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Forest Park Area Storm and Sanitary Management Plan

Report (Volume 1 of 2)

City of

Kenosha, WI

August 2014

STRAND ASSOCIATES®

Report (Volume 1 of 2) for

City of Kenosha, Wisconsin

Forest Park Area Storm and Sanitary Management Plan

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EXECUTIVE SUMMARY

INTRODUCTION

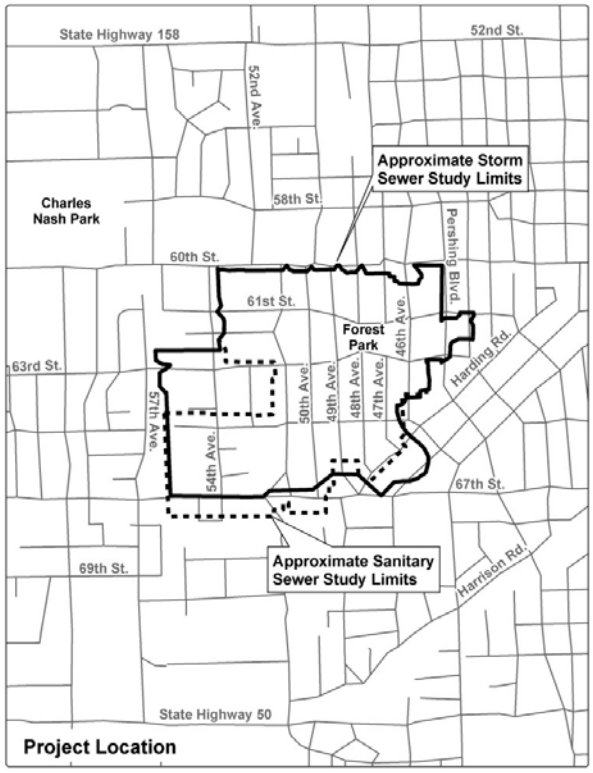


Figure ES-1 Study Area

The City of Kenosha Stormwater Utility (SWU) and Water Utility (KWU) have combined efforts to address flooding issues in the Forest Park Area through commissioning of this study (Figure ES-1). Storm events have periodically caused flooding of streets and basements. The flooding can be characterized as a combination of surface flooding and basement backups. The results of the resident survey indicate surface flooding is localized to the topographic low points within the drainage basins while basement backups are more widespread within the study area. Although surface flooding is commonly associated with the storm sewer system and basement backups with the sanitary sewer system the results of this study along with the computer modeling indicate the two systems are inter-related in regards to basement backups. The extent and duration of ponded water within the public right-of-way as well as adjacent private properties can result in rainfall-induced raised groundwater levels. Because of this, a reduction in surface flooding has the logical benefit of reducing the potential for ponded water to infiltrate into the sanitary sewer by way of defects in the sanitary sewer laterals and mainlines and through foundation drains and sump pump connections to the sanitary sewer as well as infiltration into manhole defects. Solutions focus on reducing the amount of rainfall-related flows reaching the sanitary sewer system and solutions that also rely on both sanitary sewer and storm sewer enhancements in conjunction with homeowner assistance.

Within this document, findings of the study are summarized and potential improvements to the storm and sanitary systems are listed. Over the years and during the course of this study, the City has made storm and sanitary sewer system improvements that complement the findings of this study. While these improvements will reduce flooding in the Forest Park Area for a range of storm events, it must be noted that there will always be the potential for flooding depending on the severity of a particular future storm event regardless of system improvements.

SEWERSHED CHARACTERISTICS

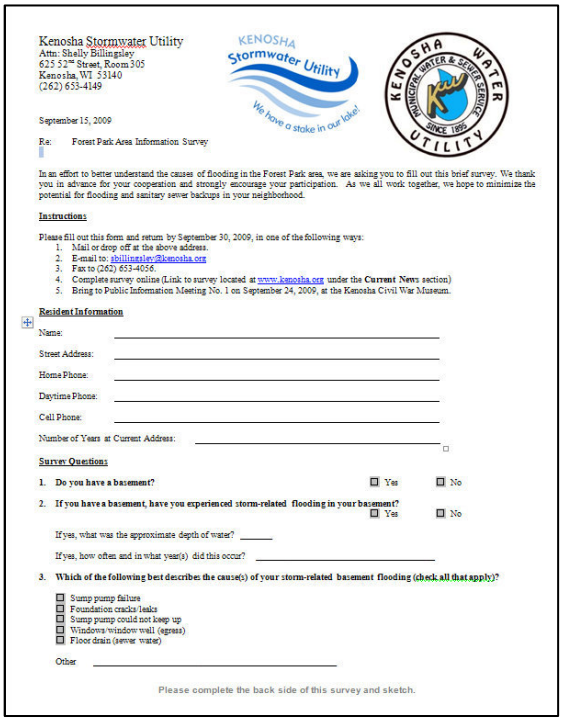
The Forest Park Area watershed is characterized by a rolling topography with positive downhill drainage in certain areas but with internally drained kettles in others. Storm sewers installed to drain the kettle areas are in many cases undersized. Combined with lack of an overland flow route to safely convey flows out of the kettles, cost-effective improvements to the storm sewer system are a challenge. Although storm sewer capacity upgrades to the outfalls to Pike Creek and Lake Michigan are not financially feasible, upgrades to inlet capacity while also implementing temporary detention in an attempt to shave peak flows in downstream sewers is a viable and potentially cost effective solution. Inlet capacity upgrades will reduce the extent and duration of surface flooding while detention will

provide a means to offset the peak flows from within the Forest Park Basin with those of other downstream contributions. Given the watershed characteristics of the Forest Park Study Area, it can be said that the areas experiencing surface flooding today would not have been allowed to be built as they exist today. Current design guidelines would have called for overland flow routes that would have required filling of kettle areas to provide positive downhill drainage and building homes at higher elevations. Alternatively, the kettle areas would have been reserved for parkland or stormwater management. This can also be said of numerous other areas within the City.

Sanitary sewers in the Forest Park North study area generally flow east and north to the intersection of Pershing Boulevard and 60th Street. Sanitary sewers in the Forest Park South study area generally flow east and south to one of two locations: 47th Avenue/67th Street and Wilson Road/45th Avenue.

RESIDENT SURVEY INFORMATION

Integral to this study is a survey (Figure ES-2) that was developed to obtain flooding and sump pump/drain tile and foundation drain information from residents in the Forest Park Area. Surveys were sent to 700 parcels and 394 surveys were returned, resulting in a 56 percent participation rate. In general, those not participating were believed to be in areas that do not experience flooding. Findings from this survey include the following:



Kenosha Stormwater Utility
Attn: Shelly Billingsley
625 52nd Street, Room 305
Kenosha, WI 53140
(262) 653-4149

KENOSHA Stormwater Utility — We have a stake in our lake!

KENOSHA WATER UTILITY — MUNICIPAL WATER & SEWER SERVICE — SINCE 1895

September 15, 2009

Re: Forest Park Area Information Survey

In an effort to better understand the causes of flooding in the Forest Park area, we are asking you to fill out this brief survey. We thank you in advance for your cooperation and strongly encourage your participation. As we all work together, we hope to minimize the potential for flooding and sanitary sewer backups in your neighborhood.

Instructions

Please fill out this form and return by September 30, 2009, in one of the following ways:
1. Mail or drop off at the above address.
2. E-mail to: sbillingsley@kenosha.org
3. Fax to (262) 653-4056.
4. Complete survey online (Link to survey located at www.kenosha.org under the **Current News** section)
5. Bring to Public Information Meeting No. 1 on September 24, 2009, at the Kenosha Civil War Museum.

Resident Information

Name: _____

Street Address: _____

Home Phone: _____

Daytime Phone: _____

Cell Phone: _____

Number of Years at Current Address: _____

Survey Questions

1. **Do you have a basement?** ☐ Yes ☐ No
2. **If you have a basement, have you experienced storm-related flooding in your basement?** ☐ Yes ☐ No

   If yes, what was the approximate depth of water? _____

   If yes, how often and in what year(s) did this occur? _____
3. **Which of the following best describes the cause(s) of your storm-related basement flooding (check all that apply)?**

   ☐ Sump pump failure
   ☐ Foundation cracks/leaks
   ☐ Sump pump could not keep up
   ☐ Windows/window well (egress)
   ☐ Floor drain (sewer water)

   Other _____

Please complete the back side of this survey and sketch.

Figure ES-2 Resident Survey

1. Parcels experiencing surface flooding are generally in areas where stormwater models completed under this study also show surface flooding.

2. Parcels experiencing basement backups are generally in areas where sanitary sewer models completed under this study also show potential for sanitary sewer basement backups.

3. Parcels that have installed standpipes, plugs, or sanitary backwater valves in their basements are generally in areas where sanitary sewer models completed under this study also show the potential for sanitary sewer basement backups.

4. Owners of 185 parcels (47 percent of respondents) indicated they have experienced storm-related flooding in their basement. The cause indicated included sump pump failure, foundation cracks/leaks, sump pump could not keep up, windows/window well entry, floor drain backups, or a combination of issues.

5. Owners of 29 parcels (9 percent of respondents) indicated their foundation drains discharge to their sanitary sewer lateral. KWU inspection history along with common construction practices during the era in which the homes within the Forest Park Basin

were built suggest as many as 80% of homes within the study area have foundation drains discharging to the sanitary lateral serving the property. Information from the KWU indicates that prior to 1967, City code required installation of foundation drains that were connected to the sanitary sewer and after 1967, City code required installation of sump pumps, which were not connected to the sanitary sewer system. KWU estimates there are approximately 600 homes with foundation drains in the Forest Park North and South Watersheds.

6. Owners of 3 parcels (1 percent of respondents) indicated their sump pump drains to their basement floor drain and, therefore, is directly connected to the sanitary sewer.

The survey results indicate that basement flooding is caused by a variety of reasons. One reason is direct connections to the sanitary sewer from foundation drains or sump pumps. Since the time the survey was completed, the KWU sump pump inspection program has been completed within the study area. All illegal cross-connections between sump pumps and sanitary laterals have been or are in the process of being eliminated.

HOMEOWNER COLLABORATION

Rainfall-induced inflows into the sanitary sewer system come from a variety of sources, both public and private. As in any neighborhood, inadequate drainage around homes can contribute to basement backups. It is evident that a number of residents have made drainage improvements around their homes but it is likely that many have not. For those that have not, the following is a list of drainage practices that each homeowner should consider to improve the drainage around their home.

1. Clean gutters and downspouts at least twice per year (once in spring and once in fall).
2. Extend gutter downspouts away from home a minimum of 3 feet.
3. Extend sump pump discharges away from the home a minimum of 3 feet. If discharge creates a drainage issue on a neighboring property, consider a discharge location that has positive drainage to the street or extend the discharge line underground discharging in the curb.
4. Slope the ground around the home to drain away from the home. Generally, an adequate slope is considered 1 inch of vertical drop in 1 foot of horizontal distance away from the house. Consider a low permeability material (clay) or impermeable liner when placing fill around home.
5. Disconnect the foundation drain/sump pump from sanitary sewer.

In addition, homeowners should report any illegal dumping of material into the storm sewer system such as concrete trucks washing to inlets. During the fall/winter it is also important to keep catch basins free of leaves, snow, and ice. Keeping leaves on terraces for fall pickup is an important practice in keeping catch basins free of leaves. Obstructions to flow in the storm sewer system slow the flow of stormwater away from the neighborhood.

SANITARY SEWER SYSTEM

The KWU continues to work on many fronts toward improvements to the Forest Park Area sanitary sewer system. In combination with potential future projects listed in this study, ongoing KWU activities are leading the way toward sanitary sewer system improvement through removal of infiltration/inflow to the sanitary sewer and increasing of conveyance capacity.

A. KWU: Sanitary Sewer Program

KWU's Sanitary Sewer Program are centered around investigation, repairs, reconstruction, and monitoring/metering as follows. Total expenditures to date on these activities exceeds $972,000.

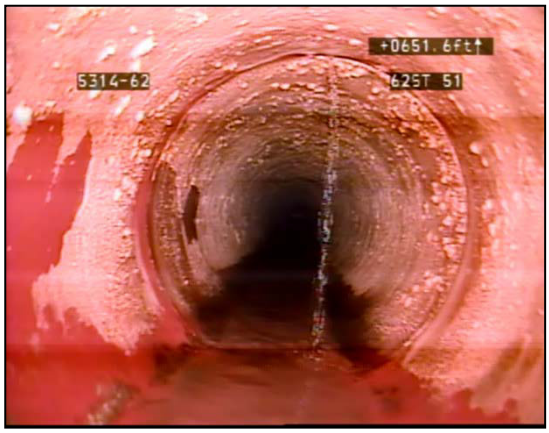


Figure ES-3 Sanitary Sewer Televising Example of Pipe Defect

1. Investigation
   a. Sewer flushing/cleaning.
   b. Televising of sanitary sewer (Figure ES-3).
   c. Sanitary sewer smoke and dye testing.
   d. Manhole inspections.
   e. Sanitary sewer flow metering.

2. Repairs
   a. Manhole rehabilitation
      (1) Replacement of open pick hole sanitary manhole lids with closed lids.
      (2) Chimney seals.
      (3) Manhole replacements where structural deficiencies exist.
   b. Sanitary sewer repairs
      (1) Repair of multiple cracked/partially collapsed pipes in Study Area.
      (2) Repair of offset joints in the Study Area.
      (3) Installation of internal pipe liner to repair structural deficiency or infiltration.
      (4) Other required repairs as deemed necessary.

3. Reconstruction/Monitoring
   a. Sanitary Sewer Reconstruction–The sanitary sewer on Pershing Boulevard (60th to 61st Street) and on 61st Street (Pershing Boulevard to 46th Avenue) was reconstructed/upsized in 2010.
   b. Sanitary Sewer Reconstruction–In 2010, sanitary sewers on 46th Avenue, 47th Avenue, and 51st Avenue were reconstructed.

4. Monitoring/Metering

   a. Sanitary Sewer Flow Monitoring/Alarm System–This is an automatic flow monitoring system installed in various manholes throughout the sanitary sewer system that provides continuous, real-time flow and alarm information accessible via computer to KWU 24 hours per day. Two of these flow monitoring devices are located at strategic locations in the Forest Park Study Area. This monitoring system brings a better understanding of the sanitary sewer system dynamics during wet weather and improves response times to those events.

   b. An independent float alarm system is also installed at strategic locations within the sanitary sewer collection system. This system acts as a redundant backup to the monitoring and alarm system outlined above.

B. Study Findings and Potential Future Projects

This study separated the study area into a north study area and a south study area. The existing sanitary sewer capacity was evaluated for a series of theoretical wet weather conditions using a hydraulic computer model. This model confirmed the presence of significant surcharging in both study areas during wet weather conditions.

1. Findings

   a. For the north study area, the model results indicate surcharging (potential for basement backups) for all wet weather events equal to or greater than a 6-month recurrence interval event (this equates to a rainfall rate of 1.42 inches/hour during a 30-minute duration storm event). Recent improvements within this basin have increased capacity to between a 2-year and 5-year recurrence interval event overall for the North Basin. In addition, the improvements have been installed downstream of the intersection of 61st Street and 46th Avenue in accordance with the recommendations necessary to convey the flow associated with a 100-year storm event

   b. For the south study area, the model results indicate surcharging (potential for basement backups) for all wet weather events equal to or greater than a 5-year recurrence interval event.

   c. The City's existing ordinances were reviewed and appear to contain the necessary language to allow the City to prevent and/or eliminate infiltration/inflow (I/I) from private sources.

   d. Preliminary I/I estimates indicate that foundation drain/sump pump connections may account for a significant percentage of the I/I in the basins.

2. Potential Future Projects

   a. Foundation Drain Disconnection–Work with homeowners who have foundation drains and/or sump pumps connected to the sanitary sewer system. Develop

alternatives to reconnect to the storm sewer system or surface discharge. Preliminary I/I estimates indicate that foundation drain/sump pump connections may account for a significant percentage of the I/I in the basins. Elimination of these cross-connections will greatly improve the performance of the sanitary sewers, specifically during rainfall events. This improved performance includes the minimization of the potential for basement backups.

b. Sanitary Manhole Rehabilitation Program–Continue KWU's Sanitary Manhole Rehabilitation Program to address structural and I/I-related issues identified by KWU staff during their televising, smoke testing, and manhole inspection investigations.

c. Sanitary Sewer Rehabilitation Program–Continue KWU's Sanitary Sewer Rehabilitation Program to address structural and I/I-related issues identified by KWU staff during their televising, smoke testing, and manhole inspection investigations.

d. Sanitary Sewer Improvements

(1) Forest Park North (Figure ES-4)–Reconstruct/upsize sanitary sewers along Pershing Boulevard from 60th Street to 61st Street. Reconstruct/upsize sanitary sewers along 61st Street from Pershing Boulevard to 50th Avenue. KWU completed the Pershing Boulevard reconstruction/upsizing and the 61st Street reconstruction/upsizing (Pershing Boulevard to 46th Avenue) in 2010.

Figure ES-4 Forest Park North Potential Future Sanitary Sewer Upgrades

Figure ES-5 Forest Park South Potential Future Sanitary Sewer Upgrades

(2) Forest Park South (Figure ES-5)–Reconstruct/upsize sanitary sewers along 65th Street from 48th Avenue to 51st Avenue. However, it is recommended that additional flow metering be conducted prior to design to confirm the recommended sizes.

STORM SEWER SYSTEM

The SWU continues to work on many fronts toward improvements to the Forest Park Area storm sewer system. In combination with potential future projects listed in this study and KWU activities, on-going SWU activities are complementing the efforts to reduce basement backups in the Forest Park Area.

A. SWU: Storm Sewer Program

The Kenosha Stormwater Utility (SWU) Storm Sewer Program is centered around investigation, repairs, reconstruction, and metering as follows.

1. Investigation

   a. Storm sewer and storm structure flushing/cleaning–This was completed leading up to the storm sewer televising completed as part of this study.

   b. Televising of storm sewer and storm structures (Figure ES-6)–This was completed in early 2010.

   c. Resident Survey–As part of the survey completed under this study, individuals from Strand and the SWU met with individuals regarding specific drainage concerns. This was completed in the fall of 2009.

   d. Field verification of existing infrastructure–As part of this study, SWU surveyors acquired elevations of existing storm sewer infrastructure for use in the hydraulic models.

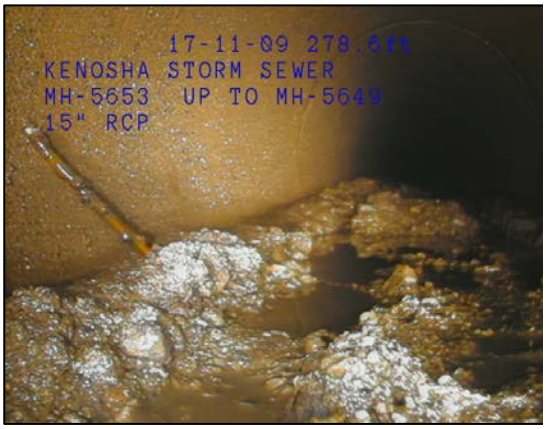


Figure ES-6 Storm Sewer Televising Example of Obstruction

   e. High water mark elevations–As part of this study, SWU staff obtained high water mark information and sent surveyors out to collect high water mark elevations. This information was used during development of the hydraulic models.

   f. Home low entry point survey–As part of this study, SWU surveyors acquired low entry point elevations for approximately 125 homes within the study area to estimate the impacts to homes during specific rainfall events.

2. Repairs

   a. Storm manhole and inlet rehabilitation.

   b. Storm manhole cover replacement: This includes replacing a solid cover with a grated cover to increase the ability for the storm sewer system to accept additional flows.

3. Reconstruction/Monitoring

   a. Storm Sewer and Inlet Reconstruction on 50th Avenue: The storm sewer system was reconstructed/upsized to provide a 10-year storm sewer and inlet capacity on 50th Avenue (from 61st Street to 63rd Street).

4. Metering

   a. Storm sewer system metering is planned for the future.

B. Study Findings and Potential Future Projects

This study separated the study area into a north study area and a south study area. The existing storm sewer capacity was evaluated using a hydraulic computer model for a series of storm events ranging from 1.54 inches over a 2-hour duration storm to 3.64 inches over a 2-hour duration storm. A 2-hour duration storm event is the storm duration that creates the highest peak flows in the Forest Park Area storm sewer system and is considered the critical duration storm event. This model confirmed there are significant bottlenecks in the storm sewer system downstream of the Forest Park North and South Areas. These bottlenecks would only be removed if additional storm sewer capacity were provided all of the way to the Pike Creek and Lake Michigan outfalls or if detention were provided within the Forest Park Basin to allow excess flow to be detained and offset peak flows with those of downstream contributions It also confirmed the Forest Park North and South watersheds have less than a 10-year storm sewer inlet and storm sewer capacity.

An alternatives analysis was completed seeking to provide a 10-year storm sewer capacity (2.23 inches over a 2-hour duration storm event) in the Forest Park North and South watersheds. The 10-year storm sewer capacity is a requirement of new developments in Kenosha, is considered the industry standard for new developments, and was used as a goal in this study. Use of the 10-year goal also translates to reduced extents and duration of ponded water in yards outside of the City-owned right-of-way during modest and larger storm events. This reduction has the logical benefit of reducing the potential for ponded water to infiltrate (becoming rainfall-induced raised groundwater levels) into the sanitary sewer by way of defects in the sanitary sewer laterals and mainlines and through foundation drains and sump pump connections to the sanitary sewer as well as infiltration into manhole defects. This benefit is difficult to quantify because of the unknowns related to the soil infiltration rate in terrace and yard areas.

As the study progressed, it became evident that providing a 10-year storm sewer and inlet capacity in the Forest Park North and South watersheds would be financially burdensome on the City. While it would provide significant improvement to the system, a certain number of homes would still likely be prone to surface flooding and basement backups during larger storm events. With this in mind, it appears that initial efforts to reduce basement backups by way of reducing the amount of rainfall-related flows reaching the sanitary sewer system should focus on removing known foundation drains and sump pump connections to the sanitary sewer system as well as fixing sanitary sewer system defects and implementing inlet capacity upgrades and on-site storm water detention. In this way, incremental steps can be taken to reduce basement backups by first focusing on the sanitary sewer system and tracking the performance of the improvements over time prior to contemplating more expansive solutions. This is a financially prudent way to approach reducing basement backups in the Forest Park Area. The sanitary sewer upgrades completed on Pershing Boulevard and 61st Street in

2010 show promise that sanitary sewer upgrades are having a positive impact on reduction of basement backups. Should the performance of the incremental improvements prove to be inadequate, this study includes recommendations on further stormwater system improvements that do provide a 10-year storm sewer system capacity that could be pursued in the future.

1. Findings

   a. In the Forest Park North Area, hydraulic models show that under existing conditions, 3, 3, and 6 homes would experience surface flooding through low entry points for the 10-, 25-, and 100-year storm events, respectively. The 10-, 25-, and 100-year storm events correspond to rainfall amounts 2.23, 2.73, and 3.64 inches over a 2-hour duration storm event, respectively. To arrive at this finding, hydraulic model output was compared to elevations at these homes provided by SWU surveyors.

   b. In the Forest Park South Area, hydraulic models show that under existing conditions, 1, 4, and 7 homes would experience surface flooding through low entry points for the 10-, 25-, and 100-year storm events, respectively. The 10-, 25-, and 100-year storm events correspond to rainfall amounts 2.23, 2.73, and 3.64 inches over a 2-hour duration storm event, respectively. To arrive at this finding, hydraulic model output was compared to elevations at these homes provided by SWU surveyors.

   c. Upsizing of localized downstream bottleneck storm sewers to relieve the Forest Park North and South Areas would have the effect of increasing flows at the downstream terminus of the bottleneck upsizing, which may have the effect of shifting flooding issues from the Forest Park North and South Areas to downstream areas. Storm water detention would allow the peak discharge rate within the Forest Park Basin to be offset from those of downstream areas thus eliminating the concern of shifting flooding issues downstream.

   d. Upsizing of storm sewers from the Forest Park North and South Areas to the Pike Creek and Lake Michigan outfalls to relieve the Forest Park North and South Areas appears to be financially infeasible.

2. Potential Future Projects

   a. Sump Pump Collection Systems–In areas where sump pumps discharge to roadways or over sidewalks making for potential intermittent or sustained safety issues, the City should consider sump pump collection systems that would collect multiple sump pump discharges and route them underground to the nearest storm sewer inlet. These systems will also likely be instrumental in collecting the disconnected foundation drains that will be drained by sump pump systems.

   b. 46th Avenue to Pershing Boulevard Relief Sewer–Identified as Alternative 12 in the study, a relief sewer extending from the midblock inlets on 46th Avenue (between 60th and 61st Street) to Pershing Boulevard could be constructed. This relief sewer would be coupled with disconnection of the storm sewer that

currently connects these inlets to the mainline storm sewer on 61st Street. This incremental improvement appears to provide significant relief to this persistently flooded area while not significantly increasing flow rates or hydraulic grade lines downstream. The City should confirm that the increase in hydraulic grade line at the storm sewer connection at Pershing Boulevard will not affect surrounding buildings. However, during the 10-, 25-, and 100-year storm events, the homes at 6028 and 6051 46th Avenue area would still be prone to surface flooding into the home low entry point, according to hydraulic model output.

c. Storm Sewer, Manhole and Inlet Rehabilitation Program–Continue SWU's Storm Sewer, Manhole, and Inlet Rehabilitation Program to address deficiencies and defects identified by storm sewer, manhole, and inlet televising.

d. Storm Sewer System Metering–To gain additional information to assist in further validation of the operation of the storm sewer system, SWU can install flow meters in strategic locations within the storm sewer system.

e. Terrace and Yard Infiltration Rate Testing–To gain additional information regarding the potential contribution of surface flooding in terraces and yards to sanitary sewer inflows, SWU/KWU can provide double-ring infiltrometer testing to determine in-situ infiltration rates in areas experiencing persistent surface flooding in terraces and yards.

f. Potential Future Improvements (Figure ES-7)–Alternative 3 for the Forest Park North Area and Alternative 6 for the Forest Park South Area appear to be the most cost-effective alternatives to achieve a 10-year storm sewer capacity. It is recommended that these two alternatives be pursued in combination with sanitary sewer improvements in an incremental fashion that makes sense from an economical perspective. The City could also consider purchase and removal of homes, perhaps up to 13 or more homes, to remove surface flooding-prone homes from the watershed.

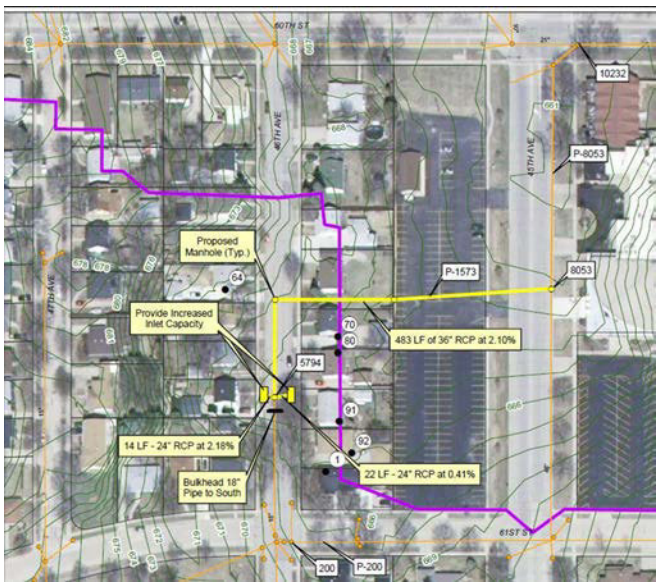


Figure ES-7 Forest Park North Potential Storm Sewer Upgrades

g. Public Information Framework–The City can expand upon existing public information efforts while continuing to educate the public on ways residents can assist in reducing private I/I into the sanitary system.

h. Potential Funding Opportunities–The City can investigate funding opportunities through Wisconsin Department of Natural Resource and Federal Emergency Management Agency to provide potential budgetary relief for projects.

IMPLEMENTATION PLAN FOR POTENTIAL FUTURE PROJECTS

The focus of the implementation plan is to provide incremental improvement to both the storm and sanitary sewer systems. After a thorough review of the alternatives and information provided in this report, the SWU and KWU have developed a strategy for implementation of improvements to improve the performance of the storm sewers in the Forest Park area.

This study recommends an incremental solution to the surface flooding and basement backup issues within the Forest Park Basin. Within the Forest Park Basins, KWU has collected valuable flow data within the sanitary sewer system for a series of wet weather events. The response of the system to these various wet weather events correlates closely to the computer model completed as part of this study. Based on this correlation KWU feels comfortable in increasing capacity within the sanitary sewer system to convey the anticipated flow for a 100-year storm event. This will require KWU to install a larger diameter sanitary sewers or new relief sewers on 61st Street between 46th Avenue and 50th Avenue and on 65th Street between 48th Avenue and 50th Avenue. Following the sanitary sewer improvements continual monitoring of the flow within the sanitary sewer system will allow the City to assess the impact the enhancements have made on sanitary sewer flow rates and determine if upgrades within the storm sewer system are warranted. Should the sanitary sewer system upgrades prove to be inadequate in regards to reducing flow within the sanitary sewer system, additional SWU capacity upgrades within the study area would be implemented. These upgrades would generally follow Alternative SW2 and SW3.

Table ES-1 itemizes the steps to implement this plan.

TABLE ES-1

IMPLEMENTATION PLAN–POTENTIAL FUTURE PROJECTS

Rank No.	Component	Opinion of Probable Construction Cost	Tentative Timeline	Goal
	SANITARY SEWER SYSTEM (KWU)			
KWU1	Sanitary Sewer–Pershing Blvd.–60th Street to 61st Street	$290,000	Completed 2010	Increase ability for sanitary sewer to handle rainfall-related inflows.
KWU2	Sanitary Sewer–61st Street–Pershing Blvd. to 46th Avenue	$190,500	Completed 2010	Increase ability for sanitary sewer to handle rainfall-related inflows.
KWU3	Sanitary Sewer Reconstruction (Forest Park North): -61st Street (46th Avenue to 50th Avenue)	$545,000	Construction: 2014	Increase ability for sanitary sewer to handle rainfall-related inflows.
KWU4	Sanitary Sewer Reconstruction (Forest Park South): -Flow Metering Prior to Construction -65th Street (48th Avenue to 51st Aveue)	$375,000	Construction: 2014	Increase ability for sanitary sewer to handle rainfall-related inflows.
KWU5	Sanitary Manhole Rehabilitation Program	$300,000	Ongoing	Reduce rainfall-related flows from entering sanitary sewer.
KWU6	Sanitary Sewer Rehabilitation Program	On-going	Ongoing	Reduce rainfall-related flows from entering sanitary sewer.
	STORM SEWER SYSTEM (SWU)			
SWU1	City-Wide Comprehensive Stormwater Management Plan in progress	TBD	Complete by 2014	Increase understanding of storm sewer system's response to rainfall events.
SWU2	Forest Park Underground Detention	$1,630,000	TBD	Achieve a 10-year storm sewer system capacity in the Forest Park North Study Areas
SWU3	Little League Underground Detention	$1,650,000	TBD	Achieve a 10-year storm sewer system capacity in the Forest Park South Study Areas
SWU4	Relief Storm Sewer: 46th Avenue to Pershing Boulevard	$199,000	Design: 2013 Construction: 2015	Disconnect 46th Avenue from 61st Street mainline storm sewer and add capacity to more efficiently drain the low point on 46th Avenue.
SWU5	Storm Manhole and Inlet Rehabilitation Program	$51,000	Ongoing	Maintain integrity of storm sewer system.
SWU6	Storm Sewer Rehabilitation Program	On-going	Ongoing	Maintain conveyance capacity of storm sewer system.
	JOINT SANITARY AND STORM SEWER SYSTEMS			
JOINT1	Seek Funding Opportunities	NA	On-going	Potential budgetary relief.
JOINT2	Storm/Sanitary Disconnection: -Foundation Drain Disconnection -Sump Pump Collection Systems	$6,000 to $12,000 per home To Be Determined (TBD)	**TBD**	Reduce rainfall-related flows from entering sanitary sewer.
JOINT3	Public Information Framework	TBD	On-going	Increase public understanding of ways residents can reduce private I/I.

SECTION 1
INTRODUCTION

1.01 INTRODUCTION

This report summarizes the methods and results of a study completed by Strand Associates, Inc.® (Strand) to develop a storm and sanitary sewer management plan for the Forest Park Area in the City of Kenosha (City). Figure 1.01-1 shows the location of the study area and surrounding areas of the City. The Forest Park Area is predominantly a fully developed urban watershed (including upstream and downstream areas) having a highly interconnected storm sewer system and a sanitary sewer system prone to wet weather flooding issues. The City has experienced significant flooding and basement backups related to a number of factors, including a potentially undersized storm sewer system, cross connections between private sump pumps/drain tiles and the sanitary sewer system, and topographical constraints in the Forest Park neighborhood. A combination of these factors also leads to periodic bypass pumping of sanitary sewer to the storm sewer (at the intersection of 46th and 61st Street). The City has moved forward to solve flooding issues in the Forest Park area as evidenced by past studies in 1999, 2006, 2007, and sanitary flow monitoring in 2009.

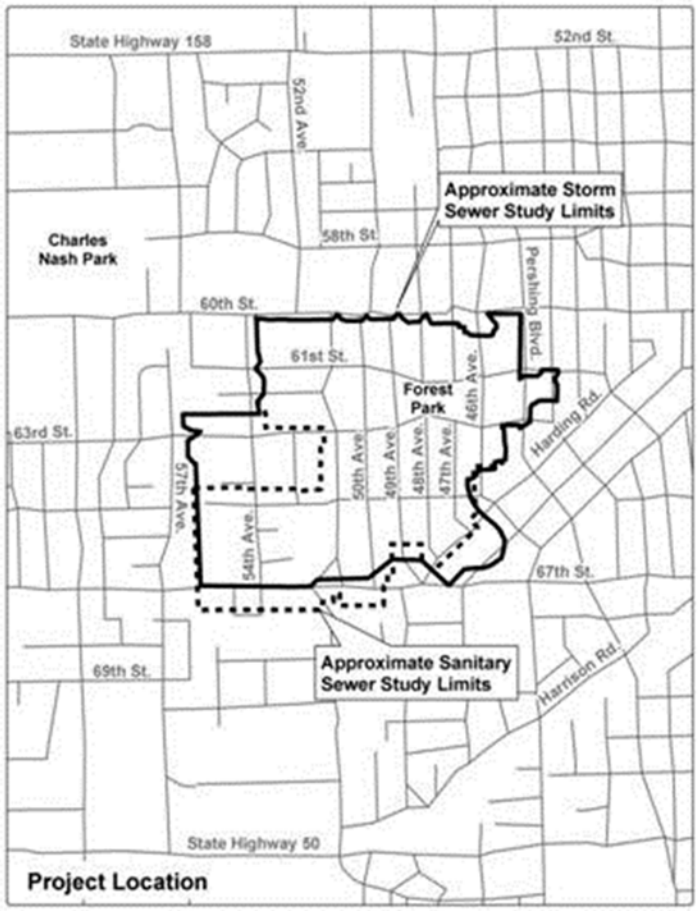
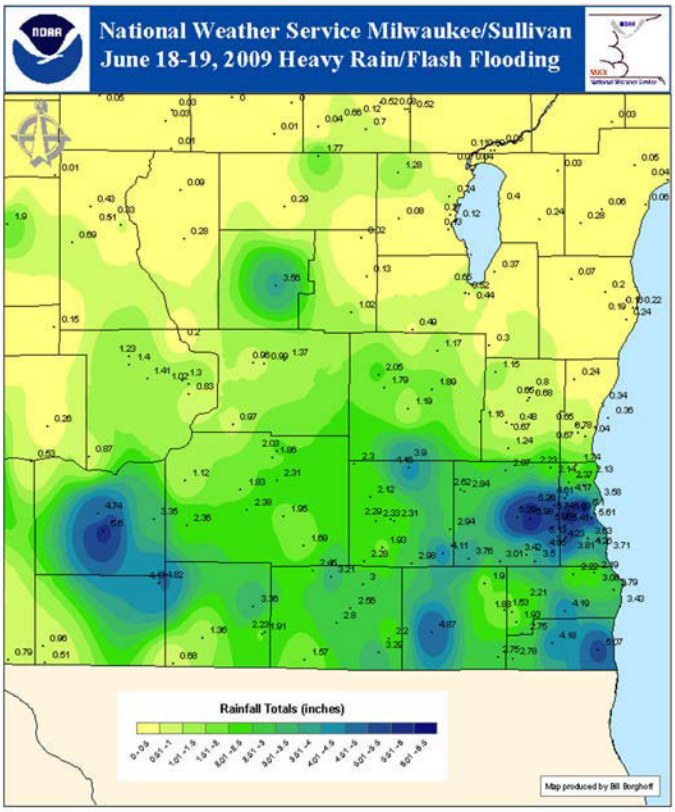


Figure 1.01-1 Study Area Location and Surrounding Areas of the City

The Forest Park Area is historically prone to flooding, most recently on June 19, 2009. Figure 1.01-2 shows a National Weather Service graphic that represents the June 18-19, 2009 rain event that caused extensive flooding. A significant rainfall event also occurred on May 20-23, 2004 that created widespread flooding. City staff provided survey elevation data documenting reported flooding high water marks that occurred as a result of a May 20-23, 2004 storm event.



Source: National Weather Service

Figure 1.01-2 Rainfall Totals (June 18 to 19, 2009) Rain Event

Much of the development in this watershed occurred prior to the advent and implementation of strong guidelines on stormwater management, resulting in several areas with stormwater system capacity issues. From a stormwater perspective, this plan will address ways to mitigate the existing stormwater flooding problems in the Forest Park Area. From a sanitary sewer perspective, this plan will address ways to improve wet weather operational issues with the goal of eliminating wet weather sanitary sewer backups. We have approached this plan treating stormwater and sanitary sewer problems as interrelated issues. Doing so allows for implementation of the plan in a collective, prioritized fashion.

1.02 SCOPE OF STUDY

The following key elements were included in the study.

A. Storm Sewer Condition Analysis

Strand assisted the City in hiring H.R. Stewart, Inc. (H.R. Stewart) to televise the condition of storm sewer mainlines, inlet leads, inlets, and manholes within the limits of the detailed study area (Forest Park North and South areas). The televising reports provided by H.R. Stewart were reviewed by Strand and a summary of our observations are included in Section 3.

B. Storm Sewer Capacity Analysis

An XPSWMM model was developed for the limits of detailed study *area* using XPSWMM two-dimensional model. In the upstream, downstream, and south tributary areas, a skeletonized model of the mainline storm sewers was developed. Utilizing this model, the following tasks were performed.

1. Estimation of inlet capacity in the limits of detailed area to assess whether there is sufficient capacity to pass the 10-year design storm.

2. Performance of a critical duration analysis to determine the rainfall duration creating the highest peak flows in the storm sewer network.

3. Calibration of the XPSWMM model for the May 20 to 23, 2004, storm event based on high water level location information received from City staff in the limits of the detailed study area and City survey of those locations.

4. Geographic Information System (GIS) figure showing the estimated pipe capacity of each modeled pipe within the limits of the detailed study area under existing conditions. This analysis identified areas currently vulnerable to flooding during extreme storm events. This analysis was performed assuming unlimited inlet capacity to determine the actual pipe capacity of a particular pipe should there be adequate inlet capacity to match the pipe capacity.

5. Alternatives analysis to analyze up to four ways to pass the 10-year storm event in the limits of the detailed study area including a write-up, an opinion of probable construction cost, and a GIS figure. Amendment No. 2 to this project incorporates four additional alternatives seeking to pass the 10-year storm event including upgrading the inlets and inlet leads in the Forest Park North and South areas. Amendment No. 3 incorporates analysis of an alternative to provide local improvements to the area between 46th Avenue and Pershing Boulevard.

C. Sump Pump/Drain Tile Connection Database

A sump pump/drain tile connection database was created based on information collected by the following efforts in the notification area described in Section 4. Results of this effort are included in Section 4–Resident Survey Information.

1. Development of a survey form in hard-copy and on-line format.

2. Distribution of the survey form to residents in the notification area.

3. Contact of residents in the notification area via telephone.

4. Site visit to residents in the notification area that did not respond to the initial survey and for those that requested a field visit.

D. Hydrology Evaluation and Flood Extents Map

Hydrologic parameters were developed for input into the XPSWMM model for the limits of the detailed study area, upstream tributary area, and downstream tributary area. In the limits of detailed study area, hydrologic parameters were developed to each inlet. In the upstream and downstream areas, watershed parameters were developed along the mainline that was modeled. An XPSWMM two-dimensional flood extent map was generated for the 2-, 5-, 10-, 25-, 50-, and 100-year storm events under existing land use conditions in the limits of detailed study area.

E. Review of Existing Sanitary Sewer Data

Section 5 summarizes our findings based on review of existing sanitary sewer information that pertains to the sanitary sewer study area shown in Figure 1.01-1 as follows.

1. Review of the *1999 Sanitary Sewer Relief Plan*.

2. Review recommended emergency operations plan in relation to the City's existing wet weather operational practices.

3. Review of the *2007 Sanitary Sewer Flow Monitoring and Analysis* report.

4. Review the development and calibration of the City's existing 2007 hydraulic model including comparison to the 1999 tabular capacity analysis.

5. Review and summarize the following City-provided information: peak flow estimates, capacity calculations, system operational issues, flow metering data, smoke testing results, sewer televising, and manhole inspection results.

6. Provide an updated estimate of peak wet weather flows within the *sanitary sewer study area* utilizing *2007 Sanitary Sewer Flow Monitoring and Analysis* flow metering and other City-generated data.

F. Updated Capacity Analysis-Sanitary Sewer

An updated and expanded XPSWMM model was developed for the sanitary sewer study *area* to model the operation of the collection system under wet weather operating conditions. Utilizing this model, the following tasks were performed:

1. Evaluation of the wet weather operation of the sanitary sewers in the sanitary sewer study area.

2. Analysis of up to three conveyance alternatives in the sanitary sewer study area including a write-up, an opinion of probable construction cost, and a GIS figure.

3. Amendment No. 3 to this project incorporates a basin-wide estimate for Forest Park North and Forest Park South of infiltration/inflow (I/I) into the sanitary sewer system from manholes and foundation drains.

G. Private Infiltration/Inflow Program-Preliminary Development

A summary of existing private property infiltration/inflow (I/I) identification and removal programs was prepared. The summary is based on information available on the Water Environment Federations (WEF) Private Property Virtual Library (PPVL) and a recently completed evaluation performed by Strand. This effort includes a review meeting scheduled in conjunction with other project activities.

H. Educational Program

An educational program was developed using existing educational materials in, but not limited to, the following categories.

1. Impacts of discharging clear water into sanitary sewers.
2. Impacts of keeping catch basins and curb lines clean of leaves or grass clippings.
3. Impacts of storms on sanitary and storm sewer systems.

The following in-house materials specific to this stormwater and sanitary plan will be prepared.

1. One rendering regarding the sump pump/drain tile disconnection concept.
2. One newsletter describing the project and solutions.

I. Ordinance Reviews

The City's current code of ordinances was evaluated to recommend updates and additions beneficial in reducing long-term clear water connections to the sanitary sewer system.

J. Public Involvement Process

Two workshops were held with residents in the notification area.

K. Meetings

Four progress meetings were held with the City.

L. Implementation Plan

The implementation plan includes the development of a schedule for completion of recommended improvements and a discussion of financing options for the recommended stormwater improvements.

1.03 LOCATION OF STUDY AREA

The Forest Park Area watershed is roughly bounded by 60th Street, 56th Avenue, 67th Street, and Harding Road. The location of the study area, which is in the Root-Pike River Basin, is shown in Figure 1.03-1.

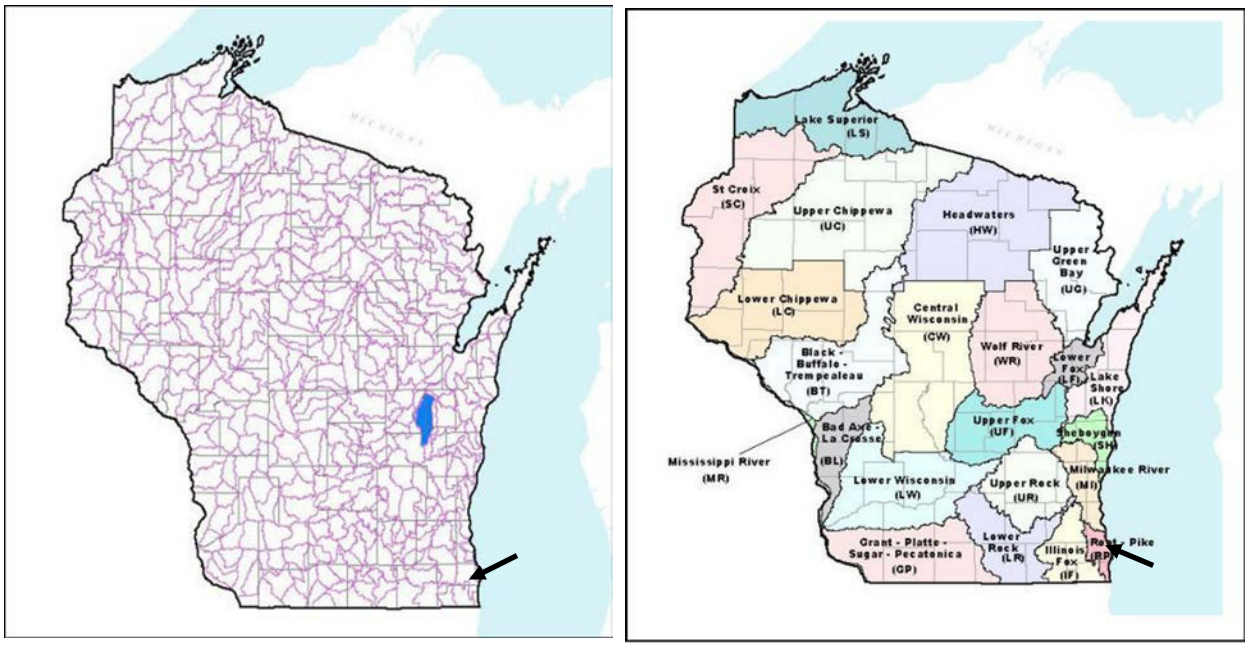


Figure 1.03-1 Study Area Location Relative to Wisconsin Department of Natural Resources Watersheds

1.04 PREVIOUS STUDIES

The following reports/plans are applicable to portions of the Forest Park Area planning area.

Pollutant Loading Analysis for City of Kenosha, HNTB, October 2008.

Sanitary Sewer Flow Monitoring and Analysis for the Kenosha Water Utility, Earth Tech, July 2007.

West 60th Street Drainage Area Flood Control Plan, HNTB, April 2006.

Sanitary Sewer Relief Plan (44th Avenue to Green Bay Road and 60th Street to 67th Street), Reukert-Mielke, October 1999.

The State of the Root-Pike River Basin, PUBL WT-700-2002, WDNR, May 2002

1.05 APPLICABLE STANDARDS AND DESIGN CRITERIA

The following information describes the existing stormwater and sanitary-related regulatory framework in the City.

A. Applicable Stormwater-Related Ordinances

1. City's Ordinances

Land disturbing and land development activities in the City are regulated by the following City Ordinances regarding stormwater and erosion control.

a. Chapter XXXVI–Postconstruction Stormwater Management Ordinance–This ordinance has requirements related to total suspended solids reduction, peak discharge reduction, infiltration, protective areas, and fueling and maintenance areas. It also has a requirement for appropriate emergency overland flow for all stormwater management facilities.

This ordinance has a companion document titled Kenosha Stormwater Management Criteria. This criteria specifies that storm sewers shall be designed for a 10-year storm event using the rational method. An overflow path is also required that provides 6 inches of freeboard from the design 100-year water surface elevation and any adjacent building.

The ordinance gives two choices for peak discharge control:

(1) By design, best management practices (BMPs) shall be employed to maintain or reduce the peak runoff discharge rates as compared to predevelopment conditions of the 24-hour 2-year design storm applicable to the postconstruction site.

(2) By design, BMPs shall be designed and employed to reduce the peak discharge rates of the postconstruction conditions of any storm in areas where there is inadequate storm sewer or drainageway capacity. The control of peak discharge shall be required for all areas draining to navigable streams or to storm sewer systems that do not have at least capacity of the 5-year rational method storm. Any site with inadequate capacity downstream shall have the peak discharge reduced to a proportional share of the available downstream capacity based on the ratio of the development's area to the total drainage area. The available downstream capacity shall be set by the capacity of storm sewer pipes when flowing full, the overflow level for ditches and the top of the upstream end of the pipe for any culverts. None of these criteria shall preempt more stringent release rates.

b. Chapter XXXIII–Land-Disturbing Erosion and Sediment Control Ordinance.

c. Chapter XXXVII–Illicit Stormwater Discharges and Connections.

d. Chapter V–Public Works and Services–This ordinance requires sump pump discharge lines to connect to the nearest available storm sewer line or at least 10 feet from a tributary where storm sewer is not available.

2. Kenosha County Ordinances

It is our understanding, through discussions with City staff, Kenosha County has no regulatory authority over stormwater and erosion control requirements in the City.

3. Southeast Wisconsin Regional Planning Commission

It is our understanding that Southeast Wisconsin Regional Planning Commission (SEWRPC) imposes no requirements regarding floodplain or stormwater management in the City. However, SEWRPC will become involved at the request of the City.

4. State of Wisconsin-NR 151

Development activities are also regulated by Wisconsin Department of Natural Resources (WDNR) NR 151, which applies to new development and redevelopment that has 1 acre or more of land-disturbing construction activity. NR 151 has stormwater and erosion control requirements falling under the following general categories. The WDNR is in the process of updating NR 151, which will change some of the current requirements. The full current NR 151 code can be found at:

http://www.legis.state.wi.us/rsb/code/nr/nr151.pdf

In addition, the WDNR Wet Detention Basin standard, which is used to comply with the detention standards of NR 151, is available at the following Web site:

http://www.dnr.state.wi.us/org/water/wm/nps/stormwater/techstds.htm

a. Erosion Control (Construction Site Performance Standards)

(1) Implement BMPs to reduce the sediment load carried to runoff by 80 percent.

(2) Minimize tracking of sediment from the construction site onto roads and other paved surfaces.

(3) Minimize the discharge of sediment as part of site dewatering.

(4) Protect separate storm drain inlet structures from receiving sediment.

b. Stormwater (Postconstruction Site Performance Standards)

(1) Total suspended solids reduction of 80 percent for new development and 40 percent for redevelopment.

(2) Peak discharge control for the 2-year storm as follows. “By design, BMPs shall be employed to maintain or reduce the peak runoff discharge rates, to the maximum extent practicable, as compared to pre-development conditions for the 2-year, 24-hour design storm applicable to the post-construction site…”.

(3) Infiltration.

(4) Protective Areas.

(5) Fueling and Maintenance Areas.

B. Applicable Sanitary Sewer-Related Ordinances

1. Chapter XXII-Kenosha Water Utility Water and Sewerage System City of Kenosha Ordinances

a. Chapter V–Public Works and Services

(1) Section 5.115–Sump Pumps-Regulates the installation and discharge of sump pumps. This ordinance specifically prohibits the discharge of sump pumps into the sanitary sewer.

b. Chapter IX–Building Code

(1) Section 9.08–Enforcement Procedures-Provides authority to inspect buildings to verify conformance with applicable building codes, including sewer connections.

(2) Section 9.17–Razing of Buildings-Outlines procedures to be followed during demolition of buildings. No mention is made of procedures for abandoning sewer laterals.

(3) Section 9.18–Swimming Pools; Hot Tubs-Regulates drainage of facilities, specifically prohibiting discharge to the sanitary sewer.

(4) Section 9.25–Downspout Discharge-regulates the discharge of downspouts. Note: This ordinance does not specifically prohibit downspout discharge to the sanitary sewer.

c. Chapter XVI–Property Maintenance Code

(1) Section 16.18–Exterior of Structure–Regulates drainage of roofs. Note: This ordinance does not specifically prohibit downspout discharge to the sanitary sewer.

(2) Section 16.23–Plumbing Systems Facilities and Fixture Requirements–Regulates connection of building sewers to the sewer system.

d. Chapter XXXII–Kenosha Water Utility–Water and Sewerage Systems–This entire chapter regulates the water and sewerage systems. Section 32.07 presents Rules and Regulations Governing the Sewerage System. Specific areas worthy of mention include:

(1) Rule 05-04–Responsibility For Water and Sanitary Sewer Pipes, Appurtenances, and Connections–This rule specifically states the responsibility for lateral repair and maintenance rests with the property owner.

(2) Rule 08-02–Downspouts and Sumps Discharge Prohibited–Specifically states that discharge from sump pumps and downspouts to the sewerage system is prohibited. This clarifies earlier instances where the code may be silent on this issue.

2. Kenosha County Ordinances

It is our understanding through discussions with City staff that Kenosha County has no regulatory authority over sanitary sewer requirements in the City.

3. Southeast Wisconsin Regional Planning Commission

As a planning agency, SEWRPC does not regulate the day-to-day operations of the Kenosha sewerage system.

4. State of Wisconsin-NR 110

Sanitary sewer design and operation activities are also regulated by WDNR NR 110. The full current NR 110 code can be found at:

http://www.legis.state.wi.us/rsb/code/nr/nr110.pdf

1.07 DEFINITIONS AND ABBREVIATIONS

The following definitions and abbreviations are presented as an aid to the reader.

A. Definitions

Average Sediment Depth–The average depth of deposited sediment measured over the entire pond area.

Average Current Normal Pool Depth–The average depth of water measured over the entire pond area. This is the difference between the water surface and the top of sediment.

Average Current Total Pond Depth–The average depth of the pond if all deposited sediment were removed. This is the difference between the water surface and the existing bottom of the pond.

Control Structure–The manmade structure that controls the water released from a stormwater facility to the outfall.

Curve Number–The Soil Conservation Service has devised a method of computing runoff from an area based on a system of curve numbers. The curve number for an area of land is obtained by examining the land use and soil type of the land area.

Flume–The structure or channel upstream of the stormwater facility used to convey stormwater to the facility.

Forebay–The area of the pond near the inlet where heavy sediments are encouraged to settle out of the stormwater that enters a facility.

Outfall–The piping, channel, or other equipment downstream of the control structure used to transfer water out of the control structure to the surrounding environment.

Recurrence Interval–The probability that a given rainfall event will occur in a given year. For example, a 100-year rainfall event has a 1 percent chance of occurring in a given year (1/100 = 0.01 = 1 percent), a 5-year rainfall event has a 20 percent chance of occurring in a given year (1/5 = 0.20 = 20 percent).

Subbasin–The parts of a drainage basin that, when combined, create the entire drainage basin for a facility.

Time of Concentration (T_c)–"…the time for runoff to travel from the hydraulically most distant point of the watershed to a point of interest within the watershed," SCS, 1986.

Time Distribution of Rainfall–The amount of rainfall that has fallen during a storm event versus the amount of time that has elapsed during a storm event.

Weir–A wall spanning the control structure. When the water level of the pond reaches the top of the weir, water flows over the weir and out of the pond.

B. Abbreviations

1D	one dimensional
2D	two dimensional
ABFE	Advisory Base Flood Elevation
BFE	Base Flood Elevation
BMP	Best Management Practices
cfs	cubic feet per second
City	City of Kenosha
CMP	corrugated metal pipe
CN	Connection
EXTRAN	Extended Transport
FDM	Facilities Development Manual

FEMA	Federal Emergency Management Agency
ft	feet
FMA	Flood Management Assistance
GIS	Geographic Information System
gpm	gallons per minute
HDPE	high density polyethylene
HGL	hydraulic grade line
HMG	Hazardous Mitigation Grant
H.R. Stewart	H.R. Stewart, Inc.
HSG	Hydrologic Soils Groups
I/I	infiltration/inflow
IGLD	International Great Lake Datum
SWU	Kenosha Stormwater Utility
KWU	Kenosha Water Utility
LF	linear foot
MMSD	Milwaukee Metropolitan Sewerage District
MS4	municipal separate storm sewer system
NCDC	National Climatic Data Center
NFIP	National Flood Insurance Program
NGVD	National Geodetic Vertical Datum
NOAA	National Oceanic and Atmospheric Administration
NRCS	National Resource Conservation Service
OPCC	Opinion of Probable Construction Cost
PA	Public Assistance
PDM	Pre-Disaster Hazard Mitigation Grant
PLE	permanent limited easement
POS	Point-of-Sale
PPVL	Private Property Virtual Library
RFC	Repetitive Flood Claims
RCN	runoff curve number
SCADA	supervisory control and data acquisition
SEWRPC	Southeastern Wisconsin Regional Planning Commission
SRL	Severe Repetition Loss Claims
Strand	Strand Associates, Inc.®
SWMM	Stormwater Management Model
T_c	time of concentration
TIN	triangulated irregular network
USEPA	United States Environmental Protection Agency
WDNR	Wisconsin Department of Natural Resources
WEF	Water Environment Federations
WinSLAMM™	Windows Source Loading and Management Model
XP-SWMM™	XP Software Stormwater Management Model

SECTION 2
CONTRIBUTING WATERSHED CHARACTERISTICS

2.01 BASIN CHARACTERISTICS AFFECTING STORMWATER RUNOFF

A. General

The amount of stormwater discharging from a watershed depends on a number of individual characteristics. Watershed size and topography, land use, soil types and degree of saturation, type of drainage system (storm sewers, open channels), and amount of watershed storage available all affect stormwater discharge. To quantify stormwater flows and volumes, an inventory of watershed physical characteristics in the Forest Park Area watershed was completed. This section describes physical land characteristics in the Forest Park Area watershed that impact stormwater runoff.

B. Drainage Patterns

Existing drainage patterns, watershed designations, and locations and sizes of storm sewer and other water features are identified in Figure 2.01-1 (enclosed in the pocket at the end of this report).

The modeled watershed consists of approximately 4,208 acres and is located in the central portion of the City with a portion of the watershed to the south and west being in the Village of Pleasant Prairie. The watershed is generally bounded by 45th Street to the north, 85th Street to the south, State Highway 31 to the west, and Lake Michigan to the east. This watershed has a highly interconnected storm sewer system that drains to storm sewer outfalls at Pike Creek at 45th Street and 25th Avenue, at Lake Michigan at the end of 60th Street, and at Lake Michigan at the end of 73rd Street. The storm sewer system consists of inlets, manholes, storm sewers, grass-lined swales (mostly in Pleasant Prairie), and wet and dry detention basins. The limits of detailed storm sewer study area watersheds are designated as Forest Park North (1E:FPNxxx) and Forest Park South (1E:FPSxxx) watersheds as shown on Figure 2.01-1. The Forest Park North watershed is approximately 103 acres and Forest Park South watershed is approximately 59 acres. The upstream tributary area watersheds draining through the Forest Park Area are designated Forest Park West (1E:FPWxxx) watersheds. The Forest Park West watershed is approximately 302 acres. Downstream of the Forest Park Area, watersheds are designated as follows.

1. Pike Creek (1E:PCxxx) watersheds, approximately 1,013 acres, for areas draining mainly to the northwest to the Pike Creek outfall.
2. Center Mainline (1E:CMxxx) watersheds, approximately 766 acres, for areas draining mainly to the east to Lake Michigan at the 60th Street outfall.
3. South Mainline (1E:SMxxx) watersheds, approximately 1,941 acres, for areas draining mainly to the southeast to Lake Michigan at the 73rd Street outfall.

C. Soils

The amount of stormwater runoff produced by a storm event is impacted by the types of soil underlying the watershed. Soils having a high percentage of sand and gravel will absorb a higher percentage of stormwater runoff than will soils having high clay content. This means that sandy soil generally produces less runoff than clay soil.

The Natural Resource Conservation Service (NRCS) classifies soil types in categories known as Hydrologic Soil Groups (HSG). Group A soils consist of sandy soils having high infiltration rates and low runoff potential. Group B soils have moderately fine to moderately coarse textures and moderate runoff potential. Group C soils are typically silty clay loam soils having moderately fine to fine textures and a low infiltration capacity. Examples of Group D soils are clays, soils with a permanent high water table, and shallow soils over nearly impervious material. Group D soils have a very low infiltration capacity and have high runoff potential.

Hydrologic soil groups in the modeled area are identified in Table 2.01-1 and illustrated in Figure 2.01-2 (enclosed in a pocket at the end of this report). According to the Kenosha County Wisconsin, Soils Survey (published by the United States Department of Agriculture Soil Conservation Service in cooperation with the University of Wisconsin; Wisconsin Geological and Natural History Survey, Soils Department; and Wisconsin Agricultural Experiment Station) local soils are primarily silt loam and silty clay loam. These soils are classified by the NRCS as mainly HSG Group C soils. Infiltration rates for the Group B soils range from 0.15 to 0.30 inches per hour. Infiltration rates for the Group C soils range from 0.05 to 0.15 inches per hour. The percentages of each hydrologic soil group are shown in Tables 2.01-1 and 2.01-2.

HSG	Percent of Watershed
A	1.4
A/D	1.5
B	26.8
B/D	15.1
C	54.6
D	0.5
Total	**100.0**

Table 2.01-1 Hydrologic Soil Groups

D. Land Use

Land use is another factor that affects the amount of stormwater runoff that will be produced by a rainstorm. Urbanization and development reduce the ability of the ground to absorb stormwater, typically causing peak discharges and runoff volumes to increase. The time from the beginning of the storm event to the occurrence of the peak runoff may also be significantly shortened.

Existing land use in the modeled watersheds is shown in Figure 2.01-3. Existing land use is based on the WinSLAMM data provided by the City that originated from the *Pollutant Load Analysis for City of Kenosha,* HNTB, October 31, 2008. In the Village of Pleasant Prairie areas, the SEWRPC Year 2000 land use map was used to designate the appropriate WinSLAMM land use. Both data sources were supplemented with a review of aerial photography to define the appropriate land use. For purposes of hydrologic runoff parameters, land uses designated as streets were assigned to the average WinSLAMM land use proportionate to the amount of that land use within the particular watershed. Percent imperviousness was then generated based upon the amount of pervious and impervious in each WDNR Standard Landuse File. Table 2.01-3 summarizes the existing hydrologic parameters for each drainage basin.

TABLE 2.01-2

KENOSHA MODELED WATERSHEDS SOILS

Symbol	Soil	HSG[1]	Percent of Watershed
AtA	Ashkum silty clay loam, 0 to 3% slopes	B/D	9.38%
AzA	Aztalan loam, 0 to 2% slopes	C	0.87%
AzB	Aztalan loam, 2 to 6% slopes	C	1.55%
BcA	Beecher silt loam, 1 to 3% slopes	C	4.29%
BmB	Boyer loamy sand, 1 to 6% slopes	B	0.09%
Cv	Clayey land	C	0.97%
Cw	Colwood silt loam	B/D	0.05%
EtB	Elliott silty clay loam, 2 to 6% slopes	C	9.46%
FmB	Fox sandy loam, 1 to 6% slopes	B	1.30%
FoB	Fox loam, 2 to 6% slopes	B	3.02%
FrB	Fox loam, clayey substratum, 2 to 6% slopes	B	0.55%
Gf	Granby fine sandy loam	A/D	1.47%
GnA	Granby fine sandy loam, brown subsoil variant, 0 to 3 % slopes	B	0.63%
HbB	Hebron sandy loam, 2 to 6% slopes	B	0.35%
HeB2	Hebron loam, 2 to 6% slopes, eroded	B	0.70%
KaA	Kane loam, 1 to 3% slopes	B	2.85%
Lu	Loamy Land	B	7.65%
MeB	Markham silt loam, 2 to 6% slopes	C	18.92%
MeB2	Markham silt loam, 2 to 6% slopes, Eroded	C	0.84%
MeC2	Markham silt loam, 6 to 12% slopes, eroded	C	0.36%
MgA	Martinton silt loam, 1 to 3% slopes	C	0.04%
MIA	Matherton loam, clayey substratum, 1 to 3% slopes	C	1.02%
Mzc	Montgomery silty clay	D	0.08%
MzdB	Morley silty loam, 2 to 6% slopes	C	8.96%
mzdB2	Morley silty loam, 2 to 6% slopes, eroded	C	1.95%
Na	Navan silt loam	D	0.45%
Ph	Pella silt loam	B/D	4.94%
Ry	Rough broken land	B	0.00%
Sf	Sandy and gravelly land	A	1.44%
So	Sebewa silt loam, clayey substratum	B/D	0.73%
SrB	Sisson fine sandy loam, 1 to 6% slopes	B	2.51%
VaB	Varna silt loam, 2 to 6% slopes	C	5.42%
W	Water	D	0.12%
WnA	Wasepi sandy loam, clayey substratum, 1 to 3% slopes	B	7.05%
		Total	100.00%

[1] HSG = Hydrologic soils group

TABLE 2.01-3

HYDROLOGIC PARAMETERS

Basin ID	Structure ID	Drainage Basin Area (ac)	Tc (min)	Total Impervious Area (ac)	Impervious (%)	Total Pervious Area (ac)	Pervious (%)	Pervious RCN
CM1	800	30.32	21.9	11.59	38%	18.73	62%	61
CM10	10215	48.36	18.7	35.49	73%	12.87	27%	64
CM11	13112	27.11	25.5	16.47	61%	10.64	39%	61
CM12	12921	59.77	24.8	34.66	58%	25.11	42%	64
CM13	12737	118.49	36.1	57.84	49%	60.64	51%	68
CM14	12350	42.98	28.6	23.84	55%	19.13	45%	70
CM15	7497	12.78	29.2	6.53	51%	6.25	49%	71
CM16	10224	8.64	15.1	3.74	43%	4.91	57%	72
CM17	11971	1.68	12.9	0.75	45%	0.93	55%	74
CM18	12146	9.21	17.3	4.24	46%	4.97	54%	71
CM19	6139	40.63	16.9	15.43	38%	25.20	62%	74
CM2	900	41.91	17.7	25.95	62%	15.97	38%	61
CM20	6089	10.46	18.3	3.97	38%	6.50	62%	74
CM21	6057	17.68	16.5	6.71	38%	10.96	62%	74
CM22	6046	8.63	14.4	3.27	38%	5.36	62%	74
CM23	6040	16.56	21.7	7.18	43%	9.38	57%	74
CM24	6028	1.97	17.9	0.75	38%	1.22	62%	74
CM3	15978	17.81	16.3	11.22	63%	6.58	37%	61
CM4	3161	16.17	10.1	11.83	73%	4.34	27%	61
CM5	3173	79.83	26.1	49.06	61%	30.77	39%	62
CM6	3183	35.72	22.7	21.61	60%	14.11	40%	63
CM7	3192	61.40	23.3	40.59	66%	20.81	34%	61
CM8	3206	33.45	17.8	19.84	59%	13.61	41%	61
CM9	3097	24.38	16.9	17.92	74%	6.45	26%	63
FPN1	5820	0.11	9.9	0.04	38%	0.07	62%	74
FPN10	5797	0.36	8.7	0.14	38%	0.22	62%	74
FPN11	5734	0.17	5.0	0.06	38%	0.11	62%	74
FPN12	5733	1.56	19.8	0.59	38%	0.97	62%	74
FPN13	5736	0.84	11.7	0.32	38%	0.52	62%	74
FPN14	5799	0.73	12.8	0.15	21%	0.57	79%	70
FPN15	5789	2.70	25.3	0.57	21%	2.12	79%	66
FPN16	5802	0.26	7.0	0.11	43%	0.15	57%	62
FPN17	5796	0.07	8.3	0.03	38%	0.04	62%	61
FPN18	17546	0.19	16.6	0.07	38%	0.12	62%	61
FPN19	5795	0.46	10.0	0.18	38%	0.29	62%	68
FPN2	5819	0.27	6.8	0.10	38%	0.17	62%	74
FPN20	5793	1.42	10.0	0.54	38%	0.88	62%	72
FPN21	17545	0.50	5.2	0.19	38%	0.31	62%	71
FPN22	5792	0.54	7.6	0.20	38%	0.33	62%	74
FPN23	5784	0.19	7.0	0.07	38%	0.12	62%	74
FPN24	5786	0.53	12.2	0.20	38%	0.33	62%	74
FPN25	5787	2.61	12.1	0.99	38%	1.62	62%	74
FPN26	5785	1.20	13.3	0.45	38%	0.75	62%	74
FPN27	5781	2.27	7.1	0.48	21%	1.79	79%	67
FPN28	5737	0.73	7.3	0.15	21%	0.57	79%	71
FPN29	5740	2.51	18.8	0.95	38%	1.56	62%	73
FPN3	5816	0.86	15.5	0.33	38%	0.53	62%	74
FPN30	5739	2.58	15.7	0.98	38%	1.60	62%	74
FPN31	5741	0.76	10.4	0.29	38%	0.47	62%	74
FPN32	5742	2.00	12.8	0.76	38%	1.24	62%	73
FPN33	5743	0.16	5.0	0.06	38%	0.10	62%	67
FPN34	5748	0.19	9.9	0.07	38%	0.12	62%	74
FPN35	5747	0.59	16.0	0.23	38%	0.37	62%	74
FPN36	5746	0.16	5.0	0.06	38%	0.10	62%	74
FPN37	5771	3.08	16.0	1.17	38%	1.91	62%	69
FPN38	5772	1.37	10.4	0.29	21%	1.08	79%	67
FPN39	5769	3.46	11.3	1.31	38%	2.15	62%	72
FPN4	5817	0.27	10.9	0.10	38%	0.16	62%	74
FPN40	5767	0.98	9.3	0.51	53%	0.46	47%	71
FPN41	5766	1.83	10.4	0.87	47%	0.97	53%	71
FPN42	5764	0.76	8.3	0.37	49%	0.39	51%	74
FPN43	5763	0.88	8.0	0.42	48%	0.46	52%	74
FPN44	5762	1.20	8.2	0.56	47%	0.64	53%	74
FPN45	5760	1.44	10.8	0.55	38%	0.90	62%	68
FPN46	5759	0.40	11.5	0.15	38%	0.25	62%	68
FPN47	5758	0.70	8.0	0.26	38%	0.43	62%	71
FPN48	5756	1.95	13.4	0.74	38%	1.21	62%	69
FPN49	5752	0.03	6.6	0.01	38%	0.02	62%	74
FPN5	5803	0.11	5.0	0.07	64%	0.04	36%	74
FPN50	5755	0.38	12.6	0.14	38%	0.24	62%	74
FPN51	5619	0.11	5.0	0.04	38%	0.07	62%	74
FPN52	5618	0.52	10.9	0.20	38%	0.32	62%	74
FPN53	5613	0.81	11.3	0.31	38%	0.50	62%	74
FPN54	5615	2.81	14.3	1.07	38%	1.75	62%	74
FPN55	5621	1.05	16.7	0.43	41%	0.62	59%	74
FPN56	5620	0.21	5.0	0.08	38%	0.13	62%	74
FPN57	5657	0.99	11.2	0.38	38%	0.62	62%	65
FPN58	5659	1.63	21.1	0.62	38%	1.01	62%	74
FPN59	5660	3.03	11.5	1.15	38%	1.88	62%	71
FPN6	5805	1.46	13.3	0.55	38%	0.90	62%	73
FPN60	5655	0.50	7.0	0.19	38%	0.31	62%	72
FPN61	5654	3.87	15.2	1.46	38%	2.41	62%	69
FPN62	5652	1.69	8.2	0.64	38%	1.05	62%	69
FPN63	5656	0.44	9.7	0.17	38%	0.27	62%	70
FPN64	5650	7.07	21.4	2.20	31%	4.87	69%	71
FPN65	5648	2.68	14.2	1.01	38%	1.66	62%	67
FPN66	5651	0.43	8.0	0.16	38%	0.27	62%	67
FPN67	5626	4.86	17.9	1.84	38%	3.02	62%	69

Basin ID	Structure ID	Drainage Basin Area (ac)	Tc (min)	Total Impervious Area (ac)	Impervious (%)	Total Pervious Area (ac)	Pervious (%)	Pervious RCN
FPN68	5625	0.80	7.0	0.30	38%	0.50	62%	67
FPN69	5627	1.54	10.7	0.58	38%	0.96	62%	66
FPN7	5806	1.19	15.4	0.45	38%	0.74	62%	68
FPN70	5633	3.52	18.5	1.33	38%	2.19	62%	63
FPN71	5628	0.49	10.4	0.19	38%	0.30	62%	66
FPN72	5629	0.49	14.3	0.19	38%	0.31	62%	74
FPN73	5630	0.41	5.0	0.15	38%	0.25	62%	74
FPN74	5637	0.40	9.0	0.24	59%	0.17	41%	74
FPN75	5635	0.47	5.0	0.43	92%	0.04	8%	74
FPN76	5631	0.67	10.3	0.38	57%	0.29	43%	74
FPN77	5632	3.28	12.5	1.33	40%	1.96	60%	72
FPN78	5638	0.90	9.1	0.34	38%	0.56	62%	71
FPN79	5640	0.97	11.0	0.37	38%	0.60	62%	72
FPN8	5801	1.55	9.8	0.59	38%	0.96	62%	66
FPN80	3961	1.83	7.2	1.58	86%	0.25	14%	67
FPN81	3960	0.64	7.3	0.59	92%	0.05	8%	72
FPN82	8551	1.06	6.8	0.97	92%	0.09	8%	74
FPN83	8162	0.43	7.0	0.40	92%	0.03	8%	74
FPN84	5777	0.44	6.8	0.17	38%	0.28	62%	74
FPN85	5775	0.25	6.5	0.09	38%	0.15	62%	74
FPN86	5778	0.32	8.4	0.12	38%	0.20	62%	74
FPN87	5779	0.56	8.0	0.21	38%	0.35	62%	74
FPN9	5790	0.43	9.3	0.16	38%	0.27	62%	65
FPS1	6024	1.86	9.6	0.71	38%	1.16	62%	74
FPS10	5721	1.45	7.6	0.55	38%	0.90	62%	74
FPS11	5720	2.24	11.2	0.85	38%	1.39	62%	74
FPS12	5718	1.52	11.8	0.58	38%	0.94	62%	74
FPS13	5715	2.37	15.6	0.90	38%	1.47	62%	74
FPS14	5716	0.09	5.0	0.03	38%	0.06	62%	74
FPS15	5714	0.64	10.9	0.24	38%	0.40	62%	74
FPS16	5713	0.09	5.0	0.04	38%	0.06	62%	74
FPS17	5751	0.91	10.2	0.35	38%	0.57	62%	74
FPS18	5749	0.59	11.5	0.22	38%	0.36	62%	74
FPS19	5712	2.70	16.2	1.02	38%	1.68	62%	74
FPS2	6025	0.61	13.4	0.23	38%	0.38	62%	74
FPS20	5710	0.14	5.0	0.05	38%	0.09	62%	74
FPS21	5706	1.06	6.4	0.40	38%	0.66	62%	74
FPS22	5707	2.86	7.8	1.09	38%	1.78	62%	74
FPS23	5708	0.38	6.7	0.14	38%	0.23	62%	74
FPS24	5704	0.32	5.0	0.12	38%	0.20	62%	74
FPS25	5709	0.07	5.0	0.03	38%	0.04	62%	74
FPS26	5701	0.97	9.8	0.37	38%	0.61	62%	70
FPS27	5703	3.44	14.4	1.31	38%	2.14	62%	70
FPS28	5606	0.55	5.0	0.21	38%	0.34	62%	73
FPS29	9733	0.54	5.0	0.21	38%	0.34	62%	69
FPS3	6023	1.87	11.6	0.71	38%	1.16	62%	74

Basin ID	Structure ID	Drainage Basin Area (ac)	Tc (min)	Total Impervious Area (ac)	Impervious (%)	Total Pervious Area (ac)	Pervious (%)	Pervious RCN
FPS30	5609	3.51	23.6	1.33	38%	2.18	62%	71
FPS31	5608	2.67	16.0	1.06	40%	1.62	60%	72
FPS32	5611	0.29	11.6	0.12	41%	0.17	59%	74
FPS33	5610	1.11	11.3	0.42	38%	0.69	62%	74
FPS34	5671	0.48	8.2	0.18	38%	0.30	62%	74
FPS35	5672	2.39	21.3	0.91	38%	1.49	62%	74
FPS36	5670	0.46	11.4	0.18	38%	0.29	62%	74
FPS37	5678	2.07	15.3	0.78	38%	1.28	62%	74
FPS38	5677	2.22	17.0	0.84	38%	1.38	62%	66
FPS39	5683	0.64	9.8	0.24	38%	0.40	62%	69
FPS4	5722	0.43	8.7	0.16	38%	0.27	62%	74
FPS40	5682	1.73	9.9	0.66	38%	1.07	62%	69
FPS41	5681	0.98	10.6	0.53	54%	0.45	46%	74
FPS42	5679	0.49	11.0	0.31	63%	0.18	37%	74
FPS43	5675	0.37	11.1	0.14	38%	0.23	62%	69
FPS44	5676	0.50	11.4	0.19	38%	0.31	62%	74
FPS45	5673	4.54	19.9	1.95	43%	2.59	57%	71
FPS46	5666	0.11	5.0	0.04	38%	0.07	62%	71
FPS47	5665	0.85	15.2	0.32	38%	0.53	63%	74
FPS48	5668	0.60	13.0	0.23	38%	0.37	62%	74
FPS49	5663	2.71	14.3	1.03	38%	1.68	62%	73
FPS5	5725	0.26	5.7	0.10	38%	0.16	62%	74
FPS50	5662	1.07	14.4	0.41	38%	0.66	62%	72
FPS6	5726	0.14	5.0	0.05	38%	0.08	62%	74
FPS7	5727	0.48	10.9	0.18	38%	0.29	62%	74
FPS8	5728	0.27	10.7	0.10	38%	0.17	62%	74
FPS9	5719	0.11	5.0	0.04	38%	0.07	62%	74
FPW1	11959	48.19	24.5	24.31	50%	23.87	50%	72
FPW10	7566	12.45	19.5	3.96	32%	8.49	68%	74
FPW11	KEN_COMMON	8.65	7.9	4.04	47%	4.61	53%	74
FPW12	8161	37.70	9.6	15.96	42%	21.74	58%	74
FPW13	11358	14.91	25.4	4.98	33%	9.93	67%	73
FPW2	11763	9.23	12.7	4.63	50%	4.61	50%	72
FPW3	16964	8.05	23.9	5.63	70%	2.41	30%	74
FPW4	11553	12.00	23.8	5.75	48%	6.26	52%	71
FPW5	10239	10.72	16.7	4.84	45%	5.88	55%	74
FPW6	9727	30.86	33.7	8.40	27%	22.46	73%	72
FPW7	OLD_ELM	5.58	6.9	4.09	73%	1.49	27%	74
FPW8	NASH	85.73	36.7	29.56	34%	56.17	66%	72
FPW9	7637	17.83	26.9	6.43	36%	11.40	64%	72
PC1	13463	25.27	21.7	14.02	55%	11.25	45%	62
PC10	7388	40.25	24.0	19.36	48%	20.89	52%	74
PC11	12182	32.30	23.2	15.74	49%	16.55	51%	74
PC12	12373	3.01	11.8	1.84	61%	1.17	39%	73
PC13	8070	6.62	19.5	3.72	56%	2.89	44%	74
PC14	8064	6.08	16.7	3.23	53%	2.85	47%	72

Basin ID	Structure ID	Drainage Basin Area (ac)	Tc (min)	Total Impervious Area (ac)	Impervious (%)	Total Pervious Area (ac)	Pervious (%)	Pervious RCN
PC15	8094	10.10	13.7	4.93	49%	5.17	51%	72
PC16	8353	30.07	35.3	14.74	49%	15.34	51%	74
PC17	8378	54.69	22.9	27.75	51%	26.94	49%	70
PC18	8404	35.19	21.5	13.63	39%	21.56	61%	68
PC19	1-HILLSIDE	368.41	33.6	205.69	56%	162.72	44%	72
PC2	7731	35.68	19.5	22.08	62%	13.60	38%	68
PC20	15295	19.28	15.2	6.18	32%	13.10	68%	72
PC3	7725	76.28	16.2	63.17	83%	13.11	17%	61
PC4	8035	88.22	27.9	47.95	54%	40.27	46%	64
PC5	14412	18.42	15.6	6.30	34%	12.12	66%	62
PC6	10862	43.49	23.1	25.14	58%	18.34	42%	63
PC7	11081	32.90	14.8	24.55	75%	8.35	25%	59
PC8	11484	54.81	22.0	35.81	65%	19.00	35%	70
PC9	9763	56.85	28.6	30.12	53%	26.73	47%	74
SM1	4655	10.24	24.5	3.88	38%	6.36	62%	61
SM10	10257	36.03	31.6	20.20	56%	15.84	44%	61
SM11	2902	9.30	19.2	4.93	53%	4.37	47%	61
SM12	16427	125.33	29.8	75.88	61%	49.46	39%	52
SM13	16517	14.79	20.7	7.96	54%	6.83	46%	59
SM14	2466	1.82	5.0	1.06	58%	0.76	42%	61
SM15	2799	26.60	23.0	16.80	63%	9.80	37%	56
SM16	3320	52.68	25.2	24.67	47%	28.01	53%	58
SM17	4160	11.53	16.8	6.14	53%	5.38	47%	55
SM18	10300	37.95	23.3	17.60	46%	20.35	54%	60
SM19	4538	25.41	12.0	14.28	56%	11.13	44%	64
SM2	4696	12.47	16.3	4.85	39%	7.63	61%	61
SM20	10361	45.26	23.1	19.79	44%	25.47	56%	74
SM21	371	9.00	5.0	8.01	89%	1.00	11%	73
SM22	10362	19.63	19.5	11.36	58%	8.28	42%	64
SM23	4239	218.00	32.4	98.87	45%	119.13	55%	67
SM24	GRAYSTONE	61.25	27.9	30.73	50%	30.52	50%	75
SM25	4979	91.31	36.8	24.01	26%	67.30	74%	74
SM26	4466	42.25	22.1	15.20	36%	27.04	64%	74
SM27	15517	9.65	22.0	3.55	37%	6.10	63%	74
SM28	2-GANGLER	710.06	41.2	360.20	51%	349.86	49%	71
SM29	10001	10.63	13.9	4.29	40%	6.35	60%	73
SM3	16048	12.89	28.1	7.00	54%	5.89	46%	61
SM30	5431	65.94	28.2	24.47	37%	41.47	63%	73
SM31	5473	20.58	14.3	7.80	38%	12.78	62%	73
SM32	5491	41.65	21.5	17.81	43%	23.84	57%	70
SM33	5548	5.02	15.2	1.94	39%	3.09	61%	70
SM34	5554	25.38	15.9	9.62	38%	15.76	62%	71
SM35	9-BIBLE CHURCH	10.30	16.8	6.11	59%	4.19	41%	74
SM36	5698	5.85	11.3	2.43	42%	3.42	58%	73
SM4	16032	22.89	23.6	10.62	46%	12.27	54%	61
SM5	5368	15.04	21.3	4.79	32%	10.25	68%	61
SM6	2941	12.17	34.3	3.97	33%	8.20	67%	61
SM7	4	56.42	20.7	21.75	39%	34.67	61%	63
SM8	3	50.23	30.9	27.41	55%	22.82	45%	61
SM9	2990	15.23	18.6	8.14	53%	7.09	47%	61
	Totals/Averages	**4208.45**		**2130.50**	**44%**	**2077.96**	**56%**	**70**

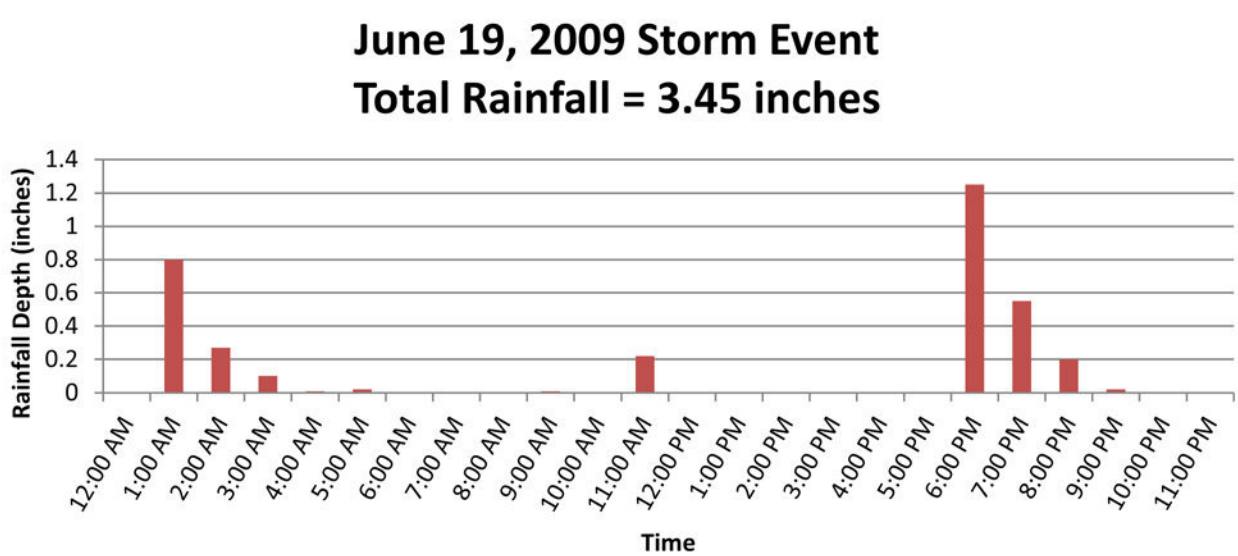
2.02 RAINFALL DATA

A. Storm Event Selection

The City provided data for two rainfall events, June 18 to 19, 2009 and May 20 to 23, 2004. Because of the reported wide variability in the June 18 to 19, 2009 storm event, this storm event was deleted from consideration for purposes of the stormwater system analysis. The June 19, 2009, storm event is shown in Figure 2.02-1.

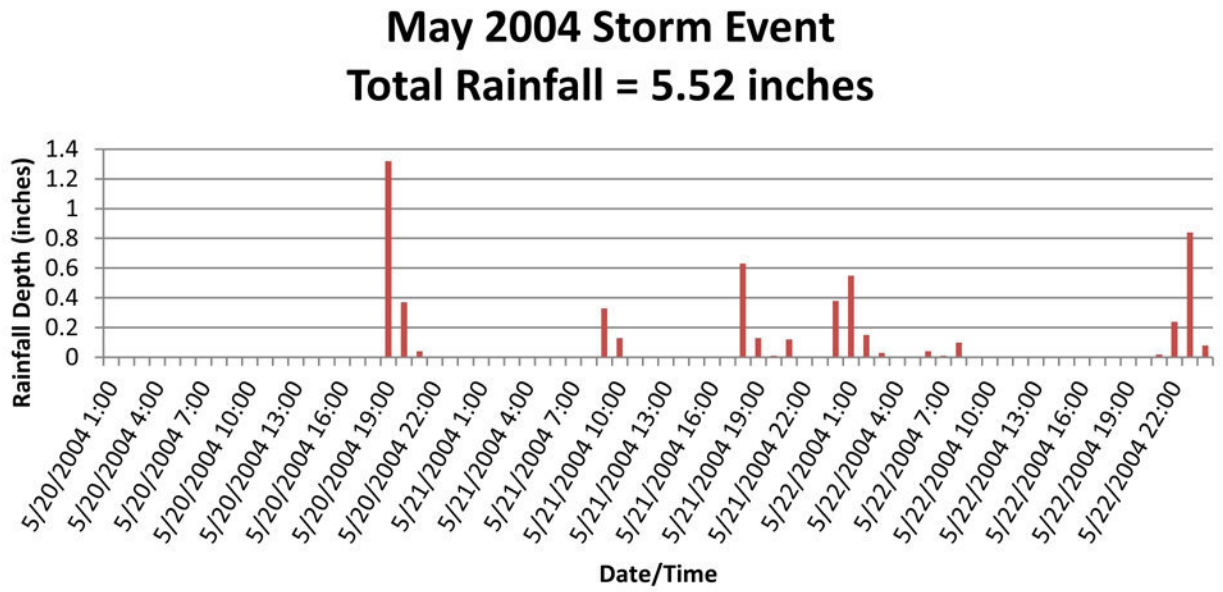
The May 20 to 23, 2004, storm event is shown in Figure 2.02-2 and corresponds to just less than a 54-hour 50-year storm event (cumulative 5.52 inches of rainfall) when comparing to SEWRPC rainfall amounts and durations and starting the rainfall event at 6 P.M. on May 20, 2004. The storm could also be considered a series of six distinct 2-year or less storm events of 2- to 4-hour duration when comparing to SEWRPC rainfall amounts and durations. The May 20 to 23, 2004, storm event is used in calibration of the storm sewer XPSWMM model.

The May 20 to 23, 2004, storm event was preceded in the month by 4.32 inches of rainfall (May 1 to 19, 2004) according to rainfall data from the Kenosha Regional Airport. This is about 1 inch more than the average rainfall for the month of May (3.38 inches). In addition, during the preceding one-week period (May 13 to 19, 2004), the study area received 2.04 inches of rainfall. This is approximately 60 percent of the average rainfall for the month of May (3.38 inches) occurring in one week prior to the May 20 to 23, 2004, rainfall event. This amount of rainfall is well above average and supports the use of Antecedent Moisture Condition III, which corresponds to a fully saturated ground condition, when running this storm for calibration of the model. Antecedent Moisture Condition II is considered an average ground moisture condition.



Source: Kenosha Water Utility (KWU) Rain Gauge

Figure 2.02-1 Rainfall Characteristics June 19, 2009 Storm Event



Source: National Climatic Data Center (NCDC)

Figure 2.02-2 Rainfall Characteristics of May 2004 Storm Event

B. Expected Precipitation Depths

According to the National Oceanic and Atmospheric Administration (NOAA), the City receives an average annual precipitation of 39.91 inches. Significant runoff-producing events typically occur during spring and summer thunderstorms as a result of stormwater runoff from short-duration, intense storm events. The depth and duration of rainfall in a watershed for a given storm event has a major impact on the amount of stormwater runoff produced.

Predicted rainfall depths for the City from SEWRPC Technical Report No. 40, *Rainfall Frequency in the Southeastern Wisconsin Region*, April 2000; for storm events of various frequencies are summarized in Table 2.02-1. These rainfall totals are used in conjunction with the SEWRPC 90th Percentile temporal distribution to estimate peak storm discharges.

Recurrence Interval and Depths (inches)						
Storm Duration	**2 Years[a]**	**5 Years[a]**	**10 Years[a]**	**25 Years**	**50 Years**	**100 Years**
5 Minutes	0.40	0.48	0.54	0.62	0.68	0.74
10 Minutes	0.64	0.76	0.85	0.98	1.08	1.19
15 Minutes	0.83	0.98	1.07	1.21	1.31	1.41
30 Minutes	1.07	1.29	1.45	1.68	1.85	2.02
60 Minutes	1.31	1.60	1.84	2.20	2.50	2.82
2 Hours	1.54	1.93	2.23	2.73	3.16	3.64
3 Hours	1.68	2.07	2.40	2.93	3.39	3.89
6 Hours	1.95	2.40	2.79	3.44	4.03	4.70
12 Hours	2.24	2.74	3.17	3.89	4.53	5.25
24 Hours	2.57	3.14	3.62	4.41	5.11	5.88
48 Hours	3.04	3.71	4.20	4.94	5.53	6.13
72 Hours	3.29	3.94	4.40	5.09	5.63	6.17
5 Days	3.77	4.42	4.84	5.43	5.86	6.26
10 Days	4.68	5.42	5.89	6.55	7.03	7.46

[a] Factors presented in United States Weather Bureau TP-40 were applied to the SEWRPC 2000 annual series depths with recurrence intervals of 2, 4, and 10 years, converting those depths to the partial duration series amounts set forth in this table. The annual series depths were adjusted as follows:

2-year: multiplied by 1.136; 5-year: multiplied by 1.042; and 10-year multiplied by 1.010

Source: Rodgers and Potter and SEWRPC

Table 2.02-1 Predicted Rainfall Depths from SEWRPC Technical Report No. 40

2.03 LAKE MICHIGAN WATER LEVEL

The City provided information showing the Lake Michigan average lake level is 577.42 (NGVD29 Vertical Datum) but historically ranges from 1 foot below that elevation to 2 feet above that elevation. According to the NOAA Web site, the elevation of Lake Michigan at Milwaukee on May 20, 2004, at 7 P.M. (start of the May 20 to 23, 2004, storm event) is 578.15 in the International Great Lake Datum 1985 (IGLD85). According to NOAA's Vertical Datums Transformational Tool 2.2.7, the conversion between IGLD85 and NGVD 29 is to add 0.78 feet to the IGLD85 elevation. Table 2.03-1 shows the Lake Michigan lake levels.

Historic Lake Level Conditions	Elevation IGLD 85 (ft)	Elevation NGVD 29 (ft)
Minimum Lake Level	--	576.42
Average Lake Level	--	577.42
Maximum Lake Level	--	579.42
May 20, 2004, 7 P.M.	578.15	578.93

Table 2.03-1 Lake Elevations–Lake Michigan (National Geodetic Vertical Datum of 1929–NGVD 1929)

2.04 RAIN GAUGES IN KENOSHA

There are three rain gauges in the City that provided data at the onset of this project as follows.

1. Kenosha Regional Airport (KENW)–Hourly data is available.
2. Kenosha Water Utility–5-minute data is available.
3. Kenosha Wastewater Treatment Plan-Daily rainfall totals are available.
4. Village of Pleasant Prairie-Sewer D-Daily rainfall totals are available.

2.05 EXISTING SURFACE FLOODING PROBLEMS

There are numerous locations of surface flooding within the Forest Park study area and in other parts of the City. In general, flooding in the City, and elsewhere, typically is as a result of one, or a combination, of several factors:

1. Lack of positive drainage: The flat surface topography in certain areas of the City discourages positive drainage of stormwater. In certain cases, the stormwater drainage is in a sawtooth pattern whereby storm sewer handles smaller storm flows but numerous depressional areas are created to accomplish surface drainage. As a result, stormwater accumulates in the depressional areas during larger storm events, causing flooding of adjacent land.

2. Insufficient storage capacity: The capacity of depressional areas at many locations is exceeded by the volume of stormwater runoff discharging to the depressional area. This causes water levels in the depressional area to back up onto adjacent streets or yards.

3. Insufficient outlet capacity: Constructed drainage structures have insufficient capacities to convey the peak discharge from intense storm events.

4. Insufficient inlet capacity: Drainage from streets and other surface areas may be restricted by the limited capacity of street or low point inlets.

5. High lake/river/creek levels: High lake and river levels reduce the outlet capacity of trunk storm sewer lines.

6. Drainage Basin Interconnections: Cross connections allow stormwater from another drainage basin or subbasin to enter into an adjacent basin, which may overwhelm drainage facilities in the adjacent basin. In this report, we refer to these as interconnections simply because stormwater can go two directions at these locations.

7. First Floor Elevation Built Too Low With Insufficient Overflow Route: Original buildings in older areas of communities frequently were constructed with few regulations or considerations regarding storm sewer and overland flow routes. This results in homes being built in what could be considered urban environment floodplain.

SECTION 3
CONDITION ANALYSIS

3.01 STORM SEWER CONDITION ANALYSIS

H.R. Stewart was hired by the City to televise the condition of the storm sewer mainlines, inlet leads, inlets, and manholes within the limits of the detailed study area. The study area consists of an area bounded by 60th Street to the north, 67th Street to the south, 54th Avenue to the west, and Pershing Boulevard to the east. Approximately 20,000 linear feet of storm sewer televising was completed. The storm sewer on 50th Avenue between 61st Street and 63rd Street was not televised since it was reconstructed in fall 2009.

A. Televising Coordination

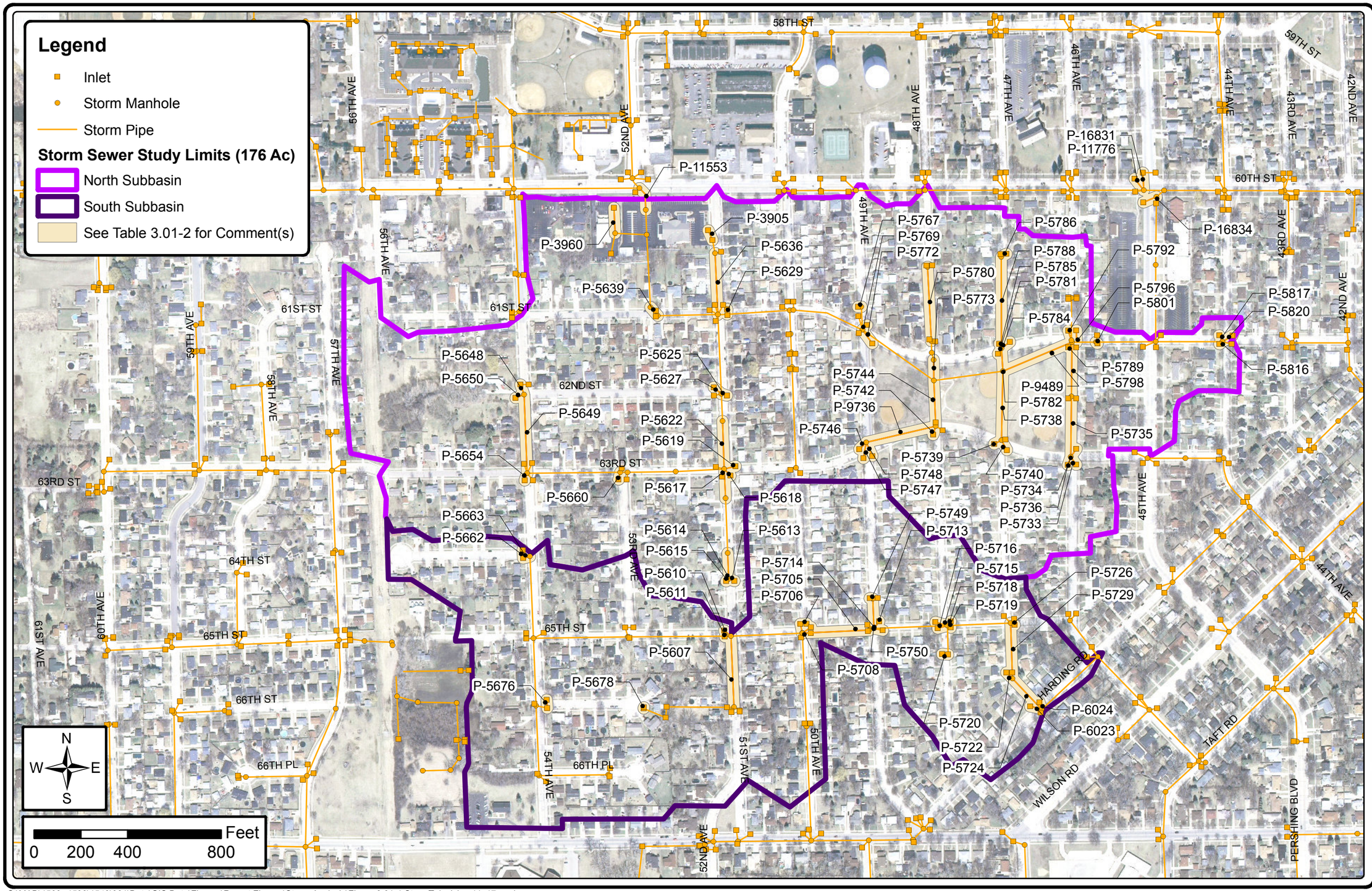
The executed televising contract and purchase order number was sent to H.R. Stewart on Friday, October 9, 2009. An initial kickoff meeting was held via phone conference with Jim Stewart (H.R. Stewart), Jen Jefferson (Strand), Jon Lindert (Strand), and Shelly Billingsley (City) on Monday, October 19, 2009. The initial kickoff meeting included discussion of the project scope, payment procedures, televising maps to be prepared by Strand, and televising schedule.

Because of other project obligations and weather conflicts, H.R. Stewart was not able to begin televising work until late November 2009. Another meeting was held on Wednesday, November 18, 2009, at the City of Kenosha Municipal Building with Rod Emery (H.R. Stewart), Jen Jefferson (Strand), Shelly Billingsley (City), Tara Zerzanek (City), and Jack Barber (City). This meeting addressed more specific topics including the condition rating parameters for the inlets and manholes, placement of defect pipes/structures on a Web site, and coordination required with the City. Condition rating parameters were established with extensive input from the City as it is important for the rating parameters to be understood by the end users. Tara Zerzanek and Jack Barber work primarily in the field and are working with Rod Emery to address storm lines that require heavy cleaning, dumping of debris accumulated from light cleaning, and storage of the vacuum truck at the City yard. Throughout the televising process, photos of defected areas were posted on a Web site accessible by Strand and the City.

Televising of mainline pipes and inlet leads was complete on approximately January 27, 2010. Complete computer-generated reports and DVDs arrived at Strand and the City on March 3, 2010. H.R. Stewart has provided deliverables throughout mid-March 2010. As part of the condition rating analysis, H.R. Stewart provided a visual condition rating documented in the section below.

B. Televising Results

The computer-generated inspection reports provided by H.R. Stewart were summarized and evaluated for mainline pipes and inlet leads. Pipes with comments noted on the televising inspection reports are shown on Figure 3.01-1. The televising comment legend can be found in Table 3.01-1. Specific comments corresponding to pipe links shown on Figure 3.01-1 can be found in Table 3.01-2. Appropriate adjustments were made to the loss coefficients and Manning's nvalues in the XPSWMM™ storm sewer model to reflect defects noted in Table 3.01-2.



STORM SEWER TELEVISING RESULTS
(2005 AERIALS)
FOREST PARK AREA STORM AND SANITARY MANAGEMENT PLAN
CITY OF KENOSHA
KENOSHA COUNTY, WISCONSIN

STRAND ASSOCIATES, INC.® ENGINEERS

FIGURE 3.01-1
1540.001

S:\MAD\1500--1599\1540\001\Data\GIS Data\Figures\Report Figures\Storm Analysis\Figure 3.01-1 StormTelevising 11x17.mxd

Abbreviation	Description
BJ	Broken Joint
B	Broken Pipe
C	Crack
CC	Crack, Circumferential
CL	Crack, Longitudinal
CM	Cracks, Multiple
CN	Connection
D	Deformed Drain/Sewer
DEG	Attached Deposits
DER	Settled Deposits (Coarse)
DES	Settled Deposits (Fine)
FC	Fracture, Circumferential
FL	Fracture, Longitudinal
H	Hole in Drain/Sewer
I	Infiltration
JD	Joint Displaced
JD(L)	Joint Displaced (Large)
JD(M)	Joint Displaced (Medium)
LD	Line of Sewer Deviates Down
LL	Line of Sewer Deviates Left
MC	Material Change
OB	Other Obstacles
OPH	Open Pick Hole
PC	Pipe Collapsed
PL	Punched in Lateral
R	Roots
SA	Survey Abandoned
SC	Pipe Size Change
SP	Separated Pipe

Table 3.01-1 Televising Comment Legend

The televising videos were reviewed at the locations where CN (Connection) was noted on the inspection reports. It does not appear any of the connections are from the sanitary sewer. Clear water can be seen discharging through some of the connections, and others appear to be inlet leads tied into the mainline with no manhole structure.

A gas line appears to be going through the storm sewer line (P-5788) located on 47th Avenue north of 61st Street (refer to Figure 3.01-2 on the following page). This defect is noted as an H (Hole in Drain/Sewer) on the inspection report.

H.R. Stewart also generated a CD that contains defect photos. This information has been mailed to the Kenosha Stormwater Utility (SWU).

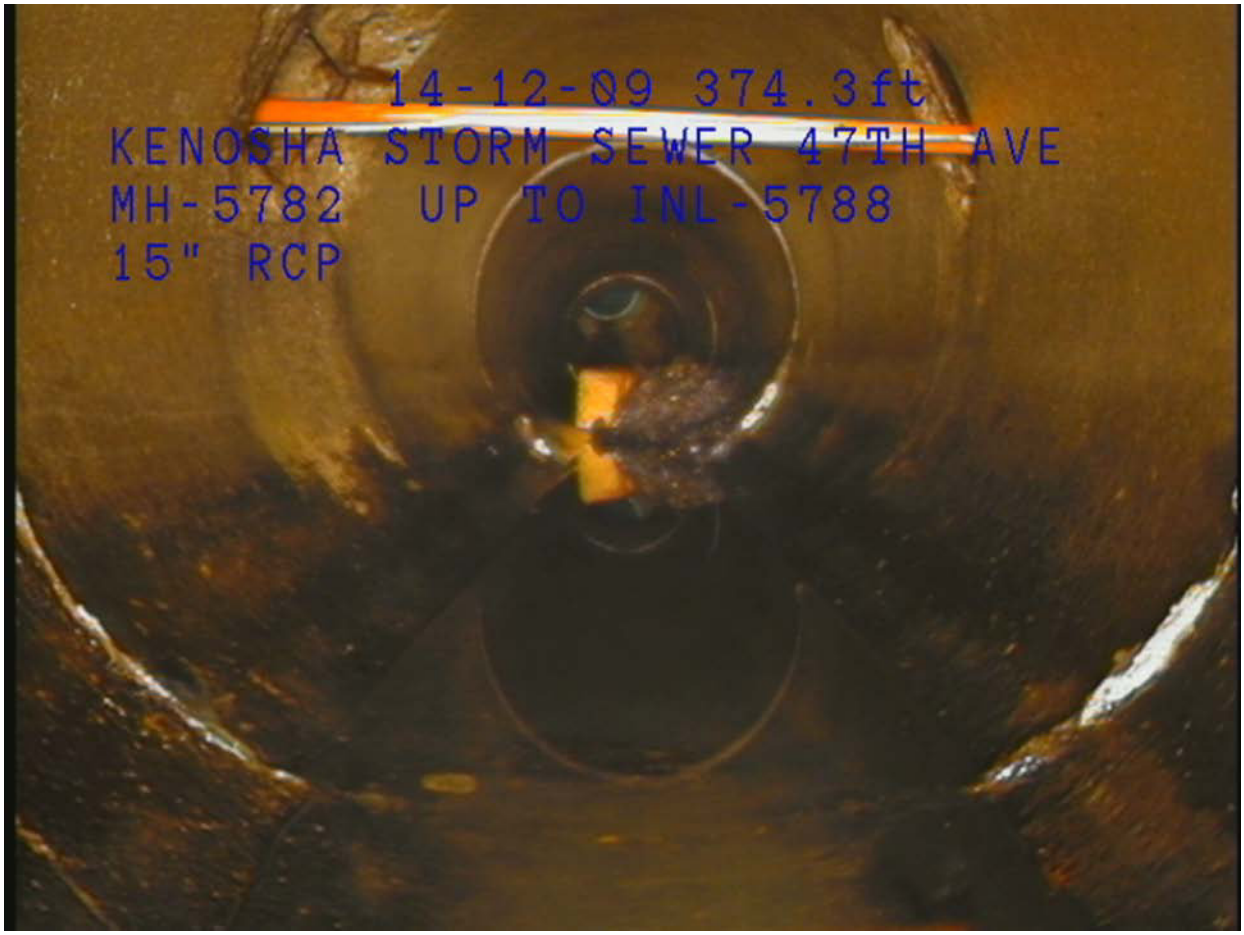


Figure 3.01-2 Storm Sewer Line (P-5788)

TABLE 3.01-2

SUMMARY OF STORM SEWER TELEVISING

Pipe ID	Pipe Type	Upstream Structure	Downstream Structure	Location		Televising Comment
				Street	Intersection	
P-3905	Inlet	3905	5635	51st Ave.	(N) 61st St.	CL, CM, LL, SA
P-3960	Inlet	3960	15944	-	(W) 51st Ave./60th St.	CN
P-5607	Main	5607	5612	51st Ave.	(S) 65th St.	MC
P-5610	Inlet	5610	5612	-	51st Ave./65th St.	MC
P-5611	Inlet	5611	5612	-	51st Ave./65th St.	B, SA
P-5613	Inlet	5613	5614	51st Ave.	(S) 63rd St.	B-(2)
P-5614	Main	5614	5616	51st Ave.	Between 63rd St./65th St.	FL
P-5615	Inlet	5615	5614	51st Ave.	(S) 63rd St.	B, SA
P-5617	Main	5617	5622	51st Ave.	(S) 63rd St.	CL
P-5618	Inlet	5618	5622	-	51st Ave./63rd St.	SA
P-5619	Inlet	5619	5622	-	51st Ave./63rd St.	OB
P-5622	Main	5622	5623	51st Ave.	(N) 63rd St.	D
P-5625	Inlet	5625	5624	-	51st Ave./62nd St.	DES
P-5627	Inlet	5627	5624	-	51st Ave./62nd St.	DES
P-5629	Inlet	5629	Main	-	51st Ave./61st St.	CN, LD, MC-(2)
P-5636	Main	5636	5634	51st Ave.	(N) 61st St.	B, CC
P-5639	Main	5639	5641	60th St.	(W) 51st Ave.	CN
P-5648	Inlet	5648	5649	-	54th Ave./62nd St.	SA
P-5649	Main	5649	5653	54th Ave.	62nd St./63rd St.	SA
P-5650	Inlet	5650	5649	-	54th Ave./62nd St.	OB
P-5654	Inlet	5654	5653	-	54th Ave./63rd St.	DER, SA
P-5660	Inlet	5660	5661	-	53rd Ave./63rd St.	D
P-5662	Inlet	5662	5663	-	54th Ave./64th St.	BJ
P-5663	Inlet	5663	5664	-	54th Ave./64th St.	B, BJ
P-5676	Inlet	5676	5675	-	54th Ave./65th St.	BJ
P-5678	Inlet	5678	5677	-	65th Place	OB
P-5705	Main	5705	5711	65th St.	50th Ave./49th Ave.	OB
P-5706	Inlet	5706	5705	-	50th Ave./65th St.	JD(L)-(2)
P-5708	Inlet	5708	5705	-	50th Ave./65th St.	JD(M)
P-5713	Inlet	5713	9731	-	49th Ave./65th St.	MC-(2), SA, SDR
P-5714	Inlet	5714	9731	-	49th Ave./65th St.	B
P-5715	Inlet	5715	5717	-	48th Ave./65th St.	B, JD, SA
P-5716	Inlet	5716	5717	-	48th Ave./65th St.	MC-(2)
P-5718	Inlet	5718	5717	-	48th Ave./65th St.	CL, JD, MC, SA
P-5719	Inlet	5719	5717	-	48th Ave./65th St.	B
P-5720	Inlet	5720	5721	48th Ave.	(S) 65th St.	OB, SA
P-5722	Inlet	5722	5724	47th Ave.	Between 65th St./Harding Rd.	JD-(2)
P-5724	Main	5724	6026	47th Ave.	(N) Harding Rd.	CM, CN-(2)
P-5726	Inlet	5726	5729	-	47th Ave./65th St.	JD(L), SA
P-5729	Main	5729	5724	47th Ave.	(S) 65th St.	CN
P-5733	Inlet	5733	5735	-	46th Ave./63rd St.	MC
P-5734	Inlet	5734	5735	-	46th Ave./63rd St.	MC

Pipe ID	Pipe Type	Upstream Structure	Downstream Structure	Location		Televising Comment
				Street	Intersection	
P-5735	Main	5735	5798	46th Ave.	(N) 63rd St.	CL-(3)
P-5736	Inlet	5736	5735	-	46th Ave./63rd St.	B, MC
P-5738	Main	5738	9489	47th Ave.	Forest Park	SA
P-5739	Inlet	5739	5738	-	47th Ave./63rd St.	B, JD(M)
P-5742	Inlet	5742	5744	-	48th Ave./63rd St.	DER
P-5744	Main	5744	9735	48th Ave.	Forest Park	OB, SA
P-5746	Inlet	5746	9736	-	49th Ave./63rd St.	OB
P-5747	Inlet	5747	9736	-	49th Ave./63rd St.	R
P-5748	Inlet	5748	9736	-	49th Ave./63rd St.	B-(2), JD(L), MC
P-5749	Inlet	5749	5750	49th Ave.	(N) 65th St.	SA, SP
P-5750	Main	5750	9731	49th Ave.	(N) 65th St.	DEG
P-5767	Inlet	5767	5768	49th Ave.	(N) 61st St.	B-(2)
P-5769	Inlet	5769	5770	-	49th Ave./61st St.	B-(2), MC-(2)
P-5772	Inlet	5772	5770	-	50th Ave./61st St.	JD(M)
P-5773	Main	5773	9735	48th Ave.	Forest Park	B, FL-(2)
P-5780	Main	5780	5776	48th Ave.	(N) 61st St.	FC
P-5781	Inlet	5781	5782	-	47th Ave./61st St.	H
P-5782	Main	5782	9489	47th Ave.	47th Ave./61st St.	B-(2), CL-(2)
P-5784	Inlet	5784	5782	-	47th Ave./61st St.	B, JD(M), MC-(2)
P-5785	Inlet	5785	5782	-	47th Ave./61st St.	B-(3)
P-5786	Inlet	5786	5788	47th Ave.	(N) 61st St.	D, H
P-5788	Main	5788	5782	47th Ave.	(N) 61st St.	DER, H
P-5789	Inlet	5789	Main	-	46th Ave./61st St.	CN
P-5792	Inlet	5792	17547	-	46th Ave./61st St.	MC
P-5796	Inlet	5796	Main	-	46th Ave./61st St.	B, MC
P-5798	Main	5798	5791	46th Ave.	(S) 61st St.	CL, MC
P-5801	Inlet	5801	5800	61st St.	(E) 46th Ave.	DER
P-5816	Inlet	5816	5818	-	44th Ave./61st St.	B-(2)
P-5817	Inlet	5817	5818	-	44th Ave./61st St.	R-(2)
P-5820	Inlet	5820	5818	-	44th Ave./61st St.	B
P-5740	Inlet	5740	5738	-	47th Ave./63rd St.	B, JD(L), MC
P-6023	Inlet	6023	6026	-	47th Ave./Harding Rd.	OB
P-6024	Inlet	6024	6026	-	47th Ave./Harding Rd.	JD, MC
P-9489	Main	9489	5791	46th Ave.	Forest Park	CN
P-9736	Main	9736	5744	63rd St.	48th Ave./49th Ave.	B-(2), JD-(2), MC, SA
P-11553	Main	11553	8162	52nd Ave.	(S) 61st St.	LL
P-11766	Inlet	11766	10231	-	45th Ave./60th St.	SA
P-16381	Inlet	16381	10231	-	45th Ave./60th St.	OB
P-16834	Inlet	16834	10233	-	45th Ave./60th St.	SA

C. Condition Ratings

In addition to televising, H.R. Stewart also provided a visual condition rating based on condition rating parameters established by the City (Table 3.01-3) for the Forest Park study area. Manhole ratings were also supplemented by field survey structure reports completed by Strand.

Rating Value	Description	Defect Example
1	Good Condition	No additional work to be completed.
2	Minor Defects	Tuck pointing, rings and casting.
3	Severe Defect	Bottom cracked or wall cracked.
4	Total Failure	Combination of above examples.

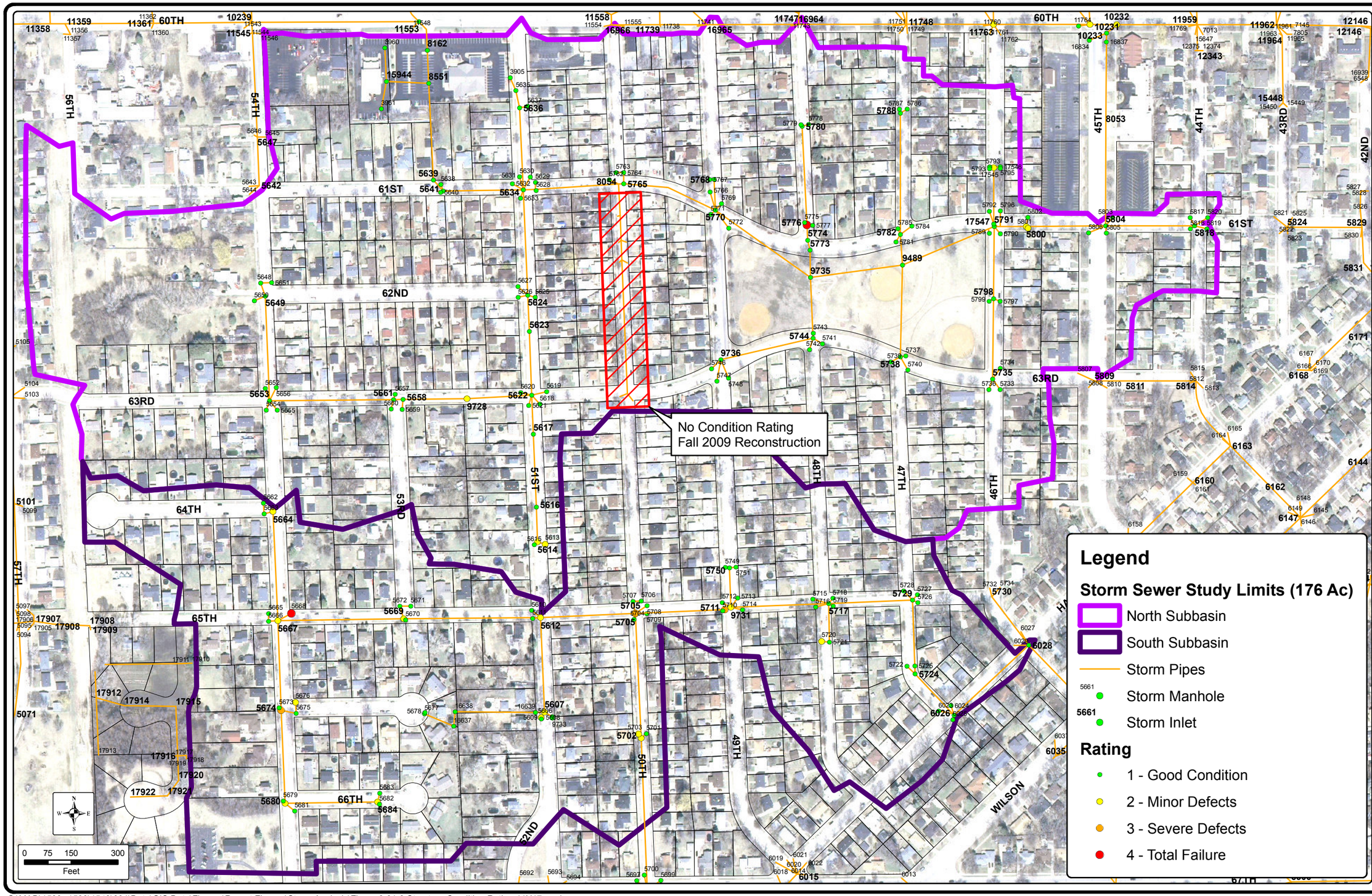
Table 3.01-3 Condition Rating Parameters

There are 205 manholes and inlets in the study area. The compiled data shows that 178 structures (87 percent) are in good condition and twenty-five (12 percent) have either minor or severe defects. Only two structures (1 percent) are noted as total failures (MH 5776 and INL 5668). An overall summary of manhole and inlet conditions ratings by type can be found in Table 3.01-4. Figure 3.01-3 shows the rating of each structure and corresponds to the ratings identified in Table 3.01-5.

	1 - Good Condition	2 - Minor Defects	3 - Severe Defects	4 - Total Failure	Total	Percentage of Total
Manholes	47	16	3	1	67	33%
Inlets	131	6	0	1	138	67%
Total	178	22	3	2	205	
Percentage of Total	87%	11%	1%	1%		

Table 3.01-4 Summary of Structure Condition Ratings

It is recommended the City use this information to generate a priority list of problem areas and develop a plan to rectify. Some areas have the potential to be completed within the alternatives suggested within this report.



STRUCTURE CONDITION RATING

FOREST PARK AREA STORM AND SANITARY MANAGEMENT PLAN
CITY OF KENOSHA
KENOSHA COUNTY, WISCONSIN

STRAND ASSOCIATES, INC.® ENGINEERS

FIGURE 3.01-3
1540.001

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TABLE 3.01-5

STRUCTURE CONDITION RATING

Structure ID	Structure Type	Condition Rating
3905	Inlet	1
3960	Inlet	1
3961	Inlet	1
5606	Inlet	1
5607	Manhole	2
5608	Inlet	2
5609	Inlet	1
5610	Inlet	1
5611	Inlet	1
5612	Manhole	2
5613	Inlet	2
5614	Manhole	2
5615	Inlet	1
5616	Manhole	1
5617	Manhole	1
5618	Inlet	1
5619	Inlet	1
5620	Inlet	1
5621	Inlet	1
5622	Manhole	1
5623	Manhole	1
5624	Manhole	1
5625	Inlet	1
5626	Inlet	1
5627	Inlet	1
5628	Inlet	1
5629	Inlet	1
5630	Inlet	1
5631	Inlet	1
5632	Inlet	1
5633	Inlet	1
5634	Manhole	1
5635	Inlet	1
5636	Manhole	1
5637	Inlet	1
5638	Inlet	1
5639	Manhole	1
5640	Inlet	1
5641	Manhole	1
5648	Inlet	1
5649	Manhole	1
5650	Inlet	1

Structure ID	Structure Type	Condition Rating
5651	Inlet	1
5652	Inlet	1
5653	Manhole	1
5654	Inlet	1
5655	Inlet	1
5656	Inlet	1
5657	Inlet	1
5658	Manhole	1
5659	Inlet	1
5660	Inlet	1
5661	Manhole	1
5662	Inlet	1
5663	Inlet	1
5664	Manhole	2
5665	Inlet	1
5666	Inlet	1
5667	Manhole	2
5668	Inlet	4
5669	Manhole	2
5670	Inlet	1
5671	Inlet	1
5672	Inlet	1
5673	Inlet	1
5674	Manhole	3
5675	Inlet	1
5676	Inlet	2
5677	Inlet	1
5678	Inlet	1
5679	Inlet	1
5680	Manhole	2
5681	Inlet	1
5682	Inlet	1
5683	Inlet	1
5684	Manhole	2
5697	Inlet	1
5698	Manhole	1
5699	Inlet	1
5700	Inlet	1
5701	Inlet	1
5702	Manhole	2
5703	Inlet	2
5704	Inlet	1

Structure ID	Structure Type	Condition Rating
5705	Manhole	3
5706	Inlet	1
5707	Inlet	1
5708	Inlet	1
5709	Inlet	1
5710	Inlet	1
5711	Manhole	3
5712	Inlet	1
5713	Inlet	1
5714	Inlet	1
5715	Inlet	1
5716	Inlet	1
5717	Manhole	1
5718	Inlet	1
5719	Inlet	1
5720	Inlet	2
5721	Inlet	1
5722	Inlet	1
5724	Manhole	1
5725	Inlet	1
5726	Inlet	1
5727	Inlet	1
5728	Inlet	1
5729	Manhole	1
5733	Inlet	1
5734	Inlet	1
5735	Manhole	1
5736	Inlet	1
5737	Inlet	1
5738	Manhole	1
5739	Inlet	1
5740	Inlet	1
5741	Inlet	1
5742	Inlet	1
5743	Inlet	1
5744	Manhole	1
5746	Inlet	1
5747	Inlet	1
5748	Inlet	1
5749	Inlet	1
5750	Manhole	1
5751	Inlet	1

Structure ID	Structure Type	Condition Rating
5762	Inlet	1
5763	Inlet	1
5764	Inlet	1
5765	Manhole	1
5766	Inlet	1
5767	Inlet	1
5768	Manhole	1
5769	Inlet	1
5770	Manhole	1
5771	Inlet	1
5772	Inlet	1
5773	Manhole	1
5774	Manhole	1
5775	Inlet	1
5776	Manhole	4
5777	Inlet	1
5778	Inlet	1
5779	Inlet	1
5780	Manhole	1
5781	Inlet	1
5782	Manhole	1
5784	Inlet	1
5785	Inlet	1
5786	Inlet	1
5787	Inlet	1
5788	Manhole	1
5789	Inlet	1

Structure ID	Structure Type	Condition Rating
5790	Inlet	1
5791	Manhole	1
5792	Inlet	1
5793	Inlet	1
5794	Manhole	2
5795	Inlet	1
5796	Inlet	1
5797	Inlet	1
5798	Manhole	1
5799	Inlet	1
5800	Manhole	2
5801	Inlet	2
5802	Inlet	1
5803	Inlet	1
5804	Manhole	1
5805	Inlet	1
5806	Inlet	1
5816	Inlet	1
5817	Inlet	1
5818	Manhole	1
5819	Inlet	1
5820	Inlet	1
6023	Inlet	1
6024	Inlet	1
6025	Inlet	1
6026	Manhole	1
6028	Manhole	1

Structure ID	Structure Type	Condition Rating
8162	Manhole	1
8551	Manhole	1
9489	Manhole	1
9728	Manhole	2
9731	Manhole	2
9733	Inlet	1
9735	Manhole	1
9736	Manhole	1
10231	Manhole	2
10232	Manhole	2
10233	Manhole	1
11553	Manhole	1
11763	Manhole	2
11764	Inlet	1
11766	Inlet	1
15944	Manhole	1
16637	Manhole	1
16638	Manhole	1
16639	Manhole	1
16831	Inlet	1
16834	Inlet	1
16837	Inlet	1
17545	Inlet	1
17546	Inlet	1
17547	Manhole	1

3.02 SANITARY SEWER CONDITION ANALYSIS

During the past two years, KWU staff completed manhole inspections and smoke testing on sanitary sewers in the entire study area. Information gathered during the 2008 to 2009 field activities has been compiled in the City's GIS database. This information has also been compiled in an Excel spreadsheet.

City staff prepared an overall summary of the 310 manholes included in the 2009 manhole inspections and smoke testing. All manholes are located in the Forest Park tributary basin. A copy of the City's summary is included as Table 3.02-1.

Open pick holes were found on 135 manholes. This represents 44 percent of the manholes included in the 2009 inspection program. Open pick holes can represent a significant source of inflow. For example, a single 1-inch open pick hole can contribute 25 gallons per minute (gpm) of inflow with 2 inches of ponded water over the top.

Some source of I/I on 71 manholes. This represents 23 percent of the manholes included in the 2009 inspection program.

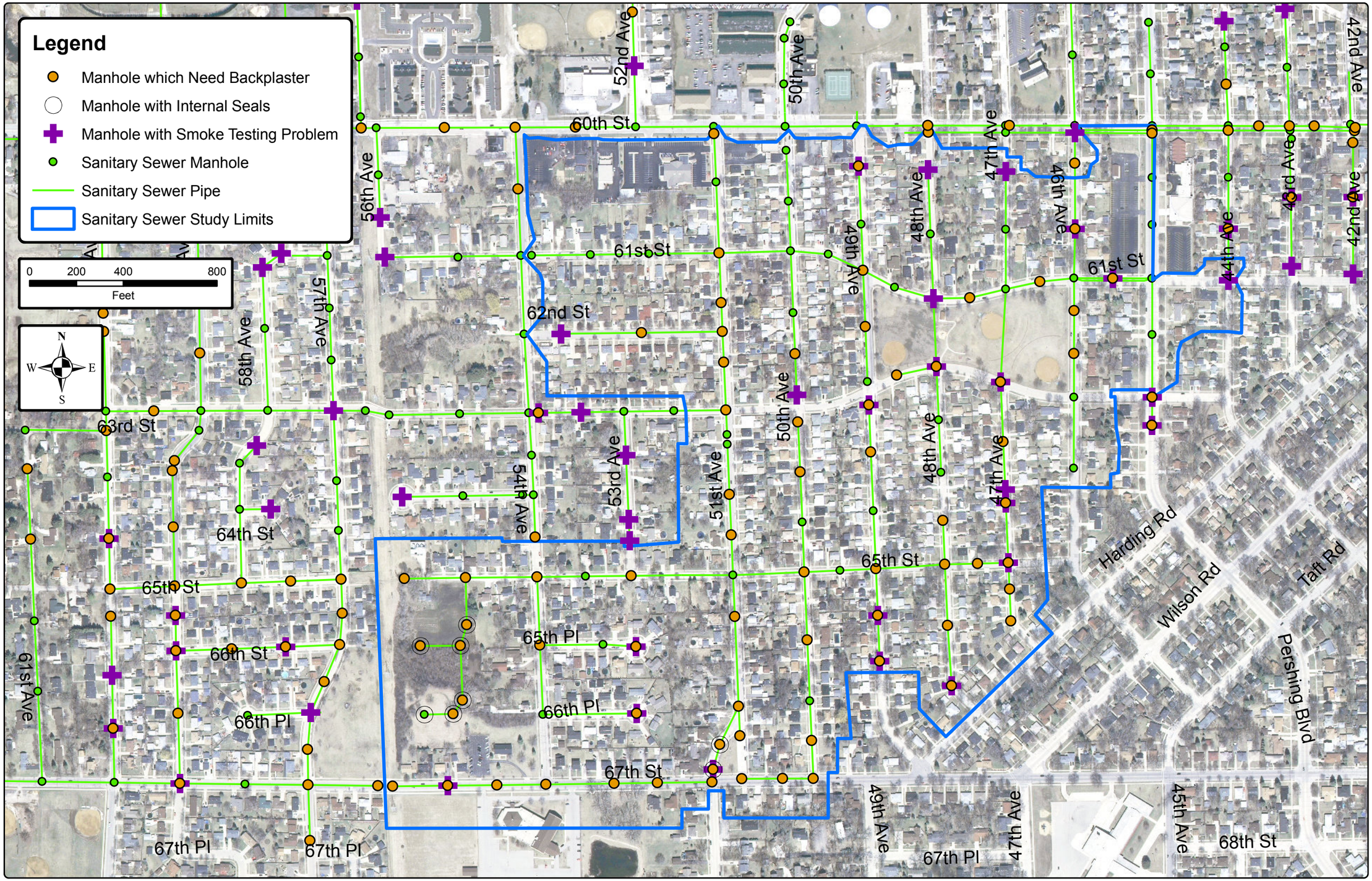
Of the 310 manholes inspected, 110 manholes were assessed as having either a "high" or "medium" "Problem Assessment" (City terminology), or overall condition assessment. This represents 37 percent of the manholes in the 2009 evaluation area.

Figures 3.02-1, 3.02-2, and 3.02-3 document the results of the manhole inspections and smoke testing.

Manholes can contribute large quantities of I/I to the collection system. Fortunately, they also represent a relatively easily accessed component of the collection system, making rehabilitation more cost-effective than other components of the system such as pipes.

In 2010, KWU staff televised portions of the sewers in the study area. Figure 3.02-4 shows the extents of the sewer televising program in the study area and highlights segments of sewers where defects were noted. Table 3.02-2 presents a summary of the defects noted.

Sections 5, 6, and 8 present additional information pertaining to defects noted in the sanitary sewer system and how these defects will be addressed as part of the alternative analysis.



SMOKE TESTING RESULTS

FOREST PARK AREA STORM AND SANITARY MANAGEMENT PLAN
CITY OF KENOSHA
KENOSHA COUNTY, WISCONSIN

STRAND ASSOCIATES, INC.® ENGINEERS

FIGURE 3.02-1
1540.001

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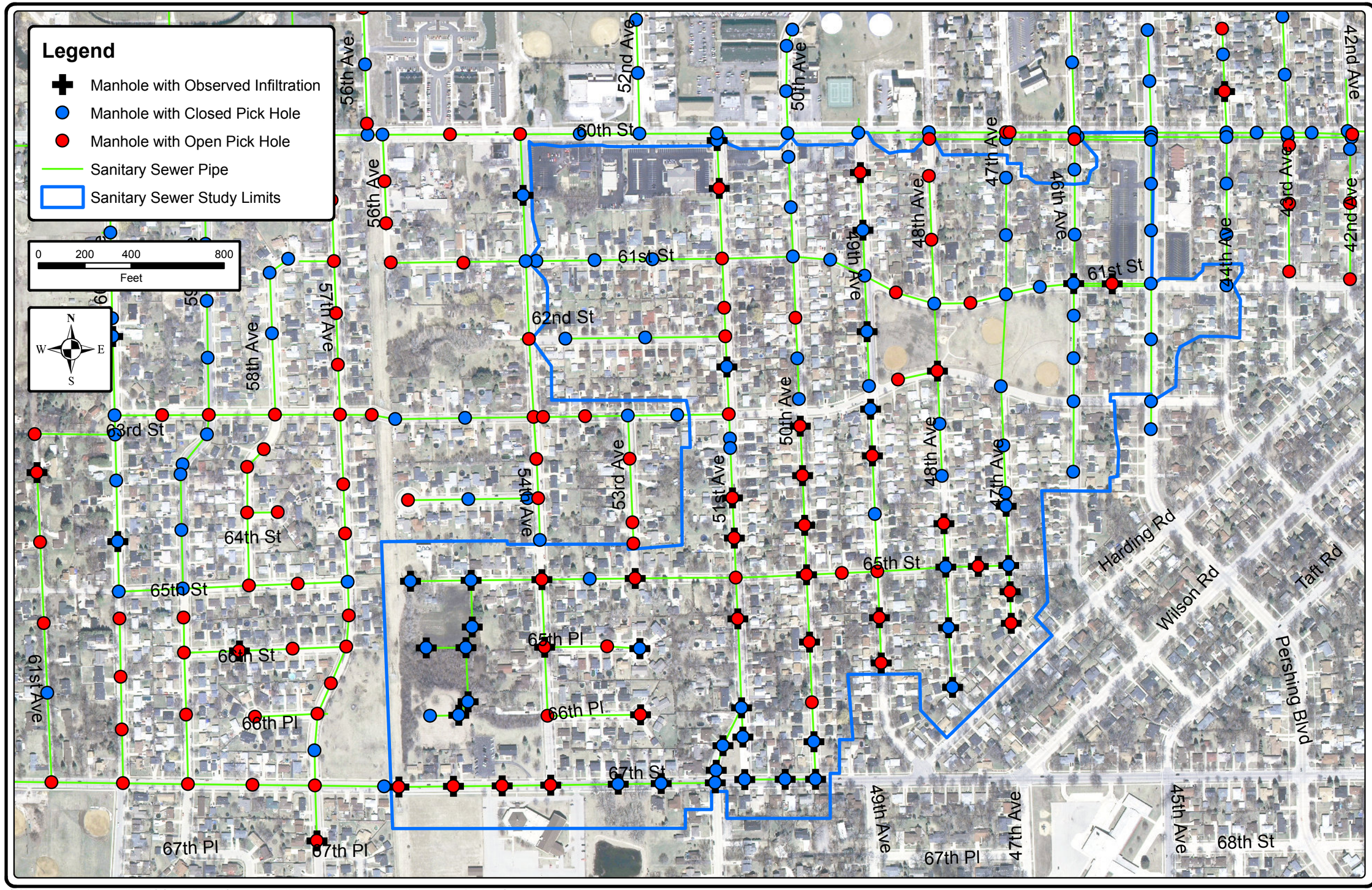

MANHOLE DEFECTS

FOREST PARK AREA STORM AND SANITARY MANAGEMENT PLAN
CITY OF KENOSHA
KENOSHA COUNTY, WISCONSIN

STRAND ASSOCIATES, INC.® ENGINEERS

FIGURE 3.02-2
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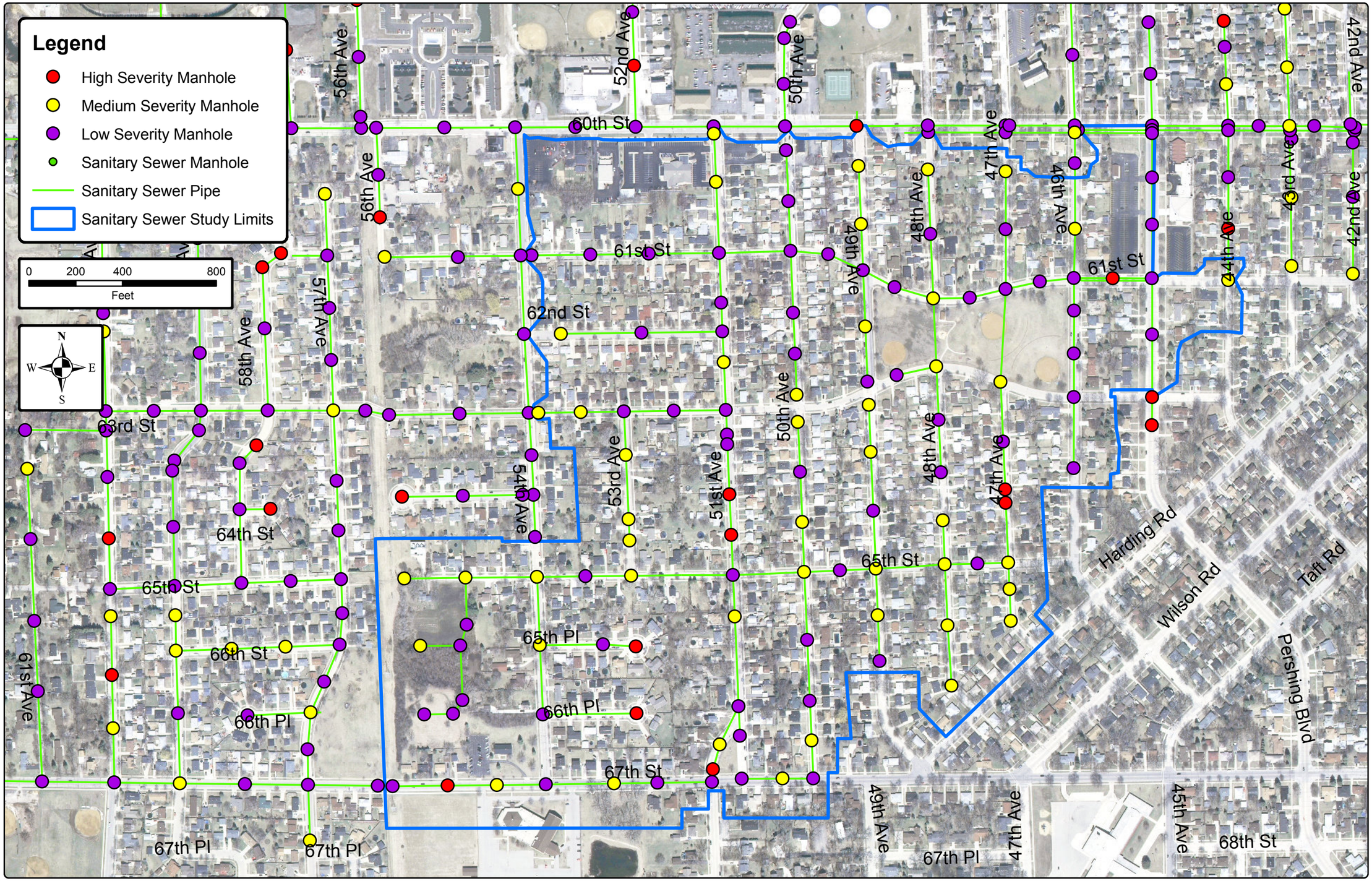

MANHOLE SEVERITY RATING

FOREST PARK AREA STORM AND SANITARY MANAGEMENT PLAN
CITY OF KENOSHA
KENOSHA COUNTY, WISCONSIN

STRAND ASSOCIATES, INC.® ENGINEERS

FIGURE 3.02-3
1540.001

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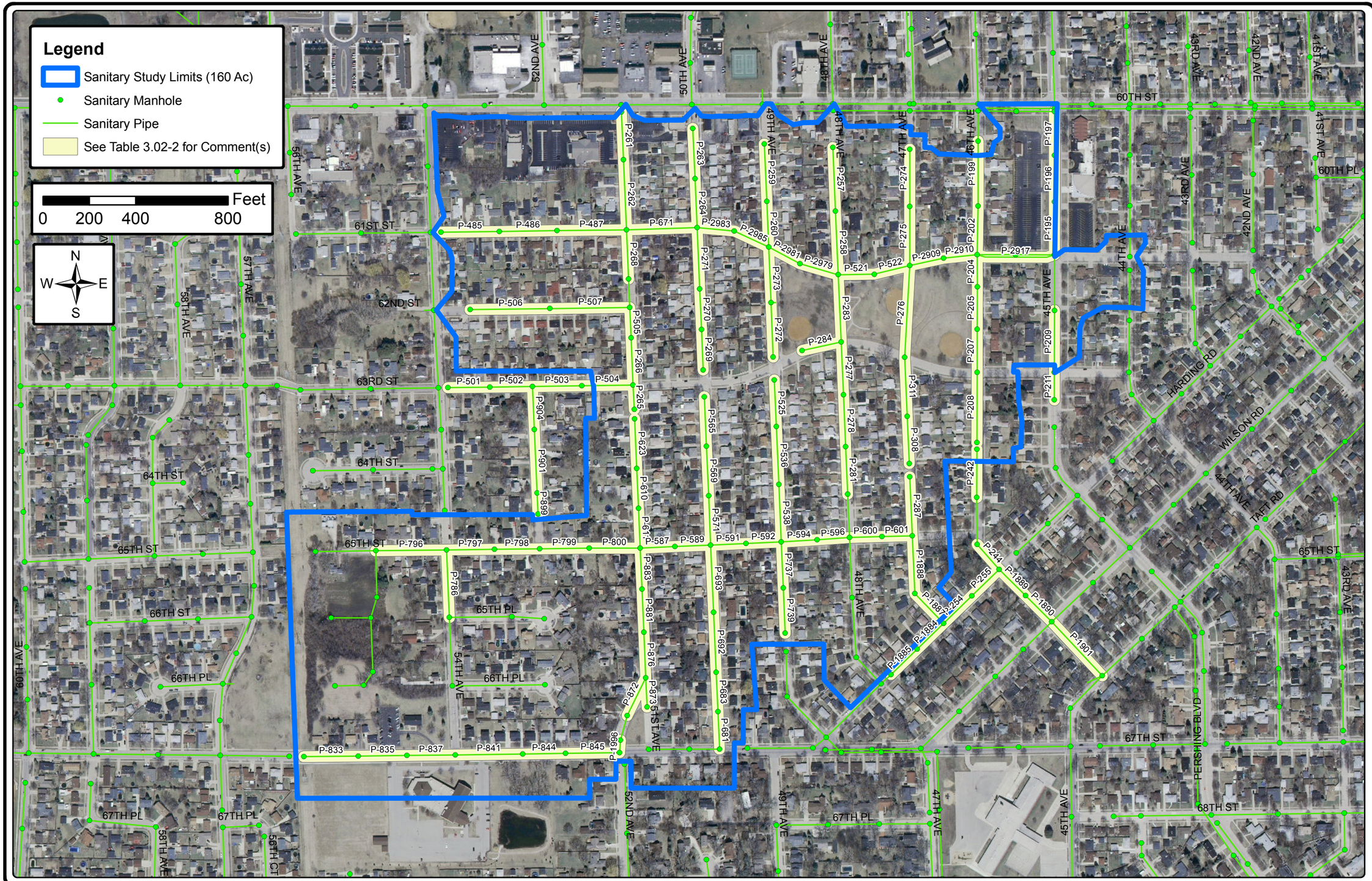

SANITARY SEWER TELEVISING RESULTS
(2005 AERIALS)
FOREST PARK AREA STORM AND SANITARY MANAGEMENT PLAN
CITY OF KENOSHA
KENOSHA COUNTY, WISCONSIN

STRAND ASSOCIATES, INC.® ENGINEERS

FIGURE 3.02-4
1540.001

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TABLE 3.02-1

MANHOLE INSPECTION AND SMOKE TESTING RESULTS

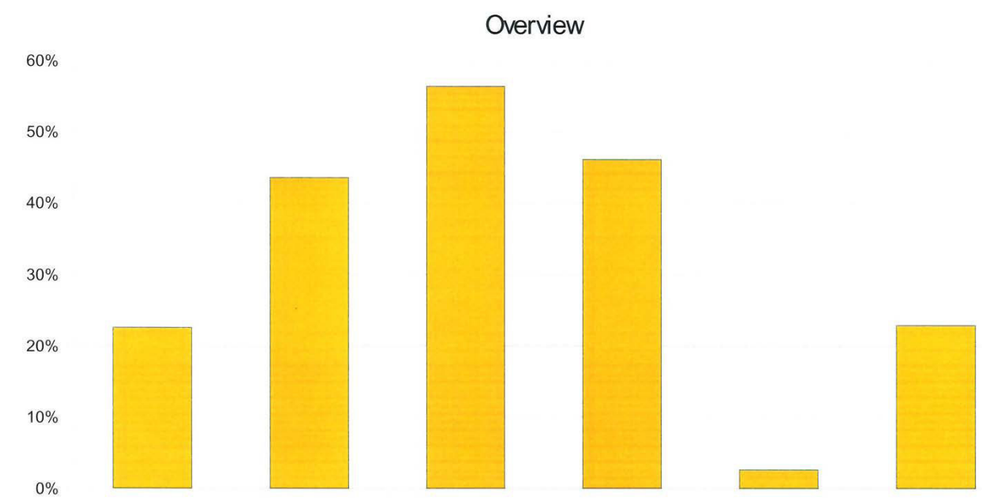
Forest Park SSES-Primary Basin and Outlying Area

	Number:	Percent:
Manholes Inspected & Smoke Tested	**310**	
Manholes with Smoke-related Problems	70	23%
Manholes with Open Pick Holes	135	44%
Manholes with Closed Pick Holes	175	56%
Manholes Needing Backplaster	143	46%
Manholes with Seals	8	3%
Manholes with One or More Points of Infiltration	71	23%
Manhole Building Material	Number:	Percent:
Precast	219	71%
Block	88	28%
Poured	3	1%
Brick	0	0%
Pavement Types	Number:	Percent:
Concrete	193	62%
Asphalt	99	32%
Asphalt Over	15	5%
Turf	5	2%
Gravel/Dirt	1	0.3%
Pavement Quality	Number:	Percent:
Small Cracks	119	38%
Tight	108	35%
Cracks/Gaps	75	24%
Deteriorated	9	3%

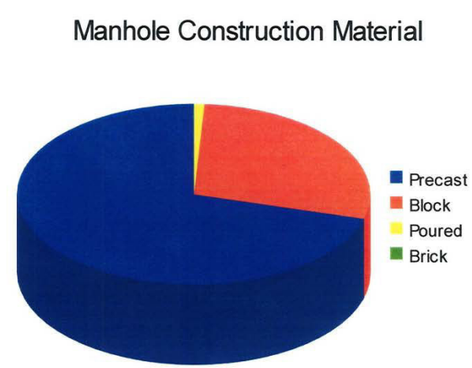
Forest Park SSES-Primary Basin and Outlying Area

Breakdown of Infiltration	Number:	% of Total
Wall Infiltration	50	16%
Ring Infiltration	37	12%
Cone Infiltration	19	6%
Bench Infiltration	10	3%
Problem Assessment	Number:	Percent:
Low Severity	200	65%
Medium Severity	82	26%
High Severity	28	9%
Pipes in Basin by Diameter	Length in Feet	
6" Diameter	246.9	
8" Diameter	48546.2	
10" Diameter	13094.7	
12" Diameter	1639.9	
15" Diameter	5077.4	
18" Diameter	6017.3	
21" Diameter	518.6	
Total Length of Pipes in Basin	**75141**	
Pipe Outside of Smoke Testing	4434.6	
Actual Length of Pipe Smoke Tested	**70706.4**	

Forest Park SSES-Primary Basin and Outlying Area



Forest Park SSES-Primary Basin and Outlying Area



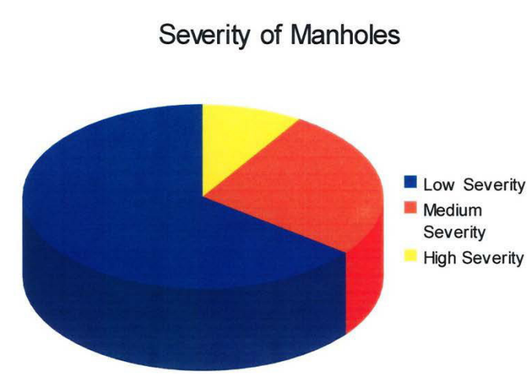


TABLE 3.02-2

SANITARY SEWER TELEVISING RESULTS

Pipe ID	Tape Number	Upstream Structure		Downstream Structure		Location		Televising Comment
		Report	Model	Report	Model	Street	Intersection	
P-485, P-486, P-487	FP-001	54AVE61st	1824	51AVE61st	669	61st St.	51st Ave./54th Ave.	CC, CL, DES-(3), I-(11), JD, R
P-268	FP-004	62ST51AV	1891	51AVE61st	669	51st Ave.	61st St./62nd St.	CL, DES-(2), I, OPH-(2)
P-671	FP-005	61st50AVE	669	61st51AVE	672	61st St.	50th Ave./51st Ave.	I, LD-(3), OPH
P-2962, P-2986	FP-006	61st50AVE	672	61st49AVE	879	61st St.	49th Ave./50th Ave.	CC, CL, LD-(6)
P-2961, P-2979	FP-007	61st49AVE	879	61st48AVE	884	61st St.	48th Ave./49th Ave.	CL, I, LD-(1), OPH
P-263, P-264	FP-008	60ST50AVE	674	61st50AV	672	50th Ave.	(N) 61st St.	C, DES, JD, R-(3)
P-269, P-270, P-271	FP-009	63ST50AV	946	61st50AV	943	50th Ave.	63rd St./61st St.	CL, DES-(2), I-(2), JD-(1), OPH, R-(4)
P-271	FP-010	612250AV	943	61st50AV	672	50th Ave.	(S) 61st St.	DES, LD-(3)
P-283	FP-011	481061st	991	48AV61st	884	48th Ave.	Forest Park	R
P-272	FP-013	6122-49AV	962	63ST49AV	961	49th Ave.	(N) 63rd St.	C-(2), CL-(5), JD-(3), R
P-273	FP-014	6122 49AV	961	61st49AVE	879	49th Ave.	(S) 61st St.	CL, CM, DES-(2), JD
P-259, P-260	FP-015	60ST49AVE	877	49AVE61st	879	49th Ave.	(N) 61st St.	C, CL, DES, I-(2), JD, OPH
P-671	FP-016	51AV61stR	669	50AV61stR	672	61st St.	50th Ave./51st Ave.	CL, DES, LD-(4), OPH
P-261	FP-017	60ST51AV	671	6019-51AV	670	51st Ave.	(S) 60th St.	DES
P-262	FP-018	6019-51AVE	670	61st51AVE	669	51st Ave.	(N) 61st St.	CC, DES, JD, OPH
P-506, P-507	FP-019	531462ST	1895	62ST51AV	1891	62nd St.	(W) 51st Ave.	I, OPH
P-503, P-504	FP-020	63ST53AVE	1885	51AVE65ST	16366	63rd St.	51st Ave./53rd Ave.	C, DES-(3), I, LD-(7)
P-501, P-502	FP-021	54AVE63ST	1888	63ST53AVE	1885	63rd St.	53rd Ave./54th Ave.	CC, CL-(2), LD, OPH-(2)
P-899, P-901, P-904	FP-022	65ST53AVE	3090	63ST53AVE	1885	53rd Ave.	(S) 63rd St.	DES-(2), OPH-(2)
P-265	FP-023	6307-51AVE	940	63ST51AVE	16366	51st Ave.	(S) 63rd St.	C, JD, MC, SC
P-266, P-505	FP-024	63ST51AV	16366	62ST51AV	1891	51st Ave.	62nd St./63rd St.	C-(7), CC, DES, LD-(2)
P-277, P-278	FP-025	6341-48AV	993	63ST48AVE	991	48th Ave.	(S) 63rd St.	C, JD-(2), LD-(2) PC-(2), R-(4)
P-284	FP-027	481763rdST	1002	63rdST48THAVE	991	63rd St.	(W) 48th Ave.	DES-(2)
P-257, P-258	FP-028	601248THAVE	887	61st48THAVE	884	48th Ave.	(N) 61st St.	OPH
P-308, P-311	FP-029	634247thAVE	1004	6322-47AVE	1003	47th Ave.	(S) 63rd St.	C-(2), DES, JD-(3)
P-276	FP-030	63ST47AVE	976	61st47AVE	16369	47th Ave.	Forest Park	C-(2), CL-(2), I, LD-(2)
-	FP-031	-	976	-	-	-	47th Ave./63rd St.	C
P-274, P-275	FP-032	601247AVE	969	61st47AVE	16369	47th Ave.	(N) 61st St.	C-(3), CL-(2), DES-(2), JD, LD, R
P-521, P-522, P-2909, P-2910	FP-033	61st48AVE	884	61st46AVE	16369	61st St.	48th Ave./46th Ave.	C-(2), CL-(3), JD, LD-(2), OPH, R
P-199, P-202	FP-034	601246AVE	358	46AVE61st	374	46th Ave.	(N) 61st St.	C-(2), CL-(2), DES-(2), JD, LD
P-208	FP-035	632646AVE	468	63ST46AVE	467	46th Ave.	(S) 63rd St.	C, CC, CL, DES-(2), JD-(3), LD, R
P-207	FP-036	63ST-46AVE	467	6203-46AV	466	46th Ave.	(N) 63rd St.	DES-(3), MC
P-204, P-205	FP-037	620146AVE	466	61st46AVE	374	46th Ave.	61st St./63rd St.	C, CC, CL-(2), DES-(5)
P-2917	FP-038	61st46AVE	374	61stPERSHINGBLVD	356	61st St.	46th Ave./Pershing Blvd.	C, CM, CL-(3), DES-(2), JD, LD-(4), OPH
P-833, P-835	FP-040	552467ST	3079	540567ST	3076	67th St.	54th Ave./55th Ave.	CC, OPH-(2)
P-837, P-841	FP-041	540567ST	3076	530267ST	3074	67th St.	52nd Ave./54th Ave.	CL, LD, OPH
P-844, P-845	FP-042	530267ST	3074	67ST52AVE	3072	67th St.	52nd Ave./54th Ave.	DES, LD
P-1996	FP-045	67ST51AVE	3072	662451AVE	3087	51st Ave.	(N) 67th St.	DES-(2)
P-796	FP-047	55AVE65ST	16266	111FT	2920	65th St.	54th Ave./55th Ave.	PL
P-796	FP-048	111FTSOF55AVE65ST	16266	54AVE65STREET	2920	65th St.	54th Ave./55th Ave.	I-(2), PL
P-797, P-798	FP-049	65STR54AV	2920	53AVE65ST	2976	65th St.	53rd Ave./54th Ave.	LD, OPH
P-799, P-800	FP-050	53AVE65ST	2976	51AVE65ST	2631	65th St.	51st Ave./53rd Ave.	CM, LD-(2), OPH, PL, R

Pipe ID	Tape Number	Upstream Structure		Downstream Structure		Location		Televising Comment
		Report	Model	Report	Model	Street	Intersection	
P-587	FP-051	51STAVE65THST	2631	40FT	2630	65th St.	50th Ave./51st Ave.	C-(2), CC, CL, LD, PC
P-589	FP-052	40'EOF51AVE65ST	2630	50AVE65ST	2594	65th St.	50th Ave./51st Ave.	B, C, CC, CL-(3), CM, PC-(2)
P-786	FP-058	54thAVE65THPL	2921	54thAVE65THST	2920	54th Ave.	65th Pl./65th St.	OPH
P-872	FP-061	661251STAVE	3086	655351STAVE	3082	51st Ave.	(N) 67th St.	DES-(3), LD-(2)
P-873, P-876	FP-062	661151STAVEDEADENDMH	3083	553351STAVE	3081	51st Ave.	(N) 67th St.	CC, CL, CM, DES, I, JD-(3), OPH, PC
P-881, P-883	FP-063	653351SSTAVE	3081	65THSTAND51STAVE	2631	51st Ave.	(S) 65th St.	B, C-(3), CL, CM, DES-(4), I, JD, LD-(2), PC-(5), PL-(4)
P-623	FP-064	631651STAVE	2743	65STSTAND51STAVE	2709	51st Ave.	(N) 65th St.	DES-(2), PL
P-623	FP-065	631651AVE	2743	633051AVE	2709	51st Ave.	(N) 65th St.	DES-(3), I
P-611	FP-066	640251STAVE	2707	65ST51STAVE	2631	51st Ave.	(N) 65th St.	DES
P-610	FP-067	633351AVE	2709	640251AVE	2707	51st Ave.	(N) 65th St.	DES-(2)
P-681, P-683	FP-071	50AVE67ST	2836	655350AVE	2833	50th Ave.	(N) 67th St.	JD
P-692	FP-072	655350AVE	2833	65ST50AVE	2831	50th Ave.	(N) 67th St.	DES-(2), R-(4)
P-692	FP-073	652050AVE	2833	75S652050AVE	2831	50th Ave.	(N) 67th St.	DES-(6), LD
P-693	FP-074	652050AVE	2831	65ST50AVE	2594	50th Ave.	(S) 65th St.	DES-(2), R-(4)
P-211	114-10	PERSH BLVD-6308	472	62ST-PERSHBLVD	471	Pershing Blvd.	(S) 63rd St.	DES-(4), PL
P-209	115-10	62ST-PERSHBLVD	471	6120-PERSHBLVD	470	Pershing Blvd.	(N) 63rd St.	DES-(6), I
P-209	116-10	PRESHBLVD-62ST	471	6120=PERSHBLVD	470	Pershing Blvd.	(N) 63rd St.	DES-(6), JD
P-195	FP10-009	61st PERSHING BLVD.	356	236' N. OF 61st/PERSHING BLVD.	355	Pershing Blvd.	(N) 61st St.	CL, DES, JD-(3), LD-(2) PC
P-196	FP10-010	6032 PERSHING BLVD.	355	6015 PERSHING BLVD.	354	Pershing Blvd.	(N) 61st St.	B, C, CL, JD-(7), PC
P-197	FP-10-011	6015-PERSHING BLVD.	354	60ST/PERSHING BLVD.	6090	Pershing Blvd.	(S) 60th St.	DES-(4), I
P-692	FP-10-001	S OF 6525 100-FT	2833	6525 50 AVE	2831	50th Ave.	(S) 65th St.	DES
P-693	FP-10-002	6525 50 AVE	2831	65ST50AVE	2594	50th Ave.	(S) 65th St.	CL, CM, LD, OPH, PL, R
P-565	FP-10-004	63ST50AVE	2610	65ST50AVE	2599	50th Ave.	(S) 63rd St.	C, DES-(2), OPH
P-569, P-571	FP-10-005	6323 50 AVE	2599	65ST50AVE	2594	50th Ave.	(N) 65th St.	DES-(8), JD, OPH
P-737, P-739	FP-10-007	6539 49 AVE	2840	49AVE61st	2496	49th Ave.	(S) 65th St.	DES, JD, OPH
P-525, P-536, P-538	FP-10-008	63ST/49AVE	2507	65ST/49AVE	2496	49th Ave.	(N) 65th St.	DES, LD-(2), PC
P-242	FP-10-012	6330 46AVE	624	46AVE/HARDING	622	46th Ave.	(N) 65th St.	DES-(2), JD
P-244	FP-10-014	65ST46AVE	621	46AVE/HARDING	604	46th Ave.	(N) Harding Rd.	JD-(3)
P-1889	FP-10-016	46AVE/HARDING	604.00	6536 46AVE	603	46th Ave.	(S) Harding Rd.	CN-(6), DES
P-1890	FP-10-017	6536 46AVE	603	46AVE/WILSON RD	602	46th Ave.	(N) Wilson Rd.	CM
P-1901	FP-10-018	WILSONRD/46AVE	602	TAFTRD/46AVE	4324	46th Ave.	(N) Taft Rd.	C, CC-(2), CL-(2), CM-(3)
P-1885	FP-10-019	4728 HARDING RD	4320	46TH AVE/HARDING RD	4319	Harding Rd.	47th Ave./48th Ave.	DES-(3), LD, JD
P-591, P-592	FP-10-020	50th AVE/65TH ST	2594	49TH AVE/65TH ST	2496	65th St.	49th Ave./50th Ave.	C, CC, DES-(2), JD-(2), LD, OPH-(2)
P-594, P-596	FP-10-021	49TH AVE/65ST ST	2496	48TH AVE/65TH ST	999	65th St.	48th Ave./49th Ave.	CC-(4), DES, JD-(3), LD, PL-(3)
P-600, P-601	FP-10-022	65TH ST/48TH AVE	999	65TH ST/47th AVE	1005	65th St.	47th Ave./48th Ave.	C, CC, CL, JD-(2), MC
P-525	FP-10-024	6305 49TH AVE	2507	6349 49TH AVE	2499	49th Ave.	(S) 63rd St.	DES
P-1884	FP-10-026	174'N OF 4728 HARDING	4319	47th AVE/HARDING RD	635	Harding Rd.	47th Ave./48th Ave.	DES, MC
P-254, P-255	FP-10-027	47th AVE/HARDING	635	46TH AVE/HARDING RD	604	Harding Rd.	46th Ave./47th Ave.	DES, JD-(2), LD-(2)
P-525	FP-10-028	6324 49TH AVE	2507	63ST/49AVE	2499	49th Ave.	(S) 63rd St.	DES
P-281	FP-10-029	6341 48TH AVE	993	6551 48TH AVE	1001	48th Ave.	63rd St./65th St.	JD, R
P-277	FP-10-030	6320 48TH AVE	16339	65ST/48TH AVE	991	48th Ave.	63rd St./65th St.	JD
P-287	FP-10-031	6349 47th AVE	1006	65TH ST/47th AVE	1005	47th Ave.	(N) 63rd St.	C, CM-(2), JD-(2), PC-(4)
P-1887, P-1888	FP-10-032	65ST/47AVE	1005	47AVE/HARRISON	635	47th Ave.	65th St./Harding Rd.	CL, I, JD, OPH, R-(5)

SECTION 4
RESIDENT SURVEY INFORMATION

4.01 GENERAL

A survey was developed with input from City staff to obtain valuable flooding and sump pump/drain tile connection information from residents in the Forest Park area. Various modes of communication were required to successfully complete this task. In addition to mailing the survey to residents, a survey was also developed on the Zoomerang Web site to allow for online completion. Phone calls and home visits to residents were also utilized to obtain survey information from area residents.

A. Survey Participation

The online survey was launched and paper copies of the surveys were mailed to Forest Park residents during the week of September 14, 2009. During the weekend of October 3, 2009, phone calls were completed by Strand to approximately 450 residents who had not yet responded to the survey, of which 89 surveys (23 percent) were completed via the phone. Home visits took place on Saturday, October 24, and Saturday, November 7, to contact residents who had not responded to the survey. Another 119 surveys (30 percent) were collected during neighborhood canvassing. Online participation brought in 52 surveys (13 percent) and 134 mailed-in surveys (34 percent), which comprised the remainder of the survey total. Of the 700 occupied parcels, 394 surveys were returned, resulting in 56 percent participation. Table 4.01-1 summarizes participation by survey type.

Survey Type	Time Frame	Percentage	No. of Respondents
Mail	Mid-September-November	34%	134
Neighborhood Canvassing	October 24, 2009 and November 7, 2009	30%	119
Phone	October 3, 2009	23%	89
Online	Mid-September-November	13%	52
	Total	**100%**	**394**

Table 4.01-1 Survey Means of Completion and Timing

B. Survey Results

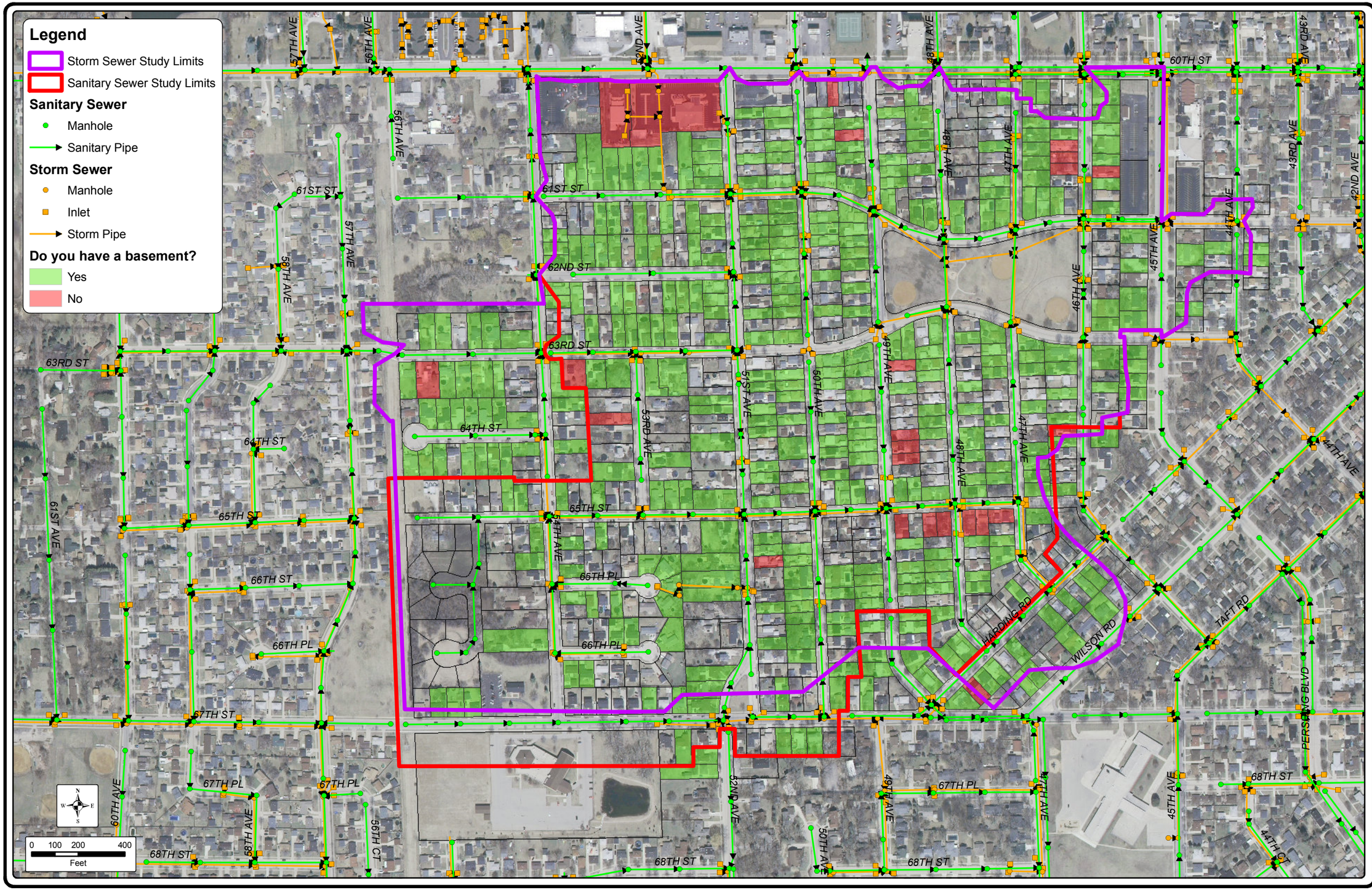
Results for select survey questions were compiled on multiple figures showing the response per parcel. The question asked on the resident survey is found below each figure heading along with a brief summary of the findings. The sample survey and survey tabulation summary can be found in Appendix A.

1. Basement Locations (Figures 4.01-1 and 4.01-2)

Do you have a basement?

a. Of those who responded, 94 percent had basements, 6 percent did not.

b. Primary locations where homes did not have basements included those on the west side of 46th Avenue (north of 61st Street), the east side of 49th Avenue (between 63rd Street and 65th Street), and the south side of 65th Street (between 49th Avenue and 47th Avenue).

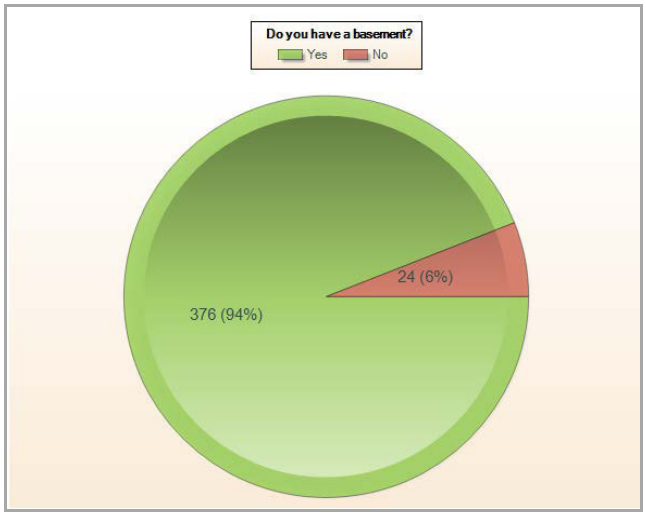


BASEMENTS
SURVEY RESULTS
FOREST PARK AREA STORM AND SANITARY MANAGEMENT PLAN
CITY OF KENOSHA
KENOSHA COUNTY, WISCONSIN

STRAND ASSOCIATES, INC.® ENGINEERS

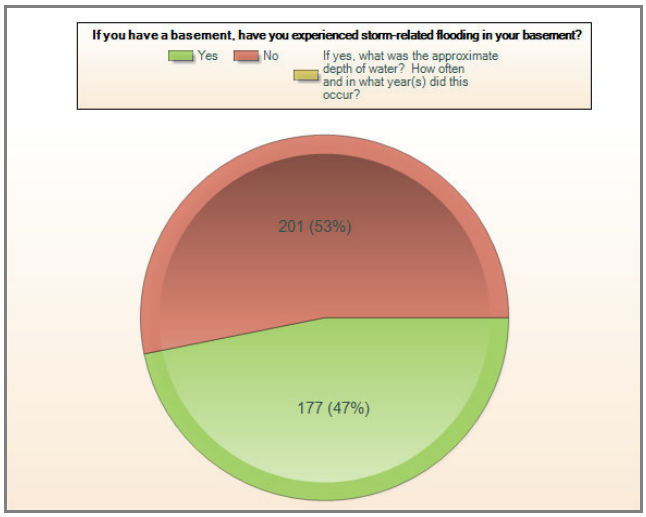
FIGURE 4.01-1
1540.001

S:\MAD\1500--1599\1540\001\Data\GIS Data\Figures\Survey Results\Figure 4.01-1 Basement 11x17.mxd



Source: Zoomerang Web site

Figure 4.01-2 Basement Presence



Source: Zoomerang Web site

Figure 4.01-3 Basement Flooding

2. Basement Flooding (Figures 4.01-3 and 4.01-4)

If you have a basement, have you experienced storm-related flooding in your basement?

Of those who responded, slightly fewer people (47 percent) have experienced storm-related flooding than those who have not experienced storm-related flooding (53 percent).

Respondents to this question were able to identify the approximate depth of water and in what years it has occurred. Specific responses can be found within the data downloaded from the Zoomerang Web site (Appendix A).

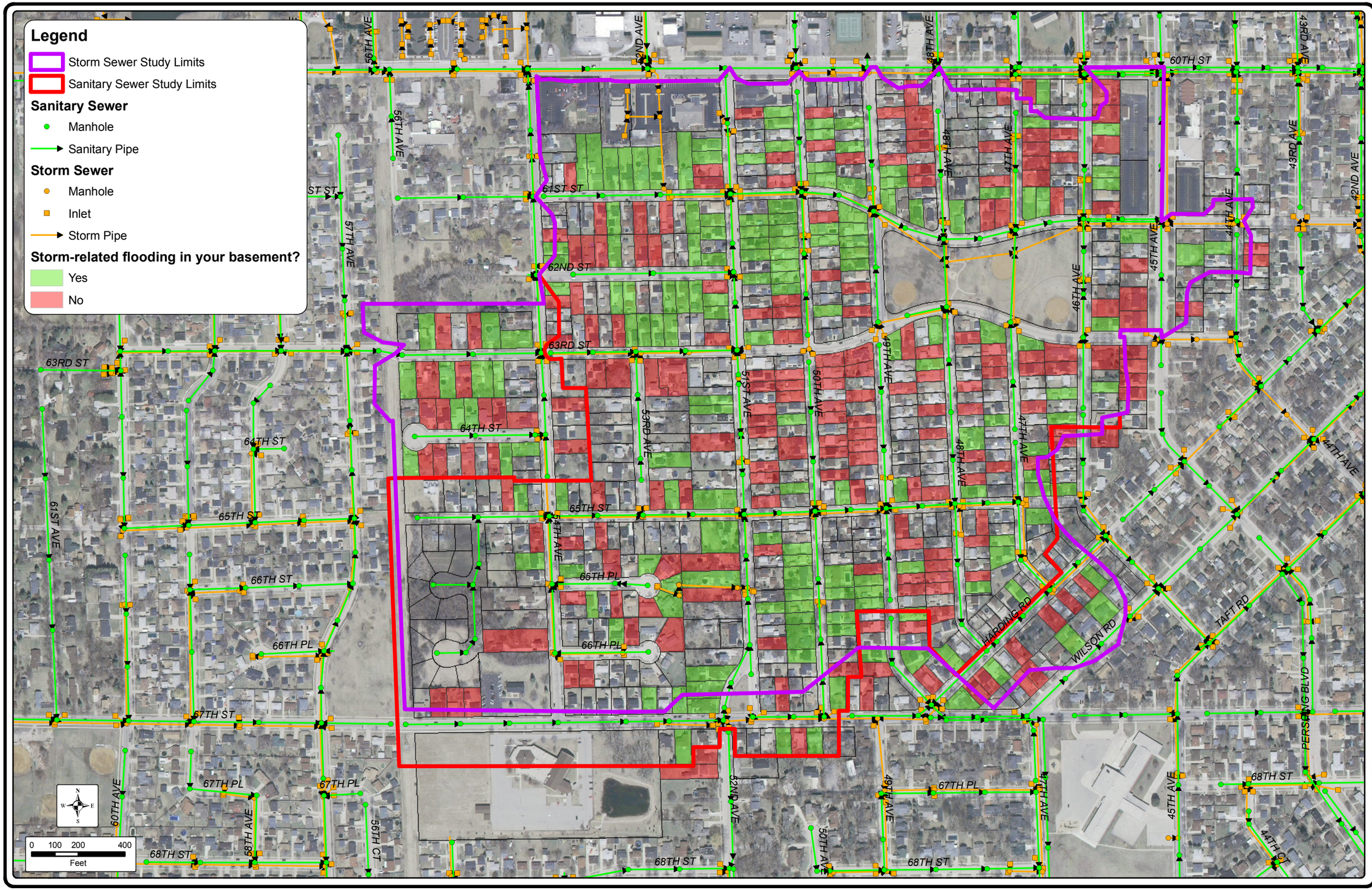
3. Type of Basement Flooding (Figures 4.01-5 and 4.01-6)

Which of the following best describes the cause(s) of your storm-related flooding (check all that apply)?

a. Foundation cracks/leaks were responsible for 33 percent of storm-related flooding occurring in basements while 36 percent of basements had flooding as a result of sewer water backup (floor drain).

b. Sump pumps were responsible for 15 percent of storm-related flooding occurring in basements, 15 percent of residents had sump pumps that could not keep up and another 18 percent had water that came in through window wells.

c. Some residents experienced multiple issues (which is why the total percentage is greater than 100 percent).



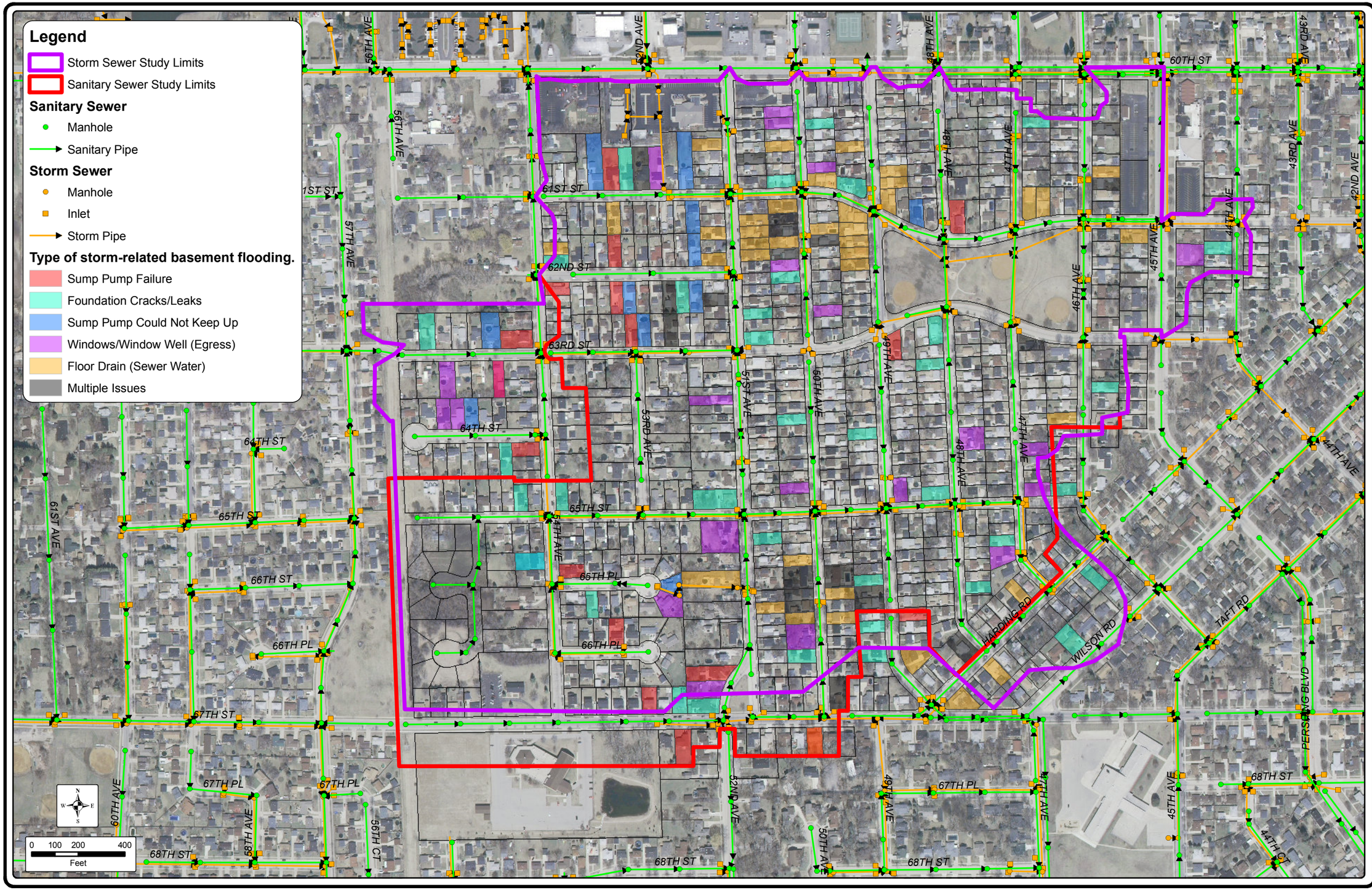
BASEMENT FLOODING SURVEY RESULTS

FOREST PARK AREA STORM AND SANITARY MANAGEMENT PLAN
CITY OF KENOSHA
KENOSHA COUNTY, WISCONSIN

STRAND ASSOCIATES, INC.® ENGINEERS

FIGURE 4.01-4
1540.001

S:\MAD\1500--1599\1540\001\Data\GIS Data\Figures\Survey Results\Figure 4.01-4 Basement Flooding 11x17.mxd



TYPE OF BASEMENT FLOODING SURVEY RESULTS

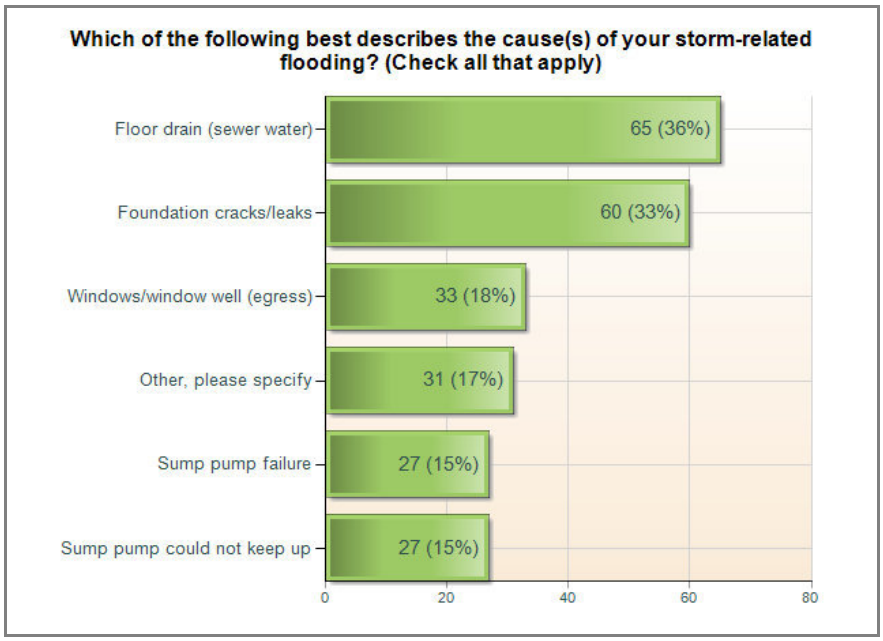
FOREST PARK AREA STORM AND SANITARY MANAGEMENT PLAN
CITY OF KENOSHA
KENOSHA COUNTY, WISCONSIN

STRAND ASSOCIATES, INC.® ENGINEERS

FIGURE 4.01-5
1540.001

S:\MAD\1500--1599\1540\001\Data\GIS Data\Figures\Survey Results\Figure 4.01-5 Type Basement Flooding 11x17.mxd

d. Other causes include poor grading or drainage around the home, disconnected gutters, drain tile issues, or tree root clogging. Some residents responded that the storm-related flooding came from their basement floor drain, but it was not sewer water. In other cases, the resident did not know why or did not remember.



Zoomerang Web site

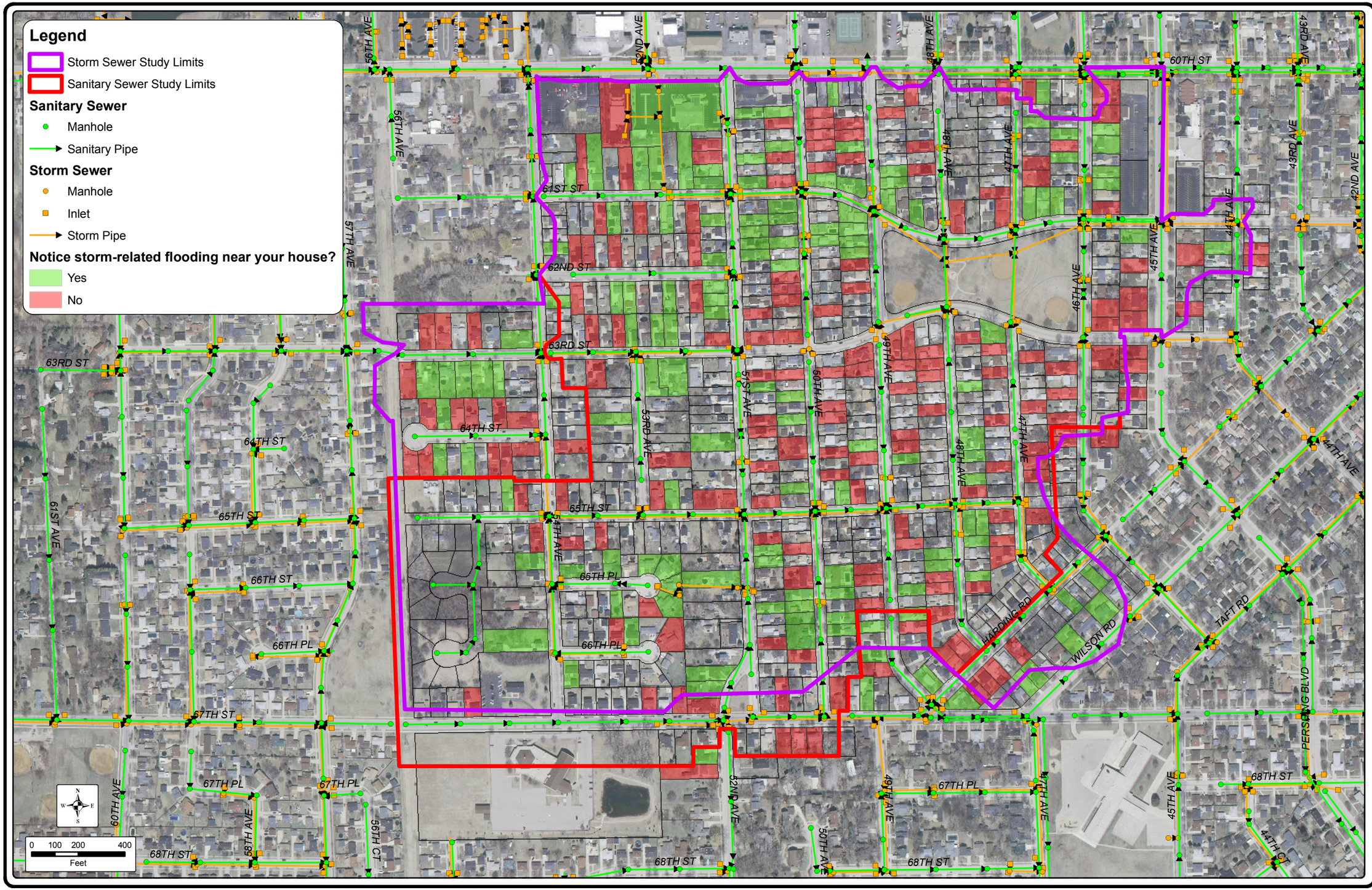
Figure 4.01-6 Storm-Related Flooding

4. Flooding Near Home (Figures 4.01-7 and 4.01-8)

At the time when you experienced water in your basement, was the street flooded in front of your house?

a. Of those who answered this question, 31 percent identified that the street was flooded while 69 percent answered that the street was not flooded at the time they experienced water in their basement.

b. This question may have been easily confused, and answered interchangeably, with the next question regarding whether or not they noticed storm-related flooding in front of their house.



FLOODING NEAR YOUR HOUSE SURVEY RESULTS

FOREST PARK AREA STORM AND SANITARY MANAGEMENT PLAN

CITY OF KENOSHA
KENOSHA COUNTY, WISCONSIN

STRAND ASSOCIATES, INC.® ENGINEERS

FIGURE 4.01-7
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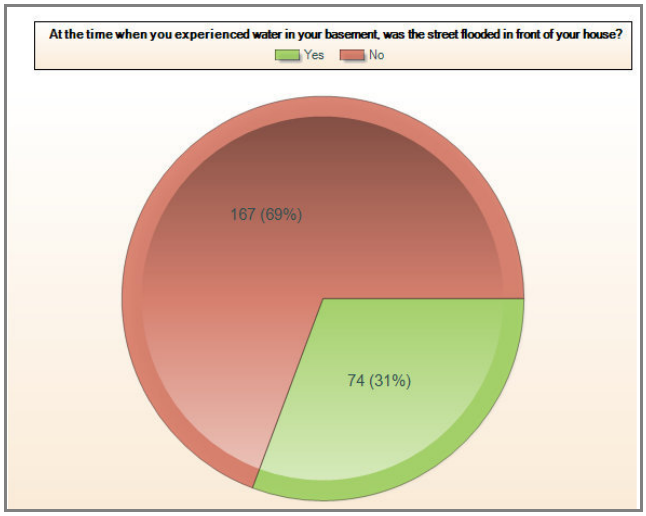
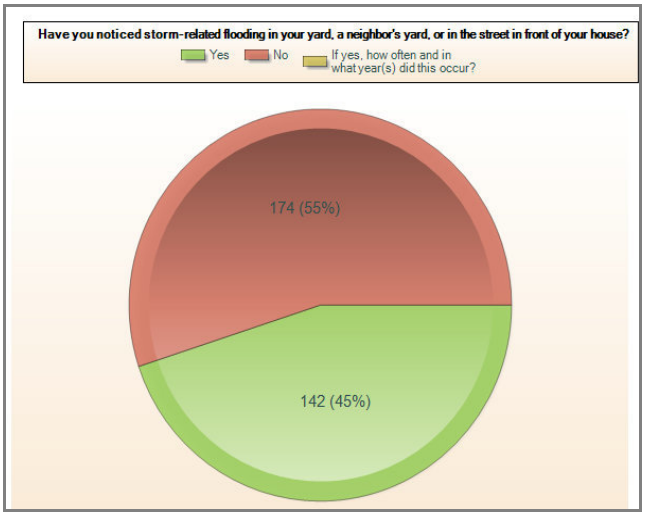


Zoomerang Web site

Figure 4.01-8 Basement/Street Flooding



Zoomerang Web site

Figure 4.01-9 Yard/Street Flooding

5. Street Flooding (Figures 4.01-9 and 4.01-10)

Have you noticed storm-related flooding in your yard, a neighbor's yard, or in the street in front of your house?

Of those responding, 55 percent did not notice any flooding in the street or yards during storm events and 45 percent did notice flooding.

Respondents to this question were able to identify locations, limits, and depths of flooding. Hand sketches were also provided by some residents. This information was extremely valuable to identify specific locations within the study area that experience flooding.

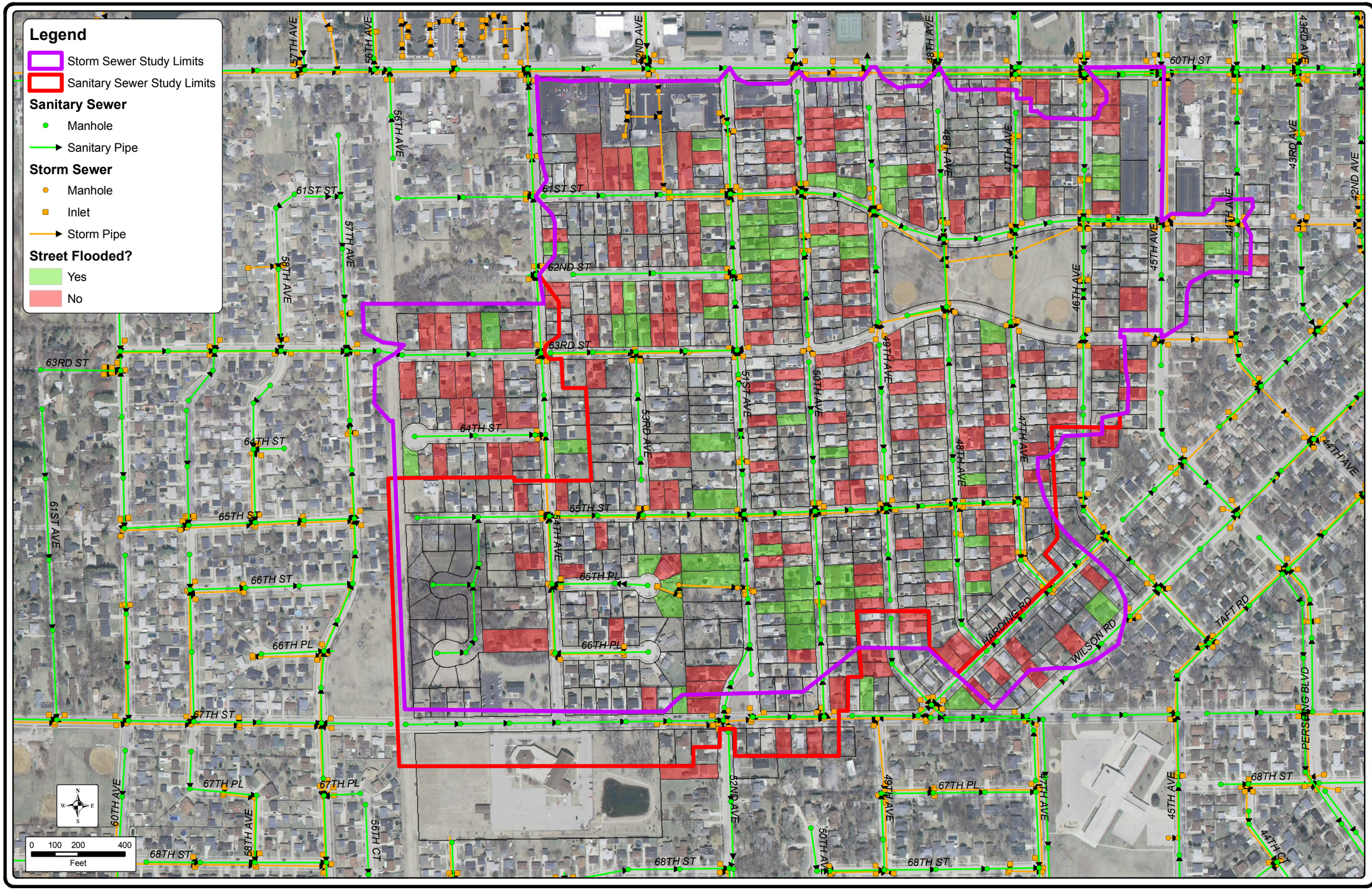
6. Foundation Drainage (Figures 4.01-11, 4.01-12 and 4.01-13)

How is the foundation of your home drained?

a. Many residents have foundation drains that are connected to the sump pump (34 percent), along with many residents who do not know how their foundation is drained (26 percent).

b. Other responses (14 percent) included residents who selected multiple answers for this question (e.g., exterior perimeter drain tile connected to sump pump or exterior drain tile connected to sanitary sewer).

Figure 4.01-12 identifies the explicit locations of residents (29 parcels, 9 percent) who indicated the foundation of their home drained to the sanitary sewer lateral. This figure also includes

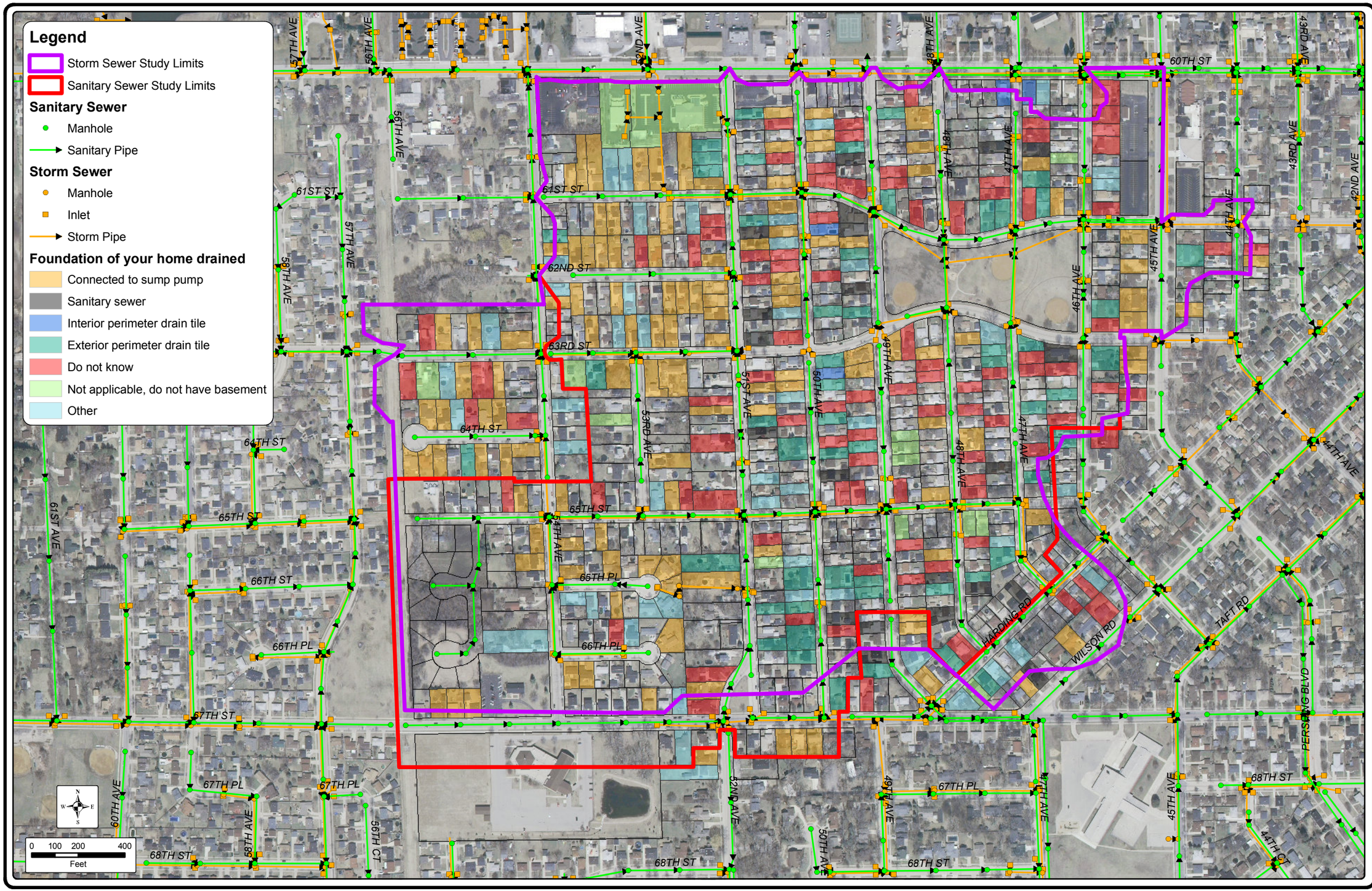


STREET FLOODING
SURVEY RESULTS
FOREST PARK AREA STORM AND SANITARY MANAGEMENT PLAN
CITY OF KENOSHA
KENOSHA COUNTY, WISCONSIN

STRAND ASSOCIATES, INC.® ENGINEERS

FIGURE 4.01-10
1540.001

S:\MAD\1500--1599\1540\001\Data\GIS Data\Figures\Survey Results\Figure 4.01-10 Street Flooded 11x17.mxd



FOUNDATION OF YOUR HOME DRAINED
SURVEY RESULTS

FOREST PARK AREA STORM AND SANITARY MANAGEMENT PLAN
CITY OF KENOSHA
KENOSHA COUNTY, WISCONSIN

STRAND ASSOCIATES, INC.® ENGINEERS

FIGURE 4.01-11
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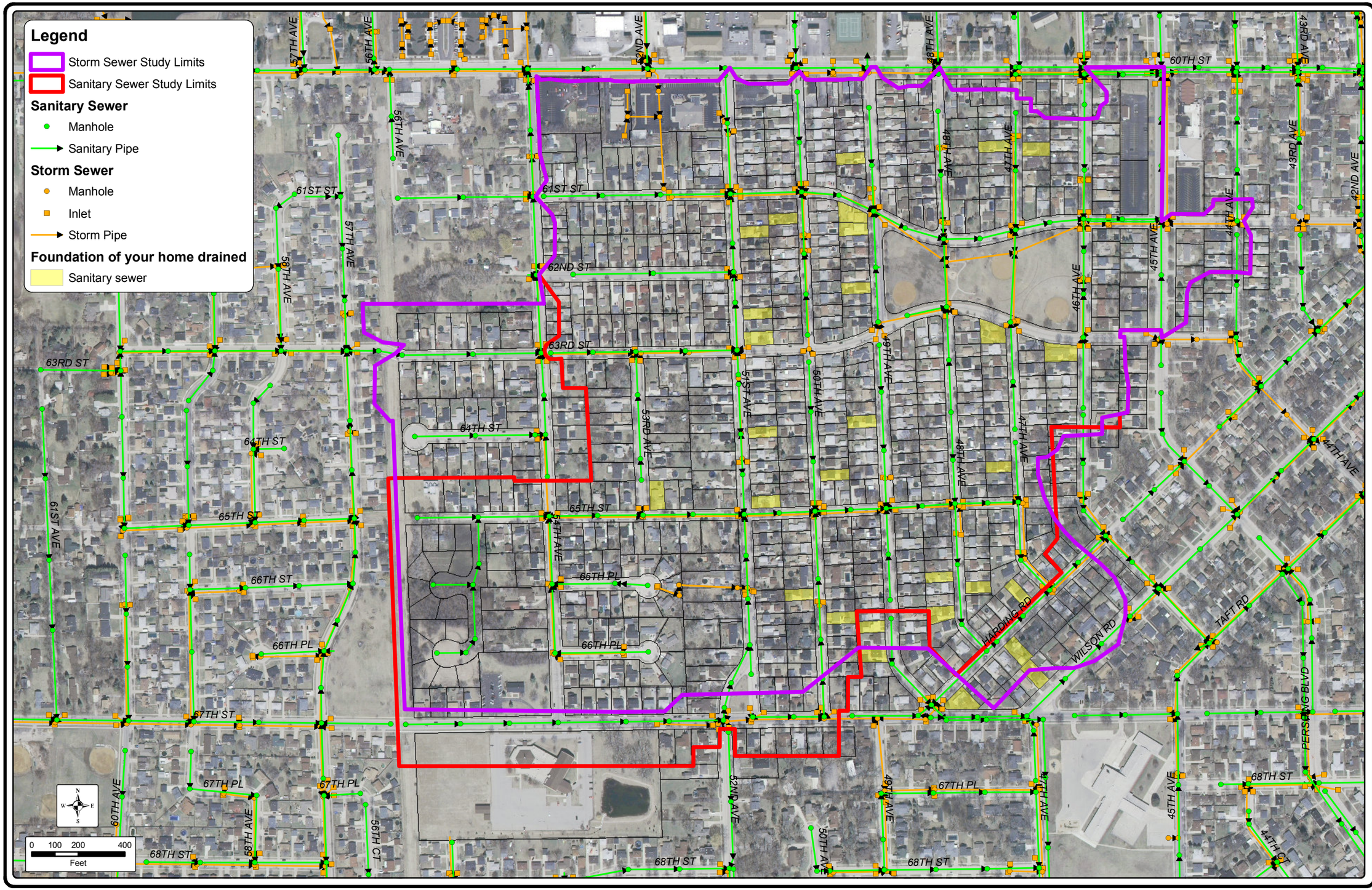
S:\MAD\1500--1599\1540\001\Data\GIS Data\Figures\Survey Results\Figure 4.01-11 Foundation Drained 11x17.mxd



FOUNDATION OF YOUR HOME DRAINED - SANITARY SEWER SURVEY RESULTS

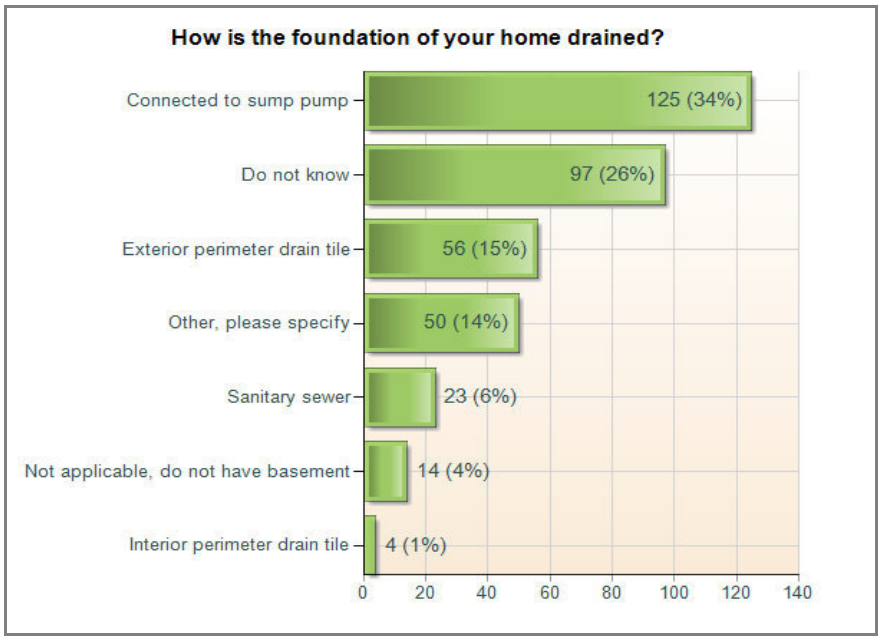
FOREST PARK AREA STORM AND SANITARY MANAGEMENT PLAN
CITY OF KENOSHA
KENOSHA COUNTY, WISCONSIN

STRAND ASSOCIATES, INC.® ENGINEERS

FIGURE 4.01-12
1540.001

S:\MAD\1500--1599\1540\001\Data\GIS Data\Figures\Survey Results\Figure 4.01-12 Foundation Drained - Sanitary Sewer 11x17.mxd

residents who indicated their foundation ultimately drained to the sanitary sewer within the "Other, please specify" response answer.



Zoomerang Web site

Figure 4.01-13 Foundation Drainage

7. Sump Pump Discharge (Figures 4.01-14, 4.01-15, and 4.01-16)

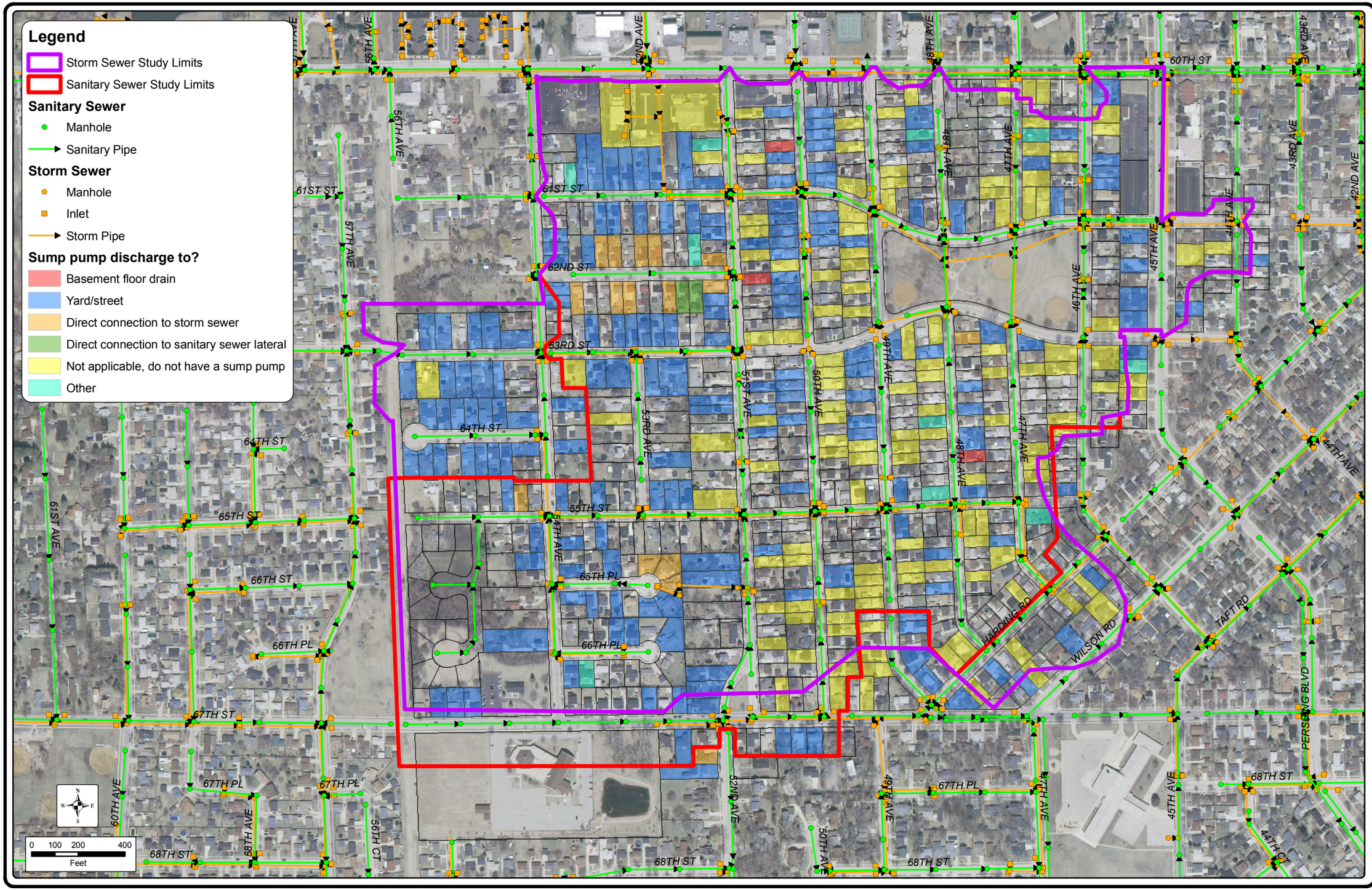
Where does your sump pump discharge to?

a. The majority of residents (52 percent) answered that their sump pump drained to the yard/street. While doing the neighborhood canvassing, it was apparent that many homes did drain to the yard, as the hoses were visible in the yard, or to the street, as many residents have cut out a section of the curb so water drains (or freezes) directly in the gutter of the street.

b. Another 39 percent of residents do not own sump pumps, and 5 percent of residents have a direct connection to the storm sewer. Homes on 62nd Street between 54th Avenue and 51st Avenue have their sump pumps directly connected to the storm sewer.

c. The remainder of the residents (3 percent) do not know where their sump pump discharges to.

Figure 4.01-15 identifies the explicit locations of residents who indicated their sump pump discharges to the sanitary sewer. It appears the two homes (1 percent) on 62nd Street (near



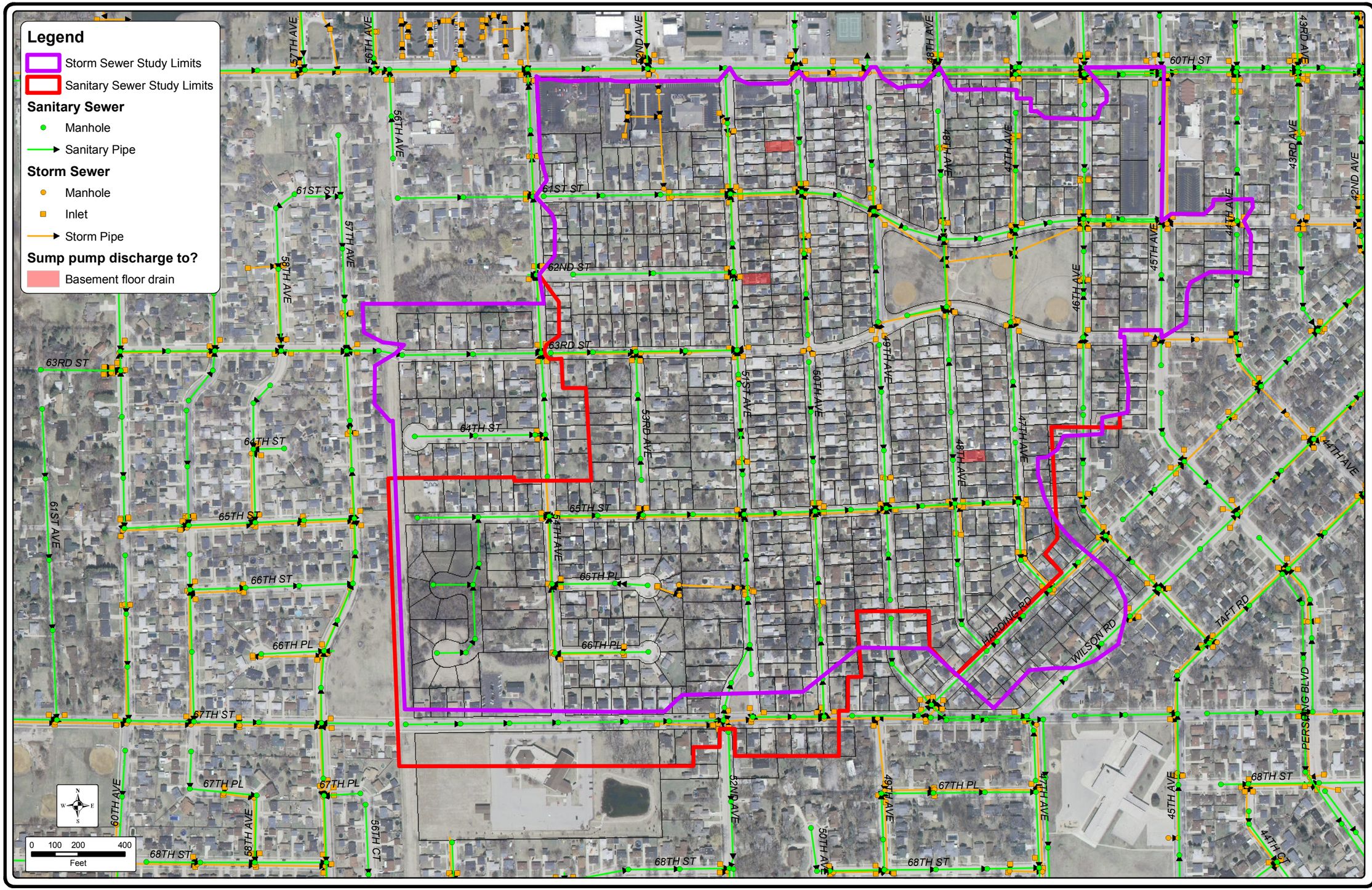
SUMP PUMP DISCHARGE TO SURVEY RESULTS

FOREST PARK AREA STORM AND SANITARY MANAGEMENT PLAN
CITY OF KENOSHA
KENOSHA COUNTY, WISCONSIN

STRAND ASSOCIATES, INC.®
ENGINEERS

FIGURE 4.01-14
1540.001

S:\MAD\1500--1599\1540\001\Data\GIS Data\Figures\Survey Results\Figure 4.01-14 Sump Pump Discharge 11x17.mxd



SUMP PUMP DISCHARGE TO SANITARY SEWER LATERAL OR BASEMENT FLOOR DRAIN SURVEY RESULTS

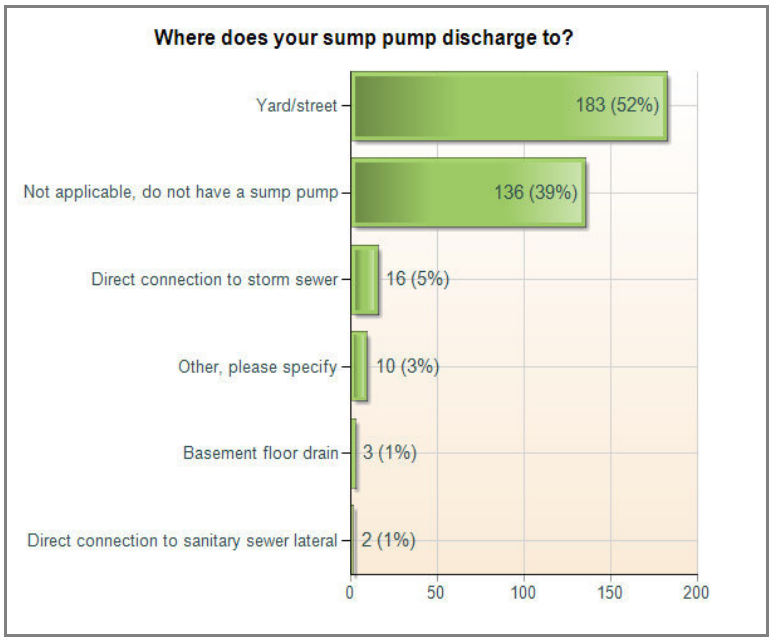
FOREST PARK AREA STORM AND SANITARY MANAGEMENT PLAN
CITY OF KENOSHA
KENOSHA COUNTY, WISCONSIN

STRAND ASSOCIATES, INC.® ENGINEERS

FIGURE 4.01-15
1540.001

S:\MAD\1500--1599\1540\001\Data\GIS Data\Figures\Survey Results\Figure 4.01-15 Sump Pump Discharge - Sanitary Sewer Basement 11x17.mxd

51st Avenue) should have answered "Direct connection to storm sewer" instead of "Direct connection to sanitary sewer lateral," as it is our understanding homes on that street have been retrofitted to connect directly to the storm sewer. Only three residents (1 percent) answered that their sump pump discharges to their basement floor drain.



Zoomerang Web site

*Disregard responses to 'Direct connection to sanitary sewer lateral', question answered incorrectly.

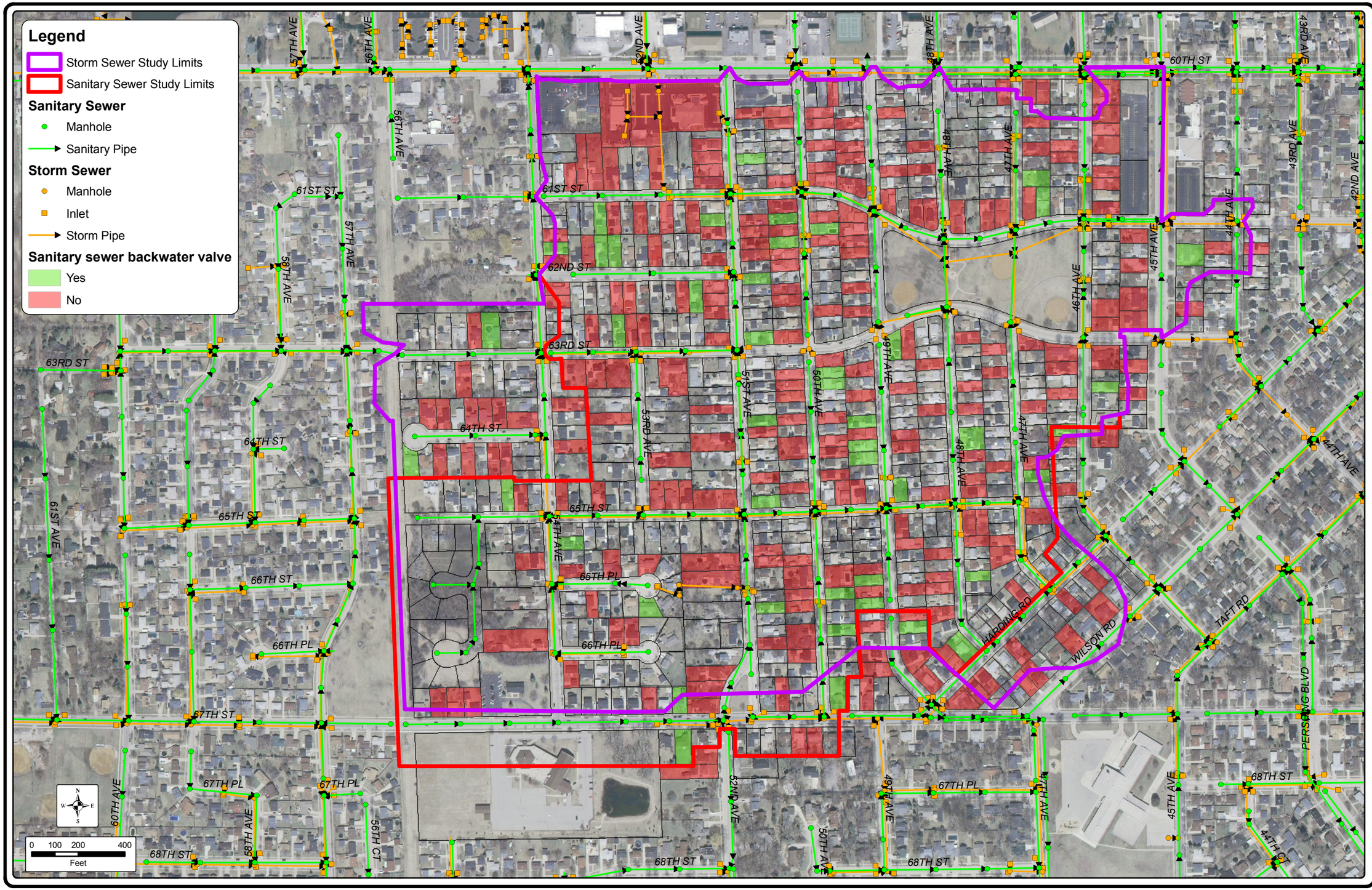
Figure 4.01-16 Sump Pump Discharge

8. Backwater Valve Installations (Figures 4.01-17 and 4.01-18)

Do you have a sanitary sewer backwater valve?

a. Of those who answered this question, only 15 percent had sanitary sewer backwater valves with the remaining 85 percent not having one at their home.

b. Many residents did not know what a sanitary sewer backwater valve was and either needed an explanation or did not answer this question.



SANITARY SEWER BACKWATER VALVE SURVEY RESULTS

FOREST PARK AREA STORM AND SANITARY MANAGEMENT PLAN

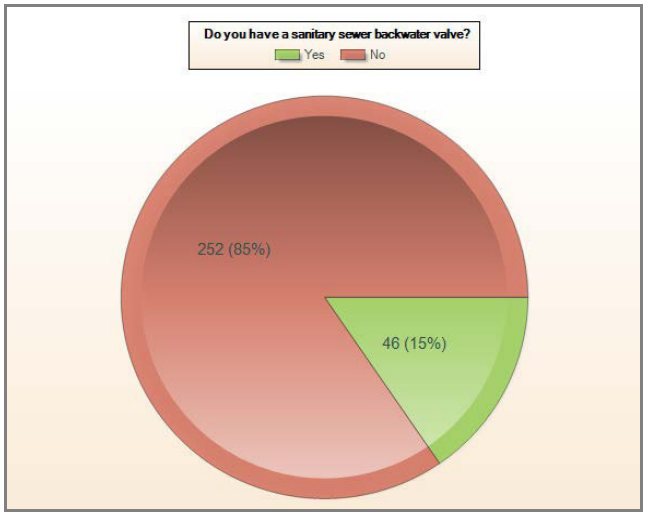
CITY OF KENOSHA

KENOSHA COUNTY, WISCONSIN

STRAND ASSOCIATES, INC.® ENGINEERS

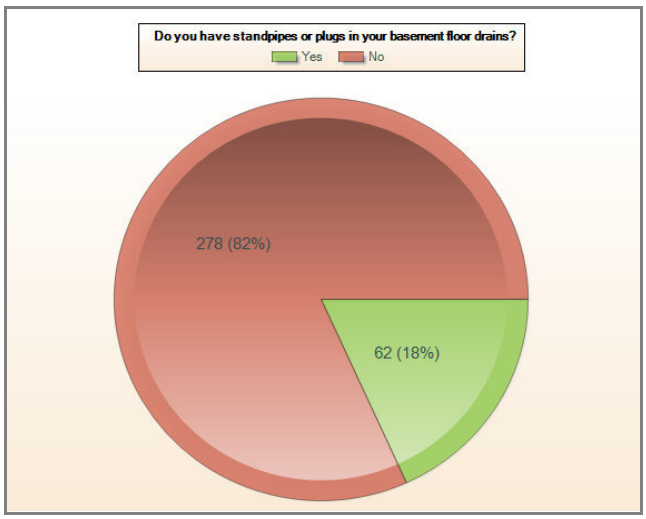
FIGURE 4.01-17
1540.001

S:\MAD\1500--1599\1540\001\Data\GIS Data\Figures\Survey Results\Figure 4.01-17 Backwater Valve 11x17.mxd



Zoomerang Web site

Figure 4.01-18 Backwater Valve



Zoomerang Web site

Figure 4.01-19 Standpipe/Plug

9. Standpipe Ownership (Figures 4.01-19 and 4.01-20)

Do you have standpipes or plugs in your basement floor drains?

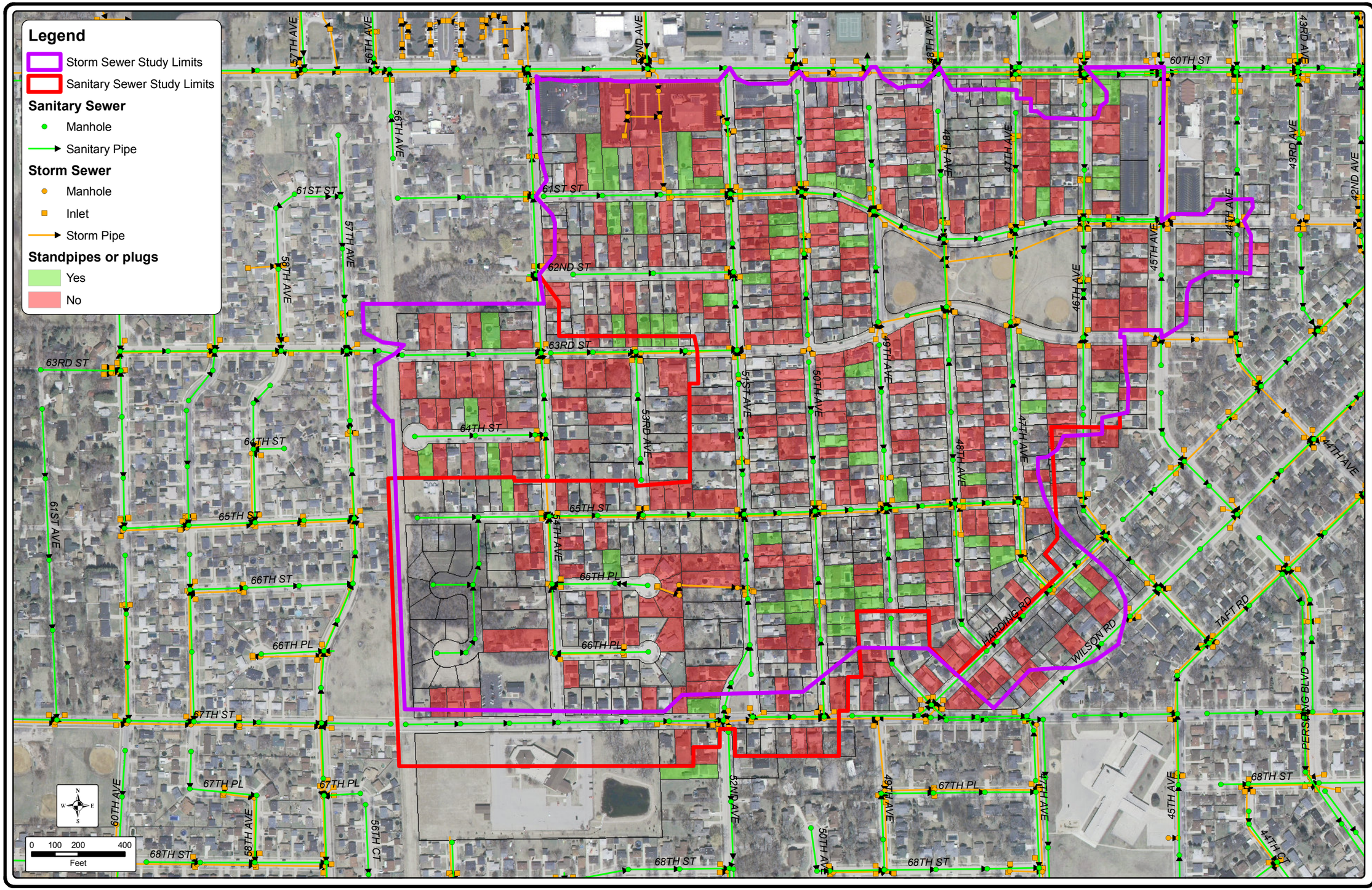
Of those who answered this question, 18 percent had either a standpipe or plug and 82 percent did not.

Residents had the option to request a representative stop by their home during the neighborhood canvassing to address specific questions or locations of flooding. Strand representatives met with 19 residents on Saturday, November 7, 2009. A list of remaining residents who requested a visit but were unavailable at the time of canvassing was provided to the City. The City intends to address the remaining requests.

C. Correlation of Survey Results to Existing Conditions

Figure 4.01-21 presents a comparison of reported areas of parcel and street flooding (Figures 4.01-7 and 4.01-10) with the XPSWMM two-dimensional output associated with the calibrated model. It should be noted the stormwater model was calibrated using a May 2004 rainfall event, whereas the resident survey results are associated with the June 2009 rainfall event. However, the figure does verify the model accurately depicts known areas of street and parcel flooding.

Figure 4.01-22 presents a comparison of reported areas of basement backups from floor drain (sewer water) (Figure 4.01-5) with the sanitary sewer XPSWMM model output. Sanitary sewers predicted to have significant surcharging are shown on the figure along with the parcels that reported the floor drain (sewer water) backups. Again, the model output correlates well with the reported basement backups.



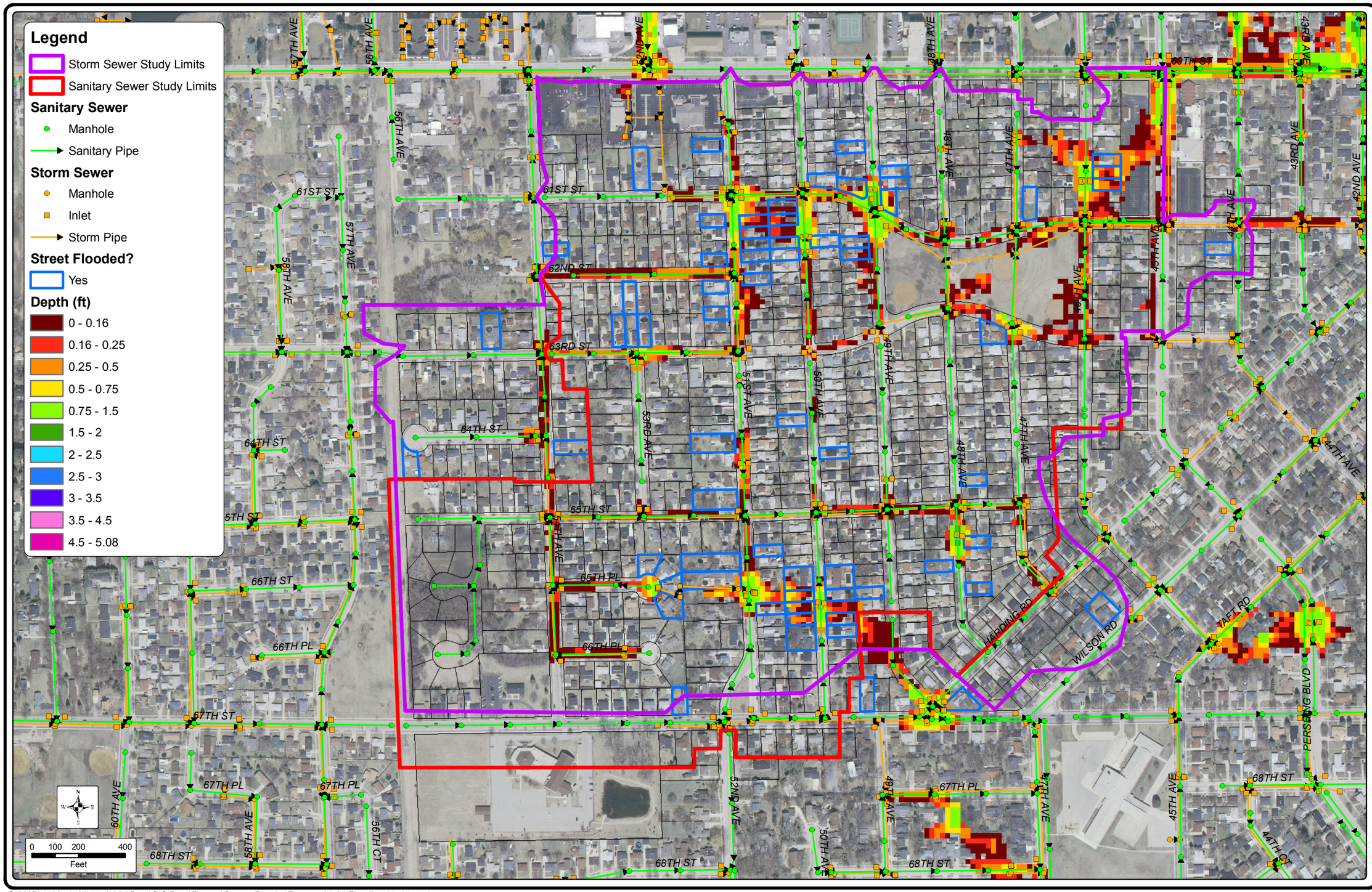
STANDPIPES OR PLUGS IN YOUR BASEMENT FLOOR DRAINS
SURVEY RESULTS

FOREST PARK AREA STORM AND SANITARY MANAGEMENT PLAN
CITY OF KENOSHA
KENOSHA COUNTY, WISCONSIN

STRAND ASSOCIATES, INC.® ENGINEERS

FIGURE 4.01-20
1540.001

S:\MAD\1500--1599\1540\001\Data\GIS Data\Figures\Survey Results\Figure 4.01-20 Standpipes 11x17.mxd

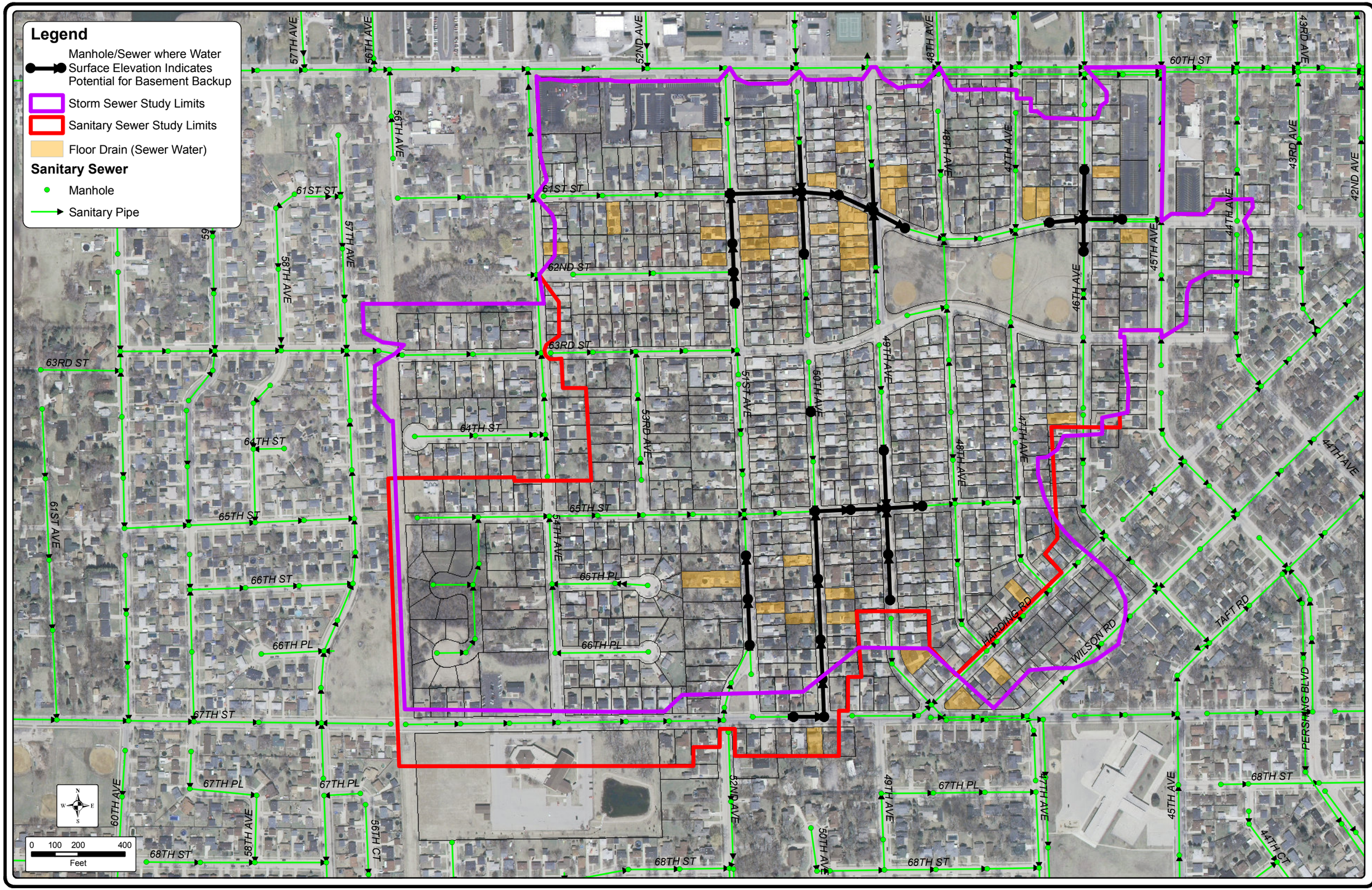


STREET FLOODING LOCATIONS / MODELING FLOODING COMPARISON
MAY 20-23, 2004 STORM EVENT
FOREST PARK AREA STORM AND SANITARY MANAGEMENT PLAN
CITY OF KENOSHA
KENOSHA COUNTY, WISCONSIN

STRAND ASSOCIATES, INC.® ENGINEERS

FIGURE 4.01-21
1540.001

S:\MAD\1500--1599\1540\001\Data\GIS Data\Figures\Survey Results\Figure 4.01-21 Flooding 11x17.mxd



SANITARY SEWER MODEL/REPORTED BASEMENT BACKUPS COMPARISON

FOREST PARK AREA STORM AND SANITARY MANAGEMENT PLAN
CITY OF KENOSHA
KENOSHA COUNTY, WISCONSIN

STRAND ASSOCIATES, INC.® ENGINEERS

FIGURE 4.01-22
1540.001

S:\MAD\1500--1599\1540\001\Data\GIS Data\Figures\Survey Results\Figure 4.01-22 Basement Backups 11x17.mxd

D. Conclusions

It is recommended the City further investigate parcels shown on Figures 4.01-12 and 4.01-15 that indicate foundation and sump pump discharge to the sanitary sewer. A plan should be generated to eliminate these connections. Removal of these connections is an important step toward eliminating unnecessary inflow to the sanitary sewer system.

A large percentage of residents discharge their sump pump to the yard or street, as shown on Figure 4.01-14. According to conversations with residents and the City, sump pump discharge to the street can be problematic during the winter months and cause an ice buildup on streets and driveways. Installation of a mini storm sewer could be investigated. Sump pump discharge pipes could be routed (underground) to a sump pump collection system located behind the curb and ultimately discharged into a storm sewer inlet. The installation of mini storm sewer systems could be incorporated into street reconstruction projects or as part of the alternatives suggested within this report.