# SECTION 5
# REVIEW OF EXISTING SANITARY SEWER DATA

## 5.01 PREVIOUS STUDIES AND REPORTS

### A. Review of Existing Information

The City has completed two “formal” collection system analyses over the last decade. In 1999, a *Sanitary Sewer Relief Plan* provided an analysis of selected storm and sanitary sewers in the City. This evaluation provides a summary of information relative to the sanitary sewers in the study area; pipe diameters, slopes, tributary areas, and estimated flow rates are presented in a tabular format. The report also presents some preliminary recommendations for potential short-term operational changes that could be implemented as well as potential long-term infrastructure modifications that could be installed to address localized flooding issues.

In 2007, a *Sanitary Sewer Flow Monitoring and Analysis* was completed. This study included flow monitoring within the collection system, analysis of the flow metering data, development of a hydraulic model, analysis of the existing collection system under wet weather conditions, and recommendations for potential infrastructure improvements.

In addition to these two evaluations, City personnel have collected flow metering and rain gauge data and completed manhole inspections, smoke testing, and sanitary sewer televising. A discussion of this information can be found in Section 5.02.

1. Sanitary Sewer Relief Plan (1999)

This study was completed to develop an emergency operation plan for the KWU for four trunk sewers that have experienced flooding within the City. Approximately 11,000 feet of interceptor sewers ranging in size from 6 to 18 inches were analyzed. Trunk Sewer No. 1 discharges into an 18-inch interceptor at the intersection of 54th Avenue and 60th Street (Trunk Sewer No. 1 combines with flows from the study area at the intersection of Pershing Boulevard and 60th Street). Trunk Sewer Nos. 2, 3, and 4 are located within the Forest Park study area and discharge into an 18-inch interceptor sewer at the intersection of 60th Street and Pershing Boulevard. The following summary was taken from the *Sanitary Sewer Relief Plan* and includes the description, capacity analysis results, and recommendations for Trunk Sewer Nos. 2, 3, and 4. A copy of pertinent report figures can be found in Appendix B. These figures show the locations of the various trunk sewers analyzed as part of the 1999 evaluation.

a. Trunk Sewer No. 2

Trunk Sewer No. 2 consists of 8- and 10-inch sewers and is located in 61st Street and Pershing Boulevard and flows from 54th Street to the connection with the 18-inch interceptor sewer at the intersection of 60th Street and Pershing Boulevard. No backups were reported along this trunk sewer during a storm on April 23, 1999, and four backups were reported after a storm on June 15, 1999. Ponding was observed over manholes 669 (61st Street and 51st Avenue) and 884 (61st Street and 48th Avenue). A capacity analysis of the sewer was completed and indicated surcharging when a simulated wet weather flow of 450 gpm was added to the design flow.

The report recommended the use of a 600 gpm portable bypass pump at manhole 884 (intersection of 61st Street and 48th Avenue) during intense rain events to relieve the sewer. The report also suggested (after system inspection, I/I removal, and flow monitoring) two potential permanent alternatives of relaying 2,600 feet of 8- to 10-inch sewer with 12-inch sewer from manhole 6090 to 669 or constructing a 500 gpm "peak flow" pumping station at manhole 885 with 725 feet of 6-inch force main discharging to the 18-inch interceptor sewer in 60th Street.

The report also included a cursory review of the storm sewer along 61st Street west of 49th Avenue, which indicated frequent surcharging during both 2- and 10-year storm events.

b. Trunk Sewer No. 3

Trunk Sewer No. 3 is an 8-inch-diameter sewer that flows north along 51st Avenue from 63rd Street to 61st Street where it discharges into Truck Sewer No. 2. Three basement backups were reported in this trunk sewer after the April 23, 1999, storm and six backups were reported after the June 15, 1999 storm (two of these homes reported backups from both storms).

The report indicates the surcharging along this sewer is likely related to the surcharging in Trunk Sewer No. 2.

The report also indicated a cursory review of the nearby storm sewer in 51st Avenue suggests the storm sewer is undersized for both 2- and 10-year storm events.

c. Trunk Sewer No. 4

Trunk Sewer No. 4 is an 8-inch-diameter sewer that flows north along 50th Avenue from 63 Street to 61st Street where it discharges into Trunk Sewer No. 2. Two basement backups were reported in this trunk sewer after the April 23, 1999, storm and one backup was reported after the June 15, 1999 storm.

The report indicates the surcharging along this sewer is likely related to the surcharging in Trunk Sewer No. 2.

The report also indicated a cursory review of the nearby storm sewer in 50th Avenue suggests the storm sewer is undersized for both 2- and 10-year storm events.

d. Recommendations

Following are the recommendations from the report:

(1) Conduct sewer manhole inspections and smoke testing of sewers in the service areas tributary to trunk sewers.

(2) Review and correct landscaping and drainage around residential structures susceptible to flooding.

(3) Initiate operation of new portable bypass pumps.

(4) Install flow monitors and manhole surcharge slide monitors in areas of suspected surcharging.

(5) Subscribe to weather forecasting service to predict likelihood of surcharging.

(6) Install Supervisory Control and Data Acquisition (SCADA) telemetry and a continuous surcharge monitoring station at manhole 2.09.

If backups and/or chronic bypassing persists after the completion of the above recommendations, the following long-term measures were recommended.

(1) Relay Trunk Sewer No. 2 as described above.
(2) Conduct public education program.
(3) Investigate undersized storm sewers.

2. Sanitary Sewer Flow Monitoring and Analysis for the Kenosha Water Utility (2007)

This study was completed to identify causes of high flows and actions necessary to relieve surcharging in the study areas. Fifteen flow meters were installed in various manholes; three of the meters were installed in the Forest Park Study Area. The following summary includes only information for the current Forest Park Study area (identified as Basin 1 in the 2007 report.) A copy of the pertinent report figures can be found in Appendix B.

a. Flow Metering

Flow meters were operable at most sites by March 9, 2005. The flow meters were removed on October 7, 2005. Because of dry weather, the flow meters were reinstalled at the same sites on March 9, 2006, and were removed October 31, 2006. Collected flow data was analyzed to determine base flow, instantaneous peak flow, 24-hour peak flow, and independent I/I. Wet weather inflow was projected for the 5-, 10-, 25-, and 50-year design storm events. The 3-hour 5-year storm and 3-hour 10-year storm were used for calibration and verification of the hydraulic model.

b. Basin Results

Basin 1 had three flow meters, B-5, B-6, and B-7, that were tributary to the Forest Park Study Area. The 24-hour peaking factors for B-5 (in 60th Street east of Pershing Boulevard), B-6 (in Pershing Blvd just south of 60th Street), and B-7 (just west of the intersection at 61st Street and 49th Avenue) were determined to be 3.7, 7.6, and 9.4, respectively. Instantaneous peaking factors were 7.2, 19.5, and 33.6, respectively. The high peaking factors for B-6 and B-7 indicated the potential for large volumes of I/I.

c. XPSWMM Modeling

An XPSWMM model was created for the study area. The model consisted of dry weather and wet weather inputs.

Dry weather inputs were derived by averaging three consecutive daily flows following a period of five days with little or no rain. Dry weather inputs were assigned to various manholes (sewersheds) in the study area, and model parameters (average per-capita or per-acre daily wastewater flow rates) were adjusted to match the model-simulated output to the measured flow.

Wet weather inputs were generated using projected design storm peak flow rates, based on monitored precipitation data. The time of concentrations, curve number, and basin areas were adjusted to calibrate the model for the 3-hour, 5-year projected design storm, and the 3-hour, 10-year projected design storm was used to verify the model. The calibrated model was then used to project the 3-hour, 50-year event used to develop the conveyance/storage alternatives.

d. Recommendations

(1) Infiltration/Inflow Removal

The report recommended reducing I/I in the sanitary sewer system. The report proposed sealing the manhole frame and chimney interface and installing solid gasketed manhole covers as two very cost-effective approaches. The report also recommended removing illegally connected sump pumps and downspouts.

(2) Conveyance/Storage Alternatives

The report provided recommendations for conveyance and storage alternatives. One conveyance recommendation was to replace the 10-inch sewers in 61st Street and Pershing Boulevard and 18-inch interceptor in 60th Street with 24-inch sewers. The proposed storage option to relieve the 61st Street trunk sewer was a 2.4-million-gallon storage facility between 49th and 46th Avenues.

## 5.02 CITY OF KENOSHA EXISTING INFORMATION

The City has collected flow metering data and rain gauge data and completed manhole inspections, smoke testing, and sanitary sewer televising.

### A. Flow Metering Data

Flow metering data was collected in 2008 at MH-5724 (also called location B-7, 4907 61st Street) and in 2009 at MH-5724 and MH-999 (for September and October, 65th Street and 48th Avenue). MH-5724 receives flow from the western half of the north basin and MH-999 from the entire south basin.

### B. Rain Gauge Data

The City has provided rain gauge data for the June 19, 2009, storm event from the wastewater treatment plant and Kenosha Water Utility (KWU). The wastewater treatment plant and KWU received approximately 4.06 inches and 3.45 inches of rain, respectively.

### C. Manhole Inspections

Manhole inspection reports were provided for the entire Forest Park Study Area. Section 3 presented an overview of the manhole inspection results.

### D. Smoke Testing

Smoke testing results were provided for the entire Forest Park Study Area. Section 3 presented an overview of the smoke testing results.

### E. Sanitary Sewer Televising

Sanitary sewer televising results were provided for many sewers in the study area. Section 3 presented an overview of the sewers televised and the results of the televising.

# SECTION 6
# ENGINEERING ANALYSIS: SANITARY SEWER

## 6.01 HYDRAULIC ANALYSIS

### A. Purpose of Evaluation

A sanitary sewer system model was developed for two basins (referred to as the north and south basins) in the Forest Park study area. Figure 6.01-1 shows the study area limits, the existing sanitary sewers in the area, and the location of previously installed flow meters. Figure 6.01-2 shows the sewers included in the hydraulic model. The hydraulic model was used to estimate flow rates and depths in the sanitary sewer system based on flow metering data and sewer system characteristics. The model evaluation was used to develop an overall understanding of the operation of the existing collection system under a variety of wet weather conditions. The results of this evaluation are discussed in this section. The model was also used to evaluate conveyance alternatives for the study area. The alternatives analysis is presented in Section 8.

### B. Methodology

For the sanitary sewer evaluation, the computer software XPSWMM was utilized. This software allows the user to evaluate the operation of a collection system under surcharged and nonsurcharged conditions.

Dry and wet weather input hydrographs based on historical flow metering data were developed for this evaluation. 2008 and 2009 flow metering data was available from the City at the flow meter location B-7, located in the north basin. Flow metering results for three locations in the north basin (B-5, B-6, and B-7) from 2005 and 2006 were also available. Figure 6.01-1 shows the location of the flow meters.

Flow metering data was available for MH-999 (referred to as S-1) for September and October 2009. This metering location is in the south basin of the Forest Park study area. Figure 6.01-1 shows the location of this flow meter.

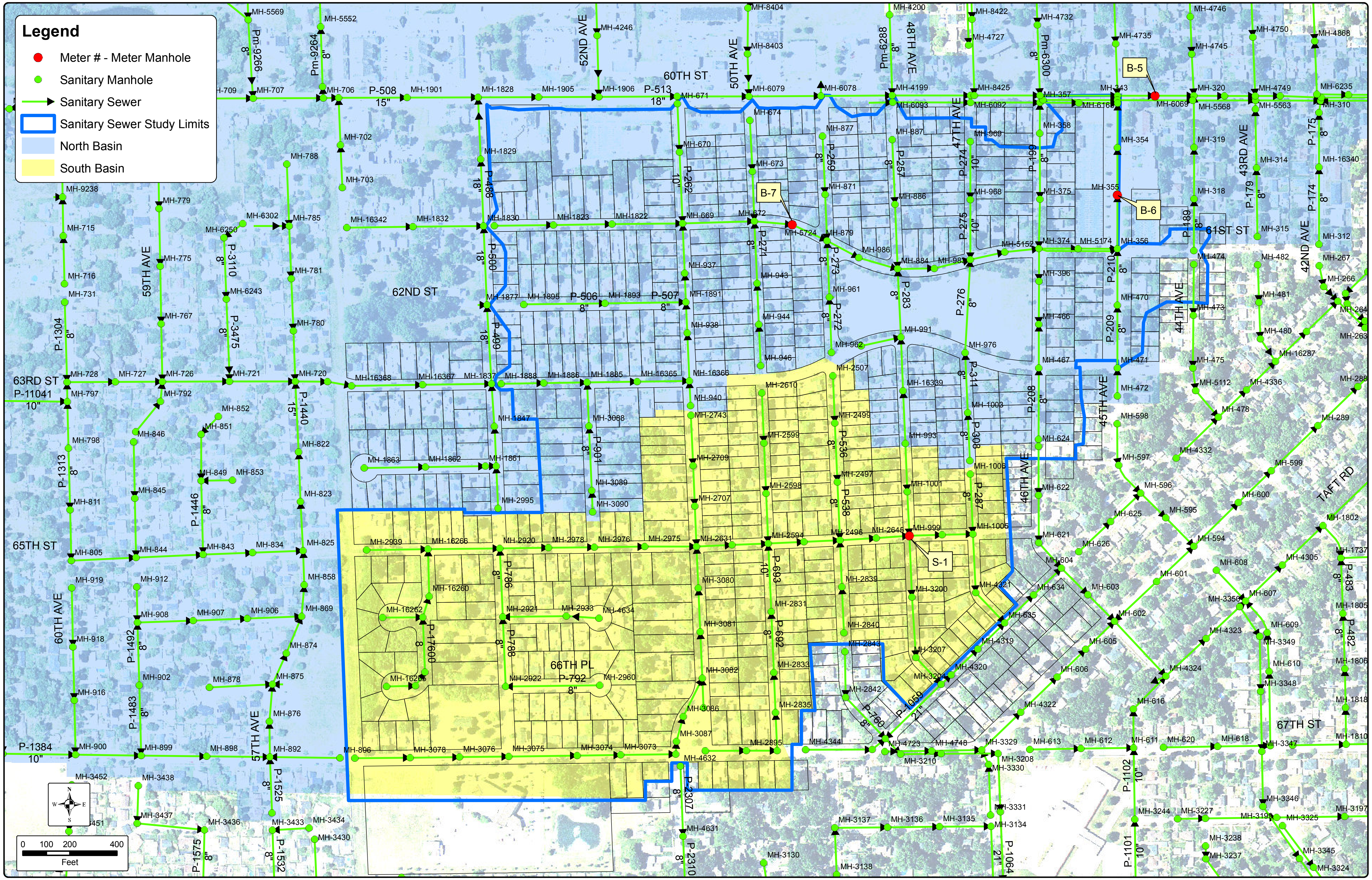
Table 6.01-1 summarizes the theoretical rainfall intensities associated with the various rainfall events included in the analysis. Rainfall intensities were used in conjunction with flow metering data to develop wet weather model input hydrographs for various design storms. This is discussed in more detail later in this section.

| Recurrence Interval | Theoretical Rainfall Intensity[1] (in/hr) |
|---|---|
| 6-month | 1.42 |
| 1-year | 1.74 |
| 2-year | 2.14 |
| 5-year | 2.58 |
| 10-year | 2.90 |
| 25-year | 3.36 |
| 50-year | 3.70 |
| 100-year | 4.04 |

[1] SEWRPC Technical Memo No. 40–Rainfall Frequency in the Southeastern Wisconsin Region.

**Table 6.01-1 Theoretical Rainfall Intensities**

The hydraulic model was used to calculate the hydraulic capacity of the existing sanitary sewer system under existing conditions. Figure 6.01-2 shows the sewers included in the hydraulic model, along with the flow metering locations. Figure 6.01-3 shows a schematic of the sanitary sewer network as modeled, including pertinent pipe and manhole information. Input to the hydraulic model includes the following:



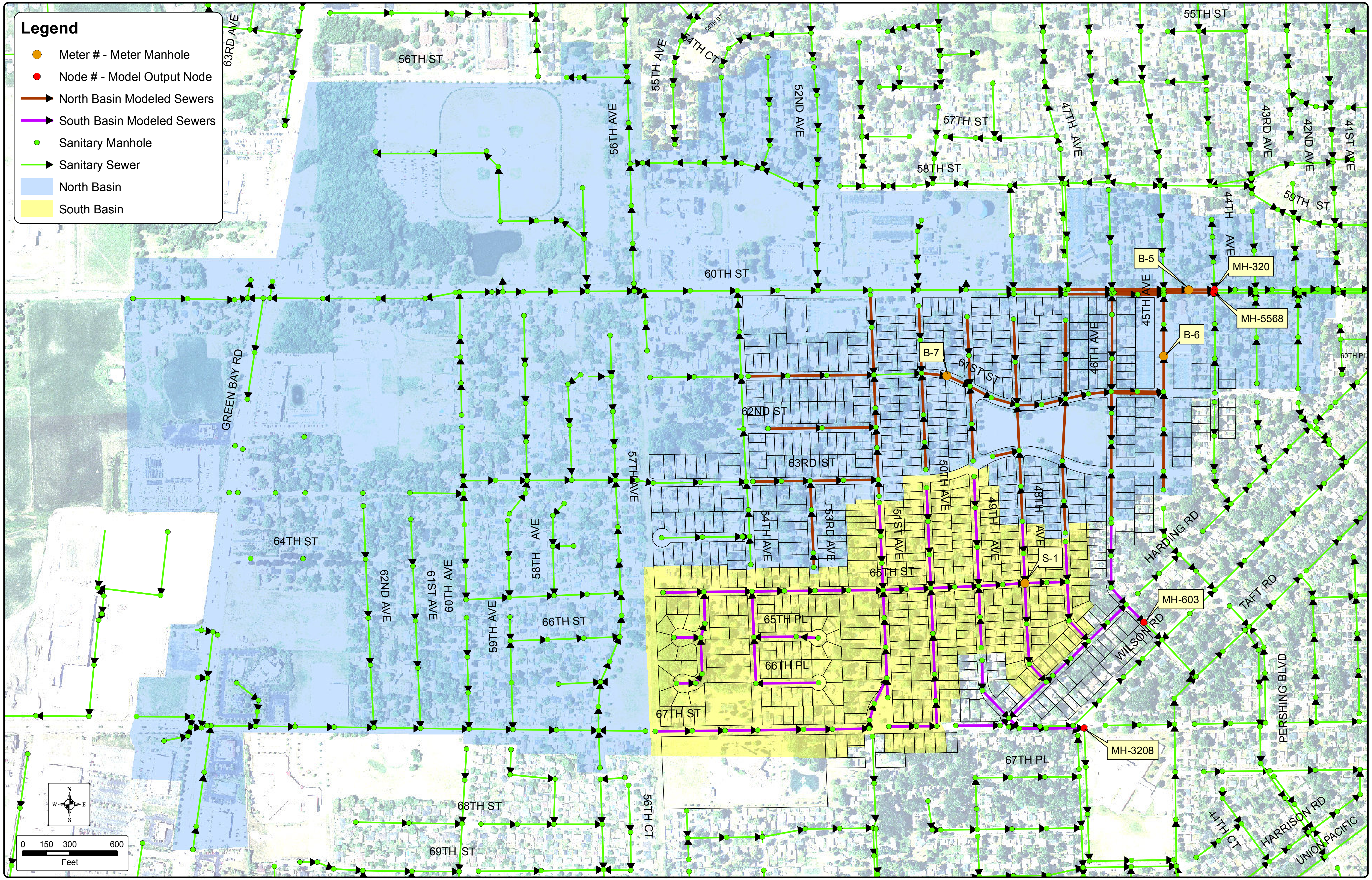

SANITARY SEWER STUDY LIMITS

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

STRAND ASSOCIATES, INC.® ENGINEERS

FIGURE 6.01-1
1540.001

S:\MAD\1500--1599\1540\001\Data\GIS Data\Figures\Sewer Analysis\Figure 6.01-1 - Sanitary Study Limits 11x17.mxd



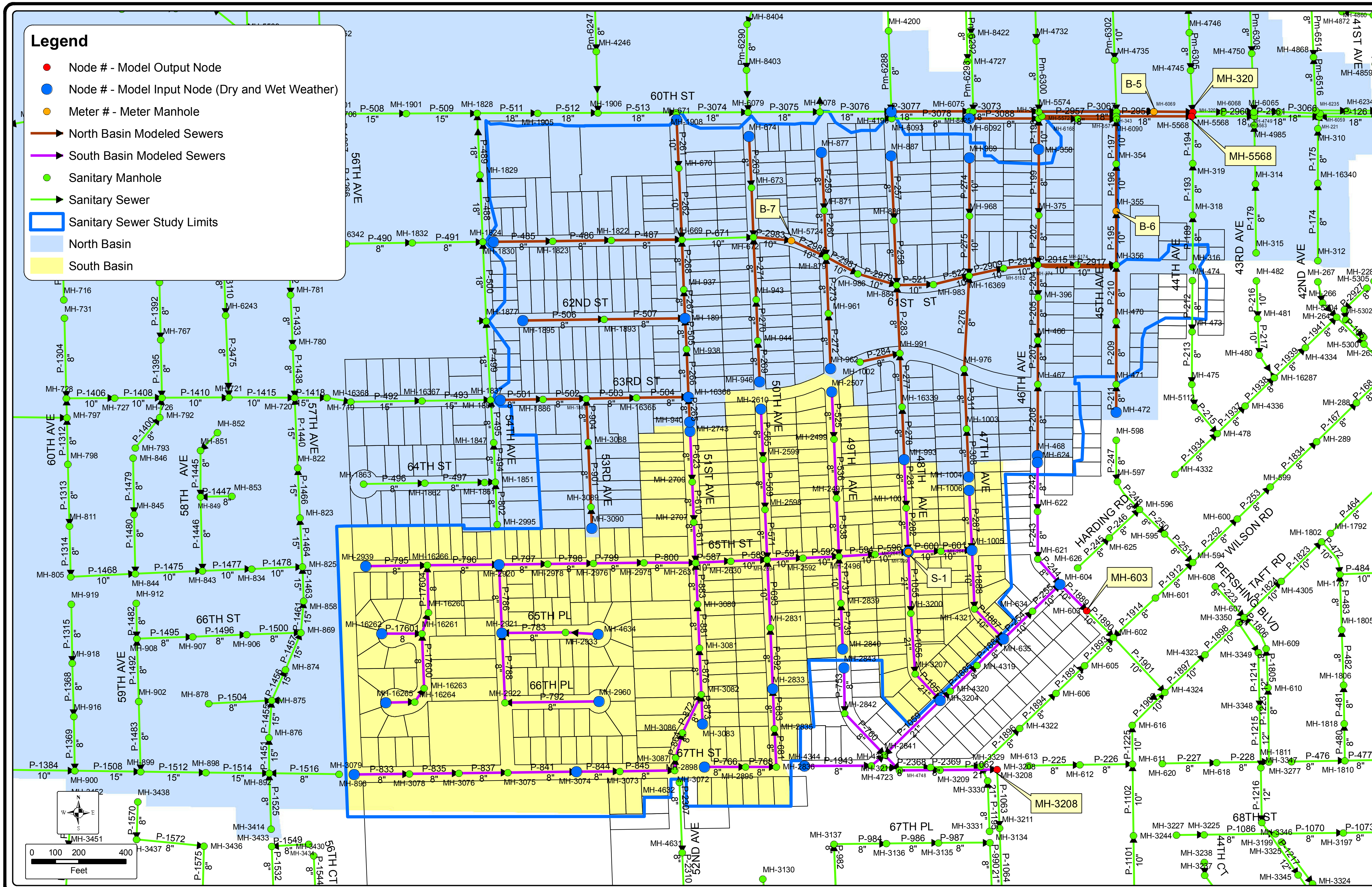

**MODELED SEWERS**

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

STRAND ASSOCIATES, INC.® ENGINEERS

FIGURE 6.01-2
1540.001

S:\MAD\1500--1599\1540\001\Data\GIS Data\Figures\Sewer Analysis\Figure 6.01-2 - Modeled Sewers 11x17.mxd




MODEL SCHEMATIC

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

STRAND ASSOCIATES, INC.® ENGINEERS

FIGURE 6.01-3
1540.001

S:\MAD\1500--1599\1540\001\Data\GIS Data\Figures\Sewer Analysis\Figure 6.01-3 - Model Schematic 11x17.mxd

- The physical geometry of the sanitary sewer system, including pipe sizes and shapes, and ground and invert elevations. For this project, physical information regarding the sanitary system was obtained from the City's sanitary sewer GIS layer along with record drawing information provided by the City.

- Roughness coefficients for existing sewers (referred to as conduits in the model).

- Input hydrographs at critical manholes (referred to as nodes in the model) in the system. For this project, hydrographs were computed using existing flow metering data.

- Boundary conditions defining starting water surface elevations and outlet conditions. For the north basin, the downstream boundary condition was an assumed water surface elevation in the sewers located in 60th Street. For the south basin, the downstream boundary condition was assumed water surface elevations in manholes 603 and 3208 (Refer to Figure 6.02-2).

- Appendix C contains tabular data associated with the sanitary sewer hydraulic model.

Output information from the Extended Transport (EXTRAN) model includes the following:

- Time histories of flows and depths through individual sanitary sewer pipes for various modeled dry and wet weather events.

- Estimates of wastewater volumes in the system at various locations for wet weather events. This can be used to size potential wet weather storage facilities.

1. Dry Weather Model Input

Dry weather average daily base flow at metering locations B-7 and S-1 was determined by averaging all flow data from days where there was no measured rainfall and the metered flows did not exhibit elevated base flows due to previously documented wet weather. Based on this methodology, the dry weather average daily base flows for B-7 and S-1 were determined to be 21 gpm and 34 gpm, respectively.

Dry weather peak base flow for areas between metering locations B-7 and B-6 was determined to be approximately 2.5 times the average daily base flow observed in B-7 based on historical flow metering information. This is based on a comparison of B-6 and B-7 during the 2005 to 2006 metering session. A dry weather peak base flow of 21 gpm x 2.5 = 52.5 gpm was used.

Dry weather peak base flow for tributary areas upstream of metering location B-5 and Pershing Boulevard was assumed to be 709 gpm based on historical flow metering results. Although the majority of the sewers located in the B-5 basin were not included in the computer model, it was necessary to determine the flows in the 60th Street sewers, since the north basin of the study area discharges to the 60th Street sewers and, therefore, impacts the model and the operation of the sewers in the study area. Refer to Figures 6.01-1 through 6.01-3 for a delineation of the modeled sewers and the sewers tributary to the Pershing Boulevard/60th Street intersection.

The hydraulic model requires that the dry weather daily diurnal variation in flow be entered. The diurnal flow variation documents the routine changes in wastewater flow rate that occur throughout a typical day. Peak dry weather flows typically occur in the morning (7 to 9 A.M. ±) with another smaller peak in the evening as residents return home. Historical flow metering was used to document the daily diurnal flow variation at metering locations B-7 and S-1. The diurnal pattern of flow variation for Meter B-7 was then used to develop dry weather flow input diurnal variations in the north basin, while the diurnal variation at Meter S-1 was used to develop dry weather inputs in the south basin.

Dry weather flows were entered at selected nodes (manholes) for each basin. For the north basin a percentage flow for each node was calculated by summing the number of homes tributary to the selected node. For example, 12 homes are tributary to MH-3090 (located in the north basin) out of 146 homes tributary to flow meter B-7. Thus, the dry weather flow for MH-3090 is:

[(12 homes/146 homes) * (21 gpm) = 1.7 gpm]

For the south basin a percentage flow for each node was calculated for two tributaries. The tributary area upstream of MH-2920 includes recently constructed subdivisions where more typical amounts of I/I are expected. The tributary area downstream of MH-2920 includes older homes where higher amounts of I/I would be expected. Refer to the following wet weather model input section for additional detail on calculating the percentage flow for each node in the south basin.

Figure 6.01-3 shows the location of dry weather flow input manholes.

2. Wet Weather Model Input

Wet weather inputs for Basin B-7 were obtained from 15-minute flow metering data provided by the City. The June 19, 2009, rainfall event was utilized as the base modeled storm event (Appendix D contains an analysis of the rainfall and flow metering information associated with the June 19, 2009 event). The flow metering data was used to obtain hydrographs for the rainfall event. Wet weather flows were distributed to the same nodes that received dry weather inputs and the same flow distribution methodology was used as previously described for the north basin. For example, 12 homes are tributary to MH-3090 out of 146 homes tributary to Basin B-7. Thus, the 15-minute flow metering data for MH-3090 is:

[(12 homes/146 homes) x (15 minute measured flow [cfs])] = MH-3090 Wet Weather Input (cfs).

Flow metering data obtained from the June 19, 2009, storm event was used directly as wet weather input for nodes upstream of Meter B-7.

For the south basin, the peak flow from the area tributary to MH-2920 was determined using conventional design parameters since this area consists of newer homes with more typical I/I expected. The peak flow is shown below: A peaking factor of 4 was assumed.

Peak Flow = 100 gpcd x 2.54 people/home x 4 x 67 homes = 68,072 gal/day.

This peak flow rate was divided by the estimated 100-year flow rate at metering point S-1 to determine the percentage of flow to MH-2920.

68,072 gal/day/3,100,000 gal/day = 0.022 (2.2%) (Percentage of S-1 Flow tributary to MH-2920)

Using the percentage above, wet weather and dry weather flows were distributed to each input node by summing the number of homes tributary to the selected node. For example, 8 homes are tributary to MH-2921 out of 67 homes tributary to the MH-2920 basin. Therefore, the wet weather flow to MH-2921 is:

(8 homes/67 homes) x 0.022 x 68,072 gpd = 179 gpd

Flow metering data was not available for the June 19, 2009, storm event for Basins B-6 and B-5 (The metering data available for these basins was during 2005 and 2006). However, existing flow metering data from the 2005/2006 flow metering period was used to compare the responses of the basins during a wet weather event.

Table 6.01-2 shows two methods that were used to determine theoretical peak flows for Basin B-6. Previous evaluations of the study area utilized a rainfall event that occurred on March 13, 2006. This was the rainfall event that resulted in the largest rainfall-induced peak flow during the 2005 to 2006 metering period. A comparison of the instantaneous peak flow metered for Basin B-6 and Basin B-7 in March 2006 indicates a peak flow ratio of 0.86.

An alternative method for comparing theoretical peak flows from tributary areas is to compare the total number of homes tributary to each flow meter. Table 6.01-2 compares the number of homes tributary to each basin. The tributary home ratio of Basin B-6 to Basin B-7 is 0.96.

These two comparisons, a peak flow ratio and a tributary home ratio, indicate the anticipated peak flows from Basin B-6 would be expected to be slightly less than the flows from Basin B-7. Given the uncertainty associated with flow metering, I/I sources, and other factors, it was conservatively assumed the flow for Basin B-6 would be equal to the flow from Basin B-7.

| Meter Location/ Basin ID | Instantaneous Peak Flow[1] (gpm) | Tributary Homes |
|---|---|---|
| B-6 | 649 | 140 |
| B-7 | 754 | 146 |
| Ratio–B-6/B-7 | 0.86 | 0.96 |

[1] For March 13, 2006, rainfall event.

**Table 6.01-2 Basin Comparison–Basins B-6 and B-7**

| Meter Location / Basin ID | Instantaneous Peak Flow[1] (gpm) | Tributary Homes |
|---|---|---|
| B-5 | 5,094 | 964 |
| B-7 | 754 | 146 |
| Ratio–B-5/B-7 | 6.76 | 6.60 |

[1] For March 13, 2006, rainfall event.

**Table 6.01-3 Basin Comparison–Basins B-5 and B-7**

A similar procedure was used to develop an estimated peak flow from Basin B-5. Table 6.01-3 show the two methods used in the Basin B-5 analysis. Based on the peak flow and tributary home comparison, Basin B-5 peak flows were assumed to be 7.0 times the peak flows from Basin B-7.

For Basin S-1, flow metering data was not available for the June 19, 2009, storm event, nor was there data available for 2005/2006. Data was available for September/October 2009.

Table 6.01-4 presents a comparison of wet weather daily average flow and instantaneous peak flow for Basins S-1 and B-7. It is recommended that additional flow metering data be obtained for Basin S-1 to confirm the assumptions used in the modeling.

| Meter Location/ Basin ID | Dry Weather Base Flow (gpm) | Wet Weather Daily Average Flow[1] (gpm) | Instantaneous Peak Flow (gpm) | Tributary Homes |
|---|---|---|---|---|
| S-1 | 34 | 320 | 560 | 267 |
| B-7 | 21 | 202 | 360 | 146 |
| Ratio–S-1/B-7 | 1.62 | 1.58 | 1.56 | 1.83 |

[1] For October 23, 2009 rainfall event.

**Table 6.01-4 Basin Comparison–Basins S-1 and B-7**

To further evaluate and compare the two basins, the ratio of wet weather average to dry weather base flow and the ratio of instantaneous peak flow to dry weather base flow were compared for the October rainfall event. Table 6.01-5 summarizes this comparison.

| Meter Location/ Basin ID | Dry Weather Base Flow (gpm) | Wet Weather Daily Average Flow[1] (gpm) | Ratio–Wet Weather Average to Dry Weather Base | Instantaneous Peak Flow (gpm) | Ratio–Instantaneous Peak to Dry Weather Base |
|---|---|---|---|---|---|
| S-1 | 34 | 320 | 9.4 | 560 | 16.5 |
| B-7 | 21 | 202 | 9.6 | 360 | 17.1 |

[1] For October 23, 2009 rainfall event.

**Table 6.01-5 Basin Comparison–Basins S-1 and B-7**

The comparisons presented in Table 6.01-5 indicate the two basins responded in a similar fashion to the October 2009 rainfall event. Therefore, metered peak flows for Basin B-7 were multiplied by two to approximate the peak flows in Basin S-1. Given the ratios established in Table 6.01-4 (1.56 to 1.8), this should represent a slightly conservative approach to approximating these flows.

It should be noted that development of the peak flow approximations was required because flow metering information was not available for all metering sites for the June 19, 2009, rainfall event. This necessitated the development of ratios comparing B-7 and other previously metered basins. KWU staff continue to maintain flow meters in the study area and continue to gather wet weather data that adds to the understanding of the operation of the sanitary sewers during wet weather. Prior to design of any collection system improvements, all available flow metering information should be reevaluated, and a final design flow should be established for all improvements. This may require additional flow metering data. It is worth noting that KWU staff continue to identify and remove sources of I/I in the sanitary sewer system, thereby potentially reducing the peak wet weather flow in the system. Since historical flow metering results do not reflect these reductions in I/I and peak flow rates, more current flow metering data would be particularly valuable.

3. Design Storm Development

Wet weather flow inputs for various recurrence interval rainfall events were developed using a ratio of SEWRPC rainfall data to the June 19, 2009 rainfall. The June 19, 2009, event was determined to be approximately a 50-year event (refer to Appendix D for an analysis of the June 19, 2009 rainfall event). The estimated maximum rainfall intensity associated with the June 19, 2009, rainfall event was 3.76 inches/hour.

Table 6.01-6 documents the ratios utilized to scale the peak flow inputs for the June 19, 2009, rainfall event to other rainfall recurrence interval events.

| Recurrence Interval | SEWRPC Theoretical Rainfall Rate[1] (in/hr) | Ratio–SEWRPC Theoretical Rainfall Rate to June 19, 2009 Base Event[2] |
|---|---|---|
| 6-month | 1.42 | 0.384[3] |
| 1-year | 1.74 | 0.470 |
| 2-year | 2.14 | 0.578 |
| 5-year | 2.58 | 0.697 |
| 10-year | 2.90 | 0.784 |
| 25-year | 3.36 | 0.908 |
| 50-year | 3.70 | 1.000 |
| 100-year | 4.04 | 1.092 |

[1]Rainfall rate in inches per hour as published for a rainfall event with a duration of 30 minutes.
[2]Assumes June 19, 2009, rainfall event recurrence interval of 50 years. Refer to Appendix D.
[3]Six-month ratio computed as 1.42 ÷ 3.70 = 0.384.

**Table 6.01-6 Ratio–June 19, 2009, Rainfall to SEWRPC Theoretical Events**

C. Model Calibration

Following the development and distribution to nodes of the dry weather flow inputs, the model was run. Output of the model was reviewed to compare modeled dry weather flows to flow rates metered in the system (including estimated "metered" flow rates as developed in Section 6.01(B)(1). A comparison of total calculated dry weather flow with dry weather model results is presented in Table 6.01-7.

| Flow Meter | Location | Peak Calculated Flow (gpm) | Modeled Flow (gpm) |
|---|---|---|---|
| B-7 (MH-5724) | 61st Street Between 49th Ave. and 50th Ave. | 34 | 33 |
| B-6 (MH-355) | 45th Ave. North of 61st Street | 118 | 116 |
| B-5 (MH-6069) | 60th Street East of 45th Ave. | 1,134 | 1129 |
| S-1 (MH-999) | Intersection of 48th Ave. and 65th Street | 51 | 50 |

**Table 6.01-7 Comparison Modeled vs. Metered Flow–Dry Weather**

In a similar fashion, wet weather flow inputs were distributed for the June 19, 2009, rainfall event and the model was run. Table 6.01-8 presents a comparison of total calculated wet weather flow with wet weather model results.

| Flow Meter | Location | Peak Calculated Flow (gpm) | Modeled Flow (gpm) |
|---|---|---|---|
| B-7 (MH-5724) | 61st Street Between 49th Ave. and 50th Ave. | 930 | 931 |
| B-6 (MH-355) | 45th Ave. North of 61st Street | 1,892 | 1,912 |
| B-5 (MH-6069) | 60th Street East of 45th Ave. | 7,072 | 7,661 |
| S-1 (MH-999) | Intersection of 48th Ave. and 65th Street | 1,852 | 1,897 |

**Table 6.01-8 Comparison of Modeled vs. Metered Flow–Wet Weather**

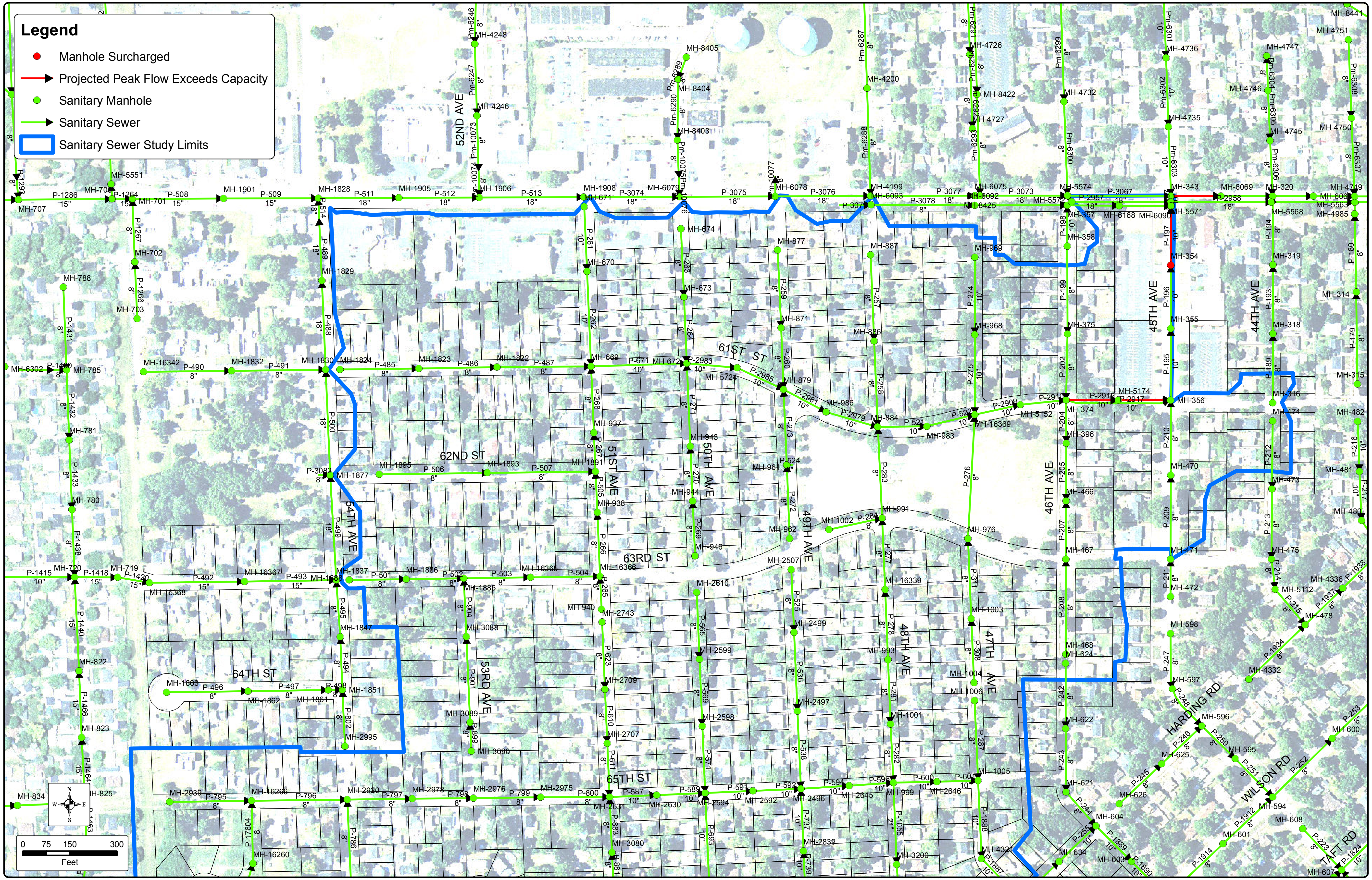
## 6.02 HYDRAULIC ANALYSIS–EXISTING SANITARY SEWER SYSTEM

Design Storm Evaluation

The hydraulic model was used to model the north and south basin wet weather response to a selection of design storm events. The June 19, 2009, event was used as a base storm event for the model. Tables 6.02-1 and 6.02-2 are a comparison of the peak dry and wet weather data from the June 19, 2009, storm event at each sewer and manhole, including peak flows in sewers and peak water depths in manholes.

The results of the north basin modeling are shown on Figures 6.02-1 through 6.02-8 and listed in Tables 6.02-3 through 6.02-10. The results of the south basin modeling are shown in Figures 6.02-9 through 6.02-16 and listed in Tables 6.02-11 through 6.02-18. One figure and one table were developed for each design storm event for each basin in the study area. The figures show surcharged manholes and sewers where the projected peak flow exceeds the sewer capacity (assumes full pipe flow) for the design rain event. The table associated with each rain event lists surcharge depths in critical manholes, along with a summary of the overall performance of the system.

The north basin modeling results indicate surcharging for all eight modeled design storms. The 6-month and 1-year design storms indicate relatively minor surcharging that may not require conveyance improvements to handle the projected peak flows during those design storms. The 2-year design storm predicts surcharging along 61st Street (between Pershing Boulevard and 46th Street), Pershing Boulevard, and 60th Street with surcharging over 1.0 foot in Pershing Boulevard (MH-354). The 5-year design storm predicts surcharging along 61st Street (between Pershing Boulevard and 50th Street), Pershing Boulevard, and 60th Street with surcharge levels over 2 feet in Pershing Boulevard (MH-355) and 61st Street (MH-5174). The 10-year, 25-year, 50-year, and 100-year design storms predict surcharging along 61st Street, Pershing Boulevard, and 60th Street. Maximum surcharge levels for the 100-year design storm are predicted at approximately 10 feet in MH-672 and MH-5724.



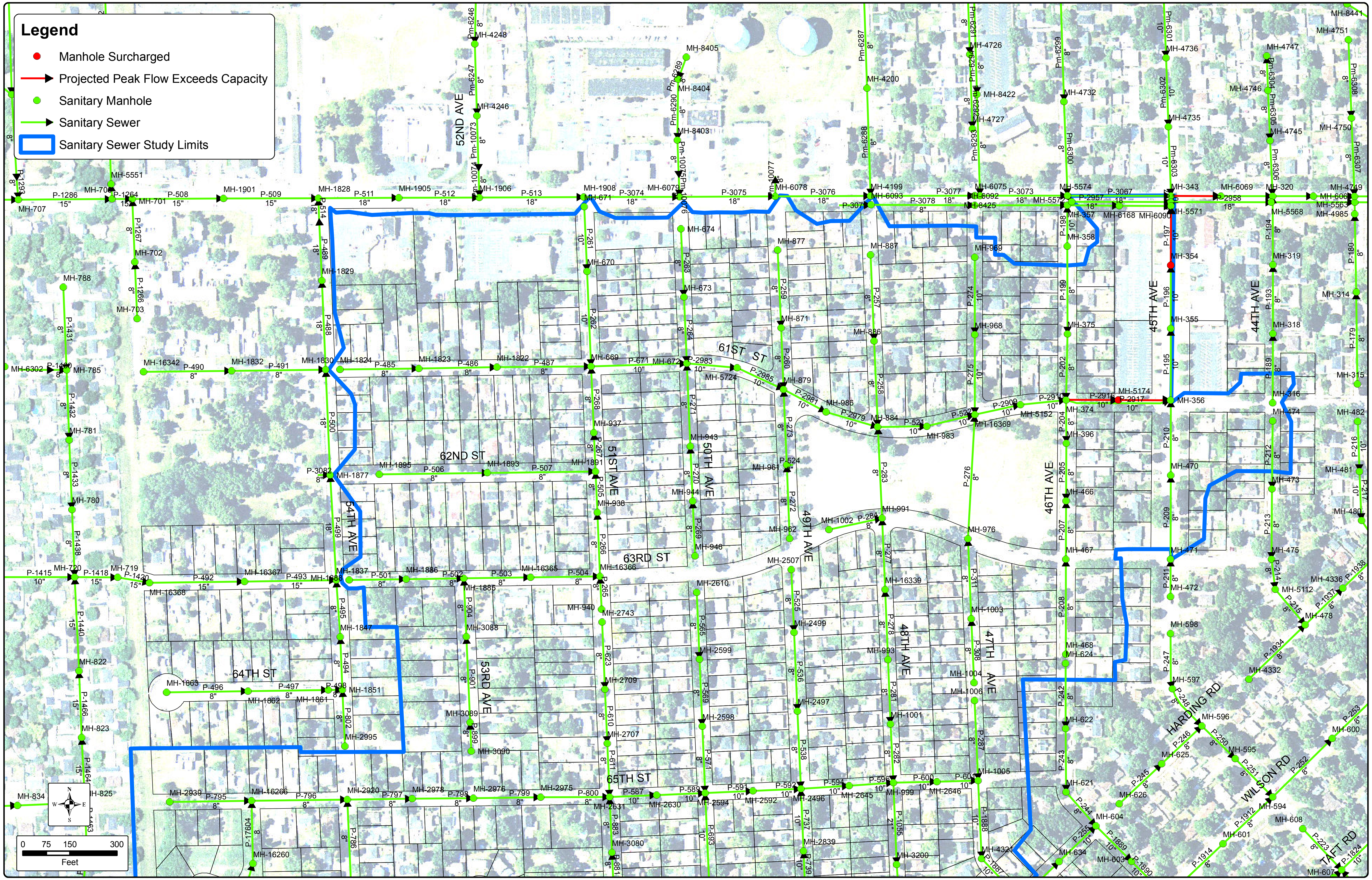

**NORTH BASIN - SANITARY SEWER CAPACITY EVALUATION**
**6-MONTH RECURRENCE INTERVAL EVENT**

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

STRAND ASSOCIATES, INC.® ENGINEERS

FIGURE 6.02-1
1540.001

S:\MAD\1500--1599\1540\001\Data\GIS Data\Figures\Sewer Analysis\Sewer Analysis 031510\Figure 6.02-1 - 6Month Existing North 11x17.mxd



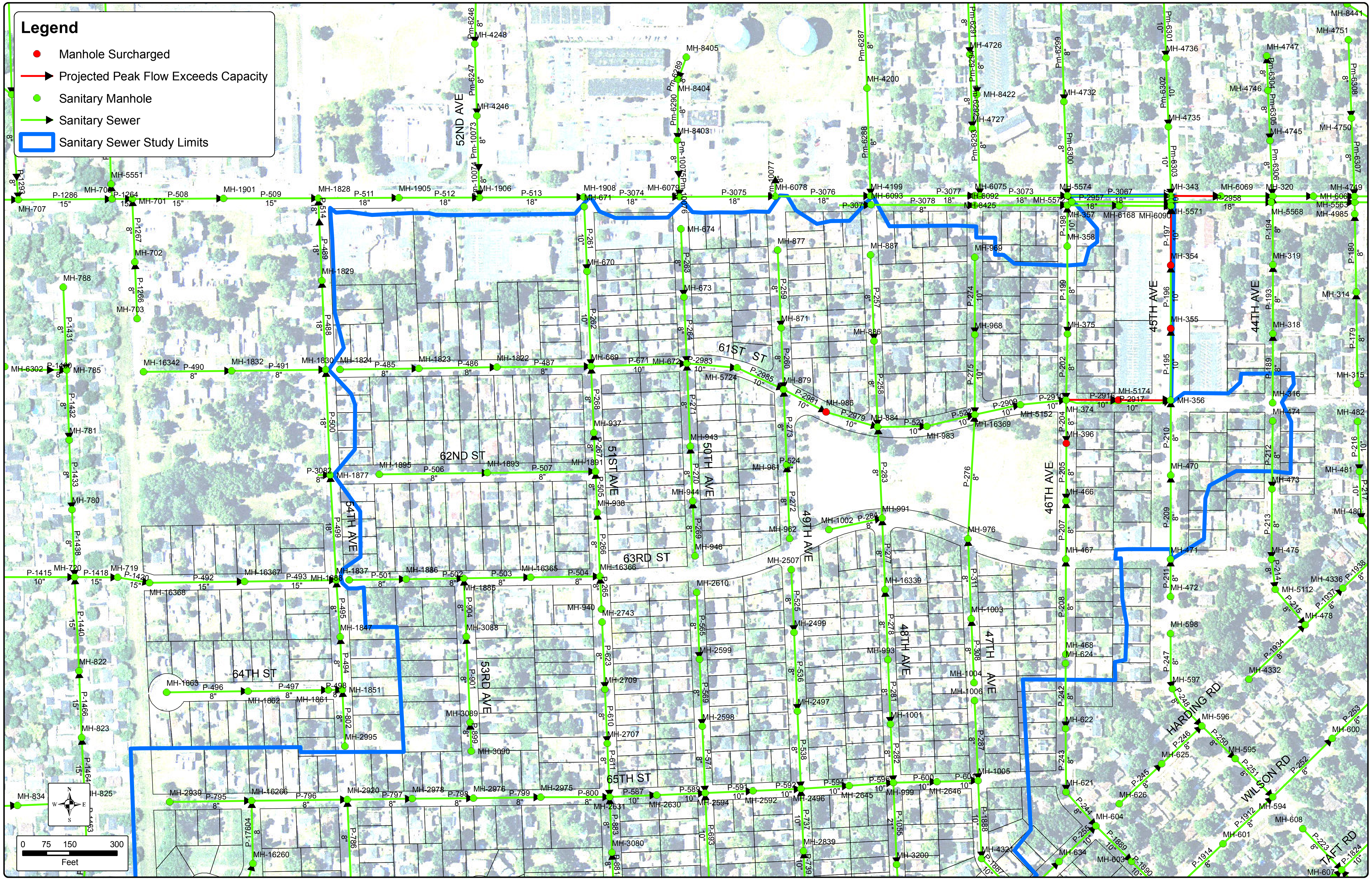

**NORTH BASIN - SANITARY SEWER CAPACITY EVALUATION**
**1-YEAR RECURRENCE INTERVAL EVENT**

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

STRAND ASSOCIATES, INC.®
ENGINEERS

FIGURE 6.02-2
1540.001

S:\MAD\1500--1599\1540\001\Data\GIS Data\Figures\Sewer Analysis\Sewer Analysis 031510\Figure 6.02-2 - 1Year Existing North 11x17.mxd



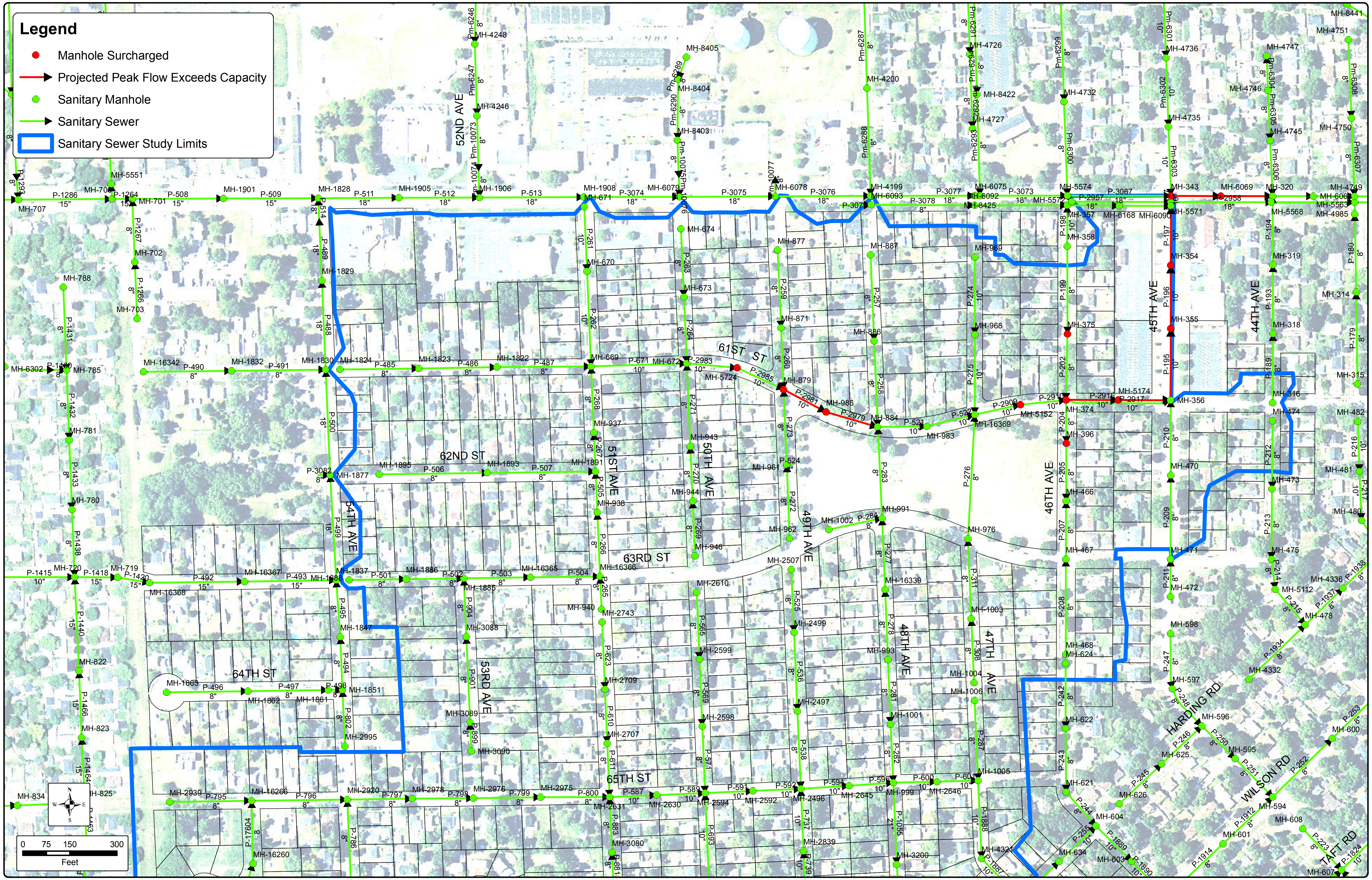

NORTH BASIN - SANITARY SEWER CAPACITY EVALUATION
2-YEAR RECURRENCE INTERVAL EVENT

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

STRAND ASSOCIATES, INC.® ENGINEERS

FIGURE 6.02-3
1540.001

S:\MAD\1500--1599\1540\001\Data\GIS Data\Figures\Sewer Analysis\Sewer Analysis 031510\Figure 6.02-3 - 2Year Existing North 11x17.mxd



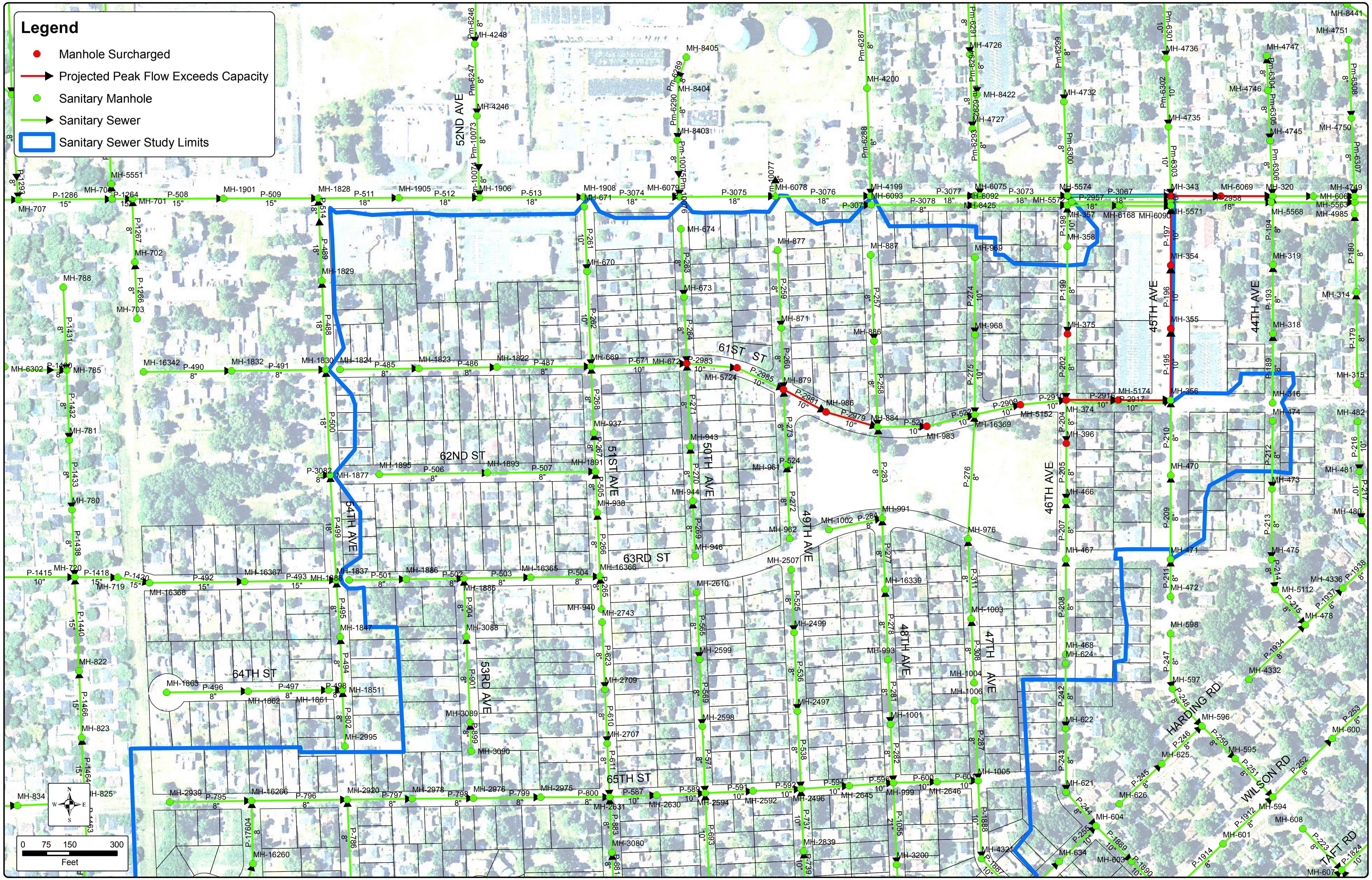

**NORTH BASIN - SANITARY SEWER CAPACITY EVALUATION**
**5-YEAR RECURRENCE INTERVAL EVENT**

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

STRAND ASSOCIATES, INC.®
ENGINEERS

FIGURE 6.02-4
1540.001

S:\MAD\1500--1599\1540\001\Data\GIS Data\Figures\Sewer Analysis\Sewer Analysis 031510\Figure 6.02-4 - 5Year Existing North 11x17.mxd



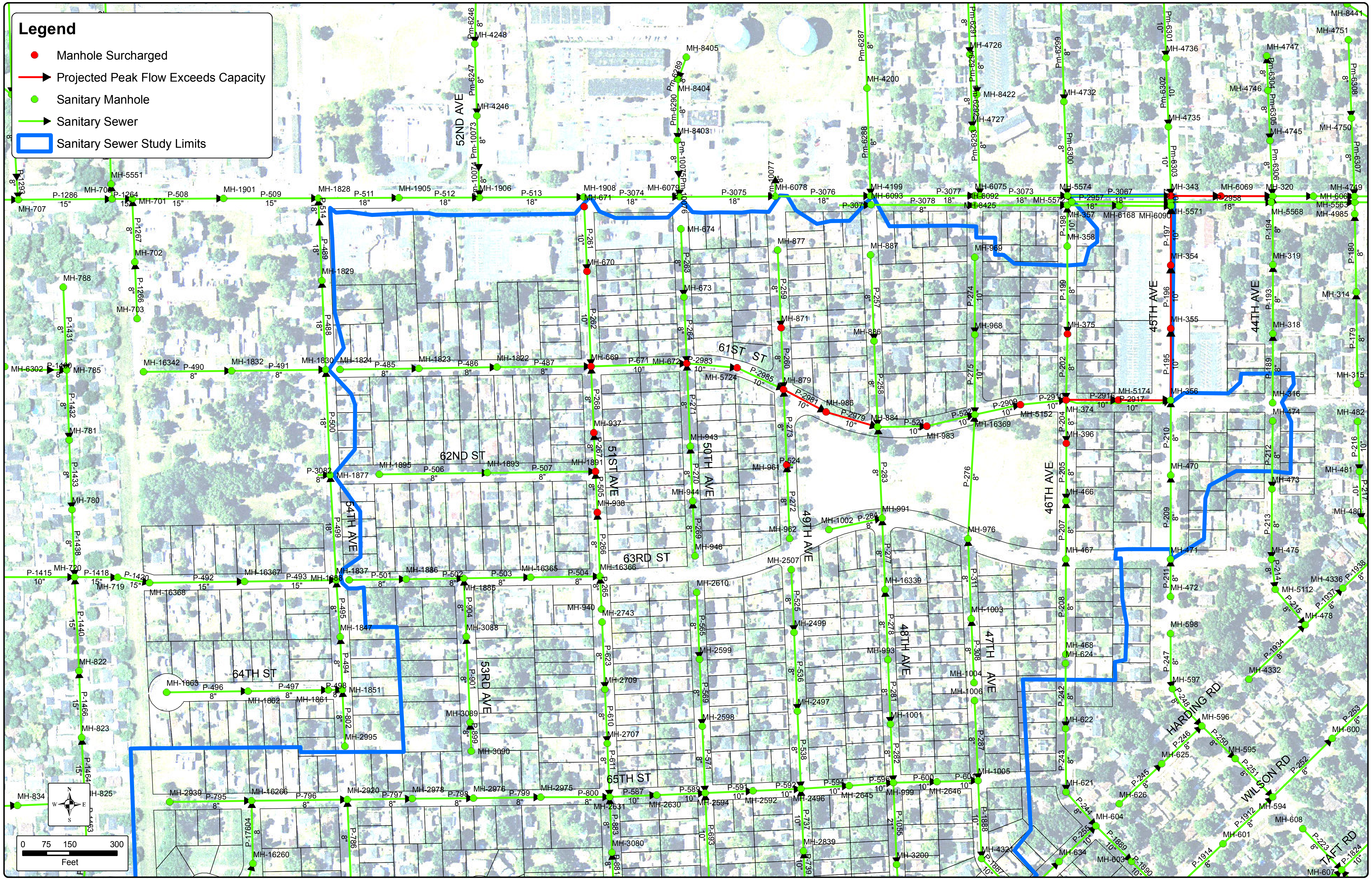

NORTH BASIN - SANITARY SEWER CAPACITY EVALUATION
10-YEAR RECURRENCE INTERVAL EVENT

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

STRAND ASSOCIATES, INC.® ENGINEERS

FIGURE 6.02-5
1540.001

S:\MAD\1500--1599\1540\001\Data\GIS Data\Figures\Sewer Analysis\Sewer Analysis 031510\Figure 6.02-5 - 10Year Existing North 11x17.mxd



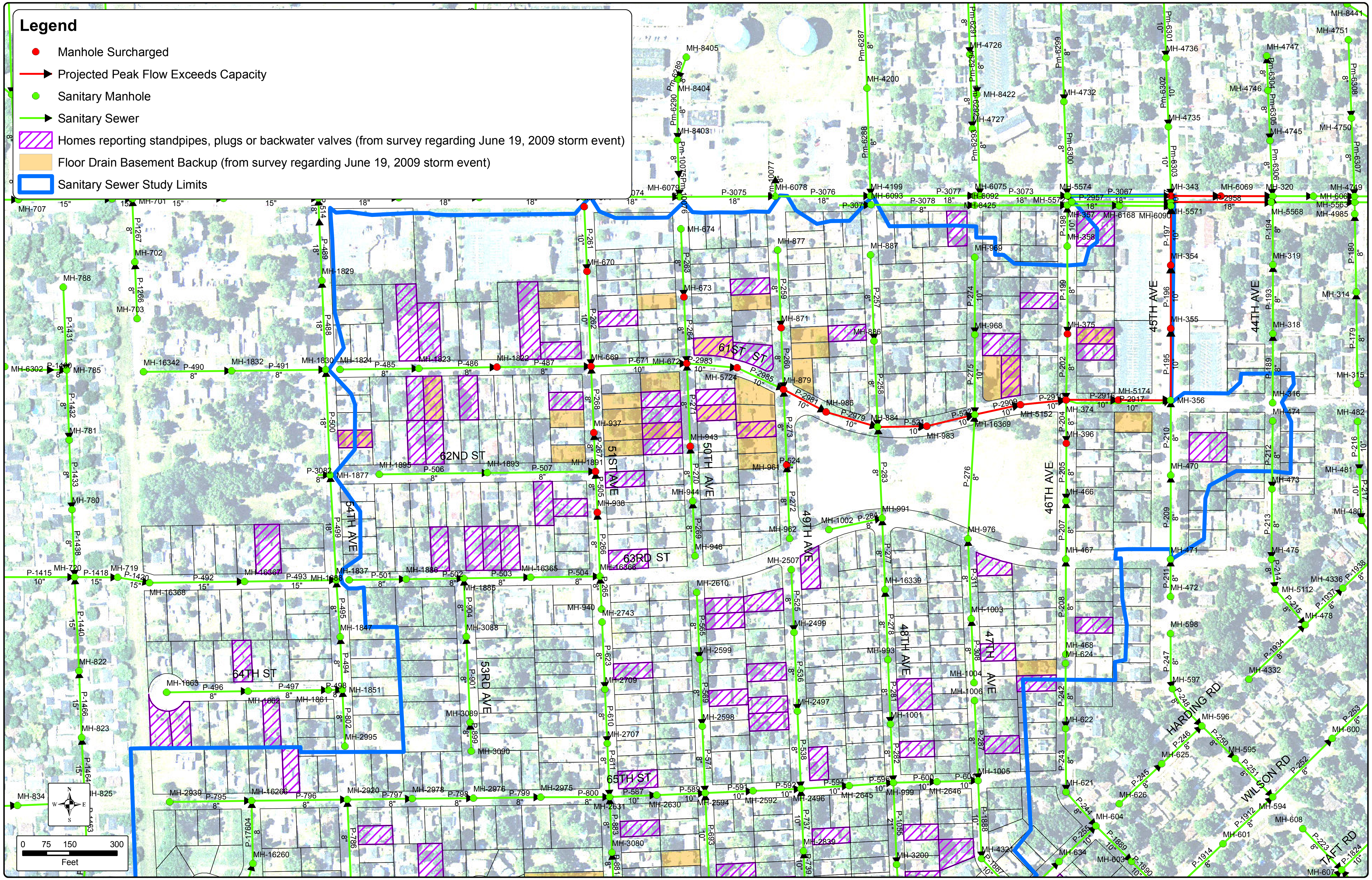

NORTH BASIN - SANITARY SEWER CAPACITY EVALUATION
25-YEAR RECURRENCE INTERVAL EVENT

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

STRAND ASSOCIATES, INC.®
ENGINEERS

FIGURE 6.02-6
1540.001

S:\MAD\1500--1599\1540\001\Data\GIS Data\Figures\Sewer Analysis\Sewer Analysis 031510\Figure 6.02-6 - 25Year Existing North 11x17.mxd



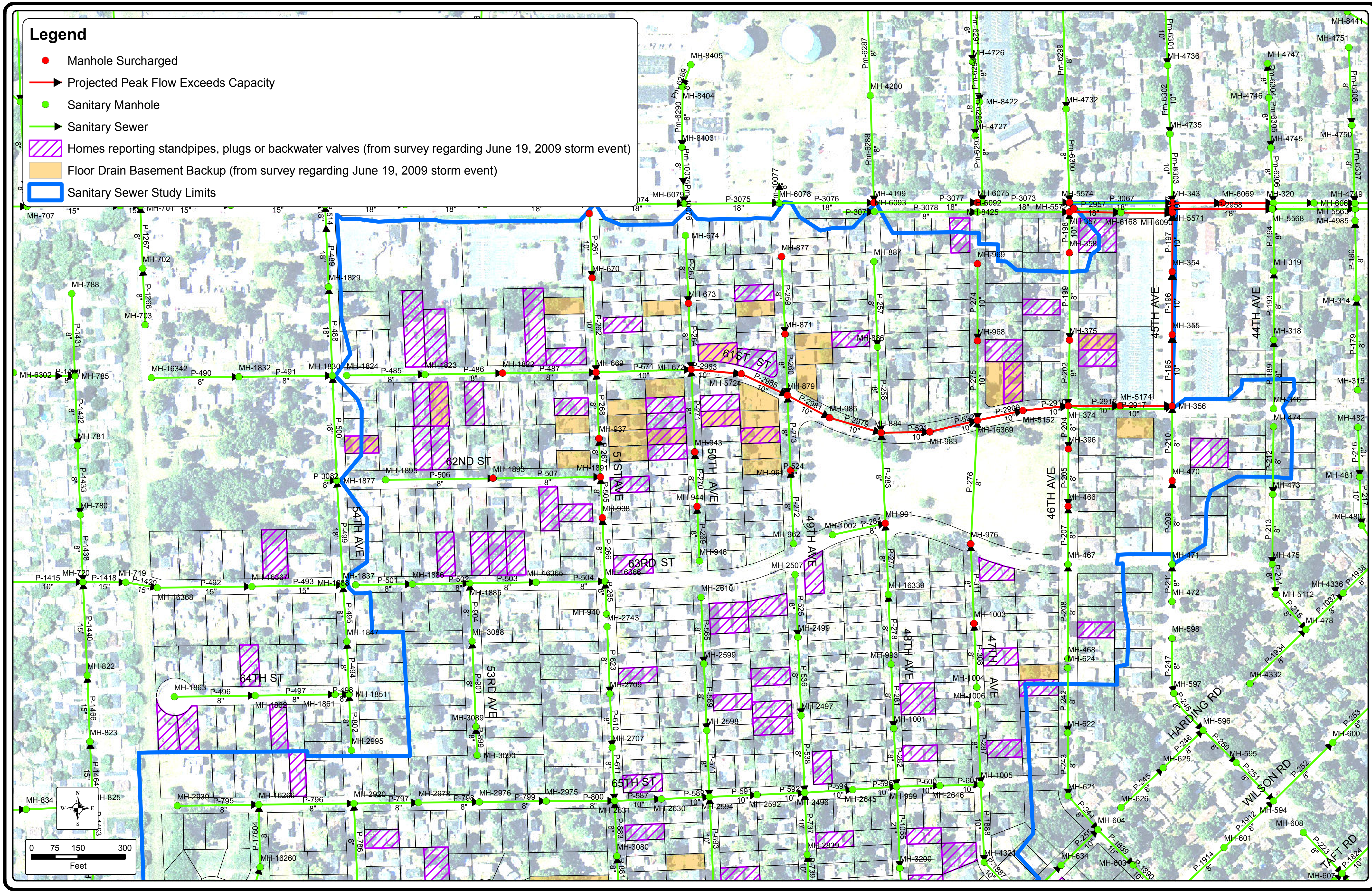

# NORTH BASIN - SANITARY SEWER CAPACITY EVALUATION
## 50-YEAR RECURRENCE INTERVAL EVENT

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

STRAND ASSOCIATES, INC.®
ENGINEERS

FIGURE 6.02-7
1540.001

S:\MAD\1500--1599\1540\001\Data\GIS Data\Figures\Sewer Analysis\Sewer Analysis 031510\Figure 6.02-7 - 50Year Existing North 11x17.mxd



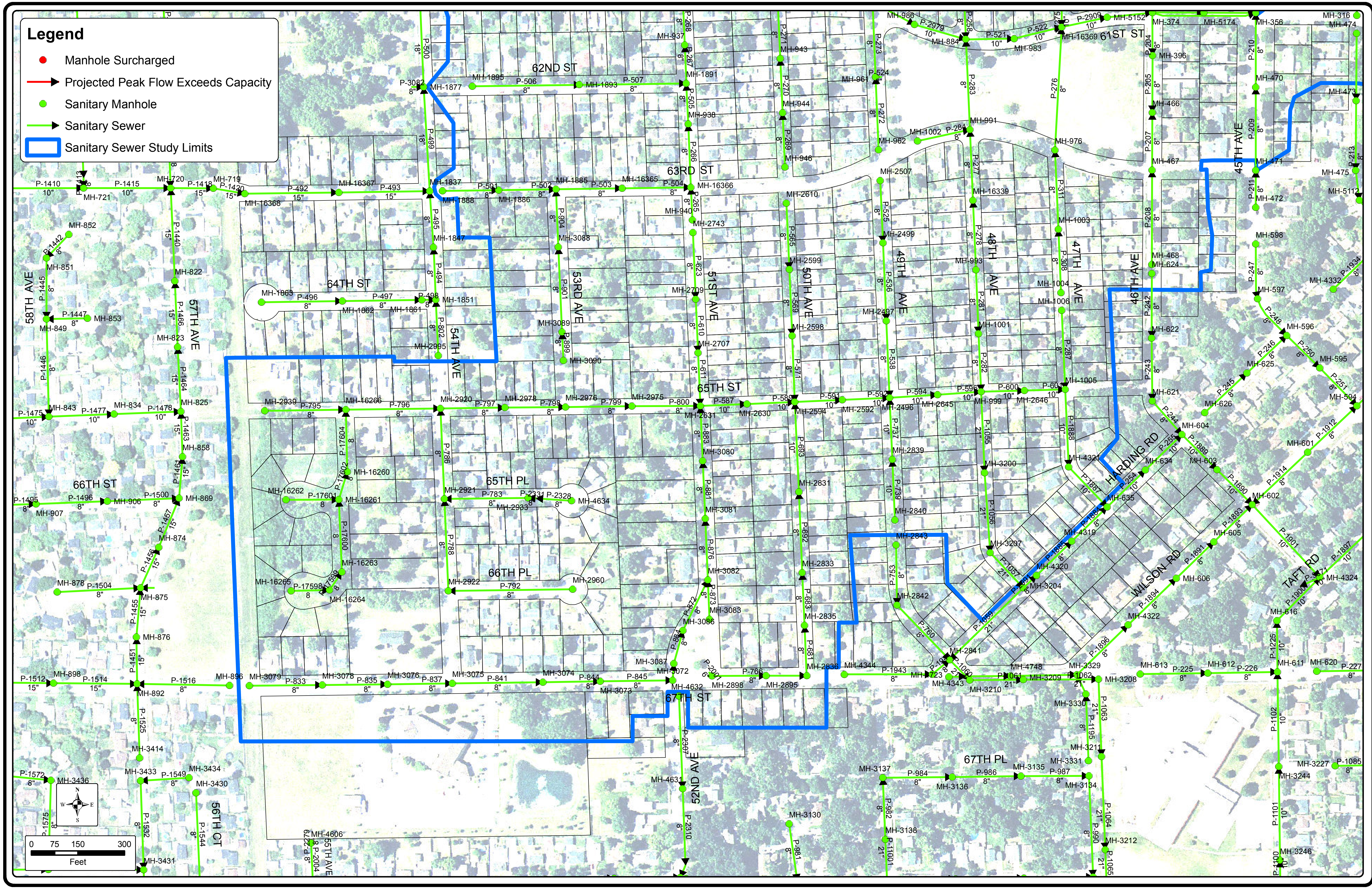

# NORTH BASIN - SANITARY SEWER CAPACITY EVALUATION
## 100-YEAR RECURRENCE INTERVAL EVENT

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

STRAND ASSOCIATES, INC.®
ENGINEERS

FIGURE 6.02-8
1540.001

S:\MAD\1500--1599\1540\001\Data\GIS Data\Figures\Sewer Analysis\Sewer Analysis 031510\Figure 6.02-8 - 100Year Existing North 11x17.mxd



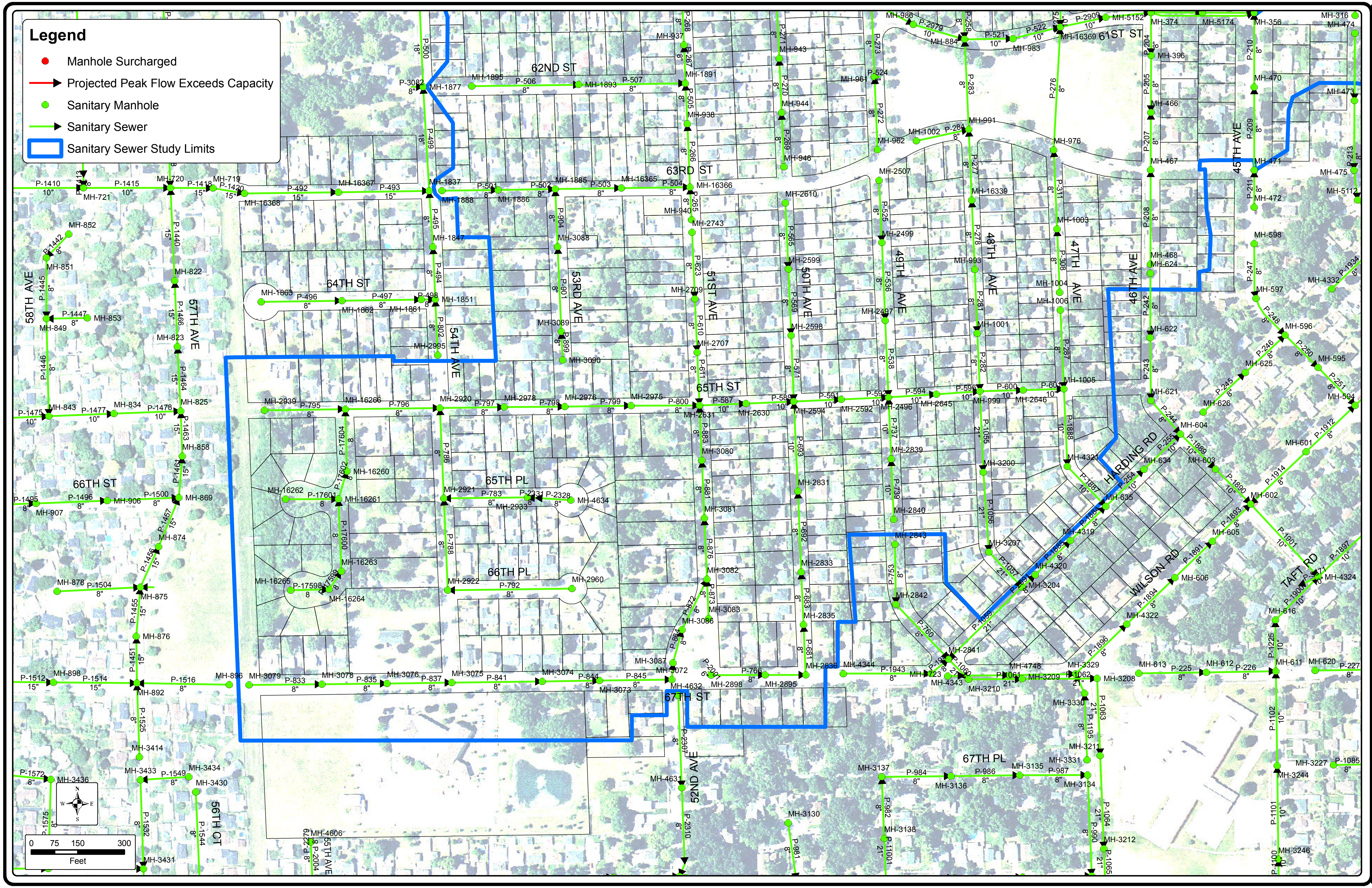

SOUTH BASIN - SANITARY SEWER CAPACITY EVALUATION
6-MONTH RECURRENCE INTERVAL EVENT

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

STRAND ASSOCIATES, INC.®
ENGINEERS

FIGURE 6.02-9
1540.001

S:\MAD\1500--1599\1540\001\Data\GIS Data\Figures\Sewer Analysis\Sewer Analysis 031510\Figure 6.02-9 - 6Month Existing South 11x17.mxd



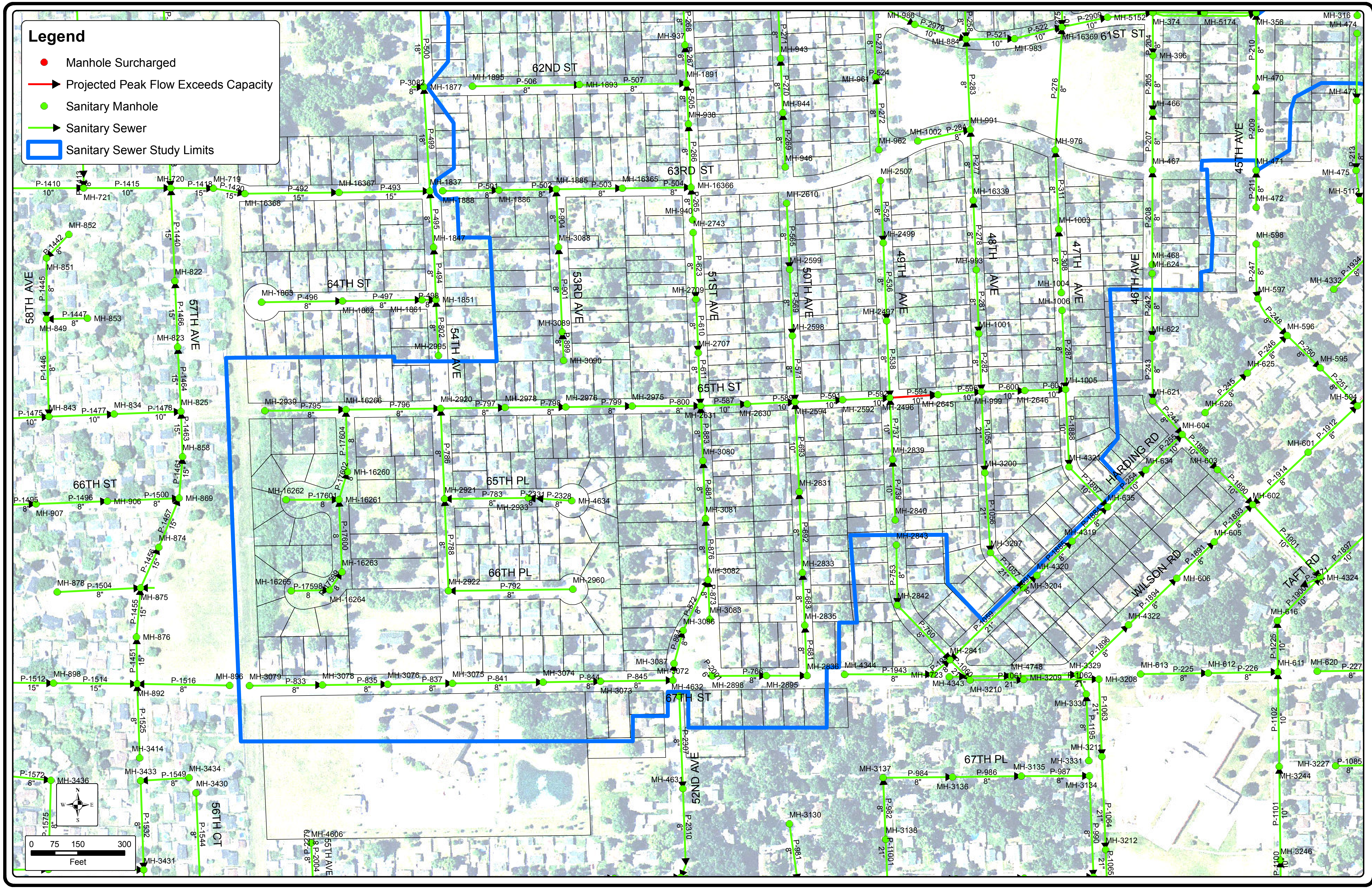

SOUTH BASIN - SANITARY SEWER CAPACITY EVALUATION
1-YEAR RECURRENCE INTERVAL EVENT

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

STRAND ASSOCIATES, INC.® ENGINEERS

FIGURE 6.02-10
1540.001

S:\MAD\1500--1599\1540\001\Data\GIS Data\Figures\Sewer Analysis\Sewer Analysis 031510\Figure 6.02-10 - 1Year Existing South 11x17.mxd



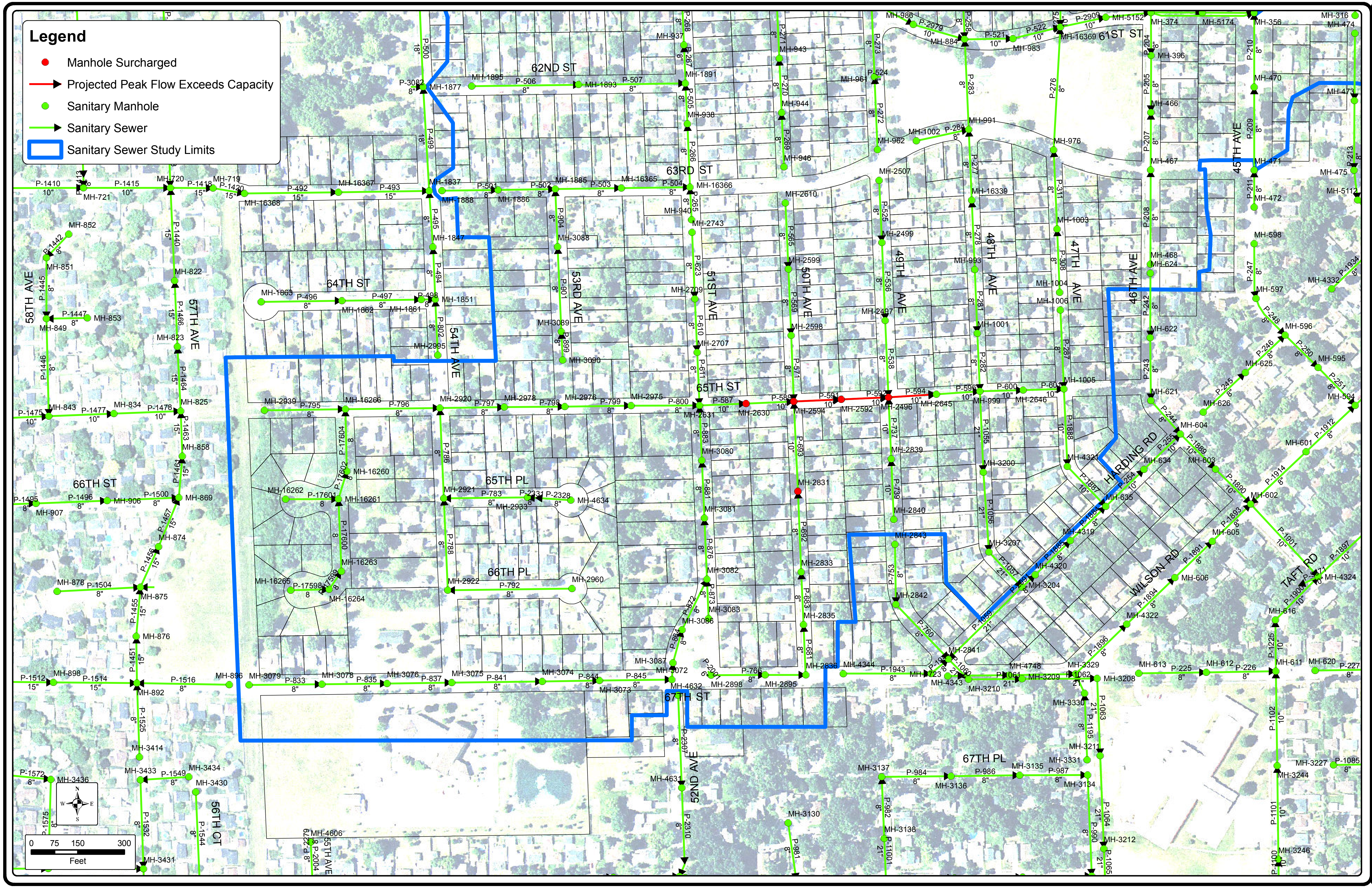

SOUTH BASIN - SANITARY SEWER CAPACITY EVALUATION
2-YEAR RECURRENCE INTERVAL EVENT

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

STRAND ASSOCIATES, INC.® ENGINEERS

FIGURE 6.02-11
1540.001

S:\MAD\1500--1599\1540\001\Data\GIS Data\Figures\Sewer Analysis\Sewer Analysis 031510\Figure 6.02-11 - 2Year Existing South 11x17.mxd



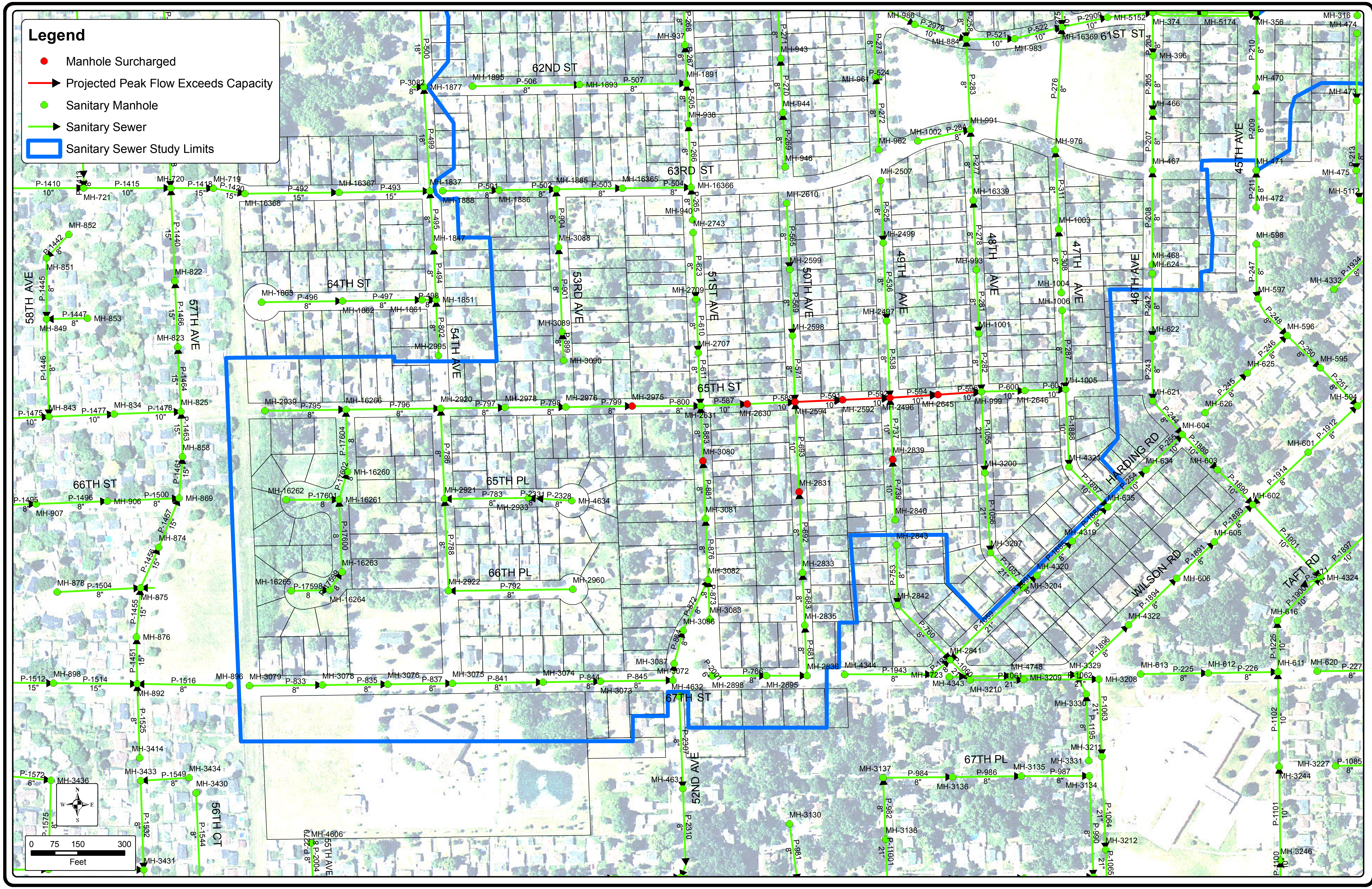

SOUTH BASIN - SANITARY SEWER CAPACITY EVALUATION
5-YEAR RECURRENCE INTERVAL EVENT

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

STRAND ASSOCIATES, INC.®
ENGINEERS

FIGURE 6.02-12
1540.001

S:\MAD\1500--1599\1540\001\Data\GIS Data\Figures\Sewer Analysis\Sewer Analysis 031510\Figure 6.02-12 - 5Year Existing South 11x17.mxd



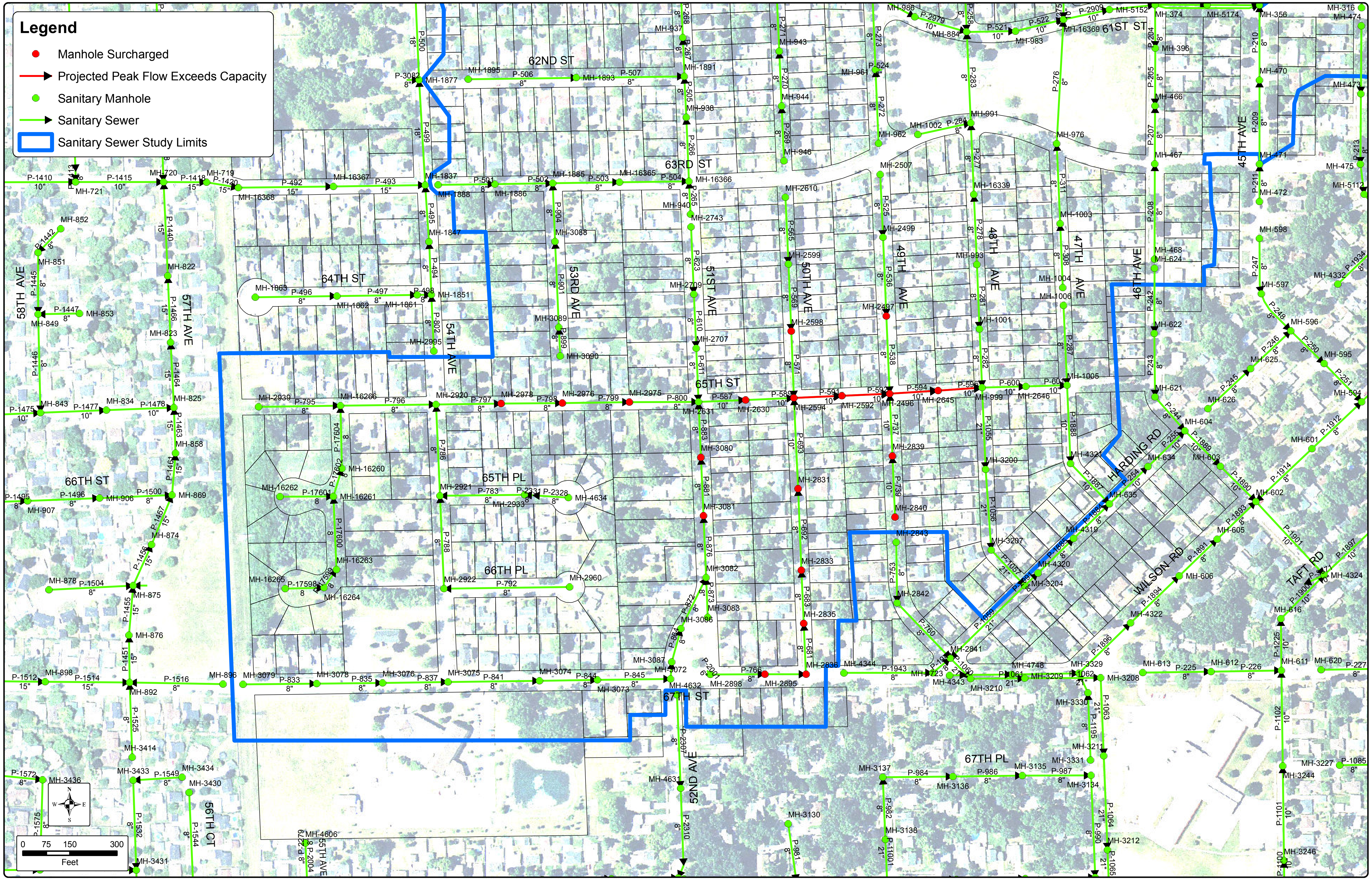

SOUTH BASIN - SANITARY SEWER CAPACITY EVALUATION
10-YEAR RECURRENCE INTERVAL EVENT

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

STRAND ASSOCIATES, INC.® ENGINEERS

FIGURE 6.02-13
1540.001

S:\MAD\1500--1599\1540\001\Data\GIS Data\Figures\Sewer Analysis\Sewer Analysis 031510\Figure 6.02-13 - 10Year Existing South 11x17.mxd



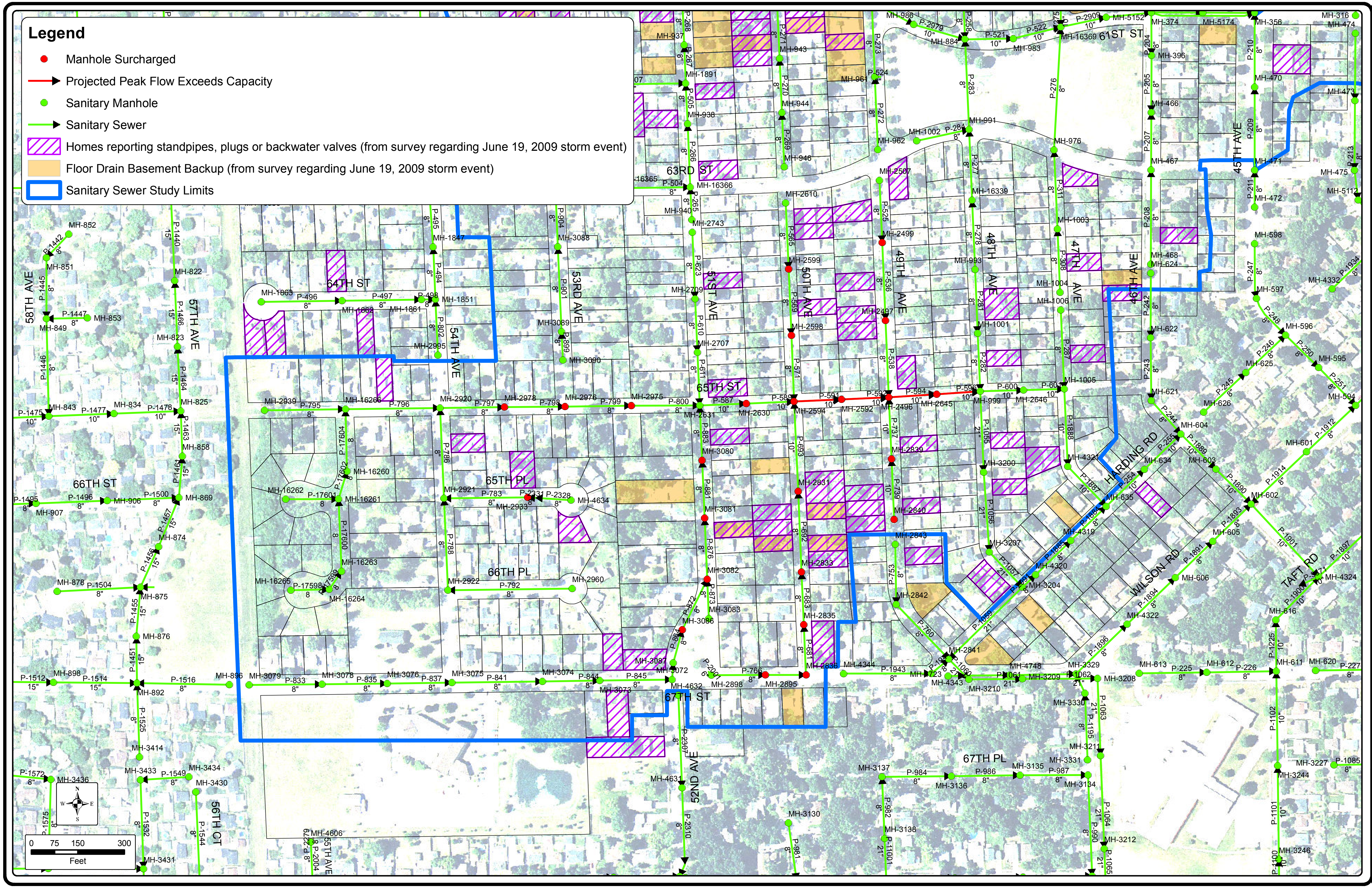

SOUTH BASIN - SANITARY SEWER CAPACITY EVALUATION
25-YEAR RECURRENCE INTERVAL EVENT

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

STRAND ASSOCIATES, INC.®
ENGINEERS

FIGURE 6.02-14
1540.001

S:\MAD\1500--1599\1540\001\Data\GIS Data\Figures\Sewer Analysis\Sewer Analysis 031510\Figure 6.02-14 - 25Year Existing South 11x17.mxd



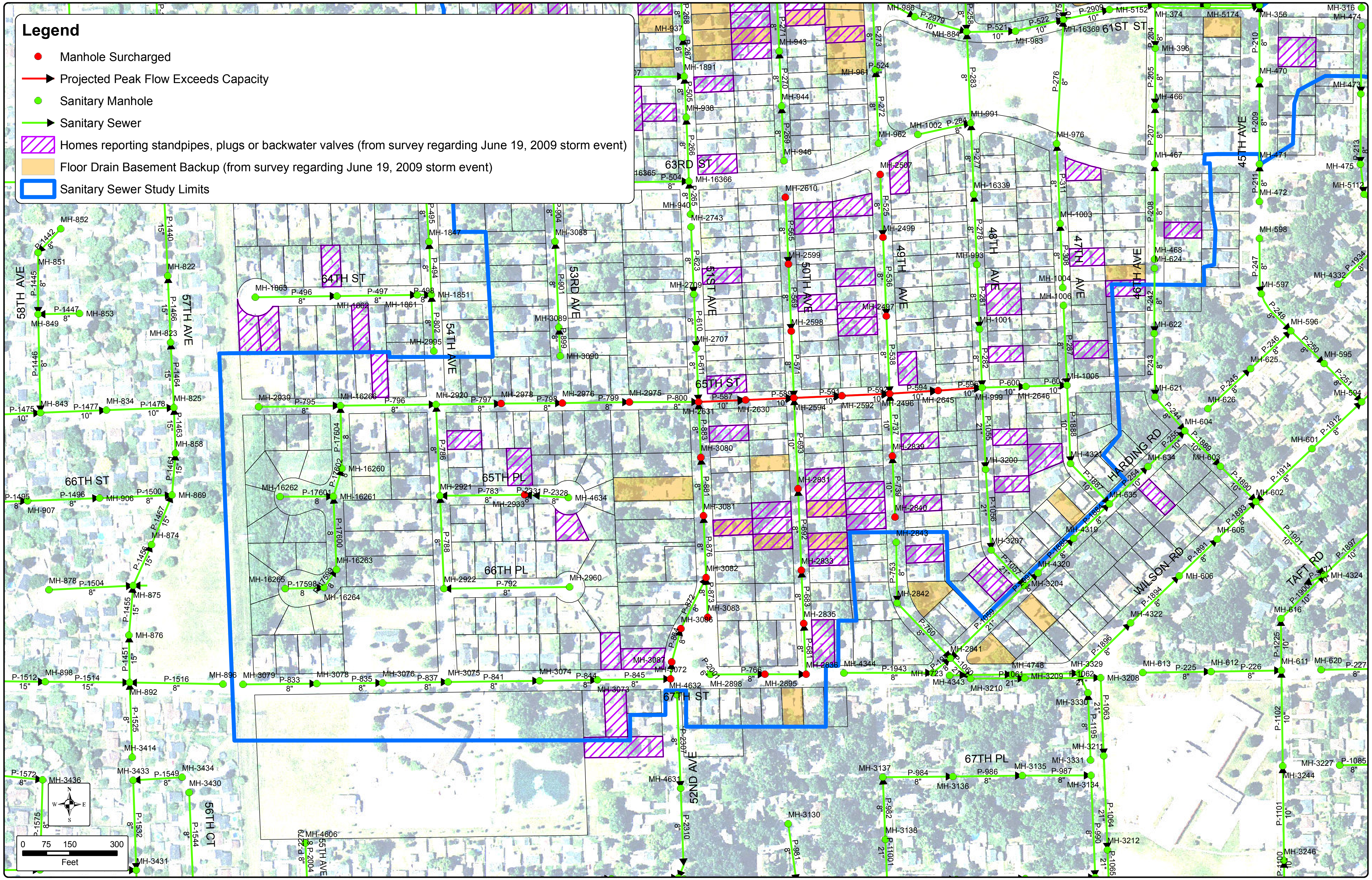

SOUTH BASIN - SANITARY SEWER CAPACITY EVALUATION
50-YEAR RECURRENCE INTERVAL EVENT

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

STRAND ASSOCIATES, INC.®
ENGINEERS

FIGURE 6.02-15
1540.001

S:\MAD\1500--1599\1540\001\Data\GIS Data\Figures\Sewer Analysis\Sewer Analysis 031510\Figure 6.02-15 - 50Year Existing South 11x17.mxd




# SOUTH BASIN - SANITARY SEWER CAPACITY EVALUATION
## 100-YEAR RECURRENCE INTERVAL EVENT

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

STRAND ASSOCIATES, INC.® ENGINEERS

FIGURE 6.02-16
1540.001

S:\MAD\1500--1599\1540\001\Data\GIS Data\Figures\Sewer Analysis\Sewer Analysis 031510\Figure 6.02-16 - 100Year Existing South 11x17.mxd

The south basin modeling results indicate surcharging for five of the eight modeled design storms. Surcharging is not predicted for the 6-month, 1-year, and 2-year design storms. The 5-, 10-, 25-, 50-, and 100-year design storms model higher levels of surcharging. The surcharging generally occurs along 65th street from 48th Avenue to 51st Avenue. The maximum surcharge level for the 100-year design storm is modeled at 7.7 feet in MH-2630.

Figures 6.02-7, 6.02-8, 6.02-15, and 6.02-16 also show the homes that reported (June 2009 survey) having a backwater valve, standpipe, or plug installed. Had these devices not been installed, it is likely the flooding in both basins would have impacted additional homes.

A complete printout of manhole and pipe results for the model runs associated with the various design storms can be found in Appendix E.

## TABLE 6.02-1

## JUNE 19, 2009, BASE RAINFALL EVENT–COMPARISON OF PEAK AND DRY WEATHER FLOW RATES NORTH BASIN

Conduit (Pipe) Summary - Dry Weather vs. June 19, 2009 Rainfall Event

| | Dry Weather | | Wet Weather | | | |
|---|---|---|---|---|---|---|
| Conduit Name | Peak Flow (cfs) | Total Flow (ft^3) | Peak Flow (cfs) | Total Flow (ft^3) | Difference in Peak Flow (cfs) | Difference in Total Flow (ft^3) |
| P-485 | 0.011 | 2,845 | 0.321 | 17,583 | 0.310 | 14,737 |
| P-486 | 0.011 | 2,843 | 0.407 | 17,579 | 0.396 | 14,736 |
| P-487 | 0.011 | 2,838 | 0.360 | 17,568 | 0.350 | 14,729 |
| P-671 | 0.055 | 14,611 | 1.549 | 90,391 | 1.495 | 75,780 |
| P-2983 | 0.074 | 19,811 | 2.088 | 122,244 | 2.014 | 102,433 |
| P-2985 | 0.074 | 19,801 | 2.086 | 122,232 | 2.012 | 102,431 |
| P-2981 | 0.111 | 29,849 | 2.516 | 152,767 | 2.405 | 122,919 |
| P-2979 | 0.111 | 29,833 | 2.516 | 152,759 | 2.405 | 122,926 |
| P-521 | 0.150 | 40,052 | 2.965 | 184,204 | 2.816 | 144,152 |
| P-522 | 0.150 | 40,040 | 2.970 | 184,194 | 2.820 | 144,153 |
| P-2909 | 0.196 | 52,545 | 3.514 | 222,305 | 3.318 | 169,761 |
| P-2910 | 0.196 | 52,534 | 3.515 | 222,293 | 3.318 | 169,760 |
| P-2915 | 0.219 | 58,429 | 2.071 | 204,359 | 1.853 | 145,930 |
| P-2916 | 0.219 | 58,402 | 2.062 | 204,343 | 1.843 | 145,941 |
| P-195 | 0.238 | 63,696 | 3.162 | 248,385 | 2.923 | 184,689 |
| P-196 | 0.238 | 63,675 | 3.163 | 248,375 | 2.925 | 184,700 |
| P-506 | 0.010 | 2,754 | 0.307 | 16,790 | 0.296 | 14,036 |
| P-507 | 0.010 | 2,748 | 0.380 | 16,779 | 0.370 | 14,031 |
| P-501 | 0.009 | 2,280 | 0.260 | 14,210 | 0.251 | 11,930 |
| P-502 | 0.009 | 2,277 | 0.259 | 14,208 | 0.251 | 11,931 |
| P-503 | 0.015 | 3,881 | 0.441 | 24,236 | 0.427 | 20,355 |
| P-504 | 0.014 | 3,873 | 0.441 | 24,231 | 0.426 | 20,358 |
| P-899 | 0.006 | 1,615 | 0.183 | 10,036 | 0.177 | 8,421 |
| P-901 | 0.006 | 1,612 | 0.183 | 10,034 | 0.177 | 8,422 |
| P-904 | 0.006 | 1,610 | 0.183 | 10,032 | 0.177 | 8,422 |
| P-265 | 0.002 | 570 | 0.061 | 3,377 | 0.059 | 2,807 |
| P-266 | 0.022 | 5,962 | 0.749 | 36,844 | 0.727 | 30,882 |
| P-505 | 0.022 | 5,958 | 0.657 | 36,842 | 0.635 | 30,884 |
| P-267 | 0.038 | 10,223 | 1.116 | 62,860 | 1.078 | 52,638 |
| P-268 | 0.038 | 10,215 | 1.106 | 62,851 | 1.068 | 52,636 |
| P-261 | 0.006 | 1,613 | 0.181 | 10,029 | 0.175 | 8,416 |
| P-262 | 0.006 | 1,610 | 0.296 | 10,027 | 0.290 | 8,416 |
| P-269 | 0.013 | 3,325 | 0.367 | 20,168 | 0.354 | 16,843 |
| P-270 | 0.012 | 3,323 | 0.418 | 20,166 | 0.406 | 16,842 |
| P-271 | 0.012 | 3,321 | 0.390 | 20,158 | 0.378 | 16,837 |
| P-263 | 0.007 | 1,900 | 0.295 | 11,724 | 0.288 | 9,824 |
| P-264 | 0.007 | 1,898 | 0.295 | 11,717 | 0.288 | 9,819 |
| P-272 | 0.014 | 3,610 | 0.279 | 10,928 | 0.266 | 7,317 |
| P-273 | 0.014 | 3,605 | 0.248 | 10,918 | 0.234 | 7,313 |
| P-259 | 0.024 | 6,460 | 0.344 | 19,624 | 0.320 | 13,164 |
| P-260 | 0.024 | 6,456 | 0.335 | 19,622 | 0.311 | 13,166 |
| P-278 | 0.023 | 6,079 | 0.281 | 18,521 | 0.258 | 12,441 |
| P-277 | 0.023 | 5,976 | 0.281 | 18,417 | 0.258 | 12,442 |
| P-283 | 0.023 | 5,966 | 0.324 | 18,406 | 0.301 | 12,440 |
| P-284 | 0.000 | - | 0.000 | - | 0.000 | - |
| P-257 | 0.016 | 4,275 | 0.198 | 13,057 | 0.182 | 8,782 |
| P-258 | 0.016 | 4,270 | 0.198 | 13,053 | 0.182 | 8,783 |
| P-308 | 0.023 | 6,081 | 0.281 | 18,523 | 0.258 | 12,441 |
| P-311 | 0.023 | 6,074 | 0.280 | 18,516 | 0.258 | 12,442 |
| P-276 | 0.023 | 6,067 | 0.273 | 18,503 | 0.251 | 12,435 |
| P-275 | 0.024 | 6,447 | 0.296 | 19,624 | 0.272 | 13,177 |
| P-208 | 0.021 | 5,699 | 0.264 | 17,409 | 0.243 | 11,710 |
| P-207 | 0.021 | 5,697 | 0.264 | 17,408 | 0.243 | 11,710 |
| P-205 | 0.021 | 5,695 | 0.297 | 17,404 | 0.275 | 11,710 |
| P-204 | 0.021 | 5,689 | 0.263 | 17,401 | 0.241 | 11,712 |
| P-199 | 0.002 | 234 | -0.842 | (7,560) | -0.843 | (7,794) |
| P-202 | 0.001 | 232 | -0.842 | (7,554) | -0.843 | (7,786) |
| P-211 | 0.020 | 5,321 | 0.248 | 16,299 | 0.228 | 10,978 |
| P-209 | 0.020 | 5,319 | 0.248 | 16,297 | 0.228 | 10,978 |
| P-210 | 0.020 | 5,312 | 0.251 | 16,289 | 0.231 | 10,977 |
| P-3077 | 2.527 | 673,809 | 17.094 | 1,391,022 | 14.567 | 717,213 |
| P-3073 | 2.525 | 673,672 | 17.095 | 1,390,903 | 14.570 | 717,231 |
| P-3067 | 2.525 | 673,606 | 12.370 | 1,352,138 | 9.845 | 678,533 |
| P-3069 | 2.523 | 673,402 | 12.370 | 1,351,962 | 9.846 | 678,560 |
| P-3070 | 2.523 | 673,311 | 12.370 | 1,351,888 | 9.847 | 678,577 |
| P-3088 | 0.024 | 6,461 | 0.198 | 13,058 | 0.174 | 6,597 |
| P-3092 | 0.045 | 12,301 | 1.299 | 39,128 | 1.254 | 26,828 |
| P-3093 | 0.045 | 12,296 | 1.301 | 39,123 | 1.256 | 26,828 |
| P-17061 | 0.282 | 75,923 | 4.466 | 287,466 | 4.183 | 211,543 |
| P-2956 | 0.000 | - | 4.716 | 38,703 | 4.716 | 38,703 |
| P-2957 | 0.000 | - | 4.714 | 38,706 | 4.714 | 38,706 |
| P-2958 | 0.282 | 75,896 | 9.011 | 326,159 | 8.729 | 250,263 |
| P-197 | 0.238 | 63,644 | 3.165 | 248,351 | 2.927 | 184,707 |
| P-274 | 0.024 | 6,457 | 0.297 | 19,630 | 0.273 | 13,173 |
| P-2917 | 0.000 | - | 1.469 | 27,750 | 1.469 | 27,750 |
| P-198 | 0.021 | 5,846 | 1.109 | 26,077 | 1.087 | 20,231 |
| FREE # 1 | 2.523 | 673,302 | 12.370 | 1,351,879 | 9.847 | 678,577 |
| FREE # 2 | 0.282 | 75,896 | 9.011 | 326,159 | 8.729 | 250,263 |

Junction (Manhole) Summary - Dry Weather vs. June 19, 2009 Rainfall Event

| | Dry Weather | | | Wet Weather | | | |
|---|---|---|---|---|---|---|---|
| Junction Name | Invert Elevation (ft) | Maximum Elevation (ft) | Difference in Elevation (ft) | Invert Elevation (ft) | Maximum Elevation (ft) | Difference in Elevation (ft) | Change in Maximum Elevation (ft) |
| MH-1002 | 678.59 | 678.59 | 0.00 | 678.59 | 678.59 | 0.00 | 0.00 |
| MH-1003 | 670.22 | 670.29 | 0.07 | 670.22 | 670.44 | 0.22 | 0.15 |
| MH-1004 | 679.20 | 679.24 | 0.04 | 679.20 | 679.34 | 0.14 | 0.09 |
| MH-16339 | 670.60 | 677.47 | 6.87 | 670.60 | 677.57 | 6.97 | 0.10 |
| MH-16365 | 685.47 | 685.54 | 0.07 | 685.47 | 685.82 | 0.35 | 0.28 |
| MH-16366 | 683.15 | 683.19 | 0.04 | 683.15 | 683.38 | 0.23 | 0.19 |
| MH-16369 | 660.52 | 660.67 | 0.15 | 660.52 | 666.15 | 5.63 | 5.49 |
| MH-1822 | 675.04 | 675.08 | 0.04 | 675.04 | 677.26 | 2.22 | 2.18 |
| MH-1823 | 682.14 | 682.17 | 0.03 | 682.14 | 682.30 | 0.16 | 0.13 |
| MH-1824 | 688.94 | 689.27 | 0.33 | 688.94 | 689.42 | 0.48 | 0.15 |
| MH-1885 | 686.34 | 686.40 | 0.06 | 686.34 | 686.67 | 0.33 | 0.27 |
| MH-1886 | 687.93 | 687.97 | 0.04 | 687.93 | 688.13 | 0.20 | 0.16 |
| MH-1888 | 689.51 | 689.55 | 0.04 | 689.51 | 689.71 | 0.20 | 0.16 |
| MH-1891 | 672.49 | 672.57 | 0.09 | 672.49 | 679.03 | 6.54 | 6.45 |
| MH-1893 | 680.52 | 680.56 | 0.04 | 680.52 | 680.72 | 0.20 | 0.17 |
| MH-1895 | 683.92 | 683.97 | 0.05 | 683.92 | 684.15 | 0.23 | 0.19 |
| MH-3088 | 688.42 | 688.45 | 0.03 | 688.42 | 688.58 | 0.16 | 0.12 |
| MH-3089 | 689.52 | 689.57 | 0.05 | 689.52 | 689.75 | 0.23 | 0.18 |
| MH-3090 | 690.25 | 690.28 | 0.03 | 690.25 | 690.42 | 0.17 | 0.14 |
| MH-320 | 642.91 | 643.44 | 0.53 | 642.91 | 644.24 | 1.33 | 0.80 |
| MH-343 | 644.54 | 645.34 | 0.80 | 644.54 | 648.59 | 4.05 | 3.25 |
| MH-354 | 649.05 | 649.30 | 0.25 | 649.05 | 652.38 | 3.33 | 3.08 |
| MH-355 | 651.27 | 651.45 | 0.18 | 651.27 | 655.48 | 4.21 | 4.03 |
| MH-356 | 653.87 | 654.05 | 0.18 | 653.87 | 659.04 | 5.17 | 4.99 |
| MH-357 | 651.50 | 651.59 | 0.09 | 651.50 | 652.02 | 0.52 | 0.43 |
| MH-358 | 657.67 | 657.72 | 0.05 | 657.67 | 658.00 | 0.33 | 0.28 |
| MH-374 | 655.17 | 655.40 | 0.23 | 655.17 | 660.15 | 4.98 | 4.76 |
| MH-375 | 656.42 | 656.48 | 0.06 | 656.42 | 659.36 | 2.94 | 2.88 |
| MH-396 | 656.07 | 656.15 | 0.08 | 656.07 | 660.20 | 4.13 | 4.05 |
| MH-4199 | 674.91 | 675.30 | 0.39 | 674.91 | 676.01 | 1.10 | 0.71 |
| MH-466 | 662.54 | 662.59 | 0.05 | 662.54 | 662.68 | 0.14 | 0.09 |
| MH-467 | 669.02 | 669.07 | 0.05 | 669.02 | 669.17 | 0.15 | 0.11 |
| MH-468 | 678.62 | 678.67 | 0.05 | 678.62 | 678.78 | 0.16 | 0.11 |
| MH-470 | 660.35 | 660.41 | 0.06 | 660.35 | 660.55 | 0.20 | 0.14 |
| MH-471 | 669.63 | 669.67 | 0.04 | 669.63 | 669.77 | 0.14 | 0.09 |
| MH-472 | 672.62 | 672.67 | 0.05 | 672.62 | 672.78 | 0.16 | 0.11 |
| MH-5152 | 657.82 | 657.96 | 0.15 | 657.82 | 663.28 | 5.47 | 5.32 |
| MH-5174 | 654.42 | 654.77 | 0.35 | 654.42 | 659.60 | 5.18 | 4.84 |
| MH-5568 | 645.49 | 645.68 | 0.19 | 645.49 | 646.65 | 1.16 | 0.97 |
| MH-5571 | 647.10 | 647.30 | 0.20 | 647.10 | 648.53 | 1.43 | 1.22 |
| MH-5572 | 651.17 | 651.17 | 0.00 | 651.17 | 651.77 | 0.60 | 0.60 |
| MH-5574 | 649.86 | 650.30 | 0.44 | 649.86 | 652.58 | 2.72 | 2.28 |
| MH-5724 | 666.50 | 666.61 | 0.11 | 666.50 | 674.98 | 8.48 | 8.37 |
| MH-6069 | 644.22 | 644.80 | 0.58 | 644.22 | 646.66 | 2.44 | 1.86 |
| MH-6075 | 664.66 | 665.01 | 0.35 | 664.66 | 665.62 | 0.96 | 0.60 |
| MH-6090 | 648.12 | 648.30 | 0.18 | 648.12 | 648.96 | 0.84 | 0.65 |
| MH-6092 | 669.68 | 669.72 | 0.04 | 669.68 | 669.79 | 0.11 | 0.07 |
| MH-6168 | 649.80 | 649.89 | 0.09 | 649.80 | 650.41 | 0.61 | 0.52 |
| MH-669 | 669.72 | 669.98 | 0.26 | 669.72 | 677.12 | 7.40 | 7.15 |
| MH-670 | 670.64 | 670.68 | 0.04 | 670.64 | 677.16 | 6.52 | 6.48 |
| MH-671 | 672.22 | 672.26 | 0.04 | 672.22 | 677.19 | 4.97 | 4.93 |
| MH-672 | 667.61 | 667.73 | 0.12 | 667.61 | 676.02 | 8.41 | 8.29 |
| MH-673 | 674.22 | 674.25 | 0.03 | 674.22 | 676.06 | 1.84 | 1.81 |
| MH-674 | 680.96 | 680.99 | 0.03 | 680.96 | 681.10 | 0.14 | 0.11 |
| MH-871 | 669.42 | 669.50 | 0.08 | 669.42 | 673.91 | 4.49 | 4.41 |
| MH-877 | 673.92 | 673.98 | 0.06 | 673.92 | 674.21 | 0.29 | 0.23 |
| MH-879 | 665.37 | 665.53 | 0.16 | 665.37 | 673.83 | 8.46 | 8.30 |
| MH-884 | 664.16 | 664.30 | 0.14 | 664.16 | 670.59 | 6.43 | 6.29 |
| MH-886 | 676.44 | 676.49 | 0.05 | 676.44 | 676.59 | 0.15 | 0.10 |
| MH-887 | 681.39 | 681.44 | 0.05 | 681.39 | 681.54 | 0.15 | 0.10 |
| MH-937 | 671.56 | 671.65 | 0.09 | 671.56 | 678.35 | 6.79 | 6.71 |
| MH-938 | 673.51 | 673.58 | 0.07 | 673.51 | 679.29 | 5.78 | 5.72 |
| MH-940 | 688.29 | 688.30 | 0.01 | 688.29 | 688.35 | 0.06 | 0.05 |
| MH-943 | 673.68 | 673.72 | 0.04 | 673.68 | 676.18 | 2.50 | 2.46 |
| MH-944 | 677.68 | 677.72 | 0.04 | 677.68 | 677.87 | 0.19 | 0.15 |
| MH-946 | 681.69 | 681.73 | 0.04 | 681.69 | 681.89 | 0.20 | 0.16 |
| MH-961 | 667.79 | 667.84 | 0.05 | 667.79 | 673.86 | 6.07 | 6.01 |
| MH-962 | 679.79 | 679.82 | 0.03 | 679.79 | 679.89 | 0.10 | 0.06 |
| MH-968 | 667.62 | 667.73 | 0.11 | 667.62 | 667.93 | 0.31 | 0.21 |
| MH-969 | 668.42 | 668.51 | 0.09 | 668.42 | 668.70 | 0.28 | 0.20 |
| MH-976 | 663.37 | 663.44 | 0.07 | 663.37 | 666.25 | 2.88 | 2.81 |
| MH-983 | 662.32 | 662.49 | 0.17 | 662.32 | 668.50 | 6.18 | 6.00 |
| MH-986 | 664.80 | 664.97 | 0.17 | 664.80 | 672.38 | 7.58 | 7.41 |
| MH-991 | 670.54 | 670.65 | 0.11 | 670.54 | 670.91 | 0.37 | 0.25 |
| MH-993 | 681.29 | 681.35 | 0.06 | 681.29 | 681.47 | 0.18 | 0.12 |

**TABLE 6.02-2**

**JUNE 19, 2009, BASE RAINFALL EVENT–COMPARISON OF PEAK AND DRY WEATHER FLOW RATES SOUTH BASIN**

Conduit (Pipe) Summary - Dry Weather vs. June 19, 2009 Rainfall Event

| | Dry Weather | | Wet Weather | | | |
|---|---|---|---|---|---|---|
| Conduit Name | Peak Flow (cfs) | Total Flow (ft^3) | Peak Flow (cfs) | Total Flow (ft^3) | Difference in Peak Flow (cfs) | Difference in Total Flow (ft^3) |
| P-795 | 0.001 | 154 | 0.025 | 1336 | 0.024 | 1,183 |
| P-796 | 0.001 | 304 | 0.042 | 2331 | 0.041 | 2,027 |
| P-797 | 0.012 | 2700 | 0.508 | 25086 | 0.497 | 22,387 |
| P-798 | 0.012 | 2696 | 0.507 | 25084 | 0.495 | 22,387 |
| P-799 | 0.012 | 2693 | 0.532 | 25081 | 0.521 | 22,388 |
| P-800 | 0.011 | 2689 | 0.560 | 25077 | 0.549 | 22,388 |
| P-587 | 0.048 | 11299 | 1.863 | 102988 | 1.815 | 91,689 |
| P-589 | 0.048 | 11293 | 1.869 | 102979 | 1.821 | 91,685 |
| P-591 | 0.081 | 18987 | 3.072 | 172729 | 2.991 | 153,742 |
| P-592 | 0.081 | 18979 | 3.074 | 172725 | 2.993 | 153,746 |
| P-594 | 0.103 | 24288 | 3.903 | 220458 | 3.800 | 196,170 |
| P-596 | 0.103 | 24281 | 3.903 | 220443 | 3.800 | 196,162 |
| P-1055 | 0.119 | 27967 | 4.494 | 253839 | 4.376 | 225,872 |
| P-1056 | 0.118 | 27942 | 4.494 | 253863 | 4.376 | 225,921 |
| P-1057 | 0.118 | 27928 | 4.494 | 253850 | 4.376 | 225,922 |
| P-281 | 0.008 | 1931 | 0.325 | 17446 | 0.316 | 15,514 |
| P-282 | 0.008 | 1929 | 0.324 | 17443 | 0.316 | 15,514 |
| P-525 | 0.014 | 3246 | 0.535 | 29107 | 0.521 | 25,862 |
| P-536 | 0.014 | 3242 | 0.525 | 29104 | 0.511 | 25,862 |
| P-538 | 0.014 | 3237 | 0.521 | 29097 | 0.507 | 25,861 |
| P-739 | 0.009 | 2086 | 0.341 | 18640 | 0.332 | 16,554 |
| P-737 | 0.009 | 2081 | 0.336 | 18634 | 0.327 | 16,553 |
| P-565 | 0.014 | 3246 | 0.537 | 29107 | 0.523 | 25,861 |
| P-569 | 0.014 | 3243 | 0.528 | 29103 | 0.514 | 25,860 |
| P-571 | 0.014 | 3239 | 0.521 | 29095 | 0.507 | 25,857 |
| P-766 | 0.010 | 2319 | 0.462 | 20933 | 0.452 | 18,615 |
| P-768 | 0.010 | 2316 | 0.396 | 20933 | 0.386 | 18,616 |
| P-681 | 0.010 | 2314 | 0.382 | 20931 | 0.372 | 18,617 |
| P-683 | 0.010 | 2311 | 0.405 | 20928 | 0.395 | 18,616 |
| P-692 | 0.019 | 4474 | 0.726 | 40664 | 0.707 | 36,190 |
| P-693 | 0.019 | 4468 | 0.723 | 40660 | 0.704 | 36,192 |
| P-263 | 0.012 | 2859 | 0.476 | 25621 | 0.464 | 22,762 |
| P-610 | 0.012 | 2857 | 0.476 | 25619 | 0.464 | 22,763 |
| P-611 | 0.012 | 2853 | 0.476 | 25616 | 0.463 | 22,763 |
| P-833 | 0.007 | 1545 | 0.260 | 13956 | 0.253 | 12,411 |
| P-835 | 0.007 | 1543 | 0.260 | 13954 | 0.253 | 12,412 |
| P-837 | 0.007 | 1541 | 0.259 | 13952 | 0.253 | 12,411 |
| P-841 | 0.007 | 1538 | 0.259 | 13949 | 0.253 | 12,411 |
| P-844 | 0.015 | 3469 | 0.582 | 31393 | 0.567 | 27,924 |
| P-845 | 0.015 | 3465 | 0.582 | 31391 | 0.567 | 27,926 |
| P-1996 | 0.015 | 3461 | 0.582 | 31387 | 0.567 | 27,926 |
| P-864 | 0.015 | 3460 | 0.582 | 31384 | 0.567 | 27,924 |
| P-872 | 0.015 | 3457 | 0.571 | 31375 | 0.556 | 27,918 |
| P-873 | 0.010 | 2319 | 0.397 | 20933 | 0.387 | 18,614 |
| P-876 | 0.024 | 5772 | 0.946 | 52310 | 0.921 | 46,538 |
| P-881 | 0.024 | 5769 | 0.937 | 52307 | 0.913 | 46,538 |
| P-883 | 0.024 | 5763 | 0.928 | 52299 | 0.904 | 46,536 |
| P-792 | 0.001 | 154 | 0.026 | 1404 | 0.025 | 1,250 |
| P-788 | 0.001 | 152 | 0.026 | 1401 | 0.025 | 1,248 |
| P-2328 | 0.000 | 77 | 0.109 | 956 | 0.108 | 878 |
| P-786 | 0.001 | 235 | 0.204 | 3020 | 0.202 | 2,786 |
| P-17598 | 0.000 | 77 | 0.009 | 500 | 0.009 | 423 |
| P-17599 | 0.000 | 77 | 0.009 | 500 | 0.009 | 423 |
| P-17600 | 0.000 | 77 | 0.009 | 499 | 0.008 | 423 |
| P-17601 | 0.000 | 77 | 0.009 | 500 | 0.009 | 423 |
| P-17602 | 0.001 | 153 | 0.017 | 998 | 0.017 | 845 |
| P-17604 | 0.001 | 152 | 0.017 | 997 | 0.017 | 845 |
| P-783 | 0.000 | 6 | 0.122 | 987 | 0.122 | 980 |
| P-287 | 0.004 | 1003 | 0.166 | 8930 | 0.161 | 7,926 |
| P-1888 | 0.008 | 1775 | 0.298 | 16034 | 0.290 | 14,259 |
| P-1887 | 0.008 | 1770 | 0.298 | 16031 | 0.290 | 14,260 |
| P-1885 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 |
| P-1884 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 |
| P-2991 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 |
| P-600 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 |
| P-601 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 |
| P-1059 | 0.121 | 28596 | 4.605 | 260064 | 4.484 | 231,469 |
| P-1060 | 0.130 | 30666 | 4.943 | 278757 | 4.813 | 248,091 |
| P-1061 | 0.130 | 30656 | 4.943 | 278748 | 4.813 | 248,092 |
| P-1062 | 0.130 | 30630 | 4.943 | 278715 | 4.813 | 248,085 |
| P-1943 | 0.005 | 1080 | 0.182 | 9790 | 0.177 | 8,710 |
| P-1944 | 0.005 | 1074 | 0.182 | 9786 | 0.177 | 8,712 |
| P-753 | 0.004 | 1004 | 0.166 | 8930 | 0.161 | 7,926 |
| P-760 | 0.004 | 1000 | 0.165 | 8929 | 0.161 | 7,928 |
| P-254 | 0.012 | 2851 | 0.479 | 25823 | 0.467 | 22,972 |
| P-255 | 0.012 | 2848 | 0.479 | 25820 | 0.467 | 22,972 |
| P-242 | 0.005 | 1159 | 0.199 | 10658 | 0.194 | 9,499 |
| P-243 | 0.005 | 1157 | 0.199 | 10657 | 0.194 | 9,500 |
| P-244 | 0.005 | 1155 | 0.199 | 10655 | 0.194 | 9,500 |
| P-1889 | 0.021 | 4850 | 0.826 | 44441 | 0.805 | 39,590 |
| P-1890 | 0.021 | 4847 | 0.826 | 44434 | 0.805 | 39,587 |
| FREE # 1 | 0.130 | 30631 | 4.943 | 278715 | 4.813 | 248,084 |
| FREE # 2 | 0.021 | 4847 | 0.826 | 44435 | 0.805 | 39,588 |

Junction (Manhole) Summary - Dry Weather vs. June 19, 2009 Rainfall Event

| | Dry Weather | | | Wet Weather | | | |
|---|---|---|---|---|---|---|---|
| Junction Name | Invert Elevation (ft) | Maximum Elevation (ft) | Difference in Elevation (ft) | Invert Elevation (ft) | Maximum Elevation (ft) | Difference in Elevation (ft) | Change in Maximum Elevation (ft) |
| MH-993 | 681.42 | 681.46 | 0.04 | 681.42 | 681.65 | 0.23 | 0.19 |
| MH-999 | 672.26 | 672.39 | 0.13 | 672.26 | 672.99 | 0.73 | 0.60 |
| MH-1001 | 678.42 | 678.45 | 0.03 | 678.42 | 678.58 | 0.16 | 0.13 |
| MH-2496 | 674.80 | 674.95 | 0.15 | 674.80 | 679.45 | 4.65 | 4.49 |
| MH-2497 | 677.12 | 677.18 | 0.06 | 677.12 | 679.74 | 2.62 | 2.56 |
| MH-2499 | 678.62 | 678.68 | 0.06 | 678.62 | 680.05 | 1.43 | 1.37 |
| MH-2507 | 679.79 | 679.85 | 0.06 | 679.79 | 680.31 | 0.52 | 0.46 |
| MH-2592 | 675.72 | 675.84 | 0.12 | 675.72 | 681.46 | 5.74 | 5.62 |
| MH-2594 | 676.67 | 676.79 | 0.12 | 676.67 | 683.44 | 6.77 | 6.65 |
| MH-2598 | 679.86 | 679.91 | 0.05 | 679.86 | 683.68 | 3.82 | 3.77 |
| MH-2599 | 681.74 | 681.79 | 0.05 | 681.74 | 683.93 | 2.19 | 2.14 |
| MH-2610 | 683.62 | 683.67 | 0.05 | 683.62 | 684.18 | 0.56 | 0.51 |
| MH-2630 | 677.62 | 677.72 | 0.10 | 677.62 | 684.17 | 6.55 | 6.46 |
| MH-2631 | 678.49 | 678.59 | 0.10 | 678.49 | 684.89 | 6.40 | 6.30 |
| MH-2645 | 673.92 | 674.04 | 0.12 | 673.92 | 676.09 | 2.17 | 2.06 |
| MH-2707 | 687.24 | 687.29 | 0.05 | 687.24 | 687.52 | 0.28 | 0.23 |
| MH-2709 | 688.55 | 688.60 | 0.05 | 688.55 | 688.84 | 0.29 | 0.24 |
| MH-2743 | 689.81 | 689.87 | 0.06 | 689.81 | 690.12 | 0.31 | 0.26 |
| MH-2831 | 677.62 | 677.69 | 0.07 | 677.62 | 683.65 | 6.03 | 5.95 |
| MH-2833 | 679.94 | 680.00 | 0.06 | 679.94 | 684.22 | 4.28 | 4.22 |
| MH-2835 | 680.34 | 680.40 | 0.06 | 680.34 | 684.32 | 3.98 | 3.92 |
| MH-2836 | 681.30 | 681.35 | 0.05 | 681.30 | 684.43 | 3.13 | 3.08 |
| MH-2839 | 675.72 | 675.77 | 0.05 | 675.72 | 679.48 | 3.76 | 3.70 |
| MH-2840 | 676.34 | 676.39 | 0.05 | 676.34 | 679.51 | 3.17 | 3.12 |
| MH-2895 | 681.82 | 681.88 | 0.06 | 681.82 | 684.51 | 2.69 | 2.63 |
| MH-2898 | 686.93 | 686.96 | 0.03 | 686.93 | 687.11 | 0.18 | 0.14 |
| MH-2920 | 681.86 | 681.92 | 0.06 | 681.86 | 685.86 | 4.00 | 3.94 |
| MH-2921 | 683.02 | 683.04 | 0.02 | 683.02 | 685.88 | 2.86 | 2.84 |
| MH-2922 | 689.61 | 689.62 | 0.01 | 689.61 | 689.69 | 0.08 | 0.07 |
| MH-2933 | 683.30 | 684.03 | 0.73 | 683.30 | 685.89 | 2.59 | 1.87 |
| MH-2939 | 694.42 | 694.43 | 0.01 | 694.42 | 694.49 | 0.07 | 0.06 |
| MH-2960 | 691.21 | 691.22 | 0.01 | 691.21 | 691.29 | 0.08 | 0.07 |
| MH-2975 | 679.38 | 679.44 | 0.06 | 679.38 | 685.14 | 5.76 | 5.70 |
| MH-2976 | 680.26 | 680.32 | 0.06 | 680.26 | 685.39 | 5.13 | 5.07 |
| MH-2978 | 681.06 | 681.12 | 0.06 | 681.06 | 685.61 | 4.55 | 4.50 |
| MH-3072 | 688.71 | 688.78 | 0.07 | 688.71 | 689.11 | 0.40 | 0.33 |
| MH-3073 | 689.79 | 689.85 | 0.06 | 689.79 | 690.16 | 0.37 | 0.31 |
| MH-3074 | 690.67 | 690.73 | 0.06 | 690.67 | 691.04 | 0.37 | 0.31 |
| MH-3075 | 693.74 | 693.77 | 0.03 | 693.74 | 693.93 | 0.19 | 0.15 |
| MH-3076 | 695.95 | 695.98 | 0.03 | 695.95 | 696.14 | 0.19 | 0.15 |
| MH-3078 | 698.15 | 698.18 | 0.03 | 698.15 | 698.34 | 0.19 | 0.16 |
| MH-3079 | 700.61 | 700.64 | 0.03 | 700.61 | 700.80 | 0.19 | 0.16 |
| MH-3080 | 680.42 | 680.49 | 0.07 | 680.42 | 685.53 | 5.11 | 5.04 |
| MH-3081 | 682.12 | 682.19 | 0.07 | 682.12 | 686.22 | 4.10 | 4.03 |
| MH-3082 | 683.76 | 683.83 | 0.07 | 683.76 | 686.96 | 3.20 | 3.13 |
| MH-3083 | 686.41 | 686.45 | 0.04 | 686.41 | 687.03 | 0.62 | 0.58 |
| MH-3086 | 686.46 | 686.51 | 0.05 | 686.46 | 687.21 | 0.75 | 0.70 |
| MH-3087 | 687.81 | 687.86 | 0.05 | 687.81 | 688.09 | 0.28 | 0.23 |
| MH-3200 | 671.09 | 671.23 | 0.14 | 671.09 | 671.83 | 0.74 | 0.60 |
| MH-3204 | 668.99 | 669.13 | 0.14 | 668.99 | 669.75 | 0.76 | 0.62 |
| MH-3207 | 669.76 | 669.89 | 0.13 | 669.76 | 670.48 | 0.72 | 0.58 |
| MH-4634 | 692.92 | 692.92 | 0.00 | 692.92 | 692.95 | 0.03 | 0.03 |
| MH-16260 | 694.21 | 694.23 | 0.02 | 694.21 | 694.29 | 0.08 | 0.06 |
| MH-16261 | 694.71 | 694.72 | 0.01 | 694.71 | 694.77 | 0.06 | 0.05 |
| MH-16262 | 695.61 | 695.62 | 0.01 | 695.61 | 695.65 | 0.04 | 0.04 |
| MH-16263 | 695.91 | 695.92 | 0.01 | 695.91 | 695.95 | 0.04 | 0.04 |
| MH-16264 | 696.40 | 696.41 | 0.01 | 696.40 | 696.44 | 0.04 | 0.03 |
| MH-16265 | 696.84 | 696.85 | 0.01 | 696.84 | 696.89 | 0.05 | 0.04 |
| MH-16266 | 691.66 | 691.68 | 0.02 | 691.66 | 691.76 | 0.10 | 0.08 |
| MH-635 | 668.62 | 668.67 | 0.05 | 668.62 | 668.89 | 0.27 | 0.22 |
| MH-1005 | 671.40 | 671.44 | 0.04 | 671.40 | 671.62 | 0.22 | 0.18 |
| MH-1006 | 680.42 | 680.45 | 0.03 | 680.42 | 680.57 | 0.15 | 0.12 |
| MH-2646 | 672.32 | 672.32 | 0.00 | 672.32 | 672.32 | 0.00 | 0.00 |
| MH-4319 | 670.11 | 670.11 | 0.00 | 670.11 | 670.11 | 0.00 | 0.00 |
| MH-4320 | 671.59 | 671.59 | 0.00 | 671.59 | 671.59 | 0.00 | 0.00 |
| MH-4321 | 670.02 | 670.06 | 0.04 | 670.02 | 670.24 | 0.22 | 0.18 |
| MH-604 | 666.32 | 666.38 | 0.06 | 666.32 | 666.64 | 0.32 | 0.27 |
| MH-634 | 667.43 | 667.48 | 0.05 | 667.43 | 667.71 | 0.28 | 0.23 |
| MH-2841 | 667.25 | 667.37 | 0.12 | 667.25 | 667.95 | 0.70 | 0.58 |
| MH-2842 | 674.07 | 674.11 | 0.04 | 674.07 | 674.27 | 0.20 | 0.16 |
| MH-2843 | 674.88 | 674.92 | 0.03 | 674.88 | 675.07 | 0.19 | 0.16 |
| MH-3208 | 663.88 | 664.00 | 0.12 | 663.88 | 664.57 | 0.69 | 0.57 |
| MH-3209 | 665.65 | 665.78 | 0.13 | 665.65 | 666.34 | 0.69 | 0.57 |
| MH-3210 | 666.68 | 666.81 | 0.13 | 666.68 | 667.39 | 0.71 | 0.58 |
| MH-4343 | 673.09 | 673.41 | 0.32 | 673.09 | 673.58 | 0.49 | 0.17 |
| MH-4344 | 674.52 | 674.56 | 0.04 | 674.52 | 674.72 | 0.20 | 0.17 |
| MH-602 | 663.12 | 663.17 | 0.05 | 663.12 | 663.44 | 0.32 | 0.27 |
| MH-603 | 664.72 | 664.78 | 0.06 | 664.72 | 665.04 | 0.32 | 0.27 |
| MH-621 | 675.42 | 675.45 | 0.03 | 675.42 | 675.58 | 0.16 | 0.13 |
| MH-622 | 677.43 | 677.46 | 0.03 | 677.43 | 677.60 | 0.17 | 0.14 |
| MH-624 | 679.49 | 679.52 | 0.03 | 679.49 | 679.66 | 0.17 | 0.14 |

## TABLE 6.02-3
## 6-MONTH RECURRENCE INTERVAL MANHOLE/PIPE SURCHARGE SUMMARY NORTH BASIN

| Location | Description |
|---|---|
| Pershing Boulevard | ▪ Minor surcharging of 0.06 feet in MH-354.<br>▪ Pipe segment P-197 projected peak flow equals full gravity capacity. |
| 61st Street | ▪ Pipe Segments P-2915 and P-2916 projected peak flow is full gravity capacity. |

## TABLE 6.02-4
## 1-YEAR RECURRENCE INTERVAL MANHOLE/PIPE SURCHARGE SUMMARY NORTH BASIN

| Location | Description |
|---|---|
| Pershing Boulevard | ▪ Minor surcharging of 0.51 feet in MH-354.<br>▪ Pipe segment P-197 projected peak flow is 1.2 times full gravity capacity. |
| 61st Street | ▪ Minor surcharging of 0.29 feet in MH-5174.<br>▪ Pipe Segments P-2915-and P-2916 projected peak flow is 1.2 times the full gravity capacity. |

## TABLE 6.02-5
## 2-YEAR RECURRENCE INTERVAL MANHOLE/PIPE SURCHARGE SUMMARY NORTH BASIN

| Location | Description |
|---|---|
| Pershing Boulevard | ▪ Surcharging of 1.13 feet and 0.94 feet in MH-354 and MH-355, respectively.<br>▪ Pipe segment P-197 projected peak flow is 1.5 times full gravity capacity. |
| 61st Street | ▪ Surcharging of 0.88 feet in MH-5174.<br>▪ Surcharging of 0.01 feet in MH-986.<br>▪ Pipe Segments P-2915-and P-2916 projected peak flow is 1.3 times the full gravity capacity. |
| 60th Street | ▪ Surcharging of 0.42 feet in MH-6069.<br>▪ Pipe Segment P-3069 projected peak flow is 2.0 times the full gravity capacity. |
| 46th Avenue | ▪ Minor surcharging of 0.33 feet in MH-396. |

## TABLE 6.02-6
## 5-YEAR RECURRENCE INTERVAL MANHOLE/PIPE SURCHARGE SUMMARY NORTH BASIN

| Location | Description |
|---|---|
| Pershing Boulevard | ▪ A maximum surcharge depth of 2.02 feet in MH-355.<br>▪ Pipe segment P-197 projected peak flow is 1.7 times full gravity capacity. |
| 61st Street | ▪ A maximum surcharge depth of 2.16 feet in MH-5174.<br>▪ A maximum surcharge depth of 0.34 feet in MH-879.<br>▪ Pipe Segments P-2915-and P-2916 projected peak flow is 1.3 times the full gravity capacity. |
| 60th Street | ▪ Surcharging of 0.57 feet in MH-6069.<br>▪ Pipe Segment P-3069 projected peak flow is 2.1 times the full gravity capacity. |
| 46th Avenue | ▪ Surcharging of 1.26 feet in MH-396. |

## TABLE 6.02-7
## 10-YEAR RECURRENCE INTERVAL MANHOLE/PIPE SURCHARGE SUMMARY NORTH BASIN

| Location | Description |
|---|---|
| Pershing Boulevard | ▪ A maximum surcharge depth of 2.33 feet in MH-355.<br>▪ Pipe segment P-197 projected peak flow is 1.7 times full gravity capacity. |
| 61st Street | ▪ A maximum surcharge depth of 2.64 feet in MH-5174.<br>▪ A maximum surcharge depth of 1.63 feet in MH-879.<br>▪ A maximum surcharge depth of 0.98 feet in MH-374.<br>▪ Pipe Segments P-2915-and P-2916 projected peak flow is 1.3 times the full gravity capacity.<br>▪ Pipe Segments P-2981-and P-2979 projected peak flow is 1.3 times the full gravity capacity. |
| 60th Street | ▪ Surcharging of 0.65 feet in MH-6069.<br>▪ Pipe Segment P-3069 projected peak flow is 2.1 times the full gravity capacity. |
| 46th Avenue | ▪ Surcharging of 1.77 feet in MH-396. |

## TABLE 6.02-8
## 25-YEAR RECURRENCE INTERVAL MANHOLE/PIPE SURCHARGE SUMMARY NORTH BASIN

| Location | Description |
|---|---|
| Pershing Boulevard | ▪ A maximum surcharge depth of 2.87 feet in MH-355.<br>▪ Pipe segment P-197 projected peak flow is 1.8 times full gravity capacity. |
| 61st Street | ▪ A maximum surcharge depth of 3.49 feet in MH-5174.<br>▪ A maximum surcharge depth of 4.79 feet in MH-879.<br>▪ A maximum surcharge depth of 1.87 feet in MH-374.<br>▪ A maximum surcharge depth of 4.96 feet in MH-5724.<br>▪ Pipe Segments P-2915-and P-2916 projected peak flow is 1.3 times the full gravity capacity.<br>▪ Pipe Segments P-2981-and P-2979 projected peak flow is 1.5 times the full gravity capacity. |
| 60th Street | ▪ Surcharging of 0.77 feet in MH-6069.<br>▪ Pipe Segment P-3069 projected peak flow is 2.1 times the full gravity capacity. |
| 46th Avenue | ▪ Surcharging of 2.67 feet in MH-396. |
| 51st Avenue | ▪ Surcharging of 3.03 feet in MH-937. |

## TABLE 6.02-9
## 50-YEAR RECURRENCE INTERVAL MANHOLE/PIPE SURCHARGE SUMMARY NORTH BASIN

| Location | Description |
|---|---|
| Pershing Boulevard | ▪ A maximum surcharge depth of 3.38 feet in MH-355.<br>▪ Pipe segment P-197 projected peak flow is 1.9 times full gravity capacity. |
| 61st Street | ▪ A maximum surcharge depth of 4.25 feet in MH-5174.<br>▪ A maximum surcharge depth of 7.34 feet in MH-879.<br>▪ A maximum surcharge depth of 2.65 feet in MH-374.<br>▪ A maximum surcharge depth of 7.65 feet in MH-5724.<br>▪ Pipe Segments P-2915-and P-2916 projected peak flow is 1.3 times the full gravity capacity.<br>▪ Pipe Segments P-2981-and P-2979 projected peak flow is 1.6 times the full gravity capacity. |
| 60th Street | ▪ Surcharging of 0.94 feet in MH-6069.<br>▪ Pipe Segment P-3069 projected peak flow is 2.2 times the full gravity capacity. |
| 46th Avenue | ▪ Surcharging of 3.46 feet in MH-396. |
| 51st Avenue | ▪ Surcharging of 6.12 feet in MH-937. |

## TABLE 6.02-10
## 100-YEAR RECURRENCE INTERVAL MANHOLE/PIPE SURCHARGE SUMMARY NORTH BASIN

| Location | Description |
|---|---|
| Pershing Boulevard | ▪ A maximum surcharge depth of 8.55 feet in MH-355.<br>▪ Pipe segment P-197 projected peak flow is 2.0 times full gravity capacity. |
| 61st Street | ▪ A maximum surcharge depth of 9.73 feet in MH-5174.<br>▪ A maximum surcharge depth of 10.05 feet in MH-879.<br>▪ A maximum surcharge depth of 8.10 feet in MH-374.<br>▪ A maximum surcharge depth of 10.0 feet in MH-5724.<br>▪ Pipe Segments P-2915-and P-2916 projected peak flow is 1.3 times the full gravity capacity.<br>▪ Pipe Segments P-2981-and P-2979 projected peak flow is 1.7 times the full gravity capacity. |
| 60th Street | ▪ Surcharging of 3.29 feet in MH-6069.<br>▪ Pipe Segment P-3069 projected peak flow is 2.3 times the full gravity capacity. |
| 46th Avenue | ▪ Surcharging of 9.03 feet in MH-396. |
| 51st Avenue | ▪ Surcharging of 8.57 feet in MH-937. |

## TABLE 6.02-11
## 6-MONTH RECURRENCE INTERVAL MANHOLE/PIPE SURCHARGE SUMMARY SOUTH BASIN

| Location | Description |
|---|---|
| | No Surcharging Modeled |

## TABLE 6.02-12
## 1-YEAR RECURRENCE INTERVAL MANHOLE/PIPE SURCHARGE SUMMARY SOUTH BASIN

| Location | Description |
|---|---|
| | No Surcharging Modeled |

## TABLE 6.02-13
## 2-YEAR RECURRENCE INTERVAL MANHOLE/PIPE SURCHARGE SUMMARY SOUTH BASIN

| Location | Description |
|---|---|
| 65th Street | ▪ Pipe segment P-594 projected peak flow is 1.2 times full gravity capacity. |

## TABLE 6.02-14
## 5-YEAR RECURRENCE INTERVAL MANHOLE/PIPE SURCHARGE SUMMARY SOUTH BASIN

| Location | Description |
|---|---|
| 65th Street | ▪ Surcharging of 0.93 feet in MH-2592.<br>▪ Pipe segment P-592 projected peak flow is 1.1 times full gravity capacity.<br>▪ Surcharging of 0.52 feet in MH-2630.<br>▪ Pipe segment P-591 projected peak flow is 1.1 times full gravity capacity.<br>▪ Pipe segment P-594 projected peak flow is 1.4 times full gravity capacity. |

**TABLE 6.02-15**
**10-YEAR RECURRENCE INTERVAL MANHOLE/PIPE SURCHARGE SUMMARY SOUTH BASIN**

| Location | Description |
|---|---|
| 65th Street | ▪ Surcharging of 1.81 feet in MH-2592.<br>▪ Pipe segment P-592 projected peak flow is 1.2 times full gravity capacity.<br>▪ Surcharging of 1.36 feet in MH-2594.<br>▪ Pipe segment P-591 projected peak flow is 1.2 times full gravity capacity.<br>▪ Surcharging of 1.72 feet in MH-2630.<br>▪ Pipe segment P-594 projected peak flow is 1.6 times full gravity capacity. |
| 50th Avenue | ▪ Surcharging of 1.39 feet in MH-2831. |

**TABLE 6.02-16**
**25-YEAR RECURRENCE INTERVAL MANHOLE/PIPE SURCHARGE SUMMARY SOUTH BASIN**

| Location | Description |
|---|---|
| 65th Street | ▪ Surcharging of 3.49 feet in MH-2592.<br>▪ Pipe segment P-592 projected peak flow is 1.4 times full gravity capacity.<br>▪ Surcharging of 3.36 feet in MH-2594.<br>▪ Pipe segment P-591 projected peak flow is 1.4 times full gravity capacity.<br>▪ Surcharging of 2.10 feet in MH-2496.<br>▪ Pipe segment P-594 projected peak flow is 1.8 times full gravity capacity. |
| 50th Avenue | ▪ Surcharging of 3.43 feet in MH-2831. |

**TABLE 6.02-17**
**50-YEAR RECURRENCE INTERVAL MANHOLE/PIPE SURCHARGE SUMMARY SOUTH BASIN**

| Location | Description |
|---|---|
| 65th Street | ▪ Surcharging of 4.91 feet in MH-2592.<br>▪ Pipe segment P-592 projected peak flow is 1.5 times full gravity capacity.<br>▪ Surcharging of 5.10 feet in MH-2594.<br>▪ Pipe segment P-591 projected peak flow is 1.5 times full gravity capacity.<br>▪ Surcharging of 5.72 feet in MH-2630.<br>▪ Pipe segment P-594 projected peak flow is 2.0 times full gravity capacity. |
| 51st Avenue | ▪ Surcharging of 4.44 feet in MH-3080. |
| 50th Avenue | ▪ Surcharging of 5.20 feet in MH-2831. |

**TABLE 6.02-18**
**100-YEAR RECURRENCE INTERVAL MANHOLE/PIPE SURCHARGE SUMMARY SOUTH BASIN**

| Location | Description |
|---|---|
| 65th Street | ▪ Surcharging of 6.46 feet in MH-2592.<br>▪ Pipe segment P-592 projected peak flow is 1.7 times full gravity capacity.<br>▪ Surcharging of 6.97 feet in MH-2594.<br>▪ Pipe segment P-591 projected peak flow is 1.6 times full gravity capacity.<br>▪ Surcharging of 7.69 feet in MH-2630.<br>▪ Pipe segment P-594 projected peak flow is 2.2 times full gravity capacity. |
| 51st Avenue | ▪ Surcharging of 6.62 feet in MH-3080. |
| 50th Avenue | ▪ Surcharging of 7.09 feet in MH-2831. |

# SECTION 7
# ENGINEERING ANALYSIS: STORM SEWER

## 7.01 HYDROLOGIC ANALYSIS

### A. Purpose of Evaluation

A watershed model was developed for the Forest Park Area and upstream and downstream areas. This model estimated peak discharges and stormwater runoff volumes from individual drainage subbasins under existing land use conditions. This data was used to size stormwater detention and conveyance facilities and estimate potential flood depths at critical watershed locations.

### B. Methodology

For this project, hydrologic models were developed using the RUNOFF module of the computer model xp-swmm Version 2009. xp-swmm is a proprietary model based on the United States Environmental Protection Agency (USEPA)-developed Stormwater Management Model (SWMM). xp-swmm estimates peak stormwater discharges and volumes based on mathematical input parameters representing precipitation depth and time distribution, drainage area, land use, and time of concentration for each subbasin. Primary input parameters include the drainage area, runoff curve number (RCN), and time of concentration ($T_c$). The RCN considers land use and percentage of impervious area, soil type, and saturation conditions to impact the volume of stormwater runoff generated for a given rainfall depth. The $T_c$ is the time it takes for stormwater to travel from the most hydrologically remote point in the watershed to the subbasin outlet. Parameters representing rainfall depth and distribution and watershed storage are also included in the model.

Based on user input coding, xp-swmm generates hydrographs for each subbasin, routes them through storage areas, and combines them at appropriate locations. The result is a rainfall-runoff model of the storm event of interest. For this project, hydrographs were generated for the 2-, 5-, 10-, 25-, 50- and 100-year storms under existing land use conditions. The SEWRPC rainfall amounts and distribution were analyzed for this project. A sensitivity analysis was performed in the original report to identify the storm duration resulting in the highest probable peak discharges at various watershed locations (typically referred to as the “critical duration”). Our analysis concluded that the critical storm duration creating the greatest peak discharges watershed-wide under existing land use conditions is a 2-hour storm. We have analyzed each of our alternatives for the 10-, 25- and 100-year storm events of 2-hour duration. In some cases the 25- and 100-year storm event was not run if the 10-year impacts were not significant.

### C. Hydrologic Modeling Results

Table 7.01-1 includes summaries of peak discharges calculated by xp-swmm for each subbasin in the modeled watersheds for existing land use conditions for a 2-hour duration storm. Peak discharges for the May 20 to 23, 2004, storm are arrived at by using RCNs that are 25 percent higher than existing land use conditions to account for the substantial rainfall in the weeks leading up to the May 20 to 23, 2004, storm event as described in Section 2.

## TABLE 7.01-1

## STORM SEWER MODELING

| Basin ID | Structure ID | Max Flow (cfs) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 2-Yr | 5-Yr | 10-Yr | 25-Yr | 50-Yr | 100-Yr | May 04 |
| CM1 | 800 | 6.8 | 13.6 | 20.0 | 32.2 | 44.0 | 58.2 | 17.5 |
| CM10 | 10215 | 45.6 | 67.3 | 84.9 | 115.1 | 141.9 | 172.2 | 50.3 |
| CM11 | 13112 | 14.1 | 22.9 | 30.5 | 44.0 | 56.3 | 70.6 | 21.2 |
| CM12 | 12921 | 32.3 | 52.3 | 69.4 | 99.6 | 127.2 | 159.3 | 50.2 |
| CM13 | 12737 | 48.1 | 79.4 | 106.6 | 155.3 | 200.0 | 252.4 | 93.3 |
| CM14 | 12350 | 25.6 | 40.1 | 52.3 | 73.8 | 93.1 | 115.4 | 41.1 |
| CM15 | 7497 | 7.0 | 11.1 | 14.6 | 20.7 | 26.3 | 32.7 | 12.5 |
| CM16 | 10224 | 5.2 | 8.5 | 11.3 | 16.2 | 20.7 | 26.0 | 9.2 |
| CM17 | 11971 | 1.2 | 1.9 | 2.5 | 3.6 | 4.5 | 5.6 | 1.9 |
| CM18 | 12146 | 5.5 | 8.9 | 11.8 | 17.0 | 21.8 | 27.3 | 9.5 |
| CM19 | 6139 | 23.8 | 38.8 | 51.7 | 74.7 | 95.7 | 120.0 | 45.6 |
| CM2 | 900 | 26.3 | 42.2 | 55.7 | 79.7 | 101.7 | 127.1 | 35.9 |
| CM20 | 6089 | 6.0 | 9.8 | 13.0 | 18.8 | 24.1 | 30.2 | 11.6 |
| CM21 | 6057 | 10.5 | 17.1 | 22.7 | 32.8 | 42.0 | 52.7 | 20.0 |
| CM22 | 6046 | 5.3 | 8.6 | 11.4 | 16.5 | 21.1 | 26.4 | 10.1 |
| CM23 | 6040 | 10.0 | 15.9 | 20.9 | 29.8 | 37.9 | 47.2 | 18.2 |
| CM24 | 6028 | 1.1 | 1.9 | 2.5 | 3.6 | 4.6 | 5.7 | 2.2 |
| CM3 | 15978 | 11.8 | 18.9 | 24.8 | 35.3 | 44.7 | 55.7 | 15.9 |
| CM4 | 3161 | 16.4 | 24.4 | 30.9 | 42.2 | 52.1 | 63.4 | 16.6 |
| CM5 | 3173 | 43.8 | 70.2 | 92.8 | 132.8 | 169.0 | 211.4 | 64.5 |
| CM6 | 3183 | 20.8 | 33.3 | 44.0 | 62.9 | 80.0 | 99.9 | 30.2 |
| CM7 | 3192 | 39.8 | 62.2 | 81.1 | 114.4 | 144.5 | 179.1 | 52.9 |
| CM8 | 3206 | 19.1 | 31.2 | 41.6 | 60.2 | 77.2 | 97.2 | 27.6 |
| CM9 | 3097 | 23.3 | 34.5 | 43.6 | 59.2 | 73.0 | 88.6 | 25.2 |
| FPN1 | 5820 | 0.1 | 0.1 | 0.2 | 0.2 | 0.3 | 0.4 | 0.1 |
| FPN10 | 5797 | 0.2 | 0.4 | 0.5 | 0.7 | 0.9 | 1.2 | 0.4 |
| FPN11 | 5734 | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.2 |
| FPN12 | 5733 | 0.9 | 1.4 | 1.9 | 2.7 | 3.5 | 4.4 | 1.7 |
| FPN13 | 5736 | 0.5 | 0.9 | 1.2 | 1.7 | 2.2 | 2.7 | 1.0 |
| FPN14 | 5799 | 0.2 | 0.4 | 0.6 | 1.0 | 1.3 | 1.7 | 0.7 |
| FPN15 | 5789 | 0.4 | 0.9 | 1.4 | 2.3 | 3.2 | 4.3 | 1.6 |
| FPN16 | 5802 | 0.1 | 0.2 | 0.3 | 0.4 | 0.6 | 0.7 | 0.2 |
| FPN17 | 5796 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.2 | 0.0 |
| FPN18 | 17546 | 0.1 | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | - |
| FPN19 | 5795 | 0.2 | 0.4 | 0.5 | 0.8 | 1.0 | 1.3 | 0.6 |
| FPN2 | 5819 | 0.2 | 0.3 | 0.4 | 0.6 | 0.8 | 1.0 | 0.3 |
| FPN20 | 5793 | 0.8 | 1.4 | 1.9 | 2.8 | 3.6 | 4.5 | 2.1 |
| FPN21 | 17545 | 0.3 | 0.5 | 0.7 | 1.0 | 1.3 | 1.7 | - |
| FPN22 | 5792 | 0.4 | 0.6 | 0.8 | 1.1 | 1.5 | 1.8 | 0.6 |
| FPN23 | 5784 | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.7 | 0.2 |
| FPN24 | 5786 | 0.3 | 0.6 | 0.7 | 1.1 | 1.4 | 1.7 | 0.6 |
| FPN25 | 5787 | 1.7 | 2.7 | 3.6 | 5.2 | 6.7 | 8.4 | 3.0 |

| Basin ID | Structure ID | Max Flow (cfs) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 2-Yr | 5-Yr | 10-Yr | 25-Yr | 50-Yr | 100-Yr | May 04 |
| FPN26 | 5785 | 0.8 | 1.2 | 1.6 | 2.3 | 3.0 | 3.8 | 1.4 |
| FPN27 | 5781 | 0.5 | 1.2 | 1.7 | 2.8 | 3.9 | 5.2 | 1.8 |
| FPN28 | 5737 | 0.3 | 0.5 | 0.7 | 1.1 | 1.4 | 1.9 | 0.7 |
| FPN29 | 5740 | 1.4 | 2.2 | 3.0 | 4.3 | 5.6 | 7.1 | 2.7 |
| FPN3 | 5816 | 0.5 | 0.9 | 1.1 | 1.6 | 2.1 | 2.6 | 0.9 |
| FPN30 | 5739 | 1.6 | 2.5 | 3.4 | 4.9 | 6.3 | 7.8 | 2.8 |
| FPN31 | 5741 | 0.5 | 0.8 | 1.1 | 1.6 | 2.0 | 2.5 | 0.9 |
| FPN32 | 5742 | 1.2 | 2.0 | 2.6 | 3.8 | 4.9 | 6.1 | 2.2 |
| FPN33 | 5743 | 0.3 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 | 0.2 |
| FPN34 | 5748 | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.2 |
| FPN35 | 5747 | 0.4 | 0.6 | 0.8 | 1.1 | 1.4 | 1.8 | 0.7 |
| FPN36 | 5746 | 0.3 | 0.4 | 0.4 | 0.6 | 0.7 | 0.8 | 0.2 |
| FPN37 | 5771 | 1.4 | 2.4 | 3.3 | 4.9 | 6.4 | 8.2 | 2.8 |
| FPN38 | 5772 | 0.3 | 0.7 | 1.0 | 1.6 | 2.2 | 3.0 | 1.1 |
| FPN39 | 5769 | 2.0 | 3.3 | 4.5 | 6.5 | 8.4 | 10.7 | 3.7 |
| FPN4 | 5817 | 0.2 | 0.3 | 0.4 | 0.5 | 0.7 | 0.9 | 0.3 |
| FPN40 | 5767 | 0.8 | 1.3 | 1.6 | 2.3 | 2.9 | 3.6 | 1.1 |
| FPN41 | 5766 | 1.3 | 2.1 | 2.7 | 3.9 | 4.9 | 6.1 | 2.0 |
| FPN42 | 5764 | 0.7 | 1.0 | 1.3 | 1.8 | 2.3 | 2.8 | 0.9 |
| FPN43 | 5763 | 0.8 | 1.2 | 1.5 | 2.1 | 2.6 | 3.3 | 1.0 |
| FPN44 | 5762 | 1.0 | 1.5 | 2.0 | 2.8 | 3.5 | 4.3 | 1.4 |
| FPN45 | 5760 | 0.7 | 1.2 | 1.6 | 2.4 | 3.1 | 4.0 | 1.3 |
| FPN46 | 5759 | 0.2 | 0.3 | 0.4 | 0.7 | 0.9 | 1.1 | 0.4 |
| FPN47 | 5758 | 0.4 | 0.7 | 0.9 | 1.3 | 1.7 | 2.2 | 0.7 |
| FPN48 | 5756 | 1.1 | 1.8 | 2.4 | 3.5 | 4.6 | 5.8 | 1.9 |
| FPN49 | 5752 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.0 |
| FPN5 | 5803 | 0.2 | 0.3 | 0.3 | 0.4 | 0.5 | 0.6 | 0.2 |
| FPN50 | 5755 | 0.2 | 0.4 | 0.5 | 0.7 | 1.0 | 1.2 | 0.4 |
| FPN51 | 5619 | 0.2 | 0.2 | 0.3 | 0.4 | 0.4 | 0.5 | 0.1 |
| FPN52 | 5618 | 0.3 | 0.5 | 0.7 | 1.0 | 1.3 | 1.7 | 0.6 |
| FPN53 | 5613 | 0.5 | 0.9 | 1.1 | 1.6 | 2.1 | 2.6 | 0.9 |
| FPN54 | 5615 | 1.7 | 2.8 | 3.8 | 5.4 | 6.9 | 8.7 | 3.3 |
| FPN55 | 5621 | 0.7 | 1.1 | 1.4 | 2.0 | 2.6 | 3.2 | 1.2 |
| FPN56 | 5620 | 0.2 | 0.2 | 0.3 | 0.5 | 0.6 | 0.7 | 0.3 |
| FPN57 | 5657 | 0.4 | 0.7 | 1.0 | 1.5 | 2.0 | 2.5 | 0.8 |
| FPN58 | 5659 | 0.9 | 1.5 | 1.9 | 2.8 | 3.6 | 4.5 | 1.8 |
| FPN59 | 5660 | 1.6 | 2.8 | 3.7 | 5.5 | 7.1 | 9.1 | 3.1 |
| FPN6 | 5805 | 0.9 | 1.4 | 1.9 | 2.8 | 3.5 | 4.5 | 1.6 |
| FPN60 | 5655 | 0.3 | 0.5 | 0.7 | 1.0 | 1.3 | 1.7 | 0.5 |
| FPN61 | 5654 | 1.7 | 3.0 | 4.1 | 6.2 | 8.1 | 10.4 | 3.5 |
| FPN62 | 5652 | 0.9 | 1.5 | 2.0 | 3.0 | 3.9 | 5.0 | 1.7 |
| FPN63 | 5656 | 0.2 | 0.4 | 0.5 | 0.8 | 1.0 | 1.3 | 0.4 |
| FPN64 | 5650 | 2.6 | 4.7 | 6.5 | 9.8 | 12.9 | 16.6 | 6.6 |
| FPN65 | 5648 | 1.1 | 1.9 | 2.7 | 4.1 | 5.4 | 6.9 | 2.3 |
| FPN66 | 5651 | 0.2 | 0.3 | 0.5 | 0.7 | 0.9 | 1.2 | 0.4 |
| FPN67 | 5626 | 2.1 | 3.6 | 4.9 | 7.4 | 9.7 | 12.4 | 4.4 |

| Basin ID | Structure ID | Max Flow (cfs) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 2-Yr | 5-Yr | 10-Yr | 25-Yr | 50-Yr | 100-Yr | May 04 |
| FPN68 | 5625 | 0.4 | 0.7 | 0.9 | 1.4 | 1.8 | 2.3 | 0.7 |
| FPN69 | 5627 | 0.6 | 1.1 | 1.6 | 2.4 | 3.2 | 4.1 | 1.3 |
| FPN7 | 5806 | 0.5 | 0.9 | 1.2 | 1.8 | 2.4 | 3.1 | 1.0 |
| FPN70 | 5633 | 1.0 | 1.9 | 2.7 | 4.3 | 5.8 | 7.6 | 2.4 |
| FPN71 | 5628 | 0.2 | 0.4 | 0.5 | 0.8 | 1.0 | 1.3 | 0.4 |
| FPN72 | 5629 | 0.3 | 0.5 | 0.7 | 0.9 | 1.2 | 1.5 | 0.6 |
| FPN73 | 5630 | 0.3 | 0.5 | 0.6 | 0.9 | 1.1 | 1.4 | 0.5 |
| FPN74 | 5637 | 0.4 | 0.6 | 0.8 | 1.1 | 1.3 | 1.6 | 0.5 |
| FPN75 | 5635 | 0.9 | 1.2 | 1.4 | 1.8 | 2.1 | 2.4 | 0.6 |
| FPN76 | 5631 | 0.7 | 1.0 | 1.3 | 1.7 | 2.1 | 2.6 | 0.8 |
| FPN77 | 5632 | 2.0 | 3.2 | 4.3 | 6.3 | 8.0 | 10.1 | 3.5 |
| FPN78 | 5638 | 0.5 | 0.9 | 1.2 | 1.7 | 2.2 | 2.8 | 0.9 |
| FPN79 | 5640 | 0.6 | 0.9 | 1.3 | 1.8 | 2.4 | 3.0 | 1.0 |
| FPN8 | 5801 | 0.6 | 1.1 | 1.6 | 2.4 | 3.2 | 4.1 | 1.3 |
| FPN80 | 3961 | 3.0 | 4.0 | 4.9 | 6.3 | 7.5 | 8.9 | 2.3 |
| FPN81 | 3960 | 1.2 | 1.6 | 1.9 | 2.4 | 2.8 | 3.2 | 0.8 |
| FPN82 | 8551 | 2.1 | 2.8 | 3.3 | 4.1 | 4.8 | 5.6 | 1.4 |
| FPN83 | 8162 | 0.8 | 1.1 | 1.3 | 1.6 | 1.9 | 2.3 | 0.6 |
| FPN84 | 5777 | 0.3 | 0.5 | 0.7 | 1.0 | 1.2 | 1.6 | 0.5 |
| FPN85 | 5775 | 0.2 | 0.3 | 0.4 | 0.5 | 0.7 | 0.8 | 0.3 |
| FPN86 | 5778 | 0.2 | 0.4 | 0.5 | 0.7 | 0.9 | 1.1 | 0.4 |
| FPN87 | 5779 | 0.4 | 0.6 | 0.8 | 1.2 | 1.5 | 1.9 | 0.7 |
| FPN9 | 5790 | 0.2 | 0.3 | 0.4 | 0.7 | 0.9 | 1.1 | 0.4 |
| FPS1 | 6024 | 1.2 | 2.0 | 2.7 | 3.8 | 4.9 | 6.1 | 2.2 |
| FPS10 | 5721 | 1.0 | 1.6 | 2.1 | 3.0 | 3.9 | 4.8 | 1.7 |
| FPS11 | 5720 | 1.5 | 2.4 | 3.1 | 4.5 | 5.8 | 7.2 | 2.6 |
| FPS12 | 5718 | 1.0 | 1.6 | 2.1 | 3.1 | 3.9 | 4.9 | 1.8 |
| FPS13 | 5715 | 1.4 | 2.3 | 3.1 | 4.5 | 5.7 | 7.2 | 2.6 |
| FPS14 | 5716 | 0.2 | 0.2 | 0.3 | 0.4 | 0.4 | 0.5 | 0.1 |
| FPS15 | 5714 | 0.4 | 0.7 | 0.9 | 1.3 | 1.6 | 2.1 | 0.7 |
| FPS16 | 5713 | 0.1 | 0.1 | 0.1 | 0.2 | 0.3 | 0.3 | 0.1 |
| FPS17 | 5751 | 0.6 | 1.0 | 1.3 | 1.9 | 2.4 | 3.0 | 1.0 |
| FPS18 | 5749 | 0.4 | 0.6 | 0.8 | 1.2 | 1.5 | 1.9 | 0.7 |
| FPS19 | 5712 | 1.6 | 2.6 | 3.5 | 5.0 | 6.5 | 8.1 | 3.1 |
| FPS2 | 6025 | 0.4 | 0.6 | 0.8 | 1.2 | 1.5 | 1.9 | 0.7 |
| FPS20 | 5710 | 0.3 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 | 0.2 |
| FPS21 | 5706 | 0.7 | 1.2 | 1.6 | 2.3 | 2.9 | 3.6 | 1.3 |
| FPS22 | 5707 | 2.0 | 3.2 | 4.3 | 6.1 | 7.8 | 9.7 | 3.3 |
| FPS23 | 5708 | 0.3 | 0.4 | 0.6 | 0.8 | 1.0 | 1.3 | 0.4 |
| FPS24 | 5704 | 0.2 | 0.4 | 0.5 | 0.7 | 0.9 | 1.1 | 0.4 |
| FPS25 | 5709 | 0.0 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.1 |
| FPS26 | 5701 | 0.5 | 0.9 | 1.2 | 1.8 | 2.3 | 2.9 | 1.0 |
| FPS27 | 5703 | 1.7 | 2.8 | 3.9 | 5.8 | 7.5 | 9.5 | 3.4 |
| FPS28 | 5606 | 0.4 | 0.6 | 0.8 | 1.1 | 1.5 | 1.9 | 0.7 |
| FPS29 | 9733 | 0.3 | 0.5 | 0.7 | 1.0 | 1.3 | 1.7 | 0.6 |
| FPS3 | 6023 | 1.2 | 2.0 | 2.6 | 3.7 | 4.8 | 6.0 | 2.1 |

| Basin ID | Structure ID | Max Flow (cfs) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 2-Yr | 5-Yr | 10-Yr | 25-Yr | 50-Yr | 100-Yr | May 04 |
| FPS30 | 5609 | 1.5 | 2.6 | 3.5 | 5.2 | 6.8 | 8.7 | 3.3 |
| FPS31 | 5608 | 1.5 | 2.5 | 3.3 | 4.8 | 6.2 | 7.8 | 2.8 |
| FPS32 | 5611 | 0.2 | 0.3 | 0.4 | 0.6 | 0.8 | 1.0 | 0.3 |
| FPS33 | 5610 | 0.7 | 1.2 | 1.6 | 2.3 | 2.9 | 3.6 | 1.3 |
| FPS34 | 5671 | 0.3 | 0.5 | 0.7 | 1.0 | 1.3 | 1.6 | 0.6 |
| FPS35 | 5672 | 1.3 | 2.1 | 2.8 | 4.1 | 5.3 | 6.6 | 2.6 |
| FPS36 | 5670 | 0.3 | 0.5 | 0.7 | 0.9 | 1.2 | 1.5 | 0.5 |
| FPS37 | 5678 | 1.3 | 2.1 | 2.7 | 3.9 | 5.0 | 6.3 | 2.3 |
| FPS38 | 5677 | 0.8 | 1.4 | 2.0 | 3.1 | 4.1 | 5.3 | 1.8 |
| FPS39 | 5683 | 0.3 | 0.5 | 0.8 | 1.1 | 1.5 | 1.9 | 0.6 |
| FPS4 | 5722 | 0.3 | 0.5 | 0.6 | 0.9 | 1.1 | 1.4 | 0.5 |
| FPS40 | 5682 | 0.9 | 1.5 | 2.0 | 3.0 | 4.0 | 5.1 | 1.7 |
| FPS41 | 5681 | 0.9 | 1.4 | 1.8 | 2.4 | 3.0 | 3.7 | 1.2 |
| FPS42 | 5679 | 0.5 | 0.8 | 1.0 | 1.3 | 1.6 | 2.0 | 0.6 |
| FPS43 | 5675 | 0.2 | 0.3 | 0.4 | 0.6 | 0.8 | 1.1 | 0.4 |
| FPS44 | 5676 | 0.3 | 0.5 | 0.7 | 1.0 | 1.3 | 1.6 | 0.6 |
| FPS45 | 5673 | 2.4 | 4.0 | 5.3 | 7.7 | 10.0 | 12.6 | 4.6 |
| FPS46 | 5666 | 0.2 | 0.3 | 0.3 | 0.4 | 0.5 | 0.6 | 0.2 |
| FPS47 | 5665 | 0.5 | 0.8 | 1.1 | 1.6 | 2.1 | 2.6 | 1.0 |
| FPS48 | 5668 | 0.4 | 0.6 | 0.8 | 1.2 | 1.5 | 1.9 | 0.7 |
| FPS49 | 5663 | 1.6 | 2.6 | 3.5 | 5.0 | 6.5 | 8.2 | 3.0 |
| FPS5 | 5725 | 0.2 | 0.3 | 0.4 | 0.6 | 0.7 | 0.9 | 0.3 |
| FPS50 | 5662 | 0.6 | 1.0 | 1.3 | 1.9 | 2.5 | 3.1 | 1.2 |
| FPS6 | 5726 | 0.2 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.2 |
| FPS7 | 5727 | 0.3 | 0.5 | 0.7 | 1.0 | 1.2 | 1.5 | 0.5 |
| FPS8 | 5728 | 0.2 | 0.3 | 0.4 | 0.6 | 0.7 | 0.9 | 0.3 |
| FPS9 | 5719 | 0.2 | 0.3 | 0.3 | 0.4 | 0.5 | 0.6 | 0.1 |
| FPW1 | 11959 | 29.7 | 46.8 | 61.2 | 86.5 | 109.3 | 135.8 | 49.9 |
| FPW10 | 7566 | 6.1 | 10.2 | 13.8 | 20.2 | 26.2 | 33.2 | 13.5 |
| FPW11 | KEN_COMMON | 7.3 | 11.2 | 14.6 | 20.4 | 25.6 | 31.7 | 10.1 |
| FPW12 | 8161 | 27.7 | 44.1 | 57.8 | 82.0 | 103.9 | 129.1 | 43.9 |
| FPW13 | 11358 | 6.4 | 10.8 | 14.6 | 21.6 | 28.1 | 35.7 | 14.9 |
| FPW2 | 11763 | 7.0 | 10.9 | 14.3 | 20.1 | 25.3 | 31.4 | 10.3 |
| FPW3 | 16964 | 8.1 | 11.6 | 14.4 | 19.2 | 23.4 | 28.1 | 9.5 |
| FPW4 | 11553 | 6.7 | 10.8 | 14.3 | 20.5 | 26.1 | 32.7 | 11.9 |
| FPW5 | 10239 | 7.4 | 11.7 | 15.3 | 21.6 | 27.4 | 34.0 | 12.3 |
| FPW6 | 9727 | 9.1 | 16.2 | 22.6 | 34.4 | 45.5 | 58.7 | 26.4 |
| FPW7 | OLD_ELM | 8.0 | 11.3 | 13.9 | 18.4 | 22.2 | 26.5 | 6.9 |
| FPW8 | NASH | 29.5 | 50.3 | 68.7 | 102.0 | 133.0 | 169.5 | 73.4 |
| FPW9 | 7637 | 7.4 | 12.6 | 17.1 | 25.2 | 32.8 | 41.6 | 17.0 |
| PC1 | 13463 | 12.1 | 20.3 | 27.3 | 40.0 | 51.7 | 65.4 | 19.7 |
| PC10 | 7388 | 25.8 | 40.4 | 52.7 | 74.1 | 93.5 | 115.7 | 44.4 |
| PC11 | 12182 | 21.5 | 33.4 | 43.5 | 61.1 | 77.0 | 95.3 | 36.1 |
| PC12 | 12373 | 3.0 | 4.5 | 5.7 | 7.7 | 9.6 | 11.6 | 3.6 |
| PC13 | 8070 | 5.5 | 8.3 | 10.6 | 14.6 | 18.1 | 22.2 | 7.7 |
| PC14 | 8064 | 4.6 | 7.1 | 9.2 | 12.9 | 16.2 | 20.0 | 6.8 |

| Basin ID | Structure ID | Max Flow (cfs) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 2-Yr | 5-Yr | 10-Yr | 25-Yr | 50-Yr | 100-Yr | May 04 |
| PC15 | 8094 | 7.5 | 11.8 | 15.5 | 21.9 | 27.7 | 34.4 | 11.0 |
| PC16 | 8353 | 16.6 | 25.9 | 33.7 | 47.5 | 59.9 | 74.2 | 30.5 |
| PC17 | 8378 | 31.8 | 50.9 | 67.2 | 96.1 | 122.2 | 152.6 | 53.5 |
| PC18 | 8404 | 13.4 | 23.5 | 32.6 | 49.2 | 64.7 | 83.0 | 29.5 |
| PC19 | 1-HILLSIDE | 221.1 | 339.9 | 440.1 | 614.4 | 771.4 | 951.7 | 364.7 |
| PC2 | 7731 | 27.3 | 41.9 | 54.1 | 75.1 | 94.1 | 115.9 | 36.5 |
| PC20 | 15295 | 8.9 | 15.4 | 21.1 | 31.5 | 41.1 | 52.4 | 19.5 |
| PC3 | 7725 | 93.4 | 131.9 | 162.6 | 214.3 | 259.6 | 310.3 | 85.4 |
| PC4 | 8035 | 40.7 | 67.4 | 90.6 | 132.0 | 170.3 | 215.0 | 68.3 |
| PC5 | 14412 | 4.2 | 8.6 | 12.8 | 20.9 | 28.7 | 38.1 | 11.3 |
| PC6 | 10862 | 23.1 | 37.7 | 50.2 | 72.5 | 92.9 | 116.6 | 35.7 |
| PC7 | 11081 | 30.3 | 45.2 | 57.4 | 78.4 | 97.0 | 118.2 | 33.0 |
| PC8 | 11484 | 46.5 | 69.3 | 88.1 | 120.5 | 149.2 | 182.0 | 58.9 |
| PC9 | 9763 | 37.7 | 57.8 | 74.6 | 103.9 | 130.0 | 160.2 | 61.3 |
| SM1 | 4655 | 2.2 | 4.3 | 6.4 | 10.3 | 14.1 | 18.6 | 5.7 |
| SM10 | 10257 | 14.4 | 24.2 | 32.8 | 48.3 | 62.6 | 79.4 | 24.5 |
| SM11 | 2902 | 4.1 | 7.0 | 9.6 | 14.3 | 18.6 | 23.7 | 7.0 |
| SM12 | 16427 | 42.7 | 74.8 | 103.4 | 155.8 | 204.8 | 262.7 | 67.7 |
| SM13 | 16517 | 5.9 | 10.4 | 14.3 | 21.4 | 28.1 | 36.0 | 10.2 |
| SM14 | 2466 | 1.3 | 2.0 | 2.6 | 3.8 | 4.9 | 6.2 | 1.8 |
| SM15 | 2799 | 13.3 | 21.9 | 29.4 | 42.8 | 55.1 | 69.5 | 19.0 |
| SM16 | 3320 | 13.6 | 25.8 | 37.1 | 58.3 | 78.4 | 102.8 | 28.9 |
| SM17 | 4160 | 4.0 | 7.3 | 10.3 | 15.9 | 21.2 | 27.5 | 7.1 |
| SM18 | 10300 | 11.2 | 20.8 | 29.6 | 45.8 | 61.2 | 79.7 | 23.6 |
| SM19 | 4538 | 16.2 | 26.5 | 35.2 | 50.8 | 64.8 | 81.0 | 23.4 |
| SM2 | 4696 | 3.2 | 6.3 | 9.2 | 14.8 | 20.1 | 26.6 | 8.0 |
| SM20 | 10361 | 27.1 | 43.1 | 56.7 | 80.8 | 102.7 | 128.0 | 49.9 |
| SM21 | 371 | 16.6 | 22.1 | 26.3 | 33.3 | 39.3 | 45.9 | 12.2 |
| SM22 | 10362 | 11.6 | 18.7 | 24.8 | 35.6 | 45.4 | 56.9 | 17.3 |
| SM23 | 4239 | 80.6 | 137.5 | 187.6 | 278.2 | 362.5 | 461.4 | 165.0 |
| SM24 | GRAYSTONE | 41.0 | 62.9 | 81.4 | 113.5 | 142.2 | 175.4 | 68.2 |
| SM25 | 4979 | 29.3 | 50.7 | 69.7 | 104.3 | 136.6 | 174.9 | 84.4 |
| SM26 | 4466 | 21.6 | 35.7 | 47.8 | 69.4 | 89.2 | 112.6 | 46.0 |
| SM27 | 15517 | 70.8 | 70.8 | 70.8 | 70.8 | 70.8 | 70.8 | 70.8 |
| SM28 | 2-GANGLER | 327.2 | 518.7 | 683.1 | 972.3 | 1235.6 | 1540.7 | 610.7 |
| SM29 | 10001 | 6.7 | 10.9 | 14.5 | 21.0 | 26.9 | 33.7 | 11.7 |
| SM3 | 16048 | 5.1 | 8.8 | 12.0 | 17.7 | 23.1 | 29.4 | 8.8 |
| SM30 | 5431 | 29.5 | 49.1 | 66.2 | 96.7 | 124.9 | 158.0 | 64.9 |
| SM31 | 5473 | 11.9 | 19.7 | 26.4 | 38.4 | 49.3 | 62.0 | 23.1 |
| SM32 | 5491 | 20.1 | 33.7 | 45.4 | 66.5 | 85.9 | 108.8 | 39.3 |
| SM33 | 5548 | 2.4 | 4.2 | 5.7 | 8.4 | 11.0 | 14.0 | 4.8 |
| SM34 | 5554 | 12.7 | 21.4 | 29.1 | 42.8 | 55.6 | 70.6 | 25.4 |
| SM35 | 9-BIBLE CHURCH | 9.4 | 14.1 | 17.9 | 24.4 | 30.1 | 36.7 | 12.3 |
| SM36 | 5698 | 3.9 | 6.3 | 8.4 | 12.0 | 15.4 | 19.2 | 6.5 |
| SM4 | 16032 | 7.2 | 13.2 | 18.6 | 28.6 | 38.0 | 49.3 | 14.7 |
| SM5 | 5368 | 2.5 | 5.4 | 8.2 | 13.8 | 19.3 | 26.0 | 8.0 |
| SM6 | 2941 | 1.7 | 3.6 | 5.5 | 9.2 | 12.8 | 17.2 | 5.7 |
| SM7 | 4 | 15.2 | 29.2 | 42.2 | 66.3 | 89.5 | 117.3 | 37.2 |
| SM8 | 3 | 19.3 | 32.7 | 44.6 | 66.0 | 85.9 | 109.3 | 33.6 |
| SM9 | 2990 | 6.9 | 11.8 | 16.1 | 23.9 | 31.1 | 39.7 | 11.6 |

[1] In the May 2004 calibration model, Basins FPM 20 and 21 are combined at Structure ID 5793 and Basins FPM 17 and 19 are combined at Structure ID 5795. This is done to mimic the existence of only one inlet on each side of 46th Avenue between 60th and 61st Streets during the May 2004 storm event. Subsequent model runs have two inlets on each side of the street.

## 7.02 HYDRAULIC ANALYSIS

A. Methodology

The Extended Transport (EXTRAN) module of the xp-swmm computer model was used to calculate the hydraulic capacity of the existing storm sewer system under existing conditions. Figure 7.02-1 shows a schematic of the storm sewer network as modeled. EXTRAN is a dynamic flow routing model that routes inflow hydrographs through an open channel and/or closed conduit system, computing the time history of flows and heads throughout the system. Input to EXTRAN includes the following:

1. The physical geometry of the storm sewer system, including storm sewer sizes and shapes, ground and invert elevations, and storm sewer connectivity information. For this project, physical information regarding the storm sewer system was obtained from the City's storm sewer GIS layer along with field survey information collected by the City.

2. Data regarding special hydraulic structures in the system including weirs, orifii, and storage junctions.

3. Roughness coefficients for existing and proposed conduits.

4. Inflow hydrographs at critical nodes in the system. For this project, hydrographs were computed using the xp-swmm RUNOFF module, as described in Section 7.01B.

5. Boundary conditions defining starting water surface elevations and other inlet and outlet conditions.

   Critical components of this modeling effort are the "boundary conditions" used at the pipe discharge at Lake Michigan and the grease interceptor discharge at Pike Creek. "Boundary condition" means the assumed elevation of the water surface at the discharge point of the storm sewer or open channel being modeled.

   For this project, Tables 7.02-1 and 7.02-2 show the boundary conditions for the Pike Creek and Lake Michigan outfalls, respectively. Section 2 describes the origin of this data.

   The Pike Creek 100-year boundary condition of 598.92 is the elevation generated during the 2-hour 10-year duration storm event at the Pike Creek outfall. The 25-year and 50-year boundary conditions are generated by prorating between the 10-year free outfall condition and the 598.92 elevation.

   The 10-Year Stillwater Elevation of Lake Michigan published in the *Flood Insurance Study, City of Kenosha, Wisconsin, Kenosha County*, FEMA, December 5, 1996, is 583.10 (NGVD29). However, information provided by the City in a December 14, 2009, e-mail indicates that the average water surface elevation of Lake Michigan at Kenosha is approximately 578.2 (NGVD29) with average high and low water surface elevations of approximately 580.2 (NGVD29) and 577.20 (NGVD29), respectively. Given this data, the

City indicated that the appropriate Lake Michigan 100-year boundary condition for modeling purposes is 580.00. The 25- and 50-year boundary conditions are generated by prorating between the 10-year boundary condition (which is the maximum lake level (high end of the range) of Lake Michigan (according to the City) and the 580.00 elevation.

| Return Frequency | Elevation (ft) |
|---|---|
| May 2004 WSEL | Free Outfall |
| 1-Year | Free Outfall |
| 2-Year | Free Outfall |
| 5-Year | Free Outfall |
| 10-Year | Free Outfall-596.94 |
| 25-Year | 597.27 |
| 50-Year | 597.82 |
| 100-Year | 598.92 |

**Table 7.02-1 Boundary Conditions at Pike Creek Outfall (NGVD 29 Datum)**

| Return Frequency | Elevation (ft) |
|---|---|
| May 2004 WSEL | 578.93 |
| 1-Year | 579.42 |
| 2-Year | 579.42 |
| 5-Year | 579.42 |
| 10-Year | 579.42 |
| 25-Year | 579.52 |
| 50-Year | 579.68 |
| 100-Year | 580.00 |

**Table 7.02-2 Boundary Conditions at Lake Michigan Outfalls (NGVD 29 Datum)**

6. Stage-storage-outflow data for impoundments in the watershed, including detention at the Gangler, Graystone, Hillside, Kenosha Bible Church, Kenosha Commons, Lincoln Park, Nash Park, and Old Elm sites.

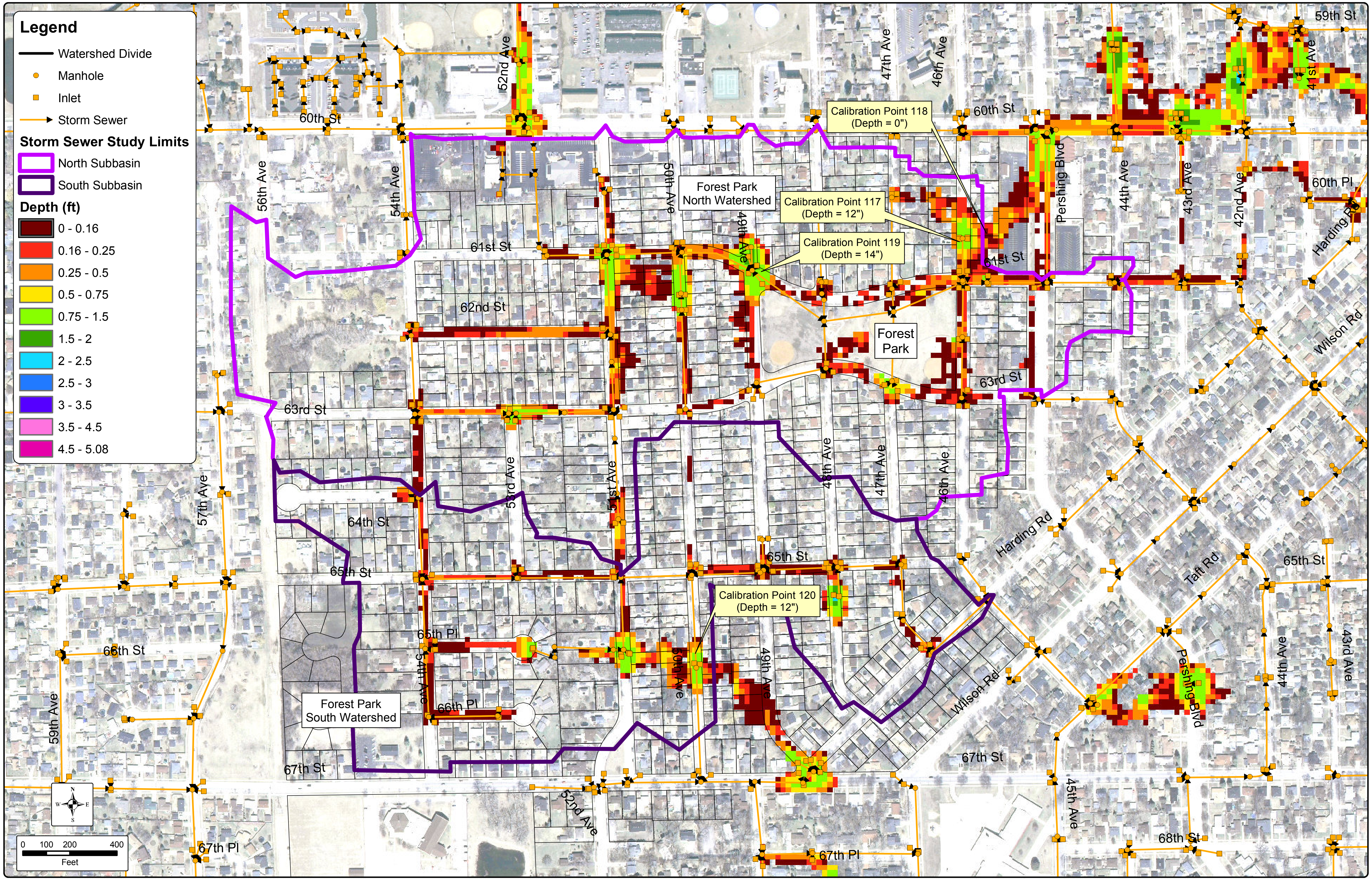
Output information from the EXTRAN model includes the following:

1. Time histories of flows and depths through individual storm sewer facility reaches for various storm events.

2. Estimates of cumulative stormwater volumes overflowing the system at various locations for extreme storm events.

B. Model Calibration

Calibration of the model to reproduce the elevations and flooding volumes that were reported during the May 2004 storm event was performed to compare modeled results with observed conditions. Figure 7.02-2 shows the locations of the high water depths provided by the City for the May 2004 storm event as well as the modeled flood extents during the May 2004 storm event. The model was calibrated to the elevations surveyed as the high water mark at Survey Point 117 (46th Avenue between 50th and 61st Street), Survey Point 118 (46th Avenue between 50th and 61st Street), Survey Point 119 (northeast corner of the 49th Avenue/61st Street intersection), and Survey Point 120 (50th Avenue between 65th Street and 67th Street). The surveyed depth of water is 12 inches, 0 inches, 14 inches, and 12 inches, respectively. The model shows that during the May 20 to 23, 2004, storm event the




**MAY 20-23, 2004 STORM EVENT**
**FLOOD EXTENTS**

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

STRAND ASSOCIATES, INC.® ENGINEERS

FIGURE 7.02-2
1540.001

S:\MAD\1500--1599\1540\001\Data\GIS Data\Figures\Report Figures\Storm Analysis\Figure 7.02-2 May 2004 Storm Event Map 11x17.mxd corresponding depth of water at these locations is approximately 11.8 inches, 0.70 inches, 17.4 inches, and 7.8 inches, respectively. The model is thus within 0.2 inches, 0.70 inches, 3.4 inches, and 4.2 inches of the City's measured elevations for an average of within 0.4 inches.

Given the uncertainty in the accuracy of these elevations/depths because they were based on memory of an event that occurred approximately six years ago, we believe based on these results, the model provides a reasonable representation of stormwater storage and conveyance in the modeled watershed during the May 20 to 23, 2004 storm event.

Modifications made to the model to arrive at this calibration include the following:

1. Use of Neenah inlet grate curves to simulate one-dimensional (1D) and two-dimensional (2D) inlet capture. All inlet grates were modeled with a 20 percent clogging factor.

2. Manholes with open grate lids in 2004 were modeled with 2D inlet capture meaning that flows entering them are restricted in accordance with Neenah inlet grate curves. There were six sealed lids in 2004 and the remaining manholes had open grate lids. The open grate lids were not provided with a clogging factor.

3. Use of a 1D and 2D 30 percent clogging factor at the following nodes (inlets): 5701, 5703, 5608, 5609, 5606, and 9733.

4. Use of a 2D 30 percent clogging factor at the following nodes (manholes): 5702, 5607, 9736, and 5768.

5. Use of a 1D and 2D 35 percent clogging factor at the following nodes (inlets): 5767, 5766, 5769, 5772, and 5771.

6. Use of a 2D land use that mimics houses in areas of flooding with a Manning's "n" of 5 and all other surfaces with a Manning's "n" of 0.024. Flows in the 2D model thus are basically forced around houses for conveyance by the Manning's "n" differential.

7. Increase of pervious area curve numbers by 25 percent to account for the substantial rainfall in the weeks leading up to the May 20 to 23, 2004 storm event. The 25 percent increase in pervious area curve numbers increase the composite pervious area curve number from 69 (Antecedent Moisture Condition II) up to 86. This closely approximates Antecedent Moisture Condition III.

8. Insertion of standard loss factors and "n" values in the base model and supplementing of these with increased loss factors and "n" value increases to account for comments and defects reported in the storm sewer televising reports.

9. Use of a starting water surface elevation at the Lake Michigan outfalls recorded by NOAA in Milwaukee as the lake water surface elevation at 7 P.M. on May 20, 2004.

C. Design-Storm Evaluation

Modeling of existing conditions shows there are numerous areas with undersized stormwater conveyance facilities frequently exceeding their capacities and flood adjacent lands and streets. Table 7.02-3 lists the design capacity and physical characteristics of modeled links in the stormwater conveyance system.

Modeling provided the following observations:

1. Estimated Pipe Capacity in Limits of Detailed Study Area: Figure 7.02-3 shows the existing pipe capacity of each modeled pipe within the limits of the detailed study area. This analysis was performed assuming there is adequate inlet capacity for the various storm events to force a pipe control situation. This analysis reflects the true capacity of the pipe should there be adequate inlet capacity for the particular storm event or should the City provide additional inlets to match the design storm capacity of the pipe. The designated pipe capacity on this figure is based on model output that shows which storm event the upstream end of each pipe segment begins to surcharge to or above the ground surface.

   As shown in Figure 7.02-3, there are several conclusions that can be made as follows:

   a. Forest Park North: There are significant storm sewer conveyance bottlenecks downstream of the Forest Park North area including the 42nd Avenue/59th Street and the Pershing Boulevard/60th Street area, as evidenced by the 2- and 5-year pipe capacities in the area. These bottleneck areas are a major cause of flooding in the Forest Park North Area.

   b. Forest Park South: There are numerous significant storm sewer conveyance bottlenecks downstream of the Forest Park South area including the 50th Avenue/67th Street area with a 5-year capacity and along 67th Place where there is a 2-year capacity. These bottleneck areas are a major cause of flooding in the Forest Park South area.

   c. There are numerous pipes in the modeled system that are listed between 10- and 100-year pipe capacity. One drawback to an analysis of this type is that the analysis assumes unlimited inlet capacity, which means that unless a matching inlet capacity exists in the watershed, the listed capacity will not be realized. For example, it is likely that even if a pipe had a 100-year potential capacity, it may never be realized because the watershed probably has only between a 2- to 10-year inlet capacity.

      It is also important to realize that higher pipe capacities (10- to 100-year) shown on the figure are many times only at that capacity because upstream surface ponding attenuates flows to downstream conduits and results in a lower hydraulic grade line (HGL). Should a relief storm sewer be provided to relieve the upstream flooding, the particular storm sewer capacity would go down because of the increased flow.

It is also important to note that any change in either conveyance (pipe size change) or storage (addition of detention) will immediately change Figure 7.02-3 in the area of the improvement.

2. Existing Conditions Flood Extents Maps: Figures 7.02-4 through 7.02-9 show the existing conditions flood extents maps. These models were run with a 20 percent clogging factor to mimic what might be an expected level of blockage during a typical storm event.

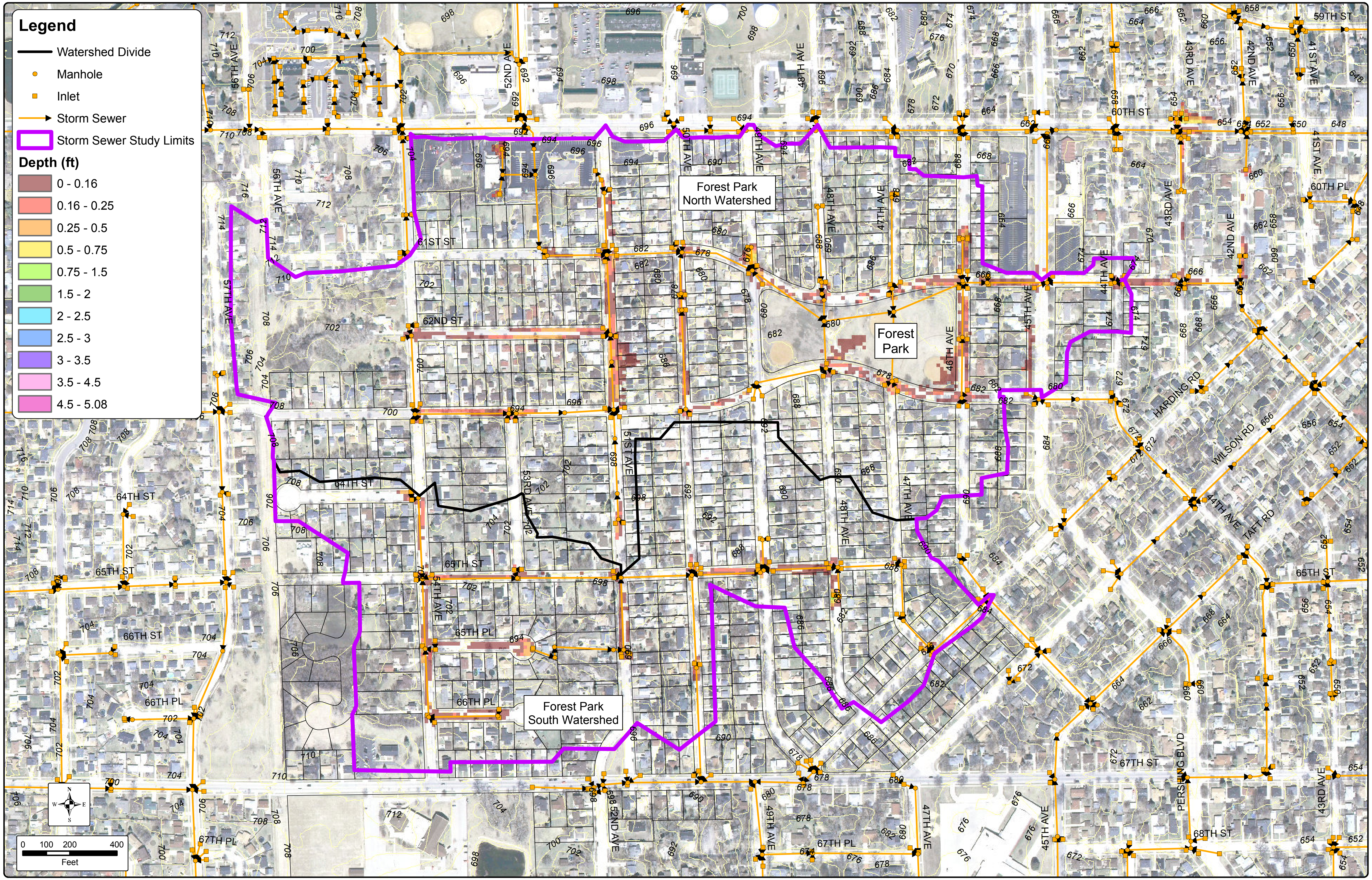
3. Automated Inlet Capacity Estimation: An automated inlet capacity estimation was completed utilizing xp-swmm 2D. Both the Forest Park North and South watersheds have less than a 10-year inlet capacity. Table 7.02-4 shows the existing and additional numbers of inlets necessary in the watersheds to achieve a 10-year inlet capacity. The locations of these inlets are shown in Figures 9.03-3 and 9.07-1. This analysis was completed following WisDOT Facilities Development Manual (FDM) Procedure 13-25-30 Inlet Clogging Factors (35 percent clogging factor at sump inlets and 45 percent clogging factor at on-grade inlets) with no greater than 3 inches of water depth. In locations where multiple inlets are shown, these inlets could be replaced with a single high capacity inlet during design. Alternatives 1 through 7 described in Section 9 utilize this analysis as appropriate for the Alternative.

| | **Existing Inlets** | **Rebuild Existing Inlets*** | **New Inlets** |
|---|---|---|---|
| Forest Park North | 84 | 33 | 50 |
| Forest Park South | 48 | 21 | 32 |
| **Total** | **132** | **54** | **82** |

*Only rebuild existing inlets where new inlets are needed.

**Table 7.02-4 Automated Inlet Capacity Estimation**

4. Spreadsheet Inlet and Inlet Lead Capacity Estimation: As part of Amendment No. 2 to this project, a spreadsheet inlet and inlet lead capacity estimation was completed for the Forest Park North and South Areas to convey the 10-year, 2-hour design storm event. This analysis was completed using the following assumptions:
   a. Analysis is under existing land use conditions.
   b. Analysis is independent of the mainline storm sewer capacity such that inlet leads are sized for full flow capacity without tailwater.
   c. Existing non-City standard inlets and grates are upgraded to City standard inlets and grates (R3067 Casting, Type V Grate).
   d. Analysis is completed following WisDOT Facilities Development Manual (FDM) Procedure 13-25-30 Inlet Clogging Factors (35 percent clogging factor at sump inlets and 45 percent clogging factor at on-grade inlets) with no greater than 3 inches of water depth at a particular inlet.
   e. Classification of an inlet as a Sag or On-Grade inlet was completed using the best available information for this planning-level study. We anticipate the inlet analysis will be rerun in specific areas during design to capture any changes to the sag/on-grade classification after field survey is complete.



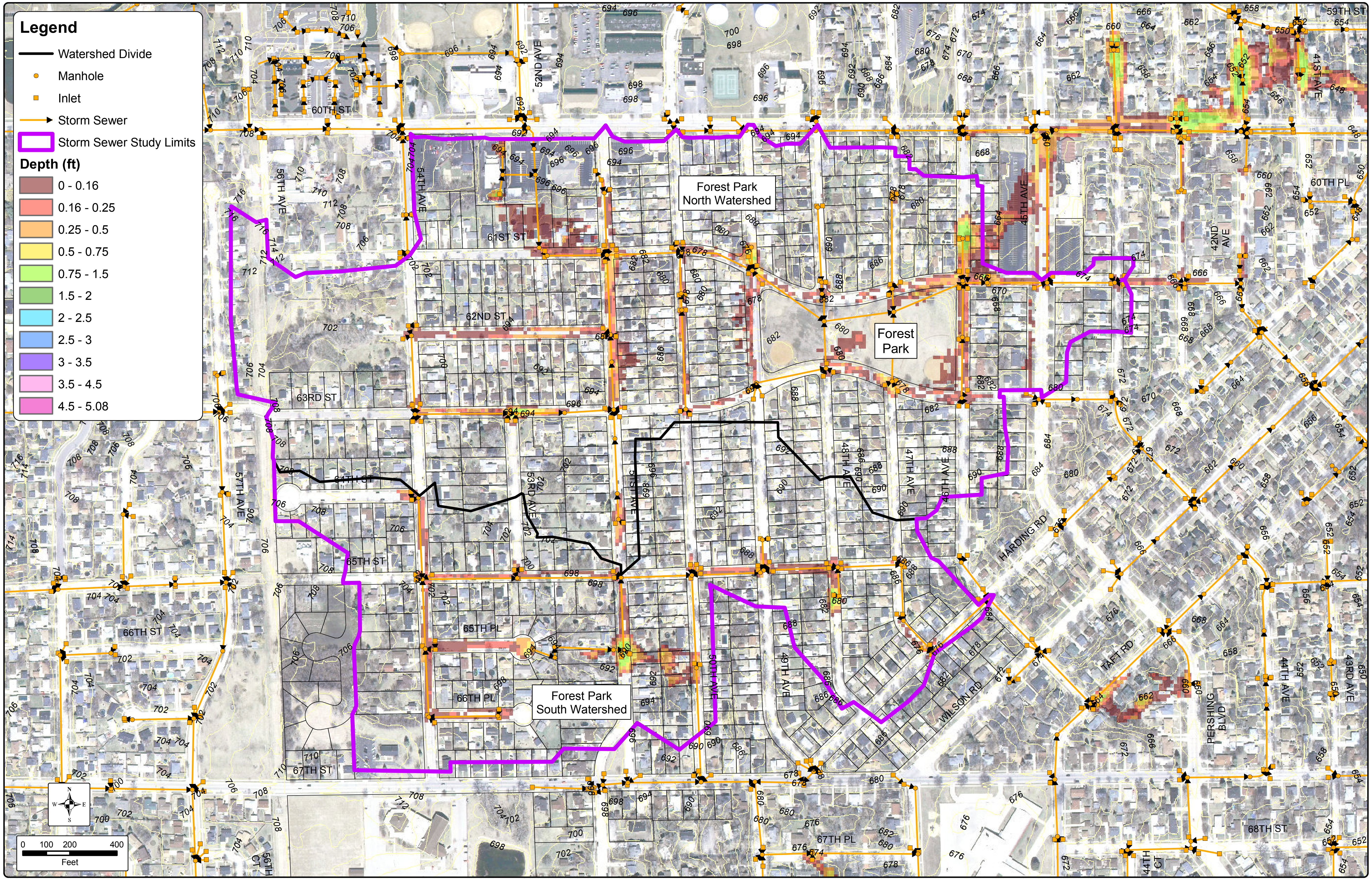

**2-YEAR 2-HOUR DURATION FLOOD EXTENTS**

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

STRAND ASSOCIATES, INC.® ENGINEERS

FIGURE 7.02-4
1540.001

S:\MAD\1500--1599\1540\001\Data\GIS Data\Figures\Report Figures\Storm Analysis\Figure 7.02-4 2yr 2hr 11x17.mxd



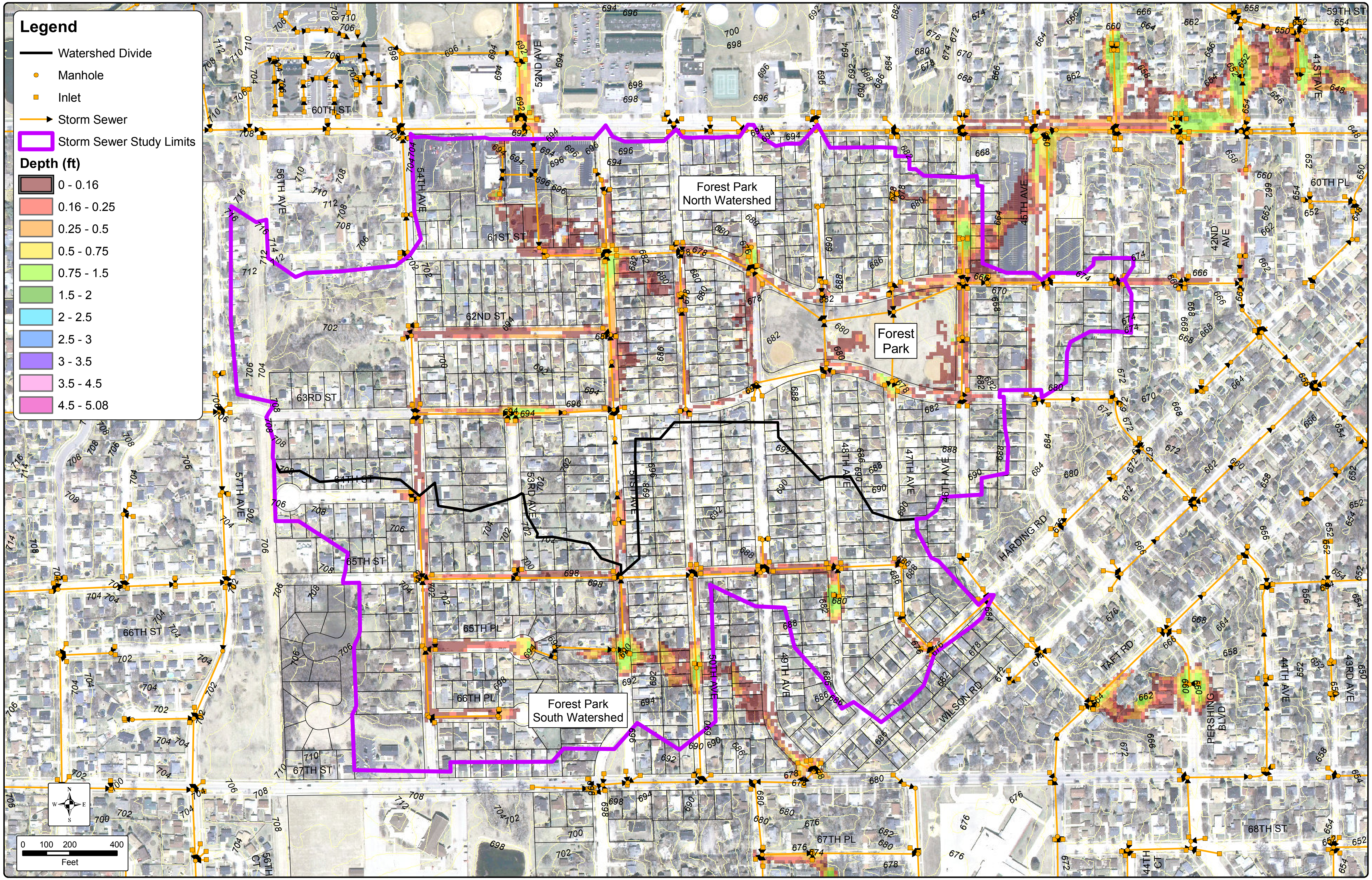

# 5-YEAR 2-HOUR DURATION FLOOD EXTENTS

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

STRAND ASSOCIATES, INC.® ENGINEERS

FIGURE 7.02-5
1540.001

S:\MAD\1500--1599\1540\001\Data\GIS Data\Figures\Report Figures\Storm Analysis\Figure 7.02-5 5yr 2hr 11x17.mxd



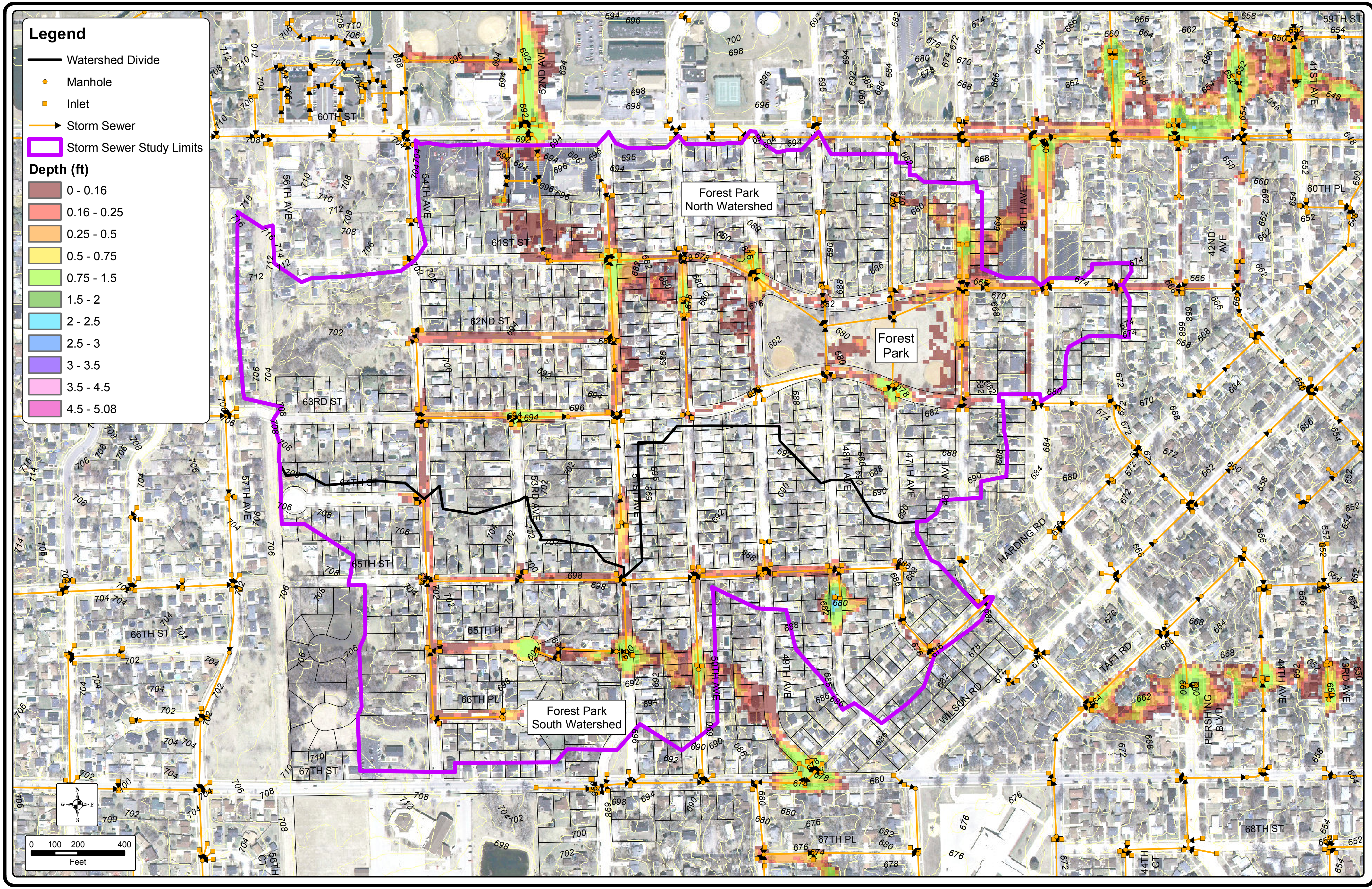

# 10-YEAR 2-HOUR DURATION FLOOD EXTENTS

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

STRAND ASSOCIATES, INC.® ENGINEERS

FIGURE 7.02-6
1540.001

S:\MAD\1500--1599\1540\001\Data\GIS Data\Figures\Report Figures\Storm Analysis\Figure 7.02-6 10yr 2hr 11x17.mxd



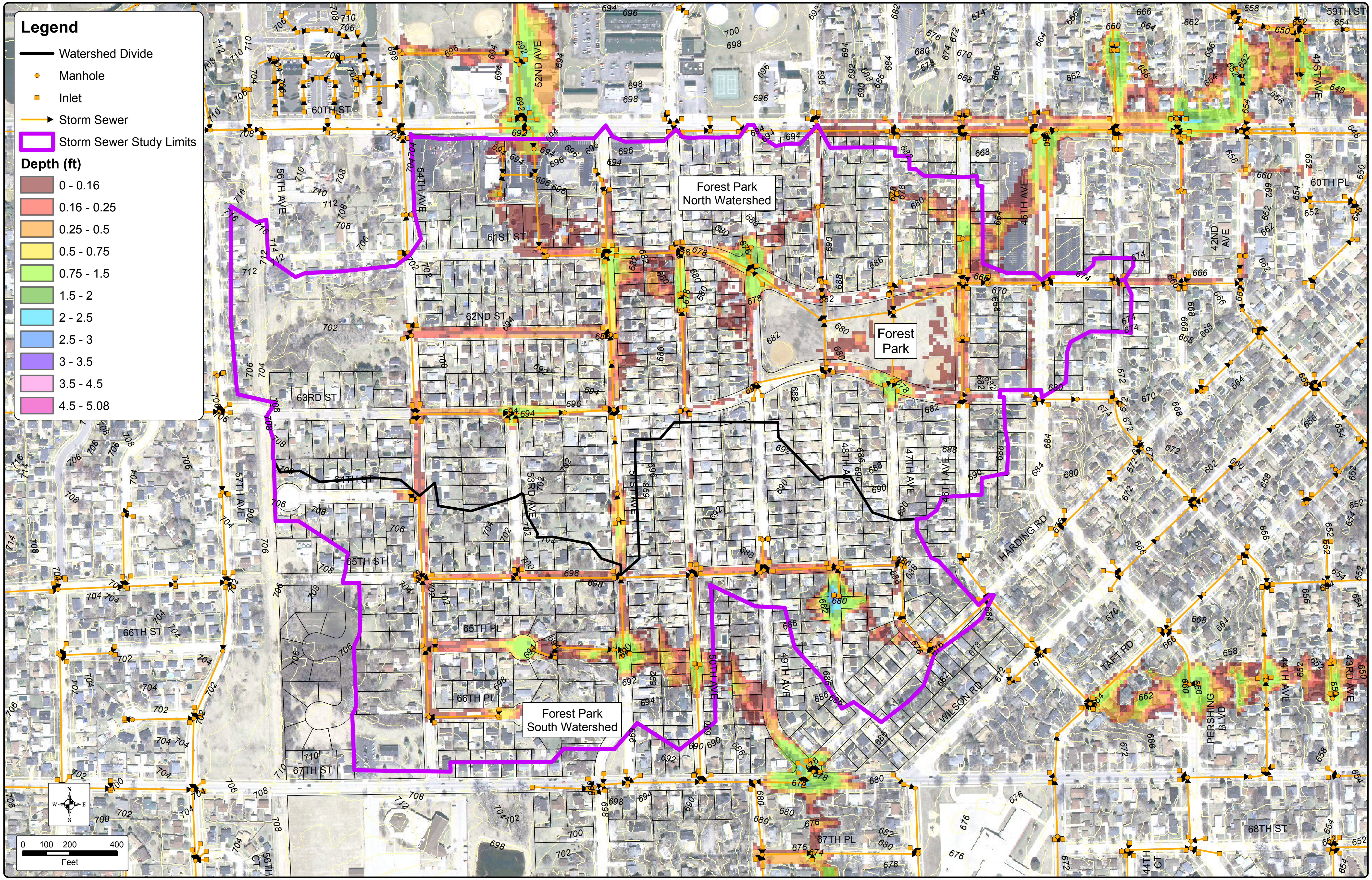

# 25-YEAR 2-HOUR DURATION FLOOD EXTENTS

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

STRAND ASSOCIATES, INC.® ENGINEERS

FIGURE 7.02-7
1540.001

S:\MAD\1500--1599\1540\001\Data\GIS Data\Figures\Report Figures\Storm Analysis\Figure 7.02-7 25yr 2hr 11x17.mxd



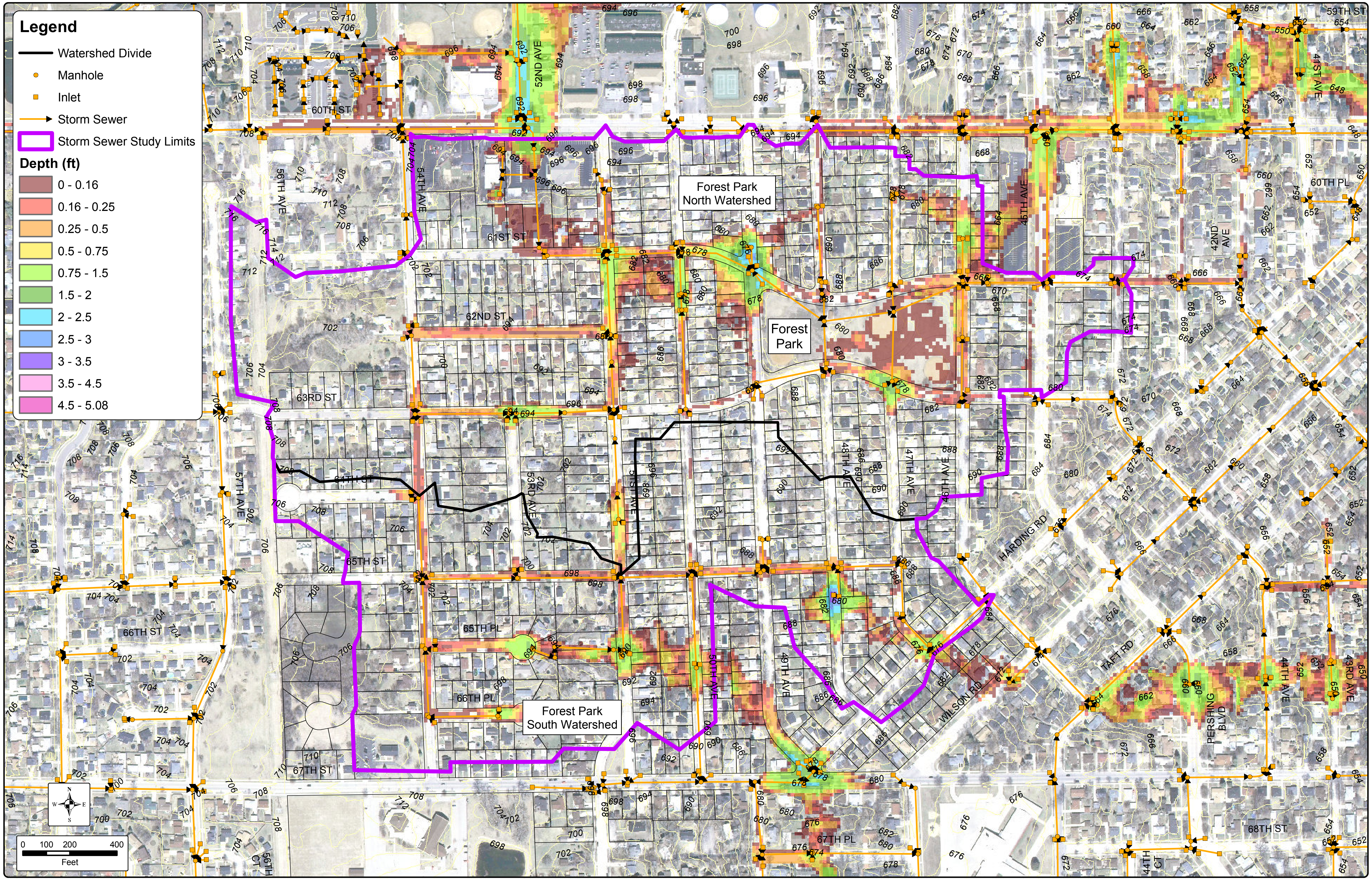

## 50-YEAR 2-HOUR DURATION FLOOD EXTENTS

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

STRAND ASSOCIATES, INC.® ENGINEERS

FIGURE 7.02-8
1540.001

S:\MAD\1500--1599\1540\001\Data\GIS Data\Figures\Report Figures\Storm Analysis\Figure 7.02-8 50yr 2hr 11x17.mxd




100-YEAR 2-HOUR DURATION
FLOOD EXTENTS

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

STRAND ASSOCIATES, INC.® ENGINEERS

FIGURE 7.02-9
1540.001

S:\MAD\1500--1599\1540\001\Data\GIS Data\Figures\Report Figures\Storm Analysis\Figure 7.02-9 100yr 2hr 11x17.mxd

This analysis also shows that both the Forest Park North and South watersheds have less than a 10-year inlet capacity. Table 7.02-5 shows the existing and additional numbers of inlets necessary in the watersheds to achieve a 10-year inlet capacity. Table 7.02-6 shows the storm sewer inlet lead upsizing necessary to achieve a 10-year inlet lead capacity. Figures 7.02-10 and 7.02-11 show the locations of the required inlet and inlet lead improvements to convey the 10-year design storm. The calculations supporting these two figures are located in Appendices R and S.

| | **Existing Inlets** | **Existing City Standard Inlets** | **Rebuild Existing Inlets** | **Existing R-3067V Casting-Needs Further Investigation** | **New Inlets** |
|---|---|---|---|---|---|
| Forest Park North | 89 | 13 | 73 | 1 | 53 |
| Forest Park South | 53 | 7 | 43 | 13 | 33 |
| **Total** | **142** | **20** | **116** | **14** | **86** |

**Table 7.02-5 Spreadsheet Inlet Capacity Estimation**

| | **12-Inch Inlet Lead (ft)** | **15-Inch Inlet Lead (ft)** | **18-Inch Inlet Lead (ft)** | **Total Length (ft)** |
|---|---|---|---|---|
| Forest Park North | 1,334 | 210 | 43 | 1,587 |
| Forest Park South | 677 | 261 | 20 | 953 |
| **Total Length (ft)** | **2,011** | **471** | **63** | **2540** |

**Table 7.02-6 Required Inlet Lead Upsizing**

The placement of these inlets is a planning-level deliverable. We recommend that the final placement of the inlets be determined during design. Please note the attached figures show inlets that have R-3067V castings that need further investigation. It appears these inlets have been rebuilt with the new casting. However, it is unclear if the box structure was rebuilt with the City 2-foot by 3-foot box standard. For cost estimating purposes in this report, it is assumed that these inlets will need to be rebuilt with a 2-foot by 3-foot box.

The inlet and inlet lead upgrades described above were incorporated into the xp-swmm model. The model was run for the 10-, 25-, and 100-year design storm events using appropriate tailwater conditions at the Pike Creek and Lake Michigan outfalls. The resultant flood extent maps are included as Figures 7.02-12, 7.02-13, and 7.02-14 for the Forest Park North Area and Figures 7.02-15, 7.02-16, and 7.02-17 for the Forest Park South Area. These can be compared with the existing conditions flood extents maps included as Figures 7.02-18, 7.02-19, and 7.02-20 for the Forest Park North Area and Figures 7.02-21, 7.02-22, and 7.02-23 for the Forest Park South Area. A comparison shows that certain locations benefit from additional inlets and upsized leads and others do not, dependent on whether there is adequate downstream mainline capacity. Appendix L and M include the storm sewer mainline 10-year storm event profiles under existing conditions for the Forest Park North and South Areas, respectively.

The opinion of probable construction cost for the inlet and inlet lead upgrades is shown in Table 7.02-7 including design and construction contingencies. The detailed opinions of probable cost are included in Appendix G.

| | Opinion of Probable Construction Cost |
|---|---|
| **Forest Park North** | $561,600 |
| **Forest Park South** | $354,900 |

**Table 7.02-7 Opinion of Probable Construction Cost-Inlet and Inlet Lead Improvements**

5. 60th Street/52nd Avenue Intersection Modeling: Figures 7.02-4 through 7.02-9 show the original existing conditions flood extent maps for the 2-, 5-, 10-, 25-, 50-, and 100-year storm events. The original existing conditions flood extent maps utilized the xp-swmm modeling framework upstream of this intersection as included in a previous consultant's xp-swmm mainline model and as outlined in our Agreement with the City. During completion of the Amendment No. 2 services, it was determined the mainline model needed to be expanded to better represent the storm sewer system and localized flooding in this area. For this reason, the xp-swmm model was expanded to add an existing storm sewer from the 58th Street/52nd Avenue intersection to the 58th Street/51st Avenue intersection. The 58th Street/51st Avenue intersection is located at a lower elevation than the 60th Street/52nd Avenue intersection and, thus, will begin flooding prior to the 60th Street/52nd Avenue intersection.

   The xp-swmm model was rerun to create new existing conditions flood extent maps for the 10-, 25-, and 100-year storm events (Figures 7.02-18 through 7.02-20). As shown in Figure 7.02-18 (10-year storm event), the 58th Street/51st Avenue intersection floods and the 60th Street/52nd Avenue intersection does not flood because the 58th Street/51st Avenue intersection is at a lower elevation. It is our understanding that this is more in-line with the City's field observations in this area. Figure 7.02-19 (25-year storm event), likewise, shows less depth of flooding in the 60th Street/52nd Avenue intersection than the 58th Street/51st Avenue intersection when compared to the original flood extent maps (Figures 7.02-7) for the same reason. During the 100-year storm event (Figure 7.02-20), however, the effect is less pronounced as the flooding becomes interconnected between the two intersections. From a freeboard standpoint at 5150 52nd Avenue, there is N/A, 0.64 feet, and -0.66 feet of freeboard for the 10-, 50-, and 100-year storm events, respectively. It is our understanding that the City will provide documentation of the results of conversations with property owners surrounding the 60th Street/52nd Avenue intersection regarding the history of flooding at the intersection.

## TABLE 7.02-3

## STORM SYSTEM CHARACTERISTICS

| Name | Diameter (ft) | Shape | Roughness | Conduit Slope (%) | Length (ft) | Design Flow (cfs) |
|---|---|---|---|---|---|---|
| P-1 | 2.50 | Circular | 0.014 | 0.37 | 32 | 23 |
| P-10.1 | 1.50 | Circular | 0.014 | 1.54 | 88 | 12 |
| P-100 | 4.00 | Circular | 0.014 | 2.53 | 9 | 212 |
| P-1000 | 5.17 | Special | 0.014 | 2.21 | 35 | 660 |
| P-10001.1 | 4.00 | Circular | 0.014 | 1.13 | 353 | 142 |
| P-1001 | 1.00 | Trapezoidal | 0.060 | 0.12 | 343 | 46 |
| P-1002 | 1.00 | Trapezoidal | 0.150 | 0.76 | 644 | 45 |
| P-1003 | 0.50 | Trapezoidal | 0.011 | 1.25 | 349 | 30 |
| P-10042 | 2.50 | Circular | 0.014 | 0.31 | 116 | 21 |
| P-10196 | 6.50 | Circular | 0.014 | 0.30 | 236 | 269 |
| P-10197 | 6.50 | Circular | 0.014 | 0.33 | 331 | 279 |
| P-10199.1 | 4.50 | Circular | 0.014 | 1.09 | 179 | 190 |
| P-10215 | 8.00 | Circular | 0.014 | 0.36 | 56 | 506 |
| P-10221 | 4.00 | Circular | 0.014 | 14.51 | 38 | 508 |
| P-10222 | 4.00 | Circular | 0.014 | 0.45 | 146 | 89 |
| P-10224 | 3.50 | Circular | 0.014 | 0.12 | 188 | 33 |
| P-10226 | 3.50 | Circular | 0.014 | 0.12 | 17 | 32 |
| P-10229 | 4.00 | Circular | 0.014 | 0.57 | 194 | 102 |
| P-10231.1 | 1.75 | Circular | 0.014 | 1.89 | 86 | 20 |
| P-10232.1 | 4.00 | Circular | 0.014 | 0.81 | 258 | 120 |
| P-10233.1 | 4.00 | Circular | 0.014 | 1.96 | 42 | 187 |
| P-10235 | 3.00 | Circular | 0.014 | 0.76 | 53 | 54 |
| P-10239 | 3.00 | Circular | 0.014 | 0.90 | 537 | 59 |
| P-10240 | 2.50 | Circular | 0.014 | 0.56 | 404 | 29 |
| P-10241 | 3.00 | Circular | 0.014 | 0.40 | 166 | 39 |
| P-10257 | 7.00 | Circular | 0.014 | 0.29 | 118 | 318 |
| P-10259 | 7.57 | Rectangular | 0.014 | 0.06 | 70 | 320 |
| P-10260 | 7.00 | Circular | 0.014 | 0.04 | 256 | 111 |
| P-10298 | 6.50 | Circular | 0.014 | 0.33 | 331 | 280 |
| P-10299.1 | 6.50 | Circular | 0.014 | 0.37 | 289 | 296 |
| P-10300.1 | 6.50 | Circular | 0.014 | 0.35 | 280 | 290 |
| P-10301 | 6.50 | Circular | 0.014 | 0.36 | 290 | 293 |
| P-10326 | 6.50 | Circular | 0.014 | 0.71 | 149 | 410 |
| P-10347 | 3.50 | Circular | 0.014 | 0.32 | 76 | 53 |
| P-10357 | 6.50 | Circular | 0.014 | 0.24 | 166 | 239 |
| P-10361.1 | 4.00 | Circular | 0.014 | 0.49 | 420 | 93 |
| P-10362.1 | 6.50 | Circular | 0.014 | 0.36 | 473 | 290 |
| P-10366 | 5.00 | Circular | 0.014 | 7.30 | 27 | 653 |
| P-10464.1 | 4.50 | Circular | 0.014 | 0.63 | 333 | 145 |
| P-10549.1 | 4.50 | Circular | 0.014 | 0.55 | 56 | 135 |
| P-10554 | 8.00 | Circular | 0.014 | 0.32 | 207 | 482 |
| P-10673 | 4.50 | Circular | 0.014 | 0.41 | 554 | 117 |
| P-10862.1 | 6.50 | Circular | 0.014 | 0.31 | 259 | 271 |
| P-1100 | 0.00 | Trapezoidal | 0.011 | 16.52 | 21 | 18,822 |
| P-11073.1 | 6.50 | Circular | 0.014 | -0.12 | 61 | 165 |
| P-11074.1 | 6.50 | Circular | 0.014 | 0.46 | 221 | 331 |
| P-11081.1 | 6.50 | Circular | 0.014 | 0.27 | 289 | 255 |
| P-111 | 1.50 | Circular | 0.014 | 0.16 | 82 | 4 |
| P-11264 | 6.50 | Circular | 0.014 | 0.39 | 284 | 304 |
| P-11271 | 6.50 | Circular | 0.014 | 0.03 | 160 | 86 |
| P-11272.1 | 6.50 | Circular | 0.014 | 0.59 | 134 | 373 |
| P-11352 | 3.00 | Circular | 0.014 | 0.39 | 157 | 39 |
| P-11358 | 3.00 | Circular | 0.014 | 0.98 | 47 | 61 |
| P-11359 | 3.00 | Circular | 0.014 | 1.01 | 285 | 62 |
| P-11361 | 3.00 | Circular | 0.014 | 1.41 | 315 | 74 |
| P-11414.1 | 4.50 | Circular | 0.014 | 0.73 | 331 | 156 |
| P-11482 | 6.00 | Circular | 0.014 | 0.20 | 35 | 175 |
| P-11484.1 | 6.00 | Circular | 0.014 | 0.79 | 169 | 350 |
| P-11553 | 3.50 | Circular | 0.014 | 0.79 | 103 | 83 |
| P-11748 | 1.50 | Circular | 0.014 | 5.10 | 279 | 22 |
| P-11763.1 | 1.50 | Circular | 0.014 | 1.99 | 309 | 14 |
| P-11959.1 | 4.00 | Circular | 0.014 | 0.67 | 255 | 98 |
| P-11962 | 4.00 | Circular | 0.014 | 0.41 | 274 | 85 |
| P-11971 | 3.00 | Circular | 0.014 | 1.05 | 533 | 64 |
| P-12 | 1.50 | Circular | 0.014 | 0.00 | 59 | 0 |
| P-12146 | 4.00 | Circular | 0.014 | 0.59 | 29 | 102 |
| P-12146N | 4.00 | Circular | 0.014 | 1.35 | 32 | 141 |
| P-12155 | 3.50 | Circular | 0.014 | 3.31 | 67 | 170 |
| P-12160 | 4.00 | Circular | 0.014 | 0.80 | 98 | 118 |
| P-12182 | 6.00 | Circular | 0.014 | 0.26 | 256 | 200 |
| P-12189 | 6.00 | Circular | 0.014 | 0.09 | 173 | 120 |
| P-12190 | 6.00 | Circular | 0.014 | 0.32 | 170 | 222 |
| P-12349 | 4.00 | Circular | 0.014 | 0.18 | 181 | 56 |
| P-12350 | 7.00 | Circular | 0.014 | 0.33 | 291 | 339 |
| P-12373 | 6.00 | Circular | 0.014 | 0.16 | 205 | 155 |
| P-12376 | 4.00 | Circular | 0.014 | 0.41 | 180 | 85 |
| P-12379 | 6.00 | Circular | 0.014 | 0.61 | 173 | 307 |
| P-12541 | 7.00 | Circular | 0.014 | 0.33 | 424 | 343 |
| P-12547.1 | 7.00 | Circular | 0.014 | 0.12 | 66 | 207 |
| P-12552.1 | 7.00 | Circular | 0.014 | 0.34 | 280 | 344 |
| P-12601.1 | 6.50 | Circular | 0.014 | 0.46 | 170 | 330 |
| P-12737.1 | 7.00 | Circular | 0.014 | 0.36 | 275 | 358 |
| P-12745.1 | 7.00 | Circular | 0.014 | 0.30 | 277 | 323 |
| P-12921 | 8.00 | Circular | 0.014 | 0.29 | 185 | 458 |
| P-12923 | 8.00 | Circular | 0.014 | 0.33 | 146 | 486 |
| P-12928 | 8.00 | Circular | 0.014 | 0.30 | 365 | 461 |
| P-13112 | 8.00 | Circular | 0.014 | 0.34 | 304 | 493 |
| P-13117 | 8.00 | Circular | 0.014 | 0.31 | 159 | 475 |
| P-13120 | 8.00 | Circular | 0.014 | 0.32 | 161 | 477 |
| P-13124 | 8.00 | Circular | 0.014 | 0.31 | 387 | 474 |
| P-13127 | 8.00 | Circular | 0.014 | 0.34 | 114 | 495 |
| P-13129 | 8.00 | Circular | 0.014 | 0.33 | 95 | 484 |
| P-13131 | 8.00 | Circular | 0.014 | 0.32 | 112 | 480 |
| P-13135 | 8.00 | Circular | 0.014 | 0.32 | 157 | 478 |
| P-13141 | 8.00 | Circular | 0.014 | 0.31 | 201 | 474 |
| P-13295 | 8.00 | Circular | 0.014 | 0.30 | 280 | 467 |
| P-13299 | 8.00 | Circular | 0.014 | 0.33 | 126 | 483 |
| P-13463 | 6.50 | Circular | 0.014 | 0.71 | 81 | 409 |
| P-13464 | 6.50 | Circular | 0.014 | 0.38 | 217 | 299 |
| P-1400[1] | 20.00 | Natural | 0.014 | 3.00 | 28 | 342,875 |
| P-14302 | 7.00 | Circular | 0.014 | 0.10 | 390 | 185 |
| P-14386 | 2.50 | Circular | 0.014 | 0.18 | 291 | 16 |
| P-14412.1 | 6.50 | Circular | 0.014 | 0.41 | 326 | 312 |
| P-1486 | 6.50 | Circular | 0.014 | 0.36 | 300 | 292 |
| P-1486001 | 6.50 | Circular | 0.014 | 0.86 | 52 | 452 |
| P-1487 | 6.50 | Circular | 0.014 | 0.21 | 155 | 221 |
| P-14911 | 4.00 | Circular | 0.014 | 0.63 | 24 | 106 |
| P-14912 | 4.00 | Circular | 0.014 | 0.58 | 235 | 102 |
| P-15280 | 4.50 | Circular | 0.014 | 0.42 | 463 | 118 |
| P-15284 | 6.50 | Circular | 0.014 | 0.31 | 198 | 270 |
| P-15293 | 6.00 | Circular | 0.014 | 0.79 | 95 | 349 |
| P-15294 | 6.00 | Circular | 0.014 | 0.13 | 200 | 142 |
| P-15295 | 6.00 | Circular | 0.014 | 0.14 | 231 | 146 |
| P-15306.1 | 4.50 | Circular | 0.014 | 0.26 | 174 | 93 |
| P-15312.1 | 6.50 | Circular | 0.014 | 0.18 | 102 | 205 |
| P-15316001 | 4.50 | Circular | 0.014 | 0.82 | 421 | 165 |
| P-15441 | 3.50 | Circular | 0.026 | 1.31 | 64 | 50 |
| P-15442 | 3.50 | Circular | 0.014 | 1.71 | 53 | 122 |
| P-15443 | 3.50 | Circular | 0.014 | 1.17 | 321 | 101 |
| P-15517 | 3.50 | Circular | 0.014 | 2.11 | 362 | 136 |
| P-15518 | 3.50 | Circular | 0.014 | 0.13 | 600 | 34 |
| P-15537 | 7.00 | Circular | 0.014 | 0.10 | 62 | 184 |
| P-15631 | 2.50 | Circular | 0.014 | 0.28 | 218 | 20 |
| P-15724.1 | 10.67 | Special | 0.014 | 0.26 | 102 | 519 |
| P-15798 | 8.00 | Circular | 0.014 | 0.10 | 962 | 268 |
| P-15926 | 7.00 | Circular | 0.014 | 0.15 | 254 | 230 |
| P-15927 | 7.00 | Circular | 0.014 | 0.15 | 847 | 231 |
| P-15937 | 1.50 | Circular | 0.014 | 0.51 | 175 | 7 |
| P-15944 | 0.67 | Circular | 0.009 | 1.55 | 136 | 2 |
| P-15978 | 8.50 | Circular | 0.014 | 0.02 | 303 | 128 |
| P-15986 | 10.67 | Special | 0.014 | 0.14 | 459 | 390 |

| Name | Diameter (ft) | Shape | Roughness | Conduit Slope (%) | Length (ft) | Design Flow (cfs) |
|---|---|---|---|---|---|---|
| P-16022 | 8.00 | Circular | 0.014 | 0.19 | 251 | 374 |
| P-16023 | 7.50 | Circular | 0.014 | 0.42 | 132 | 464 |
| P-16026 | 8.00 | Circular | 0.014 | 0.20 | 195 | 383 |
| P-16029 | 8.00 | Circular | 0.014 | 0.30 | 210 | 464 |
| P-16032 | 8.00 | Circular | 0.014 | 0.13 | 319 | 308 |
| P-16035 | 8.00 | Circular | 0.014 | 0.29 | 205 | 459 |
| P-16039 | 8.00 | Circular | 0.014 | 0.00 | 241 | 27 |
| P-16043 | 8.00 | Circular | 0.014 | 0.02 | 244 | 121 |
| P-16048 | 8.00 | Circular | 0.014 | 0.15 | 1,071 | 329 |
| P-16054.1 | 10.67 | Special | 0.014 | 0.02 | 532 | 148 |
| P-16387.1 | 4.50 | Circular | 0.014 | 0.64 | 73 | 146 |
| P-16389.1 | 4.50 | Circular | 0.014 | 0.77 | 194 | 161 |
| P-16395 | 4.50 | Circular | 0.014 | 0.62 | 486 | 142 |
| P-16396 | 4.50 | Circular | 0.014 | 0.31 | 73 | 102 |
| P-16397 | 4.50 | Circular | 0.014 | 1.02 | 158 | 184 |
| P-16398 | 4.50 | Circular | 0.014 | 0.41 | 456 | 117 |
| P-16399 | 6.50 | Circular | 0.014 | 0.88 | 39 | 457 |
| P-16400 | 6.50 | Circular | 0.014 | 0.32 | 102 | 276 |
| P-16401 | 6.50 | Circular | 0.014 | 0.40 | 30 | 307 |
| P-16402 | 6.50 | Circular | 0.014 | 0.34 | 207 | 283 |
| P-16403 | 6.50 | Circular | 0.014 | 0.35 | 199 | 289 |
| P-16426 | 7.00 | Circular | 0.014 | 0.34 | 208 | 344 |
| P-16427.1 | 7.00 | Circular | 0.014 | 0.31 | 70 | 332 |
| P-16430 | 7.00 | Circular | 0.014 | 0.10 | 149 | 188 |
| P-16433 | 7.00 | Circular | 0.014 | 0.10 | 239 | 188 |
| P-16434 | 7.00 | Circular | 0.014 | 0.10 | 164 | 186 |
| P-16471 | 1.50 | Circular | 0.014 | 1.95 | 141 | 14 |
| P-16505 | 7.00 | Circular | 0.014 | 0.15 | 258 | 231 |
| P-16517 | 7.00 | Circular | 0.014 | 0.10 | 186 | 185 |
| P-16637 | 1.50 | Circular | 0.009 | 0.17 | 46 | 6 |
| P-16638 | 1.50 | Circular | 0.009 | 0.48 | 258 | 10 |
| P-16639 | 1.50 | Circular | 0.009 | 2.07 | 30 | 22 |
| P-16692 | 3.50 | Circular | 0.014 | 0.18 | 528 | 40 |
| P-16856 | 8.00 | Circular | 0.014 | 0.32 | 333 | 478 |
| P-16944 | 1.50 | Circular | 0.014 | 0.59 | 46 | 7 |
| P-16964 | 1.50 | Circular | 0.014 | 2.48 | 347 | 15 |
| P-16969 | 4.00 | Circular | 0.014 | 0.73 | 190 | 114 |
| P-16979 | 1.50 | Circular | 0.014 | 0.54 | 159 | 7 |
| P-17545 | 1.00 | Circular | 0.014 | 4.58 | 7 | 7 |
| P-17546 | 1.00 | Circular | 0.014 | 5.29 | 6 | 8 |
| P-1870 | 6.50 | Circular | 0.014 | 0.00 | 35 | 15 |
| P-1871 | 7.00 | Circular | 0.014 | 0.18 | 103 | 255 |
| P-2 | 2.50 | Circular | 0.014 | 0.19 | 31 | 17 |
| P-200 | 4.00 | Circular | 0.014 | 2.53 | 83 | 212 |
| P-2273 | 3.50 | Circular | 0.014 | 0.27 | 279 | 48 |

| Name | Diameter (ft) | Shape | Roughness | Conduit Slope (%) | Length (ft) | Design Flow (cfs) |
|---|---|---|---|---|---|---|
| P-2283.1 | 3.50 | Circular | 0.014 | 0.18 | 22 | 40 |
| P-2387E | 2.50 | Circular | 0.014 | 0.91 | 15 | 36 |
| P-2387N | 6.50 | Circular | 0.014 | 30.11 | 34 | 2,672 |
| P-2390.1 | 5.00 | Circular | 0.014 | 0.74 | 317 | 208 |
| P-23901 | 5.00 | Circular | 0.014 | 0.43 | 506 | 159 |
| P-2466 | 7.00 | Circular | 0.014 | 0.19 | 1,276 | 257 |
| P-2471 | 7.00 | Circular | 0.014 | 0.87 | 157 | 554 |
| P-2477 | 7.00 | Circular | 0.014 | 0.68 | 388 | 490 |
| P-2796 | 7.00 | Circular | 0.014 | 0.10 | 188 | 184 |
| P-2799 | 7.00 | Circular | 0.014 | 0.10 | 190 | 187 |
| P-2804 | 7.00 | Circular | 0.014 | 0.10 | 179 | 188 |
| P-2848 | 8.61 | Rectangular | 0.014 | 0.06 | 68 | 387 |
| P-2902 | 7.50 | Circular | 0.014 | 0.09 | 585 | 211 |
| P-2910 | 7.50 | Circular | 0.014 | 0.43 | 166 | 470 |
| P-2913 | 7.50 | Circular | 0.014 | 0.22 | 303 | 335 |
| P-2927 | 7.50 | Circular | 0.014 | 0.08 | 168 | 198 |
| P-2932 | 7.50 | Circular | 0.014 | 0.22 | 268 | 337 |
| P-2941 | 7.50 | Circular | 0.014 | 0.00 | 255 | 45 |
| P-2943 | 7.50 | Circular | 0.014 | -0.01 | 303 | 71 |
| P-2956 | 5.00 | Circular | 0.014 | 0.02 | 1,031 | 37 |
| P-2990 | 7.50 | Circular | 0.014 | 0.13 | 151 | 260 |
| P-300 | 4.00 | Circular | 0.014 | 1.40 | 20 | 158 |
| P-3012 | 7.50 | Circular | 0.014 | 0.05 | 116 | 163 |
| P-3059 | 8.50 | Circular | 0.014 | 0.22 | 357 | 468 |
| P-3097 | 8.00 | Circular | 0.014 | 0.32 | 284 | 480 |
| P-3161 | 8.50 | Circular | 0.014 | 0.08 | 38 | 279 |
| P-3161001 | 8.50 | Circular | 0.014 | 0.01 | 276 | 120 |
| P-3163 | 8.50 | Circular | 0.014 | 0.02 | 172 | 152 |
| P-3165 | 8.50 | Circular | 0.014 | 0.02 | 112 | 133 |
| P-3168 | 8.00 | Circular | 0.014 | 0.73 | 102 | 726 |
| P-3173 | 8.00 | Circular | 0.014 | 0.39 | 291 | 532 |
| P-3177 | 8.00 | Circular | 0.014 | 0.40 | 288 | 535 |
| P-3178 | 8.00 | Circular | 0.014 | 0.40 | 241 | 537 |
| P-3181 | 8.00 | Circular | 0.014 | 0.36 | 129 | 505 |
| P-3182.1 | 8.00 | Circular | 0.014 | 0.41 | 170 | 543 |
| P-3183.1 | 8.00 | Circular | 0.014 | 0.98 | 62 | 838 |
| P-3185.1 | 8.00 | Circular | 0.014 | 0.39 | 266 | 527 |
| P-3189.1 | 8.00 | Circular | 0.014 | 0.27 | 171 | 439 |
| P-3192 | 8.00 | Circular | 0.014 | 0.36 | 472 | 510 |
| P-3194 | 8.00 | Circular | 0.014 | 0.47 | 126 | 579 |
| P-3200 | 8.00 | Circular | 0.014 | 0.29 | 346 | 458 |
| P-3202 | 8.00 | Circular | 0.014 | 0.36 | 146 | 510 |
| P-3206 | 8.00 | Circular | 0.014 | 0.29 | 172 | 453 |
| P-3209 | 8.00 | Circular | 0.014 | 0.42 | 142 | 546 |
| P-3315 | 7.00 | Circular | 0.014 | 0.10 | 183 | 186 |

| Name | Diameter (ft) | Shape | Roughness | Conduit Slope (%) | Length (ft) | Design Flow (cfs) |
|---|---|---|---|---|---|---|
| P-3318 | 7.00 | Circular | 0.014 | 0.11 | 36 | 199 |
| P-3320 | 7.00 | Circular | 0.014 | 0.06 | 199 | 140 |
| P-3323 | 7.00 | Circular | 0.014 | 0.00 | 33 | 19 |
| P-368 | 6.50 | Circular | 0.014 | 0.63 | 139 | 385 |
| P-371 | 6.50 | Circular | 0.014 | 0.30 | 293 | 267 |
| P-3905 | 1.00 | Circular | 0.029 | 0.77 | 45 | 1 |
| P-3960 | 0.67 | Circular | 0.009 | 1.65 | 108 | 2 |
| P-3961 | 0.67 | Circular | 0.009 | 2.12 | 89 | 3 |
| P-3967 | 3.50 | Circular | 0.014 | 0.04 | 139 | 18 |
| P-4 | 5.00 | Circular | 0.014 | 0.09 | 346 | 72 |
| P-400 | 4.00 | Circular | 0.014 | 0.71 | 5 | 73 |
| P-4081 | 1.00 | Circular | 0.014 | 0.45 | 274 | 2 |
| P-4160 | 6.50 | Circular | 0.014 | 0.23 | 289 | 231 |
| P-4162 | 7.00 | Circular | 0.014 | 0.59 | 289 | 456 |
| P-4180 | 6.50 | Circular | 0.014 | 0.36 | 272 | 294 |
| P-4183 | 6.50 | Circular | 0.014 | 0.36 | 294 | 291 |
| P-4239 | 6.50 | Circular | 0.014 | 0.35 | 305 | 288 |
| P-4466.1 | 4.00 | Circular | 0.014 | 0.66 | 427 | 108 |
| P-4467 | 4.00 | Circular | 0.014 | 0.85 | 225 | 123 |
| P-4468 | 3.50 | Circular | 0.014 | 2.51 | 126 | 148 |
| P-4498 | 6.50 | Circular | 0.014 | 0.35 | 448 | 289 |
| P-4536 | 6.50 | Circular | 0.014 | 0.68 | 40 | 402 |
| P-4538 | 6.50 | Circular | 0.014 | 0.32 | 162 | 276 |
| P-4597 | 8.00 | Circular | 0.014 | 0.39 | 563 | 532 |
| P-4655 | 8.00 | Circular | 0.014 | 0.28 | 350 | 448 |
| P-4664 | 8.00 | Circular | 0.014 | 0.17 | 271 | 345 |
| P-4696 | 8.00 | Circular | 0.014 | 0.38 | 533 | 519 |
| P-4818 | 8.00 | Circular | 0.014 | 0.15 | 686 | 323 |
| P-4967 | 4.00 | Circular | 0.014 | 0.83 | 295 | 122 |
| P-4970 | 4.50 | Circular | 0.014 | 0.81 | 304 | 164 |
| P-4979.1 | 4.50 | Circular | 0.014 | 0.64 | 326 | 146 |
| P-4992.1 | 4.50 | Circular | 0.014 | 0.80 | 327 | 164 |
| P-4996.1 | 5.00 | Circular | 0.014 | 0.46 | 613 | 163 |
| P-500 | 4.00 | Circular | 0.014 | 0.69 | 262 | 111 |
| P-5010.1 | 2.50 | Circular | 0.014 | 1.20 | 56 | 42 |
| P-5026 | 2.00 | Circular | 0.014 | 0.12 | 394 | 7 |
| P-5368 | 5.00 | Circular | 0.014 | 0.08 | 512 | 67 |
| P-5425 | 4.00 | Circular | 0.014 | 0.60 | 764 | 95 |
| P-5430 | 4.00 | Circular | 0.014 | -0.77 | 8 | 117 |
| P-5431 | 4.00 | Circular | 0.014 | -0.12 | 312 | 45 |
| P-5447 | 3.50 | Circular | 0.014 | 24.65 | 6 | 464 |
| P-5448 | 4.00 | Circular | 0.014 | 0.21 | 163 | 61 |
| P-5451.1 | 3.50 | Circular | 0.014 | 0.77 | 175 | 82 |
| P-5454.1 | 3.50 | Circular | 0.014 | 0.73 | 298 | 80 |
| P-5458.1 | 3.50 | Circular | 0.014 | 1.16 | 92 | 101 |

| Name | Diameter (ft) | Shape | Roughness | Conduit Slope (%) | Length (ft) | Design Flow (cfs) |
|---|---|---|---|---|---|---|
| P-5469 | 3.50 | Circular | 0.014 | 0.45 | 252 | 63 |
| P-5473.1 | 3.50 | Circular | 0.014 | 0.31 | 84 | 52 |
| P-5489.1 | 3.50 | Circular | 0.014 | 0.31 | 270 | 52 |
| P-5491.1 | 3.50 | Circular | 0.014 | 0.30 | 370 | 51 |
| P-5548 | 2.50 | Circular | 0.014 | 0.80 | 351 | 34 |
| P-5551 | 2.50 | Circular | 0.014 | 0.60 | 449 | 30 |
| P-5554.1 | 2.50 | Circular | 0.014 | 0.60 | 214 | 30 |
| P-5569.1 | 2.50 | Circular | 0.014 | 0.80 | 249 | 34 |
| P-5606 | 1.50 | Circular | 0.009 | 3.33 | 28 | 28 |
| P-5607 | 1.50 | Circular | 0.014 | 0.25 | 303 | 5 |
| P-5608 | 1.50 | Circular | 0.026 | 5.47 | 20 | 11 |
| P-5609 | 0.83 | Circular | 0.014 | -5.58 | 5 | 5 |
| P-5610 | 0.83 | Circular | 0.009 | 2.46 | 37 | 5 |
| P-5611 | 0.67 | Circular | 0.029 | 2.12 | 26 | 1 |
| P-5612 | 1.50 | Circular | 0.014 | 1.02 | 305 | 10 |
| P-5613 | 0.67 | Circular | 0.026 | 2.62 | 26 | 1 |
| P-5614 | 0.83 | Circular | 0.014 | 0.38 | 111 | 1 |
| P-5615 | 0.67 | Circular | 0.029 | 2.88 | 14 | 1 |
| P-5616 | 1.25 | Circular | 0.014 | 0.69 | 235 | 5 |
| P-5617 | 1.25 | Circular | 0.014 | 1.90 | 125 | 8 |
| P-5618 | 0.67 | Circular | 0.029 | 2.91 | 39 | 1 |
| P-5619 | 1.00 | Circular | 0.026 | 2.23 | 48 | 2 |
| P-5620 | 1.00 | Circular | 0.026 | 3.13 | 37 | 3 |
| P-5621 | 0.67 | Circular | 0.026 | 4.89 | 34 | 1 |
| P-5622 | 1.25 | Circular | 0.014 | 3.55 | 205 | 11 |
| P-5623 | 1.25 | Circular | 0.014 | 1.85 | 117 | 8 |
| P-5624 | 2.00 | Circular | 0.014 | 0.75 | 339 | 18 |
| P-5625 | 1.00 | Circular | 0.027 | 2.08 | 25 | 2 |
| P-5626 | 0.83 | Circular | 0.026 | 2.90 | 31 | 2 |
| P-5627 | 0.83 | Circular | 0.027 | 2.51 | 42 | 1 |
| P-5628 | 1.00 | Circular | 0.026 | 55.62 | 4 | 12 |
| P-5629 | 0.67 | Circular | 0.026 | 23.29 | 22 | 3 |
| P-5630 | 1.00 | Circular | 0.026 | 3.59 | 47 | 3 |
| P-5631 | 0.67 | Circular | 0.026 | 5.20 | 43 | 1 |
| P-5632 | 1.00 | Circular | 0.026 | 6.07 | 40 | 4 |
| P-5633 | 0.67 | Circular | 0.026 | 1.71 | 29 | 1 |
| P-5634 | 4.00 | Circular | 0.014 | 0.69 | 39 | 111 |
| P-5635 | 1.00 | Circular | 0.026 | 6.89 | 57 | 4 |
| P-5636 | 1.00 | Circular | 0.014 | 2.92 | 263 | 6 |
| P-5637 | 1.00 | Circular | 0.026 | 6.53 | 26 | 4 |
| P-5638 | 0.83 | Circular | 0.026 | 3.43 | 22 | 2 |
| P-5639 | 3.50 | Circular | 0.014 | 1.24 | 48 | 104 |
| P-5640 | 0.83 | Circular | 0.026 | -0.67 | 9 | 1 |
| P-5641 | 3.50 | Circular | 0.014 | 1.30 | 254 | 107 |
| P-5648 | 1.00 | Circular | 0.029 | 0.27 | 45 | 1 |
| P-5649 | 1.25 | Circular | 0.017 | 0.25 | 336 | 2 |
| P-5650 | 0.83 | Circular | 0.026 | 1.05 | 38 | 1 |
| P-5651 | 0.83 | Circular | 0.026 | 0.23 | 35 | 0 |
| P-5652 | 0.83 | Circular | 0.026 | 2.61 | 42 | 2 |
| P-5653 | 1.25 | Circular | 0.014 | 0.80 | 398 | 5 |
| P-5654 | 0.83 | Circular | 0.029 | 1.68 | 62 | 1 |
| P-5655 | 0.83 | Circular | 0.026 | 3.40 | 39 | 2 |
| P-5656 | 0.83 | Circular | 0.026 | 1.51 | 48 | 1 |
| P-5657 | 0.83 | Circular | 0.026 | 1.00 | 18 | 1 |
| P-5658 | 1.25 | Circular | 0.014 | 0.56 | 206 | 4 |
| P-5659 | 0.83 | Circular | 0.026 | 1.45 | 32 | 1 |
| P-5660 | 0.83 | Circular | 0.026 | 1.93 | 31 | 1 |
| P-5661 | 1.25 | Circular | 0.014 | 0.00 | 31 | 0 |
| P-5662 | 0.83 | Circular | 0.026 | 0.86 | 35 | 1 |
| P-5663 | 1.00 | Circular | 0.026 | 1.95 | 30 | 2 |
| P-5664 | 1.25 | Circular | 0.014 | 1.26 | 350 | 7 |
| P-5665 | 0.83 | Circular | 0.026 | 0.90 | 25 | 1 |
| P-5666 | 1.00 | Circular | 0.026 | 0.53 | 30 | 1 |
| P-5667 | 1.50 | Circular | 0.014 | 0.35 | 404 | 6 |
| P-5668 | 0.83 | Circular | 0.026 | 2.09 | 49 | 1 |
| P-5669 | 1.50 | Circular | 0.014 | 0.38 | 440 | 6 |
| P-5670 | 0.83 | Circular | 0.026 | 1.52 | 7 | 1 |
| P-5671 | 0.83 | Circular | 0.026 | 1.44 | 35 | 1 |
| P-5672 | 1.00 | Circular | 0.026 | 4.56 | 42 | 3 |
| P-5673 | 0.83 | Circular | 0.026 | 0.93 | 11 | 1 |
| P-5674 | 1.50 | Circular | 0.014 | 0.18 | 288 | 4 |
| P-5675 | 1.00 | Circular | 0.026 | 0.27 | 49 | 1 |
| P-5676 | 0.83 | Circular | 0.026 | 0.14 | 35 | 0 |
| P-5677 | 1.50 | Circular | 0.009 | 0.91 | 102 | 14 |
| P-5678 | 1.00 | Circular | 0.026 | 10.72 | 5 | 5 |
| P-5679 | 0.83 | Circular | 0.026 | 22.71 | 10 | 5 |
| P-5680 | 1.50 | Circular | 0.014 | 0.26 | 299 | 5 |
| P-5681 | 0.83 | Circular | 0.026 | 4.58 | 39 | 2 |
| P-5682 | 0.83 | Circular | 0.026 | 1.23 | 10 | 1 |
| P-5683 | 0.83 | Circular | 0.026 | 1.50 | 29 | 1 |
| P-5684 | 1.25 | Circular | 0.014 | 0.15 | 296 | 2 |
| P-5685 | 1.00 | Circular | 0.026 | 0.29 | 242 | 1 |
| P-5687 | 1.25 | Circular | 0.026 | 4.44 | 21 | 6 |
| P-5688 | 1.25 | Circular | 0.026 | 1.55 | 39 | 3 |
| P-5691 | 2.00 | Circular | 0.014 | 0.94 | 107 | 20 |
| P-5695 | 2.00 | Circular | 0.014 | 2.17 | 311 | 32 |
| P-5697 | 1.00 | Circular | 0.026 | 4.06 | 46 | 3 |
| P-5698 | 2.00 | Circular | 0.014 | 2.32 | 230 | 32 |
| P-5699 | 1.00 | Circular | 0.026 | 1.81 | 54 | 2 |
| P-5700 | 0.83 | Circular | 0.026 | 3.74 | 49 | 2 |
| P-5701 | 0.83 | Circular | 0.026 | 4.71 | 21 | 2 |
| P-5702 | 1.50 | Circular | 0.014 | 0.19 | 488 | 4 |
| P-5703 | 0.83 | Circular | 0.026 | -1.89 | 16 | 1 |
| P-5704 | 0.83 | Circular | 0.026 | 1.36 | 20 | 1 |
| P-5705S | 1.50 | Circular | 0.014 | 0.25 | 400 | 5 |
| P-5706 | 0.67 | Circular | 0.026 | 2.27 | 26 | 1 |
| P-5707 | 0.83 | Circular | 0.009 | 3.21 | 40 | 6 |
| P-5708 | 0.67 | Circular | 0.017 | 2.87 | 45 | 2 |
| P-5709 | 0.67 | Circular | 0.017 | 1.12 | 37 | 1 |
| P-5710 | 0.67 | Circular | 0.026 | -2.63 | 8 | 1 |
| P-5711 | 1.50 | Circular | 0.014 | 3.84 | 21 | 19 |
| P-5712 | 0.67 | Circular | 0.017 | 3.51 | 33 | 2 |
| P-5713 | 0.67 | Circular | 0.020 | 4.71 | 37 | 2 |
| P-5714 | 0.67 | Circular | 0.017 | 1.89 | 38 | 1 |
| P-5715 | 0.83 | Circular | 0.012 | 2.61 | 53 | 4 |
| P-5716 | 0.67 | Circular | 0.017 | 1.45 | 43 | 1 |
| P-5717 | 2.00 | Circular | 0.014 | 0.34 | 270 | 12 |
| P-5718 | 0.67 | Circular | 0.020 | 2.72 | 22 | 1 |
| P-5719 | 0.67 | Circular | 0.017 | 5.40 | 16 | 2 |
| P-5720 | 0.67 | Circular | 0.012 | 0.40 | 25 | 1 |
| P-5721 | 1.25 | Circular | 0.014 | -0.24 | 124 | 3 |
| P-5722 | 0.67 | Circular | 0.017 | 4.91 | 36 | 2 |
| P-5724 | 2.00 | Circular | 0.014 | 0.69 | 182 | 17 |
| P-5725 | 0.67 | Circular | 0.017 | 7.64 | 26 | 3 |
| P-5726 | 0.67 | Circular | 0.020 | 4.39 | 19 | 2 |
| P-5727 | 0.67 | Circular | 0.017 | 2.29 | 23 | 1 |
| P-5728 | 0.67 | Circular | 0.017 | 1.65 | 41 | 1 |
| P-5729 | 2.00 | Circular | 0.014 | 0.57 | 237 | 16 |
| P-5733 | 0.67 | Circular | 0.017 | 2.78 | 41 | 2 |
| P-5734 | 0.83 | Circular | 0.009 | 1.28 | 42 | 4 |
| P-5735 | 1.00 | Circular | 0.014 | 4.56 | 258 | 7 |
| P-5736 | 0.67 | Circular | 0.026 | 1.00 | 36 | 1 |
| P-5737 | 0.83 | Circular | 0.009 | 10.18 | 17 | 10 |
| P-5738 | 1.00 | Circular | 0.017 | 0.46 | 295 | 2 |
| P-5739 | 0.67 | Circular | 0.017 | 2.82 | 35 | 2 |
| P-5740 | 0.83 | Circular | 0.009 | 6.23 | 48 | 8 |
| P-5741 | 0.67 | Circular | 0.026 | 1.63 | 35 | 1 |
| P-5742 | 0.67 | Circular | 0.028 | 4.27 | 38 | 1 |
| P-5743 | 0.67 | Circular | 0.026 | 1.05 | 16 | 1 |
| P-5744 | 1.00 | Circular | 0.017 | 1.75 | 195 | 4 |
| P-5746 | 0.67 | Circular | 0.026 | 3.20 | 42 | 1 |
| P-5747 | 0.67 | Circular | 0.017 | 3.69 | 70 | 2 |
| P-5748 | 0.67 | Circular | 0.017 | 3.85 | 64 | 2 |
| P-5749 | 0.67 | Circular | 0.020 | 2.68 | 13 | 1 |
| P-5750 | 1.00 | Circular | 0.014 | 1.41 | 127 | 4 |

| Name | Diameter (ft) | Shape | Roughness | Conduit Slope (%) | Length (ft) | Design Flow (cfs) |
|---|---|---|---|---|---|---|
| P-5751 | 0.67 | Circular | 0.017 | 2.89 | 21 | 2 |
| P-5752 | 1.00 | Circular | 0.014 | 1.99 | 29 | 5 |
| P-5754 | 1.00 | Circular | 0.014 | 3.26 | 430 | 6 |
| P-5755 | 1.00 | Circular | 0.014 | 2.01 | 25 | 5 |
| P-5756 | 1.00 | Circular | 0.014 | 2.05 | 11 | 5 |
| P-5757 | 1.75 | Circular | 0.014 | 1.25 | 63 | 12 |
| P-5758 | 1.00 | Circular | 0.014 | 1.97 | 20 | 5 |
| P-5759 | 1.00 | Circular | 0.014 | 1.97 | 18 | 5 |
| P-5760 | 1.00 | Circular | 0.014 | 2.03 | 10 | 5 |
| P-5761 | 1.75 | Circular | 0.014 | 0.68 | 79 | 12 |
| P-5762 | 1.00 | Circular | 0.014 | 2.00 | 34 | 5 |
| P-5763 | 1.00 | Circular | 0.014 | 2.00 | 25 | 5 |
| P-5764 | 1.00 | Circular | 0.014 | 2.09 | 36 | 5 |
| P-5765 | 4.00 | Circular | 0.014 | 0.87 | 312 | 125 |
| P-5766 | 0.67 | Circular | 0.017 | 2.38 | 61 | 1 |
| P-5767 | 0.67 | Circular | 0.017 | 7.31 | 15 | 3 |
| P-5768 | 0.83 | Circular | 0.017 | 0.73 | 99 | 1 |
| P-5769 | 0.67 | Circular | 0.017 | 3.84 | 28 | 2 |
| P-5770 | 4.00 | Circular | 0.014 | 0.82 | 375 | 121 |
| P-5771 | 0.67 | Circular | 0.026 | 4.22 | 20 | 1 |
| P-5772 | 0.67 | Circular | 0.017 | 1.41 | 72 | 1 |
| P-5773 | 1.00 | Circular | 0.014 | 6.41 | 88 | 8 |
| P-5774 | 1.00 | Circular | 0.014 | 5.57 | 32 | 8 |
| P-5775 | 0.83 | Circular | 0.026 | 7.48 | 10 | 3 |
| P-5776 | 1.00 | Circular | 0.014 | 3.42 | 50 | 6 |
| P-5777 | 0.83 | Circular | 0.026 | 5.34 | 18 | 2 |
| P-5778 | 0.83 | Circular | 0.026 | 3.35 | 22 | 2 |
| P-5779 | 0.83 | Circular | 0.026 | 3.53 | 7 | 2 |
| P-5780 | 1.00 | Circular | 0.014 | 2.69 | 317 | 5 |
| P-5781 | 0.67 | Circular | 0.026 | 6.63 | 28 | 1 |
| P-5782 | 1.25 | Circular | 0.014 | 8.56 | 99 | 18 |
| P-5784 | 0.67 | Circular | 0.017 | 1.35 | 45 | 1 |
| P-5785 | 0.34 | Circular | 0.017 | 6.99 | 20 | 0 |
| P-5786 | 0.67 | Circular | 0.017 | 2.24 | 25 | 1 |
| P-5787 | 0.83 | Circular | 0.009 | 2.57 | 13 | 5 |
| P-5788 | 1.25 | Circular | 0.016 | 0.31 | 389 | 3 |
| P-5789 | 1.00 | Circular | 0.017 | 28.87 | 14 | 15 |
| P-5790 | 0.67 | Circular | 0.017 | 4.65 | 30 | 2 |
| P-5791 | 4.00 | Circular | 0.014 | 2.53 | 10 | 212 |
| P-5792 | 1.00 | Circular | 0.009 | 1.50 | 43 | 6 |
| P-5793 | 1.00 | Circular | 0.014 | 2.18 | 14 | 5 |
| P-5794 | 1.50 | Circular | 0.014 | 0.84 | 181 | 9 |
| P-5795 | 1.00 | Circular | 0.014 | 0.41 | 22 | 2 |
| P-5796 | 0.67 | Circular | 0.017 | 7.46 | 50 | 3 |
| P-5797 | 0.67 | Circular | 0.009 | 3.47 | 22 | 3 |

| Name | Diameter (ft) | Shape | Roughness | Conduit Slope (%) | Length (ft) | Design Flow (cfs) |
|---|---|---|---|---|---|---|
| P-5798 | 1.00 | Circular | 0.014 | 1.56 | 232 | 4 |
| P-5799 | 0.67 | Circular | 0.009 | 2.42 | 16 | 3 |
| P-5800 | 4.00 | Circular | 0.014 | 0.73 | 256 | 144 |
| P-5801 | 0.67 | Circular | 0.028 | 3.25 | 9 | 1 |
| P-5802 | 0.67 | Circular | 0.026 | 2.61 | 30 | 1 |
| P-5803 | 0.67 | Circular | 0.026 | 2.82 | 35 | 1 |
| P-5804 | 4.00 | Circular | 0.014 | 0.89 | 328 | 126 |
| P-5805 | 0.67 | Circular | 0.026 | 5.72 | 24 | 1 |
| P-5806 | 0.67 | Circular | 0.026 | 4.71 | 59 | 1 |
| P-5816 | 0.50 | Circular | 0.017 | 0.67 | 16 | 0 |
| P-5817 | 0.50 | Circular | 0.017 | 0.40 | 30 | 0 |
| P-5818 | 1.00 | Circular | 0.014 | 1.40 | 285 | 4 |
| P-5819 | 0.83 | Circular | 0.026 | 0.51 | 41 | 1 |
| P-5820 | 0.50 | Circular | 0.017 | 0.48 | 50 | 0 |
| P-600 | 4.00 | Circular | 0.014 | 0.96 | 221 | 130 |
| P-6023 | 0.67 | Circular | 0.009 | 2.96 | 45 | 3 |
| P-6024 | 0.83 | Circular | 0.009 | 1.18 | 32 | 3 |
| P-6025 | 0.67 | Circular | 0.017 | 7.72 | 15 | 3 |
| P-6026 | 2.50 | Circular | 0.014 | 0.63 | 329 | 30 |
| P-6028 | 2.50 | Circular | 0.014 | 0.61 | 316 | 30 |
| P-6032 | 2.50 | Circular | 0.014 | 2.38 | 304 | 59 |
| P-6040 | 2.50 | Circular | 0.014 | 0.51 | 445 | 27 |
| P-6046 | 2.50 | Circular | 0.014 | 0.79 | 225 | 34 |
| P-6049 | 2.50 | Circular | 0.014 | 2.65 | 255 | 62 |
| P-6054 | 2.50 | Circular | 0.014 | 1.38 | 163 | 45 |
| P-6057 | 3.50 | Circular | 0.014 | 0.19 | 260 | 41 |
| P-6072 | 3.50 | Circular | 0.014 | 0.19 | 270 | 40 |
| P-6084 | 3.50 | Circular | 0.014 | 0.27 | 171 | 48 |
| P-6087 | 3.50 | Circular | 0.014 | 0.18 | 221 | 40 |
| P-6089 | 3.50 | Circular | 0.014 | 0.25 | 189 | 47 |
| P-6125 | 7.00 | Circular | 0.014 | 0.34 | 279 | 344 |
| P-6128 | 7.00 | Circular | 0.014 | 0.25 | 107 | 298 |
| P-6132 | 3.50 | Circular | 0.014 | 0.50 | 232 | 66 |
| P-6134 | 3.50 | Circular | 0.014 | 0.40 | 296 | 59 |
| P-6136 | 3.50 | Circular | 0.014 | 0.44 | 187 | 62 |
| P-6137 | 3.50 | Circular | 0.014 | 0.54 | 280 | 69 |
| P-6139 | 3.50 | Circular | 0.014 | 0.38 | 272 | 57 |
| P-6213 | 7.50 | Circular | 0.014 | 0.32 | 490 | 401 |
| P-6220 | 7.50 | Circular | 0.014 | 0.12 | 181 | 243 |
| P-7[1] | 0.00 | Natural | 0.014 | 0.45 | 114 | 151,685 |
| P-700 | 3.00 | Circular | 0.014 | 1.00 | 18 | 62 |
| P-705E.1 | 1.50 | Circular | 0.014 | 0.81 | 288 | 9 |
| P-7384 | 6.00 | Circular | 0.014 | 0.21 | 203 | 181 |
| P-7388 | 6.00 | Circular | 0.014 | 0.24 | 287 | 192 |
| P-7391 | 6.00 | Circular | 0.014 | 0.25 | 183 | 195 |

| Name | Diameter (ft) | Shape | Roughness | Conduit Slope (%) | Length (ft) | Design Flow (cfs) |
|---|---|---|---|---|---|---|
| P-7397 | 6.00 | Circular | 0.014 | 0.61 | 202 | 307 |
| P-7481 | 4.00 | Circular | 0.014 | -2.62 | 75 | 216 |
| P-7497 | 3.50 | Circular | 0.014 | 0.15 | 39 | 37 |
| P-7566.1 | 2.50 | Circular | 0.014 | 0.83 | 249 | 35 |
| P-7571 | 2.50 | Circular | 0.014 | 2.62 | 308 | 62 |
| P-7637 | 2.50 | Circular | 0.014 | 0.05 | 186 | 9 |
| P-7640 | 2.50 | Circular | 0.014 | 0.29 | 95 | 21 |
| P-7641 | 2.50 | Circular | 0.014 | 1.83 | 65 | 52 |
| P-7642 | 2.50 | Circular | 0.014 | 0.79 | 202 | 34 |
| P-7725 | 6.50 | Circular | 0.014 | 0.67 | 45 | 397 |
| P-7728 | 6.50 | Circular | 0.014 | 0.24 | 220 | 239 |
| P-7731 | 6.50 | Circular | 0.014 | 0.19 | 245 | 211 |
| P-800 | 10.67 | Special | 0.014 | 0.02 | 312 | 143 |
| P-8028 | 6.50 | Circular | 0.014 | 0.36 | 70 | 291 |
| P-8029E | 6.50 | Circular | 0.014 | 0.20 | 10 | 218 |
| P-8029N | 4.00 | Circular | 0.014 | 4.68 | 31 | 288 |
| P-8035 | 6.50 | Circular | 0.014 | 0.27 | 243 | 252 |
| P-8036 | 6.50 | Circular | 0.014 | 0.35 | 173 | 287 |
| P-8039.1 | 6.50 | Circular | 0.014 | 0.41 | 171 | 310 |
| P-8042.1 | 6.50 | Circular | 0.014 | 0.75 | 154 | 423 |
| P-8051 | 1.00 | Circular | 0.014 | 1.98 | 8 | 5 |
| P-8053 | 4.00 | Circular | 0.014 | 0.46 | 291 | 91 |
| P-8054 | 4.00 | Circular | 0.014 | 0.69 | 16 | 111 |
| P-8055 | 1.75 | Circular | 0.014 | 0.67 | 102 | 12 |
| P-8064 | 4.00 | Circular | 0.014 | 0.60 | 185 | 103 |
| P-8070 | 4.00 | Circular | 0.014 | 0.72 | 214 | 113 |
| P-8094 | 4.00 | Circular | 0.014 | 0.58 | 99 | 102 |
| P-8145 | 2.50 | Circular | 0.014 | 1.27 | 246 | 43 |
| P-8161.1 | 3.00 | Circular | 0.014 | 0.40 | 396 | 39 |
| P-8162 | 3.50 | Circular | 0.014 | 0.98 | 106 | 93 |
| P-8163.1 | 2.50 | Circular | 0.014 | 1.05 | 119 | 39 |
| P-8165 | 3.00 | Circular | 0.014 | 0.49 | 226 | 43 |
| P-8256 | 6.50 | Circular | 0.014 | 0.31 | 39 | 269 |
| P-8258.1 | 6.50 | Circular | 0.014 | 0.31 | 235 | 269 |
| P-8261.1 | 6.50 | Circular | 0.014 | 0.35 | 256 | 287 |
| P-8346.1 | 4.50 | Circular | 0.014 | 0.59 | 88 | 141 |
| P-8347 | 1.50 | Circular | 0.014 | 1.50 | 148 | 12 |
| P-8353.1 | 4.50 | Circular | 0.014 | 0.71 | 428 | 154 |
| P-8378.1 | 4.50 | Circular | 0.014 | 0.66 | 307 | 148 |
| P-8381.1 | 4.50 | Circular | 0.014 | 0.23 | 419 | 87 |
| P-8384.1 | 4.00 | Circular | 0.014 | 1.39 | 151 | 158 |
| P-8387.1 | 4.00 | Circular | 0.014 | 0.84 | 142 | 122 |
| P-8402 | 4.00 | Circular | 0.014 | 1.14 | 291 | 142 |
| P-8404 | 4.00 | Circular | 0.014 | 1.12 | 267 | 141 |
| P-8410 | 4.00 | Circular | 0.014 | 1.36 | 314 | 156 |

| Name | Diameter (ft) | Shape | Roughness | Conduit Slope (%) | Length (ft) | Design Flow (cfs) |
|---|---|---|---|---|---|---|
| P-8412 | 4.00 | Circular | 0.014 | 1.26 | 97 | 150 |
| P-8551 | 3.50 | Circular | 0.014 | 0.96 | 310 | 92 |
| P-900.1 | 10.67 | Special | 0.014 | 0.24 | 228 | 500 |
| P-9447 | 7.00 | Circular | 0.014 | 0.15 | 113 | 230 |
| P-9468 | 3.50 | Circular | 0.014 | 0.18 | 193 | 40 |
| P-9488 | 3.50 | Circular | 0.014 | 0.19 | 161 | 40 |
| P-9489 | 4.00 | Circular | 0.014 | 1.39 | 300 | 157 |
| P-9727 | 2.50 | Circular | 0.014 | 0.32 | 294 | 21 |
| P-9728 | 1.25 | Circular | 0.014 | 0.56 | 208 | 4 |
| P-9731 | 2.00 | Circular | 0.014 | 0.84 | 314 | 19 |
| P-9732 | 2.50 | Circular | 0.014 | 0.39 | 312 | 24 |
| P-9733 | 0.83 | Circular | 0.026 | -1.18 | 4 | 1 |
| P-9735 | 4.00 | Circular | 0.014 | 0.77 | 298 | 117 |
| P-9736 | 1.00 | Circular | 0.017 | 4.29 | 305 | 6 |
| P-9738 | 4.00 | Circular | 0.014 | 0.50 | 153 | 95 |
| P-9745 | 4.00 | Circular | 0.014 | 1.82 | 219 | 180 |
| P-9763 | 6.00 | Circular | 0.014 | 0.12 | 219 | 138 |
| P-9764 | 6.00 | Circular | 0.014 | 0.32 | 158 | 221 |
| P-9765 | 6.00 | Circular | 0.014 | 0.11 | 306 | 131 |
| P-9766 | 6.00 | Circular | 0.014 | 0.19 | 189 | 169 |
| P-9823 | 8.00 | Circular | 0.014 | 0.23 | 142 | 403 |
| P-9886 | 6.50 | Circular | 0.014 | 0.17 | 218 | 200 |
| P-9891 | 6.50 | Circular | 0.014 | 0.45 | 214 | 328 |
| P-9996.1 | 4.00 | Circular | 0.014 | 0.96 | 303 | 131 |
| P-GRAY | 1.25 | Circular | 0.014 | 3.50 | 8 | 11 |
| PC_W1 | 0.05 | Circular | 0.014 | 0.00 | 10 | 0 |
| PC_W1 | 0.05 | Circular | 0.014 | 0.00 | 10 | 0 |
| PC_W2 | 0.05 | Circular | 0.014 | 0.00 | 10 | 0 |
| PC_W2 | 0.05 | Circular | 0.014 | 0.00 | 10 | 0 |
| PC_W3 | 0.05 | Circular | 0.014 | 0.00 | 10 | 0 |
| PC_W3 | 0.05 | Circular | 0.014 | 0.00 | 10 | 0 |
| PCTANK_O1 | 0.05 | Circular | 0.014 | 0.00 | 10 | 1,816 |
| PCTANK_O1 | 0.05 | Circular | 0.014 | 0.00 | 10 | 1,816 |
| S-10 | 1.00 | Natural | 0.014 | 1.15 | 88 | 190 |
| S-10001 | 0.00 | Natural | 0.014 | 1.26 | 353 | 198 |
| S-10199 | 1.00 | Natural | 0.014 | 0.13 | 179 | 63 |
| S-10231 | 1.00 | Natural | 0.014 | 0.48 | 86 | 219 |
| S-10232 | 1.00 | Natural | 0.014 | 0.00 | 258 | 230 |
| S-10233 | 1.00 | Natural | 0.014 | -0.45 | 42 | 118 |
| S-10299 | 1.00 | Natural | 0.014 | 0.06 | 289 | 43 |
| S-10300 | 0.00 | Natural | 0.014 | 0.72 | 280 | 269 |
| S-10361 | 0.00 | Natural | 0.015 | -0.95 | 420 | 173 |
| S-10362 | 1.00 | Natural | 0.014 | 0.13 | 428 | 63 |
| S-10464 | 1.00 | Natural | 0.014 | 0.00 | 333 | 97 |
| S-10549 | 1.00 | Natural | 0.014 | 0.00 | 56 | 6 |

| Name | Diameter (ft) | Shape | Roughness | Conduit Slope (%) | Length (ft) | Design Flow (cfs) |
|---|---|---|---|---|---|---|
| S-10862 | 1.00 | Natural | 0.014 | 1.07 | 259 | 183 |
| S-11073 | 1.00 | Natural | 0.014 | 0.00 | 61 | 6 |
| S-11074 | 1.00 | Natural | 0.014 | 1.19 | 221 | 193 |
| S-11081 | 0.00 | Natural | 0.015 | 1.86 | 289 | 241 |
| S-11272 | 0.00 | Natural | 0.014 | 0.29 | 134 | 95 |
| S-11414 | 1.00 | Natural | 0.014 | 1.21 | 331 | 195 |
| S-11484 | 1.00 | Natural | 0.014 | 0.00 | 169 | 6 |
| S-11763 | 1.00 | Natural | 0.014 | 1.91 | 309 | 439 |
| S-11959 | 1.00 | Natural | 0.014 | 2.12 | 255 | 462 |
| S-12547 | 0.05 | Natural | 0.014 | 1.75 | 66 | 234 |
| S-12552 | 1.00 | Natural | 0.014 | 0.25 | 208 | 158 |
| S-12601 | 1.00 | Natural | 0.014 | 0.19 | 170 | 78 |
| S-12737 | 1.00 | Natural | 0.014 | 0.60 | 275 | 247 |
| S-12745 | 1.00 | Natural | 0.014 | 0.12 | 277 | 111 |
| S-14412 | 1.00 | Natural | 0.014 | 0.40 | 326 | 112 |
| S-15306 | 1.00 | Natural | 0.014 | 1.02 | 174 | 178 |
| S-15312 | 1.00 | Natural | 0.014 | 1.59 | 102 | 223 |
| S-15724 | 1.00 | Natural | 0.014 | 1.81 | 102 | 238 |
| S-16054 | 1.00 | Natural | 0.014 | 0.00 | 532 | 138 |
| S-16387 | 1.00 | Natural | 0.014 | 0.01 | 73 | 17 |
| S-16389 | 1.00 | Natural | 0.014 | 1.03 | 194 | 180 |
| S-16427 | 1.00 | Natural | 0.014 | 0.00 | 70 | 6 |
| S-2390 | 0.00 | Natural | 0.014 | 1.36 | 317 | 207 |
| S-23901 | 1.00 | Natural | 0.014 | 0.57 | 506 | 134 |
| S-3182 | 1.00 | Natural | 0.014 | 0.00 | 170 | 10 |
| S-3183 | 1.00 | Natural | 0.014 | 0.00 | 62 | 10 |
| S-3185 | 1.00 | Natural | 0.014 | 0.75 | 266 | 275 |
| S-3189 | 1.00 | Natural | 0.014 | 0.00 | 171 | 10 |
| S-4466 | 1.00 | Natural | 0.014 | 0.47 | 427 | 121 |
| S-4979 | 1.00 | Natural | 0.014 | 1.69 | 326 | 230 |
| S-4992 | 0.00 | Natural | 0.014 | 0.65 | 327 | 143 |
| S-4996 | 1.00 | Natural | 0.014 | 0.81 | 613 | 159 |
| S-5010 | 1.00 | Natural | 0.014 | -2.54 | 56 | 282 |
| S-5451 | 1.00 | Natural | 0.014 | 0.85 | 175 | 163 |
| S-5454 | 1.00 | Natural | 0.014 | 1.64 | 298 | 226 |
| S-5458 | 1.00 | Natural | 0.014 | -0.96 | 92 | 173 |
| S-5473 | 1.00 | Natural | 0.014 | 2.39 | 84 | 274 |
| S-5489 | 1.00 | Natural | 0.014 | 0.00 | 270 | 6 |
| S-5491 | 1.00 | Natural | 0.014 | 0.00 | 370 | 6 |
| S-5554 | 1.00 | Natural | 0.014 | 1.69 | 214 | 230 |
| S-5569 | 1.00 | Natural | 0.014 | 1.22 | 249 | 196 |
| S-7566 | 1.00 | Natural | 0.014 | 0.60 | 249 | 137 |
| S-8039 | 1.00 | Natural | 0.014 | 1.17 | 171 | 192 |
| S-8042 | 1.00 | Natural | 0.014 | 1.09 | 154 | 184 |
| S-8145 | 0.00 | Natural | 0.014 | 1.12 | 246 | 187 |

| Name | Diameter (ft) | Shape | Roughness | Conduit Slope (%) | Length (ft) | Design Flow (cfs) |
|---|---|---|---|---|---|---|
| S-8161 | 1.00 | Natural | 0.014 | 0.00 | 396 | 99 |
| S-8163 | 0.00 | Natural | 0.015 | 2.73 | 119 | 292 |
| S-8258 | 1.00 | Natural | 0.014 | -0.25 | 235 | 88 |
| S-8261 | 1.00 | Natural | 0.014 | 0.09 | 256 | 54 |
| S-8346 | 1.00 | Natural | 0.014 | 0.00 | 88 | 6 |
| S-8353 | 1.00 | Natural | 0.014 | 0.00 | 428 | 148 |
| S-8378 | 1.00 | Natural | 0.014 | 0.00 | 307 | 175 |
| S-8381 | 1.00 | Natural | 0.014 | 0.00 | 419 | 193 |
| S-8384 | 1.00 | Natural | 0.014 | 0.00 | 151 | 250 |
| S-8387 | 1.00 | Natural | 0.014 | 0.00 | 142 | 210 |
| S-900 | 0.00 | Natural | 0.015 | 0.95 | 228 | 309 |
| S-9996 | 1.00 | Natural | 0.014 | 0.52 | 303 | 128 |

[1] P-1400 and P-7 are open channel sections downstream of the Pike Creek Outfall. These sections were surveyed by the City from the flow line and up approximately 19 feet in elevation. The design flow reported for the XSECTION entered in xp-swmm is thus reported with basically unlimited capacity. In reality, this XSECTION will likely only realize a fraction of the reported design flow.