

Clean Water 2020 Program

GRAVITY SEWER SYSTEM OPERATION AND MAINTENANCE PROGRAM (GSOMP)

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Program Summary and Intent

Introduction and Objectives

The City of Columbia (City) has developed a Gravity Sewer system operation and maintenance program (GSOMP) to establish procedures and schedules for prioritizing and implementing the continual assessment of the City’s Gravity Sewer system. The GSOMP includes a description of the methods and standard procedures that are used in the management, operation and maintenance of the Gravity Sewer system.

This GSOMP has been prepared in accordance with the requirements of Paragraph 12 of the Consent Decree (CD) entered by order dated May 21, 2014 in *The United States of America and State of South Carolina by and through the Department of Health and Environmental Control (SCDHEC) vs. the City of Columbia*, Civil Action No. 3:13-2429-TWL, DOJ Case Number 90-5-1-1-00954.

Below is a list of the CD requirements for the Gravity Sewer System Operation and Maintenance Program (GSOMP) and the sections of this document that address each requirement.

Table 0-1 CD Requirements for the Gravity Sewer System Operation and Maintenance Program

CD Section	CD Requirements	GSOMP Section
V. 12 main paragraph	“Management, Operations, and Maintenance (MOM) Programs. Columbia shall develop and implement the specific MOM Programs set forth below and ensure that each MOM Program has a written, defined purpose; a written, defined goal; is documented in writing with specific detail as required herein; is implemented by trained personnel; has established performance measures; and has written procedures for periodic review.”	Section 1. GSOMP Overview
12. i. (i)	“Written procedures for inspection and maintenance of Columbia’s Gravity Sewer systems (i.e., Gravity Sewer Lines, manholes, inverted siphons, etc.). “	Section 2. Written Procedures for Inspections and Maintenance of Gravity Sewer System
12. i. (ii)	“Written preventive operations and maintenance schedules and procedures including, but not limited to, the following routine activities: A. Inspection and maintenance of all Gravity Sewer , manholes and inverted siphons. B. Observing and documenting Gravity Sewer, manhole[s] and inverted siphon conditions, including grease, roots and/or debris accumulation. C. Identifying and documenting maintenance needs and any emergency planning needs. D. Scheduling preventive maintenance work/cleaning on a WCTS-wide basis. At a minimum, Columbia shall prioritize, inspect, and if necessary, clean its Gravity Sewer, manholes and inverted siphons on a regular basis (i.e. such that, while priority portions of the WCTS may be inspected with more frequency, the entire Gravity Sewer system is inspected, and cleaned where necessary, at a frequency designed to prevent future SSOs).”	Section 3. Written Preventive Operations and Maintenance Schedules
12. i. (iii)	“Engineering evaluation of potential sulfide and corrosion control needs. The GSOMP shall require, and Columbia shall generate, a summary report of findings with sulfide and corrosion control	Section 4. Engineering Evaluation of

CD Section	CD Requirements	GSOMP Section
	methods and the schedule for implementation of selected measures, where applicable.”	Potential Sulfide and Corrosion
12. i. (iv)	“Inspection of Gravity Sewer, manhole[s], and inverted siphon easements, including inspection of: creek crossings, stream bank encroachment toward Gravity Sewer, manholes and inverted siphons, and easement accessibility (including the need to control vegetative growth or encroachment of man-made structures or activities that could threaten the integrity of the affected Gravity Sewer, manholes or inverted siphon). Inspections shall include written reports, and where appropriate, representative photographs or videos of appurtenances being inspected (Gravity Sewer, manholes, inverted siphons, and creek crossings, etc.). The GSOMP shall require inspectors to promptly report any observed SSOs to their area supervisors and to record any evidence of SSOs which may have occurred since the last inspection. Columbia shall report any observed SSO in accordance with the SORP and the NPDES Permit.”	Section 5. Inspection and Maintenance of Gravity Sewer System
12.i.(v)	“A schedule for the maintenance of easements.”	
12. i. (vi)	“A description of resource commitment such as staffing, contractual support and equipment.”	Section 6. Description of Resource Commitment
12. i. (vii)	“Data attributes for the Sewer Mapping Program allowing program data to be compared in Columbia’s GIS system against other pertinent data such as occurrence of SSOs, including repeat SSO locations, and permit violations.”	Section 7. Data Attributes for Sewer Mapping Program
12. i. (viii)	“Subparagraph 12.i.(viii) – An inventory management system that requires Columbia to maintain: <ul style="list-style-type: none"> A. Lists of critical equipment and critical spare parts; B. An inventory of the critical spare parts and critical equipment stored at Columbia’s facilities, and a list of where the remaining critical spare parts and critical equipment not stored at Columbia’s facilities may be obtained to allow repairs in a reasonable amount of time; and C. Written procedures for updating the critical spare parts and equipment inventories in the inventory management system. “ 	Section 8. Inventory Management System
12. i. (ix)	“A common information system that Columbia will use to track implementation of the GSOMP, track maintenance activities, and track management, operation and maintenance performance indicators.”	Section 9. Information Management System (IMS)
12. i. (x)	“The Key Performance Indicators (“KPIs”) Columbia will track to measure performance of the WCTS using the information system referenced in Paragraph 12.i.(ix) above. These KPIs shall include, but are not limited to: <ul style="list-style-type: none"> A. The linear footage of Gravity Sewer inspections, the linear footage of Gravity Sewer cleaned, the number of manholes inspected, the number of manholes cleaned/maintained, the number of inverted siphons inspected, the number of inverted siphons cleaned/maintained and the number of SSOs per mile of Gravity Sewer; and B. Maintenance activity tracked by type (corrective, preventive, and emergency).” 	Section 10. Key Performance Indicators (KPIs)
12. i. (xi)	“Reports which list equipment problems and the status of work orders generated during the prior month.”	Section 11. Equipment Problem Reports

CD Section	CD Requirements	GSOMP Section
12. i. (xii)	"An implementation schedule specifying dates and actions."	Section 12. GSOMP Implementation Schedule

Acronyms & Abbreviations

ARV – Air Release Valve

CCTV – Closed Circuit Television

CD – Consent Decree

City – City of Columbia

CM – Corrective Maintenance

CMMS – Computerized Maintenance Management System

CW2020 – City’s program to manage consent decree compliance

DUE – Department of Utilities and Engineering

EPA – United States Environmental Protection Agency

FOG – Fats, Oils and Grease

FTE – Full Time Equivalent

GIS – Geographic Information System

GSOMP – Gravity Sewer System Operation and Maintenance Program

H₂S – Hydrogen Sulfide

I/I – Inflow and Infiltration

IMS – Information Management System

MACP – Manhole Assessment and Certification Program

NASSCO – National Association of Sewer Service Company

O&M – Operations and Maintenance

PACP – Pipeline Assessment and Certification Program

PM – Preventive Maintenance

SCDHEC – South Carolina Department of Health and Environmental Control

SOP – Standard Operating Procedure

SSO – Sanitary Sewer Overflow

WCTS – Wastewater Collection and Transmission System

WMD – Wastewater Maintenance Division

Section 1 GSOMP Overview

The GSOMP Overview addresses the following specific requirements of the CD:

- Subparagraph 12.i. – Gravity Sewer System Operation and Maintenance Program. Within eighteen (18) months after Date of Entry of this Consent Decree, Columbia shall submit to EPA and SCDHEC for review, comment, and approval, a Gravity Sewer System Operations and Maintenance Program (GSOMP) with the goal of eliminating future SSOs, particularly those caused by FOG, roots and/or debris obstructions. At a minimum, the GSOMP Program shall include, and Columbia shall implement, the requirements set forth in Paragraph 12.i.(i) through (xii) below.

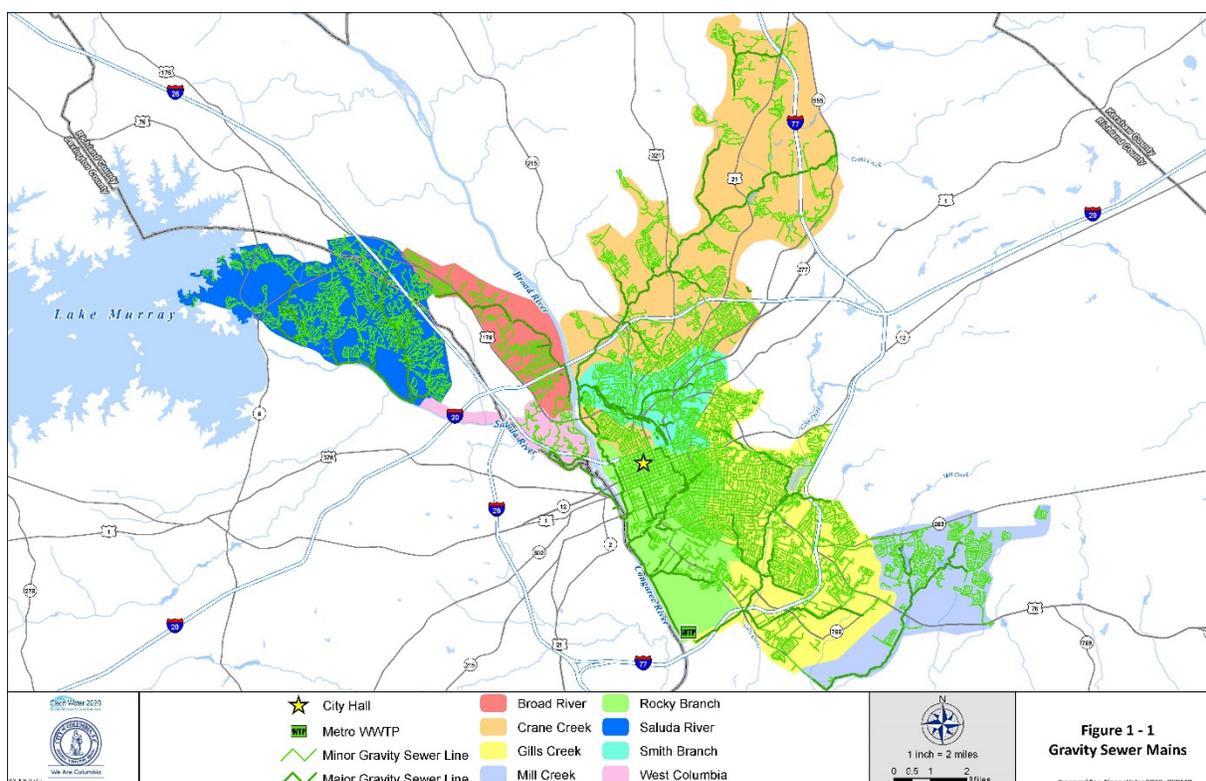
1.1 GSOMP Goal

The goal of the Gravity Sewer System Operation and Maintenance Program is to eliminate future Sanitary Sewer Overflows (SSOs), particularly those caused by Fats, Oils, and Grease (FOG), roots and/or debris obstructions.

1.2 Description of the Gravity Sewer System

Currently, there are approximately 1,070 miles of Gravity Sewer system and approximately 28,000 manholes owned by the City located both inside city limits and in portions of Richland and Lexington counties.

An overview of the Gravity Sewer system is located in **Figure 1-1**.



1.3 Organizational Structure

The Gravity Sewer system is operated and maintained by the City's Department of Utilities and Engineering. The City maintains organizational charts depicting roles and responsibilities for management, operations and maintenance of the Gravity Sewer system.

Section 2 Written Procedures for Inspection and Maintenance of Gravity Sewer System

This section describes the City of Columbia's process to develop the written procedures for inspection and maintenance of the Gravity Sewer system, as required in Subparagraph 12.i.(i) of the Consent Decree.

- Subparagraph 12.i.(i) – Written procedures for inspection and maintenance of the City's Gravity Sewer systems (i.e., Gravity Sewer Lines, manholes, inverted siphons, etc.).

Written procedures for the inspection and maintenance of the City's Gravity Sewer systems include the development of procedures in the following areas:

1. Inspection of Gravity Sewer System Lines Standard Operating Procedures (SOPs)
2. Inspection of Manhole SOPs
3. Maintenance of Gravity Sewer System Lines SOPs
4. Maintenance of Manhole SOPs

2.1 Written Procedures for the Inspection of Gravity Sewer System

A formalized Gravity Sewer system inspection program requires SOPs to identify the causes of a wastewater collection system problem. Once a problem has been identified, the exact location and magnitude can be determined in order to gauge how to correct the problem through internal investigation of the location.

2.1.1 Written Procedures for the Inspection of Gravity Sewer System

The following are the WMD Sewer Line Standard Operating Procedures for the inspection of sewer pipelines:

Table 2-1 WMD Gravity Sewer System Standard Operating Procedures

SOP No.	Description
300-01	CCTV Inspection Mainlines
300-02	CCTV Inspection Service Lateral
300-04	Dye Testing
300-08	Smoke Testing
300-07	Tracing Service Laterals
300-09	Sewer Line Rapid Assessment Tool Operations

2.1.2 Written Procedures for the Inspection of Gravity Sewer System and Manholes

The following are the WMD Manhole Standard Operating Procedures for the inspection of sewer manholes:

Table 2-2 WMD Manhole Standard Operating Procedures for the Inspection of Gravity Sewer System Manholes

SOP No.	Description
300-06	Routine Manhole Inspections
300-08	Critical Manhole Inspections

2.2 Written Standard Operating Procedures (SOPs) for the Gravity Sewer System

A formalized Gravity Sewer system maintenance program requires SOPs be developed for use by the City, including, but not limited to routine system maintenance procedures that are followed by personnel to ensure quality. The City's cleaning program is a vital maintenance activity for properly operating the Gravity Sewer system.

- Written procedures for inspection and maintenance of Columbia's Gravity Sewer systems (i.e., Gravity Sewer System Lines, manholes, inverted siphons, etc.).

2.2.1 Written Procedures for the Maintenance of Gravity Sewer System

The following are the WMD Gravity Sewer system Standard Operating Procedures for the maintenance of Gravity Sewer System Lines:

Table 2-3 WMD Gravity Sewer Line SOPs for the Maintenance of Gravity Sewer System Lines

SOP No.	Description
200-01	Cleaning Mainline
200-02	Cleaning Mainline with a Root Saw
200-03	Clearing Mainline Blockage
200-04	Clearing Lateral Blockage
200-05	Clearing Lateral Blockage with Rigid Rodding Machine

2.2.2 Written Procedures for the Maintenance of Gravity Sewer System Manholes

WMD Gravity Sewer System Manhole Standard Operating Procedures for the maintenance of sewer manholes are under development.

Section 3 Written Preventive Operations and Maintenance Schedules

This section describes the City of Columbia's written preventive operations and maintenance schedules and procedures for the inspection and maintenance of the Gravity Sewer system, as required in Subparagraph 12.i.(ii) of the Consent Decree.

- Subparagraph 12.i.(ii) – Written preventive operations and maintenance schedules and procedures including, but not limited to, the following routine activities:
 - A. Inspection and maintenance of all Gravity Sewers, manholes and inverted siphons.
 - B. Observing and documenting Gravity Sewer, manhole[s] and inverted siphon conditions, including grease, roots and/or debris accumulation
 - C. Identifying and documenting maintenance needs and any emergency planning needs
 - D. Scheduling preventive maintenance work/cleaning on a WCTS-wide basis. At a minimum, Columbia shall prioritize, inspect, and if necessary, clean its Gravity Sewers, manholes and inverted siphons on a regular basis (i.e. such that, while priority portions of the WCTS may be inspected with more frequency, the entire Gravity Sewer system is inspected, and cleaned where necessary, at a frequency designed to prevent future SSOs).

3.1 Written Preventive Operations and Maintenance Schedules

The following sections describe the written preventive operations and maintenance schedules for the inspection and maintenance of Gravity Sewer systems, and Manholes by the Wastewater Maintenance Division.

3.1.1 Inspection and Maintenance of Gravity Sewer Systems

Preventive operations and maintenance work is conducted by both in-house and contract crews on an ongoing basis. Inspection of the Gravity Sewer system provides information on the condition of the Gravity Sewer system. The maintenance of the Gravity Sewer system includes the cleaning of Gravity Sewer system.

The preventive maintenance scheduling is the function of the WMD's Superintendent, Assistant Superintendents and Supervisors. The purpose of the scheduling within the WMD is to ensure that resources, personnel and material are available to conduct the work.

The Gravity Sewer system line inspection and maintenance (cleaning) goals are described in the following tables:

Table 3-1 Annual Gravity Sewer System Line Inspection Program

Task Description	Pipeline Inspection
Unit of Measure	Feet / Miles
System Inventory	5,649,600 / 1,070
Annual Target / Goal Task Frequency (10%)	564,960 / 107

Table 3-2 Annual Gravity Sewer System Line Maintenance (Cleaning) Program

Task Description	Pipeline Cleaning
Unit of Measure	Feet / Miles
System Inventory	5,649,600 / 1,070
Annual Target / Goal Task Frequency (20%)	1,129,920 / 214

Note: 1,070 miles of Gravity Sewer (5,649,600 lf)

3.1.2 Manhole Inspection Schedule

The preventive operations and maintenance schedules for the inspection of the Gravity Sewer system's manholes are conducted by both in-house and contract crews on an ongoing basis. Inspection of the manholes provides information on their condition.

The preventive maintenance scheduling of manholes is the function of the WMD's Superintendent, Assistant Superintendents and Supervisors. The purpose of the scheduling within the WMD is to ensure that resources, personnel, and material are available to conduct the work.

The manhole inspection goals are described in the following table:

Table 3-3 Annual Manhole Inspection Schedule and Program

Task Description	Manhole Inspection
Unit of Measure	Each
System Inventory	28,000
Annual Target / Goal Task Frequency (10%)	2,800

3.1.3 Inverted Siphon Inspection Schedule

The preventive operations and maintenance schedules for the visual inspection of the Gravity Sewer system's inverted siphons are conducted by both in-house and contract crews on an ongoing basis. Inspection of the siphons provides information on their condition.

The preventive maintenance scheduling of siphons is the function of the WMD's Superintendent, Assistant Superintendents and Supervisors. The purpose of the scheduling within the WMD is to ensure that resources, personnel, and material are available to conduct the work.

The inverted siphon inspection goals are described in the following table:

Table 3-4 Annual Inverted Siphon Inspection Schedule and Program

Task Description	Siphon Inspection
Unit of Measure	Each
System Inventory	2
Annual Target / Goal Task Frequency (50%)	1

3.2 Observing and Documenting Gravity Sewer System Conditions

This Section describes the method that the WMD and its contractor use to observe and document Gravity Sewer system, manhole and inverted siphon conditions, including grease, roots and/or debris accumulation.

The Wastewater Maintenance Division uses and adheres to the National Association of Sewer Service Companies (NASSCO) Pipeline Assessment and Certification Program (PACP) and the Manhole Assessment and Certification Program (MACP). These standards use *condition scores* when determining the condition of an asset during its inspection, assigning a numerical value of 1 to 5, where 1 indicates almost a new condition with little or no deterioration, and a condition score of 5 indicates complete failure.

Through the use of these standards, the WMD uses six specific operations and maintenance codes to describe various types of foreign objects that are found in sewers and may interfere with operations of the conveyance system. The following six groups comprise the operation and maintenance codes:

1. Deposits
2. Roots
3. Infiltration
4. Obstacles/Obstructions
5. Vermin
6. Testing and Grouting

3.3 Identifying and Documenting Maintenance Needs and Emergency Planning Needs

This section describes the process for identifying and documenting maintenance needs and emergency planning needs at the WMD.

The WMD identifies and documents maintenance needs through its Gravity Sewer system inspection program. Maintenance needs are identified through a number of sources, customer calls, directed to the WMD, Closed Circuit Television (CCTV) and Sewer Line Rapid Assessment Tool (SL Rat) data gathered by WMD crews.

Once information is documented, work is prioritized based on the severity of the problems. Low level maintenance needs receive a lower level priority versus an emergency status. Emergencies are responded to immediately and corrective actions are implemented to prevent a system failure.

3.4 Scheduling Preventive Maintenance Work and Cleaning

This section describes the scheduling of preventive maintenance work to inspect and clean the Gravity Sewer system.

The WMD has developed a cleaning frequency, and the identification of recurring problem areas and a plan to routinely clean these areas more frequently. The WMD schedules routine preventive maintenance activities to prevent service interruptions and establish a proactive maintenance program.

The following is an overview of the annual performance and future maintenance of the Sanitary Sewer system:

Table 3-5 Targeted Annual Preventive Maintenance Work and Cleaning

Annual Performance Indicator	2015/16
Gravity Sanitary Sewer Inspection Rate miles / 100 miles of pipe	10.70
Gravity Sanitary Sewer Cleaning Rate miles / 100 miles of pipe	21.40
Gravity Sanitary Sewer Manhole Inspection (ea.)	2,800

Section 4 Engineering Evaluation of Potential Sulfide and Corrosion

This section describes the City of Columbia's procedures to describe the sulfide and corrosion control needs of the Gravity Sewer system, as required in Subparagraph 12.i.(iii) of the Consent Decree.

- Subparagraph 12.i.(iii) – Engineering evaluation of potential sulfide and corrosion control needs. The GSOMP shall require, and Columbia shall generate, a summary report of findings with sulfide and corrosion control methods and the schedule for implementation of selected measures, where applicable.

4.1 Engineering Evaluation of Potential Sulfide and Corrosion Control

The Sulfide and Corrosion Control element of the GSOMP is established to address corrosion issues associated primarily with the formation of hydrogen sulfide (H_2S) in the Gravity Sewer system. The purpose of the corrosion control component of the program is to provide a systematic means for identifying and correcting corrosion problems before they cause a failure in critical wastewater pipelines and gravity main assets. Depending upon conditions present, there are several types of corrosion that may need to be addressed:

- Degradation of concrete structures caused by the presence of H_2S and moisture in manholes or concrete pipes
- Corrosion of ferrous metals (rust) resulting from improperly applied or maintained protective coating systems (paint) (This can be accelerated in areas where the metal is exposed to H_2S .)
- Corrosion of a variety of metals caused by aggressive or corrosive soils

Under the GSOMP, the City shall implement the following:

- Engineering evaluation of Gravity Sewer system to identify sulfide-related corrosion risks and areas of concern
- Summary report of findings that identifies corrosion control and mitigation alternatives
- Schedule for implementation of selected measures

4.2 Engineering Corrosion Evaluation and Summary Report of Gravity Sewer System

Corrosion in the Gravity Sewer system can lead to material failures that may result in structural failures and/or in excessive inflow and infiltration (I/I) entering the system. In addition, corrosion can result in catastrophic failures such as gravity main ruptures or sewer cave-ins that result in SSOs. Internal corrosion in sewers is typically a result of hydrogen sulfide produced by biological reduction of sulfate to sulfide by anaerobic bacteria that reside in anoxic wastewater and slime layers that accumulate on pipe, concrete structures, and sediment surfaces. The resulting sulfide is transformed into hydrogen sulfide (H_2S) gas, which is then converted to sulfuric acid (H_2SO_4) by aerobic bacteria that reside above the water

line in the Gravity Sewer system. The acid can result in severe corrosion of metals, reinforced concrete and mortar.

The City's corrosion defect identification and evaluation process will include the following elements, as applicable:

- Identification of Gravity Sewer system components at risk of corrosion
- Prioritization and inspection, as needed, of at-risk Gravity Sewer system components to identify corrosion defects
- Corrosion defect documentation and analysis
- Prioritization of repairs for corrosion defects

The elements of the Engineering Corrosion Evaluation and Summary Report are described in detail in the following sections for the Gravity Sewer system.

STEP 1: IDENTIFY AREAS OF THE GRAVITY SEWER SYSTEM AT RISK OF CORROSION

A desktop evaluation of available data will be used to identify areas that meet the following criteria for corrosion potential:

- Manholes and Gravity Sewer system segments directly downstream of a force main discharge, as determined from the City's geographic information system (GIS)
- Drop manholes or other manholes with excessive turbulence, as determined from review of GIS, existing inspection data, or maintenance personnel knowledge of the system
- Areas with a concentration of odor complaints, as determined from review of service requests, or areas with odor problems, as documented by maintenance personnel
- Areas with low velocity/long detention times, as determined from the hydraulic model (as model results are available) or maintenance personnel knowledge of the system

STEP 2: PRIORITIZE AND INSPECT AREAS AT RISK OF CORROSION

The Gravity Sewer systems, manholes, and gravity mains at risk for corrosion, as identified in **Step 1**, are included as higher priority in the overall prioritization process for condition assessment by physical inspection.

- Manholes at risk of corrosion are inspected, as necessary, using routine manhole inspections.
- Gravity Sewer systems at risk of corrosion are inspected, as necessary, using CCTV or zoom camera inspection.
- Gravity main segments identified through desktop analysis as being at risk of corrosion and having a high probability and consequence of failure are inspected using one or a combination of the field inspection methods.

- Corrosion inspection may also include installation of continuous odor monitors, liquid phase wastewater sampling, wastewater temperature readings, or assessment of ventilation in pump stations.

STEP 3: DOCUMENT AND ANALYZE CORROSION DEFECTS

The corrosion defects identified through field inspections will be documented in the City's information management system (IMS). Manhole and Gravity Sewer system defects will be coded using the National Association of Sewer Service Company's (NASSCO) Manhole Assessment and Certification Program (MACP) and Pipeline Assessment and Certification Program (PACP) standard codes for corrosion defects, referencing the City's manhole and pipe identification numbers.

Defects will be reviewed and analyzed to determine the source and cause of the corrosion. If necessary, additional investigation can be performed to determine the source of hydrogen sulfide gas or cause of corrosion if no hydrogen sulfide is present. This information can be used to evaluate and implement corrosion reduction measures for corrosion prone areas of the Gravity Sewer system, as appropriate. For example, operational changes can be evaluated to reduce wastewater detention time and generation of hydrogen sulfide in the system. If corrosion is due to the nature of the wastewater, upstream industrial discharges can be investigated through the industrial pretreatment program.

STEP 4: SUMMARY REPORT TO PRIORITIZE DEFECTS FOR REPAIR OR CORRECTIVE ACTION

Corrosion defects identified through this process will be incorporated into the overall repair and rehabilitation prioritization process under the infrastructure rehabilitation (IR) program.

For those sites where corrosion could result in a failure or where odors must be abated, the City may evaluate alternative control technologies, including but not limited to, chemical addition, aeration, and replacement or armoring of materials subject to corrosion damage. Any Gravity Sewer system components that are found to be in imminent danger of failure will be addressed.

Section 5 Inspection and Maintenance of Gravity Sewer System

This section describes the City of Columbia's procedures for the inspection and maintenance of gravity sewers, manholes, and easements including inspection and maintenance of: creek crossings, stream bank encroachment toward Gravity Sewer systems, and manholes and easement accessibility of the Gravity Sewer system, as required in Subparagraph 12.i.(iv) and 12.i.(v) of the Consent Decree.

- Subparagraph 12.i.(iv) – Inspection of Gravity Sewer, manhole[s], and inverted siphon easements, including inspection of: creek crossings, stream bank encroachment toward Gravity Sewer, manholes and inverted siphons, and easement accessibility (including the need to control vegetative growth or encroachment of man-made structures or activities that could threaten the integrity of the affected Gravity Sewer, manholes or inverted siphon). Inspections shall include written reports, and where appropriate, representative photographs or videos of appurtenances being inspected (Gravity Sewer, manholes, inverted siphons, and creek crossings, etc.). The GSOMP shall require inspectors to promptly report any observed SSOs to their area supervisors and to record any evidence of SSOs which may have occurred since the last inspection. Columbia shall report any observed SSO in accordance with the SORP and the NPDES Permit.
- Subparagraph 12.i.(v) – A schedule for the maintenance of easements.

5.1 Inspection of Gravity Sewer System, Manholes, and Maintenance of Easements

The Inspection and Maintenance of Gravity Sewer System, Manholes, and Easements that includes the inspection of creek crossings, stream bank encroachment toward Gravity Sewer system assets (including the need to control vegetative growth or encroachment of man-made structures) will provide a systematic means for identifying and correcting problems at these locations before failure in critical Gravity Sewer system assets.

The WMD is proposing to address these areas through the following phased approach:

- Site evaluation, prioritization, and preliminary information regarding creek crossings and stream bank encroachments
- Evaluation and condition assessment of creek crossings and stream bank encroachments through field investigation
- Operation and maintenance strategy to operate and maintain creek crossings and stream bank encroachments, to include the identification and reporting of SSOs
- Preliminary design of sites, including those crossings and stream banks where repairs are necessary to prevent failure of assets

5.2 Maintenance of Easement

The planned maintenance schedule for easements will be conducted annually. Easement maintenance will include vegetation clearing to provide unimpeded access to assets located in the City's easements.

The schedule will include both significant one-time scheduled clearing activities and annual easement maintenance.

5.3 Schedule of Maintenance of Easements

The initial schedule of maintenance of easements will ensure that all easements and assets are inspected on an annual basis. Gravity Sewer system assets located in easements are required to be inspected and maintained by the Wastewater Maintenance Division. The maintenance of these easements is defined as the inspection, cleaning and clearing of these easements to allow for easy access to operate and maintain Gravity Sewer system assets located in these easements.

Continuous maintenance of easements is a critical component to implementing an overall easement preventive maintenance program, and ensures that response times are kept to a minimum on corrective activities. Staff allocates resources to complete the maintenance of easements. The purpose of the scheduling within the WMD is to ensure that resources, personnel and materials are available to complete the work. On an annual basis, the WMD has allocated a budget to hire a contractor to maintain the City's easements.

Section 6 Description of Resource Commitment

This section describes the City of Columbia's resource commitment such as staffing, contractual support and equipment needs for the Gravity Sewer system, as required in Subparagraph 12.i.(vi) of the Consent Decree.

- Subparagraph 12.i.(vi) – A description of resource commitment such as staffing, contractual support and equipment.

6.1 Staffing

A description of current resource commitments such as staffing, contractual support and equipment is required in order to establish support for the implementation of a GSOMP and to demonstrate the duties and responsibilities of the positions within the Gravity Sewer system operations and maintenance. The WMD Superintendent is responsible for management of approximately 100 division employees.

The following is the description of the Wastewater Maintenance Division current resource commitment:

Table 6-1 Wastewater Maintenance Division (WMD) Current Resource Commitment

Occupational Title	Number of Full Time Equivalents (FTE)
Superintendent	1.0
Assistant Superintendent	2.0
Senior Staff Assistant	1.0
Administrative Secretary	1.0
Senior Office Assistant	1.0
Office Assistant	1.0
Material Inv. Clerk I	1.0
Supervisor	3.0
Foreman	15.0
Operators (A – D & Trainee)	75.0
Total Staffing	101.0

6.2 Contractual Support

The WMD current contractual resource commitment includes the following contracts used to support the operations and maintenance of the WMD:

Table 6-2 Current Resource Commitment

No.	Contract
1	Annual Sanitary Sewer Root Control
2	Annual Sanitary Sewer Beaver and Dam Removal
3	Annual Sanitary Sewer Herbicide Contract
4	Annual Sanitary Sewer Mechanical Clearing
5	Annual CCTV and Manhole Inspection

6.3 Equipment

The WMD has a significant number of pieces of equipment currently used to perform the day-to-day operations and maintenance (O&M) of the Gravity Sewer system:

Table 6-3 WMD Equipment Currently Used for Day-to-Day O&M

Equipment	Number of Pieces
A-Frame	1
Air Compressor	5
Air Hammer	9
Auger	1
Auger/Gas Powered	1
Backhoe	11
Boring Machine	1
Breaker	2
Bush Hog	1
Bush Hog Deck	2
4" By-Pass Pump	1
Cable Machine	2
Camera	1
Small Camera	2
Camera Truck	3
Camera Van	1
Chain Saw	5
Chipping Hammer	4
Compressor	1
Concrete Saw	3
Crew Cab	14
Crew Cab 870	1
4x4 Crew Cab	2
Crew Cab Dump Truck	1
Drill	4
Dump Truck	8
Easement Machine	1
Equinox	1
Excavator	3
Mini Excavator	2
Track Excavator	1
Flatbed	4
Flatbed Dump Truck	2
Sedan	1
Generator	13
Generator/CCTV Trailer	1
Jet Washing Truck	3
Hook/Lift Roll Off	2
Laser	1
Loader	1
Low Boy Trailer	1
Low Boy Truck	1

Equipment	Number of Pieces
Mortar Mixer	1
Mud Hog Pump	5
Pick Up	23
Pipe Bursting Machine	2
Pipe Laser	1
Pipe Saw	17
Portable Generator	3
Pull Trailer	1
Pump	4
3" Pump	2
4" Pump	2
Rodder	1
Rodding Machine	5
Roll Off Container	4
Rubber Tire Loader	1
Saw	13
Sewer Vent Fan	2
Shin Cutter	1
Skid Steer	4
Sludge Dewatering Roll Off Boxes	5
Smoke Fan	1
Smoke Machine	4
Stoppage Truck	1
SUV	1
Tamper	10
Tandem Dump Truck	2
Traffic Arrowboard	6
Trailer	25
Transit	2
Utility Vehicle	2
Vacuum Truck	4
Van	1
Vibrating Plate Tamp	2
Vibrating Tamp	1
Water Truck	3
Welder	1

Section 7 Data Attributes for Sewer Mapping Program

This section describes the City of Columbia's data attributes for sewer mapping for the Gravity Sewer system, as required in Subparagraph 12.i.(vii) of the Consent Decree.

- Subparagraph 12.i.(vii) – Data attributes for the Sewer Mapping Program allowing program data to be compared in Columbia's GIS system against other pertinent data such as the occurrence of SSOs, including repeat SSO locations, and permit violations.

7.1 Data Attributes for Sewer Mapping Program

The City will have data attributes that will allow data to be compared spatially against other pertinent data such as work activities and sanitary sewer overflows.

The City's Computerized Maintenance Management System (CMMS), Cityworks®, will use the City's GIS as its asset inventory, allowing for data resulting from Gravity Sewer system activities, such as work orders and SSOs, to be spatially analyzed and associated with an asset in GIS.

Data will be collected for sewer pipes, manholes, and air release valves (ARVs). The primary attributes that will be collected for each of these sewer system assets are listed in the following tables.

Table 7-1 Sewer Manhole or Pipe End Structure Data Attributes

Sewer Manhole or Pipe End Structures
Structure type (manhole, etc.)
Horizontal and vertical (elevation) of the structure rim (X and Y) location in South Carolina
Depth to bottom (lowest point)
Depth to shelf
Shape of structure (round, etc.)
Wall material
Presence of rehabilitation
Cover and rim condition
Wall condition
Evidence of surcharging
Access issues
Required internal and external photographs
Additional attributes required by NASSCO MACP Level 2 inspections

Table 7-2 Sewer Pipes Data Attributes

Sewer Pipes
Flow type (gravity or force main)
Diameter
Material
Shape of pipe
Upstream invert elevation
Downstream invert elevation
Slope
Flow direction (GIS digitized direction)
Upstream and downstream system network connectivity (as defined by GIS network)
Condition of pipe (from zoom camera and CCTV work in NASSCO PACP format)
Siphon (Yes/No – the pipe functions as a siphon)
Presence of air valves or other gas relief
Photographs and videos as required by PACP and the inspection specifications

7.2 Sewer Mapping Pertinent Data

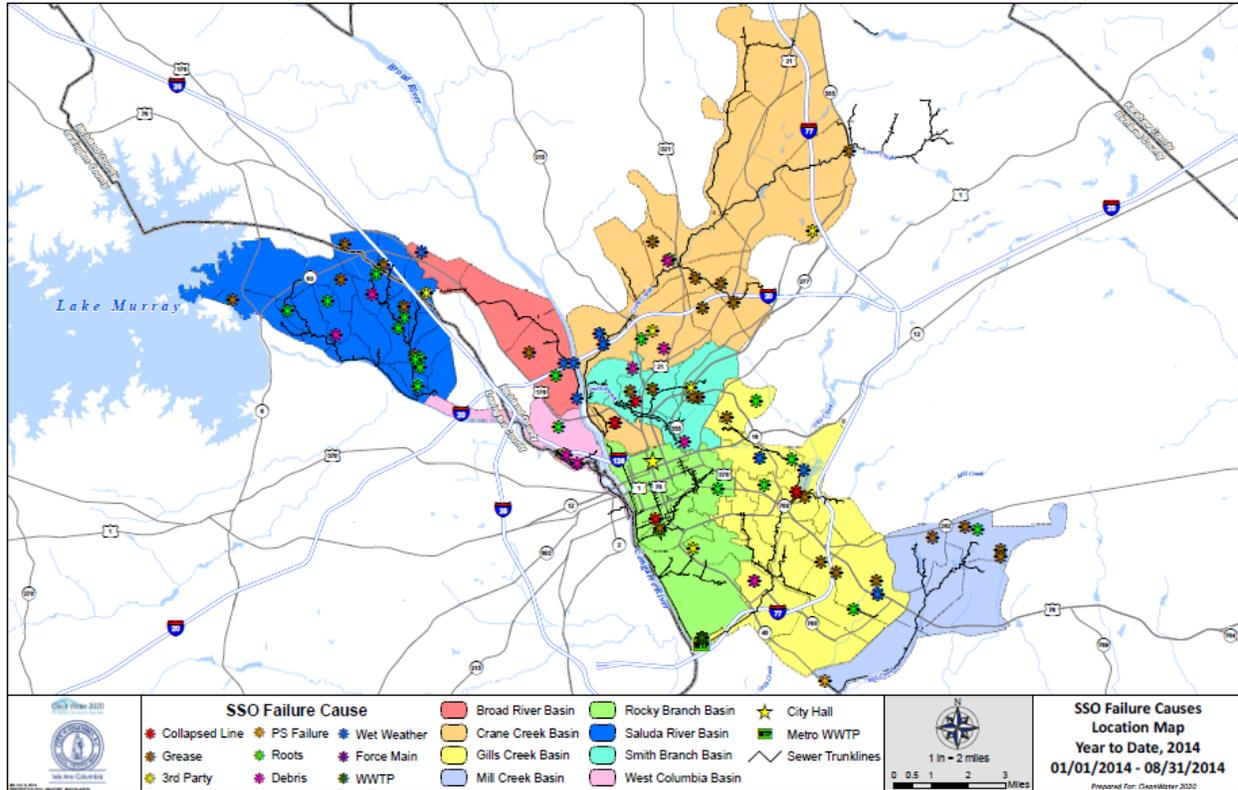
SSOs and other historical data are being compared spatially by the City and reported monthly.

The following data are being provided spatially:

Table 7-3 Monthly SSO Data

SSO No.	County	SSO Date	Street	Asset ID	SSO Volume
SCDHEC SSO Number	County of SSO	Date SSO Occurred	Street Address	Asset GIS ID Number	Volume of SSO

Figure 7-1 Sanitary Sewer Overflow Map January-August 2014 (example)



Section 8 Inventory Management System

This section describes the procedures that the City of Columbia will use in the execution of their Inventory Management System needs for the Gravity Sewer system, as required in Subparagraph 12.i.(viii) of the Consent Decree (A-C).

- Subparagraph 12.i.(viii) – An inventory management system that requires Columbia to maintain:
 - A. Lists of critical equipment and critical spare parts;
 - B. An inventory of the critical spare parts and critical equipment stored at Columbia’s facilities, and a list of where the remaining critical spare parts and critical equipment not stored at Columbia’s facilities may be obtained to allow repairs in a reasonable amount of time; and
 - C. Written procedures for updating the critical spare parts and equipment inventories in the inventory management system.

8.1 Lists of Critical Equipment and Spare Parts

The WMD maintains a significant inventory of critical equipment and spare parts to operate and maintain the Gravity Sewer system. This includes critical equipment and spare parts necessary for emergency and reactive O&M activities, as well as preventive O&M activities. If the need for additional critical equipment or spare parts arises, the City has the option of renting the equipment or purchasing critical spare parts from a local vendor or utilizing one of its existing maintenance contractors. The City stores its equipment and critical spare parts at the WMD.

The following definition was developed for determining if equipment or spare parts are critical to gravity system operations: “Critical equipment and parts are those which, when failure occurs, will result in a sanitary sewer overflow (SSO) or impede the response to an emergency.”

8.2 An Inventory of Critical Equipment and Spare Parts

Based upon the definition above, the following spare parts and equipment are considered critical.

Table 8-1 Critical Equipment and Purpose

Critical Equipment No.	Equipment	Purpose
1	Utility Vehicle	Amphibious all-terrain vehicle used to provide access to wetlands areas that are difficult to access and maintain using conventional public works equipment.
2	Back Hoe	Excavating equipment with the primary purpose to remove dirt and provide access to utility assets i.e., manholes, sewer lines, sewer laterals.

Critical Equipment No.	Equipment	Purpose
3	Jet Washing Truck	A high pressure water jetting unit used to clear obstructions in the wastewater collection system.
4	Vacuum Truck	A combination pressure cleaning and vacuum unit used to clean and remove debris sewer lines and manholes in the wastewater collection system.
5	Ditch Boxes	Box-shaped sheathing made of steel, permanently braced across a trench for excavation and pipe laying.
6	Track Machines	Excavating equipment with the primary purpose to remove large areas of dirt and provide access to utility assets i.e., manholes, sewer lines, sewer laterals.
7	CCTV (cameras)	Fixed-view camera with rotating head allowing full radial view of joints and the ability to provide a spot diagnosis of a problem during an emergency.
8	Bypass Pumps	Pumps to pump wastewater in the event of an emergency.
9	Bypass Pipe	Bypass pipe utilized in the event of an emergency.

Table 8-2 Critical Spare Parts and Purpose

Critical Spare Parts/Part No.	Part Name	Purpose
WW-0300/41	Speedy Plug	Stopping flow in a pipeline for maintenance or repair downstream.
WW-1200/07 - 20	Pipe HDPE	Pipe used to convey wastewater.
WW-1500/01 - 21	Fernco Clay to Plastic Fernco Plastic to Clay	A Fernco is a rubber sewer coupling with a worm drive clamp on either side and used to together two pieces of pipe.
WW-300/67 - 73.2	Pipe	Pipe used to convey wastewater.
WW-0700/02	Lime	A white powder used to reduce bacteria.
WW-1700/03	Gravity Sewer Plug (Various sizes)	A gravity sewer plug used to plug a wastewater gravity pipeline to prevent damage and potential overflows.

8.2.1 Location of Critical Equipment and Spare Parts

The critical equipment and spare parts are stored at the Public Works Department, Wastewater Maintenance Division, 2910 Colonial Drive, Columbia, SC 29203.

- WMD Warehouse Inventory
 - A full listing of the equipment and spare parts kept at the WMD. The listing includes the following information for each spare part:
Part Number / Part Description / Quantity Available
- Public Works Department Yard
 - Critical equipment utilized by the WMD is located at the Public Works Department facility. This equipment includes various mainline cleaning equipment, maintenance trucks, portable diesel bypass pumps, and portable generators.
- Local Suppliers
 - A general listing of critical equipment and parts required to respond to an emergency is available and used by WMD staff. This list also contains a roster of suppliers the City frequently employs to deliver equipment and spare parts not kept in inventory.
 - If equipment is obsolete or is no longer manufactured and fails, the City will not repair the item, but will replace the item with an available equivalent.
 - To ensure that critical equipment and parts can be procured in a reasonable amount of time, the following procurement protocols are in place:
 - The City Manager may authorize a purchase of up to \$50,000 in an emergency without approval from City Council. No single critical item is expected to exceed this amount.
 - The suppliers on the list have noted that they can generally provide the identified critical equipment and spare parts within one week for the WMD. However, in the event that the emergency (collapsed line, force main failure), it is expected that critical equipment will be used to institute bypass pumping in the interim.

8.3 Written Procedures for Updating Equipment

INVENTORY MANAGEMENT OF CRITICAL SPARE EQUIPMENT AND PARTS STANDARD OPERATING PROCEDURES

Standard Operating Procedures have been developed to govern the management of the Critical Spare Equipment and Parts Inventory maintained at the Wastewater Maintenance Division. The WMD will continue to use a manual paper-based system for inventory management until the development of the CMMS. Procedures for managing critical equipment and spare parts are located in the following Warehousing SOPs table.

Table 8-3 Warehousing Standard Operating Procedures (SOPs)

No.	SOP Title
601	Wastewater Maintenance Warehouse Operations
602	Receiving Inventory Procedures
603	Inventory Ordering Procedures
604	Counting Inventory Procedures
605	Auditing Procedures

Section 9 Information Management System (IMS)

This section describes the procedures that the City of Columbia will use in the execution of their Information Management System needs of the Gravity Sewer system, as required in Subparagraph 12.i.(ix) of the Consent Decree.

- Subparagraph 12.i.(ix) – A common information system that Columbia will use to track implementation of the GSOMP, track maintenance activities, and track management, operation, and maintenance performance indicators.

9.1 Common Information System to Track GSOMP Implementation

Cityworks® will be the primary IMS (also a computerized maintenance management system [CMMS]) that supports work and asset management functions of the GSOMP. Preventive, corrective, and emergency work orders will be managed through Cityworks®, as well as asset condition data associated with collection systems. Work order and asset data housed in Cityworks® will be the primary source for O&M activity reporting and analysis of key performance indicators.

9.2 Maintenance Activities

Maintenance activities include preventive, corrective, and emergency maintenance, activities generally associated with each type of maintenance activity. Tracking of maintenance activities by type will be accomplished from both the Cityworks® work order system and Excel-based inspection forms. This tracking process will facilitate O&M performance measurement in accordance with the CD.

The IMS will provide access to real-time information about the location, condition, maintenance, and performance history of the collection system's assets. The IMS will provide a single repository for information related to corrective and preventive maintenance history, asset inventory and attributes, asset inspections and condition monitoring data, and asset inventory and spare parts, thereby tracking the full lifecycle of the asset installation through replacement. All management and maintenance activities, performed by both internal and external staff, will be tracked in the IMS to provide an accurate and complete maintenance and condition history. The IMS will also incorporate standardized analyses for assessing the reliability and the condition of the assets, facilitating repair and replacement decisions.

Preventive Maintenance

Preventive work orders will be auto-scheduled and auto-generated through Cityworks® to be proactive with maintenance activities. Using Cityworks® to schedule and generate these work orders automatically will ensure accountability and completion of the preventive work orders and help document the improved system performance and reduced emergency repairs.

Corrective Maintenance

Corrective maintenance work orders are generated to address identified deficiencies discovered during the course of routine inspections or in response to equipment failures. Inspections currently being conducted are CCTV inspections, dye testing, and smoke testing. Follow-up work orders for corrective maintenance are issued when staff members identify an issue through the inspection process.

Emergency Maintenance

Emergency or reactive maintenance includes overflow response or activities conducted in order to mitigate the potential for a sanitary sewer overflow such as:

- Initiation/use of stand-by power (e.g., portable generators or alternative power sources as deemed appropriate)
- Use of portable pumps and/or bypass/pump-around operations
- Procedures associated with overflow response

9.3 Management, Operation, and Maintenance Performance

Indicators

The IMS will monitor maintenance effectiveness through the use of Key Performance Indicators (KPIs), which will facilitate a transition to proactive maintenance rather than reactive. The IMS will contain codes to distinguish between proactive and reactive maintenance. The IMS will also support regulatory compliance and monitoring through the use of advanced reporting. A dashboard will be created to display KPIs through the robust querying and reporting capabilities of Cityworks®. A number of core, standardized reports will be developed that support performance management and facilitate compliance with the CD.

Section 10 Key Performance Indicators (KPIs)

This section describes the City of Columbia’s procedures to identify the Key Performance Indicators of the Gravity Sewer system, as required in Subparagraph 12.i.(x) (A-B) of the Consent Decree.

- Subparagraph 12.i.(x) – The key performance indicators (“KPIs”) Columbia will track to measure performance of the WCTS using the information system referenced in Subparagraph 12.i.(ix). These KPIs shall include, but are not limited to:
 - A. The linear footage of Gravity Sewer inspections, the linear footage of Gravity Sewers cleaned, the number of manholes inspected, the number of manholes cleaned/maintained, the number of inverted siphons inspected, the number of inverted siphons cleaned/maintained and the number of SSOs per mile of Gravity Sewer; and
 - B. Maintenance activity tracked by type (corrective, preventive, and emergency).

Table 10-1 Key Performance Indicators

KPI No.	Activity	Goal	Measure
WMD – 1	Linear Footage of Gravity Sewer System Inspected	Annual Footage Inspect 10% of Gravity Sewer System	Percent of Gravity Sewer System Inspected by Miles of Pipe
WMD – 2	Linear Footage of Gravity Sewer System Cleaned	Annually Clean 20% of Wastewater Collection System	Percent of Gravity Sewer System Cleaned Annually
WMD – 3	Number of Manholes Inspected	Annually Inspected 10% of Manholes	Percent of Manholes Inspected Annually
WMD – 4	Number of Manholes Cleaned / Maintained	Annually Cleaned / Maintained 10% of Manholes	Percent of Manholes Cleaned / Maintained Annually
WMD – 5	Number of Siphons Inspected	Annually Inspect 50% of Siphons	Percent of Siphons Inspected Annually
WMD – 6	Number of Siphons Cleaned / Maintained	Annually Cleaned / Maintained 50% Siphons	Percent of Siphon Cleaned / Maintained Annually
WMD – 7	Number of SSOs per mile of Gravity Sewer System	Reduction in the number of SSOs per mile of pipe	Percent of SSOs per mile of pipe

Section 11 Equipment Problem Reports

The purpose of this section is to identify reports which list equipment problems and the status of work orders generated during the prior month to meet the requirements of the following Consent Decree section.

- Subparagraph 12.i.(xi) – Reports which list equipment problems and the status of work orders generated during the prior month.

11.1 Equipment Problem Reporting

The WMD measures and maintains a downtime log which personnel fill out that indicates if the equipment is down and the status of the equipment (e.g., City of Columbia Drivers Inspection Report). Equipment problems are directed to the City’s maintenance staff or an outside vendor, as appropriate, for repair and maintenance.

11.2 Work Order Status

Work order status is tracked monthly through the City’s CMMS, Cityworks®. Work orders are generated through the City’s call center, by WMD personnel and reported monthly through the “WMD Monthly Performance Report.”

- Status is recorded by the number of service requests generated that resulted in the creation of a work order.
- At the end of each month, “open” or “closed” status is identified, reported and categorized. Open work orders are attributed to the following:
 - Point of Time (open work orders on the last day of the month)
 - Work orders requiring construction and excavation of location (long term fix)
 - Resolution involving additional investigation

Section 12 GSOMP Implementation Schedule

The purpose of this section is to identify an implementation schedule, outlined in **Table 12-1**, which will be implemented within two years of EPA approval of the Gravity Sewer System Operation and Maintenance Program.

- Subparagraph 12.i.(xii) – An implementation schedule specifying dates and actions.

Table 12-1 GSOMP Implementation Schedule

No.	GSOMP Section	CD Section	Corrective Action Description	Implementation Schedule
2.1	2.2.2	12.i.(i)	Written Procedures for Maintenance of Gravity Sewer system Manholes	Implemented 6 months from EPA approval of GSOMP
3.1	3.4	12.i.(ii)	Gravity Line Preventive Maintenance Plan (GLPMP) <ul style="list-style-type: none"> ▪ Implementation of Frequency Goals ▪ Routine Hydraulic Cleaning Program ▪ Preventive Maintenance Decision Tool ▪ Employee Training Plan 	Implemented 24 months from EPA approval of GSOMP
4.1	4.1; 4.2	12.i.(iii)	Evaluation of potential sulfide and corrosion control of the WCTS. Engineering evaluation and development of findings, recommendations, budgetary cost estimate and selected measures.*	Implemented 24 months from EPA approval of GSOMP of TSOMP
5.1	5.1	12.i.(iv)	The inspection and evaluation of crossings and stream bank encroachment areas with a higher likelihood of a Sanitary Sewer Overflows (SSO), and the preparation of this plan will be divided into phases. The first phase is the identification of high risk locations using a risk assessment model which will consider the current condition of these assets and the risk of failure and a comprehensive field investigation of crossings and stream bank encroachments to identify significant problems at these locations. Gravity Sewer Easement survey and marking and initial clearing to survey the limits, where practical.	Implemented 24 months from EPA approval of GSOMP Completed within 5 years of EPA approval. A five year time frame is required to accommodate
6.1	6.1; 6.2; 6.3	12.i.(vi)	Evaluation of resource commitment as part of the implementation of the GSOMP.	Implemented 24 months of EPA approval of GSOMP and ongoing during the implementation of the GSOMP

*Recommended action consistent with the TSOMP dated February 2015