Master Stormwater Management Plan (MSMP) Addendum #3

ERA Project #W23030.00

Prepared For:
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Master Stormwater Management Plan Addendum #3

It shall be noted that the recommendations presented in this addendum are based on the best available information provided at the time of the master plan analysis. The recommended projects and costs are conceptual and preliminary in nature and should only be used for planning purposes. Before moving forward with any of the recommended projects, a field survey shall be conducted to verify existing conditions analysis, to verify the level of service of the recommended projects, and to produce refined cost estimates.

ACRONYMS

BCA – Benefit Cost Analysis
BCR – Benefit - Cost Ratio
CIP – Capital Improvement Plan
CRS – Community Rating System
EOPCC – Engineer's Opinion of Probable Construction Cost
ERA – Engineering Resource Associates, Inc.
FEMA – Federal Emergency Management Agency
GI – Green Infrastructure
GIS – Graphical Information System
HGL – Hydraulic Grade Line
IDNR-OWR – Illinois Department of Natural Resources/Office of Water Resources
IDOT - Illinois Department of Transportation
IEMA – Illinois Emergency Management Agency
IEPA – Illinois Environmental Protection Agency
ISWS – Illinois State Water Survey
LiDAR – Light Detection and Ranging
LOS – Level of Service
MSMP – 2011 Master Stormwater Management Plan
MWRDGC – Metropolitan Water Reclamation District of Greater Chicago
NCSWCD – North Cook Soil and Water Conservation District
NFIP – National Flood Insurance Program
NPDES – National Pollutant Discharge Elimination System
SWMP – 1993, 1996, and 2002 Stormwater Management Plan
USACOE– US Army Corps of Engineers
WMO – Cook County Watershed Management Ordinance
WMA – Watershed Master Plan
WSEL – Water Surface Elevation

INTRODUCTION

The Village of Northbrook formed a Stormwater Management Commission to review flooding problems throughout the Village. Through the recommendation of the Commission, a new Master Stormwater Management Plan (MSMP) was established in 2011. The MSMP identified twenty-two locations where stormwater remediation projects would reduce the probability and frequency of flooding in the Village. The MSMP defined the following hierarchy of priority:

1. Reduction in structure damage due to stormwater flooding
2. Reduction in flooding of streets or front yards causing limited access for emergency responders
3. Reduction in rear and side yard flooding
4. Manage development/redevelopment to reduce flooding

Subsequently, Addendum #1 in 2012 and Addendum #2 in 2015 were approved, adding nine more locations where flooding problems were mitigated. Over the course of the seven years since the last Addendum was approved, additional flooding locations were identified and the Commission's interest in creating a third addendum to the MSMP grew. A total of thirty-four locations of flooding concern were identified for consideration in this addendum. The Commission vetted the flood prone locations using the hierarchy of priority set forth in the MSMP which resulted in eight priority locations for analysis in Addendum #3. This Addendum #3 report is an extension of Addendum #1 and Addendum #2.

The eight locations identified for analysis in the MSMP Addendum #3 are listed below and shown in Figure 1:

- Study Location 12 – Wescott Road / Oak Avenue / Maple Avenue
- Study Location 13B – Marcee Lane
- Study Location 11 – Jeffery Courts / Woodhill Drive
- Study Location 13A – Woodbine Lane
- Study Location 10 – Sunset Lane
- Study Location 33 – Longvalley Drive
- Study Location 1 – Koepke Road
- Study Location 5 – Bordeaux Drive

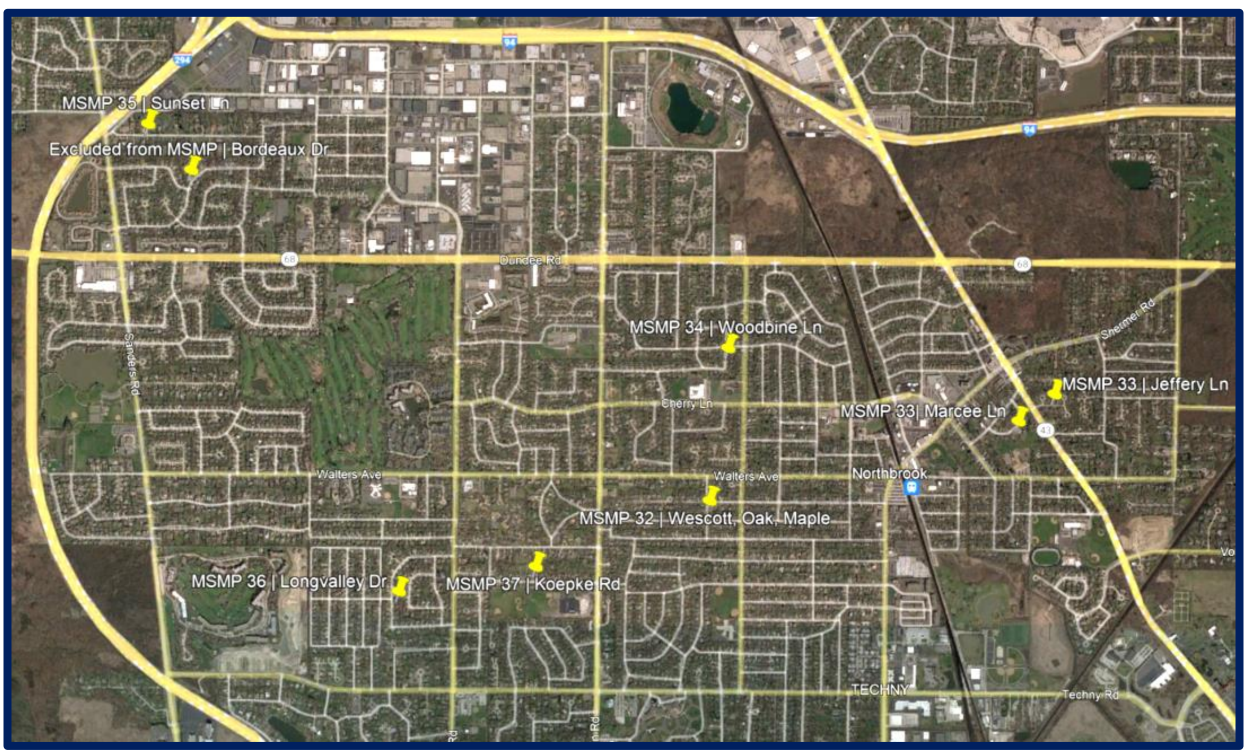

Figure 1: Locations of the eight study areas included in the MSMP #3 Addendum.

Table 1 below summarizes annual rainfall totals as well as highlights significant monthly totals and significant rainfall events since the last Addendum was completed in 2015. Also in Table 1 is the Normal Precipitation, which is the historical average monthly and annual rainfall.

Table 1: Historic Rainfall Data in Northbrook; data collected from US Climate Data and Weather Sentry/DTN.

Year	Total Precipitation (inches)	Normal Precipitation (inches)	Significant Rainfall Events Date and Rainfall Depths
2015			
April	3.16	3.58	rain event 04-10-15 of 1.85 inches rain
June	6.10	3.86	rain event 06-16-15 of 1.45 inches rain
2015 Total	30.92	37.10	
2016			
June	4.57	3.86	rain event 06-23-16 of 1.59 inches rain
July	4.65	3.50	rain event 07-24-16 of 2.71 inches rain
2016 Total	33.27	37.10	
2017			
April	5.25	3.58	rain event 04-30-17 of 1.53 inches rain
May	4.67	4.01	rain event 05-01-17 of 1.33 inches rain
June	5.88	3.86	rain event 06-14-17 of 1.69 inches rain
			rain event 06-28-17 of 1.89 inches rain
July	7.52	3.50	rain event 07-12-17 of 3.28 inches rain
October	8.18	2.70	rain event 10-14-17 of 3.27 inches rain
2017 Total	42.21	37.10	
2018			
May	8.04	4.01	rain event 05-02-18 of 1.73 inches rain
			rain event 05-14-18 of 1.72 inches rain
			rain event 05-21-18 of 1.59 inches rain
June	9.75	3.86	rain event 06-09-18 of 3.72 inches rain
			rain event 06-26-18 of 1.45 inches rain
August	6.55	4.84	rain event 08-28-18 of 1.76 inches rain
September	4.55	3.24	rain event 09-03-18 of 1.97 inches rain
October	4.28	2.70	rain event 10-01-18 of 1.05 inches rain
2018 Total	46.88	37.10	
2019			
May	6.20	4.01	rain event 05-01-19 of 0.91 inches rain
June	4.76	3.86	rain event 06-12-19 of 0.86 inches rain
July	6.55	3.50	rain event 07-18-19 of 2.30 inches rain
			rain event 07-21-19 of 2.24 inches rain
September	7.52	3.24	rain event 09-13-19 of 1.93 inches rain
2019 Total	44.08	37.10	
2020			
April	4.04	3.58	rain event 04-29-20 of 1.71 inches rain
May	7.35	4.01	rain event 05-17-20 of 2.76 inches rain
2020 Total	35.73	37.10	
2021			
June	5.63	3.86	rain event 06-25-21 of 1.86 inches rain
October	6.01	2.70	rain event 10-24-21 of 1.71 inches rain
2021 Total	25.17	37.10	
2022			
April	4.93	3.58	rain event 04-22-22 of 1.26 inches rain
May	4.08	4.01	rain event 05-03-22 of 1.12 inches rain
July	5.48	3.50	rain event 07-23-22 of 1.47 inches rain
2022 Total	32.59	37.10	
2023			
February	3.44	1.56	rain event 02-22-23 of 1.09 inches rain
March	3.31	2.50	rain event 03-31-23 of 1.09 inches rain
April	2.77	3.58	rain event 04-04-23 of 1.11 inches rain
2023 Total (through May)	12.22	13.50	

The Village of Northbrook (Village) contracted Engineering Resource Associates, Inc. (ERA) to prepare the third addendum to the Master Stormwater Management Plan. The existing conditions for each of the eight study locations were evaluated to determine the existing level of service, as well as impacts to structures and properties which see benefits from proposed projects. Proposed alternatives for each study location were analyzed to produce preferred proposed projects for each of the eight study locations. ERA estimated construction and engineering costs for each of the preferred alternatives and weighed the total estimated project cost against their benefits to produce a ranked list of recommended projects as shown in Table 2 below. When a project was recommended for a study location, a MSMP project number was assigned to it. Not all study locations included a recommended project.

The same methodology for ranking projects from the previous MSMP addendums was used to rank the projects in Addendum #3. From the eight studied locations, six projects are recommended and assigned a MSMP project number per the rankings table below. Study Location 5 did not include a recommended project. Study Locations 11 & 13B were combined into a single recommended project due to proximity and storage needs for both. The non-prioritized locations were reviewed in relation to the eight study locations and will be considered in future plans. This report provides a summary of the complete analysis performed to produce the ranked list of recommended projects and includes guidance for project implementation.

MSMP ADDENDUM #3 PROJECT PRIORITIZATION SUMMARY

Table 2: MSMP Addendum #3 Project Prioritization*

Project Prioritization	Project Number	Study Location	Street(s)	Level of Service	Structures Benefited	Properties Benefited	EOPCC
1	MSMP 32	12	Wescott Rd / Oak Ave / Maple Ave	10-yr	10	14	$ 2,378,000
2	MSMP 33	13B & 11	Marcee Ln & Jeffrey Cts / Woodhill Dr	10-yr	7	13	$ 4,463,000
3	MSMP 34	13A	Woodbine Lane	10-yr	4	17	$ 3,402,000
4	MSMP 35	10	Sunset Lane	10-yr	4	12	$ 794,000
5	MSMP 36	33	Longvalley Drive	10-yr	1	6	$ 1,138,000
6	MSMP 37	1	Koepke Road	10-yr	1	2	$ 1,181,000
7	N/A	5	Bordeaux Drive	10-yr	0	3	$ 222,000

*Full Table located on Page 51 and in Appendix D

The level of service is defined as the storm event for which a project can provide benefits to the impacted properties. It is categorized by the likelihood of storm occurrence in any given year. Colloquially called the "10-year storm", it has a 1 in 10 (10%) chance of occurring any given year. A "100-year storm" would have a 1 in 100 (1%) chance of occurring in any given year, a "2-year storm" a 1 in 2 (50%) chance, and in such manner for other storm events. A 10-year level of service is proposed for all projects, meaning each project can reliably provide benefits to the study location's impacted properties in the 10-year storm, which is consistent with previous addenda.

It shall be noted that the proposed projects will not see the same benefits during less frequent storm events (4% / 25-year storm, 2% / 50-year storm, 1% / 100-year storm) as they were designed with a level of service for the 10-year / 10% frequency storm. For example, a 100-year storm occurring over a study location after a recommended project was constructed would see the same number of impacted structures as in the 100-year storm pre-project.

STUDY LOCATION ANALYSIS

ERA produced hydraulic and hydrologic modeling to analyze deficiencies in the existing stormwater system for each of the eight priority study locations. With additional proposed conditions modeling, ERA produced proposed projects that provide a 10-year level of service at each of the priority study location areas. A 10-year level of service was selected to maintain consistency with previously recommended projects from the MSMP and MSMP addendums.

ERA prepared cost estimates for each of the proposed projects. Benefits were estimated utilizing Assessor's data to tabulate potential damage to properties and structures impacted in the existing conditions that will see improvements from the recommended projects. The benefits were compared to the estimated costs for each proposed project to produce a benefit cost ratio (BCR). The higher the BCR, the more benefits are realized in relation to the project's estimated cost. A combination of the benefit cost ratios, number of properties benefited, and number of structures benefited for each project were scored to produce a ranked list of projects consistent with methodology used in the past addenda. When a proposed project was recommended for a study location, the project was assigned a MSMP project number where Addendum #2 left off. Not all study locations included a recommended project.

HYDRAULIC AND HYDROLOGIC MODELING

Existing Conditions

ERA had previously produced existing conditions hydraulic & hydrologic XPSWMM-2D models as part of the Metropolitan Water Reclamation District of Greater Chicago (MWRDGC) 2014 Northbrook Master Plan Pilot Study. The models from the pilot study were updated with new available information to create existing conditions models for each of the eight MSMP Addendum #3 priority study locations.

The following resources were used to construct updated existing conditions models for the eight MSMP Addendum #3 priority areas in XPSWMM-2D:

- GIS Data from Cook County
    - Cadastral data
    - 2017 LiDAR Topographic Data
    - 2021 Aerials
- GIS Data from the Village
- As-built plans and/or design plans from the Village for projects adjacent to each of the priority areas
- Resident flooding reports from Stormwater Management Commission Meeting Minutes
- Site visits for localized drainage issues
- Bulletin 75 rainfall depth data for northeastern Illinois & Huff distribution curves.

> Note that the previous MSMP and MSMP addendums utilized Bulletin 70 rainfall data from the Illinois State Water Survey (ISWS). Bulletin 75 includes updated rainfall data as published by the ISWS in March 2020. A comparison of rainfall depths for northeastern Illinois is shown in Table 3 located on the next page.

Table 3: Comparison of rainfall depths from Bulletin 70 & 75

	Bulletin 70 Rainfall Depths for NE Illinois (inches)		Bulletin 75 Rainfall Depths for NE Illinois (inches)	
	10-yr Freq.	100-yr Freq.	10-yr Freq.	100-yr Freq.
1-hr Duration	2.10	3.56	2.42	4.03
2-hr Duration	2.64	4.47	2.99	4.97
3-hr Duration	2.86	4.85	3.30	5.49
6-hr Duration	3.35	5.68	3.86	6.43
12-hr Duration	3.89	6.59	4.48	7.46
24-hr Duration	4.47	7.58	5.15	8.57

The hydraulic and hydrologic models used for analysis did not include the following items:

- Groundwater analysis
- Field survey
- Inlet capacity analysis
- Conditions of existing stormwater infrastructure (system assumed to be unclogged and fully functional)

Cook County's 2017 topographic information was imported into the XPSWMM-2D model to create a digital terrain model (DTM). The DTM is required to create the 2D surface grid needed to perform hydraulic computations for overland flows. The Village storm sewer GIS data did not include invert elevation data for *all* storm structures. When missing invert data in GIS, design or as-bult plans for adjacent projects were used to supplement missing invert data when possible. When no invert data could be found, engineering judgement was used to apply a standard minimum depth of cover over the provided storm sewer diameters. Cover depths and pipe diameters were subtracted from the rim elevations to estimate the invert elevations. A critical duration analysis was performed for each project area. The existing conditions 10-year and 100-year critical duration inundation limits for each of the priority areas can be found in Appendix A.

Proposed Conditions

The existing conditions models were used as a baseline to produce proposed alternative models for each of the eight priority areas. The preferred alternative for each of the study locations included a 10-year level of service for the critical duration storm. This is consistent with the level of service provided in the 2011 Master Stormwater Management Plan and subsequent addenda. The 10-year level of service design provides reliable benefits to the structures and properties impacted during the 10-year storm in existing conditions. In addition to benefits to structures and properties, all the projects, recommended or not, ultimately provide roadway vehicular accessibility for the 10-year storm, defined as roadway ponding of six inches (6") or less, for the properties impacted from the 10-year storm in existing conditions. All the proposed alternatives were evaluated for downstream impacts up to the 100-year storm and include detention volume as needed to attenuate flows. To be conservative in estimating costs, underground storage systems were proposed in all alternatives that required storage volume. This is consistent with recent MSMP projects that included volume storage.

COSTS

Engineer's Opinion of Probable Construction Costs (EOPCCs) were created for each of the proposed projects. 2023 DOTestimate for Illinois, recent bid tabs for similar construction done in Cook County in neighboring municipalities, and professional opinion of construction costs were utilized to prepare these estimates. Costs for easement or intragovernmental agreements were not included in the estimates. Cost estimates for pavement restoration are calculated assuming that only disturbances are to be replaced (patching) and not the full width of the roadway. Items incidental (landscape restoration, utility adjustments, etc.) to the main construction line items were estimated as best as possible from available information. Cost estimates shall be updated and refined as each project is implemented and field survey is acquired for final design. The cost estimates for each project can be found in Appendix B. These costs shall be revised as needed as market costs and demands fluctuate.

BENEFITS

ERA quantified the benefits of each recommended project and divided it by the total project cost to produce benefit-cost ratios (BCRs) for each project. The benefit analysis followed the methodology of previous addendums. A 10-year critical duration storm was used in all benefit analyses to be consistent with the level of service provided for the recommended projects in the previous addendums.

Structural benefits were counted at each building that was inside or touching the flooding limits in existing conditions and was outside of the flooding limits in the proposed model in the same level of service storm. Building outlines from GIS and aerial images added to the XPSWMM model were used to estimate this quantity. Property benefits were counted at each parcel inside or touching the flooding limits in existing conditions that are shown outside of the flooding limits in proposed conditions in the level of service storm. Cook County GIS parcel lines were imported into the XPSWMM model to estimate this quantity. ERA then identified each address impacted by the improvements and collected the building, land, and market values from the 2022 Cook County Assessor's website. In addition to the values, ERA collected the land area, building area and number of stories from the Cook County Assessor's website. For each address, ERA solved for the average land value per square foot and the average building value per square foot.

To estimate the structural benefit at each property, ERA started by estimating the footprint of the home based on the number of stories and total square footage. Then ERA multiplied the building footprint by the average building value per square foot. ERA assumed that up to fifty percent (50%) of this value could be damaged each 10-year storm event and that up to five, 10-year storm events could occur during the useful life (50-years) of the proposed storm sewers. This provided the structural benefit per house (cost savings) and those values were totaled to find the structural benefit predicted for each infrastructure improvement.

Similarly, ERA estimated the value of the property benefit by finding the ratio of the land value per square foot relative to an estimated cost per improvement (estimated to be $2.75 per square foot). ERA used that ratio and assumed up to thirty-five percent (35%) of each yard can be damaged every five years during the 10-year storm event for the duration of the useful life of the storm sewer improvements (50-years). This provided a monetary property benefit per parcel and those values were summed up to quantify the benefit at each proposed improvement.

The benefit analysis can also include items like amount of time a homeowner cannot use their back yard, ability to maintain the yard after rainfall events, cost for maintenance of the improvements, impact of inflation over time, elevations of low entries relative to the elevation of flooding, and many other factors. To provide the Village with enough information to prioritize the improvements with a uniform approach, ERA opted for the method described above and relied on the data available from the County Assessor's database. BCRs for grant applications may require additional demographic and elevation information for the properties benefiting from the proposed improvements.

RANKINGS

The same methodology for ranking projects from previous addendums was used in Addendum #3. Projects are ranked as the composite of rankings of three categories: benefit-cost ratios (BCRs), the number of properties benefited, and the number of structures benefited. The BCRs for each project were ranked numerically starting with a rank of one for projects with the highest BCR, a rank of two for the next highest BCR, and continuing the ranking of all projects in such a matter for the category. The number of structures benefited were ranked in a similar manner, with the projects with the highest number of structures benefited receiving a ranking of one for the category. Structures were considered benefited when existing inundation limits intersected or got in close proximity to primary residences, including attached garages. The number of properties benefited were also ranked in a similar matter, with the projects with highest number receiving a ranking of one for the category. Properties were considered benefited when existing inundation limits were located in the yards of properties, or additionally counted as a property benefited if the roadway ponded over six inches in front of a property in existing conditions. Ties are allowed in any category with the next highest scored project receiving the subsequent rank as if there was no tie. For example, if two projects had the same number of structures benefited, they may each have a rank of 2 for the category, with the project with the next highest number of structures benefited receiving a rank of 4.

The rankings from each category were averaged for each project to develop a composite score for the project. The lower the overall composite score, the higher the project ranks overall. If there is a same composite score for projects, the tiebreaker goes to the project with the highest number structures benefited, followed by the number of properties benefited. The complete Project Prioritization table can be found in Appendix D.

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PRIORITY STUDY LOCATION FACT SHEETS

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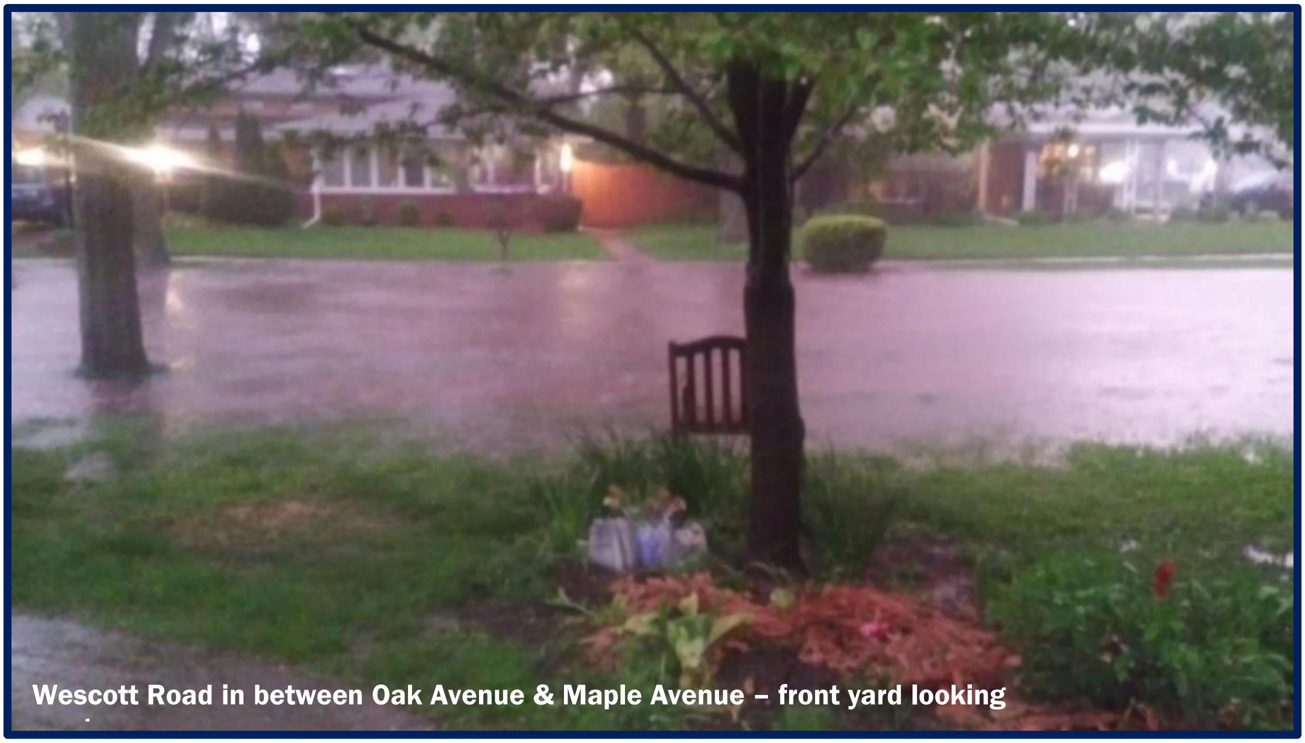
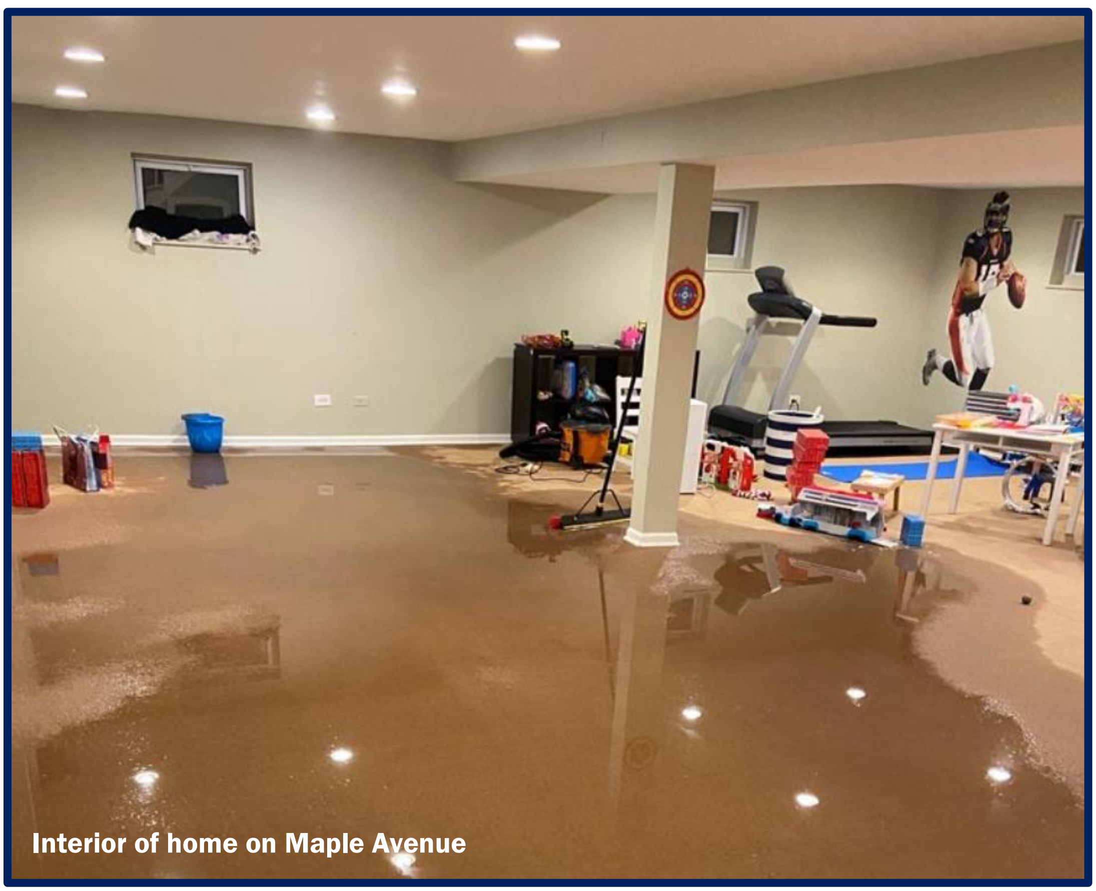
MSMP 32 | STUDY LOCATION 12 | WESCOTT RD / OAK AVE / MAPLE AVE | FACT SHEET



Wescott Road in between Oak Avenue & Maple Avenue – front yard looking

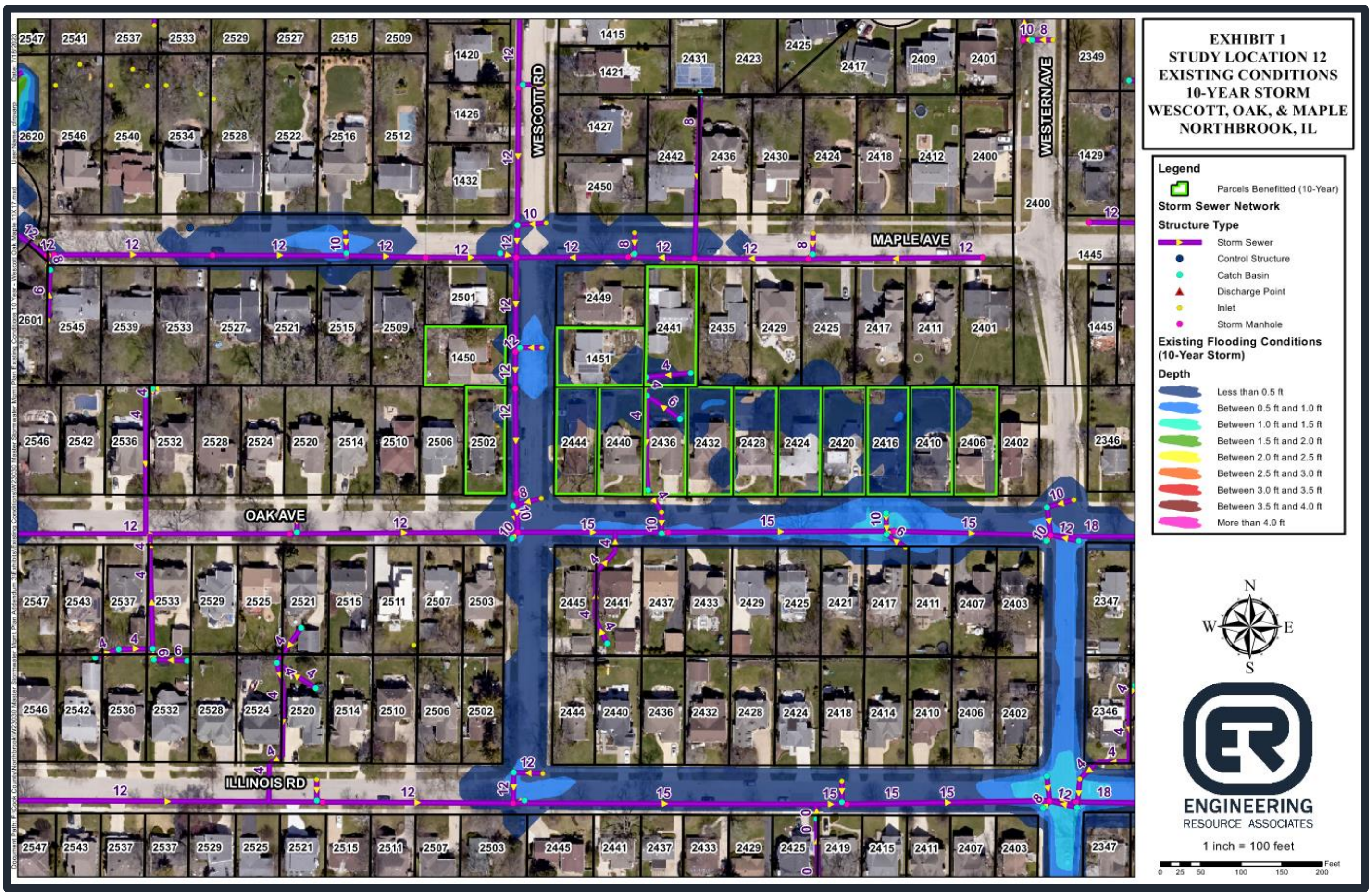


Interior of home on Maple Avenue

Existing Conditions Description

This study location is located in an older part of the Village with a grid system. Approximately 47 acres are tributary to a small depressional area on Wescott Road in between Oak Avenue and Maple Avenue. The storm sewer at this location does not have sufficient capacity, causing the depressional area on Wescott Road to pond and eventually flow overland east and pond through rear private yards.

The existing system has less than a 10-year level of service as ponding occurs in the rear yards due to Wescott Road overtopping and gets high enough to impact several structures and properties. Vehicular access is also impeded in several locations. Exhibit 1 below shows the existing conditions 10-year critical duration storm inundation limits. Full size existing conditions inundation exhibits, including the 100-year critical duration storm, can be found in Appendix A.

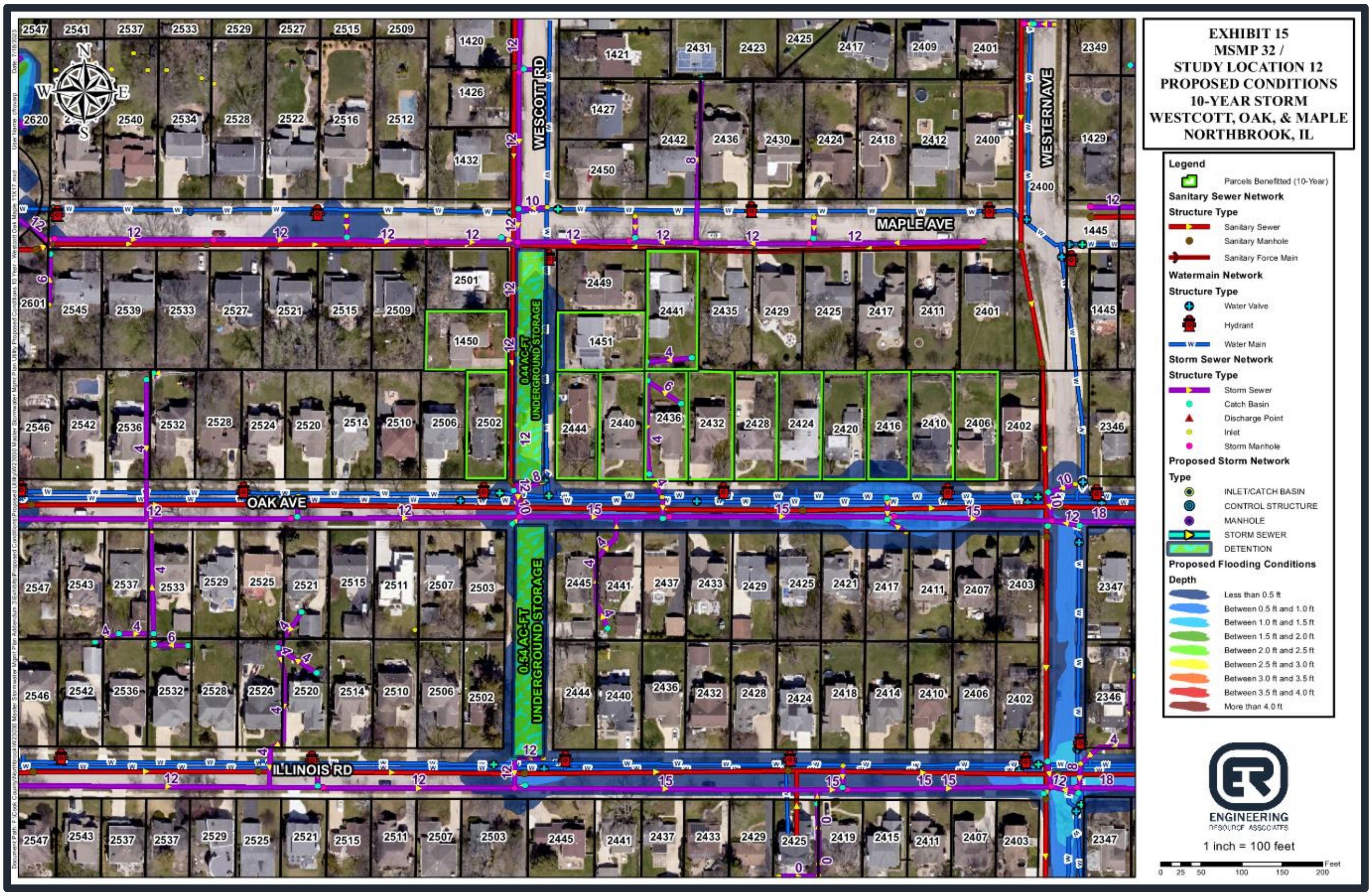


10-yr Existing Conditions Impacts

- Over 1-ft of ponding in roadway
- 10 properties with impeded vehicular access
- 10 structures impacted
- 14 properties with yards impacted

Recommended Project

The preferred alternative provides underground storage to reduce the surface storage that was creating impacts to adjacent structures and properties. Approximately 1 ac-ft of underground volume storage is provided on Wescott Road in two vaults. One vault is located in between Maple Avenue and Oak Avenue. The other vault is located in between Oak Avenue and Illinois Road. There are no downstream impacts as there are no conveyance improvements associated with the improvements. The proposed improvements are shown in Exhibit 15 below. This is a recommended project as it provides a 10-year level of service for an area where it was previously lacking, consistent with the recommended projects from the previous addendums. It is assigned project number MSMP 32. A full-size Exhibit 15, as well as the Preliminary Type, Size, & Location Plans of the recommended project, can be found in Appendix A.



Permits and Coordination

No outside permit or coordination are expected for this project.

Summary of Recommended Project Costs and Benefits

Project	Study Location	Street	Level of Service	BCR	Structures Benefited	Properties Benefited	EOPCC	Average Cost Per Structure	Average Cost Per Property
MSMP 32	12	Wescott Rd / Oak Ave / Maple Ave	10-yr	0.31	10	14	$ 2,378,000	$ 237,800	$ 169,900

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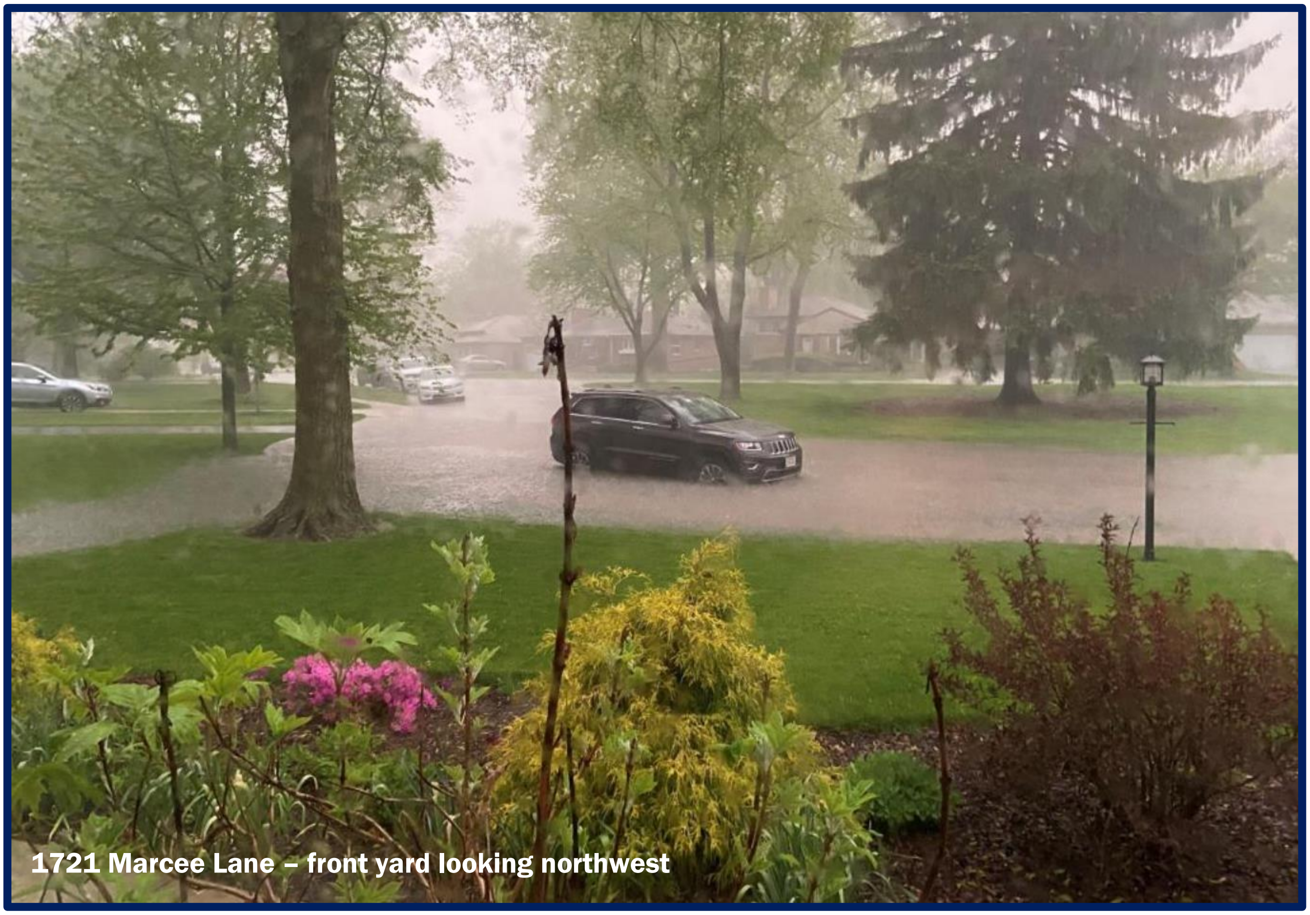
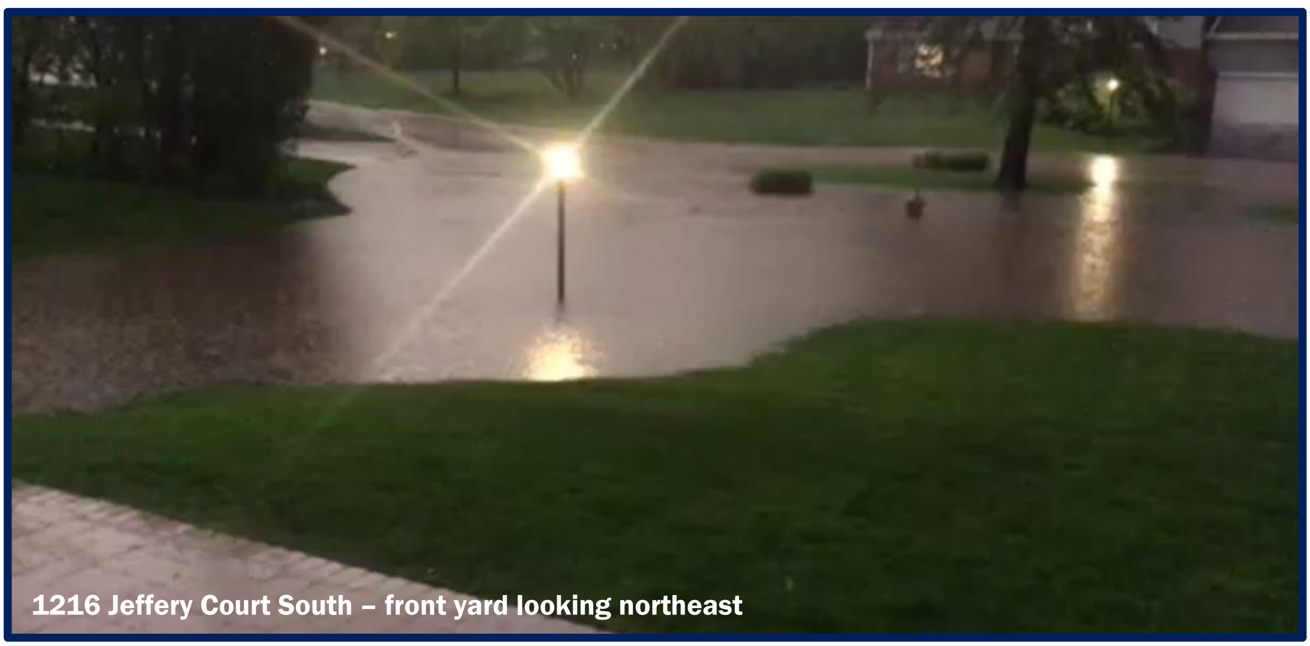
MSMP 33 | STUDY LOCATIONS 13B & 11 | MARCEE LN & JEFFREY CTS/WOODHILL DR | FACT SHEET



1721 Marcee Lane – front yard looking northwest

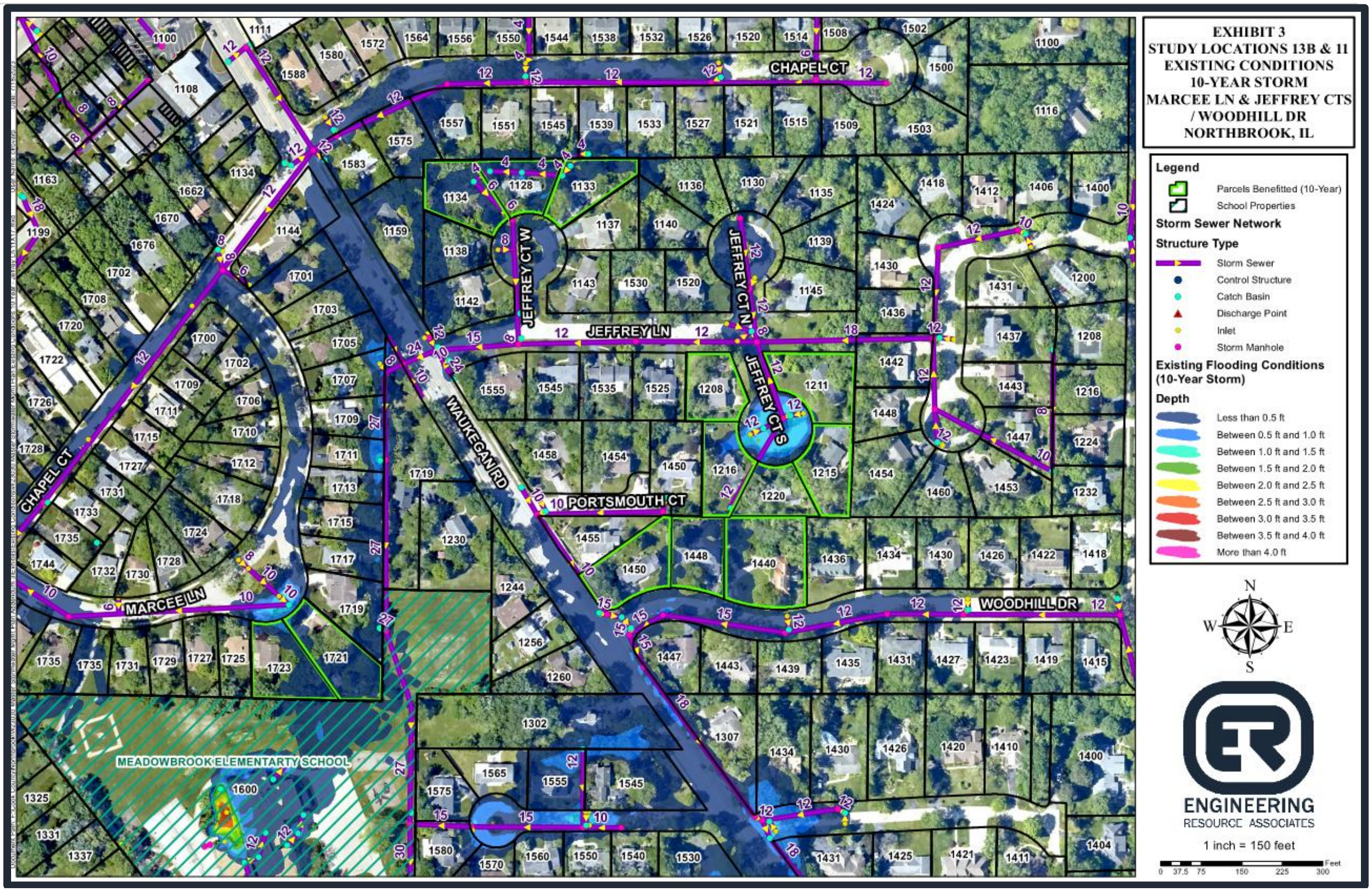


1216 Jeffery Court South – front yard looking northeast

Existing Conditions Description

Study locations 13B and 11 have been combined into a single fact sheet due to their proximity and since their proposed improvements each require storage volume to be provided in a shared detention system. Study location 13B is situated at the roadway bump out on Marcee Lane. There is a depressional area at this location with approximately 5 acres of tributary area that is served by a storm sewer. The storm sewer is undersized, and ponding occurs in the roadway depressional area. When ponding at this location gets high enough, flows head south overland through private side yards to the Meadowbrook Elementary School, which is a part of School District 28. The existing system has less than a 10-year level of service as the storm sewer lacks adequate capacity and ponding gets high enough to impact structures and properties. Vehicular access is also impeded due to the roadway ponding.

Study location 11 is centered near Jeffrey Courts South and West and Woodhill Drive. Jeffrey Court South is a low-lying cul-de-sac served by a storm sewer. When the storm sewer reaches its maximum capacity, the cul-de-sac begins to pond. When ponding at this location gets high enough, flows head south overland through private side yards towards Woodhill Drive. There is also a rear yard storm system on 1216 Jeffery Court South that surcharges towards the properties on Woodhill Drive due to the lack of adequate capacity in the cul-de-sac. An overland flow route along the northern rear lot lines of Jeffrey Court West has approximately two acres of tributary area. The flow route is poorly defined, causing flows to head through side yards of several homes. The existing system has less than a 10-year level of service as the ponding that occurs at Jeffrey Court South gets high enough to impact several structures and properties due to the undersized storm sewer. The overland flow route in the rear yards of Jeffrey Court West does not have sufficient capacity to contain flows. Vehicular access is also impeded in several locations. Exhibit 3 shows the existing conditions 10-year critical duration storm inundation limits for both study locations. Full size existing conditions inundation exhibits, including the 100-year critical duration storm, can be found in Appendix A.

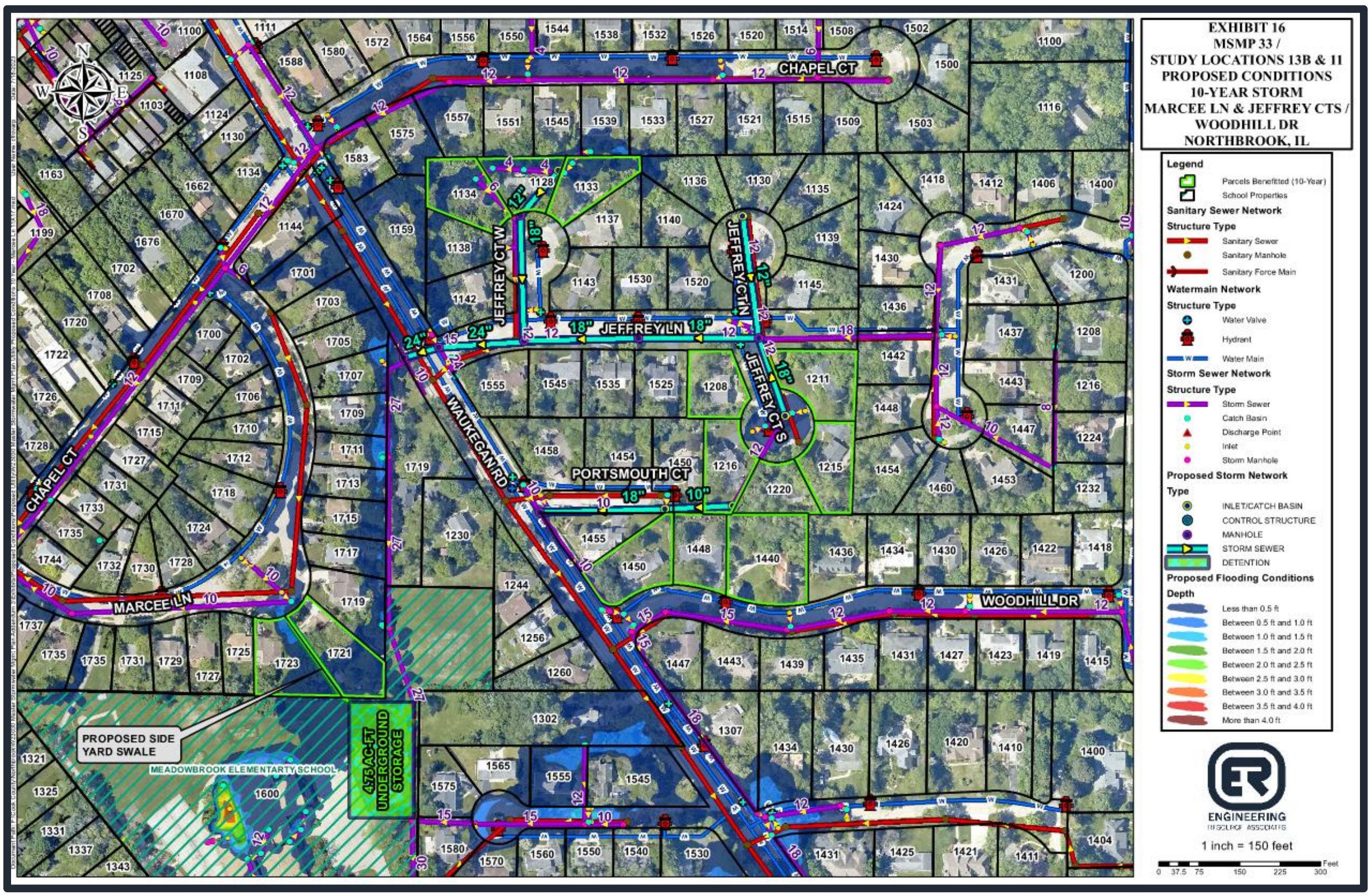


10-yr Existing Conditions Impacts

- Over 1-ft of ponding in roadway
- 13 properties with impeded vehicular access
- 7 structures impacted
- 10 properties with yards impacted

Recommended Project

Conveyance improvements are recommended for study locations 13B and 11 For study location 11, upsized pipes are recommended for each of the Jeffery Courts to the west side of Waukegan Road. The pipe improvements will provide a 10-year level of service to Jeffrey Courts South and West. Upsized storm sewer is also proposed along Portsmouth Court to connect to the rear yard storm sewer behind 1216 Jeffrey Court. At Marcee Lane, conveyance improvements are recommended by way of lowering the side yard swale in between 1721 & 1723 Marcee Lane. To attenuate flows, an underground storage system is proposed at the northeast corner of the Meadowbrook Elementary School where both conveyance improvements combine. The 4.75 ac-ft of storage provided at this location attenuates flows and also provides a benefit to ponding seen on the school property since there is a 0.2 ft reduction in surface ponding on the school property in the 100-year critical duration storm. All the proposed improvements are shown in Exhibit 16 below. This is a recommended project as it provides a 10-year level of service for an area where it was previously lacking, consistent with the recommended projects from the previous addendums. It is assigned project number MSMP 33. A full-size Exhibit 16, as well as the Preliminary Type, Size, & Location Plans of the recommended project, can be found in Appendix A.



Permits and Coordination

A permit from the Illinois Department of Transportation (IDOT) is anticipated for the proposed storm sewer crossing under Waukegan Road. An Illinois Environmental Protection Agency (IEPA) National Pollutant Discharge Elimination System (NPDES) permit will be required for land disturbances over an acre. Coordination with School District 28 will be required for installation of the underground detention on the Meadowbrook School property.

Summary of Recommended Project Costs and Benefits

Project	Study Location	Street	Level of Service	BCR	Structures Benefited	Properties Benefited	EOPCC	Average Cost Per Structure	Average Cost Per Property
MSMP 33	13B & 11	Marcee Ln & Jeffrey Cts / Woodhill Dr	10-yr	0.16	7	13	$ 4,463,000	$ 637,600	$ 343,300

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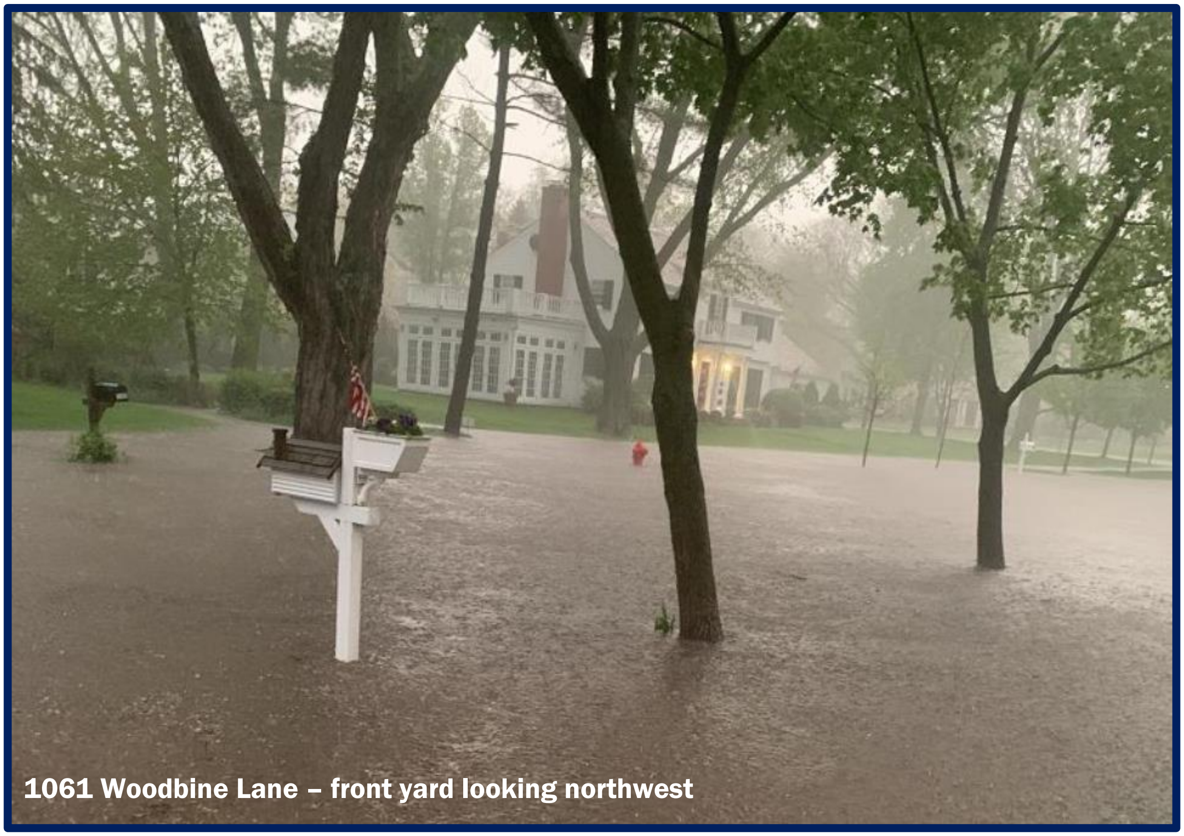
MSMP 34 | STUDY LOCATION 13A | WOODBINE LANE | FACT SHEET

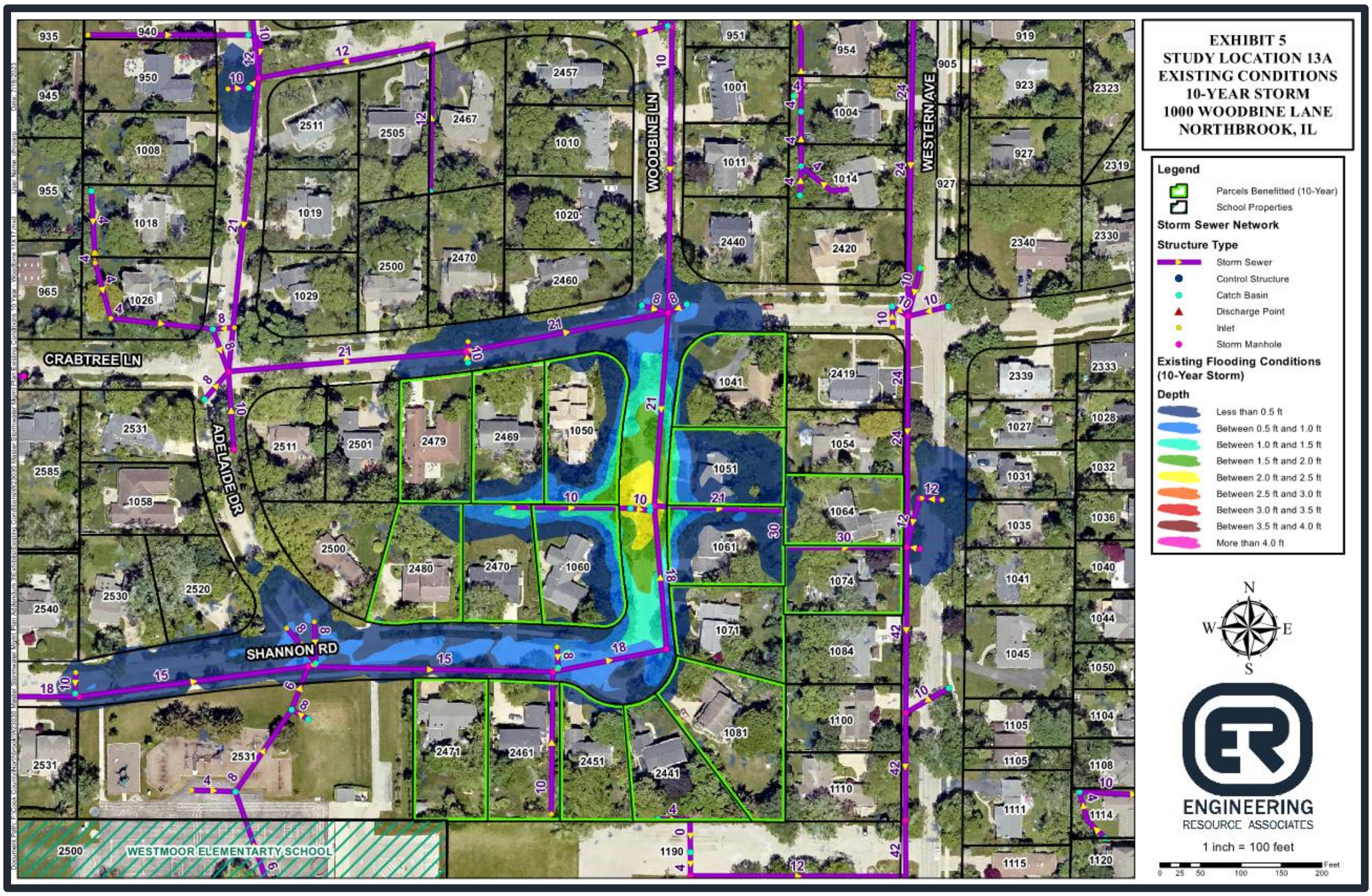

1061 Woodbine Lane – front yard looking northwest


1051 Woodbine Lane– front yard south lot line looking north

Existing Conditions Description

This study location has a depressional area located in the midblock right-of-way of Woodbine Lane, in between Crabtree Lane and Shannon Road. The depressional area has a tributary area of +/- 55 acres via storm sewer or overland flow. It is drained via a storm sewer that heads east through private property to Western Avenue. The storm sewer does not have sufficient capacity, causing the depressional area on Woodbine Lane to pond and eventually flow overland east through private yards to Western Avenue.

The system has less than a 10-year level of service as the ponding in the roadway gets high enough to impact several structures, properties, and impedes vehicular access in the roadway. The model shows that the storm sewer heading east from Woodbine Lane not only lacks sufficient capacity for upstream flows, but also has a high tailwater at its connection to Western Avenue that backs up to the depressional area on Woodbine Lane. Exhibit 5 below shows the existing conditions 10-year critical duration storm inundation limits. Full size existing conditions inundation exhibits, including the 100-year critical duration storm, can be found in Appendix A.

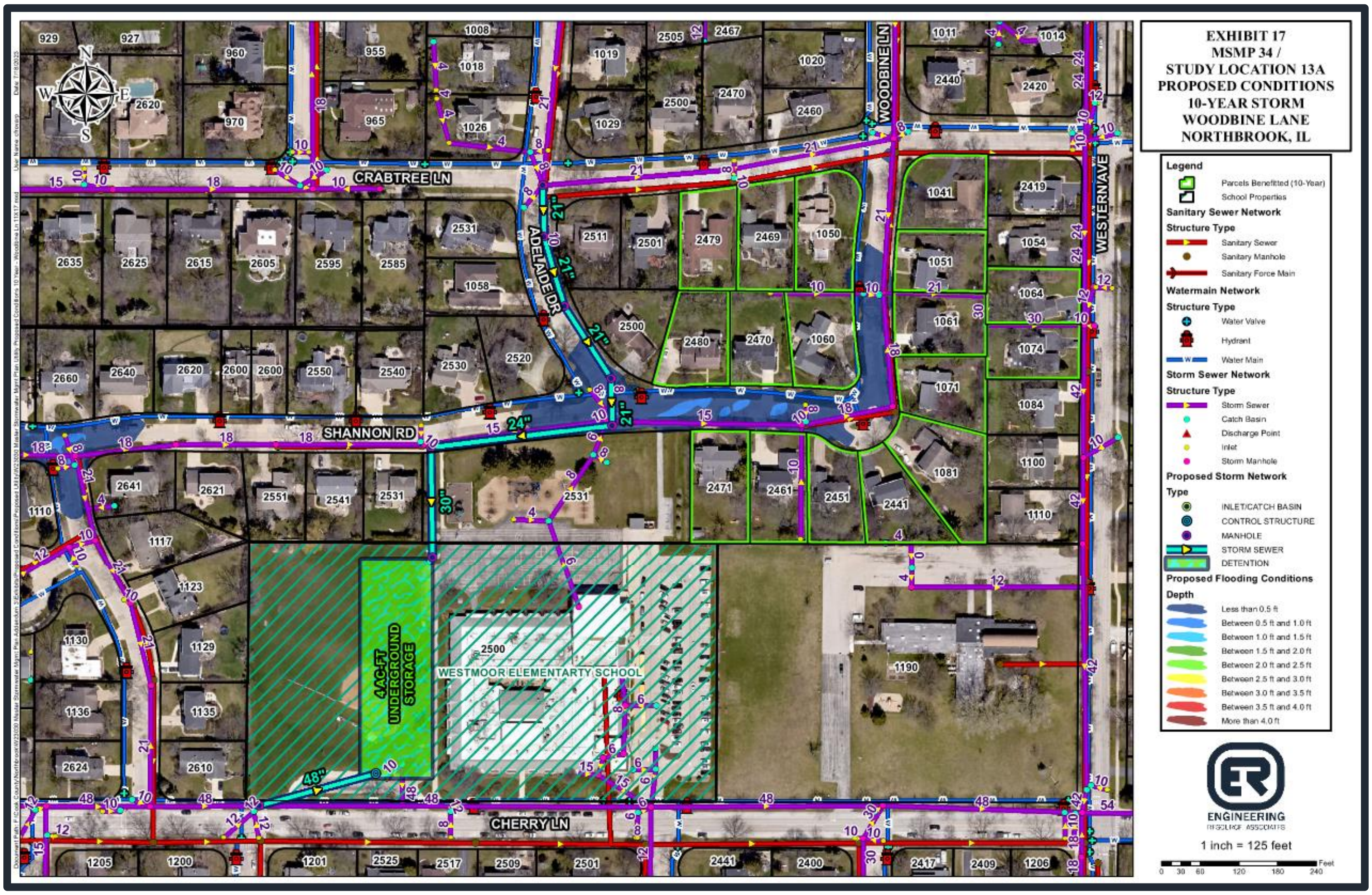


10-yr Existing Conditions Impacts

- Over 2-ft of ponding in roadway
- 17 properties with impeded vehicular access
- 4 structures impacted
- 10 properties with yards impacted

Recommended Project

The preferred alternative reroutes the Adelaide Drive storm sewer south to a new detention facility on Westmoor Elementary School, which is a part of School District 28. The Adelaide Drive sewer reroute offloads approximately 8.2 acres of tributary area from the Woodbine Lane sag to the new detention facility. Storm sewer on Shannon Road west of the intersection with Adelaide Drive will also be routed to the new detention facility. The Shannon Road sewer reroute offloads 8.9 acres of direct tributary area from the Woodbine Lane sag to the new detention facility. Storm sewer along Cherry Lane is also routed into the basin to relieve the HGL downstream, including Western Avenue. Interception of flows from Cherry Lane is necessary for this design as intercepting only the local flows from the north could not achieve a 10-year level of service. 4 ac-ft is required to provide a 10-year level of service. Since intercepting flows from Shannon Road and Cherry Lane, it was advantageous to layout the vault as shown in Exhibit 17 below. This is a recommended project as it provides a 10-year level of service for an area where it was previously lacking, consistent with the recommended projects from the previous addendums. It is assigned project number MSMP 34. A full-size Exhibit 17, as well the Preliminary Type, Size, & Location Plans of the recommended project, can be found in Appendix A.



Permits and Coordination

An Illinois Environmental Protection Agency (IEPA) National Pollutant Discharge Elimination System (NPDES) permit will be required for land disturbances over an acre. Coordination with School District 28 will be required for installation of the underground detention on the Westmoor Elementary School property.

Summary of Recommended Project Costs and Benefits

Project	Study Location	Street	Level of Service	BCR	Structures Benefited	Properties Benefited	EOPCC	Average Cost Per Structure	Average Cost Per Property
MSMP 34	13A	Woodbine Lane	10-yr	0.15	4	17	$ 3,402,000	$ 850,500	$ 200,100

MSMP 35 | STUDY LOCATION 10 | SUNSET LANE | FACT SHEET

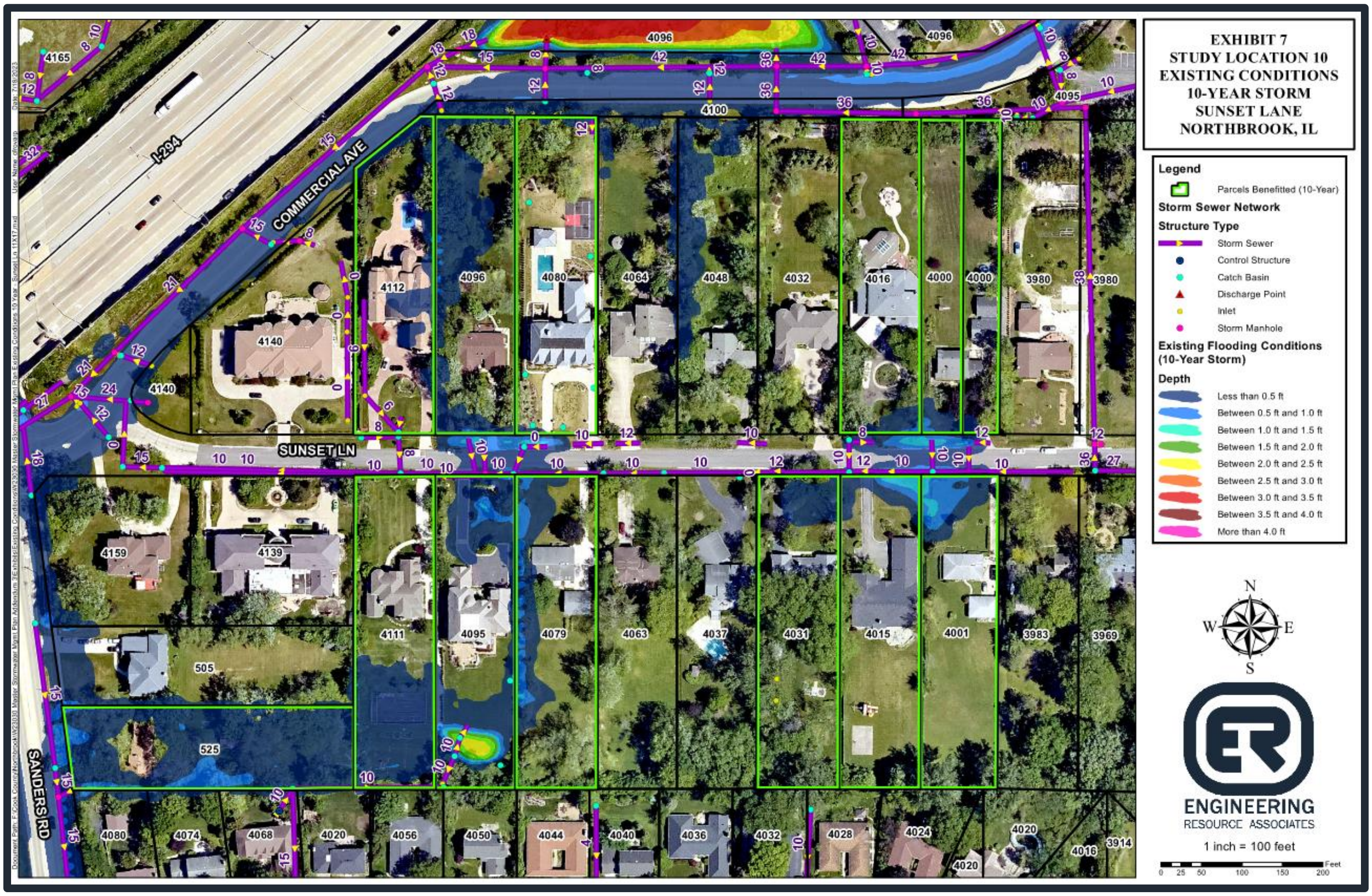
4095 Sunset Lane – side yard looking north

4001 Sunset Lane – roadway looking south

Existing Conditions Description

Sunset Lane has an unimproved roadway cross-section. A ditch and driveway culvert system is served by an existing storm sewer that collects flow from the ditches to Commercial Avenue. A 2017 MSMP project redirected flows from the eastern portion of Sunset Lane north into an expanded detention basin along Commercial Avenue. While the eastern portion of Sunset Lane received improvements from the 2017 project, locations along Sunset Lane west of the diversion pipe have continued to experience flooding. Approximately 16 acres remains tributary to the western portion of Sunset Lane and the storm sewer is undersized creating two ponded areas in the roadway.

The existing system has less than a 10-year level of service as the two ponded areas in the roadway get high enough to impact several structures, properties, and impede vehicular access in the roadway. Exhibit 7 below shows the existing conditions 10-year critical duration storm inundation limits. The diversion pipe constructed as part of the recent MSMP project is shown on 3980 Sunset Lane. Full size existing conditions inundation exhibits, including the 100-year critical duration storm, can be found in Appendix A.

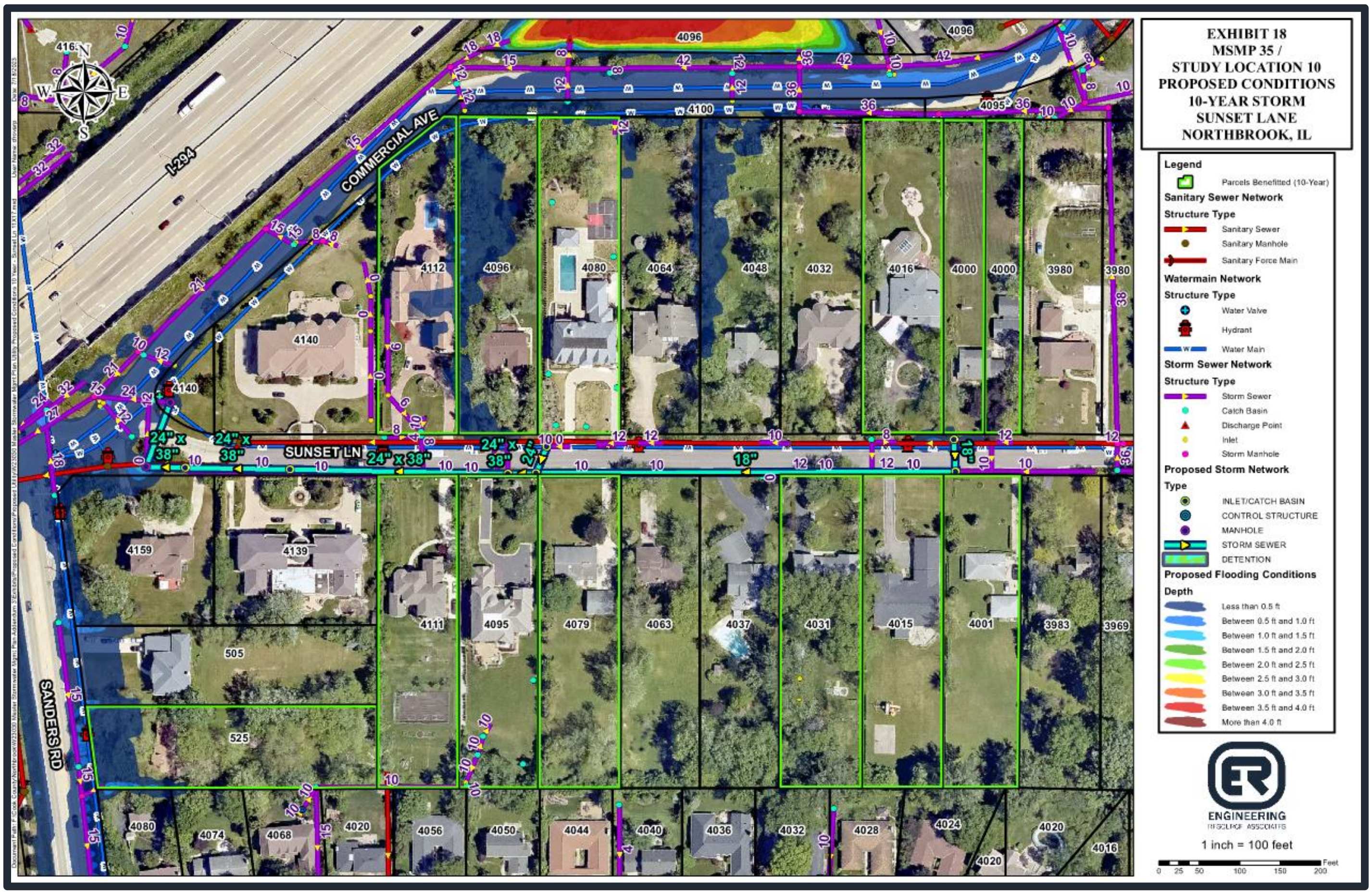


10-yr Existing Conditions Impacts

- Over 1-ft of ponding in roadway
- 8 properties with impeded vehicular access
- 4 structures impacted
- 12 properties with yards impacted

Recommended Project

The preferred alternative provides conveyance improvements along Sunset Lane. Approximately 1,120 linear feet of upsized storm sewer would replace the existing system and connect to the system on Commercial Avenue. There are no downstream water surface elevation increases, particularly the ponded area at the intersection of Sanders Road and Commercial Avenue, due to the proposed conveyance improvements in both the 10-year and 100-year storm events. With no downstream impacts, storage volume is not needed for this project. The proposed improvements are shown in Exhibit 18 below. This is a recommended project as it provides a 10-year level of service for an area where it was previously lacking, consistent with the recommended projects from the previous addendums. It is assigned project number MSMP 35. A full-size Exhibit 18, as well as the Preliminary Type, Size, & Location Plans of the recommended project, can be found in Appendix A.



Permits and Coordination

No outside permit or coordination are expected for this project.

Summary of Recommended Project Costs and Benefits

Project	Study Location	Street	Level of Service	BCR	Structures Benefited	Properties Benefited	EOPCC	Average Cost Per Structure	Average Cost Per Property
MSMP 35	10	Sunset Lane	10-yr	0.79	4	12	$ 794,000	$ 198,500	$ 66,200

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MSMP 36 | STUDY LOCATION 33 | LONGVALLEY DRIVE | FACT SHEET

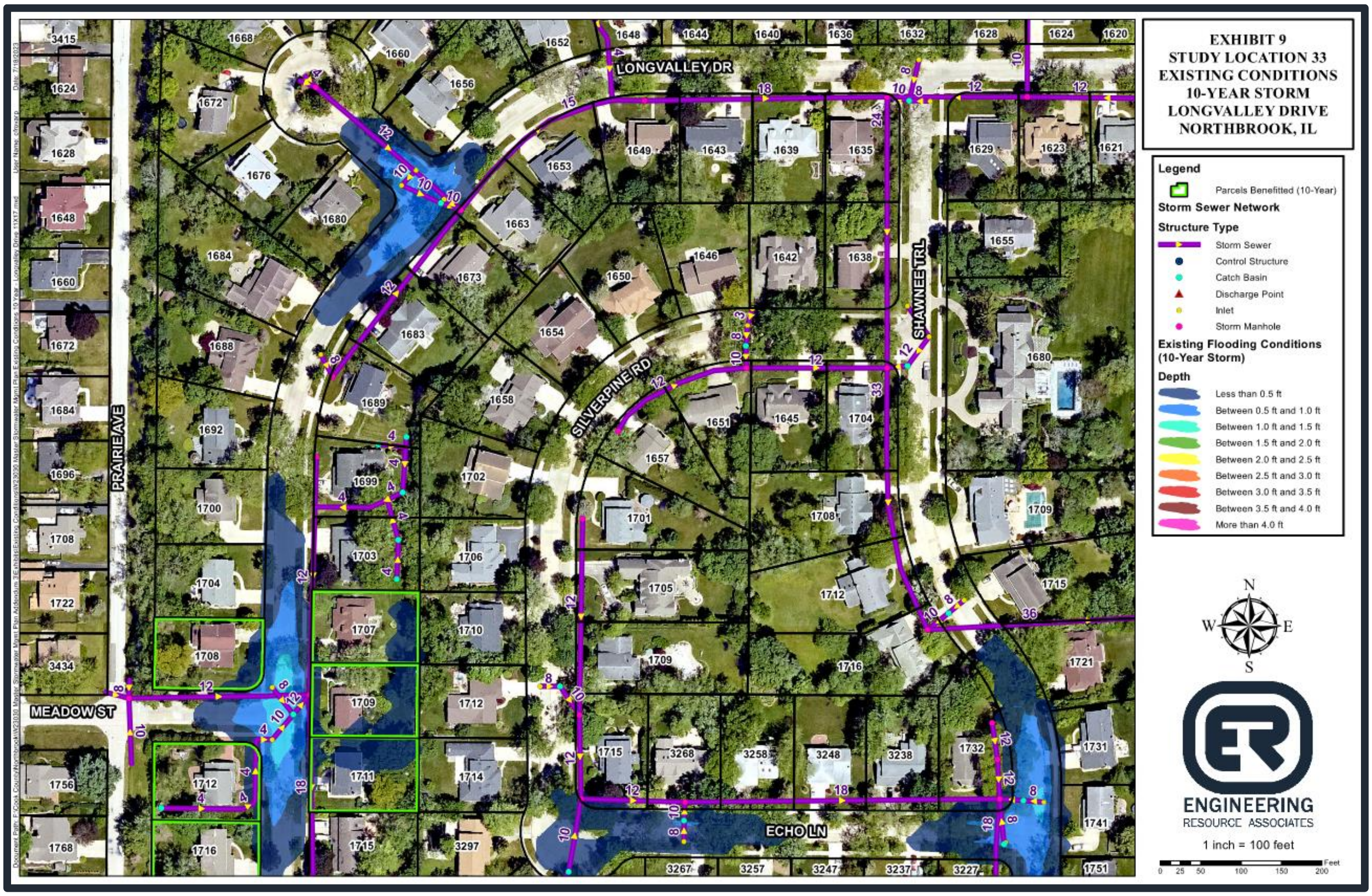

1709 Longvalley Drive– front yard looking northwest


Interior of home on Longvalley Drive

Existing Conditions Description

This study location has a depressional area located at the intersection of Longvalley Drive and Meadow Street. The depressional area has a tributary area of +/- 30 acres via storm sewer or overland flow. It is drained via a storm sewer that heads south along Longvalley Drive. The storm sewer does not have adequate capacity, causing the depressional area on pond.

The existing system has less than a 10-year level of service as the ponded area in the roadway get high enough to impact several structures, properties, and impede vehicular access in the roadway. Exhibit 9 below shows the existing conditions 10-year critical duration storm inundation limits. Full size existing conditions inundation exhibits, including the 100-year critical duration storm, can be found in Appendix A.

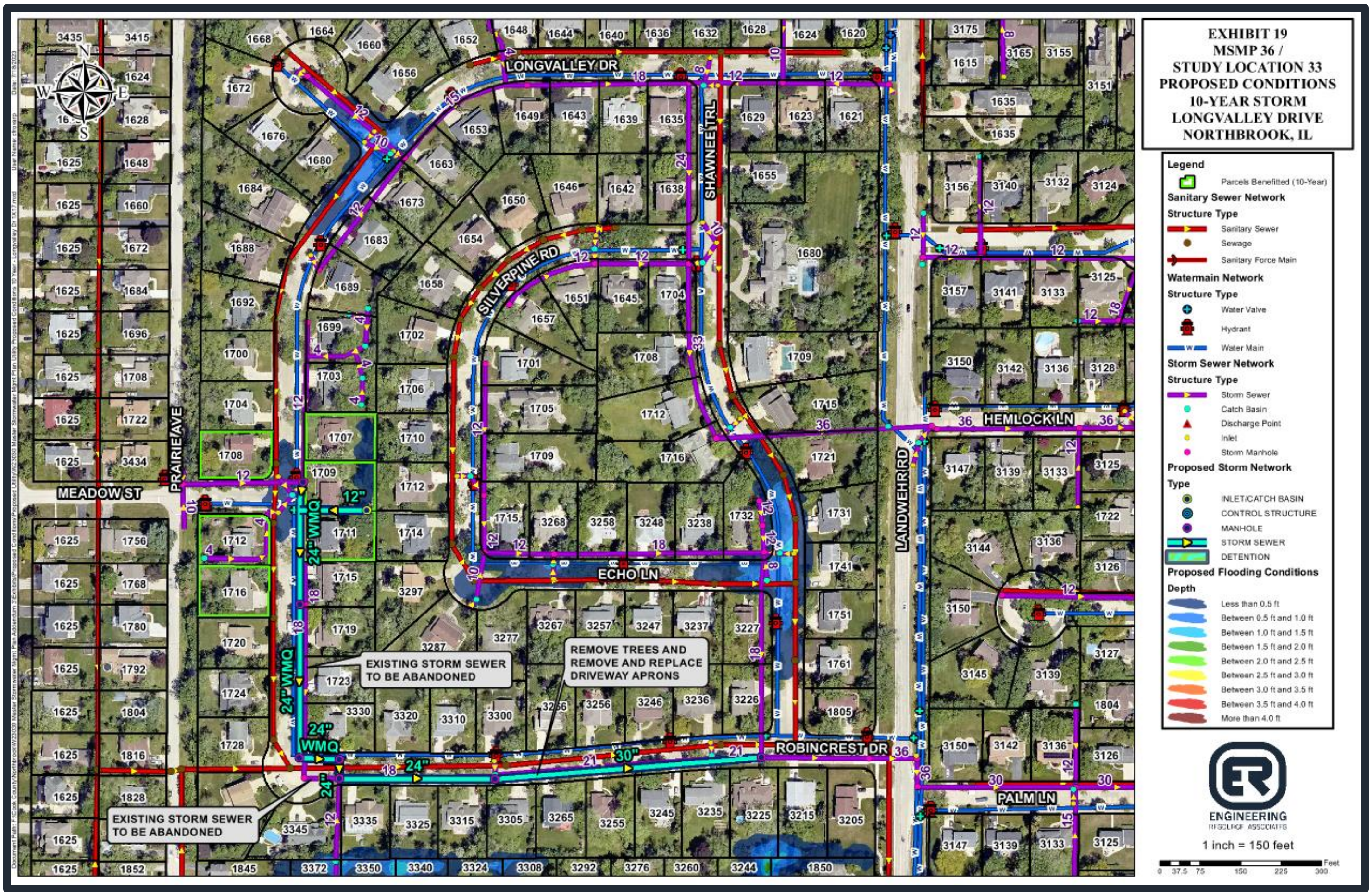


10-yr Existing Conditions Impacts

- Over 1-ft of ponding in roadway
- 6 properties with impeded vehicular access
- 1 structure impacted
- 5 properties with yards impacted

Recommended Project

The preferred alternative provides conveyance improvements along Longvalley Drive and Robincrest Drive. Approximately 1,400 linear feet of upsized storm sewer would replace the existing system. There are no downstream water surface elevation impacts due to the proposed conveyance improvements in both the 10-year and 100-year storm events. With no downstream impacts, storage volume is not needed for this project. The proposed improvements are shown in Exhibit 19 below. This is a recommended project as it provides a 10-year level of service for an area where it was previously lacking, consistent with the recommended projects from the previous addendums. It is assigned project number MSMP 36. A full-size Exhibit 19, as well as the Preliminary Type, Size, & Location Plans of the recommended project, can be found in Appendix A.



Permits and Coordination

No outside permit or coordination are expected for this project.

Summary of Recommended Project Costs and Benefits

Project	Study Location	Street	Level of Service	BCR	Structures Benefited	Properties Benefited	EOPCC	Average Cost Per Structure	Average Cost Per Property
MSMP 36	33	Longvalley Drive	10-yr	0.09	1	6	$ 1,138,000	$ 1,138,000	$ 189,700

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MSMP 37 | STUDY LOCATION 1 | KOEPKE ROAD | FACT SHEET

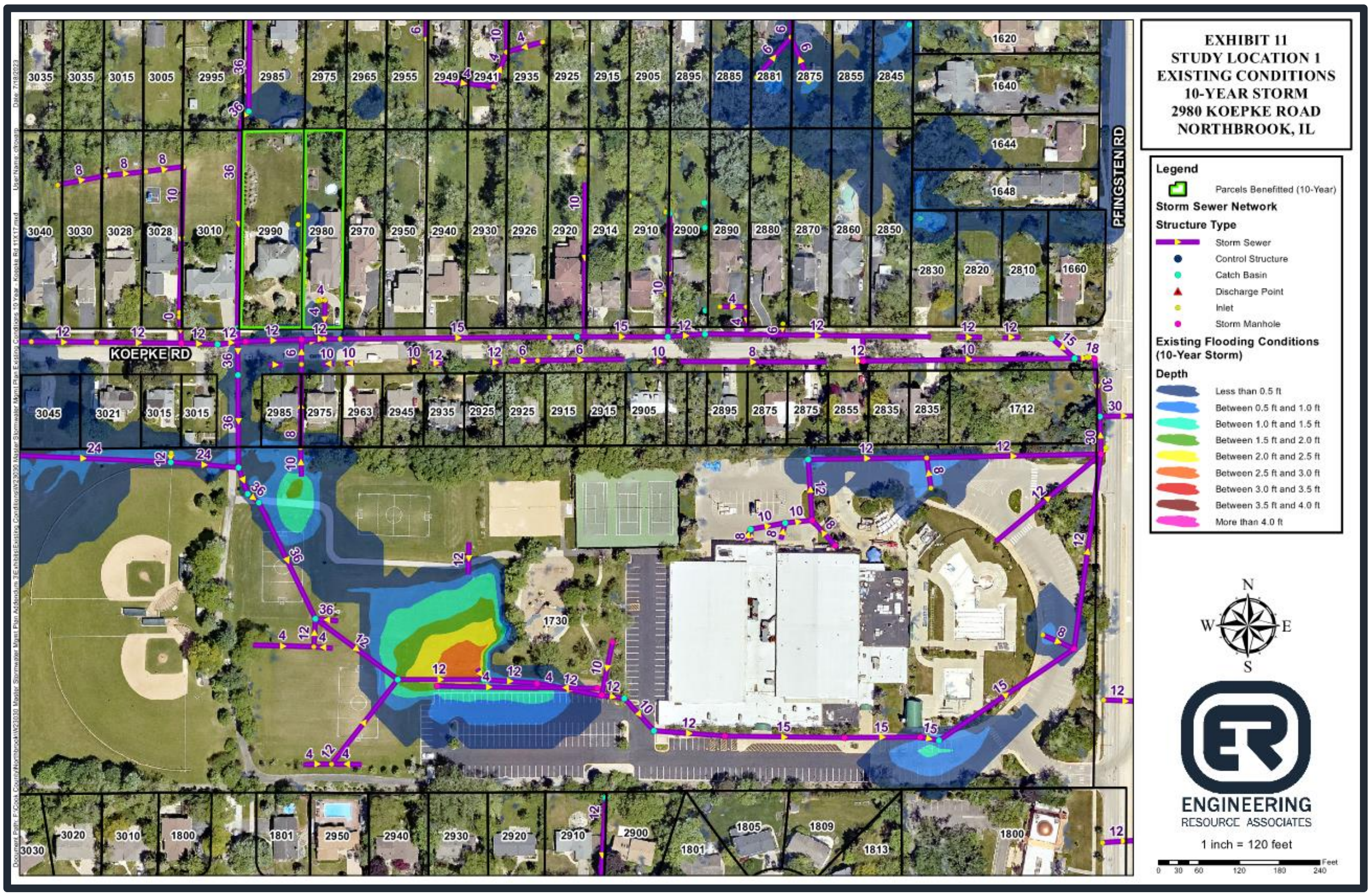
2980 Koepke Road – front yard looking west

2980 Koepke Road – side yard looking west

Existing Conditions Description

Koepke Road has an unimproved roadway cross-section. A poorly defined ditch at the edge of the roadway direct flows to an existing storm sewer that flows east. The area is generally flat, with little grade change between the roadway and homes. A tributary area of approximately 3 acres is tributary to the storm sewer this study location. When the storm sewer at this location reaches its maximum capacity, ponding quickly spreads out to adjacent properties due to the lack of grade change between the roadway and properties. Private storm sewer systems with rim elevations at or lower than the rims in the road backup and exasperate ponding issues in the area.

The existing system has less than a 10-year level of service as the undersized storm sewer allows for flows to pond and impact structures and properties. Exhibit 11 below shows the existing conditions 10-year critical duration storm inundation limits. The condition of the storm sewer at this study location has been reported as in poor condition (collapsed or crushed pipes & offset manholes for example). Full size existing conditions inundation exhibits, including the 100-year critical duration storm, can be found in Appendix A.

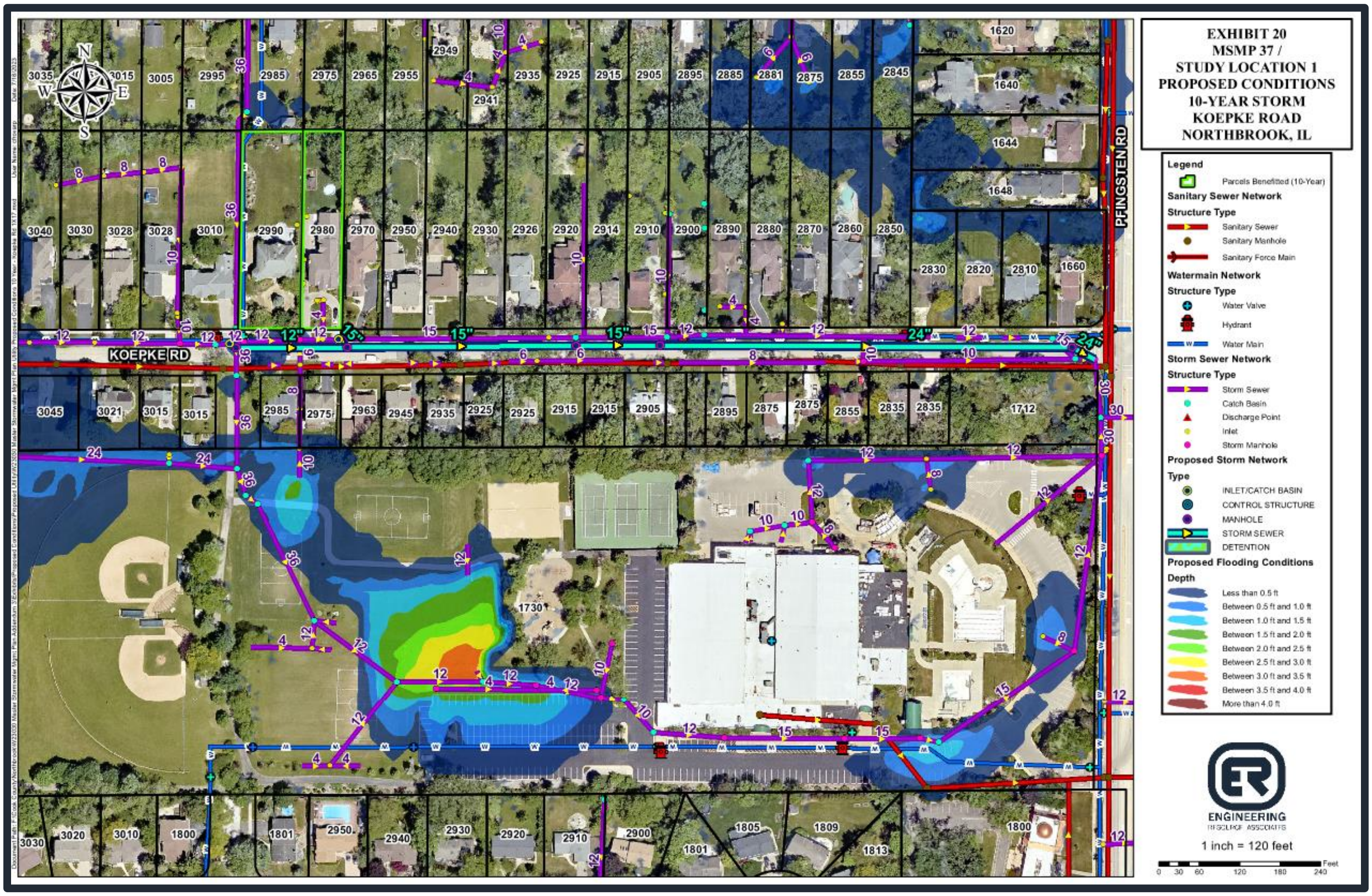


10-yr Existing Conditions Impacts

- 1 structure impacted
- 2 properties with yards impacted

Recommended Project

The preferred alternative provides conveyance improvements along Koepke Road. Improvements have been recommended for sections all the way to Pfingsten Road. Approximately 1,200 linear feet of upsized storm sewer would replace the undersized system. There are no downstream water surface elevation impacts due to the proposed conveyance improvements in both the 10-year and 100-year storm events. With no downstream impacts, storage volume is not needed for this project. The proposed improvements are shown in Exhibit 20 below. This is a recommended project as it provides a 10-year level of service for an area where it was previously lacking, consistent with the recommended projects from the previous addendums. It is assigned project number MSMP 37. A full-size Exhibit 20, as well as the Preliminary Type, Size, & Location Plans of the recommended project, can be found in Appendix A.



Permits and Coordination

No outside permit or coordination are expected for this project.

Summary of Recommended Project Costs and Benefits

Project	Study Location	Street	Level of Service	BCR	Structures Benefited	Properties Benefited	EOPCC	Average Cost Per Structure	Average Cost Per Property
MSMP 37	1	Koepke Road	10-yr	0.15	1	2	$ 1,181,000	$ 1,181,000	$ 590,500

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STUDY LOCATION 5 | BORDEAUX DRIVE FACT SHEET

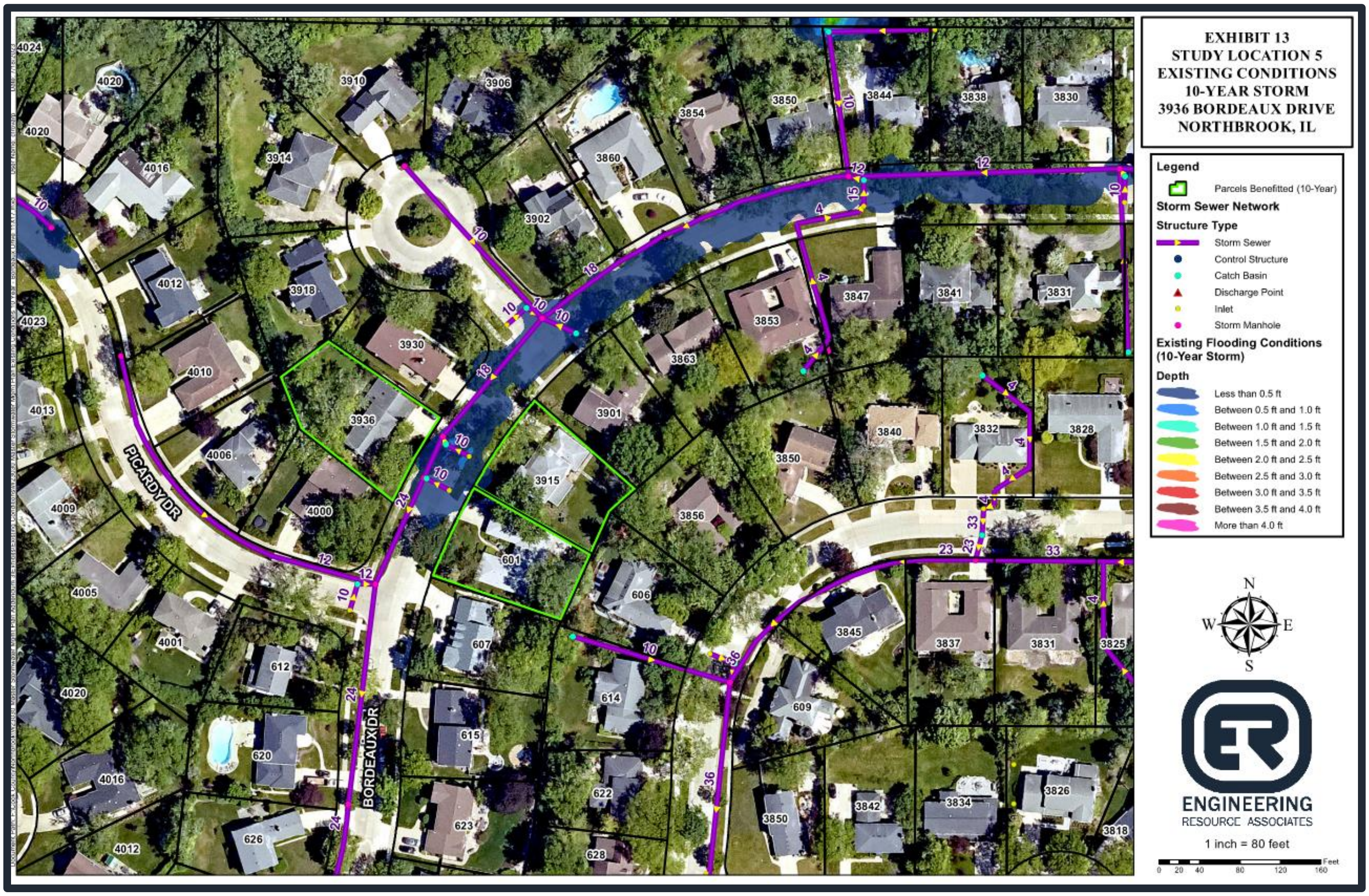
3936 Bordeaux Drive – debris line on garage door (*Photo taken before improvements were made*)

3936 Bordeaux Drive – recent window well improvements

Existing Conditions Description

This study location has a depressional area located in front of 3936 Bordeaux Drive. The depressional area has a tributary area of +/- 17 acres via storm sewer or overland flow. It is drained via a storm sewer that heads south along Bordeaux Drive. The storm sewer does not have sufficient capacity, causing the depressional area on pond.

The existing system has over a 25-year level of service in relation to structure and property impacts. Since the reported incident of flooding, the Village has provided inlet improvements at this location. Also, the homeowner had raised the elevations of the existing window-well as part of the Village cost sharing program. This area does experience impeded vehicular access in the 10-year storm event. Exhibit 13 below shows the existing conditions 10-year critical duration storm inundation limits. Full size existing conditions inundation exhibits, including the 100-year critical duration storm, can be found in Appendix A.

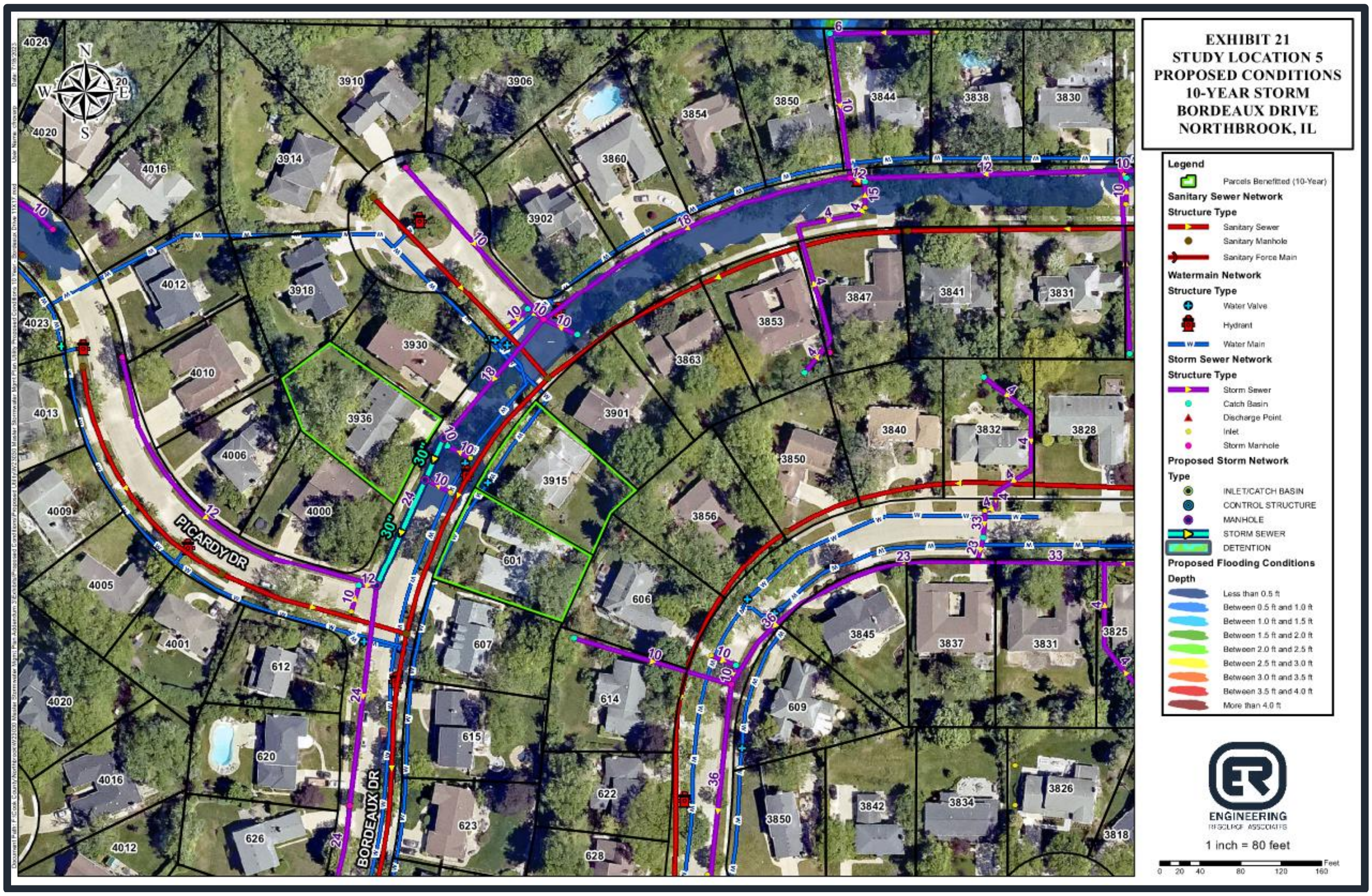


10-yr Existing Conditions Impacts

- Over 1-ft of ponding in roadway
- 3 properties with impeded vehicular access

Preferred Alternative

The preferred alternative provides conveyance improvements along Bordeaux Drive to provide 10-year vehicular access. Approximately 160 linear feet of upsized storm sewer would replace the existing system. There are no downstream water surface elevation impacts due to the proposed conveyance improvements in both the 10-year and 100-year storm events. With no downstream impacts, storage volume is not needed for this project. The proposed improvements are shown in Exhibit 21 below. This is not a recommended project as it already provides a 10-year level of service in relation to property and structural impacts in existing conditions. The recent homeowner and Village projects have made an additional project unnecessary. A full-size Exhibit 21, as well as the Preliminary Type, Size, & Location Plans of the recommended project, can be found in Appendix A.



Permits and Coordination

No outside permit or coordination are expected for this project.

Summary of Preferred Alternative Costs and Benefits

Project	Study Location	Street	Level of Service	BCR	Structures Benefited	Properties Benefited	EOPCC	Average Cost Per Structure	Average Cost Per Property
N/A	5	Bordeaux Drive	10-yr	N/A	0	3	$ 222,000	N/A	N/A

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NON-PRIORITIZED AREAS

Of the thirty-four total locations, eight were chosen to be studied as a part of Addendum #3. In addition to the prioritized study locations, ERA reviewed the remaining twenty-six non-prioritized locations. The non-prioritized areas were reviewed in proximity to the prioritized areas and remain under consideration for future stormwater management master plans. These twenty-six areas will be considered in future addendums to the Master Stormwater Management Plan and the subsequent Capital Improvement Plans. These locations should be revisited as needs, risk, and funding change in the Village.

Smaller projects that may only benefit one to two properties may be local drainage issues rather than watershed or regional improvements. The Village has programs in place to assist homeowners looking for private property improvements. These local drainage improvements may include raising window well elevations, installing sump pumps or battery backups, re-grading yards to promote positive drainage, installing yard drains, drywells, or rain gardens to absorb excess rainwater and reducing ponding times in low areas. For additional information on these and other local, private drainage improvements, see Appendix E, Private Property Improvements.

COMMUNITY RATING SYSTEM

The Village of Northbrook participates in the National Flood Insurance Program's (NFIP) Community Rating System (CRS) and has a Class 6 rating. To maintain this rating, the Village completes CRS Activities and every five years their score is reevaluated based on the competed Activities. At a Class 6, the Village can offer their residents in the floodplain a twenty percent (20%) reduction on their flood insurance rates and residents outside the floodplain can receive a ten percent (10%) reduction on their flood insurance rates.

Under Activity 450, Stormwater Management, the Village can earn a maximum of 315 points towards their CRS 6 rating for having a Watershed Master Plan (WMP) that includes a plan of action to address current and expected drainage problems. In addition to the other preventative measures (adoption of State and County Ordinances, stormwater regulations for new developments, participation in the County's Hazard Mitigation Plan, etc.), a WMP provides the Village with a tool to make decisions that can reduce the increased flooding from development on a watershed-wide scale. A WMP can be used to inform the Village's CIP and should outline programs and improvements that benefit the watershed, rather than individual residents. Greater credit is given for protecting floodplain and repetitive loss structures.

The Village can earn credit for construction of small flood control projects that reduce the risk of flood water reaching buildings under Activity 530, Flood Protection. However, the structures benefiting from the improvement must be in the regulatory floodplain or identified as a repetitive loss property and the improvement must provide a 25-year level of protection. The locations included in this Addendum #3 do not include floodplain properties and credit under Activity 530 is not anticipated.

The Village may opt to include elements from Appendix E, Private Property Improvements, in their Program for Public Information (PPI). If the Village follows the guidelines under Activity 330, sharing methods for flood protection at low entries, utilities, and lower levels to residents via mailings, online outreach, newspaper postings and brochures and handouts in Village Hall and Public Works, will contribute to their PPI score.

FUNDING OPPORTUNITIES

PROJECT SYNCING

Project timelines may be delayed or accelerated based on easement agreements or inter-governmental agreements, but, when possible, stormwater improvement project should occur with other Public Works Department infrastructure projects in the same corridor to provide overall cost savings to the Village. Combining stormwater projects with watermain, sanitary sewer, roadway resurfacing, or complete infrastructure replacement project allows for cost saving by eliminating redundant restoration costs. It also provides economy of scale in engineering design and during construction. An engineer can survey and produce final design plans for all utilities at once. A contractor will typically have lower line-item bid costs for large reconstruction projects versus infrastructure projects that deal with a single utility.

INTERGOVERNMENTAL PARTNERSHIPS

In this Addendum, two recommended projects identify underground stormwater storage on School District properties. To be constructed as proposed, these improvements require an intergovernmental agreement with the School District 28 to use their open space for underground storage. The Village and local agencies have a successful history of installing underground flood control structures; most recently at Wescott Park. The proposed improvements at Meadowbrook School will benefit the residents in Study Location 11, Jeffery Courts and Woodhill Drive and Study Location 13B, Marcee Lane. The proposed underground storage at Westmoor Elementary School will benefit the residents in Study Location 13A, Woodbine Lane.

Agreements may include construction easements, permanent maintenance or stormwater easements or land swaps. Intergovernmental agreements can aid in meeting the Village's stormwater goals, while also meeting the needs of the other stakeholders. The timing of these agreements can affect the prioritization of the master stormwater management plan recommended projects. As partnership agreements are reached, those projects should be prioritized by the Village.

FUNDING OPPORTUNITIES

The following matrices outline various grant programs that may be available for these MSMP projects in Northbrook. These grants offer funding for stormwater, flood protection and green infrastructure (GI) water quality improvement projects. GI practices can be effective in reducing flows to storm sewer systems and to local waterways and reduce the amount of sediment and erosion in ponds and streams. If beneficial and if land use and land ownership allow, the Village may consider exploring surface storage with GI to underground storage to qualify for more grants. The Village shall also evaluate the utility fee for implementation of the recommended projects.

FUNDING OPPORTUNITIES FOR STORMWATER AND WATER QUALITY PROJECTS		
Grant Program	Green Infrastructure Grant Opportunities (GIGO)	IEPA Water Pollution Control Loan Program
Program Purpose	Fund stormwater management techniques or practices with the primary goal to preserve, restore, mimic, or enhance natural hydrology.	Provide low-interest loans through the State Revolving Fund (SRF) for stormwater and wastewater projects.
Program Administrator	Illinois Environmental Protection Agency	Illinois Environmental Protection Agency
Eligible Projects	Bioinfiltration, retention/infiltration, detention pond creation/retrofit, wetland creation/modification, floodplain reconnection, watershed-wide projects, rainwater harvesting, downspout disconnections, BMP design and construction	New drinking water or wastewater infrastructure construction, upgrading or rehabilitating existing infrastructure; storm water related projects that benefit water quality; and other projects that protect or improve the quality of Illinois' rivers, streams and lakes.
Eligible Applicants	Any Grant Accountability and Transparency Act (GATA) Pre-Qualified entity including watershed groups, units of government, universities and colleges, park districts, conservation organizations	Private or public applicants who design and construct water quality improvements in Illinois.
Application Process	2-10 projects awarded annually between $75,000 and $2,500,000 between FY2021 through FY2025	Annual program run through the State Revolving Fund (SRF) Funding nomination forms due in March for the upcoming fiscal year; bid advertisements in April and final bid documents due in June. Awarded in July after Letter of Commitment received.
Local Match Required	25% match required	SRF Loan Program Current Loan Interest Rate: 1.24%

FUNDING OPPORTUNITIES FOR STORMWATER AND WATER QUALITY PROJECTS		
Grant Program	FEMA Building Resilient Infrastructure and Communities (BRIC) Grant	FEMA Hazard Mitigation Grant Program (HMGP)
Program Purpose	Provide states and local communities with funding to improve communities' resilience against natural disasters including wildfires, drought, hurricanes, earthquakes, extreme heat and flooding.	Reduces or eliminates long-term risk to people and property from future disasters
Program Administrator	FEMA/IEMA	FEMA/IEMA
Eligible Projects	Projects that demonstrate proactive investment in community resilience against natural disasters.	Retrofitting existing buildings to make them less susceptible to damage, purchasing and demolishing hazard prone property, drainage improvements and infrastructure retrofits to reduce risk of failure, slope stabilization projects to reduce risk, HMP development projects. Properties must be maintained with eligible open space uses in perpetuity.
Eligible Applicants	States, local communities, tribes, and territories.	States where a federal disaster was declared within 30 days of a hazard event (extreme flood event)
Application Process	Deadline for local agencies to apply for IEMA-OHS funding is June 30, 2023. Program is offered annually.	Local agencies, partnered with the IEMA, in good standing with NFIP and a HMP at the time of the grant deadline
Local Match Required	90% Federal Share, 10% Local Match	Varies based on size of project and State match, often 25% match required. ICC funds can be applied to local match.

FUNDING OPPORTUNITIES FOR STORMWATER AND WATER QUALITY PROJECTS		
Grant Program	MWRDGC Stormwater Partnership Program	MWRDGC Green Infrastructure Partnership Opportunity Program
Program Purpose	The program funds projects in Cook County that address flooding and drainage concerns. These projects utilize a variety of traditional engineered solutions such as localized detention, upsizing critical storm sewers and culverts, pumping stations, and establishing drainage ways, alongside green infrastructure.	Increase investment of GI throughout Cook County to reduce stormwater flows to local sewer systems and prevent combined sewer overflows, address local flooding and draining problems, promote GI as a complimentary way to manage stormwater with natural systems, increase a community's "green space", and provide water quality improvements.
Program Administrator	MWRDGC	MWRDGC
Eligible Projects	Conceptual and shovel-ready projects in communities that have a socio-economic need, provide a structural flood benefit, and can show cost-effectiveness. (not for nuisance flooding)	Stormwater management projects using green infrastructure (GI). Grant priorities retention capacity, impervious area reduction, structural benefits, sewer service improvements and flood prone area improvements.
Eligible Applicants	Public entity whose project is within MWRD's corporate boundaries	Public entity whose project is within MWRD's corporate boundaries
Application Process	Annual IGA reimbursement program, fund approx. 7 projects annually, varies yearly	Annual IGA reimbursement program, funding varies yearly, applications due in August
Local Match Required	Grant provides 100% of construction related costs, only.	Grant provides 100% of GI construction related costs, only.

RANKINGS AND RECOMMENDATIONS

The recommended projects should be implemented in the order of the priority ranking as shown in the table below as funding is acquired and successful coordination with outside governmental agencies occurs. The top four projects scored high enough, and have existing deficiencies severe enough, that they can be implemented as standalone stormwater projects. The remaining recommended projects are recommended to be implemented with other types of capital improvement projects (watermain, roadway reconstructions, etc.) in the Village. However, project syncing shall still be considered for all the projects. Grant funding should be sought out for all projects when applicable, but in general projects that have a high BCR, involve green infrastructure, or coordination with other governmental agencies will have a greater opportunity to receive grant funding.

MSMP ADDENDUM #3 PROJECT PRIORITIZATION

Rank [1]	Score [2]	Project Number	Study Location	Street(s)	Level of Service [3]	Benefit-Cost Ratio	Benefit-Cost Ratio Rank	Structures Benefited	Structures Rank	Properties Benefited	Properties Rank	Engineer's Opinion of Probable Construction Costs [5]	Average Cost Per Structure	Average Cost Per Property
1	1.67	MSMP 32	12	Wescott Rd / Oak Ave / Maple Ave	10-yr	0.31	2	10	1	14	2	$ 2,378,000	$ 237,800	$ 169,900
2	2.67	MSMP 33	13B & 11	Marcee Ln & Jeffrey Cts / Woodhill Dr[4]	10-yr	0.16	3	7	2	13	3	$ 4,463,000	$ 637,600	$ 343,300
3	2.67	MSMP 34	13A	Woodbine Lane	10-yr	0.15	4	4	3	17	1	$ 3,402,000	$ 850,500	$ 200,100
4	2.67	MSMP 35	10	Sunset Lane	10-yr	0.79	1	4	3	12	4	$ 794,000	$ 198,500	$ 66,200
5	5.33	MSMP 36	33	Longvalley Drive	10-yr	0.09	6	1	5	6	5	$ 1,138,000	$ 1,138,000	$ 189,700
6	5.33	MSMP 37	1	Koepke Road	10-yr	0.15	4	1	5	2	7	$ 1,181,000	$ 1,181,000	$ 590,500
7	6.67	N/A	5	Bordeaux Drive[6]	10-yr	0.00	7	0	7	3	6	$ 222,000	N/A	N/A

NOTES:

1. ERA followed the ranking methodology from the past Addendums to the Village Stormwater Master Plan. A lower score ranks higher. For projects with identical scores, the number of structures benefited is the first tie breaker, followed by the number of properties benefited.

2. The score is the average of the BCR, number of structures benefited, and number of properties benefited.

3. Level of service is the storm event for which a project can provide benefits to the impacted properties. It is categorized by the likelihood of storm occurrence in any given year. Colloquially called the "10-year storm", it has a 1 in 10 (10%) chance of occurring any given year. A "100-year storm" would have a 1 in 100 (1%) chance of occurring in any given year, a "2-year storm" a 1 in 2 (50%) chance, and in such manner for other storm events.

4. Projects 11 and 13B are combined into one project since they share a single location for storage volume.

5. Estimated based on 2023 costs. Rounded to the nearest thousand. Includes estimated cost of engineering. See preliminary EOPCC provided for each project location for more detailed cost breakdown.

6. Recent Village improvements are shown to exceed 10-yr LOS in existing conditions. Additional improvements are not recommended. No MSMP project number assigned.

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APPENDIX A – EXHIBITS & PLANS

Existing Conditions Exhibits

Exhibit 1: Study Location 12 | Wescott Rd / Oak Ave / Maple Ave - 10-year Existing Conditions
Exhibit 2: Study Location 12 | Wescott Rd / Oak Ave / Maple Ave - 100-year Existing Conditions
Exhibit 3: Study Location 13B & 11 | Marcee Ln & Jeffery Cts / Woodhill Dr - 10-yr Existing Conditions
Exhibit 4: Study Location 13B & 11 | Marcee Ln & Jeffery Cts / Woodhill Dr - 100-yr Existing Conditions
Exhibit 5: Study Location 13A | Woodbine Lane - 10-yr Existing Conditions
Exhibit 6: Study Location 13A | Woodbine Lane - 100-yr Existing Conditions
Exhibit 7: Study Location 10 | Sunset Lane - 10-year Proposed Conditions
Exhibit 8: Study Location 10 | Sunset Lane - 100-yr Existing Conditions
Exhibit 9: Study Location 33 | Longvalley Drive - 10-yr Existing Conditions
Exhibit 10: Study Location 33 | Longvalley Drive - 100-yr Existing Conditions
Exhibit 11: Study Location 1 | Koepke Road - 10-yr Existing Conditions
Exhibit 12: Study Location 1 | Koepke Road - 100-yr Existing Conditions
Exhibit 13: Study Location 5 | Bordeaux Drive - 10-yr Existing Conditions
Exhibit 14: Study Location 5 | Bordeaux Drive - 100-yr Existing Conditions

Proposed Conditions Exhibits

Exhibit 15: MSMP 32 | Study Location 12 | Wescott Rd / Oak Ave / Maple Ave - 10-year Proposed Conditions
Exhibit 16: MSMP 33 | Study Locations 13B & 11 | Marcee Ln & Jeffery Cts / Woodhill Dr - 10-year Proposed Conditions
Exhibit 17: MSMP 34 | Study Location 13A | Woodbine Lane - 10-year Proposed Conditions
Exhibit 18: MSMP 35 | Study Location 10 | Sunset Lane - 10-year Proposed Conditions
Exhibit 19: MSMP 36 | Study Location 33 | Longvalley Drive - 10-year Proposed Conditions
Exhibit 20: MSMP 37 | Study Location 1 | Koepke Road - 10-year Proposed Conditions
Exhibit 21: Study Location 5 | Bordeaux Drive - 10-year Proposed Conditions

Preliminary Type, Size, & Location (T, S, & L) Plans

MSMP 32 | Study Location 12 | Wescott Rd / Oak Ave / Maple Ave
MSMP 33 | Study Locations 13B & 11 | Marcee Ln & Jeffery Cts / Woodhill Dr
MSMP 34 | Study Location 13A | Woodbine Lane
MSMP 35 | Study Location 10 | Sunset Lane
MSMP 36 | Study Location 33 | Longvalley Drive
MSMP 37 | Study Location 1 | Koepke Road
Study Location 5 | Bordeaux Drive

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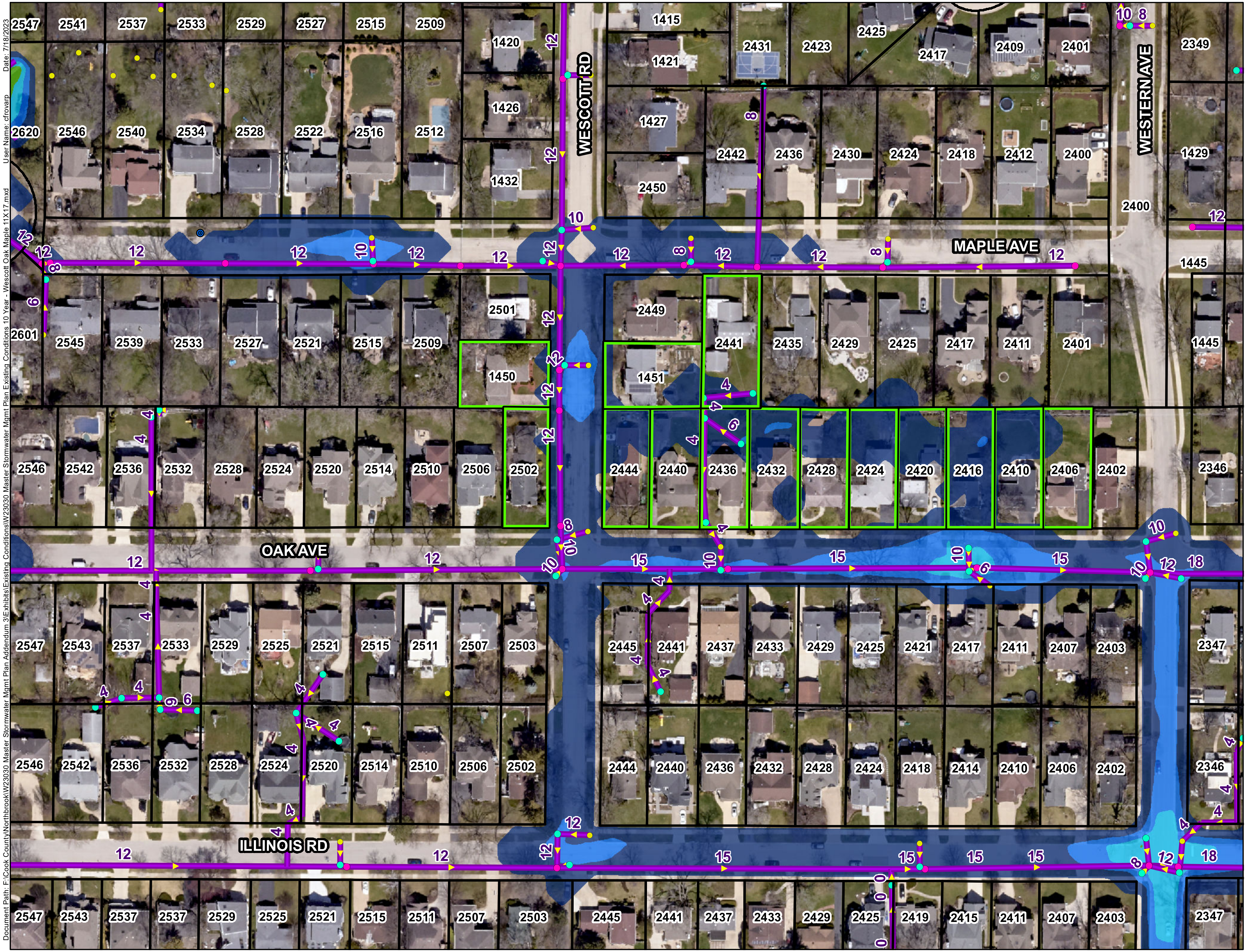
EXHIBIT 1
STUDY LOCATION 12
EXISTING CONDITIONS
10-YEAR STORM
WESCOTT, OAK, & MAPLE
NORTHBROOK, IL



Legend

Parcels Benefitted (10-Year)

Storm Sewer Network

Structure Type

- Storm Sewer
- Control Structure
- Catch Basin
- Discharge Point
- Inlet
- Storm Manhole

Existing Flooding Conditions (10-Year Storm)

Depth

- Less than 0.5 ft
- Between 0.5 ft and 1.0 ft
- Between 1.0 ft and 1.5 ft
- Between 1.5 ft and 2.0 ft
- Between 2.0 ft and 2.5 ft
- Between 2.5 ft and 3.0 ft
- Between 3.0 ft and 3.5 ft
- Between 3.5 ft and 4.0 ft
- More than 4.0 ft

N W E S

ENGINEERING RESOURCE ASSOCIATES

1 inch = 100 feet

0 25 50 100 150 200 Feet

Date: 7/18/2023

User Name: cfrovarp

Document Path: F:\Cook County\Northbrook\W23030 Master Stormwater Mgmt Plan Addendum 3\Exhibits\Existing Conditions\W23030 Master Stormwater Mgmt Plan Existing Conditions 10 Year - Wescott Oak Maple 11X17.mxd

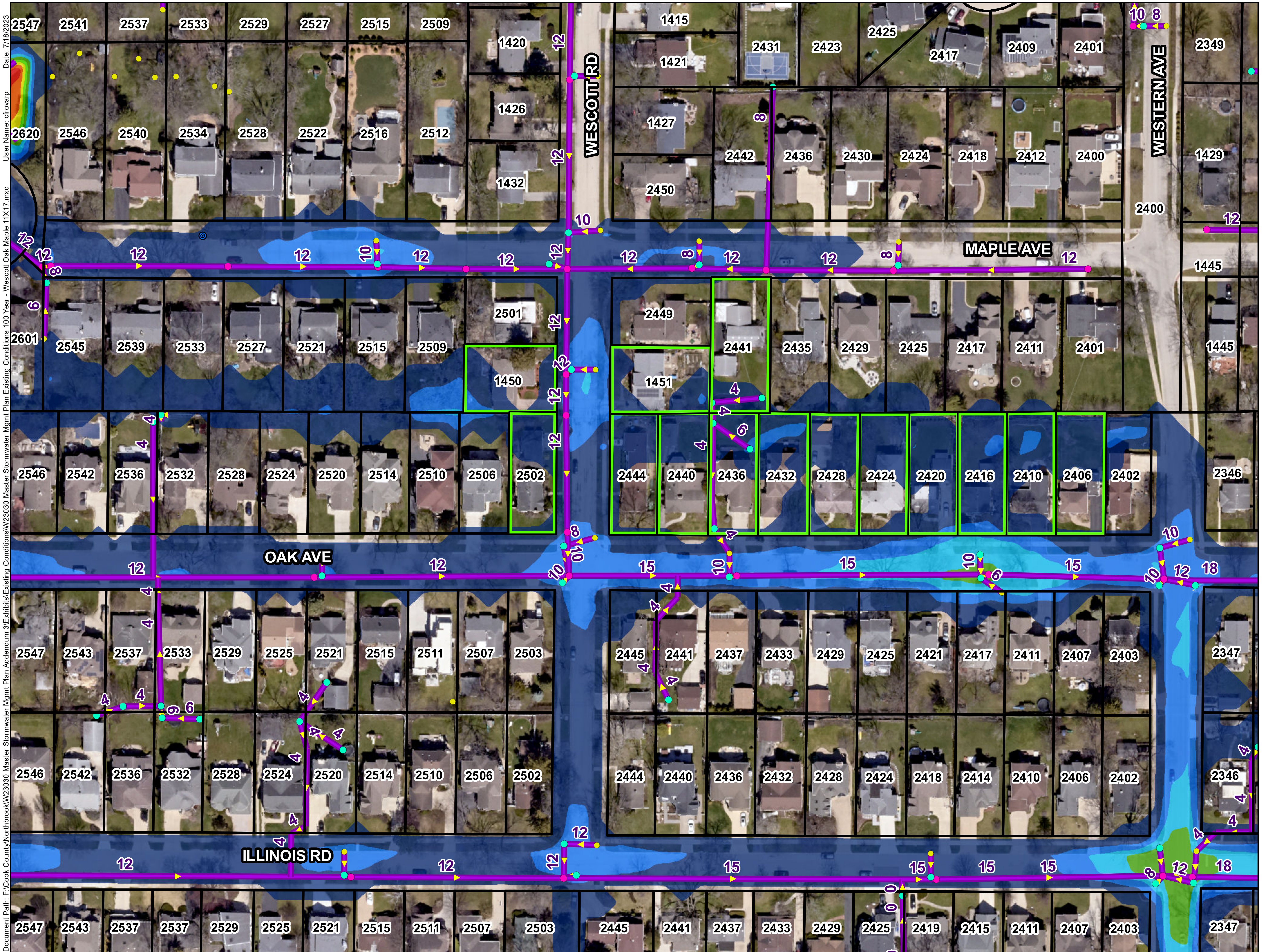


EXHIBIT 2
STUDY LOCATION 12
EXISTING CONDITIONS
100-YEAR STORM
WESCOTT, OAK, & MAPLE
NORTHBROOK, IL

Legend

Parcels Benefitted (10-Year)

Storm Sewer Network

Structure Type

- Storm Sewer
- Control Structure
- Catch Basin
- Discharge Point
- Inlet
- Storm Manhole

Existing Flooding Conditions (100-Year Storm)

Depth

- Less than 0.5 ft
- Between 0.5 ft and 1.0 ft
- Between 1.0 ft and 1.5 ft
- Between 1.5 ft and 2.0 ft
- Between 2.0 ft and 2.5 ft
- Between 2.5 ft and 3.0 ft
- Between 3.0 ft and 3.5 ft
- Between 3.5 ft and 4.0 ft
- More than 4.0 ft

N W E S

ENGINEERING RESOURCE ASSOCIATES

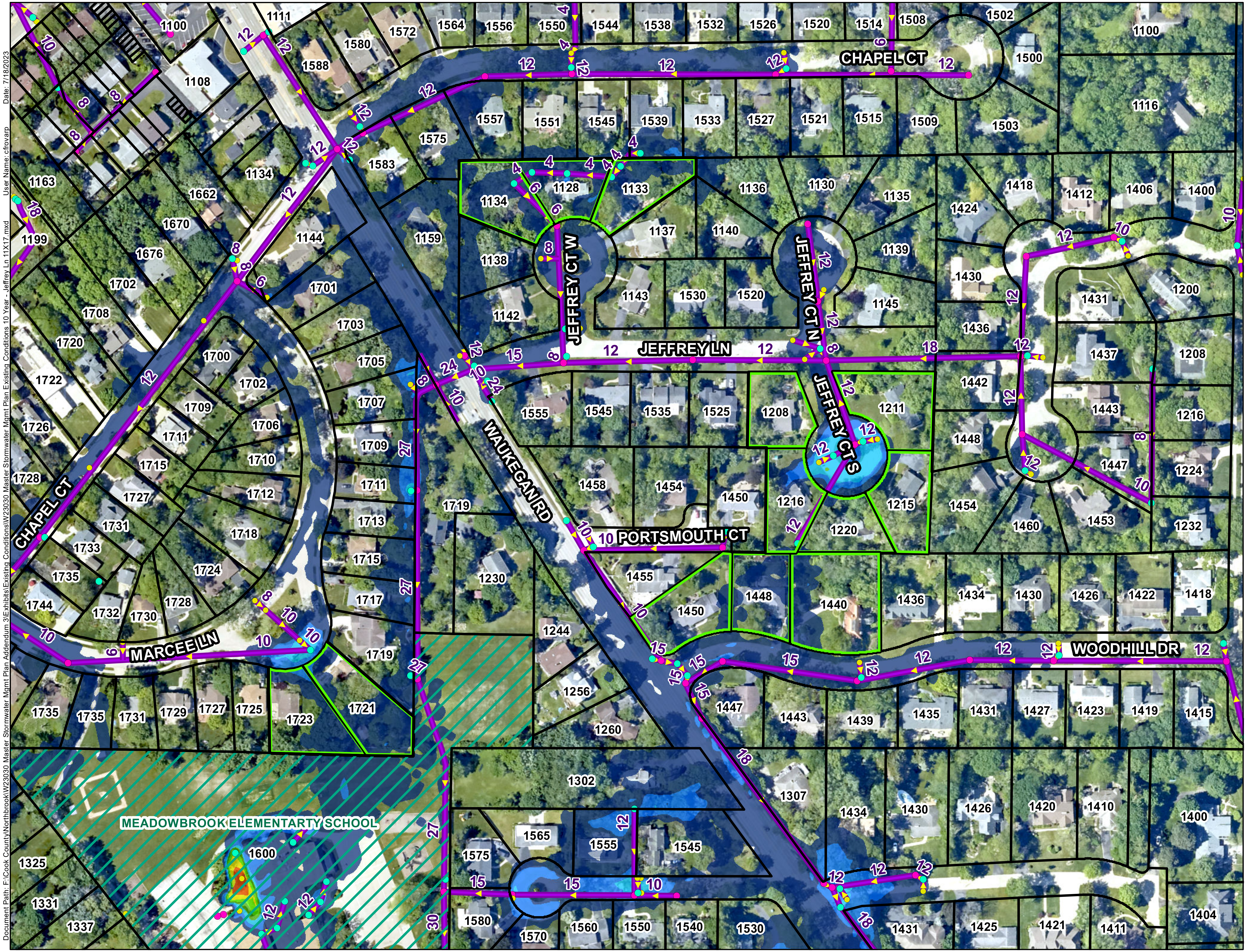
1 inch = 100 feet

0 25 50 100 150 200 Feet

Date: 7/18/2023 User Name: cfrovarp

Document Path: F:\Cook County\Northbrook\W23030 Master Stormwater Mgmt Plan Addendum 3\Exhibits\Existing Conditions\W23030 Master Stormwater Mgmt Plan Existing Conditions 100 Year - Wescott Oak Maple 11X17.mxd

EXHIBIT 3
STUDY LOCATIONS 13B & 11
EXISTING CONDITIONS
10-YEAR STORM
MARCEE LN & JEFFREY CTS / WOODHILL DR
NORTHBROOK, IL



Legend

- Parcels Benefitted (10-Year)
- School Properties

Storm Sewer Network

Structure Type

- Storm Sewer
- Control Structure
- Catch Basin
- Discharge Point
- Inlet
- Storm Manhole

Existing Flooding Conditions (10-Year Storm)

Depth

- Less than 0.5 ft
- Between 0.5 ft and 1.0 ft
- Between 1.0 ft and 1.5 ft
- Between 1.5 ft and 2.0 ft
- Between 2.0 ft and 2.5 ft
- Between 2.5 ft and 3.0 ft
- Between 3.0 ft and 3.5 ft
- Between 3.5 ft and 4.0 ft
- More than 4.0 ft

N W E S

ENGINEERING RESOURCE ASSOCIATES

1 inch = 150 feet

0 37.5 75 150 225 300 Feet

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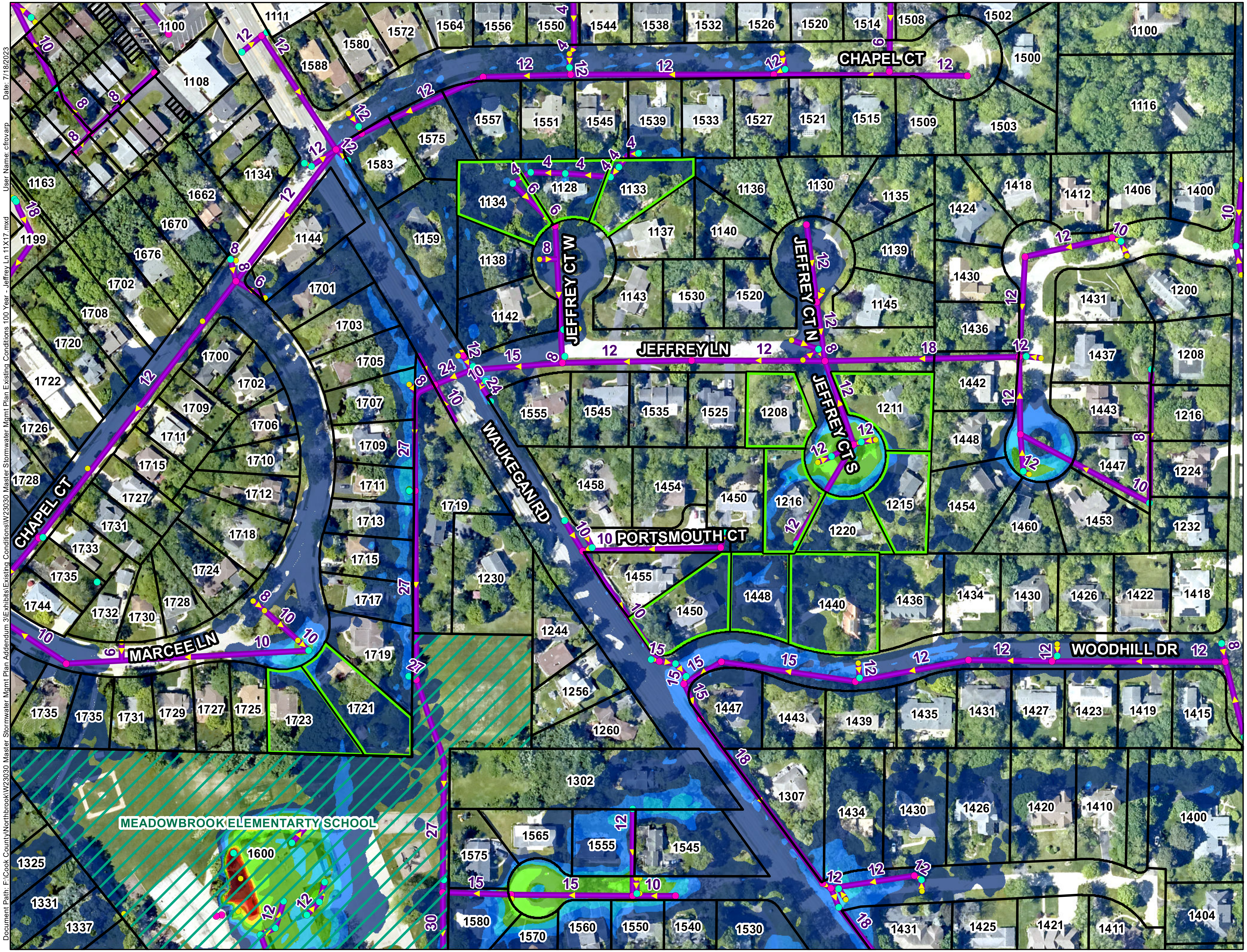
EXHIBIT 4
STUDY LOCATIONS 13B & 11
EXISTING CONDITIONS
100-YEAR STORM
MARCEE LN & JEFFREY CTS / WOODHILL DR
NORTHBROOK, IL



Legend

- Parcels Benefitted (10-Year)
- School Properties

Storm Sewer Network

Structure Type

- Storm Sewer
- Control Structure
- Catch Basin
- Discharge Point
- Inlet
- Storm Manhole

Existing Flooding Conditions (100-Year Storm)

Depth

- Less than 0.5 ft
- Between 0.5 ft and 1.0 ft
- Between 1.0 ft and 1.5 ft
- Between 1.5 ft and 2.0 ft
- Between 2.0 ft and 2.5 ft
- Between 2.5 ft and 3.0 ft
- Between 3.0 ft and 3.5 ft
- Between 3.5 ft and 4.0 ft
- More than 4.0 ft

N W E S

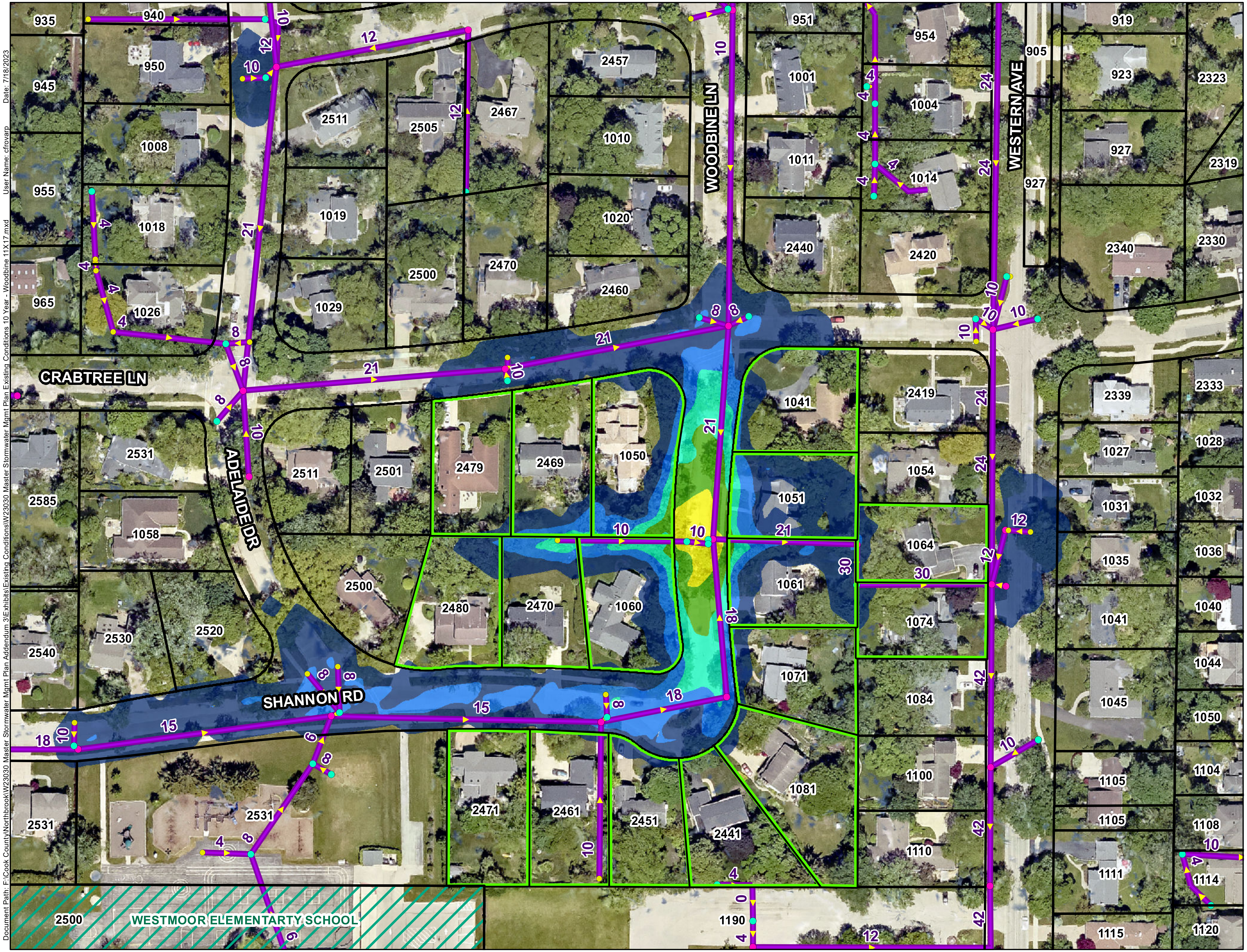
ENGINEERING RESOURCE ASSOCIATES

1 inch = 150 feet

0 37.5 75 150 225 300 Feet

Document Path: F:\Cook County\Northbrook\W23030 Master Stormwater Mgmt Plan Addendum 3\Exhibits\Existing Conditions\W23030 Master Stormwater Mgmt Plan Existing Conditions 100 Year - Jeffrey Ln 11X17.mxd User Name: cfrovarp Date: 7/18/2023

EXHIBIT 5
STUDY LOCATION 13A
EXISTING CONDITIONS
10-YEAR STORM
1000 WOODBINE LANE
NORTHBROOK, IL



Legend

- Parcels Benefitted (10-Year)
- School Properties

Storm Sewer Network

Structure Type

- Storm Sewer
- Control Structure
- Catch Basin
- Discharge Point
- Inlet
- Storm Manhole

Existing Flooding Conditions (10-Year Storm)

Depth

- Less than 0.5 ft
- Between 0.5 ft and 1.0 ft
- Between 1.0 ft and 1.5 ft
- Between 1.5 ft and 2.0 ft
- Between 2.0 ft and 2.5 ft
- Between 2.5 ft and 3.0 ft
- Between 3.0 ft and 3.5 ft
- Between 3.5 ft and 4.0 ft
- More than 4.0 ft

N
W E
S

ENGINEERING
RESOURCE ASSOCIATES

1 inch = 100 feet

0 25 50 100 150 200 Feet

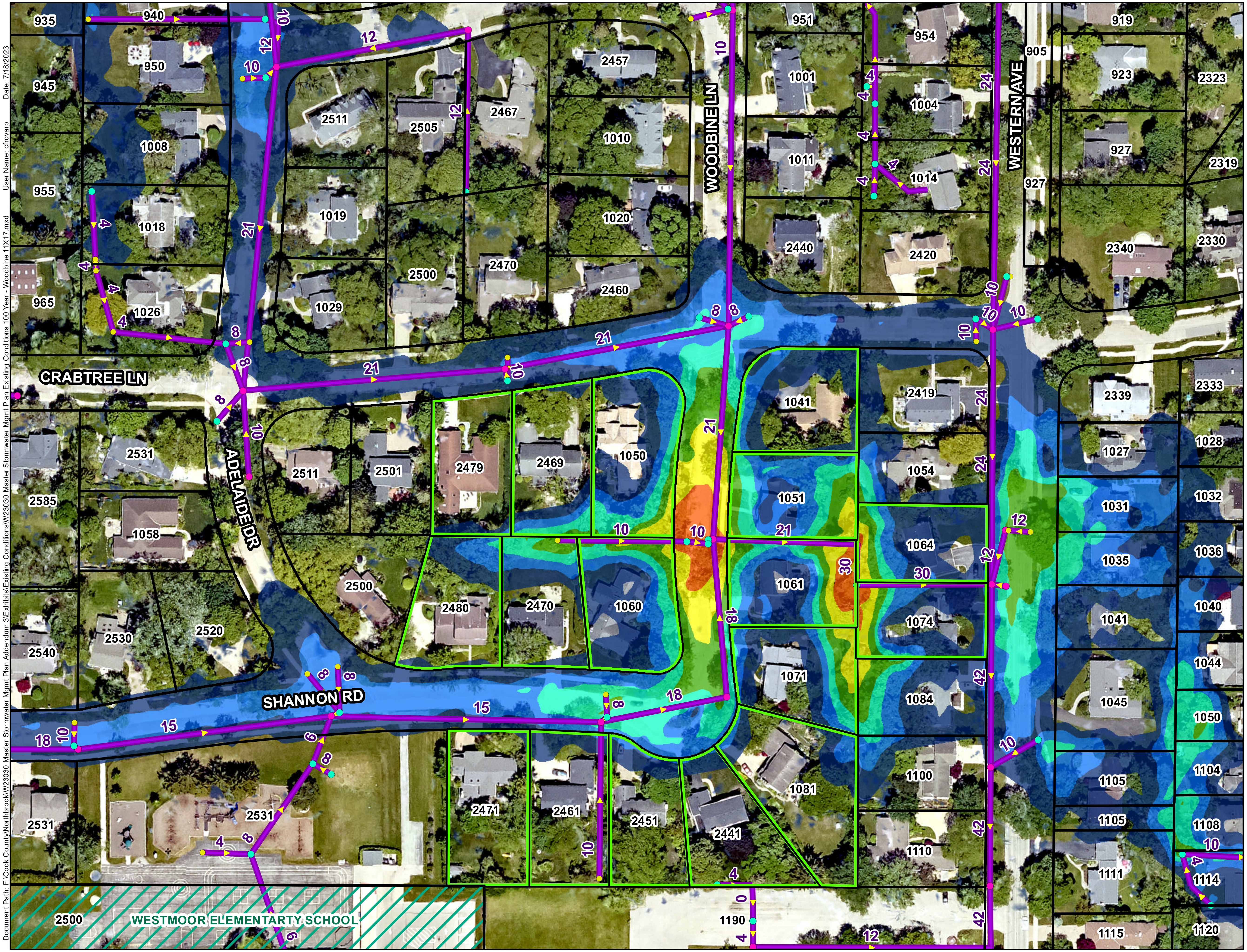


EXHIBIT 6
STUDY LOCATION 13A
EXISTING CONDITIONS
100-YEAR STORM
1000 WOODBINE LANE
NORTHBROOK, IL

Legend

- Parcels Benefitted (10-Year)
- School Properties

Storm Sewer Network

Structure Type

- Storm Sewer
- Control Structure
- Catch Basin
- Discharge Point
- Inlet
- Storm Manhole

Existing Flooding Conditions (100-Year Storm)

Depth

- Less than 0.5 ft
- Between 0.5 ft and 1.0 ft
- Between 1.0 ft and 1.5 ft
- Between 1.5 ft and 2.0 ft
- Between 2.0 ft and 2.5 ft
- Between 2.5 ft and 3.0 ft
- Between 3.0 ft and 3.5 ft
- Between 3.5 ft and 4.0 ft
- More than 4.0 ft

N W E S

ENGINEERING RESOURCE ASSOCIATES

1 inch = 100 feet

0 25 50 100 150 200 Feet

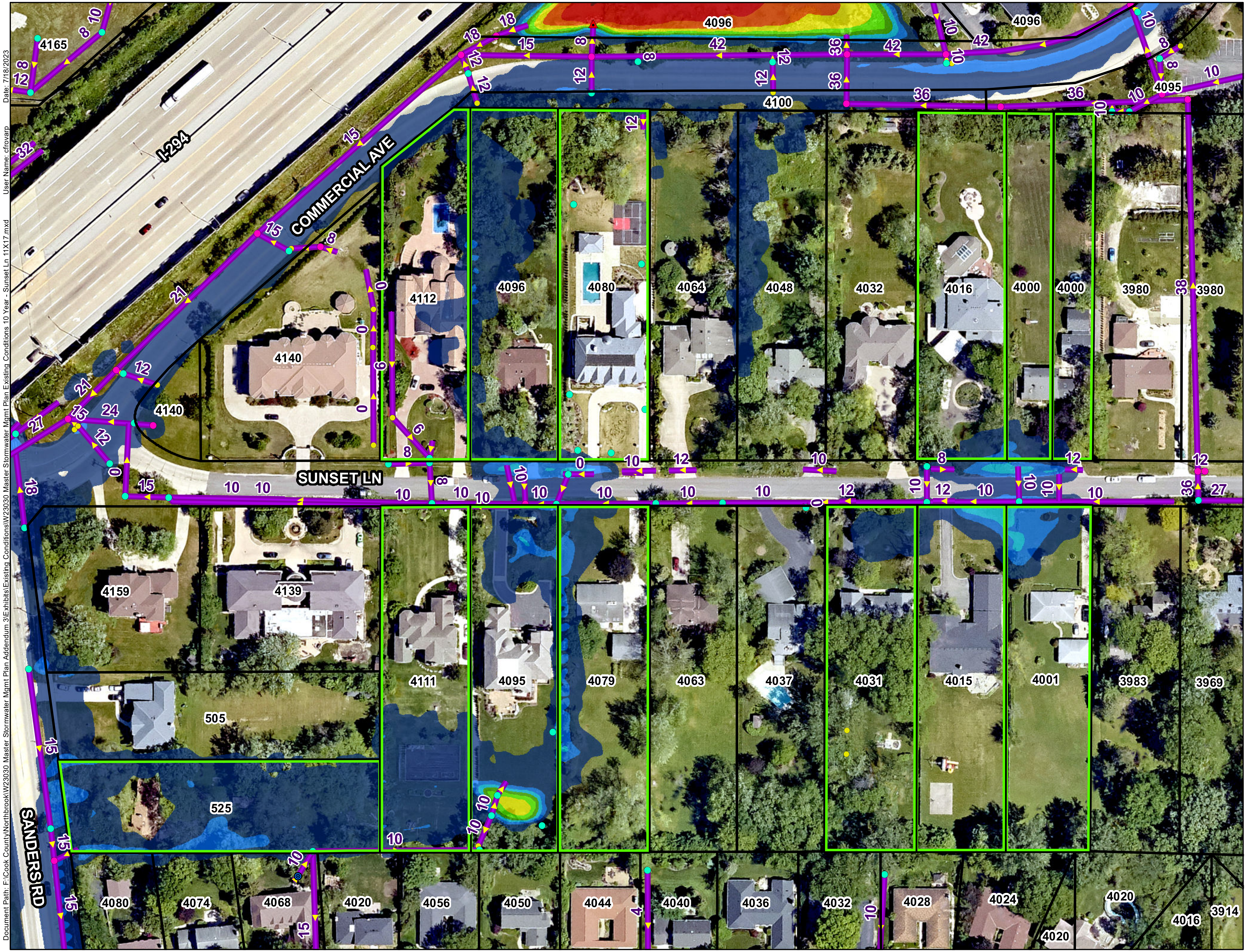


EXHIBIT 7
STUDY LOCATION 10
EXISTING CONDITIONS
10-YEAR STORM
SUNSET LANE
NORTHBROOK, IL

Legend

Parcels Benefitted (10-Year)

Storm Sewer Network

Structure Type

- Storm Sewer
- Control Structure
- Catch Basin
- Discharge Point
- Inlet
- Storm Manhole

Existing Flooding Conditions (10-Year Storm)

Depth

- Less than 0.5 ft
- Between 0.5 ft and 1.0 ft
- Between 1.0 ft and 1.5 ft
- Between 1.5 ft and 2.0 ft
- Between 2.0 ft and 2.5 ft
- Between 2.5 ft and 3.0 ft
- Between 3.0 ft and 3.5 ft
- Between 3.5 ft and 4.0 ft
- More than 4.0 ft

N E S W

ENGINEERING RESOURCE ASSOCIATES

1 inch = 100 feet

0 25 50 100 150 200 Feet

Date: 7/18/2023

User Name: cfrovarp

Document Path: F:\Cook County\Northbrook\W23030 Master Stormwater Mgmt Plan Addendum 3\Exhibits\Existing Conditions\W23030 Master Stormwater Mgmt Plan Existing Conditions 100 Year - Sunset Ln 11X17.mxd

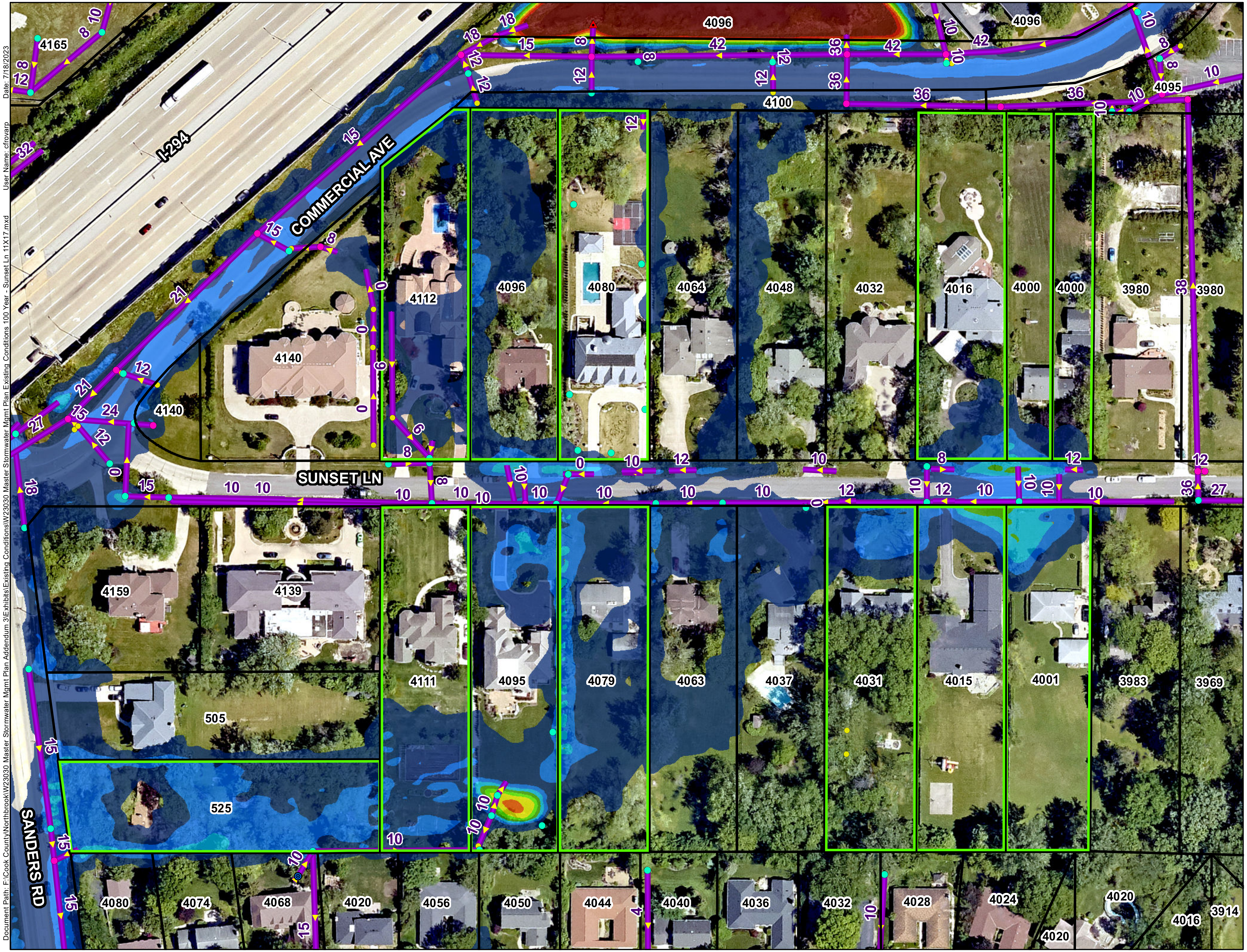


EXHIBIT 8
STUDY LOCATION 10
EXISTING CONDITIONS
100-YEAR STORM
SUNSET LANE
NORTHBROOK, IL

Legend

Parcels Benefitted (10-Year)

Storm Sewer Network

Structure Type

- Storm Sewer
- Control Structure
- Catch Basin
- Discharge Point
- Inlet
- Storm Manhole

Existing Flooding Conditions (100-Year Storm)

Depth

- Less than 0.5 ft
- Between 0.5 ft and 1.0 ft
- Between 1.0 ft and 1.5 ft
- Between 1.5 ft and 2.0 ft
- Between 2.0 ft and 2.5 ft
- Between 2.5 ft and 3.0 ft
- Between 3.0 ft and 3.5 ft
- Between 3.5 ft and 4.0 ft
- More than 4.0 ft

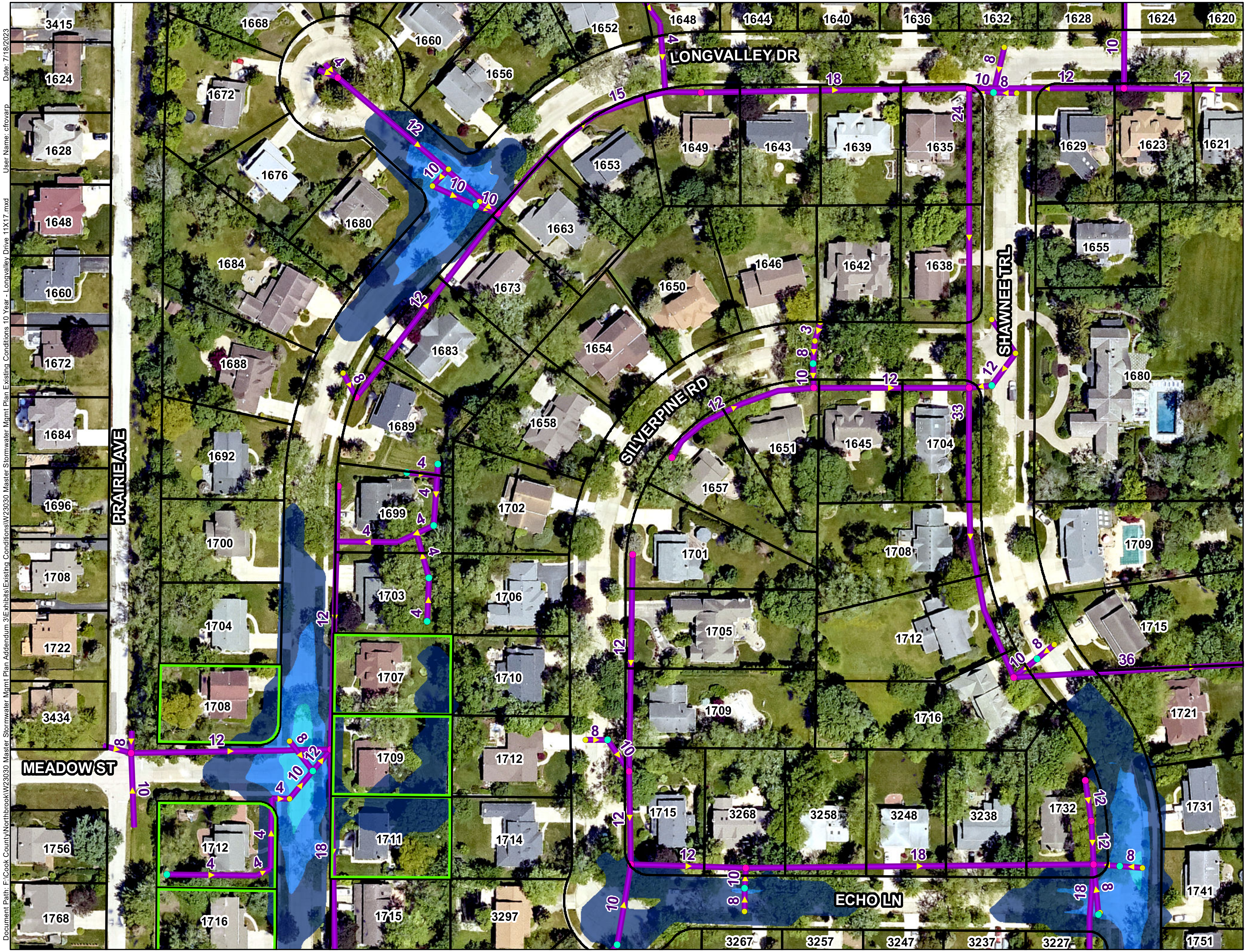
N E S W

ENGINEERING RESOURCE ASSOCIATES

1 inch = 100 feet

Feet 0 25 50 100 150 200

EXHIBIT 9
STUDY LOCATION 33
EXISTING CONDITIONS
10-YEAR STORM
LONGVALLEY DRIVE
NORTHBROOK, IL



Legend

Parcels Benefitted (10-Year)

Storm Sewer Network

Structure Type

- Storm Sewer
- Control Structure
- Catch Basin
- Discharge Point
- Inlet
- Storm Manhole

Existing Flooding Conditions (10-Year Storm)

Depth

- Less than 0.5 ft
- Between 0.5 ft and 1.0 ft
- Between 1.0 ft and 1.5 ft
- Between 1.5 ft and 2.0 ft
- Between 2.0 ft and 2.5 ft
- Between 2.5 ft and 3.0 ft
- Between 3.0 ft and 3.5 ft
- Between 3.5 ft and 4.0 ft
- More than 4.0 ft

N W E S

ENGINEERING RESOURCE ASSOCIATES

1 inch = 100 feet

0 25 50 100 150 200 Feet

Date: 7/18/2023

User Name: cfrovarp

Document Path: F:\Cook County\Northbrook\W23030 Master Stormwater Mgmt Plan Addendum 3\Exhibits\Existing Conditions\W23030 Master Stormwater Mgmt Plan Existing Conditions 10 Year - Longvalley Drive 11X17.mxd

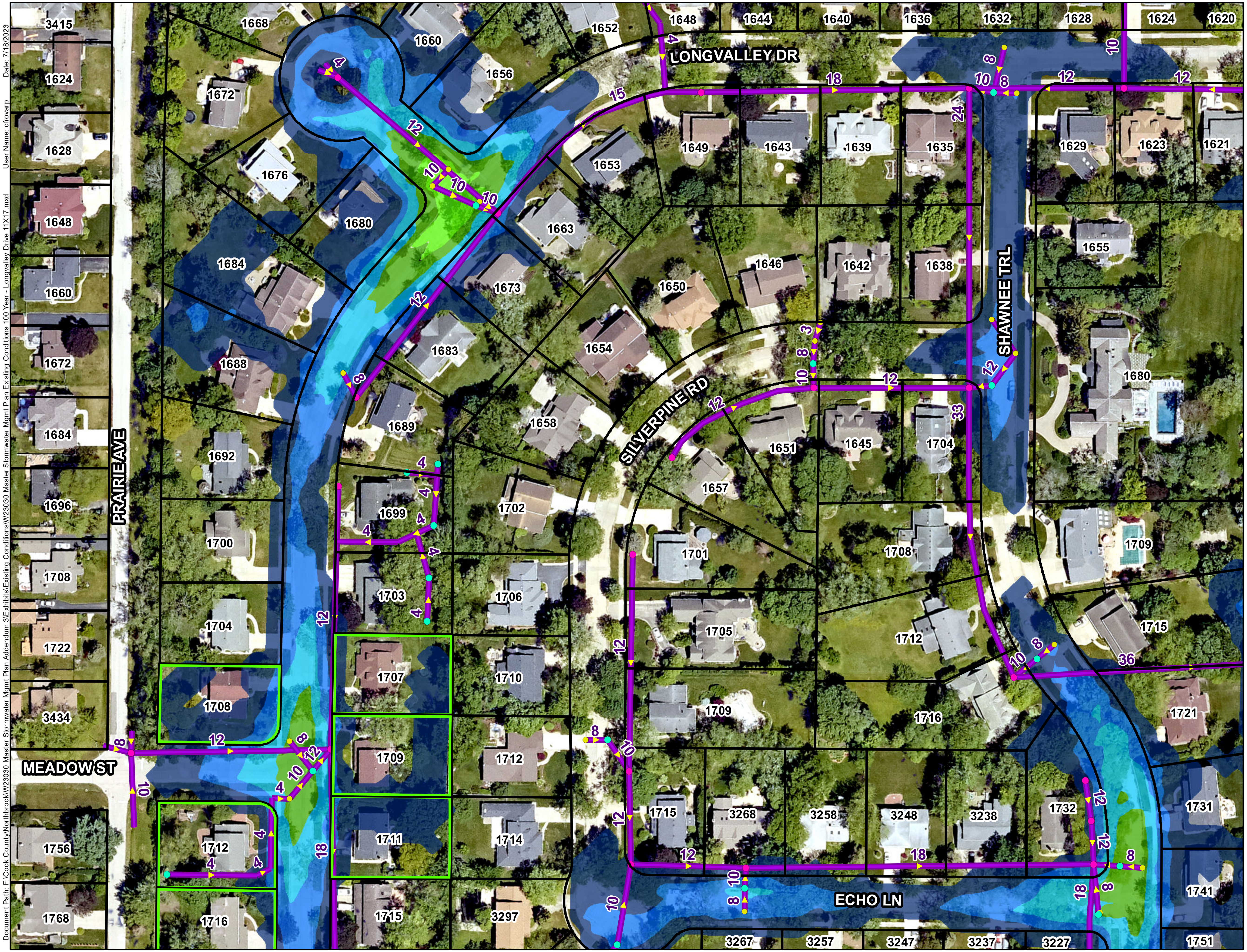


EXHIBIT 10
STUDY LOCATION 33
EXISTING CONDITIONS
100-YEAR STORM
LONGVALLEY DRIVE
NORTHBROOK, IL

Legend

Parcels Benefitted (10-Year)

Storm Sewer Network

Structure Type

- Storm Sewer
- Control Structure
- Catch Basin
- Discharge Point
- Inlet
- Storm Manhole

Existing Flooding Conditions (100-Year Storm)

Depth

- Less than 0.5 ft
- Between 0.5 ft and 1.0 ft
- Between 1.0 ft and 1.5 ft
- Between 1.5 ft and 2.0 ft
- Between 2.0 ft and 2.5 ft
- Between 2.5 ft and 3.0 ft
- Between 3.0 ft and 3.5 ft
- Between 3.5 ft and 4.0 ft
- More than 4.0 ft

N E S W

ENGINEERING RESOURCE ASSOCIATES

1 inch = 100 feet

0 25 50 100 150 200 Feet

Document Path: F:\Cook County\Northbrook\W23030 Master Stormwater Mgmt Plan Addendum 3\Exhibits\Existing Conditions\W23030 Master Stormwater Mgmt Plan Existing Conditions 100 Year - Longvalley Drive 11X17.mxd User Name: cfovarp Date: 7/18/2023

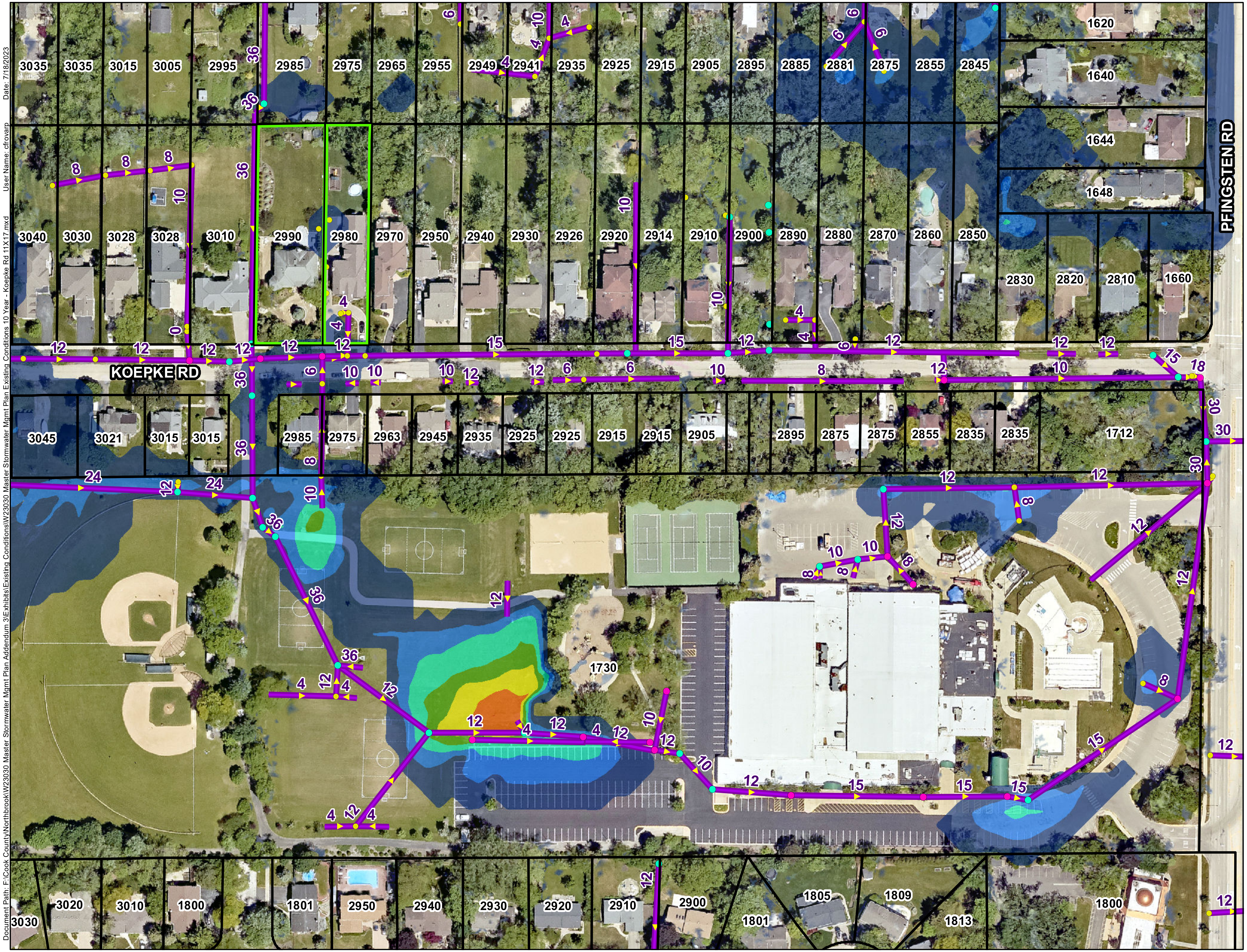


EXHIBIT 11
STUDY LOCATION 1
EXISTING CONDITIONS
10-YEAR STORM
2980 KOEPKE ROAD
NORTHBROOK, IL

Legend

Parcels Benefitted (10-Year)

Storm Sewer Network

Structure Type

- Storm Sewer
- Control Structure
- Catch Basin
- Discharge Point
- Inlet
- Storm Manhole

Existing Flooding Conditions (10-Year Storm)

Depth

- Less than 0.5 ft
- Between 0.5 ft and 1.0 ft
- Between 1.0 ft and 1.5 ft
- Between 1.5 ft and 2.0 ft
- Between 2.0 ft and 2.5 ft
- Between 2.5 ft and 3.0 ft
- Between 3.0 ft and 3.5 ft
- Between 3.5 ft and 4.0 ft
- More than 4.0 ft

N
W E
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ENGINEERING
RESOURCE ASSOCIATES

1 inch = 120 feet

0 30 60 120 180 240 Feet

Date: 7/18/2023
User Name: cfrovarp
Document Path: F:\Cook County\Northbrook\W23030 Master Stormwater Mgmt Plan Addendum 3\Exhibits\Existing Conditions\W23030 Master Stormwater Mgmt Plan Existing Conditions 10 Year - Koepke Rd 11X17.mxd

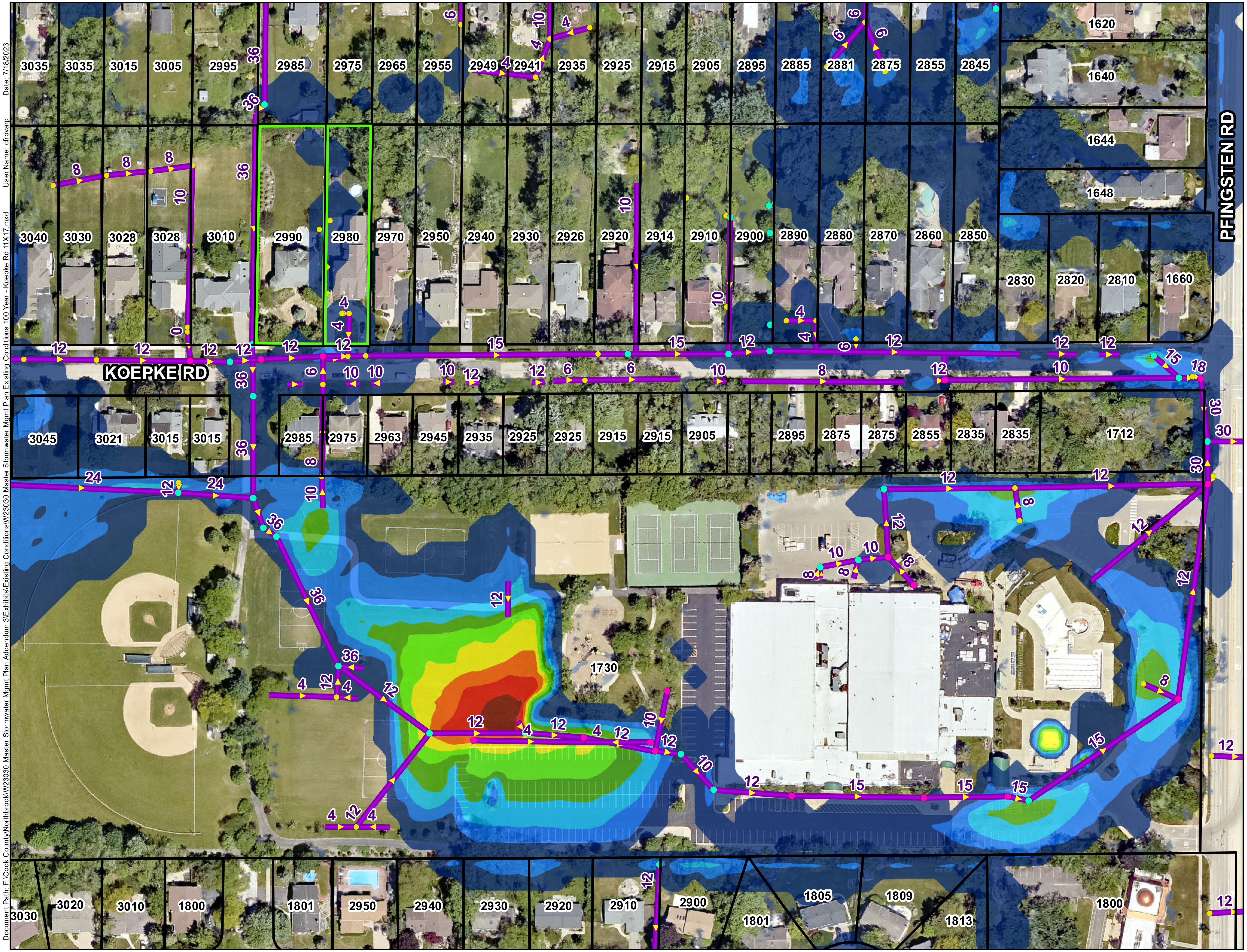


EXHIBIT 12
STUDY LOCATION 1
EXISTING CONDITIONS
100-YEAR STORM
2980 KOEPKE ROAD
NORTHBROOK, IL

Legend

Parcels Benefitted (10-Year)

Storm Sewer Network

Structure Type

- Storm Sewer
- Control Structure
- Catch Basin
- Discharge Point
- Inlet
- Storm Manhole

Existing Flooding Conditions (100-Year Storm)

Depth

- Less than 0.5 ft
- Between 0.5 ft and 1.0 ft
- Between 1.0 ft and 1.5 ft
- Between 1.5 ft and 2.0 ft
- Between 2.0 ft and 2.5 ft
- Between 2.5 ft and 3.0 ft
- Between 3.0 ft and 3.5 ft
- Between 3.5 ft and 4.0 ft
- More than 4.0 ft

N E S W

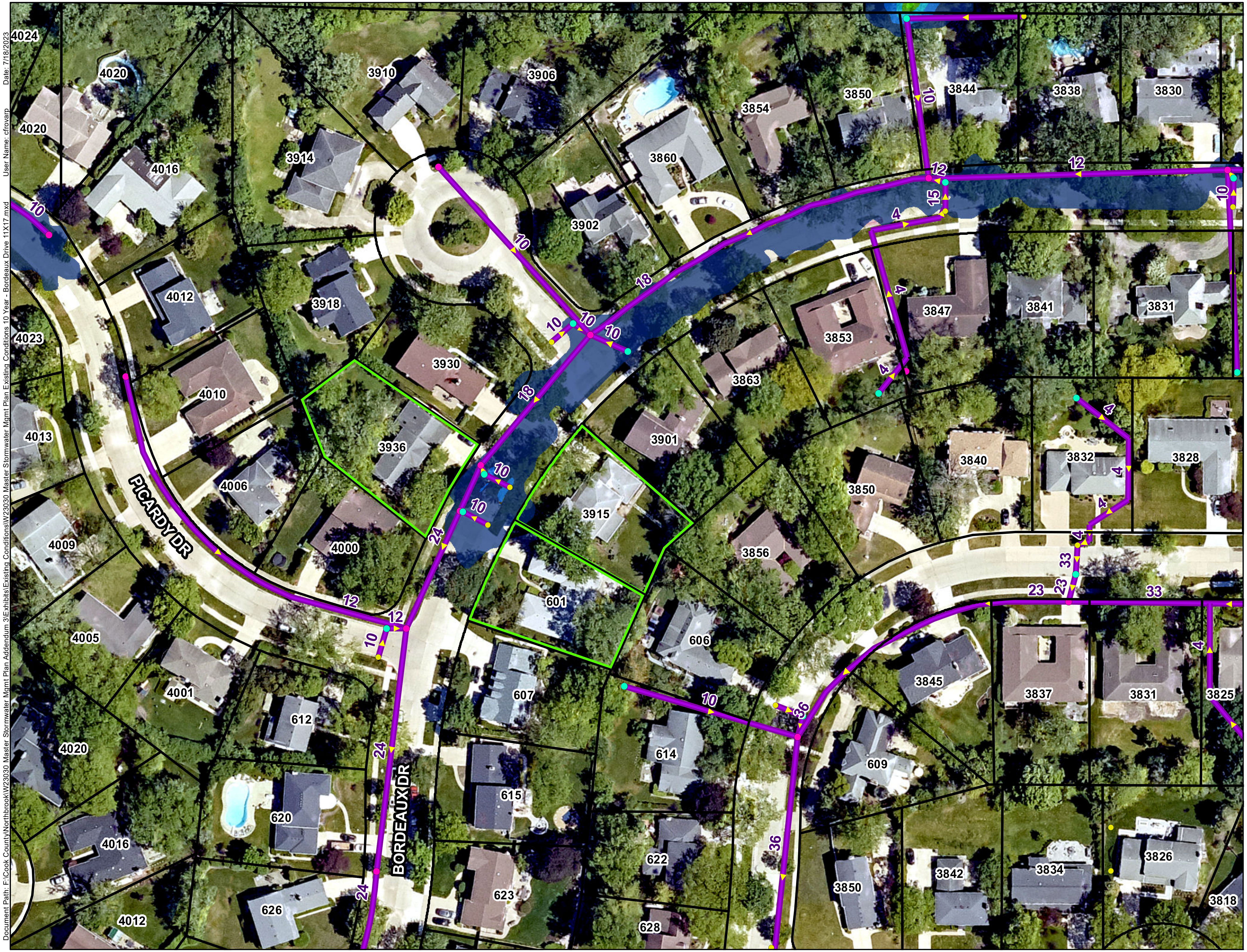
ENGINEERING RESOURCE ASSOCIATES

1 inch = 120 feet

0 30 60 120 180 240 Feet

Document Path: F:\Cook County\Northbrook\W23030 Master Stormwater Mgmt Plan Addendum 3\Exhibits\Existing Conditions\W23030 Master Stormwater Mgmt Plan Existing Conditions 100 Year - Koepke Rd 11X17.mxd User Name: cfrovarp Date: 7/18/2023

EXHIBIT 13
STUDY LOCATION 5
EXISTING CONDITIONS
10-YEAR STORM
3936 BORDEAUX DRIVE
NORTHBROOK, IL



Date: 7/18/2023 User Name: cfovarp Document Path: F:\Cook County\Northbrook\W23030 Master Stormwater Mgmt Plan Addendum 3\Exhibits\Existing Conditions\W23030 Master Stormwater Mgmt Plan Existing Conditions 10 Year - Bordeaux Drive 11X17.mxd

Legend

Parcels Benefitted (10-Year)

Storm Sewer Network

Structure Type

- Storm Sewer
- Control Structure
- Catch Basin
- Discharge Point
- Inlet
- Storm Manhole

Existing Flooding Conditions (10-Year Storm)

Depth

- Less than 0.5 ft
- Between 0.5 ft and 1.0 ft
- Between 1.0 ft and 1.5 ft
- Between 1.5 ft and 2.0 ft
- Between 2.0 ft and 2.5 ft
- Between 2.5 ft and 3.0 ft
- Between 3.0 ft and 3.5 ft
- Between 3.5 ft and 4.0 ft
- More than 4.0 ft

N W E S

ENGINEERING RESOURCE ASSOCIATES

1 inch = 80 feet

0 20 40 80 120 160 Feet

EXHIBIT 14
STUDY LOCATION 5
EXISTING CONDITIONS
100-YEAR STORM
3936 BORDEAUX DRIVE
NORTHBROOK, IL

Legend

Parcels Benefitted (10-Year)

Storm Sewer Network

Structure Type

- Storm Sewer
- Control Structure
- Catch Basin
- Discharge Point
- Inlet
- Storm Manhole

Existing Flooding Conditions (100-Year Storm)

Depth

- Less than 0.5 ft
- Between 0.5 ft and 1.0 ft
- Between 1.0 ft and 1.5 ft
- Between 1.5 ft and 2.0 ft
- Between 2.0 ft and 2.5 ft
- Between 2.5 ft and 3.0 ft
- Between 3.0 ft and 3.5 ft
- Between 3.5 ft and 4.0 ft
- More than 4.0 ft

N
W E
S

ENGINEERING RESOURCE ASSOCIATES

1 inch = 80 feet

0 20 40 80 120 160 Feet

Document Path: F:\Cook County\Northbrook\W23030 Master Stormwater Mgmt Plan Addendum 3\Exhibits\Existing Conditions\W23030 Master Stormwater Mgmt Plan Existing Conditions 100 Year - Bordeaux Drive 11X17.mxd User Name: cfrovarp Date: 7/18/2023

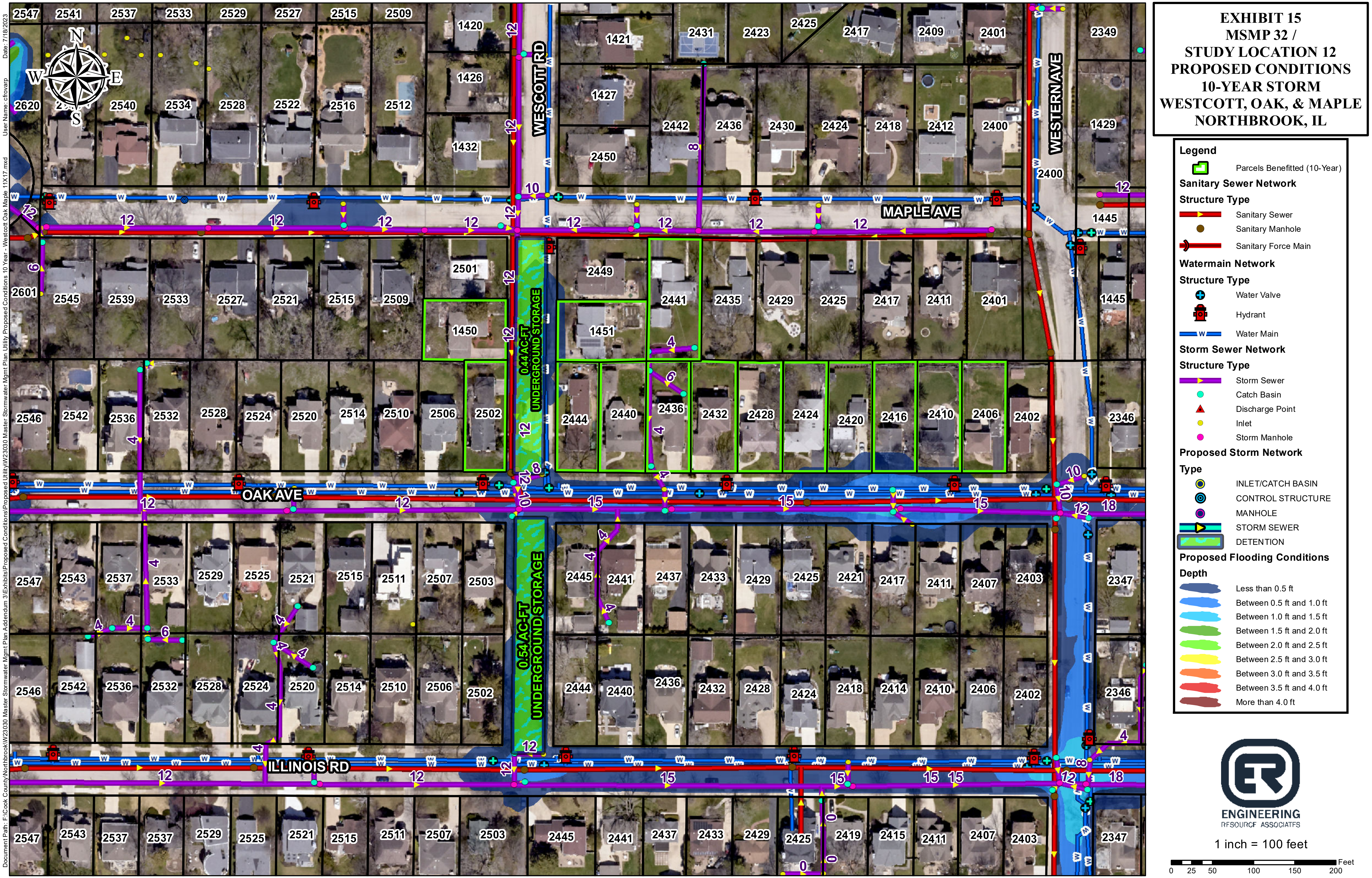


EXHIBIT 15
MSMP 32 /
STUDY LOCATION 12
PROPOSED CONDITIONS
10-YEAR STORM
WESTCOTT, OAK, & MAPLE
NORTHBROOK, IL
Legend
Parcels Benefitted (10-Year)
Sanitary Sewer Network
Structure Type
Sanitary Sewer
Sanitary Manhole
Sanitary Force Main
Watermain Network
Structure Type
Water Valve
Hydrant
Water Main
Storm Sewer Network
Structure Type
Storm Sewer
Catch Basin
Discharge Point
Inlet
Storm Manhole
Proposed Storm Network
Type
INLET/CATCH BASIN
CONTROL STRUCTURE
MANHOLE
STORM SEWER
DETENTION
Proposed Flooding Conditions
Depth
Less than 0.5 ft
Between 0.5 ft and 1.0 ft
Between 1.0 ft and 1.5 ft
Between 1.5 ft and 2.0 ft
Between 2.0 ft and 2.5 ft
Between 2.5 ft and 3.0 ft
Between 3.0 ft and 3.5 ft
Between 3.5 ft and 4.0 ft
More than 4.0 ft
ENGINEERING
RESOURCE ASSOCIATES
1 inch = 100 feet
0 25 50 100 150 200 Feet
WESCOTT RD
WESTERN AVE
MAPLE AVE
OAK AVE
ILLINOIS RD
0.44 AC-FT UNDERGROUND STORAGE
0.54 AC-FT UNDERGROUND STORAGE
N
E
S
W
Date: 7/18/2023
User Name: cfrovarp

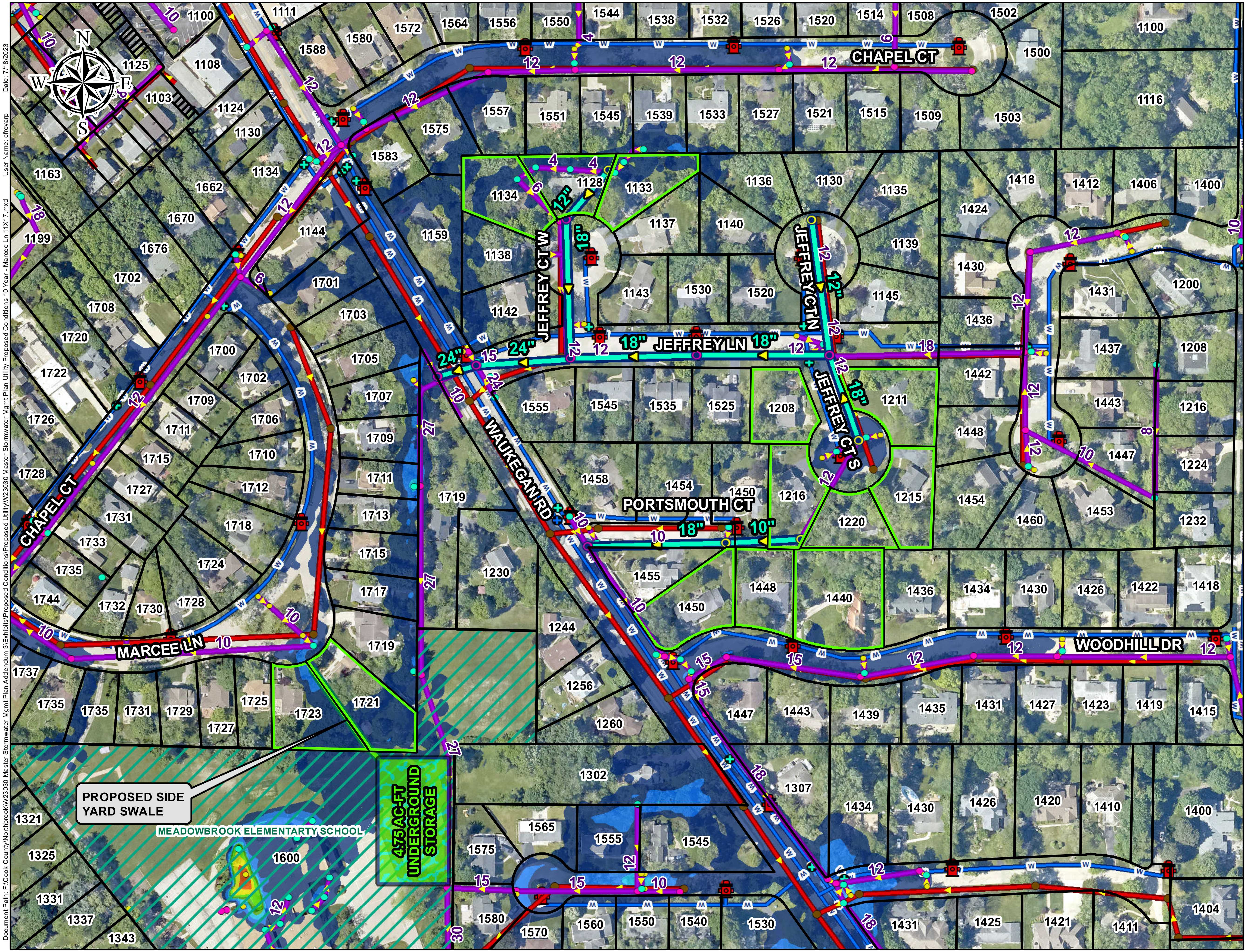


EXHIBIT 16
MSMP 33 / STUDY LOCATIONS 13B & 11 PROPOSED CONDITIONS 10-YEAR STORM MARCEE LN & JEFFREY CTS / WOODHILL DR NORTHBROOK, IL

Legend

- Parcels Benefitted (10-Year)
- School Properties

Sanitary Sewer Network

Structure Type
- Sanitary Sewer
- Sanitary Manhole
- Sanitary Force Main

Watermain Network

Structure Type
- Water Valve
- Hydrant
- Water Main

Storm Sewer Network

Structure Type
- Storm Sewer
- Catch Basin
- Discharge Point
- Inlet
- Storm Manhole

Proposed Storm Network

Type
- INLET/CATCH BASIN
- CONTROL STRUCTURE
- MANHOLE
- STORM SEWER
- DETENTION

Proposed Flooding Conditions

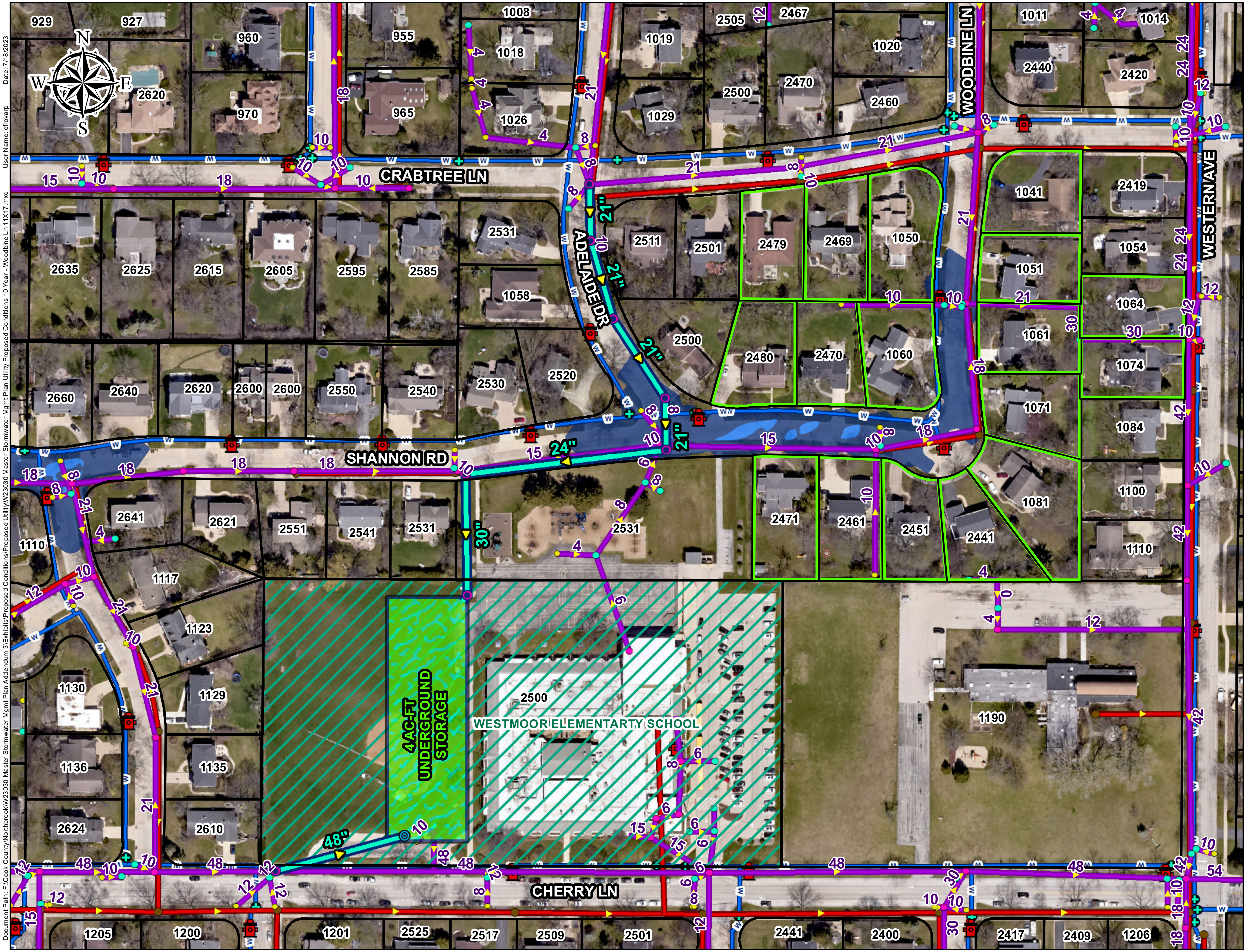
Depth
- Less than 0.5 ft
- Between 0.5 ft and 1.0 ft
- Between 1.0 ft and 1.5 ft
- Between 1.5 ft and 2.0 ft
- Between 2.0 ft and 2.5 ft
- Between 2.5 ft and 3.0 ft
- Between 3.0 ft and 3.5 ft
- Between 3.5 ft and 4.0 ft
- More than 4.0 ft

ENGINEERING RESOURCE ASSOCIATES

1 inch = 150 feet

0 37.5 75 150 225 300 Feet

EXHIBIT 17
MSMP 34 / STUDY LOCATION 13A PROPOSED CONDITIONS 10-YEAR STORM WOODBINE LANE NORTHBROOK, IL



Legend

- Parcels Benefitted (10-Year)
- School Properties

Sanitary Sewer Network

Structure Type

- Sanitary Sewer
- Sanitary Manhole
- Sanitary Force Main

Watermain Network

Structure Type

- Water Valve
- Hydrant
- Water Main

Storm Sewer Network

Structure Type

- Storm Sewer
- Catch Basin
- Discharge Point
- Inlet
- Storm Manhole

Proposed Storm Network

Type

- INLET/CATCH BASIN
- CONTROL STRUCTURE
- MANHOLE
- STORM SEWER
- DETENTION

Proposed Flooding Conditions

Depth

- Less than 0.5 ft
- Between 0.5 ft and 1.0 ft
- Between 1.0 ft and 1.5 ft
- Between 1.5 ft and 2.0 ft
- Between 2.0 ft and 2.5 ft
- Between 2.5 ft and 3.0 ft
- Between 3.0 ft and 3.5 ft
- Between 3.5 ft and 4.0 ft
- More than 4.0 ft

ENGINEERING RESOURCE ASSOCIATES

1 inch = 125 feet

0 30 60 120 180 240 Feet

User Name: cfrovarp Date: 7/18/2023

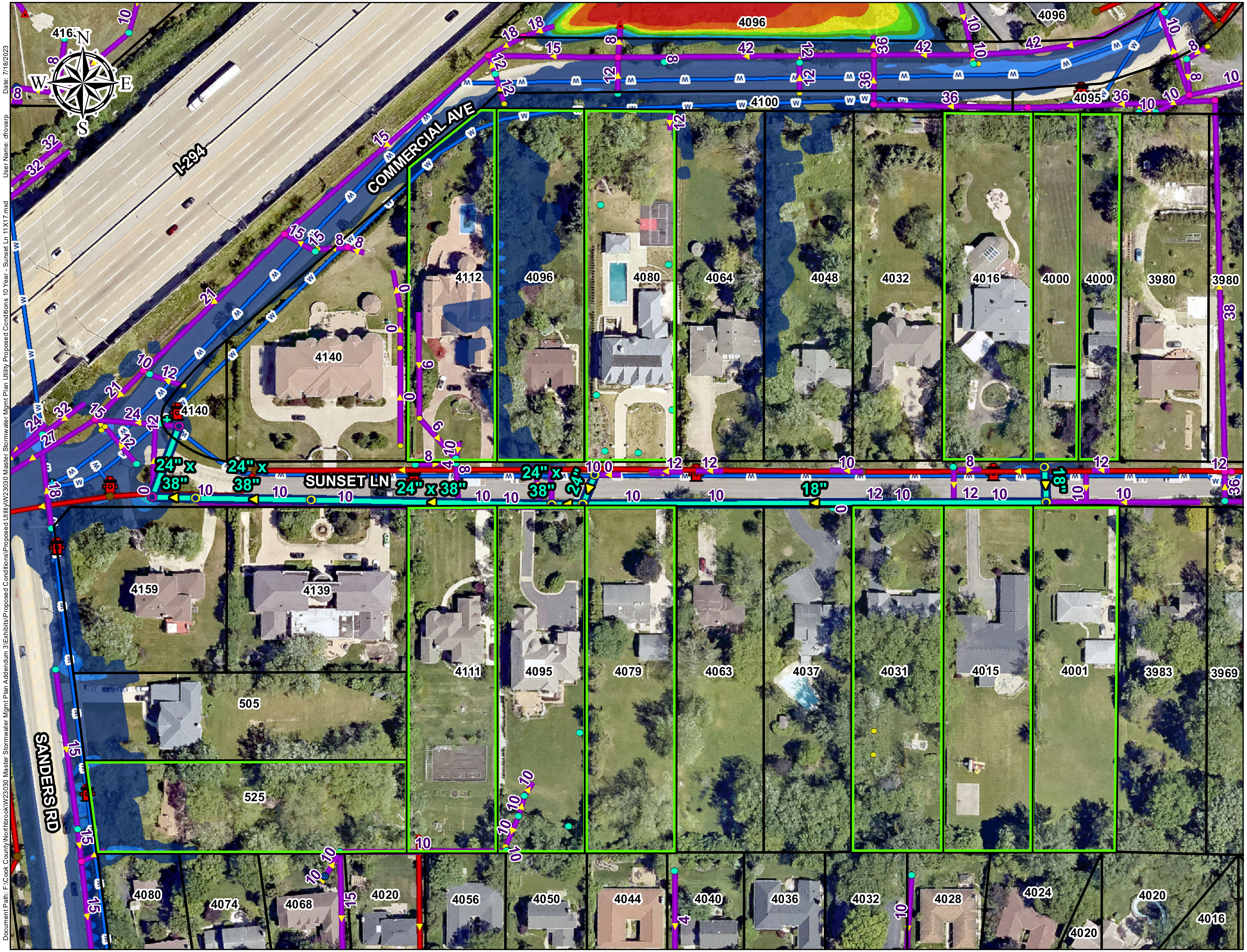


EXHIBIT 18
MSMP 35 / STUDY LOCATION 10
PROPOSED CONDITIONS
10-YEAR STORM
SUNSET LANE
NORTHBROOK, IL

Legend

Parcels Benefitted (10-Year)

Sanitary Sewer Network

Structure Type

- Sanitary Sewer
- Sanitary Manhole
- Sanitary Force Main

Watermain Network

Structure Type

- Water Valve
- Hydrant
- Water Main

Storm Sewer Network

Structure Type

- Storm Sewer
- Catch Basin
- Discharge Point
- Inlet
- Storm Manhole

Proposed Storm Network

Type

- INLET/CATCH BASIN
- CONTROL STRUCTURE
- MANHOLE
- STORM SEWER
- DETENTION

Proposed Flooding Conditions

Depth

- Less than 0.5 ft
- Between 0.5 ft and 1.0 ft
- Between 1.0 ft and 1.5 ft
- Between 1.5 ft and 2.0 ft
- Between 2.0 ft and 2.5 ft
- Between 2.5 ft and 3.0 ft
- Between 3.0 ft and 3.5 ft
- Between 3.5 ft and 4.0 ft
- More than 4.0 ft

ENGINEERING RESOURCE ASSOCIATES

1 inch = 100 feet

0 25 50 100 150 200 Feet

Date: 7/18/2023 User Name: dfovarp

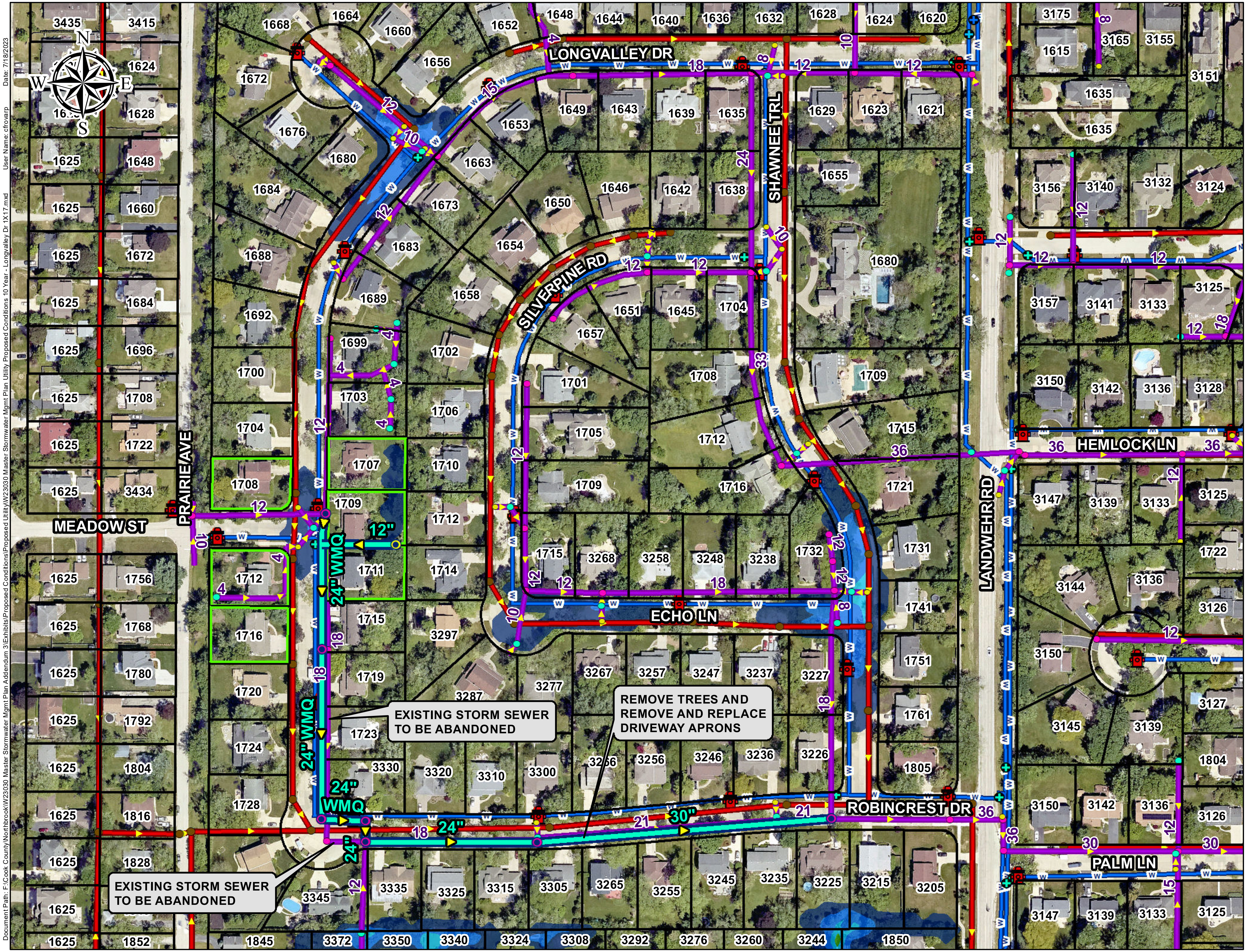


EXHIBIT 19
MSMP 36 / STUDY LOCATION 33
PROPOSED CONDITIONS
10-YEAR STORM
LONGVALLEY DRIVE
NORTHBROOK, IL

Legend

- Parcels Benefitted (10-Year)

Sanitary Sewer Network

Structure Type

- Sanitary Sewer
- Sewage
- Sanitary Force Main

Watermain Network

Structure Type

- Water Valve
- Hydrant
- Water Main

Storm Sewer Network

Structure Type

- Storm Sewer
- Catch Basin
- Discharge Point
- Inlet
- Storm Manhole

Proposed Storm Network

Type

- INLET/CATCH BASIN
- CONTROL STRUCTURE
- MANHOLE
- STORM SEWER
- DETENTION

Proposed Flooding Conditions

Depth

- Less than 0.5 ft
- Between 0.5 ft and 1.0 ft
- Between 1.0 ft and 1.5 ft
- Between 1.5 ft and 2.0 ft
- Between 2.0 ft and 2.5 ft
- Between 2.5 ft and 3.0 ft
- Between 3.0 ft and 3.5 ft
- Between 3.5 ft and 4.0 ft
- More than 4.0 ft

ENGINEERING RESOURCE ASSOCIATES

1 inch = 150 feet

0 37.5 75 150 225 300 Feet

Document Path: F:\Cook County\Northbrook\W23030 Master Stormwater Mgmt Plan Addendum 3\Exhibits\Proposed Conditions\Proposed Utility\W23030 Master Stormwater Mgmt Plan Utility Proposed Conditions 10 Year - Koepke Rd 1X17.mxd User Name: cfrovarp Date: 7/18/2023

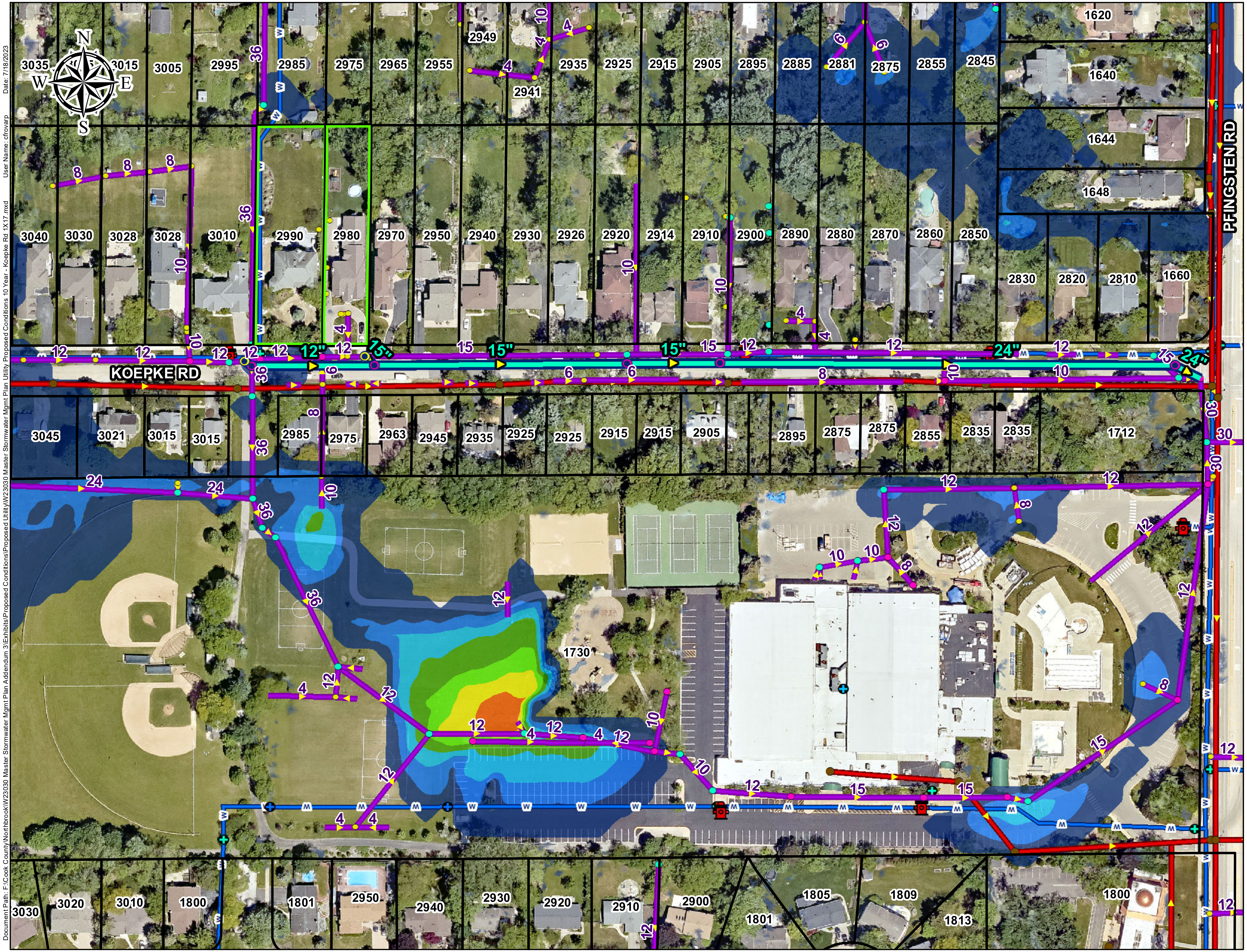


EXHIBIT 20
MSMP 37 / STUDY LOCATION 1
PROPOSED CONDITIONS
10-YEAR STORM
KOEPKE ROAD
NORTHBROOK, IL

Legend

Parcels Benefitted (10-Year)

Sanitary Sewer Network

Structure Type

- Sanitary Sewer
- Sanitary Manhole
- Sanitary Force Main

Watermain Network

Structure Type

- Water Valve
- Hydrant
- Water Main

Storm Sewer Network

Structure Type

- Storm Sewer
- Catch Basin
- Discharge Point
- Inlet
- Storm Manhole

Proposed Storm Network

Type

- INLET/CATCH BASIN
- CONTROL STRUCTURE
- MANHOLE
- STORM SEWER
- DETENTION

Proposed Flooding Conditions

Depth

- Less than 0.5 ft
- Between 0.5 ft and 1.0 ft
- Between 1.0 ft and 1.5 ft
- Between 1.5 ft and 2.0 ft
- Between 2.0 ft and 2.5 ft
- Between 2.5 ft and 3.0 ft
- Between 3.0 ft and 3.5 ft
- Between 3.5 ft and 4.0 ft
- More than 4.0 ft

ENGINEERING RESOURCE ASSOCIATES

1 inch = 120 feet

0 30 60 120 180 240 Feet

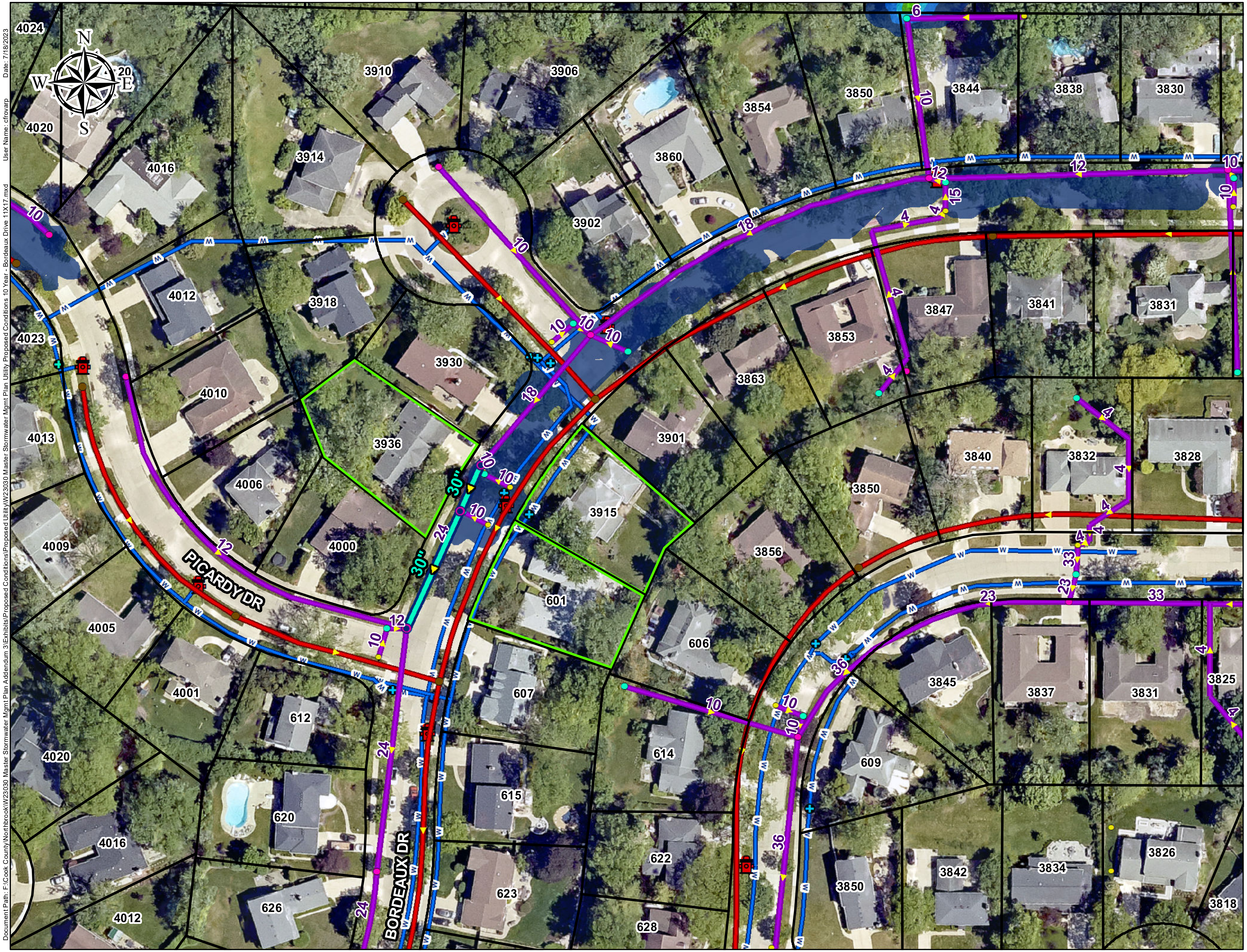


EXHIBIT 21
STUDY LOCATION 5
PROPOSED CONDITIONS
10-YEAR STORM
BORDEAUX DRIVE
NORTHBROOK, IL

Legend

Parcels Benefitted (10-Year)

Sanitary Sewer Network

Structure Type

- Sanitary Sewer
- Sanitary Manhole
- Sanitary Force Main

Watermain Network

Structure Type

- Water Valve
- Hydrant
- Water Main

Storm Sewer Network

Structure Type

- Storm Sewer
- Catch Basin
- Discharge Point
- Inlet
- Storm Manhole

Proposed Storm Network

Type

- INLET/CATCH BASIN
- CONTROL STRUCTURE
- MANHOLE
- STORM SEWER
- DETENTION

Proposed Flooding Conditions

Depth

- Less than 0.5 ft
- Between 0.5 ft and 1.0 ft
- Between 1.0 ft and 1.5 ft
- Between 1.5 ft and 2.0 ft
- Between 2.0 ft and 2.5 ft
- Between 2.5 ft and 3.0 ft
- Between 3.0 ft and 3.5 ft
- Between 3.5 ft and 4.0 ft
- More than 4.0 ft

ENGINEERING RESOURCE ASSOCIATES

1 inch = 80 feet

0 20 40 80 120 160 Feet

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REVISIONS:					
DATE	BY	DESCRIPTION	DATE	BY	DESCRIPTION

DRAWN BY: CF
CHECKED BY: MM
APPROVED BY: MG

ENGINEERING RESOURCE ASSOCIATES

35701 WEST AVENUE, SUITE 150
WARRENVILLE, ILLINOIS 60555
PHONE (630) 393-3060
FAX (630) 393-2152

10 S. RIVERSIDE PLAZA, SUITE 875
CHICAGO, ILLINOIS 60606
PHONE (312) 474-7841
FAX (312) 474-6099

2416 GALEN DRIVE
CHAMPAIGN, ILLINOIS 61821
PHONE (217) 351-6268
FAX (217) 355-1902

NORTHBROOK

TITLE:
MSMP 32 / STUDY LOCATION 12
PROPOSED CONDITIONS 10-YEAR STORM
WESCOTT, OAK, & MAPLE, NORTHBROOK, IL

SCALE: 1 inch = 50 feet
DATE: JUNE 2023
PROJECT: W23030.00
SHEET: 1 OF 7

REVISIONS:					
DATE	BY	DESCRIPTION	DATE	BY	DESCRIPTION

DRAWN BY: CF
CHECKED BY: MM
APPROVED BY: MG

ENGINEERING RESOURCE ASSOCIATES

3S701 WEST AVENUE, SUITE 150
WARRENVILLE, ILLINOIS 60555
PHONE (630) 393-3060
FAX (630) 393-2152

10 S. RIVERSIDE PLAZA, SUITE 875
CHICAGO, ILLINOIS 60606
PHONE (312) 474-7841
FAX (312) 474-6099

2416 GALEN DRIVE
CHAMPAIGN, ILLINOIS 61821
PHONE (217) 351-6268
FAX (217) 355-1902

NORTHBROOK

TITLE: MSMP 33 / STUDY LOCATIONS 13B & 11
PROPOSED CONDITIONS 10-YEAR STORM
MARCEE LN / JEFFREY CTS, NORTHBROOK, IL

SCALE: 1 inch = 80 feet
DATE: JUNE 2023
PROJECT: W23030.00
SHEET: 2 OF 7

REVISIONS:					
DATE	BY	DESCRIPTION	DATE	BY	DESCRIPTION

DRAWN BY: CF
CHECKED BY: MM
APPROVED BY: MG

ENGINEERING RESOURCE ASSOCIATES

3S701 WEST AVENUE, SUITE 150
WARRENVILLE, ILLINOIS 60555
PHONE (630) 393-3060
FAX (630) 393-2152

10 S. RIVERSIDE PLAZA, SUITE 875
CHICAGO, ILLINOIS 60606
PHONE (312) 474-7841
FAX (312) 474-6099

2416 GALEN DRIVE
CHAMPAIGN, ILLINOIS 61821
PHONE (217) 351-6268
FAX (217) 355-1902

NORTHBROOK

TITLE: MSMP 34 / STUDY LOCATION 13A
PROPOSED CONDITIONS 10-YEAR STORM
WOODBINE LN, NORTHBROOK, IL

SCALE: 1 inch = 60 feet
DATE: JUNE 2023
PROJECT: W23030.00
SHEET: 3 OF 7

REVISIONS:					
DATE	BY	DESCRIPTION	DATE	BY	DESCRIPTION

DRAWN BY: CF
CHECKED BY: MM
APPROVED BY: MG

ENGINEERING RESOURCE ASSOCIATES

3S701 WEST AVENUE, SUITE 150
WARRENVILLE, ILLINOIS 60555
PHONE (630) 393-3060
FAX (630) 393-2152

10 S. RIVERSIDE PLAZA, SUITE 875
CHICAGO, ILLINOIS 60606
PHONE (312) 474-7841
FAX (312) 474-6099

2416 GALEN DRIVE
CHAMPAIGN, ILLINOIS 61821
PHONE (217) 351-6268
FAX (217) 355-1902

NORTHBROOK

TITLE: MSMP 35 / STUDY LOCATION 10
PROPOSED CONDITIONS 10-YEAR STORM
SUNSET LN, NORTHBROOK, IL

SCALE: 1 inch = 50 feet
DATE: JUNE 2023
PROJECT: W23030.00
SHEET: 4 OF 7

REVISIONS: DATE	BY	DESCRIPTION	DATE	BY	DESCRIPTION	DRAWN BY: CF CHECKED BY: MM APPROVED BY: MG	
ENGINEERING RESOURCE ASSOCIATES	3S701 WEST AVENUE, SUITE 150 WARRENVILLE, ILLINOIS 60555 PHONE (630) 393-3060 FAX (630) 393-2152	10 S. RIVERSIDE PLAZA, SUITE 875 CHICAGO, ILLINOIS 60606 PHONE (312) 474-7841 FAX (312) 474-6099	2416 GALEN DRIVE CHAMPAIGN, ILLINOIS 61821 PHONE (217) 351-6268 FAX (217) 355-1902	NORTHBROOK	TITLE: MSMP 36 / STUDY LOCATION 33 PROPOSED CONDITIONS 10-YEAR STORM LONGVALLEY DRIVE, NORTHBROOK, IL	SCALE: 1 inch = 80 feet DATE: JUNE 2023 PROJECT: W23030.00 SHEET: 5 OF 7	

REVISIONS:					
DATE	BY	DESCRIPTION	DATE	BY	DESCRIPTION

DRAWN BY: CF
CHECKED BY: MM
APPROVED BY: MG

ENGINEERING RESOURCE ASSOCIATES

3S701 WEST AVENUE, SUITE 150
WARRENVILLE, ILLINOIS 60555
PHONE (630) 393-3060
FAX (630) 393-2152

10 S. RIVERSIDE PLAZA, SUITE 875
CHICAGO, ILLINOIS 60606
PHONE (312) 474-7841
FAX (312) 474-6099

2416 GALEN DRIVE
CHAMPAIGN, ILLINOIS 61821
PHONE (217) 351-6268
FAX (217) 355-1902

NORTHBROOK

TITLE:
MSMP 37 / STUDY LOCATION 1
PROPOSED CONDITIONS 10-YEAR STORM
KOEPKE ROAD, NORTHBROOK, IL

SCALE: 1 inch = 60 feet
DATE: JUNE 2023
PROJECT: W23030.00
SHEET: 6 OF 7

REVISIONS:					
DATE	BY	DESCRIPTION	DATE	BY	DESCRIPTION

DRAWN BY: CF
CHECKED BY: MM
APPROVED BY: MG

ENGINEERING RESOURCE ASSOCIATES

3S701 WEST AVENUE, SUITE 150
WARRENVILLE, ILLINOIS 60555
PHONE (630) 393-3060
FAX (630) 393-2152

10 S. RIVERSIDE PLAZA, SUITE 875
CHICAGO, ILLINOIS 60606
PHONE (312) 474-7841
FAX (312) 474-6099

2416 GALEN DRIVE
CHAMPAIGN, ILLINOIS 61821
PHONE (217) 351-6268
FAX (217) 355-1902

NORTHBROOK

TITLE:
STUDY LOCATION 5
PROPOSED CONDITIONS 10-YEAR STORM
BORDEAUX DRIVE, NORTHBROOK, IL

SCALE: 1 inch = 40 feet
DATE: JUNE 2023
PROJECT: W23030.00
SHEET: 7 OF 7

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APPENDIX B – ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COSTS

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Engineer's Opinion of Probable Cost
PRELIMINARY
Village of Northbrook, Cook County
Master Stormwater Management Plan Addendum 3
Prepared by Engineering Resource Associates, Inc.
6/26/2023

MSMP 32 | Wescott Road / Oak Avenue / Maple Ave - Study Location 12

NO.	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	COST
1	TREE PROTECTION FENCING	FOOT	400	$ 10.00	$ 4,000.00
2	TREE ROOT PRUNING	EACH	200	$ 250.00	$ 50,000.00
3	TREE REMOVAL (SPECIAL)	EACH	5	$ 5,000.00	$ 25,000.00
4	TRENCH BACKFILL	CU YD	6000	$ 35.00	$ 210,000.00
5	EXPLORATORY EXCAVATION	CU YD	80	$ 90.00	$ 7,200.00
6	TOPSOIL FURNISH AND PLACE, 4"	SQ YD	670	$ 15.00	$ 10,050.00
7	SODDING, SALT TOLERANT	SQ YD	670	$ 30.00	$ 20,100.00
8	INLET FILTERS	EACH	25	$ 135.00	$ 3,375.00
9	COMBINATION CURB AND GUTTER REMOVAL	FOOT	2400	$ 28.00	$ 67,200.00
10	HOT-MIX ASPHALT SURFACE REMOVAL 2"	SQ YD	1666	$ 25.00	$ 41,650.00
11	SIDEWEALK REMOVAL	SQ FT	6000	$ 10.00	$ 60,000.00
12	DRIVEWAY PAVEMENT REMOVAL	SQ YD	156	$ 18.00	$ 2,808.00
13	REMOVING INLETS	EACH	2	$ 300.00	$ 600.00
14	REMOVING MANHOLES	EACH	5	$ 620.00	$ 3,100.00
15	PORTLAND CEMENT CONCRETE SIDEWALK 5 INCH (SPECIAL)	SQ FT	6000	$ 22.00	$ 132,000.00
16	DETECTABLE WARNINGS	EACH	8	$ 46.00	$ 368.00
17	COMBINATION CONCRETE CURB AND GUTTER, TYPE B-6.12	FOOT	2400	$ 65.00	$ 156,000.00
18	AGGREGATE BASE COURSE, TYPE B 2"	SQ YD	156	$ 20.00	$ 3,120.00
19	HMA DRIVEWAY PAVEMENT	SQ YD	156	$ 50.00	$ 7,800.00
20	ADJUSTING WATER MAIN 6"	FOOT	700	$ 210.00	$ 147,000.00
21	ADJUSTING WATER SERVICE	FOOT	400	$ 60.00	$ 24,000.00
22	ADJUSTING SANITARY SEWER SERVICE LINE	FOOT	1000	$ 75.00	$ 75,000.00
23	REMOVAL AND DISPOSAL OF UNSUITABLE MATERIAL	CU YD	1800	$ 70.00	$ 126,000.00
24	STORM SEWERS, CLASS B, TYPE 2, 18"	FOOT	60	$ 150.00	$ 9,000.00
25	INLETS, TYPE A	EACH	8	$ 3,500.00	$ 28,000.00
26	MANHOLES, TYPE A, 6'-DIAMETER, TYPE 3 FRAME AND GRATE	EACH	2	$ 4,200.00	$ 8,400.00
27	HOT-MIX ASPHALT BINDER COURSE, IL- 9.5, N50	TON	185	$ 150.00	$ 27,750.00
28	HOT-MIX ASPHALT SURFACE COURSE, IL-9.5, MIX "D", N50	TON	374	$ 135.00	$ 50,490.00
29	THERMOPLASTIC PAVEMENT MARKING - LINE 12"	FOOT	600	$ 10.00	$ 6,000.00
30	THERMOPLASTIC PAVEMENT MARKING - LINE 24"	FOOT	25	$ 26.00	$ 650.00
31	UNDERGROUND STORAGE SYSTEM (SPECIAL)	AC-FT	1	$ 400,000.00	$ 400,000.00
32	EARTH EXCAVATION	CU YD	1613	$ 40.00	$ 64,520.00
33	EROSION CONTROL BLANKET	SQ YD	670	$ 8.00	$ 5,360.00
34	PRE-CONSTRUCTION VIDEOTAPING	L SUM	1	$ 7,500.00	$ 7,500.00
35	MOBILIZATION	L SUM	1	$ 18,000.00	$ 18,000.00
36	CONSTRUCTION LAYOUT	L SUM	1	$ 27,000.00	$ 27,000.00
37	TRAFFIC CONTROL AND PROTECTION, (SPECIAL)	L SUM	1	$ 45,000.00	$ 45,000.00
38	EASEMENT DOCUMENTATION	L SUM	1	$ 5,500.00	$ 5,500.00

15% CONTINGENCY	$ 281,900.00
CONSTRUCTION SUBTOTAL	$ 2,161,441.00
PHASE I AND PHASE II ENGINEERING	$ 216,100.00
PROJECT TOTAL	$ 2,377,541.00

Engineer's Opinion of Probable Cost
PRELIMINARY
Village of Northbrook, Cook County
Master Stormwater Management Plan Addendum 3
Prepared by Engineering Resource Associates, Inc.
6/26/2023

MSMP 33 | Marcee Lane & Jeffery Courts / Woodhill Drive - Study Locations 13B & 11

NO.	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	COST
1	TREE PROTECTION FENCING	FOOT	200	$ 10.00	$ 2,000.00
2	TREE ROOT PRUNING	EACH	10	$ 250.00	$ 2,500.00
3	TREE REMOVAL (SPECIAL)	EACH	10	$ 5,000.00	$ 50,000.00
4	TRENCH BACKFILL	CU YD	1475	$ 35.00	$ 51,625.00
5	EXPLORATORY EXCAVATION	CU YD	90	$ 90.00	$ 8,100.00
6	TOPSOIL FURNISH AND PLACE, 4"	SQ YD	6043	$ 15.00	$ 90,645.00
7	SODDING, SALT TOLERANT	SQ YD	6043	$ 30.00	$ 181,290.00
8	INLET FILTERS	EACH	20	$ 135.00	$ 2,700.00
9	COMBINATION CURB AND GUTTER REMOVAL	FOOT	1032	$ 28.00	$ 28,896.00
10	HOT-MIX ASPHALT SURFACE REMOVAL 2"	SQ YD	846	$ 25.00	$ 21,150.00
11	SIDEWEALK REMOVAL	SQ FT	100	$ 10.00	$ 1,000.00
12	DRIVEWAY PAVEMENT REMOVAL	SQ YD	125	$ 18.00	$ 2,250.00
13	REMOVING INLETS	EACH	8	$ 300.00	$ 2,400.00
14	REMOVING MANHOLES	EACH	11	$ 620.00	$ 6,820.00
15	STORM SEWER REMOVAL 12"	FOOT	1116	$ 22.00	$ 24,552.00
16	STORM SEWER REMOVAL 15"	FOOT	158	$ 24.00	$ 3,792.00
17	STORM SEWER REMOVAL 24"	FOOT	68	$ 30.00	$ 2,040.00
18	PORTLAND CEMENT CONCRETE SIDEWALK 5 INCH (SPECIAL)	SQ FT	100	$ 22.00	$ 2,200.00
19	COMBINATION CONCRETE CURB AND GUTTER, TYPE B-6.12	FOOT	1032	$ 65.00	$ 67,080.00
20	AGGREGATE BASE COURSE, TYPE B 2"	SQ YD	125	$ 20.00	$ 2,500.00
21	HMA DRIVEWAY PAVEMENT	SQ YD	125	$ 50.00	$ 6,250.00
22	ADJUSTING WATER MAIN 6"	FOOT	50	$ 210.00	$ 10,500.00
23	ADJUSTING WATER MAIN 8"	FOOT	25	$ 290.00	$ 7,250.00
24	ADJUSTING WATER SERVICE	FOOT	200	$ 60.00	$ 12,000.00
25	ADJUSTING SANITARY SEWER SERVICE LINE	FOOT	200	$ 75.00	$ 15,000.00
26	REMOVAL AND DISPOSAL OF UNSUITABLE MATERIAL	CU YD	440	$ 70.00	$ 30,800.00
27	STORM SEWERS, CLASS B, TYPE 1, 12"	FOOT	536	$ 140.00	$ 75,040.00
28	STORM SEWERS, CLASS B, TYPE 2, 12"	FOOT	126	$ 150.00	$ 18,900.00
29	STORM SEWERS, CLASS B, TYPE 2, 18"	FOOT	1051	$ 150.00	$ 157,650.00
30	STORM SEWERS, CLASS B, TYPE 1, 24"	FOOT	226	$ 160.00	$ 36,160.00
31	CATCH BASINS, TYPE A, 4'-DIAMETER, TYPE 8 FRAME AND GRATE	EACH	2	$ 5,000.00	$ 10,000.00
32	CATCH BASINS, TYPE A, 5'-DIAMETER, TYPE 8 FRAME AND GRATE	EACH	1	$ 5,500.00	$ 5,500.00
33	MANHOLES, TYPE A, 4'-DIAMETER, TYPE TYPE 3 FRAME AND GRATE	EACH	4	$ 3,800.00	$ 15,200.00
34	MANHOLES, TYPE A, 5'-DIAMETER, TYPE 8 GRATE	EACH	2	$ 6,700.00	$ 13,400.00
35	INLETS	EACH	12	$ 3,500.00	$ 42,000.00
36	HOT-MIX ASPHALT BINDER COURSE, IL- 9.5, N50	TON	94	$ 150.00	$ 14,100.00
37	HOT-MIX ASPHALT SURFACE COURSE, IL-9.5, MIX "D", N50	TON	190	$ 135.00	$ 25,650.00
38	THERMOPLASTIC PAVEMENT MARKING - LINE 24"	FOOT	25	$ 26.00	$ 650.00
39	EARTH EXCAVATION	CU YD	7778	$ 40.00	$ 311,120.00
40	EROSION CONTROL BLANKET	SQ YD	6043	$ 8.00	$ 48,344.00
41	UNDERGROUND STORAGE SYSTEM (SPECIAL)	AC-FT	4.75	$ 400,000.00	$ 1,900,000.00
42	PRE-CONSTRUCTION VIDEOTAPING	L SUM	1	$ 7,500.00	$ 7,500.00
43	MOBILIZATION	L SUM	1	$ 66,000.00	$ 66,000.00
44	CONSTRUCTION LAYOUT	L SUM	1	$ 50,000.00	$ 50,000.00
45	TRAFFIC CONTROL AND PROTECTION, (SPECIAL)	L SUM	1	$ 83,000.00	$ 83,000.00
46	EASEMENT DOCUMENTATION	L SUM	1	$ 12,500.00	$ 12,500.00

15% CONTINGENCY	$ 529,200.00
CONSTRUCTION SUBTOTAL	$ 4,057,254.00
PHASE I AND PHASE II ENGINEERING	$ 405,700.00
PROJECT TOTAL	$ 4,462,954.00

Engineer's Opinion of Probable Cost
PRELIMINARY
Village of Northbrook, Cook County
Master Stormwater Management Plan Addendum 3
Prepared by Engineering Resource Associates, Inc.
6/26/2023

MSMP 34 | Woodbine Lane - Study Location 13A

NO.	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE		COST	
1	TREE PROTECTION FENCING	FOOT	200	$	10.00	$	2,000.00
2	TREE ROOT PRUNING	EACH	15	$	250.00	$	3,750.00
3	TREE REMOVAL	EACH	1	$	5,000.00	$	5,000.00
4	TRENCH BACKFILL	CU YD	1112	$	35.00	$	38,920.00
5	EXPLORATORY EXCAVATION	CU YD	100	$	90.00	$	9,000.00
6	TOPSOIL FURNISH AND PLACE, 4"	SQ YD	4000	$	15.00	$	60,000.00
7	SODDING, SALT TOLERANT	SQ YD	4000	$	30.00	$	120,000.00
8	INLET FILTERS	EACH	40	$	135.00	$	5,400.00
9	COMBINATION CURB AND GUTTER REMOVAL	FOOT	100	$	28.00	$	2,800.00
10	CONCRETE PAVEMENT REMOVAL	SQ YD	70	$	25.00	$	1,750.00
11	SIDEWALK REMOVAL	SQ FT	3150	$	10.00	$	31,500.00
12	DRIVEWAY PAVEMENT REMOVAL	SQ YD	90	$	18.00	$	1,620.00
13	REMOVING INLETS	EACH	6	$	300.00	$	1,800.00
14	REMOVING MANHOLES	EACH	2	$	620.00	$	1,240.00
15	STORM SEWER REMOVAL 15"	FOOT	292	$	24.00	$	7,008.00
16	PORTLAND CEMENT CONCRETE DRIVEWAY PAVEMENT, 6 INCH	SQ YD	90	$	100.00	$	9,000.00
17	PORTLAND CEMENT CONCRETE SIDEWALK 5 INCH (SPECIAL)	SQ FT	3150	$	22.00	$	69,300.00
18	DETECTABLE WARNINGS	EACH	10	$	46.00	$	460.00
19	COMBINATION CONCRETE CURB AND GUTTER, TYPE B-6.12	FOOT	100	$	65.00	$	6,500.00
20	AGGREGATE BASE COURSE, TYPE B 2"	SQ YD	90	$	20.00	$	1,800.00
21	ADJUSTING WATER MAIN 8"	FOOT	50	$	290.00	$	14,500.00
22	ADJUSTING WATER SERVICE	FOOT	120	$	60.00	$	7,200.00
23	ADJUSTING SANITARY SEWER SERVICE LINE	FOOT	120	$	75.00	$	9,000.00
24	REMOVAL AND DISPOSAL OF UNSUITABLE MATERIAL	CU YD	330	$	70.00	$	23,100.00
25	STORM SEWERS, CLASS B, TYPE 1, 12"	FOOT	60	$	140.00	$	8,400.00
26	STORM SEWERS, CLASS B, TYPE 2, 21"	FOOT	410	$	150.00	$	61,500.00
27	STORM SEWERS, CLASS B, TYPE 2, 24"	FOOT	300	$	170.00	$	51,000.00
28	STORM SEWERS, CLASS B, TYPE 2, 48"	FOOT	60	$	260.00	$	15,600.00
29	INLETS	EACH	6	$	3,500.00	$	21,000.00
30	MANHOLES, TYPE A, 4'-DIAMETER, TYPE TYPE 3 FRAME AND GRATE	EACH	4	$	3,800.00	$	15,200.00
31	MANHOLES, TYPE A, 6'-DIAMETER, TYPE 3 FRAME AND GRATE	EACH	1	$	4,200.00	$	4,200.00
32	MANHOLES, TYPE A, 6'-DIAMETER, TYPE 8 GRATE	EACH	2	$	6,700.00	$	13,400.00
33	MANHOLES, TYPE A, 8'-DIAMETER, TYPE 3 FRAME AND GRATE	EACH	2	$	7,900.00	$	15,800.00
34	CONCRETE PAVEMENT	SY	70	$	150.00	$	10,500.00
35	THERMOPLASTIC PAVEMENT MARKING - LINE 12"	FOOT	300	$	10.00	$	3,000.00
36	UNDERGROUND STORAGE SYSTEM (SPECIAL)	AC-FT	4	$	400,000.00	$	1,600,000.00
37	EARTH EXCAVATION	CU YD	6454	$	40.00	$	258,160.00
38	EROSION CONTROL BLANKET	SQ YD	4000	$	8.00	$	32,000.00
39	PRE-CONSTRUCTION VIDEOTAPING	L SUM	1	$	7,500.00	$	7,500.00
40	MOBILIZATION	L SUM	1	$	25,000.00	$	25,000.00
41	CONSTRUCTION LAYOUT	L SUM	1	$	38,000.00	$	38,000.00
42	TRAFFIC CONTROL AND PROTECTION, (SPECIAL)	L SUM	1	$	64,000.00	$	64,000.00
43	EASEMENT DOCUMENTATION	L SUM	1	$	12,500.00	$	12,500.00

15% CONTINGENCY	$	403,400.00
CONSTRUCTION SUBTOTAL	$	3,092,808.00
PHASE I AND PHASE II ENGINEERING	$	309,300.00
PROJECT TOTAL	$	3,402,108.00

Engineer's Opinion of Probable Cost
PRELIMINARY
Village of Northbrook, Cook County
Master Stormwater Management Plan Addendum 3
Prepared by Engineering Resource Associates, Inc.
6/26/2023

MSMP 35 | Sunset Lane - Study Location 10

NO.	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	COST
1	TRENCH BACKFILL	CU YD	480	$ 35.00	$ 16,800.00
2	EXPLORATORY EXCAVATION	CU YD	80	$ 90.00	$ 7,200.00
3	TOPSOIL FURNISH AND PLACE, 4"	SQ YD	1200	$ 15.00	$ 18,000.00
4	SODDING, SALT TOLERANT	SQ YD	1200	$ 30.00	$ 36,000.00
5	INLET FILTERS	EACH	20	$ 135.00	$ 2,700.00
6	COMBINATION CURB AND GUTTER REMOVAL	FOOT	30	$ 28.00	$ 840.00
7	HOT-MIX ASPHALT SURFACE REMOVAL 2"	SQ YD	502	$ 25.00	$ 12,550.00
8	CONCRETE PAVEMENT REMOVAL	SQ YD	34	$ 25.00	$ 850.00
9	DRIVEWAY PAVEMENT REMOVAL	SQ YD	280	$ 18.00	$ 5,040.00
10	REMOVING INLETS	EACH	10	$ 300.00	$ 3,000.00
11	REMOVING MANHOLES	EACH	7	$ 620.00	$ 4,340.00
12	STORM SEWER REMOVAL 12"	FOOT	1330	$ 22.00	$ 29,260.00
13	STORM SEWER REMOVAL 15"	FOOT	134	$ 24.00	$ 3,216.00
14	PORTLAND CEMENT CONCRETE DRIVEWAY PAVEMENT, 6 INCH	SQ YD	205	$ 100.00	$ 20,500.00
15	COMBINATION CONCRETE CURB AND GUTTER, TYPE B-6.12	FOOT	30	$ 65.00	$ 1,950.00
16	AGGREGATE BASE COURSE, TYPE B 2"	SQ YD	280	$ 20.00	$ 5,600.00
17	HMA DRIVEWAY PAVEMENT	SQ YD	75	$ 50.00	$ 3,750.00
18	ADJUSTING WATER MAIN 8"	FOOT	50	$ 290.00	$ 14,500.00
19	ADJUSTING WATER SERVICE	FOOT	300	$ 60.00	$ 18,000.00
20	ADJUSTING SANITARY SEWER SERVICE LINE	FOOT	300	$ 75.00	$ 22,500.00
21	REMOVAL AND DISPOSAL OF UNSUITABLE MATERIAL	CU YD	145	$ 70.00	$ 10,150.00
22	STORM SEWERS, CLASS B, TYPE 1, 12"	FOOT	40	$ 140.00	$ 5,600.00
23	STORM SEWERS, CLASS B, TYPE 1, 18"	FOOT	560	$ 150.00	$ 84,000.00
24	STORM SEWERS, CLASS B, TYPE 1, 24"	FOOT	36	$ 170.00	$ 6,120.00
25	STORM SEWERS, CLASS B, TYPE 1, SPAN 30 RISE 19 (Equal 24)	FOOT	132	$ 250.00	$ 33,000.00
26	STORM SEWERS, CLASS B, TYPE 1, SPAN 38 RISE 24 (Equal 30)	FOOT	422	$ 280.00	$ 118,160.00
27	INLETS	EACH	5	$ 3,500.00	$ 17,500.00
28	CATCH BASINS, TYPE A, 4'-DIAMETER, TYPE 3 FRAME AND GRATE	EACH	2	$ 3,800.00	$ 7,600.00
29	CATCH BASINS, TYPE A, 5'-DIAMETER, TYPE 3 FRAME AND GRATE	EACH	2	$ 4,000.00	$ 8,000.00
30	MANHOLES, TYPE A, 6'-DIAMETER, TYPE 8 GRATE	EACH	4	$ 6,700.00	$ 26,800.00
31	CONCRETE PAVEMENT	SQ YD	34	$ 150.00	$ 5,100.00
32	HOT-MIX ASPHALT BINDER COURSE, IL- 9.5, N50	TON	56	$ 150.00	$ 8,400.00
33	HOT-MIX ASPHALT SURFACE COURSE, IL-9.5, MIX "D", N50	TON	113	$ 135.00	$ 15,255.00
34	THERMOPLASTIC PAVEMENT MARKING - LINE 24"	FOOT	15	$ 26.00	$ 390.00
35	EROSION CONTROL BLANKET	SQ YD	1111	$ 8.00	$ 8,888.00
36	PRE-CONSTRUCTION VIDEOTAPING	L SUM	1	$ 7,500.00	$ 7,500.00
37	MOBILIZATION	L SUM	1	$ 6,000.00	$ 6,000.00
38	CONSTRUCTION LAYOUT	L SUM	1	$ 15,000.00	$ 15,000.00
39	TRAFFIC CONTROL AND PROTECTION, (SPECIAL)	L SUM	1	$ 18,000.00	$ 18,000.00

15% CONTINGENCY	$ 94,200.00
CONSTRUCTION SUBTOTAL	$ 722,259.00
PHASE I AND PHASE II ENGINEERING	$ 72,200.00
PROJECT TOTAL	$ 794,459.00

Engineer's Opinion of Probable Cost
PRELIMINARY
Village of Northbrook, Cook County
Master Stormwater Management Plan Addendum 3
Prepared by Engineering Resource Associates, Inc.
6/26/2023

MSMP 36 | Longvalley Drive - Study Location 33

NO.	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	COST
1	TREE PROTECTION FENCING	FOOT	400	$ 10.00	$ 4,000.00
2	TREE REMOVAL (6 TO 15 UNITS DIAMETER)	UNIT	45	$ 30.00	$ 1,350.00
3	TREE REMOVAL (OVER 15 UNITS DIAMETER)	UNIT	225	$ 35.00	$ 7,875.00
4	TRENCH BACKFILL	CU YD	1070	$ 35.00	$ 37,450.00
5	EXPLORATORY EXCAVATION	CU YD	75	$ 90.00	$ 6,750.00
6	TOPSOIL FURNISH AND PLACE, 4"	SQ YD	2250	$ 15.00	$ 33,750.00
7	SODDING, SALT TOLERANT	SQ YD	2250	$ 30.00	$ 67,500.00
8	INLET FILTERS	EACH	20	$ 135.00	$ 2,700.00
9	SIDEWEALK REMOVAL	SQ FT	2750	$ 10.00	$ 27,500.00
10	DRIVEWAY PAVEMENT REMOVAL	SQ YD	310	$ 18.00	$ 5,580.00
11	REMOVING INLETS	EACH	2	$ 300.00	$ 600.00
12	REMOVING MANHOLES	EACH	3	$ 620.00	$ 1,860.00
13	STORM SEWER REMOVAL 12"	FOOT	30	$ 22.00	$ 660.00
14	STORM SEWER REMOVAL 18"	FOOT	880	$ 26.00	$ 22,880.00
15	STORM SEWER REMOVAL 21"	FOOT	495	$ 28.00	$ 13,860.00
16	PORTLAND CEMENT CONCRETE DRIVEWAY PAVEMENT, 6 INCH	SQ YD	310	$ 100.00	$ 31,000.00
17	PORTLAND CEMENT CONCRETE SIDEWALK 5 INCH (SPECIAL)	SQ FT	2750	$ 22.00	$ 60,500.00
18	AGGREGATE BASE COURSE, TYPE B 4"	SQ YD	610	$ 28.00	$ 17,080.00
19	TIE BARS 3/4"	EACH	110	$ 12.00	$ 1,320.00
20	PORTLAND CEMENT CONCRETE PAVEMENT 12" (JOINTED)	SQ YD	300	$ 105.00	$ 31,500.00
21	AGGREGATE BASE COURSE, TYPE B 6"	SQ YD	300	$ 32.00	$ 9,600.00
22	ADJUSTING WATER MAIN 6"	FOOT	150	$ 210.00	$ 31,500.00
23	STORM SEWERS, CLASS B, TYPE 1, 12"	FOOT	132	$ 140.00	$ 18,480.00
24	STORM SEWERS, CLASS B, TYPE 1, 18"	FOOT	30	$ 150.00	$ 4,500.00
25	STORM SEWERS, CLASS B, TYPE 2, 24", WATER MAIN QUALITY	FOOT	880	$ 250.00	$ 220,000.00
26	STORM SEWERS, CLASS B, TYPE 2, 30"	FOOT	495	$ 190.00	$ 94,050.00
27	CATCH BASINS, TYPE A, 4'-DIAMETER, TYPE 12 FRAME AND GRATE	EACH	4	$ 3,800.00	$ 15,200.00
28	MANHOLES, TYPE A, 4'-DIAMETER, TYPE 8 GRATE	EACH	6	$ 6,200.00	$ 37,200.00
29	MANHOLES, TYPE A, 6'-DIAMETER, TYPE 1 FRAME, CLOSED LID	EACH	1	$ 6,500.00	$ 6,500.00
30	REMOVAL AND DISPOSAL OF UNSUITABLE MATERIAL	CU YD	300	$ 70.00	$ 21,000.00
31	TREE, SPECIES PENDING, 3" CALIPER, BALLED AND BURLAPPED	EACH	6	$ 1,000.00	$ 6,000.00
32	PRE-CONSTRUCTION VIDEOTAPING	L SUM	1	$ 5,500.00	$ 5,500.00
33	MOBILIZATION	L SUM	1	$ 8,000.00	$ 8,000.00
34	CONSTRUCTION LAYOUT	L SUM	1	$ 13,000.00	$ 13,000.00
35	TRAFFIC CONTROL AND PROTECTION, (SPECIAL)	L SUM	1	$ 21,000.00	$ 21,000.00
36	EASEMENT DOCUMENTATION	L SUM	1	$ 12,500.00	$ 12,500.00

15% CONTINGENCY	$ 135,000.00
CONSTRUCTION SUBTOTAL	$ 1,034,745.00
PHASE I AND PHASE II ENGINEERING	$ 103,500.00
PROJECT TOTAL	$ 1,138,245.00

Engineer's Opinion of Probable Cost
PRELIMINARY
Village of Northbrook, Cook County
Master Stormwater Management Plan Addendum 3
Prepared by Engineering Resource Associates, Inc.
6/26/2023

MSMP 37 | Koepke Road - Study Location 1

NO.	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	COST
1	TREE PROTECTION FENCING	FOOT	832	$ 10.00	$ 8,320.00
2	TREE ROOT PRUNING	EACH	260	$ 250.00	$ 65,000.00
3	TRENCH BACKFILL	CU YD	1222	$ 35.00	$ 42,770.00
4	EXPLORATORY EXCAVATION	CU YD	80	$ 90.00	$ 7,200.00
5	TOPSOIL FURNISH AND PLACE, 4"	SQ YD	520	$ 15.00	$ 7,800.00
6	SODDING, SALT TOLERANT	SQ YD	520	$ 30.00	$ 15,600.00
7	INLET FILTERS	EACH	70	$ 135.00	$ 9,450.00
8	HOT-MIX ASPHALT SURFACE REMOVAL 2"	SQ YD	1404	$ 25.00	$ 35,100.00
9	SIDEWEALK REMOVAL	SQ FT	1400	$ 10.00	$ 14,000.00
10	DRIVEWAY PAVEMENT REMOVAL	SQ YD	585	$ 18.00	$ 10,530.00
11	REMOVING INLETS	EACH	26	$ 300.00	$ 7,800.00
12	REMOVING MANHOLES	EACH	16	$ 620.00	$ 9,920.00
13	STORM SEWER REMOVAL 12"	FOOT	485	$ 22.00	$ 10,670.00
14	STORM SEWER REMOVAL 15"	FOOT	785	$ 24.00	$ 18,840.00
15	PORTLAND CEMENT CONCRETE DRIVEWAY PAVEMENT, 6 INCH	SQ YD	150	$ 100.00	$ 15,000.00
16	PORTLAND CEMENT CONCRETE SIDEWALK 5 INCH (SPECIAL)	SQ FT	1400	$ 22.00	$ 30,800.00
17	AGGREGATE BASE COURSE, TYPE B 2"	SQ YD	585	$ 20.00	$ 11,700.00
18	HMA DRIVEWAY PAVEMENT	SQ YD	435	$ 50.00	$ 21,750.00
19	ADJUSTING WATER SERVICE	FOOT	702	$ 60.00	$ 42,120.00
20	ADJUSTING SANITARY SEWER SERVICE LINE	FOOT	702	$ 75.00	$ 52,650.00
21	ADJUSTING WATER MAIN 8"	FOOT	100	$ 290.00	$ 29,000.00
22	STORM SEWERS, CLASS B, TYPE 2, 15"	FOOT	485	$ 140.00	$ 67,900.00
23	STORM SEWERS, CLASS B, TYPE 1, 12"	FOOT	204	$ 140.00	$ 28,560.00
24	STORM SEWERS, CLASS B, TYPE 1, 24"	FOOT	680	$ 170.00	$ 115,600.00
25	CATCH BASINS, TYPE A, 4'-DIAMETER, TYPE 8 FRAME AND GRATE	EACH	8	$ 5,000.00	$ 40,000.00
26	INLETS, TYPE A	EACH	18	$ 3,500.00	$ 63,000.00
27	HOT-MIX ASPHALT BINDER COURSE, IL- 9.5, N50	TON	156	$ 150.00	$ 23,400.00
28	HOT-MIX ASPHALT SURFACE COURSE, IL-9.5, MIX "D", N50	TON	314.6	$ 135.00	$ 42,471.00
29	REMOVAL AND DISPOSAL OF UNSUITABLE MATERIAL	CU YD	360	$ 70.00	$ 25,200.00
30	THERMOPLASTIC PAVEMENT MARKING - LINE 12"	FOOT	50	$ 10.00	$ 500.00
31	EROSION CONTROL BLANKET	SQ YD	520	$ 8.00	$ 4,160.00
32	PRE-CONSTRUCTION VIDEOTAPING	L SUM	1	$ 7,500.00	$ 7,500.00
33	MOBILIZATION	L SUM	1	$ 9,000.00	$ 9,000.00
34	CONSTRUCTION LAYOUT	L SUM	1	$ 13,000.00	$ 13,000.00
35	TRAFFIC CONTROL AND PROTECTION, (SPECIAL)	L SUM	1	$ 22,000.00	$ 22,000.00
36	EASEMENT DOCUMENTATION	L SUM	1	$ 5,500.00	$ 5,500.00

15% CONTINGENCY	$ 140,100.00
CONSTRUCTION SUBTOTAL	$ 1,073,911.00
PHASE I AND PHASE II ENGINEERING	$ 107,400.00
PROJECT TOTAL	$ 1,181,311.00

Engineer's Opinion of Probable Cost
PRELIMINARY
Village of Northbrook, Cook County
Master Stormwater Management Plan Addendum 3
Prepared by Engineering Resource Associates, Inc.
6/26/2023

Omitted from MSMP | **Bordeaux Drive - Study Location 5**

NO.	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	COST
1	TREE REMOVAL (OVER 15 UNITS DIAMETER)	UNIT	45	$ 45.00	$ 2,025.00
2	TRENCH BACKFILL	CU YD	190	$ 35.00	$ 6,650.00
3	EXPLORATORY EXCAVATION	CU YD	20	$ 90.00	$ 1,800.00
4	TOPSOIL FURNISH AND PLACE, 4"	SQ YD	280	$ 15.00	$ 4,200.00
5	SODDING, SALT TOLERANT	SQ YD	280	$ 30.00	$ 8,400.00
6	INLET FILTERS	EACH	4	$ 175.00	$ 700.00
7	SIDEWEALK REMOVAL	SQ FT	775	$ 10.00	$ 7,750.00
8	DRIVEWAY PAVEMENT REMOVAL	SQ YD	30	$ 45.00	$ 1,350.00
9	REMOVING MANHOLES	EACH	2	$ 650.00	$ 1,300.00
10	STORM SEWER REMOVAL 24"	FOOT	160	$ 35.00	$ 5,600.00
11	PORTLAND CEMENT CONCRETE DRIVEWAY PAVEMENT, 6 INCH	SQ YD	30	$ 100.00	$ 3,000.00
12	PORTLAND CEMENT CONCRETE SIDEWALK 5 INCH (SPECIAL)	SQ FT	775	$ 25.00	$ 19,375.00
13	DETECTABLE WARNINGS	EACH	1	$ 250.00	$ 250.00
14	AGGREGATE BASE COURSE, TYPE B 2"	SQ YD	120	$ 22.00	$ 2,640.00
15	REMOVAL AND DISPOSAL OF UNSUITABLE MATERIAL	CU YD	60	$ 70.00	$ 4,200.00
16	STORM SEWERS, CLASS B, TYPE 2, 30"	FOOT	160	$ 250.00	$ 40,000.00
17	MANHOLES, TYPE A, 5'-DIAMETER, TYPE 12 FRAME AND GRATE	EACH	2	$ 5,500.00	$ 11,000.00
18	MANHOLES, TYPE A, 5'-DIAMETER, TYPE 1 FRAME, OPEN LID	EACH	2	$ 6,200.00	$ 12,400.00
19	MANHOLES, TYPE A, 5'-DIAMETER, TYPE 8 GRATE	EACH	1	$ 6,400.00	$ 6,400.00
20	TIE BARS 3/4"	EACH	50	$ 12.00	$ 600.00
21	PORTLAND CEMENT CONCRETE PAVEMENT 12" (JOINTED)	SQ YD	125	$ 105.00	$ 13,125.00
22	AGGREGATE BASE COURSE, TYPE B 6"	SQ YD	125	$ 32.00	$ 4,000.00
23	TREE, SPECIES PENDING, 3" CALIPER, BALLED AND BURLAPPED	EACH	2	$ 1,200.00	$ 2,400.00
24	STREET LIGHTING REMOVE AND REPLACE (SPECIAL)	EACH	1	$ 6,000.00	$ 6,000.00
25	PRE-CONSTRUCTION VIDEOTAPING	L SUM	1	$ 2,500.00	$ 2,500.00
26	MOBILIZATION	L SUM	1	$ 2,000.00	$ 2,000.00
27	CONSTRUCTION LAYOUT	L SUM	1	$ 3,000.00	$ 3,000.00
28	TRAFFIC CONTROL AND PROTECTION, (SPECIAL)	L SUM	1	$ 3,000.00	$ 3,000.00

15% CONTINGENCY	$ 26,300.00
CONSTRUCTION SUBTOTAL	$ 201,965.00
PHASE I AND PHASE II ENGINEERING	$ 20,200.00
PROJECT TOTAL	$ 222,165.00

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APPENDIX C – BENEFIT COST ANALYSIS

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ENGINEERING RESOURCE ASSOCIATES

Master Stormwater Management Plan
Addendum 3
Village of Northbrook IL
W23030.00

BENEFIT ANALYSIS
MSMP 32 | Wescott Road / Oak Avenue / Maple Avenue - Study Location 12

Date: 7/7/2023
Prepared By: MGM
Checked By: MAG

Wescott, Oak, Maple **P12** **2022 Assessor Certified Values**

Address	PIN	Building	Land	Market	Building Area	Number of Stories	Land Area	Build Cost Per Sq Ft	Land Value Per Sq Ft	Structural	Yard
1451 Westcott Rd	04-09-305-013-0000	$ 33,373.00	$ 10,628.00	$ 440,010.00	1403	1.0	8175	$23.79	$1.30	Y	Y
2444 Oak Ave	04-09-305-001-0000	$ 27,764.00	$ 9,237.00	$ 370,010.00	1377	1.0	7105	$20.16	$1.30	Y	Y
2440 Oak Ave	04-09-305-002-0000	$ 30,348.00	$ 9,653.00	$ 400,010.00	1833	1.0	7425	$16.56	$1.30	Y	Y
2436 Oak Ave	04-09-305-003-0000	$ 51,977.00	$ 9,653.00	$ 616,300.00	3053	2.0	7425	$17.02	$1.30	Y	Y
2432 Oak Ave	04-09-305-004-0000	$ 64,348.00	$ 9,653.00	$ 740,010.00	2957	2.0	7425	$21.76	$1.30	Y	Y
2428 Oak Ave	04-09-305-005-0000	$ 48,348.00	$ 9,653.00	$ 580,010.00	3024	2.0	7425	$15.99	$1.30	Y	Y
2424 Oak Ave	04-09-305-006-0000	$ 31,348.00	$ 9,653.00	$ 410,010.00	1144	2.0	7425	$27.40	$1.30	Y	Y
2420 Oak Ave	04-09-305-007-0000	$ 30,348.00	$ 9,653.00	$ 400,010.00	1443	1.5	7425	$21.03	$1.30	Y	Y
2416 Oak Ave	04-09-305-008-0000	$ 28,348.00	$ 9,653.00	$ 380,010.00	804	1.0	7425	$35.26	$1.30	Y	Y
2410 Oak Ave	04-09-305-009-0000	$ 46,348.00	$ 9,653.00	$ 560,010.00	2544	2.0	7425	$18.22	$1.30	Y	Y
2406 Oak Ave	04-09-305-010-0000	$ 32,348.00	$ 9,653.00	$ 420,010.00	1492	2.0	7425	$21.68	$1.30	N	Y
2441 Maple Ave	04-09-305-014-0000	$ 40,325.00	$ 12,675.00	$ 530,000.00	1247	1.5	9750	$32.34	$1.30	N	Y
1450 Wescott Rd	04-09-304-013-0000	$ 36,638.00	$ 11,363.00	$ 480,010.00	1203	1.0	7575	$30.46	$1.50	N	Y
2502 Oak Ave	04-09-304-011-0000	$ 55,343.00	$ 10,658.00	$ 660,010.00	2504	2.0	7105	$22.10	$1.50	N	Y

Benefit Analysis **Wescott, Oak, Maple** **P12**

Building Footprint	Percent Damage In Structure	Frequency of Structural Damage	Percent of Land Area Damaged	Frequency of Property Damage	Estimated Cost of Land Improvements per sq ft	Structural Benefit	Property Benefit
1403.0	50%	5	35%	5	$2.75	$83,432.50	$6,763.27
1377.0	50%	5	35%	5	$2.75	$69,410.00	$5,878.09
1833.0	50%	5	35%	5	$2.75	$75,870.00	$6,142.82
1526.5	50%	5	35%	5	$2.75	$64,971.25	$6,142.82
1478.5	50%	5	35%	5	$2.75	$80,435.00	$6,142.82
1512.0	50%	5	35%	5	$2.75	$60,435.00	$6,142.82
572.0	50%	5	35%	5	$2.75	$39,185.00	$6,142.82
962.0	50%	5	35%	5	$2.75	$50,580.00	$6,142.82
804.0	50%	5	35%	5	$2.75	$70,870.00	$6,142.82
1272.0	50%	5	35%	5	$2.75	$57,935.00	$6,142.82
746.0	50%	0	35%	5	$2.75	$0.00	$6,142.82
831.3	50%	0	35%	5	$2.75	$0.00	$8,065.91
1203.0	50%	0	35%	5	$2.75	$0.00	$7,231.00
1252.0	50%	0	35%	5	$2.75	$0.00	$6,782.36
NOTES:						$653,123.75	$90,006.00

Assume Building Footprint is Building Area divided by Number of Stories per Assessor's website.
Assume up to 50% of basements are damaged during flood events
Assume a 10-year event can occur 5 times in the concrete storm sewer useful life
Assume property improvements at $2.75 per square foot with a useful life of 10 years
Assume useful life of a concrete storm sewer is 50-years

Total Benefit : $743,129.75

Total Cost : $ 2,377,541.00

BCR : 0.31

ENGINEERING RESOURCE ASSOCIATES

Master Stormwater Management Plan
Addendum 3
Village of Northbrook IL
W23030.00

BENEFIT ANALYSIS

MSMP 33| Marcee Lane & Jeffery Courts / Woodhill Drive - Study Locations 13B & 11

Date: 7/7/2023
Prepared By: MGM
Checked By: MAG

Marcee Ln & Jeffery Cts / Woodhill Dr **P13B & P11** **2022 Assessor Certified Values**

Address	PIN	Building	Land	Market	Building Area	Number of Stories	Land Area	Build Cost Per Sq Ft	Land Value Per Sq Ft	Structural	Yard
1450 Woodhill Dr	04-10-407-002-0000	$ 41,695.00	$ 19,305.00	$ 610,000.00	1714	1.0	14850	$24.33	$1.30	Y	Y
1448 Woodhill Dr	04-10-407-003-0000	$ 52,410.00	$ 18,590.00	$ 710,000.00	2591	2.0	14300	$20.23	$1.30	Y	Y
1440 Woodhill Dr	04-10-407-010-0000	$ 52,977.00	$ 31,023.00	$ 840,000.00	3658	2.0	23864	$14.48	$1.30	N	Y
1216 Jeffrey Ct	04-10-201-061-0000	$ 55,885.00	$ 16,115.00	$ 720,000.00	2202	1.0	12396	$25.38	$1.30	Y	Y
1220 Jeffrey Ct	04-10-201-062-0000	$ 65,265.00	$ 11,735.00	$ 770,000.00	3210	1.0	9027	$20.33	$1.30	N	Y
1133 Jeffrey Ct	04-10-201-045-0000	$ 69,029.00	$ 16,972.00	$ 860,010.00	3102	2.0	13055	$22.25	$1.30	N	Y
1128 Jeffrey Ct	04-10-201-044-0000	$ 39,781.00	$ 12,549.00	$ 523,300.00	2022	1.0	9653	$19.67	$1.30	Y	Y
1134 Jeffrey Ct	04-10-201-041-0000	$ 53,530.00	$ 19,470.00	$ 730,000.00	2862	2.0	14977	$18.70	$1.30	Y	Y
1721 Marcee Ln	04-10-303-037-0000	$ 38,934.00	$ 27,066.00	$ 660,000.00	1397	1.5	16916	$27.87	$1.60	Y	Y
1723 Marcee Ln	04-10-303-038-0000	$ 14,411.00	$ 25,722.00	$ 401,330.00	1326	1.0	16076	$10.87	$1.60	Y	Y

Benefit Analysis **Marcee Ln & Jeffery Cts / Woodhill Dr** **P13B & P11**

Building Footprint	Percent Damage in Structure	Frequency of Structural Damage	Percent of Land Area Damaged	Frequency of Property Damage	Estimated Cost of Land Improvements per sq ft	Structural Benefit	Property Benefit
1714.0	50%	5	35%	5	$2.75	$104,237.50	$12,285.00
1295.5	50%	5	35%	5	$2.75	$65,512.50	$11,830.00
1829.0	50%	0	35%	5	$2.75	$0.00	$19,741.91
2202.0	50%	5	35%	5	$2.75	$139,712.50	$10,255.00
3210.0	50%	0	35%	5	$2.75	$0.00	$7,467.73
1551.0	50%	0	35%	5	$2.75	$0.00	$10,800.36
2022.0	50%	5	35%	5	$2.75	$99,452.50	$7,985.73
1431.0	50%	5	35%	5	$2.75	$66,912.50	$12,390.00
931.3	50%	5	35%	5	$2.75	$64,890.00	$17,223.82
1326.0	50%	5	35%	5	$2.75	$36,027.50	$16,368.55
						$576,745.00	$126,348.09

NOTES:

Assume Building Footprint is Building Area divided by Number of Stories per Assessor's website.
Assume up to 50% of basements are damaged during flood events
Assume a 10-year event can occur 5 times in the concrete storm sewer useful life
Assume property improvements at $2.75 per square foot with a useful life of 10 years
Assume useful life of a concrete storm sewer is 50-years

Total Benefit : $703,093.09

Total Cost : $ 4,462,954.00

BCR : 0.16

ENGINEERING RESOURCE ASSOCIATES

Master Stormwater Management Plan
Addendum 3
Village of Northbrook IL
W23030.00

BENEFIT ANALYSIS
MSMP 34 | Woodbine Lane - Study Location 13A

Date: 7/7/2023
Prepared By: MGM
Checked By: MAG

Woodbine Ln **P13A** **2022 Assessor Certified Values**

Address	PIN	Building	Land	Market	Building Area	Number of Stories	Land Area	Build Cost Per Sq Ft	Land Value Per Sq Ft	Structural Flooding	Yard Flooding
1051 Woodbine Ln	04-09-113-001-0000	$76,765.00	$20,235.00	$970,000.00	3653	2.0	13490	$21.01	$1.50	Y	Y
1061 Woodbine Ln	04-09-102-027-0000	$62,408.00	$20,592.00	$830,000.00	3119	2.0	13728	$20.01	$1.50	Y	Y
1050 Woodbine Ln	04-09-112-005-0000	$58,959.00	$26,042.00	$850,010.00	3140	2.0	17361	$18.78	$1.50	Y	Y
1060 Woodbine Ln	04-09-112-009-0000	$48,150.00	$23,850.00	$720,000.00	2555	1.0	15900	$18.85	$1.50	Y	Y
2470 Shannon Rd	04-09-112-008-0000	$59,852.00	$20,148.00	$800,000.00	2789	2.0	13432	$21.46	$1.50	N	Y
2469 Crabtree Ln	04-09-112-004-0000	$67,915.00	$23,085.00	$910,000.00	4075	1.0	15390	$16.67	$1.50	N	Y
2479 Crabtree Ln	04-09-112-003-0000	$64,535.00	$21,465.00	$860,000.00	3658	1.0	14310	$17.64	$1.50	N	Y
2480 Shannon Rd	04-09-112-007-0000	$57,581.00	$21,300.00	$788,810.00	2909	2.0	14200	$19.79	$1.50	N	Y
1064 Western Ave	04-09-102-028-0000	$57,491.00	$18,053.00	$755,440.00	2679	2.0	12035	$21.46	$1.50	N	Y
1074 Western Ave	04-09-102-029-0000	$61,948.00	$18,053.00	$800,010.00	3008	2.0	12035	$20.59	$1.50	N	Y

Benefit Analysis **Woodbine Ln** **P13A**

Building Footprint	Percent Damage in Structure	Frequency of Structural Damage	Percent of Land Area Damaged	Frequency of Property Damage	Estimated Cost of Land Improvements per sq ft	Structural Benefit	Property Benefit
1826.5	50%	5	35%	5	$2.75	$95,956.25	$12,876.82
1559.5	50%	5	35%	5	$2.75	$78,010.00	$13,104.00
1570.0	50%	5	35%	5	$2.75	$73,698.75	$16,572.18
2555.0	50%	5	35%	5	$2.75	$120,375.00	$15,177.27
1394.5	50%	0	35%	5	$2.75	$0.00	$12,821.45
4075.0	50%	0	35%	5	$2.75	$0.00	$14,690.45
3658.0	50%	0	35%	5	$2.75	$0.00	$13,659.55
1454.5	50%	0	35%	5	$2.75	$0.00	$13,554.55
1339.5	50%	0	35%	5	$2.75	$0.00	$11,488.27
1504.0	50%	0	35%	5	$2.75	$0.00	$11,488.27
						$368,040.00	$135,432.82

NOTES:

Assume Building Footprint is Building Area divided by Number of Stories per Assessor's website.
Assume up to 50% of basements are damaged during flood events
Assume a 10-year event can occur 5 times in the concrete storm sewer useful life
Assume property improvements at $2.75 per square foot with a useful life of 10 years
Assume useful life of a concrete storm sewer is 50-years

Total Benefit : $503,472.82

Total Cost : $ 3,402,108.00

BCR : 0.15

ENGINEERING RESOURCE ASSOCIATES

Master Stormwater Management Plan
Addendum 3
Village of Northbrook IL
W23030.00

BENEFIT ANALYSIS
MSMP 35 | Sunset Lane - Study Location 10

Date: 7/7/2023
Prepared By: MGM
Checked By: MAG

Sunset Ln **P10** **2022 Assessor Certified Values**

Address	PIN	Building	Land	Market	Building Area	Number of Stories	Land Area	Build Cost Per Sq Ft	Land Value Per Sq Ft	Structural Flooding	Yard Flooding
4016 Sunset Ln	04-06-303-016-0000	$ 107,020.00	$ 32,980.00	$ 1,400,000.00	7760	2	38800	$13.79	$0.85	N	Y
4000 Sunset Ln	04-06-303-031-0000	$ 34,489.00	$ 32,980.00	$ 480,000.00	1424	1	38800	$24.22	$0.85	N	Y
4031 Sunset Ln	04-06-303-023-0000	$ 26,000.00	$ 25,996.00	$ 519,960.00	1224	1	38800	$21.24	$0.67	N	Y
4015 Sunset Ln	04-06-303-024-0000	$ 65,725.00	$ 32,980.00	$ 987,050.00	4455	1	38800	$14.75	$0.85	Y	Y
4001 Sunset Ln	04-06-303-025-0000	$ 22,595.00	$ 24,017.00	$ 466,120.00	1250	1	38800	$18.08	$0.62	N	Y
4112 Sunset Ln	04-06-303-034-0000	$ 107,044.00	$ 30,956.00	$ 1,380,000.00	8096	2	36419	$13.22	$0.85	N	Y
4096 Sunset Ln	04-06-303-011-0000	$ 20,500.00	$ 20,486.00	$ 409,860.00	1786	1	38800	$11.48	$0.53	N	Y
4080 Sunset Ln	04-06-303-012-0000	$ 138,020.00	$ 32,980.00	$ 138,020.00	7340	2	38800	$18.80	$0.85	N	Y
4095 Sunset Ln	04-06-303-019-0000	$ 123,020.00	$ 32,980.00	$ 1,560,000.00	6372	2	38800	$19.31	$0.85	Y	Y
4079 Sunset Ln	04-06-303-020-0000	$ 22,504.00	$ 22,500.00	$ 450,040.00	1380	1	38800	$16.31	$0.58	Y	Y
4111 Sunset Ln	04-06-303-018-0000	$ 92,020.00	$ 32,980.00	$ 1,250,000.00	5090	2	38800	$18.08	$0.85	N	Y
525 Sanders Rd	04-06-303-008-0000	$ 15,820.00	$ 12,987.00	$ 288,070.00	1041	1	35100	$15.20	$0.37	Y	Y

Benefit Analysis **Sunset Ln** **P10**

Building Footprint	Percent Damage in Structure	Frequency of Structural Damage	Percent of Land Area Damaged	Frequency of Property Damage	Estimated Cost of Land Improvements per sq ft	Structural Benefit	Property Benefit
3880.0	50%	0	35%	5	$2.75	$0.00	$20,987.27
1424.0	50%	0	35%	5	$2.75	$0.00	$20,987.27
1224.0	50%	0	35%	5	$2.75	$0.00	$16,542.91
4455.0	50%	5	35%	5	$2.75	$164,312.50	$20,987.27
1250.0	50%	0	35%	5	$2.75	$0.00	$15,283.55
4048.0	50%	0	35%	5	$2.75	$0.00	$19,699.27
1786.0	50%	0	35%	5	$2.75	$0.00	$13,036.55
3670.0	50%	0	35%	5	$2.75	$0.00	$20,987.27
3186.0	50%	5	35%	5	$2.75	$153,775.00	$20,987.27
1380.0	50%	5	35%	5	$2.75	$56,260.00	$14,318.18
2545.0	50%	0	35%	5	$2.75	$0.00	$20,987.27
1041.0	50%	5	35%	5	$2.75	$39,550.00	$8,264.45
						$413,897.50	$213,068.55

NOTES:

Assume Building Footprint is Building Area divided by Number of Stories per Assessor's website.
Assume up to 50% of basements are damaged during flood events
Assume a 10-year event can occur 5 times in the concrete storm sewer useful life
Assume property improvements at $2.75 per square foot with a useful life of 10 years
Assume useful life of a concrete storm sewer is 50-years

Total Benefit : $626,966.05

Total Cost : $ 794,459.00

BCR : 0.79

ENGINEERING RESOURCE ASSOCIATES

Master Stormwater Management Plan
Addendum 3
Village of Northbrook IL
W23030.00

BENEFIT ANALYSIS
MSMP 36 | Longvalley Drive - Study Location 33

Date: 7/7/2023
Prepared By: MGM
Checked By: MAG

Longvalley Dr | P33 | 2022 Assessor Certified Values

Address	PIN	Building	Land	Market	Building Area	Number of Stories	Land Area	Build Cost Per Sq Ft	Land Value Per Sq Ft	Structural	Yard
1709 Longvalley Dr	04-17-111-045-0000	$32,910.00	$18,090.00	$510,000.00	2241	2.0	12060	$14.69	1.5	Y	Y
1711 Longvalley Dr	04-17-111-001-0000	$32,910.00	$18,090.00	$510,000.00	2174	2.0	12060	$15.14	1.5	N	Y
1707 Longvalley Dr	04-17-111-044-0000	$31,641.00	$18,090.00	$497,310.00	2053	1.0	12060	$15.41	1.5	N	Y
1708 Longvalley Dr	04-17-114-001-0000	$34,265.00	$18,225.00	$524,900.00	2563	2.0	12150	$13.37	1.5	N	Y
1716 Longvalley Dr	04-17-101-057-0000	$43,965.00	$19,035.00	$630,000.00	3020	2.0	12690	$14.56	1.5	N	Y

Benefit Analysis | Longvalley Dr | P33

Building Footprint	Percent Damage in Structure	Frequency of Structural Damage	Percent of Land Area Damaged	Frequency of Property Damage	Estimated Cost of Land Improvements per sq ft	Structural Benefit	Property Benefit
1120.5	50%	5	35%	5	$2.75	$41,137.50	$11,511.82
1087.0	50%	0	35%	5	$2.75	$0.00	$11,511.82
2053.0	50%	0	35%	5	$2.75	$0.00	$11,511.82
1281.5	50%	0	35%	5	$2.75	$0.00	$11,597.73
1510.0	50%	0	35%	5	$2.75	$0.00	$12,113.18
						$41,137.50	$58,246.36

NOTES:
Assume Building Footprint is Building Area divided by Number of Stories per Assessor's website.
Assume up to 50% of basements are damaged during flood events
Assume a 10-year event can occur 5 times in the concrete storm sewer useful life
Assume property improvements at $2.75 per square foot with a useful life of 10 years
Assume useful life of a concrete storm sewer is 50-years

Total Benefit : $99,383.86

Total Cost : $ 1,138,245.00

BCR : 0.09

ENGINEERING RESOURCE ASSOCIATES

Master Stormwater Management Plan
Addendum 3
Village of Northbrook IL
W23030.00

BENEFIT ANALYSIS
MSMP 37 | Koepke Road - Study Location 1

Date: 6/26/2023
Prepared By: MGM
Checked By: MAG

Koepke Rd P1 2022 Assessor Certified Values

Address	PIN	Building	Land	Market	Building Area	Number of Stories	Land Area	Build Cost Per Sq Ft	Land Value Per Sq Ft	Structural	Yard
2980 Koepke Rd	04-17-202-018-0000	$ 105,270.00	$ 26,730.00	$ 1,320,000.00	3967	2.0	17820	$26.54	$1.50	Y	Y
2990 Koepke Rd	04-17-202-052-0000	$ 66,310.00	$ 39,690.00	$ 1,060,000.00	4051	2.0	26460	$16.37	$1.50	N	Y

Benefit Analysis Koepke Rd P1

Building Footprint	Percent Damage in Structure	Frequency of Structural Damage	Percent of Land Area Damaged	Frequency of Property Damage	Estimated Cost of Land Improvements per sq ft	Structural Benefit	Property Benefit
1983.5	50%	5	35%	5	$2.75	$131,587.50	$17,010.00
2025.5	50%	0	35%	5	$2.75	$0.00	$25,257.27
						$131,587.50	$42,267.27

NOTES:

Assume Building Footprint is Building Area divided by Number of Stories per Assessor's website.
Assume up to 50% of basements are damaged during flood events
Assume a 10-year event can occur 5 times in the concrete storm sewer useful life
Assume property improvements at $2.75 per square foot with a useful life of 10 years
Assume useful life of a concrete storm sewer is 50-years

Total Benefit : $173,854.77

Total Cost : $ 1,181,311.00

BCR : 0.15

APPENDIX D – PROJECT PRIORITIZATION

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MSMP ADDENDUM #3 PROJECT PRIORITIZATION

Rank [1]	Score [2]	Project Number	Study Location	Street(s)	Level of Service [3]	Benefit-Cost Ratio	Benefit-Cost Ratio Rank	Structures Benefited	Structures Rank	Properties Benefited	Properties Rank	Engineer's Opinion of Probable Construction Costs [5]	Average Cost Per Structure	Average Cost Per Property
1	1.67	MSMP 32	12	Wescott Rd / Oak Ave / Maple Ave	10-yr	0.31	2	10	1	14	2	$ 2,378,000	$ 237,800	$ 169,900
2	2.67	MSMP 33	13B & 11	Marcee Ln & Jeffrey Cts / Woodhill Dr[4]	10-yr	0.16	3	7	2	13	3	$ 4,463,000	$ 637,600	$ 343,300
3	2.67	MSMP 34	13A	Woodbine Lane	10-yr	0.15	4	4	3	17	1	$ 3,402,000	$ 850,500	$ 200,100
4	2.67	MSMP 35	10	Sunset Lane	10-yr	0.79	1	4	3	12	4	$ 794,000	$ 198,500	$ 66,200
5	5.33	MSMP 36	33	Longvalley Drive	10-yr	0.09	6	1	5	6	5	$ 1,138,000	$ 1,138,000	$ 189,700
6	5.33	MSMP 37	1	Koepke Road	10-yr	0.15	4	1	5	2	7	$ 1,181,000	$ 1,181,000	$ 590,500
7	6.67	N/A	5	Bordeaux Drive[6]	10-yr	0.00	7	0	7	3	6	$ 222,000	N/A	N/A

NOTES:

1. ERA followed the ranking methodology from the past Addendums to the Village Stormwater Master Plan. A lower score ranks higher. For projects with identical scores, the number of structures benefited is the first tie breaker, followed by the number of properties benefited.

2. The score is the average of the BCR, number of structures benefited, and number of properties benefited.

3. Level of service is the storm event for which a project can provide benefits to the impacted properties. It is categorized by the likelihood of storm occurrence in any given year. Colloquially called the "10-year storm", it has a 1 in 10 (10%) chance of occurring any given year. A "100-year storm" would have a 1 in 100 (1%) chance of occurring in any given year, a "2-year storm" a 1 in 2 (50%) chance, and in such manner for other storm events.

4. Projects 11 and 13B are combined into one project since they share a single location for storage volume.

5. Estimated based on 2023 costs. Rounded to the nearest thousand. Includes estimated cost of engineering. See preliminary EOPCC provided for each project location for more detailed cost breakdown.

6. Recent Village improvements are shown to exceed 10-yr LOS in existing conditions. Additional improvements are not recommended. No MSMP project number assigned.

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APPENDIX E – PRIVATE PROPERTY IMPROVEMENTS

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GREEN INFRASTRUCTURE: BIO-RETENTION / RAIN GARDENS .

Bio-retention is a stormwater management practice that comprises shallow depressions that incorporates soil amendments and native vegetation to temporarily store and filter stormwater runoff, increase soil porosity, and facilitate drainage. Bio-retention areas are suitable for residential areas. Bio-retention is not suitable in locations with continuous flow or a high-water table, sites with slopes greater than 20 percent, locations less than 10 feet from a structure with a basement, locations less than 5 feet from a structure without a basement, areas with a tributary area that is too large and cannot be broken into smaller areas, and available space for which bio-retention is not adequate. The following table summarizes the minimum standards and criteria for the design of a bio-retention facility.

DESIGN PARAMETERS*

Design Storm	Varies, 6-month to 25-year
Drainage Area	5 acres (max.)
Site Slopes	6% (max.)
Sizing	5% of tributary impervious area
Dimensions	2:1 length to width ratio (min.)
Ponding Depth	6 inch (max.)
Drawdown Time	48 hour (max.)
Underlying Soils	0.27 inch/hour infiltration rate (min.) pH 5.5 to 6.5
Water Table Depth	2 feet below the bottom layer (min.)
Pretreatment	Level spreader or grass filter strip
Observation Wells	N/A
Additional Parameters	Must safely bypass higher flows, requires native vegetation

** Industry standards; permitting through the Village to ensure compliance with local and county requirements.*

CONSTRUCTION AND COSTS

The construction of bio-retention areas is critical to the success of the best management practice (BMP). Existing sub-grade should not be compacted and the site must be protected from the effects of erosion and sedimentation prior to and during construction of the bio-retention area. Bio-retention often replaces areas that would have been landscaped and require more maintenance, resulting in a lower net cost for bio-retention. In addition, the use of bio-retention can decrease the cost for stormwater conveyance systems at a site. The actual cost for bio-retention depends upon the drainage area controlled, storage area provided, or surface area consumed.

ADVANTAGES	DISADVANTAGES
• Applicable to small drainage areas, • Works well in highly impervious areas, • Works well in retrofit applications, • Relatively low maintenance, • Increases groundwater recharge, • Reduces runoff volume, • Ongoing improvement in soil porosity, • Improves water quality, • Recharges groundwater, • Reduces stormwater temperature impacts, • Enhances evapotranspiration, • Provides habitat, and • Enhances aesthetics.	• Requires extensive landscaping, • Should not be used in areas with steep slopes, • Construction must be carefully monitored to prevent compactions and clogging of the soils, • Additional sedimentation control practices are needed to block loose soil material from the area, • Soils upstream must be stabilized before draining into the bio-retention area to prevent clogging, • Inadequate pretreatment can cause a gradual reduction of infiltration rates, • Lack of proper maintenance can reduce the longevity of bio-retention area, • Knowledge of engineering and horticulture is required for successful implementation, and • Takes 2-3 years to establish functions.

MAINTENANCE

The following table provides guidance for maintaining a bio-retention BMP.

Maintenance Activity	Frequency
• Pruning and weeding, • Mulch replacement due to erosion, • Removal of trash and debris, • Removal of invasive plant species, • Supplemental watering during periods of extended drought, • Replacement of plantings.	As needed
• Inspect inflow points for clogging; remove any sediment and correct erosion, • Evaluate the health of trees, shrubs, and plants.	Semi-annually
• Cut down perennial plantings at the end of the growing season, • Test pH of planting soils. Apply limestone if pH is below 5.2 and apply iron sulfate plus sulfur if pH is above 7.0.	Annually
• Replace mulch over the entire area, and • Replace pea gravel if warranted	2- to 3-years

FLOOD REDUCTION

The design of a bioretention area can be revised to provide both infiltration and detention volume. Bio-retention areas can improve water quality, decrease peak discharge and decrease runoff volumes. The results depend upon the volume of storage, infiltration rate of the underlying soils, and the intensity and frequency of the rainfall. Studies have shown a reduction in peak discharge and runoff volume ranging from 10 to 50 percent, even for larger storms.

RESIDENTIAL RETROFIT

When constructing bio-retention areas as retrofits on a single residential lot, or across several lots as a shared BMP, the cost escalates significantly, due to the need to haul off a significant amount of earth. To reduce price in a residential retrofit scenario, it may be beneficial to provide a rain garden with less engineered soils. These modifications may require more maintenance by the homeowner to encourage and promote plant establishment. This retrofit option provides less infiltration potential, and a lesser degree of water quality improvements, but provides the same amount of surface storage and flood benefit.

GREEN INFRASTRUCTURE: VEGETATED SWALES

Vegetated Swales are broad, shallow, trapezoidal or parabolic channels, densely planted with a variety of trees, shrubs, and/or grasses. They are designed to capture and infiltrate stormwater runoff from adjacent impervious surfaces, allowing some pollutants to settle out in the process. Check dams may be used to improve filtration and infiltration opportunities.

DESIGN PARAMETERS*

Design Storm	Infiltrate the 1-inch storm, convey the 10-year storm
Drainage Area	5 acres (max.) 1- to 2-acres (preferred)
Site Slopes	6% (max.)
Sizing	10-20% of tributary area
Dimensions	2- to 8-feet bottom width 3:1 maximum side slopes 1% to 3% longitudinal slopes
Ponding Depth	18 inch (max.)
Drawdown Time	24 hour (max.)
Underlying Soils	0.5 inch/hour infiltration rate (min.)
Water Table Depth	2 feet below the bottom layer (min.)
Pretreatment	Forbay or level spreader
Observation Wells	N/A
Additional Parameters	Check dams should be used if slope exceeds 3%

** Industry standards; permitting through the Village to ensure compliance with local and county requirements.*

The effectiveness of a vegetated swale is impacted by the design of the swale. A major concern when designing vegetated swales is to make certain that the velocities in the swale do not cause erosion; therefore, site specific calculations should be performed. In addition to filtration, the planting soil bed provides rooting for the vegetation in the swale. The swale should be vegetated with the proper grass species based on specific site, soils and hydric conditions present along the channel. This vegetation intercepts rainfall and slows direct runoff from sloped roofs. The type of vegetation depends on the depth of the growing media and local climate.

CONSTRUCTION AND COSTS

The construction of vegetated swales is critical to the success of the BMP. The key construction elements are to begin vegetated swale construction only after the erosion and sediment control measures are in place, excavating equipment should operate from the side of the swale to reduce soil compaction, vegetation should be established as soon as possible to prevent erosion and scour and ensure the swale is stabilized before receiving upland stormwater flow. Vegetated swales are considered relatively low-cost control measures that provide a cost-effective alternative to traditional infrastructures with curb, gutter, and underground storm sewers.

GREEN INFRASTRUCTURE: VEGETATED SWALES

ADVANTAGES	DISADVANTAGES
• Relatively low maintenance requirements, • Increases groundwater recharge, • Easily integrated into the site landscaping, • Improves water quality, • Less expensive than traditional storm sewer systems, • Reduces runoff velocity, and • Effective in removal of Total Suspended Solids (TSS), with removal rates of 80 percent, • Generally more storage than pipes.	• Large land requirement, • Higher maintenance than traditional storm sewer systems, • Cannot be used in areas with steep slopes, • Possible re-suspension of sediment, and • Potential for stagnant water that may create nuisance odor / mosquito problems, • Not feasible with small Row ditch

MAINTENANCE

Compared to other stormwater management measures, the required maintenance of vegetated swales is relatively low. The most common reason vegetated swales fail is due to sedimentation and clogging of the pore spaces within the underground storage media. Proper maintenance activities ensure the functionality of vegetated swales for many years.

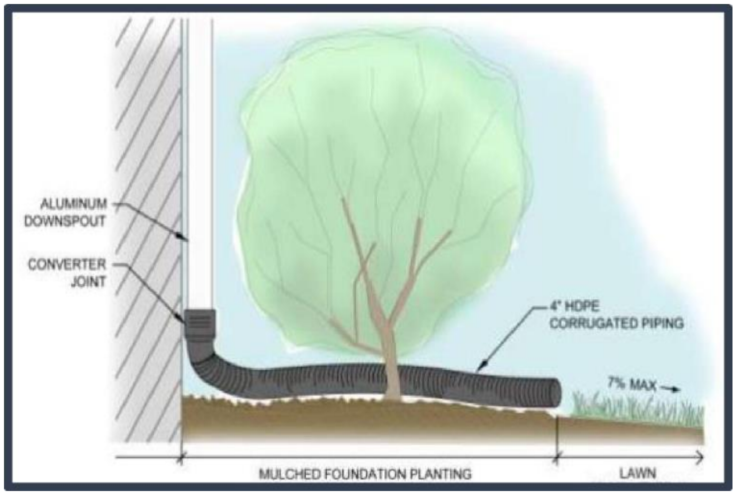
Maintenance Activity	Frequency
• Mow grass to maintain a height of 4 to 6 inches; remove grass clippings. • Mow only when swale is dry to avoid rutting. • Remove sediment from the pretreatment device, channel, and upstream of any check dams.	As needed (frequent/ seasonal)
• Inspect grass side slopes for erosion and formation of rills or gullies, and correct. • Inspect inlet and outlet. Remove trash/debris and correct erosion. • Inspect and correct erosion problems in the soil bed of dry swales. • Based on inspection, plant an alternative grass species if grass cover is not successfully established. • Inspect pea gravel for clogging, and correct. • Inspect swale immediately after the spring melt, remove residuals and replace damaged vegetation without disturbing remaining vegetation. • If roadside or parking lot runoff is directed to the swale, mulching and/or soil aeration/manipulation may be required in the spring to restore soil structure and moisture capacity and to reduce the impacts of deicing agents.	Annually (Semi-annually, year 1)
• Till or cultivate the surface of the soil bed if drawdown time exceeds 48 hours • Remove sediment buildup within the bottom of the swale once it has accumulated to 25 percent of the original design volume. • Plant alternative grass species in the event of unsuccessful establishment. • Reseed bare areas; install appropriate erosion control measures when native soil is exposed or erosion channels are forming. • Inspect and correct check dams when channelization, obstructions, erosion, etc. are identified. • Water during dry periods, fertilize and apply pesticide only when absolutely necessary.	As needed

FLOOD REDUCTION

The performance of vegetated swales is determined by the timing and magnitude of inflows, available storage volume, and channel length. Considering the limited detention volume provided by vegetated swales, the peak flow and volume reduction associated with this type of green infrastructure is limited.

GREEN INFRASTRUCTURE: IMPERVIOUS AREA DISCONNECTION

Impervious area disconnection aims to slow down the rate of stormwater runoff, using pervious areas to filter and infiltrate stormwater. This practice reduces the volume of stormwater draining into the municipal storm sewer by draining rooftops, driveways, sidewalks, patios, and other impervious areas to grass swales, bio-retention areas, infiltration trenches or other infiltration devices. The two primary types of impervious area disconnection are downspout disconnection and pavement disconnection. Downspout disconnection is shown in the image to the right.



DESIGN CONSIDERATIONS

Roofs and driveways contribute toxic chemicals, oil, and metals to stormwater runoff. Routing rooftop runoff to vegetated areas will reduce runoff volume and peak discharge, as well as improve water quality by slowing runoff, allowing for filtration, and providing opportunity for infiltration and evapotranspiration. Disconnecting impervious areas is not appropriate for use in areas with slopes exceeding 6 percent, or areas with highly erodible soils. The maximum roof surface area directed to any one downspout disconnection is 300 square feet. Additionally, the infiltration area should be setback at least 10 feet from the building foundation and flow along at least 20 feet of permeable areas prior to leaving the property.

CONSTRUCTION AND COSTS

Downspout extensions are relatively inexpensive and could be installed by residents. Downspout and footing drain disconnections are considered relatively low-cost control measures that provide a cost-effective method to reducing flows into municipal stormwater systems and promoting infiltration.

ADVANTAGES	DISADVANTAGES
• Reduced peak discharge, • Increased infiltration and evapotranspiration, • Improved water quality, • Decreased stormwater runoff volume, • Increased stormwater time of concentration, and • Easily retrofitted into existing urban areas at minimal cost.	• Potential for erosion, • Potential for standing/stagnant water, and • Increased potential for basement seepage.

MAINTENANCE

The required maintenance is relatively low. The table below includes general maintenance activities.

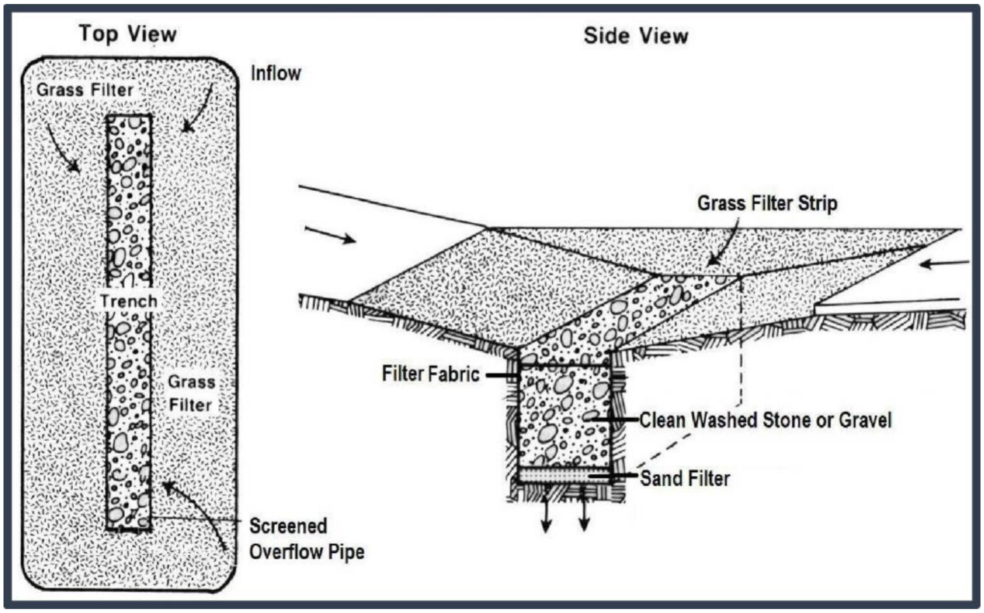
Maintenance Activity	Frequency
• Mowing, weed control, and watering of vegetation • Reseeding bare areas. • Clearing of debris and blockages.	As needed (seasonal)
• Health evaluation of the vegetation.	biannual

FLOOD REDUCTION

The use of pervious areas for rooftop discharge has the ability to reduce the quantity of site stormwater runoff and improve the quality of the stormwater that does discharge from the site. Disconnecting impervious areas can reduce or eliminate surface runoff during small storms and reduce runoff from low to medium density residential developments and smaller commercial sites. However, there is large variation in the reduction in runoff volume and peak discharge from disconnecting impervious areas during large storms.

GREEN INFRASTRUCTURE: INFILTRATION TRENCHES

An Infiltration Trench is a stone filled trench with a level bottom used to capture stormwater runoff and allow infiltration into the surrounding soils from the bottom and sides of the trench. Infiltration trenches are excavated areas typically filled with stone to create an underground reservoir for stormwater runoff. The runoff volume is stored in the void space between the stones within the trench and gradually exfiltrates through the bottom and sides of the trench into the surrounding soils.



Schueler, Tom. 1987. *Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs.* Metropolitan Washington Council of Governments, Washington D.C.

DESIGN PARAMETERS*

Design Storm	Varies
Drainage Area	5 acres (max.)
Site Slopes	20% (max.)
Sizing	2% to 3% of tributary impervious area
Dimensions	3- to 8- feet deep 25 ft. trench width (max.) 1% slope storage bed (max.)
Ponding Depth	N/A
Drawdown Time	48 hour (max.)
Underlying Soils	0.5 inch/hour infiltration rate (min.) 30% clay (max.)
Water Table Depth	2 feet below the bottom layer (min.)
Pretreatment	Level spreader, grass filter strip or other
Observation Wells	Every 50 feet
Additional Parameters	Aggregate Fill 1.5 to 3 inches in diameter with 30% to 40% void space

By diverting runoff into the soil, an infiltration trench not only improves the water quality, but also helps to preserve the natural water balance on a site and can recharge groundwater. Infiltration trenches are designed primarily for stormwater quality. However, they can provide limited runoff quantity control, particularly for smaller storm events. Due to the relatively narrow shape, infiltration trenches can be adapted to many different types of sites and can be utilized in retrofit situations. Wider, shallow trenches are preferred as they reduce the risk of clogging by spreading the flow over a larger area for infiltration. Due to their high potential for failure, these facilities must only be considered for sites where upstream sediment control can be ensured. Infiltration trenches are not intended to trap sediment; therefore, pretreatment measures are needed to prevent clogging and failure.

** Industry standards; permitting through the Village to ensure compliance with local and county requirements.*

CONSTRUCTION AND COSTS

The construction cost of infiltration trenches can vary greatly depending on the configuration, location, design requirements, materials used, and site-specific conditions.

ADVANTAGES	DISADVANTAGES
• Works well in highly impervious areas, such as parking lots • Provides for groundwater recharge • Works well on small sites with porous soils • Small land requirement • Works well in retrofit applications	• Increased maintenance to prevent clogging • Construction requirements to prevent compaction • Additional area and/or infrastructure needed for pretreatment • Significant setback requirements • Restrictions on the placement due to groundwater contamination and soil infiltration capacity

MAINTENANCE

Maintenance of infiltration trenches is critical to keep the surface permeable. Vehicles should not be parked or driven on a vegetated infiltration trench, and care should be taken to avoid excessive compaction.

Maintenance Activity	Frequency
• Ensure that the tributary area, facility, and inlets are clear of debris, • Ensure that the tributary area is stabilized, • Remove sediment and oil/grease from pretreatment devices and overflow structures, • Mow grass; filter strips should be mowed as necessary; remove grass clippings.	Monthly
• Check observation wells following 3 days of dry weather; failure to percolate within this time period indicates clogging. • Remove trees that start to grow in the vicinity of the trench.	Semi-annually
• Perform complete rehabilitation of the trench to maintain design storage capacity, • Excavate trench walls to expose clean soils, and • Replace pea gravel layer.	As needed

FLOOD REDUCTION

Infiltration trenches are designed primarily for stormwater quality with a design storm that is a frequent, small event such as the one-year storm. They will provide a reduction in peak discharge and runoff volume as well as improved water quality for all storm events equal to or less than the design storm.

GREEN INFRASTRUCTURE: POROUS PAVEMENT

Porous pavement consists of a permeable surface course (porous asphalt, porous concrete, or various porous structural pavers), which allow rapid infiltration of stormwater. The surface course is underlain by a uniformly-graded stone bed, which provides temporary storage for peak rate control and promotes infiltration. Porous concrete systems require a very high level of construction workmanship to ensure that they function as designed. They experience a high failure rate if they are not designed, constructed, and maintained properly.

DESIGN CONSIDERATIONS*

Design Storm	2-year
Drainage Area	0.25 - 10 acres
Site Slopes	5% (max.)
Sizing	N/A
Dimensions	Varies
Ponding Depth	N/A
Drawdown Time	48 hour (max.)
Underlying Soils	0.27 inch/hour infiltration rate (min.) 30% Clay (max.)
Water Table Depth	2- to 4-feet below the bottom layer (min.)
Pretreatment	Vegetated filter strip
Observation Wells	N/A
Additional Parameters	Infiltration beds shall have a flat slope. Any fill should be done using the stone subbase material. All systems should be designed with an overflow system. Water level should never rise to the level of pavement surface.

** Industry standards; permitting through the Village to ensure compliance with local and county requirements.*

CONSTRUCTION AND COSTS

Some of the key constructability considerations for porous pavement include control of erosion and sediment, installation at the end of construction, avoiding compaction of subgrade, the bottom of the storage bed should be at a level grade, geotextile and bed aggregate should be placed immediately after approval of subgrade preparation, clean, uniformly graded aggregate is placed in the bed in 8-inch lifts and lightly compacted. Porous pavement is most susceptible to failure during construction, and therefore it is important that the construction be undertaken in such a way as to prevent compaction and contamination of soils. Pervious asphalt is higher in cost than standard asphalt due to additional labor and experience required for installation as well as the added cost in the underlying stone bed, which is generally deeper than a conventional subbase and wrapped in geotextile.

GREEN INFRASTRUCTURE: POROUS PAVEMENT

ADVANTAGES	DISADVANTAGES
• Reduce the rate and volume of runoff, • Increases groundwater recharge, • Applicable in ultra-urban environments, • Provides reduction in runoff volume, • Improved water quality, • Improved traction in rain and snow conditions.	• High failure rate and short life span, • High maintenance requirements, • Special attention to design and construction needed • Restrictions on use in areas with low permeability soils, wellhead protection zones, or aquifer. • Recharge areas, • Restrictions on use by heavy vehicles, • Increased cost compared to conventional pavements, • Potential for groundwater contamination in high permeability soils and high-water table, • Siting must be carefully planned to avoid areas of recent fill or compacted fill, and • Limited salt application and regular plowings required.

MAINTENANCE

Similar to other infiltration practices, clogging is the primary maintenance concern of porous pavement. To prevent clogging of the porous pavement after construction, flow onto the pavement should be limited and routine cleaning should be performed.

Maintenance Activity	Frequency
• Ensure that the tributary area, facility, and inlets are clear of debris. • Ensure that the tributary area is stabilized. • Remove sediment and oil/grease from pretreatment devices and overflow structures. • Mow grass; filter strips should be mowed as necessary; remove grass clippings.	Monthly
• Abrasives such as sand should not be applied on or adjacent to the pervious pavement. • Snow plowing should be done with the blade about one inch above the surface. • Salt is an acceptable deicer, though nontoxic, organic deicers are preferred.	Winter
• Check observation wells following 3 days of dry weather; failure to percolate within this time period indicates clogging. • Inspect pretreatment devices and diversion structures for sediment buildup and structural damage. • Remove trees that start to grow in the vicinity of the trench. • Clean all inlet structures within or draining to the infiltration bed.	Semi-annually
• Perform complete rehabilitation of the trench to maintain design storage capacity. • Excavate trench walls to expose clean soils. • Vacuum pavement 2 or 3 times per year. • Maintain planted areas adjacent to pavement. • Immediately clean any soil deposited on pavement. • Clean inlets draining to the subsurface bed twice per year. • Patch damaged pavement areas less than 50 square feet with standard pavement. • Patch damaged pavement area greater than 50 square feet with porous pavement.	As needed

FLOOD REDUCTION

When compared to traditional asphalt pavement, porous pavement has been shown to reduce runoff volume. Runoff from permeable pavement is less than the runoff from traditional asphalt pavement depending on the type of permeable pavement used, with higher runoff reductions from increased void space and voids filled with sand, which had less clogging.

GREEN INFRASTRUCTURE: RAINWATER HARVESTING

Rainwater harvesting systems treat stormwater as a resource rather than a waste product. It is a more sustainable urban drainage infrastructure that attempts to minimize the use of drinking water for irrigation purposes. Cisterns, rain barrels, vertical storage, and similar devices have been used to capture stormwater from the roofs of buildings.

DESIGN CONSIDERATIONS

Rainwater harvesting systems can be used in low traffic residential areas to reduce potable water needs for uses such as irrigation while also reducing stormwater discharges. Cisterns and rain barrels vary in size and material and some systems include treatment and filtration systems. Buried systems should contain an observation well and all systems must include a bypass or overflow for large storms.

ADVANTAGES	DISADVANTAGES
• Provides additional stormwater storage capacity, • Reduced potable water consumption, • Peak discharge reduction, and • Availability of water during periods of drought or restricted water use.	• Limited storage volume, and • Water-harvesting systems are not always fully utilized.

CONSTRUCTION AND COSTS

Some of the key constructability concerns for a rainwater harvesting system are ensuring harvested water is not connected to the potable water system and is clearly marked “reclaimed water”, cisterns must be watertight with a smooth interior surface and covers should have a tight fit to keep out surface water, animals, dust and light. Rainwater harvesting system costs vary depending on the material of the cistern system capacity, pump characteristics, filtration system, and other appurtenances.

MAINTENANCE

The required maintenance is noted in the table below.

Maintenance Activity	Frequency
• Clean filtration system.	Monthly
• Flush cisterns to remove sediment. • Brush the inside surfaces and thoroughly disinfect. • Empty cistern before first frost. • Inspect and clean cistern vents, floats, and sensors. • Inspect the cistern foundation for cracks, voids, and slippage. • Inspect the cistern and piping for leaks.	Annually

FLOOD REDUCTION

The roof runoff reduction that can be achieved from rain barrel or cistern varies by the size of the rail barrel. Rail barrels reduce the amount of potable water used for outdoor use.

GRADING: OVERLAND FLOW SWALES

In newer subdivisions, residential lots are designed for surface water to flow away from the structure towards the lot lines. An overland flow swale is provided along the property lines within an easement, which is designed to keep the area open. This swale allows stormwater runoff to flow towards drainage infrastructure, such as detention basins.

DESIGN CONSIDERATIONS

Older subdivisions may not have been designed with overland flow swales, or any other means of conveying stormwater away from the structures. In newer subdivisions, the overland flow swales may become obstructed or filled. Property owners build fences, garages, sheds, and other obstructions, which block the flow in the original swale. This can be rectified by removing the obstructions and restoring the swales in newer subdivisions or an overland flow swale can be constructed in older subdivisions.

CONSTRUCTION AND COSTS

The effectiveness of an overland flow swale is impacted by the surrounding grading and drainage area. Some specific design considerations include the grading of adjacent properties, tributary area and grading and flow restrictions downstream. Construction costs for overland flow swales can vary significantly. The grading process for an individual residential parcel can be accomplished by a small crew of workers in a day or two. Key construction elements to consider that could add substantial cost and extend the project timeline include encroachments on stormwater easements, existing structures that would need to be relocated, public utilities, access and the amount of soil that can effectively be excavated.

ADVANTAGES	DISADVANTAGES
• Occupants usually do not have to leave the structure during construction, • Typically, less expensive than structure elevation or relocation, • Structural flood protection provided without significant changes to the structure.	• Will not reduce flood insurance premiums, • The swale may hold water for an extended period of time following a storm event.

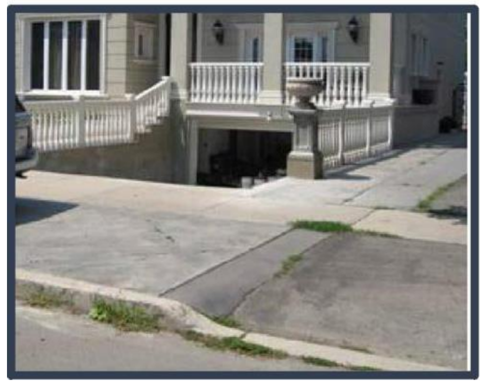
MAINTENANCE

Maintenance tasks in these areas should be no different than that which the residents are currently performing. These include watering, fertilizing and mowing the turf grass.

FLOOD REDUCTION

Overland flow swales can improve the drainage around a structure and reduce the occurrence of structural flooding. Overland flow swales are not intended to store stormwater runoff, but rather convey runoff away from a structure towards an outfall. Therefore, installing an overland flow swale will impact the location of surface storage, but will not reduce the volume of stormwater runoff.

GRADING: DRIVEWAY BERMS



Reverse sloped driveways are often used in high-density neighborhoods, where there is not sufficient area for detached garages. This type of driveway creates a significant flood risk when it directs overland stormwater flows into homes. Water that enters homes through reverse sloped driveways can cause structural damage and contribute to sewer backups, if this water enters basement floor drains. One solution is to construct a driveway berm. This can be achieved by either raising the sidewalk and/or reconstructing the entire driveway. This can reduce the chances that overland flooding will enter the structure through the reverse sloped driveway. An alternative solution is to convert the lower level garage into a basement and completely fill in the reverse-slope driveway. The garage door is removed and the opening is sealed. Then, fill is placed around the former garage until a positive slope is achieved away from the structure, towards the street.

DESIGN CONSIDERATIONS

The effectiveness of a driveway berm is impacted by the surrounding grading and drainage area. Some specific design considerations to keep in mind when considering a driveway berm include the slope of the existing driveway, tributary area draining toward the structure, depth of ponding in the adjacent street and drainage within the garage and lower level of the structure.

CONSTRUCTION AND COSTS

The key construction elements to consider when constructing a driveway berm are the use of nonerodable materials, compaction of the berm and maintaining a smooth grade transition from the berm. Constructing a driveway berm and replacing the driveway is approximately the same cost as replacing the driveway.

ADVANTAGES	DISADVANTAGES
• Occupants usually do not have to leave the structure during construction, • Typically, less expensive than structure elevation or relocation, • Structural flood protection provided without significant changes to the structure.	• Will not reduce flood insurance premiums, • Overtopping or failure eliminates any protection provided, • Interior drainage must be provided.

MAINTENANCE

There is no additional maintenance for the driveway berm from the maintenance of driveway.

FLOOD REDUCTION

Driveway berms can improve the drainage around a structure and reduce the occurrence of structural flooding; however, they provide a limited amount of protection. The height of the berm is limited based on the length of the driveway and surrounding grading. When creating a high point in the driveway, the slope of the driveway must remain within the allowable limits set by the local ordinances. Additionally, if there is a sidewalk across the driveway, the slope of the sidewalk must remain in compliance with ADA requirements. Driveway berms may reduce the occurrence of structural flooding, but will not reduce the volume of stormwater runoff.

GRADING: BARRIERS (BERMS/LEVEES/FLOODWALLS)

When properly designed and constructed, berms and levees can be effective in reducing structural damage from overbank flooding. The sides of a levee or berm are sloped to provide stability and resist erosion; thus, the width is usually six to eight times its height. As a result, taller levees require more land. A floodwall is an engineered structure made of reinforced concrete or reinforced concrete block and varies in height from 1-to 20-feet. Similar to berms and levees, a floodwall can surround a structure or a portion of a structure. Barriers are not typically used to resolve structural flooding in urban areas due to the potential impacts on adjacent properties; however, there are some situations where this flood mitigation strategy may be used. Some appropriate applications of barriers include areas outside the regulatory floodplain where the barrier can be constructed without adverse impacts to adjacent properties, and structures with a low opening that can be protected without adverse impacts to adjacent properties. The local floodplain management ordinance must be reviewed for restrictions on the use of barriers. Levees, berms, and floodwalls may not be used to bring a substantially improved or substantially damaged home into compliance with the local floodplain management ordinance. The height of the barrier needed to adequately protect the structure should also be considered. If the height of the levee, berm, or floodwall would make the project cost-prohibitive, then alternatives should be considered.

DESIGN CONSIDERATIONS

Levees and floodwalls should be built to protect the residence from predicted flood heights as depicted on FEMA FIRMs, FIS, or local flood vulnerability analysis. The higher the levee or floodwall, the greater the depth of water that builds behind it and the greater the water pressure exerted on the barrier. Taller levees and floodwalls must be designed and constructed to withstand the increased pressures. Local zoning and building codes may restrict the use, size, and location of barriers. If the flood depth at the project site is above the practical height limits of available barriers, an alternative mitigation method should be considered. The bearing capacity and permeability of the soils encountered may have a significant impact on the choice of barriers as a flood protection option. A berm or floodwall should be as far from the building as possible to reduce the threat of seepage and hydrostatic pressure. The levee or floodwall can always be overtopped by a higher-than-expected flood regardless of the height of the barrier. Overtopping is a greater concern for a levee than a floodwall because a small amount of overtopping can cause erosion at the top of the levee and cause it to fail.

CONSTRUCTION AND COSTS

To facilitate slope stability as well as maintenance and safe grass mowing, the side slopes of most levees should not be steeper than 1 foot vertically to 3 feet horizontally (1:3). Trees and large shrubs should not be located on barriers as they can be overturned during high wind events and compromise the structural integrity of the levee. When trees and shrubs die, their roots decay, leaving cavities for water to pass through, which can cause the barrier to fail.

The costs can vary greatly depending on the height, length, construction materials, labor, access closures, interior drainage systems, and the distance between the construction site and the source of the fill dirt used to build the levee or berm. In general, the practical, cost-effective heights of these levees and floodwalls are usually limited to 6 feet and 4 feet, respectively.

GRADING: BARRIERS (BERMS/LEVEES/FLOODWALLS)

ADVANTAGES	DISADVANTAGES
• Reduces the flood risk to the structure and contents (if the design flood level is not exceeded), • Reduces the physical, financial, and emotional strains that accompany flood events, • Can protect multiple structures, • Occupants usually do not have to leave the structure during construction, • Typically, less expensive than structure elevation or relocation, and • Structural flood protection is provided without significant changes to the structure,	• May require land to construct (levees and berms typically require more land than floodwalls), • Will not reduce flood insurance premiums, • Overtopping or failure eliminates any protection provided, • Human intervention is required to seal any openings, • May restrict access to the structure, • Interior drainage must be provided, and • Could cause flooding of upstream and downstream properties.

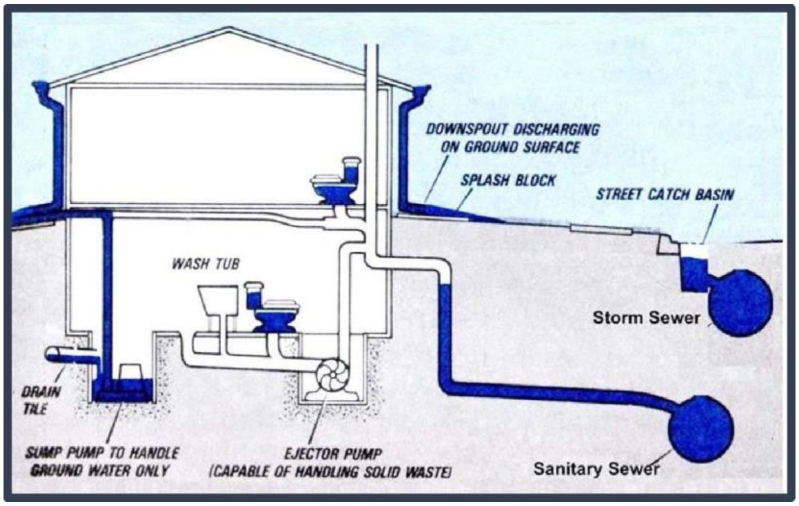
MAINTENANCE

A barrier requires periodic inspections and maintenance to address any necessary repairs. Small problems, such as cracks, loss of surface vegetation, erosion and scour, animal tunnels, and trees and shrubs can quickly become large problems during a flood event. A barrier should be inspected at a least each spring and fall, before each impending flood, and after each flood event.

FLOOD REDUCTION

Berms, levees, and floodwalls have been proven to protect structures from flooding; however, they may increase the risk of flooding upstream and downstream. As a result, there are strict regulations on the construction of barriers that may prevent their implementation in some areas. Typically, construction of a barrier will block the flow to an area and that lost storage volume must be compensated. When barriers are used, they are effective up to the design elevation. If the barrier is overtopped, the flood protection is lost.

PLUMBING: OVERHEAD SEWER SYSTEMS



MWRD. August 2015. *Technical Guidance Manual for the Implementation of the Watershed Management Ordinance.*

An overhead sewer is generally viewed as the most cost-effective sewer backup protection measure for residential basements. A sump is installed under the basement floor to intercept sewage flowing from basement fixtures and the basement floor drain. An ejector pump in the sump pushes sewage up above the flood level. From there it can drain by gravity into the sewer service line. Plumbing fixtures on the first floor continue to drain by gravity to the service line. If the water level in the municipal sewer system reaches an elevation of the overhead sewer where it exits the structure, a check valve in the pipe from the ejector pump keeps the water within the pipes. An overhead sewer can help prevent water flowing from the exterior to the interior of the structure through the sanitary sewer and/or stormwater drainage systems and should be considered for sanitary sewer drainage systems with fixtures below the flood protection level.

ADVANTAGES	DISADVANTAGES
• Human intervention is not required for an overhead sewer to work and • More dependable than a standpipe or backflow valve.	• Increased risk of structural damage, since hydrostatic pressures on the basement walls and floor cannot equalize, • Require periodic maintenance, and • More expensive than a standpipe or backflow valve.

DESIGN CONSIDERATIONS

Some specific design considerations to keep in mind before installing an overhead sewer include anticipated water level, source of basement flooding experienced, strength of the existing foundation walls and floors, plumbing connections inside the structure, condition of the service lateral between the municipal sewer and the structure, groundwater elevation and the location of the sump pit. In addition to the plumbing required for an overhead sewer, a battery backup or generator is also recommended. The ejector pump requires electricity to work, which is more likely to occur during a storm event when the ejector pump is needed.

CONSTRUCTION AND COSTS

Although more dependable than a standpipe, an overhead sewer is more expensive. A plumbing contractor must reconstruct the pipes in the basement and install the ejector pump.

MAINTENANCE

Common maintenance practices for overhead sewers include maintenance of the ejector pump, cleaning the sump pit, cleaning the pump inlet screen, cleaning, inspection and oiling of the sump pump, adjusting the float on the pump and replacement of the pump as needed.

FLOOD REDUCTION

Overhead sewers are typically installed in most new residential homes and can be retrofitted into an existing structure to provide added protection from flooding of below ground areas. The flood reduction is limited to the individual structure and these systems are not intended to protect a structure from overbank flooding or basement seepage in areas with high groundwater tables.

DRY FLOODPROOFING: RAISED WINDOW WELLS

Properties that do not have adequate protection of their low opening can effectively raise the low opening height with a window well. Window wells can prevent water from entering the basement and prevent rotting of window sills, which may reduce the ability of the windows to hold back flood water.

DESIGN CONSIDERATIONS

Window wells should be installed around all windows that are close to or below the ground surface. The ultimate height of the window well depends on the level of flood protection desired, appearance, cost and height of the window. The outer edges of the window well should be sealed to the side of the structure and the bottom of the well should be a least six inches below the underside of the window.

CONSTRUCTION AND COSTS

The height of the raised window well and the soils should be considered when constructing a window well. Raised window wells can be overtopped by higher-than-expected floods regardless of the height of the barrier. The key factors to consider when constructing a raised window well include improvement of the drainage inside the window well, utilizing a mixture of coarse material at the bottom of the well and proper lot grading that directs overland water away from window wells. A window well cover should be installed if the volume of roof water that can spill directly into the window well or rain that can fall into the well are significant. The cost of constructing a raised window well varies depending upon the material used, size of the window, and height the window well is raised.

ADVANTAGES	DISADVANTAGES
• Reduces the flood risk to the structure and contents (if the design flood level is not exceeded), • Reduces the physical, financial, and emotional strains that accompany flood events, • Typically, less expensive than structure elevation or relocation, and • Structural flood protection is provided without significant changes to the structure.	• Will not reduce flood insurance premiums, • Overtopping or failure eliminates any protection provided, • May restrict egress access to the structure.

MAINTENANCE

Raised window wells require periodic inspections and maintenance to address any necessary repairs. The window and the seal around the window should be checked annually for cracks and potential leaks. Also, there should be positive drainage away from the window well.

FLOOD REDUCTION

Raising a window well can reduce the structural flooding that results from this low opening. The level of flood protection is limited to the height of the window well, which should not exceed two or three feet.

DRY FLOODPROOFING: GLASS BLOCK BASEMENT WINDOWS

An alternative to a raised window well is to remove the glass from the window and replaced it with glass blocks. When installed properly, glass blocks can withstand the pressure of shallow ponding floodwaters. The glass blocks will reduce the occurrence of seepage through a lower level window.

DESIGN CONSIDERATIONS

Replacing a window with glass blocks will render the window inoperable, but the glass will still allow natural light into the area. If the window is serving as an emergency exit, it cannot be replaced with glass blocks. Glass block should not be used if floodwaters are known to carry debris, floodwaters flow at high velocities, floodwaters remain high for over 24 hours or in structures with frame and masonry veneer walls. Local zoning and building codes may also restrict the use of glass block in buildings that require emergency exits.

CONSTRUCTION AND COSTS

Cost for construction will vary based on accessibility, block chosen, size of window and condition of existing window openings.

MAINTENANCE

The components of glass block basement windows must be inspected and preserved to maintain the flood protection. The glass blocks and the seal around the window should be checked annually for cracks and potential leaks.

ADVANTAGES	DISADVANTAGES
• Reduces the flood risk to the structure and contents if the design flood level is not exceeded, • May be less costly than other retrofitting measures, • Does not require the extra land, • Reduces the physical, financial, and emotional strains that accompany flood events, and • Retains the structure in its present environment.	• Does not satisfy the NFIP requirement for bringing Substantially Damaged or Improved residential structures into compliance, • Requires ongoing maintenance, • Does not reduce flood insurance premiums for residential structures, • May not provide protection if measures fail or the flood event exceeds the design parameters, • May result in more damage than flooding if design loads are exceeded, walls collapse, floors buckle, or the building floats, • Does not eliminate the need to evacuate during floods, May • adversely affect the appearance of the building, May lead to • damage of the building and its contents if the glass blocks leak, and • Does not minimize the potential for damage from high-velocity flood flow.

FLOOD REDUCTION

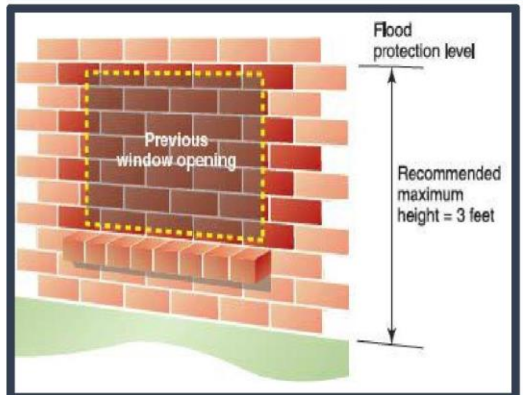
If the low opening to the structure is a lower level window and overland flow is getting into the structure through the window, installing glass blocks can reduce the occurrence of structural flooding. However, the level of flood protection is limited based on the sealant and strength of the glass blocks.

DRY FLOODPROOFING: PERMANENT FLOOD SHIELDS FOR EXTERIORS

Removing basement windows and doors that are the first entry point for floodwaters, and incorporating them into the wall system can seal a building from floodwaters and alleviate structural flooding. The decision to eliminate an opening depends on the use of the opening, location and the ease with which the opening can be filled and sealed. Sealing an opening is dependent on the wall or foundation's ability to resist the loads. If the walls or foundation are structurally insufficient to carry these loads, they must be reinforced prior to sealing the opening. Sealants used to seal openings in walls or floors should be able to withstand being submerged for the anticipated duration of flooding.

DESIGN CONSIDERATIONS

Permanent flood shields for exterior openings work well in areas that can be re-graded to flow away from the structure and at exterior openings that are not needed for ingress/egress. The key design considerations include flood durations less than 24 hours, flow velocity and structural constraints.



FEMA P-936. Available at https://www.fema.gov/media-library/assets/documents/34270.

CONSTRUCTION AND COSTS

Constructability considerations include location of opening, access for workers and materials. Cost for construction will vary based on accessibility, size and condition of opening, type of material used to seal the opening and type of facing material necessary to match the existing structure.

MAINTENANCE

ADVANTAGES	DISADVANTAGES
• Reduces the flood risk to the structure and contents if the design flood level is not exceeded, • May be less costly than other retrofitting measures, Does • not require the extra land to construct, • Reduces the physical, financial, and emotional strains that accompany flood events, and • Retains the structure in its present environment.	• Does not satisfy the NFIP requirement for bringing Substantially Damaged or Improved residential structures into compliance. • Does not reduce flood insurance premiums for residential structures. • May not provide protection if measures fail or the flood event exceeds the design parameters. • May result in more damage than flooding if design loads are exceeded, walls collapse, floors buckle, or the building floats. • May adversely affect the appearance of the building. May not • reduce damage to the exterior of the building and other property. • May lead to damage of the building and its contents if the sealant system leaks. • Local zoning and building codes may restrict sealing openings • Involves increased costs for a design professional.

The permanent flood shields must be inspected and maintained. Annual inspections should include inspection of walls, floors, and inspection of floodproof coatings for cracks and potential leaks.

FLOOD REDUCTION

If the low opening to the structure is a lower level window or garage door and overland flow is getting into the structure through the window, sealing the opening can reduce the occurrence of structural flooding. However, the flood protection is limited to the structure and the sealant used.

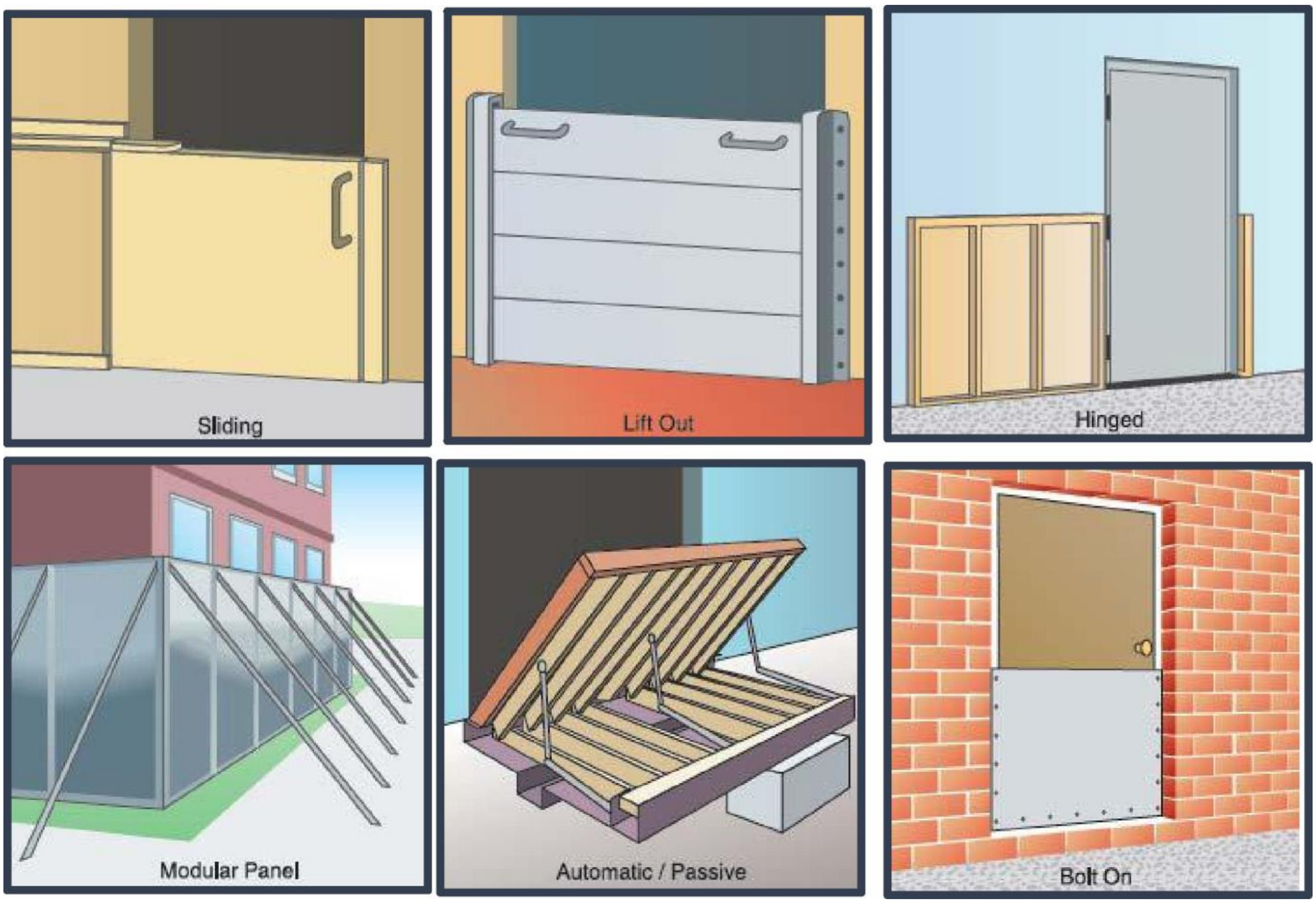
DRY FLOODPROOFING: REMOVABLE FLOOD SHIELDS FOR EXTERIORS

During flood conditions, doors typically present the largest openings requiring protection from water intrusion into the building. Flood shields or panels are watertight structural systems that bridge the openings in walls to prevent the entry of floodwaters. Flood shields work in tandem with waterproof barriers to resist water penetration. Although flood shields are most often temporary measures, they can also be used as a permanent floodproofing measure. Flood shields transfer flood-induced forces to the adjacent structural components, which can overstress the structural capabilities of the building. Most flood shields are mounted against the exterior of the opening, allowing rising floodwaters to further compress the gaskets and seals between the flood shield and the wall system or frame of the opening.

DESIGN CONSIDERATIONS

The key design considerations include flood durations less than 24 hours, flow velocity, warning time, floodborne debris, installation requirements and availability of personal to seal the opening.

FEMA. July 2013. *Floodproofing Non-Residential Buildings.* FEMA P-936. Available at https://www.fema.gov/media-library/assets/documents/34270.



CONSTRUCTION AND COSTS

Exterior flood shields require human intervention; therefore, someone must be willing and able to install all flood shields and carry out all other activities required for the successful operation of the system. As a result, not only must someone be physically capable of carrying out these activities, they must be available in time to do so before floodwaters arrive. The cost for exterior flood shields vary based on the type of shield (manual or automatic), material, and the size of the opening.

DRY FLOODPROOFING: REMOVABLE FLOOD SHIELDS FOR EXTERIORS

ADVANTAGES	DISADVANTAGES
• Reduces the flood risk to the structure if the design flood level is not exceeded, • May be less costly than other retrofitting measures, • Does not require the extra land, and • Retains the structure in its present environment.	• Does not satisfy the NFIP requirement for bringing Substantially Damaged or Improved residential structures into compliance, • Requires ongoing maintenance, • Does not reduce flood insurance premiums for residential structures, • Typically requires human intervention and adequate warning time, • May not provide protection if measures fail or the flood event exceeds the design parameters, • May result in more damage than flooding if design loads are exceeded, walls collapse, floors buckle, or the building floats, • Does not eliminate the need to evacuate during floods, May • adversely affect the appearance of the building if shields are not aesthetically pleasing, • May not reduce damage to the exterior of the building and other property, • May lead to damage of the building and its contents if the sealant system leaks, and • Does not minimize the potential for damage from high-velocity flood flow.

MAINTENANCE

The components of the flood shields must be inspected and maintained on a regular basis. Maintenance requirements include develop an inventory and location list of all closures, annual inspection of the closures, inspection and replacement of any rubberized seals as needed and inspection of walls, floors and floodproof coatings for cracks and potential leaks.

FLOOD REDUCTION

Removable Flood Shields for Exterior Openings can seal a low opening that is receiving overland flow and reduce the occurrence of structural flooding. However, the flood protection is limited. Only the structure with the sealed opening will see a reduction in flooding. Also, the level of flood protection is dependent on someone being available to correctly install the flood shield in a timely manner.

ACQUISITION AND DEMOLITION

Acquisition and demolition typically involves purchase of a flood-damaged structure, tearing it down, and restoring the property to open space. This mitigation strategy may be the most practical when a home has sustained extensive damage, especially severe structural damage. The most important considerations relate to how badly the home has been damaged. Property acquisition is a complex process and the procedures for property title transfer from a private owner to a government entity are detailed and extensive. Every precaution is made to protect the private property owner's rights and to ensure they are fully aware of the aspects of the transaction. For a community to quality for FEMA grant for acquisition projects, three basic requirements must first be met. First, the local community must inform the property owners interested in the acquisition program that the community will not use its condemnation authority to purchase their property and that participation in the program is strictly voluntary. Secondly, the subsequent deed to the property to be acquired will be amended such that the landowner will be restricted from receiving any further Federal disaster assistance grants, the property shall remain in open space in perpetuity, and the property will be retained in ownership by a public entity. Third, any replacement housing will be located outside of the 100-year floodplain.

DESIGN CONSIDERATIONS

Design considerations to keep in mind before acquiring and demolishing an existing structure include property acquisition is a long process (two- to three-years) and construction costs should account for inflation during that time and an acquired property must be deed restricted as open space. This deed restriction will limit future use of the property.

ADVANTAGES	DISADVANTAGES
• Permanently removed the problem since the structure no longer exists, • Allows a substantially damaged or substantially improved structure to be brought into compliance with the local floodplain management ordinance, • Expands open space and enhances natural and beneficial uses, and • May be eligible for funding under FEMA's mitigation grant programs.	• Cost may be prohibitive, • Resistance may be encountered by local communities due to loss of tax base, maintenance of empty lots, and liability for injuries on empty, community-owned lots.

CONSTRUCTION AND COSTS

Some of the key construction elements to consider are the presence of hazardous materials (asbestos, lead paint, etc.), historic site determination, sensitive environmental features on the site and the presence of endangered species near the project site. Acquisition is a relatively expensive mitigation measure. Examples of cost estimating items that may need to be considered include pre-flood fair market value, mitigation of hazardous materials, disconnection of existing utilities, demolition and disposal of debris, title search, legal fees, and appraisals, site restoration and project management.

MAINTENANCE

The ownership of the original site may be transferred to the local community, which then has the maintenance and security responsibilities associated with the vacated site.

FLOOD REDUCTION

Structure relocation permanently mitigates the flood risk to the structure involved, since the structure is moved out of a flood-prone area. Also, additional storage capacity is provided on the original site location once the obstruction to flood flows is removed. As a result, there is a benefit to the adjacent properties to the original site location.

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