

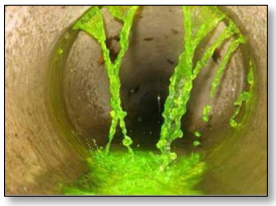


COLLECTION SYSTEM CAPACITY, MANAGEMENT, OPERATIONS, AND MAINTENANCE PLAN

CITY OF AURORA, ILLINOIS

NPDES Permit No. IL0048518

MAY 2018

Last revised March 2022

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Acronyms

CBOD – Carbonaceous Biochemical Oxygen Demand

CDL – Commercial Driver's License

CFR – Code of Federal Regulations

CIPP – Cured-in-Place Pipe

Cl – Chlorine

CMOM – Capacity, Management, Operations, and Maintenance

CSO – Combined Sewer Overflow

DMR – Discharge Monitoring Report

FMWRD – Fox Metro Water Reclamation District

FOG – Fats, Oils, and Greases

FSE – Food Service Establishment

GIS – Geographic Information System

GRS – Grease Removal System

I/I – Inflow and Infiltration

IEPA – Illinois Environmental Protection Agency

LTCP – Long Term Control Plan

NPDES - National Pollutant Discharge Elimination System

P – Phosphorus

PVC – Polyvinyl Chloride

SCADA – Supervisory Control and Data Acquisition

SSES – Sanitary Sewer Evaluation Survey

SSO – Sanitary Sewer Overflow

TSS – Total Suspended Solids

USEPA – United States Environmental Protection Agency

Introduction

Background

Sanitary sewer collection systems are designed and built in order to carry wastewater from private properties to a wastewater treatment plant. In the case of combined sewer collection systems, stormwater is also collected and added to the wastewater. In order to prevent overflows from the collection system that pose risks to public health and the environment, the City of Aurora strives to effectively and continuously manage, operate, and maintain its collection system.

Purpose

This CMOM Plan documents the resources and procedures used by the City of Aurora to manage, operate, and maintain its collection system in order to provide its customers with a high level of service. It also meets the regulatory requirements of Special Condition 9 of the City's NPDES Permit No. IL0048518.

Future Updates

The resources and procedures used to manage, operate, and maintain the City's collection system are bound to change over time. These changes might be brought about by factors such as staffing, budget, or technology, to name a few. In any event, this CMOM Plan should be updated whenever there is a significant change to the City's collection system management, operation, or maintenance.

Collection System Management

Legal Authority

Federal and state regulations together make the City responsible for overflows from the City's sanitary and combined sewer systems. In Illinois, the IEPA enforces the NPDES requirements, which state:

- The City must take all reasonable steps to minimize or prevent any discharge in violation of its NPDES permit if the discharge has a reasonable likelihood of adversely affecting human health or the environment (40 CFR 122.41(d));
- The City must at all times properly operate and maintain the facilities and systems necessary to comply with its NPDES permit (40 CFR 122.41(e));
- Overflows from sanitary sewers are prohibited (Ill. Admin Code 306.304); and
- Dry weather overflows from combined sewers are prohibited (Ill. Admin Code 306.305).

Aurora's Municipal Code includes a sewer use ordinance that provides the City with the authority to manage its sewer systems in order to maintain compliance with these Federal and state regulations. Specifically, this ordinance:

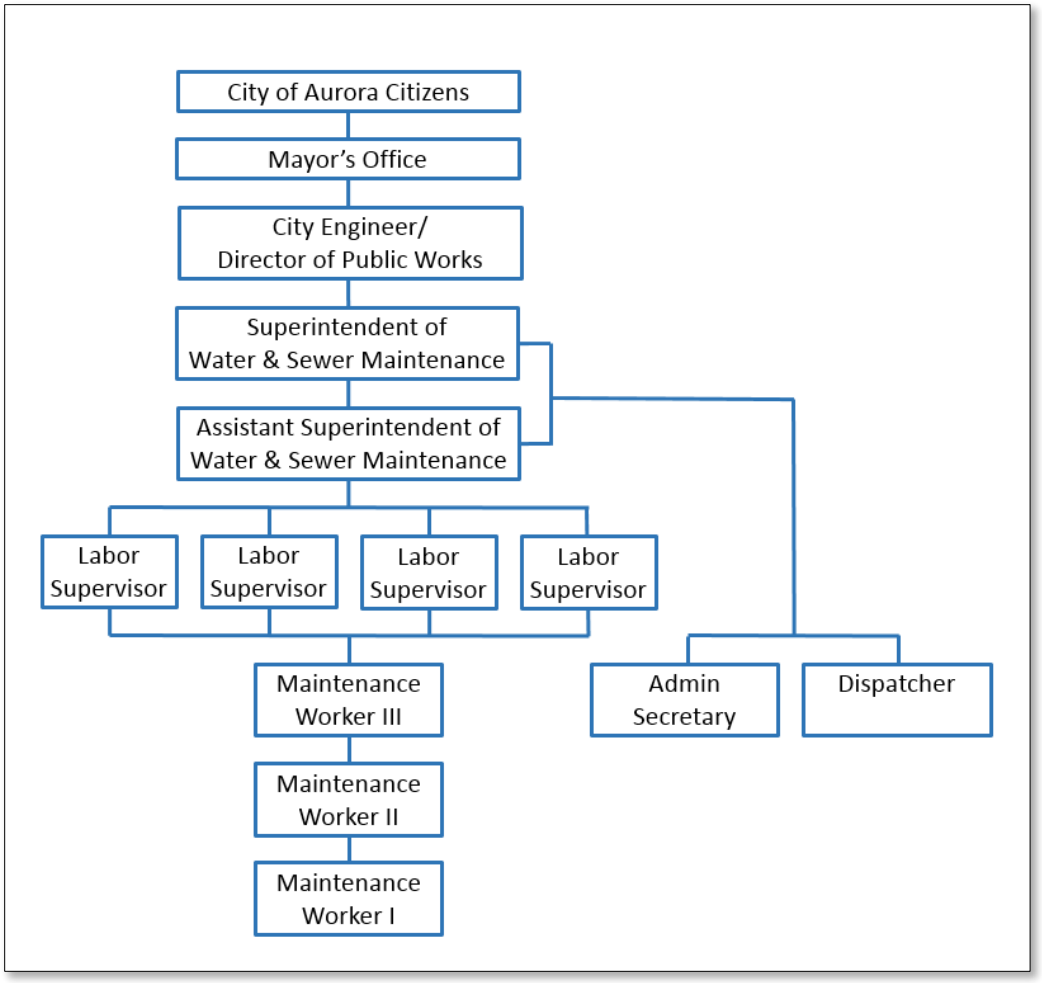
- Prohibits the introduction of liquids or solids to the sewer system that create any nuisance or unsanitary condition, damage any part of the sewer system, or in any way interfere with the sewage treatment process (Sec. 48-132);
- Prohibits the introduction of new inflow sources to the sanitary sewer system (Sec. 48-133);
- Requires that new sanitary sewer construction tributary to the combined sewer system be designed to minimize and/or delay inflow contribution to the combined sewer system (Sec. 48-103);
- Requires that inflow sources on the combined sewer system be connected to a storm sewer within a reasonable period of time, if a storm sewer becomes available (Sec. 48-103);
- Provides that any new building domestic waste connection be distinct from the building inflow connection, to facilitate disconnection if a storm sewer becomes available (Sec. 48-103);
- Assures that CSO impacts from non-domestic sources are minimized by determining which non-domestic discharges, if any, are tributary to CSOs (Sec. 48-135 through 48-137); and
- Assures that the owners of all publicly owned systems with sewers tributary to the City's collection system have adequate operation and maintenance procedures in place (Sec. 48-140 and 48-141).

Aspects of the sewer use ordinance applicable to new development and re-development are enforced by the City's Buildings & Permits Division, as well as the Engineering Division. FMWRD also administers and enforces its ordinances within the City limits. But the operation and maintenance of the City's collection system is the responsibility of the City's Water & Sewer Maintenance Division.

Organizational Structure and Staffing

The Water & Sewer Maintenance Division is comprised of: a Superintendent, an Assistant Superintendent, Labor Supervisors, Maintenance Workers at three distinct levels, a Dispatcher, and an Administrative Assistant. Figure 1 is an Organizational Chart illustrating the Division's chain-of-command.

Figure 1: Organizational Chart for the Water & Sewer Maintenance Division



The responsibilities of each position within the Water & Sewer Maintenance Division are described below.

- Maintenance Worker I – Employees in this position perform a variety of manual tasks using hand tools, shovels, rakes, rotary motors and similar equipment. This position also requires some skill in the operation of trucks, snow plows and salt spreading equipment, and the maintenance and repair of such equipment. Employees at this level will install, maintain, and repair elements of the water distribution system and the sewer system, including work in confined spaces. The minimum qualifications for employees at this level are: 18 years of age, completion of two years of high school, and the ability to obtain an Illinois Class B CDL within 60 days from the date of hire.

- Maintenance Worker II – Employees in this position perform semi-skilled manual labor using heavy equipment such as end loaders, manhole rehabilitation equipment, water main line stops, tapping equipment, valve operation equipment, as well as hand tools such as chain saws, picks, and all equipment used by a Maintenance Worker I. Employees at this level will be a crew

leader in the absence of a Maintenance Worker III. The minimum qualifications for employees at this level are: completion of two years of high school, two years of experience as a laborer in a maintenance field, and possession of a valid Illinois Class B CDL.

- Maintenance Worker III – Employees in this position perform skilled and semi-skilled manual labor using heavy equipment such as backhoes, and combination sewer vacuum jet rodders. This position also requires the use of all equipment used by Maintenance Workers I and II. Employees at this level will be a crew leader for installing, maintaining, and repairing elements of the water distribution system and the sewer system. The minimum qualifications for employees at this level are: completion of two years of high school, three years of experience as a laborer in a maintenance field, and possession of a valid Illinois Class A CDL.

- Administrative Secretary – An employee in this position performs varied and responsible clerical and secretarial duties. This position involves typing reports and correspondence, taking and transcribing dictation, assisting the public with inquiries, and providing the public with general information about departmental rules, regulations, and procedures. The minimum qualifications for an employee in this position are: a high school diploma or GED with course work in typing and general office procedures; the ability to type 50 words per minute corrected; and two years of clerical experience.

- Dispatcher – An employee in this position operates a variety of communication equipment to respond to calls from the public and dispatches maintenance crews to various public works facilities and work sites. This position also involves: coordinating water and sewer utility locate requests; tracking shift activities with the assignment of personnel, vehicles, and equipment; assisting with the creation of service requests; and assisting with the processing of purchase orders. An employee in this position may perform secretarial duties when the Administrative Secretary is absent. The minimum qualification for an employee in this position is completion of four years of high school (or equivalent knowledge, skill, and mental development).

- Labor Supervisor – Employees in this position are responsible for the supervision and direction of a group of maintenance workers or equipment mechanics performing a variety of manual, semi-skilled and skilled tasks in the general maintenance, upkeep and repair of infrastructure, equipment and vehicles. Employees at this level will operate a personal computer and general office equipment. Duties may be performed at an outside location or indoor repair facility. The minimum qualifications for employees at this level are: completion of four years of high school (or equivalent knowledge, skill, and mental development), four years of experience in maintenance of water and sewer distribution systems, including two years of increasingly responsible experience in a Department of Public Works, possession of a valid Illinois Class A CDL, and a Class D Water Operator's Certificate.

- Assistant Superintendent of Water & Sewer Maintenance – An employee in this position manages and is responsible for all operations, activities and employees in the Water & Sewer Maintenance Division, including: planning, assigning, and directing work; interviewing and training employees; appraising performance; rewarding and disciplining employees; addressing

complaints; and resolving problems. An employee in this position must be able to analyze and interpret technical documents, write reports and business correspondence, effectively present information, define problems, and draw valid conclusions. The Assistant Superintendent of Water & Sewer Maintenance fulfills the duties of the Superintendent in the Superintendent's absence. The minimum qualifications for an employee in this position are one year of supervisory experience and at least one of the following: an Associate's degree or equivalent from a two-year college or technical school; six months to one year of related experience and/or training; or an equivalent combination of education and experience.

- Superintendent of Water & Sewer Maintenance – An employee in this position organizes, directs, and administers a comprehensive water and sewer maintenance operation for the City of Aurora. Essential functions of this position include: establishing and administering divisional operating policies and procedures; budgeting for future divisional needs and costs; monitoring the expenditure of allocated funds for divisional operation; formulating specifications for requisitioning new equipment, tools, and supplies; coordinating divisional activities with various other City departments; and directing the documentation of divisional activities. The minimum qualifications for an employee in this position are: four years of supervisory experience in water distribution and sewer maintenance; and a Bachelor's Degree with major coursework in a field related to Civil Engineering (or equivalent knowledge, skill, and mental development).

Since 1988, the Water & Sewer Maintenance Division has consistently maintained 39 employees. The only exceptions have come when an open position was being advertised. During this period, the City's population has grown by 40% and the length of the sewer system has grown with it.

None of the staff assigned to the Water & Sewer Maintenance Division is assigned just to operation and maintenance of the wastewater collection system. This staff is also responsible for maintenance and repair of the water distribution system and response to the City's utility locate requests. Besides those responsibilities, employees from the Water & Sewer Maintenance Division are called upon to help other City Divisions with tasks such as snow removal, emergency tree removal, and clean-up following fish kills. Some of these demands are offset by the assistance the Water & Sewer Maintenance Division receives from other City divisions. This assistance includes: vehicle maintenance; pavement repair; and maintenance of pumps, stand-by generators, and control systems.

The Water & Sewer Maintenance Division supplements its work force through contracted services and several inter-governmental agreements with FMWRD. Contracted services include: flow monitoring, preparation of the City's Discharge Monitoring Reports (DMRs), GIS data input, sewer and manhole replacement and rehabilitation, sewer cleaning and televising, landscape restoration, and pavement restoration. The inter-governmental agreements with FMWRD provide staff for maintenance of the CSO Treatment Facility (CSO 027) and on-call services for sewer investigation and rehabilitation.

The Water & Sewer Maintenance Division operates in two shifts throughout most of the year, but moves to three shifts during the winter. The shift hours are:

Regular Shift Hours

- First shift 7:00 am to 3:30 pm Monday through Friday
- Second shift 3:00 pm to 11:30 pm Monday through Friday
- Week Day Standby Duty 11:30 pm to 7:00 am Monday through Friday
- Saturday Standby Duty 12:00 am Saturday to 12:00 am Sunday
- Sunday Standby Duty 12:00 am Sunday to 12:00 am Monday

Winter Shift Hours

- First shift 7:00 am to 3:30 pm Monday through Friday
- Second shift 3:00 pm to 11:30 pm Monday through Friday
- Third shift 11:00 pm to 7:30 am Sunday through Thursday

Winter shift hours generally run between Thanksgiving and early March, but the actual start and end dates are determined based on the weather.

Internal Communication

Internal communication is critical between all levels of the Water & Sewer Maintenance Division, simply because of the number of people involved in day-to-day operations. This communication involves top-down, bottom-up, and lateral exchange of information among staff.

Daily responsibilities and priorities are communicated from management to staff using the Daily Work Schedule. The Daily Work Schedule is developed weekday afternoons by the Assistant Superintendent with input from the Labor Supervisors. It is reviewed by the Superintendent and then distributed to staff at the start of each weekday morning shift. General information from management is posted for all employees to see on a bulletin board in the Water & Sewer Maintenance Facility.

Labor Supervisors meet with the Superintendent and Assistant Superintendent daily. The Safety Committee provides maintenance workers the opportunity to discuss safety concerns with management. Maintenance workers are also encouraged to submit written suggestions to improve operations using a suggestion box.

The nature of the Labor Supervisors' work requires frequent collaboration. They work together closely and regularly fill in for one another. Maintenance workers are cross-trained and rotated into and out of crews periodically, which promotes lateral communication among the staff.

Training

Training is necessary to ensure the effectiveness and safety of the Water & Sewer Maintenance Division's operations. Safety training is typically provided by video or on-site by industry professionals according to the schedule shown in Figure 2. Attendance at each safety training session is documented with a sign-in sheet that is kept in a binder. Safety Data Sheets containing instructions about the proper use and storage of chemicals are available at the Water & Sewer Maintenance Facility near the time clock and the tool cage.

Figure 2: Safety Training Schedule for Water & Sewer Maintenance Division

Topic	Employees	Recurrence
Construction Safety, Workplace Safety, OSHA Compliance, etc.	All	Twice Monthly (1st and 3rd Tuesdays)
Confined Space	All	Every Year
Trench Excavation Safety	All	Every Year
CPR	All	Once Every Two Years

When the Water & Sewer Maintenance Division acquires new equipment, any training necessary for operation of the equipment is provided by the manufacturer or the supplier.

New hires receive utility locator training. That training may be repeated as a refresher course, as necessary. Maintenance Worker IIs receive backhoe training if they desire to move up to a Maintenance Worker III position.

Figure 3: Training for Water & Sewer Maintenance Division

All other training is provided informally, through on-the-job training by the Water & Sewer Maintenance Division's more experienced employees. This training includes: routine pipeline maintenance, repair, and replacement; forklift training; lift station inspection and maintenance; record keeping; emergency response procedures; and traffic control procedures. This type of training is built into the organizational structure of the Division because maintenance workers must master new skills in order to move up on the Organizational Chart.

Budget

The Water & Sewer Maintenance Division's services are funded by the City's Water & Sewer Fund. Since the Water & Sewer Fund is an enterprise fund, the City collects fees from users and those fees must only be used to fund operations of the enterprise activity. The balance in the Water & Sewer Fund varies

from year to year, based on the number of users, the amount of water used, the rates charged, and the City's costs for labor, equipment, materials, and contracted services. A three year summary of the Water & Sewer Fund's revenues and expenditures is shown in Figure 4. The data in Figure 4 includes costs for the collection system, as well as the water distribution network, since the City does not separate these costs.

Figure 4: Water & Sewer Fund Annual Revenues and Expenditures

	2015		2016		2017	
Item	Budget	Expenditures	Budget	Expenditures	Budget	Expenditures
Salaries	$ 2,956,661	$ 2,988,786	$ 3,102,717	$ 3,217,016	$ 3,237,571	$ 3,141,177
Employee Benefits	$ 1,534,102	$ 1,807,845	$ 1,746,792	$ 1,739,043	$ 1,825,869	$ 1,931,709
Professional Fees	$ 324,000	$ 272,090	$ 270,900	$ 250,374	$ 231,800	$ 222,742
Utility Services	$ 4,400	$ 4,386	$ 4,500	$ 4,668	$ 4,500	$ 6,510
Cleaning Services	$ 66,700	$ 46,052	$ 86,400	$ 68,460	$ 89,900	$ 85,641
Repairs & Maintenance Services	$ 2,123,300	$ 1,619,909	$ 2,163,260	$ 1,904,560	$ 2,141,200	$ 1,876,495
Rentals/Leases	$ 10,500	$ 2,029	$ 2,000	$ 2,148	$ 11,000	$ 9,617
Insurance	$ 9,000	$ 9,000	$ 36,000	$ 36,000	$ 36,000	$ 36,000
Travel & Professional Development	$ 18,700	$ 15,416	$ 14,600	$ 13,056	$ 22,200	$ 24,302
Communication Charges	$ 35,680	$ 35,390	$ 38,800	$ 37,529	$ 48,764	$ 45,022
Other Services & Charges	$ 15,600	$ 11,791	$ 16,500	$ 12,681	$ 15,800	$ 16,807
Administrative Services	$ 1,053,130	$ 1,053,130	$ 1,116,657	$ 1,114,230	$ 1,158,565	$ 1,158,565
Supplies - General	$ 31,900	$ 25,923	$ 44,000	$ 34,437	$ 30,500	$ 23,702
Supplies - Energy	$ 220,500	$ 173,890	$ 234,000	$ 137,532	$ 279,000	$ 160,413
Supplies - Computer	$ -	$ 544	$ 17,000	$ 15,483	$ 2,600	$ 391
Supplies - Repairs - Maintenance	$ 483,600	$ 430,864	$ 469,600	$ 407,531	$ 506,800	$ 490,190

Capital Outlay - Utility Services	$ -	$ -	$ 876,000	$ 724,915	$ 284,900	$ 284,466
Capital Outlay - Machine - Equipment	$ -	$ -	$ -	$ -	$ -	$ -
Capital Outlay - Vehicles	$ -	$ -	$ -	$ -	$ -	$ -
LTCP Improvements*	$ 7,505,000	$ 6,872,780	$ 8,050,000	$ 2,731,225	$ 8,376,000	$ 4,879,895
Sanitary Sewer Eval & Rehab	$ 3,210,000	$ 2,311,833	$ 3,211,000	$ 1,695,072	$ 4,479,800	$ 3,025,562
Total	$ 19,602,773	$ 17,681,658	$ 21,500,726	$ 14,145,960	$ 22,782,769	$ 17,419,206

*Note: This row includes data from both the Water & Sewer Fund and the LTCP Fund

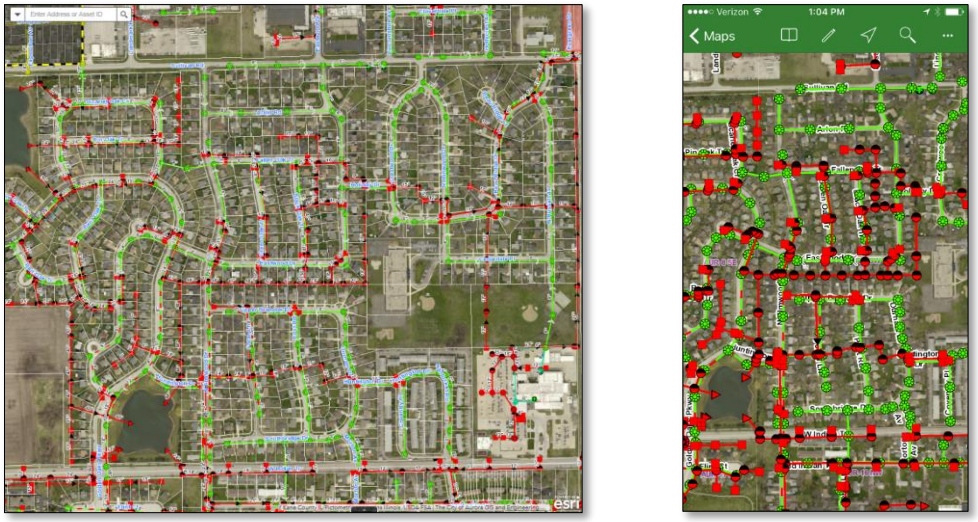
The Repairs & Maintenance Services line item in Figure 4 includes routine maintenance as well as small repairs and emergency repairs. Larger projects that are not urgent are incorporated into the Capital Improvement Plan, which is updated annually. Sewers are typically televised one year or more in advance of a road resurfacing project. Television inspection of the sewers reveals locations where repair or replacement is necessary. If the repair or replacement requires excavation within the roadway, the project is scheduled in advance of the road resurfacing. If the sewer can be repaired without excavation, or if the excavation is outside the limits of the roadway, the project is scheduled without regard to the road resurfacing schedule.

The City of Aurora procures equipment, materials, and contracted services using purchase orders. Once a vendor completes the City's Vendor Application, a purchase order can be requisitioned by identifying the vendor and the budget account to which the expenditure will be charged. Expenditures of more than $5,000 require multiple quotes. Expenditures of more than $25,000 also require approval by the City Council.

Information Systems

The City's sanitary sewer system and combined sewer system have been mapped in GIS, along with the FMWRD's interceptor sewers. Over time, basic mapping data such as manhole location and pipe size is being enhanced with invert elevations, links to sewer inspection videos, and links to record drawings. GIS mapping is accessible in the office and in the field for Water & Sewer Maintenance Division employees that have been assigned mobile devices. These mobile devices are increasingly being used to track the Division's maintenance activities in GIS.

Figure 5: GIS Mapping



The GIS mapping is updated continuously using as-built plans from new development projects and capital improvement projects, or with mark-ups provided by Water & Sewer Maintenance Division staff. Paper atlas books are printed periodically from the GIS data. These hard copies can be used when the digital maps are not accessible, such as during a power outage or when the City's GIS server is down.

Service requests come to the Water & Sewer Maintenance Division in several ways: phone calls directly to the Water & Sewer Maintenance Division, phone calls referred by another City department, e-mail messages, and PublicStuff notifications. Regardless of their format, service requests are typically received by the Dispatcher who determines the area of the City to which the request should be assigned (West Aurora, East Aurora, or the Fox Valley). The Dispatcher then forwards the request to a maintenance worker assigned to that area. The maintenance worker typically responds by visiting the site that day or the following day. If the maintenance worker is unable to resolve the service request at that time, the Labor Supervisor is notified and a maintenance crew is scheduled to resolve the service request.

There are 16 CSOs within the City. Each overflow is fitted with a flow sensor that continually measures the flow depth at the CSO. Data collected by the flow sensor is downloaded monthly. This data informs the City of the frequency and duration of overflows.

Critical elements of the City's sewer systems are inspected routinely, including the four sanitary lift stations and CSO 001. Whenever a lift station is not working properly, there is a significant risk of widespread sewer back-ups. For this reason, the lift stations are inspected every week day to make sure they are operating normally. CSO 001 has the largest tributary area of the City's 16 CSOs and it is the most prone to overflow. Therefore, the CSO is inspected from above ground weekly and from within the CSO chamber monthly. If a maintenance worker identifies a maintenance need during these routine inspections, the Labor Supervisor is notified and a maintenance crew is scheduled to perform the necessary maintenance.

The Fox River Study Group and FMWRD work together to collect monthly samples from the Fox River and Indian Creek, which are the receiving waters for the City's 16 CSOs. Collected samples are laboratory tested for various water quality parameters, including CBOD, pH, TSS, NH_3, P, Cl, and fecal coliforms. Samples are collected at the following City of Aurora locations:

- Sullivan Road crossing of the Fox River;
- North Avenue crossing of the Fox River;
- Ashland Avenue crossing of the Fox River;
- IL Route 25 (Broadway) crossing of Indian Creek;
- Ohio Street crossing of Indian Creek;
- Austin Avenue crossing of Indian Creek; and
- Reckinger Road crossing of Indian Creek.

Customer Service

To provide customers with a high level of service, the Water & Sewer Maintenance Division responds to service requests quickly and professionally. City representatives are also expected to interact with customers politely.

As soon as a service request is received, the Dispatcher forwards the service request to a maintenance worker. The maintenance worker typically responds by visiting the site that day or the following day. The maintenance worker arrives at the site in a vehicle marked with the City logo and wearing a City identification badge. If the maintenance worker is unable to resolve the service request at that time, the Labor Supervisor is notified and a maintenance crew is scheduled to resolve the request as soon as possible. Details about each service request are entered into a searchable database that has records dating back to 1984.

While the maintenance worker can only offer to address issues for which the City is responsible, the maintenance worker should:

- Listen carefully to customers,
- Be knowledgeable about what the City can and cannot do for its customers, and
- Demonstrate an understanding of the customer's situation.

In some cases, the service request was made by a customer trying to deal with a significant, unplanned expense. Furthermore, and particularly in the case of sewer back-ups, the customer may also be dealing with significant damage to objects of sentimental value. Therefore, the maintenance worker should be prepared for the customer to be under stress.

Notification

On or before the 25th day of each month, the City is required to submit a DMR for its 16 CSOs. The DMRs must be submitted by mail and digitally.

- Paper DMRs are prepared on IEPA forms and mailed to the IEPA at the address specified in the City's NPDES Permit No. IL0048518. The DMR form for the CSO Treatment Facility (CSO 027) requires water quality data collected by FMWRD during discharges. The required water quality data includes: BOD, pH, TSS, NH_3, P, Cl, fecal coliforms, and total flow. The DMR form for all other CSOs requires the date, duration, estimated discharge hours, and estimated discharge

volume for each overflow. The paper DMRs are reviewed and signed by Eric Schoeny, Drainage & Underground Coordinator, City of Aurora, 630-256-3711, eschoeny@aurora-il.org.

- Digital DMRs are submitted using the USEPA's Central Data Exchange (https://cdx.epa.gov/). The digital DMR for the CSO Treatment Facility (CSO 027) requires water quality data collected by FMWRD during discharges. The required water quality data includes: BOD, pH, TSS, NH_3, P, Cl, fecal coliforms, and total flow. Digital DMRs for all other CSOs simply require notification of number of overflows during the month. The digital DMRs are submitted by: Mark Phipps, Professional Engineer, City of Aurora, 630-256-3231, mphipps@aurora-il.org.

Whenever a SSO or dry weather CSO occurs, the City is required to notify the IEPA regional wastewater staff within 24 hours of the occurrence by telephone, fax, e-mail, or voice mail. Within 5 days of the occurrence, the City is required to submit a written report to the IEPA at:

BOW/CAS – MC #19
1021 N. Grand Ave. E.
P.O. Box 19276
Springfield, IL 62794.

The written report must be prepared on the IEPA's Sanitary Sewer Overflow or Bypass Notification Summary Report form. This form requires the date and time the IEPA was notified, the date and time of the overflow, a description of the circumstances causing the overflow, rainfall data (if applicable), a description of the overflow location, and supporting documents (i.e. cover letter and maps of the overflow locations). The form is signed by Eric Schoeny, Superintendent of Water & Sewer Maintenance, City of Aurora, 630-256-3711, eschoeny@aurora-il.org. Copies of the report are also e-mailed to:

- Manager, IEPA Des Plaines Office
- Executive Director, FMWRD
- Director of Field Operations, FMWRD
- Director of Public Works, City of Aurora

Collection System Operation

Service Area

There are approximately 49,000 active services connected to the City's collection system. 94% those are residential services and 99% are within the City limits.

The City's collection system is roughly 500 miles in length, including 12,500 manholes, 4 sanitary lift stations, and 1.5 miles of force main. The collection system spreads out over 46 square miles and is divided into more than 50 sewer basins. Sewer basins are distinguished by an individual connection to one of the interceptor sewers. These basins are shown on the Sewer Basin Map in Appendix 1.

Figure 6 illustrates how the pipe sizes vary for the gravity sewers within the collection system. Pipe sizes smaller than 8 inches, elliptical pipes, and pipes of unknown size are not represented in the figure, but each of these categories comprises 1% or less of the gravity sewers. Force mains range in size between 4 inches and 10 inches, with nearly half the force main being 6 inches in diameter.

Figure 7 illustrates how the pipe material varies for the gravity sewers within the collection system, where the pipe material has been documented. It should be noted, however, that the pipe material has only been documented for 34% of the collection system.

Figure 6: Gravity Sewers by Pipe Size

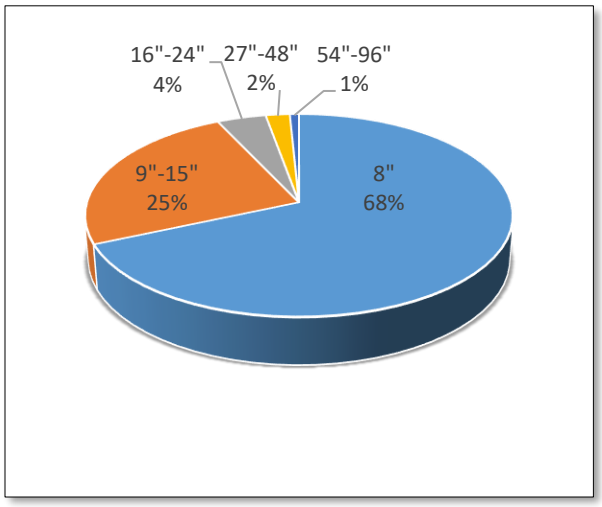
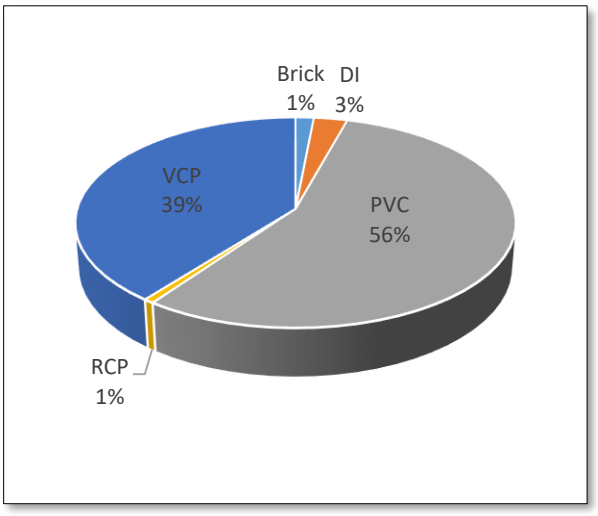


Figure 7: Gravity Sewers by Pipe Material



The combined sewer system is a subset of the collection system covering nearly 11 square miles. It includes 157 miles of sewer and one of the City's lift stations. There are 16 CSOs within the City limits. The locations of these overflows and the limits of the combined sewer area are shown on the CSO Basin Map in Appendix 2.

Responsibility for the collection system is shared between the FMWRD, the City, and private property owners. The Original Combined Sewer Interceptor and sanitary sewers 15 inches and larger are owned by FMWRD. The City owns sanitary sewers smaller than 15 inches and all other combined sewers, regardless of their size. Private property owners are responsible for the sewer service connecting an individual building to a sewer main.

Wastewater from the collection system is treated at the Fox Metro Wastewater Treatment Plant located 2 miles south of the City limits at 682 State Route 31 in Oswego. The plant is owned and operated by FMWRD.

New Development and Redevelopment

The construction of every new public sanitary sewer and every new private sewer service involves oversight by the City and FMWRD through a multi-phase process. The IEPA is also involved, except when the project consists of a sewer service for a single building expected to produce less than 1,500 gallons per day of wastewater.

Proposed construction plans must meet the Standard Specifications for Water & Sewer Main Construction in Illinois, the FMWRD Sewer Use Ordinance No. 859, and the City's Engineering Standards. Permits are issued after the proposed construction plans have been reviewed and approved by each government agency. FMWRD's Manhole/Sewer Pipe Materials and Installation Specifications, which applies throughout the City, is included as Appendix 3, but some of the more pertinent specifications are summarized below.

- New pipe and fittings must be PVC. The minimum pipe thickness varies with the depth of cover.
- The minimum pipe diameter for new sewer mains is 8 inches. For new sewer services it is 6 inches.
- The maximum distance between new manholes is 400 feet.
- Service connections to a new main must be made with a tee or wye at a 45 degree angle. Service connections to an existing main (10 inches or larger) must be made using an Inserta Tee.

During construction, the City inspects the installation of new sewer mains and FMWRD inspects the installation of new services. Prior to accepting a new sewer main, the sewer must pass pressure and deflection tests. The manholes must pass a vacuum test, too. Reports from these tests are filed with both the City and FMWRD. Then, after passing these tests, the new sewer is televised, record drawings are prepared, and the GIS mapping is updated. The new sewer is finally accepted by City Council resolution.

Level of Service

The City's Water & Sewer Maintenance Division has established operational procedures to provide customers with a high level of service. These operational procedures are intended to:

- Prevent overflows from sanitary sewers;
- Prevent dry weather overflows from combined sewers; and
- Respond to customer service requests the same day or the following day.

The City is also working toward the goal of reducing wet weather overflows from combined sewers as part of its CSO LTCP. By December 31, 2030, the City expects to be able to demonstrate that on a system-wide annual average basis, the combined sewer system will capture and treat at least 85% (by volume) of the combined sewage.

Monitoring the Collection System

Each year the City cleans and televises the portion of its collection system along roads likely to be resurfaced in the next few years. Manholes in these locations are also inspected. This information

allows the City to perform necessary dig repairs before the roads are resurfaced. It also assures the City is taking steps to proactively monitor the condition of its collection system. In any given year, additional sewers and manholes are likely to be inspected, particularly in areas where an underground infrastructure project is planned or where there is reason to believe sewer maintenance may be needed. Figure 8 shows the length of sewers televised and the number of manholes inspected by the City over the past several years.

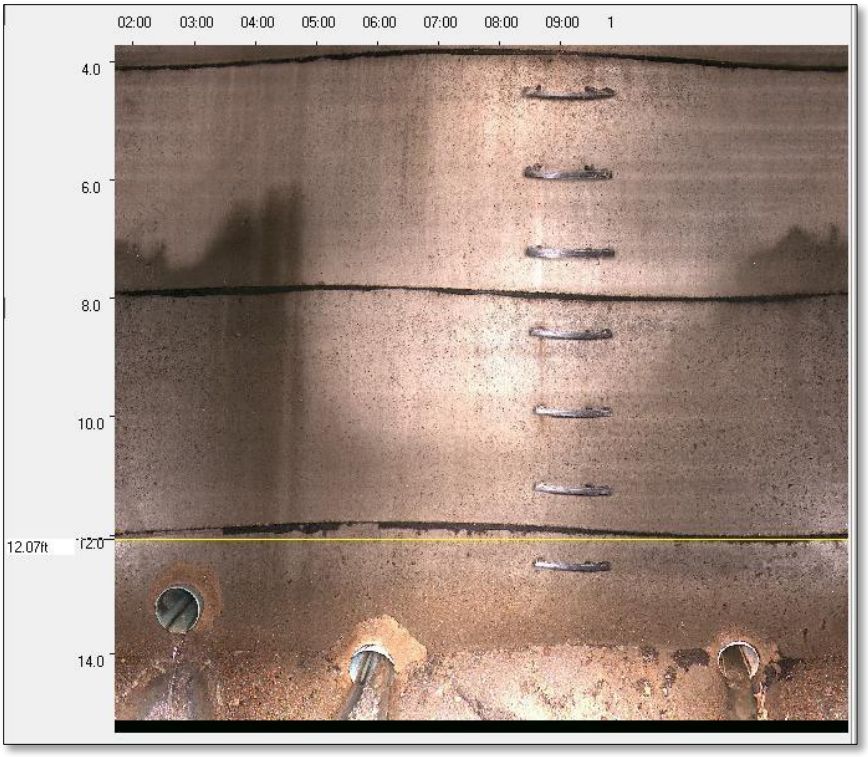
Figure 8: Length of Sewer Televised and Number of Manholes Inspected by Year

Year	Sewer Length (mi)	Sewer Length (% of System)	Manholes (number)	Manholes (% of System)
2014	10.8	2%	128	1%
2015	11.1	2%	149	1%
2016	23	5%	486	4%
2017	41.9	8%	852	7%

Individual television inspection videos are recorded from manhole to manhole. Each video is stamped with the time and date the video was recorded and with the unique identifier assigned to the upstream and downstream manholes. Inspection reports summarize the inspection findings, noting the type and location of service connections, as well as pipe conditions that may warrant maintenance. These conditions may include pipe fractures, offset joints, infiltration, root intrusion, sedimentation, or the build-up of other solids within the pipe. The videos and inspection reports are cataloged for future reference. Over time, the videos and inspection reports are being linked to the City's GIS mapping.

Manholes are inspected visually and using a camera, by both City staff and consultants. Visual inspection from inside the manhole is labor-intensive since it requires a two-person crew with training in confined space entry. Camera inspection can save time. It also provides a digital image that is helpful for prioritizing maintenance needs. The City owns a pole camera that is particularly helpful for inspecting deep manholes, large diameter manholes, and shallow flat-top manholes. 360 degree panoramic manhole images can be obtained through contracted services.

Figure 9: Panoramic Image of a 360 Degree Manhole Inspection



The FMWRD regulates the character of wastewater discharged to the collection system through the administration and enforcement of two ordinances.

- The Industrial Wastewater Pretreatment Ordinance requires a permit to discharge to the collection system. Individual permits are required for Significant Industrial Users and Categorical Industrial Users, whereas General Permits are required for other types of industries. The Ordinance sets prohibitive discharge standards, requires pretreatment to meet those standards, and requires permittees to demonstrate compliance through sampling and reporting according to a prescribed schedule. This Ordinance incorporates the National Categorical Pretreatment Standards and the Illinois Pretreatment Program requirements.

- The Fats, Oils, and Greases (FOG) Ordinance requires Food Service Establishments (FSEs) and Non-FSE FOG Discharges to install appropriate grease removal systems (GRS). The Ordinance includes specifications for GRS sizing and installation. It also prescribes a maintenance schedule, based on the type of GRS. Permittees are required to document cleaning and maintenance of the GRS and keep these records for a minimum of 3 years. Maintenance records must be submitted to the FMWRD upon request.

Lift stations are inspected every week day to make sure they are operating normally. Locations of the 4 sanitary lift stations are listed below.

1. White Eagle, 4100 Palmer Drive
2. Clark Street, 155 Baje Industrial Drive

3. Butterfield East 2550 Frieder Lane
4. Linden Estates, 3112 Moraine Drive

A more detailed or site specific checklist may be posted inside the lift station, but in general the following tasks are performed as part of a routine lift station inspection.

1. Let Water Production know the inspection is beginning.
2. Turn off the security alarm.
3. Visually inspect the area.
4. Listen and smell for anything unusual.
5. Check the building heater and fan.
6. Inspect the generator.
    a. Visually inspect for leaks.
    b. Check the oil and radiator fluid levels.
    c. Check the battery and water level.
    d. Check the engine block heater.
7. Test the generator.
    a. Start the generator.
    b. Transfer the electric service to the generator by activating the transfer switch.
    c. Perform these checks separately.
8. Check the wet well for excessive rags or grease and clean the screens, if necessary.
9. Log the generator and pump hours. Date and initial the log.
10. Empty the trash can, sweep the floor, and knock down spider webs.
11. Reset the security alarm.
12. Lock the door and notify Water Production the inspection has concluded.

The log of generator hours is used to determine whether the generator has operated between tests. The log of pump hours indicates whether the dual pumps are running in a normal lead-lag sequence. One pump running notably longer than the other is indicative of a problem with that pump. When an inspection reveals the need for some type of maintenance, typically resetting pump controls, removing rags or grease from the wet well, changing the oil, or replacing parts, the Labor Supervisor is notified and a contractor is scheduled to perform the maintenance.

All 4 of the City's sanitary lift stations are equipped with SCADA, which allows the Water Production Division to monitor the wet well levels remotely 24 hours a day, 7 days a week. When there is a SCADA communications failure at one of the lift stations, a maintenance worker is stationed at the lift station site until communications are restored. During that time, the maintenance worker monitors the wet well level and makes sure the pumps turn on.

14 of the City's 16 CSOs have been fitted with a portable ISCO 2150 Area Velocity meter that continually measures the flow depth at the CSO. Flow is also metered within the CSO Treatment Facility (CSO 027). CSO 016 is the only CSO in the City without a flow meter, but it is actually a lift station with a wet well alarm. Data collected by the CSO flow meters is downloaded monthly in order to monitor the frequency and duration of overflows. CSO 001 has the largest tributary area and is the most prone to overflow, so it is also visually inspected regularly – from above ground weekly and from within the CSO chamber monthly. The locations of the 16 CSOs are shown on the CSO Basin Map in Appendix 2. Appendix 4

includes detail drawings of each CSO showing the configuration of the overflow and the location of the flow sensor.

Emergency Preparedness and Response

Among the City's collection system assets, its 4 sanitary lift stations are its most critical. Whenever a lift station is not working properly, there is a significant risk of widespread sewer back-ups. Because of this risk, the lift station wet well levels are monitored with SCADA 24 hours a day, 7 days a week. They are also visually inspected every week day. Furthermore, each lift station has built-in redundancy in its pumps and power supply.

All 4 sanitary lift stations consist of 2 submersible pumps that normally run in a lead and lag sequence. During high flows, transducer level sensors prompt the pumps to run as a pair. Each lift station has a back-up submersible pump on site that can be used to replace a faulty pump. In case of a power outage, each lift station is equipped with a gas powered back-up generator system that automatically starts when a power loss is detected. The City also has a contractor on-call to assist with specialized emergency lift station maintenance.

In certain emergency situations, the circumstances make it necessary to setup a temporary pumping system to bypass a malfunctioning lift station. In such situations, the following equipment is necessary:

- A 6" diesel-driven, trailer-mounted pump;
- A 6" suction hose;
- 6" discharge hoses;
- A 6" adapter to reverse a hose end from male to female;
- A valve key to lift/turn the backflow check valve;
- Rubber gloves; and
- Hammers, screwdrivers, crescent wrenches, chisels, and other miscellaneous tools.

General procedures for bypass pumping are described below. Water & Sewer Maintenance Division staff periodically practice these procedures so they are ready in an emergency.

1. Make sure the site is safe and bypass pumping is the only feasible option.
2. Silence any alarms and check the available power supply.
3. Back the trailer-mounted pump up to the wet well doors, leaving enough room to connect the suction hose and discharge hose to the pump.
4. Open the wet well doors and safety grates and slide the suction hose into the wet well.
5. Open the check valve vault doors. Remove the flange cap and connect the discharge hose to the flange and pump. Lift the handle on the backflow check valve.
6. Make sure the end of the suction hose is deep enough in the wet well (just below the pipe flowing into the wet well).
7. Disconnect the pump from the truck and secure the jacks.
8. Start the pump at low speed and wait for it to prime. Then adjust the speed for optimal output.
9. Monitor the pump and hoses. Replace any hoses leaking on land. Set up barricades or ramps over the hoses, as needed.

In case of a widespread City emergency where bypass pumping is needed at multiple lift stations at the same time, the Water & Sewer Maintenance Division will prioritize the lift stations as noted below, based on the largest service area and the highest potential for damage.

1. White Eagle, 4100 Palmer Drive
2. Clark Street, 155 Baje Industrial Drive
3. Butterfield East 2550 Frieder Lane
4. Linden Estates, 3112 Moraine Drive

Collection System Maintenance and Equipment

Planned Maintenance

Planned maintenance of the collection system can prevent the damages associated with sewer back-ups. And, by limiting the number of emergencies, it can also reduce the cost of maintenance and improve employee morale. The basic elements of the City's planned maintenance program are television inspection of sewers, sewer jetting, and root control.

Sewers are televised and jetted by crews on three sewer cleaning trucks that rotate through the collection system. Sewer cleaning trucks are typically assigned each day to a Township ¼ Section in each of the City's three distinct areas: West Aurora, East Aurora, and the Fox Valley. Sewers in the assigned ¼ Section are cleaned from manhole to manhole, then televised with a basic sewer camera. Crews review the video image in the field to verify the cleaning was successful. This process is repeated if additional cleaning is necessary. When a collapsed pipe or other urgent need is identified during this process, the crew notifies a Labor Supervisor immediately. Less urgent maintenance needs, such as minor root intrusion, are scheduled after a Labor Supervisor reviews the video. A crew moves on to a new ¼ Section once all the sewers in the previous ¼ Section have been jetted. Sewer jetting dates are tracked using GIS.

Each month, the Water & Sewer Maintenance Division also televises and jets the sewers listed on their Problem List of Sewers. Over time, capital improvement projects have reduced the number of problem sewers.

Unplanned Maintenance

Unplanned maintenance is typically brought about by a sewer back-up, observation of a surcharged manhole, sinkhole, or due to a structural failure discovered while performing sewer televising. When a sewer back-up has been reported, the City's first objective is to determine the cause. Then the City can determine whether the maintenance responsibility belongs to the City or the private property owner.

At the most basic level, sewer back-ups are caused either by a blockage in the sewer or by too much flow through the sewer. In some cases, both may be the case. Blockages in the sewer might be the result of oil and grease deposits, root intrusion, a collapsed pipe, or a lift station failure. Excess flow might come from pipes connected to the sewer, such as storm drains, downspouts, or foundation drains. It also might come from seepage through leaky joints in the sewer or manholes.

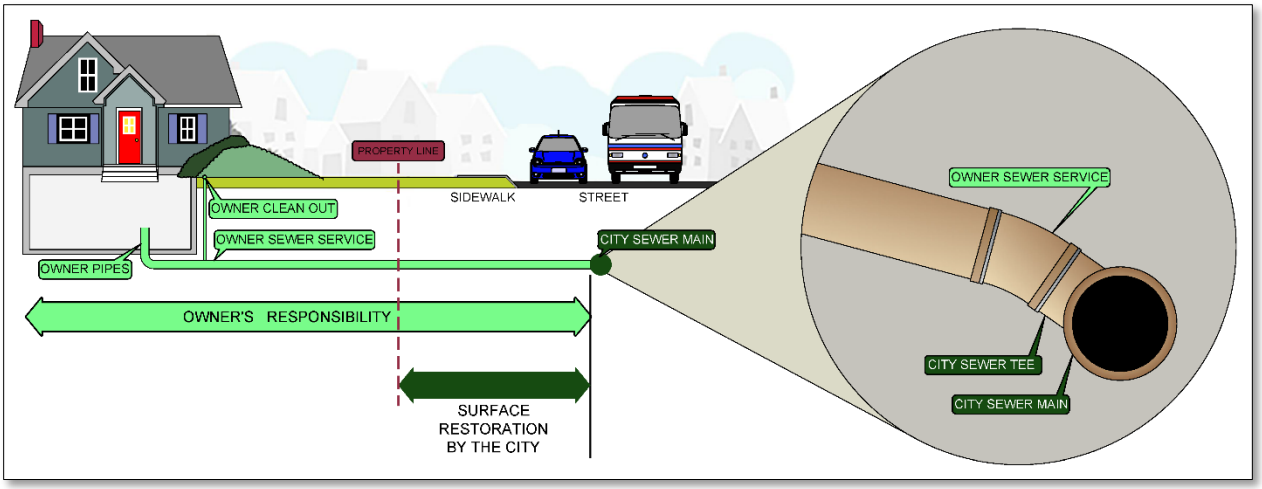
A maintenance worker is typically the first to respond to a sewer back-up. First, the maintenance worker should check the nearest manholes downstream and upstream from the sewer back-up. If the water level in these manholes is elevated, or if a high water mark or a debris line is evident, the problem most likely is in the City sewer system. If the water level in these manholes is normal and the sewer back-up remains, the problem is in the private sewer service. If the water level in these manholes is normal and the sewer back-up has receded, then additional information is needed.

Next, the maintenance worker checks for evidence of a sink hole, or recent construction in the area. A sink hole in the vicinity of a sewer back-up is a strong indication of a pipe collapse. Disturbed soil and

pavement patching are evidence of recent construction that may have compromised the capacity of the sewer service or the sewer main.

If this investigation is not conclusive, the maintenance worker notifies the Labor Supervisor. The Labor Supervisor then schedules a maintenance crew to televise the sewer. The crew will start by televising the City's sewer main. The video may reveal a blockage or the source of excess flow. If the problem is found within the sewer main or at a mainline tee, the City is responsible to correct the problem. If the televising indicates there are no problems with the sewer main, the private property owner is advised to hire a contractor to have their sewer service televised. If the problem is located within the private sewer service, the private property owner is responsible to correct the problem. Figure 10 illustrates the limits of the City's responsibility and private property owner's responsibility.

Figure 10: Sewer Maintenance Responsibility



In the past sewer back-up reports were stored in a database. The City is currently developing a GIS based process for storing sewer back-up data.

Inventory of Parts and Materials

The Water & Sewer Maintenance Division keeps the parts and materials most commonly used for sewer maintenance in stock at the Maintenance Facility (649 South River Street). These items are:

- 4", 6", 8", 10", 12", and 15" non-shear mission couplings (clay-to-plastic and plastic-to-plastic)
- 4", 6", 8", 10", 12", 15", and 18" SDR-26 PVC pipe
- 2", 3", 4", and 6" concrete adjustment rings
- 4", 7", and 9" manhole frames with solid lids
- 4' x 32" manhole sections with bases
- Mastic
- Chimney seals
- Test plugs
- Bricks and mortar
- Hydraulic Cement
- Select granular backfill (CA-6 and CA-7)
- Liquid dye

Figure 11: Inventory of Parts and Materials

When stock items need to be replenished, or when more specialized items are needed, the Water & Sewer Maintenance Division can obtain parts and materials from one of the following local suppliers 24-hours a day, 7 days a week.

- Mid American Water, Inc. – 1500 E. Mountain Street, Aurora, 630-851-4500
- Water Products Company – 3255 E. New York Street, Aurora, 630-898-6100

Labor Supervisors can place an order by completing a Material Request Form and having the form approved by the Superintendent or Assistant Superintendent.

Inventory of Vehicles, Equipment and Tools

The fleet of vehicles and equipment used to maintain the City's collection system includes: backhoes, end loaders, skidsteers, dump trucks, crew cabs, sewer cleaning trucks, utility trucks, pumps, air compressors, generators, saws, arrow boards and more. Each vehicle and piece of equipment in the fleet is numbered as shown on the Water & Sewer Maintenance Vehicles and Equipment Inventory in Appendix 5.

Figure 12: Inventory of Vehicles and Equipment

The City's Central Garage tracks vehicle mileage and notifies Water & Sewer Maintenance whenever a vehicle is due for routine maintenance. Any employee that notices a potential maintenance issue with a vehicle or piece of equipment fills out and submits an equipment maintenance request form.

Most maintenance and repairs are performed by the City's Fleet Maintenance Division at Central Garage. One exception is small engine repair, which is performed by contracted services.

Each truck in the Water & Sewer Maintenance Division is assigned a specific set of tools that is stored on the truck in lock boxes. For example, the trucks used to respond to service calls are equipped with manhole hooks, dye tablets, and utility marking paint for general sewer inspection. The sewer manhole rehab truck is equipped with the tools and materials listed below.

- Air compressor
- Generator
- Tripod
- Safety winches
- Harnesses
- Bricks and mortar
- Hydraulic cement
- Barricades
- Work fence
- Personal protective equipment
- Hammers, screwdrivers, wrenches, and other miscellaneous hand tools

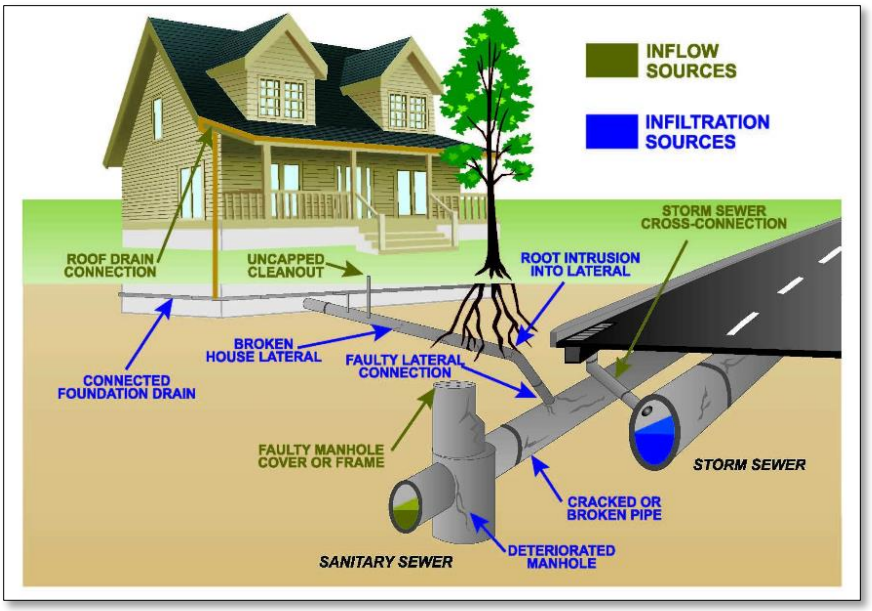
Employees can request replacement tools whenever a tool wears out or is lost. Additional tools can be requested at any time.

Collection System Capacity Evaluation

Inflow and Infiltration

The base flow in sanitary and combined sewers is wastewater from residential and non-residential buildings. In combined sewers, it is normal for the flow rate to spike in response to a storm, but it signals a problem in sanitary sewers. Stormwater and groundwater can enter a sanitary sewer system from a variety of sources, as illustrated in Figure 13. Water that flows rapidly into the system and subsides quickly after the storm is considered inflow. Infiltration enters the system slowly and may continue long after the storm. Inflow and infiltration (I/I) in a sanitary sewer system are problematic because they can cause sewer overflows and violations of the City's NPDES permits.

Figure 13: Common I/I Sources



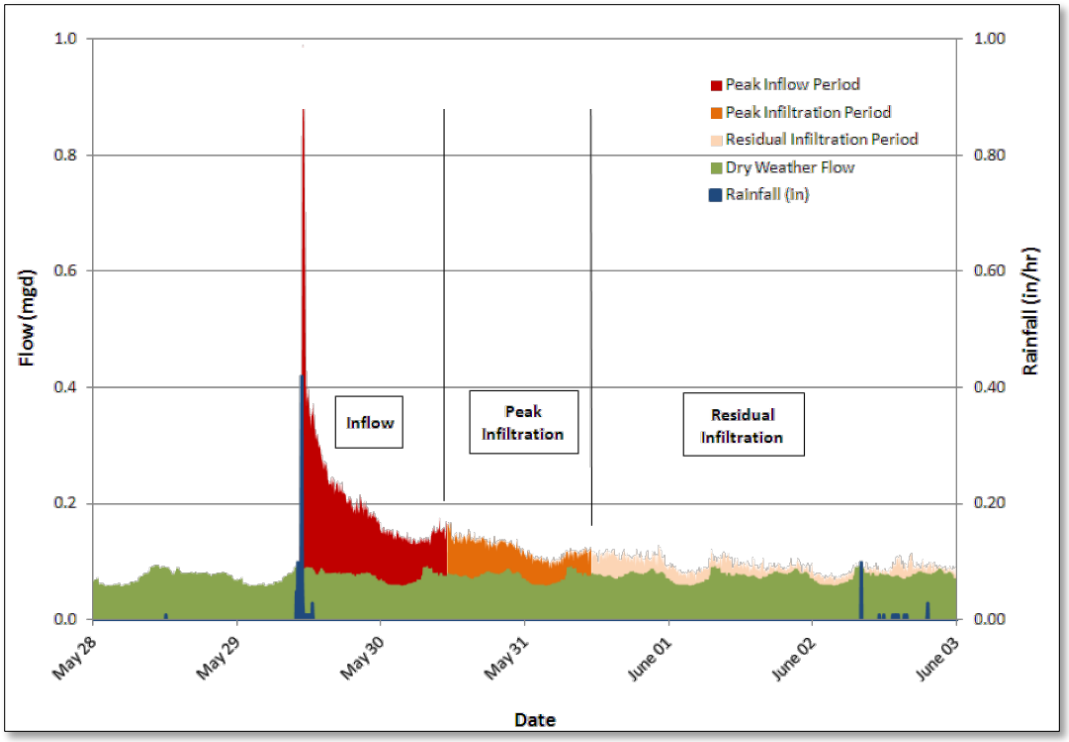
Source: http://www.oregonohio.org/engineering/engineering/inflow-infiltration.html

Flow Monitoring

The City uses ISCO 2150 Area Velocity meters to monitor the flow in its collection system. 14 of these meters are permanently installed at CSOs so they can monitor the frequency and duration of overflows. Another 8 meters are temporarily deployed throughout the collection system in strategic locations. From time-to-time, the meters are moved to new locations in order to identify portions of the collection system with excessive I/I.

Flow meters measure the depth and velocity of flow in a pipe over time. The flow rate can then be calculated using the measured depth and velocity, along with the pipe diameter. Figure 14 illustrates how I/I in the collection system becomes evident when comparing flow monitoring data with rainfall data.

Figure 14: I/I Determination Using Flow Monitoring Data



Source: RJN Group - CMOM: Flow Monitoring, SSES and I/I Analysis
APWA Fox Valley CMOM Seminar – May 25, 2016

When the City initiates a SSES to identify sewers with excessive I/I, one of the primary decisions is where to place the meters. Site selection should be based on the following considerations:

- Meter the Major Branches - Meters should be placed near junctions of sizable branches of the collection system. The meters should be installed on all but one branch at a junction. (Flow in the unmetered branch can be calculated by addition or subtraction.)

- Data Quality - Meters should be placed in locations with smooth, laminar flow beyond the influence of bends, drops, and lift stations.

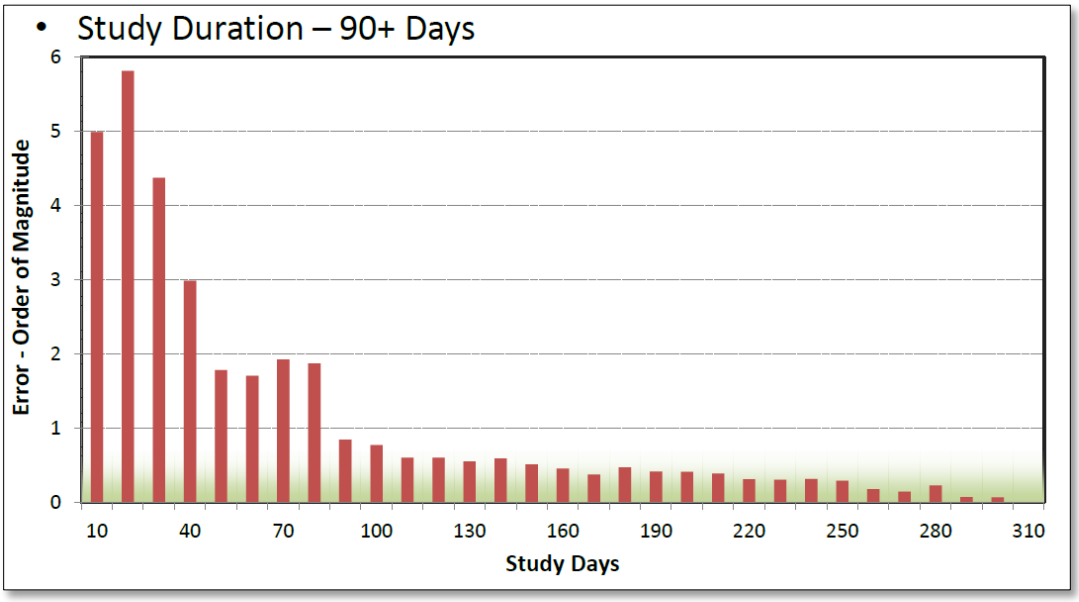
- Meter Accessibility – Meters should be placed in locations that are easily accessible with a vehicle and that require minimal traffic control.

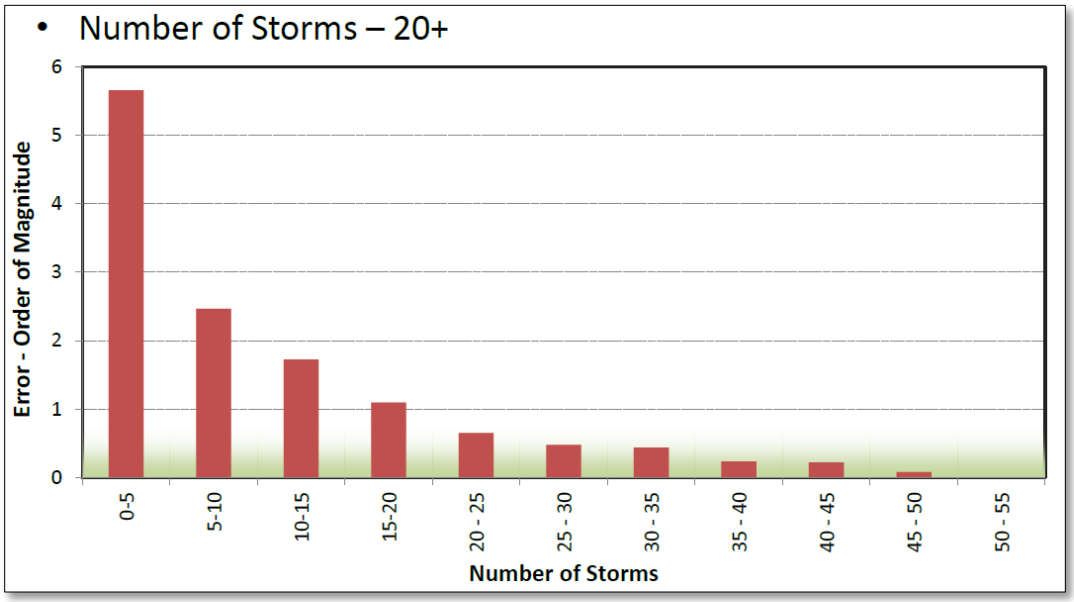
Appendix 6 contains maps showing the placement of meters during two stages of the City's SSES in Basin 48. The initial meter placement helped the City identify a specific neighborhood that was responsible for a significant portion of the I/I in the Basin. After several months and several storm events, the City honed in on specific branches of the sewer system in that neighborhood by moving more meters into the neighborhood from remote locations in the Basin.

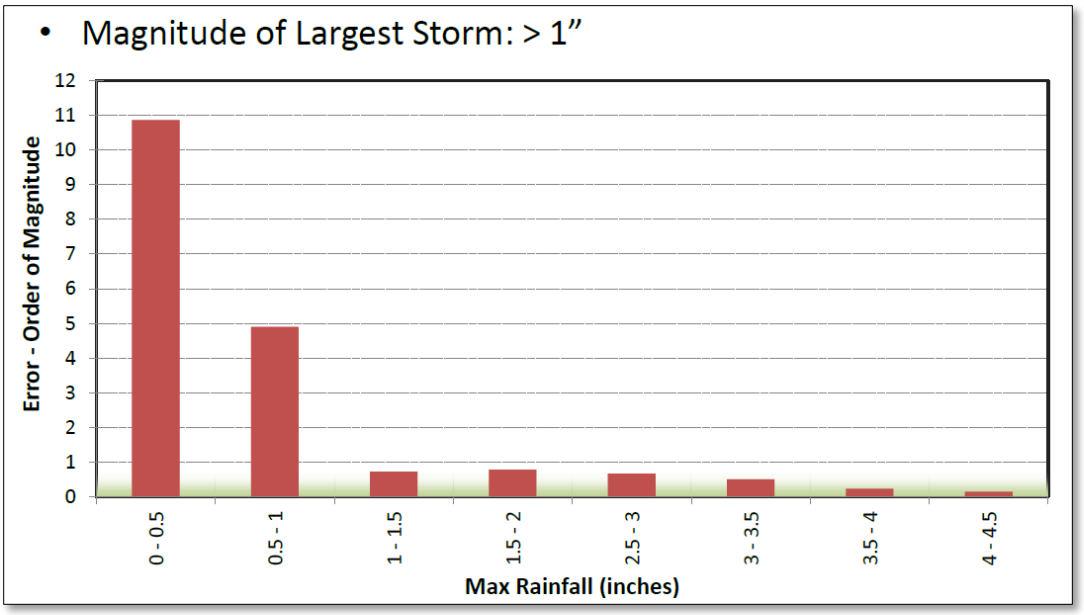
Another important decision in a SSES is the length of the monitoring period. Storms vary in their intensity and duration. The I/I observed in a collection system during a short duration, high intensity storm event may be drastically different from the I/I observed in a longer, less intense storm. Collecting

more data from a wider variety of storms will lead to more informed decisions. But, the timing and character of storms is unpredictable. So there is no standard length for a SSES monitoring period. Determining the appropriate length involves some judgement based on the frequency and intensity of storms throughout the course of a monitoring period. The three charts in Figure 15 provide guidance from the RJN Group on determining the appropriate length of a SSES monitoring period.

Figure 15: SSES Monitoring Period







Source: RJN Group - CMOM: Flow Monitoring, SSES and I/I Analysis
APWA Fox Valley CMOM Seminar – May 25, 2016

Flow meters must be maintained before and during the monitoring period. The meters should be calibrated in a laboratory before they are installed in the collection system and then re-calibrated within the system at least once every three months. Batteries must be replaced periodically and any accumulation of debris on the meter can inhibit data collection. When the City undertakes a SSES, a contractor typically installs and maintains the meters. The contractor's scope of services includes: initial meter calibration; downloading the collected data twice per month; and performing the necessary maintenance, such as replacing batteries and cleaning the probes and transducers.

Manhole Monitoring

In some cases, visual manhole inspections can provide useful information about I/I and the capacity of the collection system. During and shortly after storm events, sources of I/I might be plainly visible in manholes. The joints just below the frame and at the base of the manhole are likely sources, plus any visible cracks.

I/I sources may be inundated when flows are high, but valuable information can still be collected in these conditions. If the water surface is higher than the crown of the pipe, the pipe is considered surcharged. Surcharged pipes within a localized area indicate a blockage or bottleneck in the system, as long as the pipes in the wider area are not also surcharged. When surcharged pipes are found, it is useful to document the time and the measured distance from the manhole rim to the water surface. Tracking that measurement over time indicates whether flow through the manhole is stable, increasing, or decreasing. If a surcharged pipe results in basement back-ups, the measured distances over time can be used to estimate the critical elevation at which basement back-ups begin and end.

The City owns an ADS ECHO Level Monitor that records the depth of water in a manhole over time and provides text and e-mail notifications when the depth reaches critical elevations. This level monitor can

be installed in a manhole and later moved to another manhole. The critical elevations should be re-programmed at each location based on site specific considerations.

Smoke and Dyed Water Testing

Smoke testing and dyed water testing are two additional tools that can be used to find sources of I/I in a collection system. Smoke testing is best suited for detecting: downspout connections; cross-connections between storm drains and sanitary sewers; and other point sources of inflow. Dyed water testing is used to confirm a suspected source of I/I.

Smoke testing involves plugging both ends of the sewer test section with sandbags inside a manhole. Test sections should generally be 400 feet or less. Smoke can be introduced into the test section using smoke candles or liquid smoke. The smoke should be pushed into the sewer using two high-capacity blowers. If properly connected to the sanitary sewer system, smoke should exit the vent stacks of surrounding properties. If smoke exits at any other location, that location is a source of I/I. Photographs should be used to document evidence of I/I, similar to the example in Figure 16. Smoke testing should only be performed during daylight hours. Plus, it works best in dry weather with little wind.

Figure 16: Evidence of I/I Sources

Source: RJN Group - CMOM: Flow Monitoring, SSES and I/I Analysis
APWA Fox Valley CMOM Seminar – May 25, 2016

The City uses a concentrated liquid dye for its dyed water testing. After identifying a suspect sewer or manhole, the nearby ground surface should be flooded and the dye should be applied to the flooded area. I/I is confirmed in the suspect sewer or manhole when the dyed water is observed in the collection system, as shown in Figure 16.

It can be alarming to the public to see smoke pouring out of the collection system, so public notification is important prior to the start of a test. The W&S Maintenance Division typically leaves door hangers at every address adjacent to a test area 24 hours before testing and provides daily updates when the testing lasts more than one day. Daily notifications are also provided to the Police Department, Fire Department, and the Customer Service Call Center.

Building Inspections

Finding sump pumps and foundation drains that are illegally connected to the sanitary sewer system typically requires plumbing inspections inside buildings. This is a labor intensive endeavor and usually

includes scheduling appointments on evenings and weekends, if contact with 100% of the residents in the area is necessary. When an inspector finds a suspicious connection to the sanitary service, a dyed water test can be used to confirm the illegal connection.

Figure 17: Illegal Sump Pump Connection to a Sewer Service

Source: RJN Group - CMOM: Flow Monitoring, SSES and I/I Analysis
APWA Fox Valley CMOM Seminar – May 25, 2016

Modeling

A hydraulic model of the collection system can be used to evaluate the collection system's capacity, as well as the effectiveness of potential sewer rehabilitation alternatives. As part of its CSO LTCP, the City hired a consultant to build a hydraulic model of its combined sewer system using XP-SWMM software. Model input data included dry weather wastewater flows, manhole rim and invert elevations, pipe sizes and materials, land use data, soil data, and rain data. The model was calibrated with flow monitoring data for dry weather and wet weather conditions. Finally, potential improvements were modeled to determine a series of projects that would reduce CSOs. These improvements included sewer separation projects, construction of storage facilities, and green infrastructure projects. Before designing the proposed CSO 01 Storage Facility, the City plans to update the model with completed projects and new flow monitoring data.

Assessment of the Collection System Capacity

With very few exceptions, the City's sanitary sewer system was planned, designed and constructed with enough capacity to avoid overflows and sewer back-ups. Master planning for the sanitary sewer system began in the 1950's and led to sewers installed low enough to minimize the number of lift stations. The sewers were sized based on a conservative estimate of future land use densities. In order to maximize capacity in the combined sewer system, sanitary bypass sewers were constructed to route wastewater flow from separate sewer areas around the combined sewer system. Nearly all of the overflows and sewer back-ups in the separate sanitary sewer system occur because of pipe failure or an obstruction in the sewer. Whenever excessive I/I results in SSOs or back-ups, the City initiates a SSES and makes any necessary improvements. There is an ongoing SSES related to sewer back-ups near the intersection of

Inverness Drive and Clarendon Lane, but there is no backlog of necessary sanitary sewer improvements waiting for funding.

The City's CSO LTCP was submitted in 2010 and was approved by the IEPA in 2015. Prior to official approval, the City began implementing its CSO LTCP. Construction of the projects identified in the approved plan has continued steadily since and the projects are scheduled to be completed by December 31, 2030. At that point, the City expects that on a system-wide annual average basis, the combined sewer system will capture and treat at least 85% (by volume) of the combined sewage.

Collection System Rehabilitation

Alternative Approaches

As the elements of a collection system age, the infrastructure may need more than routine maintenance. Rehabilitation may be necessary to restore structural integrity, control excessive I/I, or increase system capacity. Rehabilitation alternatives can generally be divided into two categories: trenchless and open cut. Trenchless alternatives repair existing sewers and manholes without excavation. Open cut alternatives require excavation so the existing infrastructure can be replaced or repaired. Typical rehabilitation alternatives are described below.

Trenchless Alternatives

- Full Length CIPP Lining – A flexible tube saturated with resin is inverted into the original pipe from manhole to manhole and then expanded to fit tightly against the original pipe. The resin is cured by steam pressure to form a continuous pipe liner inside the original pipe. Service connections are restored from inside the lined pipe using a self-propelled robotic cutting device with a television camera.

Figure 18: Cured-in-Place Pipe Liner Installation

Source: http://visu-sewer.com

- Sectional CIPP Lining – A resin-saturated tube is placed inside a protective launching device, winched through the sewer pipe and robotically positioned at the defective section. The end of the launching device is then opened and the resin-saturated tube is inverted and expanded to fit tightly against the original pipe using controlled air pressure. Once the resin has cured, the inversion bladder and launching device are removed from the pipe.

- CIPP T-Liner – A resin-saturated liner is loaded onto a protective launching device, winched through the sewer pipe and robotically positioned at the service lateral connection. The liner is designed to fit tightly against a section of the service lateral and the circumference of the sewer main in a continuous, single piece. A mainline bladder is inflated to press the liner against the mainline pipe using controlled air pressure. Then the lateral tube is inverted into the lateral pipe using an inversion bladder. Once the resin has cured, the bladders and launching device are removed from the pipe.

- Pressure Test and Grout – A joint sealing packer is robotically positioned at the pipe joint. Then the end elements of the packer are expanded using controlled air pressure to form a tight seal against the inside wall of the pipe, completely isolating the joint from the remainder of the pipe. Chemical sealant is pumped through a hose into this isolated area at a pressure exceeding the groundwater pressure. A pressure test is used to confirm the sealed joint can maintain a minimum pressure for a set period of time.

- Manhole Joint Sealing – Holes are drilled through the manhole wall at each point of leakage. Grout ports are then placed in these drilled holes, creating a watertight seal between the manhole and each port. A chemical sealant is pumped into each port through a hose until material refusal or until a predetermined quantity has been injected. Once the injection is complete, the ports are removed and the remaining holes are filled with mortar. This procedure is used for pre-cast manholes and masonry manholes alike, except when there are numerous leaks in a masonry manhole. In that case, two coats of cementitious waterproof lining are applied before pumping the chemical sealant.

- Manhole Lining - A monolithic cementitious liner is sprayed onto the walls, chimney and bench of the manhole.

Figure 19: Monolithic Cementitious Manhole Liner

Source: http://trenchlesstechnology.com

Open Cut Alternatives

- Manhole-to-Manhole Replacement - The existing sewer is completely removed and replaced between two manholes.

- Dig Repairs – A section of the existing sewer is completely removed and replaced.

- Chimney Rehabilitation – The existing masonry between the top of the corbel and the bottom of the frame is removed. New concrete adjusting rings are set in a butyl rope and external seals are applied to all exposed chimney components.

Depending on the site specific circumstances surrounding a rehabilitation project, some of the alternatives listed above may not be appropriate. For example, a CIPP liner should not be used to rehabilitate a collapsed pipe. Within the range of appropriate options for a given application, the selection of one alternative over another may be based on a number of factors, such as cost, durability, and disruption to the work area. Figure 20 compares various rehabilitation alternatives and provides approximate unit prices for each.

Figure 20: Comparison of Rehabilitation Alternatives

Type of Rehabilitation	Trenchless/Open Cut	Restores Structural Integrity	Controls Excessive I/I	Can Increase Capacity	N/A after Structural Failure	Durability	Disruption to the Work Area	Approximate Unit Price
Full Length CIPP Lining	TR	X	X	X	X	Max	Min	$35/LF
Sectional CIPP Lining	TR	X	X		X	Max	Min	$770/LF
CIPP T-Liner	TR	X	X		X	Max	Min	$2,900/EA
Pressure Test and Grout	TR		X		X	Min	Min	$50/Joint
Manhole Joint Sealing	TR		X		X	Min	Min	$1,150/EA
Manhole Lining	TR		X		X	Max	Min	$2,000/EA
Manhole-to-Manhole Replacement	OC	X	X	X		Max	Max	$300/FT
Dig Repairs	OC	X	X			Max	Max	$300/FT
Chimney Rehabilitation	OC		X			Max	Min	$2,500/EA

The approximate unit prices shown in Figure 20 can vary significantly based on a wide range of conditions, but they illustrate the relative cost difference for typical applications. It should be noted the unit prices do not include the cost of flow control/bypass pumping or the cost of cleaning prior to rehabilitation.

Back-up Prevention Assistance Program

The City encourages residents that have experienced one or more sewer back-ups to install sewer back-up protection by offering residents a 50% rebate on the cost of the project up to a maximum City cost of $5,000. A document describing the application process and the types of projects eligible for the rebate is included as Appendix 7.

Asset Management

The City's sanitary sewer system and combined sewer system have been mapped in GIS. This mapping forms a digital inventory of the City's collection system assets. The size of the collection system has grown from approximately 50 miles in 1905 to its current size of nearly 500 miles. Figure 21 shows how Aurora's population has grown through the years and provides an estimate of the size of the City's collection system, assuming the collection system grew at the same rate as the population.

Figure 21: Aurora's Population and Estimated Collection System Size through the Years

Year	Aurora Population	Aurora Sewer (mi)
1905	26,974	50
1910	29,800	57
1920	36,300	74
1930	46,589	101
1940	47,200	102
1950	50,600	111
1960	63,715	145
1970	74,200	172
1980	81,293	190
1990	99,581	237
2000	142,990	349
2010	197,899	491
2018	201,110	499

Due in part to the fact that portions of its collection system were built over 100 years ago, the City regularly monitors the condition of its collection system assets. Each year the City cleans and televises the portion of its collection system along roads likely to be resurfaced in the next few years. Manholes

in these locations are also inspected. Many of the City's oldest sewers have held up well over the years. Some have been replaced, but those that are still in service are in good working condition.

Among the City's collection system assets, lift stations are its most critical. Whenever a lift station is not working properly, there is a significant risk of widespread sewer back-ups. Because of this risk, the lift station wet well levels are monitored with SCADA 24 hours a day, 7 days a week. They are also visually inspected every week day.

Collection system rehabilitation is funded by the City's Water & Sewer Fund. Since the Water & Sewer Fund is an enterprise fund, the City collects fees from users and those fees must only be used to fund operations of the enterprise activity. Fees are adjusted periodically to account for inflation and projected needs. Figure 4 shows the City's average annual Water & Sewer Fund budget 2015-2017 has exceeded $20 million, which has been sufficient to keep up with necessary maintenance and repairs, as well as planned capital improvements.

System Evaluation

The number and nature of collection system overflows is an important measure of the effectiveness of the City's efforts to manage, operate, and maintain the collection system. The Water & Sewer Maintenance Division proactively maintains the collection system to limit the number of overflows, but the system is nearly 500 miles in length so some unplanned maintenance can be expected. Figure 22 shows only 5 SSOs were discovered or reported between 2017 and 2021. 3 of those SSOs were addressed immediately by cleaning the sewer and distributing FOG information. Two SSO that occurred during the above time period were caused by excessive I/I. In order to address the excessive I/I a SSES was performed which resulted in 6,400 feet of sewer lining and the construction of a 650 foot relief sewer to resolve a bottleneck in the collection system.

Figure 22: SSO History

Year	Total	Causes	Solution
2017	1	1 – wet weather (12 residences)	Performed SSE, lined 6,400 lf sanitary sewer
2018	1	1 – wet weather (4 residences)	Installed 650 lf relief sewer
2019	1	grease buildup (5 residences)	Removed blockage, distributed FOG information
2020	1	grease buildup (1 residence)	Remove blockage, distributed FOG information
2021	1	grease buildup (surcharged 1 manhole)	Remove blockage, distributed FOG information

The City is working toward the goal of reducing wet weather overflows from combined sewers as part of its CSO LTCP. The City began implementing its LTCP prior to its official approval and construction has continued steadily since then. The projects are scheduled to be completed by December 31, 2030, but Figure 23 demonstrates the progress that has already been made. 1983 was a wet weather year prior to the City starting implementation of its LTCP.

Figure 23: Number of Overflows at CSOs by Year