City of Elmhurst

Comprehensive Flooding Plan

Storm Sewer System Analysis

Elmhurst, Illinois

Prepared for

City of Elmhurst
209 N. York Street
Elmhurst, IL 60126

April 2012

Prepared by

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CBBEL Project No. 10-0506

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EXECUTIVE SUMMARY

This report presents the results of a comprehensive flood plan completed by Christopher B. Burke Engineering, Ltd. (CBBEL) at the request of the City of Elmhurst (City). This comprehensive flood plan was developed in response to the widespread flooding experienced throughout the City during the summer of 2010. During the storm events of June 23 and July 23-24, the City experienced record rainfalls that resulted in hundreds of flooded residences. Homes throughout the City were severely damaged due to overland flooding, sump pump failures, and sanitary sewer backups.

The main focus of this study is ten flood-prone areas that experience significant flooding during heavy rains. Using information collected from various sources, existing conditions computer models were developed to determine the cause of flooding for each of the ten study areas. The existing level of flood protection was quantified for each of the ten study areas. To ensure that the computer models were producing accurate results, they were calibrated to surveyed high water elevations collected from the July 2010 storm event.

Using the calibrated computer models, proposed drainage improvements were simulated to determine their flood reduction benefits. Proposed drainage improvements analyzed in this study included: increased storm sewer sizes, constructing relief sewers, creating flood storage in open space, providing flood storage underground, and increasing pumping rates of existing stormwater pumping stations. Based on the results of the proposed conditions computer modeling, it is evident that significant expenditures will be required to increase the level of flood protection for the ten study areas. The conceptual cost estimates for the proposed improvements range from $670,000 to $46.5 million. A complete description of the costs and benefits of each project is included in this report.

In addition to the ten flood study areas, a review of the City's current stormwater regulations was performed. A hydrologic analysis of 16 recently redeveloped properties was developed to compare the stormwater runoff of pre- and post-redevelopment conditions. Specifically, the study focused on the City's requirement of downspouts and sump pumps to be directly connected to the storm sewer. Additionally, the effect of deeper basements on groundwater was also analyzed. Based on the results of the analysis, CBBEL recommends the following modifications to the City's current stormwater regulations: (1) prescribe a maximum allowable impervious area percentage per residential lot, (2) remove the current requirement of directly connecting sump pumps and downspouts to the storm sewer system and redirect them to a rain garden, and (3) consider mitigation storage for displaced groundwater due to deeper basements.

Additionally, CBBEL developed a Flood Protection System for new construction in flood-prone areas of the City. A database was developed that correlates parcels within flood-prone areas to the 100-year flood elevations determined in the XP-SWMM analysis. CBBEL recommends that all new construction be elevated to at least two feet above the XP-SWMM generated 100-year flood elevations.

INTRODUCTION

The City of Elmhurst (City) is a mostly residential community with a total area of 10.2 square miles and a population of approximately 44,000 people. The majority of the City's development began in the 1920's, during which a large population growth took place and the City implemented large public infrastructure projects. A City-wide combined sewer system was constructed as part of the public infrastructure projects to control the sanitary waste and stormwater runoff, which was a common practice for communities developed in this period. A combined sewer system is one in which a single pipe is used to convey both sanitary sewage and stormwater runoff.

The combined sewer system remained functional until the 1960's, when the City converted the combined system into separate sanitary and storm sewer systems. New storm and sanitary sewers were constructed and used in conjunction with the existing combined sewers, as part of a phased sewer separation project throughout the City.

As shown in Figure 1, a natural drainage divide (orange area) is located through the middle of the City; areas south and west of the divide drain to Salt Creek and the areas north and east of the divide drain toward Addison Creek. The low-lying areas of the City, depicted in dark green on Figure 1, and in particular the southwest portion of the City, are the most susceptible to overbank flooding.

In August 1987, record rainfalls caused significant overbank flooding along Salt Creek, which resulted in millions of dollars in damages. Southwest Elmhurst was hit especially hard by the 1987 flood, due to its low elevation and proximity to Salt Creek. In response to the 1987 flooding, the City built a levee along Salt Creek to protect the low-lying areas from overbank flooding. To control the stormwater runoff from the area behind the levee, stormwater pumping stations were constructed to convey the internal drainage to Salt Creek when creek levels are high and gravity drainage is not possible.

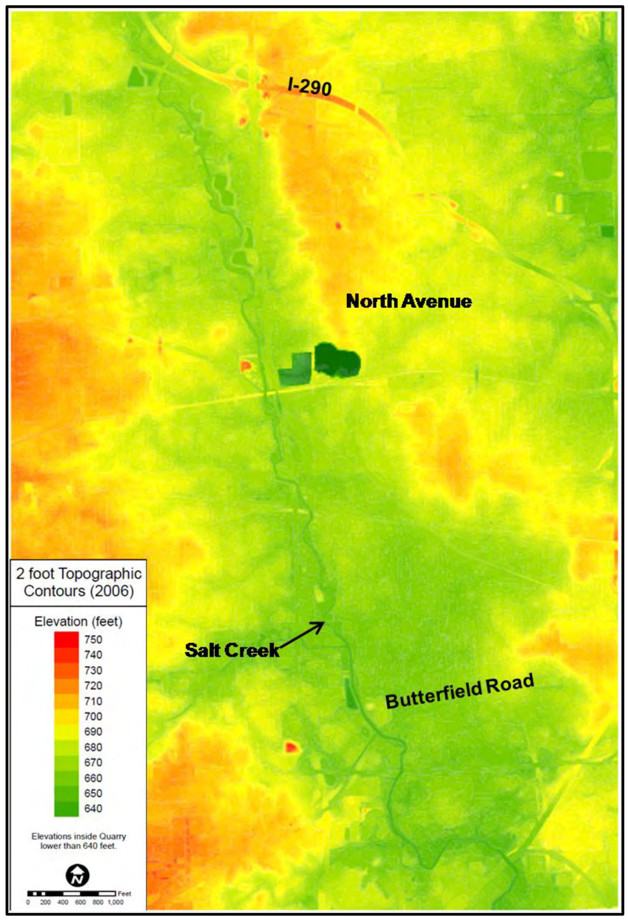

Figure 1. City of Elmhurst Topography

During the summer of 2010, City-wide flooding occurred during the June 23 and July 23 -24 storm events. The July 23-24' storm event was particularly devastating, when nearly seven inches of rain was measured in twelve hours according to the U.S. Geological Survey (USGS) Salt Creek gage in Elmhurst (Gage 05531300). The depth and duration (intensity) of the precipitation measured during the July 2010 storm event exceeded a 100-year storm event according to rainfall depths and durations published in Bulletin 70. Bulletin 70 is the widely accepted rainfall study used to design stormwater management infrastructure in Northeastern Illinois. The 100-year design storm event refers to a storm event that has a 1% chance of occurring in any given year. During the July 2010 storm event, the existing storm sewer system and pumping stations could not handle the large runoff volumes, resulting in the flooding of hundreds of homes. In addition to overland flooding, many houses experienced sanitary sewer backups due to the large volume of clear water that entered the sanitary sewer system.

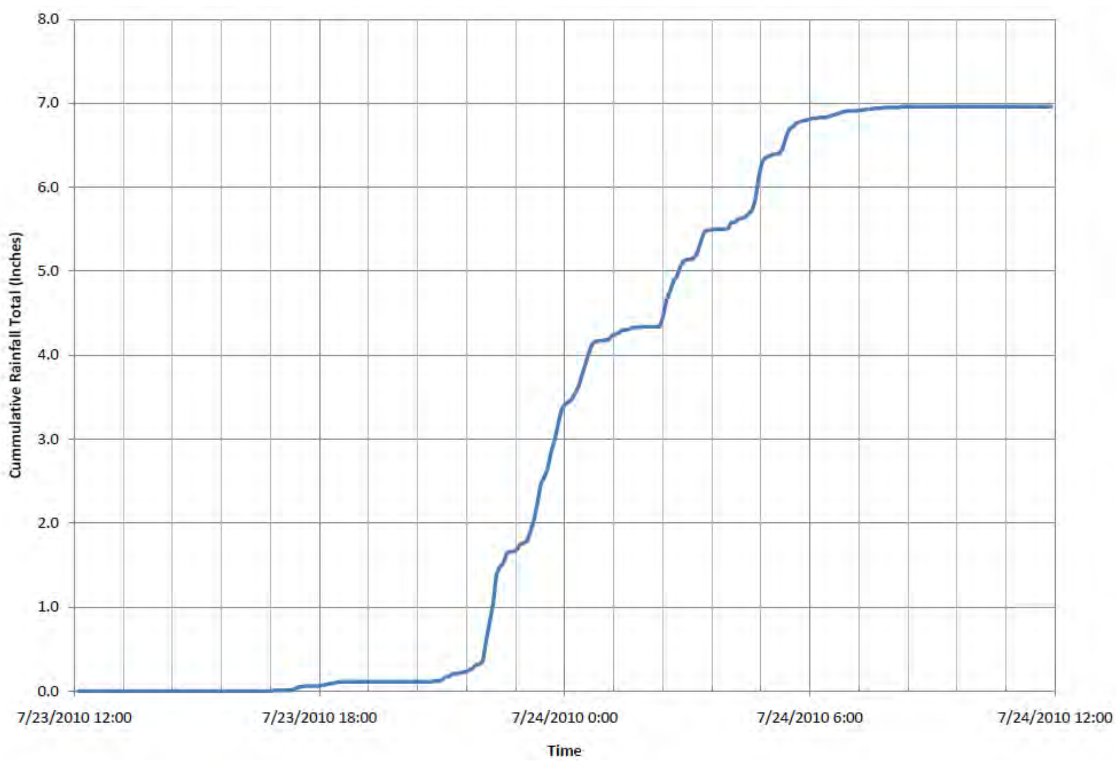

Figure 2. July 23-24, 2010 Cumulative Rainfall Total – USGS Gage 05531300 in Elmhurst

In response to the 2010 flooding, the City hired Christopher B. Burke Engineering, Ltd. (CBBEL) and RJN Group (RJN), to complete a comprehensive flood plan for the City. The main objective of the study was to analyze ten key flood problem areas and to develop concept-level drainage improvements to alleviate the flooding in each. Concept-level cost estimates for the proposed improvements were also prepared. Other goals of the study were to analyze flood proofing options and to review the City's existing stormwater regulations regarding single-family homes and analyze their effect on the stormwater collection system.

STUDY METHODOLOGY

As part of the comprehensive flood plan, ten flood study areas were analyzed to determine the existing level of flood protection and develop concept-level drainage improvements to reduce the frequency and severity of flooding. The ten flood study areas (shown on Figure 3) were identified based on reports from City staff regarding historic flood problem areas, and consist of the following locations:

1) Pine Street
2) Geneva Avenue
3) York Street to Salt Creek, between McKinley Avenue and Butterfield Road
4) York Street to Salt Creek, between McKinley Avenue and Butterfield Road
5) Larch Avenue
6) Seminole Avenue
7) York Street at I-290
8) Brynhaven Subdivision
9) Pick Subdivision
10) Butterfield Road Area (Yorkfield)

Figure 3. Location Map - Ten Flood Study Areas

The ten flood study areas were analyzed using XP-SWMM computer software, which is a proprietary program based on the US Environmental Protection Agency's (EPA) Storm Water Management Model (SWMM). XP-SWMM is a dynamic hydrologic and hydraulic modeling program that is ideal for analyzing stormwater management systems. XP-SWMM simulates rainfall-runoff responses for user-specified storm events (hydrologic component) and analyzes the performance of the stormwater management system (hydraulic component).

As described above, there are two main components to the XP-SWMM model: the hydrologic component (watershed characteristics, impervious area, topography, etc.) and the hydraulic component (storm sewer size, slope, material, etc.). Input data for the hydrologic and hydraulic components was collected from various sources, including:

- 500 residential flood questionnaires following the 2010 flooding
- City's GIS storm sewer database
- As-built drawings for the storm sewer system
- Pump station plans and operating procedures
- Previous drainage studies completed for the City
- Field investigations/survey completed by CBBEL staff
- DuPage County two-foot aerial topographic mapping

To develop the hydrologic component of the computer model, each study area was delineated into subbasins based on DuPage County two-foot aerial topography and storm sewer location. Hydrologic parameters, such as area, Runoff Curve Number (CN), and time of concentration (t_c), were calculated based on topography and the current land use. The CN value is a measure of the imperviousness of each subbasin and is used to predict the runoff response for each subbasin. The time of concentration is the longest time it takes a drop of water to reach the outlet of the subbasin.

The hydraulic elements of the model, including storm sewer diameters, lengths, material, slopes, etc., were taken from the City's GIS storm sewer database. Because the database is incomplete for some portions of the study areas, as-built drawings and survey information were used to supplement this information. In addition to the storm sewer network, overland flow routes and depressional storage areas were entered into the model using the aerial topography. If a sewer did not have sufficient capacity to convey the tributary runoff, the system surcharges out of the manhole rim. When this occurs, water will flow by gravity along the overland flow routes that follow the topography. Where overland flow routes converge at depressional areas, ponding areas were entered into the model so that the depth and volume of ponding could be determined. Additionally, other hydraulic elements such as stormwater pumping stations and restrictors were added to the model in the appropriate locations.

Using precipitation data from the USGS gage on Salt Creek, the July 2010 storm event was simulated using the XP-SWMM model for each study area. The results of the models were compared to high water marks collected by City staff from the July 2010 storm event. A total of 27 high water marks that cover seven out of the ten study areas were collected throughout the City. A location map of the surveyed high water elevations is provided on Exhibit 2. The hydrologic parameters for each study area were adjusted until the modeled results matched the observed elevations.

Once the models were calibrated, a critical duration analysis was performed for each study area. The critical storm duration was determined for each study area using rainfall depths published in Bulletin 70.

The critical duration refers the storm duration that produces the highest flowrates and flood elevations. To determine the existing level of flood protection for each of the study areas, the critical storm duration was simulated for 2-, 5-, 10-, 25-, 50-, and 100-year return intervals. The level of protection is defined as the highest flood frequency that does not result in flood damage. An example of a 50-year level of protection is shown on Figure 4.

Based on the results of the XP-SWMM modeling, the cause of flooding was identified and the flood reduction benefits for the various proposed drainage improvements were analyzed for each study area. The proposed drainage improvements analyzed in this study include: increasing storm sewer sizes, constructing relief sewers, creation of flood storage (above-ground and underground), and increasing pumping capacities. Using the XP-SWMM existing conditions models as baseline conditions models, the proposed improvements were analyzed to determine their associated flood reduction benefits.

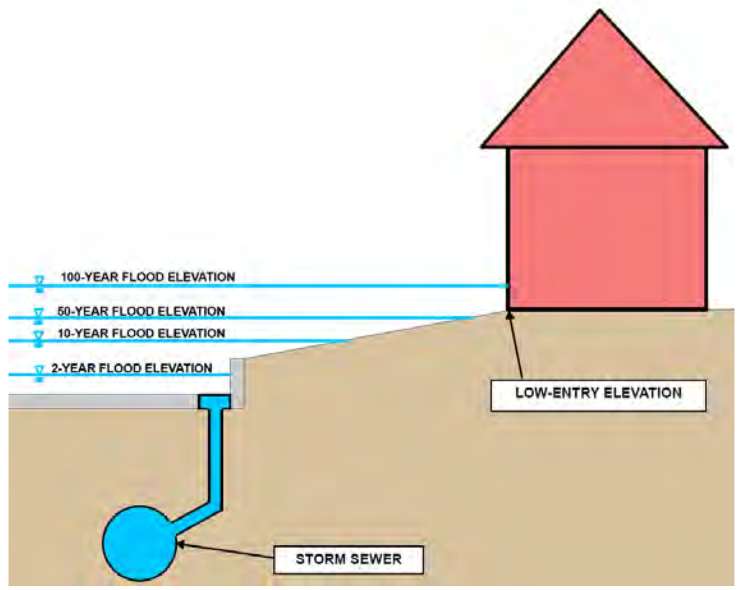

Figure 4. Level of Flood Protection

Concept-level cost estimates were prepared for each proposed drainage alternative. There are many unknowns that can affect the ultimate design and cost of the project, including utility conflicts, soil conditions, and right-of-limits. Due to these uncertainties, a 20% contingency has been added to the engineer's estimate of probable cost. Engineering for each project has also been included in the estimate as 10% of the total cost of the project. The cost estimates do not include such items as land acquisition, temporary/permanent construction easements, relocation of utilities, and the cost of recreational facilities in open space.

The following sections of the report have been organized by study area. Each section details the existing and proposed condition study area and provides the engineer's estimate of probable cost for each alternative.

PINE STREET STUDY AREA

The Pine Street Study Area is located south of Schiller Street, east of Willow Road, and north of 1st Street, as shown in Figure 5. The drainage area, which is that portion of the City that contributes runoff, is approximately 88 acres at the intersection of 1st Street and Avon Road. Pine Street is located within a large depressional area, which is drained by a single 18-inch storm sewer. Because the overland flow route out of the depressional area is elevated higher than many of the houses within this area, street, yard, and eventually structural flooding occurs during more significant storm events. The Pine Street storm sewer is connected to the 48-inch storm sewer that flows east along 1st Street. Because the lowest rim elevations of the storm sewer system are located along Pine Street, this location is one of the first to experience surcharging of the system.

Figure 5. **Overview of Pine Street Study Area**

4.1 PINE STREET EXISTING CONDITIONS

Due to the limited capacity of the existing storm sewer system and the lack of a designated overland flow route, this area along Pine Street is especially susceptible to flooding. Based on the results of the existing conditions XP-SWMM analysis, street and yard flooding occurs in this area for storm events greater than the 10-year frequency. Structural flooding occurs for storm events greater than a 25-year return interval. For the 100-year storm event, 20 homes experience flooding.

During the July 2010 storm event, significant street and home flooding was reported within the subdivision along Pine Street and Avon Road, particularly along the low spot at on each street. Based on the XP-SWMM computer modeling, there was approximately 2.2 feet of flooding on Pine Street and 20 homes were affected by the flooding. The XP-SWMM simulated inundation area for the July 2010 storm event is shown as Figure 6.

Figure 6. Pine Street XP-SWMM Simulated Inundation Area – July 2010 Storm Event

4.2 PINE STREET PROPOSED CONDITIONS

Several proposed improvements were evaluated to increase the level of flood protection for the study area. Because several of the homes in the flood problem area flooded during the July 2011 storm event, the goal of the proposed drainage improvements is to eliminate the structural flooding along Pine Street and Avon Road.

<u>Alternative #1 – 50-Year Relief Sewer/Expand Detention Storage</u>

As shown on Exhibit 3A, Alternative #1 provides a 50-year level of protection for the homes in this study area through the following drainage improvements:

- Installation of 200 linear feet of 24-inch diameter relief sewer and 270 linear feet of 12-inch diameter storm sewer from the low spots on Pine Street and Avon Road, respectively, south to 1st Street.
- Installation of 30 linear feet of 21-inch diameter relief sewer that connects the existing 48-inch diameter sewer under the railroad from the south to the proposed 36-inch diameter relief sewer along 1st Street.

- Replace 310 linear feet of existing 54-inch diameter storm sewer in-kind for positive drainage east of the existing 48-inch diameter storm sewer under the railroad.

- Installation of 430 linear feet of 27-inch diameter relief sewer transitioning to 1,380 linear feet of 36-inch diameter relief sewer along 1st Street from Pine Street to Golden Meadows Park flood storage area.

- Provide an additional 7 acre-feet of gravity-drained flood storage in Golden Meadows Park. The flood storage area basin would outlet to the existing storm sewer system.

Alternative #2 – 100-Year Relief Sewer/Excavate Existing Detention Storage

As shown on Exhibit 3B, Alternative #2 provides a 100-year level of protection for the homes along Pine Street and Avon Road in this study area through the following drainage improvements:

- Installation of 200 linear feet of 30-inch diameter relief sewer and 270 linear feet of 21-inch storm sewer from the low spots on Pine Street and Avon Road, respectively, south to 1st Street.

- Installation of 30 linear feet of 27-inch diameter relief sewer from existing 48-inch diameter sewer under railroad from the south connecting to the proposed 48-inch diameter relief sewer along 1st Street.

- Replace 310 linear feet of existing 54-inch diameter storm sewer in-kind for positive drainage east of the existing 48-inch diameter storm sewer under the railroad.

- Installation of 540 linear feet of 42-inch diameter relief sewer transitioning to 1,270 linear feet of 48-inch diameter relief sewer along 1st Street from Pine Street to Golden Meadows Park detention storage.

- Provide an additional 17 acre-feet of gravity-drained flood storage in Golden Meadows Park. The detention basin would outlet to the existing storm sewer system.

A summary of the cost estimates for the 50- and 100-year levels of flood protection is provided in Table 1. These costs do not include such items as land acquisition, temporary/permanent construction easements, relocation of utilities, and the costs of recreational facilities in the open space.

Table 1. Summary of Pine Street Alternatives

Alternative ID	Level of Protection	Engineer's Estimate of Probable Cost	
		Above-Ground Storage	Underground Storage
Alternative #1	50-year	$1,650,000	$3,810,000
Alternative #2	100-year	$2,560,000	$7,970,000

GENEVA AVENUE STUDY AREA

The Geneva Avenue study area is located west of the Tri-State Tollway, between North Avenue and 1st Street, as shown in Figure 7. The drainage area for the study area measures approximately 109 acres to the existing outlet in East End Park. The flood problem area consists of a low-lying area along Geneva Avenue, between 3rd Street and North Avenue.

Storm sewers and overland flow routes convey stormwater runoff through this low-lying area towards East End Park. Houses along the east side of Geneva Avenue block the overland flow route and cause stormwater runoff to pond in this location. A single 33-inch diameter storm sewer serves as the only outlet for this area. East End Park, which drains through two pipes under the southbound entrance ramp of the Tri-State Tollway, fills up with stormwater when the capacities of those pipes are exceeded. During heavy rains, the ponding of stormwater in the park eventually reaches the houses along the east side of Geneva Avenue.

Figure 7. Overview of Geneva Avenue Study Area

5.1 GENEVA AVENUE EXISTING CONDITIONS

For storm events greater than the 25-year frequency, street and structural flooding occurs along Geneva Avenue. When street flooding reaches approximately one foot in depth, stormwater is able to drain overland through the residential properties to East End Park. Structural flooding occurs for five homes during the 50-year storm event and eight homes during the 100-year storm event.

During the July 2010 storm event, significant flooding was reported along Geneva Avenue. Based on the XP-SWMM computer modeling, there was approximately 1.4 feet of flooding on Geneva Avenue and nine homes were affected by the flooding. The XP-SWMM simulated inundation area for the July 2010 storm event is shown as Figure 8.

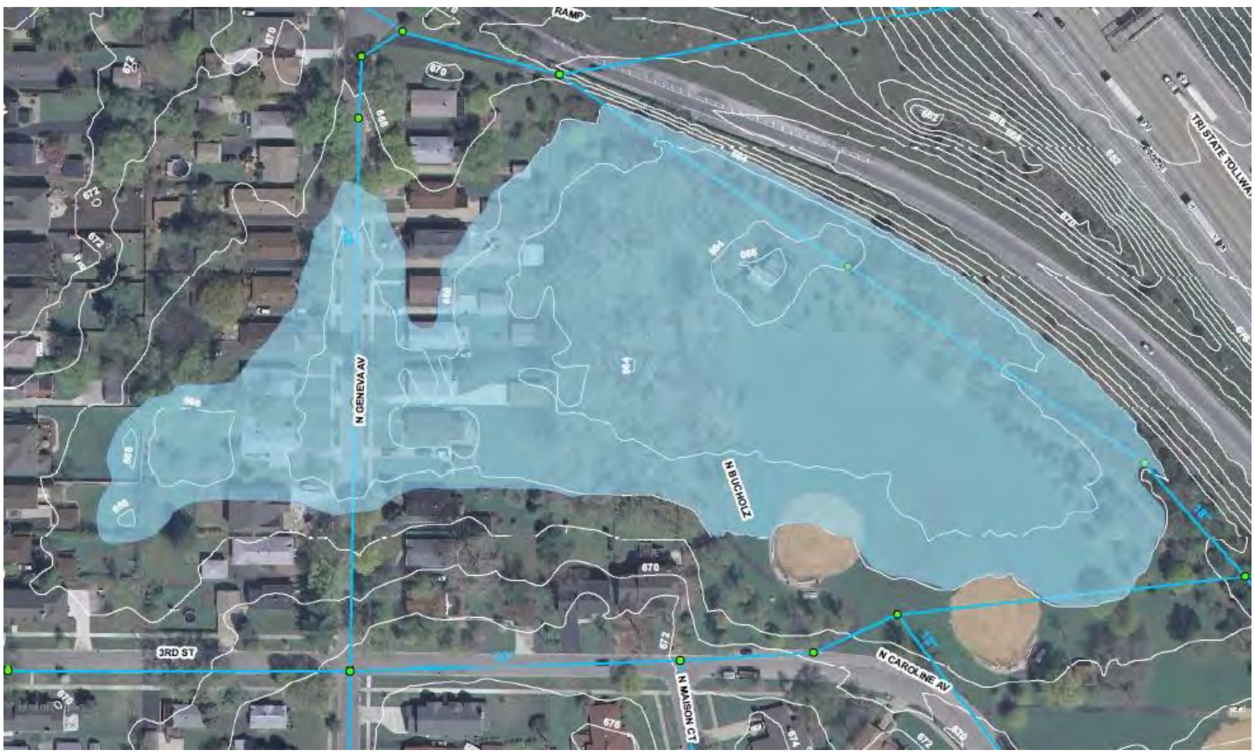

Figure 8. Geneva Avenue XP-SWMM Simulated Inundation Area – July 2010 Storm Event

5.2 GENEVA AVENUE PROPOSED CONDITIONS

Several proposed improvements were evaluated to increase the level of flood protection for the study area. Due to the lack of sites available for flood storage in this study area, the proposed alternatives focused on utilizing East End Park. Due to the existing topography, East End Park currently functions as a stormwater detention area, as evidenced by the July 2010 inundation area. The goal of the proposed drainage improvements is to eliminate the Geneva Avenue street/structural flooding by implementing conveyance improvements and creating offsetting flood storage at East End Park.

<u>Alternative #1 – Relief Sewer/Expand Detention Storage</u>

As shown on Exhibit 4, Alternative #1 provides a 100-year level of protection for the homes in this study area through the following drainage improvements:

- Installation of 950 linear feet of 2-foot by 5-foot box relief sewer between the low spot at Geneva Avenue and the East End Park flood storage basin.
- Reroute existing 36-inch diameter storm sewer around proposed flood storage area and tie-in to existing 12-inch from Caroline Avenue.
- Provide an additional 4 acre-feet of flood storage in East End Park. The existing outlet of the flood storage area will remain unchanged.

A summary of the cost estimates for Alternative #1 is provided in Table 2. These costs do not include such items as land acquisition, temporary/permanent construction easements, relocation of utilities, and the costs of recreational facilities in the open space.

Table 2. Summary of Geneva Avenue Alternative #1

Alternative ID	Level of Protection	Engineer's Estimate of Probable Cost	
		Above-Ground Storage	Underground Storage
Alternative #1	100-year	$1,300,000	$3,890,000

SOUTHWEST STUDY AREA

The Southwest Study Area is located between Salt Creek and York Street, between Butterfield Road and the Illinois Prairie Path. The Southwest Study Area consists of a North Study Area (north of Madison Street) and a South Study Area (south of Madison Street).

As shown in Figure 9, a total area of approximately 1,000 acres drains westward to Salt Creek via storm sewers and overland flow routes. During intense storm events, stormwater runoff follows the overland flow routes to localized depressional areas scattered throughout Southwest Elmhurst. Although there is an overland flow path into these depressional areas, there is no designated overland flow route out of them. The only outlet for these low-lying areas is a single storm sewer, which during intense storm events, is at capacity and does not provide positive drainage for the area. The storm sewer inlets in the low areas may see stormwater runoff from areas that are 10-20 times the size of the tributary area that they were designed to handle.

There are five major flood problem areas within Southwest Elmhurst. These flood problem areas (shown on Figure 9) consist of the following:

A) Spring Road and Harrison Street
B) Saylor Avenue and Jackson Avenue
C) Vallette Street and Swain Avenue
D) Washington Street
E) Crescent Avenue and Cambridge Avenue

It should be noted that the names of these flood problems areas were assigned based on proximity to a street/intersection; the flood problem areas extend well outside of the streets by which they are identified.

Figure 9. Overview of Southwest Study Area

6.1 SOUTHWEST EXISTING CONDITIONS

During small events, stormwater runoff is collected in inlets and conveyed to Salt Creek through one of the four major trunk sewers within Southwest Elmhurst. These major trunk sewers (from north to south) run along McKinley Avenue, Madison Street, Jackson Street, and Harrison Street. During small storm events when the levels of Salt Creek are lower, these storm sewers drain by gravity to Salt Creek. During larger, intense storm events when the capacities of the inlets/storm sewers are exceeded, the flow of stormwater does not follow the storm sewer drainage boundaries (yellow lines) but rather the overland flow routes (red arrows) toward the low-lying areas. When the elevation of Salt Creek rises above the gravity-drained trunk sewers, stormwater pumping stations convey flow from these storm sewers to Salt Creek. The stormwater pumping stations that serve Southwest Elmhurst are summarized in Table 3.

Table 3. Stormwater Pumping Stations – Southwest Elmhurst

Pump Station Location	Number of Pumps	Pump Capacity (cfs)
McKinley Avenue	2	134
Berkeley & Adams	2	147
Jackson Street	1	134
Harrison Street	1	45

There are 57 houses with reverse-slope driveways located throughout Southwest Elmhurst. As shown in Figure 10, the majority of these homes are concentrated along Parkside and Prospect Avenue, between Butterfield Road and Adams Street. Street flooding in these locations is especially problematic, as excessive street ponding overtops the sidewalks and flows down the driveways into the homes. The overtopping elevation of the sidewalk was surveyed for every reverse-slope driveway in Southwest Elmhurst. These 57 homes were included in the Jackson Avenue & Saylor Avenue area (Problem Area B).

Figure 10. Location Map of Reverse-Slope Driveways in Southwest Elmhurst

During the July 2010 storm event, widespread flooding was reported throughout Southwest Elmhurst. There were several different causes of the flooding, including: sanitary sewer backups, sump pump failure, overland flooding, and seepage. Excessive street ponding led to the flooding of many homes with reverse-slope driveways. The flooded areas, as taken from the XP-SWMM model calibrated to the July 2010 surveyed high water elevations, are provided on Figure 11.

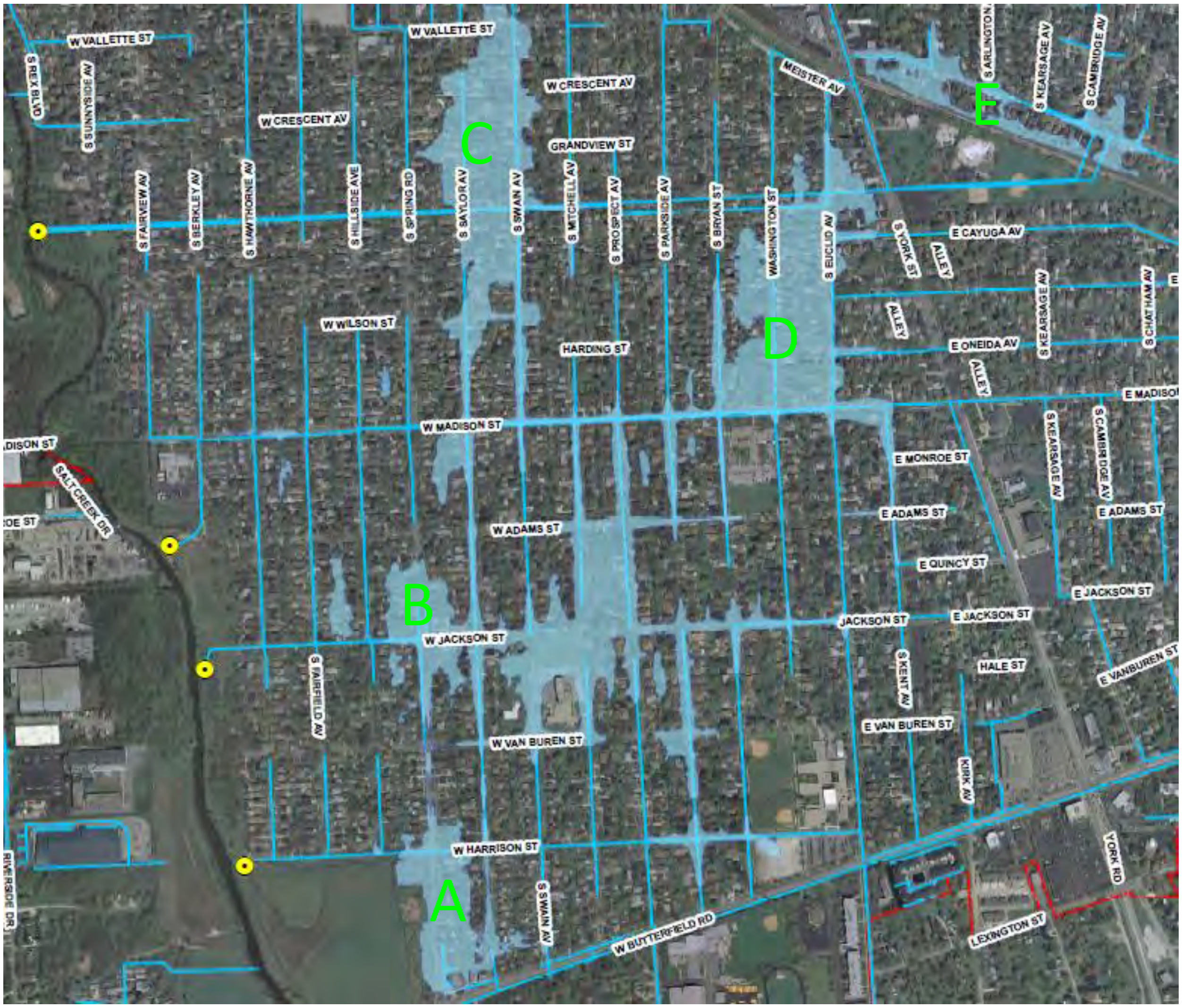

Figure 11. Southwest XP-SWMM Simulated Inundation Area – July 2010 Storm Event

The computed water surface elevations from the July 2010 XP-SWMM analysis were compared to the Lowest Adjacent Grade (LAG) and surveyed elevations of the homes within the inundated areas. Based on this information, a total of 251 homes were damaged due to overland flooding. Of these 251, 21 were homes with reverse-slope driveways. The majority of the impacted homes are located along Parkside and Prospect Avenue, between Jackson Street and Butterfield Road. A summary of the July 2010 flooding for the Southwest Study area is provided in Table 4.

Table 4. Existing Conditions Summary – Southwest Study Area

Problem Area ID	Problem Area Location	Number of Homes Within July 2010 Inundation Area	Depth of Flooding (ft)	Existing Level of Flood Protection
A	Spring Rd & Harrison St	17	1.9	5-year
B	Saylor Ave & Jackson Ave	65	2.0	5-year
C	Vallette St & Swain Ave	94	1.6	2-year
D	Washington St	62	2.0	5-year
E	Crescent Ave & Cambridge Ave	13	1.8	10-year
TOTAL		**251**		

To determine the existing level of flood protection for the five flood problem areas within Southwest Elmhurst, a critical duration analysis was performed by simulating design storm events in the calibrated XP-SWMM model. Based on the results of the existing conditions XP-SWMM modeling, the existing level of protection for each flood problem area was determined. In addition, the number of homes damaged per flood frequency was quantified. A summary of the existing level of flood protection for each problem area is provided in Table 5.

Table 5. Existing Conditions Level of Flood Protection – Southwest Study Area

Problem Area ID	Problem Area Location	Number of Houses Flooded Per Flood Frequency					
		2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
A	Spring Rd & Harrison St	0	0	13	13	15	17
B	Saylor Ave & Jackson Ave	0	0	4	11	47	104
C	Vallette St & Swain Ave	0	5	7	55	80	94
D	Washington St	0	0	13	30	53	63
E	Crescent Ave & Cambridge Ave	0	0	0	3	10	38
TOTAL		**0**	**5**	**37**	**112**	**205**	**316**

6.2 SOUTHWEST PROPOSED CONDITIONS

CBBEL analyzed five drainage alternatives for the Southwest Study Area. The objective of the alternatives is to provide a 100-year level of flood protection for each of the five flood problem areas. The drainage improvements proposed in Southwest Elmhurst consist of: upsizing of existing storm sewers, constructing relief sewers, creating gravity-drained flood storage in open space, and upsizing the stormwater pumping stations. The creation of pump-evacuated flood storage on the open parcels sites was evaluated as part of this study, but was dismissed as a feasible option due to the loss of the current recreational use of the site.

Alternative #1 – Gravity Flood Storage

As shown on Exhibit 5A, Alternative #1 utilizes the available open space in Southwest Elmhurst to create gravity-drained flood storage. In conjunction with the flood storage, relief sewers will be constructed to convey floodwater to the storage areas. Outlet pipes and restrictors will also be constructed to connect the storage facilities to the existing storm sewer system. The proposed improvements for Alternative #1 consist of:

- Construct 65 acre-feet of gravity-drained flood storage.
    - 36 acre-feet at York Commons Park.
    - 6 acre-feet at Early Childhood Elementary School.
    - 18 acre-feet at Bryan Middle School.
    - 3 acre-feet at Jackson Elementary School.
    - 2 acre-feet at Christ United Church.
- Construct 6,100 linear feet of relief sewer to convey floodwaters to storage sites.
    - Upsize existing 18-inch storm sewer along Bryan Street to twin 2-foot by 3-foot boxes.
    - Construct 36-inch storm sewer between Cambridge Avenue and York Commons Park storage area.
    - Upsize existing 18-inch storm sewer along Washington Street to twin 2-foot by 3-foot boxes.

Because flood storage is proposed at various locations throughout Southwest Elmhurst, multiple flood problem areas in this study area benefit from this alternative. However, since they are spread out, the flood storage area primarily benefit one or two flood problem areas. A description of each proposed flood storage area is provided below.

York Commons Park

The potential gravity-drained flood storage that can be provided at York Commons Park is 36 acre-feet. This storage is created by excavating the open space areas of the park to an average depth of six feet, which was determined based on the invert elevations of the existing storm sewer system. The proposed flood storage at York Commons Park benefits both the Washington Street (D) and Crescent Avenue & Cambridge Avenue (E) flood problem areas. Creating the flood storage at this area would offset the increased flows from the proposed Cambridge Avenue relief sewer and also attenuate stormwater that would otherwise drain to the Washington Street area. Because this alternative utilizes the maximum amount of gravity-drained flood storage at this location, any reduction in the provided flood storage would also decrease the flood reduction benefits for these two flood problem areas.

Early Childhood Elementary School

The potential gravity-drained flood storage that can be provided at Early Childhood Elementary School is 6 acre-feet. This storage is created by excavating the open space area at the south end of the school to an average depth of eight feet, which was determined based on the invert elevations of the existing storm sewer system. The proposed flood storage at Early Childhood Elementary School benefits the Washington Street area (Flood Problem Area D). The creation of flood storage at this site offsets the increased flows from the proposed relief sewer from Washington Street. Because this alternative utilizes the maximum amount of gravity-drained flood storage that can be provided at this location, any reduction in the provided flood storage would also decrease the flood reduction benefits realized at Washington Street.

Bryan Middle School

The potential gravity-drained flood storage that can be provided at Bryan Middle School is 18 acre-feet. This storage is created by excavating the open space area located west of the school to an average depth of eight feet, which was determined based on the invert elevations of the existing storm sewer system. The proposed flood storage at Bryan Middle School primarily benefits the Jackson Avenue & Saylor Avenue (B) and Spring Road & Harrison Street (C) flood problem areas. The creation of flood storage at this site diverts flow from the Jackson Street and Harrison Street storm sewers, which alleviates flooding at these two problem areas. Because this alternative utilizes the maximum amount of gravity-drained flood storage that can be provided at this location, any reduction in the provided flood storage would also decrease the flood reduction benefits for these two areas.

Jackson Elementary School/Christ United Church

A total of 5 acre-feet of gravity-drained flood storage can be provided on the open parcels adjacent to Jackson Elementary School (3 acre-feet) and Christ United Church (2 acre-feet). This storage is created by excavating each open space area to an average depth of three feet, which was determined based on the invert elevations of the existing storm sewer system. The proposed flood storage at this location primarily benefits the Jackson Avenue & Saylor Avenue (B) flood problem area. The creation of flood storage at this location provides a diversion for excessive street ponding in this area. Because this alternative utilizes the maximum amount of gravity-drained flood storage that can be provided at this location, any reduction in the provided flood storage would also decrease the flood reduction benefits for the Jackson Avenue & Saylor Avenue area.

As shown in Table 6, multiple flood problem areas within Southwest Elmhurst benefit from this alternative, although the majority of the flood reduction benefits are realized in Flood Problem Areas B, D, and E, where 150 of the 250 homes were removed from the 100-year inundation area.

Table 6. Southwest Study Area – Alternative #1 Level of Flood Protection

Problem Area ID	Problem Area Location	Number of Houses Flooded Per Flood Frequency					
		2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
A	Spring Rd & Harrison St	0	0	0	13	13	15
B	Saylor Ave & Jackson Ave	0	0	0	7	8	14
C	Vallette St & Swain Ave	0	5	6	9	43	84
D	Washington St	0	0	0	15	31	41
E	Crescent Ave & Cambridge Ave	0	0	0	0	0	0
TOTAL		**0**	**5**	**6**	**44**	**95**	**154**

The conceptual cost estimate for Alternative #1 is $6.9 million assuming above-ground flood storage and $27.3 million assuming underground flood storage. These costs do not include such items as land acquisition, temporary/permanent construction easements, relocation of utilities, and the costs of recreational facilities in the open space.

<u>Alternative #2 – Gravity Flood Storage/Increased Pumping</u>

This alternative is an enhancement to Alternative #1 that provides a 100-year level of protection for Flood Problem Areas B, D, and E. As shown on Exhibit 5B, Alternative #2 combines the gravity-drained flood storage from Alternative #1 with increased pumping capacities at the Jackson Street and Berkeley & Adams stormwater pumping stations. The main trunk sewers that convey floodwaters to the stormwater pumping stations will be upsized as well. Because the pump capacities will be increased, compensatory storage is required to offset the additional flows to Salt Creek. Although the required compensatory storage volume can be accommodated in the Eldridge Park Reservoir, the additional flows will have to be conveyed directly to the reservoir using a forcemain. The direct-piping of the increased flows is required to be in compliance with DuPage County permitting requirements for the proposed project. The proposed improvements included in Alternative #2 (in addition to those listed in Alternative #1) consist of the following:

- Upsize 7,900 linear feet of storm sewer along Madison Street, Hillside Avenue, and Jackson Street.
    - Upsize 66-inch storm sewer along Madison with twin 6-foot' by 10-foot box.
    - Upsize 66-inch storm sewer along Hillside Avenue with 5-foot by 10-foot box.
    - Upsize 66-inch storm sewer along Jackson Street with twin 5-foot by 12-foot box.
- Increase pump capacity at Jackson Street stormwater pumping station from 134 cfs to 236 cfs.
- Increase pump capacity at Berkeley & Adams stormwater pumping station from 147 cfs to 213 cfs.
- Install 2,400 linear feet of forcemain to convey increased pump flows to Eldridge Park Reservoir.

The conceptual cost estimate for Alternative #2 is $26.1 million assuming above-ground flood storage and $46.5 million assuming underground flood storage. The pump station cost estimates include the following components: wet well, pump, electric and controls, backup generator, site work, and forcemains to Eldridge Park Reservoir. The cost estimates do not include such items as land acquisition, temporary/permanent construction easements, relocation of utilities, and the costs of recreational facilities in the open space.

Table 7. Southwest Study Area – Alternative #2 Level of Flood Protection

Problem Area ID	Problem Area Location	Number of Houses Flooded Per Flood Frequency					
		2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
A	Spring Rd & Harrison St	0	0	0	13	13	15
B	Saylor Ave & Jackson Ave	0	0	0	1*	1*	1*
C	Vallette St & Swain Ave	0	5	6	9	43	74
D	Washington St	0	0	0	0	1*	11*
E	Crescent Ave & Cambridge Ave	0	0	0	0	0	0
TOTAL		**0**	**5**	**6**	**23**	**58**	**101**

*Individual house flood proofing is an option due to shallow flooding depths

Alternative #2A – Increased Pumping Stand-Alone Option

This alternative uses the pump station and relief sewer upgrades from Alternative #2, but does not include any flood storage areas. The pumping capacities of the Jackson Street and Berkeley & Adams stormwater pumping stations will be increased, and the main trunk sewers that convey floodwaters to the stormwater pumping stations will be upsized as well. Because the pump capacities will be increased, compensatory storage is required to offset the additional flows to Salt Creek. Although the required compensatory storage volume can be accommodated in the Eldridge Park Reservoir, the additional flows will have to be conveyed directly to the reservoir using a forcemain. The direct-piping of the increased flows is required to be in compliance with DuPage County permitting requirements for the proposed project. The proposed improvements included in Alternative #2A consist of the following:

- Upsize 7,900 linear feet of storm sewer along Madison Street, Hillside Avenue, and Jackson Street.
    - Upsize 66-inch storm sewer along Madison with twin 6-foot' by 10-foot box.
    - Upsize 66-inch storm sewer along Hillside Avenue with 5-foot by 10-foot box.
    - Upsize 66-inch storm sewer along Jackson Street with twin 5-foot by 12-foot box.
- Increase pump capacity at Jackson Street stormwater pumping station from 134 cfs to 236 cfs.
- Increase pump capacity at Berkeley & Adams stormwater pumping station from 147 cfs to 213 cfs.
- Install 2,400 linear feet of forcemain to convey increased pump flows to Eldridge Park Reservoir.

Table 8 provides a summary of the flood reduction benefits of Alternative #2A. The conceptual cost estimate for Alternative #2A is $19.2 million. The pump station cost estimates include the following components: wet well, pump, electric and controls, backup generator, site work, and forcemains to Eldridge Park Reservoir. The cost estimates do not include such items as land acquisition, temporary/permanent construction easements, and the relocation of utilities.

Table 8. Southwest Study Area – Alternative #2A Level of Flood Protection

Problem Area ID	Problem Area Location	Number of Houses Flooded Per Flood Frequency					
		2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
A	Spring Rd & Harrison St	0	0	12	13	15	16
B	Saylor Ave & Jackson Ave	0	0	0	2	21	31
C	Vallette St & Swain Ave	0	4	7	39	70	93
D	Washington St	0	0	3	11	23	36
E	Crescent Ave & Cambridge Ave	0	0	0	3	10	38
TOTAL		**0**	**4**	**22**	**68**	**139**	**214**

<u>Alternative #3 –Increased Pumping: Flood Problem Area A</u>

This alternative provides a 100-year level of protection for Flood Problem Area A. As shown on Exhibit 5C, Alternative #3 upsizes the storm sewer along Harrison Street and increases the pumping capacity of the Harrison Street stormwater pumping station. Because the pump capacity will be increased, compensatory storage is required to offset the additional flow to Salt Creek. Although the required compensatory storage volume can be accommodated in the Eldridge Park Reservoir, the additional flows will have to be conveyed directly to the reservoir using a forcemain. The direct-piping of the increased flows is required to be in compliance with DuPage County permitting requirements for the proposed project. The proposed improvements included in Alternative #2 (in addition to those listed in Alternative #1) consist of the following:

- Upsize 1,250 linear feet of 57-inch storm sewer along Harrison Street to a 4-foot by 10-foot box.
- Increase pump capacity at Harrison Street stormwater pumping station from 45 cfs to 124 cfs.
- Install 250 linear feet of forcemain to convey increased pump flows to Eldridge Park Reservoir.

The conceptual cost estimate for Alternative #3 is $3.7 million. The pump station cost estimates include the following components: wet well, pump, electric and controls, backup generator, site work, and forcemains to Eldridge Park Reservoir. The cost estimates do not include such items as land acquisition, temporary/permanent construction easements, and the relocation of utilities.

Table 9. Southwest Study Area – Alternative #3 Level of Flood Protection

Problem Area ID	Problem Area Location	Number of Houses Flooded Per Flood Frequency					
		2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
A	Spring Rd & Harrison St	0	0	0	0	0	0
TOTAL		**0**	**0**	**0**	**0**	**0**	**0**

Alternative #4 –Increased Pumping: Flood Problem Area C

This alternative provides a 100-year level of protection for Flood Problem Area C. As shown on Exhibit 5D, Alternative #3 upsizes the storm sewer along Swain Avenue, provides a relief sewer along McKinley Avenue, and increases the pumping capacity of the McKinley Avenue stormwater pumping station. Because the pump capacity will be increased, compensatory storage is required to offset the additional flow to Salt Creek. Although the required compensatory storage volume can be accommodated in the Eldridge Park Reservoir, the additional flows will have to be conveyed directly to the reservoir using a forcemain. The direct-piping of the increased flows is required to be in compliance with DuPage County permitting requirements for the proposed project. The proposed improvements included in Alternative #3 consist of the following:

- Upsize 1,160 linear feet of 24-inch storm sewer along Swain Avenue to a 3-foot by 6-foot box.
- Construct 3,010 linear feet of 5-foot by 8-foot relief sewer along McKinley Avenue.
- Increase pump capacity at McKinley Avenue stormwater pumping station from 45 cfs to 124 cfs.
- Install 3,800 linear feet of forcemain to convey increased pump flows to Eldridge Park Reservoir.

The conceptual cost estimate for Alternative #4 is $11.5 million. The pump station cost estimates include the following components: wet well, pump, electric and controls, backup generator, site work, and forcemains to Eldridge Park Reservoir. The cost estimates do not include such items as land acquisition, temporary/permanent construction easements, and the relocation of utilities.

Table 10. Southwest Study Area – Alternative #4 Level of Flood Protection

Problem Area ID	Problem Area Location	Number of Houses Flooded Per Flood Frequency					
		2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
C	Vallette St & Swain Ave	0	0	0	0	1*	7*
TOTAL		**0**	**0**	**0**	**0**	**1**	**7**

*Individual house flood proofing is an option due to shallow flooding depths

The objective of the five proposed alternatives is to provide a 100-year level of flood protection for each of the five flood problems located in Southwest Elmhurst. A summary of the level of flood protection and cost for each alternative is provided in Table 11 below.

Table 11. Summary of Alternatives for Southwest Study Area

Alternative ID	Level of Protection	Engineer's Estimate of Probable Cost	
		Above-Ground Storage	Underground Storage
Alternative #1	10-year through 100-Year	$6,910,000	$27,260,000
Alternative #2	100-year	$26,100,000	$46,450,000
Alternative #2A	5-year through 100-Year	$19,210,000	N/A
Alternative #3	100-year	$3,730,000	N/A
Alternative #4	100-year	$11,530,000	N/A

LARCH AVENUE STUDY AREA

The Larch Avenue study area is located west of York Street, between Armitage Avenue and Fremont Avenue, as shown in Figure 12. The drainage area is approximately 79 acres, and the general drainage pattern within the watershed is from west to east. Stormwater runoff drains overland to this stretch of Larch Avenue, which is located within a depressional area. The outlet for this low-lying area is a single 18-inch storm sewer and there is no designated overland flow path. The Jaycee Tot Lot, which is a playground located on the east side of Larch Avenue, is below street level and frequently experiences flooding.

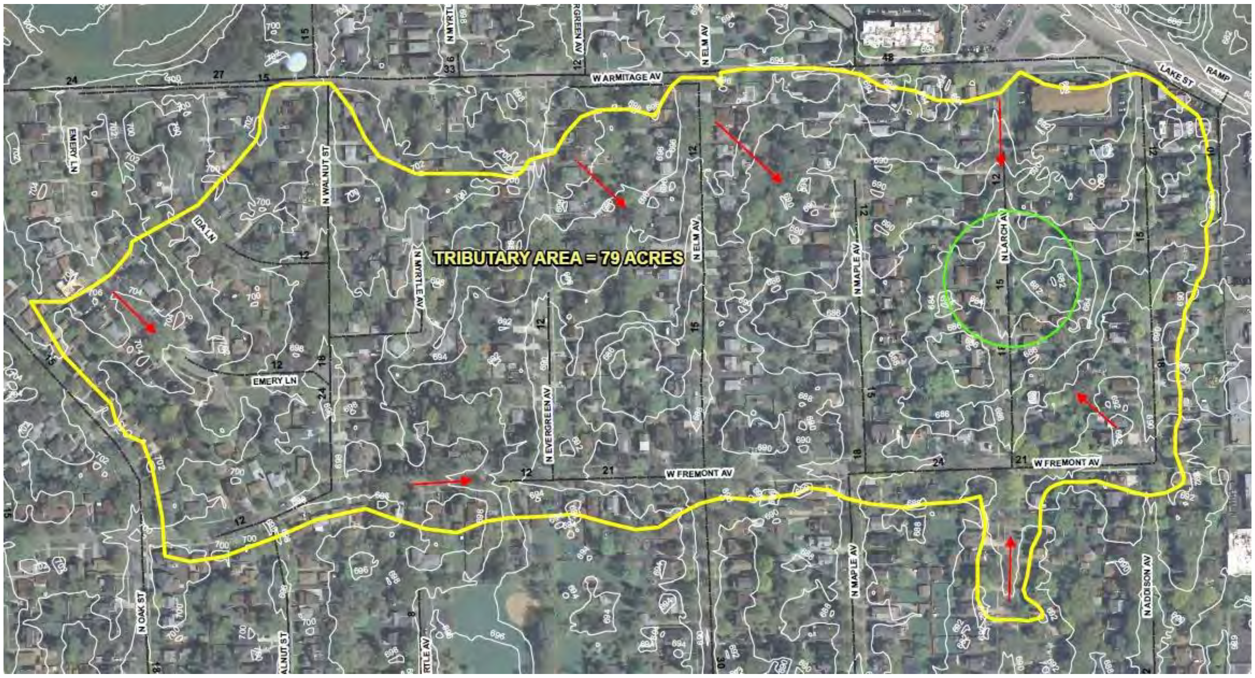

Figure 12. Overview of Larch Avenue Study Area

6.3 LARCH AVENUE EXISTING CONDITIONS

Based on the results of the existing conditions XP-SWMM analysis, the Jaycee Tot Lot experiences flooding for storm events greater than the 2-year frequency. Because the Jaycee Tot Lot is the lowest point along the storm sewer system, the system surcharges in this area when the capacity of the storm sewer is exceeded.

For storm events greater than the 25-year frequency, street ponding occurs along Larch Avenue, in addition to stormwater ponding in the adjacent Jaycee Tot Lot.

For storm events greater than the 50-year return interval, structural flooding occurs at three homes located along Addison Avenue.

During the July 2010 storm event, significant flooding was reported at the Jaycee Tot lot area, with street flooding along Larch Avenue. Based on the XP-SWMM computer modeling, there was approximately 0.3 feet of flooding on Larch Avenue and approximately 1.8 feet flooding in the Jaycee Tot Lot. Additionally, structural flooding occurred at three homes along Addison Avenue. The XP-SWMM simulated inundation area for the July 2010 storm event is shown as Figure 13.

Figure 13. Larch Avenue XP-SWMM Simulated Inundation Area – July 2010 Storm Event

6.4 LARCH AVENUE PROPOSED CONDITIONS

Several proposed improvements were evaluated to increase the level of flood protection for the study area. The goal of the proposed drainage improvements is to reduce street ponding along Larch Avenue and provide a 100-year level of flood protection for the homes along Addison Avenue.

<u>Alternative #1 – Relief Sewer/Expand Detention Storage</u>

As shown on Exhibit 6, Alternative #1 provides a 100-year level of protection for Larch Avenue and the 3 homes along Addison Avenue, and provides increases the level of flood protection for the Jaycee Tot Lot, through the following drainage improvements:

- Installation of 24-inch diameter storm sewer to outlet Jaycee Tot Lot to Larch Avenue storm sewer system.
- Installation of 1,100 linear feet of 36-inch diameter relief sewer to convey flow from Larch Avenue to the storm sewer under Lake Street.

- Replacement of existing Addison Avenue storm sewer with 300 linear feet of 12-inch diameter storm sewer that will outlet to south storage basin.

- Installation of 110 linear feet of 42-inch diameter relief sewer with backflow preventer to convey flow from the Larch and Addison Avenue storm sewers to south storage basin.

- Provide an additional 7 acre-feet of flood storage by expanding the north (6 acre-feet) and south (1 acre-foot) York/I-290 detention basins, respectively. The existing outlet of the north detention basin will remain unchanged while an additional 36-inch diameter storm sewer will be tunneled under the I-290 Expressway to connect the south basin to the north basin.

A summary of the cost estimates for Larch Avenue Alternative #1 is provided in Table 12. These costs do not include such items as land acquisition, temporary/permanent construction easements, and the relocation of utilities.

Table 12. Summary of Larch Avenue Alternative #1

Alternative ID	Level of Protection	Engineer's Estimate of Probable Cost	
		Above-Ground Storage	Underground Storage
Alternative #1	100-year	$1,800,000	$3,970,00

SEMINOLE AVENUE STUDY AREA

The Seminole Avenue study area is located north of the Illinois Prairie Path and west of York Street, as shown on Figure 14. The flood problem area is the low lying-area located at the intersection of Seminole Avenue and Cottage Hill Avenue. An area of approximately 179 acres drains by storm sewer and overland flow to this low spot, which outlets through a 48-inch diameter storm sewer that drains westward until its ultimate outlet into Salt Creek. During intense storm events when the level of Salt Creek is high, flow from the storm sewer is conveyed to the creek by the Randolph & West stormwater pumping station. Because there is no overland flow path for this low-lying area, street flooding (and eventually structural flooding) occurs along Seminole Avenue during storm events that exceed the capacity of the existing storm sewer.

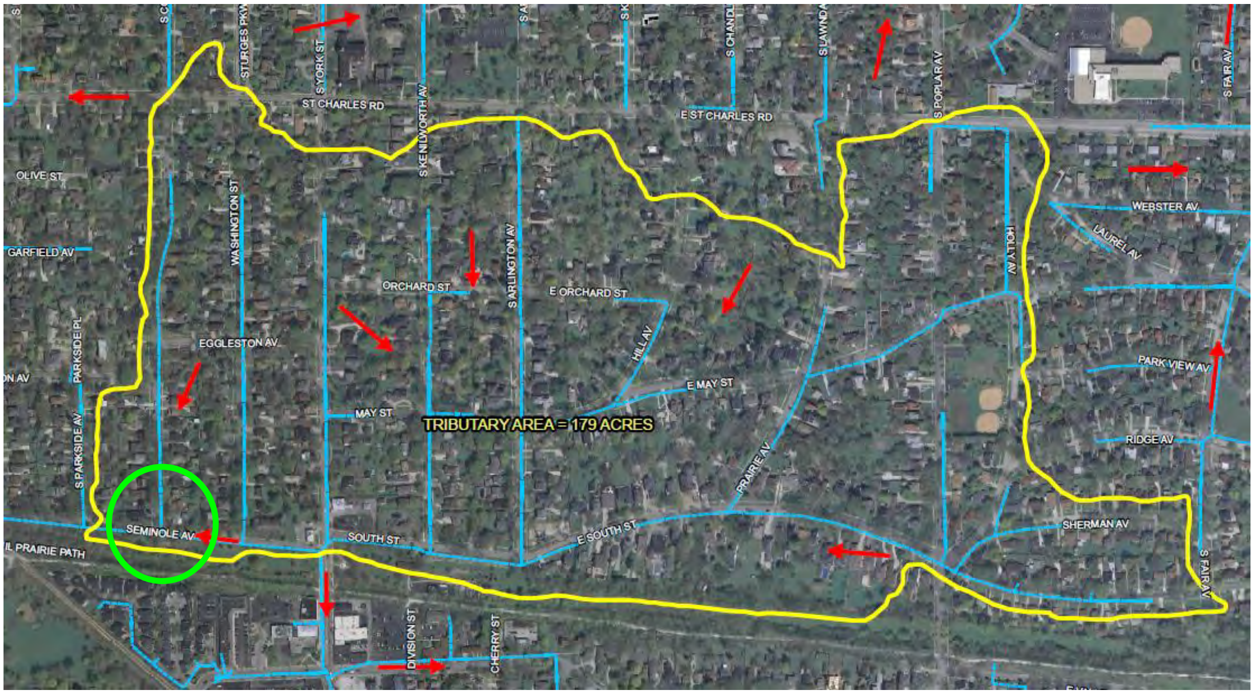

Figure 14. Overview of Seminole Avenue Study Area

8.1 SEMINOLE AVENUE EXISTING CONDITIONS

Based on the results of the existing conditions XP-SWMM analysis, street flooding occurs at the intersection of Seminole Avenue and Cottage Hill Avenue for storm events greater than the 25-year frequency. Structural flooding (1 home) occurs for storm events equal to a 50-year frequency while the 100-year critical storm event causes structural flooding for 4 homes.

During the July 2010 storm event, significant street flooding occurred at the intersection of Seminole Avenue and Cottage Hill Avenue. Based on the XP-SWMM computer modeling, there was approximately one foot of flooding at this location and three homes were affected by the flooding. The XP-SWMM simulated inundation area for the July 2010 storm event is shown as Figure 15.

Figure 15. Seminole Avenue XP-SWMM Simulated Inundation Area – July 2010 Storm Event

8.2 SEMINOLE AVENUE PROPOSED CONDITIONS

Because the existing level of flood protection in this study area is relatively high (25-year), the objective of the proposed drainage improvements was to provide flood protection during the larger-magnitude storm events. Due to the limited open space that is available in this study area, two drainage alternatives (described in detail below) were determined to be the most feasible options for increasing the level of flood protection for this study area. These drainage alternatives both rely on the creation of flood storage on open parcels that are owned by the Elmhurst Park District.

<u>Alternative #1 – Relief Sewer/Flood Storage at Pioneer Park</u>

As shown on Exhibit 7A, Alternative #1 provides a 100-year level of protection for the homes in this study area through the following drainage improvements:

- Installation of 1,300 linear feet of relief sewer from the low spot at Seminole Avenue and Cottage Hill Avenue to Pioneer Park.

- Provide an additional 4 acre-feet of gravity-drained flood storage by utilizing the open space on Pioneer Park.

Alternative #2 – Overland Flow Route/Flood Storage along Seminole Avenue

As shown on Exhibit 7B, Alternative #2 provides a 100-year level of protection for the homes in this study area through the following drainage improvements:

- Provide an additional 3 acre-feet of gravity-drained flood storage by utilizing the Elmhurst Park District property between Seminole Avenue and the Illinois Prairie Path.
- Create an emergency overflow route along the south side of Seminole Avenue to convey street flooding to the flood storage area.

A summary of the cost estimates for the proposed Seminole Avenue alternatives is provided in Table 13. These costs does not include such items as land acquisition, temporary/permanent construction easements, relocation of utilities, and the costs of recreational facilities in the open space.

Table 13. Summary of Seminole Avenue Alternatives

Alternative ID	Level of Protection	Engineer's Estimate of Probable Cost	
		Above-Ground Storage	Underground Storage
Alternative #1	100-year	$810,000	$2,080,00
Alternative #2	100-year	$350,000	$1,310,000

YORK STREET/I-290 STUDY AREA

The York Street/I-290 study area is located along the stretch of York Street located immediately north and south of the I-290 underpass. This stretch of road is adjacent to stormwater detention basins located along the west side of the road, as shown in Figure 16. The drainage area for this site consists of an approximately 157-acre area. Stormwater runoff from the I-290 Expressway and associated York Street and Lake Street ramps drains to the site via storm sewer and overland flow. Residential, commercial, and recreational areas west of the I-290 Expressway and north of Armitage Avenue also contribute stormwater runoff to the area. A single 24-inch diameter storm sewer outlets the north storage basin, and when its storage capacity of this basin is exceeded, stormwater ponding occurs along this stretch of York Street.

Figure 16. **Overview of York Street/I-290 Study Area**

9.1 YORK STREET/I-290 EXISTING CONDITIONS

Based on the results of the existing conditions XP-SWMM analysis, the detention basins have an approximately 50-year capacity. Therefore, during storm events greater than a 50-year frequency, roadway flooding occurs along York Street. Although there is no structural flooding associated with this flood problem area, the roadway flooding causes significant traffic delays and congestion on adjacent roadways.

During the July 2010 storm event, significant roadway flooding was reported along York Street south of Crestview Avenue, and the York Road exit ramp off of I-290 West. Based on the XP-SWMM computer modeling, there was approximately one foot of street ponding at York Street south of Crestview Avenue and the York Street exit ramp off of I-290 West. The XP-SWMM simulated inundation area for the July 2010 storm event is shown as Figure 17.

Figure 17. York Street/I-290 XP-SWMM Simulated Inundation Area – July 2010 Storm Event

9.2 YORK STREET/I-290 PROPOSED CONDITIONS

Several proposed improvements were evaluated to increase the level of flood protection for the study area. The goal of the proposed drainage improvements is to eliminate the roadway flooding that occurs along York Street south of Crestview Avenue and on the York Street exit ramp off of I-290 west.

<u>Alternative #1 – Expand Detention Storage</u>

As shown on Exhibit 8, Alternative #1 provides a 100-year level of protection for York Road south of Crestview Avenue and for the York Road exit ramp off of I-290 west through the following drainage improvements:

- Provide an additional 5 acre-feet and 1 acre-foot of flood storage by expanding the north and south York/I-290 detention basins, respectively. The existing outlet of the north detention basin will remain unchanged.

A summary of the cost estimates for the proposed York Street/I-290 alternatives is provided in Table 14. These costs do not include such items as land acquisition, temporary/permanent construction easements, and the relocation of utilities.

Table 14. Summary of York Street/I-290 Alternative #1

Alternative ID	Level of Protection	Engineer's Estimate of Probable Cost	
		Above-Ground Storage	Underground Storage
Alternative #1	100-year	$670,000	$2,640,00

BRYNHAVEN SUBDIVISION STUDY AREA

Brynhaven Subdivision is located along the Tri-State Tollway, between the Illinois Prairie Path and 1st Street, as shown in Figure 18. The drainage area for this study area consists of an approximately 447-acre area. The flood problem area is the low-lying area located at the northeast corner of the subdivision (Park Avenue). Stormwater runoff is conveyed through storm sewers and overland flow routes to this point, but due to the railroad tracks to the north and the Tri State Tollway to the east, there is no overland flow route for this low-lying area. The only outlet is a 48-inch diameter storm sewer that drains eastward under the Tri-State Tollway to the Lower Elmhurst Reservoir, as shown in Figure 18.

When the capacity of the storm sewer system is exceeded, street and yard flooding occurs along Park Avenue. During larger storm events, structural flooding occurs at the homes located within this low-lying area.

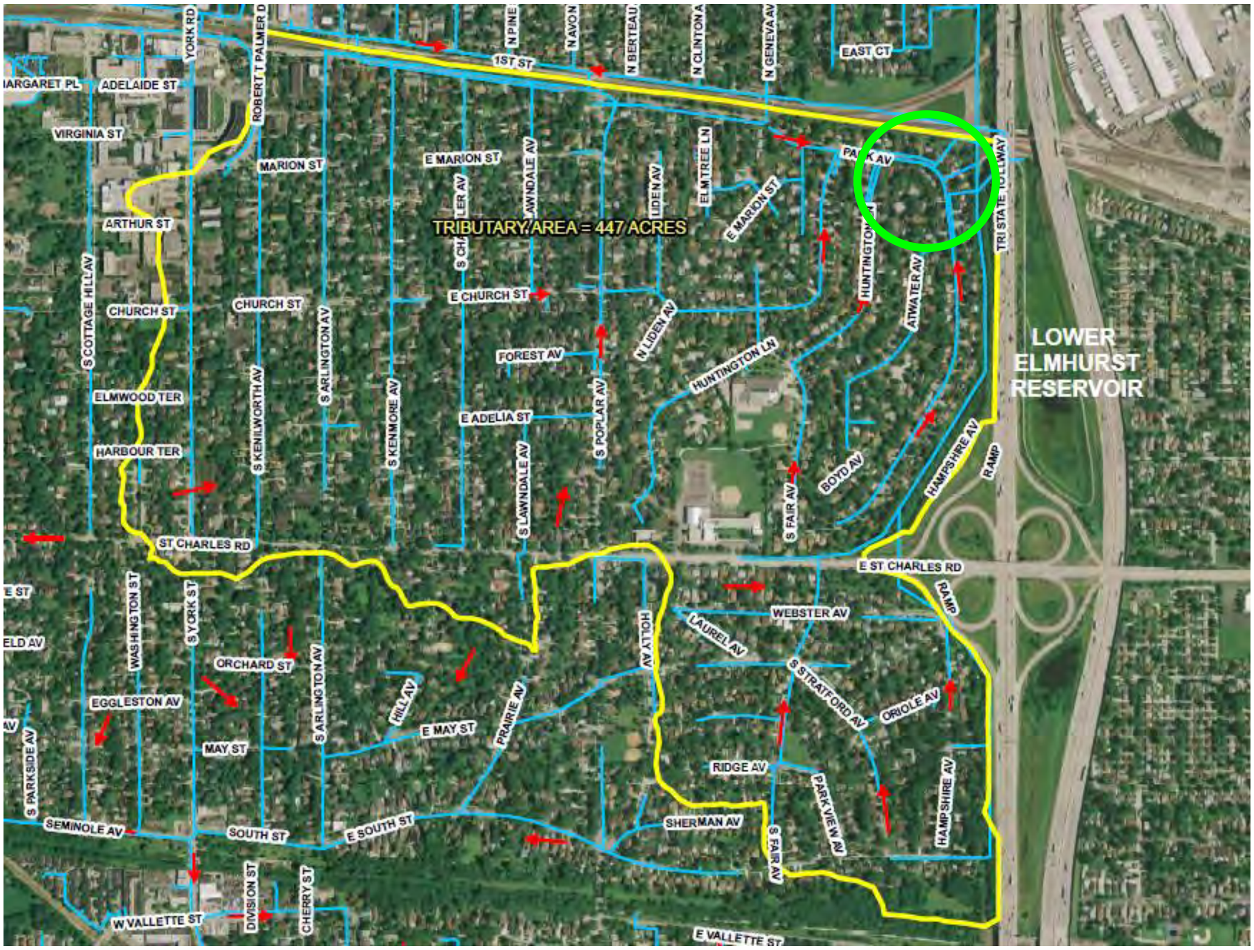

Figure 18. Brynhaven Subdivision Study Area Watershed Boundary

10.1 BRYNHAVEN SUBDIVISION EXISTING CONDITIONS

For storm events greater than the 50-year frequency, the Park Avenue storm sewer surcharges, resulting in significant yard and street flooding in this area. For storm events equal to or greater than the 100-year frequency, the ponding in this area causes structural flooding.

During the July 2010 storm event, significant street and yard flooding was reported along Park Avenue. Based on the XP-SWMM computer modeling, there was approximately 1.2 feet of flooding on Park Avenue and two homes were affected by the flooding. The XP-SWMM simulated inundation area for the July 2010 storm event is provided as Figure 19.

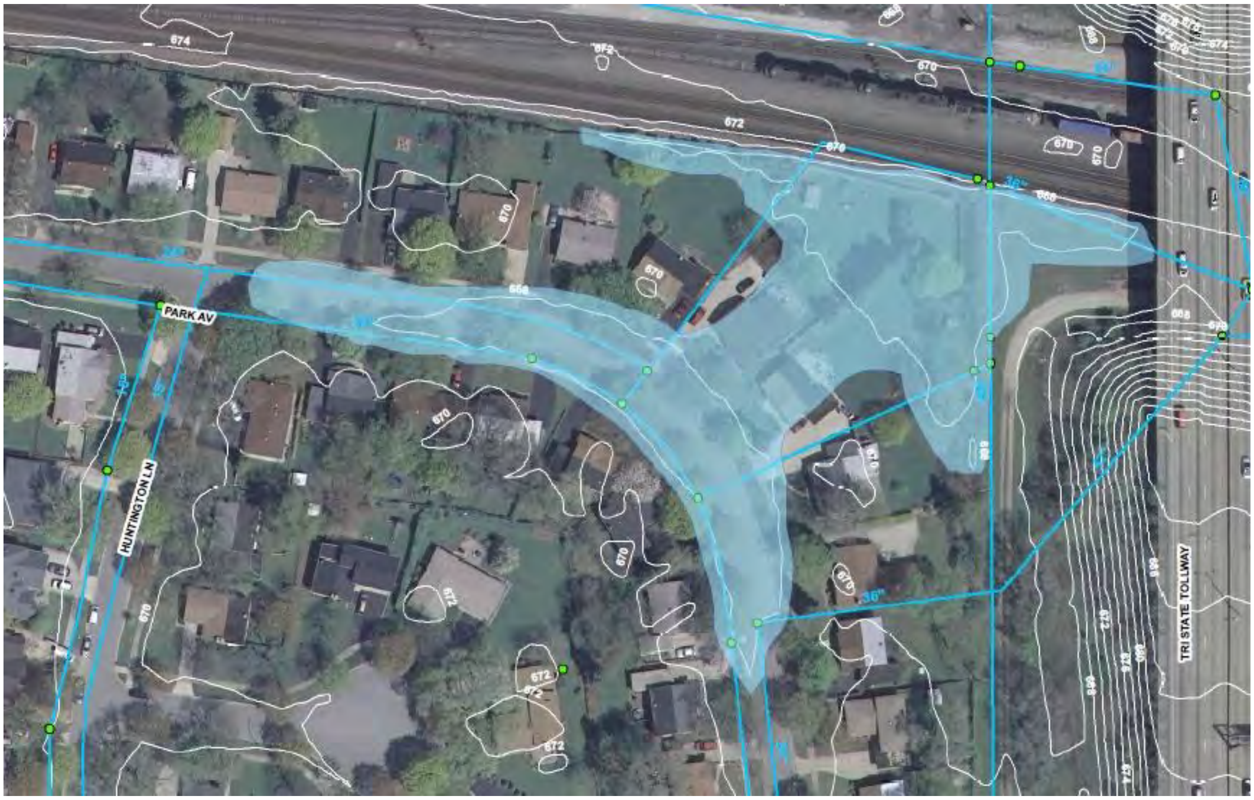

Figure 19. Brynhaven XP-SWMM Simulated Inundation Area – July 2010 Storm Event

10.2 BRYNHAVEN SUBDIVISION PROPOSED CONDITIONS

Several proposed improvements were evaluated to increase the level of flood protection for the study area. The goal of the proposed drainage improvements is to alleviate the street/structural flooding along Park Avenue. Potential flood storage sites were identified on the north side of the railroad tracks to offset the conveyance improvements implemented along Park Avenue.

<u>Alternative #1 – Relief Sewer/Expand Detention Storage</u>

Because flood storage at Golden Meadows Park is required, this alternative is an add-on to Pine Street Alternative #2. As shown on Exhibit 9A, Alternative #1 provides a 100-year level of protection for the street and homes in this study area, as well as the Pine Street study area, through the following drainage improvements:

- Construct Pine Street Alternative #2.
- Provide an additional 5 acre-feet of flood storage by expanding the proposed Golden Meadows Park flood storage area. The outlet of the detention basin will connect to existing storm sewer.
- Installation of 500 linear feet of 2-foot by 4-foot relief sewer between Park Avenue and the expanded Golden Meadows Park flood storage area.

Alternative #2 – Relief Sewer/Excavate Detention Storage

As shown on Exhibit 9B, Alternative #2 provides a 100-year level of flood protection for the street and homes in this study area through the following drainage improvements:

- Installation of 350 linear feet of 2-foot by 4-foot relief sewer, from Park Avenue to the proposed flood storage area.
- Provide 3 acre-feet of flood storage by excavating the open parcel between the railroad and the Tri-State Tollway. The outlet of the flood storage area will connect to existing storm sewer.

A summary of the cost estimates for the proposed Brynhaven Subdivision alternatives is provided in Table 15. These costs does not include such items as land acquisition, temporary/permanent construction easements, relocation of utilities, and the costs of recreational facilities in the open space.

Table 15. Summary of Brynhaven Subdivision Alternatives

Alternative ID	Level of Protection	Engineer's Estimate of Probable Cost	
		Above-Ground Storage	Underground Storage
Alternative #1	100-year	$890,000*	$2,480,00*
Alternative #2	100-year	$1,670,000	$2,620,00

*Cost in addition to Pine Street Alternative #1

PICK SUBDIVISION STUDY AREA

Pick Subdivision is located west of Salt Creek and north of St. Charles Road, as shown in Figure 20. The general drainage pattern is from west to east through the subdivision toward Salt Creek. The flood problem area within the subdivision is the depressional area located near the intersection of Thomas Street and Monterey Avenue. Stormwater runoff from an approximately 66-acre area drains through this localized depression, which consists of a portion of Monterey Avenue and the rear yards of adjacent homes. A single 15-inch storm sewer outlets this low-lying area, which eventually drains to Salt Creek via the 30-inch storm sewer along Thomas Street. Although the Thomas Street storm sewer is outfitted with a backflow prevention device, when the level of Salt Creek is high, there is no positive drainage from the subdivision to the creek. The lack of positive drainage results in frequent street and yard flooding.

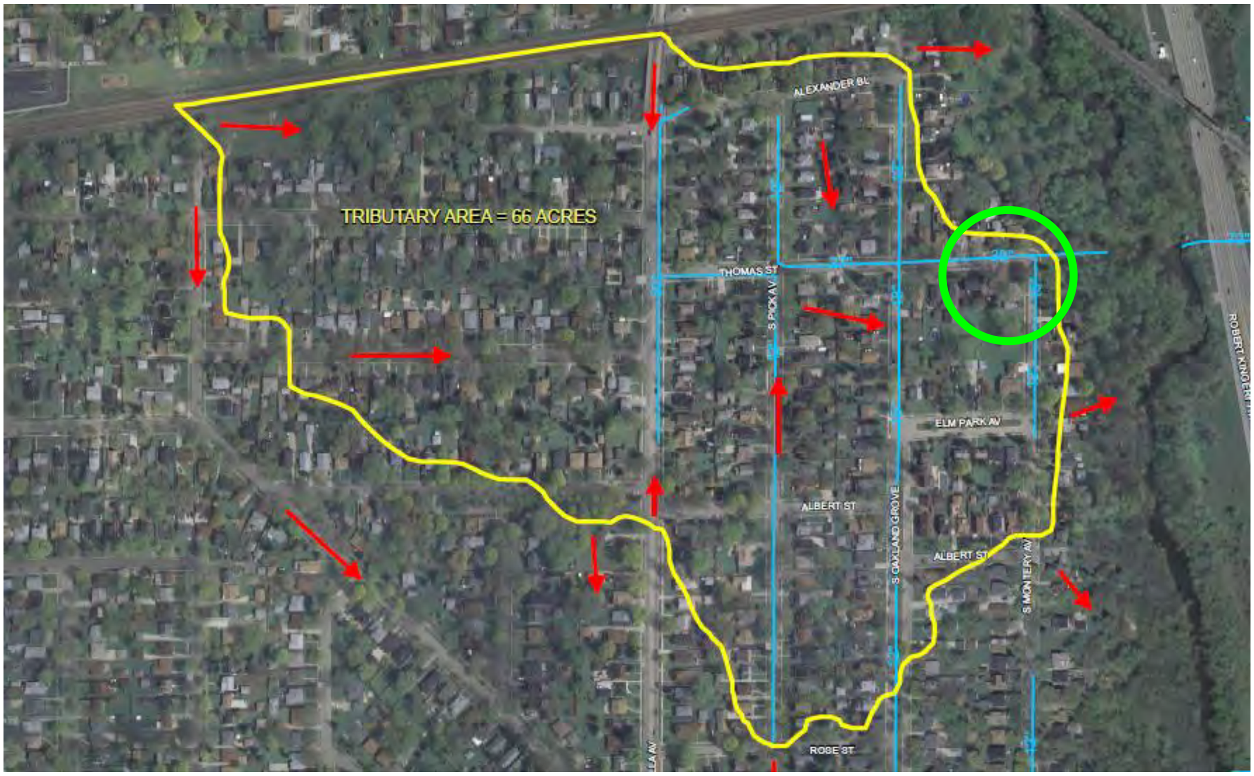

Figure 20. Overview of Pick Subdivision

11.1 PICK SUBDIVISION EXISTING CONDITIONS

Based on the results of the XP-SWMM modeling, street and yard flooding occurs near the intersection of Thomas Street and Monterey Avenue for storm events greater than the 5-year frequency and structural flooding (1 home) occurs for storm events equal to a 100-year frequency.

During the July 2010 storm event, significant street and yard flooding occurred at the intersection of Thomas Street and Monterey Avenue. Based on the XP-SWMM computer modeling, there was approximately 1.5 feet of flooding at this location, although no homes were shown to be impacted by the flooding and there were no reports of structural flooding through the flood questionnaires. The XP-SWMM simulated inundation area for the July 2010 storm event is shown as Figure 21.

Figure 21. Pick Subdivision XP-SWMM Simulated Inundation Area – July 2010 Storm Event

11.2 PICK SUBDIVISION PROPOSED CONDITIONS

Because yard and street flooding occurs for even small storm events, three proposed drainage alternatives were analyzed that provide various levels of flood protection for this area. The three alternatives are described in detail below.

Alternative #1 – Relief Sewer/Pump Station

As shown on Exhibit 10A, Alternative #1 provides a 100-year level of protection for the flood problem through the following drainage improvements:

- Upsize approximately 560 linear feet of 15- to 30-inch diameter storm sewer to 3-foot x 5-foot box storm sewer from the low spot at Thomas Street and Monterey Avenue to Salt Creek.

- Upsize the existing outlet of the depressional area from a 6-inch diameter pipe to a 2-foot by 4-foot box storm sewer.

- Construct a 60-cfs capacity pump station to provide positive drainage from the storm sewer system to Salt Creek.

Although this alternative provides a 100-year level of protection for the subdivision, the proposed pump station increases flows to Salt Creek, and compensatory storage will be required to mitigate the increases. Due to the limited parcels available for compensatory storage in this area, and the distance between this study area and the Eldridge Park Reservoir, permitting for this alternative will be difficult.

Alternative #2 – Underground Pipe Storage
Alternative #2, as shown on Exhibit 10B, increases the level of flood protection from the 5-year to a 10-year level of protection by providing flood storage in oversized storm sewers. The drainage improvements included in this alternative consist of:

- Provide 1 ac-ft of underground storage using approximately 1,200 linear feet of 4-foot by 10-foot box storm sewers.

- Upsize the existing outlet of the depressional area from a 6-inch diameter pipe to a 12-inch diameter pipe.

Alternative #3 – Underground Detention Storage
As shown on Exhibit 10C, Alternative #3 provides a 100-year level of protection through the following drainage improvements:

- Provide 4 ac-ft of underground storage in the rear yards of homes.

- Construct a 5-cfs capacity pump station to outlet underground storage area.

A summary of the cost estimates for the proposed Pick Subdivision alternatives is provided in Table 16. These costs does not include such items as land acquisition, temporary/permanent construction easements, and the relocation of utilities.

Table 16. Summary of Pick Subdivision Alternatives

Alternative ID	Level of Protection	Engineer's Estimate of Probable Cost
Alternative #1	100-year	$3,010,000
Alternative #2	10-year	$1,570,000
Alternative #3	100-year	$2,340,000

BUTTERFIELD ROAD (YORKFIELD) STUDY AREA

Yorkfield Subdivision is located south of Butterfield Road and east of York Street, as shown on Figure 22. The overall drainage area for the study area is approximately 248 acres, 165 acres of which is tributary to the existing 48-inch diameter storm sewer located along Butterfield Road (IL 56). The remaining 83 acres of drainage area consists of the area south of Butterfield Road (IL 56) and east of York Street.

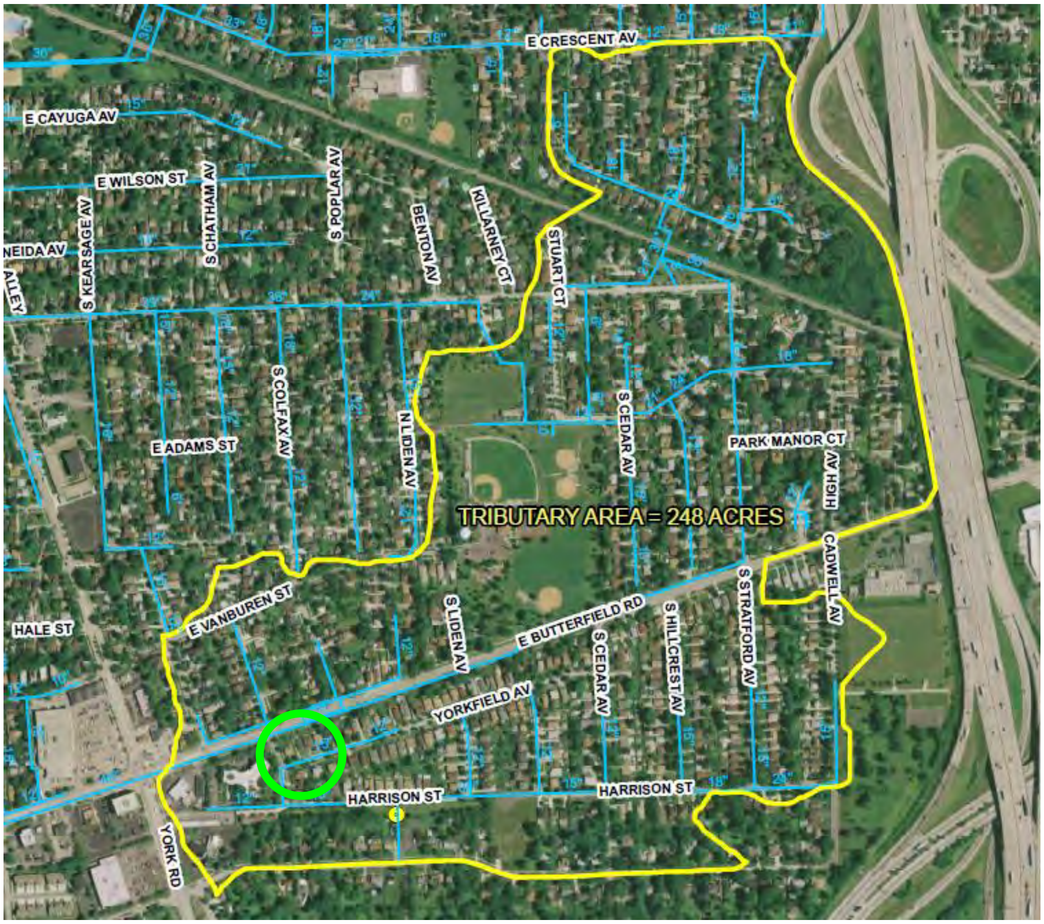

Figure 22. Overview of Yorkfield Subdivision Study Area

12.1 BUTTERFIELD ROAD (YORKFIELD) EXISTING CONDITIONS

The overall drainage pattern of the study area is from north to south, with stormwater runoff being conveyed via storm sewer and overland flow to the detention basin located south of Harrison Street. The detention basin is a dry-bottomed facility with a capacity of approximately 8 acre-feet. During small storm events, a 1-cfs capacity pump station is utilized to drain the detention basin but during more significant storm events when the level of the basin rises, an overflow grate structure drains the basin by gravity to the pipe network to the south.

The Butterfield Road storm sewer, with approximately 165 acres of tributary area, surcharges for storm events greater than the 10-year frequency at the low point in the street and drains overland down Chatham Avenue. The overflow collects at the low spot near the intersection of Yorkfield Avenue and

Chatham Avenue, which causes damages to the homes in this area. Several of these homes have reverse-slope driveways, which makes street flooding especially problematic at this location.

To alleviate the flooding in the subdivision, several improvements have been made recently to the drainage system, including:

- Installation of a berm and regrading along Butterfield Road to minimize overflows from the 48-inch diameter sewer into the subdivision.

- Debris removal along the Butterfield Road right-of-way (ROW) to improve performance of inlets.

- Construction of a trench drain that spans the width of Yorkfield Avenue at the low spot of the street.

- Construction of a 36-inch diameter relief sewer from the low spot on Yorkfield Avenue to the Harrison Street detention basin.

- Expansion of the Harrison street detention basin to provide additional storage capacity.

Although these improvements significantly improved the drainage system, Yorkfield Subdivision experienced flooding during the July 2010 storm event. During the storm, significant flooding was reported within the subdivision, particularly along the low spot at Yorkfield and Chatham Avenue. Based on the XP-SWMM computer modeling, there was approximately 0.4 feet of flooding on Yorkfield Avenue and 11 homes were affected by the flooding. The XP-SWMM simulated inundation area for the July 2010 storm event is shown as Figure 23.

Figure 23. Yorkfield XP-SWMM Simulated Inundation Area – July 2010 Storm Event

12.2 BUTTERFIELD ROAD (YORKFIELD) PROPOSED CONDITIONS

Several proposed improvements were evaluated to increase the level of flood protection for the study area. Because several of the homes in the flood problem area have reverse-slope driveways, the goal of the proposed drainage improvements is to eliminate street ponding near the Yorkfield Avenue and Chatham Avenue intersection.

Alternative #1 – Relief Sewer/Expand Detention Storage

As shown on Exhibit 11A, Alternative #1 provides a 100-year level of protection for the homes in this study area through the following drainage improvements:

- Installation of 400 linear feet of 36-inch diameter relief sewer between the low spot at Yorkfield Avenue and the Harrison Street detention basin.
- Provide an additional 5 acre-feet of flood storage by expanding the Harrison Street detention basin onto the adjacent open parcel. A 36-inch diameter pipe is necessary to equalize the two basins. The existing outlet of the detention basin will remain unchanged.

Alternative #2 – Relief Sewer/Excavate Existing Detention Storage

As shown on Exhibit 11B, Alternative #2 provides a 100-year level of protection for the homes in this study area through the following drainage improvements:

- Installation of 400 linear feet of 36-inch diameter relief sewer between the low spot at Yorkfield Avenue and the Harrison Street detention basin.

- Provide an additional 5 acre-feet of flood storage in the existing Harrison Street detention basin by utilizing retaining walls and excavating the side slopes and bottom. The existing outlet of the detention basin will remain unchanged.

A summary of the cost estimates for the proposed Yorkfield Subdivision alternatives is provided in Table 17. These costs does not include such items as land acquisition, temporary/permanent construction easements, relocation of utilities, and the costs of recreational facilities in the open space.

Table 17. Summary of Yorkfield Subdivision Alternatives

Alternative ID	Level of Protection	Engineer's Estimate of Probable Cost	
		Above-Ground Storage	Underground Storage
Alternative #1	100-year	$710,000	$2,290,00
Alternative #2	100-year	$1,880,000	N/A

COMPENSATORY STORAGE ANALYSIS

For those proposed alternatives that resulted in increased flows to Salt Creek, a compensatory storage analysis was completed to determine the flood storage required to mitigate these increased flows. Of the proposed alternatives for the ten study areas, the following alternatives result in increased flows to Salt Creek:

- Southwest Alternatives #2 and #2A: upsizing Jackson Street (134 cfs to 236 cfs) and Berkeley & Adams stormwater pumping stations (147 cfs to 213 cfs).

- Southwest Alternative #3: upsizing Harrison Street stormwater pumping station (45 cfs to 124 cfs).

- Southwest Alternative #3: upsizing McKinley Avenue stormwater pumping station (134 cfs to 290 cfs).

- Pick Subdivision Alternative #1: construction of 60-cfs capacity stormwater pumping station.

To offset the increased pumping rates from these alternatives, potential compensatory storage locations were identified from the open parcels located along Salt Creek. A location map of these parcels is provided as Exhibit 12. Of the identified sites, the Eldridge Park Reservoir is considered to be the most feasible compensatory storage area since it is a City-owned parcel and contains available storage volume. Based on the City's current accounting of available storage, there is approximately 50 acre-feet of storage volume available in Eldridge Park. However, this storage volume was allocated as compensatory storage for floodplain fill along the Roosevelt Road corridor, and any alternate use of the storage volume will require approval from DuPage County. In addition, the modification of the operation of the Elmhurst Quarry was also analyzed as a potential compensatory storage option.

To complete the compensatory storage analysis, the Lower Salt Creek FEQ model prepared as part of the DuPage County Floodplain Mapping Effort was updated to reflect the proposed pump station improvements. The results of the model simulation showed increases in both the 0.04-foot water surface elevation increase and flows that exceed a 10% increase for any of the storm events contained in the simulation. The DuPage County Countywide Stormwater and Floodplain Ordinance (Ordinance) requires that any proposed increases be contained in a flood easement. The increases due to the proposed improvements extended all the way beyond the DuPage County border into Cook County. Obtaining easements for such an extended portion of the creek would be extremely expensive and difficult to obtain.

Due to the proposed increases in elevation and flow, additional simulations were completed to see if the Eldridge Park and Elmhurst Quarry Reservoirs could be used to mitigate the increases in flow created by the additional proposed pump capacities. Numerous Salt Creek FEQ simulations were conducted and none of the simulations produced sufficient mitigation for the proposed pump station at the Pick Subdivision. Numerous combinations of modifications to the Eldridge Park Reservoir intake structure were completed, but the reach of Salt Creek between the pump station discharge and the Eldridge Park Reservoir showed increases greater than the Ordinance thresholds. The only option that was effective in mitigating the flow increases associated with the Southwest Elmhurst locations was routing all of the increased discharge directly to the reservoir through forcemains. Based on the results of the FEQ analysis, the required Eldridge Park storage volume was quantified for each pump alternative in Southwest Elmhurst, and is summarized in Table 18.

The available storage volume in Eldridge Park can potentially accommodate a maximum of two of the pump station upgrades. To provide mitigation for all four of the Southwest Elmhurst pump station upgrades, additional compensatory storage must be provided on one of the identified offsite parcels.

Table 18. Summary of Required Compensatory Storage

Alternative ID	Pump Station Location	Capacity (cfs)		Storage Volume Required to Mitigate Downstream Impacts* (ac-ft)
		Existing	Proposed	
SW Alternative #2	Berkeley & Adams	147	213	20
	Jackson Street	134	236	30
SW Alternative #3	Harrison Street	45	125	30
SW Alternative #4	McKinley Avenue	134	290	34
Total		460	864	114**

BACKUP POWER - STORMWATER PUMPING STATIONS

Of the stormwater pumping stations on Salt Creek, only the Berkeley & Adams pump station has a standby generator. The other four pump stations along Salt Creek are serviced by dual ComEd feeds. To further reduce the risk of a pump failure during a power outage, CBBEL recommends that standby generators be installed at these pump stations as well. Cost estimates were developed for the installation of standby generators at these pump stations are provided in Table 19.

Table 19. Stormwater Pumping Stations – Southwest Elmhurst

Pump Station Location	Number of Pumps	Pump Capacity (cfs)	Estimated Cost Standby Generator
Harrison Street	1	45	$350,000
Jackson Street	1	134	$475,000
McKinley Avenue	2	134	$550,000
Randolph & West	2	182	$600,000

PERVIOUS PAVEMENT

An alternative method of providing flood storage is utilizing the void space in the stone layers below pervious pavement. Pervious pavement allows rainfall to infiltrate through its surface, in contrast to traditional pavement techniques where all rainfall becomes runoff. Referring to Figure 24, the pervious layer allows rainfall to percolate through the pavement into the stone layers, where the stormwater is stored in the void spaces of the stone.

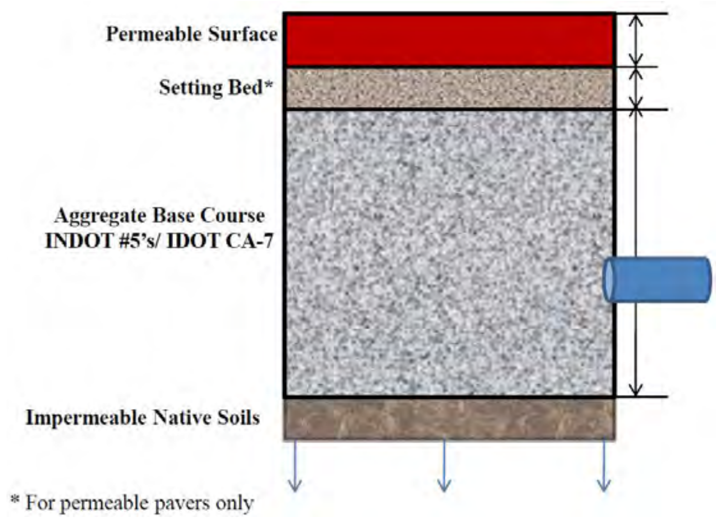

Figure 24. Typical Pervious Pavement Cross-Section

Because the material at the bottom of the excavation is either clay or saturated soil, the storage capacity is limited to the volume of the stone voids. For a given volume of the aggregate base course, approximately 36% consists of void space. An underdrain is installed to outlet the stormwater by gravity to the existing storm sewer system. Since stormwater is temporarily stored in the stone and attenuated through the use of an underdrain, the system functions similarly to a traditional stormwater detention basin.

Using the Pine Street study area as an example, pervious pavement was analyzed as a potential flood reduction alternative. Because there are no alleys located in the Pine Street study area, the incorporation of pervious pavement is limited to the streets, which can be reconfigured using pervious asphalt. As described in the Pine Street section of the report, flood storage volumes of 7 and 17 acre-feet are required for 50- and 100-year levels of flood protection. To determine the amount of pervious pavement required to provide these storage volumes, the following assumptions were used:

- One-half of the street width can be used for pervious pavement (12 ft); the other half is reserved for utilities.
- The porosity of the stone sub-base is 36%.
- The average depth of the stone is six feet, determined using the invert elevations of the existing storm sewer system.

As shown in Table 20, providing the necessary flood storage through pervious pavement would require the reconfiguration of miles of roadway. On this scale, providing flood storage using pervious pavement would also require significantly higher costs than those alternatives using conventional flood storage techniques.

Table 20. Pervious Pavement Summary – Pine Street Study Area

Level of Protection	Storage Volume Required (ac-ft)	Length of Road Required (ft)	Estimated Cost
50-Year	7	11,800	$8,300,000
100-Year	17	28,600	$20,000,000

FLOOD PROOFING

Because the proposed drainage alternatives for the ten study areas will require significant expenditures to significantly increase the level of flood protection, flood proofing of individual homes was analyzed as an alternative to the large-scale infrastructure improvements. Flood proofing candidates included those houses that experience overland flooding as a result of shallow flooding depths (less than one foot) during the 100-year storm event. Using the Lowest Adjacent Grades (LAGs), surveyed elevations, and the 100-year flood elevations from the existing conditions XP-SWMM analysis, the flooding depths were determined for each house within the 100-year inundation area.

Based on the residential flood questionnaires following the July 2010 storm event, CBBEL performed a site visit of 30 houses that reported overland flooding. Appropriate flood proofing options were assigned to each house based on the unique method of flood entry to each residence. Flood proofing measures included in this analysis included:

- Installation of glass block windows
- Raising window wells
- Installation of water-proof window well covers
- Regrading of sidewalks/driveways
- Construction of retaining walls

Based on the required measures to flood proof the residence, a construction cost was developed for each home. To account for the significant variability involved with individual house flood proofing, an average cost of $10,000 was determined to flood proof each individual home. Homes that were subjected to shallow flooding depths (less than one foot) were identified as potential flood proofing candidates in each study area. Using the average flood proofing cost of $10,000, along with the number of flood proofing candidates, the total cost of providing flood protection through individual house flood proofing was quantified for each study area. Table 21 provides a summary of potential flood proofing options per study area.

Table 21. Potential Flood Proofing Candidates Per Study Area

Study Area	# of Flood Proofing Candidates	Average Flood Proofing Estimate ($/home)	Total Study Area Flood Proofing Estimate ($)
Pine Street	5	10,000	50,000
Geneva Avenue	9	10,000	90,000
Spring/Harrison Area	4	10,000	40,000
Washington Street	31	10,000	310,000
Saylor/Jackson Street	67	10,000	670,000
Crescent Avenue	36	10,000	360,000
Swain/Vallette Avenue	79	10,000	790,000
Larch Avenue	3	10,000	30,000
Seminole Avenue	4	10,000	40,000
York Street at I-290	0	10,000	0
Brynhaven Subdivision	2	10,000	20,000
Pick Subdivision	1	10,000	10,000
Yorkfield Subdivision	6	10,000	60,000
Totals	**246**	**---**	**2,460,000**

Table 22. Comparison of Costs: Drainage Improvements vs. Flood Proofing Options

Alternative ID	Proposed Improvements			Flood Proofing		
	# of Homes Removed	Cost ($/home)	Total Cost*	# of Homes Removed	Cost ($/home)	Total Cost
Southwest #1	162	$42,700	$6,910,000	217	$10,000	$2,170,000
Southwest #2	215	$121,400	$26,100,000			
Southwest #3	17	$219,500	$3,730,000			
Southwest #4	87	$132,600	$11,530,000			
Pine Street #1	16	$103,200	$1,650,000	5	$10,000	$50,000
Pine Street #2	20	$128,000	$2,560,000			
Geneva Ave #1	8	$162,500	$1,300,000	8	$10,000	$80,000
Larch Ave #1	3	$600,000	$1,800,000	3	$10,000	$30,000
Brynhaven #1	22**	$156,900	$3,450,000	7**	$10,000	$70,000
Brynhaven #2	2	$835,000	$1,670,000	2	$10,000	$20,000
Pick #1	1	$3,010,000	$3,010,000	1	$10,000	$10,000
Pick #3	1	$2,340,000	$2,340,000			
Seminole #1	4	$202,500	$810,000	4	$10,000	$40,000
Yorkfield #1	11	$64,600	$710,000	6	$10,000	$60,000
Yorkfield #2	11	$171,000	$1,880,000			

*Assuming above-ground flood storage and does not include land costs or mitigating storage
**Includes homes in Pine Street and Brynhaven study areas

REDEVELOPED PROPERTIES ANALYSIS

To determine the impacts of recently redeveloped single-family lots on the stormwater collection system, a hydrologic analysis was developed to compare the stormwater runoff between redeveloped properties and the previous homes on the same lot. Specifically, this study focused on the requirement for new development to directly connect roof drains and sump pumps to the storm sewer system. The direct connections physically modify the following two hydrologic parameters: (1) directly connected impervious area (DCIA) and (2) time of concentration. DCIA refers to all impervious surfaces that drain directly into the stormwater collection system, preventing any infiltration from taking place. Because the pre-construction roof drains are assumed to have discharged overland to the rear yard where some infiltration occurs, these roofs are classified as indirectly connected impervious areas. The time of concentration is the longest time it takes a drop of water to reach the lowest point of the lot.

Because DCIA and time of concentration can be quantified based on the pre- and post-construction site plans, a hydrologic analysis was performed on 16 redeveloped single-family properties to determine the hydrologic impact of the direct connections. Pre-construction refers to the lot developed in the 1950's – 1960's with a house on it and post-construction refers to the redevelopment of the lot with a larger house.

As shown in Table 23, the total impervious area under pre- and post-construction conditions remains relatively unchanged (average of +3%). However, because the downspouts and sump pumps for the redevelopments are directly connected to the storm sewer system instead of discharging overland, the amount of DCIA increases significantly (average of +32%).

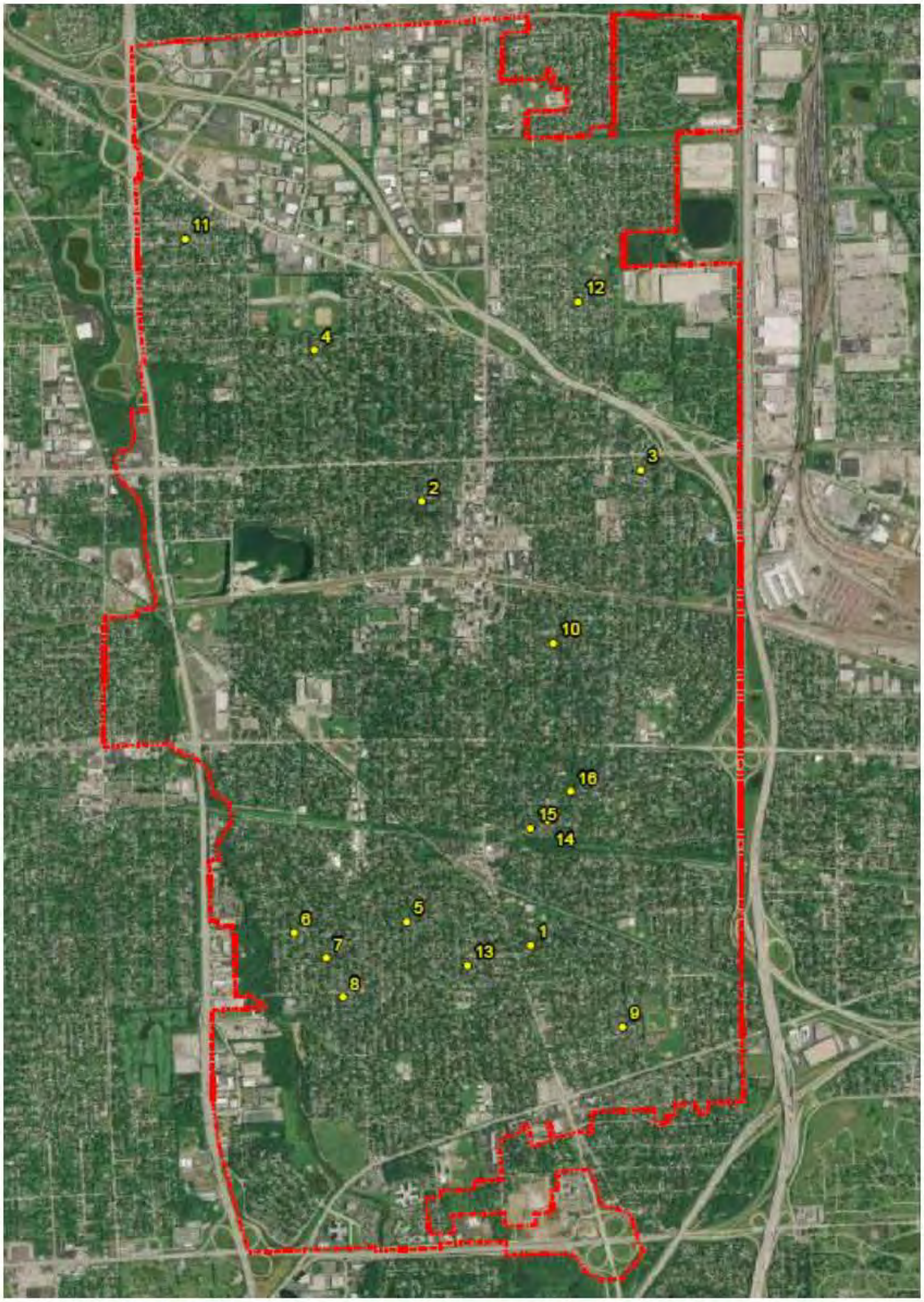

Figure 25. Location Map of Redeveloped Properties

Table 23. Pre- and Post-Construction Impervious Area Comparison

Lot Number	Address	Area (acres)	Pre-Construction		Post-Construction		Change in DCIA (%)
			Impervious %	DCIA %	Impervious %	DCIA %	
1	171 Wilson	0.19	35	5	43	43	38
2	210 Maple	0.34	47	12	32	32	20
3	300 Clinton	0.26	22	5	35	35	30
4	454 Emery	0.19	43	8	47	47	39
5	656 Mitchell	0.17	44	5	47	47	42
6	676 Berkeley	0.26	41	23	36	36	13
7	718 Fairfield	0.20	32	7	40	40	33
8	786 Hillside	0.16	43	7	42	42	35
9	841 Poplar	0.17	47	13	43	43	30
10	187 Kenmore	0.28	38	6	42	42	36
11	591 Belden	0.21	28	7	34	34	27
12	576 Howard	0.18	40	1	36	36	35
13	720 Washington	0.16	44	5	44	44	39
14	195 South	0.39	25	5	49	49	44
15	497 Arlington	0.34	32	15	41	35	20
16	223 May	0.32	23	9	36	34	25
	Average	**0.24**	**37**	**8**	**40**	**40**	**32**

Pre-Construction Conditions

As shown in Table 23, 16 redeveloped single-family properties with an average lot size of 0.24 acres (9,150 ft^2) were included in this study. The outlier in this list is 210 Maple Street, which involved the redevelopment of two existing single-family lots into one large lot. A site plan for a typical lot is shown in Figure 26. In general, the pre-construction single-family lot consisted of a home located in the center of the lot with a long driveway that spanned from the street to a detached garage located at the rear of the lot. Because the downspouts from the original home are assumed to have discharged overland to the rear yard, the DCIA consists primarily of those portions of the driveway and front sidewalk that drained directly to the street. We have also assumed that none of the roof drainage from the pre-construction condition was connected to the sanitary sewer system, although it is unclear if this was true for all of the homes.

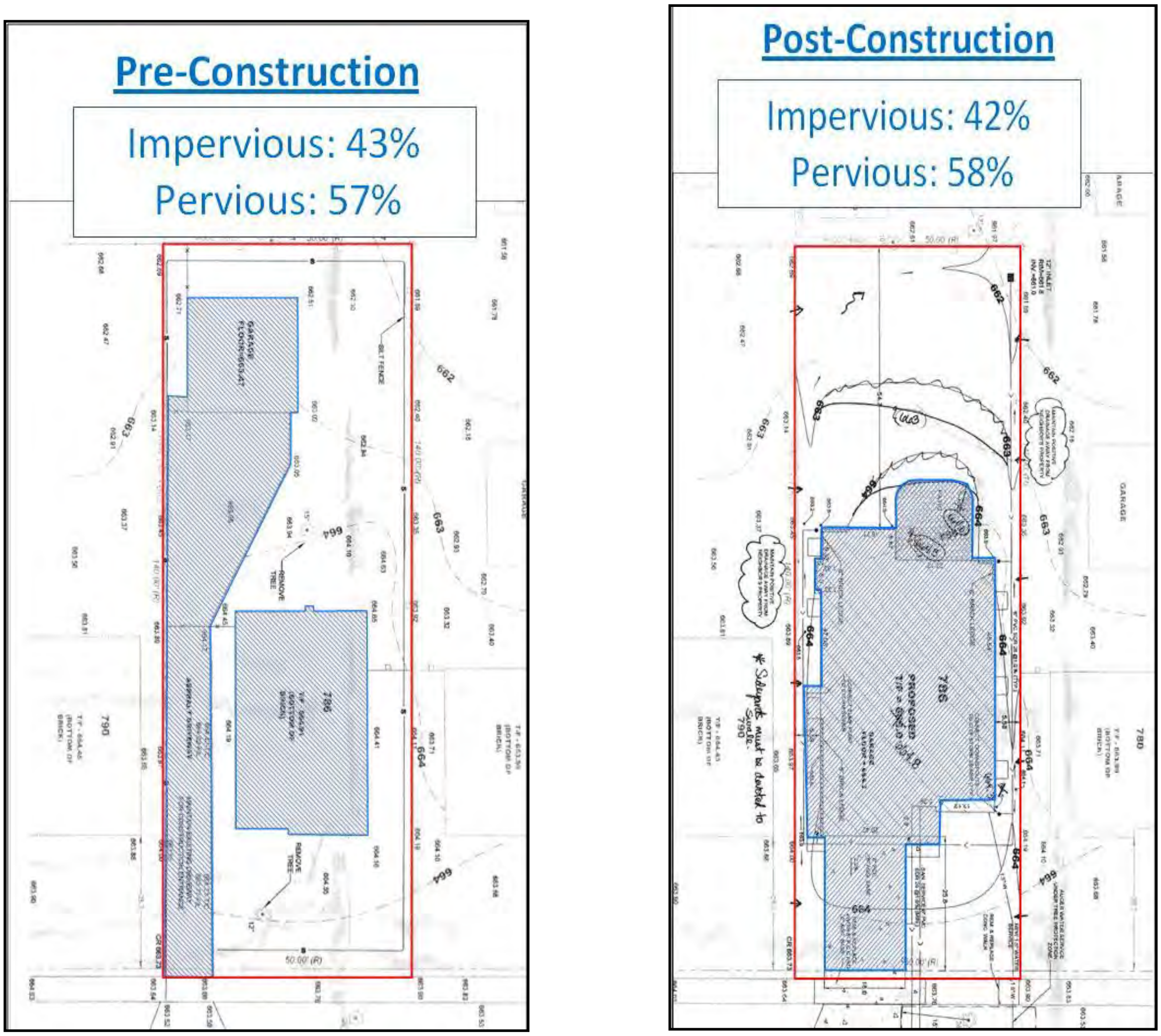

Figure 26. Pre- and Post-Construction Site Plan for 786 Hillside Avenue

<u>Post-Construction Conditions</u>

Although the total impervious area of the redeveloped lots did not change significantly, the redevelopment did alter the drainage characteristics of each lot. Referring to Figure 26, in general, the post-construction lot consists of:

- A larger single-family home with an attached garage and shorter driveway.
- Directly connected downspouts and sump pumps.
- Overland flow swales and storm drains in side and rear yards.

12.3 HYDROLOGIC ANALYSIS

The Hydrologic Engineering Center – Hydrologic Modeling System (HEC-HMS) Version 3.5 computer program, developed by the U.S. Army Corps of Engineers, was used to model the pre- and post-construction hydrology. The HEC-HMS hydrologic model was used to generate stormwater runoff volumes and hydrographs for each residential lot based on user-specified hydrologic parameters and rainfall data.

The hydrologic parameters for each lot were determined based on the methodology outlined in *TR-55: Urban Hydrology for Small Watersheds* (U.S. Department of Agriculture, 1986). In the HEC-HMS hydrologic model, the following information was input for each residential lot:

- Area
- Curve number (CN)
- Time of concentration (t_c)
- Directly connected impervious area (DCIA)

A summary of the calculated hydrologic parameters for each lot is provided in Table 24.

Both observed and design storm events were simulated in the hydrologic model. The July 23-24, 2010 rainfall data was taken from the measurements recorded at the USGS gage (05531300) located on Salt Creek in Elmhurst. Rainfall depths taken from Bulletin 70 were used as design event rainfall data. To understand the effect of the redevelopments for different storm events, the 1-, 6-, and 24-hour storm events were simulated for 1-, 2-, 10-, and 100-year return intervals. These storm events were selected so that a broad range of storms were analyzed, from short, high-intensity storm events to high-volume, low-intensity storm events.

Table 24. Summary of Hydrologic Parameters

Address	Area (ac)	Pre-Construction			Post-Construction		
		DCIA (%)	Curve Number	Time of Concentration (min)	DCIA (%)	Curve Number	Time of Concentration (min)
171 Wilson	0.19	5	81	7.8	43	74	4.2
210 Maple	0.34	12	82	12.6	32	74	15.0
300 Clinton	0.26	5	78	10.8	35	74	10.8
454 Emery	0.19	8	82	10.2	47	74	13.2
656 Mitchell	0.17	5	83	10.8	47	74	4.2
676 Berkeley	0.26	23	78	19.8	36	74	11.4
718 Fairfield	0.20	7	80	12.0	40	74	6.6
786 Hillside	0.16	7	83	13.8	42	74	6.0
841 Poplar	0.17	13	82	18.0	43	74	6.0
187 Kenmore	0.28	6	80	14.4	42	74	6.0
591 Belden	0.21	7	79	8.4	34	74	3.0
576 Howard	0.18	1	82	12.0	36	74	7.2
720 Washington	0.16	5	83	13.2	44	74	8.4
195 South	0.39	5	79	15.6	49	74	13.2
497 Arlington	0.34	15	79	12.0	35	76	6.0
223 May	0.32	9	78	12.6	34	75	12.6
TOTAL	3.82						

Results and Conclusions

To summarize the pre- and post-construction hydrologic model results, the runoff hydrographs from the 16 properties were added together. This allows the analysis of the hydrologic impacts of one redeveloped property, as well as the cumulative effect of a cluster of redeveloped properties. The properties analyzed in this study are spread throughout the City of Elmhurst and do not function together.

The results of the hydrologic analysis indicate that the direct connections have the most significant impact during the more frequent, higher-intensity storm events. As shown in Table 25, for the 1-year, 1-hour storm event, the total flowrate from the redevelopment increases by 202%. Similarly, the runoff volume increases by 100% for this storm event. However, for the 100-year, 1-hour storm event, the flowrate and volume increases dropped to 28% and 17%, respectively. The post-construction increases are less dramatic for the 6-hour storm duration, and even lower increases are shown for the 24-hour duration. Although the redeveloped flowrates show a decrease for the 100-year, 24-hour storm event, this can be attributed to the large decrease shown for 210 Maple Street.

Table 25. Summary of HEC-HMS Hydrologic Model Results for Combined Properties

Increase in Flowrate, Q (%) Pre- to Post-Construction			
Return Interval	**1-Hour Storm Duration**	**6-Hour Storm Duration**	**24-Hour Storm Duration**
1	202.4	110.0	10.2
2	130.5	61.3	6.2
10	58.4	18.4	1.4
100	28.1	5.6	0.0
July 2010	12.4		
Increase in Runoff Volume, V (%) Pre- to Post-Construction			
Return Interval	**1-Hour Storm Duration**	**6-Hour Storm Duration**	**24-Hour Storm Duration**
1	100.0	46.0	29.2
2	73.0	33.3	21.2
10	39.0	18.1	11.3
100	16.5	8.1	5.1
July 2010	5.9		

For small duration, high-intensity storm events, such as the 1-year, 1-hour storm event, while there is a significant increase in flows (202%) and volumes (100%), storm sewers are capable of handling these smaller storm events.

The results of the July 2010 storm event indicate a 12% increase in flowrates and a 6% increase in runoff volume for the redeveloped properties. Because it was a high-volume, longer-duration storm event (6.84 inches in 12 hours), the results for the July 2010 storm event are consistent with those results obtained for the less-frequent design storm events. Based on the results of this analysis, it is evident that the redeveloped properties contribute additional runoff volume and increase flowrates. However, the redeveloped properties do not have a significant impact on large storm events such as the July 2010 storm event. This is further demonstrated in Table 26, which shows that the redeveloped properties compose only a small percentage of the ten flood-prone study areas within the City of Elmhurst.

Table 26. Redeveloped Homes in Ten Flood Study Areas

Study Area Location	# of Homes Redeveloped After 1994*	Area of Redevelopment (acres)	% of Study Area	Existing Level of Flood Protection
Pine Street	18	3.6	4.1	10-Year
Geneva Avenue	69	13.8	11.2	25-Year
Southwest (South)	215	43.0	7.0	5-Year
Southwest (North)	336	67.2	16.8	2-Year
Larch Avenue	64	12.8	16.2	25-Year
Seminole Avenue	73	14.6	8.2	25-Year
York Street at I-290	17	3.4	2.2	50-Year
Brynhaven Subdivision	100	20.0	4.2	50-Year
Pick Subdivision	5	1.0	1.5	5-Year
Yorkfield Subdivision	42	8.4	3.4	25-Year

*Taken from exhibit entitled, "Date of Construction – Residential Properties Within Residential Zoning Districts," dated September 30, 2010

12.4 SOIL COMPACTION

Soils are classified into hydrologic soil groups (HSG's) based on their infiltration capacity. HSG classifications are Groups A, B, C, and D, with Group A soils having a high infiltration rate and therefore low runoff potential and Group D soils, which have a low infiltration rate and therefore high runoff potential. Based on the Natural Resources Conservation Service (NRCS) soil survey for DuPage County, the majority of the soils throughout the City of Elmhurst are classified as Markham-Ashkum-Beecher silt loam (Map Unit Symbol 854B). Based on the NRCS soil survey for DuPage County, the HSG for this soil type is a Group C, or somewhat poorly drained soil.

The hydrologic analysis developed as part of this study makes the assumption that the soil on each individual lot has the same infiltration capacity as the soil prior to redevelopment. The heavy equipment used during the construction process exerts great pressure on the soil surface that it presses the soil aggregates together, which reduces the size and continuity of the pores. The decrease in pore space reduces the capacity of the soil to hold water and limits the ability of water to move through the soil. Because its infiltration capacity has been reduced, there is an increase in stormwater runoff for the compacted soil.

Because the existing soils are somewhat poorly drained, it can be assumed that any infiltration capacity that the soil had prior to construction would be very minimal after compaction. In other words, compacting the soil would shift its HSG from Group C to Group D. To account for the effects of soil compaction in the hydrologic analysis, it was assumed that 10% of the pervious area on each redeveloped lot consists of Group D soils. This represents the area immediately surrounding the footprint of the redeveloped home that would experience soil compaction as a result of the construction process. It is assumed that the remainder of pervious areas would maintain their existing infiltration capacity, as construction equipment would be concentrated near the footprint of the home.

Table 27 provides a comparison of the post-construction flowrate and runoff volume increases, assuming no soil compaction and 10% soil compaction. In general, the compacted soil contributes an additional 0 – 2% increase in flowrates and runoff volumes from the redeveloped sites. As shown in Table 27, the compacted soil has no impact during the more frequent, higher-intensity storm events such as the 1-year, 1-hour storm event (0%), while the most significant increases in flowrates and runoff volumes occur during the more frequent, higher volume storm events such as the 1-year, 24-hour storm event (additional 1.7% and 1.1%). The results for the July 2010 storm event indicate a 0.9% increase in runoff volume, while the peak flowrate remains unchanged.

Table 27. Comparison of HEC-HMS Hydrologic Model Results – No Compaction vs. 10% Compaction

Increase in Flowrate, Q (%) Pre- to Post-Construction						
Return Interval	1-Hour Storm Duration		6-Hour Storm Duration		24-Hour Storm Duration	
	No Compaction	10% Compaction	No Compaction	10% Compaction	No Compaction	10% Compaction
1	202.4	202.4	110.0	110.0	10.2	11.9
2	130.5	130.5	61.3	61.3	6.2	7.4
10	58.4	60.2	18.4	20.5	1.4	2.1
100	28.1	29.7	5.6	6.9	0.0	0.0
July 2010	12.4	12.8				
Increase in Runoff Volume, V (%) Pre- to Post-Construction						
Return Interval	1-Hour Storm Duration		6-Hour Storm Duration		24-Hour Storm Duration	
	No Compaction	10% Compaction	No Compaction	10% Compaction	No Compaction	10% Compaction
1	100.0	100.0	46.0	47.8	29.2	30.3
2	73.0	75.8	33.3	34.6	21.2	22.7
10	39.0	39.0	18.1	19.4	11.3	12.6
100	16.5	17.7	8.1	9.0	5.1	5.9
July 2010	5.9	6.8				

12.5 BASEMENT DEPTH

The redevelopment of homes not only results in larger building footprints, but it also typically results in a basement that is deeper than the previous home. The effect of a deeper foundation has two adverse impacts on groundwater: (1) it displaces the volume of groundwater that was previously occupied by that portion of the soil and (2) it causes sump pumps to discharge longer and more frequently. While the increase in sump pump discharges is difficult to quantify, the displaced groundwater volume can be calculated based on the soil type and the pre- and post-construction building information.

The majority of Elmhurst is made up of silty clay and clay soils that are somewhat poorly drained. The volume of groundwater contained in a certain volume of soil can be determined by the soil's porosity. The porosity of the soil is that portion of the soil that is not occupied by solid mineral matter and therefore can be occupied by groundwater. Typical porosity values for silt and clay soil types are 46% and 42%, respectively. Because Elmhurst consists of both soil types, an average soil porosity of 44% is used in this analysis.

Using the site plans for pre- and post-construction, the areas of the building footprints were determined for the 16 redeveloped properties. As shown in Table 28, the building footprint increased by an average of 1,195 ft^2.

Table 28. Comparison of Pre- and Post-Construction Building Footprints

Lot	Address	Pre-Construction Footprint (ft^2)	Post-Construction Footprint (ft^2)	Change in Footprint (ft^2)
1	171 Wilson	1,263	2,483	1,220
2	210 Maple	2,570	2,047	-523
3	300 Clinton	871	2,526	1,655
4	454 Emery	1,350	2,396	1,045
5	656 Mitchell	1,220	2,134	915
6	676 Berkeley	784	2,222	1,437
7	718 Fairfield	1,220	2,570	1,350
8	786 Hillside	1,133	2,134	1,002
9	841 Poplar	828	2,047	1,220
10	187 Kenmore	1,437	2,962	1,525
11	591 Belden	1,133	2,134	1,002
12	576 Howard	1,002	2,047	1,045
13	720 Washington	1,045	1,655	610
14	195 South	2,701	3,572	871
15	497 Arlington	1,263	3,833	2,570
16	223 May	1,133	3,311	2,178
	Average	1,310	2,505	1,195

While the area of the post-construction foundation has increased by over 90%, the effect on groundwater is further exacerbated by a deeper basement. Figure 27 shows the groundwater displacement areas as a result of redevelopment, assuming the redeveloped basement is two feet deeper than existing conditions. It is assumed that the area directly beneath the existing foundation has been compacted; therefore, the groundwater-holding capacity of the soil in this zone has been significantly reduced. However, the areas that are two feet below the existing foundation and between the pre- and post-construction building footprints, as shown in brown in Figure 27, are the zones of displaced groundwater volume due to the deeper basement. It should be noted that the volume of displaced groundwater is dependent on the existing groundwater level, since under saturated conditions, the volume provided in the void spaces is already occupied. Likewise, under extremely dry conditions, additional groundwater volume may be displaced, as the areas outside of the existing building footprint and above the pre-construction foundation may contain available volume in the soil's void spaces.

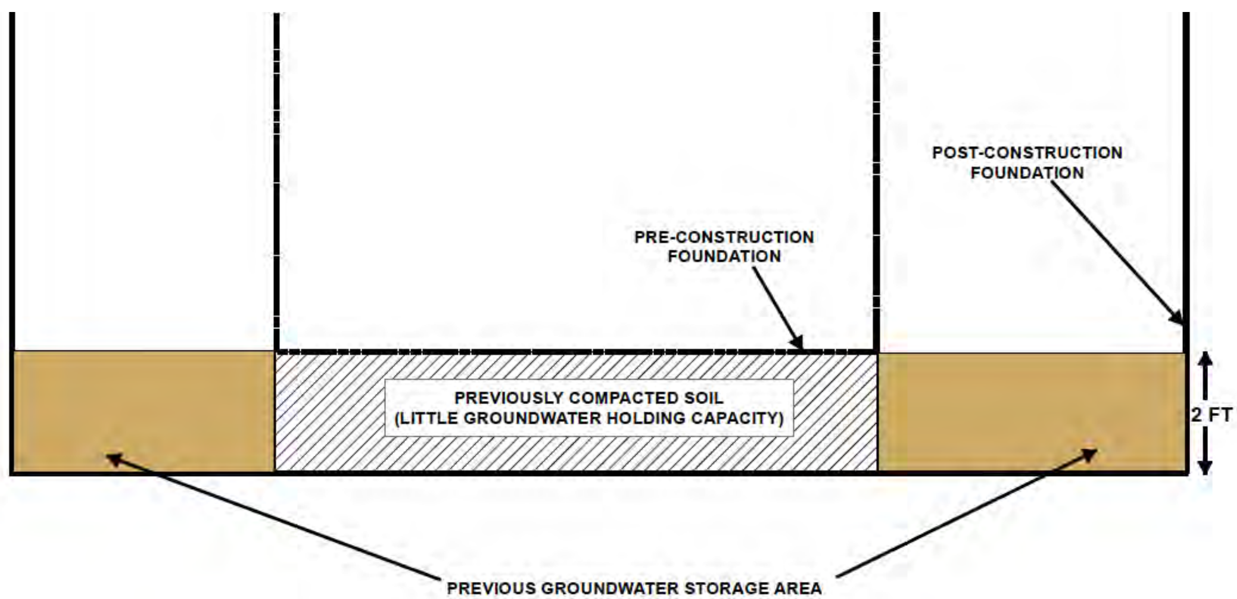

Figure 27. Groundwater Displaced by Deeper Basement

Table 29 summarizes the volume of groundwater that would be displaced by basements that are two feet deeper than pre-construction conditions. Using the average soil porosity of 44% and the calculated soil volumes, the volume of displaced groundwater was determined. As shown in Table 29, an average volume of 1,052 ft^3 of groundwater is displaced by each redeveloped home, assuming the basements are two feet deeper. Considering there were 1,934 homes redeveloped in Elmhurst since 1994 (based on exhibit entitled, "Date of Construction – Residential Properties within Residential Zoning Districts," dated September 30, 2010), this translates to a cumulative volume of approximately 2,035,000 ft^3, or 47 acre-feet.

Table 29. Summary of Groundwater Displacement

Lot	Address	Change in Footprint (ft^2)	Change in Volume* (ft^3)	Volume of Groundwater Displaced (ft^3)
1	171 Wilson	1,220	2,439	1,073
2	210 Maple	-523	1,524	671
3	300 Clinton	1,655	3,311	1,457
4	454 Emery	1,045	2,091	920
5	656 Mitchell	915	1,830	805
6	676 Berkeley	1,437	2,875	1,265
7	718 Fairfield	1,350	2,701	1,188
8	786 Hillside	1,002	2,004	882
9	841 Poplar	1,220	2,439	1,073
10	187 Kenmore	1,525	3,049	1,342
11	591 Belden	1,002	2,004	882
12	576 Howard	1,045	2,091	920
13	720 Washington	610	1,220	537
14	195 South	871	1,742	767
15	497 Arlington	2,570	5,140	2,262
16	223 May	2,178	4,356	1,917
	Average	1,195	2,390	1,052

*Assuming redeveloped basements are two feet deeper than existing conditions

Because of the cumulative effect that redeveloped properties have on groundwater storage, it is our recommendation that the City consider that future redevelopments be required to mitigate for the displaced storage volume. This volume can be provided in a rain garden, underground pipes, in the void spaces of gravel, or a combination of these three.

12.6 ORDINANCE RECOMMENDATIONS

Based on the results of the redeveloped properties and basement depth analyses, CBBEL suggests making modifications to the City's current stormwater regulations. These suggestions include the following:

1) The City may want to consider modifying the Zoning Ordinance to prescribe a maximum allowable impervious percentage for development. Under the current City code, there is no maximum threshold specified. It is our recommendation that 50% of the total lot area be adopted as the maximum allowable impervious percentage. If the City chooses to incorporate this threshold into the Zoning Ordinance, CBBEL recommends the following modification to **Section 7.2-4 (Maximum Lot Coverage)**: "No building, together with its accessory structures, shall occupy in excess of 25 percent of the area of the lot upon which it is constructed. In addition, the total impervious area, which includes roofs, sidewalks, driveways, and roads, shall occupy no more than 50 percent of the total lot area."

2) The City may also want to consider modifying the Building and Plumbing Code to remove the requirement of directly connecting sump pumps and downspouts to the storm sewer. It is recommended that sumps pumps and downspouts from new construction be required to drain overland to a rain garden constructed in the rear/side yard of the subject property. To incorporate this recommendation into the Building Code, **Section 24.23 (Grading Plan – Downspouts and Sump Discharges)** should be modified as follows: "A topographic survey and grading plan shall be required for all additions, garages, driveways and any structure that requires a footing. All downspouts and sump discharges shall drain overland to a rain garden located on the subject property. The rain garden shall be located at least fifteen (15) feet away from the building location and shall be located outside of the zone of influence for the sanitary sewer. A storm drain shall also be installed to convey excess flows to the storm sewer system." In addition, the Plumbing Code, **Section 27.30 (Building Drainage)** should be modified as follows: "All downspouts and stormwater sump pumps shall meet the requirements set forth in Section 24.23 of the Building Code."

3) The City may also want to consider modifying the Building Code to require any new development that proposes a deeper basement to provide mitigation for the displaced groundwater storage volume. If the City chooses to incorporate this requirement, CBBEL recommends that the following language be added as **Section 24.24 (Basement Depth)** to the Building Code, "Any redevelopment that proposes a basement that is deeper than the existing structure shall provide mitigation for the displaced groundwater storage volume. This volume may be provided in a rain garden, underground pipes, in the void spaces of gravel, or a combination of these."

ELEVATION OF NEW STRUCTURES

To protect future development in the identified flood problem areas, CBBEL recommends that the City implement a Flood Protection System for any new development or redevelopment in these areas. Using the database of City parcels and the existing conditions XP-SWMM model results for the ten flood study areas, the 100-year flood elevation was assigned to every address within the flood problem areas. It is recommended that the finished floor of any new development or redevelopment be elevated to the XP-SWMM 100-year flood elevation plus two feet of freeboard.

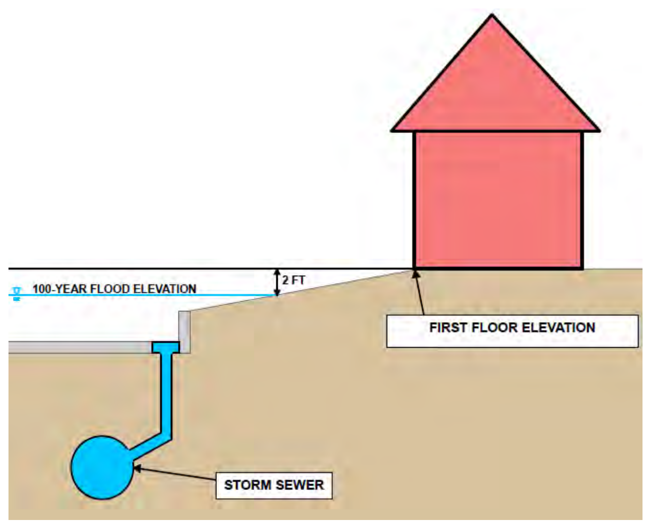

Figure 28. Flood Protection System

To incorporate the Flood Protection System into the City's Ordinance, the following language should be added as ***Section 14.05 (Flood Protection Elevation)***: "New structures located within City-identified flood-prone areas shall be elevated to at least two feet above the 100-year flood elevation, as established in the *Parcel-Flood Elevation Database*. The *Parcel-Flood Elevation Database* as set forth in Appendix B is incorporated as part of this section. In addition to the requirements of this section, properties located within the Regulatory Floodplain according to the FEMA Flood Insurance Rate Maps shall also meet the requirements of the DuPage Countywide Stormwater and Flood Plain Ordinance."

To allow City staff and developers to identify the 100-year flood elevation for a specific property within a flood problem area, the database has been provided in two formats: (1) an Excel spreadsheet that contains each parcel address and corresponding 100-year flood elevation and (2) a GIS shapefile of City parcels that contains the corresponding 100-year flood elevation in the shapefile's Attribute Table.

SUMMARY

Based on the results of the XP-SWMM hydrologic and hydraulic modeling, it was determined that many homes currently have a low level of flood protection, especially those homes in Southwest Elmhurst. The level of flood protection for a design storm event refers to the water surface elevation produced during a particular design storm that causes flooding. From the ten areas analyzed in this study, the existing level of protection ranged from the 2-year through the 50-year return intervals.

To increase the level of flood protection in these ten flood-prone areas, concept-level drainage improvements were analyzed to determine the associated flood reduction benefits. These drainage improvements consisted of the following: creation of flood storage in open space, underground detention storage, construction of relief sewers, upsizing existing storm sewers, and increasing stormwater pumping capacities. Several of the proposed alternatives will require offsite compensatory storage, which significant limits the feasibility of the project due to the cost and permitting requirements. The conceptual cost estimates for the proposed improvements range from $670,000 to $46.5 million.

Because the proposed drainage improvements will require significant expenditures, flood proofing of individual houses was analyzed as an alternative solution. Because many structures are damaged as a result of shallow flood depths, flood proofing is a viable alternative to the large public infrastructure improvements. Although there is significant variability and flood proofing measures need to be evaluated on a case-by-case basis, this option should be pursued by homeowners that experience overland flooding.

Recommended modifications to current stormwater practices required by the City have been provided to improve the performance of the stormwater collection system and to prevent flood damages. To improve the function of the storm sewer system, CBBEL recommends that the following revisions be made to the City Ordinance: specify a maximum allowable impervious percentage per lot, remove the requirement of directly connecting sump pumps and downspouts to the storm sewer, and require redevelopments with deeper basements to provide mitigation for displaced groundwater storage volume. In addition, CBBEL also recommends that all new construction in the identified flood-prone areas be elevated to at least two feet above the XP-SWMM generated 100-year flood elevation in those areas.

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NO	DATE	NATURE OF REVISION	CHKD.

FILE NAME

DSGN.
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CHKD.
SCALE: 1"=
PLOT DATE:
CAD USER:
MODEL:

TITLE:
YORKFIELD STUDY AREA
ALTERNATIVE #2

PROJ. NO. 10-0506
DATE:
SHEET 1 OF 1
DRAWING NO.
EXH 11B

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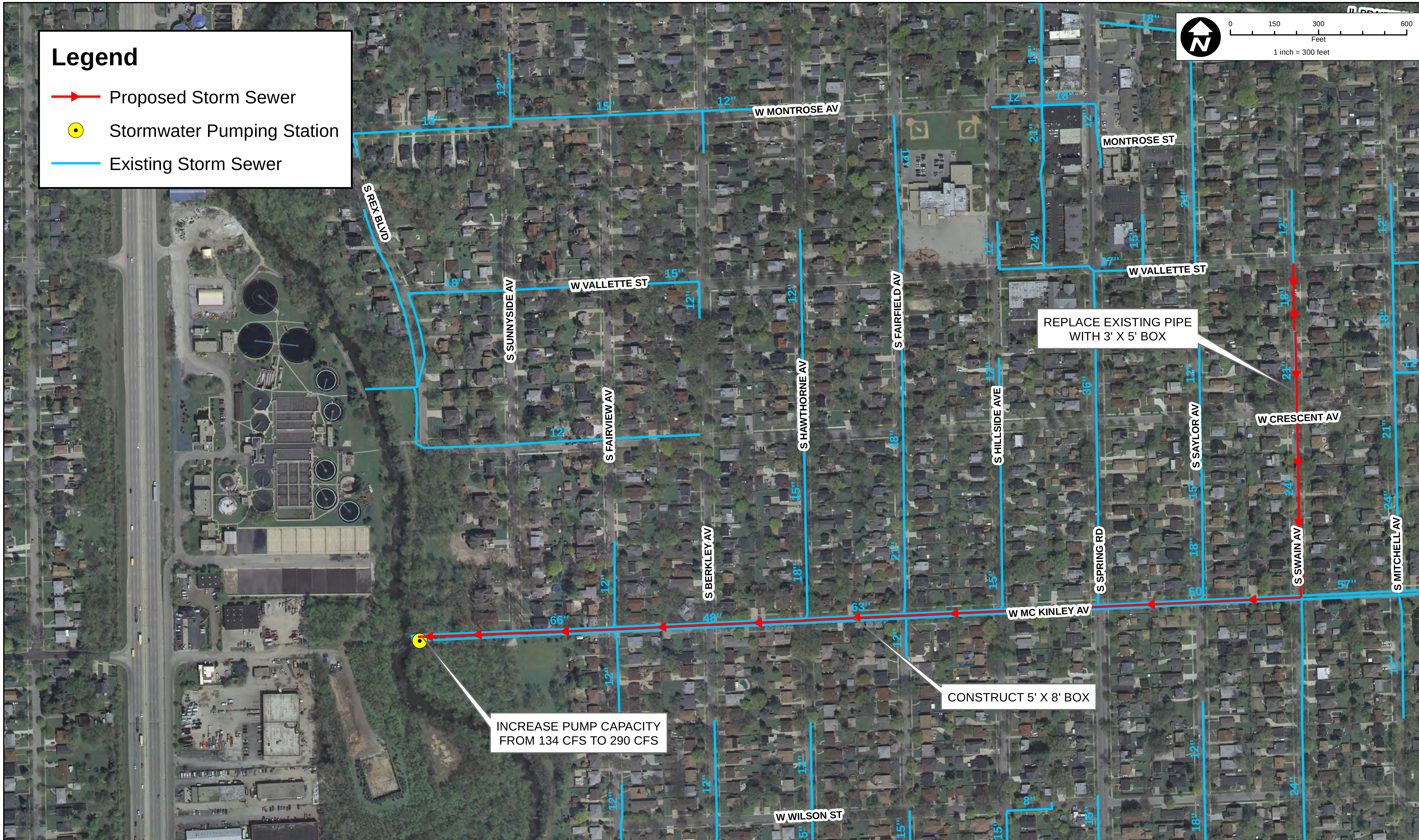

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ALTERNATIVE #4

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EXH 5D

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TITLE:
SOUTHWEST STUDY AREA
ALTERNATIVE #3

PROJ. NO. 10-0506
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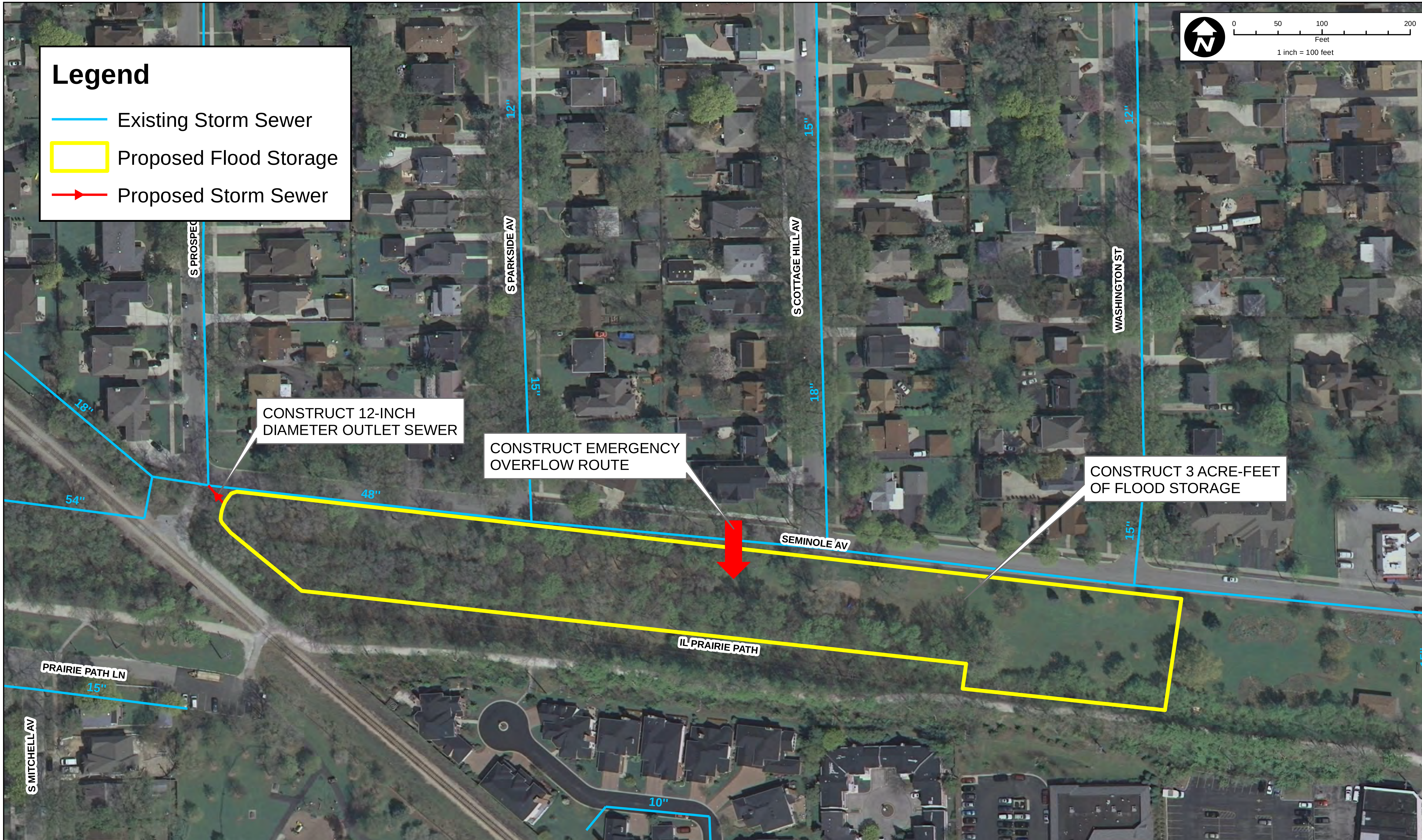

CHRISTOPHER B. BURKE ENGINEERING LTD 9575 West Higgins Road, Suite 600 Rosemont, Illinois 60018 (847) 823-0500	CLIENT: CITY OF ELMHURST	DSGN. DWN. CHKD. SCALE: 1"= PLOT DATE: CAD USER: MODEL: NO. DATE NATURE OF REVISION CHKD. FILE NAME	TITLE: SEMINOLE AVENUE STUDY AREA ALTERNATIVE #2

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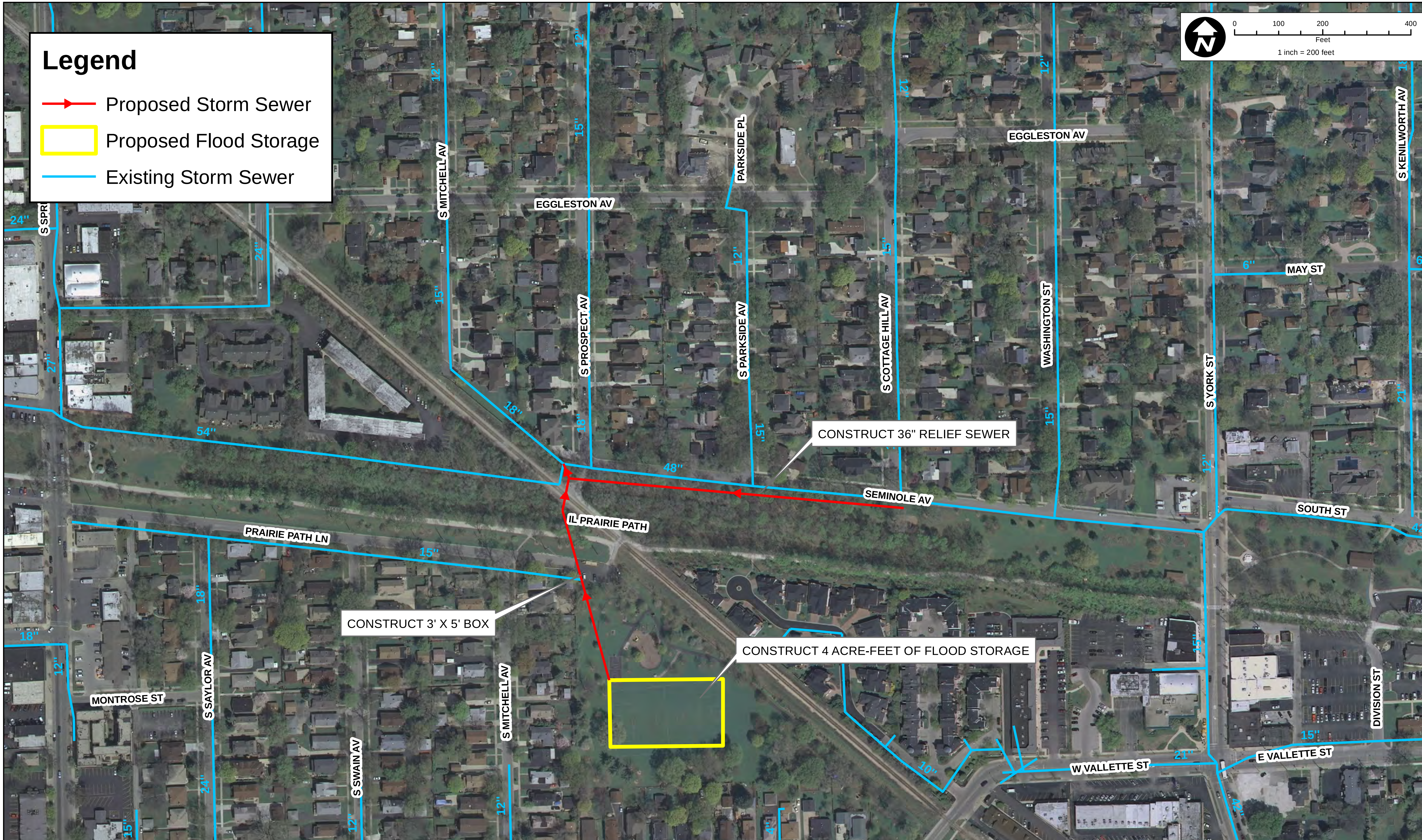

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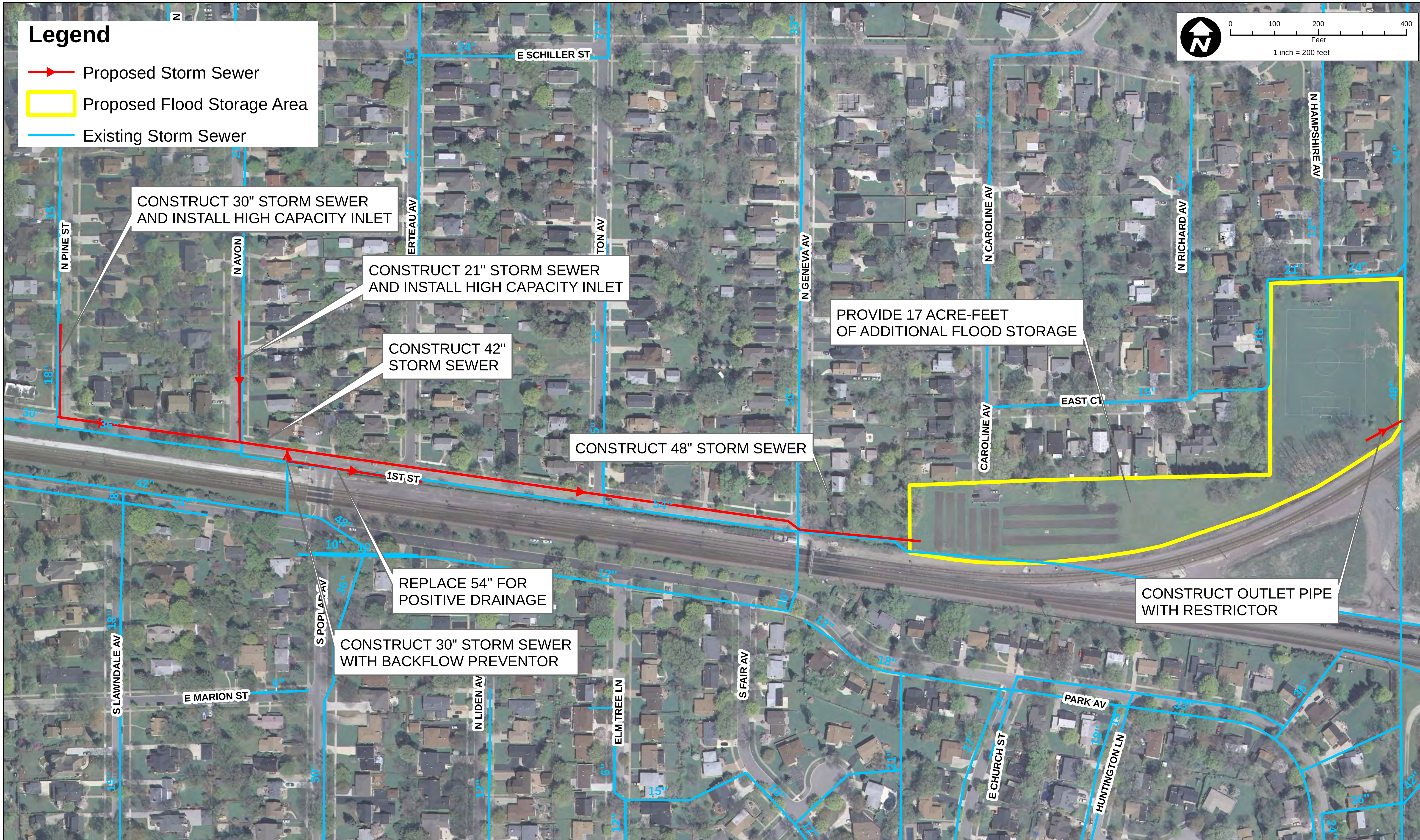

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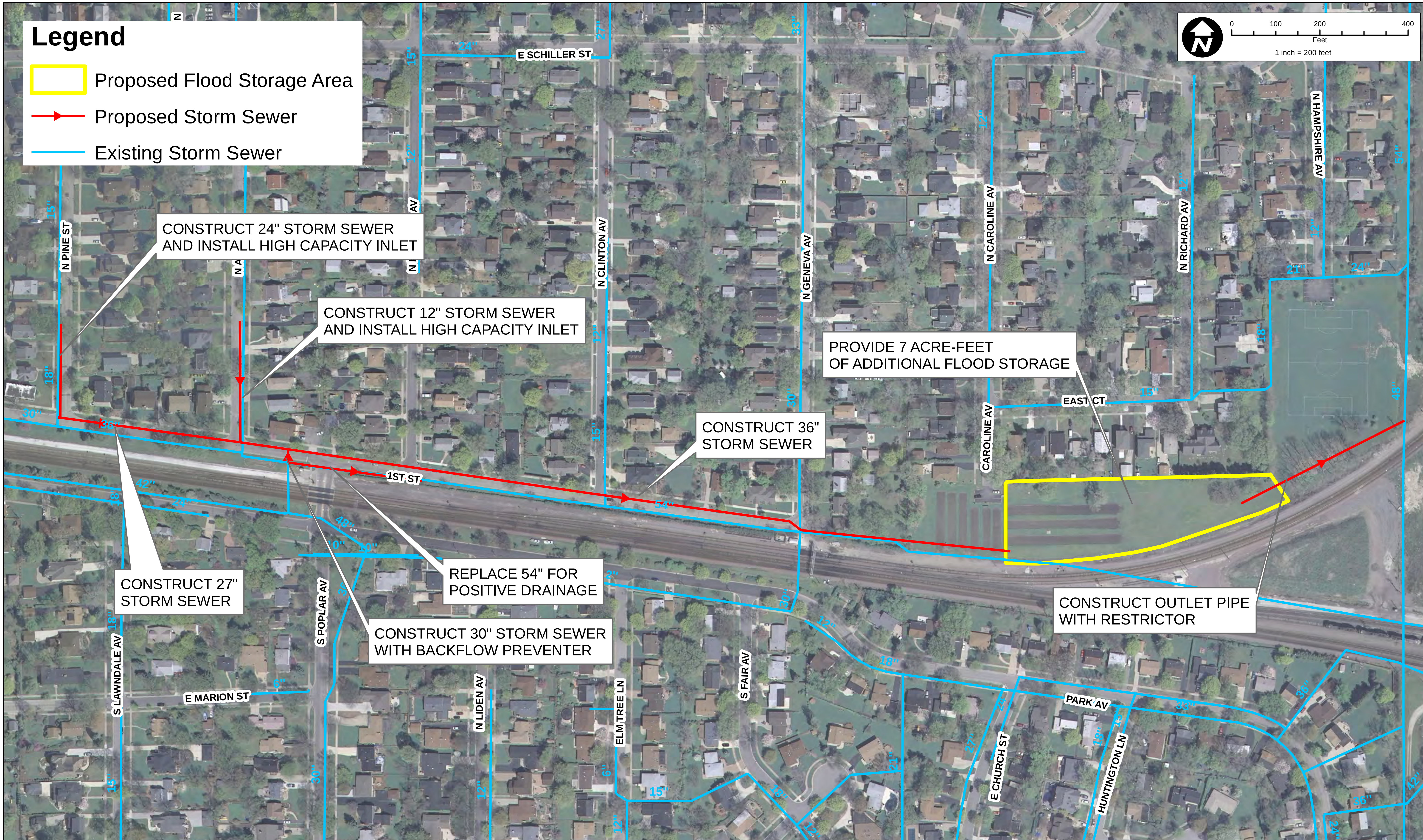

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PROJ. NO. 10-0506
DATE:
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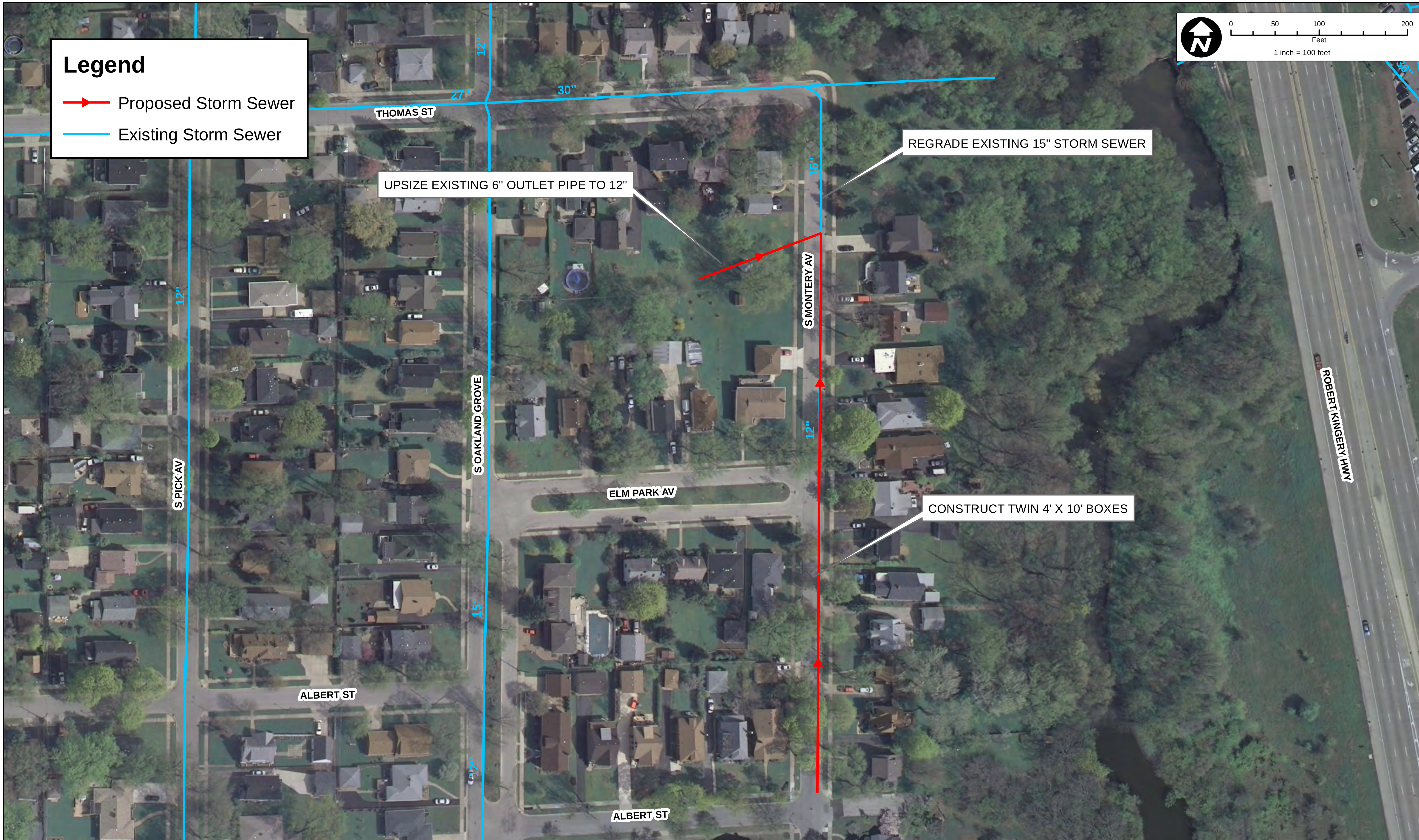

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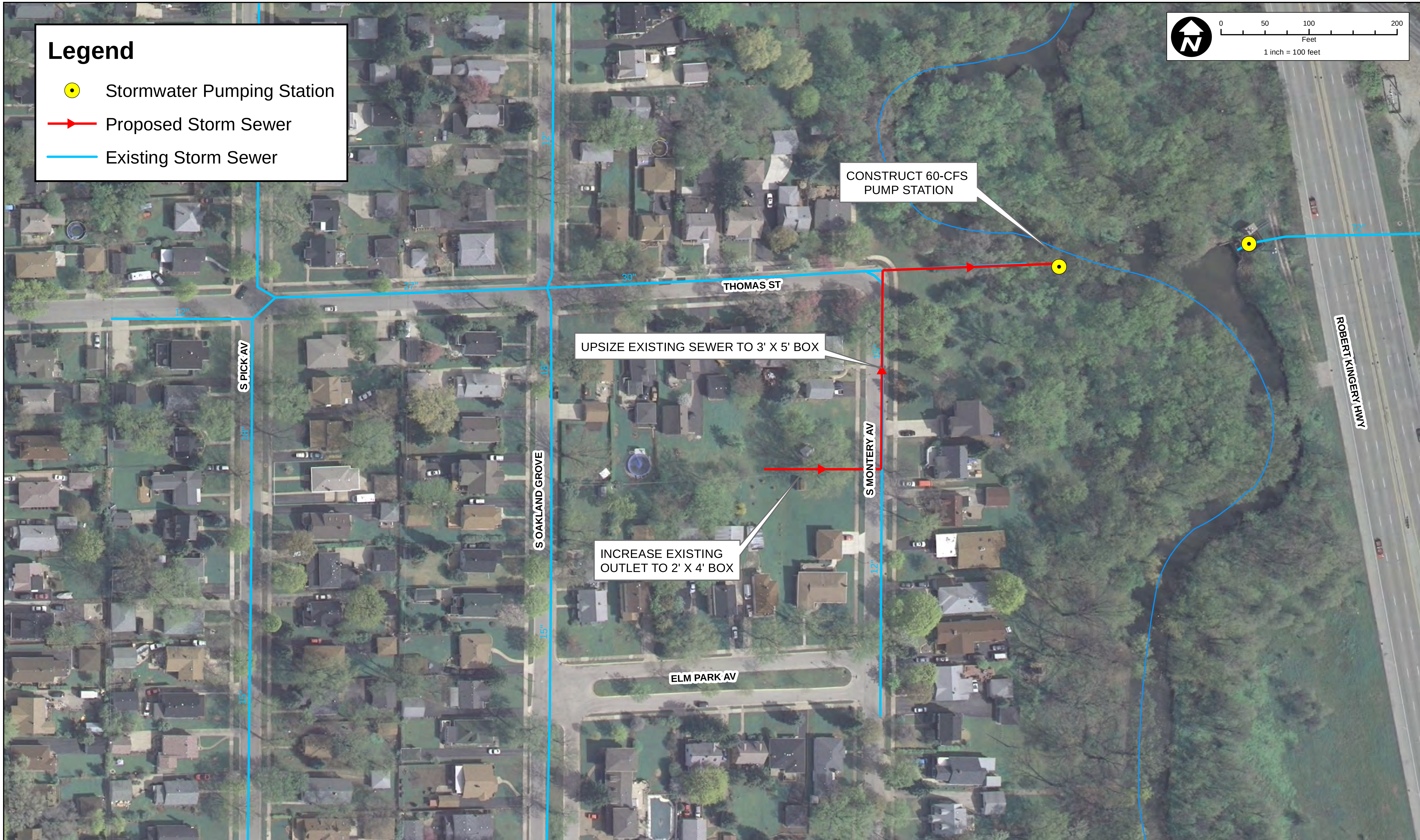

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PICK SUBDIVISION STUDY AREA
ALTERNATIVE #1

PROJ. NO. 10-0506
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EXH 10A

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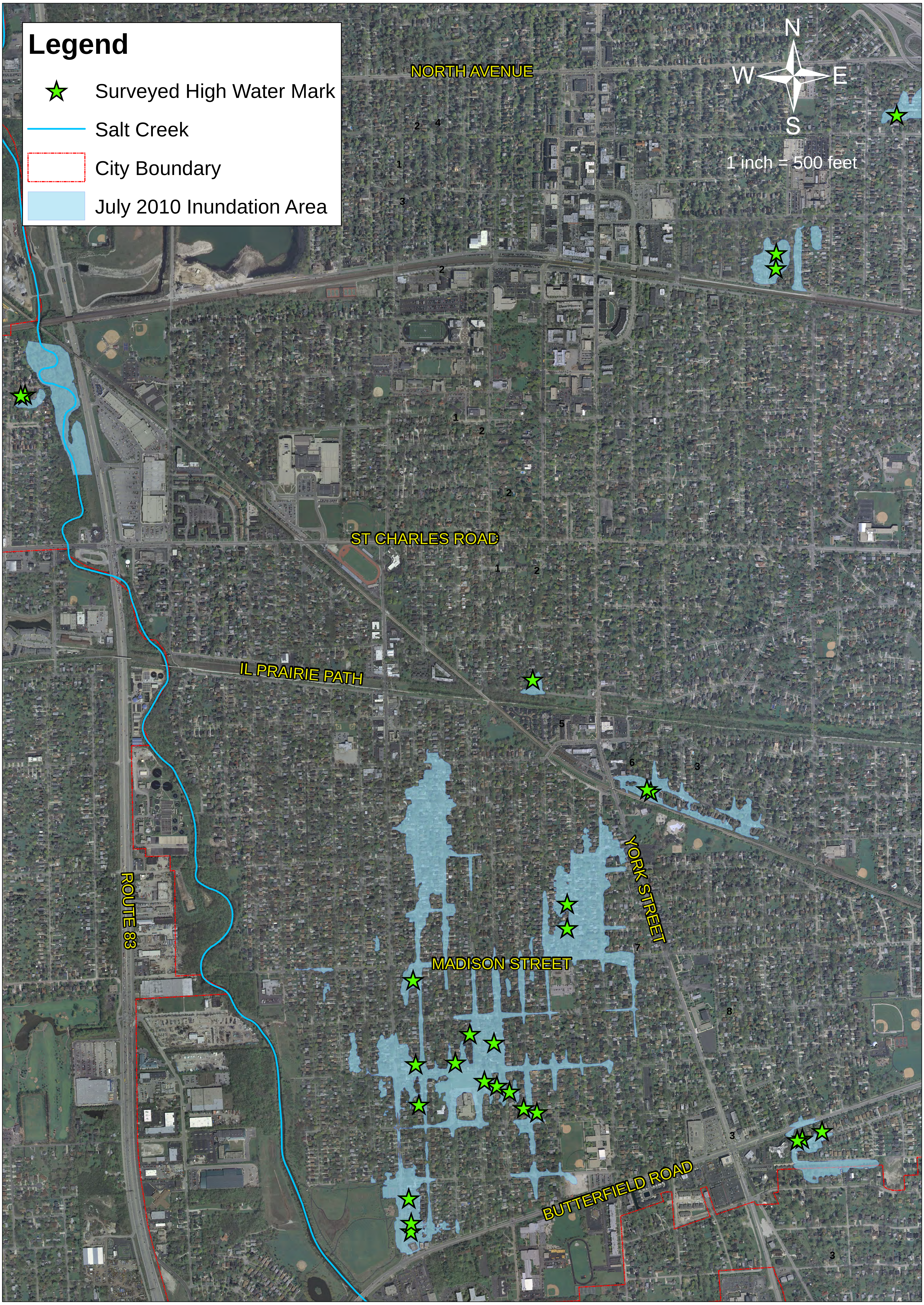

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9575 West Higgins Road, Suite 600
Rosemont, IL 60018
(847) 823-0500 / FAX (847) 823-0520

CLIENT: CITY OF ELMHURST	JOB#: 10-0506	DSGN.: LJS	CHKD.:
TITLE: SURVEYED HIGH WATER MARK LOCATION MAP		DATE: 12/19/11	EXHIBIT 2

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TITLE:
GENEVA AVENUE STUDY AREA
ALTERNATIVE #1

PROJ. NO. 10-0506
DATE:
SHEET 1 OF 1
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EXH 4

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CLIENT:
CITY OF ELMHURST

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TITLE:
JUNE/JULY 2010
FLOOD QUESTIONNAIRE
RESPONSE SUMMARY

PROJ. NO. 10-0441
DATE:
SHEET 4 OF 4
DRAWING NO.
EXH 1

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				DWN.	LJS
				CHKD.	
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TITLE: JUNE/JULY 2010 FLOOD QUESTIONNAIRE RESPONSE SUMMARY

PROJ. NO. 10-0441
DATE:
SHEET 3 OF 4
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CLIENT: CITY OF ELMHURST

NO.	DATE	NATURE OF REVISION	CHKD.

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CHKD.:
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PROJ. NO. 10-0441
DATE:
SHEET 2 OF 4
DRAWING NO. EXH 1

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Rosemont, Illinois 60018
(847) 823-0500

CLIENT: CITY OF ELMHURST

NO.	DATE	NATURE OF REVISION	CHKD.

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DWN.: LJS
CHKD.:
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DATE:
SHEET 1 OF 4
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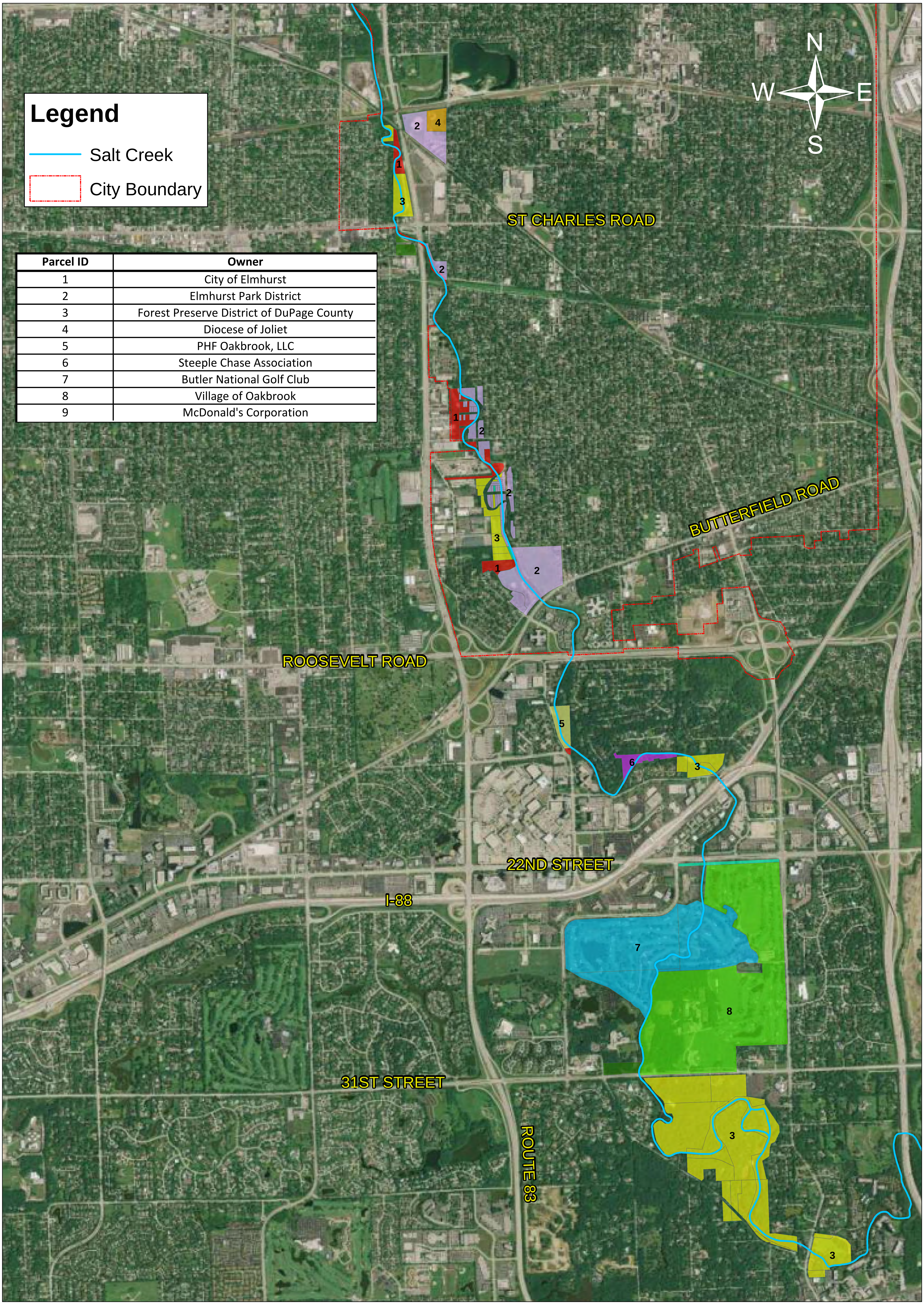

Parcel ID	Owner
1	City of Elmhurst
2	Elmhurst Park District
3	Forest Preserve District of DuPage County
4	Diocese of Joliet
5	PHF Oakbrook, LLC
6	Steeple Chase Association
7	Butler National Golf Club
8	Village of Oakbrook
9	McDonald's Corporation

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Rosemont, IL 60018
(847) 823-0500 / FAX (847) 823-0520

CLIENT	JOB#	DSGN.	CHKD.
CITY OF ELMHURST	10-0506	LJS	
TITLE: COMPENSATORY STORAGE PARCEL LOCATION MAP		DATE 9/6/11	
		EXHIBIT 12	

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Rosemont, Illinois 60018
(847) 823-0500

CLIENT:
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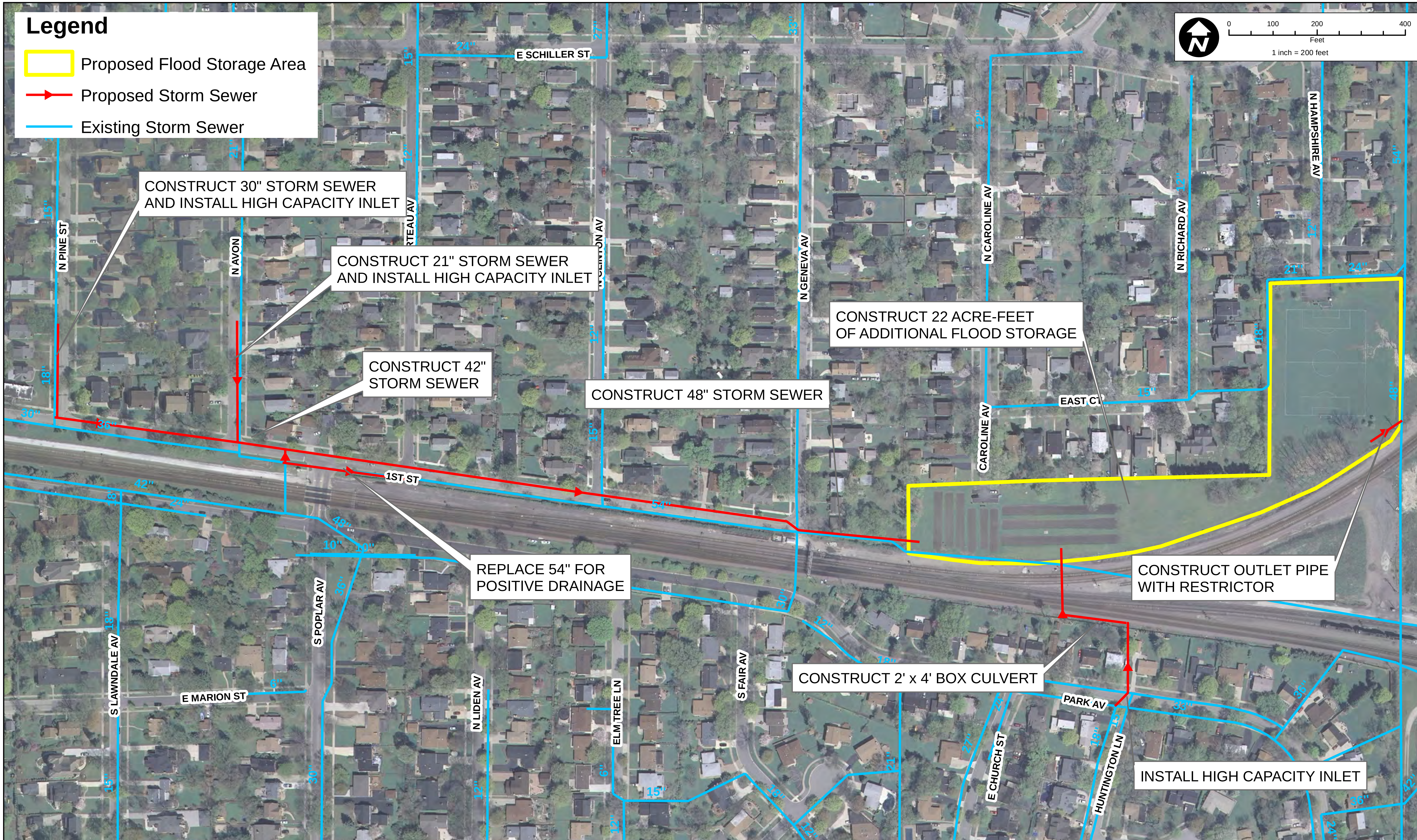
MODEL:
FILE NAME

TITLE:
BRYNHAVEN STUDY AREA
ALTERNATIVE #2

PROJ. NO.
DATE:
SHEET 1 OF 1
DRAWING NO.
EXH 9B



CHRISTOPHER B. BURKE ENGINEERING LTD
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CLIENT: CITY OF ELMHURST

NO.	DATE	NATURE OF REVISION	CHKD.

DSGN.
DWN.
CHKD.
SCALE: 1"=
PLOT DATE:
CAD USER:
MODEL:
FILE NAME

TITLE: BRYNHAVEN STUDY AREA ALTERNATIVE #1

PROJ. NO. 10-0506
DATE:
SHEET 1 OF 1
DRAWING NO. EXH 9A