COUNTY OF SAN MATEO

Emerald Lake Heights
Sewer Maintenance District

SEWER MASTER PLAN

Prepared by:
Brown and Caldwell
December 1999

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EXECUTIVE SUMMARY

In December 1996, the County of San Mateo engaged Brown and Caldwell to prepare a sewer system master plan for the Emerald Lake Heights Sewer Maintenance District (ELHSMD). 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 ELHSMD. 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 233 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 17,600 linear feet of sewer lines. A total of seven 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 497 feet of the collection system was inspected. No 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 sewers along Cordilleras Road, Lake Boulevard, Canyon Lane, and Lakeview Way were evaluated for this study. Results of the analysis indicate that approximately 2,000 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 two capital improvement projects were developed for the ELHSMD. The two projects were developed to provide increased hydraulic capacity to the Cordilleras Road trunk sewer. Estimated total construction cost for the projects is approximately $226,900. The location of the improvement projects is listed below:

1. Cordilleras Road
2. Edgewood Road

SECTION 1

INTRODUCTION

This chapter introduces the sewer mater planning process for the Emerald Lake Heights Sewer Maintenance District (ELHSMD) 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 ELHSMD is located on the San Francisco Peninsula in the area roughly bounded by California and Wilmington Way in the south, Edgewood County Park in the west, Edgewood Road in the north, and Cordilleras Road, Oak Knoll Drive and Jefferson Avenue 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 ELHSMD 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 Emerald Lake Heights 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 Emerald Lake Heights Sewer Maintenance District (ELHSMD) 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.

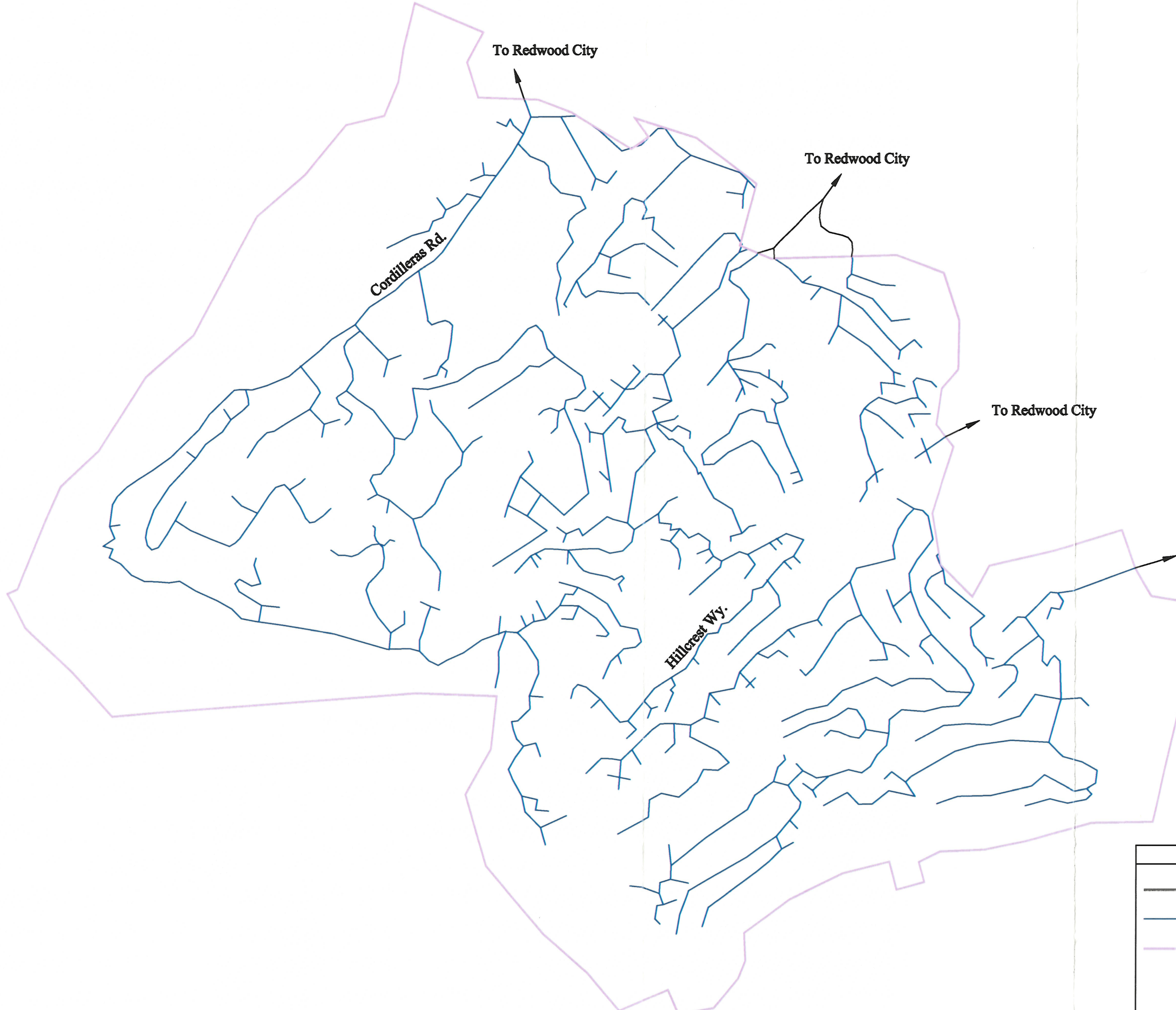
Description of Existing Facilities

The ELHSMD'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 20 miles of 6-inch to 15-inch-diameter vitrified clay and polyvinyl chloride pipe. Most of the collection system has been constructed within the last 20 years.

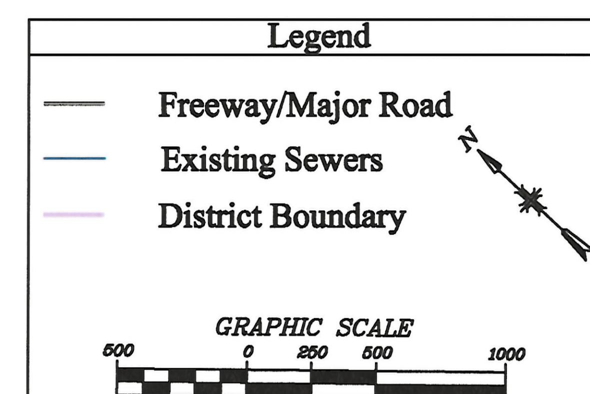
The major trunk sewers in the ELHSMD are the Cordilleras Road, Lake Boulevard, Canyon Lane, and Lakeview Way trunk sewers. These sewers roughly divide the ELHSMD into four major drainage areas. Figure 2-1 depicts the ELHSMD boundaries and collection system.

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 (E for ELHSMD). The next four numbers identify the manhole within the ELHSMD. 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 Emerald Lake Heights Sewer Maintenance District (ELHSMD), 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 ELHSMD 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 ELHSMD 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				Comment
			Roots	Grease	Paper	Inspection	
610	Acacia Ln	1985				x	Permit 0592
644	Acacia Ln	1985				x	Permit 0879
55	Agua Vista Ct	1985				x	Permit 0761
711	Bayview Wy	1985				x	Permit 0574
815	Bayview Wy	1985				x	Permit 0598
835	Bayview Wy	1985				x	Permit 0643
846	Bayview Wy	1985				x	Permit 0686
3937	Brookline Wy	1985				x	Permit 0631
3940	Brookline Wy	1985				x	
3950	Brookline Wy	1985				x	Permit 0864
632	California Wy	1985				x	Permit 0697
707	California Wy	1985				x	Permit 0604
742	California Wy	1985				x	Permit 0746
758	California Wy	1985				x	Permit 0590
819	California Wy	1985				x	Permit 0841
1840	Cordilleras Rd	1980	xx				
1979	Cordilleras Rd	1987				x	Permit 1488
2027	Cordilleras Rd	1985				x	Permit 0553
706	Diablo Wy	1985				x	Permit 0570
939	Edgecliff Wy	1985				x	Permit 0788
1320	Edgewood Rd	1993					No cleanout
2139	Edgewood Rd	1986				x	Sunken sewer trench, Permit 1026
919	Fallen Leaf Wy	1986				x	Permit 1128, Lateral OK
923	Fallen Leaf Wy	1985				x	Permit 0718
205	Ferndale Wy	1991				x	Permit 2038
738	Glenmere Wy	1985				x	Permit 0880
3817	Hamilton Wy	1988					Cleanout OK
418	Hillcrest Wy	1985				x	Permit 0870
763	Hillcrest Wy	1986				x	Permit 1319
551	Hillside Rd	1985				x	Permit 0791
579	Hillside Rd	1989				x	Permit 1767 &1953
3902	Jefferson Ave	1985				x	Permit 0548
3910	Jefferson Ave	1985				x	Permit 0575
3996	Jefferson Ave	1985				x	Permit 0615
511	Lakemead Wy	1985				x	Permit 0562
703	Lakemead Wy	1985				x	Permit 0609
719	Lakemead Wy	1985				x	Permit 0601
727	Lakemead Wy	1985				x	Permit 0632
334	Lakeview Wy	1987	xx				
338	Lakeview Wy	1977	xx				Loose riser
342	Lakeview Wy	1996					No cleanout, Permit 2682
358	Lakeview Wy	1992	xxx				Needs repair
436	Lakeview Wy	1984				x	Lateral OK,

Street number	Street name	Year	Reason for Callout				Comment
			Roots	Grease	Paper	Inspection	
							Permit 0470
456	Lakeview Wy	1980	xx				
460	Lakeview Wy	1986				x	Broken lateral
507	Lakeview Wy	1994			x		Lateral backup
512	Lakeview Wy	1995					No cleanout, Permit 2561
528	Lakeview Wy	1987					Rocks, Contractor hit lateral
577	Lakeview Wy	1986				x	Permit 0756
773	Lakeview Wy	1985				x	Permit 0795
803	Lakeview Wy	1985				x	Permit 0657
904	Lakeview Wy	1988				x	Permit 1637
925	Lakeview Wy	1985				x	Permit 0769
960	Lakeview Wy	1985				x	Permit 0784
982	Lakeview Wy	1985				x	Permit 0785
998	Lakeview Wy	1985				x	Permit 0786
1004	Lakeview Wy	1985				x	Permit 0799
1005	Lakeview Wy	1985				x	Permit 0761
1008	Lakeview Wy	1985				x	Permit 0743
606	Lombardy Wy	1985				x	Permit 0614
642	Lombardy Wy	1986				x	Permit 1302
3	North View Wy	1990	xx		x		Lateral OK
8	North View Wy	1990	xxx				
9	North View Wy	1986					No cleanout
12	North View Wy	1979	x		x		
3327	Oak Knoll Dr	1995				x	Permit 2499
3370	Oak Knoll Dr	1986				x	Permit 1335, 2 tie-ins to main
3419	Oak Knoll Dr	1985				x	Permit 0716
3657	Oak Knoll Dr	1993					Permit 2385 Voided (Uninspected Work).
504	Oak Park Wy	1985				x	Permit 0723
517	Oak Park Wy	1987					Permit 1537, No cleanout
566	Oak Park Wy	1985				x	Permit 0917
657	Oak Park Wy	1987				x	Permit 1600
685	Oak Park Wy	1985				x	Permit 0658
675	Oakview Wy	1985				x	Permit 0681 & 0682
707	Oakview Wy	1985				x	Permit 0778
702	Paradise Wy	1987				x	Permit 1359
167	Springdale Wy	1987				x	Permit 1373, Lateral OK
571	Summit Dr	1985				x	Permit 0772
524	Sunset Wy	1985				x	Permit 0541
530	Sunset Wy	1985				xx	
546	Sunset Wy	1988				x	Permit 1558
664	Sunset Wy	1985				x	Permit 0641
695	Sylvan Wy	1985				x	Permit 0924

Street number	Street name	Year	Reason for Callout				Comment
			Roots	Grease	Paper	Inspection	
720	Temescal Wy	1991				x	Permits 1497, 1876, 1897, 2131
741	Temescal Wy	1986				x	Permit 1247
761	Temescal Wy	1985				x	Permit 0824
714	Vernal Wy	1985				x	Permit 0902
815	Villa Vista Ct	1985				x	Permit 0754, Cleanout OK
819	Villa Vista Ct	1985				x	Permit 0635
630	Vista Dr	1985				x	Permit 0752, No cleanout
704	Vista Dr	1985				x	Permit 0807
712	Vista Dr	1985				x	Permit 0811
739	Vista Dr	1985				x	Permit 0690
22	W Summit Dr	1975	x				Lateral OK
25	W Summit Dr	1980				x	Damaged lateral
27	W Summit Dr	1980	x				Lateral OK
35	W Summit Dr	1979	x		x		Lateral OK
44	W Summit Dr	1995	xx		x		
55	W Summit Dr	1992	xxx				
57	W Summit Dr	1995	x				Lateral OK
902	Wilmington Wy	1987				x	Permit 1548
929	Wilmington Wy	1985				x	Permit 0571
930	Wilmington Wy	1985				x	Permit 0566
1022	Wilmington Wy	1985				x	Permit 0726
1025	Wilmington Wy	1988				x	Permit 1644
1029	Wilmington Wy	1988				x	Permit 1516
1037	Wilmington Wy	1985				x	Permit 0948
1040	Wilmington Wy	1986				x	Permit 0943
1043	Wilmington Wy	1985				x	Permit 0573

Table 3-2. Callout Summary for Sewer Mains

Street number	Street name	Year	Reason for Callout				Comment
			Roots	Grease	Paper	Inspection	
1540	Cordilleras Rd	1986					Flooding (2)
326	Lakeview Wy	1994	xx				
358	Lakeview Wy	1990	xx				
358	Lakeview Wy	1995	xx				
365	Lakeview Wy	1978			xx		
456	Lakeview Wy	1986	x		x		
456	Lakeview Wy	1993		x			Main flushed
568	Lakeview Wy	1992	xx				
13	W Summit Dr	1984	xx				

SECTION 4

MANHOLE INSPECTION

The manhole inspection program was conducted during the winter and spring of 1997. Field crews documented the condition of 233 manholes in the Emerald Lake Heights Sewer Maintenance District (ELHSMD). 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 ELHSMD. Manholes were selected for inspection to provide a representative sample of the manholes in the ELHSMD.

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	4
Roots	8
Grease	94
Frame and Cover Problems	1
Active or signs of Infiltration/Inflow	2
Major Debris in Channel	51
Manholes Inspected	233

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

Pipes with separated joints greater than moderate and deflections greater than 1 inch	5
Pipes with greater than minor corrosion	0
Pipes with infiltration/inflow	0
Pipes with greater than light grease	30
Pipes with greater than light roots	9
Pipes with roots and grease	0
Pipes with cracks and fractures	5
Pipes with plugs and obstructions	10

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.

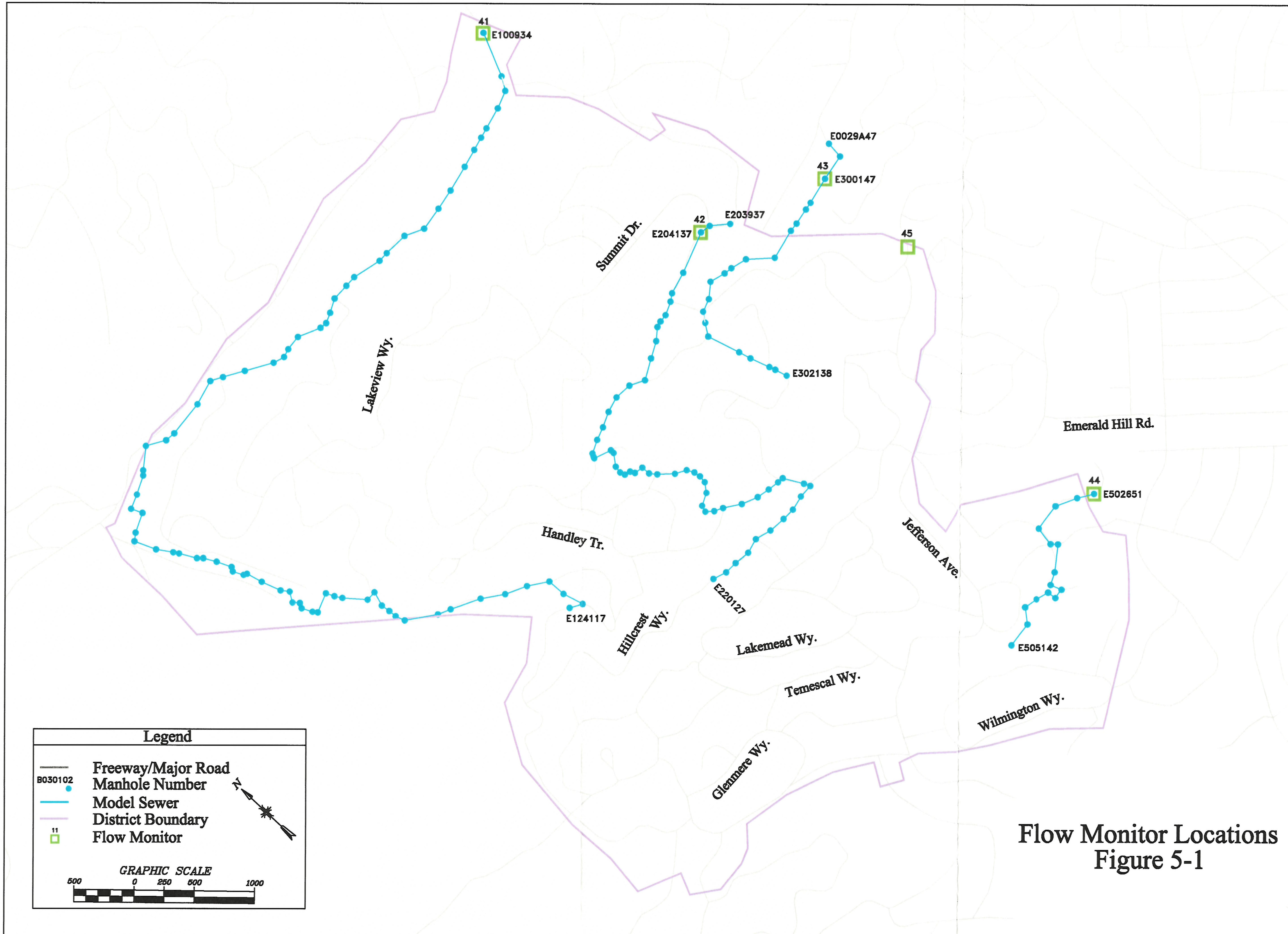
Purpose and Objective

The purpose of the flow monitoring program was to measure the existing collection system flows at various locations in the Emerald Lake Heights Sewer Maintenance District (ELHSMD). 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 Fire Station #19 at the intersection of California Way and Jefferson Avenue to determine how collection system flows reacted to various rainfall events.

Table 5-1 summarizes the measured flow rates for each monitoring station in the ELHSMD 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
31	0.02	0.08	0.71
41	0.01	0.04	1.08
42	0.01	0.02	0.29
43	0.01	0.02	0.25
44	0.01	0.03	0.17
45	0.01	0.21	0.72



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 17,600 linear feet of sewer lines in the Emerald Lake Heights Sewer Maintenance District (ELHSMD). 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.

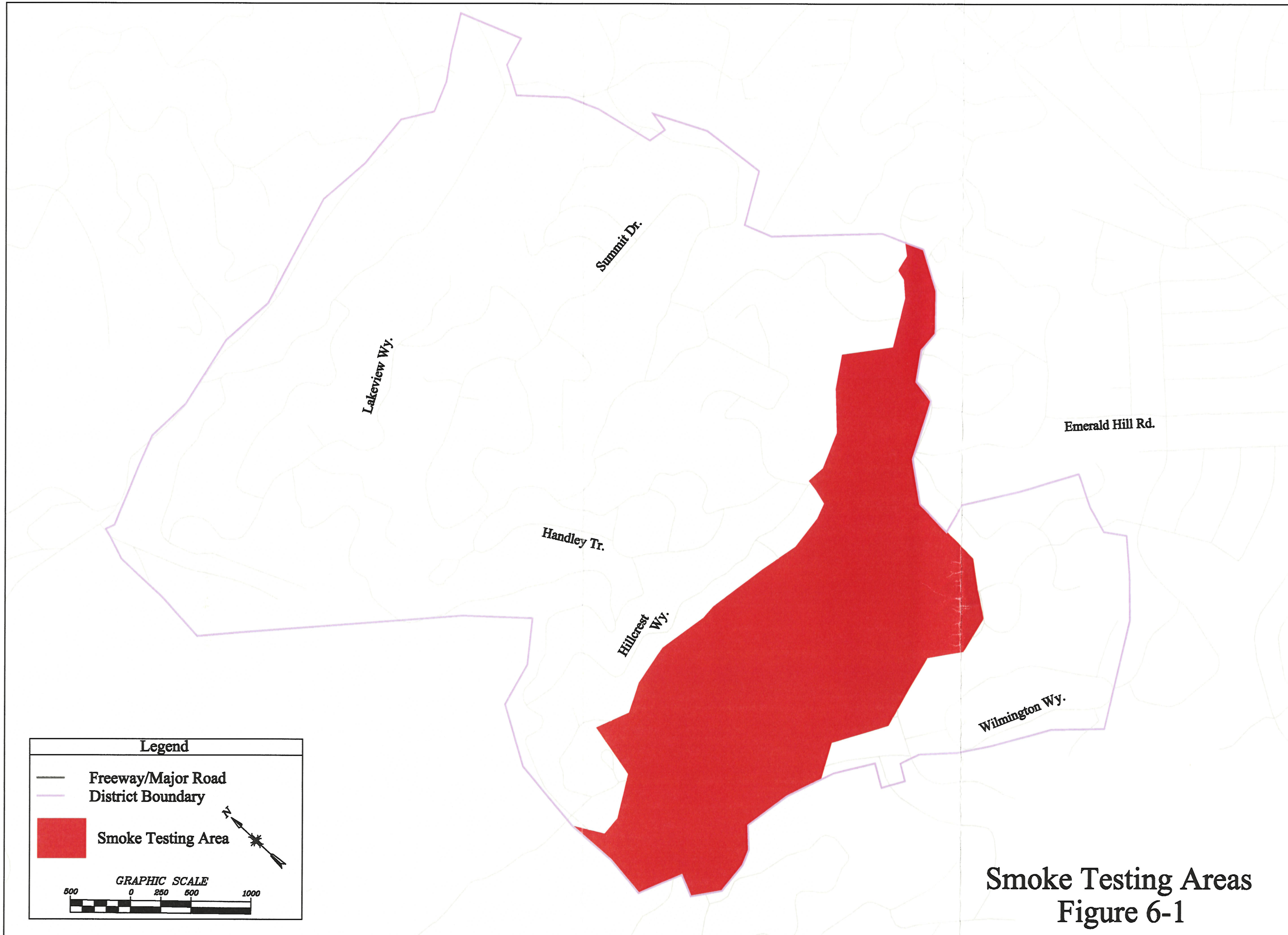
Smoke Testing Results

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 ELHSMD 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 seven defects were located and documented during the program. The only defect noted during the program was missing or damaged cleanout covers. 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.

Table 6-1. Smoke Testing Defect Summary

Defect type	Number of defects
Cleanout	7
Lateral	0
Illegal drain	0
Storm drain cross connection	0
Manhole leaks	0
Pavement cracks	0
Other	0
Total footage tested:	17,600



Smoke Testing Areas
Figure 6-1

SECTION 7

TELEVISION INSPECTION PROGRAM

The television inspection program was conducted during the winter of 1999. Field crews inspected approximately 497 linear feet of sewer lines in the Emerald Lake Heights Sewer Maintenance District (ELHSMD). 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

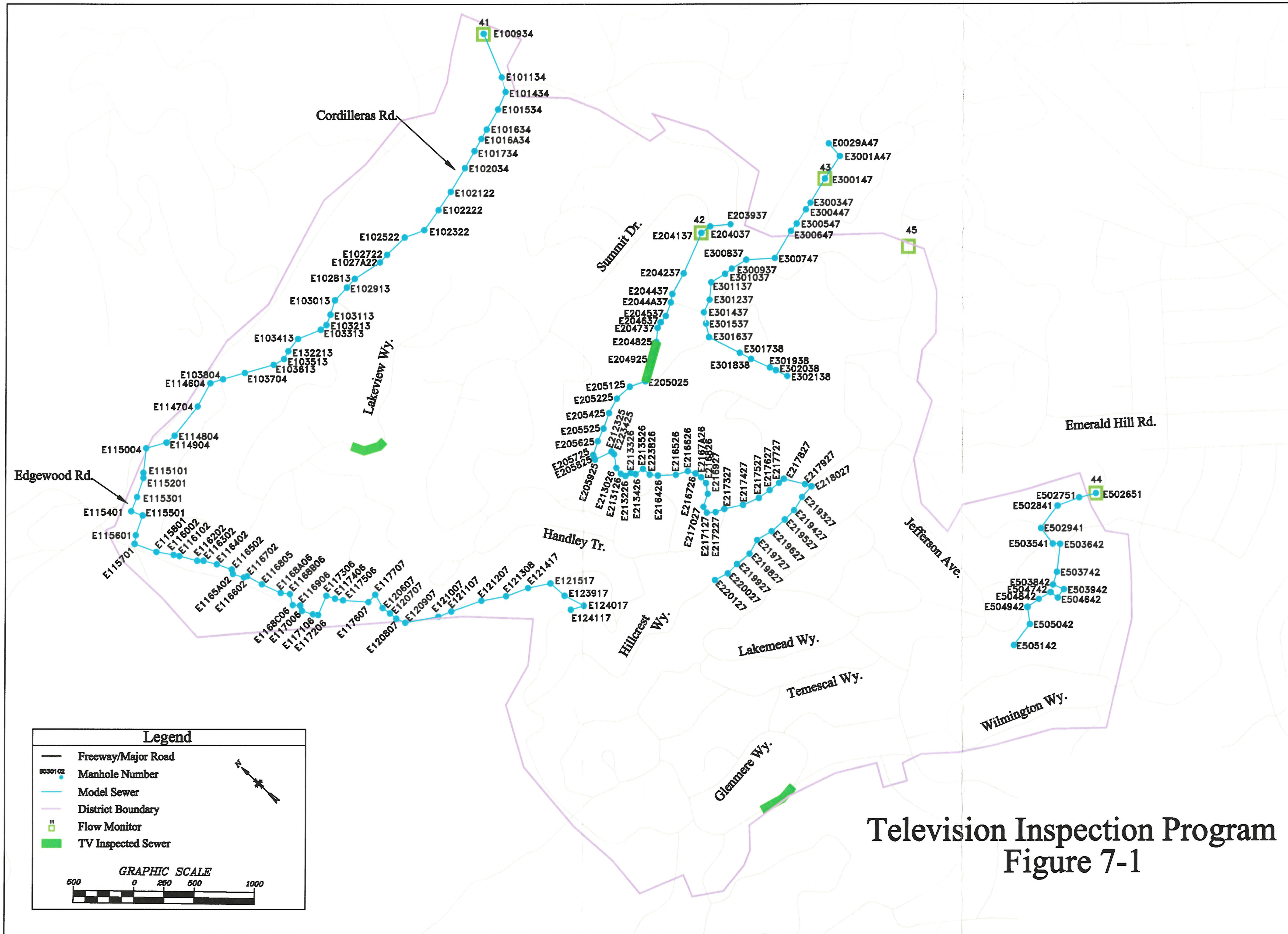
The areas scheduled for television inspection in the ELHSMD area are shown on Figure 7-1. Sewers were selected for television inspection if they met one of the following four criteria:

- 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 700 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	1186
Footage Completed	497
Cracks	
Radial	0
Longitudinal	0
Joints	
Minor Offset Joint	0
Major Offset Joint	0
Laterals	
Protruding Lateral	0
Defect at Connection	0
Dead Connection	0
Roots	
Roots at Joint	0
Roots at Lateral	0
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	0
Pipe Out of Round	0
Structural	
Piece Missing	0
Shattered/Broken	0
Crushed or Collapsed	0
Mineral Stains	
At Joint	0
At Cracks	0
Sulfide Corrosion	
Minor	0
Severe	0
Tap Connection	7



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 Emerald Lake Heights Sewer Maintenance District (ELHSMD).

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 ELHSMD area.

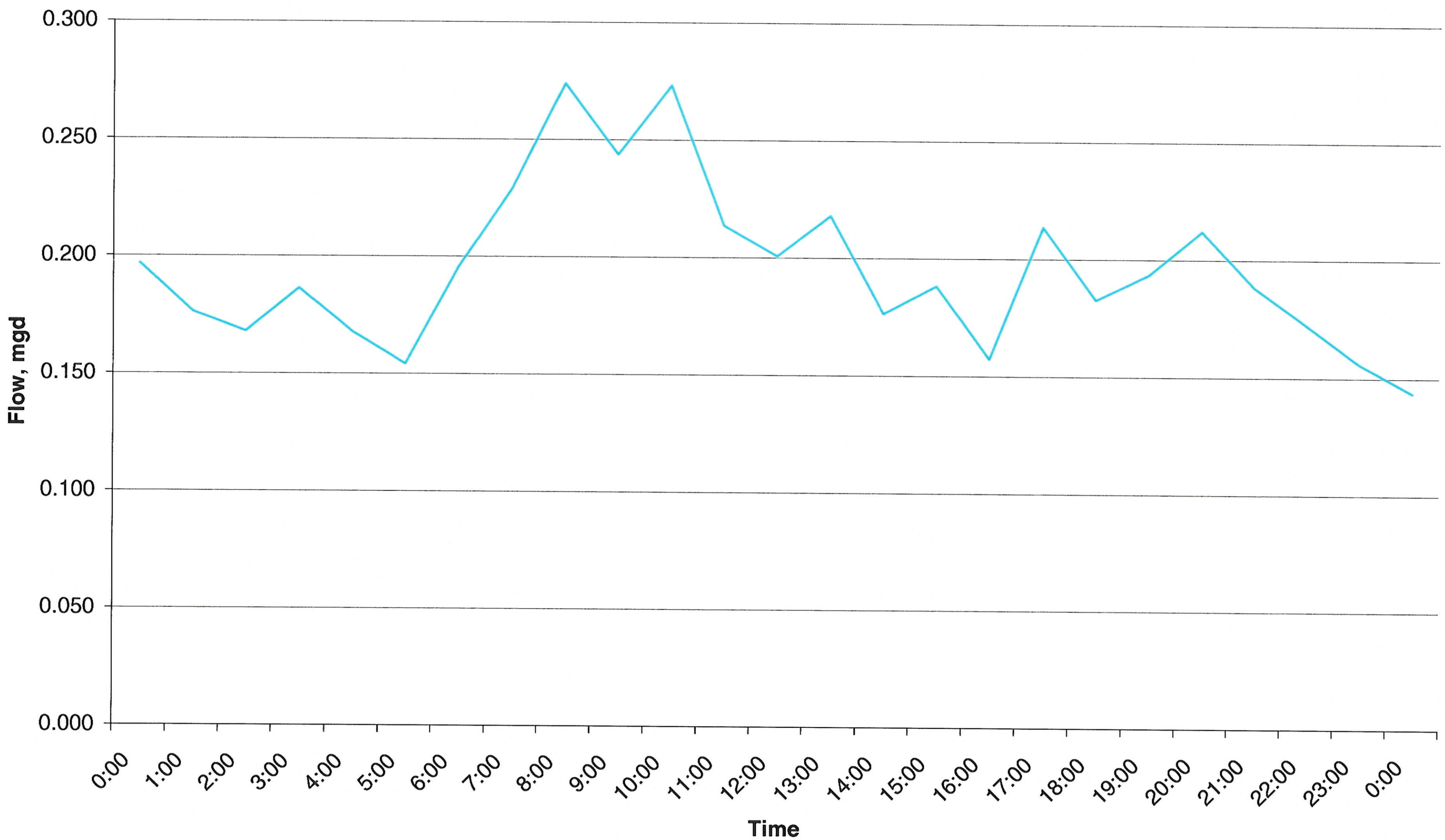
BSF projections were not prepared for future land use conditions. Land use planners for the County and affected City agencies indicated that growth or significant infilling were not expected in the future.

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.

Table 8-1. Base Sanitary Flow Rates

Flow monitor	Base sanitary flow, mgd
41	0.255
42	0.105
43	0.037
44	0.029
45	0.197

Typical Dry Weather Hydrograph
Figure 8-1



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 Emerald Lake Heights Sewer Maintenance District (ELHSMD).

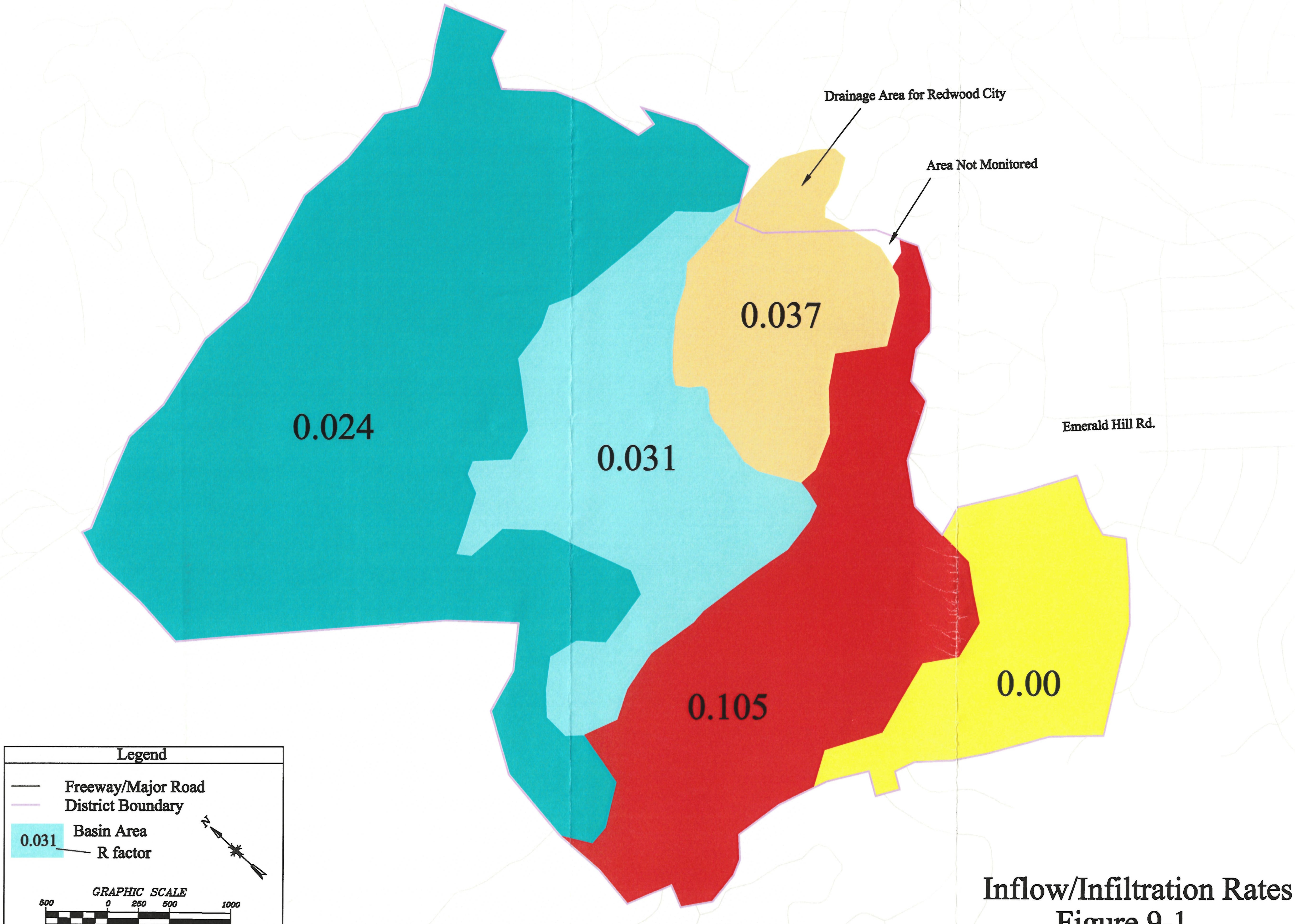
Wet Weather Flow

I/I consists of direct inflow of storm water runoff and rainfall-induced infiltration of storm water 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. The flow monitoring service area also includes portions of Redwood City.

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.

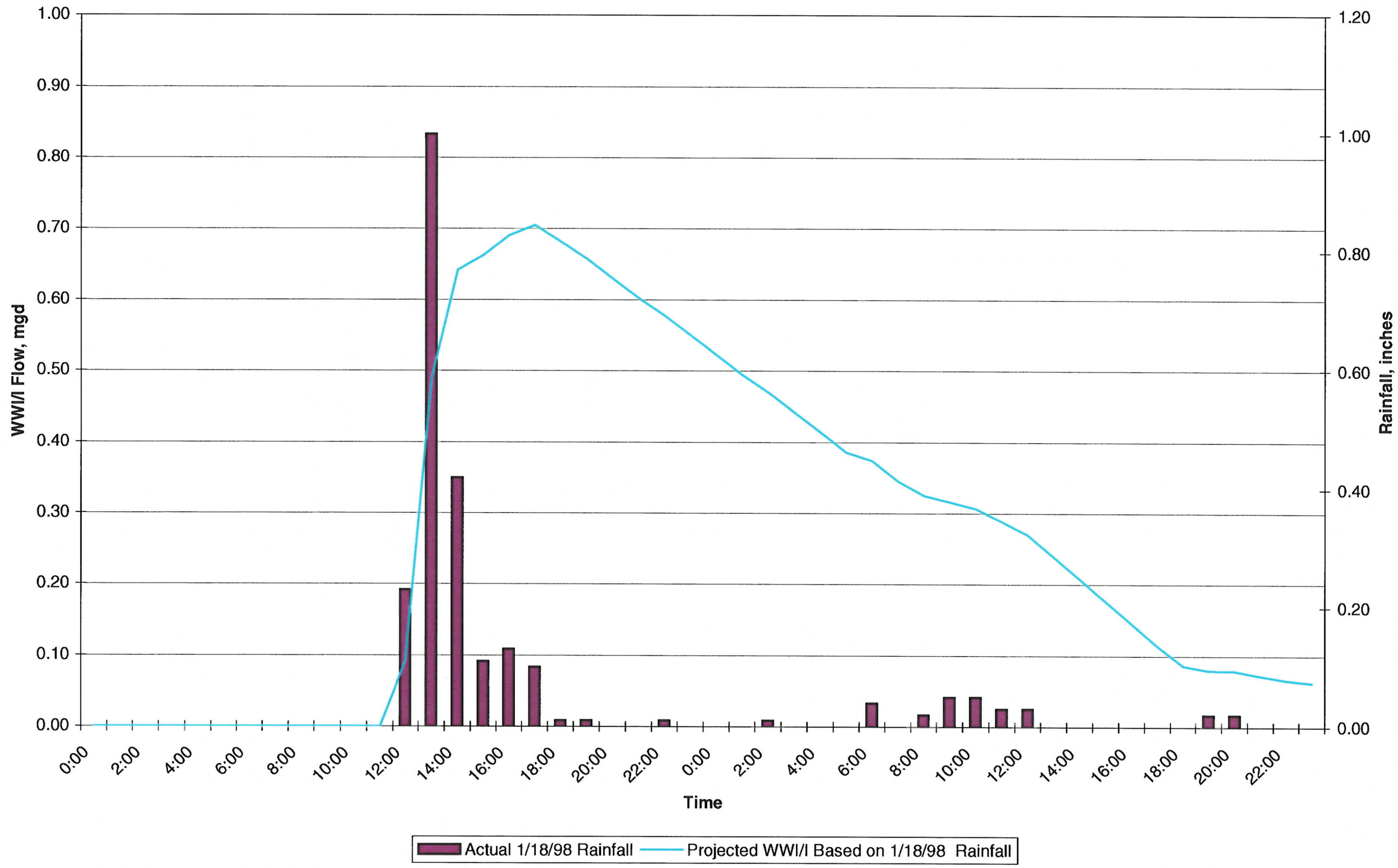
Unit hydrographs were developed for each basin to develop wet weather hydrographs for use in the model. Unit hydrographs are based on the "R" factor and the individual runoff characteristics for each basin. Synthetic hydrographs were added to the base flow hydrographs and the total flow hydrograph was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



Note: ELHSMD also receives flow from Redwood City.

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 Emerald Lake Heights Sewer Maintenance District's (ELHSMD) 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

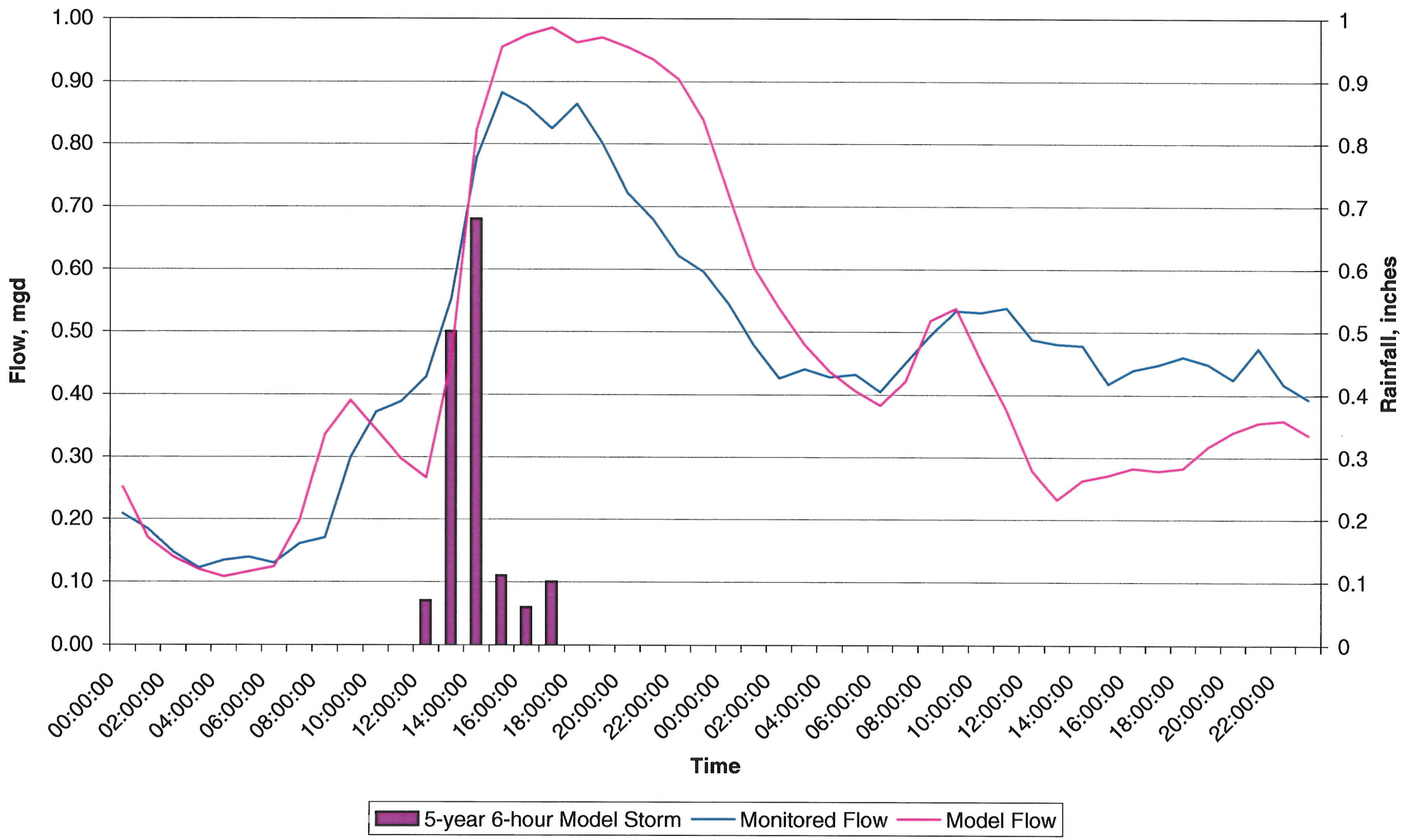
Major trunk sewers in each of the sewer Districts were modeled to determine where capacity deficiencies exist. The HYDRA model developed by PIZER, Inc., was used to simulate wastewater flows in the each of the Districts collection systems. HYDRA routes flow hydrographs (developed in Section 9) through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

For the ELHSMD, the Cordilleras Road, Lake Boulevard, Canyon Lane, and Lakeview Way trunk sewers were modeled. These sewers include nearly all the pipelines 8 inches in diameter or larger in the ELHSMD. These trunk sewers are composed of 6-inch-, 8-inch- and 15-inch-diameter gravity sewers.

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

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SECTION 11

MODEL RESULTS

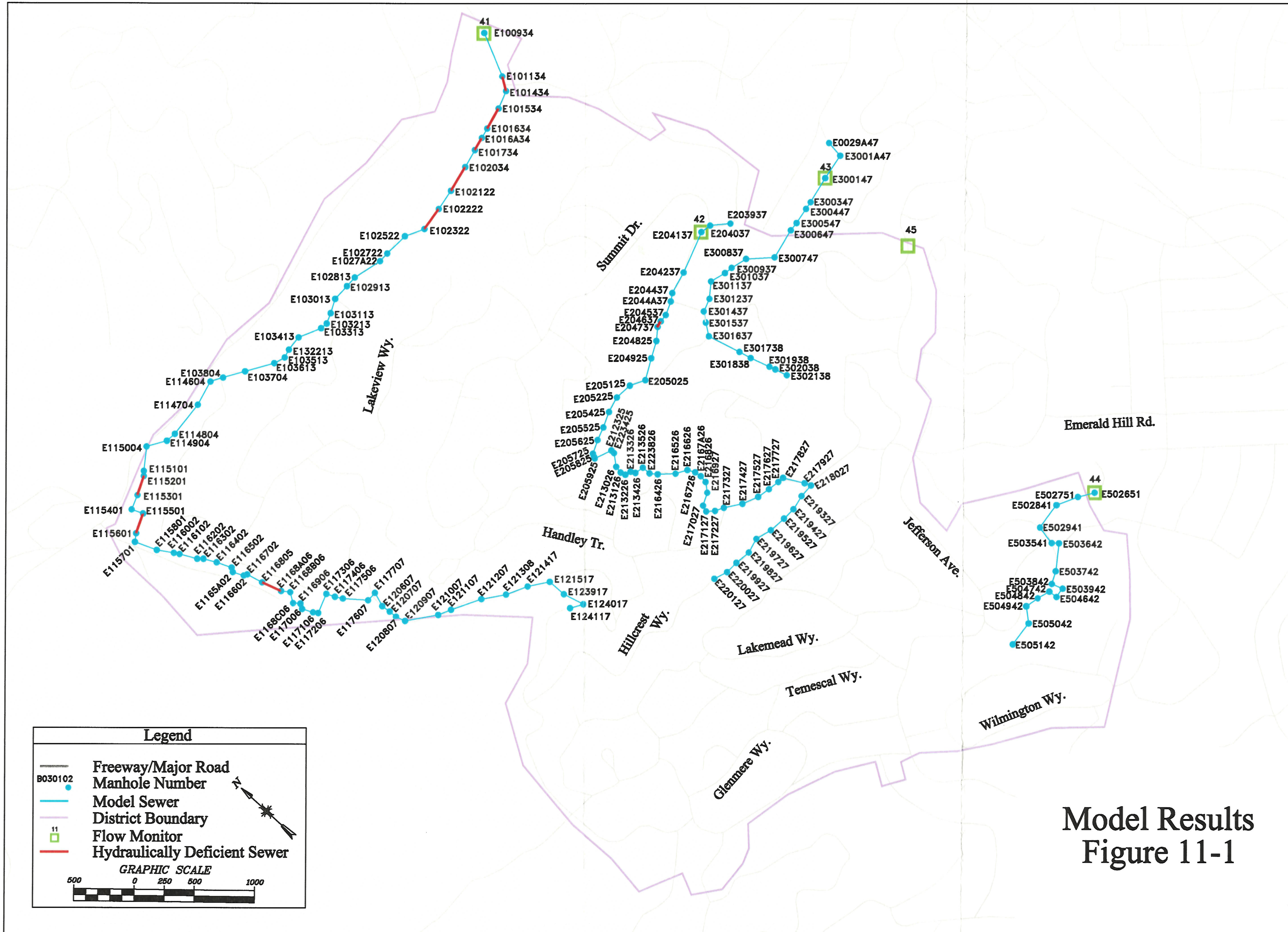
An evaluation of the pipeline capacities was performed using the flows developed in Sections 8 and 9 and the hydraulic model described in Section 10. This section describes the results of the capacity evaluation developed for the Emerald Lake Heights Sewer Maintenance District (ELHSMD).

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 two sections of the Cordilleras Road trunk sewer have insufficient capacity and are 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 Emerald Lake Heights Sewer Maintenance District (ELHSMD) collection system to adequately convey peak wet weather flows. This section presents the recommended improvements for correcting 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.

Relief/Replacement 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 pipe and replacement pipes. For this report, alternatives and costs have been developed assuming the existing sewer will be replaced by a larger sewer. The main drawback to relief sewers is the increased amount of sewer pipe in the ground for the maintenance crews. 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 2,000 linear feet of the Cordilleras Road trunk sewer was identified as hydraulically deficient. A 10-inch and 15-inch replacement sewer is recommended to relieve the existing trunk sewer. The location of the recommended replacement sewers 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
E115601	E115201	6	451	10
E102322	E101134	8	1515	15
Total			1966	

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 demonstrating 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.

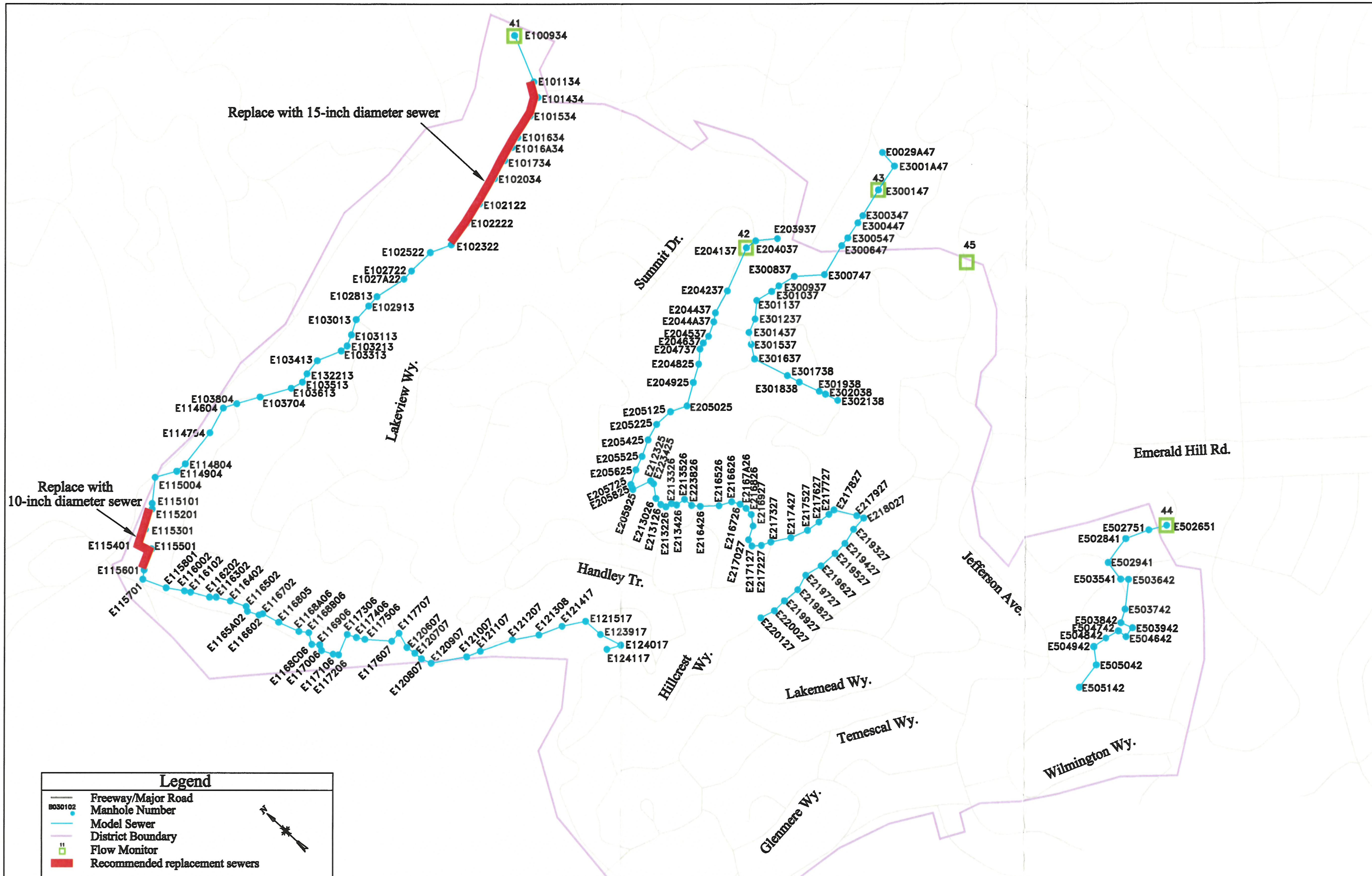
The capacity limitation of 0.24 mgd in the 8-inch sewer in Cordilleras Road requires a 0.50-mgd reduction in the projected PWWF of 0.74 mgd as shown in Appendix E. Effectively, 67 percent of the PWWF will need to be eliminated from the system through a comprehensive rehabilitation program of the district. 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 $7.88 million for the 20 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 15 miles. Therefore, the estimated construction cost for lateral rehabilitation is $3.96 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 $11.84 million. The estimated replacement construction cost for the increased capacity of sewer in Cordilleras Road is $226,900 as shown for the two capital improvement projects listed in Table 14-1.

Wastewater Cost of Treatment

The cost of treating the increased PWWF will have to be borne by the ratepayers 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 0.74 million gallons, as shown in Figure 9-2 as the area under the projected wet weather flow line, equals $925 per peak flow event. Given that this is a once in 5-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 Redwood City 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 Emerald Lake Heights Sewer Maintenance District (ELHSMD) are necessary to correct identified hydraulic and structural deficiencies. This section presents the recommended improvement for correction the hydraulic deficiencies presented in Section 13 and the structural problems identified in Section 7.

Capital Projects

A total of two capital improvement projects were developed for the Emerald Lake Heights District. None of the projects are required to correct structural deficiencies that create increased maintenance costs or deterioration in the sewer that may be to the point where failure may occur in the near future. Two projects were developed to provide increased hydraulic capacity to the Cordilleras Road trunk sewer. Alternatives have been developed for the following projects in the Emerald Lake Heights District:

1. Cordilleras Road
2. Edgewood 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 is 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.). Estimated construction cost for the projects is $226,900.

Table 14-1. Recommend Capital Improvement Program

Project Description	Priority	Minimum construction cost, dollars	Maximum construction cost, dollars
Cordilleras Road	1	181,800	181,800
Edgewood Road	1	45,100	45,100
Totals		226,900	226,900

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 workload 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.

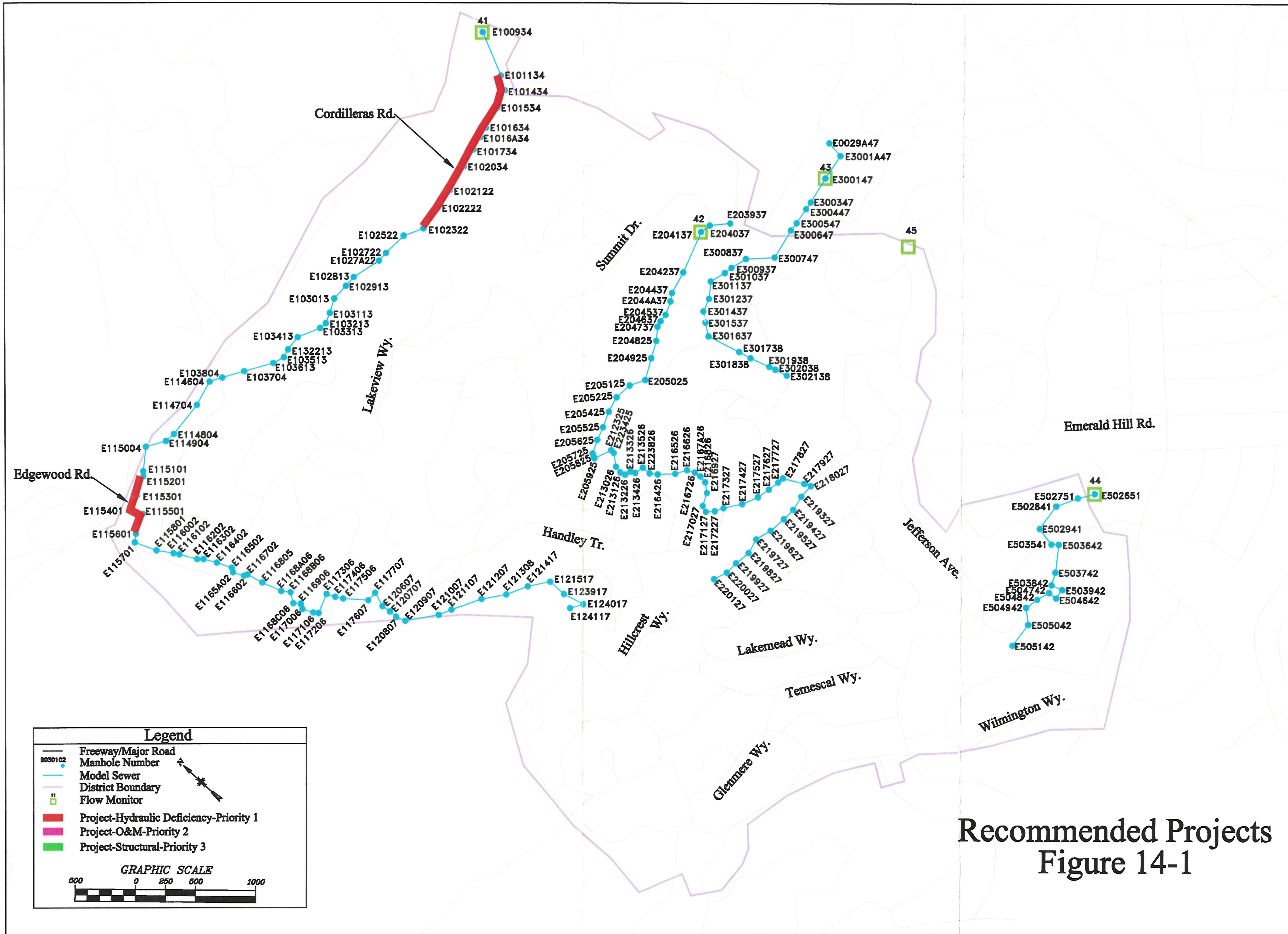
Other Collection System Options

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 ratepayer. 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 Emerald Lake Heights Sewer Maintenance District (ELHSMD) in Section 14 will require that the District make some investment in its sanitary sewer collection system. As a consequence, the District will need to charge slightly higher rates to customers. The impact of recommended CIP expenditure 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 ELHSMD residential unit equivalents. The impact of the CIP expenditures on the rates assessed SFRs was determined by (1) determining level of the CIP expenditure considered over the 5-year study 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 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 recommended 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 ELHSMD system was estimated from accounting information provided by County staff. 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 for over 5 years) 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 add to or subtract from their existing reserve fund balance. This assumption may change if the County conducts a reserve study, which may determine that the reserve balance may be used or that it must be replenished. Table 15-1 below contains a summary of the revenue requirements and rate development.

Impact of Revised Revenue Requirements

Current rates for old and new users are $322 and $233/residential unit equivalent, respectively. Alternative 1 sees a maximum rate increase for old and new users of 11 and 50 percent to $359/residential unit equivalent in FY 2003/04. This analysis assumes that the increased cost, both as a result of the CIP and increases in general expenses, are absorbed equally by all customers. The table provided in Appendix G summarizes the revenue requirements including CIP level for the proposed alternative along with the calculated rates. As no significant growth is expected in ELHSMD, the number of equivalent residential units used to calculate the rates is 1,536. The full development of the rates for the proposed alternative and is contained in Appendix G. Table 15-1 contains a summary of the rate development.

Table 15-1. Emerald Lakes Alternative 1 Summary Rate Development

Item	Projected, dollars				
	1999/00	2000/01	2001/02	2002/03	2003/04
Gross expenses	569,984	587,084	604,696	622,837	641,523
Total offsetting revenue	88,852	88,991	89,134	89,282	89,434
Use of fund balance	-	-	-	-	-
Net revenue requirements	481,132	498,093	515,562	533,555	552,089
Annual rate assuming 1,536 connections	313	324	336	347	359

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 $50,000 in the case of Emerald Lake along with emergency repair reserves. Assuming ELHSMD has approximately 105,000 feet of equivalent 6-inch diameter pipe (assuming 21,000 feet modeled length represents 20 percent of the system) and assuming $85/foot replacement cost yields an estimated minimum system replacement value of $8,900,000. Using the guideline above the County should thus maintain between $90,000 and $270,000 for emergency reserves. Thus, the total minimum recommended reserves would be between $139,000 and $320,000 for

ELHSMD. 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.

Figure 1

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

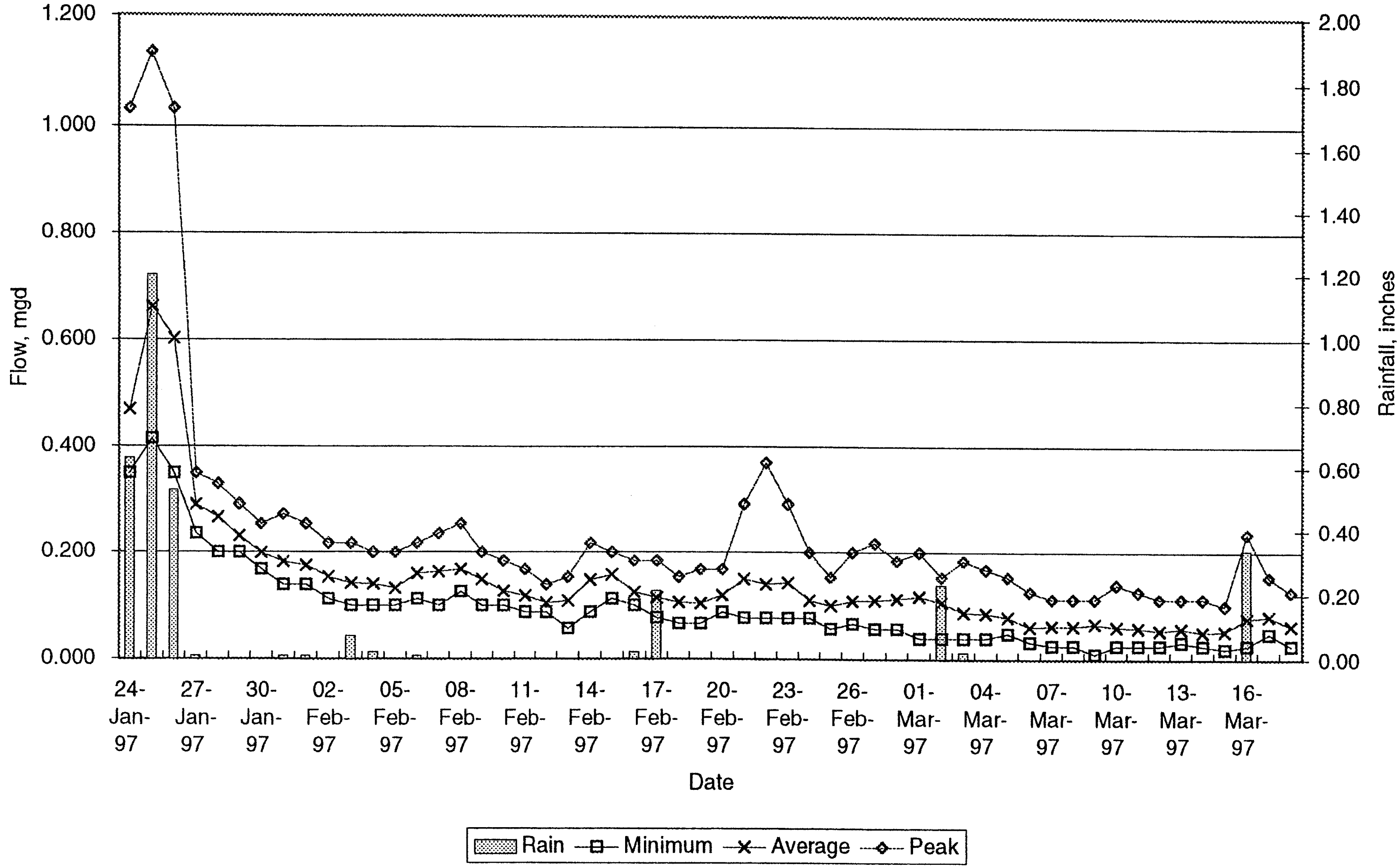
ATTACHMENT A

FLOW MONITORING SITE RECONNAISSANCE FORMS

ATTACHMENT C

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

County of San Mateo
Daily Flow Rates -- Site 11 -- 2815 Adeline, near Alvarado
8" Diameter



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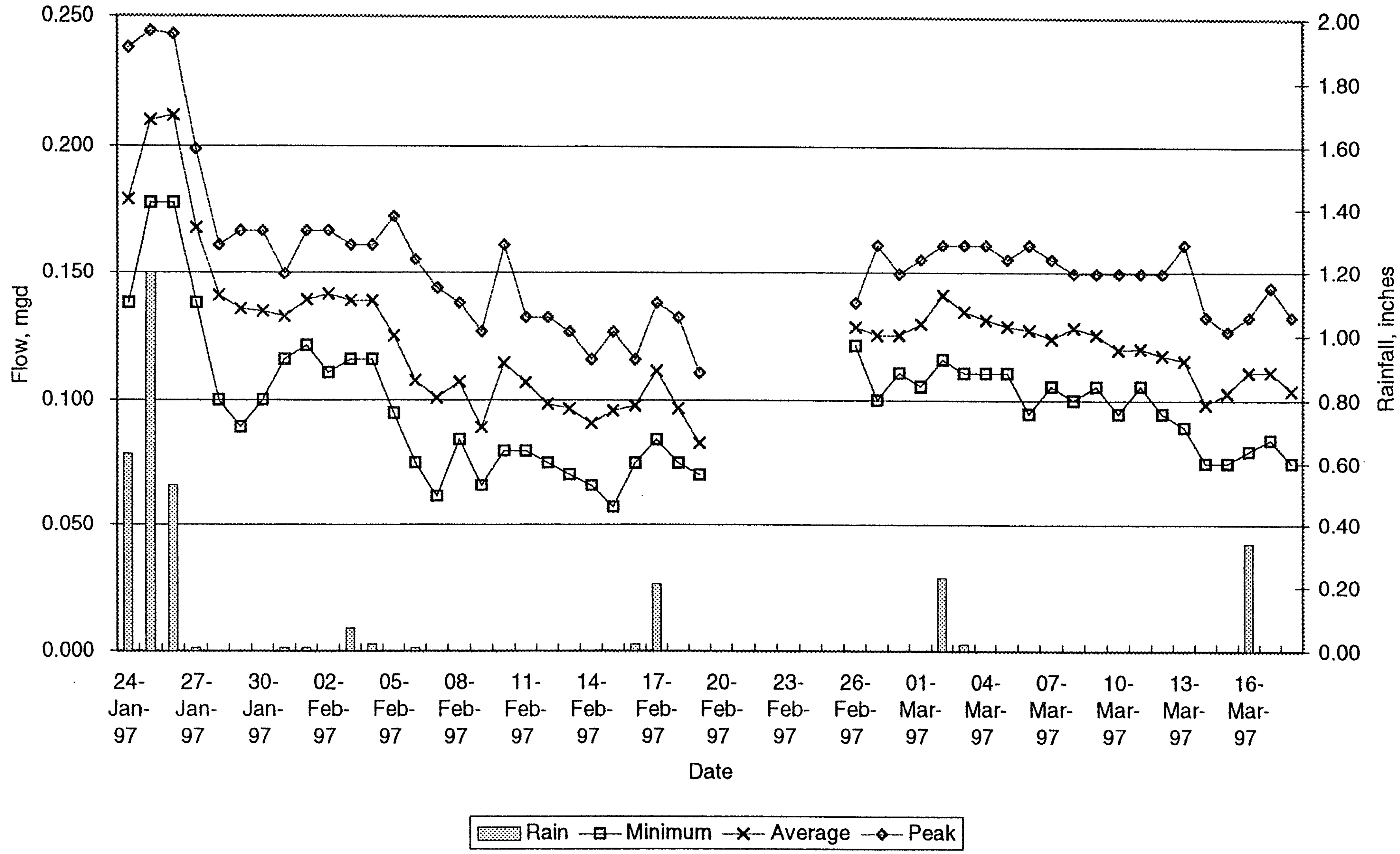
Country of San Mateo
Daily Flow Rates -- Site 12 -- 2872 Canyon Rd.
8" Diameter



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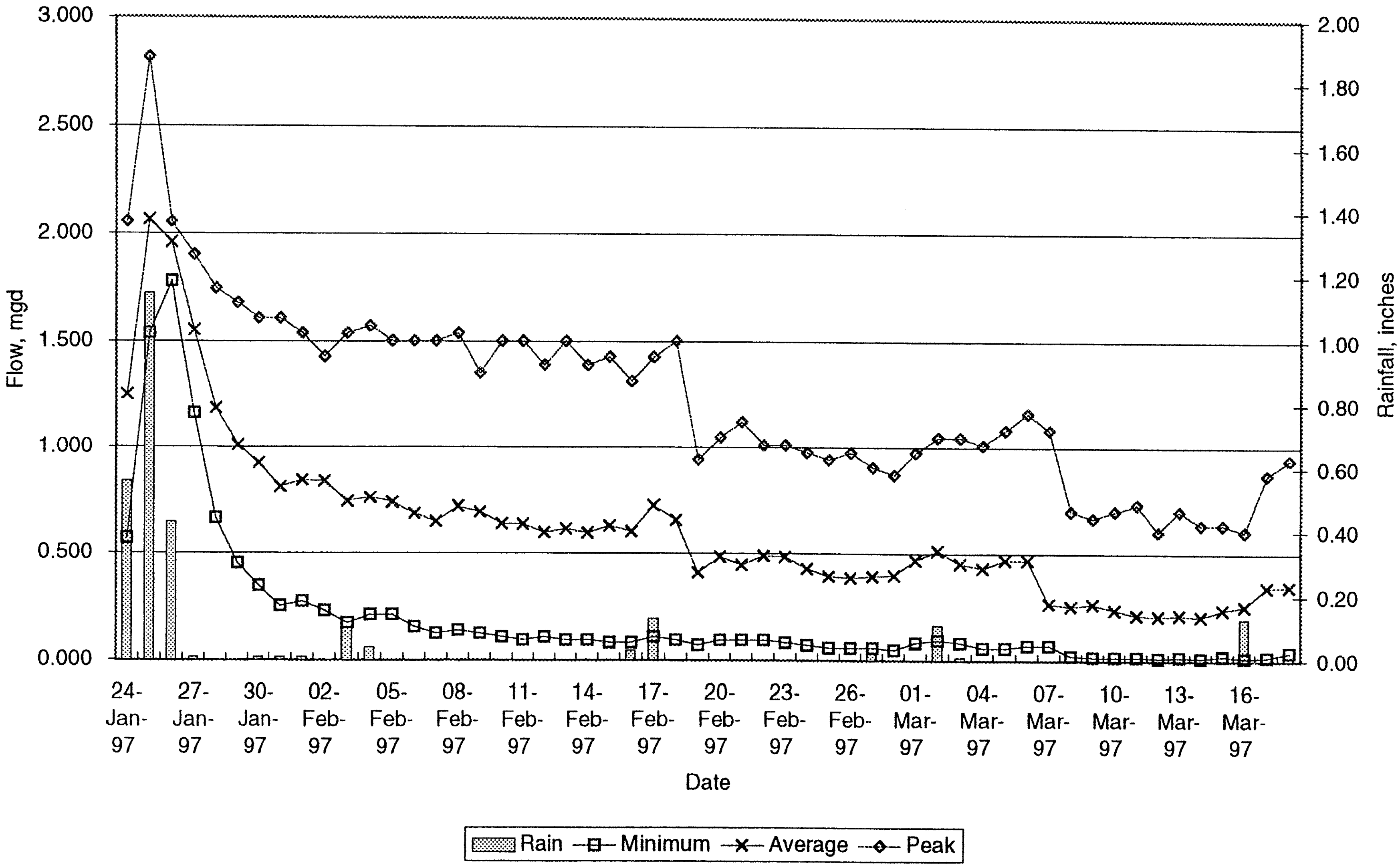
County of San Mateo
Daily Flow Rates -- Site 21 -- Polhemus Rd. below Ascension
10" Diameter



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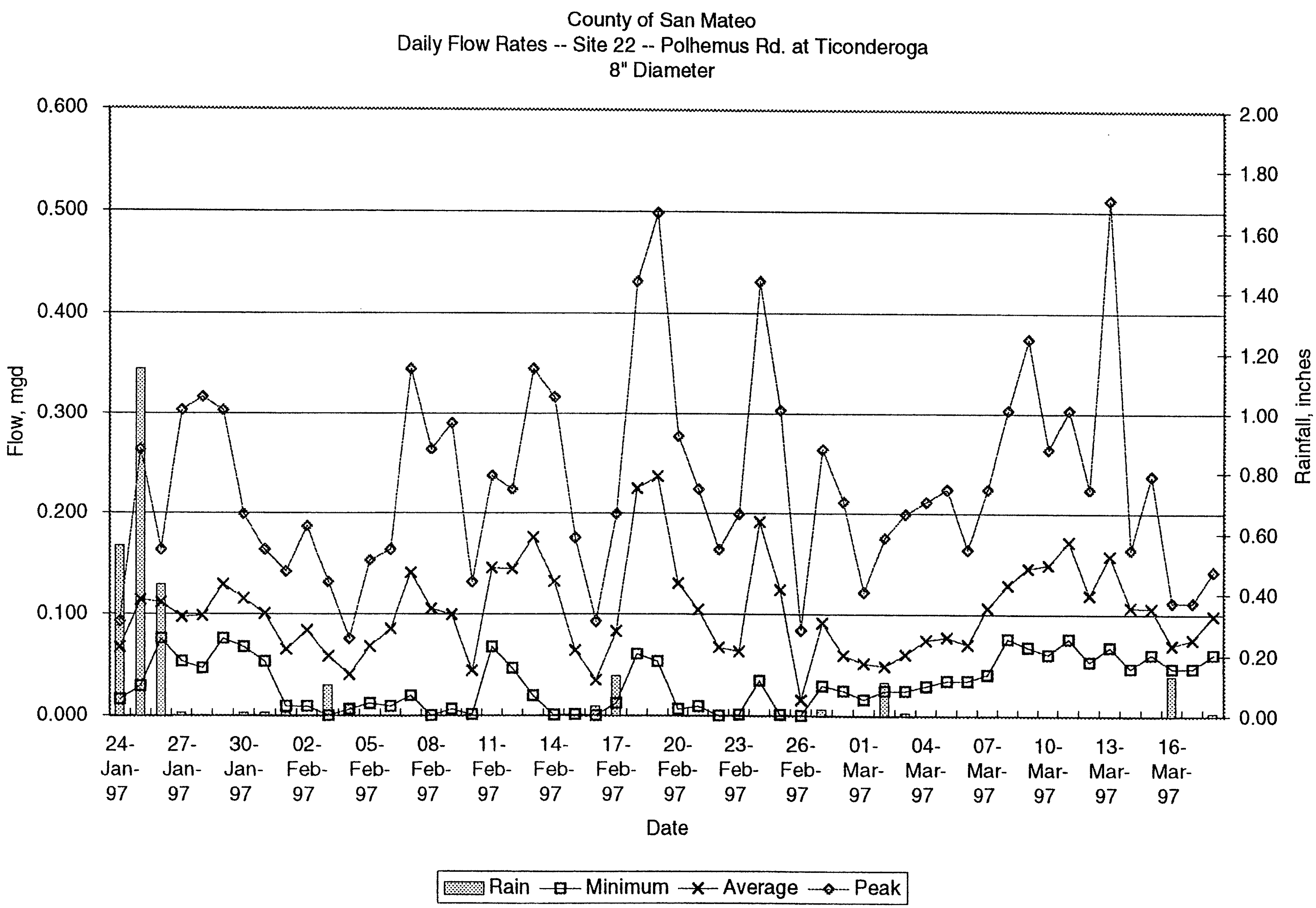

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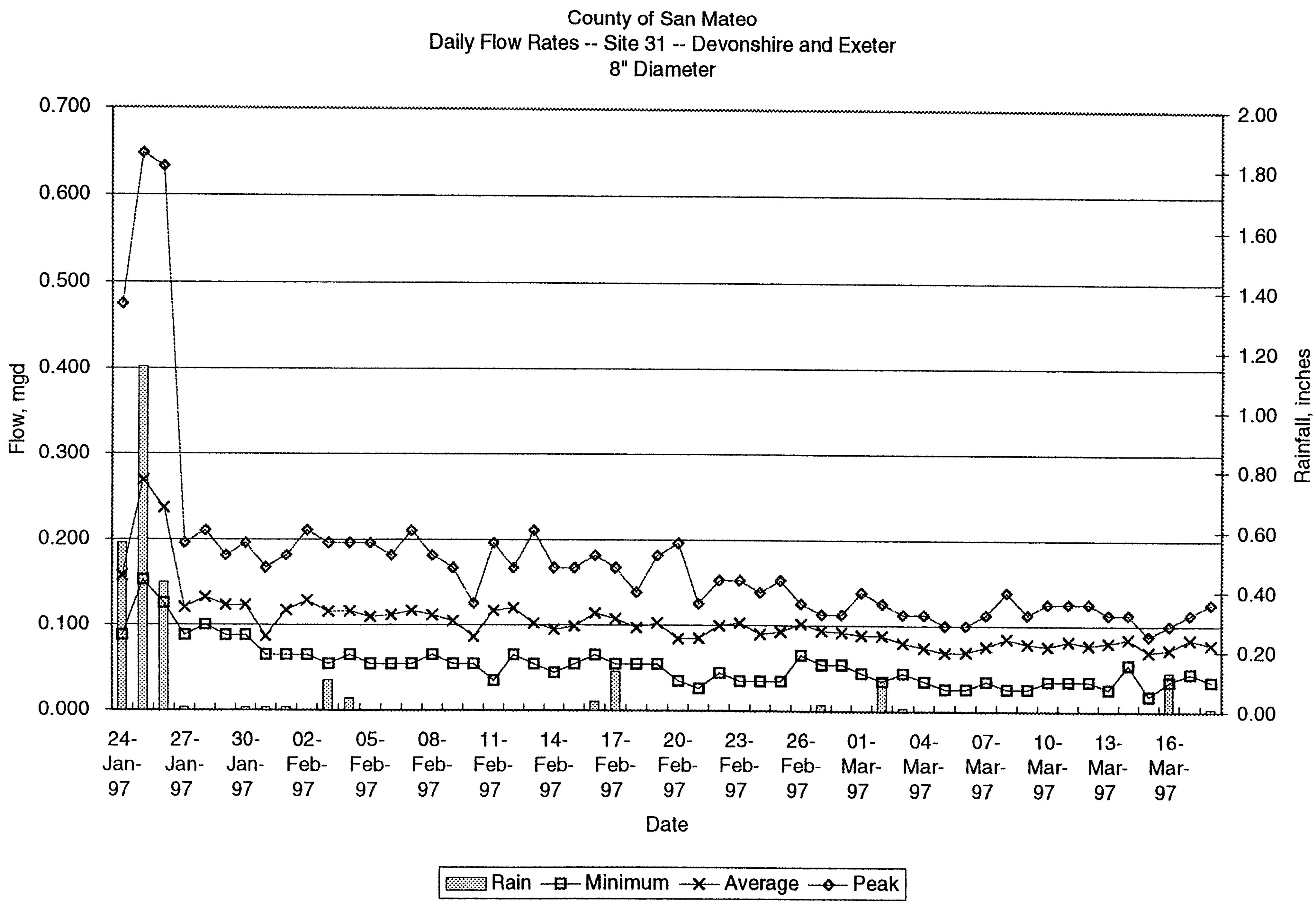

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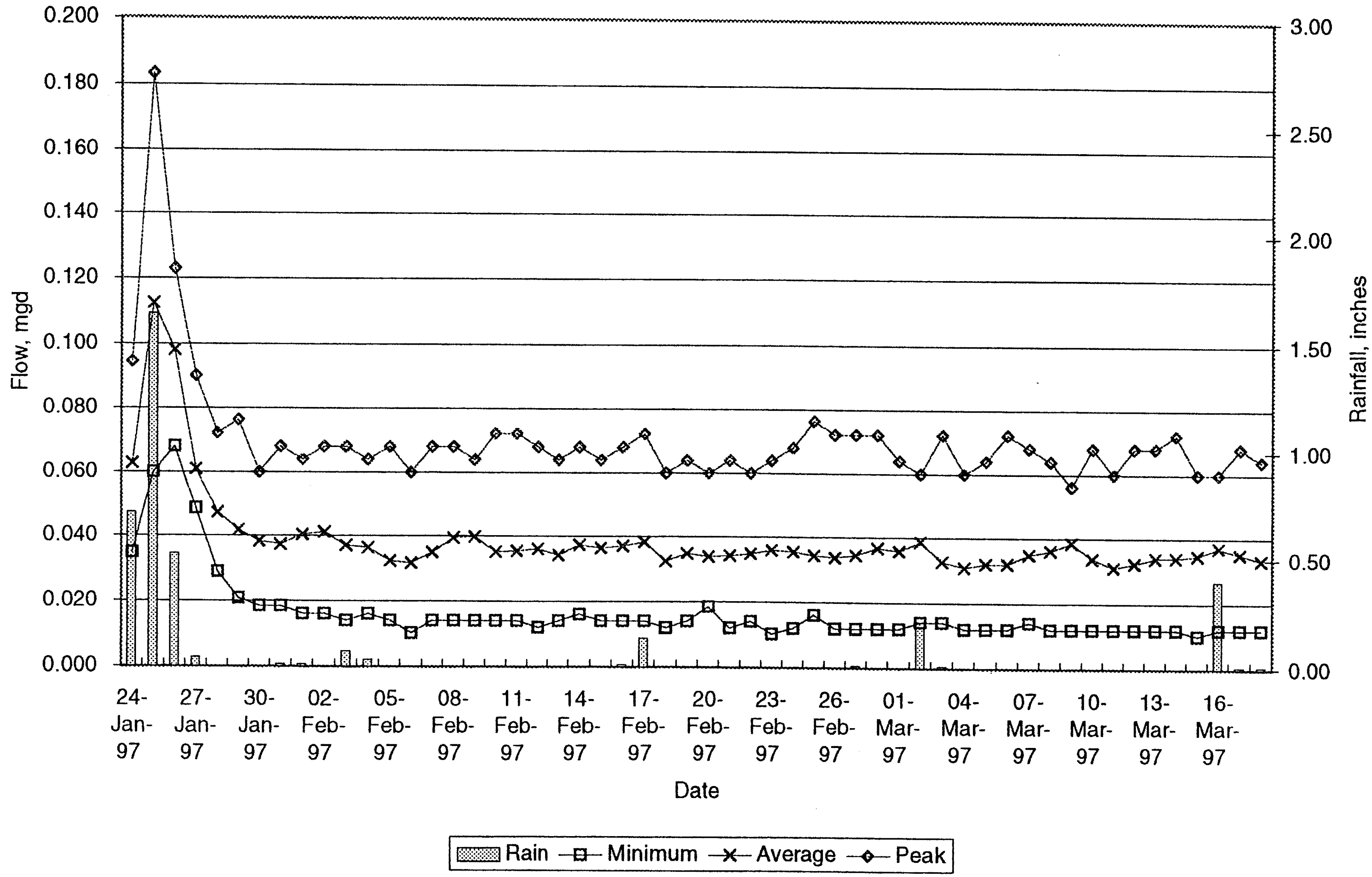
County of San Mateo
Daily Flow Rates -- Site 41 -- 1706 Cordilleras
8" Diameter



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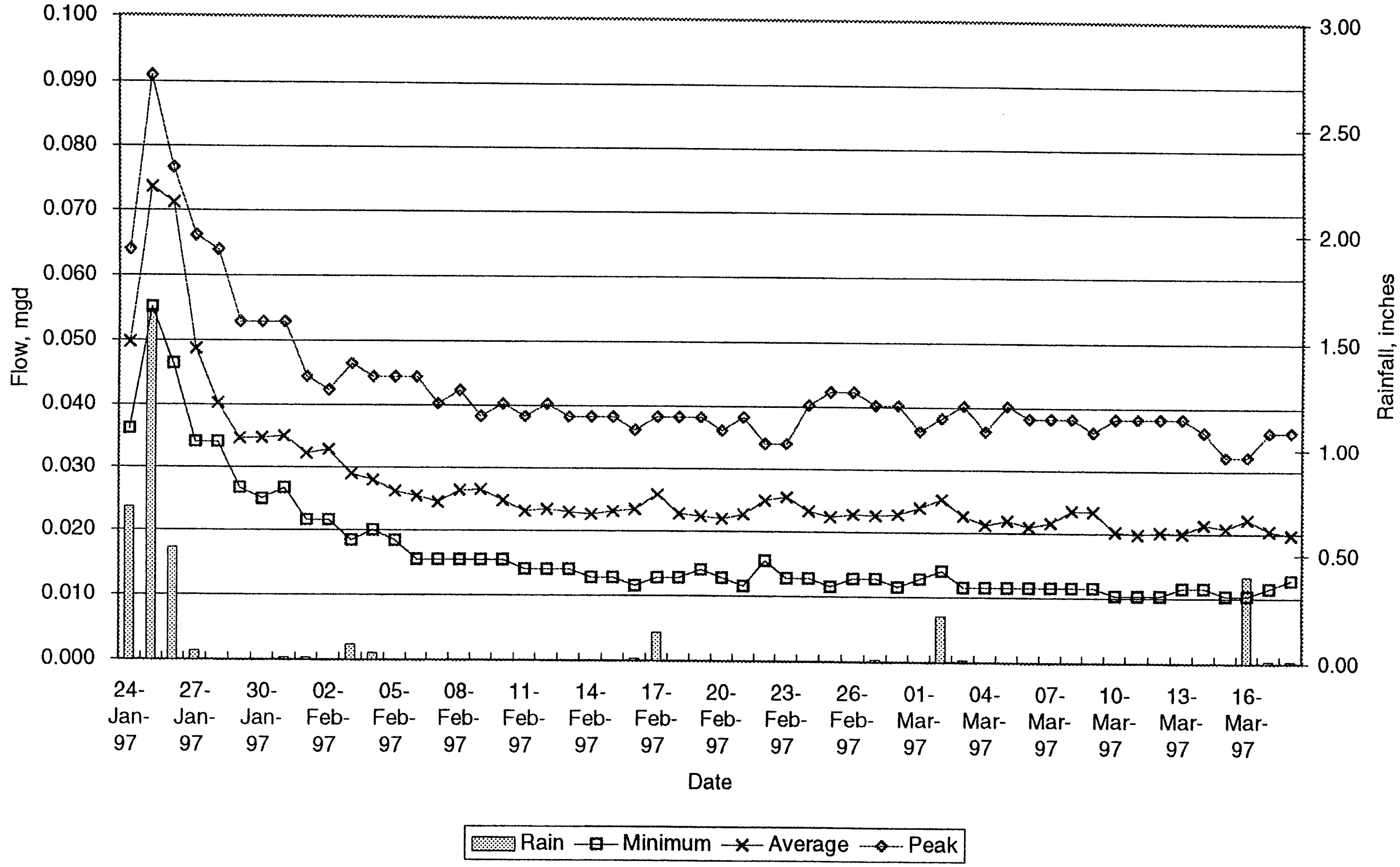
County of San Mateo
Daily Flow Rates -- Site 42 -- Lake Blvd. and Oak Knoll
8" Diameter



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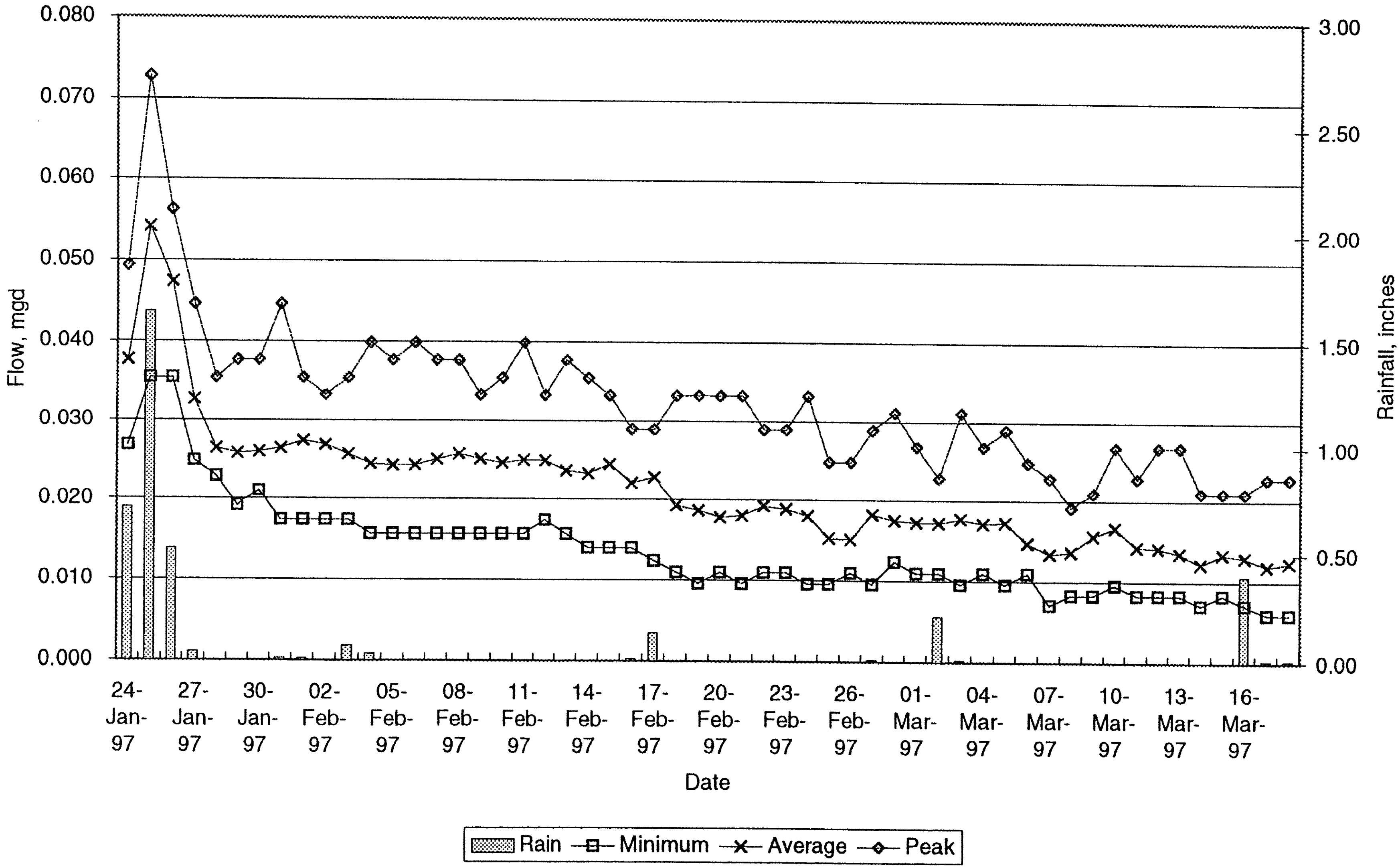
County of San Mateo
Daily Flow Rates -- Site 43 -- Glenwood Drive at Garret Pk.
6" Diameter



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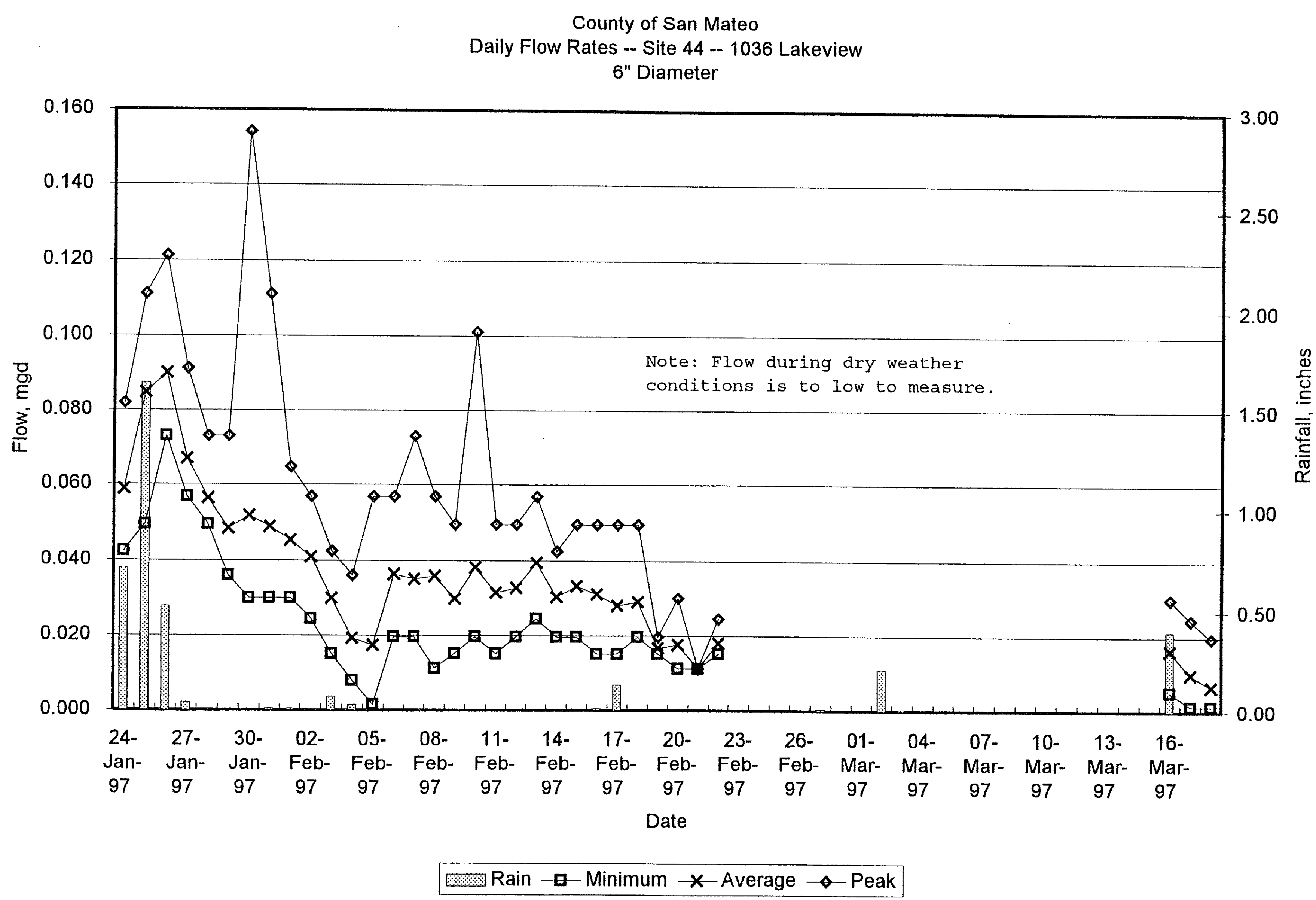

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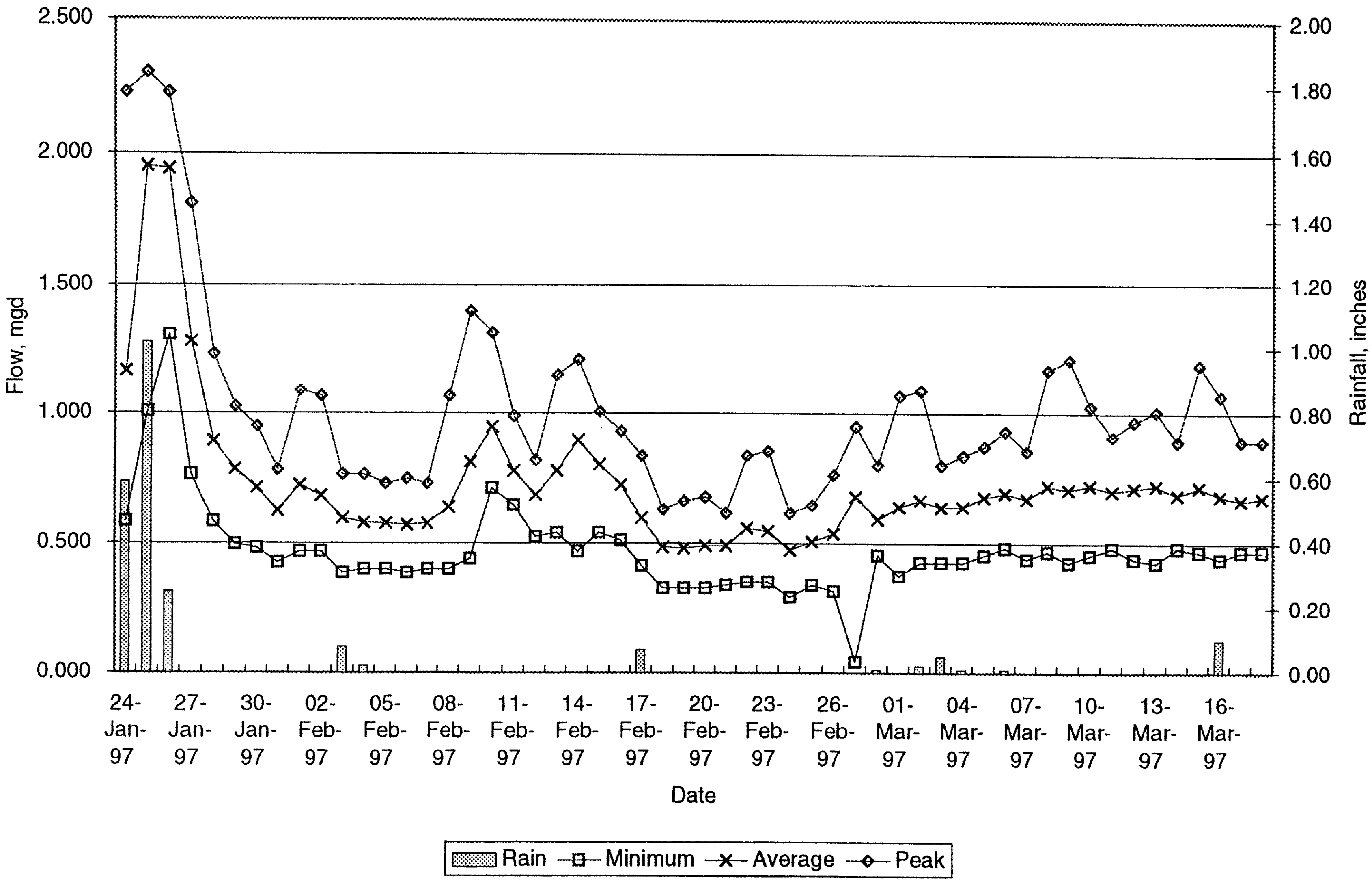
County of San Mateo
Daily Flow Rates -- Site 51 -- Douglas Ct.
30" Diameter



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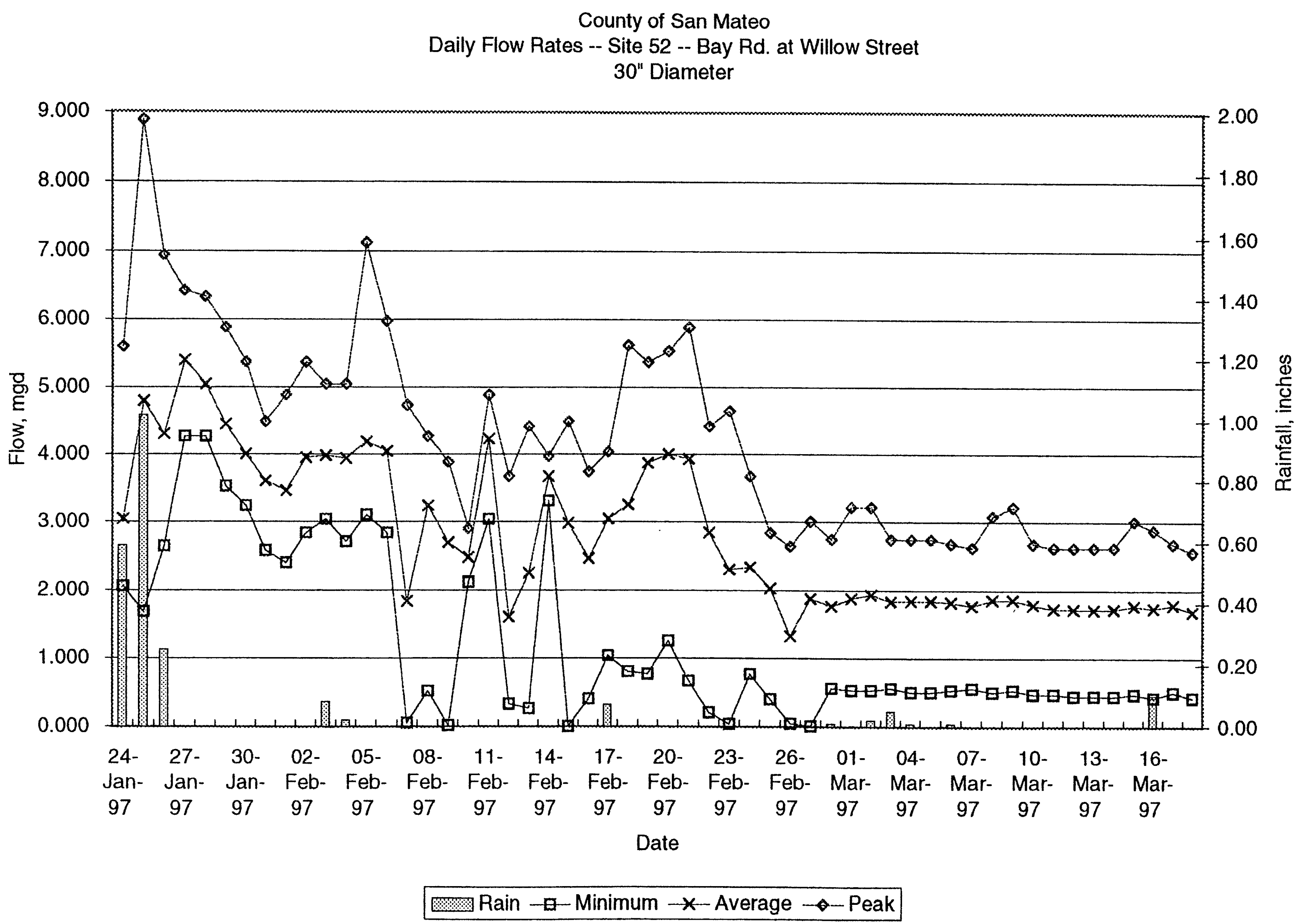

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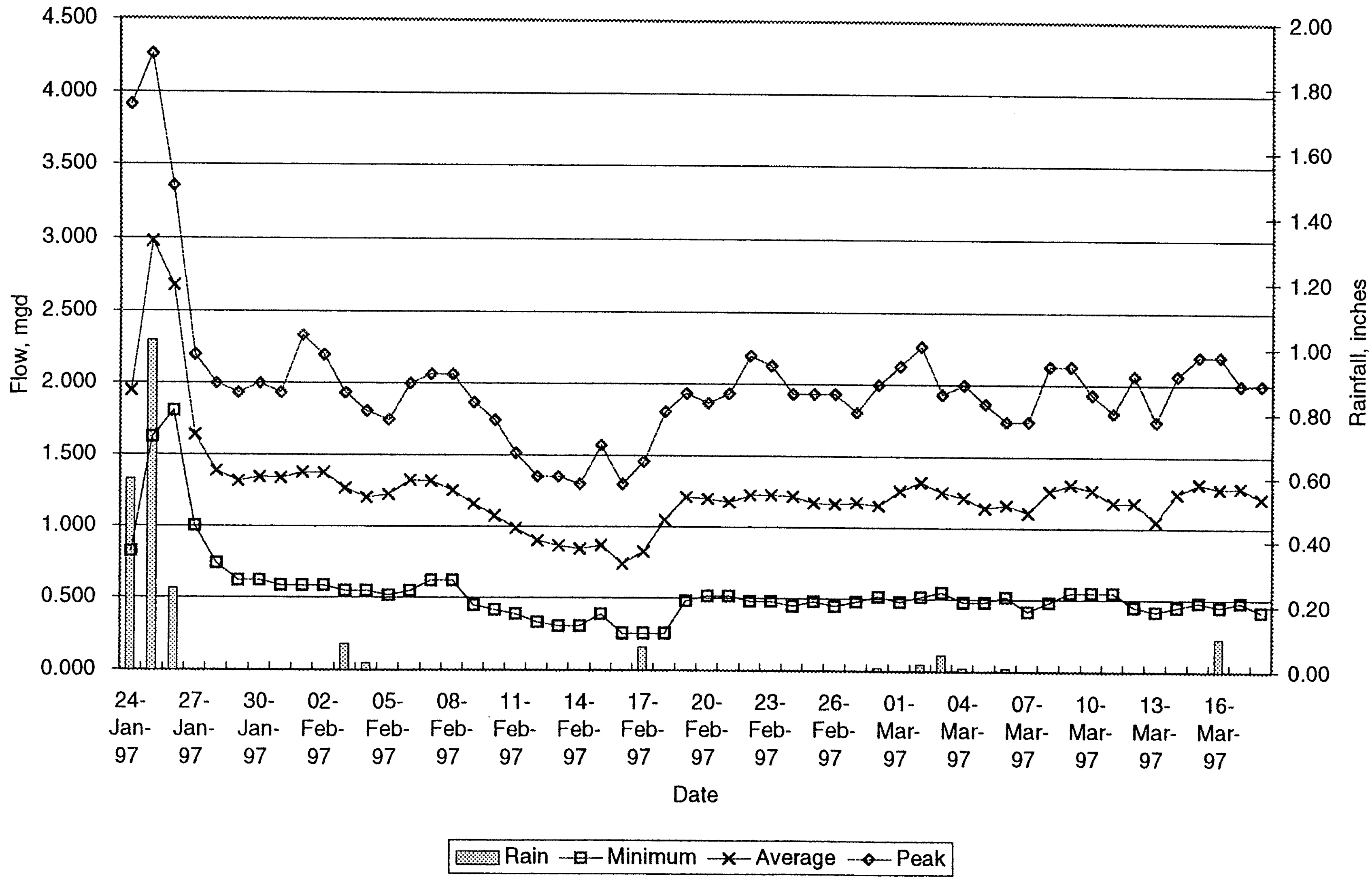
County of San Mateo
Daily Flow Rates -- Site 53 -- 559 Oakside
21" Diameter



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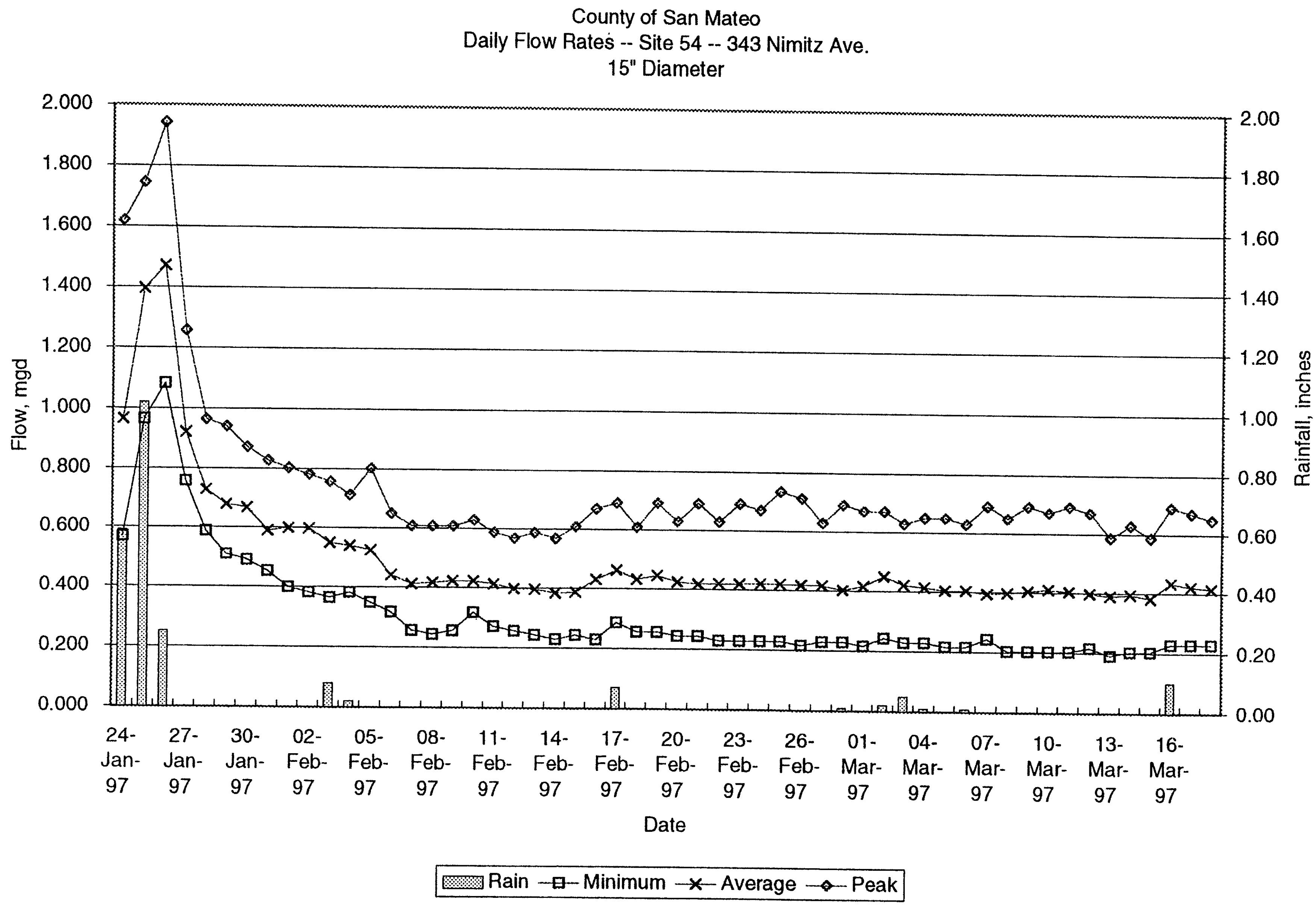

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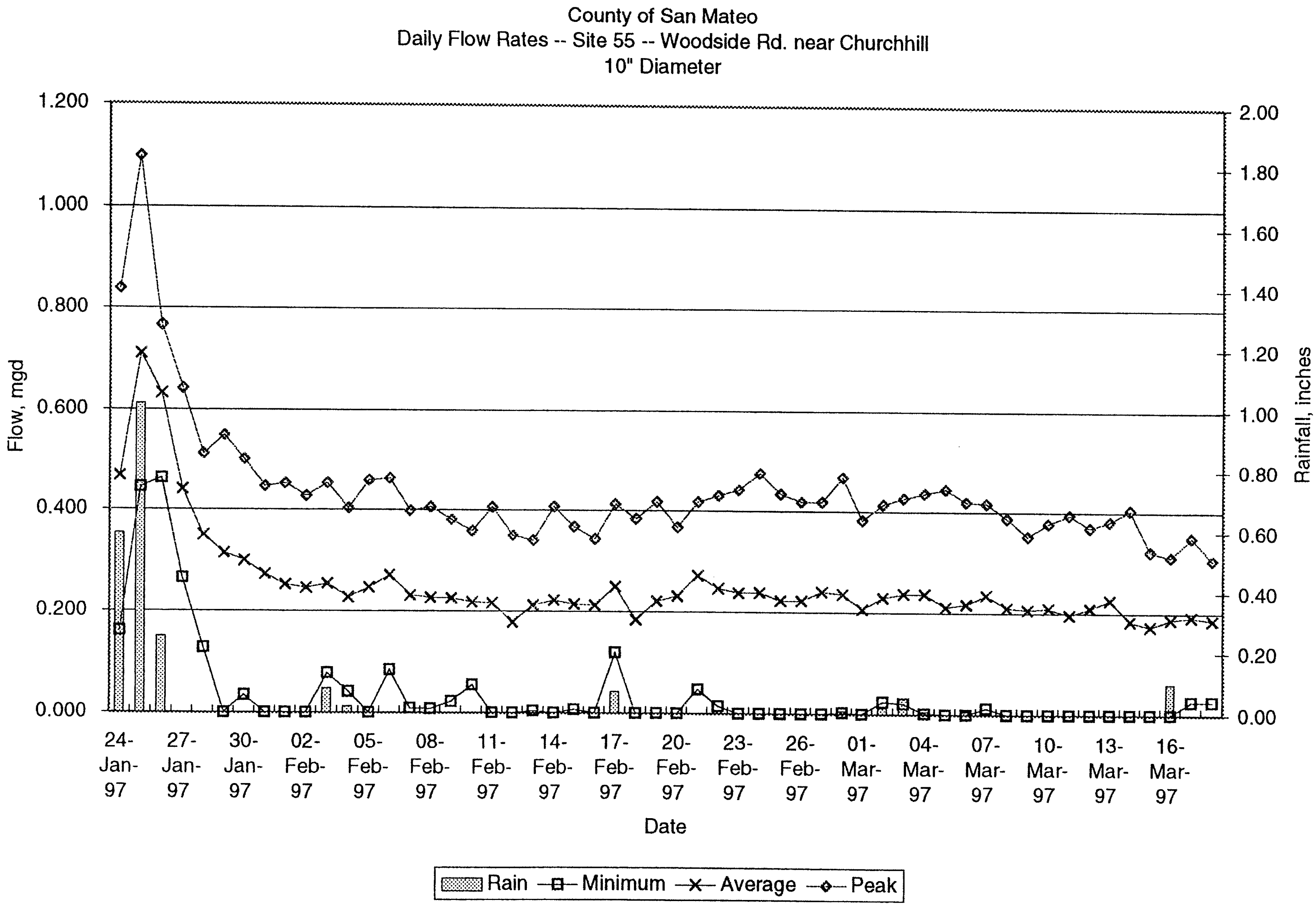

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APPENDIX C

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

County of San Mateo - Wastewater Master Plan
Mainline Sewer Internal Inspection
District: Emerald Lake

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	EST. I/I FLOW RATE, gpm	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					
1	3251 Oak Knoll Dr.	2035	2034		126																																		Unable to tape
2	3252 Oak Knoll Dr.	2034	2033		120																																		Unable to tape
3	3253 Oak Knoll Dr.	2061	2060		160																																		Unable to tape
4	3254 Oak Knoll Dr.	2060	2033		27																																		Unable to tape
5	3244 Oak Knoll Dr.	2033	2032		280																																		Unable to tape
6	122 Springdale Way	1083	1088		58		6	PVC																															Unable to tape
7	122 Springdale Way	1090	1083		97		6	PVC																															Unable to tape
8	2441 Lake Blvd.	2014	2049		110																																		Unable to tape
9	2441 Lake Blvd.	2049	2050		210		8	PVC																															Unable to tape
10	2442 Lake Blvd.	2049	2048		186		8	PVC																															Unable to tape
11	719 California	4137	4136		203	203	6	PVC	12/23/98	4-9																									2			1	
12	734 California	4136	4135		181	181	6	PVC	12/23/98	4-10																									4			2	
13	734 California	4136	4142		113	113	6	PVC	12/23/98	4-11																									1			1	
14	734 California	4142	4144		86		6	PVC	12/23/98	4-12																													Unable to get up and top MH is locked.
TOTAL					1186	497																													7				

APPENDIX E

HYDRAULIC MODEL 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	

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EMERALD LAKE HEIGHTS 5-year 6-hour Storm

*** CORDILLERAS41 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
1	42	0.0095	563.90	0.0	0.1	0.10	0.31	568.50	570.00	
		6	563.50	0.0	0.0	2.01	32.09	564.10	563.70	
E124117						0.41		4.40	6.30	
2	180	0.2472	563.50	0.0	0.1	0.10	1.56	570.00	523.00	
		6	519.00	0.0	0.0	6.60	6.31	563.60	519.10	
E124017						0.19		6.40	3.90	
3	205	0.5707	519.00	0.0	0.1	0.10	2.38	523.00	408.00	
		6	402.00	0.0	0.0	9.03	4.15	519.08	402.08	
E123917						0.16		3.92	5.92	
4	110	0.0827	402.00	0.1	0.1	0.15	0.91	408.00	397.00	
		6	392.90	0.0	0.0	4.83	16.35	402.14	393.04	
E121517						0.29		5.86	3.96	
5	160	0.1662	392.90	0.1	0.1	0.15	1.28	397.00	370.00	
		6	366.30	0.0	0.0	6.36	11.54	393.03	366.43	
E121417						0.25		3.97	3.57	
6	60	0.1383	366.30	0.1	0.1	0.15	1.17	370.00	362.00	
		6	358.00	0.0	0.0	5.91	12.65	366.43	358.13	
E121308						0.26		3.57	3.87	
7	275	0.0065	358.00	0.1	0.1	0.15	0.25	362.00	360.00	
		6	356.20	0.0	0.0	1.98	58.13	358.28	356.48	
E121207						0.57		3.72	3.52	
8	87	0.0690	356.20	0.1	0.1	0.15	0.83	360.00	354.00	
		6	350.20	0.0	0.0	4.51	17.91	356.35	350.35	
E121107						0.30		3.65	3.65	
9	325	0.1117	350.20	0.1	0.1	0.15	1.05	354.00	316.00	
		6	313.90	0.0	0.0	5.42	14.07	350.34	314.04	
E121007						0.27		3.66	1.96	
10	50	0.0420	313.90	0.1	0.1	0.15	0.64	316.00	314.00	
		6	311.80	0.0	0.0	3.78	22.95	314.07	311.97	
E120907						0.34		1.93	2.03	
11	110	0.0264	311.80	0.1	0.1	0.15	0.51	314.00	316.00	
		6	308.90	0.0	0.0	3.24	28.97	311.99	309.09	
E120807						0.39		2.01	6.91	
12	90	0.0189	308.90	0.1	0.1	0.15	0.43	316.00	314.00	
		6	307.20	0.0	0.0	2.88	34.22	309.11	307.41	
E120707						0.42		6.89	6.59	

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MGD

EMERALD LAKE HEIGHTS 5-year 6-hour Storm

*** CORDILLERAS41 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
13	150	0.0187	307.20	0.1	0.1	0.15	0.43	314.00	310.00	
		6	304.40	0.0	0.0	2.87	34.42	307.41	304.61	
E120607						0.42		6.59	5.39	
14	30	0.2467	304.40	0.1	0.1	0.15	1.56	310.00	304.00	
		6	297.00	0.0	0.0	7.35	9.47	304.52	297.12	
E117707						0.23		5.48	6.88	
15	250	0.0316	297.00	0.1	0.1	0.20	0.56	304.00	296.00	
		6	289.10	0.0	0.0	3.75	35.27	297.21	289.31	
E117607						0.43		6.79	6.69	
16	70	0.0329	289.10	0.1	0.1	0.20	0.57	296.00	292.00	
		6	286.80	0.0	0.0	3.81	34.60	289.31	287.01	
E117506						0.43		6.69	4.99	
17	35	0.2171	286.80	0.1	0.1	0.20	1.47	292.00	284.00	
		6	279.20	0.0	0.0	7.49	13.46	286.93	279.33	
E117406						0.27		5.07	4.67	
18	133	0.0165	279.20	0.1	0.1	0.20	0.87	284.00	281.00	
		8	277.00	0.0	0.0	2.86	22.64	279.42	277.22	
E117306						0.34		4.58	3.78	
19	70	0.0159	277.00	0.1	0.1	0.20	0.85	281.00	280.19	
		8	275.89	0.0	0.0	2.82	23.12	277.23	276.12	
E117206						0.34		3.77	4.07	
20	135	0.0276	275.89	0.1	0.1	0.20	0.52	280.19	277.26	
		6	272.16	0.0	0.0	3.58	37.73	276.11	272.38	
E117106						0.45		4.08	4.88	
21	30	0.4633	272.16	0.1	0.1	0.20	2.14	277.26	274.36	
		6	258.26	0.0	0.0	9.99	9.21	272.27	258.37	
E117006						0.23		4.99	15.99	
22	55	0.0225	258.26	0.1	0.2	0.25	1.02	274.36	273.82	
		8	257.02	0.0	0.0	3.41	24.23	258.49	257.25	
E116906						0.35		15.87	16.57	
23	75	0.0265	257.02	0.1	0.2	0.25	1.10	273.82	265.23	***
		8	255.03	0.0	0.0	1.09	22.34	257.42	255.80	
E1168C06						0.33		16.40	9.43	
24	50	0.0194	255.03	0.1	0.2	0.25	0.94	265.23	262.26	***
		8	254.06	0.0	0.0	1.09	26.13	255.80	255.74	
E1168B06						0.36		9.43	6.52	

EMERALD LAKE HEIGHTS 5-year 6-hour Storm

*** CORDILLERAS41

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	320	0.0011	254.06	0.1	0.2	0.25	0.11	262.26	258.00	***
		6	253.70	0.0	0.0	1.94	233.70	255.74	254.20	8
E1168A06						1.00	0.14	6.52	3.80	10
26	150	0.0580	253.70	0.1	0.2	0.25	0.76	258.00	250.00	
		6	245.00	0.0	0.0	4.98	32.55	253.91	245.21	
E116805						0.41		4.09	4.79	
27	32	0.0441	245.00	0.1	0.2	0.25	0.66	250.00	253.59	
		6	243.59	0.0	0.0	4.50	37.34	245.22	243.81	
E116702						0.44		4.78	9.78	
28	70	0.1484	243.49	0.1	0.2	0.25	1.21	253.59	246.00	
		6	233.10	0.0	0.0	6.85	20.35	243.65	233.26	
E116602						0.32		9.94	12.74	
29	58	0.0353	233.10	0.1	0.2	0.25	1.27	246.00	242.05	
		8	231.05	0.0	0.0	4.00	19.36	233.31	231.26	
E1165A02						0.31		12.69	10.79	
30	120	0.0322	231.05	0.1	0.2	0.25	0.56	242.05	234.99	
		6	227.19	0.0	0.0	4.04	43.71	231.29	227.43	
E116502						0.48		10.76	7.56	
31	100	0.0233	227.19	0.1	0.2	0.25	0.48	234.99	231.56	
		6	224.86	0.0	0.0	3.60	51.35	227.45	225.12	
E116402						0.53		7.54	6.44	
32	69	0.0203	224.86	0.1	0.2	0.25	0.97	231.56	226.96	
		8	223.46	0.0	0.0	3.30	25.55	225.10	223.70	
E116302						0.36		6.46	3.26	
33	128	0.0183	223.46	0.1	0.2	0.25	0.43	226.96	229.02	
		6	221.12	0.0	0.0	3.31	57.97	223.74	221.40	
E116202						0.57		3.22	7.62	
34	66	0.0124	221.12	0.1	0.2	0.25	0.35	229.02	226.30	
		6	220.30	0.0	0.0	2.90	70.32	221.44	220.62	
E116102						0.64		7.58	5.68	
35	140	0.0143	220.30	0.1	0.2	0.25	0.38	226.30	224.00	
		6	218.30	0.0	0.0	3.05	65.58	220.60	218.60	
E116002						0.61		5.70	5.40	
36	105	0.0351	218.30	0.1	0.2	0.25	0.59	224.00	222.31	
		6	214.61	0.0	0.0	4.19	42.64	218.54	214.85	
E115801						0.48		5.46	7.46	

EMERALD LAKE HEIGHTS 5-year 6-hour Storm

*** CORDILLERAS41 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	45	0.0178	214.61	0.1	0.2	0.25	0.90	222.31	217.91	***
		8	213.81	0.0	0.0	1.12	27.84	214.98	214.67	
E115701						0.38		7.33	3.24	
38	145	0.0028	213.81	0.1	0.2	0.25	0.17	217.91	217.50	***
		6	213.40	0.0	0.0	1.98	150.34	214.67	213.90	6
E115601						1.00	0.08	3.24	3.60	8
39	80	0.0342	213.40	0.1	0.2	0.25	0.58	217.50	215.46	
		6	210.66	0.0	0.0	4.15	43.20	213.64	210.90	
E115501						0.48		3.86	4.56	
40	85	0.0278	210.66	0.1	0.2	0.25	0.52	215.46	212.00	***
		6	208.30	0.0	0.0	1.98	47.98	211.13	209.42	
E115401						0.51		4.33	2.58	
41	145	0.0007	208.30	0.1	0.2	0.25	0.08	212.00	213.00	***
		6	208.20	0.0	0.0	1.98	304.41	209.42	208.70	8
E115301						1.00	0.17	2.58	4.30	10
42	45	0.0089	208.20	0.1	0.2	0.25	0.30	213.00	213.00	
		6	207.80	0.0	0.0	2.60	84.79	208.56	208.16	
E115201						0.72		4.44	4.84	
43	230	0.0196	207.80	0.1	0.2	0.25	0.95	213.00	208.00	
		8	203.30	0.0	0.0	3.28	26.54	208.05	203.55	
E115101						0.37		4.95	4.45	
44	172	0.0581	203.30	0.1	0.2	0.25	0.76	208.00	200.00	
		6	193.30	0.0	0.0	5.01	33.15	203.51	193.51	
E115004						0.42		4.49	6.49	
45	130	0.0415	193.30	0.1	0.2	0.25	0.64	200.00	195.00	
		6	187.90	0.0	0.0	4.44	39.22	193.53	188.13	
E114904						0.46		6.47	6.87	
46	295	0.0227	187.90	0.1	0.2	0.25	0.47	195.00	189.00	
		6	181.20	0.0	0.0	3.59	53.05	188.17	181.47	
E114804						0.54		6.83	7.53	
47	260	0.0089	181.20	0.1	0.2	0.25	0.30	189.00	184.89	
		6	178.89	0.0	0.0	2.58	83.16	181.55	179.24	
E114704						0.71		7.45	5.65	
48	145	0.0156	178.89	0.1	0.2	0.25	0.39	184.89	181.03	
		6	176.63	0.0	0.0	3.14	62.79	179.19	176.93	
E114604						0.59		5.70	4.10	

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MGD

EMERALD LAKE HEIGHTS 5-year 6-hour Storm

*** CORDILLERAS41

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
49	145	0.0078	176.63	0.1	0.2	0.35	0.60	181.03	182.00	
		8	175.50	0.0	0.0	2.62	57.70	177.01	175.88	
E103804						0.56		4.02	6.12	
50	270	0.0381	175.50	0.1	0.2	0.35	1.32	182.00	170.00	
		8	165.20	0.0	0.0	4.55	26.09	175.74	165.44	
E103704						0.36		6.26	4.56	
51	74	0.0054	165.20	0.1	0.2	0.35	0.50	170.00	170.00	
		8	164.80	0.0	0.0	2.31	69.30	165.62	165.22	
E103613						0.63		4.38	4.78	
52	83	0.0217	164.80	0.2	0.3	0.44	1.00	170.00	168.00	
		8	163.00	0.0	0.0	4.04	44.47	165.13	163.33	
E103513						0.49		4.87	4.67	
53	182	0.0126	163.00	0.2	0.3	0.44	0.76	168.00	169.00	
		8	160.70	0.0	0.0	3.34	58.28	163.38	161.08	
E132213						0.57		4.62	7.92	
54	110	0.0036	160.20	0.2	0.3	0.44	0.41	168.50	168.00	
		8	159.80	0.0	0.0	1.97	108.64	160.77	160.37	4
E103413						0.86	0.04	7.73	7.63	10
55	40	0.0225	159.80	0.2	0.3	0.44	1.02	168.00	166.00	
		8	158.90	0.0	0.0	4.09	43.67	160.12	159.22	
E103313						0.48		7.88	6.78	
56	108	0.0046	158.90	0.2	0.3	0.44	0.46	166.00	164.00	
		8	158.40	0.0	0.0	2.35	96.28	159.42	158.92	
E103213						0.78		6.58	5.08	
57	196	0.0036	158.40	0.2	0.3	0.44	0.41	164.00	163.00	
		8	157.70	0.0	0.0	1.97	109.62	158.98	158.28	4
E103113						0.86	0.04	5.02	4.72	10
58	103	0.0049	157.70	0.2	0.3	0.44	0.47	163.00	162.50	
		8	157.20	0.0	0.0	2.39	94.03	158.21	157.71	
E103013						0.77		4.79	4.79	
59	34	0.0088	157.20	0.2	0.3	0.44	0.64	162.50	162.00	
		8	156.90	0.0	0.0	2.96	69.74	157.62	157.32	
E102913						0.63		4.88	4.68	
60	235	0.0264	156.90	0.2	0.3	0.44	1.10	162.00	156.00	***
		8	150.70	0.0	0.0	1.97	40.33	157.47	151.75	
E102813						0.46		4.53	4.25	

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EMERALD LAKE HEIGHTS 5-year 6-hour Storm

*** CORDILLERAS41 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
61	68	0.0074	150.70	0.2	0.3	0.44	0.58	156.00	156.00	***
		8	150.20	0.0	0.0	1.97	76.40	151.75	151.50	
E1027A22						0.67		4.25	4.50	
62	330	0.0061	150.20	0.2	0.3	0.44	0.53	156.00	166.00	***
		8	148.20	0.0	0.0	1.97	84.15	151.50	150.41	
E102722						0.71		4.50	15.59	
63	200	0.0085	148.20	0.2	0.3	0.45	0.62	166.00	164.00	***
		8	146.50	0.0	0.0	1.98	71.66	150.41	149.73	
E102522						0.64		15.59	14.27	
64	245	0.0086	146.50	0.3	0.5	0.74	0.63	164.00	158.00	***
		8	144.40	0.0	0.0	3.29	118.23	149.73	147.33	6
E102322						1.00	0.11	14.27	10.67	10
65	277	0.0090	144.40	0.3	0.5	0.74	0.64	158.00	152.00	***
		8	141.90	0.0	0.0	3.29	115.28	147.33	144.76	4
E102222						0.91	0.10	10.67	7.24	10
66	300	0.0023	141.90	0.3	0.5	0.74	0.33	152.00	148.00	***
		8	141.20	0.0	0.0	3.29	226.72	144.76	141.98	10
E102122						1.00	0.41	7.24	6.02	12
67	134	0.0343	141.20	0.3	0.5	0.74	1.26	148.00	145.50	***
		8	136.60	0.0	0.0	3.29	59.11	141.98	138.14	
E102034						0.57		6.02	7.36	
68	142	0.0042	136.60	0.3	0.5	0.74	0.44	145.50	143.50	***
		8	136.00	0.0	0.0	3.29	168.48	138.14	136.78	8
E101734						1.00	0.30	7.36	6.72	10
69	65	0.0231	136.00	0.3	0.5	0.74	1.03	143.50	143.00	***
		8	134.50	0.0	0.0	3.29	72.09	136.78	136.01	
E1016A34						0.65		6.72	6.99	
70	82	0.0012	134.50	0.3	0.5	0.74	0.24	143.00	144.50	***
		8	134.40	0.0	0.0	3.29	313.61	136.01	135.19	12
E101634						1.00	0.51	6.99	9.31	15
71	190	0.0126	134.40	0.3	0.5	0.74	0.76	144.50	144.00	***
		8	132.00	0.0	0.0	3.29	97.44	135.19	133.18	
E101534						0.79		9.31	10.82	
72	70	0.0029	132.00	0.3	0.5	0.74	0.36	144.00	142.00	***
		8	131.80	0.0	0.0	3.29	204.89	133.18	132.47	10
E101434						1.00	0.38	10.82	9.53	12

EMERALD LAKE HEIGHTS 5-year 6-hour Storm

*** CORDILLERAS41 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
73 E101134	400	0.0095 15	131.80 128.00	0.4 0.0	0.7 0.0	0.99 3.54 0.38	3.53 27.95	142.00 132.27 9.73	133.00 128.47 4.53	

Lateral length= 9995 Upstream length= 9995

*** A42 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
74 E220127	120	0.0825 6	587.80 577.90	0.0 0.0	0.0 0.0	0.07 4.00 0.21	0.90 7.53	592.00 587.90 4.10	583.00 578.00 5.00	
75 E220027	106	0.0420 6	577.90 573.45	0.0 0.0	0.0 0.0	0.07 3.13 0.24	0.64 10.54	583.00 578.02 4.98	578.00 573.57 4.43	
76 E219927	126	0.0552 6	573.45 566.50	0.0 0.0	0.0 0.0	0.07 3.45 0.23	0.74 9.19	578.00 573.56 4.44	571.00 566.61 4.39	
77 E219827	110	0.0623 6	566.25 559.40	0.0 0.0	0.0 0.0	0.07 3.60 0.22	0.79 8.65	571.00 566.36 4.64	563.00 559.51 3.49	
78 E219727	130	0.1023 6	559.40 546.10	0.0 0.0	0.0 0.0	0.07 4.33 0.20	1.01 6.75	563.00 559.50 3.50	550.00 546.20 3.80	
79 E219627	113	0.0850 6	546.10 536.50	0.0 0.0	0.0 0.0	0.07 4.04 0.21	0.92 7.41	550.00 546.20 3.80	541.00 536.60 4.40	
80 E219527	155	0.0897 6	536.50 522.60	0.0 0.0	0.0 0.0	0.07 4.13 0.20	0.94 7.21	541.00 536.60 4.40	527.00 522.70 4.30	
81 E219427	115	0.0717 6	522.60 514.35	0.0 0.0	0.0 0.0	0.07 3.79 0.21	0.84 8.06	527.00 522.71 4.29	518.00 514.46 3.54	

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EMERALD LAKE HEIGHTS 5-year 6-hour Storm

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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
82	180	0.0581	514.35	0.0	0.0	0.07	0.76	518.00	509.00	
		6	503.90	0.0	0.0	3.51	8.96	514.46	504.01	
E219327						0.23		3.54	4.99	
83	40	0.0125	503.90	0.0	0.0	0.07	0.35	509.00	508.00	
		6	503.40	0.0	0.0	1.96	19.31	504.06	503.56	
E218027						0.31		4.94	4.44	
84	195	0.0200	503.40	0.0	0.0	0.07	0.45	508.00	505.00	
		6	499.50	0.0	0.0	2.34	15.26	503.54	499.64	
E217927						0.28		4.46	5.36	
85	55	0.0045	499.50	0.0	0.0	0.07	0.21	505.00	505.00	
		6	499.25	0.0	0.0	1.39	32.02	499.70	499.45	
E217827						0.41		5.30	5.55	
86	165	0.0573	499.25	0.0	0.0	0.07	0.75	505.00	494.00	
		6	489.80	0.0	0.0	3.49	9.02	499.36	489.91	
E217727						0.23		5.64	4.09	
87	135	0.0085	489.80	0.0	0.0	0.07	0.29	494.00	493.00	
		6	488.65	0.0	0.0	1.71	23.39	489.97	488.82	
E217627						0.34		4.03	4.18	
88	90	0.0161	488.65	0.0	0.0	0.07	0.40	493.00	491.00	
		6	487.20	0.0	0.0	2.15	17.01	488.80	487.35	
E217527						0.29		4.20	3.65	
89	100	0.0320	487.20	0.0	0.0	0.07	0.56	491.00	488.00	
		6	484.00	0.0	0.0	2.81	12.07	487.33	484.13	
E217427						0.26		3.67	3.87	
90	110	0.0450	484.00	0.0	0.0	0.07	0.67	488.00	483.00	
		6	479.05	0.0	0.0	3.20	10.18	484.12	479.17	
E217327						0.24		3.88	3.83	
91	70	0.0764	479.05	0.0	0.0	0.07	0.87	483.00	479.50	
		6	473.70	0.0	0.0	3.88	7.81	479.16	473.81	
E217227						0.21		3.84	5.69	
92	35	0.0114	473.70	0.0	0.0	0.07	0.34	479.50	479.00	
		6	473.30	0.0	0.0	1.90	20.19	473.86	473.46	
E217127						0.32		5.64	5.54	
93	156	0.0183	473.30	0.0	0.0	0.07	0.43	479.00	477.04	***
		6	470.44	0.0	0.0	0.54	15.94	473.52	470.97	
E217027						0.29		5.48	6.07	

EMERALD LAKE HEIGHTS 5-year 6-hour Storm

*** A42 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
94	80	0.0000	470.44	0.0	0.0	0.07	0.00	477.04	475.64	***
		6	470.44	0.0	0.0	0.54	999.99	470.97	470.94	0
E216927						0.00	0.00	6.07	4.70	0
95	60	0.0240	470.44	0.0	0.0	0.07	0.49	475.64	475.00	
		6	469.00	0.0	0.0	2.51	13.93	470.58	469.14	
E216826						0.27		5.06	5.86	
96	75	0.0127	469.00	0.0	0.0	0.07	0.35	475.00	474.00	
		6	468.05	0.0	0.0	1.97	19.18	469.16	468.21	
E2167A26						0.31		5.84	5.79	
97	36	0.0319	468.05	0.0	0.0	0.07	0.56	474.00	474.00	
		6	466.90	0.0	0.0	2.81	12.08	468.18	467.03	
E216726						0.26		5.82	6.97	
98	110	0.0109	466.90	0.0	0.0	0.07	0.33	474.00	474.00	
		6	465.70	0.0	0.0	1.87	20.67	467.06	465.86	
E216626						0.32		6.94	8.14	
99	92	0.0293	465.70	0.0	0.0	0.07	0.54	474.00	472.00	
		6	463.00	0.0	0.0	2.72	12.60	465.83	463.13	
E216526						0.26		8.17	8.87	
100	70	0.0571	463.00	0.0	0.0	0.07	0.75	472.00	466.00	
		6	459.00	0.0	0.0	3.49	9.03	463.11	459.11	
E216426						0.23		8.89	6.89	
101	100	0.2770	459.00	0.0	0.0	0.07	1.66	466.00	436.00	
		6	431.30	0.0	0.0	6.27	4.10	459.08	431.38	
E223826						0.16		6.92	4.62	
102	145	0.1393	431.30	0.0	0.0	0.07	1.17	436.00	416.00	
		6	411.10	0.0	0.0	4.83	5.78	431.39	411.19	
E213526						0.18		4.61	4.81	
103	35	0.6171	411.10	0.0	0.0	0.07	2.47	416.00	394.00	
		6	389.50	0.0	0.0	8.35	2.75	411.16	389.56	
E213426						0.13		4.84	4.44	
104	31	0.2419	389.50	0.0	0.0	0.07	1.55	394.00	386.00	
		6	382.00	0.0	0.0	5.95	4.39	389.58	382.08	
E213326						0.16		4.42	3.92	
105	60	0.2300	382.00	0.0	0.0	0.07	1.51	386.00	372.00	
		6	368.20	0.0	0.0	5.83	4.50	382.08	368.28	
E213226						0.16		3.92	3.72	

EMERALD LAKE HEIGHTS 5-year 6-hour Storm

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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
106	45	0.1644	368.20	0.0	0.0	0.07	1.28	372.00	365.00	
		6	360.80	0.0	0.0	5.14	5.32	368.29	360.89	
E213126						0.18		3.71	4.11	
107	105	0.2238	360.80	0.0	0.0	0.07	1.49	365.00	342.00	
		6	337.30	0.0	0.0	5.77	4.56	360.88	337.38	
E213026						0.16		4.12	4.62	
108	12	0.2333	335.30	0.0	0.0	0.07	1.52	340.00	338.00	
		6	332.50	0.0	0.0	5.87	4.47	335.38	332.58	
E223425						0.16		4.62	5.42	
109	270	0.0474	332.50	0.0	0.0	0.07	0.69	338.00	326.00	
		6	319.70	0.0	0.0	3.26	9.91	332.62	319.82	
E212325						0.24		5.38	6.18	
110	55	0.0636	319.70	0.1	0.1	0.20	0.79	326.00	323.00	
		6	316.20	0.0	0.0	4.83	25.70	319.88	316.38	
E205925						0.36		6.12	6.62	
111	50	0.0400	316.20	0.1	0.1	0.20	0.63	323.00	318.00	
		6	314.20	0.0	0.0	4.13	32.38	316.41	314.41	
E205825						0.41		6.59	3.59	
112	105	0.0171	314.20	0.1	0.1	0.20	0.41	318.00	316.00	
		6	312.40	0.0	0.0	3.06	49.47	314.46	312.66	
E205725						0.52		3.54	3.34	
113	175	0.0469	312.40	0.1	0.1	0.20	0.68	316.00	308.00	
		6	304.20	0.0	0.0	4.37	29.92	312.60	304.40	
E205625						0.39		3.40	3.60	
114	155	0.1432	304.20	0.1	0.1	0.20	1.19	308.00	289.00	
		6	282.00	0.0	0.0	6.43	17.11	304.35	282.15	
E205525						0.29		3.65	6.85	
115	55	0.0364	282.00	0.1	0.2	0.29	0.60	289.00	286.00	
		6	280.00	0.0	0.0	4.42	48.14	282.26	280.26	
E205425						0.51		6.74	5.74	
116	75	0.0080	279.60	0.1	0.2	0.29	0.28	286.00	285.00	
		6	279.00	0.0	0.0	2.28	102.58	280.01	279.41	4
E205225						0.82	0.01	5.99	5.59	8
117	200	0.0250	279.00	0.1	0.2	0.29	0.50	285.00	281.00	
		6	274.00	0.0	0.0	3.88	58.03	279.28	274.28	
E205125						0.57		5.72	6.72	

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EMERALD LAKE HEIGHTS 5-year 6-hour Storm

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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
118	206	0.0073	274.00	0.1	0.2	0.29	0.58	281.00	286.00	
		8	272.50	0.0	0.0	2.42	49.92	274.35	272.85	
E205025						0.52		6.65	13.15	
119	150	0.0067	272.50	0.1	0.2	0.29	0.55	286.00	285.00	
		8	271.50	0.0	0.0	2.35	52.17	272.86	271.86	
E204925						0.53		13.14	13.14	
120	120	0.0052	271.50	0.1	0.2	0.29	0.49	285.00	283.58	***
		8	270.88	0.0	0.0	1.28	59.26	271.95	271.60	
E204825						0.57		13.05	11.98	
121	45	0.0004	270.88	0.1	0.2	0.29	0.14	283.58	282.86	***
		8	270.86	0.0	0.0	1.28	202.06	271.60	271.53	10
E204737						1.00	0.15	11.98	11.33	12
122	95	0.0124	270.86	0.2	0.2	0.34	0.76	282.86	282.08	
		8	269.68	0.0	0.0	3.07	44.98	271.19	270.01	
E204637						0.49		11.67	12.07	
123	170	0.0069	269.68	0.2	0.2	0.34	0.56	282.08	276.00	
		8	268.50	0.0	0.0	2.50	60.15	270.07	268.89	
E204537						0.58		12.01	7.11	
124	45	0.0102	268.50	0.2	0.2	0.34	0.69	276.00	274.94	
		8	268.04	0.0	0.0	2.86	49.57	268.85	268.39	
E2044A37						0.52		7.15	6.55	
125	165	0.0100	268.04	0.2	0.2	0.34	0.68	274.94	276.30	
		8	266.39	0.0	0.0	2.84	50.12	268.39	266.74	
E204437						0.52		6.55	9.56	
126	340	0.0050	266.39	0.2	0.2	0.34	0.48	276.30	273.00	
		8	264.70	0.0	0.0	2.23	71.08	266.82	265.13	
E204237						0.64		9.48	7.87	
127	145	0.0697	264.70	0.2	0.2	0.34	1.79	273.00	262.00	
		8	254.60	0.0	0.0	5.58	18.99	264.91	254.81	
E204137						0.31		8.09	7.19	
128	195	0.0241	254.60	0.2	0.2	0.34	1.05	262.00	255.00	
		8	249.90	0.0	0.0	3.88	32.28	254.87	250.17	
E204037						0.41		7.13	4.83	

Lateral length= 6178 Upstream length= 6178

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EMERALD LAKE HEIGHTS 5-year 6-hour Storm

*** B43

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
129 E302138	120	0.1183 6	354.20 340.00	0.0 0.0	0.2 0.0	0.18 5.77 0.29	1.08 16.28	361.00 354.34 6.66	346.00 340.14 5.86	
130 E302038	40	0.0875 6	340.00 336.50	0.0 0.0	0.2 0.0	0.18 5.16 0.31	0.93 18.94	346.00 340.15 5.85	342.00 336.65 5.35	
131 E301938	220	0.1077 6	336.50 312.80	0.0 0.0	0.2 0.0	0.18 5.57 0.29	1.03 17.07	342.00 336.65 5.35	319.00 312.95 6.05	
132 E301838	60	0.1283 6	312.80 305.10	0.0 0.0	0.2 0.0	0.18 5.95 0.28	1.13 15.64	319.00 312.94 6.06	312.00 305.24 6.76	
133 E301738	300	0.0810 6	305.10 280.80	0.0 0.0	0.2 0.0	0.18 5.02 0.31	0.90 19.68	312.00 305.26 6.74	286.00 280.96 5.04	
134 E301637	90	0.0756 6	280.80 274.00	0.0 0.0	0.2 0.0	0.18 4.89 0.32	0.86 20.38	286.00 280.96 5.04	280.00 274.16 5.84	
135 E301537	110	0.0200 6	274.00 271.80	0.0 0.0	0.2 0.0	0.18 3.09 0.46	0.45 39.61	280.00 274.23 5.77	276.00 272.03 3.97	
136 E301437	22	0.2182 6	271.80 267.00	0.0 0.0	0.2 0.0	0.18 7.34 0.26	1.47 11.99	280.00 271.93 8.07	274.00 267.13 6.87	
137 E301237	140	0.3029 6	267.00 224.60	0.0 0.0	0.2 0.0	0.18 8.31 0.24	1.73 10.18	274.00 267.12 6.88	228.00 224.72 3.28	
138 E301137	140	0.0943 6	224.60 211.40	0.0 0.0	0.2 0.0	0.18 5.30 0.30	0.97 18.24	228.00 224.75 3.25	215.00 211.55 3.45	
139 E301037	50	0.1300 6	211.40 204.90	0.0 0.0	0.2 0.0	0.18 5.98 0.28	1.13 15.53	215.00 211.54 3.46	209.00 205.04 3.96	
140 E300937	230	0.0365 6	204.90 196.50	0.0 0.0	0.2 0.0	0.18 3.83 0.39	0.60 29.31	209.00 205.09 3.91	200.00 196.69 3.31	

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EMERALD LAKE HEIGHTS 5-year 6-hour Storm

*** B43

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
141	245	0.0629	196.50	0.0	0.2	0.18	0.79	200.00	185.00	
		6	181.10	0.0	0.0	4.59	22.34	196.67	181.27	
E300837						0.33		3.33	3.73	
142	180	0.0422	181.10	0.1	0.3	0.32	0.65	185.00	177.00	
		6	173.50	0.0	0.0	4.80	49.56	181.36	173.76	
E300747						0.52		3.64	3.24	
143	35	0.1057	173.50	0.1	0.3	0.32	1.02	177.00	174.00	
		6	169.80	0.0	0.0	6.66	31.32	173.70	170.00	
E300647						0.40		3.30	4.00	
144	300	0.1033	169.80	0.1	0.3	0.32	1.01	174.00	143.00	
		6	138.80	0.0	0.0	6.60	31.68	170.00	139.00	
E300547						0.41		4.00	4.00	
145	103	0.0495	138.80	0.1	0.3	0.32	0.70	143.00	138.00	
		6	133.70	0.0	0.0	5.08	45.77	139.05	133.95	
E300447						0.50		3.95	4.05	
146	215	0.0270	133.70	0.1	0.3	0.32	0.52	138.00	133.00	
		6	127.90	0.0	0.0	4.12	62.00	133.99	128.19	
E300347						0.59		4.01	4.81	
147	148	0.0169	127.90	0.1	0.3	0.32	0.41	133.00	134.00	
		6	125.40	0.0	0.0	3.49	78.35	128.24	125.74	
E300147						0.68		4.76	8.26	
148	105	0.0181	125.40	0.1	0.3	0.32	0.42	134.00	128.00	
		6	123.50	0.0	0.0	3.58	75.70	125.73	123.83	
E3001A47						0.67		8.27	4.17	

Lateral length= 2853 Upstream length= 2853

*** C44

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
149	180	0.0050	546.50	0.0	0.0	0.03	0.22	556.00	550.00	
		6	545.60	0.0	0.0	1.14	13.49	546.63	545.73	
E505142						0.27		9.37	4.27	

EMERALD LAKE HEIGHTS 5-year 6-hour Storm

*** C44 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
150	230	0.0457	545.60	0.0	0.0	0.03	0.67	550.00	550.00	
		6	535.10	0.0	0.0	2.59	4.46	545.68	535.18	
E505042						0.16		4.32	14.82	
151	80	0.0650	535.10	0.0	0.0	0.03	0.80	550.00	534.00	
		6	529.90	0.0	0.0	2.98	3.74	535.18	529.98	
E504942						0.15		14.82	4.02	
152	105	0.0840	529.90	0.0	0.0	0.03	0.91	534.00	526.48	
		6	521.08	0.0	0.0	3.26	3.29	529.97	521.15	
E504842						0.14		4.03	5.33	
153	20	0.0135	521.08	0.0	0.0	0.03	0.37	526.48	526.01	
		6	520.81	0.0	0.0	1.65	8.21	521.19	520.92	
E504742						0.22		5.29	5.09	
154	50	0.0082	520.81	0.0	0.0	0.03	0.28	526.01	524.00	
		6	520.40	0.0	0.0	1.38	10.53	520.93	520.52	
E504642						0.24		5.08	3.48	
155	55	0.0436	520.40	0.1	0.0	0.09	0.66	524.00	522.00	
		6	518.00	0.0	0.0	3.34	13.03	520.53	518.13	
E503942						0.26		3.47	3.87	
156	120	0.0225	518.00	0.1	0.0	0.09	0.47	522.00	520.00	
		6	515.30	0.0	0.0	2.59	18.14	518.15	515.45	
E503842						0.30		3.85	4.55	
157	250	0.0172	515.30	0.1	0.0	0.09	0.41	520.00	520.00	
		6	511.00	0.0	0.0	2.35	20.75	515.46	511.16	
E503742						0.32		4.54	8.84	
158	45	0.0333	511.00	0.1	0.0	0.09	0.57	520.00	518.00	
		6	509.50	0.0	0.0	3.00	14.90	511.14	509.64	
E503642						0.28		8.86	8.36	
159	144	0.0729	509.50	0.1	0.0	0.09	0.85	518.00	506.00	
		6	499.00	0.0	0.0	4.07	10.08	509.62	499.12	
E503541						0.24		8.38	6.88	
160	195	0.0497	499.00	0.1	0.0	0.09	0.70	506.00	494.00	
		6	489.30	0.0	0.0	3.52	12.20	499.13	489.43	
E502941						0.26		6.87	4.57	
161	130	0.0615	489.30	0.1	0.0	0.09	0.78	494.00	486.00	
		6	481.30	0.0	0.0	3.84	10.97	489.42	481.42	
E502841						0.25		4.58	4.58	

EMERALD LAKE HEIGHTS 5-year 6-hour Storm

*** C44

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
162 E502751	100	0.0510 6	481.30 476.20	0.1 0.0	0.0 0.0	0.09 3.55 0.26	0.71 12.05	486.00 481.43 4.57	480.00 476.33 3.67	

Lateral length= 1704 Upstream length= 1704

APPENDIX F

CAPITAL IMPROVEMENT PROJECTS

District: Emerald Lake | Priority: 1

Project: Cordilleras Road

Project Purpose: Hydraulics

Project Location: Cordilleras Road near Canyon Road
MH 1011 - 1023

Existing Conditions:

Pipeline: 1515 feet of 8-inch diameter
Television Inspection: Not Inspected
Operation & Maintenance 3 callouts/year: Y / N
Manhole Inspection: Roots / Pipe / Grease
Hydraulics: Yes, needs 15-inch diameter replacement sewer

Alternative 1: Replace with 15-inch diameter sewer

Alternative 1 Cost: $181,800

Alternative 2: n/a

Alternative 2 Cost:

Alternative 3: n/a

Alternative 3 Cost:

Project Concerns:

Recommended Alternative:

District: Emerald Lake Priority: 1

Project: Edgewood Road

Project Purpose: Hydraulics

Project Location: Edgewood Road
MH 1152-1156

Existing Conditions:

Pipeline: 451 feet of 6-inch diameter
Television Inspection: Not Inspected
Operation & Maintenance 3 callouts/year: Y / N
Manhole Inspection: Roots / Pipe / Grease
Hydraulics: Yes, needs 10-inch diameter replacement sewer

Alternative 1: Replace with 10-inch diameter sewer

Alternative 1 Cost: $45,100

Alternative 2: n/a

Alternative 2 Cost:

Alternative 3: n/a

Alternative 3 Cost:

Project Concerns:

Recommended Alternative:

APPENDIX G

SANITARY SEWER RATE MODELS

Inflator 3%

Emerald Lake Alternative 1 CIP Summary

Project	Priority	Alternative 1	Alt 1 Description
Cordilleras Road	1	$ 181,800	Replace sewer
Edgewood Road	1	$ 45,100	Replace sewer
Total		$ **226,900**	

Emerald Lake 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	$ 84,644	$ 66,311	$ 90,513	$ 123,946	$ 127,664	$ 131,494	$ 135,439	$ 139,502	$ 143,687	$ 147,998
Capital Projects*	$ -	$ -	$ 19,974	$ -	$ -	$ 45,380	$ 46,741	$ 48,144	$ 49,588	$ 51,076
Debt Service	$ -	$ -	$ 275	$ -	$ -	$ -	$ -	$ -	$ -	$ -
O&M	$ 40,716	$ 56,168	$ 79,934	$ 53,208	$ 54,804	$ 56,448	$ 58,142	$ 59,886	$ 61,683	$ 63,533
Other	$ -	$ 2,200	$ 65,828	$ 4,251	$ 4,379	$ 4,510	$ 4,645	$ 4,785	$ 4,928	$ 5,076
Sewage Treatment	$ 237,301	$ 312,316	$ 308,398	$ 313,085	$ 322,478	$ 332,152	$ 342,116	$ 352,380	$ 362,951	$ 373,840
Source Control	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Gross Expenses	$ **362,661**	$ **436,995**	$ **564,922**	$ **494,490**	$ **509,325**	$ **569,984**	$ **587,084**	$ **604,696**	$ **622,837**	$ **641,523**
Offsetting Revenue										
Secure Property Taxes**	$ 4,093	$ 4,300	$ 4,526	$ 4,829	$ 4,500	$ 4,635	$ 4,774	$ 4,917	$ 5,065	$ 5,217
Unsecured Property Taxes	$ 559	$ 571	$ 574	$ 574	$ 550	$ 550	$ 550	$ 550	$ 550	$ 550
Interest Earned***	$ 33,455	$ 53,182	$ 68,214	$ 82,048	$ 67,087	$ 67,087	$ 67,087	$ 67,087	$ 67,087	$ 67,087
HOPTR	$ 85	$ 84	$ 87	$ 88	$ 80	$ 80	$ 80	$ 80	$ 80	$ 80
Annexation Charges	$ -	$ 14,203	$ 22,876	$ 400	$ 400	$ 400	$ 400	$ 400	$ 400	$ 400
Connection Charges	$ 21,010	$ 1,496	$ 89,387	$ 87,724	$ 15,600	$ 15,600	$ 15,600	$ 15,600	$ 15,600	$ 15,600
Miscellaneous Revenue	$ 70	$ 69	$ 13,417	$ 4,154	$ 500	$ 500	$ 500	$ 500	$ 500	$ 500
Total Offsetting Revenue	$ **59,272**	$ **73,905**	$ **199,081**	$ **179,817**	$ **88,717**	$ **88,852**	$ **88,991**	$ **89,134**	$ **89,282**	$ **89,434**
Use of Fund Balance	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Net Revenue Requirements	$ **303,389**	$ **363,090**	$ **365,841**	$ **314,673**	$ **420,608**	$ **481,132**	$ **498,093**	$ **515,562**	$ **533,555**	$ **552,089**
Annual Rate Assuming 1,536 Connections****					**274**	**313**	**324**	**336**	**347**	**359**

Note:

*Projected CIP is paid 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 for "Old" EL customers is $322 and $233 for "New" EL customers.

Emerald Lake 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	$ 857,976	$ 898,282	$ 1,088,134	$1,341,742	$ 1,341,742	$ 1,341,742	$1,341,742	$1,341,742	$1,341,742	$1,341,742
Additions to/(Use of) Balance	$ 40,306	$ 189,852	$ 253,608	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Ending Fund Balance	$ 898,282	$ 1,088,134	$ 1,341,742	$1,341,742	$ 1,341,742	$ 1,341,742	$1,341,742	$1,341,742	$1,341,742	$1,341,742