

**STORMWATER MASTER PLAN FOR THE  
ROBERTS ROAD DRAINAGE AREA**



**CONTRACT 14-821-5C**

**PROJECT SITE:**

**BEDFORD PARK, BRIDGEVIEW, HICKORY HILLS, JUSTICE, PALOS HILLS, IL**

**71<sup>ST</sup> STREET DITCH, 79<sup>TH</sup> STREET SEWER, JUSTICE DITCH, LUCAS DITCH,  
AND LUCAS DIVERSION DITCH SUBWATERSHEDS OF THE CAL-SAG WATERSHED**

**CALUMET SERVICE AREA**

**PREPARED FOR:**

**METROPOLITAN WATER RECLAMATION DISTRICT  
OF GREATER CHICAGO  
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**VOLUME 1 OF 2**

**NOVEMBER 1, 2016**

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\*Six separate exhibits provided, one each for an overview of the entire project area, followed by detailed views of each of the six major subwatersheds. (The Roberts Road and Lucas Ditch subwatersheds are combined on a single detailed view exhibit.)

\*\*Four separate exhibits provided, one each for the 2-hr Northern Subbasins, 2-Hr Southern Subbasins, 24-hr Northern Subbasins, and 24-hr Southern Subbasins.

\*\*\*Four separate exhibits provided, one each for Rain Gardens, Rain Cisterns, Infiltration Trenches, and Permeable Pavement.

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## **Executive Summary**

The Roberts Road Stormwater Master Plan (SMP) determined the locations and causes of local flooding within the Roberts Road study area, which includes most of Justice, Hickory Hills and Palos Hills, and portions of Bridgeview and Bedford Park. The goals of the project are twofold:

1. To develop concept-level alternatives that reduce flooding and protect every home in the study area against basement and first floor flooding during the 1% annual chance design storm;
2. To engage and encourage the public to be part of the solution by installing green infrastructure (“GI”) and stormwater best management practices (“BMPs”) on their private property, which will reduce damages on their own property, their neighbors, and homes downstream.

The Roberts Road study area includes six separate subwatersheds. 71<sup>st</sup> Street Ditch, 79<sup>th</sup> Street Ditch, and Justice Ditch are located at the north end of the study area and discharge to the Illinois & Michigan Canal. Lucas Ditch, Lucas Diversion Ditch, and Roberts Road Sewer subwatersheds are located at the south end of the study area and discharge to Stony Creek, just upstream of Stony Creek’s confluence with the Calumet Sag Channel.

22 problem areas were identified by the local municipalities and transportation agencies within the study area. These known problem areas were modeled by V3 using XP-SWMM. Through a review of the modeling results, an additional 4 problem areas were identified by V3. All 26 of these problem areas were evaluated to determine the apparent cause of flooding, and proposed alternatives were developed for each problem area. Large scale capital improvement projects were identified to eliminate structural flooding, including new or expanded storage on undeveloped parcels, storm sewer improvements, rerouting storm sewers, ditch maintenance, and ditch regrading to improve conveyance capacity. It is understood that large scale improvements are not always economically feasible or have a high enough benefit versus cost ratio, so medium scale capital improvement projects (scaled back versions of the large scale projects) were also identified to reduce structural flooding for this study area. An analysis was also performed to determine the benefit of residential level green infrastructure and widespread implementation of private property BMPs on each of the problem areas, with and without the large or medium scale improvements in place.

The large scale projects were found to be effective in protecting the vast majority of homes from flooding, with most alternatives achieving essentially 100% reductions in first floor flooding. Medium scale projects reduce flooding but not for every home; however the projects can be implemented at a lesser total project cost. Private property GI and BMPs can also reduce damages, although GI/BMPs alone will not solve the problem. According to the modeling results, throughout the entire study area, the following levels of protection are expected. (The values below represent the percent of structures that are expected to be removed from first floor flooding, or removed from flooding adjacent to the foundation, upon completion of the alternatives. The ranges given for % removed are for the 2-hour and 24-hour storms).

- **Benefit to structures with first floor flooding:**
  - Large scale projects benefit 91-95% of structures
  - Medium scale projects benefit 67-84% of structures
  - GI and BMPs alone benefit 46-47% of structures
  - GI and BMPs with medium-scale projects benefit 83-86% of structures
- **Benefit to structures with flooding adjacent to the foundation:**
  - Large scale projects benefit 64-73% of structures
  - Medium scale projects benefit 53-60% of structures
  - GI and BMPs alone benefit 30-39% of structures
  - GI and BMPs with medium-scale projects benefit 62-70% of structures

At the beginning of this study, as many as 40% of homeowners indicated that they installed BMPs or would be willing to install BMPs. Through the year-long public outreach and engagement campaign, the number increased to over 60% at the end of the study. The most positive response was towards rain barrels and native plants. Encouraging rain barrel use can provide a gateway, or a means, for people to begin thinking differently about stormwater and about private property GI/BMPs. With a shift in mindset, including acknowledgement that everyone can be part of the flooding solution, and thinking of rainwater as a resource instead of a waste product, it may be possible to encourage greater use of GI/BMPs such as rain gardens, infiltration trenches, and permeable pavers, which have a greater ability to store rainfall, reduce runoff and reduce flooding.

The GI/BMP results assume that every private property owner, such as homeowners and business entities, within the study area is willing to install GI or BMPs to capture the first 0.6 – 1.1 inches of rainfall, through rain gardens, infiltration trenches, rain cisterns, or permeable pavers with underlying stone storage. A spot-check of several parcels within the study area shows that it may be difficult to fit the full required size of some of the GI/BMPs on an individual lot, due to features such as decks, pools, detached garages and sheds, playsets, and landscaping areas. The results also assume that all public entities, such as municipalities, park districts or utility companies, participate in this process as well, by constructing BMPs/GI to store and promote infiltration within the right-of-way or other usable space before waters enter the storm sewer system. For roadway systems this can be accomplished through permeable pavements in the parking lanes, open-bottom catch basins in the stormwater system, vegetated swales in the parkway, or oversized storm sewers to provide some storage in addition to the design conveyance capacity.

The construction costs were estimated as follows:

- **Large scale projects:**
  - \$192.8M total for all projects
  - \$140k - \$57.6M per each project
  - \$175k - \$5.3M per structure benefitted, based on first floor flooding
  - \$65k - \$1.8M per structure benefitted, based on flooding adjacent to the foundation
- **Large scale projects, if constructed in conjunction with roadway improvement projects:**
  - \$165.5M total for all projects
  - \$140k - \$46.2M per each project
  - \$152k - \$4.5M per structure benefitted, based on first floor flooding
  - \$54k - \$1.5M per structure benefitted, based on flooding adjacent to the foundation
- **Medium scale projects:**
  - \$156.9M total for all projects
  - \$140k - \$31.7M per each project
  - \$128k - \$5.2M per structure benefitted, based on first floor flooding
  - \$65k - \$1.7M per structure benefitted, based on flooding adjacent to the foundation
- **Medium scale projects, if constructed in conjunction with roadway improvement projects:**
  - \$138.1M total for all projects
  - \$140k - \$31.6M per each project
  - \$95k - \$4.5M per structure benefitted, based on first floor flooding
  - \$54k - \$1.6M per structure benefitted, based on flooding adjacent to the foundation
- **All public and private property GI / BMPs, constructed throughout the study area:**
  - \$55.4M - \$191M, to capture 0.6 inches of rainfall (amount just for 12,300 homes)
  - \$92.3M - \$351M, to capture 1.1 inches of rainfall (amount just for 12,300 homes)

## **Introduction**

The purpose of this Stormwater Master Plan is to determine the locations and causes of local flooding within the Roberts Road Drainage Area, and to develop concept-level alternatives and construction cost estimates to reduce flood damages for a 1% annual chance design storm (“100-year design storm”). A second goal is to engage the public in a meaningful way, encourage their participation in stormwater management activities on private property, and explore and shift the cultural perception that flooding is “someone else’s problem to solve”.

The Roberts Road Drainage Area is shown in Exhibit 1. The study area is roughly bounded by the Illinois & Michigan Canal (I&M Canal) and the Chicago Sanitary and Shipping Canal (“CSSC”) on the north, Stony Creek on the south, varies from 88th Avenue to South LaGrange Road (US-45) on the west, and Harlem Avenue on the east. The study area is bisected by Roberts Road and includes part or all of the municipalities of Bedford Park, Bridgeview, Hickory Hills, Justice, and Palos Hills. (The residential area of Bedford Park is outside the study area).

The study area includes six subwatersheds (71<sup>st</sup> Ditch, Justice Ditch, 79<sup>th</sup> Street Sewer, Roberts Road, Lucas Ditch, and Lucas Diversion Ditch) of the Cal-Sag Watershed, five of which were defined in the District’s Detailed Watershed Plan (“DWP”) for the Calumet-Sag Channel Watershed, August 2009. A sixth subwatershed was added to the delineation, the Roberts Road Sewer subwatershed. This subwatershed is adjacent to the Lucas Ditch and Lucas Diversion Ditch Watersheds, but is delineated separately because it has its own outlet to Stony Creek. It is discussed in conjunction with the Lucas Ditch subwatershed, for the purpose of this report, and to avoid confusion between “Roberts Road Drainage Area” (which encompasses all six subwatersheds) and “Roberts Road Subwatershed” (which is the smaller subwatershed outletting to Stony Creek).

The Roberts Road Drainage Area is primarily served by a separate storm sewer system. The north part of the study area (71st Street Ditch, Justice Ditch, and 79<sup>th</sup> Street Sewer subwatersheds) drains to the I&M Canal and the CSSC. The south part of the study area (Lucas Ditch and Lucas Diversion Ditch subwatersheds) drains to Stony Creek and ultimately the Cal-Sag Channel. In general, the storm sewer systems and other conveyance systems are undersized and there is a lack of storage, resulting in drainage problems in moderate to large storm events. This drainage area was selected for study by the MWRD at the request of the Southwest Conference of Mayors.

The DWP included an identification of problem areas within the Roberts Road study area’s subwatersheds (as identified by the local municipalities and IDOT in 2009). The DWP included a classification of problem areas as “local” or “regional” and a hydrologic and hydraulic analysis of the open waterways, and development of project alternatives to reduce damages within the regional problem areas. The DWP included several storage and conveyance alternatives within the Roberts Road study area, but showed that some flooding still remains in a 100-year flood with implementation of the alternatives. The DWP did not evaluate local problem areas or analyze closed drainage systems such as storm sewers.

The goal of the Roberts Road Drainage Area stormwater study is to evaluate all problem areas (local and regional problem areas identified in the DWP, plus any additional problem areas that are identified through this study) and recommend alternatives that can provide a 100-year level of protection to all structures within the problem areas, including protection against basement flooding. This will include a restudy of the areas evaluated in the DWP to provide additional flood protection, as well as a new study of problem areas that were omitted from the DWP project. Reducing street and yard flooding is not a goal of this project, although street and yard flooding will be reduced as a consequence of projects that reduce structural house flooding.

The cost to implement alternatives that provide all structures with a 100-year level of protection is high. Therefore, another goal of the Roberts Road Drainage Area stormwater study is to refine the recommended alternatives to identify a separate set of “medium scale” alternatives that may provide a lesser degree of protection, but can be implemented at a more achievable cost. “Residential scale” alternatives are also proposed, consisting of green infrastructure and stormwater best management practices, to capture small amounts of rainfall and reduce flooding on the property and also on all properties downstream. Further, the recommendations of this study identify logical progressive or staged construction activities that represent priority or pre-requisite based alternatives.

This study recommends alternatives that require construction within the public right-of-way, public lands such as parks, schools, etc., or private property, including single family residential private property. Locations of these alternatives will be prioritized for study as follows: 1, alternatives located in the public right-of-way; 2, alternatives located on public lands; and 3, alternatives located on private property.

## **Stakeholder Summary**

A number of stakeholders were involved in the process of preparing this Stormwater Master Plan. The study area includes six subwatersheds that encompass parts or all of five communities, which were all involved in this project as major stakeholders:

- City of Hickory Hills
- City of Palos Hills
- Village of Bedford Park
- Village of Bridgeview
- Village of Justice

Cook County Department of Transportation and Highways was also involved as a major stakeholder, particularly with respect to Roberts Road, which is planned for reconstruction and rehabilitation in the near future.

The general public was also involved as a stakeholder in this Stormwater Master Plan (SMP), as described in the Outreach sections of this SMP.

Other stakeholders include landowners that will be asked to participate in the proposed project alternatives, including IDOT, ComEd, the Archdiocese of Chicago, the Forest Preserve District of Cook County, the Hickory Hills Park District, Illinois Tollway, CN railroad, the Sterling Estates Manufactured Home Community, and many private property owners on which public capital improvement projects are proposed. These other stakeholders have not been involved in the project to date, but will need to participate as cooperative partners to successfully implement the proposed alternatives.

## **Outreach Efforts**

### **Outreach to Governmental Stakeholders**

The governmental stakeholders were engaged early on in this project, and continued to participate throughout preparation of the study.

- August 7, 2014: Kickoff / Scoping meeting with MWRD, five communities, and CCDOTH, to collect data related to locations and types of flooding problems within the study area.
- September 10, 2014: MWRD attended CCDOTH meeting with Roberts Road communities to discuss planned roadway improvements.
- February 19, 2015: MWRD attended another CCDOTH meeting with Roberts Road communities to discuss planned roadway improvements. CCDOTH agreed to defer construction of Roberts Road until completion of the SMP, so that any alternatives on Roberts Road could be considered for incorporation within the Roberts Road improvement plans.
- June 17, 2015: Roundtable progress meeting with five communities and CCDOTH, to review consultant-generated exhibits summarizing locations of known flood problems and possible alternatives.

- October 5, 7 and 13, 2015: Individual progress meetings with each municipality, focused on further data collection regarding sanitary sewer overflows and basement flooding due to sanitary backup.
- March 16, 2016: Progress meeting with municipalities, focused on presenting the draft Public Education and Outreach Toolkit and materials.

Governmental stakeholders were also invited to the public outreach meetings, and most did attend and participate in those meetings. These stakeholders were also contacted throughout the project with various requests for data and information; all stakeholders were responsive, helpful, and instrumental in providing the necessary information to conduct this study.

### Outreach to the General Public

The project utilized a very specific, tried and true method for researching and developing the education, outreach and behavior change campaigns. This tried and true method is summarized in this section of the SMP and presented in detail in Appendix A: Public Outreach.

To truly address long-standing flooding and stormwater issues in Cook County, the public must adopt certain behaviors and accept certain realities; the public must be part of the solution. To persuade people to take action, it is important to appeal to them through their existing values and experiences. As previous public engagement efforts on stormwater issues have shown, educating them with facts alone won't work, and there is no "one size fits all" campaign.

A summary of the public outreach effort is presented herein. A complete description can be found in Appendix A: Public Outreach.

### Initial Research

Before developing an outreach campaign to engage and inspire the public, we first sought to understand their values, knowledge and current behaviors, so that the outreach campaign could be tailored specifically to the Roberts Road stakeholders. This initial research was done through a questionnaire and also through a series of public meetings/workshops.

A two-part questionnaire was developed and sent to every address within the Roberts Road Drainage Area. The questionnaire was also available electronically, and most governmental stakeholders posted the links on their websites, Facebook pages, etc. Part 1 of the questionnaire asked specific questions about whether the home or street had flooded, and if so, how often and why. The results of Part 1 were used to identify existing problem locations. Part 2 of the questionnaire asked specific questions to determine the public's existing attitudes, opinions and values with respect to both flooding and to their community in general. The results of Part 2 directly informed the subsequent outreach campaign.

A series of public meetings were held in November 2015, as a focus group / workshop to delve more deeply into understanding the attitudes and opinions of the public regarding flooding, the party(ies) responsible for solving flooding problems, their knowledge of private property BMPs to reduce flooding, and their willingness to cooperate as partners in the solutions. The meetings were designed as interactive workshops in which the public was an active participant rather than a passive listener, to allow for gathering of opinions and ideas, and to allow the public a chance to feel "heard". Two meetings were opened to the general public and advertised through print media, social media, community group email/contact lists, and through the municipalities. A third meeting was a "crash" of a pre-established

Rotary Club meeting; many attempts were made to schedule “crashes” of other community group meetings, but were not successful during this time period.

### Public Outreach and Education Campaign Development

Based on the results of the questionnaire and the November meetings, a public outreach and education campaign was developed. Print and social media messages, flyers, fact sheets, articles, and mailings were all created to speak to the values of the community while also inspiring homeowners to understand that they can be part of the solution. The materials also provided the public with tools to invest in their own stormwater management solutions on their own properties. The outreach materials were presented to the municipal stakeholders in spring 2016, and customized for each municipality based on feedback received.

### Public Outreach and Education Campaign Roll-out

The final materials were distributed throughout the study area through various messengers and pathways in the late spring / early summer. The campaign roll-out also included several public meetings, including a Stormwater Expo for residents to see, touch, and learn about various BMPs. Meetings also included “crashes” of pre-existing community meetings such as the Rotary Club, Garden Club, Farmers Markets, etc., to provide materials and education about stormwater BMPs.

Municipalities were also provided with a toolkit of outreach materials and messages, and a timeline/schedule for distributing those messages in the future, so that the current outreach efforts can continue indefinitely.

The effectiveness of the message was measured with a post-campaign questionnaire distributed throughout the watershed in May/June 2016, to compare to the 2015 questionnaire results and measure the change in public attitude and willingness to participate in stormwater solutions.

## **Outreach Results**

### Results of Outreach to Governmental Stakeholders

The outreach to the governmental stakeholders was successful in collecting the necessary data to support the engineering effort, including locations of known flooding, various sewer atlases, as-built plans of prior improvements, etc. Governmental stakeholders were also helpful and engaged in reviewing the proposed alternatives during a June 2015 meeting, and offered valuable feedback. Minutes of these meetings can be found in Appendix A.

Outreach to the governmental stakeholders was also performed as part of the public outreach and education campaign. Governmental stakeholders offered feedback on the outreach campaign and messaging materials, and participated in various open meetings.

### Results of Outreach to General Public: Public Attitudes towards Flooding and Green Infrastructure

The first outreach activity involved asking the general public to complete a questionnaire to collect information on flooding locations and gauge the public’s opinion towards flooding and flood reduction measures.

The first questionnaire was distributed to approximately 12,000 addresses in the study area via US Mail in July 2015. Over 420 responses were received, roughly half as hard copies returned in the mail and half as

surveymonkey.com responses. (The mailing included a QR code and a web address to complete the survey online). Although this is a small percentage of the total mailing, the respondents were widely distributed across the study area. 75% of respondents experienced flooding, and 25% did not. The results showed that as many as 41% of respondents had installed some type of green infrastructure, with the highest percentage of respondents selecting rain barrels and native plantings. Rain barrels and native plantings have the lowest amount of stormwater storage associated with them (compared to the other green infrastructure measures that were considered), but they are important measures. They may provide a “gateway” for the public to begin considering stormwater as a positive resource instead of a negative waste product, and may act to shift the public’s mindset and lead to future consideration or implementation of other BMPs such as rain cisterns, rain gardens, and permeable pavements, which have a higher ability to reduce runoff and reduce flooding.

The complete results of the 2015 questionnaire can be found in Appendix B, including a copy of the questionnaire and a graphical copy of the results. Map exhibits in Appendix B show where the locations of respondents are according to watershed location and the types of flooding events experienced or the respondents’ perception of or attitude toward those flooding events or stormwater BMP practices.

A second questionnaire was distributed in May/June 2016, with results found in Appendix C, including graphical results and GIS map-based results. The second questionnaire asked some of the same questions as the first. 350 questionnaires were received, which is slightly less than the first questionnaire, but results were widespread across the study area. The goal of the second questionnaire was to measure the public’s shift in attitude towards flooding and green infrastructure as a result of the year-long outreach and education process.

The second questionnaire produced two key findings: more people are willing to implement green infrastructure, and more people believe that reducing flooding should be a joint effort between government and property owners (rather than solely a government responsibility). It is believed that the public outreach and education campaign was successful in shifting public opinion in a positive direction, although more work is necessary to achieve full public support and implementation of private property green infrastructure. Table 0 summarizes these results.

**Table 0: Comparison of 2015 and 2016 Questionnaire Results**

Question	No. of Respondents		% of Respondents		% Change
	2015	2016	2015	2016	
<i>Have you done or would you be willing to do these GI measures:</i>					
Install a rain barrel	128	179	30%	51%	68%
Install a rain cistern	24	36	6%	10%	80%
Plant a rain garden	87	133	21%	38%	83%
Use native plants	174	219	41%	62%	51%
Use permeable pavers	85	118	20%	34%	67%
<i>Who do you believe is responsible for reducing flood damages?</i>					
Private landowners	28	20	7%	6%	-14%
Government	105	88	25%	25%	1%
Businesses and developers	49	59	12%	17%	44%
No one (Act of God)	19	11	5%	3%	-31%
Everyone is partially responsible	134	162	32%	46%	45%
<i>Total Number of Questionnaires Received</i>	421	351			

### Results of Outreach to General Public: Participation in Meetings

The public meetings had mixed success. The meeting formats successfully provided a means of sharing and receiving information. The Stormwater Expo also received good feedback, with attendees able to touch and see various stormwater BMPs, ask questions about installation and maintenance and purpose, and bring home useful literature. Municipal representatives were also on hand to answer site-specific questions.

While the content and organization of the open meetings and Expo was well-reviewed, attendance was low. The study area has not experienced a significant or damaging rainfall event in the past few years, so it is believed that stormwater and flooding are not at the forefront of people's minds.

The results of the second questionnaire showed that people received notification of the Expo (and other events), but people did not take initiative to attend the events. It will be important for future meetings to "meet people where they are," both emotionally and physically. Additionally, presenting at existing community meetings such as garden clubs, rotary clubs, church groups, farmer's markets, etc., can provide an effective way to reach large numbers of civic-minded people, who can then spread the stormwater message through their pre-established communication pathways.

Future Stormwater Expos can be hosted as "pop-up meetings", to occur shortly after the next significant storm event, when people will be most receptive to learning about ways to manage stormwater and most motivated to attend. The materials and booths that were prepared for the 2016 Stormwater Expo can be easily and quickly reproduced for a future meeting.

## **Existing Conditions Summary**

The subwatershed divides established as part of the MWRD's Detailed Watershed Plans were reviewed against the topographic mapping, survey data, storm sewer atlases, and other available information to refine subwatersheds as necessary. The subwatershed divides used for this stormwater master plan generally match the subwatershed divides established in the DWP. A comparison of the DWP divides and the Stormwater Master Plan divides are shown on Exhibits 2 and 3. Those exhibits also show locations where accumulated floodwaters cross subwatershed divides during higher flow events.

Existing land use mapping, aerial mapping, soil mapping, wetland mapping, FEMA floodplain mapping, and MWRD inundation mapping was also reviewed to establish the existing conditions. These baseline maps can be found as Exhibits 4 – 12. An overview of the topographic maps, showing the topographic relief of the study area as a whole and of each individual subbasin, can be found in Exhibits 13 - 18. Detailed overviews of each subwatershed can be found in Exhibits 19 - 23, and discussed in detail later in this study, on a subwatershed-by-subwatershed basis.

## **Description of Flooding Issues**

Drainage problems are shown in Table 1, based on a review of the Cal-Sag DWP, discussions with the municipalities in 2014 and 2015, review of information provided by the municipalities, a review of the XP-SWMM model results, and a review of questionnaire responses submitted by residents in 2015.

### **Flooding due to Stormwater Runoff**

Identified drainage problems exist in all six subwatersheds, largely as a result of undersized conveyance systems and lack of stormwater storage. The effect of stormwater runoff and overland flow from rainfall events is yard flooding, street flooding, and structure flooding. Reports were received of flooding of first floors of homes or businesses due to overland flow. Basement flooding was also reported due to overland flow, overflowing ditches, and/or surcharged storm sewers producing stormwater runoff that entered basements through window wells, windows or doors.

Problem Areas A through Z were identified by the municipalities or through modeling, and generally represent large areas of flooding and inundation. Problems AA through BZ were reported by residents on the questionnaires and are generally specific to a single family house or another single structure. Sometimes these residential problem areas overlap the larger municipal problem area, but may have a site-specific issue that can be partially or wholly mitigated by a smaller residential-scale project. The locations of problem areas A through Z can be found in Exhibits 24 - 28. The locations of problem areas AA through BZ can be found in Appendix D.

### **Basement Flooding and Sanitary Sewer Backup**

The study area is a separate sewer area. Very few reports of basement flooding due to sanitary sewer backup were made. The resident questionnaires indicated approximately 35 occurrences of basement flooding due to sanitary sewer backup, but it is unclear whether these occurrences were a result of the main sanitary line backing up into the home, versus tree roots or other blockages in the service line, or a power outage / sump pump failure. The questionnaire sought to differentiate these types of responses, but the “check all that apply” nature of the specific question does not allow for determination of the specific cause of sanitary sewer backup.

The locations with sanitary backup into basements were plotted on a map (see Exhibit Q7 in Appendix B). The locations are scattered throughout the study area. If sanitary sewer backup was caused by a surcharging main line during a storm event due to inflow and infiltration, then we would have expected several questionnaire respondents in a similar geographic area to respond with complaints of sewer backup. No clusters of this type of problem were observed on the mapped results, and all four municipalities with single family homes said that basement flooding due to sewer backup during a storm event is not a problem in their community.

Problems associated with the sanitary sewer system are discussed further in Appendix E: Sanitary Sewer Assessment. There are opportunities for the municipalities to improve their sanitary sewer systems, but these improvements and opportunities are largely dissociated from stormwater flooding and surface drainage problems.

**Table 1 – Summary of Reported Drainage Problems**

<b>Problem ID</b>	<b>Municipality</b>	<b>Sub-watershed</b>	<b>Source of Problem*</b>	<b>Type of Problem Reported</b>	<b>Location</b>	<b>Problem Description</b>
A	Justice & Bedford Park	71st St Ditch	DWP (JU3), JU	Overbank flooding, basement flooding, ponding, storm sewer capacity	71st Street Ditch	71st St Ditch and downstream culvert appear to be undersized, resulting in flooding
B	Justice	71st St Ditch	DWP (JU2), JU	Ponding	East of Cork Ave between 73rd Pl and 75th St	Storm sewers downstream of depressional area / detention area appear to be undersized, resulting in flooding due to a combination of undersized storm sewers and undersized basin.
G	Bridgeview	71st St Ditch	V3	Ponding, storm sewer capacity, house flooding	south of 79th St, east of Roberts Rd	Storm sewers along 78th Ave, north of 79th St are undersized causing flooding south of 79th St and east of Roberts Rd
Y	Bridgeview	71st St Ditch	V3	Ponding, Storm sewer capacity	South of 71st St between 76th Ave and Harlem Ave	Storm sewers throughout neighborhood south of 71 <sup>st</sup> Street and east of the railroad are undersized. Excess runoff flows to the low area south of 71 <sup>st</sup> Street, resulting in flooding.
D	Bridgeview & Justice	71 <sup>st</sup> St Ditch and 79th St Storm Sewer	JU, DWP (BV4), 8/14 Mtg	Storm sewer capacity	Roberts Rd between 79th Street and 83rd Street	Roberts Rd storm sewers appear to be undersized, resulting in flooding
F	Justice	79th St Storm Sewer	6/15 Mtg	Ponding, Storm sewer capacity	South of 79th St, North of I-294, between 88th Ave and 82nd Ave	The neighborhood lacks a well-defined stormwater management system, with poorly defined ditches, minimal storm sewer system with insufficient inlets, and large tributary flows from the south. Storm sewers between 79th St. and the Tollway (between 88th Ave and 82nd Ave) appear to be undersized or lacking. The result is flooding south of 79 <sup>th</sup> Street, particularly between 85 <sup>th</sup> Ct and 84 <sup>th</sup> Ct.

**Table 1 – Summary of Reported Drainage Problems**

<b>Problem ID</b>	<b>Municipality</b>	<b>Sub-watershed</b>	<b>Source of Problem*</b>	<b>Type of Problem Reported</b>	<b>Location</b>	<b>Problem Description</b>
H	Justice	79th St Storm Sewer	DWP (JU4)	Storm sewer capacity	South of/under I-294 between 86th & 87th Aves	The DWP reported that the storm sewer under the Tollway (between 86th Ave and 87th Ave) appears to be undersized, resulting in flooding upstream of the sewer. The modeling shows that the Tollway sewer is sized appropriately, but the drainage system upstream (along 83 <sup>rd</sup> Street) has insufficient capacity and results in flooding.
I	Justice, Hickory Hills	79th St Storm Sewer	JU, DWP (HH2), 8/14 Mtg	Overbank flooding, basement flooding, ponding, storm sewer capacity, pavement flooding	85th St at 8900 West	Homes between 90th Ave and 88th Ave flood, runoff overtops 88th Ave, and Sunset Apartment Complex floods
J	Hickory Hills	79th St Storm Sewer	DWP (HH3)	Basement flooding, ponding, storm sewer capacity	85th St to 83rd St at 8600 West	There is inadequate conveyance and storage capacity in the area, resulting in basement flooding and ponding between 85th St and 83rd St (at 8600 West and on 85 <sup>th</sup> Court)
K	Hickory Hills	79th St Storm Sewer	DWP, 8/14 Mtg	Storm sewer capacity, ponding, street flooding	87th Street at 8200 west	Basin overtops and blocks 87th St
W	Hickory Hills	79th St Storm Sewer	6/15 Mtg	Storm sewer capacity, ponding	Blue Ridge Avenue	Subdivision west of Blue Ridge Ave floods
C	Justice	Justice Ditch	JU	Ponding	North and south of 76th Pl between Garden Ln and Oak Grove Ave	Areas north and south of 76th Pl flood, due to inadequate capacity in Justice Ditch, and very little topographic relief in the area.
E	Unincorporated	Justice Ditch	V3	Ponding, Storm sewer capacity	Within Sterling Estates	Homes in Sterling Estates flood due to inadequate capacity of the enclosed Justice Ditch storm sewer and the ditches and culverts under the railroad.
Q	Palos Hills	Lucas Ditch	DWP (PHI2, PHI6), 8/14 Mtg	Ponding, storm sewer capacity	82nd Ave and Eleanor Ave, and along Lucas Ditch between 102nd and 105th Streets, and 101st at Roberts	Areas adjacent to Lucas Ditch flood because of sediment and debris build up (101st St to 105th St)

**Table 1 – Summary of Reported Drainage Problems**

<b>Problem ID</b>	<b>Municipality</b>	<b>Sub-watershed</b>	<b>Source of Problem*</b>	<b>Type of Problem Reported</b>	<b>Location</b>	<b>Problem Description</b>
U	Palos Hills	Lucas Ditch	DWP (PHI3)	Overbank flooding, basement flooding, bank erosion	111th St and 86th Ave	Buildings adjacent to Lucas Ditch flood when Stony Creek is high
V	Palos Hills & Unincorporated	Lucas Ditch	6/15 Mtg	Overbank flooding, house flooding, ponding	West of 88th Ave near Taos Dr	Home on the west side of 88th Ave floods. Erosion problems downstream of this location
N	Palos Hills	Lucas Ditch (Roberts)	8/14 Mtg, CB	Storm sewer capacity, basement flooding, roadway flooding	99th St and Roberts Rd	Intersection of 99th St/Roberts Rd floods (primary flooding attributed to drainage from Hickory Hills Golf Club and upstream subdivisions, overwhelming the downstream system)
O	Hickory Hills	Lucas Ditch (Roberts)	DWP (HH6, PHI8)	Overbank flooding, storm sewer capacity, basement flooding, ponding, bank erosion, wetland and riparian area degradation	95th St at 84th Ct	Homes/apartments near Hickory Hills Woods forest preserve flood
P	Palos Hills	Lucas Ditch (Roberts)	DWP (PHI7)	Overbank flooding, ponding	88th Ave and 99th St	Intersection of 88th Ave and 99th St has overbank flooding and ponding
V	Palos Hills & Unincorporated	Lucas Ditch	6/15 Mtg	Overbank flooding	88 <sup>th</sup> Ave near Taos Dr.	Drainage ditch and driveway culvert undersized, resulting in residential flooding
X	Hickory Hills, Palos Hills	Lucas Ditch (Roberts)	HH	Ponding, storm sewer capacity, house flooding	Near 96th St and 87th Ave	Hill Creek Shopping Center detention basin is undersized resulting in flooding of downstream properties
L	Hickory Hills	Lucas Diversion Ditch	DWP (HH4), 8/14 Mtg	Basement flooding, ponding, storm sewer capacity, roadway flooding	Roberts Rd between 90th and 95 <sup>th</sup> , and 95 <sup>th</sup> St east of Roberts Rd	Roberts Rd storm sewers appear to be undersized, resulting in flooding on Roberts Road. 95th St also floods, as a result of significant overland flow from the north and insufficient inlet and conveyance capacity, which is restricting highway access.
M	Hickory Hills	Lucas Diversion Ditch	DWP (HH1)	Overbank flooding, basement flooding, ponding, bank erosion, maintenance	98th St at 7700 West	Ditches at 98th St/7700 West have insufficient capacity, resulting in flooding (ponding, basement flooding)

**Table 1 – Summary of Reported Drainage Problems**

<b>Problem ID</b>	<b>Municipality</b>	<b>Sub-watershed</b>	<b>Source of Problem*</b>	<b>Type of Problem Reported</b>	<b>Location</b>	<b>Problem Description</b>
R	Palos Hills	Lucas Diversion Ditch	DWP (PHI1)	Overbank flooding, basement flooding, ponding	100th Pl and 78th Ave	Intersection of 100th Pl and 78th Ave floods because Lucas Diversion Ditch has insufficient capacity
S	Bridgeview	Lucas Diversion Ditch	DWP (BV2), 8/14 Mtg	Basement flooding, ponding, storm sewer capacity	100th Pl between 76th Ave and Harlem Ave	Excessive ponding occurs at 100th Pl between 76th Ave and Harlem Ave
T	Palos Hills, Bridgeview	Lucas Diversion Ditch	DWP (PHI4, PHI9), 8/14 Mtg	Basement flooding, ponding, storm sewer capacity, bank erosion, maintenance	Lucas Diversion Ditch from 102nd to 105th	Areas adjacent to Lucas Diversion Ditch flood because of sediment and debris build up (upstream of 103rd St) and insufficient conveyance capacity in the ditch.
Z	Bridgeview	Lucas Diversion Ditch	V3	Storm sewer capacity	Mobile home community south of 87 <sup>th</sup> , west of Harlem	Extremely flat topography and limited storm sewer infrastructure results in flooding.
AA - BZ	All	All	Questionnaires	Basement flooding, house flooding	Varies	Basement and first floor structural house flooding at various locations, as described in the resident questionnaires

\*Source of Problem Reports:

- DWP (DWP ID) = "Detailed Watershed Plan for the Calumet-Sag Channel Watershed" (ID from Table 2.2.1) prepared for MWRD in August 2009
- JU = Letter from Justice Village Engineer to Congressman Lipinski, 3/10/00
- 8/14 Mtg = August 7, 2014 roundtable meeting with MWRD, V3 and Municipalities
- 6/15 Mtg = June 17, 2015 roundtable meeting with MWRD, V3 and Municipalities
- V3 = Modeling performed by V3 for this Study
- CB = "Roberts Road Flood Evaluation" prepared by Christopher B. Burke Engineering for the City of Palos Hills, April 2015
- Questionnaires = Questionnaire responses provided by general public, July-August 2015
- HH = Hickory Hills letter to ISWS, 9/20/13

## **Hydraulics and Hydrology Summary (Existing Conditions)**

XP-SWMM models were built to represent the existing conditions and create a baseline for comparing proposed alternatives. One model was built to represent the 71<sup>st</sup> Street Ditch, 79<sup>th</sup> Street Sewer, and Justice Ditch subwatersheds, generally referred to in this report as the “north model”. A second model was built to represent the Lucas Ditch, Roberts Road (typically included with Lucas Ditch on the exhibits) and Lucas Diversion Ditch subwatersheds, generally referred to in this report as the “south model”.

In general, the models include:

- Curve Numbers based on land use and soil type, generated following the same methodology used in the DWP;
- Times of concentration based on NRCS methodology;
- Rainfall depths based on Bulletin 70 Table 13 for Northeastern Illinois;
- Drainage subbasins that were based on a review of the Cook County 1-ft topography; DWP subbasins; storm sewersheds per municipal atlases, roadway storm sewer plans, and topographic survey; and field visits;
- Major waterways that were modeled as open channels within XP-SWMM using cross sections obtained from the HEC-RAS models developed for the DWP;
- Culverts along the major waterways to update/validate the HEC-RAS data, based on a 2015 survey;
- Storm sewers based on a combination of 2015 survey, as-built plans, and municipal storm sewer atlases. In general, storm sewers in problem areas were modeled based on survey data or as-built plans. Storm sewers in non-problem areas may have been estimated based on atlases and estimates of slopes and inverts in certain locations. These estimates provided representative storm sewers as input to the model to allow for distribution of runoff throughout the watershed and to account for variations in hydrograph peak timing;
- Overland and overflow routes that were modeled based on the Cook County 1-ft topography and field visits;
- A truncated piece of the I&M Canal (north model) or Cal-Sag Canal (south model) as an open channel within XP-SWMM to represent the potential effects of backwater from these waterways on the upstream tributary systems;
- A boundary condition at the upstream and downstream ends of the truncated Canals, which was estimated from approximated discharges and a rating curve of flow versus elevation as obtained from the modeling of the Chicago Waterway System and truncated HEC-RAS model results from the Canals (the underlying models and information of which were supplied by Fluid Clarity for use in this study).

A more thorough description of the model and methodology can be found in Appendix F. The hydrologic input parameters are shown in Exhibits F1 – F5, and the operations of the Hickory Hills Reservoir are shown in Exhibit F6. Exhibits F7 – F8 provide a skeleton view of the XP-SWMM model. The XP-SWMM nodes and detailed schematics are shown in Exhibits F9 – F20.

### **Critical Duration Analysis**

A critical duration analysis of the existing conditions model was performed for the 100-year storm event. The 24-hour storm was identified as the critical duration storm for the north and south models as a whole. Because some problem areas are the result of local drainage systems that are inadequate to handle intense rainfall, the 2-hour storm was also modeled in the existing and proposed condition to represent the short, intense rain storms. Additional information on the critical duration analysis can be found in Appendix F.

## Existing XP-SWMM Analysis and Results

XP-SWMM was performed using the 1-D XP-SWMM model. The complexity of the 1-D model was felt to be sufficient for purposes of evaluating the identified drainage problems within the north and south modeled watersheds, especially given the spread out nature of identified problems. It was felt that increased complexity through use of a 2-D XP-SWMM interface and additional fine grid spacing to better understand the flooding related to the “flatter” areas was not warranted given the required increase of run times, data reduction, alternative comparison, and ultimately, translation to our GIS partner for exhibit preparation. Therefore, the resultant inundation maps are approximated using XP-SWMM 1-D model results overlaid with a GIS raster file of elevation data.

Creation of the inundation maps was automated in GIS, using the water elevation at XP-SWMM nodes versus the ground elevation from the Cook County topography raster file. In areas with depressional storage or flood storage, the inundation was mapped using the XP-SWMM node that represents the storage element. In areas with road flooding, the inundation was mapped using the storm sewer hydraulic grade line, where it exceeds the rim elevations. Interpolation of elevations between XP-SWMM nodes was performed to show variable inundation elevations between modeled nodes. In areas with ditch and stream flooding, the XP-SWMM elevation was assigned to open channel cross sections based on model results, and GIS interpolated elevations between the cross-sections. Areas of overland flow are also mapped, based on modeled depths. The inundation maps provide a general representation of flooding areas, but should not be relied upon as an exact representation of flood locations.

As shown in the inundation maps and in the tabular results presented in Appendix F, flooding begins for recurrence intervals as frequent as the 5-year storm in some locations. Widespread flooding occurs throughout the study area for the 100-year storm. Exhibits 29 through 32 illustrate inundation mapping for the 50-year and 100-year storms. Tables 2 and 3 below provide an estimate of the number of homes that may be flooded in the existing condition. (The methodology used to calculate the number of homes is described in the Design Criteria section of this report.)

**Table 2 – Estimate of Homes that May have Water Adjacent to the Foundation, Existing Condition**

Subwatershed	2-hr		24-hr	
	100-yr Exist	50-yr Exist	100-yr Exist	50-yr Exist
Lucas Diversion Ditch	130	78	264	172
Lucas Ditch	276	198	187	103
71st St Ditch	105	58	119	53
79th St Storm Sewer	184	151	197	155
Justice Ditch	86	59	61	20
<b>Total</b>	<b>781</b>	<b>544</b>	<b>828</b>	<b>503</b>

**Table 3 – Estimate of Homes that May have Water on the First Floor, Existing Condition**

Subwatershed	2-hr		24-hr	
	100-yr Exist	50-yr Exist	100-yr Exist	50-yr Exist
Lucas Diversion Ditch	35	10	0	0
Lucas Ditch	131	68	84	36
71st St Ditch	19	4	33	6
79th St Storm Sewer	94	68	104	77
Justice Ditch	28	17	15	5
<b>Total</b>	<b>307</b>	<b>167</b>	<b>236</b>	<b>124</b>

### Model Verification

Detailed model calibration was outside the scope of this study, and reliable high water marks were not provided. To verify the results of the XP-SWMM models, the locations of reported flooding were compared to the locations of flooding as shown in the model. With one exception, the XP-SWMM model indicated flooding in the areas of reported problems, and the representative flooding generally matched the descriptions of flooding provided by the municipalities.

One exception was at the Hickory Hills Reservoir. The City of Hickory Hills reported two occurrences of the reservoir overtopping which apparently resulted in flooding of 87<sup>th</sup> Street. The XP-SWMM simulation of the 100-year storm did not result in overtopping, but the 500-year storm did. In order to better understand the rainfall runoff relationship and consequent stormwater runoff to the Hickory Hills Reservoir, the September 2008 rainfall data was obtained from Cook County and input the XP-SWMM model to simulate that large and historic rainfall event. Straight input of the raw rainfall data for the September 2008 storm event did not produce reservoir overtopping, but adjustment of the model for sensitivity to the possibility of saturated soils conditions in combination with pump failure for periods of time did suggest that overtopping for certain conditions could occur. For example, the sensitivity analysis modeled various scenarios, involving an Antecedent Moisture Condition of III (corresponding to the many days of rainfall and potential saturated soil conditions preceding the September 2008 storm event) and scenarios with the pumps turned off (simulating a condition in which high water levels in the downstream storm sewer system would trigger the pumps to stop operating or outright electrical failure for periods of time). In each of these scenarios, the XP-SWMM model indicated the potential for reservoir overtopping. Because these pump settings and antecedent moisture conditions are specialized, but possible, variations of the basic model due to unknown conditions during the September 2008 storm, the baseline model was accepted as valid. Therefore, the baseline model maintains the initial pump configuration and the Antecedent Moisture Condition II RCN values. In other words, no further adjustments to the baseline model were made as a result of the Hickory Hills Reservoir model review.

Additionally, the peak flows and water surface elevations established by the existing conditions XP-SWMM model were compared to the flows and elevations reported in the Cal-Sag DWP for the major ditches that are the subject of this study, and for the Stony Creek corridor in particular. In general, the flows and water surface elevations correlated well.

## **Design Criteria**

Project alternatives were designed with a goal of protecting all structures from flooding during the 100-year critical duration storm event. Both the 2-hr and 24-hr duration storms were analyzed.

### **Establishing Flood Protection Elevations**

To determine an alternative's effectiveness to reduce or eliminate structural flood damage, it was necessary to estimate a flood protection elevation for each problem area. This was performed in two different but complimentary ways.

First, the flood protection elevation for a general area was based on a review of the 1-foot topography and aerial photography within a problem area, with a goal of choosing an elevation that provides approximately one foot of freeboard to the approximate house location. In general, the contour elevations were studied, and a whole-number or half-number contour were chosen as the elevation at which damage appears to begin, with the flood protection elevation set approximately six inches to one foot below that damage elevation.

Secondly, the specific flood protection elevations of each individual home were estimated based on the ground elevation at the "address dot" from the Cook County GIS layer of the same name, with a +0.66 foot adjustment to account for the typical low entry elevation being higher than the ground elevation. The ground elevations used in this GIS analysis were obtained from the Cook County elevation Raster file. These house-specific flood protection elevations are not based on a professional land survey and do not reflect the presence (or lack) of structural elements that can affect a home's actual low entry elevation, such as variations in the height of foundation versus ground, significant ground slope along a home's footprint (which affects the elevation of the "address dot"), raised window wells, windows below grade without window wells, depressed driveways, etc. These house-specific flood protection elevations were compared to the model results at each XPSWMM node to create an estimate of the number of homes that may be impacted by each problem, and that may benefit from each alternative, but this number should only be used as a general estimate. In reality, the actual number of homes that are impacted by a problem area, and that benefit from a proposed alternative, will likely differ from the estimated value.

It is recommended that an actual low entry survey be performed prior to commencement of any of the recommended alternatives, to clarify and confirm the actual flood protection elevation, and adjust the project design accordingly to provide the desired protection.

(The +0.66 foot adjustment was chosen based on a comparison of surveyed low entry elevations versus estimated raster elevations at the GIS address dots, as performed in the adjacent Melvina Ditch Watershed. This comparison showed that low entry elevations vary significantly, but on average, the low entry elevation is 0.66 feet higher than the ground at the center of the structure. The DWP reported similar results for a separate comparison area.)

The approximate locations of homes that may experience flooding of the first floor of their home in the existing condition, based on the +0.66 ft adjustment, are shown on Exhibits 34 – 37. These exhibits also show homes that would have water against the foundation of the home (because the water surface is greater or equal to the "house dot" elevation.)

### **Establishing Flood Protection Flow Rate**

The XP-SWMM model includes two sets of links: one set of links to represent the defined stormwater management system, such as storm sewers and open channel ditches; and a second set of links to

represent overland flow and overflow routes across the subwatersheds and through the neighborhoods, as a result of the surcharged stormwater management system. The overflow routes connect surcharging nodes with downstream receiving systems, and are modeled as open channel links with a conveyance capacity approximately equal to that of the natural topography along the route.

In some problem areas, using the XP-SWMM overflow links is a better predictor of whether flooding may occur, rather than using the elevation at a node on the defined stormwater management system. These areas are places where, when overflow occurs, water flows past a house(s) and causes damage. When the overflow is eliminated, the damages are also reduced or eliminated. In these areas, the overland flow link is used as the point-of-comparison for evaluating the effectiveness of an alternative. When flows in the overland flow link are zero, or equal to a rate that can be conveyed through a side yard swale or street or other conveyance path without damage, then the potential for damage is reduced. Therefore, these areas use a flow rate goal as a measure of whether house damages may occur, rather than an elevation. This is referred to as a “Flood Protection Flow Rate” in this report.

### Other Design Criteria

Other design criteria include:

- Bulletin 70 rainfall
- Storm sewers were designed to:
  - Provide adequate conveyance and capacity to reduce flooding to meet the residential structure protection goal; in most cases, the storm sewers have a minimum 10-year level of service based on a flowing full capacity.
  - Provide 2 feet of cover, minimum, between top/pipe and ground.
- Storage areas were graded with:
  - 3:1 side slopes.
  - Flat bottoms, to be planted with native vegetation.
  - A 5-foot buffer between the property line and the start of grading
  - Storage volumes were calculated based upon a maximum high water level approximately equal to the elevation at which water would leave the property (Zero freeboard).
- Ditches were graded with:
  - Cross slopes that provided positive drainage, smoothed out “roller coaster” profiles, tie into existing culverts, and provide positive drainage where backpitched sections exist today;
  - 2:1 side slopes;

## **Alternatives Identification and Analysis (Proposed Conditions)**

Alternatives to reduce flooding were identified for each problem area listed by the municipalities, the DWP, and the modeling. In some locations, problem areas were grouped together for analysis and comparison, as some alternatives could be successful in reducing flooding in multiple problem areas.

The goal of the alternatives is to eliminate residential structure flooding during the 100-year storm event, including basement flooding. Proposed improvements generally fall into one of three categories: large scale, medium scale, and residential scale. For the purpose of this study, “large scale” projects are those that appear to meet the District’s goal and eliminate potential for flooding during a 100-year storm, based on the results of the modeling. “Medium scale” projects are those that have a meaningful reduction in flooding, but may not eliminate all structural damages during a 100-year storm. “Residential scale” improvements are those that are solely located on a private property for the benefit of that property owner and/or his immediate neighbors or downstream neighbors, primarily to reduce or eliminate flood damages in small, localized areas of flooding. “Residential scale” improvements also include stormwater best management practices, which may reduce runoff and contribute to reductions in flood damages downstream.

### **Large and Medium Scale Alternatives for Problem Areas Identified by Municipalities**

“Large scale” and “medium scale” alternatives were identified for each problem area.

Alternatives that were considered generally fall into these categories:

- ***Additional storage capacity***, either by expanding an existing storage facility, creating a new storage facility if open space parcels exist, or by creating underground detention.
- ***Additional conveyance capacity***, either by performing maintenance to restore original design capacities, expanding existing conveyance routes by upsizing existing pipes or reshaping ditches, adding new and/or parallel conveyance routes, or adding relief sewers.
- ***Reductions in runoff***, by implementing stormwater best management practices and green infrastructure on private properties on a widespread basis throughout the watersheds.
- ***Urban redevelopment***, to remove flood-prone properties from low areas, convert the low areas into open green spaces to provide both a flood control and a green space / recreational use and benefit, and construct new housing units on higher ground to replace the lost units of housing.

#### **Large Scale Alternatives**

Large scale alternatives were designed to reduce or eliminate structural flooding during the 100-year storm event. Large scale projects are located in the public right-of-way as first locational priority. A second priority location is public spaces such as parks or school fields, private utility right-of-ways (such as the ComEd right-of-way), and open spaces on industrial or commercial areas. A third priority location is private residential properties, and is only proposed when public right-of-way or public spaces are not available for the proposed improvements.

A summary description of each large scale alternative is presented in Table 4. A detailed description is presented in the Subwatershed-specific section of this report.

#### **Medium Scale Alternatives**

Some of the pipe sizes included in the large scale alternatives may seem larger than what is standard in engineering designs. These large sizes are a result of the design standard of no residential flooding, and

also a result of the 2-hr storm (which is critical in many locations). The conveyance capacity required by the 2-hour storm is large. With more detailed survey and a more detailed analysis, it may be possible to refine and reduce the pipe sizes. A detailed survey of the residential low entry elevations would allow for refinement of the flood protection level, which could allow for more water on the ground and subsequently smaller pipe sizes. The refinement of the model and the engineering assumptions could also allow for small modifications to pipe size as the design advances.

A set of “medium scale” alternatives was prepared, which uses the “large scale” alternative and scales it back to a lesser alternative that may be easier to construct or less costly. The medium scale alternative is not designed to meet a certain level of protection or provide storage/conveyance for a certain storm event, but rather, is designed to provide a more feasible, more constructible, and less costly alternative to the large scale alternative.

All of the large scale alternatives were reviewed, and those that included very large diameter proposed pipes were scaled back to a medium scale alternative, with pipes roughly half the size of the large scale alternative.

Additionally, the proposed storage areas associated with the Large Scale alternatives were reviewed. In most cases, the proposed storage can be relocated to another nearby area, if the identified location is not available for stormwater use. Relocating the storage may require property acquisition and increase cost, but the total proposed volume appears to be feasible in each alternative. The exception is with Alternative L2, which proposes a significant amount of new storage adjacent to the Illinois Tollway. The Illinois Tollway is beginning to plan for future improvements to I-294 and it is hoped that the recommended stormwater improvements can be constructed in concert with the Tollway’s planned expansion. However, the Tollway’s concept for the 95<sup>th</sup> Street interchange is unknown. Furthermore, the number of underground utilities within the Tollway right-of-way at the interchange may also prevent full build-out of Alternative L2 as recommended. Therefore, a medium-scale alternative is proposed in this area as well, utilizing half of the recommended storage.

Although the medium-scale pipes and storage area do not provide the full volume and conveyance necessary to meet the 100-year level of protection, there are significant positive benefits that can still be gained by scaling back the recommendations.

These scaled-back “medium scale” alternatives are presented in Table 4, described later in this report, and are noted with a “-med” suffix in the Alternative ID.

#### Summary of Large and Medium Scale Alternatives

A summary of the large and medium scale capital improvement project alternatives that appear to produce the greatest benefit are shown in Table 4. A detailed description of these alternatives, organized by subwatershed, can be found in the subsequent section of this study.

Additional alternatives were also considered, but do not appear as feasible or beneficial. These additional alternatives are discussed in the subwatershed-specific sections of this report, but not shown in the summary below.

Conceptual design plans for each of these proposed large and medium scale alternatives are included as Exhibits 38 – 63.

**Table 4: Summary of Proposed Large Scale and Medium Scale Alternatives**

<b>Proposed Alternative IDs</b>	<b>Problem Area</b>	<b>Subwater-shed</b>	<b>Municipality</b>	<b>Proposed Alternative Description</b>	<b>Approximate Location</b>
A	A	71st St Ditch	Justice & Bedford Park	Provide storage on cemetery and expand existing storage near Lipinski Community Center to reduce discharge into ditch.	Between Roberts Rd and Archer Rd north of 71st St
B	B	71st St Ditch	Justice	Install storm sewer along 75th St to bring part of the runoff directly to the I&M Canal.	Between I&M Canal and Basin northeast of 88th Ave and 75th St
B-med	B	71st St Ditch	Justice	This is identical to alternative B, except the proposed pipe size is reduced to provide a lower magnitude of benefit at a lower cost.	Between I&M Canal and Basin northeast of 88th Ave and 75th St
Y	Y	71st St Ditch	Bridgeview	Increase lateral storm sewer sizes to provide additional storage during larger storm events.	Area enclosed by Harlem Ave, 71st St, 79th St, and the railroad
D & G	D	71st St Ditch and 79th St Storm Sewer	Bridgeview & Justice	Remove restrictor and increase storm sewer size to proposed storage northwest of Roberts Rd/79th St.. Increase storm sewer size on 78th Ave and install additional storm sewer to bring part of runoff to proposed storage northwest of Roberts Rd/79th St.	Roberts Rd and 79th St
F	F	79th St Storm Sewer	Justice	Increase storm sewer sizes along 79th St and the north-south roads, add curb and gutter on the neighborhood streets, and provide proposed storage in cemetery/driving range property.	Between 79th St and I-294
F-med	F	79th St Storm Sewer	Justice	This is identical to alternative F, except the proposed pipe size is reduced to provide a lower magnitude of benefit at a lower cost.	Between 79th St and I-294
H & J	H	79th St Storm Sewer	Justice	Install additional parallel storm sewer along 83rd St and through Gateway Truck and Refrigeration property. Provide proposed storage on 3 vacant lots. Lower bottom of Sunset Apartments detention basin 1.5' to 2'.	East of 88th Ave and south of I-294

**Table 4: Summary of Proposed Large Scale and Medium Scale Alternatives**

Proposed Alternative IDs	Problem Area	Subwater-shed	Municipality	Proposed Alternative Description	Approximate Location
I & W	I	79th St Storm Sewer	Justice, Hickory Hills	Install storm sewer along Blue Ridge Ave to proposed storage on cemetery property. Provide proposed storage on cemetery property to reduce overflows over 90th Ave. Increase inlet and storm sewer capacity throughout subdivision to reduce storm sewer overflows adjacent to homes. Increase volume of existing storage northwest of 83rd St and 88th Ave. Maintain inlets north of 83 <sup>rd</sup> Street.	Blue Ridge Ave, north of 87th St, and area near 90th Ave and 83rd St
I-med & W-med	I & W	79th St Storm Sewer	Justice, Hickory Hills	This is identical to alternative I & W, except the proposed pipe size is reduced to provide a lower magnitude of benefit at a lower cost.	Blue Ridge Ave, north of 87th St, and area near 90th Ave and 83rd St
K	K	79th St Storm Sewer	Hickory Hills	Increase inlet capacity within the wetland area and/or regular maintenance of existing inlets	Hickory Hills Reservoir northwest of Roberts Rd and 87th Ave
C	C	Justice Ditch	Justice	Increase storage volume and storm sewer sizes throughout area and redirect flow from Justice Ditch (under Garden Ln) to 60" storm sewer at intersection of Garden Ln/76th Pl.	Along Justice Ditch and 76th Place
E	E	Justice Ditch	Unincorporated	Redevelopment within Sterling Estates with green space and conveyance channel. Existing trailers relocated to vacant trailer lots to create the green corridor.	North of I-294 and west of Garden Ln
Q.1*	Q	Lucas Ditch	Palos Hills	Dredge channel and restore original conveyance capacity, including adjusting existing culverts to restore positive drainage slope.	Lucas Ditch
Q.1-med*	Q	Lucas Ditch	Palos Hills	This is the same as Q.1, except the existing culverts remain unchanged to provide a lower magnitude of benefit at a lower cost.	Lucas Ditch
Q.2*	Q	Lucas Ditch	Palos Hills	Install 72" storm sewer under 83rd Ct to connect Lucas Ditch and West Stony Creek	83rd Ct, between Lucas Ditch and West Stony Creek
U.1	U	Lucas Ditch	Palos Hills	Install floodwall along Lucas Ditch and Stony Creek to isolate floodplain	South of West Stony Creek/Lucas Ditch confluence

**Table 4: Summary of Proposed Large Scale and Medium Scale Alternatives**

<b>Proposed Alternative IDs</b>	<b>Problem Area</b>	<b>Subwater-shed</b>	<b>Municipality</b>	<b>Proposed Alternative Description</b>	<b>Approximate Location</b>
U.2	U	Lucas Ditch	Palos Hills	Move apartment complexes to open space north of 111th St.	South of 111th St, east of Lucas Ditch
V	V	Lucas Ditch	Palos Hills & Unincorporated	Lower ditch and install box culvert under driveway. Lower driveway profile to 618 to prevent adjacent property from flooding.	West of 88th Ave, south of Taos Dr
N*	N	Lucas Ditch (Roberts)	Palos Hills	Grade proposed basin near maintenance building on west side of golf course property, regrade existing basin along main overflow route through golf course. Install pipe from golf course to proposed storage area in Indian Woods Park. Install pipe from Indian Woods Park storage to Lucas Ditch. Reduce size of pipe connecting Roberts Rd storm sewer system and Lucas Ditch.	Hickory Hills Golf Club
O.1	O	Lucas Ditch (Roberts)	Hickory Hills	Remove wall in corner of parking lot, install pipe to route overflows around adjacent apartment complex to ditch	Flamingo Terrace, south of 95th St, west of Hickory Hills Golf Course
O.2	O	Lucas Ditch (Roberts)	Hickory Hills	Upsize existing storm sewers and provide positive slope from upstream ditch to downstream ditch	Flamingo Terrace, south of 95th St, west of Hickory Hills Golf Course
O.3	O	Lucas Ditch (Roberts)	Hickory Hills	Remove wall in corner of parking lot and grade overflow path through forest preserve property	Flamingo Terrace, south of 95th St, west of Hickory Hills Golf Course
P	P	Lucas Ditch (Roberts)	Palos Hills	Regrade west basin to provide additional volume	88th Ave/99th St , west of Hickory Hill Golf Course
RobRd*	M, N, Q, R, S, T	Roberts	Palos Hills, Hickory Hills, Bridgeview	Upsize the Roberts Road storm sewer diameter and adjust inverts to provide a positive slope throughout the system with additional drainage capacity	Roberts Rd, I-294 to Stony Creek
RobRd-med*	M, N, Q, R, S, T	Roberts	Palos Hills, Hickory Hills, Bridgeview	Leave the existing Roberts Road storm sewer in place, without replacement. If future roadway needs warrant storm sewer replacement, then the larger diameter pipe should be considered.	Roberts Rd, I-294 to Stony Creek

**Table 4: Summary of Proposed Large Scale and Medium Scale Alternatives**

Proposed Alternative IDs	Problem Area	Subwater-shed	Municipality	Proposed Alternative Description	Approximate Location
L1	L	Lucas Diversion Ditch	Hickory Hills	Grade proposed detention basin in the Park District property along Roberts Rd	Corner of Roberts Rd/91st Pl
L2	L	Lucas Diversion Ditch	Hickory Hills	Install 48" storm sewer along 94th St and outlet to proposed basin NW of 294 NW ramp. Connect proposed basin into existing infield basin NW of 95th St/294 and connect to detention basins east of I-294. Create new storage east of I-294.	94 <sup>th</sup> Street and I-294/95th St
L2-med	L	Lucas Diversion Ditch	Hickory Hills	This is identical to alternative L2, except the proposed basin sizes are reduced by 50% to provide a lower magnitude of benefit at a lower cost and with less potential for utility conflict.	94 <sup>th</sup> Street and I-294/95th St
M	M	Lucas Diversion Ditch	Hickory Hills	Grade proposed basin in ComEd property and increase storm sewer and ditch capacity in area	76th Ave, south of 95th St
M-med	M	Lucas Diversion Ditch	Hickory Hills	This is identical to alternative M, except the proposed pipe size is reduced to provide a lower magnitude of benefit at a lower cost.	76th Ave, south of 95th St
T*	R & T	Lucas Div. Ditch	Palos Hills	Lower channel between 103rd St and 107th St	Lucas Div. Ditch, south of 103rd
S*	S	Lucas Diversion Ditch	Bridgeview	Expand existing detention basin east of 76th Ave. Route runoff from sub-basin north of basin and 72" pipe (near Apco Packaging) to detention basin. Install outlet pipe that ties in to 103rd St storm sewer.	East of 76th Ave, north of 103rd St
X	X	Roberts	Hickory Hills Palos Hills	Purchase two adjacent properties, and expand existing detention basin.	NW of 96 <sup>th</sup> St. and 87 <sup>th</sup> Ave.
Z	Z	Lucas Div. Ditch	Bridgeview	Improve stormwater management system in mobile home community	West of Harlem, South of 87th

\*Alternatives N, Q1, Q2, S, T and RobRd are designed to work together, and should be considered parts of a larger, comprehensive alternative to manage stormwater and reduce flooding within the Lucas Ditch and Lucas Diversion Ditch subwatersheds.

Proposed Analysis of Large and Medium Scale Alternatives

XP-SWMM was used to model the impact of the proposed alternatives on flooding and evaluate the effectiveness of the alternatives to reduce flood damages. The existing conditions XP-SWMM model was used as the baseline, and updated to reflect the various alternatives that were considered. The same methodology used for the existing XP-SWMM analysis was used for the proposed conditions analysis. Additional information on the methodology and analysis can be found in Appendix F.

The large scale alternatives in the “north” subwatersheds were all modeled together in a single proposed XP-SWMM model, and the large scale alternatives in the “south” subwatersheds were all modeled together in a second single proposed XP-SWMM model. The alternatives do not appear to hydraulically influence each other, except where noted in the descriptions. Therefore, the proposed alternatives can be implemented over time, as funds and resources allow, and the benefit of each alternative can be expected even if the other proposed alternatives in other problem areas are not constructed.

The exception to this is alternatives N, Q1, Q2, S, T and RobRd, which are designed to work together. All pieces of this alternative must be constructed to realize the full benefit across the corresponding problem areas. For example, the full benefit shown in problem area N will not be realized until all of those proposed improvements are implemented.

The proposed XP-SWMM models for the large scale alternatives were used as the baseline for the medium scale alternatives. The proposed model was adjusted accordingly to create the medium scale model.

#### Results of Large and Medium Scale Alternatives

The detailed tabular results of the XP-SWMM analyses are shown in Appendix F. The tables in Appendix F provide the existing versus proposed water surface elevations and the reductions in flood depth as a result of each large and medium scale alternative. A summary of the results is presented later in this study, within the discussion for each individual subwatershed. The total number of structures that benefit from these alternatives, across the entire study area, is presented below in Tables 5 and 6.

**Table 5 – Structures Benefitted (Reduction in Water Adjacent to Foundation), by Proposed Large or Medium Scale Improvements**

Subwatershed	2-hr							24-hr						
	100-yr Exist	100-yr Prop, Large	Benefiting Structures (No.)	Benefit (%)	100-yr Prop, Medium	Benefiting Structures (No.)	Benefit (%)	100-yr Exist	100-yr Prop, Large	Benefiting Structures (No.)	Benefit (%)	100-yr Prop, Medium	Benefiting Structures (No.)	Benefit (%)
Lucas Diversion Ditch	130	94	36	28%	101	29	22%	264	262	2	1%	262	2	1%
Lucas Ditch	276	18	258	93%	82	194	70%	187	24	163	87%	50	137	73%
71st St Ditch	105	39	66	63%	39	66	63%	119	3	116	97%	3	116	97%
79th St Storm Sewer	184	34	150	82%	118	66	36%	197	6	191	97%	6	191	97%
Justice Ditch	86	29	57	66%	29	57	66%	61	7	54	89%	7	54	89%
<b>Total</b>	<b>781</b>	<b>214</b>	<b>567</b>	<b>73%</b>	<b>369</b>	<b>412</b>	<b>53%</b>	<b>828</b>	<b>302</b>	<b>526</b>	<b>64%</b>	<b>328</b>	<b>500</b>	<b>60%</b>

**Table 6 – Structures Benefitted (Reduction in Water on First Floor), by Proposed Large or Medium Scale Improvements**

Subwatershed	2-hr							24-hr						
	100-yr Exist	100-yr Prop, Large	Benefiting Structures (No.)	Benefit (%)	100-yr Prop, Med.	Benefiting Structures (No.)	Benefit (%)	100-yr Exist	100-yr Prop, Large	Benefiting Structures (No.)	Benefit (%)	100-yr Prop, Med.	Benefiting Structures (No.)	Benefit (%)
Lucas Diversion Ditch	35	4	31	89%	12	23	66%	0	0	0	n/a	0	0	n/a
Lucas Ditch	131	2	129	98%	48	83	63%	84	20	64	76%	34	50	60%
71st St Ditch	19	2	17	89%	6	13	68%	33	0	33	100%	0	33	100%
79th St Storm Sewer	94	2	92	98%	31	63	67%	104	1	103	99%	2	102	98%
Justice Ditch	28	4	24	86%	4	24	86%	15	0	15	100%	2	13	87%
<b>Total</b>	<b>307</b>	<b>14</b>	<b>293</b>	<b>95%</b>	<b>101</b>	<b>206</b>	<b>67%</b>	<b>236</b>	<b>21</b>	<b>215</b>	<b>91%</b>	<b>38</b>	<b>198</b>	<b>84%</b>

Exhibits depicting the expected inundation limits in the existing condition, and with large scale and medium scale alternatives included, can be found in Exhibits 64 - 79

### **Residential Scale Improvements: Best Management Practices to Reduce Flooding**

Several stormwater best management practices (“BMPs”) to reduce flooding were considered and analyzed. A wide range of BMPs exists, with a wide range of application and result. Many of these “green infrastructure” practices such as rain gardens, bioswales, and permeable pavers, provide water quality benefits, water infiltration benefits, and runoff reduction benefits. Other practices do not fall under the banner of “green infrastructure” and may not reduce runoff, but can be effective at reducing flooding in individual homes. These other practices include items such as plumbing improvements, grading improvements, and wet or dry floodproofing.

#### Description of BMPs

Appendix G presents a detailed description of many BMPs that can be implemented on a residential scale. The appendix includes a description of the practice, the applicability in different scenarios, advantages and disadvantages of using the practice, design considerations, constructability considerations, cost considerations, and maintenance considerations. A description of each BMP’s ability to reduce runoff and mitigate flooding, either at an individual residence or cumulatively in a subwatershed, is also provided.

The following BMPs are described in Appendix G:

- Green Infrastructure
  - Bio-retention/Rain Gardens
  - Vegetated Swales
  - Green Roofs
  - Impervious Area Disconnection
  - Infiltration Trenches
  - Porous Pavement
  - Rainwater Harvesting
  - Urban Infiltration Planters
  - Dry Wells
  - Other Types of Green Infrastructure
- Grading
  - Overland Flow Swales
  - Foundation Backfill
  - Driveway Berms
  - Barriers (Berms/Levees/Floodwalls)
- Plumbing
  - Plumbing Repairs
  - Standpipes
- Backflow Valves
- Internal Drainage Systems
- Overhead Sewer Systems
- Wet Floodproofing
  - Installing Openings
  - Elevating Utilities
- Dry Floodproofing
  - Raised Window Wells
  - Glass Block Basement Windows
  - Continuous Impermeable Walls
  - Floodproofed Core Interior Areas
  - Permanent Flood Shields for Exterior Openings
  - Removable Flood Shields for Exterior Openings
- Other Mitigation Options
  - Structure Elevations
  - Structure Relocations
  - Acquisition and Demolition

#### Analysis of Widespread Residential-Scale BMP Implementation

A goal of the MWRD is to change the cultural mindset of residents of Cook County so that people understand every property is part of the “problem”, and everyone can be part of the “solution”. Based upon our results and modeling, BMPs and GI alone cannot solve the drainage issues in the study area, especially in areas with clay soils, but they can reduce levels of flooding. BMPs and GI can reduce

drainage problems and have a noticeable impact on flooding levels if implemented on a widespread basis across the study area, and especially if constructed in conjunction with capital improvement projects (CIPs). As shown later in this report, if every homeowner stored the first 0.6 – 1.1 inches of rainfall on their individual property, it would be effective in eliminating flood damages at some structures, although many damage locations would remain. BMPs and GI in conjunction with CIPs can have a meaningful impact to reduce and eliminate structure damages.

The effects of widespread BMP use were simulated in the XP-SWMM models. Because exact location and type of BMP is unknown and will vary from property to property, specific BMPs were not explicitly modeled. Instead, rainfall depths were adjusted to simulate the impact of reduced runoff on downstream drainage problems. Because the MWRD's goal is to protect all houses from flooding in the 100-year storm, the 50-year rainfall was used to simulate the effect of widespread BMP implementation during a 100-year storm.

For example, the 100-year 24-hour storm produces 7.58 inches of rainfall, whereas the 50-year 24-hour storm produces 6.5 inches of rainfall. Comparing the existing 100-year model results versus the existing 50-year model results provides a representation of the impact of removing 1.1 inches of rainfall runoff via stormwater BMPs.

Similarly, the 100-year 2-hour storm produces 4.47 inches of rainfall, whereas the 50-year 2-hour storm produces 3.82 inches of rainfall. Comparing the existing 100-year model results versus the existing 50-year model results provides a representation of the impact of removing 0.6 inches of rainfall from the drainage areas via stormwater BMPs.

#### Public Willingness to Participate in Residential-Scale BMPs

The success of this alternative is dependent on homeowner willingness to install BMPs and GIs on their property. The initial phase of the public outreach campaign (in summer/fall 2015) showed that as many as 40% of homeowners had installed BMPs or would be willing to install BMPs, with the highest response rates equal to rain barrels and native plants.

Through the year-long public outreach and engagement campaign, the number increased to over 60% at the end of the study. The most positive response was towards rain barrels and native plants. Encouraging rain barrel use can provide a means for people to begin thinking differently about stormwater and about private property GI/BMPs. With a shift in mindset, including acknowledgement that everyone can be part of the flooding solution, and thinking of rainwater as a resource instead of a waste product, it may be possible to encourage greater use of GI/BMPs such as rain gardens, infiltration trenches, and permeable pavers, which have a greater ability to store rainfall, reduce runoff and reduce flooding.

A summary of the questionnaire results is shown in Table 0 earlier in this report, and the full results of the 2015 and 2016 surveys are provided in Appendices B and C.

#### Removing 1.1 inches of Rainfall via Residential-Scale BMPs

1.1 inches of rainfall runoff could be removed in many different ways or combinations of ways, including:

*Rain Garden:* a 3,000 square foot rain garden (70' x 43') with a 4" depth could store 1.1 inches of water from a typical 0.25 acre lot. This would occupy 30% of the parcel, or nearly all of the rear yard, and cost approximately \$10,000. The cost to direct downspouts into the rain garden is not included, but would be required to provide the benefits.

*Infiltration trench:* a 360 square foot infiltration trench (70' x 5.5') with an 8-ft depth could store 1.1 inches of water from a typical 0.25 acre lot. This would impact approximately 3% of the lot, with an approximate cost of \$28,600 per trench. The cost to direct downspouts into the rain garden is not included, but would be required to provide the benefits.

*Porous pavement:* replacing 715 square feet of traditional pavement with porous pavement containing a four foot thick stone storage layer would store 1.1 inches of rain from a typical 0.25 acre lot. This would cover approximately 6.5 percent of the lot, but could be constructed on the footprint of existing pavements, for no new impact to the lot's usability. The cost is estimated as \$32,175, excluding the cost of directing downspouts to flow over the driveway.

*Rain cistern:* Constructing a large rain cistern, 12 feet in diameter, and 12 feet tall, would store 1.1 inches of rain from a 0.25 acre lot. This could be constructed for approximately \$7,500, plus the cost of rerouting gutters and downspouts to flow into the cistern, plus possible additional cost for landscape screening. This could capture garage and house roofs, but would not capture runoff from driveways and patios. Underground cisterns of equal size provide an equal benefit at greater cost, and could also capture runoff from driveways and patios, but would cost several thousand dollars more to export displaced soil. Rain cisterns need to be emptied in advance of a storm to make the storage capacity available to the next rainstorm.

Exhibits 80 – 83 show what each of these measures might look like, using a randomly selected residential block within the study area. As shown on these exhibits, items such as swimming pools, decks, detached garages and sheds, and placement of various amenities on the lot can make it difficult to fit the full size of these BMPs.

#### Removing 0.6 inches of Rainfall via Residential-Scale BMPs

0.6 inches of rainfall runoff could be removed in many different ways or combinations of ways, including:

*Rain Garden:* a 1,635 square foot rain garden (70' x 23') with a 4" depth could store 0.6 inches of water from a typical 0.25 acre lot. This would occupy approximately half of the rear yard, and cost approximately \$5,500.

*Infiltration trench:* a 200 square foot infiltration trench (70' x 3') with an 8-ft depth could store 0.6 inches of water from a typical 0.25 acre lot. This would impact approximately 2% of the lot, with an approximate cost of \$15,560 per trench.

*Porous pavement:* replacing 400 square feet of traditional pavement with porous pavement containing a four foot thick stone storage layer would store 0.6 inches of rain from a typical 0.25 acre lot. This would cover approximately 4 percent of the lot, but could be constructed on the footprint of existing pavements, for no new impact to the lot's usability. The cost is estimated as \$18,000, excluding the cost of directing downspouts to flow over the driveway.

*Rain cistern:* Constructing a large rain cistern, 8.5 feet in diameter, and 11 feet tall, would store 0.6 inches of rain from a 0.25 acre lot. This could be constructed for approximately \$4,500, plus the cost of rerouting gutters and downspouts to flow into the cistern, plus possible additional cost for landscape screening. This could capture garage and house roofs, but would not capture runoff from driveways and patios. Underground cisterns of equal size provide an equal benefit at greater cost, and could also capture runoff from driveways and patios, but would cost several thousand

dollars more to export displaced soil. Rain cisterns need to be emptied in advance of a storm to make the storage capacity available to the next rainstorm.

Exhibits 84 – 87 show what each of these measures might look like, using a randomly selected residential block within the study area. Although these BMPs fit better on the property compared to BMPs that capture 1.1 inches of rain, it may still be difficult to get the full intended size on some residential lots, without impacting existing property amenities and features.

### Construction Considerations for Residential Scale BMPs

Construction considerations for each type of residential scale BMP are discussed in the Appendix G narrative. A summary of important items for consideration is presented here.

Appropriate Placement. BMPs with storage elements, such as rain gardens, infiltration trenches, and permeable pavements with underlying stone, require careful planning to ensure the appropriate placement of the BMP on the lot.

- As described in Appendix G, setbacks are recommended for some items. The setbacks are encouraged to keep the resultant saturated soils away from structure foundations, to avoid basement seepage and other similar issues.
- In areas with clay soils where infiltration rates are expected to be low, underdrains may be necessary to prevent a soil saturation problem, and to allow for evacuation of the storage element prior to the next storm event.
- BMPs must be placed logically at a low point to collect runoff from the individual's property or from his neighbor's property.
- Roof downspouts and/or gutters may need to be rerouted to direct flow towards the BMPs.
- The additional cost of downspout and/or gutter rerouting, and underdrains if necessary, is not included in the cost estimates associated with these BMPs.

Appropriate Selection. BMPs must also be selected carefully to ensure the product provides the intended result, and a site inspection may be necessary as a functional evaluation of the measure. For example, there are many types of permeable pavers on the market that have varying degrees of permeability, and providing the correct underlying stone storage layer is important to ensure functionality as intended.

Drawdown of Storage BMPs. BMPs that are intended to collect water for future reuse, such as rain barrels and particularly rain cisterns, should be emptied in advance of the next storm event to ensure the storage volume is available to the next storm event. If large rain cisterns are implemented on a widespread basis, the MWRD may wish to consider a communications strategy to remind residents to empty the reservoirs.

Cost Considerations. The residential BMPs that have the greatest ability to reduce flooding are those that incorporate storage elements. However, many of these residential BMPs are costly when constructed as a retrofit.

For example, when a rain garden or bio-retention feature is incorporated into a new subdivision, the developer is able to plan for the associated earth excavation and balance earthwork onsite. This reduces earth moving costs, which makes these features relatively low-cost in a new development. However, when constructing these items as retrofits on a single residential lot, or across several lots as a shared BMP, the cost escalates significantly. It is unlikely that the excavated material could be disposed of onsite, which requires haul-off at a cost of approximately \$30 per cubic yard of material.

A fully engineered bio-retention area may need an excavation of approximately 8” for surface storage, overexcavation of 3” for mulch plus 18” for a bioswale soil mix. This results in an excavation of approximately 2.5 feet, plus import of appropriate soil for the bioswale or rain garden growing media. In a residential retrofit scenario, costs can be reduced by using a shallower soil layer, and using 50% native soils within that layer. With the reduction in earth excavation, it may be possible to place the spoils onsite without negatively changing the grading or impacting adjacent property owners, further reducing cost. For best success to promote infiltration and minimize maintenance, a properly designed soil layer is recommended. However, the lower cost retrofit option can provide the same flood storage benefit, and the lower cost will allow for more installations. The lower cost option may require more maintenance to establish plants and plant health.

Cost can also be reduced if the homeowner provides the labor himself, although some elements – such as earth haul off, if necessary – would probably require a contractor. The cost of a fully engineered bio-retention rain garden to capture 0.6 inches of rain is estimated as \$43,000, whereas the residential retrofit option is estimated as \$4,800.

A cost evaluation and analysis is currently underway to determine whether significant cost savings can be realized if residential-scale BMPs are constructed on a widespread basis throughout a neighborhood or throughout the county. This analysis includes engaging local union plumbers to provide cost estimates, and an estimate of savings associated with economies of scale, for overhead sewers and rain cisterns. The results of this evaluation will be provided separately at a future date.

The MWRD or municipality may wish to consider providing financial assistance to individual homeowners who wish to implement BMPs, or to provide a reduction in user fees or taxes if BMPs are implemented. If funding assistance is made available to homeowners, the financial assistance could be contingent on a site inspection(s) to ensure proper placement and construction of the BMP.

#### Providing BMPs and Green Infrastructure in the Public ROW

The XP-SWMM model assumes that every property, including commercial and industrial properties, as well as public rights of way, participate in removing the first 0.6 – 1.1 inches of rainfall. Commercial and industrial properties can use some of the same measures recommended for residential properties, such as infiltration trenches, permeable pavements, and rain cisterns, upsized for the size of the parcel. Other measures described in Appendix G, such as green roofs, are also available options for commercial and industrial properties.

GI in the public ROW can be provided through permeable pavements in the parking lanes, open-bottom catch basins in the stormwater system, vegetated swales in the parkway, or oversized storm sewers to provide some storage in addition to the design conveyance capacity.

To capture the first 1.1 inches of rainfall, 6 cf of storage is required for every linear foot of ROW. This can be provided through a 36” storage pipe, upsizing conveyance pipes (eg, from a 24” conveyance pipe to a 42” storage and conveyance pipe), providing permeable pavement with an underlying storage layer (equal to 4 feet of depth and 4 feet of width, with 40% porosity), or providing vegetated swales with underlying stone storage within the parkway.

To capture the first 0.6 inches of rainfall within the right of way, 3.3 cf of storage is required for every linear foot of ROW. This can be provided by upsizing conveyance pipes (eg, from a 12” conveyance pipe to a 24” – 30” storage and conveyance pipe), providing permeable pavement with an underlying storage layer (equal to 2 feet of depth and 4 feet of width, with 40% porosity), or providing vegetated swales with underlying stone storage within the parkway.

Results of Widespread Residential-Scale BMP Implementation, with and without CIPs

The results of widespread BMP implementation is summarized in the individual subwatershed sections of this report, illustrated in Exhibits 88 through 111, and detailed in Appendix F. As shown, in most locations, the BMPs alone are not enough to eliminate flood damage, although there is a meaningful reduction for many homeowners. Widespread flooding will still occur with just BMPs in place, but the depth will be reduced such that some homes are no longer damaged. CIPs are still necessary to protect all homes.

An analysis of BMPs without any CIPs was performed. Comparing the 100-year existing condition results to the 100-year storm with BMPs, shows a reduction in flooding that benefits some homeowners, but not everyone, and widespread flooding still occurs.

An analysis was also performed with both BMPs and CIPs in place. Comparing the 100-year proposed storm results with CIPs implemented, versus the 100-year storm results with CIPs and BMPs implemented, shows the additional benefit that can be achieved with widespread BMP implementation in conjunction with CIPs. This was performed for both the large scale CIPs and medium scale CIPs.

The MWRD’s goal, with respect to CIPs, is to eliminate structural flooding. The modeling shows that the recommended large scale CIP alternatives can reduce flood levels to below the approximated flood protection level, but streets and yards will still be flooded in large storm events. Widespread implementation of BMPs can assist in lowering the flood levels further, to provide additional protection to homes, and to reduce and mitigate some of the street flooding and nuisance flooding that occurs during small storms.

The modeling shows that the medium scale CIP alternatives reduce flood damages but do not eliminate structural flooding. When medium scale CIPs are combined with widespread BMPs, the result is similar to the level of benefit shown with large scale CIPs without any GI or BMPs. These results are summarized within each subwatershed’s section of this report and in Tables 7 and 8, and presented in detail in Appendix F.

**Table 7 – Structures Benefitted (Reduction in Water Adjacent to Foundation) by Widespread BMP Implementation**

Subwatershed	2-hr				24-hr			
	100-yr Exist	100-yr with BMPs	Benefit-ing Structures (No.)	Benefit (%)	100-yr Exist	100-yr with BMPs	Benefit-ing Structures (No.)	Benefit (%)
Lucas Diversion Ditch	130	78	52	40%	264	172	92	35%
Lucas Ditch	276	198	78	28%	187	103	84	45%
71st St Ditch	105	58	47	45%	119	53	66	55%
79th St Storm Sewer	184	151	33	18%	197	155	42	21%
Justice Ditch	86	59	27	31%	61	20	41	67%
<b>Total</b>	<b>781</b>	<b>544</b>	<b>237</b>	<b>30%</b>	<b>828</b>	<b>503</b>	<b>325</b>	<b>39%</b>

**Table 8 – Structures Benefitted (Reduction in Water on First Floor)  
by Widespread BMP Implementation**

Subwatershed	2-hr				24-hr			
	100-yr Exist	100-yr with BMPs	Benefiting Structures (No.)	Benefit (%)	100-yr Exist	100-yr with BMPs	Benefiting Structures (No.)	Benefit (%)
Lucas Diversion Ditch	35	10	25	71%	0	0	0	n/a
Lucas Ditch	131	68	63	48%	84	36	48	57%
71st St Ditch	19	4	15	79%	33	6	27	82%
79th St Storm Sewer	94	68	26	28%	104	77	27	26%
Justice Ditch	28	17	11	39%	15	5	10	67%
<b>Total</b>	<b>307</b>	<b>167</b>	<b>140</b>	<b>46%</b>	<b>236</b>	<b>124</b>	<b>112</b>	<b>47%</b>

The model assumes that every property, including commercial and industrial properties, as well as public rights of way, participate in removing the first 0.6 – 1.1 inches of rainfall. This includes 100% of residential properties. In reality, achieving 50% participation may be a better goal, and even that may be a stretch goal. If only 50% of homeowners participate, those homeowners would need to provide double the amount of storage to achieve the results shown in the model.

The campaign to reach out to the public, provide education on stormwater BMPs, and encourage widespread use, is expected to begin in Spring 2016. This report will be updated with the outcome and conclusions in Summer 2016, including a discussion of the percent of people who may be willing to provide BMPs or GI measures that can have a meaningful impact on flood reduction.

### **Residential Scale Alternatives for Problem Areas Identified by Resident Questionnaires**

Over 420 questionnaires were returned out of about 12,000 sent. These returned residential questionnaires were reviewed in detail. Of those returned questionnaires, 78 identified flooding of the first floor or flooding of the basement due to overland flow (stormwater runoff) entering the basement. GIS was used to plot the locations of these flood complaints and compare them to the municipal-identified drainage problems. Some resident complaints are located in identified flood problem areas, but many are not, as may be seen by comparing the residential questionnaires Identified Problem Locations exhibit in Appendix D with the Existing Conditions Overview exhibits (Exhibits 19-23).

These resident complaints were reviewed and analyzed qualitatively to create a catalog of individual problem reports, preliminary/conceptual assessment of cause, and a conceptual identification of alternatives to reduce the problem. This assessment was performed based on available data including the Cook County 1-ft topographic mapping, aerial photos, storm sewer atlases where available, topographic survey where available, and a field visit. The identified alternatives largely consist of:

- Private property regrading to move runoff away from the home’s foundation;
- Redirecting downspouts to move runoff away from the home’s foundation;
- Increasing inlet capacity and/or number of inlets at low points in a street to allow runoff to enter the storm sewer system more quickly;
- Adding “speed bumps” or raising curbs at depressed driveways, to reduce the amount of runoff that flows from a street down a depressed driveway and into a garage/house;
- Establishing and/or re-establishing drainage swales to convey water past a house’s foundation;

- Raising window wells.
- *Note: Stormwater BMPs and Green Infrastructure should also be considered at many of these residential properties, to reduce runoff and reduce flooding in these locations.*

The catalog of alternatives for problem areas identified through the resident questionnaires can be found in Appendix D. This includes a general location map showing the locations of these problem areas, and includes the following for each problem area:

- Description of the resident’s complaint;
- Identification of apparent cause of the drainage problem;
- Description of stormwater infrastructure that appears present at the location;
- Description of alternative(s) that could be pursued to mitigate the problem;
- Field visit notes and photographs;
- Schematic exhibits showing the 1-ft topographic contours and simple linework to indicate flow direction, storm sewers, drainage structures, and observed problems and opportunities based on a field visit.

It is important to note that the questionnaire asked whether flooding occurred in the past 5 years, but did not include the logical follow-up question “*Have you made improvements on your property, or has your municipality made improvements to the public stormwater infrastructure, to reduce potential for future flooding?*” It is possible that some of the identified problems have already been mitigated and are no longer a problem. In fact, the list of communities that indicated problems with flooding was submitted to the municipalities prior to this draft report for their review. Some municipalities followed up with each complainant and stated that some or all problems indicated in the questionnaire had been mitigated, either through a City/Village project or through resident actions.

The catalog will provide each community with a list of house-level problem areas, and provide them with known information as a “jump start” towards understanding the cause and reducing the problem. Each municipality was provided a list of addresses and a description of the complaints in fall 2015, and the municipalities indicated that some of the complaints have already been mitigated.

## **71<sup>st</sup> Street Ditch Subwatershed**

A description of the existing conditions, proposed improvements, and results of the XP-SWMM analyses for the 71<sup>st</sup> Street Ditch Subwatershed follows.

### **Existing Conditions**

The 71<sup>st</sup> Street Ditch subwatershed is at the northern end of the study area. It includes portions of the Villages of Bedford Park (but none of the residential area of Bedford Park), Bridgeview, and Justice. It is roughly bounded by Harlem Avenue on the east and 79<sup>th</sup> Street on the south. The western limit varies and is roughly Cork Avenue or the Illinois & Michigan (I&M) Canal. The north limit also varies and is roughly north of Toyota Park and north of Suburban Lane. It also includes an area south of 79<sup>th</sup> Street that is roughly bound by 79<sup>th</sup> Street on the north, Roberts Rd on the west, Harlem on the east, and 83<sup>rd</sup> – 87<sup>th</sup> Streets on the south. Area tributary to the Hickory Hills Reservoir is part of both the 71<sup>st</sup> Street Ditch subwatershed and the 79<sup>th</sup> Street Sewer subwatershed. The reservoir collects runoff from the upstream drainage area, stores it, and releases it via pump station through an 18” force main to a float-level monitored splitter box located north of 79<sup>th</sup> Street at 82<sup>nd</sup> Avenue. Flows here are split between the 79<sup>th</sup> Street and Roberts Road storm sewer systems by two weirs located in the structure. This description is general and approximate; Exhibit 19 shows the subwatershed and its limits in detail.

Land use within the subwatershed varies and includes single and multi-family residential, industrial areas, Toyota Park, and Resurrection Cemetery.

Stormwater detention facilities exist for many of the industrial properties, as well as Toyota Park. Open ponds also exist within Resurrection Cemetery.

Areas east of and including Roberts Road are drained by storm sewers that flow north and discharge to an open ditch located at 70<sup>th</sup> and Roberts Road and flows through an undeveloped portion of the Resurrection Cemetery. Areas west of Roberts Road flow via overland flow and storm sewers to the 71<sup>st</sup> Street Ditch. The ditch from 70<sup>th</sup> and Roberts Road combines with the 71<sup>st</sup> Street Ditch at 86<sup>th</sup> Avenue. At this location, the 71<sup>st</sup> Street Ditch flows west, through a culvert under the CN railroad, and out into the I&M Canal.

### **Description of Proposed Large Scale Alternatives**

Alternative A (Villages of Justice & Bedford Park) provides additional stormwater detention in the 71<sup>st</sup> St Ditch subwatershed, reducing the flow travelling through 71<sup>st</sup> Street Ditch and subsequently reducing the identified drainage problems along the ditch. The majority of the proposed volume is provided at a proposed 400 ac-ft detention basin within the cemetery property located south of the intersection of Roberts Road and Archer Road. This proposed basin is located along an existing ditch, at the existing outlet of the Roberts Road storm sewer system. This property is owned by the Archdiocese of Chicago and the proposed storage location is currently not in use as a cemetery.

This alternative also includes a 10 ac-ft vertical expansion of the existing detention basin located adjacent to the Lapinski Community Center. The outlet from the basin will need to cross existing utilities located between 71<sup>st</sup> Street Ditch and the detention basin; the exact location and depth of these utilities should be investigated to ensure feasibility and/or identify utility relocations, if necessary.

Two other alternatives were considered for this problem area, but not recommended:

1. Increase the conveyance capacity of 71<sup>st</sup> Street Ditch. This was not recommended because of space constraints, including 71<sup>st</sup> Street to the north and a reported utility (water mains) running in close proximity to the south side of the ditch.
2. Adding a second culvert under the railroad, as suggested by past studies. Our model shows that a second culvert reduces water surface elevations in the ditch by approximately 0.9 feet in the 100-year storm, but our model still shows structure flooding for residents on the south side of the ditch even after doubling the capacity of the railroad culvert. This is due to the restrictive capacity of the ditch itself and the volume of flow tributary to the ditch. Therefore, this alternative does not mitigate all structure flooding. If the full storage volume recommended in this alternative is not possible to provide due to land acquisition or other reasons, then it may be necessary to pursue a combination of storage plus a new culvert at this outlet location.

The feasibility of this alternative is largely dependent on acquiring the cemetery land for flood control use; the MWRD has successfully negotiated with the Archdiocese in the past for land acquisition. If the cemetery land is not available, then the necessary storage could possibly be relocated to the open space on the KinderMorgan industrial property northwest of 71<sup>st</sup> Street and 86<sup>th</sup> Avenue. Water currently floods into this open space and there are likely wetlands present, but the space could be regraded for more efficient storage. If the KinderMorgan storage does not completely offset the storage shown on the cemetery property, then it may also be necessary to construct the second railroad culvert to improve discharge capacity under the railroad, in conjunction with providing storage upstream of the 71<sup>st</sup> Street ditch on the KinderMorgan property.

The engineer's estimated opinion of construction cost for this alternative is \$31,720,000. The cost estimate is reduced to \$31,670,000 if constructed in conjunction with roadway improvements (and the roadway portions of the project cost are paid through a separate roadway budget/fund).

Alternative B (Village of Justice) reduces drainage problems at Problem Area B. The flood problem in this area is a combination of insufficient storage in the reservoir for the 100-year storm and insufficient capacity downstream of the reservoir. This Alternative proposes a new outlet from the existing detention basin, along 75<sup>th</sup> Street, and discharging to the I&M canal. This would include construction of two 48" parallel storm sewer outlets from the south side of the detention basin to the south, then west along 75<sup>th</sup> Street, north along Garden Avenue, and west along Jocar Drive, under the CN railroad, and outletting to the I&M Canal. The modeling results show that this new storm sewer increases the conveyance capacity downstream of the pond, lowers the water surface elevation at the storage area, and reduces potential for residential flooding. The existing outlet to the north is maintained, so any release rate restrictions that may be associated with discharge to the north would not be exceeded. If the release rate from the storage facility is a concern, it would be possible to restrict flow in the southern direction by either installing a control structure that restricts discharge in the smaller storms and/or only allow full access to the southern route during larger storms that currently result in damage.

Two other alternatives were considered, but not recommended:

1. Past studies have suggested a proposed storm sewer running north in order to achieve a similar benefit. Our analysis indicates that this could exacerbate existing flooding problems downstream along the 71<sup>st</sup> Street Ditch. Therefore we proposed to bring flow directly to the I&M Canal via the proposed southern route, rather than bringing additional runoff to the 71<sup>st</sup> Street Ditch which is frequently at capacity in existing conditions.
2. The aerial photos show an area of vacant space to the east of the existing basin, north of 75<sup>th</sup> Street. An alternative was considered to expand the existing reservoir to the east into that vacant

area. The modeling shows that an expanded reservoir would still not have adequate capacity to meet the 100-year goal. Therefore, this alternative was not recommended.

It should be noted that this alternative requires constructing a new culvert or pipe under the CN Railroad and will require coordination with and a permit from the Railroad.

The engineer's estimated opinion of construction cost for this alternative is \$5,120,000. The cost estimate is reduced to \$4,070,000 if constructed in conjunction with roadway improvements (and the roadway portions of the project cost are paid through a separate roadway budget/fund).

Problems D and G (Villages of Bridgeview & Justice) are in close proximity to each other and overflows connect the problem areas for larger storm events. Therefore the following proposed alternatives benefit both problem areas D & G.

Alternative D (Villages of Bridgeview & Justice) consists of removing a recently installed restrictor plate located on Roberts Road just south of 79<sup>th</sup> Street, and replacing the existing storm sewers downstream (north) of this structure with a 60" storm sewer that will discharge to a proposed 140 ac-ft detention basin on cemetery property at the northwest corner of 79<sup>th</sup> Street and Roberts Road. The recently installed restrictor was apparently not designed to meet a permit criterion, but rather, to provide a limited detention function within the upstream newly constructed large diameter sewer system while minimizing the potential for exacerbation of upstream flooding. The restrictor was not shown to be fully effective for flood reduction in our modeling for the 100-year storm, as it results in a surcharged storm sewer that floods Roberts Road and the surrounding area. Mitigating for flooding to the south will be best achieved through the use of the proposed storage basin instead of limited pipe detention. The storage basin is proposed on a piece of cemetery property that is currently unused, and the basin was shaped to have as little impact on future cemetery development as possible, given the MWRD flood reduction objectives.

If the proposed Alternative A basin is not constructed, then the Roberts Road storm sewer from Alternative D basin would outlet to the existing ditch instead of the Alternative A basin. The flow rate to the ditch is not expected to increase in the proposed condition, because of the positive effect of flow attenuation from the proposed Alternative D basin. If the Alternative A basin is not constructed, the benefit expected upstream of the Alternative D basin will be unchanged.

Included in this alternative is a reconfiguration of the control structure located just north of 79<sup>th</sup> Street and 82<sup>nd</sup> Avenue. The 18" force main from the Hickory Hills Reservoir outlets to this structure, and flow is split between the 79<sup>th</sup> Street storm sewer system to the west and the Roberts Road storm sewer system to the north in the existing condition. In the proposed condition, the connection to 79<sup>th</sup> Street storm sewer system will be disconnected to reduce drainage problems tributary to the 79<sup>th</sup> Street subwatershed. Additionally, the existing "floats" in the junction chamber (which turn the pumps on and off) will be removed, and the pumps are proposed to cycle normally, based solely on the presence of water within the Hickory Hills Reservoir. All runoff pumped from Hickory Hills Reservoir will be conveyed to the proposed detention basin at the northwest corner of 79<sup>th</sup> Street and Roberts Road (Alternative D basin).

The basin proposed in this alternative also benefits problem area G, and is an integral part of Alternative G. Removing the junction chamber downstream of the Hickory Hills Reservoir to direct all flow to the north (instead of splitting and sending some flow to the west, as in the existing condition) also reduces drainage problems in Problem Area F.

The feasibility of this alternative is dependent on acquiring the cemetery land for flood control use; the MWRD has successfully negotiated with the Archdiocese in the past for land acquisition.

Alternative G (Village of Bridgeview) consists of replacing the existing 36” and 42” storm sewers along 78<sup>th</sup> Avenue, north of 79<sup>th</sup> Street, with 54” storm sewer and also installing a 54” storm sewer along 79<sup>th</sup> Street that conveys runoff to the Alternative D detention basin. When runoff coming from the area southeast of Roberts Road and 79<sup>th</sup> Street reaches the junction at 79<sup>th</sup> Street and 78<sup>th</sup> Avenue, the flow will be split between the two 54” storm sewers, with some runoff flowing north to the existing 54” storm sewer and some runoff flowing west to the Alternative D storage basin.

This alternative is dependent on construction of the Alternative D basin, and the full benefit shown with Alternative G will not be realized if the Alternative D basin is not constructed. (Some benefit will be realized in Alternative G without the Alternative D basin, due to the larger pipe and increased conveyance to the north along 78<sup>th</sup> Avenue, but the full benefit shown will not be realized.)

The engineer’s estimated opinion of construction cost for Alternatives D and G combined is \$15,520,000. The cost estimate is reduced to \$13,540,000 if constructed in conjunction with roadway improvements (and the roadway portions of the project cost are paid through a separate roadway budget/fund).

Alternative Y (Village of Bridgeview) proposes installing larger storm sewers throughout the area enclosed by 71<sup>st</sup> Street, Harlem Avenue, 79<sup>th</sup> Street, and the Indiana Harbor Belt Railroad. The 12”, 15”, 18”, and 24” laterals in the area will be replaced with 48” storm sewers. The existing 60”, 66”, and 72” trunk sewers on Oketo, 72nd Street and Ferdinand Avenue will remain as-is. The larger laterals provide an increase in conveyance capacity while also providing storage volume for larger storm events. When the trunk sewer on Oketo is at capacity, the trunk sewer will act as a natural hydraulic restrictor and the storage in the 48” sewers will be utilized.

This alternative will also require installing new high capacity inlets throughout the neighborhood to deliver flow efficiently into the proposed sewers without bypass flow downstream to the problem area.

An alternative was considered, using larger pipes through the neighborhoods further south which are also tributary to the trunk sewer on Oketo. The model results showed that these pipes had a lesser or minimal influence on results at the problem area, and the problem area could be mitigated with the recommended area alone.

Another alternative was considered that provided additional flood protection beyond that required to bring the flood elevation well below the “house dot” flood protection elevations due to the extremely flat area of this sub-basin. This alternative considered using 66” proposed pipes instead of 48” proposed storm sewers, in the area between 71<sup>st</sup> Street and 79<sup>th</sup> Street. These larger pipes did reduce computed water surface elevations by approximately 0.3 feet and brought the elevations to approximate street level protection, however, the large cost associated with increasing thousands of feet of pipe from 48” as proposed under Alternative Y, to 66” as considered with this alternative, outweighed the small incremental benefit provided by the larger pipes. Even so, individual homes and entry elevations should be checked as this Alternative unfolds to insure protection for all residents within this topographically flat area.

Because the trunk sewer remains unchanged in this scenario, the laterals can be upsized in any order of streets, and performed whenever the roads are replaced or rehabilitated, to minimize cost of this Alternative.

The engineer’s estimated opinion of construction cost for this alternative is \$17,520,000. The cost estimate is reduced to \$15,590,000 if constructed in conjunction with roadway improvements (and the roadway portions of the project cost are paid through a separate roadway budget/fund).

Toyota Park Alternative consists of additional storage at the Toyota Park site. Several resident questionnaires suggested that flooding in the 71st Street Ditch area was a result of Toyota Park at the upstream end of the subwatershed. An alternative to further restrict drainage from Toyota Park into the downstream system was evaluated. In the existing condition, it appears that runoff from the Toyota Park site is routed to a detention basin in the southwest corner of the site, which restricts runoff before releasing through an apparent 12” storm sewer into the 71st Street storm sewer (and ultimately the 71st Street Ditch.) The 12” sewer appears to have sufficiently limited capacity to control flows that are conveyed into the downstream system. During larger storms, the 12” storm sewer does restrict flows and results in flooding of Toyota Park’s parking lot, but does not appear to result in increased flows downstream into the 71st Street storm sewer or ditch.

An alternative to further reduce flow through the 12” storm sewer was evaluated. The Toyota Park drainage area was removed from the model completely, simulating a scenario in which additional stormwater detention would be added to the site to capture and control 100% of the site’s runoff. Although this is an extreme alternative, it was effective in testing the sensitivity of the model (and resultant flooding) due to the effects of Toyota Park runoff. The model found that removing all of the Toyota Park runoff had no noticeable effects on flooding downstream. Therefore, this alternative was not explored further and additional storage is not recommended at Toyota Park.

A cost opinion was not developed for this alternative.

If additional detention is desired to control flooding of the Toyota Park site parking lots, this could be achieved through expansion of existing basins and/or construction of underground detention.

#### Results: 71<sup>st</sup> Street Ditch Subwatershed

Tables 9 and 10 below provide results from the XP-SWMM analysis of the proposed alternatives, in terms of the structures being benefitted by the proposed Alternative improvements. Two numbers are provided: the number of homes that could have water adjacent to the foundation, and the number of homes that could have water entering the home (based on the ground elevation at the “house dot” location per GIS +0.66 feet.) This methodology is explained earlier in this report.

Tables showing the existing versus proposed results for the 100-year storms, and a comparison of the model results to the “flood protection elevation” or the “flood protection flow rate,” can be found in Appendix F.

Results for problem areas D and G are shown in the 79<sup>th</sup> Street Sewer Subwatershed section of this report, due to the interconnectivity between Alternatives D, G and F.

**Table 9 – Structures Benefitted (Reduction in Water Adjacent to Foundation) by Large Scale Proposed Improvements, 71<sup>st</sup> Street Ditch Subwatershed**

Problem Area	2-hr				24-hr			
	100-yr Exist	100-yr Prop Large Scale	Benefiting Structures (No.)	Benefit (%)	100-yr Exist	100-yr Prop Large Scale	Benefiting Structures (No.)	Benefit (%)
Problem A	7	0	7	100%	24	0	24	100%
Problem B	5	0	5	100%	40	0	40	100%
Problem Y	31	24	7	23%	19	2	17	89%
Problem DG	62	15	47	76%	36	1	35	97%
<b>Total</b>	<b>105</b>	<b>39</b>	<b>66</b>	<b>63%</b>	<b>119</b>	<b>3</b>	<b>116</b>	<b>97%</b>

**Table 10 – Structures Benefitted (Reduction in Water Above First Floor) by Large Scale Proposed Improvements, 71<sup>st</sup> Street Ditch Subwatershed**

Problem Area	2-hr				24-hr			
	100-yr Exist	100-yr Prop Large Scale	Benefiting Structures (No.)	Benefit (%)	100-yr Exist	100-yr Prop Large Scale	Benefiting Structures (No.)	Benefit (%)
Problem A	7	0	7	100%	7	0	7	100%
Problem B	0	0	0	n/a	23	0	23	100%
Problem Y	6	0	6	100%	0	0	0	n/a
Problem DG	6	2	4	67%	3	0	3	100%
<b>Total</b>	<b>19</b>	<b>2</b>	<b>17</b>	<b>89%</b>	<b>33</b>	<b>0</b>	<b>33</b>	<b>100%</b>

Note that the inundation mapping shows three structures remaining with water on the first floor, on South 78<sup>th</sup> Ave in Problem Area D, in the 100-year 2-hour storms. At two of those structures, depth of flooding above the estimated first floor elevation is less than 0.10 feet. It is possible that refinements of the design and a detailed survey of the home's low entry elevation may show that the structures are removed completely. Therefore, the data tables show the structures benefitting from Alternative D, although it still is shown as impacted in the exhibits.

At the third structure in Problem Area D, the depth of flooding above the first floor is estimated as 0.4 feet in the proposed condition. This is a reduction from the existing condition, but not a complete removal. It is possible that refinements of the design and a detailed survey of the structure's low entry elevation may enable the removal of the structure completely. It is also possible that it will be difficult to protect this structure, given the low elevation compared to the surrounding area.

Additionally, the inundation mapping shows two homes remaining with water on the first floor, on Thomas and Oketo in Problem Area Y, in the 100-year 2-hour storms. The depth of flooding above the estimated first floor elevations is less than 0.01 feet at one home, and less than 0.25 feet at the other. It is possible that refinements of the design and a detailed survey of the homes' low entry elevations may remove the homes completely. Therefore, the data tables show the homes as benefitting from Alternative Y, although they are still shown as impacted in the exhibits.

## Description of Proposed Medium Scale Alternatives

The large scale alternatives presented above are expected to meet the MWRD’s goal of providing a 100-year level of protection to residential structures. In locations where proposed large scale engineering solutions are costly, difficult to construct, or otherwise challenging to implement, a scaled-back “medium scale” version of the engineering solution is suggested to provide some benefits but not the full 100-year benefit. These are identical to the large scale alternatives, except as noted below:

Proposed Alternative B-med : The proposed large scale improvement uses dual 48” pipes on 75<sup>th</sup> Street, under the CN railroad, and out to the I&M Canal. The medium scale alternative B-med eliminates the parallel pipe and proposes a single 48” storm sewer along the same alignment, including a new crossing of the CN railroad with a proposed 48” diameter sewer.

The engineer’s estimated opinion of construction cost for this medium-scale alternative is \$2,940,000. The cost estimate is reduced to \$2,190,000 if constructed in conjunction with roadway improvements (and the roadway portions of the project cost are paid through a separate roadway budget/fund).

### Results with Medium Scale Alternatives

Tables 11 and 12 below compares the existing, proposed large-scale, and proposed medium-scale results in the subwatershed. As shown, the medium-scale results provide a benefit to the problem areas, but do not completely protect every home to the 100-year storm.

**Table 11 – Structures Benefitted (Reduction in Water Adjacent to Foundation) by Medium Scale Proposed Improvements, 71<sup>st</sup> Street Ditch Subwatershed**

Problem Area	2-hr				24-hr			
	100-yr Exist	100-yr Prop Med Scale	Benefiting Structures (No.)	Benefit (%)	100-yr Exist	100-yr Prop Med Scale	Benefiting Structures (No.)	Benefit (%)
Problem A	7	0	7	100%	24	0	24	100%
Problem B	5	0	5	100%	40	0	40	100%
Problem Y	31	24	7	23%	19	2	17	89%
Problem DG	62	15	47	76%	36	1	35	97%
<b>Total</b>	<b>105</b>	<b>39</b>	<b>66</b>	<b>63%</b>	<b>119</b>	<b>3</b>	<b>116</b>	<b>97%</b>

**Table 12 – Structures Benefitted (Reduction in Water Above First Floor) by Medium Scale Proposed Improvements, 71<sup>st</sup> Street Ditch Subwatershed**

Problem Area	2-hr				24-hr			
	100-yr Exist	100-yr Prop Med Scale	Benefiting Structures (No.)	Benefit (%)	100-yr Exist	100-yr Prop Med Scale	Benefiting Structures (No.)	Benefit (%)
Problem A	7	0	7	100%	7	0	7	100%
Problem B	0	0	0	n/a	23	0	23	100%
Problem Y	6	2	4	67%	0	0	0	n/a
Problem DG	6	4	2	33%	3	0	3	100%
<b>Total</b>	<b>19</b>	<b>6</b>	<b>13</b>	<b>68%</b>	<b>33</b>	<b>0</b>	<b>33</b>	<b>100%</b>

**Description of Proposed Residential Scale Alternatives (BMPs and GI), with and without CIPs**

Tables 13 - 18 below compare the results of widespread BMP implementation throughout the subwatershed, with and without large or medium scale capital projects in place.

**Table 13 –Structures Benefitted (Reduction in Water Adjacent to Foundation) by Widespread BMP Implementation (and no capital projects), 71<sup>st</sup> Street Ditch Subwatershed**

Problem Area	2-hr				24-hr			
	100-yr Exist	100-yr BMPs	Benefiting Structures (No.)	Benefit (%)	100-yr Exist	100-yr BMPs	Benefiting Structures (No.)	Benefit (%)
Problem A	7	3	4	57%	24	10	14	58%
Problem B	5	0	5	100%	40	23	17	43%
Problem Y	31	21	10	32%	19	1	18	95%
Problem DG	62	34	28	45%	36	19	17	47%
<b>Total</b>	<b>105</b>	<b>58</b>	<b>47</b>	<b>45%</b>	<b>119</b>	<b>53</b>	<b>66</b>	<b>55%</b>

**Table 14 –Structures Benefitted (Reduction in Water Above First Floor) by Widespread BMP Implementation (and no capital projects), 71<sup>st</sup> Street Ditch Subwatershed**

Problem Area	2-hr				24-hr			
	100-yr Exist	100-yr BMPs	Benefiting Structures (No.)	Benefit (%)	100-yr Exist	100-yr BMPs	Benefiting Structures (No.)	Benefit (%)
Problem A	7	0	7	100%	7	1	6	86%
Problem B	0	0	0	n/a	23	5	18	78%
Problem Y	6	1	5	83%	0	0	0	n/a
Problem DG	6	3	3	50%	3	0	3	100%
<b>Total</b>	<b>19</b>	<b>4</b>	<b>15</b>	<b>79%</b>	<b>33</b>	<b>6</b>	<b>27</b>	<b>82%</b>

**Table 15 –Structures Benefitted (Reduction in Water Adjacent to Foundation) by Large Scale Alternatives and Widespread BMP Implementation, 71<sup>st</sup> Street Ditch Subwatershed**

Problem Area	2-hr							24-hr						
	100-yr Exist	100-yr Prop Large Scale	Benefiting Structures (No.)	Benefit (%)	100-yr Prop Large Scale w/BMPs	Benefiting Structures (No.)	Benefit (%)	100-yr Exist	100-yr Prop Large Scale	Benefiting Structures (No.)	Benefit (%)	100-yr Prop Large Scale w/BMPs	Benefiting Structures (No.)	Benefit (%)
Problem A	7	0	7	100%	0	7	100%	24	0	24	100%	0	24	100%
Problem B	5	0	5	100%	0	5	100%	40	0	40	100%	0	40	100%
Problem Y	31	24	7	23%	9	22	71%	19	2	17	89%	1	18	95%
Problem DG	62	15	47	76%	4	58	94%	36	1	35	97%	0	36	100%
<b>Total</b>	<b>105</b>	<b>39</b>	<b>66</b>	<b>63%</b>	<b>13</b>	<b>92</b>	<b>88%</b>	<b>119</b>	<b>3</b>	<b>116</b>	<b>97%</b>	<b>1</b>	<b>118</b>	<b>99%</b>

**Table 16 –Structures Benefitted (Reduction in Water Above First Floor) by Large Scale Alternatives and Widespread BMP Implementation, 71<sup>st</sup> Street Ditch Subwatershed**

Problem Area	2-hr							24-hr						
	100-yr Exist	100-yr Prop Large Scale	Benefiting Structures (No.)	Benefit (%)	100-yr Prop Large Scale w/BMPs	Benefiting Structures (No.)	Benefit (%)	100-yr Exist	100-yr Prop Large Scale	Benefiting Structures (No.)	Benefit (%)	100-yr Prop Large Scale w/BMPs	Benefiting Structures (No.)	Benefit (%)
Problem A	7	0	7	100%	0	7	100%	7	0	7	100%	0	7	100%
Problem B	0	0	0	n/a	0	0	n/a	23	0	23	100%	0	23	100%
Problem Y	6	0	6	100%	0	6	100%	0	0	0	n/a	0	0	n/a
Problem DG	6	2	4	67%	1	5	83%	3	0	3	100%	0	3	100%
<b>Total</b>	<b>19</b>	<b>2</b>	<b>17</b>	<b>89%</b>	<b>1</b>	<b>18</b>	<b>95%</b>	<b>33</b>	<b>0</b>	<b>33</b>	<b>100%</b>	<b>0</b>	<b>33</b>	<b>100%</b>

**Table 17 –Structures Benefitted (Reduction in Water Adjacent to Foundation) by Medium Scale Alternatives and Widespread BMP Implementation, 71<sup>st</sup> Street Ditch Subwatershed**

Problem Area	2-hr							24-hr						
	100-yr Exist	100-yr Prop Med Scale	Benefit-ing Structures (No.)	Benefit (%)	100-yr Prop Med Scale w/BMPs	Benefit-ing Structures (No.)	Benefit (%)	100-yr Exist	100-yr Prop Med Scale	Benefit-ing Structures (No.)	Benefit (%)	100-yr Prop Med Scale w/BMPs	Benefit-ing Structures (No.)	Benefit (%)
Problem A	7	0	7	100%	0	7	100%	24	0	24	100%	0	24	100%
Problem B	5	0	5	100%	0	5	100%	40	0	40	100%	0	40	100%
Problem Y	31	24	7	23%	9	22	71%	19	2	17	89%	9	10	53%
Problem DG	62	15	47	76%	4	58	94%	36	1	35	97%	4	32	89%
<b>Total</b>	<b>105</b>	<b>39</b>	<b>66</b>	<b>63%</b>	<b>13</b>	<b>92</b>	<b>88%</b>	<b>119</b>	<b>3</b>	<b>116</b>	<b>97%</b>	<b>13</b>	106	89%

**Table 18 –Structures Benefitted (Reduction in Water Above First Floor) by Medium Scale Alternatives and Widespread BMP Implementation, 71<sup>st</sup> Street Ditch Subwatershed**

Problem Area	2-hr							24-hr						
	100-yr Exist	100-yr Prop Med Scale	Benefit-ing Structures (No.)	Benefit (%)	100-yr Prop Med Scale w/BMPs	Benefit-ing Structures (No.)	Benefit (%)	100-yr Exist	100-yr Prop Med Scale	Benefit-ing Structures (No.)	Benefit (%)	100-yr Prop Med Scale w/BMPs	Benefit-ing Structures (No.)	Benefit (%)
Problem A	7	0	7	100%	0	7	100%	7	0	7	100%	0	7	100%
Problem B	0	0	0	n/a	0	0	n/a	23	0	23	100%	0	23	100%
Problem Y	6	2	4	67%	0	6	100%	0	0	0	n/a	0	0	n/a
Problem DG	6	4	2	33%	1	5	83%	3	0	3	100%	1	2	67%
<b>Total</b>	<b>19</b>	<b>6</b>	<b>13</b>	<b>68%</b>	<b>1</b>	<b>18</b>	<b>95%</b>	<b>33</b>	<b>0</b>	<b>33</b>	<b>100%</b>	<b>1</b>	<b>32</b>	<b>97%</b>

## **79<sup>th</sup> Street Sewer Subwatershed**

A description of the existing conditions, proposed improvements, and results of the XP-SWMM analyses for the 79<sup>th</sup> Street Sewer Subwatershed follows.

### **Existing Conditions**

The 79<sup>th</sup> Street Sewer Subwatershed is in the north-central end of the study area. It includes portions of the Villages of Bridgeview and Justice and the City of Hickory Hills. It is roughly bound by 79<sup>th</sup> Street on the north, Roberts Rd on the east, 89<sup>th</sup> – 91<sup>st</sup> Streets on the south, and Kean Avenue on the west. This description is general and approximate; Exhibit 20 shows the subwatershed and the limits in detail.

Land use within the subwatershed varies and includes single family and multi-family residential, commercial areas, the Lithuanian National Cemetery, Archer Woods Memorial Park Cemetery, the Illinois Tollway, and some Cook County Forest Preserve area.

Stormwater detention facilities exist for some of the commercial and multi-family properties. As stated above, the area tributary to the Hickory Hills Reservoir is part of both 71<sup>st</sup> Street Ditch and 79<sup>th</sup> Street Sewer subwatersheds; this reservoir collects runoff from the upstream drainage area, stores it, and releases it via pump station to the 79<sup>th</sup> Street storm sewer.

South of I-294, runoff generally flows to the north via storm sewers and overland flow, and crosses I-294 via a 60" pipe at 86<sup>th</sup> Court and via an 18" force main (from the Hickory Hills Reservoir) at 85<sup>th</sup> Street. These sewers continue north to 79<sup>th</sup> Street. North of I-294, runoff flows north to 79<sup>th</sup> Street and into the 79<sup>th</sup> Street storm sewer. This large diameter pipe conveys the runoff to the west, across the CN railroad, and into the I&M Canal just south of LaGrange Road.

### **Description of Proposed Large Scale Alternatives**

Alternative F (Village of Justice) consists of roadway and storage improvements to provide a better defined stormwater management system through a neighborhood that is lacking, including increasing inlet and storm sewer capacity where storm sewer infrastructure currently exists, replacing rural roadway cross sections with streets that have curb and gutter. Proposed storm sewers will convey runoff from the residential area to the proposed 100 ac-ft detention basin north of 79<sup>th</sup> Street on cemetery and driving range property.

The improvements also include a large diameter storm sewer along the north side of 79<sup>th</sup> Street, up to dual 72" sewers, to convey the runoff that is currently ponding and inundating many structures between the Tollway and 79<sup>th</sup> Street. The dual 72" sewers deliver water to the proposed storage area on the driving range. The driving range storage area would outlet to the existing 48-inch diameter 79<sup>th</sup> Street storm sewer which continue west to the I&M Canal.

The proposed storage on the driving range property is shaped to avoid impacts to the tee boxes, but would lower the grassed range area to provide a stormwater storage location during storm events. The storage can be reshaped as necessary on the driving range property or relocated to the adjacent cemetery property.

The alignment of storm sewers through the neighborhood south of 79<sup>th</sup> Street is flexible and may be oriented differently than shown on the exhibit, based on locations of other utilities, identified design constraints, and based on programmed roadway rehabilitation projects. Constructing the storm sewer improvements in conjunction with programmed roadway rehabilitation projects could reduce the overall

cost of this project, as the roadway component of the project cost could be paid for through the programmed roadway funds.

An alternative to constructing curb and gutter throughout the neighborhood would be to establish positive ditch flow throughout the neighborhood, consisting of properly sized and sloped ditches, which would flow downstream towards larger ditches or flow into larger trunk storm sewers. This could provide a lower cost solution due to reduction in pipe cost and roadway improvement cost, but at a greater impact to individual homes. There is potential for the ditches to encroach into front yards, particularly towards the downstream end of the system, and in places where there may be slightly elevated front yards (that would subsequently require more earthwork in the right-of-way/yard to tie the ditch slopes into the yard grades).

Alternative F also benefits by the proposed improvements in problem areas D and G. Alternatives D and G reduce overflow and street flooding, a part of which is the reduction of the amount of overland flow crossing from the east side of Roberts Road (within the Problem D and G areas) to the west (into the Problem F area). Alternative D also benefits Alternative F, because flow from the Hickory Hills Reservoir (which is split in the existing condition) is redirected to flow entirely to the north in the proposed Alternative D, resulting in a reduction of flow to the west on 79<sup>th</sup> Avenue and subsequently reducing the drainage problems in area F.

The engineer's estimated opinion of construction cost for this alternative is \$28,460,000. The cost estimate is reduced to \$21,890,000 if constructed in conjunction with roadway improvements (and the roadway portions of the project cost are paid through a separate roadway budget/fund).

Problem G is discussed in the 71<sup>st</sup> Street Ditch Subwatershed section.

Problems H and J (Village of Justice & City of Hickory Hills) are closely related and therefore the proposed alternatives below benefit both problem areas.

The proposed alternative consists of lowering the existing detention basin normal water level at Sunset Apartments by 1.5' to 2' to provide additional storage. The alternative includes replacing the existing outlet pipe with a 30" storm sewer at a lower elevation. This new storage provides sufficient capacity to attenuate flows to the Tollway pipe downstream, and the storage in conjunction with increased conveyance capacity results in a reduction in drainage problems through this problem area.

Also included in this alternative is a 7 ac-ft storage area constructed on three vacant parcels east of the Sunset Apartments and west of 85<sup>th</sup> Court. The basin is constructed in a low depressional area and provides adequate storage to capture and store runoff to reduce the potential for flooding on the adjacent area. The basin is proposed to discharge to the north through an existing ditch, and then flow west through the 83<sup>rd</sup> Street storm sewer system.

This alternative also improves the 83<sup>rd</sup> Street storm sewer system, with proposed installation of 36" – 48" proposed storm sewer parallel to the existing 36" storm sewer, west along 83<sup>rd</sup> Street and north through the industrial properties between 83<sup>rd</sup> Street and I-294, along the existing sewer alignment. This additional capacity relieves the storm sewer surcharging and flooding in this area, and provides a positive conveyance route from the flooded area along 85<sup>th</sup> Court and from the Sunset Avenue apartment complex, to the culvert under the Tollway.

Additional alternatives were considered but not recommended:

1. Replacement of the Tollway culvert was not recommended. This alternative was suggested in prior reports, however, the modeling shows that the existing pipe does not appear to be

undersized or contributing to the flooding problems. Furthermore, a larger culvert would have a high cost to jack a pipe under the Tollway.

2. Enlargement of the existing detention basins in the industrial area immediately south of the Tollway was not recommended, as there did not appear to be adequate space for this improvement, and the volume provided would not have been adequate to mitigate the drainage problems.

The engineer's estimated opinion of construction cost for this alternative is \$1,810,000 for the improvements in area H and \$1,320,000 for the improvements in area J. The cost estimate for alternative H is reduced to \$1,660,000 if constructed in conjunction with roadway improvements (and the roadway portions of the project cost are paid through a separate roadway budget/fund).

Problems I and W (Village of Justice & City of Hickory Hills) are closely related and therefore the proposed alternatives below benefit both problem areas. Flooding problems were observed along Blue Ridge Avenue, and also downstream along the existing storm sewer system that meanders through the neighborhood between 90<sup>th</sup> Avenue and 88<sup>th</sup> Avenue.

The proposed alternative in this area includes several components to provide additional storage and conveyance capacity.

A 72" equivalent elliptical storm sewer is proposed to convey flow from the intersection of Forest Drive and Blue Ridge Avenue, north along Blue Ridge Avenue, and discharge to a proposed 27 ac-ft detention basin on cemetery property. The cemetery property in this area contains an existing ditch, and the area appears unused by the cemetery. This reduces drainage problems between 85<sup>th</sup> Street and 84<sup>th</sup> Street by removing some of the runoff area that is tributary to that location, reduces overflow from the west across 90<sup>th</sup> Avenue to the east, and reduces drainage problems along Blue Ridge Avenue by providing a larger storm sewer with greater conveyance capacity. Additional high capacity inlets should also be constructed along Blue Ridge Avenue to deliver runoff into the storm sewer system.

Flow from the proposed cemetery basin is conveyed to an existing detention basin at the northwest corner of 88<sup>th</sup> Avenue and 83<sup>rd</sup> Street, which is proposed to be expanded to a 47 ac-ft basin. The proposed 30" sewer connecting the two detention basins will follow the alignment of an existing 24" sewer.

The subdivision west of Blue Ridge Avenue has two roadway "sag" locations where the existing storm sewers surcharge and flood the road. Flooded waters flow through the residential lots and may damage adjacent homes. One sag area is in the middle of the Shady Lane block, where additional inlets and a new storm sewer is proposed to capture and convey runoff into the proposed cemetery pond. The second area is along Blue Ridge Avenue, at Chestnut Drive. It is recommended that the subdivision's stormwater infrastructure be modeled to a higher degree of accuracy and precision, including inlet capacity, to determine if additional inlets are warranted elsewhere in the neighborhood to further reduce potential for surcharge and overflow through the neighborhood that could affect the nearby residential properties.

No changes are proposed to the stormwater infrastructure system between 90<sup>th</sup> Avenue and 88<sup>th</sup> Avenue, with the exception of removing or abandoning the sewer connection from the intersection of Forest Drive and Blue Ridge Avenue to 90<sup>th</sup> Avenue, and removing or abandoning the existing pipe from Blue Ridge Avenue (south of Chestnut Drive) to the existing 90<sup>th</sup> Avenue Ditch. By removing or abandoning these connections, the area that remains tributary to the storm sewers and ditch between 90<sup>th</sup> Ave and 88<sup>th</sup> Ave is small enough that it is not expected to result in flooding within that area.

An additional problem area is on 83<sup>rd</sup> Street, where a low area north of 83<sup>rd</sup> Street is drained by inlets and a storm sewer and flows east. The storm sewer east of 88<sup>th</sup> Avenue appears to have adequate capacity, but the homes at the low area on 83<sup>rd</sup> Street have reported flooding. It appears this flooding is due to insufficient inlet capacity and/or clogged inlets, reducing the ability of this area to drain during a large storm, and contributing to flooding on 83<sup>rd</sup> Street. The inlets should be increased to provide additional capacity and redundancy in case of blocked inlets, and the area should be maintained with regularity to ensure inlet grates are free and clear to drain runoff into the sewer system.

Several other alternatives were considered in this area.

1. Upsizing the storm sewer system from 90<sup>th</sup> Avenue to 88<sup>th</sup> Avenue was considered to provide additional conveyance capacity and reduce surcharge through the area, however, the storm sewers follow an assumed easement through the rear and side yards of 18 single family properties, and construction improvements within this alignment appeared to result in a large disruption to these residential properties, versus the proposed alignment which is primarily within the public right-of-way. Increasing conveyance without additional storage could also exacerbate problems downstream, and therefore this alternative was not pursued further.
2. Another alternative that was considered was combining the two proposed storage areas onto a single basin on the cemetery property. This would result in a larger impact to the cemetery and an impact into the existing burial sites, which is not a recommended alternative.
3. The neighborhood does not have a well-defined drainage system. The recommended alternative is expected to reduce the drainage problems associated with structural flooding. Improving the overall drainage system for the neighborhood, either through establishing well defined ditches/swales and culverts, or through converting all streets to curb and gutter with storm sewer, would also improve the neighborhood's drainage systems. This is not recommended because it is not necessary to reduce drainage problems associated with a specific drainage complaint, but may be considered for a neighborhood-wide benefit to control nuisance flooding.

The existing storage basin at the northwest corner of 83<sup>rd</sup> Street and 88<sup>th</sup> Avenue provides stormwater detention storage for the townhome community on 81<sup>st</sup> Street. The basin is adjacent to existing open space that appears available for expansion, and therefore an expansion of the basin to provide more storage is proposed by this alternative. However, the existing basin includes a large berm on the south and east edges, which may be classified by IDNR as a Class I dam. The bottom of the existing basin is higher than the grades at 83<sup>rd</sup> Street to the immediate south and Cork Ave (88<sup>th</sup> Ave) to the east, and the high water level in the existing basin is approximately 12 feet higher than 83<sup>rd</sup> Street and the homes on 83<sup>rd</sup> Street (and Cork Avenue (88<sup>th</sup> Avenue) and businesses to the east). Failure of the berm could inundate the homes to the south and businesses to the east. The proposed storage improvements at this basin avoid impacts to the existing southern berm (possible dam), but additional dam safety permitting and requirements may be needed to expand the storage volume within the basin.

The engineer's estimated opinion of construction cost for this alternative (Alternatives I and W combined) is \$7,600,000. The cost estimate is reduced to \$7,110,000 if constructed in conjunction with roadway improvements (and the roadway portions of the project cost are paid through a separate roadway budget/fund).

Alternative K Flooding at 87<sup>th</sup> Street has been observed, adjacent to the Hickory Hills Reservoir. The flooding was attributed to overtopping of the Hickory Hills Reservoir, with two occurrences observed in the past decade. Our model results indicate that the 100-year synthetic storm does not overtop the reservoir or contribute to flooding, but larger storm events may result in reservoir overtopping, especially

with high antecedent moisture conditions. Additionally, it is possible that flooding that was observed on 87<sup>th</sup> Street was due to the low wetland area that is between 87<sup>th</sup> Street and the Hickory Hills Reservoir, and not from the Hickory Hills Reservoir itself. This wetland area appears to have inlets to drain runoff into the large diameter storm sewer (which flows into the Hickory Hills Reservoir), but if the inlets do not have sufficient capacity or the inlets are blocked with debris, then the wetland depression would fill and overflow onto the roadway, resulting in roadway impacts as observed in the reports. The large diameter storm sewer from 87<sup>th</sup> Street north to the Hickory Hills Reservoir appears to have adequate capacity for the 100-year storm.

Therefore, the recommended improvements in this area include increasing the inlet capacity within the wetland area and/or performing regular maintenance to keep the inlets free and clear of debris. Because the area is a wetland, the additional inlets could be elevated above the existing ground surface. This would protect and maintain wetland hydrology during the small to moderate storm events, while providing additional inlet capacity during the larger storm events.

Results: 79<sup>th</sup> Street Sewer Subwatershed

Tables 19-20 below provide the results from the XP-SWMM analysis of the proposed alternatives, in terms of the structures being benefitted by the proposed Alternative improvements. Two numbers are provided: the number of homes that could have water adjacent to the foundation, and the number of homes that could have water entering the home (based on the ground elevation at the “house dot” location per GIS +0.66 feet.) This methodology is explained earlier in this report.

Tables showing the existing versus proposed results for the 100-year storms, and a comparison of the model results to the “flood protection elevation” or the “flood protection flow rate,” can be found in Appendix F.

**Table 19 – Structures Benefitted (Reduction in Water Adjacent to Foundation) by Large Scale Proposed Improvements, 79<sup>th</sup> Street Sewer Subwatershed**

Problem Area	2-hr				24-hr			
	100-yr Exist	100-yr Prop Large Scale	Benefit-ing Structures (No.)	Benefit (%)	100-yr Exist	100-yr Prop Large Scale	Benefit-ing Structures (No.)	Benefit (%)
Problem K	3	3	0	0%	3	3	0	0%
Problem I	11	7	4	36%	5	3	2	40%
Problem W	7	5	2	29%	1	0	1	100%
Problem F	161	19	142	88%	184	0	184	100%
Problem J	1	0	1	100%	1	0	1	100%
Problem H	1	0	1	100%	3	0	3	100%
<b>Total</b>	<b>184</b>	<b>34</b>	<b>150</b>	<b>82%</b>	<b>197</b>	<b>6</b>	<b>191</b>	<b>97%</b>

**Table 20 – Structures Benefitted (Reduction in Water Above First Floor) by Large Scale Proposed Improvements, 79<sup>th</sup> Street Sewer Subwatershed**

Problem Area	2-hr				24-hr			
	100-yr Exist	100-yr Prop Large Scale	Benefiting Structures (No.)	Benefit (%)	100-yr Exist	100-yr Prop Large Scale	Benefiting Structures (No.)	Benefit (%)
Problem K	1	1	0	0%	1	1	0	0%
Problem I	5	0	5	100%	3	0	3	100%
Problem W	2	1	1	50%	1	0	1	100%
Problem F	86	0	86	100%	97	0	97	100%
Problem J	0	0	0	n/a	1	0	1	100%
Problem H	0	0	0	n/a	1	0	1	100%
<b>Total</b>	<b>94</b>	<b>2</b>	<b>92</b>	<b>98%</b>	<b>104</b>	<b>1</b>	<b>103</b>	<b>99%</b>

Note that the inundation mapping and tables of results show one home remaining with water on the first floor, on Blue Ridge Avenue, in the 2-hour storm in Problem Area W. The depth of flooding above the first floor is estimated as 0.6 feet. This is a reduction from the existing condition, which was damaged with 0.95 feet of water. It is possible that refinements of the design and a detailed survey of the home’s low entry elevation may remove the home completely. It is also possible that it will be difficult to protect this home, given the low elevation compared to the surrounding area.

Additionally, the inundation mapping shows one home remaining with water on the first floor, on W. 83<sup>rd</sup> Street in Problem Area I, in the 100-year 24-hour and 2-hour storms. The depth of flooding above the estimated first floor elevation is less than 0.20 feet. It is possible that refinements of the design and a detailed survey of the home’s low entry elevation may remove the home completely. Therefore, the data tables below show the home as benefitting from Alternative I, although it still is shown as impacted in the exhibits.

### **Description of Proposed Medium Scale Alternatives**

The large scale alternatives presented above are expected to meet the MWRD’s goal of providing a 100-year level of protection to residential structures. In locations where proposed large scale engineering solutions are costly, difficult to construct, or otherwise challenging to implement, a scaled-back “medium scale” version of the engineering solution is suggested to provide some benefits but not the full 100-year benefit. These are identical to the large scale alternatives, except as noted below:

Proposed Alternative F-med: The large scale alternative F includes several thousand feet of dual storm sewers with large diameters, ranging from 48” to 72”. The medium scale alternative F-med reduces this proposed capacity by 50%, using only single storm sewers. The proposed size in the large scale alternative remains unchanged, but the capacity is reduced by eliminating the proposed parallel pipe.

The engineer’s estimated opinion of construction cost for this medium-scale alternative is \$24,320,000. The cost estimate is reduced to \$18,660,000 if constructed in conjunction with roadway improvements (and the roadway portions of the project cost are paid through a separate roadway budget/fund).

Proposed Alternative I-med & W-med: The medium scale alternative, I-med & W-med, uses a proposed 48” storm sewer on Blue Ridge Avenue instead of the proposed 58” x 91” elliptical (72” round equivalent) storm sewer that is proposed in the large-scale improvement.

The engineer’s estimated opinion of construction cost for this medium-scale alternative is \$6,640,000. The cost estimate is reduced to \$6,310,000 if constructed in conjunction with roadway improvements (and the roadway portions of the project cost are paid through a separate roadway budget/fund).

Results with Medium Scale Alternatives

Tables 21-22 below compares the existing, proposed large-scale, and proposed medium-scale results in the subwatershed. As shown, the medium-scale results provide a benefit to the problem areas, but do not completely of protect every home to the 100-year storm.

**Table 21 –Structures Benefitted (Reduction in Water Adjacent to Foundation) by Medium Scale Proposed Improvements, 79<sup>th</sup> Street Sewer Subwatershed**

Problem Area	2-hr				24-hr			
	100-yr Exist	100-yr Prop Med Scale	Benefiting Structures (No.)	Benefit (%)	100-yr Exist	100-yr Prop Med Scale	Benefiting Structures (No.)	Benefit (%)
Problem K	3	3	0	0%	3	3	0	0%
Problem I	11	8	3	27%	5	3	2	40%
Problem W	7	7	0	0%	1	0	1	100%
Problem F	161	100	61	38%	184	0	184	100%
Problem J	1	0	1	100%	1	0	1	100%
Problem H	1	0	1	100%	3	0	3	100%
<b>Total</b>	<b>184</b>	<b>118</b>	<b>66</b>	<b>36%</b>	<b>197</b>	<b>6</b>	<b>191</b>	<b>97%</b>

**Table 22 –Structures Benefitted (Reduction in Water Above First Floor) by Medium Scale Proposed Improvements, 79<sup>th</sup> Street Sewer Subwatershed**

Problem Area	2-hr				24-hr			
	100-yr Exist	100-yr Prop Med Scale	Benefiting Structures (No.)	Benefit (%)	100-yr Exist	100-yr Prop Med Scale	Benefiting Structures (No.)	Benefit (%)
Problem K	1	1	0	0%	1	1	0	0%
Problem I	5	2	3	60%	3	1	2	67%
Problem W	2	2	0	0%	1	0	1	100%
Problem F	86	26	60	70%	97	0	97	100%
Problem J	0	0	0	n/a	1	0	1	100%
Problem H	0	0	0	n/a	1	0	1	100%
<b>Total</b>	<b>94</b>	<b>31</b>	<b>63</b>	<b>67%</b>	<b>104</b>	<b>2</b>	<b>102</b>	<b>98%</b>

**Description of Proposed Residential Scale Alternatives (BMPs and GI), with and without CIPs**

Tables 23 - 28 below compare the results of widespread BMP implementation throughout the subwatershed, with and without large or medium scale capital projects in place.

**Table 23 –Structures Benefitted (Reduction in Water Adjacent to Foundation) by Widespread BMP Implementation (and no capital projects), 79<sup>th</sup> Street Sewer Subwatershed**

Problem Area	2-hr				24-hr			
	100-yr Exist	100-yr BMPs	Benefiting Structures (No.)	Benefit (%)	100-yr Exist	100-yr BMPs	Benefiting Structures (No.)	Benefit (%)
Problem K	3	2	1	33%	3	2	1	33%
Problem I	11	8	3	27%	5	3	2	40%
Problem W	7	6	1	14%	1	0	1	100%
Problem F	161	134	27	17%	184	146	38	21%
Problem J	1	0	1	100%	1	1	0	0%
Problem H	1	1	0	0%	3	3	0	0%
<b>Total</b>	<b>184</b>	<b>151</b>	<b>33</b>	<b>18%</b>	<b>197</b>	<b>155</b>	<b>42</b>	<b>21%</b>

**Table 24 –Structures Benefitted (Reduction in Water Above First Floor) by Widespread BMP Implementation (and no capital projects), 79<sup>th</sup> Street Sewer Subwatershed**

Problem Area	2-hr				24-hr			
	100-yr Exist	100-yr BMPs	Benefiting Structures (No.)	Benefit (%)	100-yr Exist	100-yr BMPs	Benefiting Structures (No.)	Benefit (%)
Problem K	1	0	1	100%	1	0	1	100%
Problem I	5	4	1	20%	3	3	0	0%
Problem W	2	2	0	0%	1	0	1	100%
Problem F	86	62	24	28%	97	74	23	24%
Problem J	0	0	0	n/a	1	0	1	100%
Problem H	0	0	0	n/a	1	0	1	100%
<b>Total</b>	<b>94</b>	<b>68</b>	<b>26</b>	<b>28%</b>	<b>104</b>	<b>77</b>	<b>27</b>	<b>26%</b>

**Table 25 –Structures Benefitted (Reduction in Water Adjacent to Foundation) by Large Scale Alternatives and Widespread BMP Implementation, 79<sup>th</sup> Street Sewer Subwatershed**

Problem Area	2-hr							24-hr						
	100-yr Exist	100-yr Prop Large Scale	Benefiting Structures (No.)	Benefit (%)	100-yr Prop Large Scale w/BMPs	Benefiting Structures (No.)	Benefit (%)	100-yr Exist	100-yr Prop Large Scale	Benefiting Structures (No.)	Benefit (%)	100-yr Prop Large Scale w/BMPs	Benefiting Structures (No.)	Benefit (%)
Problem K	3	3	0	0%	2	1	33%	3	3	0	0%	2	1	33%
Problem I	11	7	4	36%	3	8	73%	5	3	2	40%	3	2	40%
Problem W	7	5	2	29%	0	7	100%	1	0	1	100%	0	1	100%
Problem F	161	19	142	88%	0	161	100%	184	0	184	100%	0	184	100%
Problem J	1	0	1	100%	0	1	100%	1	0	1	100%	0	1	100%
Problem H	1	0	1	100%	0	1	100%	3	0	3	100%	0	3	100%
<b>Total</b>	<b>184</b>	<b>34</b>	<b>150</b>	<b>82%</b>	<b>5</b>	<b>179</b>	<b>97%</b>	<b>197</b>	<b>6</b>	<b>191</b>	<b>97%</b>	<b>5</b>	<b>192</b>	<b>97%</b>

**Table 26 –Structures Benefitted (Reduction in Water Above First Floor) by Large Scale Alternatives and Widespread BMP Implementation, 79<sup>th</sup> Street Sewer Subwatershed**

Problem Area	2-hr							24-hr						
	100-yr Exist	100-yr Prop Large Scale	Benefiting Structures (No.)	Benefit (%)	100-yr Prop Large Scale w/BMPs	Benefiting Structures (No.)	Benefit (%)	100-yr Exist	100-yr Prop Large Scale	Benefiting Structures (No.)	Benefit (%)	100-yr Prop Large Scale w/BMPs	Benefiting Structures (No.)	Benefit (%)
Problem K	1	1	0	0%	0	1	100%	1	1	0	0%	0	1	100%
Problem I	5	0	5	100%	1	4	80%	3	0	3	100%	1	2	67%
Problem W	2	1	1	50%	0	2	100%	1	0	1	100%	0	1	100%
Problem F	86	0	86	100%	0	86	100%	97	0	97	100%	0	97	100%
Problem J	0	0	0	n/a	0	0	n/a	1	0	1	100%	0	1	100%
Problem H	0	0	0	n/a	0	0	n/a	1	0	1	100%	0	1	100%
<b>Total</b>	<b>94</b>	<b>2</b>	<b>92</b>	<b>98%</b>	<b>1</b>	<b>93</b>	<b>99%</b>	<b>104</b>	<b>1</b>	<b>103</b>	<b>99%</b>	<b>1</b>	<b>103</b>	<b>99%</b>

**Table 27 –Structures Benefitted (Reduction in Water Adjacent to Foundation) by Medium Scale Alternatives and Widespread BMP Implementation, 79<sup>th</sup> Street Sewer Subwatershed**

Problem Area	2-hr							24-hr						
	100-yr Exist	100-yr Prop Med Scale	Benefiting Structures (No.)	Benefit (%)	100-yr Prop Med Scale w/BMPs	Benefiting Structures (No.)	Benefit (%)	100-yr Exist	100-yr Prop Med Scale	Benefiting Structures (No.)	Benefit (%)	100-yr Prop Med Scale w/BMPs	Benefiting Structures (No.)	Benefit (%)
Problem K	3	3	0	0%	2	1	33%	3	3	0	0%	2	1	33%
Problem I	11	8	3	27%	7	4	36%	5	3	2	40%	3	2	40%
Problem W	7	7	0	0%	6	1	14%	1	0	1	100%	0	1	100%
Problem F	161	100	61	38%	78	83	52%	184	0	184	100%	78	106	58%
Problem J	1	0	1	100%	0	1	100%	1	0	1	100%	0	1	100%
Problem H	1	0	1	100%	0	1	100%	3	0	3	100%	0	3	100%
<b>Total</b>	<b>184</b>	<b>118</b>	<b>66</b>	<b>36%</b>	<b>93</b>	<b>91</b>	<b>49%</b>	<b>197</b>	<b>6</b>	<b>191</b>	<b>97%</b>	<b>83</b>	<b>114</b>	<b>58%</b>

**Table 28 –Structures Benefitted (Reduction in Water Above First Floor) by Medium Scale Alternatives and Widespread BMP Implementation, 79<sup>th</sup> Street Sewer Subwatershed**

Problem Area	2-hr							24-hr						
	100-yr Exist	100-yr Prop Med Scale	Benefiting Structures (No.)	Benefit (%)	100-yr Prop Med Scale w/BMPs	Benefiting Structures (No.)	Benefit (%)	100-yr Exist	100-yr Prop Med Scale	Benefiting Structures (No.)	Benefit (%)	100-yr Prop Med Scale w/BMPs	Benefiting Structures (No.)	Benefit (%)
Problem K	1	1	0	0%	0	1	100%	1	1	0	0%	0	1	100%
Problem I	5	2	3	60%	1	4	80%	3	1	2	67%	1	2	67%
Problem W	2	2	0	0%	2	0	0%	1	0	1	100%	0	1	100%
Problem F	86	26	60	70%	10	76	88%	97	0	97	100%	10	87	90%
Problem J	0	0	0	n/a	0	0	n/a	1	0	1	100%	0	1	100%
Problem H	0	0	0	n/a	0	0	n/a	1	0	1	100%	0	1	100%
<b>Total</b>	<b>94</b>	<b>31</b>	<b>63</b>	<b>67%</b>	<b>13</b>	<b>81</b>	<b>86%</b>	<b>104</b>	<b>2</b>	<b>102</b>	<b>98%</b>	<b>11</b>	<b>93</b>	<b>89%</b>

## **Justice Ditch Subwatershed**

A description of the existing conditions, proposed improvements, and results of the XP-SWMM analyses for the Justice Ditch Subwatershed follows.

### **Existing Conditions**

The Justice Ditch Subwatershed is in the north-central end of the study area. It includes a portion of the Village of Justice and unincorporated Cook County. It is roughly bound by 75<sup>th</sup> Street on the north, 85<sup>th</sup> – 88<sup>th</sup> Avenues at the east, 79<sup>th</sup> Street on the south, and the CN Railroad on the west. It also includes I-294 south of 79<sup>th</sup> Street to 85<sup>th</sup> Avenue. This description is general and approximate; Exhibit 21 shows the subwatershed and the limits in detail.

Land use within the subwatershed varies and includes residential single family, a trailer park community, commercial areas, Bethania Cemetery, and the Tollway.

There are some stormwater detention storage facilities within the subwatershed, including in the cemetery, near Blazer Avenue, and in the trailer community.

Upstream/east of Garden Lane, Justice Ditch is partially enclosed; some reaches upstream of Garden Lane are open ditches and some reaches are closed storm sewer, as it meanders through a residential neighborhood. At Garden Lane, flow from the ditch can split. Some flow travels north in a storm sewer along Garden Lane, and then west via storm sewer, under the CN railroad, and discharges to the I&M Canal. The ditch also enters an enclosed system in a storm sewer through the Sterling Estates mobile home community, under the CN railroad, and discharges to the I&M Canal at a second location.

### **Description of Proposed Large Scale Alternatives**

Alternative C (Village of Justice) consists of a combination of increased detention volume and conveyance capacity along the historic route of the Justice Ditch, which has been enclosed in storm sewer in some reaches.

A 4.5 ac-ft basin is proposed on one of two baseball fields at the southwest corner of 76<sup>th</sup> Place and 88<sup>th</sup> Avenue. This storage attenuates flow to reduce elevations in the upstream leg of the Justice Ditch, which is downstream of the proposed basin.

A 2.5 ac-ft of additional volume is proposed in two detention basins at the southeast and southwest corners of Blazer Avenue and 76<sup>th</sup> Place. An existing basin is located at the southeast corner, which is proposed to be expanded, and a new basin is proposed at the southwest corner on four vacant (undeveloped) residential lots. These basins will be interconnected with an equalizer pipe to function as a single basin. The purpose is to serve as a surcharge basin, to allow water from the 76<sup>th</sup> Place sewer to backup into the storage area, rather than surcharging onto the roadway.

The primary discharge route from the basin is to the north, and then west along 76<sup>th</sup> Place, through a proposed 42" storm sewer that flows west to the existing 60" storm sewer on Garden Avenue. The existing 60" Garden Avenue storm sewer is shown to have adequate capacity to handle the proposed flow rates without surcharging. Inlet capacity along Garden Avenue may need to be increased to allow all runoff on Garden Avenue to flow into the storm sewer. Lateral storm sewers that are tributary to Garden Avenue and 76<sup>th</sup> Place may also need additional inlets and/or larger diameter pipes to handle the local

street runoff. It should be noted that the model assumes this flow can enter the system without restriction due to insufficient inlets.

The two proposed basins have a secondary discharge path, three feet higher than the primary discharge path, to the historic Justice Ditch route to the south / southwest. This secondary flow path is only utilized during higher storms. In the existing condition, the existing detention basin at the intersection of Blazer Avenue and 76<sup>th</sup> Place discharges to the south / southwest into the historic Justice Ditch, which has limited capacity between the basin and Garden Avenue, and frequently causes structure damage along the ditch. The proposed configuration results in a reduction in flow to the historic Justice Ditch, which reduces drainage problems along the ditch; the model results show that the adjacent homes are not expected to flood in the 100-year storm.

An Urban Redevelopment alternative was also considered in this area, but not recommended. The proposed alternative included opening up the historic Justice Ditch (removing the enclosed sections) and providing a natural open channel flow path with adequate capacity for the 100-year flows, with a terraced ditch cross section to provide green space and recreational opportunities along the banks during a low flow scenario. This would have required acquisition of many single family homes along the path of the ditch, plus acquisition of additional single family homes to replace all lost housing units with higher density dwellings such as condos or townhouses. The recommended alternative appears to reduce flooding without property acquisition, and as such, this alternative was not pursued further.

The engineer's estimated opinion of construction cost for this alternative is \$2,010,000. The cost estimate is reduced to \$1,670,000 if constructed in conjunction with roadway improvements (and the roadway portions of the project cost are paid through a separate roadway budget/fund).

Alternative E (Unincorporated Cook County) is a redevelopment of the Sterling Estates property. Justice Ditch flows through the trailer park community in an enclosed sewer. The sewer does not have adequate capacity, and the inadequate capacity results in flooding within the trailer park community. Alternative C reduces flows through the trailer park community, but not enough to provide 100 year flood protection.

To alleviate the flooding and standing water, a proposed channel and redevelopment of a portion of Sterling Estates is proposed.

The channel will run along the south end of the community and contain the water during regular and 100 year rainfall events, which will reduce the flooding. In addition, redevelopment of the southwest area will further reduce the flooding and standing water. The redevelopment will add common area, new roads and new units, as shown in the exhibit.

The purpose of redevelopment is to reshape a community while maintaining its character. Creating open space in the southwest area of Sterling Estates will enhance the community by adding a natural environment, as shown in Common Area labeled on the exhibit. It has been stated by the EPA that, *"Open space provides recreational areas for residents and helps to enhance the beauty and environmental quality of a neighborhood."* The common area contains greenspace for activities such as playing Frisbee. A play area includes swings, slides and jungle gyms for children. A naturalized wetland enhances the area with native plants and attracts a variety of birds. A berm provides screening and additional protection from flooding. Meandering paths surround the common area for leisurely strolls. A gazebo and benches scattered throughout the common area provides relaxation for the residents. The common area offers residents a place to get away from the hustle and bustle of everyday life.

However, redevelopment of the southwest area will displace area residents. Sterling Estates is approximately 82 acres. Currently, the mobile homes occupy approximately 77% of the community with 23% vacant units, as indicated by the Post Office on the returned questionnaires following the July 2015 questionnaire mailing. Approximately 24% of the residents located in low flood-prone areas will be relocated to other higher areas of the community. In addition, 34 new units will be made available, with 26 excess units remaining. Since there is adequate space available, the displaced residents will have the opportunity to choose a desired place for their mobile home. Because the home is mobile, it can be relocated without losing the home itself.

Residents in this area will benefit from the construction of a channel and redevelopment of the southwest area. The channel will alleviate flooding and standing water, while the redevelopment will enhance the community with greenspace and amenities. Additionally, displaced residents will choose a location for their mobile home within the community. In turn, the enhanced community will be a desired location for future residents, resulting in an enriched neighborhood.

Another alternative was considered, consisting of expanding the detention basins in Alternative C to provide more capacity than currently proposed. This would require acquisition of three or more residential homes to enlarge the basins further, but could reduce outflows to the Justice Ditch enough to provide the desired level of flood protection within the Sterling Estates trailer community. The Sterling Estates redevelopment option is recommended over this alternative because it preserves all housing units within the Sterling Estates community, provides a green space and recreational benefit, and does not require additional single family property acquisition at Blazer and 76<sup>th</sup> Place.

A third alternative was considered, consisting of utilizing the vacant trailer lots and rearranging the mobile homes away from the flooded areas, without providing the redevelopment alternative and associated benefits. Flooding will still result within the Sterling Estates Community, but the impact to lots would be reduced.

The engineer's estimated opinion of construction cost for this alternative is \$4,200,000. The cost estimate is reduced to \$3,800,000 if constructed in conjunction with roadway improvements (and the roadway portions of the project cost are paid through a separate roadway budget/fund).

#### Results: Justice Ditch Subwatershed

Tables 29-30 below provide the results from the XP-SWMM analysis of the proposed alternatives, in terms of the structures being benefitted by the proposed Alternative improvements. Two numbers are provided: the number of homes that could have water adjacent to the foundation, and the number of homes that could have water entering the home (based on the ground elevation at the "house dot" location per GIS +0.66 feet.) This methodology is explained earlier in this report.

Tables showing the existing versus proposed results for the 100-year storms, and a comparison of the model results to the "flood protection elevation" or the "flood protection flow rate," can be found in Appendix F.

Note that the inundation mapping shows two homes remaining with water on the first floor, on Oak Grove Avenue in Problem Area C, in the 100-year 24-hour storm. The depth of flooding above the estimated first floor elevation is less than 0.10 feet. It is expected that refinements of the design and a detailed survey of the home's low entry elevation will remove these homes completely. Therefore, the data tables below show these two homes as benefitting from Alternative C.

**Table 29 –Structures Benefitted (Reduction in Water Adjacent to Foundation)  
by Large Scale Proposed Improvements, Justice Ditch Subwatershed**

Problem Area	2-hr				24-hr			
	100-yr Exist	100-yr Prop Large Scale	Benefit-ing Structures (No.)	Benefit (%)	100-yr Exist	100-yr Prop Large Scale	Benefit-ing Structures (No.)	Benefit (%)
Problem C	13	5	8	62%	38	7	31	82%
Problem E	73	24	49	67%	23	0	23	100%
<b>Total</b>	<b>86</b>	<b>29</b>	<b>57</b>	<b>66%</b>	<b>61</b>	<b>7</b>	<b>54</b>	<b>89%</b>

**Table 30 –Structures Benefitted (Reduction in Water Above First Floor)  
by Large Scale Proposed Improvements, Justice Ditch Subwatershed**

Problem Area	2-hr				24-hr			
	100-yr Exist	100-yr Prop Large Scale	Benefit-ing Structures (No.)	Benefit (%)	100-yr Exist	100-yr Prop Large Scale	Benefit-ing Structures (No.)	Benefit (%)
Problem C	0	0	0	n/a	11	0	11	100%
Problem E	28	4	24	86%	4	0	4	100%
<b>Total</b>	<b>28</b>	<b>4</b>	<b>24</b>	<b>86%</b>	<b>15</b>	<b>0</b>	<b>15</b>	<b>100%</b>

Note that the inundation mapping shows two homes remaining with water on the first floor, on Oak Grove Avenue in Problem Area C, in the 100-year 24-hour storm. The depth of flooding above the estimated first floor elevation is less than 0.10 feet. It is expected that refinements of the design and a detailed survey of the home’s low entry elevation may remove these homes completely. Therefore, the data tables show these two homes as benefitting from Alternative C.

**Description of Proposed Medium Scale Alternatives**

No medium-scale alternatives are proposed in the Justice Ditch subwatershed. Tables 31 and 32 are not included.

**Table 31 – Not included**

**Table 32 – Not included**

**Description of Proposed Residential Scale Alternatives (BMPs and GI), with and without CIPs**

Tables 33 - 38 below compare the results of widespread BMP implementation throughout the subwatershed, with and without large or medium scale capital projects in place.

**Table 33 –Structures Benefitted (Reduction in Water Adjacent to Foundation), Justice Ditch**

Problem Area	2-hr				24-hr			
	100-yr Exist	100-yr BMPs	Benefit-ing Structures (No.)	Benefit (%)	100-yr Exist	100-yr BMPs	Benefit-ing Structures (No.)	Benefit (%)
Problem C	13	5	8	62%	38	9	29	76%
Problem E	73	54	19	26%	23	11	12	52%
<b>Total</b>	<b>86</b>	<b>59</b>	<b>27</b>	<b>31%</b>	<b>61</b>	<b>20</b>	<b>41</b>	<b>67%</b>

**Table 34 –Structures Benefitted (Reduction in Water Above First Floor) by Widespread BMP Implementation (and no capital projects), Justice Ditch Subwatershed**

Problem Area	2-hr				24-hr			
	100-yr Exist	100-yr BMPs	Benefit-ing Structures (No.)	Benefit (%)	100-yr Exist	100-yr BMPs	Benefit-ing Structures (No.)	Benefit (%)
Problem C	0	0	0	n/a	11	5	6	55%
Problem E	28	17	11	39%	4	0	4	100%
<b>Total</b>	<b>28</b>	<b>17</b>	<b>11</b>	<b>39%</b>	<b>15</b>	<b>5</b>	<b>10</b>	<b>67%</b>

**Table 35 –Structures Benefitted (Reduction in Water Adjacent to Foundation) by Large Scale Alternatives and Widespread BMP Implementation, Justice Ditch Subwatershed**

Problem Area	2-hr							24-hr						
	100-yr Exist	100-yr Prop Large Scale	Benefiting Structures (No.)	Benefit (%)	100-yr Prop Large Scale w/BMPs	Benefiting Structures (No.)	Benefit (%)	100-yr Exist	100-yr Prop Large Scale	Benefiting Structures (No.)	Benefit (%)	100-yr Prop Large Scale w/BMPs	Benefiting Structures (No.)	Benefit (%)
Problem C	13	5	8	62%	3	10	77%	38	7	31	82%	5	33	87%
Problem E	73	24	49	67%	21	52	71%	23	0	23	100%	0	23	100%
<b>Total</b>	<b>86</b>	<b>29</b>	<b>57</b>	<b>66%</b>	<b>24</b>	<b>62</b>	<b>72%</b>	<b>61</b>	<b>7</b>	<b>54</b>	<b>89%</b>	<b>5</b>	<b>56</b>	<b>92%</b>

**Table 36 –Structures Benefitted (Reduction in Water Above First Floor) by Large Scale Alternatives and Widespread BMP Implementation, Justice Ditch Subwatershed**

Problem Area	2-hr							24-hr						
	100-yr Exist	100-yr Prop Large Scale	Benefiting Structures (No.)	Benefit (%)	100-yr Prop Large Scale w/BMPs	Benefiting Structures (No.)	Benefit (%)	100-yr Exist	100-yr Prop Large Scale	Benefiting Structures (No.)	Benefit (%)	100-yr Prop Large Scale w/BMPs	Benefiting Structures (No.)	Benefit (%)
Problem C	0	0	0	n/a	0	0	n/a	11	0	11	100%	0	11	100%
Problem E	28	4	24	86%	4	24	86%	4	0	4	100%	0	4	100%
<b>Total</b>	<b>28</b>	<b>4</b>	<b>24</b>	<b>86%</b>	<b>4</b>	<b>24</b>	<b>86%</b>	<b>15</b>	<b>0</b>	<b>15</b>	<b>100%</b>	<b>0</b>	<b>15</b>	<b>100%</b>

Table 37 – Not Included

Table 38 – Not Included

## **Lucas Ditch and Roberts Road Subwatersheds**

A description of the existing conditions, proposed improvements, and results of the XP-SWMM analyses for the Lucas Ditch and Roberts Road Subwatersheds follows.

### **Existing Conditions**

The Lucas Ditch and Roberts Road Subwatersheds are in the southwest portion of the study area. A portion of the Cities of Hickory Hills and Palos Hills and the Village of Justice are included in these subwatersheds. The subwatersheds are roughly bound by 93<sup>rd</sup> St – 87<sup>th</sup> St on the north, Roberts Road on the east, Stony Creek and 111<sup>th</sup> Street on the south, and 90<sup>th</sup> Avenue on the west. This description is general and approximate; Exhibit 22 shows the subwatersheds and their corresponding limits in detail.

Land use within the subwatersheds varies and includes single family and multi-family residential, commercial areas, the Hickory Hills Golf Club, Moraine Valley Community College, and Cook County Forest Preserve.

There are some stormwater detention facilities within the subwatersheds.

North of 95<sup>th</sup> Street, stormwater runoff generally flows in an easterly direction via overland flow and storm sewers, and enters the Roberts Road storm sewer system. Roberts Road is under the jurisdiction of the Cook County Department of Transportation and Highways (CCDOTH).

Between 95<sup>th</sup> Street and 99<sup>th</sup> Street, runoff generally flows towards the Hickory Hills Golf Club via storm sewers and overland flow. Water travels through the Golf Club via storm sewers and open waters. An open ditch between 98<sup>th</sup> Street and Gladys Lane conveys the runoff east into a storm sewer that enters the Roberts Road storm sewer at 98<sup>th</sup> Place.

The Roberts Road storm sewer flows in a southerly direction within this subwatershed. At 101<sup>st</sup> Street, a junction box is located on the Roberts Road storm sewer. This box essentially splits the Roberts Road storm sewer flow into two directions: southerly through the storm sewer, and west into Lucas Ditch.

South of 101<sup>st</sup> Street along Roberts Road, storm flow in the Roberts Road sewer flows south. Additional runoff from Roberts Road itself and from a small tributary area adjacent to Roberts Road enters the Roberts Road storm sewer, but in general, there is not significant new drainage area tributary to the Roberts Road storm sewer south of 101<sup>st</sup> Street. The Roberts Road storm sewer discharges to Stony Creek at Roberts Road.

South of 101<sup>st</sup> Street and west of Roberts Road, runoff flows through the tributary drainage area via storm sewers, open ditches and overland flow into Lucas Ditch. Lucas Ditch flows south and west through Palos Hills and discharges into Stony Creek at about 8700 west.

During extreme storm events, the Lucas Ditch and Lucas Diversion Ditch subwatersheds combine and flow is comingled, as described below.

### **Description of Proposed Large Scale Alternatives**

Problems N, Q, R, S, and T (City of Palos Hills & Village of Bridgeview) are in close proximity to each other. These problem areas are tributary to the Lucas Ditch, to the Roberts Road storm sewer, and to the Lucas Diversion Ditch, each of which discharge to Stony Creek. All three of these major conveyance ways (Lucas Ditch, Lucas Diversion Ditch, and Roberts Road) are lacking conveyance capacity in places,

and lacking storage in the upstream watershed. During large storm events, the major conveyance ways are surcharged, and waters cross between each of the three subwatersheds, resulting in hydraulic and hydrologic connectivity between all of these problem areas in larger storm events.

Alternatives N, Q1, Q2, S, T and RobRd benefit all the problem areas, and should be considered as elements of a single large project to achieve a common goal. In general, these alternatives are designed to provide additional storage capacity, additional conveyance capacity, and to better separate the subwatersheds to minimize potential for flooding and for waters to cross between the subwatersheds. The proposed alternatives include some rerouting of flow from one area to another, with storage to attenuate any increase in flow. Therefore, the proposed conveyance and storage elements work together and provide benefit to the area as a whole.

Alternative N (City of Palos Hills) reduces flooding in a residential area, by removing some of the area and flow that is tributary to the residential area. The alternative consists of providing 16.5 ac-ft of additional storage on the Hickory Hills Golf Club property by constructing two storage basins along the current ditch alignment. The basins are placed to reduce impacts to existing golf course operations, but the layout is flexible and can be adjusted as desired. These basins reduce the flow rate downstream at 82<sup>nd</sup> Avenue.

This alternative also includes redirecting flow from the ditch at the southeast corner of the Hickory Hills Golf Club, which is tributary to the Roberts Road storm sewer system in the existing condition. The alternative includes a high capacity slope box at 82<sup>nd</sup> Avenue to capture flow from the Golf Club property and direct it into a proposed 48” storm sewer flowing south along 82<sup>nd</sup> Avenue, and then discharging to a proposed 19.5 ac-ft storage basin on the Indian Woods Park property, located at the southeast corner of 99<sup>th</sup> Street and 82<sup>nd</sup> Avenue. The stored runoff will then discharge to the Lucas Ditch at 82<sup>nd</sup> Avenue.

This alternative reduces flow from the Roberts Road drainage system entering the Lucas Ditch drainage system (with some flow attenuation via the proposed storage basins). Because additional tributary area is being brought to Lucas Ditch at 82<sup>nd</sup> Avenue, the amount of flow that is allowed to enter Lucas Ditch from the Roberts Road sewer at 101<sup>st</sup> Street will be reduced, to balance the tributary areas and flow rates. At 101<sup>st</sup> Street, an existing 46” x 74” elliptical sewer (60” equivalent) allows water from the Roberts Road storm sewer to flow west into Lucas Ditch. (The existing Roberts Road storm sewer also continues downstream to Stony Creek at this location.) This 60” equivalent storm sewer from Roberts Road to Lucas Ditch at 101<sup>st</sup> Street will be reduced to a proposed 30” storm sewer. Alternative RobRd describes the proposed connection from Roberts Road east to Lucas Diversion Ditch at 101<sup>st</sup> Street, to balance flow between the two subwatersheds and provide an overall net benefit to the region.

The positive consequence of implementation of this portion of the alternative is a net decrease in flows to Lucas Ditch, a decrease in flows through the neighborhood downstream of Hickory Hills Golf Club, and a reduction in structure flooding adjacent to Lucas Ditch and within the identified neighborhood. Improvements to Roberts Road to attenuate flooding along Roberts Road are described elsewhere in this report.

One alternative to the storage basins on the golf club property was considered. The existing culvert under 82<sup>nd</sup> Avenue was evaluated to see if it could be “blocked” at the higher portion of the culvert. This would allow low to moderate flows to pass through the culvert without change from existing condition. In larger storms, the blockage at the top of the culvert would result in water ponding behind the culvert on Golf Club property, effectively storing water on the Golf Club without constructing a physical detention area. Topography appeared to suggest that this could be a feasible alternative. However, there was not enough storage realized with this alternative to provide a meaningful benefit, and the resultant berm would likely have been considered a Class I dam. Therefore, this was not pursued further as an alternative.

The engineer's estimated opinion of construction cost for this alternative is \$8,900,000. The cost estimate is reduced to \$8,750,000 if constructed in conjunction with roadway improvements (and the roadway portions of the project cost are paid through a separate roadway budget/fund).

Alternative Q (City of Palos Hills) includes four components to reduce drainage problems and flooding along Lucas Ditch. These two major components of the alternative are described as Q1 and Q2 on the exhibits and tables.

Alternative Q1 involves dredging and regrading portions of Lucas Ditch to provide a consistent positive slope from 80<sup>th</sup> Court to 88<sup>th</sup> Avenue. The topographic survey of Lucas Ditch suggests sediment accumulation along portions of the ditch, and identifies culverts that are backpitched or elevated above the ditch channel bottom. As shown in the cursory uncontaminated soils evaluation presented in Table 60 later in this report, the sediment may be impacted by urban runoff and may not be suitable for acceptance at a CCDD facility. Earthwork removal is approximately 10% of the estimated cost of Alternative Q1, and this portion of the project cost could double, approximately, if it is not suitable for disposal at a CCDD facility.

The engineer's estimated opinion of construction cost for this alternative is \$5,510,000. The cost estimate is reduced to \$4,760,000 if constructed in conjunction with roadway improvements (and the roadway portions of the project cost are paid through a separate roadway budget/fund).

Two additional proposed project elements are located along Lucas Ditch to reduce flooding problems as part of Alternative Q2: one on Sun Valley Drive, and another in the neighborhood southwest of Roberts and 103<sup>rd</sup>. Both of these areas are shown as inundated in the existing condition with several homes inundated at the first floor.

Sun Valley Drive is located north of Lucas Ditch between 84<sup>th</sup> and 88<sup>th</sup> Avenues. Stormwater runoff flows from north to south as sheet flow and storm sewer flow, across Sun Valley Drive and towards Lucas Ditch. A ridge along Lucas Ditch prevents the water from entering the ditch directly, and water ponds in the rear yards of Sun Valley Drive, flooding several homes. Storm sewer capacity is not adequate to drain the rear yard area. The Sun Valley alternative includes constructing an additional 60" storm sewer, or several sewers with equivalent capacity, along with high capacity inlet boxes to provide additional drainage to this area. The storm sewers flow a short distance and discharge to Lucas Ditch, providing relief to this area.

The engineer's estimated opinion of construction cost for this alternative is \$360,000. The cost estimate is reduced to \$290,000 if constructed in conjunction with roadway improvements (and the roadway portions of the project cost are paid through a separate roadway budget/fund).

East of Lucas Ditch between 103<sup>rd</sup> and 105<sup>th</sup> Streets is a neighborhood that also appears to have flood damages as a result of insufficient storm sewer capacity, as well as backwater from Lucas Ditch surcharging through the storm sewer system and resulting in flooding. The neighborhood has a rural roadway cross section with ditches, and some storm sewers in the ditches. Runoff follows the topography and flows from south to north to 103<sup>rd</sup> Street, and then enters the 103<sup>rd</sup> Street storm sewer system and flows west along 103<sup>rd</sup> to outlet to Lucas Ditch. Backwater from Lucas Ditch surcharges through this storm sewer and results in flooding in the area south of 103<sup>rd</sup> Street. The water surface elevation of Lucas Ditch at 105<sup>th</sup> Street is lower than at 103<sup>rd</sup>, so the proposed alternative includes installing or rerouting storm sewers on two of the streets in this neighborhood to flow south, against the natural topography, and discharge to Lucas Ditch at 105<sup>th</sup> Street. This will reduce potential for backwater from Lucas Ditch to

surcharge through the new storm sewer, because the tailwater condition is lower. It also reduces potential for surcharging in the existing system, because some runoff is removed from the existing system. 83<sup>rd</sup> Avenue and 82<sup>nd</sup> Court are both relatively flat streets (unlike 82<sup>nd</sup> Avenue – 81<sup>st</sup> Avenue) so constructing the storm sewer from north to south is not expected to result in deep storm sewer cuts if constructed along these streets. The storm sewers could be constructed in conjunction with proposed curb and gutter, or they could be constructed to capture flow from the ditch system and send the ditch flow south to 105<sup>th</sup> Street.

The engineer's estimated opinion of construction cost for this alternative is \$1,380,000. The cost estimate is reduced to \$960,000 if constructed in conjunction with roadway improvements (and the roadway portions of the project cost are paid through a separate roadway budget/fund).

Alternative Q2 proposes a 72" storm sewer along 83<sup>rd</sup> Court and Palos Drive to act as a relief sewer and provide additional capacity within the Lucas Ditch subwatershed. The relief sewer is oriented with the southerly flow in Lucas Ditch, and conveys the runoff directly to Stony Creek. This reduces water surface elevations within Lucas Ditch and provides a benefit by reducing flooding along Lucas Ditch. This alternative does include a new outfall to Stony Creek. Because Stony Creek was also included in the model it was able to be evaluated, to make sure the new pipe (which discharges to Stony Creek upstream of Lucas Ditch) does not increase flow rates or cause damages within Stony Creek. These results are presented later in this report, and show that Stony Creek is not impacted by this alternative, due to a reduction in flows to Stony Creek from the upstream Roberts Road sewer and Lucas Diversion Ditch.

The engineer's estimated opinion of construction cost for this alternative is \$3,070,000. The cost estimate is reduced to \$2,550,000 if constructed in conjunction with roadway improvements (and the roadway portions of the project cost are paid through a separate roadway budget/fund).

Alternative S (Village of Bridgeview) reduces drainage problems in Lucas Diversion Ditch, within the industrial area, and along Roberts Road by providing additional storage and rerouting flow to use the available storage. This proposed storage plays a key role in the reconfiguration of flow between the Roberts Road, Lucas Ditch, and Lucas Diversion Ditch subwatersheds.

In the existing condition, a large 72" storm sewer flows south through the industrial area between 76<sup>th</sup> Avenue and Industrial Drive, then west along 100<sup>th</sup> Place, and discharges to Lucas Diversion Ditch. The alternative includes abandoning the 72" storm sewer under 100<sup>th</sup> Place, and installing a proposed 72" storm sewer at the east end of 100<sup>th</sup> Place to convey the existing flow south to the existing detention basin northeast of 76<sup>th</sup> Avenue and Claridge Drive.

The alternative also includes a proposed expansion of this existing basin within the open space east of 76<sup>th</sup> Avenue, to provide 100 ac-ft of new storage. The west half of this basin appears to be owned by the Bridgeview Park District, and the east half by the Village of Bridgeview, per the Cook County Assessor's office data.

The existing dual culverts that drain the existing basin under 76<sup>th</sup> Avenue and through the Cook County Courthouse property will be abandoned. Instead, a proposed 42" storm sewer flowing south along 76<sup>th</sup> Avenue will drain the expanded detention basin to the existing 103<sup>rd</sup> Street storm sewer system, which outlets to the Lucas Diversion Ditch at 103<sup>rd</sup> Street.

The analysis shows that the existing 103<sup>rd</sup> Street storm sewer system has sufficient capacity to handle this flow, but this should be verified by televising the sewers and confirming capacity and condition of the

pipes. If the pipes are found to be lacking in capacity, then the existing dual pipes flowing west from the basin through the Cook County Courthouse property could be maintained (instead of abandoned) to provide the additional required capacity.

The alternative S improvements play a key role in reducing flooding in the south Roberts Road sub-watersheds. The alternative significantly reduces flows in the section of Lucas Diversion Ditch upstream of 103<sup>rd</sup> Street, which lowers the 100-year water surface elevation to acceptable levels in the ditch, while also making “space” in the ditch for additional flows from the Lucas Ditch and Roberts Road sub-watersheds as a result of proposed improvements within those subwatersheds.

The engineer’s estimated opinion of construction cost for this alternative is \$9,080,000. The cost estimate is reduced to \$7,720,000 if constructed in conjunction with roadway improvements (and the roadway portions of the project cost are paid through a separate roadway budget/fund).

Alternative T (City of Palos Hills & Village of Bridgeview) reduces drainage problems in problem areas R and T.

The alternative involves increasing the capacity of the downstream section of Lucas Diversion Ditch by dredging and lowering the ditch from downstream of 103<sup>rd</sup> Street to upstream of 107<sup>th</sup> Street. The existing ditch has an inconsistent slope along this stretch. The alternative proposes lowering the thalweg of the ditch immediately downstream of the 103<sup>rd</sup> Street culvert by approximately 2.4 feet, and then providing a constant positive slope from 103<sup>rd</sup> to 107<sup>th</sup>. This alternative removes accumulated sediment, increases the capacity of the Lucas Diversion Ditch, and lowers the water surface elevations. Large gas lines run along the Lucas Diversion Ditch through this improvement area, but a review of available gas line plans suggests that this alternative is feasible. As shown in the cursory uncontaminated soils evaluation presented in Table 60 later in this report, the sediment may be impacted by urban runoff and may not be suitable for acceptance at a CCDD facility. Earthwork removal is approximately 20% of the estimated cost of Alternative T, and this portion of the project cost could double, approximately, if it is not suitable for disposal at a CCDD facility.

Another alternative considered lowering the culvert under 103<sup>rd</sup> Street by two feet, and lowering the Lucas Diversion Ditch upstream of 103<sup>rd</sup> Street. Because Alternative S appears to provide a significant reduction of flow to Lucas Diversion Ditch, lowering the culvert and ditch upstream of 103<sup>rd</sup> Street did not provide a significant benefit beyond that provided by Alternative S and Alternative T downstream of 103<sup>rd</sup> Street. The results indicate that lowering the ditch upstream of 103<sup>rd</sup> Street lowered the computed water surface levels by an additional 0.01 – 0.24 feet, in addition to the lowering provided by S and T downstream of 103<sup>rd</sup>. This was not considered a significant enough benefit to justify the expected cost, and therefore this alternative was not recommended.

The engineer’s estimated opinion of construction cost for this alternative is \$580,000.

Alternative RobRd (City of Palos Hills & Village of Bridgeview) includes replacing the existing 84” diameter storm sewer from 98<sup>th</sup> Place to Stony Creek with a proposed 96” storm sewer at constant slope. To achieve a positive slope and reduce the hydraulic grade line, the sewer is lowered in some locations. The alternative also includes replacing existing 60” and 66” storm sewer between 89<sup>th</sup> Place and 95<sup>th</sup> Street with 72” storm sewer. This alternative reduces flooding in the problem areas along Roberts Road and also throughout the Lucas Ditch and Lucas Diversion Ditch subwatersheds, and will reduce overflows to and between Lucas Diversion Ditch and Lucas Ditch.

The alternative also includes two east-west sewers, proposed on 101st St and 103rd St to bring flow from Roberts Rd into the Lucas Diversion Ditch. This reduces drainage problems on Roberts Road, and takes advantage of new conveyance “space” in Lucas Diversion Ditch that results from construction of the proposed storage basin in Alternative S. The exhibits show the proposed east-west sewers on 101st and 103rd Streets, but there is flexibility to construct these east-west sewers on other streets. If other streets are programmed for future roadway rehabilitation, these sewers could be moved to those streets, to allow for funding efficiencies by combining the sewer improvements with roadway improvements. The proposed storage in Alternative S must be in place before the east-west sewers bring flow into Lucas Diversion Ditch.

Cook County Department of Transportation and Highways has proposed a roadway resurfacing project along much of this stretch of Roberts Road. It may be possible to combine these proposed alternatives with the proposed CCDOTH project, to gain construction efficiencies and reduce project cost. At a minimum, provisions for the future connections to those east-west sewers (such as the proposed manholes/junction boxes on Roberts Road with sewer stubs to the east) should be constructed as part of the CCDOTH Roberts Road project, to avoid impacting Roberts Road a second time after the Alternative S storage is in place. This alternative will require coordination with CCDOTH.

The engineer’s estimated opinion of construction cost for this alternative is \$28,690,000. The cost estimate is reduced to \$20,610,000 if constructed in conjunction with roadway improvements (and the roadway portions of the project cost are paid through a separate roadway budget/fund).

Alternative O (City of Hickory Hills) improves the drainage condition at Problem Area O, an existing multi-family apartment dwelling known as Flamingo Terrace. In the existing condition, runoff from the adjacent Forest Preserve enters a storm sewer that follows the south and east edges of the parking lot, passes under an adjacent property, and outlets to a ditch. The storm sewer does not have adequate capacity for flow from the Forest Preserve and is susceptible to blockage from forest preserve debris. Consequently, flow from the forest preserve ditch flows over the top of the headwall, onto the apartment property on the south edge of the property, where it is “trapped” against a vertical retaining wall in the southeast corner of the parking lot without a positive outlet. Additionally, runoff from the apartment buildings themselves and the drainage area to the west flows towards the retaining wall and is trapped, contributing to flooding. There is an open culvert near the southeast corner of the parking lot, which also flows east to the downstream Forest Preserve ditch, but it is not located at the low point of the property, and the culvert appears to be backpitched based on the existing survey. These conditions contribute to flooding of the property.

The proposed improvement involves removing a section of wall in the southeast corner of the apartment parking lot to eliminate ponding against the wall and the subsequent property flooding. It appears that the wall can be removed from the corner without impacting the adjacent properties, but this should be reviewed and confirmed. The existing parking lot curb is also proposed to be modified, to allow any water that flows onto the parking lot to flow off at the southeast corner, before damaging adjacent structures. As the runoff leaves the southeast corner of the property it will be collected in a proposed slope box, and a proposed 36” storm sewer will convey the flow around the apartment complex east of the Flamingo Terrace property to the downstream ditch on forest preserve property. The existing downstream ditch will be lowered by 12-18” downstream of the outlet, to provide positive drainage from the property in the proposed condition. The lowered section of ditch is approximately 150 feet long. The engineer’s estimated opinion of construction cost for this alternative is \$180,000.

Two other alternatives were considered to reduce flooding in this area. A second alternative involves replacing the existing storm sewer from the forest preserve ditch south of the property, to the forest

preserve ditch east of the adjacent property. The existing sewer does not have positive slope or adequate capacity, so this alternative will provide adequate capacity to reduce overflows onto the site. This will also include an inlet at the low point (at the southeast corner) to allow drainage from that area. This second alternative also includes lowering 150 feet of the downstream ditch by 12-18" to provide positive drainage downstream. Construction of the storm sewer will impact the parking lot of both the Flamingo Terrace property and the adjacent property to the east. This alternative does not remove the flow obstruction (wall) in the southeast corner, so there is still potential for flooding when a storm event exceeds the design storm associated with the proposed pipe. The engineer's estimated opinion of construction cost for this alternative is \$200,000.

A third alternative leaves the existing storm sewer infrastructure and wall in place, but constructs a bypass / overflow swale or ditch through the Forest Preserve property along the south and east edges of the multi-family parcels. This will reduce the amount of runoff (overflow) draining onto the Flamingo Terrace site, and subsequently reduce potential for flooding. This alternative will create a new swale / ditch on Forest Preserve property. All three alternatives will require approvals and/or coordination with the Forest Preserve District of Cook County; this third alternative proposes the most work on Forest Preserve land, but has the smallest disturbance to the multi-family residential property, although access to the Forest Preserve work area may need to come through the multi-family properties. The engineer's estimated opinion of construction cost for this alternative is \$140,000.

Alternative P (City of Palos Hills) is located at Problem Area P at the intersection of 88<sup>th</sup> Avenue and 99<sup>th</sup> Street, where road flooding has been reported. Recent roadway improvements in this vicinity included expanding an existing detention basin. However, our modeling shows that roadway flooding and basin overtopping would still occur and result in adjacent flooding of homes during a 100-year storm. It is possible that the existing basins were constructed to provide detention for nearby roadway improvements and/or designed for a smaller magnitude storm event. The existing basins do improve the condition compared to the pre-existing condition, but a proposed expansion of the basins is still recommended.

The alternative consists of expanding the west portion of the detention basin at the southwest corner of the intersection of 99<sup>th</sup> Street and 88<sup>th</sup> Avenue to provide 7.6 acre-feet of additional storage.

The alternative should also include a topographic survey of low entry elevations of the adjacent homes, as this study uses an approximation for the low-entry elevation, as described. The proposed improvement shows that no damage occurs to structures using the approximated elevation, but this comparison should be made using the actual surveyed low entry elevations. If the proposed improvement still results in structure flooding, the playground area adjacent to the west detention basin could be lowered to provide additional storage (beyond the 7.6 ac-ft described here) during the 100-year storm. The playground would be unavailable for play during larger storm events, though it would remain usable the majority of the time. Depending on the amount of additional storage that is required, it may be possible to provide a terrace between the bottom and top of the basin, to elevate the playground above the smallest storms. The cost estimate associated with this alternative assumes that 7.6 ac-ft of new storage is adequate to protect the structures. The estimate does not include additional excavation and playground lowering or reconstruction that may be needed if the actual surveyed low entry elevations suggest additional storage is necessary.

The engineer's estimated opinion of construction cost for this alternative is \$500,000.

Alternative V (City of Palos Hills & Unincorporated) is located at Problem Area V west of 88<sup>th</sup> Avenue and south of Taos Drive, where a ditch through forest preserve property passes under a residential driveway via a culvert. The culvert is undersized and the driveway is high, causing water to backup behind the culvert and resulting in flooding of a home, according to municipal reports. Contour mapping

does not suggest flooding of the home, but the home appears to have a walk-out basement that could allow water to enter the home at an elevation that is lower than shown on the contours.

The proposed alternative consists of lowering the driveway to provide a lower overflow, from an elevation of 619.18 to 618.0. The driveway that requires lowering is next door to the home that is reported to be damaged. The proposed alternative also includes replacing the existing 43" x 68" culvert under the driveway with a 3' x 6' box culvert to provide additional capacity, and also lowering the culvert inverts and ditch thalweg to accommodate the lowered driveway.

This alternative is constructed entirely on private property and will require participation and cooperation of the adjacent homeowner to allow this work to proceed.

The engineer's estimated opinion of construction cost for this alternative is \$270,000.

Alternative U (City of Palos Hills) is located at Problem Area U, at the confluence of Stony Creek and Lucas Ditch, where existing condos and an apartment building experience flooding.

The DWP examined alternatives for this area and recommended installing floodwalls/levees to protect the buildings from flood damage. Our analysis considered several alternatives, including additional storage upstream to attenuate flows, but even with all proposed upstream improvements in place, the apartments are still shown as being damaged in the proposed condition. Therefore, the proposed Alternative U is consistent with the DWP recommended alternative, and includes proposed floodwalls or levees along both sides of Lucas Ditch just south of 111<sup>th</sup> Street.

Pumps will be required to maintain drainage behind the proposed walls. Runoff generated by the condo/apartment complex itself will result in flooding of the buildings behind the wall, if pumps are not included behind the wall. Backup power systems should also be included.

The alternative also includes a segment of wall on the north side of Stony Creek just west of the confluence of Lucas Ditch, to protect homes located north of the creek at that location.

The engineer's estimated opinion of construction cost for this alternative is \$2,150,000.

Another way to protect the residents and reduce damages at this location, without constructing a flood control project, is to relocate the condos and apartment building to a vacant property on 111<sup>th</sup> Street, directly across the street from this property. The area north of 111<sup>th</sup> Street is on higher ground and not expected to flood as a result of Lucas Ditch or Stony Creek. The new buildings could be constructed while maintaining the old buildings, and residents could move upon completion. The old buildings could be demolished and the land could be returned to open space to provide recreation and/or natural green space at the confluence. The site could also be used as a wetland mitigation site to meet permit requirements associated with other alternatives in the study area. Although this is a more costly alternative than the flood walls, it would provide more resilience by moving the buildings to higher ground, provide protection against even larger storm events than the design 100-year storm, and provide an opportunity for green space and recreation.

There are 94 condo units (per the Cook County Assessor's data) ranging in value from \$80,000 - \$160,000, and one apartment building with a value of nearly \$0.5M. Using an average condo value of \$130,000, and assuming the cost to relocate the buildings is equal to their value, this alternative may cost around \$12.7M, not including demo costs, cost to create new green space/storage, or cost of new infrastructure and site improvements on the vacant property.

Alternative X (City of Hickory Hills & City of Palos Hills) is located at Problem Area X, which is an area of residential flooding due to an undersized detention basin that overtops. The proposed alternative consists of purchasing two adjacent properties west of the existing detention basin at Hill Creek Shopping Center and providing 4ac-ft of additional volume. The model shows that the enlarged basin lowers the water surface elevations adequately to meet the MWRD’s flood protection goals.

The engineer’s estimated opinion of construction cost for this alternative is \$1,570,000.

Results: Lucas Ditch and Roberts Road Subwatersheds

Tables 39-40 below provide the results of the XP-SWMM analysis of the proposed alternatives, in terms of the structures being benefitted by the proposed Alternative improvements. Two numbers are provided: the number of homes that could have water adjacent to the foundation, and the number of homes that could have water entering the home (based on the ground elevation at the “house dot” location per GIS +0.66 feet.) This methodology is explained earlier in this report.

Tables showing the existing versus proposed results for the 100-year storms, and a comparison of the model results to the “flood protection elevation” or the “flood protection flow rate,” can be found in Appendix F.

**Table 39 –Structures Benefitted (Reduction in Water Adjacent to Foundation) by Large Scale Proposed Improvements, Lucas Ditch and Roberts Road Subwatersheds**

Problem Area	2-hr				24-hr			
	100-yr Exist	100-yr Prop Large Scale	Benefit-ing Structures (No.)	Benefit (%)	100-yr Exist	100-yr Prop Large Scale	Benefit-ing Structures (No.)	Benefit (%)
Problem O	1	0	1	100%	0	0	0	n/a
Problem P	2	0	2	100%	0	0	0	n/a
Problem NQRT	252	6	246	98%	155	1	154	99%
Problem U	16	12	4	25%	31	23	8	26%
Problem V	1	0	1	100%	1	0	1	100%
Problem X	4	0	4	100%	0	0	0	n/a
<b>Total</b>	<b>276</b>	<b>18</b>	<b>258</b>	<b>93%</b>	<b>187</b>	<b>24</b>	<b>163</b>	<b>87%</b>

**Table 40 –Structures Benefitted (Reduction in Water Above First Floor)  
by Large Scale Proposed Improvements, Lucas Ditch and Roberts Road Subwatersheds**

Problem Area	2-hr				24-hr			
	100-yr Exist	100-yr Prop Large Scale	Benefit-ing Structures (No.)	Benefit (%)	100-yr Exist	100-yr Prop Large Scale	Benefit-ing Structures (No.)	Benefit (%)
Problem O	0	0	0	n/a	0	0	0	n/a
Problem P	0	0	0	n/a	0	0	0	n/a
Problem NQRT	121	0	121	100%	56	0	56	100%
Problem U	9	2	7	78%	27	20	7	26%
Problem V	1	0	1	100%	1	0	1	100%
Problem X	0	0	0	n/a	0	0	0	n/a
<b>Total</b>	<b>131</b>	<b>2</b>	<b>129</b>	<b>98%</b>	<b>84</b>	<b>20</b>	<b>64</b>	<b>76%</b>

Lucas Ditch, Lucas Diversion Ditch, and Roberts Road all discharge to Stony Creek. This alternative includes rerouting of flow from one subbasin to another, to provide a better defined path for runoff and to provide conveyance and storage to reduce flooding in the 100-year event. An analysis of Stony Creek was performed to check for impacts to Stony Creek due to changes in the tributary areas and flow directions upstream. The alternatives are not expected to result in any negative impacts to Stony Creek; this is shown in a table in Appendix F.

### **Description of Proposed Medium Scale Alternatives**

The large scale alternatives presented above are expected to provide a 100-year level of protection to residential structures. In locations where proposed large scale engineering solutions are costly, difficult to construct, or otherwise challenging to implement, a scaled-back “medium scale” version of the engineering solution is suggested to provide some benefits but not the full 100-year benefit. These are identical to the large scale alternatives, except as noted below:

Proposed Q.1-med: This medium scale alternative, Q1-med, includes the same ditch improvements as recommended in the large scale alternative Q1, but eliminates the proposed culvert replacement and leaves existing culverts as-is.

The engineer’s estimated opinion of construction cost for this medium-scale alternative is \$2,710,000. The cost estimate is reduced to \$970,000 if constructed in conjunction with roadway improvements (and the roadway portions of the project cost are paid through a separate roadway budget/fund).

Proposed Alternative RobRd-med: The RobRd large-scale alternative includes replacing the existing 84” diameter storm sewer from 98<sup>th</sup> Place to Stony Creek with a proposed 96” storm sewer at constant slope. The RobRd large scale alternative also includes replacing existing 60” and 66” storm sewer between 89<sup>th</sup> Place and 95<sup>th</sup> Street with 72” storm sewer. This large scale alternative reduces flooding in the problem areas along Roberts Road and also throughout the Lucas Ditch and Lucas Diversion Ditch subwatersheds, and flow from the three subwatersheds comingles during the existing condition. The medium scale alternative is to keep the Roberts Road storm sewer as-is without any change, but still make the other improvements that are recommended at problem areas M, N, Q, R, S and T.

The medium scale alternative also includes the two east-west sewers that are proposed on 101st St and 103rd St to bring flow from Roberts Rd into the Lucas Diversion Ditch. This reduces drainage problems on Roberts Road, and takes advantage of new conveyance “space” in Lucas Diversion Ditch that results from construction of the proposed storage basin in Alternative S. The exhibits show the proposed east-west sewers on 101st and 103rd Streets, but there is flexibility to construct these east-west sewers on other streets. If other streets are programmed for future roadway rehabilitation, these sewers could be moved to those streets, to allow for funding efficiencies by combining the sewer improvements with roadway improvements.

These east-west sewers are included in both RobRd (large scale) and RobRd-Med alternatives. The proposed storage in Alternative S must be in place before the east-west sewers bring flow into Lucas Diversion Ditch. Given that the CCDOTH’s proposed Roberts Road repaving project is scheduled for the near future, provisions for the future connections to those east-west sewers (such as the proposed manholes/junction boxes on Roberts Road with sewer stubs to the east) could be constructed as part of the CCDOTH Roberts Rd project, to avoid impacting Roberts Road a second time after the Alternative S storage is in place.

If future Roberts Road roadway rehabilitation projects are proposed (in many years, after the current Roberts Road pavement rehab project is complete) then the larger diameter pipe could be reconsidered as part of that improvement.

The engineer’s estimated opinion of construction cost for this medium-scale alternative is \$5,170,000. The cost estimate is reduced to \$4,810,000 if constructed in conjunction with roadway improvements (and the roadway portions of the project cost are paid through a separate roadway budget/fund).

Results with Medium Scale Alternatives

Tables 41-42 below compare the existing, proposed large-scale, and proposed medium-scale results in the subwatershed. As shown, the medium-scale results provide a benefit to the problem areas, but do not completely protect every home to the 100-year storm.

**Table 41 –Structures Benefitted (Reduction in Water Adjacent to Foundation) by Medium Scale Proposed Improvements, Lucas Ditch and Roberts Road Subwatersheds**

Problem Area	2-hr				24-hr			
	100-yr Exist	100-yr Prop Med Scale	Benefit-ing Structures (No.)	Benefit (%)	100-yr Exist	100-yr Prop Med Scale	Benefit-ing Structures (No.)	Benefit (%)
Problem O	1	0	1	100%	0	0	0	n/a
Problem P	2	0	2	100%	0	0	0	n/a
Problem NQRT	252	71	181	72%	155	27	128	83%
Problem U	16	11	5	31%	31	23	8	26%
Problem V	1	0	1	100%	1	0	1	100%
Problem X	4	0	4	100%	0	0	0	n/a
<b>Total</b>	<b>276</b>	<b>82</b>	<b>194</b>	<b>70%</b>	<b>187</b>	<b>50</b>	137	73%

**Table 42 –Structures Benefitted (Reduction in Water Above First Floor)  
by Medium Scale Proposed Improvements, Lucas Ditch and Roberts Road Subwatersheds**

Problem Area	2-hr				24-hr			
	100-yr Exist	100-yr Prop Med Scale	Benefiting Structures (No.)	Benefit (%)	100-yr Exist	100-yr Prop Med Scale	Benefiting Structures (No.)	Benefit (%)
Problem O	0	0	0	n/a	0	0	0	n/a
Problem P	0	0	0	n/a	0	0	0	n/a
Problem NQRT	121	46	75	62%	56	13	43	77%
Problem U	9	2	7	78%	27	21	6	22%
Problem V	1	0	1	100%	1	0	1	100%
Problem X	0	0	0	n/a	0	0	0	n/a
<b>Total</b>	<b>131</b>	<b>48</b>	<b>83</b>	<b>63%</b>	<b>84</b>	<b>34</b>	<b>50</b>	<b>60%</b>

**Description of Proposed Residential Scale Alternatives (BMPs and GI), with and without CIPs**

Tables 43 - 48 below compare the results of widespread BMP implementation throughout the subwatershed, with and without large or medium scale capital projects in place.

**Table 43 –Structures Benefitted (Reduction in Water Adjacent to Foundation) by Widespread BMP Implementation (and no capital projects), Lucas Ditch and Roberts Road Subwatersheds**

Problem Area	2-hr				24-hr			
	100-yr Exist	100-yr BMPs	Benefiting Structures (No.)	Benefit (%)	100-yr Exist	100-yr BMPs	Benefiting Structures (No.)	Benefit (%)
Problem O	1	0	1	100%	0	0	0	n/a
Problem P	2	0	2	100%	0	0	0	n/a
Problem NQRT	252	190	62	25%	155	76	79	51%
Problem U	16	4	12	75%	31	26	5	16%
Problem V	1	1	0	0%	1	1	0	0%
Problem X	4	3	1	25%	0	0	0	n/a
<b>Total</b>	<b>276</b>	<b>198</b>	<b>78</b>	<b>28%</b>	<b>187</b>	<b>103</b>	<b>84</b>	<b>45%</b>

**Table 44 –Structures Benefitted (Reduction in Water Above First Floor) by Widespread BMP Implementation (and no capital projects), Lucas Ditch and Roberts Road Subwatersheds**

Problem Area	2-hr				24-hr			
	100-yr Exist	100-yr BMPs	Benefiting Structures (No.)	Benefit (%)	100-yr Exist	100-yr BMPs	Benefiting Structures (No.)	Benefit (%)
Problem O	0	0	0	n/a	0	0	0	n/a
Problem P	0	0	0	n/a	0	0	0	n/a
Problem NQRT	121	67	54	45%	56	17	39	70%
Problem U	9	0	9	100%	27	18	9	33%
Problem V	1	1	0	0%	1	1	0	0%
Problem X	0	0	0	n/a	0	0	0	n/a
<b>Total</b>	<b>131</b>	<b>68</b>	<b>63</b>	<b>48%</b>	<b>84</b>	<b>36</b>	<b>48</b>	<b>57%</b>

**Table 45 –Structures Benefitted (Reduction in Water Adjacent to Foundation) by Large Scale Alternatives and Widespread BMP Implementation, Lucas Ditch and Roberts Road Subwatersheds**

Problem Area	2-hr							24-hr						
	100-yr Exist	100-yr Prop Large Scale	Benefiting Structures (No.)	Benefit (%)	100-yr Prop Large Scale w/BMPs	Benefiting Structures (No.)	Benefit (%)	100-yr Exist	100-yr Prop Large Scale	Benefiting Structures (No.)	Benefit (%)	100-yr Prop Large Scale w/BMPs	Benefiting Structures (No.)	Benefit (%)
Problem O	1	0	1	100%	0	1	100%	0	0	0	n/a	0	0	n/a
Problem P	2	0	2	100%	0	2	100%	0	0	0	n/a	0	0	n/a
Problem NQRT	252	6	246	98%	0	252	100%	155	1	154	99%	0	155	100%
Problem U	16	12	4	25%	1	15	94%	31	23	8	26%	19	12	39%
Problem V	1	0	1	100%	0	1	100%	1	0	1	100%	0	1	100%
Problem X	4	0	4	100%	3	1	25%	0	0	0	n/a	0	0	n/a
<b>Total</b>	<b>276</b>	<b>18</b>	<b>258</b>	<b>93%</b>	<b>4</b>	<b>272</b>	<b>99%</b>	<b>187</b>	<b>24</b>	<b>163</b>	<b>87%</b>	<b>19</b>	<b>168</b>	<b>90%</b>

**Table 46 –Structures Benefitted (Reduction in Water Above First Floor) by Large Scale Alternatives and Widespread BMP Implementation, Lucas Ditch and Roberts Road Subwatersheds**

Problem Area	2-hr							24-hr						
	100-yr Exist	100-yr Prop Large Scale	Benefiting Structures (No.)	Benefit (%)	100-yr Prop Large Scale w/BMPs	Benefiting Structures (No.)	Benefit (%)	100-yr Exist	100-yr Prop Large Scale	Benefiting Structures (No.)	Benefit (%)	100-yr Prop Large Scale w/BMPs	Benefiting Structures (No.)	Benefit (%)
Problem O	0	0	0	n/a	0	0	n/a	0	0	0	n/a	0	0	n/a
Problem P	0	0	0	n/a	0	0	n/a	0	0	0	n/a	0	0	n/a
Problem NQRT	121	0	121	100%	0	121	100%	56	0	56	100%	0	56	100%
Problem U	9	2	7	78%	0	9	100%	27	20	7	26%	16	11	41%
Problem V	1	0	1	100%	0	1	100%	1	0	1	100%	0	1	100%
Problem X	0	0	0	n/a	0	0	n/a	0	0	0	n/a	0	0	n/a
<b>Total</b>	<b>131</b>	<b>2</b>	<b>129</b>	<b>98%</b>	<b>0</b>	<b>131</b>	<b>100%</b>	<b>84</b>	<b>20</b>	<b>64</b>	<b>76%</b>	<b>16</b>	<b>68</b>	<b>81%</b>

**Table 47 –Structures Benefitted (Reduction in Water Adjacent to Foundation) by Medium Scale Alternatives and Widespread BMP Implementation, Lucas Ditch and Roberts Road Subwatersheds**

Problem Area	2-hr							24-hr						
	100-yr Exist	100-yr Prop Med Scale	Benefiting Structures (No.)	Benefit (%)	100-yr Prop Med Scale w/BMPs	Benefiting Structures (No.)	Benefit (%)	100-yr Exist	100-yr Prop Med Scale	Benefiting Structures (No.)	Benefit (%)	100-yr Prop Med Scale w/BMPs	Benefiting Structures (No.)	Benefit (%)
Problem O	1	0	1	100%	0	1	100%	0	0	0	n/a	0	0	n/a
Problem P	2	0	2	100%	0	2	100%	0	0	0	n/a	0	0	n/a
Problem NQRT	252	71	181	72%	51	201	80%	155	27	128	83%	2	153	99%
Problem U	16	11	5	31%	1	15	94%	31	23	8	26%	20	11	35%
Problem V	1	0	1	100%	0	1	100%	1	0	1	100%	0	1	100%
Problem X	4	0	4	100%	0	4	100%	0	0	0	n/a	0	0	n/a
<b>Total</b>	<b>276</b>	<b>82</b>	<b>194</b>	<b>70%</b>	<b>52</b>	<b>224</b>	<b>81%</b>	<b>187</b>	<b>50</b>	<b>137</b>	<b>73%</b>	<b>22</b>	<b>165</b>	<b>88%</b>

**Table 48 –Structures Benefitted (Reduction in Water Above First Floor) by Medium Scale Alternatives and Widespread BMP Implementation, Lucas Ditch and Roberts Road Subwatersheds**

Problem Area	2-hr							24-hr						
	100-yr Exist	100-yr Prop Med Scale	Benefiting Structures (No.)	Benefit (%)	100-yr Prop Med Scale w/BMPs	Benefiting Structures (No.)	Benefit (%)	100-yr Exist	100-yr Prop Med Scale	Benefiting Structures (No.)	Benefit (%)	100-yr Prop Med Scale w/BMPs	Benefiting Structures (No.)	Benefit (%)
Problem O	0	0	0	n/a	0	0	n/a	0	0	0	n/a	0	0	n/a
Problem P	0	0	0	n/a	0	0	n/a	0	0	0	n/a	0	0	n/a
Problem NQRT	121	46	75	62%	33	88	73%	56	13	43	77%	0	56	100%
Problem U	9	2	7	78%	0	9	100%	27	21	6	22%	17	10	37%
Problem V	1	0	1	100%	0	1	100%	1	0	1	100%	0	1	100%
Problem X	0	0	0	n/a	0	0	n/a	0	0	0	n/a	0	0	n/a
<b>Total</b>	<b>131</b>	<b>48</b>	<b>83</b>	<b>63%</b>	<b>33</b>	<b>98</b>	<b>75%</b>	<b>84</b>	<b>34</b>	<b>50</b>	<b>60%</b>	<b>17</b>	<b>67</b>	<b>80%</b>

## **Lucas Diversion Ditch Subwatershed**

A description of the existing conditions, proposed improvements, and results of the XP-SWMM analyses for the Lucas Diversion Ditch Subwatershed follows.

### **Existing Conditions**

The Lucas Diversion Ditch subwatershed is in the southeastern portion of the study area. It includes portions of the Cities of Hickory Hills and Palos Hills and the Village of Bridgeview. It is roughly bound by 83<sup>rd</sup> – 86<sup>th</sup> Street on the north, Harlem Avenue on the east, Stony Creek on the south and Roberts Road on the west. This description is general and approximate; Exhibit 23 shows the subwatershed and the limits in detail.

Land use within the subwatershed varies and includes single family and multi-family residential, a mobile home community, commercial areas, industrial areas, and I-294.

Many of the industrial areas have stormwater detention facilities to attenuate some of the flow within the subwatershed.

The open Lucas Diversion Ditch originates at 99<sup>th</sup> Street and 76<sup>th</sup> Avenue, where two large storm sewers discharge into the open ditch. Upstream/north of that point, runoff is conveyed through the subwatershed via storm sewers and overland flow; some open ditches are also present to convey flow. Lucas Diversion Ditch flows in a southerly direction through a ComEd right-of-way and discharges to Stony Creek at about 7800 west.

Between 99<sup>th</sup> Street and 103<sup>rd</sup> Street, along Roberts Road, flow from the Lucas Ditch and Lucas Diversion Ditch subwatersheds comingles during large storm events. Lucas Diversion Ditch does not have adequate capacity during large storm events, resulting in flooding along the ditch and the connected storm sewers, particularly near Roberts Road. Flooded/ponded waters flow west into the Lucas Ditch subwatershed.

### **Description of Proposed Large Scale Alternatives**

Alternative L (City of Hickory Hills) includes several components to reduce drainage problems and flooding on Roberts Road and 95<sup>th</sup> Street, which serves as the major entry point into the study area from the I-294 interchange. Past storm events have reportedly closed 95<sup>th</sup> Street immediately west of I-294 and prevented access to and from the Tollway. Two major components of the alternative are described as L.1 and L.2 on the exhibits and tables. Alternative RobRd also helps mitigate this drainage problem; this RobRd alternative is discussed elsewhere in this report.

Alternative L.1. Alternative L.1 includes excavating a proposed basin at the southwest corner of 91<sup>st</sup> Place and Roberts Road that will act as a surcharge basin and only be used when the Roberts Road storm sewer system is close to surcharging. This will help reduce flooding on Roberts Road, reduce bypass flows from Roberts Road to 95<sup>th</sup> Street, and reduce the pavement flooding and traffic impacts that have been experienced in past storm events.

The engineer's estimated opinion of construction cost for this alternative is \$2,650,000. The cost estimate is reduced to \$1,220,000 if constructed in conjunction with roadway improvements (and the roadway portions of the project cost are paid through a separate roadway budget/fund).

Alternative RobRd. Improvements to the storm sewer sizes along Roberts Road will also help reduce surcharge and flooding as a result of the Roberts Road storm sewer, reduce bypass flow from Roberts Road to 95<sup>th</sup> Street, and improve the flooding situation on 95<sup>th</sup> Street. These improvements on Roberts Road are described in alternative “RobRd” elsewhere in this report.

Alternative L.2. This alternative also includes improvements in the 95<sup>th</sup> Street and I-294 area, including installing a 48” storm sewer along 94<sup>th</sup> Street. Currently, lateral sewers on the north-south streets (Avenues and Courts) drain south to the 95<sup>th</sup> Street trunk sewer. The lateral sewers are sized for a small storm event, 5-10 year design capacity, and some have round Type 1 inlet grates with low inlet capacities. Significant flow bypasses the lateral storm sewer system in a large storm event and travels down the streets to 95<sup>th</sup> Street, resulting in flooding on 95<sup>th</sup> Street and subsequent road closures.

The purpose of the proposed 94<sup>th</sup> Street sewer is to provide high capacity inlets at the intersections along 94<sup>th</sup> Street to capture all bypass flow that is coming from the north to 95<sup>th</sup> Street at the south, and deliver the bypass flow into the proposed 94<sup>th</sup> Street sewer. The lateral sewers on the north-south streets (Courts and Avenues) are to remain connected to the 95<sup>th</sup> Street sewer; the proposed 94<sup>th</sup> Street sewer will cross the existing north-south laterals and this should be examined for potential utility conflicts. If conflicts are present, several options are available to mitigate the conflicts such as, (1) the conflicts could be mitigated by changing the location and/or orientation of the proposed sewer system, but still capturing the same amount of flow from upstream of 95<sup>th</sup> Street, to remove the runoff from 95<sup>th</sup> Street. (2) Constructing junction boxes could allow the north-south laterals to pass through the 94<sup>th</sup> Street sewer, which would allow intermingling of flow between the two systems, but still serve the same intent, which is to intercept bypass flow on the north-south streets with a proposed sewer prior to the waters reaching 95<sup>th</sup> Street as overland flow.

The proposed 94<sup>th</sup> Street storm sewer will bring the tributary runoff to a proposed 26 ac-ft detention basin northwest of the I-294 southbound off ramp, to remove the flow from 95<sup>th</sup> Street. The proposed detention basin will be connected to the existing northwest infield detention basin with a proposed 24” storm sewer. An expansion of the existing detention basin northeast of the 95<sup>th</sup> Street and I-294 is also proposed, as is excavating a proposed detention basin on the property southeast of 95<sup>th</sup> Street and I-294.

These proposed basins would be connected by proposed storm sewers, many along existing storm sewer alignments. A 42” storm sewer is proposed to connect the existing infield detention basin northwest of 95<sup>th</sup> Street and I-294, to the detention basins east of I-294. I-294 crosses over 95<sup>th</sup> Street at this location, so the proposed 42” storm sewer could be constructed under 95<sup>th</sup> Street or in the 95<sup>th</sup> Street ROW without impacting the Tollway.

The existing 15” restrictor pipe for the existing basin northeast of 95<sup>th</sup> Street and I-294 will need to be replaced with a 24” restrictor pipe to help eliminate 95<sup>th</sup> Street flooding problems. This will increase the discharge rate to downstream, but this is attenuated through the larger proposed storage volumes immediately downstream, and the final flow rate into the downstream-most existing storm sewer is maintained.

The proposed storage is located on existing open spaces within the Tollway ROW and adjacent open lands. Utilities and utility crossings and impacts were considered in the design of this alternative, though detailed information was not available. For example, there appear to be three gas lines running through the I-294 ROW in this vicinity. Plans were obtained from the pipeline companies but the gas lines were only shown conceptually on the gas line utility plans. The ponds were located to avoid utilities based on the information available, but the pond locations may need to be adjusted after exploratory utility potholes are obtained and exact inverts and horizontal locations are made known. Other combinations of

conveyance and detention are likely to provide similar flood benefits if utility conflicts prevent the exact alternative alignments shown.

The Illinois Tollway has initiated a master plan and conceptual design for an expansion to I-294 from Balmoral Avenue to 95<sup>th</sup> Street. The exact terminus of the southern limit of the expansion is unknown, but the proposed improvement area may be impacted by planned Tollway activities. We recommend coordinating with the Tollway, and it may be possible to combine these proposed improvements with the Tollway's proposed improvements, to provide a mutual benefit.

The engineer's estimated opinion of construction cost for this alternative is \$7,540,000. The cost estimate is reduced to \$6,890,000 if constructed in conjunction with local roadway improvements (and the roadway portions of the project cost are paid through a separate local roadway budget/fund). Further cost reductions may be possible if the excavated earthwork can be reused "onsite" with any Tollway road improvements, but these and other cost savings that may be realized through partnering with the Tollway are not quantified here.

Alternative M (Hickory Hills) is located at Problem Area M, which is flooding of properties adjacent to the 78<sup>th</sup> Avenue ditch and upstream, due to a lack of conveyance capacity within the ditch. The alternative proposes a 21.5 ac-ft detention basin in ComEd right of way upstream of the Lucas Diversion Ditch, to capture and store water before releasing to the Lucas Diversion Ditch downstream via a 3' x 4' box. This reduces the flow rate to the Lucas Diversion Ditch, and lowers the water surface elevation in the Lucas Diversion ditch, reducing the adjacent drainage problems. It also reduces runoff tributary to the 78<sup>th</sup> Avenue ditch, by bringing some water to the proposed detention basin, subsequently lowering water surface elevations in that ditch and reducing flooding.

The area shown as proposed storage currently contains ball fields used by the Park District. This alternative also includes relocating those ball fields to the north, to other undeveloped lands within the ComEd right of way.

Also included in this alternative is the installation of two 3' x 6' box culverts: one culvert from west to east on 98<sup>th</sup> Street and a second culvert from west to east on 99<sup>th</sup> Street, both between 78<sup>th</sup> Avenue and the ComEd right of way. These box culverts provide additional drainage capacity to capture and convey runoff from the industrial area, which reduces ponding north of 99<sup>th</sup> Street. The 98<sup>th</sup> Street box conveys water to the proposed storage basin; the 99<sup>th</sup> Street box culvert conveys water to the Lucas Diversion Ditch. The result of these culverts is a reduction in total flow in the 78<sup>th</sup> Avenue ditch downstream of 99<sup>th</sup> Street, as well as a reduction in flow at the upstream end of Lucas Diversion Ditch.

The alternative also involves regrading the small local drainage ditch between 98<sup>th</sup> Street and 99<sup>th</sup> Street, to positively carry flow east into the proposed detention basin.

The engineer's estimated opinion of construction cost for this alternative is \$5,370,000. The cost estimate is reduced to \$4,500,000 if constructed in conjunction with roadway improvements (and the roadway portions of the project cost are paid through a separate roadway budget/fund).

Alternatives RobRd, S, T are discussed in the Lucas Ditch Subwatershed section of this study.

Alternative Z is associated with a problem area located west of Harlem Avenue and south of 87<sup>th</sup> Street. This area is part of a trailer park, and is very flat. The topographic contours show only one foot of topographic relief across the trailer park community. The model shows flooding, but the storm sewer

system in the model was estimated, as the details of the stormwater management system were not surveyed in this area and limited storm sewer atlas information was available. Surcharged storm sewers and overland flow may go east and into the Harlem Avenue storm sewer system (outside the limits of the study area), or it may go west and into the ComEd right of way and south to Lucas Diversion Ditch. Due to the extremely flat topographic condition of this area, exact flow patterns cannot be defined without an extensive and detailed topographic survey. This area is located in the Village of Bridgeview, and the Village did not indicate any flooding problems in this area. Although street and yard flooding may be experienced in this area, the flood depths are expected to be shallow, and the interior of the trailer homes (which are typically elevated 24" off the ground) are not expected to be damaged.

Because there are no structural damages associated with this area, there is no proposed alternative. If desired by the Village of Bridgeview, an alternative to reduce street and yard flooding could be considered. This would require a topographic survey to identify overland flow routes and identify the subsurface stormwater management system. Further, an engineering analysis would also be required to identify deficiencies in the system. Proposed alternatives would likely include construction of additional inlets, drainage swales to direct runoff into the inlets, and improved storm sewer capacity.

Results: Lucas Diversion Ditch Subwatershed

Tables 49-50 below provide the results of the XP-SWMM analysis of the proposed alternatives, in terms of the structures being benefitted by the proposed Alternative improvements. Two numbers are provided: the number of homes that could have water adjacent to the foundation, and the number of homes that could have water entering the home (based on the ground elevation at the “house dot” location per GIS +0.66 feet.) This methodology is explained earlier in this report.

Tables showing the existing versus proposed results for the 100-year storms, and a comparison of the model results to the “flood protection elevation” or the “flood protection flow rate,” can be found in Appendix F.

**Table 49 –Structures Benefitted (Reduction in Water Adjacent to Foundation) by Large Scale Proposed Improvements, Lucas Diversion Ditch Subwatershed**

Problem Area	2-hr				24-hr			
	100-yr Exist	100-yr Prop Large Scale	Benefit-ing Structures (No.)	Benefit (%)	100-yr Exist	100-yr Prop Large Scale	Benefit-ing Structures (No.)	Benefit (%)
Problem L	46	21	25	54%	0	0	0	n/a
Problem M	3	0	3	100%	1	0	1	100%
Problem S	9	1	8	89%	1	0	1	100%
Problem Z	72	72	0	0%	262	262	0	0%
<b>Total</b>	<b>130</b>	<b>94</b>	<b>36</b>	<b>28%</b>	<b>264</b>	<b>262</b>	<b>2</b>	<b>1%</b>

**Table 50 –Structures Benefitted (Reduction in Water Above First Floor)  
by Large Scale Proposed Improvements, Lucas Diversion Ditch Subwatershed**

Problem Area	2-hr				24-hr			
	100-yr Exist	100-yr Prop Large Scale	Benefit-ing Structures (No.)	Benefit (%)	100-yr Exist	100-yr Prop Large Scale	Benefit-ing Structures (No.)	Benefit (%)
Problem L	32	4	28	88%	0	0	0	n/a
Problem M	1	0	1	100%	0	0	0	n/a
Problem S	2	0	2	100%	0	0	0	n/a
Problem Z	0	0	0	n/a	0	0	0	n/a
<b>Total</b>	<b>35</b>	<b>4</b>	<b>31</b>	<b>89%</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>n/a</b>

Note that the inundation mapping shows six structures remaining with water on the first floor, on W 95<sup>th</sup> Street, South 77<sup>th</sup> Court, South 77<sup>th</sup> Avenue and South 76<sup>th</sup> Court, in Problem Area L, in the 100-year 2-hour storm. The depth of flooding above the estimated first floor elevations is 0.01 feet to 0.25 feet at four of the six structures. It is possible that refinements of the design and a detailed survey of the low entry elevations may to remove the structures completely. Therefore, the data tables show the four structures as benefitting from Alternative L, although they are still shown as impacted in the exhibits.

At the fifth and sixth structure, the depth of flooding above the first floor is estimated as 0.26 feet (fifth structure) and 1.2 feet (sixth structure) in the proposed condition. This is a reduction from the existing condition, which was damaged with 1.25 and 2.2 feet of water. It is possible that refinements of the design and a detailed survey of the structure’s low entry elevation may remove the structures completely, especially the fifth structure. It is also possible that it will be difficult to protect these structures, especially the sixth structure, given the low elevation compared to the surrounding area.

**Description of Proposed Medium Scale Alternatives**

The large scale alternatives presented above are expected to provide a 100-year level of protection to residential structures. In locations where proposed large scale engineering solutions are costly, difficult to construct, or otherwise challenging to implement, a scaled-back “medium scale” version of the engineering solution is suggested to provide some benefits but not the full 100-year benefit. These are identical to the large scale alternatives, except as noted below:

Proposed Alternative L2-med: The large scale alternative L2 includes several proposed storage basins in the Illinois Tollway right-of-way and adjacent open lands at 95<sup>th</sup> Street and I-294. If existing utilities or future Tollway plans do not allow the storage to be built as proposed, or if utility relocations or Tollway negotiations result in a higher cost for the storage, then smaller storage basins could still produce some benefit to the problem area. This medium scale alternative L-med reduces the size of each proposed large scale basin by 50%. (The basin north of the 95<sup>th</sup> Street ramp in the northwest quadrant; the basin in the northeast quadrant; and the basin south of 95<sup>th</sup> Street east of the ramps are all reduced in size).

The engineer’s estimated opinion of construction cost for this medium-scale alternative is \$6,460,000. The cost estimate is reduced to \$5,810,000 if constructed in conjunction with roadway improvements (and the roadway portions of the project cost are paid through a separate roadway budget/fund).

Proposed Alternative M-med: The proposed large scale improvements include a 3' x 6' box culvert on 98<sup>th</sup> Street and 99<sup>th</sup> Street. The medium scale alternative M-med uses a smaller 36-inch pipe, in case cost or utility conflicts prevent the larger boxes.

The engineer's estimated opinion of construction cost for this medium-scale alternative is \$3,510,000. The cost estimate is reduced to \$2,990,000 if constructed in conjunction with roadway improvements (and the roadway portions of the project cost are paid through a separate roadway budget/fund).

Results with Medium Scale Alternatives

Tables 51-52 below compare the existing, proposed large-scale, and proposed medium-scale results in the subwatershed. As shown, the medium-scale results provide a benefit to the problem areas, but do not completely protect every home to the 100-year storm.

**Table 51 –Structures Benefitted (Reduction in Water Adjacent to Foundation) by Medium Scale Proposed Improvements, Lucas Diversion Ditch Subwatershed**

Problem Area	2-hr				24-hr			
	100-yr Exist	100-yr Prop Med Scale	Benefiting Structures (No.)	Benefit (%)	100-yr Exist	100-yr Prop Med Scale	Benefiting Structures (No.)	Benefit (%)
Problem L	46	26	20	43%	0	0	0	n/a
Problem M	3	0	3	100%	1	0	1	100%
Problem S	9	3	6	67%	1	0	1	100%
Problem Z	72	72	0	0%	262	262	0	0%
<b>Total</b>	<b>130</b>	<b>101</b>	<b>29</b>	<b>22%</b>	<b>264</b>	<b>262</b>	<b>2</b>	<b>1%</b>

**Table 52 –Structures Benefitted (Reduction in Water Above First Floor) by Medium Scale Proposed Improvements, Lucas Diversion Ditch Subwatershed**

Problem Area	2-hr				24-hr			
	100-yr Exist	100-yr Prop Med Scale	Benefiting Structures (No.)	Benefit (%)	100-yr Exist	100-yr Prop Med Scale	Benefiting Structures (No.)	Benefit (%)
Problem L	32	10	22	69%	0	0	0	n/a
Problem M	1	0	1	100%	0	0	0	n/a
Problem S	2	2	0	0%	0	0	0	n/a
Problem Z	0	0	0	n/a	0	0	0	n/a
<b>Total</b>	<b>35</b>	<b>12</b>	<b>23</b>	<b>66%</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>n/a</b>

**Description of Proposed Residential Scale Alternatives (BMPs and GI), with and without CIPs**

Tables 53 - 58 below compare the results of widespread BMP implementation throughout the subwatershed, with and without large or medium scale capital projects in place.

**Table 53 –Structures Benefitted (Reduction in Water Adjacent to Foundation) by Widespread BMP Implementation (and no capital projects), Lucas Diversion Ditch Subwatershed**

Problem Area	2-hr				24-hr			
	100-yr Exist	100-yr BMPs	Benefiting Structures (No.)	Benefit (%)	100-yr Exist	100-yr BMPs	Benefiting Structures (No.)	Benefit (%)
Problem L	46	28	18	39%	0	0	0	n/a
Problem M	3	1	2	67%	1	0	1	100%
Problem S	9	2	7	78%	1	0	1	100%
Problem Z	72	47	25	35%	262	172	90	34%
<b>Total</b>	<b>130</b>	<b>78</b>	<b>52</b>	<b>40%</b>	<b>264</b>	<b>172</b>	<b>92</b>	<b>35%</b>

**Table 54 –Structures Benefitted (Reduction in Water Above First Floor) by Widespread BMP Implementation (and no capital projects), Lucas Diversion Ditch Subwatershed**

Problem Area	2-hr				24-hr			
	100-yr Exist	100-yr BMPs	Benefiting Structures (No.)	Benefit (%)	100-yr Exist	100-yr BMPs	Benefiting Structures (No.)	Benefit (%)
Problem L	32	9	23	72%	0	0	0	n/a
Problem M	1	0	1	100%	0	0	0	n/a
Problem S	2	1	1	50%	0	0	0	n/a
Problem Z	0	0	0	n/a	0	0	0	n/a
<b>Total</b>	<b>35</b>	<b>10</b>	<b>25</b>	<b>71%</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>n/a</b>

**Table 55 –Structures Benefitted (Reduction in Water Adjacent to Foundation) by Large Scale Alternatives and Widespread BMP Implementation, Lucas Diversion Ditch Subwatershed**

Problem Area	2-hr							24-hr						
	100-yr Exist	100-yr Prop Large Scale	Benefiting Structures (No.)	Benefit (%)	100-yr Prop Large Scale w/BMPs	Benefiting Structures (No.)	Benefit (%)	100-yr Exist	100-yr Prop Large Scale	Benefiting Structures (No.)	Benefit (%)	100-yr Prop Large Scale w/BMPs	Benefiting Structures (No.)	Benefit (%)
Problem L	46	21	25	54%	2	44	96%	0	0	0	n/a	0	0	n/a
Problem M	3	0	3	100%	0	3	100%	1	0	1	100%	0	1	100%
Problem S	9	1	8	89%	1	8	89%	1	0	1	100%	0	1	100%
Problem Z	72	72	0	0%	47	25	35%	262	262	0	0%	172	90	34%
<b>Total</b>	<b>130</b>	<b>94</b>	<b>36</b>	<b>28%</b>	<b>50</b>	<b>80</b>	<b>62%</b>	<b>264</b>	<b>262</b>	<b>2</b>	<b>1%</b>	<b>172</b>	<b>92</b>	<b>35%</b>

**Table 56 –Structures Benefitted (Reduction in Water Above First Floor) by Large Scale Alternatives and Widespread BMP Implementation, Lucas Diversion Ditch Subwatershed**

Problem Area	2-hr							24-hr						
	100-yr Exist	100-yr Prop Large Scale	Benefiting Structures (No.)	Benefit (%)	100-yr Prop Large Scale w/BMPs	Benefiting Structures (No.)	Benefit (%)	100-yr Exist	100-yr Prop Large Scale	Benefiting Structures (No.)	Benefit (%)	100-yr Prop Large Scale w/BMPs	Benefiting Structures (No.)	Benefit (%)
Problem L	32	4	28	88%	0	32	100%	0	0	0	n/a	0	0	n/a
Problem M	1	0	1	100%	0	1	100%	0	0	0	n/a	0	0	n/a
Problem S	2	0	2	100%	0	2	100%	0	0	0	n/a	0	0	n/a
Problem Z	0	0	0	n/a	0	0	n/a	0	0	0	n/a	0	0	n/a
<b>Total</b>	<b>35</b>	<b>4</b>	<b>31</b>	<b>89%</b>	<b>0</b>	<b>35</b>	<b>100%</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>n/a</b>	<b>0</b>	<b>0</b>	<b>n/a</b>

**Table 57 –Structures Benefitted (Reduction in Water Adjacent to Foundation) by Medium Scale Alternatives and Widespread BMP Implementation, Lucas Diversion Ditch Subwatershed**

Problem Area	2-hr							24-hr						
	100-yr Exist	100-yr Prop Med Scale	Benefit-ing Structures (No.)	Benefit (%)	100-yr Prop Med Scale w/BMPs	Benefit-ing Structures (No.)	Benefit (%)	100-yr Exist	100-yr Prop Med Scale	Benefit-ing Structures (No.)	Benefit (%)	100-yr Prop Med Scale w/BMPs	Benefit-ing Structures (No.)	Benefit (%)
Problem L	46	26	20	43%	2	44	96%	0	0	0	n/a	0	0	n/a
Problem M	3	0	3	100%	0	3	100%	1	0	1	100%	0	1	100%
Problem S	9	3	6	67%	2	7	78%	1	0	1	100%	0	1	100%
Problem Z	72	72	0	0%	47	25	35%	262	262	0	0%	172	90	34%
<b>Total</b>	<b>130</b>	<b>101</b>	<b>29</b>	<b>22%</b>	<b>51</b>	<b>79</b>	<b>61%</b>	<b>264</b>	<b>262</b>	<b>2</b>	<b>1%</b>	<b>172</b>	<b>92</b>	<b>35%</b>

**Table 58 –Structures Benefitted (Reduction in Water Above First Floor) by Medium Scale Alternatives and Widespread BMP Implementation, Lucas Diversion Ditch Subwatershed**

Problem Area	2-hr							24-hr						
	100-yr Exist	100-yr Prop Med Scale	Benefit-ing Structures (No.)	Benefit (%)	100-yr Prop Med Scale w/BMPs	Benefit-ing Structures (No.)	Benefit (%)	100-yr Exist	100-yr Prop Med Scale	Benefit-ing Structures (No.)	Benefit (%)	100-yr Prop Med Scale w/BMPs	Benefit-ing Structures (No.)	Benefit (%)
Problem L	32	10	22	69%	0	32	100%	0	0	0	n/a	0	0	n/a
Problem M	1	0	1	100%	0	1	100%	0	0	0	n/a	0	0	n/a
Problem S	2	2	0	0%	0	2	100%	0	0	0	n/a	0	0	n/a
Problem Z	0	0	0	n/a	0	0	n/a	0	0	0	n/a	0	0	n/a
<b>Total</b>	<b>35</b>	<b>12</b>	<b>23</b>	<b>66%</b>	<b>0</b>	<b>35</b>	<b>100%</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>n/a</b>	<b>0</b>	<b>0</b>	<b>n/a</b>

## **Other Suggested Improvements and Recommendations**

Other non-project specific improvements and programs are recommended for the drainage area.

### **Private Property Assistance Program**

A non-project recommendation of this study is to create a program through which any property owner can request an appointment for a private property “inspection”, for the purpose of identifying deficiencies and opportunities to improve drainage and reduce flooding problems on the property. Some municipalities already provide this type of service, on an informal, unadvertised, and as-requested basis; it has been beneficial for the property owners. During informal discussions with affected residents in the study area, the residents indicated a need for this type of program. Many property owners do not have the technical understanding or know-how to assess their problems and figure out what needs to happen to mitigate the problem.

The program could task an individual employee with responsibility to serve as the point-of-contact for any interested property owner. The employee would visit the property to identify possible pathways for water to enter the home (eg, low window wells, poor grading, poor downspout placement, etc.) and provide information to the homeowner to help the owner take the proper next steps. Communication of this program to residents is also necessary, so that residents can take advantage of the services as needed.

### **Funding or Cost Share Programs for GIs or BMPs**

During the community outreach meetings, many residents expressed a desire or need for funding assistance so they could implement private property GIs or BMPs. The MWRD or municipalities may wish to consider a program through which financial funding assistance is made available to individual homeowners. This could include:

- Financial assistance for installation of GI/BMPs that provide storage to reduce stormwater runoff (such as permeable pavers, rain cisterns, or rain gardens);
- Grants or cost-sharing for overhead sewer or backflow preventers when a resident demonstrates a history of past problems (there were very few reports of basement flooding due to sewer backup within the study area), and/or to help homeowners acquire and install a battery backup sump pump;
- Municipal participation in the MWRD’s free Rain Barrel program to encourage residents to adopt this “gateway” BMP; Palos Hills and Hickory Hills already participate in this program, and it is available to the other communities in the study area as well.

### **Additional Inlets**

In general, the study area could benefit from additional storm sewer inlets to deliver flow into the existing (or proposed) storm sewer system. As roadway projects are completed throughout the study area, additional inlets and higher capacity inlets should be specified to remove water from the street and deliver it to the storm sewer system more efficiently. This will reduce the amount of flow that bypasses the storm sewer inlet grates and flows downstream, often creating or exacerbating a drainage problem. In general, an analysis of a “typical block” found that in the smaller storms, the storm sewers have greater capacity than the inlets, particularly in areas where Type 1 round inlet grates are used. Changing the inlet type and adding more inlets will allow more water to flow into the storm sewer system, rather than flowing overland and down the streets towards low problem areas.

The additional inlets will not be able to deliver more flow to the sewer than the sewers can handle. When the sewers reach capacity, water will surcharge onto the streets and flow down the streets to the low areas, which is the same as today's existing condition. Additional inlets are expected to reduce the amount of water flowing to low areas in the smaller storm events. They will also allow for faster draining of ponded waters during larger storm events, after the peaks have passed and the sewers have capacity.

## **Geotechnical and Environmental Considerations**

### **Wetland Considerations**

All of the alternatives were evaluated to determine the potential presence of Waters of the United States (WOUS), including wetlands under US Army Corps of Engineers jurisdiction, or isolated waters of Cook County which may be affected and any potential USACE permit requirements. The first step in the evaluation was to show the Subwatershed Divides on USGS Hydrologic Atlas, National Wetland Inventory Map and Cook County Soil Survey. The USGS Hydrologic Atlas was used to determine if any of the existing ditches, such as the Lucas Diversion Ditch, may have replaced a blue-line stream and would therefore be considered part of a historic connection to a USACE jurisdictional waterway.

Each of the North and South Alternatives were then evaluated to determine potential WOUS/wetland impacts and/or USACE permit requirements.

Many of the alternatives involve the construction of outfalls to WOUS with little or no apparent impacts to wetlands. Individually, the construction of these outfalls would qualify for Regional Permit 8, Utility Lines (RP8). A wetland delineation will be required for all aspects of the project that may involve a Regional Permit application. RP8 allows up to 1.0 acre of impact, although mitigation is required for impacts to WOUS greater than 0.10 acre. Each alternative could be considered a single and complete project, depending on how construction of each alternative may occur.

Alternatives Q.1, Q.2, and R&T, involve potential regrading of Lucas Ditch and/or Lucas Diversion Ditch, both of which are likely under USACE jurisdiction. The regrading may be considered “maintenance” and qualify for Regional Permit 9, Maintenance. However, the regrading will likely disturb the extensive riparian vegetation along both ditches. Based on this disturbance the USACE could require an Individual Permit for all alternatives involving Lucas Ditch, Lucas Diversion Ditch and Stony Creek.

When wetland permits are required, this typically triggers the need for an approval of the soil erosion and sediment control plans by the South Cook County Soil and Water Conservation District, and also triggers the need for an IEPA permit for water quality.

Wetland considerations and requirements are discussed further in Appendix H, along with exhibits and a detailed table summarizing the anticipated impacts and required permits and mitigation for each alternative. A brief summary of wetland requirements is presented here in Table 59.

**Table 59: Cursory Wetland Evaluation**

<b>Proposed Alternative IDs</b>	<b>Subwatershed</b>	<b>Municipality</b>	<b>Potential for Jurisdictional Wetlands?</b>	<b>Potential for Wetland / Waters of the US Permit Required?</b>	<b>Potential for Mitigation?</b>
A	71st St Ditch	Justice & Bedford Park	Y	Y	Y, proposed basin could provide mitigation
B	71st St Ditch	Justice	Y	Y	N
Y	71st St Ditch	Bridgeview	N	N	N
D & G	71st St Ditch and 79th St Storm Sewer	Bridgeview & Justice	N	Possible WMO	N

**Table 59: Cursory Wetland Evaluation**

Proposed Alternative IDs	Subwatershed	Municipality	Potential for Jurisdictional Wetlands?	Potential for Wetland / Waters of the US Permit Required?	Potential for Mitigation?
F	79th St Storm Sewer	Justice	N	N	N
H & J	79th St Storm Sewer	Justice	N	N	N
I & W	79th St Storm Sewer	Justice, Hickory Hills	N	N	N
K	79th St Storm Sewer	Hickory Hills	N	N	N
C	Justice Ditch	Justice	N	N	N
E	Justice Ditch	Unincorp-orated	N	N	N
Q.1*	Lucas Ditch	Palos Hills	Y	Y	Possible, restoration along streambank could suffice
Q.2*	Lucas Ditch	Palos Hills	Y	Y	N
U.1	Lucas Ditch	Palos Hills	Y	N	N
U.2	Lucas Ditch	Palos Hills	Y	N	N
V.1	Lucas Ditch	Palos Hills & Unincorp-orated	Uncertain	Uncertain	N
N*	Lucas Ditch (Roberts)	Palos Hills	Y	Y	N
O.1	Lucas Ditch (Roberts)	Hickory Hills	Y	Y	N
O.2	Lucas Ditch (Roberts)	Hickory Hills	Y	Y	N
O.3	Lucas Ditch (Roberts)	Hickory Hills	Y	Y	N
P	Lucas Ditch (Roberts)	Palos Hills	Unlikely	Unlikely	N
RobRd*	Roberts	Palos Hills, Hickory Hills, Bridgeview	Y	Possible	N
L1	Lucas Diversion Ditch	Hickory Hills			
L2	Lucas Diversion Ditch	Hickory Hills			
M	Lucas Diversion Ditch	Hickory Hills	Y	Y	N
T*	Lucas Diversion Ditch	Palos Hills	Y	Y	N
S*	Lucas Diversion Ditch	Bridgeview	Y	Y	N

*Note: the medium-scale alternatives would have the same potential as the large-scale alternatives listed here.*

## CCDD Considerations

Most of the various project alternatives are expected to involve earth excavation and disposal. Storm sewer improvements may involve smaller volumes of earth excavation for the trench, and the proposed storage areas and expanded storage areas will involve larger volumes of earth excavation and disposal. An “uncontaminated soil” evaluation of these construction spoils should be performed for each project site, upon commencement of any alternative. Any soil accepted at a clean soil fill operation, or soil mixed with other clean construction or demolition debris (CCDD) materials and accepted at a CCDD fill operation, must be certified to be uncontaminated in accordance with Section 22.51(f)(2)(B) of the Environmental Protection Act [415 ILCS 5/22.51(f)(2)(B)].

The results of the uncontaminated soil evaluation has the potential to significantly increase earthwork cost if data testing shows that the material cannot be accepted by a CCDD facility.

A cursory uncontaminated soil evaluation was performed for each project site, to provide a high level evaluation of the potential for each project’s excavated materials to be accepted by a CCDD facility. V3 reviewed the following sources from USEPA and Illinois EPA databases: LUST, RCRA, SRP, CERCLIS, TRI, Landfills or TSD facilities. These facilities represent environmental concerns and have the potential to affect the acceptance of soils to a CCDD facility. Table 60 shows the potential for excavated material from each project alternative to be accepted by a CCDD facility. This is not a formal evaluation, and a complete evaluation is required upon selection of an alternative(s).

### Acceptance by a CCDD Facility Categories:

- High Potential – majority residential land use, low number of sources
- Medium Potential – mixed land use, moderate number of sources
- Low Potential – majority industrial land use, high number of sources
- Low\* Potential applies to an existing basin or ditch that is proposed for enlargement or reshaping as part of the alternative. Material at the bottom of the basin or ditch may contain sediment that is impacted by urban runoff.

**Table 60: Cursory Uncontaminated Soil Evaluation**

Proposed Alternative IDs	Subwatershed	Municipality	Potential for Acceptance by a CCDD Facility	Comments
A	71st St Ditch	Justice & Bedford Park	Low	Industrial use, moderate number of sources
B	71st St Ditch	Justice	High	Residential use, no sources
Y	71st St Ditch	Bridgeview	Medium	Mixed use, moderate number of sources
D & G	71st St Ditch & 79th St Sewer	Bridgeview & Justice	Medium	Mixed use, moderate number of sources
F	79th St Sewer	Justice	High	Mostly residential, low number of sources
H & J	79th St Sewer	Justice	Medium / Low*	Mixed use, low number of sources. Existing urban stormwater basin.
I & W	79th St Sewer	Justice, Hickory Hills	High / Low*	Residential use, no sources. Existing urban stormwater basin.
K	79th St Sewer	Hickory Hills	High	Residential use, no sources

**Table 60: Cursory Uncontaminated Soil Evaluation**

Proposed Alternative IDs	Subwatershed	Municipality	Potential for Acceptance by a CCDD Facility	Comments
C	Justice Ditch	Justice	High	Residential use, low number of sources
E	Justice Ditch	Unincorporated	High	Residential use, no sources
Q.1	Lucas Ditch	Palos Hills	Medium / Low*	Residential use, no sources. Existing urban ditch.
Q.2	Lucas Ditch	Palos Hills	High	Residential use, no sources
U.1	Lucas Ditch	Palos Hills	High	Residential use, no sources
U.2	Lucas Ditch	Palos Hills	High	Residential use, no sources
V	Lucas Ditch	Palos Hills & Unincorporated	High	Residential use, no sources
N	Lucas Ditch (Roberts)	Palos Hills	High / Low*	Residential use, no sources. Existing urban stormwater basin.
O.1	Lucas Ditch (Roberts)	Hickory Hills	High	Residential use, no sources
O.2	Lucas Ditch (Roberts)	Hickory Hills	High	Residential use, no sources
O.3	Lucas Ditch (Roberts)	Hickory Hills	High	Residential use, no sources
P	Lucas Ditch (Roberts)	Palos Hills	High / Low*	Residential use, no sources. Existing urban stormwater basin.
RobRd	Roberts	Palos Hills, Hickory Hills, Bridgeview	Low	Industrial use, moderate number of sources
L1	Lucas Div. Ditch	Hickory Hills	Medium	Mixed use, moderate number of sources
L2	Lucas Div. Ditch	Hickory Hills	Medium / Low*	Mixed use, moderate number of sources. Existing urban stormwater basin.
M	Lucas Div. Ditch	Hickory Hills	Medium	Mixed use, low number of sources
T	Lucas Div. Ditch	Palos Hills	Medium / Low*	Residential use, no sources. Existing urban ditch.
S	Lucas Div. Ditch	Bridgeview	Medium / Low*	Mixed use, low number of sources. Existing urban stormwater basin.
X	Roberts	Hickory Hills Palos Hills	Medium / Low*	Mixed use, low number of sources. Existing urban stormwater basin.

*Note: the medium-scale alternatives would have the same potential as the large-scale alternatives listed here.*

### Geotechnical Considerations

A geotechnical evaluation was not performed. Groundwater issues and soil stability issues are not expected at any of the proposed capital improvement project alternative sites, but each site should be evaluated in detail upon selection for design, to ensure proper consideration of these factors. High groundwater could reduce potential to dig some of the proposed detention facilities to a deeper depth.

Groundwater and soil issues could also influence or impact the ability to construct certain BMPs or GI measures.

The cost estimates assume soils are suitable for the proposed projects and special geotechnical features or mitigation is not required by any of the project alternatives.

## **Construction Cost Estimate Summary**

Engineer's estimated opinions of probable construction cost (EEOGCC) were prepared for each project alternative, reflecting the conceptual nature of the alternatives. Four separate estimates are provided:

- Large scale alternatives, constructed as stand-alone projects
- Large scale alternatives, constructed as part of a roadway project
- Medium scale alternatives, constructed as stand-alone projects
- Medium scale alternatives, constructed as part of a roadway project

These estimates are shown in Appendix I: Engineer's Estimated Opinion of Probable Construction Cost.

### **Unit Costs and Assumptions**

Unit costs were developed for the project by V3's professional cost estimators, and applied uniformly to all alternatives within this project. The estimates provide a planning-level cost estimate, and include many assumptions, reflective of the conceptual nature of the alternatives. These assumptions include:

- It is assumed that all earthwork must be hauled off. If space exists on a parcel to store the excavated material, earthwork costs could be reduced substantially.
- Earth Excavation pricing does not include contingencies for potential rock excavation or the presence of contaminants in excess of TACO Tier 1 standards. Costs for both of these eventualities will be substantial. More engineering data will be necessary to quantify the impact to the project budget and schedule. All Earth Excavation budgets are predicated on disposal at local CCDD facilities. They do not include trucking or disposal costs for subtitle D landfill disposal.
- Earth excavation volumes are approximate. They are equal to the increased storage volume, plus an additional 2' of excavation over the pond's footprint to account for excavation below the NWL and above the HWL. Property acquisition costs for residential property acquisition were approximated using Zillow estimates from January, 2016.
- It is assumed that storage on cemeteries, industrial parcels, commercial parcels, park district sites, and utility rights of way can be provided without any land acquisition cost. These property owners may require some compensation, which could be a reduction in user fees, improvement of other areas of their land (such as constructing new park amenities or making ecological improvements to a forested area), or other similar compensation. These potential costs are not included here.
- The cost of native plantings includes the cost to plant each basin and perform three years of maintenance and monitoring.
- Pavement cost is based on patching only. Complete roadway replacement or rehabilitation is not included, except for streets that are converted to curb and gutter and require full replacement.
- Pavement section for patching assumes a typical section, and may require refinement based on the jurisdiction's preferences and requirements.
- Asphalt Material Escalation is not included in this estimate. The Current Bituminous Price Index per IDOT is \$378.33.
- This estimate does not include escalation factors for labor, fuel, equipment etc., all pricing is in Spring 2016 Dollars.
- This estimate does not include: Water Main Installation, ROW Acquisition, or Soft Costs not specifically listed in the individual detailed estimate breakdowns.
- The estimates include soft costs such as:
  - Topographic Survey, Construction Layout and As-Builts: 3%
  - Design & Permitting, 10%

- Construction Administration, 6%
- P&P Bonds, Insurance, & General Conditions, 4.25%
- Contractor Mobilization, 6%
- Traffic Control, 1%
- Environmental Testing, 1%
- The estimates include a 20% general construction contingency to reflect the conceptual nature of the designs.

### **Opportunities for Funding Efficiencies**

To achieve funding efficiencies, it is recommended that the storm sewer alternatives be constructed in conjunction with planned roadway improvement projects. This reduces the overall cost of the stormwater project, as the costs associated with the contractor’s mobilization, pavement reconstruction or rehabilitation, site restoration, maintenance of traffic, and some utility work would be necessary to achieve the roadway improvement project goals. The incremental cost of the stormwater project is then the cost of any new or upsized sewer, utility trench, earthwork excavation, and drainage structures beyond those required by the roadway improvement project.

Specifically, the Roberts Road improvements that are proposed should be called to the attention of Cook County Department of Transportation and Highways, and the proposed improvements at I-294 and 95<sup>th</sup> Street should be called to the attention of the Illinois Tollway. Both agencies are planning capital improvement projects in the vicinity of the proposed alternatives, and there could be an opportunity to construct the stormwater improvements in conjunction with the roadway projects.

### **Summary of Estimated Costs and Structures Benefitted**

Tables 61 - 64 present the cost of each alternative, as a stand-alone project and also as a portion of a larger roadway rehabilitation project. The table also provides a normalized cost to allow comparison between alternatives, based on the number of houses that are “removed” from flooding during the 100-year storm event. The medium scale alternatives that are shown provide a smaller project cost, but because the number of houses “removed” is also reduced, the cost per structure benefitted is actually higher with some medium alternatives.

Tables 61 and 63 are based on “removal” of water adjacent to a home’s foundation, and tables 62 and 64 are based on “removal” of water on the first floor of a home. This is based on the “address dot” GIS analysis described earlier in this report, and is only meant to represent the magnitude of benefit produced by each alternative. Detailed low entry elevation surveys were not performed for this study. The actual number of homes that are expected to have water adjacent to the foundation or first floor may vary in both the existing and the proposed conditions.

The proposed alternatives also provide many other benefits not described in the tables, including reductions in yard flooding of many properties not identified in the tables, reductions in flood depths on streets, reductions in traffic impacts, reduction in impacts to commercial and industrial properties / business operations, improved emergency access, and other similar benefits.

**Table 61 – Engineer’s Estimated Opinion of Probable Construction Cost, Large Scale Alternatives. Structures Benefitted Based on Removal of Water Adjacent to Foundation.**

Alternative	Subwatershed	Cost Estimate, Large Scale project, Constructed as a Stand-Alone project	Cost Estimate, Large Scale project, Constructed in Conjunction with Roadway Project	Struct-ures Benefitted (No.)	Cost Per Structure Benefitted	Cost Per Structure Benefitted (Constr. with Road Project)
Alt A	71st St Ditch	\$31,720,000	\$31,670,000	24	\$1,322,000	\$1,320,000
Alt B	71st St Ditch	\$5,120,000	\$4,070,000	40	\$128,000	\$102,000
Alt Y	71st St Ditch	\$17,520,000	\$15,590,000	17	\$1,031,000	\$917,000
Alt D & G	71st St Ditch	\$15,520,000	\$13,540,000	47	\$330,000	\$288,000
<b>Total</b>	<b>71st St Ditch</b>	<b>\$69,880,000</b>	<b>\$64,870,000</b>	<b>128</b>	<b>\$546,000</b>	<b>\$507,000</b>
Probs I&W	79th Street Sewer	\$7,600,000	\$7,110,000	6	\$1,267,000	\$1,185,000
Alt F	79th Street Sewer	\$28,460,000	\$21,890,000	184	\$155,000	\$119,000
Alt J	79th Street Sewer	\$1,320,000	\$1,320,000	1	\$1,320,000	\$1,320,000
Alt H	79th Street Sewer	\$1,810,000	\$1,660,000	3	\$603,000	\$553,000
<b>Total</b>	<b>79th St Sewer</b>	<b>\$39,190,000</b>	<b>\$31,980,000</b>	<b>194</b>	<b>\$202,000</b>	<b>\$165,000</b>
Alt C	Justice Ditch	\$2,010,000	\$1,670,000	31	\$65,000	\$54,000
Alt E	Justice Ditch	\$4,200,000	\$3,800,000	49	\$86,000	\$78,000
<b>Total</b>	<b>Justice Ditch</b>	<b>\$6,210,000</b>	<b>\$5,470,000</b>	<b>80</b>	<b>\$78,000</b>	<b>\$68,000</b>
Alt O	Lucas Ditch	\$140,000	\$140,000	1	\$140,000	\$140,000
Alt P	Lucas Ditch	\$500,000	\$500,000	2	\$250,000	\$250,000
Alt NQRT+RobRd	Lucas Ditch	\$48,490,000	\$38,500,000	246	\$197,000	\$157,000
Alt U	Lucas Ditch	\$2,150,000	\$2,150,000	8	\$269,000	\$269,000
Alt V	Lucas Ditch	\$270,000	\$270,000	1	\$270,000	\$270,000
Alt X	Lucas Ditch	\$1,570,000	\$1,570,000	4	\$393,000	\$393,000
<b>Total</b>	<b>Lucas Ditch</b>	<b>\$52,850,000</b>	<b>\$42,860,000</b>	<b>261</b>	<b>\$202,000</b>	<b>\$164,000</b>
<b>Combined NQRST+RobRd</b>		<b>\$57,570,000</b>	<b>\$46,220,000</b>	<b>254</b>	<b>\$227,000</b>	<b>\$182,000</b>
Alt L	Lucas Div. Ditch	\$10,190,000	\$8,110,000	25	\$408,000	\$324,000
Alt M	Lucas Div. Ditch	\$5,370,000	\$4,500,000	3	\$1,790,000	\$1,500,000
Alt S	Lucas Div. Ditch	\$9,080,000	\$7,720,000	8	\$1,135,000	\$965,000
<b>Total</b>	<b>Lucas Div. Dtch</b>	<b>\$24,640,000</b>	<b>\$20,330,000</b>	<b>36</b>	<b>\$684,000</b>	<b>\$565,000</b>
<b>Total, Entire Roberts Road Drainage Area</b>		<b>\$192,770,000</b>	<b>\$165,510,000</b>	<b>699</b>	<b>\$276,000</b>	<b>\$237,000</b>

**Table 62 – Engineer’s Estimated Opinion of Probable Construction Cost, Large Scale Alternatives. Structures Benefitted Based on Removal of Water Above First Floor.**

Alternative	Subwatershed	Cost Estimate, Large Scale project, Constructed as a Stand-Alone project	Cost Estimate, Large Scale project, Constructed in Conjunction with Roadway Project	Structures Benefitted (No.)	Cost Per Structure Benefitted	Cost Per Structure Benefitted (Constr. with Road Project)
Alt A	71st St Ditch	\$31,720,000	\$31,670,000	7	\$4,531,000	\$4,524,000
Alt B	71st St Ditch	\$5,120,000	\$4,070,000	23	\$223,000	\$177,000
Alt Y	71st St Ditch	\$17,520,000	\$15,590,000	6	\$2,920,000	\$2,598,000
Alt D & G	71st St Ditch	\$15,520,000	\$13,540,000	4	\$3,880,000	\$3,385,000
<b>Total</b>	<b>71st St Ditch</b>	<b>\$69,880,000</b>	<b>\$64,870,000</b>	<b>40</b>	<b>\$1,747,000</b>	<b>\$1,622,000</b>
Alt I & W	79th St Sewer	\$7,600,000	\$7,110,000	6	\$1,267,000	\$1,185,000
Alt F	79th St Sewer	\$28,460,000	\$21,890,000	97	\$293,000	\$226,000
Alt J	79th St Sewer	\$1,320,000	\$1,320,000	1	\$1,320,000	\$1,320,000
Alt H	79th St Sewer	\$1,810,000	\$1,660,000	1	\$1,810,000	\$1,660,000
<b>Total</b>	<b>79th St Sewer</b>	<b>\$39,190,000</b>	<b>\$31,980,000</b>	<b>105</b>	<b>\$373,000</b>	<b>\$305,000</b>
Alt C	Justice Ditch	\$2,010,000	\$1,670,000	11	\$183,000	\$152,000
Alt E	Justice Ditch	\$4,200,000	\$3,800,000	24	\$175,000	\$158,000
<b>Total</b>	<b>Justice Ditch</b>	<b>\$6,210,000</b>	<b>\$5,470,000</b>	<b>35</b>	<b>\$177,000</b>	<b>\$156,000</b>
Alt O	Lucas Ditch	\$140,000	\$140,000	0	n/a	n/a
Alt P	Lucas Ditch	\$500,000	\$500,000	0	n/a	n/a
Alt NQRT+RobRd	Lucas Ditch	\$48,490,000	\$38,500,000	121	\$401,000	\$318,000
Alt U	Lucas Ditch	\$2,150,000	\$2,150,000	7	\$307,000	\$307,000
Alt V	Lucas Ditch	\$270,000	\$270,000	1	\$270,000	\$270,000
Alt X	Lucas Ditch	\$1,570,000	\$1,570,000	0	n/a	n/a
<b>Total</b>	<b>Lucas Ditch</b>	<b>\$52,850,000</b>	<b>\$42,860,000</b>	<b>128</b>	<b>\$413,000</b>	<b>\$335,000</b>
<b>Combined NQRST+RobRd</b>		<b>\$57,570,000</b>	<b>\$46,220,000</b>	<b>123</b>	<b>\$468,000</b>	<b>\$376,000</b>
Alt L	Lucas Div. Ditch	\$ 10,190,000	\$8,110,000	28	\$364,000	\$ 290,000
Alt M	Lucas Div. Ditch	\$5,370,000	\$4,500,000	1	\$5,370,000	\$4,500,000
Alt S	Lucas Div. Ditch	\$ 9,080,000	\$7,720,000	2	\$4,540,000	\$3,860,000
<b>Total</b>	<b>Lucas Div. itch</b>	<b>\$24,640,000</b>	<b>\$20,330,000</b>	<b>31</b>	<b>\$795,000</b>	<b>\$656,000</b>
<b>Total, Entire Roberts Road Drainage Area</b>		<b>\$192,770,000</b>	<b>\$165,510,000</b>	<b>339</b>	<b>\$569,000</b>	<b>\$488,000</b>

**Table 63 – Engineer’s Estimated Opinion of Probable Construction Cost, Medium Scale Alternatives. Structures Benefitted Based on Removal of Water Adjacent to Foundation.**

Alternative	Subwatershed	Cost Estimate, Medium Scale project, Constructed as a Stand-Alone project	Cost Estimate, Medium Scale project, Constructed in Conjunction with Roadway Project	Structures Benefitted (No.)	Cost Per Structure Benefitted	Cost Per Structure Benefitted (Constr. with Road Project)
Alt A	71st St Ditch	\$31,720,000	\$31,670,000	24	\$1,322,000	\$1,320,000
Alt B-med	71st St Ditch	\$2,940,000	\$2,190,000	40	\$74,000	\$55,000
Alt Y	71st St Ditch	\$17,520,000	\$15,590,000	17	\$1,031,000	\$917,000
Alt D & G	71st St Ditch	\$15,520,000	\$13,540,000	47	\$330,000	\$288,000
<b>Total</b>	<b>71st St Ditch</b>	<b>\$67,700,000</b>	<b>\$62,990,000</b>	<b>128</b>	<b>\$529,000</b>	<b>\$492,000</b>
Alt I & W - med	79th St Sewer	\$6,640,000	\$6,310,000	4	\$1,660,000	\$1,578,000
Alt F - med	79th St Sewer	\$24,320,000	\$18,660,000	184	\$132,000	\$101,000
Alt J	79th St Sewer	\$1,320,000	\$1,320,000	1	\$1,320,000	\$1,320,000
Alt H	79th St Sewer	\$1,810,000	\$1,660,000	3	\$603,000	\$553,000
<b>Total</b>	<b>79th St Sewer</b>	<b>\$34,090,000</b>	<b>\$27,950,000</b>	<b>192</b>	<b>\$178,000</b>	<b>\$146,000</b>
Alt C	Justice Ditch	\$2,010,000	\$1,670,000	31	\$65,000	\$54,000
Alt E	Justice Ditch	\$4,200,000	\$3,800,000	49	\$86,000	\$78,000
<b>Total</b>	<b>Justice Ditch</b>	<b>\$6,210,000</b>	<b>\$5,470,000</b>	<b>80</b>	<b>\$78,000</b>	<b>\$68,000</b>
Alt O	Lucas Ditch	\$140,000	\$140,000	1	\$140,000	\$140,000
Alt P	Lucas Ditch	\$500,000	\$500,000	2	\$250,000	\$250,000
NQRT+RobRd-med	Lucas Ditch	\$22,170,000	\$18,910,000	181	\$122,000	\$104,000
Alt U	Lucas Ditch	\$2,150,000	\$2,150,000	8	\$269,000	\$269,000
Alt V	Lucas Ditch	\$270,000	\$270,000	1	\$270,000	\$270,000
Alt X	Lucas Ditch	\$1,570,000	\$1,570,000	4	\$393,000	\$393,000
<b>Total</b>	<b>Lucas Ditch</b>	<b>\$26,530,000</b>	<b>\$23,270,000</b>	<b>196</b>	<b>\$135,000</b>	<b>\$119,000</b>
<b>Combined NQRST+RobRd</b>		<b>\$31,250,000</b>	<b>\$31,250,000</b>	<b>187</b>	<b>\$167,000</b>	<b>\$142,000</b>
Alt L-med	Lucas Div. Ditch	\$9,110,000	\$7,030,000	20	\$456,000	\$352,000
Alt M-med	Lucas Div. Ditch	\$3,510,000	\$2,990,000	3	\$1,170,000	\$997,000
Alt S	Lucas Div. Ditch	\$9,080,000	\$7,720,000	6	\$1,513,000	\$1,287,000
<b>Total</b>	<b>Lucas Div. Ditch</b>	<b>\$21,700,000</b>	<b>\$17,740,000</b>	<b>29</b>	<b>\$748,000</b>	<b>\$612,000</b>
<b>Total, Entire Roberts Road Drainage Area</b>		<b>\$156,230,000</b>	<b>\$137,420,000</b>	<b>625</b>	<b>\$250,000</b>	<b>\$220,000</b>

**Table 64 – Engineer’s Estimated Opinion of Probable Construction Cost, Medium Scale Alternatives. Structures Benefitted Based on Removal of Water Above First Floor.**

Alternative	Subwatershed	Cost Estimate, Medium Scale project, Constructed as a Stand-Alone project	Cost Estimate, Medium Scale project, Constructed in Conjunction with Roadway Project	Structures Benefitted (No.)	Cost Per Structure Benefitted	Cost Per Structure Benefitted (Constr. with Road Project)
Alt A	71st St Ditch	\$31,720,000	\$31,670,000	7	\$4,531,000	\$4,524,000
Alt B-med	71st St Ditch	\$2,940,000	\$2,190,000	23	\$128,000	\$95,000
Alt Y	71st St Ditch	\$17,520,000	\$15,590,000	4	\$4,380,000	\$3,898,000
Alt D & G	71st St Ditch	\$15,520,000	\$13,540,000	3	\$5,173,000	\$4,513,000
<b>Total</b>	<b>71st St Ditch</b>	<b>\$67,700,000</b>	<b>\$62,990,000</b>	<b>37</b>	<b>\$1,830,000</b>	<b>\$1,702,000</b>
Alt I & W - med	79th St Sewer	\$6,640,000	\$6,310,000	4	\$1,660,000	\$1,578,000
Alt F - med	79th St Sewer	\$24,320,000	\$18,660,000	97	\$251,000	\$192,000
Alt J	79th St Sewer	\$1,320,000	\$1,320,000	1	\$1,320,000	\$1,320,000
Alt H	79th St Sewer	\$1,810,000	\$1,660,000	1	\$1,810,000	\$1,660,000
<b>Total</b>	<b>79th St Sewer</b>	<b>\$34,090,000</b>	<b>\$27,950,000</b>	<b>103</b>	<b>\$331,000</b>	<b>\$271,000</b>
Alt C	Justice Ditch	\$2,010,000	\$1,670,000	9	\$223,000	\$186,000
Alt E	Justice Ditch	\$4,200,000	\$3,800,000	24	\$175,000	\$158,000
<b>Total</b>	<b>Justice Ditch</b>	<b>\$6,210,000</b>	<b>\$5,470,000</b>	<b>33</b>	<b>\$188,000</b>	<b>\$166,000</b>
Alt O	Lucas Ditch	\$140,000	\$140,000	0	n/a	n/a
Alt P	Lucas Ditch	\$500,000	\$500,000	0	n/a	n/a
NQRT+RobRd-med	Lucas Ditch	\$22,170,000	\$18,910,000	75	\$296,000	\$252,000
Alt U	Lucas Ditch	\$2,150,000	\$2,150,000	7	\$307,000	\$307,000
Alt V	Lucas Ditch	\$270,000	\$270,000	1	\$270,000	\$270,000
Alt X	Lucas Ditch	\$1,570,000	\$1,570,000	0	n/a	n/a
<b>Total</b>	<b>Lucas Ditch</b>	<b>\$26,530,000</b>	<b>\$23,270,000</b>	<b>82</b>	<b>\$324,000</b>	<b>\$284,000</b>
<b>Combined NQRST+RobRd</b>		<b>\$31,250,000</b>	<b>\$26,630,000</b>	<b>75</b>	<b>\$417,000</b>	<b>\$355,000</b>
Alt L-med	Lucas Div. Dtch	\$9,110,000	\$7,030,000	22	\$414,000	\$320,000
Alt M-med	Lucas Div. Dtch	\$3,510,000	\$2,990,000	1	\$3,510,000	\$2,990,000
Alt S	Lucas Div. Dtch	\$9,080,000	\$7,720,000	0	n/a	n/a
<b>Total</b>	<b>Lucas Div. Dch</b>	<b>\$21,700,000</b>	<b>\$17,740,000</b>	<b>23</b>	<b>\$943,000</b>	<b>\$771,000</b>
<b>Total, Entire Roberts Road Drainage Area</b>		<b>\$156,230,000</b>	<b>\$137,420,000</b>	<b>278</b>	<b>\$562,000</b>	<b>\$494,000</b>

\*Alternatives N, Q1, Q2, S, T and RobRd are designed to work together, and should be considered parts of a larger, comprehensive alternative to manage stormwater and reduce flooding within the Lucas Ditch and Lucas Diversion Ditch subwatersheds.

## Direct Comparison of Large and Medium Scale Cost and Structures Benefitted

Table 65 provides a direct comparison of costs and costs per structure benefitted for the medium and large alternatives. The amount of structures benefitted, as shown in this table, are those that have water removed from the foundation.

In most cases, the total project cost and the cost per structure benefitted are reduced, but in some locations the cost per structure benefitted is higher with the medium alternatives, due to a disproportionate reduction in structures benefitted compared to cost.

**Table 65: Comparison of Engineer's Cost Estimate of Proposed Large Scale versus Medium Scale Alternatives**

Alternative	Subwatershed	Cost Estimate, Constructed as a Stand-Alone project	Cost Estimate, Constructed in Conjunction with Roadway Project	Max. No. Structures Benefitted (Reduction in Water Adjacent to Foundation) (No.)	Cost Per Structure Benefitted (stand-alone project)	Cost Per Structure Benefitted (Constructed w/Roadway Project)
Alt B	71st St Ditch	\$5,120,000	\$4,070,000	40	\$128,000	\$102,000
Alt B-med	71st St Ditch	\$2,940,000	\$2,190,000	40	\$74,000	\$55,000
Alt I & W	79th St Sewer	\$7,600,000	\$7,110,000	6	\$1,267,000	\$1,185,000
Alt I & W - med	79th St Sewer	\$6,640,000	\$6,310,000	4	\$1,660,000	\$1,578,000
Alt F (24-hr)	79th St Sewer	\$28,460,000	\$21,890,000	184	\$155,000	\$119,000
Alt F-med (24h)	79th St Sewer	\$24,320,000	\$18,660,000	184	\$132,000	\$101,000
Alt F (2-hr)	79th St Sewer	\$28,460,000	\$21,890,000	142	\$200,000	\$154,000
Alt F-med (2-hr)	79th St Sewer	\$24,320,000	\$18,660,000	61	\$399,000	\$306,000
Alt NQRT+RobRd	Lucas Ditch	\$48,490,000	\$38,500,000	246	\$197,000	\$157,000
NSRTRobRd-med	Lucas Ditch	\$22,170,000	\$18,910,000	181	\$122,000	\$104,000
Combined NQRST+RobRd		\$57,570,000	\$46,220,000	254	\$227,000	\$182,000
Combined NQRST+RobRd-med		\$31,250,000	\$26,630,000	187	\$167,000	\$142,000
Alt L	Lucas Div. Ditch	\$10,190,000	\$8,110,000	25	\$408,000	\$324,000
Alt L-med	Lucas Div. Ditch	\$9,110,000	\$7,030,000	20	\$456,000	\$352,000
Alt M	Lucas Div. Ditch	\$5,370,000	\$4,500,000	3	\$1,790,000	\$1,500,000
Alt M-med	Lucas Div. Ditch	\$3,510,000	\$2,990,000	3	\$1,170,000	\$997,000

## Large vs Medium Scale Alternatives

The cost of structures benefitted for large and medium scale alternatives is compared in Table 65. The following selection of alternatives is recommended:

Problem Area B: Although the number of structures benefitted by the large and medium scale alternative is equal in Problem Area B, the depth of water on the streets and yards is deeper in the medium-scale alternative. The large scale alternative B has a greater benefit to traffic, but the medium scale B-med provides protection of structures. Therefore, the lower cost medium scale Alternative B-med is recommended in Problem Area B.

Problem Area I & W: The large scale alternative removes all structures, whereas two structures remain damaged in the medium scale alternative. The cost per structure benefitted is lower in the large scale alternative. If funds are available, the large scale Alternative I & W is recommended over the medium scale alternative in this problem area.

Problem Area F: In this area, the 24-hour storm event produces the most damage. Both the large and the medium scale alternatives remove all structures during the 100-year event. In the 2-hour storm, the large alternative removes all structures whereas the medium alternative leaves 80 structures with water adjacent to the foundation. The cost per structure benefitted is lower in the large scale alternative, when the 2-hour duration benefits are considered. Therefore, to protect an additional 80 homes, the large scale Alternative F is recommended over the medium scale alternative.

Problem Area N / Q / R / S / T: In this combined problem area, Alternatives N, Q1, Q2, S, T and RobRd are designed to work together to reduce flood damages within the Lucas Ditch, Roberts Road, and Lucas Diversion Ditch subwatersheds. Alternatives Q1 and RobRd each have an associated medium-scale alternative.

Alternative Q1-med is recommended over the large scale Alternative Q1. The large scale alternative Q1 has a greater benefit to yard and street flooding, traffic, and reductions in water surface elevations, but the medium scale Q1-med provides protection of structures. Therefore, the lower cost medium scale Alternative Q1-med is recommended in Problem Area Q. However, it is recommended that the engineer verify low entry elevations with a detailed survey, and reassess this recommendation. If the estimated low entry elevations vary from the actual surveyed low entry elevations, it may be beneficial to pursue Alternative Q1 (large scale) for the added protection and possible ability to remove homes from the floodplain and reduce flood insurance premiums.

Alternative RobRd-med is also recommended over the large scale RobRd, because the cost of structures benefitted is lower and the total cost is lower. The large scale Alternative RobRd includes improvements to storm sewers under Roberts Road, and the medium scale Alternative RobRd-med omits these improvements all together. If funding sources are available, constructing Alternative RobRd (large scale) would remove an additional 65 homes from this flood-prone area, reduce street flooding and traffic impacts, and possibly allow some properties to be removed from the floodplain (with subsequent reductions in flood insurance premiums). If the full Alternative RobRd is not constructed, it is recommended that additional high capacity inlets be placed on Roberts Road during the roadway reconstruction project, to allow more water to enter the existing storm sewer system to reduce the amount of bypass flow that runs down the road and contributes to problems at the low spots.

### Cost Estimate for Private Property BMPs

Costs were also estimated for the private property BMP improvements. The individual cost of each alternative is shown in Appendix G. The cost of the four specific measures described in this narrative are presented below in Table 66, based on the individual BMP cost multiplied by the 12,300 properties in the study area. As shown, the costs of watershed-wide implementation are substantial.

As described previously, the analysis showing the benefits of GI and BMPs constructed across the entire study area assumes that all land owners, such as commercial and industrial properties, park districts, schools, and rights of way, all participate towards removing 0.6 or 1.1 inches of rain. The cost table shown below is for residential property implementation only.

**Table 66 – Cost of Private Property BMPs on Residential Properties, with Widespread Implementation**

Residential BMP	Estimated Cost to Capture:		Watershed-wide Cost to Capture:	
	1.1 inches of rain	0.6 inches of rain	1.1 inches of rain	0.6 inches of rain
Rain Garden	\$8,750	\$4,800	\$107,625,000	\$59,040,000
Infiltration Trench	\$28,600	\$15,560	\$351,780,000	\$191,388,000
Rain Cistern	\$7,500 –	\$4,500 -	\$92,250,000	\$55,350,000
	\$16,500	\$9850	-	-
Permeable Pavers	\$25,000	\$14,000	\$307,500,000	\$172,200,000

## **Prioritization and Project Ranking**

Problem areas that were reported by municipalities were weighted as a higher priority than problem areas reported by individual residents on the flooding questionnaires. The municipal-reported problems generally included areas that impacted multiple homes, resulted in property damage, and resulted in traffic impacts. The individual-reported problems generally included areas that only impacted a single resident; very few individual-reported problem areas were located adjacent to or close to a second individual-reported problem area.

### **Prioritization of Alternatives for Municipally-Identified Problem Areas**

Project alternatives within the municipal-identified problem areas are prioritized as shown below. Generally, the projects with the lowest cost-per-structure benefitted are prioritized highest, but some projects also receive a high ranking due to current funding opportunities, or a larger number of structures benefitted. The specific ranking was determined using the following criteria:

- *Immediate:* These two projects are located in areas with planned roadway improvements.
- *High:* These are projects that benefit more than 30 structures with a cost less than \$200,000 per structure benefitted (based on removing water adjacent to a home's foundation).
- *Medium:* These are projects that benefit less than 30 structures with a cost less than \$200,000 per structure benefitted (based on removing water adjacent to a home's foundation).
- *Medium-Low:* These are projects that cost less than \$500,000 per structure benefitted, or, cost more than \$500,000 per structure benefitted but benefit more than 10 structures.
- *Low:* These are projects that cost more than \$500,000 per structure benefitted and benefit fewer than 10 structures.

**Table 67 – Project Prioritization**

Alternative	Subwatershed	Community	Cost Estimate, Constructed as a Stand-Alone project	Cost Estimate, Constructed in Conjunction with Roadway Project	Max. No. Benefiting Structures (No.)	Cost Per Structure Benefitted (Stand-Alone Project)	Cost Per Structure Benefitted (Constr. with Road Project)	Priority
NQSRTRobRd-med	Lucas Ditch	Hickory Hills, Palos Hills, Bridgeview, Justice	\$31,250,000	\$26,630,000	187	\$167,000	\$142,000	Immediate*
Alt L	Lucas Div. Ditch	Hickory Hills	\$10,190,000	\$8,110,000	25	\$408,000	\$324,000	Immediate*
Alt B-med	71st St Ditch	Justice	\$2,940,000	\$2,190,000	40	\$74,000	\$55,000	High
Alt F	79th Street Sewer	Justice	\$28,460,000	\$21,890,000	184	\$155,000	\$119,000	High
Alt C	Justice Ditch	Justice	\$2,010,000	\$1,670,000	31	\$65,000	\$54,000	High
Alt E	Justice Ditch	Unincorporated	\$4,200,000	\$3,800,000	49	\$86,000	\$78,000	High
Alt O	Lucas Ditch	Hickory Hills	\$140,000	\$140,000	1	\$140,000	\$140,000	Med
Alt P	Lucas Ditch	Palos Hills	\$500,000	\$500,000	2	\$250,000	\$250,000	Med
Alt D & G	71st St Ditch	Bridgeview & Justice	\$15,520,000	\$13,540,000	47	\$330,000	\$288,000	Med
Alt U	Lucas Ditch	Palos Hills	\$2,150,000	\$2,150,000	8	\$269,000	\$269,000	Low-Med
Alt X	Lucas Ditch	Hickory Hills & Palos Hills	\$1,570,000	\$1,570,000	4	\$393,000	\$393,000	Low-Med
Alt A	71st St Ditch	Justice & Bedford Park	\$31,720,000	\$31,670,000	24	\$1,322,000	\$1,320,000	Low-Med
Alt Y	71st St Ditch	Bridgeview	\$17,520,000	\$15,590,000	17	\$1,031,000	\$917,000	Low-Med
Alt V	Lucas Ditch	Palos Hills & Unincorporated	\$270,000	\$270,000	1	\$270,000	\$270,000	Low-Med
Alt H	79th Street Sewer	Justice	\$1,810,000	\$1,660,000	3	\$603,000	\$553,000	Low
Probs I&W	79th Street Sewer	Justice, Hickory Hills	\$7,600,000	\$7,110,000	6	\$1,267,000	\$1,185,000	Low
Alt J	79th Street Sewer	Justice	\$1,320,000	\$1,320,000	1	\$1,320,000	\$1,320,000	Low
Alt M	Lucas Div. Ditch	Hickory Hills	\$5,370,000	\$4,500,000	3	\$1,790,000	\$1,500,000	Low

*\*Refer to the discussion below for additional information on why these alternatives were selected as an immediate priority.*

Additional Considerations for Municipally-Identified Projects

The additional items should be taken into consideration when evaluating the prioritization and when evaluating each Alternative.

*Alternative NQSRTRobRd-med:* Cook County Department of Transportation is planning improvements to Roberts Road in the immediate future. Work on Roberts Road could be incorporated into CCDOTH’s plans. Although the specific recommendation does not include the proposed sewer replacement project on Roberts Road itself, if additional funds are available and/or if CCDOTH is planning to replace the sewer, then Alternative RobRd should be added to provide the additional house protection. Other elements of the project include some storm sewer work on Roberts Road associated with Alternative L,

which should be included in the CCDOTH plans. In addition to the immediacy of the CCDOTH project, this Alternative protects a large number of homes at a relatively low cost per structure benefitted.

Construction of this alternative can be staged over a multi-year period, as funding is available.

- It is recommended that Alternative S and N be constructed first, and especially the work on Roberts Road associated with Alternative N.
  - Alternative S is the most important alternative because it reduces flows to Lucas Diversion Ditch, while lowering elevations enough to reduce frequent structure flooding between Roberts Road and Lucas Diversion Ditch. It is also necessary to complete this alternative before Alternative RobRd (if this portion of the Alternative is selected for implementation) because a piece of Alternative RobRd brings additional flow from the Roberts Road system to the Lucas Diversion Ditch.
  - Note that Alternative S was identified as having a medium probability for acceptance by a CCDD facility. Environmental testing is necessary to determine the soil characteristics. If some material requires haul-off to a Subtitle D Landfill, the cost of this option would increase.
  - Alternative N is a high priority piece of this alternative because it reduces flows to an undersized Roberts Road storm sewer system and also to the Lucas Ditch. It also reduces overflows from the Hickory Hills Golf Club property that frequently damages structures near Roberts Road and 99th Street.
- Alternatives R, T and Q should be completed next, because they improve conveyance capacity through both Lucas Ditch and Lucas Diversion Ditch, which will reduce structure damage from overbank flooding.
- If the full RobRd alternative is not selected, it would still be beneficial to add additional inlet capacity into the existing Roberts Road storm sewer system, through use of high capacity inlet grates and/or additional inlets to the existing laterals, if feasible under the proposed CCDOTH plans.

In summary, Alternative priorities N and S provide additional storage volume to greatly reduce peak flows at the upstream end of both major ditches while Alternative priorities R, T and Q increase conveyance capacity within the systems and finally, construction of Alternative priority RobRd reduces or eliminates overflows between the watersheds.

*Alternative L:* The Illinois Tollway is beginning master planning and conceptual design of I-294 improvements. The southern end of their improvement section is 95<sup>th</sup> Street, where significant new storage and sewer improvements are proposed. Although this Alternative has a relatively high cost per structure benefitted, many of the benefitted structures are commercial properties. The alternative reduces the flooding situation on 95<sup>th</sup> Street, which currently restricts access to I-294 during large storms. The traffic benefit of this alternative is substantial, and not quantified in the table. Note that Alternative L was identified as having a medium probability for acceptance by a CCDD facility. Environmental testing is necessary to determine the soil characteristics. If some material requires haul-off to a Subtitle D Landfill, the cost of this option would increase.

*Alternative F:* The total cost of Alternative F is large. This project includes installation of new storm sewer on many residential blocks. This project can be phased over time, in conjunction with planned roadway improvement projects, and as funds are available.

*Alternative D & G:* Construction of this alternative can be staged over a multi-year period, as funding is available. Note that this alternative was identified as having a medium probability for acceptance by a

CCDD facility. Environmental testing is necessary to determine the soil characteristics. If some material requires haul-off to a Subtitle D Landfill, the cost of this option would increase.

*Alternative A:* This alternative includes excavation of a large stormwater storage facility. The alternative benefits 24 structures, but the cost per structure benefitted is high, primarily due to the cost of earthwork. If there is a location to place excavated material without requiring a haul-off, then the total cost of this alternative could be reduced, and the cost per structure benefitted may be more feasible. Furthermore, there are approximately 29 homes that are not damaged by flooding, but access to the home is cut off by flooded roadways. If these homes were included in the “structure benefitted” calculation, the cost per structure benefitted would be reduced, but still greater than \$500,000. Conversely, the proposed storage location was identified as having a low probability of acceptance by a CCDD facility, which could mean that some material would need to be hauled to a Subtitle D Landfill at a greater cost, which would then make the total cost, and cost per structure benefitted, higher. A detailed CCDD analysis including soil sampling would be required to know for certain.

*Alternative Y:* Construction of this alternative can be staged over a multi-year period, as funding is available. Note that Alternative Y was identified as having a medium probability for acceptance by a CCDD facility. Environmental testing is necessary to determine the soil characteristics. If some material requires haul-off to a Subtitle D Landfill, the cost of this option would increase.

*Alternative H:* This alternative includes lowering the normal water elevation of an existing detention basin. The cost assumes earth excavation will be necessary, which has driven up the cost of this alternative. If the normal water level can be lowered without excavation (for example, by modifying an existing restrictor and/or outlet pipe), the cost could be reduced, and this may become a more cost effective alternative. Note that Alternative H was identified as having a medium probability for acceptance by a CCDD facility. Environmental testing is necessary to determine the soil characteristics. If some material requires haul-off to a Subtitle D Landfill, the cost of this option would increase.

#### Prioritization / Recommendations of Residential Scale Alternatives

Stormwater GI and BMPs are shown to have a benefit, if constructed on a widespread basis across the study area. Continued outreach to the public, and public education, is recommended to encourage private property participation in stormwater improvements. It is recommended that funding or grant source be identified to provide financial assistance to homeowners who wish to implement this measure. This has a twofold benefit: increased participation in providing GI/BMPs, as the funding helps people overcome the cost barrier associated with implementation; and a grant or cost assistance program provides a means through which the MWRD or municipality can inspect the GI/BMP to ensure proper placement and installation.

#### Other Recommendations

The municipalities and CCDOTH are encouraged to consider stormwater improvements with any type of capital improvement project. The cost to add storage to a project is much lower when it is a part of another CIP. The results of the watershed-wide analysis of BMPs/GI is based on participation of both homeowners (to install BMPs/GI on their individual lots) and municipalities (to install BMPs/GI within the rights of way.) All right of way projects should include storage elements, such as larger pipes under the street, permeable pavement with stone storage where appropriate, or bioswales along the parkway.

Larger storage volumes should be incorporated in public and private development projects where possible; for example, instead of providing only the minimum storage to meet detention requirements,

additional storage should be provided for a flood control benefit, when land is available and when sufficient tributary runoff is available to fill the new storage spaces.

In general, it was found that inlet capacity was lacking on most storm sewer systems, resulting in bypass flow running down the street and collecting in low areas, leading to damages at homes in those low areas. Replacing all inlets with higher capacity inlets is recommended, either as a stand-alone retrofit project, or to be incorporated into roadway plans as roadways are rehabilitated or reconstructed.

#### Prioritization of Alternatives for Individual-Reported Problem Areas

Individual-reported problems (from the questionnaire) were prioritized as high, medium and low priority problems as follows:

- *High priority individual problems* were those that reported flooding of the first floor of the home;
- *Medium priority individual problems* were those that reported basement flooding; these were separated into medium priority problem areas resulting from sanitary backup (as reported on the questionnaires) and medium priority problem areas resulting from overland flow entering a basement via window wells, windows, doors, etc.;
- *Low priority individual problems* were those that reported basement flooding as a result of sump pump failure, seepage, or foundation cracks; and those that reported yard or street flooding, or other non-structural flooding.

The high priority and medium priority (due to overland flow) individual-reported problem areas were reviewed and analyzed qualitatively to create a catalog of individual problem reports, preliminary/conceptual assessment of cause, and a conceptual identification of alternatives to reduce the problem. These alternatives AA – BZ are included in Appendix D. The alternatives are not ranked, and can be prioritized by each municipality based on their knowledge of whether the problem remains, resident willingness to cooperate in the solution, and municipal funds and resources.

Alternatives for medium priority individual-reported problem areas that are a result of sanitary sewer backup are discussed in Appendix E.

Many of the “solutions” to mitigate these residential, single lot problems involve residential-scale Gi or BMPs. It is recommended that the “private property assistance program” described earlier in this report be formed, to provide residents a means to formally seek assistance in identifying their problem, and understanding what the proper next steps are.

## **Real Estate, Utilities, and Permitting Considerations**

### **Real Estate Considerations**

Many of the projects require stakeholder coordination and cooperation, particularly with respect to real estate considerations. Most of the proposed storage locations are not on public property, due to a lack of open public spaces available for storage. Property purchase and/or easements will be required to use the spaces described below. In all cases, the current use of the open space was considered and the proposed storage was designed to reduce impacts to the space to the extent possible, but the exact location and shape of the storage area can be tweaked to better suit the needs of the property owners. There may be an opportunity for the MWRD to assist with other improvements desired by the property owners, in exchange for using the vacant lands for storage, to create a win-win situation for the property owners.

### **Permanent Impacts**

Alternatives A, D, G, F, I, and W include proposed storage on space that appears to be unused on local cemeteries. Coordination with the Archdiocese of Chicago, Bethania Cemetery, Mount Glenwood Memorial Gardens and/or Archer Woods Memorial Park Cemetery will be required. The MWRD has had success working with the Archdiocese of Chicago to construct proposed stormwater projects on cemetery spaces in other areas of Cook County.

Alternatives A, H, J, L.2, M, S, and X include proposed storage on spaces that are owned by industrial and commercial property owners. Coordination with these property owners will be required. If the property owner had identified a future expansion into the open space, or to use the open space for future stormwater detention needs, then it may be possible to provide the proposed storage underground in an underground storage reservoir (at a much higher cost), or to provide the anticipated stormwater detention in conjunction with the proposed flood storage.

Alternatives L.2, M, RobRd, R, and T, include proposed storage within the ComEd right-of-way. Coordination will be required with ComEd and with the other utilities that have easements to use the corridor, to make sure the proposed storage use meets the requirements of the other utilities. MWRD and V3 have had success working with ComEd to create new storage within existing ROWs elsewhere in the Chicagoland area.

Alternatives C, L.1, N, and P include proposed storage within municipal Park District property, and/or impact existing Park facilities. Coordination with these municipal entities will be required to ensure all user needs are being met.

Alternatives F and N include proposed storage on existing golf courses and driving ranges. The proposed storage was designed to fit into the existing course operations with fewest impacts, but proposed storage locations and shapes can be revised to fit future golf course plans and operations.

Alternative L2 proposes storage on Tollway and/or IDOT right of way. Coordination will be required with these agencies to use their ROW for the proposed regional benefit, and to ensure that the proposed storage can be constructed along with planned roadway expansion projects.

Alternatives H, J, and X require storage or other use of existing single family residential properties. These properties would need to be acquired. The estimated cost of these properties is based on a Zillow estimate from January 2016.

## Temporary Impacts

Temporary construction easements may be required for several alternatives. In situations where an existing storm sewer or culvert would be replaced with a larger one, impacts were considered temporary. In these situations, temporary construction easements would likely be required.

Ownership of land along and adjacent to waterways was difficult to determine (such as the I&M Canal, Lucas Ditch, Stony Creek, Lucas Diversion Ditch, and other unnamed ditches) as there are typically no PIN numbers associated with these lands. Ownership of the “right-of-way” of the waterway would need to be determined, and the appropriate coordination with the owner would need to take place to pursue the proposed regrading and dredging of the waterways.

Alternatives A, C, I, W, M, O.1, Q.2, and S would require both a temporary easement for construction access and a permanent utility easement, as there is proposed storm sewer on the property. These proposed storm sewers are located in areas where they would not impact structures or the general use of the property. Hence, a permanent utility easement may be appropriate, rather than complete acquisition of the property.

## **Utility Considerations**

Many of the proposed improvements will impact existing utilities. The proposed designs sought to avoid these impacts to the greatest extent possible, but the designs were based on limited available data. For example, project alternative L2 is located at the interchange of I-294 and 95<sup>th</sup> Street. We are aware of three gaslines running through the I-294 ROW in this vicinity. Plans were obtained from the pipeline companies but gaslines were only shown conceptually on the gas plans. The ponds were located to avoid utilities based on information available, but pond locations may need to be adjusted after exploratory utility potholes are obtained and exact inverts and horizontal locations are made known.

Similar utility considerations and explorations will be required for other proposed alternatives, particularly the alternatives that include very large diameter pipes, as there is a higher likelihood for a large diameter pipe to conflict with an existing utility (versus a smaller diameter proposed pipe). If a utility conflict is identified, it could be mitigated in several ways, dependent on the nature of the conflict: by shifting the location of the proposed storm sewer; by changing the material of the proposed storm sewer; by constructing a proposed siphon at the crossing; or by relocating the existing utility. Existing utility services may also be impacted by proposed alternatives, and may require replacement or reconnection.

## **Permitting Considerations**

Each proposed alternative was reviewed to determine the expected permit requirements associated with the project. Permits may be required from the following agencies:

- Illinois State Tollway Approval/Permit required for work in Tollway ROW
- Illinois Department of Transportation Approval / Permit required for work in IDOT ROW, or for constructing a storage basin adjacent to IDOT ROW
- CCDOTH Approval / Permit required for work on a CCDOTH roadway
- Illinois Department of Natural Resources (IDNR) Floodway Construction Permit required for work in a mapped or unmapped floodway
- IDNR Dam Modification permit, for work on an existing dam or increasing storage capacity behind an existing dam

- MWRD Floodplain Permit required for work in the FEMA floodplain or for work in the MWRD inundation area (as defined in the DWP)
- MWRD Approval required for modifications of an existing stormwater detention permit, for modifications to an existing detention facility
- FEMA CLOMR/LOMR could be pursued to remap (remove) floodplain in areas that could see a benefit in the flood insurance premiums through construction of the proposed improvements
- Municipal approvals required for work within each municipality
- CCDD evaluation required for all projects that include disposal of clean construction and demolition debris

These are summarized in Table 68 below. Note this table excludes wetland permits, which are discussed in the Wetland section of this report and in Appendix H. This table also excludes permits which are anticipated for every project, such as the Illinois Environmental Protection Agency (IEPA) Permit to discharge stormwater runoff from a construction site.

**Table 68 – Anticipated Permit Requirements**

Permit Type	A	B	C	D	G	E	F	H & J	I & W	Y	L. 1	L. 2	M	N	O	P	Q. 1	Q. 2	Rob-Rd	R & T	S	U	V	X
Illinois State Tollway Approval/Permit required							X					X												
IDOT Approval / Permit required	X				X	X	X					X											X	
CCDOH Approval / Permit required				X	X						X			X			X	X				X		
IDNR Floodway Construction Permit required	X		X										X	X			X	X	X	X			X	
MWRD Floodplain Permit required	X	X	X										X	X			X	X	X	X	X	X	X	
MWRD Approval required for possible modification of an existing stormwater detention permit		X	X	X		X	X	X	X			X		X		X						X		X
FEMA CLOMR/LOMR could be pursued to remap (remove) floodplain	X	X	X										X	X			X	X	X	X	X	X	X	
IDNR Dam Permit									X															
<b>Municipal Approvals</b>																								
Bedford Park	X																							

Permit Type	A	B	C	D	G	E	F	H & J	I & W	Y	L. 1	L. 2	M	N	O	P	Q. 1	Q. 2	Ro b-Rd	R & T	S	U	V	X
Bridgeview				X	X					X		X								X	X			
Hickory Hills								X	X		X	X	X		X				X					X
Justice	X	X	X	X			X	X	X															
Palos Hills														X		X	X	X	X	X		X	X	X
Unincorporated						X																	X	
CCDD certification																								