CITY OF WASHINGTON, ILLINOIS
Committee of the Whole Agenda Communication

Meeting Date: October 10, 2022

Prepared By: Dennis Carr – City Engineer

Agenda Item: Smoke Testing Report

Explanation: Slides have been prepared to walk through some aldermen questions regarding the key issue with our existing trunkline. While the largest issue of our existing trunkline is capacity, exposed manholes and mainline sewer above the creek bed also add future risk during large rain events. These structures and mainline sewers can be struck by large debris that could dislodge or even damage them causing huge problems.

Strand has in the past expressed a concern of the I&I and the need to remediate it. It was also expressed that the I&I problem could be lessened, but to what extent would vary and could be expensive.

Hamilton proposed the potential for I&I remediation to lower flows in the trunkline enough to maintain the current trunkline with the addition of two by-pass lines to increase capacity.

Smoke testing identifies the most defect types for the time/money involved. It is the best place to start hunting I&I. The City also has been inspecting manholes and televising/lining our mainline in an effort to reduce I&I.

The City contracted Robinson Engineering to perform smoke testing in all of three sanitary basins and the older part of a fourth that drain to the east side of STP1. These basins showed high peaking factors during Strand's flow monitoring and combine to account for a majority of the flow into STP1. While the smoke testing did identify a lot of defects, the sum of the flows remediated with these defects do not total the amount necessary to achieve the goal of the Hamilton Alternative that included the two by-pass lines.

Robinson Engineering has completed the smoke testing and has assembled the attached report.

Robinson identified 818 defects but reduced the number to 816 when two were found to be redundant. The 816 defects have an estimated cost to repair at $1,805,726 and would remove 1,744 gallons per minute of stormwater from our sanitary sewer. Robinson's calculations for the flow are based on a storm intensity of 1.65 inches per hour, which is right around a 2-3 year event.

Robinson listed 6 primary recommendations. Recommendations 2 and 3 are currently in the distribution crews' scope of work throughout the year. The crew inspects manholes and televises our sewer system. They then use the televising to identify pipes that need lined and staff budgets for CIPP lining to be performed. Staff will begin budgeting to replace the lids that allow stormwater in.

Staff is working on recommendation 4 to repair whatever cross connection is happening at the inlets that smoked. Staff is also planning to investigate recommendation 5 on the outfall near the creek.

Recommendation 6 is to fix the lower costing residential items (downspouts, window wells, and cleanout caps at an estimated cost of $33,900.

Robinson's secondary recommendations include performing lateral televising to further identify defective laterals and identify potential foundation drain connections that may not have shown smoke. We should also perform internal building inspections for the homes that had smoke inside the home to identify sump pump, diverter valves, combination sumps, or other private sources of I&I. The final recommendation was to perform the private disconnections of the remaining issues.

While removing this water will benefit the systems functionality, it does not remove enough I&I from the system to make the by-pass option presented by Hamilton a viable solution. As was discussed prior to the smoke testing, per the flow monitoring done by Strand, we would need to reduce flows by over 8,000 gpm for the by-pass option.

Fiscal Impact: Further I&I testing takes time and more money. I&I Remediation takes time and money, both from the city and homeowner. City Staff did not budget for lateral repair payments in this budget. Staff will look to begin budgeting for manhole frame and lid replacements as well as lateral repair payments.

Recommendation Summary: Staff recommends informing residents with downspout and cleanout cap issues that they must disconnect/repair these nuisances as defined in Chapter 96 of the City Code. These two defect types could reduce flows by approximately 662 gpm.

Staff recommends informing residents with faulty laterals that the City Code will allow them a $500 (maximum) payment from the City if they repair their lateral and the benefits of the I&I reduction.

§ 52.089 GRANT INCENTIVE - REPAIRS ONLY

The owner shall also be eligible for a grant of the lesser of five hundred dollars ($500.00) or the costs of repairing a sewer lateral provided the following conditions have been met:

(A) The owner and occupant (in those cases where an owner does not reside in the premises) have complied with all provisions of this Chapter.

(B) The problem with the sewer lateral was discovered pursuant to one of the testing procedures set forth in this Chapter.

(C) The owner repairs the sewer lateral in a manner satisfactory to the City with the repair to be accomplished within one (1) year of the date of the test.

(D) The owner shall provide satisfactory proof to the City of the costs of the repair.

The grant shall be paid only to the owner of the property at the time of the repair. The owner shall provide satisfactory proof to the City within ninety (90) days of notification of same by the City of their eligibility.

Staff recommends no further testing in the areas previously smoke tested.

Staff is working on an internal plan to reduce the 895.6 gpm estimated to enter the sanitary sewer from municipal infrastructure. The plan is to begin investigating the inlet/catch basins as well as televise/line the mainline segments with defects. We will look to begin budgeting to repair seals and lids in future budgets.

Existing Trunkline

(Per Hamilton Report)

- Sewer east of STP1 is 42”
- Trunkline size increases from 21”-36”
- Capacity = 6.69 mgd or 4,646 gpm
  - Design Peaking Factor of 2.53 yields 26,443 population equivalent (PE).

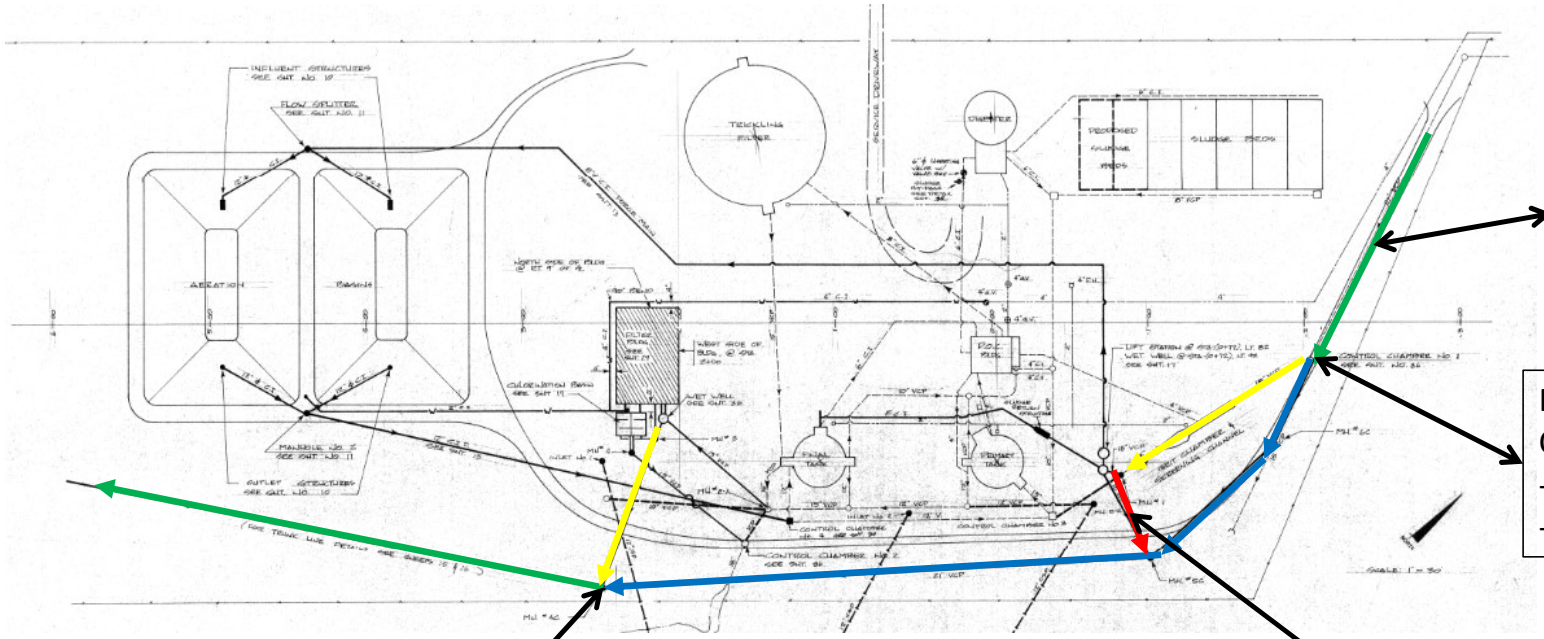
- Average Flow is 1,281 gpm - Dry Weather
  - Design Peaking Factor of 2.53 yields 18,446 population equivalent (PE)
    - 2.53 Peaking Factor would yield 3,241 gpm

Sewer Treatment Plant 1

- Pre 1971 - Used to treat all sewage east of plant
  - Capacity of STP1 was 0.6 mgd
- In 1971, plans to add aeration basins and a trunkline in preparation for STP2.
- Plant couldn't meet regulations
  - 2013 - IEPA consent order to not allow it as a dry weather treatment facility
- Until plant decommissioned in 2019, it treated minimal flows but returned the flow to the trunkline.
  - During high flows it would be ran until plant was full, then the high flows would by-pass the plant.
    - Essentially acted as a small detention facility with treatment capacity.

Sewer Treatment Plant 1 – 1971 Flow Diagram

(Per Strand Report)



Basins 6,7,8, and 9 flow into east end of STP1

Flow is Split at Control Chamber 1
- Split Flow continues Blue
- Split Flow Yellow to STP1

Upon IEPA Consent – Changed Flows from STP1 rejoin trunkline after primary treatment
-Also acts to remove the initial spike in flow

Wet Weather High Flow By-pass

Strand Flow Meter Data - Every Storm Metered was Over Capacity

(Per Strand Report)

Date	Rain Gauge 1				Rain Gauge 2			
	Total Rainfall (in)	Total Duration (hr)	Maximum Rainfall Intensity	Maximum Rainfall Recurrence Interval	Total Rainfall (in)	Total Duration (hr)	Maximum Rainfall Intensity	Maximum Rainfall Recurrence Interval
July 6, 2016	1.77	4.50	0.75 in over 5 minutes (min.)	1.5 years	1.65	4.25	0.52 in over 15 min.	4.9 months
August 12, 2016	2.83	13.50	0.52 in over 15 min.	4.9 months	2.49	13.50	0.53 in over 15 min.	5.1 months
August 30, 2016	1.98	3.50	0.85 in over 15 min.	2.6 years	2.3	4.50	0.72 in over 15 min.	1.3 years

- July 6, 2016 – 4,743 gpm (1 yr)
- August 12, 2016 – 6,225 gpm (5 mo)
- August 30, 2016 – 16,117 gpm (2 yr)

- Each event exceeds 4,646 gpm capacity of trunkline

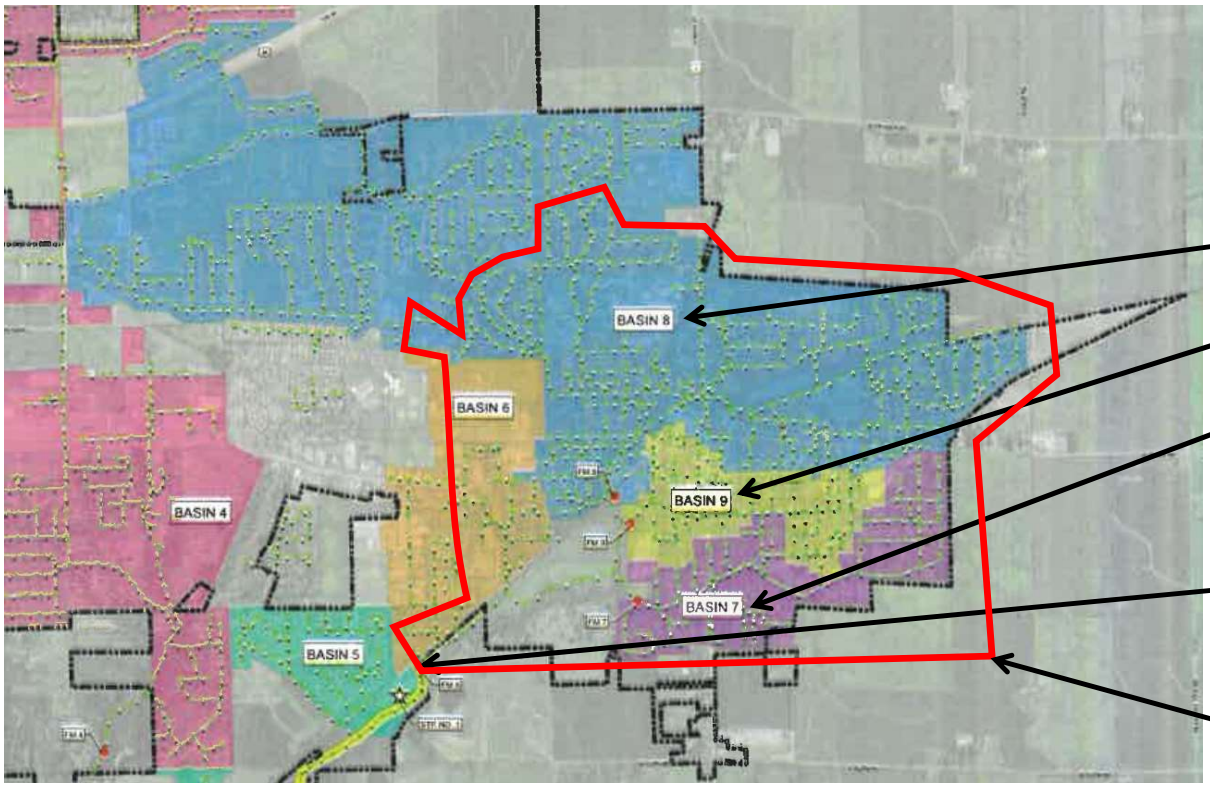
Table 2.02-3 Wet Weather Flow Metering Data

FM	Average Dry Flow (gpm)	Peak Wet Weather Flow (gpm)					
		July 6, 2016	Peaking Factor	August 12, 2016	Peaking Factor	August 30, 2016	Peaking Factor
FM 1	179	641	3.57	1,341	7.48	2,290	12.77
FM 2	1,024	5,759	5.62	10,571	10.32	12,114	11.83
FM 3[1]	17	139	8.27	139	8.27	139	8.27
FM 4	349	639	1.83	795	2.28	909	2.60
FM 5	981	5,708	5.82	8,867	9.04	11,470	11.69
FM 6	633	4,719	7.45	7,133	11.27	11,671	18.44
FM 7	56	511	9.20	1,754	31.57	3,142	56.57
FM 8	636	3,610	5.67	3,557	5.59	9,584	15.06
FM 9	78	622	7.97	914	11.71	3,391	43.45

[1] Wet weather flow for FM-3 is from June 22, 2016

Existing Peaking Factors – Huge I&I Problem

(Per Strand Report)



- Industry Design Standard is 2.53
- Basin 8 – 15.06
- Basin 9 – 43.45
- Basin 7 – 56.57
- Flow Meter 6 – 18.44 (East of STP1)
- Smoke testing boundary

Wet Weather Consequences

- Not all rain events cause IEPA Violations.
  - Some just surcharge the line but don't have enough flow to escape manhole covers.
- IEPA Violations will eventually bring forward a consent decree without action.

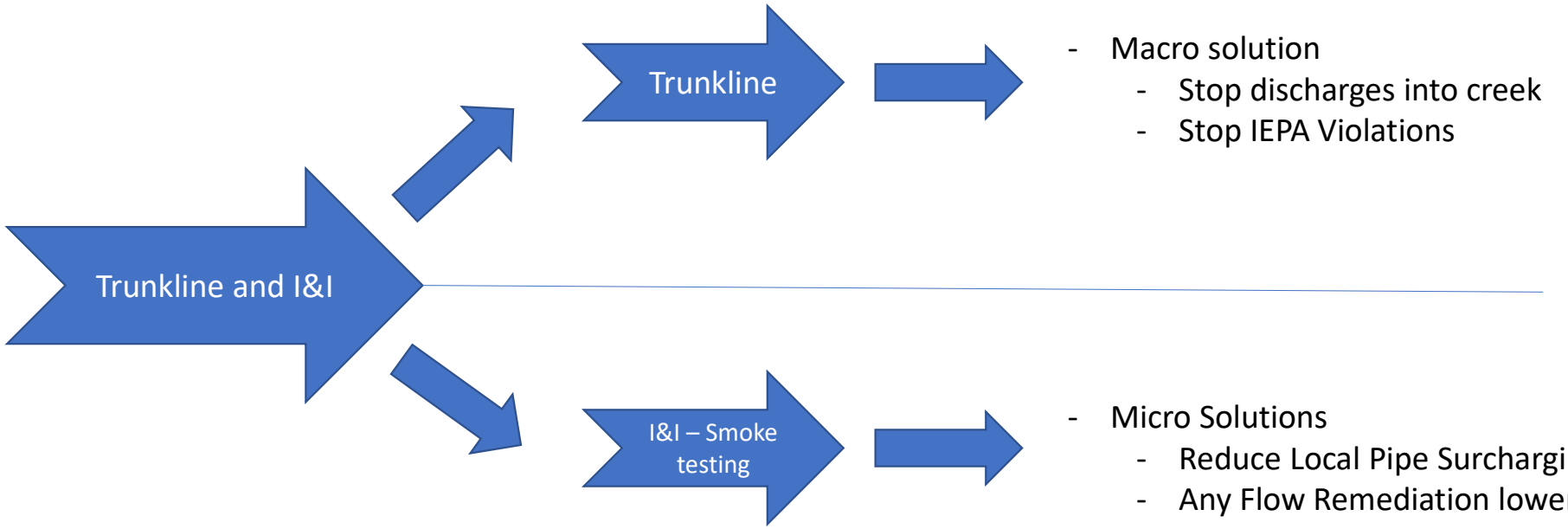
I&I Remediation

- Continuous Remediation of I&I is needed for a healthy utility system.
- City Staff is working to remove municipal side of I&I.
- Smoke Testing identified the Residential low hanging fruit.
  - Downspouts, Cleanouts, Sump Pumps, Area Drains, and Lateral Defects
- Further testing gets more expensive, intrusive, and takes more time with uncertain results.
  - Lateral Launching
  - Internal Building Investigations
    - This testing may not even get us to the target.

Conclusion

- Our trunkline cannot handle the current sanitary flow during rain events even as small as a 2 year event without backing up.
- The smoke testing was not able to identify enough I&I remediation for By-Pass Option.
  - 1,744 gpm identified
    - 8,291 gpm needed for Hamilton's By-Pass Option (7,826 gpm capacity)
    - 11,471 gpm needed for existing trunkline (4,646 gpm capacity)
- Trunkline needs to be larger to handle flows or will incur more IEPA violations.
- IEPA Violations will eventually lead to another consent decree.
  - IEPA's solution may require more than current project.

I&I Remediation doesn't appear to be the "Silver Bullet" to trunkline capacity issues



- Macro solution
  - Stop discharges into creek
  - Stop IEPA Violations

- Micro Solutions
  - Reduce Local Pipe Surcharging
  - Any Flow Remediation lowers treatment cost

I&I Remediation may solve surcharged pipe residential backups

City of Washington

2022 Smoke Testing Program

REL Project #22-R0435

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INTRODUCTION

In 2022, the City of Washington (City) authorized Robinson Engineering (REL) to perform smoke testing of the sanitary sewer collection system in areas where high volumes of storm water infiltration and inflow (I&I) had been identified through flow monitoring. This study is in accordance with the City's interest to further evaluate their conveyance system between the decommissioned wastewater treatment plant #1 and their current Treatment Plant. In 2017, the City was presented with options to look at addressing stormwater inflow into the sanitary sewer or build a larger trunkline sewer to handle the extreme flow increases during wet weather. Instead of performing the smoke testing initially, a larger sewer was designed. Before construction of this project moved forward, the current City Council wanted to investigate addressing stormwater I&I into the sewer as a possible alternative to the larger trunkline project.

The results of this study will help identify the many locations where I&I is entering the system and enable the City to better manage future operation, maintenance, and repairs of the system. Potential sources of I&I that are contributing to the overloading of the sanitary sewer system during rainfall events will be reported. The defects found in this study and subsequent repairs made from the findings will help to reduce the amount of excess stormwater flowing to the City of Washington's wastewater treatment system.

The following pages present the results of the current smoke testing study including quantification and analysis of defects identified, and a recommended rehabilitation and repair approach for the identified defects. Investigations summarized in this report include the inspection of approximately 29.919 miles of sanitary sewer and the identification of 818 potential sewer defects. The areas investigated with smoke testing for this report can be seen in *Figure 1.*

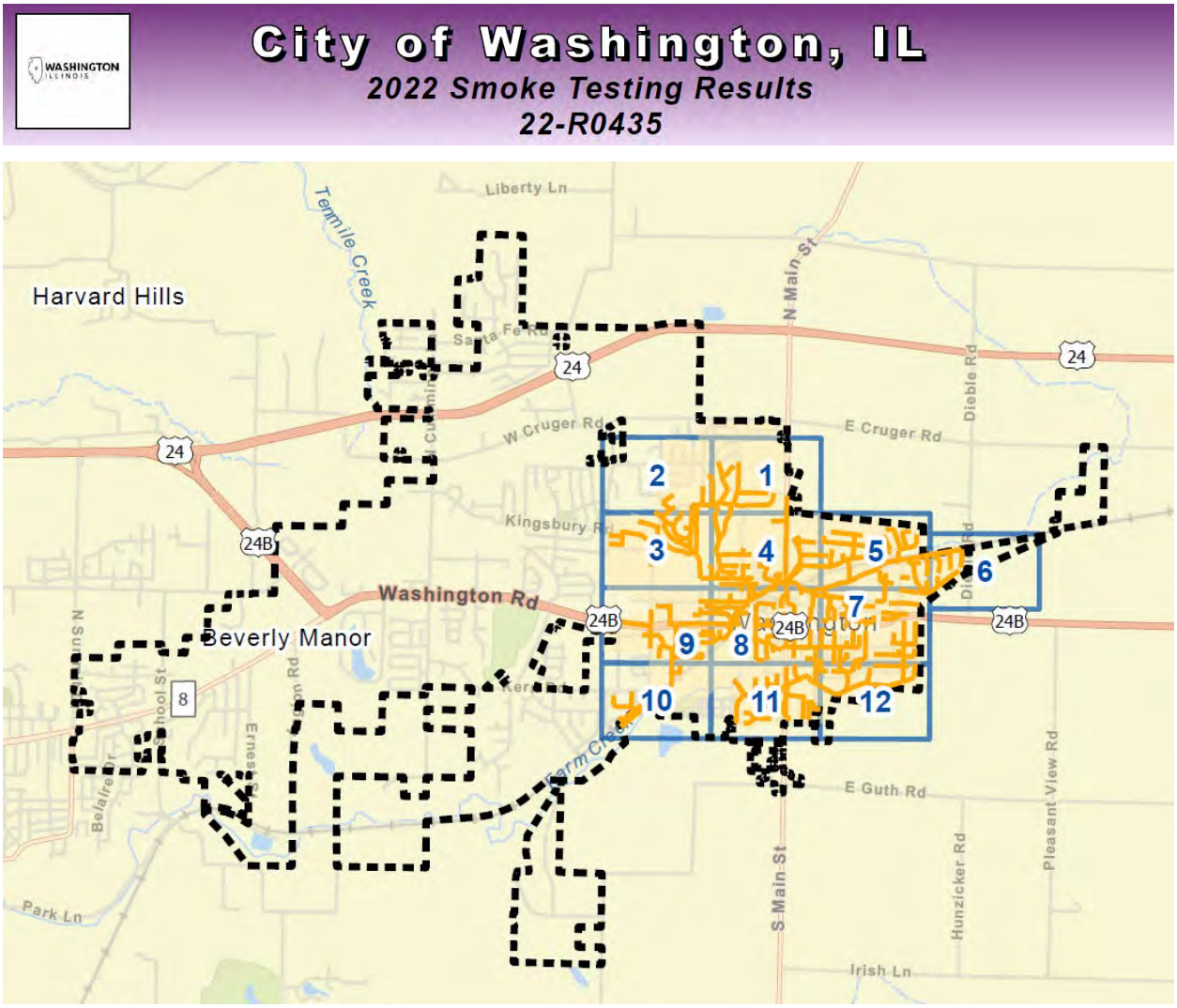

Figure 1: Sewers highlighted in yellow indicate the smoke test study area for the City of Washington.

SMOKE TESTING - PROCEDURE

Smoke testing is a cost-effective method used to detect I&I sources in a sewer system. Smoke blowers are put on opposite ends of a pipe reach, and the testing crew observes any smoke that escapes the system. Sewer defects found include both public and private sector defects. Common private sector defects include downspouts, area drains, cleanouts, lateral defects, foundation drains, stairwell drains, window well drains and sump pumps that are connected either directly or indirectly to the sanitary sewer. Public sector defects include manhole defects, cross-connected storm sewers or catch basins, mainline defects and collapsed sewers typically associated with sinkholes.

REL crews performed the smoke testing in June, July, and August of 2022. A total of 157,972 feet of public sewers were investigated. The smoke testing was conducted during dry weather and unsaturated ground conditions, which are the best soil conditions that allow smoke to migrate to the surface and be visible.

Public Notification

Because smoke testing is a highly visible activity and can draw the attention of the property owners in the areas being tested, REL has established a public notification process to help educate and alert the property owners. Before starting the smoke testing, the City mailed two informational letters to residents identifying and introducing the project. Next, door hangers were placed at each affected property which informed residents about the smoke testing taking place in their area. The door hangers also explained how the smoke is non-toxic, how to best avoid getting smoke in their building, when the testing would be conducted and who to call if smoke entered their building. While door tagging, REL crews made face to face contact with the businesses and institutional properties to make them aware of the testing. In addition to being informed about the general smoke testing project details, the police and fire departments were contacted daily by REL crews, notifying where the work was occurring and helping to ensure that they would not inadvertently respond to calls pertaining to smoke being reported in the testing area.

Data Collection and Viewing

The smoke testing consisted of a 4-person crew using two pickup trucks and a pair of "Hurco Ripcord" smoke blowers for each setup. These blowers can each output more than 4,000 cubic feet per minute (cfm) of airflow, allowing for maximum identification of sewer deficiencies. This dual blower smoke testing method is utilized by Robinson to maximize the amount of smoke going into the sewer system and increase the probability of visibly identifying defects.

"Hurco" non-toxic liquid smoke was the only smoke used for testing. Starting at the upstream end of the system, one blower was set on an upstream manhole and the other blower was set at approximately 300 - 500 feet downstream at another manhole. In instances where smoke was blowing strongly into nearby residences outside of the testing area, sandbags were used to isolate the sewer segment being tested to help alleviate smoke from continuing to enter these buildings.

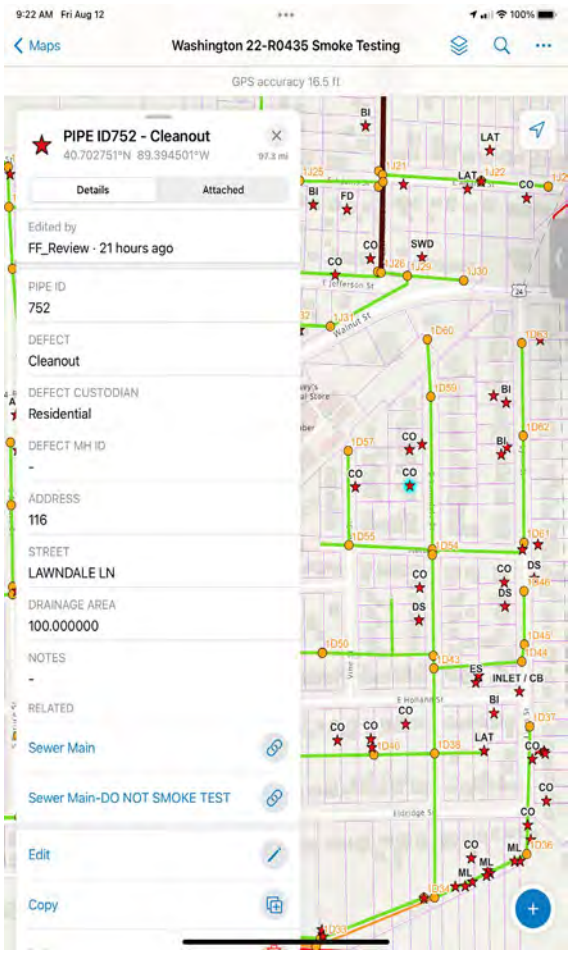

Figure 2: Field Maps application and smoke test defects.

A digital data collection method was used on iPads through the Environmental Systems Research Institute (ESRI's) proprietary "Field Maps" application as shown in *Figure 2*. Additionally, defect data and testing results were displayed in real-time for the City through use of ESRI's ArcGIS Online (AGO) platform. The AGO website included a map viewer showing defect locations, digital photographs as well as a dashboard of gauges showing progress of sewers tested,

number of defects found and other useful project information including data searches and filters. An image of the online dashboard viewer is shown in *Figure 3*.

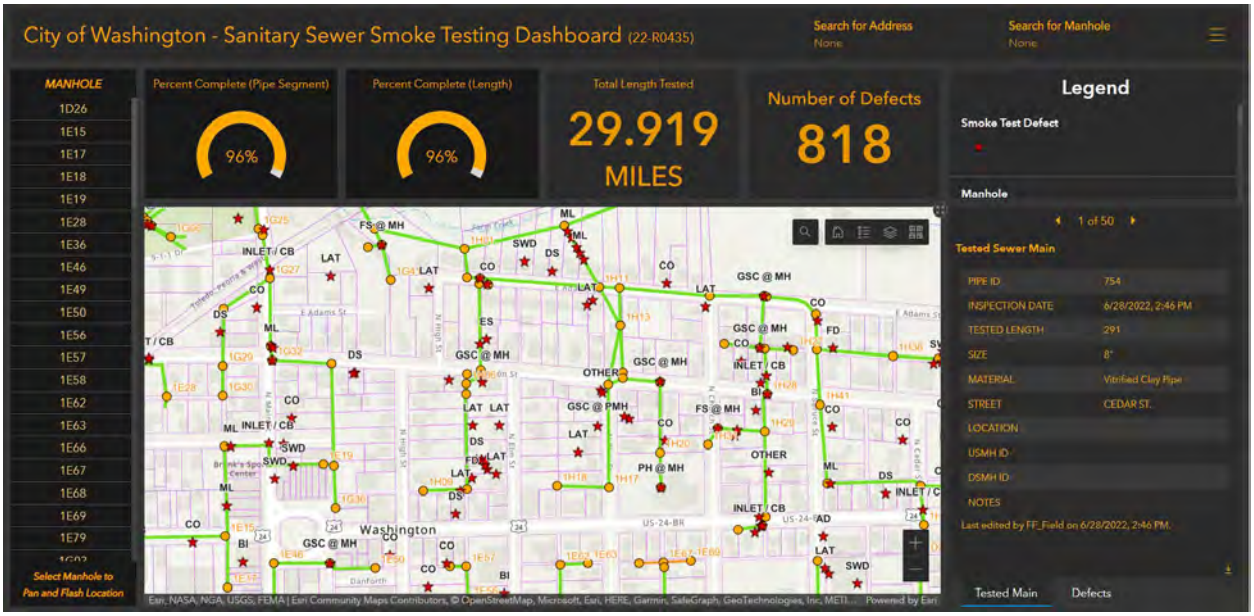

Figure 3: REL's Online Smoke Testing Dashboard Viewer Application.

During testing, the presence of smoke was recorded if it was seen at any of the following locations:

- Area Drain
- Building Interior
- Cleanout
- Creek / Stream
- Downspouts
- Drainage Ditch
- Driveway Drain
- External Sump
- Foundation Drain
- Frame Seal @ MH
- Frame Seal @ Private MH
- Gasket Seal Cover @ MH
- Gasket Seal Cover @ Private MH
- Lateral
- Main Line
- Other
- Pick Hole @ MH
- Pick Hole @ Private MH
- Stairwell Drain
- Storm Inlet / CB
- Window Well Drain

SMOKE TESTING, I&I DEFECTS IDENTIFIED

Overall, there were 816 potential sewer defects identified on this project. For each typical inflow defect location and type, (area drains, cleanouts, downspouts, driveway drains and storm inlets) the difference in the variable volumes of inflow is related to where the defect is located and the overall drainage area

contributing to that defect. Using the rational method equation of Q=CIA, we can calculate flow where "Q" is peak discharge (flow) and "C" is the runoff coefficient specific to paved or unpaved areas, "I" is the rainfall intensity in inches/hour and "A" is the drainage area in acres. For all other I&I defect locations and types, a standard array of I&I flow values was used assigned to estimate the contribution of I&I.

With each defect identified, there are also repair recommendations made. Repair efficiencies for are an estimate of the repair effectiveness for a specific defect and repair recommendation based on factors like repair type/method, if the repair is typically done correctly to begin with, if the repair tends to deteriorate or fail over time and/or if it can possibly get reconnected as an I&I source again later. Repair efficiencies are expressed as a percentage and can be used as a guide to help reasonably predict the amount of flow reduction that can be achieved after recommended repairs have been made and the I&I sources eliminated.

Area Drain: Seven (7) area drains were found emitting smoke during testing. The correct use of an area drain is for the transfer of rainfall or surface stormwater away from the lawn, patio or other location to the street or storm sewer where it can drain to creeks or waterways. In these cases, the smoking area drains were connected to the sanitary sewer redirecting the stormwater away from the property but contributing to the overloading of the sanitary sewer with excess stormwater. Depending on the size of the area, these drains can be significant contributors of I&I. The estimated repair efficiency for fixing area drains is 80%.

Building Interior: Forty-eight (48) houses were found to have smoke inside the building, when residents informed the testing crew of the occurrence. In some cases, these could indicate an improperly connected sump pump to the system, however they could also indicate problems with the plumbing configuration, such as floor drains or sinks without a p-trap. For these

cases, we generally recommend that a follow-up building inspection be conducted to get a more thorough inspection of the internal plumbing and to better determine the exact nature of the issue at each location.

Cleanouts: One hundred and eighty (180) cleanouts were found to be emitting smoke. Each cleanout that smoked had a drainage area specific for that location. While cleanouts are appropriate connections to sanitary sewers and facilitate maintenance, they must be sealed to prevent inflow from entering the sanitary sewer system. In most cases, homeowners can effectively seal these cleanouts by purchasing new covers. In other cases, it may be necessary to excavate around the stack or the vertical riser portion of the cleanout pipe that extends from the ground surface down to the service lateral pipe leading to the mainline sewer. The estimated repair efficiency for cleanout cover repairs is 80%.

Creek/Stream: One (1) Creek/Stream defect was located. In this type of defect, a pipe in the side of the creek bed was found to be smoking upon inspection. This defect type can potentially contribute a significant portion of I&I, as the water moving through the creek bed has access to enter and overload the sanitary sewer system. We recommend that further inspections on the sources of the smoking pipes be performed, and appropriate corresponding actions taken. The estimated repair efficiency of for this defect is not yet known and can be determined after further investigations are completed.

Downspouts: Ninety-seven (97) structures were found with downspouts emitting smoke during testing. These downspouts can contribute large areas of drainage to the sanitary sewer system, resulting in significant contributions of I&I. The recommended repair for these defects is to properly disconnect the downspouts by digging them up and then plugging and capping them with a wing plug and cement mortar cap thereby disconnecting these pipe connections that lead into the sanitary sewer. The estimated repair efficiency for disconnecting downspouts is 80%.

Drainage Ditch: One (1) drainage ditch was found smoking in the project area. Drainage ditches usually run along property lines and are used to collect and redirect overland stormwater flows from rainfall. Since they are typically made in permeable ground surface conditions and can have relatively large drainage areas, they can be large sources of I&I. It is recommended that this drainage ditch is dyed water flooded in conjunction with closed-circuit televising (CCTV) to further pinpoint and quantify the point of sanitary sewer leakage and connection to this ditch. The estimated repair efficiency for disconnecting drainage ditches by repairing sanitary sewer pipes is 90%.

Driveway Drain: Three (3) locations were found with a driveway drain connected to the sanitary sewer. Driveway drains can collect large amounts of surface rainwater and are usually located at the sloped end of the driveway area. These are recommended to be disconnected from the sanitary sewer system as they are large contributors of I&I. The estimated repair efficiency of fixing driveway drains is 80%.

External Sump Pumps: Six (6) locations were found with an external sump pump connection to the sanitary sewer. In these instances, there was either an internal storm sump pump discharge hose connected to a nearby cleanout, or they were fully external sump pump basins that were observed smoking. Sump pumps can be large contributors of I&I with newer pumps having the pumping capacity of rates up to 20+ gallons per minute (gpm). The estimated repair efficiency for disconnection of sump pumps is 75%.

Foundation Drain: Fourteen (14) foundation drains were observed smoking. It is recommended that these be followed up with an internal plumbing inspection and service lateral televising to confirm the connection point of the foundation drain to the sewer and help determine the appropriate means of disconnection. Foundation drains can be large contributors of I&I due to the potential for large drainage areas surrounding the buildings. The estimated repair efficiency for foundation drains is 80%.

Frame Seal: Fifty (50) manholes were found and identified as having a defective or leaking frame seal throughout the testing. These manholes exhibiting smoke from around the base of the manhole frames typically have a frame seal offset from the manhole structure and/or defective adjusting rings which allow I&I though the frame adjustment area. The manhole frame and adjustment rings are recommended to be sealed and adjusted. The estimated repair efficiency for this work is 75%.

Pick Hole and Gasket Seal Covers: These are I&I defects related to the manhole covers. Forty-eight (48) manholes were identified with a pick hole lid during smoke testing, and these holes allow stormwater to enter the sanitary sewer system. Fifty-two (52) manholes were identified as having a loosely fitting gasket seal cover or poor fitting lid thereby allowing I&I into the system during rainfall events. These manhole lid defects are a relatively simple repair. The City can purchase and replace these older or poor fitting covers with new ones, thereby reducing I&I into the system. The estimated repair efficiency for this work is 85%.

Lateral Defects: One-hundred forty-four (144) service lateral defects were found on 102 service laterals. The drainage areas of these lateral defects are estimated at 100 square feet of drainage per each location smoking. The amount of infiltration contributed by each lateral defect is directly related to the drainage area contributing to the defect. Lateral defects can be repaired by either spot repairs, replacing the lateral or doing service lateral lining. The estimated repair efficiency for lateral replacement is 85%.

Main Line: Sixty-nine (69) main line pipe defects were found. Like leaking lateral defects, the drainage areas of these defects are also estimated at 100 square feet per each location identified smoking. Main line sewer defects can be repaired by replacing the piping, doing mainline sewer cured-in-place pipelining (CIPP), or doing spot repairs. Before these repairs are conducted, it is recommended to perform CCTV of each section of mainline sewer that was identified smoking. The estimated repair efficiency for main line replacement is 85%.

Other: Thirty-six (36) defects were classified as "other" defects when they were found during smoke testing. Some of these defects include cisterns, gas meter caps, electrical boxes, and many more. In most cases, the cause of the sanitary cross connection to these defects needs to be further inspected. The contributions to I&I can be attributed to the drainage areas of the surrounding environment, or the size/capacity of the cistern. The estimated repair efficiencies for these "other" defects will vary on a case-to-case basis.

Stairwell Drain: Fifteen (15) stairwell drains were found to be connected to the sanitary system. The drainage area for these defects can be calculated from the total area of the stairs and stairwell and the surface where the drain is located. These defects can be very difficult and expensive to remove from the system and are often the last to be considered for enforcement actions or for sequenced private sector source disconnection programs. The estimated repair efficiency for stairwell drains is 80%.

Storm Inlet/CB: Thirty-six (36) storm inlet/catch basin defects were found in the project area. This defect type has the potential to be the largest source of inflow and infiltration out of all possible defects, as it could be the result of direct connections between the sanitary and storm systems or cross-connected sources. The drainage areas for these defects are no less than 500 square feet, with most of them contributing more than 1,000 square feet of drainage area into the sanitary system. These defects are of high importance to be repaired but recommended first for dyed water flooding, performed in conjunction with CCTV. The estimated repair efficiency for fixing storm inlets is 80% but can vary depending on the other sources contributing that can be identified during follow-up dyed water flooding.

Window Well Drain: Nine (9) window well defects were found during testing. These are not typically large contributors of inflow and infiltration but can be significant depending on the drainage area of the yard pitched toward them. Window wells can also be an indicators of additional sources like foundation drains and/or sump pump connections to the sanitary which can be substantial contributors of I&I. Flows from window well drains can be estimated by calculating the area of the window well drain as well as any surrounding area that can drain into the well. The estimated repair efficiency of window wells is 80% and usually just involves putting a window well cover over the window well.

In total, there were 816 total defects found during smoke testing that are contributing an estimated 1,744 gpm of I&I in this study area, with a total estimated repair or follow up cost of $1,805,726. The following table summarizes the counts of these defects identified. A detailed summary of the Smoke Testing results

including a detail report of the deficiencies, and recommended repairs can be found in Appendix 1 while photos of the defects can be seen in Appendix 2, and exhibits showing their locations can be seen in Appendix 3.

Table 1: Smoke Test Results Summary

Row Labels	Count of DEFECTS *
Area Drain	7
Building Interior	48
Cleanout	180
Creek / Stream	1
Downspouts	97
Drainage Ditch	1
Driveway Drain	3
External Sump	6
Foundation Drain	14
Frame Seal @ MH	48
Frame Seal @ Private MH	2
Gasket Seal Cover @ MH	50
Gasket Seal Cover @ Private MH	2
Lateral	144
Main Line	69
Other	36
Pick Hole @ MH	48
Stairwell Drain	15
Storm Inlet / CB	36
Window Well Drain	9
Grand Total	**816**

Table 2: Smoke Testing Repair Summary for Residential Area

	SMOKE TEST DEFECT	QUANTITY	REHABILITATION/ RECOMMENDATION	UNIT COST	TOTAL COST	ESTIMATED I&I (gpm)	TOTAL ESTIMATED I&I (gpm)	RATIO OF COST PER FLOW ($/gpm)
RESIDENTIAL	**Total:**	517			$1,201,950		833.3	
	Area Drain	6	Re-route Drain to Storm Sewer	$8,500	$51,000	2.1	12.5	$4,075
	Building Interior	46	Follow up with Bldg Inspection	$350	$16,100	0.2	9.2	$1,750
	Cleanout	166	Install New Cleanout Cover	$100	$16,600	0.5	80.9	$205
	Downspouts	94	Remove Downspout from Sewer	$150	$14,100	5.9	556.5	$25
	Drainage Ditch	1	Follow up with Dyed Water	$1,500	$1,500	5	5.0	$300
	Driveway Drain	3	Re-route Drain to Storm Sewer	$10,000	$30,000	3.2	9.5	$3,158
	External Sump	6	Remove from Sanitary	$750	$4,500	4.5	27.0	$167
	Foundation Drain	14	Separate Storm from Sanitary	$8,500	$119,000	4.5	63.0	$1,889
	Frame Seal @ Private MH	2	Seal & Adjust Manhole Frame	$2,150	$4,300	1.2	2.4	$1,792
	Gasket Seal Cover @ Private MH	2	Install Gasket Seal Cover	$250	$500	1.7	3.4	$147
	Lateral	140	Point Repair or CIPP Liner	$8,500	$833,000	0.3	42.0	N/A
	Other	17	TBD	-	-	0.7	11.9	-
	Stairwell Drain	11	Re-route Drain to Storm Sewer	$10,000	$110,000	0.5	5.5	$20,000
	Window Well Drain	9	Install Window Well Cover	$150	$1,350	0.5	4.5	$300

Table 3: Smoke Testing Repair Summary for Municipal Area

	SMOKE TEST DEFECT	QUANTITY	REHABILITATION/ RECOMMENDATION	UNIT COST	TOTAL COST	ESTIMATED I&I (gpm)	TOTAL ESTIMATED I&I (gpm)	RATIO OF COST PER FLOW ($/gpm)
MUNICIPAL	**Total:**	279			$564,926		895.6	
	Area Drain	1	Re-route Drain to Storm Sewer	$8,500	$8,500	2.1	2.1	$4,075
	Cleanout	4	Install New Cleanout Cover	$100	$400	0.5	1.9	$205
	Creek / Stream	1	Follow up with Dyed Water	$1,500	$1,500	10	10.0	$150
	Downspouts	2	Remove Downspout from Sewer	$150	$300	5.9	11.8	$25
	Frame Seal @ MH	48	Seal & Adjust Manhole Frame	$2,150	$103,200	1.2	57.6	$1,792
	Gasket Seal Cover @ MH	50	Install Gasket Seal Cover	$250	$12,500	1.7	85.0	$147
	Lateral	2	Point Repair or CIPP Liner	$8,500	$17,000	0.3	0.6	$28,333
	Main Line	69	Point Repair or CIPP Liner	$50*(Length)	$335,526	1.5	103.5	$3,242
	Other	16	TBD	-	-	0.7	11.2	-
	Pick Hole @ MH	48	Install Gasket Seal Cover	$250	$12,000	3.0	144.0	$83
	Stairwell Drain	2	Re-route Drain to Storm Sewer	$10,000	$20,000	0.5	1.0	$20,000
	Storm Inlet / CB	36	Follow up with Dyed Water	$1,500	$54,000	13.0	466.8	$116

Table 4: Smoke Testing Repair Summary for Commercial Area

	SMOKE TEST DEFECT	QUANTITY	REHABILITATION/ RECOMMENDATION	UNIT COST	TOTAL COST	ESTIMATED I&I (gpm)	TOTAL ESTIMATED I&I (gpm)	RATIO OF COST PER FLOW ($/gpm)
COMMERCIAL	**Total:**	20			$38,850		14.9	
	Building Interior	2	Follow up with Bldg Inspection	$350	$700	0.2	0.4	$1,750
	Cleanout	10	Install New Cleanout Cover	$100	$1,000	0.5	4.9	$205
	Downspouts	1	Remove Downspout from Sewer	$150	$150	5.9	5.9	$25
	Lateral	2	Point Repair or CIPP Liner	$8,500	$17,000	0.3	0.6	$28,333
	Other	3	TBD	-	-	0.7	2.1	-
	Stairwell Drain	2	Re-route Drain to Storm Sewer	$10,000	$20,000	0.5	1.0	$20,000

COST-EFFECTIVENESS CONSIDERATIONS

In nearly all municipal sanitary sewer systems, certain defects contributing I&I are considered cost-effective, or worthwhile to expend limited dollars on to repair, while others are not. The general approach is to expend the least amount of money to reduce the highest amount of I&I, thereby getting the biggest "bang for the buck."

The determination of what repairs are deemed cost-effective is based on the premise that the I&I allocation for each defect takes away from capacity at the existing wastewater treatment plant and/or in the existing sewer mains. In essence, the lost capacity can eventually force the City to construct a new or larger wastewater treatment plant and larger diameter interceptors to convey the flows without occurrence of sanitary sewer overflows (SSOs). System overflow problems that exist because of high I&I levels result in a substantial percentage of defects being considered worthwhile to repair. In the City's case, the determination of which specific repairs are deemed cost-effective can be reasonably based on the amount of estimated I&I associated with each defect type and the dollars required to correct those defects.

We have previously estimated the cost of a new wastewater treatment plant to cost at least $12/gallon per day. This is equal to $17,280/GPM. Repairs that have a ratio of cost per flow that is lower than this value can therefore be considered cost-effective. The City's current wastewater treatment plant design average daily flow is 2.1 MGD with capability to treat peak flow of 3.8 MGD. We have indicated the cost-effective repairs in the Smoke Test Summary Report in Appendix 1 for consideration.

RECOMMENDATIONS / NEXT STEPS

To effectively spend the money required to make the repairs of the defects found during the Smoke Testing it is recommended that the City also conduct comprehensive manhole inspections and then combine any public sector smoke testing manhole repairs with repairs recommended from manhole inspections. Then the plans and specifications can be created for bidding and released as a larger project. By handling the repairs in this in this manner, it will allow for the prices to come in lower, by providing a proportionate saving in costs gained by an increase in quantities and level of production, also known as the economy of scale.

Primary Recommendations / Initial Steps:

1. **Fix Public Sector Manhole Defects –** To effectively start reducing I&I on the public sector side of the system, it is recommended that the identified manhole cover and frame seal defects be repaired as soon as possible. Replacing pick-hole lids & poor fitting or non-gasketed lids is considered a relatively simple repair for the City. Estimated costs for purchasing replacement covers are approximately $25,000 for the replacement of one-hundred and one (100) lids that were found to allow I&I into the system. This work can be conducted in-house by City staff or can be bid and included as part of a larger sewer manhole rehabilitation project. The total estimated costs of manhole frame seal defect repairs identified in this project are $107,500. The overall project estimate for all manhole cover and frame seal repair work identified is approximately $132,500.

2. **Consider Comprehensive Manhole Inspections for a Larger Manhole Rehabilitation Program –** Due to the large number of manhole defects observed during smoke testing, performing comprehensive manhole inspections for this portion of the system is a recommended next step. Some areas exhibited pick-hole and other cover inflow sources while frame seal defects were also common. Before moving forward with these repairs, consideration should be given to comprehensively identifying additional manhole defects through visual inspections and then this identified work can be coupled with other high priority manhole repairs identified during the manhole inspections.

   Depending on how many additional manhole repairs are identified, the City could consider applying for a Water Pollution Control Loan Program (WPCLP) loan through the Illinois Environmental

Protection Agency's State Revolving Fund (SRF) to fund the sanitary sewer system manhole rehabilitation program.

3. **CCTV Smoking Sewer Mains & Cured-In-Place Pipelining (CIPP) Repairs –** Numerous sewer mains were identified as smoking during this project. At a minimum, those identified with smoke defects are recommended to be cleaned and televised and then repaired with cured-in-place pipelining to provide structural repairs and to lessen the effects of I&I entering at those locations. Cured-in-place pipelining may need to be coupled with point repairs, service lateral grouting and or service lateral T-lining to effective seal up mainlines from identified I&I sources. The extent of the additional repairs needed can be further evaluated after CCTV inspection is done. The cost of cured-in-place pipelining alone for mainline deficiencies found is estimated at $335,526.

4. **Perform follow-up Dyed Water Testing in Conjunction with CCTV –** This project identified thirty-six storm inlets that are cross-connected and/or directly connected to the sanitary sewer. Prior to their disconnection or repair, the detail of each cross connection is recommended to be further evaluated with dyed water flooding performed in conjunction with CCTV. Additionally, the one Creek/Stream defect and Drainage Ditch defect are also recommended for dyed water flooding. This will enable the City to pinpoint and quantify the specific defect types contributing to these cross-connections, their location and what repairs are needed, i.e., mainline lining, lateral lining, chemical grouting, manhole repairs, etc. The estimated cost for conducting dyed water testing itself is approximately $57,000. The additional cost for CCTV services is not factored into this cost estimate as sewer televising companies will usually provide an hourly rate to perform this slower production type of work. However, performing the CCTV portion of the work in-house with City staff can eliminate the need to solicit contracted services for CCTV.

5. **Wet Weather Investigations for Defects Near Creeks –** It is undetermined if the smoking pipes found near creeks are an inflow source where I&I is entering the sanitary sewer system during wet weather, or if these are bypasses that allow excess wet weather I&I to leave the sanitary sewer system at connection points to the creeks. To better understand these locations that smoked, follow up wet weather investigations are needed to determine the details of the piping configuration and flow

conditions at these locations. CCTV is also recommended in these areas to determine entry and exit points for these smoking culvert pipes adjacent to creeks.

6. **Private Sector Source Disconnections (Phase-1) –** As one of the first steps in addressing private sector I&I in the collection system, the City is recommended to pursue corrections to the defects often considered relatively simple repairs and part of a Phase-1, Private Sector Source Disconnection program. These defects will typically include window wells and covers, cleanout caps and downspout disconnections. These repairs are generally $150 or less to repair and from an I&I removal standpoint are a sound investment. From this study, one hundred and eighty (180) cleanouts, nine (9) window wells and ninety-seven (97) downspouts were found contributing I&I to the system and they can be corrected at a cost of approximately $33,900.

Secondary Recommendations / Future Steps:

7. **Consider a Lateral Televising, Lateral Repair and Foundation Drain Disconnection Program –** This project identified one hundred forty-four (144) lateral defects that were located on one hundred and two (102) distinct properties and fourteen (14) properties that had foundation drains smoking. The City should consider televising the laterals at these properties as part of an overall Lateral Televising, Lateral Repair and Foundation Drain Disconnection Program to assess the internal condition of these pipes. This is also an effective way to identify additional footing tile / foundation drain connections to the private service lateral that can be large contributors of I&I. The estimated cost of televising and lining service laterals identified with defects on this project is $867,000. The estimated cost for televising and disconnecting the (14) identified foundation drains is $119,000. This work can be considered after other high priority work is completed.

8. **Perform Internal Building Inspections –** This project identified forty-eight (48) homes with building interior smoke identified as a possible I&I source. It is recommended the City follow up with internal building inspections at these properties to identify sump pumps, diverter valves, combination sumps and any other private sector I&I sources that may not have been found during the smoke testing phase, but could exist in addition to any dry floor drains, p-traps, etc. The estimate cost of doing 48

Internal Building inspections is estimated at $16,800. This work can be considered after the Primary Recommendations / Initial Steps and the associated repair work is completed.

9. **Consider Private Sector Source Disconnections (Phases 2 & 3) –** After any internal building inspections are conducted and a lateral televising, lateral lining and foundation drain repair program is completed, and all other cost-effective defects have been repaired, the City can consider disconnection of sump pumps, diverter valves, combo sumps, area drains, stairwell drains, driveway drains and any other connections which are not compliant with City Code (Chapter 52, § 52.081) and the Illinois Administrative Code (Ill. Admin. Code tit. 77, § 890.200). The estimated cost associated with disconnecting area drains identified in this study is $59,500, driveways drains - $30,000, external sumps - $4,500, and stairwell drains - $150,000.

APPENDIX 1

Defect Summary and Detail Reports

WASHINGTON ILLINOIS

City of Washington

Smoke Test Summary Report

22-R0435

Defect	Number of Defects	Estimated I/I GPM	Repair Cost	$/GPM	
Area Drain	7	14.6	$59,500	$4,075	*
Building Interior	48	9.6	$16,800	$1,750	*
Cleanout	180	87.7	$18,000	$205	*
Creek / Stream	1	10.0	$1,500	$150	*
Downspouts	97	574.3	$14,550	$25	*
Drainage Ditch	1	5.0	$1,500	$300	*
Driveway Drain	3	9.5	$30,000	$3,158	*
External Sump	6	27.0	$4,500	$167	*
Foundation Drain	14	63.0	$119,000	$1,889	*
Frame Seal @ MH	48	57.6	$103,200	$1,792	*
Frame Seal @ Private MH	2	2.4	$4,300	$1,792	*
Gasket Seal Cover @ MH	50	85.0	$12,500	$147	*
Gasket Seal Cover @ Private MH	2	3.4	$500	$147	*
Lateral	144	43.2	$867,000	$20,069	
Main Line	69	103.5	$335,526	$3,242	*
Other	36	25.2	$0	$0	*
Pick Hole @ MH	48	144.0	$12,000	$83	*
Stairwell Drain	15	7.5	$150,000	$20,000	
Storm Inlet / CB	36	466.8	$54,000	$116	*
Window Well Drain	9	4.5	$1,350	$300	*
Totals	**816**	**1,744**	**$1,805,726**		

*** Indicates cost-effecive repairs**