



Department Source: City Utilities - Sewer/Stormwater

To: City Council

From: City Manager & Staff

Council Meeting Date: May 15, 2017

Re: Update on Sewer System Inflow and Infiltration Reduction Efforts and Impact on the Reduction of Overflows and Sewer Backups into Buildings

Executive Summary

Staff has prepared a report describing the efforts to reduce the volume of Inflow and Infiltration (I&I) entering the sewer collection system and efforts to reduce impacts of I&I on system operation. This report includes a brief description of I&I, a history of I&I problems and a description of work which has been completed to either reduce I&I or address impacts on system operation. The overall results show the rehabilitation work is resulting in a reduction in the peak flows in the sewer collection system in the area where the work has been completed. The rehabilitation work, combined with the other maintenance work and waste water treatment plant operational modifications have resulted in a significant reduction in the frequency and number of sanitary sewer overflows from the sanitary sewer collection system to the environment.

Discussion

Councilwoman Peters requested a report providing an update of the status of the inflow and infiltration reduction efforts being performed by the Sewer Utility Division. This report is intended to provide a brief description of Inflow and Infiltration (I&I), a history of I&I problems with the City's collection system, work to reduce I&I or address impacts to system operation and the effectiveness of the efforts to date.

Inflow and Infiltration and History of Problems

Excess rain water or ground water that enters the sanitary sewer collection system is referred to as inflow and infiltration, or more commonly, I&I. Inflow refers to rain water that flows into the sanitary sewer system via direct connections. The storm drainage and sanitary sewer systems are separate however, items such as roof drains, foundation drains, private storm drains, sump pumps are sometimes connected to the sanitary sewer system. These allow significant amounts of rainwater to enter the sanitary sewer. Infiltration refers to rain water and ground water that enters the sanitary sewer collection system through cracks, joint failures, faulty connections, etc. in sewer pipes and manholes. Infiltration generally increases as the sewer system ages and needs replacement or rehabilitation.

Sanitary sewer systems are designed to convey wastewater from homes and businesses. I&I adds rainwater and ground water to the sanitary sewer system which is transported and must be treated like wastewater. During periods of rainfall, the flow due to I&I can increase enough to be the major portion of water in the sanitary sewer system and can increase to the point that all the capacity of the sewer system is used. Once the available capacity is used, the sewer system can then backup into buildings or overflow from manholes and be



City of Columbia

701 East Broadway, Columbia, Missouri 65201

released to the environment. These overflows violate state and federal environmental regulations and can create a public health risk. I&I can also interfere with operations of wastewater treatment facilities resulting in lesser quality water being discharged from the treatment facility.

I&I is a problem that many sewer systems across the country are being required to address through regulatory enforcement actions (abatement orders or consent decrees) by state environmental agencies and/or the United States Environmental Protection Agency. The City recently entered into an Abatement Order (AOC) and a Memorandum of Understanding (MOU) with the Missouri Department of Natural Resources related to wet weather sanitary sewer overflows. The AOC and MOU require the Sewer Utility and Storm Water Utilities to develop an Integrated Management Plan for the utilities. This plan must follow the EPA's "Integrated Municipal Storm water and Wastewater Planning Approach Framework." The intent of this plan is to prioritize the needs of both utilities in a manner that maintains compliance with regulatory standards and will allow for addressing the most pressing public health and environmental issues first. It is anticipated that this plan will identify additional programs to address I&I resulting in a reduction in the frequency of sanitary sewer overflows and building backups due to excessive I&I.

The backups and sanitary sewer overflows due to I&I are not new or recent problems for the City's sewer collection system. There are records of backups into buildings due to I&I as far back as the late 1960s and records of sanitary overflows due to I&I as far back as the 1970s. These problems likely were occurring for a much longer period of time however, records do not exist. The EPA's Construction Grants Program was used to fund the majority of the cost for the City of Columbia Regional Wastewater Treatment Plant (CRWWTP) and interceptor/trunk sewers. These projects totaled approximately \$51 million with funding being 75% federal grants, 15% state grants and 10% City funding. As part of the grant program, the city was required to perform an analysis of I&I and subsequently conducted a Sewer System Evaluation Survey of the city's sewer system. This survey was completed in 1978 and it identified extraneous flows due to I&I of over 48 million gallons a day during periods of rainfall (5 year frequency storm lasting 4.5 hours). The reports from the survey recommended rehabilitation of some problems that were determined to be cost effective in 1978. In addition, it was recommended the city's maintenance program be expanded to include rehabilitation of I&I sources not considered cost-effective in 1978, to prevent additional I&I due to further deterioration. *Records do not indicate that the recommended rehabilitation program was ever initiated following these studies.* I&I has continued to cause operational problems with the collection system and the waste water treatment plant resulting in sanitary sewer overflows and sewer backups into buildings. Currently, the average daily flow at the waste water treatment plant is approximately 15.7 million gallons per day. During periods of heavy rainfall plant flow rates can exceed 80 million gallons per day.

In 2004, Black & Veatch completed a Wastewater System Facilities Planning Report for the city. This report identified basins in the sanitary sewer system that have excessive I&I. The report recommended that a comprehensive I&I investigation be conducted to identify I&I



City of Columbia

701 East Broadway, Columbia, Missouri 65201

sources for removal. Following these recommendations, TREKK Design Group was hired in 2008 to conduct a pilot investigation. Based on the Facilities Planning Report and the pilot investigation, in 2010, staff prepared a report for Council that outlined a program to reduce the amount of I&I entering the City's sewer system. This program recommended a basin based I&I reduction program consisting of three phases for each basin. The work included in each phase is as follows:

Study Phase:

- Flow monitor sewer system in study area to establish baseline condition
- Smoke testing
- CCTV inspections
- Manhole inspections
- Internal and external building inspections

Construction Phase:

- Rehabilitate all priority public sewer mains and all defective public sewers in study area.
- Rehabilitate defective sewer manholes in study area.
- Replace/rehabilitate defective service connections and service laterals located within public right-of-way or easement that are connected to public sewer mains. Defective service laterals will be rehabilitated or replaced from the connection point with the public sewer to the public right-of-way or edge of the sewer easement where a cleanout will be installed.
- Rehabilitate any portion of a defective PCC sewer located within the flood plain.
- Work with property owners to get sources removed.

Confirmation Phase

- Perform post construction flow monitoring to determine the effectiveness of the work performed. (Previously referred to as determination of the change in the ratio of the average wet weather flow to the average dry weather flow.)

Following this report, Chapter 22 of the City Code was revised in 2011 to establish an abatement financial assistance program and an inflow and infiltration reduction program. The first program basically allows for the city to repair violations on private property and includes provisions for the property owner to reimburse the city for the costs of the repairs by payments on their utility bill at 4% interest. The second program provides for city reimbursement to property owners for removal of certain sources of I&I on their property.

In January 2011, the Missouri Department of Natural Resources contacted the City regarding the excessive number of wet weather sanitary sewer overflows from the collection system. This prompted the City to propose a significant amount of I&I reduction work and system rehabilitation work be funded. The funding was proposed as part of the 2013 Sewer Bond issued approved by the voters in November 2013.

Work Performed to Date

Attached is a Diagram that shows the sewer basins where I&I reduction work has been or is being completed. This shows four basins in the Flat Branch Watershed and four basins in the County House Watershed. The study phase has been completed in all eight of these basins.



City of Columbia

701 East Broadway, Columbia, Missouri 65201

This consisted of smoke testing approximately 368,000 feet of sewer main and inspection of 7,751 buildings. The smoke testing and building inspection identified 6,504 problems with the public sewers and 572 private problems. Based on the information from the studies, GIS information and closed circuit TV inspections, sewer main and manhole rehabilitation projects have been developed and authorized in fiscal years 2012, 2014, 2015 and 2016. An additional project is planned for fiscal year 2017. These projects have rehabilitated the identified issues with the public sewers in Flat Branch Basins A, B and D and County House Basin A and a portion in the other four basins shown on the diagram. Since 2012 approximately 27.8 miles of the sewer system has been rehabilitated through these projects with a total cost of approximately \$11.9 million. Three basins in Flat Branch have had flow monitoring performed after the rehabilitation work was completed and the results show the following reductions in peak flows:

Flat Branch Basin A: 40% reduction in peak flow.

Flat Branch Basin B: 24% reduction in peak flow.

Flat Branch Basin D: 19% reduction in peak flow.

Post rehabilitation flow monitoring is currently being performed in County House Basin A. The planned FY2017 project would complete the entire County House Branch watershed. Once the rehabilitation work is completed in these areas, flow monitoring will be performed to determine the effectiveness of the work on reducing peak flows.

City staff performed smoke testing of a small section of the downtown area where very large peak flows had been observed. This identified seven private problems. Staff worked with the property owners to have these corrected. Post correction flow monitoring was performed and a 74% reduction in peak flows was achieved. This area is also shown on the attached diagram.

The City has also completed several private common collector elimination projects in recent years. The focus of the private common collector program is to replace private sewers with public sewers. Reduction in inflow and infiltration is also a result of replacement of the private sewers. Nine projects have been completed at a cost of approximately \$2.5 million. 23 additional private common collector projects are identified in the CIP, one is under construction, construction will begin soon on another and several are in design. Total cost for these is estimated to be approximately \$9.2 million.

Sewer Maintenance crews have completed many point repairs to sewer mains, repaired many manholes and made adjustments to manholes to reduce inflow and infiltration into the system or reduce the frequency of sanitary sewer overflows from the system. This included raising or eliminating vents on over 30 manholes and siphon structures. The lowest vent on one structure has been more than five feet below the surface of the creek in the past.

The largest capacity restriction in the City's sewer system is the pump station at the Regional Waste Water Treatment Plant. During large rains, the pump station does not have the capacity to convey all of the wastewater in the collection system causing water to back up



in the collection system. Attached is a diagram that shows the location of the waste water treatment plant and the sewer mains that back up during these large rain events. As shown on the diagram, many of the manhole overflows from the collection system are located on or, immediately upstream, of the sewers that are backed up due to the capacity restriction at the wastewater treatment plant. Once this was identified as a significant cause of sanitary sewer overflows, modifications to the pumps and pump controls were completed. These modifications allowed for an increase pumping capacity at the treatment plant. Operating procedures during periods of rain and when rain is anticipated were modified to utilize the additional pumping capacity. This has allowed for an increased pumping capacity of approximately 20 million gallons per day. This resulted in an increase of the maximum flow through the waste water treatment plant of approximately 82 million gallons per day. Future conversion of the former sludge lagoon to a peak flow storage lagoon should allow for the maximum flow rate to be increased to approximately 100 million gallons per day.

Results / Effectiveness

The combination of these activities has resulted in a significant decrease in the frequency of sanitary sewer overflows from the collection system. During the 21 months since the pump modifications and procedural changes were implemented, there have only been five storms that have resulted in sanitary sewer overflows from the collection system. The total rainfall for each of these storms was; 4.45, 2.28, 3.26, 5.98 and 5.53 inches. During the 21 month period prior to the modifications, there were eight storms that resulted in overflows. The total rainfall for each was; 4.16, 5.16, 5.62, 1.31, 2.83, 1.99, 1.56 and 2.44 inches. The attached chart shows the number of sanitary sewer overflows per year and total rainfall for each of the past four years. The second chart shows reported wet weather sewer backups each for each of the past four years. These show a significant reduction in the frequency of backups and overflows. While a reduction in backups is shown, not all backups are reported by property owners.

The efforts to reduce inflow and infiltration into the collection system and efforts to reduce the impacts to system operation are resulting in improved operation of the system. Peak flows are being reduced and the frequency of sanitary sewer overflows and building backups appear to be reduced. It is necessary to continue with these efforts to ensure the advances achieved can be maintained and improved in the future. The Integrated Management Plan is anticipated to include recommendations to improve on the efforts to reduce sewer overflows and building backups.

Fiscal Impact

Short-Term Impact: None with this report.

Long-Term Impact: None with this report.



Vision & Strategic Plan Impact

Vision Impacts:

Primary Impact: Community Facilities & Services, Secondary Impact: Environment, Tertiary Impact: Not Applicable

Strategic Plan Impacts:

Primary Impact: Infrastructure, Secondary Impact: Operational Excellence, Tertiary Impact: Not Applicable

Comprehensive Plan Impacts:

Primary Impact: Infrastructure, Secondary Impact: Environmental Management, Tertiary Impact: Not Applicable

Legislative History

Date	Action
05/15/2017	Public Hearing for the FY 2017 sanitary sewer main and manhole rehabilitation project.
04/17/2017	Setting a public hearing for the FY 2017 sanitary sewer main and manhole rehabilitation project.
07/05/2016	Public Hearing for the FY 2016 sanitary sewer main and manhole rehabilitation project.
06/06/2016	(R61-16) Setting a public hearing for the FY 2016 sanitary sewer main and manhole rehabilitation project.
09/08/2015	(R141-15) Authorizing an agreement for professional engineering services with TREKK Design Group for an Inflow and Infiltration study of the County House Branch-D and Flat Branch G basin areas.
09/08/2015	(R140-15) Authorizing an agreement for professional engineering services with TREKK Design Group for post-rehabilitation flow data analysis for the Flat Branch -A, Flat Branch- B and Site 12 basin areas.
05/18/2015	Public Hearing for the sanitary sewer main and manhole rehabilitation project.
04/20/2015	(R66-15) Setting a public hearing for construction of the FY 2015 sanitary sewer main and manhole rehabilitation project.



City of Columbia

701 East Broadway, Columbia, Missouri 65201

01/05/2015	(R4-15) Authorizing an agreement with TREKK Design Group for the development of a hydraulic model of the proposed Lower Southwest Outfall Relief Sewer as it relates to sanitary sewer overflows along the County House Branch watershed.
10/20/2014	(REP 95-14) Sanitary Sewer Backflow Prevention Device Program
09/02/2014	(REP 84-14) Evaluation of Inflow and Infiltration Reduction in Flat Branch Basin D.
04/07/2014	Public Hearing for the sanitary sewer main and manhole rehabilitation project.
03/03/2014	(R32-14) Setting a public hearing for construction of the FY 2014 sanitary sewer main and manhole rehabilitation project.
02/17/2014	(REP 17-14) Evaluation of I&I Program
02/17/2014	(REP 16-14) Aldeah – Sewer and Storm Water Issues.
11/18/2013	(B329-13) Appropriating funds for the improvement and rehabilitation of sanitary sewer pipes and manholes in the Bear Creek and Flat Branch Creek watersheds.
10/07/2013	(R204-13) Transferring funds for the improvement and rehabilitation of sanitary sewer pipes and manholes in the Bear Creek and Flat Branch Creek watersheds.
08/05/2013	(B194-13) Calling a special election relation to the issuance of Sewer System Revenue Bonds. I&I work funding from the ballot issue was specifically discussed during the public hearing.
07/01/2013	Pre-Council – Infrastructure presentation by Public Works staff.
05/20/2013	Pre-Council – Sewer Utility Ballot presentation by Public Works staff.
08/06/2012	(R130-12) Authorizing an agreement for engineering services with TREKK Design Group for completion of an inflow and infiltration study of the sewer collection system.
04/16/2012	Determining it is in the public interest to construct the sanitary sewer main and manhole rehabilitation project.



City of Columbia

701 East Broadway, Columbia, Missouri 65201

04/02/2012	Public Hearing for the Sanitary Sewer Main and Manhole Rehabilitation Project.
03/19/2012	(R40-12) Setting a Public Hearing for FY 2012 Sanitary Sewer Main and Manhole Rehabilitation Project.
11/21/2011	Pre-Council – Abatement Order on Consent presentation by Public Works staff.
08/01/2011	(R132-11) Authorizing an agreement for engineering services with TREKK Design Group for completion of an inflow and infiltration study of the sewer collection system.
07/18/2011	(REP 121-11) – Backwater Protection
03/07/2011	(B54-11) Amending Chapter 22 of the City Code to establish and I&I Reduction Program.
03/07/2011	(REP 45-11) Sanitary Sewer Evaluation Study Defect Summary
11/01/2010	(R228-10) Authorizing an agreement for engineering services with TREKK Design Group for completion of an inflow and infiltration study of the sewer collection system.
12/12/2009	Winter council Retreat – Inflow and Infiltration presentation by Public Works staff.
07/22/2009	Council Work Session – Inflow and Infiltration presentation by Public Works staff and TREKK consultants.
08/18/2008	(R191-08) Authorizing an agreement with TREKK Design Group for engineering services related to an inflow and infiltration study of the collection system.
01/02/2007	Public Hearing for Sewer Utility Master Plan. Public Works staff made a presentation to Council (I&I issues were discussed). Council adopted the Sewer Utility Master Plan.
01/18/2006	Council Mini Retreat – Sewer Utility Master Plan presentation by Public Works staff.



City of Columbia

701 East Broadway, Columbia, Missouri 65201

Suggested Council Action

This report is for information only.