CITY OF HARPER WOODS

DRINKING WATER ASSET MANAGEMENT PLAN

JANUARY 2018

AEW Project No. 0180-0199
WSSN: 03020

Prepared By:

Civil Engineers
Surveyors
Architects

Anderson, Eckstein and Westrick, Inc.

Table of Contents

Appendices

Tables

Figures

1.0 EXECUTIVE SUMMARY

To comply with the Public Act 399, Rule 1606 that requires all municipalities to submit an Asset Management Plan (AMP), the City of Harper Woods evaluated the City's drinking water assets utilizing existing information and an AMP was completed to assess the condition of the existing water main system.

The City of Harper Woods is a strong steward of drinking water management, and takes a proactive position in protecting its residents and property owners. Through development and implementation of the AMP, the insight and understanding of the system's drinking water assets has significantly improved, and a comprehensive investigation included condition assessment of assets, capital improvement needs, and enhancement of the existing Graphical Information System (GIS) which includes mapping, database and system information.

Recognizing the complexity of developing and implementing a comprehensive and viable Drinking Water Asset Management plan, the City DPW staff and AEW evaluated the City's drinking water assets. A multi-phased approach was taken in which communication and interaction played a major role. This included a complex mixture of fact finding, criteria development, professional judgment, staff knowledge of the system, and common sense.

Harper Woods' drinking water assets include over 46 miles of water main, 456 gate valves and 427 fire hydrants. Based on funding limitations, a condition assessment was made based upon previously collected data for the system. Assets were then analyzed to determine their Probability of Failure (POF) and Consequence of Failure (COF). The POF takes into account the history of water main breaks while the COF takes into account financial, safety and transportation impacts. The POF and COF scores are then multiplied together resulting in the *criticality score* or the *Business Risk Exposure (BRE) score*. The BRE score is used to prioritize what assets are most critically in need of repair.

The findings and recommendations included in this report are not intended to change land use or policies of the community, but to provide guidance and affordable alternatives for managing the City's drinking water needs. While it is important to expeditiously complete studies and investigations, it is also imperative that staff, managers and users are allowed sufficient time to absorb the benefits of this program

It was understood from the inception of this investigation that the research and findings presented, were to provide direction and insight into the Harper Woods drinking water system. This Executive Summary provides a brief overview of the investigation, and evaluation of the system assets, condition, operation and needs. A more comprehensive discussion follows in the body of this report.

2.0 INTRODUCTION

The City of Harper Woods purchases water from the Great Lakes Water Authority (GLWA). The GLWA provides drinking water to approximately 3.9 million people in southeastern Michigan communities. The GLWA system uses surface water drawn from two intakes in the Detroit River. The water is directed to four (4) large water treatment plants for processing. A fifth water treatment plant, located in St. Clair County, uses surface water from Lake Huron. The City of Harper Woods receives their water from the Water Works Park and Northeast Plant (Detroit River Plant).

The City of Harper Woods currently owns and operates the City's drinking water system with a limited funding source. The majority of the water mains in Harper Woods were constructed prior to 1960. Since 1990 the City has replaced just over 3 miles of water main and its last water main project was completed 20 years ago in 1998.

Rule 1606 of the Administrative Rules of Michigan's Safe Drinking Water Act, 1796 PA 399, as amended (Act 399), states the AMP shall be included in the General Plan starting on January 1, 2018. The City of Harper Woods was tasked with investigating their drinking water system and creating an asset management plan (AMP). An Asset Management Plan, as defined by Act 399, is

> "A program that identifies the desired level of service at the lowest life cycle cost for rehabilitating, repairing, or replacing the assets associated with the waterworks system."

With the continually aging drinking water infrastructure, and limited resources (equipment, labor and funding) to evaluate the drinking water system, the City of Harper Woods relied on existing information of the drinking water system to develop a drinking water Asset Management Plan (AMP). In addition to compiling an inventory of all drinking water assets, the drinking water AMP will complete the following items,

1. Determine the level of service of the Harper Woods drinking water system.
2. Designate the criticality of all assets.
3. Analyze costs associated with long term O & M strategies and support of the assets management program.
4. Consider long-term funding & capital improvement planning for drinking water assets.
5. Recommend an implementation schedule for the asset management program.

After completing the drinking water AMP the City will be able to maintain the drinking water infrastructure at the desired level of service to provide for current and future use. Continuous investigation of the drinking water system will be necessary to continue to retain the system's inventory. Additionally, the Drinking Water AMP should be updated every year in order to provide the most up-to-date information for the City.

3.0 SYSTEM CHARACTERISTICS

The City of Harper Woods' drinking water system is comprised of three major components; water mains, gate valves and fire hydrants. The City currently owns over 46 miles of water mains, 456 gate valves and 427 fire hydrants. All City owned drinking water related assets have been cataloged and stored in the Harper Woods geodatabase. This geodatabase serves as the data repository for all GIS related information for the City, providing efficient and accurate means of maintaining and updating asset inventories and information, as well as providing for improved data dissemination across the organization. Database schematics have been reviewed and revised as part of this project, ensuring that the most relevant data pertaining to these drinking water system assets is accounted for in the database.

4.0 ASSET REGISTRY

Not all assets are equally critical to a utility's operation. Some assets are extremely critical to the system while others are less critical. In order to determine the criticality of assets there are two important questions,

1.) What is the probability an asset will fail?
2.) What is the consequence of failure?

In order to determine the probability of failure (POF) of an asset there are many factors that must be considered including age, condition of asset, failure history, historical knowledge, experience with the type of asset, maintenance records, and knowledge regarding how the asset is likely to fail. The consequence of failure (COF) is also dependent on many factors including cost of repair, social cost, costs associated with damage caused by the failure, and transportation costs created by the failure.

Assigning criticality is the result of examining both the POF and COF. Assets which have the greatest POF and COF will be the assets that are most critical. The criticality score is ultimately determined by multiplying the POF and COF scores. The POF and COF scores range from 1 to 5 resulting in criticality scores ranging from 1 to 25. Any asset with a criticality score (BRE) of 14 or greater is considered to be critical which was determined by using the current annual budget as described in section 9.0 Capital Improvement Plan.

The subsequent sections will discuss how the condition assessment was performed, how the POF and COF were calculated, and the resulting criticality score for each asset. Location maps for existing water mains, gate wells and fire hydrants can be found in Appendix A and B.

4.1 WATER MAINS

4.1.1 Water Main Condition Assessment

The City of Harper Woods currently owns over 46 miles of water mains ranging in size from 6 inches to 16 inches. Table 1 shows the total length of water main for each size of pipe. This information was exported from Harper Woods' GIS data base. The City has maintained an inventory of water main breaks throughout the drinking water system. The rate of water main breaks per 150 feet of pipe was translated into the POF score for each water main run on a scale of 1 to 5, whereby 1 indicates no recorded breaks and 5 indicates an excessive amount of breaks. Section 4.1.2 further describes the POF scoring system. Table 2 summarizes the proportional dissemination of the 245,056 feet of water mains in the City.

Table 1: City Water Mains

Diameter (inch)	Total Length (feet)
6	18,946
8	193,842
12	24,327
16	7,941
Total	245,056

Table 2: Water Main Probably of Failure Scores

Diameter (inch)	POF Score (feet)				
	1	2	3	4	5
6	5,787	5,135	4,664	2,293	1,067
8	73,467	79,232	35,834	3,822	1,488
12	10,839	10,339	3,149	0	0
16	7,941	0	0	0	0
Total	98,033	94,706	43,648	6,115	2,554

4.1.2 Water Main Criticality

Of the many factors that can be used to calculate the probability of failure, the history of water main breaks was ultimately determined to be the driving factor. Water mains occasionally suffer breaks due to a variety of reasons. However, mains which experience a greater number of breaks are more likely to continue

suffering breaks, causing greater disruption to consumers. Therefore, amount of breaks per 150 feet of water main was converted into the following POF scores:

Table 3: Water Main Breaks POF Factor Score Criteria

Water Main Breaks (#/150 Ft)	Score
0	1
< 0.2	2
0.2 - 0.4	3
0.4 - 0.6	4
> 0.6	5

The consequence of failure (COF) was calculated using four driving factors: proximity to a major roadway, pipe size, pipe age, and if the water main diameter is undersized. Each factor is assigned a numerical value ranging from one half (0.5) to one and one half (1.5) as follows,

1.) Roadway Type – Water mains that are located within a major road's right-of-way (ROW) will pose a significant interruption to traffic if a failure occurs and was determined to have a higher consequence of failure than water mains located within a local road's ROW or within a private property easement. Water mains located within major roadways were assigned a factor score of (1.5), water mains located within local roadways were assigned a factor score of (1.0) and water mains located within a private easement were assigned a factor score of (0.5). The following are considered major roadways: Kelly Rd, Beaconsfield Rd, Harper Ave, Vernier Rd, and 8 Mile Rd.

2.) Pipe Size – Pipes with larger diameters are expected to pass much more flow than smaller diameter pipes. As pipe size increases, so does the consequence of failure. Therefore, each pipe size was assigned a factor score as follows,

Table 4: Pipe Size COF Factor Score Criteria

Pipe Diameter (inch)	Score
6	0.5
8	0.8
12	1.2
16	1.5

3.) Pipe Age – The older a water main is, the more likely repairs will need to be made, causing more water service disruptions to the customers. As pipe age increases, so does the consequence of failure. Therefore, each pipe age was assigned a factor score as follows,

Table 5: Pipe Age COF Factor Score Criteria

Water Main Install Year	Score
< 1960	1.5
1960s	1.3
1970s	0.1
1980s	0.8
1990s	0.5

4.) Undersized Pipe – Water mains that are considered undersized are at risk of providing inadequate water flow to properly supply the Fire Department with the capability to fight fires. As the discrepancy between the size of the pipe and the desired size of pipe increases, so does the consequence of failure. All major roadways should have a minimum water main size of 12 inches while local roadways and water main within private easements should have minimum diameter of 8 inches. Therefore, each pipe was assigned a factor score as follows,

Table 6: Undersized Pipe COF Factor Score Criteria

Required diameter minus existing diameter (inch)	Score
0	0.5
2	1.0
4	1.3
6	1.5

Once the individual COF factor scores have been calculated the COF of the water main is then calculated by summing the factor scores.

The criticality score is then determined by multiplying the POF and COF scores. Harper Woods' water mains yielded a minimum criticality score of 2.4, a maximum score of 18.0, and an average criticality score of 6.5. Table 7 shows the length of water main in each criticality score grouping. The full criticality analysis can be found in Appendix C.

Table 7: Water Main Criticality Scores

Criticality Score	Length (ft)	Percent
< 5.0	98,033	40.0%
5.0 – 10.0	92,586	37.8%
10.0 – 13.9	45,541	18.6%
14.0 – 17.9	7,830	3.2%
≥ 18.0	1,067	0.4%
Total	245,056	100%

4.1.3 Water Main Replacement

Three installation methods were considered for water main replacement which are open cut, pipe bursting and directional drill. Open cut replacement consists of fully excavating the location of the new water main, installing it, and connecting the new water main to the existing drinking water system. Pipe bursting involves pulling a new water main through the existing water main with a breaker head on the pipe that breaks apart the existing pipe, requiring little to no excavation. Directional drilling also involves little to no excavation as well. It

involves drilling through the existing subgrade in the desired location of the new water main, before pulling the new main through the drilled hole.

After gathering information from previous AEW water main projects Table 8 was created to display the estimated replacement cost per foot of water main by diameter and replacement method. These prices include design services, construction inspection and construction administration prices as well as gate valve and hydrant costs. Since deciding which replacement method to use is project specific and typically chosen during the design phase of a project, the most expensive replacement method, Open Cut, was used for this report. Estimated replacement costs for each segment of water main can be found can be found in Appendix C.

Table 8: Water Main Replacement – Unit Costs

		Open Cut ($/Ft)	Directional Drill ($/Ft)	Pipe Bursting ($/Ft)
PIPE SIZE (IN)	8	$335	$290	$290
	12	$365	$300	$300
	16	$400	$310	$310

4.2 GATE VALVES

4.2.1 Gate Valve Condition Assessment

The drinking water system contains approximately 456 gate valves. Gate valve assessments were based on the rate of water main breaks on the water main they were connected to. Similarly to the water main condition assessment, each gate valve was rated on a scale of 1 to 5, with 1 having a water main break rate of (0.0) and 5 have a break rate of more than 0.6. Table 9 summarizes the ratings for gate valves based on the water main break rate on its connected water main. Supporting data for the POF rating be found in Appendix D.

Table 9: Gate Valve POF Ratings

Rating	Gate Valves
5	6
4	16
3	79
2	169
1	186
Total	456

4.2.2 Gate Valve Criticality

Of the many factors that can be used to calculate the probability of failure, the history of water main breaks on joining water mains was ultimately determined to be the driving factor. Because gate valves are primarily replaced during water main replacement projects, the probability of failure of the connecting water main was used.

The consequence of failure was calculated using the same driving factors as the water mains: water main age, pipe size, road type and whether the gate valves incoming water main is undersized. Each factor is assigned a numerical value ranging from one half (0.5) to one and one half (1.5) as follows,

1.) Roadway Type – The same Roadway Type scoring system used for the water mains was used for the gate valves. See the Road Type description in section 4.1.2 Water Main Criticality.

2.) Pipe Size – The same Pipe Size scoring system used for the water mains was used for the gate valves. See Table 4: Pipe Size COF Factor Score Criteria.

3.) Gate Valve Age – The same scoring system used for the water mains was used for the gate vales. See Table 5: Pipe Age COF Factor Score Criteria.

4.) Undersized Pipe – The same scoring system used for the water mains was used for gate valves. See Table 6: Undersized Pipe COF Factor Score Criteria.

Once the individual COF factor scores have been calculated the COF of the gate valves were then calculated by summing the individual COF factor scores.

The criticality score is then determined by multiplying the POF and COF scores. Harper Woods' gate valves yielded a minimum criticality score of 2.6, a maximum score of 24.0, and an average criticality score of 7.2. Table 10 shows the number of gate valves in each criticality grouping. The full criticality analysis can be found in Appendix D.

Table 10: Gate Valve Criticality Ratings

Criticality Score	Gate Valves	Percent
< 5.0	186	40.2%
5.0 – 10.0	171	36.9%
10.1 – 13.9	56	12.1%
14.0 – 17.9	43	9.3%
≥ 18.0	7	1.5%
Total	915	100%

4.2.3 Gate Valve Rehabilitation/Replacement

Rehabilitation or replacement of individual gate valves was not considered due to the limited information known about the gate valves. It is recommended that a gate valve condition investigation program be implement to determine the actual condition of the City's gate valves. The information gathered for this report did not take into account the physical condition of the gate valves or how well they currently operate. As gate valves get older and deteriorate they become more difficult to close and may not properly operate anymore. This can cause problems during emergency water main repairs and construction projects. By implementing a gate valve condition investigation program individual replacement of the poorly functioning gate valves can be determined. Until this data is gathered the only gate valves estimated for replacement in this report are those on the critical water main runs.

If a program is developed to replace individual gate valves Table 11 can be used to estimate the cost for full replacement of gate valves per valve size. Replacement costs were derived from anticipated pay items for the replacement of one structure and valve. Current weighted average item prices, taken from Michigan Engineers' Resource Library (MERL), were used for unit prices. It was

assumed that the water structure and valve being replaced is in pavement. Note, design services, construction inspection and construction administration prices were not factored into the replacement costs.

Table 11: Gate Valve Replacement Costs – Unit Costs

Valve Size (inch)	Gate Valve & Well	Gate Valve & Box
4	$ 7,400	$ 3,800
6	$ 7,600	$ 4,100
8	$ 7,900	$ 4,300
10	$ 8,400	$ 6,000
12	$ 8,700	$ 5,500
16	$ 12,400	$ 9,000
20	$ 15,000	$ 11,650
24	$ 17,000	$ 14,300

4.3 FIRE HYDRANTS

4.3.1 Fire Hydrant Condition Assessment

The City of Harper Woods' drinking water system contains approximately 427 fire hydrants. Fire hydrant assessments were based on previously obtained information including their age and the rate of water main breaks on the water main they are located on. Each fire hydrant was rated on a score of 1 to 5, with 1 having a water main break rate of zero (0.0) and 5 having a break rate of more than 0.6 breaks per 150 feet of water main. Table 12 summarizes the ratings for fire hydrants based on water main break rate on adjacent water mains. Supporting data for the structure ratings can be found in Appendix E.

Table 12: Fire Hydrant POF Ratings

Rating	Hydrants
5	5
4	17
3	78
2	180
1	147
Total	427

4.3.2 Fire Hydrant Criticality

Of the many factors that can be used to calculate the probability of failure, the history of water main breaks of the water main that a fire hydrant is connected was determined to be the POF. Like gate valves, fire hydrants are primarily replaced during water main replacement projects so the probability of failure was tied to the water main break rate.

The consequence of failure was calculated using the same criteria as the water mains and gate valves: water main age, pipe size, road size and whether the incoming water main is undersized. Each factor is assigned a numerical value ranging from one half (0.5) to one and one half (1.5) as follows,

1.) Roadway Type – The same Roadway Type scoring system used for the water mains was used for hydrants. See the Road Type description in section 4.1.2 Water Main Criticality.
2.) Pipe Size – The same scoring system used for the water mains was used for hydrants. See Table 4: Pipe Size COF Factor Score Criteria.
3.) Gate Valve Age – The same scoring system used for the water mains was used for the gate vales. See Table 5: Pipe Age COF Factor Score Criteria.
4.) Undersized Pipe – The same scoring system used for the water mains was used for hydrants. See Table 6: Undersized Pipe COF Factor Score Criteria.

Once the individual COF factor scores have been calculated the COF of the fire hydrants are then calculated by summing the individual COF factor scores.

The criticality score is then determined by multiplying the POF and COF scores. Harper Woods' fire hydrants yielded a minimum criticality score of 2.3, a maximum score of 18.0, and an average criticality score of 7.0. Table 13 shows the number of fire hydrants in each criticality grouping. The full criticality analysis can be found in Appendix E.

Table 13: Fire Hydrant Criticality Scores

Criticality Score	Hydrants	Percent
< 5.0	147	34.4%
5.0 – 10.0	188	44.0%
10.1 – 13.9	67	15.7%
14.0 – 17.9	21	4.9%
≥ 18.0	4	0.9%
Total	427	100%

4.3.3 Fire Hydrant Rehabilitation/Replacement

Similar to gate valve replacement, fire hydrants typically are only replaced during water main replacement projects or in emergencies such as accidents that involve damage to a fire hydrant or when hydrant valves break or become inoperable. With the limited information known about the City's fire hydrants it is not practical to estimate individual fire hydrant replacement. It is recommended that a condition investigation program be implemented to gather more information the City's fire hydrants. If the program is implemented then a plan to repair/replace individual fire hydrants can be created. Until this data is gathered the only fire hydrants estimated for replacement in this report are those on the critical water main runs.

For reference, Table 14 shows the replacement cost of a single fire hydrant. Current weighted average item prices, taken from Michigan Engineers' Resource Library (MERL), was used to estimate the unit price cost. Note, design services, construction inspection and construction administration prices were not factored into the replacement costs.

Table 14: Fire Hydrant Replacement - Unit Costs

Item	Unit Cost
Fire Hydrant Removal	$ 500
Fire Hydrant Assembly	$ 4,000
Total	$ 4,500

5.0 REMAINING SERVICE LIFE

The remaining service life (RSL) of an asset is the design life less the years in service. The material, quality of construction, usage, and environment can all affect the RSL of drinking water assets. The life of water mains, gate valves and fire hydrants varies greatly from the design life making it very difficult to accurately predict the RSL. Continued re-evaluation and proper maintenance of all assets is essential in extending the RSL of drinking water assets.

The following tables show the theoretical design life of water mains based on their material as well as the theoretical design life of gate valves and fire hydrants. The majority of water mains, gate valves and fire hydrants in Harper Woods were installed prior to 1960 making them at least 60 years old.

Table 15: Theoretical Design Life – Water Mains

Material	Theoretical Design Life (years)
Cast Iron	90
Ductile Iron	90

Table 16: Theoretical Design Life – Gate Valves and Fire Hydrants

Structure	Theoretical Design Life (years)
Gate Valve	90
Fire Hydrant	70

All of the water mains in the City are known to be cast iron or ductile iron making the service life of them around 90 years. Table 17 shows that only 2% of the City's water mains will approach their design life sometime within the next 2 to 11 years. The next section further analyzes the City's replacement needs.

Table 17: Water Main Installation by Decade

Decade Installed	Water Main (feet)	Percent
1930s	4,896	2%
1940s	67,335	27%
1950s	113,923	46%
1960s	10,054	4%
1970s	4,269	2%
1980s	26,891	11%
1990s	17,688	7%
Total	245,056	100%

6.0 ESTIMATED REPLACMENT NEEDS

As mentioned in the previous section, some of the City's water main are approaching their theoretical design life. Table 18 was created to show the theoretical design life remaining per length (feet) of water main as well as the criticality scores (BRE) calculated during critical analysis. The table shows that 21.4% of the City's water mains will approach their design life in 10 to 15 years and 7.2% will reach theirs in 15 to 20 years. This means that 28.6% of the water mains will have outlasted or will approach their design life in 20 years. Currently, 3,500 feet of water main would need to be replaced each year for 20 years to replace these mains. The estimated cost to do so would be approximately $24,000,000 today or just over $1,500,000 per year for a period of 20 years. These values are not included in the Capital Improvement Plan but were created to show the true replacement needs of the water main system.

Table 18: Water Main Theoretical Design Life Costs

		Theoretical Design Life Remaining by Length (ft)				
		10 yrs to <15 yrs	15yrs to 20 yrs	10 yrs to 20 yrs Total	>20 yrs	Total
BRE	X < 3	0	0	0	29,999	29,999
	3 ≥ X < 4	9,199	3,158	12,357	31,568	43,925
	4 ≥ X < 5	6,326	0	6,326	17,782	24,109
	5 ≥ X < 6	0	0	0	21,998	21,998
	6 ≥ X < 7	0	0	0	40,522	40,522
	7 ≥ X < 8	5,491	9,430	14,921	0	14,921
	8 ≥ X < 9	9,207	0	9,207	1,615	10,822
	9 ≥ X < 10	0	0	0	4,323	4,323
	10 ≥ X < 11	13,156	3,542	16,697	19,879	36,576
	11 ≥ X < 12	981	0	981	0	981
	12 ≥ X < 13	0	0	0	0	0
	13 ≥ X < 14	3,149	0	3,149	4,834	7,984
	14 ≥ X < 15	2,521	1,528	4,049	0	4,049
	15 ≥ X < 16	0	0	0	0	0
	X > 16	2,293	0	2,293	2,554	4,847
Total		52,324	17,658	69,982	175,075	245,056
%		21.4%	7.2%	28.6%	71.4%	100.0%
Cost		$ 17,937,396	$ 5,915,439	$ 23,852,834	N/A	N/A
Future Cost*/20 yrs		$ 1,205,318	$ 342,393	$ 1,547,711	N/A	N/A

*assumed 3% inflation over 10 years: Future Cost = (Outlasted to 20 Years Total Cost) x $(1 + i)^n$

7.0 LEVEL OF SERVICE

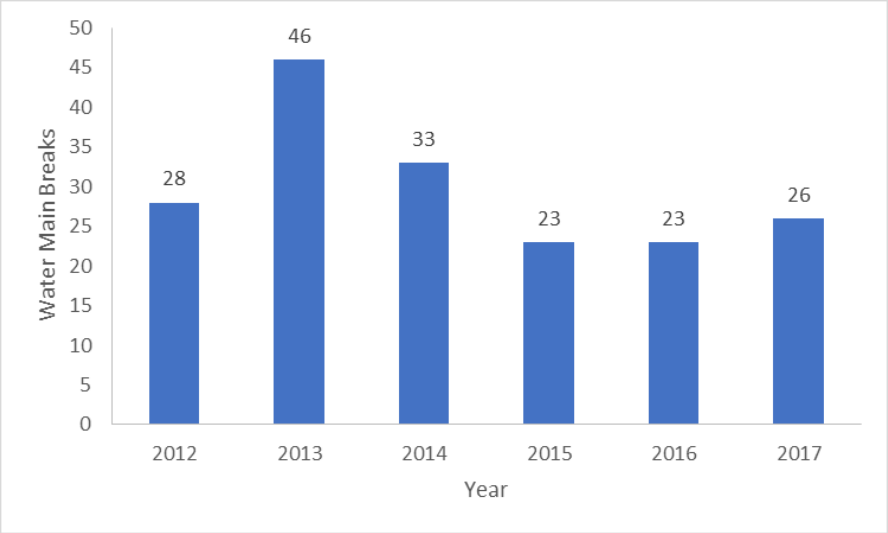
To reasonably serve Harper Woods a desired Level of Service (LOS) must be established. Level of Service was defined in the 2011 International Infrastructure Management Manual as

> "the outputs a customer receives from the organization".

In terms of the City's drinking water system, the level of service would be the satisfaction of the residents, business owners and property owners. There are many factors that can affect the perceived LOS of the system including water main breaks, primary & secondary drinking water violations, and areas of low pressure within the system.

Figure 1 displays the City's recorded annual water main breaks over the last 6 years. The average water main breaks over that span is 29.8 and down to 24.0 the past 3 years. To increase the LOS of the water system a goal of less than 20 breaks annually should be set for the future.

Figure 1: Annual Water Main Breaks Graph



The National Primary Drinking Water Regulations are limits set by the EPA for substances that are thought to pose a threat to health when present in drinking water at certain levels. Secondary Drinking Water Regulations set by the EPA are non-enforceable federal guidelines regarding taste, odor, color and certain other non-aesthetic effects of drinking water. These contaminants normally do not have any adverse health effects. To achieve a desirable level of service it is the City's goal to meet these regulations.

In 2015 a Water Distribution System Reliability Study and Master Plan was completed by AEW that analyzed and evaluated the City's water distribution system using a computer modeling software. The software modeled the system's flow, pressure and head loss information from hydrant flow tests. From the analysis it was determined that the system is working well during average day, maximum day and peak hour scenarios during periods of regular user demand. However, when analyzing for available fire flow some areas of concern were detected

where the model predicts hydrants will have difficulty delivering the recommended fire flow while maintaining 20 psi within the distribution system. As part of the report, a capital improvement plan (CIP) was created that recommended additional looping within the system to improve available fire flow. The improvements proposed were added to the existing model to predict the effect on the distribution system. The model was run for the existing maximum day scenario to determine in general how well the distribution system will theoretically work and to predict the available fire flow while maintaining 20 psi within the distribution system. Based on the model's output for this scenario, the water system, with the improvements, continues to generally work well during the existing maximum day demand. Additionally, the deficiencies in predicted available fire flows noted prior to the proposed improvements showed significant improvement. The deficiencies were not eliminated entirely, but the areas of concern showed dramatic contraction. Completing the projects on the CIP from the Water Distribution System Reliability Study and Master Plan will improve the system level of service.

8.0 WATER DISTRUBUTUION SYSTEM RELIABILTY STUDY AND MASTER PLAN CAPITAL IMPROVEMENT PLAN

The CIP improvements recommended in the 2015 Water Distribution System Reliability Study and Master Plan, mentioned in the previous section, can be found in Table 19. All of the proposed water main improvements in the table, excluding the water main on Arthur Ave, are new water mains that will loop the existing system. The proposed water main improvement on Arthur Ave will replace and upsize the existing main from 6 inches to 8 inches. Using the estimated cost of $335/ft from section 4.1.3 it will cost $2,003,300 to complete the recommended loops today. It is recommended these improvements be completed over an 8 year period. The total cost over an 8 year period assuming an inflation rate of 3% over 4 years will be $2,254,732. These replacement costs are included in this report's CIP found in the next section.

Table 19: Water Distribution System Reliability Study and Master Plan CIP

Street Name	Project Limits	Length (ft)	Proposed Diameter (in)
Canton Ave	Vernier to Woodmont	3,955	8
Helen Ave	Kenmore to Hunt Club	835	8
Chester Ave	Huntington to Manchester	435	8
Arthur Ave	Woodmont to Huntington	350	8
Proposed Easement	Woodmont to Huntington	405	8
Total Footage		**5,980**	

9.0 CAPITAL IMPROVEMENT PLAN

A Capital Improvement Plan (CIP) provides for both capital projects and fiscal needs to coordinate the location, timing and financing of capital improvements over a 20 year period of time. Through the condition assessment and criticality calculations, a prioritized list of water main runs for replacement has been established using the current annual budget for water system improvements of $300,000. Please note that this list should be used for general guidance and does not take into account water mains that may need to be replaced on a street that is being reconstructed. These adjustments should be made annually during the development of the detailed CIP. The estimated cost associated with replacing any gate valve or fire hydrant on these water mains is built into the replacement cost of the water main. A detailed cost estimate can be found in Appendix G.

The CIP shown in Table 20 includes the cost to complete the improvements mentioned in section 8.0, repair critical water mains, and costs associated to better maintain the system. An inflation rate of 3% over a 6 year period was assumed when calculating the Water Main Replacement costs. The water mains included to be replaced in the CIP (BRE ≥ 14) can be found in Appendix F and the locations of these water mains can be found in Appendix G.

Table 20: Capital Improvement Plan

	Complete Reliability Study Loops	Water Main Replacement (BRE ≥ 14)	Condition Investigation	GV & Hydrant Replacement	Valve Exercising	Meter Pits O&M	Asset Management	Total
Year 1	$ 284,000	$ -	$ -	$ -	$ 10,000	$ 1,000	$ 5,000	$ 300,000
Year 2	$ 284,000	$ -	$ -	$ -	$ 10,000	$ 1,000	$ 5,000	$ 300,000
Year 3	$ 284,000	$ -	$ -	$ -	$ 10,000	$ 1,000	$ 5,000	$ 300,000
Year 4	$ 284,000	$ -	$ -	$ -	$ 10,000	$ 1,000	$ 5,000	$ 300,000
Year 5	$ 264,000	$ -	$ 20,000	$ -	$ 10,000	$ 1,000	$ 5,000	$ 300,000
Year 6	$ 284,910	$ -	$ -	$ 33,000	$ 10,000	$ 1,000	$ 5,000	$ 333,910
Year 7	$ 284,910	$ -	$ -	$ 33,000	$ 10,000	$ 1,000	$ 5,000	$ 333,910
Year 8	$ 284,910	$ -	$ -	$ 33,000	$ 10,000	$ 1,000	$ 5,000	$ 333,910
Year 9	$ -	$ 296,549	$ -	$ 33,000	$ 10,000	$ 1,000	$ 5,000	$ 345,549
Year 10	$ -	$ 296,549	$ -	$ 33,000	$ 10,000	$ 1,000	$ 5,000	$ 345,549
Year 11	$ -	$ 296,549	$ -	$ 33,000	$ 10,000	$ 1,000	$ 5,000	$ 345,549
Year 12	$ -	$ 296,549	$ -	$ 33,000	$ 10,000	$ 1,000	$ 5,000	$ 345,549
Year 13	$ -	$ 296,549	$ -	$ 33,000	$ 10,000	$ 1,000	$ 5,000	$ 345,549
Year 14	$ -	$ 296,549	$ -	$ 33,000	$ 10,000	$ 1,000	$ 5,000	$ 345,549
Year 15	$ -	$ 296,549	$ 20,000	$ -	$ 10,000	$ 1,000	$ 5,000	$ 332,549
Year 16	$ -	$ 296,549	$ -	$ 33,000	$ 10,000	$ 1,000	$ 5,000	$ 345,549
Year 17	$ -	$ 296,549	$ -	$ 33,000	$ 10,000	$ 1,000	$ 5,000	$ 345,549
Year 18	$ -	$ 296,549	$ -	$ 33,000	$ 10,000	$ 1,000	$ 5,000	$ 345,549
Year 19	$ -	$ 296,549	$ -	$ 33,000	$ 10,000	$ 1,000	$ 5,000	$ 345,549
Year 20	$ -	$ 296,549	$ -	$ 33,000	$ 10,000	$ 1,000	$ 5,000	$ 345,549

The Capital Improvement Plan was created to ensure the drinking water system continues to operate at the desired level of service to provide for current and future use. Below is a more detailed description of the CIP items:

Water Main Replacement: annual cost to replace water mains with a criticality (BRE) score of 14 or greater. See Appendix F & G for information regarding location, diameter, length, cost, etc. of the individual water mains.

Reliability Study Loops: annual cost to install new/replace existing water mains recommended from the City's 2015 Water Distribution Reliability Study and Master Plan. Table 19 lists the location and length of these proposed water mains. See Appendix G for the proposed locations of these water mains on a map.

Condition Investigation: cost required to inspect all gate valves and fire hydrants to determine if repair or replacement is warranted. Currently, the POF for gate valves and fire hydrants only take into account the condition of the water main they are connected to and lack to include the actual condition of the valves and hydrants. After the Condition Investigation is complete a more effected criticality

analysis can be done for the valves and hydrants. Due to budget constraints the Condition Investigation is recommended to be completed year 5 of the CIP so the critical gate valves and fire hydrants can start being replace from years 6-20. It is recommended a Condition Investigation be done every 10 years.

GV & Hydrant Replacement: annual cost required to replace gate valves and fire hydrants with a criticality score of 14 or greater from updated criticality analysis once the Condition Investigation is completed. It was assumed that 2 (two) 12 inch gate valve & wells, two (2) 12 inch gate valve & boxes, and one fire hydrant would be replace annually.

Valve Exercising: annual cost required to "exercise", open and close, gate valves and fire hydrant valves so they do not seize-up due to corrosion.

Meter Pit O & M: annual cost to inspect and maintain the meter pits in the City.

Asset Management: annual cost that includes keeping the asset management plan up to date with the most current information available. This consists of updating the City's GIS data base, criticality analysis spreadsheets, and capital improvement plans with information from the Condition Investigation, future water break records, and future construction projects.

10.0 WATER AND SEWER RATES

Harper Woods currently charges all parcels connected to the public water and/or sewer system water and sewer Meter Charges, a Debt Service Charge, and Commodity Charges as well as Industrial Waste Control Charges. To fund the first 5 years of the Capital Improvement Plan shown in the previous section the City will need to raise their current rates approximately 3% which will create a budget of around $300,000 for water main projects. Funding for CIP years 6-20 should be re-evaluated towards the end of year 5 of the CIP. Table 21 shows the breakdown of the City's current Water and Sewer Rates.

Table 21: Water and Sewer Rates

CITY OF HARPER WOODS ***EXISTING WATER & SEWER RATES*** ***2017 BUDGET YEAR***	
RATE CATEGORY	***EXISTING RATE (MONTHLY)***
Meter Charge -Per Equivalent Meter	
Water Meter Charge Total	**$7.92**
Sewer Meter Charge Total	**$13.97**
Total Meter Charge	**$21.89**
Meter Charge (Quarterly) -Per Meter	
Refuse User Fee	**$1.67**
Debt Service Charge -Per Equivalent Meter	
Total Meter Charge	**$2.50**
Commodity Charge - Sewer -Per MCF	
Total Commodity Sewer	**$22.88**
Commodity Charge - Water -Per MCF	
Total Commodity Water	**$19.31**
Combined Water & Sewer Comm. Charge	**$42.19**
Grand Total (Including 2.0 MCF/quarter Use)	**$54.18**
Industrial Waste Control Charges	**Per GLWA Adopted Rates**

11.0 CONCLUSION

This Drinking Water Asset Management Plan presents the methodology and findings of the condition assessment of the Harper Woods drinking water assets, including the five (5) criteria set forth by the Michigan Department of Environmental Quality as follows:

1. Determining the level of service of the Harper Woods drinking water system.
2. Designating the criticality of all assets.
3. Cost analysis associated with long term operation and maintenance (O&M) strategies and support of the assets management program.
4. Development of a long-term funding/capital improvement plan for drinking water assets.
5. Develop an implementation schedule for the asset management program.

Based on the Asset Management Plan and system evaluation, there are water mains, gate valves and fire hydrants currently in need of replacement.

It is the recommendation herein that the locations presented in the Capital Improvement Plan be replaced as follows:

Capital Improvement, Years 1 to 5

- Begin water system loop improvements recommend in the City's 2015 Water Distribution System Reliability Study and Master Plan outlined in section 8.0.

Capital Improvement, Years 6 to 20

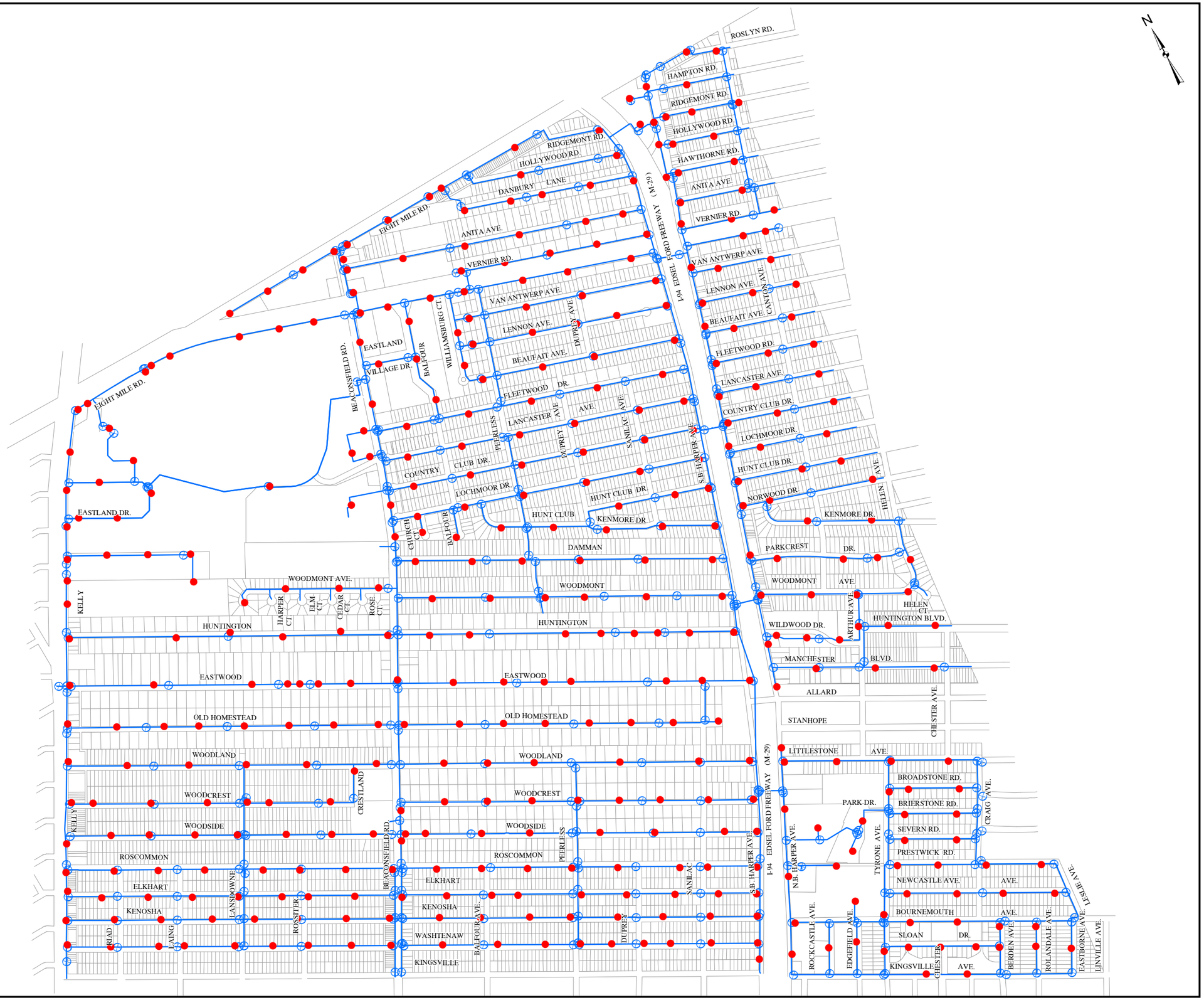
- Complete water system loop improvements.
- Replace water mains and associated gate valves and fire with a criticality score (BRE) of 14 or greater found in Appendix G.

- Replace or repair individual gate valves and fire hydrants based on the Condition Investigation.

In addition to the replacement of assets determined in the Capital Improvement Plan the following are recommended:

- Continue with a drinking water asset investigation program for the entire drinking water system.
- Update the Asset Management Plan on a yearly basis, incorporating newly collected data and yearly improvements.
- Start a valve turning program and exercise all of the gate valves in City at least once a year.
- Develop and adopt policies to assess, repair and/or replace drinking water system assets concurrent with road construction projects.

APPENDIX A: EXISTING WATER MAIN, GATE VALVE AND FIRE HYDRANT LOCATIONS



CITY of HARPER WOODS

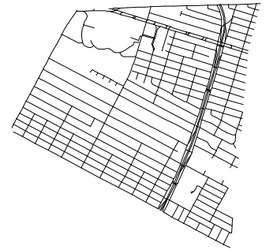
City of Harper Woods 1951 Michigan

Overall Water System

CAUTION

THIS MAP IS INTENDED FOR REFERENCE PURPOSES ONLY

ANDERSON, ECKSTEIN AND WESTRICK, INC. AND THE CITY OF HARPER WOODS DO NOT GUARANTEE THE ACCURACY OF THIS INFORMATION AND DISCLAIMS ALL LIABILITY FROM ALL CLAIMS, SUITS, DEMANDS AND JUDGEMENTS ARISING FROM THE USE OF THIS INFORMATION



ANDERSON, ECKSTEIN AND WESTRICK, INC.
Civil Engineers • Surveyors • Architects
51301 Schoenherr Road, Shelby Township, Michigan 48315
Phone 586-726-1234 Fax 586-726-8760

Water Main

Hydrant

Gate Valve

DATE PRINTED: February 2, 2018	DATE CREATED: January 31, 2018
SCALE: N.T.S.	MAP DOCUMENT: OverallWaterSystem.mxd
PROJECT NO: 0180-0199	CREATED BY: JMM / CHECKED BY: JT

APPENDIX B: EXISTING WATER MAIN LOCATIONS BY DIAMETER

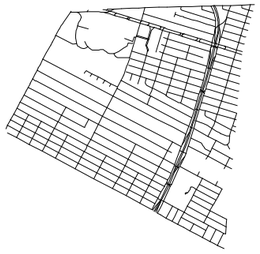
CITY of HARPER WOODS

Water Main Diameter Summary

CAUTION

THIS MAP IS INTENDED FOR REFERENCE PURPOSES ONLY

ANDERSON, ECKSTEIN AND WESTRICK, INC. AND THE CITY OF HARPER WOODS DO NOT GUARANTEE THE ACCURACY OF THIS INFORMATION AND DISCLAIMS ALL LIABILITY FROM ALL CLAIMS, SUITS, DEMANDS AND JUDGEMENTS ARISING FROM THE USE OF THIS INFORMATION



ANDERSON, ECKSTEIN AND WESTRICK, INC.
Civil Engineers • Surveyors • Architects
51301 Schoenherr Road, Shelby Township, Michigan 48315
Phone 586-726-1234 Fax 586-726-8780

6" Main
12" Main
8" Main
16" Main

DATE PRINTED: January 31, 2018	DATE CREATED: January 31, 2018
SCALE: N.T.S.	MAP DOCUMENT: MainSize.mxd
PROJECT NO: 0180-0199	CREATED BY: JMM / CHECKED BY: JT

APPENDIX C: CRITICALITY ANALYSIS – WATER MAINS

Street	From	To	Run ID	Material	Road Type	Year Installed	Diameter (in.)	Length (ft.)	Recorded Breaks	Breaks per 150 ft.	Consequence of Failure Criteria				Consequence of Failure (COF)	Probability of Failure (POF): Breaks/150 ft.	Criticality Score (BRE)	Replacement Cost
											Pipe Age	Pipe Size	Undersize Pipe	Road Type				
8 Mile	Beaconsfield	Ridgemont	R085	Cast Iron	Major	1938	8	2603	1	0.06	1.5	0.8	1.3	1.5	5.1	2.0	10.2	$ 871,884
8 Mile	Harper	Roslyn	R138	Cast Iron	Major	1940	8	548	0	0.00	1.3	0.8	1.3	1.5	4.9	1.0	4.9	$ 183,470
8 Mile	Beaconsfield	Vernier	R086	Cast Iron	Major	1967	8	1354	0	0.00	0.9	0.8	1.3	1.5	4.5	1.0	4.5	$ 453,552
Anita	Beaconsfield	Harper	R081	Cast Iron	Local	1940	8	3205	6	0.28	1.3	0.8	0.5	1.0	3.6	3.0	10.8	$ 1,073,551
Anita	Harper	E.C.L.	R128	Cast Iron	Local	1950	8	1042	2	0.29	1.1	0.8	0.5	1.0	3.4	3.0	10.2	$ 348,920
Arthur	Manchester	Huntington	R110	Cast Iron	Local	1950	8	429	1	0.35	1.1	0.8	0.5	1.0	3.4	3.0	10.2	$ 143,824
Arthur	Huntington	Woodmont	R111	Cast Iron	Local	1950	6	344	0	0.00	1.1	0.5	1.0	1.0	3.6	1.0	3.6	$ 115,321
Balfour	Vernier	Fleetwood	R066	Cast Iron	Local	1962	8	1314	1	0.11	0.9	0.8	0.5	1.0	3.2	2.0	6.4	$ 440,133
Balfour	Lochmoor	Cul de Sac	R071	Cast Iron	Local	1953	6	322	0	0.00	1.1	0.5	1.0	1.0	3.6	1.0	3.6	$ 107,871
Beacon Elementary	Beaconsfield	West	R146	Cast Iron	Private	1940	8	150	0	0.00	1.3	0.8	0.5	0.5	3.1	1.0	3.1	$ 50,236
Beaconsfield	Damman	Fleetwood	R156	Cast Iron	Major	1940	8	1378	3	0.33	1.3	0.8	1.3	1.5	4.9	3.0	14.7	$ 461,512
Beaconsfield	Kingsville	Roscommon	R026	Cast Iron	Major	1940	6	1143	2	0.26	1.3	0.5	1.5	1.5	4.8	3.0	14.4	$ 382,878
Beaconsfield	Woodland	Damman	R028	Cast Iron	Major	1950	8	2138	1	0.07	1.1	0.8	1.3	1.5	4.7	2.0	9.4	$ 716,389
Beaconsfield	Kingsville	Woodland	R027	Cast Iron	Major	1940	8	2225	0	0.00	1.3	0.8	1.3	1.5	4.9	1.0	4.9	$ 745,315
Beaconsfield	8 Mile	Fleetwood	R029	Cast Iron	Major	1940	12	1277	0	0.00	1.3	1.1	0.5	1.5	4.4	1.0	4.4	$ 466,140
Beaconsfield	8 Mile	Vernier	R030	Cast Iron	Major	1976	12	810	0	0.00	0.7	1.1	0.5	1.5	3.8	1.0	3.8	$ 295,591
Beaconsfield Apartments	Beaconsfield	West	R150	Cast Iron	Private	1969	8	933	0	0.00	0.9	0.8	0.5	0.5	2.7	1.0	2.7	$ 312,661
Beaufait	Harper	Williamsburg	R077	Cast Iron	Local	1949	8	2249	3	0.20	1.3	0.8	0.5	1.0	3.6	3.0	10.8	$ 753,480
Beaufait	Harper	E.C.L.	R123	Cast Iron	Local	1950	8	1173	0	0.00	1.1	0.8	0.5	1.0	3.4	1.0	3.4	$ 393,021
Berden	Kingsville	Bournemouth	R093	Cast Iron	Local	1950	8	561	0	0.00	1.1	0.8	0.5	1.0	3.4	1.0	3.4	$ 187,870
Bournemouth	Harper	Eastbourne	R088	Cast Iron	Local	1950	8	2958	1	0.05	1.1	0.8	0.5	1.0	3.4	2.0	6.8	$ 990,788
Brierstone	Tyrone	Craig	R105	Cast Iron	Local	1950	8	940	0	0.00	1.1	0.8	0.5	1.0	3.4	1.0	3.4	$ 315,051
Broadstone	Tyrone	Craig	R106	Cast Iron	Local	1950	8	941	2	0.32	1.1	0.8	0.5	1.0	3.4	3.0	10.2	$ 315,367
Canton	Vernier	Anita	R130	Cast Iron	Local	1960	8	287	0	0.00	0.9	0.8	0.5	1.0	3.2	1.0	3.2	$ 96,222
Canton	Anita	Roslyn	R132	Duct Iron	Local	1990	8	1642	0	0.00	0.5	0.8	0.5	1.0	2.8	1.0	2.8	$ 550,056
Cedar Ct	Woodmont	Cul de Sac	R022	Cast Iron	Local	1952	6	119	1	1.26	1.1	0.5	1.0	1.0	3.6	5.0	18.0	$ 39,941
Chandler Park H.S.	Kelly	East	R154	Cast Iron	Private	1940	6	1619	0	0.00	1.3	0.5	1.0	0.5	3.3	1.0	3.3	$ 542,528
Church Ct	Lochmoor	Cul de Sac	R070	Cast Iron	Local	1957	6	185	0	0.00	1.1	0.5	1.0	1.0	3.6	1.0	3.6	$ 62,068
Country Club	Beaconsfield	Harper	R075	Cast Iron	Local	1953	8	3348	6	0.27	1.1	0.8	0.5	1.0	3.4	3.0	10.2	$ 1,121,670
Country Club	Harper	E.C.L.	R120	Cast Iron	Local	1945	8	1361	1	0.11	1.3	0.8	0.5	1.0	3.6	2.0	7.2	$ 455,776

Street	From	To	Run ID	Material	Road Type	Year Installed	Diameter (in.)	Length (ft.)	Recorded Breaks	Breaks per 150 ft.	Consequence of Failure Criteria				Consequence of Failure (COF)	Probability of Failure (POF): Breaks/150 ft.	Criticality Score (BRE)	Replacement Cost
											Pipe Age	Pipe Size	Undersize Pipe	Road Type				
Craig West	Prestwick	Littlestone	R100	Cast Iron	Local	1950	8	1086	2	0.28	1.1	0.8	0.5	1.0	3.4	3.0	10.2	$ 363,918
Crestland	Woodcrest	Woodland	R007	Duct Iron	Local	1996	8	400	0	0.00	0.5	0.8	0.5	1.0	2.8	1.0	2.8	$ 134,058
Damman	Beaconsfield	Harper	R063	Cast Iron	Local	1950	8	3475	3	0.13	1.1	0.8	0.5	1.0	3.4	2.0	6.8	$ 1,164,034
Danbury	Vernier	Harper	R082	Duct Iron	Local	1964	8	2182	0	0.00	0.9	0.8	0.5	1.0	3.2	1.0	3.2	$ 730,835
Eastbourne	Kingsville	Bournemouth	R095	Cast Iron	Local	1950	8	618	0	0.00	1.1	0.8	0.5	1.0	3.4	1.0	3.4	$ 207,061
Eastland Mall	Eastland Dr		R151	Cast Iron	Private	1957	12	5354	0	0.00	1.1	1.1	0.5	0.5	3.2	1.0	3.2	$ 1,954,169
Eastland Mall 2	8 Mile	South	R153	Cast Iron	Private	1940	8	415	0	0.00	1.3	0.8	0.5	0.5	3.1	1.0	3.1	$ 138,903
Eastland Mall 2	Eastland Drive	North	R152	Cast Iron	Private	1957	8	6141	0	0.00	1.1	0.8	0.5	0.5	2.9	1.0	2.9	$ 2,057,156
Eastland Village	Beaconsfield	Balfour	R067	Cast Iron	Local	1962	8	552	0	0.00	0.9	0.8	0.5	1.0	3.2	1.0	3.2	$ 184,882
Eastwood	Kelly	Beaconsfield	R010	Cast Iron	Local	1940	8	3579	9	0.38	1.3	0.8	0.5	1.0	3.6	3.0	10.8	$ 1,199,010
Eastwood	Beaconsfield	Harper	R058	Cast Iron	Local	1940	8	3769	6	0.24	1.3	0.8	0.5	1.0	3.6	3.0	10.8	$ 1,262,661
Edgefield	Kingsville	Bournemouth	R090	Cast Iron	Local	1950	8	556	1	0.27	1.1	0.8	0.5	1.0	3.4	3.0	10.2	$ 186,100
Elkhart	Kelly	Beaconsfield	R003	Duct Iron	Local	1984	8	3456	3	0.13	0.6	0.8	0.5	1.0	2.9	2.0	5.8	$ 1,157,595
Elkhart	Beaconsfield	Harper	R049	Duct Iron	Local	1988	8	3772	2	0.08	0.6	0.8	0.5	1.0	2.9	2.0	5.8	$ 1,263,780
Elm Ct	Woodmont	Cul de Sac	R021	Cast Iron	Local	1952	6	119	0	0.00	1.1	0.5	1.0	1.0	3.6	1.0	3.6	$ 39,920
Fleetwood	Harper	E.C.L.	R122	Cast Iron	Local	1950	8	1178	2	0.25	1.1	0.8	0.5	1.0	3.4	3.0	10.2	$ 394,750
Fleetwood	Beaconsfield	Peerless	R068	Cast Iron	Local	1961	8	1341	1	0.11	0.9	0.8	0.5	1.0	3.2	2.0	6.4	$ 449,289
Fleetwood	Peerless	Harper	R155	Cast Iron	Local	1940	8	1998	0	0.00	1.3	0.8	0.5	1.0	3.6	1.0	3.6	$ 669,356
Hampton	Harper	E.C.L.	R136	Cast Iron	Local	1950	6	948	5	0.79	1.1	0.5	1.0	1.0	3.6	5.0	18.0	$ 317,424
Harper Ct	Woodmont	Cul de Sac	R019	Cast Iron	Local	1952	6	109	0	0.00	1.1	0.5	1.0	1.0	3.6	1.0	3.6	$ 36,524
Harper North	Vernier	Hunt Club	R039	Cast Iron	Major	1950	6	2541	4	0.24	1.1	0.5	1.5	1.5	4.6	3.0	13.8	$ 851,184
Harper North	Hunt Club	Manchester	R038	Cast Iron	Major	1957	6	2184	1	0.07	1.1	0.5	1.5	1.5	4.6	2.0	9.2	$ 731,730
Harper North	8 Mile	Hawthorne	R041	Duct Iron	Major	1950	12	1132	1	0.13	1.1	1.1	0.5	1.5	4.2	2.0	8.4	$ 413,047
Harper North	Kingsville	Littlestone	R037	Cast Iron	Major	1950	6	2399	0	0.00	1.1	0.5	1.5	1.5	4.6	1.0	4.6	$ 803,810
Harper North	Vernier	Hawthorne	R040	Duct Iron	Major	1955	12	848	0	0.00	1.1	1.1	0.5	1.5	4.2	1.0	4.2	$ 309,402
Harper South	Vernier	Woodmont	R035	Cast Iron	Major	1950	16	3691	0	0.00	1.1	1.5	0.5	1.5	4.6	1.0	4.6	$ 1,476,589
Harper South	Woodmont	Kingsville	R036	Cast Iron	Major	1957	16	4249	0	0.00	1.1	1.5	0.5	1.5	4.6	1.0	4.6	$ 1,699,625
Harper South	Vernier	Ridgemont	R034	Cast Iron	Major	1950	12	1437	0	0.00	1.1	1.1	0.5	1.5	4.2	1.0	4.2	$ 524,546
Harper Woods High School 1	Beaconsfield	West	R148	Cast Iron	Private	1940	8	651	0	0.00	1.3	0.8	0.5	0.5	3.1	1.0	3.1	$ 217,978
Hawthorne	Harper	Canton	R133	Cast Iron	Local	1950	8	790	1	0.19	1.1	0.8	0.5	1.0	3.4	2.0	6.8	$ 264,585

Street	From	To	Run ID	Material	Road Type	Year Installed	Diameter (in.)	Length (ft.)	Recorded Breaks	Breaks per 150 ft.	Consequence of Failure Criteria				Consequence of Failure (COF)	Probability of Failure (POF): Breaks/150 ft.	Criticality Score (BRE)	Replacement Cost
											Pipe Age	Pipe Size	Undersize Pipe	Road Type				
Helen	Woodmont	Kenmore	R114	Cast Iron	Local	1950	8	710	0	0.00	1.1	0.8	0.5	1.0	3.4	1.0	3.4	$ 237,894
Helen Ct	Woodmont	Cul de Sac	R113	Cast Iron	Local	1955	6	188	0	0.00	1.1	0.5	1.0	1.0	3.6	1.0	3.6	$ 62,918
Hollywood	8 Mile	Harper	R083	Cast Iron	Local	1938	6	1600	6	0.56	1.5	0.5	1.0	1.0	4.0	4.0	16.0	$ 536,139
Hollywood	Harper	E.C.L.	R134	Cast Iron	Local	1940	6	981	2	0.31	1.3	0.5	1.0	1.0	3.8	3.0	11.4	$ 328,542
Hunt Club	Harper	Helen	R118	Cast Iron	Local	1945	8	1528	5	0.49	1.3	0.8	0.5	1.0	3.6	4.0	14.4	$ 511,967
Hunt Club	Lochmoor	Duprey	R072	Cast Iron	Local	1953	8	1295	1	0.12	1.1	0.8	0.5	1.0	3.4	2.0	6.8	$ 433,895
Hunt Club	Harper	Duprey	R073	Cast Iron	Local	1955	8	1487	1	0.10	1.1	0.8	0.5	1.0	3.4	2.0	6.8	$ 498,252
Huntington	Kelly	Beaconsfield	R011	Cast Iron	Local	1945	8	3542	5	0.21	1.3	0.8	0.5	1.0	3.6	3.0	10.8	$ 1,186,545
Huntington	Beaconsfield	Harper	R060	Cast Iron	Local	1941	8	3587	4	0.17	1.3	0.8	0.5	1.0	3.6	2.0	7.2	$ 1,201,716
Huntington	Arthur	E.C.L.	R109	Cast Iron	Local	1950	8	972	1	0.15	1.1	0.8	0.5	1.0	3.4	2.0	6.8	$ 325,687
I-94 Crossover	Vernier	Van Antwerp	R042	Cast Iron	Major	1957	12	332	0	0.00	1.1	1.1	0.5	1.5	4.2	1.0	4.2	$ 121,140
I-94 Crossover 2	Country Club	Lochmoor	R043	Cast Iron	Major	1957	12	259	0	0.00	1.1	1.1	0.5	1.5	4.2	1.0	4.2	$ 94,661
I-94 Crossover 3	Woodmont	Huntington	R044	Cast Iron	Major	1957	12	259	0	0.00	1.1	1.1	0.5	1.5	4.2	1.0	4.2	$ 94,508
I-94 Crossover 4	Woodland	Woodcrest	R045	Cast Iron	Major	1957	12	263	0	0.00	1.1	1.1	0.5	1.5	4.2	1.0	4.2	$ 96,065
I-94 Easement	Harper North	Harper South	R139	Cast Iron	Major	1957	8	633	0	0.00	1.1	0.8	1.3	1.5	4.7	1.0	4.7	$ 212,033
Johnstone Park	Beaconsfield	West	R149	Cast Iron	Local	1940	6	161	0	0.00	1.3	0.5	1.0	1.0	3.8	1.0	3.8	$ 53,947
Kelly	Kingsville	Eastwood	R024	Cast Iron	Major	1940	12	3076	4	0.20	1.3	1.1	0.5	1.5	4.4	2.0	8.8	$ 1,122,847
Kelly	Eastwood	8 Mile	R025	Cast Iron	Major	1940	12	2893	1	0.05	1.3	1.1	0.5	1.5	4.4	2.0	8.8	$ 1,055,837
Kenmore	Harper	Duprey	R074	Cast Iron	Local	1955	8	1389	1	0.11	1.1	0.8	0.5	1.0	3.4	2.0	6.8	$ 465,378
Kenmore	Norwood	E.C.L.	R115	Cast Iron	Local	1950	8	1602	1	0.09	1.1	0.8	0.5	1.0	3.4	2.0	6.8	$ 536,544
Kenosha	Kelly	Beaconsfield	R002	Duct Iron	Local	1983	8	3530	1	0.04	0.6	0.8	0.5	1.0	2.9	2.0	5.8	$ 1,182,425
Kenosha	Beaconsfield	Harper	R048	Duct Iron	Local	1983	8	3774	0	0.00	0.6	0.8	0.5	1.0	2.9	1.0	2.9	$ 1,264,293
Kingsville	Harper	Eastbourne	R087	Cast Iron	Local	1948	6	2951	1	0.05	1.3	0.5	1.0	1.0	3.8	2.0	7.6	$ 988,447
Kroger	Harper	West	R140	Cast Iron	Private	1957	8	254	0	0.00	1.1	0.8	0.5	0.5	2.9	1.0	2.9	$ 85,090
Lancaster	Beaconsfield	Harper	R076	Cast Iron	Local	1950	8	3328	4	0.18	1.1	0.8	0.5	1.0	3.4	2.0	6.8	$ 1,114,988
Lancaster	Harper	E.C.L.	R121	Cast Iron	Local	1945	8	1245	0	0.00	1.3	0.8	0.5	1.0	3.6	1.0	3.6	$ 417,092
Lansdowne	Washtenaw	Woodland	R055	Cast Iron	Local	1940	8	1904	1	0.08	1.3	0.8	0.5	1.0	3.6	2.0	7.2	$ 637,863
Lennon	Harper	Williamsburg	R079	Cast Iron	Local	1954	8	2252	3	0.20	1.1	0.8	0.5	1.0	3.4	2.0	6.8	$ 754,575
Lennon	Harper	E.C.L.	R124	Cast Iron	Local	1950	8	1041	1	0.14	1.1	0.8	0.5	1.0	3.4	2.0	6.8	$ 348,640
Leslie	Bournemouth	Prestwick	R097	Cast Iron	Local	1950	8	673	0	0.00	1.1	0.8	0.5	1.0	3.4	1.0	3.4	$ 225,312

Street	From	To	Run ID	Material	Road Type	Year Installed	Diameter (in.)	Length (ft.)	Recorded Breaks	Breaks per 150 ft.	Consequence of Failure Criteria				Consequence of Failure (COF)	Probability of Failure (POF): Breaks/150 ft.	Criticality Score (BRE)	Replacement Cost
											Pipe Age	Pipe Size	Undersize Pipe	Road Type				
Littlestone	Harper	Craig	R103	Cast Iron	Local	1950	8	2070	3	0.22	1.1	0.8	0.5	1.0	3.4	3.0	10.2	$ 693,558
Lochmoor	Harper	Helen	R119	Cast Iron	Local	1945	8	1365	1	0.11	1.3	0.8	0.5	1.0	3.6	2.0	7.2	$ 457,330
Lochmoor	Beaconsfield	Harper	R069	Cast Iron	Local	1953	8	3365	4	0.18	1.1	0.8	0.5	1.0	3.4	2.0	6.8	$ 1,127,263
Manchester	Harper	E.C.L.	R107	Cast Iron	Local	1957	8	2093	1	0.07	1.1	0.8	0.5	1.0	3.4	2.0	6.8	$ 701,156
Newcastle	Harper	Leslie	R099	Cast Iron	Local	1950	8	1929	2	0.16	1.1	0.8	0.5	1.0	3.4	2.0	6.8	$ 646,325
Norwood	Harper	Helen	R117	Cast Iron	Local	1950	8	1541	0	0.00	1.1	0.8	0.5	1.0	3.4	1.0	3.4	$ 516,078
Old Homestead	Kelly	Beaconsfield	R009	Duct Iron	Local	1987	8	3408	0	0.00	0.6	0.8	0.5	1.0	2.9	1.0	2.9	$ 1,141,763
Old Homestead	Beaconsfield	East End	R057	Duct Iron	Local	1987	8	3481	0	0.00	0.6	0.8	0.5	1.0	2.9	1.0	2.9	$ 1,166,226
Park Place of Harper Woods	Tyrone	West	R142	Cast Iron	Private	1984	8	710	0	0.00	0.6	0.8	0.5	0.5	2.4	1.0	2.4	$ 237,822
Parkcrest	Harper	Helen	R116	Cast Iron	Local	1950	8	1648	0	0.00	1.1	0.8	0.5	1.0	3.4	1.0	3.4	$ 552,036
Peerless	Woodcrest	Woodland	R053	Duct Iron	Local	1945	8	402	0	0.00	1.3	0.8	0.5	1.0	3.6	1.0	3.6	$ 134,728
Peerless	Washtenaw	Woodcrest	R054	Cast Iron	Local	1945	8	1511	0	0.00	1.3	0.8	0.5	1.0	3.6	1.0	3.6	$ 506,029
Peerless	Damman	S. of Woodmont	R062	Cast Iron	Local	1952	8	569	0	0.00	1.1	0.8	0.5	1.0	3.4	1.0	3.4	$ 190,470
Peerless	Damman	Lancaster	R064	Cast Iron	Local	1950	8	1323	0	0.00	1.1	0.8	0.5	1.0	3.4	1.0	3.4	$ 443,153
Peerless	Vernier	Fleetwood	R065	Cast Iron	Local	1950	8	1267	0	0.00	1.1	0.8	0.5	1.0	3.4	1.0	3.4	$ 424,331
Prestwick	Harper	Leslie	R098	Cast Iron	Local	1950	8	1740	6	0.52	1.1	0.8	0.5	1.0	3.4	4.0	13.6	$ 582,996
Ridgemont	8 Mile	Harper	R084	Cast Iron	Local	1938	6	693	2	0.43	1.5	0.5	1.0	1.0	4.0	4.0	16.0	$ 232,005
Ridgemont	Harper	E.C.L.	R135	Duct Iron	Local	1997	8	968	0	0.00	0.5	0.8	0.5	1.0	2.8	1.0	2.8	$ 324,407
Rockcastle	Kingsville	Bournemouth	R089	Cast Iron	Local	1950	8	553	2	0.54	1.1	0.8	0.5	1.0	3.4	4.0	13.6	$ 185,261
Rolandale	Kingsville	Bournemouth	R094	Cast Iron	Local	1950	8	559	4	1.07	1.1	0.8	0.5	1.0	3.4	5.0	17.0	$ 187,372
Roscommon	Beaconsfield	Harper	R050	Duct Iron	Local	1991	8	3880	1	0.04	0.5	0.8	0.5	1.0	2.8	2.0	5.6	$ 1,299,803
Roscommon	Kelly	Beaconsfield	R004	Duct Iron	Local	1990	8	3684	0	0.00	0.5	0.8	0.5	1.0	2.8	1.0	2.8	$ 1,234,277
Rose Ct	Woodmont	Cul de Sac	R023	Cast Iron	Local	1952	6	119	0	0.00	1.1	0.5	1.0	1.0	3.6	1.0	3.6	$ 39,962
Roslyn	8 Mile	E.C.L.	R137	Duct Iron	Local	1998	8	483	1	0.31	0.5	0.8	0.5	1.0	2.8	3.0	8.4	$ 161,880
Salter Park	Harper	East	R143	Cast Iron	Private	1984	8	929	0	0.00	0.6	0.8	0.5	0.5	2.4	1.0	2.4	$ 311,149
Sanilac	Old Homestead	Eastwood	R059	Duct Iron	Local	1940	8	429	0	0.00	1.3	0.8	0.5	1.0	3.6	1.0	3.6	$ 143,843
Severn	Tyrone	Craig	R104	Cast Iron	Local	1950	8	928	5	0.81	1.1	0.8	0.5	1.0	3.4	5.0	17.0	$ 311,019
Sloan	Tyrone	Berden	R096	Cast Iron	Local	1950	8	1216	3	0.37	1.1	0.8	0.5	1.0	3.4	3.0	10.2	$ 407,338
Starr Academy	Harper	East	R144	Cast Iron	Private	1957	8	573	0	0.00	1.1	0.8	0.5	0.5	2.9	1.0	2.9	$ 191,972
Starr Academy 2	Bournemouth	North	R145	Cast Iron	Private	1950	6	220	0	0.00	1.1	0.5	1.0	0.5	3.1	1.0	3.1	$ 73,697

Street	From	To	Run ID	Material	Road Type	Year Installed	Diameter (in.)	Length (ft.)	Recorded Breaks	Breaks per 150 ft.	Consequence of Failure Criteria				Consequence of Failure (COF)	Probability of Failure (POF): Breaks/150 ft.	Criticality Score (BRE)	Replacement Cost
											Pipe Age	Pipe Size	Undersize Pipe	Road Type				
Tyrone	Kingsville	Prestwick	R091	Cast Iron	Local	1950	8	1195	1	0.13	1.1	0.8	0.5	1.0	3.4	2.0	6.8	$ 400,385
Tyrone	Prestwick	Littlestone	R092	Cast Iron	Local	1950	8	1098	0	0.00	1.1	0.8	0.5	1.0	3.4	1.0	3.4	$ 367,936
Van Antwerp	Harper	Williamsburg	R080	Cast Iron	Local	1950	8	2229	3	0.20	1.1	0.8	0.5	1.0	3.4	3.0	10.2	$ 746,658
Van Antwerp	Harper	E.C.L.	R125	Cast Iron	Local	1950	8	1057	0	0.00	1.1	0.8	0.5	1.0	3.4	1.0	3.4	$ 354,138
Vernier	Kelly	Beaconsfield	R031	Cast Iron	Major	1940	12	3149	7	0.33	1.3	1.1	0.5	1.5	4.4	3.0	13.2	$ 1,149,531
Vernier	Beaconsfield	Harper	R032	Cast Iron	Major	1940	12	3238	1	0.05	1.3	1.1	0.5	1.5	4.4	2.0	8.8	$ 1,181,986
Vernier North	Harper	Peerless	R033	Cast Iron	Major	1940	8	2277	0	0.00	1.3	0.8	1.3	1.5	4.9	1.0	4.9	$ 762,725
Vernier North	Harper	E.C.L.	R127	Cast Iron	Major	1955	8	1065	0	0.00	1.1	0.8	1.3	1.5	4.7	1.0	4.7	$ 356,901
Vernier South	Harper	E.C.L.	R126	Cast Iron	Major	1950	8	992	0	0.00	1.1	0.8	1.3	1.5	4.7	1.0	4.7	$ 332,378
Washtenaw	Kelly	Beaconsfield	R001	Duct Iron	Local	1979	8	3460	2	0.09	0.7	0.8	0.5	1.0	3.0	2.0	6.0	$ 1,158,982
Washtenaw	Beaconsfield	Harper	R047	Duct Iron	Local	1980	8	3831	1	0.04	0.6	0.8	0.5	1.0	2.9	2.0	5.8	$ 1,283,381
Wildwood	Harper	Arthur	R108	Cast Iron	Local	1960	8	1142	0	0.00	0.9	0.8	0.5	1.0	3.2	1.0	3.2	$ 382,547
Williamsburg Ct	Vernier	Beaufait	R078	Cast Iron	Local	1964	8	950	0	0.00	0.9	0.8	0.5	1.0	3.2	1.0	3.2	$ 318,091
Woodcrest	Beaconsfield	Harper	R052	Duct Iron	Local	1940	8	3776	0	0.00	1.3	0.8	0.5	1.0	3.6	1.0	3.6	$ 1,264,995
Woodcrest	Kelly	Crestland	R006	Duct Iron	Local	1996	8	3100	0	0.00	0.5	0.8	0.5	1.0	2.8	1.0	2.8	$ 1,038,594
Woodland	Beaconsfield	Harper	R056	Cast Iron	Local	1945	8	3754	3	0.12	1.3	0.8	0.5	1.0	3.6	2.0	7.2	$ 1,257,525
Woodland	Kelly	Beaconsfield	R008	Cast Iron	Local	1950	8	3500	2	0.09	1.1	0.8	0.5	1.0	3.4	2.0	6.8	$ 1,172,423
Woodmont	Beaconsfield	Harper	R061	Cast Iron	Local	1952	8	3534	5	0.21	1.1	0.8	0.5	1.0	3.4	3.0	10.2	$ 1,183,805
Woodmont	Beaconsfield	Cul de Sac	R012	Cast Iron	Local	1952	8	1736	2	0.17	1.1	0.8	0.5	1.0	3.4	2.0	6.8	$ 581,677
Woodmont	Harper	Helen Ct	R112	Cast Iron	Local	1950	8	1686	0	0.00	1.1	0.8	0.5	1.0	3.4	1.0	3.4	$ 564,907
Woodside	Kelly	Beaconsfield	R005	Duct Iron	Local	1992	8	3529	2	0.09	0.5	0.8	0.5	1.0	2.8	2.0	5.6	$ 1,182,282
Woodside	Beaconsfield	Harper	R051	Cast Iron	Local	1950	8	3822	0	0.00	1.1	0.8	0.5	1.0	3.4	1.0	3.4	$ 1,280,416

APPENDIX D: CRITICALITY ANALYSIS – GATE VALVES

Street	Valve ID	Run ID	Road Type	Year Installed	Diameter (in)	Recorded Breaks	Consequence of Failure Criteria				Consequence of Failure (COF)	Probability of Failure (POF): Breaks/150 ft.	Criticality Score (BRE)
							Pipe Age	Pipe Size	Undersize Pipe	Road Type			
8 Mile	V435	R085	Major	1938	8	1	1.3	0.8	1.3	1.5	4.9	2.0	9.8
8 Mile	V139	R085	Major	1938	8	1	1.3	0.8	1.3	1.5	4.9	2.0	9.8
8 Mile	V439	R085	Major	1938	8	1	1.3	0.8	1.3	1.5	4.9	2.0	9.8
8 Mile	V438	R085	Local	1938	8	1	1.3	0.8	0.5	1.0	3.6	2.0	7.2
8 Mile	V138	R085	Major	1938	8	1	1.3	0.8	1.3	1.5	4.9	2.0	9.8
8 Mile	V136	R085	Major	1938	8	1	1.3	0.8	1.3	1.5	4.9	2.0	9.8
8 Mile	V135	R085	Major	1938	8	1	1.3	0.8	1.3	1.5	4.9	2.0	9.8
8 Mile	V146	R086	Major	1967	8	0	1.3	0.8	1.3	1.5	4.9	1.0	4.9
8 Mile	V140	R086	Major	1967	8	0	1.3	0.8	1.3	1.5	4.9	1.0	4.9
8 Mile	V456	R138	Major	1940	8	0	1.3	0.8	1.3	1.5	4.9	1.0	4.9
8 Mile	V441	R138	Major	1940	8	0	1.3	0.8	1.3	1.5	4.9	1.0	4.9
Anita	V434	R081	Local	1940	8	6	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Anita	V137	R081	Local	1940	8	6	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Anita	V127	R081	Local	1940	8	6	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Anita	V126	R081	Major	1940	8	6	1.3	0.8	1.3	1.5	4.9	3.0	14.7
Anita	V445	R128	Local	1950	8	2	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Anita	V016	R128	Local	1950	8	2	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Arthur	V046	R110	Local	1950	8	1	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Arthur	V389	R111	Local	1950	6	0	1.3	0.5	1.0	1.0	3.8	1.0	3.8
Arthur	V042	R111	Local	1950	6	0	1.3	0.5	1.0	1.0	3.8	1.0	3.8
Balfour	V172	R066	Local	1962	8	1	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Balfour	V170	R066	Local	1962	8	1	1.3	0.8	0.5	1.0	3.6	2.0	7.2

Street	Valve ID	Run ID	Road Type	Year Installed	Diameter (in)	Recorded Breaks	Consequence of Failure Criteria				Consequence of Failure (COF)	Probability of Failure (POF): Breaks/150 ft.	Criticality Score (BRE)
							Pipe Age	Pipe Size	Undersize Pipe	Road Type			
Balfour	V145	R066	Local	1962	8	1	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Balfour	V203	R071	Local	1953	6	0	1.3	0.5	1.0	1.0	3.8	1.0	3.8
Beacon Elementary	V391	R146	Private	1940	8	0	1.3	0.8	0.5	0.5	3.1	1.0	3.1
Beaconsfield	V399	R026	Major	1940	6	2	1.3	0.5	1.5	1.5	4.8	3.0	14.4
Beaconsfield	V334	R026	Major	1940	6	2	1.3	0.5	1.5	1.5	4.8	3.0	14.4
Beaconsfield	V330	R026	Major	1940	6	2	1.3	0.5	1.5	1.5	4.8	3.0	14.4
Beaconsfield	V454	R027	Major	1940	8	0	1.3	0.8	1.3	1.5	4.9	1.0	4.9
Beaconsfield	V295	R027	Major	1940	8	0	1.3	0.8	1.3	1.5	4.9	1.0	4.9
Beaconsfield	V338	R027	Major	1940	8	0	1.3	0.8	1.3	1.5	4.9	1.0	4.9
Beaconsfield	V333	R027	Major	1940	8	0	1.3	0.8	1.3	1.5	4.9	1.0	4.9
Beaconsfield	V328	R027	Major	1940	8	0	1.3	0.8	1.3	1.5	4.9	1.0	4.9
Beaconsfield	V323	R027	Major	1940	8	0	1.3	0.8	1.3	1.5	4.9	1.0	4.9
Beaconsfield	V268	R028	Major	1950	8	1	1.3	0.8	1.3	1.5	4.9	2.0	9.8
Beaconsfield	V261	R028	Major	1950	8	1	1.3	0.8	1.3	1.5	4.9	2.0	9.8
Beaconsfield	V260	R028	Major	1950	8	1	1.3	0.8	1.3	1.5	4.9	2.0	9.8
Beaconsfield	V232	R028	Major	1950	8	1	1.3	0.8	1.3	1.5	4.9	2.0	9.8
Beaconsfield	V219	R028	Major	1950	8	1	1.3	0.8	1.3	1.5	4.9	2.0	9.8
Beaconsfield	V424	R029	Major	1940	12	0	1.3	1.2	0.5	1.5	4.5	1.0	4.5
Beaconsfield	V175	R029	Major	1940	12	0	1.3	1.2	0.5	1.5	4.5	1.0	4.5
Beaconsfield	V143	R030	Major	1976	12	0	1.1	1.2	0.5	1.5	4.3	1.0	4.3
Beaconsfield	V143	R030	Major	1976	12	0	1.1	1.2	0.5	1.5	4.3	1.0	4.3
Beaconsfield	V142	R030	Major	1976	12	0	1.1	1.2	0.5	1.5	4.3	1.0	4.3

Street	Valve ID	Run ID	Road Type	Year Installed	Diameter (in)	Recorded Breaks	Consequence of Failure Criteria				Consequence of Failure (COF)	Probability of Failure (POF): Breaks/150 ft.	Criticality Score (BRE)
							Pipe Age	Pipe Size	Undersize Pipe	Road Type			
Beaconsfield	V141	R030	Major	1976	12	0	1.1	1.2	0.5	1.5	4.3	1.0	4.3
Beaconsfield	V177	R156	Major	1940	8	3	1.3	0.8	1.3	1.5	4.9	3.0	14.7
Beaconsfield	V201	R156	Major	1940	8	3	1.3	0.8	1.3	1.5	4.9	3.0	14.7
Beaconsfield	V197	R156	Major	1940	8	3	1.3	0.8	1.3	1.5	4.9	3.0	14.7
Beaconsfield Apartments	V177	R150	Major	1969	8	0	1.3	0.8	1.3	1.5	4.9	1.0	4.9
Beaconsfield Apartments	V174	R150	Private	1969	8	0	1.3	0.8	0.5	0.5	3.1	1.0	3.1
Beaufait	V395	R077	Local	1949	8	3	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Beaufait	V165	R077	Local	1949	8	3	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Beaufait	V164	R077	Local	1949	8	3	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Beaufait	V160	R077	Local	1949	8	3	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Beaufait	V119	R123	Major	1950	8	0	1.3	0.8	1.3	1.5	4.9	1.0	4.9
Beaufait	V024	R123	Local	1950	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Berden	V072	R093	Local	1950	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Berden	V068	R093	Local	1950	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Bournemouth	V095	R088	Major	1950	8	1	1.3	0.8	1.3	1.5	4.9	2.0	9.8
Bournemouth	V077	R088	Local	1950	8	1	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Bournemouth	V071	R088	Local	1950	8	1	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Brierstone	V085	R105	Local	1950	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Brierstone	V056	R105	Local	1950	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Broadstone	V086	R106	Local	1950	8	2	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Broadstone	V053	R106	Local	1950	8	2	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Canton	V014	R130	Local	1960	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6

Street	Valve ID	Run ID	Road Type	Year Installed	Diameter (in)	Recorded Breaks	Consequence of Failure Criteria				Consequence of Failure (COF)	Probability of Failure (POF): Breaks/150 ft.	Criticality Score (BRE)
							Pipe Age	Pipe Size	Undersize Pipe	Road Type			
Canton	V013	R132	Local	1990	8	0	0.5	0.8	0.5	1.0	2.8	1.0	2.8
Canton	V004	R132	Local	1990	8	0	0.5	0.8	0.5	1.0	2.8	1.0	2.8
Canton	V001	R132	Local	1990	8	0	0.5	0.8	0.5	1.0	2.8	1.0	2.8
Chandler Park H.S.	V249	R154	Private	1940	6	0	1.3	0.5	1.0	0.5	3.3	1.0	3.3
Chandler Park H.S.	V248	R154	Local	1940	6	0	1.3	0.5	1.0	1.0	3.8	1.0	3.8
Country Club	V394	R075	Local	1953	8	6	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Country Club	V199	R075	Major	1953	8	6	1.3	0.8	1.3	1.5	4.9	3.0	14.7
Country Club	V196	R075	Local	1953	8	6	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Country Club	V195	R075	Local	1953	8	6	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Country Club	V191	R075	Local	1953	8	6	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Country Club	V190	R075	Local	1953	8	6	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Country Club	V110	R120	Major	1945	8	1	1.3	0.8	1.3	1.5	4.9	2.0	9.8
Country Club	V027	R120	Local	1945	8	1	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Craig East	V059	R101	Local	1950	8	0	1.3	0.8	0.5	1.0	3.6	4.0	14.4
Craig East	V054	R101	Local	1950	8	0	1.3	0.8	0.5	1.0	3.6	4.0	14.4
Craig East	V052	R101	Local	1950	8	0	1.3	0.8	0.5	1.0	3.6	4.0	14.4
Craig West	V058	R100	Local	1950	8	2	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Craig West	V055	R100	Local	1950	8	2	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Crestland	V406	R007	Local	1996	8	0	0.5	0.8	0.5	1.0	2.8	1.0	2.8
Damman	V218	R063	Local	1950	8	3	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Damman	V217	R063	Local	1950	8	3	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Damman	V214	R063	Local	1950	8	3	1.3	0.8	0.5	1.0	3.6	2.0	7.2

Street	Valve ID	Run ID	Road Type	Year Installed	Diameter (in)	Recorded Breaks	Consequence of Failure Criteria				Consequence of Failure (COF)	Probability of Failure (POF): Breaks/150 ft.	Criticality Score (BRE)
							Pipe Age	Pipe Size	Undersize Pipe	Road Type			
Damman	V213	R063	Local	1950	8	3	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Damman	V212	R063	Local	1950	8	3	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Danbury	V436	R082	Local	1964	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Danbury	V437	R082	Local	1964	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Danbury	V130	R082	Local	1964	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Danbury	V129	R082	Local	1964	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Danbury	V128	R082	Local	1964	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Eastbourne	V066	R095	Local	1950	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Eastbourne	V064	R095	Local	1950	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Eastland Mall 2	V431	R152	Private	1957	12	0	1.3	1.2	0.5	0.5	3.5	1.0	3.5
Eastland Mall 2	V237	R152	Private	1957	12	0	1.3	1.2	0.5	0.5	3.5	1.0	3.5
Eastland Mall 2	V247	R152	Local	1957	12	0	1.3	1.2	0.5	1.0	4.0	1.0	4.0
Eastland Mall 2	V245	R152	Private	1957	12	0	1.3	1.2	0.5	0.5	3.5	1.0	3.5
Eastland Mall 2	V242	R152	Private	1957	8	0	1.3	0.8	0.5	0.5	3.1	1.0	3.1
Eastland Mall 2	V241	R152	Private	1957	8	0	1.3	0.8	0.5	0.5	3.1	1.0	3.1
Eastland Mall 2	V238	R152	Private	1957	12	0	1.3	1.2	0.5	0.5	3.5	1.0	3.5
Eastland Mall 2	V240	R152	Private	1957	12	0	1.3	1.2	0.5	0.5	3.5	1.0	3.5
Eastland Mall 2	V240	R152	Private	1957	12	0	1.3	1.2	0.5	0.5	3.5	1.0	3.5
Eastland Mall 2	V173	R152	Local	1957	12	0	1.3	1.2	0.5	1.0	4.0	1.0	4.0
Eastland Mall 2	V423	R153	Private	1940	8	0	1.3	0.8	0.5	0.5	3.1	1.0	3.1
Eastland Village	V432	R067	Local	1962	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Eastland Village	V171	R067	Local	1962	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6

Street	Valve ID	Run ID	Road Type	Year Installed	Diameter (in)	Recorded Breaks	Consequence of Failure Criteria				Consequence of Failure (COF)	Probability of Failure (POF): Breaks/150 ft.	Criticality Score (BRE)
							Pipe Age	Pipe Size	Undersize Pipe	Road Type			
Eastwood	V417	R010	Local	1940	8	9	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Eastwood	V258	R010	Local	1940	8	9	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Eastwood	V257	R010	Local	1940	8	9	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Eastwood	V255	R010	Local	1940	8	9	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Eastwood	V254	R010	Local	1940	8	9	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Eastwood	V259	R058	Local	1940	8	6	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Eastwood	V262	R058	Local	1940	8	6	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Eastwood	V263	R058	Local	1940	8	6	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Eastwood	V050	R058	Local	1940	8	6	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Edgefield	V092	R090	Local	1950	8	1	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Edgefield	V090	R090	Local	1950	8	1	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Elkhart	V381	R003	Local	1984	8	3	0.8	0.8	0.5	1.0	3.1	2.0	6.2
Elkhart	V378	R003	Local	1984	8	3	0.8	0.8	0.5	1.0	3.1	2.0	6.2
Elkhart	V370	R003	Local	1984	8	3	0.8	0.8	0.5	1.0	3.1	2.0	6.2
Elkhart	V361	R003	Local	1984	8	3	0.8	0.8	0.5	1.0	3.1	2.0	6.2
Elkhart	V358	R003	Local	1984	8	3	0.8	0.8	0.5	1.0	3.1	2.0	6.2
Elkhart	V335	R003	Local	1984	8	3	0.8	0.8	0.5	1.0	3.1	2.0	6.2
Elkhart	V390	R049	Local	1988	8	2	0.8	0.8	0.5	1.0	3.1	2.0	6.2
Elkhart	V332	R049	Local	1988	8	2	0.8	0.8	0.5	1.0	3.1	2.0	6.2
Elkhart	V313	R049	Local	1988	8	2	0.8	0.8	0.5	1.0	3.1	2.0	6.2
Elkhart	V312	R049	Local	1988	8	2	0.8	0.8	0.5	1.0	3.1	2.0	6.2
Elkhart	V310	R049	Local	1988	8	2	0.8	0.8	0.5	1.0	3.1	2.0	6.2

Street	Valve ID	Run ID	Road Type	Year Installed	Diameter (in)	Recorded Breaks	Consequence of Failure Criteria				Consequence of Failure (COF)	Probability of Failure (POF): Breaks/150 ft.	Criticality Score (BRE)
							Pipe Age	Pipe Size	Undersize Pipe	Road Type			
Elkhart	V308	R049	Local	1988	8	2	0.8	0.8	0.5	1.0	3.1	2.0	6.2
Fleetwood	V176	R068	Major	1961	8	1	1.3	0.8	1.3	1.5	4.9	2.0	9.8
Fleetwood	V169	R068	Local	1961	8	1	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Fleetwood	V168	R068	Local	1961	8	1	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Fleetwood	V117	R122	Major	1950	4	2	1.3	0.0	FALSE	1.5	2.8	3.0	8.4
Fleetwood	V025	R122	Local	1950	8	2	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Fleetwood	V166	R155	Local	1940	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Fleetwood	V159	R155	Local	1940	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Fleetwood	V158	R155	Local	1940	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Hampton	V387	R136	Major	1950	6	5	1.3	0.5	1.5	1.5	4.8	5.0	24.0
Hampton	V002	R136	Local	1950	8	5	1.3	0.8	0.5	1.0	3.6	5.0	18.0
Harper North	V100	R037	Major	1950	8	0	1.3	0.8	1.3	1.5	4.9	1.0	4.9
Harper North	V447	R038	Major	1957	8	1	1.3	0.8	1.3	1.5	4.9	2.0	9.8
Harper North	V449	R038	Major	1957	8	1	1.3	0.8	1.3	1.5	4.9	2.0	9.8
Harper North	V450	R038	Major	1957	8	1	1.3	0.8	1.3	1.5	4.9	2.0	9.8
Harper North	V037	R038	Major	1957	8	1	1.3	0.8	1.3	1.5	4.9	2.0	9.8
Harper North	V120	R039	Major	1950	8	4	1.3	0.8	1.3	1.5	4.9	3.0	14.7
Harper North	V118	R039	Major	1950	8	4	1.3	0.8	1.3	1.5	4.9	3.0	14.7
Harper North	V116	R039	Major	1950	8	4	1.3	0.8	1.3	1.5	4.9	3.0	14.7
Harper North	V115	R039	Major	1950	8	4	1.3	0.8	1.3	1.5	4.9	3.0	14.7
Harper North	V114	R039	Major	1950	8	4	1.3	0.8	1.3	1.5	4.9	3.0	14.7
Harper North	V112	R039	Major	1950	8	4	1.3	0.8	1.3	1.5	4.9	3.0	14.7

Street	Valve ID	Run ID	Road Type	Year Installed	Diameter (in)	Recorded Breaks	Consequence of Failure Criteria				Consequence of Failure (COF)	Probability of Failure (POF): Breaks/150 ft.	Criticality Score (BRE)
							Pipe Age	Pipe Size	Undersize Pipe	Road Type			
Harper North	V109	R039	Major	1950	8	4	1.3	0.8	1.3	1.5	4.9	3.0	14.7
Harper North	V106	R039	Major	1950	8	4	1.3	0.8	1.3	1.5	4.9	3.0	14.7
Harper North	V021	R039	Major	1950	8	4	1.3	0.8	1.3	1.5	4.9	3.0	14.7
Harper North	V444	R040	Major	1955	12	0	1.3	1.2	0.5	1.5	4.5	1.0	4.5
Harper North	V442	R041	Major	1950	12	1	1.3	1.2	0.5	1.5	4.5	2.0	9.0
Harper North	V010	R041	Major	1950	12	1	1.3	1.2	0.5	1.5	4.5	2.0	9.0
Harper South	V440	R034	Major	1950	12	0	1.3	1.2	0.5	1.5	4.5	1.0	4.5
Harper South	V430	R035	Major	1950	16	0	1.3	1.5	0.5	1.5	4.8	1.0	4.8
Harper South	V185	R035	Major	1950	16	0	1.3	1.5	0.5	1.5	4.8	1.0	4.8
Harper South	V187	R035	Major	1950	16	0	1.3	1.5	0.5	1.5	4.8	1.0	4.8
Harper South	V122	R035	Major	1950	16	0	1.3	1.5	0.5	1.5	4.8	1.0	4.8
Harper South	V458	R036	Major	1957	16	0	1.3	1.5	0.5	1.5	4.8	1.0	4.8
Harper South	V415	R036	Major	1957	16	0	1.3	1.5	0.5	1.5	4.8	1.0	4.8
Harper South	V410	R036	Major	1957	16	0	1.3	1.5	0.5	1.5	4.8	1.0	4.8
Harper South	V409	R036	Major	1957	16	0	1.3	1.5	0.5	1.5	4.8	1.0	4.8
Harper South	V040	R036	Major	1957	16	0	1.3	1.5	0.5	1.5	4.8	1.0	4.8
Harper South	V039	R036	Major	1957	16	0	1.3	1.5	0.5	1.5	4.8	1.0	4.8
Harper Woods High School 1	V198	R148	Private	1940	6	0	1.3	0.5	1.0	0.5	3.3	1.0	3.3
Hawthorne	V012	R133	Local	1950	8	1	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Hawthorne	V011	R133	Local	1950	8	1	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Helen	V034	R114	Local	1950	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Helen	V031	R114	Local	1950	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6

Street	Valve ID	Run ID	Road Type	Year Installed	Diameter (in)	Recorded Breaks	Consequence of Failure Criteria				Consequence of Failure (COF)	Probability of Failure (POF): Breaks/150 ft.	Criticality Score (BRE)
							Pipe Age	Pipe Size	Undersize Pipe	Road Type			
Helen Ct	V033	R113	Local	1955	6	0	1.3	0.5	1.0	1.0	3.8	1.0	3.8
Hollywood	V133	R083	Local	1938	6	6	1.3	0.5	1.0	1.0	3.8	4.0	15.2
Hollywood	V132	R083	Local	1938	6	6	1.3	0.5	1.0	1.0	3.8	4.0	15.2
Hollywood	V131	R083	Local	1938	6	6	1.3	0.5	1.0	1.0	3.8	4.0	15.2
Hollywood	V009	R134	Local	1940	6	2	1.3	0.5	1.0	1.0	3.8	3.0	11.4
Hollywood	V008	R134	Local	1940	8	2	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Hunt Club	V206	R072	Local	1953	8	1	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Hunt Club	V204	R072	Local	1953	8	1	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Hunt Club	V209	R073	Local	1955	8	1	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Hunt Club	V207	R073	Local	1955	8	1	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Hunt Club	V188	R073	Local	1955	8	1	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Hunt Club	V107	R118	Major	1945	8	5	1.3	0.8	1.3	1.5	4.9	4.0	19.6
Hunt Club	V029	R118	Local	1945	8	5	1.3	0.8	0.5	1.0	3.6	4.0	14.4
Huntington	V252	R011	Local	1945	8	5	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Huntington	V250	R011	Local	1945	8	5	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Huntington	V231	R011	Major	1945	8	5	1.3	0.8	1.3	1.5	4.9	3.0	14.7
Huntington	V230	R060	Local	1941	8	4	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Huntington	V229	R060	Local	1941	8	4	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Huntington	V233	R060	Local	1941	8	4	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Huntington	V228	R060	Local	1941	8	4	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Huntington	V227	R060	Local	1941	8	4	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Huntington	V043	R109	Local	1950	8	1	1.3	0.8	0.5	1.0	3.6	2.0	7.2

Street	Valve ID	Run ID	Road Type	Year Installed	Diameter (in)	Recorded Breaks	Consequence of Failure Criteria				Consequence of Failure (COF)	Probability of Failure (POF): Breaks/150 ft.	Criticality Score (BRE)
							Pipe Age	Pipe Size	Undersize Pipe	Road Type			
I-94 Crossover	V121	R042	Major	1957	12	0	1.3	1.2	0.5	1.5	4.5	1.0	4.5
I-94 Crossover	V020	R042	Major	1957	12	0	1.3	1.2	0.5	1.5	4.5	1.0	4.5
I-94 Crossover 2	V393	R043	Major	1957	12	0	1.3	1.2	0.5	1.5	4.5	1.0	4.5
I-94 Crossover 2	V111	R043	Major	1957	12	0	1.3	1.2	0.5	1.5	4.5	1.0	4.5
I-94 Crossover 3	V039	R044	Major	1957	12	0	1.3	1.2	0.5	1.5	4.5	1.0	4.5
I-94 Crossover 3	V038	R044	Major	1957	12	0	1.3	1.2	0.5	1.5	4.5	1.0	4.5
I-94 Crossover 4	V409	R045	Major	1957	12	0	1.3	1.2	0.5	1.5	4.5	1.0	4.5
I-94 Crossover 4	V101	R045	Major	1957	12	0	1.3	1.2	0.5	1.5	4.5	1.0	4.5
I-94 Easement	V455	R139	Major	1957	8	0	1.3	0.8	1.3	1.5	4.9	1.0	4.9
I-94 Easement	V007	R139	Major	1957	8	0	1.3	0.8	1.3	1.5	4.9	1.0	4.9
Johnstone Park	V392	R149	Local	1940	6	0	1.3	0.5	1.0	1.0	3.8	1.0	3.8
Kelly	V398	R024	Major	1940	12	4	1.3	1.2	0.5	1.5	4.5	2.0	9.0
Kelly	V383	R024	Major	1940	12	4	1.3	1.2	0.5	1.5	4.5	2.0	9.0
Kelly	V275	R024	Major	1940	12	4	1.3	1.2	0.5	1.5	4.5	2.0	9.0
Kelly	V256	R024	Major	1940	12	4	1.3	1.2	0.5	1.5	4.5	2.0	9.0
Kelly	V420	R025	Major	1940	12	1	1.3	1.2	0.5	1.5	4.5	2.0	9.0
Kelly	V419	R025	Major	1940	12	1	1.3	1.2	0.5	1.5	4.5	2.0	9.0
Kelly	V251	R025	Major	1940	12	1	1.3	1.2	0.5	1.5	4.5	2.0	9.0
Kelly	V246	R025	Major	1940	12	1	1.3	1.2	0.5	1.5	4.5	2.0	9.0
Kelly	V253	R025	Major	1940	12	1	1.3	1.2	0.5	1.5	4.5	2.0	9.0
Kenmore	V211	R074	Local	1955	8	1	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Kenmore	V210	R074	Local	1955	8	1	1.3	0.8	0.5	1.0	3.6	2.0	7.2

Street	Valve ID	Run ID	Road Type	Year Installed	Diameter (in)	Recorded Breaks	Consequence of Failure Criteria				Consequence of Failure (COF)	Probability of Failure (POF): Breaks/150 ft.	Criticality Score (BRE)
							Pipe Age	Pipe Size	Undersize Pipe	Road Type			
Kenmore	V208	R074	Local	1955	8	1	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Kenmore	V104	R115	Local	1950	8	1	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Kenmore	V103	R115	Local	1950	8	1	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Kenosha	V377	R002	Local	1983	8	1	0.8	0.8	0.5	1.0	3.1	2.0	6.2
Kenosha	V371	R002	Local	1983	8	1	0.8	0.8	0.5	1.0	3.1	2.0	6.2
Kenosha	V368	R002	Local	1983	6	1	0.8	0.5	1.0	1.0	3.3	2.0	6.6
Kenosha	V362	R002	Local	1983	8	1	0.8	0.8	0.5	1.0	3.1	2.0	6.2
Kenosha	V380	R002	Local	1983	6	1	0.8	0.5	1.0	1.0	3.3	2.0	6.6
Kenosha	V331	R002	Local	1983	8	1	0.8	0.8	0.5	1.0	3.1	2.0	6.2
Kenosha	V386	R048	Local	1983	8	0	0.8	0.8	0.5	1.0	3.1	1.0	3.1
Kenosha	V344	R048	Local	1983	8	0	0.8	0.8	0.5	1.0	3.1	1.0	3.1
Kenosha	V329	R048	Major	1983	6	0	0.8	0.5	1.5	1.5	4.3	1.0	4.3
Kenosha	V315	R048	Local	1983	8	0	0.8	0.8	0.5	1.0	3.1	1.0	3.1
Kenosha	V314	R048	Local	1983	8	0	0.8	0.8	0.5	1.0	3.1	1.0	3.1
Kenosha	V311	R048	Local	1983	8	0	0.8	0.8	0.5	1.0	3.1	1.0	3.1
Kingsville	V324	R046	Local	1940	8	1	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Kingsville	V322	R046	Local	1940	8	1	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Kingsville	V321	R046	Local	1940	8	1	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Kingsville	V319	R046	Local	1940	8	1	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Kingsville	V318	R046	Local	1940	8	1	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Kingsville	V443	R087	Local	1948	6	1	1.3	0.5	1.0	1.0	3.8	2.0	7.6
Kingsville	V096	R087	Local	1948	6	1	1.3	0.5	1.0	1.0	3.8	2.0	7.6

Street	Valve ID	Run ID	Road Type	Year Installed	Diameter (in)	Recorded Breaks	Consequence of Failure Criteria				Consequence of Failure (COF)	Probability of Failure (POF): Breaks/150 ft.	Criticality Score (BRE)
							Pipe Age	Pipe Size	Undersize Pipe	Road Type			
Kingsville	V073	R087	Local	1948	6	1	1.3	0.5	1.0	1.0	3.8	2.0	7.6
Kingsville	V374	R147	Local	1940	8	0	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Kingsville	V373	R147	Local	1940	8	0	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Kingsville	V375	R147	Local	1940	8	0	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Kingsville	V365	R147	Local	1940	8	0	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Kingsville	V364	R147	Local	1940	8	0	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Kingsville	V325	R147	Local	1940	8	0	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Kroger	V461	R140	Private	1957	8	0	1.3	0.8	0.5	0.5	3.1	1.0	3.1
Kroger	V460	R140	Private	1957	8	0	1.3	0.8	0.5	0.5	3.1	1.0	3.1
Lancaster	V433	R076	Major	1950	8	4	1.3	0.8	1.3	1.5	4.9	2.0	9.8
Lancaster	V184	R076	Local	1950	8	4	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Lancaster	V183	R076	Local	1950	8	4	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Lancaster	V182	R076	Local	1950	8	4	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Lancaster	V180	R076	Local	1950	8	4	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Lancaster	V179	R076	Local	1950	8	4	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Lancaster	V113	R121	Major	1945	6	0	1.3	0.5	1.5	1.5	4.8	1.0	4.8
Lancaster	V026	R121	Local	1945	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Lansdowne	V369	R055	Local	1940	8	1	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Lansdowne	V367	R055	Local	1940	8	1	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Lansdowne	V359	R055	Local	1940	8	1	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Lansdowne	V356	R055	Local	1940	8	1	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Lansdowne	V352	R055	Local	1940	8	1	1.3	0.8	0.5	1.0	3.6	2.0	7.2

Street	Valve ID	Run ID	Road Type	Year Installed	Diameter (in)	Recorded Breaks	Consequence of Failure Criteria				Consequence of Failure (COF)	Probability of Failure (POF): Breaks/150 ft.	Criticality Score (BRE)
							Pipe Age	Pipe Size	Undersize Pipe	Road Type			
Lansdowne	V350	R055	Local	1940	8	1	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Lennon	V162	R079	Local	1954	8	3	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Lennon	V161	R079	Local	1954	8	3	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Lennon	V157	R079	Local	1954	8	3	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Lennon	V123	R079	Local	1954	8	3	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Lennon	V023	R124	Local	1950	8	1	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Lennon	V022	R124	Major	1950	8	1	1.3	0.8	1.3	1.5	4.9	2.0	9.8
Leslie	V065	R097	Local	1950	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Littlestone	V102	R103	Major	1950	8	3	1.3	0.8	1.3	1.5	4.9	3.0	14.7
Littlestone	V088	R103	Local	1950	8	3	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Littlestone	V051	R103	Local	1950	8	3	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Lochmoor	V202	R069	Local	1953	8	4	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Lochmoor	V200	R069	Major	1953	8	4	1.3	0.8	1.3	1.5	4.9	2.0	9.8
Lochmoor	V194	R069	Local	1953	8	4	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Lochmoor	V192	R069	Local	1953	8	4	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Lochmoor	V189	R069	Local	1953	8	4	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Lochmoor	V186	R069	Local	1953	8	4	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Lochmoor	V108	R119	Major	1945	8	1	1.3	0.8	1.3	1.5	4.9	2.0	9.8
Lochmoor	V028	R119	Local	1945	8	1	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Manchester	V049	R107	Major	1957	8	1	1.3	0.8	0.5	1.5	4.1	2.0	8.2
Manchester	V048	R107	Local	1957	8	1	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Manchester	V045	R107	Local	1957	8	1	1.3	0.8	0.5	1.0	3.6	2.0	7.2

Street	Valve ID	Run ID	Road Type	Year Installed	Diameter (in)	Recorded Breaks	Consequence of Failure Criteria				Consequence of Failure (COF)	Probability of Failure (POF): Breaks/150 ft.	Criticality Score (BRE)
							Pipe Age	Pipe Size	Undersize Pipe	Road Type			
Manchester	V044	R107	Local	1957	8	1	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Newcastle	V453	R099	Local	1950	8	2	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Newcastle	V080	R099	Local	1950	8	2	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Newcastle	V063	R099	Local	1950	8	2	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Norwood	V105	R117	Major	1950	8	0	1.3	0.8	1.3	1.5	4.9	1.0	4.9
Norwood	V030	R117	Local	1950	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Old Homestead	V271	R009	Local	1987	8	0	0.8	0.8	0.5	1.0	3.1	1.0	3.1
Old Homestead	V274	R009	Local	1987	8	0	0.8	0.8	0.5	1.0	3.1	1.0	3.1
Old Homestead	V273	R009	Local	1987	8	0	0.8	0.8	0.5	1.0	3.1	1.0	3.1
Old Homestead	V272	R009	Local	1987	8	0	0.8	0.8	0.5	1.0	3.1	1.0	3.1
Old Homestead	V270	R057	Major	1987	8	0	0.8	0.8	1.3	1.5	4.4	1.0	4.4
Old Homestead	V269	R057	Local	1987	8	0	0.8	0.8	0.5	1.0	3.1	1.0	3.1
Old Homestead	V267	R057	Local	1987	8	0	0.8	0.8	0.5	1.0	3.1	1.0	3.1
Old Homestead	V266	R057	Local	1987	8	0	0.8	0.8	0.5	1.0	3.1	1.0	3.1
Old Homestead	V265	R057	Local	1987	8	0	0.8	0.8	0.5	1.0	3.1	1.0	3.1
Park Place of Harper Woods	V234	R142	Private	1984	8	0	0.8	0.8	0.5	0.5	2.6	1.0	2.6
Park Place of Harper Woods	V236	R142	Private	1984	8	0	0.8	0.8	0.5	0.5	2.6	1.0	2.6
Parkcrest	V448	R116	Major	1950	8	0	1.3	0.8	1.3	1.5	4.9	1.0	4.9
Parkcrest	V388	R116	Local	1950	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Parkcrest	V032	R116	Local	1950	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Peerless	V284	R053	Local	1945	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Peerless	V345	R054	Local	1945	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6

Street	Valve ID	Run ID	Road Type	Year Installed	Diameter (in)	Recorded Breaks	Consequence of Failure Criteria				Consequence of Failure (COF)	Probability of Failure (POF): Breaks/150 ft.	Criticality Score (BRE)
							Pipe Age	Pipe Size	Undersize Pipe	Road Type			
Peerless	V341	R054	Local	1945	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Peerless	V309	R054	Local	1945	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Peerless	V305	R054	Local	1945	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Peerless	V290	R054	Local	1945	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Peerless	V225	R062	Local	1952	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Peerless	V223	R062	Local	1952	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Peerless	V215	R062	Local	1952	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Peerless	V397	R064	Local	1950	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Peerless	V216	R064	Local	1950	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Peerless	V205	R064	Local	1950	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Peerless	V193	R064	Local	1950	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Peerless	V181	R064	Local	1950	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Peerless	V167	R065	Local	1950	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Peerless	V152	R065	Major	1950	8	0	1.3	0.8	1.3	1.5	4.9	1.0	4.9
Prestwick	V452	R098	Local	1950	8	6	1.3	0.8	0.5	1.0	3.6	4.0	14.4
Prestwick	V081	R098	Local	1950	8	6	1.3	0.8	0.5	1.0	3.6	4.0	14.4
Prestwick	V062	R098	Local	1950	8	6	1.3	0.8	0.5	1.0	3.6	4.0	14.4
Prestwick	V060	R098	Local	1950	8	6	1.3	0.8	0.5	1.0	3.6	4.0	14.4
Prestwick	V061	R102	Local	1950	8	0	1.3	0.8	0.5	1.0	3.6	4.0	14.4
Ridgemont	V134	R084	Local	1938	6	2	1.3	0.5	1.0	1.0	3.8	4.0	15.2
Ridgemont	V006	R135	Local	1997	8	0	0.5	0.8	0.5	1.0	2.8	1.0	2.8
Ridgemont	V003	R135	Local	1997	8	0	0.5	0.8	0.5	1.0	2.8	1.0	2.8

Street	Valve ID	Run ID	Road Type	Year Installed	Diameter (in)	Recorded Breaks	Consequence of Failure Criteria				Consequence of Failure (COF)	Probability of Failure (POF): Breaks/150 ft.	Criticality Score (BRE)
							Pipe Age	Pipe Size	Undersize Pipe	Road Type			
Rockcastle	V094	R089	Local	1950	8	2	1.3	0.8	0.5	1.0	3.6	4.0	14.4
Rockcastle	V091	R089	Local	1950	8	2	1.3	0.8	0.5	1.0	3.6	4.0	14.4
Rolandale	V070	R094	Local	1950	8	4	1.3	0.8	0.5	1.0	3.6	5.0	18.0
Rolandale	V067	R094	Local	1950	8	4	1.3	0.8	0.5	1.0	3.6	5.0	18.0
Roscommon	V401	R004	Local	1990	8	0	0.5	0.8	0.5	1.0	2.8	1.0	2.8
Roscommon	V402	R004	Major	1990	8	0	0.5	0.8	1.3	1.5	4.1	1.0	4.1
Roscommon	V382	R004	Local	1990	8	0	0.5	0.8	0.5	1.0	2.8	1.0	2.8
Roscommon	V379	R004	Local	1990	8	0	0.5	0.8	0.5	1.0	2.8	1.0	2.8
Roscommon	V360	R004	Local	1990	8	0	0.5	0.8	0.5	1.0	2.8	1.0	2.8
Roscommon	V357	R004	Local	1990	8	0	0.5	0.8	0.5	1.0	2.8	1.0	2.8
Roscommon	V355	R004	Local	1990	8	0	0.5	0.8	0.5	1.0	2.8	1.0	2.8
Roscommon	V336	R004	Major	1990	8	0	0.5	0.8	1.3	1.5	4.1	1.0	4.1
Roscommon	V403	R050	Major	1991	8	1	0.5	0.8	1.3	1.5	4.1	2.0	8.2
Roscommon	V337	R050	Major	1991	8	1	0.5	0.8	1.3	1.5	4.1	2.0	8.2
Roscommon	V339	R050	Local	1991	8	1	0.5	0.8	0.5	1.0	2.8	2.0	5.6
Roscommon	V307	R050	Local	1991	8	1	0.5	0.8	0.5	1.0	2.8	2.0	5.6
Roscommon	V306	R050	Local	1991	8	1	0.5	0.8	0.5	1.0	2.8	2.0	5.6
Roscommon	V304	R050	Local	1991	8	1	0.5	0.8	0.5	1.0	2.8	2.0	5.6
Roscommon	V303	R050	Local	1991	8	1	0.5	0.8	0.5	1.0	2.8	2.0	5.6
Roscommon	V302	R050	Major	1991	8	1	0.5	0.8	1.3	1.5	4.1	2.0	8.2
Roslyn	V005	R137	Local	1998	8	1	0.5	0.8	0.5	1.0	2.8	3.0	8.4
Salter Park	V235	R143	Private	1984	8	0	0.8	0.8	0.5	0.5	2.6	1.0	2.6

Street	Valve ID	Run ID	Road Type	Year Installed	Diameter (in)	Recorded Breaks	Consequence of Failure Criteria				Consequence of Failure (COF)	Probability of Failure (POF): Breaks/150 ft.	Criticality Score (BRE)
							Pipe Age	Pipe Size	Undersize Pipe	Road Type			
Salter Park	V426	R143	Private	1984	8	0	0.8	0.8	0.5	0.5	2.6	1.0	2.6
Salter Park	V099	R143	Private	1984	8	0	0.8	0.8	0.5	0.5	2.6	1.0	2.6
Sanilac	V416	R059	Local	1940	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Sanilac	V264	R059	Local	1940	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Severn	V083	R104	Local	1950	8	5	1.3	0.8	0.5	1.0	3.6	5.0	18.0
Severn	V057	R104	Local	1950	8	5	1.3	0.8	0.5	1.0	3.6	5.0	18.0
Sloan	V075	R096	Local	1950	8	3	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Sloan	V069	R096	Local	1950	8	3	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Starr Academy	V098	R144	Private	1957	8	0	1.3	0.8	0.5	0.5	3.1	1.0	3.1
Starr Academy	V097	R144	Private	1957	4	0	1.3	0.0	1.3	0.5	3.1	1.0	3.1
Starr Academy 2	V093	R145	Private	1950	6	0	1.3	0.5	1.0	0.5	3.3	1.0	3.3
Tyrone	V079	R091	Local	1950	8	1	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Tyrone	V078	R091	Local	1950	8	1	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Tyrone	V076	R091	Local	1950	8	1	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Tyrone	V074	R091	Local	1950	8	1	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Tyrone	V459	R092	Local	1950	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Tyrone	V087	R092	Local	1950	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Tyrone	V084	R092	Local	1950	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Tyrone	V082	R092	Local	1950	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Van Antwerp	V156	R080	Local	1950	8	3	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Van Antwerp	V154	R080	Local	1950	8	3	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Van Antwerp	V153	R080	Local	1950	8	3	1.3	0.8	0.5	1.0	3.6	3.0	10.8

Street	Valve ID	Run ID	Road Type	Year Installed	Diameter (in)	Recorded Breaks	Consequence of Failure Criteria				Consequence of Failure (COF)	Probability of Failure (POF): Breaks/150 ft.	Criticality Score (BRE)
							Pipe Age	Pipe Size	Undersize Pipe	Road Type			
Van Antwerp	V124	R080	Major	1950	8	3	1.3	0.8	1.3	1.5	4.9	3.0	14.7
Van Antwerp	V019	R125	Major	1950	8	0	1.3	0.8	1.3	1.5	4.9	1.0	4.9
Vernier	V421	R031	Major	1940	12	7	1.3	1.2	0.5	1.5	4.5	3.0	13.5
Vernier	V243	R031	Major	1940	12	7	1.3	1.2	0.5	1.5	4.5	3.0	13.5
Vernier	V244	R031	Major	1940	12	7	1.3	1.2	0.5	1.5	4.5	3.0	13.5
Vernier	V148	R031	Major	1940	12	7	1.3	1.2	0.5	1.5	4.5	3.0	13.5
Vernier	V425	R032	Major	1940	8	1	1.3	0.8	1.3	1.5	4.9	2.0	9.8
Vernier	V147	R032	Major	1940	12	1	1.3	1.2	0.5	1.5	4.5	2.0	9.0
Vernier	V429	R032	Major	1940	12	1	1.3	1.2	0.5	1.5	4.5	2.0	9.0
Vernier	V427	R032	Major	1940	12	1	1.3	1.2	0.5	1.5	4.5	2.0	9.0
Vernier North	V428	R033	Major	1940	8	0	1.3	0.8	1.3	1.5	4.9	1.0	4.9
Vernier North	V151	R033	Major	1940	8	0	1.3	0.8	1.3	1.5	4.9	1.0	4.9
Vernier North	V150	R033	Major	1940	8	0	1.3	0.8	1.3	1.5	4.9	1.0	4.9
Vernier North	V149	R033	Major	1940	8	0	1.3	0.8	1.3	1.5	4.9	1.0	4.9
Vernier North	V125	R033	Major	1940	8	0	1.3	0.8	1.3	1.5	4.9	1.0	4.9
Vernier North	V446	R127	Major	1955	8	0	1.3	0.8	1.3	1.5	4.9	1.0	4.9
Vernier North	V017	R127	Major	1955	8	0	1.3	0.8	1.3	1.5	4.9	1.0	4.9
Vernier South	V018	R126	Local	1950	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Vernier South	V015	R126	Major	1950	8	0	1.3	0.8	1.3	1.5	4.9	1.0	4.9
Washtenaw	V400	R001	Local	1979	8	2	1.1	0.8	0.5	1.0	3.4	2.0	6.8
Washtenaw	V376	R001	Local	1979	8	2	1.1	0.8	0.5	1.0	3.4	2.0	6.8
Washtenaw	V372	R001	Local	1979	8	2	1.1	0.8	0.5	1.0	3.4	2.0	6.8

Street	Valve ID	Run ID	Road Type	Year Installed	Diameter (in)	Recorded Breaks	Consequence of Failure Criteria				Consequence of Failure (COF)	Probability of Failure (POF): Breaks/150 ft.	Criticality Score (BRE)
							Pipe Age	Pipe Size	Undersize Pipe	Road Type			
Washtenaw	V366	R001	Local	1979	8	2	1.1	0.8	0.5	1.0	3.4	2.0	6.8
Washtenaw	V363	R001	Local	1979	8	2	1.1	0.8	0.5	1.0	3.4	2.0	6.8
Washtenaw	V326	R001	Local	1979	8	2	1.1	0.8	0.5	1.0	3.4	2.0	6.8
Washtenaw	V457	R047	Major	1980	8	1	0.8	0.8	1.3	1.5	4.4	2.0	8.8
Washtenaw	V457	R047	Local	1980	8	1	0.8	0.8	0.5	1.0	3.1	2.0	6.2
Washtenaw	V343	R047	Local	1980	8	1	0.8	0.8	0.5	1.0	3.1	2.0	6.2
Washtenaw	V342	R047	Local	1980	8	1	0.8	0.8	0.5	1.0	3.1	2.0	6.2
Washtenaw	V340	R047	Local	1980	8	1	0.8	0.8	0.5	1.0	3.1	2.0	6.2
Washtenaw	V320	R047	Local	1980	8	1	0.8	0.8	0.5	1.0	3.1	2.0	6.2
Washtenaw	V317	R047	Local	1980	8	1	0.8	0.8	0.5	1.0	3.1	2.0	6.2
Washtenaw	V316	R047	Major	1980	8	1	0.8	0.8	1.3	1.5	4.4	2.0	8.8
Wildwood	V451	R108	Local	1960	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Wildwood	V047	R108	Local	1960	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Williamsburg Ct	V155	R078	Major	1964	8	0	1.3	0.8	1.3	1.5	4.9	1.0	4.9
Williamsburg Ct	V163	R078	Local	1964	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Woodcrest	V405	R006	Local	1996	8	0	0.5	0.8	0.5	1.0	2.8	1.0	2.8
Woodcrest	V385	R006	Local	1996	8	0	0.5	0.8	0.5	1.0	2.8	1.0	2.8
Woodcrest	V353	R006	Local	1996	8	0	0.5	0.8	0.5	1.0	2.8	1.0	2.8
Woodcrest	V351	R006	Local	1996	8	0	0.5	0.8	0.5	1.0	2.8	1.0	2.8
Woodcrest	V346	R006	Local	1996	8	0	0.5	0.8	0.5	1.0	2.8	1.0	2.8
Woodcrest	V412	R052	Local	1940	6	0	1.3	0.5	1.0	1.0	3.8	1.0	3.8
Woodcrest	V411	R052	Local	1940	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6

Street	Valve ID	Run ID	Road Type	Year Installed	Diameter (in)	Recorded Breaks	Consequence of Failure Criteria				Consequence of Failure (COF)	Probability of Failure (POF): Breaks/150 ft.	Criticality Score (BRE)
							Pipe Age	Pipe Size	Undersize Pipe	Road Type			
Woodcrest	V294	R052	Local	1940	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Woodcrest	V292	R052	Local	1940	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Woodcrest	V291	R052	Local	1940	6	0	1.3	0.5	1.0	1.0	3.8	1.0	3.8
Woodcrest	V289	R052	Local	1940	6	0	1.3	0.5	1.0	1.0	3.8	1.0	3.8
Woodcrest	V288	R052	Local	1940	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Woodland	V281	R008	Major	1950	8	2	1.3	0.8	1.3	1.5	4.9	2.0	9.8
Woodland	V279	R008	Local	1950	8	2	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Woodland	V278	R008	Local	1950	8	2	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Woodland	V277	R008	Local	1950	8	2	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Woodland	V276	R008	Local	1950	8	2	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Woodland	V407	R056	Local	1945	8	3	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Woodland	V280	R056	Local	1945	8	3	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Woodland	V283	R056	Local	1945	8	3	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Woodland	V282	R056	Local	1945	8	3	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Woodland	V286	R056	Local	1945	8	3	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Woodland	V285	R056	Local	1945	8	3	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Woodmont	V221	R012	Local	1952	8	2	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Woodmont	V224	R061	Local	1952	8	5	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Woodmont	V396	R061	Local	1952	8	5	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Woodmont	V226	R061	Local	1952	8	5	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Woodmont	V222	R061	Local	1952	8	5	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Woodmont	V220	R061	Major	1952	8	5	1.3	0.8	1.3	1.5	4.9	3.0	14.7

Street	Valve ID	Run ID	Road Type	Year Installed	Diameter (in)	Recorded Breaks	Consequence of Failure Criteria				Consequence of Failure (COF)	Probability of Failure (POF): Breaks/150 ft.	Criticality Score (BRE)
							Pipe Age	Pipe Size	Undersize Pipe	Road Type			
Woodmont	V041	R061	Local	1952	8	5	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Woodmont	V389	R112	Local	1950	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Woodmont	V036	R112	Major	1950	8	0	1.3	0.8	1.3	1.5	4.9	1.0	4.9
Woodside	V296	R005	Major	1992	8	2	0.5	0.8	1.3	1.5	4.1	2.0	8.2
Woodside	V384	R005	Local	1992	8	2	0.5	0.8	0.5	1.0	2.8	2.0	5.6
Woodside	V354	R005	Local	1992	8	2	0.5	0.8	0.5	1.0	2.8	2.0	5.6
Woodside	V349	R005	Local	1992	8	2	0.5	0.8	0.5	1.0	2.8	2.0	5.6
Woodside	V348	R005	Local	1992	8	2	0.5	0.8	0.5	1.0	2.8	2.0	5.6
Woodside	V347	R005	Local	1992	8	2	0.5	0.8	0.5	1.0	2.8	2.0	5.6
Woodside	V414	R051	Local	1950	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Woodside	V413	R051	Local	1950	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Woodside	V404	R051	Local	1950	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Woodside	V297	R051	Local	1950	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Woodside	V301	R051	Local	1950	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Woodside	V300	R051	Local	1950	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Woodside	V299	R051	Local	1950	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6

APPENDIX E: CRITICALITY ANALYSIS – FIRE HYDRANTS

Street	Hydrant ID	Run ID	Road Type	Year Installed	Diameter (in)	Recorded Breaks	Consequence of Failure Criteria				Consequence of Failure (COF)	Probability of Failure (POF): Breaks/150 ft.	Criticality Score (BRE)
							Pipe Age	Pipe Size	Undersize Pipe	Road Type			
8 Mile	H345	R085	Major	1957	8	1	1.3	0.8	1.3	1.5	4.9	2.0	9.8
8 Mile	H349	R085	Major	1957	8	1	1.3	0.8	1.3	1.5	4.9	2.0	9.8
8 Mile	H350	R085	Major	1957	8	1	1.3	0.8	1.3	1.5	4.9	2.0	9.8
8 Mile	H407	R085	Major	1957	8	1	1.3	0.8	1.3	1.5	4.9	2.0	9.8
8 Mile	H408	R085	Major	1957	8	1	1.3	0.8	1.3	1.5	4.9	2.0	9.8
8 Mile	H344	R086	Major	1957	8	0	1.3	0.8	1.3	1.5	4.9	1.0	4.9
8 Mile	H346	R086	Major	1957	8	0	1.3	0.8	1.3	1.5	4.9	1.0	4.9
8 Mile	H347	R086	Major	1957	8	0	1.3	0.8	1.3	1.5	4.9	1.0	4.9
8 Mile	H348	R086	Major	1957	8	0	1.3	0.8	1.3	1.5	4.9	1.0	4.9
8 Mile	H410	R138	Major	1957	8	0	1.3	0.8	1.3	1.5	4.9	1.0	4.9
Anita	H338	R081	Local	1957	8	6	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Anita	H339	R081	Local	1957	8	6	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Anita	H340	R081	Local	1957	8	6	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Anita	H341	R081	Local	1957	8	6	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Anita	H342	R081	Local	1957	8	6	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Anita	H406	R081	Local	1957	8	6	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Anita	H005	R128	Local	1990	8	2	0.5	0.8	0.5	1.0	2.8	3.0	8.4
Anita	H007	R128	Local	1990	8	2	0.5	0.8	0.5	1.0	2.8	3.0	8.4
Arthur	H062	R111	Local	1953	6	0	1.3	0.5	1.0	1.0	3.8	1.0	3.8
Balfour	H313	R066	Local	1940	8	1	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Balfour	H318	R066	Local	1940	8	1	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Balfour	H401	R066	Local	1940	8	1	1.3	0.8	0.5	1.0	3.6	2.0	7.2

Street	Hydrant ID	Run ID	Road Type	Year Installed	Diameter (in)	Recorded Breaks	Consequence of Failure Criteria				Consequence of Failure (COF)	Probability of Failure (POF): Breaks/150 ft.	Criticality Score (BRE)
							Pipe Age	Pipe Size	Undersize Pipe	Road Type			
Balfour	H264	R071	Local	1940	6	0	1.3	0.5	1.0	1.0	3.8	1.0	3.8
Beaconsfield	H241	R027	Major	1950	8	0	1.3	0.8	1.3	1.5	4.9	1.0	4.9
Beaconsfield	H360	R027	Major	1950	8	0	1.3	0.8	1.3	1.5	4.9	1.0	4.9
Beaconsfield	H361	R027	Major	1950	8	0	1.3	0.8	1.3	1.5	4.9	1.0	4.9
Beaconsfield	H377	R028	Major	1953	8	1	1.3	0.8	1.3	1.5	4.9	2.0	9.8
Beaconsfield	H303	R029	Major	1957	12	0	1.3	1.2	0.5	1.5	4.5	1.0	4.5
Beaconsfield	H315	R029	Major	1957	12	0	1.3	1.2	0.5	1.5	4.5	1.0	4.5
Beaconsfield	H343	R030	Major	1957	12	0	1.3	1.2	0.5	1.5	4.5	1.0	4.5
Beaconsfield	H427	R030	Major	1957	12	0	1.3	1.2	0.5	1.5	4.5	1.0	4.5
Beaconsfield	H266	R156	Major	1953	8	3	1.3	0.8	1.3	1.5	4.9	3.0	14.7
Beaconsfield	H278	R156	Major	1953	8	3	1.3	0.8	1.3	1.5	4.9	3.0	14.7
Beaconsfield Apartments	H291	R150	Private	1990	8	0	0.5	0.8	0.5	0.5	2.3	1.0	2.3
Beaconsfield Apartments	H292	R150	Private	1990	8	0	0.5	0.8	0.5	0.5	2.3	1.0	2.3
Beaconsfield Apartments	H293	R150	Private	1990	8	0	0.5	0.8	0.5	0.5	2.3	1.0	2.3
Beaufait	H032	R077	Local	1957	8	3	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Beaufait	H309	R077	Local	1957	8	3	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Beaufait	H310	R077	Local	1957	8	3	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Beaufait	H311	R077	Local	1957	8	3	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Beaufait	H020	R123	Local	1996	8	0	0.5	0.8	0.5	1.0	2.8	1.0	2.8
Beaufait	H021	R123	Local	1996	8	0	0.5	0.8	0.5	1.0	2.8	1.0	2.8
Berden	H095	R093	Local	1945	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Berden	H424	R093	Local	1945	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6

Street	Hydrant ID	Run ID	Road Type	Year Installed	Diameter (in)	Recorded Breaks	Consequence of Failure Criteria				Consequence of Failure (COF)	Probability of Failure (POF): Breaks/150 ft.	Criticality Score (BRE)
							Pipe Age	Pipe Size	Undersize Pipe	Road Type			
Bournemouth	H091	R088	Local	1940	8	1	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Bournemouth	H092	R088	Local	1940	8	1	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Bournemouth	H106	R088	Local	1940	8	1	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Brierstone	H079	R105	Local	1940	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Brierstone	H080	R105	Local	1940	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Broadstone	H076	R106	Local	1940	8	2	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Broadstone	H077	R106	Local	1940	8	2	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Chandler Park H.S.	H271	R154	Private	1952	6	0	1.3	0.5	1.0	0.5	3.3	1.0	3.3
Chandler Park H.S.	H272	R154	Private	1952	6	0	1.3	0.5	1.0	0.5	3.3	1.0	3.3
Chandler Park H.S.	H273	R154	Private	1952	6	0	1.3	0.5	1.0	0.5	3.3	1.0	3.3
Chandler Park H.S.	H274	R154	Private	1952	6	0	1.3	0.5	1.0	0.5	3.3	1.0	3.3
Church Ct	H265	R070	Local	1967	6	0	1.3	0.5	1.0	1.0	3.8	1.0	3.8
Country Club	H034	R075	Local	1940	8	6	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Country Club	H036	R075	Local	1940	8	6	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Country Club	H280	R075	Local	1940	8	6	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Country Club	H281	R075	Local	1940	8	6	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Country Club	H285	R075	Local	1940	8	6	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Country Club	H286	R075	Local	1940	8	6	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Country Club	H028	R120	Local	1997	8	1	0.5	0.8	0.5	1.0	2.8	2.0	5.6
Country Club	H029	R120	Local	1997	8	1	0.5	0.8	0.5	1.0	2.8	2.0	5.6
Country Club	H041	R120	Local	1997	8	1	0.5	0.8	0.5	1.0	2.8	2.0	5.6
Crestland	H364	R007	Local	1996	8	0	0.5	0.8	0.5	1.0	2.8	1.0	2.8

Street	Hydrant ID	Run ID	Road Type	Year Installed	Diameter (in)	Recorded Breaks	Consequence of Failure Criteria				Consequence of Failure (COF)	Probability of Failure (POF): Breaks/150 ft.	Criticality Score (BRE)
							Pipe Age	Pipe Size	Undersize Pipe	Road Type			
Damman	H254	R063	Local	1960	8	3	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Damman	H255	R063	Local	1960	8	3	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Damman	H256	R063	Local	1960	8	3	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Damman	H257	R063	Local	1960	8	3	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Damman	H258	R063	Local	1960	8	3	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Damman	H405	R063	Local	1960	8	3	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Danbury	H351	R082	Local	1964	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Danbury	H352	R082	Local	1964	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Danbury	H353	R082	Local	1964	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Danbury	H355	R082	Local	1964	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Eastbourne	H093	R095	Local	1940	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Eastland Mall 2	H276	R152	Private	1957	12	0	1.3	1.2	0.5	0.5	3.5	1.0	3.5
Eastland Mall 2	H294	R152	Private	1957	12	0	1.3	1.2	0.5	0.5	3.5	1.0	3.5
Eastland Mall 2	H295	R152	Private	1957	12	0	1.3	1.2	0.5	0.5	3.5	1.0	3.5
Eastland Mall 2	H296	R152	Private	1957	12	0	1.3	1.2	0.5	0.5	3.5	1.0	3.5
Eastland Mall 2	H297	R152	Private	1957	12	0	1.3	1.2	0.5	0.5	3.5	1.0	3.5
Eastland Mall 2	H299	R152	Private	1957	8	0	1.3	0.8	0.5	0.5	3.1	1.0	3.1
Eastland Mall 2	H394	R153	Private	1957	8	0	1.3	0.8	0.5	0.5	3.1	1.0	3.1
Eastland Village	H314	R067	Local	1940	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Eastwood	H227	R010	Local	1954	8	9	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Eastwood	H232	R010	Local	1954	8	9	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Eastwood	H236	R010	Local	1954	8	9	1.3	0.8	0.5	1.0	3.6	3.0	10.8

Street	Hydrant ID	Run ID	Road Type	Year Installed	Diameter (in)	Recorded Breaks	Consequence of Failure Criteria				Consequence of Failure (COF)	Probability of Failure (POF): Breaks/150 ft.	Criticality Score (BRE)
							Pipe Age	Pipe Size	Undersize Pipe	Road Type			
Eastwood	H239	R010	Local	1954	8	9	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Eastwood	H378	R010	Local	1954	8	9	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Eastwood	H379	R010	Local	1954	8	9	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Eastwood	H380	R010	Local	1954	8	9	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Eastwood	H216	R058	Local	1955	8	6	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Eastwood	H219	R058	Local	1955	8	6	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Eastwood	H222	R058	Local	1955	8	6	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Eastwood	H373	R058	Local	1955	8	6	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Eastwood	H374	R058	Local	1955	8	6	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Eastwood	H375	R058	Local	1955	8	6	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Eastwood	H376	R058	Local	1955	8	6	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Edgefield	H102	R090	Local	1945	8	1	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Elkhart	H160	R003	Local	1984	8	3	0.8	0.8	0.5	1.0	3.1	2.0	6.2
Elkhart	H161	R003	Local	1984	8	3	0.8	0.8	0.5	1.0	3.1	2.0	6.2
Elkhart	H162	R003	Local	1984	8	3	0.8	0.8	0.5	1.0	3.1	2.0	6.2
Elkhart	H163	R003	Local	1984	8	3	0.8	0.8	0.5	1.0	3.1	2.0	6.2
Elkhart	H164	R003	Local	1984	8	3	0.8	0.8	0.5	1.0	3.1	2.0	6.2
Elkhart	H165	R003	Local	1984	8	3	0.8	0.8	0.5	1.0	3.1	2.0	6.2
Elkhart	H166	R003	Local	1984	8	3	0.8	0.8	0.5	1.0	3.1	2.0	6.2
Elkhart	H113	R049	Local	1988	8	2	0.8	0.8	0.5	1.0	3.1	2.0	6.2
Elkhart	H117	R049	Local	1988	8	2	0.8	0.8	0.5	1.0	3.1	2.0	6.2
Elkhart	H167	R049	Local	1988	8	2	0.8	0.8	0.5	1.0	3.1	2.0	6.2

Street	Hydrant ID	Run ID	Road Type	Year Installed	Diameter (in)	Recorded Breaks	Consequence of Failure Criteria				Consequence of Failure (COF)	Probability of Failure (POF): Breaks/150 ft.	Criticality Score (BRE)
							Pipe Age	Pipe Size	Undersize Pipe	Road Type			
Elkhart	H168	R049	Local	1988	8	2	0.8	0.8	0.5	1.0	3.1	2.0	6.2
Elkhart	H169	R049	Local	1988	8	2	0.8	0.8	0.5	1.0	3.1	2.0	6.2
Elkhart	H170	R049	Local	1988	8	2	0.8	0.8	0.5	1.0	3.1	2.0	6.2
Elkhart	H171	R049	Local	1988	8	2	0.8	0.8	0.5	1.0	3.1	2.0	6.2
Elkhart	H172	R049	Local	1988	8	2	0.8	0.8	0.5	1.0	3.1	2.0	6.2
Fleetwood	H304	R068	Local	1940	8	1	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Fleetwood	H305	R068	Local	1940	8	1	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Fleetwood	H022	R122	Local	1996	8	2	0.5	0.8	0.5	1.0	2.8	3.0	8.4
Fleetwood	H023	R122	Local	1996	8	2	0.5	0.8	0.5	1.0	2.8	3.0	8.4
Fleetwood	H024	R122	Local	1996	8	2	0.5	0.8	0.5	1.0	2.8	3.0	8.4
Fleetwood	H306	R155	Local	1940	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Fleetwood	H307	R155	Local	1940	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Fleetwood	H308	R155	Local	1940	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Hampton	H002	R136	Local	1990	6	5	0.5	0.5	1.0	1.0	3.0	5.0	15.0
Harper North	H068	R037	Major	1940	8	0	1.3	0.8	1.3	1.5	4.9	1.0	4.9
Harper North	H072	R037	Major	1940	8	0	1.3	0.8	1.3	1.5	4.9	1.0	4.9
Harper North	H104	R037	Major	1940	8	0	1.3	0.8	1.3	1.5	4.9	1.0	4.9
Harper North	H107	R037	Major	1940	8	0	1.3	0.8	1.3	1.5	4.9	1.0	4.9
Harper North	H054	R038	Major	1940	8	1	1.3	0.8	1.3	1.5	4.9	2.0	9.8
Harper North	H067	R038	Major	1940	8	1	1.3	0.8	1.3	1.5	4.9	2.0	9.8
Harper North	H421	R038	Major	1940	8	1	1.3	0.8	1.3	1.5	4.9	2.0	9.8
Harper North	H014	R039	Major	1957	8	4	1.3	0.8	1.3	1.5	4.9	3.0	14.7

Street	Hydrant ID	Run ID	Road Type	Year Installed	Diameter (in)	Recorded Breaks	Consequence of Failure Criteria				Consequence of Failure (COF)	Probability of Failure (POF): Breaks/150 ft.	Criticality Score (BRE)
							Pipe Age	Pipe Size	Undersize Pipe	Road Type			
Harper North	H017	R039	Major	1957	8	4	1.3	0.8	1.3	1.5	4.9	3.0	14.7
Harper North	H026	R039	Major	1957	8	4	1.3	0.8	1.3	1.5	4.9	3.0	14.7
Harper North	H031	R039	Major	1957	8	4	1.3	0.8	1.3	1.5	4.9	3.0	14.7
Harper North	H008	R040	Major	1991	12	0	0.5	1.2	0.5	1.5	3.7	1.0	3.7
Harper North	H409	R041	Major	1991	12	1	0.5	1.2	0.5	1.5	3.7	2.0	7.4
Harper North	H411	R041	Major	1991	12	1	0.5	1.2	0.5	1.5	3.7	2.0	7.4
Harper North	H415	R041	Major	1991	12	1	0.5	1.2	0.5	1.5	3.7	2.0	7.4
Harper North	H416	R041	Major	1991	12	1	0.5	1.2	0.5	1.5	3.7	2.0	7.4
Harper South	H357	R034	Major	1987	12	0	0.8	1.2	0.5	1.5	4.0	1.0	4.0
Harper South	H109	R036	Major	1953	16	0	1.3	1.5	0.5	1.5	4.8	1.0	4.8
Harper South	H110	R036	Major	1953	16	0	1.3	1.5	0.5	1.5	4.8	1.0	4.8
Harper Woods High School 1	H279	R148	Private	1953	6	0	1.3	0.5	1.0	0.5	3.3	1.0	3.3
Hawthorne	H417	R133	Local	1990	8	1	0.5	0.8	0.5	1.0	2.8	2.0	5.6
Hawthorne	H418	R133	Local	1990	8	1	0.5	0.8	0.5	1.0	2.8	2.0	5.6
Helen	H050	R114	Local	1940	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Hollywood	H354	R083	Local	1969	6	6	1.3	0.5	1.0	1.0	3.8	4.0	15.2
Hollywood	H356	R083	Local	1969	6	6	1.3	0.5	1.0	1.0	3.8	4.0	15.2
Hollywood	H004	R134	Local	1990	6	2	0.5	0.5	1.0	1.0	3.0	3.0	9.0
Hollywood	H414	R134	Local	1990	6	2	0.5	0.5	1.0	1.0	3.0	3.0	9.0
Hunt Club	H262	R072	Local	1940	8	1	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Hunt Club	H263	R072	Local	1940	8	1	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Hunt Club	H038	R073	Local	1940	8	1	1.3	0.8	0.5	1.0	3.6	2.0	7.2

Street	Hydrant ID	Run ID	Road Type	Year Installed	Diameter (in)	Recorded Breaks	Consequence of Failure Criteria				Consequence of Failure (COF)	Probability of Failure (POF): Breaks/150 ft.	Criticality Score (BRE)
							Pipe Age	Pipe Size	Undersize Pipe	Road Type			
Hunt Club	H261	R073	Local	1940	8	1	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Hunt Club	H403	R073	Local	1940	8	1	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Hunt Club	H039	R118	Local	1976	8	5	1.1	0.8	0.5	1.0	3.4	4.0	13.6
Hunt Club	H043	R118	Local	1976	8	5	1.1	0.8	0.5	1.0	3.4	4.0	13.6
Hunt Club	H419	R118	Local	1976	8	5	1.1	0.8	0.5	1.0	3.4	4.0	13.6
Huntington	H245	R011	Local	1954	8	5	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Huntington	H246	R011	Local	1954	8	5	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Huntington	H247	R011	Local	1954	8	5	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Huntington	H248	R011	Local	1954	8	5	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Huntington	H381	R011	Local	1954	6	5	1.3	0.5	1.0	1.0	3.8	3.0	11.4
Huntington	H382	R011	Local	1954	6	5	1.3	0.5	1.0	1.0	3.8	3.0	11.4
Huntington	H242	R060	Local	1955	8	4	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Huntington	H243	R060	Local	1955	8	4	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Huntington	H244	R060	Local	1955	8	4	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Huntington	H383	R060	Local	1955	8	4	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Huntington	H384	R060	Local	1955	8	4	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Huntington	H385	R060	Local	1955	8	4	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Huntington	H386	R060	Local	1955	8	4	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Huntington	H387	R060	Local	1955	8	4	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Huntington	H060	R109	Local	1957	8	1	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Huntington	H061	R109	Local	1957	8	1	1.3	0.8	0.5	1.0	3.6	2.0	7.2
I-94 Easement	H428	R139	Major	1984	8	0	0.8	0.8	0.5	1.5	3.6	1.0	3.6

Street	Hydrant ID	Run ID	Road Type	Year Installed	Diameter (in)	Recorded Breaks	Consequence of Failure Criteria				Consequence of Failure (COF)	Probability of Failure (POF): Breaks/150 ft.	Criticality Score (BRE)
							Pipe Age	Pipe Size	Undersize Pipe	Road Type			
Kelly	H015	R024	Major	1952	12	4	1.3	1.2	0.5	1.5	4.5	2.0	9.0
Kelly	H173	R024	Major	1952	12	4	1.3	1.2	0.5	1.5	4.5	2.0	9.0
Kelly	H174	R024	Major	1952	12	4	1.3	1.2	0.5	1.5	4.5	2.0	9.0
Kelly	H175	R024	Major	1952	12	4	1.3	1.2	0.5	1.5	4.5	2.0	9.0
Kelly	H240	R024	Major	1952	12	4	1.3	1.2	0.5	1.5	4.5	2.0	9.0
Kelly	H372	R024	Major	1952	12	4	1.3	1.2	0.5	1.5	4.5	2.0	9.0
Kelly	H275	R025	Major	1952	12	1	1.3	1.2	0.5	1.5	4.5	2.0	9.0
Kelly	H277	R025	Major	1952	12	1	1.3	1.2	0.5	1.5	4.5	2.0	9.0
Kelly	H298	R025	Major	1952	12	1	1.3	1.2	0.5	1.5	4.5	2.0	9.0
Kelly	H300	R025	Major	1952	12	1	1.3	1.2	0.5	1.5	4.5	2.0	9.0
Kelly	H390	R025	Major	1952	12	1	1.3	1.2	0.5	1.5	4.5	2.0	9.0
Kelly	H391	R025	Major	1952	12	1	1.3	1.2	0.5	1.5	4.5	2.0	9.0
Kenmore	H259	R074	Local	1940	8	1	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Kenmore	H260	R074	Local	1940	8	1	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Kenmore	H404	R074	Local	1940	8	1	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Kenmore	H048	R115	Local	1940	8	1	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Kenmore	H049	R115	Local	1940	8	1	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Kenosha	H045	R002	Local	1983	8	1	0.8	0.8	0.5	1.0	3.1	2.0	6.2
Kenosha	H140	R002	Local	1983	8	1	0.8	0.8	0.5	1.0	3.1	2.0	6.2
Kenosha	H141	R002	Local	1983	8	1	0.8	0.8	0.5	1.0	3.1	2.0	6.2
Kenosha	H142	R002	Local	1983	6	1	0.8	0.5	1.0	1.0	3.3	2.0	6.6
Kenosha	H143	R002	Local	1983	8	1	0.8	0.8	0.5	1.0	3.1	2.0	6.2

Street	Hydrant ID	Run ID	Road Type	Year Installed	Diameter (in)	Recorded Breaks	Consequence of Failure Criteria				Consequence of Failure (COF)	Probability of Failure (POF): Breaks/150 ft.	Criticality Score (BRE)
							Pipe Age	Pipe Size	Undersize Pipe	Road Type			
Kenosha	H144	R002	Local	1983	8	1	0.8	0.8	0.5	1.0	3.1	2.0	6.2
Kenosha	H145	R002	Local	1983	8	1	0.8	0.8	0.5	1.0	3.1	2.0	6.2
Kenosha	H425	R002	Local	1983	6	1	0.8	0.5	1.0	1.0	3.3	2.0	6.6
Kenosha	H112	R048	Local	1983	8	0	0.8	0.8	0.5	1.0	3.1	1.0	3.1
Kenosha	H116	R048	Local	1983	8	0	0.8	0.8	0.5	1.0	3.1	1.0	3.1
Kenosha	H146	R048	Local	1983	8	0	0.8	0.8	0.5	1.0	3.1	1.0	3.1
Kenosha	H147	R048	Local	1983	8	0	0.8	0.8	0.5	1.0	3.1	1.0	3.1
Kenosha	H148	R048	Local	1983	8	0	0.8	0.8	0.5	1.0	3.1	1.0	3.1
Kenosha	H149	R048	Local	1983	8	0	0.8	0.8	0.5	1.0	3.1	1.0	3.1
Kenosha	H150	R048	Local	1983	8	0	0.8	0.8	0.5	1.0	3.1	1.0	3.1
Kenosha	H151	R048	Local	1983	8	0	0.8	0.8	0.5	1.0	3.1	1.0	3.1
Kingsville	H114	R046	Local	1950	8	1	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Kingsville	H122	R046	Local	1950	8	1	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Kingsville	H123	R046	Local	1950	8	1	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Kingsville	H124	R046	Local	1950	8	1	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Kingsville	H152	R046	Local	1950	8	1	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Kingsville	H153	R046	Local	1950	8	1	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Kingsville	H097	R087	Local	1945	6	1	1.3	0.5	1.0	1.0	3.8	2.0	7.6
Kingsville	H099	R087	Local	1945	6	1	1.3	0.5	1.0	1.0	3.8	2.0	7.6
Kingsville	H154	R147	Local	1950	8	0	1.3	0.8	0.5	1.0	3.6	4.0	14.4
Kingsville	H155	R147	Local	1950	8	0	1.3	0.8	0.5	1.0	3.6	4.0	14.4
Kingsville	H156	R147	Local	1950	8	0	1.3	0.8	0.5	1.0	3.6	4.0	14.4

Street	Hydrant ID	Run ID	Road Type	Year Installed	Diameter (in)	Recorded Breaks	Consequence of Failure Criteria				Consequence of Failure (COF)	Probability of Failure (POF): Breaks/150 ft.	Criticality Score (BRE)
							Pipe Age	Pipe Size	Undersize Pipe	Road Type			
Kingsville	H157	R147	Local	1950	8	0	1.3	0.8	0.5	1.0	3.6	4.0	14.4
Kingsville	H158	R147	Local	1950	8	0	1.3	0.8	0.5	1.0	3.6	4.0	14.4
Kingsville	H159	R147	Local	1950	8	0	1.3	0.8	0.5	1.0	3.6	4.0	14.4
Kroger	H429	R140	Private	1991	8	0	0.5	0.8	0.5	0.5	2.3	1.0	2.3
Lancaster	H030	R076	Local	1940	8	4	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Lancaster	H033	R076	Local	1940	8	4	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Lancaster	H287	R076	Local	1940	8	4	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Lancaster	H288	R076	Local	1940	8	4	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Lancaster	H289	R076	Local	1940	8	4	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Lancaster	H290	R076	Local	1940	8	4	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Lancaster	H025	R121	Local	1997	8	0	0.5	0.8	0.5	1.0	2.8	1.0	2.8
Lancaster	H027	R121	Local	1997	8	0	0.5	0.8	0.5	1.0	2.8	1.0	2.8
Lennon	H322	R079	Local	1957	8	3	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Lennon	H323	R079	Local	1957	8	3	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Lennon	H326	R079	Local	1957	8	3	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Lennon	H327	R079	Local	1957	8	3	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Lennon	H400	R079	Local	1957	8	3	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Lennon	H016	R124	Local	1996	8	1	0.5	0.8	0.5	1.0	2.8	2.0	5.6
Lennon	H018	R124	Local	1996	8	1	0.5	0.8	0.5	1.0	2.8	2.0	5.6
Lennon	H019	R124	Local	1996	8	1	0.5	0.8	0.5	1.0	2.8	2.0	5.6
Littlestone	H069	R103	Local	1938	8	3	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Littlestone	H070	R103	Local	1938	8	3	1.3	0.8	0.5	1.0	3.6	3.0	10.8

Street	Hydrant ID	Run ID	Road Type	Year Installed	Diameter (in)	Recorded Breaks	Consequence of Failure Criteria				Consequence of Failure (COF)	Probability of Failure (POF): Breaks/150 ft.	Criticality Score (BRE)
							Pipe Age	Pipe Size	Undersize Pipe	Road Type			
Littlestone	H071	R103	Local	1938	8	3	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Littlestone	H075	R103	Local	1938	8	3	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Lochmoor	H037	R069	Local	1964	8	4	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Lochmoor	H267	R069	Local	1964	8	4	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Lochmoor	H282	R069	Local	1964	8	4	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Lochmoor	H283	R069	Local	1964	8	4	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Lochmoor	H284	R069	Local	1964	8	4	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Lochmoor	H402	R069	Local	1964	8	4	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Lochmoor	H040	R119	Local	1998	8	1	0.5	0.8	0.5	1.0	2.8	2.0	5.6
Lochmoor	H042	R119	Local	1998	8	1	0.5	0.8	0.5	1.0	2.8	2.0	5.6
Manchester	H063	R107	Local	1938	8	1	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Manchester	H064	R107	Local	1938	8	1	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Manchester	H065	R107	Local	1938	8	1	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Newcastle	H086	R099	Local	1940	8	2	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Newcastle	H088	R099	Local	1940	8	2	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Newcastle	H089	R099	Local	1940	8	2	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Newcastle	H090	R099	Local	1940	8	2	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Norwood	H044	R117	Local	1995	8	0	0.5	0.8	0.5	1.0	2.8	1.0	2.8
Norwood	H046	R117	Local	1995	8	0	0.5	0.8	0.5	1.0	2.8	1.0	2.8
Norwood	H047	R117	Local	1995	8	0	0.5	0.8	0.5	1.0	2.8	1.0	2.8
Old Homestead	H224	R009	Local	1987	8	0	0.8	0.8	0.5	1.0	3.1	1.0	3.1
Old Homestead	H226	R009	Local	1987	8	0	0.8	0.8	0.5	1.0	3.1	1.0	3.1

Street	Hydrant ID	Run ID	Road Type	Year Installed	Diameter (in)	Recorded Breaks	Consequence of Failure Criteria				Consequence of Failure (COF)	Probability of Failure (POF): Breaks/150 ft.	Criticality Score (BRE)
							Pipe Age	Pipe Size	Undersize Pipe	Road Type			
Old Homestead	H228	R009	Local	1987	8	0	0.8	0.8	0.5	1.0	3.1	1.0	3.1
Old Homestead	H231	R009	Local	1987	8	0	0.8	0.8	0.5	1.0	3.1	1.0	3.1
Old Homestead	H233	R009	Local	1987	8	0	0.8	0.8	0.5	1.0	3.1	1.0	3.1
Old Homestead	H235	R009	Local	1987	8	0	0.8	0.8	0.5	1.0	3.1	1.0	3.1
Old Homestead	H238	R009	Local	1987	8	0	0.8	0.8	0.5	1.0	3.1	1.0	3.1
Old Homestead	H074	R057	Local	1986	8	0	0.8	0.8	0.5	1.0	3.1	1.0	3.1
Old Homestead	H214	R057	Local	1986	8	0	0.8	0.8	0.5	1.0	3.1	1.0	3.1
Old Homestead	H215	R057	Local	1986	8	0	0.8	0.8	0.5	1.0	3.1	1.0	3.1
Old Homestead	H217	R057	Local	1986	8	0	0.8	0.8	0.5	1.0	3.1	1.0	3.1
Old Homestead	H218	R057	Local	1986	8	0	0.8	0.8	0.5	1.0	3.1	1.0	3.1
Old Homestead	H220	R057	Local	1986	8	0	0.8	0.8	0.5	1.0	3.1	1.0	3.1
Old Homestead	H221	R057	Local	1986	8	0	0.8	0.8	0.5	1.0	3.1	1.0	3.1
Old Homestead	H223	R057	Local	1986	8	0	0.8	0.8	0.5	1.0	3.1	1.0	3.1
Park Place of Harper Woods	H426	R142	Private	1940	6	0	1.3	0.5	0.5	0.5	2.8	1.0	2.8
Park Place of Harper Woods	H430	R142	Private	1940	8	0	1.3	0.8	0.5	0.5	3.1	1.0	3.1
Parkcrest	H051	R116	Local	1940	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Parkcrest	H052	R116	Local	1940	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Parkcrest	H053	R116	Local	1940	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Prestwick	H083	R098	Local	1940	8	6	1.3	0.8	0.5	1.0	3.6	4.0	14.4
Prestwick	H084	R098	Local	1940	8	6	1.3	0.8	0.5	1.0	3.6	4.0	14.4
Prestwick	H085	R098	Local	1940	8	6	1.3	0.8	0.5	1.0	3.6	4.0	14.4
Prestwick	H087	R098	Local	1940	8	6	1.3	0.8	0.5	1.0	3.6	4.0	14.4

Street	Hydrant ID	Run ID	Road Type	Year Installed	Diameter (in)	Recorded Breaks	Consequence of Failure Criteria				Consequence of Failure (COF)	Probability of Failure (POF): Breaks/150 ft.	Criticality Score (BRE)
							Pipe Age	Pipe Size	Undersize Pipe	Road Type			
Ridgemont	H358	R084	Local	1967	6	2	1.3	0.5	1.0	1.0	3.8	4.0	15.2
Ridgemont	H003	R135	Local	1997	8	0	0.5	0.8	0.5	1.0	2.8	1.0	2.8
Ridgemont	H412	R135	Local	1997	8	0	0.5	0.8	0.5	1.0	2.8	1.0	2.8
Ridgemont	H413	R135	Local	1997	6	0	0.5	0.5	1.0	1.0	3.0	1.0	3.0
Rockcastle	H103	R089	Local	1945	8	2	1.3	0.8	0.5	1.0	3.6	4.0	14.4
Rolandale	H094	R094	Local	1945	8	4	1.3	0.8	0.5	1.0	3.6	5.0	18.0
Rolandale	H423	R094	Local	1945	8	4	1.3	0.8	0.5	1.0	3.6	5.0	18.0
Roscommon	H182	R004	Local	1990	8	0	0.5	0.8	0.5	1.0	2.8	1.0	2.8
Roscommon	H183	R004	Local	1990	8	0	0.5	0.8	0.5	1.0	2.8	1.0	2.8
Roscommon	H184	R004	Local	1990	8	0	0.5	0.8	0.5	1.0	2.8	1.0	2.8
Roscommon	H185	R004	Local	1990	8	0	0.5	0.8	0.5	1.0	2.8	1.0	2.8
Roscommon	H186	R004	Local	1990	8	0	0.5	0.8	0.5	1.0	2.8	1.0	2.8
Roscommon	H187	R004	Local	1990	8	0	0.5	0.8	0.5	1.0	2.8	1.0	2.8
Roscommon	H188	R004	Local	1990	8	0	0.5	0.8	0.5	1.0	2.8	1.0	2.8
Roscommon	H120	R050	Local	1991	8	1	0.5	0.8	0.5	1.0	2.8	2.0	5.6
Roscommon	H121	R050	Local	1991	8	1	0.5	0.8	0.5	1.0	2.8	2.0	5.6
Roscommon	H176	R050	Local	1991	8	1	0.5	0.8	0.5	1.0	2.8	2.0	5.6
Roscommon	H177	R050	Local	1991	8	1	0.5	0.8	0.5	1.0	2.8	2.0	5.6
Roscommon	H178	R050	Local	1991	8	1	0.5	0.8	0.5	1.0	2.8	2.0	5.6
Roscommon	H179	R050	Local	1991	8	1	0.5	0.8	0.5	1.0	2.8	2.0	5.6
Roscommon	H180	R050	Local	1991	8	1	0.5	0.8	0.5	1.0	2.8	2.0	5.6
Roscommon	H181	R050	Local	1991	8	1	0.5	0.8	0.5	1.0	2.8	2.0	5.6

Street	Hydrant ID	Run ID	Road Type	Year Installed	Diameter (in)	Recorded Breaks	Consequence of Failure Criteria				Consequence of Failure (COF)	Probability of Failure (POF): Breaks/150 ft.	Criticality Score (BRE)
							Pipe Age	Pipe Size	Undersize Pipe	Road Type			
Roslyn	H001	R137	Local	1998	8	1	0.5	0.8	0.5	1.0	2.8	3.0	8.4
Salter Park	H118	R143	Private	1940	8	0	1.3	0.8	0.5	0.5	3.1	1.0	3.1
Severn	H081	R104	Local	1940	8	5	1.3	0.8	0.5	1.0	3.6	5.0	18.0
Severn	H082	R104	Local	1940	8	5	1.3	0.8	0.5	1.0	3.6	5.0	18.0
Sloan	H096	R096	Local	1945	8	3	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Sloan	H098	R096	Local	1945	8	3	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Sloan	H100	R096	Local	1945	8	3	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Starr Academy	H108	R144	Private	1940	8	0	1.3	0.8	0.5	0.5	3.1	1.0	3.1
Starr Academy 2	H105	R145	Private	Pre-1960	6	0	1.5	0.5	1.0	0.5	3.5	1.0	3.5
Tyrone	H101	R091	Local	1940	8	1	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Tyrone	H422	R091	Local	1940	8	1	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Tyrone	H078	R092	Local	1940	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Van Antwerp	H320	R080	Local	1957	8	3	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Van Antwerp	H324	R080	Local	1957	8	3	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Van Antwerp	H325	R080	Local	1957	8	3	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Van Antwerp	H328	R080	Local	1957	8	3	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Van Antwerp	H012	R125	Local	1992	8	0	0.5	0.8	0.5	1.0	2.8	1.0	2.8
Van Antwerp	H013	R125	Local	1992	8	0	0.5	0.8	0.5	1.0	2.8	1.0	2.8
Vernier	H301	R031	Major	1957	12	7	1.3	1.2	0.5	1.5	4.5	3.0	13.5
Vernier	H393	R031	Major	1957	12	7	1.3	1.2	0.5	1.5	4.5	3.0	13.5
Vernier	H395	R031	Major	1957	10	7	1.3	0.0	1.0	1.5	3.8	3.0	11.4
Vernier	H395	R031	Major	1957	12	7	1.3	1.2	0.5	1.5	4.5	3.0	13.5

Street	Hydrant ID	Run ID	Road Type	Year Installed	Diameter (in)	Recorded Breaks	Consequence of Failure Criteria				Consequence of Failure (COF)	Probability of Failure (POF): Breaks/150 ft.	Criticality Score (BRE)
							Pipe Age	Pipe Size	Undersize Pipe	Road Type			
Vernier	H396	R031	Major	1957	12	7	1.3	1.2	0.5	1.5	4.5	3.0	13.5
Vernier	H397	R031	Major	1957	12	7	1.3	1.2	0.5	1.5	4.5	3.0	13.5
Vernier	H398	R031	Major	1957	12	7	1.3	1.2	0.5	1.5	4.5	3.0	13.5
Vernier	H399	R031	Major	1957	12	7	1.3	1.2	0.5	1.5	4.5	3.0	13.5
Vernier	H316	R032	Major	1957	12	1	1.3	1.2	0.5	1.5	4.5	2.0	9.0
Vernier	H317	R032	Major	1957	12	1	1.3	1.2	0.5	1.5	4.5	2.0	9.0
Vernier	H319	R032	Major	1957	12	1	1.3	1.2	0.5	1.5	4.5	2.0	9.0
Vernier	H329	R032	Major	1957	12	1	1.3	1.2	0.5	1.5	4.5	2.0	9.0
Vernier	H330	R032	Major	1957	12	1	1.3	1.2	0.5	1.5	4.5	2.0	9.0
Vernier	H331	R032	Major	1957	12	1	1.3	1.2	0.5	1.5	4.5	2.0	9.0
Vernier	H332	R032	Major	1957	12	1	1.3	1.2	0.5	1.5	4.5	2.0	9.0
Vernier North	H333	R033	Major	1957	8	0	1.3	0.8	1.3	1.5	4.9	1.0	4.9
Vernier North	H334	R033	Major	1957	8	0	1.3	0.8	1.3	1.5	4.9	1.0	4.9
Vernier North	H335	R033	Major	1957	8	0	1.3	0.8	1.3	1.5	4.9	1.0	4.9
Vernier North	H336	R033	Major	1957	8	0	1.3	0.8	1.3	1.5	4.9	1.0	4.9
Vernier North	H337	R033	Major	1957	8	0	1.3	0.8	1.3	1.5	4.9	1.0	4.9
Vernier North	H006	R127	Major	1991	6	0	0.5	0.5	1.5	1.5	4.0	1.0	4.0
Vernier North	H009	R127	Major	1991	8	0	0.5	0.8	1.3	1.5	4.1	1.0	4.1
Vernier South	H010	R126	Major	1991	8	0	0.5	0.8	1.3	1.5	4.1	1.0	4.1
Vernier South	H011	R126	Major	1991	8	0	0.5	0.8	1.3	1.5	4.1	1.0	4.1
Washtenaw	H132	R001	Local	1979	8	2	1.1	0.8	0.5	1.0	3.4	2.0	6.8
Washtenaw	H133	R001	Local	1979	8	2	1.1	0.8	0.5	1.0	3.4	2.0	6.8

Street	Hydrant ID	Run ID	Road Type	Year Installed	Diameter (in)	Recorded Breaks	Consequence of Failure Criteria				Consequence of Failure (COF)	Probability of Failure (POF): Breaks/150 ft.	Criticality Score (BRE)
							Pipe Age	Pipe Size	Undersize Pipe	Road Type			
Washtenaw	H134	R001	Local	1979	8	2	1.1	0.8	0.5	1.0	3.4	2.0	6.8
Washtenaw	H135	R001	Local	1979	8	2	1.1	0.8	0.5	1.0	3.4	2.0	6.8
Washtenaw	H136	R001	Local	1979	8	2	1.1	0.8	0.5	1.0	3.4	2.0	6.8
Washtenaw	H137	R001	Local	1979	8	2	1.1	0.8	0.5	1.0	3.4	2.0	6.8
Washtenaw	H138	R001	Local	1979	8	2	1.1	0.8	0.5	1.0	3.4	2.0	6.8
Washtenaw	H139	R001	Local	1979	8	2	1.1	0.8	0.5	1.0	3.4	2.0	6.8
Washtenaw	H111	R047	Local	1980	8	1	0.8	0.8	0.5	1.0	3.1	2.0	6.2
Washtenaw	H115	R047	Local	1980	8	1	0.8	0.8	0.5	1.0	3.1	2.0	6.2
Washtenaw	H125	R047	Local	1980	8	1	0.8	0.8	0.5	1.0	3.1	2.0	6.2
Washtenaw	H126	R047	Local	1980	8	1	0.8	0.8	0.5	1.0	3.1	2.0	6.2
Washtenaw	H127	R047	Local	1980	8	1	0.8	0.8	0.5	1.0	3.1	2.0	6.2
Washtenaw	H128	R047	Local	1980	8	1	0.8	0.8	0.5	1.0	3.1	2.0	6.2
Washtenaw	H129	R047	Local	1980	8	1	0.8	0.8	0.5	1.0	3.1	2.0	6.2
Washtenaw	H130	R047	Local	1980	8	1	0.8	0.8	0.5	1.0	3.1	2.0	6.2
Washtenaw	H131	R047	Local	1980	8	1	0.8	0.8	0.5	1.0	3.1	2.0	6.2
Wildwood	H058	R108	Local	1952	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Wildwood	H066	R108	Local	1952	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Wildwood	H420	R108	Local	1952	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Williamsburg Ct	H312	R078	Local	1945	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Williamsburg Ct	H321	R078	Local	1945	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Woodcrest	H201	R006	Local	1996	8	0	0.5	0.8	0.5	1.0	2.8	1.0	2.8
Woodcrest	H202	R006	Local	1996	8	0	0.5	0.8	0.5	1.0	2.8	1.0	2.8

Street	Hydrant ID	Run ID	Road Type	Year Installed	Diameter (in)	Recorded Breaks	Consequence of Failure Criteria				Consequence of Failure (COF)	Probability of Failure (POF): Breaks/150 ft.	Criticality Score (BRE)
							Pipe Age	Pipe Size	Undersize Pipe	Road Type			
Woodcrest	H203	R006	Local	1996	8	0	0.5	0.8	0.5	1.0	2.8	1.0	2.8
Woodcrest	H204	R006	Local	1996	8	0	0.5	0.8	0.5	1.0	2.8	1.0	2.8
Woodcrest	H205	R006	Local	1996	8	0	0.5	0.8	0.5	1.0	2.8	1.0	2.8
Woodcrest	H362	R006	Local	1996	8	0	0.5	0.8	0.5	1.0	2.8	1.0	2.8
Woodcrest	H363	R006	Local	1996	8	0	0.5	0.8	0.5	1.0	2.8	1.0	2.8
Woodcrest	H073	R052	Local	1995	8	0	0.5	0.8	0.5	1.0	2.8	1.0	2.8
Woodcrest	H207	R052	Local	1995	8	0	0.5	0.8	0.5	1.0	2.8	1.0	2.8
Woodcrest	H209	R052	Local	1995	6	0	0.5	0.5	1.0	1.0	3.0	1.0	3.0
Woodcrest	H211	R052	Local	1995	6	0	0.5	0.5	1.0	1.0	3.0	1.0	3.0
Woodcrest	H367	R052	Local	1995	8	0	0.5	0.8	0.5	1.0	2.8	1.0	2.8
Woodcrest	H368	R052	Local	1995	8	0	0.5	0.8	0.5	1.0	2.8	1.0	2.8
Woodcrest	H369	R052	Local	1995	6	0	0.5	0.5	1.0	1.0	3.0	1.0	3.0
Woodcrest	H370	R052	Local	1995	6	0	0.5	0.5	1.0	1.0	3.0	1.0	3.0
Woodland	H225	R008	Local	1952	8	2	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Woodland	H229	R008	Local	1952	8	2	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Woodland	H230	R008	Local	1952	8	2	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Woodland	H234	R008	Local	1952	8	2	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Woodland	H237	R008	Local	1952	8	2	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Woodland	H206	R056	Local	1952	8	3	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Woodland	H208	R056	Local	1952	8	3	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Woodland	H210	R056	Local	1952	8	3	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Woodland	H212	R056	Local	1952	8	3	1.3	0.8	0.5	1.0	3.6	2.0	7.2

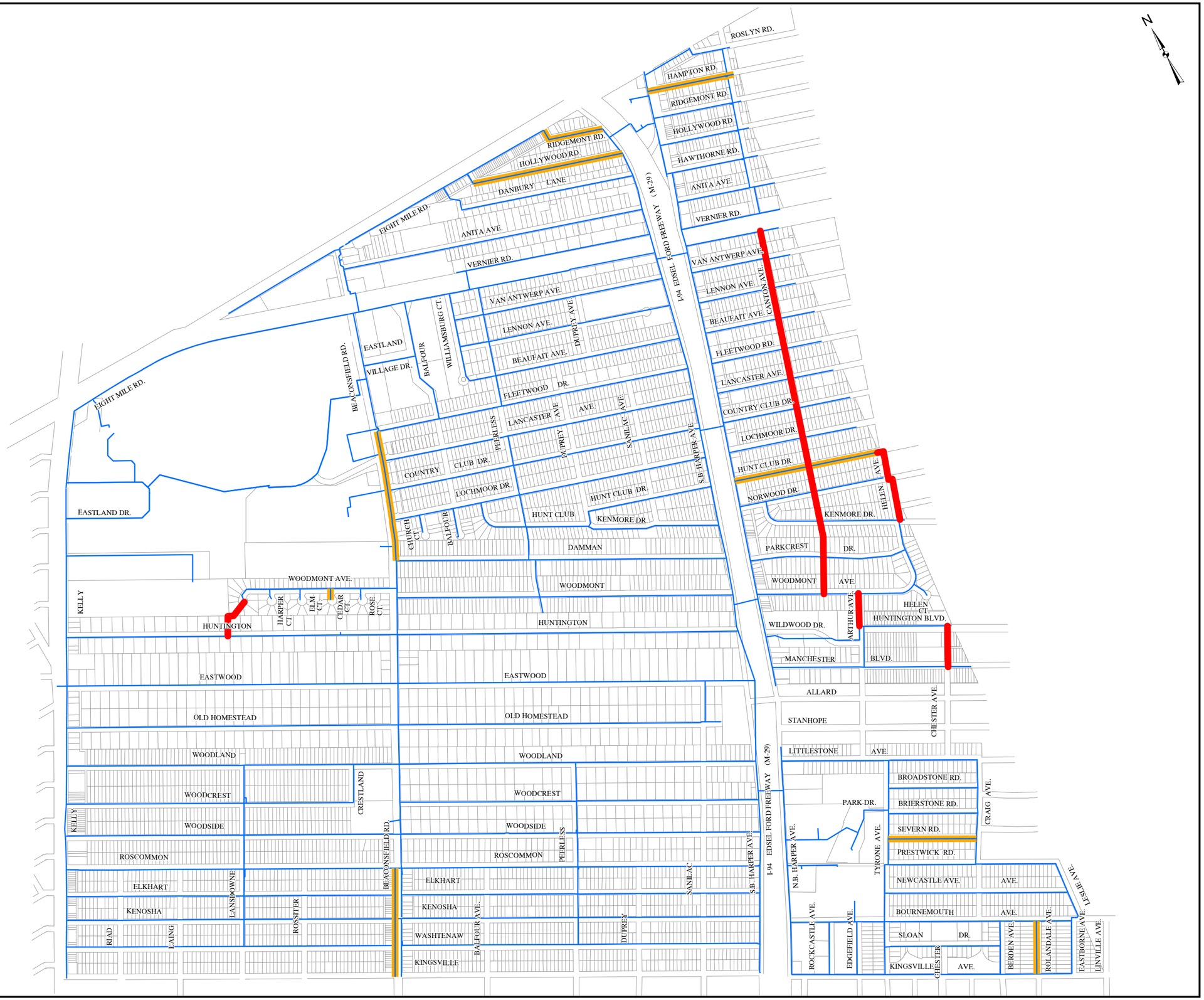
Street	Hydrant ID	Run ID	Road Type	Year Installed	Diameter (in)	Recorded Breaks	Consequence of Failure Criteria				Consequence of Failure (COF)	Probability of Failure (POF): Breaks/150 ft.	Criticality Score (BRE)
							Pipe Age	Pipe Size	Undersize Pipe	Road Type			
Woodland	H213	R056	Local	1952	8	3	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Woodland	H366	R056	Local	1952	8	3	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Woodmont	H268	R012	Local	1954	8	2	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Woodmont	H269	R012	Local	1954	8	2	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Woodmont	H270	R012	Local	1954	8	2	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Woodmont	H389	R012	Local	1954	8	2	1.3	0.8	0.5	1.0	3.6	2.0	7.2
Woodmont	H249	R061	Local	1955	8	5	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Woodmont	H250	R061	Local	1955	8	5	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Woodmont	H251	R061	Local	1955	8	5	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Woodmont	H252	R061	Local	1955	8	5	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Woodmont	H253	R061	Local	1955	8	5	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Woodmont	H388	R061	Local	1955	8	5	1.3	0.8	0.5	1.0	3.6	3.0	10.8
Woodmont	H055	R112	Local	1945	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Woodmont	H056	R112	Local	1945	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Woodmont	H057	R112	Local	1945	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Woodmont	H059	R112	Local	1945	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Woodside	H194	R005	Local	1992	8	2	0.5	0.8	0.5	1.0	2.8	2.0	5.6
Woodside	H195	R005	Local	1992	8	2	0.5	0.8	0.5	1.0	2.8	2.0	5.6
Woodside	H196	R005	Local	1992	8	2	0.5	0.8	0.5	1.0	2.8	2.0	5.6
Woodside	H197	R005	Local	1992	8	2	0.5	0.8	0.5	1.0	2.8	2.0	5.6
Woodside	H198	R005	Local	1992	8	2	0.5	0.8	0.5	1.0	2.8	2.0	5.6
Woodside	H199	R005	Local	1992	8	2	0.5	0.8	0.5	1.0	2.8	2.0	5.6

Street	Hydrant ID	Run ID	Road Type	Year Installed	Diameter (in)	Recorded Breaks	Consequence of Failure Criteria				Consequence of Failure (COF)	Probability of Failure (POF): Breaks/150 ft.	Criticality Score (BRE)
							Pipe Age	Pipe Size	Undersize Pipe	Road Type			
Woodside	H200	R005	Local	1992	8	2	0.5	0.8	0.5	1.0	2.8	2.0	5.6
Woodside	H119	R051	Local	1950	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Woodside	H189	R051	Local	1950	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Woodside	H190	R051	Local	1950	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Woodside	H191	R051	Local	1950	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Woodside	H192	R051	Local	1950	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Woodside	H193	R051	Local	1950	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Woodside	H359	R051	Local	1950	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6
Woodside	H371	R051	Local	1950	8	0	1.3	0.8	0.5	1.0	3.6	1.0	3.6

APPENDIX F: PROPOSED CAPITAL IMPROVEMENT PLAN

Street	From	To	Run ID	Material	Road Type	Year Installed	Diameter (in.)	Length (ft.)	Recorded Breaks	Breaks per 150 ft.	Consequence of Failure Criteria				Consequence of Failure (COF)	Probability of Failure (POF): Breaks/150 ft.	Criticality Score (BRE)	Replacement Cost
											Pipe Age	Pipe Size	Undersize Pipe	Road Type				
Cedar Ct	Woodmont	Cul de Sac	R022	Cast Iron	Local	1952	6	119	1	1.26	1.1	0.5	1.0	1.0	3.6	5.0	18.0	$ 39,941
Hampton	Harper	E.C.L.	R136	Cast Iron	Local	1950	6	948	5	0.79	1.1	0.5	1.0	1.0	3.6	5.0	18.0	$ 317,424
Rolandale	Kingsville	Bournemouth	R094	Cast Iron	Local	1950	8	559	4	1.07	1.1	0.8	0.5	1.0	3.4	5.0	17.0	$ 187,372
Severn	Tyrone	Craig	R104	Cast Iron	Local	1950	8	928	5	0.81	1.1	0.8	0.5	1.0	3.4	5.0	17.0	$ 311,019
Hollywood	8 Mile	Harper	R083	Cast Iron	Local	1938	6	1600	6	0.56	1.5	0.5	1.0	1.0	4.0	4.0	16.0	$ 536,139
Ridgemont	8 Mile	Harper	R084	Cast Iron	Local	1938	6	693	2	0.43	1.5	0.5	1.0	1.0	4.0	4.0	16.0	$ 232,005
Beaconsfield	Damman	Fleetwood	R156	Cast Iron	Major	1940	8	1378	3	0.33	1.3	0.8	1.3	1.5	4.9	3.0	14.7	$ 461,512
Hunt Club	Harper	Helen	R118	Cast Iron	Local	1945	8	1528	5	0.49	1.3	0.8	0.5	1.0	3.6	4.0	14.4	$ 511,967
Beaconsfield	Kingsville	Roscommon	R026	Cast Iron	Major	1940	6	1143	2	0.26	1.3	0.5	1.5	1.5	4.8	3.0	14.4	$ 382,878

APPENDIX G: MAP OF PROPOSED CAPITAL IMPROVEMENT PLAN LOCATIONS



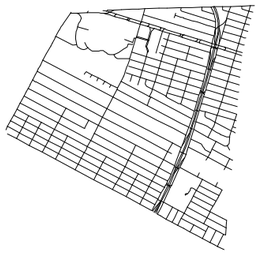
CITY of HARPER WOODS

Proposed Capital Improvement Plan Locations

CAUTION

THIS MAP IS INTENDED FOR REFERENCE PURPOSES ONLY

ANDERSON, ECKSTEIN AND WESTRICK, INC. AND THE CITY OF HARPER WOODS DO NOT GUARANTEE THE ACCURACY OF THIS INFORMATION AND DISCLAIMS ALL LIABILITY FROM ALL CLAIMS, SUITS, DEMANDS AND JUDGEMENTS ARISING FROM THE USE OF THIS INFORMATION



ANDERSON, ECKSTEIN AND WESTRICK, INC.
Civil Engineers • Surveyors • Architects
51301 Schoenherr Road, Shelby Township, Michigan 48315
Phone 586-726-1234 Fax 586-726-8760

Existing Water Mains

Existing Water Mains Proposed for Replacement

Water Main Proposed From 2015 Reliability Study

DATE PRINTED: February 10, 2018	DATE CREATED: February 2, 2018
SCALE: N.T.S.	MAP DOCUMENT: WaterAMP_CIP.mxd
PROJECT NO: 0180-0199	CREATED BY: JMM / CHECKED BY: JT