Storm Sewer System Evaluation

Prepared for

City of Ionia

September 2019

2130311

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1 INTRODUCTION

The City of Ionia has committed to implementing an asset management program for its public stormwater system. The Michigan Department of Environmental Quality, through its Stormwater, Asset management, and Wastewater (SAW) program has provided guidelines for the asset management program as well as funding to help develop a plan for implementing the program.

Asset management is a collection of best management practices which promote the perpetual and reliable operation and maintenance of the asset. The goal of the asset management program is to provide service for the system owners who pay for the service, at the level of service they desire, for the lowest possible life cycle cost perpetually. A core principal of asset management is to use known information about the condition of physical assets along with the consequences of an asset failure to make decisions about actions to prevent such failures.

The City of Ionia storm water system, shown in Map 1, includes storm sewers, culverts, open drains, and detention basins, conveying runoff from lands throughout the City and surrounding areas to the Grand River. The Yeomans and Inman County Drain and the Kanouse County Drain are also within the City limits and help convey storm water to the Grand River.

Prein&Newhof has performed an evaluation of the City of Ionia storm sewer system. This storm sewer system evaluation was completed to provide objective information upon which the asset management program can be developed. This evaluation includes an inventory of physical assets which comprise the system, an assessment of the current condition of the assets, a rating system for establishing repair and replacement priorities, and improvement recommendations pertaining to the needs of the system.

2 INVENTORY

An inventory of storm sewer system assets was prepared for the asset management plan. The inventory contains information on the size, material, and installation year of manholes, catch basins, sewer pipes, and culverts.

2.1 Records Review

The inventory was compiled using a Geographic Information System (GIS). The GIS serves as a repository of data from which the information about each asset can be displayed on maps. The maps enable data driven decision making.

The inventory was compiled from available documentation including prior system maps and record plans. Prior GIS information was provided by the City. Data from the City was used as the starting point to develop the inventory. Record plans were reviewed to confirm the pipe sizes, material, installation year, and inverts.

Record plans showing the original construction of the storm sewers were not available for a large portion of the systems. For storm sewers without record plans, age information was estimated from available records and surrounding storm sewers.

2.2 Field Verification

The system inventory was verified by locating manholes, opening the lids, visually confirming the number and orientation of connecting pipes, surveying the rim and invert elevations where needed, and storing Global Position System (GPS) coordinates. The GPS coordinates result in increased accuracy to make the GIS a more useful tool for future purposes, including capital improvement planning and routine maintenance operations.

2.3 Summary of Storm Sewer Inventory

The City of Ionia storm sewer system includes 124,200 feet of storm sewer pipes ranging from 4 to 60 inches in diameter, 446 manholes, 1,011 catch basins, and 9 culverts ranging from 12 inch diameter pipe up to a 6x3 foot rectangular box culvert. The City owns 3 storm detention ponds.

The non-City owned systems shown in Map 1 include approximately 60,000 feet of gravity sewer pipe ranging from 8 to 48 inches in diameter and 676 manholes and catch basins. Many of

the City's sewers connect directly into the Grand River or systems owned by either a County Drain District or MDOT, which eventually flow into the Grand River. The Yeomans and Inman County Drain conveys stormwater on the west side of the City to the Grand River, and the Kanouse County Drain conveys stormwater on the east side of the City to the Grand River.

Figure 1 shows a summary of the gravity sewer inventory for City owned sewers. Figure 2 provides further detail on the age and material of gravity sewer pipe. Non-City owned assets are not included in Figures 1 and 2. The pipe materials are primarily clay pipe installed in the 1940's through 1950's and primarily concrete pipe installed in the 1960's to present. Maps 2, 3, and 4 show the inventory of pipes by pipe diameters, installation year, and pipe material. The inventory details for culverts are shown in Table 1.

3 CONDITION ASSESSMENT

3.1 Manholes and Catch Basins

An assessment of the physical condition of manholes and catch basins was made by visual inspection from above ground. Condition assessments were made on the structure, the steps, the casting, and accumulation of sediment and debris in the sumps. Approximately 92% of the structures were inspected and assessed; occasional structures were omitted due to access limitations.

The majority of the structures were found in good to moderate condition. Some deficiencies that can be addressed as part of system operations and maintenance efforts were found in various locations. Further details including locations of these individual manholes are available for City maintenance staff in the GIS.

3.2 Gravity Sewer Pipes

An assessment of the physical condition of gravity sewer pipes was made. Descriptions of the assessment methods and condition observations are provided below.

3.2.1 Zoom Camera Inspections

Inspections were made from inside manholes using a pole mounted video camera equipped with a spot light and an optical zoom lens. An assessment of the condition of any observed offset joints, roots, debris, infiltration, corrosion, or other structural defects was made.

Condition ratings of 1-5 were assigned to gravity sewer pipes, where 5 represents the most severe defect and 1 represents no noted defect.

Zoom camera inspections have limitations for longer distances between manholes but provide a clear view of the ends of the pipe near the manhole. The observable distance varies typically between 50 and 150 feet and is affected by factors such as pipe alignment, roots, debris, and steam.

The zoom camera inspection provides an efficient way to identify pipes with severe problems and was used as a low cost screening tool to identify pipes that required additional, more detailed inspections.

3.2.2 Closed Circuit Televising with PACP Assessment

Closed Circuit Televising (CCTV) inspections were completed using remotely operated video cameras that travel through the sewer. The CCTV inspection provides up close visual detail through the entire length of pipe from manhole to manhole.

The National Association of Sewer Service Companies (NASSCO) defines a set of standards for documenting sewer pipe conditions with its Pipeline Assessment and Certification Program (PACP). PACP provides a standard method for documenting the location, type, and severity of sewer defects. The type of each defect is categorized as either a structural defect or an operations and maintenance defect. Structural defects include cracks, holes, sags, and corrosion. Operations and maintenance observations include roots, deposits, infiltration, and grease. Each defect is assigned a condition rating of 1-5, with 5 being the most severe defect.

The PACP standard was followed for sewer pipe condition assessments from CCTV inspections. The details of each CCTV inspection are available for reference in the GIS.

3.2.3 External Utility Penetrations

Inspections revealed as many as 3 locations with external utilities (including gas, phone, electric, or cable lines) penetrating the storm sewers. Suspected utility penetrations were encountered with zoom camera inspections or CCTV inspection. The City will work with the utility companies to correct these problems. The current status of utility penetration observations is shown in Table 2, and a photo example is shown in Appendix A.

3.2.4 Summary of Gravity Sewer Pipe Conditions

Map 5 shows the gravity sewer pipes that were inspected by each method. Approximately 62% of the pipes have been inspected by the zoom camera method and approximately 24% have been televised. The remaining pipe conditions were inferred due to the pipe being newly constructed or inaccessible to the camera.

Structural defects including cracked and broken pipes were observed in a variety of locations. Examples of significant structural defects found are shown on photos in Appendix A. Other structural problems may also exist in pipes which have not been assessed with CCTV inspections.

4 RISK OF FAILURE

A Risk of Failure (RoF) rating system was developed and used to rate the approximate likelihood of structural failures based on the condition assessments. Each manhole, catch basin, sewer pipe, and culvert was assigned a RoF rating of 1-5, with 5 being the worst condition or highest RoF.

RoF ratings for sewer pipes and culverts are shown on Map 6A and manholes and catch basins on Map 6B. RoF ratings are summarized in Figure 3. The majority of these assets have a relatively low risk of failure in their current condition. However, the pipes with the highest RoF ratings are already experiencing structure failures that will need to be addressed.

5 CONSEQUENCE OF FAILURE

A Consequence of Failure (CoF) rating system was developed and used to rate the social, economic and environmental impacts of potential sewer failures. Each pipe was assigned a rating of 1-5, with 5 representing the most severe consequences.

Sewers under major roads were given high CoF ratings because of the financial cost and impact on the public to make emergency repairs. Sewers below other infrastructure were given high CoF ratings because a sinkhole or a repair excavation may cause additional damage. Sewers in densely populated areas were given high CoF ratings because more people would be affected by the failure. Sewers which carry relatively large amounts of water were given high CoF ratings because structural failures could more rapidly develop into sink holes. All of these factors were considered and the resulting values were adjusted to ensure a useful distribution of ratings across the system.

The CoF ratings were reviewed with City staff and are shown on Map 7.

6 CRITICALITY

The RoF ratings and the CoF ratings were combined into a third rating system known as criticality. The criticality rating is the result of multiplying the RoF by the CoF, producing ratings ranging from 1-25. The criticality ratings, shown on Map 8, should be considered when establishing the order of priorities for system improvements.

7 CAPACITY

Long term capacity needs should always be considered before making system improvements. If a pipe in need of repair also requires increased capacity, this may affect the decision on how to make repairs. For example, an interior lining may be considered as a repair option in some cases, but if the capacity needs to be increased then open excavation to replace the sewer may be the more financially appropriate decision.

A capacity study was completed for the Ionia storm sewer system using hydraulic modeling. The capacity study is presented in a September 2019 report entitled "Sewer Flow Study: Stormwater Collection System and Capacity Analysis" by Prein&Newhof.

The study found that several of the storm sewer pipes in the City have less capacity than current design standards and should be master planned for capacity improvements. In many of these areas the City's field experience does not show the same capacity issues. The capacity improvements identified with the study are included with the capital improvement recommendations only in areas where structural issues are also present.

8 CAPITAL IMPROVEMENT RECOMMENDATIONS

Considering the condition assessments and criticality analysis described above, as well as the findings of the capacity studies, the following improvements should be incorporated into the City of Ionia Capital Improvement Plan (CIP).

8.1 Sewer Reconstruction, Rehabilitation, and Spot Repairs

Pipes recommended for reconstruction because of structural pipe defects are shown in red on Map 9. When reconstructing streets and additional utilities, complete reconstruction of storm sewers within the project limits should be considered.

Pipes that are candidates for rehabilitation through Cured in Place Pipe (CIPP) lining are shown in orange on Map 9. Rehabilitation through CIPP lining may repair structural defects without the high cost of restoration.

Pipes with localized defects which can be remedied with spot repairs are shown on Map 9. Spot repairs are categorized by dig or (CIPP) line. Distances from manholes to repair locations can be determined in the GIS mapping system.

8.2 Level of Service Improvements

8.2.1 New Storm Sewers to Unserved Properties

When street reconstruction projects provide the opportunity for storm sewer reconstruction, extension of new storm sewers to unserved properties should be considered. When providing public storm sewers under streets to serve existing properties, storm sewer laterals should be extended to the right of way.

If additional development is proposed on the north side of the City, a detention pond is recommended to control stormwater discharge during rain events.

8.2.2 New Storm Sewer along Jackson Street and Railroad

Construction of a new storm sewer along Jackson Street, from Perry Park to Railroad Street, and along Railroad from Jackson to Jefferson is recommended to re-route drain water and alleviate adjacent residents' flooding issues.

8.2.3 Adams Street (Dexter to Depot)

Reconstruction of Adams Street storm sewer is recommended between Dexter and Depot. Surface flooding is seen in this area during rain events and several additional structural issues were found in this pipe.

8.2.4 Main Street (Library to Rich)

Flow blockage of 50% to 75% of the pipe capacity was found in the storm sewer on Main Street between Library and Rich. The blockage appears to be concrete that was poured into the storm sewer and cured in the pipe. Due to the large amount of concrete, removal by jetting does not appear feasible. Construction of a parallel overflow storm sewer is recommended to allow for stormwater conveyance with minimal construction within the Main Street brick pavement.

8.2.5 Increase Mill Street Storm Outlet

The Mill Street storm outlet that discharges into the Grand River should be replaced with a larger diameter pipe to reduce flood risk for properties upstream.

8.2.6 Storm pipes through private property

Several areas in the City have storm pipe in private property and close to buildings. Many of these pipes have buried manholes and are difficult to access for maintenance. If it is not feasible to move pipe into the road Right-of-Way, easements should be secured for all pipe on private property. All buried manholes should be made accessible.

8.3 Sewer Cleaning and Televising

A routine sewer cleaning and televising plan should be developed as part of ongoing asset management program activities. A planned cleaning schedule should be implemented to reduce the risk of failure. Priority should be given to older sewers with no prior televising inspection. Root intrusion and flow blockage data collected during zoom camera inspection can also be used when developing a cleaning schedule and should be considered along with past cleaning records and maintenance history. Condition assessments and capital improvement priorities should be updated on a routine basis from findings.

9 CONCLUSION

The City of Ionia is responsible for approximately 24 miles of storm sewers and culverts. Prein&Newhof has performed an evaluation of the City storm sewers to provide objective information upon which the asset management program can be developed. The condition assessments of the inventoried assets can be used to determine short term needs as well as long term life cycle costs. Criticality ratings can be used to prioritize repair and replacement needs. Information and documentation linked to the GIS can be used to improve decision making and increase maintenance efficiency.

The City of Ionia's storm water asset management program also includes the development of a Capital Improvement Plan (CIP) to implement the needed improvements. The projects addressed in this report have been incorporated into the CIP and the timing of the projects has been coordinated with anticipated street improvements, water system improvements, waste water system improvements, and available funding. Priorities should be reevaluated as projects are completed and when new information about the system needs becomes available.

The goal of the asset management program is to provide services for the system owners who pay for the service, at the level of service they desire, for the lowest possible life cycle cost perpetually. In order to meet this goal, the asset inventory, condition assessments, and ratings should always be kept up to date and used for making decisions about actions needed to avoid failures in the storm sewer system.

Tables

Table 1: Culvert Inventory and Condition Assessment

Supporting	Crossing	Culvert Size	Material	Condition Assessment Method	RoF Rating
unnamed road on Fairgrounds	floodplain	12” Diameter	Concrete	Estimated	2
Wells St.	Wells St. Pond outlet to County Drain	24” Diameter	Concrete	Zoom Camera	1
Lafayette St.	unnamed creek	Box – 6’ x 3’	Concrete	Estimated	1
Washington St.	unnamed creek	Box – 6’ x 3’	Concrete	Zoom Camera	2
Railroad St.	unnamed creek	Eliptical – 2.5’ x 4.5’	Corrugated Metal	Zoom Camera	1
Fred Meijer Grand River Valley Rail Trail	unnamed creek	Eliptical – 2.7’ x 4’	Corrugated Metal	Zoom Camera	1
Fred Thwaites Grand River Trail	unnamed creek	24” Diameter	Corrugated Metal	Estimated	1
Fred Thwaites Grand River Trail	unnamed creek	24” Diameter	Concrete	Estimated	1
creek embankment	ditch next to bike path	18” Dia.	Concrete	Estimated	1

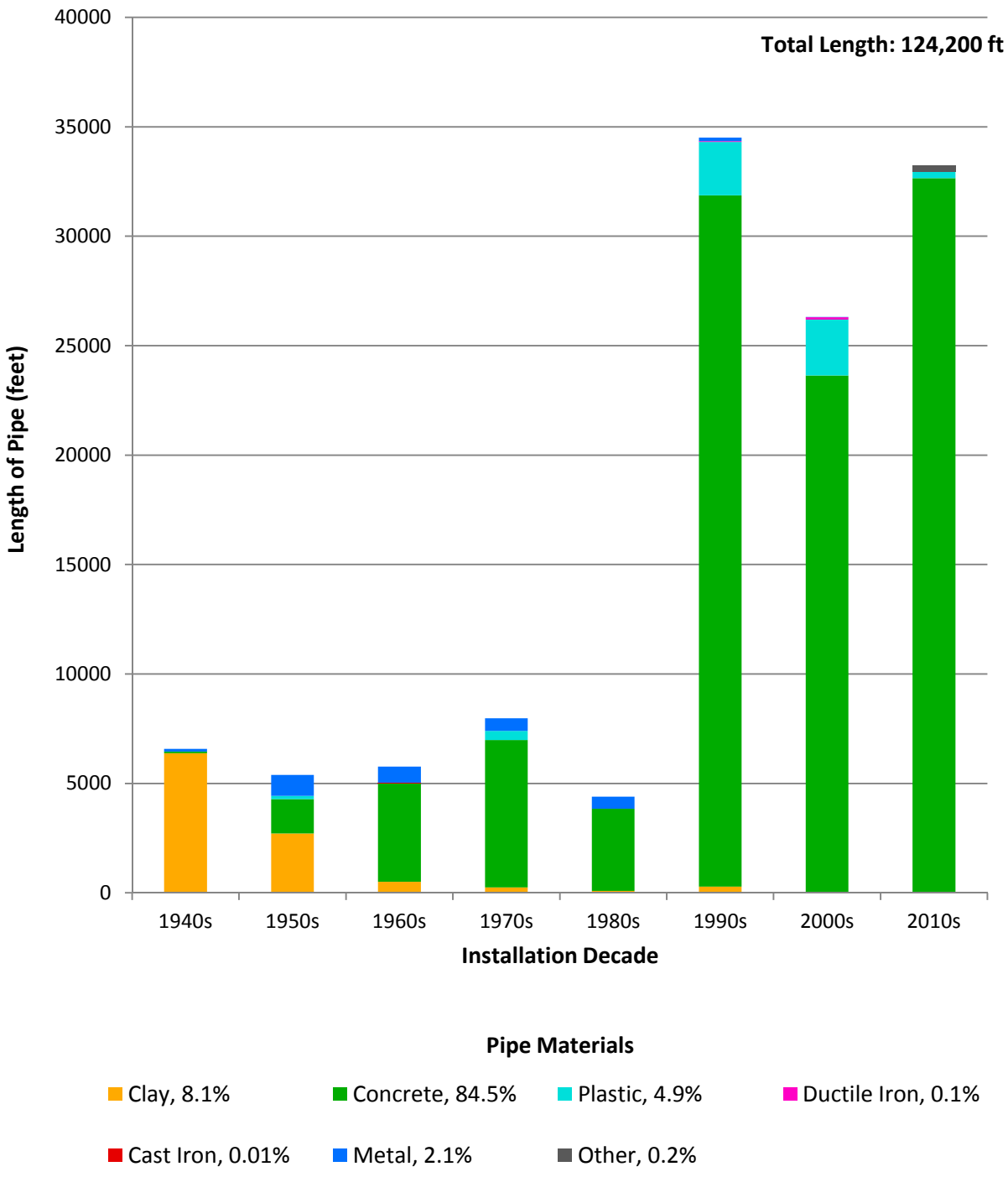
Table 2: Utility Penetrations

Location	Upsteam MH	Downstream MH	Distance	Description	Status*
Jones St.	CB-820	CB-822	estimated 75 ft E of CB-822	black pipe	existing
King St.	CB-406	CB-408	19 ft N of CB-408	black pipe	existing
Dye St.	CB-932	CB-934	121 ft N of CB-934	clay pipe	removed

*Status information should be confirmed with utility owners

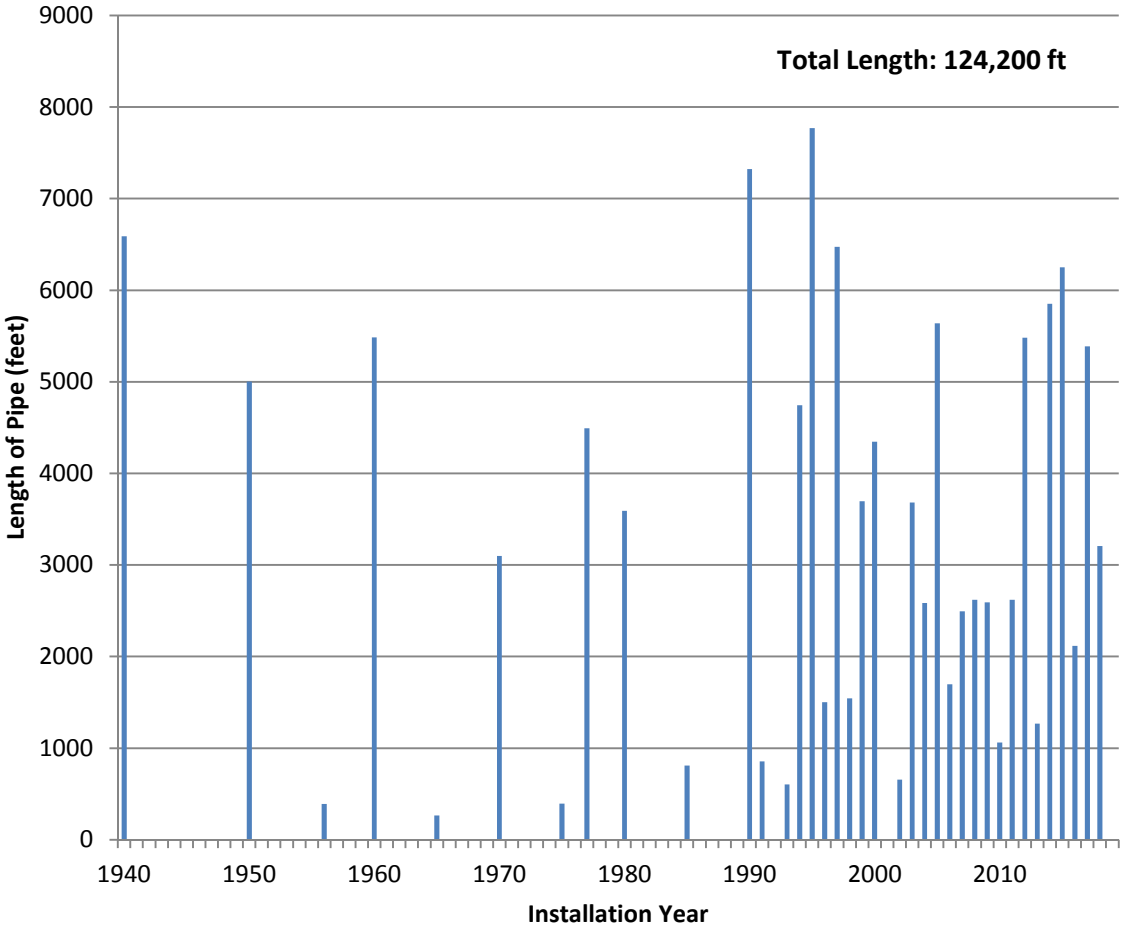
Figures

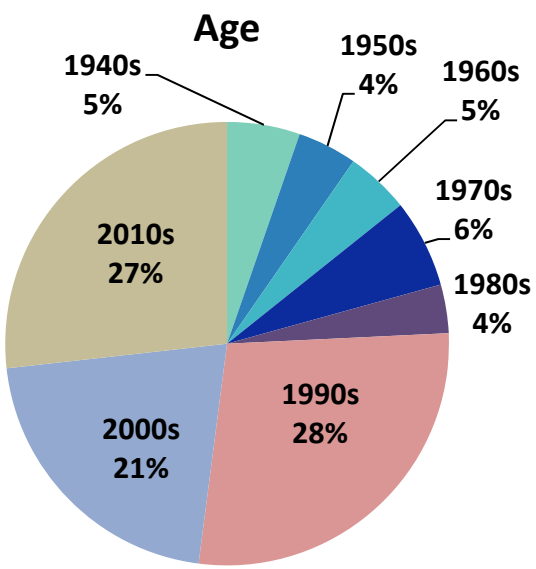
Gravity Sewer Inventory Summary

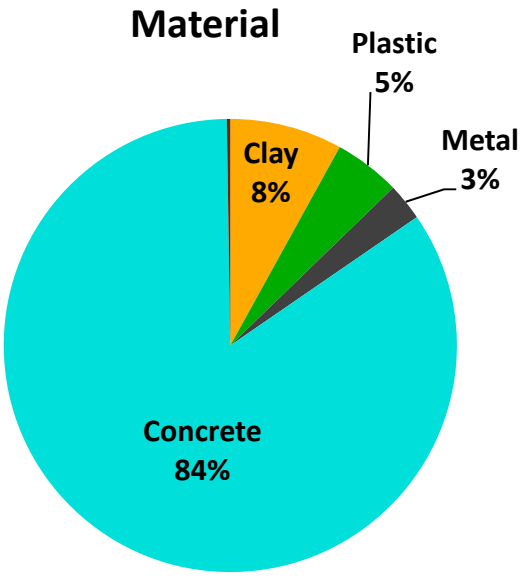


Includes City-owned gravity storm sewer pipe . Does not include service laterals or private systems.

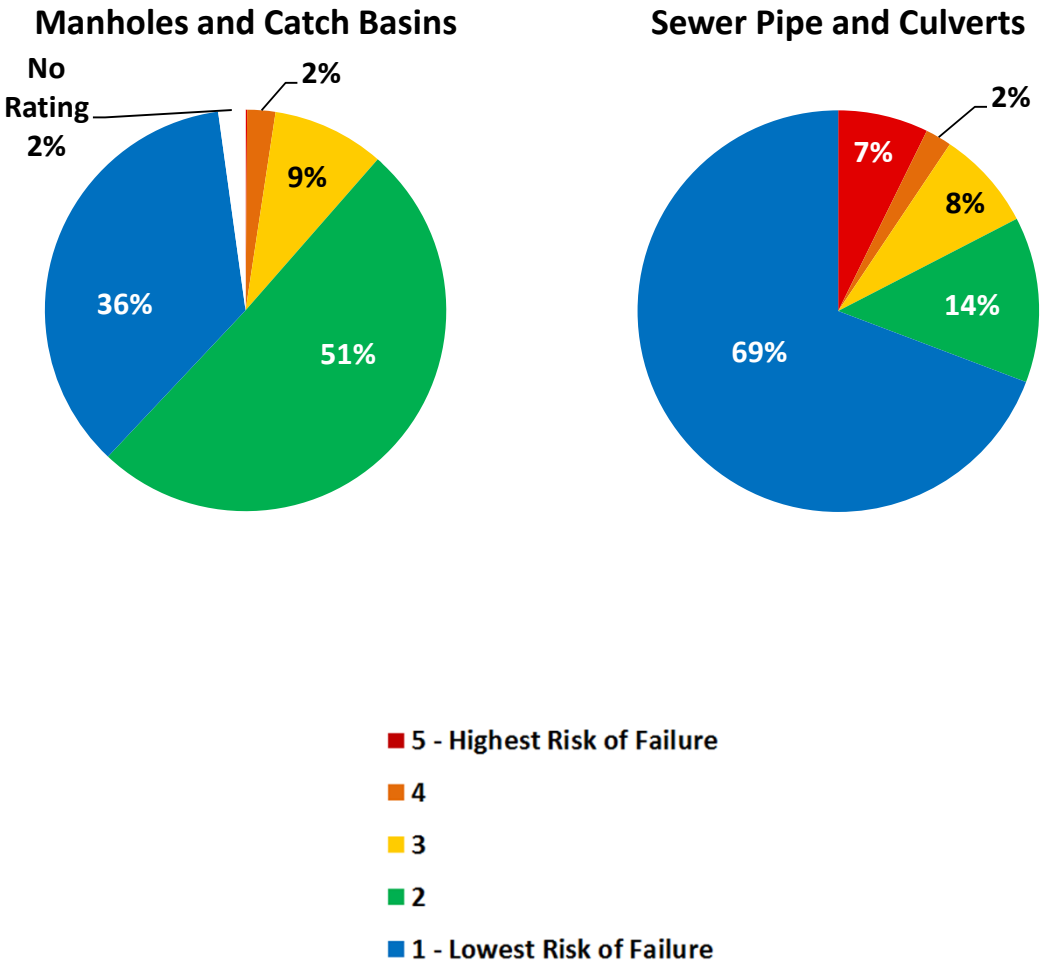
Gravity Sewer Pipe Age and Materials



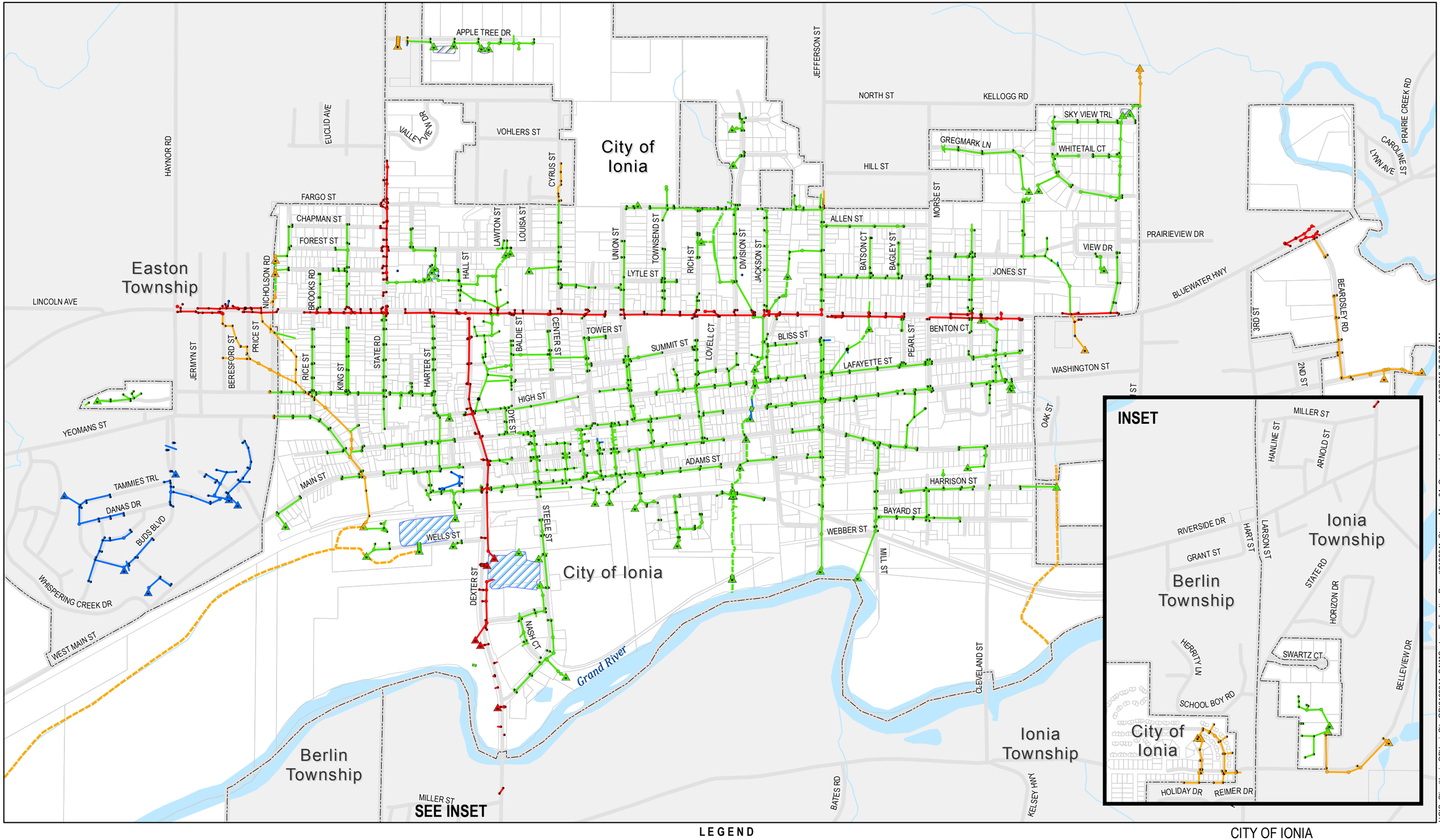




Risk of Failure Rating Summary



Maps



N

1,000 500 0 1,000 Feet

LEGEND

Catch Basin Ownership	Manhole Ownership	Outfall Ownership	Gravity Sewer Ownership	Culvert Ownership	Open Drain Ownership	Pond Ownership
City of Ionia	City of Ionia	City of Ionia	City of Ionia	City of Ionia	City of Ionia	City of Ionia
Ionia County	Ionia County	Ionia County	Ionia County	Ionia County	Ionia County	Private
MDOT	MDOT	MDOT	MDOT	MDOT		
Private	Private	Private	Private	Private		
Unknown	Unknown					

CITY OF IONIA
IONIA COUNTY, MICHIGAN
STORMWATER COLLECTION SYSTEM

MAP 1: OWNERSHIP

SEPTEMBER 2019

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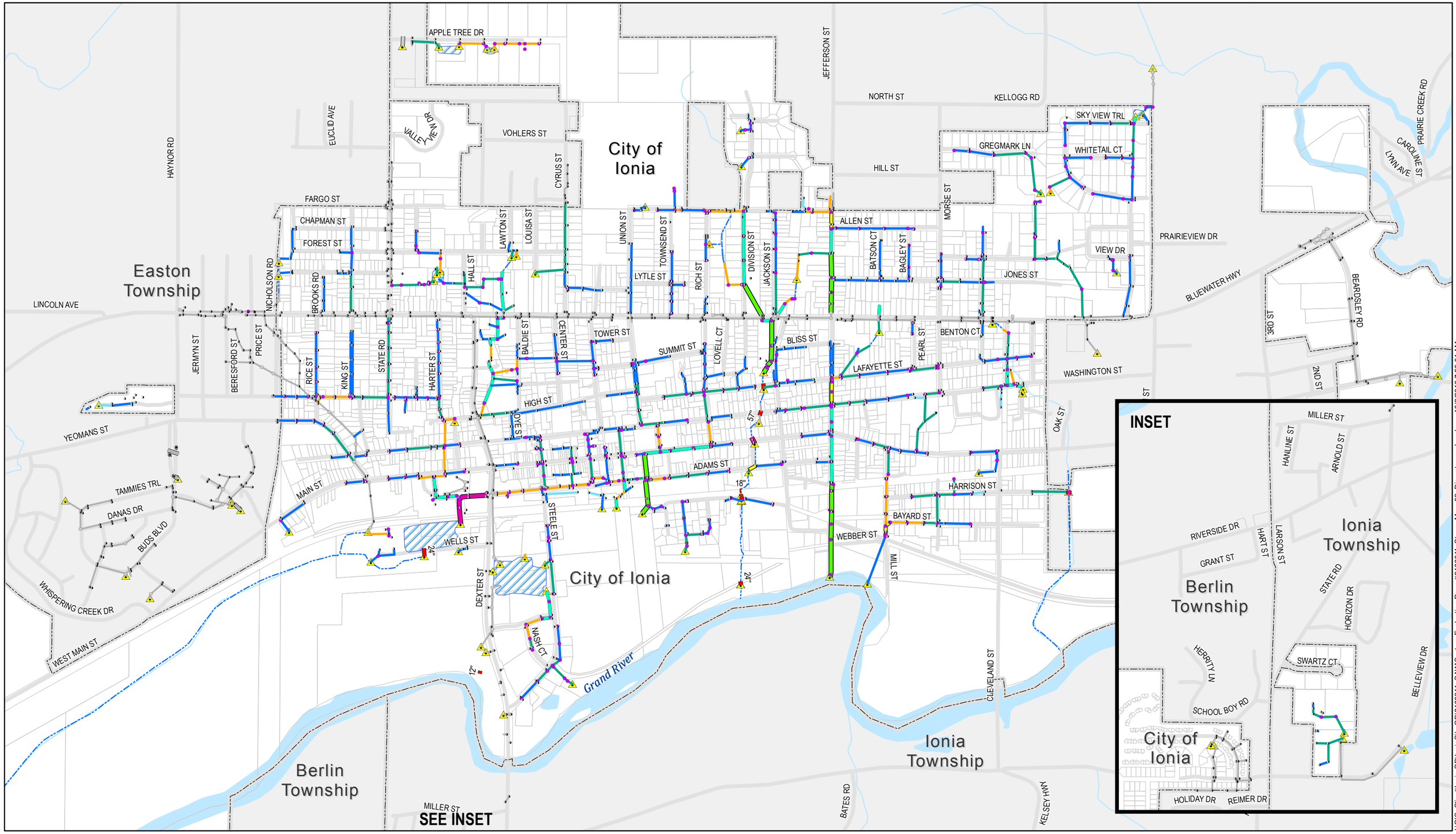

Feet
1,000 500 0 1,000

LEGEND

Gravity Sewer Diameter
- 6" - 8"
- 10" - 12"
- 15" - 18"
- 21" - 24"
- 30" - 35"
- 36" - 42"
- 48" - 54"
- 57" - 66"

- Culvert
- Open Drain
- Pond
- Manhole
- Catch Basin
- Outfall
- Gravity Sewer Owned by Others
- Culvert Owned by Others
- Manhole Owned by Others
- Catch Basin Owned by Others

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MAP 2: PIPE DIAMETER

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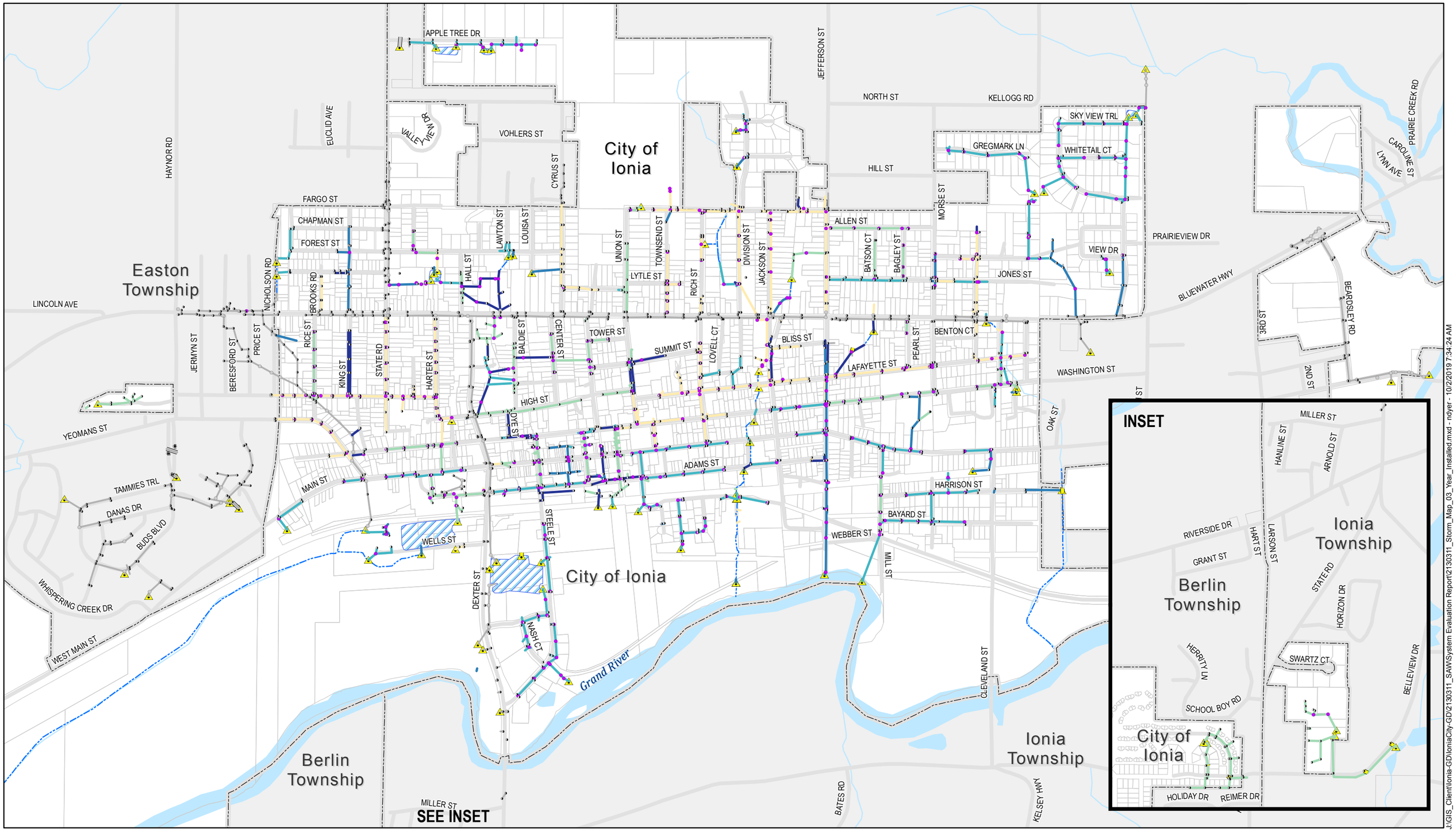

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1,000 500 0 1,000 Feet

LEGEND

Gravity Sewer Install Year

- Unknown
- 1940s and 1950s
- 1960s and 1970s
- 1980s and 1990s
- 2000s
- 2010s

- Culvert
- Open Drain
- Pond
- Manhole
- Catch Basin
- Outfall
- Gravity Sewer Owned by Others
- Culvert Owned by Others
- Catch Basin Owned by Others

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MAP 3: YEAR INSTALLED

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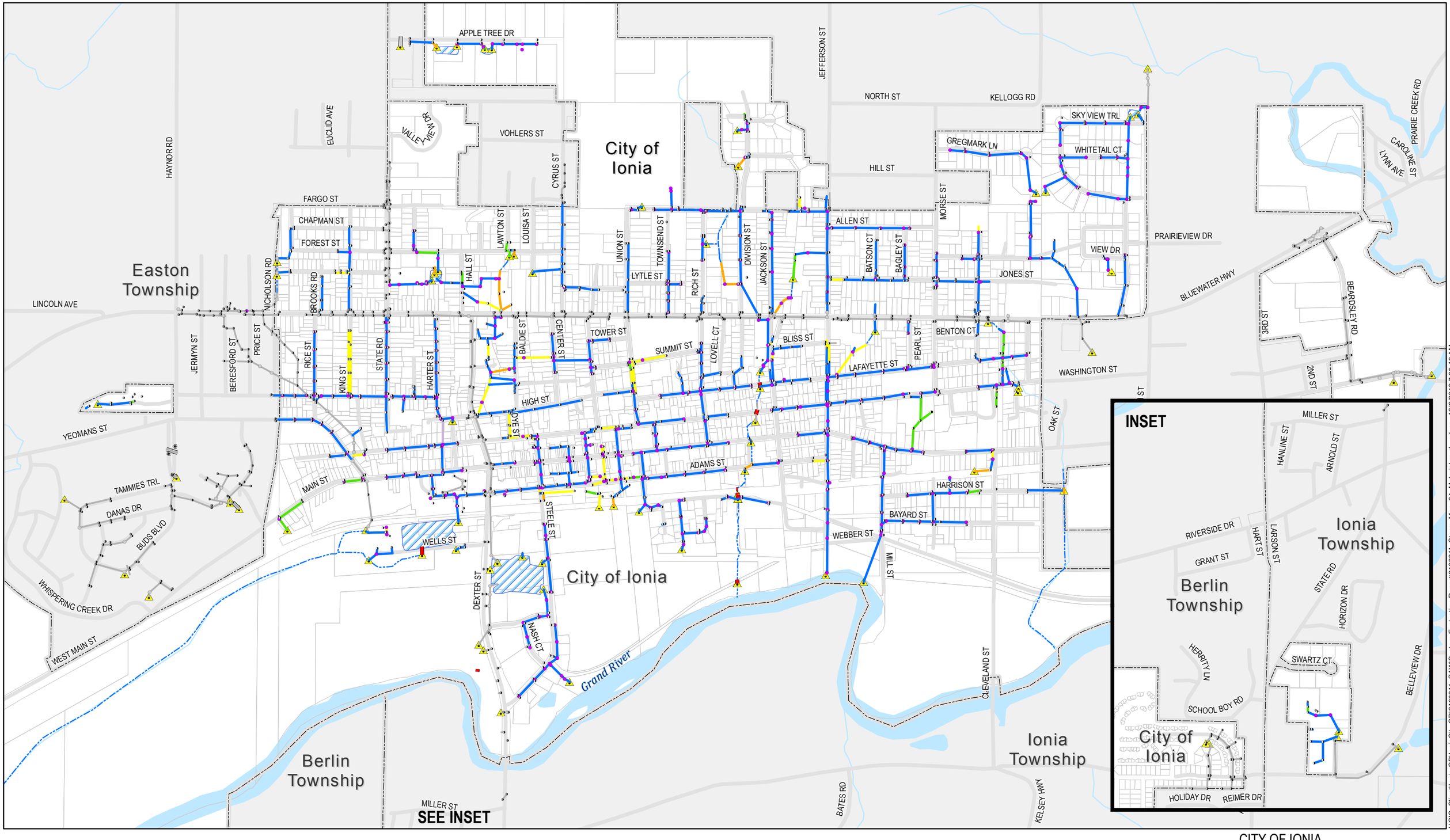

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1,000 500 0 1,000 Feet

LEGEND

Gravity Sewer Material
- Concrete
- Plastic
- Clay
- Corrugated Metal
- Cast Iron
- Other

- Open Drain
- Culvert
- Pond
- Manhole
- Catch Basin
- Outfall
- Gravity Sewer Owned by Others
- Culvert Owned by Others
- Catch Basin Owned by Others

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MAP 4: PIPE MATERIAL

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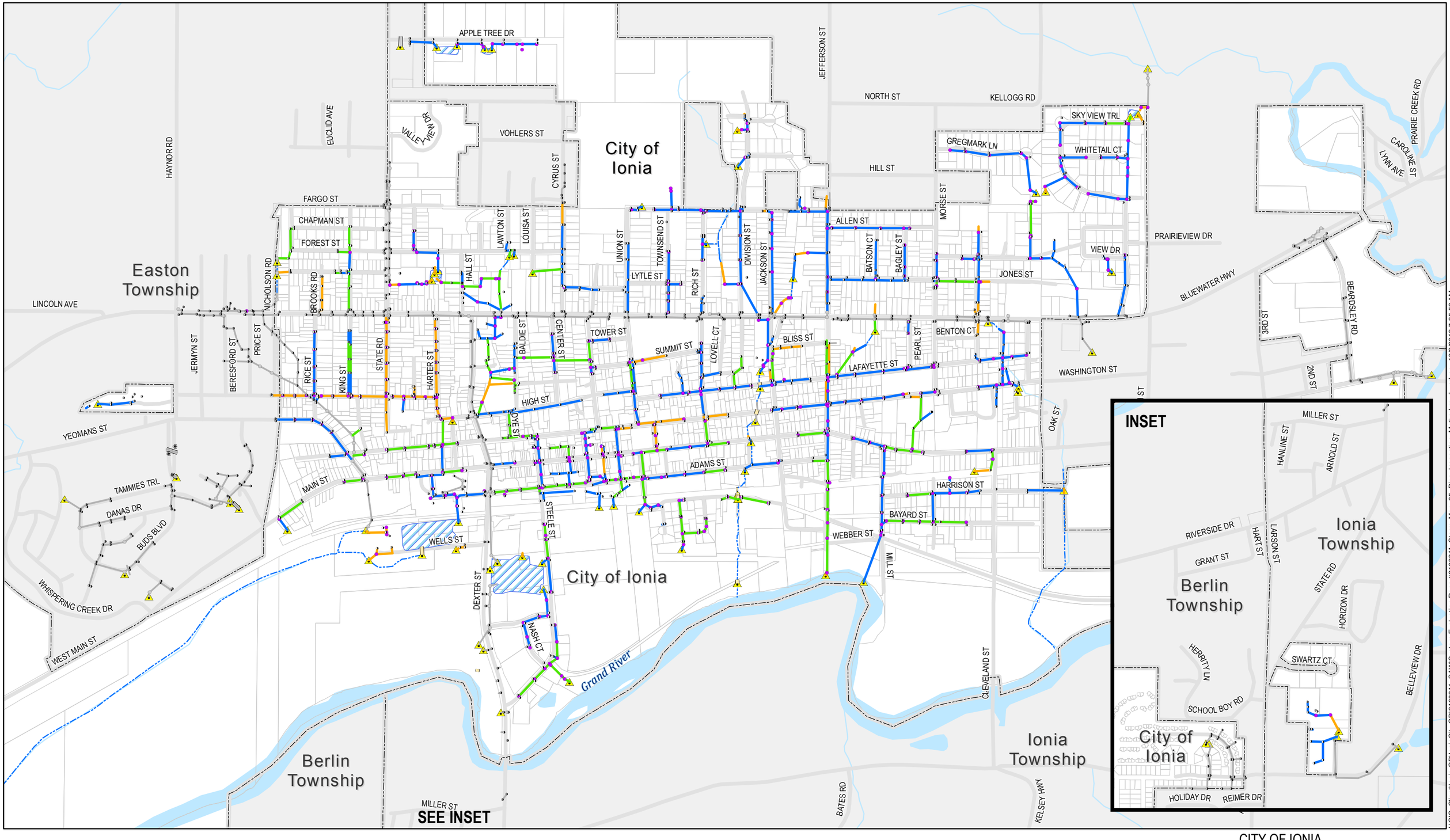

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1,000 500 0 1,000 Feet

LEGEND

Gravity Sewer Inspection Method
- PACP
- Zoom Camera
- Inferred

- Culvert
- Open Drain
- Pond
- Manhole
- Catch Basin
- Outfall
- Gravity Sewer Owned by Others
- Culvert Owned by Others
- Catch Basin Owned by Others

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MAP 5: PIPE INSPECTION METHOD

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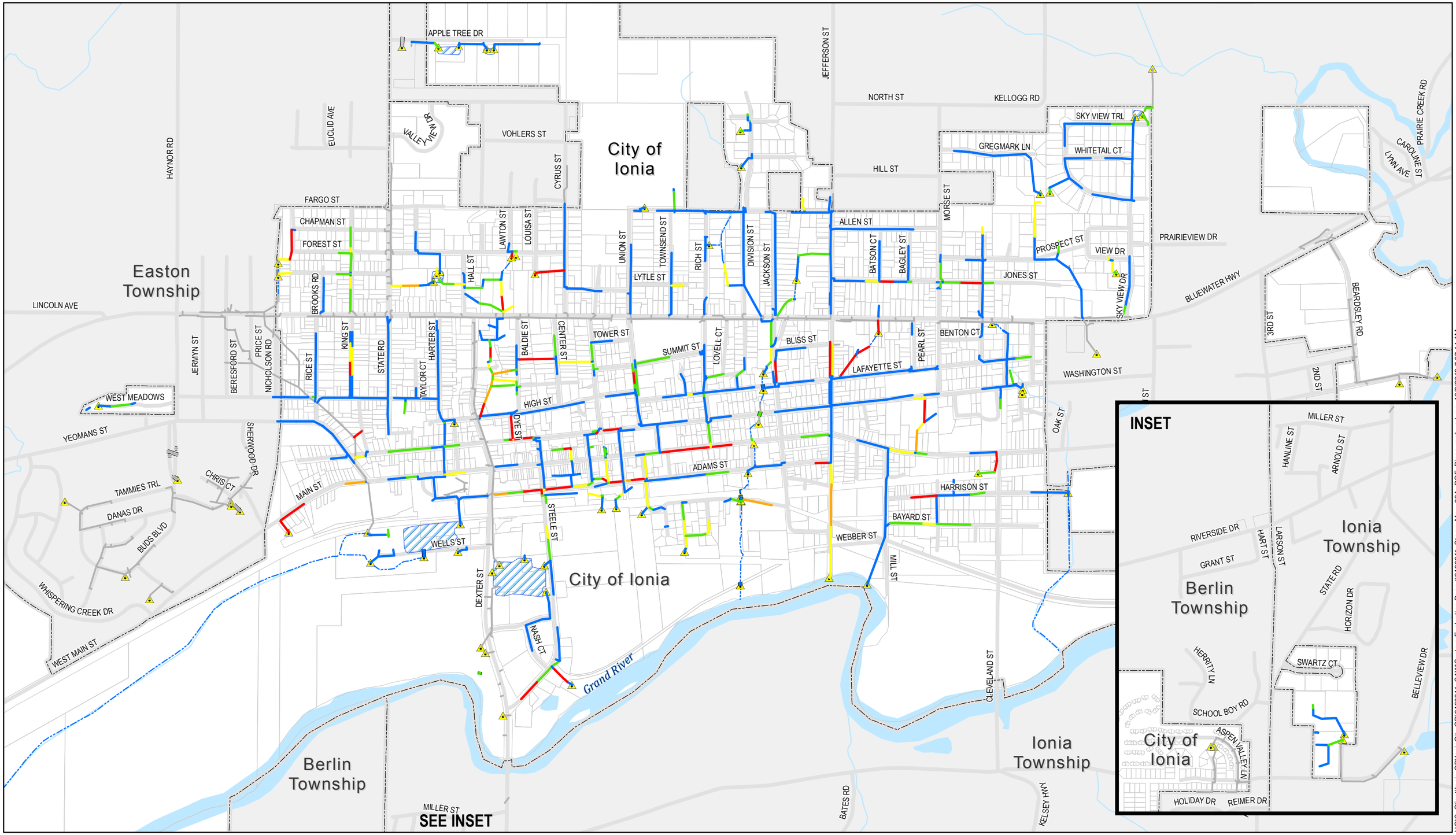

N

1,000 500 0 1,000 Feet

LEGEND

Gravity Sewer Risk of Failure
- 1 - Lowest Risk of Failure
- 2
- 3
- 4
- 5 - Highest Risk of Failure

Culvert Risk of Failure
- 1 - Lowest Risk of Failure
- 2
- 3
- 4
- 5 - Highest Risk of Failure

- Open Drain
- Pond
- Outfall
- Gravity Sewer Owned by Others
- Culvert Owned by Others

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MAP 6A: RISK OF FAILURE - PIPES

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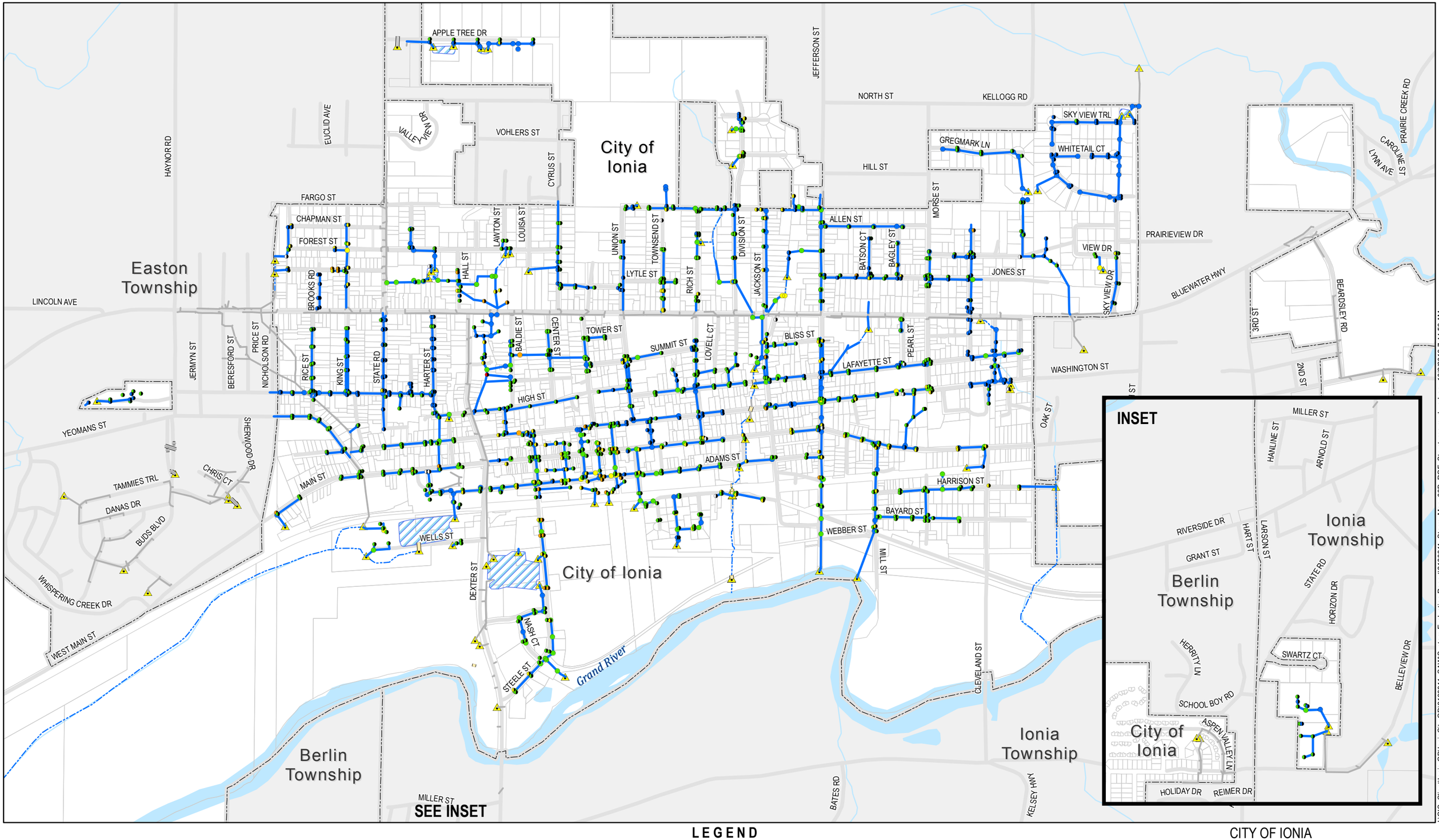

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1,000 500 0 1,000 Feet

LEGEND

Catch Basin Risk of Failure
- Not Rated
- 1 - Lowest Risk of Failure
- 2
- 3
- 4
- 5 - Highest Risk of Failure

Manhole Risk of Failure
- 1 - Lowest Risk of Failure
- 2
- 3
- 4
- 5 - Highest Risk of Failure

- Gravity Sewer
- Culvert
- Open Drain
- Pond
- Outfall
- Gravity Sewer Owned by Others
- Culvert Owned by Others

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MAP 6B: RISK OF FAILURE - STRUCTURES

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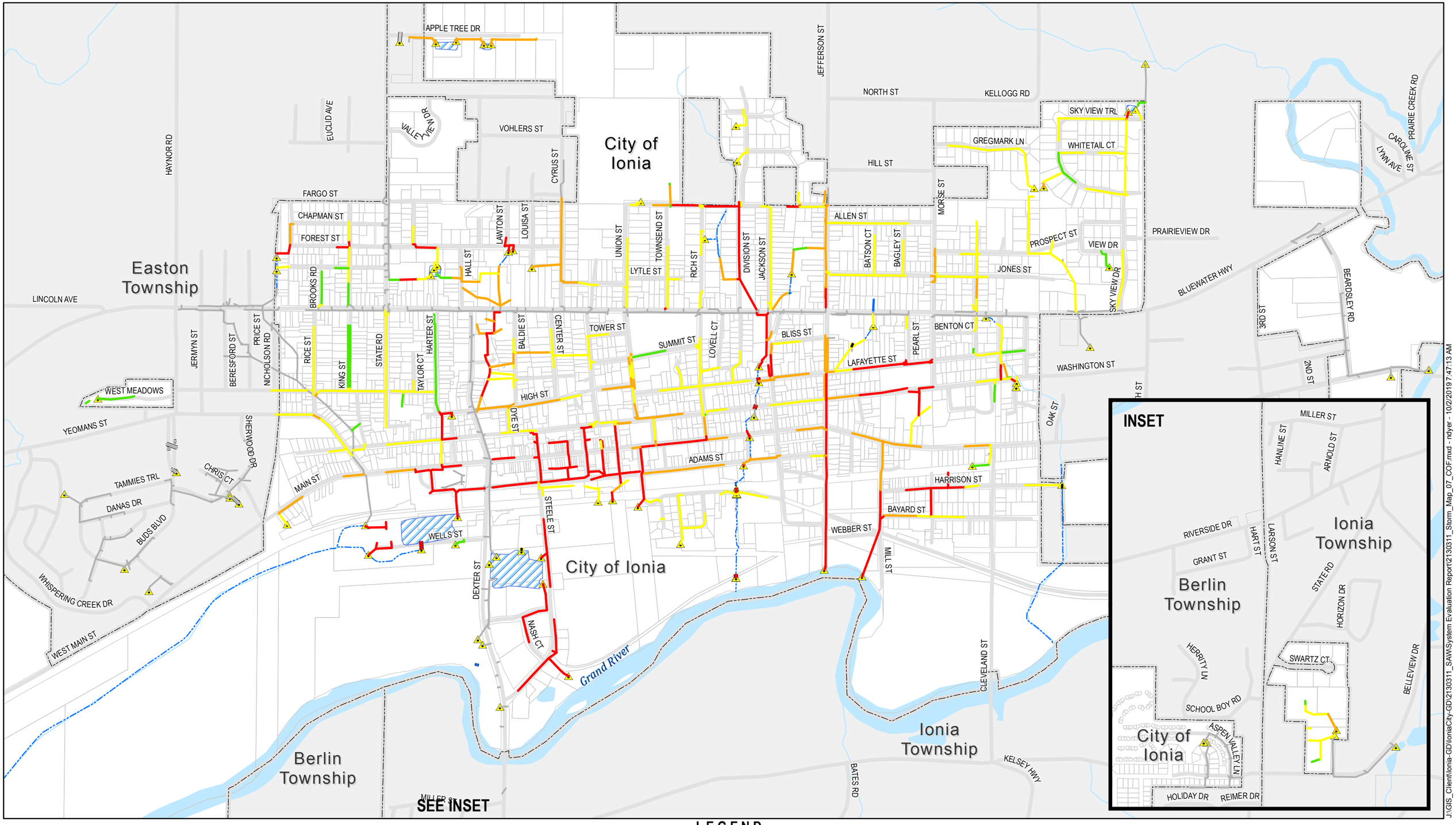

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N

1,000 500 0 1,000 Feet

LEGEND

Gravity Sewer Consequence of Failure
- None
- 1 - Lowest Consequence of Failure
- 2
- 3
- 4
- 5 - Highest Consequence of Failure

Culvert Consequence of Failure
- None
- 1 - Lowest Consequence of Failure
- 2
- 3
- 4
- 5 - Highest Consequence of Failure

- Open Drain
- Pond
- Outfall
- Gravity Sewer Owned by Others
- Culvert Owned by Others

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MAP 7: CONSEQUENCE OF FAILURE

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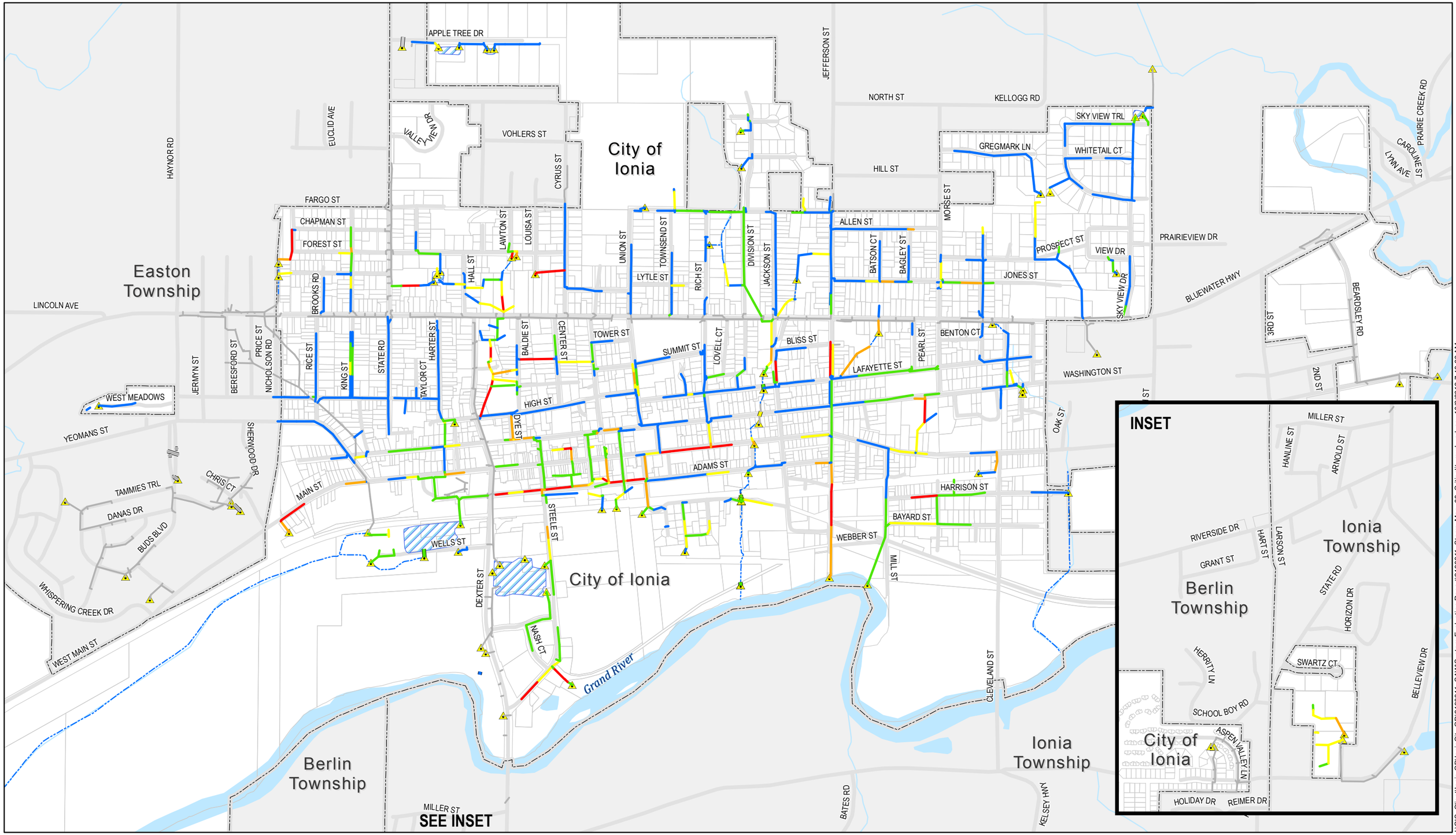

Feet
1,000 500 0 1,000

LEGEND

Gravity Sewer Criticality
- 1 - Least Critical
- 2
- 3
- 4
- 5 - Most Critical

Culvert Criticality
- 1 - Least Critical
- 2
- 3
- 4
- 5 - Most Critical

- Open Drain
- Pond
- Outfall
- Gravity Sewer Owned by Others
- Culvert Owned by Others

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MAP 8: CRITICALITY

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APPLE TREE DR
JEFFERSON ST
NORTH ST
KELLOGG RD
SKY VIEW TRL
WHITETAIL CT
GREGMARK LN
HILL ST
MORSE ST
PRAIRIEVIEW DR
PROSPECT ST
VIEW DR
SKY VIEW DR
JONES ST
ALLEN ST
BATSON CT
BAGLEY ST
EUCLID AVE
VALLEY VIEW DR
VOHLERS ST
CYRUS ST
City of Ionia
HAYNOR RD
FARGO ST
CHAPMAN ST
FOREST ST
LAWTON ST
LOUISA ST
UNION ST
TOWNSEND ST
RICH ST
DIVISION ST
JACKSON ST
LYTLE ST
HALL ST
Easton Township
LINCOLN AVE
BLUEWATER HWY
BROOKS RD
PRICE ST
NICHOLSON RD
BERESFORD ST
JERMYN ST
RICE ST
KING ST
STATE RD
HARTER ST
BALDIE ST
CENTER ST
TOWER ST
SUMMIT ST
LOVELL CT
BLISS ST
LAFAYETTE ST
PEARL ST
BENTON CT
WASHINGTON ST
3RD ST
BEARDSLEY RD
2ND ST
WEST MEADOWS
YEOMANS ST
SHERWOOD DR
HIGH ST
DYE ST
ADAMS ST
HARRISON ST
BAYARD ST
TAMMIES TRL
CHRIS CT
DANAS DR
BUDS BLVD
WHISPERING CREEK DR
MAIN ST
WELLS ST
STEELE ST
WEBBER ST
MILL ST
DEXTER ST
NASH CT
WEST MAIN ST
City of Ionia
Grand River
Ionia Township
CLEVELAND ST
Berlin Township
MILLER ST
SEE INSET
BATES RD
KELSEY HWY

INSET

MILLER ST
HANLINE ST
ARNOLD ST
RIVERSIDE DR
GRANT ST
HART ST
LARSON ST
Ionia Township
Berlin Township
STATE RD
HORIZON DR
HERRITY LN
SWARTZ CT
BELLEVIEW DR
SCHOOL BOY RD
ASPEN VALLEY LN
City of Ionia
HOLIDAY DR
REIMER DR

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N

1,000 500 0 1,000 Feet

LEGEND

Pipe Repair Recommendation
- Line
- Dig & Replace

Storm Sewer Spot Repair
- Dig & Replace
- Line

- Culvert
- Open Drain
- Pond
- Manhole
- Outfall
- Gravity Sewer Owned by Others
- Culvert Owned by Others

CITY OF IONIA
IONIA COUNTY, MICHIGAN
STORMWATER COLLECTION SYSTEM

MAP 9: RECOMMENDED SYSTEM IMPROVEMENTS

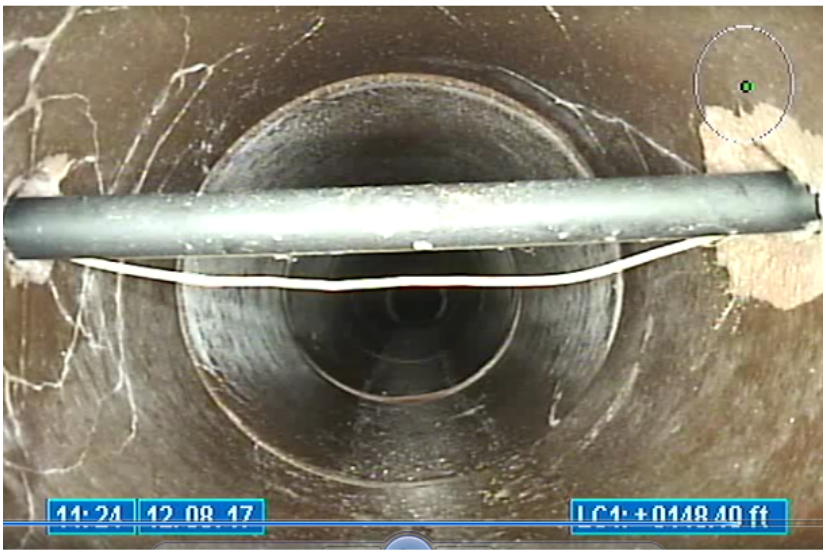
SEPTEMBER 2019

Prein&Newhof
2130311

Appendix A

Photographs – Examples of Pipe Defect Observations

Photographs – Examples of Pipe Defect Observations



King Street north of Hackett St.
CB-406 to CB-408
Utility penetration

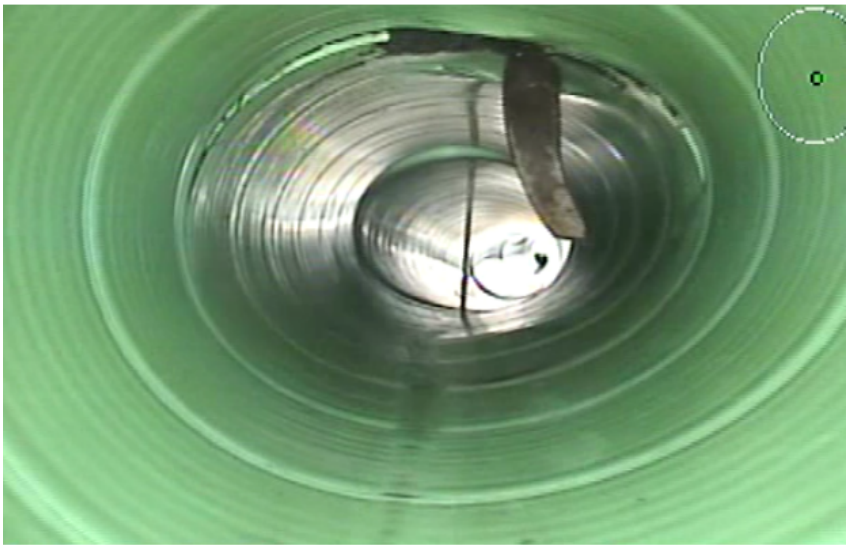
Main St. northeast of VanderHeyden Ct.
MH-176 to outfall
Broken

Photographs – Examples of Pipe Defect Observations

Main St. west of Steele St.
MH-90 to MH-89
Concrete obstruction in pipe

Cross country pipe south of M-21
MH-212 to outlet
Broken

Photographs – Examples of Pipe Defect Observations



Forest at Lawton
CB-462 to outfall
Deformed, cracked, and metal intrusions in pipe