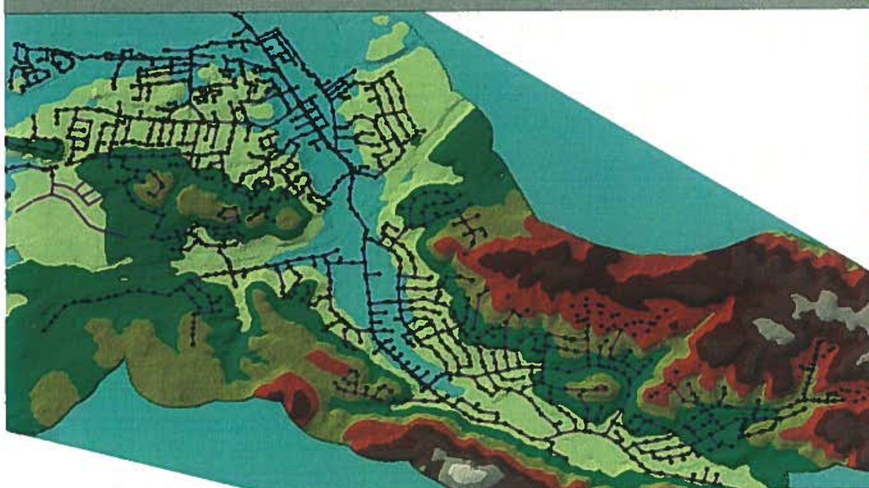
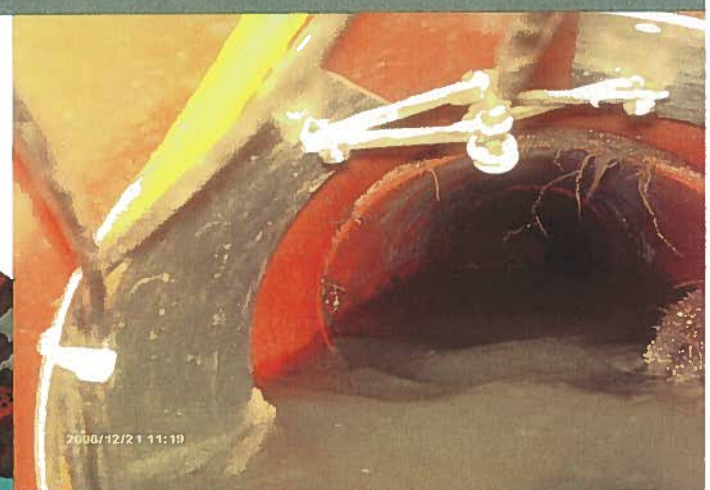
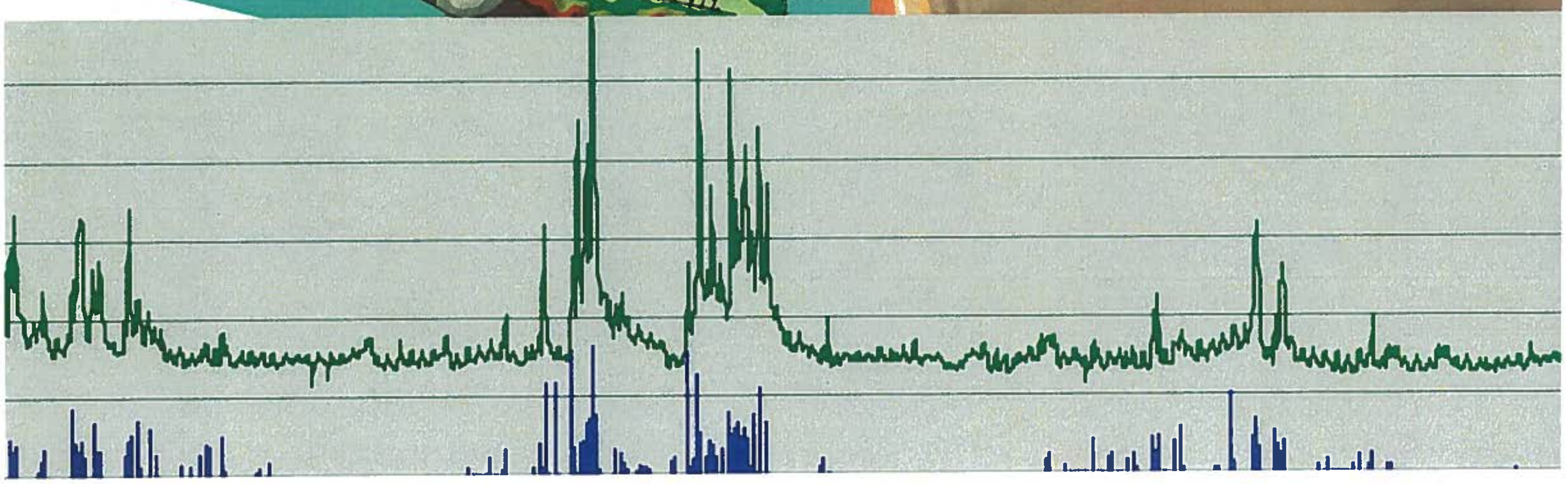
DUDEK ENGINEERING+ENVIRON

CITY OF PINOLE
SEWER MASTER PLAN
MAY 2008







DECEMBER 2007

PREPARED FOR
City of Pinole
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Pinole, CA 94564

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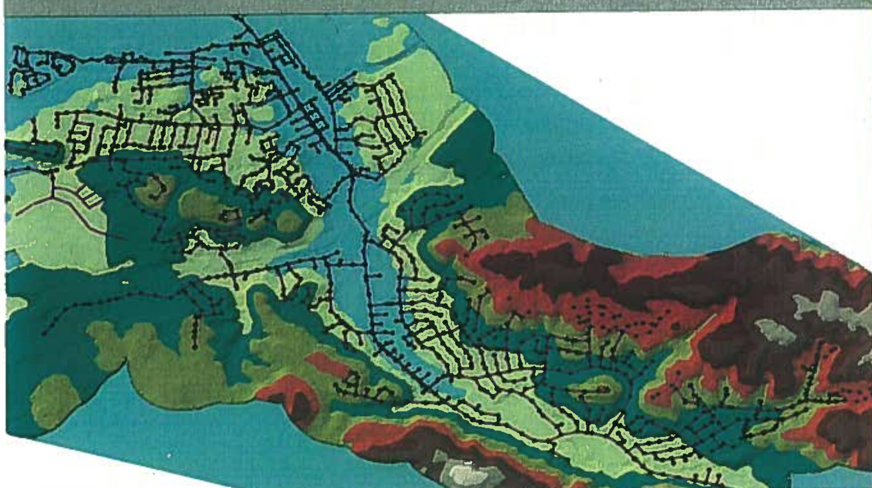
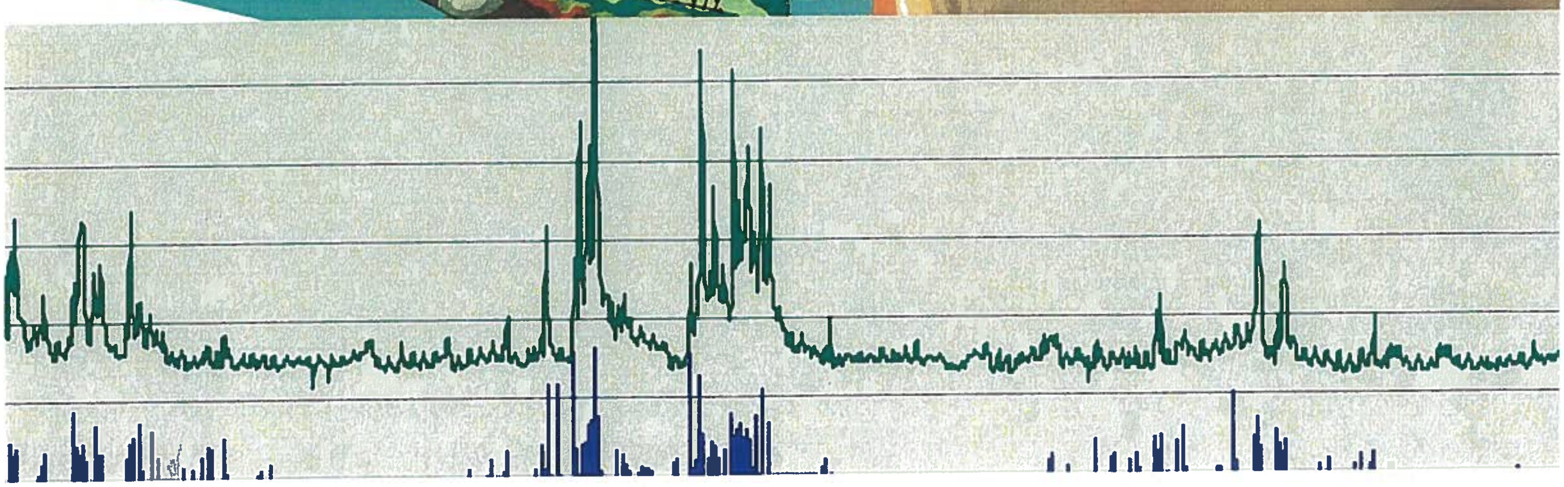
Encinitas, CA 9

DUDEK ENGINEERING+ENVIRON

CITY OF PINOLE
SEWER MASTER PLAN
MAY 2008





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CITY OF PINOLE

SEWER MASTER PLAN

May 2008

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CITY OF PINOLE

SEWER COLLECTION SYSTEM MASTER PLAN

Prepared For:

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May 2008

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City of Pinole

- Dean Allison, P.E. .... Director of Public Works
- Ana Morales .... Administrative Secretary
- Mark Adams .... Collection System Manager
- Steve Elfers .... Collection System Manager (Ret.)

Table of Contents

Table of Figures

Table of Tables

1.0 Executive Summary

1.1 Background

The City of Pinole owns and operates a wastewater collection system and a wastewater treatment plant. The collection system is a set of underground piping that carries wastewater from homes and businesses to the wastewater treatment plant. The treatment plant removes impurities from the wastewater for disposal through a deep water outfall near Rodeo. The collection system and treatment plant are governed by State and Federal regulations. These regulations are administered by the California Regional Water Quality Control Board, San Francisco Bay Region.

The primary regulatory requirements for the operation of the collection system and wastewater treatment plant are referred to as National Pollution Discharge Elimination System (NPDES) permits. The current NPDES permit (March 2007) requires the completion of a Collection System Master Plan by June 1, 2008. The Master Plan is to include (1) A ten-year Capital Improvement Program (2) A scheduled Inflow/Infiltration Reduction program and (3) Consider options for expanding legal authority to reduce I/I from the Hercules collection system. Item three is discussed in Chapter Six.

The Regional Water Quality Board has implemented Waste Discharge Requirements (WDRs). The goal of the WDRs is the elimination of sanitary sewer overflows (SSOs). The WDRs require preparation of a Sewer System Management Plan (SSMP) that describes the current condition of the collection system and the business plan needed to operate the collection system without overflow. This Sewer System Master Plan fulfills the requirements of the NPDES permit as well as a major portion of the SSMP (System Evaluations and Capacity Analysis) requirements. The completed SSMP is due by August 2008.

During the preparation of the Sewer Master Plan, key issues with the operations of the collection system were identified. The issues are directly related to the Inflow and Infiltration Reduction Program and the Capacity Assurance Plan which form the basis of the Collection System Capital Improvements Program. Each issue will be discussed briefly in the Executive Summary.

- **Collection System Capital Improvements Program**
    - **Inflow and Infiltration Reduction**
        - **Flow Analysis**
    - **Condition Assessments**
        - **2007 CCTV Inspections**
        - **2007 Smoke Testing**
        - **Operations and Maintenance**
    - **Capacity Assurance**
        - **Mapping/GIS**
        - **Capacity Analysis and Conclusions**

1.2 Issue One: Inflow and Infiltration

1.2.1 Observations

- An analysis of treatment plant flows and recorded rainfall for the last three years shows pronounced flow increases with rainfall. Flow solely from Pinole increased from an average daily flow of 1.7 million gallons per day to over 7.6 mgd. This is an increase of 4.5 times the average daily flow. Total WWTP flows from Pinole and Hercules combined increased to over 13.0 mgd, from an average of 3.5 mgd as shown in Figure 1-1.
- These flow increases are due to inflow and infiltration. Inflow and infiltration (I/I) are extraneous flows entering the collection system through a combination of ways, including improper connections, cracks, holes in pipes (both public and private) and manhole defects.
- A system wide flow measurement program in 2006/2007 placed 6 flow meters at key locations in the collection system. The purpose was to quantify and locate I/I.
- The highest I/I occurred in Areas 5 and 6, the Meadows and Old Downtown areas respectively.
- Both current and previous smoke testing programs have located large numbers of inflow defects located on private service laterals. Private service laterals connect homes or businesses to the City's collection system and are the responsibility of the owners. CCTV inspections revealed numerous defects associated with private service laterals.

1.2.2 Conclusions

- Further Condition Assessments are needed to characterize additional sources of inflow and infiltration.
- Private service laterals contribute significantly to system inflow and infiltration.

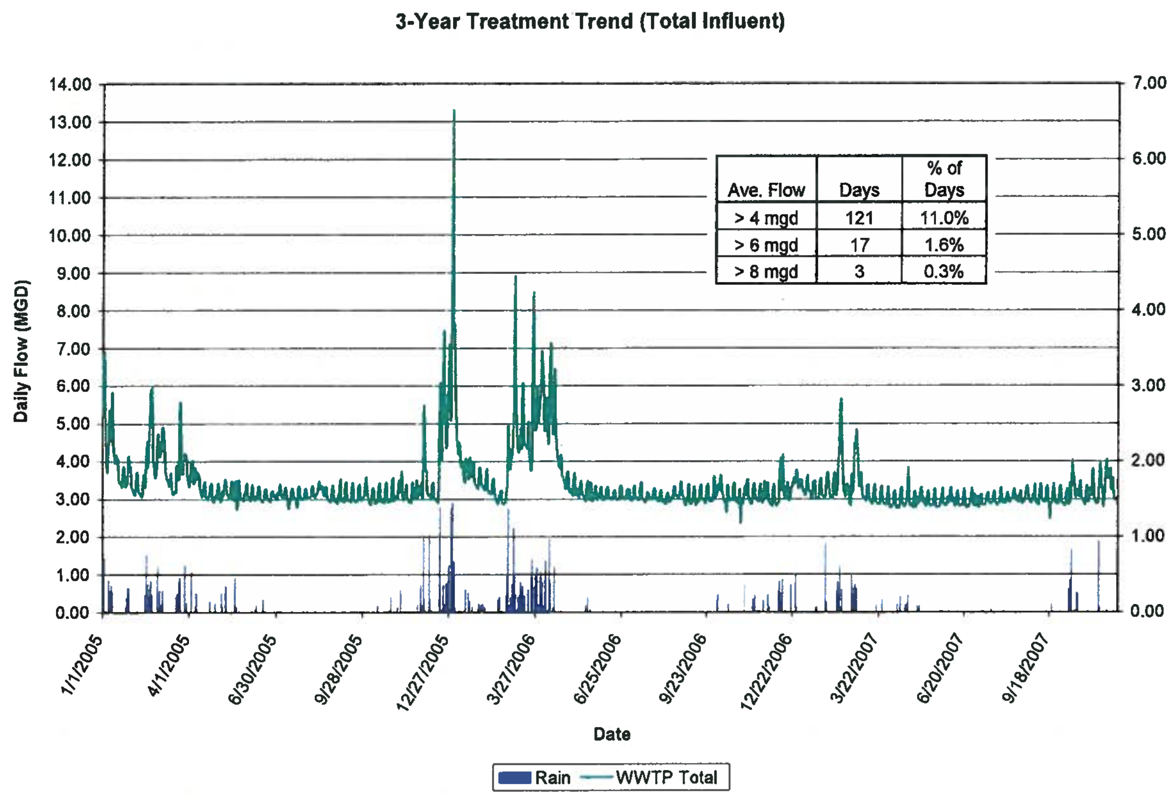
1.2.3 Recommendations

- The City should establish a program of monitoring flows during the wet season to further identify sources of inflow and infiltration and to assess rehabilitation efforts.
- The City should establish a lateral rehabilitation program whereby private laterals are tested/repaired/replaced whenever a property is sold or when the City is performing sewer work in the vicinity.
- A pilot private lateral inspection should be performed on all older, City-owned properties to determine the general condition of laterals throughout the City.

1.2.4 Accomplishments

- Flow measurements were made during the wet season 2006/2007 as a part of the Master Plan and in 2007/2008 as a part of the lift station study.
- An I/I analysis identified the quantity and location of inflow and infiltration.
- Basins with highest increases in flow rate during wet weather were further studied using smoke testing and television inspection (CCTV).

Figure ES - 1 WWTP Flow Measurements



As shown, the Total Flow into the WWTP (from Pinole and Hercules) increases greatly during rainfall events and returns to normal flows within a day or two. This increase and rapid return to normal indicates significant inflow defects in the collection systems. Note that this chart plots daily volume and not the peak rates that have occurred.

1.3 Issue Two: Condition Assessments

The physical conditions of the CCTV inspected portions of the system were generally poor. This is in part due to the selection of the area with the highest observed wet weather increases in flow volume. This condition may not be characteristic of the entire system.

To gain a complete picture of the collection system condition, additional inspections are required. Collection systems are evaluated through a combination of flow measurements, TV inspections, smoke testing and physical inspections. The following sections describe briefly the results from Condition Assessments performed during the Sewer Master Plan preparation.

1.3.1 Televised Inspections (CCTV)

1.3.2 Observations:

- Based on the increased flows in Basin 5 (Meadows), TV inspections were performed.
- The TV inspections revealed that much of the pipe was in poor condition, with cracked pipes, root intrusions (See Figure ES-3), and offset joints.
- Most of the roots observed have grown into the collection system through private lateral connections.
- Recent lining projects appear to be in fair condition.
- Minimal active infiltration (leaking) was observed due to dry weather conditions and lowered ground water levels.

1.3.3 Conclusions:

- The general condition of the system in the Meadows area is poor.
- The entire collection system needs to be CCTV inspected to identity and locate additional defects and complete the system Condition Assessments.
- Improvements to computer hardware and network connections may be required to safeguard and retrieve recorded CCTV information (video, stills and reports).

1.3.4 Recommendations:

- The City should fund, schedule and implement a program that CCTV inspects 100% of the system in the first year with in-house forces. Subsequent years would inspect 20%.
- Document and implement processes for recording, storing and securing CCTV data.
- Short term repairs/rehabilitation needs are listed and should be accomplished (2008).

1.3.5 Accomplishments

- A TV inspection unit was outfitted and software and hardware installed to facilitate the capture, interpretation and storage of TV inspections.
- The staff is becoming increasingly knowledgeable in TV operations.
- During the Master Plan study, approximately seven percent (7%) of the system was inspected using the City's new video equipment and software.
- The observations from the TV crews have resulted in scheduled additional repairs.

1.4 Issue Two: Condition Assessments (Continued)

1.4.1 Smoke Testing

1.4.2 Observations:

- Based on the increased flow rates in Basin 6 (Old Downtown), Smoke Testing was performed to identify improper connections (See Figure ES-2) that contribute inflow.
- The Smoke Testing positively identified locations of inflow.
- The majority of inflow defects identified were on private laterals.
- No direct connections to the City's storm drain system were observed.
- A few manhole covers positively indicated inflow potential. See Figure ES-4.

1.4.3 Conclusions:

- Large Inflow defects indicated by the flow data were not positively identified in the smoke testing program.
- Most of the observed defects located were on private service laterals.

1.4.4 Recommendations:

- The City should completely smoke test the system during Dry Weather during the next year. Subsequent years would inspect 20% of the system per year.
- The defects identified in the smoke testing program should be eliminated.
- The City should promulgate regulations for proper operation and maintenance of private service laterals with special emphasis on the removal of inflow defects.

1.4.5 Accomplishments

- City staff participation in the Smoke Testing program provided valuable insight into the skills needed to successfully perform Smoke Testing with City Staff.
- City staff is preparing to train additional operations staff in smoke testing techniques.

Figure ES - 2 Improper Connections

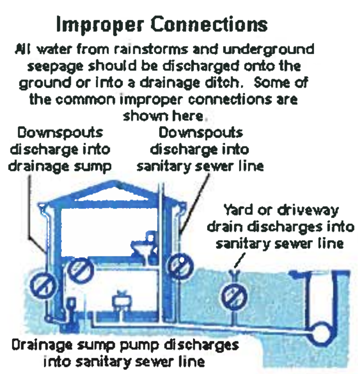


Figure ES - 3 CCTV Results (Root Intrusion)

Figure ES - 4 Smoke Testing – Manhole

If smoke can get out, then rain can get in.

1.5 Issue Two: Condition Assessments (Continued)

1.5.1 Operations and Maintenance Analysis

1.5.2 Observations:

- During the Master Planning process, the operations and maintenance staff reviewed its operations and identified problem areas.
- Operations processes were more fully documented.
- Training was performed by senior staff to educate newer staff members on the overflow reporting and mitigation, cleaning processes, smoke testing and CCTV operations.
- Increased awareness of the positive aspects of the WDR compliance was noted.
- No current process is in place to update GIS/mapping with field observations.

1.5.3 Conclusions:

- Senior staff is actively engaged in succession planning and training.
- Staff awareness is constantly improving through training and practical experience.
- Staff is well motivated to accomplish required work.

1.5.4 Recommendations:

- The City should continue its proactive compliance program through active training.
- Compliance with improving access through relocation from back yards and easements should be identified through the GIS.
- Potential cross connections with the storm drain should be investigated using GIS and physical inspection to identify potential storm drain crossings.
- Define a process to update the GIS from field observations and changes in pipe/manhole materials and alignments.
- Staff should update the GIS to include Age and Material to aid in focused Condition Assessments.

1.5.5 Accomplishments

- The staff has modified its cleaning practices and frequency at the High School pedestrian bridge and at Ramona Street and Pinole Creek.
- Rerouting was accomplished to improve maintenance access at the Pinole Shores Business Park. Additional access through realignment is planned at Santa Barbara @Silverado.
- The Panattoni Sewer Study described the potential opportunity for risk reduction with fail-safe line for the San Pablo Avenue Lift Station.
- A Lift Station Rehabilitation/Replacement/Removal Study is being performed.
- Smart Lids that alert operators to potential overflows are being installed at three overflow prone locations.
- A short-term manhole rehabilitation program has been identified.
- A short-term pipeline lining and/or replacement program has been identified.
- Photos and videos of CCTV inspection were linked to GIS database to allow ready review and retrieval.

1.6 <u>Issue Three: Capacity Assurance</u>

Through an improved GIS, flow measurements and flow meter calibrated hydraulic modeling, potential areas of capacity restrictions have been identified based on available data. A set of potential capacity enhancement projects has been identified and costs estimated to address <u>predicted</u> capacity restrictions. Hydraulic capacity is considered restricted when depth exceeds 1/2 pipe height for pipes less than 18 inches and ¾ of the pipe height for pipes greater or equal to 18 inches.

1.6.1 Observations:

- In general, the system has adequate capacity to convey normal dry weather flows.
- Exceptions include areas around Pinon and Orleans, which operate at near capacity during dry weather.
- The approach to the Hazel Street Pump Station approaches capacity during wet weather.
- As rainfall occurs and inflow and infiltration defects are activated, the system is predicted to have increased hydraulic capacity restrictions based on available data.
- These predicted capacity restrictions are predominately located along the trunk line in Pinole Valley Road and in the area around Pinon and Orleans.
- The Staff has NOT observed sewer overflows in the Pinole Valley Road (PVR) area.

1.6.2 Conclusions:

- Staff indicates that capacity restrictions are not a cause of overflow in the Pinole system.

1.6.3 Recommendations:

- Potential capacity related replacements should be scheduled but not commenced until completion of additional condition assessments (Invert surveys, post-rehab flow measurements, CCTV and Smoke Testing).
- Capacity issues should be addressed with Inflow and Infiltration Reductions prior to implementation of replacement projects.
- Engineering surveys should be conducted to ensure highly accurate invert elevations along the PVR trunk line.
- This information should be incorporated into the GIS and hydraulic model.
- Additional hydraulic modeling should be performed to evaluate capacity if the manholes are allowed to surcharge prior to any capacity related projects being implemented.

1.6.4 Accomplishments

- Engineering survey of sewer inverts along Pinon was performed to confirm potential for overflows.
- Flow is being rerouted in the San Pablo Avenue / Pinon Area and this may alleviate capacity restrictions observed in this area.
- The City is currently studying a Lift Station Elimination program which could reduce the potential for capacity related overflows in the Hazel Street and Meadows Areas.
- Staff provided updated depth to invert information for manholes along PVR trunk.

1.7 Overall Conclusions

The collection system is currently subject to significant increases in flow due to inflow and infiltration defects. The first course of action is to fully assess the conditions of the entire collection system as quickly as possible. Once the system has been characterized, funding can be focused on the best processes to address the defects in the areas with highest returns.

A City Facility/ Volunteer Pilot Private Lateral Program should be commenced immediately with the goal of determining the overall condition of private service laterals by test sampling of 100 laterals. Laterals would be CCTV and smoke tested to determine structural integrity and improper connections. These inspections should start with City owned facilities with private service laterals constructed prior to 1975 and include privately owned laterals in areas of Old Downtown and the Meadows Area. Low cost Incentives such as post lateral testing cleaning and minor repairs should be provided to volunteer property owners. This program will provide valuable data to determine the cost effectiveness of a full private lateral repair program.

Capacity related projects should be deferred until rehabilitation/repair/replacement projects have been completed. The following set of projects addresses key elements of the I/I Reduction Program and Capacity Assurance Planning. Additional projects, identified by the City further define the complete Collection System Capital Improvements Program:

Collection System Capital Improvement Program

Inflow and Infiltration Reduction Program

1. Perform a complete condition assessment.
2. Implement a Private Lateral Testing/Repair/Replacement Program coordinated with changes in property or City pipeline projects.
3. Repair and rehabilitation projects to improve pipeline and manhole conditions.

Capacity Assurance Planning

1. Perform engineering surveys of candidate capacity projects
2. Revise hydraulic models with updated inverts and revised criteria.
3. Replace capacity restricted pipelines contingent on completion of Condition Assessments and Rehabilitation/Replacement Projects.

The Table ES-1 provides the planning level estimated financial requirements for a constrained Capital Improvements Program.

Table ES - 1 Recommended Collection System Projects

	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	2014-1015	2015-1016	2016-1017	2017-2018
Part One: Condition Assessment										
Pilot Private Lateral Program*		$40,000	$40,000							
Install Smart Covers at selected locations	$10,000	$10,000	$10,000							
Physical Inspection (Above Ground MH)	$30,000	$30,000	$30,000	$30,000	$30,000	$30,000	$30,000	$30,000	$30,000	$30,000
Purchase 6 Flow Meters Installed		$30,000								
Annual Maintenance and Data Analysis			$6,000	$6,000	$6,000	$6,000	$6,000	$6,000	$6,000	$6,000
Preventative Maintenance (Cleaning)	$40,000	$40,000	$40,000	$40,000	$40,000	$40,000	$40,000	$40,000	$40,000	$40,000
Smoke testing (5 Year cycle)	$40,000	$40,000	$40,000	$40,000	$40,000	$40,000	$40,000	$40,000	$40,000	$40,000
CCTV (5 Year Cycle 20% per Year)	$80,000	$80,000	$80,000	$80,000	$80,000	$80,000	$80,000	$80,000	$80,000	$80,000
Program Management	$60,000	$60,000	$60,000	$60,000	$60,000	$60,000	$60,000	$60,000	$60,000	$60,000
Subtotal Condition Assessment	***$260,000***	***$330,000***	***$306,000***	***$256,000***	***$256,000***	***$256,000***	***$256,000***	***$256,000***	***$256,000***	***$256,000***
Part Two: I/I Reduction Projects										
Annual Sewer Rehab Program (Pipe and manhole)	$150,000	$150,000	$150,000	$150,000	$150,000	$150,000	$150,000			
Sewer Lateral Rehabilitation Program		$ 10,000	$100,000	$100,000	$100,000	$100,000	$100,000			
Neighborhood Rehabilitation	$ 10,000	$ 10,000	$ 250,000	$ 250,000	$ 250,000	$ 250,000	$ 250,000	$ 250,000	$ 250,000	$ 250,000
Subtotal Repair/Rehab/Replacements Subtotal	***$160,000***	***$170,000***	***$500,000***	***$500,000***	***$500,000***	***$500,000***	***$500,000***	***$250,000***	***$250,000***	***$250,000***
Part Three: Capacity Assurance Projects										
Hazel Street Pump Station	$200,000	$1,000,000								
Mapping/Model Updates		$25,000								
Santa Barbara Relocation	$50,000									
Pinon Relief (Reroute SPA LS FM)	$250,000									
Subtotal Capacity Assurance	***$500,000***	***$1,025,000***	***$0***	***$0***	***$0***	***$0***	***$0***	***$0***	***$0***	***$0***
Total Funding Programmed	***$920,000***	***$1,525,000***	***$806,000***	***$756,000***	***$756,000***	***$756,000***	***$756,000***	***$506,000***	***$506,000***	***$506,000***

2.0 Introduction

2.1 Background

The City of Pinole, incorporated in 1903, provides wastewater collection and treatment to approximately 19,000 inhabitants. The sewer flows follow the natural drainage basin which is dominated by Pinole Creek. Sewer collection systems closely mimic nature by using gravity to move the sewage from the customer's homes and businesses to the wastewater treatment plant. The sewer flows end at the treatment plant where treatment occurs. The treated effluent is pumped to Rodeo where it is discharged into a deepwater outfall approximately 3,000 feet offshore.

The first treatment plant was constructed on San Pablo Bay at the end of Tennent Avenue in 1955. This facility provided primary treatment for Pinole and Hercules. The plant has undergone major improvements to meet an expanding population and more stringent environmental regulations. This report addresses the immediate and long term needs of the Pinole collection system upstream of the treatment plant.

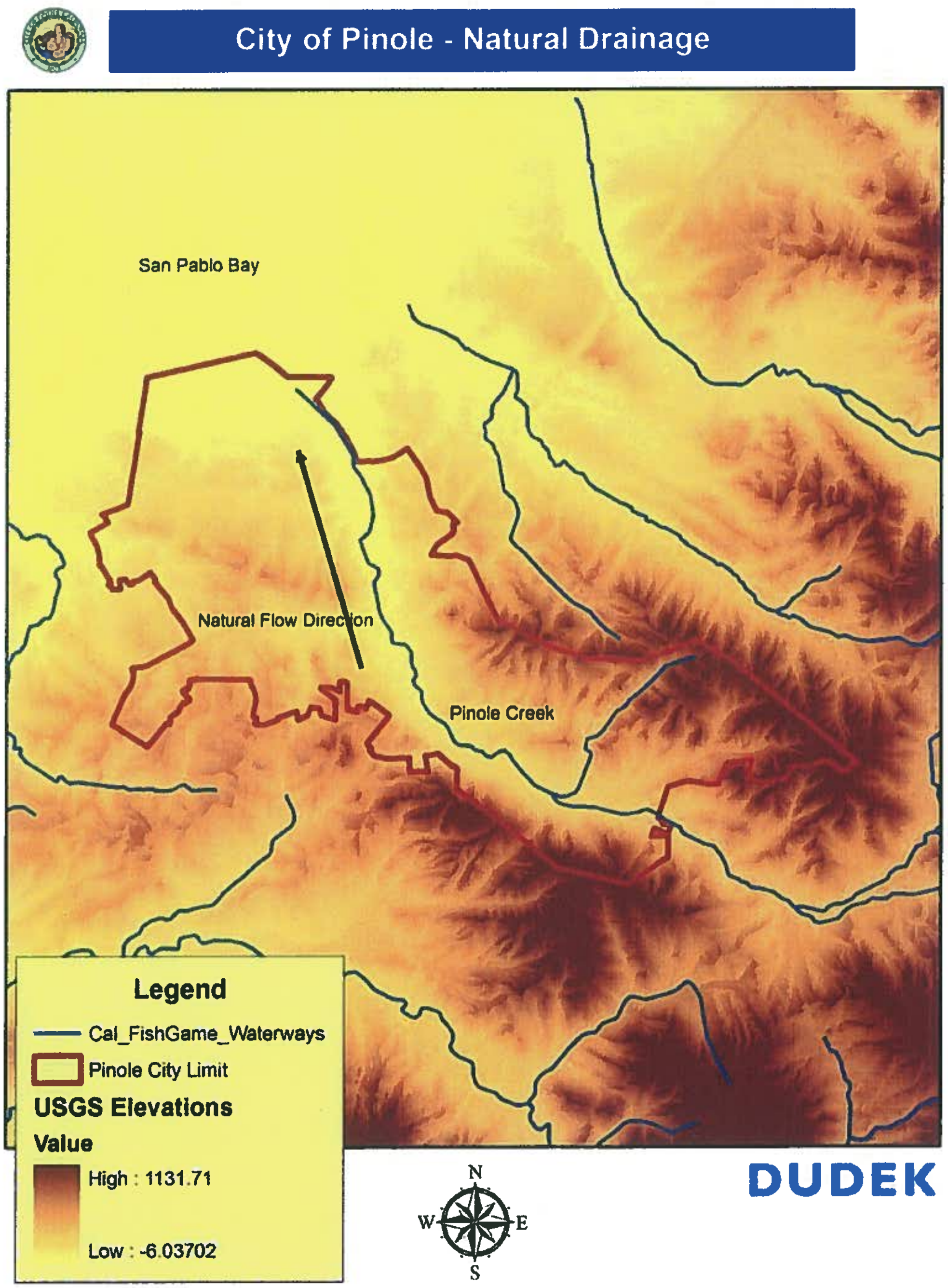
2.2 Study Area

The City of Pinole is located north and east of San Francisco on the shores of San Pablo Bay. The study area for this report is defined by the extents of the collection system within the City Limits excluding small portions of the City service by the West County Sanitary District. The study area is shown in its regional context in Figure 2-1 on the following page.

The slope of the study area is generally from the southeast to the northwest along Pinole Creek. This topography provides the general direction of flow within the collection system. Figure 2-2 shows the general drainage pattern through elevation maps and the stream dataset from the California Department of Fish and Game.

Figure 2-1 Study Area Location

Figure 2-2 Natural Drainage



2.3 Scope and Purpose

The City of Pinole owns and operates a wastewater collection system to remove water borne wastes from residences and businesses within the City limits. To improve the operations and management of these facilities DUDEK was authorized to prepare a Sewer Master Plan in 2007. The primary objectives of the plan were:

- Review and partial update of the City's Sewer System GIS
- Flow Measurement of sewer flows at key manholes
- Inflow and Infiltration analysis of flow data
- I&I Source identification through smoke testing and CCTV review
- Development and calibration of a hydraulic model of the collection system
- Performance of a capacity analysis of the collection system
- Development of projects to address capacity deficiencies
- Collection system CIP recommendations

The primary purpose of the plan is to provide a basis for compliance with the Regional Water Quality Board NPDES Permit and the Waste Discharge Requirements (WDRs). Specific to the NPDES Permit Conditions, a Collection System Master Plan providing a 10 year capital improvement project and an implementation schedule for a Inflow and Infiltration Reduction Program is required by June 1, 2008. This is provided in Table 1 in the Executive Summary.

This document also covers aspects of the Sanitary Sewer Management Plan required for compliance with the WDRs. This document specifically addresses the System Evaluation and Capacity Analysis portions of the requirements and establishes the level of funding required to perform complete condition assessments and to serve as the basis of a Capacity Assurance Plan. This complete Collection System Capital Improvements Project, when implemented, will reduce the occurrence of capacity and condition related overflows through rehabilitation, repair, replacement and capacity enhancement.

During the development of the SCSMP, DUDEK developed a web site that may be modified and used as a part of the public outreach program required by the State WDRs. A significant additional item was enhancing the mapping/GIS and performing operations analysis to assure that as much information is known as possible about the "State of the Sewer System." These activities further address the Measures and Activities portion of the Regional SSMP requirements.

3.0 Analysis Methods

This section provides and overview of updating GIS, flow measurement plan, I&I analysis, source detection, hydraulic modeling and capacity results. Details follow in chapters describing the results.

3.1 GIS Review and Update

One of Dudek's tasks in preparing the Sewer System Master Plan for the City of Pinole was to update a portion of the Sewer System GIS. These updates were limited to trunk lines that were 10 inches in diameter and above, including smaller lines found in critical reaches. Dudek staff began the update process by first migrating data layers received from the City into a geodatabase in ArcGIS. This would allow staff to perform advanced feature manipulation and processing of the data in order to prepare a model of the Sewer Collection System.

The first step in this preparation was to update the Sewer System GIS using data obtained from the City's Field Atlas. The Field Atlas included mark-ups for pipes and appurtenances that needed to be added or deleted, as well as diameter and invert elevations for select features. Along the major trunks, updates to the invert elevations were input using Rim-to-Invert measurements obtained by City crews. For the Primrose/Pinon area, survey data was utilized.

To resolve the varied datums found in the elevation data, a high resolution digital elevation map (DEM) was acquired to cover the city. Using the Spatial Analyst tool in ArcGIS, manhole rim elevations were obtained from the DEM, and then invert elevations were calculated from manholes with known depths. The unknown inverts were set using a minimum percentage slope, along with a maximum depth. These levels of accuracy are appropriate for routine maintenance of the collection system and for concept level capacity planning.

In addition to updating the GIS, some new functionality was added. Video obtained during CCTV inspection was linked to the corresponding pipe. By clicking on a pipe, the CCTV video can be viewed.

DUDEK reviewed and incorporated data from the paper maintenance maps, survey data provided in the Pinon/Primrose area and from field measurements made by the operations staff for selected manholes located along the trunk and in critical areas. In addition to this data collection, estimations of pipeline inverts for smaller pipes were made. This resulted in a combination of data sources that were used to prepare the hydraulic model. These data sources have been recorded in the GIS for reference in the future.

The GIS data is critical in that it is used as the basis of the planning and operations of the collection system. The staff reviewed and provided clarifications several times throughout the planning process. To improve the GIS operations for the City, a procedure should be established to make certain that field observations differing from the GIS should be reported and modifications made. By providing a GIS Update Process the GIS data quality will continually improve. The GIS data quality can also be made more useful for planning operations by including the age and material of the pipe.

The GIS dataset will also become important as the Collection System CIP is implemented. It will become the source of management presentations and for project progress tracking. It is important that the operations staff become familiar with the capabilities of the GIS so that they can use it to their advantage. It should be a short term goal for the City to have an accurate and up to date map of the collection system available for all interested parties.

The quality of the current GIS is greatly improved and will be the basis of maintenance atlas maps. Using the updated maps and established flow paths through the system, a Flow Measurement Plan was prepared and measurements performed in the wet season of 2007.

Figure 3-1 shows the entire sewer collection system for the City of Pinole. Pipes larger than 10 inches are shown in red. Flow drains from the southeast to the northwest generally along Pinole Valley Road (PVR) and Tennent Avenue. The large pipes are the major collectors and trunk of the system. All flows end at the Wastewater Treatment Plant (WWTP) located at the end of Tennent Avenue. This Sewer Collection System Master Plan and the GIS update covers the Pinole sewer collection system upstream of the WWTP.

3.2 Flow Measurement Plan

The staff reviewed the initial GIS and made specific recommendations for modifications to accurately reflect the flow directions in the system. Based on these recommendations, the entire collection system was divided into six (6) sub-areas.

Four separate flow measurement companies were contacted and submitted proposals to provide the flow measurement services. Geotivity, Inc. was selected to perform the work based on their ability to install quickly and to provide flow data via the internet.

Six flow meters were installed in the collection system in December 2006 and they remained until March 2007. Flow data was collected at six locations simultaneously under both dry and wet weather conditions. While it was a dry year, there were several small rainfall events that occurred during the monitoring season. That allowed I/I to be observed. The location of the flow measuring devices is shown in Figure 3-2. The various colors represent areas that drain to a flow meter location.

In future flow measurement programs, the following changes should be made. Site 1 located near Martinez Court was a very low flow site that should be monitored with a weir device. Site 6 should be moved upstream to isolate as much as possible the operations of the WWTP. The plant uses the collection system for storage under certain operating conditions.

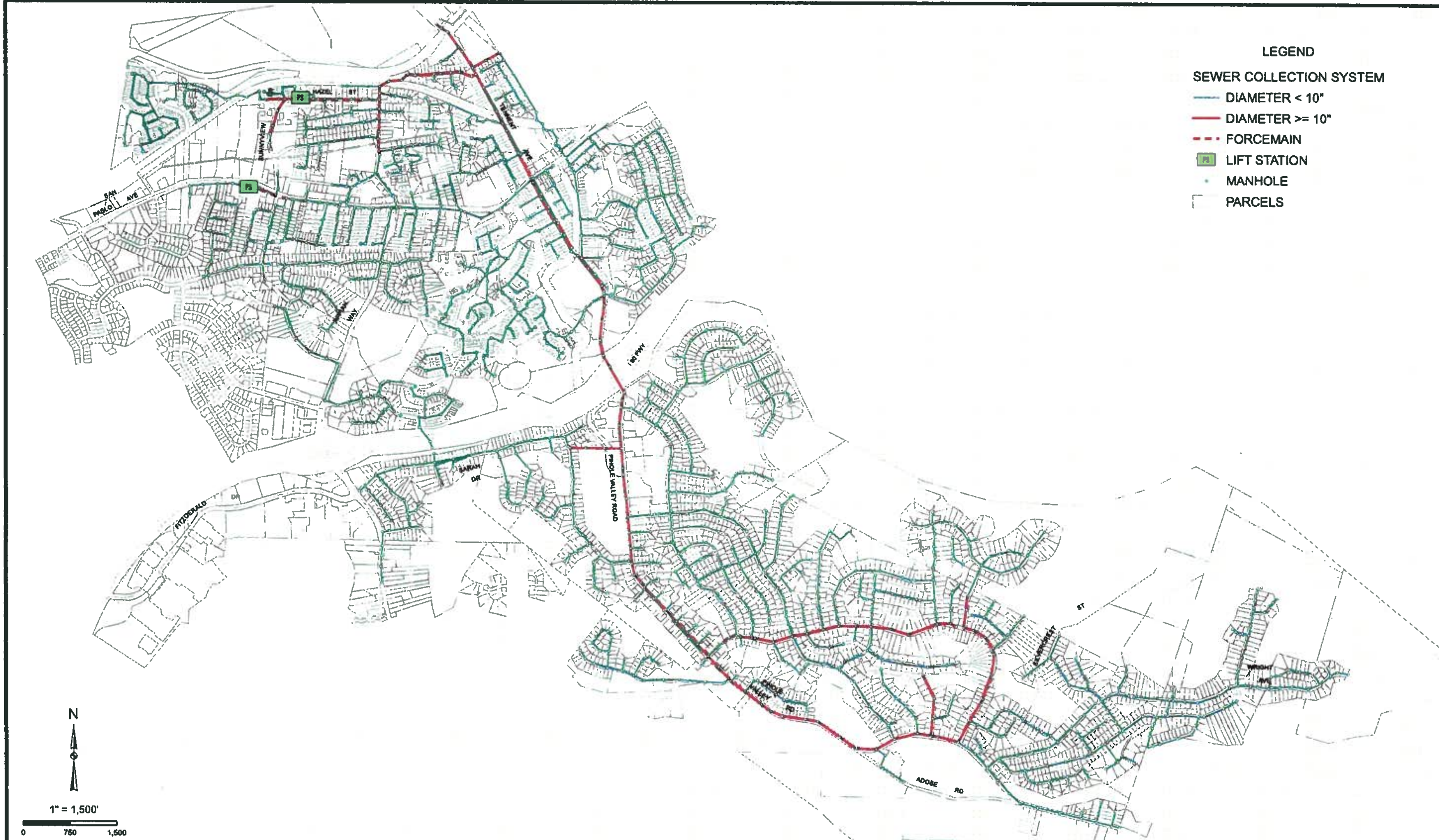


FIGURE 3-1 CITY OF PINOLE SEWER COLLECTION SYSTEM

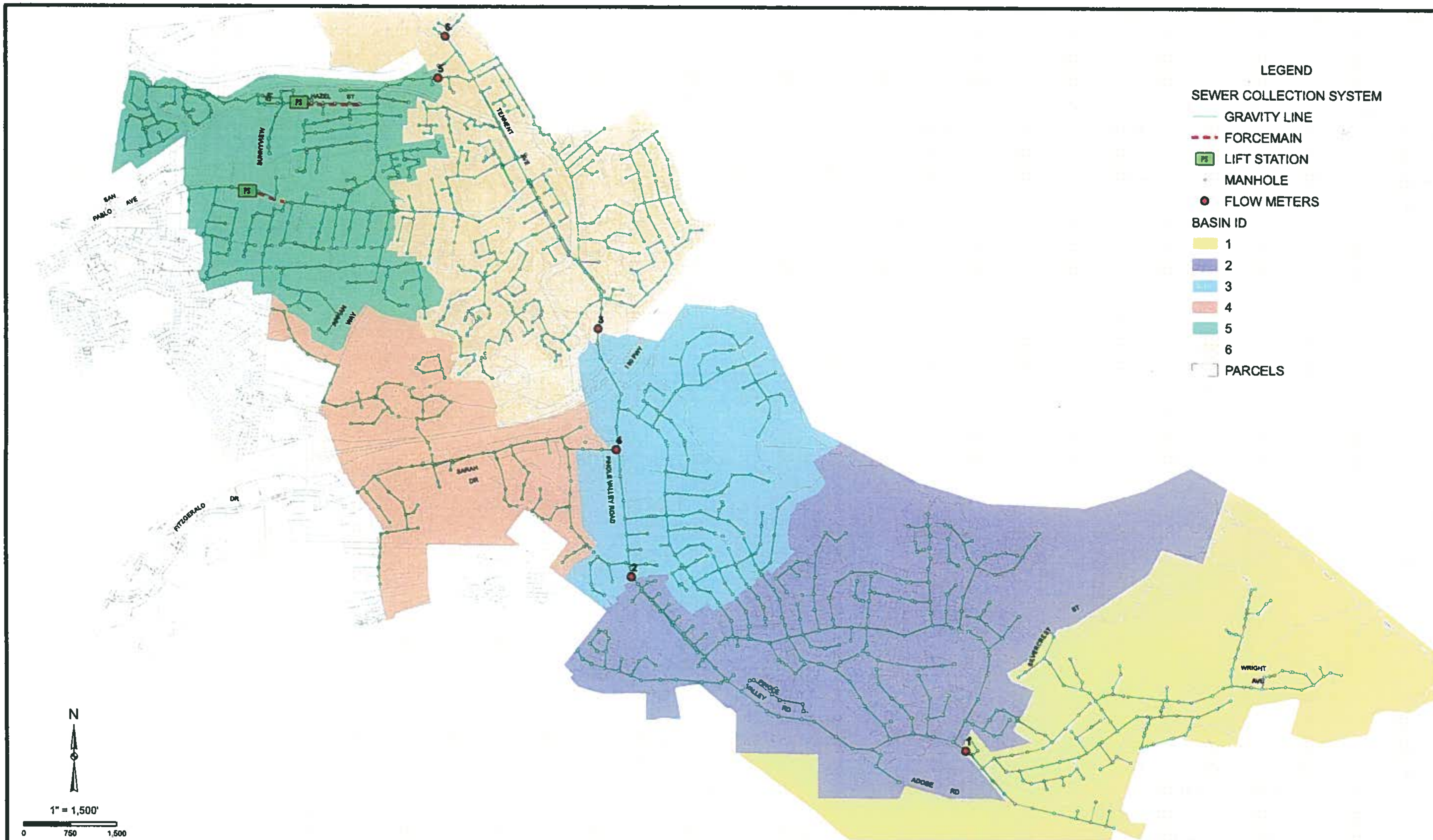


FIGURE 3-2 FLOW MEASUREMENT LOCATIONS AND SUB BASINS

3.3 Flow Data Analysis

By analyzing the data from the flow meters, each basin's flow characteristics were quantified and compared. The flow data is used to define the average Dry Weather flow and Wet Weather responses. Based on these observations the basins with highest inflow and infiltration rates were determined. See Chapter 4 Flow Characteristics for more analytical detail.

Flow metered Basins 5 and 6 were identified as the highest contributors of Inflow and Infiltration. Basin 5 was further physically inspected using closed circuit television camera (CCTV) inspection and Basin 6 was smoke tested. CCTV is used to investigate all types of visible internal defects while smoke testing is used to determine the location of inflow defects..

Based on the flow responses observed, two sub-basins were identified for further physical inspection. Chapter 4 – Flow Characteristics discusses the findings of the flow data analysis.

3.4 Source Detection

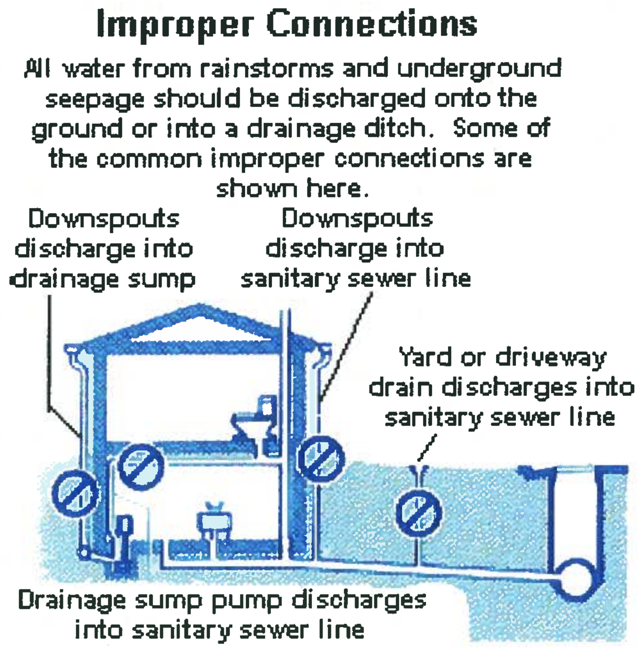
Based on the dominant defect flow observed in the flow data analysis, Basin 5 was selected for further CCTV work and Basin 6 was selected for smoke testing. These are common techniques used to identify the specific location of infiltration and inflow leaks in the system.

3.4.1 Smoke Testing

Smoke testing is accomplished by blowing smoke under low pressure through the sewer manholes. Figure 3-3 shows where smoke may exit through improper connections, inflow defects, and through air vents on houses. Inflow defects are direct connections to the surface which allow rainfall to enter the collection system. This rainfall or defect flow greatly reduces the capacity of the system to convey wastewater. These direct connections when located are relatively inexpensive to repair and greatly reduce the peak rainfall entering the system. Basin 6 (the downtown area) was identified as having the greatest increase in peak flow rate. This is an indication of inflow types of defects.

In September 2007 smoke testing was performed in Basin 6. In 50,000 feet of pipe, 35 inflow defects were observed. Note that smoke testing provides a positive indication of inflow defects only in areas where there are no sags and there is adequate air space. Positive findings accurately locate inflow sources. Negative findings DO NOT prove that inflow defects aren't present. Of the 35 smoke defects identified in the Smoke Testing Program, nearly all were from private laterals. Private laterals are the pipes beginning at the home or business and ending at the connection to the City's collector pipe. This is consistent with previous smoke testing done by the City. It points out that there is basis to undertake an aggressive Multi-Modal Private Lateral Inspection program.

Figure 3-3 Smoke Testing to find Improper Connections



3.4.2 CCTV Inspection

Flow measurements and field maintenance discussions identified Basin 5 (The Meadows Area) as having high rainfall induced infiltration problems. Using the recently acquired CCTV equipment and software, the City performed inspection of the collection system from April through July 2007. Figure 6-7 shows pipes that were inspected by the City crews. DUDEK linked most of the CCTV inspection reports to the GIS to aid in review of the internal pipe conditions.

3.5 Capacity Analysis (Hydraulic Modeling)

Using the GIS database and the flow data observed a hydraulic model was prepared to evaluate the capacity of the collection system. The model was calibrated for Existing Dry weather and for the wet weather event of 2/10/2007. The calibrated model was used to identify capacity restrictions that became the basis of a set of projects that are needed to minimize the potential for capacity related overflows.

Chapter 6 discusses the technical aspects of the Capacity Analysis performed using the hydraulic model.

3.6 Capacity Enhancement Project Recommendations

Based on the hydraulic deficiencies observed in the model and numerous conversations with operations staff, a set of candidate capacity enhancement projects is recommended. These include not only replacement pipelines but also further Condition Assessments and Capacity Surveys to determine the overall condition of the collection system. See Table 7-3 or Table ES-1 for a list of these projects.

4.0 Flow Characteristics

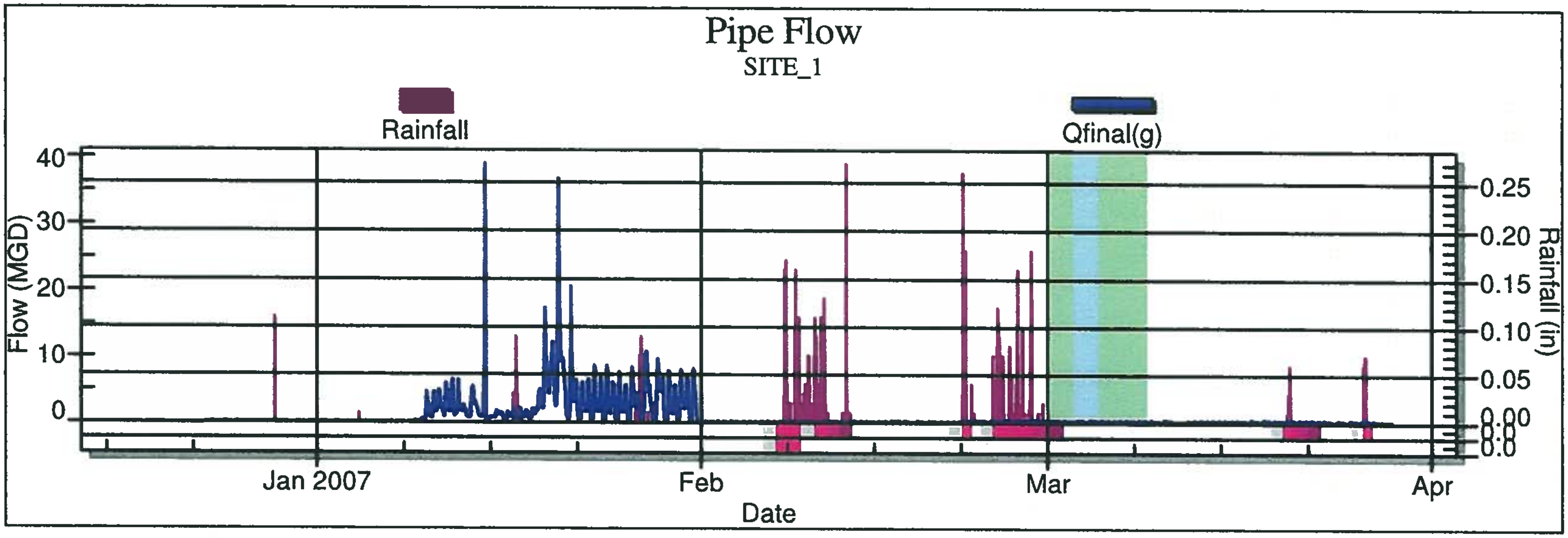
Following the verification of the sewer collection system GIS, sites were selected to divide the entire collection system up into six sub-basins. These sub-basins isolate various parts of the collection system to determine the general flow characteristics and to identify the areas most responsive to rainfall. Six flow meters were installed in December 2006 for a period of 90 days.

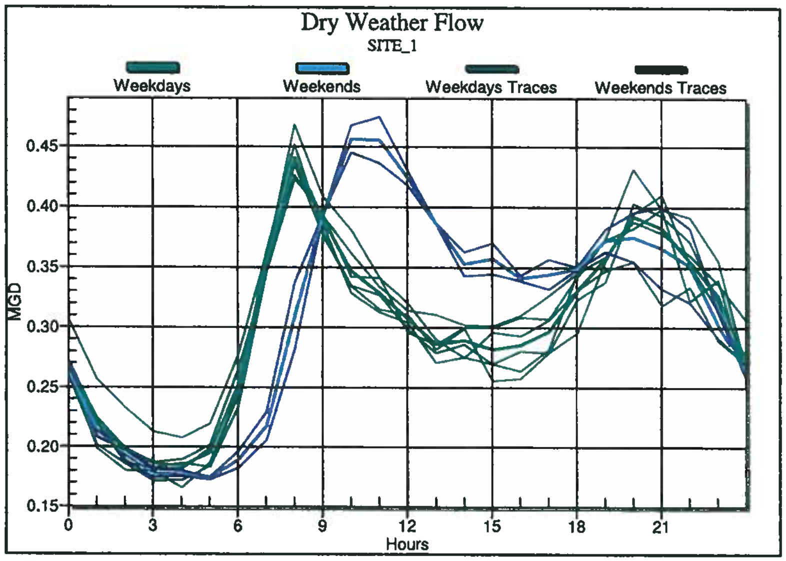
These flow meters provided sufficient flow data to clearly define the operating characteristics of the collection system during normal dry periods and during and following rainfall events. The follow subsections describe the findings of the flow measurement program. The flow measurements and subsequent flow data analysis presented here become the basis of the collection system model calibration.

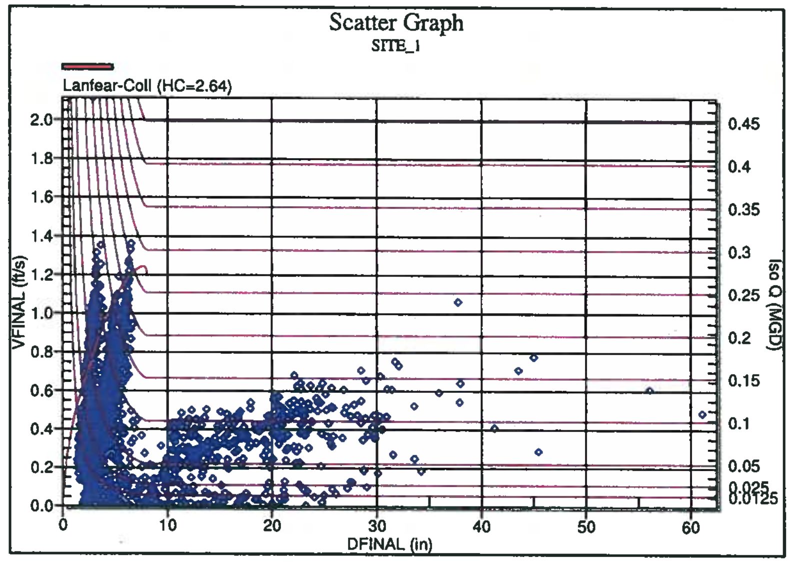
The location of the flow meters and the pipes that drain to each flow meter are presented in Figure 3.

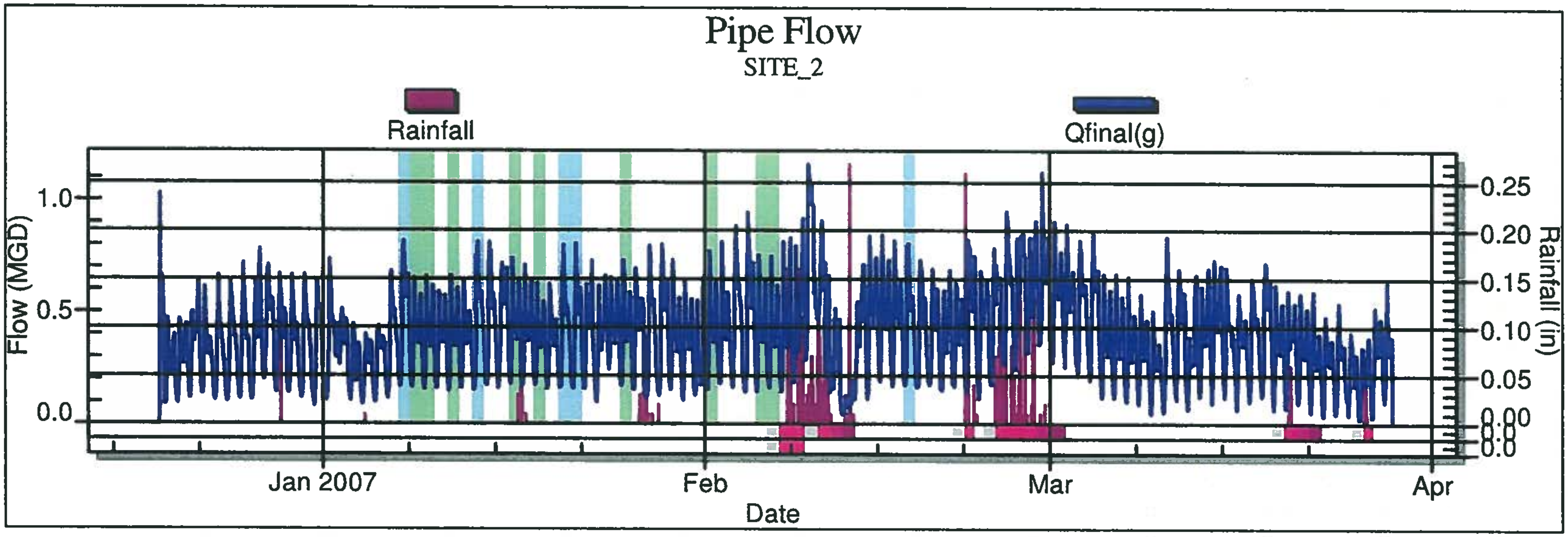
4.1 Characteristic Flow Charts

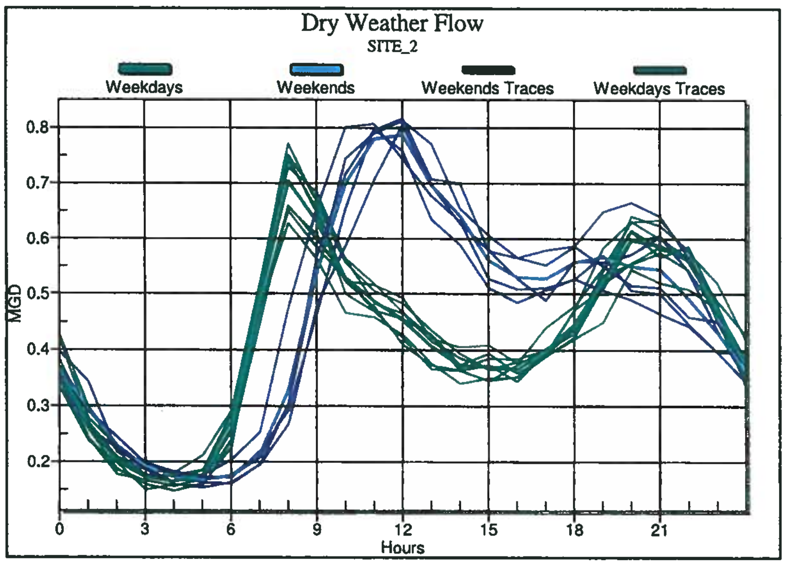
The following pages graphically show three charts per page for each site. These represent the overall flow meter data collected for the monitoring period, the average dry weather flows on weekdays and weekends, and the scattergraph representing the overall operations of the flow meter for the monitoring period. These graphs and their interpretations are discussed in more detail in the sections following.

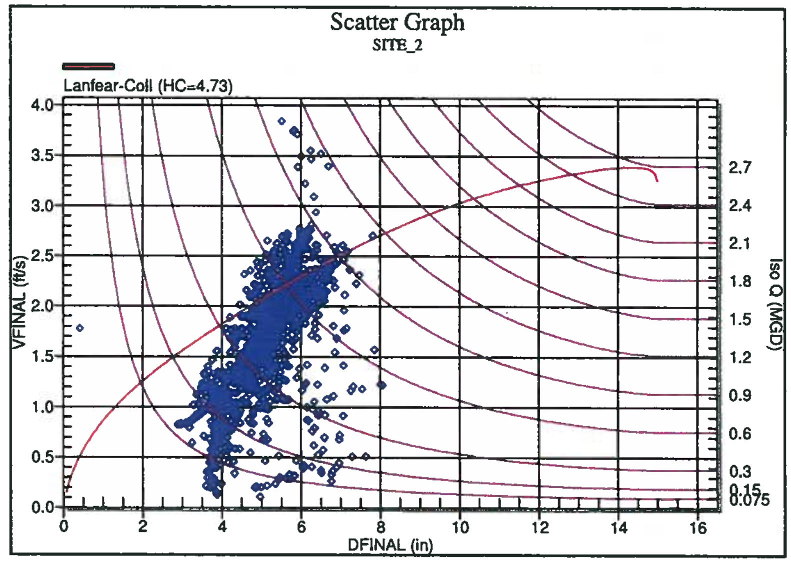

Pipe Flow
SITE_1
Rainfall
Qfinal(g)
Flow (MGD)
40
30
20
10
0
Rainfall (in)
0.25
0.20
0.15
0.10
0.05
0.00
Jan 2007
Feb
Mar
Apr
Date

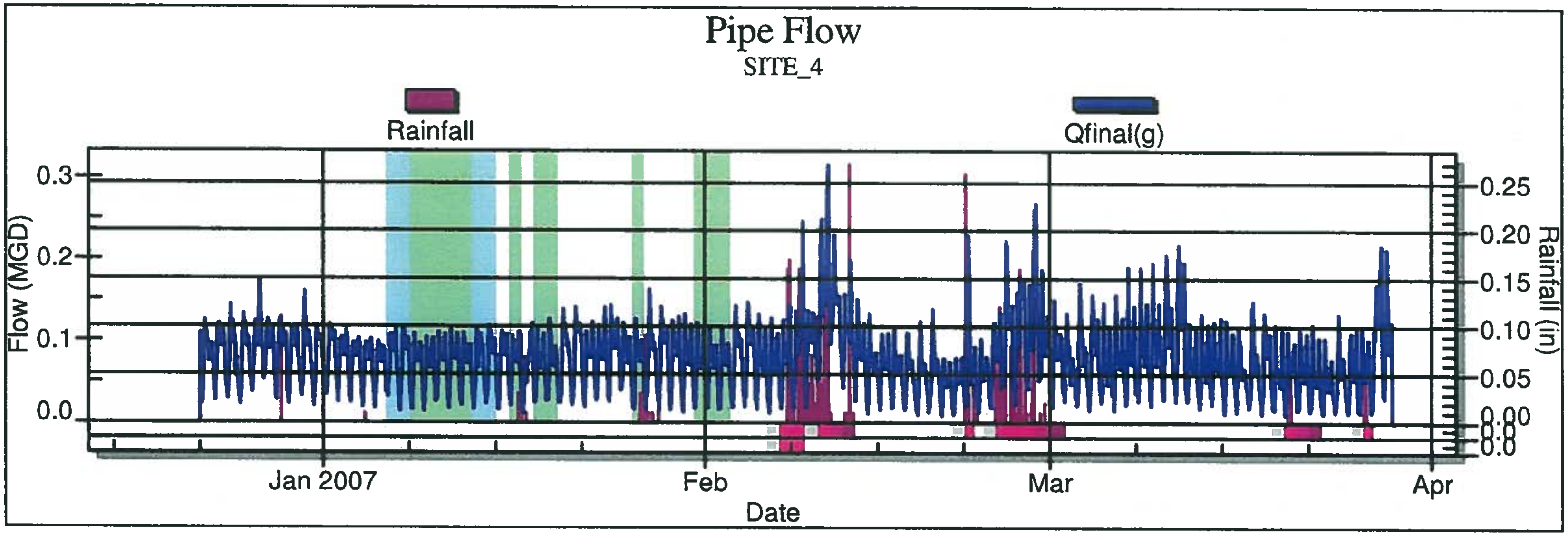

Dry Weather Flow
SITE_1
Weekdays
Weekends
Weekdays Traces
Weekends Traces
MGD
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0
3
6
9
12
15
18
21
Hours

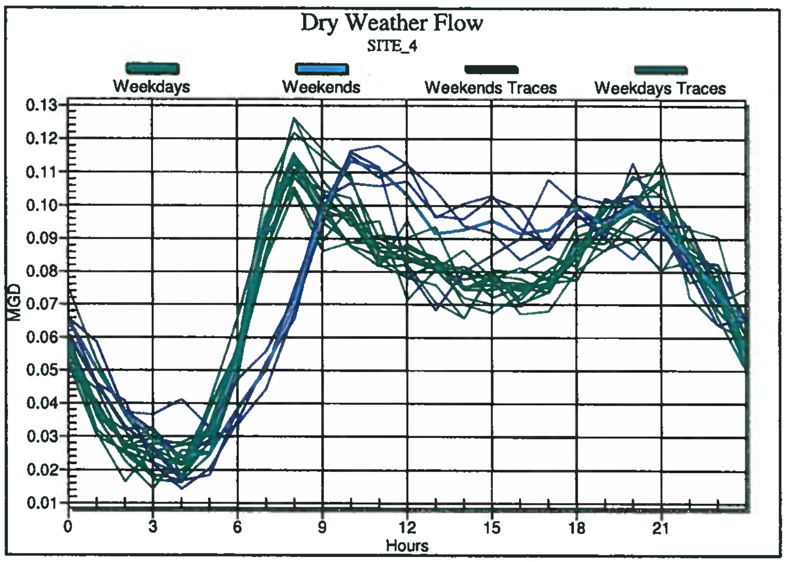

Scatter Graph
SITE_1
Lanfear-Coll (HC=2.64)
VFINAL (ft/s)
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Iso Q (MGD)
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0.025
0.0125
0
10
20
30
40
50
60
DFINAL (in)

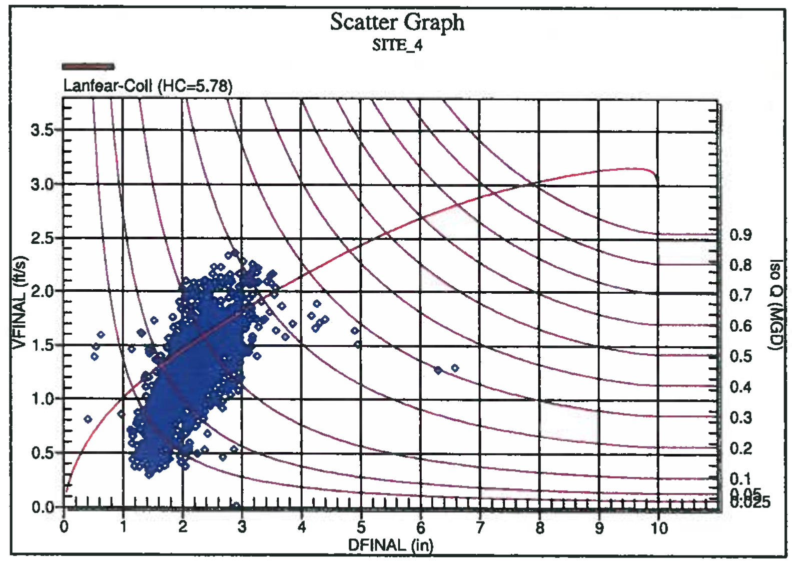

Pipe Flow
SITE_2
Rainfall
Qfinal(g)
Flow (MGD)
1.0
0.5
0.0
Rainfall (in)
0.25
0.20
0.15
0.10
0.05
0.00
Jan 2007
Feb
Mar
Apr
Date

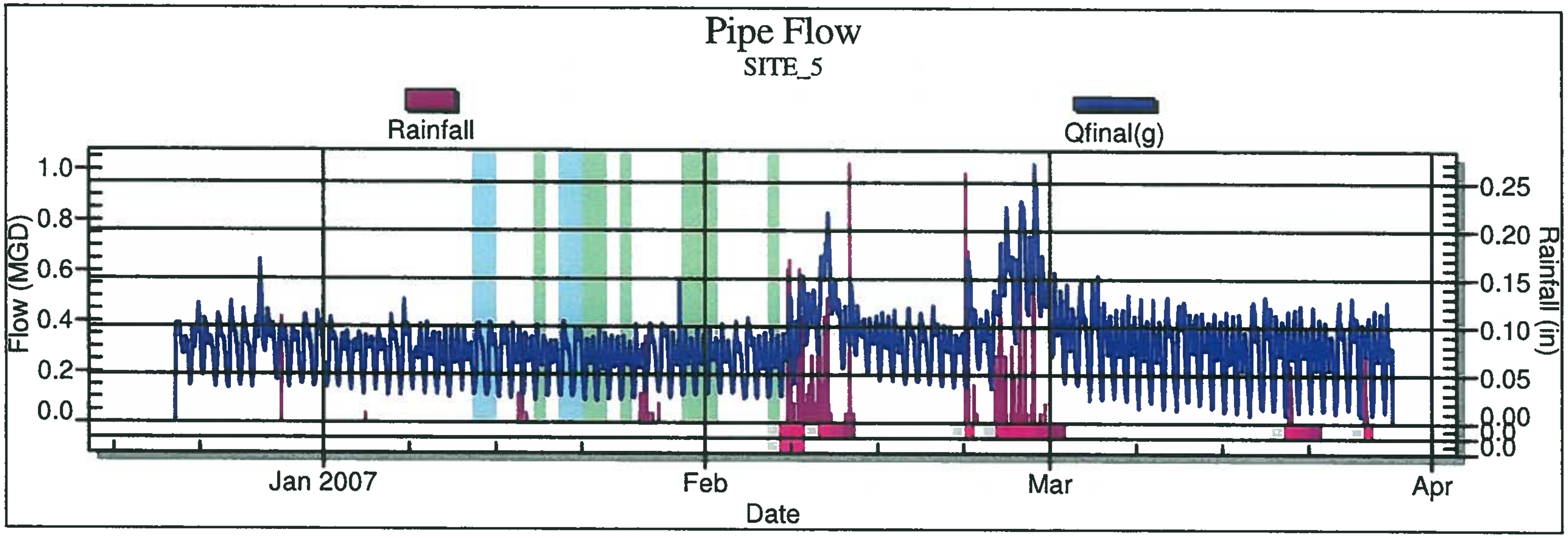

Dry Weather Flow
SITE_2
Weekdays
Weekends
Weekends Traces
Weekdays Traces
MGD
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0
3
6
9
12
15
18
21
Hours

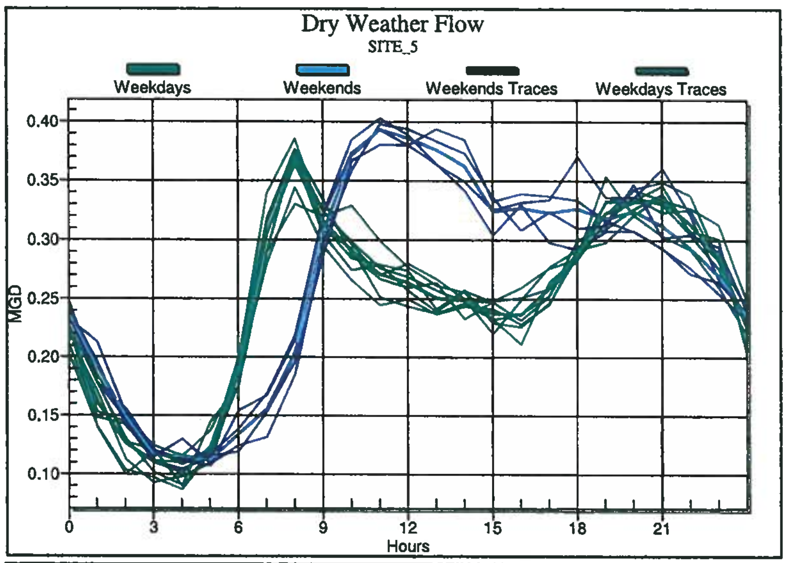

Scatter Graph
SITE_2
Lanfear-Coll (HC=4.73)
VFINAL (ft/s)
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
2
4
6
8
10
12
14
16
DFINAL (in)
Iso Q (MGD)
2.7
2.4
2.1
1.8
1.5
1.2
0.9
0.6
0.3
0.15
0.075

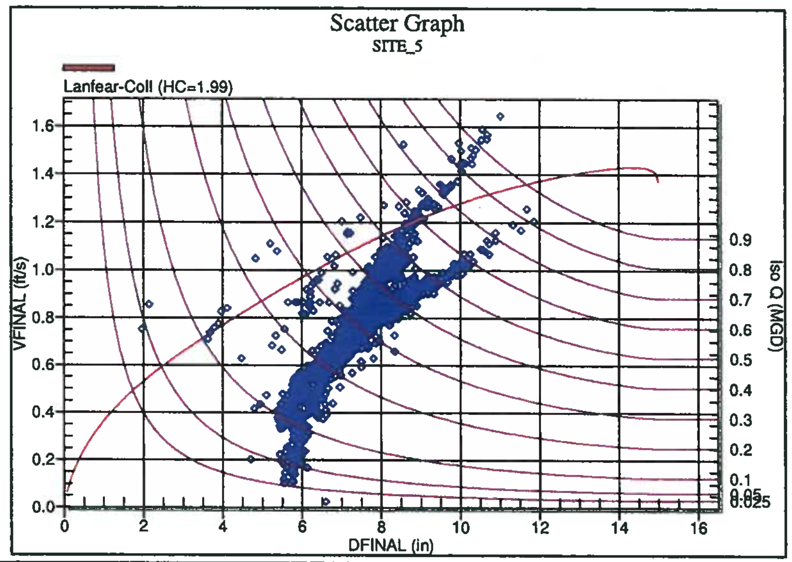

Pipe Flow
SITE_4
Rainfall
Qfinal(g)
Flow (MGD)
Rainfall (in)
Jan 2007
Feb
Mar
Apr
Date

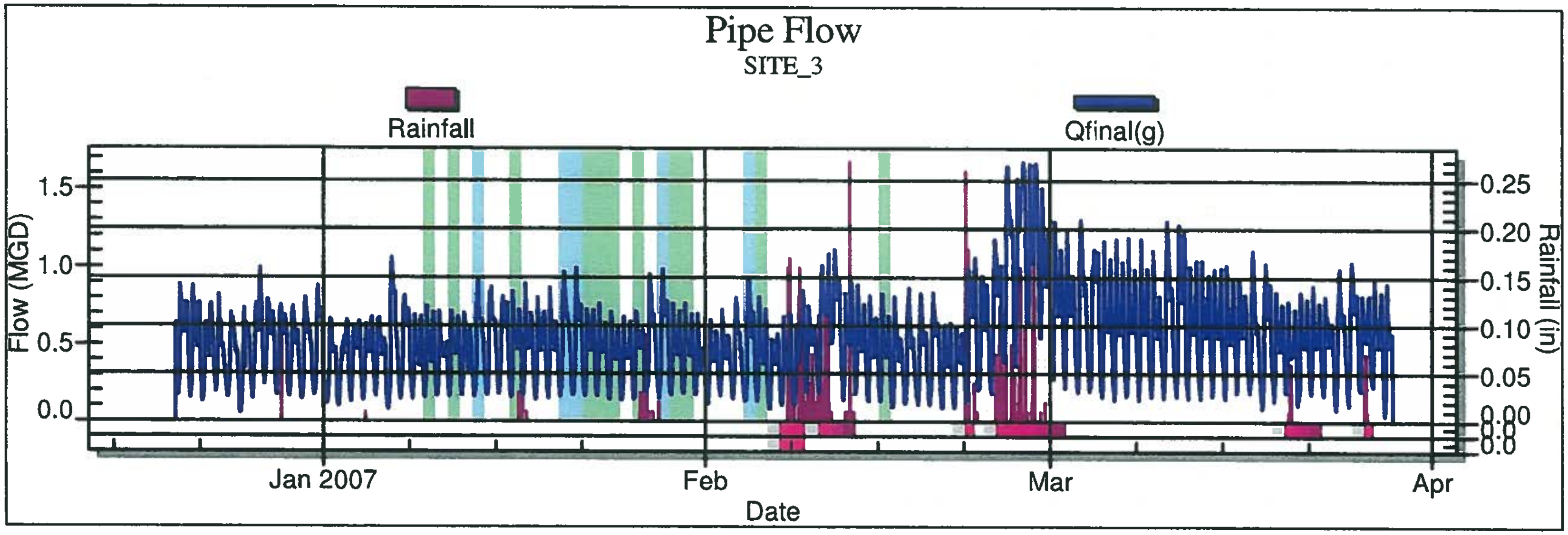

Dry Weather Flow
SITE_4
Weekdays
Weekends
Weekends Traces
Weekdays Traces
MGD
Hours

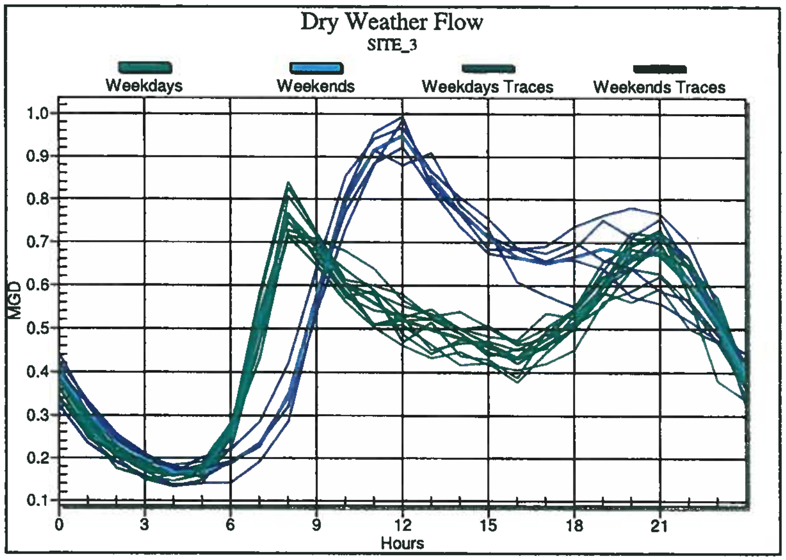

Scatter Graph
SITE_4
Lanfear-Coll (HC=5.78)
VFINAL (ft/s)
DFINAL (in)
Iso Q (MGD)

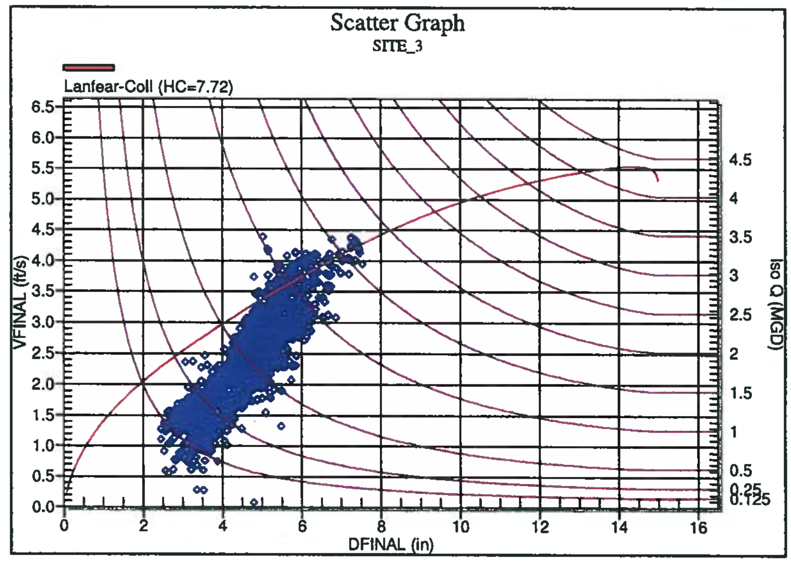

Pipe Flow
SITE_5
Rainfall
Qfinal(g)
Flow (MGD)
Rainfall (in)
Jan 2007
Feb
Mar
Apr
Date

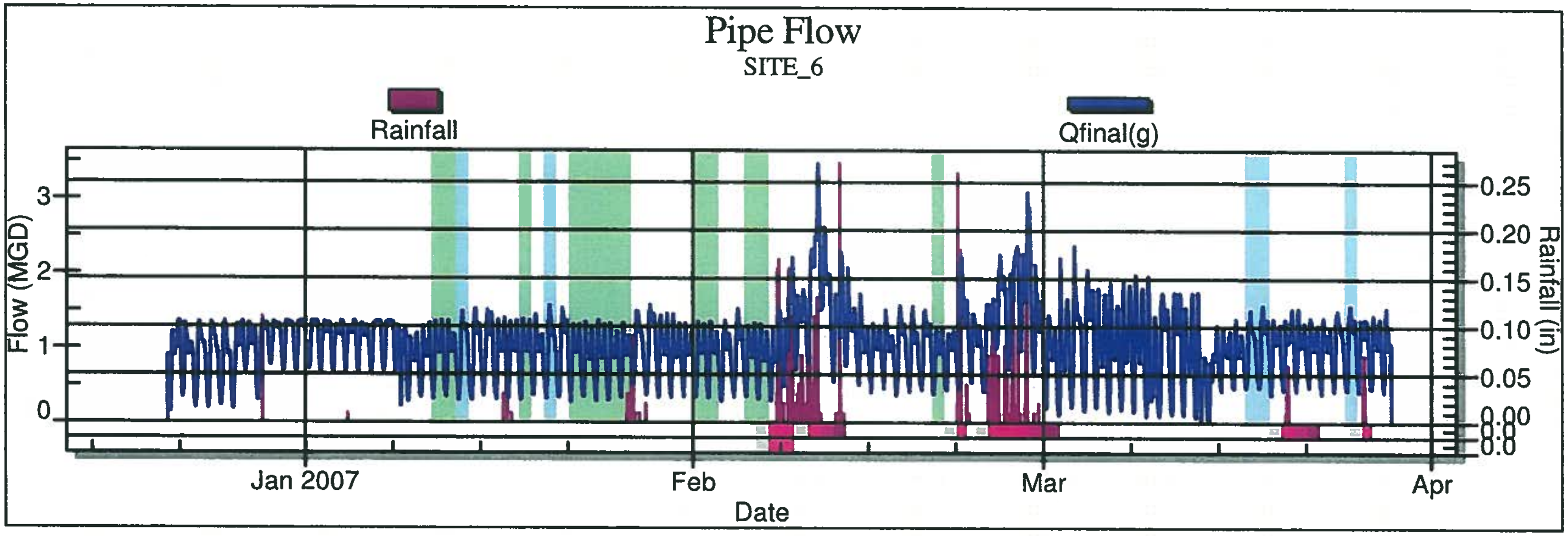

Dry Weather Flow
SITE_5
Weekdays
Weekends
Weekends Traces
Weekdays Traces
MGD
Hours

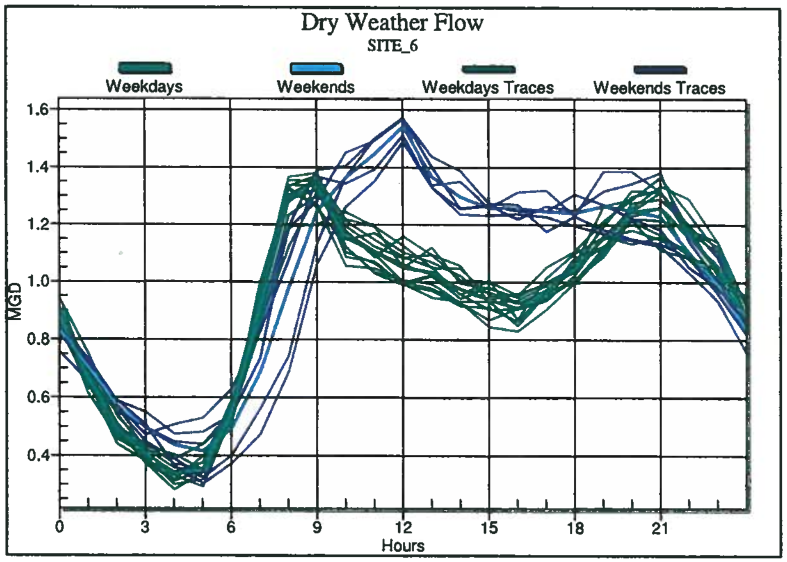

Scatter Graph
SITE_5
Lanfear-Coll (HC=1.99)
VFINAL (ft/s)
DFINAL (in)
Iso Q (MGD)

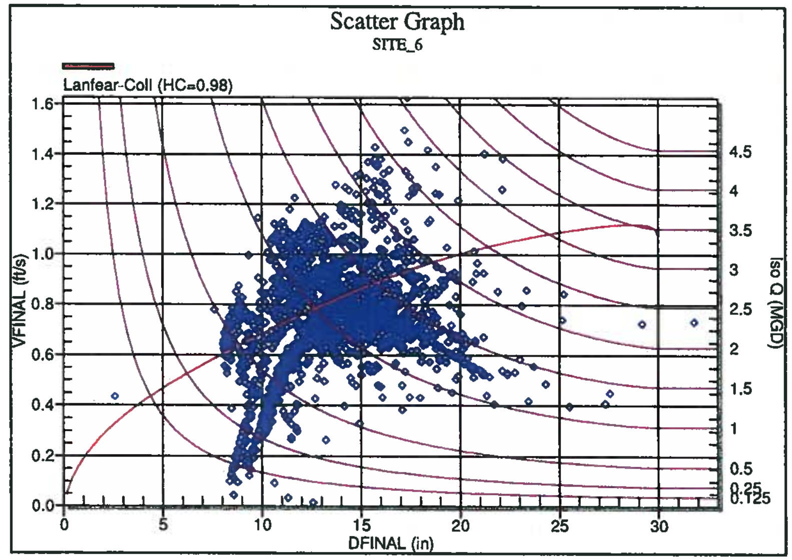

Pipe Flow
SITE_3
Rainfall
Qfinal(g)
Flow (MGD)
1.5
1.0
0.5
0.0
Rainfall (in)
0.25
0.20
0.15
0.10
0.05
0.00
Jan 2007
Feb
Mar
Apr
Date


Dry Weather Flow
SITE_3
Weekdays
Weekends
Weekdays Traces
Weekends Traces
MGD
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
3
6
9
12
15
18
21
Hours


Scatter Graph
SITE_3
Lanfear-Coll (HC=7.72)
VFINAL (ft/s)
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Iso Q (MGD)
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0.25
0.125
0
2
4
6
8
10
12
14
16
DFINAL (in)


Pipe Flow
SITE_6
Rainfall
Qfinal(g)
Flow (MGD)
Rainfall (in)
Jan 2007
Feb
Mar
Apr
Date


Dry Weather Flow
SITE_6
Weekdays
Weekends
Weekdays Traces
Weekends Traces
MGD
Hours


Scatter Graph
SITE_6
Lanfear-Coll (HC=0.98)
VFINAL (ft/s)
DFINAL (in)
Iso Q (MGD)

4.2 Normal Dry Flows

To characterize the flows during dry periods, flow data was analyzed during periods in which no rainfall occurred and there were no lingering effects of previous rainfall. A characteristic hydrograph (flow variation by hour for a day) was prepared for each of the sites. This hydrograph is also called a diurnal curve and is used in the model and for the determination of defect flow quantities.

The following table lists each of the flow meter sites and the corresponding hourly average flow during the dry weather days of the measurement period.

Table 4-1 Average Dry Weather Results

City of Pinole Flow Measurement Results						
Total Average Hourly Flow for Dry Day Selection (mgd)						
Hour	**Q_1**	**Q_2**	**Q_3**	**Q_4**	**Q_5**	**Q_6**
0	0.271	0.343	0.370	0.057	0.234	0.877
1	0.219	0.240	0.265	0.039	0.173	0.671
2	0.196	0.187	0.198	0.027	0.138	0.500
3	0.185	0.164	0.162	0.024	0.118	0.402
4	0.183	0.153	0.149	0.022	0.111	0.343
5	0.195	0.168	0.159	0.032	0.132	0.352
6	0.251	0.247	0.245	0.055	0.199	0.551
7	0.353	0.460	0.479	0.093	0.309	0.921
8	0.440	0.670	0.718	0.114	0.369	1.309
9	0.388	0.616	0.671	0.101	0.321	1.349
10	0.346	0.534	0.591	0.096	0.304	1.162
11	0.328	0.482	0.557	0.086	0.288	1.107
12	0.306	0.450	0.512	0.084	0.275	1.057
13	0.285	0.406	0.488	0.082	0.265	1.036
14	0.289	0.369	0.468	0.076	0.261	0.981
15	0.281	0.366	0.445	0.076	0.250	0.944
16	0.285	0.368	0.419	0.075	0.248	0.911
17	0.296	0.396	0.450	0.076	0.267	0.976
18	0.329	0.443	0.496	0.085	0.299	1.055
19	0.357	0.521	0.582	0.094	0.328	1.162
20	0.392	0.575	0.635	0.099	0.338	1.249
21	0.382	0.565	0.646	0.099	0.342	1.280
22	0.354	0.531	0.572	0.085	0.322	1.168
23	0.325	0.452	0.487	0.075	0.292	1.055

Note: A variety of dry days were used to create the average dry day for each site.

These flow averages in millions of gallons per day are then converted into Hourly Flow Factors for use in the model. The following Table and graph shows the Hourly Flow Factors for each site.

Table 4-2 Dry Hourly Flow Factors

City of Pinole Flow Measurement Results						
Hourly Flow Factors						
Hour	**Q_1**	**Q_2**	**Q_3**	**Q_4**	**Q_5**	**Q_6**
0	0.90	0.85	0.83	0.78	0.91	0.94
1	0.73	0.59	0.59	0.54	0.67	0.72
2	0.65	0.46	0.44	0.37	0.53	0.54
3	0.61	0.41	0.36	0.33	0.46	0.43
4	0.61	0.38	0.33	0.30	0.43	0.37
5	0.65	0.41	0.36	0.44	0.51	0.38
6	0.83	0.61	0.55	0.75	0.77	0.59
7	1.17	1.14	1.07	1.27	1.20	0.99
8	1.46	1.66	1.60	1.57	1.43	1.40
9	1.29	1.52	1.50	1.39	1.25	1.44
10	1.15	1.32	1.32	1.32	1.18	1.24
11	1.09	1.19	1.24	1.18	1.12	1.18
12	1.02	1.11	1.14	1.15	1.07	1.13
13	0.95	1.00	1.09	1.12	1.03	1.11
14	0.96	0.91	1.04	1.04	1.01	1.05
15	0.93	0.90	0.99	1.04	0.97	1.01
16	0.94	0.91	0.93	1.02	0.96	0.98
17	0.98	0.98	1.00	1.05	1.04	1.04
18	1.09	1.10	1.11	1.17	1.16	1.13
19	1.18	1.29	1.30	1.29	1.27	1.24
20	1.30	1.42	1.42	1.35	1.31	1.34
21	1.27	1.40	1.44	1.35	1.33	1.37
22	1.18	1.31	1.27	1.17	1.25	1.25
23	1.08	1.12	1.09	1.02	1.13	1.13
Max HFF	1.5	1.7	1.6	1.6	1.4	1.4

The following chart shows the Flow Factors. The high degree of similarity shows that most of the flow contributed to the system is similar. Note that Site I has a high early morning flow factor of 0.60 which may indicate high groundwater effects. The remainder of the sites shows an hourly flow factor of 0.40. Site I's higher value also suppresses its peak flow factor to 1.4 which is nearly the same as that at the most downstream site, Site 6.

All sites in the Pinole system exhibit a higher than predicted minimum to average flow ratio. This is sometimes used as a guide to indicate higher nighttime infiltration rates Figure 4-2 shows the predicted values and the observed values. The blue line is the expected minimum flow factor based on WEF MOP 9 (1988). The gray lines are the 5% deviations. Interpretation – Points lying above the expected minimum flow factors exhibit higher minimum flow rates that are expected. Overall high groundwater infiltration is the likely culprit.

Figure 4-1 Hourly Flow Factors

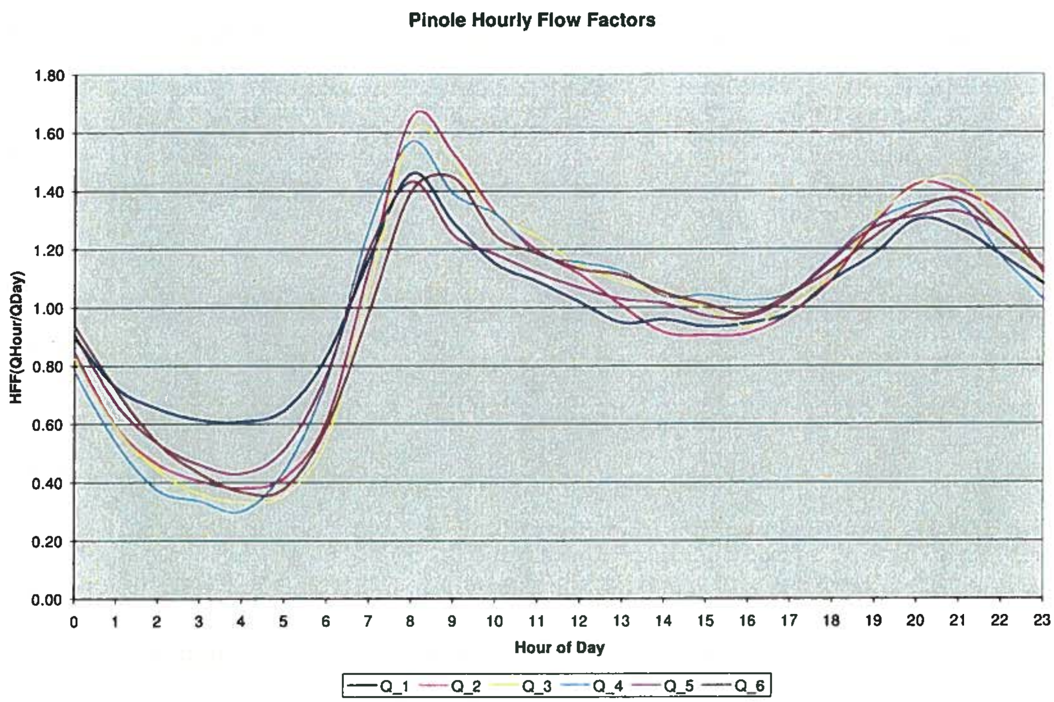
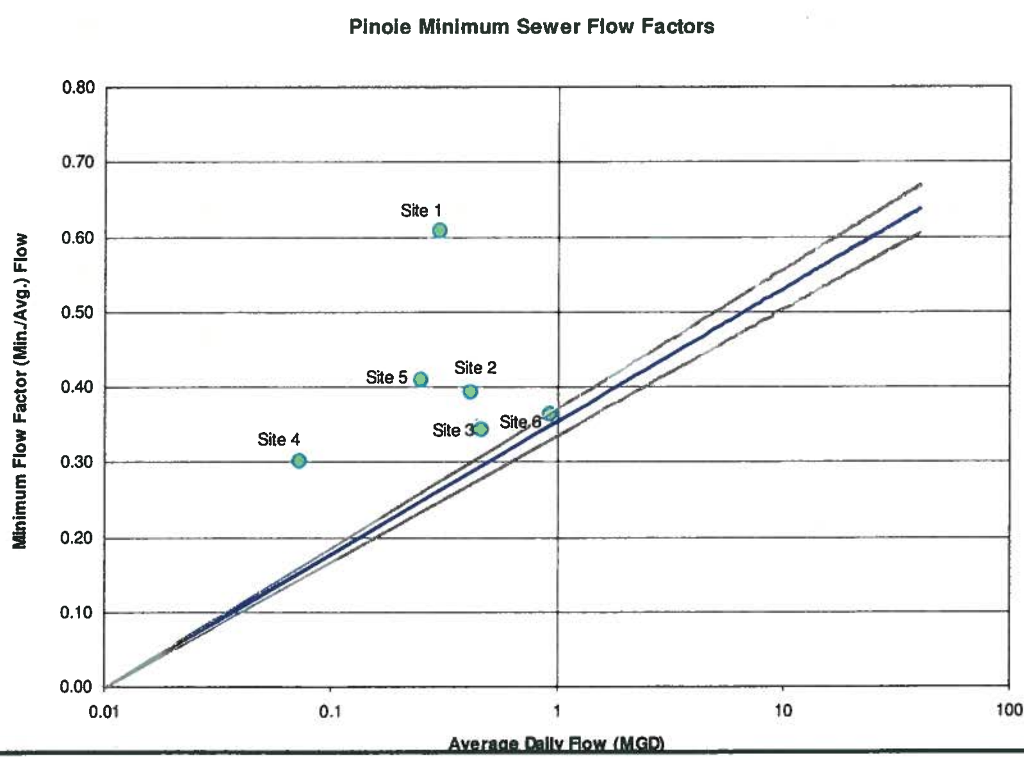


Figure 4-2 Minimum Flow Ratios



4.3 Wet Weather Flows

Note that each basin is of different length, area and IDM. To compare each basin on an equal basis we "normalize" by one of these factors. The following table shows the measurements for each one of these parameters.

Table 4-3 Basin Measurements

	Length	Footprint	Area
Meter	(Feet)	(IDM)	(Acres)
SITE_1	27,474	40.37	607
SITE_2	56,254	87.49	614
SITE_3	33,566	53.43	283
SITE_4	24,972	35.92	216
SITE_5	50,586	68.59	269
SITE_6	65,750	97.71	446
Average	43,100	63.92	406

IDM is calculated by multiplying the diameter in inches by the feet of that length and dividing by 5280 to yield Inch Diameter Mile. It is a surrogate for the exposed surface area of the pipe and is often used when high infiltration rates are expected.

Wet weather flows are calculated by taking the difference in hourly hydrographs between the Average Dry Day and the rainfall event. Due to the variability of rainfall distribution over the system we use the average of several events to define the average increase in flow rate. This increase in flow rate is then normalized by the chosen parameter (IDM) to allow comparisons of basins of varying measurements.

Defect flows are characterized by the mechanism that they enter the system. Inflow is through direct connections of the pipe to the surface while Infiltration is through indirect connections.

Inflow is characterized by rapid increases in the flow as the rainfall begins and rapid return to normal flows when the rainfall stops. As a result inflow is characterized by the change in flow rate from dry weather to wet weather.

Conversely, infiltration is characterized by steady increases and decreases in flow rates whose onset and ending greatly lag the beginning and ending of a rainfall event. Rainfall Induced Infiltration (RII) is dependent on changes in groundwater elevations. RII is characterized by changes in flow volume from dry weather to wet weather.

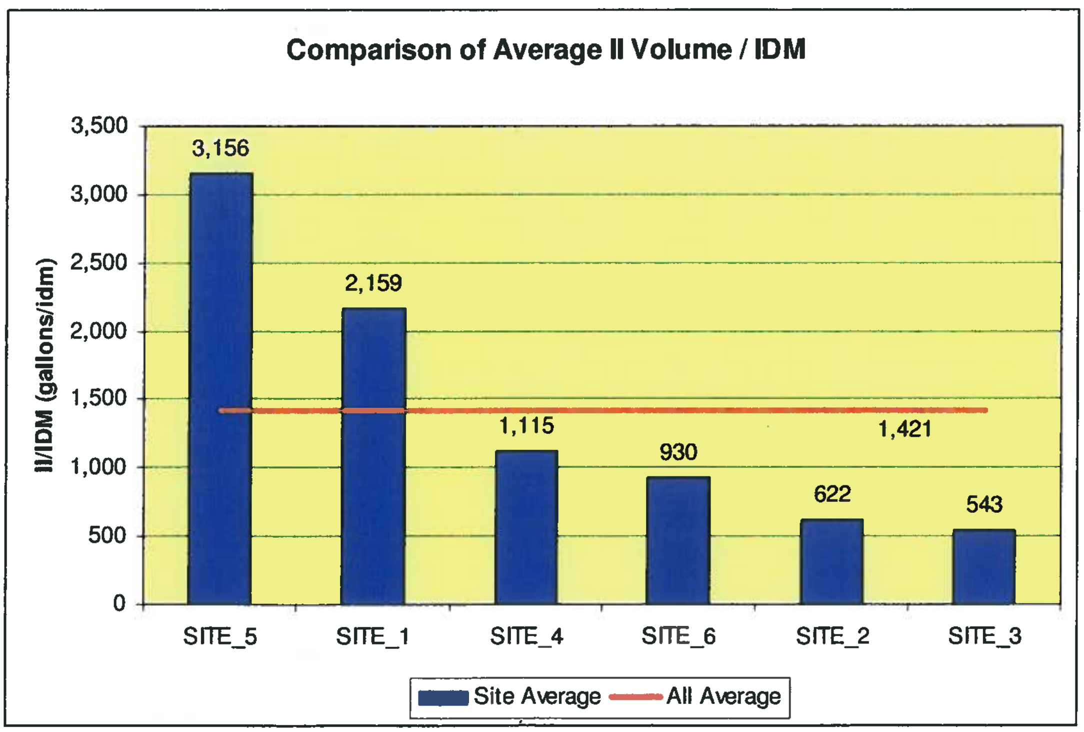
Table 4-4 and Figure 4-3 that follow indicate the changes in Flow Volume (Infiltration) for each of the sites and storm events, along with the sites ranking for that parameter.

Table 4-4 Infiltration Response Ranking

Net II Volume (gallons) per IDM							
Meter	2/7/2007	2/22/2007	2/24/2007	3/19/2007	3/26/2007	Average	Priority
SITE_1	1,016	1,345	7,469	705	259	2,159	2
SITE_2	631	653	1,251	149	426	622	5
SITE_3	455	981	1,107	19	154	543	6
SITE_4	646	783	3,799	242	106	1,115	3
SITE_5	1,152	1,712	12,125	391	400	3,156	1
SITE_6	1,440	1,183	1,391	469	168	930	4
IDM = Inch Diameter Mile (feet*Diameter(inches)/5280) Indicator of pipe surface area							

Shown graphically in the following figure, Site 5 shows the highest average increase in flow volume (infiltration)

Figure 4-3 Increase in flow volume (Infiltration)

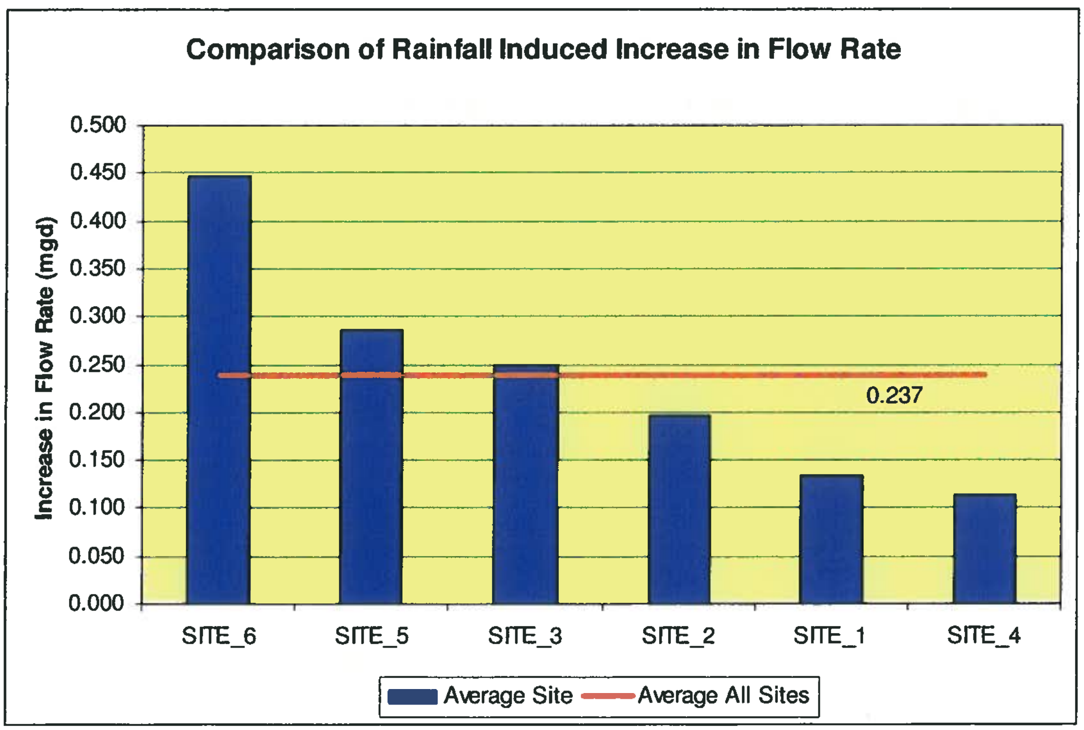


The following table and graph, show the results of measuring increases in flow rate as an indicator of Inflow responses in the system.

Table 4-5 Increase in Flow Rate (Inflow)

Net II Peak (mgd)							
Meter	2/7/2007	2/22/2007	2/24/2007	3/19/2007	3/26/2007	Average	Priority
SITE_1	0.097	0.126	0.263	0.123	0.059	0.134	5
SITE_2	0.223	0.191	0.319	0.114	0.131	0.196	4
SITE_3	0.089	0.29	0.634	0.155	0.075	0.249	3
SITE_4	0.156	0.15	0.189	0.041	0.029	0.113	6
SITE_5	0.222	0.303	0.679	0.134	0.094	0.286	2
SITE_6	0.652	0.406	0.548	0.352	0.279	0.447	1

Figure 4-4 Increase in Flow Rate (Inflow)



On average, Site 6 showed the largest increase in net peak flow rate. This indicates that it sees the strongest effects of rainfall.

Based on these observations, it was recommended that Basin 5 be CCTV inspected while the soil was still saturated to provide positive observations of infiltration increases. Highlights of the CCTV inspection and review of Basin 5 are included in the Existing System Evaluation Section.

It was also recommended that Basin 6 be smoke tested for location of inflow defects. Special care should be given to any potential cross connections in the system. Results of the Smoke Testing Results are included in the Existing System Evaluation Section.

5.0 System Characteristics

5.1 Collection System

5.1.1 Pipes

The collection system is composed of pipelines that drain the system by gravity or that move flow from lower elevations to higher elevations through pressure pipes (force mains). The following table characterizes the important aspects of the piped system.

Table 5-1 Pipe Length by Type

Pipe Length		
Gravity	259,297	Feet
Pressure	1,627	Feet
Total	260,924	Feet
	49	Miles

The pipelines vary in size depending on the number of customers served and the available slope. In most modern collection systems a minimum pipe size of eight inches is recommended. Note that over 40% of the Pinole collection system is less than 8 inches in diameter.

Table 5-2 Gravity Pipe Length by Diameter

Size Distribution		
Inches	Feet	PerCent
4	1,009	0.4%
6	87,855	33.9%
8	140,319	54.1%
10	13,230	5.1%
12	5,893	2.3%
15	4,931	1.9%
18	4,507	1.7%
24	631	0.2%
30	922	0.4%
Total	259,297	

Of special concern to the future of the collection system is the Private Sewer Lateral. This pipe connects each house or business to the City's collection system. In Pinole there are approximately 6,050 lots connected to the system (Excludes 150 vacant lots). If we estimate that the average distance from the City main to the house is 35 feet, there are 6,050 lots X 35 feet/lot = 211,750 feet of privately owned sewer lines. These lines should also be investigated through a Multi-Modal Lateral Inspection program to be developed as an additional program.

5.1.2 Pump Stations

The City owns and operates two lift stations to convey flow from low lying areas to higher elevations where the flow continues by gravity to the WWTP. The two pump stations are located at San Pablo Avenue and at Hazel Street.

A pump station consists of a Wet Well for storing incoming sewer flows, Pumps for pumping out the stored flow and a Force Main or pressure pipe that moves the flow from the pump to the discharge wet well.

The following table describes the characteristics of the pump stations.

Table 5-3 Pump Station Characteristics

Name	Serves	Storage	Pumps	Pump Size	FM Dia	FM Length	Material
San Pablo	293	2880	2	975 gpm	6	625	Asbestos
Hazel Street	487	2963	2	1800 gpm	6	940	Asbestos

Since pump stations are much more complex than the gravity portion of the system they are more prone to failure and should be eliminated if at all possible.

Both of these pump stations were discussed in the Panattoni Study. Flow loads in the Hazel Street Station appear lower than the numbers provided by the City Staff. The recommendations made by the Panattoni Study were to relieve the San Pablo Pump Station by routing its flow through Sugar City to the Hazel Street Pump Station. The calibrated model prepared as a part of the Master Plan shows that the pipes coming into the Hazel PS and downstream of the forcemain in Orleans are overloaded. It is therefore recommended that the Pump Station Elimination Feasibility Study be performed to evaluate the potential for completely removing both lift stations.

Further it is recommended that the instrumentation at the Pump Stations be upgraded to allow the pump stations flows and pump operations to be monitored from the WWTP SCADA system or from the internet. This will allow a much more detailed analysis of the operational characteristics of these stations.

6.0 System Evaluation

6.1 Inflow and Infiltration

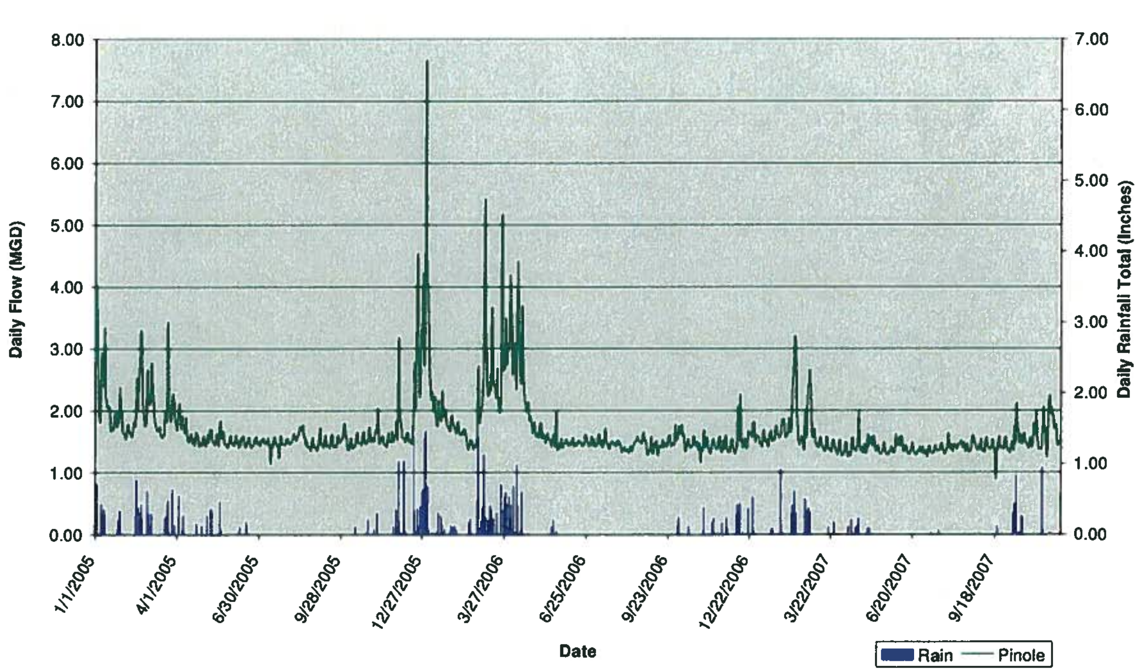
Inflow and Infiltration results from the flow measurement program are described in Section 4.3 above. In general the system shows a high incidence of groundwater or base infiltration during dry weather periods. The system shows pronounced Rainfall Induced Inflow and Infiltration during the monitored wet weather period. Further analysis of the long term trends and defect flows in the system can be found by analysis of the wastewater treatment plant records. This is discussed in the following section.

6.1.1 WWTP Flow Analysis

In December 2007 and in April 2008, the City provided Dudek with historical influent flows and rainfall for both Pinole and Hercules from January 2005. The following graph shows the results of plotting that data.

Pinole Flows

Figure 6-1 WWTP Historical Daily Flow Volume (Pinole Only)



From this graph it is easily observed that there is a significant impact of rainfall events on the treatment plant inflow. It also shows that there is little change in the dry weather flows during this three year period. The WWTP data was combined with the Flow Measurement Program data to provide flow data for the hydraulic model. The results are discussed in the Chapter on Capacity Analysis.

Based on this data it was observed that the total volume of flow entering the Treatment Plant from Pinole is about 1.7 million gallons per day (mgd) during dry weather conditions. As Figure 6-1 shows, the rainfall event of 12/31/2005 resulted in a daily volume of 7.6 million gallons. This would indicate that almost 6.0 million gallons of rainfall entered the sewer collection system and was conveyed to the plant. The calculated wet weather peaking factor for daily volume is 7.6 MGD/1.7 MGD = 4.5. Note that the Peaking Factor for Peak Rate could not be calculated due to inoperable flow meters during the 12/31/2005 event.

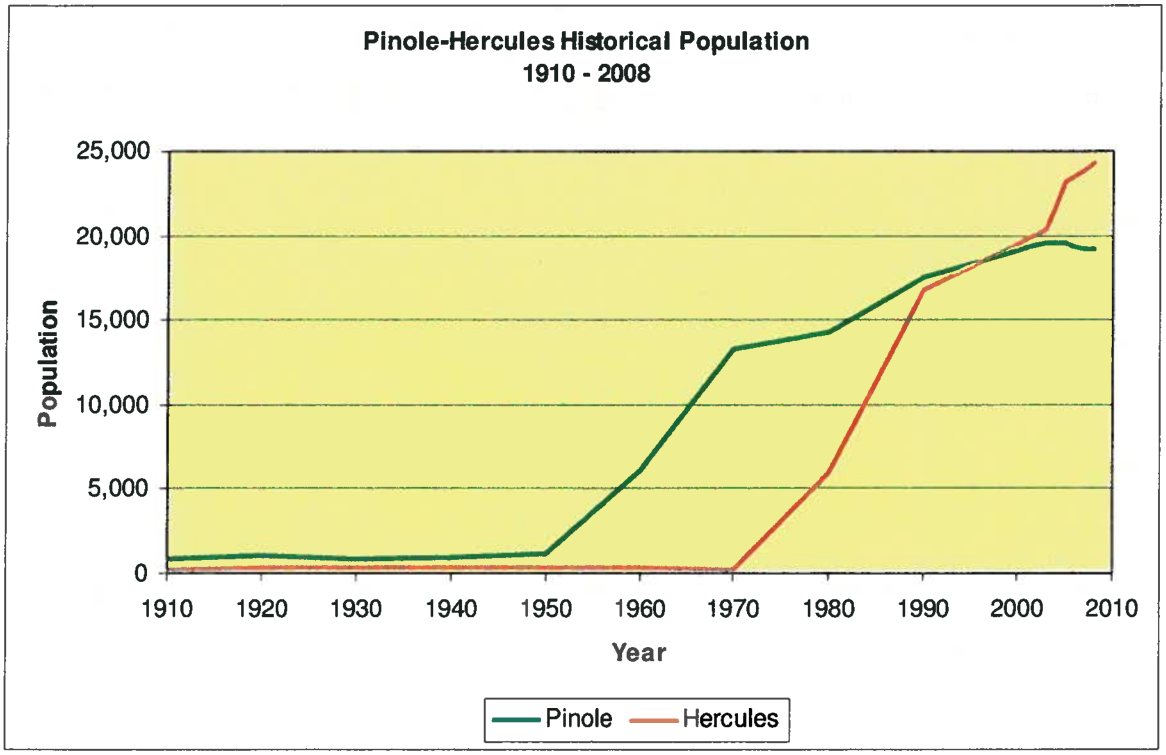
The Pinole-Hercules WWTP receives wastewater flows from Pinole and Hercules. The Hercules collection system is currently being studied and a Sewer Collection System Master Plan is being prepared by DUDEK. Analysis of the WWTP flow data provided by the City was performed for both cities.

Based on this data it was observed that the total volume of flow entering the Treatment Plant from Hercules is about 1.7 million gallons per day (mgd) during dry weather conditions. the rainfall event of 12/31/2005 resulted in a daily volume of 5.6 million gallons. This would indicate that almost 4.0 million gallons of rainfall entered the sewer collection system and was conveyed to the plant. The calculated wet weather peaking factor for daily volume is 5.6 MGD/1.7 MGD = 3.5. Note that the Peaking Factor for Peak Rate could not be calculated due to inoperable flow meters during the 12/31/2005 event.

The current population for Pinole and Hercules is 19,123 and 24,324 capita respectively. This indicates that while the flows into the treatment plant are identical, Hercules serves over 5,000 more people. Dividing the 1.7 MGD for each City by the population we find that the average wastewater flow per person in Pinole is 89 gallons per day (gpd) while the average wastewater flow per person in Hercules is 70 gallons per day or 25% less. Taking into account the relative ages of the collection system, it is likely that the additional 19 gallons per day during dry weather is coming from groundwater leaking into the collection system (Base Infiltration). The following graph displays the populations of the respective cities since 1910. Note that the rapid population growth in Pinole occurred between 1950 and 1970 while the rapid population growth in Hercules occurred from 1970 to 1990. This indicates that on average the pipes in the Pinole system are 20 years older. From 1950 to 1970 the prevalent pipe material was vitrified clay pipe with mortared joints. These joints often fail due to shifting allowing groundwater to enter the system.

An option to consider in the management of the total collection system is the possibility of bringing the Pinole and Hercules systems under a single administrative control exercised through the Pinole-Hercules Wastewater Joint Powers Authority. The single organization would then be focused on the proper operation and maintenance of all facilities related to wastewater.

Figure 6-2 Historical Population Pinole-Hercules



6.1.2 Smoke Testing

Smoke testing is accomplished by blowing a chemical based smoke into the collection system and observing its exit through inflow defects and through legitimate roof vents. Smoke testing is widely recognized as a relatively low cost method to determine the location of inflow defects. One of the limitations of the smoke testing is that areas that operate in high flow conditions or in which there are bellies and sags. In these areas smoke cannot pass and inflow defects are not identified.

Basin 6 was identified as the most likely candidate for smoke testing due to its pronounced inflow response during wet weather events. Smoke testing was accomplished in late August during dry weather conditions. The subcontractor reported identification of 37 potential inflow defects in Basin 6, two of which were later investigated and dismissed by operations personnel. The locations of the defects are listed in Table 6-1 and shown in Figure 6-1.

As shown, the dominant defect location is in private yards, which indicates potential damage to private laterals. This is consistent with observations in Basin 5 which were made in 1996. A partial list of the defects observed in the 1996 study is listed in Table 6-2.

Flow measurements and field observations by operations staff indicates a large source of inflow. A single large source for this inflow is anticipated but has not been located in any investigations to date (2007). It is recommended that the City continue to use smoke testing AND to further analyze the potential for storm drain cross connections to locate potential inflow defects.

Figure 6-3 shows orange flags where smoke was observed. Note that this is a private lateral that appears to be leaking at each joint. Also notice the depression in the ground (left of photograph) that probably indicates that some subsidence has occurred and that rainwater collects at this low point. The location of positive smoke identified inflow defects in Basin 6 is shown in the following photos.

Figure 6-3 Private Lateral Positive Smoke

Figure 6-4 Private Lateral Smoke

In addition to private laterals, inflow can occur from City owned sources.

Manholes in traffic areas are prone to damage and become a significant source of inflow. The following photograph shows the smoke testing results of a manhole. It is also common to see manhole covers with pick holes for lifting in the collection system. These should be replaced routinely or manhole dish inserts should be installed.

Water ponding at the curb line may cause inflows. Rainfall that drains to a well maintained storm drainage system will NOT enter these openings.

Figure 6-5 Manhole with inflow defect

Table 6-1 2007 Smoke Testing Results

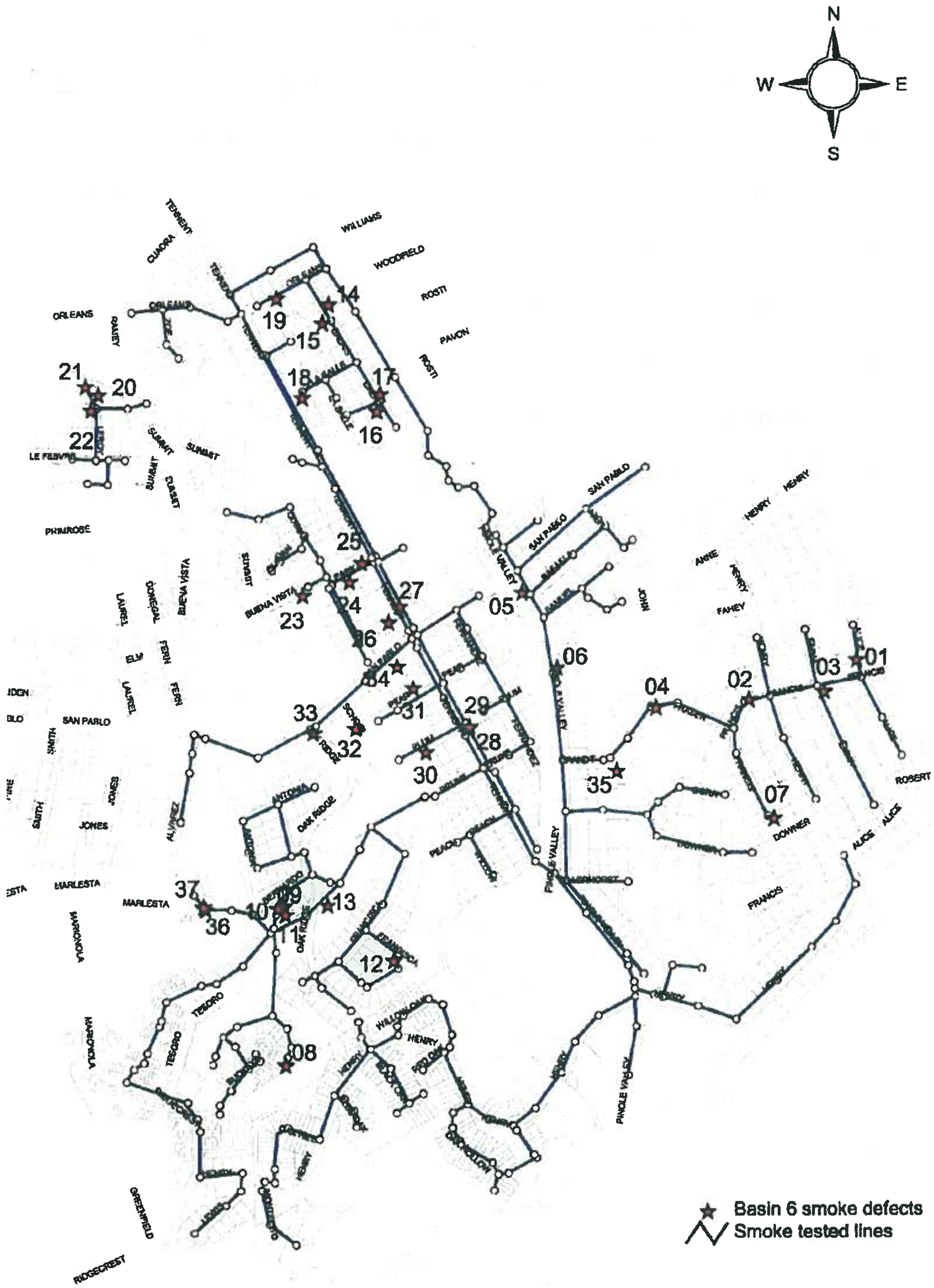
City Of Pinole Smoke Defect Log

Defect ID	Date	Zone	Location	Description	Smoke Density	Area (ft2)
1	8/27/2007	E	2638 Alice	Open drain on driveway	L/M	100
2	8/27/2007	E	2636 Frances	Smoke coming from cracks on driveway	L	100
3	8/27/2007	E	Frances & Elma	Smoke coming from unknown source in ivy plants	L/M	100
4	8/27/2007	E	2554 Fraser	Around corbel	L	100
5	8/27/2007	E	732 Pinole	Open trap near roof line of house	H	1
6	8/27/2007	E	871 Pinole Valley	Smoke from unkown source in bush	M/H	100
7	8/27/2007	E	2585 Frances	Smoke coming from cracks on sidewalk & bush	L/M	500
8	8/27/2007	S	1525 Buckeye	Smoke coming from ground behind house near manhole	M/H	500
9	8/28/2007	S	909 Bernardo	Broken cleanout	M/H	100
10	8/28/2007	S	909 Bernardo	Cracks on driveway	L	100
11	8/28/2007	S	907 Bernardo	Possible cleanout in bushs	M/H	100
12	8/28/2007	S	1120 Fransiscus	Retaining wall	L/M	500
13	8/28/1997	S	Easment (park)	Around corbel	M	100
14	8/28/2007	N	279 Calais	Front yard	M	200
15	8/28/2007	N	288 Calais	Front yard	L/M	200
16	8/28/2007	N	320 Calais	Front yard	M	200
17	8/28/2007	N	319 Calais	Front yard under rock	L/M	200
18	8/28/2007	N	2302 LaSalle	Front yard	M	300
19	8/28/2007	N	2320 Orleans	Front yard near fence	L	100
20	8/29/2007	W	305 Leroy	Driveway @ walkway	L/M	100
21	8/29/2007	W	306 Leroy	Street cleanout, from crack around stub	L	100
22	8/29/2007	W	336 Leroy	Front yard bush near sidewalk	L/M	100
23	8/29/2007	W	Esment Next to Buena Vista	Field behind fence	M/H	100
24	8/29/2007	W	605 Quinan	Sidewalk	L/M	100
25	8/29/2007	W	592 Tennent	Near sidewalk	L/M	100
26	8/29/2007	W	660 Tennent	Broken cleanout cover	M/H	100
27	8/29/2007	W	660 Tennent	Cleanout @ sidewalk	L/M	100
28	8/29/2007	W	Tennant & Plum	Storm drain	M	20000
29	8/29/2007	W	Tennent & Plum	Watermeter	L/M	200
30	8/29/2007	W	Tennent & Plum	Grass area between sidewalk & curb	L/M	100
31	8/29/2007	W	Pear across from City Hall	Possible lateral under driveway	L	100
32	8/29/2007	W	Pear @ St. Joseph parish	Driveway	M	1000
33	8/29/2007	W	Oak Ridge & San Pablo	Storm drain	M	TBD
34	8/29/2007	W	2235 San Pablo	Cleanout cover	H	100
35	8/29/2007	E	Brandt	Possible illegal cleanout	H	500
36	8/29/2007	E	Apts @ Marlesta	Grass area	L/M	200
37	8/29/2007	E	Apts @ Marlesta	Grass area @ electrical vault	L/M	200

Table 6-2 1996 Smoke Testing Results (Partial)

1996 Smoke Testing Basin 5				
St_Address	Type	Type_2	Loc_1	Loc_2
856 Marlesta	Roof Drain	Patio Drain		
876 Marlesta	Roof Drain			
1015 East Meadow	Pipeleak		Sidewalk	
825 Nob Hill	Pipeleak		Sidewalk	
827 Nob Hill	Pipeleak		Driveway	
829 Nob Hill	Pipeleak		Driveway	Sidewalk
822 Nob Hill	Pipeleak		Sidewalk	
880 Meadows	Pipeleak		Right Corner	Front Yard
870 Meadows	Pipeleak		Driveway	
854 East Meadow	Pipeleak		Meter Box	Side Yard
925 East Meadows	Pipeleak		Meter Box	Front Yard
905 Meadows	Pipeleak		Front Door	Driveway
916 Meadows	Pipeleak		Meter Box	Sidewalk
920 Meadows	Pipeleak		Meter Box	Sidewalk
530 Sunnyview	Pipeleak		Pool Drain	Carport
935 Nob Hill	Pipeleak		Meter Box	
825 East Meadow	Pipeleak		Meter Box	Driveway

Figure 6-6 Smoke Testing Defect Locations

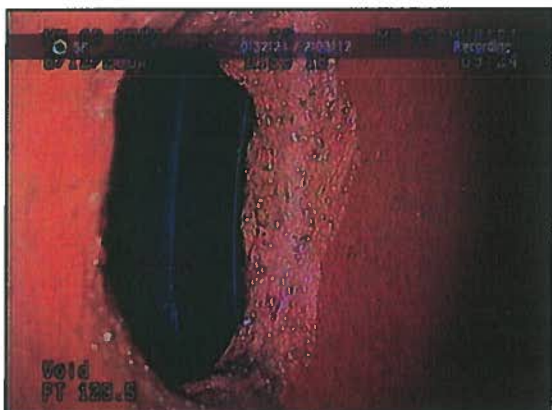


6.1.3 CCTV Inspection

The results of the CCTV inspection of Basin 5 show a generally deteriorated system. The results are presented in a separate appendix. Point repairs and replacement pipe segments will be made as a part of this report.

Flow measurements and field maintenance discussions identified Basin 5 as having high rainfall induced infiltration problems. Using the recently acquired CCTV equipment and software, the City performed inspection of the collection system from April through July 2007. Figure 6-7 shows pipes that were inspected by the City crews. DUDEK linked most of the CCTV inspection reports to the GIS to aid in review of the internal pipe conditions. Figure 6-7 shows the types of defects observed and the condition of the system in Flow Metering Basin 5. This area is known to have a significant response to even small rainfall events through the Flow Measurement Program and through Lift Station operations.

Figure 6-7 CCTV Defects Basin 5 (Meadows)



Void with unknown connection

Left Lateral with Dirt

Offset Joint with Dirt

Lateral Left with roots and dirt

A count of observations for each pipe segment was made from the CCTV database. This highlights those areas of greatest observed defects. This is shown in Figure 6-7. Pipes in purple were CCTV inspected while pipes shown in red have more than 10 defects in a segment.

Pipes that are shown in light green were not inspected at the time of this report. Pipes shown in purple were inspected but no defects were observed.

6.1.4 Maintenance Analysis

Maintenance analysis is a review of known system problems and areas that require higher than normal operations. The City has provided a list of Hot Spots and a list of Call Outs for review. These will be mapped and presented in conjunction with predicted problem areas from the hydraulic model. As of October 2007, the following information was provided for Hot Spots and other known problem areas. Figure 6-8 shows the locations of the priority maintenance areas.

Table 6-3 Priority Maintenance Areas

City of Pinole **HOT LIST** *Sanitary Sewer*

Area	Sec	MH-MH	Location	Equip	overflow	Comments
C	3	8 to 6	Silverado	Hydro	OF	Easement to Santa Barbara Roots
D	5	10 to 12	Gerz	Hydro	OF	Easement to Estates Roots
D	7	4 to 5	Ramona	Hydro	OF	Heavy grease build-up Engineering/design
D	8a	6 to 5	Alamo	Hydro	OF	Roots
D	11	9	PVR	Hydro		PVR to easement Grease
E	1	12 to 11	Hoke	Hydro	OF	Roots
E	2a	7 t 6	PVR	Hydro		Grease
E	5	8 to 10	Sarah	Hydro	OF	Freeway easement Engineering/MH
F	8	3	Appian	Hydro	OF	Grease Engineering/MH/Flows
G	9	6 to 4	SPA	Rod	OF	MH in sidewalk 07 - Rehab
H	4b	6 to 9	Brenda	Rod/Hy	OF	Easement to Alfred Roots
H	7	15 to 13	Pinon	Hydro		Easement to Alfred Precautionary
I	2	4 to 3	PVR	Hydro	OF	Grease - Flat
I	3	13 to 12	PVR	Hydro	OF	Up old Henry-Grease
I	10d	1 to 2	PVR	Hydro	OF	Up new Henry-Grease
I	5	9 to 8	Downer	Hydro	OF	Grease Engineering
I	9	4 to 5	Henry	Hydro	OF	Downstream toward John Belly
J	1	9 to 8	Creek trail	Hydro	OF	Syphon Grit/Grease - Aged
J	1a	4 to 5	Senior Center	Hydro	OF	From parking lot-trail Roots

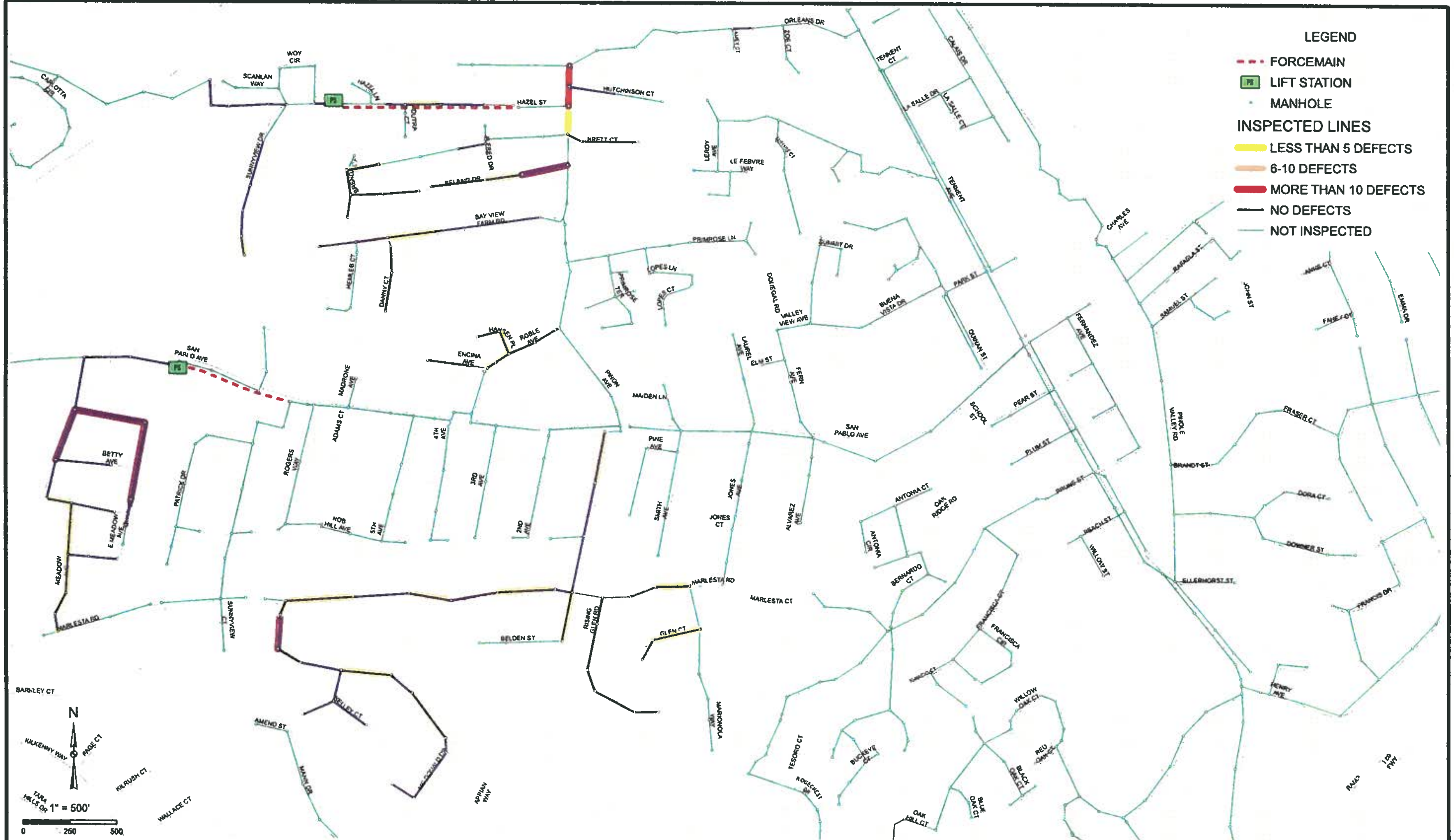


FIGURE 6-8 CCTV INSPECTION LOCATIONS AND DEFECTS

FIGURE 6-9 PRIORITY MAINTENANCE AREAS

6.1.5 Other Observations

6.1.5.1 Pump Stations

In addition to the analyses above, general observations of the conditions in the system were made. The following photograph shows the Hazel Street Pump Station. This facility is located in a flood prone area (Note the storm drain and the low wall around the entry hatch) and would likely be inundated in larger rainfall events. This facility should be relocated or eliminated if at all possible.

The Panattoni Study, conducted in June 2006, recommends that the San Pablo Avenue Pump Station should be eliminated by rerouting its flow through Sugar City to the Hazel Street PS. The Panattoni Study recommends that the Hazel Street Pump Station should be upgraded at an estimated cost of nearly $1.0 million. The report also opined that downstream pipes were likely to be surcharged.

Based on calibrated flows, capacity analyses performed on the collection system show that the pipes coming into the Hazel Street are also overloaded. Additionally, the downstream flows surcharge the system under wet weather condition. A complete Pump Station Elimination study should be commenced to look at possible elimination of both the San Pablo and Hazel Street Pump Stations through the use of trenchless technologies. It is likely that the operations and maintenance cost savings would be significant.

Figure 6-10 Hazel Street Pump Station

6.1.5.2 The Meadows Area

Special attention was given to the area known as the "Meadows". Bounded on the north by San Pablo Avenue, on the east by Sunnyview, on the south by Marlesta Road and on the west by the "Hill", the Meadow's sewer system drains to the San Pablo Pump Station. During even small wet weather events, this system becomes overloaded and overflows may occur. Additionally, the Meadows has been plagued by a significant inflow response evidenced by the rapid increases of flow and depth in the pipes. The Meadows also serves as a natural drainage way for approximately 60 acres of land.

The recent CCTV program revealed numerous offset joints, cracks and root intrusions in a portion of the Meadows area. There was on average an observation every 20 feet. The line in East Meadow Avenue is in very poor condition and is the number one priority for Condition Related Replacement. This project will consist of approximately 3,275 feet of eight inch pipe and 17 manholes.

Prior to design and construction, smoke testing should be performed in the Meadows to update the findings of the 1988 program. This will quickly identify positive inflow sources. Special attention must be paid to the potential for storm drain connections to the sewer system. The following figure shows the proximity of storm drains to sewer system on an enhanced elevation background.

In the long term, the Meadows may also be served through a connection to the West County Sanitary District through a 350 foot extension of the line in Marlesta and a 1,000 foot extension in San Pablo Avenue. This area has been discussed in the Panattoni Study as well where it was recommended that the flows be routed through the Sugar City property to the Hazel Street Pump Station. The Hazel Street PS would require upgrading (Approximately $1.0 million) plus all downstream lines would have to be upsized. These lines are included as the Hazel Street PS Approach ($398,149), the Orleans Pinon Primrose ($1,586,786) and the Tennent WWTP to Park ($2,093,019). While the two latter projects would still be required, the approximately $1.5 million for the Pump Station Upgrade and Hazel Street PS Approach may be better spent in an alternative gravity alignment.

Regardless of the long term solution, this area needs immediate attention through replacement or relining.

6.1.6 Repair/Rehab/Replacement Projects

Based on the basic observed conditions and the GIS data, the following condition related projects were identified. The extent of the condition related projects are directly dependent on the observations of the system evaluation performed through the Condition Assessment Program. These projects are a program for relining of approximately 5,000 feet pipelines and manholes. This project is consistent with current relining program implemented by the City. The other major identified project is the repair/rehab/replacement of the Meadows Area collection system.

6.2 Condition Assessment Program

To comply with the WDR System Evaluation requirements and to refine the funding level requirements for rehabilitation, the Condition Assessment Program will continue. The elements of this program are:

(1) GIS Update to include data related to age of pipe, material and incorporate survey data at key locations.
(2) Physical Inspection (Above Ground)
(3) Wet Weather Flow Measurements 2008 Wet Season
(4) Installation of 6 ground water wells (Currently being performed)
(5) Smoke Testing of the remainder of the system beginning with Basin 5
(6) CCTV Inspection of the remainder of the system beginning in Basin 6

The approximate costs for this program are shown in the Table ES-1.

6.3 Hydraulic Modeling

A hydraulic model of the physical aspects of the collection system was developed from the revised GIS. Flows for the model were derived from Contra Costa County Parcel GIS and the flow measurement results. Flows were allocated to pipes in the model by using the nearest parcel. The overall flow per residential unit (EDU) was calculated from the flow measurements made during the Flow Monitoring Program and from the WWTP records. This flow was applied to the overall model and then adjusted to calibrate to the observed flows. The results of this process were a calibrated model for the Existing Dry Weather conditions and for the 2/10/2007 rainfall event.

6.3.1 Flow Allocation

Flows were distributed in the model using a parcel layer obtained from Contra Costa County. Flow meters were installed at six (6) sites within the city. The total flows measured at these sites were divided up among all the parcels adjacent to wastewater lines upstream of each site. The amount of flow allocated to each parcel was determined using a combination of the land use, number of residences and acreage of each parcel. Initial allocations were adjusted using the flow measurement data to determine the existing flow per EDU.

6.3.2 Capacity Criteria

Capacity for sewer pipes is defined by the ratio of the depth of flow to the diameter of the pipe. Capacity for the dry weather flows is defined as follows:

Capacity Criteria	
Inches	d/D
4	50%
6	50%
8	50%
10	50%
12	50%
15	50%
18	75%
24	75%
30	75%

Table 6-4 Capacity Criteria

Using the model, the depth/Diameter ratios were observed for each flow scenario. The replacement diameter for each flow scenario was used as the basis of a planning level cost estimate. The planning level estimate uses a unit cost of $18.85/in-diameter/foot.
The replacement diameters are based on maintaining the current slope. As additional information is developed in the Preliminary Design Report costs may vary.

Projects were created from logically located segments of deficient pipe. The projects were then prioritized based on the criteria discussed in the following section.

7.0 Capacity Enhancement Projects

To determine which project is scheduled for completion first, a method of prioritization was defined. To determine the priority, the following factors were considered: (1) Existing Dry Weather Capacity Restriction (2) Number of customers served (3) Proximity to waterway. If a project addresses an identified existing problem then it has the highest priority for replacement. Flow volume is directly related to the number of customers served. Capacity restrictions should be removed through projects beginning from the downstream to the upstream. This will minimize the volume of potential spills by addressing larger volumes first. Finally if an overloaded section is located near a waterway, the likelihood of environmental and public relations damages is greater.

Figure 7-1 shows the buffering that was used in the GIS to rank the proximity of the projects.

The following list shows the Capacity Enhancement Projects in their priority order.

Table 7-1 Project Priority

Priority	Project Name	ExDry	Total Units	Proximity
1	PVR Henry To Shea	Y	3048	250
2	PVR_Shea_To_Collins	Y	1735	250
3	Orleans Pinon Primrose	Y	1217	1000
4	PVR Collins to Doidge	Y	948	250
5	Sarah I-80 to Creek	Y	499	250
6	Orleans Calais Brandt	Y	399	250
7	Primrose to Patrick	Y	683	9999
8	Tennent WWTP to Park	N	5359	500
9	Tennent Park to Henry	N	3607	250
10	Doidge Avenue	N	563	250
11	Hazel Street PS Approach	N	283	250
12	San Pablo Avenue	N	195	1000
13	Prune to Oak Ridge	N	164	250
14	Tennent to Summit	N	56	1000
15	Henry PVR to Red Oak	N	18	250
16	Pinon Appian Marlesta McDonald	N	253	9999
17	Miscellaneous	N	Varies	Varies

7.1 Capacity Enhancement Projects

Using the planning level cost estimates discussed above the following table lists the capacity restoration projects.

Table 7-2 Project Estimates by Scenario

Capacity Replacement Summary	Modeled Flow Conditions				
Project Name	Existing Dry	Future Dry	RehabRed40	Rainfall 0.3 iph	Rainfall 0.4 iph
PVR Henry To Shea	$ 561,688	$ 561,688	$ 2,539,171	$ 3,032,290	$ 3,160,328
PVR_Shea_To_Collins	$ 136,840	$ 136,840	$ 1,292,303	$ 1,550,161	$ 1,601,272
Orleans Pinon Primrose	$ 857,373	$ 863,141	$ 1,354,326	$ 1,586,786	$ 1,672,441
PVR Collins to Doidge	$ 665,868	$ 665,868	$ 1,728,413	$ 2,066,439	$ 2,123,224
Sarah I-80 to Creek	$ 62,699	$ 62,699	$ 754,735	$ 983,895	$ 1,037,558
Orleans Calais Brandt	$ 140,663	$ 140,663	$ 1,333,459	$ 1,575,232	$ 1,637,985
Primrose to Patrick	$ 388,605	$ 388,605	$ 599,006	$ 688,690	$ 748,038
Tennent WWTP to Park	$ -	$ -	$ 1,587,644	$ 2,093,019	$ 2,168,136
Tennent Park to Henry	$ -	$ -	$ 1,469,525	$ 1,793,062	$ 1,814,771
Doidge Avenue	$ -	$ -	$ 788,554	$ 965,595	$ 1,039,991
Hazel Street PS Approach	$ -	$ -	$ 308,514	$ 398,149	$ 425,409
San Pablo Avenue	$ -	$ -	$ 209,610	$ 258,945	$ 277,347
Prune to Oak Ridge	$ -	$ -	$ 221,157	$ 292,908	$ 307,210
Tennent to Summit	$ -	$ -	$ 158,667	$ 202,639	$ 202,639
Henry PVR to Red Oak	$ -	$ -	$ 200,050	$ 324,526	$ 330,028
Pinon Appian Marlesta McDonald	$ -	$ -	$ 474,128	$ 584,381	$ 619,495
Miscellaneous	$ -	$ -	$ 499,236	$ 617,793	$ 629,278
Planning Level Estimate	**$ 2,813,737**	**$ 2,819,504**	**$ 15,518,498**	**$ 19,014,511**	**$ 19,795,149**

To further refine the program of improvements, costs were allocated to the sixth year of the project. This allows for completion of substantial portions of the Condition Assessment and the Rehab/Repair/Replacement Programs. These efforts, coupled with on-going flow measurements and improved GIS and modeling data, will allow the preliminary designs to be refined. The costs presented are current dollars (2008) and represent planning level cost estimates. Actual estimates will be refined as more data is collected and analyzed. The overall projects in context of the total Capital Improvements Projects are shown in Table ES-1 and Table7-3.

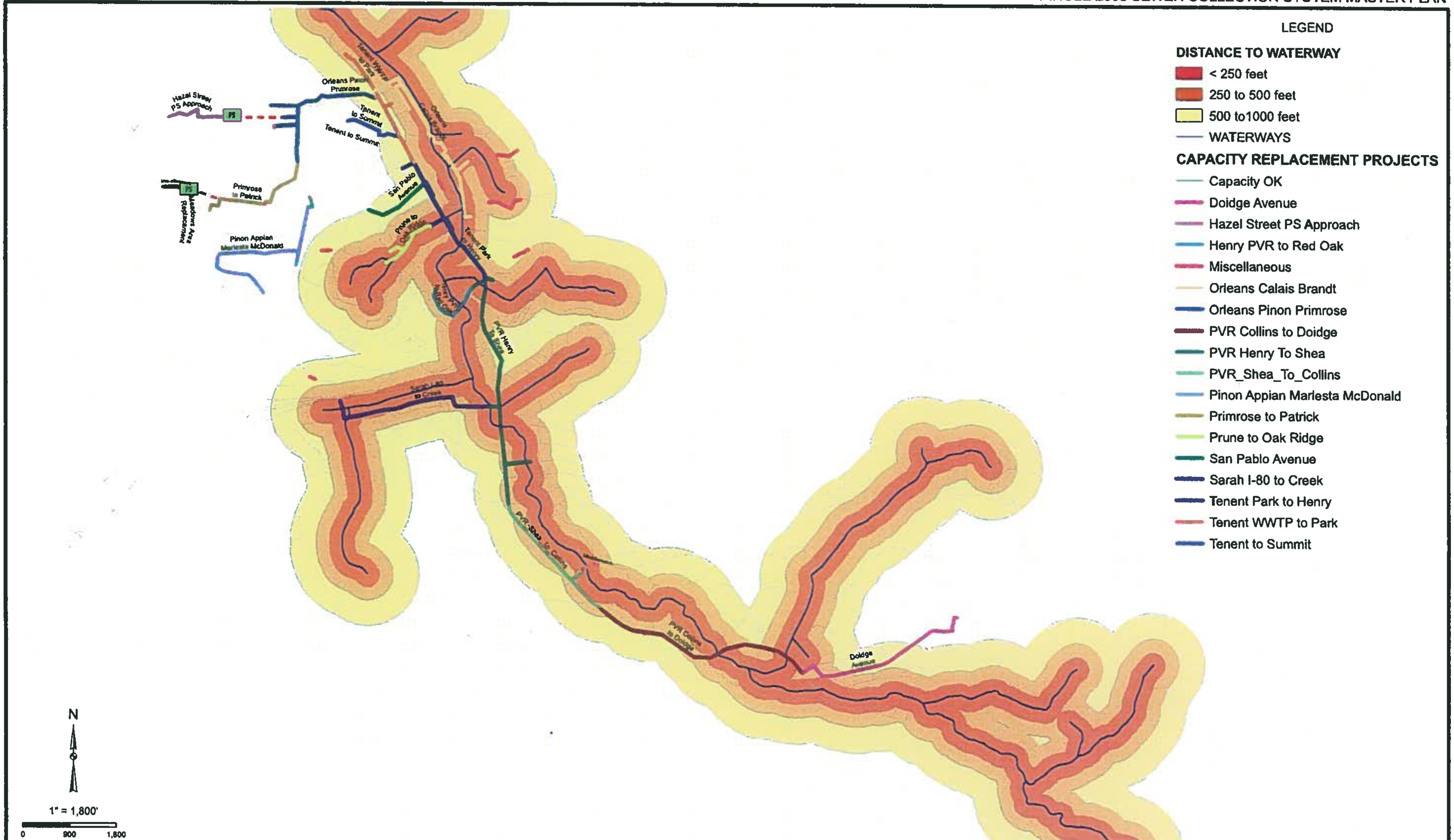


FIGURE 7-1
STREAM BUFFER

Table 7-3 Proposed Capital Improvements Projects

City of Pinole Collection System Capital Improvements Projects						Long Term Projects (5-Year Increments)			
I/I Reduction Program	5-Year Collection System Projects (Near Term)					10 Year	15 Year	20 Year	25 Year
	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013	2013-2018	2018-2023	2023-2028	2028-2033
Condition Assessment Projects	Near Term					Long Term			
Pilot Private Lateral Program*	$ 75,000								
Flow Measurements (Pre/Post Rehab)	$ 30,000		$ 30,000		$ 30,000	$ 60,000	$ 90,000	$ 60,000	$ 90,000
Smoke (5 Year / 10 Year Cycle)	$ 38,895	$ 38,895	$ 38,895	$ 38,895	$ 38,895	$ 97,236	$ 97,236	$ 97,236	$ 97,236
CCTV (5 Year / 10 Year Cycle)	$ 77,789	$ 77,789	$ 77,789	$ 77,789	$ 77,789	$ 194,473	$ 194,473	$ 194,473	$ 194,473
Physical Inspection	$ 30,251	$ 30,251	$ 30,251	$ 30,251	$ 30,251	$ 75,628	$ 75,628	$ 75,628	$ 75,628
Program Management (25% Subtotal)	$ 44,234	$ 36,734	$ 44,234	$ 36,734	$ 44,234	$ 106,834	$ 114,334	$ 106,834	$ 114,334
Condition Assessment Subtotal	$ 296,169	$ 183,669	$ 221,169	$ 183,669	$ 221,169	$ 534,172	$ 571,672	$ 534,172	$ 571,672
Repair/Rehab/Replacements	Near Term					Long Term			
Pipe and MH Relining (5k/yr)*	$ 604,294	$ 475,000	$ 475,000	$ 475,000	$ 475,000	$ 2,375,000	$ 2,375,000	$ 2,375,000	$ 2,375,000
The Meadows Rehabilitation	$ 211,125	$ 211,125							
Repair/Rehab/Replacements Subtotal	$ 815,419	$ 686,125	$ 475,000	$ 475,000	$ 475,000	$ 2,375,000	$ 2,375,000	$ 2,375,000	$ 2,375,000
Capacity Assurance Projects	Near Term					Long Term			
Invert Surveys (Capacity Candidates)	$ 37,092								
Mapping/Model Updates	$ 40,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000
PVR Henry To Shea						$ 3,032,290			
PVR_Shea_To_Collins							$ 1,550,161		
Orleans Pinon Primrose							$ 1,586,786		
PVR Collins to Doidge							$ 2,066,439		
Sarah I-80 to Creek								$ 983,895	
Orleans Calais Brandt								$ 1,575,232	
Primrose to Patrick								$ 688,690	
Tennent WWTP to Park								$ 2,093,019	
Tennent Park to Henry									$ 1,793,062
Doidge Avenue									$ 965,595
Hazel Street PS Approach									$ 398,149
San Pablo Avenue									$ 258,945
Prune to Oak Ridge									$ 292,908
Tennent to Summit									$ 202,639
Henry PVR to Red Oak									$ 324,526
Pinon Appian Marlesta McDonald									$ 584,381
Miscellaneous									$ 617,793
Capacity Assurance Subtotal	$ 77,092	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 3,057,290	$ 5,228,386	$ 5,365,837	$ 5,462,998
Period Total	$ 1,188,680	$ 874,794	$ 701,169	$ 663,669	$ 701,169	$ 5,966,462	$ 8,175,058	$ 8,275,009	$ 8,409,669
Average Annual	*$ 1,188,680*	*$ 874,794*	*$ 701,169*	*$ 663,669*	*$ 701,169*	*$ 1,193,292*	*$ 1,635,012*	*$ 1,655,002*	*$ 1,681,934*

** Future funding to be determined based on results of this program*

7.2 Conclusions

The collection system is currently subject to significant increases in flow due to inflow and infiltration defects. The first course of action is to fully assess the conditions of the entire collection system as quickly as possible. Once the system has been characterized, funding can be focused on the best processes to address the defects in the areas with highest returns.

A Volunteer Pilot Private Lateral Program should be commenced immediately with the goal of determining the overall condition of private service laterals by test sampling of 100 laterals. Laterals would be CCTV and smoke tested to determine structural integrity and improper connections. These inspections should start with City owned facilities with private service laterals constructed prior to 1975 and include privately owned laterals in areas of Old Downtown and the Meadows Area. Low cost Incentives such as post lateral testing cleaning and minor repairs should be provided to volunteer property owners. This program will provide valuable data to determine the cost effectiveness of a full private lateral repair program.

Capacity related projects should be deferred until rehabilitation/repair/replacement projects have been completed. The following set of projects addresses key elements of the I/I Reduction Program and Capacity Assurance Planning. Additional projects, identified by the City further define the complete Collection System Capital Improvements Program:

During the course of the study, it was noted that there is a traditional disconnect between the treatment plant and the collection system. To effectively manage the large number of improvements that are recommended in both areas, a management goal should be to promote communication between personnel through cross training and regular interaction. A potential near-term project involving both parties would be the addition of the lift station operational data to the WWTP SCADA system. If this project can be completed prior to the implementation of the Meadows Rehabilitation project, it would also serve to document the effectiveness of the repairs. The effectiveness could then be used as a benchmark for other project planning.

City revenues from the Wastewater Enterprise Fund are possible only through the efficient planning, operation and maintenance of both the collection system and the treatment plant.

Smoke Testing Study
City of Pinole
Sewer Basin 6

September 2007

Prepared for:
City of Pinole
c/o Dudek & Associates
605 3rd Street
Encinitas CA 92024

Prepared by:
ADS ENVIRONMENTAL SERVICES

INTRODUCTION

ADS Environmental Services was contracted by Dudek & Associates, Inc. to perform approximately 52,000 lineal feet of smoke testing in sewer basin 6 within the City of Pinole sanitary sewer system. This basin was chosen for evaluation since it showed sharply elevated Rainfall Dependent Inflow and Infiltration (RDII) responses during a previously conducted RDII study in Winter of 2007.

The purpose of the Sanitary Sewer Evaluation Survey (SSES) work described herein was to locate sources of excess rainwater intrusion or Inflow and to determine the location of any such defects in the selected basin of the Pinole sanitary sewer system.

The potential inflow defects are listed in tabular format herein along with graphical maps depicting the locations of all the defects discovered during smoke testing. Conclusions and recommendations for follow up investigation by the City of Pinole are included.

STUDY AREA

The smoke testing was conducted in the following areas:

Basin 6

This basin covers an area of about 375 acres and contains a total of about 66,000 lineal feet of sewer pipe, of which about 52,000 feet of piping was smoke tested. This basin is immediately upstream of the treatment plant and is bounded by Henry Ave to the south, Marionola Way, Smith and Leroy Ave to the west, Orleans and Calais Drive to the north, and Alice Way to the East.

The basin in which sewer pipes were smoke tested is depicted in the map as Figure 1. A defect location map is attached as Figure 2. Photographs with defect location descriptions and GPS coordinates indicated are included as a part of Appendix A.

DATA COLLECTION AND ENTRY

ADS logged smoke testing results on daily field forms and documented defects using a Ricoh Model 500SE digital camera with integral GPS coordinate embedding onto each smoke defect photograph. Each of the photographs were post-processed using GPS-Photo Link software provided by GeoSpatial Experts, LLC. This enabled each photo to be properly projected onto the City GIS map in the correct locations (within approximately 20 feet) using the California State Plane Projection, zone 3, in units of feet. The GIS (ArcView) database files used to generate the defect map in Figure 2 are included on a data and photo CD included as a part of Appendix A. This will enable the City of Pinole to import the defect data into their GIS system for future reference and follow up work.

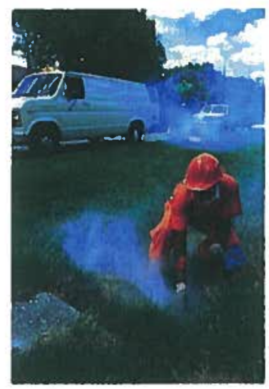
SMOKE TESTING

Smoke testing identifies defects that allow rainwater to enter into the sewer system or odors to escape to the atmosphere. Smoke testing is intended to detect potential points of inflow due to direct connections to the sewer such as storm sewer cross-connections and point source leaks in drainage paths or ponding areas, roof leaders, cellars, yard or area drains, fountain drains, abandoned building sewers, and faulty service connections.

PROCEDURE

Smoke testing was conducted primarily with a three-person crew using 4,000 cfm Ripcord™ or equivalent blowers and non-toxic Liquid Smoke™ exhaust heat smoke generating fluid. This system emanates a very thick visible cloud of smoke directly into the sewer main line being tested. This drives smoke laden air back through mains and up lateral connections to any openings to the atmosphere, including designed openings such as rooftop plumbing vents and also unintended openings or "defects" as described previously (e.g. storm connections, roof leaders, etc.). Typically, smoke testing was limited to four line segments or about 1000 to 1500 lineal feet per test.

All observations regarding each identified defect or potential rainwater leak location were documented on daily field forms. Information includes smoke location, personnel, date, and number of defects found per test. In addition, a field log of defects and related address information was kept allowing the defect photos to be labeled later. The following defect or leak point information is included on the daily field forms or logs:



- Manhole smoke setup ID,
- Numbered digital photo,
- Description of leak including address,
- Magnitude of smoke emanating from the defect,
- Approximate area drained by the defect.

The map in Figure 1 shows the smoke testing piping within basin 6 along with the 39 smoke setup locations.

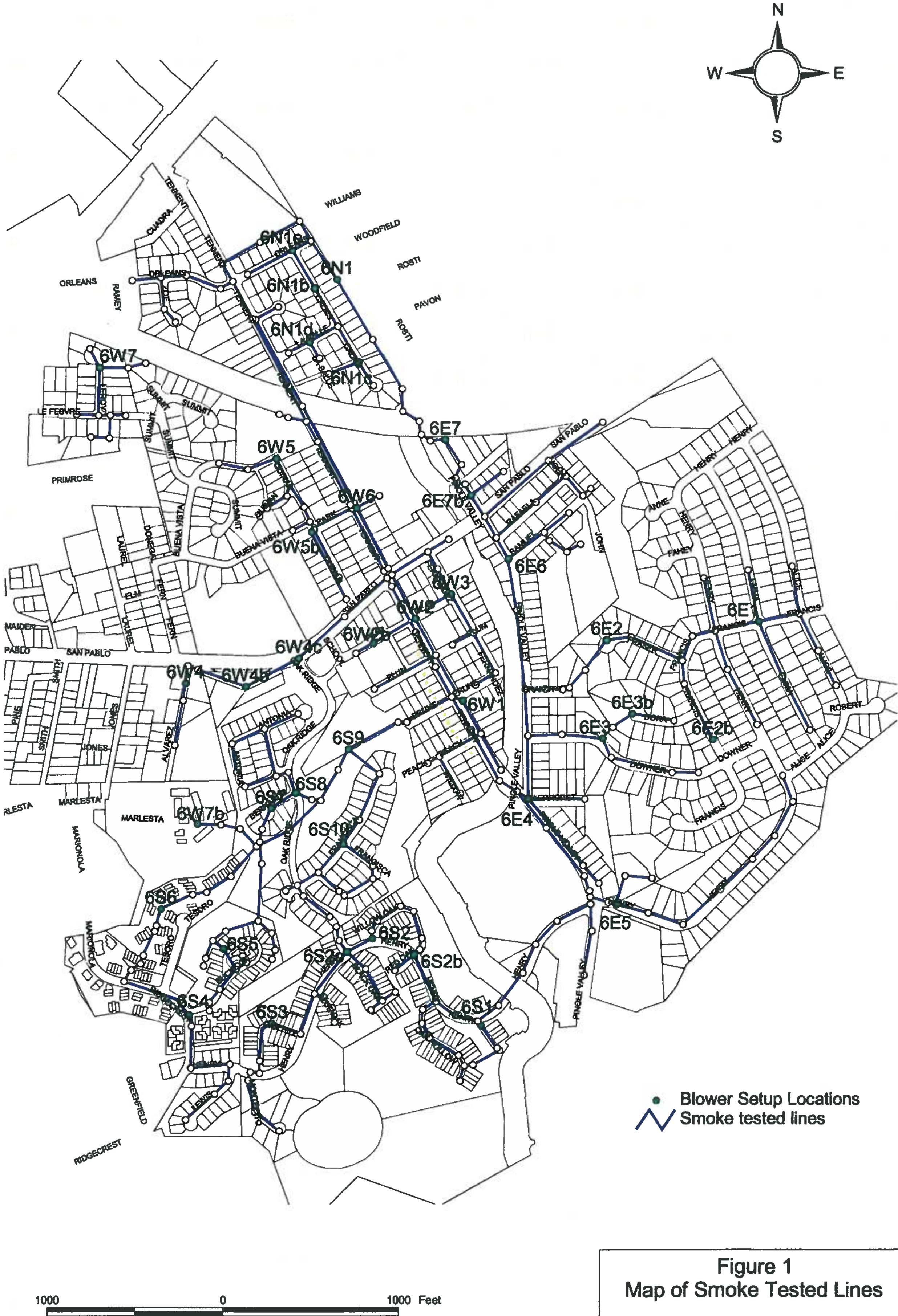


Figure 1
Map of Smoke Tested Lines

Basin 6
City of Pinole - 2007

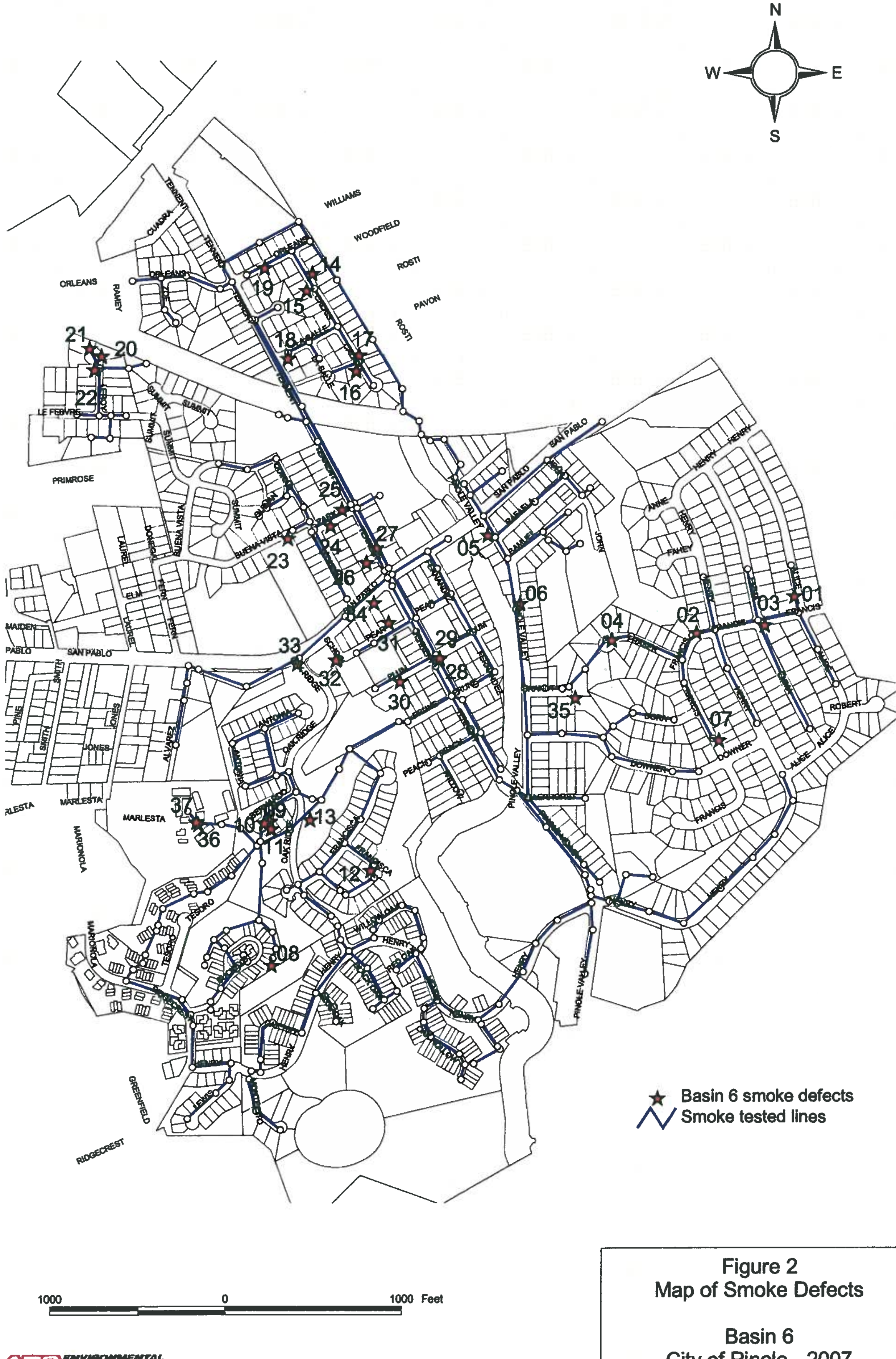


Figure 2
Map of Smoke Defects

Basin 6
City of Pinole - 2007

Digital photographs of all smoke leaks discovered were taken to document the leak location. The digital photographs are associated with the respective smoke defect. The photos are numbered according to a serialized 2-digit ID number. These photo ID numbers are associated with each discovered defect listed in Table 1 of this report. These photo ID numbers are also associated with each defect in the GIS database.

The photographs were taken of actual smoke emanating from the defect where possible during the testing. The photographs typically include the location of the smoke with reference to some recognizable topographic feature (e.g., corner of house, fire plug, mail box, etc.).

Smoke Testing Notifications

Approximately 2 to 7 days prior to smoke testing, ADS personnel distributed Smoke Testing Notices to all potentially affected residents and businesses. The notices were delivered to individual residences and commercial establishments within the zones to be tested. Each notice was placed and attached to the door or entryway of each location. A Copy of a notification form as well as the associated City permit are included in Appendix B.

The ADS Field Manager maintained communication with the primary City contact so local fire departments as well as others as determined by the City were kept up-to-date on a daily basis to ensure the proper authorities were aware of the smoke testing activities.

Defect Location Methodology

Defects were located on the map based on GPS coordinates obtained directly by the camera, while physical address information was also included where applicable in field logs and photo labels.

Each smoke defect discovered was logged on a field log along with type of defect (manhole, mainline, private service lateral, etc.), leak location (grass, pavement, etc.), and degree of smoke observed (e.g. light - L, medium- M, heavy - H).

Analysis

The severity of each potential inflow defect logged during this portion of the collection system study was estimated using the Rational Formula:

$$Q = C \times I \times A$$

Where,

> Q = flow rate (L^3/T)
> C = runoff coefficient based on surface type (--)
> I = rainfall intensity (L/T)
> A = surface area (L^2)

A rainfall intensity (I) was assumed of 1.0 inch per hour, allowing theoretical defect inflow rates to be listed in units of flow rate per inch or rain. To calculate the surface area, field crews estimated the extent of the area that would drain into the defect during a rain event based on field observation. The severity of the inflow defects can be estimated based on the quantity of smoke observed, the particular type of defect, and the associated drainage area. The coefficient "C" is set equal to 1 assuming all of the flow from the associated drainage area entered the defect.

It is noted that the severity of potential nuisance odors associated with the defects discovered are likely mostly attributable to degree or density of smoke observed and relative proximity to residential inhabitants.

Smoke Testing Results

A total of thirty seven (37) defects were identified during the smoke testing process. The highest number of defects (15) was discovered in the West-middle zones of the basin 6 area followed by the east zone with 10 defects.

The majority of these defects were found along private laterals and cleanouts and several along mainlines (e.g. manhole surface seal). A summary of defects is presented in Table 1. Inflow rates (gallons per inch of rain) into each defect were estimated based on the Rational Formula and indicated in Table 1.

In some cases, effective drainage areas or actual potential for inflow rate may be significantly higher than those estimated using the Rational Formula. For example, locations where severely dilapidated street pavement and manhole surface seals (or the presence of vented manholes) may allow an order of magnitude higher inflow rate than estimated for that defect during periods of significant sheet runoff or street flooding.

Table 1 - Smoke Defect Summary

Defect ID	Date	Zone	Defect Type	CA Zone 3 Coordinates (feet) East	North	Location	Description	Smoke Density	Area (ft2)	Inflow Rate (gal/in rain)
1	8/27/2007	E	Area Drain	562953	4206651	2638 Alice	Open drain on driveway	L/M	100	62
2	8/27/2007	E	Lateral	562785	4206583	2636 Frances	Smoke coming from cracks on driveway	L	100	62
3	8/27/2007	E	Lateral	562904	4206599	Frances & Elma	Smoke coming from unknown source in Ivy plants	L/M	100	62
4	8/27/2007	E	Manhole	562639	4206567	2554 Fraser	Around corbel	L	100	62
5	8/27/2007	E	Drain Vent	562420	4206743	732 Pinole	Open trap near roof line of house	H	1	1
6	8/27/2007	E	Lateral	562480	4206627	871 Pinole Valley	Smoke from unkown source in bush	M/H	100	62
7	8/27/2007	E	Lateral	562829	4206398	2585 Frances	Smoke coming from cracks on sidewalk & bush	L/M	500	312
8	8/27/2007	S	Lateral or main	562067	4205988	1525 Buckeye	Smoke coming from ground behind house near manhole	M/H	500	312
9	8/28/2007	S	Cleanout	562057	4206237	909 Bernardo	Broken cleanout	M/H	100	62
10	8/28/2007	S	Lateral	562047	4206234	909 Bernardo	Cracks on driveway	L	100	62
11	8/28/2007	S	Lateral	562059	4206225	907 Bernardo	Possible cleanout in bushs	M/H	100	62
12	8/28/2007	S	Lateral	562232	4206157	1120 Fransiscus	Retaining wall	L/M	500	312
13	8/28/1997	S	Manhole	562126	4206242	Easment (park)	Around corbel	M	100	62
14	8/28/2007	N	Lateral	562102	4207190	279 Calais	Front yard	M	200	125
15	8/28/2007	N	Lateral	562093	4207160	288 Calais	Front yard	L/M	200	125
16	8/28/2007	N	Lateral	562183	4207023	320 Calais	Front yard	M	200	125
17	8/28/2007	N	Lateral	562187	4207050	319 Calais	Front yard under rock	L/M	200	125
18	8/28/2007	N	Lateral	562065	4207041	2302 LaSalle	Front yard	M	300	187
19	8/28/2007	N	Lateral	562020	4207197	2320 Orleans	Front yard near fence	L	100	62
20	8/29/2007	W	Lateral	561741	4207038	305 Leroy	Driveway @ walkway	L/M	100	62
21	8/29/2007	W	Cleanout	561720	4207050	306 Leroy	Street cleanout, from crack around stub	L	100	62
22	8/29/2007	W	Lateral	561730	4207014	336 Leroy	Front yard bush near sidewalk	L/M	100	62
23	8/29/2007	W	Lateral or main	562074	4206729	Easment Next to Buena Vista	Field behind fence	M/H	100	62
24	8/29/2007	W	Lateral	562147	4206753	605 Quinan	Sidewalk	L/M	100	62
25	8/29/2007	W	Lateral	562165	4206782	592 Tennent	Near sidewalk	L/M	100	62
26	8/29/2007	W	Cleanout	562210	4206690	660 Tennent	Broken cleanout cover	M/H	100	62
27	8/29/2007	W	Cleanout	562227	4206716	660 Tennent	Cleanout @ sidewalk	L/M	100	62
28	8/29/2007	W	Storm Drain	562342	4206526	Tennant & Plum	Storm drain	M	20000	12467
29	8/29/2007	W	Lateral	562343	4206528	Tennent & Plum	Watermeter	L/M	200	125
30	8/29/2007	W	Lateral	562275	4206486	Tennent & Plum	Grass area between sidewalk & curb	L/M	100	62
31	8/29/2007	W	Lateral	562252	4206587	Pear across from City Hall	Possible lateral under driveway	L	100	62
32	8/29/2007	W	Lateral	562163	4206520	Pear @ St. Joseph parish	Driveway	M	1000	623
33	8/29/2007	W	Storm Drain	562096	4206511	Oak Ridge & San Pablo	Storm drain	M	TBD	--
34	8/29/2007	W	Cleanout	562226	4206621	2235 San Pablo	Cleanout cover	H	100	62
35	8/29/2007	E	Cleanout	562579	4206465	Brandt	Possible illegal cleanout	H	500	312
36	8/29/2007	E	Lateral or main	561933	4206229	Apts @ Marlesta	Grass area	L/M	200	125
37	8/29/2007	E	Lateral or main	561930	4206233	Apts @ Marlesta	Grass area @ electrical vault	L/M	200	125

Conclusions and Recommendations

These defects discovered through smoke testing typically represent some of the most significant inflow sources to the sewer collection system and are often easily remediated. ADS recommends that the City conduct the following actions:

1) Address all of the direct-connect type defects (e.g. storm drains) such as those identified herein by permanently sealing these sources after first providing the associated residences with appropriate and reasonable drainage alternatives for these former connections;

2) Schedule field reconnaissance of selected manholes during heavy rain events for direct observation of magnitude of inflow rate. The selected manholes should include those directly identified in this study such as defects 4, and 13 since these are involve manhole seal integrity. Also, defect 4 may allow additional inflow into the system as a result of rainwater seepage into the street base-course through cracks in the street, then into the manhole at the street interface.

3) Potential lateral line integrity issues predominated the defects found. They account for up to 25 of the 37 defects discovered. This suggests that a lateral integrity assessment on a large scale may be warranted in this basin area.

The smoke testing attempted to locate sewer line direct connection (open to the atmosphere) defects that can cause inflow (and sometimes odor problems) within the study area. It should be noted that this study can only be used as a guide to rank the defects that should provide the largest amount of Inflow reduction per rehabilitation dollar spent. It is difficult to give precise estimates of the effects of rehabilitating a particular defect because of the complex and dynamic nature of the defect's response to rainfall. In some cases, fixing a defect in one area can transfer the problem to another area (e.g. disallowing street or other area drainage in one defect location may cause flooding to worsen and enter a new defect location).

Appendix A

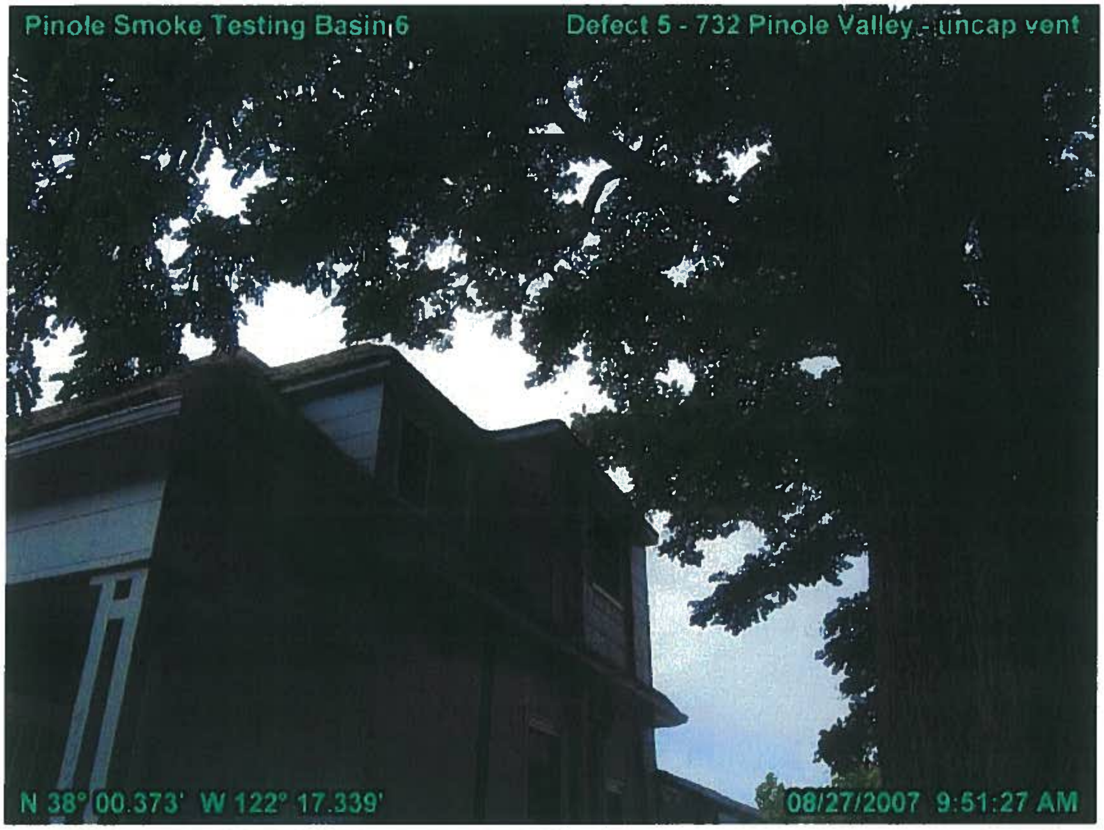
Digital Photographs


Pinole Smoke Testing Basin 6
Defect 1 - 2638 Alice - driveway drain
N 38° 00.321' W 122° 16.976'
08/27/2007 7:27:57 AM


Pinole Smoke Testing Basin 6
Defect 2 - 2636 Francis - sidewalk
2636
N 38° 00.285' W 122° 17.090'
08/27/2007 7:51:17 AM


Pinole Smoke Testing Basin 6
Defect 3 - Francis & Elma - ivy
N 38° 00.293' W 122° 17.010'
08/27/2007 7:55:59 AM

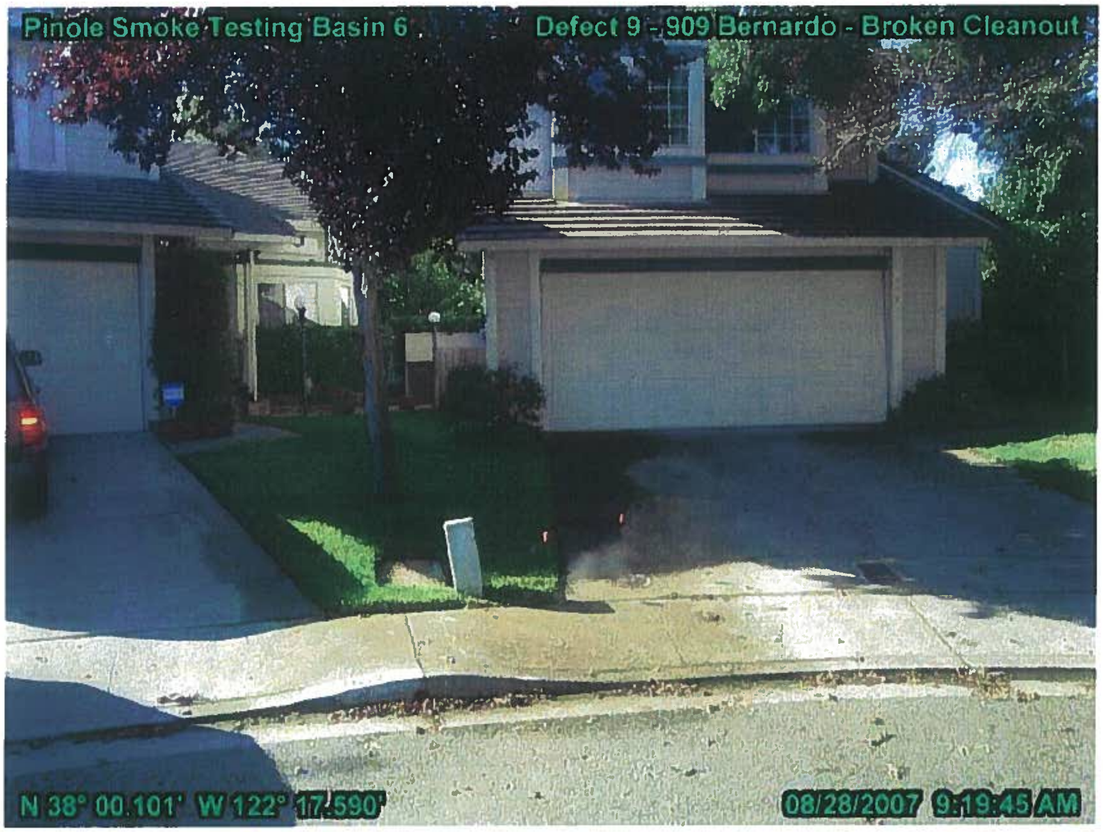

Pinole Smoke Testing Basin 6
Defect 4 - 2554 Fraser - MH rim seal
N 38° 00.277' W 122° 17.190'
08/27/2007 8:28:27 AM


Pinole Smoke Testing Basin 6
Defect 5 - 732 Pinole Valley - uncap vent
N 38° 00.373' W 122° 17.339'
08/27/2007 9:51:27 AM


Pinole Smoke Testing Basin 6
Defect 6 - 871 Pinole Valley - bushes
N 38° 00.310' W 122° 17.299'
08/27/2007 9:54:36 AM


Pinole Smoke Testing Basin 6
Defect 7 - 2585 Francis - yard
N 38° 00.185' W 122° 17.061'
08/27/2007 11:09:47 AM


Pinole Smoke Testing Basin 6
Defect 8 - 1525 Buckeye - dirt lot
N 37° 59.966' W 122° 17.585'
08/27/2007 2:28:53 PM


Pinole Smoke Testing Basin 6
Defect 9 - 909 Bernardo - Broken Cleanout
N 38° 00.101' W 122° 17.590'
08/28/2007 9:19:45 AM

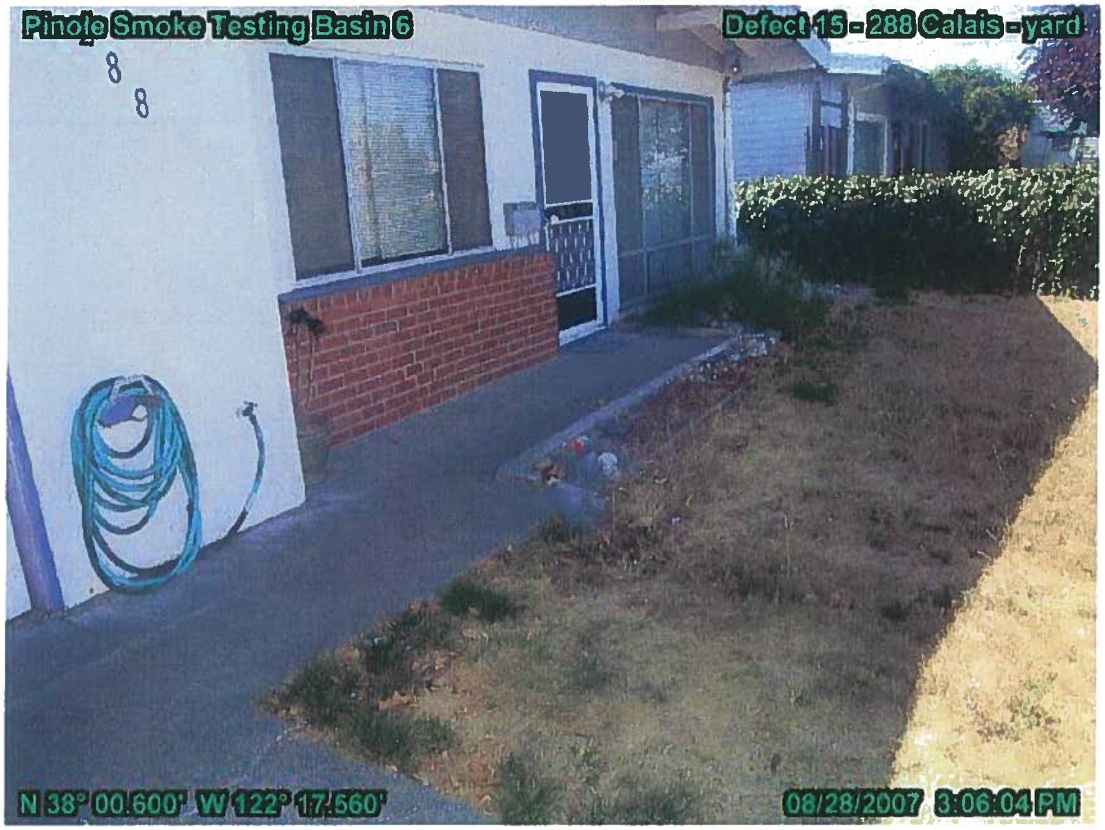

Pinole Smoke Testing Basin 6
Defect 10 - 909 Bernardo - driveway cracks
909
N 38° 00.099' W 122° 17.597'
08/28/2007 9:40:52 AM


Pinole Smoke Testing Basin 6
Defect 11 - 907 Bernardo - Planter
N 38° 00.094' W 122° 17.589'
08/28/2007 9:42:52 AM


Pinole Smoke Testing Basin 6
Defect 12 - SE Corner Francisca - Front Yard
N 38° 00.057' W 122° 17.471'
08/28/2007 10:29:37 AM

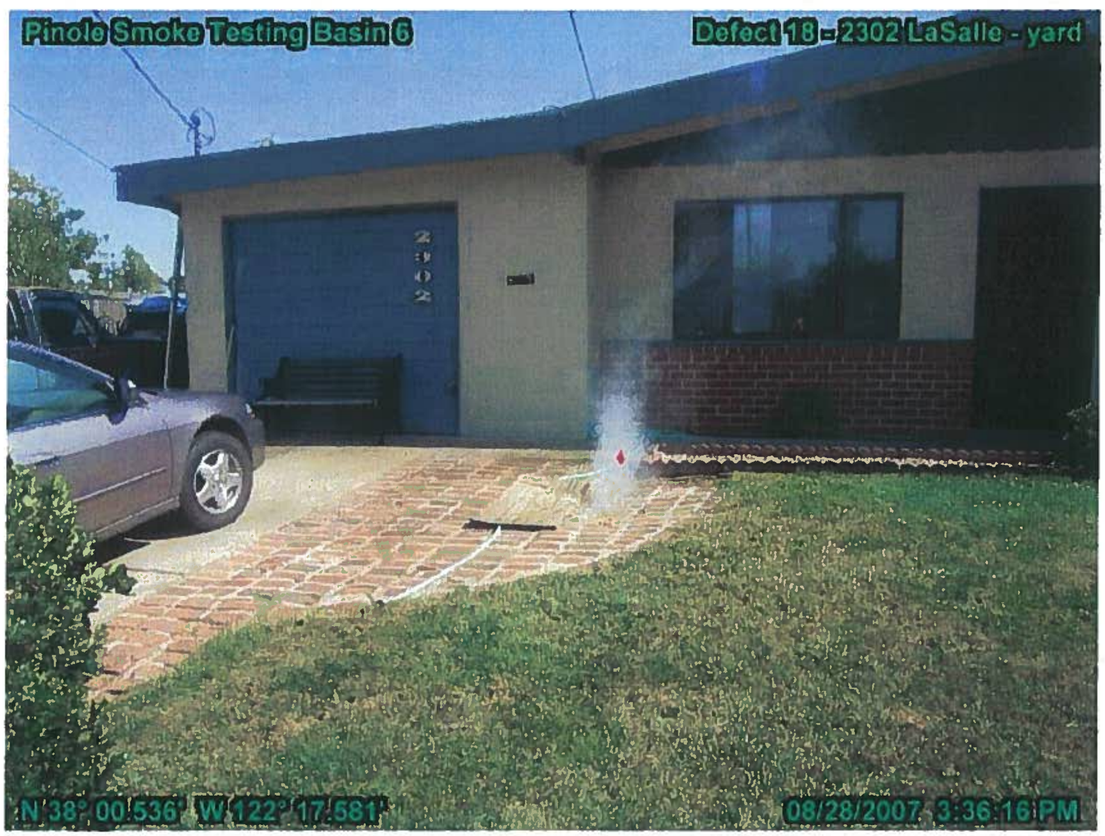

Pinole Smoke Testing Basin 6
Defect 13 - Park - around corbel
N 38° 00.103' W 122° 17.543'
08/28/2007 10:52:30 AM


Pinole Smoke Testing Basin 6
Defect 14 - 279 Calais - yard
N 38° 00.616' W 122° 17.554'
08/28/2007 3:05:12 PM


Pinole Smoke Testing Basin 6
Defect 15 - 288 Calais - yard
N 38° 00.600' W 122° 17.560'
08/28/2007 3:06:04 PM


Pinole Smoke Testing Basin 6
Defect 16 - 320 Calais - yard
N 38° 00.525' W 122° 17.500'
08/28/2007 3:14:58 PM


Pinole Smoke Testing Basin 6
Defect 17 - 319 Calais - yard
N 38° 00.540' W 122° 17.497'
08/28/2007 3:20:28 PM


Pinole Smoke Testing Basin 6
Defect 18 - 2302 LaSalle - yard
N 38° 00.536' W 122° 17.581'
08/28/2007 3:36:16 PM


Pinole Smoke Testing Basin 6
Defect 19 - 2320 Orleans - yard
2320
N 38° 00.620' W 122° 17.611'
08/28/2007 3:50:20 PM


Pinole Smoke Testing Basin 6
Defect 20 - 305 Leroy - Driveway @ Sidewalk
305
N 38° 00.535' W 122° 17.801'
08/29/2007 8:20:47 AM


Pinole Smoke Testing Basin 6
Defect 21 - 306 Leroy - Street Cleanout Rim
N 38° 00.542' W 122° 17.816'
08/29/2007 8:21:22 AM


Pinole Smoke Testing Basin 6
Defect 22 - 336 Leroy - Bushes
N 38° 00.522' W 122° 17.809'
08/29/2007 8:22:30 AM


Pinole Smoke Testing Basin 6
Defect 23 - Buena Vista - Field
N 38° 00.367' W 122° 17.576'
08/29/2007 9:04:59 AM


Pinole Smoke Testing Basin 6
Defect 24 - 605 Quinan - sidewalk
N 38° 00.379' W 122° 17.526'
08/29/2007 9:06:57 AM


Pinole Smoke Testing Basin 6
Defect 25 - 592 Tennent - planter/sidewalk
N 38° 00.395' W 122° 17.513'
08/29/2007 9:08:03 AM

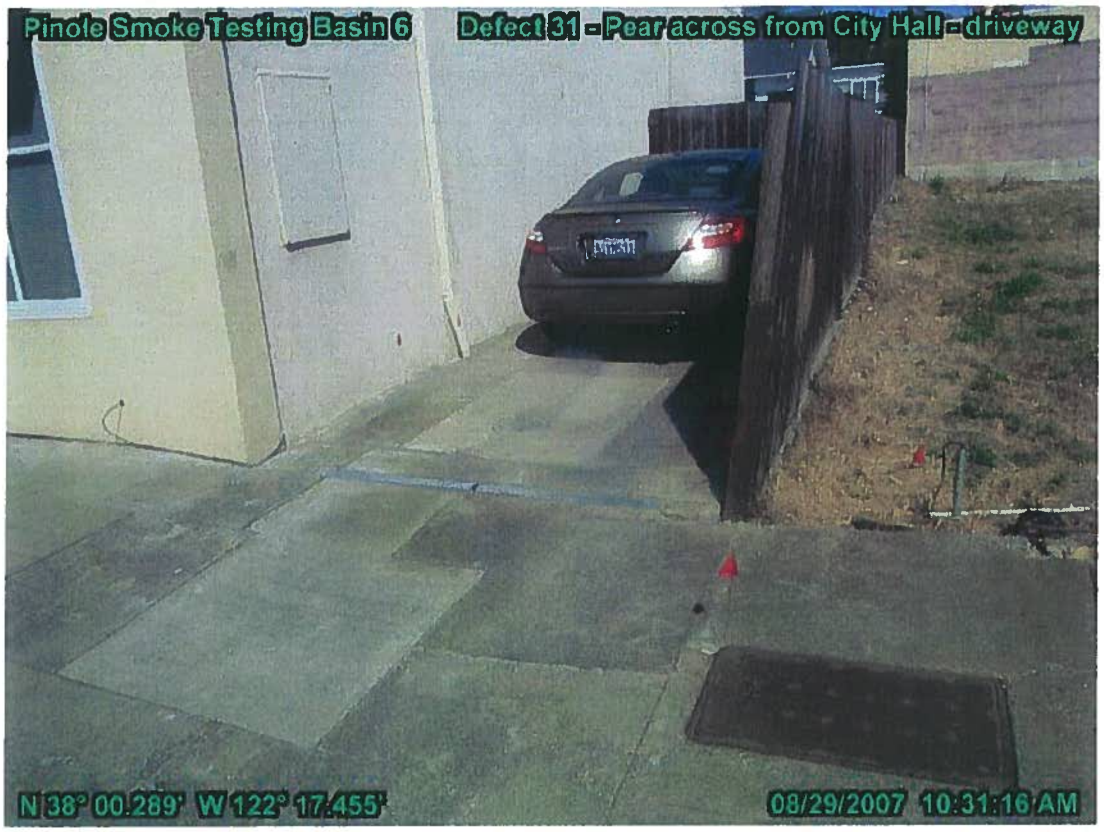

Pinole Smoke Testing Basin 6
Defect 26 - 660 Tennent - Broken Cleanout Cover
N 38° 00.345' W 122° 17.483'
08/29/2007 9:31:56 AM


Pinole Smoke Testing Basin 6
Defect 27 - 660 Tennent - Cleanout @ sidewalk
N 38° 00.359' W 122° 17.471'
08/29/2007 9:32:53 AM


Pinole Smoke Testing Basin 6
Defect 28 - Tennent & Plum - Storm Drain
N 38° 00.256' W 122° 17.394'
08/29/2007 9:53:44 AM


Pinole Smoke Testing Basin 6
Defect 29 - Tennent & Plum - water meter
N 38° 00.257' W 122° 17.393'
08/29/2007 9:54:17 AM


Pinole Smoke Testing Basin 6
Defect 30 - Tennent & Plum - Grass next to house
N 38° 00.235' W 122° 17.440'
08/29/2007 9:57:12 AM


Pinole Smoke Testing Basin 6
Defect 31 - Pear across from City Hall - driveway
N 38° 00.289' W 122° 17.455'
08/29/2007 10:31:16 AM


Pinole Smoke Testing Basin 6
Defect 32 - Pear & St Joseph - driveway
USA
N 38° 00.254' W 122° 17.516'
08/29/2007 10:35:39 AM


Pinole Smoke Testing Basin 6
Defect 33 - Oak Ridge & San Pablo - storm drain
N 38° 00.249' W 122° 17.562'
08/29/2007 10:53:49 AM


Pinole Smoke Testing Basin 6
Defect 34 - 2235 San Pablo - cleanout cover
N 38° 00.308' W 122° 17.473'
08/29/2007 1:41:48 PM


Pinole Smoke Testing Basin 6
Defect 35 - Brandt - large cleanout cover
N 38° 00.222' W 122° 17.232'
08/29/2007 2:42:17 PM


Pinole Smoke Testing Basin 6
Defect 36 - Apartments @ Marlesta - grass area
N 38° 00.097' W 122° 17.674'
08/29/2007 3:18:26 PM


Pinole Smoke Testing Basin 6 Defect 37 - Apartments @ Marlesta - electrical vault
N 38° 00.099' W 122° 17.677'
08/29/2007 3:19:04 PM

APPENDIX B

SMOKE TESTING NOTICE AND CITY PERMIT

SANITARY SEWER SYSTEM SMOKE TESTING NOTICE TO RESIDENTS AND BUSINESSES

On August 26 through August 31, 2007, inspection crews will be conducting a physical survey of the sanitary sewer collection system. This study will involve the opening of manholes in the streets and backyard utility easements. One important task of the survey will be the **"SMOKE TESTING"** of sewer lines to locate breaks and defects in the sewer system. During this testing, white or gray smoke will exit from the vent pipes on the roof of homes, businesses and from breaks in the sewer lines. The smoke is **NON TOXIC, LEAVES NO RESIDUE, AND CREATES NO FIRE HAZARD.** The smoke has a slight odor similar to burning paper and may cause minor throat irritation if inhaled. Persons with respiratory conditions such as asthma, bronchitis or emphysema should not be exposed to smoke of any kind. The smoke should not enter your home or business unless defective plumbing exists or drain traps are dry. If smoke should enter your house notify the smoke testing crews that will be working in the immediate vicinity.

If you have seldom used drains, please pour a gallon of water in the drain to fill the drain trap. This procedure will help prevent the possibility of smoke entering your living areas through seldom used drains. Please note that if smoke enters your home or business, the potential also exists for dangerous sewer gases to enter your home. (Although a rare occurrence, should smoke enter your home, we recommend you consult a licensed plumber.)

Field crews will be performing inspections of all manholes in the area. **AT NO TIME WILL FIELD CREWS HAVE TO ENTER YOUR BUSINESS OR RESIDENCE.** Information gained from this study will be used to repair and improve the wastewater collection system.

ADS Environmental Services has been contracted by the City of Pinole to perform the field testing and your cooperation is appreciated. If you, or anyone you know lives in the test area and are concerned about the possibility of smoke entering your property or should you have any questions concerning this study, please phone the **City of Pinole Public Works Office at (510) 724-9010.**

ADS ENVIRONMENTAL SERVICES®

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ADS ENVIRONMENTAL SERVICES®

PERMIT NUMBER **PW07-00105**

CITY OF PINOLE PERMIT

2131 Pear Street, Pinole, CA 94564
Office: (510) 724-8912

Inspection Request: (510) 724-8914

☐ **BUILDING DIVISION** ☒ **PUBLIC WORKS**

WORKERS' COMPENSATION DECLARATION

I hereby affirm under penalty of perjury one of the following declarations:

___ I have and will maintain a certificate of consent to self-insure for workers' compensation, as provided for by Section 3700 of the Labor Code, for the performance of the work for which this permit is issued.

_Y_ I have and will maintain workers' compensation insurance, as required by Section 3700 of the Labor Code, for the performance of the work for which this permit is issued. My workers' compensation insurance carrier and policy number are:

Carrier

Policy Number On File

(This section need not be completed if the permit is for one hundred dollars ($100) or less.)

___ I certify that in the performance of the work for which this permit is issued, I shall not employ any person in any manner so as to become subject to the workers' compensation laws of California, and agree that if I should become subject to the workers' compensation provisions of Section 3700 of the Labor Code, I shall forthwith comply with those provisions.

Date 8/28/2007 Applicant See application

WARNING: Failure to secure workers' compensation coverage is unlawful, and shall subject an employer to criminal penalties and civil fines up to one hundred thousand dollars ($100,000), in addition to the cost of compensation, damages as provided for in section 3706 of the labor code, interest, and attorneys fees.

OWNER/BUILDER DECLARATION

I hereby affirm under penalty of perjury that I am exempt from the Contractors License Law for the following reason (Sec. 7031.5, Business and Professions Code: Any city or county which requires a permit to construct, alter, improve, demolish, or repair any structure, prior to its issuance, also requires the applicant for such permit to file a signed statement that he or she is licensed pursuant to the provisions of the Contractors License Law (Chapter 9 (commencing with Section 7000) of Division 3 of the Business and Professions Code) or that he or she is exempt therefrom and the basis for the alleged exemption. Any violation of Section 7031.5 by any applicant for a permit subjects the applicant to a civil penalty of not more than five hundred dollars ($500).

___ I, as owner of the property or by employees with wages as their sole compensation, will do the work and the structure is not intended or offered for sale (Sec. 7044, Business and Professions Code: The Contractors License Law does not apply to an owner of property who builds or improves thereon, and who does such work himself or herself or through his or her own employees, provided that such improvements are not intended or offered for sale. If however, the building or improvement is sold within one year of completion, the owner-builder will have the burden of proving that he or she did not build or improve for the purpose of sale.)

___ I, as owner of the property, am exclusively contracting with licensed contractors to construct the project (Sec. 7004, Business and Professions Code: The Contractors License Law does not apply to an owner of property who builds or improves thereon, and who contracts for such projects with a contractor(s) licensed pursuant to the Contractors License Law.).

___ I am exempt under Sec. ___________ , B&PC for this reason

____

Date 8/28/2007 Owner ____________________

APPLICATION APPROVAL

This permit does not become valid until signed by the Building Official or his Deputy and fees are paid and receipt is acknowledged in time and space provided.

Signature of Deputy ____________________

APPLICATION TYPE: ENCROACHMENT

SUB TYPE: TEMPORARY

DATE: 8/28/2007

PARCEL NBR:

JOB ADDRESS: Various locations

OWNER:
CITY OF PINOLE

CONTRACTOR:
ADS

DESCRIPTION OF WORK:
Sewer smoke testing in various areas throughout the city

VALUATION: 0.00

CONSTRUCTION:

OCCUPANCY TYPE:

FEES:

TOTAL FEE: 0.00

TOTAL DUE: 0.00

JOB SITE ADDRESS: Various Locations

SPECIAL CONDITIONS OR COMMENTS:
NO FEE PERMIT per DEAN.

DAILY LOGS

City Of Pinole Smoke Defect Log

Defect ID	Date	Zone	Location	Description	Smoke Density	Area (ft2)
1	8/27/2007	E	2638 Alice	Open drain on driveway	L/M	100
2	8/27/2007	E	2636 Frances	Smoke coming from cracks on driveway	L	100
3	8/27/2007	E	Frances & Elma	Smoke coming from unknown source in Ivy plants	L/M	100
4	8/27/2007	E	2554 Fraser	Around corbel	L	100
5	8/27/2007	E	732 Pinole	Open trap near roof line of house	H	1
6	8/27/2007	E	871 Pinole Valley	Smoke from unkown source in bush	M/H	100
7	8/27/2007	E	2585 Frances	Smoke coming from cracks on sidewalk & bush	L/M	500
8	8/27/2007	S	1525 Buckeye	Smoke coming from ground behind house near manhole	M/H	500
9	8/28/2007	S	909 Bernardo	Broken cleanout	M/H	100
10	8/28/2007	S	909 Bernardo	Cracks on driveway	L	100
11	8/28/2007	S	907 Bernardo	Possible cleanout in bushs	M/H	100
12	8/28/2007	S	1120 Fransiscus	Retaining wall	L/M	500
13	8/28/1997	S	Easment (park)	Around corbel	M	100
14	8/28/2007	N	279 Calais	Front yard	M	200
15	8/28/2007	N	288 Calais	Front yard	L/M	200
16	8/28/2007	N	320 Calais	Front yard	M	200
17	8/28/2007	N	319 Calais	Front yard under rock	L/M	200
18	8/28/2007	N	2302 LaSalle	Front yard	M	300
19	8/28/2007	N	2320 Orleans	Front yard near fence	L	100
20	8/29/2007	W	305 Leroy	Driveway @ walkway	L/M	100
21	8/29/2007	W	306 Leroy	Street cleanout, from crack around stub	L	100
22	8/29/2007	W	336 Leroy	Front yard bush near sidewalk	L/M	100
23	8/29/2007	W	Easment Next to Buena Vista	Field behind fence	M/H	100
24	8/29/2007	W	605 Quinan	Sidewalk	L/M	100
25	8/29/2007	W	592 Tennent	Near sidewalk	L/M	100
26	8/29/2007	W	660 Tennent	Broken cleanout cover	M/H	100
27	8/29/2007	W	660 Tennent	Cleanout @ sidewalk	L/M	100
28	8/29/2007	W	Tennant & Plum	Storm drain	M	20000
29	8/29/2007	W	Tennent & Plum	Watermeter	L/M	200
30	8/29/2007	W	Tennent & Plum	Grass area between sidewalk & curb	L/M	100
31	8/29/2007	W	Pear across from City Hall	Possible lateral under driveway	L	100
32	8/29/2007	W	Pear @ St. Joseph parish	Driveway	M	1000
33	8/29/2007	W	Oak Ridge & San Pablo	Storm drain	M	TBD
34	8/29/2007	W	2235 San Pablo	Cleanout cover	H	100
35	8/29/2007	E	Brandt	Possible illegal cleanout	H	500
36	8/29/2007	E	Apts @ Marlesta	Grass area	L/M	200
37	8/29/2007	E	Apts @ Marlesta	Grass area @ electrical vault	L/M	200

Smoke Testing Study
City of Pinole Basin 6

August, 2007

GEOTIVITY

Data Summary Report

For

DUDEK Engineering & Environmental

City of Pinole Flow Study

CITY OF PINOLE CALIFORNIA
1903

Prepared by:
GEOtivity Inc.
Suite 304A Hardy Place
Kelowna, BC V1Y 8H2
March 21, 2007

Ph: 250-469-9012
Fx: 250-862-3116
Toll Free: 866-722-3261

GEOTIVITY

May 30, 2007

Noah Walker
Principal Utility Planner
DUDEK Engineering & Environmental
750 South 2nd Street
Encinitas, CA 92024

Re: Pinole Flow Monitoring Summary

Please find enclosed a summary of GEOtivity's analysis of the flow monitoring project within the City of Pinole. Included in this report are the results of the data analysis, site descriptions as well as concluding remarks.

Due to the large volume of data collected and mass number of scientific and statistical computations required for these conclusions, GEOtivity has included only the pertinent information that is summarized in this report. Information such as graphs, data points, accuracy verifications, field visits and sensor information can all be found on the SCADAserve website at **www.scadaserve.com**.

GEOtivity has performed numerous flow studies spanning over two decades of flow monitoring; with this experience GEOtivity has been able to successfully implement and create a methodology specifically for this application. This document is designed to illustrate these practices and methodologies developed by GEOtivity. Should you require any further analysis of this site or have questions about the content of this document please do not hesitate to contact us for further clarification.

Professionally,

Jason Ostoforov, B.Sc.
Engineering Technologist

Table of Contents

Project Overview

Introduction

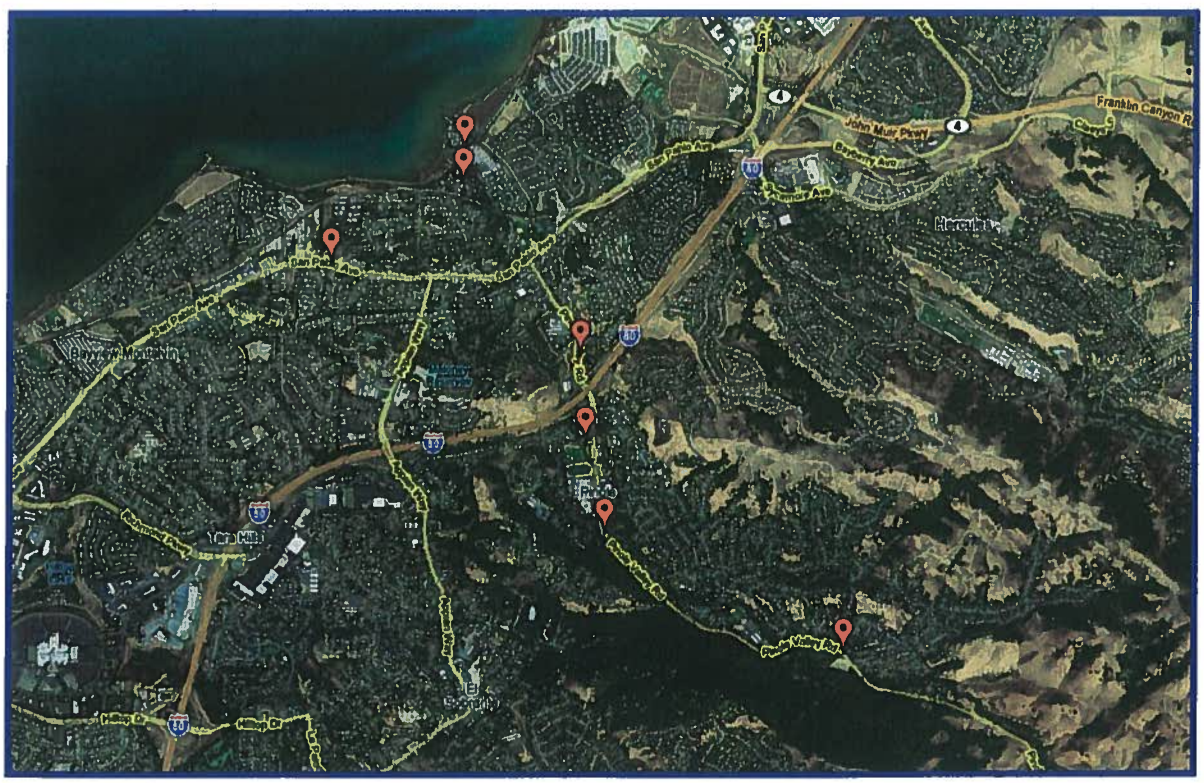
DUDEK Engineering and Environmental contracted the services of GEOtivity to conduct a flow monitoring project at six locations known as sites 1, 2, 3, 4, 5 and 6 in order to determine flow rates at these particular locations. Monitoring for this project occurred over the early winter of 2006 and conducted to the early spring of 2007 January 24th, 2007 with the date ranges of February 15th, 2007 to March 7th, 2007 chosen for analysis. This report summarizes the results of this study period including: site information, data accuracy, data analysis, and statistical breakdown of various hydraulic parameters.

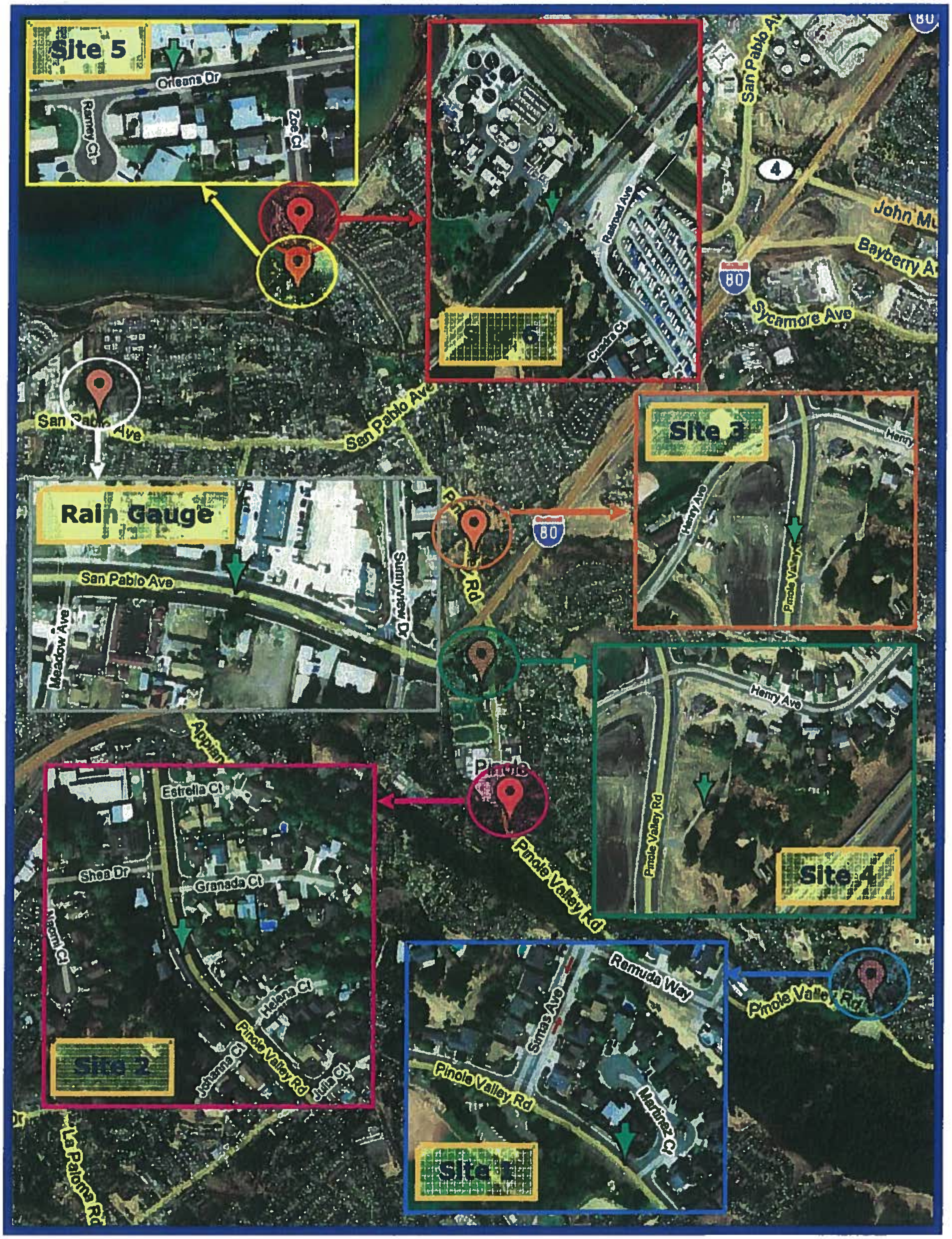
At these 6 locations GEOtivity installed its latest wireless flow monitoring platform, the ***Qtrek v.3***, equipped with redundant high resolution pressure transducers and an acoustic Doppler velocity sensor. Data was collect with a five minute sample rate and uploaded to the GEOtivity's ***SCADAserve***, a web-based asset management platform.

Utilizing the benefits of wireless technology, GEOtivity's quality control group was able to monitor the data in near real-time to ensure quality data and integrity. GEOtivity was able to properly assess data quality and equipment functionality which allowed GEOtivity to capture 100% data population over the monitoring period. In addition to not losing single sample GEOtivity field verifications on average showed that monitor readings where within 99% accuracy compared to on site verifications. Details of this verification are included in this report.

Study Area

The areas of study for this project were within the boundaries of the City of Pinole. Locations throughout the City were monitored specifically to focus on daily flow rates within the sanitary collection system.




Site 5
Orleans Dr
Raney Ct
Zoe Ct
Site 6
Railroad Ave
Cuadra Ct
San Pablo Ave
John Muir
Bayberry Ave
Sycamore Ave
80
4
San Pablo Ave
Site 3
Henry Ave
Pinole Valley
Rain Gauge
San Pablo Ave
Meadow Ave
Sunnyview Dr
80
Henry Ave
Pinole Valley Rd
Site 4
Pinole
Appian
Estrella Ct
Shea Dr
Granada Ct
Helena Ct
Johanna Ct
Julia Ct
Pinole Valley Rd
Site 2
Pinole Valley Rd
Remuda Way
Simas Ave
Pinole Valley Rd
Martinez Ct
Site 1
Pinole Valley Rd
La Paloma Rd

Equipment

Qtrek V.3 Flow Monitor

The ***Qtrek V.3*** is a rugged, flexible system that collects quality data in the harsh sewer environment. The ***Qtrek V.3*** is appropriate for permanent or portable applications. The following is a description of the full capabilities of this monitoring platform.

The ***Qtrek V.3*** can take up to sixteen different sensors at one time, eight digital and eight analog. The ***Qtrek V.3*** comes standard with two depth and one velocity sensor. Any sensors with a 4-20ma or 0-5V input can be utilized, including but not limited to, ultrasonic level, redundant velocity, temperature, pH and water quality. This allows for expandable, highly integrated flow monitoring when several measurements are required. The platform can be adapted to use only one sensor if a weir or flume equation is the preferred method of measurement.

Highly accurate depth, velocity, and water quality data can be collected on a user-defined interval. Data processing and review is facilitated through the Internet. This high tech, user-friendly technology makes analysis and reporting more efficient and effective.

GEOtivity is the sole manufacturer of the flow monitoring equipment used in this study. Not only does GEOtivity manufacture, we also design, test and build the ***Qtrek V.3*** monitoring platform we used in this project. Our in-house expertise has allowed GEOtivity to catapult into the twenty-first century with Internet compatible wireless technology and unlimited Unix SQL server. We have the capabilities to monitor tens of thousands of manholes simultaneously and have them automatically update and connect to our server every 60 minutes. It is these advances that are truly revolutionizing the industry, by providing customers with the most cost effective solutions to their monitoring programs by using the latest advancements in technology.

Dealing with GEOtivity gives our clients a huge advantage because we have the ability to design, build and manufacture our monitoring equipment in-house. We have the capability to turn product around overnight and solve complex problems, including custom solutions for unique or unordinary challenges.

Depth is measured utilizing redundant high resolution, stainless steel pressure transducers in combination with Pitot-hydrostatic-neutralizing (PHN), technology. PHN technology allows GEOtivity's sensors to accurately measure fluid flow level without incorrectly monitoring external pressures created through Bernoulli or Venturi effects. Other manufacturers' sensors are plagued with the problem of measuring incorrect depth under fast flow conditions, also known as velocity-induced depth errors. GEOtivity's sensors are shielded by all other pressures and measure the exact hydrostatic pressure at the location on the sensor known as the "dead zone".

GEOtivity's manufacturing facility in Kelowna, BC Canada

It is this location where velocity is zero, no matter how fast the fluid is flowing. This is the same concept used by the airline industry to accurately monitor air velocity, and the difference between static and dynamic velocity.

The difference between our depth calibrations compared to other techniques is that we do not assume zero to be in air. In order to accurately determine the most reliable regression curve for depth, we take two readings, depth at one inch and depth at 12-inches or greater. This methodology gives us two primary depth calibration points and always yields an accurate curve relating voltage to actual pressure or depth. Prior to installation the field crew re-verifies depth in a controlled environment checking three different points to verify the lab calibrated curve. If required the field crew recalibrates depth on site utilizing the two point method.

Velocity is measured utilizing ultrasonic Doppler technology. Velocity is proportional to the difference between transmitted and received frequencies multiplied by a constant known as (K). The K value is determined in the flow lab in which the sensor and electronic cards are calibrated against an in-line Foxboro mag-meter which is 0.1 % accurate, and a calibrated propeller meter. Multiple velocities are tested from 0.05 to 10 ft/s. Volumetric analysis and draw down tests are also used to verify the meter's accuracy. Continuous Time Averaging (CTA) is utilized to determine the average flow velocity in which 500 KHz is transmitted into the flow stream for a minimum of 10 seconds and maximum of 30 seconds. Sound waves bounce off particulate matter in the flow stream, and the return signals are continually averaged during the sampling interval. This method allows us to stay in the analog realm as long as possible, thereby capturing a larger snapshot of return signals. The signals are averaged to determine the average velocity. Our solution is a combination of analog and digital techniques.

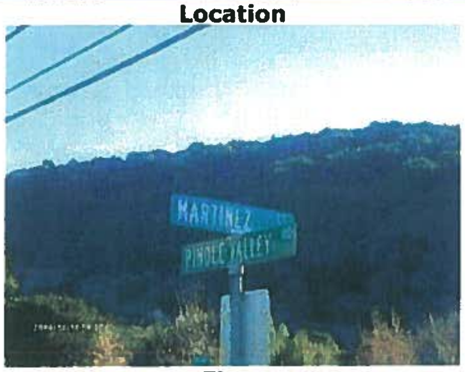
Velocity is calibrated in the lab, and verified on site utilizing a point velocity meter. The propeller meter utilizes four optical points per rotation, hence increasing the per turn accuracy four times. Hydraulic profiling is used to determine the on-site average velocity, which is then compared to the meter's actual reading. Depending on the level we utilize either t-section or 9-point profiles.

Site Profile and Analysis

Site 1

This site is located on Pinole Valley Road, near the entrance to Martinez Court. Traffic at this location was deemed to be low, and no additional traffic control was needed to perform safe entry. This manhole features a 10 inch inflow and outflow pipe constructed of concrete and deemed to be in good condition over the course of the study. This site also featured a secondary inflow that entered the manhole approximately three feet above the invert and is believed to have negligible impact in the monitoring application. This location also had a flume installed to overcome hydraulic challenges associated with low flow. Monitoring at this location was successful as hydraulic conditions at this site were deemed to be good.

Location

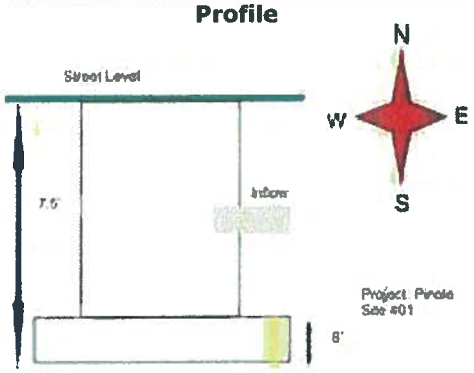


Equipment

Flow

Downstream (Flume)

Profile



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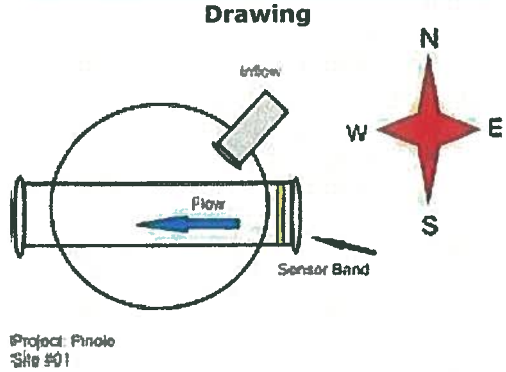
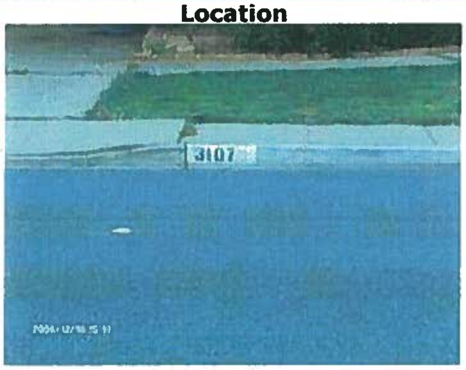


Site 2

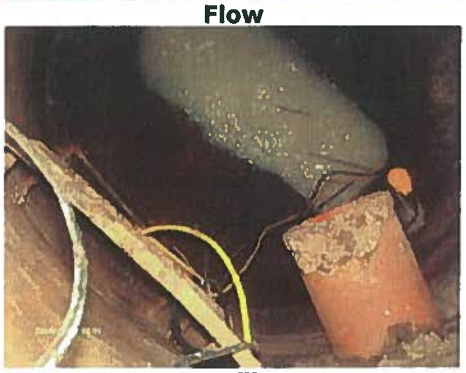
This site is located in the southbound lane on Pinole Valley Road, between Granada Court and Helena Court. Traffic at this location was deemed to be low, and no additional traffic control was needed to perform safe entry. This manhole features a 15 inch inflow and outflow pipe constructed of concrete and deemed to be in good condition over the course of the study. This site also featured a secondary inflow that entered the manhole approximately three feet above the invert and is believed to have negligible impact in the monitoring application. Site investigations and photos show the flow to moderately turbulent by the presence of ripples in the flow; however, there was sufficient flow coverage at this site to mitigate any impact on the monitoring. Monitoring at this location was successful as hydraulic conditions at this site were deemed to be good.

Location



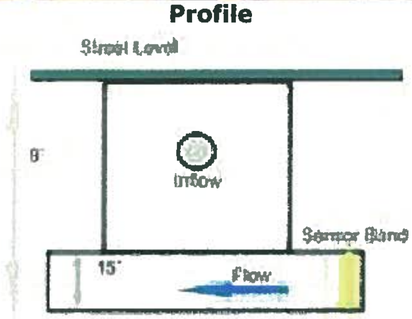
Equipment

Flow



Downstream

Profile



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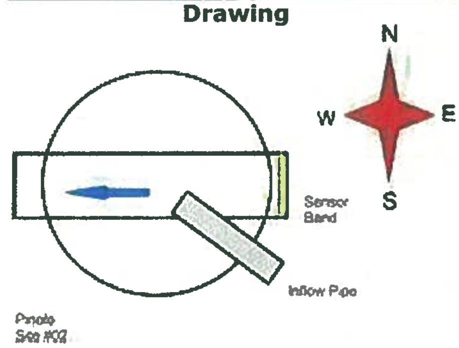
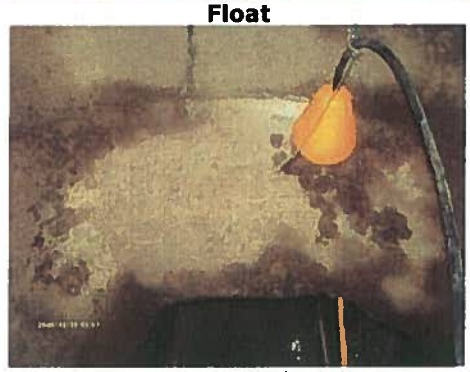


Site 3

This site is located in the southbound lane on Pinole Valley Road, between Henry Avenue and Interstate 80. Traffic at this location was deemed to be low, and no additional traffic control was needed to perform safe entry. This manhole features a 15 inch inflow and outflow pipe constructed of concrete and deemed to be in good condition over the course of the study. Site investigations and photos show the flow to moderately turbulent by the presence of ripples and waves in the flow; however, there was sufficient flow coverage at this site to mitigate any impact on the monitoring. Monitoring at this location was successful as hydraulic conditions at this site were deemed to be good.

Location

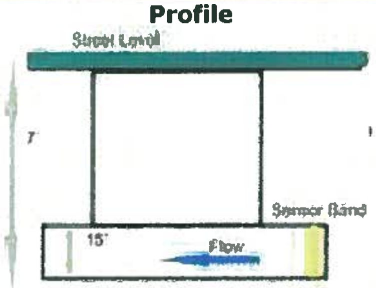
Float



Upstream

Channel

Profile



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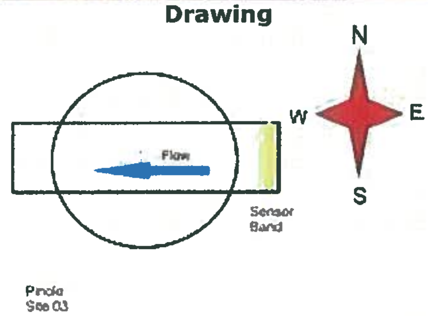
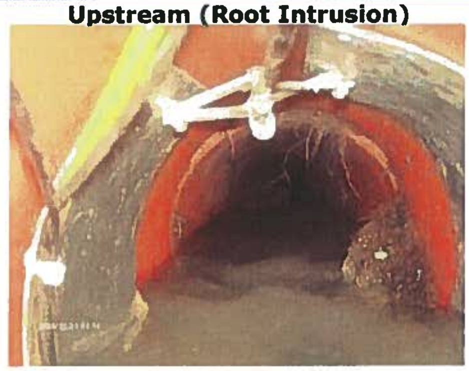


Site 4

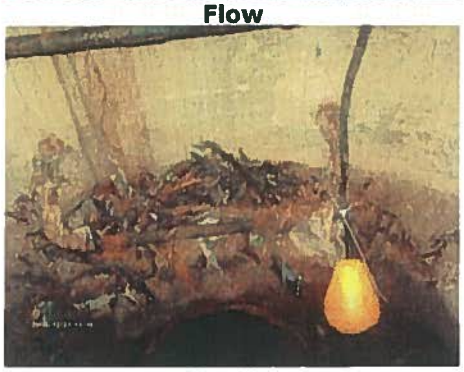
This site is located near a foot bridge just South of Sarah Court on Pinole Valley Road. There was no traffic at this location and no additional traffic control was needed to perform safe entry. This manhole features a 10 inch inflow and outflow pipe constructed of concrete and deemed to be in good condition over the course of the study. Site investigations and photos show the flow to moderately turbulent by the presence of ripples and waves in the flow; however, there was sufficient flow coverage at this site to mitigate any impact on the monitoring. Site investigations indicated there where root intrusions at this location, which may be contributing to the turbulent flow conditions noted at this location. Overall monitoring at this location was successful as hydraulic conditions at this site were deemed to be good.

Location

Upstream (Root Intrusion)



Flow



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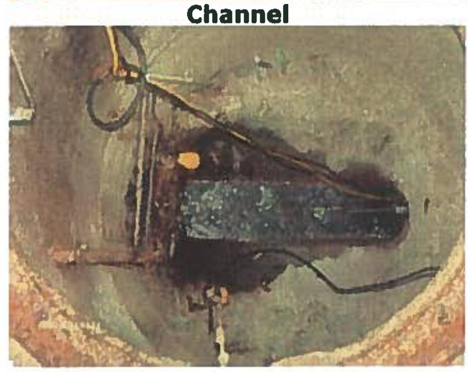
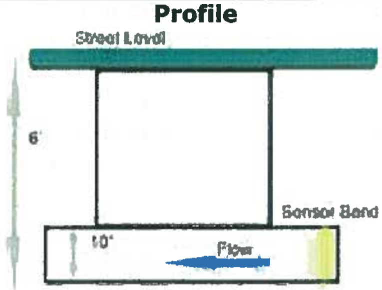


Profile



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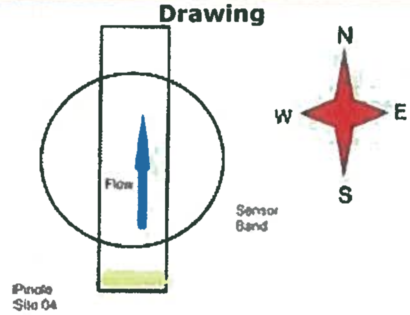


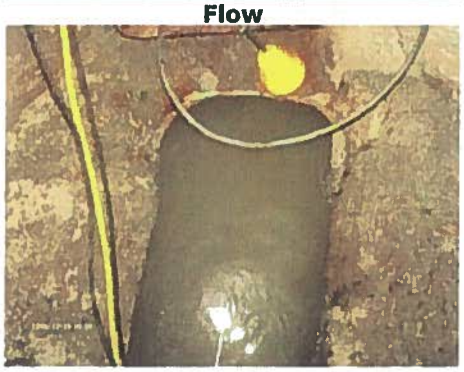
Site 5

This site is located near on Orleans Drive, between Zoe Court and Ramey Court. Traffic at this location was deemed to be low, and no additional traffic control was needed to perform safe entry. This manhole features a 15 inch inflow and outflow pipe constructed of concrete and deemed to be in good condition over the course of the study. Overall monitoring at this location was successful as hydraulic conditions at this site were deemed to be good.

Location

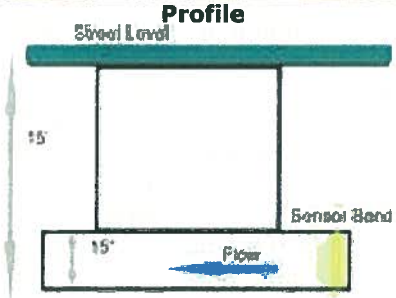
Upstream

Flow

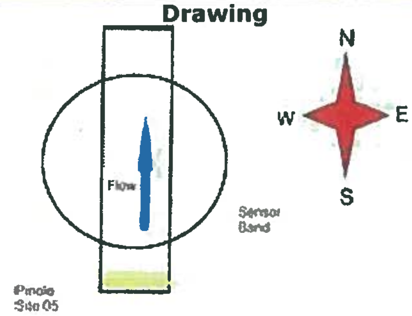


Channel

Profile



Drawing

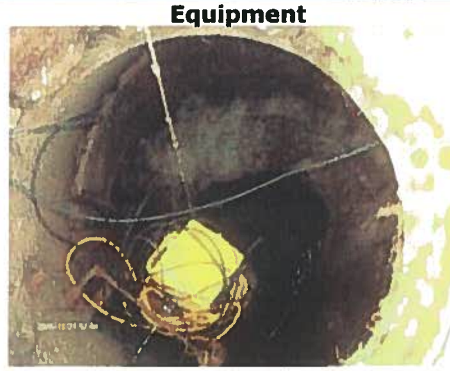


Site 6

This site is located near on the sidewalk of Bay Trail, just prior to the entrance to the waste water treatment plant. There was no traffic at this location and no additional traffic control was needed to perform safe entry. This manhole features a 30 inch inflow and outflow pipe constructed of concrete and deemed to be in good condition over the course of the study. Overall monitoring at this location was successful as hydraulic conditions at this site were deemed to be good.

Location

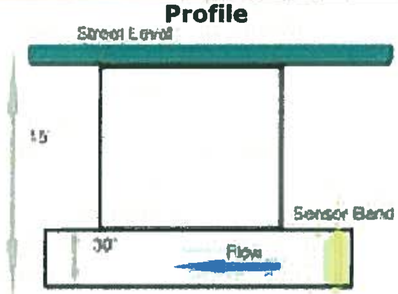
Equipment



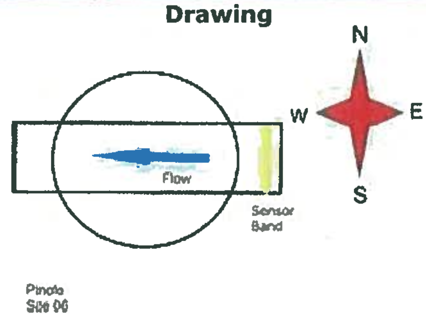
Flow

Channel

Profile



Drawing



For a complete assessment of this location please refer to the posted Site Documentation (S-Doc) form available on the ***SCADAserve***.

Data Verification

Accuracy

In order to determine site accuracy and also to develop a pipe rating curve it is essential that in-situ hydraulic profiling be conducted. Site profiling consists of the taking manual depth readings and performing an on site velocity profile, which was done by GEOtivity's highly skilled field crews. During the monitoring period, field crews performed routine maintenance to the monitoring locations to verify monitoring equipment and documented site conditions. Each time a site was visited, GEOtivity's field crews performed the following quality assurance steps that ensured the accuracy of your data:

Depth Verification - Each field visit our field crews to manually measure the depth of flow and compare these readings with those of the flow meter. Three independent verifications, each five minutes apart, were performed for each depth sensor attached to the flow meter.

Velocity profile and Verification - When adequate depth was available, each field visit a velocity profile was performed. A third party point velocity meter was used to perform a cross sectional profile of the velocity at different locations in the channel. Three independent verifications each five minutes apart were performed for each velocity sensor attached to the flow monitor.

Power supply verification - During each field visit the monitor's power supply was manually verified against real time power supply data reported. The power supply was immediately replaced, if required.

Connectivity Verification - The field crews were required to observe the flow meter in operation and must observe, record, and report events including sampling and communication.

Data Review - During each site visit raw data was reviewed by a qualified QA/QC data technician. The crew was not permitted to leave the site until the technician approved the data received from the flow meter and verifications received from the field crew.

Field Calibration Summary

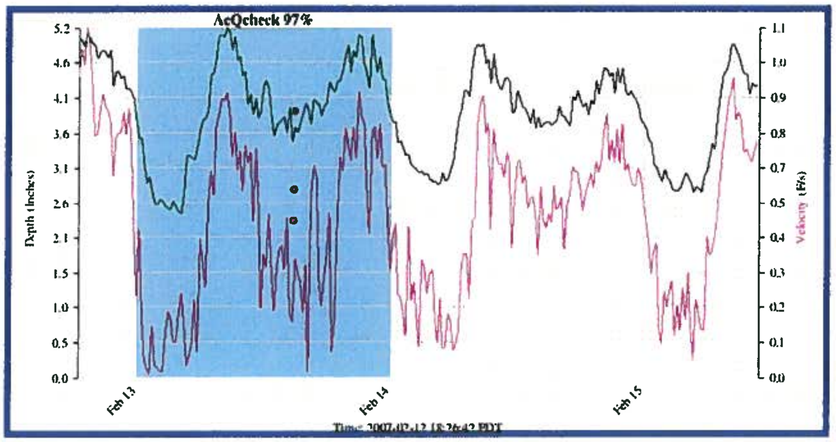
In order to maintain the highest quality data, GEOtivity's field crews work closely with QA/QC department and perform routine site verification when they are on site. Field verifications are called in from the field to our SCADA department where a highly trained QA/QC technician verifies on site field measurements with the real-time data feed from the installed flow monitors. Field crews are not allowed to leave site until an accuracy of at least 95% is attained between on site measurements and monitor readings. The results of this process are shown in the table below

All field calibration data and charts can be found on the project website at **www.scadaserve.com**.

Site 1

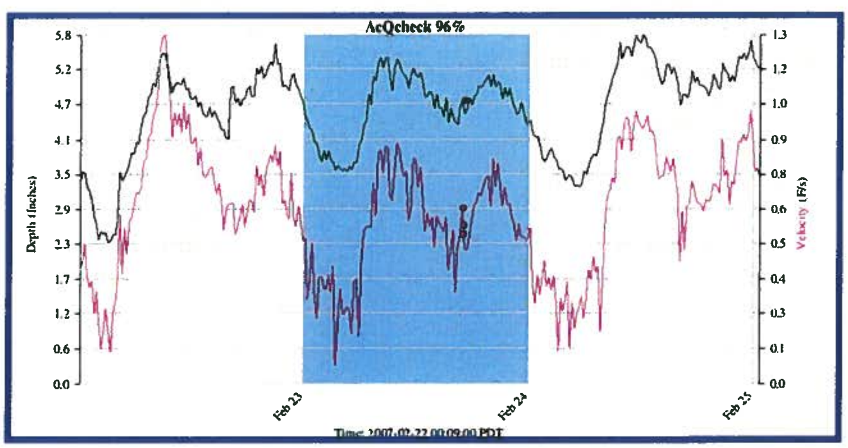
February 13th, 2007

Parameter	Actual	Monitor	Accuracy
Depth (in)	3.94	3.98	99%
Velocity (f/s)	0.52	0.50	96%
Flow (g/s)	0.20	0.20	97%



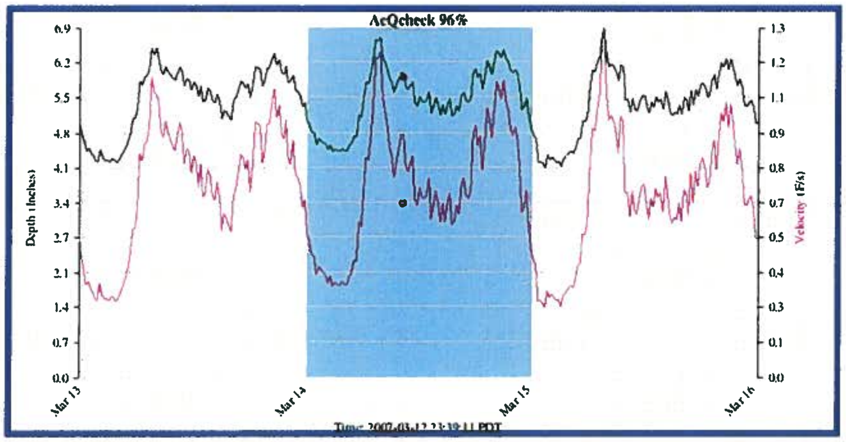
February 23rd, 2007

Parameter	Actual	Monitor	Accuracy
Depth (in)	4.72	4.62	98%
Velocity (f/s)	0.60	0.57	94%
Flow (g/s)	0.30	0.30	96%



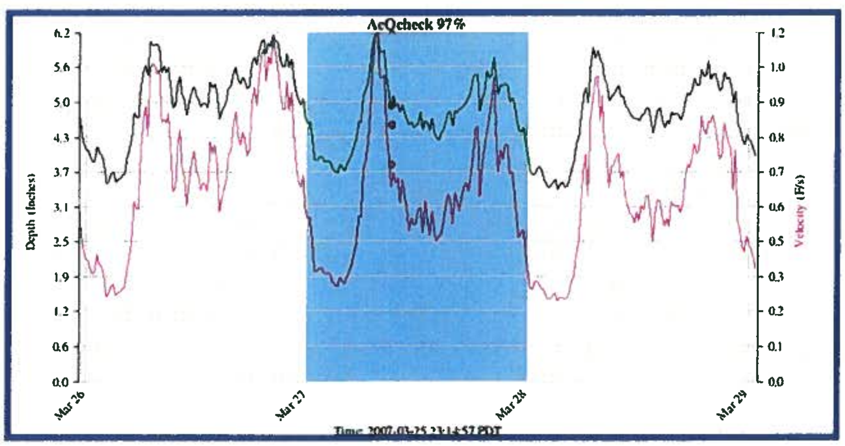
March 14th, 2007

Parameter	Actual	Monitor	Accuracy
Depth (in)	5.91	5.95	99%
Velocity (f/s)	0.66	0.67	98%
Flow (g/s)	0.50	0.50	96%



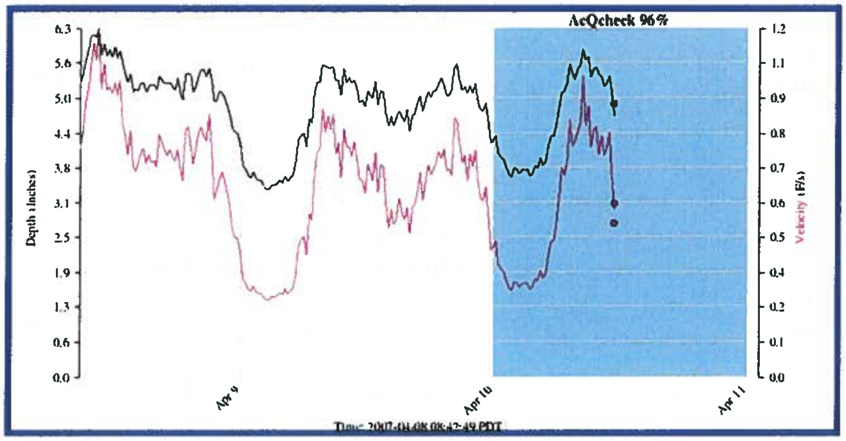
March 27th, 2007

Parameter	Actual	Monitor	Accuracy
Depth (in)	4.92	4.93	100%
Velocity (f/s)	0.70	0.71	96%
Flow (g/s)	0.50	0.40	97%



April 10th, 2007

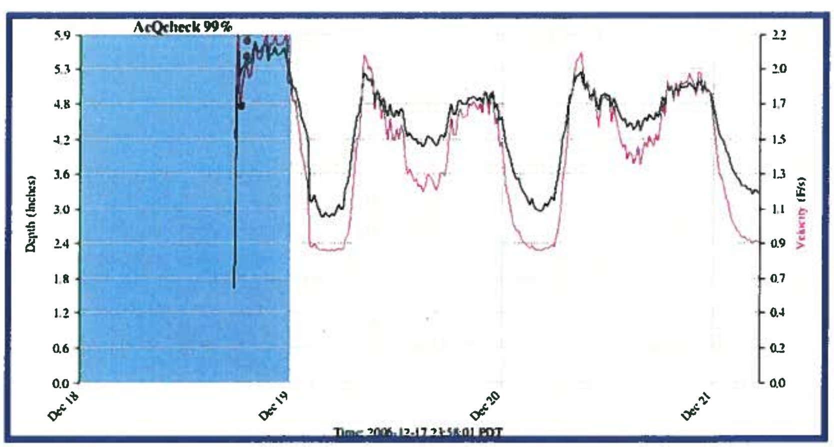
Parameter	Actual	Monitor	Accuracy
Depth (in)	4.92	4.94	98%
Velocity (f/s)	0.51	0.50	98%
Flow (g/s)	0.30	0.30	96%



Site 2

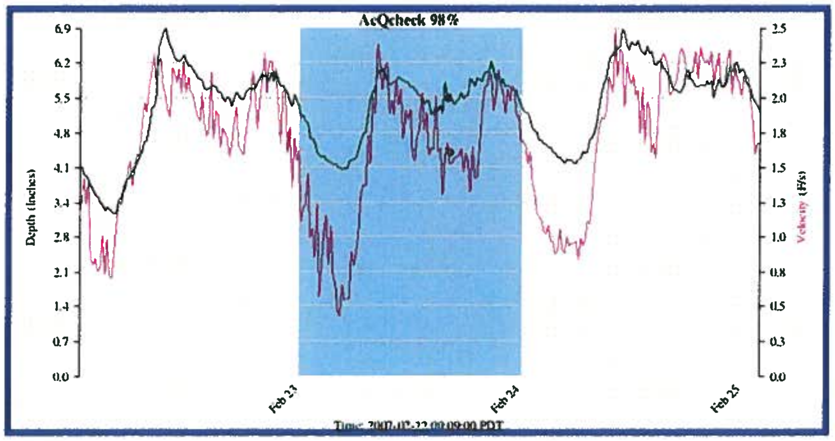
December 18th, 2006

Parameter	Actual	Monitor	Accuracy
Depth (in)	4.72	4.80	98%
Velocity (f/s)	2.10	2.12	99%
Flow (g/s)	1.60	1.60	97%



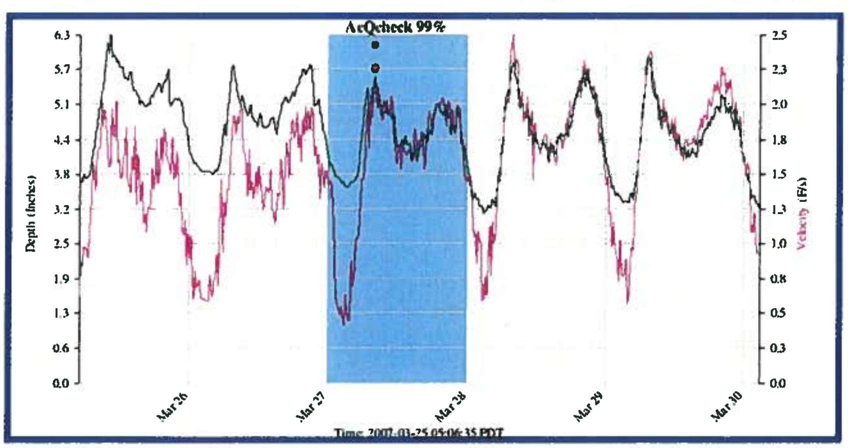
February 23rd, 2007

Parameter	Actual	Monitor	Accuracy
Depth (in)	5.51	5.64	98%
Velocity (f/s)	1.61	1.51	93%
Flow (g/s)	1.50	1.50	97%



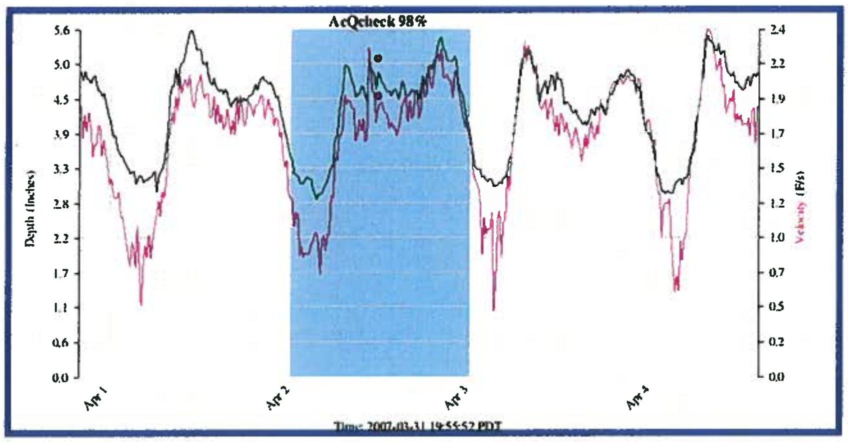
March 27th, 2007

Parameter	Actual	Monitor	Accuracy
Depth (in)	5.71	5.69	100%
Velocity (f/s)	2.30	2.29	100%
Flow (g/s)	2.20	2.20	99%



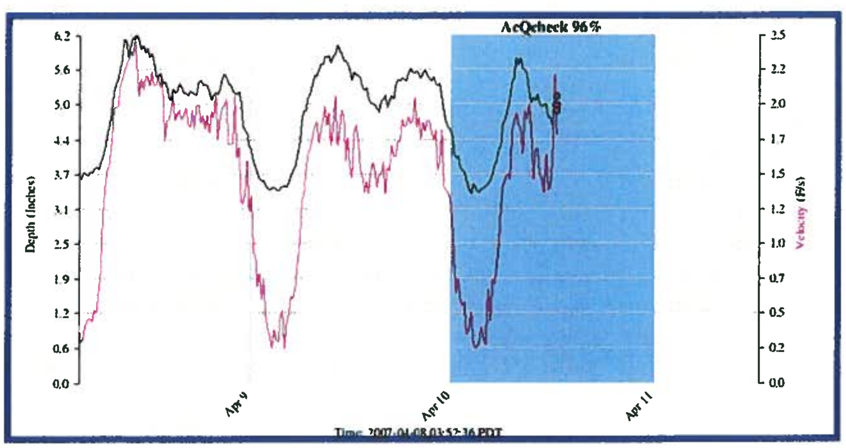
April 2nd, 2007

Parameter	Actual	Monitor	Accuracy
Depth (in)	5.12	5.09	99%
Velocity (f/s)	2.06	2.10	98%
Flow (g/s)	1.70	1.80	98%



April 10th, 2007

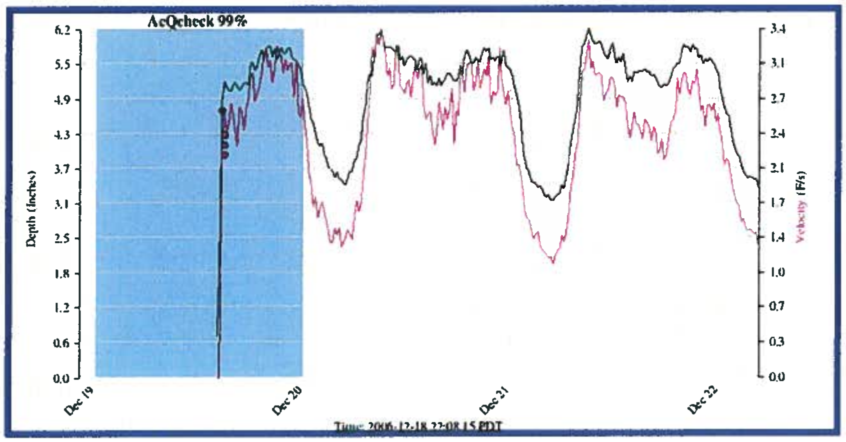
Parameter	Actual	Monitor	Accuracy
Depth (in)	4.92	4.90	100%
Velocity (f/s)	1.98	1.88	95%
Flow (g/s)	1.60	1.50	96%



Site 3

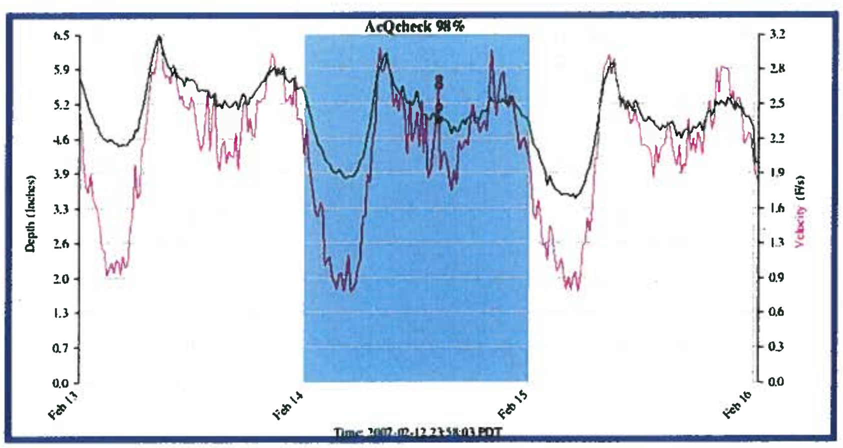
December 19th, 2006

Parameter	Actual	Monitor	Accuracy
Depth (in)	4.72	4.86	97%
Velocity (f/s)	2.30	2.27	99%
Flow (g/s)	1.70	1.80	97%



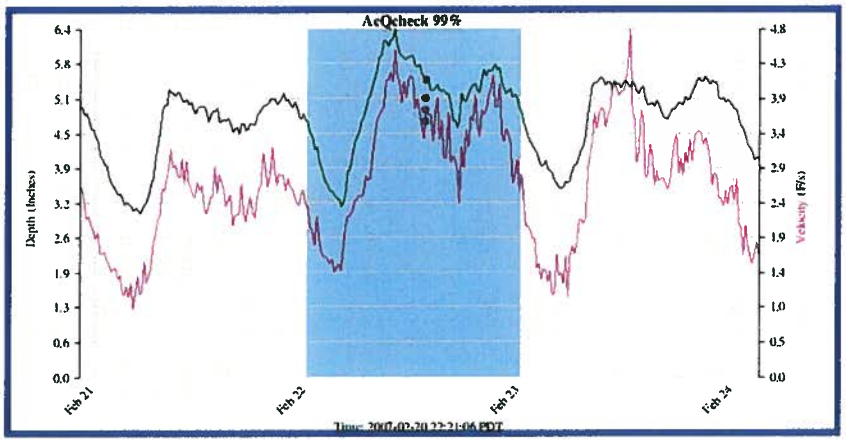
February 14th, 2007

Parameter	Actual	Monitor	Accuracy
Depth (in)	4.92	5.07	97%
Velocity (f/s)	2.65	2.58	97%
Flow (g/s)	2.10	2.10	98%



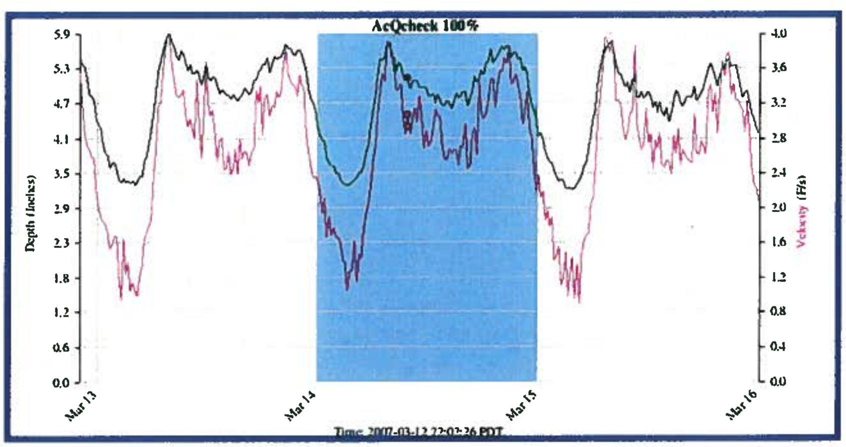
February 22nd, 2007

Parameter	Actual	Monitor	Accuracy
Depth (in)	5.51	5.49	100%
Velocity (f/s)	3.71	3.70	100%
Flow (g/s)	3.50	3.40	99%



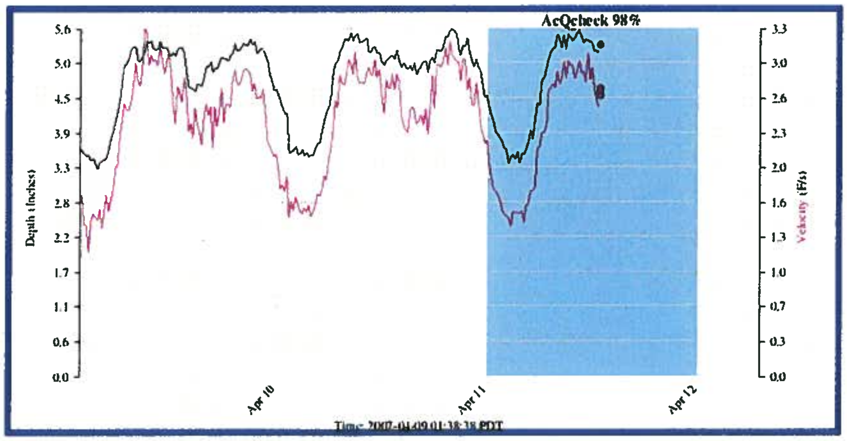
March 14th, 2007

Parameter	Actual	Monitor	Accuracy
Depth (in)	5.12	5.07	99%
Velocity (f/s)	3.01	2.99	99%
Flow (g/s)	2.50	2.50	99%



April 11th, 2007

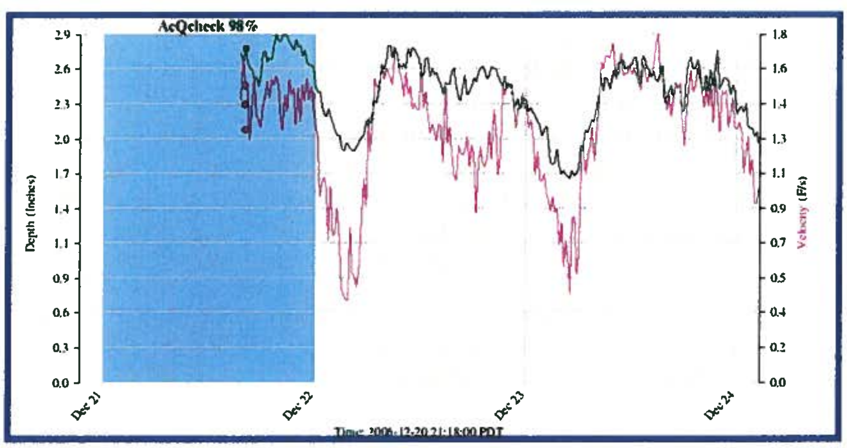
Parameter	Actual	Monitor	Accuracy
Depth (in)	5.12	5.09	99%
Velocity (f/s)	2.06	2.10	98%
Flow (g/s)	1.70	1.80	98%



Site 4

December 20th, 2006

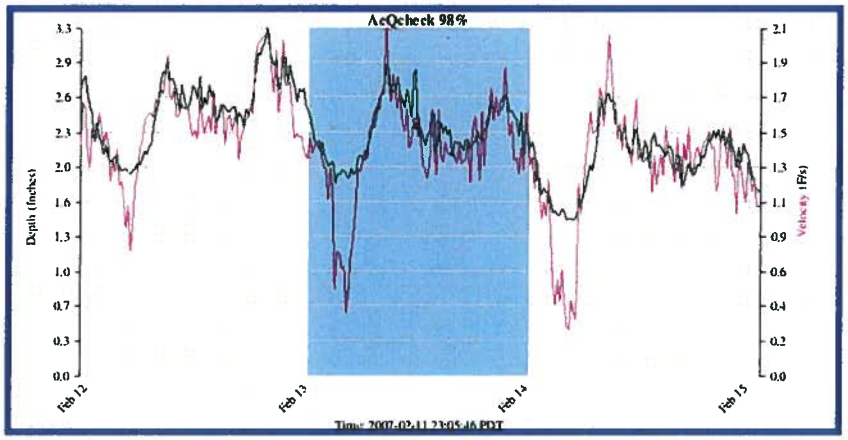
Parameter	Actual	Monitor	Accuracy
Depth (in)	2.76	2.80	99%
Velocity (f/s)	1.43	1.41	98%
Flow (g/s)	0.40	0.40	98%



February 13th, 2007

Parameter	Actual	Monitor	Accuracy
Depth (in)	2.36	2.38	99%
Velocity* (f/s)	N/A	N/A	N/A
Flow* (g/s)	N/A	N/A	N/A

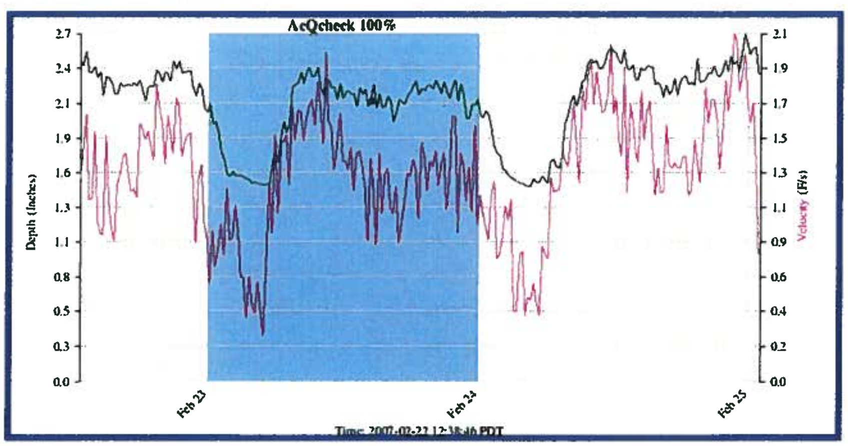
*insufficient depth to perform a velocity profile.



February 23rd, 2007

Parameter	Actual	Monitor	Accuracy
Depth (in)	2.17	2.18	99%
Velocity* (f/s)	N/A	N/A	N/A
Flow* (g/s)	N/A	N/A	N/A

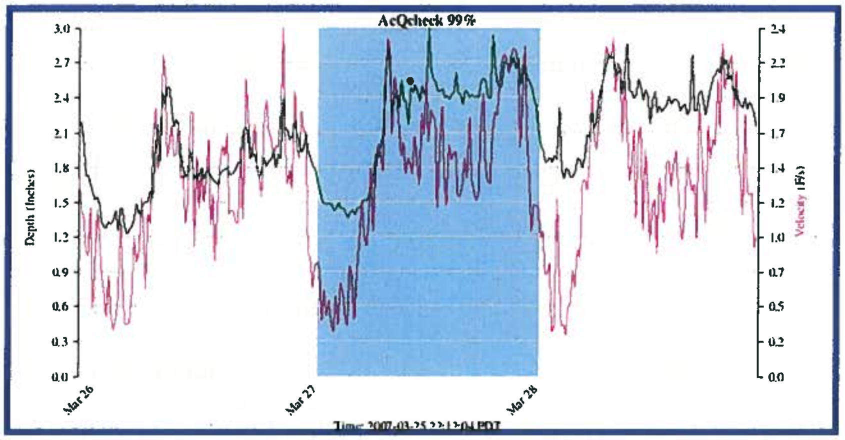
*insufficient depth to perform a velocity profile.



March 27th, 2007

Parameter	Actual	Monitor	Accuracy
Depth (in)	2.56	2.57	99%
Velocity* (f/s)	N/A	N/A	N/A
Flow* (g/s)	N/A	N/A	N/A

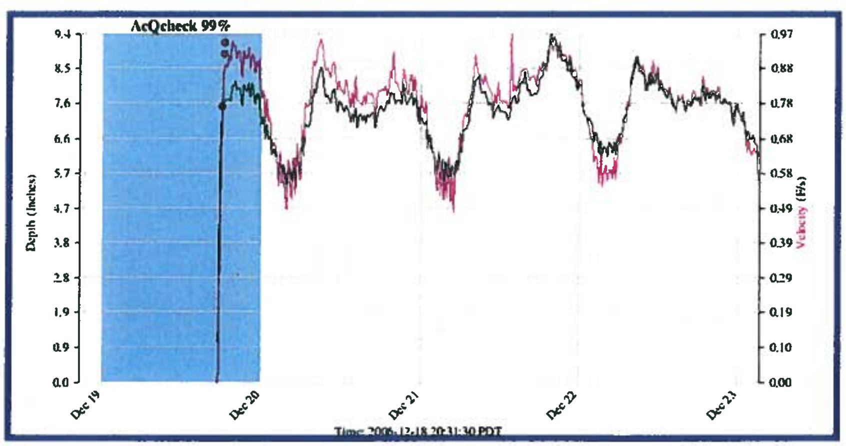
*insufficient depth to perform a velocity profile.



Site 5

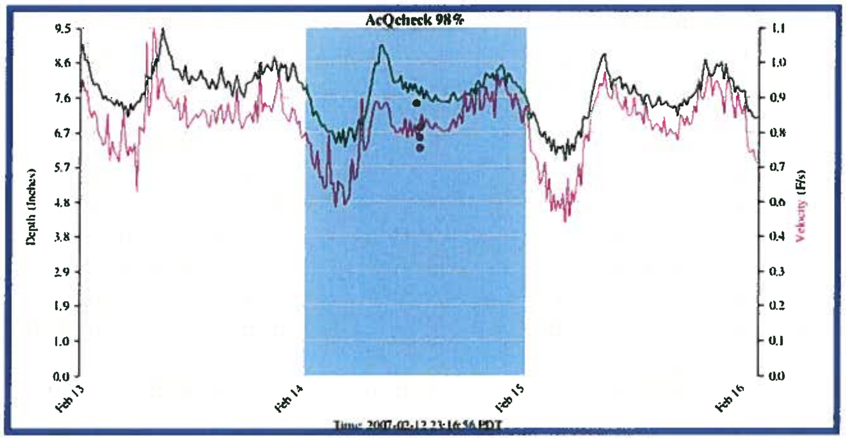
December 19th, 2006

Parameter	Actual	Monitor	Accuracy
Depth (in)	7.48	7.55	99%
Velocity (f/s)	0.97	1.00	98%
Flow (g/s)	1.40	1.40	97%



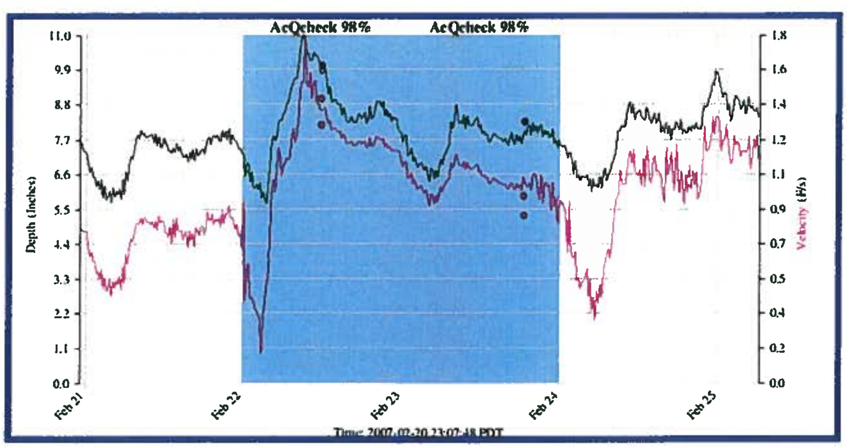
February 14th, 2007

Parameter	Actual	Monitor	Accuracy
Depth (in)	7.48	7.71	97%
Velocity (f/s)	0.75	0.74	99%
Flow (g/s)	1.10	1.10	98%



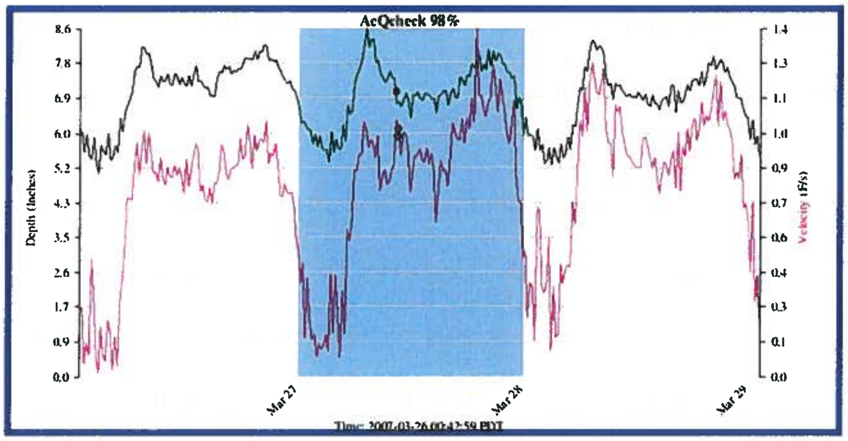
February 22nd, 2007 & February 23rd, 2007

Parameter (Feb 22)	Actual	Monitor	Accuracy
Depth (in)	10.04	10.07	100%
Velocity (f/s)	1.40	1.44	97%
Flow (g/s)	2.80	2.90	97%
Parameter (Feb 23)	**Actual**	**Monitor**	**Accuracy**
Depth (in)	8.27	8.05	97%
Velocity (f/s)	0.92	0.90	98%
Flow (g/s)	1.50	1.40	94%



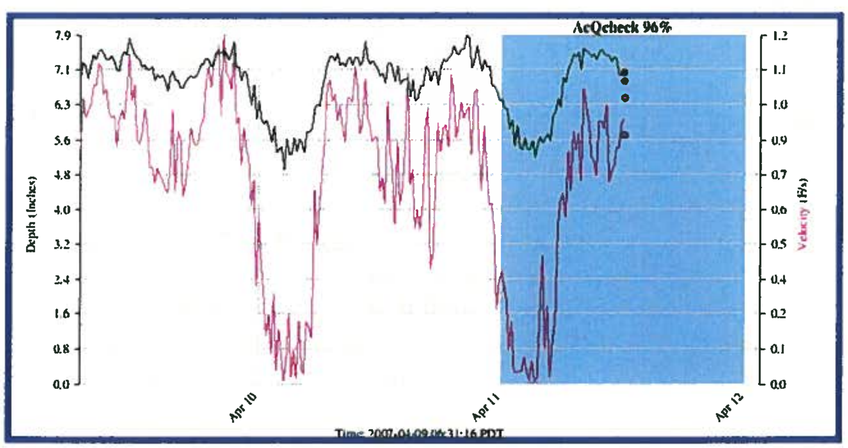
March 27th, 2007

Parameter	Actual	Monitor	Accuracy
Depth (in)	7.09	7.00	99%
Velocity (f/s)	1.00	0.95	95%
Flow (g/s)	1.30	1.20	94%



April 11th, 2007

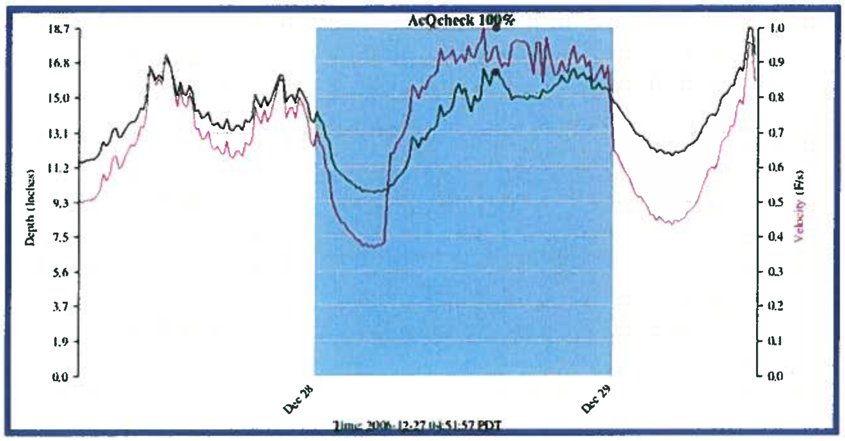
Parameter	Actual	Monitor	Accuracy
Depth (in)	7.02	7.02	100%
Velocity (f/s)	0.94	0.83	87%
Flow (g/s)	1.20	1.10	87%



Site 6

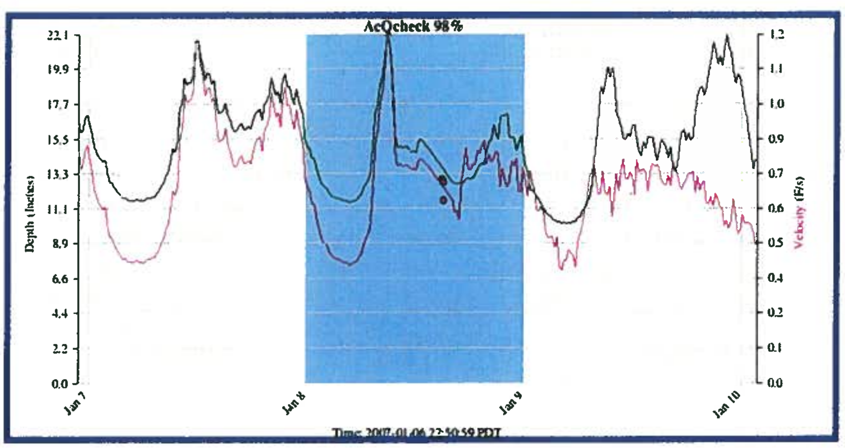
December 28th, 2006

Parameter	Actual	Monitor	Accuracy
Depth (in)	4.72	4.80	98%
Velocity (f/s)	2.10	2.12	99%
Flow (g/s)	1.60	1.60	97%



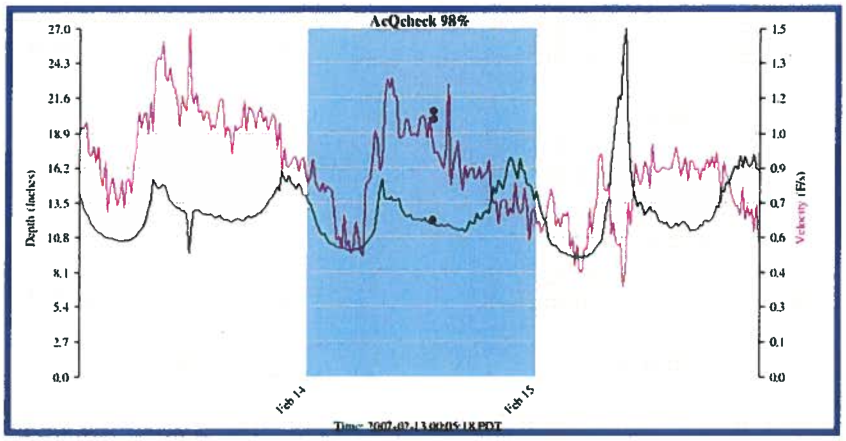
January 8th, 2007

Parameter	Actual	Monitor	Accuracy
Depth (in)	4.92	4.92	100%
Velocity (f/s)	1.53	1.60	96%
Flow (g/s)	1.20	1.30	96%



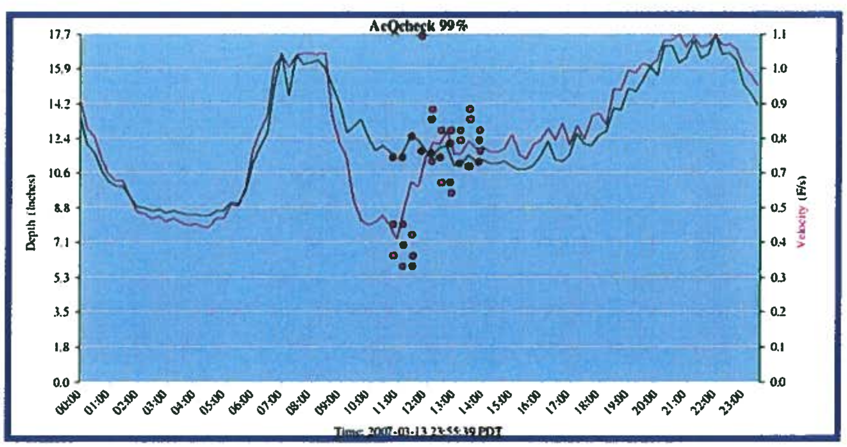
February 14th, 2007

Parameter	Actual	Monitor	Accuracy
Depth (in)	5.31	5.39	99%
Velocity (f/s)	2.08	2.09	99%
Flow (g/s)	1.80	1.90	98%



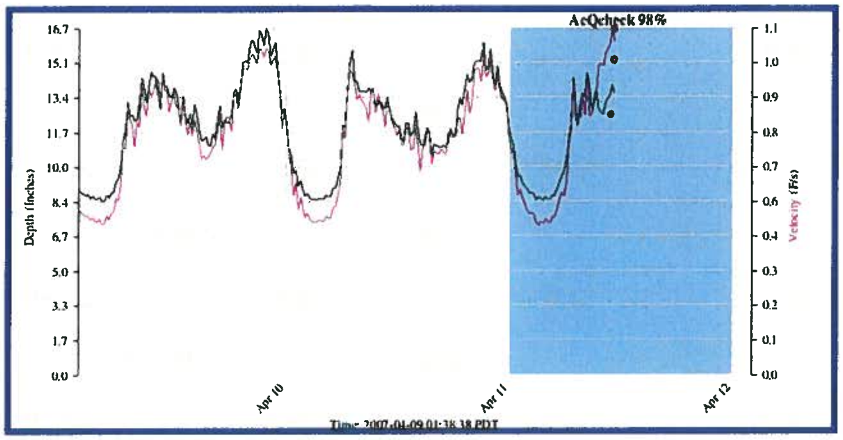
March 14th, 2007

Parameter	Actual	Monitor	Accuracy
Depth (in)	5.71	5.69	100%
Velocity (f/s)	2.30	2.29	100%
Flow (g/s)	2.20	2.20	99%



April 11th, 2007

Parameter	Actual	Monitor	Accuracy
Depth (in)	4.92	4.90	100%
Velocity (f/s)	1.98	1.88	95%
Flow (g/s)	1.60	1.50	94%



Data Collection & Analysis

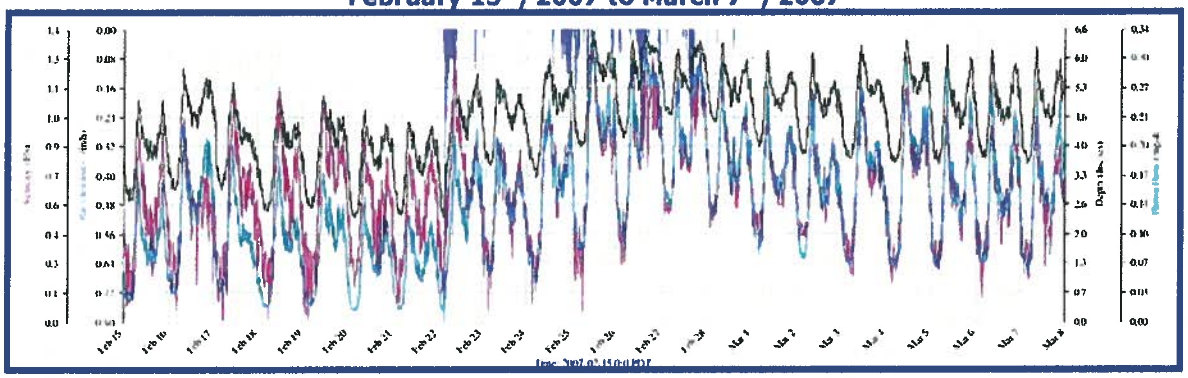
Flow data collected during the monitoring period was used to quantify daily flow volumes from each of the monitoring locations. In addition to daily flow volumes, GEOtivity has provided plots of the depth-velocity relationship also included is flow, scatter plots of velocity and flow versus depth, as well as times of daily minimum, maximum and average hydraulic parameters. This section summarizes the results of this monitoring period.

Due to the large volume of data collect in this study only a portion of the data will be analyzed in this report. This set of data is representative of the whole data set collect for this project and encompasses both dry and weather flows.

Site 1

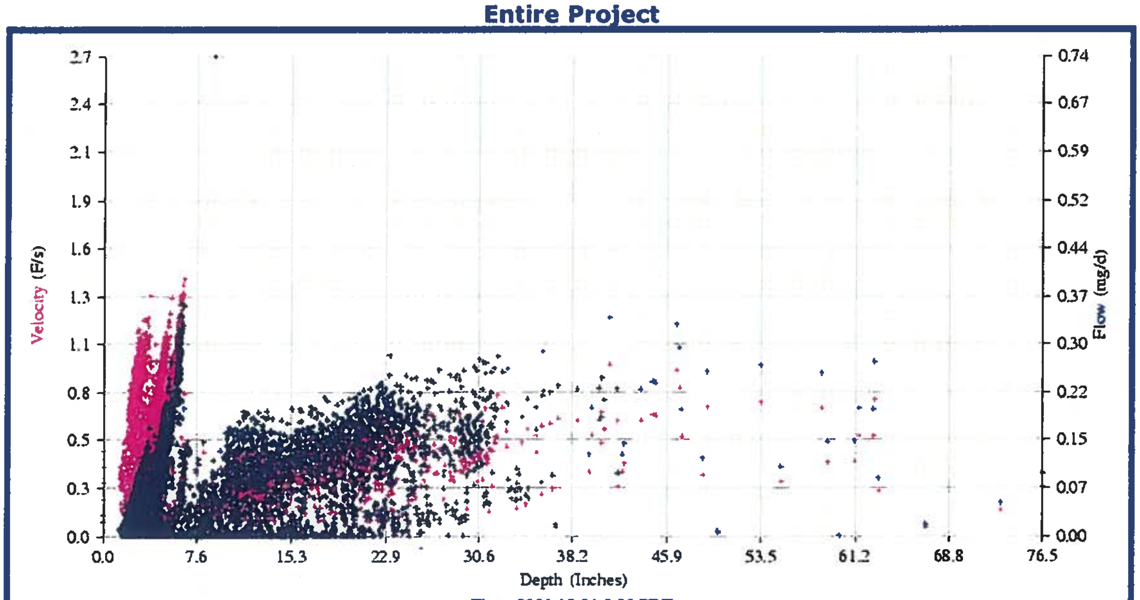
Line Graph: Depth, Velocity & Flow

February 15th, 2007 to March 7th, 2007

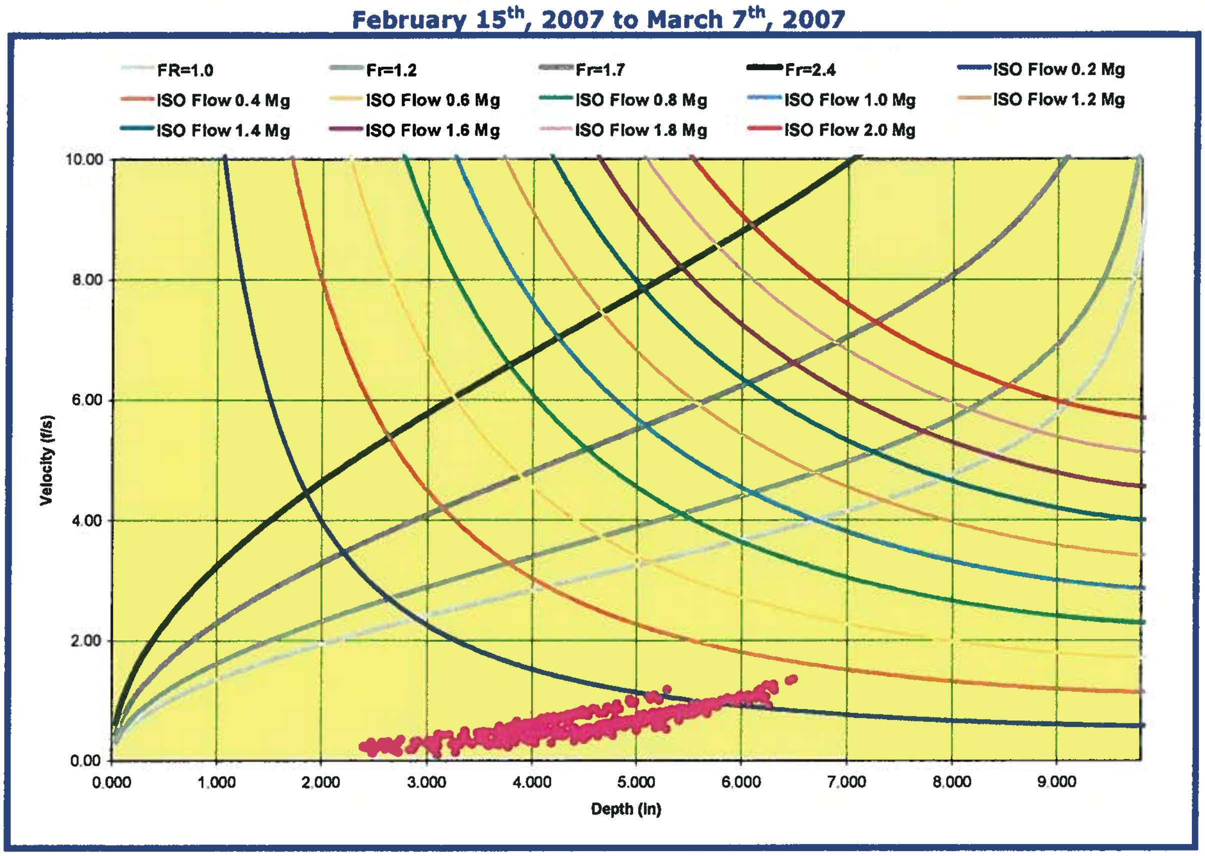


Scatter Plot: Depth & Flow vs. Depth

Entire Project



Hydraulic Analysis

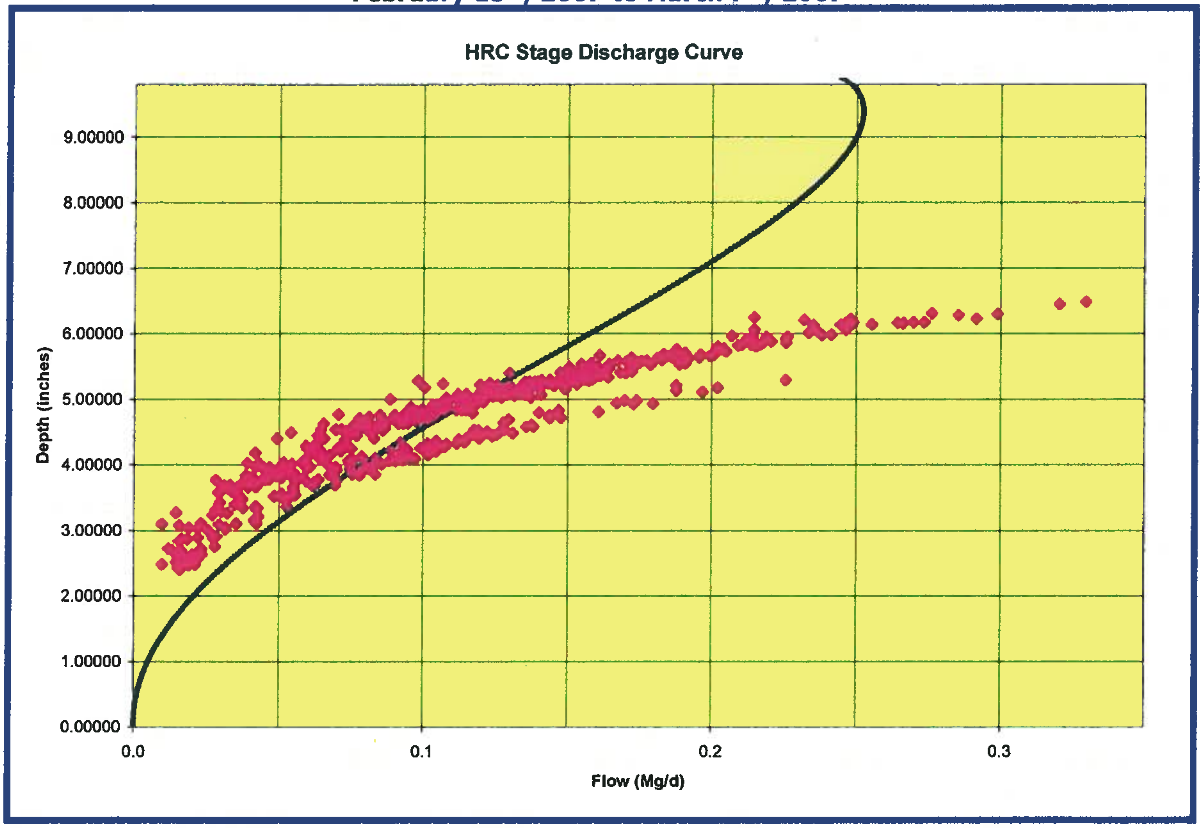


The plot above is a scatter plot of velocity vs. depth overlaid on our **GEO*grid*** hydraulic analysis chart. The hydraulic conditions are represented by the Froude lines in shades of grey and ISO flow regimes represented by the rainbow of colors. Data below the FR=1.0 line indicates laminar flow that is sub-critical and ideal for monitoring. Hydraulic conditions above the FR=1.0 (higher Froude number) begin to deteriorate as flow becomes turbulent and unstable. A Froude number greater than FR=2.4 represents turbulent flow that is unsuitable for monitoring.

The analysis shows that the data collected at this location to be stable. The data collected during this period shows that all the data falls under the Fr=1 region indicating that flow is ideal for monitoring; however, velocity is below recommended scouring velocity of 2.0 f/s. Overall, data collection was successful at this location.

Pipe Performance & Stage Discharge Analysis

February 15th, 2007 to March 7th, 2007

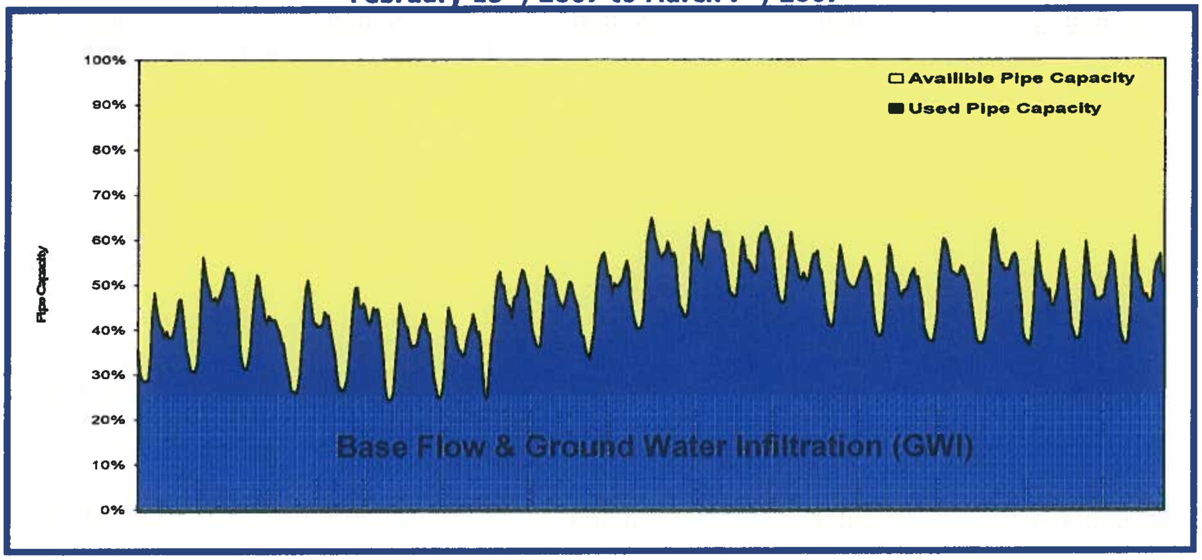


The plot above is a scatter plot of depth vs. flow overlaid on our **HRC** (Hydraulic Rating Coefficient) Pipe Performance chart. The HRC Pipe Performance chart illustrates the Actual Pipe Performance derived from the monitoring process.

This design curves is based upon Hydraulic Rating Coefficient (HRC) determined from field profiling and monitor data. For this 10 inch pipe the maximum design flow rate is 0.25 Mg/d which occurs at a depth of 9.4 inches and an average HRC value of 1.274.

Capacity & Rainfall Derived Inflow & Infiltration Analysis

February 15th, 2007 to March 7th, 2007



The monitoring period was conducted during both dry and wet weather conditions; thereby producing typical daily flow patterns as a result of residential, commercial or industrial sources in addition to increased flows derived from inflow and infiltration. The analysis is a good representation of typical daily flow regimes resulting from base flow and ground water infiltration. Comparing these typical daily flows to flows during and after storm events provides a good understanding of the current capacity in the system as well as illustrating the presence of inflow and infiltration. The following details the results of the minimum, maximum and average measured capacity.

Summary Statistics

	Inches	% of Pipe Size
Minimum Depth	2.41	24%
Maximum Depth	6.49	65%
Average Depth	4.65	47%

The plot above illustrates both typical diurnal capacity demand as well as the impact of various storm events on the collection system. The shaded portion of the plot illustrates this typical capacity need resulting from the presence of base flow and natural permeation of the sewer to ambient moisture. The dark purple region illustrates capacity demand resulting from storm events. The rapid increase in flow is the result of the presence of inflow upstream of this location. Inflow is the result of rainfall directly entering the sewer system often resulting from poor manhole seals or illegal connections.

Average maximum daily flow was measured to be 0.112 Mg/d and the **maximum peak flow rate measured to be 0.330 Mg/d**.

Based on our monitoring program the following ratio was determined:

$$\text{Maximum Peaking Factor} = \frac{\text{Maximum Flow}}{\text{Average Flow}} = \frac{0.33\ \text{Mg/d}}{0.112\ \text{Mg/d}} = 2.95$$

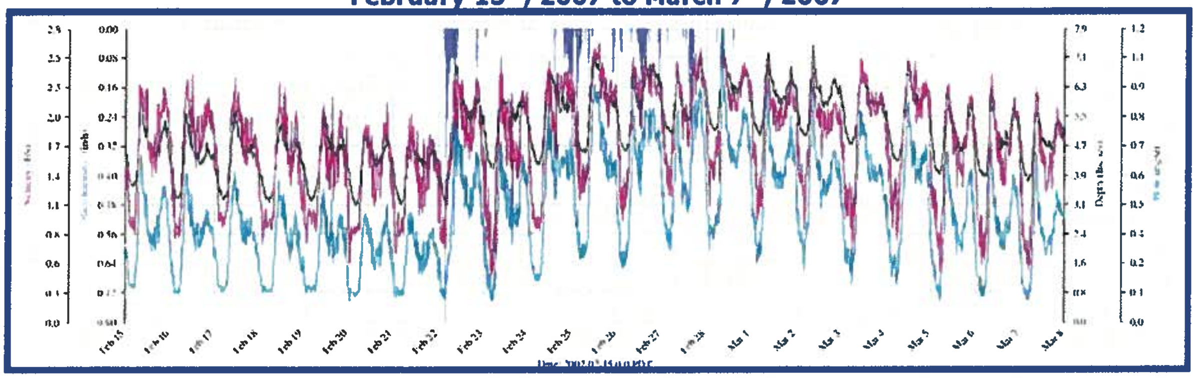
Summary Statistics

	Depth (Inches)					Velocity (f/s)					Flow (Mg/d)				
TimeStamp (PDT)	Average	Min	at	Max	at	Average	Min	at	Max	at	Average	Min	at	Max	at
02/15/07	3.865	2.713	03:13	5.101	08:28	0.520	0.099	04:53	0.917	08:33	0.081	0.022	03:13	0.170	08:28
02/16/07	4.514	2.925	02:48	5.960	08:18	0.525	0.101	04:53	0.974	08:53	0.130	0.030	02:48	0.258	08:18
02/17/07	4.110	2.908	05:03	5.573	10:58	0.569	0.036	05:58	1.099	11:08	0.096	0.029	05:03	0.216	10:58
02/18/07	3.818	2.458	05:12	5.519	11:07	0.589	0.111	06:12	1.125	11:37	0.081	0.015	05:12	0.211	11:07
02/19/07	3.904	2.503	04:02	5.266	10:42	0.620	0.093	04:53	1.074	11:17	0.086	0.016	04:02	0.186	10:42
02/20/07	3.646	2.292	03:52	4.973	09:02	0.533	0.193	03:47	0.905	09:12	0.069	0.011	03:52	0.159	09:02
02/21/07	3.595	2.378	03:22	4.619	09:47	0.516	0.079	03:47	0.823	21:07	0.065	0.013	03:22	0.129	09:47
02/22/07	4.399	2.309	03:22	5.751	21:02	0.702	0.139	03:37	1.292	09:17	0.122	0.011	03:22	0.235	21:02
02/23/07	4.598	3.498	04:47	5.621	08:12	0.578	0.136	03:42	0.890	09:02	0.131	0.055	04:47	0.221	08:12
02/24/07	4.732	3.254	05:32	6.090	12:22	0.643	0.176	05:12	1.012	12:42	0.146	0.043	05:32	0.273	12:22
02/25/07	5.334	3.911	05:32	6.668	11:42	0.798	0.169	06:27	1.404	11:42	0.200	0.079	05:32	0.344	11:42
02/26/07	5.567	4.119	04:02	6.592	15:32	0.878	0.297	03:12	1.358	15:32	0.222	0.092	04:02	0.334	15:32
02/27/07	5.555	4.620	05:22	6.494	19:12	0.886	0.536	01:52	1.329	20:52	0.218	0.129	05:22	0.322	19:12
02/28/07	5.295	4.474	04:06	6.469	08:26	0.784	0.460	02:06	1.209	08:36	0.191	0.118	04:06	0.319	08:26
03/01/07	5.023	3.948	04:06	6.187	08:36	0.701	0.351	04:21	1.127	08:41	0.167	0.081	04:06	0.284	08:36
03/02/07	4.847	3.721	04:56	6.162	08:31	0.664	0.415	01:36	1.126	08:36	0.152	0.068	04:56	0.282	08:31
03/03/07	4.926	3.618	05:06	6.448	10:16	0.673	0.212	05:36	1.092	11:06	0.162	0.062	05:06	0.316	10:16
03/04/07	4.998	3.543	05:06	6.594	11:02	0.685	0.203	03:31	1.156	11:02	0.170	0.058	05:06	0.335	11:02
03/05/07	4.799	3.490	04:41	6.423	08:41	0.614	0.268	04:51	1.092	08:41	0.150	0.055	04:41	0.313	08:41
03/06/07	4.827	3.588	05:16	6.286	08:36	0.601	0.151	03:36	0.949	09:21	0.151	0.060	05:16	0.296	08:36
03/07/07	4.823	3.523	03:46	6.340	21:16	0.575	0.228	04:46	0.988	08:31	0.152	0.057	03:46	0.303	21:16
Average	4.63	3.32	N/A	5.96	N/A	0.65	0.21	N/A	1.09	N/A	0.14	0.05	N/A	0.26	N/A

Site 2

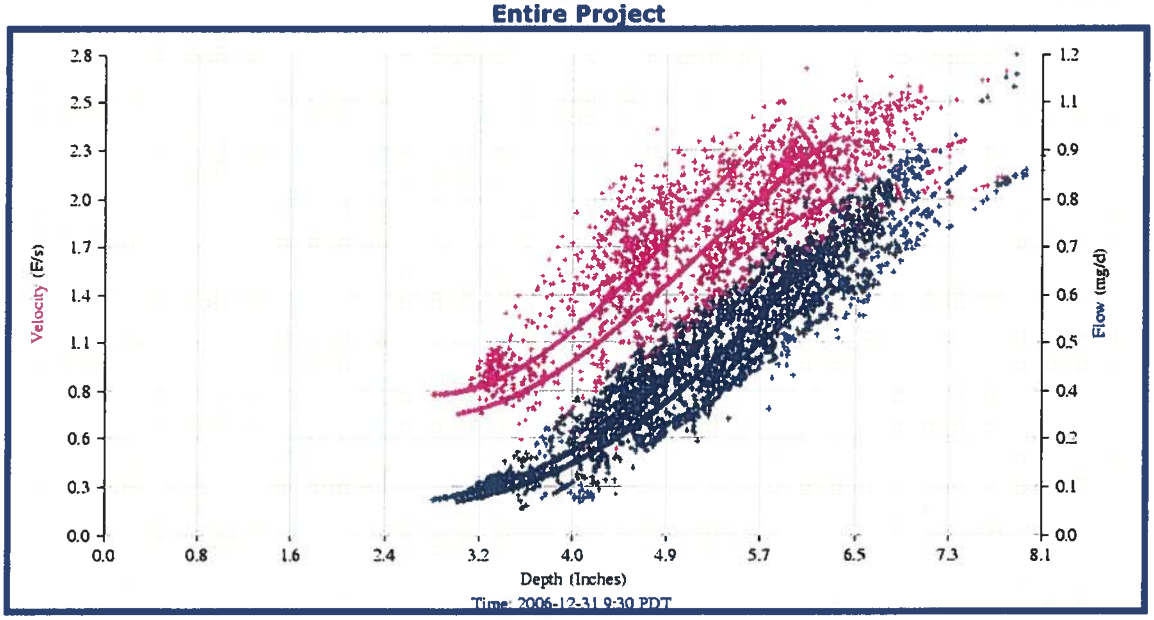
Line Graph: Depth, Velocity & Flow

February 15th, 2007 to March 7th, 2007

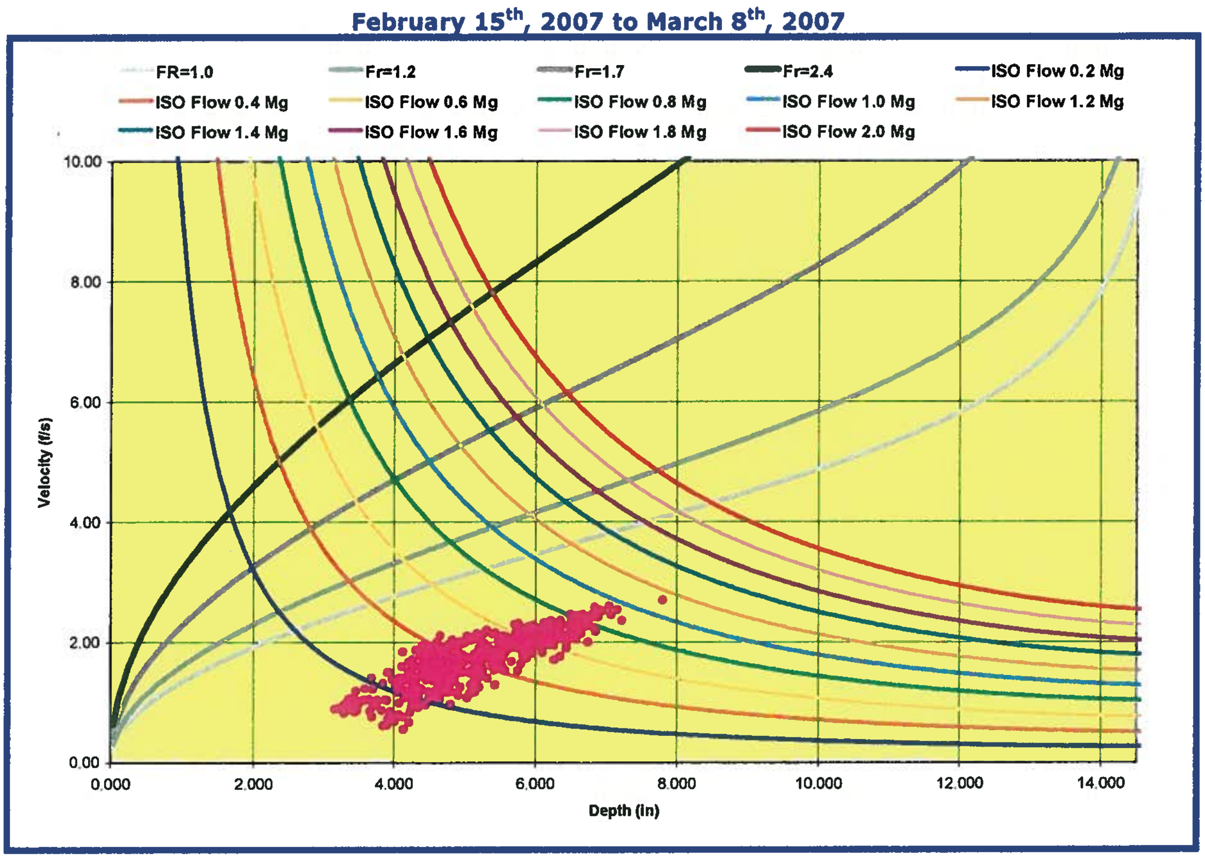


Scatter Plot: Depth & Flow vs. Depth

Entire Project



Hydraulic Analysis

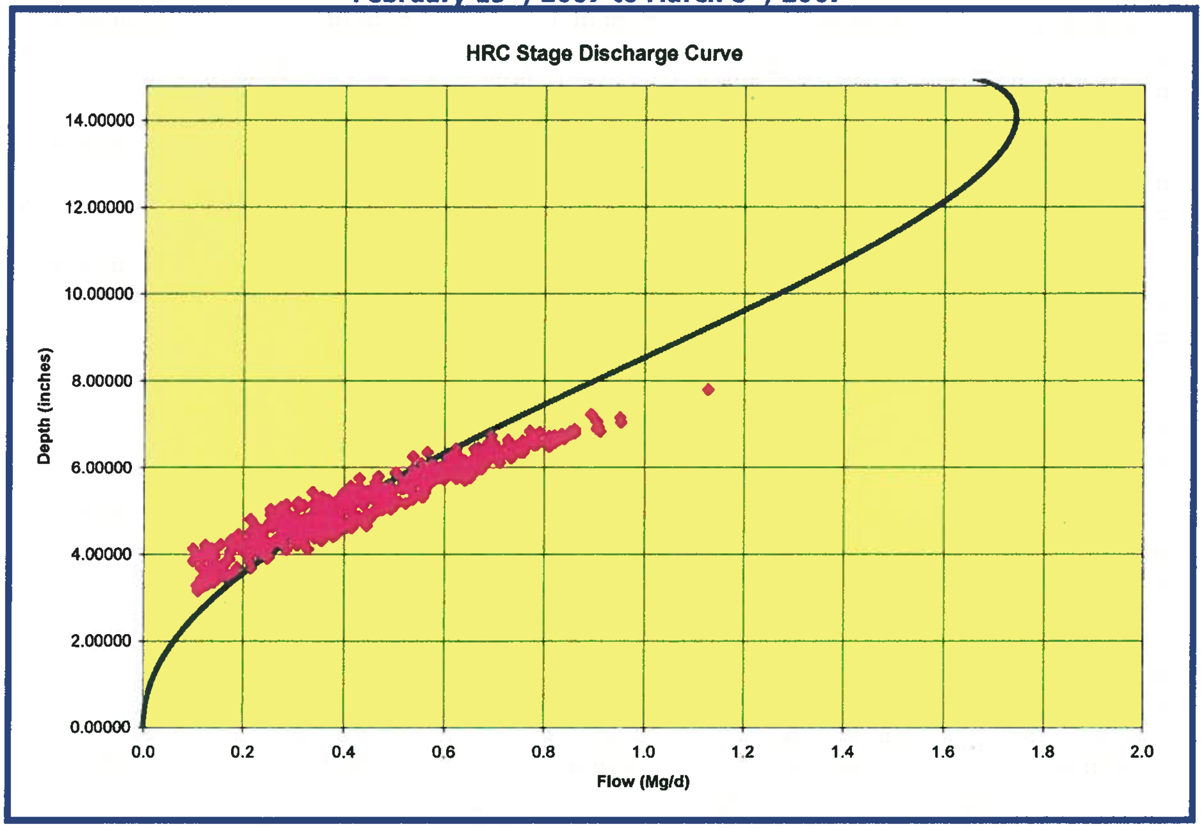


The plot above is a scatter plot of velocity vs. depth overlaid on our **GEO*grid*** hydraulic analysis chart. The hydraulic conditions are represented by the Froude lines in shades of grey and ISO flow regimes represented by the rainbow of colors. Data below the FR=1.0 line indicates laminar flow that is sub-critical and ideal for monitoring. Hydraulic conditions above the FR=1.0 (higher Froude number) begin to deteriorate as flow becomes turbulent and unstable. A Froude number greater than FR=2.4 represents turbulent flow that is unsuitable for monitoring.

The analysis shows that the data collected at this location to be stable. The data collected during this period shows that all the data falls under the Fr=1 region indicating that flow is ideal for monitoring.

Pipe Performance & Stage Discharge Analysis

February 15th, 2007 to March 8th, 2007

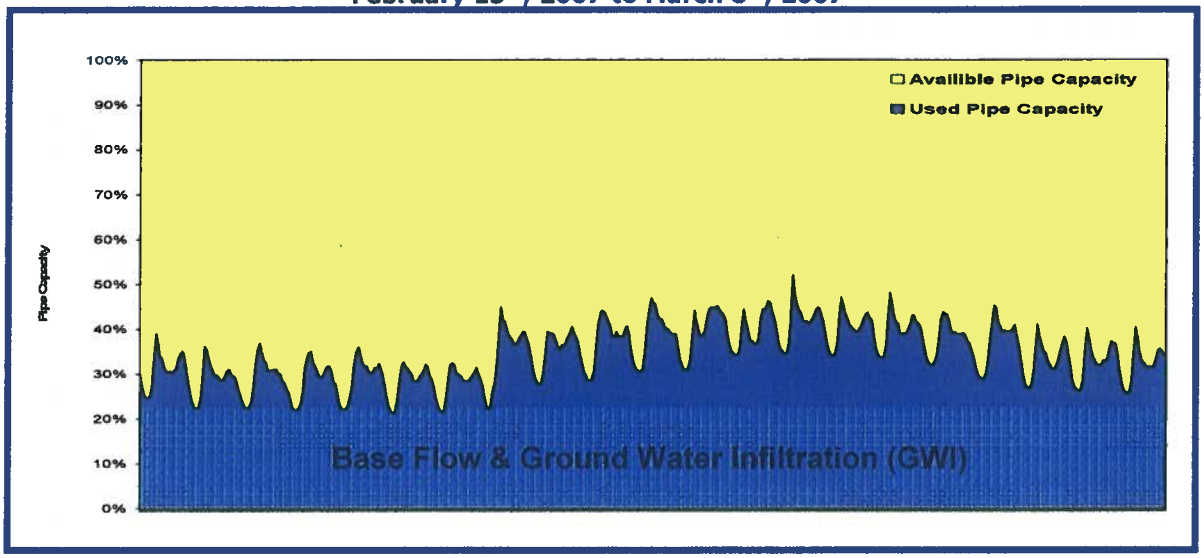


The plot above is a scatter plot of depth vs. flow overlaid on our **HRC** (Hydraulic Rating Coefficient) Pipe Performance chart. The HRC Pipe Performance chart illustrates the Actual Pipe Performance derived from the monitoring process.

This design curves is based upon Hydraulic Rating Coefficient (HRC) determined from field profiling and monitor data. For this 15 inch pipe the maximum design flow rate is 1.74 Mg/d which occurs at a depth of 14 inches and an average HRC value of 2.982.

Capacity & Rainfall Derived Inflow & Infiltration Analysis

February 15th, 2007 to March 8th, 2007



The monitoring period was conducted during both dry and wet weather conditions; thereby producing typical daily flow patterns as a result of residential, commercial or industrial sources in addition to increased flows derived from inflow and infiltration. The analysis is a good representation of typical daily flow regimes resulting from base flow and ground water infiltration. Comparing these typical daily flows to flows during and after storm events provides a good understanding of the current capacity in the system as well as illustrating the presence of inflow and infiltration. The following details the results of the minimum, maximum and average measured capacity.

Summary Statistics

	Inches	% of Pipe Size
Minimum Depth	3.16	21%
Maximum Depth	7.80	52%
Average Depth	5.13	35%

The plot above illustrates both typical diurnal capacity demand as well as the impact of various storm events on the collection system. The shaded portion of the plot illustrates this typical capacity need resulting from the presence of base flow and natural permeation of the sewer to ambient moisture. The dark purple region illustrates capacity demand resulting from storm events. The rapid increase in flow is the result of the presence of inflow upstream of this location. Inflow is the result of rainfall directly entering the sewer system often resulting from poor manhole seals or illegal connections.

Average maximum daily capacity was measured to be 0.44 Mg/d and the **maximum peak flow rate measured to be 1.13 Mg/d**.

Based on our monitoring program the following ratio was determined:

$$\text{Maximum Peaking Factor} = \frac{\text{Maximum Flow}}{\text{Average Flow}} = \frac{1.13\ \text{Mg/d}}{0.44\ \text{Mg/d}} = 2.57$$

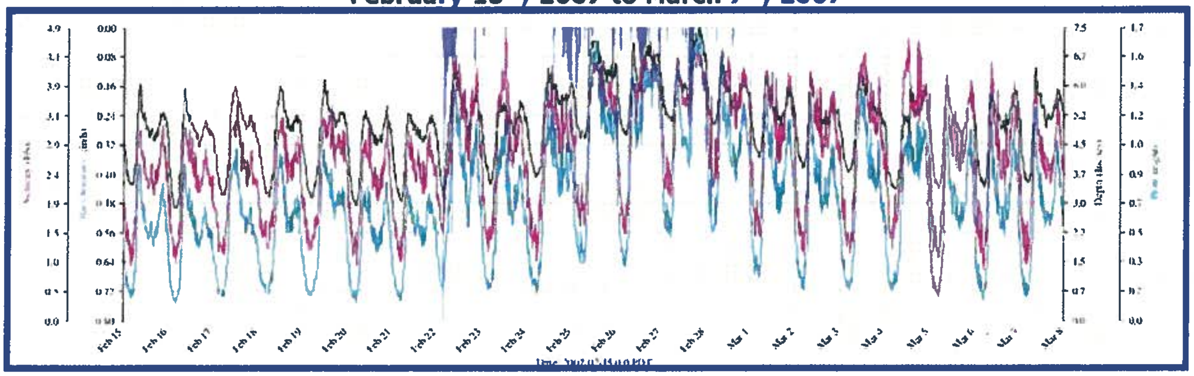
Summary Statistics

	Depth (Inches)					Velocity (f/s)					Flow (Mg/d)				
TimeStamp (PDT)	Average	Min	at	Max	at	Average	Min	at	Max	at	Average	Min	at	Max	at
02/15/07	4.660	3.633	05:10	6.114	08:45	1.693	0.573	05:00	2.693	10:35	0.370	0.090	05:00	0.722	08:45
02/16/07	4.328	3.265	05:10	5.696	08:45	1.708	0.723	05:00	2.529	11:50	0.338	0.099	05:00	0.631	09:00
02/17/07	4.359	3.281	04:45	5.863	11:19	1.623	0.805	02:25	2.625	11:04	0.326	0.110	04:15	0.673	11:04
02/18/07	4.300	3.195	05:54	5.352	12:14	1.478	0.614	02:19	2.542	14:39	0.293	0.093	02:19	0.599	10:49
02/19/07	4.374	3.202	04:39	5.854	12:14	1.422	0.660	01:59	2.528	15:19	0.286	0.096	06:59	0.601	10:54
02/20/07	4.239	3.116	04:44	5.181	20:54	1.396	0.424	01:14	2.316	08:09	0.269	0.065	01:14	0.530	20:44
02/21/07	4.213	3.153	04:44	5.095	09:14	1.372	0.492	01:49	2.403	18:24	0.260	0.071	01:49	0.512	09:34
02/22/07	5.200	3.179	04:09	6.908	09:29	1.748	0.636	01:39	2.742	20:09	0.454	0.081	03:44	0.915	09:34
02/23/07	5.321	4.042	05:09	6.485	15:39	1.582	0.328	04:29	2.857	08:24	0.418	0.058	04:29	0.830	08:24
02/24/07	5.560	4.153	05:39	7.022	11:04	1.809	0.810	06:19	2.774	11:34	0.508	0.155	06:09	0.930	11:34
02/25/07	5.799	4.485	06:54	7.095	11:44	2.035	0.262	19:24	3.252	19:29	0.598	0.077	19:24	1.087	12:29
02/26/07	5.927	4.538	05:09	7.058	19:33	2.024	0.855	03:54	2.913	18:38	0.612	0.177	03:54	1.036	18:38
02/27/07	5.975	5.038	05:08	7.147	20:23	2.042	1.017	05:03	2.880	18:03	0.615	0.241	05:03	1.005	18:03
02/28/07	6.238	5.121	04:28	7.972	08:43	2.068	0.960	01:58	2.919	08:28	0.661	0.252	01:58	1.228	08:28
03/01/07	6.049	5.001	04:43	7.272	08:48	1.928	0.870	03:38	2.792	21:38	0.589	0.207	03:38	0.974	08:48
03/02/07	5.979	4.967	04:48	7.500	08:38	1.845	0.756	04:23	2.535	08:53	0.555	0.174	04:23	0.977	08:53
03/03/07	5.696	4.744	05:08	6.800	10:03	1.829	0.536	05:43	2.781	10:08	0.521	0.117	05:43	0.936	10:53
03/04/07	5.544	4.273	05:18	7.076	11:33	1.867	0.478	05:43	2.820	15:28	0.520	0.090	05:43	0.949	12:08
03/05/07	4.989	3.924	04:53	6.335	08:48	1.571	0.379	04:53	2.435	09:03	0.379	0.063	04:53	0.747	09:03
03/06/07	4.918	3.862	05:23	6.351	08:38	1.557	0.495	04:13	2.435	08:23	0.370	0.081	04:13	0.751	08:28
03/07/07	4.821	3.744	04:27	6.239	08:32	1.461	0.446	04:32	2.396	08:32	0.338	0.072	04:32	0.748	08:32
Average	**5.17**	**4.00**	**N/A**	**6.50**	**N/A**	**1.72**	**0.62**	**N/A**	**2.67**	**N/A**	**0.44**	**0.12**	**N/A**	**0.83**	**N/A**

Site 3

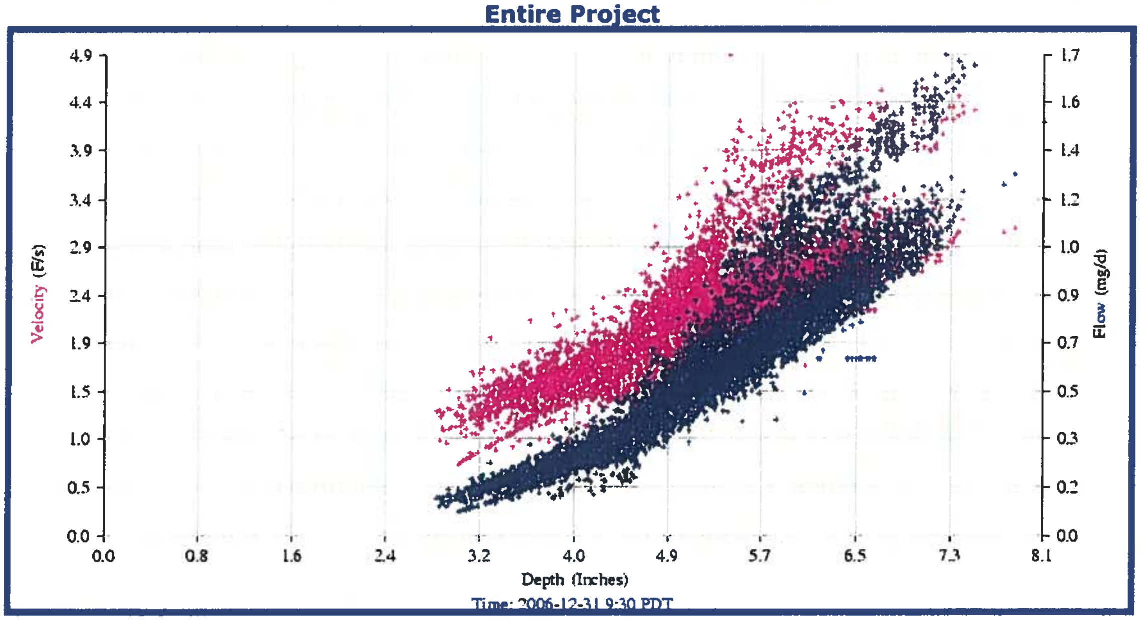
Line Graph: Depth, Velocity & Flow

February 15th, 2007 to March 7th, 2007



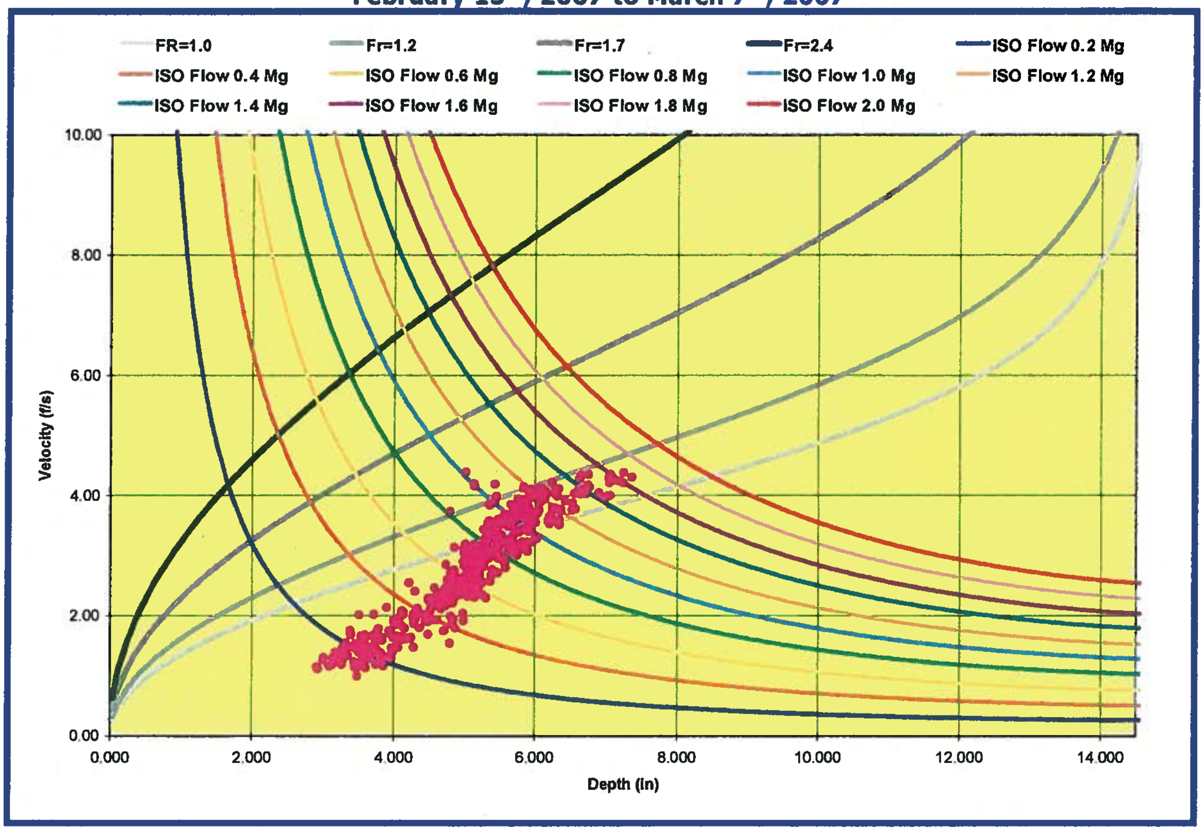
Scatter Plot: Depth & Flow vs. Depth

Entire Project



Hydraulic Analysis

February 15th, 2007 to March 7th, 2007

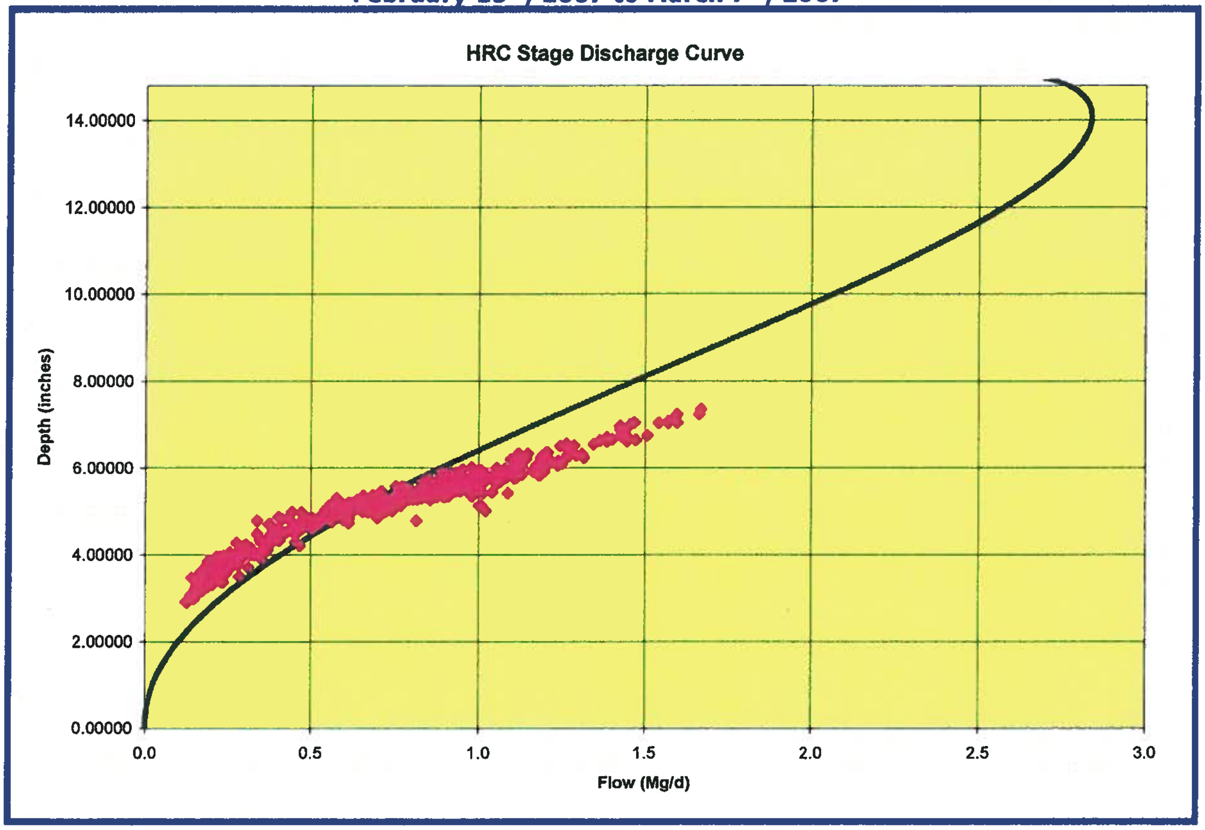


The plot above is a scatter plot of velocity vs. depth overlaid on our ***GEOgrid*** hydraulic analysis chart. The hydraulic conditions are represented by the Froude lines in shades of grey and ISO flow regimes represented by the rainbow of colors. Data below the FR=1.0 line indicates laminar flow that is sub-critical and ideal for monitoring. Hydraulic conditions above the FR=1.0 (higher Froude number) begin to deteriorate as flow becomes turbulent and unstable. A Froude number greater than FR=2.4 represents turbulent flow that is unsuitable for monitoring.

The analysis shows that the data collected at this location to be relatively stable. The data collected during this period shows that a large portion of the flow is in the Fr=1.2 region indicating that flow is straying away from laminar condition by the presence of ripples and waves in the flow. Overall, data collection was successful at this location.

Pipe Performance & Stage Discharge Analysis

February 15th, 2007 to March 7th, 2007

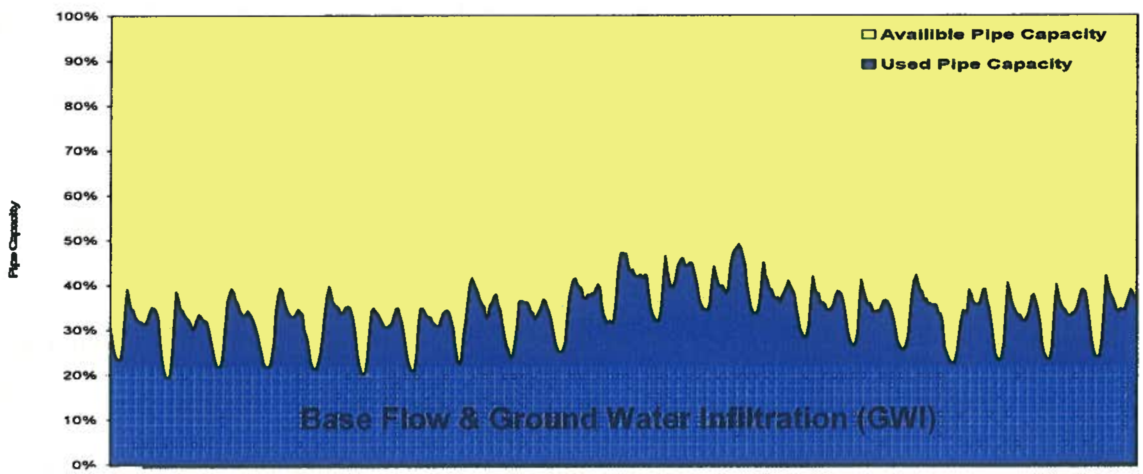


The plot above is a scatter plot of depth vs. flow overlaid on our **HRC** (Hydraulic Rating Coefficient) Pipe Performance chart. The HRC Pipe Performance chart illustrates the Actual Pipe Performance derived from the monitoring process.

This design curves is based upon Hydraulic Rating Coefficient (HRC) determined from field profiling and monitor data. For this 15 inch pipe the maximum design flow rate is 2.83 Mg/d which occurs at a depth of 14 inches and an average HRC value of 4.855.

Capacity & Rainfall Derived Inflow & Infiltration Analysis

February 15th, 2007 to March 7th, 2007



The monitoring period was conducted during both dry and wet weather conditions; thereby producing typical daily flow patterns as a result of residential, commercial or industrial sources in addition to increased flows derived from inflow and infiltration. The analysis is a good representation of typical daily flow regimes resulting from base flow and ground water infiltration. Comparing these typical daily flows to flows during and after storm events provides a good understanding of the current capacity in the system as well as illustrating the presence of inflow and infiltration. The following details the results of the minimum, maximum and average measured capacity.

Summary Statistics

	Inches	% of Pipe Size
Minimum Depth	2.91	19%
Maximum Depth	7.36	49%
Average Depth	5.08	34%

The plot above illustrates both typical diurnal capacity demand as well as the impact of various storm events on the collection system. The shaded portion of the plot illustrates this typical capacity need resulting from the presence of base flow and natural permeation of the sewer to ambient moisture. The dark purple region illustrates capacity demand resulting from storm events. The rapid increase in flow is the result of the presence of inflow upstream of this location. Inflow is the result of rainfall directly entering the sewer system often resulting from poor manhole seals or illegal connections.

Average maximum daily capacity was measured to be 0.71 Mg/d and the **maximum peak flow rate measured to be 1.67 Mg/d**.

Based on our monitoring program the following ratio was determined:

$$\text{Maximum Peaking Factor} = \frac{\text{Maximum Flow}}{\text{Average Flow}} = \frac{1.67\ \text{Mg/d}}{0.71\ \text{Mg/d}} = 2.35$$

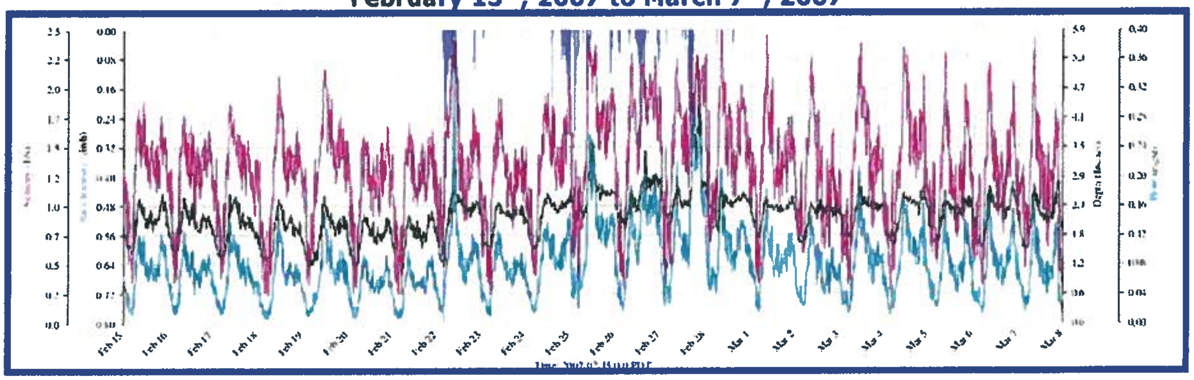
Summary Statistics

	Depth (Inches)					Velocity (f/s)					Flow (Mg/d)				
TimeStamp (PDT)	Average	Min	at	Max	at	Average	Min	at	Max	at	Average	Min	at	Max	at
02/15/07	4.718	3.393	02:00	6.117	08:54	2.275	0.821	04:29	3.543	21:09	0.511	0.114	04:29	0.968	08:34
02/16/07	4.486	2.847	03:34	6.016	08:44	2.254	0.887	04:44	3.394	08:54	0.481	0.095	04:44	0.995	08:54
02/17/07	4.681	3.188	05:04	6.026	11:34	2.316	0.894	04:44	3.730	12:44	0.526	0.111	04:44	1.090	12:19
02/18/07	4.622	3.101	06:19	5.997	12:19	2.324	0.695	05:44	3.778	12:29	0.518	0.087	05:44	1.101	11:34
02/19/07	4.690	3.066	05:04	6.199	11:34	2.469	0.924	03:24	3.840	15:44	0.565	0.114	04:54	1.076	11:39
02/20/07	4.465	2.943	05:09	5.630	21:09	2.260	0.853	05:04	3.605	11:14	0.475	0.094	05:04	0.882	21:29
02/21/07	4.516	3.017	05:14	5.404	08:29	2.269	0.814	04:34	3.524	20:14	0.482	0.096	04:34	0.856	20:14
02/22/07	5.087	3.061	04:04	6.546	09:59	3.112	1.119	03:14	4.873	21:04	0.781	0.148	03:14	1.618	09:59
02/23/07	4.865	3.463	04:39	5.646	20:03	2.755	0.729	05:29	4.987	12:28	0.646	0.107	05:29	1.273	12:28
02/24/07	5.215	3.599	04:58	6.560	11:08	2.773	0.687	05:18	4.555	13:08	0.727	0.105	05:18	1.338	13:08
02/25/07	5.997	4.567	07:08	7.411	13:18	3.245	1.379	06:33	4.805	14:38	1.009	0.295	06:33	1.785	13:08
02/26/07	6.080	4.656	05:18	7.221	17:48	3.435	1.225	04:13	4.960	19:18	1.078	0.268	04:13	1.726	14:43
02/27/07	6.184	5.041	05:18	7.594	19:53	3.617	1.711	05:03	5.132	17:58	1.147	0.404	05:03	1.871	17:58
02/28/07	5.727	4.836	03:03	7.017	08:38	3.559	1.983	04:03	4.990	12:08	1.005	0.473	04:03	1.679	08:33
03/01/07	5.268	4.108	04:58	6.480	08:38	3.078	1.071	05:33	4.786	11:38	0.794	0.197	04:48	1.358	08:58
03/02/07	5.069	3.871	04:33	6.469	08:48	2.892	0.952	04:33	4.426	20:03	0.713	0.154	04:33	1.362	08:33
03/03/07	5.086	3.726	04:43	6.581	11:03	2.943	0.850	05:18	5.135	12:53	0.745	0.136	05:18	1.495	12:53
03/04/07	4.795	3.316	05:57	6.159	13:52	3.074	0.990	03:12	4.919	23:17	0.723	0.143	03:27	1.451	13:52
03/05/07	4.853	3.346	04:37	6.366	08:57	2.700	0.531	03:57	4.199	22:22	0.640	0.076	03:57	1.326	08:57
03/06/07	4.911	3.400	04:37	6.171	08:47	2.632	0.584	04:47	4.695	20:47	0.637	0.080	04:47	1.374	08:42
03/07/07	5.036	3.491	04:47	6.624	08:47	2.493	0.579	03:42	4.127	08:37	0.621	0.084	03:42	1.348	08:37
Average	5.06	3.62	N/A	6.39	N/A	2.78	0.97	N/A	4.38	N/A	0.71	0.16	N/A	1.33	N/A

Site 4

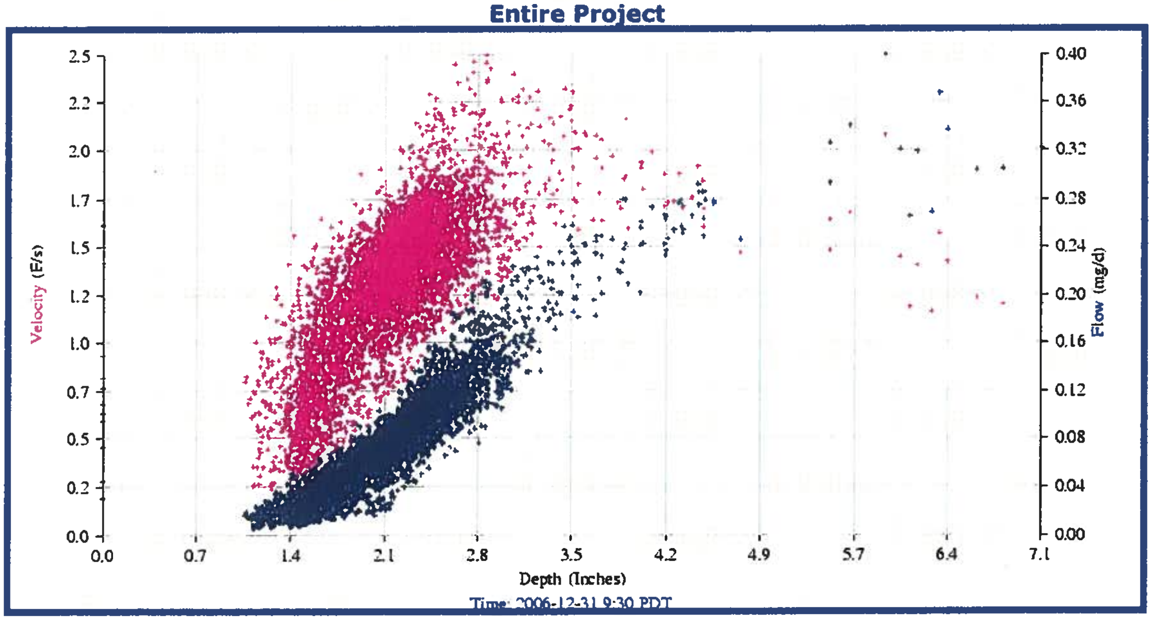
Line Graph: Depth, Velocity & Flow

February 15th, 2007 to March 7th, 2007

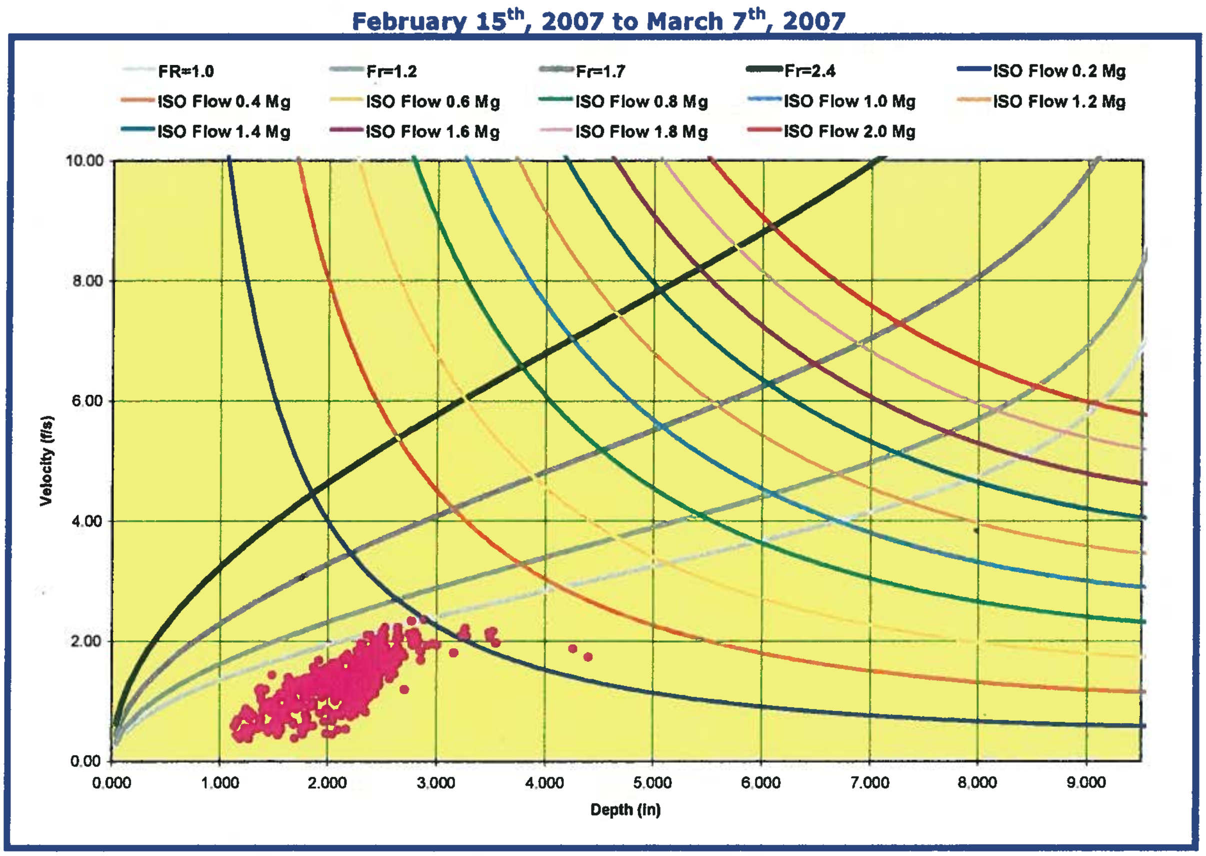


Scatter Plot: Depth & Flow vs. Depth

Entire Project



Hydraulic Analysis

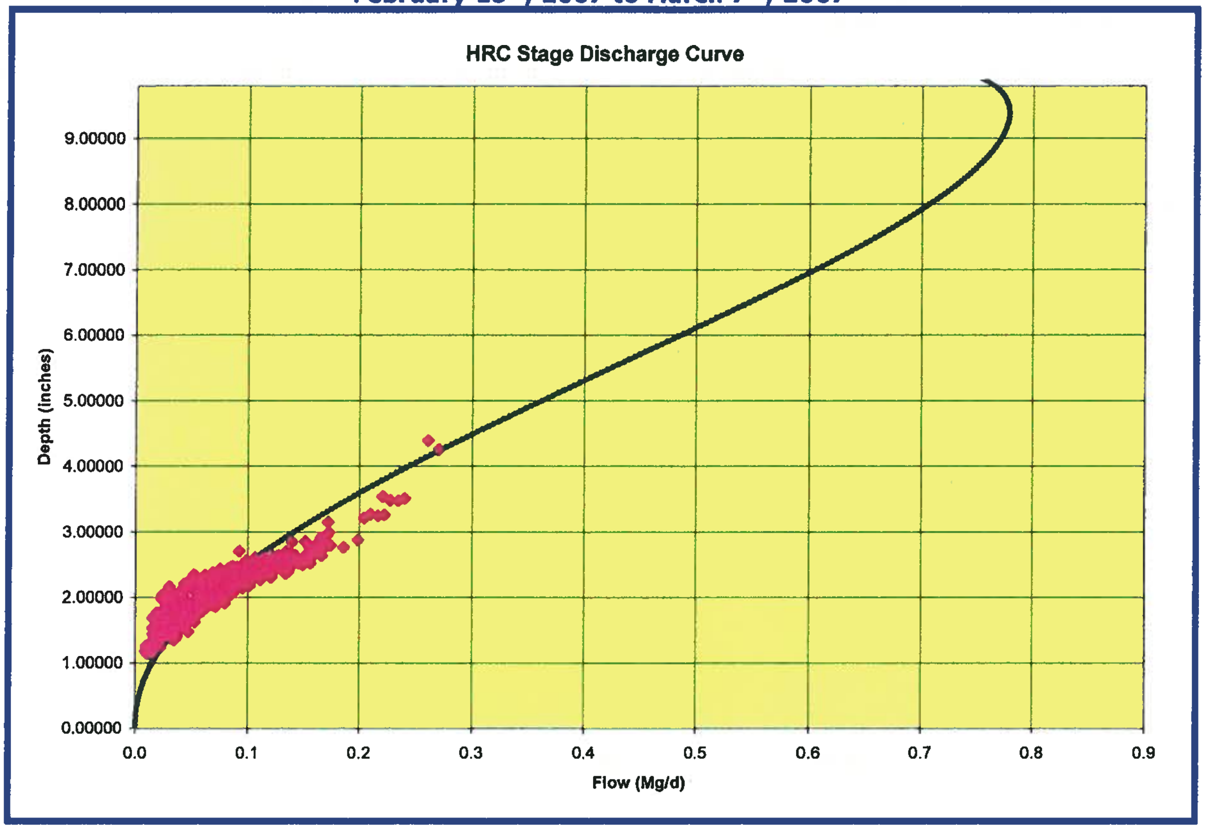


The plot above is a scatter plot of velocity vs. depth overlaid on our **GEO*grid*** hydraulic analysis chart. The hydraulic conditions are represented by the Froude lines in shades of grey and ISO flow regimes represented by the rainbow of colors. Data below the FR=1.0 line indicates laminar flow that is sub-critical and ideal for monitoring. Hydraulic conditions above the FR=1.0 (higher Froude number) begin to deteriorate as flow becomes turbulent and unstable. A Froude number greater than FR=2.4 represents turbulent flow that is unsuitable for monitoring.

The analysis shows that the data collected at this location to be stable. The data collected during this period shows that all the data falls under the Fr=1 region indicating that flow is ideal for monitoring; however, velocity is below recommended scouring velocity of 2.0 f/s. Overall, data collection was successful at this location.

Pipe Performance & Stage Discharge Analysis

February 15th, 2007 to March 7th, 2007

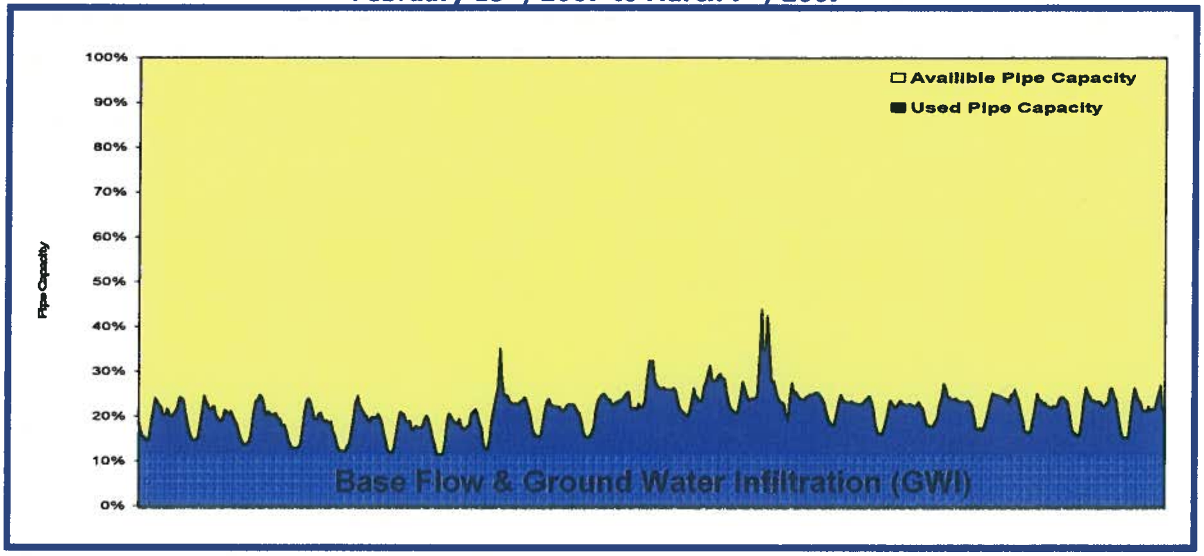


The plot above is a scatter plot of depth vs. flow overlaid on our **HRC** (Hydraulic Rating Coefficient) Pipe Performance chart. The HRC Pipe Performance chart illustrates the Actual Pipe Performance derived from the monitoring process.

This design curves is based upon Hydraulic Rating Coefficient (HRC) determined from field profiling and monitor data. For this 10 inch pipe the maximum design flow rate is 0.78 Mg/d which occurs at a depth of 9.4 inches and an average HRC value of 3.93.

Capacity & Rainfall Derived Inflow & Infiltration Analysis

February 15th, 2007 to March 7th, 2007



The monitoring period was conducted during both dry and wet weather conditions; thereby producing typical daily flow patterns as a result of residential, commercial or industrial sources in addition to increased flows derived from inflow and infiltration. The analysis is a good representation of typical daily flow regimes resulting from base flow and ground water infiltration. Comparing these typical daily flows to flows during and after storm events provides a good understanding of the current capacity in the system as well as illustrating the presence of inflow and infiltration. The following details the results of the minimum, maximum and average measured capacity.

Summary Statistics

	Inches	% of Pipe Size
Minimum Depth	1.13	11%
Maximum Depth	4.40	44%
Average Depth	2.15	22%

The plot above illustrates both typical diurnal capacity demand as well as the impact of various storm events on the collection system. The shaded portion of the plot illustrates this typical capacity need resulting from the presence of base flow and natural permeation of the sewer to ambient moisture. The dark purple region illustrates capacity demand resulting from storm events. The rapid increase in flow is the result of the presence of inflow upstream of this location. Inflow is the result of rainfall directly entering the sewer system often resulting from poor manhole seals or illegal connections.

Average maximum daily capacity was measured to be 0.79 Mg/d and the **maximum peak flow rate measured to be 2.70 Mg/d**.

Based on our monitoring program the following ratio was determined:

$$\text{Maximum Peaking Factor} = \frac{\text{Maximum Flow}}{\text{Average Flow}} = \frac{2.70\ \text{Mg/d}}{0.79\ \text{Mg/d}} = 3.42$$

GEOTIVITY

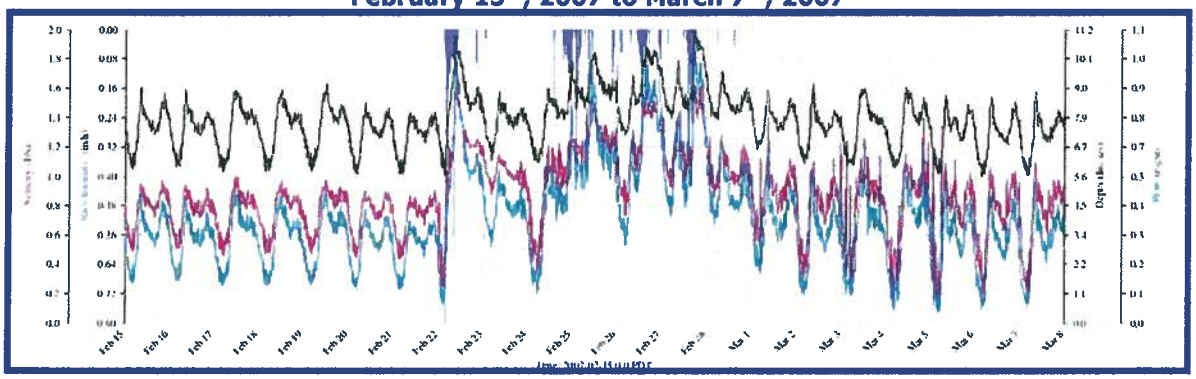
Summary Statistics

	Depth (Inches)					Velocity (f/s)					Flow (Mg/d)				
TimeStamp (PDT)	Average	Min	at	Max	at	Average	Min	at	Max	at	Average	Min	at	Max	at
02/15/07	3.865	2.713	03:13	5.101	08:28	0.520	0.099	04:53	0.917	08:33	0.081	0.022	03:13	0.170	08:28
02/16/07	4.514	2.925	02:48	5.960	08:18	0.525	0.101	04:53	0.974	08:53	0.130	0.030	02:48	0.258	08:18
02/17/07	4.110	2.908	05:03	5.573	10:58	0.569	0.036	05:58	1.099	11:08	0.096	0.029	05:03	0.216	10:58
02/18/07	3.818	2.458	05:12	5.519	11:07	0.589	0.111	06:12	1.125	11:37	0.081	0.015	05:12	0.211	11:07
02/19/07	3.904	2.503	04:02	5.266	10:42	0.620	0.093	04:53	1.074	11:17	0.086	0.016	04:02	0.186	10:42
02/20/07	3.646	2.292	03:52	4.973	09:02	0.533	0.193	03:47	0.905	09:12	0.069	0.011	03:52	0.159	09:02
02/21/07	3.595	2.378	03:22	4.619	09:47	0.516	0.079	03:47	0.823	21:07	0.065	0.013	03:22	0.129	09:47
02/22/07	4.399	2.309	03:22	5.751	21:02	0.702	0.139	03:37	1.292	09:17	0.122	0.011	03:22	0.235	21:02
02/23/07	4.598	3.498	04:47	5.621	08:12	0.578	0.136	03:42	0.890	09:02	0.131	0.055	04:47	0.221	08:12
02/24/07	4.732	3.254	05:32	6.090	12:22	0.643	0.176	05:12	1.012	12:42	0.146	0.043	05:32	0.273	12:22
02/25/07	5.334	3.911	05:32	6.668	11:42	0.798	0.169	06:27	1.404	11:42	0.200	0.079	05:32	0.344	11:42
02/26/07	5.567	4.119	04:02	6.592	15:32	0.878	0.297	03:12	1.358	15:32	0.222	0.092	04:02	0.334	15:32
02/27/07	5.555	4.620	05:22	6.494	19:12	0.886	0.536	01:52	1.329	20:52	0.218	0.129	05:22	0.322	19:12
02/28/07	5.295	4.474	04:06	6.469	08:26	0.784	0.460	02:06	1.209	08:36	0.191	0.118	04:06	0.319	08:26
03/01/07	5.023	3.948	04:06	6.187	08:36	0.701	0.351	04:21	1.127	08:41	0.167	0.081	04:06	0.284	08:36
03/02/07	4.847	3.721	04:56	6.162	08:31	0.664	0.415	01:36	1.126	08:36	0.152	0.068	04:56	0.282	08:31
03/03/07	4.926	3.618	05:06	6.448	10:16	0.673	0.212	05:36	1.092	11:06	0.162	0.062	05:06	0.316	10:16
03/04/07	4.998	3.543	05:06	6.594	11:02	0.685	0.203	03:31	1.156	11:02	0.170	0.058	05:06	0.335	11:02
03/05/07	4.799	3.490	04:41	6.423	08:41	0.614	0.268	04:51	1.092	08:41	0.150	0.055	04:41	0.313	08:41
03/06/07	4.827	3.588	05:16	6.286	08:36	0.601	0.151	03:36	0.949	09:21	0.151	0.060	05:16	0.296	08:36
03/07/07	4.823	3.523	03:46	6.340	21:16	0.575	0.228	04:46	0.988	08:31	0.152	0.057	03:46	0.303	21:16
Average	**4.63**	**3.32**	**N/A**	**5.96**	**N/A**	**0.65**	**0.21**	**N/A**	**1.09**	**N/A**	**0.14**	**0.05**	**N/A**	**0.26**	**N/A**

Site 5

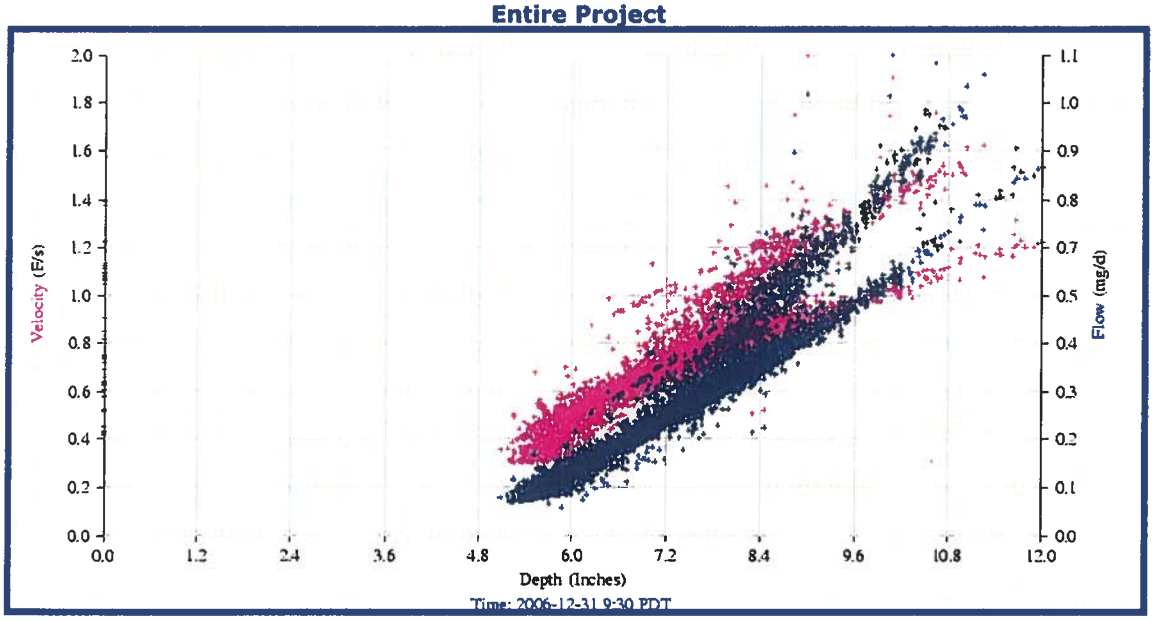
Line Graph: Depth, Velocity & Flow

February 15th, 2007 to March 7th, 2007



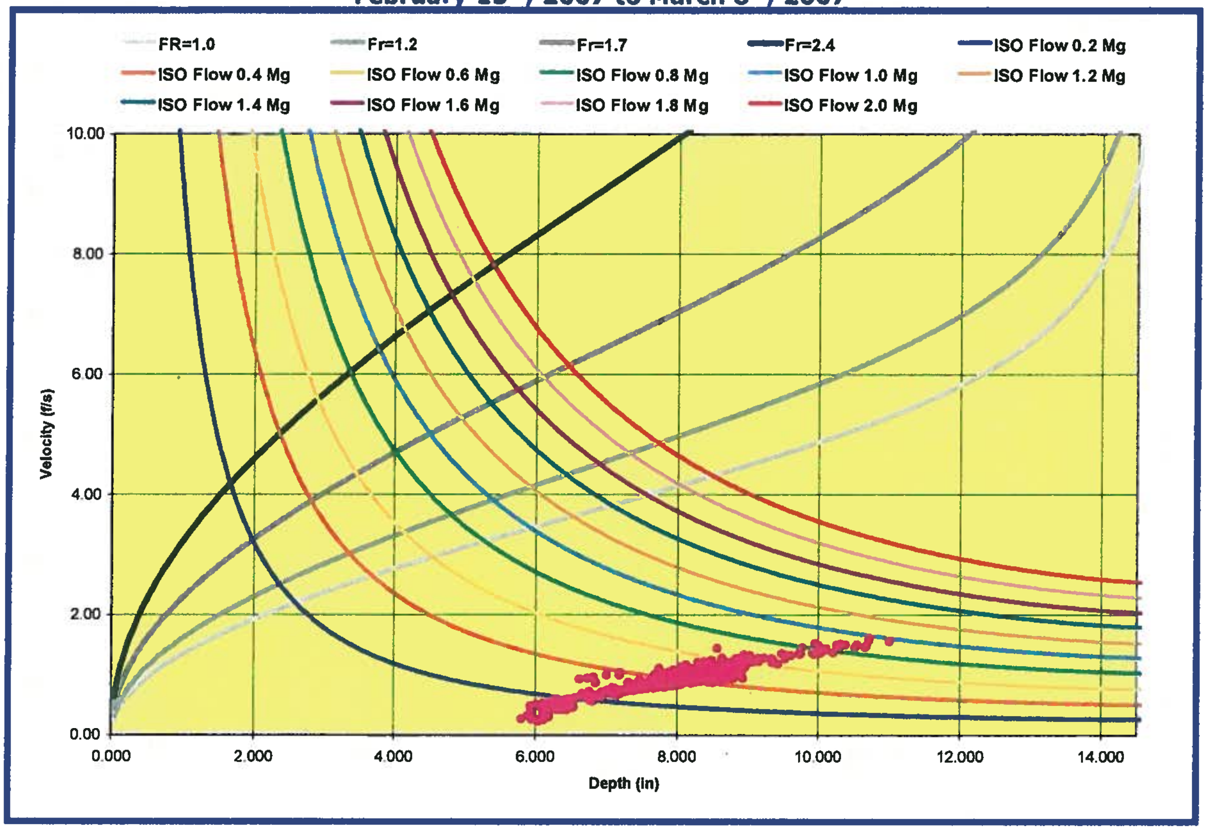
Scatter Plot: Depth & Flow vs. Depth

Entire Project



Hydraulic Analysis

February 15th, 2007 to March 8th, 2007

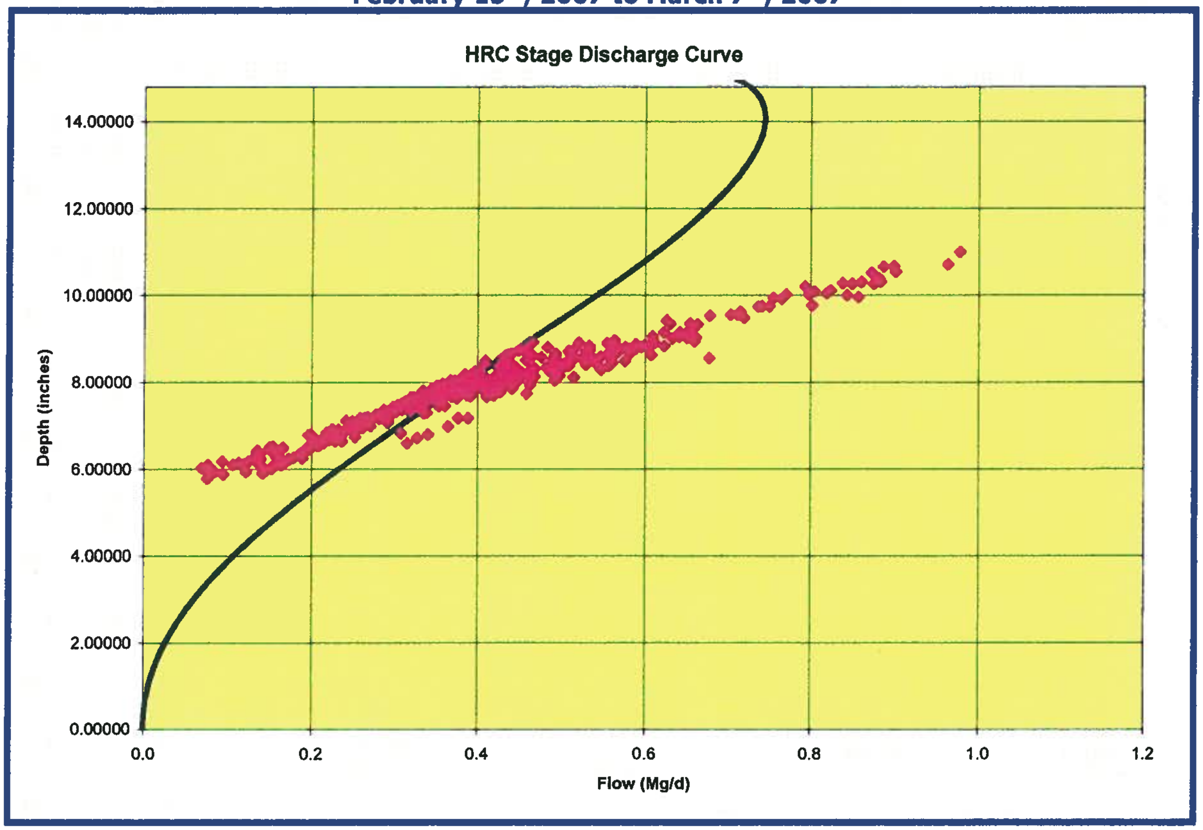


The plot above is a scatter plot of velocity vs. depth overlaid on our **GEO*grid*** hydraulic analysis chart. The hydraulic conditions are represented by the Froude lines in shades of grey and ISO flow regimes represented by the rainbow of colors. Data below the FR=1.0 line indicates laminar flow that is sub-critical and ideal for monitoring. Hydraulic conditions above the FR=1.0 (higher Froude number) begin to deteriorate as flow becomes turbulent and unstable. A Froude number greater than FR=2.4 represents turbulent flow that is unsuitable for monitoring.

The analysis shows that the data collected at this location to be stable. The data collected during this period shows that all the data falls under the Fr=1 region indicating that flow is ideal for monitoring; however, velocity is below recommended scouring velocity of 2.0 f/s. Overall, data collection was successful at this location.

Pipe Performance & Stage Discharge Analysis

February 15th, 2007 to March 7th, 2007

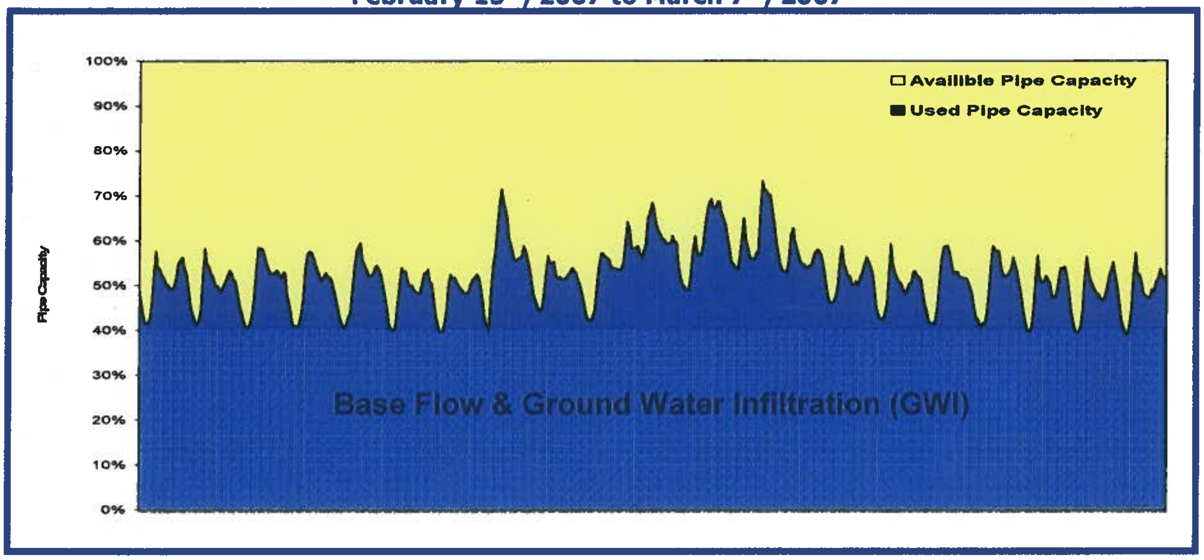


The plot above is a scatter plot of depth vs. flow overlaid on our **HRC** (Hydraulic Rating Coefficient) Pipe Performance chart. The HRC Pipe Performance chart illustrates the Actual Pipe Performance derived from the monitoring process.

This design curves is based upon Hydraulic Rating Coefficient (HRC) determined from field profiling and monitor data. For this 15 inch pipe the maximum design flow rate is 0.74 Mg/d which occurs at a depth of 14 inches and an average HRC value of 1.274.

Capacity & Rainfall Derived Inflow & Infiltration Analysis

February 15th, 2007 to March 7th, 2007



The monitoring period was conducted during both dry and wet weather conditions; thereby producing typical daily flow patterns as a result of residential, commercial or industrial sources in addition to increased flows derived from inflow and infiltration. The analysis is a good representation of typical daily flow regimes resulting from base flow and ground water infiltration. Comparing these typical daily flows to flows during and after storm events provides a good understanding of the current capacity in the system as well as illustrating the presence of inflow and infiltration. The following details the results of the minimum, maximum and average measured capacity.

Summary Statistics

	Inches	% of Pipe Size
Minimum Depth	5.79	39%
Maximum Depth	11.00	73%
Average Depth	7.82	52%

The plot above illustrates both typical diurnal capacity demand as well as the impact of various storm events on the collection system. The shaded portion of the plot illustrates this typical capacity need resulting from the presence of base flow and natural permeation of the sewer to ambient moisture. The dark purple region illustrates capacity demand resulting from storm events. The rapid increase in flow is the result of the presence of inflow upstream of this location. Inflow is the result of rainfall directly entering the sewer system often resulting from poor manhole seals or illegal connections.

Average maximum daily capacity was measured to be 0.387 Mg/d and the **maximum peak flow rate measured to be 0.977 Mg/d**.

Based on our monitoring program the following ratio was determined:

$$\text{Maximum Peaking Factor} = \frac{\text{Maximum Flow}}{\text{Average Flow}} = \frac{0.98\ \text{Mg/d}}{0.39\ \text{Mg/d}} = 2.51$$

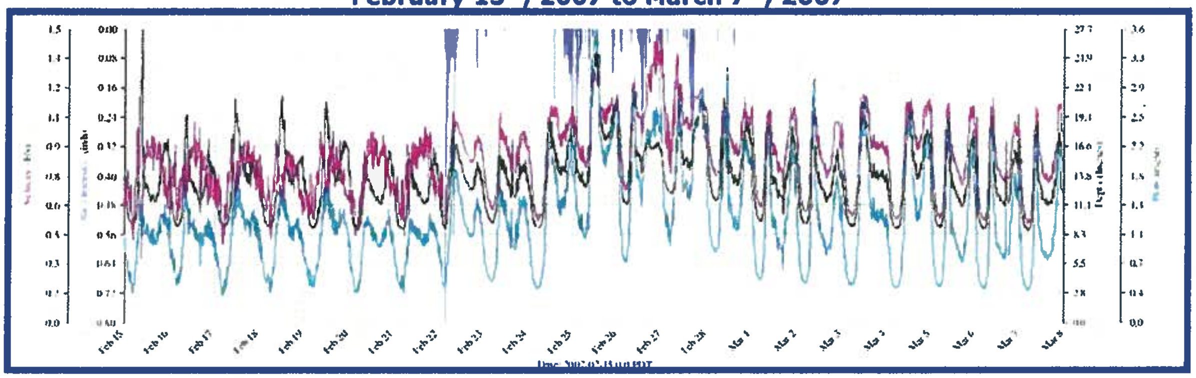
Summary Statistics

	Depth (Inches)					Velocity (f/s)					Flow (Mg/d)				
TimeStamp (PDT)	Average	Min	at	Max	at	Average	Min	at	Max	at	Average	Min	at	Max	at
02/15/07	7.525	5.560	04:25	9.507	08:36	0.788	0.462	04:25	0.981	20:10	0.320	0.124	04:25	0.502	08:36
02/16/07	7.445	5.610	04:35	9.165	08:25	0.768	0.474	04:35	0.985	08:15	0.307	0.128	04:35	0.483	08:25
02/17/07	7.518	5.422	05:40	9.182	11:45	0.768	0.435	05:40	1.019	12:45	0.314	0.112	05:40	0.497	12:40
02/18/07	7.467	5.487	04:55	9.314	12:10	0.760	0.449	06:15	1.021	12:00	0.308	0.118	06:15	0.514	12:00
02/19/07	7.537	5.595	04:35	9.605	12:04	0.780	0.475	04:10	0.995	11:54	0.320	0.131	04:10	0.516	12:04
02/20/07	7.285	5.411	04:09	8.583	08:49	0.745	0.411	04:09	0.932	21:14	0.291	0.106	04:09	0.433	19:44
02/21/07	7.204	5.383	03:24	8.476	10:39	0.731	0.418	03:24	0.928	22:04	0.281	0.107	03:24	0.419	22:04
02/22/07	8.493	5.343	03:34	11.142	09:19	1.119	0.142	03:04	1.860	09:34	0.544	0.037	03:04	1.143	09:34
02/23/07	7.685	6.002	04:19	9.191	08:19	1.024	0.751	23:49	1.171	08:19	0.421	0.263	04:19	0.597	08:19
02/24/07	7.779	5.733	06:29	10.189	23:49	0.920	0.250	05:29	1.412	23:54	0.397	0.071	05:29	0.807	23:54
02/25/07	9.118	7.793	02:04	10.736	11:59	1.277	1.005	06:54	2.179	10:39	0.647	0.420	06:54	1.232	10:39
02/26/07	8.986	6.838	05:39	10.796	16:49	1.225	0.715	04:49	1.628	14:39	0.622	0.261	04:49	0.970	16:14
02/27/07	9.201	7.516	05:09	11.479	17:44	1.260	0.925	04:39	2.105	14:14	0.651	0.382	04:39	1.093	14:14
02/28/07	8.455	7.421	05:49	9.857	08:24	1.056	0.851	04:39	1.388	01:34	0.489	0.343	04:39	0.718	08:24
03/01/07	7.757	6.274	02:38	9.163	08:38	0.890	0.463	04:33	1.553	08:38	0.373	0.152	02:18	0.788	08:38
03/02/07	7.466	5.793	04:23	9.328	08:43	0.785	0.169	04:23	1.496	23:23	0.318	0.048	04:23	0.637	23:23
03/03/07	7.559	5.601	06:38	9.300	10:23	0.816	0.263	05:53	1.456	12:18	0.339	0.071	05:53	0.748	12:18
03/04/07	7.562	5.442	04:33	9.442	11:28	0.805	0.103	04:33	1.716	20:18	0.339	0.027	04:33	0.827	20:18
03/05/07	7.332	5.469	03:08	8.999	08:13	0.745	0.119	05:33	1.542	06:13	0.298	0.032	04:23	0.592	06:13
03/06/07	7.209	5.296	03:58	8.834	08:33	0.728	0.121	03:58	1.159	07:58	0.285	0.030	03:58	0.540	07:58
03/07/07	7.220	5.438	04:18	9.180	08:33	0.730	0.110	03:33	1.130	08:18	0.287	0.028	03:33	0.556	08:33
Average	7.80	5.93	N/A	9.59	N/A	0.89	0.43	N/A	1.36	N/A	0.39	0.14	N/A	0.70	N/A

Site 6

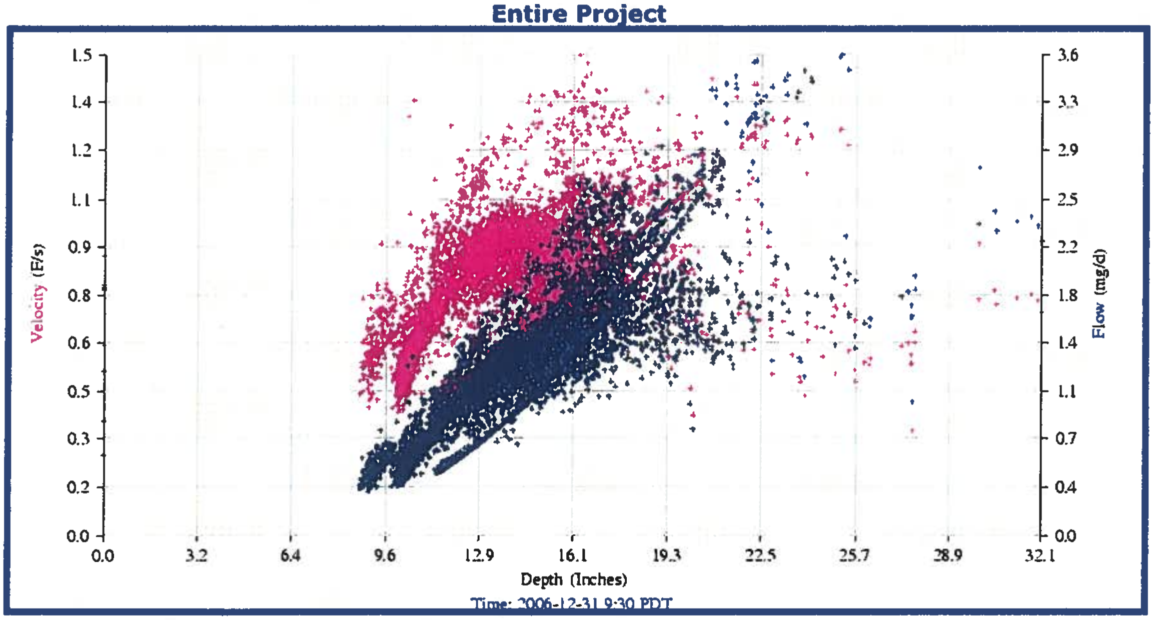
Line Graph: Depth, Velocity & Flow

February 15th, 2007 to March 7th, 2007

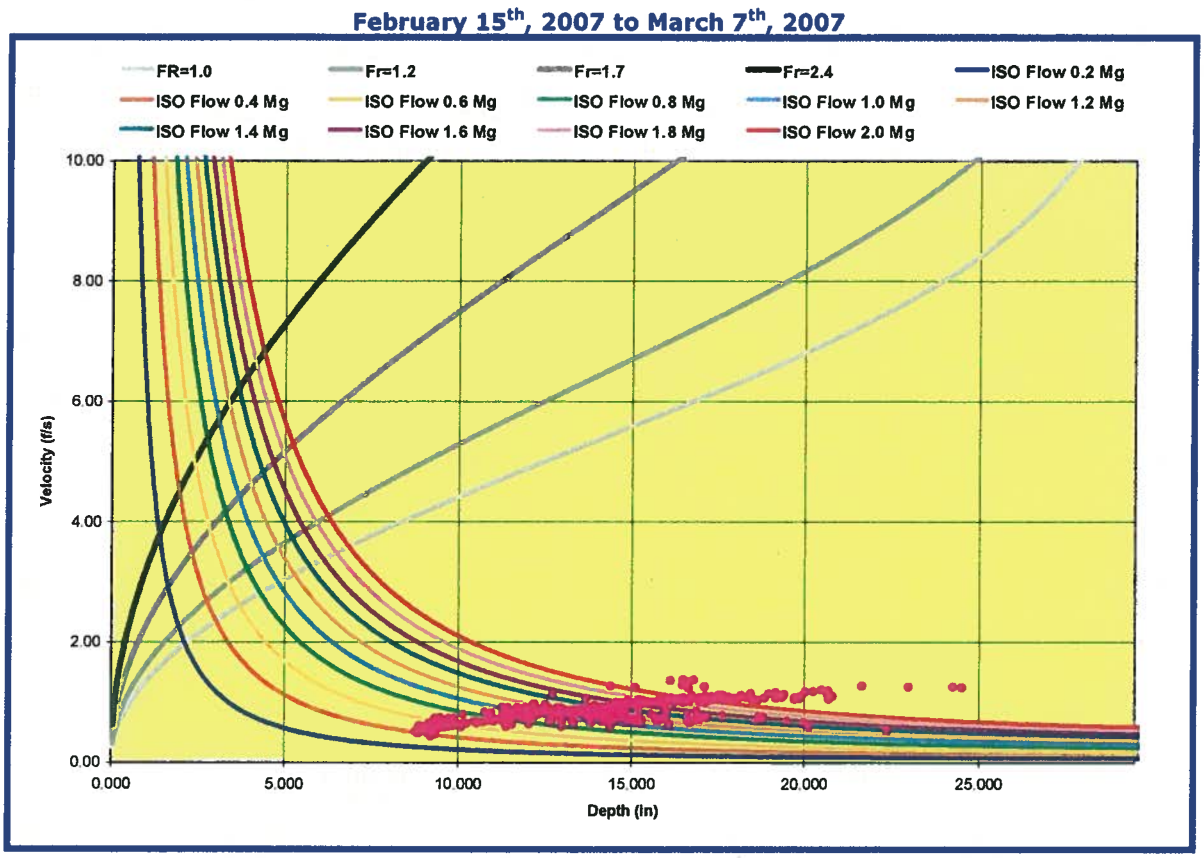


Scatter Plot: Depth & Flow vs. Depth

Entire Project



Hydraulic Analysis

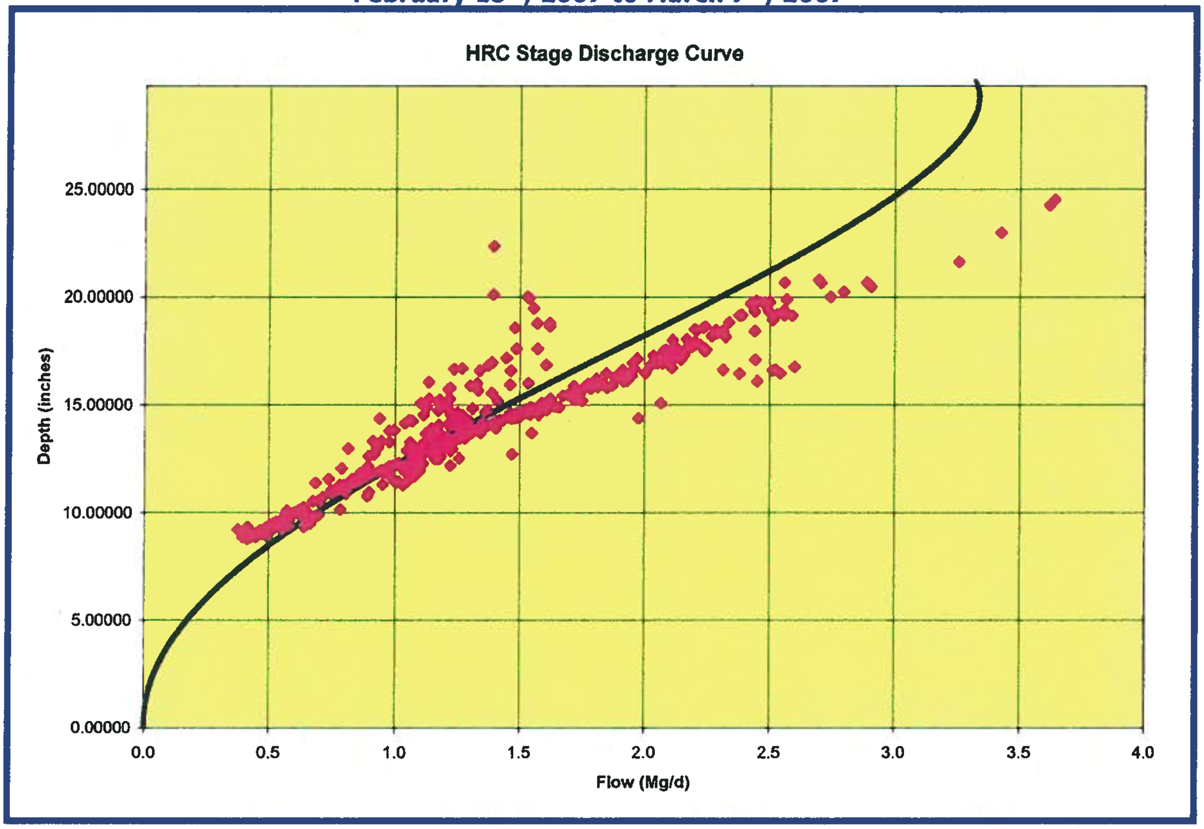


The plot above is a scatter plot of velocity vs. depth overlaid on our **GEO*grid*** hydraulic analysis chart. The hydraulic conditions are represented by the Froude lines in shades of grey and ISO flow regimes represented by the rainbow of colors. Data below the FR=1.0 line indicates laminar flow that is sub-critical and ideal for monitoring. Hydraulic conditions above the FR=1.0 (higher Froude number) begin to deteriorate as flow becomes turbulent and unstable. A Froude number greater than FR=2.4 represents turbulent flow that is unsuitable for monitoring.

The analysis shows that the data collected at this location to be stable. The data collected during this period shows that all the data falls under the Fr=1 region indicating that flow is ideal for monitoring; however, velocity is below recommended scouring velocity of 2.0 f/s. Overall, data collection was successful at this location.

Pipe Performance & Stage Discharge Analysis

February 15th, 2007 to March 7th, 2007

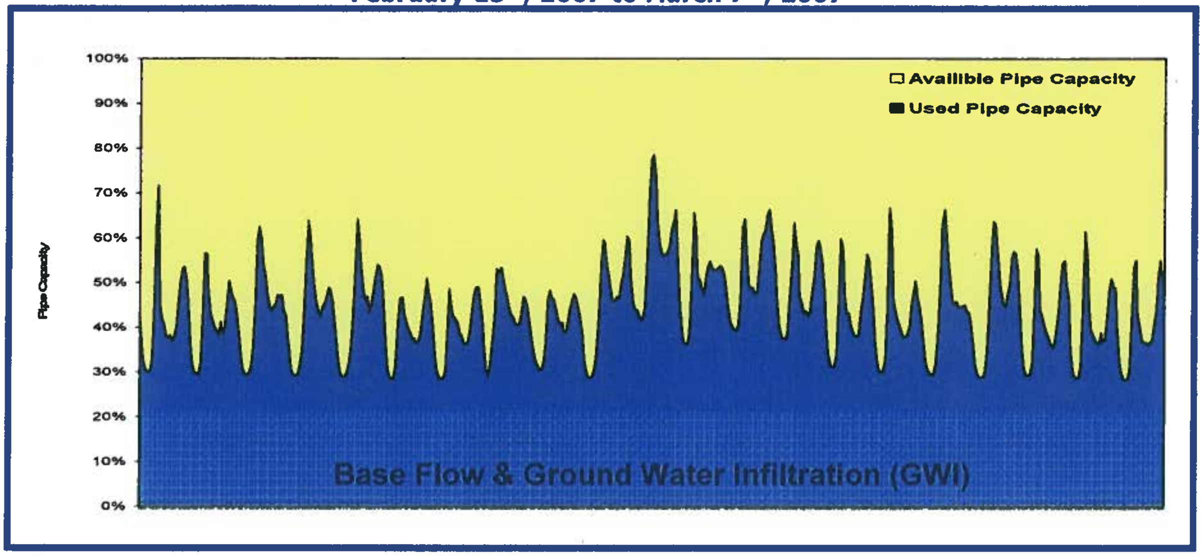


The plot above is a scatter plot of depth vs. flow overlaid on our **HRC** (Hydraulic Rating Coefficient) Pipe Performance chart. The HRC Pipe Performance chart illustrates the Actual Pipe Performance derived from the monitoring process.

This design curves is based upon Hydraulic Rating Coefficient (HRC) determined from field profiling and monitor data. For this 30 inch pipe the maximum design flow rate is 3.34 Mg/d which occurs at a depth of 29.3 inches and an average HRC value of 0.812.

Capacity & Rainfall Derived Inflow & Infiltration Analysis

February 15th, 2007 to March 7th, 2007



The monitoring period was conducted during both dry and wet weather conditions; thereby producing typical daily flow patterns as a result of residential, commercial or industrial sources in addition to increased flows derived from inflow and infiltration. The analysis is a good representation of typical daily flow regimes resulting from base flow and ground water infiltration. Comparing these typical daily flows to flows during and after storm events provides a good understanding of the current capacity in the system as well as illustrating the presence of inflow and infiltration. The following details the results of the minimum, maximum and average measured capacity.

Summary Statistics

	Inches	% of Pipe Size
Minimum Depth	8.79	28%
Maximum Depth	24.51	79%
Average Depth	13.76	44%

The plot above illustrates both typical diurnal capacity demand as well as the impact of various storm events on the collection system. The shaded portion of the plot illustrates this typical capacity need resulting from the presence of base flow and natural permeation of the sewer to ambient moisture. The dark purple region illustrates capacity demand resulting from storm events. The rapid increase in flow is the result of the presence of inflow upstream of this location. Inflow is the result of rainfall directly entering the sewer system often resulting from poor manhole seals or illegal connections.

Average maximum daily capacity was measured to be 1.30 Mg/d and the **maximum peak flow rate measured to be 3.64 Mg/d**.

Based on our monitoring program the following ratio was determined:

$$\text{Maximum Peaking Factor} = \frac{\text{Maximum Flow}}{\text{Average Flow}} = \frac{3.64\ \text{Mg/d}}{1.30\ \text{Mg/d}} = 2.8$$

Summary Statistics

	Depth (Inches)					Velocity (f/s)					Flow (Mg/d)				
TimeStamp (PDT)	Average	Min	at	Max	at	Average	Min	at	Max	at	Average	Min	at	Max	at
02/15/07	13.267	9.218	04:04	28.896	09:23	0.751	0.140	09:18	1.063	06:49	0.999	0.337	04:49	2.270	09:13
02/16/02	12.904	9.094	04:13	20.043	09:03	0.770	0.035	16:43	1.223	16:13	1.008	0.068	16:43	1.862	08:38
02/17/07	13.551	8.919	05:18	21.310	10:53	0.743	0.384	04:48	1.128	20:53	1.056	0.307	04:48	1.959	12:08
02/18/07	13.468	8.995	05:48	21.716	11:48	0.720	0.395	06:18	1.102	00:28	1.008	0.316	06:18	1.836	12:08
02/19/07	13.665	8.875	05:33	21.311	11:33	0.732	0.447	04:18	1.080	03:18	1.044	0.351	04:18	2.044	11:43
02/20/07	12.322	8.706	04:43	16.663	08:03	0.755	0.397	03:38	1.091	14:18	0.943	0.310	03:38	1.556	09:13
02/21/07	12.199	8.724	05:38	17.007	08:08	0.771	0.387	05:33	1.260	06:53	0.943	0.298	05:33	1.457	08:48
02/22/07	13.377	8.831	03:53	19.311	07:58	0.853	0.525	03:53	1.111	07:33	1.204	0.409	03:53	2.375	07:58
02/23/07	12.604	9.296	04:53	15.980	08:42	0.821	0.570	04:53	1.111	08:42	1.073	0.477	04:53	1.909	08:42
02/24/07	13.851	8.776	05:22	20.122	23:27	0.875	0.520	05:22	1.186	23:52	1.339	0.402	05:22	2.519	23:52
02/25/07	17.768	12.687	06:42	25.976	12:22	1.044	0.793	06:42	1.407	10:22	2.093	1.013	06:42	3.791	11:47
02/26/07	15.587	11.022	05:12	21.719	08:42	1.092	0.655	04:17	1.573	23:37	1.872	0.714	05:12	3.034	08:42
02/27/07	16.244	12.094	05:42	22.944	09:02	1.090	0.623	05:17	1.575	08:17	1.928	0.750	05:17	3.128	09:07
02/28/07	15.099	11.455	04:57	24.834	11:02	0.946	0.751	04:57	1.167	20:32	1.546	0.836	04:57	3.185	11:02
03/01/07	13.565	8.887	17:07	19.963	08:57	0.866	0.531	17:07	1.116	08:27	1.263	0.417	17:07	2.472	08:52
03/02/07	13.127	9.206	04:57	23.716	09:07	0.845	0.561	04:57	1.137	09:02	1.185	0.464	04:57	3.059	09:07
03/03/07	13.613	9.050	05:22	21.760	11:22	0.854	0.546	05:22	1.196	09:52	1.268	0.441	05:22	2.789	11:22
03/04/07	14.081	8.861	04:42	21.263	12:27	0.880	0.528	04:42	1.197	13:42	1.386	0.414	04:42	2.711	12:27
03/05/07	12.865	8.950	05:02	20.388	08:57	0.825	0.537	05:02	1.191	21:47	1.137	0.426	05:02	2.368	09:02
03/06/07	12.664	8.760	05:12	20.056	08:52	0.805	0.518	05:12	1.162	08:37	1.088	0.399	05:12	2.469	08:37
03/07/07	12.447	8.684	04:22	20.276	09:12	0.796	0.511	04:22	1.126	20:37	1.057	0.389	04:22	2.269	09:12
Average	**13.73**	**9.48**	**N/A**	**21.20**	**N/A**	**0.85**	**0.49**	**N/A**	**1.20**	**N/A**	**1.26**	**0.45**	**N/A**	**2.43**	**N/A**

Conclusions

The monitoring program put in place at sites 1, 2, 3, 4, 5 and 6 in the City of Pinole was deemed to be successful. GEOtivity meet all contract requirements, obtained a 100% data population and was able to achieve greater than 95% data accuracy. GEOtivity's data analysis performed at this location indicated that this site was an excellent monitoring location and provided near ideal monitoring conditions.

Thank you for your partnership with GEOtivity. Should there be any questions or require further explanation about the content of this report please feel free to contact your local GEOtivity Account Executive for further assistance and a free consultation.

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