1 severe offset joint
2 sags
roots
Operation & Maintenance 3 callouts/year: [Y] / N
Manhole Inspection: [Roots] / Pipe / Grease
Hydraulics: No

Alternative 1: Increase Operations & Maintenance (rc)
Spot Repair (1)

Alternative 1 Cost: $233,200

Alternative 2: Pipe Bursting
Spot Repair (1)

Alternative 2 Cost: $279,700

Alternative 3: Remove and Replace

Alternative 3 Cost: $278,900

Project Concerns:

Recommended Alternative:

District: Crystal Springs

Priority: 3

Project: Polhemus Road (South)

Project Purpose: Structural

Project Location: Southern section of Polhemus Road
MH 194A-209A, MH 194A-208, MH 209A-253, MH 253-261,
MH 256A-260

Existing Conditions:

Pipeline: 397 feet of 6-inch diameter
439 feet of 10-inch diameter
2219 feet of 12-inch diameter

Television Inspection: Not inspected

Operation & Maintenance 3 callouts/year: Y / N

Manhole Inspection: Roots / Pipe / Grease

Hydraulics: No

Alternative 1: Reinspect at later date.

Alternative 1 Cost: $4,000

Alternative 2:

Alternative 2 Cost:

Alternative 3:

Alternative 3 Cost:

Project Concerns:

Recommended Alternative:

APPENDIX G

SANITARY SEWER RATE MODELS

Inflator 3%

Crystal Springs Alternative 1 CIP Summary

Project	Priority	Alternative 1	Alt 1 Description
Polhemus Road (North)	1	$ 582,100	Replace sewers
Randall Road	2	$ 61,300	Increase O & M, 2 Spot Repair
Timberlane Way	2	$ 211,700	Increase O & M
North Parrot Drive	3	$ 180,000	Replace sewers
Lexington Avenue	3	$ 126,000	Increase O & M, 1 Spot Repair
Enchanted Way	3	$ 30,100	Increase O & M, 1 Spot Repair
Rainbow Drive	3	$ 271,400	Increase O & M, 1 Spot Repair
South Ascension Drive	3	$ 233,200	Increase O & M, 1 Spot Repair
Polhemus Road (South)*	3	$ 4,000	Reinspect at a later date
Total		$ 1,699,800	

Note:
*TV Inspection was not performed

Crystal Springs Alternative 1 Revenue Requirements

Item	1994/95	1995/96	1996/97	1997/98	Projected 1998/99 Budget	Projected 1999/00	2000/01	2001/02	2002/03	2003/04
Expenses										
Admin/Eng	$ 46,760	$ 26,385	$ 27,765	$ 115,365	$ 118,826	$ 122,391	$ 126,063	$ 129,845	$ 133,740	$ 137,752
Capital Projects*	$ -	$ -	$ 250,026	$ -	$ -	$ 339,960	$ 350,159	$ 360,664	$ 371,483	$ 382,628
Debt Service	$ 116,157	$ 116,157	$ 131,162	$ 131,970	$ 131,970	$ 131,970	$ 131,970	$ 131,970	$ 131,970	$ 131,970
O&M	$ 128,828	$ 117,529	$ 129,127	$ 268,077	$ 276,119	$ 284,402	$ 292,934	$ 301,723	$ 310,774	$ 320,097
Other	$ -	$ -	$ 48,060	$ 600	$ 618	$ 636	$ 655	$ 675	$ 695	$ 716
Sewage Treatment	$ 216,115	$ 180,342	$ 122,471	$ 162,276	$ 167,145	$ 172,159	$ 177,324	$ 182,643	$ 188,123	$ 193,766
Source Control	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Gross Expenses	$ 507,860	$ 440,413	$ 708,611	$ 678,288	$ 694,678	$ 1,051,519	$ 1,079,105	$1,107,519	$ 1,136,786	$ 1,166,930
Offsetting Revenue										
Secure Property Taxes**	$ 17,403	$ 18,119	$ 18,733	$ 19,762	$ 20,000	$ 20,600	$ 21,218	$ 21,855	$ 22,510	$ 23,185
Unsecured Property Taxes	$ 2,367	$ 2,395	$ 2,367	$ 2,338	$ 2,500	$ 2,500	$ 2,500	$ 2,500	$ 2,500	$ 2,500
Interest Earned***	$ 44,094	$ 70,318	$ 82,425	$ 73,546	63,362	63,362	63,362	63,362	63,362	63,362
HOPTR	$ 359	$ 352	$ 358	$ 357	$ 500	$ 500	$ 500	$ 500	$ 500	$ 500
Annexation Charges	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Connection Charges	$ 696	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Miscellaneous Revenue	$ 30,174	$ 292	$ 388	$ 2,024	$ 500	$ 500	$ 500	$ 500	$ 500	$ 500
Total Offsetting Revenue	$ 95,093	$ 91,476	$ 104,271	$ 98,027	$ 86,862	$ 87,462	$ 88,080	$ 88,717	$ 89,373	$ 90,048
Use of Fund Balance	$ -	$ -	$ (89,420)	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Net Revenue Requirements	$ 412,767	$ 348,937	$ 514,920	$ 580,261	$ 607,815	$ 964,056	$ 991,025	$1,018,802	$ 1,047,413	$ 1,076,882
Annual Rate Assuming 1,499 Connections****					405	643	661	680	699	718

Note:
*Projected CIP is paid for over 5 years.
**Secure Property Tax revenue is assumed to increase at 3% per year
***Interest Earned in projected years is calculated as 5% of Beginning Fund Balance
****Current Rate is $352

Crystal Springs Alternative 1 Fund Balance

Item	1994/95	1995/96	1996/97	1997/98	Projected 1998/99 Budget	Projected 1999/00	2000/01	2001/02	2002/03	2003/04
Beginning Fund Balance	$ 1,096,129	$ 1,193,956	$ 1,356,668	$ 1,267,248	$ 1,267,248	$ 1,267,248	$ 1,267,248	$1,267,248	$ 1,267,248	$ 1,267,248
Additions to/(Use of) Balance	$ 97,827	$ 162,712	$ (89,420)	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Ending Fund Balance	$ 1,193,956	$ 1,356,668	$ 1,267,248	$ 1,267,248	$ 1,267,248	$ 1,267,248	$ 1,267,248	$1,267,248	$ 1,267,248	$ 1,267,248

Crystal Springs Alternative 2 CIP Summary

Project	Priority	Alternative 2	Alt 2 Description
Polhemus Road (North)	1	$ -	
Randall Road	2	$ 73,200	Pipe Bursting, 2 Spot Repair
Timberlane Way	2	$ 208,115	Pipe Bursting, Sliplining, 1 Spot Repair
North Parrot Drive	3	$ -	
Lexington Avenue	3	$ 127,000	Pipe Bursting, Sliplining, 1 Spot Repair
Enchanted Way	3	$ 35,900	Pipe Bursting, 1 Spot Repair
Rainbow Drive	3	$ 325,600	Pipe Bursting, 1 Spot Repair
South Ascension Drive	3	$ 279,700	
Polhemus Road (South)*	3		
Total		$ 1,049,515	

Note:
*TV Inspection was not performed.

Crystal Springs Alternative 2 Revenue Requirements

Item	1994/95	1995/96	1996/97	1997/98	Projected 1998/99 Budget	Projected 1999/00	2000/01	2001/02	2002/03	2003/04
Expenses										
Admin/Eng	$ 46,760	$ 26,385	$ 27,765	$ 115,365	$ 118,826	$ 122,391	$ 126,063	$ 129,845	$ 133,740	$ 137,752
Capital Projects*	$ -	$ -	$ 250,026	$ -	$ -	$ 209,903	$ 216,200	$ 222,686	$ 229,367	$ 236,248
Debt Service	$ 116,157	$ 116,157	$ 131,162	$ 131,970	$ 131,970	$ 131,970	$ 131,970	$ 131,970	$ 131,970	$ 131,970
O&M	$ 128,828	$ 117,529	$ 129,127	$ 268,077	$ 276,119	$ 284,402	$ 292,934	$ 301,723	$ 310,774	$ 320,097
Other	$ -	$ -	$ 48,060	$ 600	$ 618	$ 636	$ 655	$ 675	$ 695	$ 716
Sewage Treatment	$ 216,115	$ 180,342	$ 122,471	$ 162,276	$ 167,145	$ 172,159	$ 177,324	$ 182,643	$ 188,123	$ 193,766
Source Control	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Gross Expenses	$ 507,860	$ 440,413	$ 708,611	$ 678,288	$ 694,678	$ 921,462	$ 945,147	$ 969,542	$ 994,669	$ 1,020,550
Offsetting Revenue										
Secure Property Taxes**	$ 17,403	$ 18,119	$ 18,733	$ 19,762	$ 20,000	$ 20,600	$ 21,218	$ 21,855	$ 22,510	$ 23,185
Unsecured Property Taxes	$ 2,367	$ 2,395	$ 2,367	$ 2,338	$ 2,500	$ 2,500	$ 2,500	$ 2,500	$ 2,500	$ 2,500
Interest Earned***	$ 44,094	$ 70,318	$ 82,425	$ 73,546	63,362	63,362	63,362	63,362	63,362	63,362
HOPTR	$ 359	$ 352	$ 358	$ 357	$ 500	$ 500	$ 500	$ 500	$ 500	$ 500
Annexation Charges	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Connection Charges	$ 696	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Miscellaneous Revenue	$ 30,174	$ 292	$ 388	$ 2,024	$ 500	$ 500	$ 500	$ 500	$ 500	$ 500
Total Offsetting Revenue	$ 95,093	$ 91,476	$ 104,271	$ 98,027	$ 86,862	$ 87,462	$ 88,080	$ 88,717	$ 89,373	$ 90,048
Use of Fund Balance	$ -	$ -	$ (89,420)	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Net Revenue Requirements	$ 412,767	$ 348,937	$ 514,920	$ 580,261	$ 607,815	$ 833,999	$ 857,066	$ 880,825	$ 905,296	$ 930,502
Annual Rate Assuming 1,499 Connections******					405	556	572	588	604	621

Note:
*Projected CIP is paid for over 5 years.
**Secure Property Tax revenue is assumed to increase at 3% per year
***Interest Earned in projected years is calculated as 5% of Beginning Fund Balance
****Current Rate is $352

Crystal Springs Alternative 2 Fund Balance

Item	1994/95	1995/96	1996/97	1997/98	Projected 1998/99 Budget	Projected 1999/00	2000/01	2001/02	2002/03	2003/04
Beginning Fund Balance	$ 1,096,129	$ 1,193,956	$ 1,356,668	$ 1,267,248	$ 1,267,248	$ 1,267,248	$ 1,267,248	$ 1,267,248	$ 1,267,248	$ 1,267,248
Additions to/(Use of) Balance	$ 97,827	$ 162,712	$ (89,420)	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Ending Fund Balance	$ 1,193,956	$ 1,356,668	$ 1,267,248	$ 1,267,248	$ 1,267,248	$ 1,267,248	$ 1,267,248	$ 1,267,248	$ 1,267,248	$ 1,267,248

Crystal Springs Alternative 3 CIP Summary

Project	Priority	Alternative 3	Alt 3 Description
Polhemus Road (North)	1	$ -	
Randall Road	2	$ 67,700	Remove and Replace
Timberlane Way	2	$ 238,935	Remove and Replace
North Parrot Drive	3	$ -	
Lexington Avenue	3	$ 2,500	Reinspect in 10 years
Enchanted Way	3	$ 33,200	Remove and Replace
Rainbow Drive	3	$ 306,800	Remove and Replace
South Ascension Drive	3	$ 278,900	
Polhemus Road (South)*	3		
Total		$ 928,035	

Note:
*TV Inspection was not performed

Crystal Springs Alternative 3 Revenue Requirements

Item	1994/95	1995/96	1996/97	1997/98	Projected 1998/99 Budget	Projected 1999/00	2000/01	2001/02	2002/03	2003/04
Expenses										
Admin/Eng	$ 46,760	$ 26,385	$ 27,765	$ 115,365	$ 118,826	$ 122,391	$ 126,063	$ 129,845	$ 133,740	$ 137,752
Capital Projects*	$ -	$ -	$ 250,026	$ -	$ -	$ 185,607	$ 191,175	$ 196,910	$ 202,818	$ 208,902
Debt Service	$ 116,157	$ 116,157	$ 131,162	$ 131,970	$ 131,970	$ 131,970	$ 131,970	$ 131,970	$ 131,970	$ 131,970
O&M	$ 128,828	$ 117,529	$ 129,127	$ 268,077	$ 276,119	$ 284,402	$ 292,934	$ 301,723	$ 310,774	$ 320,097
Other	$ -	$ -	$ 48,060	$ 600	$ 618	$ 636	$ 655	$ 675	$ 695	$ 716
Sewage Treatment	$ 216,115	$ 180,342	$ 122,471	$ 162,276	$ 167,145	$ 172,159	$ 177,324	$ 182,643	$ 188,123	$ 193,766
Source Control	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Gross Expenses	**$ 507,860**	**$ 440,413**	**$ 708,611**	**$ 678,288**	**$ 694,678**	**$ 897,166**	**$ 920,122**	**$ 943,766**	**$ 968,120**	**$ 993,205**
Offsetting Revenue										
Secure Property Taxes**	$ 17,403	$ 18,119	$ 18,733	$ 19,762	$ 20,000	$ 20,600	$ 21,218	$ 21,855	$ 22,510	$ 23,185
Unsecured Property Taxes	$ 2,367	$ 2,395	$ 2,367	$ 2,338	$ 2,500	$ 2,500	$ 2,500	$ 2,500	$ 2,500	$ 2,500
Interest Earned***	$ 44,094	$ 70,318	$ 82,425	$ 73,546	63,362	63,362	63,362	63,362	63,362	63,362
HOPTR	$ 359	$ 352	$ 358	$ 357	$ 500	$ 500	$ 500	$ 500	$ 500	$ 500
Annexation Charges	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Connection Charges	$ 696	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Miscellaneous Revenue	$ 30,174	$ 292	$ 388	$ 2,024	$ 500	$ 500	$ 500	$ 500	$ 500	$ 500
Total Offsetting Revenue	**$ 95,093**	**$ 91,476**	**$ 104,271**	**$ 98,027**	**$ 86,862**	**$ 87,462**	**$ 88,080**	**$ 88,717**	**$ 89,373**	**$ 90,048**
Use of Fund Balance	$ -	$ -	$ (89,420)	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Net Revenue Requirements	**$ 412,767**	**$ 348,937**	**$ 514,920**	**$ 580,261**	**$ 607,815**	**$ 809,703**	**$ 832,041**	**$ 855,049**	**$ 878,747**	**$ 903,157**
Annual Rate Assuming 1,499 Connections******					**405**	**540**	**555**	**570**	**586**	**603**

Note:
*Projected CIP is paid for over 5 years
**Secure Property Tax revenue is assumed to increase at 3% per year
***Interest Earned in projected years is calculated as 5% of Beginning Fund Balance
****Current Rate is $352

Crystal Springs Alternative 3 Fund Balance

Item	1994/95	1995/96	1996/97	1997/98	Projected 1998/99 Budget	Projected 1999/00	2000/01	2001/02	2002/03	2003/04
Beginning Fund Balance	$ 1,096,129	$ 1,193,956	$ 1,356,668	$ 1,267,248	$ 1,267,248	$ 1,267,248	$ 1,267,248	$ 1,267,248	$ 1,267,248	$ 1,267,248
Additions to/(Use of) Balance	$ 97,827	$ 162,712	$ (89,420)	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Ending Fund Balance	$ 1,193,956	$ 1,356,668	$ 1,267,248	$ 1,267,248	$ 1,267,248	$ 1,267,248	$ 1,267,248	$ 1,267,248	$ 1,267,248	$ 1,267,248

Crystal Springs Average Alternative CIP Summary

Project	Priority	Minimum Cost	Maximum Cost	Average
Polhemus Road (North)	1	$582,100	$582,100	$582,100
Randall Road	2	$61,300	$73,200	$67,250
Timberlane Way	2	$208,115	$238,935	$223,525
North Parrot Drive	3	$0	$180,000	$90,000
Lexington Avenue	3	$2,500	$127,000	$64,750
Enchanted Way	3	$30,100	$35,900	$33,000
Rainbow Drive	3	$271,400	$325,600	$298,500
South Ascension Drive	3	$233,200	$279,700	$256,450
Polhemus Road (South)*	3	$4,000	$4,000	$4,000
Total		$1,392,715	$1,846,435	$1,619,575

Note:
*TV Inspection was not performed.

Crystal Springs Average Alternative Revenue Requirements

Item	1994/95	1995/96	1996/97	1997/98	Projected 1998/99 Budget	Projected 1999/00	2000/01	2001/02	2002/03	2003/04
Expenses										
Admin/Eng	$ 46,760	$ 26,385	$ 27,765	$ 115,365	$ 118,826	$ 122,391	$ 126,063	$ 129,845	$ 133,740	$ 137,752
Capital Projects*	$ -	$ -	$ 250,026	$ -	$ -	$ 323,915	$ 333,632	$ 343,641	$ 353,951	$ 364,569
Debt Service	$ 116,157	$ 116,157	$ 131,162	$ 131,970	$ 131,970	$ 131,970	$ 131,970	$ 131,970	$ 131,970	$ 131,970
O&M	$ 128,828	$ 117,529	$ 129,127	$ 268,077	$ 276,119	$ 284,402	$ 292,934	$ 301,723	$ 310,774	$ 320,097
Other	$ -	$ -	$ 48,060	$ 600	$ 618	$ 636	$ 655	$ 675	$ 695	$ 716
Sewage Treatment	$ 216,115	$ 180,342	$ 122,471	$ 162,276	$ 167,145	$ 172,159	$ 177,324	$ 182,643	$ 188,123	$ 193,766
Source Control	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Gross Expenses	$ 507,860	$ 440,413	$ 708,611	$ 678,288	$ 694,678	$ 1,035,474	$ 1,062,579	$ 1,090,497	$ 1,119,253	$ 1,148,871
Offsetting Revenue										
Secure Property Taxes**	$ 17,403	$ 18,119	$ 18,733	$ 19,762	$ 20,000	$ 20,600	$ 21,218	$ 21,855	$ 22,510	$ 23,185
Unsecured Property Taxes	$ 2,367	$ 2,395	$ 2,367	$ 2,338	$ 2,500	$ 2,500	$ 2,500	$ 2,500	$ 2,500	$ 2,500
Interest Earned***	$ 44,094	$ 70,318	$ 82,425	$ 73,546	63,362	63,362	63,362	63,362	63,362	63,362
HOPTR	$ 359	$ 352	$ 358	$ 357	$ 500	$ 500	$ 500	$ 500	$ 500	$ 500
Annexation Charges	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Connection Charges	$ 696	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Miscellaneous Revenue	$ 30,174	$ 292	$ 388	$ 2,024	$ 500	$ 500	$ 500	$ 500	$ 500	$ 500
Total Offsetting Revenue	$ 95,093	$ 91,476	$ 104,271	$ 98,027	$ 86,862	$ 87,462	$ 88,080	$ 88,717	$ 89,373	$ 90,048
Use of Fund Balance	$ -	$ -	$ (89,420)	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Net Revenue Requirements	$ 412,767	$ 348,937	$ 514,920	$ 580,261	$ 607,815	$ 948,011	$ 974,498	$ 1,001,780	$ 1,029,880	$ 1,058,824
Annual Rate Assuming 1,499 Connections******					405	632	650	668	687	706

Note:
*Projected CIP is paid for over 5 years.
**Secure Property Tax revenue is assumed to increase at 3% per year
***Interest Earned in projected years is calculated as 5% of Beginning Fund Balance
****Current Rate is $352

Crystal Springs Average Alternative Fund Balance

Item	1994/95	1995/96	1996/97	1997/98	Projected 1998/99 Budget	Projected 1999/00	2000/01	2001/02	2002/03	2003/04
Beginning Fund Balance	$ 1,096,129	$ 1,193,956	$ 1,356,668	$ 1,267,248	$ 1,267,248	$ 1,267,248	$ 1,267,248	$ 1,267,248	$ 1,267,248	$ 1,267,248
Additions to/(Use of) Balance	$ 97,827	$ 162,712	$ (89,420)	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Ending Fund Balance	$ 1,193,956	$ 1,356,668	$ 1,267,248	$ 1,267,248	$ 1,267,248	$ 1,267,248	$ 1,267,248	$ 1,267,248	$ 1,267,248	$ 1,267,248