CITY OF LOS ANGELES

SEWER ODOR CONTROL MASTER PLAN

Wastewater Engineering Services Division

Bureau of Sanitation

AUGUST 2011

CITY OF LOS ANGELES
CALIFORNIA

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August 31, 2011

SA 135

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Greetings:

RE: Settlement Agreement and Final Order – Civil Action No. 01-191-RSWL and Civil Action No. 98-9039-RSWL Consolidated – 2011 Odor Master Plan

Pursuant to Section G, Paragraph 45, and Modification #1 of the Collection System Settlement Agreement and Final Order (CSSA), the City would like to present the 2011 Odor Control Master Plan.

The updated plan includes results of new investigations, new areas of concern, changes in odor control activities, progress towards completion of odor control deliverables, and completed odor control projects and results.

Odor control remains a high priority as the City continues to aggressively and proactively respond, investigate, and address all sewer odors. The two state-of-the-art Air Treatment Facilities (ATFs) have been completed and are partially responsible for the reduction in sewer related odor complaints from 134 during fiscal year (FY) 2009/10, to 106 during FY 2010/11, a 21 percent decrease. During FY 2010/11, the City recorded the least amount of odor complaints since the beginning of the CSSA.

If you have any questions, please contact Scott Hare at (323) 342-1583.

Sincerely,

Ali Poosti, Acting Division Manager
Wastewater Engineering Services Division
Bureau of Sanitation

Encl.
AP/SH

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CERTIFICATION

Re: Settlement Agreement and Final Order – Civil Action No. 01-191-RSWL and Civil Action No. 98-9039-RSWL Consolidated – 2011 Sewer Odor Master Plan

I certify under penalty of law that this document and its attachments were prepared either by me personally or under my direction or supervision in a manner designed to ensure that qualified and knowledgeable personnel properly gathered and presented the information contained therein. I further certify, based on my personal knowledge or on my inquiry of those individuals immediately responsible for obtaining the information that to the best of my knowledge and belief the information is true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowing and willful submission of a materially false statement.

[signature]

Ali Poosti, Acting Division Manager
Wastewater Engineering Services Division
Bureau of Sanitation

8/30/11
Date

TABLE OF CONTENTS

ACRONYMS and ABBREVIATIONS

ATF	Air Treatment Facility
AVORS	Additional Valley Outfall Relief Sewer
BOD	Biochemical Oxygen Demand
BOS	Bureau of Sanitation
CBD	Central Business District (Sewer)
CFM	Cubic Feet per Minute
CIP	Capital Improvement Program
CIS	Coastal Interceptor Sewer
CSSA	Collection System Settlement Agreement
ECIS	East Central Interceptor Sewer
EVIS	East Valley Interceptor Sewer
EVRS	East Valley Relief Sewer
GBIS	Glendale-Burbank Interceptor Sewer
H_2S	Hydrogen Sulfide
HSA	Hyperion Service Area
HTP	Hyperion Treatment Plant
LAGWRP	L.A.-Glendale Water Reclamation Plant
LARWQCB	L.A. Regional Water Quality Control Board
LCIS	La Cienega Interceptor Sewer
LCSFVRS	La Cienega-San Fernando Valley Relief Sewer
MH	Maintenance Hole
NCOS	North Central Outfall Sewer
NEIS	North-East Interceptor Sewer
NHIS	North Hollywood Interceptor Sewer
NORS	North Outfall Replacement Sewer
NOS	North Outfall Sewer
NOTF	North Outfall Treatment Facility
NPDES	National Pollutants Discharge Elimination System
OAB	Odor Advisory Board
PPM	Parts per Million
SLA	South Los Angeles
SSO	Sanitary Sewer Overflow
TISA	Terminal Island Service Area
TIWRP	Terminal Island Water Reclamation Plant
TWRP	Tillman Water Reclamation Plant
USEPA	U.S. Environmental Protection Agency
VOC	Volatile Organic Compounds
VORS	Valley Outfall Relief Sewer
VSF	Valley Spring (Lane) – Forman (Ave) Intersection
WCED	Wastewater Collection Engineering Division
WCSD	Wastewater Collection Services Division
WHIS	West Hollywood Interceptor Sewer

WLAIS	West L.A. Interceptor Sewer
WRS	Westwood Relief Sewer

EXECUTIVE SUMMARY

INTRODUCTION

The City of Los Angeles operates a wastewater collection system that consists of approximately 6,700 miles of sewers, 47 pumping plants, diversion structures, and various support facilities. This system collects sewage from 550 square miles and transports it to one of four sewage treatment plants operated by the City.

A natural phenomenon within any wastewater collection system is the production of odorous gases especially hydrogen sulfide (H_2S), the ventilation of sewers, and the consequential release of that H_2S. The City has been working diligently to address these odor issues and has made significant progress in controlling odors within its sewer system.

Many odor control measures are being implemented. The use of air scrubbers at various problem locations in the collection system has significantly reduced gas pressure in the sewer system and two state-of-the art Air Treatment Facilities (ATFs) utilizing biotrickling filters have recently been constructed and went into operation this past year. The City has also been installing "air curtains" at strategic points in the sewer system to block the unwanted movement of gas within the sewers. The City installed an air curtain near the drop structure at 23rd & San Pedro with very good results. Air curtains were recently installed at each of the three diversion structures that used to divert flow away from the NOS and into the NORS during the NOS rehabilitation. Furthermore, the City continues to apply odor control chemicals to sewage which has reduced hydrogen sulfide levels in treated sewers by up to 90 percent.

The City's on-going operation and maintenance efforts have also provided significant benefits to the odor control program. The trap maintenance hole modification and upgrade project, and construction of local sewers has alleviated the migration of odors from large diameter sewers into residential sewer systems while perpetual sewer cleaning has decreased the potential for septic conditions to occur. The multi-year rehabilitation of the lower NOS is complete and flow has been routed back into the NOS away from the North Outfall Replacement Sewer (NORS). This has greatly reduced the flow in the NORS, resulting in a noticeable reduction in gas pressure in the NORS and at the NORS siphon. This, in combination with the new ATFs, has greatly reduced gas pressure within sewers in the Crenshaw/Baldwin Hills/Culver City areas, reducing odor complaints and improving the quality of life for the residents.

The $2 million, two-year ATF Review Study that started in 2008 is complete and has proposed a variety of solutions. Regarding the five proposed ATFs placed on hold pending the results of the study, the report concluded that the City needs only one strategically placed ATF at Mission and Jesse. In lieu of the other ATFs, the study proposed the use of air curtains, air dampers in drop structures, and flow management as methods to control sewer gas. This study has proved to be invaluable in increasing our knowledge of sewer odors and gas movement in the collection system.

These odor control measures have produced a successful odor control program in the City of Los Angeles and odor complaints continue to decline steadily. The City continues to operate an odor complaint hotline, which allows for a more timely response and a quick resolution to sewer-related odor complaints.

This Master Plan evaluates the current odor control program, conducts studies in strategic areas throughout the city, identifies causes of odors, and provides recommendations for improvements. It will be updated on an annual basis to assure that odor control strategies/measures are periodically challenged, solutions remain proactive, and technologies are current and effective.

EVALUATION OF THE COLLECTION SYSTEM

Through analysis of odor complaints and spot testing of sewer pressure, the City identified several key areas to study. Specific sewers in these areas were targeted for detailed testing and analysis based on the location of odor complaints as well as the physical characteristics of the sewers such as insufficient pipe slope, severe slope reductions, and the proximity of problematic structures such as inverted siphons, drop structures, and junction structures.

Four areas with pockets of unusually high levels of complaints have been identified as "Areas of Concern" (AOC) and the sewers in these areas received the most investigation. They are:

- AOC1 - East NOS Corridor – NOS
- AOC2 - La Cienega/San Fernando Corridor – LCSFVRS/WHIS/LCIS
- AOC3 - Baldwin Hills/Culver City Area – NORS/ECIS/NOS/WLAIS/WRS/NCOS
- AOC4 - East Valley Area – AVORS/EVRS/VORS/NHIS/NOS

In order to gain a more complete and accurate overview of the collection system, four additional areas have been identified as "Areas of Study" (AOS) and were analyzed as well. They are:

- AOS1 - South Los Angeles Area – NOS
- AOS2 - Coastal Interceptor Sewer – CIS
- AOS3 - Harbor Area
- AOS4 - West Valley Area – VORS/AVORS/EVIS

Air pressure and hydrogen sulfide (H_2S) levels in the sewers in each area are monitored in order to qualify and quantify the odors, help identify the causes of odor complaints, and help determine the optimum solutions.

RECOMMENDATIONS/CONSIDERATIONS

For the Areas of Concern, the following options are being considered:

AOC1 - East NOS Corridor

Recommendations made by the ATF Review Study

- Construct an ATF at the Mission & Jesse Drop Structure. *(Currently in design)*
- Install adjustable air dampers in the air return line of drop structures
- Install air curtains at the Mission & Jesse Drop Structure to block the movement of gas.
- Manipulate flows at the diversion structures leading into the drop structures in order to better control gas movement within the sewer system.
- The system is dynamic therefore the City needs to be flexible to optimize the system

Other Recommendations (not from the ATF Review Study)

- Direct more flow down the NOS towards the Enterprise Siphon to achieve scouring velocity and minimize debris build up in the siphon.
- Place a scrubber upstream of the Gilroy Street Siphon.

AOC2 - La Cienega/San Fernando Corridor

- Control gas pressures using sewer flow management by manipulating sewage flow at various diversion structures

  Consider re-routing more flow away from the LCSFVRS and into the NOS toward LAG
- Continue chemical injection at the Tillman Treatment Plant
- Unplug the Genesee Siphon's airline to allow air to move across the siphon
- After the airline is unplugged, evaluate the need to increase the capacity of the Genesee Scrubber

AOC3 - Baldwin Hills/Culver City Area

- Continue monitoring the NOS and NCOS in the vicinity of the previous airline connection between these two sewers near the Fox Hills Mall.
- Continue monitoring the WLAIS and WRS for any increase in pressure
- Continue to monitor the effectiveness of the Jefferson and La Cienega ATF and the 6000 Jefferson ATF

- Analyze any change in gas pressures resulting from the construction of air curtains at NORS Diversions 1, 2, and 3

AOC4 - East Valley Area

- Continue monitoring pressures on the EVRS, NHIS, and VORS, and seal maintenance holes where necessary
  - Conduct flow gauging on the NHIS
  - Conduct focused pressure testing on the EVRS downstream of the NHIS

For the Areas of Study, the following options are being considered:

AOS1 - South Los Angeles Area

- Pressures have dropped significantly since the last test due largely to the NCOS ATF which is strategically located to pull gas from the upper and lower NOS in the Maze area and the new air curtains which prevent backpressure from downstream.
- Re-test for pressure and/or H_2S periodically to allow adequate time to address any odor issues that may occur in the future

AOS2 - Coastal Interceptor Sewer

- Re-test for pressure and/or H_2S periodically to allow adequate time to address any odor issues that may occur in the future

AOS3 - Harbor Area

- Re-test for pressure and/or H_2S periodically to allow adequate time to address any odor issues that may occur in the future

AOS4 - West Valley Area

- Re-test for pressure and/or H_2S periodically to allow adequate time to address any odor issues that may occur in the future

To meet the immediate needs of the collection system, the City will continue all odor control activities including odor complaint response and investigation, routine sewer maintenance, chemical addition, air withdraw1 and treatment using scrubbers, sewer construction and repair, and on-going monitoring of sewer air pressure and odor concentration.

1.0 INTRODUCTION

1.1 History of the Sewer System

The City of Los Angeles operates and maintains a complex wastewater collection system that serves a 550 square mile area with a network of pipes that range in size from 6-inches to 150-inches in diameter. The pipes running beneath the City total approximately 6,700 linear miles. This does not include the hundreds of miles of privately owned sewer laterals which connect private residences and industrial clients to the City's sewers. Although the City of Los Angeles has had some type of sewer conveyance system since the late 1800's, it consisted of transporting the sewage in pipes to the edge of town or low population areas and discharging it into a field or ditch. The system expanded and by 1908 could accommodate a population of 750,000 and discharged into the ocean at the present location of the Hyperion Treatment Plant. However, the sewage was not being treated at all. It was not until 1920 that the residents voted to begin sewage treatment, beginning our modern sewage conveyance and treatment system. Odors have always been an issue with residents from the very beginnings of the sewer system and as the City has enlarged its sewer system, odor control has become a larger area of concern.

The City of Los Angeles is expanding and will continue to expand in the future. Upgrading the sewer system and the treatment plants has been and will continue to be an on-going process in order to handle the anticipated increase in sewage that accompanies an increasing population and to address the aging infrastructure. This will need to be accompanied by a continuous and increasingly sophisticated effort to control sewer odors.

A key part of the City's odor control efforts is the formulation of this Odor Control Master Plan which evaluates the current odor control program and provides recommendations for future efforts. As part of the evaluation process, the City reviewed its existing odor complaint procedures, investigation and cleaning practices, preventive maintenance schedules, operation and maintenance policies and practices, and mitigation measures including manhole sealing, trap maintenance hole repair, and chemical treatment. This Master Plan presents the results of this evaluation along with the recommendations.

1.2 Odor Generation

Prior to 1923, very little was known about the generation and release of sewer odors in Los Angeles or elsewhere. It was generally known that air ventilating from sewers could be offensive at times, but little was known about the specific odor compounds or how they were formed. Sewer gases can include nitrogen, oxygen, carbon dioxide, hydrogen sulfide, ammonia, and methane. Organic gases such as volatile organic compounds (VOCs) contribute to the nuisance odors but the major cause of odors in wastewater is hydrogen sulfide (H2S), an inorganic gas that is detectable even in very low concentrations. Hydrogen sulfide has a rotten egg smell and is heavier than air, so it does not disperse into the atmosphere.

A natural phenomenon within any wastewater collection system is the production of odorous gases. Over the last decade the potential for odorous air release from the sewer system has increased due to the effectiveness of the City's industrial pretreatment program, which includes the removal of heavy metals that would otherwise precipitate dissolved sulfide from solution. The City has been working diligently to address these odor issues and has made significant progress in controlling odors within its sewer system.

Hydrogen sulfide is generated within sewage when sulfates, naturally present in wastewater, are converted to hydrogen sulfide by bacteria residing in the slime layer on the pipe walls, or on debris in the wastewater. This activity increases when certain conditions exist in the collection system such as low dissolved oxygen content, high-strength wastewater, long detention times, and elevated wastewater temperatures. For example, low sloping sewers cause the flow to slow down, resulting in the increased settling of organic solids and grit in the sewer. This debris deposition further slows down the flow. Consequently, this condition increases sewage detention times in the sewer, allowing the sewage to become oxygen deficient or septic.

Hydrogen sulfide and other dissolved gases are released in areas of turbulent flow. For that reason, higher hydrogen sulfide concentrations are generally found near line bends, pipe size changes, areas of dynamic slope changes, junction structures, diversion structure, siphons, etc. This gas will typically escape the sewer system through maintenance holes as part of the natural movement of air in and out of the sewer system caused by the daily rise and fall of flow levels in the sewers. However, constrictions in the sewer or reduced sewer headspace due to continuous high flows can result in venting of gases from the sewers.

1.3 History of Odor Control

During the design and construction of the North Outfall Sewer (NOS) in the mid 1920s, it was recognized that settled debris in the bottom of sewers can increase odor production. Therefore, the NOS was designed with a slope which would provide the highest possible water velocity to prevent debris deposition. Furthermore, the NOS was constructed with a semi-elliptical cross section and lined with corrosion-resistant clay tiles above the spring line. However, an inspection in 1936 found that large portions of the sewer were missing tiles, mortar joints between the tiles were reduced to mushy gypsum, and the concrete behind the tiles was found to be soft and porous. Engineers realized that the solution to preventing damage and deterioration of the sewer pipes was to prevent the formation of hydrogen sulfide gas and its oxidation to sulfuric acid, thus reducing the accumulation of acid on the pipe walls.

On February 24, 1937, the Board of Public Works adopted the Board report recommending that the City conduct an experiment to ventilate a portion of the NOS to reduce the formation of acid producing gas. The experiment used a fan to evacuate air at one location and admitted fresh air at various intervals along the sewer. Ventilation started on January 3, 1938. Daily records were kept of the following items: fan speed, quantity of exhausted air, temperatures of the exhaust air and atmosphere, H_2S content of the exhaust air, amount of vacuum in suction line, and quantity of air admitted at the various openings in the sewer. At the end of the experiment in November 1938, the condition of the entire outfall was so greatly improved that the City Engineer recommended that a permanent ventilation station be built at the test site. More ventilation stations were constructed to ventilate other sections of the NOS and the Central Outfall sewer as well. In the 1940s, it was discovered that inverted siphons were a significant cause of gas ventilating from the NOS due to the blockage of the sewer's headspace caused by the siphon. Ventilation and deodorization systems were installed on the upstream side of the siphons to prevent odors releasing into the atmosphere.

In the 1950s and 60s the City of Los Angeles grew considerably and the volume of wastewater had subsequently increased. As existing collection systems began to reach capacity, additional sewers were constructed to carry the increased flow. This increased flow and its gas ended up in the NOS and other outfall sewers, increasing the ventilation of gas from these outfalls. Since the principles of natural sewer ventilation were not understood at this time, it was decided to seal the offending maintenance holes with tar and sand, and occasionally, insert trays filled with activated charcoal to adsorb the odor compounds.

Unknown at the time, sealing maintenance holes to prevent the release of gas resulted in increased pressure in the sewer. With no pathway for release, the pressure increased at those locations, causing sewer odors to vent through other maintenance holes nearby and in many cases, be forced up house connections and released through the roof vents of homes. The City began installing "gas traps" on tributary sewers to prevent the upstream migration of sewer pressure. In some cases, new sewers were built to intercept tributary sewers and route the flow to a location where air pressure could be controlled.

The increase in sewage and subsequent increase in pressure led to more odor complaints and the City began an aggressive program of chemical addition in the early 1990s. Chemicals are commonly used today to react with or remove dissolved sulfide and hydrogen sulfide from wastewater. Since hydrogen sulfide gas is the main compound responsible for odor complaints, chemical addition strategies for eliminating it were developed as far back as the early 1940s when the City was adding chemicals to control odors from sewers on an as-needed basis. Chlorine or hypochlorite solutions were used due to availability and effectiveness. In the 1950s, iron-containing solutions such as ferrous chloride and ferric chloride dominated as supplies increased and costs became more reasonable. Iron solutions are still a very common chemical used for sulfide control in sewers and have a high degree of effectiveness; however, due to their rising cost, the City of Los Angeles has shifted to magnesium hydroxide, which is less costly and more effective. The City also utilizes sodium hydroxide to shock dose sewers with high sulfide generation. The chemical addition program targeted those locations most susceptible to generating sewer odors and therefore, where it would have the greatest benefit for the entire system.

It was not until the mid-1990s that the dynamics of natural sewer pressurization were identified and better understood by scientists and engineers. Many large-diameter sewer depressurization projects were designed and installed in various parts of the country based on the new natural pressurization dynamics research. These successful projects demonstrated that the pressure effect in sewers could be calculated to a high degree of certainty and that control measures could be successfully designed, installed and operated.

The odor control program consists of systematic monitoring of the wastewater system, an effective operation and maintenance program, effective response procedures, adequate design standards, construction of relief sewers, construction of new odor control facilities, and implementation of new technologies. Additionally, in an on-going effort to better understand the nature of sewer odors and provide for continued improvements, the odor control program includes field investigations and analysis to identify the character of odors throughout the collection system.

The odor-control measures employed/planned by the City all work in concert with each other. It is these elements, when put together, that make the City's wastewater collection odor control program effective. The City has developed an odor complaint hotline, which allows for a more timely response, and quicker resolution of sewer-related odor complaints. The application of odor control chemicals has reduced hydrogen sulfide concentration in treated sewers by up to 90%. The use of air scrubbers at various hotspot locations in the collection system has contributed to a reduction in the release of odors in known venting areas. The construction of relief sewers such as East Central Interceptor Sewer and North East Interceptor Sewer Phase I have provided relief and reduced the high air pressures occurring in the sewer due to hydraulically overloaded pipes. The on-going repair of trap maintenance holes and construction of local sewers has alleviated the migration of odors from large-diameter sewers into neighborhoods and properties. The on-going maintenance program has decreased the potential for septic conditions. These odor control measures have led to a successful odor control program. While it is impossible to completely eliminate odor complaints, the City has and will continue to mitigate sewer odors through monitoring, complaint response, and effective implementation of odor control technologies.

The City's overall goal is to implement a cost effective and community-supported odor control program that will mitigate and control sewer odors, effectively inform the neighborhood councils, community groups and the Odor Advisory Board of the odor issues, and inform and advise the Board of Public Works and the City Council on the odor control program.

1.4 Collection System Settlement Agreement and Origin of the Master Plan

The City was required to develop an Odor Control Master Plan as part of the Collection System Settlement Agreement (CSSA). The CSSA is a settlement between the City and several organizations including the USEPA, the LARWQCB, the Santa Monica Baykeeper, and community groups representing residents in South Los Angeles. In January 2001, the parties filed a lawsuit against the City of Los Angeles which alleged that the City's Sanitary Sewer Overflows (SSOs) and odor problems violated the Clean Water Act and the terms and conditions of the National Pollutants Discharge Elimination System (NPDES) Permits for the Hyperion Treatment Plant and the Terminal Island Water Reclamation Plant for the operation and maintenance of the City's sewer system. In October 29, 2004, the Court officially approved and implemented the Collection System Settlement Agreement (CSSA) between the City of Los Angeles and the EPA.

Sewer odor was a major and pervasive issue in some South Los Angeles areas. The CSSA addressed the odor problems by requiring the City to complete and institute numerous studies, projects, programs and capital improvement projects. One of the major requirements was the preparation of a City-wide odor control master plan. The master plan was to include an assessment of known problem areas, additional testing and monitoring, and recommended actions. The City was to develop the plan in consultation with the Odor Advisory Board. The first Odor Control Master Plan was issued in 2006 and was the first comprehensive odor control master plan produced by the City. Prior to this, there were standard operating procedures and measures in place to control odors, but no detailed plan on how to systematically reduce odors throughout the collection system.

In November 2009, a Modification to the Settlement Agreement was entered by the Court. The modification contained additional measures that the City needed to address including updating the Odor Master Plan annually.

1.5 Purpose and Objectives

The purpose of the Odor Control Master Plan is to be both educational and functional. This document will provide a history of the odor issues in the City's wastewater collection system, establish an understanding of the science of sewer odor production and the technologies available, and present a proactive plan to manage and address the sewer odors.

The general objectives of the Odor Control Master Plan are:

- Provide an overview of odor issues associated with the wastewater collection system.
- Document and evaluate the current odor control program.
- Document the effort to characterize odors and identify their causes within the collection system.
- Provide recommendations to effectively manage odors in the collection system.

- Provide a proactive systematic approach to odor prevention and control.

The objective of the City's wastewater collection system odor control program is to proactively address sewer odor issues in the wastewater collection system by performing the following activities:

- Monitoring the wastewater collection system;
- Documenting and respond to odor complaints;
- Improving the design of the sewer system;
- Installing/building odor-control units/facilities;
- Dosing selected pipelines with chemicals to eliminate components that lead to odors and;
- Investigating new technologies to identify better materials or processes to control odors.

Additionally, in an on-going effort to better understand the nature of sewer odors, the odor control program includes an effort to investigate the character of odors throughout the collection system and evaluate the current operation and maintenance policies and practices.

The effort to monitor the sewer system will involve developing and implementing a city-wide odor and ventilation monitoring system including installing hydrogen sulfide gas monitors (data loggers) in sewer maintenance holes, installing sewer air pressure monitors to measure pressure differences in key locations to detect the potential for off-gassing to the atmosphere, and collecting data to determine the odor-causing characteristics of sewage. After sufficient amounts of this data have been collected, it will be analyzed along with the sewer system's physical characteristics including the location of system restrictions and sewer gas constrictions such as siphons, in order to identify and prioritize potential causes and sources of odors. The City will also conduct various innovative tests such as concurrent air withdrawal and air pressure measurement tests (fan tests) to verify the cause of venting gasses from the sewer system and to help identify and validate appropriate solutions.

The City already has a system in place for documenting and responding to odor complaints. The City will continue this effort and will work with the residents to promptly and effectively address their concerns.

The City has developed and implemented an extensive system of capital improvement projects to reduce odors and improve the overall operation of the collection system. These projects include the reconstruction of major sewers which reduce the system's off-gassing by increasing sewer headspace, the construction of permanent gas/odor removal and filtering facilities, and chemical injection systems that will inhibit the generation of hydrogen sulfide gas within the sewage.

The City has also embarked on an effort to identify and evaluate new technologies to mitigate and resolve odor issues. The City will implement the new technologies, where appropriate, through either the operation and maintenance program or the capital improvement program. The City will also optimize the operation of this technology, monitoring and adjusting the systems to ensure maximum effectiveness.

The overall strategy and goal is to implement a community-supported odor control program that will keep the public informed at various levels and to inform and advise the Board of Public Works and the City Council at every stage of the program.

1.6 Task Descriptions

The following general tasks are the basis of the odor control program:

- Monitor and respond to odor complaints.
- Measure hydrogen sulfide levels and air pressure in sewers to determine the quantity and quality of sewer venting gas.
- Collect and test samples to determine the characteristics of the sewage
- Research physical characteristics of the sewer system including the location of restriction and sewer gas constrictions such as siphons and slope reductions.
- Analyze all data and information collected and determine the causes of the odors.
- Identify available, appropriate solutions and any technology available to help manage, mitigate, or eliminate odors.
- Evaluate the various alternatives and technologies.
- Recommend cost effective alternatives that are supported by the community.
- Keep the community informed through meetings with the Odor Advisory Board and public outreach efforts such as attending community meetings and distributing informative literature.
- Implement the recommendations through the operation and maintenance program or the capital improvement program.
- Monitor the performance of new applied technologies and make improvements as necessary.
- Summarize all of the findings, requirements, recommendations, and results in this master plan so that it becomes the blue print for mitigating sewer odors in our neighborhoods.
- Manage the odor control program and monitor its effectiveness. Make adjustments and improvements to the system as necessary to maximize performance.

2.0 EXISTING COLLECTION SYSTEM

The City's wastewater collection system is comprised of a network of underground pipes that extend throughout the city, conveying wastewater to one of four treatment plants for processing. The City-owned and operated system consists of approximately 6,700 miles of major interceptor and mainline sewers. Approximately 650 miles of these sewers are primary sewers, which range in size from 16 inches to over 12 feet in diameter. Approximately 170 miles of the primary sewers are major interceptor and outfall sewers. The rest of the sewers (approx. 5,850 miles) are smaller secondary sewers that range in diameter from 6 inches to 15 inches. The system also includes 47 pumping plants, diversion structures, and various other support facilities such as maintenance yards.

The City owns and operates four major wastewater treatment facilities: Hyperion Treatment Plant (HTP) in Playa del Rey, the Donald C. Tillman Water Reclamation Plant (TWRP) in the Sepulveda Basin, Los Angeles-Glendale Water Reclamation Plant (LAGWRP) across the freeway from Griffith Park, and the Terminal Island Water Reclamation Plant (TIWRP) near the Los Angeles Harbor.

The system provides service to approximately 600,000 private residences, commercial establishments and industries within the City. The private sewer laterals, which connect buildings to the City's mainline sewers, are privately owned and maintained, and their total length is approximately 11,000 miles. The City also has contracts to provide waste water services to 29 satellite agencies. The agencies contracting with the City operate their own collection systems, which discharge into the City's system. Payment is based on the amount and volume of flow measured at their connection to the City's system.

The City's wastewater service area consists of two distinct drainage basin areas: the Hyperion Service Area (HSA) and the Terminal Island Service Area (TISA). The HSA covers over 500 square miles (mi^2) and serves the majority of the Los Angeles population. In addition, this service area includes several non-City agencies that contract with the City for wastewater service. The TISA is approximately 18 mi^2 and serves the Los Angeles Harbor area.

2.1 Hyperion Service Area Interceptor and Outfall Sewers

The following sixteen sewers comprise the major interceptor and outfall system for the HSA:

2.1.1 Coastal Interceptor Sewer (CIS)

The CIS serves the coastal area of the Santa Monica Bay north of the Hyperion Treatment Plant (HTP) to Topanga State Beach near Malibu. This sewer conveys wastewater directly to the HTP from Pacific Palisades, Venice, Mar Vista, the City of Santa Monica, and adjacent areas served by the Los Angeles County Sanitation District (such as Marina Del Rey).

The CIS is a circular pipe that ranges in diameter from 24 to 72 inches and is approximately 9.4 miles in length. Some parts are constructed of vitrified clay and other parts are reinforced concrete pipe. The concrete pipe is lined with polyvinyl chloride (PVC) to prevent corrosion of the concrete by sewer gasses.

2.1.2 Central Outfall Sewer (COS)

The COS was constructed in 1907 and originally conveyed wastewater directly to the Pacific Ocean. Now it conveys wastewater to the HTP. The COS is about 10 miles long and is, for the most part, elliptical in shape measuring 60 inches wide by 73 inches high, although some portions are 57-inch and 69-inch-diameter circular sections. Its original construction was brick and mortar. It was rehabilitated in the 1940s by replacing some of the brick and mortar, and subsequently lining the sewer with steel mesh and gunite. Currently the COS is undergoing rehabilitation to be completed by 2017.

2.1.3 North Outfall Sewer (NOS)

The NOS is one of the primary outfall sewers used to convey wastewater to the HTP. The NOS extends upstream from the HTP through Culver City, into downtown Los Angeles, continuing east of the Elysian Hills, turning north to travel around the Santa Monica Mountains, and then west through the southern portion of the San Fernando Valley (approximately 58 miles in length).

The NOS was constructed from the mid 1920s to the early 1930s. It is a combination circular and semi-elliptical sewer constructed of concrete, reinforced concrete, and vitrified clay. The portions of the NOS constructed of concrete are lined with clay tiles to resist corrosion. The downstream portion of the NOS (from the HTP to the intersection of La Cienega Boulevard and Rodeo Road) has been rehabilitated and therefore, flow is being diverted back to this section relieving the NORS.

2.1.4 North Central Outfall Sewer (NCOS)

The North Central Outfall Sewer (NCOS) was constructed in 1957 to provide additional capacity to the system between the Baldwin Hills area and the HTP. This sewer relieves the lower portion of the NOS. The NCOS is a circular sewer with a maximum diameter of 114 inches and is close to 8 miles long. It is constructed of reinforced concrete pipe lined with PVC.

2.1.5 North Outfall Replacement Sewer (NORS)

The North Outfall Replacement Sewer (NORS) was completed in 1993. The NORS is a circular pipe, which ranges in diameter from 96 to 150 inches. The NORS is constructed from reinforced concrete pipe lined with PVC.

2.1.6 West Los Angeles Interceptor Sewer (WLAIS)

The WLAIS primarily serves the West Los Angeles area by conveying wastewater to the NOS. The upstream portion of the WLAIS varies in size from 33 to 60 inches and is comprised of circular and semi-elliptical segments constructed in the 1920s. The lower section was constructed in 1950 with circular, reinforced concrete pipe lined with PVC, and includes an elevated box section (4’ H x 6’ W) crossing over Ballona Creek in Culver City. The entire WLAIS is approximately 4 miles long.

2.1.7 Westwood Relief Sewer (WRS)

The WRS was constructed in 1962 to provide additional capacity for overloaded sewers in the Westwood area. It also accepts some wastewater from Beverly Hills. The WRS is about 4.5 miles long, is circular in shape, varies in size from 33 inches to 60 inches, and is constructed of vitrified clay pipe and reinforced concrete pipe. The sewer crosses the creek using a concrete box similar to that used by the WLAIS, discharging into the NOS in Culver City.

2.1.8 Wilshire-Hollywood Interceptor Sewer (WHIS)

The WHIS was constructed in the early to mid 1970s in order to intercept wastewater from trunk sewers in the Hollywood area and convey this flow to the La Cienega-San Fernando Valley

Relief Sewer. This sewer ranges in diameter from 24 to 69 inches and is constructed of vitrified clay pipe and reinforced concrete pipe lined with PVC.

2.1.9 La Cienega Interceptor Sewer (LCIS)

The LCIS serves West Hollywood and the area that lies roughly between West Hollywood and Baldwin Hills. It was constructed in the 1920s with circular and semi-elliptical reinforced concrete pipe ranging in size from 27 inch diameter circular pipe to 63 inch-tall elliptical pipe. The LCIS is slightly over 6 miles long and outlets into the NOS at Jefferson and Rodeo. The LCIS has been undergoing rehabilitation in various phases to be completed by 2015.

2.1.10 La Cienega-San Fernando Valley Relief Sewer (LCSFVRS)

The LCSFVRS was constructed in 1955 to relieve the NOS at the downstream (east) end of the San Fernando Valley near Toluca Lake. The LCSFVRS routes sewage directly through the Santa Monica Mountains and to the West Hollywood area. At Sierra Bonita Avenue, it splits into twin 42-inch pipes that join back into one 60-inch pipe downstream. The sewer travels through the Genesee Siphon near Venice Boulevard and along Genesee Avenue before reconnecting with the NOS near the intersection of Rodeo Road and Jefferson Boulevard. The LCSFVRS is approximately 11 miles long and is primarily constructed of reinforced concrete pipe lined with PVC, and ranges in diameter from 48 to 84 inches. The downstream portion of the LCSFVRS is a combination of 99-inch semi-elliptical and 99-inch by 115-inch rectangular sections.

2.1.11 Valley Outfall Relief Sewer (VORS)

The VORS was constructed between 1953 and 1962 to relieve the NOS in the San Fernando Valley and essentially parallels the NOS for much of the Valley (approximately 16 miles). The VORS is constructed of PVC-lined, reinforced concrete pipe and ranges in diameter from 24 to 66 inches.

2.1.12 Additional Valley Outfall Relief Sewer (AVORS)

The AVORS was installed in the late 1960s to provide additional hydraulic relief to the NOS and the VORS in the western portion of the San Fernando Valley. This sewer is one of the major pipelines conveying flow to the Tillman Water Reclamation Plant. The AVORS also parallels the NOS. It is constructed of vitrified clay pipe and PVC-lined reinforced concrete pipe ranging in diameter from 48 to 96 inches, and is over 10 miles long.

2.1.13 East Valley Relief Sewer (EVRS)

The EVRS was constructed in the early 1980s to relieve the AVORS and the NOS near Kester Avenue and Magnolia Boulevard. Wastewater within this relief sewer can be routed through the NOS towards either the LA/Glendale Water Reclamation Plant or through the Santa Monica Mountains via the LCSFVRS to the HTP. The EVRS is almost 7 miles long. It varies in diameter from 39 inches to 51 inches, and is constructed of vitrified clay pipe and reinforced concrete pipe lined with PVC.

2.1.14 East Valley Interceptor Sewer (EVIS)

The EVIS was constructed in 1987 and routes wastewater from the northeastern areas of the San Fernando Valley (City of San Fernando, Sylmar, Pacoima, Mission Hills, Panorama City, etc.) to the Tillman Plant. This sewer is constructed of vitrified clay pipe and PVC lined-reinforced concrete pipe. It varies in diameter from 36 inches to 84 inches, and is close to 9 miles long.

2.1.15 East Central Interceptor Sewer (ECIS)

The ECIS was constructed in 2004. It relieves the east-west segment of the NOS, from its outlet connection to the NCOS to the vicinity of Mission Road and Jesse Street near the Los Angeles River. The ECIS is approximately 11.5 miles long and 11 feet in diameter.

2.1.16 Northeast Interceptor Sewer (NEIS)

The NEIS is approximately 10 miles in length extending from Mission Road and Jesse Street to Pecan Grove where the future Glendale Burbank Interceptor will be connected. The NEIS is being constructed in two phases. Construction of Phase I was completed in 2005. The NEIS Phase II has been combined with the GBIS and both are now in the pre-construction phase. Construction is scheduled to be completed by 2020.

2.1.17 Eagle Rock Interceptor Sewer (ERIS)

The ERIS was constructed in 2006. ERIS is a circular lined clay pipe, 12 to 48-inch in diameter that was micro-tunneled and trenched. It runs northward from San Fernando Road and Eagle Rock Boulevard then branches into two lines, ending at Eagle Rock Boulevard and Fairpark Avenue and the vicinity of Avenue 51 and York Boulevard. ERIS intercepts flow in the Eagle Rock and Highland Park area and conveys it to NEIS.

2.2 Terminal Island Service Area Interceptor Sewers and Force Mains

The TISA collection system consists of a network of major interceptor sewers and force mains that ultimately discharge into TITP for treatment and disposal. TISA collection system is comprised of four interceptor sewer systems. The four interceptor sewer systems are named after the respective force main through which their flow is pumped to the TITP. The following sections discuss the four interceptor sewer systems further.

2.2.1 Fries Avenue Interceptor Sewer System (FISS)

Wastewater collected from the Wilmington Basin is discharged into the Fries Avenue Interceptor Sewer System (FISS). The FISS also serves various industrial dischargers, some of which are on Harbor Department property. The FISS consists of four major pumping plants serving their respective interceptor (primary) sewers. The first three major pumping plants are Hawaiian and B Pumping Plant (No. 677), East Wilmington Pumping Plant (No. 676), and Fries Avenue Pumping Plant (No. 666). These three major pumping plants discharge directly to TITP via a common 30-inch force main known as the Fries Avenue Force Main. The Fries Avenue Force Main receives additional flow from a connecting pumping plant located in the northern portion of Terminal Island. This fourth pumping plant is the Harris Avenue Pumping Plant (No. 669) and is tributary to only the TITP via the Fries Avenue Force Main. The 30-inch Fries Avenue Force Main is the single major means of wastewater conveyance from the Wilmington Basin to Terminal Island, and crosses under the East Basin Channel of the Los Angeles Harbor.

2.2.2 San Pedro Interceptor Sewer System (SPISS)

The San Pedro Interceptor Sewer System (SPISS) serves most of the residential areas of San Pedro, the industrial area consisting primarily of the Phillips Conoco Refinery, and some industrial facilities located on Harbor Department property. The SPISS contains one major pumping plant serving its respective primary sewers. The major pumping plant is San Pedro Pumping Plant (No. 691). This pumping plant discharges directly to TITP via a 30-inch force main, the principle means of wastewater conveyance from San Pedro Basin. The 30-inch San Pedro force main traverses the Los Angeles Harbor Main Channel near the Vincent Thomas Memorial Bridge. A supplement to the SPISS system allows all flows from the Wilmington Basin into FISS to be diverted to the San Pedro Pumping Plant.

2.2.3 Terminal Way Interceptor Sewer System (TISS)

Terminal Way Interceptor Sewer System (TISS) collects wastewater from the residential areas of the Coastal Zone of San Pedro Basin, the land use areas along Harbor Boulevard, the heavy industrial area south of 22nd Street, and Terminal Island not tributary to Harris Avenue Pumping Plant. Wastewater collected by the TISS from the Coastal Zone and industrial area south of 22nd Street is conveyed by means of a double-barrel siphon traversing the Main Channel of Los Angeles Harbor toward the sole major pumping plant of the TISS: the Terminal Way Pumping Plant (No. 671). This pumping plant is connected to TITP via a dual force main system (24-inch and 20-inch) that provides system redundancy.

2.2.4 Former U.S. Navy Sewer System and Facility

The former "U.S. Navy Sewer System and Facility" consists of four separate force mains (two 6-inch, one 12-inch, and one 20-inch), a pumping plant, and collector sewers that previously served the U.S. Naval Reservation on Terminal Island. After the decommissioning of the U.S. Navy facilities, the City of Long Beach took over the assets of the U.S. Navy Sewer System and Facility that continues to deliver wastewater to the TITP.

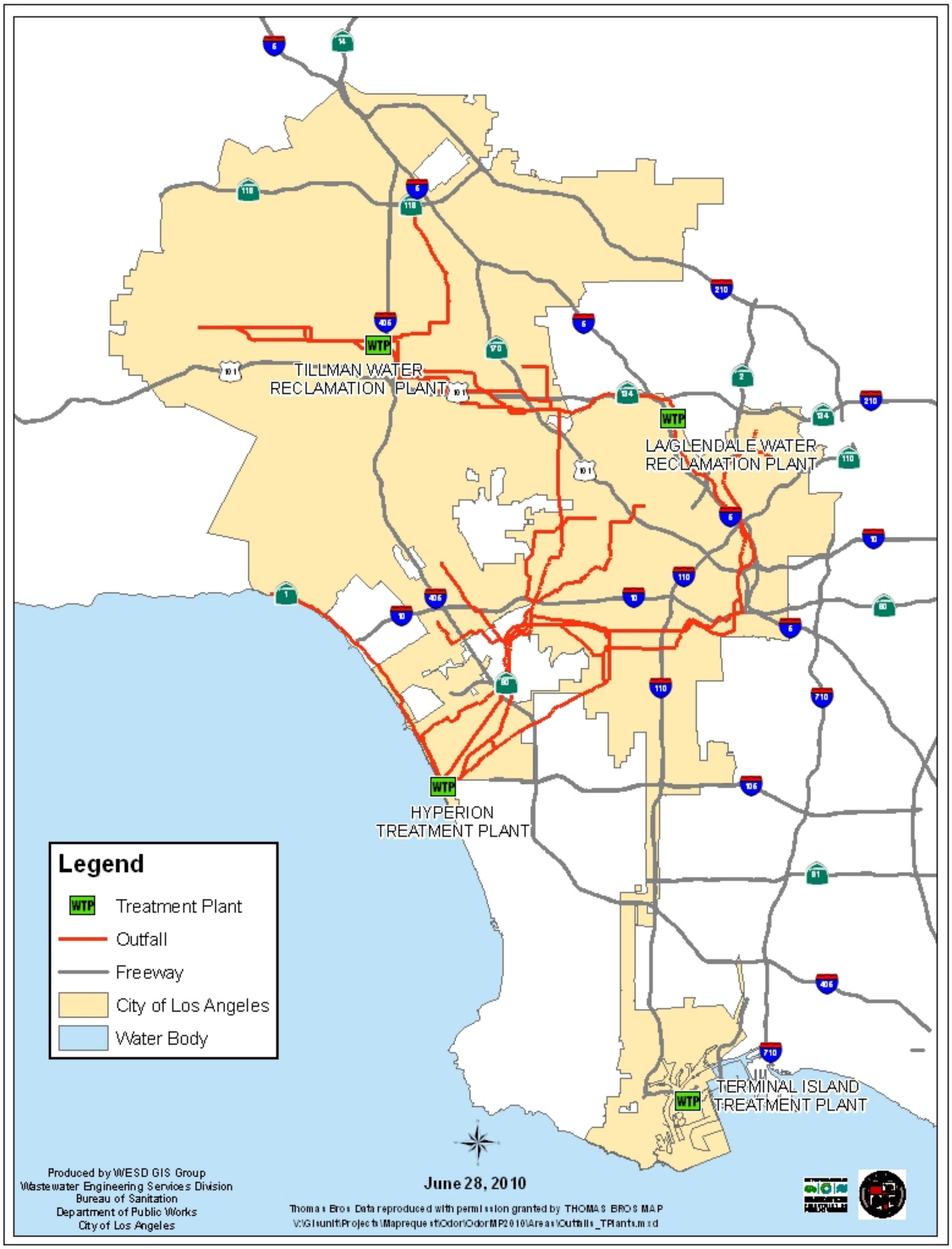
TILLMAN WATER
RECLAMATION PLANT
LA/GLENDALE WATER
RECLAMATION PLANT
HYPERION
TREATMENT PLANT
TERMINAL ISLAND
TREATMENT PLANT
Legend
WTP Treatment Plant
Outfall
Freeway
City of Los Angeles
Water Body
Produced by WESD GIS Group
Wastewater Engineering Services Division
Bureau of Sanitation
Department of Public Works
City of Los Angeles
June 28, 2010
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FIG. 2.1

3.0 OUTREACH

The City has been actively engaged in outreach activities for the residents of Los Angeles regarding the Bureau's Sewer Odor Control Program. The outreach has multiple purposes. The first is to educate the public about the City's efforts to control odors and about tools the City has made available to the public to facilitate their communication with the City. The other goal is to gather feedback from the public about the City's odor control efforts in order to measure the effectiveness of our programs and re-evaluate and modify them if necessary.

The odor control outreach program can be divided into three principal components:

1. Communication and coordination with the community-based Odor Control Advisory Board,
2. Distribution of flyers and refrigerator magnets containing odor control information and means of contacting the City for sewer odor issues,
3. Conducting an annual survey of the public in those areas where odors are the worst in order to gather feedback.

3.1 Odor Advisory Board

As part of the CSSA, the City was also required to create an Odor Advisory Board with members representing South Los Angeles communities to help assess the odor issues and review the City's mitigation efforts CSSA authorized the Odor Advisory Board to work closely with the City in its effort to resolve and mitigate sewer odors to the maximum extent practicable. The CSSA states that the Odor Advisory Board's role will last for the term of the Settlement Agreement (10 yr-term), unless it is terminated by mutual consent of all the parties. The Board serves as the City's primary point-of-contact with residents of south Los Angeles regarding sewer odor control issues.

The Odor Advisory Board interest focuses mostly in the south Los Angeles communities (mainly around MLK/Rodeo between La Cienega and Arlington) which fall within the 8th, 9th and 10th Council Districts. The Odor Advisory Board was formed in September 2002 and began meeting on a monthly basis. Odor complaints, odor investigation procedure, the mitigation measures and the long-term odor control efforts underway by the City were provided to the Odor Advisory Board for review and input.

The Air Treatment Facilities (ATFs) were to be placed at strategic points throughout the City, concentrated in those areas with the most odor complaints, many of which were in South Los Angeles. The original locations of the ATFs were presented to the OAB and subsequently, when the construction of five of the ATFs were placed on hold until the outcome of the ATF Review Study, the City again approached the Board for input and comments. The City reported to the OAB on the progress of the study. The Board members have attended several field trips including a fan test, a tour of the Hyperion Treatment Plant, the East Central Interceptor Sewer (ECIS) construction site, and the ATF at Jefferson & La Cienega. The Odor Advisory Board also met with the independent odor expert to provide input for the independent review of the odor control report called for in the CSSA.

The Board members made several recommendations for improving both the City's odor hotline and the outreach effort to inform residents about the hotline, and assisted in the Odor Hotline public outreach by distributing the flyers. The City, along with the Community Liaison, has attempted to recruit new members. As part of the Modification to the Settlement Agreement, the

OAB was expanded. The OAB meets now on an as-needed basis and continues to communicate with the Community Liaison.

The Odor Advisory Board continues to provide valuable input in the City's odor control effort including outreach efforts and providing feedback regarding the effectiveness of the odor control facilities and concerns of the community.

3.2 Odor Expert and Community Liaison

As part of the Modification to the CSSA that was entered into in November 2009, the City hired an Independent Odor Expert (Expert) and a Community Liaison. The role of the Independent Odor Expert was to review ATF Review Study reports and provide comments and recommendations. The Expert also attended OAB meetings where he discussed any material he received from the City and answered questions from the OAB. The Odor Expert worked closely with the City and served through the completion of the study. The Community Liaison facilitates information exchange and discussion between the community and the City regarding odor conditions, sewer odor control activities, and the ATF Review Study. The Community Liaison will serve until June 30, 2014, which is the completion date for the CSSA.

3.3 Odor Outreach Program

3.3.1 Annual Survey

Since June 2006, the City has conducted annual feedback interviews to measure the effectiveness of the Sewer Odor Hotline. The interview process includes conducting street interviews at problematic locations throughout the City, mailing questionnaires to residents that complained through the Odor Hotline, and distributing surveys to community groups. All of the results are compiled and the survey results are reported in the CSSA Annual Report.

The 2011 odor survey was conducted by mail focusing on residents who called the City with sewer odor issues. Overall, the community feedback regarding the City's level of service was outstanding as opposed to last year's survey. The majority of the respondents were satisfied with the City's Odor Reporting Hotline. Many commented on how quickly; usually within the same day, City crew responded after they made the call. Most odor issues were resolved and even if not immediately; they were encouraged that the City is working on it. Some of the suggestions made regarding the improvement of the hotline were to advertise it more and to create better communication between the call center and the Department in charge.

3.3.2 Newspaper Advertising

The City has advertised the hotline in community-based newspapers in the South Los Angeles area in previous years. The odor issues in the area have become less frequent to non existent. The Bureau may continue to use this method as a tool to inform residents about the hotline as needed.

3.3.3 Flyer Distribution

Odor control hotline flyers and magnets are distributed at community fairs, BOS Open Houses, neighborhood council presentations, and any other community meeting. The City distributes educational flyers that explain the City's odor control program and advertise the odor control hotline and a web site which the City operates as well. A sample of the odor control outreach flyer is attached at the end of this section.

4.0 SEWER ODOR GENERATION AND EMMISION

4.1 Odor (H_2S) Generation

Hydrogen sulfide is generated within sewage when sulfates, naturally present in wastewater, are converted to hydrogen sulfide by bacteria residing in the slime layer on the pipe walls, or on debris in the wastewater. This activity increases when certain conditions exist in the collection system such as low dissolved oxygen content, high-strength wastewater, long detention times, and elevated wastewater temperatures. For example, low sloping sewers cause the flow to slow down, resulting in the increased settling of organic solids and grit in the sewer. This debris deposition further slows down the flow. Consequently, this condition increases sewage detention times in the sewer, allowing the sewage to become oxygen deficient or septic.

4.2 The Phenomenon of Sewer Pressurization

Studies of air flow in the City's sewer system, especially in those areas that are experiencing strong and frequent sewer odors, show that the primary cause of odor release is pressurization of the sewer headspace.

Pressurization of the headspace is directly related to the following:

- Friction drag, influenced by wastewater velocity
- Change in wastewater velocity, influenced by change in slopes
- Physical characteristics of the system which influence airflow, such as:

  a- Depth of flow (d/D) and headspace constriction
  b- Diameter changes in downstream direction
  c- Inverted siphons
  d- Confluence of major tributary sewers
  e- Negative slope change

Friction Drag and Air Movement in Conduits

The driving force which moves air within sewer pipes is friction between the sewer headspace air and the moving wastewater. For most of the sewer system, the only resistance to air movement in a sewer pipe is friction between the air and the walls of the pipe. Given these two principals, it is possible to generate a velocity gradient profile for air movement in sewers (Fig. 4.2.1). As might be anticipated, the velocity of the air is at a maximum near the surface of the water and decreases rapidly with increasing distance from the sewage. It is important to note that there are no stagnant air zones and that virtually *all* air in a sewer is moving with the wastewater.

There are many minor factors which act to enhance or diminish this friction and therefore the velocity and pressure of air in sewers. The friction factor between the water and air increases when the surface of the water is "roughened" by the generation of waves and "whitecaps" through turbulence or water velocities in excess of 5-feet-per-second (fps). This type of turbulence can be generated by steep slopes or drops.

Strong turbulence, such as that generated by large hydraulic jumps, long gravity drops, or a spraying force main, increases friction dramatically since the water is churned into individual droplets. The droplets have many times the surface area of smooth water flow and therefore generate increased friction with the air. This high friction added to the effects of increased sewage velocity can move high volumes of air down sewers. To make matters worse, turbulence in wastewater also increases the release of odors and corrosion-causing compounds from wastewater, such as hydrogen sulfide gas.

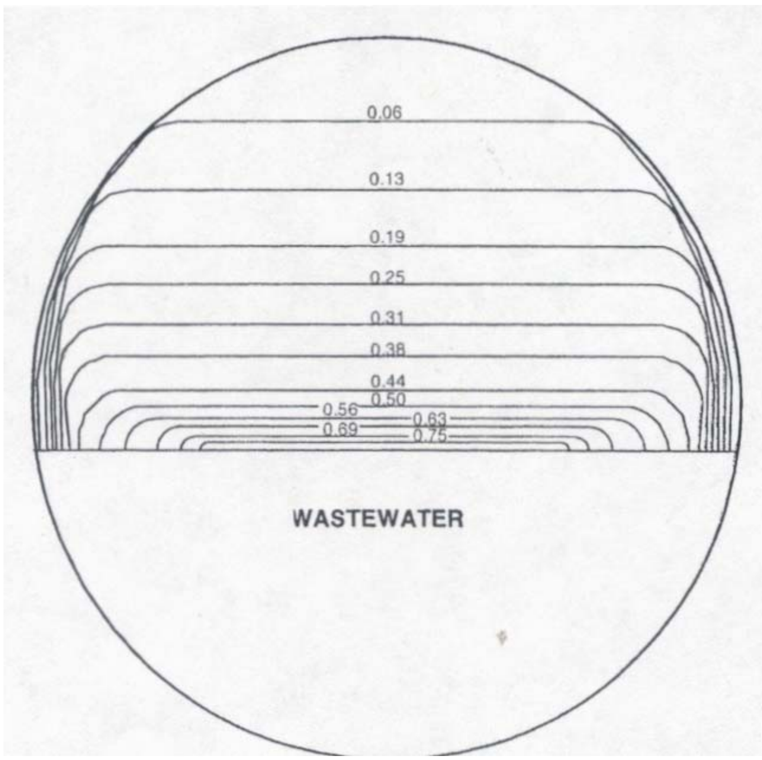


FIGURE 4.2.1
IDEALIZED AIR VELOCITY CONTOURS
IN PERCENT OF WASTEWATER VELOCITY

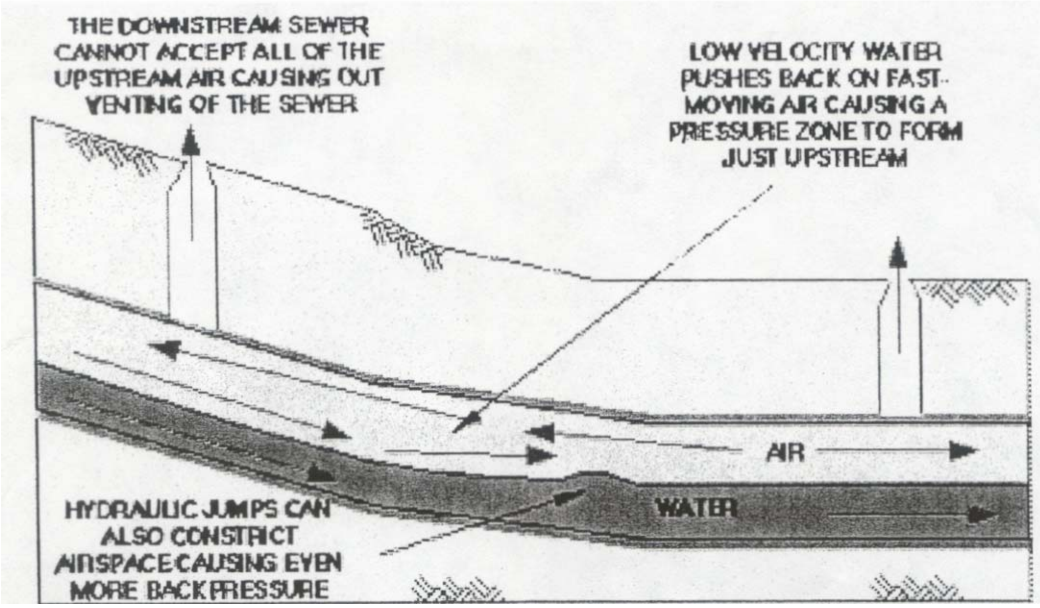


FIGURE 4.2.2
PRESSURIZATION DUE TO SLOPE CHANGE

4.2.1 Pressurization Due to Slope Reduction

Just as fast-moving wastewater can accelerate air movement; conversely, a slow-moving, calm water surface will exert minimal drag on the air and move relatively small volumes of air. Additionally, if the wastewater flow decelerates, then the friction between the fast-moving air and the slow-moving sewage will slow the air movement. Therefore, when the velocity of wastewater decreases due to a flattening of sewer slopes, the fast-moving air from upstream collides into the slower air in the flatter segment, generating high gas pressure. This high pressure pushes sewer gasses through the nearest openings and into the atmosphere, causing complaints (Fig. 4.2.2).

4.2.2 Pressurization Due to Air Headspace Constriction

The ratio of wastewater flow depth to the pipe diameter is expressed as d/D. When the pipe is half full, this ratio equals 0.5 and it equals 1 when the pipe is running full. Since the headspace above the wastewater conveys moving air, a constriction in this space will "squeeze" this air and it will become pressurized. Headspace constriction is one of the main causes of pressurization in the collection system. As the wastewater flow increases, it takes up more space in the pipe (the d/D increases) and the gasses are forced out and escape through any available routes such as house connections or vent holes.

4.2.3 Reducing Pipe Diameter in the Downstream Direction

A pipe's diameter is sometimes reduced in the downstream direction in order to "squeeze" past an existing underground structure. This creates a choke point in the pipe. The surface of the flow approaching this bottleneck tends to rise, forcing the air above into wave fronts that are pushed backwards. When these air waves collide with the air traveling downstream, pressurization occurs, forcing the gasses out of the sewer system.

4.2.4 Inverted Siphons

Any extensive sewage collection system in a metropolitan area is usually designed with inverted siphons due to the abundance of interfering structures. Inverted siphons are pipes or other conduits that dips down in order to pass under a structure blocking the path of the pipe. Because they have to dip down, they are always full of water and have no headspace in the pipe available for the movement of air. They therefore block the flow of any air that is traveling down the pipe towards them. Alternate air pipes called "air jumpers" are built for the air movement past the siphon and they join with the sewer once the siphon ends. Some jumpers are undersized and have become a source of gas pressurization.

4.2.5 Confluence of Major Tributary Sewers

Turbulence in wastewater flow not only leads to higher gas pressures in the sewers but also facilitates the release of hydrogen sulfide gas from the sewage into the headspace. When gas vents from a sewer into the atmosphere, it is the hydrogen sulfide gas that people smell and find so offensive. When one flow stream enters into another at a strong angle (i.e. perpendicular), it generates significant turbulence and leads to pressure and strong odor releases.

5.0 ODOR CONTROL TECHNOLOGIES

There are many technologies and strategies available to address odors in the collection system including liquid phase treatment, vapor phase treatment, and hydraulic improvements.

5.1 Liquid Phase Treatment

Liquid Phase Treatment is the addition of chemicals into the sewage in order to limit the generation of hydrogen sulfide (H_2S). Various chemicals can be employed for this purpose. The most common chemicals used are discussed below.

5.1.1 Calcium Nitrate (BIOXIDE)

Adding nitrates reduces sulfide generation in the sewage by replacing sulfates as the source of oxygen for the bacteria. This reduces the conversion of sulfates to sulfides. Calcium nitrate can affect sewage plant operations if overdosed. The increased nitrate levels in the sewage may result in the formation of nitrogen gas bubbles that inhibit settling in the treatment plant's primary clarifiers. But, when properly dosed, calcium nitrate will not have any negative impact on either pump station or treatment plant operations. As a benefit, the addition of calcium nitrate may result in a small reduction of BOD_5 in the plant influent, and furthermore, calcium is a required micro-nutrient for biomass growth.

5.1.2 Iron Salt

Ferrous chloride is an iron salt that reacts with sulfides and precipitates them out of the liquid. When this salt is added to wastewater, it immediately separates into ferrous iron and chloride. The ferrous iron then reacts with the sulfides to form ferrous sulfide, an iron-bound sulfide molecule that cannot dissolve in the wastewater. The subsequent decrease in dissolved sulfides reduces vapor phase H2S concentrations, reducing odor emissions. Its disadvantages include its proclivity, depending on the relative solubility of the potential resultant compounds, to react with negatively charged ions in the wastewater other than sulfide.

5.1.3 Metal Salts

Metal salts, such as ferrous sulfate, react with hydrogen sulfide and precipitate it out of solution by forming an insoluble metallic sulfide. The dose is 4.5 grams of ferrous sulfate for each gram of sulfide to be oxidized. This is less expensive than peroxide or chlorine.

The primary disadvantage of the above products is that they may contain a high free acid content which will increase the pH of the sewage. This can interfere with biodegradation of the waste.

5.1.4 Potassium Permanganate

This is a strong oxidizing agent that reacts with hydrogen sulfide in a variety of ways, depending on whether the stream is acidic or alkaline. In waste streams in which the pH is neutral, a variety of reactions occur, yielding elemental sulfur, sulfate, thionates, dithionates, and manganese sulfide end products. Potassium permanganate has been fairly effective when added to sludge dewatering operations, where it is added to the suction side of the sludge pumps feeding the dewatering unit. It has a few disadvantages. Dosages are difficult to predict and control in most liquid applications. The high cost and high dose, 6 or 7 parts of potassium permanganate are needed for each part of hydrogen sulfide, are discouraging. Safety precautions are required for handling and storage.

5.1.5 Chlorine and Sodium Hypochlorite

Chlorine combines with water to form hypochlorous and hydrochloric acid which kills the bacteria that produce hydrogen sulfide. It also oxidizes the sewage, which helps prevent the production of hydrogen sulfide. There are several disadvantages associated with chlorine. Chlorine also kills the beneficial, waste-degrading bacteria used to treat sewage. It also combines with urine in the waste stream to form chloramines, which are difficult to remove. Toxic or carcinogenic chlorinated hydrocarbons may form during treatment of chlorinated sewage. Additionally, chlorine is a hazardous material, requiring special safety precautions.

5.1.6 Hydrogen Peroxide

Hydrogen peroxide reacts with hydrogen sulfide, forming sulfur and water (see the chemical equation below). The reaction occurs quickly. Generally, 90% of the reaction occurs within 10 to 15 minutes and is completed within 20 to 30 minutes. For this reason, it is used to treat local problems only, since it doesn't have long-lasting or far-reaching effects. Any excess hydrogen peroxide decomposes, releasing oxygen and water, thereby increasing the dissolved oxygen in the stream. There are some disadvantages. It is relatively expensive and dangerous. It requires special safety procedures when handling, including the use of protective clothing. Face shields must be worn during bulk storage loading, repair, and maintenance of the facility. Spontaneous combustion is possible.

hydrogen peroxide + hydrogen sulfide ⟶ elemental sulfur + water

pH < 8.5 $$H_2O + H_2S \longrightarrow S + 2H_2O$$

hydrogen peroxide + sulfide ion ⟶ sulfite ion + water

pH > 8.5 $$2H_2O_2 + S^{2-} \longrightarrow SO_2^{2-} + 2H_2O$$

5.1.7 Oxygen/Air Injection

Oxygenation helps beneficial aerobic and facultative anaerobic bacteria reproduce faster than undesirable anaerobes. This allows the beneficial bacteria to consume more of the available nutrients. Its beneficial use is typically limited to force main applications due to its low saturation characteristics under atmospheric conditions.

oxygen + ionized hydrogen sulfide $\xrightarrow{\textit{bacteria}^*}$ thiosulfate ion + water

$$2O_2 + 2HS^+ \xrightarrow{\textit{bacteria}^*} S_2O_3^{2-} + H_2O$$

* anaerobic or facultative anaerobic bacteria

5.1.8 Caustic Shock Dosing

Sodium hydroxide is added directly to the sewage through a maintenance hole upstream of the sulfide producing zone. It is added at a volume and rate to elevate and pH above 12.5 for at least 30 minutes to inactivate or kill the sulfate reducing bacteria. Periodic caustic shock dosing can effectively remove all sulfide forms.

5.1.9 Magnesium Hydroxide

Continuous Addition – As the pH of wastewater rises, the natural state of sulfides in the wastewater shifts away from offensive H2S gas and towards dissolved sulfides in solution. Magnesium hydroxide raises the pH of wastewater and has a residual buffering capacity that maintains an elevated pH for a significant distance downstream of the application point. For this reason, magnesium hydroxide is continuously added to wastewater to raise and buffer it pH to within a range of 7.5 to 8.6. At a pH of 8.6, only 3% of sulfides exists as H2S gas while the vast majority of sulfides are held in solution in the form of disulfide and dissolved sulfide. Consequently, maintaining a high pH provides effective odor control.

5.2 Vapor Phase Treatment

Another strategy is Vapor Phase Treatment, which involves containing or treating the gasses and odors directly. Treatment methods involve either containing the gasses or filtering odors from gasses escaping from the collection system. Applications include sealing maintenance holes, inserting devices into maintenance holes, or constructing large facilities such as carbon scrubbers, biofilters, or biotrickling filters, the technology that the ATFs employ.

5.2.1 Sealing Maintenance holes

The most straightforward method to treat odors in the vapor phase is to contain the vapors. The simplest solution is to simply prevent the gas from venting from the sewer system through the maintenance holes by sealing the maintenance hole lid with a mixture of roofing tar and sand. Sealing of maintenance holes is performed mostly on maintenance holes located on the large diameter sewers that experience headspace pressurization.

5.2.2 Gas Trap Maintenance Hole

Another solution to trapping the gas is to construct a gas trap maintenance hole. A gas trap maintenance hole forms a water seal similar to a p-trap, which blocks sewer gasses from traveling upstream past the structure. They are constructed at locations where small diameter sewers discharge into large outfall sewers and they prevent pressurized sewer gases from being forced from the large sewer into the smaller sewers.

5.2.3 Maintenance Hole Inserts

Inserts (e.g. Bioteg MH Biofilter) filter odors from sewer gases traveling up maintenance holes and are used at several locations throughout the city. Microorganisms in the filter media oxidize and remove odors from the gas before it exits the maintenance hole lid.

5.2.4 Large Air Treatment Facilities

Large air treatment facilities can be constructed to reduce the air pressure in sewers and remove the odors from large volumes of sewer gases before releasing it into the atmosphere. These facilities include carbon scrubbers, biofilters, and biotrickling filters.

5.2.4.1 Carbon scrubbers

Carbon scrubbers use activated carbon to adsorb H_2S as it passes through the media. Advantages of carbon scrubbers include having a small footprint and a H_2S removal rate of up to 99.5%. Scrubbers have several disadvantages including:

- Can only handle small flow rates (typically less than 20,000-CFM)
- Carbon media can require frequent replacement, depending on loadings
- Significant O&M cost
- Upgrading is difficult if flows increase due to process expansion
- Can let other odorous compounds pass through when media becomes "spent"
- Requires frequent operator attention to check state of media

5.2.4.2 Biofilters

Biofilters have proven to be an effective technology for removing VOC-type odors, hydrogen sulfide, and ammonia from air exhausted from livestock facilities. Biofilters are used quite frequently in waste water treatment systems. Proper biofilter design is critical for providing effective and economical treatment. To ensure proper performance, information regarding the relationship between unit flow rate through the biofilter media and the unit pressure drop across the media is needed. A biofilter uses microorganisms supported on organic media (bark, wood chips, compost) to convert odorous gases into non-odorous compounds. An organic media biofilter can destroy up to 90% of the VOCs in a foul air stream. Contaminated air passes through the filter where the microorganisms consume the organic carbon and produce CO2, water, and biomass. The bacteria residing in the water film on the media oxidize hydrogen sulfide to sulfuric acid, much of which is washed out of the bed as a result of the irrigation process or during wet weather events.

Organic media biofilters uses non-hazardous compounds, employ a relatively simple concept and require little maintenance, however they do have several disadvantages which include the following:

- Large footprint required (up to 2,500 sq ft. for 30,000 CFM @ 20 PPM H2S)
- Large capital cost
- Difficult to upgrade for increased air flows
- Settling of biofilter media can cause air channels to form in the media bed, reducing performance over time
- Organic media needs to be replaced after 3-5 years

5.2.4.3 Biotrickling Filter

Biotricking filters use the most current technology available. Water trickles over the filters, which are columns filled with inert packing media and a biofilm develops on the surface of the media. The biofilm is nourished by nutrients fed into the trickling stream to support biofilm growth. Most of the pollutant degradation occurs in the biofilm by a mass transfer and biological process. Natural media used in the filters can include soil, peat, compost, or bark, however, most biotrickling filters use engineered media which provide the advantages of natural media with a lower rate of fouling and longer life. The water is recycled over the media and the system is also supplied with essential nutrients for the biological organisms, which are the primary method in which contaminants are removed from the air. The organisms responsible for odor removal are usually aerobic since the system is well aerated. Contaminated gas is supplied either co-current or countercurrent to the water's direction. Biotrickling filters operate similar to biofilters with a more complex removal system that is suited to treat compounds that when degraded, produce an acidic by-product such as H2S.

5.3 Hydraulic Design Improvements

In some cases odors vent from the sewer due to poor or inadequate hydraulic design. Another strategy for reducing odors venting from the collection system is implementing the adequate sewer design criteria to avoid hydraulic and geometric characteristics that either increase the production of odors or constrict the flow of gas in the sewer headspace, forcing it out of the sewer.

5.3.1 Low Flow Velocity

If sewage flows too slowly, sediment within the sewage settles out and deposits within the pipe. These deposits provide an ideal environment for an anaerobic slime layer where hydrogen sulfide is produced. Sewers should be designed to provide an adequate flow velocity to reduce the deposition of solids within the sewage and help eliminate the development of H2S.

5.3.2 Inverted Siphons

Significant odor issues have been associated with air pressure build-up on the upstream side of inverted siphons. It lies with the fact that the sewer pipe in a siphon flows completely full with no headspace within the pipe to convey the gas. Therefore, air ducts or "air jumpers" are needed to transport the gases across the siphon. These air jumpers have historically been undersized. Air jumper should be designed to provide sufficient headspace to convey the air across.

6.0 ODOR CONTROL MEASURES

Municipalities face daily challenges in their effort to control and mitigate sewer-related odors. The City has implemented a successful program to control and reduce odors within its collection system which has made significant improvements. Various measures are employed to reduce the generation and release of odors from the sewer system. They include:

- odor complaint response and investigation;
- routine sewer maintenance;
- chemical addition;
- air withdrawal and treatment from the collection system;
- sewer construction and repair; and
- on-going monitoring of sewer air pressure and odor concentration.

This section discusses these various odor control measures and procedures the City uses as part of the Odor Control Program.

6.1 Odor Complaint Response and Investigation

The Bureau of Sanitation, Wastewater Collection Systems Division (WCSD) responds to various odor complaints from the public. However, complaint investigation is geared toward identifying and mitigating sewer-related odors. Non-sewer issues are referred to other city departments or outside agencies for follow-up investigation and mitigation efforts.

The public can file an odor complaint through a 24-hour, operator-assisted odor complaint hotline (1-866-44SEWER) or use the City's website at www.lasewers.org. The City is trying to emphasize the 3-1-1 phone number for government services and information as the best way to file an odor complaint. Additional complaints are received through direct contact from the public and referrals from council offices other city departments.

The odor complaint response and investigation involves the following process:

1. The complaint is directed to the appropriate maintenance yard
2. A field crew investigates the complaint, identifies the source and determines/implements necessary actions to mitigate the odor such as cleaning the sewer, sealing maintenance holes, inspecting trap maintenance holes for structural integrity and function, or referring the matter to other city departments or outside agencies if it is not related to sewers.
3. The crew documents its findings and actions on an Odor Complaint Response Form and submits document for review and data entry.

4. For hotline complaints, WCSD informs the complainant within 7 days of the complaint about the findings, actions, and/or status of investigation and also gathers feedback. A 30-day callback is conducted if the complainant so requests.
5. Follow-up inspections are conducted if necessary
6. Problems not correctable by maintenance staff are referred to WCSD's Engineering Section for further investigation and possible solution. Typical engineering activities include:
   - reviewing sewer plans
   - conducting on-site field visits
   - reviewing odor complaints in the surrounding area
   - reviewing available flow monitoring data
   - monitoring pressure and H_2S levels and evaluating the data
   - requesting repair of trap maintenance holes or other sewer structures by an on-call contractor
   - proposing a capital improvement project (CIP) such as hydraulic relief pipes, air treatment facilities, chemical addition systems, etc.

Sewer related complaints are caused by sewer ventilation in which foul air is forced out and released from maintenance holes and trap maintenance holes or other sewer structures or facilities such as pump plant and treatment plants; by sewers that have become septic due to debris build-up causing a surcharged or hydraulically loaded system; or by properties with house connection laterals directly connected to large diameter sewers. Sewer related odors account for 22% of the complaints received or 106 complaints. Compared to last fiscal year 2009/10, sewer related complaints were reduced by 21%. Projects performed over the past year have significantly contributed to the lower number of complaints in comparison to last year. The reduction is due to the completion of the rehabilitation and commissioning of the lower portion of the North Outfall Sewer, the completion of the Phase 1 and 2 Trap Maintenance Hole Upgrade and Rehabilitation Project, the La Cienega/Rodeo Maintenance hole upgrade and air curtain installation on the NOS/LCSFVRS diversion structure, the installation of air curtains on the three main NORS diversion structures, and the commissioning and full activation of new Air Treatment Facilities on ECIS/LCSFVRS and NCOS. The combination of all these projects have allowed a greater zone of negative pressure to be achieved from the ATFs and the existing carbon scrubbers. Overall, the completion of the projects mentioned above and continued maintenance has made a marked improvement to the reduction of the sewer related odor complaints. This year's total number of sewer related complaints is the lowest since we have been collecting information for the CSSA. The City continues to pursue odor remediation measures to reduce complaints when possible.

The remaining 78% of odor complaints investigated were non-sewer related. They include odors from standing water, dirty alley, stormwater catch basin sources, owner plumbing trouble, etc. All sewer related odor complaints were properly investigated and addressed, while non-sewer related odors were referred to the appropriate City department or other government agencies. For the break down of odor complaints please see table 6.1.1, and figure 6.1.2.

	Q1	Q2	Q3	Q4	Total
Trap MH	1	2	0	1	4
Sewer Ventilation	32	4	5	13	54
HC to Lines >18"	4	4	0	1	9
Septic Condition	11	8	4	2	25
Construction Related	3	1	4	2	10
Pump Plant Odor	1	1	0	0	2
Treatment Plant Odor	0	2	0	0	2
					106

TABLE 6.1.1

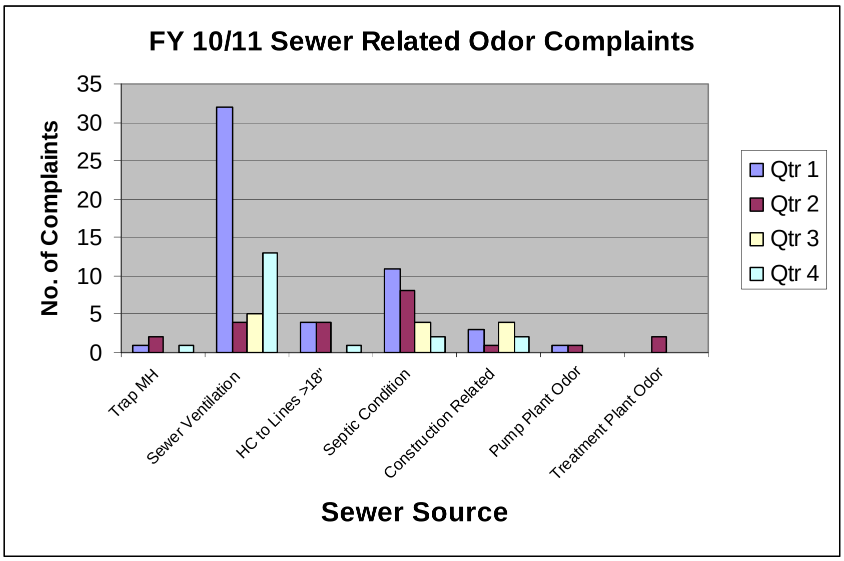


FIG. 6.1.2

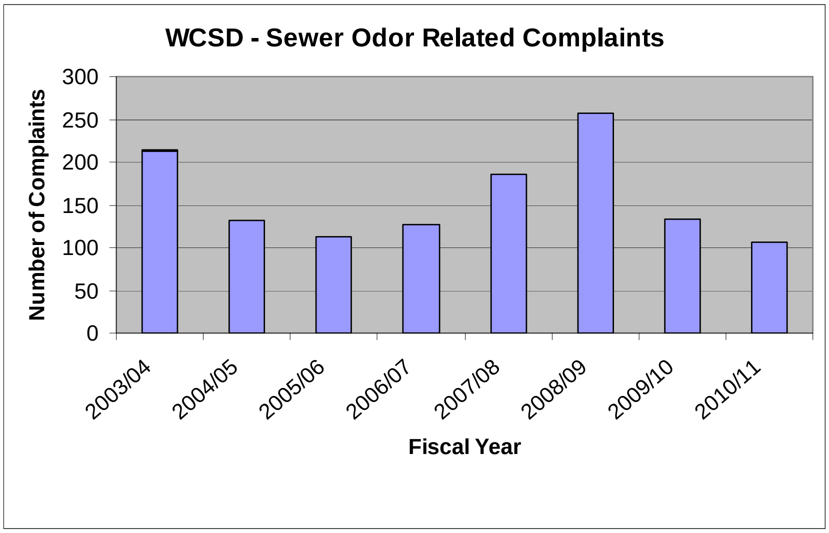


FIG. 6.1.3

6.2 Routine Sewer Maintenance

Routine sewer maintenance is necessary to allow the wastewater to flow freely and unimpeded in the sewer pipe. Obstructions in the sewer slow the sewage and cause debris to settle. As discussed earlier, this promotes the generation of hydrogen sulfide. Preventive maintenance includes sewer cleaning, root control, and trap inspection and/or maintenance. Other maintenance includes sealing sewer maintenance holes or other access points, where needed, to prevent the release of foul odors.

- **Sewer Cleaning and Root Control**
  Sewer pipes are inspected and cleaned periodically to prevent conditions that exacerbate hydrogen sulfide generation. There are several traditional cleaning techniques used to clear blockages. They include hydroflushing, rodding, and bucketing.

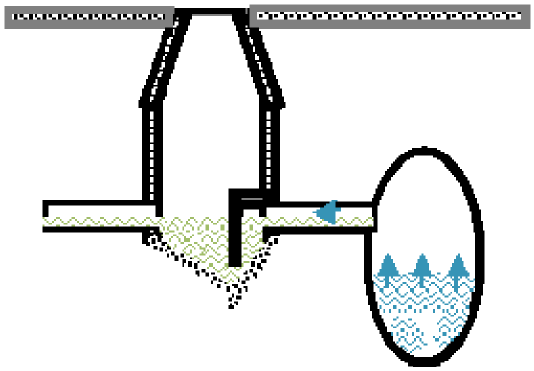
  Hydroflushing – Directs a high-velocity stream of water against the pipe wall. This process removes debris and grease build-up and clears blockages within small-diameter pipes.

  Rodding – A continuous or sectional rod with a blade at the end is inserted into the pipe and rotated. This action breaks-up grease deposits, cuts roots, and loosens debris.

  Bucketing – A cylindrical “bucket” with one closed end is pulled through the line, removing sediment and other material. This process partially removes large deposits of silt, sand, gravel, and some types of solid waste.

All sewers are cleaned at least once every five years and more frequently in known "hot spots". Approximately 65,000 pipe segments (2800 miles) are cleaned annually. In addition to hydraulic and mechanical cleaning, chemicals are applied into root infested sewers to clear the roots from the pipe. Approximately 400 miles of sewers are treated annually.

- **Trap Maintenance Hole Inspection and Cleaning**

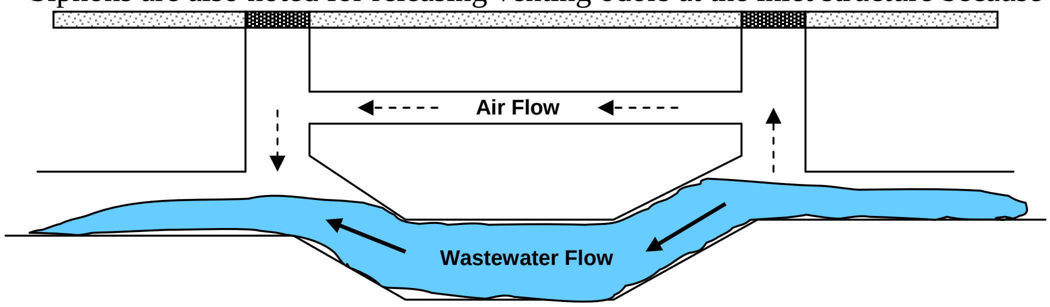


Trap maintenance holes are inspected and cleaned on a quarterly basis. These structures are used to prevent the migration of sewer gases throughout the collection system. They are typically located where small sewers, 6-inches to 15-inches, connect to large interceptor and outfall sewers since high gas pressures are more prevalent in large sewers. Trap maintenance holes act similarly to p-traps used in residential plumbing by creating a water seal that blocks the sewer gases.

- **Siphon Inspection and Cleaning**

Sewer siphons descend to carry sewage under obstructions such as rivers, storm drains, or other utilities, and then regain elevation after passing the obstruction. The siphon always remains full of water, causing the sewage to move very slowly through a siphon during periods of low flow. For this reason, siphons and other submerged lines are prone to debris deposition and are likely sources of high H_2S generation. To prevent this, siphons are cleaned quarterly.

Siphons are also noted for releasing venting odors at the inlet structure because the full pipe blocks the air flowing downstream with the sewage. High turbulence at the siphon inlet aggravates this problem by stripping H_2S out of solution and sending it airborne, adding to the odor. An air duct called an "air jumper" conveys the airflow past the siphon from the inlet to the outlet structure. Air jumpers often follow the sunken (inverted) path of the siphon line, allowing condensate to collect and impede the air movement unless it is drained. To prevent this, inverted airlines either drain automatically with pump systems or are dewatered manually using a vacuum truck. The pump systems are inspected periodically and manual vacuuming is performed on an as-needed basis.



- **Sealing Maintenance Holes**

Sewer maintenance holes provide access for maintenance crews. However, they also provide a route for sewer gases to escape when pressures build up. Sewer gasses can become pressurized for multiple reasons. At times of high sewage flow, the sewage

occupies a greater proportion of sewer volume than at times of low flow. As a consequence, some air in the sewer is displaced and finds its way out through maintenance holes or other access structures. Conversely, as flows decrease, fresh air is drawn into the sewers. This is a natural ventilation process that occurs in the collection system. As sewage flows, air in the pipe's headspace is dragged with it. Higher velocity flows will tend to pull in and drag more air down the pipes. When this air is blocked by an obstruction, it will vent through any relief available such as nearby maintenance holes. In areas where odors continuously vent, maintenance holes are sealed. Typically, this is done as part of regular maintenance activities or in response to odor complaints.

6.3 Chemical Control Technologies

Chemical or "liquid phase" control technologies limit the production of hydrogen sulfide by preventing sulfides from forming in sewage. There are numerous chemicals and methods employed for controlling sulfides, depending on the conditions under which they are being employed. For example, chemicals can halt new sulfide production or neutralize existing sulfides. The Bureau of Sanitation has researched and tested many types of liquid phase treatment since the early 1990s. Pilot studies were conducted to measure the performance of various chemical applications such as sodium hydroxide (caustic soda), ferric chloride addition, ferrous chloride, hydrogen peroxide, calcium nitrate (Bioxide), and magnesium hydroxide (Thioguard). The City began routine application of odor control chemicals in 1997.

Developing a chemical control program requires an extensive survey of the collection system in order to accurately choose a chemical and locate an injection point that will be effective. This process is described below.

1. Review odor complaint history – Look for repeat odor complaints in a community.
2. Review collection system maps - Check size and type of nearby sewers (local sewer, interceptor sewer, or outfall sewer), pipe slope, flow rates and levels, locations of maintenance holes, junctions or tributary structures, and any pump plants or siphons.
3. Preliminary sampling – Sample the wastewater for total and dissolved sulfides, pH, and temperature. Hydrogen sulfide is measured using hand held meters and/or continuous data logging monitors. Sample all major tributary points to the problem

area and proceed toward the upstream reaches. This is a quick and effective method to isolate problem areas requiring further investigation.

4. Determine baseline H_2S profile and sulfide mass loading – Once a problem area is isolated, additional samples are taken to develop the baseline data profile which includes maximum, minimum, and average H_2S levels over a period of 24-hours or more. This will be compared with data taken during the trial-and-error applications to measure effectiveness. Analysis of dissolved sulfide concentrations in samples along with known flow information helps determine the amount of sulfide present and where it is coming from.
5. Determine location for chemical injection – The monitoring data will identify the area generating sulfide. The injection point will be located at the most upstream reach of the generation zone to ensure adequate treatment.

Although there are theoretical formulas and rules regarding the dosing requirements for each liquid phase treatment process, it is not an exact science. Field analysis of the results and subsequent adjustments are required. Therefore, trial and error applications are common until an adequate dose level is achieved. Continuous monitoring is necessary to determine a cause-and-effect relationship of each treatment. Monitoring for H_2S is typically performed inside the maintenance holes because hydrogen sulfide dilutes immediately after exhausting into ambient air making concentrations much lower in the air outside the maintenance hole. Along with monitoring, each application should be correlated with the corresponding number of odor complaints in the affected area. A reduction in the number of odor complaints is an indication that the dosing levels are working.

Currently the Bureau of Sanitation is using a 50% sodium hydroxide solution called caustic soda and continuous Thioguard (magnesium hydroxide) addition to chemically control odors in the collection system.

- **Caustic Shock Dosing Application**

The Bureau of Sanitation has been using caustic soda in a process called "caustic shock dosing" routinely since 1997 to control sulfide generation. The selection of this treatment was based on positive past experiences and its success in neighboring municipalities such as Los Angeles County and Orange County. Additionally, this treatment is ideal for the sewers targeted due to their long detention times which allow adequate contact time for treatment. Furthermore, caustic shock dosing is a very flexible process and can be mobilized quickly to treat any area of the collection system.

Periodic caustic shock dosing can effectively remove all sulfide forms. It inactivates, or kills, the biological slime layer where sulfates are transformed to sulfides. Monitoring has shown that the slime layer requires 3 to 5 days to re-form and reach full sulfide production again, depending upon pH, temperature, and contact time of the caustic soda. It rebounds more quickly in warmer weather. Therefore, the frequency of the shock dosing schedule varies with the seasons so as to prevent a complete rebound of hydrogen sulfide production.

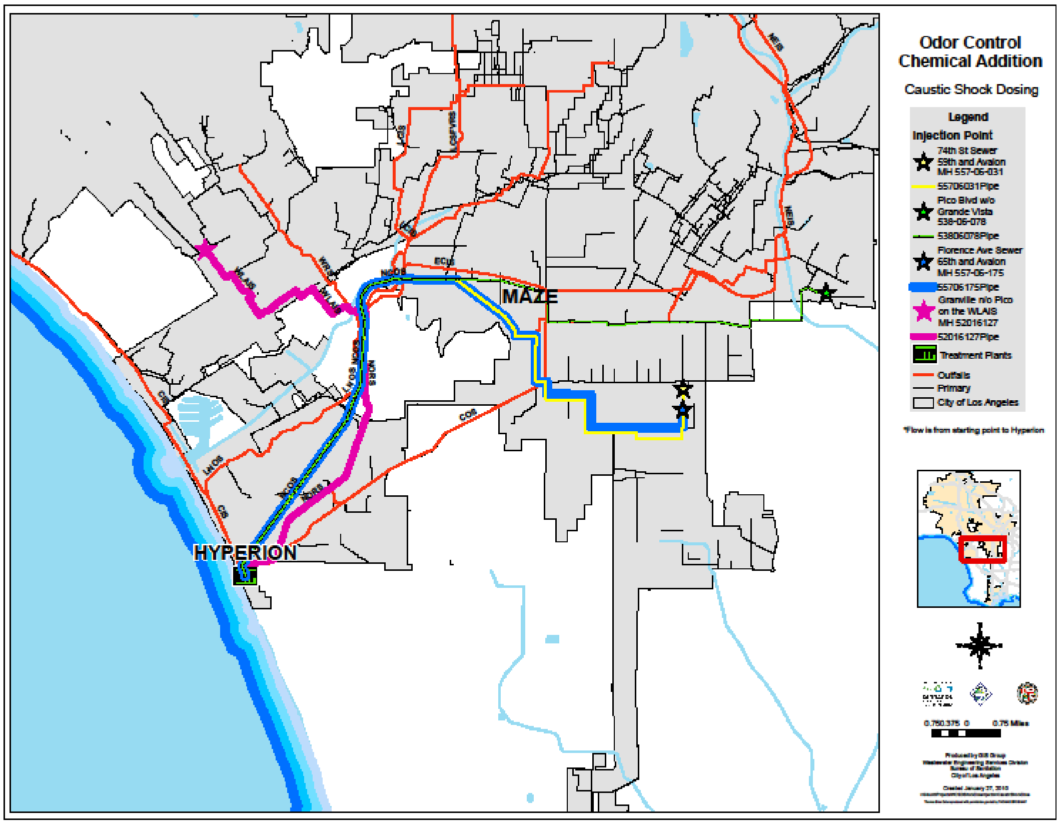


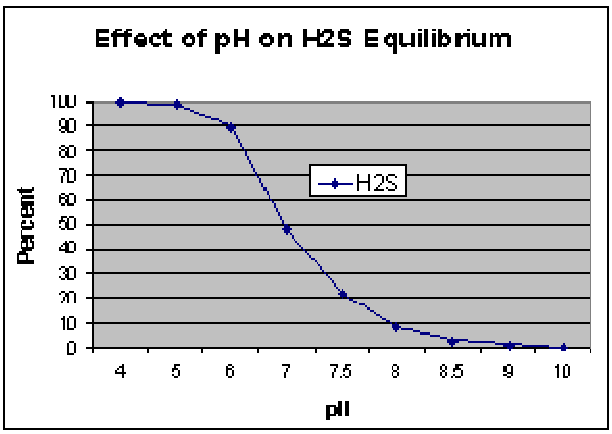
FIG. 6.3.1

Caustic soda is added directly to the wastewater stream through a maintenance hole upstream of the area to be treated and at the sulfide-producing zone. It is added at a volume and rate sufficient to elevate the pH above 12.5 for at least 30 minutes to inactivate or kill the sulfate-reducing bacteria. Continuous pH monitors are placed downstream of the application point to confirm that adequate treatment levels are attained. Caustic soda is applied upstream of the sulfide-generating area 1 to 3 times per week, depending on the generation rate and time of year. It is currently being applied to sewer reaches upstream of the Maze area which accounts for approximately 46% of the sulfide loading to the Maze Area Sewer System. The caustic injection in the South Los Angeles area is conducted on the Florence Ave Sewer and 74th Street Sewer. Both sewers are tributary to the South Branch of the

Maze. Caustic shock dose application continues in the WLAIS due to higher H2S concentrations as a result of high dissolved sulfide generation caused by solids deposition in the large diameter sewer. See figure 6.3.1 for the chemical flow path.

As a safety precaution, all chemical applications are scheduled in advance and announced to all collection system personnel to avoid accidental contact with the chemical as it passes down the sewer system. Additionally, the treatment plant is notified prior to application. A shock dose schedule bulletin is distributed to wastewater collection system personnel, including those at treatment plants and the Bureaus of Engineering and Contract Administration. The bulletin includes location, date, time and volume of caustic soda to be added to the collection system.

- **Magnesium Hydroxide Continuous Addition**



As the pH of wastewater rises, the natural state of sulfides in the wastewater shifts away from offensive H_2S gas and towards dissolved sulfides in solution. Magnesium hydroxide raises the pH of wastewater and has a residual buffering capacity that maintains an elevated pH for a significant distance downstream of the application point. For this reason, magnesium hydroxide is continuously added to wastewater to raise and buffer its pH to within a range of 7.5 and 8.6. As the graph shows, at a pH of 7, approximately 50% of all sulfides exist as H_2S gas. At pH 8, that number falls to 10% and at pH 8.6, only 3% of sulfides exist as H_2S gas while the vast majority of sulfides are held in solution in the form of disulfide and dissolved sulfide. A slight drop in pH results in a significant increase in H_2S produced and thus emitted into the atmosphere. Consequently, maintaining a high pH provides effective odor control.

The City has been using a 65% magnesium hydroxide slurry as a non-hazardous means to regulate the pH of its wastewater since September 2003 as the result of a successful pilot testing. This application requires 20 to 25 gallons of magnesium hydroxide per million gallons of wastewater to control odors. Currently, magnesium hydroxide is injected from the Tillman Water Reclamation Plant and is introduced to AVORS to raise the pH of the downstream sewers in the NOS, EVRS, and the LCSFVRS. See figure 6.3.2 for the chemical flow path. This benefits both the Studio City area, Hollywood and Mid-City areas. The magnesium hydroxide addition in the Boyle Heights area was replaced by caustic shock dose treatment as described earlier.

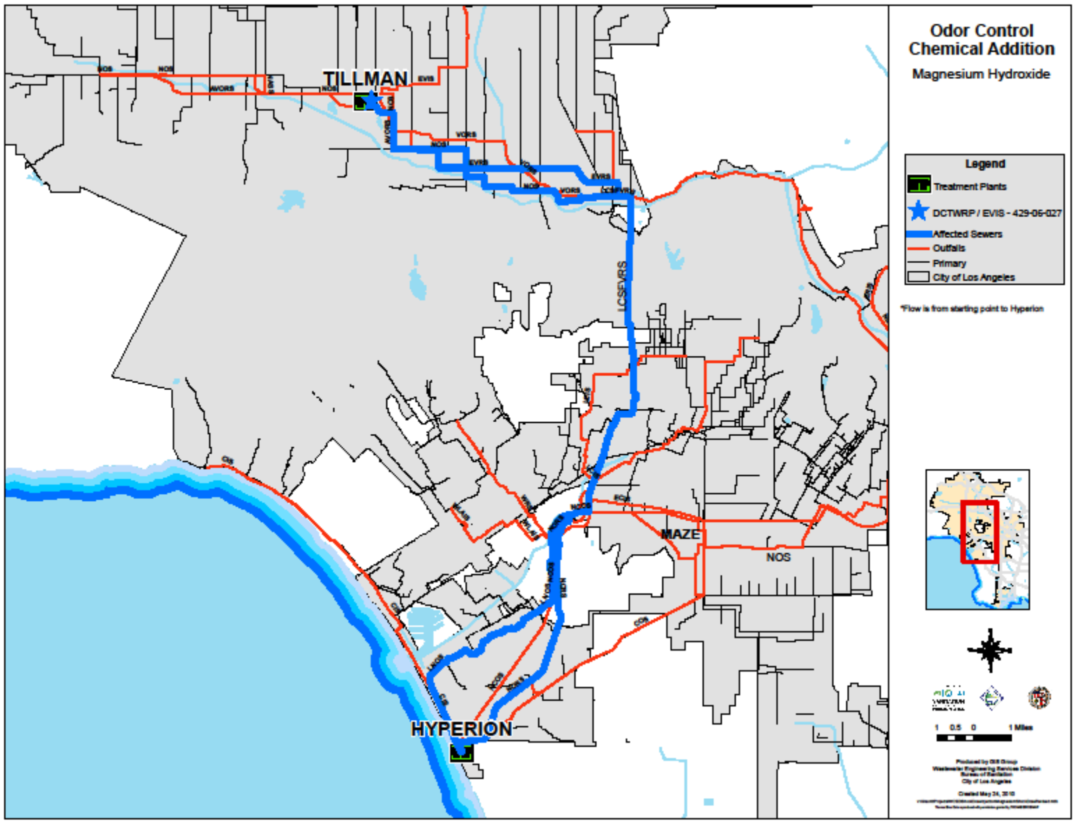


FIG. 6.3.2

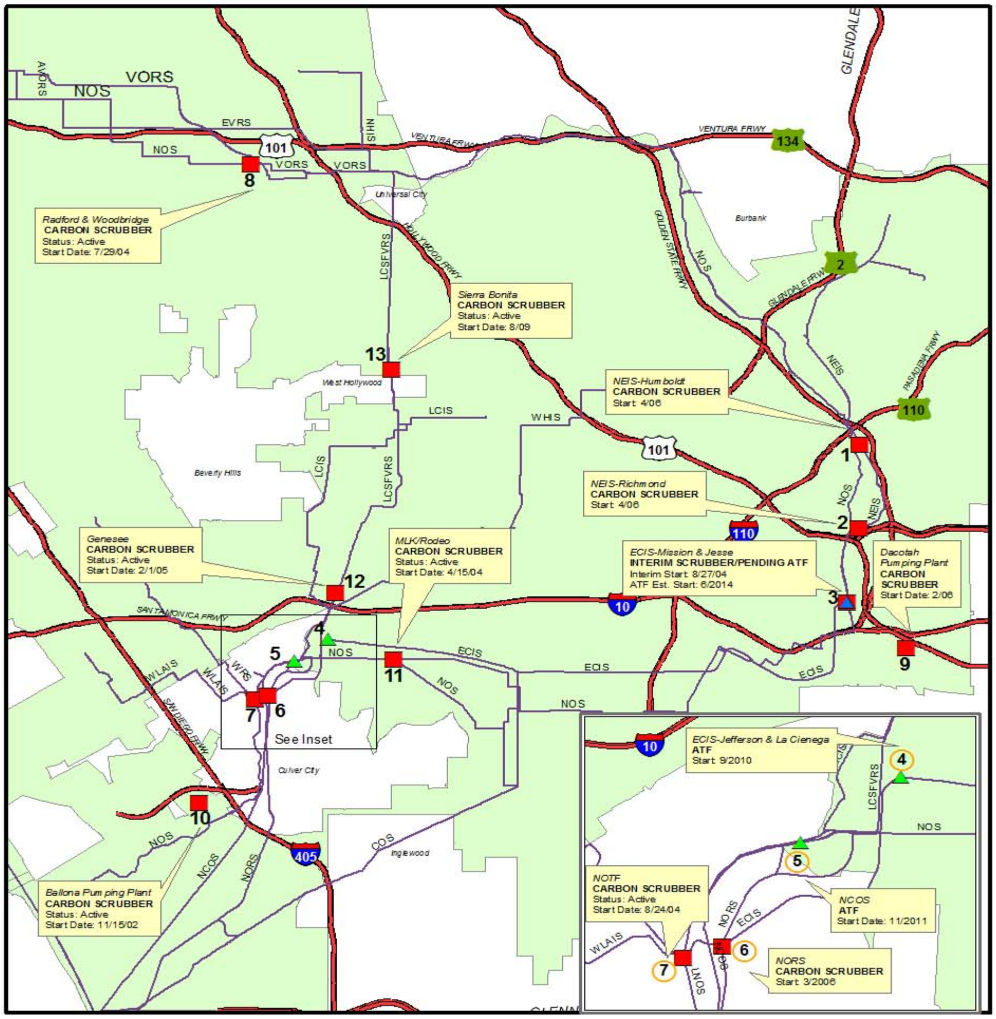
6.4 Air Treatment

The City has conducted multiple studies of sewer gas pressure and odors. The studies have identified distinct high pressure zones in sewers around the South LA area including:

- North Outfall Sewer (NOS)
- Maze Area Sewer System (Maze)
- La Cienega San Fernando Valley Relief Sewer (LCSFVRS)
- North Outfall Replacement Sewer (NORS)
- West Los Angeles Interceptor Sewer (WLAIS)
- Westwood Relief Sewer (WRS)

To address the high pressure zones and localize odor hot spots in the collection system, carbon scrubbers were constructed and permanent air treatment facilities were constructed to alleviate and mitigate the odor emissions from the collection system (see figure 6.1)

Operating & Planned Sewer Air Treatment Systems



Sewer Air Treatment Systems

No.	Name	Type	Size(cfm)	Cost($M)
1	NEIS - Humboldt	Carbon Scrubber	10,000	0.4
2	NEIS - Richmond	Carbon Scrubber	10,000	0.4
3	ECIS - Mission & Jesse	Interim Carbon Scrubber Pending ATF	10,000 12,000	0.2 12.0
4	ECIS - Jefferson/La Cienega	ATF	20,000	14.7
5	NCOS - 6000 Jefferson	ATF	12,000	16.0
6	NORS ECIS	Carbon Scrubber	10,000	0.3
7	NOTF	Carbon Scrubber	10,000	0.2
8	Radford & Woodbridge	Carbon Scrubber	5,000	0.3
9	Dacotah Pumping Plant	Carbon Scrubber	3,000	0.5
10	Ballona Pumping Plant	Carbon Scrubber	5,000	0.5
11	MLK & Rodeo	Carbon Scrubber	5,000	O&M
12	Genesee Siphon	Carbon Scrubber	5,000	0.3
13	Sierra Bonita	Carbon Scrubber	10,000	0.6

Existing Air Treatment Facility (ATF)
Air Treatment Facility (ATF) Pending
Existing Scrubber
Outfalls
Freeway
Los Angeles City
Outside Los Angeles City

Definitions: **INTERIM: Future ATF Planned or Pending**

Wastewater Engineering Services Division
Bureau of Sanitation
City of Los Angeles

Created 12/21/09
Updated 07/21/2011

0 2,450 4,900 9,800 14,700 19,600 Feet

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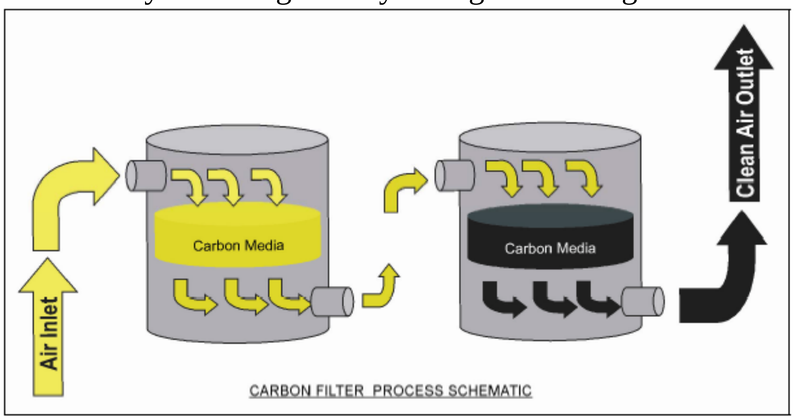
Thomas Bros Data reproduced with permission granted by THOMAS BROS MAP

Figure 6.4

Figure **6.4** shows locations and information on the existing Odor Control units and the planned ATF.

6.4.1 Carbon Adsorption

Conventional carbon adsorption systems offer an effective approach to controlling odors in many situations. In municipal installations, odorous air is typically directed through a vessel containing adsorption media such as activated carbon. Odorous compounds in sewer gases are adsorbed onto the media. Adsorption systems in the City's wastewater collection system are generally configured as single media bed system. Activated carbons



are highly porous materials. Due to large surface areas, activated carbon is able to adsorb hydrogen sulfide, other reduced sulfur compounds and volatile organic compounds

(VOC). These odor-causing compounds are attracted to and adhere to the carbon's pore structure. This process relieves the air pressure in the system while preventing the release of odors. There are currently thirteen carbon scrubbers operating in the wastewater collection system.

Scrubbers are operated under a permit issued by the South Coast Air Quality Management District (SCAQMD). As required by the permit, an operations staff monitors the hydrogen sulfide concentration of the influent air and the treated emissions in order to gage the performance of the scrubber. The typical hydrogen sulfide removal rate is 99%. These readings are posted on a quarterly basis on the City's odor website at www.lasewers.org. Carbon media in each unit is replaced periodically before expected odor contaminant breakthrough. The frequency of change-out, range from monthly to quarterly to bi-annually depending on the contaminant loadings to the carbon scrubber. Interim carbon scrubbers have been installed with plans to replace these units, if necessary, with permanent air treatment facilities (ATFs). They include:

1. ECIS Drop Structure - Mission and Jesse
2. NORS/ECIS Junction

3. NEIS Drop Structure - Humboldt and San Fernando Rd
4. NEIS - Richmond

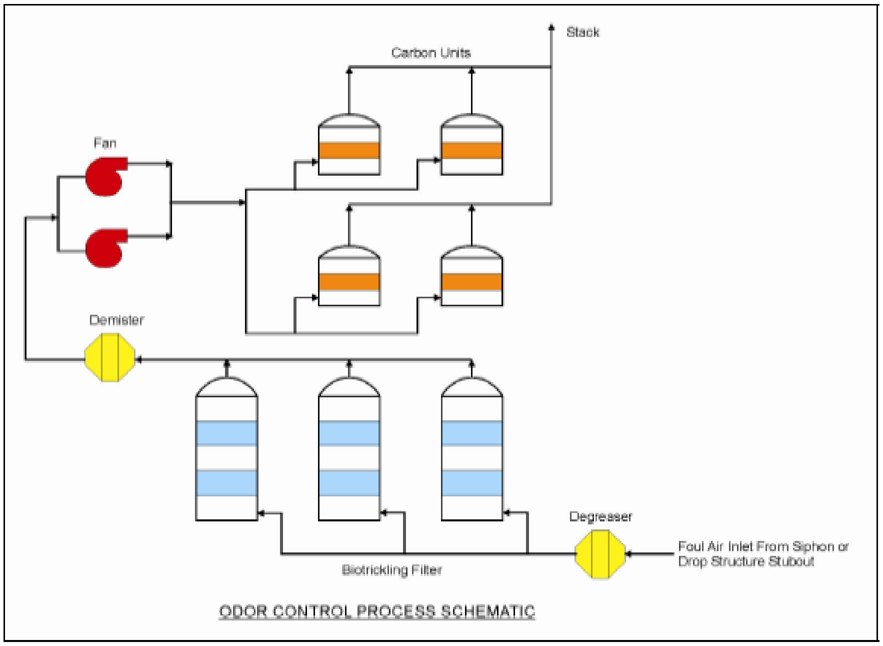
Seven additional carbon scrubbers are installed at other sites to address localized odor hotspots within the collection system. They include:

1. LCSFVRS – Sierra Bonita
2. LCSFVRS Siphon – Genesee
3. NOS Siphon – Radford
4. Maze/NOS Junction – Rodeo and Martin Luther King
5. WLAIS/NOS Junction – North Outfall Treatment Facility (NOTF)
6. Ballona Pump Plant
7. Dakotah Pump Plant

6.4.2 Air Treatment Facilities (ATF)

Since the study in 2001 has been completed, additional sewers have been constructed, and other sewer repair and replacement projects have been completed. Due to these changes in the collection system, the City has come to question some of the assumptions that led to the recommendation for scrubbers and ultimately the ATFs at several of the proposed locations. The City conducted the ATF Review Study. As part of the Modification to the Collection System Settlement Agreement which was entered by the Court in November 2009, the City was required to hire an Independent Odor Expert to review the City's interim and final findings from the ATF Review Study (Study). Consequently construction of 5 ATFs was placed on hold. The Study was completed in November of 2010.

The City has elected to use Air Treatment Facilities (ATF) using a 2-stage odor control system employing biotrickling filtration technology followed by a carbon adsorption polishing step.



Biotrickling filter technology utilizes microbial cells that are attached to a medium inside the reactor, which then oxidize the odorous constituents to odorless compounds. The odor contaminants transfer from the gas to the liquid phase and subsequently to the microbial biofilm, or it is transferred directly from the gas to the biofilm, where it is oxidized biologically to odorless compounds. The oxidative by-products, namely sulfuric acid, are the removed through the trickling effluent. The treated effluent is then polished by carbon adsorption.

Two ATFs have been constructed and are in operation. One is the ATF at East Central Interceptor Sewer Siphon and LCSFVRS (Jefferson & La Cienega) and the other is the ATF at North Central Outfall Sewer Siphon (NCOS). The ATFs were strategically placed to reduce the long standing odor issues in the South Los Angeles/Baldwin Hills area. The ATF at ECIS is designed to ventilate and treat the ECIS at the siphon and the LCSFVRS to mitigate sewer gas emissions. The facility will be treating 20,000 cfm of foul air. The ATF located at 6000 Jefferson Blvd is designed to ventilate the pressurized North Central Outfall Sewer (NCOS) in order to mitigate emission of sewer gas. The facility will treat 12,000 cfm of foul air.

6.5 Flow Management

Flow management plays a major role in odor control, especially in the area of air dynamics and ventilation. Hydraulic flow has an influence on air movement. It is well documented that on major interceptor and outfall sewers, hydraulic flow will drag the air above it. As a result, air moves within the pipe. Throughout the day, as part of the diurnal pattern of flow, the wastewater flow will rise and fall. When flows rise, air is pushed out the system. Conversely, when flows fall, air is pulled into the system. The air pressure is significant especially in sewers that are at or reaching capacity, meaning the hydraulic flow levels are high. Balancing flows in the system will relieve air pressure in the system.

6.6 Air Curtains

Air curtains play a vital role in controlling the air movement in the sewers. The purpose of the air curtain is to isolate the air movement in the interceptor sewer and control movement of sewer air from entering other portions of the collections system.

6.7 Sewer Construction and Repair

Sewer construction and repair play an important role in the City's odor control effort. Some odor problems are inherent in a given sewer's design and require auxiliary sewers to be built. Some problems are the result of failing components which need repair or replacement. Additionally, the City has been engaged in a large capital improvement program constructing new, major sewers which have multiple benefits for the collection system as a whole, one of which is odor control.

The City is continuously identifying locations where house connection laterals from private properties tie directly into a large outfall sewer instead of a small, local sewer. This is a direct source of odors since large sewers are much more likely to have high odor levels and high gas pressures. A direct connection allows odors from the large line to escape up the house connection and into the house or property. To address this issue, the City constructs local sewers adjacent to the large sewer to which the house connections will be reconnected in order to isolate the properties from the odor source. A trap maintenance hole is constructed at the end of the local line before connecting back to the large diameter sewer.

Trap maintenance holes are inspected quarterly and as part of an odor complaint investigation. As previously stated, there are instances when the integrity of these structures is compromised, in which case, the defective trap is repaired. The Bureau has identified all known problematic trap maintenance holes and has begun a program of repairing them on a systematic basis. This fiscal year, the City approved a new standard design of a trap maintenance hole. The new design will ensure a continuous seal and allow crews better accessibility to maintain the trap maintenance hole without compromising the seal. As a result of the modified Collection System Settlement Agreement, a project to upgrade 300 trap maintenance holes using the new trap design standard will be implemented in the upcoming fiscal years (see FIG. 6.5). Phase 1 and 2 of the trap maintenance hole upgrade have been completed. 73 priority 1 trap maintenance holes were constructed. This construction met the June 30, 2011 CSSA deadline for replacement of all high priority traps in South Los Angeles. The major focus of trap repairs will be performed in the South Los Angeles area. It is expected that these upgrades will significantly improve sewer odor releases where trap maintenance holes are located.

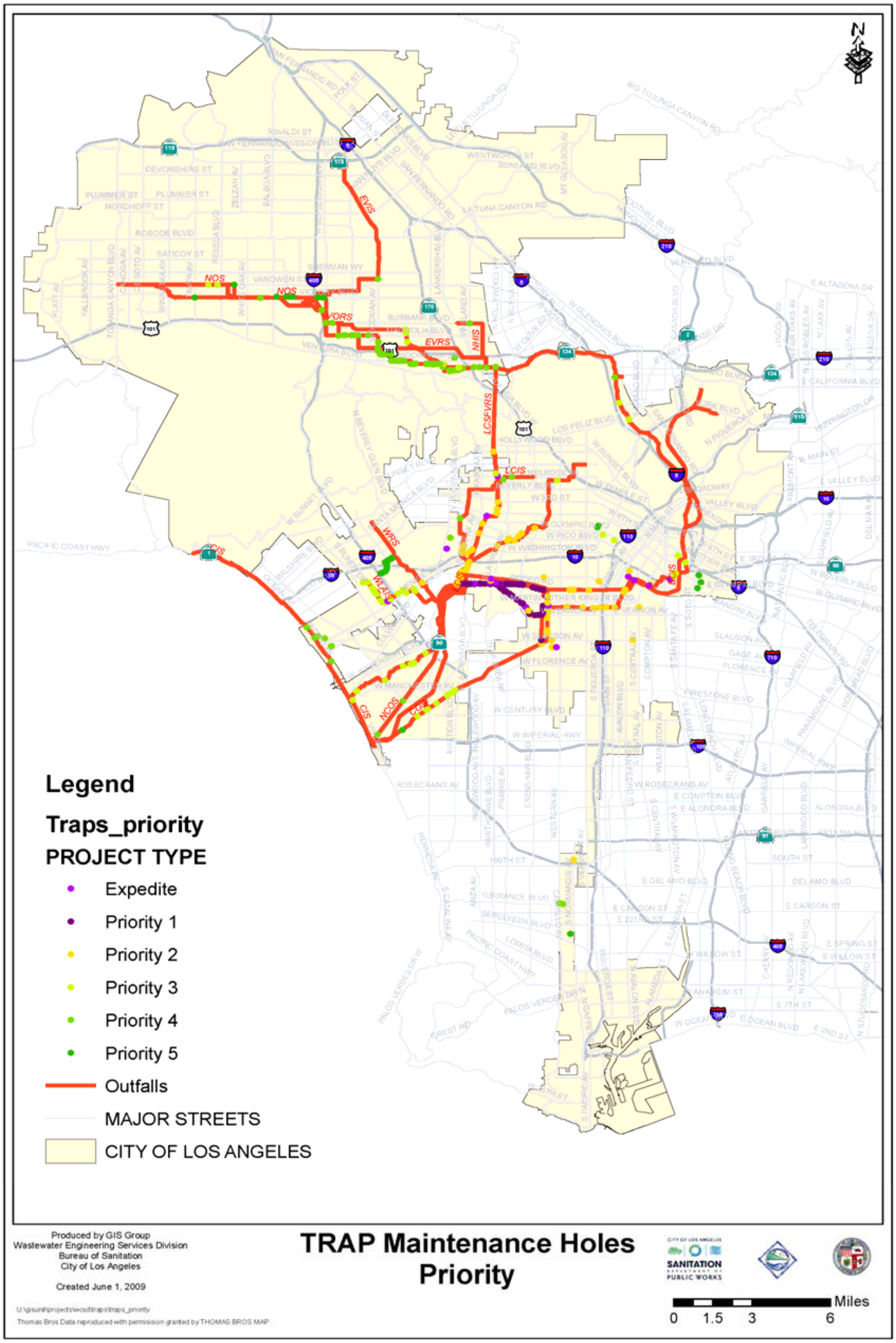

Legend
Traps_priority
PROJECT TYPE
Expedite
Priority 1
Priority 2
Priority 3
Priority 4
Priority 5
Outfalls
MAJOR STREETS
CITY OF LOS ANGELES
Produced by GIS Group
Wastewater Engineering Services Division
Bureau of Sanitation
City of Los Angeles
Created June 1, 2009
TRAP Maintenance Holes
Priority
SANITATION
Miles
0 1.5 3 6

FIG. 6.5

The City's program of constructing new, major sewers has many benefits, including odor control. The new sewers provide much-needed additional capacity to the collection system and relieve the existing sewers, which are carrying flows over their intended capacity. This not only improves the hydraulic capacity of the system, but also decreases the air pressures in the pipe's headspace above the flow. As flow is diverted from the existing sewers, the air space in these pipes increases and the air pressure therefore decreases. This reduces the likelihood of sewer gases venting out of the sewer system. The City continues to assess the hydraulic needs of the wastewater collection system and provide hydraulic relief where needed, reducing air pressure in the system. Flow diversion from NORS to Lower NOS in March 2010 has caused pressure reduction in the NORS siphon at the 405 Freeway. See Table 9.3 for more information.

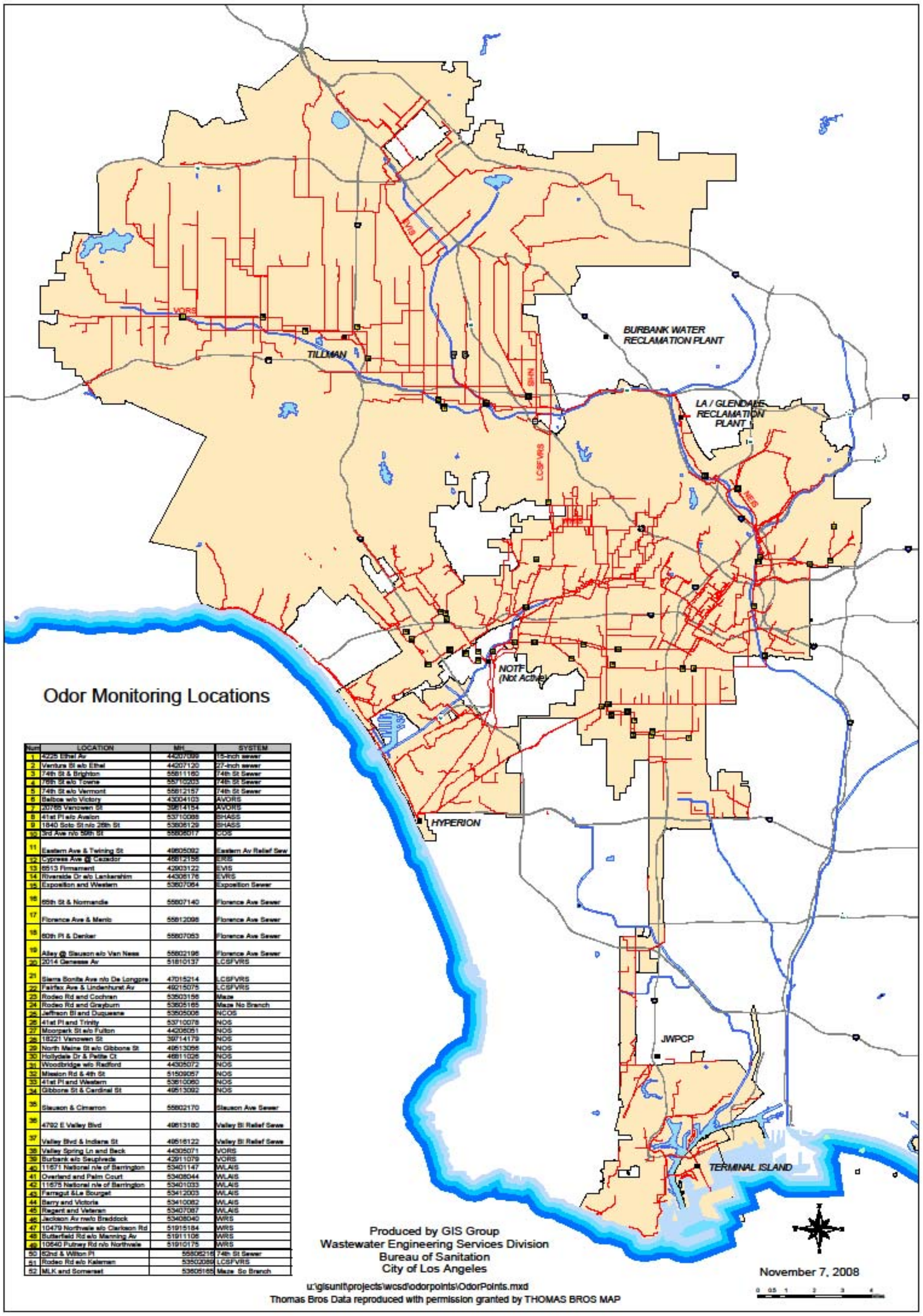
6.8 Monitoring

The collection system is regularly monitored in order to identify the source and cause of sewer related odors. A number of monitoring stations have been established at strategic locations in order to measure the parameter associated with odors (See Fig 6.6).

These locations include known odor hot spots, outfall and interceptor sewers, pressure zones, areas of turbulence, sharp slope change in sewer pipes (grade breaks), and sewer pipes with long detention times such as flat, low-velocity sewers. Parameters evaluated are:

a. Wastewater Characteristics – includes total and dissolved sulfides, pH, and temperature. These characteristics determine the potential for H_2S formation.
b. H_2S Gas Concentration – determines potential for odor complaints if released.
c. Air Pressure – determines potential sites of odor release
d. Sewer Odor Complaints – helps evaluate effectiveness of odor control measures and helps identify potential hot spots in the collection system

Monitoring is conducted at least semi-annually at designated points to gage the seasonal variation in odor generation and to monitor the adequacy and effectiveness of any chemical treatment. It is also used to confirm the location and potential of odor hotspots locations. This information is used as part of the odor master planning efforts.



Num	LOCATION	MH	SYSTEM
1	4225 Ethel Av	44207099	15-inch sewer
2	Ventura Bl e/o Ethel	44207120	27-inch sewer
3	74th St & Brighton	55811160	74th St Sewer
4	76th St e/o Towne	55710203	74th St Sewer
5	74th St e/o Vermont	55812157	74th St Sewer
6	Balboa w/o Victory	43004103	AVORS
7	20765 Vanowen St	39814154	AVORS
8	41st Pl e/o Avalon	53710088	SHASS
9	1840 Soto St n/o 28th St	53806129	SHASS
10	3rd Ave n/o 59th St	55808017	COS
11	Eastern Ave & Twining St	49605092	Eastern Av Relief Sew
12	Cypress Ave @ Cazador	48812158	ERS
13	6513 Firmament	42903122	EVIS
14	Riverside Dr e/o Lankershim	44306176	EVRS
15	Exposition and Western	53607064	Exposition Sewer
16	65th St & Normandie	55607140	Florence Ave Sewer
17	Florence Ave & Menlo	55812098	Florence Ave Sewer
18	60th Pl & Denker	55607053	Florence Ave Sewer
19	Alley @ Slauson e/o Van Ness	55602196	Florence Ave Sewer
20	2014 Genesee Av	51810137	LCSFVRS
21	Sierra Bonita Ave n/o De Longpre	47015214	LCSFVRS
22	Fairfax Ave & Lindenhurst Av	49215075	LCSFVRS
23	Rodeo Rd and Cochran	53503158	Maze
24	Rodeo Rd and Grayburn	53605165	Maze No Branch
25	Jeffrson Bl and Duquesne	53505006	NCOS
26	41st Pl and Trinity	53710078	NOS
27	Moorpark St e/o Fulton	44206051	NOS
28	18221 Vanowen St	39714179	NOS
29	North Maine St e/o Gibbons St	49513056	NOS
30	Hollydale Dr & Petite Ct	48811026	NOS
31	Woodbridge w/o Radford	44305072	NOS
32	Mission Rd & 4th St	51509057	NOS
33	41st Pl and Western	53610060	NOS
34	Gibbons St & Cardinal St	49513092	NOS
35	Slauson & Cimarron	55602170	Slauson Ave Sewer
36	4792 E Valley Blvd	49613180	Valley Bl Relief Sewe
37	Valley Blvd & Indiana St	49516122	Valley Bl Relief Sewe
38	Valley Spring Ln and Beck	44305071	VORS
39	Burbank e/o Seuplveda	42911079	VORS
40	11671 National n/e of Barrington	53401147	WLAIS
41	Overland and Palm Court	53408044	WLAIS
42	11675 National n/e of Barrington	53401033	WLAIS
43	Farragut &Le Bourget	53412003	WLAIS
44	Barry and Victoria	53410062	WLAIS
45	Regent and Veteran	53407087	WLAIS
46	Jackson Av nw/o Braddock	53408040	WRS
47	10479 Northvale e/o Clarkson Rd	51915184	WRS
48	Butterfield Rd e/o Manning Av	51911106	WRS
49	10640 Putney Rd n/o Northvale	51910175	WRS
50	82nd & Wilton Pl	55806216	74th St Sewer
51	Rodeo Rd e/o Kalsman	53502089	LCSFVRS
52	MLK and Somerset	53605165	Maze So Branch

FIG. 6.6

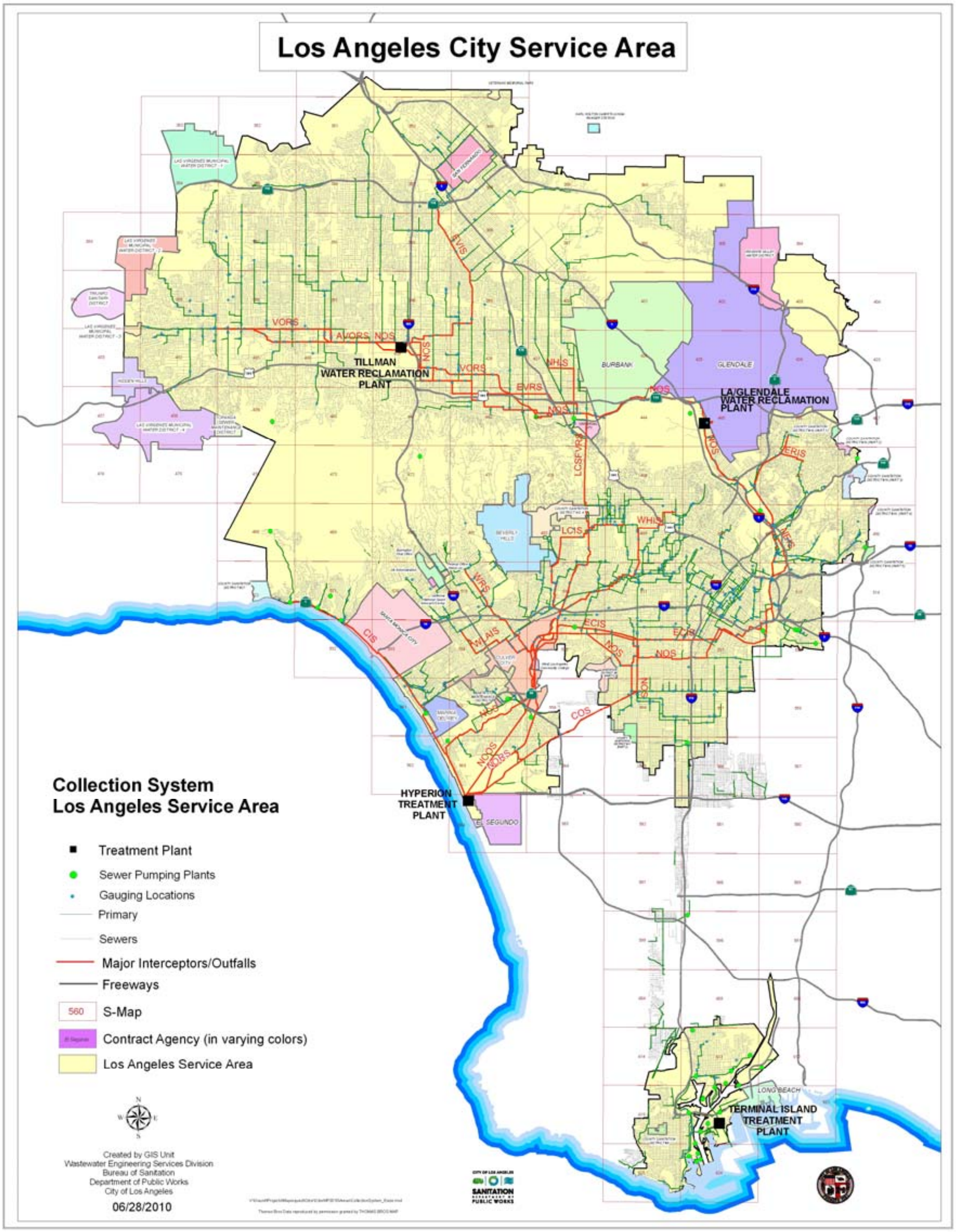

Los Angeles City Service Area
Collection System
Los Angeles Service Area
Treatment Plant
Sewer Pumping Plants
Gauging Locations
Primary
Sewers
Major Interceptors/Outfalls
Freeways
S-Map
Contract Agency (in varying colors)
Los Angeles Service Area
TILLMAN WATER RECLAMATION PLANT
LA/GLENDALE WATER RECLAMATION PLANT
HYPERION TREATMENT PLANT
TERMINAL ISLAND TREATMENT PLANT
BURBANK
GLENDALE
SEGUNDO
LONG BEACH
Created by GIS Unit
Wastewater Engineering Services Division
Bureau of Sanitation
Department of Public Works
City of Los Angeles
06/28/2010

FIG. 6.7

7.0 STUDIED AREAS

This section will provide a technical document for each of the four locations identified as Areas of Concern (AOC) and four locations identified as Areas of Study (AOS) (see Fig. 7.2). Testing locations within these areas were selected based on a detailed study of the physical characteristics of the collection system in the area as well as history of odor complaints (see Fig. 7.1). Each document contains an introduction, test results, data analysis, conclusion and recommendation.

7.1 AOC - Areas of Concern

- East NOS Corridor
- La Cienega/San Fernando Corridor
- Baldwin Hills/Culver City Area
- East Valley Area

7.2 AOS - Areas of Study

- South Los Angeles Area
- Coastal Interceptor Sewer
- Harbor
- West Valley Area

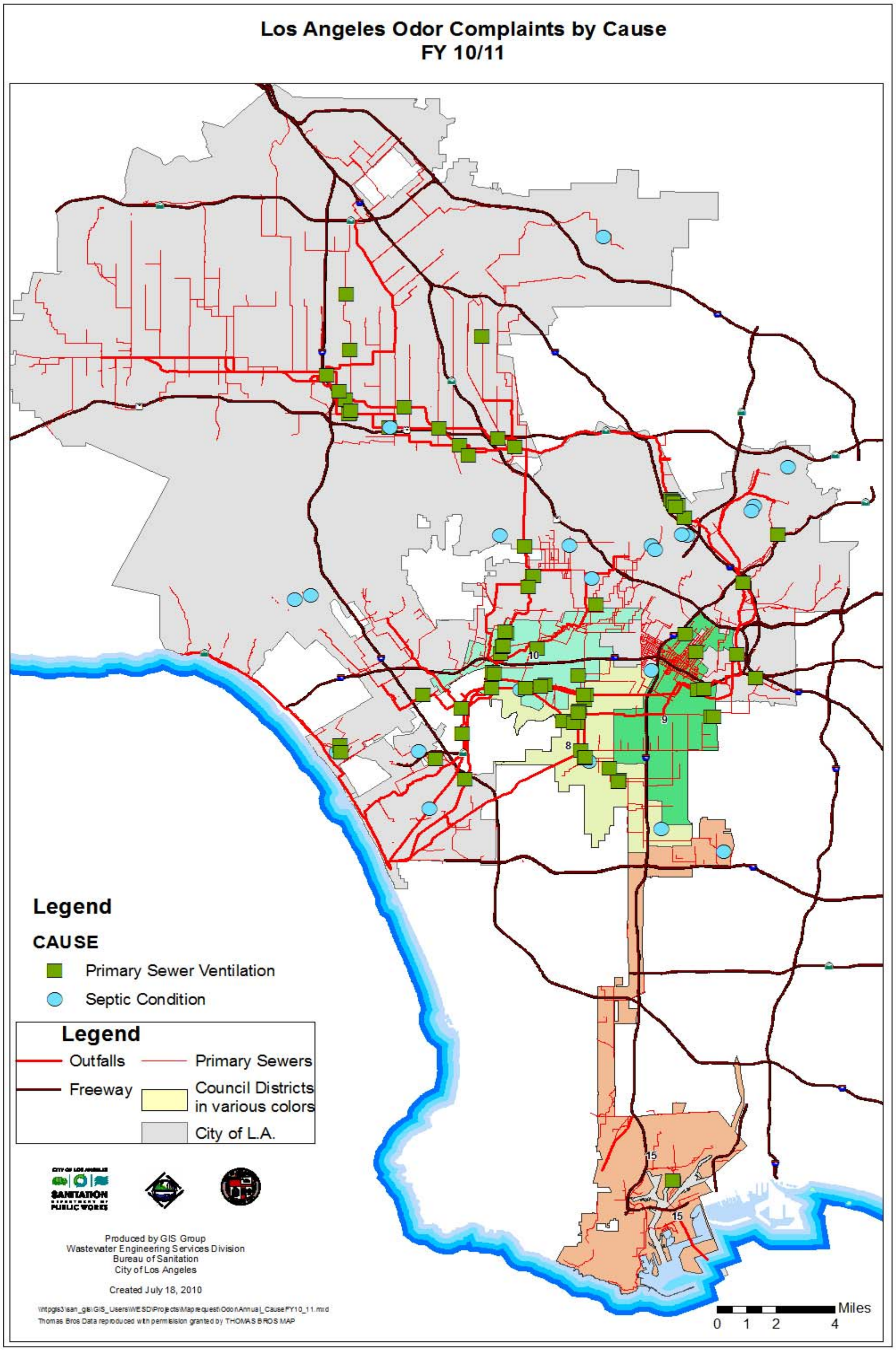

Los Angeles Odor Complaints by Cause
FY 10/11
Legend
CAUSE
Primary Sewer Ventilation
Septic Condition
Legend
Outfalls
Primary Sewers
Freeway
Council Districts in various colors
City of L.A.
Produced by GIS Group
Wastewater Engineering Services Division
Bureau of Sanitation
City of Los Angeles
Created July 18, 2010
Thomas Bros Data reproduced with permission granted by THOMAS BROS MAP
Miles
0 1 2 4

FIG. 7.1

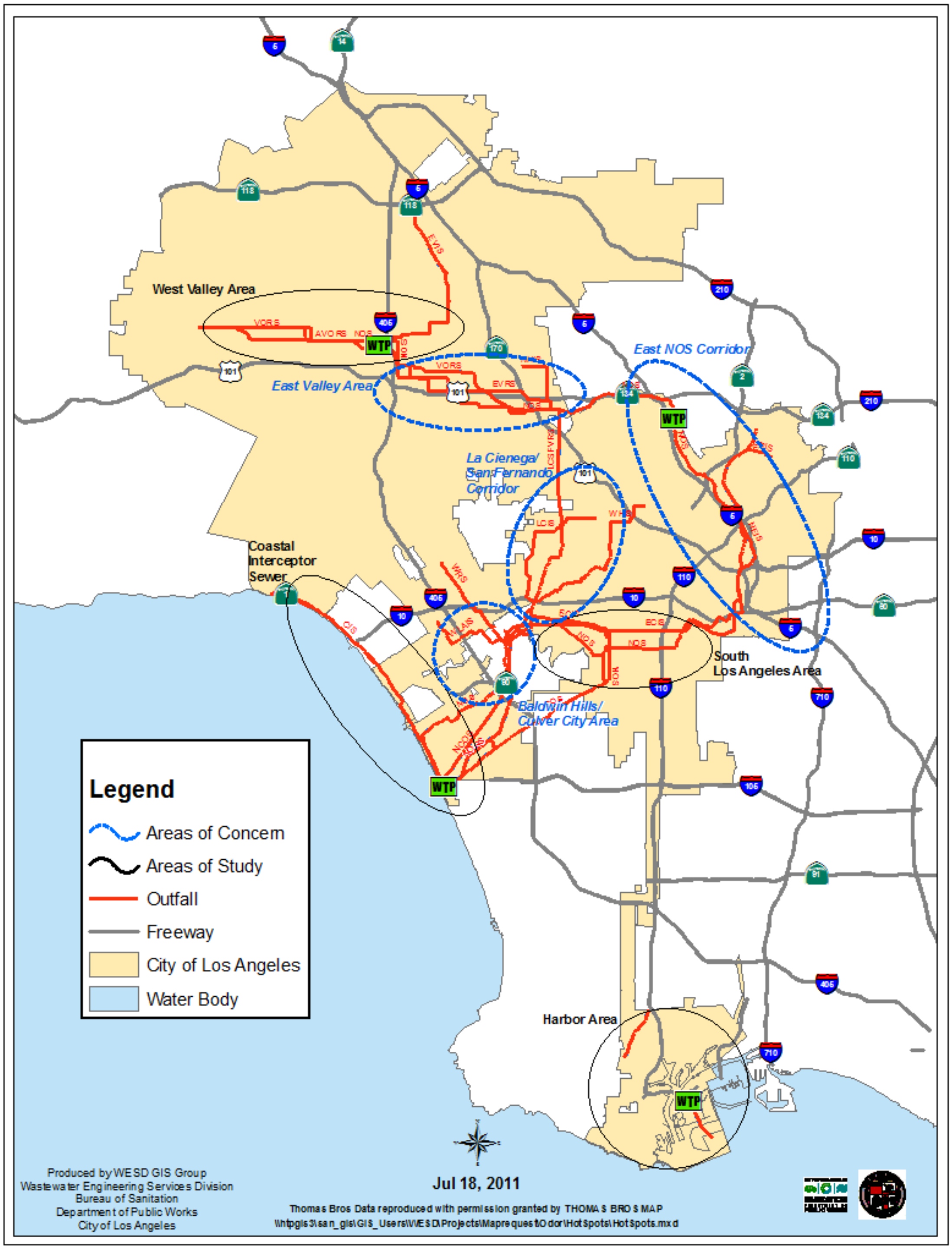

West Valley Area
East Valley Area
East NOS Corridor
La Cienega/ San Fernando Corridor
Coastal Interceptor Sewer
South Los Angeles Area
Baldwin Hills/ Culver City Area
Harbor Area
WTP
Legend
Areas of Concern
Areas of Study
Outfall
Freeway
City of Los Angeles
Water Body
Produced by WESD GIS Group
Wastewater Engineering Services Division
Bureau of Sanitation
Department of Public Works
City of Los Angeles
Jul 18, 2011
Thomas Bros Data reproduced with permission granted by THOMAS BROS MAP

FIG. 7.2

8.0 AREAS OF CONCERN

8.1 AOC1 - East NOS Corridor

INTRODUCTION

This report provides a discussion and analysis of the sewer air pressure test conducted for the East North Outfall Sewer Corridor Sewer System on April 2011. This area of concern covers the NOS, starting upstream at the Los Angeles Glendale Water Reclamation Plant (LAGWRP) and moving southerly to the Enterprise Siphon located at Mission and Enterprise in the Boyle Heights area. The NOS receives returned biosolids from LAG which makes it more susceptible to venting odorous gas, which could lead to odor complaints. The entire area was first monitored by instantaneous air pressure readings with a handheld digital manometer. Then more focused testing took place with continuous pressure monitors installed at those locations showing high pressures.

MONITORING LOCATIONS

Table 8.1 is a list of the monitoring locations in the East NOS Corridor between the LAG Treatment Plant and the Enterprise Siphon at the Los Angeles River. Figure 8.1 displays a map of these locations. There are several sewer structures and pipeline conditions along this segment that may increase sewer gas pressure and cause odor complaints. These include the Gilroy Siphon and the Enterprise Siphon. Also included are junction structures, diversion structures, and drop structures. The reason each monitoring location was chosen is stated in Table 8.1.

TEST RESULTS

Table 8.1

ID	LOCATION	MH NO.	SEWER	JUSTIFICATION	2011 PRESSURE (in/w.c.)	2010 PRESSURE (in/w.c.)	2006 PRESSURE (in/w.c.)	H2S AVG/MAX (ppm)	FLOW (CFS)
1	GLENFELIZ & HOLLYPARK	46802060	NOS	Siphon Pressure Effect	-0.08	-	-	6.8/88	57
2	HOLLYDALE & PETITE CT	46811026	NOS	Siphon Pressure Effect	0.19	0.19	0.01	9/60	62
3	FLETCHER/2 FRWY	46811045	NOS	Siphon Pressure Effect	0.17	-	-	8.5/40	62
4	BLAKE & OROS	49505024	NOS	Slope Reduction (Alternate for Blake & Barclay)	0.05	0	0.04	-	67
5	HUMBOLDT DIVERSION	49509121	NOS	NOS to NEIS Diversion	-0.03	-	-	-	74
6	BARRANCA & 18TH	49509097	NOS	D/S of Humboldt Diversion	-0.21	-	-	-	17
7	MISSION RD N/O 6TH ST	51509154	NOS	Drop Structure Effect	0.31	0.24	0.02	10/111	36
8	MISSION & 7TH (Meyer's Building)	51513001	NOS	D/S of Mission & Jesse Drop Structure	0.28	-	-	-	43
9	MISSION RD U/S SIPHON	51513003	NOS	Siphon Pressure Effect	[1] 0.37 [2] 0.35	0.05	0.12	-	48

[1] Instantaneous pressure taken April 21st, 2011
[2] Instantaneous pressure taken May 2nd, 2011

TESTING LOCATIONS

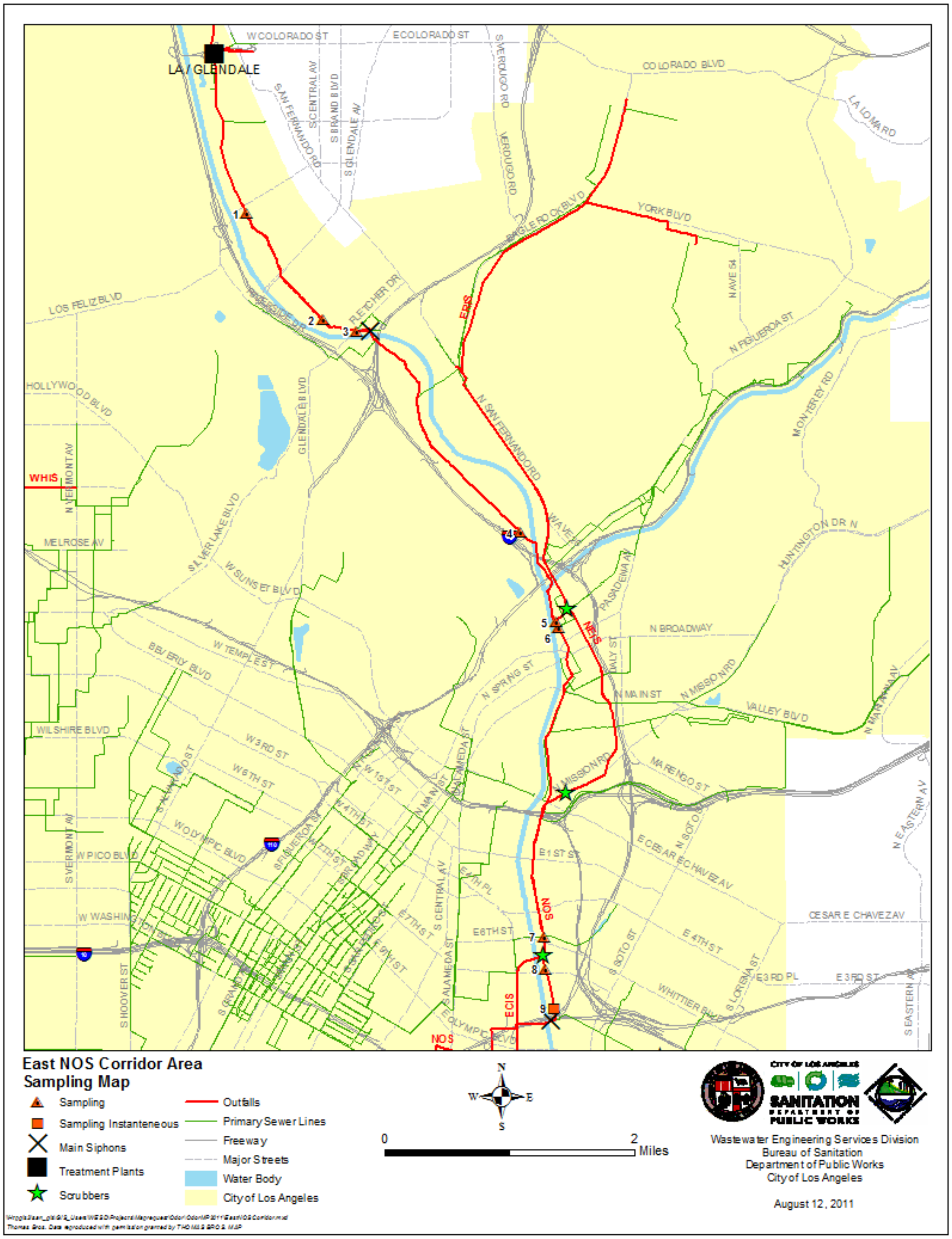


FIG. 8.1

DATA ANALYSIS

The pressure in the NOS along the eastern corridor ranges between pockets of very negative pressure to pockets of high pressure at various locations. Similar to last year, the average pressures upstream of the Gilroy Street Siphon is 0.19 in.-wc. The average pressures around the Humboldt drop structure is 0.05 in.-wc upstream of the drop structure to -0.21in.-wc downstream of the drop structure. Moving southerly on the NOS, the pressures increase. The average pressure upstream of the Mission and Jesse Drop Structure is 0.31inches, increasing from 0.24 recorded in 2010. The average pressure downstream of the Mission and Jesse drop was 0.28 in.-wc. The instantaneous pressure upstream of the Enterprise Siphon was recorded at 0.35 in.-wc. In 2007, flow entering the Mission & Jesse drop structure was significantly reduced by diverting more flow from the NOS to the NEIS at the upstream Humboldt drop structure. The reduced flow at the Mission and Jesse drop allowed more air to escape up the drop structure and hence, into the NOS. In 2010, following the ATF Review Study, wastewater flow in the NOS was altered to achieve a more balanced airflow downstream of the Humboldt drop structure. As a result, more flow remained in the NOS, sending more wastewater to the Mission & Jesse and 23rd & San Pedro drops.

CONCLUSIONS

The positive pressure at Hollydale and Petite is a result of the Gilroy Siphon's back pressure. In addition, continued discharge of biosolids from the upstream LA-Glendale Water Reclamation Plant is contributing to the hydrogen sulfide concentration spikes along this alignment.

The positive pressure along the NOS near Mission and Jesse may be a result of pressure escaping from the ECIS up the Mission and Jesse (NOS-to-ECIS) drop structure. The pressure at Mission and 7th may be due to this pressure from the Mission and Jesse Drop Structure and/or the Enterprise Siphon's back pressure.

POTENTIAL SOLUTIONS

Placing a scrubber near the Gilroy Siphon's inlet will relieve pressure building up behind the siphon.

Providing local sewers for residential sewer connections rather than direct connections to the NOS will isolate these homes from the high gas pressure in the NOS.

More studies are needed to better understand the hydrogen sulfide levels caused by the LAGWRP discharges and any odor ventilation this may cause.

As part of the ATF Review Study (completed November of 2010), a consulting firm hired by the City performed a more detailed study to understand gas movement around drop structures together with flow management scenarios that could potentially improve conditions in the NOS. Their observations and recommendations are as follows:

OBSERVATIONS

- The existing air scrubbers generally reduce pressures along the NEIS and ECIS. This appears to be especially the case with the Mission and Jesse interim scrubber. Measurable pressure reductions occur in the NEIS and ECIS when this scrubber is turned on.
- The Humboldt scrubber only appears to affect pressure in its immediate vicinity
- Plugging the air return lines at drop structures generally resulted in increasing pressures within the NEIS and ECIS, but created favorable conditions within the NOS.
- In general, decreasing the flow down the Humboldt drop and increasing it down the Mission & Jesse drop decreased pressures in the NOS. Those locations where the pressures didn't decrease remained at atmospheric levels.

Fig. 8.1.1 shows the area studied by the ATF Review Study.

ATF Review Study – Drop Structure Study Area

FIG. 8.1.1

RECOMMENDATIONS

ATFs

- No forced air treatment systems (ATFs) are recommended for the following locations:
    - Humboldt Drop Structure
    - Richmond Drop Structure
    - 23rd & San Pedro Drop Structure

- An ATF is recommended at the Mission & Jesse Drop Structure. *(Currently in design)*

ATF-Related Work

- To pinpoint the air removal rates necessary to achieve the desired impact at Mission & Jesse, a fan test is warranted.

Other Construction Projects

- There is evidence that the installation of a flow regulation device, such as an adjustable damper, in the air return line of the following drop structures may be beneficial:

    - Division Drop Structure
    - Humboldt Drop Structure
    - Mission & Jesse Drop Structure
    - 23rd & San Pedro Drop Structure

  However, it is recommended that the drop structure model (hydrolab) testing be completed before finalizing the damper concept.

Flow Diversions

- It is recommended that the stop logs at Humboldt be configured in such a manner that a minimum amount of flow is directed into the NEIS. *(Completed following the Flow Management Study of the drop structures as part of the ATF Review Study)*

- The flow diversion recommendations must be revisited following the completion of the physical model (hydrolab) testing.

Follow-up Testing

- The effects of the recommendations for the Mission & Jesse drop structure should be verified with a full-scale fan test field study aimed at verifying the combined effect of the air plugging devices (damper and curtains) and the ATF.

- The system is dynamic therefore the City needs to be flexible to optimize the system.

EXISTING/PLANNED PROJECTS

- Plan to direct more flow towards the Enterprise Siphon to achieve scouring velocity and minimize debris build up in the siphon

- Install an air curtain at the Mission and Jesse diversion structure to control back flow from the drop structure into the NOS

RECOMMENDATIONS/CONSIDERATIONS

- Continue to monitor this area for pressure and hydrogen sulfide levels
- Control air flow dynamics through sewer flow management by manipulating sewage flow through various sewers
- Place scrubber upstream of the Gilroy Street Siphon

8.2 AOC2 - La Cienega/San Fernando Corridor
LCSFVRS-WHIS-LCIS

INTRODUCTION

The 11-mile La Cienega San Fernando Valley Relief Sewer (LCSFVRS) was constructed in the mid 1950s to relieve the NOS in the Toluca Lake area in the southeast San Fernando Valley. The upper reach of the LCSFVRS starts at the intersection of Valley Spring Lane and Forman Avenue and travels south through the Santa Monica Mountains to Sierra Bonita Avenue where it splits into twin 42-inch diameter pipes at Sierra Bonita Avenue and Hollywood Boulevard. It becomes a single 60-inch diameter pipe at the intersection of Martel Avenue and Clinton Street. The sewer continues south and travels through the Genesee Siphon situated just south of Venice Boulevard and Genesee Avenue and eventually reconnects with the NOS near the intersection of Rodeo Road and Jefferson Boulevard in Baldwin Park.

The upper reach of the LCSFVRS, which travels between the Hollywood Hills and the Fairfax District, has a history of high gas pressure due to the combined effect of a high approach velocity and geometric slope reduction downstream of Sierra Bonita and Hollywood Boulevard. Odor complaints along the LCSFVRS prompted the City to investigate the causes and determine appropriate measures to alleviate the odor emissions. Two carbon scrubbers were constructed along the LCSFVRS. The 5,000 cfm Genesee Scrubber was constructed at the lower reach of the LCSFVRS at the Genesee Siphon and the 10,000 cfm Sierra Bonita Scrubber was constructed at the upper reach of the LCSFVRS at De Longpre Street and Gardner Avenue. Furthermore, a chemical addition program, utilizing a continuous addition of magnesium hydroxide, was implemented for this area in September 2005. Since the completion of the Sierra Bonita Scrubber, the sewer gas pressure has decreased to below atmospheric levels, in most cases.

For this year's test, the area of concern along the LCSFVRS corridor was expanded to incorporate tributary sewers including the West Hollywood Interceptor Sewer (WHIS), and the La Cienega Interceptor Sewer (LCIS). This test primarily utilized instantaneous pressure samples taken between 11:00 am and noon. The diurnal pressure patterns showed that this time period best represented the sewer's average pressure.

Due to a recent increase in odor complaints in the vicinity of Genesee siphon along the LCSFVRS, a sub-study was conducted earlier in the year focusing only on this siphon, its airline, the active scrubber and their combined effects. This report is attached at the end of this section for a more in-depth look. See sub-section 8.2.1.

TEST RESULTS

Table 8.2
Monitoring Locations and Results

ID	LOCATION	STRUCT. NO.	SEWER	2011 PRESSURE	2010 PRESSURE	2006 PRESSURE	H2S AVG/MAX (ppm)	FLOW (CFS)
1	SIERRA BONITA S/O HOLLYWOOD	47015212	LCSFVRS	Not accessible	-0.38	0.45	4/29	56
2	SIERRA BONITA N/O DE LONGPRE	47015001	LCSFVRS	-0.01	-	-	19/63	56
3	GARDNER AT DE LONGPRE	47016185	LCSFVRS	-0.03	-	-	1/10	56
4	GARDNER & HAMPTON	49204108	LCSFVRS	0.05	-0.72	0.46	-	56
5	GARDNER N/O SANTA MONICA BL	49204109	LCSFVRS	0.15	-0.12	-0.24	-	56
6	ROSEWOOD E/O POINSETTIA PL	49208189	Primary Sewer Confluence to the LCSFVRS	0.01	0.01	0.12	-	13
7	300 HAUSER ST	49216010	LCSFVRS	0.19	0.05	0.13	-	132
8	700 8TH ST	51803209	LCSFVRS	0.30	0.1	0.08	-	148
9	1500 GENESEE	51807165	LCSFVRS	0.47	0.18	0.18	-	148
10	5900 GENESEE N/O SIPHON	51810137	LCSFVRS	0.75	0.32	0.3	-	164
11	LA CIENEGA @ KLOS	53502024	LCSFVRS	-0.03	-	-	-	192

ID	LOCATION	STRUCT. NO.	SEWER	2011 PRESSURE	2010 PRESSURE	2006 PRESSURE	H2S AVG/MAX (ppm)	FLOW (CFS)
12	LA CIENEGA @ SEE'S CANDY	53502052	LCSFVRS	-0.1	-	-	-	192
13	RODEO RD & KALSMAN	53502089	LCSFVRS & NOS	0.04	-0.01	0	-	192
			WHIS					
14	840 NORTON AVE	51702134	WHIS	0.00	0.04	-	-	4
15	VENICE & SAN VICENTE	51705210	WHIS	0.05	0.1	0.01	-	25
			LCIS					
16	MELROSE & DETROIT	49208066	LCIS	0.01	-0.02	0.07	-	5
17	BURCHARD & VENICE	51810199	LCIS	0.01	0.07	0.01	-	21
18	FAIRFAX & LA CIENEGA	51814122	LCIS	-0.05	-	-	-	24
19	BY SEE'S CANDY	53502116	LCIS	-0.03	0.04	-	-	24
20	RODEO & JEFFERSON BL	53502081	LCIS TO NOS	-0.05	-0.14	0.01	-	24

TESTING LOCATIONS

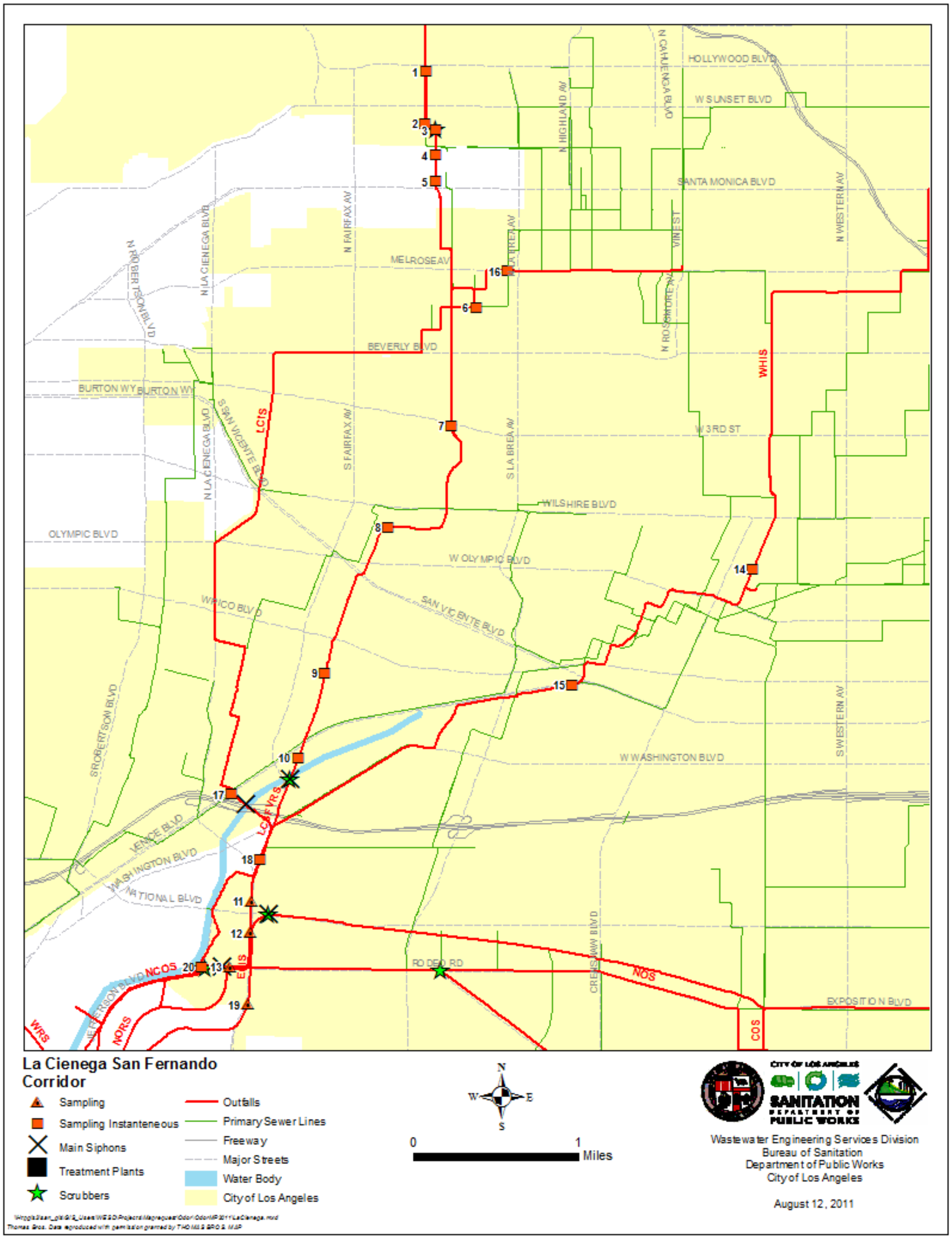


FIG. 8.2

DATA ANALYSIS

The recorded air pressure at Sierra Bonita north of De Longpre was -0.01 inches of water column (in.-wc). Further downstream, directly south of the Sierra Bonita scrubber, the pressure was -0.03. Even further downstream, the pressure increases to 0.05. Although most pressure readings were low or even negative, they have increased since last year. For instance, the pressure at Gardner north of Santa Monica was 0.15, compared to -0.12 last year.

The lower reach of the corridor, which extends from Martel Avenue to Genesee Street, is still pressurized due to the Genesee siphon that is located at Genesee Street and Cologne south east of Venice Boulevard. This siphon has a 36” above-ground airline that has been blocked (possibly to allow all sewer gas to be extraced by the scrubber upstream of the siphon. The pressures recorded during the latest round of testing were 0.75 in.-wc at the siphon. The three succesive pressure readings moving upstream away from the siphon were 0.47, 0.30, and 0.19. This shows that back pressure from the Genesee siphon may be affecting the pressure as far upstream as the Sierra Bonita scrubber. The data from the 2010 testing followed the same pattern but the pressures were significantly less. The Genesee Siphon Scrubber is relatively old and probably in need of an upgrade to a higher rate of air withdrawal such as 7,500 CFM.

Downstream of the Genesee Siphon, the pressure in the LCSFVRS is negative or zero which may be due to the benefits of the Jefferson/La Cienega Air Treatment Facility. Currently this ATF is pulling 6,700 cfm from the LCSFVRS.

The other two major sewers in this study; the WHIS and the LCIS, are not problematic and have remained relatively unchanged since 2006.

CONCLUSION

The upper section of LCSFVRS is currently depressurized but this may change if pressure building up behind the Genesee Siphon is not relieved. The back pressure from this siphon is the most likely cause of the positive gas pressures measured in the lower reachs of this sewer. The 36” airline may need to be unblocked so that some gas can travel downstream past the siphon where it can be removed by the Jefferson & La Cienega ATF. The Genesee scrubber may also need to be upsized.

The LCIS and the WHIS showed no real pressure problems.

RECOMMENDATIONS/CONSIDERATIONS

- Continue to monitor this area for pressure and hydrogen sulfide
- Control air flow dynamics through sewer flow management by manipulating sewage flow through various sewers

  - Consider re-routing flow away from the LCSFVRS to the NOS to LAG
- Continue chemical injection at the Tillman Treatment Plant
- Unblock the Genesee Siphon's airline to allow air to move across the siphon
- After the airline is unblocked, evaluate the need to increase the capacity of the Genesee Scrubber

8.2.1 Genesee Scrubber Study – January 2011

BACKGROUND

The La Cienega-San Fernando Valley Relief Sewer (LCSFVRS) runs through the Hollywood and Fairfax areas on the way down towards Baldwin Village where it connects to the North Outfall Sewer (NOS). Shortly before it reaches the NOS, the LCSFVRS has to pass under the Ballona Channel. To get under the channel, the sewer forms an inverted siphon referred to as the Genesee Siphon. The lower portion of the LCSFVRS has historically had consistently high gas pressures within the sewer. Much of this pressure is probably due to gas getting blocked at the Genesee Siphon. High gas pressures exist as far as five miles upstream of the siphon.

In order to relieve some of this pressure, a carbon scrubber (Genesee Scrubber) was placed immediately upstream of the Genesee Siphon and is rated to remove air from the sewer at the rate of 5,000 cubic feet per minute (cfm). The scrubber was commissioned in February of 2005 and is located within the Department of Water & Power property on the corner of Fairfax Avenue and Venice Boulevard. See Figure 8.2.1a.

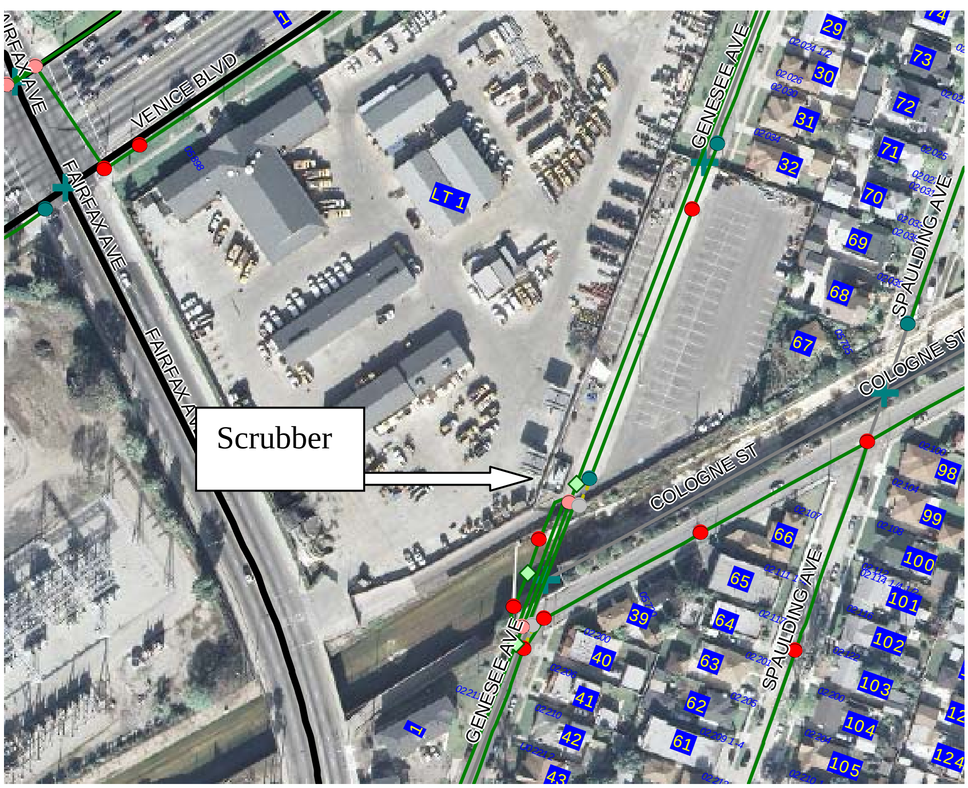


Figure 8.2.1a

OBJECTIVE

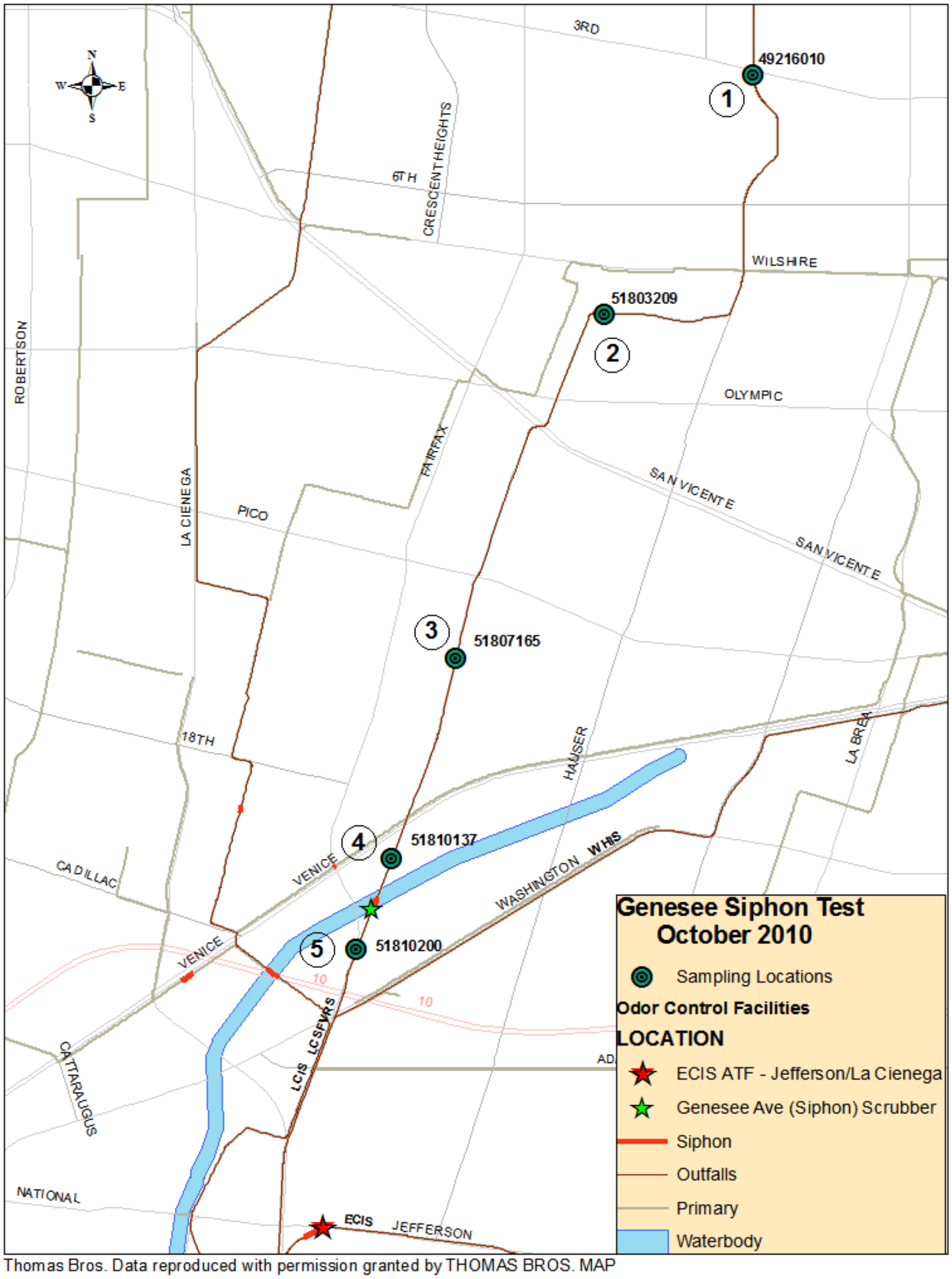
The objective of the study is to assess the current effectiveness of the scrubber and to evaluate the possibility of rehabilitating or upsizing it in order to reduce the high gas pressure within the LCSFVRS.

PROCEDURE

The pressure test was conducted twice. The first test was from September 30th, 2010 to October 14th, and the second test was from October 21st to October 27th. Differential Data Loggers were used to measure pressure. The data was downloaded from the data loggers after each test. The scrubber was turned off for 48 hours during both tests to measure the pressure difference with the units on and off.

TESTING LOCATIONS

Location No.	Structure No.	Street	Intersection	Comments	Pipe Size (in.)
1	49216010	3rd St.	Hauser	U/S of Siphon	72
2	51803209	8th St.	Alandele Av.	U/S of Siphon	78
3	51807165	Genesee Av.	S/o Saturn	U/S of Siphon	78
4	51810137	Genesee Av.	At Terminus	U/S of Siphon	84
5	51810200	Fairfax Av.	Genesee	D/S of Siphon	84



3RD
49216010
1
6TH
CRESCENT HEIGHTS
WILSHIRE
51803209
2
OLYMPIC
ROBERTSON
LA CIENEGA
PICO
FAIRFAX
SAN VICENTE
SAN VICENTE
3
51807165
18TH
HAUSER
LA BREA
4
51810137
VENICE
CADILLAC
WASHINGTON
WHIS
VENICE
5
51810200
10
10
LCSFVRS
LCIS
CATTARAUGUS
NATIONAL
ECIS
JEFFERSON
Genesee Siphon Test
October 2010
Sampling Locations
Odor Control Facilities
LOCATION
ECIS ATF - Jefferson/La Cienega
Genesee Ave (Siphon) Scrubber
Siphon
Outfalls
Primary
Waterbody
Thomas Bros. Data reproduced with permission granted by THOMAS BROS. MAP

FIG. 8.2.1b

RESULTS

The following tables summarize the maximum, minimum, and average pressures at all tested locations.

First Test

September 30, 2010 – October 4, 2010

Pressure (in.-wc) with Scrubber ON

Location #	Max. Pressure	Min. Pressure	Average
1	Equip. Failed		
2	Equip. Failed		
3	0.86	0.03	0.35
4	0.99	0.09	0.66
5	0.15	-0.05	0.03

Pressure (in.-wc) with Scrubber OFF

Location #	Max. Pressure	Min. Pressure	Average
4	1.34	0.11	0.85

Second Test

October 21, 2010 – October 27, 2010

Pressure (in.-wc) with Scrubber ON

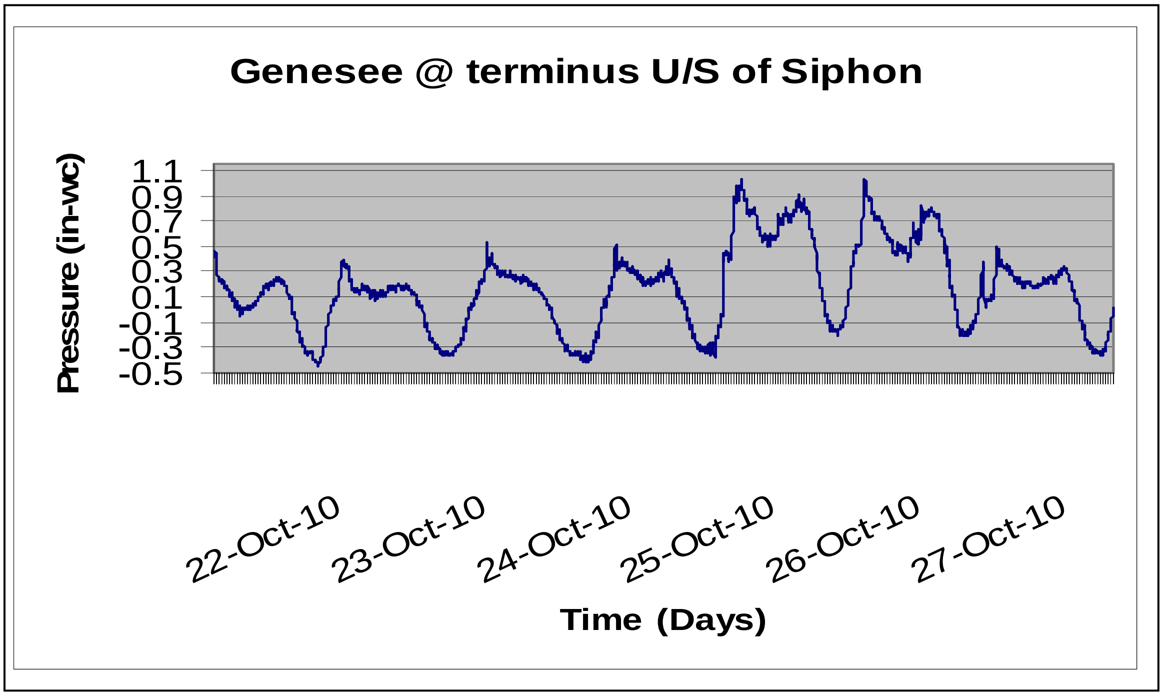
Location #	Max. Pressure	Min. Pressure	Average
1	0.24	-0.09	0.08
2	0.35	-0.08	0.15
3	0.5	-0.09	0.24
4	0.51	-0.39	0.13
5	0.14	-0.06	0.04

Pressure (in.-wc) with Scrubber OFF

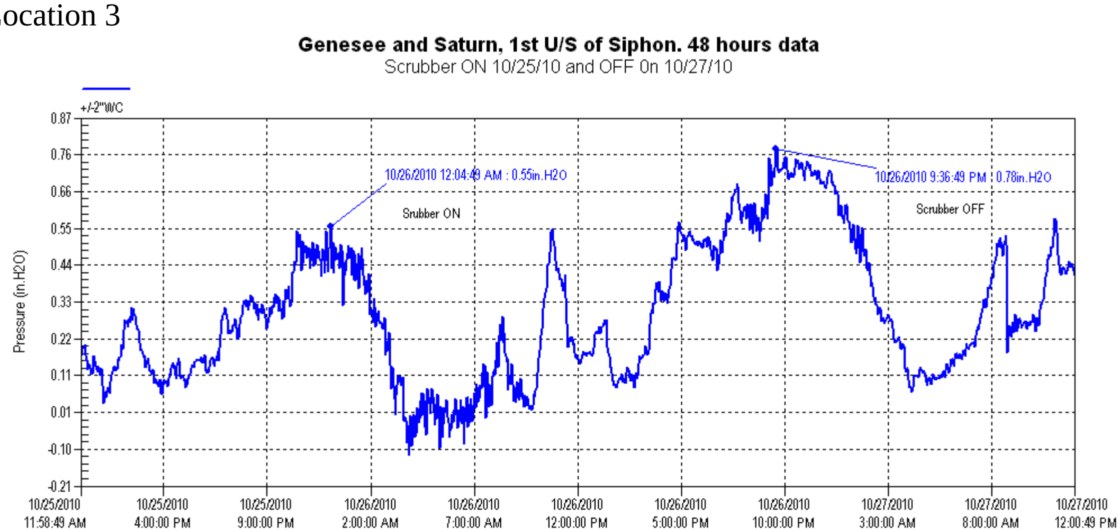
Location #	Max. Pressure	Min. Pressure	Average
1	Equip. failed		
2	0.70	0.02	0.40
3	0.78	-0.12	0.32
4	1.01	-0.15	0.48
5	0.21	-0.09	0.07

The following graphs show the varying pressure at each location tested during the second test.

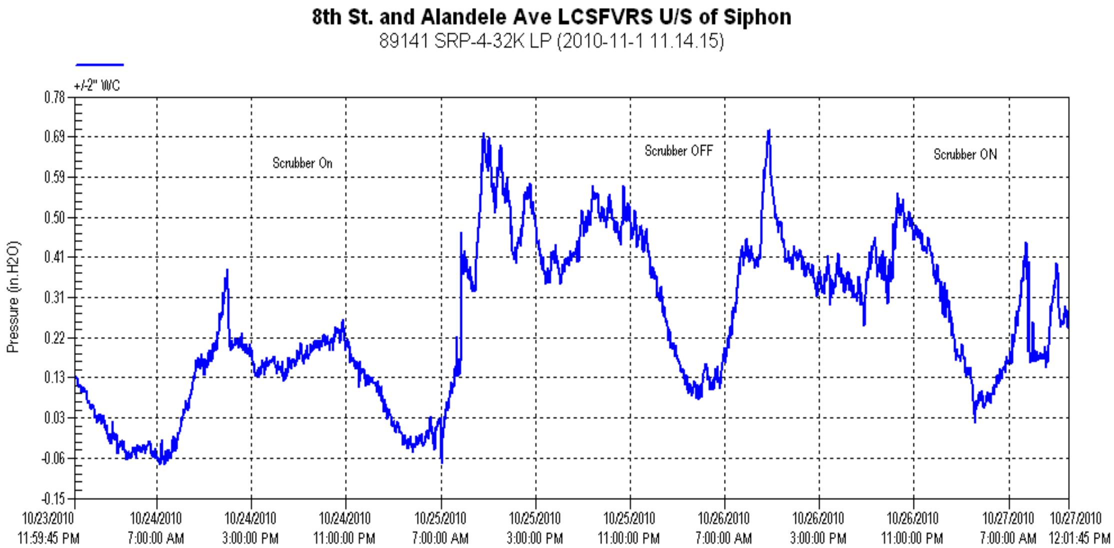
Location 4



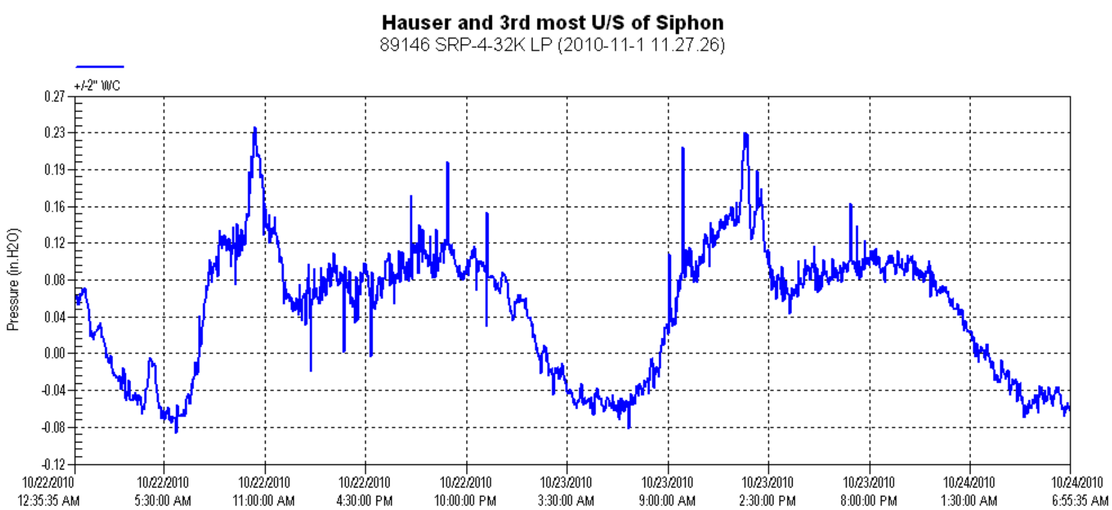
Location 3



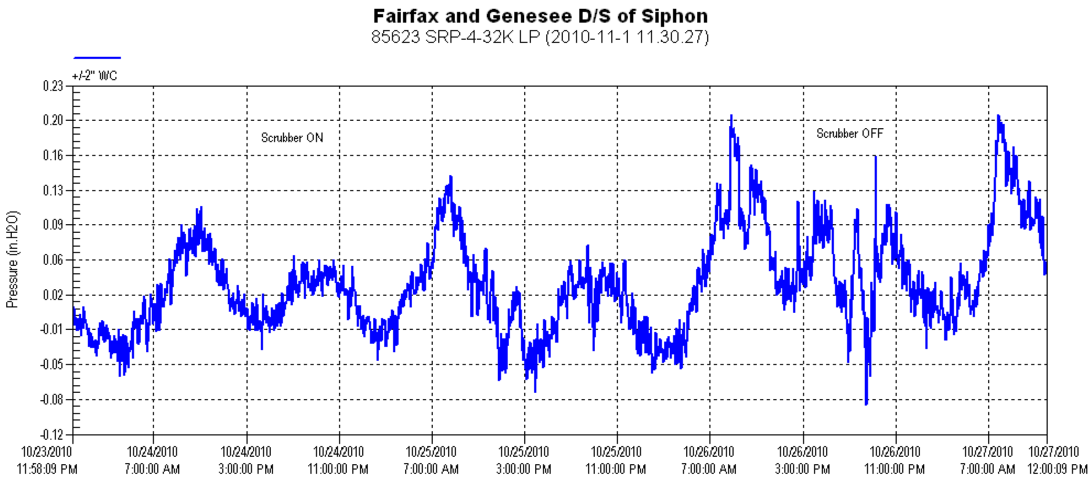
Location 2

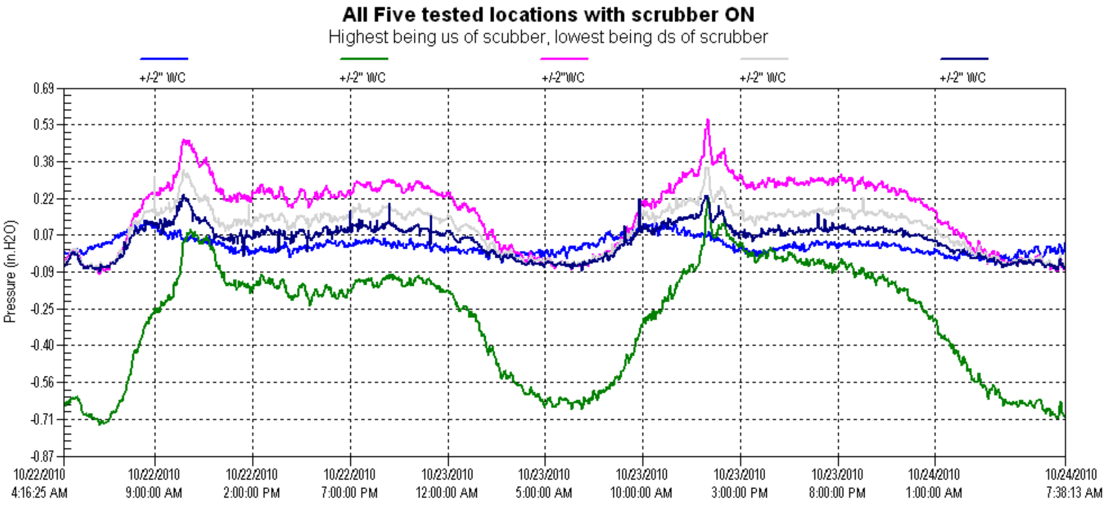


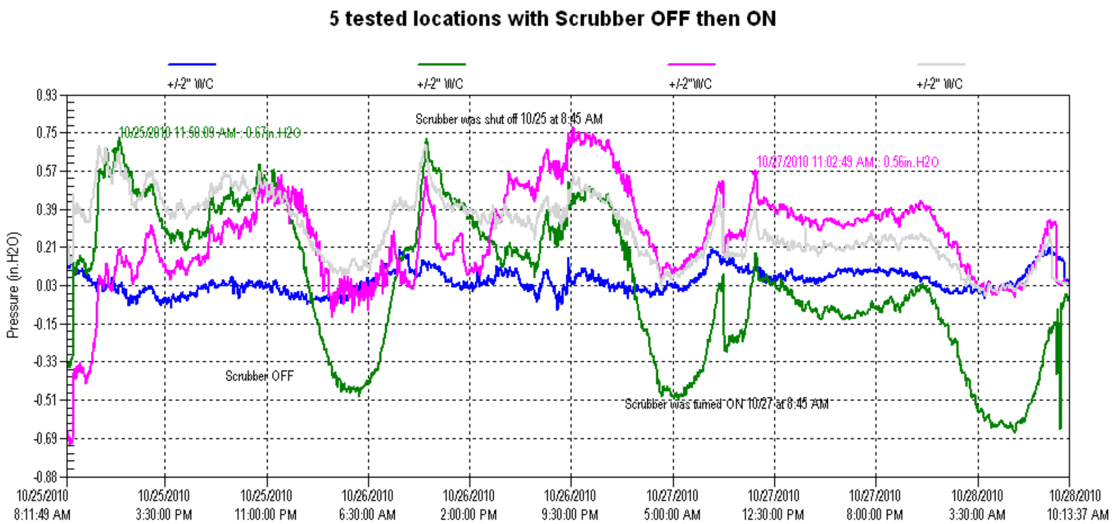
Location 1



Location 5


Fairfax and Genesee D/S of Siphon
85623 SRP-4-32K LP (2010-11-1 11.30.27)
+/-2" WC
Pressure (in.H2O)
0.23
0.20
0.16
0.13
0.09
0.06
0.02
-0.01
-0.05
-0.08
-0.12
Scrubber ON
Scrubber OFF
10/23/2010 11:58:09 PM
10/24/2010 7:00:00 AM
10/24/2010 3:00:00 PM
10/24/2010 11:00:00 PM
10/25/2010 7:00:00 AM
10/25/2010 3:00:00 PM
10/25/2010 11:00:00 PM
10/26/2010 7:00:00 AM
10/26/2010 3:00:00 PM
10/26/2010 11:00:00 PM
10/27/2010 7:00:00 AM
10/27/2010 12:00:09 PM


All Five tested locations with scrubber ON
Highest being us of scubber, lowest being ds of scrubber
+/-2" WC
+/-2" WC
+/-2"WC
+/-2" WC
+/-2" WC
Pressure (in.H2O)
0.69
0.53
0.38
0.22
0.07
-0.09
-0.25
-0.40
-0.56
-0.71
-0.87
10/22/2010 4:16:25 AM
10/22/2010 9:00:00 AM
10/22/2010 2:00:00 PM
10/22/2010 7:00:00 PM
10/23/2010 12:00:00 AM
10/23/2010 5:00:00 AM
10/23/2010 10:00:00 AM
10/23/2010 3:00:00 PM
10/23/2010 8:00:00 PM
10/24/2010 1:00:00 AM
10/24/2010 7:38:13 AM


5 tested locations with Scrubber OFF then ON
+/-2" WC
+/-2" WC
+/-2"WC
+/-2" WC
Pressure (in.H2O)
10/25/2010 11:58:09 AM: -0.67in.H2O
Scrubber was shut off 10/25 at 8:45 AM
10/27/2010 11:02:49 AM: 0.56in.H2O
Scrubber OFF
Scrubber was turned ON 10/27 at 8:45 AM
0.93
0.75
0.57
0.39
0.21
0.03
-0.15
-0.33
-0.51
-0.69
-0.88
10/25/2010 8:11:49 AM
10/25/2010 3:30:00 PM
10/25/2010 11:00:00 PM
10/26/2010 6:30:00 AM
10/26/2010 2:00:00 PM
10/26/2010 9:30:00 PM
10/27/2010 5:00:00 AM
10/27/2010 12:30:00 PM
10/27/2010 8:00:00 PM
10/28/2010 3:30:00 AM
10/28/2010 10:13:37 AM

RESULTS

- Location 4 exhibited highest recorded pressure during the first test at 1.34 in.-wc on October 4th while the scrubber was turned off.
- The highest recorded pressure during the second test was 0.78 in.-wc on October 25th while the scrubber was turned off. The lower pressures during the 2nd test may be due to the beneficial effect of the new ATF at Jefferson and La Cienega which removes gas from the LCSFVRS. It was beginning its start-up phase and increasing its air removal rate during this pressure test. It reached its 100% removal rate during the second test.
- The highest recorded pressure downstream of the siphon was 0.20 in.-wc at Location 5.
- When comparing all five test locations, the diurnal pressure patterns for all locations during both tests were synchronized, with and without the scrubber running.
- The zone of influence of the siphon was noticed as far back as 3rd and Hauser (approximately 5 miles).
- The gas pressure was highest just upstream of the siphon and gradually decreases upstream.
- The average sewage flow depth is 34 inches resulting in a d/D of 0.40 for a pipe diameter of 84 inches.
- The calculated air flow rate within the LCSFVRS is approximately 3,500 CFM.
- A CCTV was conducted January 4th, 2011. The test showed that the air line was blocked by a concrete bulkhead which forced the foul air back to the scrubber.

CONCLUSION

As a result of blocked airline, the effectiveness assessment of the scrubber cannot be accurately determined at this time. A thorough investigation is underway to determine the circumstances of which the bulkhead was constructed under.
Once the blocked airline is reopened which allows the air to flow through, then a follow-up pressure test will be conducted to accurately assess the scrubber's capacity to alleviate the air pressure.

8.3 AOC3 - Baldwin Hills/Culver City Area NORS-ECIS-NOS-WLAIS-WRS-NCOS

INTRODUCTION

The Baldwin Hills/Culver City Area includes outfall and interceptor sewers servicing the West Los Angeles/Culver City and Baldwin Hills areas bounded by Jefferson Boulevard to the north, San Diego Freeway to the south, La Cienega Boulevard to the east, and Palms to the west. The sewers include the North Outfall Replacement Sewer (NORS), East Central Interceptor Sewer (ECIS), North Outfall Sewer (NOS), West Los Angeles Interceptor Sewer (WLAIS), Westwood Relief Sewer (WRS), and North Central Outfall Sewer (NCOS). The area covered is presented in Figure 8.3.

The West Los Angeles/Culver City/Baldwin Hills areas are currently experiencing negative to low gas pressure partly because of the existing Air Treatment Facilities (ATFs) and also because of flow diversions that took place in 2009 and 2010, from the NORS to the NOS.

The NORS has been highly pressurized for many years and was the source of significant sewer gas ventilation, due to the large volume of gas traveling into the NORS headspace from upstream sewers, its limited headspace resulting from the excess flow being diverted from the NOS, and the undersized air jumper at the NORS siphon. The gas that pressurized the NORS was from the confluence of flow routed to the NORS from the outfalls connected to it including the ECIS, the LCIS, the LCSFVRS, the WLAIS and the WRS.

The lower reach of the North Outfall Sewer (NOS) had been closed and under rehabilitation for several years. During the rehabilitation, sewage from the West LA Interceptor Sewer (WLAIS) and Westwood Relief Sewer (WRS) traditionally carried by the NOS was being diverted into the NORS via Diversion 3. With the rehabilitation of the lower portion complete, that flow was returned to the NOS on December 18, 2009. It is estimated that 76 cfs of West Los Angeles sewage is being diverted to the lower NOS instead of the NORS.

Additionally, in January 2010 another section of the NOS rehabilitation, from Diversion 3 to the upper reach at Jefferson and Rodeo, was completed, allowing more flow to return to the NOS at Diversion 2. The combined result of both diversions has reduced flow in NORS, therefore increasing headspace and reducing pressure.

Currently two permanent Air Treatment Facilities (ATFs) are in operation. One facility is at Jefferson and La Cienega at the ECIS siphon and the other is at 6000 Jefferson at the NCOS siphon. Their influence on the various outfalls will be discussed in this Tech Memo. For the full report on the Post ATF Baldwin Hills Sewer Pressure Study from March 2011, see Appendix A.

For more detail on the NORS Post-NOS Rehab Pressure Test conducted in January of 2011 ater flow was returned to the NORS from the NOS, please see Sub-section 9.3.1 attached to this Tech Memo.

For the Air Curtain Assessment Pressure Test, please see Sub-Section 8.3.2.

This tech memo will analyze the pressure data taken for the Post ATF Baldwin Hills Sewer Pressure Study conducted in March of 2011. Some of the locations addressed are not normally part of the Baldwin Hills/Culver City Area Tech Memo, but since they may or may not be part of the ATF zone of influence, it makes sense to include them to create a more complete picture. This report will extract data taken only during those days where both ATFs and scrubbers were operating in order to define a baseline pressure during normal operating conditions.

TEST RESULTS

Table 9.3

ID	LOCATION	DESCRIPTION	STRUCT. NO.	SEWER	POST ATF 2011	POST NOS DIV	PRE NOS DIV	H2S AVG/ MAX (ppm)	FLOW (CFS)
1	35TH & GRAND	U/S of USC Drop	53705181	ECIS	0.24	-	-	-	142
2	EXPOSITION & POTOMAC	U/S of ECIS ATF	53504216	ECIS	0.20	-	-	-	172
3	JEFFERSON W/O COCHRAN	Directly U/S of ATF	53503213	ECIS	0.05	-	-	-	172
4	LACIENEGA & ALADDIN	U/S Junction Structure	53506116	ECIS	0.04	0.02	0.28	-	172
5	9940 JEFFERSON/JXN	Junction Structure	53509022	ECIS/NORS	0.00	-0.01	0.26	-	172
6	LA CIENEGA @ KLOS	ATF Effect	53502024	LCSFVRS	0.00	-	-	-	192
7	LA CIENEGA @ SEE'S CANDY	ATF Effect	53502052	LCSFVRS	-0.1	-	-	-	192
8	KALSMAN & RODEO	ATF Effect	53502089	LCSFVRS	0.04	-	-	-	192
9	RODEO & COCHRAN	ATF Effect	53503156	NOS	0.05	-	-	9/37	134
*	JEFFERSON & HOLDREGE U/S DIV2	U/S Diversion Structure	53506091	NOS	-	-0.38	-	-	210
*	9310 JEFFERSON	Between Diversion Structures	53505028	NOS	-	0.07	-	-	80
10	LEAHY & JEFFERSON	U/S Diversion Structure	53505029	NOS	0.01	0.05	0.33	-	-
*	WLA COLLEGE	Flow Div. Effect	53513013	NOS	-	-0.06	-	-	-
*	BERNARDO & EVEWARD	Flow Div. Effect	55901009	NOS	-	0.03	-	-	-
11	FOX HILLS MALL U/S SIPHON	Siphon	55905008	NOS	-0.03	0.05	-	-	-
12	AIRLINE BTWN NOS & NCOS	Airline	56008055	NOS/NCOS	0.01	-0.01	-	-	-

ID	LOCATION	DESCRIPTION	STRUCT. NO.	SEWER	POST ATF 2011	POST NOS DIV	PRE NOS DIV	H2S AVG/ MAX (ppm)	FLOW (CFS)
13	LA CIENEGA & RODEO	ATF Effect	53502090	NCOS	0.18	-	-	-	134
*	6050 JEFFERSON	Siphon Outlet	53505007	NCOS	-	-	-0.33	-	134
14	PXP OIL FIELD NR. WLA COLLEGE	ATF Effect	53505016	NCOS	-0.94	-	-	-	135
15	GREENVALLEY CIR & BRISTOL PKWY	Siphon Inlet	55905005	NCOS	-0.81	-0.17	-	-	135
*	6000 BLK JEFFERSON (DIV. 2)	Diversion Structure	53505018	NORS	-	-	0.16	-	211
16	IVY & PERHAM	U/S Junction Structure	53506132	NORS	0	-0.02	0.04	-	0.05
17	CULVER CITY PARK	U/S Junction Structure	53505021	NORS	0.07	0.02	0.05	-	131
18	DIVERSION 3 (TO NORS)	ATF Effect	53509006	NORS	0.00	-	-	-	1
19	WLA COLLEGE BY WALL	D/S Junction Structure	53513007	NORS	0.06	0.05	0.27	-	301
20	HANNUM & BRISTOL PKWY	U/S Siphon	55905006	NORS	0.02	0.19	0.29	-	301
*	VENICE & OVERLAND	Flow Div. Effect	53407074	WLAIS	-	0.10	-	-	33
21	FARRAGUT & LE BOURGET	ATF Effect	53408044	WLAIS	0.01	-	-	-	36
*	FARRAGUT & LE BOURGET	U/S Diversion Structure	53412003	WLAIS	-	-0.04	-0.03	-	41
*	3726 JASMINE	U/S Diversion Structure	53404122	WRS	-	0.18	-	-	21
22	JACKSON NW/O BRADDOCK	ATF Effect	53408040	WRS	0.00	-	-	-	43

* 2010 Odor Master Plan Sampling Location

TESTING LOCATIONS

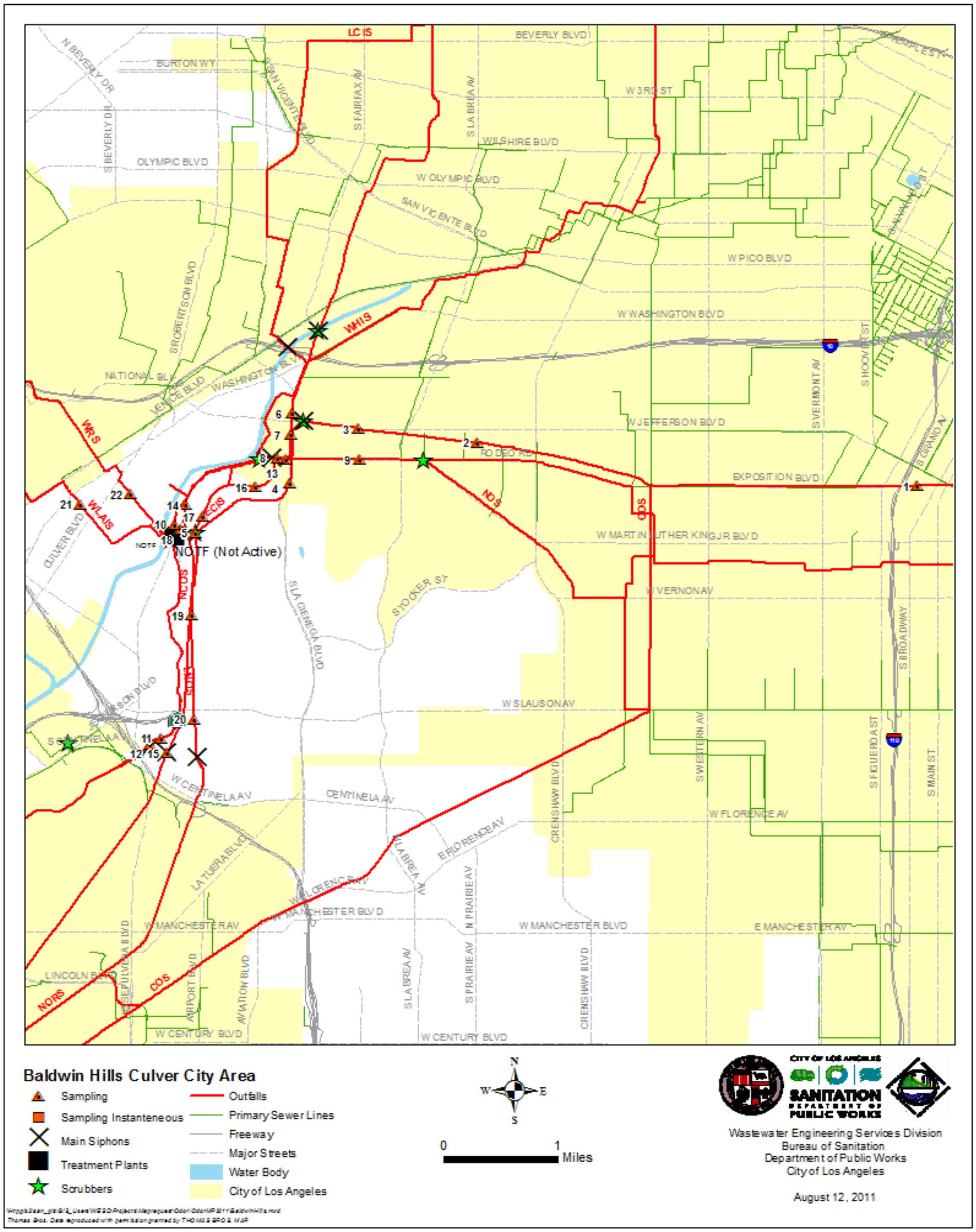


FIG. 8.3

DATA ANALYSIS

The average pressure within the ECIS was low in the vicinity of the Jefferson & La Cienega ATF. Pressures as high as 0.24 in.-wc were measured within the ECIS at the most upstream end of the test.

The Jefferson & La Cienega ATF is also pulling air from the lower section of the LCSFVRS, and the locations tested were monitored between -0.1 and 0.04 in.-wc.

The pressure in the NOS was between -0.03 in.-wc just upstream of the NOS Siphon under the 405 Freeway and 0.05 in.-wc at Location 9 near the intersection of Rodeo and Cochran. The average pressure at the location of the airline that connects the NOS headspace to the NCOS headspace was 0.01 in.-wc.

The pressure within the NCOS was -0.01 upstream of the 6000 Jefferson ATF to -0.94 downstream of the ATF. Further downstream, near the siphon inlet under the 405 Freeway, the average pressure was recorded at -0.94 in.-wc.

In west LA, the WLAIS and the WRS were measured at 0.01 and 0.0 in.-wc respectively.

The NORS has shown the greatest improvement since the flow diversion and the start-up of the ATFs. After the NOS diversion, the NORS pressure decreased notably. After the ATF start-up, pressure was reduced even further. Pressure within most of the NORS is now negative

Table 8.3.1

ECIS/NORS	**Avg Pressure (in H2O)**			**Description**
MH No.	Pre NOS Diversion	Post NOS Diversion	Post ATF Start-up	
535-06-116	0.28	0.02	0.04	ECIS U/S of ECIS/NORS Junction
535-09-022	0.26	-0.01	0.00	ECIS/NORS Junction
535-13-007	0.27	0.05	0.06	NORS D/S of ECIS/NORS Junction
559-05-006	0.29	0.19	0.02	NORS U/S of NORS Siphon

CONCLUSION

Currently, gas pressure within the entire NCOS is negative.

The pressure in the West LA sewers is generally low.

There are definitive changes in the NORS and the downstream end of the ECIS due to the NOS diversion and the presence of the ATFs. Pressure has fallen dramatically and there have been no odor issues since this return of flow to the NOS. The average pressures are negative or very low. Flow management, both air and wastewater, will be an integral part of balancing gas pressure throughout the sewer system.

The ECIS has improved significantly in and around the vicinity of the Jefferson & La Cienega ATF. However, further upstream away from the ATF's zone of influence, the sewer remains pressurized with average pressures of 0.20 to 0.24 in.-wc.

RECOMMENDATIONS/CONSIDERATIONS

- Continue monitoring the NOS and NCOS in the vicinity of the airline connection between these two sewers near the Fox Hills Mall.
- Continue monitoring the WLAIS and WRS for any increase in pressure
- Continue to monitor the effectiveness of the Jefferson & La Cienega ATF and the 6000 Jefferson ATF
- Analyze any change in airflow dynamics that result from the construction of sewer air curtains at NORS Diversions 1, 2, and 3.

8.3.1 NORS Post-NOS Rehab Pressure Test – January 2011

History

The North Outfall Replacement Sewer (NORS) was constructed in 1993. Immediately following the completion of the NORS, the City began rehabilitating the lower portion of the North Outfall Sewer (NOS) running from the Hyperion Treatment Plant north through the Culver City and Baldwin Village areas. In order to allow the rehabilitation work, all flow normally carried by the NOS was diverted to the newly commissioned NORS through a series of three diversion structures. As a result, the NORS has been carrying this excess flow with high gas pressure since it was put into service.

The City has attributed the high gas pressure to a combination of problems. First, many large sewers converge and delivered high volumes of gas into the NORS. Secondly, the NORS headspace was very small due to the high flow levels. This reduced headspace restricted the sewer's capacity for gas movement. Lastly, the airlines at the NORS Siphon under the 405 Freeway are undersized and were inadequate for the amount of gas traveling within the NORS. This caused gas to back up behind the siphon instead of traveling through it. The result was unusually high gas pressure within all of the NORS.

However, the rehabilitation of the NOS was recently completed and flow was gradually returned to the NOS, reducing the flow levels in the NORS. Furthermore, two Air Treatment Facilities (ATFs) have recently been constructed which vacuum gas from the East Central Interceptor Sewer (ECIS) and the North Central Outfall Sewer (NCOS) immediately upstream of the NORS. The new ATF at the intersection of Jefferson Boulevard and La Cienega Boulevard removes gas from the ECIS at a rate of 20,000 cubic feet per minute (cfm) which is double the removal rate of the carbon scrubber it replaced.

The City expected gas pressure within the NORS to fall as a result of returning flow to the NOS and began monitoring pressure once flow to the NOS began. The rehabilitation work on the NOS was performed in two stages and as each stage was completed, some flow was returned to the NOS. The first stage of rehabilitation work from Hyperion to Diversion 3 was completed in 2009. As a result, flow from the Westwood Relief Sewer and the West LA Interceptor Sewer was returned to the NOS in December of that year. That same month, the City performed a pressure test in the NORS as flow was returned to the NOS and the results showed significantly lower pressures than the historical average. Instantaneous "spot testing" after the new ATFs were running at 100 percent capacity in October of 2010 showed even lower pressure that was often negative. This testing convinced the City to conduct a long-term pressure test of the NORS to verify the low pressures.

Objective

On January 6, 2011, the City placed eight pressure monitors on or near the NORS in order to continuously record gas pressures for one week. Analysis of the results was expected to provide a good picture of the new diurnal pressure patterns and the new average daily gas pressures within the NORS and help determine whether any additional remedial action was necessary to solve pressure issues within the NORS and if so, then what solutions would have been most appropriate.

Scope

The pressure test was conducted using continuous pressure data loggers that recorded gas pressure every two minutes. Eight locations were monitored beginning on January 6, 2011 and ending January 13, 2011. The scrubber at the NORS/ECIS junction (NORS/ECIS scrubber) was intentionally turned off for 48 hours from January 10 through January 12 for analysis purposes. The eight monitoring locations are listed below in Figure 1 and their locations are shown in Figure 2 on the following page.

Sampling Locations		
	Location	MH Number
1	Hannum Av. nr. Bristol Pkwy NORS	559-05-006
2	Sophomore Dr. (WLA College) NORS	535-09-011
3	ECIS/NORS Junction ECIS/NORS	535-09-022
4	Culver City Park NORS	535-05-021
5	Ivy & Perham NORS	535-06-132
6	La Cienega & Aladdin ECIS	535-06-116
7	Jefferson & Leahy Diversion 3 to NORS	535-09-006
8	Jefferson w/o Cochran ECIS u/s of siphon	535-03-213

Figure 1

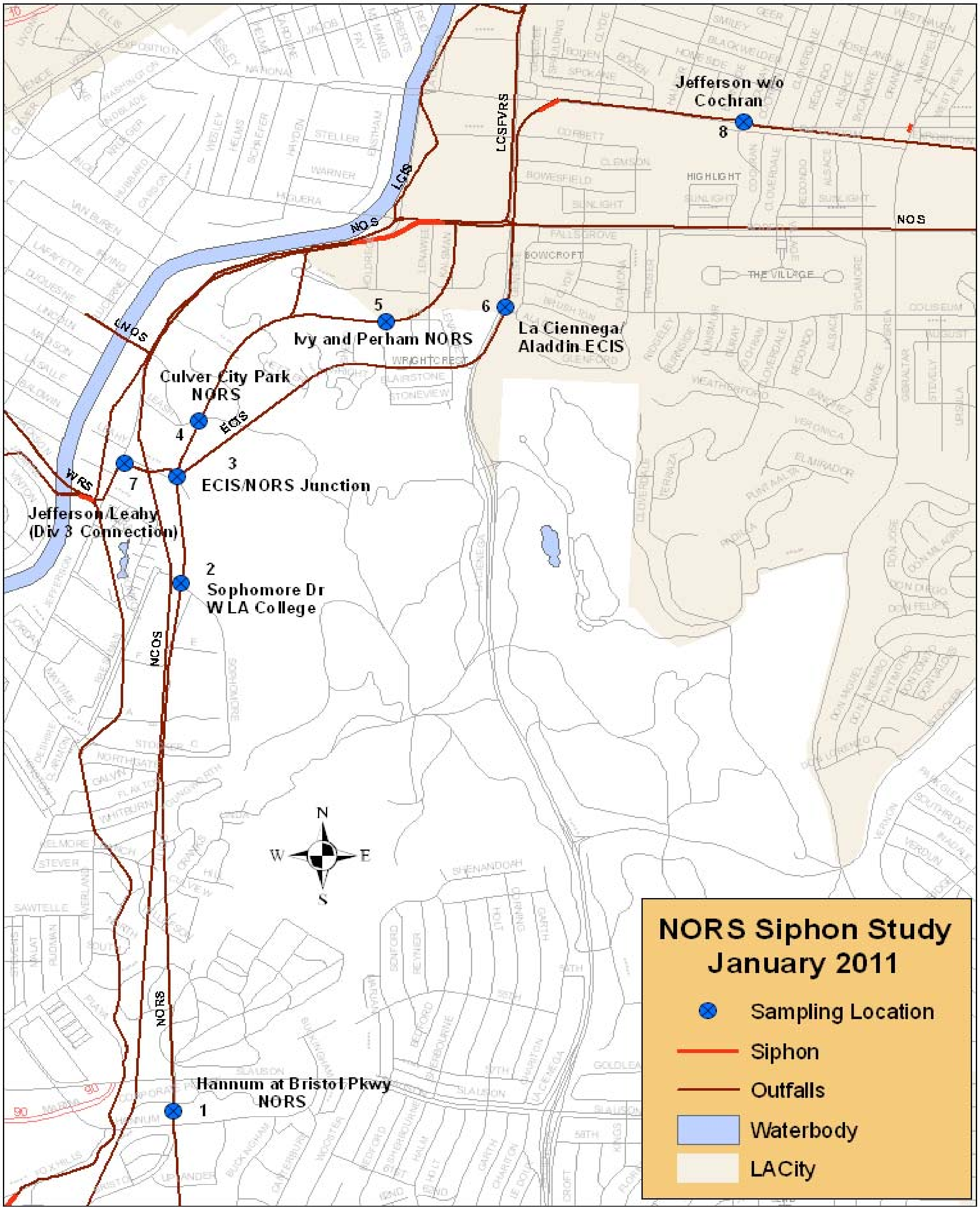


Figure 2

Thomas Bros. Data reproduced with permission granted by THOMAS BROS. MAP

Results

The following tables (Figures 3 and 4) summarize the test results with the NORS/ECIS scrubber in active mode (ON) and in passive mode (OFF). The average temperature within the sewer system during the test ranged between 62-64 degrees Fahrenheit.

Pressure Summary Table, with scrubber ON		
	Location	High/Low Pressure
1	Hannum Av. nr. Bristol Pkwy NORS	0.03/-0.22 in-wc
2	Sophomore Dr. (WLA College) NORS	0.01/-0.21 in-wc
3	ECIS/NORS Junction ECIS/NORS	0.04/-0.28 in-wc
4	Culver City Park NORS	-0.04/-0.30 in-wc
5	Ivy & Perham NORS	-0.01/-0.17 in-wc
6	La Cienega & Aladdin ECIS	0.07/-0.26 in-wc
7	Jefferson & Leahy Divr. 3 to NORS	0.04/-0.21 in-wc
8	Jefferson w/o Cochran ECIS u/s of siphon	0.13/-0.08 in-wc

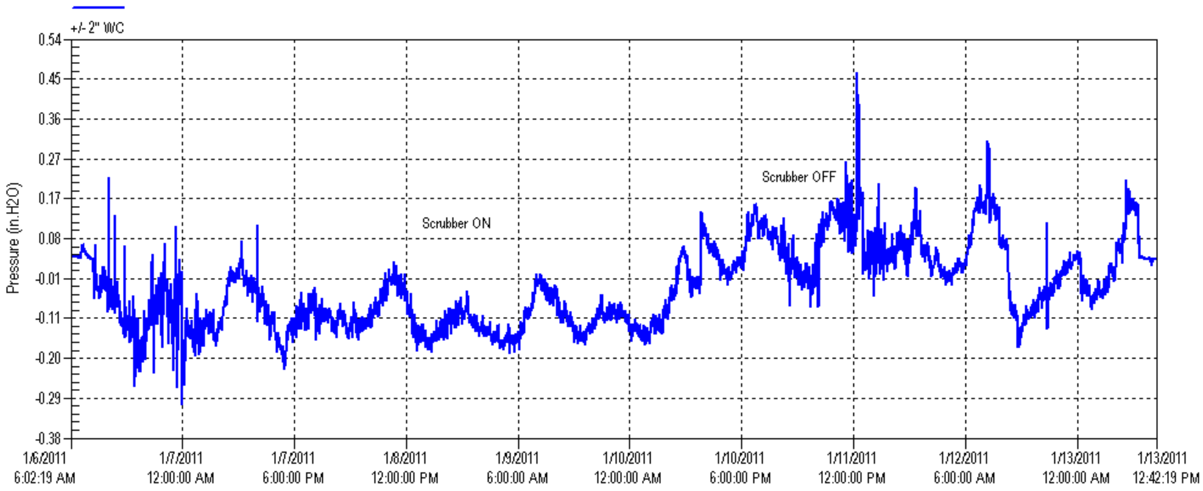
Figure 3

Pressure Summary Table, with scrubber OFF		
	Location	High/Low Pressure
1	Hannum Av. nr. Bristol Pkwy NORS	0.26/-0.17 in-wc
2	Sophomore Dr. (WLA College) NORS	0.17/-0.18 in-wc
3	ECIS/NORS Junction ECIS/NORS	0.15/-0.25 in-wc
4	Culver City Park NORS	0.04/-0.30 in-wc
5	Ivy & Perham NORS	0.08/-0.17 in-wc
6	La Cienega & Aladdin ECIS	0.10/-0.15 in-wc
7	Jefferson & Leahy Divr. 3 to NORS	0.15/-0.19 in-wc
8	Jefferson w/o Cochran ECIS u/s of siphon	0.13/-0.08 in-wc

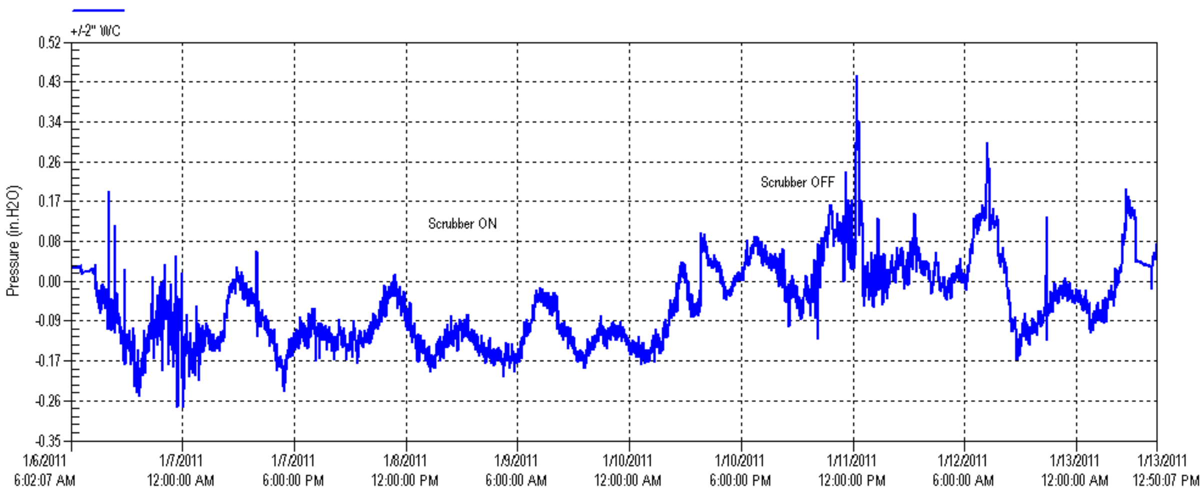
Figure 4

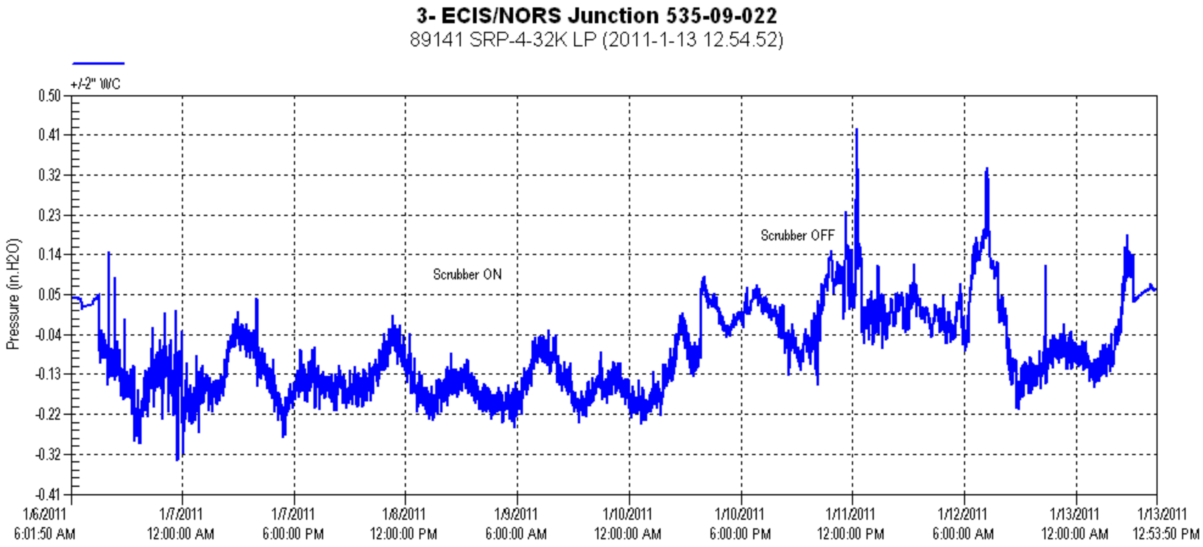
The followings charts show the gas pressure at each location during the testing period.

1- Hannum @ Bristol Pkwy (NORS U/S of Siphon) 559-05-006
86933 SRP-4-32K LP (2011-1-13 12.43.52)



2- Sophomore Dr, W LA college (NORS) 535-09-011
86211 SRP-4-32K LP (2011-1-13 12.50.36)




3- ECIS/NORS Junction 535-09-022
89141 SRP-4-32K LP (2011-1-13 12.54.52)
+/-2" WC
Pressure (in.H2O)
Scrubber ON
Scrubber OFF
0.50
0.41
0.32
0.23
0.14
0.05
-0.04
-0.13
-0.22
-0.32
-0.41
1/6/2011 6:01:50 AM
1/7/2011 12:00:00 AM
1/7/2011 6:00:00 PM
1/8/2011 12:00:00 PM
1/9/2011 6:00:00 AM
1/10/2011 12:00:00 AM
1/10/2011 6:00:00 PM
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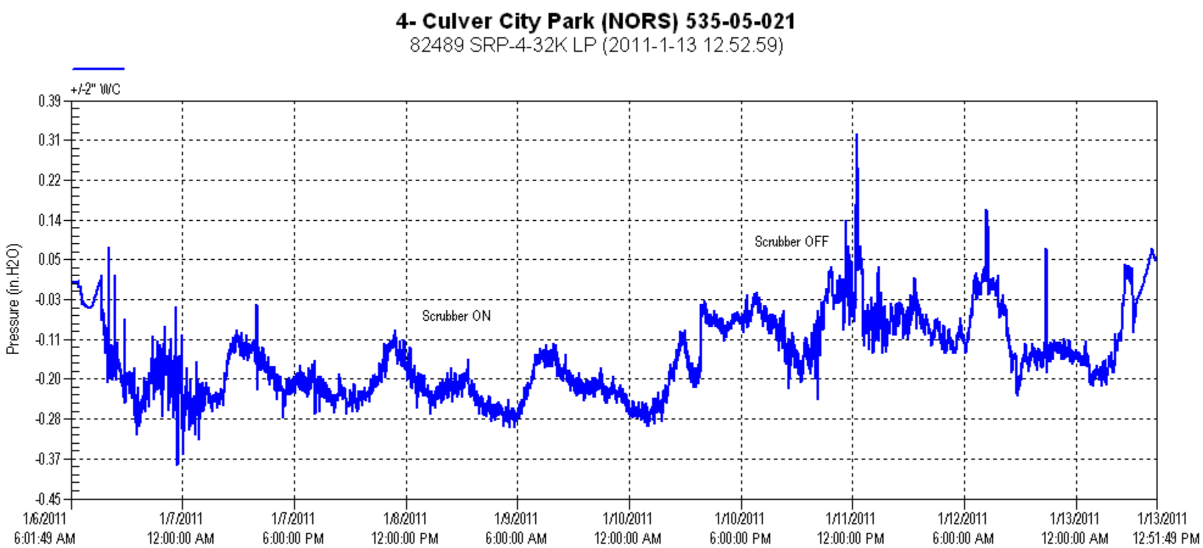
1/13/2011 12:53:50 PM


4- Culver City Park (NORS) 535-05-021
82489 SRP-4-32K LP (2011-1-13 12.52.59)
+/-2" WC
Pressure (in.H2O)
Scrubber ON
Scrubber OFF
0.39
0.31
0.22
0.14
0.05
-0.03
-0.11
-0.20
-0.28
-0.37
-0.45
1/6/2011 6:01:49 AM
1/7/2011 12:00:00 AM
1/7/2011 6:00:00 PM
1/8/2011 12:00:00 PM
1/9/2011 6:00:00 AM
1/10/2011 12:00:00 AM
1/10/2011 6:00:00 PM
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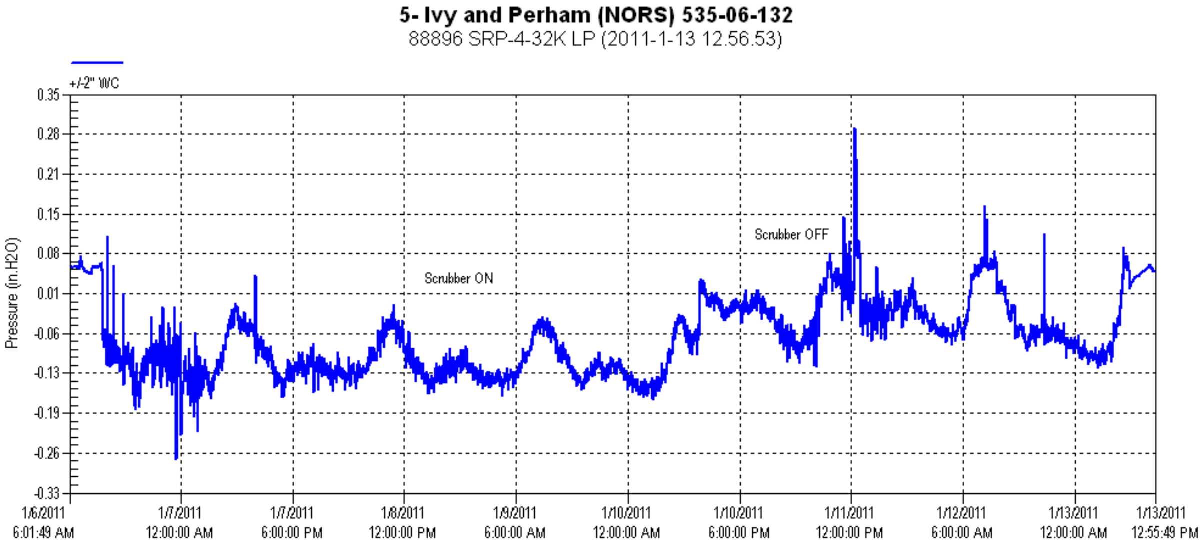
1/13/2011 12:51:49 PM


5- Ivy and Perham (NORS) 535-06-132
88896 SRP-4-32K LP (2011-1-13 12.56.53)
+/-2" WC
Pressure (in.H2O)
0.35
0.28
0.21
0.15
0.08
0.01
-0.06
-0.13
-0.19
-0.26
-0.33
Scrubber ON
Scrubber OFF
1/6/2011 6:01:49 AM
1/7/2011 12:00:00 AM
1/7/2011 6:00:00 PM
1/8/2011 12:00:00 PM
1/9/2011 6:00:00 AM
1/10/2011 12:00:00 AM
1/10/2011 6:00:00 PM
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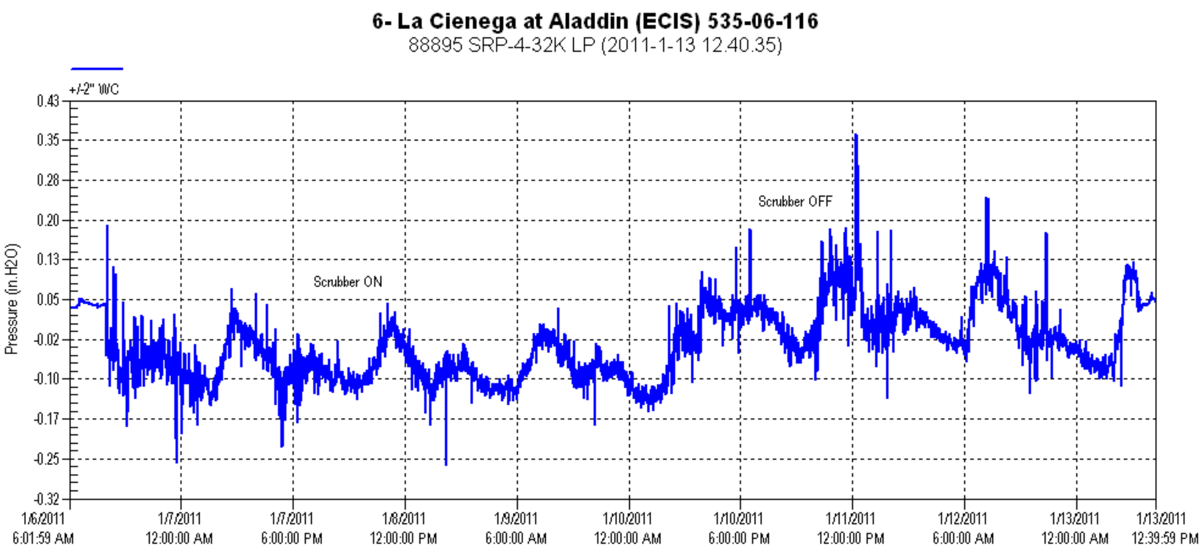
1/13/2011 12:55:49 PM


6- La Cienega at Aladdin (ECIS) 535-06-116
88895 SRP-4-32K LP (2011-1-13 12.40.35)
+/-2" WC
Pressure (in.H2O)
0.43
0.35
0.28
0.20
0.13
0.05
-0.02
-0.10
-0.17
-0.25
-0.32
Scrubber ON
Scrubber OFF
1/6/2011 6:01:59 AM
1/7/2011 12:00:00 AM
1/7/2011 6:00:00 PM
1/8/2011 12:00:00 PM
1/9/2011 6:00:00 AM
1/10/2011 12:00:00 AM
1/10/2011 6:00:00 PM
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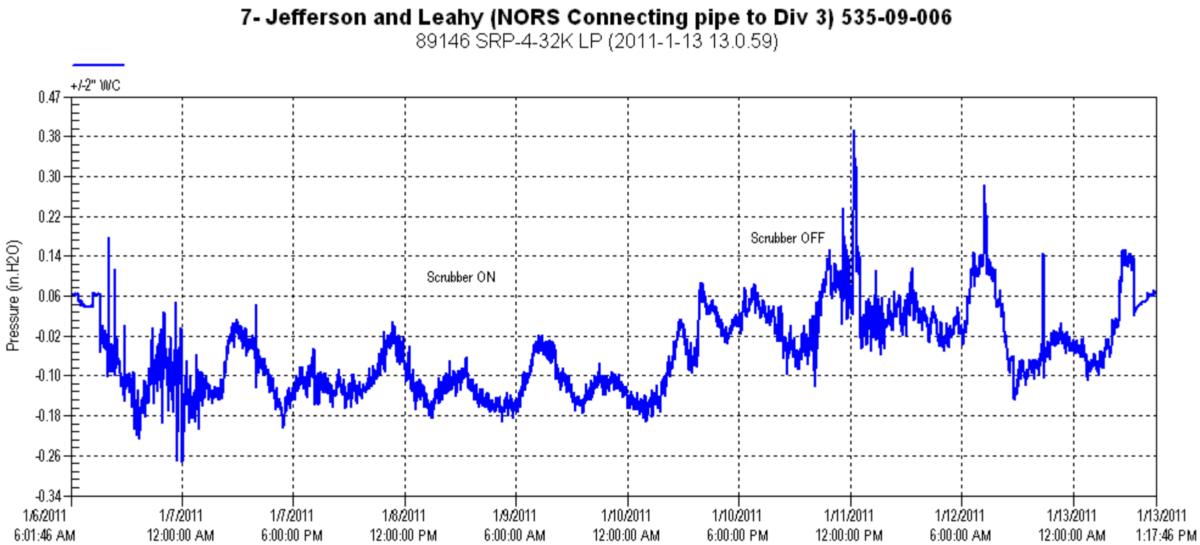
1/13/2011 12:39:59 PM


7- Jefferson and Leahy (NORS Connecting pipe to Div 3) 535-09-006
89146 SRP-4-32K LP (2011-1-13 13.0.59)
+/-2" WC
Pressure (in.H2O)
Scrubber ON
Scrubber OFF
0.47
0.38
0.30
0.22
0.14
0.06
-0.02
-0.10
-0.18
-0.26
-0.34
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1/7/2011 6:00:00 PM
1/8/2011 12:00:00 PM
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1/10/2011 6:00:00 PM
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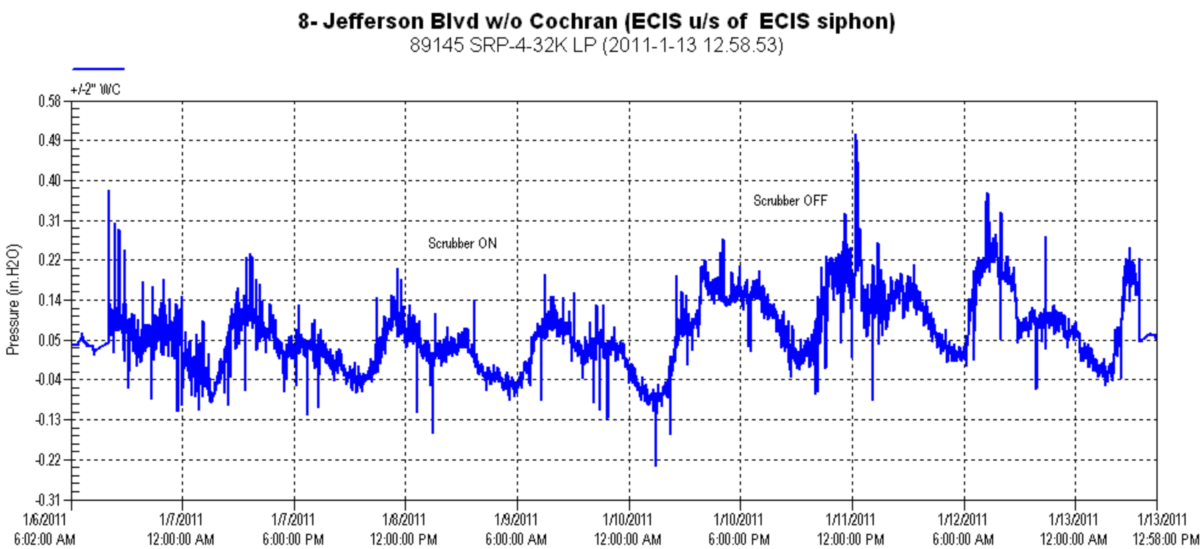
1/13/2011 1:17:46 PM


8- Jefferson Blvd w/o Cochran (ECIS u/s of ECIS siphon)
89145 SRP-4-32K LP (2011-1-13 12.58.53)
+/-2" WC
Pressure (in.H2O)
Scrubber ON
Scrubber OFF
0.58
0.49
0.40
0.31
0.22
0.14
0.05
-0.04
-0.13
-0.22
-0.31
1/6/2011 6:02:00 AM
1/7/2011 12:00:00 AM
1/7/2011 6:00:00 PM
1/8/2011 12:00:00 PM
1/9/2011 6:00:00 AM
1/10/2011 12:00:00 AM
1/10/2011 6:00:00 PM
1/11/2011 12:00:00 PM
1/12/2011 6:00:00 AM
1/13/2011 12:00:00 AM
1/13/2011 12:58:00 PM

Analysis

The test data revealed record low pressures in the NORS. When the NORS/ECIS scrubber was ON, the daily peak pressure within the NORS averaged 0.03 to 0.04 in.-wc. while pressures were at or below atmospheric pressure for the majority of this time period. The monitoring location at Jefferson Boulevard w/o Cochran recorded higher pressure than the other locations during this period. This location is the furthest upstream and is located on the ECIS upstream of an inverted siphon in Jefferson Boulevard near La Cienega Boulevard. The siphon isolates this portion of the ECIS from gas pressures within the NORS and therefore, this location was expected to be less affected by the flow changes than the other monitoring locations within the NORS.

The pressure at all locations within the NORS rose noticeably when the NORS/ECIS scrubber was turned OFF. The only location that did not react to the scrubber's operation was the location at Jefferson and Cochran. With the new, lower pressures, the scrubber's zone of influence extends throughout the NORS from the NORS siphon under the 405 Freeway upstream into the ECIS, up to the ECIS siphon on Jefferson Boulevard. The highest recorded pressure when the scrubber was off was 0.26 in.-wc at Hannum Avenue near Bristol Parkway immediately upstream of the NORS siphon. This was expected since this location has historically been the worst portion of the NORS and will always have some gas pressure as gas builds up behind the siphon before pushing itself through the airline.

What is striking is the low pressures within the NORS compared to gas pressures at the same locations before the recent changes. In order to illustrate the difference in gas pressures within the NORS before and after these changes, Figure 5 below shows the diurnal pressure for the monitoring point at Hannum Avenue near Bristol Parkway in May 2009 and in January 2011.

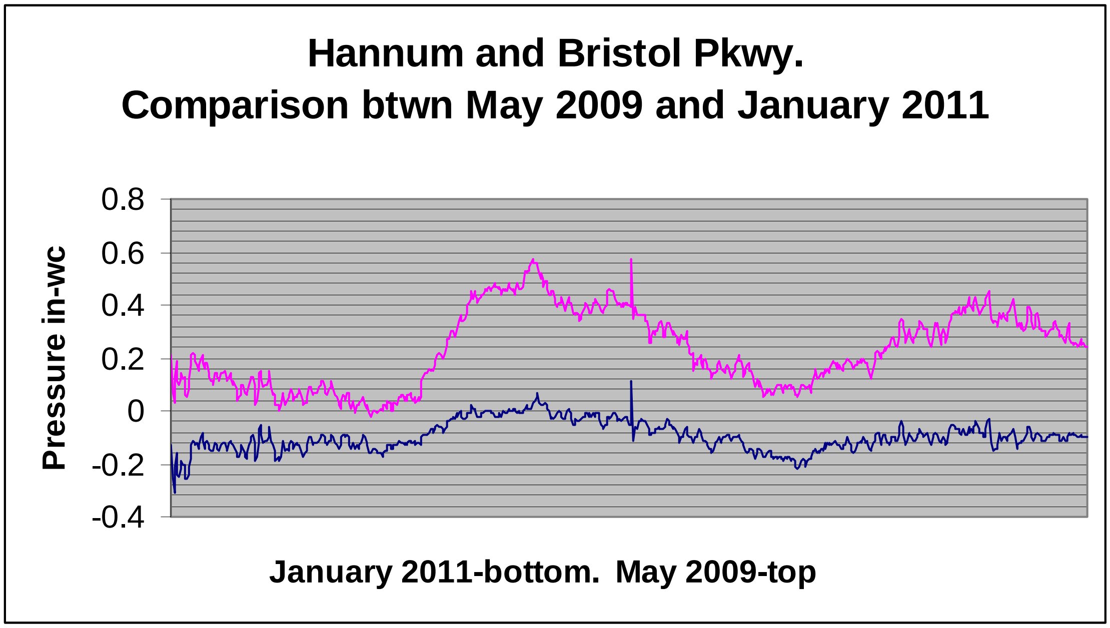


Figure 5

Both graphs show pressure with the NORS/ECIS scrubber on and show pressure for similar times of day so that the diurnal patterns match up. The graphs show that the pressure has dropped from an average of .24 in.-wc in 2009 to the point that it rarely rose above atmospheric pressure during the recent test. Similar reductions can be seen at all monitoring locations on the NORS.

Conclusion

With the NORS/ECIS Scrubber on, gas pressure within the NORS is at a level that will not cause ventilation of sewer gas into the atmosphere. At almost all locations along the NORS, sewer gas pressure is below atmospheric levels and will actually pull air into the sewer. The only location with positive pressure is near the NORS siphon. Since there are no locations for gas to escape from the sewer in this area, this location has not been subject to odor complaints, even during very high gas pressures. There is only one maintenance hole and it has a gasketed and bolted lid designed to prevent gas ventilation. Since pressure in the NORS is already negative and therefore, should not cause odor ventilation, any further remedial action to lower gas pressure within the NORS may generate additional negative pressures but a further reduction in odor complaint would be unlikely. The benefit of the NORS/ECIS scrubber is very visible from these results, and this scrubber should remain in operation. The City will continue investigating any odor complaints and will monitor the gas pressure at the NORS siphon and will report on it regularly in the annual Odor Control Master Plan as an “Area of Concern.”

8.3.2 POST AIR-CURTAIN PRESSURE TEST

NORS-NOS-NCOS-ECIS-LCIS-LCSFVRS-WRS-WLAIS-CBD

JULY 2011

Objective

Several past pressure tests along the NORS have shown a trend of high pressure from the upper-most reach of the NORS downstream to the NORS siphon that affected all sewers tributary to the NORS. The goal of the air curtains is to block and control the pressure within the NORS and thus lower pressure in the tributary sewers.

Scope

The air curtains were inserted into the following four diversion structures:

- Diversion 1 which diverts sewage flow from the NCOS to the NORS located at Rodeo Road and Kalsman Avenue.
- Diversion 2 which diverts sewage flow from the LCSFVRS and the LCIS to the NORS located just west of the ATF at 6000 Jefferson Blvd.
- Diversion 3 which diverts sewage flow from the WLAIS and the WRS to the NORS located inside the NOTF in Culver City.
- Diversion 11 (CBD/NOS Diversion to ECIS) which diverts sewage flow from the NOS and the CBD (Central Business District) Sewer to the ECIS located on Trinity Street just south of 23rd Street near downtown.

The installation began the first week of May 2011 and concluded the first week of June 2011.

A pressure test was conducted prior to the air curtain installation in order to determine the pre-curtain pressure. The Post Air Curtain Pressure Test began on July 11 and ended on July 19, 2011.

The following table shows the tested locations.

MH #	Location	Sewer
Diversion 1		
535-02-090	Rodeo Rd at La Cienega	NCOS us of Div 1
535-03-156	Rodeo & Cochran	NOS us of Div 1
535-06-132	Ivy & Perham	NORS ds of Div 1
535-05-016	PXP Oil Field	NCOS ds of Div 1
Diversion 2		
535-02-116	Corbett @ Jefferson	LCIS by see's candy
535-05-026	9500 Jefferson Blvd	NOS ds of Div 2
535-05-021	Culver City Park	NORS ds of Div 2
535-02-089	Kalsman & Rodeo Rd.	LCSFVRS us of Div 2
Diversion 3		
534-12-010	Overland and Farragut	WLAIS us of Div 3
534-08-040	Jackson nw/o Braddock	WRS us of Div 3
535-05-029	Leahy @ Pearson	NOS us of Div 3
535-09-006	Jefferson Blvd/Olive Tree	Div 3 to NORS pipe
535-09-022	NORS/ECIS Junction	NORS/ECIS ds of Div 3
535-13-007	WLA Campus Sound Wall	NORS ds of Div 3
535-13-013	WLA Campus	NOS ds of Div 3
559-05-006	Bristol Pkwy @ Hannum	NORS ds of Div 3
Diversion 11		
537-02-211	Trinity s/o 23rd u/s of Div 4	NOS diversion to ECIS
537-03-199	Alley approach to NOS	NOS approach to ECIS
537-02-175	23rd at Maple	57 " CBD to NOS

Baldwin Hills Outfall Sewer System

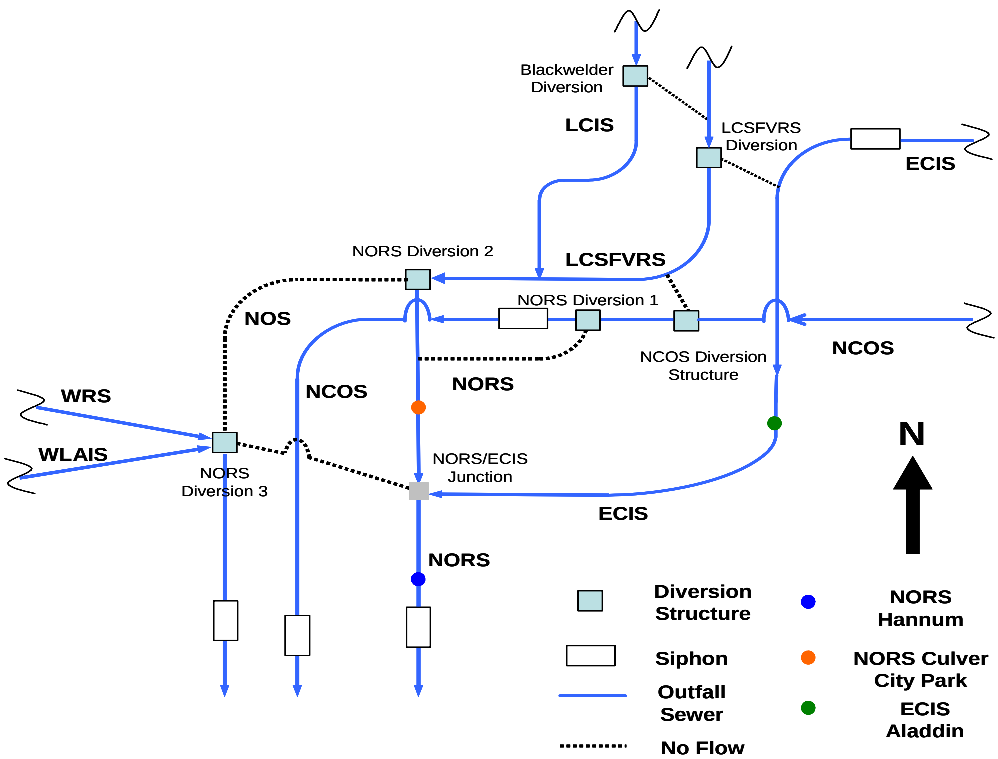


Figure 1

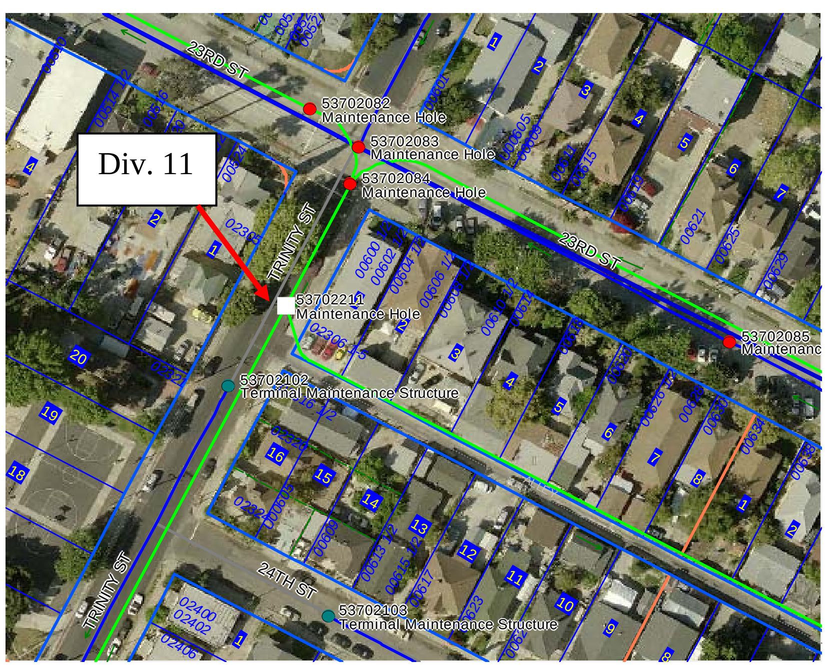


Figure 2

Data Presentation and Analysis

The following table shows a comparison between the pre and post air curtain pressure readings.

MH #	Location	Sewer	Pre Air Curtains	Post Air Curtains
			Avg in.-wc	Avg in.-wc
Diversion 1				
535-02-090	Rodeo Rd at La Cienega	NCOS u/s of Div 1	-0.02	-0.05
535-03-156	Rodeo & Cochran	NOS u/s of Div 1	-0.02	-0.08
535-06-132	Ivy & Perham	NORS d/s of Div 1	0	0.01
535-05-016	PXP Oil field	NCOS d/s of Div 1	-0.90	-0.90
Diversion 2				
535-02-116	Corbett @ Jefferson	LCIS by See's Candy	0.09	-0.01
535-05-026	9500 Jefferson Blvd	NOS d/s of Div 2	0.15	-0.02
535-05-021	Culver City Park	NORS d/s of Div 2	0.07	0.03
535-02-089	Kalsman &Rodeo Rd.	LCSFVRS u/s of Div 2	0.04	-0.01
Diversion 3				
534-12-010	Overland and Farragut	WLAIS u/s of Div 3	0.01	-0.02
534-08-040	Jackson nw/o Braddock	WRS u/s of Div 3	-0.01	0.01
535-05-029	Leahy @ Pearson	NOS u/s of Div 3	0	-0.04
535-09-006	Jefferson Blvd/Olive tree	Div 3 to NORS pipe	-0.01	-0.02
535-09-022	NORS/ECIS junction	NORS/ECIS d/s of Div 3	-0.01	-0.05
535-13-007	W LA campus sound wall	NORS d/s of Div 3	0.05	-0.02
535-13-013	W LA campus	NOS d/s of Div 3	0.02	-0.06
559-05-006	Bristol Pkwy @ Hannum	NORS d/s of Div 3	0.02	-0.02
Diversion 11				
537-02-211	Trinity s/o 23rd u/s of Div 4	NOS diversion to ECIS	0.04	-0.01
537-03-199	Alley approach to NOS	NOS approach to ECIS	0.05	-0.05
537-02-175	23rd at Maple	57 " CBD to NOS	0	-0.04

Diversion 1

The data shows no change in diurnal pressure at the four locations except for Rodeo and Cochran upstream of Diversion 1 which became more negative.

Diversion 2

The data revealed that the diurnal pressure was reduced nearly by half. Most of the locations showed negative pressure. The combined effect of the flow diversion from the NORS back to the NOS, the ATF at Jefferson and La Cienega, and the air curtain at Diversion 2 contributed to this reduction.

Diversion 3

The data revealed that the diurnal pressure has decreased. This decrease is probably the result of the two air curtains at Diversions 2 and 3 as well as the flow diversion from the NORS back to the NOS.

Diversion 11

The pressure data revealed that the air curtains installed at Diversion 11 had decreased the back pressurization of the two conduits, the CBD Sewer, and the NOS approach to the ECIS.

Conclusion

The addition of the air curtains to the sewer system as a means of controlling back pressurization is successful in achieving measurable results. As more testing in and around the affected areas is conducted on a regular basis, the continued effect of the air curtains on pressures will be assessed.

8.4 AOC4 - East Valley Area
AVORS-EVRS-VORS-NHIS-NOS

INTRODUCTION

The significant sewers in the East Valley Area are the Additional Valley Outfall Relief Sewer (AVORS), the East Valley Relief Sewer (EVRS), and portions of the North Outfall Sewer (NOS) and the Valley Outfall Relief Sewer (VORS). The North Hollywood Interceptor Sewer (NHIS), and the Forman Avenue Sewer from Camarillo Street to Valley Spring Lane is also included in this study area. These outfall sewers were tested to locate any high gas pressure and evaluated to determine the cause.

Effluent from the Tillman Water Reclamation Plant (TWRP) flows through these sewers. The TWRP does not treat biosolids but instead returns them to the sewer system to be conveyed to the Hyperion Treatment Plant. These concentrated biosolids initially travel through AVORS, then through the EVRS and the NOS to the Toluca Lake area. At the intersection of Valley Spring Lane and Forman Avenue, this flow is split between the La Cienega/San Fernando Valley Relief Sewer (LCSFVRS) and the NOS on its way to Hyperion. This high concentration of biosolids causes the sewage to produce excessive H_2S, leading to odor problems.

Several previous recommendations have been implemented that have reduced gas pressure and hydrogen sulfide concentrations in this area's sewers. The construction of a carbon scrubber at the Radford Siphon in Studio City and the addition of magnesium hydroxide to the sewer system at the TWRP are two measures that have had a significant benefit. Diverting flow from the Forman Avenue Sewer to the NOS lowered gas pressure in the Forman Avenue Sewer, reducing odor complaints in this area. Furthermore, a trap maintenance hole on the Forman Ave Sewer was removed, allowing backed-up gas to flow downstream, greatly reducing gas pressure.

This report discusses the gas pressure testing performed on sewers in this area in May 2011. This report discusses the analysis of the data, and provides some conclusions and recommendations. Table 8.4 provides a list of the monitoring locations and Figure 8.4 shows these locations on a map.

TEST RESULTS
Table 8.4

No.	LOCATION	STRUCT. NO.	SEWER	2011 PRESSURE	2010 PRESSURE	2006 PRESSURE	H2S AVG/MAX (ppm)	FLOW (cfs)
1	BURBANK BL E/O SEPULVEDA	42911079	VORS	0.13	0.08	0.15	-	12
2	BURBANK @ KESTER	42912083	VORS	0.11	0.07	0.05	-	17
3	RIVERSIDE @ WHITSETT (SIPHON)	44203170	EVRS	0.11	-	-	15/39	57
4	RIVERSIDE & WHITSETT (SIPHON)	44204168	EVRS	-	0.00	-	-	57
5	RIVERSIDE & LANKERSHIM	44306176	EVRS	0.24	0.22	0.02	-	57
6	BURBANK E/O SEPULVEDA	42911080	NOS	0.05	-	-	-	6
7	MOORPARK @ BELLAIR	44207032	NOS	0.07	-	-	-	25
8	WOODBRIDGE & WHITSETT	44208092	NOS	-	0.00	-	-	25
9	WOODBRIDGE @ LAUREL	44208090	NOS	0.04	-	-	-	25
10	WOODBRIDGE & RADFORD	44305072	NOS	-	0.03	-	-	27
11	BECK N/O CHIQUITA	44305253	NOS	-0.13	0.00	-	-	26
12	CAHUENGA & HUSTON	44303148	NHIS	0.15	0.18	0.05	-	5
13	CAHUENGA & CAMARILLO	44303147	NHIS	-	0.25	-	-	5
14	FORMAN & CAMARILLO	44303071	PRIMARY	-0.02	0.04	-	-	11
*15	FORMAN S/O RIVERSIDE	44307055	PRIMARY	-0.3	0.04	-	1/6	11
*16	VALLEY SPRING & FORMAN	44307158	VSF	-0.3	0.02	0.05	2/12	12

* Instantaneous pressure reading between 8 to 9 am.

TESTING LOCATIONS

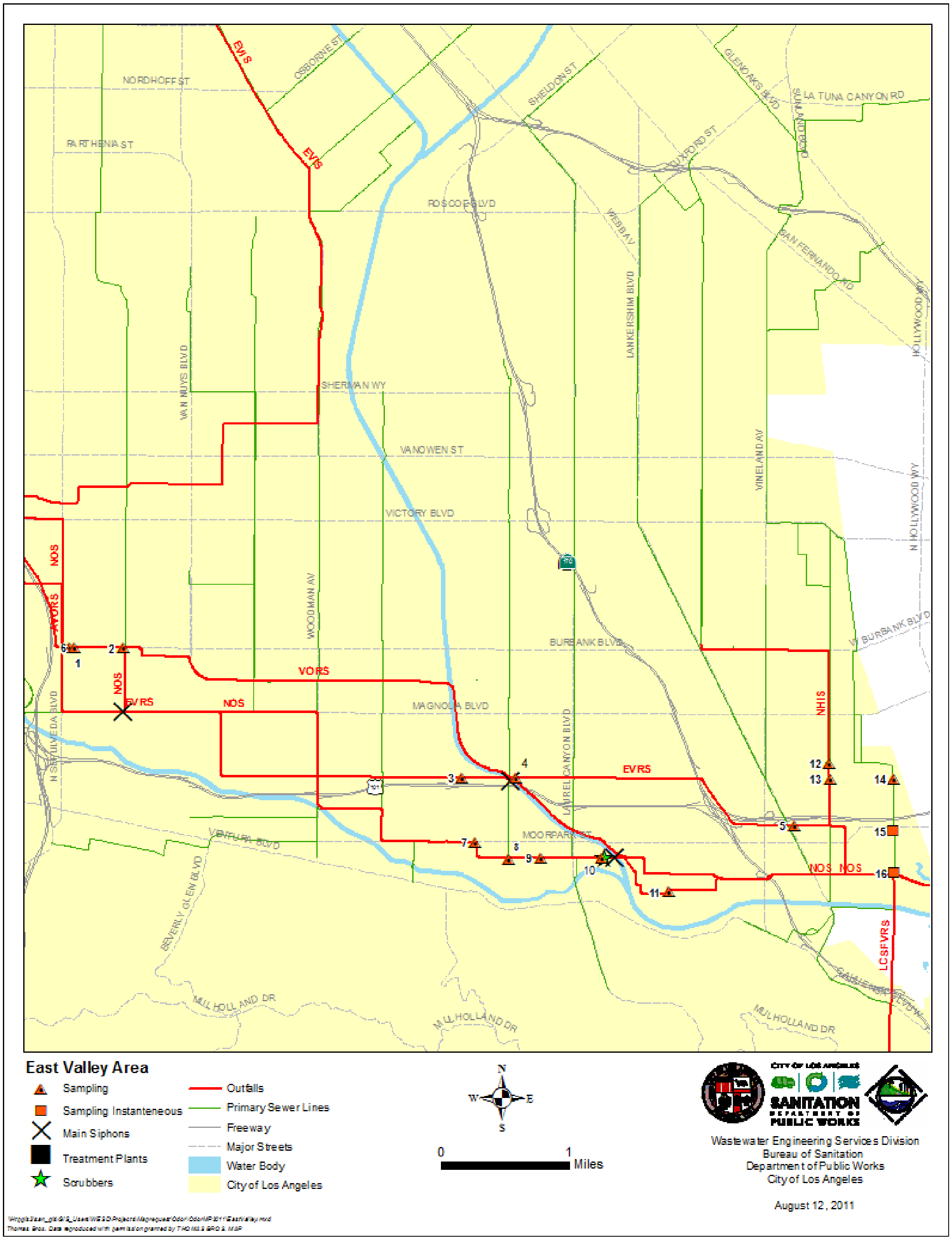


FIG. 8.4

DATA ANALYSIS

Historically, the VORS has not had odor problems except for one area near the intersection of Burbank Boulevard and Sepulveda Boulevard. Locations 1 & 2 tested gas pressures near this intersection. Location 1 at Burbank Boulevard east of Sepulveda had an average pressure of 0.13 inches of water, compared to 0.08 in 2010. Downstream on the VORS at Location 2, the average pressure was 0.11, up from 0.07 in 2010.

Not to scale

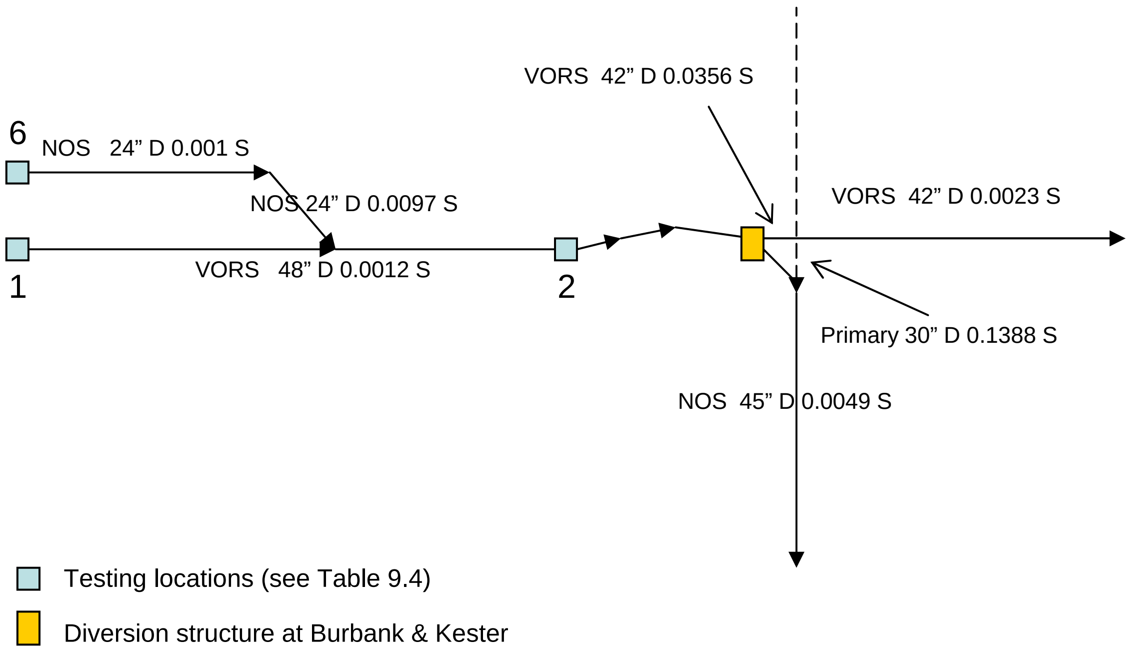


FIG. 8.4.1

Locations 7 through 11 monitored several locations on the NOS with histories of high gas pressure. The average pressures at these locations were between -0.13 downstream of the Woodbridge Siphon to 0.05 in the upstream sections of NOS. The NOS has shown significant improvements in the last few years, mainly due to the scrubber at the Woodbridge Siphon.

Two locations on the EVRS with moderate-to-high pressure readings last year were selected for monitoring this year. The first location (Location 3), upstream of the Riverside and Whitsett Siphon, had an average pressure of 0.11. The second location (Location 5) approximately 3 miles downstream at Riverside and Lankershim had an average pressure of 0.24.

The NHIS collects sewage from the east valley and flows into the EVRS near the intersection of Cahuenga and Riverside. Location 12 measured pressure in in the EVRS at Cahuenga and Huston. The average pressure was 0.15, which is similar to 2010 data.

Locations 14 &15 measured pressure on the Forman Avenue Sewer, a 30" primary sewer along Forman Avenue that empties into the LCSFVRS. The average pressure in this sewer was -0.02**.**

CONCLUSION

AVORS: This sewer was not monitored for this reporting period since it did not exibit higher than normal gas pressure or odor complaints.

VORS: The average pressure in the VORS is positive between the Tillman Treatment Plant and the Kester and Burbank diversion structure. Turbulence created by the diversion structure, together with hydraulic jumps, restricts the movement of gas, causing back pressure in this section of VORS (see Fig. 8.4.1). Additionaly, the internal average temperature in this section of the VORS was 86^{o}F compared to 81^{o} in 2010, which may explain why the pressures are higher this year.

NOS: On average, the pressure in the NOS was generally negative to slightly positive. The 5,000 cfm scrubber at Woodbridge and Radford is effectively maintaining negative pressure in the NOS upstream of the Radford siphon.

EVRS: Gas pressure in the EVRS was positive at tested locations with pressure increasing in the downstream direction. Real time flow gauging on the EVRS showed flows peaking at about 60% with velocities of 5 to 6 ft/s. There may be some turbulence at the junction with the NHIS. The EVRS also carries the concentrated biosolids from the DCTWRP. The combination of concentrated biosolids and pockets of turbulence in the system could create excessive gas in the headspace, pressurizing the EVRS and the connecting lines.

NHIS: Positive pressures were recorded on the NHIS and are mainly attributed to physical characteristics of the sewer line and back pressure from the junction with the EVRS. The NHIS sewer is comprised of relatively large diameter pipes (60" to 78") with minimal flow (approx. 5 cfs and velocities less than 3 fps per the 2010 Mike Urban model). The large available headspace becomes an escape route for pressurized gas in the EVRS.

RECOMMENDATIONS/CONSIDERATIONS

- Continue to monitor this area for pressure and hydrogen sulfide
- Control air flow dynamics through sewer flow management by manipulating sewage flow within the sewer system
- Continue monitoring pressures on the EVRS, NHIS, VORS, and seal maintenance hole lids where necessary
    - Conduct flow gauging on the NHIS
    - Conduct focused pressure testing on the EVRS downstream of the NHIS

9.0 AREAS OF STUDY

9.1 AOS1 - South Los Angeles

INTRODUCTION

In South Los Angeles, the alignment of the NOS, known as the Maze area, has historically been an area of high odor emissions and frequent odor complaints. Currently the majority of the wastewater that flows into the Maze sewer system is from various tributaries that service the South Los Angeles areas. All other flows have been diverted to NEIS and ECIS. Since these major diversions, pressures in the Maze system have been reduced.

The South Branch of the NOS picks up flow from the Florence Avenue Sewer, the 74th Street Sewer, and the Slauson Avenue Sewer. The South Branch runs along Martin Luther King Boulevard to Rodeo Road where it intersects the North Branch of the NOS. The North Branch mainly receives flow from the NOS along 41st Place with most of the flow coming from the Boyle Heights area and local flow from the 23rd and Trinity area. Most sewers that feed into the South Branch have very flat slopes so the minimum scouring velocity of 3 ft/sec. is rarely acheived. As a result, debris builds up in the sewer and the system becomes anaerobic, causing H_2S production to increase. Several projects are planned to address this in the near future. Meanwhile, the City monitors the sewers continuously for H_2S, pressure, and wastewater pH. There is a 5,000 CFM scrubber that operates at the intersection of MLK and Rodeo to clean sewer gases before it is vented into the atmosphere. Caustic shock dosing is conducted to control the generation of hydrogen sulfide along the tributary sewers to the Maze.

This area was sampled at key locations on July 6th, 2011 from 10:00 AM to noon, to look for any major changes in pressure since the last time it was tested.

TEST RESULTS

Table 9.1

ID	LOCATION	STRUCT. NO.	SEWER	2011 PRESSURE	2010 PRESSURE	2006 PRESSURE	H2S AVG/MAX (ppm)	FLOW (cfs)
1	San Pedro St Alley w/o San Pedro	53703199	NOS	-0.22	0.04	-	-	81
2	Trinity s/o 23rd St	53702211	NOS	-0.14	0.05	-	-	81
3	33rd & Trinity	53706186	NOS	-0.07	0.05	-	-	0.4
4	41st Pl & Trinity	53710078	NOS	-0.07	-0.05	-0.04	74/282	9
5	Hyde Park e/o Haas	55806092	FLORENCE AV	-0.01	0.00	-	11/60	2
6	62nd e/o Wilton	55806216	74th St	-0.02	0.00	-	3/17	22
7	4th Ave n/o Slauson	55802143	South Branch Primary	-0.08	-0.02	-	-	50
8	4th Ave s/o Vernon	53614020	South Branch Primary	Not Accessible	0.00	-	-	51
9	MLK & Somerset	53605165	NOS/Maze South Branch	-0.04	0.02	0.00	29/139	62
10	Rodeo & Grayburn	53605166	NOS/Maze North Branch	-0.13	0.00	-	-	-
11	Cochran & Rodeo	53503156	NOS D/S Maze	-0.12	0.01	-0.09	9/37	133

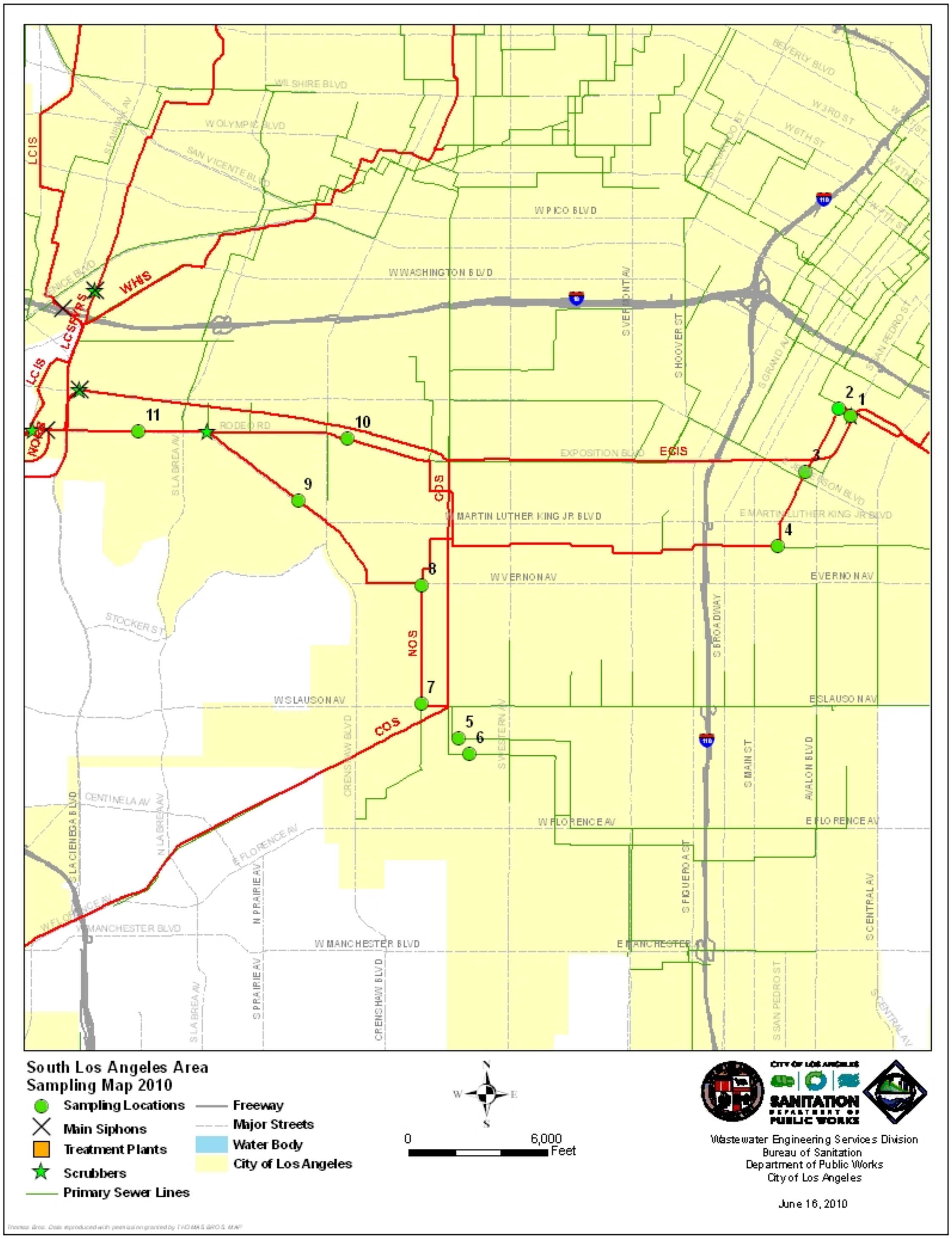

South Los Angeles Area
Sampling Map 2010
Sampling Locations
Main Siphons
Treatment Plants
Scrubbers
Primary Sewer Lines
Freeway
Major Streets
Water Body
City of Los Angeles
0
6,000
Feet
N
S
E
W
Wastewater Engineering Services Division
Bureau of Sanitation
Department of Public Works
City of Los Angeles
June 16, 2010
WILSHIRE BLVD
W OLYMPIC BLVD
SAN VICENTE BLVD
W PICO BLVD
W WASHINGTON BLVD
RODEO RD
EXPOSITION BLVD
MARTIN LUTHER KING JR BLVD
E MARTIN LUTHER KING JR BLVD
W VERNON AV
E VERNON AV
W SLAUSON AV
E SLAUSON AV
W FLORENCE AV
E FLORENCE AV
W MANCHESTER BLVD
E MANCHESTER
STOCKER ST
CENTINELA AV
S LA BREA AV
N LA BREA AV
S LA CIENEGA BLVD
CRENSHAW BLVD
N PRAIRIE AV
S PRAIRIE AV
S WESTERN AV
S VERMONT AV
S HOOVER ST
S FIGUEROA ST
S BROADWAY
S MAIN ST
AVALON BLVD
S SAN PEDRO ST
S CENTRAL AV
S GRAND AV
BEVERLY BLVD
W 3RD ST
W 6TH ST
LCIS
WHIS
NOS
COS
ECIS
1
2
3
4
5
6
7
8
9
10
11

FIG. 9.1

DATA ANALYSIS

Average pressure at the most upstream section located at 23rd and San Pedro just upstream of the drop structure, is -0.22 in-wc. At Trinity south of 23rd Street, the average pressure is -0.14 in-wc. Continuing downstream, at 33rd and Trinity, pressure is -0.07 in/wc. At Location 4 at 41st Place and Trinity, pressure continues to be negative at -.07.in-wc. Next, the Florence Ave Sewer and 74th Street Sewer were monitored upstream of their diversion into the south branch of the NOS. Pressures were negative or zero at both locations. Pressures at Locations 7, 9, and 10 varied between -0.13 and -0.04 in-wc. The average pressure at Cochran and Rodeo on the NOS was -0.12 in-wc.

CONCLUSION

Pressures have dropped significantly since the last test. This drop is mainly attributed to the NCOS ATF, which is strategically located to pull air from the upper and lower NOS in the Maze area.

RECOMMENDATIONS/CONSIDERATIONS

- Continue to monitor this area for pressure and hydrogen sulfide levels
- Control air flow dynamics through sewer flow management by manipulating sewage flow through various sewers

9.2 AOS2 - Coastal Interceptor Sewer (CIS)

INTRODUCTION

The Coastal Interceptor Sewer (CIS) is the major outfall serving Venice Westchester area. This area is relatively mountainous in the north, around Pacific Palisades, and relatively flat through Santa Monica and Venice to the south.

The CIS originates at Los Angeles County Sanitation District No. 27. It then follows the coastline along the Pacific Coast Highway, south easterly through Pacific Palisades, to a siphon just upstream of the City of Santa Monica. The CIS serves the coastal area of the Santa Monica Bay north of the HTP to Topanga State Beach near Malibu. This sewer conveys wastewater directly to the HTP from Pacific Palisades, Venice, Mar Vista, the City of Santa Monica, and adjacent areas (such as Marina Del Rey) served by the Los Angeles County Sanitation District no. 27. The CIS is a circular pipeline that ranges in diameter from 24 to 72 inches and is approximately 9.4 miles in length. It is constructed of vitrified clay pipe and reinforced concrete lined with polyvinyl chloride (PVC).

The Venice Pumping Plant is the largest pumping plant in the wastewater collection system, and the only pumping plant located on one of the wastewater collection system outfalls. The Venice Pumping Plant is located at the south end of Venice on the CIS, at Hurricane Street and the Grand Canal. The pumping plant was constructed in 1958, and modified in 1987 and again in 1997 to increase its capacity and reliability. The pumping plant currently has a theoretical capacity of 99 cfs with four pumps operating and one pump on standby. The pumping plant discharges into the CIS through a 48-inch-diameter force main extending south across the Marina Del Rey harbor entrance channel.

TEST RESULTS

Table 9.2

ID	LOCATION	STRUCT. NO.	SEWER	2011 PRESSURE	2010 PRESSURE	2006 PRESSURE	FLOW (cfs)
1	PCH	52115303	CIS	-	-0.09	-	6
2	PCH	53203005	CIS	-0.05	-0.02	0.01	5
3	PCH & ENTRADA	53203016	CIS	-	-	0.01	5
4	PCH	53203029	CIS	-0.01	-0.03	0	10
5	MAIN ST (SANTA MONICA)	53314073	CIS	-0.02	0.00	0	-
6	MAIN ST (SANTA MONICA)	53314072	CIS	-	0.00	-	-
7	VIA DOLCE R/W	56111066	CIS	0.01	0.00	0	-
8	VISTA DEL MAR	56208041	CIS	-0.67	-0.82	0.03	55
9	VISTA DEL MAR	56313039	CIS	-0.67	-0.73	0.03	55

DATA ANALYSIS

Instantaneous pressure readings were taken along CIS in May 19th, 2011 between 11:00 AM to noon. Pressures were generally negative on the upstream to very negative in the downstream part of CIS.

CONCLUSION

The test indicated that sewer gas pressure in this area is not a problem.

RECOMMENDATIONS/CONSIDERATIONS

- Continue to monitor this area for pressure and hydrogen sulfide
- Control air flow dynamics through sewer flow management by manipulating sewage flow through various sewers

TESTING LOCATIONS

FIG. 9.2

9.3 AOS3 - Harbor Area

INTRODUCTION

This section discusses the pressure test conducted in the Harbor Area Primary Sewer System in April of 2010. There are four interceptor sewer systems in the Harbor area that convey the wastewater generated in this area to the Terminal Island Treatment Plant. The interceptor sewer systems are named after their respective force mains through which their flow is pumped to the TITP.

Fries Avenue Interceptor Sewer System (FISS), consists of three major pumping plants and their respective interceptor sewers, all of which serve the community of Wilmington. The FISS also serves various industrial dischargers, some of which are on Harbor Department property.

Terminal Way Interceptor Sewer System (TISS) collects and transports wastewater from the San Pedro area to the TITP. The TISS also serves the industrial area south of 22nd Street and Terminal Island. The main pumping plant on this system is the Terminal Way Pumping Plant.

San Pedro Interceptor Sewer System (SPISS) serves the residential areas of San Pedro and Wilmington and the industrial area consisting primarily of the Phillips Conoco Refinery. It also serves some industrial discharges located on Harbor Department property.

A supplement to this system allows all flows from the FISS to be diverted to the San Pedro Pumping Plant. The only exception to this is that the flow from the Harris Avenue Pumping Plant remains tributary to TITP via the Fries Avenue Force Main.
The "U.S. Navy Sewer System and Facility" consists of four separate force mains (two 6", one 12", and one 20"), a pumping plant, and collector sewers that used to serve the U.S. Naval Reservation on Terminal Island. After the decommissioning of the U.S. Navy, the City of Long Beach took over the assets of the US Navy Sewer System and Facility that deliver the wastewater to the TITP.

TEST RESULTS

Table 9.3

ID	LOCATION	STRUCT. NO.	SEWER	2011 PRESSURE	2010 PRESSURE	2006 PRESSURE	FLOW (cfs)
1	ALAMEDA N/O F ST	61311139	HARBOR	0.012	-0.01	0	-
2	MCFARLAND AV R/W	61311112	HARBOR	0.015	0.00	0.002	-
3	B ST	61313048	HARBOR	NO ACCESS	0.00	0	-
4	WILMINGTON & SAN PEDRO	61908038	HARBOR	-0.01	-0.09	0.001	-
5	CHANNEL ST	61908083	HARBOR	0.00	0.00	-0.004	-
6	PACIFIC AV	62005014	HARBOR	0.033	0.02	-	-
7	HARBOR BL	62009041	HARBOR	0.02	0.02	0	2.17
8	PACIFIC AV	62516010	HARBOR	0.00	-0.02	0	0.5
9	CRESCENT AV R/W	62401114	HARBOR	0.012	0.01	-0.001	0.5
10	HARBOR BL R/W	62013030	HARBOR	0.01	0.01	0	-

DATA ANALYSIS

Instantaneous pressures were taken on June 8th, 2011 between 11:00 AM to 1:00 PM. Pressures varied between -0.01 and 0.03. Fairly similar to previous years where pressure hovers close to atmospheric level.

CONCLUSION

The test indicated that sewer air pressure in this area is generally near atmospheric level therefore it is not a problem.

RECOMMENDATIONS/CONSIDERATIONS

- Continue to monitor this area for pressure and hydrogen sulfide
- Control air flow dynamics through sewer flow management by manipulating sewage flow through various sewers

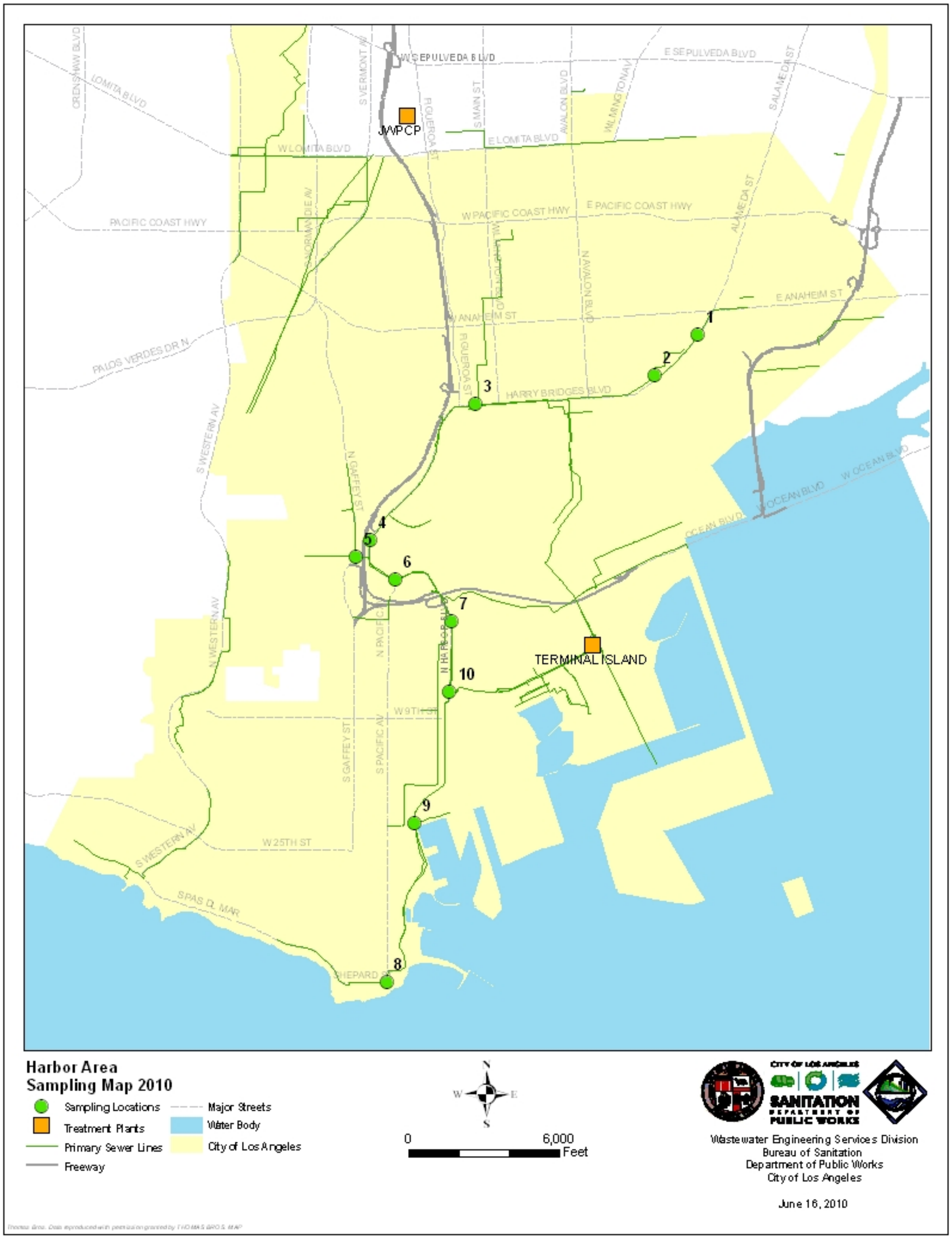

W SEPULVEDA BLVD
E SEPULVEDA BLVD
JWPCP
W LOMITA BLVD
E LOMITA BLVD
PACIFIC COAST HWY
W PACIFIC COAST HWY
E PACIFIC COAST HWY
E ANAHEIM ST
W ANAHEIM ST
PALOS VERDES DR N
HARRY BRIDGES BLVD
S WESTERN AV
N GAFFEY ST
N WESTERN AV
TERMINAL ISLAND
W 9TH ST
S GAFFEY ST
S PACIFIC AV
W 25TH ST
S WESTERN AV
W OCEAN BLVD
OCEAN BLVD
1
2
3
4
5
6
7
8
9
10
Harbor Area
Sampling Map 2010
Sampling Locations
Treatment Plants
Primary Sewer Lines
Freeway
Major Streets
Water Body
City of Los Angeles
0
6,000
Feet
Wastewater Engineering Services Division
Bureau of Sanitation
Department of Public Works
City of Los Angeles
June 16, 2010

FIG. 9.3

9.4 AOS4 - West Valley Area

INTRODUCTION

This section discusses the pressure test conducted in the West San Fernando Valley Area sewers in April, 2010. Wastewater generated in the west valley is conveyed to four interceptor sewers: the North Outfall Sewer (NOS), the Valley Outfall Relief Sewer (VORS), the Additional Valley Outfall Relief Sewer (AVORS), and the East Valley Interceptor Sewer (EVIS). Most of the wastewater flow is routed to the Tillman Water Reclamation Plant (TWRP).

TEST RESULTS

Table 9.4

ID	LOCATION	STRUCT. NO.	SEWER	2011 PRESSURE	2010 PRESSURE	2006 PRESSURE	FLOW (cfs)
1	VANOWEN & MASON	39614176	VORS	-0.014	0.00	-0.001	2
2	VANOWEN & ETIWANDA	39714176	VORS	-0.01	0.00	-	13
3	VICTORY E/O ETIWANDA	43002139	AVORS	0.04	0.07	0.04	33
4	WOODMAN & HART	39914195	EVIS	0.02	0.02	-	36
5	VICTORY & HASKELL	42902209	EVIS	0.04	0.03	0.02	18

DATA ANALYSIS

Instantaneous gas pressure readings were taken on May 11, 2011 between 10:00 AM to noon in the western part of San Fernando Valley. Pressures were generally around atmospheric level in the VORS, and EVIS sewers. Location 3 on the AVORS at Victory Bl. east of Etiwanda had an average pressure of 0.04 in-wc. This MH is upstream of a siphon.

CONCLUSION

The test indicated that sewer air pressure in this area is generally near atmospheric level; therefore it is not a problem.

RECOMMENDATIONS/CONSIDERATIONS

- Continue to monitor this area for pressure and hydrogen sulfide, especially near Victory and Etiwanda
- Control air flow dynamics through sewer flow management by manipulating sewage flow through various sewers

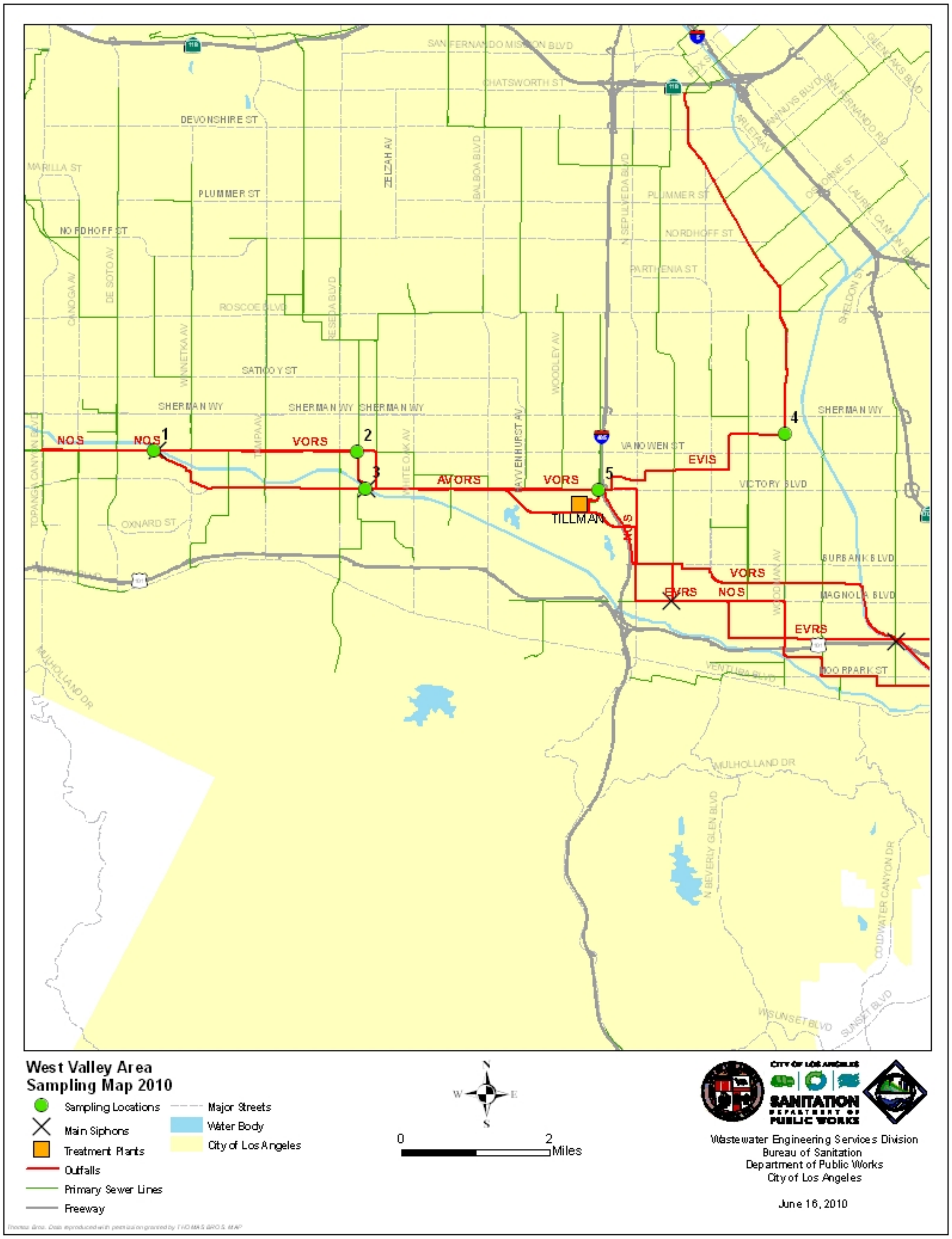

West Valley Area
Sampling Map 2010
Sampling Locations
Main Siphons
Treatment Plants
Outfalls
Primary Sewer Lines
Freeway
Major Streets
Water Body
City of Los Angeles
Miles
Wastewater Engineering Services Division
Bureau of Sanitation
Department of Public Works
City of Los Angeles
June 16, 2010
NOS
VORS
AVORS
EVIS
EVRS
TILLMAN
SHERMAN WY
VICTORY BLVD
OXNARD ST
BURBANK BLVD
MAGNOLIA BLVD
MULHOLLAND DR
DEVONSHIRE ST
PLUMMER ST
NORDHOFF ST
ROSCOE BLVD
SATICOY ST
VANOWEN ST

FIG. 9.4

10.0 AIR TREATMENT FACILITY (ATF) REVIEW STUDY NOVEMBER 2010

The consultant team of HDR Engineering/Malcolm Pirnie conducted a study of the City's wastewater collection system in order to evaluate the ability of proposed ATFs to provide satisfactory odor relief to the collection system.

The study was performed between January 2008 and November 2010 and cost approximately $2 million. It analyzed the sewer system as a whole, focusing on known causes of sewer odors and included both current conditions and planned modifications to the sewer system. The study was divided into multiple sub-components for more effective analysis.

Two of the study's components were the analysis of sewer drop structures and the analysis of inverted sewer siphons. Each were evaluated to better understand their effects on gas movement and pressurization and to determine solutions to the problems caused by each of these structures. The analysis involved extensive field testing, model testing, and the review and consideration of sewer plans, previous testing, and odor complaints. Another component of the study was the creation of a computer model that uses current flow data and sewer geometry to predict locations of high gas pressure. A fourth component of the study was the analysis of total non-methane hydrocarbons associated with sewage, focusing on how to effectively remove them from sewer gas. The final component was a review of the proposed ATFs and whether each proposed ATF was the best solution for its application and if not, identifying alternative solutions. The study's findings were presented in a final report.

In order to assure a broad perspective that included input by the community, an independent sewer odor control expert was hired to observe aspects of the study and provide a third-party review of the study's investigations, findings, conclusions, and recommendations. The expert provided independent input to the consultant team and also briefed the community regarding aspects of the study including his opinion of the study's conclusions and recommendations. This helped the community accept the final outcome of the study.

At the study's conclusion, the consultant team recommended only building one of the four ATFs on hold (Mission and Jesse ATF). A variety of other solutions were proposed for the various locations. The recommendations of the study are summarized below. Details of the study are discussed in the final report titled *Air Treatment Facility (ATF) Review Study Final Report* dated November 2010.

ATF Review Study Recommendations/Suggestions

ATFs

Humboldt ATF - Not necessary
Richmond ATF - Not necessary
Mission & Jesse ATF - Construct as planned
23rd and San Pedro ATF - Not necessary
NORS-ECIS ATF - Not necessary

Alternative Solutions (to be constructed)

- The consultant team suggested installing an air flow regulation device, such as an adjustable damper, in the air return line of the following drop structures:
  - Division Drop Structure
  - Humboldt Drop Structure
  - Richmond Drop Structure
  - Mission & Jesse Drop Structure
  - 23rd & San Pedro Drop Structure
- The report also recommended installing air curtains at the Mission & Jesse Drop Structure in order to block the movement of gas.

Flow Diversions

The consultant recommended manipulating flows at the diversion structures leading into the drop structures in order to better control gas movement within the sewer system.

Follow-up Testing

The report recommended follow-up testing after the ATFs and other improvements were in place and operating in order to determine the effectiveness of the improvements. The system is dynamic therefore the City needs to be flexible to optimize the system.

Supplemental Report

HDR Engineering is currently preparing a supplemental report for this study in order to provide some additional information, clarify information presented in their final report as requested by EPA, as well as incorporate findings learned during follow-up testing of drop structure models which occurred after the final report was prepared.

11.0 RECOMMENDATIONS/CONSIDERATIONS

To meet immediate odor control needs, the City will continue all current odor control activities including odor complaint response and investigation, routine sewer maintenance, chemical addition, air withdraw and treatment using scrubbers and ATFs, sewer construction and repair, trap MH replacement program, and on-going monitoring of sewer air pressure and H_2S concentration.

Continuous pressure testing equipment will be used to perform long-term pressure and H_2S tests through the system in order to gather more accurate and more comprehensive pressure data of the sewer system. Additionally, pressure testing will be performed wherever pressure problems arise or where there are special circumstances where valuable information can be gained. Spot testing will continue as well throughout the system to allow thorough monitoring of the collection system.

The implementation plan is developed with the intention to provide immediate needs while satisfying long-term requirements. Table 12.1 presents the implementation plan for the various odor control projects and programs either already underway or recommended by this master plan.

Table 12.2 presents project cost data obtained from the WCIP Project Description and 10-Year Expenditure Plan 2006/07 – 2015/16.

The Sewer Odor Control Master Plan will be updated annually to assure that odor control strategies/measures are periodically challenged, solutions remain proactive, and technologies are current and effective.

TABLE 11.1
ODOR CONTROL IMPLEMENTATION PLAN

	Short-term Plan	Intermediate Plan	Long-term Plan
East NOS Corridor	- Continue to Monitor - Flow Management - Install air curtain to isolate NOS from back flow through M&J Drop Structure	- Continue to Monitor - Flow Management - Scrubber @ Gilroy Siphon - Mission and Jesse ATF	- Continue to Monitor - Flow Management - Mission and Jesse ATF
La Cienega / San Fernando Corridor	- Continue to Monitor - Flow Management - Alleviate pressure at Genesee Siphon – possible repair work on siphon	- Continue to Monitor - Flow Management - Upgrade Trap MHs	- Continue to Monitor - Flow Management
Baldwin Hills / Culver City Area	- Continue to Monitor - Flow Management - Analyze airflow dynamics as a result of NORS Divs. 1, 2 and 3 air curtains	- Continue to Monitor - Flow Management - Upgrade Trap MHs	- Continue to Monitor - Flow Management - Upgrade Trap MHs
East Valley Area	- Continue to Monitor - Flow Management - Continue pressure and H2S monitoring on EVRS/NHIS - Seal MHs where necessary	- Continue to Monitor - Flow Management - Upgrade Trap MHs	- Continue to Monitor - Flow Management - Upgrade Trap MHs
South Los Angeles	- Continue to Monitor - Flow Management - Upgrade Trap MHs	- Continue to Monitor - Flow Management	- Continue to Monitor - Flow Management
Coastal Interceptor Sewer (CIS)	- Continue to Monitor - Flow Management	- Continue to Monitor - Flow Management	- Continue to Monitor - Flow Management - Upgrade Trap MHs
Harbor Area	- Continue to Monitor - Flow Management	- Continue to Monitor - Flow Management	- Continue to Monitor - Flow Management
West Valley Area	- Continue to Monitor - Flow Management	- Continue to Monitor - Flow Management	- Continue to Monitor - Flow Management - Upgrade Trap MHs

	Short-term Plan	Intermediate Plan	Long-term Plan
Odor Hotline Outreach	On-going	On-going	On-going

TABLE 11.2
ODOR CONTROL PROJECT/PROGRAM COST

Title	Estimated Cost ($)	Estimated Completion Date
ATF ECIS – Mission & Jesse	12,000,000	6/2014
Atwater Village Sewer Odor Mitigation Plan	740,000	1/2014
Chemical Treatment Application	3,500,000/yr	On-going
11 Odor Control Units Carbon Expense	1,600,000/yr	On-going
Trap Maintenance Hole Program	3,100,000	2013
Outreach	50,000/yr	On-going
Odor Control – Future	500,000/yr	On-going

Source: WCIP Project Description and 10-Year Expenditure Plan 2006/07 – 2015/16

APPENDIX A

Post ATF Baldwin Hills Sewer Pressure Study
March 2011

Background

The City recently constructed two biotrickling filter Air Treatment Facilities (ATFs) in the Baldwin Hills area. The two ATFs are the Jefferson/La Cienega ATF and the 6000 Jefferson ATF and both have been in full operation since January of 2011. The Jefferson/La Cienega ATF extracts gas from East Central Interceptor Sewer (ECIS) and the La Cienega/San Fernando Valley Relief Sewer (LCSFVRS) at the rate of 13,500 cfm and 6,500 cfm respectively. The 6000 Jefferson ATF extracts gas from the North Central Outfall Sewer (NCOS) at the rate of 12,000 cfm. Near this same time, the City completed the rehabilitation of the North Outfall Sewer (NOS) and diverted a significant amount of flow from the North Outfall Replacement Sewer (NORS) back into the NOS, greatly reducing the flow in the NORS. The City has suspected that these events would help reduce sewer gas pressure within the NORS as well as other large sewers. In order to confirm this, the City recently tested gas pressure within the NORS and found that pressure did fall dramatically to the point that the upper portion of the NORS upstream of the siphon under the 405 Freeway has little or no gas pressure.

Purpose

The purpose of this test is to follow up on the recent pressure test of the NORS with a more comprehensive study of additional sewers within the area in an effort to comprehend the total positive impact of the ATFs and to assess gas pressure in the sewer network upstream and downstream of the ATFs.

Scope

This pressure test monitored pressure at twenty two locations on seven major sewers as shown in Table 1 and Figure 1. All monitoring locations have been tested for pressure in the past and historically have been a source of sewer odor ventilation. Pressure was recorded using continuous pressure data loggers that recorded gas pressure every two minutes. All 22 locations were monitored beginning on March 9, 2011 and ending March 22, 2011.

During this test, two carbon scrubbers in the area were turned off and back on in order to determine if and how their benefit to the system has changed as a result of the recent developments. The two scrubbers are the NORS/ECIS Scrubber at the junction of the NORS and the ECIS and the NOTF Scrubber at the junction of the WLAIS, the WRS, and the NOS. The following schedule summarizes the on-off operation during the testing.

Scrubber Operation Schedule

Date	NOTF Scrubber	NORS/ECIS Scrubber
Monday, March 14	On	On
Wednesday, March 16	Off	On
Friday, March 18	Off	Off
Monday, March 21	On	Off
Tuesday, March 22	On	On

Monitoring Locations

	Location	Sewer	MH #
1	35th St. & Grand Av.	ECIS	537-05-181
2	Exposition Bl. @ Potomac Av.	ECIS	535-04-216
3	Jefferson Bl. w/o Cochran Av.	ECIS	535-03-213
4	La Cienega Bl. & Aladdin St.	ECIS	535-06-116
5	ECIS/NORS Junction	ECIS	535-09-022
6	La Cienega Bl. @ KLOS	LCSFVRS	535-02-024
7	La Cienega Bl. @ See's Candy	LCSFVRS	535-02-052
8	Kalsman Dr. & Rodeo Rd.	LCSFVRS	535-02-089
9	Rodeo Rd. & Cochran Av.	NOS	535-03-156
10	Leahy/Pearson Parking Lot	NOS	535-05-029
11	Fox Hills Dr. u/s of NORS Siphon	NOS	559-05-008
12	Special Air Line @ Fox Hills Mall	NOS	560-08-055
13	La Cienega Bl. & Rodeo Rd.	NCOS	535-02-090
14	PXP Oil Field nr. WLA College	NCOS	535-05-016
15	Green Valley Crl. @ Bristol Pkwy.	NCOS	559-05-005
16	Ivy Way & Perham Dr.	NORS	535-06-132
17	Culver City Park	NORS	535-05-021
18	Diversion 3 (to NORS)	NORS	535-09-006
19	WLA College (behind sound wall)	NORS	535-13-007
20	Hannum Av. & Bristol Pkwy	NORS	559-05-006
21	Farragut Dr. & Le Bourget Av.	WLAIS	534-08-044
22	Jackson nw/o Braddock	WRS	534-08-040

Table 1

Monitoring Locations

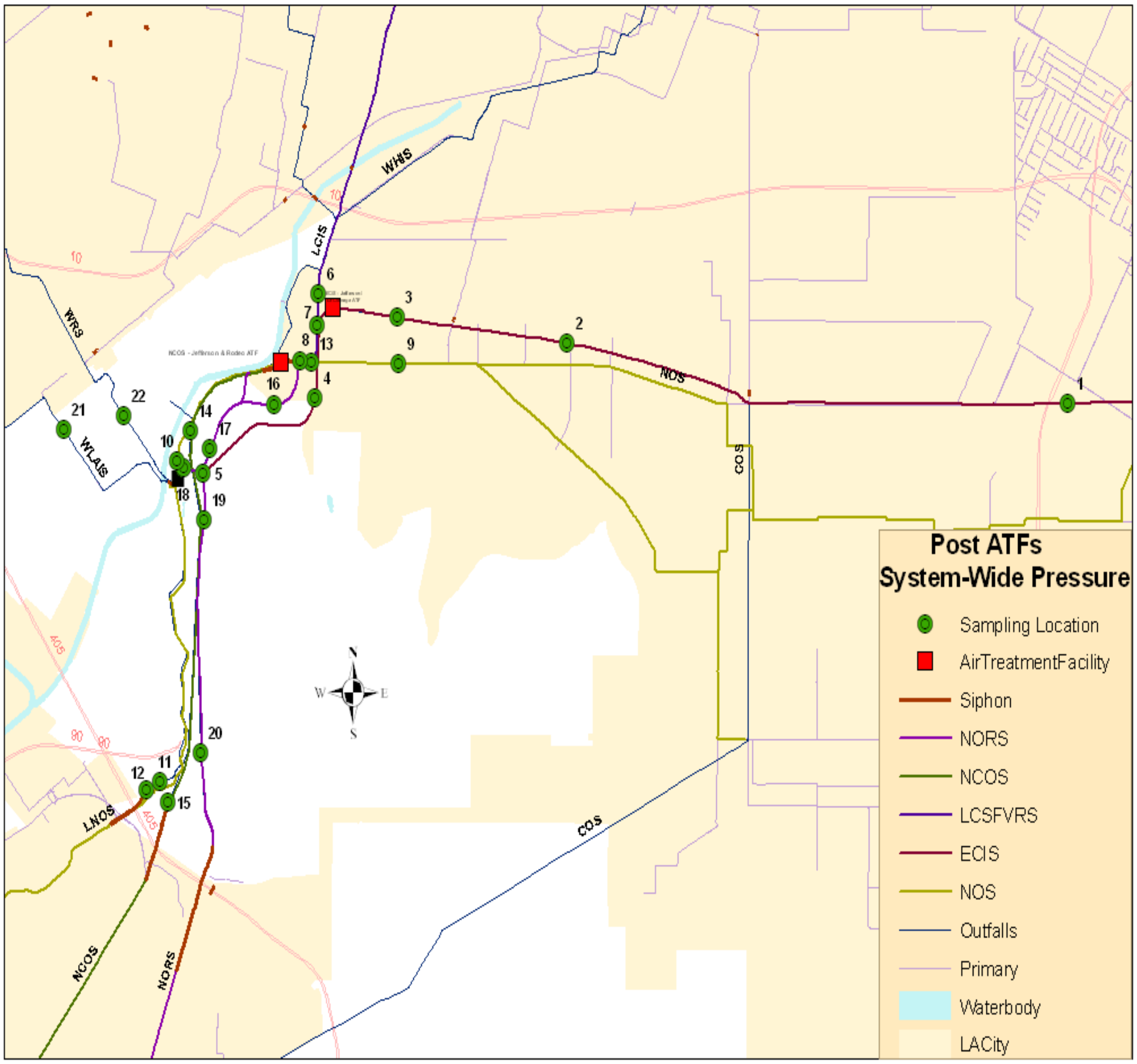
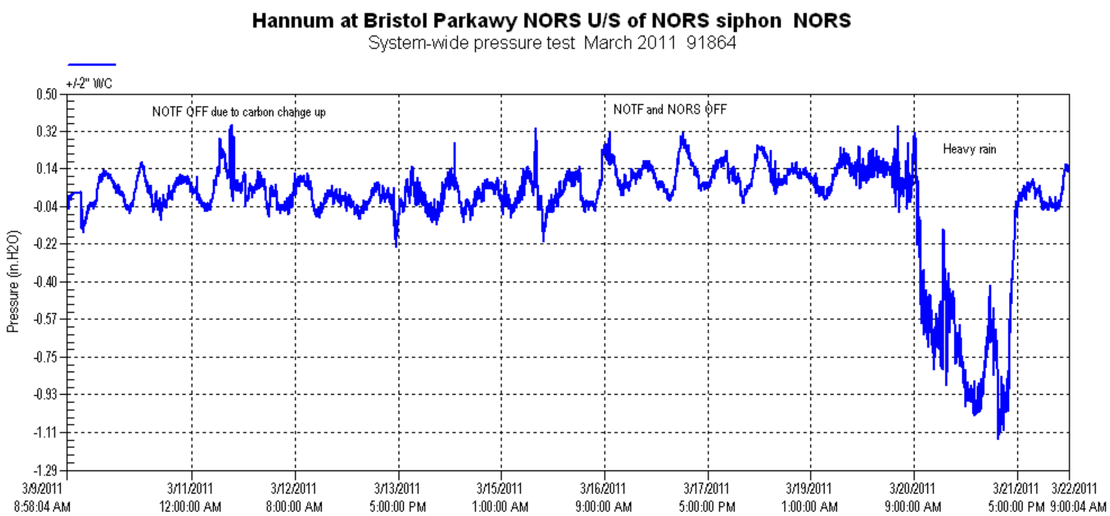


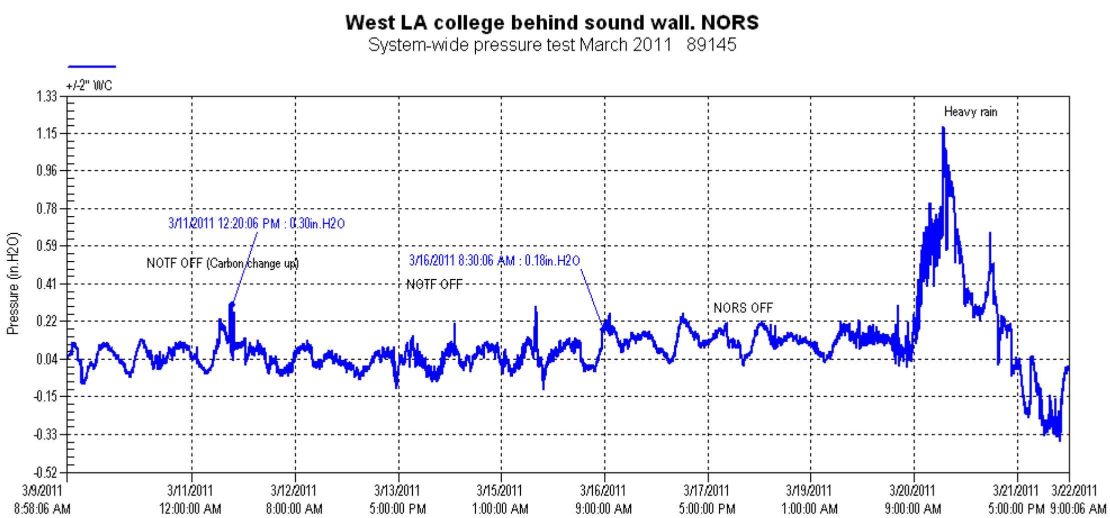
Figure 1

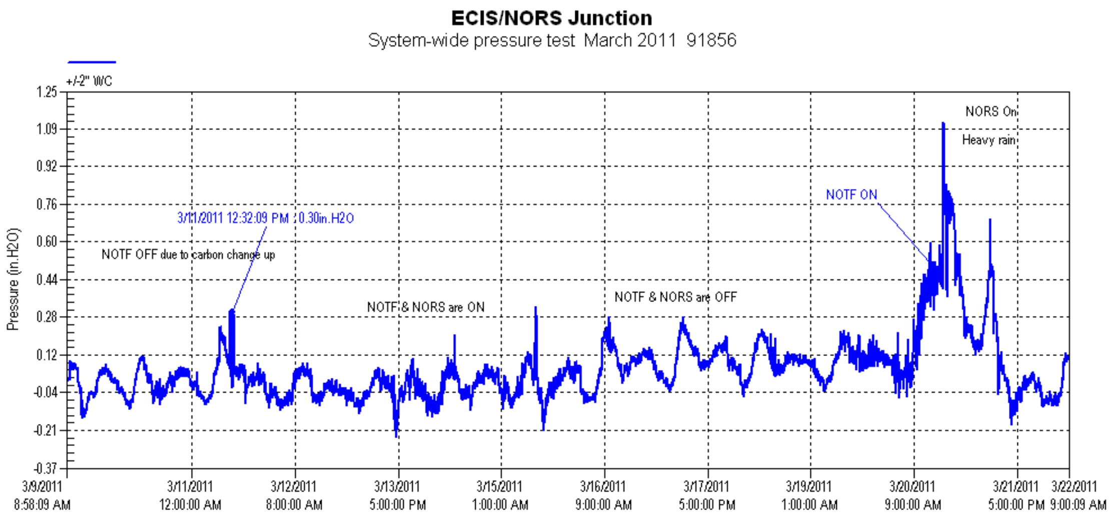
Thomas Bros. Data reproduced with permission granted by THOMAS BROS. MAP

Testing Results

NORS Locations






ECIS/NORS Junction
System-wide pressure test March 2011 91856
+/-2" WC
Pressure (in.H2O)
3/11/2011 12:32:09 PM : 0.30in.H2O
NOTF OFF due to carbon change up
NOTF & NORS are ON
NOTF & NORS are OFF
NOTF ON
NORS On
Heavy rain
1.25
1.09
0.92
0.76
0.60
0.44
0.28
0.12
-0.04
-0.21
-0.37
3/9/2011 8:58:09 AM
3/11/2011 12:00:00 AM
3/12/2011 8:00:00 AM
3/13/2011 5:00:00 PM
3/15/2011 1:00:00 AM
3/16/2011 9:00:00 AM
3/17/2011 5:00:00 PM
3/19/2011 1:00:00 AM
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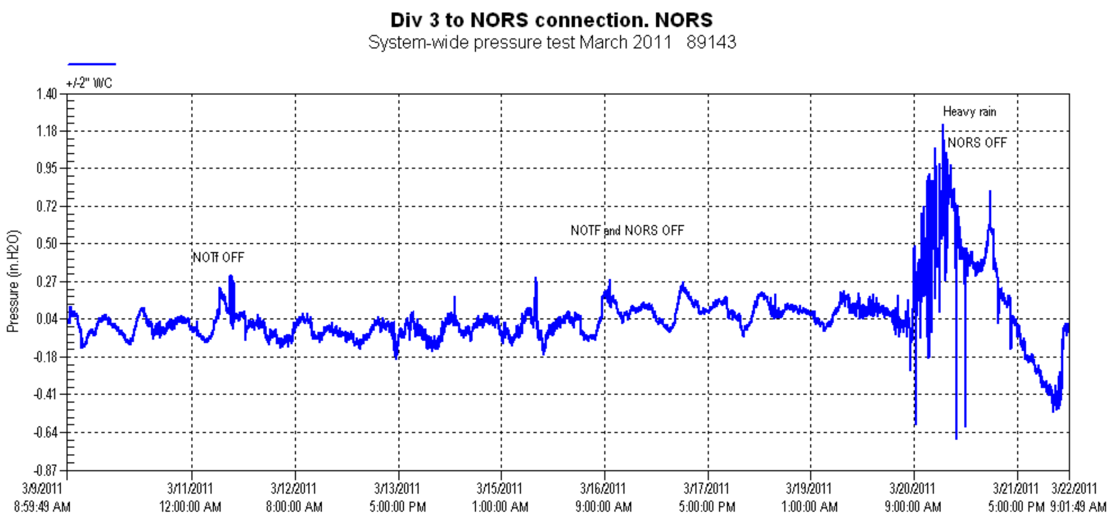
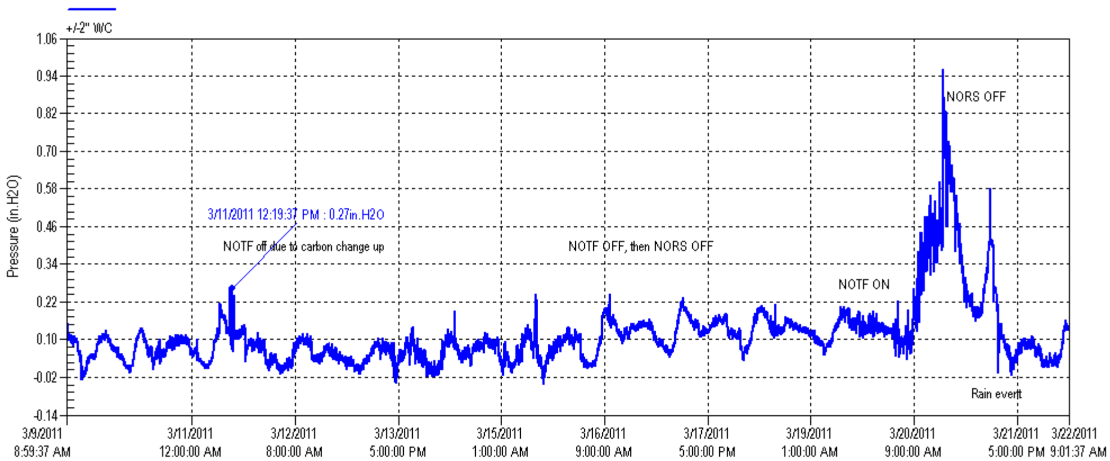
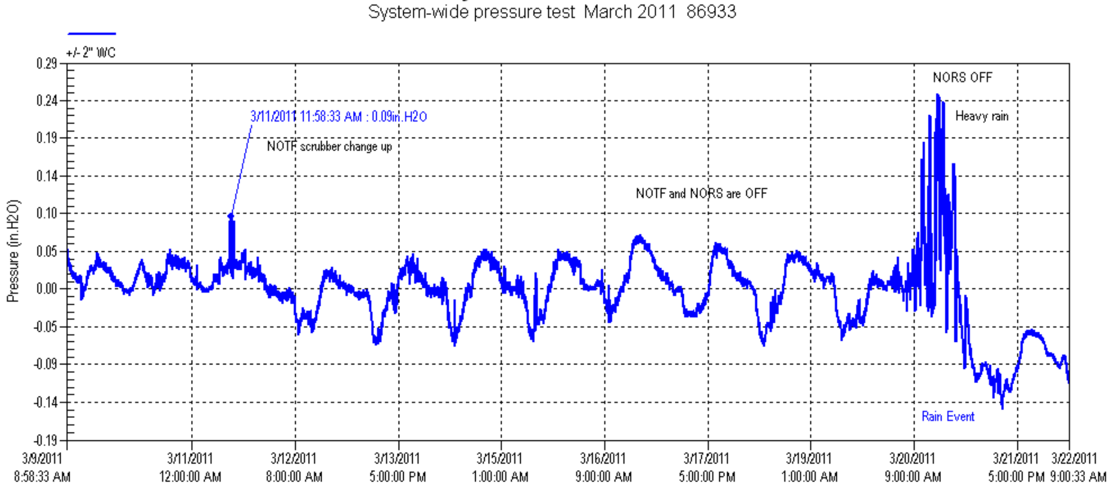
3/21/2011 5:00:00 PM
3/22/2011 9:00:09 AM


Div 3 to NORS connection. NORS
System-wide pressure test March 2011 89143
+/-2" WC
Pressure (in.H2O)
NOTf OFF
NOTF and NORS OFF
Heavy rain
NORS OFF
1.40
1.18
0.95
0.72
0.50
0.27
0.04
-0.18
-0.41
-0.64
-0.87
3/9/2011 8:59:49 AM
3/11/2011 12:00:00 AM
3/12/2011 8:00:00 AM
3/13/2011 5:00:00 PM
3/15/2011 1:00:00 AM
3/16/2011 9:00:00 AM
3/17/2011 5:00:00 PM
3/19/2011 1:00:00 AM
3/20/2011 9:00:00 AM
3/21/2011 5:00:00 PM
3/22/2011 9:01:49 AM

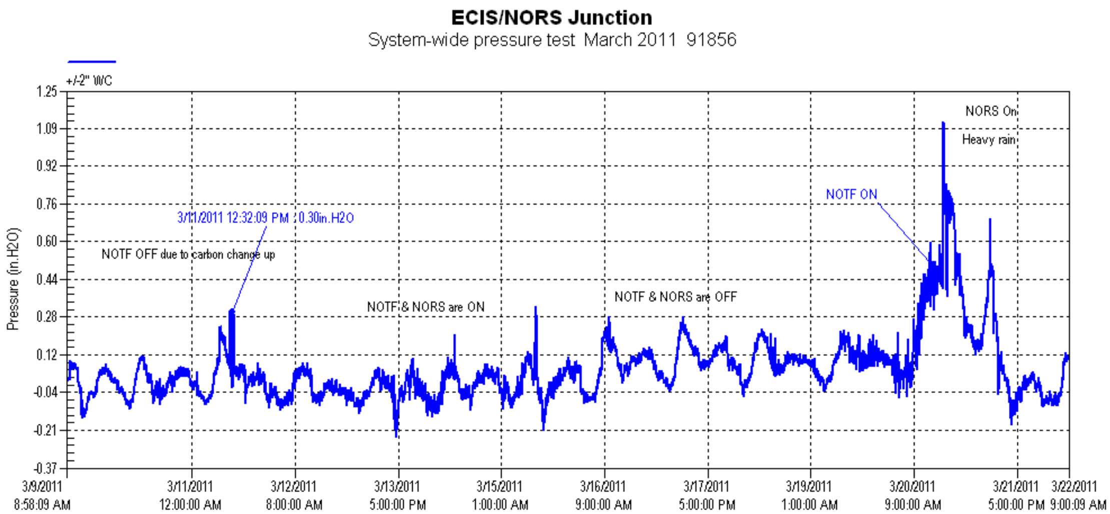
Culver City Park NORS
System-wide pressure test March 2011 89146

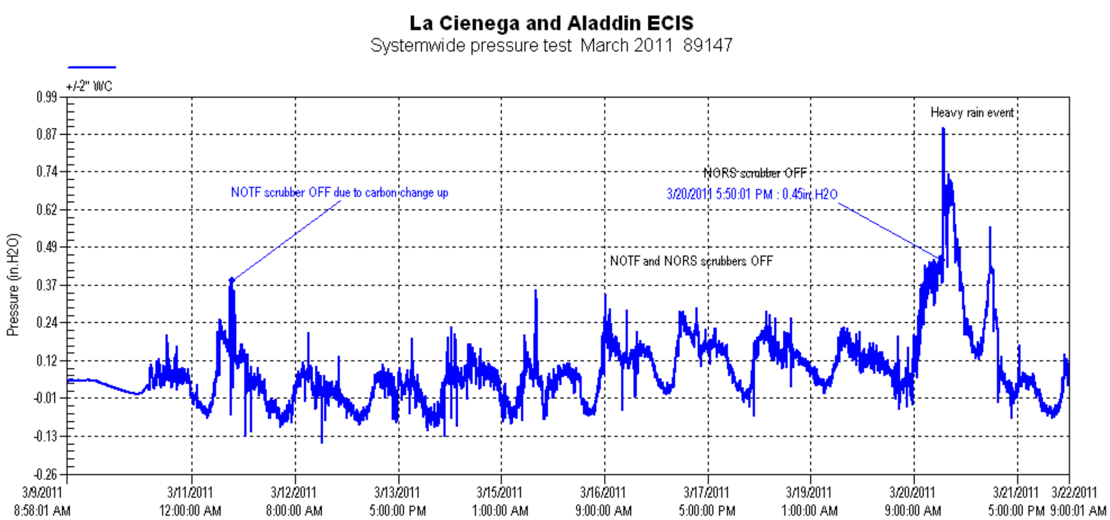


Ivy and Perham NORS
System-wide pressure test March 2011 86933

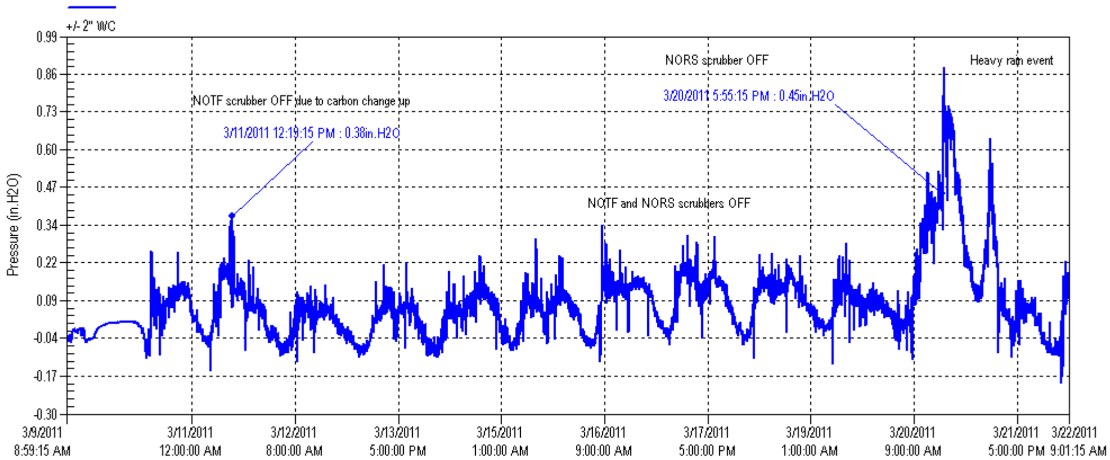


ECIS Locations

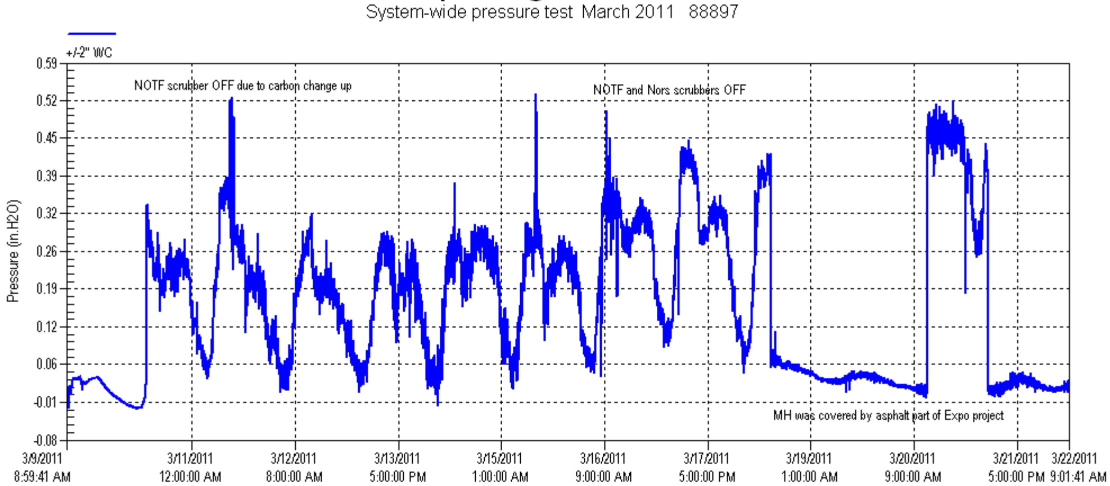


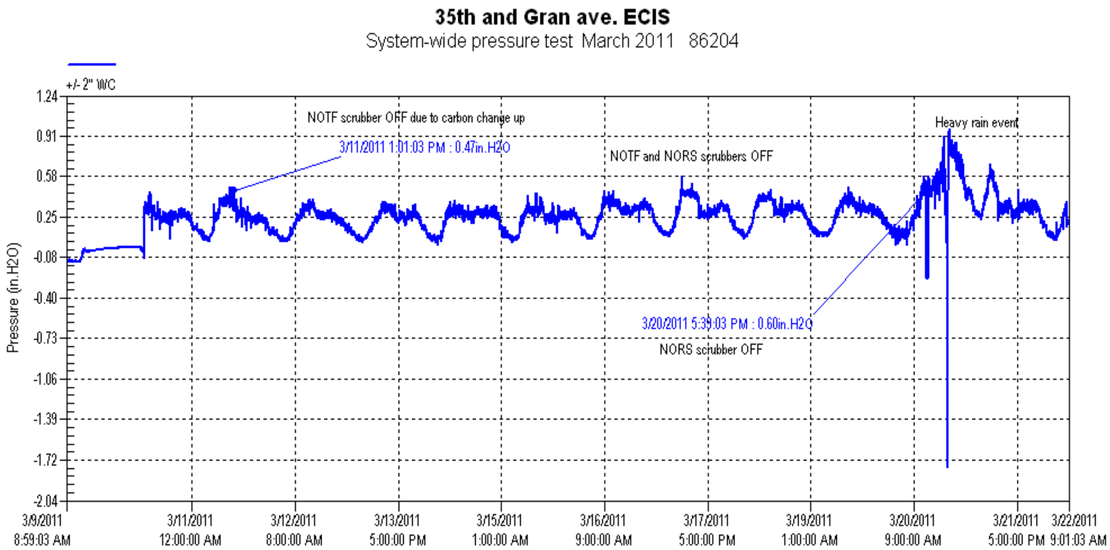


Jefferson w/o Cochran ECIS U/S of Siphon/ATF
System-wide pressure test March 2011 85627



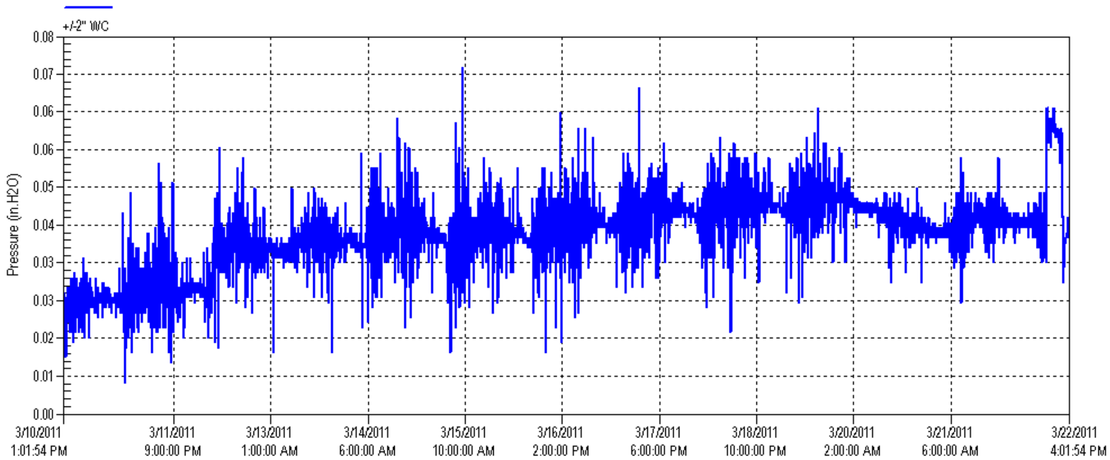
Exposition @ Potomac ECIS
System-wide pressure test March 2011 88897



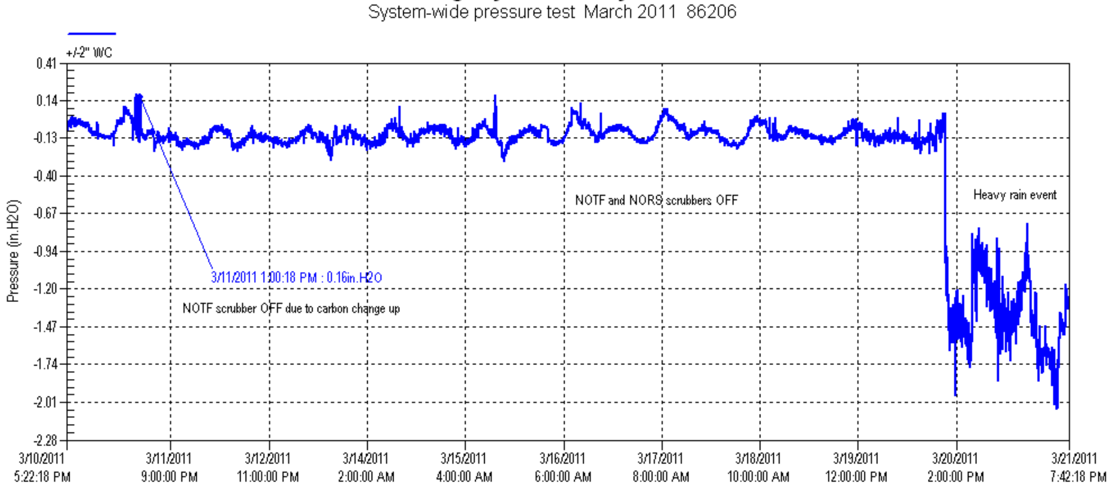

35th and Gran ave. ECIS
System-wide pressure test March 2011 86204
+/- 2" WC
NOTF scrubber OFF due to carbon change up
3/11/2011 1:01:03 PM : 0.47in.H2O
NOTF and NORS scrubbers OFF
Heavy rain event
3/20/2011 5:39:03 PM : 0.60in.H2O
NORS scrubber OFF
Pressure (in.H2O)
1.24
0.91
0.58
0.25
-0.08
-0.40
-0.73
-1.06
-1.39
-1.72
-2.04
3/9/2011 8:59:03 AM
3/11/2011 12:00:00 AM
3/12/2011 8:00:00 AM
3/13/2011 5:00:00 PM
3/15/2011 1:00:00 AM
3/16/2011 9:00:00 AM
3/17/2011 5:00:00 PM
3/19/2011 1:00:00 AM
3/20/2011 9:00:00 AM
3/21/2011 5:00:00 PM
3/22/2011 9:01:03 AM

LCSFVRS Locations

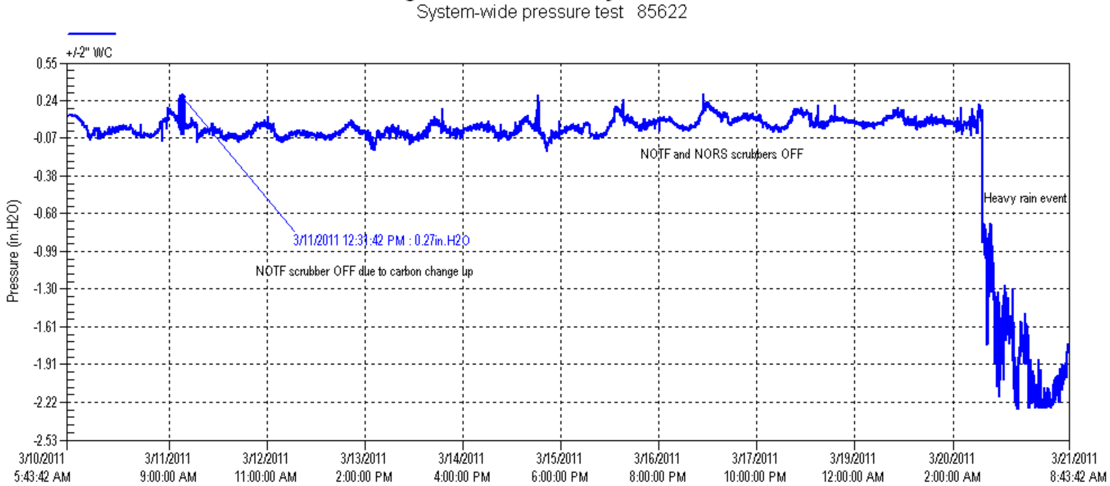
Kalsman and Rodeo LCSFVRS
System-wide pressure test March 2011 89141



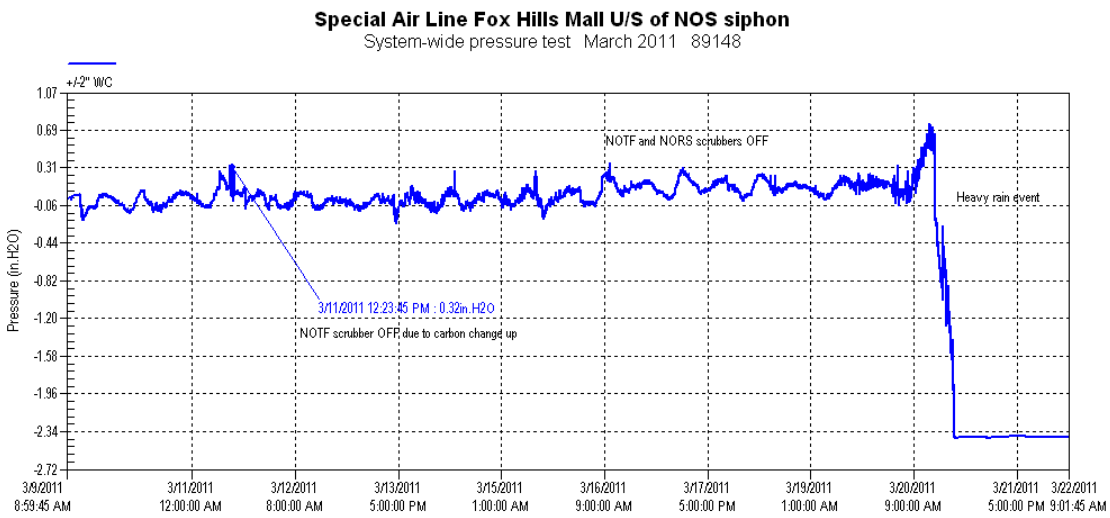
La Cienega by See's candy D/S of ATF
System-wide pressure test March 2011 86206

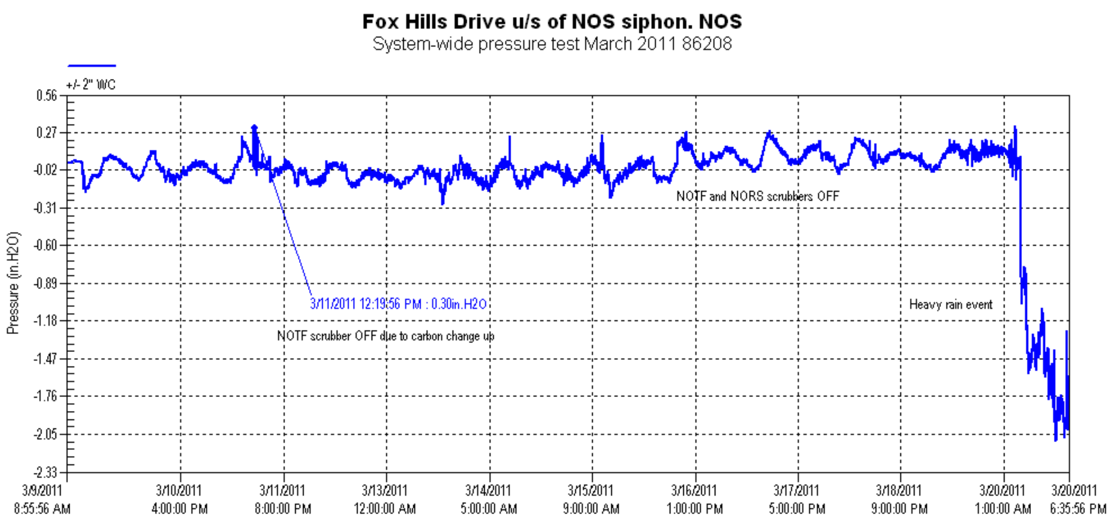


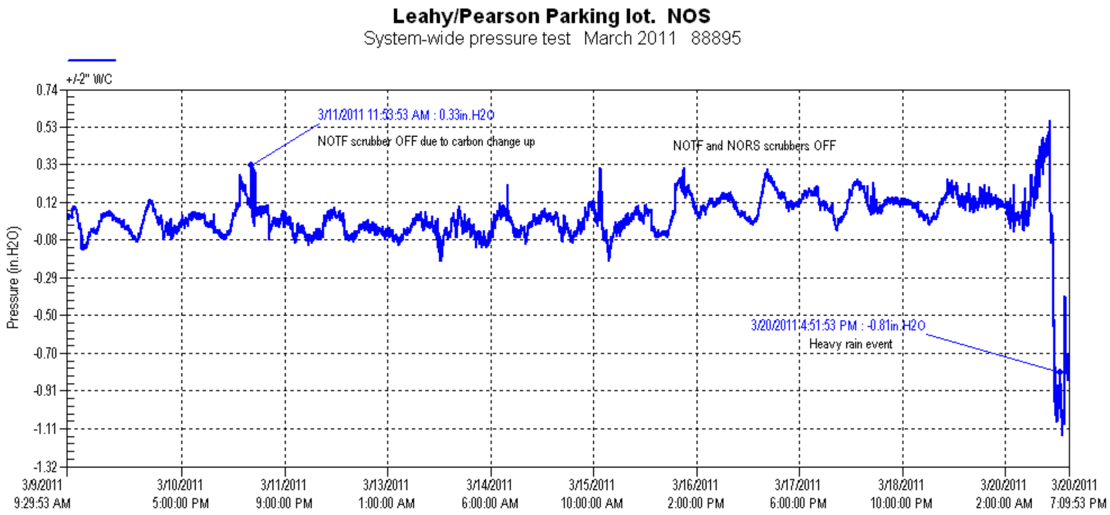
La Cienega Blvd U/S of ATF by KLOS. LCSFVRS
System-wide pressure test 85622

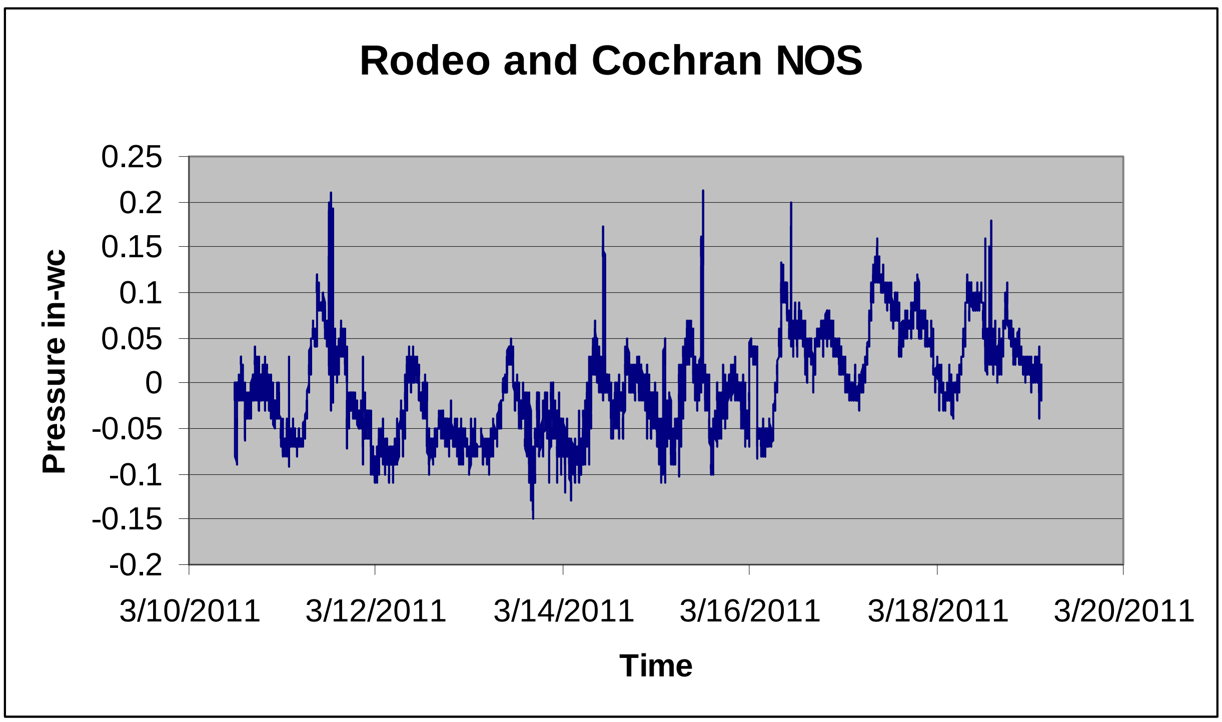


NOS Locations

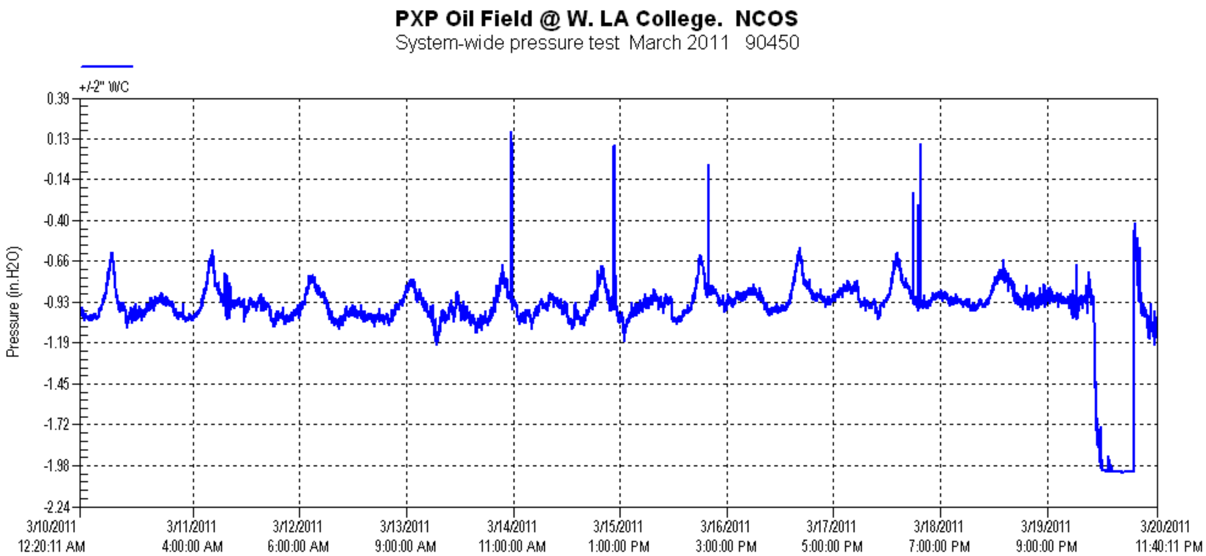


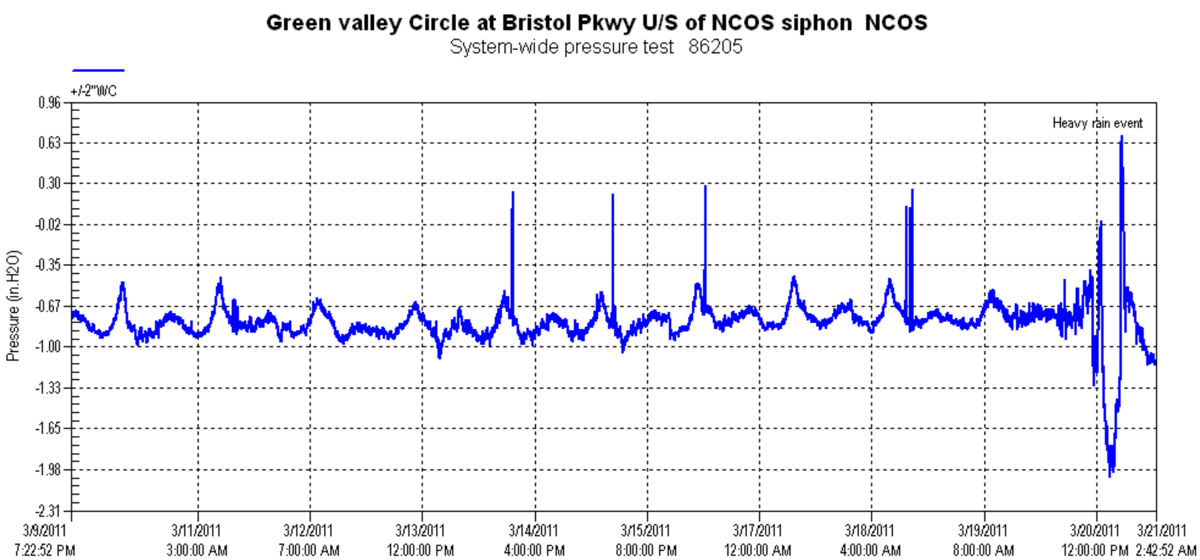


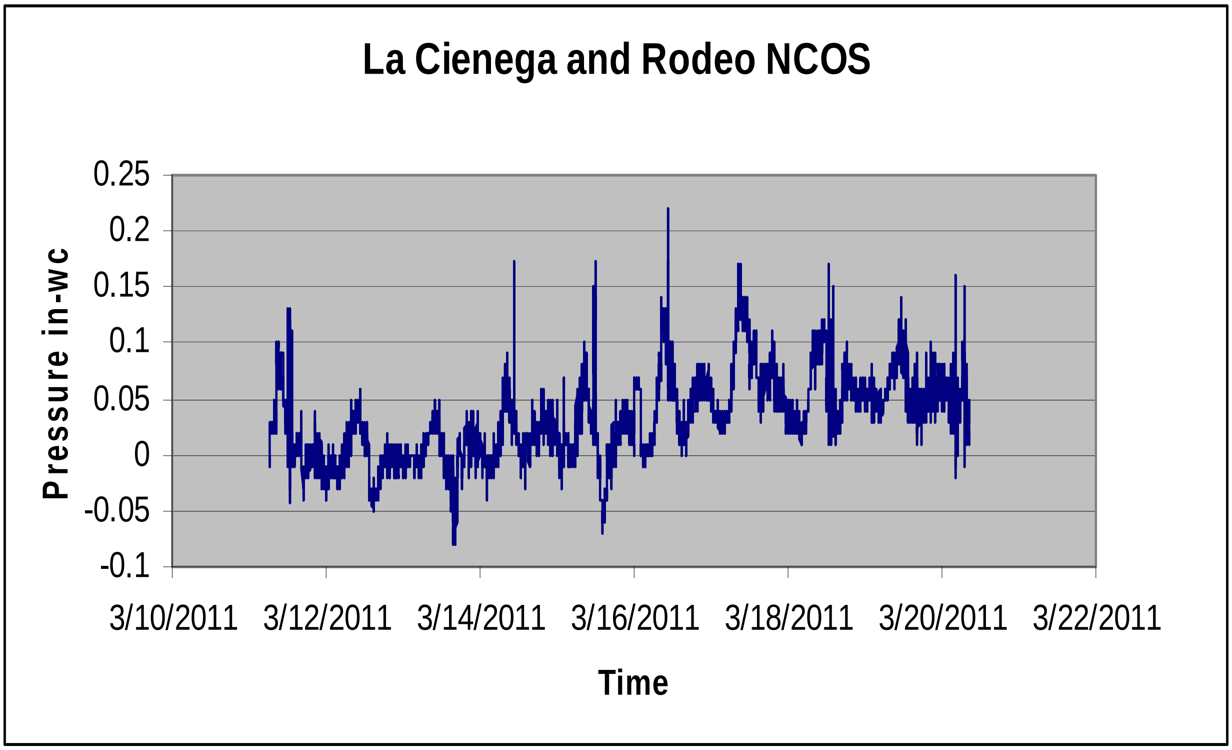

Leahy/Pearson Parking lot. NOS
System-wide pressure test March 2011 88895
+/-2" WC
Pressure (in.H2O)
3/11/2011 11:53:53 AM : 0.33in.H2O
NOTF scrubber OFF due to carbon change up
NOTF and NORS scrubbers OFF
3/20/2011 4:51:53 PM : -0.81in.H2O
Heavy rain event
0.74
0.53
0.33
0.12
-0.08
-0.29
-0.50
-0.70
-0.91
-1.11
-1.32
3/9/2011 9:29:53 AM
3/10/2011 5:00:00 PM
3/11/2011 9:00:00 PM
3/13/2011 1:00:00 AM
3/14/2011 6:00:00 AM
3/15/2011 10:00:00 AM
3/16/2011 2:00:00 PM
3/17/2011 6:00:00 PM
3/18/2011 10:00:00 PM
3/20/2011 2:00:00 AM
3/20/2011 7:09:53 PM


Rodeo and Cochran NOS
Pressure in-wc
0.25
0.2
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
-0.2
3/10/2011
3/12/2011
3/14/2011
3/16/2011
3/18/2011
3/20/2011
Time

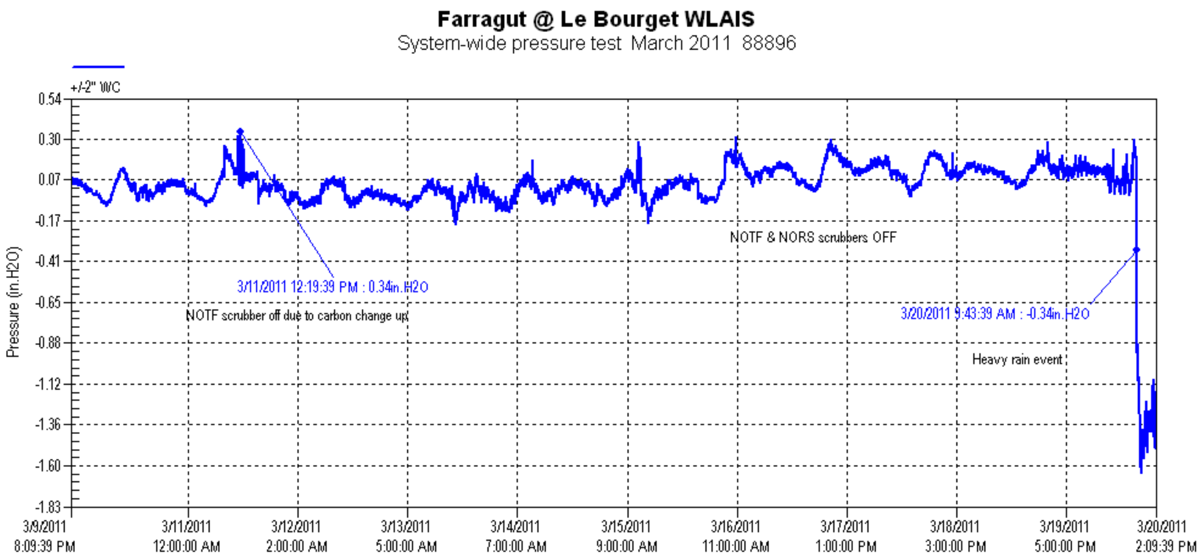
NCOS locations



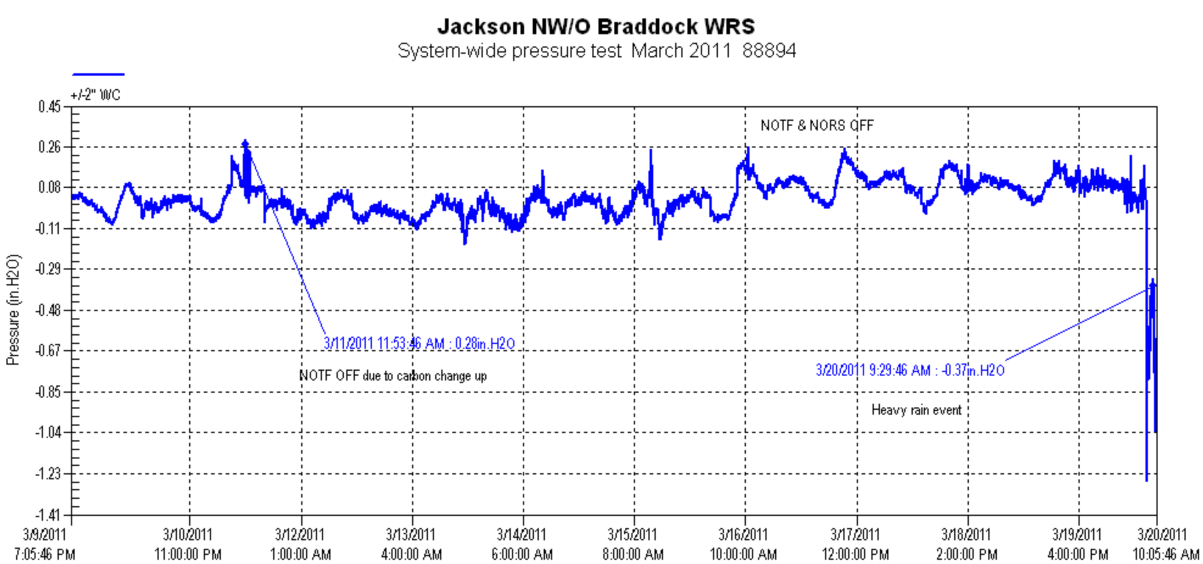



La Cienega and Rodeo NCOS
Pressure in-wc
0.25
0.2
0.15
0.1
0.05
0
-0.05
-0.1
3/10/2011
3/12/2011
3/14/2011
3/16/2011
3/18/2011
3/20/2011
3/22/2011
Time

WLAIS location



WRS location



Analysis

The testing revealed very low pressure throughout the 22 tested locations and significant pressure reductions at most locations. The only high pressure encountered was in the ECIS upstream of the siphon on Jefferson Boulevard. The highest recorded pressure was 0.35 in.-wc (inches of water column) at 35th Street & Grand Avenue followed by 0.29 in-wc also in the ECIS at Exposition & Potomac Avenue. The high pressure in the ECIS is primarily due to the drag effect from the drop structure at Mission and Jesse and the drop structure at 23rd and San Pedro. The pressure at each location is near or below atmospheric pressure, except within the ECIS, where the pressure is still approximately 50% lower than historical pressures (see Table 2).

Table 2 shows the maximum and minimum pressure (with both the NORS and NOTF scrubbers running) for the March 2011 test and previous pressure readings at the same locations for comparison reasons.

A heavy rain event (approximately 2 inches) was recorded on March 20th and 21st that affected the pressure reading. Most locations reflected a drop in pressure as of result the rain.

Location	Sewer	MH #	Pressure			
			March 2011	Previous		
			Max/Min	Max/Min	Date	
35th St. @ Grand Av.	ECIS	537-05-181	0.35/0.07	0.6/0.27	May-08	*
Exposition @ Potomac Av.	ECIS	535-04-216	0.29/0.04	0.6/0.25	May-08	*
Jefferson w/o Cochran	ECIS	535-03-213	0.13/-0.08	0.24/0.03	May-08	*
La Cienega @ Aladdin	ECIS	535-06-116	0.10/-0.09	0.4/0.1	May-09	*
ECIS/NORS Junction	ECIS	535-09-022	0.09/-0.12	0.14/0.02	May-10	*
La Cienega @ KLOS	LCSFVRS	535-02-024	0.06/-0.09	0.2/-0.01	Oct-09	*
La Cienega @ See's Candy	LCSFVRS	535-02-052	-0.05/-0.19	0.18/0.01	Oct-09	*
Kalsman and Rodeo	LCSFVRS	535-02-089	0.04/0.03	0.13/0.05	Oct-10	*
Rodeo and Cochran	NOS	535-03-156	0.04/-0.01	0.03/0.00	Apr-10	
Leahy/Pearson Parking Lot	NOS	535-05-029	0.11/-0.1	0.17/-0.08	Oct-10	
Fox Hills Dr. u/s of siphon	NOS	559-05-008	0.09/-0.09	0.07/-0.08	May-09	
Special air line Fox Hills Mall	NOS	560-08-055	0.06/-0.13	0.09/-0.05	May-09	
La Cienega and Rodeo	NCOS	535-02-090	0.05/-0.03	0.06/-0.04	Oct-10	
PXP Oil field @ W. LA college	NCOS	535-05-016	-0.75/-1.0	0.05/-0.15	Nov-10	*
Green Valley Crl @ Bristol pkwy	NCOS	559-05-005	-0.6/-0.9	-0.09/-0.2	Dec-09	
Ivy and Perham	NORS	535-06-132	0.05/-0.05	0.27/0.08	May-08	*
Culver City park	NORS	535-05-021	0.13/0.00	0.22/0.01	Aug-10	*
Div 3 to NORS	NORS	535-09-006	0.04/-0.12	0.13/-0.03	Aug-10	*
NORS behind sound wall	NORS	535-13-007	0.12/-0.05	0.22/0.00	Dec-09	*
Hannum @ Bristol Pkwy	NORS	559-05-006	0.03/-0.09	0.23/-0.02	Aug-10	*
Farragut @ Le Bourget	WLAIS	534-08-044	0.07/-0.1	0.09/-0.06	Dec-09	
Jackson nw/o Braddock	WRS	534-08-040	0.05/-0.1	no data		

* Denotes significant reduction in pressure between March 2011 test and tests conducted prior to the recent changes.

Table 2 – Current vs. Previous Pressure Readings

Influence of NORS and NOTF Scrubbers

Gas pressure increased significantly when the NOTF scrubber was turned off. However, when the NORS/ECIS Scrubber was also turned off, the pressure did not increase much more. This is contrary to the notion that two scrubbers should extract significantly more gas than just one. This limited impact of the second scrubber is probably due to the following reasons:

1) The NOTF Scrubber relieves mainly the WRS, WLAIS, and the NOS. It is connected to the NORS through an empty 54" pipe via Diversion 3 but wouldn't have much effect on the NORS.

2) The NORS/ECIS Scrubber relieves mainly the ECIS and NORS

The graph below shows the diurnal pressures during the time when the scrubbers were turned off and on.

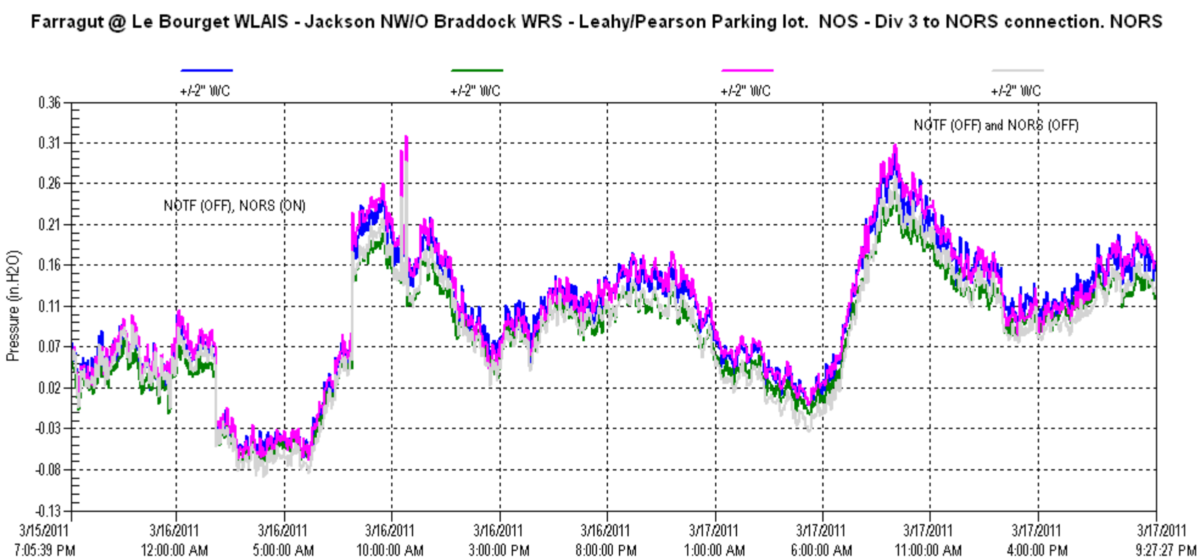


Figure 2 below shows the influence of the ATFs combined with NOS rehabilitation. The sampled location was along the NORS at the West LA College which is downstream of the NORS/ECIS junction and just a few miles upstream of NORS siphon.

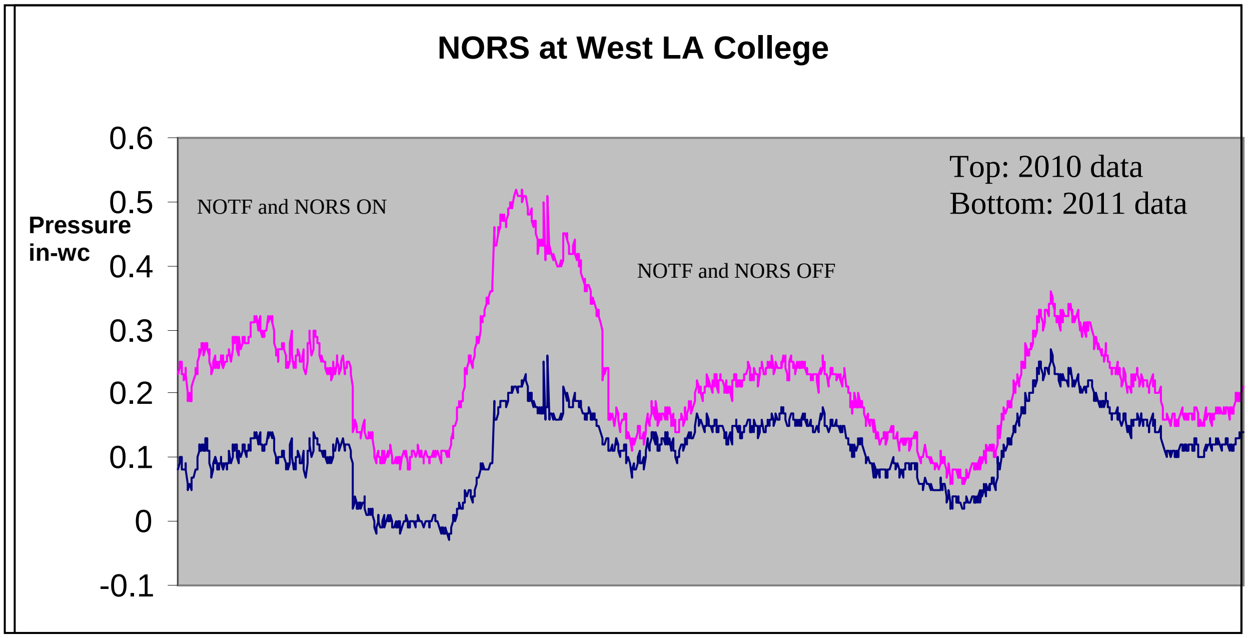


Figure 2

Figure 3 below compares maximum and minimum pressure before and after the ATFs and the NOS rehabilitation.

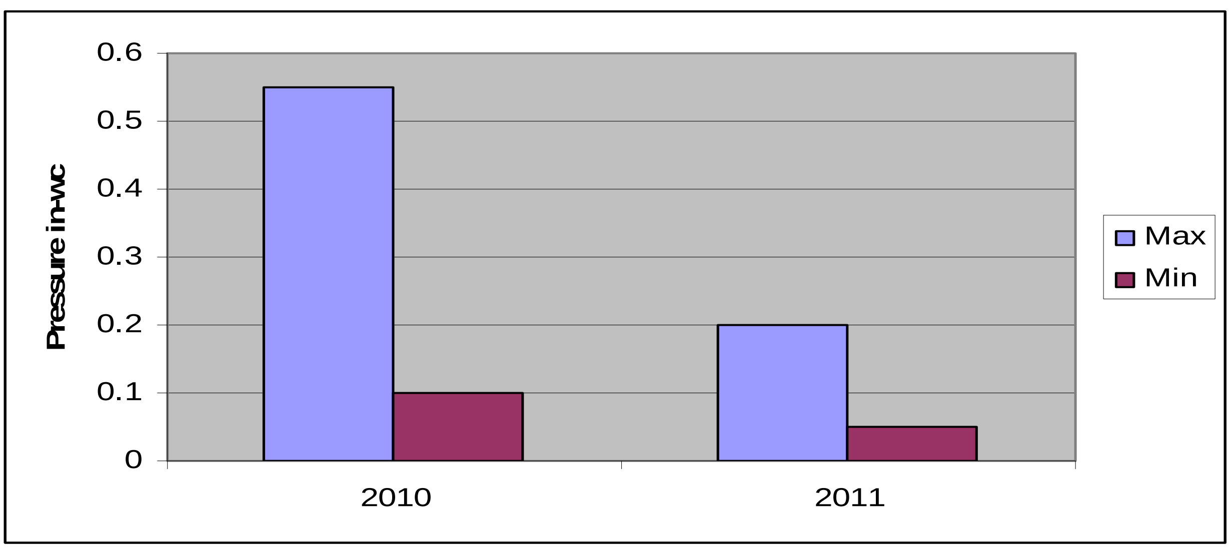


Figure 3

Conclusion

This pressure test showed the signigicant improvement in sewer gas pressure that resulted from the rehabilitation of the NOS and the newly-constructed ATFs. The majority of the 22 locations tested showed a significant drop in pressure in comparison to the recorded pressure prior to January 2011 due to these odor control improvements. The only high pressure was in the ECIS upstream of the ECIS siphon. Here, the gas pressure was reduced by half but is still present. However, the planned construction of another ATF at Mission and Jesse by 2014 is expected to reduce gas pressure within the ECIS even more.

A planned project will soon install rubber curtains in the sewer headspace at the three diversion structures that diverted flow from the NOS to the NORS during the rehabilitation of the NOS. The sewer pressures will be measured again after the completion of this project to determine its impact on gas pressures.