SEWER ODOR CONTROL MASTER PLAN

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Wastewater Engineering Services Division
Bureau of Sanitation
Department of Public Works
City of Los Angeles

CITY OF LOS ANGELES
SANITATION
DEPARTMENT OF
PUBLIC WORKS

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EXECUTIVE SUMMARY

INTRODUCTION

The City of Los Angeles operates a wastewater collection system that consists of approximately 6,500 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. Over the last decade the potential for odors venting 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. Odor control measures are being implemented and new state-of-the art odor control facilities are being planned. The City has developed an odor complaint hotline, which allows for more timely responses and quick resolutions to sewer-related odor complaints. The application of odor control chemicals to sewage has reduced hydrogen sulfide concentration in treated sewers by up to 90%. The use of air scrubbers at various hot spot locations in the collection system has reduced the release of odors in known venting areas, and the construction of relief sewers has reduced the air pressure in 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 to local residences. The on-going maintenance program has decreased the potential for septic conditions to occur. These odor control measures have produced a successful odor control program in the City of Los Angeles. Sewer odors and odor complaints continue to decline steadily.

The Odor Control 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. The Sewer Odor Master Plan 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

The City identified and studied key areas of the sewer system based on the number of odor complaints and targeted these areas for detailed testing and analysis. Testing locations were selected based on the frequency of odor complaints as well as the physical characteristics of the collection system in the area. The physical characteristic include insufficient slope, severe slope reductions, downstream diameter reductions, major junction structures, and proximity to an inverted siphon, etc.

Four areas in the city with an unusually high number of complaints were identified as "hot spot" areas. They are:

- Studio City/North Hollywood Area – NOS & NHIS
- The Maze Area - South Los Angeles – NOS
- Sierra Bonita/West Hollywood Area VSF – LCSFVRS
- West Los Angeles/Culver City Area – WLAIS & WRS

Five additional areas were also identified as potential areas of concern and were analyzed in order to gain an accurate overview of the collection system. They are:

- Venice - Westchester Area (CIS)
- Baldwin Hills - Wilshire (WHIS/LCIS)
- Harbor Area
- West Valley
- East Los Angeles – Boyle Heights

Air pressure and hydrogen sulfide (H_2S) levels in the sewers in each area were monitored in order to qualify and quantify the odors, identify the cause of odors, and determine the optimum solutions.

RECOMMENDATIONS

For the hot spots, the recommendations are as follows:

Studio City/N. Hollywood Area

- Recommend pressure and hydrogen sulfide level be tested on a semi-annual basis for sewers with positive pressure in the NHIS, EVRS, NOS and VORS to periodically monitor the condition of the system.

- Recommend the chemical addition at Tillman to reduce the level of hydrogen sulfide in the collection system. (IMPLEMENTED – Since the implementation, the H2S level has been going down significantly in the EVRS).

- Recommend the construction of Radford/Woodbridge scrubber. (IMPLEMENTED – After scrubber on line, the pressure is being reduced significantly which led to the reduction in odor complaints.)

- Recommend the construction of the Glendale Burbank Interceptor Sewer (GBIS) as the long-term approach for odor control by reducing the pressure in the area. (IMPLEMENTED – The GBIS environmental process clearance is anticipated to be considered by Council in November 2006)

The Maze Area

- Since the flow from the Florence Avenue Sewer, which has a high level of H2S, has been diverted from the NOS to the COS, it is recommended that the pressure and H2S levels in the COS be monitored closely to ensure that pressure and H2S have not shifted to the COS, creating a new hotspot in the system. Should future monitoring indicate that odors have increased in the COS, it is recommended that routine cleaning of COS be evaluated as an option to further reduce the H2S concentration.

- Recommend that the Florence Avenue Sewer and the 74th Street Sewer be routinely cleaned to reduce hydrogen sulfide levels in the collection system.

- Recommend chemical treatment in the Maze area to reduce the hydrogen sulfide level. (IMPLEMENTED)

- With the completion of the East-Central Interceptor Sewer (ECIS) and the Northeast Interceptor Sewer (NEIS) and with the interim odor scrubbers operating, the City is conducting an extensive review of the underlying assumptions for the Odor Control facilities.

  The City is now reviewing the entire ATF Program after gaining operating experience with the interim carbon scrubbers at the various ATF sites. Each site is being reviewed to determine if the underlying assumptions made before the ECIS and the NEIS were constructed are still valid now that they are completed and operational. These site-specific reviews will also help to optimize the design of the permanent ATFs. The ECIS and North Outfall Replacement Sewer (NORS) ATF reviews include a fan test at the request of the Odor Advisory Board to test the behavior of airflow across the NORS siphon under the 405 Freeway.

Sierra Bonita/West Hollywood Area

Valley Spring Lane Forman (VSF) Intersection Area:

- High air pressure in the NOS/LCSFVRS/Forman Ave Sewer junction at the intersection of Valley Spring and Forman is creating an odor issue for homes in the area that are directly connected to the 30-inch sewer. It is recommended that flow in Forman Ave be diverted to the NOS to lower the pressure in the Forman sewer line.

- After the diversion, pressure monitoring should be conducted to determine whether there is a need to construct an 8” parallel sewer so that the homes along Forman Ave between Valley Spring Lane and Riverside Drive can reconnect to the new line.

- Recommend the construction of the Glendale Burbank Interceptor Sewer (GBIS) as the long-term solution for odor control by reducing the pressure in the VSF area. (IMPLEMENTED – The GBIS environmental process clearance is anticipated to be considered by Council in November 2006)

LCSFVRS Upper Reach:

- Recommend the construction of the scrubber for the Sierra Bonita area to reduce sewer pressure in the Hollywood area which will reduce pressure and address the odor issues. (IMPLEMENTED – scrubber is in construction). Pressure and H2S testing is recommended after the scrubber is online to determine the scrubber's effectiveness.

LCSFVRS Lower Reach

- With the 10,000 cfm carbon scrubber in operation at the Genesee Siphon site, the LCSFVRS Lower Reach is depressurized. It is recommended to keep the scrubber in operation and monitor the reach to evaluate the scrubber's effectiveness.

- Recommend the Chemical Addition at Tillman to reduce the level of hydrogen sulfide in the collection system. (IMPLEMENTED).

West L.A./Culver City Area

- Recommend the installation of the NOTF Scrubber to reduce pressure in the WLAIS/WRS. (IMPLEMENTED)

- Debris accumulates in the WLAIS and WRS and may be causing an increase in the hydrogen sulfide levels in the sewers. The construction of additional maintenance holes is planned in order to facilitate the cleaning of this debris. After these maintenance holes are built and the sewers are cleaned, it is recommended that hydrogen sulfide levels and pressure are monitored. If odor is still an issue, chemical addition should be evaluated as another option.

For the areas identified as potential areas of concern, the recommendations are as follows:

Venice/Westchester Area
Testing indicated that pressure is not a problem in the system. It is recommended that pressure and H_2S levels be re-tested every 3 years to allow adequate time to address any odor issues that may occur in the future.

Harbor Area
Testing indicated that pressure is not a problem in the system. It is recommended that pressure and H_2S levels be re-tested every 3 years to allow adequate time to address any odor issues that may occur in the future.

Baldwin Hills /Wilshire Area

- For the LCIS sewer at Melrose Ave/Detroit St where an instantaneous pressure measurement showed positive pressure in the collection system, it is recommended that the H_2S level, the pressure level and the odor complaints be monitored on a semi-annual basis so that necessary action can be taken in a timely manner.

- Testing indicated that pressure is not a problem at other testing locations in the Baldwin Hills/Wilshire area. It is recommended that pressure and H_2S levels be re-tested every 3 years to allow adequate time to address any odor issues that may occur in the future.

West Valley Area

- For the area along Burbank e/o Sepulveda where an instantaneous pressure measurement showed positive pressure in the collection system, it is recommended that the H_2S level, the pressure level and the odor complaints be monitored on a semi-annual basis so that necessary action can be taken in a timely manner.

- Testing didn't indicate that pressure would be an issue at other testing locations in the West Valley area. It is recommended that pressure and H_2S levels be re-tested every 3 years to ensure the timing in address the odor issue should it occur.

East Los Angeles – Boyle Heights Area

- Recommend the construction of the Odor Control Hollydale Sewer Project that will build an 8-inch diameter sewer in Hollydale Drive, parallel to the existing 42-inch diameter North Outfall Sewer (NOS). House connections will be reconnected to the new 8-inch line. (IMPLEMENTED – project scope of work and budget were approved and project is being designed)

- Diversions of flow from the NOS to ECIS and future diversion to the NEIS at the Humboldt Shaft site will significantly reduce the flow in the NOS and therefore will further reduce the pressure in the NOS. It is recommended that after flow is diverted to the NEIS, the pressure and H2S level in NOS be monitored so that the City may re-evaluate the system under the new flow scenarios.

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 withdraw and treatment using scrubbers, sewer construction and repair, and on-going monitoring of sewer air pressure and odor concentration.

Continuous pressure testing equipment will be used to re-test areas of concern which have thus far only been tested with instantaneous, spot testing equipment in order to gather more accurate and more comprehensive pressure data of the sewer system.

One recent development underway is the NORS Siphon Fan Test that will help determine the relationship between the NORS siphon and pressure upstream in the Baldwin Hills area. It will also help in understanding the air flow dynamics in and around the NORS siphon (a major sewer siphon with airlines) and the sewer system in general and in determining the solution for the existing odor issues in the area, including the need for an ATF on the NORS.

The most significant recommendation is the ATF Study that will re-evaluate the ATF implementation program in light of recent experiences and test results when scrubbers are operating at different modes.

For example, at 23rd and San Pedro, odor complaints began when the ECIS was put into use and the scrubber went online. The complaints ended when the scrubber's fans were turned off and the sewer air was allowed to vent passively through the scrubber's carbon. This suggests that the carbon may not adequately filter odors from gas that is forced through quickly with a fan but that it is able to filter odors from air that moves through passively and therefore, more slowly. The scrubbers have since been turned off and operate in a passive mode to minimize odor complaints.

The use of air scrubbers at various locations in the collection system has contributed to a reduction in the release of odors in known venting areas. Flow diversions from the NOS to the ECIS at 23rd and San Pedro and at Mission & Jesse in August 2004 and an additional diversion proposed to the NEIS at the Humboldt Shaft site in 2006/07 will significantly reduce the flow in the NOS. This will most likely decrease the pressure within the NOS and may defer any immediate need for pressure relief devices such as scrubbers or ATFs. As a result of diverting flow from the NOS to NEIS, less flow from the NOS will be diverted at Mission & Jesse at least until the rehabilitation of the NOS, tentatively scheduled for completion in 2012.

Therefore, the necessity for the ATFs at the 23rd & San Pedro, Mission & Jesse, Humboldt, and Richmond sites as will as when each would be needed will be assessed in the ATF study. In addition, the scope of the ATF Study should include odor testing and laboratory analysis, additional pressure testing at key locations in the collection system, and analysis of impacts to upcoming capital improvement sewer projects to ensure that the solutions proposed, and ultimately constructed, are the optimal solution and the best use of funds for mitigating sewer odors.

1.0 INTRODUCTION

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.

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.

The City of Los Angeles is expanding and will continue to expand in the future. Upgrading the wastewater collection 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 a future program. As part of the evaluation process, the City evaluated 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.

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 has 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.

2.0 PURPOSE OF THE ODOR CONTROL MASTER PLAN

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.

3.0 OBJECTIVE OF THE ODOR CONTROL PROGRAM

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:

- monitor the wastewater collection system;
- document and respond to odor complaints;
- improve the design of the sewer system;
- install/build odor-control units/facilities;
- dose selected pipelines with chemicals to eliminate components that lead to odors and;
- investigate 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.

4.0 TASK DESCRIPTIONS

The odor control program can be summarized by the following general tasks:

- 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 if the sewers are venting gas.
- 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.

5.0 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 6,500 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 Treatment Plant (TITP) in the vicinity of the Los Angeles Harbor.

The system provides service to about 600,000 connections within the City. The house connection sewers, 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 outside 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 strength 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.

5.1 Hyperion Service Area Interceptor and Outfall Sewers

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

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 with vitrified clay pipe and others with reinforced concrete pipe. The concrete pipe is lined with polyvinyl chloride (PVC) to prevent corrosion of the concrete by sewer gasses.

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.

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) is currently being rehabilitated and therefore, flow is being diverted away from this section. Flow is being diverted into the North Central Outfall Sewer (NCOS) at the intersection of La Cienega Boulevard and Rodeo Road and into the North Outfall Replacement Sewer (NORS) in the Baldwin Hills area.

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.

North Outfall Replacement Sewer (NORS)

The North Outfall Replacement Sewer (NORS), completed in 1993, relieves the NOS from the HTP to the point where the NCOS connects to the NOS in Baldwin Hills (approx. 8 miles). The NORS can also accept flow from several other interceptor sewers.

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.

West Los Angeles Interceptor Sewer (WLAIS)

The WLAIS primarily serves the West Los Angeles area by conveying wastewater to the NOS or to the NORS. 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. It currently flows into the NORS through a diversion structure.

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. This sewer, which previously discharged into the NOS in Culver City, now discharges into the NORS via the same diversion structure that routes flow from the WLAIS.

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.

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, which is then diverted into the NORS.

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 and later joins back into one 60-inch pipe. It travels through the Genesee Siphon near Venice Boulevard and 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.

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.

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.

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.

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.

East Central Interceptor Sewer (ECIS)

The ECIS was constructed in 2004. It will relieve 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.

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. NEIS is constructed in 2 phases. Construction of NEIS Phase I was completed in 2005. The City has selected NEIS Phase II Alignment and initiated the Environmental Impact Report process as part of the Integrated Resources Plan (IRP).

5.2 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.

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.

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.

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.

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.

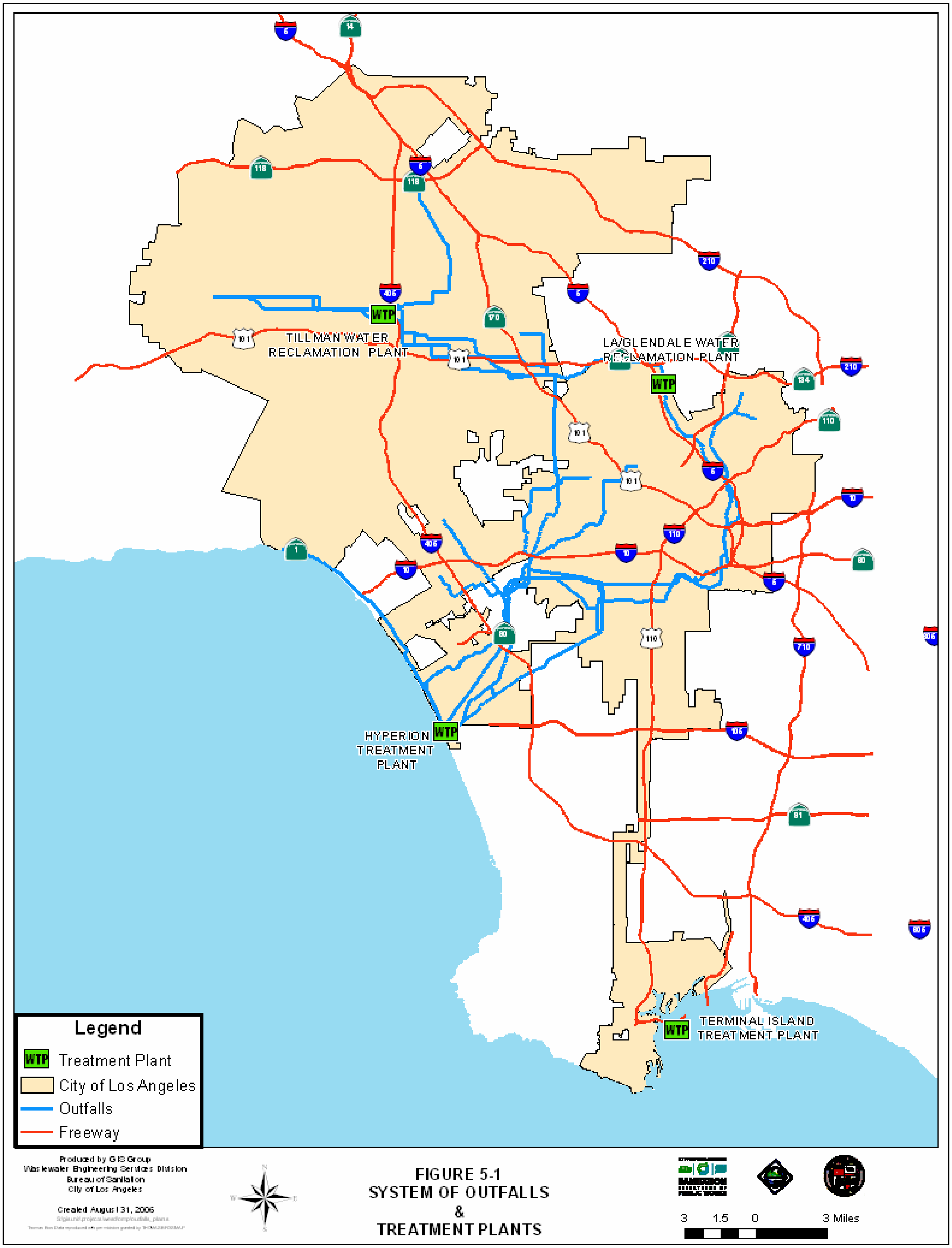


FIGURE 5-1
SYSTEM OF OUTFALLS
&
TREATMENT PLANTS

6.0 SEWER ODOR GENERATION AND EMMISION

6.1 Odor (H2S) 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.

6.2 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- Operation and Maintenance frequency

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. 6.2.1). 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.

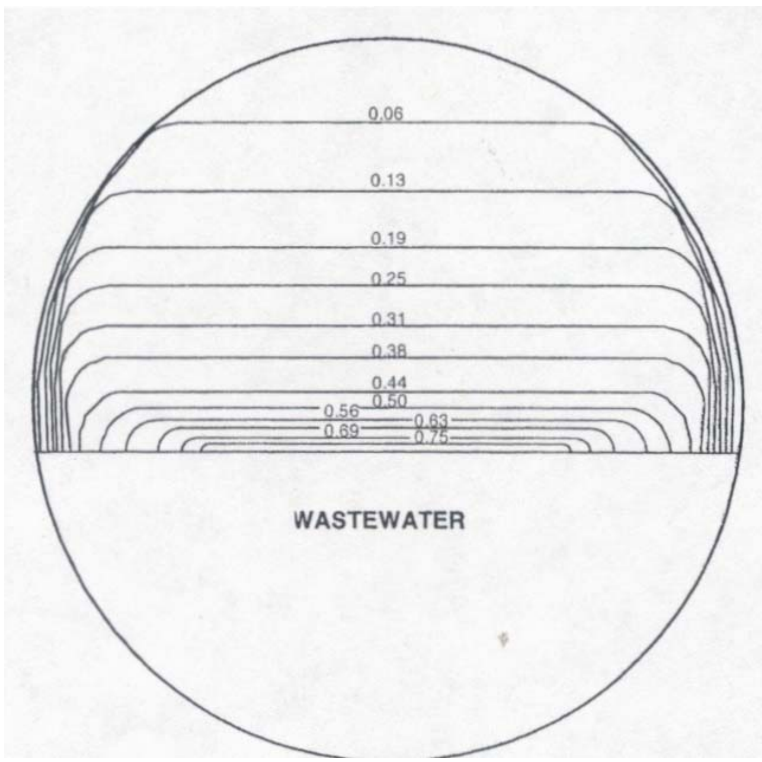


FIGURE 6.2.1
IDEALIZED AIR VELOCITY CONTOURS
IN PERCENT OF WASTEWATER VELOCITY

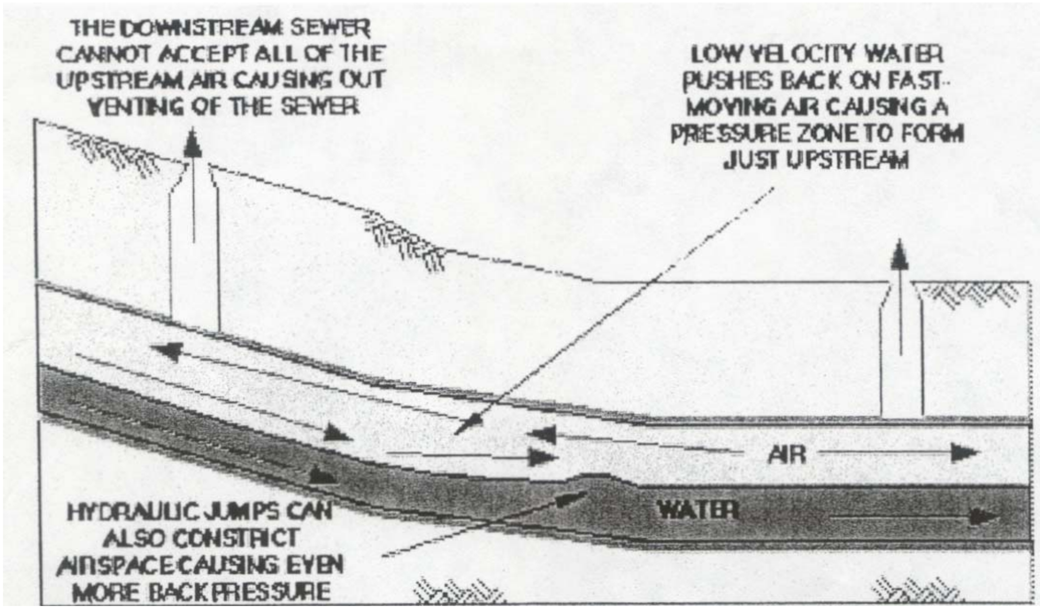


FIGURE 6.2.2
PRESSURIZATION DUE TO SLOPE CHANGE

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. 6.2.2).

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.

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.

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 pipe or other conduit 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.

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.

7.0 ODOR ADVISORY BOARD AND ODOR OUTREACH PROGRAM

7.1 ODOR ADVISORY BOARD

In 1998, the Santa Monica Bay-Keepers filed a third party lawsuit against the City of Los Angeles after the large El Nino-related sewer spills. The EPA joined as plaintiffs in the lawsuit in January 2001 because of dry-weather sanitary sewer overflows and sewer odors. Groups representing communities in South Los Angeles joined the lawsuit because of the sewer odors issue. The court issued a Case Management Order (CMO) dated July 3, 2001 requiring the City to implement its Odor Control Program and hire an independent odor consultant to review the City's sewer odor control effort; and create an Odor Control Advisory Board with members representing the South Los Angeles communities to help assess the odor issues and review the City's mitigation efforts. Additionally, the CMO required the City to establish an odor hotline which the City has since established, along with a new related website.

The Odor Advisory Board was formed in September 2002 and started meeting on a monthly basis. Currently it meets on a quarterly or as needed basis. Odor complaints, odor investigation procedure, the mitigation measures and the long-term odor control efforts underway by the City have been provided to the Odor Advisory Board for review and input. The Odor Advisory Board interest focuses mostly in the south LA communities (mainly around MLK/Rodeo between La Cienega and Arlington) which fall within the 8th, 9th and 10th council districts.

The information on planned construction of several Air Treatment Facilities (ATFs) which will be placed at strategic points throughout the City, concentrated in those areas with the most odor complaints was also presented to the Board for input and comments. The Board members also attended several field trips including a Fan Test, the Hyperion Treatment Plant, and the East Central Interceptor Sewer (ECIS) construction site at the southeast corner of La Cienega Avenue and Jefferson Boulevard. The Odor Advisory Board also met with the independent odor consultant to provide input for the Independent Review of the Odor Control report.

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. The Settlement Agreement superseded the CMO and authorized the Odor Advisory Board to continue to work closely with the City in its effort to resolve and mitigate sewer odors to the maximum extent practicable. The CSSA stated 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 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 as included in the newsletters.

The Odor Advisory Board continues to provide valuable input in the City's odor control effort including providing input in the development of the Odor Hotline Outreach Plan, reviewing and commenting on the Odor Complaints Report, and assessing the effectiveness of the interim odor control facilities.

7.2 ODOR OUTREACH PROGRAM

The City has been actively engaged in outreach activities to 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. The first is the communication and coordination with the community-based Odor Control Advisory Board. The second is the distribution of flyers and refrigerator magnets containing odor control information and means of contacting the City for sewer odor issues. The third is an annual survey of the public in those areas where odors are the worst in order to gather feedback.

The Odor Control Advisory Board consists of residents from South Los Angeles who are concerned about sewer odors in their neighborhood and interested in being involved in solving the problem. The Board serves as the City's primary point-of-contact with both the public and the settlement agreement plaintiffs regarding sewer odor control issues. The City has been actively involved in keeping the board functioning at a time when attendance has been decreasing and the City is currently recruiting new members.

The City is distributing educational flyers and magnets that explain the City's odor control program and advertise an odor control hotline and a web site that are available for bringing sewer odors to the attention of the City. As of June 2006 the Bureau has ordered 19,000 Odor Control flyers and 300 magnets. A sample of the odor control outreach flyer is attached at the end of this section. They are distributed at meetings and other public events including the following:

- i. City Council District Offices.
- ii. Public Affairs Office
- iii. Public Works Week celebration at the Van Nuys, Harbor City, Boyle Heights, and WLA Senior Centers
- iv. Panorama City Recreation Center, Boyle Heights Neighborhood Fair, and McArthur Park Neighborhood Fair
- v. PW Open House in the East Valley
- vi. Neighborhood Council Meetings

In June 2006, the City conducted feedback interviews to measure the effectiveness of the Sewer Odor Hotline. The interview process included conducting street interviews at each of the 4 Odor Hotspot locations, mailing questionnaires to the people who complained through the Odor Hotline, and conducting presentations and distributing surveys at the South L.A., Mar Vista, and Studio City Neighborhood Councils.

Overall, the community feedback has been very positive and encouraging.   About half of the survey respondents noticed decreases in sewer odors over the past four years. Most of the comments for improving the hotline pointed out the importance of maintaining a quick response time to odor complaints. The survey revealed that most of the participants welcomed information about the hotline and the City is therefore considering additional efforts to increase public awareness of this service

8.0 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.

8.1 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.

8.1.1 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.

8.1.2 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 H_2S 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.

8.1.3 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.

8.1.4 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.

8.1.5 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.

8.1.6 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 $$H_2O_2 + H_2S \longrightarrow S + 2H_2O$$

hydrogen peroxide + sulfide ion → sulfite ion + water

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

8.1.7 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 forcemain applications due to its low saturation characteristics under atmospheric conditions.

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

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

*** anaerobic or facultative anaerobic bacteria**

8.1.8 Caustic Shock Dosing - Sodium hydroxide (caustic) shock dosing is the primary treatment technology used by the City to reduce hydrogen sulfide. This chemical is injected at several points upstream of "hot spots" to reduce sulfide generation. Since implementation, odor complaints have decreased in the Maze area of the sewer system by 74% between 1997 and 2000 and drastic reductions were seen in hydrogen sulfide concentrations. Due to the increasing cost of sodium hydroxide, the City started using a continuous addition of ferrous chloride in 2000.

8.1.9 Magnesium Hydroxide - Corrosion of the sewers is controlled by the annual application of magnesium hydroxide slurry to the crown of primary sewers susceptible to corrosion. The magnesium hydroxide neutralizes any sulfuric acid present on the pipe surface and raises the pH to about 10. The high pH renders the environment hostile to the bacteria responsible for the acid generation, preventing re-colonization. This program has reduced the rate of corrosion and deterioration in the sewers, extending the time until rehabilitation is needed. It is also added directly to the wastewater flow to increase the pH, thus shifting the sulfide speciation equilibrium towards a greater amount of disulfide and dissolved sulfide and a lesser amount of hydrogen sulfide. In this way, hydrogen sulfide-related odors are reduced.

8.2 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.

8.2.1 The most straightforward method is odor containment. The simplest solution is preventing gas from venting from maintenance holes by sealing the maintenance hole lid with a mixture of roofing tar and sand. This is performed mostly on the large diameter sewers that experience headspace pressurization.

8.2.2 Another solution is constructing a gas trap maintenance hole. This type of maintenance hole contains a flap which blocks sewer gasses from traveling upstream past the structure. They are constructed at locations where small diameter sewers discharge into a large outfall sewer and they prevent pressurized sewer gases from being forced from the large sewer into the smaller sewers.

8.2.3 Maintenance hole 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.

8.2.4 Vortex Flow Inserts can be used at vertical drops in the sewer system such as in manhole drops, pumping station wet wells and force main discharges. Free-falling sewage typically drags air into the receiving structure and creates turbulence at the water surface, which releases H_2S gas, thus pressurizing the receiving structure. This is a significant source of odors at drop structures and also causes rapid and extensive damage to concrete and metal sewer piping and mechanical equipment. Using proprietary technology, the Vortex Flow sewer insert diverts the sewage into a circular vortex. This flow is directed into a drop pipe, where the high centrifugal forces cause the sewage to hug the wall, creating an air core down the center of the pipe. The slightly negative pressure created in the air core sucks the odorous gases down towards the pool at the bottom, where the gases are entrained by the sewage flow. In the energy-dissipating pool, the sewage is further oxygenated using the energy of the falling flow. According to the manufacturer, these oxygen molecules then bond with dissolved H_2S to form hydrogen sulfate (H_2SO_4). Unlike dissolved H_2S, which readily becomes airborne, H_2SO_4 remains dissolved at low concentrations. In effect, the dissolved H_2S molecules would become locked into the waste stream when they are converted into H_2SO_4.

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.

8.2.5 A carbon scrubber utilizes activated carbon to adsorb H_2S as it passes through. Its advantages include a small footprint and a H_2S removal rate of up to 99.5%. It has several disadvantages:

- 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

8.2.6 Biofilters have proven to be an effective technology for removing VOC-type odors, hydrogen sulfide, and ammonia from air exhausted from livestock facilities and is used quite frequently in waste water 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 CO_2, 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. They do, however, have several disadvantages which include the following:

- Large footprint required (up to 2,500 sq ft. for 30,000 CFM @ 20 PPM H_2S)
- 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

8.2.7 A biotrickling filter is one of the latest technologies available. It consists of columns filled with inert packing media, over the surface of which water is allowed to trickle. A biofilm develops on the surface of the media. Contaminated gas is supplied either co-current or countercurrent to the water's direction. Natural media can include soil, peat, compost, or bark. Engineered media biofilters are an attempt to provide the advantages of natural media with the liquid phase and biomass control available in a biotrickling filter.

8.3 Hydraulic Design Improvements

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.

8.3.1 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 H_2S.

8.3.2 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.

9.0 ODOR CONTROL MEASURES

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 (H_2S), 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 float away into the atmosphere. However, 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.

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.

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. It was then recognized that the solution 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 ventilating a portion of the NOS. The experiment consisted of using a fan to evacuate air at one location and admitting 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 station be built at the test site. More stations were constructed to ventilate other sections of the NOS and the Central Outfall sewer as well.

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.

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 targeted its chemical addition program at 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 understood by scientists and engineers. Many large-diameter sewer depressurization projects were designed and installed in various part 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.

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. As discussed earlier, 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 withdraw 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 measures and also discusses new procedures the City plans to use as part of the Odor Control Program.

9.1 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. Additionally, odor complaints are received through the city-wide 3-1-1 phone number for government services and information; through direct contact from the public; or referrals from council offices, other city departments, or other agencies.

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.

9.2 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.

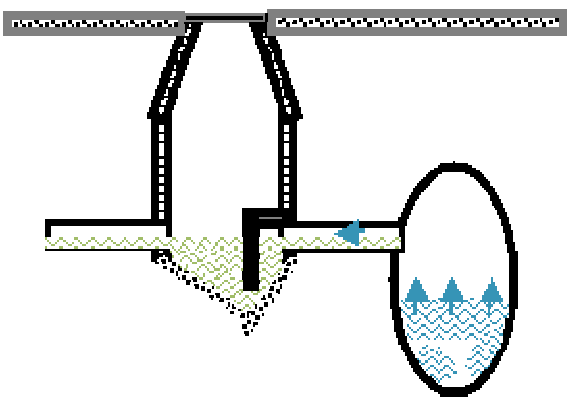
    Hydroflushing – Directs a high-velocity stream of water against the pipe wall. This process removes debris and grease build-up and clears blockages within small-diameter pipes.

    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.

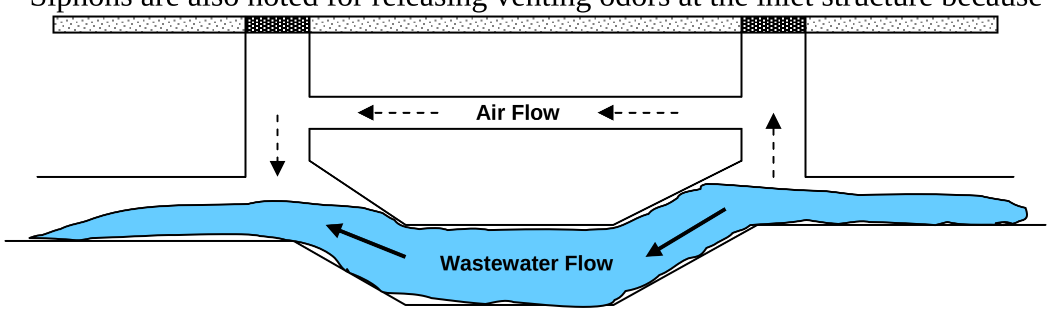
- **Trap Maintenance Hole Inspection and Cleaning**



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.

9.3 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 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 reform 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.

Caustic soda is added directly to the sewage through a maintenance hole upstream of the area to be treated and at the sulfide-producing zone. It is added at a volume and

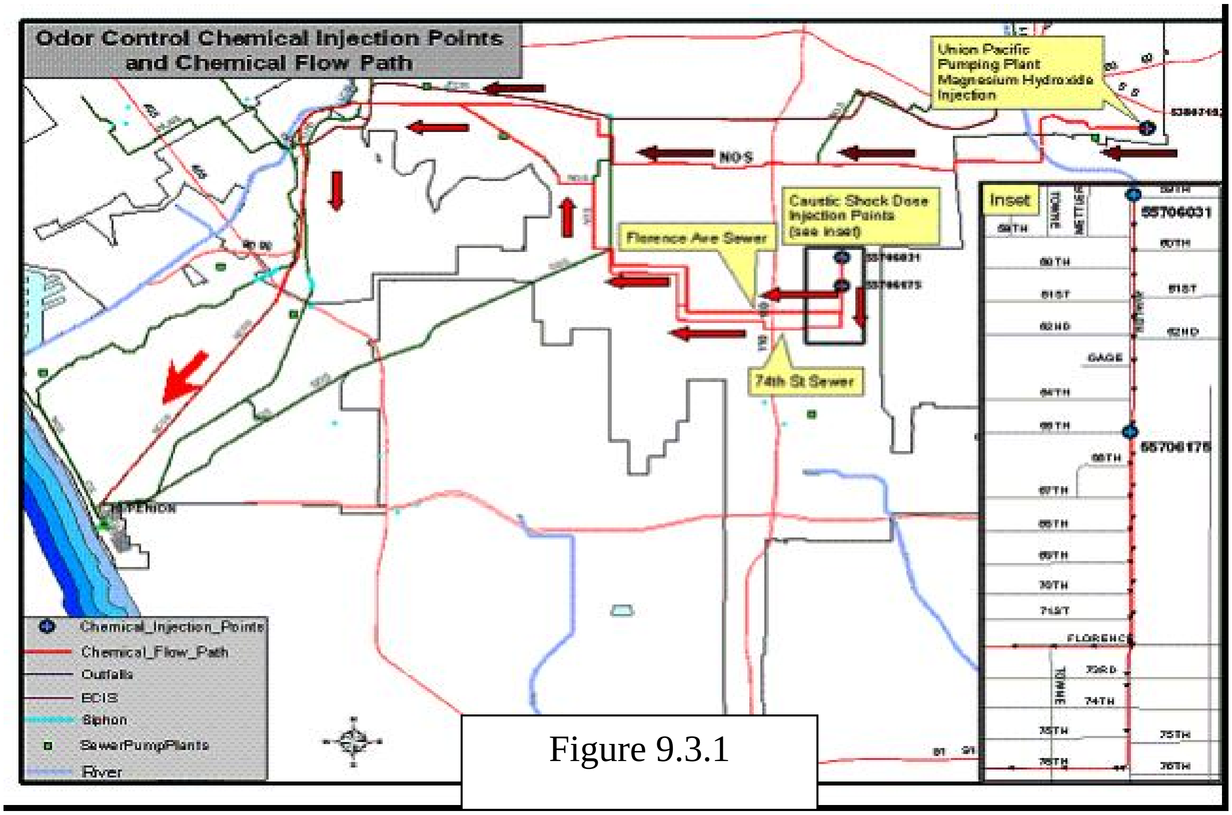
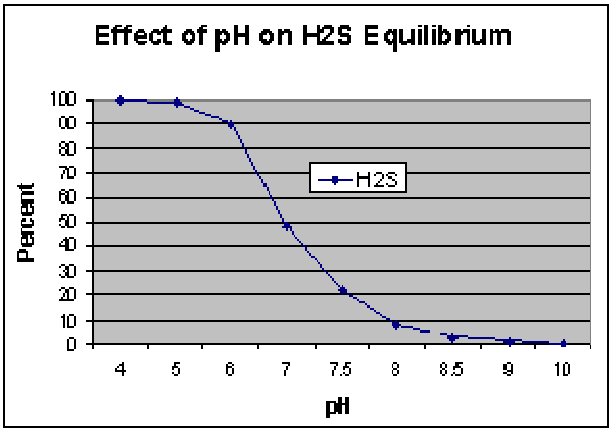


Figure 9.3.1

rate sufficient to elevate the pH above 12.5 for at least 30 minutes so as 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 applied to sewer reaches upstream of the Maze sewer area which account for approximately 46% of the sulfide loading to the Maze Area Sewer System. This has helped control odors in the South LA area. See figure 9.3.1 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 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 test conducted on the North Outfall Sewer (NOS). This test was an effort to reduce odors along the NOS and ultimately in the Maze Area. The NOS accounts for 39% of the sulfide loading in the Maze Area Sewer System. This application requires 20 to 25 gallons of magnesium hydroxide per million gallons of wastewater to control odors. The magnesium hydroxide is introduced via the Boyle Heights Area Sewer System at the Union Pacific Pump Plant. Also Tillman Treatment Plant is another point used for magnesium hydroxide injection to raise the pH in NOS, EVRS, and LCSFVRS systems.

9.4 Air Treatment

The City has conducted multiple studies of sewer gas pressure and odors. In the spring of 2001, the City embarked on a comprehensive air pressure monitoring study of several large-diameter sewers in central Los Angeles in order to identify the cause of persistent odor complaints along these sewers. The study identified distinct high pressure zones in sewers around the South LA area including:

- Large diameter sewers along the North Outfall Sewer, Maze Area Sewer System and La Cienega San Fernando Relief Sewer.

- the North Outfall Replacement Sewer (NORS)
- the West Los Angeles Interceptor Sewer (WLAIS) and Westwood Relief Sewer (WRS), both of which tie into the NORS

In July of 2001, the City then conducted the ECIS Odor Control Study. These studies and other odor complaint investigations led to the recommendation that odor removal equipment be installed at various locations along major sewers in the South L.A. and central L.A. areas. Temporary facilities were constructed while more comprehensive, permanent facilities were planned and designed.

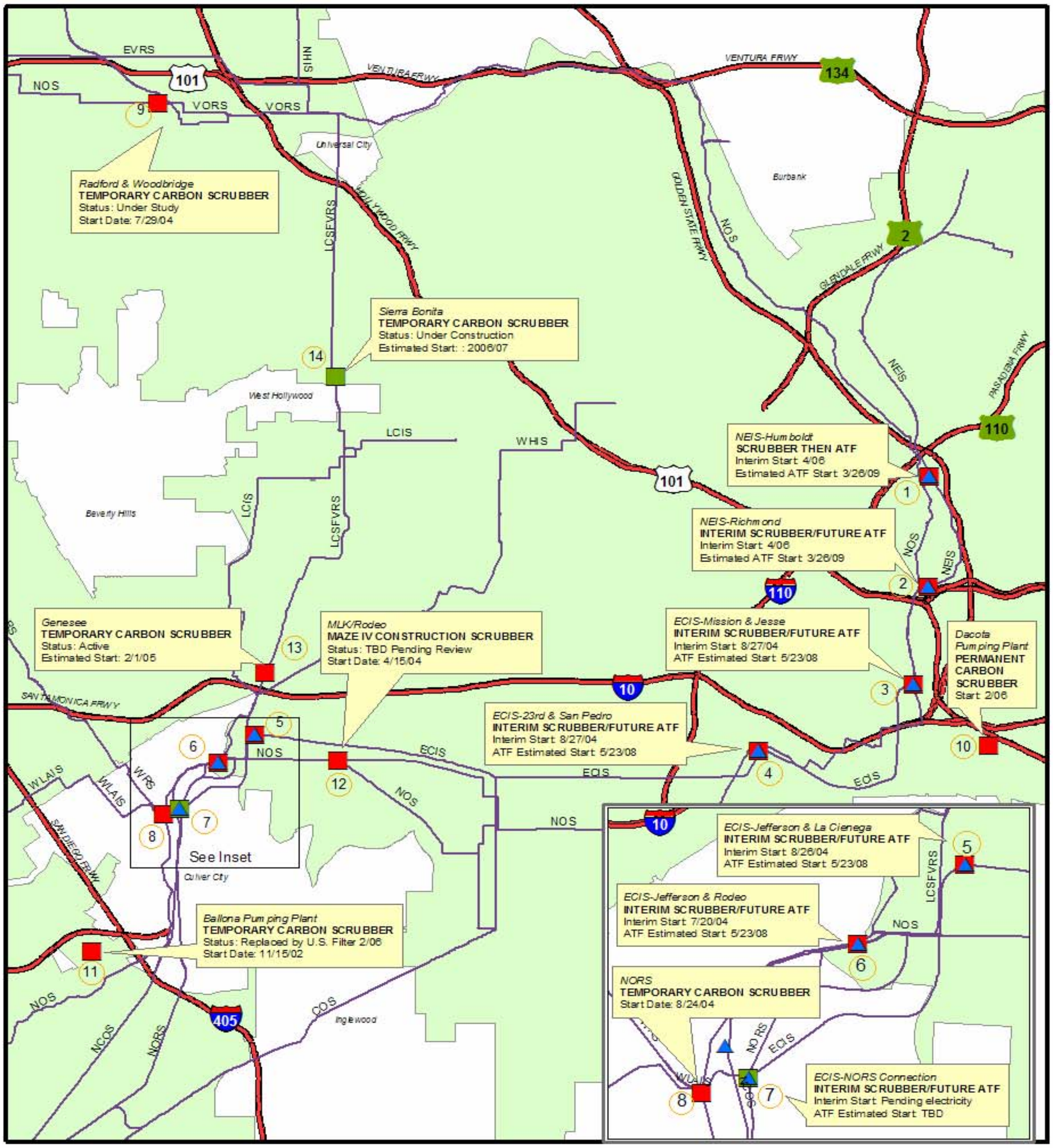
The temporary remedy involved constructing carbon scrubbers along a segment of the ECIS and at various pressure zones in the collection system. Activated carbon is commonly used to filter foul air, which is forcibly removed from the sewer and passed through the carbon, to which the odors adhere. This 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 with one more scheduled to become operational soon.

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 just before odor contaminant breakthrough occurs which is typically every 3 to 6 months. However, in some units, carbon is replaced monthly due to higher levels of contaminants being removed. Many of these carbon scrubbers will be replaced by permanent air treatment facilities (ATFs).

Figure **9.1** shows location and information on the temporary scrubbers and the planned ATFs.

Sewer Odor Control Facilities



Sewer Odor Control Facilities

No.	Name	Type	Size(cfm)	Cost($M)
1	NEIS - Humboldt	Interim Carbon Scrubber/ then Future ATF	10,000 13,260	0.4 6.6
2	NEIS - Richmond	Interim Carbon Scrubber/ then Future ATF	10,000 8,600	0.4 5.4
3	ECIS - Mission & Jesse	Interim Carbon Scrubber/ then Future ATF	10,000 12,000	0.2 4.9
4	ECIS - 23rd & San Pedro	Interim Carbon Scrubber/ then Future ATF	10,000 13,900	0.2 6.3
5	ECIS - Jefferson/La Cienega	Interim Carbon Scrubber/ then Future ATF	10,000 20,000	0.3 8.3
6	ECIS-Jefferson & Rodeo	Interim Carbon Scrubber/ then Future ATF	10,000 12,000	0.3 8.0
7	ECIS-NORS Connection	Interim Carbon Scrubber/ then Future ATF	10,000 12,000	0.3 6.6
8	NORS	Carbon Scrubber	10,000	0.2
9	Radford & Woodbridge	Carbon Scrubber	5,000	0.3
10	Dacotah Pumping Plant	Carbon Scrubber	3,000	0.5
11	Ballona Pumping Plant	Carbon Scrubber	5,000	0.5
12	MLK & Rodeo	Carbon Scrubber	5,000	O&M
13	Genesee Siphon	Carbon Scrubber	5,000	0.3
14	Sierra Bonita	Carbon Scrubber under Construction	10,000	0.6

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

Definitions: **TEMPORARY: Location under study for ATF**
INTERIM: Future ATF

0 1,400 2,800 5,600 8,400 11,200 Feet

Wastewater Engineering Services Division
Bureau of Sanitation
City of Los Angeles

Created 10/11/06

S:\users\Odor MP INFO\Scrubber_ATFmapBsize2.mxd
Thomas Bros Data reproduced with permission granted by THOMAS BROS MAP

Figure 9.1

9.5 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 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 newly commissioned East Central Interceptor Sewer (ECIS), which relieved the North Outfall Sewer (NOS), is an example of this benefit. After the construction of ECIS, the air pressures in the NOS decreased, resulting in decreased odor release. A project providing a bypass from the existing 42" diameter sewer along the north side of Slauson Avenue and the existing 36" diameter sewer along the south side of Slauson Avenue to the Central Outfall Sewer (COS) in Van Ness Avenue was completed which would divert sewer flows from the Maze South Branch to the COS and further reduce air pressure within the Maze South Branch.

The construction of relief sewers such as East Central Interceptor Sewer and North East Interceptor Sewer Phase I has provided relief and reduced the high air pressures occurring due to hydraulically overloaded pipes. In addition, the seven air treatment facilities (ATFs) along these two new sewer lines are planned to be constructed in order to withdraw large volumes of air from the sewers to maintain a slight vacuum in the pipes, thus relieving the air pressure in the two pipes and any connecting sewers. Over thirteen interim odor control facilities are now in operation throughout citywide. 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.

9.6 Monitoring

The collection system is regularly monitored in order to identify the causes of odors. A number of monitoring stations have been established at strategic locations in order to measure the parameter associated with odors. 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.

10.0 STUDIED AREAS

10.1 Introduction

Due to the topography of the Los Angeles basin, there are very few viable routes for wastewater to flow by gravity down to the Hyperion Treatment Plant (HTP). In order to convey the sewage by gravity and still maintain adequate velocities, sewers were routed through the only available land area, the corridor between Ballona Creek and Culver City. The majority of the wastewater generated in the City of Los Angeles flows through this corridor (Figure 10.1). The only exceptions are the Coastal Interceptor Sewer (CIS) and the Central Outfall Sewer (COS) which passes under the 405 Freeway. The large-diameter sewers that flow through the Ballona Creek/Culver City corridor include the north and south branches of the North Outfall Sewer (NOS), the La Cienega San Fernando Valley Relief Sewer (LCSFVRS), the Westwood Relief Sewer (WRS), the West Los Angeles Interceptor Sewer (WLAIS), the North Central Outfall Sewer (NCOS), and the North Outfall Replacement Sewer (NORS).

10.2 Sewer Odor Hot-Spot Areas

The City initiated a system for identifying and quantifying the studied areas in order to focus its attention on those areas that needed it most. Odor complaint records were used to assess the severity of the odor. Four areas with unusually high number of complaints were identified as "hot spot" areas (Figure 10.2). These sewer odor hot-spot areas are identified as the following:

1- Studio City/N. Hollywood area - NOS & NHIS
2- The Maze Area of South L.A. - NOS
3- Sierra Bonita /West Hollywood area VSF - LCSFVRS
4- West Los Angeles/Culver City area - WLAIS & WRS

The City embarked on extensive research, testing, and analysis of the sewer odor hot spots using the latest technology and resources, in order to understand the flow dynamics of wastewater and sewer gases in these areas. This has helped determine the causes of the odors and helped to implement the best solutions. Within each hot spot the monitoring locations for measuring pressure and H2S levels were those areas with the critical combination of hydraulic conditions that cause sewer odors. For example, in the areas where the slope is minimal and the flow is slow, solids settle within the pipe, which increases the production of hydrogen sulfide gas. If the flow becomes turbulent, as in a drop maintenance hole; this gas becomes airborne causing pressurization of the sewers. If this flow of liquid and gas becomes constricted, air pressure builds up, as in the upstream side of a siphon. This is the type of combination needed.

Continuous differential air pressure-logging devices were used to monitor pressure during the testing period. Odalog equipment was used to monitor continuous hydrogen sulfide gas in the system.

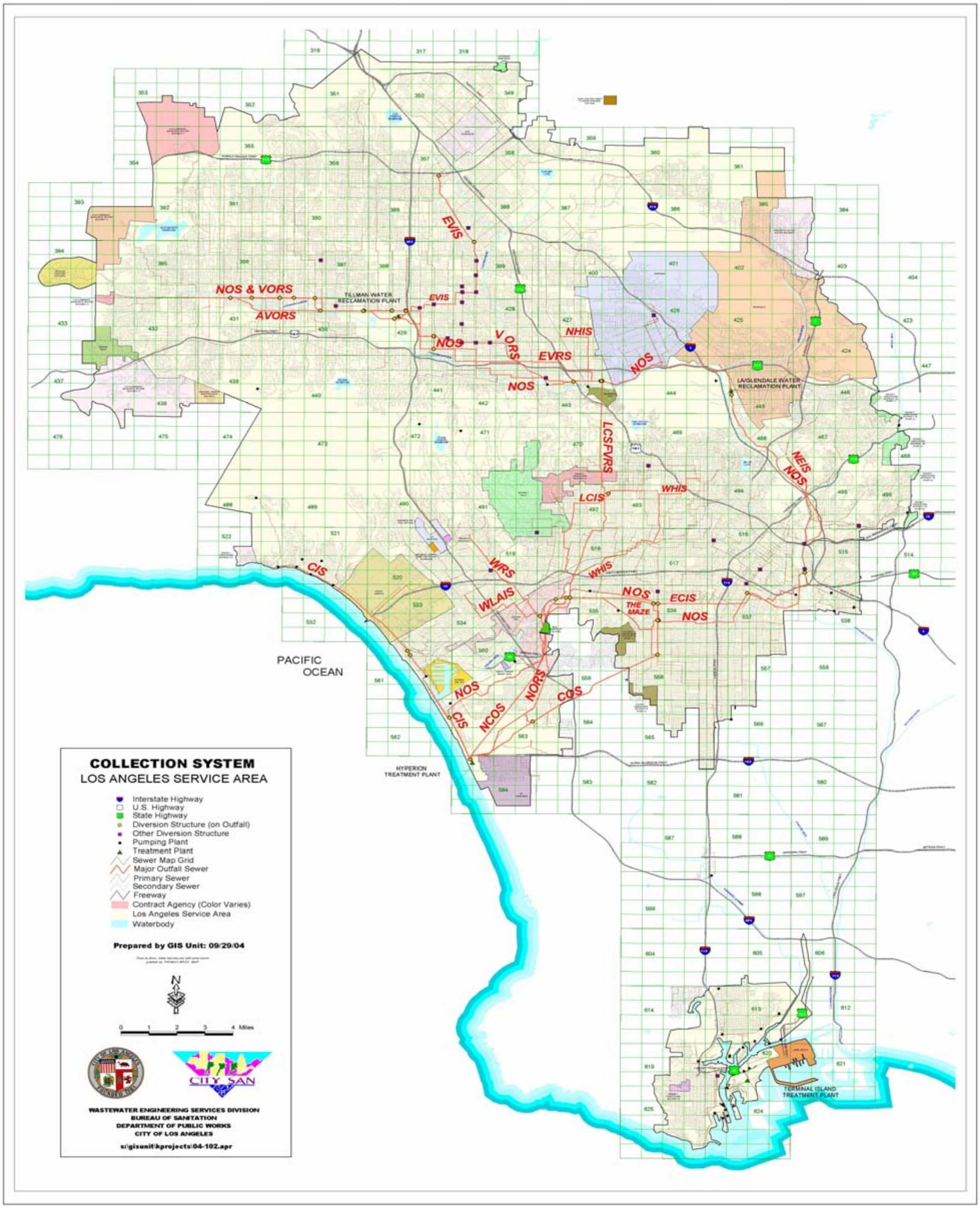

COLLECTION SYSTEM
LOS ANGELES SERVICE AREA
Interstate Highway
U.S. Highway
State Highway
Diversion Structure (on Outfall)
Other Diversion Structure
Pumping Plant
Treatment Plant
Sewer Map Grid
Major Outfall Sewer
Primary Sewer
Secondary Sewer
Freeway
Contract Agency (Color Varies)
Los Angeles Service Area
Waterbody
Prepared by GIS Unit: 09/29/04
WASTEWATER ENGINEERING SERVICES DIVISION
BUREAU OF SANITATION
DEPARTMENT OF PUBLIC WORKS
CITY OF LOS ANGELES
s:\gisunit\kprojects\04-102.apr
PACIFIC OCEAN
HYPERION TREATMENT PLANT
TILLMAN WATER RECLAMATION PLANT
LA/GLENDALE WATER RECLAMATION PLANT
TERMINAL ISLAND TREATMENT PLANT
NOS & VORS
AVORS
EVIS
NOS
V ORS
EVRS
NHIS
LCSFVRS
LCIS
WHIS
NEIS
CIS
WRS
WLAIS
ECIS
THE MAZE
NORS
NCOS
COS

Figure 10.1

10.3 Sewer Odor Potential Areas of Concern

To monitor in a systematic way, locations were also selected along the outfall and primary sewers in areas that do not have as high a frequency of odor complaints – so called "Potential Areas of Concern" (PAC) using the same criteria for choosing monitoring locations as for the hotspots. The Dwyer Digital Manometer that measures differential pressure from 0 to 4 inches in water column is used to obtain instantaneous pressure level in the system. The Sample Drawer Adapter model GX-94 is used to measure instantaneous hydrogen sulfide level in ppm.

There are 5 sewer odor PAC areas identified for systematic monitoring purpose:

1- Venice Westchester Area (CIS)
2- Baldwin Hills Wilshire (WHIS/LCIS)
3- Harbor Area
4- West Valley
5- East Los Angeles – Boyle Heights

The 5 sewer odor potential areas of concern can be found in Figure 10.2

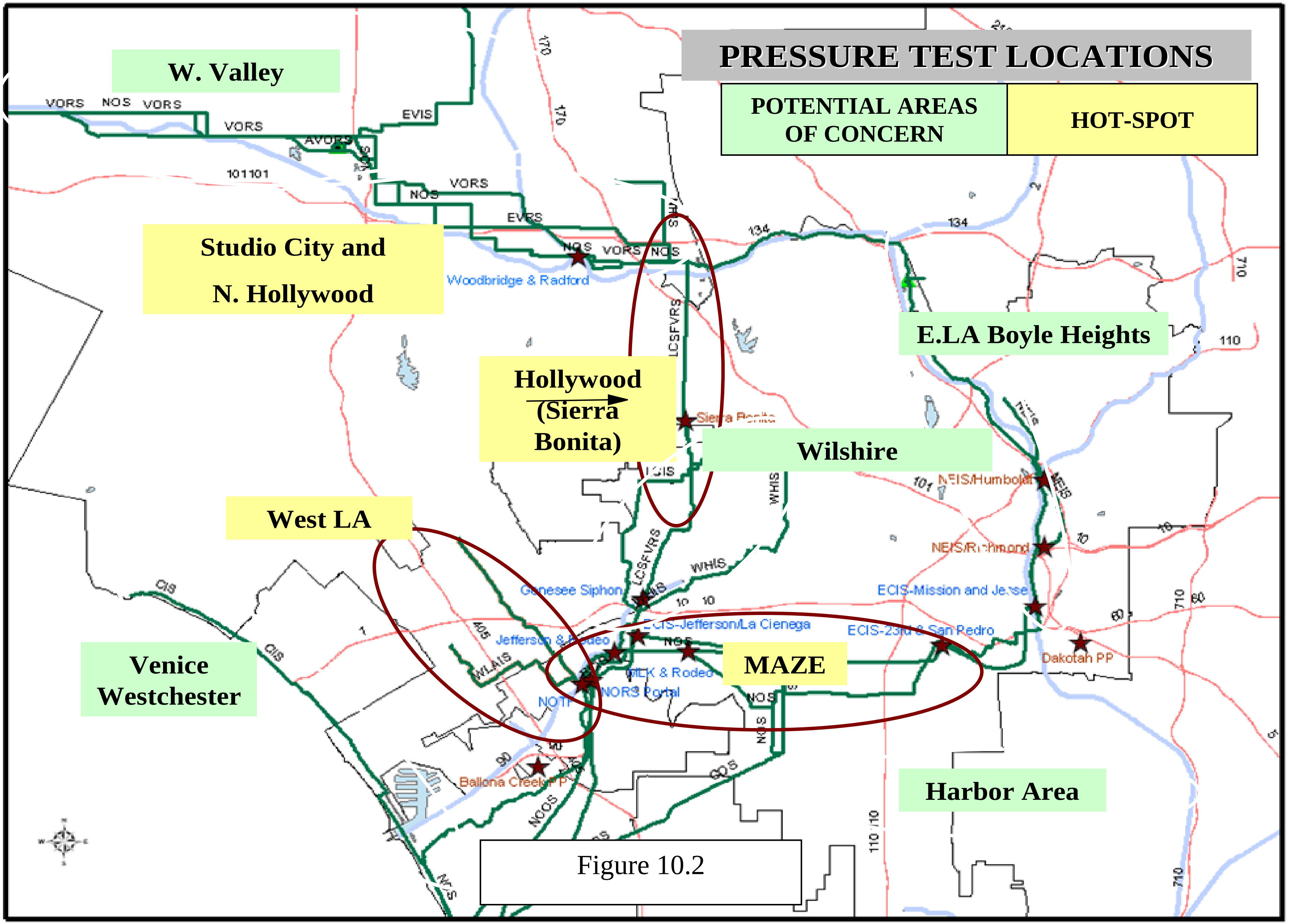

PRESSURE TEST LOCATIONS
POTENTIAL AREAS OF CONCERN
HOT-SPOT
W. Valley
Studio City and N. Hollywood
Hollywood (Sierra Bonita)
E.LA Boyle Heights
Wilshire
West LA
Venice Westchester
MAZE
Harbor Area
Woodbridge & Radford
Genesee Siphon
Jefferson & Rodeo
ECIS-Jefferson/La Cienega
ECIS-Mission and Jesse
ECIS-23rd & San Pedro
NEIS/Richmond
Dakotah PP
Ballona Creek PP
NORS Portal

Figure 10.2

11.0 TECHNICAL ANALYSIS AND DOCUMENTATION FOR SEWER ODOR HOT-SPOT AREAS

This section will provide a technical document for each of the four locations identified as a sewer odor hot-spot due to a history of odor complaints. Testing locations were selected based on a detailed study of the physical characteristics of the collection system in the area. Each document contains an introduction, test results, data analysis, conclusion and recommendation.

The four sewer odor hot-spot areas are:

- Studio City/North Hollywood Area
- The Maze Area - South Los Angeles
- Sierra Bonita/West Hollywood Area
- West Los Angeles/Culver City Area

11.1 Studio City/North Hollywood Area
EVRS-VORS-NHIS-NOS

INTRODUCTION

The Studio City/N. Hollywood area is located in the southeast corner of the San Fernando Valley in the northwest part of Los Angeles. This area had experienced odor complaints in the area west of the Radford Siphon in Studio City. The siphon allows the NOS to travel under the Tujunga Wash and is located near the intersection of Radford Avenue and Woodbridge Street. The sewers involved in the test include the North Outfall Sewer (NOS), the Valley Outfall Relief Sewer (VORS), the East Valley Relief Sewer (EVRS), and the North Hollywood Interceptor Sewer (NHIS). The main focus of the test, in addition to establishing a comprehensive pressure data base for the region, was to test the effectiveness of the existing 5,000 cfm carbon scrubber located just upstream of Radford Siphon on the NOS and east of to the Radford Siphon which is located at the intersection of Radford Ave/ Woodbridge St. and The Tujunga Wash/LA River.

TEST LOCATIONS

The pressure test was conducted between October 21, 2004 and November 1, 2004. Following a detailed study of the physical characteristics of the subject sewers in the Studio City/North Hollywood area and an analysis of odor complaint locations, 13 manholes were selected for air pressure testing. Five locations approximately a mile apart were chosen along the NOS between TWTP and the siphon, the rest were chosen to test the pressure along EVRS (four locations), VORS (two locations), and NHIS (two locations). The physical features that are known to cause odor complaints and were therefore considered when choosing the sites include severe slope reductions, reductions in pipe diameter, siphons, alignment changes, and major junctions. The tested locations and the rationale for selection are listed in Table 11.1.1. See Figure 11.1.1 for a map of the sampling locations.

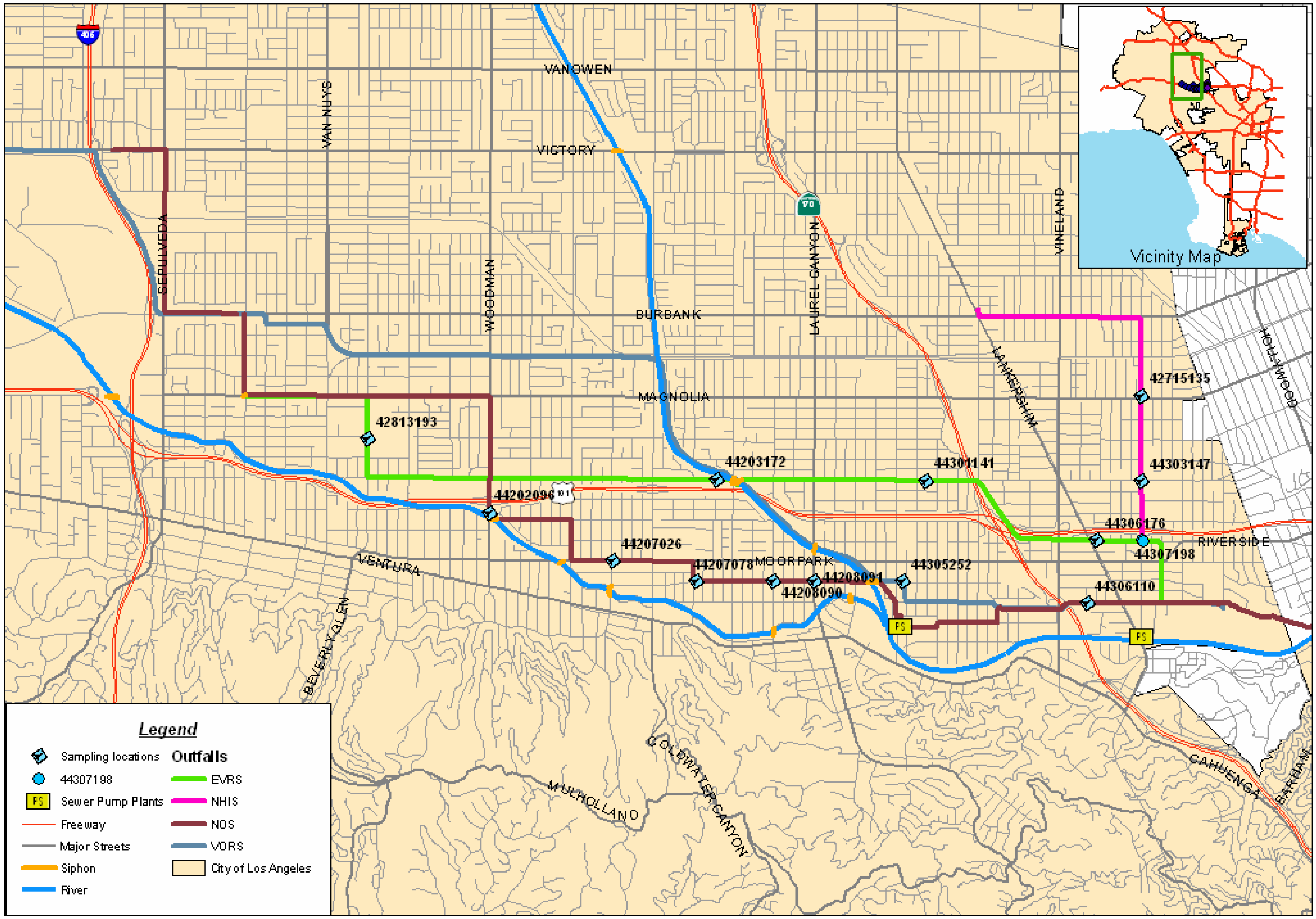


FIGURE 11.1.1
STUDIO CITY/N HOLLYWOOD SAMPLING LOCATIONS

TABLE 11.1.1
MAINTENANCE HOLES MONITORED DURING PRESSURE TEST

	Locations	MH	Rationale for Selection
EVRS	Riverside & Lankershim	443 06 176	Slope Reduction
	11570 Riverside	443 01 141	D/S of Siphon
	12000 Riverside	442 03 172	EVRS Siphon
	Tyrone & Addison	428 13 193	Slope Reduction
VORS	Valley Spring & Satsuma	443 06 110	Slope Reduction
	Woodbridge & Troost	443 05 252	Alignment Change
NHIS	Cahuenga & Huston	443 03 148	Dia. & Slope Red.
	5300 Cahuenga	427 15 135	Slope Reduction
NOS	Laurel Can. & Woodbridge	442 08 091	Radford Siphon Pressure Effect
	Laurel Grove & Woodbridge	442 08 090	
	Bellaire & Woodbridge	442 07 078	
	Moorpark & Ethel	442 07 026	
	4600 Woodman (@ Valley Heart Dr)	442 02 096	

TABLE 11.1.2
SUMMARY OF PRESSURE DATA

		Pressure (in - w.c.)		H2S (ppm)	
Sewer	Locations	Max	Avg	Max	Avg
EVRS	Riverside & Lankershim	0.76	0.02	123	24
	11570 Riverside	0.84	0.02	141	30
	12000 Riverside	0.59	0.02	123	24
	Tyrone & Addison	0.28	0.03	91	17
VORS	Valley Spring & Satsuma	0.01	-0.06	72	38
	Woodbridge & Troost	0.06	-0.02	33	13
NHIS	Cahuenga & Huston	0.90	0.05	8	0
	5300 Cahuenga	0.82	0.00	2	0
NOS	Laurel Can. & Woodbridge	-0.34	-0.66	22	7
	Laurel Grove & Woodbridge	0.34	-0.23	21	7
	Bellaire & Woodbridge	0.22	-0.11	19	5
	Moorpark & Ethel	0.16	-0.13	31	5
	4600 Woodman (@ Valley Heart Dr)	0.06	-0.04	75	12

OBSERVATION

NOS: The average pressures in the NOS were generally negative throughout all the tested locations with some exceptions of positive pressures that were recorded on one particular day during the testing period.

VORS: The average pressures in the VORS were negative with averages of -0.06 in. wc at Valley Spring & Satsuma and -0.02 in. wc at Woodbridge and Troost.

EVRS: Air pressures in the EVRS were generally positive at all tested locations. The maximum pressures are increased in the downstream direction. The average positive pressure of 0.02" water column (wc) was recorded at all locations; while the maximum positive pressure of 0.84 in. wc was recorded at 11570 Riverside Drive.

NHIS: Some positive pressure was recorded on NHIS and is mainly attributed to physical characteristics of the sewer line and back pressure from the connection with the EVRS and NHIS.

ANALYSIS

NOS

The 5,000 cfm scrubber at Woodbridge and Radford is effectively maintaining negative pressure in the NOS from the Radford siphon upstream. Each maintenance hole was chosen based on historical odor complaints as well as the physical characteristics of the sewer. The physical characteristics include severe slope reductions, downstream diameter reductions, siphons, alignment changes and major junction structures. The measured pressure data are summarized in Table 11.1.2. The average pressures at all five locations on the NOS upstream of the Radford siphon were negative during dry weather. The average hydrogen sulfide levels in the NOS range between 5 ppm – 12 ppm.

VORS

The lower portion of the VORS, from the Tujunga Wash to the intersection of Valley Spring Lane and Satsuma Avenue, is under negative pressure except for slight, late-morning positive peaks at the intersection of Woodbridge Street and Troost Avenue near the Tujunga Wash.

It is possible that pressure in the VORS is being influenced by the depressurization of the NOS by the scrubber. The diurnal patterns of the NOS and the VORS are similar, but this may be due to factors other than direct influence of the scrubber. There were no pressure-monitoring locations on the NOS downstream of the Radford Siphon in the area where the NOS and VORS join near Highway 101, and any possible influence of the scrubber on the VORS cannot be verified.

The average hydrogen sulfide levels in the VORS are between 13 ppm – 38 ppm and could potentially cause odor complaints if being released into the air due to high positive pressures.

EVRS and NHIS

The EVRS and NHIS both experienced positive pressures in the afternoon. Average pressure readings at all six locations in these two sewers were positive, during both dry and wet weather. The dry weather, maximum pressures were greater than 0.75 in. wc at four of the six locations. The diurnal patterns in both sewers were very similar, with the afternoon pressure spike in the NHIS at Cahuenga & Huston always beginning slightly before the EVRS at Riverside & Lankershim and with the magnitude in the NHIS always greater than in the EVRS. The pressure data for these two locations indicate that the NHIS could be pressurizing the EVRS through their interconnection at MH 443 07 198. However, the data for the four locations on the EVRS indicate that the pressures are higher at 11570 Riverside than at Riverside & Lankershim, which would not be the case if the NHIS was the cause of the EVRS pressurization. Also, each rise in pressure at 11570 Riverside typically starts at the same time as those at 12000 Riverside and before those seen at Riverside & Lankershim.

Sewer air pressure fluctuation in the NHIS and EVRS appear to be related, but the data do not provide for clear conclusions on the cause. High airflow due to wastewater drag and resulting pressurization in the NHIS at MH 443 07 196 is a likely candidate, but the observed pressures in the EVRS do not support this as the cause.

Pressurization of the EVRS does not appear to affect the pressures in the VORS at Valley Spring and Satsuma.

Average hydrogen sulfide levels in the EVRS are between 17 ppm – 30 ppm, and the maximum levels are between 91 ppm – 141 ppm, enough to cause odor complaints if released into the air due to high positive pressures. Hydrogen sulfide level in the NHIS is insignificant (2 ppm -8 ppm)

RECOMMENDATIONS

- Recommend pressure and hydrogen sulfide level be conducted on a semi-annual basis for sewers with positive pressure in the NHIS, EVRS, NOS and VORS to periodically monitor the condition of the system.

- Recommend the Chemical Addition at Tillman to reduce the level of hydrogen sulfide in the collection system. (IMPLEMENTED – Since the implementation, the H2S level has been going down significantly in the EVRS).

- Recommend the construction of Radford/Woodbridge scrubber. (IMPLEMENTED – After scrubber on line, the pressure is being reduced significantly which led to the reduction in odor complaints.)

- Recommend the construction of Glendale Burbank Interceptor Sewer (GBIS) to serve as the long-term approach for odor control by reducing the pressure in the area. (IMPLEMENTED – The GBIS environmental process clearance is anticipated to be considered by Council in November 2006)

11.2 The Maze Area

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. This area is the primary focus of the City’s sewer odor relief effort. The majority of the wastewater that flow into the Maze sewer system is carried by the North Outfall Sewer (NOS), which carries flow from as far north as the San Fernando Valley, carrying it southward along the Los Angeles River and approaching South L.A. from the east along 41st Place to Van Ness Avenue.

A special junction structure located at 41st Place and Van Ness Avenue directs normal dry weather flow northward along Van Ness to 39th Street. The sewer runs along 39th Street to 3rd Avenue. At 3rd Avenue, the sewer runs northward to Rodeo Road. This is known as the North Branch of the NOS. The sewer then turns west on Rodeo and runs to Diversion Structure 1, located at the intersection of La Cienega Boulevard and Rodeo Road. From there the sewer is diverted into what is known as the North Central Outfall Sewer (NCOS) and gradually turns southward along Jefferson Boulevard and carries flow to Hyperion Treatment Plant (HTP).

At the above-mentioned 41st/Van Ness special junction structure, peak flows in the NOS are directed westward along 41st Drive to 3rd Avenue. This is referred to as the west Branch of the NOS. This section of the sewer runs southward along 3rd to 43rd Street. The sewer then turns at 5th avenue to Vernon Avenue. This is known as the South Branch of the NOS. The sewer runs westward along Vernon to 11th Avenue. It then turns north on 11th to Leimart Boulevard. At Leimart the alignment runs in a northwesterly direction, diagonally toward Martin Luther King Boulevard (MLK). This portion of the sewer runs along MLK to Rodeo Road where it intersects the North Branch of the NOS.

TEST LOCATIONS

2001 Analysis of Airflow Dynamics in the Maze and LCSFVRS Sewers

In February of 2001, twelve differential air pressure data loggers (ACR SmartReader Plus 4 data loggers) were installed in selected locations along the NOS in the Maze area and along the La Cienega San Fernando Valley Relief Sewer (LCSFVRS). A second round of pressure testing was conducted in April that same year to include five more locations along the WLAIS, the WRS, and the NORS. The 2001 “Analysis of Airflow Dynamics in the Maze and LCSFVRS Sewers” discussed in detail the findings of this testing effort.

2003 ECIS/NORS/NCOS Fan Test Report

A Fan Test was conducted during the week of April 28, 2003. Three temporary air withdrawal facilities were installed at future ATF sites. Each air withdrawal facility was equipped with a variable-speed fan capable of withdrawing 10,000, 7,500, and 5,000 cubic feet of air per minute. The air withdrawn by the fans was filtered through carbon scrubbers in order to reduce odor complaints. The twelve air pressure data loggers were again installed in the same maintenance holes for one week. Air was withdrawn simultaneously from the three sites using all possible combinations of 5000, 7500, and 10000 cfm for each reach. The test results showed significant pressure reductions at 10 of the 12 locations when compared to the initial test data taken in the spring of 2001. The locations where significant air pressure reductions were not achieved were the areas near the Hyperion Treatment Plant and upstream of the Maze system. These locations were several miles downstream and upstream; respectively, of the air withdrawal locations. The most effective air withdrawal condition was when all three fans were withdrawing 10,000 cfm simultaneously. The ECIS/NORS/NCOS Fan Test Report dated July 2003 discussed in detail the Fan Test.

2004 Maze Pressure Test after Completion of ECIS

The ECIS began receiving flow on August 8, 2004. In order to determine the net effect of ECIS and the interim carbon scrubbers (at future ATF locations) on the collection system, pre and post ECIS tests were conducted to record and analyze air pressure in the sewer system with ECIS online and the scrubbers operating. Pre-ECIS test was conducted in April 2004. Post-ECIS was a two-phase test with the first phase administered between August 29 and September 13, 2004 and the second phase between September 20 and October 4, 2004. The same testing procedure and methodology was repeated in the two phases. Along with the pressure loggers, Odalog instruments that measure H_2S concentration levels were employed in order to record the variations in H_2S levels.

Note that this test was conducted while a number of temporary scrubbers were in operation. Table 11.2.3 shows the location of interim scrubbers along with the related air withdrawal capacity for each scrubber.

TABLE 11.2.3
SUMMARY OF TEMPORARY SCRUBBERS IN OPERATION DURING POST ECIS TESTING

LOCATION	SCRUBBER CAPACITY (cfm)
ECIS, 23rd & San Pedro	10,000
ECIS Siphon, Jefferson & La Cienega	10,000
NOTF, 10127 Jefferson	10,000
NCOS, Jefferson & Rodeo	10,000
NOS, MLK & Rodeo	5,000
TOTAL	**45,000**

OBSERVATION/ANALYSIS

The test data conducted after ECIS and scrubbers online showed significant pressure reductions, particularly along the NOS and the North Maze pressure zone, while the South Maze pressure zone showed slight reductions. The proposed ATFs will have a combined air withdrawal capacity of 58,000 cfm, while the interim carbon scrubbers are only operating at 45,000 cfm. This additional air withdrawal from the sewers will provide for an even greater reduction in pressures throughout. Table 11.2.4 contains a summary of data collected from tests conducted before and after ECIS and scrubbers going online. Please see Figure 11.2.1 for a map of the monitored locations.

In 2006, the construction of the Arlington Rodeo Chemical Addition Facility was completed. This facility was built in order to directly inject chemical treatment at Rodeo and Second Ave to reduce the H_2S level in the South Maze area.

In 2006, Slauson/VanNess/COS External Bypass project was constructed to provide the bypass from the existing 42" diameter sewer along the north side of Slauson Avenue and the existing 39" diameter sewer along the south side of Slauson Avenue. Flow is diverted from Florence Ave to the Central Outfall Sewer (COS) in Van Ness Avenue therefore decreasing the flow from the South Maze.

These currently completed projects resulted in the reduction of pressure and H_2S levels in the S. Maze area.

TABLE 11.2.4
SUMMARY OF MAZE AREA PRESSURE TEST DATA
PRE AND POST ECIS STARTUP

MH	LOCATION	SYS	PRE ECIS				POST ECIS			
			MAX (in wc)	AVG (in wc)	H2S MAX (ppm)	H2S AVG (ppm)	MAX (in wc)	AVG (in wc)	H2S MAX (ppm)	H2S AVG (ppm)
537-10-078	41st PL & Trinity	NOS	0.43	0.13	75	16	0.09	-0.04	21	3
536-11-080	41st & Western	NOS	0.56	0.18	101	36	0.02	-0.07	22	3
536-10-220	42nd St btwn Arlington & Van Ness	COS s/o Maze	0.2	0	N/A	N/A	0.05	-0.03	N/A	N/A
536-10-117	41st Pl & Van Ness	NOS	0.78	0.31	N/A	N/A	0.02	-0.05	14.2	N/A
536-05-010	Grayburn & Rodeo	N Maze	0.28	0.15	74	26	0.02	-0.05	30	9
536-10-137	42nd & 3rd	S Maze	0.06	-0.01	N/A	N/A	0.04	-0.01	N/A	N/A
536-05-165	MLK & Somerset	S Maze	0.28	0.06	234	70	0.11	0	233	62
535-08-303	MLK btwn Coleseum & Nicolet	S Maze	1.39	0.1	N/A	N/A	N/A	N/A	N/A	N/A
535-03-156	Cochran & Rodeo	D/s of Maze	0.26	0.02	111	48	0.04	-0.09	60	16

FIGURE 11.2.1
MAZE SAMPLING LOCATIONS

RECOMMENDATIONS

- Since the flow from the Florence Avenue sewer, which has a high level of H2S, has been diverted from the NOS to the COS, it is recommended that the pressure and H2S levels in the COS be monitored closely to ensure pressure and H2S have not shifted to the COS, creating a new hotspot in the system. Should future monitoring indicate that odor is an issue, it is recommended that routine cleaning of COS be evaluated as an option to further reduce H2S concentration.

- Recommend the Florence Avenue Sewer and the 74th Street Sewer be routinely cleaned to reduce hydrogen sulfide level in the collection system.

- Recommend chemical treatment in the Maze area to reduce the hydrogen sulfide level. (IMPLEMENTED)

- With the completion of the East-Central Interceptor Sewer (ECIS) and the Northeast Interceptor Sewer (NEIS) as the operation of the interim odor scrubbers, the City is conducting an extensive review of the underlying assumptions for the Odor Control facilities.

  The City is now reviewing the entire ATF Program after gaining operating experience with the interim carbon scrubbers at the various ATF sites. Each site is being reviewed to determine if the underlying assumptions made before the ECIS and the NEIS were constructed are still valid now that they are completed and operational. These site-specific reviews will also help to optimize the design of the permanent ATFs. The ECIS and North Outfall Replacement Sewer (NORS) ATF reviews include a fan test at the request of the Odor Advisory Board to test the behavior of airflow across the NORS siphon under the 405 Freeway.

11.3 Sierra Bonita/West Hollywood Area LCSFVRS/VSF

INTRODUCTION

Sierra Bonita/West Hollywood is an area that has experienced odor complaints along the La Cienega San Fernando Valley Relief Sewer (LCSFVRS). Many odor complaints from both L.A. residents and residents of West Hollywood prompted the City of Los Angeles to conduct pressure testing along the LCSFVRS and its tributaries. This technical memo discusses this testing, analyzes the results, and provides recommendations to address the odor issues.

The LCSFVRS (11 miles) was constructed in the mid 1950's 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 south Los Angeles.

TEST LOCATIONS

Pressure monitors were placed into maintenance holes and recorded the pressure in the sewer at strategic locations. Due to the long length of pipe possessing high pressure and strong odors, the pipe was divided into two reaches and each was tested separately in order to analyze the air flow dynamics more precisely. Maintenance holes were chosen for testing based on resident's complaints, pressurization phenomena and physical characteristics of the sewer.

The first phase of pressure testing took place in the upper reach of the LCSFVRS between December 9 and December 22, 2003. The second phase of pressure testing took place in the lower reach between February 9 and February 26, 2004. After analysis of the test results, it was determined that three distinct reaches were pressurized along the sewer due to different reasons and independently of each other. The three locations are referenced in this report as follows:

1. The **VSF** intersection, where Valley Spring Lane and Forman Ave intersect in the Toluca Lake area. The following maintenance holes were monitored.

443-07-163	located at Ledge Ave. & Valley Spring Lane
443-07-158	located at Valley Spring Lane & Forman Ave
443-11-024	located at Lakeside Golf course n/o LA River

2. **The Sierra Bonita/Upper LCSFVRS** reach which extends from Hollywood Hills to the intersection of Martel Avenue and Clinton Street. The following MHs were monitored.

470-15-212	located at Sierra Bonita s/o Hollywood Blvd
470-15-213	located at Sierra Bonita n/o Sunset Blvd
492-04-108	located at Gardner St. & Hampton Ave
492-04-109	located at Gardner St, n/o Santa Monica Blvd
492-08-171	located at Alta Vista n/o Waring Ave
492-08-172	located at Martel Ave & Clinton St

3. The **Lower LCSFVRS** reach lies roughly between the intersection of Martel Avenue and Clinton Street (to the north) and the Genesee Siphon (to the south), which lies just south of the intersection of Venice Boulevard and Genesee Avenue. In this reach, the following maintenance holes were monitored.

492-16-010	located at 300 Hauser St
518-03-209	located at 700 8^{th} St
518-07-027	located at 1200 Genesee St
518-07-165	located at 1500 Genesee St
518-10-085	located at Genesee St n/o Venice Blvd
518-10-137	located at 5900 Genesee n/o siphon

OBSERVATION

Tables 11.3.1 and 11.3.2 show a summary of air pressure data along the VSF and Sierra Bonita Reach conducted from 12/10 to 12/17/03, and LCSFVRS Lower Reach conducted from 2/11/04 to 2/18/04.

TABLE 11.3.1
Summary of Air Pressure Data
VSF and Sierra Bonita/Upper LCSFVRS Reach
12/10/03 to 12/17/03

MH No.	Air Pressure (in. wc)		
	Max.	Avg.	H2S Max (ppm)
VSF Reach			
443-07-163	0.01	-0.05	N/A
443-07-158	0.4	0.05	12
443-11-024	0.06	-0.03	N/A
Sierra Bonita/Upper LCSFVRS Reach			
470-15-212	1.05	0.27	144
470-15-213	1.31	0.54	N/A
492-04-108	1.05	0.46	92
492-04-109	1.17	0.48	35
492-08-171	0.54	0.25	3
492-08-172	0.47	0.21	63

TABLE 11.3.2
Summary of Air Pressure Data
Lower LCSFVRS Reach
2/11/04 to 2/18/04

MH No.	Air Pressure (in. wc)		
	Max.	Avg.	H2S Max (ppm)
470-15-212	1.09	0.45	56
492-04-109	0.69	-0.24	35
492-08-189	0.27	0.12	N/A
492-16-010	0.45	0.13	N/A
518-03-209	0.36	0.08	N/A
518-07-027	0.81	0.11	N/A
518-07-165	0.42	0.18	N/A
518-10-085	0.48	0.30	38
518-10-137	0.48	0.30	N/A

ANALYSIS

VSF

The positive pressure recorded at that intersection is mainly due to air dragged into the structure by the wastewater carried by the 30-inch diameter NOS. The NOS is set on a 2.17% slope as it enters the junction structure. A 36-inch diameter pipe with a slope of 0.28% carries the flow out of the junction structure in the direction of LCSFVRS.

In addition to the pressure that builds at the junction structure, there is another potential cause of pressure recorded at MH 443-07-158. A 30-inch diameter pipe carries flow into the MH along Forman Avenue while a 24-inch diameter pipe carries the flow out of the same MH and into the junction structure. This constriction in pipe size, and thus headspace, causes air pressure to build in the MH which is compounded by the backpressure from the junction structure. See Figure 11.3.1 below.

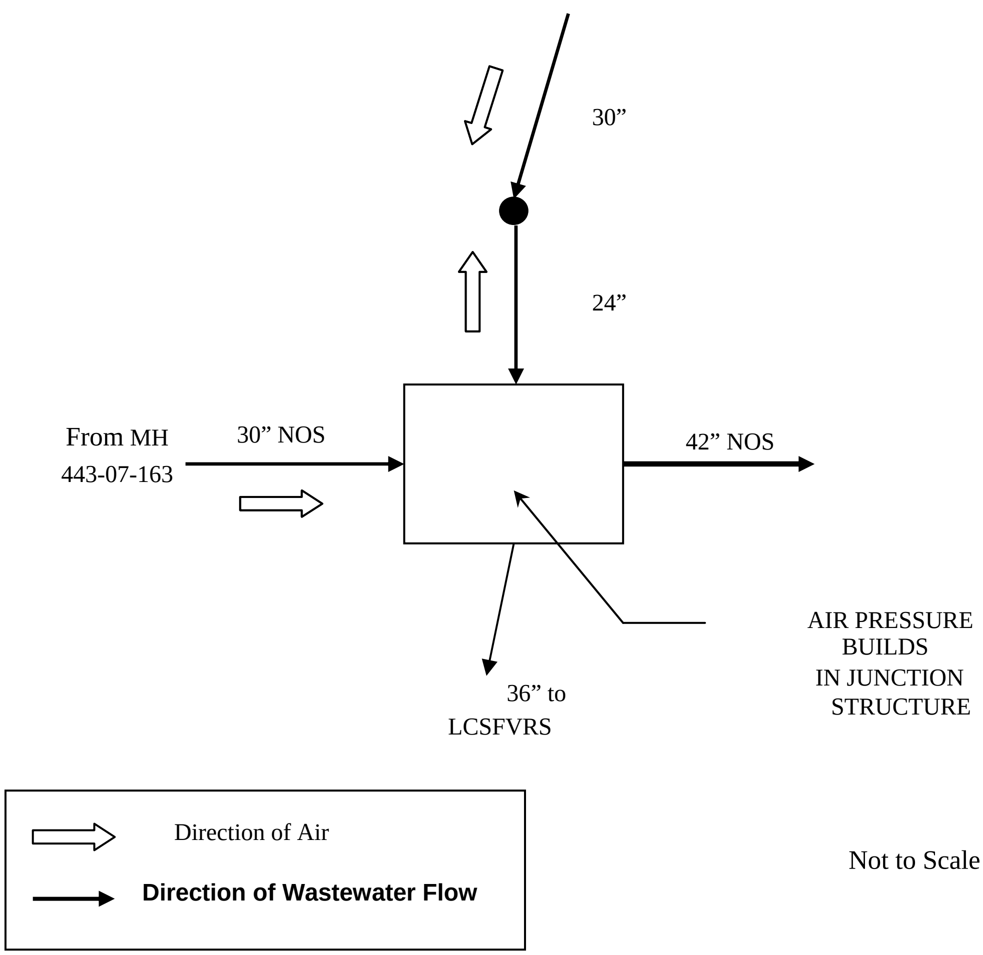


FIGURE 11.3.1

Sierra Bonita/LCSFVRS Upper Reach
This reach extends from Hollywood Hills to the intersection of Clinton Street and Martel Avenue. See Figure 11.3.2. The highest pressure was recorded at MH 470-15-213, located between Sunset Blvd and Hollywood Blvd on Sierra Bonita Avenue. This is due to the combined effect of a high approach velocity (up to 18 feet per second) of the sewage meeting an abrupt slope reduction that occurs at MH 470-15-217, which is located 260 feet downstream of the pressure monitor. It is estimated that only about 2,500 cfm of the 6,500 cfm of air that is carried by the pipe into MH 470-15-217 is able to pass into the next segment, thus creating the high pressure that was recorded at MH 470-15-213. The maximum recorded air pressure in this segment was 1.31 inches of water.

The second highest pressures were recorded at MH 492-04-109, located at the mid point of this reach between Hampton Av. and Santa Monica Blvd on Gardner Street. Two consecutive slope reductions occur in the vicinity of this maintenance hole. The first occurs upstream of the pressure monitor at MH 492-04-108, where the slope reduces from 5.89% to 2.74%. The second occurs at this maintenance hole as the slope reduces further to 1.6%. Air backs up from both of these maintenance holes and causes positive pressures of 1.17 and 1.05 inches of water measured at MH 492-04-109 and 108 respectively. This is due to the combined effect of the abrupt slope reduction and the high velocity (up to 16 feet per second) at which the pipe carries wastewater.

The next significant pressures were measured at MH 492-08-171 and MH 492-08-172. Here the maximum air pressure was measured at 0.5 inches of water. The slopes of these segments are set at a constant 1.61%. This pressure is attributed to the twin 42-inch sewers converging at MH 492-08-169, located 1,100 feet downstream of MH 492-08-172 at the intersection of Martel Avenue and Clinton Street, and to a slope reduction at MH 492-08-169 where a slope of 0.56% carries the flow out of that maintenance hole.

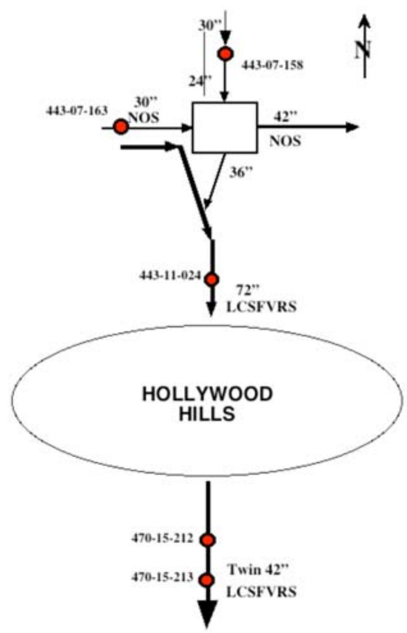


FIGURE 11.3.2

A graphical representation of the profile of the Sierra Bonita Upper Reach is shown in Figure 11.3.3. The maintenance holes are ranked according to the values of the average air pressures recorded at each of the six locations monitored. The relative elevations of each maintenance hole along the upper reach are plotted on the vertical axis, beginning with an arbitrary datum (elev. 0.0 feet) at MH 470-15-212. Note that maintenance holes 492-04-108 and 470-15-212 had the same (third highest) average air pressure during the testing period. For a map of the locations monitored see Figure 11.3.4.

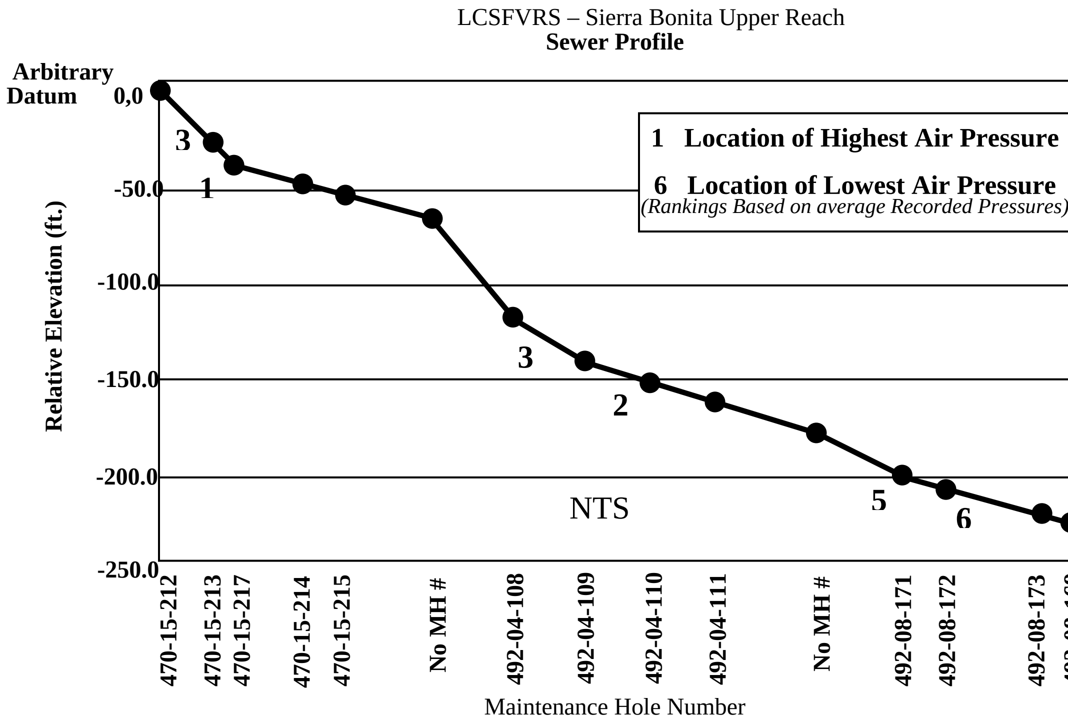


FIGURE 11.3.3

LCSFVRS Lower Reach

This reach extends from the intersection of Clinton Street and Martel Avenue to the Genesee Siphon, located at the terminus of Genesee Avenue, south of Venice Boulevard.

The highest pressure was recorded at maintenance hole 518-10-137, upstream of the siphon. The average pressures in the maintenance holes upstream of the siphon were very similar and their diurnal fluctuations exhibited similar characteristics.

CONCLUSIONS

The data recorded during testing periods at the VSF location and along the Upper and Lower LCSFVRS showed that air pressure fluctuations in each of the three reaches occur due to independently occurring ventilation phenomena. No discernable, single cause has been linked to the positive air pressure that builds in all three locations.

The high air pressure in the VSF is due to a buildup of air that is caused when more air is dragged into the junction structure than is able to exit through the reduced headspace of the outlet sewer given its smaller diameter (32 inches) and its shallow slope (0.28%).

High air pressure in the Upper LCSFVRS is mainly due to the combined effect of high wastewater velocities and sudden slope reductions along the reach. Air dragged by the flowing wastewater can not sufficiently pass through downstream sections of the sewer where velocity and thus headspace is reduced.

High air pressure in the Lower LCSFVRS is caused primarily by the Genesee Siphon. The air dragged within the headspace of the approaching sewer by the wastewater flow cannot adequately pass through the 36-inch diameter air jumper at the siphon. This causes a buildup air near the siphon’s inlet.

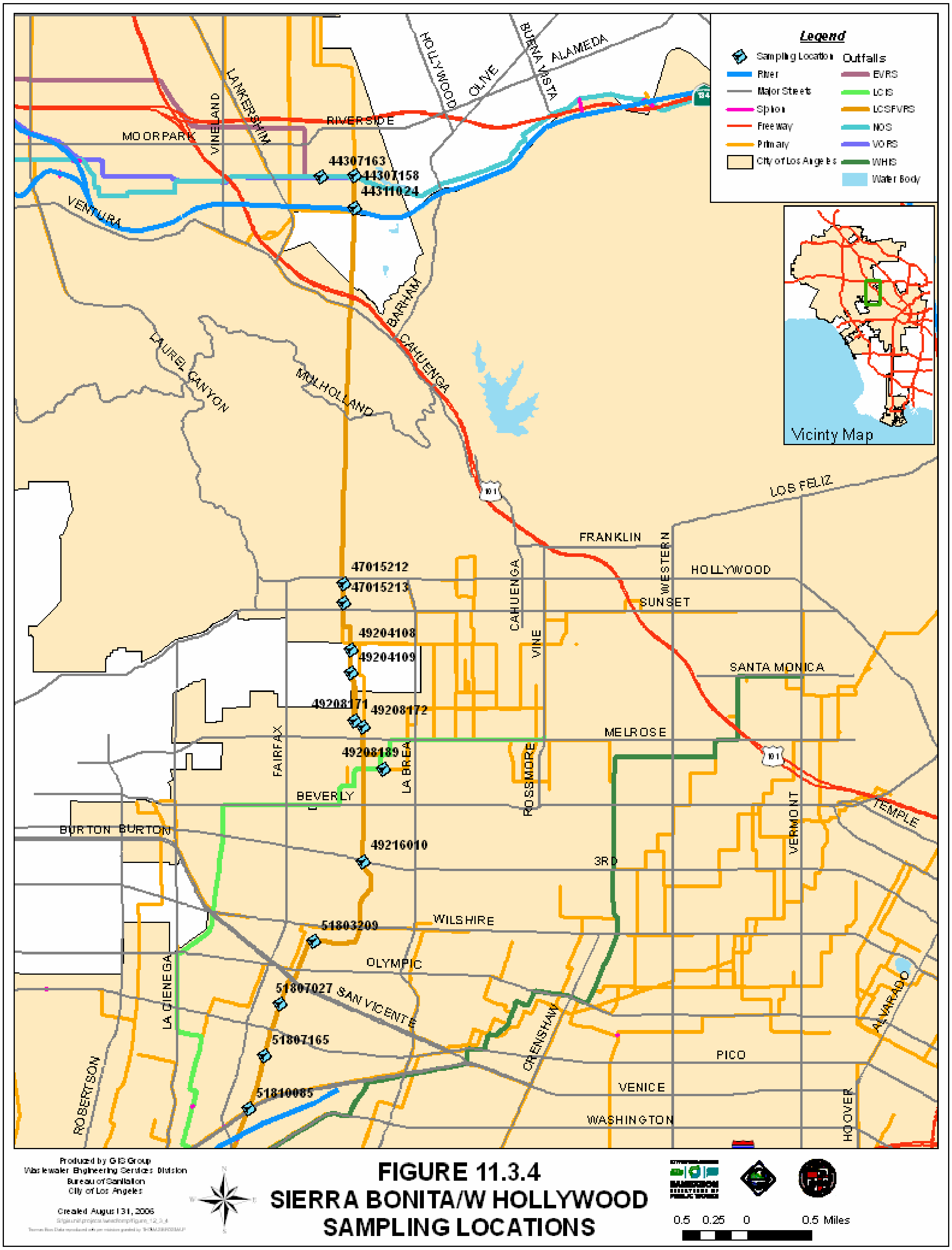


FIGURE 11.3.4
SIERRA BONITA/W HOLLYWOOD SAMPLING LOCATIONS

RECOMMENDATION

Valley Spring Lane Forman (VSF) Intersection Area:

- High air pressure in the NOS/LCSFVRS/Forman Ave Sewer junction at the intersection of Valley Spring and Foreman is creating an odor issue for homes in the area that are directly connected to the 30-inch sewer. It is recommended that flow in Forman Ave is diverted to the NOS to lower the pressure in the Forman sewer line.

- After the diversion, pressure monitoring should be conducted to determine whether there is a need to construct the 8" parallel line for the homes along Forman Ave between Valley Spring Lane and Riverside Drive to reconnect to the new line.

- Recommend the construction of Glendale Burbank Interceptor Sewer (GBIS) to serve as the long-term approach for odor control by reducing the pressure in the VSF area. (IMPLEMENTED – The GBIS environmental process clearance is anticipated to be considered by Council in November 2006)

LCSFVRS Upper Reach:

- Recommend the construction of the scrubber for Sierra Bonita area to lower the pressure in the Hollywood area which will reduce pressure and address the odor issues. (IMPLEMENTED – scrubber is in construction and expected to be on line in 2006/2007). Pressure and H_2S testing is recommended after the scrubber is online to determine the scrubber's effectiveness.

LCSFVRS Lower Reach

- With the 10,000 cfm carbon scrubber in operation at the Genesee Siphon site, the LCSFVRS Lower Reach is depressurized. It is recommended to keep the scrubber in operation and monitor the reach to evaluate the scrubber's effectiveness.

- Recommend the Chemical Addition at Tillman to reduce the level of hydrogen sulfide in the collection system. (IMPLEMENTED).

11.4 WLAIS and WRS Area

INTRODUCTION

The West Los Angeles and Culver City areas are currently experiencing moderate odor emission, however, both areas have the potential for increased odors in the future. The West LA Interceptor Sewer (WLAIS) and the Westwood Relief Sewer (WRS) are the principal sewers that carry wastewater from the West Los Angeles area to the North Outfall Relief Sewer (NORS) in Culver City.

The WLAIS is approximately 4 miles long and varies in size from 33 inches at the upper reach to 60 inches at the lower reach. The upper reach was built in 1920 and has both circular and semi-elliptical cross sections. The lower section was built in the 1950's and is a circular pipe that is lined with PVC. It crosses over Ballona Creek as an elevated 4'-high by 6'-wide concrete box. It connects to the NORS through Diversion 3, which is located in Culver City.

The WRS is approximately 4.5 miles long and its diameter varies from 33 inches to 60 inches. The pipe crosses the creek via a concrete box similar to that for the WLAIS. It connects to the NORS through the NORS 3 Diversion.

Initial pressure testing took place in both pipes from June 16 to June 22, 2004. A total of 10 maintenance holes were chosen based on the sewers' physical characteristics and odor complaints in the area. This test was part of the comprehensive plan to collect sewer pressure data before the anticipated completion of ECIS and the ATFs.

Follow-up testing was conducted from September 22 to October 4 at the locations where the highest air pressures were recorded for each sewer the previous June. This was conducted as a part of a "Post ECIS" pressure test to assess the effect of the newly constructed ECIS and interim scrubbers on the collection system.

TEST LOCATIONS

The following Tables 11.4.1 and 11.4.2 show the maintenance hole locations, the rationale for their selection, and the pressures recorded in each. The locations are listed in order; starting with the most upstream location and proceeding downstream. For a map of the locations tested see Figure 11.4.1.

TABLE 11.4.1
MANHOLES MONITORED DURING PRESSURE TESTING
June 15 to 22, 2004

	Locations	MH	Rationale for Selection
WLAIS	McLaughlin & Indianapolis	534 05 085	Siphon Pressure Effect
	Victoria & Barry	534 10 082	Odor Complaint
	Sepulveda & Regent	534 07 122	Slope Reduction
	Bentley & Venice	534 07 143	Odor Complaint
	Overland & Farragut	534 12 010	Flat Slope
WRS	Manning & Olympic	519 06 182	Slope Reduction
	Manning & Ashby	519 10 397	Slope Reduction
	National & Motor	519 15 187	Odor Complaint
	Jasmine & Palms	534 03 054	Slope Reduction
	Jackson at Ballona Creek	535 09 003	Slope Reduction

TABLE 11.4.2
SUMMARY OF PRESSURE DATA
June 15 to 22, 2004

			Air Pressure (in. wc)		
	Locations	MH	Max	Avg	H2S Max (ppm)
WLAIS	McLaughlin & Indianapolis	534 05 085	0.09	0.04	6
	Victoria & Barry	534 10 082	0.03	0.00	11
	Sepulveda & Regent	534 07 122	0.16	0.01	7
	Bentley & Venice	534 07 143	0.17	0.02	12
	Overland & Farragut	534 12 010	0.28	0.06	319
WRS	Manning & Olympic	519 06 182	0.00	-0.03	4
	Manning & Ashby	519 10 397	0.23	-0.02	N/A
	National & Motor	519 15 187	0.08	-0.01	2
	Jasmine & Palms	534 03 054	0.15	0.04	1
	Jackson at Ballona Creek	535 09 003	0.27	0.04	42

Pressures in the WLAIS generally increase in the downstream direction with the highest maximum and average pressure occurring at Overland and Farragut. Maximum pressure at this location was 0.28 (in w.c.) and average was 0.06 (in w.c.). Average pressures were positive for all five locations on the WLAIS.

Pressures in the WRS also increase in the downstream direction with the highest maximum pressures occurring at Jackson and Ballona Creek. The maximum positive pressure at this location was 0.27 (in. wc), while the average pressure was 0.04 (in. wc). Average pressures were negative at the three most upstream locations and positive at the two most downstream locations.

Post ECIS

The Post ECIS pressure test was conducted in September 2004 after ECIS and the interim scrubbers were online. The locations with the highest pressure for each sewer were Overland & Farragut on the WLAIS and Jasmine & Palms on the WRS. Table 11.4.3 is a summary and comparison of the pre and post ECIS pressures for these two locations.

TABLE 11.4.3

SUMMARY OF WLAIS & WRS PRESSURE DATA
PRE AND POST ECIS STARTUP

Location	MH	Air Pressure (in. wc)			
		Maximum		Average	
		Pre	Post	Pre	Post
Overland & Farragut	534 12 010	0.28	0.21	0.06	-0.03
Jasmine & Palms	534 03 054	0.15	0.08	0.04	-0.03

With ECIS online and scrubbers in operation, pressures at both locations were generally negative except during the maximum diurnal peaks that occur in late morning. Average pressures were negative at both points that experienced highest pressure in the WRS and WLAIS systems before ECIS.

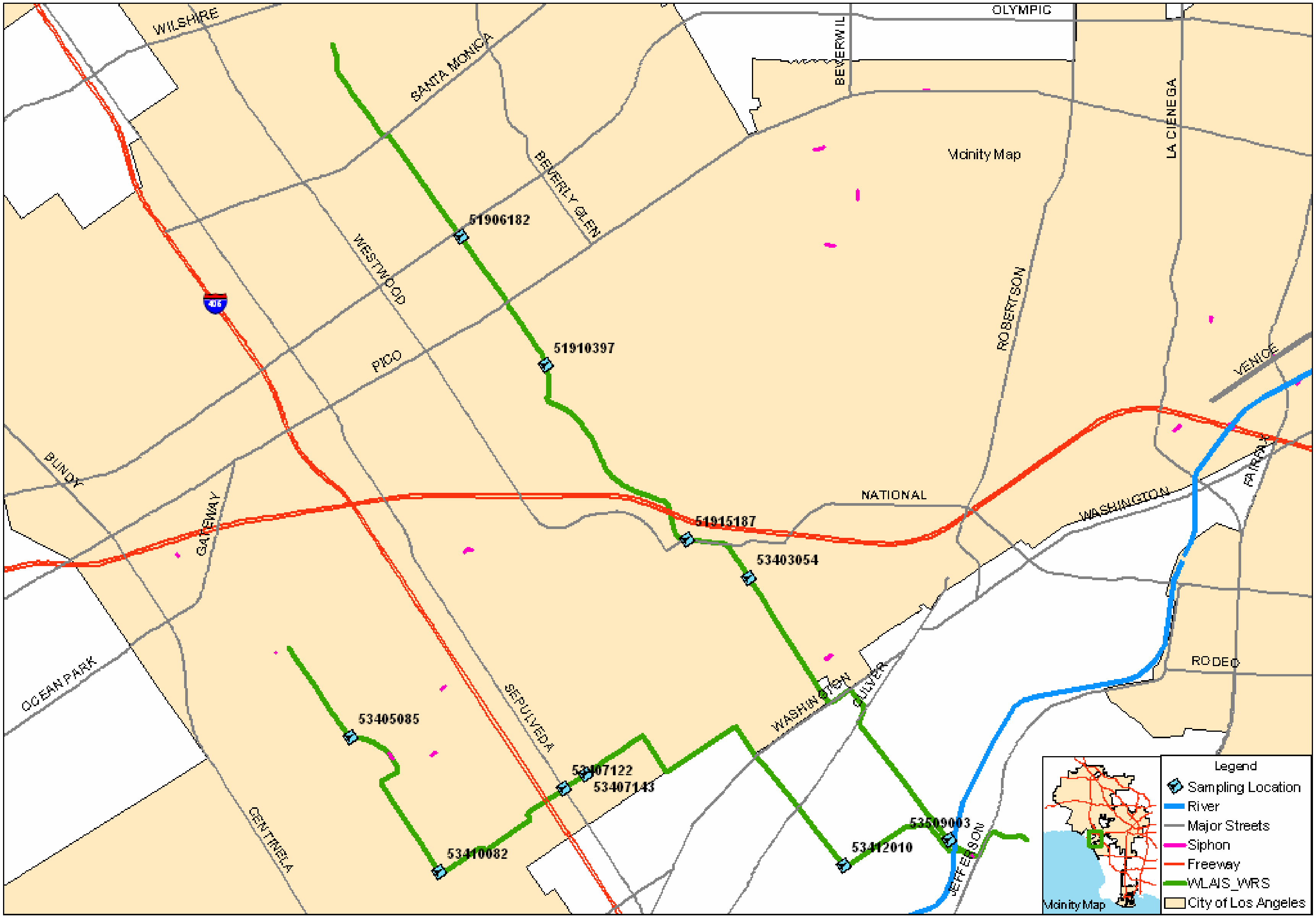


FIGURE 11.4.1
WEST LOS ANGELES SAMPLING LOCATIONS

ANALYSIS

WLAIS

The WLAIS had positive pressures at all five locations monitored from June 16 to June 22. The area upstream of the siphon always had positive pressures as seen in the data for McLaughlin and Indianapolis. The area downstream of the siphon had average pressures that were positive at all locations except Victoria & Barry, which had average pressure of 0.00 (in.wc). Victoria & Barry, Sepulveda & Regent, and Bentley & Venice all had significant periods of negative pressure. The pressures at Overland & Farragut were always positive and this location had the highest pressures of the five WLAIS locations monitored from June 16 to June 22. The area upstream of the siphon always had positive pressure as seen in the data for McLaughlin & Indianapolis. The area downstream of the siphon had average pressures that were mostly positive at all locations.

The WLAIS in general has airflows increasing from upstream to downstream. The three exceptions to this are the siphon, a short segment of 60-inch diameter pipe at a steep slope and the transition to the 48" x 72" box over Ballona Creek. The siphon is the cause of the continuously positive pressures upstream of it as seen at McLaughlin & Indianapolis. The positive pressures in the WLAIS downstream of the siphon are caused primarily by backpressure from the transition to the 48" x 72" box. The steeply sloped 60-inch diameter segment is also contributing to the backpressure that likely results in the relatively high diurnal pressure peaks seen at Sepulveda & Regent, which is the downstream manhole of this segment.

The post ECIS data for the WLAIS indicate that the interim scrubbers placed in service with ECIS are reducing pressures in the WLAIS. Data collected from the Overland & Farragut location show that average pressure was negative after ECIS was online.

WRS

The WRS had a mixture of positive and negative pressures at the five locations monitored from June 15 to June 22. Pressures in the upstream end were mostly negative. Manning & Olympic, the most upstream location, was continuously negative. Manning & Ashby and National & Motor, the next two locations downstream, had average pressures that were negative. Pressures were negative at these two locations except for the late morning diurnal peaks. Pressures at Jasmine & Palms were almost continuously positive, and pressures at Jackson & Ballona Creek were mostly positive with brief negative periods in the early morning and early afternoon. Average pressures at these last two locations were positive.

Three locations experience downstream decreases in airflow occurring at the transition from 57-inches to 42-inches in diameter at MH 519 15 129, the transition from 48-inches to 51-inches in diameter at 534 04 122 and the transition from 60-inches circular to 48-inch x 72-inch box at Ballona Creek. Backpressure from these three locations plus the 33" WRS Unit I and the 42" Robertson Relief sewer are the cause of the positive pressures seen at National & Motor, Jasmine & Palms and Jackson at Ballona Creek.

The post ECIS data for the WRS indicate that the interim scrubbers placed in service with ECIS are reducing pressures in the WRS. Data from Jasmine & Palms showed that average pressure was negative after ECIS was online. Prior to ECIS and the interim scrubbers coming online, pressures were almost continuously positive at this location.

CONCLUSIONS

Testing in September 2004 indicated that the ECIS had positive pressure upstream of the North Portal. With an interim scrubber located at the NOTF, it is almost certain that positive pressures in the ECIS and the NORS are being relieved through the NORS Diversion 3 to the interim scrubber at the NOTF. Additionally, the NOS between NORS Diversion 2 and NORS Diversion 3 have no flow, and water levels are likely quite low in this section of the NOS. Pressures from the NOS, NORS and ECIS could also be relieved to the interim scrubber at the NOTF through this section of the NOS. ECIS was not online during the 2003 NORS/NCOS Fan Test and the Culver City Park location was used during the fan test, not the NOTF where the interim scrubber is located. Positive pressures in ECIS and the location of the interim scrubber at the NOTF instead of Culver City Park are likely causes for the higher pressures seen in the post ECIS testing than in the 2003 Fan Test.

When the permanent ECIS ATFs are constructed and in service, there will be additional air withdrawal capacity that should reduce pressures in the ECIS, NOS, NORS, WLAIS and WRS beyond the reductions seen in the post ECIS testing in which the interim scrubbers were still in operation.

The location of the permanent ATF at Culver City Park instead of the NOTF will also potentially reduce air pressures in connected sewers including the WLAIS and WRS.

Diversion of the WLAIS and WRS flow into the rehabilitated lower NOS will also affect air pressures and ventilation in the ECIS, NOS, NORS, WLAIS and WRS.

Debris accumulation in the WLAIS and WRS may be causing additional localized backpressures. The limited amount of gauging data and pressure data do not allow for conclusions on location and magnitude.

RECOMMENDATIONS

- Recommend the installation of NOTF Scrubber to depressurize pressure in the WLAIS/WRS. (IMPLEMENTED)

- Debris accumulates in the WLAIS and WRS and may be causing an increase in the hydrogen sulfide levels in the sewers. The construction of additional maintenance holes is planned in order to facilitate the cleaning of this debris. After these maintenance holes are built and the sewers are cleaned, it is recommended that hydrogen sulfide levels and pressure are monitored. If odor is still an issue, chemical addition should be evaluated as another option.

12.0 TECHNICAL ANALYSIS AND DOCUMENTATION FOR POTENTIAL AREAS OF CONCERN

This section will provide a technical document for each of the five locations identified as sewer odor potential areas of concern (PAC). Testing locations were selected based on a detailed study of the physical characteristics of the collection system in the area. Each document will contain an introduction, test results, data analysis, conclusion and recommendation.

The sewer odor potential areas of concern are:

- Venice Westchester Area - CIS
- Baldwin Hills Wilshire WHIS - LCIS
- Harbor Area - Primaries
- West Valley
- East Los Angeles – Boyle Heights

12.1 Venice Westchester Area
CIS

INTRODUCTION

This report provides a discussion and analysis of the sewer air pressure test conducted for the Venice Westchester Area in December of 2004. The Coastal Interceptor Sewer (CIS) is the major outfall serving this 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 LOCATIONS

Table 12.1.1 shows the list of monitored locations on the CIS.

Figure 12.1.1: Map of the approximate monitored locations.

Locations were selected for air pressure testing along the CIS based on several factors that can create the odor-prone system. Locations were chosen based on odor complaints as well as the physical characteristics of the sewer system.

- MH 532-03-016 is directly upstream of a double barrel 2x16” siphon constructed between MH 532-03-018 and MH 532-03-028 to avoid the LA County Flood Control Channel. This siphon has a rectangular airline that is 10”x30”.

- MH 532-03-005 on Pacific Coast Highway was selected because it is 2 reaches upstream of the above mentioned siphon and also because of a sudden change in its alignment.

- MH 532-03-029 was selected because at this location two sewer lines are converging: 42” pipe at the slope of 0.0005 and 24” pipe at the slope of 0.0028. The 42” downstream of this maintenance hole has a slope of 0.0009 which results in more than 60% reduction in slope.

- MH 533-14-072 with a slope reduction from 0.0114 to 0.0018 was selected but the MH is inaccessible in the City of Santa Monica.

- MH 533-14-037 was selected because two sewer lines are converging: 36” pipe at a slope of 0.0038 and 30” pipe at a slope of 0.0018 flowing into one 48” pipe at a slope of 0.0012. This MH was also selected because of downstream slope reduction of more than 60%.

- Due to MHs 533-14-072 and 533-14-037 being inaccessible, MH 533-14-073 was selected as an alternate location.

- 561-11-066 was selected because two sewer lines are converging: 66” pipe at a slope of 0.0007 and 18” pipe at a slope of 0.0704 into a 60” x 66” box pipe at a slope of 0.0007.

- 562-08-041 was selected because of significant slope reduction: 54” pipe at a slope of 0.0033 to 72” pipe at a slope of 0.0007

The H_2S measuring equipment was not available due to calibration service.

Table 12.1.1
Monitored Locations – Venice/Westchester Area (CIS)
December 9, 2004

Structure Number	Location	Size (in)	Selection Rational	Time	Instant. Pressure (in. w.c.)
532-03-005	PCH	30	Change in alignment & upstream of Entrada siphon	10:30 am	+0.01
532-03-016	PCH / Entrada Dr	30	Entrada/PCH siphon	10:45 am	+0.01
532-03-029	PCH	42	Slope Reduction Pipe Converging	11:15 am	0.00
533-14-072	Main St (City of Santa Monica)	30	Slope Reduction	N/A	Inaccessible (Covered by Asphalt)
533-14-073	Main St (City of Santa Monica)	36	Alternate of MH 533-14-037 and 072	11:40 am	0.00
533-14-037	Main St	36	Slope Reduction Pipe Converging	N/A	Inaccessible (Inner plate)
561-11-066	Via Dolce R/W	66	At Venice Pump Station	12:15 pm	0.00
562-08-041	Vista Del Mar	54	Slope Reduction U/S of Hyperion	1:00 pm	+0.03
563-13-039	Vista Del Mar	72	Flat Slope U/S of Hyperion	1:15 pm	+0.03

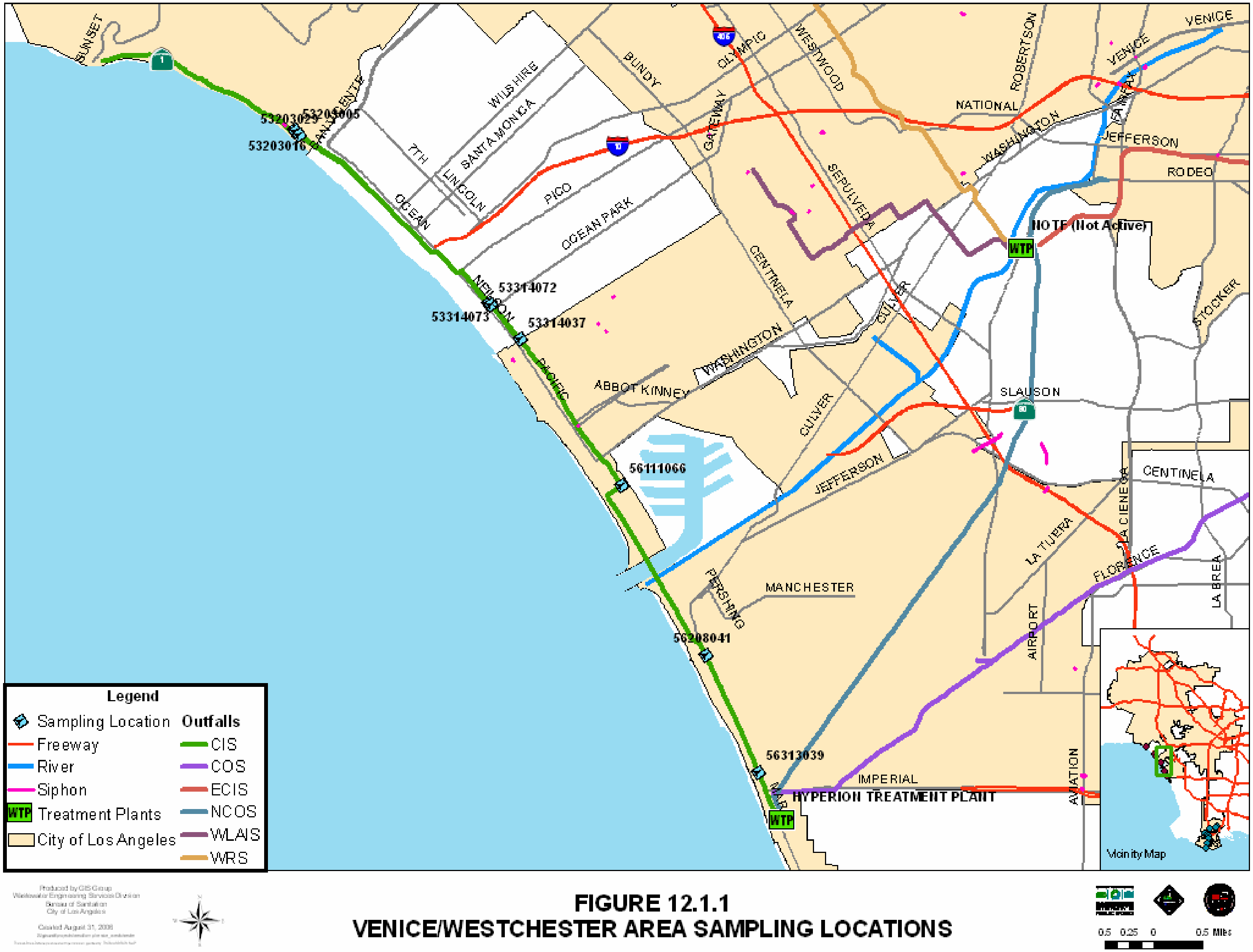


FIGURE 12.1.1
VENICE/WESTCHESTER AREA SAMPLING LOCATIONS

OBSERVATION/ANALYSIS

The instantaneous pressure test was conducted on December 9, 2004. The test indicated that sewer air pressure in this area is generally near atmospheric level. After reviewing the historical odor complaint data between March 2003 and January 2005, there were only two complaints due to ventilation issues possibly because of the pumping plant nearby. Sewer odor is not an issue in this area.

RECOMMENDATION

Testing didn't indicate that pressure would be an issue in the system. It is recommended that pressure and H_2S levels be re-tested every 3 years to ensure the timing in address the odor issue should it occur.

12.2 Baldwin Hills Wilshire
WHIS – LCIS

INTRODUCTION

Wilshire-Hollywood Interceptor Sewer (WHIS) serves the area east and south of the Hollywood area. The WHIS was constructed in the early to mid 1970s in order to intercept wastewater from trunk sewers in the Hollywood area and convey these flows 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 and reinforced concrete lined with PVC.

La Cienega Interceptor Sewer (LCIS) serves West Hollywood and the area that lies roughly between West Hollywood and the Baldwin Hills. It was constructed in the 1920s with circular and semi-elliptical reinforced concrete pipe ranging in size from 27 inches in diameter to 63 inches high in the semi-elliptical sections. The LCIS is slightly greater than 6 miles long and outlets to the NOS which then are diverted to the NORS.

TEST LOCATIONS

Table 12.2.1 shows the list of manholes to be monitored on the WHIS, LCIS, and LCSFVRS.
Figure 12.2.1 for a map of the approximate locations of monitors on this reach of sewer.

Locations were chosen for air pressure testing along LCIS, WHIS, and LCSFVRS based on several factors that can create the odor-prone system. These physical characteristics include the following:

- MH 492-08-066 (LCIS) has a slope reduction from 2.12% to 0.92%.
- MH 492-11-038 (LCIS) has a slope reduction from 1.15% to 0.65%.
- MH 492-14-042 (LCIS) has a slope reduction from 1.32% to 0.36%.
- MH 518-10-205 (LCIS) is the inlet of a siphon with 2-33" pipes and no airline to convey the gas. The approach conduit is a 39" concrete SE pipe (CCTV tape for this pipe should be viewed for possible corrosion).
- MH 535-02-081 (LCIS) is part of pipe segments with a slope of 0.07%.
- MH 518-10-199 (LCIS) is upstream to MH 518-14-004 that is a siphon with a 45" RCP and a 36" airline. There are two approach conduits, one is a 39" brick pipe and the other is a 24" primary line. The pipe downstream to the siphon is 63" brick with a slope of 0.06%.
- MH 493-10-096 (WHIS) has slope reduction from 1.0% to 0.90%.
- MH 493-14-113 (WHIS) has slope reduction from 1.17% to 0.82%.
- MH 517-02-186 (WHIS) was selected due to odor complaints.
- MH 518-12-028 (WHIS) has slope reduction from 1.44% to 0.35%.

- MH 518-14-122 (LCIS) is a 63” SE concrete pipe that also has a slope reduction from 0.09% to 0.07%.
- MH 518-14-021 (WHIS) is upstream to LCSFVRS connection.
- MH 518-14-134 (LCSFVRS) is a location selected for the Fan Test. This pipe is 99”, SE RCP with a slope of 0.0008.
- MH 535-02-089 (LCSFVRS/NOS) was also selected for the Fan Test. This pipe is 99”, SE RCP with a slope of 0.0008.
- MH 517-05-210 is one reach downstream to a MH that has a slope reduction from 0.21% to 0.07%.
- MH 517-09-154 is a 30” tributary line that flows into WHIS.

Table 12.2.1
Monitoring Locations (May 11, 2005)

Structure Number	Location	Selection Rational	System	Pressure wc	H2S ppm
492-08-066	Melrose Ave. & Detroit St.	Slope Reduction	LCIS	+0.07	0.00
492-11-038	Beverly Bl & Orange	Slope Reduction	LCIS	0.00	0.00
492-14-042	Sweetzer and Maryland	Slope Reduction	LCIS	0.00	0.00
518-10-205	Stearns Dr & Sawyer	Siphon Pressure Effect	LCIS	0.00	0.00
535-02-081	Rodeo Rd. @ Jefferson Blvd.	Flat Slope	LCIS	+0.01	6.00
518-10-199	Burchard Av & Venice	Siphon Pressure Effect	LCIS	+0.01	0.00
493-10-096	Norton Av & 1st St	Slope Reduction	WHIS	0.00	0.00
493-14-113	Norton Av & 6th St	Slope Reduction	WHIS	0.00	0.00
517-02-186	Olympic Bl e/o Crenshaw	Odor Complaints	WHIS	0.00	0.00
518-12-028	Redondo Bl s/o Rockford	Slope Reduction	WHIS	0.00	0.00
518-14-122	Fairfax Av & Smiley	Flat Slope	LCIS	+0.01	0.00
518-14-021	Washington Blvd. @ Thurman Ave.	u/s of LCSFVRS connection	WHIS	0.00	0.00

Structure Number	Location	Selection Rational	System	Pressure wc	H2S ppm
518-14-134	Fairfax s/o Blackwelder	Fan Test Location	LCSFVRS	0.00	0.00
535-02-089	Rodeo Rd	Fan Test Location	LCSFVRS and NOS	0.00	0.00
517-05-210	Venice Blvd. @ San Vicente Blvd.	Slope Reduction	WHIS	+0.01	0.00
517-09-154	Venice Blvd. @ Crenshaw Blvd.	Tributary Line	Hollywood Main Replacement	0.00	0.00

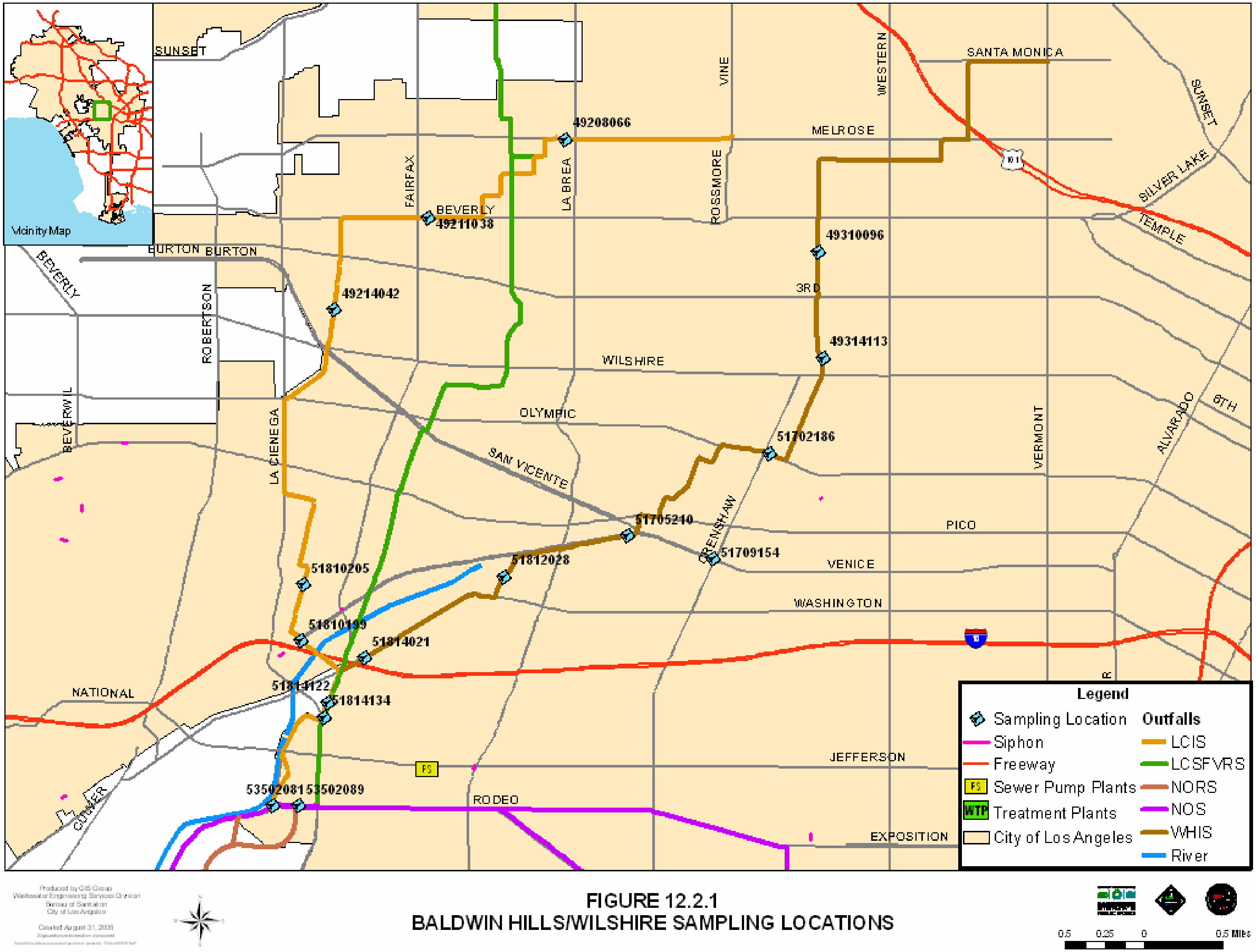


FIGURE 12.2.1
BALDWIN HILLS/WILSHIRE SAMPLING LOCATIONS

OBSERVATION/ANALYSIS

LCIS Rehab from Blackwelder to Melrose (CIP/Project # C177) – Project proposes to rehabilitate approximately 5.5 miles of the LCIS from the upstream end, near Melrose, to La Cienega Bl. and Fairfax Ave., Blackwelder Diversion Structure. The existing sewer was built in the 1920's, ranges from 27-inch to 63-inch. Majority is semi-elliptical concrete pipe with clay tile lining blocks and some are semi-elliptical brick lines concrete pipes. In addition, two siphons will be cleaned and rehabilitated if needed, and a section may need to be replaced pending hydraulic evaluations.

LCIS Rehab Rodeo to Blackwelder (CIP/Project # C072) – This project will construct a diversion structure in the intersection of Fairfax Ave and La Cienega Bl. Between the La Cienega Interceptor Sewer (LCIS) and the La Cienega San Fernando Valley Relief Sewer (LCSFVRS) and rehabilitate a 4000-foot section of the LCIS between Fairfax and Jefferson. The LCIS is a 63" semi-elliptical non-reinforced concrete pipe with tile liners and was built circa 1925. This reach of the sewer runs primarily in an easement west of La Cienega Bl. and east of Ballona Creek between Jefferson and the intersection of Fairfax Ave. and La Cienega Bl.

The instantaneous pressure and hydrogen sulfide level tests were conducted May 11, 2005. The instantaneous tests indicate there are no significant positive pressures or hydrogen sulfide in the area.

Historical odor complaint data between March 2003 and January 2005 was reviewed. Even though there were some odor complaints in the area, it was determined, due to very little positive sewer pressure and insignificant H2S level, that the LCIS and WHIS were not the cause of these complaints.

RECOMMENDATION

- For the LCIS sewer at Melrose Ave/Detroit St where an instantaneous pressure measurement showed positive pressure in the collection system, it is recommended that the H_2S level, the pressure level and the odor complaints be monitored on a semi-annual basis so that necessary action can be taken in a timely manner.

- Testing didn't indicate that pressure would be an issue at other testing locations in the Baldwin Hills/Wilshire area. It is recommended that pressure and H_2S levels be re-tested every 3 years to ensure the timing in address the odor issue should it occur.

12.3 Harbor Area

INTRODUCTION

This report provides a discussion and analysis of the sewer air pressure test data conducted for the Harbor Area Primary Sewer System on February of 2005. There are four interceptor sewer systems in the TISA that conveys the wastewater generated in the Harbor area to the Terminal Island Treatment Plant for treatment and disposal. The four interceptor sewer systems are named after the respective force main 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 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 LOCATIONS

Table 12.3.1 shows the list of manholes to be monitored in the Harbor Area sewer system.
Figure 12.3.1 for a map of the approximate locations of monitors in the system.

Locations were chosen for air pressure testing along these primary lines based on several factors that can create the odor-prone system. These physical characteristics include the following:

- Reach 613-13-048 to 613-13-023 has a slope of 0.08% (42”). There is a slope reduction at this point where upstream the slope is at 0.52%. Also MH613-13-023 is a drop maintenance hole that could create higher pressure due to increased flow turbulence.

- MH 619-08-038 is upstream of a siphon with 2 – 24” pipes and an airline sized at 18”. The double barrel siphon was constructed to go under the existing reinforced concrete 9’W x 11’H Storm drain. Mainline sewer upstream of this siphon is 36” in diameter

- MH 613-11-123 is upstream of a siphon with 2 -24” lines. Approach conduit is 36”. This siphon has an 18”airline according to the WYE-030213NW. D-27844 could not be retrieved.

- MH 613-11-112 is upstream to a pump station.

- MH 619-08-083 has a slope reduction from 0.15% to 0.07 %.

- MH 620-05-018 has a slope reduction from 0.32% to 0.28%. Also this MH is upstream to a location where several lines converge.

- MH 620-09-041 is upstream to a diversion structure.

- MH 620-13-032 is one reach upstream to a double barrel siphon, MH 620-13-009, consisting of a lower 20”pipe and a higher 30”pipe that was originally selected for test sampling. This siphon was constructed to covey the flow under the Main Channel in the Harbor area. The approaching conduit is 33”. The length of this siphon is 1420 feet and it does not have an airline, but the higher placed pipe could act as an airline during low flow periods. Because MH 620-13-032 was not accessible, MH 620-13-030 was selected instead, which is located two reaches upstream.

- MH 625-16-010 has a slope reduction from 4.15% to 0.4%.

- MH 624-01-114 has a slope reduction from 0.2% to 0.08%.

Table 12.3.1
Monitored Locations - Harbor Primary System
February 3, 2005

Structure Number	Location	Size (in)	Justification	Time	Instant Pressure (in. - wc)	H2S (ppm)
613-13-048	B St	24”	Slope Reduction	10:00am	0.0	0.0
619-08-038	Wilmington & San Pedro	36”	Siphon Pressure Effect	10:30am	+0.001	6.0
613-11-123	Alameda St	24”	Siphon Pressure Effect	9:30am	0.0	0.0
613-11-112	McFarland Ave R/W	30”	Pump Station	9:45am	+0.002	0.0
619-08-083	Channel St	33”	Slope Reduction	11:00am	-0.004	0.0
620-05-018	Pacific Ave	10”	Slope Reduction	11:30am	-0.02	0.0
620-09-041	Harbor Bl	21”	Diversion Structure	11:45am	0.0	0.0
620-13-030	Harbor Bl R/W	33”	Siphon Pressure Effect	11:50am	0.0	0.0
625-16-010	Pacific Ave	18”	Slope Reduction	1:15pm	0.0	0.0
624-01-114	Crescent Ave R/W	24”	Slope Reduction	12:15pm	-0.001	0.0

Produced by GIS Group
Wastewater Engineering Services Division
Bureau of Sanitation
City of Los Angeles

Created August 31, 2006

0.5 0.25 0 0.5 Miles

FIGURE 12.3.1
HARBOR AREA SAMPLING LOCATIONS

OBSERVATION/ANALYSIS

The instantaneous pressure and hydrogen sulfide level tests were conducted on February 3, 2005. The instantaneous test indicates that there is no high pressure in the area. The H2S tests indicate that the hydrogen sulfide level in this area is insignificant.

Historical odor complaint data between March 2003 and January 2005 was reviewed and sewer odor is not an issue in this area.

RECOMMENDATION

Testing didn't indicate that pressure would be an issue in the system. It is recommended that pressure and H_2S levels be re-tested every 3 years to ensure the timing in address the odor issue should it occur.

12.4 West Valley Area
AVORS/ VORS/ NOS/ EVIS/EVRS

INTRODUCTION

This report provides a discussion and analysis of the sewer air pressure test conducted for the West San Fernando Valley Area Sewer System on November of 2004. Wastewater generated in the western, northwestern, southwestern, and northeastern portions of the San Fernando Valley is conveyed to the 4 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). Treated effluent from the TWRP that is not reclaimed is discharged to the Los Angeles River while the solids are put back into the downstream AVORS and the East Valley Relief Sewer (EVRS) to be conveyed to Hyperion for treatment via LCSFVRS and NOS, East Branch.

TEST LOCATIONS

Table 12.4.1 shows the list of maintenance holes to be monitored in the West Fernando Valley Area Sewer System which consist of various outfalls.

Figure 12.4.1 is a map of the approximate locations of monitors in the area.

Following a detailed study of the physical characteristics of the AVORS, VORS, NOS, EVRS and EVIS, locations were chosen for air pressure testing. Each MH was chosen based on either the frequency of odor complaints in the area and/or the physical characteristics of the sewer.

- MH 396-14-176 (VORS) was selected because it is upstream to a siphon. The flow from the 27” mainline pipe enters into a siphon that has 2-20” and 1-10” pipes with a 12” airline. The flow from the siphon then exits to the 30” pipe with a slope of 0.0028. MH 396-15-168 (VORS) was also selected to monitor the pipe downstream of the siphon.

- MHs 430-02-122 (AVORS) and 430-02-139 (AVORS) are upstream to a siphon. The flow from the 66” mainline pipe at the slope of 0.0030 enters into a siphon that has 2-39” pipes with a 32” airline. The flow from the conduit then exits to a 63” with a slope of 0.0050.

- MH 430-03-161(AVORS) is 90” with a slope of 0.1%.

- MH 430-04-094 (VORS) is a 45” with a slope of 0.1% that is upstream to a diversion structure (430-04-095).

- MH 429-02-209 (EVIS) is a 69” with a slope of 0.14% located at a diversion structure.

- MH 429-03-090 (EVIS) is a 69” with a slope of 0.13% is located downstream to a primary line diversion structure at Kester and Kittridge, and upstream to a section with a change of alignment.

- MH 429-11-079 (VORS) has a slope reduction from 0.0032 (42”) to 0.0016 (45”).

- MH 429-12-156 on the NOS has a pipe reduction from upstream of 45” to downstream of 36”.

- MH 429-16-142 (EVRS) has a slope reduction from upstream of 0.57% (42”) to 0.15% (54”).

In addition to the above selected locations, the City has periodically monitored a number of stations with known odor complaints, outfall and interceptor sewers, known pressure zones, areas of turbulence, sewer system with significant slope changes and sewer reaches with long detention times, such as flat, low velocity sewers. Monitoring is conducted at least semi-annually at the designated points to gage the seasonal variation in odor generation and to monitor the system to take necessary action in a timely manner. The data collected from the periodic monitored stations in the W. Valley area is shown in table 12.4.2.

FIGURE 12.4.1
WEST VALLEY AREA SAMPLING LOCATIONS

TABLE 12.4.1 AVORS/VORS/NOS/EVIS/EVRS MONITORING DATA					
Structure Number	**Location**	**Selection Rational**	**Date & Time**	**Inst. Pressure (in – w.c.)**	**System**
396-14-176	Vanowen St @ Mason Av	U/S Siphon	11/19/04 @ 9:10 am	-0.001	VORS
396-15-168	20331 Vanowen St	D/S Siphon	11/19/04 @9.20 am	-0.00	VORS
430-02-122	Victory @ Etiwanda Av	Upstream of Etiwanda Siphon	11/19/04 @9:30 am	+0.02	AVORS
430-02-139	Victory @ E/O Etiwanda Av	U/S of Etiwanda Siphon	11/19/04@ 9.40 am	+0.04	AVORS
430-04-094	Victory Bl	U/S to Diversion Structure	11/19/04 @10:15 am	0.00	VORS
429-02-209	Victory Bl @ Haskell Av	U/S to Diversion Structure	11/19/04 @ 10:30 am	+0.02	EVIS
429-03-090	Kittridge St @ Kester	Special Junction Structure	11/19/04 @11:00 am	0.00	EVIS
430-03-161	Victory between Bertrand & Enfield	Flow Gauging Point	11/19/04 @10:00am	-0.00	AVORS
429-11-079	Burbank Bl e/o Sepulveda	Slope Change	11/19/04 @11:30 am	+0.15	VORS
429-12-154	Burbank Bl @ Kester Av	Pipe Reduction	11/19/04 @ 11:45 am	+0.05	VORS
429-12-156	Burbank Bl.@ Kester	Pipe Reduction	11/19/04 @ 12:00 pm	+0.03	NOS
429-16-142	Magnolia Bl @ Willis Av	Slope Change	11/19/04 @12:30 pm	+0.01	EVRS

TABLE 12.4.2 WEST VALLEY AREA - ADDITIONAL MONITORING DATA					
Structure Number	**Location**	**Date & Time**	**Ave H2S (ppm)**	**Instantaneous Pressure (in. – w.c.)**	**System**
429-16-065	Kester Av N/O Magnolia Bl	1/28 –2/4/05	0.2	-0.01	NOS
		4/27 – 5/4/05	0.4	0.0	
428-13-076	Magnolia and Tyrone	6/11 – 6/19/02	3.5	N/A	NOS
429-07-106	Sepulveda Bl S/O Oxnard St	1/28- 2/4/05	3.5	-0.07	AVORS
		4/27 – 5/4/05	30.9	-0.19	
428-13-193	Tyrone Av and Addison St	1/28/2005	0.2	+0.05	EVRS
		4/27 – 5/4/05	6.2	+0.08	

OBSERVATION/ANALYSIS

In general, the pressure results ranged between negative and close-to-atmospheric pressure. See Tables 12.4.1 and 12.4.2. However, the locations with the highest pressure will be monitored and more data will be available.

MH 429-12-156 on the NOS at the intersection of Burbank and Kester is downstream of the system where there are 2 incoming pipes (45” NOS at the slope of 0.0049 and the 30” primary sewer at the slope of 0.1388) merged. The pipe size was also reduced from 45” to 36”. Some slightly positive pressure was measured at this location.

MH 429-11-079 on the VORS at the intersection of Burbank and Sepulveda Blvd has the slope reduction from 0.0032 to 0.0016 and experienced a measured instantaneous positive pressure of 0.15” w.c. Due to the high pressure at this location, information on flow split and flow direction were reviewed in detail. Flow gauging at LA 06 (429-16-073) downstream of this location showed the peak flow at 45% full. It is probable that the positive pressure in Burbank Sepulveda area is mainly from the sudden slope reduction. There were 3 odor complaints in 2004 and one in 2003 that were caused by sewer ventilation around this area. It is recommended that the location at Burbank Blvd east of Sepulveda be monitored continuously for high pressure and odor complaints to identify whether this area is an Odor Sewer odor hot-spot.

Structure Number	Date	H2S (ppm)	Pressure	d/D
429-11-079	11/19/04	Unavailable	+0.15	
	4/27 to 5/4/05	25	+0.04	
	05/23/05	19.2	+0.40	
	8/30 to 9/6/05	0	+0.02	
429-11-086	01/27/04			0.45 (max) 0.33 (min)

RECOMMENDATIONS

- For the area along Burbank e/o Sepulveda where an instantaneous pressure measurement showed positive pressure in the collection system, it is recommended that the H_2S level, the pressure level and the odor complaints be monitored on a semi-annual basis so that necessary action can be taken in a timely manner.

- Testing didn't indicate that pressure would be an issue at other testing locations in the West Valley area. It is recommended that pressure and H_2S levels be re-tested every 3 years to ensure the timing in address the odor issue should it occur.

12.5 East Los Angeles Boyle Heights Area

INTRODUCTION
This report provides a discussion and analysis of the sewer air pressure test data conducted for the East Los Angeles Boyle Heights Area Sewer System on April 2005. The North Outfall Sewer is the outfall sewer in this study area to convey the sewer from LA-Glendale Water Reclamation Plant (LAG) to Hyperion Treatment Plant.

TEST LOCATIONS

Table 12.5.1 shows the list of manholes to be monitored in the East Los Angles Boyle Heights area, mostly on the NOS between LAG Treatment Plant and San Pedro.

Figure 12.5.1 for a map of the approximate locations of monitors on this reach of sewer.

Locations were chosen for air pressure testing along the NOS starting from LAG Treatment Plant and ending in the area where NOS and L A river meet. Locations were chosen based on odor complaints in the area as well as the physical characteristics of the sewer system.

- MH 468-02-125 (52”) was selected because of odor complaint in the area.
- MH 468-02-048 has a slope reduction from 0.28% to 0.12%. Pipe diameters are both 52.0”.
- MH 468-07-096 (42”) was selected because of odor complaint.
- MH 468-11-026 (42”) is a standard monitoring location.
- MH 468-11-045 is the inlet to a flow split of two 48” pipes with a slope of 0.0026 and 0.0016 that comes together at MH 468-11-046, which is also the entry to a double barrel siphon with a 36” and a 30” diameter. This siphon does not have an airline.
- MH 494-04-091 has a slope reduction from 0.49% to 0.28%, both at 48”.
- MH 495-05-035 is upstream to a location with a slope reduction from 0.40% to 0.12%, both with a diameter of 48”.
- MH 515-05-001is one reach upstream to a siphon MH 515-05-206 that has 2-42” pipes and a 36” airline. The approach conduit is 45”.
- MH 515-05-004 has a slope reduction from 0.71% (47”) to 0.25% (55”).
- MH 515-09-154 has a slope reduction from 0.57% (48”) to 0.15% (60”).
- MH 515-13-125 (60”) is upstream to a Diversion Structure MH 515-13-132.
- MH 515-09-114 is a primary line that splits into a 33” that is upstream to a siphon with 2-20” pipes and no airline, and the other leg is a 30” that empties into NOS at MH 515-09-115.
- MH 515-09-152 is the above mentioned siphon in the primary system.

- MH 515-13-003 is two reaches upstream to a siphon MH 538-01-114. There is also a change in alignment in this segment.
- MH 538-01-114 is the inlet of a siphon that is a 54” RCP with no airline. The approach conduit is a 60” concrete pipe.
- MH 515-01-125 is on a primary line upstream to a siphon MH 538-01-114. This reach is 21” with a slope of 0.0072.

Table 12.5.1
Monitoring Locations

Structure Number	Location	Justification	System	Pressure	H2S (ppm)
468-02-125	Veselich Ave R/W	Odor Complaint	NOS	+0.01	2
468-02-048	Glenfeliz Blvd	Slope Reduction	NOS	+0.01	1
468-07-096	Hollydale Dr	Odor Complaint	NOS	0	2
468-11-026	Hollydale & Petit Ct.	Standard Monitoring	NOS	+0.01	2
468-11-045	Fletcher Dr R/W	Siphon Pressure Effect	NOS	No Access	No Access
494-04-091	Blake Ave	Slope Reduction	NOS	0	7
495-05-035	Blake Ave @ Barclay St.	Slope Reduction	NOS	+0.04	7
515-05-001	Mission Rd	Siphon Pressure Effect	NOS	*Low +2.49 High +4.29	No Reading
515-05-004	Mission Rd	Slope Reduction	NOS	-0.13	10
515-09-154	Mission Rd	Slope Reduction	NOS	+0.02	7
515-13-125	Mission Rd	U/S to Diversion Structure	NOS	No Access	No Access
515-09-114	Mission Rd	Siphon Pressure Effect	Primary	+0.02	7
515-09-152	Mission Rd	Siphon Pressure Effect	Primary	No Access	No Access
515-13-003	Mission Rd	Siphon Pressure Effect NOS u/s Enterprise Siphon	NOS	+0.12	3
538-01-114	Damon St	Siphon Pressure Effect	NOS	No Access	No Access
538-01-125	Enterprise R/W	Siphon Pressure Effect	Primary	No Access	No Access

***** Please note that these pressure readings were uncharacteristically high due to equipment malfunction. The instantaneous pressures at this location are between 0.19” to 0.28” wc.

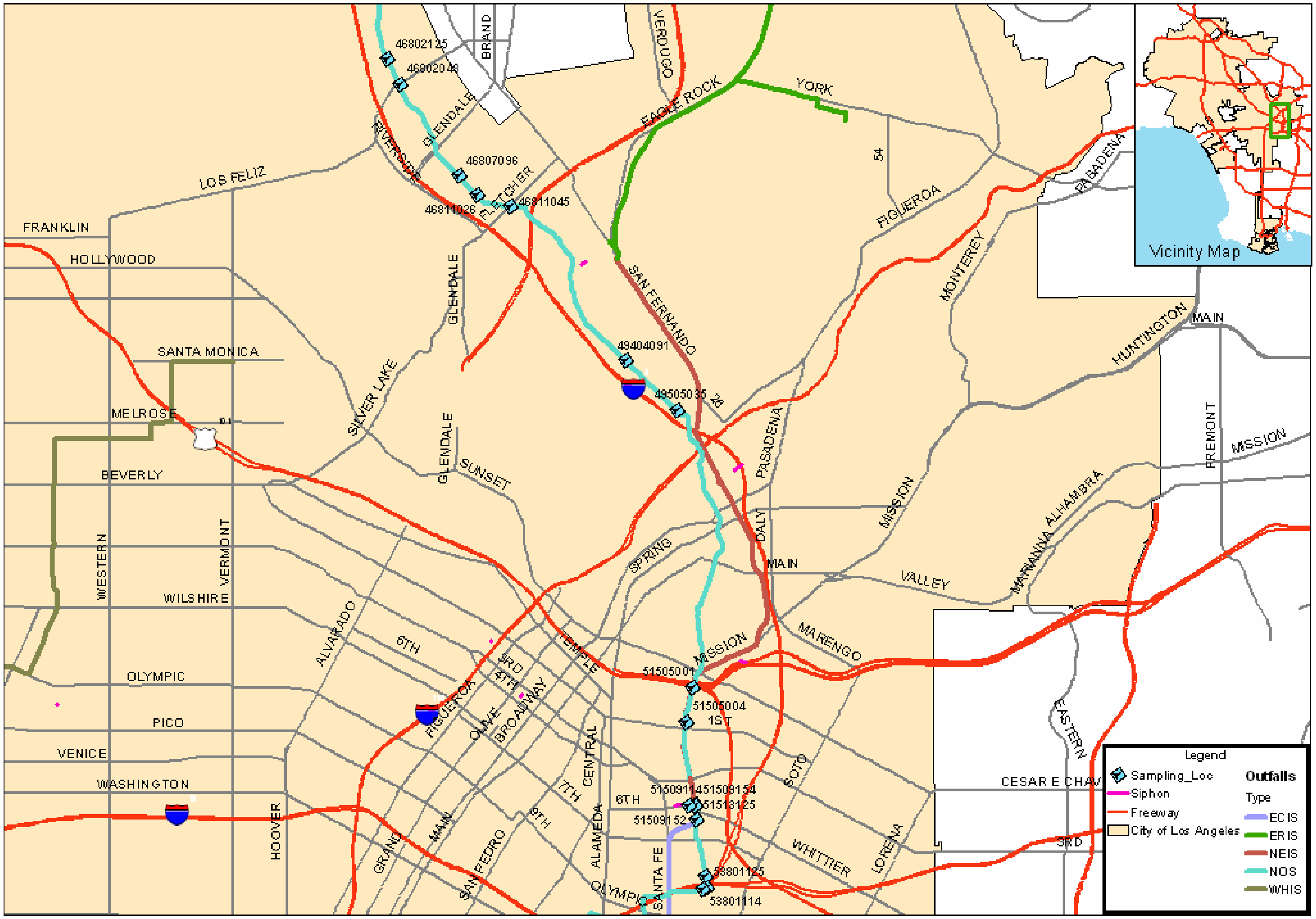


FIGURE 12.5.1
EAST LOS ANGELES/BOYLE HEIGHTS SAMPLING LOCATIONS

Produced by GIS Group
Wastewater Engineering Services Division
Bureau of Sanitation
City of Los Angeles
Created August 31, 2006

0.6 0.3 0 0.6 Miles

OBSERVATION/ANALYSIS

This test was conducted in April 2005 with a temperature of ±70ºF, no wind and sunny. The historical d/D data recorded show an average of approximately half full flow through the entire East Los Angeles segment of NOS. According to the pressure test results, the system appears to be under slight positive pressure for the most part. It is especially high directly upstream to the two siphons on the NOS. This high pressure indicates that there is no forward air movement to push the gases through the 36” airline; instead the gases are blocked at this location where the rise in pressure pushes them back upstream of the system. The only negative pressure reading was taken at the outlet of this siphon. Again the pressure starts to pick up gradually as the system moves down to the next siphon which has no airline to convey the gases.

RECOMMENDATIONS

- Recommend the construction of Odor Control Hollydale Sewer Project building 8-inch diameter sewer in Hollydale Drive, parallel to the existing 42-inch diameter North Outfall Sewer (NOS) for house connections be connected to the new 8-inch line. (IMPLEMENTED – project scope of work and budget were approved)

- Diversions of flow to ECIS and future diversion to the NEIS at the Humboldt Shaft site will significantly reduce the flow in the NOS and therefore will further reduce the pressure in the NOS. It is recommended that after all flow diverted to the NEIS, the pressure and hydrogen level in NOS be monitored and re-evaluate under the new flow scenarios.

13.0 IMPLEMENTATION PLAN

To meet the 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, sewer construction and repair, and on-going monitoring of sewer air pressure and H2S concentration.

Continuous pressure testing equipment will be used to re-test areas of concern which have thus far only been tested with instantaneous, spot testing equipment in order to gather more accurate and more comprehensive pressure data of the sewer system.

One recent development that is already underway is the NORS Siphon Fan Test that will help determine the relationship between the NORS siphon and pressure upstream in the Baldwin Hills area. It will also help in understanding the air flow dynamics in and around the NORS siphon (a major sewer siphon with airlines) and the sewer system in general and in determining the solution for the existing odor issues in the area, including the need for an ATF on the NORS.

The most significant recommendation is the ATF Study that is re-evaluating the ATF implementation program in light of recent experiences and test results encountered when the scrubbers are turned off. For example, at 23rd and San Pedro, odor complaints began when the ECIS was put into use and the scrubber went online. The complaints ended when the scrubber's fans were turned off and the sewer air was allowed to vent passively through the scrubber's carbon. This indicates that the carbon can not adequately filter odors from gas that is forced through quickly with a fan but that it is able to filter odors from air that moves through passively and therefore more slowly. The scrubbers have since been turned off and operate in a passive mode to minimize odor complaints.

The use of air scrubbers at various locations in the collection system has helped reduce the release of odors in known problem areas. The diversion of flow from the NOS to the ECIS at 23rd and San Pedro and at Mission & Jesse in August 2004 and an additional diversion proposed to the NEIS at the Humboldt Shaft site in 2006/07 will significantly reduce the flow in the NOS. This will most likely decrease the pressure within the NOS and may defer any immediate need for pressure relief devices such as scrubbers or ATFs. As the result of the flow from NOS to the NEIS, less flow from the NOS will be diverted at Mission & Jesse, at least until the rehabilitation of the NOS, tentatively scheduled for completion in 2012.

Therefore, the necessity for the ATFs at the 23rd & San Pedro, Mission & Jesse, Humboldt, and Richmond sites as well as when each would be needed will be assessed in the ATF study. In addition, the scope of the ATF Study should include odor testing and laboratory analysis, additional pressure testing at key locations in the collection system, and analysis of impacts to upcoming capital improvement sewer projects in order to ensure that the solutions proposed, and ultimately constructed, are the optimal solution and the best use of funds for mitigating sewer odors.

The implementation plan is developed with the intention to provide immediate needs while satisfying long-term requirements. Table 13.1 presents the implementation plan for the various odor control projects and programs either already underway or recommended by this master plan.

Table 13.2 presents project cost data obtained from the WCIP Project Description and 10-Year Expenditure Plan 2006/07 – 2015/16.

It is recommended that the Sewer Odor Master Plan be updated periodically – preferably on an annual basis - to assure that odor control strategies/measures are periodically challenged, solutions remain proactive and technologies are current and effective.

TABLE 13.1
ODOR CONTROL IMPLEMENTATION PLAN

	Short-term Plan	Intermediate Plan	Long-term Plan
Studio City/ North Hollywood EVRS/VORS	- Scrubber at Woodbridge & Radford - Tillman chemical addition	Monitor pressure & H2S	Relief Sewer - Proposed Glendale Burbank Interceptor Sewer
The Maze Area South Los Angeles	- Routine cleaning of Florence Ave Sewer & 74th St Sewer to reduce H2S conc. in S Maze - Conduct continuous air pressure & H2S testing in COS - Review ATF program	- Effective chemical injection program - Possible routine cleaning of COS	Potential ATFs
Sierra Bonita/ W Hollywood VSF/LCSFVRS	- 10,000 cfm scrubbers at Sierra Bonita & Genesee Siphon Site - Chemical Injection at Tillman - On-going Monitoring	- Effective chemical injection location - Conduct continuous sewer air pressure testing - Flow diversion from Forman Ave to NOS	- Relief Sewer - GBIS - Forman 8" Sewer - Analyze airflow dynamic
W Los Angeles WLAIS/WRS	- 10,000 cfm scrubber - On-going Monitoring - Construct additional maintenance holes - Clean WLAIS then determine needs	- Conduct continuous sewer air pressure testing - Possible chemical injection	Possible need for a relief sewer project
West Valley Area	Monitor area along Burbank e/o Sepulveda for sewer odor complaints, high pressure & H2S every 2 years	Monitor overall every 3 years	TBD
East LA/ Boyle Heights Area	Monitor after all diversions from NOS are complete	- Hollydale sewer - Monitor every 3 years - Re-evaluate needs of the system	TBD

	Short-term Plan	**Intermediate Plan**	**Long-term Plan**
Baldwin Hills/ Wilshire Area WHIS/LCIS	Monitor LCIS at Melrose/Detroit intersection every 2 years	Monitor overall every 3 years	TBD
Venice/Westchester Area - CIS	N/A	Monitor every 3 years	TBD
Harbor	N/A	Monitor every 3 years	TBD
NORS Siphon	Fan Test to analyze airflow dynamic	TBD	TBD
Review of ATFs program	Study to determine the ATFs' necessity under upcoming proposed improvement projects.	TBD	TBD
Odor Hotline Outreach	On-going	On-going	On-going

TABLE 13.2
ODOR CONTROL PROJECT/PROGRAM COST

Title	Estimated Cost ($)	Estimated Completion Date
ATF Biotrickling Equipment	10,003,240	06/30/2008
ATF ECIS - 23rd & San Pedro	17,896,420	05/23/2008
ATF ECIS – La Cienega & Jefferson	10,402,880	05/23/2008
ATF ECIS – Mission & Jesse	6,060,260	05/23/2008
ATF NCOS Siphon	17,325,840	05/23/2008
ATF NEIS – Humboldt & SF	9,335,120	03/26/2009
ATF NEIS – Richmond St	7,919,610	03/26/2009
ATF NORS	9,382,700	05/23/2008
Odor Control - Hollydale Sewer	4,191,300	2009/10
Sierra Bonita Scrubber	365,000	2006/07
Woodbridge Scrubber Relocation	355,200	2008/09
Chemical Treatment Application	3,515,000/yr	On-going
14 Scrubbers (Operations & Maintenance)	1,615,000/yr	On-going
Outreach	50,000/yr	On-going
Odor Control – Future	1,000,000/yr	On-going

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

14.0 REFERENCES

1. OCTC, “Analysis of Airflow Dynamics in the Maze and LCSFVRS Sewers,” November 2001.

2. OCTC, “ECIS/NORS/NCOS Fan Test Report,” July 2003.

3. Bowker & Associates, Inc., “Independent Review of the Sewer Odor Control Program for the City of Los Angeles,” January 2004.

4. Bureau of Engineering Sewer Design Manual, City of Los Angeles