LOS ANGELES COUNTY SANITATION DISTRICTS
Converting Waste Into Resources

Robert C. Ferrante
Chief Engineer and General Manager

1955 Workman Mill Road, Whittier, CA 90601-1400
Mailing Address: P.O. Box 4998, Whittier, CA 90607-4998
(562) 699-7411 • www.lacsd.org

May 11, 2022

Boards of Directors
County Sanitation Districts
of Los Angeles County

Directors:

Audit Report for December 30, 2021
Sewer Collapse and Wastewater Spill in the City of Carson

We previously reported to the Board about the sanitary sewer overflow (SSO) that occurred on Thursday, December 30, 2021, from the Sanitation Districts' 216th Street Relief Trunk Sewer in the City of Carson. The SSO was the result of the collapse of a sewer that we were in the process of replacing and that based on recent inspection did not appear to pose an imminent threat. The collapse occurred during a period of heavy rain with very high flow in the sewer and resulted in a complete flow blockage. Sewage backed up and spilled out of sewer manholes located in a residential street and reached receiving waters, including the Dominguez Channel. Sanitation Districts' staff and contractors mobilized quickly to bypass flow around the collapsed sewer and repair it, while also working to minimize impact to residents and the environment. We conducted receiving water monitoring and found that although local beaches were closed due to rain advisories, onshore and offshore stations met State Ocean Plan requirements after December 31st at all locations except Inner Cabrillo Beach and the data also indicates that the SSO did not impact the potential for odor formation in the Dominguez Channel, which was identified as a potential concern at the time of the SSO. We expedited re-inspection and subsequent repair of additional sewer reaches in the vicinity of the collapse and retained the services of GHD, a 3rd party engineering consulting firm, to perform an independent external audit of the SSO to review the cause and response as well as to conduct a programmatic review of the Sanitation Districts' sewer maintenance and inspection programs and Capital Improvement Program relative to industry standards. The purpose of this letter is to transmit the 3rd party independent review report and summarize the Sanitation Districts' commitment to implementing the report's recommendations.

External Audit of SSO

In January, the Sanitation Districts retained the services of GHD to perform an independent external audit including an investigation of the physical causes of the sewer failure, the history of inspections and plans for replacement of the sewer line, and the Sanitation Districts' response to the spill. The audit also included a comprehensive review of the Sanitation Districts' sewer maintenance and inspection programs, Capital Improvement Program, and emergency procedures relative to industry standards and other local sewer agencies' practice. Recently, GHD released their independent review report entitled *Audit of Sanitary Sewer Overflow (SSO) in the City of Carson* dated May 4, 2022 (Audit, attached), which concluded:

1. A sewer and manhole collapse resulted in a blockage of flow in the sewer causing the overflow in an upstream sewer. The exact sequence of events and cause of failure cannot be determined, however corrosion of the sewer combined with heavy rains were clearly significant contributing factors.

2. The Sanitation Districts' emergency response was timely, reasonable, and consistent with our established emergency response procedures. The Sanitation Districts made extensive efforts to communicate with affected residents and be responsive to their needs.
3. While the Sanitation Districts' maintenance programs and practices are comparable to those implemented by other similar agencies, improvements to reduce the likelihood of future failures are recommended. These improvements are detailed in the report and include items such as leveraging technology to improve condition assessment and better repair planning and prioritization for the sewers in the worst condition.

Next Steps

As mentioned above, the Sanitation Districts are working to either replace or repair all corroded sewers in the immediate area where the spill occurred. The remaining section of the sewer that failed and caused the overflow will be repaired by Fall 2022. The ongoing construction of the planned replacement sewer for this area is expected to be completed by the end of 2022.

We take our responsibility to protect public health and the environment seriously and have worked diligently to prevent overflows from our collection system, reducing the numbers of these during the past decade to well below the state average. The Audit has identified recommendations for improvements to the management of our collection system and response to emergency SSO events. We are committed to implementing as many of the Audit recommendations as possible in an accelerated fashion and the Sanitation Districts are already implementing many of the recommended changes to our maintenance and rehabilitation programs. For example, we have:

- Reinspected other vulnerable sewers to ensure their safe operation.
- Expedited over $10 million in repairs along the sewer line that failed.
- Purchased new high definition inspection equipment for sewer and sewer manhole inspections.
- Initiated development of a detailed sewer manhole inspection and rehabilitation program.

Many of the recommendations will be implemented by the end of 2022. Other recommendations, by their nature, will take longer, but the Sanitation Districts are committed to implement these expeditiously over the next few years. We will share an annual update on our progress with you to ensure that satisfactory progress is also being made on completing the longer-term implementation items.

I presented the GHD Audit findings at the May 11 Board meeting and will present to the other Boards at their next meeting.

Please contact Mr. Sam Espinoza at (562) 908-4288, extension 2101 or sespinoza@lacsd.org, or contact me at extension 1501 or rferrante@lacsd.org if you have any questions.

Very truly yours,

Robert C. Ferrante

RCF:RLT:pb

Attachment

Audit of Sanitary Sewer Overflow (SSO) in the City of Carson

Los Angeles County Sanitation Districts

4 May 2022

→ **The Power of Commitment**

Disclaimer
• This report was developed for the LA County Sanitation Districts (Districts) for the sole purpose of providing an independent external audit limited to the review of a Sanitary Sewer Overflow (SSO) that occurred on December 30, 2021, along W 212th Street at manholes 721 and 719 in the City of Carson, California. • The contents, including any opinions, conclusions, or recommendations contained in, or which may be implied from, this document must not be relied upon except for the sole purpose of its intended use as an independent external audit for the LA County Sanitation Districts. • This report is not intended in any way to provide a forensic analysis. The contents of the report, any section thereof, any opinions, conclusions, or recommendations contained in, or which may be implied from, this report must not be utilized for any form of forensic analysis. • The report relies on the information available at the time when the audit was conducted to provide opinions and conclusions. GHD reserves the right to at any time, without notice, to modify or retract any part of this report should new information becomes available. • To the maximum extent permitted by law, GHD disclaims any responsibility or liability arising from or in connection with this report.

Executive Summary

The Los Angeles County Sanitation Districts (Districts) are a public agency focused on converting waste into resources including recycled water, energy and recycled materials. Their service area covers approximately 850 square miles, includes 1,431 miles of sewers, and encompasses 78 cities and unincorporated areas of the County with a population of approximately 5.5 million people.

On December 30, 2021, the Districts' 216th Street Relocation Trunk Sewer experienced a critical failure in the City of Carson causing a Sanitary Sewer Overflow (SSO) event that impacted local residents on 212th Street and caused closure of some local beaches.

In response to the overflow, The Districts contracted with GHD to perform an independent external audit of the Carson SSO. The audit includes an investigation into the physical causes of the failure, the history of inspections and plans for replacement of the line, and the Districts' response to the SSO. The audit also includes a programmatic review of the Districts' sewer maintenance and inspection programs, Capital Improvement Program (CIP), build-over approval process, and emergency procedures relative to industry standards and other local sewer agencies, specifically the City of Los Angeles Bureau of Sanitation (LASAN) and Orange County Sanitation District (OC San).

This Report provides the results for the review completed in response to the Districts' request and includes recommendations for improving the Districts' practices and policies. The audit was based on a qualitative review of information provided by the Districts, and some independent calculations. The audit is not intended to be a forensic analysis and is limited by the quality and quantity of available data.

The audit has been broken into four separate Tasks: Task 1 - Physical Cause of Pipe Failure; Task 2 - Emergency Response to the SSO; Task 3 - Sewerage Maintenance Program and Capital Improvement Plan; and Task 4 - Review of New Technology for Detecting/Preventing SSOs. A high-level summary of each audit task is included in the following sections.

Task 1 – Physical Cause of the Pipe Failure

A detailed description of the audit into the physical cause of the failure is included in Section 3 of this report. In summary, the 216th Street Relocation Sewer failure occurred on segment pipe P20116 between manholes 644 and 476. The pipe in this area is a 48-inch diameter unlined reinforced concrete pipe (RCP) constructed in the early 1960s. In the 1990s, a two-story commercial building was built on top of and adjacent to the sewer pipe. On December 30, 2021, both manhole 476 and approximately a 15-foot length of pipe P20116 collapsed. The collapsed pipe section and manhole were located adjacent to the aforementioned building, not under it.

This section of the 216th Street Relocation Trunk Sewer exhibited considerable corrosion and a replacement project was in construction at the time of the failure. The replacement project is scheduled to be completed in December 2022. Inspection of the pipe debris revealed that the pipe wall had deteriorated to a thickness of less than 1-inch.

In analyzing a failure like this, there are likely multiple contributing factors that led to the failure. Based on the review of available information including CCTV data, examination of portions of the failed pipe, and flow information, corrosion of the sewer system (both the pipeline and the manhole) appears to be the primary factor for the cause of the failure. The wet weather surcharge on the sewer on December 30, 2021 was also likely contributing factor as it occurred during a storm. Additionally, it is unlikely that the load from the nearby building played a significant role in the collapse.

Task 2 – Emergency Response to the SSO

After the initial notification of the SSO from the public was received, a collaborative response was performed by various groups within the Districts including Wastewater Collection Systems (WCS), Construction Management (CM), and Public Information. A detailed listing of activities and timeline is included in Section 4 of this report. The following bullet items summarize the conclusions to the Emergency Response to the SSO Audit:

- The Districts' staff followed the procedures and met the requirements of their ERP. The goal of responding to an SSO within 1-hour was achieved. Additionally, regulatory notifications were completed in a timely manner.
- The Districts' decision making process for troubleshooting and finding the cause of the SSO was reasonable.
- The technical approach for the bypass and repair of the collapsed section by using contractors was also reasonable.
- The Public Information Section followed their Emergency Response Plan and successfully kept stakeholders, the public, and interested media informed of the event. The SSO communication effort was so successful, the Districts received the Grand Prize in the 2022 Environmental Communications Awards Competition from the American Academy of Environmental Engineers and Scientists.
- A review of the SSO ERPs of other agencies do not reveal major procedural differences that the Districts should include in their SSO ERP.

Task 3 – Sewerage Maintenance Program and Capital Improvement Plan

A comparison of the maintenance programs and capital improvement plans of the benchmark (regulatory requirement), the Districts, LASAN, and OC San is included in Section 5 of this report. The following bullet items summarize the audit conclusions of the sewerage maintenance program and capital improvement plan:

- The Districts perform the most frequent pipe cleaning of the three agencies. The only significant difference between the three is that OC San uses 42-inch as the regular cleaning cutoff versus 30-inch for the Districts and LASAN.
- The Districts perform CCTV inspections the most frequently of the three agencies. One difference between the the agencies is that High Definition CCTV video is a requirement for LASAN primary sewers and OC San sewers. Another difference is LASAN utilizes additional technologies, i.e., laser, sonar, and gas detection, on primary sewers.
- The Districts are in the middle of the agency requirements for consideration of capacity relief projects.
- The three agencies have different approaches to project prioritization for the CIPs. The Districts is primarily condition based while LASAN and OC San utilize additional factors including risk.
- The Districts have the shortest schedule for projects to rehabilitate the worst rated sewers.
- Based on the amount of CIP expenditures for collections projects, the Districts' Engineering group appears to be understaffed in comparison to the other agencies based on the size of the projected average annual CIP. This is especially true considering that the Districts are managing and completing projects, whereas OC San's group are generally managing projects.
- The Districts' sewer build-over process is the most established of the agencies investigated for this study. LASAN and OC San generally do not allow build-overs.
- The Districts average annual SSO performance over the last five years in terms of number of SSOs per 100 miles of sewer is in the middle of the three agencies with a value of 0.56. LASAN's is 1.54 and OC San's is 0.36.

Task 4 – Review of New Technologies for Detecting/Preventing SSOs

A listing and description of potential new technologies is included Section 6 of this report. A summary of the technologies for the Districts consideration includes:

- The Districts are currently pilot testing real time flow monitoring with a more user friendly interface that may be expanded if successful.
- Having knowledge of flow rate and flow depth at numerous locations throughout the collections system would be beneficial to early detection of SSOs. Leaders in the industry include Smartcover, SUEZ, and

Hach. The Districts currently use 20 Smartcovers. OC San utilizes Smartcovers in small numbers. LASAN is considering the installation of Smartcovers. Hach flow meters are used widely by LASAN at 216 locations. The Districts have 80 Hach flow meters and 39 by other vendors.

- Using additional equipment on pipeline inspection robots can provide greater information for sewage system operators. Equipment including high definition cameras, laser (for measuring pipe inside shape), sonar (measuring debris below water level), and pipe penetrating radar (for measuring pipe thickness and voids) are available from various vendors including CUES, RapidView-Ibach, Ditchwitch West – Subsite, and SewerVue.
- Technology is available to lower equipment into a manhole without entry to obtain a 3D scan and high-definition imagery. The Clever Scan product sets up on a tripod on top of a manhole and utilizes 4 laser scanners to create a dense point cloud and 5 HD cameras to capture imagery of the inside of a manhole.
- Advanced sewer modeling software, that simulates real-world conditions, provides users with quantifiable magnitude of the potential issues and the opportunity to explore alternative solutions with the least impact on project design, construction, and operation & maintenance costs later. Some of the modeling software to consider include InfoWorks ICM, InfoSWMM, SewerGEMS, and MIKE URBAN/+.

Recommendations for the Districts to consider are included in Section 7 of this report.

Contents

Table index

Figure index

Photos Index

Appendices

Abbreviations / Acronyms

AMP	Asset Management Plan
BOA	Build Over Agreement
CAC	Central Alarm Center
Cal OES	California Office of Emergency Services
CCFRPM	Centrifugally Cast Fiberglass-Reinforced Polymer Mortar Pipe
CCTV	Closed-Circuit Television
CIP	Capital Improvement Plan or Capital Improvement Program
CIWQS	California Integrated Water Quality System
CKC	Charles King Company
CMMS	Computerized Maintenance Management System
CM	Construction Management
CMS	Construction Management Section
CVCWA	Central Valley Clean Water Association
CSO	Combined Sewer Overflow
CWEA	California Water Environment Association
ECAP	Environmental Compliance Awareness Program
ERP	Emergency Response Plan
FOG	Fats, Oils, and Grease
FSE	Food Service Establishment
GIS	Geographic Information System
HD	High Definition
I/I	Inflow / Infiltration
LACDPH	Los Angeles County Department of Public Health
LACDPW	Los Angeles County Department of Public Works
LACSD	Los Angeles County Sanitation Districts
LASAN	City of Los Angeles Bureau of Sanitation
LBI	Lucas Builders
LEED	Leadership in Energy and Environmental Design
MACP	Manhole Assessment Certification Program

MICC	Microbially Induced Concrete Corrosion
MPU	Master Plan Update
MRP	Monitoring and Reporting Program
MSPP	Main Street Pumping Plant
NASSCO	National Association of Sewer Service Companies
NPDES	National Pollutant Discharge Elimination System
OCHCA	Orange County Health Care Agency
OC San	Orange County Sanitation District
OCSD	Orange County Sanitation District
O&M	Operation and Maintenance
PACP	Pipeline Assessment Certification Program
PI	Public Information
PIO	Public Information Officer
RCP	Reinforced Concrete Pipe
R&R	Rehabilitation and Replacement
SCADA	Supervisory Control And Data Acquisition
SRV	Surface Reinforced Visible
SSO	Sanitary Sewer Overflow and any sewer spill or overflow of sewage
SSMP	Sewer System Management Plan
SWRCB	State Water Resources Control Board
USGS	United States Geological Survey
WAM	Work and Asset Management
WAR	W.A.Rasic Construction
WCS	Wastewater Collection System
WDR	Waste Discharge Requirements also referred to as the General Waste Discharge Requirements of the State of California

1. Background and Purpose

1.1 Background

On December 30, 2021, the LA County Sanitation Districts' (Districts) 216th Street Relocation Trunk Sewer experienced a critical failure causing a Sanitary Sewer Overflow (SSO) event that impacted local residents and caused closure of some local beaches. The failure occurred in the City of Carson, just upstream of a section of pipe that runs underneath an existing building along the east side of the Interstate 110 Freeway, south of West 220th Street. Portions of the sewer and manhole collapsed causing a back-up of the trunk main that resulted in a SSO along W 212th Street at manholes 721 and 719. For orientation, refer to **Figure 1-1** for the locations of various items mentioned in this report.

Figure 1-1 Orientation Map

The section of pipe that failed had been identified for replacement and a Replacement Trunk Sewer Project is currently in construction and is scheduled to replace the 216th Street Relocation Trunk by December of 2022. Since the new trunk sewer is not yet complete, emergency repairs were provided to return the existing trunk sewer to service.

In order to understand why this failure occurred and what measures can be put in place to help avoid future SSO incidents, the Districts have asked GHD to provide an independent external audit of the SSO that occurred on December 30, 2021 in the City of Carson. The audit will be a review and analysis of the following:

- The physical cause of the failure
- The history of inspections and maintenance on the existing trunk sewer
- Plans for replacement of the trunk sewer

- The Districts' response to the December 30, 2021 SSO in the City of Carson
- Programmatic review of the Districts' sewer maintenance and inspection programs, Capital Improvement Program, build-over approval process and emergency procedures relative to industry standards.

The audit has been broken into four separate tasks in order of priority: Physical Cause of Pipe Failure, Emergency Response, Sewerage Maintenance Program and Capital Improvement Plan, and Review of New Technology for Detecting/Preventing SSOs.

Initially, the results of these tasks were documented in two separate reports: the first report covering the first task and the second report covering the latter 3 tasks. This first report, Physical Cause of Pipe Failure, was completed and submitted as a preliminary draft report under separate cover on March 30, 2022. However, and as requested by the Districts, the two reports are now combined to include all tasks under a single cover.

1.2 Purpose of Report

This report focuses on Tasks 1 through 4 as noted in the previous section.

Task 1

In order to understand why this failure occurred and what measures can be put in place to help avoid future SSO incidents, the Districts have asked GHD to provide an independent external audit of the SSO that occurred on December 30, 2021 in the City of Carson. The intent of the independent external audit report is not to provide a forensic analysis but rather to assist the Districts with the following objective:

"To *arrive at a set of best practices for sewerage maintenance programs and capital improvement programs, and the steps the Districts need to take to continue performing as a leader in this industry. It is the Districts' intent to refine current practices to further reduce the likelihood of an SSO like this event occurring in the future.*" (Task Authorization From, p 2)

Tasks 2, 3 and 4

Each section related to Tasks 2 through 4 will include a discussion of the findings based on available information and recommendations for improvements to sewer maintenance and inspection programs, Capital Improvement Program development, build-over approval process, and emergency response procedures . Additionally, a comparison of the Districts' policies and practices to industry standards and those of two other local agencies: the City of Los Angeles Bureau of Sanitation (LASAN) and Orange County Sanitation District (OC San).

It is important to note that this audit is limited by the quantity and quality of available data.

1.3 Comparison of Agencies

As noted above, the staffing, processes and procedures of the Districts will be compared to those of LASAN and OC San. The process of selecting agencies for comparison to the Districts was based on proximity to the Districts, relative size (population served), and overall focus of the agencies. In this case, both LASAN and OC San are considered well respected large wastewater focused agencies that serve adjacent geographies, and therefore may face the similar local regulations, issues, and challenges. While no two agencies will ever be the same, these two agencies are large, local, and wastewater focused which can offer the opportunity for continued collaboration and knowledge transfer. Table 1-1 shows a comparison of the three agencies' sizes and amount of infrastructure. As can be seen in **Table 1-1**, the three agencies are very different and, therefore, can be expected to have different approaches to sewer system management.

Table 1-1 Service Area, Population and Sewer Network Length Comparison

	Districts	LASAN	OC San
Service Area (square miles)	824	600	479
Population Served	5.5 million	4 million	2.6 million
Miles of Sewers	1,431	6,512	388
Miles of Sewers for Pipes Greater than 36"	321	127	153

2. Reference Information / Documents

The Task 1 audit is based on the documents received by the Districts. The assessment of the pipe failure is hence based on the information gathered and provided by the Districts which mainly included the following:

- Record drawings for the trunk sewer and the Main Street Pumping Plant
- Inspection reports for the failed sewer reach, including CCTV videos
- Build-over letter for the adjacent building
- Storm flow data
- Pump flow data
- Emergency repair files (Photos and Videos)
- Smart Cover monitoring system data
- Wastewater Collection Systems (WCS) CIP reports (2011 to 2020) and performance overview report (2008 to 2021)
- Sanitary sewer overflow response plan
- Sewer repairs, rehabilitation, and replacement plan
- Sewer system management plan and sewer system management plan audit
- Districts sewer condition monitoring program
- Main Street Pumping Plant emergency procedures
- Adjacent building load calculations
- Interviews with the Districts first responders including WCS and Construction Management (CM) section staff.
- Site visit on January 24th to the Districts Compton Field Office to see remnants of collapsed pipe and adjacent manhole, as well as visits to the Main Street Pumping Plant and SSO site.
- Standard manhole drawings
- A detailed log sheet for the purpose of this audit was prepared for the documents received. The log sheet for the data received is attached as **Appendix A** to this report.
- Input for Tasks 2, 3 and 4 are based on the following documents:
- State Water Resources Control Board WDRs (Orders)
- Best Management Practices for Sanitary Sewer Overflow (SSO) Reduction Strategies - CVCWA - Version 1.0 December 2019
- A Guide for Developing and Updating of Sewer System Management Plans (SSMPs) – CVCWA - September 2015
- Sanitation Districts of Los Angeles County - Sewer System Management Plan (SSMP) - February 2019
- Sanitation Districts of Los Angeles County - Sewer System Management Plan (SSMP) Audit -Audit Period 2019-2020
- Sanitation Districts of Los Angeles County - Wastewater Collection Systems – 2020 Capital Improvement Plan Report – Memorandum – December 22, 2020
- Sanitation Districts of Los Angeles County - Public Info Spill Response Documents 2022
- Sanitation Districts of Los Angeles County - CIWQS Event ID No. 878549 - 216th Street Replacement Trunk - SSO December 30, 2021
- www.lacsd.org/services/wastewater-programs-permits/buildover-procedures

- Sanitation Districts of Los Angeles County 1996 letter approving construction of building over 216th S Relocation Trunk Sewer
- City of Los Angeles - Sewer System Management Plan - Version 3.0 - LA Sanitation & Environment - January 25, 2019
- City of Los Angeles - Sewer System Management Plan - Attachment D1 - Wastewater Capital Improvement Program (WCIP) - Fiscal Years 2018-19 through 2027-28
- City of Los Angeles - Sewer System Management Plan - Attachment D2 - Capital Improvement Program (CIP) – Project Prioritization Criteria Definitions
- Sewer System Management Plan for Orange County Sanitation District - Volume I - September 27, 2021
- Sewer System Management Plan for Orange County Sanitation District – Appendix J – CIP Renewal and Replacement Process
- Sewer System Management Plan for Orange County Sanitation District – Appendix Q1 – OSCD SSO Emergency Response Plan
- OC SAN Waste Discharge Requirements Sewer System Management Plan Audit - April 13, 2021
- OC SAN Capital Improvement Program Annual Report Fiscal Year 2020/21
- Asset Management for Sewer Collection Systems - Fact Sheet– USA Environmental Protection Agency
- Using Acoustics to Enable Condition Based Maintenance in Gravity Sewer System – InfoSense Inc
- Little Rock Water Reclamation Authority (LRWRA) - Implement Acoustic Technology - Final Submission 2018

2.1 Districts' Staff Who Provided Information For Tasks 2, 3 and 4

The following Districts' staff provided information for the audit:

- Andre Schmidt, Division Engineer and Darrell Hatch, Supervising Engineer; Wastewater Collection Systems Section (WCS)
- Anthony Howard, Division Engineer; Sewer Design Section
- Ted Brodeur, Supervising Engineer; Construction Management Section (CM)
- Bryan Langpap, Division Engineer; Public Information Section (PI)

2.2 Third Parties Who Provided Information For Tasks 2, 3 and 4

The following staff and companies provided information for the audit:

- Eduardo Perez, Emilio Lopez, and Regidia Voong LASAN Critical Infrastructure
- Brian Waite and Troy Edwards, OC San Asset Management
- New Technology Companies/Manufactures:
- SmartCover Systems
- RapidSMART Sewer Solutions
- CUES, Inc.
- IBAK robotics

- Insight Vision
- SewerVue Technology
- SUBSITE Electronics
- Subtronics Corporation
- Ditchwitchwest

3. Task 1 – Physical Cause of Pipe Failure

3.1 Construction, Inspection, and Maintenance History of Impacted Pipe and Adjacent Manholes

This section discusses the construction, inspection, and maintenance history of the failed section of pipe and adjacent manhole based on available information.

3.1.1 Construction History

The 216th Street Relocation Sewer failure occurred on pipe segment P20116 between manholes 644 and 476. The pipe in this area is a 48-inch diameter unlined reinforced concrete pipe (RCP) constructed in the early 1960s and has a slope of 0.05% (Drawing 8-P-13). The downstream manhole 476 was constructed under the original project and is a standard Type "B" manhole for the period consisting of an unlined cast-in place concrete base connecting the inlet and outlet pipes with either a brick or precast 36-inch inside diameter shafting leading from the base to the ground surface and a 24-inch manhole cover and frame at the surface. It is unknown from the construction records what type of shafting was constructed at the location of the failure. However, based on the CCTV inspections of the sewer, debris observed in the photos and site visit to Compton Field Office, and inspection of nearby manholes constructed as part of the original project, it appears the shaft of manhole 476 was constructed of precast concrete. The upstream manhole 64 is a cast-in-place structure built by Caltrans in the 1990s in conjunction with a widening project on the Interstate 110 Freeway. This structure is PVC lined with precast concrete risers leading to the finished grade.

3.1.2 Inspection and Maintenance History

Records provided by WCS indicate that pipe segment P20116 has been closed circuit television (CCTV) inspected nine times since 2006, with the most recent inspection occurring on December 1, 2021. The inspection interval has been annual since 2016. Since at least 2012, pH testing and crown spraying of the pipe with magnesium hydroxide have occurred on about a 6-month interval to mitigate pipe corrosion. The measured pH of the pipe has ranged from 1 to 9, and most often measured between 1 and 3. This indicates the pipe and manhole were subject to high levels of acidity, leading to deterioration of the concrete.

No inspection or maintenance history of manholes 476 or 644 were provided. As could be viewed in the CCTV videos, the upstream and downstream pipes received crown spraying and the lower areas of the manhole 476 received an incidental coating. The upper segments of the manhole risers did not appear to receive any coating.

3.2 Evaluation of Pipe and Adjacent Manholes Condition

This section provides an overview of the condition of the pipe and adjacent manholes based upon information received from CCTV inspections, inspection reports, and examination of the materials taken from the collapse site.

3.2.1 Prior CCTV and Inspection Report Records

As noted in Section 3.1, the pipe segment P20116 has been CCTV inspected 9 times since 2006, although only the most recent seven, since 2016, were available for review. The CCTV videos are not high quality and seem to be impacted by the following issues:

- High water level in the pipe limits CCTV view;
- Unclear imagery due to equipment and/or material on camera lens; and
- Magnesium hydroxide crown coating obscures the view of pipe defects.

GHD observed the CCTV videos and reports and did not find additional defects not noted in the reports. The noted defects from the reports are summarized in **Table 3-1**.

Table 3-1 CCTV Videos Notes

CCTV Notes Consolidated P20116
Between MH 08 0644 & MH 08 0476

Date Inspection	Days Since Previous Inspection	Water Level MWL % Cross Sectional Area	Water Mark MWM % Cross Sectional Area	Distance From MH 08 644 Upstream MH (ft)	MAG COAT MGO	Surface Aggregate Visible SAV	Surface Aggregate Projecting SAP	Surface Reinforcement Visible SRV	Surface Reinforcment Corroded SRC	Surface Spalling SSS	Surface Aggregate Missing SAM
1/21/2016	NA	35%	50%	2.0	General Observation - Magnezium H.O Coating 50%			Surface Reinforcement Visible from 09 to 03 oclock within 8 inches of joint			
				13.1					Surface Reinforcement Corroded from 09 to 03 oclock within 8 inches of joint		
				32.5	General Observation - Magnezium H.O Coating 50%			Surface Reinforcement Visible from 09 to 03 oclock within 8 inches of joint	Surface Reinforcement Corroded from 09 to 03 oclock within 8 inches of joint		
10/11/2016	264	40%	45%	4.8	General Observation MAG Hydroxide Coating Start						
				4.9						Surface Spalling from 09 to 03 oclock within 8 inches of joint	
				19.7	General Observation Some Ribcage Effect						
				34.4				Surface Reinforcement Visible from 09 to 03 oclock within 8 inches of joint			
				37.9				Surface Reinforcement Visible from 09 to 03 oclock within 8 inches of joint		Surface Spalling from 09 to 03 oclock within 8 inches of joint	
10/4/2017	358	50%	50%	5.0	General Observation MAG Lining 40%		Surface Aggregate Projecting from 09 to 03 oclock within 8 inches of joint				
				17.3				Surface Reinforcement Visible from 09 to 03 oclock within 8 inches of joint			
				20.7							Surface Aggregate Missing from 09 to 03 oclock within 8 inches of joint
				28.9			Surface Aggregate Projecting from 09 to 03 oclock within 8 inches of joint				
10/16/2018	377	60%	60%	2.0	General Observation Magnezium H.O Coating			Surface Reinforcement Visible *Unkown* from 10 to 02 oclock within 8 inches of joint			
				26.0	General Observation Magnezium H.O Coating			Surface Reinforcement Visible *Unkown* from 10 to 02 oclock within 8 inches of joint			
11/25/2019	405	20%	35%	0.2	General Observation MAG Coat						
				2.1			Surface Aggregate Projecting from 08 to 04 oclock within 8 inches of joint				
				29.9			Surface Aggregate Projecting from 08 to 04 oclock within 8 inches of joint				
11/9/2020	350	45%	35%	2.0	General Observation M.H.O Coating						
				30.6	General Observation M.H.O Coating						
12/1/2021	387	50%	55%	2.0	General Observation 65% MAG Coat					Surface Spalling from 08 to 04 oclock within 8 inches of joint	
				5.0			Surface Aggregate Projecting from 09 to 03 oclock within 8 inches of joint				
				20.4				Surface Reinforcement Visible at 10 oclock within 8 inches of joint			
				24.0						Surface Spalling from 08 to 04 oclock within 8 inches of joint	
				24.9			Surface Aggregate Projecting from 09 to 03 oclock within 8 inches of joint				

The progression of deterioration is not as expected for several of the defect categories. For example, Surface Reinforcement Visible (SRV) is noted at 2 feet in January 2016; not noted in October 2016 or October 2017; but noted again in October 2018. This can likely be attributed to the quality and limitations of the CCTV videos. Additionally, it is possible that some SRV defects may have been rust stains on the concrete and not true reinforcement, but the quality of the video makes this distinction difficult. Moreover, the CCTV notes mention SRV less in later inspections. After the 2018 inspection, SRV is only mentioned one time at a location not previously noted. As an example, **Photo 3-1** below notes a short segment of SRV at 20'-5". It is difficult to determine if this is a rust stain or actual corroded reinforcement.

Photo 3-1 CCTV Inspection Photograph 1

Specific inspections, CCTV or physical entry, of the manhole were not performed. However, at the end of a CCTV run, the camera pans up to show the inside of the ending manhole. **Photo 3-2** and **Photo 3-3** show screenshots from the December 2021 inspection showing significant corrosion including visible aggregate, discolored walls, and exposed reinforcement in manhole 476.

Photo 3-2 CCTV Inspection Photograph 2

Photo 3-3 CCTV Inspection Photograph 3

3.2.2 Information from Collapsed Section

On January 14, 2022, GHD interviewed a Construction Management Section (CMS) staff member to gain an understanding of the collapse and restoration operations. Of note from this discussion was that the downstream manhole (476) appears to have collapsed on itself (the manhole cover was in about the same horizontal position but located several feet underground). This is illustrated in **Photo 3-4** (before the failure), **Photo 3-5** (after the failure), and **Photo 3-6** (during excavation). No manhole shafting was observed during excavation operations.

Also noteworthy in **Photo 3-4**, is that there appears to be a roof drain at the building corner which could have added even more rainwater to the area above the collapse.

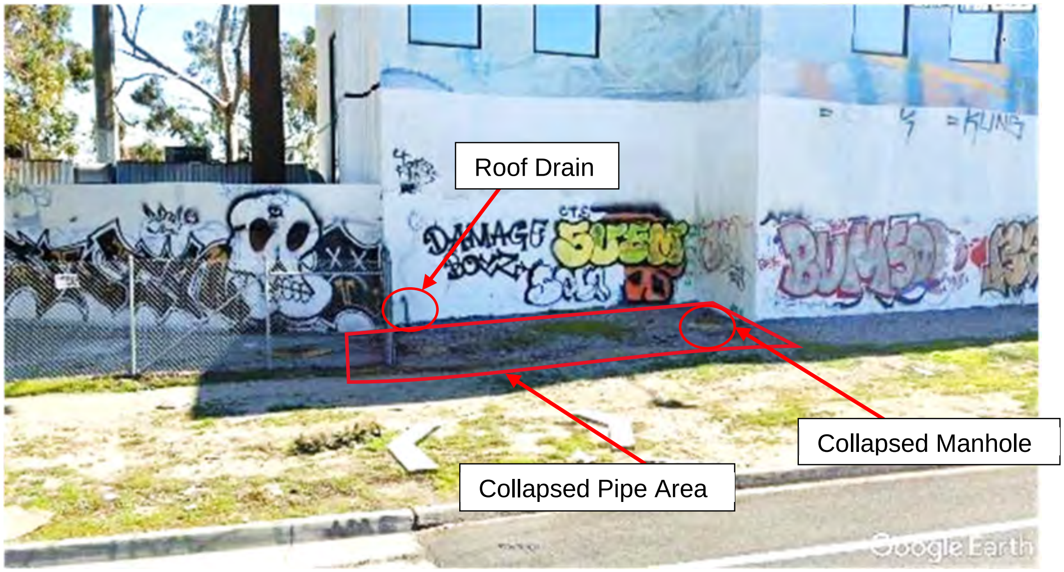


Photo 3-4 Location of the Pipe and Manhole Before the Failure

Photo 3-5 Location of the Pipe and Manhole After the Failure

Photo 3-6 Excavation in the Failure Area

Once excavated, the CMS staff observed the pipe condition and noted that the entire crown of the pipe was collapsed, the walls were as thin as approximately 1-inch, and minimal reinforcement was observed. **Photo 3-7** shows the pipe condition when first exposed.

Photo 3-7 Pipe Condition When First Exposed

Various concrete debris pieces from the collapse site were transported to the Compton Yard for storage. On January 24, 2022, GHD visited the Compton Field Office to view the debris. The pile of debris is shown in **Photo 3-8**. Some pieces easy to identify included the top of the manhole/collar and several broken pieces of pipe. The origination of the remainder of the concrete debris is unclear but none appeared to be manhole shafting or bricks. It seems possible that some of the concrete debris could have been in the original backfill when the sewer was constructed.

Photo 3-8 Pile of Debris from Collapse Site

Photo 3-9 shows a corroded pipe segment that has a wall thickness of under 1-inch. During the repair phase of the project, the CM group drilled a hole in the collapsed pipe below the spring line and measured a thickness of 3.5 inches, leading to a theory that the pipe walls were originally 3.5 inches thick. In an attempt to determine if the concrete debris could have been from the pipe or manhole shafting, two plywood templates were cut with radii of 27.5 inches for a 48-inch pipe with 3.5-inch thick walls and 21.5 inches for a 36" shafting with 3.5-inch walls (refer to **Photo 3-10**). No definitive determination of the outside wall diameter was established with the templates. Currently, 48-inch RCP typically has 5 to 6-inch-thick walls depending upon the design and manufacturer. None of the pipe pieces at the Compton Yard were found to have embedded reinforcement or rust stains from reinforcement. Later, core samples were taken from below the spring line of the existing 48-inch pipe installed under the same construction contract as the collapsed section and the thickness was measured to be 4.5-inches thick and reinforcement was observed in the samples (refer to **Photo 3-11**). This indicates that the collapsed pipe likely had 4.5-inch thick walls.

.

Photo 3-9 Corroded Pipe Section

Photo 3-10 Corroded Pipe Section with Radius Template

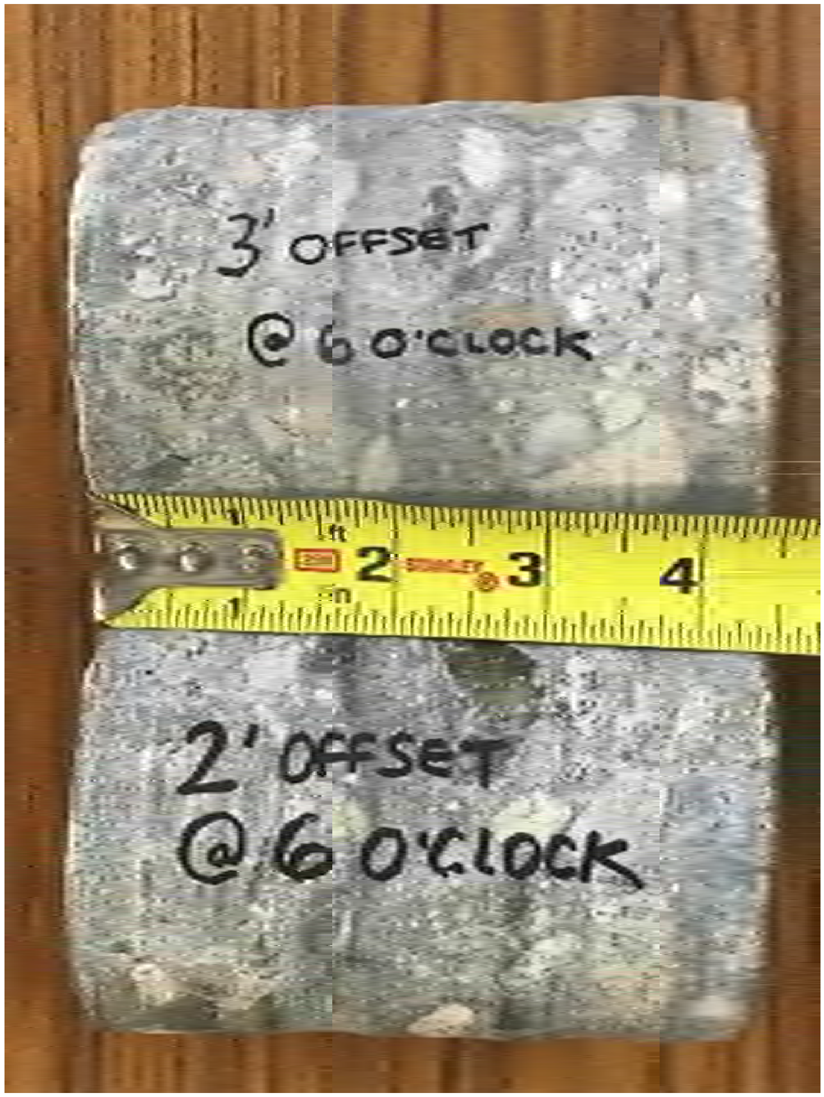


Photo 3-11 Core Samples from 216th Street Relocation Trunk from below Spring Line

As shown in **Photo 3-12**, the manhole ring and cover along with the cast in place collar were included in the debris. The concrete and grout located below the ring and cover was highly friable, indicating that it has been weakened by corrosive gasses often found in sanitary sewers.

Photo 3-12 Manhole Ring and Cover Debris

There was no apparent material from the manhole shafting, brick or precast among the debris collected and transported to the Compton Yard. This could indicate that the material broke into very small sections and washed downstream.

3.3 Evaluation of Flow Information Around the Time of Failure

Two items of flow related data available around the time of failure are the discharge from the Main Street Pumping Plant and a Smart Cover installed in Manhole 465 at roughly the mid-point between the locations of the SSO and the failure. This section will analyze what this information can reveal about the cause of the failure.

3.3.1 Pump Station Discharge and Pipe Capacity Evaluation

The major contributor of flow into the 216th Street Relocation Sewer is the Main Street Pumping Plant (MSPP). However, the 216th Street system picks up flow from approximately 20 additional local sewers between MSPP and the failure location (refer to **Figure 3-1**). Flow data is not available for these local connections but based on tributary sewer shed areas (approximately 9,524 acres upstream of the MSPP and approximately 156 acres between MSPP and the failure location), the flow at the failure location is estimated to be 1.5% to 2% higher than the discharge from the MSPP.

.

Figure 3-1 Local Lateral Locations between MSPP and Failure Location

Figure 3-2 shows the discharge from the Main Street Pumping Plant from November 1, 2021 through January 10, 2022. This graph shows the typical daily peak discharge is 6,000 to 7,000 gallons per minute (gpm). In fact, during peak dry weather, flow is consistently at or slightly below 6,000 gpm. The spikes in flow above 6,000 gpm are typically due to pumping down the wet well for daily cleaning. During storm events, the peak discharge increases to approximately 12,000 gpm. One data point on the graph shows a peak of approximately 15,550 gpm on November 16, 2021, at 11:15 AM. This was not associated with a storm; rather, it appears pump station operations caused this flow for a short period of time, approximately 15 minutes. **Figure 3-3** shows discharge on and around December 30, 2021, the day of the failure, the peak discharge was approximately 11,856 gpm at 7:30 AM. The average discharge for the morning hours of December 30, 2021, once the storm started, was approximately 11,300 gpm.

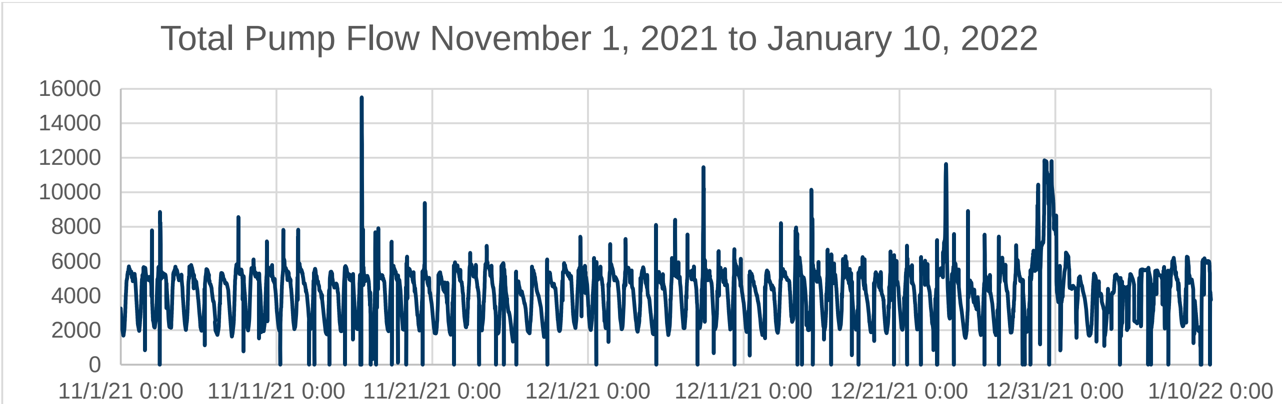


Figure 3-2 MSPP Discharge from November 1, 2021 to January 10, 2022

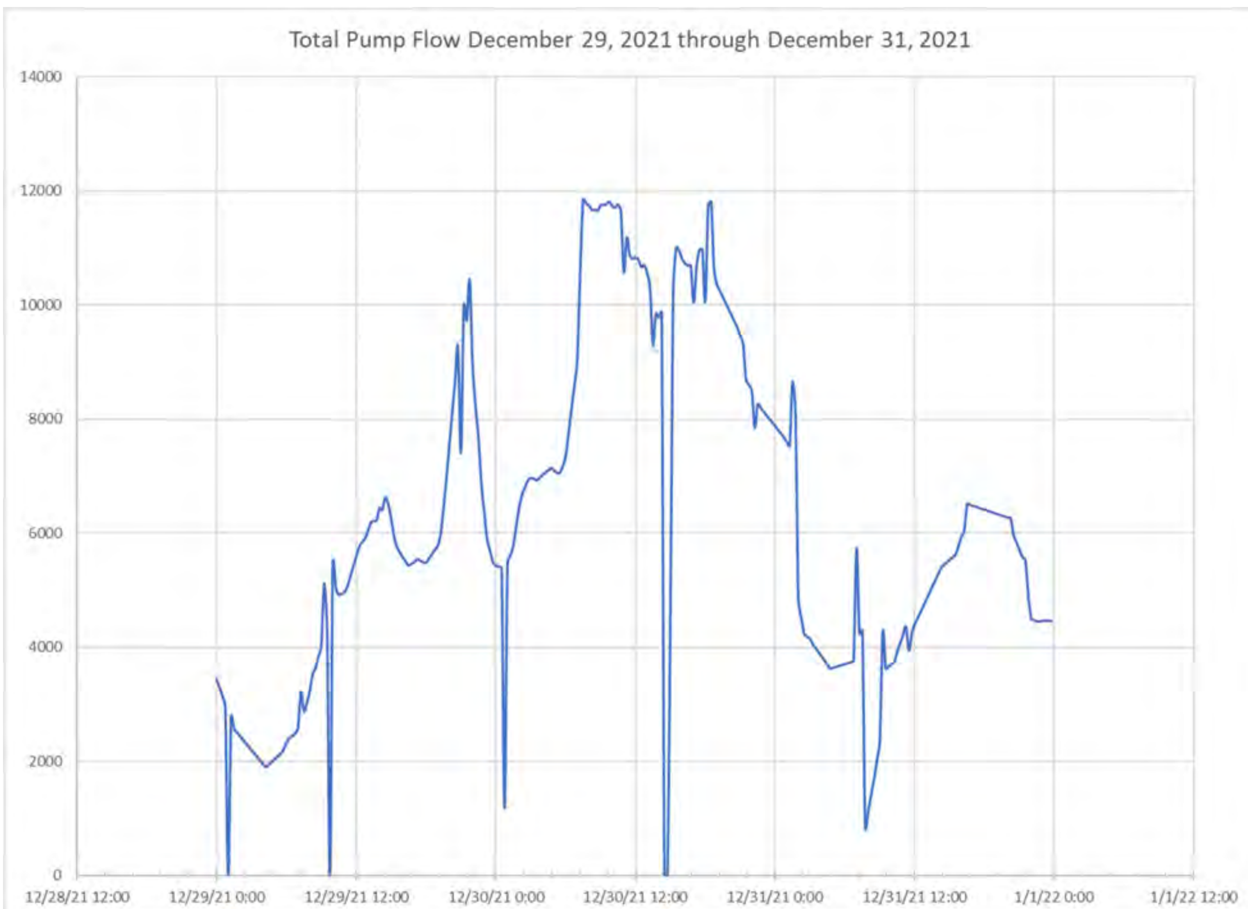


Figure 3-3 MSPP Discharge from December 29, 2021 to December 31, 2021

Table 3-2 shows the full pipe (d/D = 1) capacity of segment P20116 as calculated by solving Manning's Equation for various 'n' values (roughness coefficients). Using King's Handbook of Hydraulics as a guide, a roughness coefficient of 0.013 is typically used for smooth new pipe while 0.030 would be used for a rough pipe. Other parameters used in the calculation are the diameter which is 48-inches and the pipe slope which is 0.05%.

Table 3-2 Pipe Capacity for Various n Values

Roughness Coefficient n	Q Capacity (no pressure) gpm
0.013	14,417
0.015	12,494
0.020	9,371
0.025	7,496
0.030	6,247

Due to the roughness of the corroded pipe as observed in the CCTV videos and in the pipe segments saved in the Compton Yard, the ‘n’ value is likely in the range of 0.015 to 0.020, correlating to a pipe capacity in the range of 10,000 to 12,000 gpm. From the data collected, it is estimated that the pipe flow at the time of the failure was approximately 12,100 gpm (total is estimated based on the Main Street Pumping Plant discharge flow of 11,856 gpm plus an additional 2% flow collected from the tributary sewer shed and infiltration/inflow (I&I) during the storm). This flow rate would have caused the pipe to have been surcharged and flow under pressure. Typically, a flow calculation tool such as a sewer flow model would provide a more precise estimate of the wet weather flow and the level of surcharge for the pipe. However, a sewer model is not available for this area.

3.3.2 Smart Cover Data Evaluation

Although not directly a measurement of flow, another source of data for sewer behavior on December 30, 2021 is a Smart Cover installed in manhole 465 in Figueroa Boulevard, roughly half-way between the Main Street Pumping Plant and the failure location. A Smart Cover is an electronic device installed in a manhole that measures water level at adjustable time intervals. This water level data is viewable remotely and alarms may be set at various levels. The graph in **Figure 3-4** shows the distance from the manhole cover at ground level to the water level in the manhole 465 in approximately 10-minute intervals between December 26, 2021 and January 4, 2022. The typical distance ranges from 180 inches to 190 inches. The pipe invert is 202 inches below ground level and the crown of the 36-inch pipe is 166 inches below the ground level. At about 09:25 on December 30, 2021, the depth to the water surface decreased to about 134.3 inches. The distance then gradually increased to about 148 inches at 12:50 but then rapidly decreased back to 133.9 inches at 13:17. It remained at this level until the bypass pumping system was able drain the system on January 2, 2022 at about 01:00.

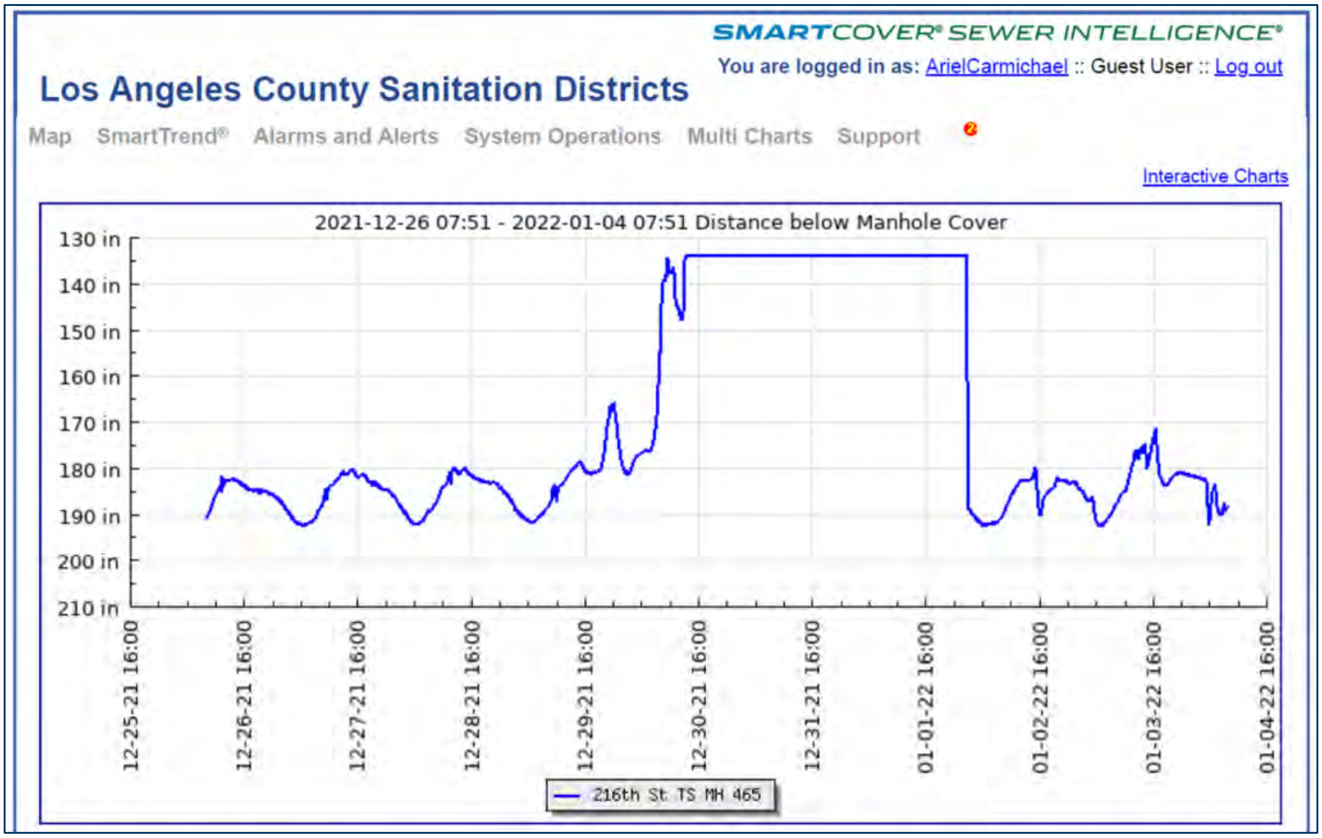


Figure 3-4 Distance from the Manhole Cover to the Water Level in Manhole 465 Between December 26, 2021 and January 4, 2022

The Main Street Pumping Plant discharge information and Smart Cover information were then combined in a single graph for December 30, 2021 (refer to **Figure 3-5**). It should be clarified that manhole 465 is not part of the 216th St Replacement Trunk. It is part of a smaller (36-inch diameter) sewer upstream of the failed sewer, which was 48-inch diameter (there is a second 30-inch sewer parallel to the sewer for MH 465). Therefore, the amount of surcharge at MH 465 is not necessarily indicative of the amount of surcharge at the failure location. This graph shows that the manhole 465 water level (blue line on the graph) generally follows the Main Street PP discharge (orange line on the graph) until about 13:17. The MSPP flow line also shows that the pump plant was shut down for a short period of time after the SSO was discovered as the cause of the SSO was being investigated. **Figure 3-5** also shows that the pipe was surcharged from about 07:30 onward as the water level (blue line on the graph) is above the crown of pipe (solid black line on the graph) by as much as 2.5 feet and was likely even higher, as this is the highest level the Smart Cover can detect. The maximum level would be approximately the same elevation as the rims of manholes 721 and 719 on 212th Street (the SSO location).

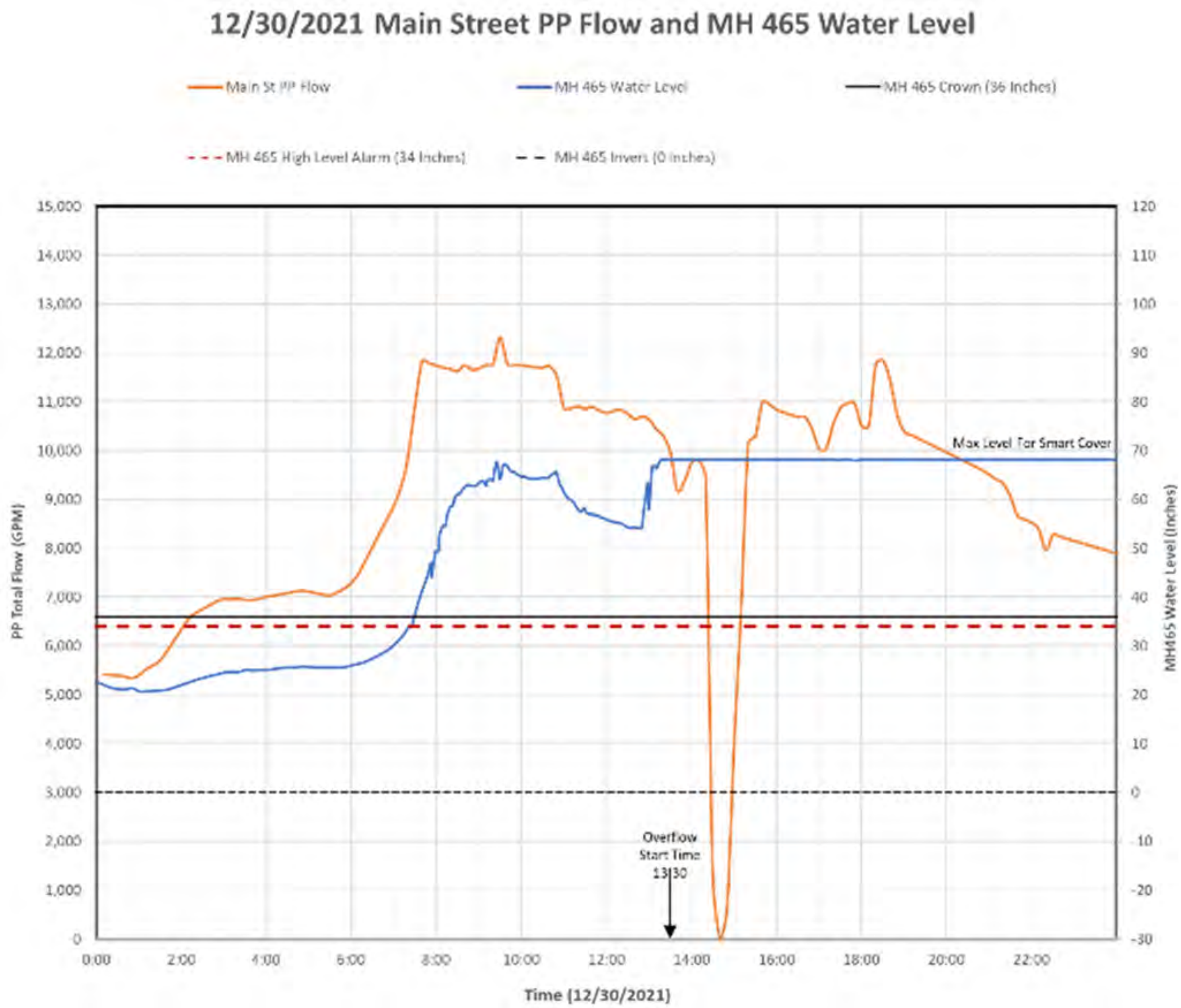


Figure 3-5 Pump Flow and Smart Cover Data Combined

3.3.3 Main Street Pumping Plant Wet Weather Operations

Based upon information contained in the February 2021 Main Street Pumping Plant (MSPP) Emergency Procedures document and discussion with WCS staff, wet weather operation of the pumping plant changed within the last year. Previously, manual operation of the Plant was required during wet weather events due to capacity limitations on the downstream sewer. This was done by monitoring Smart Covers at manhole 465 (discussed above and located downstream of the pumping plant) and manhole 470 (previously located on the 216th Street Trunk Sewer) and at manhole 241 located at a low point upstream of the plant. Operators would monitor the upstream and downstream Smart Cover data and adjust pump discharge to help prevent a SSO on either side of the pumping plant. Between 2009 and 2017 there were four capacity related overflows on the 216th Street Trunk Sewer. In October 2020, the 216th Street Replacement Trunk Sewer Phase 1 was completed, taking manhole 470 out of service, and alleviating the risk of capacity related overflow conditions on 216th Street Trunk Sewer. Because of this, manual operation of the Plant and upstream flow monitoring during wet weather was no longer necessary. After the manual operation procedure was stopped, the MSPP still had an automated control logic in place to limit the pump speed. This prevented even higher flow from MSPP, and thereby higher surcharge in the downstream sewers while also avoiding an SSO upstream of the MSPP. It should also be noted that, due to the size of the storm, it would not have been possible to prevent surcharge during the December 30 rainstorm by

.

manual operation. There is not enough storage capacity upstream of MSPP to have kept flow low enough downstream of the MSPP throughout the storm.

3.4 Summary of Replacement Timeline

On February 10, 2015, an internal Memorandum was written requesting the rehabilitation of the Condition 1 and 2 segments of the 216th Street and 216th Street Relocation Trunks within 2 years. The Districts' utilize a pipe rating system ranging from 1 through 4, with 1 being the worst condition sewers and 4 being the best condition sewers with minimal defects. This Memorandum also requested that the capacity of the sewers downstream of MSPP be increased to eliminate the risk of overflows. The actual completion of the rehabilitation/replacement project is projected to be completed approximately 7 years after the original Memorandum. The following bulleted items show the progression of the design process for the rehabilitation and replacement projects.

- February 2016 – Preliminary Design Report issued recommending replacement of both sewers with upsized sewers.
- May 2016 – RFP for Aerial Survey issued.
- October 2016 – Aerial Survey submittal received.
- February 2017 – Emergency repair of two reaches on the 216th Street Trunk were initiated (about 650 feet of 36-inch tile-lined RCP).
- September 2017 – Project was divided into two phases. Phase 1 was to expedite the replacement of the remaining 2,900 feet of 36-inch clay tile lined sewer. Phase 2 was to address the downstream 48-inch RCP.
- November 2017 – 50% plans for Phase 1 issued.
- September/December 2018 – Bid and Award of Phase 1 (250 working days, extended to 330).
- July 2019 – 50% plans for Phase 2 issued.
- September 2020/January 2021 – Bid and Award Phase 2 (350 working days).
- November 2020 – Substantial completion of Phase 1.
- December 2022 – Projected Completion of Phase 2.

3.5 Potential Pipe Build-Over Impacts on Pipe and Adjacent Manholes

The Districts do not encourage the building of improvements over sewer easements, as such encroachments may result in limited access or damage to the underlying sewers. A developer or property owner (applicant) desiring to construct an improvement over a Districts' sewer easement is required to obtain a "Build-over Agreement" (BOA) from the Districts. The Districts consider "build-over" proposals on a case-by-case basis. In the mid-1990s, a two-story building was constructed directly above the 216th Street Relocation Trunk Sewer. The build-over section is located immediately south of the failed pipe section.

3.5.1 Build-Over Agreement – Typical and This Case

3.5.1.1 Typical Build-Over Agreements

For the Districts' staff to evaluate a build-over proposal, in the current typical process, the following information is required from the developer or property owner in their build-over application:

1. A vicinity map showing the general location of the proposed improvements in relation to the surrounding streets;
2. A grading plan and site plan showing the location of the sewer easement, sewer line, and manholes in relation to the proposed improvement. Include information regarding the removal and replacement of any unsuitable soil along with cut/fill depths;

3. The calculated footing and/or traffic loadings resulting from the project, project-related activity, and post-construction activity. A list of construction equipment to be used at the site and a soils report for the project are also required; and
4. A foundation plan and a footing detail showing the elevations and locations of the footings for the improvement(s). Also include profile and/or cross section drawings showing the proposed improvement(s) in relation to the sewer line.

The information above is simultaneously forwarded to various departments within the Districts for review and their collective comments to determine if the proposed build-over request is acceptable.

Subsequent to the Districts' review of the proposed build-over request, the applicant will be advised in writing of the Districts' decision. The applicant is then required to submit two (2) sets of plans that incorporate corrections, as applicable. The submitted plans must include the following note:

> *No grading, soil removal, soil fill, or construction activity shall be performed within the Sanitation Districts' easement without on-site approval of the proposed activity by a Sanitation Districts' inspector. Contractor shall contact the Wastewater Collection Systems Manager at (310) 638-1161, a minimum of two weeks prior to the start of construction to make the necessary arrangements.*

Upon receipt of the final plans, the Districts will mail a Build-Over Agreement (BOA) to the applicant detailing the conditions under which the proposed improvements are acceptable to the Districts. It shall be the responsibility of the fee owner of the property to sign the BOA (the signature must be notarized) and return it to the Districts. The BOA is subsequently executed by the Districts' Chief Engineer and General Manager and is submitted to the Los Angeles County Recorder's Office for recordation. After the recorded BOA is received from the Recorder's Office, a copy of the document along with one set of final plans is returned to the applicant

3.5.1.2 Build-Over Agreement for This Case

Based on discussions with Districts staff, sometime in early 1996, the developer of the property at 22019 South Figueroa Street in Carson, CA submitted plans for the construction of a commercial building over the 216th Street Relocation Trunk Sewer and easement that crosses the west side of the property. Interactions with the developer were described as hostile. A May 23, 1996 letter from the Planning and Property Management Section approved the building construction subject to four (4) conditions abbreviated below:

- Access to the manhole located on the north side of the property must be maintained.
- All impacted sewer manholes shall be adjusted to grade by Districts' staff.
- All construction, excavation, and recompaction over the Districts' easement shall be performed in the presence of a Districts' Inspector.
- Excavation, backfill, and densification work shall be performed according to specifications in the 1994 edition of the Standard Specifications for Public Works Construction, "Greenbook".

Ultimately, construction of the building was completed without a formal BOA being processed and executed.

3.5.2 Evaluation of Districts Calculations

GHD reviewed the concrete pipe calculations dated January 11, 2022, from the Districts regarding the damaged sewer pipe located along the Interstate 110 freeway at 220th Street and Figueroa Boulevard in Carson, CA. This review was limited to evaluation of the loads from an existing building on the sewer pipe. GHD's calculations estimated the dead load of the building to be about 20% larger than what the Districts has presented. GHD calculated the dead load weight of the building (W_{Dbldg}) at 4,995 pounds per linear foot (plf) whereas the calculations provided by the Districts calculated W_{Dbldg} at 4,025 plf. This discrepancy is likely due to the Districts load based on the building being one-story, when it is in fact a two story building. This increase in weight would reduce the calculated factor of safety to 0.98 or approximately 1.0. A factor of safety of 1 is not suitable in this situation. When the building was constructed, means to strengthen the pipe should have been included in the project. An annotated version of the Districts' calculations is included in Appendix B. GHD is in agreement with the remainder of the calculations as presented.

The building is unlikely to have been a primary (or significant) cause of the pipe's failure. This is supported by the evidence that the failure occurred on a portion of the pipe that was not under the building.

3.6 Seismic Research

GHD obtained information from the United States Geological Survey (USGS) website for past earthquake information that occurred in Southern California and specifically in the Carson area between December 24, 2021 and December 30, 2021. **Figure 3-6** shows a broad view of earthquakes in Southern California for this period. **Figure 3-7** shows a closer view of the two (2) earthquakes that occurred in Carson during this period.

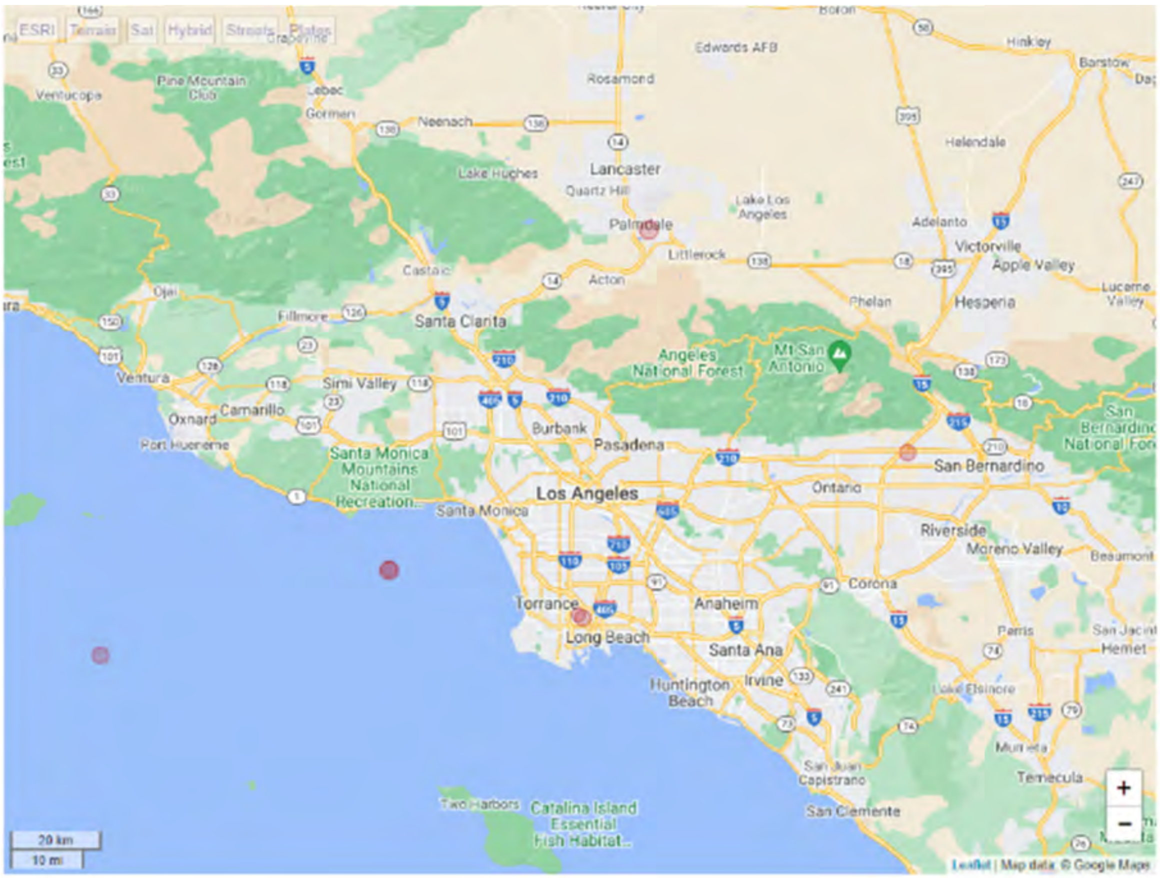


Figure 3-6 Broad View of Southern California Earthquakes

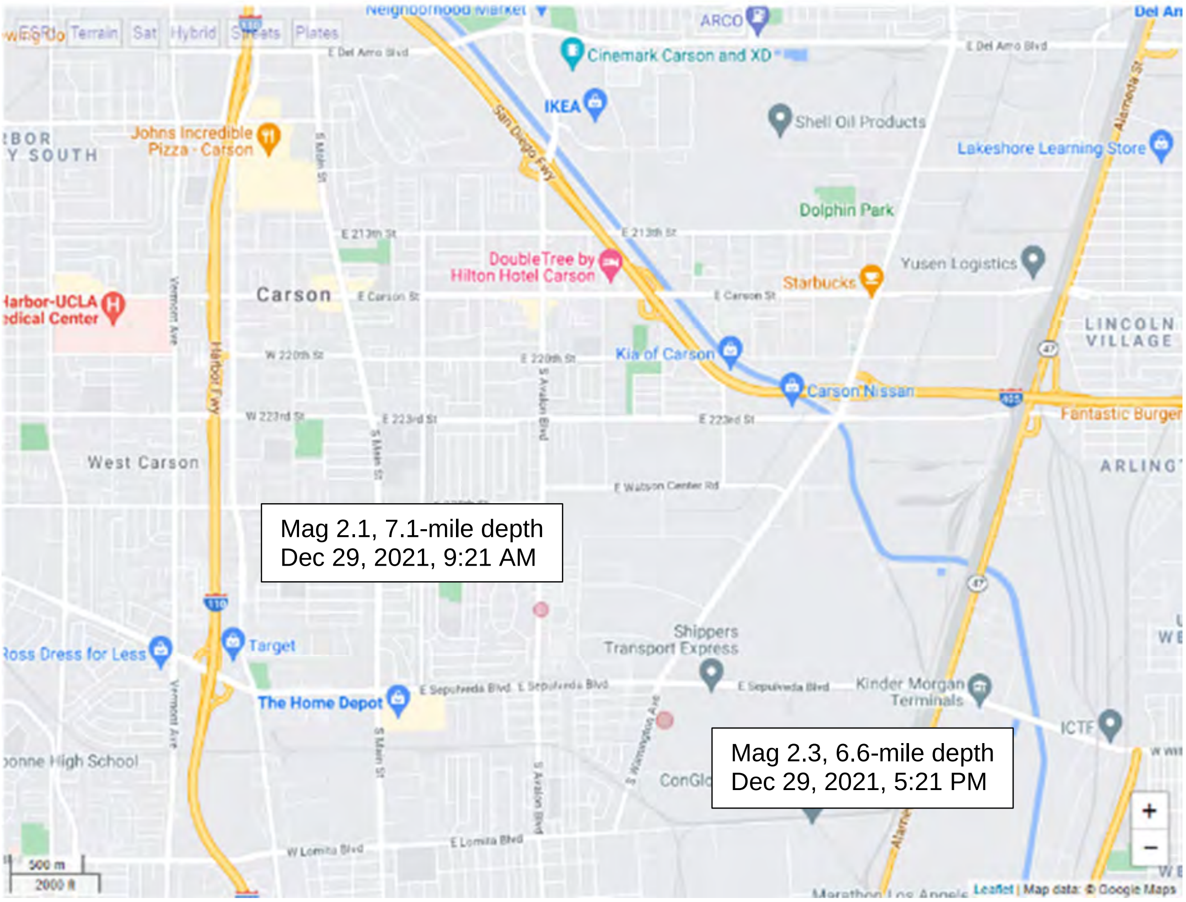


Figure 3-7 Carson Area Earthquakes

As seen in **Figure 3-7**, two earthquakes (magnitude 2.1 and 2.3) occurred in the Carson area on December 29, 2021. The epicenter of both earthquakes was more than 2 miles from the failure site. It is not believed that these seismic events were major contributors to the failure.

3.7 Potential Failure Theories

Although we know that the pipe and manhole both failed in this event, the limited information available does not point to a definitive physical cause and the sequence of the failure may never be known. What is known is that the pipe and manhole experienced severe corrosion because of microbially induced concrete corrosion (MICC). This occurs when sulfur oxidizing bacteria convert the sewer gas, hydrogen sulfide, into sulfuric acid. Unprotected concrete is corroded away by the sulfuric acid. This explains why the pH of the pipe surface, as noted in Section 3.2, was typically measured as between 1 and 3 (very acidic) during inspections.

With corrosion as the primary factor and consistent with the Districts' professional opinions, the main theories for the failure and the potential sequence of events are listed below:

Theory 1: Pipe segment P20116 corroded enough to develop a hole earlier than December 30, 2021. The soil around the pipe was initially not wet enough to flow freely through the opening in large amounts. On December 30, 2021, a sewer surcharge and surface rainfall, with added water from the adjacent building's roof drain, wettened the unpaved soil over the pipe enough to allow it to flow through the pipe wall opening, causing a sinkhole and a larger pipe failure and blockage. The sinkhole also caused a differential horizontal soil loading on the adjacent corrosion weakened manhole 476, causing it to also fail.

Theory 2: Assisted by the wet weather surcharge on December 30, 2021, pipe segment P20116 developed multiple holes along the pipe spring line. From the site excavation photographs (refer to Photo 3-7), it appears the pipe failed at the spring line and the crown fell into the pipe somewhat intact. It appears the drop of the crown happened somewhat uniformly across an approximately 15-foot-long section of the pipe. This sudden and lengthy collapse combined with the soil overburden pressure was enough to fully stop sewer flow. In typical sinkhole events, the Districts usually see a smaller pipe hole that allows for a slower introduction of soil into the pipe that flows more easily downstream causing the sinkhole to be almost "self-cleaning". The sinkhole also caused a differential horizontal soil loading on the adjacent corrosion weakened manhole 476, causing it to also fail.

Theory 3: The wet weather surcharge and surface rainfall, with added water from the adjacent building's roof drain, on December 30, 2021 caused the corrosion weakened manhole 476 to collapse within itself. This led to a greater surcharge on the system leading pipe segment P20116 to fail and causing pipe crown segments and soil to enter the sewer resulting in a sink hole and blockage. If the manhole failed first, this could explain why manhole riser debris was not found in the excavation – it was able to flow downstream before the final blockage occurred.

In analyzing a failure like this, there are typically multiple contributing factors that lead to the failure. Based on the review of available information including CCTV data, examination of portions of the failed pipe, and flow information, corrosion of the sewer system (both the pipeline and the manhole) appears to be the primary factor for the cause of the failure. The wet weather surcharge on the sewer was also likely a contributing factor as it occurred during a storm. It is unlikely that the load from the nearby building played a significant role in the collapse. The exact cause and sequence of this failure will never be known, but it appears that Theory 2 is the most probable.

3.8 Findings and Recommendations

The following sub sections summarize our conclusions for various items studied for Task 1. Many of these items are compared to the procedures of other agencies and studied in Tasks 2, 3 and 4.

3.8.1 Operation of Main Street Pumping Plant

In February 2021, due to the completion of the 216th Street Replacement Trunk Sewer Phase 1 that mitigated capacity related overflow potentials, the operation of the Main Street Pumping Plant changed from staffed manual operation to fully automated operation of the Plant during storms. Based upon the review of pump discharge flow data, Manhole Smart Cover Data, and pipe capacity calculations, it appears that the 216th Street Relocation Trunk Sewer did surcharge during the storm on December 30, 2021. A more detailed review of the wet weather flows and associated surcharge in the 216th Street Relocation Trunk Sewer should be conducted to gain a higher level of confidence of the level of surcharge. This analysis would be greatly simplified if a sewer model was available.

3.8.2 CCTV Inspections

The CCTV videos GHD viewed for this report were low quality. Observing defects and progression of defects is difficult in videos of this quality. The CCTV inspection program could be enhanced in several ways including:

- Use equipment that can capture higher quality images
- Track year to year progression of pipe defects in the lower rated sewers
- Conduct the inspections under lower flow conditions if possible, particularly for lower rated sewers
- Coordinate inspections with maintenance activities. For example, conduct the inspection before the application of crown spray. This is already the usual practice but it can be optimized.
- Review how inspection work is contracted to achieve a certain level of data quality.

3.8.3 Conditions of Pipes

From the 2015 Memorandum requesting a rehabilitation project, the unlined pipes on the 216th Street Relocation Trunk Sewer were all Rated 1 and 2 (the two poorest ratings on of scale of 4). At that time, the segment that collapsed was Rated 2. If a rehabilitation or replacement project is taking longer than recommended in the project request memorandum, the Districts should consider implementing interim measures to reduce the risk associated with the sewer collapse and/or SSO, such as rehabilitating the damaged sewer with cured-in-place pipe (CIPP) lining or other measures.

3.8.4 Inspection of Manholes and Junction Structures

It is understood that the Districts do not have a formally established inspection program for sewer manholes and junction structures. Although the role of the manhole in this failure is unclear, it certainly did not perform well in this event. It is recommended that the manholes be inspected at the same time that the pipelines are CCTV inspected, particularly for pipes currently rated 1 or 2 (the two poorest ratings on of scale of 4). A process similar to the National Association of Sewer Service Companies (NASSCO) Manhole Assessment Certification Program (MACP) is recommended to be utilized.

4. Task 2 - Emergency Response to SSO

A collaborative response to the SSO was performed by various groups within the Districts including WCS, CM, and the PI. The following sections list the response timelines and actions taken by each group.

4.1 Response to Overflow – Wastewater Collection Systems (WCS) and Construction Management

4.1.1 Timeline and Speed of Response

The timing and initial actions taken by WCS staff are listed below. All listed times are approximate.

On December 30, 2021:

- At 1:50 p.m. the Districts' Joint Water Pollution Control Plant (JWPCP) was contacted by a resident about the overflow on West 212th Street. In a follow-up discussion approximately a week later, the resident stated that the overflow was first observed at about 1:30 p.m.
- JWPCP staff contacted Districts Wastewater Collection Systems (WCS) Superintendent of Operations and Maintenance who dispatched staff to the site to investigate.
- Districts' staff arrived on site at 2:14 p.m., approximately 24 minutes after the initial notification.
- Districts' staff immediately cordoned off each end of West 212th Street to keep the public away from the overflowing manholes and dispatched additional staff.
- At 2:19 p.m, initial efforts by Districts' staff to investigate and troubleshoot the SSO focused on the Main Street Pumping Plant (MSPP) pumping operations, including turning down the speed of the pumps to reduce the flow from the plant.
- At 2:33 p.m., additional Districts' staff arrived at MSPP to assist with the troubleshooting of the plant.
- At 3:19 p.m., after determining that MSPP operation was likely not the cause of the SSO, it was suspected that a downstream blockage was causing the SSO. Districts' staff began checking downstream manholes for surcharge conditions to locate the blockage.
- At 3:25 p.m., staff determined that MH 08-0463 (near Carson Street and the Harbor Freeway) was surcharged, indicating that the blockage was downstream of this manhole.
- At 3:48 p.m., additional staff were dispatched to assist with locating the blockage. Staff checked MH D-0008 (near 228th Street and the Harbor Freeway) and was found to be not surcharged so the blockage was determined to be located between these two manholes.
- At 4:45 p.m., a sewer bypass contractor, Charles King Company (CKC), was contacted by CM staff.
- At 5:00 p.m., Districts' staff knocked on all doors of affected homes to notify residents of the spill.
- At 5:03 p.m., Districts' staff arrived at MH 08-0644 and discovered a sinkhole between MHs 08-0644 and 08-0476 along the 216th Street Relocation Trunk Sewer.
- Construction Management (CM) staff arrived at the sinkhole site at approximately 5:35 p.m. and began to assess the needs for bypassing flow around the collapsed sewer and for clearing the collapse to restore flow in the sewer.
- At 5:50 p.m., CM contacted the construction contractor Lucas Builders, Inc. (LBI) that was working on a Districts' construction project very close to the sinkhole. This contractor did not have staff available to respond to the emergency.
- At 6:15 p.m., CM contacted two other contractors, and W. A. Rasic Construction (WAR) was available to respond to the emergency.
- Sewer inspection staff arrived onsite at 6:33 p.m. and attempted to video inspect the sewer line by closed-circuit television (CCTV) from MH 08-0475, the first manhole downstream of the collapse.

.

- At 7:33 p.m., CKC staff arrived onsite and began to plan for the bypass setup.
- At 8:00 p.m., WAR staff arrived onsite to coordinate excavation of the sinkhole area to clear the sewer pipe of soil and debris to re-establish flow in the sewer.
- At 8:42 p.m. CHP was called to request closure of the offramp.
- At 9:30 p.m. the Harbor Freeway (I-110) northbound off-ramp to Figueroa and 220th Streets was closed to traffic.

On December 31, 2021:

- At 12:50 a.m. WAR started installing shoring and secured the sinkhole site by 3:00 a.m.
- The first sewer bypass pump started operation at 2:10 a.m. and a second bypass pump was added at 2:40 a.m.
- The MSPP began holding back flow at 7:39 a.m., and soon after the SSO initially ceased due to this reduction in flow.
- At 8:50 a.m., a third bypass pump started operation and at 12:15 p.m., a fourth bypass pump started operation.
- By 10:00 a.m., MSPP was no longer able to hold back sufficient flow and the SSO restarted.
- With the overflow contained to the north gutter, Districts' staff proceeded to clean and flush the south side of West 212th Street including the affected sidewalks and driveway aprons during the day while the overflow was still occurring.
- Districts' staff worked with CKC to evaluate options for installing additional bypass pumping capacity.
- A fifth bypass pump started operation at 8:45 p.m., which was nearly enough to stop the SSO.
- The SSO rate decreased as sewer flows declined and by 9:38 p.m. the SSO stopped. The total duration of the active SSO was approximately 32 hours.
- Water quality sampling began at one location on December 30, 2021. On December 31, 2021, 14 monitoring locations were added. Three offshore Long Beach monitoring locations were added on January 1, 2022, and two locations at the Torrance Lateral were added on January 4, 2022 and January 12, 2022. A total of 20 locations were monitored in response to the SSO. Preliminary bacterial monitoring results were shared with Los Angeles County Department of Public Health (LACDPH), Long Beach Health, and Orange County Health Care Agency (OCHCA) as they became available.
- Once the overflow had stopped, Districts' staff started operations to clean and flush the remaining impacted street, curb and gutter areas on the north side of West 212th Street.

On January 1, 2022:

- In the early morning hours, Districts' staff continued operations to clean and flush the remaining impacted street, curb and gutter areas on the north side of West 212th Street prior to sunrise.
- Later in the morning and into the afternoon, Districts' staff cleaned and flushed the impacted street, curb and gutter areas on the north side of West 212th Street again to ensure that they were fully clean.
- Throughout the day, Districts' staff visited impacted residents where the SSO occurred and provided a notice explaining the Districts offer of complimentary driveway cleaning and car washes.
- At 1:45 p.m., Districts' staff completed set up of the containment and proceeded to flush the storm drains.
- Cleanup of the impacted street areas was completed at 2:50 p.m.
- Cleanup of the landscape area was completed by 5:00 p.m. All cleanup activities by Districts' staff were completed by 5:55 p.m.

On January 2, 2022, Districts' staff visited residents again and clarified the restoration efforts including replacement of parkway grass and pavers and the option for onsite car washes.

On January 3, 2022, Clean Harbors conducted additional cleaning and disinfection of the area impacted by the SSO.

On January 3, 2022, four of the five beaches that were closed by LACDPH and the two Orange County beaches reopened.

On January 5, 2022:

- The Long Beach city beaches and inner Cabrillo Beach reopened.

On January 5, 2022, Clean Harbors returned to the SSO site and conducted additional cleaning and disinfection of the street, curb, and gutter on the north side of West 212th Street.

On January 6, 2022, Districts' staff provided a mobile car washing service to impacted residents that continued over several days.

Landscape repair began on January 7, 2022 and were essentially complete by the end of January 2022.

On January 7, 2022, the 42-inch corrosion-resistant Centrifugally Cast Fiberglass-Reinforced Polymer Mortar Pipe (CCFRPM) was delivered to the emergency repair site to slip-line the existing 48-inch sewer. Repair of the damaged sewer and approximately 200 feet of the downstream sewer began that evening.

On January 8, 2022:

- The downstream segments were installed by 3:20 a.m.
- The remaining CCFRPM segments were installed by 6:00 a.m.

On January 9, 2022, grout was injected in the annular space between the outside of the new 42-inch CCFRPM pipe and the inside of the existing 48-inch reinforced concrete pipe.

On January 10, 2022, the excavation where the sinkhole occurred was backfilled.

On January 11, 2022, site restoration, including general cleanup, restoration of disturbed landscaping, and equipment demobilization began.

On January 13, 2022 at 1:00 p.m., site restoration was completed.

The I-110 Freeway off-ramp to Figueroa and 220th Streets was reopened to traffic on January 13, 2022 at approximately 8:00 p.m.

4.1.2 Regulatory Notifications

After verifying the SSO was occurring, regulatory notifications were completed as follows:

- WCS staff notified the Districts' Central Alarm Center and a notification email was sent at 2:51 p.m. on December 30, 2021 to provide initial notification of the overflow to:
  - Los Angeles County Department of Public Health (LACDPH),
  - Long Beach Health and Humans Services (Long Beach Health),
  - Los Angeles County Department of Public Works (LACDPW),
  - Los Angeles Regional Water Quality Control Board (Regional Board).
- The Districts provided initial notification of the SSO to the Los Angeles County Operator at 3:05 p.m. on December 30, 2021 and follow up notifications were provided to the Los Angeles County Operator.
- The Districts provided initial notification of the SSO to the California Office of Emergency Services (Cal OES) Warning Center at 3:41 p.m. on December 30, 2021 and follow up notifications were provided to Cal OES.
- The Districts' WCS Manager contacted the Districts' Reuse and Compliance staff at 2:38 p.m. on December 30, 2021 to develop a monitoring plan.
- Reuse and Compliance staff immediately developed a monitoring plan which was finalized and distributed to Districts' staff at 8:10 a.m. on December 31, 2021.
- OCHCA was notified at 9:20 a.m. on December 31, 2021.

4.1.3 Decision Making Process

The decision-making process for the SSO response was conducted as follows. After receiving the initial notification about the SSO, staff was sent out to the site to confirm this was Districts' SSO. The decision-making process followed the following steps:

- Based upon observations at the site (water flowing out of a Districts' manhole cover) it was quickly determined to be an SSO and on a Districts' sewer line.
- Because of a prior history of SSOs at this location, it was initially thought that the MSPP operations may have been causing the SSO. After about an hour of investigations at the MSPP, it was determined that the plant did not appear to be the cause of the SSO.
- Then manholes downstream of the SSO were checked looking for a surcharge condition (upstream of a blockage) and a non-surcharge condition (downstream of the blockage). Access to several of the manholes on the 216th Street Replacement Trunk was impacted by walls and locked gates. The blockage/collapse site was located within 3 hours of SSO confirmation.
- Simultaneous with the manhole investigations, a sewer by-pass contractor, Charles King Company, was contacted as it was deemed likely bypass services would be required. CKC was onsite within 5.5 hours of SSO confirmation.
- Construction contractors were contacted within an hour of finding the collapsed area. The initial contact was with a contractor constructing a sewer for the Districts nearby on Figueroa Street but the contractor was unavailable. A second contractor, WAR, was available and on-site within 2 hours of contact, within 6 hours of SSO confirmation.

The decision-making process completed by WCS and CM was reasonable and effective.

4.1.4 Technical Approach

Once the contractors mobilized and got on site, work began on bypassing flow and repairing the collapsed pipe within 12 hours of confirmation of the SSO. The technical approach to both of these tasks is described in the following paragraphs.

A flow bypass was set up between manhole 08-644 (immediately upstream of the collapse) to manhole 08-475 (the first manhole downstream of the collapse), a distance of approximately 750 feet. Bypass hoses were lain along the Caltrans' right-of-way line and a hole was cut in the freeway sound wall to provide access for the hoses to manhole 08-475. In total, 8 temporary pumps were used to bypass the flow.

The site stabilization and pipe replacement process was performed using trench box shoring along with a combination jetter-vacuum truck and excavator for soil removal. After removing material down to the pipe invert and in the adjacent section of pipe, 42-inch Centrifugally Cast Fiberglass-Reinforced Polymer Mortar Pipe (CCFRPM) was slip-lined inside the original 48-inch RCP from the collapse site to approximately 200-feet downstream. The annular space between the exterior of the CCFRPM pipe and the existing RCP was injected with grout.

Given the tight constraints of the site, the approach to the bypass and the repair with 42-inch CCFRPM pipe are acceptable method. The CCFRPM pipe is corrosion resistant and has acceptable strength characteristics for this application. The 200-foot length of the slip lining downstream of the collapse area provides rehabilitation to the segment of the pipe located under the building. If this pipe is intended to be kept in service, additional rehabilitation of the remainder of the pipeline should be implemented. At the time of this report, it was noted that this is currently being completed.

4.2 Response to Overflow - Districts' Public Information Section

Working in conjunction with WCS and CM the Public Information (PI) Section was utilized to provide communications to the public about the SSO. The following sections list the timelines and actions taken by the Public Information Section.

4.2.1 Timeline

The timing and actions taken by Public Information Section staff are listed below. All listed times are approximate.

On December 30, 2021:

- At 5:15 p.m., the Districts' Public Information Officer (PIO) received a call from the sewer management manager providing information about an ongoing significant sewer spill
- At 6:35 p.m., the first statement was listed on the PI website with matching posts on social media channels.
- At 6:45 p.m., the first of two members from the PI Section arrived on site at 212th.
- By 7:15 p.m., Districts' staff went door-to-door, notifying all residents on 212th Street about the spill.
- By 9:30 p.m., two additional updates were published on the website and social media channels.
- Districts' staff remained onsite throughout the night and the day when the spill was stopped and the first round of road cleaning was finished.
- PIO staff remained on site until the spill was stopped.

On December 31, 2021:

- PIO staff remained at the 212th Street until 6 a.m. PIO staff then went to the second location at the Carson Street offramp of the Northbound 110 Freeway to get an update on the repairs.
- At 11 a.m., Districts' staff went door-to-door talking to residents about the spill and providing a notice to residents about what had happened and how to contact the Districts for more information. If a resident did not answer the door, a notice was left at the home.
- Three signs were posted on the street with information about the sewage spill.
- Two updates were posted on the Districts Website and social media channels.

On January 1, 2022:

- At approximately 4 p.m., Districts staff went door-to-door and spoke to over 75% of the affected households. PI offered to schedule free car washes and driveway cleaning. Residents mentioned additional damages to their parkways (grass and pavers) and one resident mentioned that air bubbles were coming from the lateral to her house.
- A second notice (English/Spanish) was provided at every home with sewer repair updates, services offered, claims form and contact information.
- Update posted to the Districts' website and social media channels.

On January 2, 2022:

- At 1 p.m., Districts' staff went door-to-door and spoke to 70% of residents. PI offered to schedule car washes and replace parkway materials.
- A third notice (English/Spanish) was handed to residents that clarified the services being offered and the claims process.
- By the end of this day, PI had spoken to 14 of the 17 households immediately affected by the spill.
- An update was posted to the Districts website and social media channels.
- Arrangements to have all notices translated to the Korean language (a Korean resident lives in the affected area) were made.

- Districts’ staff were onsite from 1 p.m. to approximately 3 p.m.

On January 3, 2022:

- At 7:30 a.m., Districts’ staff were on site with Clean Harbors, a third-party cleaning service that would be cleaning all driveways, sidewalks and the south side of the street (the other half was filled with cars). PI monitored their work while answering any questions that neighbors had.
- At 11:00 a.m., PI staff went door-to-door with the Carson Mayor Davis-Holmes, the Districts’ General Manager, and Carson community leader Dianne Thomas.
- Connected with the owner of a 15th house and learned that tenants lived in a back house. The tenants were not reached that day.
- Scheduled to have Roto-Rooter visit the home where air was observed to be bubbling from the clean out plug on their sewer lateral.
- Update posted to the Districts website and social media channels.
- Districts’ staff were onsite from 7:30 a.m. to approximately 1 p.m. In the evening, PI attempted to contact residents not reached earlier that day.

On January 4, 2022

- Followed up by phone with residents not reached the day before.
- Began scheduling onsite car washes.
- Roto Rooter serviced the sewer lateral to one home.
- Update posted to the Districts’ website and social media channels.

On January 5, 2022:

- PI staff was onsite to monitor Clean Harbors cleaning of the north side of 212th Street.
- PI staff spoke to a 16th household, a Spanish-speaking family who had been away on vacation.
- Followed up with residents to schedule mobile car washes and share expected timeframe for parkway replacement. Took note of residents who agreed to have their parkway replaced.
- Update posted to the Districts website and social media channels.
- A statement from the Districts’ General Manager was emailed to over 400 people
- Districts’ staff were on-site from 7:30 a.m. until approximately 12:00 p.m.

On January 6, 2022:

- Car washing began at 9 a.m. Districts staff followed up with the residents who had their cars washed to make sure the wash met their expectations.
- Went door-to-door offering residents a variety of parkway landscape options. Also followed up with residents to schedule their car washes.
- A fourth notice (English/Spanish) was handed to residents. This notice explained the different parkway replacement options.
- Contacted the 17th (final) household, whose preferred language is Korean.
- Districts staff provided a Korean translation of all four of the preceding handouts to household that speaks Korean.
- Update posted to the Districts website and social media channels.
- Districts’ staff were on-site from 7:30 a.m. to approximately 6 p.m.

On January 7, 2022:

- Districts’ staff were onsite to address any concerns and remind residents of what to expect that day.
- 12 cars were washed.
- Parkway replacement began with removal of existing materials.
- All residents were contacted to confirm the type of parkway they wanted.

- Update posted to the Districts' website and social media channels.
- The Districts' General Manager Statement from January 5th was posted to the Districts' website and social media channels.
- Districts' staff were on-site from 7:30 a.m. to 3:30 p.m.

4.2.2 Staffing

The staffing of the Districts' Public Information Section, in comparison to LASAN and OC San is summarized in **Table 4-1**. In addition to these staff, LASAN and OC San often utilize consultants in these groups to provide support on construction projects.

Table 4-1 Agencies' Public Information Staff

	Districts	LASAN	OC San
Public Information Staff	10	7	6

4.2.3 Communication with Stakeholders

Specific communication with various stakeholders was conducted as noted in the following sections.

On December 30, 2021:

- 6:50 p.m.: Notification email about the spill from Districts' General Manager to Carson Mayor Davis-Holmes.
- 7:30 p.m.: Notification email about the spill from Districts' General Manager to Supervisors Hahn and Mitchell and LA Councilman Buscaino.
- Night-time: Verbal notifications to the 17 affected homes and passerbys.

On December 31, 2021:

- Verbal notifications and handouts to affected residents and passerby.
- 10:30 a.m.: Update email about the spill from Districts' General Manager to Carson Mayor Davis-Holmes, Supervisors Hahn and Mitchell, and LA Councilman Buscaino.
- 1:30 p.m. : Conversation between Districts' General Manager and Supervisory District 4 deputy Matt Johnson.

On January 4, 2022:

- Visit to affected residents on 1/4/22 by the Carson Mayor Davis-Holmes and Districts' General Manager.
- Presentation to Carson City Council meeting.

On January 5, 2022: presentation to City of Carson Environmental Committee meeting.

On January 6,7,8,9,10,13 and 24: Updates were posted to the Districts' website and social media channels. Updates were also emailed to City staff, media who had shown interest in the spill and elected offices who requested updates.

On January 18, 2022:

- Presentation at Carson City Council meeting.
- Updates were emailed to City staff who posted on their social media.
- Updates were emailed to elected offices who requested updates.

4.2.4 Communication with Media

Updates of the SSO status were emailed to media who had contacted the Districts about the spill. **Table 4-2** lists the media outlets that received this information.

Table 4-2 Media Contacts List

12/30/2021 Carson Sewage Spill Media Contacts	
Name	Media Outlet
TV	
Emily Holshouser	ABC 7/KABC-TV
Jessica M. De Nova	KABC TV News
Kandiss Crone	CBS TV News
Melissa Lopez	Fox TV News
Erin Myers	KTLA 5
Shelby Nelson	KTLA
Genia Dulot	Voice of America
Radio	
Pete Demetriou	KNX 1070 Newsradio
Elly Yu	KPCC
Erin Stone	KPCC + Laist
Jill Replogle	Southern California Public Radio, College Pathways
Nate Perez	Southern California Public Radio 893. KPCC 89.1 KUOR 90.3KVLA 89.5 KJAI
Written News	
Amy Taxin	Associated Press
Alaa Elassar	CNN Digital
Donna Littlejohn	Daily Breeze
Micaela Ricaforte	The Epoch Times
Kelly Puente	Long Beach Post
Quinn Wilson	Long Beach Press-Telegram
Jim Rainey	Los Angeles Times
Eduardo Medina	New York Times
Laylan Connelly	Southern California News Group - Orange County Register
Lisa Jacobs	Southern California News Group

4.2.5 Social Media Use

Social media was used by the PI group as follows:

- At 6:35 p.m. on December 30, 2021, information about the incident was posted on the Districts' website (www.lacsd.org/sewagespill).
- Updates were also posted on all of the Sanitation Districts' social media accounts (Facebook, Instagram, Twitter and NextDoor). These posts were tagged with City of Carson and LA County Department of Public Health to help those agencies share the posts to a larger group of people.
- Updates were emailed to City staff who posted on their social media.
- Statement from Districts' General Manager (Attachment 5A) emailed to over 400 people including (but not limited to) Directors of Sanitation Districts in the Los Angeles basin, city managers and public works directors of cities served in the Los Angeles basin, and the media.

4.3 Sanitary Sewer Overflow Response Plan

In accordance with SWRCB Orders 2006-0003-DWQ and WQ 2013-0058-EXEC, all permittees must prepare a Sewer System Management Plan (SSMP) that covers the following items:

1. Goals

2. Organization
3. Legal Authority
4. Operation and Maintenance Program
5. Design and Performance Provisions
6. Overflow Emergency Response Plan
7. Fats, Oil, and Grease (FOG) Control Program
8. System Evaluation and Capacity Assurance Plan
9. Monitoring, Measurement, and Program Modifications
10. SSMP Audits
11. Communication Program

The Overflow Emergency Response Plan is included in Section 6 of the SSMP and all permittees are required to have one.

Per the SWRCB, a SSO is defined as:

a. Overflows or releases of untreated or partially treated wastewater that reach surface waters. This includes all wastewater releases to storm drain pipes that are tributary to waters of the state that are not fully recovered;
b. Overflows or releases of untreated or partially treated wastewater that do not reach surface waters of the state; and
c. Wastewater backups into buildings and on private properties that are caused by blockages or flow conditions within the portion of a sanitary sewer system.

4.3.1 Review of Districts' SSO Response Plan

The Districts' SSO Emergency Response Plan is included in Section 6 of the February 2019 SSMP. A more detailed procedure is contained in a separate document entitled Sanitary Sewer Overflow Response Plan dated 2008.

Overflow Notification

Upon receiving a report of a suspected overflow, the Districts' staff responds as follows:

- Immediate notification is made to the Districts' Long Beach Main Central Alarm Center (CAC).
- A determination is made whether the overflow could involve Sanitation Districts using sewerage facility maps and other resources. If it is possible that Sanitation Districts facilities are involved, staff immediately mobilizes primary responders and notifies regulatory agencies.
- If it is not possible that the Districts' facilities are involved, staff determines the probable responsible party and refers the matter to them for response.
- If the Districts' facilities are possibly involved, primary responders are mobilized to the scene within one-hour of notification of an overflow to assess the situation. If the primary responders confirm that an SSO involving Districts' facilities is in progress, all necessary equipment, vehicles, and crews are dispatched to the scene or recalled to the field offices to assist with overflow relief, containment and clean-up.

A flow chart for SSO related communications is shown in **Figure 4-1**.

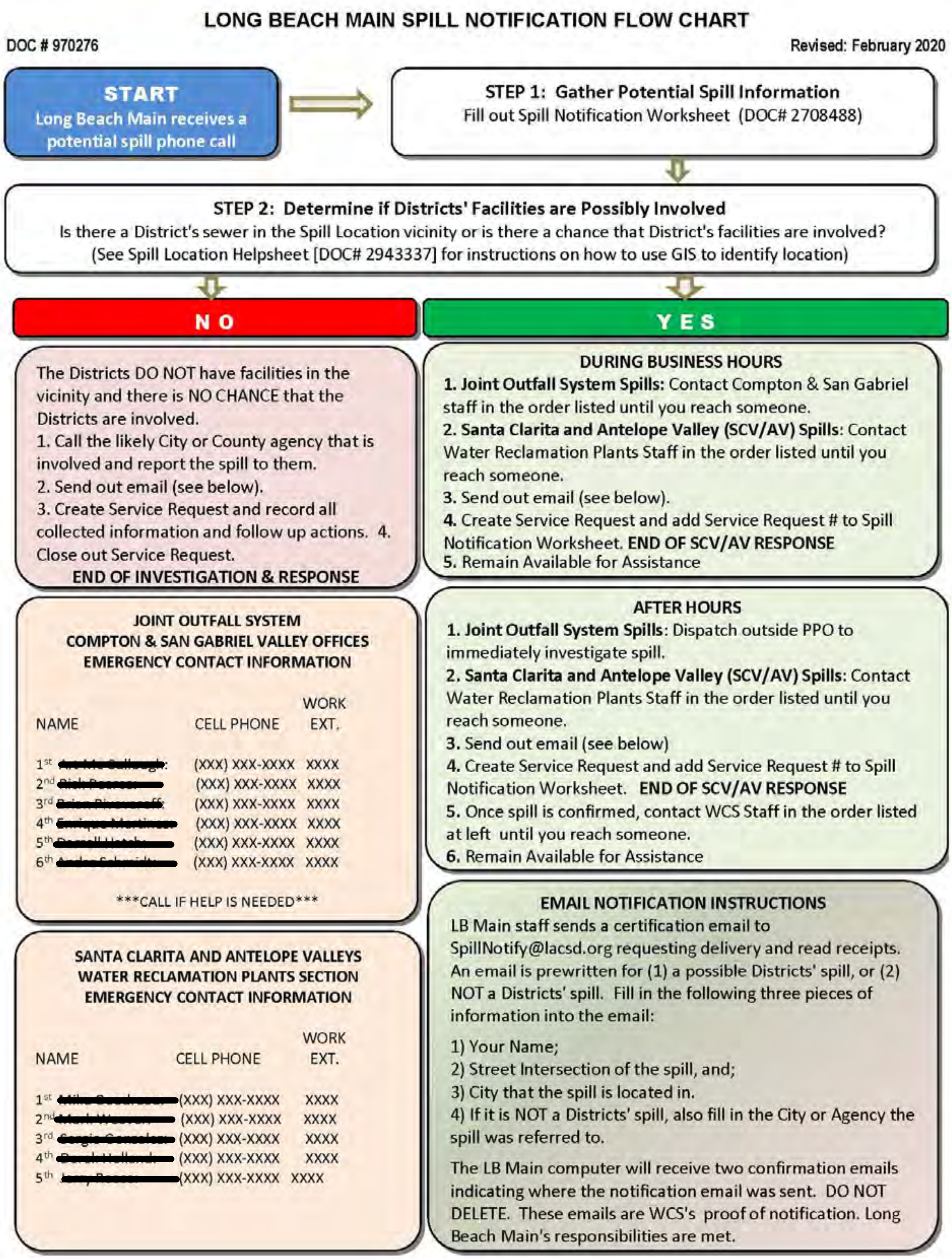


Figure 4-1 Long Beach Main Spill Notification Flow Chart

SSO Response Plan

The Districts' goals regarding overflow response are:

1. Respond to the scene within one hour of notification of an overflow and assess the situation.
2. Prevent overflow from reaching the storm drain, if possible.
3. Limit public access/contact to wastewater.
4. Stop overflow as soon as possible.
5. Contain the overflow as much as possible to minimize environmental impact.
6. Completely recover the contained overflow and return it to the sewer system.
7. Clean up the area contaminated by overflow.
8. Repair damaged facilities that caused or contributed to the overflow.
9. Gather and compile pertinent information pertaining to the overflow and notify regulatory agencies of overflow and response as soon as practical.
10. Conduct investigations todetermine the probable cause of the overflow, document the events and activities during the overflow and response activities and identify and implement measures to prevent recurrence.

Although each overflow event is unique, the Districts respond to most overflows in a somewhat standardized fashion:

1. Several crews are sent to the scene, each under the direction of a lead worker or supervisor.
2. One crew is responsible for corrective action needed to stop the overflow.
3. Another crew is responsible for containment, recovery and cleanup of the spill.
4. Personnel from the above two crews and/or separate crewmembers are responsible for excluding the public/traffic from the area affected by the overflow.

The individual steps involved in the response to a wastewater overflow event include the following:

1. Corrective Action and Site Control
2. Containment and Recovery
3. Cleanup
4. Sampling
5. Notification and Reporting
6. Post-Cleanup Activities, Mitigation, and Spill Prevention

4.3.2 Industry Standards/Benchmarks

The requirements of the Overflow Emergency Response Plan are shown in **Figure 4-2**, obtained from the SWRCB's web site.

D.13.(vi) **Overflow Emergency Response Plan** - Each Enrollee shall develop and implement an overflow emergency response plan that identifies measures to protect public health and the environment. At a minimum, this plan must include the following:

(a) Proper notification procedures so that the primary responders and regulatory agencies are informed of all SSOs in a timely manner;

(b) A program to ensure appropriate response to all overflows;

(c) Procedures to ensure prompt notification to appropriate regulatory agencies and other potentially affected entities (e.g. health agencies, regional water boards, water suppliers, etc...) of all SSOs that potentially affect public health or reach the waters of the State in accordance with the MRP. All SSOs shall be reported in accordance with this MRP, the California Water Code, other State Law, and other applicable Regional Water Board WDR or NPDES permit requirements. The SSMP should identify the officials who will receive immediate notification;

(d) Procedures to ensure that appropriate staff and contractor personnel are aware of and follow the Emergency Response Plan and are appropriately trained;

(e) Procedures to address emergency operations, such as traffic and crowd control and other necessary response activities; and

(f) A program to ensure that all reasonable steps are taken to contain and prevent the discharge of untreated and partially treated wastewater to waters of the United States and to minimize or correct any adverse impact on the environment resulting from the SSOs, including such accelerated or additional monitoring as may be necessary to determine the nature and impact of the discharge.

Figure 4-2 Overflow Emergency Response Plan Requirements

Figure 4-3 and **Figure 4-4,** from the Best Management Practices for Sanitary Sewer Overflow (SSO) Reduction Strategies by the Central Valley Clean Water Association (2019), present guidance on the process and steps to reduce and prevent SSOs. The top of the SSO Reduction Plans begins with the determination of the underlying cause and failure analysis. Based upon the results of the failure analysis, the collection system operator will then develop a corrective action plan that may include maintenance strategies, focused prevention strategies, rehabilitation prevention strategies, or a combination of these strategies for different time periods.

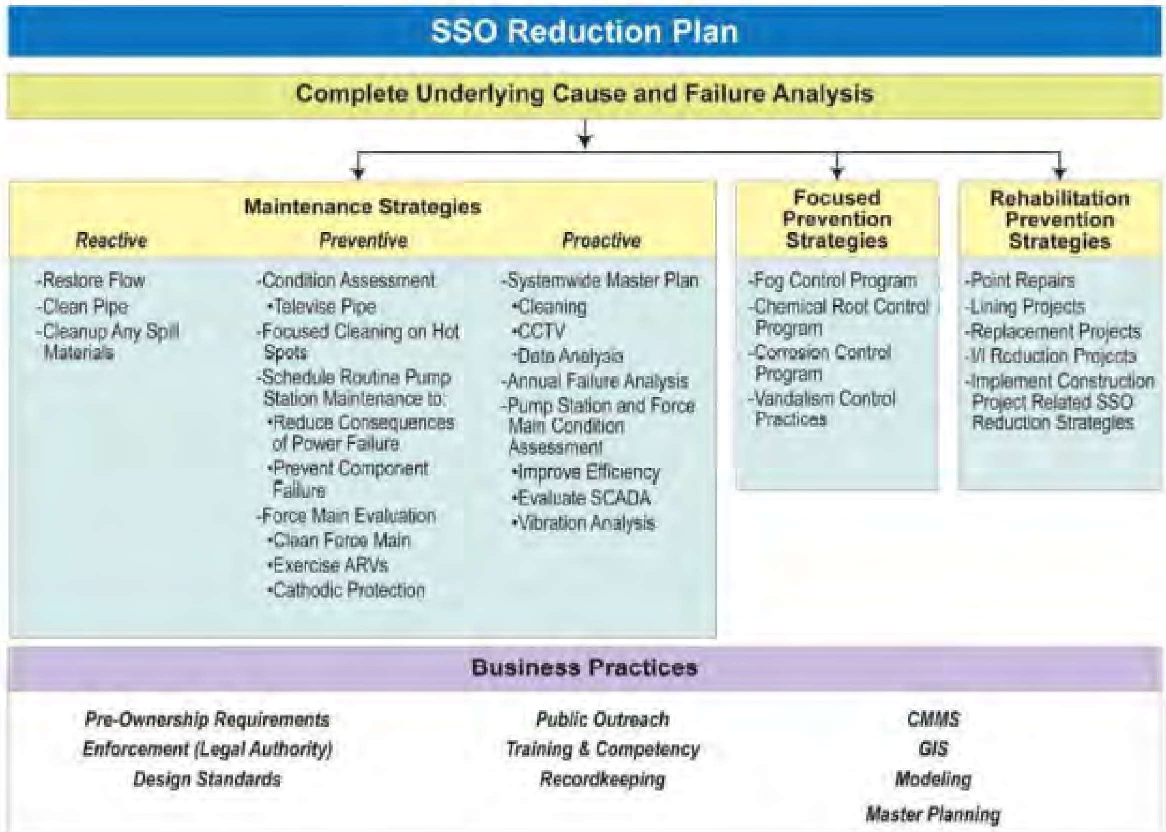


Figure 4-3 SSO Reduction Flowchart

Figure 4-4 presents guidance on a general process after an SSO starts and periodically for system assessments.

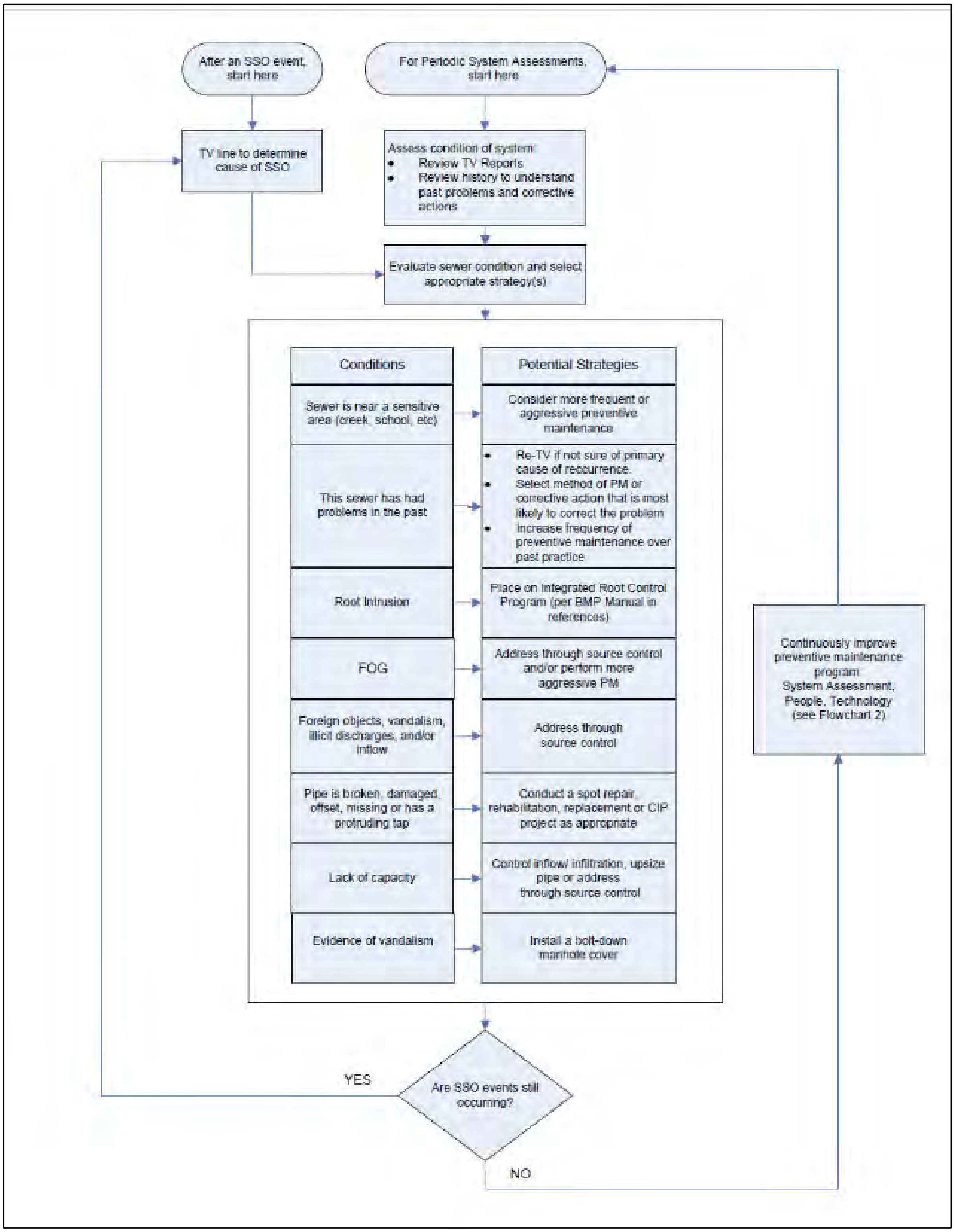


Figure 4-4 SSO Prevention Flowchart

4.3.3 City of Los Angeles Bureau of Sanitation's (LASAN) Plan

LASAN's SSO Emergency Response Plan is included in Section 6 of the January 2019 SSMP. A more detailed procedure is contained in a separate document entitled Sanitary Sewer Overflow Response and Reporting Procedures dated June 26, 2017 and included as Attachment F1 to the SSMP.

Overflow Notification Process

The City encourages citizens to report overflows to LASAN. Citizens may use the toll free telephone number "311" or (800) 773-2489 to report overflows and other sewer problems. Staff is available 24 hours per day, seven days per week to receive calls.

Receipt of Notification

During working hours, a 311 operator uses a layer in NavigateLA to determine where to direct the call and forwards the call to the appropriate district yard.

During after-hours, all 311 calls or calls directly to a yard are automatically forwarded to the Venice Pumping Plant to ensure that none are missed. Notification of possible overflow through other sources are reviewed and manually routed to the Venice Pumping Plant. A responder is dispatched to verify the overflow.

Immediate notification to appropriate parties is required for all sewer overflow that enter waters of the state such as the ocean and waterways.

A contact flow chart and contact list is included in LASAN's Response and Reporting Procedures for SSOs and Sewer or Stormwater Contamination, included below in **Figure 4-5**.

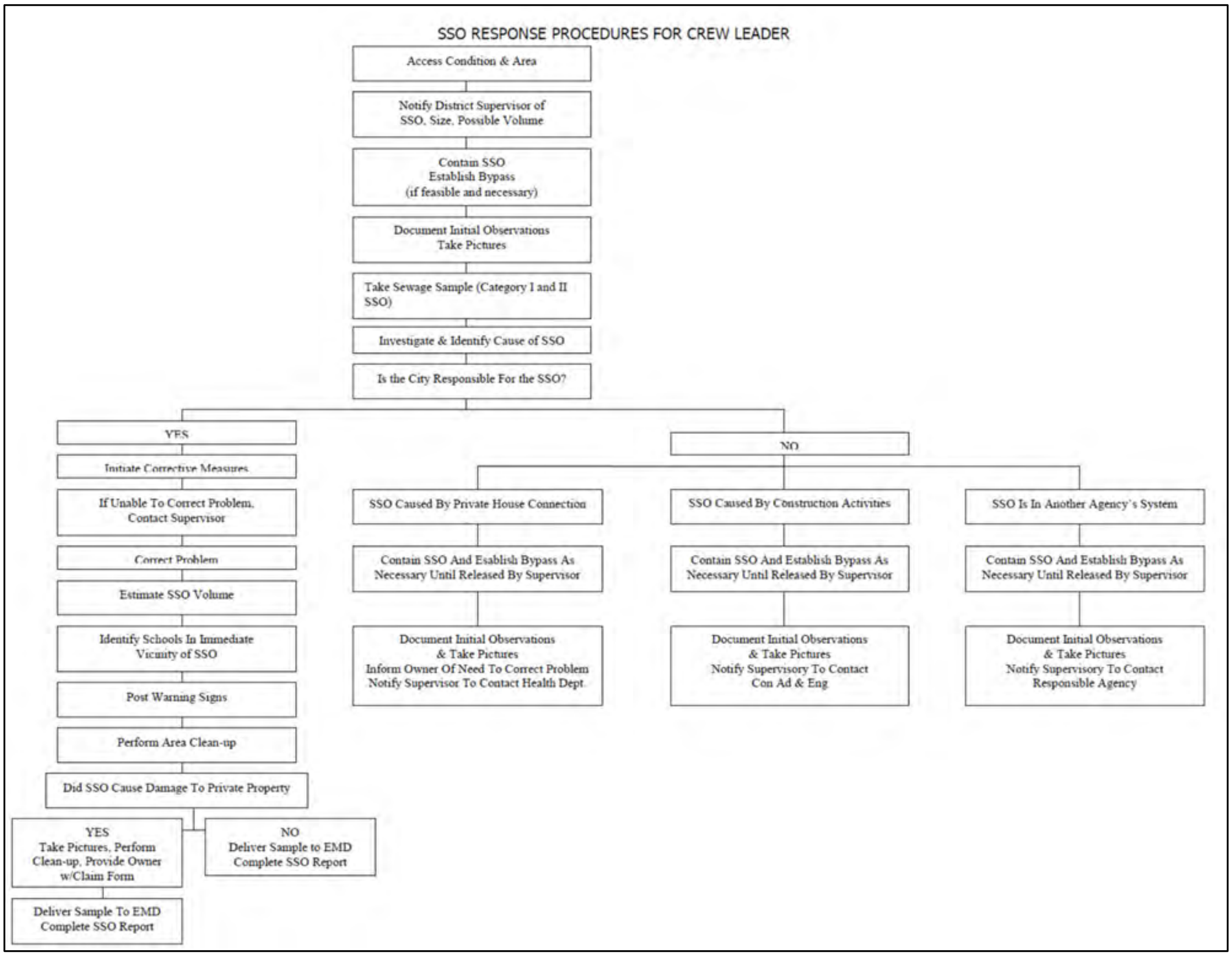


Figure 4-5 SSO Response Workflow in Response and Reporting Procedures for SSOs and Sewer or Stormwater Contamination

Appropriate Response Program

The City's Response and Reporting Procedures for SSOs and Sewer or Stormwater Contamination require full, immediate, and appropriate attention with the ultimate goal of minimizing impacts to public health and safety and the environment.

LASAN's procedures are designed to protect public health and safety, meet all regulatory reporting requirements, and ensure immediate and effective response. Spill response procedures require responders to:

1. **Contain**: Contain the SSO and establish bypass if feasible or necessary.
2. **Restore flow**: Respondents should use appropriate cleaning tools such as flushing or rodding to clear the blockage, cleaning in the upstream direction from a set-up downstream of the blockage. While cleaning, the respondent should observe the flows to ensure that the blockage does not recur downstream.
3. **Bypass, if needed**: If bypass pumping is required, it should be set up to pump around the blockage/pipe failure to convey the wastewater to the nearest downstream maintenance hole or facility. To ensure the fastest possible response, the closest crew to a reported overflow is dispatched to respond.

Emergency Response Plan and Appropriate Staff Training

The emergency response plan is clearly documented and available to all personnel. It is used as a resource in emergency response training. All wastewater operation and maintenance staff are trained on emergency response procedures at least annually.

Emergency Operation Procedures

LASAN has developed and implemented an advanced and comprehensive overflow prevention, response and reporting program. These include timely reporting to the impacted agencies and stakeholders, computer templates for estimating overflow volume, training for overflow review committee, and follow-up CCTV inspection to accurately determine cause and prevention methods.

4.3.4 Orange County Sanitation District's (OCSAN) Plan

OC San's SSO Emergency Response Plan is included in Section 7 of the September 2021 SSMP. More detail of the response is included in the Appendices to the SSMP: SSO Emergency Response Flow Chart (Appendix P1); Environmental Compliance SSO Response Procedure (Appendix P2); SSO Notification Procedures (Appendix P3); SSO Emergency Response Plan (Appendix Q1); and SOPs for SSO Emergency Response and Spill Containment (Appendix Q2).

The Emergency Response Plan consists of the following components:

a. Proper notification procedures so that the primary responders and regulatory agencies are informed of all SSOs in a timely manner;
b. A program to ensure appropriate response to all overflows;
c. Procedures to ensure prompt notification to appropriate regulatory agencies and other potentially affected entities (e.g., health agencies, regional water boards, water suppliers, etc.) of all SSOs that potentially affect public health or reach the waters of the State. All SSOs are reported in accordance with the MRP, the California Water Code, other State Law, and other applicable Regional Water Board WDR or NPDES permit requirements;
d. Procedures to ensure that appropriate staff and contractor personnel are aware of and follow the ERP and are appropriately trained;
e. Procedures to address emergency operations, such as traffic and crowd control and other necessary response activities;
f. A program to ensure that all reasonable steps are taken to contain and prevent the discharge of untreated and partially treated wastewater to waters of the United States and to minimize or correct any adverse impact on the environment resulting from the SSOs, including such accelerated or additional monitoring as may be necessary to determine the nature and impact of the discharge; and
g. A requirement for contractors to develop a Spill Prevention, Control, and Countermeasure Plan, which includes spill notification and response protocols as required by OC San or guidance provided by OC San to contractors in the event an SSO occurs is noted in the OC San Master Spec 02999 Temporary Handling of Sewage.

A SSO response flow chart for actions and notifications/reporting is in **Figure 4-6**.

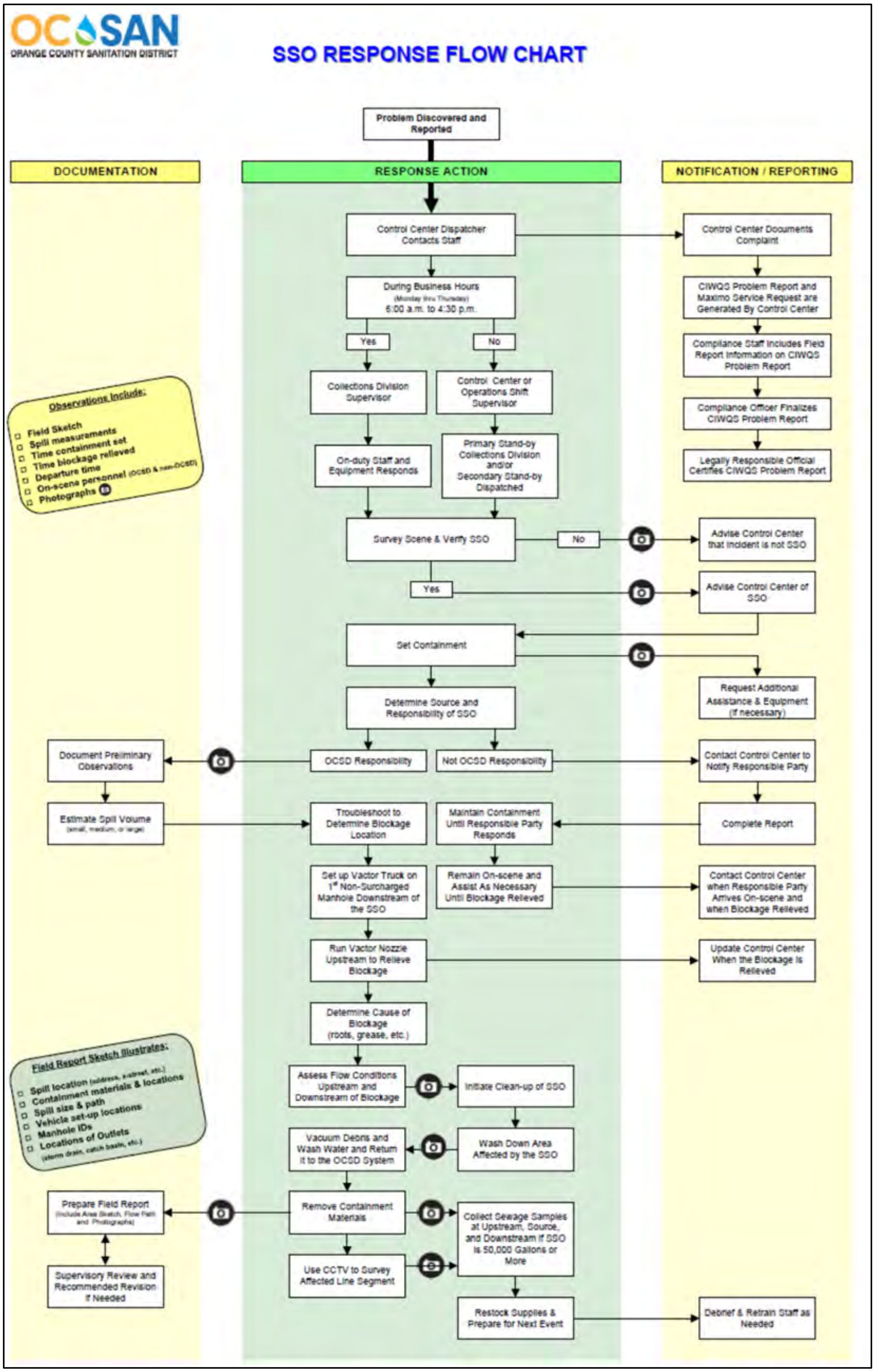


Figure 4-6 OCSAN SSO Response Flow Chart

4.3.5 Comparison of Districts' SSO Response Plan to Industry Standards and Other Local Agencies

The SSO Response plans of the Districts, LASAN, and OC San meet the baseline requirements set forth by the SWRCB. Each have different methods to present the response information, but the core information is similar for all. The minor differences between the Response Plans seem to meet the individual requirements of each agency. For example, the Districts and OC San include a step to verify they are the responsible agency for the spill as both primarily own trunk sewers but not main local collector sewers that are owned by member agencies. LASAN owns both trunks and local mains so they do not include a step to verify ownership.

LASAN and OC San also have developed SSO Response flow charts for the physical actions and notifications that are easy to read and follow. The Districts have a flow chart for SSO notifications but present SSO actions in a text-based format.

4.4 Findings and Recommendations for Improvement

Our findings on the Emergency Response to the December 30, 2021 SSO event are as follows:

- The Districts' staff followed the procedures and met the requirements of their ERP. The goal of responding to an SSO within 1-hour was achieved. Additionally, regulatory notifications were completed in a timely manner.
- The Districts' decision making process for troubleshooting and finding the cause of the SSO was reasonable.
- The technical approach for the bypass and repair of the collapsed section by using contractors was also reasonable. Fortunately the event occurred on December 30th and not the 31st. WAR and CKC (and even other contractors) may not have had staff able to respond as quickly as the New Year's Eve was celebrated on December 31st.
- The Public Information Section followed their Emergency Response Plan and successfully kept stakeholders, the public, and interested media informed of the event. The SSO communication effort was so successful, the Districts received the Grand Prize in the 2022 Environmental Communications Awards Competition from the American Academy of Environmental Engineers and Scientists.
- A review of the SSO ERPs of other agencies do not reveal major procedural differences that the Districts should include in their SSO ERP.

Areas the Districts could consider for improvement are:

- The SSMP Audits for LASAN and OC San are performed by Consultants but the Districts Audits are prepared in-house by a different section (R&C) that is not directly involved with the maintenance and repair of the collections system. Although not a requirement set forth by the SWRCB, an independent third-party Audit may provide beneficial feedback to the Districts.
- When the SSMP and SSO Response Plans are updated next, consider including a flow chart covering both the required actions and notifications.
- The Districts relied heavily on external contractors to perform the sewer bypass and repair the collapsed pipe. If the collapse and SSO occurred one or two days later, during the New Year holiday, it is unclear if contractors would have been available to respond as quickly. The Districts should continue to update and maintain their formal list of emergency contacts to facilitate quick responses from bypass or pipeline contractors.
- At minimum, on an annual basis, the Districts should update both internal and external contacts listed in the ERP, SSMP, and SSO flow charts. The Districts can also include mutual aid agreements with their member agencies to address major spills and use of resources, materials, equipment.
- The Districts' should complete additional repairs of the unlined concrete portions of the 216th Street Relocation Sewer to prolong its service life, particularly if it will be kept in service after the replacement project is completed.

5. Task 3 - Sewerage Maintenance Program and Capital Improvement Plan

Per SWRCB requirements, every enrollee must have a SSMP to provide a plan and schedule to properly manage, operate, and maintain all parts of the sanitary sewer system. This will help reduce and prevent SSOs, as well as mitigate any SSOs that do occur.

5.1 Sewer Maintenance Program Benchmarks

5.1.1 Industry Standards/Benchmarks

The industry standard/benchmark for maintenance program is set forth in the SWRCB's Order and to be documented in the enrollee's SSMP. SSMPs shall include provisions to provide proper and efficient management, operation, and maintenance of sanitary sewer systems, while taking into consideration risk management and cost benefit analyses. The Order is not prescriptive and provides general guidance for enrollees.

Related to maintenance, the enrollee shall describe routine preventive operation and maintenance activities by staff and contractors, including a system for scheduling regular maintenance and cleaning of the sanitary sewer system with more frequent cleaning and maintenance targeted at known problem areas. The Preventative Maintenance (PM) program shall have a system to document scheduled and conducted activities, such as work orders.

Additionally, the enrollee shall adopt a rehabilitation and replacement plan to identify and prioritize system deficiencies and implement short-term and long-term rehabilitation actions to address each deficiency. The program shall include regular visual and TV inspections of manholes and sewer pipes, and a system for ranking the condition of sewer pipes and scheduling rehabilitation and/or replacement. Rehabilitation and replacement shall focus on sewer pipes that are at risk of collapse or prone to more frequent blockages due to pipe defects and aging.

A suggested flow chart is shown in **Figure 5-1**, which was extracted from the Best Management Practices for Sanitary Sewer Overflow (SSO) Reduction Strategies by the Central Valley Clean Water Association (2019).

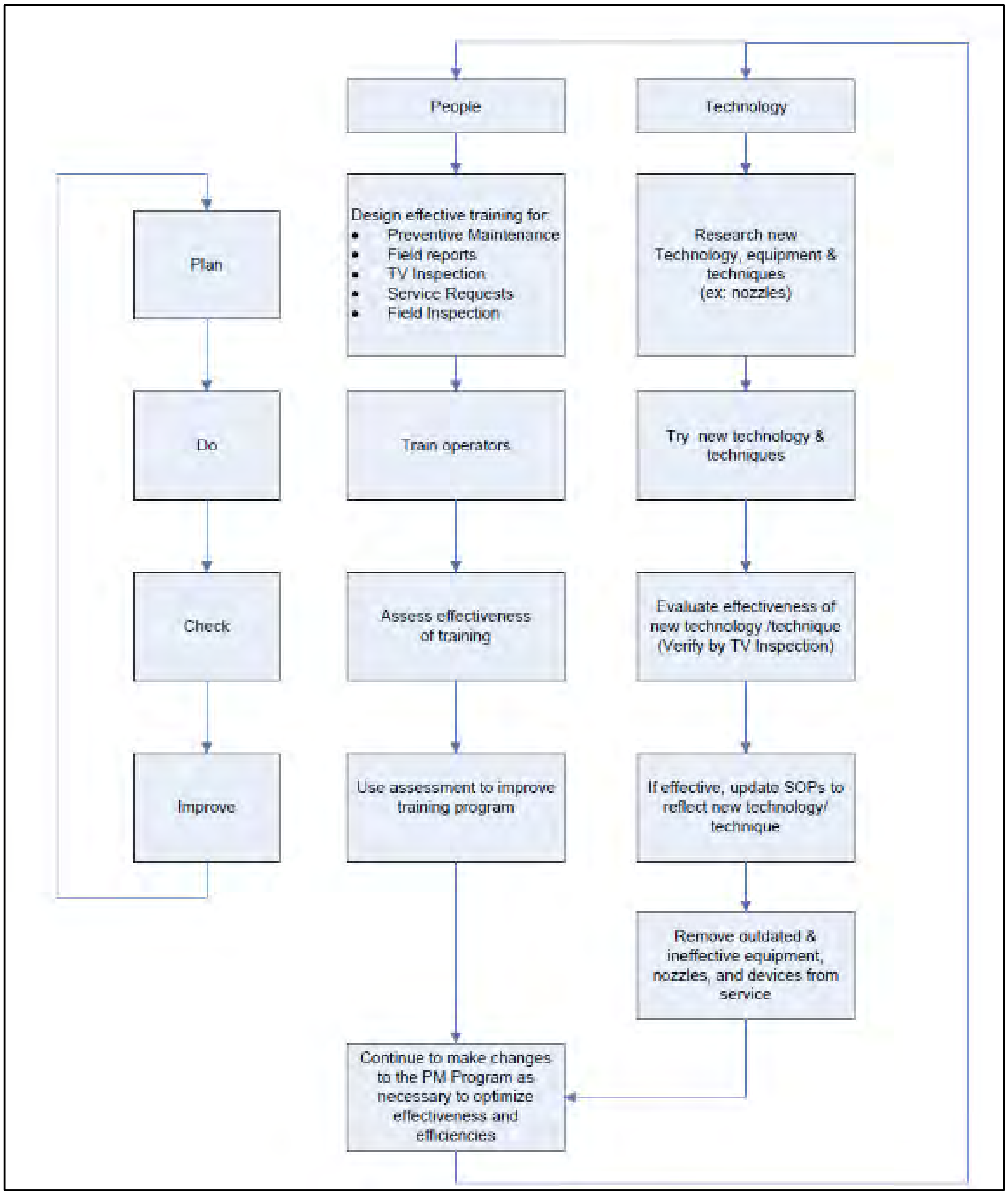


Figure 5-1 Preventive Maintenance Program

5.1.2 LASAN

Detailed operation and maintenance information from LASAN is available in Section 4 of their SSMP. The major items applicable to this audit are summarized in the following sections.

5.1.2.1 Preventative Maintenance Program

The main details of LASAN's preventative maintenance program for collection systems includes the following items:

- Cleaning and easement maintenance – "non-problem" pipes that are less than 16 inches in diameter are cleaned on a three-year cycle; pipes that are 16-30 inches are cleaned on a 5-to-6-year cycle; pipes greater than 30 inches are cleaned as needed. "Problem" pipes cleaned as needed.
- Root Control – mechanical and chemical root control as needed. Once discovered, put on schedule cycle until no re-growth is noted.
- Odor, roach, and pest control – initiated by staff observations and complaints. Remediation measures determined systematically.
- Maintenance hole raising – performed as needed and reported.
- Pumping plant maintenance – routine scheduled maintenance program for 44 pumping plants.
- Emergency repairs – conducted as needed.

All preventive maintenance actions are recorded in LASAN's CMMS.

5.1.2.2 Repair Rehabilitation and Replacement Planning

LASAN assesses and rates the condition of its sewers in an ongoing condition assessment program which includes CCTV, visual inspections, assessment of operating history and performance, and analysis and projection of performance based on asset attributes. Structural deficiencies are identified or estimated and the needed improvements developed and implemented systematically as a part of the City's sewer rehab and replacement plan. There is no program for manhole and junction structure inspections. These assets are inspected during the design phase of a rehabilitation or replacement project. The condition grades for pipe segments and associated CCTV inspection frequency are listed in **Table 5-1** provided by LA Sanitation and Environment Wastewater Engineering Services Division.

Table 5-1 Sewer Condition Assessment

Large Diameter Sewer Condition Assessment		
CCTV RANK	**Condition Description**	**Recommended Action/Response**
A	Very Good Condition • Condition is almost like new sewer pipe.	Re-CCTV in 15 years.
B	Good Condition • Light localized cracks.	Re-CCTV in 10 years.
C	Fair Condition • Moderate cracks/fractures. • Light corrosion. • Moderate infiltration. • Surcharge debris at crown.	Re-CCTV in 5 years.
D-3	Poor Condition • Reached life expectancy; 60-100 years old • Severe cracks/fractures. • Moderate mortar corrosion. • Spalling of Bricks • Delamination • Black discoloration • Bricks are crumbling	Re-CCTV in 3 years*, pre-design in 2-4 years** and schedule construction to start within 6-10 years.
D-2	Very Poor Condition • Reached life expectancy; 100-125 years old • Heavy to severe corrosion. • Large areas with tile missing. • Corrosion almost to rebar. • Cracks on Bricks and/or Mortar • Missing Bricks • Shape Deformation	Re-CCTV in 1-2 years, pre-design in 1-2 years**, and schedule construction to start within 5-6 years.
D-1	Critical Condition • Reached life expectancy; 125-150 years old • Severe corrosion throughout. • Few areas with tile remaining. • Exposed rebar.	Re-CCTV within 1 year, pre-design in 1 year, and schedule construction to start within 3-5 years.
E	Emergency Condition • Collapsed pipe/street. • Broken pipe with holes. • Dirt Pipe. • Crown of pipe is gone. • Void in backfill around pipe. • Full flow obstruction or blockage.	Repair immediately.
* For brick & Brick/Concrete Sewers Re-CCTV in 2 years. **Unless otherwise directed by WESD Division Manager and approved by PRC to start pre-design sooner.		

Revised on 12/07/2020

Conventional CCTV inspections are performed on pipes in the 8 to 16 inches diameter range. For pipes 16 inches in diameter and larger, the inspection equipment utilizes high-definition video in conjunction with laser, sonar, and gas sensors.

In addition to physical condition assessments, LASAN has an ongoing flow monitoring program and hydraulic model. System components with current or projected hydraulic deficiencies are identified.

The City uses three (3) different flow gauging programs to obtain data to evaluate sewer hydraulic condition.

- Near-time Gauging: Continuously monitors 194 locations in major outfall, interceptors, and primary sewers (pipes 16-inch and greater in diameter).
- Periodic Gauging: Monitors over 500 locations in the primary sewers and some secondary sewers (pipes 15 inch or smaller in diameter).
- Special Gauging: Provides for short-term gauging of one day to one week duration and is conducted at any sewer location upon requests by planners, engineers, and operation & maintenance staff.

The flow rates and flow depth to pipe diameter ratios (d/Ds) provided by the Flow Monitoring Program are inputs into the City's dynamic GIS-based hydraulic model of the Primary System. Operating scenarios are simulated to identify system deficiencies and to develop and prioritize capacity relief projects. This data is also used to assist in the preparation of wet-weather operation plans.

The primary collection system (pipes 16-inches and larger in diameter) is modeled against a 10-year design storm and has the capacity to convey 10-year storms and, in some parts of the system, can handle larger less frequent storms. Primary sewers indicating d/D of greater than 0.50 but less than 0.75 are monitored. Primary sewers with d/D of greater than 0.75 are the targets of further evaluation, monitoring, and identification of measures to address capacity issues. Modeled SSOs in the outfall system are reviewed to ensure an overflow will not occur in wet weather events using information such as gauging data and performance during past events.

In the secondary collection system (pipes less than 16 inches in diameter), CCTV data is reviewed to determine the height of the watermark to identify pipe segments showing d/D of greater than 0.50, which will be targeted for upsizing in secondary basin plans.

5.1.3 OC San

Detailed operation and maintenance information from OC San is available in Section 5 and Appendix I-1 of their SSMP. The major items applicable to this audit are summarized in the following sections.

5.1.3.1 Preventative Maintenance Program

The main details of OC San 's preventative maintenance program for collection systems includes the following items:

- Sewer inspection – to be discussed in Section 12.1.3.2
- Condition assessment – to be discussed in Section 12.2.3
- Sewer cleaning (including root removal) - Pipes 42-inches diameter or less are cleaned at least once every five years. Pipes larger than 42-inches are cleaned as required based on inspection or need (e.g. CIP projection, inspection). "Trouble" areas are cleaned more frequently as needed.
- Pump station maintenance - routine scheduled maintenance program pumping plants
- Chemical dosing for odor and corrosion control and wet well grease mitigation – conducted regularly as needed.
- All preventive maintenance actions are recorded in OC San's CMMS.

5.1.3.2 Repair Rehabilitation and Replacement Planning

OC San's Collections Operations and Maintenance (Collections O&M) implement a CCTV program of pipelines and manholes that is consistent with the National Association of Sewer Service Companies (NASSCO) Pipeline Assessment Certification Program (PACP) and Manhole Assessment Certification Program (MACP) standards allowing the condition of the sewer pipes and manholes to be consistently ranked and the necessity of subsequent rehabilitation or replacement efforts to be prioritized. Short-term and long-term processes are in place to facilitate an appropriate response to on-going collection of data.

The CCTV inspection interval for pipelines and manholes is 5 years. Additional inspections for special circumstances or specific projects are scheduled separately. CCTV inspections are performed by contractors who are required to submit the CCTV video in HD format.

To evaluate capacity issues, in 2002, OC San hired the consultant ADS to perform a Long-term Flow Monitoring Program. This program involved using 150 flow meters strategically placed throughout the overall collection system for a period of two years from May 2002 to May 2004. After which, the program was reduced to 75 flow meters from May 2004 to May 2007. This program was used to calibrate OC San's computerized hydraulic model and establish a baseline of flow measurements for each major trunk and flow basin. Today, the long-term flow meters have been removed, and each major flow basin or trunk has its flow metered by the permanent flow meters located at the two treatment plants. Periodically, flow meters are placed for a special project or study as needs arise, and new CIP projects are developed. As part of the Collections Capacity Evaluation Study, OC San monitored the regional collection system utilizing approximately 85 monitors placed in strategic locations between November 2016 and October 2017. The flow data is being used to calibrate the model as well as estimate the amount of inflow and infiltration that enters the system during wet weather events.

Per the 2019 Collection Capacity Evaluation Study Master Plan Update (2019 MPU), capacity design criteria are as follows:

- Sewers larger than 12 inches in diameter are determined to be deficient where the model showed a surcharge of greater than two (2) feet, or if the surcharging came to within 5 feet of the ground surface, unless the system was designed to operate under a surcharged condition, without an SSO occurring, during peak wet weather flow conditions,
- Sewers 12 inches in diameter or smaller are determined to be deficient when the ratio of the peak depth of flow to pipe diameter (d/D) is greater than 1.0 (indicating that the pipe was full) during peak wet weather flow,
- Sewer lines with depth over diameter (d/D) greater than 0.75 are considered deficient for unlined pipes during peak dry weather flow, and
- Sewer lines with d/D greater than 1.0 are considered deficient for lined pipes during dry weather flow.
- The project initiation criteria for capacity concerns is lower for smaller pipes because they are generally more affected by blockages and hydraulic inefficiencies such as offset joints. This allows capital improvement projects to be scheduled and completed before SSOs would occur due to capacity restrictions.

5.1.4 Districts

Detailed operation and maintenance information from the Districts is available in Section 4 of their SSMP. The major items applicable to this audit are summarized in the following sections.

5.1.4.1 Preventative Maintenance Program

The main details of the preventive maintenance program include:

Line Cleaning: The Districts use a variety of devices to line clean such as winch bags and combination hydraulic/vacuum units. General line cleaning guidelines have been established based on size and sewer configuration. The standard line cleaning frequencies are annually for 8 to 10-inch diameter sewers, every two years for 12 to 18-inch diameter sewers, and every four years for 21 to 27-inch diameter sewers. Sewers with diameters of 30 inches and larger are cleaned on a case-by-case basis. Sewers reaches that are known to need more frequent cleaning due to heavier debris levels are cleaned more frequently than the standards described above.

Line Checking: Sewer reaches that are not cleaned or inspected during routine maintenance activities are visually checked for anomalies at least once every two years.

Siphon Cleaning: Siphon cleaning is scheduled based on size and configuration for sewer siphons up to 84-inches in diameter. Each siphon is cleaned annually at a minimum.

Manhole Cover Adjustment: Manhole cover adjustments are performed on an as needed basis to replace broken or worn manhole frames and covers to protect public safety.

Pumping Plants: All of the Districts' pumping plants are maintained in accordance with individual maintenance plans.

All preventive maintenance activities are recorded in the Districts' Work and Asset Management (WAM) System.

5.1.4.2 Repair Rehabilitation and Replacement Planning

The Sanitation Districts maintain a Rehabilitation and Replacement Program to: 1) ensure the timely repair of sewer facilities in imminent danger of failure or blockage; 2) provide for the long range rehabilitation or replacement of obsolete or aging assets; and 3) improve system performance and reduce spills caused by pipe defects or mechanical failures. The rehabilitation and Replacement Program uses data from the Sanitation Districts' CCTV inspection and flow monitoring programs, as well as feedback from regular maintenance activities, to prioritize and schedule the rehabilitation and replacement projects. A Report of Recommended Facility Improvements is prepared annually to summarize the status of all damaged, deteriorated, or near capacity sewerage facilities. This list is also used to develop the CIP. The CCTV intervals for various pipe ratings and materials are summarized in below **Table 5-2**:

Table 5-2 Districts' CCTV Inspection Intervals

Condition Rating	Pipe Material / Inspection Interval
1 (worst)	All / annually
2	All / annually
3	Concrete / 3-years VCP and Miscellaneous / 4-years
4 (Best)	Unlined Concrete / 5-years VCP and Miscellaneous / 10-years Lined RCP and Non-Corrodible Materials / 15-years

Conventional / non-high-definition video is used for inspections. Contractors perform about 76% of the CCTV inspections and remaining 24% of the CCTV inspections are performed by Districts' staff.

The Districts assess capacity issues for gravity sewers through a process that utilizes data from several maintenance programs, including:

1. The inflow/infiltration (I/I) monitoring and reduction program, which involves identifying areas of I/I concern;
2. Flow monitoring programs, which include periodically measuring flows within Districts' sewers; and
3. A capacity relief assessment program which involves the continued evaluation of the Districts' sewers currently rated A, B, and C.

The Districts' current A, B and C capacity rating system is described in the below **Table 5-3.**

Table 5-3 Districts' Capacity Rating System

Rating	Description
A	Peak flow depth is at or above 90% pipe diameter and flows are continuing to increase; or the sewer overflow or nearly overflows during wet weather.
B	Peak flow depth is at 80 to 90% pipe diameter; peak flow depth is below 80% pipe diameter, but flows are increasing rapidly; or peak flow depth is at or above 90% pipe diameter but flows have not changed in years
C	Peak flow depth is at 70 to 80% pipe diameter.

Historically, sewers with a Capacity Rating of “A” have been recommended for relief. Sewers with a Capacity Rating of “B” or “C” are monitored annually and biennially, respectively.

In addition to the capacity assessment classifications, sewers that have the potential to be impacted by future development are identified in the project description.

5.2 Capital Improvement Plan Benchmarks

Collection system master planning is a process of comparing current and projected future peak flows to the sewer system capacity to identify where hydraulic deficiencies may occur. Once system deficiencies are identified and confirmed, the process proceeds to evaluating alternatives for addressing these deficiencies, developing cost estimates and setting priorities and timelines to implement system improvements. These deficiencies are typically developed in addition to projects that are related to findings from CCTV and/or maintenance inspections. The result is a capital improvements program/plan that will address system deficiencies and provide adequate capacity for existing and future needs. Because of the time and technical issues that must be addressed, this process is usually performed by engineers or consulting firms that specialize in sewer system master planning.

5.2.1 Industry Standards/Benchmarks

The SWRCB Order required that the SSMP shall include a capital improvement plan that addresses proper management and protection of the infrastructure assets. The plan shall include a time schedule for implementing the short-term and long-term plans plus a schedule for budgeting the funds needed for the capital improvement plan. As with the maintenance section, the Order is not prescriptive and provides general guidance for enrolees.

Outside of the Order but utilized in the industry, NASSCO recommends managing pipe and manhole assets in a risk and fact-based manner, also known as an asset management approach. Appendix D of the NASSCO PACP Manual includes guidance of a methodology to compare and prioritize assets using this approach. In this procedure, a numerical Risk Factor for an asset is calculated by multiplying the Likelihood of Failure by the Consequence of Failure. The Likelihood of Failure number is a function of the worst defect in a pipe segment. The Consequence of Failure is calculated using a system that evaluates the economic, social, and environmental costs of a failure.

5.2.2 LASAN

Using available flow and condition information, the wastewater CIP is prepared annually and covers 5 and 10-year periods. Monthly monitoring allows for reprioritization of projects throughout the year. For collections projects, LASAN’s rehabilitation schedule goal for the various D condition ratings of pipe is as noted below:

- D-1 (critical) – start predesign within 1 year, start construction within 3 to 5 years.
- D-2 (very poor) – start predesign within 1 to 2 years, start construction within 5 to 6 years.
- D-3 (poor) – start predesign within 2-4 years, start construction within 6-10 years.

LASAN utilizes a Business Case Analysis approach for the prioritization of projects and development of the CIP. The evaluation criteria used in the analysis are both qualitative and quantitative. Ten (10) criteria are scored for each proposed project to determine its overall priority. Final scores may also factor in the relative merits of the project in comparison to other proposed CIP projects. The evaluation table used by LASAN is shown in **Figure 5-2**. The first eight (8) criteria are scored by the project manager and the CIP evaluation Committee evaluates these 8 in addition to two additional criteria: Strategic Plan Alignment and Innovation.

12. PRIORITIZATION ANALYSIS

Prioritization Factors. For all project criteria, indicate total average scores (1-5) from evaluation, and include specific justification or explanation for the scoring. Business case owner or Project Manager will complete an initial scoring recommendation with justification/explanation. This will be reviewed and updated, as needed by the CIP committee.

Note – Refer to the Business Case Guidelines Document for detailed criteria and scoring definitions

Criteria	Project Manager Evaluation Score (1-5)	CIP Committee Evaluation Score (1-5)	Justification / Explanation To be completed by Project Manager/Business Case Owner
Physical Condition			
Process/ Performance Condition			
Regulatory/Environmental			
O&M and Service Level / Reliability			
Safety			
Public Benefit /Perception & Community/Growth			
Financial			
Efficiency / Energy and Process Effectiveness / Institutional Knowledge			
Strategic Plan Alignment		0	
Innovation		0	

Note: CIP Committee will review the justification (Section 4) for "Strategic Plan Alignment" and "Innovation" and determines their applicability to the project. A score of either 0 (not applicable) OR 5 (applicable) is assigned to "Strategic Plan Alignment" and "Innovation"

LA SANITATION

Figure 5-2 LASAN Evaluation Table

Each criterion is scored on a scale of 1 through 5. Guidance on the scoring is provided in the following paragraphs:

1- Physical Condition

Projects scoring in the low range (1-2) typically include projects that:

Are not driven by the condition of existing assets (ex. Sewer line to new development, construction of new facility).

Result in new construction that add redundancy to the system (ex. additional pumps, redundant sewer line) not driven by the condition of existing assets (condition is not the driver for the project).

Projects scoring in the mid-range (3-4) typically include projects that are driven by the condition of existing assets (condition is a key driver for the project).

Projects scoring in the high range (5) typically are those where physical condition is the primary driver for the project and the probability of failure is very high.

2- Performance/ Process Condition

Projects scoring in the low range (1-2) typically include projects that:

Are not driven by the process condition of existing assets (ex. sewer line to new development, construction of new facility).

Are not driven by technical obsolescence and outdated standards/requirements.

Projects scoring in the mid-range (3-4) typically include projects that are driven by the process condition of existing assets (adding redundancy to the system to mitigate capacity issues).

Projects scoring in the high range (5) typically are those where process condition is a key driver for the project and the probability of failure is very high.

3- Regulatory/ Environmental

Projects scoring in the low range (1-2) could include:

Areas of the sewer sheds that are consistently meeting SSO/CSO requirements and have not experienced historic compliance issues.

Is not required as part of an enforceable or mandated program.

Limited direct relation to permits or regulations.

Projects scoring in the high range (4-5) would include:

Facilities or assets that have numerous historic violations and where likelihood of causing beach/waterway closures, significant spills, or other environmental damage is high

Is part of an enforceable program

4- O&M and Service Level/ Reliability

From an O&M stand-point, projects that involve creation of new assets would be expected to score in the low range (1-2) in this criteria. In some cases, these can also increase O&M cost and workloads. From a Service Level/Reliability stand-point, Projects scoring in the low range (1-2) would include treatment plant and collection system facilities and assets with redundancy and capacity.

Most rehabilitation and renewal projects (plant and collection), would typically receive a score in the high range (4-5) as they are likely to reduce the cost and effort involved in historic breakdown and reactive maintenance work orders. From a service level/reliability stand-point, projects scoring in the high range (4-5) would include large diameter force mains or interceptors / tunnels that have limited redundancy and a failure would impact very large numbers of customers.

Collection capacity projects with existing overflow issues would also be given high scores, as would complex or unique assets with high cost and time for restoration (plant process assets).

5- Safety

Projects that involve creation of new assets would be expected to score in the low range (1-2) in this criteria including many growth and regulatory projects. Replacement and upgrades to assets and facilities such as chemical systems tend to reduce safety/hazard potential, which could receive higher scores (4-5 range).

6- Public Benefit/ Perception and Community / Growth

Most projects would be expected to score in the low range (1-2) in this criteria as the number of capital improvements projects specifically aimed at community growth and development is typical and most projects tend to be internally focused with limited visibility to the public.

Projects scoring in the high range (4-5) would include high profile projects that are widely talked about in the public such as a new treatment/pumping facility, major regulatory compliance efforts, projects where critical assets are involved such as bridges and highways or mass transit. Projects that attract stakeholder interest such as environmental and community groups would also receive higher scores. Projects scoring in the high range would also include politically driven projects, neighborhood expansions and improvements that support the community and would bring additional revenues and are directly linked to strategic redevelopment areas and have added benefit shared outcomes with other agencies or departments.

Projects expected to receive a moderate score (2-3) could include building and facility upgrades that enhance community aesthetics, or smaller targeted projects aligned with City/Community growth and development efforts, projects with large financial or regulatory implications, that may only receive public attention if there was a significant project issue or major event / failure.

7- Financial

Considering the type of work proposed, higher cost projects are generally scored lower.

8- Efficiency/ Energy and Process Effectiveness/ Institutional Knowledge

Most projects would be expected to score in the low range (1-2) in this criterion as the number of projects specifically aimed at efficiency/energy and optimization effectiveness are small.

Projects scoring in the high range (4-5) would include efficiency and energy driven projects such as digester gas capture, bio-solids recycling, LEED certified buildings or Envision (collection projects) certifiable projects, alternative fuel or efficient vehicle purchases, and water reuse projects. Projects that directly impact overall

process efficiency and cost reduction such as business process improvements, information technology investments will also score high.

Projects that would receive a moderate score (2-3) could include motor or pump replacements or installation of VFDs where new technology is significantly more energy efficient than older technology being replaced.

5.2.3 OCSAN

Through a review of CCTV videos and capacity analyses, the collections CIP is updated annually. The remaining useful life of pipe segments and manholes are estimated based on the most recent information. The pipeline and manhole repairs or rehabilitation schedule goal is to complete all segments with NASSCO PACP 4 or 5 ratings in 10 years or less.

Similar to the process suggested in the NASSCO PACP Manual, OC San completed an Asset Management Plan (AMP) in December 2020 as an update to the 2019 Asset Management Plan. The AMP is intended to be a tactical document summarizing OC San's plans for understanding asset condition and performance of all major assets within the treatment plants as well as the collections system for a twenty-year planning horizon. Updates to the AMP are performed on an annual basis. The AMP coordinates the efforts of operations, collections, mechanical maintenance, electrical maintenance, instrument maintenance and engineering through process teams to assure OC San's resources are focused on the high priority work functions. This AMP is continually evolving based on new condition assessments and is published annually to document the condition of the collection system and treatment plants, and to maintain a 20-year forecast of all CIP projects needed to maintain or upgrade the OC San's nearly $11 billion in assets on a prioritized risk basis.

OC San reviews new and revises existing CIP projects annually through a validation effort. The effort prioritizes projects based on need, risk, and overall resource and cash flow constraints of the agency. This effort has been modified to align with OC San levels of service which elevates the process to ensure future repeatability; yet allows for dynamic changes in agency objectives.

The Planning Division leads the Project Clearinghouse Committee which meets biweekly to discuss proposed projects that are not previously identified during the annual CIP validation cycle; yet, may be necessary to act on in the short term. The Project Clearinghouse determines if these projects are necessary and assigns the work to the appropriate OC San department.

5.2.4 Districts

Using data from the closed-circuit television (CCTV) inspection and flow monitoring programs, as well as feedback from regular maintenance activities, the WCS prepares the Waste Water Collections System CIP Report to prioritize and schedule the rehabilitation and replacement projects. The report is prepared annually to summarize the status of all damaged, deteriorated, or near capacity sewerage facilities. The report includes prioritization of projects based on condition severity using a Priority Rating system, with High (1), Medium (2), and Low (3) ratings. The desired schedule for rehabilitation projects based on ratings is noted below:

- Priority Rating 1 – project completion within 5 years.
- Priority Rating 2 – project completion within 6 to 10 years.
- Priority Rating 3 - project completion beyond 10 years.

Selected projects are budgeted in the Capital Improvement Plan (CIP). The CIP is updated annually and identifies short-term and long-term projects which are scheduled within the next 20 years based on their priority rating.

5.3 Comparison of Districts' Programs to Baseline/Industry Standards and Other Local Agencies

5.3.1 Maintenance and Inspection Programs

The Districts, LASAN, and OC San all have maintenance and inspection programs that meet the requirements of baseline SWRCB Order. The following Tables show a side-by-side comparison of notable differences in the maintenance and inspection programs of the three agencies. **Table 5-4** compares the pipe cleaning interval, **Table 5-5** compares the CCTV interval by pipe material and condition, and **Table 5-6** compares how capacity assurance is determined.

.

Table 5-4 Pipe Cleaning Interval

Districts	LASAN	OCSan
8”-10”: annually	16” and less: 3-year cycle	42” and less: 5-year cycle
12” to 18”: 2-year cycle	16” to 30”: 5 to 6-year cycle	Greater than 42”: as needed
21” to 27”: 4-year cycle	Greater than 30”: as needed	Problem pipes: as needed
Greater than 30”: as needed.	Problem pipes: as needed	

The Districts perform the most frequent pipe cleaning of the three agencies. The only significant difference between the three is that OC San uses 42-inch as the regular cleaning cutoff versus 30-inch for the Districts and LASAN.

Table 5-5 CCTV Interval by Condition and Pipe Material

Districts	LASAN	OC San
1 (all materials): 1-year	E: emergency repair	All ratings and materials: 5-years
2 (all materials): 1-year	D-1 (all materials): 1-year	
3 (concrete): 3-years 3 (VCP and Misc.): 4-years	D-2 (all materials): 1 to 2-years	
4 (unlined concrete): 5-years 4 (VCP and Misc.): 10-years 4 (Lined RCP and Non-corrodible materials): 15-years	D-3 (brick and concrete): 2-years D-3 (other materials): 3-years	
	C (all materials): 5-years	
	B (all materials): 10-years	
	A (all materials): 15-years	

Based on this information, the Districts perform CCTV inspections the most frequently of the three agencies. High Definition CCTV video is a requirement for LASAN primary sewers and OC San sewers. Additionally, LASAN utilizes additional technologies, i.e., laser, sonar, and gas detection, on primary sewers.

Table 5-6 Capacity Assurance Evaluations

Districts	LASAN	OC San
Peak flow d/D greater than 0.9	10-year flow d/D greater than 0.75	Pipes 12" and smaller: d/D =1.0 during peak WW flow Pipes greater than 12": 2' surcharge or surcharge within 5' of ground surface during peak WW flow (unless designed) Unlined pipes: d/D greater than 0.75 during peak DW flow Lined pipes: d/D greater than 1.0 during peak DW flow

Based on this information, the Districts are in the middle of the agency requirements for consideration of capacity relief projects. A sewer model is not available to assist in the capacity assurance evaluations.

5.3.2 CIP and CIP Process for Sewer Rehabilitation

The Districts, LASAN, and OC San all have CIP programs that meet the requirements of baseline SWRCB Order. **Table 5-7** below notes the major characteristics of each agency's CIP process for sewer rehabilitation.

Table 5-7 CIP Process of Agencies

	Districts	LASAN	OC San
Desired Schedule for Worst Rated Sewers	Completion within 5 years	Start construction in 3 to 5 years	Completion within 10 years
Project Prioritization Process	Primarily condition based	Business case analysis with 10 criteria	Remaining useful life estimated – asset management approach

Based on this information, the Districts have the shortest schedule for projects to rehabilitate the worst rated sewers. The three agencies have different approaches to project prioritization.

5.4 Districts Operations and Maintenance Performance

5.4.1 Districts' Performance Relative to O&M to Prevent Failures and SSOs

The most important measure of SSO prevention is the SSO record of the Districts. A query was performed for the Districts' SSO performance for the five-year period between January 1, 2017 and December 31, 2021 on the California Integrated Water Quality System Project (CIWQS) web site for public spills. The data is summarized in **Table 5-8**.

Table 5-8 Districts SSO's Performance

Total Number of SSOs	Total SSO Volume (gallons)	Total Miles of Sewer	Average Number of Spills Per 100 Sewer Miles Per Year (2017-2021)
40	9,176,853	1,431	0.56

It is worth noting that the majority of the SSO volume was caused by the December 30, 2021 SSO in Carson. Without this event, the total SSO volume would be about 8.6 million gallons less.

5.4.2 Comparison of Districts to Industry Standards and Other Local Agencies

A query was also performed for LASAN's and OC San's SSO performance for the five-year period between January 1, 2017 and December 31, 2021 on the California Integrated Water Quality System Project (CIWQS) web site for public spills. This data, along with those of the Districts, are summarized in **Table 5-9**.

Table 5-9 Agency's SSO's Performance

	Total Number of SSOs	Total SSO Volume (gallons)	Total Miles of Sewer	Average Number of Spills Per 100 Sewer Miles Per Year (2017-2021)
Districts	40	9,176,853	1,431	0.56
Districts (excluding December 30, 2021 SSO)	39	563,295	1,431	0.55
LASAN	502	12,458,210	6,512	1.54
OCSAN	7	137,539	388	0.36

5.5 District Staffing Levels

5.5.1 Current Available Staffing vs. Sewage System Rehabilitation/Replacement Workload

Table 5-10 summarizes the staffing of the Districts in comparison to LASAN and OC San for various staffing groups including engineers, technicians, and administrative staff. The table also lists each agency's typical delivery type and average annual collections related CIP.

.

Table 5-10 Agency's Typical Delivery Type and Average Annual Collections

	Districts	LASAN	OC San
Collections O&M Staff	143	227	26
Planning Group Staff	Included with O&M staff	24	15
Engineering Group Staff	27 (collections design, design review, and counter duties)	70 (collections design only) in Bureau of Engineering	21 (collections and plant design) in PMO Group, manage consultant designers
Typical CIP Design Project Delivery	Primarily In-house, consultants available	In-house but specialty projects by consultants	By consultants
2020 Onward Average Annual Collections CIP	$62 Million	$193 million	$55 million

5.5.2 Staffing Priorities

Based on the amount of CIP expenditures for collections projects, the Engineering group appears to be understaffed in comparison to the other agencies based on the size of the projected average annual CIP. This is especially true considering that the Districts are managing and completing projects, whereas OC San's group are only managing projects. The staffing shortfall may be remedied by hiring additional engineering staff or higher utilization of consultants for some collections projects designs. Starting in 2021, consultant services are available through established on-call contracts.

5.6 Sewer Build-Overs

Refer to Section 3.5 above for a discussion of the Disctricts' established build-over procedures and the process followed near the location of the failure.

5.6.1 Sewer Build-Over Process Benchmarks

5.6.1.1 Industry Standard

Based upon our research, there does not appear to be an established industry standard for build-overs of sanitary sewers. If an industry standard were to be established, similar to the Districts' process, it would be reasonable for an applicant for a build-over to provide detailed information and calculations showing the proposed project will not adversely affect the sewer infrastructure or include measures to protect the infrastructure.

5.6.1.2 LASAN

Based upon a search of the City of Los Angeles Bureau of Sanitation publications available on their website and discussions with their staff, building build-overs of sanitary sewers are discouraged and there does not appear to be an established procedure. Considering the age of the sewer system, it is likely that buildings are constructed over sewers at numerous locations throughout the City. These and future build-overs agreements or permits seem to have been and will be handled on a case-by-case basis.

5.6.1.3 OCSAN

Based upon a search of the Orange County Sanitation District's publications available on their website and discussions with their staff, building build-overs of sanitary sewers are discouraged and there does not appear to be an established procedure. Anecdotally, the OC San staff member recalled a project he was involved with in which a sewer line was relocated for a building project. As with LASAN, it is likely that buildings are constructed over sewers at numerous locations throughout the OC San's service area. These and future build-overs agreements or permits seem to have been and will be handled on a case-by-case basis.

5.6.2 Comparison of Districts' Process to Industry Standards and Other Local Agencies

The Districts' BOA process is the most established of the agencies investigated for this study. Having set procedures is beneficial to ensure all proposed projects meet a set of standards. In general, building over sewer is not a good practice. Therefore, the Districts may want to consider implementing a policy that discourages build-overs other than parking lots and allows other build-overs on a case-by-case basis.

5.7 Findings and Recommendations for Improvements

The Districts meet or exceed the baseline requirements for O&M procedures, capacity evaluations, and CIP development. Based on information from LASAN and OC San, the Districts could consider the following recommendations for improvement:

- Update and revise the specifications for conducting sewer condition assessments to include new technology such as high-definition CCTV video, adjust speed of coverage to emphasize quality of data (slowing down the camera to gain a better picture), and lighting.
- Perform CCTV on worst reaches after high flow events.
- Include methods for integration of data with CMMS or data management systems that can facilitate issuing and tracking work orders for required improvements through a common database.
- Evaluate other technologies to be used in conjunction with CCTV inspections including laser, sonar, and pipe penetrating radar.
- Develop a system to track Condition Rating 1 sewers from first assessment through construction to ensure the 5-year repair schedule is met.
- Add a new rating for most severe cases (perhaps 0, U, or E).
- Review the existing process for Rehabilitation and Replacement program (R&R), CIP, funding, and schedule to ensure the desired completion for R&R is met for the worst rated sewers.
- Implement a risk-based prioritization process that considers the consequence of failure in a more objective manner and use less subjective ratings.
- Implement a manhole inspection program that works in conjunction with the CCTV operations.
- Revisit easement language to ensure access for maintenance, monitoring, inspection, repairs, and replacement of sewers with adequate room for these activities, including related construction. Where necessary, revise and update build over language for an easement, on a case-by-case basis, and limited to parking lots, open spaces, and similar improvements. Coordinate with future tenant or building improvements to follow new easement language with the member agency permitting departments.

6. Task 4 - Review of New Technologies for Detecting/Preventing SSOs

6.1 Districts' Real-Time Flow Monitoring Pilot Study

The Districts have initiated a pilot study to install real-time flow monitoring equipment near the San Jose Creek Water Reclamation Plant. The Districts already have several dozen permanent flow monitoring locations throughout the collection systems that are able to provide data in real time. The goals of the pilot study will be to investigate the feasibility of implementing an enterprise-level project that would provide real time sewer flow information to assist with maintenance, emergency response, development monitoring, and routing of flow, including stormwater flow in a more useful format/display for the end user. The pilot study will be conducted simultaneously on two separate platforms that the Districts already use, GIS and OSI-Pi, to comparatively evaluate the two possible solutions. At the conclusion of the pilot study, staff will prepare an analysis that outlines the usefulness of the data, the feasibility to implement at an enterprise scale, cost/resources, and implementation schedule.

The pilot study is a good first step and if deemed useful, accurate, and reliable it may be useful to implement in a wider manner to manage SSOs.

6.2 Available Control Systems for SSO Detection

Having knowledge of flow rate and flow depth at numerous locations throughout the collections system would be beneficial to early detection of SSOs. Leaders in the industry include Smartcover, SUEZ, and Hach. Smartcovers are currently used in small numbers by the Districts and OC San. LASAN is considering the installation of Smartcovers. Hach is used widely by LASAN, at 216 locations, and by the Districts. The results of the Pilot Study noted in Section 6.1 should help determine if widespread use of these systems is worthwhile and feasible.

6.3 Available Technologies for Non-Invasive Pipe Condition Assessment (Non-Conventional CCTV Options)

Using additional equipment on pipeline inspection robots can provide greater information for sewage system operators. Equipment including high definition cameras, laser (for measuring pipe inside shape), sonar (measuring debris below water level), and pipe penetrating radar (for measuring pipe thickness and voids) are available from various vendors.

Photo 6-1 and **Photo 6-2** show a comparison of a close-up CCTV view from a recent inspection of the Districts' 216th Street Relocation Trunk and an image from a vendor's HD video.

Photo 6-1 216TH Street CCTV View

Photo 6-2 HD Video View

Figure 6-1 shows the wall of a reinforced concrete pipe as seen with pipe penetrating radar. The green area is the pipe wall, the solid red lines are reinforcement, and the red shaded areas are soft spots or potential voids next to the pipe.

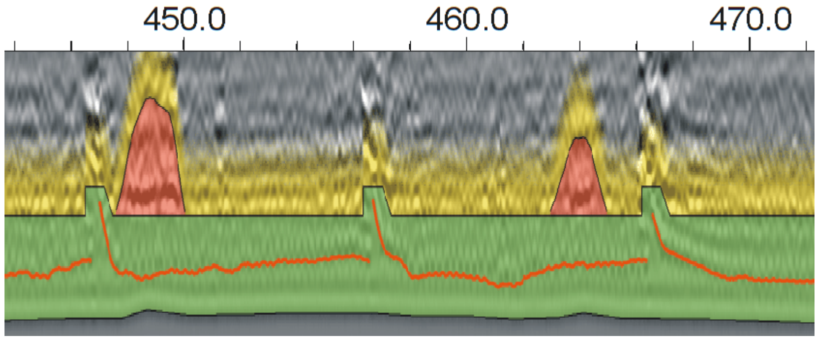


Figure 6-1 Penetration Radar View

Vendors of these technologies include CUES, RapidView-Ibach, Ditchwitch West – Subsite, and SewerVue.

6.4 Available Technologies for Non-Invasive Manhole Condition Assessment

Until recently, the only method to inspect manholes and obtain useful information was through a manned entry into the structure. Technology is now available to lower equipment into a manhole without entry to obtain a 3D scan and high-definition imagery. The Clever Scan product sets up on a tripod on top of a manhole and utilizes 4 laser scanners to create a dense point cloud and 5 HD cameras to capture imagery. The device and imagery are shown in **Photo 6-3** and

Photo 6-4.

Photo 6-3 Clever Scan Tripod

Photo 6-4 Clever Scan Imagery

.

OC San currently uses Clever Scan in their manhole inspection program.

6.5 Review of Sewer Modeling Technologies

Sewer system managers and engineers are under increasing pressure due to the impact of climate variability, extreme rain events, flooding, population growth, aging infrastructure, infiltration and inflow, urbanization, and corrosion. Numeric modeling supports informed decision-making to understand and address sewer system challenges.

Sewer system models that incorporate system flow and level data, hydraulics, sewer condition assessment, GIS, and criticality along with conventional sewer hydraulic models are tools the Districts can make use of to provide a system with the high level of service expected from its member agencies. This will require new data solutions, data management, data analysis, and reporting.

Hydraulic modeling is a tool commonly used for engineering analysis and to evaluate the benefits of proposed improvements. Mathematical/Computer based modeling of the sewer system can be used to analyze system's hydraulic behavior and performance. In addition, the model is also used to address the level of service criteria, and other requirements such as the peak hourly flow, maintaining sedimentation/scour velocities, SSO volumes, high water level elevations etc.

Hydraulic models can benefit sewer system managers and engineers by:

- Providing a tool to plan infrastructure improvements.
- Allowing analysis of current system performance and resolution of level of service shortfalls as well as understanding WHY things are happening, and better identify the source of capacity issues.
- Evaluate options and servicing strategies prior to significant capital investment.
- Determining the impact of growth and climate change on an existing system.
- Providing an evaluation of flooding conditions and SSOs.
- Predicting and analysing flow at treatment plants and pump stations.
- Developing operational and maintenance strategies.
- Proactively managing the entire system under different conditions.
- Reduce dependency on institutional knowledge through proper documentation within the model, which results in efficient system operation.
- Identifying system improvement strategies and address financial impacts.

6.5.1 Available Modeling Softwares

The underlying philosophy behind selection of an appropriate modeling software is to consider the Districts' short- and long-term goals. Advanced computer modeling software, simulating real-world conditions provide the Districts with quantifiable magnitude of the potential issues and the opportunity to explore alternative solutions with the least impact on project design, construction, and operation & maintenance costs later.

It is recommended that a model used be compatible with the Districts other systems such as GIS, Asset Management, operations and maintenance, and SCADA systems.

There are numerous sewer models available and used in the industry today that satisfy the above requirements, but each software package has its pros and cons. Some of the modeling software to consider include InfoWorks ICM, InfoSWMM, SewerGEMS, and MIKE URBAN/+. A high-level summary on each package in terms of hydraulic requirements is highlighted below:

InfoWorks ICM:

- Fully Dynamic model.
- Uses a full set of St. Venant equations. Easily handle gravity and pressurized flow with manifold forcemain systems.
- Uses four- point finite difference implicit solution algorithm that provides accuracy and stability.

.

- Can easily model hydraulic structures such as weirs, orifice, and siphons.
- Extensive Real Time Control (RTC) capability.

InfoSWMM:

- Fully Dynamic model that uses an explicit SWMM 5 engine.
- Explicit SWMM 5 engine is known to be less stable than implicit solvers.
- Can handle gravity and pressurized manifold forcemain systems like other software programs
- Easily model hydraulic structures such as weirs, orifices, and siphons.
- Note that due to the number of manifolded force mains within the system, the hydraulic engine may have problems simulating the sewer system.

SewerGEMS:

- Fully Dynamic model capable of using the SWMM 5 explicit Dynamic Wave engine or SewerGEMS own implicit solution engine.
- The implicit engine uses a four-point implicit finite difference solver which tends to be more stable than an explicit solver.
- Note that due to the number of manifolded force mains within the system, the hydraulic engine may have problems simulating the sewer system.

Mike URBAN/+:

- Fully Dynamic model that can use either SWMM or MOUSE hydraulic engines. Can handle gravity and pressurized flow with manifold forcemain systems.
- MOUSE engine uses 6 point finite difference implicit solution algorithm.
- MOUSE engine requires minimum pipe length of 10 m to maintain stability. However, it does perform better than SWMM 5 in some applications.
- Note that due to the number of manifolded force mains within the system, the hydraulic engine may have problems simulating the sewer system.

There are other factors that need to be considered in the model selection process which will be further explored in the future considering the Districts' systems, their data patterns/formats and other aspects of their operations.

6.5.2 LASAN and OCSAN Modeling Systems

LASAN utilizes a customized version of the MIKE URBAN sewer model. OC San utilizes the InfoWorks ICM sewer model. Additionally, OC San uses an Info Asset Manager as a tool to assist in data management, planning, and CIP development.

6.6 Findings and Recommendations for Improvement

Technology is available to facilitate and improve the operation and maintenance of the Districts' collection system. The recommendations for new technologies are listed below:

- If the Real Time Flow Monitoring Pilot Study is successful, consider implementing the system on a wider basis. If expanded, identifying strategic locations would also be suggested.
- Consider making HD video a requirement for all CCTV inspections.
- Evaluate and asses the application of non-invasive pipe inspection equipment and correlate data in a consistent manner with CCTV ratings.
- Sample the manhole scanning technology.
- Develop an implementation plan for and utilize a sewer model.

7. Overall Conclusions and Recommendations

7.1 Task 1 - Findings and Recommendations

7.1.1 Operation of Main Street Pumping Plant

In February 2021, due to the completion of the 216th Street Replacement Trunk Sewer Phase 1 that mitigated capacity related overflow potentials, the operation of the Main Street Pumping Plant changed from staffed manual operation to fully automated operation of the Plant during storms. Based upon the review of pump discharge flow data, Manhole Smart Cover Data, and pipe capacity calculations, it appears that the 216th Street Relocation Trunk Sewer did surcharge during the storm on December 30, 2021. A more detailed review of the wet weather flows and associated surcharge in the 216th Street Relocation Trunk Sewer should be conducted to gain a higher level of confidence of the level of surcharge. This analysis would be greatly simplified if a sewer model was available.

7.1.2 CCTV Inspections

The CCTV videos GHD viewed for this report were low quality. Observing defects and progression of defects is difficult in videos of this quality. The CCTV inspection program could be enhanced in several ways including:

- Use equipment that can capture higher quality images
- Track year to year progression of pipe defects in the lower rated sewers
- Conduct the inspections under lower flow conditions if possible, particularly for lower rated sewers
- Coordinate inspections with maintenance activities. For example, conduct the inspection before the application of crown spray. This is already the usual practice but it can be optimized.
- Review how inspection work is contracted to achieve a certain level of data quality.

7.1.3 Conditions of Pipes

From the 2015 Memorandum requesting a rehabilitation project, the unlined pipes on the 216th Street Relocation Trunk Sewer were all Rated 1 and 2 (the two poorest ratings on of scale of 4). At that time, the segment that collapsed was Rated 2. If a rehabilitation or replacement project is taking longer than recommended in the project request memorandum, the Districts should consider implementing interim measures to reduce the risk associated with the sewer collapse and/or SSO, such as rehabilitating the damaged sewer with cured-in-place pipe (CIPP) lining or other measures.

7.1.4 Inspection of Manholes and Junction Structures

It is understood that the Districts do not have a formally established inspection program for sewer manholes and junction structures. Although the role of the manhole in this failure is unclear, it certainly did not perform well in this event. It is recommended that the manholes be inspected at the same time that the pipelines are CCTV inspected, particularly for pipes currently rated 1 or 2 (the two poorest ratings on of scale of 4). A process similar to the National Association of Sewer Service Companies (NASSCO) Manhole Assessment Certification Program (MACP) is recommended to be utilized.

.

7.2 Task 2 - Findings and Recommendations

The findings on the Emergency Response to the December 30, 2021 SSO event are as follows:

- The Districts' staff followed the procedures and met the requirements of their ERP. The goal of responding to an SSO within 1-hour was achieved. Additionally, regulatory notifications were completed in a timely manner.
- The Districts' decision making process for troubleshooting and finding the cause of the SSO was reasonable.
- The technical approach for the bypass and repair of the collapsed section by using contractors was also reasonable.
- The Public Information Section followed their Emergency Response Plan and successfully kept stakeholders, the public, and interested media informed of the event. The SSO communication effort was so successful, the Districts received the Grand Prize in the 2022 Environmental Communications Awards Competition from the American Academy of Environmental Engineers and Scientists.
- A review of the SSO ERPs of other agencies do not reveal major procedural differences that the Districts should include in their SSO ERP.

Areas the Districts could consider for improvement are:

- The SSMP Audits for LASAN and OC San are performed by outside Consultants but the Districts' Audits are prepared in-house. Although not a requirement set forth by the SWRCB, an independent third-party Audit may provide beneficial feedback to the Districts.
- When the SSMP and SSO Response Plans are updated next, consider including a flow chart covering both the required actions and notifications.
- The Districts relied heavily on external contractors to perform the sewer bypass and repair the collapsed pipe. If the collapse and SSO occurred one or two days later, during the New Year holiday, it is unclear if contractors would have been available to respond as quickly. The Districts should continue to update and maintain their formal list of emergency contacts to facilitate quick responses from bypass or pipeline contractors.
- At minimum, on an annual basis, the Districts should update both internal and external contacts listed in the ERP, SSMP, and SSO flow charts. The Districts can also include mutual aid agreements with their member agencies to address major spills and use of resources, materials, equipment.
- If not already completed, the Districts' should complete additional repairs of the unlined concrete portions of the 216th Street Relocation Sewer to prolong its service life, particularly if it will be kept in service after the replacement project is completed.
- Continue implementing Public Information Group's Emergency Response Plan.

7.3 Task 3 - Findings and Recommendations

The Districts meet or exceed the baseline requirements for O&M procedures, capacity evaluations, and CIP development. Based on information from LASAN and OC San, the Districts could consider the following recommendations for improvement:

- Update and revise the specifications for conducting sewer condition assessments to include new technology such as high-definition CCTV video, adjust speed of coverage to emphasize quality of data (slowing down the camera to gain a better picture), and lighting.
- Perform CCTV on worst reaches after high flow events.
- Include methods for integration of data with CMMS or data management systems that can facilitate issuing and tracking work orders for required improvements through a common database.
- Evaluate other technologies to be used in conjunction with CCTV inspections including laser, sonar, and pipe penetrating radar.

- Develop a system to track Condition Rating 1 sewers from first assessment through construction to ensure the 5-year repair schedule is met.
- Add a new rating for most severe cases (perhaps 0, U, or E).
- Review the existing process for Rehabilitation and Replacement program (R&R), CIP, funding, and schedule to ensure the desired completion for R&R is met for the worst rated sewers.
- Implement a risk-based prioritization process that considers the consequence of failure in a more objective manner and use less subjective ratings.
- Implement a manhole inspection program that works in conjunction with the CCTV operations.
- Revisit easement language to ensure access for maintenance, monitoring, inspection, repairs, and replacement of sewers with adequate room for these activities, including related construction. Where necessary, revise and update build over language for an easement, on a case-by-case basis, and limited to parking lots, open spaces, and similar improvements. Coordinate with future tenant or building improvements to follow new easement language with the member agency permitting departments.

7.4 Task 4 - Findings and Recommendations

Technology is available to facilitate and improve the operation and maintenance of the Districts' collection system. The recommendations for new technologies are listed below:

- If the Real Time Flow Monitoring Pilot Study is successful, consider implementing the system on a wider basis. If expanded, identifying strategic locations would also be suggested.
- Consider making HD video a requirement for all CCTV inspections.
- Evaluate and asses the application of non-invasive pipe inspection equipment (Laser, Sonar, PPR, Gas Sensors) and correlate data in a consistent manner with CCTV ratings.
- Sample manhole scanning technology.
- Develop an implementation plan for and utilize a sewer model.

7.5 Overall Conclusions and Recommendations

Overall, the Districts' processes and procedures exceed the requirements set forth by the SWRCB. Additionally, in many respects, the Districts are more proactive than other local agencies in the maintenance and rehabilitation of their collection systems. Much of the Districts' success has been obtained through a vast depth of institutional knowledge afforded by long term and dedicated staff. That said, it would be beneficial for the Districts to evaluate implementing industry leading practices and technologies that go beyond the State's requirements and work towards increasing its organizational sustainability, level of service, and further reducing future SSOs. As the Districts infrastructure continues to age, its services are expected to be more transparent, and its leadership continues to be further recognized in recycled water and as a good steward of the environment.

The following items are recommended for consideration by the Districts:

- Revisit the Districts Vision, Goals, and Objectives for its sewer collections program, including performance metrics/KPIs, level of service, risk, and industry leading practices that exceed the SWRCB's requirements.
- Evaluate staffing requirements and corresponding planning level budgets for sewer system maintenance, planning, and engineering to align with updated performance metrics (inspections, cleaning, R&R, etc.) and level of service.
- Develop an implementation plan for expanding the Districts' collection system asset management program to include a risk-based planning approach for the sewer collection system.
- As part of the implementation plan, investigate current software solutions for CCTV inspections and scoring, sewer modeling, and CMMS that work in tandem to best support the Districts. Additionally, existing Districts' systems for CCMS (WAM) and GIS should be evaluated for compatibility and relevance.

Appendix A

Reference Document Log

Posted Date	File Type	File Name if Link Broken	File Name / Link	Project Name	Project Type	Doucment Type	Client / Owner	Vicinity	Contains	Document Date (s)
10-Jan-22	Folder		8-d-4 216th St Trunk Sewer	216 th St. Trunk Sewer	New Construction	Plans	County Sanitation District No 8	From Dist. No. 5 Main Trunk Sewer To Main St. Pumping Plant	Seven Sheets, Plan Profile PDF's 36" x 24" GHD combined individual sheets and labeled them "combined sheets"	1930
10-Jan-22	Folder		8-p-13 216th St Relocation Trunk Sewer	216 th St. Relocation Trunk Sewer	Relocation	Plans	County Sanitation District No 8	From 228th & Orchard To Carson Street	Six Sheets, Cover, Plan Profile, Details PDF's 36" x 24" GHD combined individual sheets and labeled them "combined sheets"	1960
10-Jan-22	Folder		8-p-33 216th St Relief Trunk Sewer	216 th St. Relief Trunk Sewer	Relief	Plans	County Sanitation District No 8		Nine Sheets, Cover, Plan Profile, Details PDF's 36" x 24" GHD combined individual sheets and labeled them "combined sheets"	1983
10-Jan-22	Folder		8-p-36 216th St Trunk Sewer Rehabilitation	216 th Street Trunk Sewer Rehabilitation	Rehabilitation	Plans	County Sanitation District No 8	From Meneta & Clarion Drive To Moneta Avenue & 212th Street	Seven Sheets, Cover, Plan Profile, Detail PDF's 36" x 24" GHD combined individual sheets and labeled them "combined sheets"	1988
10-Jan-22	Folder		8-p-84 216th St Replacement Trunk Sewer Phase 1	216 th Street Treplacement Trunk Sewer Phase 1	Replacement	Plans & Special Provisions	County Sanitation District No 8	From 215 th & Figueroa approx. To Moneta Avenue & 212th	Twenty Seven Sheets, Cover, Plan Profile, Detail PDF's 36" x 24" GHD combined individual sheets and labeled them "combined sheets"	2018
10-Jan-22	Folder		8-p-87 216th St Replacement Trunk Sewer Phase 2	216 th Street Treplacement Trunk Sewer Phase 2	Replacement	Plans	County Sanitation District No 8	From W 230 th & S Figueroa St To W 215th St & S Figueroa St	Twenty Seven Sheets, Cover, Plan Profile, Detail PDF's 36" x 24" GHD combined individual sheets and labeled them "combined sheets"	2020
10-Jan-22	Folder		WCS CIP Reports	Wastewater Collection System Reports	Recommended Improvements	Report	Sanitation Districts of Los Angeles County	All Assets	Recommended Improvements for the Wastewater Collection System, CIP Projects, Projects to be constructed, Construction Costs, Priortiy Rating	2011, 2012, 2013, 2014, 2015, 2015, 2016, 2017, 2018, 2019, 2020
10-Jan-22	Folder		WCS Performance Overview Reports	Wastewater Collection System Performance Overview Reports	Performance Overview Reports	Report, Graphs, Tables	County Sanitation Districts of Los Angeles	All Assets	Summary of maintenance, SSOs, future projects, current projects for the Fiscal Years presented in the Doucment Date (s) column	2008 - 2009 2009 - 2010 2010 - 2011 2011 - 2012 2012 - 2013 2013 - 2014 2014 - 2015 2015 - 2016 2016 - 2017 2017 - 2018 2018 - 2019 2019 - 2020 2020 - 2021
10-Jan-22	PDF		216th Emergency Repairs.pdf	Figure 1: 216 th Street Trunk Sewer System Emergency Repairs		Figure	Sanitation Districts of Los Angeles County	S. Figueroa St, W 228th St to W 212 ST		
10-Jan-22	PDF		216th Street Relocation Trunk Sewer Calculation.pdf	216 th Street Relocation Trunk Sewer	Structural Report	Structural Calculations	County Sanitation Districts of Los Angeles County	216 th Street	Calculation for pipe loads for buried RCP Pipe (using ACPA Concrete Pipe Design Manual Standard Installations)	2022
10-Jan-22	PDF	DMS-#382842-v1-PLAN_AND_PROFILE.pdf	11-Jan-22	216 th St Relocation Trunk Sewer		Plan	County Sanitation District No 8		Sheet No 4 of 6, PDF 36" x 24"	1960
10-Jan-22	PDF	DMS-#3225773-v1-216th_Street_Trunk_&_216th_Street_Relocation_Trunks_CR.pdf	11-Jan-22	216 th Street Trunk and 216 th Street Relocation Trunk Condition Report	Inspection	Report			CCTV Inspection Reports of 216th Street Trunk & 216th Street Relocation Trunk	2015
10-Jan-22	PDF	DMS-#6394990-v6-Real-time_Sewer_Flow_Monitoring_Pilot_Study_Justification_Memo.pdf	11-Jan-22	Justification for a Real-time Sewer Flow Monitoring Pilot Study	Inspection	Pilot Study	Los Angeles County Sanitation Districts		Goals of pilot study, to investigate feasibility of implementing real time sewer flow information to assits with maintenance, emergency response, development monitoring and routing flow including stormwater	2021
10-Jan-22	PDF	DMS-#6419390-v1-Buildover_#322_-_1996_letter_approving_const_of_building_at_22029_S__Figueroa_St_over_216th_St_Reloc_TS.pdf	11-Jan-22	Proposed Construction over District's Easement 22019 S. Figueroa Street		Districts Approval	County Sanitation Districts of Los Angeles County	22019 S. Figueroa Street	Correspondance between district and building owner Contains email correspondance between Districts & Building owner at S. Figueroa. Contains depth of soil to be removed for building, and Districts approval subject to four conditions.	1996
10-Jan-22	PDF		Exhibit of Easements.pdf	Exhibit of Easements		Figure	Los Angeles County Sanitation Districts	Area of Collapse	Exhibit from District's detailing: Area of collapse Buildover Agreement Easements (note 4 of 6 are NO BUILDOVER per District's)	2022

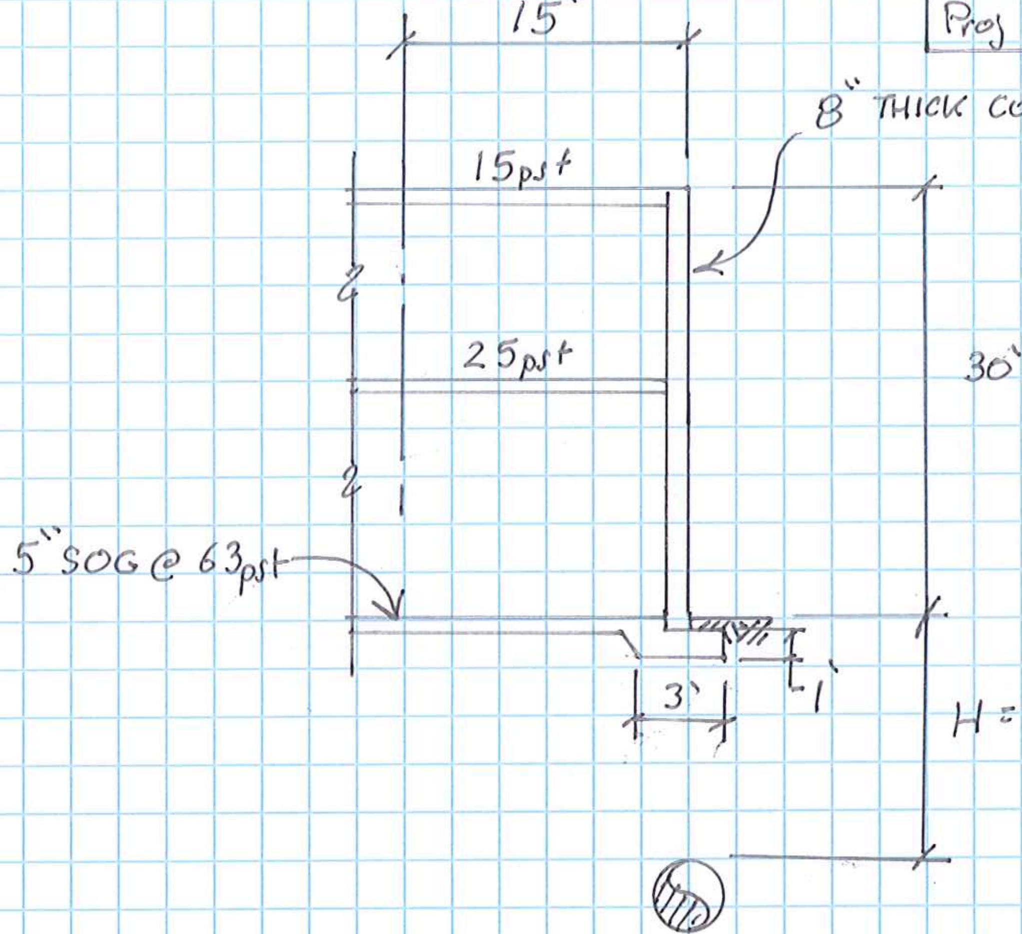
Posted Date	File Type	File Name if Link Broken	File Name / Link	Project Name	Project Type	Doucment Type	Client / Owner	Vicinity	Contains	Document Date (s)
10-Jan-22	PDF		External Audit Conducted by Black Veatch.pdf	External Audit Conducted by Black & Veatch	County of Sanitation Districts of Los Angeles County (Districts) External Audit Conducted by Black & Veatch	Report	County Sanitation Districts of Los Angeles County (Districts)		Contains: independent assessment of the County Sanitation Districts of Los Angeles County (Districts) power, instrumentation & control, and telecommunication systems in accordance with the Work Plan acepted by the California RWQCB.	2006
10-Jan-22	PDF		Letter - SanitationCasronSpillFINAL (002).pdf			Letter	Board of Supervisors County of Los Angeles	Area of Collapse	Board of Supervisors request for a **Full Incident Report** Contains list of criteria for the Incident Report to contain	2021
10-Jan-22	PDF		SANITARY SEWER OVERFLOW RESPONSE PLAN - 2008.pdf	Sanitary Sewer Overflow Response Plan	Plan	SOP	Sanitation Districts of Los Angeles County		Contains Sanitation District's: Overflow Response Goals Overflow Response Protocal Overflow Response Routes SS Flow Data	2008
10-Jan-22	PDF		Sewer Repairs Rehabilitation and Replacement Plan.pdf	Force Main Upgrade Plan, Capacity Assurance Plan, ewer Repair, Rehabilitation and Replacement Plan	Rehabilitation, Upgrade and Replacement Plan	Letter to U.S. EPA - Clean Water Act Compliance Office (WTR-7)	County Sanitation Districts of Los Angeles county	See Tables for System Upgrade locations	Contains Force Main Upgrade Plan Capacity Assurance Plan Sewer Repair Rehabilitation and Replacement Plan	2005
10-Jan-22	PDF		Sewer System Management Plan Audit 2019-2020.pdf	Sewer System Management Plan (SSMP) Audit	Audit	Report	Sanitation Districts of Los Angeles County	All Assets	SSMP Audit for 2019 - 2020	2019 - 2020
10-Jan-22	PDF		Sewer System Management Plan Feb 2019.pdf	Sewer System Management Plan (SSMP)	Management Plan	Report	Sanitation Districts of Los Angeles County	All Assets	SSMP Goals Operation and Maintenance Program Design and Performance Provisions Sanitary Sewer Overflow Response Plan Sewer System Evaluation and Capacity Assurance Plan	2019
10-Jan-22	PDF		Spill Calc - OSI Pi Trends for MSPP.pdf	Spill Volume Calculations	Figures	Figure		Main Street Pumping Plant	Contains flow and volume calculations for four different scenarious of Spills @ the Main Street Pumping Station Phase 1 No Bypass Pumping Phase 2 One Bypass Pump in Operation Phase 3 Two Bypass Pump in Operation Phase 4 Three Bypass Pump in Operation	2021
10-Jan-22	Excel		Main St PP - 2016 to Present - Pump Flow Data in GPM.xlsx	Pump Flow Data		Flow Data			Contains Pump Station Data	2016 2017 2018 2019 2020 2021
10-Jan-22	Excel		Shared Data Tracking.xlsx	Shared Data Tracking		Data Index			Assumption: Contains information / files the client shared with others and or has requested from others	
10-Jan-22	Excel		January 11, 2022\Storm+Flow+Reports+.XLSX		Storm Flow Reports	Data Index			Storm Flow Reports for Fiscal Years **ISSUE - Data Links have been removed, changed or are temporarily unavailable - GHD unable to acces - Action: request access**	1986 - Present
10-Jan-22	Word		216th Street Trunk Design Timeline.docx	216 th Street Trunk Design Timeline		Design Timeline			216th Street Replacement Trunk Sewer Replacement Phases 1 and 2 - Design Timeline	2015 - 2020
10-Jan-22	Word	DMS-#4634121-v4-LACSD_Build-over_Design_Criteria.docx	11-Jan-22	Build-Over Design Criteria for Buried Pipe		Special Provisions	County Sanitation Districts of Los Angeles County		Contians Build-Over Design Criteria for Buired Pipe	
10-Jan-22	Word		Summary_of_Districts__Sewer_Condition_Monitoring_Program.docx	Sewer Condition Monitoring Program	Rating System	Condition Rating	Los Angeles County Sanitation Districts		Contains, The Districts' sewer condition monitoring program involves the use of inspections and a condition rating system to prioritize sewer rehabilitation projects. This document contains a brief summary of the Districts' program. This is a snipped from the document	
10-Jan-22	Email	DMS-#6419519-v1-Email to Buildover Coordinator re_ 1996 approval letter for building at 22029 S_ Figueroa St in Carson added to files as Buildover #322.MSG	11-Jan-22	1996 Approval Letter for Building at 22029 Figueroa Street		Email		Area of Collapse	Contiains correspondance from Los Angeles County Sanitation Districts and the Building Owner at the Sewer System Collapse **ISSUE - GHD unable to open .DRF File, file may contain buildover agreement between building owner and the Districts - ACTION: find software to open file, and or request PDF of this file**	2022
10-Jan-22	Email	FW_ Audit info 216th Street Relocation TS - Dec 2021 Video Link for Sewer Reach Btw MH 644 and 476.msg	11-Jan-22	Audit info 216 th Street Relocation TS - Dec 2021 Vieo Link for Sewer Reach Btw MH 644 and 476		Email	Los Angeles County Sanitation Districts	Area of Collapse	Contains link to CCTV video of the collapsed reach from 12/1/21	2022

Posted Date	File Type	File Name if Link Broken	File Name / Link	Project Name	Project Type	Doucment Type	Client / Owner	Vicinity	Contains	Document Date (s)
12-Jan-22	Folder		January 12, 2022 Additions\GIS Sewerage Facilities Pipeline and Manhole Data			Document Types Vary: PDF Excel	Los Angeles County Sanitation Districts	Area of Collapse	Contains: Downloaded Videos Pipe P00533 (Folder) - **NO VIDEOS IN FOLDER** Downloaded Videos Pipe P20116 (Folder) **- Contains MP4 and PDF's of CCTV Inspection between MH 08 0644 & MH 08 0476 on seven different occasions** Map with Pipe Assets.pdf Files P00533.xlsx, P00535.xlsx, P20116.xlsx, P20117.xlsx, P20118.xlsx, P22133.xlsx Excel Data of Assets within the Collapsed Area - information in these Excel files also contains Asset Summary, Construction, Crown Spray, Line Cleaning, Inspection (including CCTV links), and observation	Dates vary: Crown Spray 2016 - present Inspection 2015 - 2021
12-Jan-22	Excel		11-2021 to Present - Pump Flow Data in GPM (1).xlsx	11-2021 to Present - Pump Flow Data in GPM		Excel			Contains: Total pump flow from November 2021 to present in GPM	2021-11 to Present
12-Jan-22	MP4		LACSD Board Meeting Presentation Part 1.mp4			MP4			Contains Par 1 LACSD Board Meeting Presentation	
12-Jan-22	MP4		LACSD Board Meeting Presentation Part 2.mp4			MP4			Contains Par 2 LACSD Board Meeting Presentation	
13-Jan-22	PDF		08-g-0023 Main Street Pumping Plant Drawings (1961).pdf	Revision of Main St. Pumping Plant	Revision	Plans	County Sanitation District No 8	21028 So Main St County of Los Angeles	Seven Ten Sheets, Structural, Structural Details, Electrical and Miscellaneous Details for pump station PDF's 36" x 24"	1961
13-Jan-22	PDF		Main Street Pumping Plant Emergency Procedures.pdf	Main Street Pumping Plant Emergency Procedures		SOP	County Sanitation District No 8	21028 S. Main Street	Contains" Emergency Data Pumping Data Force Main Data Bypass Valve Procedures Contacts List of Figures	2021
14-Jan-22	Folder		1/1/2022	Carson Sewer Spill 216 th Street Relocation	Emergency Repair	JPG / MOV		Area of Collapse - Emergency Repair	Photos / Video from Emergency Repair	1/1/2022
14-Jan-22	Folder		1/2/2022	Carson Sewer Spill 216 th Street Relocation	Emergency Repair	HEIC / JPG / MOV		Area of Collapse - Emergency Repair	Photos / Video from Emergency Repair	1/2/2022
14-Jan-22	Folder		1/3/2022	Carson Sewer Spill 216 th Street Relocation	Emergency Repair	HEIC / JPG / MOV		Area of Collapse - Emergency Repair	Photos from Emergency Repair	1/3/2022
14-Jan-22	Folder		1/4/2022	Carson Sewer Spill 216 th Street Relocation	Emergency Repair	JPG / HEIC		Area of Collapse - Emergency Repair	Photos from Emergency Repair	1/4/2022
14-Jan-22	Folder		1/5/2022	Carson Sewer Spill 216 th Street Relocation	Emergency Repair	JPG / HEIC		Area of Collapse - Emergency Repair	Photos from Emergency Repair	1/5/2022
14-Jan-22	Folder		1/6/2022	Carson Sewer Spill 216 th Street Relocation	Emergency Repair	JPG / HEIC		Area of Collapse - Emergency Repair	Photos from Emergency Repair	1/6/2022
14-Jan-22	Folder		1/7/2022	Carson Sewer Spill 216 th Street Relocation	Emergency Repair	JPG		Area of Collapse - Emergency Repair	Photos from Emergency Repair	1/7/2022
14-Jan-22	Folder		1/8/2022	Carson Sewer Spill 216 th Street Relocation	Emergency Repair	HEIC / JPG / PNG		Area of Collapse - Emergency Repair	Photos from Emergency Repair	1/8/2022
14-Jan-22	Folder		1/9/2022	Carson Sewer Spill 216 th Street Relocation	Emergency Repair	HEIC		Area of Collapse - Emergency Repair		1/9/2022
14-Jan-22	Folder		1/10/2022	Carson Sewer Spill 216 th Street Relocation	Emergency Repair	HEIC		Area of Collapse - Emergency Repair	HEIC from Emergency Repair	1/10/2022
14-Jan-22	Folder		1/11/2022	Carson Sewer Spill 216 th Street Relocation	Emergency Repair	HEIC		Area of Collapse - Emergency Repair	HEIC from Emergency Repair	1/11/2022
14-Jan-22	Folder		1/12/2022	Carson Sewer Spill 216 th Street Relocation	Emergency Repair	HEIC		Area of Collapse - Emergency Repair	HEIC from Emergency Repair	1/12/2022
14-Jan-22	Folder		1/13/2022	Carson Sewer Spill 216 th Street Relocation	Emergency Repair	HEIC		Area of Collapse - Emergency Repair	HEIC from Emergency Repair	1/13/2022
14-Jan-22	Folder		12/31/2021	Carson Sewer Spill 216 th Street Relocation	Emergency Repair	JPG / HEIC		Area of Collapse - Emergency Repair	JPG / HEIC from Emergency Repair	12/31/2021
14-Jan-22	Folder		Concrete Tickets	Carson Sewer Spill 216 th Street Relocation	Emergency Repair	JPG		Area of Collapse - Emergency Repair	JPG Concrete Ticket from January 3 2022	1/3/2022
14-Jan-22	Folder		1.01.2022.630am.730pm	Carson Sewer Spill 216 th Street Relocation at MH-08-1659	Emergency Repair	Daily Observation		Area of Collapse - Emergency Repair	Construction Observation / Inspection during on going emergency 48" RCP repair	1/2/2022
14-Jan-22	Word		2022-1-10 FIR-003 Carson 216th St. Emergency Job.docx	Carson Sewer Spill 216 th Street Relocation at MH-08-0644	Emergency Repair	WORD		Area of Collapse - Emergency Repair	Construction Observation / Inspection during slurry pour	1/10/2022
14-Jan-22	Word		2022-1-7 FIR-002 Carson 216th St. Emergency.docx	Carson Sewer Spill 216 th Street Relocation at MH-08-0644	Emergency Repair	WORD		Area of Collapse - Emergency Repair	Construction Observation / Inspection during "Hobas Pipe" lowering into trench	1/7/2022 - 1/8/2022
14-Jan-22	Excel		216th St. Reloc TS ER CARTER 1-2-2022.xlsx	Carson Sewer Spill 216 th Street Relocation at MH-08-0644	Emergency Repair	Excel		Area of Collapse - Emergency Repair	Construction Observation / Inspection	1/2/2022
14-Jan-22	Excel		216th St. Reloc TS ER CARTER 1-7-2022.xlsx	Carson Sewer Spill 216 th Street Relocation at MH-08-0644	Emergency Repair	Excel		Area of Collapse - Emergency Repair	Construction Observation / Inspection	1/8/2022
14-Jan-22	Folder		Charles King		Emergency Repair				No information in any of the folders in this location	12/31/21 - 01/05/22

Posted Date	File Type	File Name if Link Broken	File Name / Link	Project Name	Project Type	Doucment Type	Client / Owner	Vicinity	Contains	Document Date (s)
14-Jan-22	Folder		WAR		Emergency Repair	PDF			Work / Manpower Ticket located in the 01-01-22 folder - No information in any of the remaining folders	12/31/21 - 01/05/22
14-Jan-22	Folder		Pending		Emergency Repair	HEIC \ 3GP			HEIC / 3GP files with description during the emergency repair	
14-Jan-22	Folder		Slurry Tickets		Emergency Repair	None			No information in any of the folders in this location	
14-Jan-22	Folder		Sonar Data						Contains Pipe Run Scoring Sediment Report	
14-Jan-22	Word		Carson SSO Audit - Daily Check-In_2022-01-14.docx	Carson SSO Audit - Daily Check in		Meeting Minutes			Transcribed meeting minutes from meeting held on 2022-01-14	
14-Jan-22	MP4		Carson SSO Audit - Daily Check-In-20220114_092049-Meeting Recording.mp4	Carson SSO Audit - Daily Check in		Meeting MP4 Video Recording			MP4 Vieo Recording	
18-Jan-22	Folder		SmartCover Manhole Data			SmartCover Monitoring System	Los Angeles County Sanidation District		Contains SmartCover System Data Excel File SmartCover Monitoring System PDF: illustrates depth to water below MH from 2021-12-26 to 2022-01-04	
18-Jan-22	Excel		SmartCover System Data (MH 08 465 and 08 241).xlsx			SmartCover Monitoring System	Los Angeles County Sanidation District		MH Info, MH 241 and MH 465 Level Data	
18-Jan-22	PDF		SmartCover® Monitoring System - MH 241 Chart (2021.12.26-2022.01.04).pdf			SmartCover Monitoring System	Los Angeles County Sanidation District	Del Amo TS MH 241	SmartCover Monitoring System PDF: illustrates depth to water below MH from 2021-12-26 to 2022-01-04	
18-Jan-22	PDF		SmartCover® Monitoring System - MH 465 Chart (2021.12.26-2022.01.04).pdf			SmartCover Monitoring System	Los Angeles County Sanidation District	Del Amo TS MH 241	SmartCover Monitoring System PDF: illustrates depth to water below MH from 2021-12-26 to 2022-01-04	
18-Jan-22	PDF		DMS-#6432610-v1-CIWQS_SSO_Event_ID_878549.pdf			Report			216th Street Replacement Trunk SSO	December 30,2021
18-Jan-22	Email		Fw_ Condition Assessment of Sewers.msg			Info Email	LACSD - Kevin Monroe			Jan-22
18-Jan-22	PDF		SewerSystemManagementPlanS.pdf			Report	Sanitation districts of Los Angeles County		O&M Program, design and performance provisions, SSO Response plan, Fog control program, SSECAP, Monitoring, measurment and program modifications, SSMP program Audit, Communication program	Feb-19
19-Jan-22	PDF		DMS#3263229 (1).pdf			Plans and Details	Department of Transportation Caltrans	HARBOW FWY	Sanitary Sewer plans and standard details Sanitary Sewer Temporary Bypass	1991
19-Jan-22	Power Point		Carson SSO Preliminary Findings Part 1.pptx			Presentation			Tasks List /Milestone dates	
19-Jan-22	PDF		DMS#3263229.pdf			Plans and Details	Department of Transportation Caltrans	HARBOW FWY	Sanitary Sewer plans and standard details Sanitary Sewer Temporary Bypass	1991
19-Jan-22	Excel		SmartCover System Alarm Data (MH 08 465 and 08 241).xlsx			SmartCover Monitoring System	Los Angeles County Sanidation District		SmartCover System Data Excel File The following personnel get high level alarm notifications Acknowledgement	
20-Jan-22	Excel		Pipe and Manhole Construction Data.xlsx						Manhole and Pipes Features ID, Elevation, Drawing ref#, Material, Diameter,..	
24-Jan-22	Folder		Photos			JPG Photos (43 Item)			Debris at the area of collapse, Pump station, site photos	
28-Jan-22	Excel		216th St TS MH 465 Alarm Data.xlsx			SmartCover Monitoring System (Attachment to email from LACSD)	Los Angeles County Sanidation District		216TH St TS MH 465 Alarm Data from 2/17/2017 to 1/6/2022	
28-Jan-22	PDF		DMS-#4289629-v7-Main_Street_PP_Emergency_Procedure_Manual_2017.pdf			Emergency procedure (Attachment to email from LACSD)		Main street Pumping plant	Emergency Data, Flow data (SCADA 2017), Emergency Overflow info, Emergency procedure, Wet weather pump operating procedure, Contacts.	Nov-17
28-Jan-22	PDF		DMS-#4421655-v2-Wet_Weather_Pumping_Operation_Procedure_for_Mian_St_PP_-_Plant_Operator.pdf			Operating procedure (Attachment to email from LACSD)			Wet Weather pump operating procedure, SmartCover access instruction SmartCovers locations for Main St PP	
28-Jan-22	Email		Fw_ MH 8 465 Smart Cover Alarm History.msg			Info Email	LACSD - Kevin Monroe		The above listed files (3) are attacehd to this email: Alarm history for MH 8 465 and the procedure that was in place for controlling flow at Main Street PP during heavy wet weather previous to completion of the 216th Street Replacement Trunk Phase I that relieved the sewer system.	1/28/2022
28-Jan-22	Email		Fw_ MSPP Flow and Smart Cover Level Data.msg			Info Email	LACSD - Kevin Monroe		The below file is attached to this email: Graph of flow from Main St PP overlaid on the smart cover data.	1/28/2022
28-Jan-22	PDF		MSPP Flow and Smart Cover Level Data.pdf			Graph figure (Attachment to email from LACSD)			Main St PP Flow and MH 465 water level	12/30/2021

Appendix B

Annotated Structural Calculations



$W_{wall} = 100psf(30') = 3{,}000$

$W_{Roof} = 15psf(15') = 225$

$W_{Floor} = 25psf(15') = 375$

$W_{Grnd\ Flr} = 63psf(15') = 945$

$W_{FTG} = 3'(1')150pcf = 450$

$W_{DBLDG} = 4{,}995plf$

$W_{L\,bldg} = 20(15) + 2(100)15$

$= 3{,}300plf$

$$W_{bldg} = \frac{(W_{Dbldg} + W_{Lbldg})}{3'} = 2{,}765psf = W_L$$

COUNTY SANITATION DISTRICTS
of Los Angeles County

Date: 1/11/2022
Prepared By: ______
Reviewed by: ______

Determine Pipe Loads Due to Building Above Pipe

Dead Load

$W_{Wall} := 80psf \cdot 25ft = 2000 \cdot plf$ Assume 30 ft tall 8" CMU wall

$W_{Roof} := 25psf \cdot 15ft = 375 \cdot plf$ Assume roof dead load of 25 psf with a 15ft trib

$W_{Floor} := 80psf \cdot 15ft = 1200 \cdot plf$ Assume roof dead load of 60 psf with a 15ft trib

$W_{ftg} := 150psf \cdot 3ft = 450 \cdot plf$ Assume 3ft wide footing

$W_{Dbldg} := W_{Wall} + W_{Roof} + W_{Floor} + W_{ftg} = 4025 \cdot plf$ ← W_{Dbldg} = 4,995 plf

Live Load

$W_{Lbldg} := (20psf \cdot 15ft) + (100psf \cdot 15ft) = 1800 \cdot plf$

Estimated Building Weight (3 ft Ftg Width) $W_{bldg} := \frac{(W_{Dbldg} + W_{Lbldg})}{3ft} = 1941.67 \cdot psf$

Load for analysis -----> $W_L :=$ ~~2000psf~~ 2,765 psf

$Width := 3ft$

$Length := 20ft$

$a := Width + 1.00H - 2ft = 16\,ft$

$b := Length + 1.00H - 2ft = 33\,ft$

$Area := (a)(b)$ $Area = 528\,ft^2$

$w_{L\_avg} := \frac{W_L \cdot 3ft}{a}$ = $\frac{2{,}765psf(3')}{16'}$ = 518 psf $w_{L\_avg} = 375 \cdot psf$

$S_L := \begin{cases} b & \text{if } D_o > b \\ D_o & \text{otherwise} \end{cases}$ $S_L = 4.96\,ft$

$W_T := (w_{L\_avg}) \cdot b \cdot S_L$ = 518psf (33') 4.96' = 84,786 lb $W_T = 61359.38\,lb$

$L_e := b + 1.75 \cdot (0.75 \cdot D_o) = 39.51\,ft$

$W_{L\_bldg} := \frac{W_T}{L_e} =$ ~~1553.09~~ $\cdot plf$ 2,146 plf

$W_L := (W_{L\_bldg}) =$ ~~1553.09·plf~~ 2,146 plf

Determine pipe loads due to fluid loads within pipe

Sewage Weight, γ_F (per LACSD Standard Design Criteria) $\gamma_F := 63\text{pcf}$

$$W_F := \gamma_F \cdot \left(\frac{\pi \cdot D^2}{4}\right) = 791.68 \cdot \text{plf}$$

Determine Bedding Factor based on Type 4 Standard Installation

Outside Horizontal Span of Pipe	$B_c := D_o = 4.96\,\text{ft}$
Embankment Bedding Factor (ACPA Design Manual Illustration 4.22, Bfe = 1.7 for all Pipe Diameter)	$B_{fe} := 1.7$
Trench Minimum Bedding Factor (ACPA Design Manual Illustration 4.23, Bfo = 1.5 for type 4)	$B_{fo} := 1.5$
Transition Width at Top of Pipe **(per ACPA Design Manual Tables 13 through 39 - Linear Interpolation)**	$B_{dt} := 9.0 \cdot \text{ft}$

Variable Bedding Factor

$$B_{fv} := B_{fo} + \frac{(B_{fe} - B_{fo})(B_d - B_c)}{(B_{dt} - B_c)} = 1.57$$

Live Load Bedding Factor (ACPA Design Manual Illustration 4.25)

$$B_{fLL} := \begin{vmatrix} B_{fv} \text{ if } B_{fv} < 2.2 \\ 2.2 \text{ otherwise} \end{vmatrix} = 1.57$$

Determine D-Load

Safety Factor $SF := 1.25$ (LACSD Standard Design Criteria)

$$D_{0.01} := \left(\frac{W_E + W_F}{B_{fv}} + \frac{W_L}{B_{fLL}}\right) \cdot \frac{SF}{D} = 2145 \cdot \text{psf} \quad < \quad D_{LOAD} := 1750 \cdot \text{psf} \qquad \text{NG}$$

$$SF_{Calculated} := \frac{D_{LOAD}}{\left(\frac{W_E + W_F}{B_{fv} \cdot D} + \frac{W_L}{B_{fLL} \cdot D}\right)} = 1.02$$

$$SF_{Calculated} = \frac{1,750\ \text{psf}}{\left\{\left(\frac{8406.5 + 791.68}{1.57(48)}\right) + \left(\frac{2146}{1.57(48)}\right)\right\}\left(\frac{1'}{12''}\right)} = 0.98 \sim 1.0$$

GHD