ERIE STREET / MAYO AVENUE FLOOD PRONE AREA STUDY

PROJECT SITE:

WHEATON, ILLINOIS

PREPARED FOR:

THE CITY OF WHEATON
303 W WESLEY ST,
WHEATON, ILLINOIS 60187

PREPARED BY:

V3 COMPANIES
7325 JANES AVENUE
WOODRIDGE, ILLINOIS 60517
630.724.9200
V3 CONTRACT NO. 14160

AUGUST 9, 2018
REV. OCTOBER 5, 2018

Contents

Executive Summary

The Erie Street/Mayo Avenue Flood Prone Area Study determined the locations and causes of flooding within the Erie and Mayo Watersheds located in Wheaton, Illinois. The goal of this study is to develop concept-level alternatives that reduce flooding and protect homes located in the flood prone areas from the 1% annual chance design storm (100-year storm event).

Seven problem areas were identified by V3 as causing structural flooding during the 100-year storm event. These problem areas were identified during a review of the following information:

- Drainage assessment notes describing flooding issues provided by the City of Wheaton;
- Resident pictures taken during and after the September 2008 storm event;
- Resident pictures taken during and after the July 2010 storm event;
- Topography provided by V3 Survey Department and DuPage County;
- XP-SWMM existing conditions results

All seven of these problem areas were evaluated to determine the apparent cause of flooding, and proposed alternatives were developed for each problem area, including storage, conveyance, buyouts and floodproofing.

The West Erie Basin includes two problem areas that damage two homes and the East Erie Basin includes two problem areas that result in damage to 11 residential structures. The most feasible engineering alternative for the West Erie Basin can reduce water surface elevations to remove expected flooding from the homes. Due to the high cost of the engineering alternative relative to the appraised value of the two homes which are protected by the alternative, the most cost effective alternative in the West Erie basin may be a combination of buyouts and floodproofing. The most cost-effective engineering alternative for the Central & East Basin includes conveyance and storage to reduce water surface elevations below the low entry / damage elevation of the homes at a cost per benefitted structure that is less than the appraised cost of the structures themselves.

The Mayo Basin includes three problem areas with existing water surface elevations that are higher than the low entry / damage elevation of 11 residential structures. Storage and conveyance alternatives were considered to reduce water surface elevations, and buyouts and floodproofing alternatives were also considered. Three engineering alternatives that combine storage and conveyance improvements can result in water surface elevations that are below the low entry elevation for all the homes in the 100-year storm event, although two of the three alternatives result in increased storm sewer discharge into Spring Brook and require additional analysis (FEQ or unsteady HEC-RAS) to determine if the timing of the storm sewer discharge occurs prior to the timing of the peak of the creek, and whether the creek can handle the additional outflow without upstream or downstream impacts.

In both the Erie and Mayo Basins, floodproofing is the lowest cost alternative, but this does not lower the water surface elevations. The engineering alternatives have benefits beyond protection of the flooded homes, including reduced yard and nuisance flooding, improved safety and traffic access, and an increase in quality of life for the residents in the area. The economic benefit of these improvements is not included in the cost-benefit comparison. The City should consider these non-structural benefits versus the cost of the alternative, when selecting an alternative for implementation.

Introduction

The Erie Street/Mayo Avenue Flood Prone Area Study determined the locations and causes of flooding within the Erie and Mayo Drainage Basins located in Wheaton. The goal of this study is to develop concept-level alternatives that reduce flooding and protect homes located in the flood prone area from the 1% annual chance design storm (100-year design storm). Reducing street and yard flooding is not a goal of this study, although street and yard flooding may be reduced as a consequence of the identified alternatives that reduce structural house flooding.

The Erie and Mayo drainage basins and subbasin divides used for this study are shown in Exhibits 1 and 2. Adjacent drainage basins also contribute runoff to storm sewer flows of the Erie and Mayo storm water management systems. For this reason, the adjacent drainage basins were also included in the analysis.

Erie Drainage Basin

The Erie drainage basin is a 63.5 acre basin served by a separate storm sewer system. The Erie study area is roughly bounded by Hazelton Avenue on the west, Manchester Road on the north, Dorchester Avenue on the east, and Winfield Creek on the south. The Erie Basin was divided into a West, Central, and East subbasin.

The West Erie Basin is a 13.9 acre basin starting west of the Vineyard Church of DuPage. It drains west and then north to the DuPage County Fairgrounds Property through a series of 12" storm sewers. It appears the 12" storm sewer is undersized and the basin lacks a well-defined overflow path, which causes damage to structures along Erie Avenue.

The Central Erie Basin is a 32.8 acre basin tributary to an existing detention basin northeast of the Vineyard Church of DuPage which outlets through a 4" storm sewer. The runoff then flows south under Vernon Avenue and eventually discharges to Winfield Creek. The existing detention basin appears to be slightly undersized resulting in a 100-year high water level (HWL) that spills east out of the basin and damages structures. The basin only overtops to the west for the 500-year storm event. The basin does not overtop to the west and does not contribute to the West Erie Basin in storm events smaller than the 500-year storm event.

Two storage basins are located south of the White Oak Drive cul-de-sac, north of Clinton Court and are included in the Central Basin. They do not appear to contribute to flooding problems and only overflow in the 500-year storm event.

The East Erie Basin is a 16.8 acre basin that drains through a 15" storm sewer located in the backyards between Dorchester Avenue and Morgan Avenue, running south and eventually discharges to Winfield Creek. The East Erie Basin includes a bowl in the rear yards between Morgan Avenue and Pierce Avenue, which has an undersized outlet pipe and lacks a well-defined overflow path resulting in structural damaged for homes along Morgan Avenue and Pierce Avenue. The Central and East Erie Basins drain to the south through an adjacent basin and eventually discharge to Winfield Creek. The East Erie Basin overflows to the west to the Central Erie Basin in the 100-year storm event.

An additional 29.1 acre drainage basin to the south of the Erie Basin was also modeled because the Central and East Erie Basins are also tributary to these systems. The basin consists of multiple sewers that run from north to south and outlet to Winfield Creek at Clinton Court and Morgan Avenue. When the storm sewers are at capacity, runoff overflows to the south to Winfield Creek.

Mayo Drainage Basin

The Mayo Basin is a 54.2 acre basin served by a separate storm sewer system. The Mayo drainage basin is roughly bounded by Dartmouth Drive on the north, Sunset Road on the east, Wexford Circle on the west, and Spring Brook on the south. The basin drains south through a 36" storm sewer and outlets to Spring Brook. It appears the 36" storm sewer is undersized and the basin lacks a well-defined overflow path which results in damaged structures and sitting water throughout the overland flow path of the Mayo Basin. The principal overland flow path is located between homes, in the approximate center of the Paula Avenue, Center Avenue, and Mayo Avenue blocks.

Drainage Divides and Existing Conditions Summary

The basin divides provided by the City of Wheaton were reviewed against the topographic mapping, survey data, storm sewer atlases, and other available information to refine basins as necessary. The basin divides used for this study generally match the basin divides provided by the City of Wheaton, though some minor changes were made to account for both storm sewers and basin topography. A comparison of the City of Wheaton basin divides and the V3 Revised divides are shown on Exhibits 3 and 4.

Existing land use mapping, aerial mapping, soil mapping, wetland mapping, FEMA floodplain mapping, and MWRD inundation mapping was also reviewed to establish the existing conditions. These baseline maps can be found as Exhibits 34 – 51. An overview of the topographic maps, showing the topographic relief of the study area as a whole and of each individual subbasin, can be found in Exhibits 5 and 6.

Description of Flooding Issues

Drainage problems are shown in Table 1 based on a review of City of Wheaton data, resident photos taken during and after the September 2008 and July 2010 storm events, and XP-SWMM model results. The locations of these problem areas can be seen on Exhibit 7 and 8.

Table 1 – Flooding Issues

Problem ID	Basin	Location	Problem Description and Apparent Cause
A	West Erie	Backyard area between Beverly St and Erie St, just south of Manchester Rd	Ponding in backyards before overflowing to west through adjacent homes
B	West Erie	Erie Ave, just south of Manchester Rd	Ponding on street before overflowing to west through adjacent homes (to Problem Area A)
C	Central Erie	Detention basin west of Hickory Ln and Vernon Ave	Detention Basin overtops and damages adjacent structures
D	East Erie	Backyard area between Pierce Ave, Dorchester Ave, Manchester Rd, and Liberty Dr	Ponding in backyards before overflowing to east through adjacent homes
E	Mayo	Paula Ave, between Westhaven Dr and Marcey Ave	Ponding on street before overflowing to south through adjacent homes
F	Mayo	Backyard area between Center Ave, Mayo Ave, Westhaven Dr, and Marcey Ave	Ponding in backyards without outlet pipe. Overflow to south through adjacent homes (to Problem Area I).
G	Mayo	Mayo Ave, between Westhaven Dr and Marcey Ave	Ponding on street before overflowing to south through adjacent homes

Drainage problems exist largely as a result of undersized conveyance systems and lack of stormwater storage. The effect of stormwater runoff and overland flow from rainfall events is yard flooding, street flooding, and structure flooding.

Hydrology and Hydraulics Summary (Existing Conditions)

An XP-SWMM hydrologic and hydraulic analysis was conducted for the Erie/Mayo Basins to evaluate the performance of the existing stormwater management system and determine which residential structures and accessory structures may be at risk of flooding. This section describes the calculation methodology used to establish the "existing condition", describes efforts to calibrate the model to known high water marks, and presents a summary of results.

XP-SWMM Modeling

XP-SWMM is a dynamic stormwater management model that computes runoff hydrographs and can route these hydrographs through a series of hydraulic elements including storm sewers, storm sewer inlets, depressional storage areas, and overland flow routes. The dynamic program models storm flow throughout an entire storm event (and not just at a single point in time corresponding to a peak condition, as is done with static models.) The program allows stormwater runoff to "choose" its route based on the elevation and capacity in the conveyance system. For example, runoff entering a manhole would first flow downstream through a pipe, but once the pipe reaches capacity and surcharges, any additional inflow would surcharge and is either stored at the surface or flow downstream via an overland flow route, depending on the specific physical characteristics of that location.

Exhibits 9 and 10 provide a graphic representation of the XP-SWMM model, including subbasin delineation, flow direction, XP-SWMM node IDs, and hydrologic input parameters. Two separate XP-SWMM models were built; one for the Erie West, Central, and East and a second for the Mayo area.

Hydrologic Data

The basin hydrology was modeled using the SCS method, which uses a hydrograph routing technique and input parameters as described below. This method is similar to hydrograph routing performed in TR-20 or HEC-1. The following data sources were used to create the hydrologic input parameters for the model:

- Subbasin areas delineated using DuPage County 2-foot contour mapping supplemented with surveyed topography as well as the Wheaton storm sewer atlas;
- Runoff Curve Numbers established using standard SCS methodology based on land use and soil type;
- Times of Concentration based on NRCS methodology using DuPage County 2-foot contour mapping and aerial photography;
- Rainfall depths and distributions based on Bulletin 70 Table 13 for Northeastern Illinois as well as the gage records as provided by the City of Wheaton. 500-year rainfall depths were extrapolated using Bulletin 70 data.

All hydrologic calculations can be found in Appendix A.

Hydraulic Data

The following data sources were used to create the hydraulic input parameters for the model:

- Storm sewers were defined based on survey data provided by V3 Survey Department and atlas data provided by the City of Wheaton.
- Overland flow routes based on 2-ft topographic mapping from DuPage County and V3 survey where available.
- Depressional storage areas were defined using DuPage County 2-ft topographic mapping and V3 survey where available (Stage-Storage calculations can be found in Appendix A).

The XP-SWMM model represents the main conveyance routes. Not every single segment of sewer was modeled and some storm sewer segments were combined or removed from the model to simplify the model and improve computational analysis times. Inlet capacity was not modeled as a part of this study. If any of the proposed alternatives are incorporated, a more detailed analysis of inlet capacity should be completed to ensure runoff can enter the system and utilize the increased storage and sewer capacity provided by the proposed alternatives. Dual inlets and/or high-capacity inlets may be needed in some locations.

Boundary Conditions

The downstream boundary condition (tailwater condition) for the Erie Basin was set using a normal depth. As previously mentioned, the Erie Basin outlets to Winfield Creek and the DuPage County Fairgrounds storage facility. The Erie Basin is located approximately 20 feet higher than the sewer outlets. For this reason, tailwater effects of the receiving waters are unlikely to propagate upstream through the system, and a normal depth boundary condition at the outfall was considered to be reasonable for this basin. A sensitivity test was performed to confirm this assumption.

The Mayo Basin outlets to Spring Brook and the adjacent topography suggests the problems observed in the Mayo Basin are directly tied to the Spring Brook water surface elevation. For this reason the model was run with a different boundary condition for every frequency storm event. Because Spring Brook has a much larger tributary area than the study area the peak runoff leaving the study area will occur sooner than the peak elevation in Spring Brook. In these scenarios Table 7-3 "Frequencies for Coincidental Occurrence" of the HEC-22 Urban Drainage Design Manual can be used to determine the tailwater elevation based on the ratio of drainage areas for the site and Spring Brook. This table can be seen below.

Table 2 – Frequencies for Coincidental Occurrence from HEC-22 Urban Drainage Design Manual

Table 7-3. Frequencies for Coincidental Occurrence.

Area Ratio	Frequencies for Coincidental Occurrence			
	10-Year Design		100-Year Design	
	Main Stream	Tributary	Main Stream	Tributary
10,000 to 1	1	10	2	100
	10	1	100	2
1,000 to 1	2	10	10	100
	10	2	100	10
100 to 1	5	10	25	100
	10	5	100	25
10 to 1	10	10	50	100
	10	10	100	50
1 to 1	10	10	100	100
	10	10	100	100

According to the existing FEMA Flood Insurance Study for Spring Brook (effective March 2007), the total area tributary to the Spring Brook at Aurora Way, approximately 450 feet upstream of the site, is 2.78 square miles, or 1,779 acres. The proposed study area tributary to Spring Brook is approximately 78.7 acres, resulting in a ratio of approximately 23 to 1. Based on Table 2 a 50-year tailwater elevation is required for the 100-year storm event and a 10-year tailwater elevation is required for the 10-year storm event. Based on these two values the following table was developed for the rest of the storm events.

Table 3 – Tailwater Elevation Used for Each Modeled Storm Event

Storm Frequency	Tailwater Storm Frequency
1-year	1-year
2-year	2-year
5-year	5-year
10-year	10-year
25-year	25-year
50-year	25-year
100-year	50-year
500-year	100-year

Spring Brook elevations for the 10-year, 50-year, and 100-year storm events were obtained from the existing FEMA Flood Insurance Study profiles (effective March 2007). Elevations for other storm events were approximated by interpolating between known elevations.

The existing conditions model was also run using a normal depth boundary condition as a sensitivity test to determine the effect of the boundary condition on the results. Table 4 below presents the existing conditions 100-year results of this test.

Table 4 – 100-year Existing Conditions Results for Varying Boundary Conditions

Problem Area	Peak Elevation		Difference (ft)
	Normal Depth Tailwater	FEMA Flood Insurance Study 50-year Tailwater Elevation	
HMA_3	740.63	740.65	0.02
HMA_5	728.88	728.91	0.03
HMA_9	726.78	726.80	0.02
HMA_11	725.98	726.27	0.17

The results of the sensitivity test show 10 of 11 homes are damaged when no tailwater is present. Some tailwater is expected during a storm event. Before implementing any alternatives, an unsteady FEQ model could be run to tie the storm sewer improvements directly to the stream model and more precisely evaluate the alternatives and expected benefits. This FEQ modeling is outside the scope of this project.

Key Assumptions

The following lists the key assumptions that were made in the creation of the XP-SWMM model for the Erie/Mayo Basins.

- Inverts for storm sewers with no surveyed invert data were approximated based on local topography and adjacent surveyed structures. A slope of 0.5% was often used a default value. In general, these storm sewers are not directly responsible for the flooding (or for reducing the flooding) within the problem areas, but rather, serve a means to bring tributary area towards the system. The effect of this assumption is unlikely to impact the results at the problem areas.
- As previously mentioned, it was assumed storm sewer capacity, not inlet capacity, controls performance of the stormwater system; that is, it's assumed that runoff can enter the system freely through the inlets and the capacity of the local storm sewers controls what's conveyed downstream. Leaves, debris, and sediment can cause reduced inlet capacity, and routine maintenance should be completed to ensure runoff can enter the stormwater system.

Note, these assumptions and boundary conditions are considered valid for the model, when evaluating alternatives and improvements in the Erie and Mayo Basins. If this model is used as a starting-point for analysis of other areas in the future, these assumptions should be reviewed for validity in those future areas.

Model Verification

The City of Wheaton provided resident photos for the September 2008, July 2010, and April 2013 storm events taken during and after the storm event which, when used with V3 survey data, provide approximate high water level marks for the model. The April 2013 photo was taken in the Mayo Basin and essentially shows the Spring Brook floodplain elevation during the April 2013 storm event. Because this would only confirm our boundary condition and doesn't provide any additional info, the April 2013 pictures could not be used for calibration. The pictures for the September 2008 and July 2010 storm event are for problem areas in the Erie Basin.

The September 2008 precipitation data was recorded at the Countryside Gage. There was 7.03 inches of rain in 50 hours, which is slightly larger than a 50 year storm event (50 year event produces 6.84 inches in 48 hours; 100 year event produces 8.16 inches in 48 hours).

The July 2010 precipitation data was recorded at the Willow Gage. There was 6.96 inches of rain in 12 hours, which is larger than a 100 year storm event (100 year event produces 6.59 inches in 12 hours)

The simulated model results were compared to high water marks recorded in the watershed. A total of 4 resident photos were provided by the City of Wheaton, which resulted in unique high water level data for 2 areas.

Typically, a difference of less than six inches is desirable when comparing simulated versus measured high water marks for high water marks of the highest level of confidence (such as a gage record). A larger tolerance is acceptable for high water marks with lower levels of confidence, such as photographs when the corresponding high water elevation must be approximated and the timing of the photo relative to true peak may be uncertain.

Final calibration results for the storm events are shown in Table 5.

Table 5 – Calibration Results

Location	Storm Event	Approximate WSEL based on V3 survey or 2-ft contours	Simulated High Water Mark in XP-SWMM	Difference (Simulated – Measured) (ft)
110 N Morgan	July 2010	740.5	742.90	2.40
114 N Morgan	July 2010	740.5	742.90	2.40
137 N Erie - Back	September 2008	738	738.40	0.40
137 N Erie - Front	September 2008	738	738.40	0.40

The model for the September 2008 storm event results in elevations approximately 5” higher than the photos demonstrate for the September 2008 storm event.

The model for the July 2010 storm event results in elevations much higher than the elevations observed in the pictures.

There are many variables which could explain these differences, including:

- Pictures that were taken at a time when the ponded water did not yet reach the high water level or was already receding after the high water level occurred;
- Rainfall depths and intensities can change over relatively small distances. It’s possible that rainfall over the Erie Basin was actually less than the rainfall recorded at the Wheaton gages.

Because there were so few calibration photos available for these basins, the City’s records of flood problem areas were also compared with existing conditions modeling to ensure the model produces results consistent with the City’s records. Although there are not specific elevations associated with the flood complaint areas, a review of this data is useful to confirm the model is producing (or not producing) expected levels of flooding.

Critical Duration Analysis

After accepting the model as “calibrated”, the model was run to analyze the critical duration. The 100-year storm event was analyzed for the 1, 2, 3, 6, 12, 24, and 48 hour durations. The results of the analysis suggest the 2-hour and 24-hour events are critical for the 100-year storm event for the Erie Area and the 2-hour and 3-hour events are critical for the Mayo Area. The 2-hour and 24-hour (Erie Area) and the 2-hour and 3-hour (Mayo) durations were then used to analyze the remaining storm event frequencies and the proposed conditions alternatives.

Establishing Flood Protection Elevations

To determine an alternative’s effectiveness to reduce or eliminate structural flood damage, it was necessary to have a flood protection elevation for each structure in flood prone study area. V3 Survey Department completed a survey of the structures’ low entry elevation and top of foundation elevation for the structures within the flood prone areas, seen on Exhibits 31 through 33.

Existing XP-SWMM Analysis and Results

The existing conditions inundation areas and the locations of homes that may experience flooding of their home in the existing condition are shown on Exhibits 11 through 14.

The existing conditions results suggest structure damage will begin to occur at the 5-year storm event for the Erie Basin and the 25-year storm event for the Mayo Basin.

The XP-SWMM model results were used to create the Inundation and At Risk Structure Map which can be seen in Exhibits 11 and 12. A complete record of XP-SWMM results is included in the electronic transmission of project files. Table 6 summarizes the results of the modeling and shows the number of structures flooded in each storm. Appendix C provides a larger table showing key elevations from the XP-SWMM Model versus low entry elevations, which were used for our Inundation Exhibits and for identifying at-risk structures.

Table 6 – Existing Conditions Results

Storm Event	Erie Area		Mayo Area	
	Number of Damaged Properties	Total Property Value (from DuPage Cty Assessor Website)	Number of Damaged Properties	Total Property Value (from DuPage Cty Assessor Website)
1-year	0	$0	0	$0
2-year	0	$0	0	$0
5-year	1	$239,000	0	$0
10-year	4	$782,300	0	$0
25-year	7	$1,398,500	4	$1,357,400
50-year	11	$2,628,100	5	$1,674,300
100-year	13	$3,343,400	11	$3,835,000

Design Criteria

Project alternatives were designed with a goal of protecting all structures from flooding during the 100-year critical duration storm event. The 2-hr and 24-hr duration storms were analyzed for the Erie Area and the 2-hr and 3-hr duration storms were analyzed for the Mayo Area.

Other design criteria include:

- Bulletin 70 rainfall
- Storm sewers were designed to:
  - Provide adequate conveyance and capacity to reduce flooding to meet the residential structure protection goal; in most cases, the storm sewers have a minimum 10-year level of service based on a flowing full capacity.
  - Provide 2 feet of cover, minimum, between top/pipe and ground.
- Storage areas were graded with:
  - 4:1 side slopes.
  - Flat bottoms, to be planted with native vegetation.
  - A 5-foot buffer between the existing or proposed property line and the start of grading

Alternatives Identification and Analysis (Proposed Conditions)

The goal of the alternatives is to eliminate residential structure overland flooding during the 100-year storm event. The alternatives considered a range of conveyance, storage, floodproofing, and buy-out options.

Erie Area

Problems Areas A and B are depressional areas with undersized outlet pipes, Problem Area C is a basin that appears to be undersized, and Problem Area D is also a depressional area with an undersized outlet pipe Alternatives that were considered to reduce structural damage in the 100-year storm include:

1. Conveyance and Storage
2. Storage
3. Floodproofing
4. Buyouts

These alternatives are shown in Exhibits 15-18.

Proposed Alternative 1 (Erie - West): Conveyance & Storage
A conveyance and storage alternative was considered for the West Erie area. This alternative would include increased conveyance capacity for the 12” storm sewers draining the Erie Basin, to reduce ponding and drainage issues in the problem areas. The proposed pipes would need to have a diameter of 24” to 30”. This alternative also includes increased conveyance capacity for the pipe running along the backyards between Beverly Street and Erie Street.

Simply increasing the conveyance capacity without providing new storage volume reduces water surface elevation at the problem areas but results in increased flow rates downstream which may impact downstream properties. To reduce proposed peak flow rates to match existing flow rates, additional storage volume would be required in the DuPage County Fairgrounds retention basins. It is estimated that approximately 0.3 ac-ft of new storage may be required.

This alternative utilizes the existing sewer alignment but an alternative alignment could provide the same benefit (e.g., north on Erie Street and west on Manchester Road).

Because there are only two damaged structures in the West Erie Basin, increasing the size of 1,400 feet of storm sewer and providing an expansion to the existing fairgrounds ponds may not be a feasible solution.

Alternative 1 for the Erie area is shown in Exhibit 16 and the reduction in inundation areas (reflecting the proposed condition) can be seen on Exhibit 25.

The engineer's estimated opinion of probable construction cost for this alternative is $588,600 and would eliminate overland flooding in two homes.

Proposed Alternative 2 (Erie - West): Storage
A storage alternative was considered for the West Erie area, which aims to reduce flooding for the adjacent properties. Due to the fact the structure at 200 Erie Street is far below the road and is located directly within the overflow path between Erie and Beverly, this property is a prime candidate for a voluntary buy-out. By buying the property located at 200 Erie Avenue and removing the structure, the City could regrade the property and create additional storage volume in the area between Erie Ave. and Beverly Ave, which would reduce water surface elevations in the area to reduce flooding for structure at 201 Erie Avenue. This would also include some grading in adjacent rear yards.

This alternative would also include the installation of a 12" storm sewer to drain the regraded storage area to the existing 12" storm sewer running from east to west between Erie Avenue and Beverly Avenue.

Creating storage at other residences does not protect the home at 200 Erie, due to its topographically low location, but could protect the home at 201 Erie.

Alternative 2 for the Erie area is shown in Exhibit 17 and the reduction in inundation areas (reflecting the proposed condition) can be seen on Exhibit 26.

The engineer's estimated opinion of probable construction cost for this alternative is $704,200, which includes the buy-out cost for 200 Erie Street, and would eliminate overland flooding in one home.

Proposed Alternative 1 (Erie - Central & East): Conveyance & Storage
A conveyance and storage alternative was considered for the Central and East Erie problem areas. The alternative would include the installation of a new 30" storm sewer from Problem Area D (in the rear yards area) which would bring runoff to the existing basin located northwest of Hickory Lane and Vernon Avenue. The current storm sewer alignment aims to take advantage of existing easements, though the alignment could be modified if the City decides to pursue this alternative.

The alternative would also include the expansion of the existing detention basin to reduce the drainage issues in Problem Area C and to ensure peak rates from the basin are not increasing. A total volume of approximately 5 acre-feet is required for this alternative. There appears to be space to expand the basin both vertically and horizontally. The proposed alternative includes a combination of horizontal and vertical expansion, though the amount of horizontal and vertical expansion could be modified to provide the total required volume. The basin is located on private property and owner cooperation is necessary.

This alternative would also require the floodproofing of 123 and 131 White Oak Drive. As previously mentioned, the proposed 30" storm sewer route is conceptual only, and was chosen as the most direct route through the neighborhood. If a route is chosen that passes closer to the homes at 123 White Oak and 131 White Oak, there may be an opportunity to increase the capacity downstream of the depressional area behind those homes, resulting in additional benefits at those two structures.

An expansion of the existing retention basin south of the White Oak Drive cul-de-sac was also considered for possible expansion, though the existing normal water level is at an elevation such that there would be no hydraulic benefit to route water from Problem Area D to this location.

Another option to provide new storage may be to incorporate a flood forecasting system into the existing retention ponds located within the study area. The existing ponds south of White Oak Drive have a combined surface area footprint of 0.86 acres. The depth of these ponds is not currently known, but if they are six feet deep, they may provide roughly 5 acre-feet of storage below the NWL, which matches the volume of new storage needed within the subbasin. It may be possible to incorporate a small pump station and monitoring system at these existing ponds. The system would drain down these existing ponds in advance of an incoming storm event, creating 5 acre-feet of available ("new") storage to the incoming storm event, resulting in the same expected benefit as shown with the newly excavated pond. V3 has piloted some of these systems in nearby communities and can provide more information about this type of flood forecasting for resiliency system if desired.

Alternative 1 for the Erie area is shown in Exhibit 16 and the reduction in inundation areas (reflecting the proposed condition) can be seen on Exhibit 25.

The engineer's estimated opinion of probable construction cost for this alternative is $1,303,900, which includes an estimate of the property acquisition costs for the expanded basin, and would eliminate overland flooding in nine homes. The additional cost to floodproof the two remaining damaged structures is estimated to be $5,000.

Proposed Alternative 2 (Erie - Central): Storage

A storage alternative was considered for the Central Erie area, which aims to reduce flooding for the two adjacent properties. This alternative would include increased storage volume for the existing detention basin receiving Central Erie runoff to reduce ponding and drainage issues in the problem areas. The alternative would also include the modification of the outlet structure.

This alternative would also require the floodproofing of 123 and 131 White Oak Drive. Additional storage was also considered in the rear yards between White Oak and Pierce, to benefit the homes at 123 White Oak and 131 White Oak. It appears that the storage would require acquisition of the rear yards of a number of homes, and therefore the floodproofing alternative appears to be the most cost effective and the most feasible. If either 123 White Oak or 131 White Oak were purchased through a voluntary buyout program, the lot could be converted to storage to benefit the other parcel.

Alternative 2 for the Erie area is shown in Exhibit 17 and the reduction in inundation areas (reflecting the proposed condition) can be seen on Exhibit 26.

The engineer's estimated opinion of probable construction cost for this alternative is $767,200, which includes an estimate for the property acquisition cost, and would eliminate overland flooding in two homes. The additional cost to floodproof the two remaining damaged structures is estimated to be $5,000.

Proposed Alternative 2 (Erie - East): Storage

A storage alternative was considered for the East Erie area, which aims to reduce flooding using storage only. This alternative would include buy-outs of the four damaged structures located on Morgan Avenue and regrading of these four properties to provide additional storage volume between Morgan and Pierce Avenue which aims to reduce ponding and drainage issues.

Alternative 2 for the Erie area is shown in Exhibit 17 and the reduction in inundation areas (reflecting the proposed condition) can be seen on Exhibit 26.

The engineer's estimated opinion of probable construction cost for this alternative is $1,669,100, which includes an estimate of the property acquisition costs for the rear yard parcels, and would eliminate overland flooding in three homes.

Proposed Alternative 3 & 4 (Erie - West, Central, and East): Floodproofing & Buy-Out

Additional alternatives that were also considered include floodproofing (Alternative 3) or purchasing structures (Alternative 4) damaged in the 100-year storm event. A total of 13 properties would need to be floodproofed or purchased to protect all structures from flooding in the 100-year storm event.

Floodproofing 13 homes to the 100-yr level of flooding would cost approximately $652,000. If this alternative was chosen, a more detailed investigation would need to be done to determine the specific floodproofing measures required for each structure. Appendix D provides detailed information about alternatives for floodproofing structures. Table 7 summarizes the floodproofing measures that appear feasible for each source of low entry.

Table 7 – Floodproofing Recommendations (Erie)

Street	Number	Top of Foundation Elevation	Low Entry Elevation	Existing Depth of Water Above Top of Foundation Elevation	Existing Depth of Water Above Low Entry Elevation	Location of Low Entry	Potential Floodproofing Remedy
Erie St.	200	737.7	738.18	0.67	2.15	Attached Garage – Low Floor Elevation	Elevate Structure
Erie St.	201	739.99	738.7		0.36	Attached Garage – Low Floor Elevation	Driveway Berm Or Removable Flood Shield
Hickory Ln.	1770	742.03	740.03		0.05	Basement Sill	Raised Window Wells
Hickory Ln.	1845	742.26	739.16		0.92	Basement Sill	Raised Window Wells
Pierce Av.	115	743.8	744.06	0.17		-	Elevate Structure
Pierce Av.	119	743.43	743.63	0.54	0.34	Basement Sill	Elevate Structure
Pierce Av.	123	743.32	743.62	0.65	0.35	Basement Sill	Elevate Structure
Morgan Av.	122	745.72	740.7		4.11	Basement Door	Removable Flood Shield (For Door)
Morgan Av.	118	741.99	740.9	0.89	2.04	Basement Sill	Elevate Structure
Morgan Av.	114	741.77	741.27	1.12	2.47	Basement Window Well	Elevate Structure
Morgan Av.	110	745.88	740.9		4.46	Attached Garage – Low Floor Elevation	Driveway Berm Or Removable Flood Shield
White Oak Dr.	123	744.49	743.6		4.98	Basement Sliding Door	Removable Flood Shield (For Door)
White Oak Dr.	131	746.72	743.22		0.45	Basement Sill	Raised Window Wells

There are some structures being protected by the ground adjacent to the low entry point or by the window well lip, even though the water surface elevation is actually above the low entry point. There are six structures in the Erie Basin and six structures in the Mayo Basin that are protected by the adjacent grade or window well lip. These structures are not shown in the list of damaged structures, but are identified below.

- 200 Erie St.
- 201 Erie St.
- 207 Beverly St.
- 110 Vernon Av.
- 1825 Hickory Ln.
- 107 White Oak Dr.
- 111 White Oak Dr.
- 1607 Mayo Av.
- 1523 Mayo Av.
- 1518 Mayo Av.
- 1510 Mayo Av.
- 1503 Mayo Av.
- 1514 Center Av.

The approximate cost for a buy-out of 13 homes is approximately $3,343,400. These costs are based on home assessment values found on the DuPage County website, and subject to change upon completion of a professional appraisal.

Structures that are damaged in the 2-year to 100-year storm events and require floodproofing or a buy-out can be seen on Exhibit 18.

Mayo Area

Problem Areas E, F, and G are all depressional areas with no outlet pipe or an undersized outlet pipe located in the primary overflow path through the Mayo Basin. Alternatives that were considered to reduce structural damage in the 100-year storm include:

1. Conveyance
2. Storage
3. Storage & Conveyance
4. Storage
5. Floodproofing
6. Buyouts

<u>Proposed Mayo Alternative 1: Conveyance</u>

Alternative 1 is a conveyance alternative that reduces inundation in all three problem areas.

Alternative 1 includes increased conveyance throughout the Mayo area, and no private property acquisition, although the proposed storm sewers will need to be installed on new drainage easements through private property.

The proposed alternative consists of:

- Increasing storm sewer sizes between Paula Avenue and Central Avenue from 21" storm sewers to 30" - 36" storm sewers to help alleviate flooding problems for Problem Area E
- Installing a 30" outlet pipe from the depressional area located between May Ave. and Central Avenue
- Installing a 42" storm sewer from Mayo Avenue to Spring Brook

This alternative also requires that the existing 36" storm sewer running between Center Avenue and Spring Brook is maintained. The alignment of the proposed storm sewer can be changed as needed as long the additional conveyance capacity is provided at these locations in the system.

Because this alternative drains a large amount of runoff that was previously ponded throughout the basin, there will be increased flow rates from the watershed to Spring Brook. Table 8 below shows a comparison of existing and proposed release rates from the Mayo Basin.

Table 8 – Proposed Alternative 1 Mayo Basin Release Rate

	Release Rate from Mayo Basin (cfs)		
Storm Event	Existing Conditions	Proposed Alternative 1	Difference
2-yr, 2-hr	26.67	29.74	3.07
2-yr, 24-hr	14.92	15.06	0.14
100-yr, 2-hr	89.88	115.21	25.33
100-yr, 24-hr	40.74	40.97	0.23

Due to the timing of the Mayo area versus the Spring Brook watershed, this may or may not result in impacts to properties along Spring Brook. There is only a small increase in the 100-year 24-hr storm event; the larger increase associated with the 2-hr storm event may be generated from the Mayo neighborhood and passed into Spring Brook well before Spring Brook itself peaks. This can be analyzed with an unsteady flow model of Spring Brook, which is outside the scope of this project. It is anticipated that approximately one acre-foot of storage would be needed to attenuate this increase in flow. Placing storage was considered but did not appear feasible in this immediate area, as the area south of Mayo Ave is already mapped floodplain, and it can be computationally difficult to hydraulically demonstrate that a new excavation within the floodplain controls the expected flow rates.

The engineer's estimated opinion of probable construction cost for this alternative is $396,700 and would eliminate overland flooding in 11 homes.

Alternative 1 for the Mayo area can be seen on Exhibit 20 and proposed inundation areas can be seen on Exhibit 27.

Proposed Mayo Alternative 2: Storage

Alternative 2 consists of excavating the existing depressional area located at Problem Area F and replacing the existing pipe running between Central Avenue and Mayo Avenue with a new outlet pipe for the proposed detention basin. The proposed storage volume is located in the backyards located between Central Avenue and Mayo Avenue. The grading is shown in such a way that no full buy-outs would be required though the alternative does result in a buy-out of 16 properties' backyards, which may be undesirable to the property owners. If this alternative is chosen the City could consider other ways to achieve the same volume in the same general location, for example by completing a full buy-out of some properties and leaving other properties as-is. This alternative also includes installing the 36" storm sewers to replace the existing 21" storm sewer as mentioned in Alternative 1.

This alternative includes expansion of the existing basins in Westhaven Park and Madison Park, located west of Westhaven Road, to reduce the tributary flow rates draining to the low points along Mayo/Center/Paula. It appears that there is sufficient elevation change between the existing park basins and the downstream system that the basins could be expanded vertically without needing to reinstall the entire downstream system, though the outlet pipes would still need to be replaced. It should be noted that there was limited data available on the Westhaven Park and Madison Park control structures at the time of this analysis. If the City decides to move forward with this alternative (or Alternative 3 or 4) then additional survey data should be obtained during preliminary engineering to verify the results and tweak the preliminary design accordingly.

The engineer's estimated opinion of probable construction cost for this alternative is $3,176,800, which includes an estimate of the property acquisition for the rear yard parcels, and would eliminate overland flooding in 11 homes.

Alternative 2 for the Mayo area can be seen on Exhibit 21 and proposed inundation areas can be seen on Exhibit 28.

Proposed Mayo Alternative 3: Conveyance & Storage

Mayo Alternatives 1 and 2 provided engineering alternatives to protect all homes in the study area to the 100-year storm. Alternative 1 requires storage somewhere in the watershed to offset the increased flow rates to Spring Brook, and Alternative 2 requires private property storage along with expansion of existing storage basins located on public (park, school) land. Alternative 3 is a modification of Alternative 1: it includes the conveyance elements of Alternative 1, with additional storage upstream at Westhaven Park.

Alternative 3 reduces water surface elevations at Problem Area E to an elevation below the low point of entry, even lower than Alternative 1. Like Alternative 1, Alternative 3 results in an increase in flow to Spring Brook, although the Alternative 3 increase is less than the increase associated with Alternative 1. The Alternative 3 release rates can be seen in Table 9 below.

Table 9 – Proposed Alternative 3 Mayo Basin Release Rate

	Release Rate from Mayo Basin (cfs)		
Storm Event	Existing Conditions	Proposed Alt 3	Difference
2-yr, 2-hr	26.67	29.53	2.86
2-yr, 24-hr	14.92	15.46	0.54
100-yr, 2-hr	89.88	110.27	20.39
100-yr, 24-hr	40.74	40.95	0.21

As described with Alternative 1, additional analysis is needed to determine if the increase in discharge results in water surface increases on Spring Brook. Creation of 0.92 ac-ft may be sufficient to reduce the peak to match existing flow rates, if a feasible location for storage can be found. It may be possible to further reduce discharge to Spring Brook by reducing the size of the new pipe that is proposed between Paula and Center. This would raise the water surface elevation within problem area E, but it may be possible to still keep the water below the damage elevations. The exact pipe sizing and storage volumes should be evaluated during preliminary engineering. Alternative 3 for the Mayo area can be seen on Exhibit 22 and proposed inundation areas can be seen on Exhibit 29.

The engineer's estimated opinion of probable construction cost for this alternative is $537,500, and would eliminate overland flooding in 11 homes.

Proposed Mayo Alternative 4: Public Property Storage

Alternative 4 is a modification of Mayo Alternative 2: it omits the private (rear yard) storage within Alternative 2 and only involves the expansion of the basin at Westhaven Park. Although Alternative 4 will not meet the full goal of protecting all homes from the 100-year storm event, the alternative may provide a more constructible alternative that still produces meaningful benefits, although they don't fully meet the project's goal. This alternative reduces water surface elevations by 0.64 feet and is expected to protect three of the eleven homes from flooding in the 100-yr storm. The other eight homes would still be expected to receive damage in a 100-year storm, but damages would be reduced for homes in Problem Area E. A comparison of the existing and proposed damaged properties can be seen in Table 10 below.

Table 10 – Proposed Alternative 4 Mayo Basin Damaged Properties

Mayo Area Results: Alternative 4		
Storm Event	Number of Damaged Properties – Existing Condition	Number of Damaged Properties – Proposed Condition
1-year	0	0
2-year	0	0
5-year	0	0
10-year	0	0
25-year	4	4
50-year	5	5
100-yr	11	8

The engineer's estimated opinion of probable construction cost for this alternative is $140,700, and would eliminate overland flooding in three homes.

Alternative 4 for the Mayo area can be seen on Exhibit 23 and proposed inundation areas can be seen on Exhibit 30.

Proposed Mayo Alternative 5 & 6: Floodproofing & Buy-Out

Additional alternatives that were also considered to reduce flooding include floodproofing (Alternative 3) or purchasing structures (Alternative 4) damaged in the 100-year storm event.

A total of 11 properties would need to be floodproofed or purchased to reduce flooding in the 100-year storm event.

Floodproofing 11 homes would cost approximately $346,000. If this alternative was chosen, a more detailed investigation would need to be completed to determine the specific floodproofing measures required for each structure. Appendix D provides detailed information about alternatives for floodproofing structures. Based on the depth of flooding and the source of the low entry, the following floodproofing measures shown in Table 11 appear feasible:

Table 11 – Floodproofing Recommendations (Mayo)

Street	Number	Top of Foundation Elevation	Low Entry Elevation	Existing Depth of Water Above Top of Foundation Elevation	Existing Depth of Water Above Low Entry Elevation	Location of Low Entry	Potential Floodproofing Remedy
Mayo Av.	1514	726.58	725.98		0.17	Basement Window Well	Raised Window Wells
Mayo Av.	1515	727.08	726.78		0.92	Basement Window Well	Raised Window Wells
Mayo Av.	1519	727.8	726.7		0.10	Basement Sill Blocked In	Check
Paula Av.	1510	741.62	738.42		2.23	Attached Garage – Low Floor Elevation	Driveway Berm Or Removable Flood Shield
Paula Av.	1516	740.49	740.49	0.16	0.86	Basement Window Well	Elevate Structure
Paula Av.	1518	740.84	737.8		2.86	Attached Garage – Low Floor Elevation	Driveway Berm Or Removable Flood Shield
Paula Av.	1524	743.6	739.85		0.80	Attached Garage – Low Floor Elevation	Driveway Berm Or Removable Flood Shield
Paula Av.	1523	743.33	739.58		1.07	Attached Garage – Low Floor Elevation	Driveway Berm Or Removable Flood Shield
Paula Av.	1515	741.58	738.6		2.07	Attached Garage – Low Floor Elevation	Driveway Berm Or Removable Flood Shield
Paula Av.	1511	744.08	740.53		0.12	Attached Garage – Low Floor Elevation	Driveway Berm Or Removable Flood Shield
Paula Av.	1507	745.56	740.41		0.24	Attached Garage – Low Floor Elevation	Driveway Berm Or Removable Flood Shield

The approximate cost for a buy-out of 11 homes is approximately $3,835,000. These costs are based on home assessment values found on the DuPage County website. This number is not based on a current professional appraisal and is subject to change.

Structures that are damaged in the 2-year to 100-year storm events and require floodproofing or a buy-out can be seen on Exhibit 24.

Construction Estimate Summary

Engineer's estimated opinions of probable construction cost (EEOPCC) were prepared for each project alternative, reflecting the conceptual nature of the alternatives. These estimates are shown in Appendix B: Engineer's Estimated Opinion of Probable Construction Cost.

Unit Costs and Assumptions

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

- It is assumed that all earthwork must be hauled off. If space exists on a parcel to store the excavated material, earthwork costs could be reduced substantially.
- All Earth Excavation budgets are predicated on disposal at local CCDD facilities. They do not include trucking or disposal costs for subtitle D landfill disposal.
- Property acquisition costs for residential property acquisition were obtained from the Assessed value of the property, as obtained online in July 2018.
- The cost of native plantings includes the cost to plant each basin and perform three years of maintenance and monitoring.
- Pavement cost is based on patching only. Complete roadway replacement or rehabilitation is not included, except for streets that require full replacement.
- Pavement section for patching assumes a typical section, and may require refinement based on Wheaton's preferences and requirements.
- Asphalt Material Escalation is not included in this estimate. The Current Bituminous Price Index per IDOT is $473.43.
- This estimate does not include escalation factors for labor, fuel, equipment etc., all pricing is in Summer 2018 Dollars.
- This estimate does not include: Water Main Installation, ROW Acquisition, or Soft Costs not specifically listed in the individual detailed estimate breakdowns.
- The estimates include soft costs such as:
    - Topographic Survey, Construction Layout and As-Builts: 3%
    - Design & Permitting, 10%
    - Construction Administration, 6%
    - P&P Bonds, Insurance, & General Conditions, 4.25%
    - Contractor Mobilization, 6%
    - Traffic Control, 1%
    - Environmental Testing, 1%
- The estimates include a 20% general construction contingency to reflect the conceptual nature of the designs.

Opportunities for Funding Efficiencies

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

Summary of Estimated Costs

Table 12 through 14 below lists the Engineer's Opinion of Probable Construction Cost for each alternative as well as the cost per structured benefitted. All proposed alternatives reduce water surface elevations to below the damage / low entry elevation, except as noted below.

Table 12 – West Erie Cost-Benefit Summary

Storm	Existing Number of Damaged Properties	Alt 1: Convey-ance	Cost Per Structure Benefitted	Alt 2: Convey-ance & Storage	Cost Per Structure Benefitted	Alt 3: Total Flood-proofing Cost	Cost Per Structure Benefitted	Alt 4: Total Buy-Out Cost	Cost Per Structure Benefitted
1-year	0	-	-	-	-	$0	-	$0	-
2-year	1	-	-	-	-	$100,000	$100,000	$239,000	$239,000
5-year	1	-	-	-	-	$100,000	$100,000	$239,000	$239,000
10-year	1	-	-	-	-	$100,000	$100,000	$239,000	$239,000
25-year	1	-	-	-	-	$100,000	$100,000	$239,000	$239,000
50-year	2	-	-	-	-	$120,000	$60,000	$488,700	$244,350
100-year	2	$588,581	$294,291	$704,163	$704,163*	$120,000	$60,000	$488,700	$244,350

*Alternative 2 includes the removal (buy-out) of one of the two damaged structures and protects the other structure.

Table 13 – East and Central Erie Cost-Benefit Summary

Storm	Existing Number of Damaged Properties	Alt 1: Convey-ance	Cost Per Structure Benefitted	Alt 2: Convey-ance & Storage	Cost Per Structure Benefitted	Alt 3: Total Flood-proofing Cost	Cost Per Structure Benefitted	Alt 4: Total Buy-Out Cost	Cost Per Structure Benefitted
1-year	0	-	-	-	-	$0	-	$0	-
2-year	0	-	-	-	-	$0	-	$0	-
5-year	0	-	-	-	-	$0	-	$0	-
10-year	3	-	-	-	-	$25,000	$8,333	$543,300	$181,100
25-year	6	-	-	-	-	$227,000	$37,833	$1,159,500	$193,250
50-year	9	-	-	-	-	$527,000	$58,556	$2,139,400	$237,711
100-year	11	$1,303,897 + $5,000 flood-proofing	$118,991	$2,030,186 + $5,000 flood-proofing	$290,741*	$532,000	$48,364	$2,854,700	$259,518

*Alternative 2 includes the removal (buy-out) of four of the eleven damaged structures and protects the other seven structures.

Table 14 - Mayo Cost-Benefit Summary

Storm	Existing Number of Damaged Properties	Alt 1: Convey-ance Only	Cost Per Structure Benefitted	Alt 2: Convey-ance & Storage	Cost Per Structure Benefitted	Alt 3: Convey-ance and Storage	Cost Per Structure Benefitted	Alt 4: Public Property Storage	Cost Per Structure Benefitted	Alt 5: Total Flood-proofing Cost	Cost Per Structure Benefitted	Alt 6: Total Buy-Out Cost	Cost Per Structure Benefitted
1-year	0	-	-	-	-	-	-	-	-	$0	-	$0	-
2-year	0	-	-	-	-	-	-	-	-	$0	-	$0	-
5-year	0	-	-	-	-	-	-	-	-	$0	-	$0	-
10-year	0	-	-	-	-	-	-	-	-	$0	-	$0	-
25-year	4	-	-	-	-	-	-	-	-	$62,000	$15,500	$1,357,400	$339,350
50-year	5	-	-	-	-	-	-	-	-	$82,000	$16,400	$1,674,300	$334,860
100-year	11	$396,735	$36,067	$3,176,827	$288,802	$537,478	$48,862	$140,743	$46,914*	$346,000	$31,455	$3,835,000	$348,636

*Mayo Alternative 4 protects three of 11 damaged structures during the 100-yr storm and reduces damages to the structures located near Problem Area E.

Other Suggested Improvements and Considerations

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

Funding or Cost Share Programs for GIs or BMPs

Some residents within the study area may be interested in private property GIs or BMPs. The City of Wheaton may wish to consider a program through which financial funding assistance is made available to individual homeowners to help residents with these costs. This could include financial assistance for installation of GI/BMPs that provide storage to reduce stormwater runoff (such as permeable pavers, rain cisterns, or rain gardens, rain barrels), or this could include financial assistance for residents who wish to implement floodproofing measures or devices on their own, apart from a City project.

Additional Inlets

A more in depth review of inlets should be performed for the study area during Preliminary Engineering to determine if it would benefit from additional storm sewer inlets to deliver flow into the existing (or proposed) storm sewer system. If it is determined additional inlets would be beneficial, additional inlets and/or higher capacity inlets should be specified to remove water from the street and deliver it to the storm sewer system more efficiently as roadway projects are completed throughout the study area. This will reduce the amount of flow that bypasses the storm sewer inlet grates and flows downstream, often creating or exacerbating a drainage problem.

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

Real Estate Considerations

Many of the projects require stakeholder coordination and cooperation, particularly with respect to real estate considerations. Most of the proposed storage locations are not on public property, due to a lack of open public spaces available for storage. Property purchase and/or easements will be required to use the spaces. In all cases, the current use of the open space was considered and the proposed storage was designed to reduce impacts to the space to the extent possible, but the exact location and shape of the storage area can be tweaked to better suit the needs of the property owners.

Utility Considerations

Many of the proposed improvements will impact existing utilities. No utility information was available during this study, so utility considerations and explorations will be required for all proposed alternatives, particularly the alternatives that include large diameter pipes, as there is a higher likelihood for a large diameter pipe to conflict with an existing utility (versus a smaller diameter proposed pipe). If a utility conflict is identified, it could be mitigated in several ways, dependent on the nature of the conflict: by shifting the location of the proposed storm sewer; by changing the material of the proposed storm sewer; by constructing a proposed siphon at the crossing; or by relocating the existing utility. Existing utility services may also be impacted by proposed alternatives, and may require replacement or reconnection.

Wetland Considerations

The proposed alternatives were not evaluated to determine the potential presence of waters of the United States (WOUS), which include wetlands under US Army Corp of Engineers jurisdiction, or isolated water of DuPage County which may be affected and any potential USACE permit requirements. It is unlikely that any jurisdictional wetlands would be present in the proposed backyard storage areas or along the proposed storm sewer alignment. If a proposed alternative is chosen, a detailed wetland determination and impact review should be completed.

CCDD Considerations

All of the various project alternatives are expected to involve earth excavation and disposal. Storm sewer improvements may involve smaller volumes of earth excavation for the trench, and the proposed storage areas and expanded storage areas will involve larger volumes of earth excavation and disposal. An "uncontaminated soil" evaluation of these construction spoils should be performed for each project site, upon commencement of any alternative. The results of the uncontaminated soil evaluation has the potential to significantly increase earthwork cost if data testing shows that the material cannot be accepted by a CCDD facility.

Geotechnical Considerations

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

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

Recommendations

Based on the cost per benefitting structure, the floodproofing alternatives appear most cost effective alternative to fully meet the project goals in the West and Central Erie areas and the Mayo area. However, floodproofing only provides protection to the homes that incorporate floodproofing measures. The proposed engineering alternatives provide many other benefits, including reductions in yard flooding of many properties not identified in the tables, reductions in flood depths on streets, reductions in traffic impacts, reduction in impacts to business operations, improved emergency access, and other similar benefits. The value and need for these ancillary benefits should also be considered when evaluating the different project alternatives.

In the West Erie area, engineering Alternative 1 (Conveyance) provides a cost per benefitting structure that is slightly more than the value of the homes. It should be noted that these two structures have a LPE lower than the road and are located in the primary overflow path in the area. Alternative 1 may remove overland flow from the roadway to the structures' LPE but the structures may still have flooding problems as a result of runoff falling directly on the property. It appears that floodproofing or voluntary buy-outs may be the most reasonable solutions to flooding issues in the West Erie area.

In the Central & East area, Alternative 1 (Conveyance & Storage) provides a cost per benefitting structure that is less than the value of the homes, and therefore may be a cost effective solution if an engineering alternative is preferred.

The same is true for Mayo Alternative 1 (Conveyance) and Mayo Alternative 3 (Conveyance & Storage). As previously mentioned, these alternatives increase the release rate to Spring Brook so an unsteady model evaluation of Spring Brook is required to verify there are no upstream or downstream impacts on Spring Brook as a result of the increased flow rates, or, additional storage needs to be incorporated to attenuate the impacts.

Mayo Alternative 2 also provides a cost per benefitting structure that is less than the value of the homes and results in no increase to the downstream system, although Alternative 2 has an estimated cost that is considerably more than Alternatives 1 and 3. Alternative 2 may be the preferred engineering solution if the unsteady model shows Alternatives 1 & 3 result in increased release rates from the Mayo Basin.

Additionally, all alternatives shown are designed to protect to the 100-year flood, per the project goals. If a lower level of protection is acceptable, the proposed pipes and storage areas could be reduced in size, resulting in a smaller project cost but increasing the number of homes that would require floodproofing measures. For example, the XP-SWMM modeling results show that Alternative 4 (Storage) at Westhaven Park results in the 100-yr level of protection of two structures for a cost per benefitting structure less than the value of the homes being protected, and also reduces damages to the other structures located near Problem Area E. Depending on the level of protection that is acceptable to the City from the engineering alternative, there may be a more cost effective balance between engineering alternative and floodproofing alternative, which could be explored during preliminary engineering.

Appendix A: Calculations

Contents:

- CD with Model, Drawing Files, and other Source Data Files
- Time of Concentration Calculations
- Curve Number Calculations
- Stage Storage Calculations

DATA CD

CONTENTS:

- CADD Files and Survey Files
- Engineer’s Estimated Opinion of Probable Cost
- Report File
- XP-SWMM Model Files

TIME OF CONCENTRATION CALCULATIONS

Time of Concentration (Tc) Calculation

Project: Erie/Mayo Flood Prone Area Study By: LEH Date: 04/09/18
Location: Wheaton, IL

Circle One: **Present** Developed
Circle One: **T_c** T_t through subareas WE-1

Sheet Flow (Applicable to T_c only)

	Unit	Segment ID		Total
1. Surface description (table 3-1)		Short Grass Prairie		
2. Manning's roughness coeff., n (table 3-1)		0.15		
3. Flow Length, L (total L < 300 ft)	ft	100		
4. Two-yr 24-hr rainfall, P_2	in	3.04		
5. Land slope, s	ft / ft	0.015		
6. $Tt = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\,s^{0.4}}$ Compute T_t	hr	0.188		0.188

Shallow Concentrated Flow

	Unit	Segment ID 1	2	Total
7. Surface Description (paved or unpaved)		Unpaved		
8. Flow Length, L	ft	416		
9. Watercourse slope, s	ft / ft	0.035		
10. Average velocity, V (figure 3-1)	ft / s	3.00		
11. $T_c = \frac{L}{3600\,V}$ Compute T_c	hr	0.038		0.038

Channel Flow

	Unit	Segment ID 1	2	Total
12. Cross sectional flow area, a	ft^2			
13. Wetted perimeter, P_w	ft			
14. Hydraulic radius, $r = a / P_w$ Compute r	ft			
15. Channel slope, s	ft / ft			
16. Manning's roughness coeff., n				
17. $V = \frac{1.49\,r^{2/3}\,s^{1/2}}{n}$ Compute V	ft / s	3.0		
18. Flow length, L	ft			
19. $T_t = \frac{L}{3600\,V}$ Compute T_t	hr			

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) hr 0.226
min. 14

Two-year, 24-hour rainfall was taken from Bulletin 70, Table 13
The Tc flow path for this area is drawn in ArcGIS: "E:\2014\14160\Drawings\ArcGIS\NR\Roberts Road Project_14160.mxd"
3 feet per second was used for channel flow (in storm sewers or other channels)

Time of Concentration (Tc) Calculation

Project: Erie/Mayo Flood Prone Area Study By: LEH Date: 04/09/18
Location: Wheaton, IL

Circle One: **Present** Developed
Circle One: **T_c** T_t ☐ through subareas WE-2

Sheet Flow (Applicable to T_c only)

	Unit	Segment ID		
1. Surface description (table 3-1)		Short Grass Prairie		
2. Manning's roughness coeff., n (table 3-1)		0.15		
3. Flow Length, L (total L < 300 ft)	ft	100		
4. Two-yr 24-hr rainfall, P_2	in	3.04		
5. Land slope, s	ft / ft	0.020		
6. $T_t = \frac{0.007 (nL)^{0.8}}{P_2^{0.5} s^{0.4}}$ Compute T_t	hr	0.168		0.168

Shallow Concentrated Flow

	Unit	Segment ID 1	2	
7. Surface Description (paved or unpaved)		Unpaved		
8. Flow Length, L	ft	237		
9. Watercourse slope, s	ft / ft	0.025		
10. Average velocity, V (figure 3-1)	ft / s	2.55		
11. $T_c = \frac{L}{3600 V}$ Compute T_c	hr	0.026		0.026

Channel Flow

	Unit	Segment ID 1	2	
12. Cross sectional flow area, a	ft^2			
13. Wetted perimeter, P_w	ft			
14. Hydraulic radius, $r = a / P_w$ Compute r	ft			
15. Channel slope, s	ft / ft			
16. Manning's roughness coeff., n				
17. $V = \frac{1.49 r^{2/3} s^{1/2}}{n}$ Compute V	ft / s	3.0		
18. Flow length, L	ft			
19. $T_t = \frac{L}{3600 V}$ Compute T_t	hr			

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) hr 0.193
min. 12

Two-year, 24-hour rainfall was taken from Bulletin 70, Table 13
The Tc flow path for this area is drawn in ArcGIS: "E:\2014\14160\Drawings\ArcGIS\NR\Roberts Road Project_14160.mxd"
3 feet per second was used for channel flow (in storm sewers or other channels)

Time of Concentration (Tc) Calculation

Project: Erie/Mayo Flood Prone Area Study By: LEH Date: 04/09/18
Location: Wheaton, IL

Circle One: **Present** Developed
Circle One: **T_c** T_t through subareas WE-3

Sheet Flow (Applicable to T_c only)

		Segment ID			
1. Surface description (table 3-1)		Short Grass Prairie		
2. Manning's roughness coeff., n (table 3-1)		0.15		
3. Flow Length, L (total L < 300 ft)	ft	100		
4. Two-yr 24-hr rainfall, P_2	in	3.04		
5. Land slope, s	ft / ft	0.040		
6. $T_t = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\, s^{0.4}}$ Compute T_t	hr	0.127		0.127

Shallow Concentrated Flow

Segment ID		1	2	
7. Surface Description (paved or unpaved)		Unpaved		
8. Flow Length, L	ft	147		
9. Watercourse slope, s	ft / ft	0.054		
10. Average velocity, V (figure 3-1)	ft / s	3.76		
11. $T_c = \frac{L}{3600\,V}$ Compute T_c	hr	0.011		0.011

Channel Flow

Segment ID		1	2	
12. Cross sectional flow area, a	ft^2			
13. Wetted perimeter, P_w	ft			
14. Hydraulic radius, $r = a / P_w$ Compute r	ft			
15. Channel slope, s	ft / ft			
16. Manning's roughness coeff., n				
17. $V = \frac{1.49\, r^{2/3}\, s^{1/2}}{n}$ Compute V	ft / s	3.0		
18. Flow length, L	ft			
19. $T_t = \frac{L}{3600\,V}$ Compute T_t	hr			

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) hr 0.138
min. 8

Two-year, 24-hour rainfall was taken from Bulletin 70, Table 13

The Tc flow path for this area is drawn in ArcGIS: "E:\2014\14160\Drawings\ArcGIS\NR\Roberts Road Project_14160.mxd"

3 feet per second was used for channel flow (in storm sewers or other channels)

Time of Concentration (Tc) Calculation

Project: Erie/Mayo Flood Prone Area Study By: LEH Date: 04/09/18
Location: Wheaton, IL

Circle One: **Present** Developed
Circle One: **T_c** T_t through subareas WE-4

Sheet Flow (Applicable to T_c only)

		Segment ID			
1. Surface description (table 3-1)		Short Grass Prairie		
2. Manning's roughness coeff., n (table 3-1)		0.15		
3. Flow Length, L (total L < 300 ft)	ft	100		
4. Two-yr 24-hr rainfall, P_2	in	3.04		
5. Land slope, s	ft / ft	0.040		
6. $Tt = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\,s^{0.4}}$ Compute T_t	hr	0.127		0.127

Shallow Concentrated Flow

		Segment ID 1	2	
7. Surface Description (paved or unpaved)		Unpaved		
8. Flow Length, L	ft	151		
9. Watercourse slope, s	ft / ft	0.013		
10. Average velocity, V (figure 3-1)	ft / s	1.84		
11. $T_c = \frac{L}{3600\,V}$ Compute T_c	hr	0.023		0.023

Channel Flow

		Segment ID 1	2	
12. Cross sectional flow area, a	ft^2			
13. Wetted perimeter, P_w	ft			
14. Hydraulic radius, $r = a / P_w$ Compute r	ft			
15. Channel slope, s	ft / ft			
16. Manning's roughness coeff., n				
17. $V = \frac{1.49\,r^{2/3}\,s^{1/2}}{n}$ Compute V	ft / s	3.0		
18. Flow length, L	ft			
19. $T_t = \frac{L}{3600\,V}$ Compute T_t	hr			

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) hr 0.150
min. 9

Two-year, 24-hour rainfall was taken from Bulletin 70, Table 13

The Tc flow path for this area is drawn in ArcGIS: "E:\2014\14160\Drawings\ArcGIS\NR\Roberts Road Project_14160.mxd"

3 feet per second was used for channel flow (in storm sewers or other channels)

Time of Concentration (Tc) Calculation

Project: Erie/Mayo Flood Prone Area Study By: LEH Date: 04/09/18
Location: Wheaton, IL

Circle One: **Present** Developed
Circle One: **T_c** T_t ☐ through subareas WE-5

Sheet Flow (Applicable to T_c only)

			Segment ID			
1.	Surface description (table 3-1).................................		Short Grass Prairie			
2.	Manning's roughness coeff., n (table 3-1).........................		0.15			
3.	Flow Length, L (total L < 300 ft).....................................	ft	100			
4.	Two-yr 24-hr rainfall, P_2...	in	3.04			
5.	Land slope, s..	ft / ft	0.020			
6.	$Tt = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\,s^{0.4}}$ Compute T_t..................	hr	0.168		0.168	

Shallow Concentrated Flow

			Segment ID	1	2	
7.	Surface Description (paved or unpaved).........................		Unpaved			
8.	Flow Length, L..	ft	444			
9.	Watercourse slope, s..	ft / ft	0.036			
10.	Average velocity, V (figure 3-1)....................................	ft / s	3.05			
11.	$T_c = \frac{L}{3600\,V}$ Compute T_c.................	hr	0.040		0.040	

Channel Flow

			Segment ID	1	2	
12.	Cross sectional flow area, a..	ft^2				
13.	Wetted perimeter, P_w..	ft				
14.	Hydraulic radius, $r = a / P_w$ Compute r..................	ft				
15.	Channel slope, s...	ft / ft				
16.	Manning's roughness coeff., n...					
17.	$V = \frac{1.49\,r^{2/3}\,s^{1/2}}{n}$ Compute V..................	ft / s	3.0			
18.	Flow length, L..	ft				
19.	$T_t = \frac{L}{3600\,V}$ Compute T_t..................	hr				

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19).............................. hr 0.208
min. 12

Two-year, 24-hour rainfall was taken from Bulletin 70, Table 13

The Tc flow path for this area is drawn in ArcGIS: "E:\2014\14160\Drawings\ArcGIS\NR\Roberts Road Project_14160.mxd"

3 feet per second was used for channel flow (in storm sewers or other channels)

Time of Concentration (Tc) Calculation

Project: Erie/Mayo Flood Prone Area Study By: LEH Date: 04/09/18
Location: Wheaton, IL

Circle One: **Present** Developed
Circle One: **T_c** T_t ☐ through subareas CE-1

Sheet Flow (Applicable to T_c only)

		Segment ID			
1. Surface description (table 3-1)......................................		50% Short Grass Prairie, 50% smooth surfaces		
2. Manning's roughness coeff., n (table 3-1)..........................		0.0805		
3. Flow Length, L (total L < 300 ft)......................................	ft	100		
4. Two-yr 24-hr rainfall, P_2..	in	3.04		
5. Land slope, s..	ft / ft	0.010		
6. $Tt = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t..................	hr	0.134		0.134

Shallow Concentrated Flow

		Segment ID: 1	2	
7. Surface Description (paved or unpaved)..........................		paved		
8. Flow Length, L..	ft	281		
9. Watercourse slope, s...	ft / ft	0.011		
10. Average velocity, V (figure 3-1)......................................	ft / s	2.10		
11. $T_c = \frac{L}{3600\ V}$ Compute T_c.................	hr	0.037		0.037

Channel Flow

		Segment ID: 1	2	
12. Cross sectional flow area, a..	ft^2			
13. Wetted perimeter, P_w..	ft			
14. Hydraulic radius, $r = a / P_w$ Compute r...................	ft			
15. Channel slope, s..	ft / ft			
16. Manning's roughness coeff., n..				
17. $V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$ Compute V..................	ft / s	3.0		
18. Flow length, L..	ft			
19. $T_t = \frac{L}{3600\ V}$ Compute T_t..................	hr			

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)............................... hr 0.171
min. 10

Two-year, 24-hour rainfall was taken from Bulletin 70, Table 13
The Tc flow path for this area is drawn in ArcGIS: "E:\2014\14160\Drawings\ArcGIS\NR\Roberts Road Project_14160.mxd"
3 feet per second was used for channel flow (in storm sewers or other channels)

Time of Concentration (Tc) Calculation

Project: Erie/Mayo Flood Prone Area Study   By: LEH   Date: 04/09/18
Location: Wheaton, IL

Circle One: **Present** | Developed
Circle One: **T_c** | T_t | through subareas   CE-2

Sheet Flow (Applicable to T_c only)

		Segment ID			
1.	Surface description (table 3-1)		Short Grass Prairie		
2.	Manning's roughness coeff., n (table 3-1)		0.15		
3.	Flow Length, L (total L < 300 ft)	ft	100		
4.	Two-yr 24-hr rainfall, P_2	in	3.04		
5.	Land slope, s	ft / ft	0.010		
6.	$Tt = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\, s^{0.4}}$ Compute T_t	hr	0.221		0.221

Shallow Concentrated Flow

		Segment ID	1	2	
7.	Surface Description (paved or unpaved)		Unpaved		
8.	Flow Length, L	ft	360		
9.	Watercourse slope, s	ft / ft	0.033		
10.	Average velocity, V (figure 3-1)	ft / s	2.93		
11.	$T_c = \frac{L}{3600\,V}$ Compute T_c	hr	0.034		0.034

Channel Flow

		Segment ID	1	2	
12.	Cross sectional flow area, a	ft^2			
13.	Wetted perimeter, P_w	ft			
14.	Hydraulic radius, $r = a / P_w$ Compute r	ft			
15.	Channel slope, s	ft / ft			
16.	Manning's roughness coeff., n				
17.	$V = \frac{1.49\, r^{2/3}\, s^{1/2}}{n}$ Compute V	ft / s	3.0		
18.	Flow length, L	ft			
19.	$T_t = \frac{L}{3600\,V}$ Compute T_t	hr			

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) ..... hr 0.255
min. 15

Two-year, 24-hour rainfall was taken from Bulletin 70, Table 13

The Tc flow path for this area is drawn in ArcGIS: "E:\2014\14160\Drawings\ArcGIS\NR\Roberts Road Project_14160.mxd"

3 feet per second was used for channel flow (in storm sewers or other channels)

Time of Concentration (Tc) Calculation

Project: Erie/Mayo Flood Prone Area Study By: LEH Date: 04/09/18
Location: Wheaton, IL

Circle One: **Present** Developed
Circle One: **T_c** T_t through subareas CE-3

Sheet Flow (Applicable to T_c only)

		Segment ID			
1. Surface description (table 3-1)			Short Grass Prairie		
2. Manning's roughness coeff., n (table 3-1)			0.15		
3. Flow Length, L (total L < 300 ft)		ft	100		
4. Two-yr 24-hr rainfall, P_2		in	3.04		
5. Land slope, s		ft / ft	0.010		
6. $Tt = \frac{0.007 (nL)^{0.8}}{P_2^{0.5} s^{0.4}}$	Compute T_t	hr	0.221		0.221

Shallow Concentrated Flow

		Segment ID	1	2	
7. Surface Description (paved or unpaved)			Unpaved		
8. Flow Length, L		ft	351		
9. Watercourse slope, s		ft / ft	0.031		
10. Average velocity, V (figure 3-1)		ft / s	2.84		
11. $T_c = \frac{L}{3600\ V}$	Compute T_c	hr	0.034		0.034

Channel Flow

		Segment ID	1	2	
12. Cross sectional flow area, a		ft^2			
13. Wetted perimeter, P_w		ft			
14. Hydraulic radius, $r = a / P_w$	Compute r	ft			
15. Channel slope, s		ft / ft			
16. Manning's roughness coeff., n					
17. $V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$	Compute V	ft / s	3.0		
18. Flow length, L		ft			
19. $T_t = \frac{L}{3600\ V}$	Compute T_t	hr			

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) hr 0.255
min. 15

Two-year, 24-hour rainfall was taken from Bulletin 70, Table 13
The Tc flow path for this area is drawn in ArcGIS: "E:\2014\14160\Drawings\ArcGIS\NR\Roberts Road Project_14160.mxd"
3 feet per second was used for channel flow (in storm sewers or other channels)

Time of Concentration (Tc) Calculation

Project: Erie/Mayo Flood Prone Area Study   By: LEH   Date: 04/09/18
Location: Wheaton, IL

Circle One: **Present** Developed
Circle One: **T_c** T_t through subareas   CE-4

Sheet Flow (Applicable to T_c only)

	Unit	Segment ID		
1. Surface description (table 3-1)........		Short Grass Prairie		
2. Manning's roughness coeff., n (table 3-1)........		0.15		
3. Flow Length, L (total L < 300 ft)........	ft	100		
4. Two-yr 24-hr rainfall, P_2........	in	3.04		
5. Land slope, s........	ft / ft	0.005		
6. $Tt = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\, s^{0.4}}$ Compute T_t........	hr	0.292		0.292

Shallow Concentrated Flow

	Unit	Segment ID 1	2	
7. Surface Description (paved or unpaved)........		Unpaved		
8. Flow Length, L........	ft	498		
9. Watercourse slope, s........	ft / ft	0.036		
10. Average velocity, V (figure 3-1)........	ft / s	3.06		
11. $T_c = \frac{L}{3600\,V}$ Compute T_c........	hr	0.045		0.045

Channel Flow

	Unit	Segment ID 1	2	
12. Cross sectional flow area, a........	ft^2			
13. Wetted perimeter, P_w........	ft			
14. Hydraulic radius, $r = a / P_w$ Compute r........	ft			
15. Channel slope, s........	ft / ft			
16. Manning's roughness coeff., n........				
17. $V = \frac{1.49\, r^{2/3}\, s^{1/2}}{n}$ Compute V........	ft / s	3.0		
18. Flow length, L........	ft			
19. $T_t = \frac{L}{3600\,V}$ Compute T_t........	hr			

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)........ hr 0.337
min. 20

Two-year, 24-hour rainfall was taken from Bulletin 70, Table 13

The Tc flow path for this area is drawn in ArcGIS: "E:\2014\14160\Drawings\ArcGIS\NR\Roberts Road Project_14160.mxd"

3 feet per second was used for channel flow (in storm sewers or other channels)

Time of Concentration (Tc) Calculation

Project: Erie/Mayo Flood Prone Area Study By: LEH Date: 04/09/18
Location: Wheaton, IL

Circle One: **Present** Developed
Circle One: **T_c** T_t through subareas CE-5

Sheet Flow (Applicable to T_c only)

	Units	Segment ID		Total
1. Surface description (table 3-1)		Short Grass Prairie		
2. Manning's roughness coeff., n (table 3-1)		0.15		
3. Flow Length, L (total L < 300 ft)	ft	100		
4. Two-yr 24-hr rainfall, P_2	in	3.04		
5. Land slope, s	ft / ft	0.040		
6. $Tt = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\, s^{0.4}}$ Compute T_t	hr	0.127		0.127

Shallow Concentrated Flow

	Units	Segment ID 1	2	Total
7. Surface Description (paved or unpaved)		Unpaved		
8. Flow Length, L	ft	469		
9. Watercourse slope, s	ft / ft	0.043		
10. Average velocity, V (figure 3-1)	ft / s	3.32		
11. $T_c = \frac{L}{3600\,V}$ Compute T_c	hr	0.039		0.039

Channel Flow

	Units	Segment ID 1	2	Total
12. Cross sectional flow area, a	ft^2			
13. Wetted perimeter, P_w	ft			
14. Hydraulic radius, $r = a / P_w$ Compute r	ft			
15. Channel slope, s	ft / ft			
16. Manning's roughness coeff., n				
17. $V = \frac{1.49\, r^{2/3}\, s^{1/2}}{n}$ Compute V	ft / s	3.0		
18. Flow length, L	ft			
19. $T_t = \frac{L}{3600\,V}$ Compute T_t	hr			

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) hr 0.166
min. 10

Two-year, 24-hour rainfall was taken from Bulletin 70, Table 13
The Tc flow path for this area is drawn in ArcGIS: "E:\2014\14160\Drawings\ArcGIS\NR\Roberts Road Project_14160.mxd"
3 feet per second was used for channel flow (in storm sewers or other channels)

Time of Concentration (Tc) Calculation

Project: Erie/Mayo Flood Prone Area Study By: LEH Date: 04/09/18
Location: Wheaton, IL

Circle One: **Present** Developed
Circle One: **T_c** T_t through subareas CE-6

Sheet Flow (Applicable to T_c only)

	Segment ID			
1. Surface description (table 3-1)		Short Grass Prairie		
2. Manning's roughness coeff., n (table 3-1)		0.15		
3. Flow Length, L (total L < 300 ft)	ft	100		
4. Two-yr 24-hr rainfall, P_2	in	3.04		
5. Land slope, s	ft / ft	0.020		
6. $Tt = \frac{0.007 (nL)^{0.8}}{P_2^{0.5} s^{0.4}}$ Compute T_t	hr	0.168		0.168

Shallow Concentrated Flow

	Segment ID	1	2	
7. Surface Description (paved or unpaved)		Unpaved		
8. Flow Length, L	ft	120		
9. Watercourse slope, s	ft / ft	0.025		
10. Average velocity, V (figure 3-1)	ft / s	2.54		
11. $T_c = \frac{L}{3600 V}$ Compute T_c	hr	0.013		0.013

Channel Flow

	Segment ID	1	2	
12. Cross sectional flow area, a	ft^2			
13. Wetted perimeter, P_w	ft			
14. Hydraulic radius, $r = a / P_w$ Compute r	ft			
15. Channel slope, s	ft / ft			
16. Manning's roughness coeff., n				
17. $V = \frac{1.49 r^{2/3} s^{1/2}}{n}$ Compute V	ft / s	3.0		
18. Flow length, L	ft			
19. $T_t = \frac{L}{3600 V}$ Compute T_t	hr			

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) ... hr 0.181
min. 11

Two-year, 24-hour rainfall was taken from Bulletin 70, Table 13
The Tc flow path for this area is drawn in ArcGIS: "E:\2014\14160\Drawings\ArcGIS\NR\Roberts Road Project_14160.mxd"
3 feet per second was used for channel flow (in storm sewers or other channels)

Time of Concentration (Tc) Calculation

Project: Erie/Mayo Flood Prone Area Study By: LEH Date: 04/09/18
Location: Wheaton, IL

Circle One: **Present** Developed
Circle One: **T_c** T_t ☐ through subareas CE-7

Sheet Flow (Applicable to T_c only)

	Unit	Segment ID		
1. Surface description (table 3-1)........		Short Grass Prairie		
2. Manning's roughness coeff., n (table 3-1)........		0.15		
3. Flow Length, L (total L < 300 ft)........	ft	100		
4. Two-yr 24-hr rainfall, P_2........	in	3.04		
5. Land slope, s........	ft / ft	0.030		
6. $Tt = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t........	hr	0.142		0.142

Shallow Concentrated Flow

	Unit	Segment ID 1	2	
7. Surface Description (paved or unpaved)........		Unpaved		
8. Flow Length, L........	ft	144		
9. Watercourse slope, s........	ft / ft	0.056		
10. Average velocity, V (figure 3-1)........	ft / s	3.80		
11. $T_c = \frac{L}{3600\ V}$ Compute T_c........	hr	0.011		0.011

Channel Flow

	Unit	Segment ID 1	2	
12. Cross sectional flow area, a........	ft^2			
13. Wetted perimeter, P_w........	ft			
14. Hydraulic radius, $r = a / P_w$ Compute r........	ft			
15. Channel slope, s........	ft / ft			
16. Manning's roughness coeff., n........				
17. $V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$ Compute V........	ft / s	3.0		
18. Flow length, L........	ft			
19. $T_t = \frac{L}{3600\ V}$ Compute T_t........	hr			

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)........ hr 0.153
min. 9

Two-year, 24-hour rainfall was taken from Bulletin 70, Table 13

The Tc flow path for this area is drawn in ArcGIS: "E:\2014\14160\Drawings\ArcGIS\NR\Roberts Road Project_14160.mxd"

3 feet per second was used for channel flow (in storm sewers or other channels)

Time of Concentration (Tc) Calculation

Project: Erie/Mayo Flood Prone Area Study By: LEH Date: 04/09/18
Location: Wheaton, IL

Circle One: **Present** Developed
Circle One: **T_c** T_t through subareas CE-8

Sheet Flow (Applicable to T_c only)

		Segment ID			
1.	Surface description (table 3-1)		Short Grass Prairie		
2.	Manning's roughness coeff., n (table 3-1)		0.15		
3.	Flow Length, L (total L < 300 ft)	ft	100		
4.	Two-yr 24-hr rainfall, P_2	in	3.04		
5.	Land slope, s	ft / ft	0.030		
6.	$Tt = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\, s^{0.4}}$ Compute T_t	hr	0.142		0.142

Shallow Concentrated Flow

		Segment ID	1	2	
7.	Surface Description (paved or unpaved)		Unpaved		
8.	Flow Length, L	ft	284		
9.	Watercourse slope, s	ft / ft	0.032		
10.	Average velocity, V (figure 3-1)	ft / s	2.86		
11.	$T_c = \frac{L}{3600\,V}$ Compute T_c	hr	0.028		0.028

Channel Flow

		Segment ID	1	2	
12.	Cross sectional flow area, a	ft^2			
13.	Wetted perimeter, P_w	ft			
14.	Hydraulic radius, $r = a / P_w$ Compute r	ft			
15.	Channel slope, s	ft / ft			
16.	Manning's roughness coeff., n				
17.	$V = \frac{1.49\, r^{2/3}\, s^{1/2}}{n}$ Compute V	ft / s	3.0		
18.	Flow length, L	ft			
19.	$T_t = \frac{L}{3600\,V}$ Compute T_t	hr			

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) hr 0.170
min. 10

Two-year, 24-hour rainfall was taken from Bulletin 70, Table 13

The Tc flow path for this area is drawn in ArcGIS: "E:\2014\14160\Drawings\ArcGIS\NR\Roberts Road Project_14160.mxd"

3 feet per second was used for channel flow (in storm sewers or other channels)

Time of Concentration (Tc) Calculation

Project: Erie/Mayo Flood Prone Area Study   By: LEH   Date: 04/09/18
Location: Wheaton, IL

Circle One: **Present** Developed
Circle One: **T_c** T_t through subareas   EE-1

Sheet Flow (Applicable to T_c only)

		Segment ID			
1.	Surface description (table 3-1)		Short Grass Prairie		
2.	Manning's roughness coeff., n (table 3-1)		0.15		
3.	Flow Length, L (total L < 300 ft)	ft	100		
4.	Two-yr 24-hr rainfall, P_2	in	3.04		
5.	Land slope, s	ft / ft	0.010		
6.	$T_t = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\,s^{0.4}}$ Compute T_t	hr	0.221		0.221

Shallow Concentrated Flow

		Segment ID	1	2	
7.	Surface Description (paved or unpaved)		Unpaved		
8.	Flow Length, L	ft	520		
9.	Watercourse slope, s	ft / ft	0.029		
10.	Average velocity, V (figure 3-1)	ft / s	2.73		
11.	$T_c = \frac{L}{3600\,V}$ Compute T_c	hr	0.053		0.053

Channel Flow

		Segment ID	1	2	
12.	Cross sectional flow area, a	ft^2			
13.	Wetted perimeter, P_w	ft			
14.	Hydraulic radius, $r = a / P_w$ Compute r	ft			
15.	Channel slope, s	ft / ft			
16.	Manning's roughness coeff., n				
17.	$V = \frac{1.49\,r^{2/3}\,s^{1/2}}{n}$ Compute V	ft / s	3.0		
18.	Flow length, L	ft			
19.	$T_t = \frac{L}{3600\,V}$ Compute T_t	hr			

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) …… hr 0.274
min. 16

Two-year, 24-hour rainfall was taken from Bulletin 70, Table 13

The Tc flow path for this area is drawn in ArcGIS: "E:\2014\14160\Drawings\ArcGIS\NR\Roberts Road Project_14160.mxd"

3 feet per second was used for channel flow (in storm sewers or other channels)

Time of Concentration (Tc) Calculation

Project: Erie/Mayo Flood Prone Area Study   By: LEH   Date: 04/09/18
Location: Wheaton, IL

Circle One: **Present** Developed
Circle One: **T_c** T_t through subareas   EE-2

Sheet Flow (Applicable to T_c only)

		Segment ID			
1.	Surface description (table 3-1)		Short Grass Prairie		
2.	Manning's roughness coeff., n (table 3-1)		0.15		
3.	Flow Length, L (total L < 300 ft)	ft	100		
4.	Two-yr 24-hr rainfall, P_2	in	3.04		
5.	Land slope, s	ft / ft	0.010		
6.	$Tt = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t	hr	0.221		0.221

Shallow Concentrated Flow

		Segment ID	1	2	
7.	Surface Description (paved or unpaved)		Unpaved		
8.	Flow Length, L	ft	328		
9.	Watercourse slope, s	ft / ft	0.018		
10.	Average velocity, V (figure 3-1)	ft / s	2.17		
11.	$T_c = \frac{L}{3600\ V}$ Compute T_c	hr	0.042		0.042

Channel Flow

		Segment ID	1	2	
12.	Cross sectional flow area, a	ft^2			
13.	Wetted perimeter, P_w	ft			
14.	Hydraulic radius, $r = a / P_w$ Compute r	ft			
15.	Channel slope, s	ft / ft			
16.	Manning's roughness coeff., n				
17.	$V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$ Compute V	ft / s	3.0		
18.	Flow length, L	ft			
19.	$T_t = \frac{L}{3600\ V}$ Compute T_t	hr			

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) hr 0.263
min. 16

Two-year, 24-hour rainfall was taken from Bulletin 70, Table 13
The Tc flow path for this area is drawn in ArcGIS: "E:\2014\14160\Drawings\ArcGIS\NR\Roberts Road Project_14160.mxd"
3 feet per second was used for channel flow (in storm sewers or other channels)

Time of Concentration (Tc) Calculation

Project: Erie/Mayo Flood Prone Area Study   By: LEH   Date: 04/09/18
Location: Wheaton, IL

Circle One: Present | Developed
Circle One: T_c | T_t through subareas   EE-3

Sheet Flow (Applicable to T_c only)

		Segment ID			
1.	Surface description (table 3-1)		Short Grass Prairie		
2.	Manning's roughness coeff., n (table 3-1)		0.15		
3.	Flow Length, L (total L < 300 ft)	ft	100		
4.	Two-yr 24-hr rainfall, P_2	in	3.04		
5.	Land slope, s	ft / ft	0.015		
6.	$Tt = \frac{0.007 (nL)^{0.8}}{P_2^{0.5} s^{0.4}}$ Compute T_t	hr	0.188		0.188

Shallow Concentrated Flow

		Segment ID	1	2	
7.	Surface Description (paved or unpaved)		Unpaved		
8.	Flow Length, L	ft	81		
9.	Watercourse slope, s	ft / ft	0.025		
10.	Average velocity, V (figure 3-1)	ft / s	2.52		
11.	$T_c = \frac{L}{3600 V}$ Compute T_c	hr	0.009		0.009

Channel Flow

		Segment ID	1	2	
12.	Cross sectional flow area, a	ft^2			
13.	Wetted perimeter, P_w	ft			
14.	Hydraulic radius, $r = a / P_w$ Compute r	ft			
15.	Channel slope, s	ft / ft			
16.	Manning's roughness coeff., n				
17.	$V = \frac{1.49 r^{2/3} s^{1/2}}{n}$ Compute V	ft / s	3.0		
18.	Flow length, L	ft			
19.	$T_t = \frac{L}{3600 V}$ Compute T_t	hr			

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) ...... hr 0.197
min. 12

Two-year, 24-hour rainfall was taken from Bulletin 70, Table 13

The Tc flow path for this area is drawn in ArcGIS: "E:\2014\14160\Drawings\ArcGIS\NR\Roberts Road Project_14160.mxd"

3 feet per second was used for channel flow (in storm sewers or other channels)

Time of Concentration (Tc) Calculation

Project: Erie/Mayo Flood Prone Area Study — By: LEH — Date: 04/09/18

Location: Wheaton, IL

Circle One: **Present** Developed

Circle One: **T_c** T_t through subareas — EE-4

Sheet Flow (Applicable to T_c only)

	Unit	Segment ID		
1. Surface description (table 3-1)		Short Grass Prairie		
2. Manning's roughness coeff., n (table 3-1)		0.15		
3. Flow Length, L (total L < 300 ft)	ft	100		
4. Two-yr 24-hr rainfall, P_2	in	3.04		
5. Land slope, s	ft / ft	0.020		
6. $T_t = \frac{0.007 (nL)^{0.8}}{P_2^{0.5} s^{0.4}}$ Compute T_t	hr	0.168		0.168

Shallow Concentrated Flow

	Unit	Segment ID 1	2	
7. Surface Description (paved or unpaved)		Unpaved		
8. Flow Length, L	ft	171		
9. Watercourse slope, s	ft / ft	0.035		
10. Average velocity, V (figure 3-1)	ft / s	3.01		
11. $T_c = \frac{L}{3600 V}$ Compute T_c	hr	0.016		0.016

Channel Flow

	Unit	Segment ID 1	2	
12. Cross sectional flow area, a	ft^2			
13. Wetted perimeter, P_w	ft			
14. Hydraulic radius, $r = a / P_w$ Compute r	ft			
15. Channel slope, s	ft / ft			
16. Manning's roughness coeff., n				
17. $V = \frac{1.49 r^{2/3} s^{1/2}}{n}$ Compute V	ft / s	3.0		
18. Flow length, L	ft			
19. $T_t = \frac{L}{3600 V}$ Compute T_t	hr			

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) — hr: 0.183; min.: 11

Two-year, 24-hour rainfall was taken from Bulletin 70, Table 13

The Tc flow path for this area is drawn in ArcGIS: "E:\2014\14160\Drawings\ArcGIS\NR\Roberts Road Project_14160.mxd"

3 feet per second was used for channel flow (in storm sewers or other channels)

Time of Concentration (Tc) Calculation

Project: Erie/Mayo Flood Prone Area Study By: LEH Date: 04/09/18
Location: Wheaton, IL

Circle One: Present | Developed
Circle One: T_c | T_t | through subareas EE-5

Sheet Flow (Applicable to T_c only)

	Unit	Segment ID		
1. Surface description (table 3-1)		Short Grass Prairie		
2. Manning's roughness coeff., n (table 3-1)		0.15		
3. Flow Length, L (total L < 300 ft)	ft	100		
4. Two-yr 24-hr rainfall, P_2	in	3.04		
5. Land slope, s	ft / ft	0.020		
6. $T_t = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\,s^{0.4}}$ Compute T_t	hr	0.168		0.168

Shallow Concentrated Flow

	Unit	1	2	
7. Surface Description (paved or unpaved)		Unpaved		
8. Flow Length, L	ft	553		
9. Watercourse slope, s	ft / ft	0.033		
10. Average velocity, V (figure 3-1)	ft / s	2.90		
11. $T_c = \frac{L}{3600\,V}$ Compute T_c	hr	0.053		0.053

Channel Flow

	Unit	1	2	
12. Cross sectional flow area, a	ft^2			
13. Wetted perimeter, P_w	ft			
14. Hydraulic radius, $r = a / P_w$ Compute r	ft			
15. Channel slope, s	ft / ft			
16. Manning's roughness coeff., n				
17. $V = \frac{1.49\,r^{2/3}\,s^{1/2}}{n}$ Compute V	ft / s	3.0		
18. Flow length, L	ft			
19. $T_t = \frac{L}{3600\,V}$ Compute T_t	hr			

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) hr 0.221
min. 13

Two-year, 24-hour rainfall was taken from Bulletin 70, Table 13

The Tc flow path for this area is drawn in ArcGIS: "E:\2014\14160\Drawings\ArcGIS\NR\Roberts Road Project_14160.mxd"

3 feet per second was used for channel flow (in storm sewers or other channels)

Time of Concentration (Tc) Calculation

Project: Erie/Mayo Flood Prone Area Study   By: LEH   Date: 04/09/18
Location: Wheaton, IL

Circle One: **Present** Developed
Circle One: **T_c** T_t through subareas   EE-6

Sheet Flow (Applicable to T_c only)

		Segment ID			
1.	Surface description (table 3-1)		smooth surfaces		
2.	Manning's roughness coeff., n (table 3-1)		0.15		
3.	Flow Length, L (total L < 300 ft)	ft	100		
4.	Two-yr 24-hr rainfall, P_2	in	3.04		
5.	Land slope, s	ft / ft	0.030		
6.	$Tt = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\,s^{0.4}}$ Compute T_t	hr	0.142		0.142

Shallow Concentrated Flow

		Segment ID	1	2	
7.	Surface Description (paved or unpaved)		unpaved		
8.	Flow Length, L	ft	214		
9.	Watercourse slope, s	ft / ft	0.028		
10.	Average velocity, V (figure 3-1)	ft / s	2.69		
11.	$T_c = \frac{L}{3600\,V}$ Compute T_c	hr	0.022		0.022

Channel Flow

		Segment ID	1	2	
12.	Cross sectional flow area, a	ft^2			
13.	Wetted perimeter, P_w	ft			
14.	Hydraulic radius, $r = a / P_w$ Compute r	ft			
15.	Channel slope, s	ft / ft			
16.	Manning's roughness coeff., n				
17.	$V = \frac{1.49\, r^{2/3}\, s^{1/2}}{n}$ Compute V	ft / s	3.0		
18.	Flow length, L	ft			
19.	$T_t = \frac{L}{3600\,V}$ Compute T_t	hr			

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) .... hr 0.165
min. 10

Two-year, 24-hour rainfall was taken from Bulletin 70, Table 13

The Tc flow path for this area is drawn in ArcGIS: "E:\2014\14160\Drawings\ArcGIS\NR\Roberts Road Project_14160.mxd"

3 feet per second was used for channel flow (in storm sewers or other channels)

Time of Concentration (Tc) Calculation

Project: Erie/Mayo Flood Prone Area Study   By: LEH   Date: 04/09/18
Location: Wheaton, IL

Circle One: **Present** Developed
Circle One: **T_c** T_t ☐ through subareas   EE-7

Sheet Flow (Applicable to T_c only)

	Unit	Segment ID		
1. Surface description (table 3-1)		Short Grass Prairie		
2. Manning's roughness coeff., n (table 3-1)		0.15		
3. Flow Length, L (total L < 300 ft)	ft	100		
4. Two-yr 24-hr rainfall, P_2	in	3.04		
5. Land slope, s	ft / ft	0.005		
6. $Tt = \frac{0.007 (nL)^{0.8}}{P_2^{0.5} s^{0.4}}$ Compute T_t	hr	0.292		0.292

Shallow Concentrated Flow

	Unit	1	2	
7. Surface Description (paved or unpaved)		Unpaved		
8. Flow Length, L	ft	243		
9. Watercourse slope, s	ft / ft	0.006		
10. Average velocity, V (figure 3-1)	ft / s	1.25		
11. $T_c = \frac{L}{3600 V}$ Compute T_c	hr	0.054		0.054

Channel Flow

	Unit	1	2	
12. Cross sectional flow area, a	ft^2			
13. Wetted perimeter, P_w	ft			
14. Hydraulic radius, $r = a / P_w$ Compute r	ft			
15. Channel slope, s	ft / ft			
16. Manning's roughness coeff., n				
17. $V = \frac{1.49 r^{2/3} s^{1/2}}{n}$ Compute V	ft / s	3.0		
18. Flow length, L	ft			
19. $T_t = \frac{L}{3600 V}$ Compute T_t	hr			

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) ... hr 0.346
min. 21

Two-year, 24-hour rainfall was taken from Bulletin 70, Table 13
The Tc flow path for this area is drawn in ArcGIS: "E:\2014\14160\Drawings\ArcGIS\NR\Roberts Road Project_14160.mxd"
3 feet per second was used for channel flow (in storm sewers or other channels)

Time of Concentration (Tc) Calculation

Project: Erie/Mayo Flood Prone Area Study By: LEH Date: 04/09/18
Location: Wheaton, IL

Circle One: Present | Developed
Circle One: T_c | T_t through subareas ACE-1

Sheet Flow (Applicable to T_c only)

		Segment ID			
1.	Surface description (table 3-1)		Short Grass Prairie		
2.	Manning's roughness coeff., n (table 3-1)		0.15		
3.	Flow Length, L (total L < 300 ft)	ft	100		
4.	Two-yr 24-hr rainfall, P_2	in	3.04		
5.	Land slope, s	ft / ft	0.020		
6.	$Tt = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\,s^{0.4}}$ Compute T_t	hr	0.168		0.168

Shallow Concentrated Flow

		Segment ID	1	2	
7.	Surface Description (paved or unpaved)		Unpaved		
8.	Flow Length, L	ft	454		
9.	Watercourse slope, s	ft / ft	0.035		
10.	Average velocity, V (figure 3-1)	ft / s	3.02		
11.	$T_c = \frac{L}{3600\,V}$ Compute T_c	hr	0.042		0.042

Channel Flow

		Segment ID	1	2	
12.	Cross sectional flow area, a	ft^2			
13.	Wetted perimeter, P_w	ft			
14.	Hydraulic radius, $r = a / P_w$ Compute r	ft			
15.	Channel slope, s	ft / ft			
16.	Manning's roughness coeff., n				
17.	$V = \frac{1.49\,r^{2/3}\,s^{1/2}}{n}$ Compute V	ft / s	3.0		
18.	Flow length, L	ft			
19.	$T_t = \frac{L}{3600\,V}$ Compute T_t	hr			

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) hr 0.209
min. 13

Two-year, 24-hour rainfall was taken from Bulletin 70, Table 13
The Tc flow path for this area is drawn in ArcGIS: "E:\2014\14160\Drawings\ArcGIS\NR\Roberts Road Project_14160.mxd"
3 feet per second was used for channel flow (in storm sewers or other channels)

Time of Concentration (Tc) Calculation

Project: Erie/Mayo Flood Prone Area Study   By: LEH   Date: 04/09/18
Location: Wheaton, IL

Circle One: **Present** Developed
Circle One: **T_c** T_t ☐ through subareas   ACE-2

Sheet Flow (Applicable to T_c only)

	Units	Segment ID		
1. Surface description (table 3-1)………		Short Grass Prairie		
2. Manning's roughness coeff., n (table 3-1)………		0.15		
3. Flow Length, L (total L < 300 ft)………	ft	100		
4. Two-yr 24-hr rainfall, P_2………	in	3.04		
5. Land slope, s………	ft / ft	0.020		
6. $Tt = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\,s^{0.4}}$ Compute T_t………	hr	0.168		0.168

Shallow Concentrated Flow

	Units	Segment ID 1	2	
7. Surface Description (paved or unpaved)………		Unpaved		
8. Flow Length, L………	ft	302		
9. Watercourse slope, s………	ft / ft	0.043		
10. Average velocity, V (figure 3-1)………	ft / s	3.34		
11. $T_c = \frac{L}{3600\,V}$ Compute T_c………	hr	0.025		0.025

Channel Flow

	Units	Segment ID 1	2	
12. Cross sectional flow area, a………	ft^2			
13. Wetted perimeter, P_w………	ft			
14. Hydraulic radius, $r = a / P_w$ Compute r………	ft			
15. Channel slope, s………	ft / ft			
16. Manning's roughness coeff., n………				
17. $V = \frac{1.49\, r^{2/3}\, s^{1/2}}{n}$ Compute V………	ft / s	3.0		
18. Flow length, L………	ft			
19. $T_t = \frac{L}{3600\,V}$ Compute T_t………	hr			

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)……… hr 0.193
min. 12

Two-year, 24-hour rainfall was taken from Bulletin 70, Table 13
The Tc flow path for this area is drawn in ArcGIS: "E:\2014\14160\Drawings\ArcGIS\NR\Roberts Road Project_14160.mxd"
3 feet per second was used for channel flow (in storm sewers or other channels)

Time of Concentration (Tc) Calculation

Project: Erie/Mayo Flood Prone Area Study	By: LEH	Date: 04/09/18

Location: Wheaton, IL

Circle One: **Present** Developed

Circle One: **T_c** T_t ☐ through subareas	ACE-3

Sheet Flow (Applicable to T_c only)

	Unit	Segment ID		
1. Surface description (table 3-1).................................		Short Grass Prairie		
2. Manning's roughness coeff., n (table 3-1).........................		0.15		
3. Flow Length, L (total L < 300 ft).....................................	ft	100		
4. Two-yr 24-hr rainfall, P_2..	in	3.04		
5. Land slope, s...	ft / ft	0.020		
6. $Tt = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\,s^{0.4}}$ Compute T_t..................	hr	0.168		0.168

Shallow Concentrated Flow

	Unit	Segment ID 1	2	
7. Surface Description (paved or unpaved)..........................		Unpaved		
8. Flow Length, L...	ft	432		
9. Watercourse slope, s...	ft / ft	0.042		
10. Average velocity, V (figure 3-1).....................................	ft / s	3.28		
11. $T_c = \frac{L}{3600\,V}$ Compute T_c.................	hr	0.037		0.037

Channel Flow

	Unit	Segment ID 1	2	
12. Cross sectional flow area, a..	ft^2			
13. Wetted perimeter, P_w..	ft			
14. Hydraulic radius, $r = a / P_w$ Compute r..................	ft			
15. Channel slope, s...	ft / ft			
16. Manning's roughness coeff., n.......................................				
17. $V = \frac{1.49\,r^{2/3}\,s^{1/2}}{n}$ Compute V..................	ft / s	3.0		
18. Flow length, L..	ft			
19. $T_t = \frac{L}{3600\,V}$ Compute T_t..................	hr			

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19).............................. hr 0.204

min. 12

Two-year, 24-hour rainfall was taken from Bulletin 70, Table 13

The Tc flow path for this area is drawn in ArcGIS: "E:\2014\14160\Drawings\ArcGIS\NR\Roberts Road Project_14160.mxd"

3 feet per second was used for channel flow (in storm sewers or other channels)

Time of Concentration (Tc) Calculation

Project: Erie/Mayo Flood Prone Area Study By: LEH Date: 04/09/18
Location: Wheaton, IL

Circle One: **Present** Developed
Circle One: **T_c** T_t through subareas ACE-4

Sheet Flow (Applicable to T_c only)

	Segment ID				
1. Surface description (table 3-1)		Short Grass Prairie		
2. Manning's roughness coeff., n (table 3-1)		0.15		
3. Flow Length, L (total L < 300 ft)	ft	100		
4. Two-yr 24-hr rainfall, P_2	in	3.04		
5. Land slope, s	ft / ft	0.001		
6. $Tt = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\,s^{0.4}}$ Compute T_t	hr	0.555		0.555

Shallow Concentrated Flow

	Segment ID	1	2	
7. Surface Description (paved or unpaved)		Unpaved		
8. Flow Length, L	ft	218		
9. Watercourse slope, s	ft / ft	0.013		
10. Average velocity, V (figure 3-1)	ft / s	1.85		
11. $T_c = \frac{L}{3600\,V}$ Compute T_c	hr	0.033		0.033

Channel Flow

	Segment ID	1	2	
12. Cross sectional flow area, a	ft^2			
13. Wetted perimeter, P_w	ft			
14. Hydraulic radius, $r = a / P_w$ Compute r	ft			
15. Channel slope, s	ft / ft			
16. Manning's roughness coeff., n				
17. $V = \frac{1.49\,r^{2/3}\,s^{1/2}}{n}$ Compute V	ft / s	3.0		
18. Flow length, L	ft			
19. $T_t = \frac{L}{3600\,V}$ Compute T_t	hr			

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) hr 0.588
min. 35

Two-year, 24-hour rainfall was taken from Bulletin 70, Table 13
The Tc flow path for this area is drawn in ArcGIS: "E:\2014\14160\Drawings\ArcGIS\NR\Roberts Road Project_14160.mxd"
3 feet per second was used for channel flow (in storm sewers or other channels)

Time of Concentration (Tc) Calculation

Project: Erie/Mayo Flood Prone Area Study   By: LEH   Date: 04/09/18
Location: Wheaton, IL

Circle One: **Present** Developed
Circle One: **T_c** T_t ☐ through subareas   ACE-5

Sheet Flow (Applicable to T_c only)

		Segment ID			
1.	Surface description (table 3-1)		Short Grass Prairie		
2.	Manning's roughness coeff., n (table 3-1)		0.15		
3.	Flow Length, L (total L < 300 ft)	ft	100		
4.	Two-yr 24-hr rainfall, P_2	in	3.04		
5.	Land slope, s	ft / ft	0.010		
6.	$Tt = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\,s^{0.4}}$ Compute T_t	hr	0.221		0.221

Shallow Concentrated Flow

		Segment ID	1	2	
7.	Surface Description (paved or unpaved)		Unpaved		
8.	Flow Length, L	ft	367		
9.	Watercourse slope, s	ft / ft	0.015		
10.	Average velocity, V (figure 3-1)	ft / s	1.96		
11.	$T_c = \frac{L}{3600\,V}$ Compute T_c	hr	0.052		0.052

Channel Flow

		Segment ID	1	2	
12.	Cross sectional flow area, a	ft^2			
13.	Wetted perimeter, P_w	ft			
14.	Hydraulic radius, $r = a / P_w$ Compute r	ft			
15.	Channel slope, s	ft / ft			
16.	Manning's roughness coeff., n				
17.	$V = \frac{1.49\,r^{2/3}\,s^{1/2}}{n}$ Compute V	ft / s	3.0		
18.	Flow length, L	ft			
19.	$T_t = \frac{L}{3600\,V}$ Compute T_t	hr			

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) .... hr 0.273
min. 16

Two-year, 24-hour rainfall was taken from Bulletin 70, Table 13

The Tc flow path for this area is drawn in ArcGIS: "E:\2014\14160\Drawings\ArcGIS\NR\Roberts Road Project_14160.mxd"

3 feet per second was used for channel flow (in storm sewers or other channels)

Time of Concentration (Tc) Calculation

Project: Erie/Mayo Flood Prone Area Study   By: LEH   Date: 04/09/18
Location: Wheaton, IL

Circle One: **Present** Developed
Circle One: **T_c** T_t through subareas   ACE-6

Sheet Flow (Applicable to T_c only)

	Segment ID				
1. Surface description (table 3-1)………			Short Grass Prairie		
2. Manning's roughness coeff., n (table 3-1)………			0.15		
3. Flow Length, L (total L < 300 ft)………		ft	100		
4. Two-yr 24-hr rainfall, P_2………		in	3.04		
5. Land slope, s………		ft / ft	0.008		
6. $Tt = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$	Compute T_t………	hr	0.248		0.248

Shallow Concentrated Flow

	Segment ID		1	2	
7. Surface Description (paved or unpaved)………			Unpaved		
8. Flow Length, L………		ft	50		
9. Watercourse slope, s………		ft / ft	0.105		
10. Average velocity, V (figure 3-1)………		ft / s	5.23		
11. $T_c = \frac{L}{3600\ V}$	Compute T_c………	hr	0.003		0.003

Channel Flow

	Segment ID		1	2	
12. Cross sectional flow area, a………		ft^2			
13. Wetted perimeter, P_w………		ft			
14. Hydraulic radius, $r = a / P_w$	Compute r………	ft			
15. Channel slope, s………		ft / ft			
16. Manning's roughness coeff., n………					
17. $V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$	Compute V………	ft / s	3.0		
18. Flow length, L………		ft			
19. $T_t = \frac{L}{3600\ V}$	Compute T_t………	hr			

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)……… hr 0.251
min. 15

Two-year, 24-hour rainfall was taken from Bulletin 70, Table 13

The Tc flow path for this area is drawn in ArcGIS: "E:\2014\14160\Drawings\ArcGIS\NR\Roberts Road Project_14160.mxd"

3 feet per second was used for channel flow (in storm sewers or other channels)

Time of Concentration (Tc) Calculation

Project: Erie/Mayo Flood Prone Area Study By: LEH Date: 04/09/18
Location: Wheaton, IL

Circle One: **Present** Developed
Circle One: **T_c** T_t through subareas ACE-7

Sheet Flow (Applicable to T_c only)

		Segment ID			
1.	Surface description (table 3-1)		Short Grass Prairie		
2.	Manning's roughness coeff., n (table 3-1)		0.15		
3.	Flow Length, L (total L < 300 ft)	ft	100		
4.	Two-yr 24-hr rainfall, P_2	in	3.04		
5.	Land slope, s	ft / ft	0.005		
6.	$Tt = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\,s^{0.4}}$ Compute T_t	hr	0.292		0.292

Shallow Concentrated Flow

		Segment ID	1	2	
7.	Surface Description (paved or unpaved)		Unpaved		
8.	Flow Length, L	ft	222		
9.	Watercourse slope, s	ft / ft	0.025		
10.	Average velocity, V (figure 3-1)	ft / s	2.53		
11.	$T_c = \frac{L}{3600\,V}$ Compute T_c	hr	0.024		0.024

Channel Flow

		Segment ID	1	2	
12.	Cross sectional flow area, a	ft^2			
13.	Wetted perimeter, P_w	ft			
14.	Hydraulic radius, $r = a / P_w$ Compute r	ft			
15.	Channel slope, s	ft / ft			
16.	Manning's roughness coeff., n				
17.	$V = \frac{1.49\, r^{2/3}\, s^{1/2}}{n}$ Compute V	ft / s	3.0		
18.	Flow length, L	ft			
19.	$T_t = \frac{L}{3600\,V}$ Compute T_t	hr			

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) hr 0.316
min. 19

Two-year, 24-hour rainfall was taken from Bulletin 70, Table 13
The Tc flow path for this area is drawn in ArcGIS: "E:\2014\14160\Drawings\ArcGIS\NR\Roberts Road Project_14160.mxd"
3 feet per second was used for channel flow (in storm sewers or other channels)

Time of Concentration (Tc) Calculation

Project: Erie/Mayo Flood Prone Area Study By: LEH Date: 04/09/18
Location: Wheaton, IL

Circle One: **Present** Developed
Circle One: **T_c** T_t through subareas ACE-8

Sheet Flow (Applicable to T_c only)	Segment ID			
1. Surface description (table 3-1)		Short Grass Prairie		
2. Manning's roughness coeff., n (table 3-1)		0.15		
3. Flow Length, L (total L < 300 ft)	ft	100		
4. Two-yr 24-hr rainfall, P_2	in	3.04		
5. Land slope, s	ft / ft	0.011		
6. $Tt = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\, s^{0.4}}$ Compute T_t	hr	0.213		0.213

Shallow Concentrated Flow	Segment ID	1	2	
7. Surface Description (paved or unpaved)		Unpaved		
8. Flow Length, L	ft	49		
9. Watercourse slope, s	ft / ft	0.020		
10. Average velocity, V (figure 3-1)	ft / s	2.29		
11. $T_c = \frac{L}{3600\,V}$ Compute T_c	hr	0.006		0.006

Channel Flow	Segment ID	1	2	
12. Cross sectional flow area, a	ft^2			
13. Wetted perimeter, P_w	ft			
14. Hydraulic radius, $r = a / P_w$ Compute r	ft			
15. Channel slope, s	ft / ft			
16. Manning's roughness coeff., n				
17. $V = \frac{1.49\, r^{2/3}\, s^{1/2}}{n}$ Compute V	ft / s	3.0		
18. Flow length, L	ft			
19. $T_t = \frac{L}{3600\,V}$ Compute T_t	hr			
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)	hr			0.219
	min.			13

Two-year, 24-hour rainfall was taken from Bulletin 70, Table 13
The Tc flow path for this area is drawn in ArcGIS: "E:\2014\14160\Drawings\ArcGIS\NR\Roberts Road Project_14160.mxd"
3 feet per second was used for channel flow (in storm sewers or other channels)

Time of Concentration (Tc) Calculation

Project: Erie/Mayo Flood Prone Area Study   By: LEH   Date: 04/09/18
Location: Wheaton, IL

Circle One: **Present** | Developed
Circle One: **T_c** | T_t through subareas   AEE-1

Sheet Flow (Applicable to T_c only)

		Segment ID			
1.	Surface description (table 3-1)		Short Grass Prairie		
2.	Manning's roughness coeff., n (table 3-1)		0.15		
3.	Flow Length, L (total L < 300 ft)	ft	100		
4.	Two-yr 24-hr rainfall, P_2	in	3.04		
5.	Land slope, s	ft / ft	0.010		
6.	$Tt = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t	hr	0.221		0.221

Shallow Concentrated Flow

		Segment ID	1	2	
7.	Surface Description (paved or unpaved)		Unpaved		
8.	Flow Length, L	ft	457		
9.	Watercourse slope, s	ft / ft	0.042		
10.	Average velocity, V (figure 3-1)	ft / s	3.28		
11.	$T_c = \frac{L}{3600\ V}$ Compute T_c	hr	0.039		0.039

Channel Flow

		Segment ID	1	2	
12.	Cross sectional flow area, a	ft^2			
13.	Wetted perimeter, P_w	ft			
14.	Hydraulic radius, $r = a / P_w$ Compute r	ft			
15.	Channel slope, s	ft / ft			
16.	Manning's roughness coeff., n				
17.	$V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$ Compute V	ft / s	3.0		
18.	Flow length, L	ft			
19.	$T_t = \frac{L}{3600\ V}$ Compute T_t	hr			

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) .... hr 0.260
min. 16

Two-year, 24-hour rainfall was taken from Bulletin 70, Table 13
The Tc flow path for this area is drawn in ArcGIS: "E:\2014\14160\Drawings\ArcGIS\NR\Roberts Road Project_14160.mxd"
3 feet per second was used for channel flow (in storm sewers or other channels)

Time of Concentration (Tc) Calculation

Project: Erie/Mayo Flood Prone Area Study By: LEH Date: 04/09/18
Location: Wheaton, IL

Circle One: Present | Developed
Circle One: T_c | T_t through subareas AEE-2

Sheet Flow (Applicable to T_c only)

	Unit	Segment ID		Total
1. Surface description (table 3-1)		Short Grass Prairie		
2. Manning's roughness coeff., n (table 3-1)		0.15		
3. Flow Length, L (total L < 300 ft)	ft	100		
4. Two-yr 24-hr rainfall, P_2	in	3.04		
5. Land slope, s	ft / ft	0.001		
6. $Tt = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\,s^{0.4}}$ Compute T_t	hr	0.472		0.472

Shallow Concentrated Flow

	Unit	Segment ID 1	2	Total
7. Surface Description (paved or unpaved)		Unpaved		
8. Flow Length, L	ft	648		
9. Watercourse slope, s	ft / ft	0.026		
10. Average velocity, V (figure 3-1)	ft / s	2.60		
11. $T_c = \frac{L}{3600\,V}$ Compute T_c	hr	0.069		0.069

Channel Flow

	Unit	Segment ID 1	2	Total
12. Cross sectional flow area, a	ft^2			
13. Wetted perimeter, P_w	ft			
14. Hydraulic radius, $r = a / P_w$ Compute r	ft			
15. Channel slope, s	ft / ft			
16. Manning's roughness coeff., n				
17. $V = \frac{1.49\,r^{2/3}\,s^{1/2}}{n}$ Compute V	ft / s	3.0		
18. Flow length, L	ft			
19. $T_t = \frac{L}{3600\,V}$ Compute T_t	hr			

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) hr 0.541
min. 32

Two-year, 24-hour rainfall was taken from Bulletin 70, Table 13
The Tc flow path for this area is drawn in ArcGIS: "E:\2014\14160\Drawings\ArcGIS\NR\Roberts Road Project_14160.mxd"
3 feet per second was used for channel flow (in storm sewers or other channels)

Time of Concentration (Tc) Calculation

Project: Erie/Mayo Flood Prone Area Study By: LEH Date: 04/09/18
Location: Wheaton, IL

Circle One: **Present** Developed
Circle One: **T_c** T_t through subareas MA-1

Sheet Flow (Applicable to T_c only)

	Unit	Segment ID		
1. Surface description (table 3-1)		Short Grass Prairie		
2. Manning's roughness coeff., n (table 3-1)		0.15		
3. Flow Length, L (total L < 300 ft)	ft	100		
4. Two-yr 24-hr rainfall, P_2	in	3.04		
5. Land slope, s	ft / ft	0.010		
6. $Tt = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\,s^{0.4}}$ Compute T_t	hr	0.221		0.221

Shallow Concentrated Flow

	Unit	Segment ID 1	2	
7. Surface Description (paved or unpaved)		Unpaved		
8. Flow Length, L	ft	536		
9. Watercourse slope, s	ft / ft	0.032		
10. Average velocity, V (figure 3-1)	ft / s	2.86		
11. $T_c = \frac{L}{3600\,V}$ Compute T_c	hr	0.052		0.052

Channel Flow

	Unit	Segment ID 1	2	
12. Cross sectional flow area, a	ft^2			
13. Wetted perimeter, P_w	ft			
14. Hydraulic radius, $r = a / P_w$ Compute r	ft			
15. Channel slope, s	ft / ft			
16. Manning's roughness coeff., n				
17. $V = \frac{1.49\,r^{2/3}\,s^{1/2}}{n}$ Compute V	ft / s	3.0		
18. Flow length, L	ft			
19. $T_t = \frac{L}{3600\,V}$ Compute T_t	hr			

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) hr 0.273
min. 16

Two-year, 24-hour rainfall was taken from Bulletin 70, Table 13
The Tc flow path for this area is drawn in ArcGIS: "E:\2014\14160\Drawings\ArcGIS\NR\Roberts Road Project_14160.mxd"
3 feet per second was used for channel flow (in storm sewers or other channels)

Time of Concentration (Tc) Calculation

Project: Erie/Mayo Flood Prone Area Study   By: LEH   Date: 04/09/18
Location: Wheaton, IL

Circle One: **Present** Developed
Circle One: **T_c** T_t through subareas   MA-2

Sheet Flow (Applicable to T_c only)

		Segment ID			
1.	Surface description (table 3-1)................................		Short Grass Prairie		
2.	Manning's roughness coeff., n (table 3-1)........................		0.15		
3.	Flow Length, L (total L < 300 ft)................................	ft	100		
4.	Two-yr 24-hr rainfall, P_2..	in	3.04		
5.	Land slope, s..	ft / ft	0.015		
6.	$Tt = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\,s^{0.4}}$ Compute T_t..................	hr	0.188		0.188

Shallow Concentrated Flow

			Segment ID 1	2	
7.	Surface Description (paved or unpaved)........................		Unpaved		
8.	Flow Length, L...	ft	426		
9.	Watercourse slope, s...	ft / ft	0.039		
10.	Average velocity, V (figure 3-1).................................	ft / s	3.17		
11.	$T_c = \frac{L}{3600\,V}$ Compute T_c.................	hr	0.037		0.037

Channel Flow

			Segment ID 1	2	
12.	Cross sectional flow area, a......................................	ft^2			
13.	Wetted perimeter, P_w..	ft			
14.	Hydraulic radius, $r = a / P_w$ Compute r..................	ft			
15.	Channel slope, s..	ft / ft			
16.	Manning's roughness coeff., n....................................				
17.	$V = \frac{1.49\,r^{2/3}\,s^{1/2}}{n}$ Compute V..................	ft / s	3.0		
18.	Flow length, L..	ft			
19.	$T_t = \frac{L}{3600\,V}$ Compute T_t..................	hr			

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)........................... hr 0.225
min. 14

Two-year, 24-hour rainfall was taken from Bulletin 70, Table 13
The Tc flow path for this area is drawn in ArcGIS: "E:\2014\14160\Drawings\ArcGIS\NR\Roberts Road Project_14160.mxd"
3 feet per second was used for channel flow (in storm sewers or other channels)

Time of Concentration (Tc) Calculation

Project: Erie/Mayo Flood Prone Area Study   By: LEH   Date: 04/09/18
Location: Wheaton, IL

Circle One: **Present** Developed
Circle One: **T_c** T_t through subareas   MA-3

Sheet Flow (Applicable to T_c only)

	Unit	Segment ID		
1. Surface description (table 3-1)		Short Grass Prairie		
2. Manning's roughness coeff., n (table 3-1)		0.15		
3. Flow Length, L (total L < 300 ft)	ft	100		
4. Two-yr 24-hr rainfall, P_2	in	3.04		
5. Land slope, s	ft / ft	0.030		
6. $Tt = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\,s^{0.4}}$ Compute T_t	hr	0.142		0.142

Shallow Concentrated Flow

	Unit	Segment ID 1	2	
7. Surface Description (paved or unpaved)		Unpaved		
8. Flow Length, L	ft	395		
9. Watercourse slope, s	ft / ft	0.013		
10. Average velocity, V (figure 3-1)	ft / s	1.80		
11. $T_c = \frac{L}{3600\,V}$ Compute T_c	hr	0.061		0.061

Channel Flow

	Unit	Segment ID 1	2	
12. Cross sectional flow area, a	ft^2			
13. Wetted perimeter, P_w	ft			
14. Hydraulic radius, $r = a / P_w$ Compute r	ft			
15. Channel slope, s	ft / ft			
16. Manning's roughness coeff., n				
17. $V = \frac{1.49\,r^{2/3}\,s^{1/2}}{n}$ Compute V	ft / s	3.0		
18. Flow length, L	ft			
19. $T_t = \frac{L}{3600\,V}$ Compute T_t	hr			

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) .... hr 0.203
min. 12

Two-year, 24-hour rainfall was taken from Bulletin 70, Table 13
The Tc flow path for this area is drawn in ArcGIS: "E:\2014\14160\Drawings\ArcGIS\NR\Roberts Road Project_14160.mxd"
3 feet per second was used for channel flow (in storm sewers or other channels)

Time of Concentration (Tc) Calculation

Project: Erie/Mayo Flood Prone Area Study By: LEH Date: 04/09/18
Location: Wheaton, IL

Circle One: Present Developed
Circle One: T_c T_t through subareas MA-4

Sheet Flow (Applicable to T_c only)

		Segment ID			
1. Surface description (table 3-1)		Short Grass Prairie			
2. Manning's roughness coeff., n (table 3-1)		0.15			
3. Flow Length, L (total L < 300 ft)	ft	100			
4. Two-yr 24-hr rainfall, P_2	in	3.04			
5. Land slope, s	ft / ft	0.020			
6. $Tt = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\,s^{0.4}}$ Compute T_t	hr	0.168		0.168	

Shallow Concentrated Flow

		Segment ID 1	2	
7. Surface Description (paved or unpaved)		Unpaved		
8. Flow Length, L	ft	367		
9. Watercourse slope, s	ft / ft	0.035		
10. Average velocity, V (figure 3-1)	ft / s	3.03		
11. $T_c = \frac{L}{3600\,V}$ Compute T_c	hr	0.034		0.034

Channel Flow

		Segment ID 1	2	
12. Cross sectional flow area, a	ft^2			
13. Wetted perimeter, P_w	ft			
14. Hydraulic radius, $r = a / P_w$ Compute r	ft			
15. Channel slope, s	ft / ft			
16. Manning's roughness coeff., n				
17. $V = \frac{1.49\,r^{2/3}\,s^{1/2}}{n}$ Compute V	ft / s	3.0		
18. Flow length, L	ft			
19. $T_t = \frac{L}{3600\,V}$ Compute T_t	hr			

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) hr 0.201

min. 12

Two-year, 24-hour rainfall was taken from Bulletin 70, Table 13

The Tc flow path for this area is drawn in ArcGIS: "E:\2014\14160\Drawings\ArcGIS\NR\Roberts Road Project_14160.mxd"

3 feet per second was used for channel flow (in storm sewers or other channels)

Time of Concentration (Tc) Calculation

Project: Erie/Mayo Flood Prone Area Study By: LEH Date: 04/09/18
Location: Wheaton, IL

Circle One: Present Developed
Circle One: T_c T_t through subareas MA-5

Sheet Flow (Applicable to T_c only)

	Units	Segment ID		
1. Surface description (table 3-1)		Short Grass Prairie		
2. Manning's roughness coeff., n (table 3-1)		0.15		
3. Flow Length, L (total L < 300 ft)	ft	100		
4. Two-yr 24-hr rainfall, P_2	in	3.04		
5. Land slope, s	ft / ft	0.020		
6. $Tt = \frac{0.007 (nL)^{0.8}}{P_2^{0.5} s^{0.4}}$ Compute T_t	hr	0.168		0.168

Shallow Concentrated Flow

	Units	Segment ID 1	2	
7. Surface Description (paved or unpaved)		Unpaved		
8. Flow Length, L	ft	255		
9. Watercourse slope, s	ft / ft	0.063		
10. Average velocity, V (figure 3-1)	ft / s	4.04		
11. $T_c = \frac{L}{3600 V}$ Compute T_c	hr	0.018		0.018

Channel Flow

	Units	Segment ID 1	2	
12. Cross sectional flow area, a	ft^2			
13. Wetted perimeter, P_w	ft			
14. Hydraulic radius, $r = a / P_w$ Compute r	ft			
15. Channel slope, s	ft / ft			
16. Manning's roughness coeff., n				
17. $V = \frac{1.49 r^{2/3} s^{1/2}}{n}$ Compute V	ft / s	3.0		
18. Flow length, L	ft			
19. $T_t = \frac{L}{3600 V}$ Compute T_t	hr			

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) ... hr 0.185
min. 11

Two-year, 24-hour rainfall was taken from Bulletin 70, Table 13

The Tc flow path for this area is drawn in ArcGIS: "E:\2014\14160\Drawings\ArcGIS\NR\Roberts Road Project_14160.mxd"

3 feet per second was used for channel flow (in storm sewers or other channels)

Time of Concentration (Tc) Calculation

Project: Erie/Mayo Flood Prone Area Study | By: LEH | Date: 04/09/18
Location: Wheaton, IL

Circle One: **Present** Developed
Circle One: **T_c** T_t through subareas MA-6

Sheet Flow (Applicable to T_c only)

	Segment ID				
1. Surface description (table 3-1)		Short Grass Prairie		
2. Manning's roughness coeff., n (table 3-1)		0.15		
3. Flow Length, L (total L < 300 ft)	ft	100		
4. Two-yr 24-hr rainfall, P_2	in	3.04		
5. Land slope, s	ft / ft	0.015		
6. $Tt = \frac{0.007 (nL)^{0.8}}{P_2^{0.5} s^{0.4}}$ Compute T_t	hr	0.188		0.188

Shallow Concentrated Flow

	Segment ID	1	2	
7. Surface Description (paved or unpaved)		Unpaved		
8. Flow Length, L	ft	337		
9. Watercourse slope, s	ft / ft	0.016		
10. Average velocity, V (figure 3-1)	ft / s	2.05		
11. $T_c = \frac{L}{3600 V}$ Compute T_c	hr	0.046		0.046

Channel Flow

	Segment ID	1	2	
12. Cross sectional flow area, a	ft^2			
13. Wetted perimeter, P_w	ft			
14. Hydraulic radius, $r = a / P_w$ Compute r	ft			
15. Channel slope, s	ft / ft			
16. Manning's roughness coeff., n				
17. $V = \frac{1.49 r^{2/3} s^{1/2}}{n}$ Compute V	ft / s	3.0		
18. Flow length, L	ft			
19. $T_t = \frac{L}{3600 V}$ Compute T_t	hr			

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) hr 0.234
min. 14

Two-year, 24-hour rainfall was taken from Bulletin 70, Table 13

The Tc flow path for this area is drawn in ArcGIS: "E:\2014\14160\Drawings\ArcGIS\NR\Roberts Road Project_14160.mxd"

3 feet per second was used for channel flow (in storm sewers or other channels)

Time of Concentration (Tc) Calculation

Project: Erie/Mayo Flood Prone Area Study By: LEH Date: 04/09/18
Location: Wheaton, IL

Circle One: **Present** Developed
Circle One: **T_c** T_t through subareas MA-7

Sheet Flow (Applicable to T_c only)

		Unit	Segment ID		
1. Surface description (table 3-1)			Short Grass Prairie		
2. Manning's roughness coeff., n (table 3-1)			0.15		
3. Flow Length, L (total L < 300 ft)		ft	100		
4. Two-yr 24-hr rainfall, P_2		in	3.04		
5. Land slope, s		ft / ft	0.040		
6. $Tt = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\,s^{0.4}}$	Compute T_t	hr	0.127		0.127

Shallow Concentrated Flow

		Unit	Segment ID 1	2	
7. Surface Description (paved or unpaved)			Unpaved		
8. Flow Length, L		ft	361		
9. Watercourse slope, s		ft / ft	0.050		
10. Average velocity, V (figure 3-1)		ft / s	3.59		
11. $T_c = \frac{L}{3600\,V}$	Compute T_c	hr	0.028		0.028

Channel Flow

		Unit	Segment ID 1	2	
12. Cross sectional flow area, a		ft^2			
13. Wetted perimeter, P_w		ft			
14. Hydraulic radius, $r = a / P_w$	Compute r	ft			
15. Channel slope, s		ft / ft			
16. Manning's roughness coeff., n					
17. $V = \frac{1.49\,r^{2/3}\,s^{1/2}}{n}$	Compute V	ft / s	3.0		
18. Flow length, L		ft			
19. $T_t = \frac{L}{3600\,V}$	Compute T_t	hr			

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) .... hr 0.155
min. 9

Two-year, 24-hour rainfall was taken from Bulletin 70, Table 13
The Tc flow path for this area is drawn in ArcGIS: "E:\2014\14160\Drawings\ArcGIS\NR\Roberts Road Project_14160.mxd"
3 feet per second was used for channel flow (in storm sewers or other channels)

Time of Concentration (Tc) Calculation

Project: Erie/Mayo Flood Prone Area Study By: LEH Date: 04/09/18
Location: Wheaton, IL

Circle One: **Present** Developed
Circle One: **T_c** T_t through subareas MA-8

Sheet Flow (Applicable to T_c only)

		Segment ID		
1. Surface description (table 3-1)		Short Grass Prairie		
2. Manning's roughness coeff., n (table 3-1)		0.15		
3. Flow Length, L (total L < 300 ft)	ft	100		
4. Two-yr 24-hr rainfall, P_2	in	3.04		
5. Land slope, s	ft / ft	0.040		
6. $T_t = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\,s^{0.4}}$ Compute T_t	hr	0.127		0.127

Shallow Concentrated Flow

		Segment ID 1	2	
7. Surface Description (paved or unpaved)		Unpaved		
8. Flow Length, L	ft	82		
9. Watercourse slope, s	ft / ft	0.049		
10. Average velocity, V (figure 3-1)	ft / s	3.56		
11. $T_c = \frac{L}{3600\,V}$ Compute T_c	hr	0.006		0.006

Channel Flow

		Segment ID 1	2	
12. Cross sectional flow area, a	ft^2			
13. Wetted perimeter, P_w	ft			
14. Hydraulic radius, $r = a / P_w$ Compute r	ft			
15. Channel slope, s	ft / ft			
16. Manning's roughness coeff., n				
17. $V = \frac{1.49\,r^{2/3}\,s^{1/2}}{n}$ Compute V	ft / s	3.0		
18. Flow length, L	ft			
19. $T_t = \frac{L}{3600\,V}$ Compute T_t	hr			

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) hr 0.133
min. 8

Two-year, 24-hour rainfall was taken from Bulletin 70, Table 13
The Tc flow path for this area is drawn in ArcGIS: "E:\2014\14160\Drawings\ArcGIS\NR\Roberts Road Project_14160.mxd"
3 feet per second was used for channel flow (in storm sewers or other channels)

Time of Concentration (Tc) Calculation

Project: Erie/Mayo Flood Prone Area Study By: LEH Date: 04/09/18
Location: Wheaton, IL

Circle One: **Present** Developed
Circle One: **T_c** T_t ☐ through subareas MA-9

Sheet Flow (Applicable to T_c only)

		Segment ID			
1.	Surface description (table 3-1)		Short Grass Prairie		
2.	Manning's roughness coeff., n (table 3-1)		0.15		
3.	Flow Length, L (total L < 300 ft)	ft	100		
4.	Two-yr 24-hr rainfall, P_2	in	3.04		
5.	Land slope, s	ft / ft	0.020		
6.	$Tt = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\,s^{0.4}}$ Compute T_t	hr	0.168		0.168

Shallow Concentrated Flow

		Segment ID	1	2	
7.	Surface Description (paved or unpaved)		Unpaved		
8.	Flow Length, L	ft	282		
9.	Watercourse slope, s	ft / ft	0.032		
10.	Average velocity, V (figure 3-1)	ft / s	2.87		
11.	$T_c = \frac{L}{3600\,V}$ Compute T_c	hr	0.027		0.027

Channel Flow

		Segment ID	1	2	
12.	Cross sectional flow area, a	ft^2			
13.	Wetted perimeter, P_w	ft			
14.	Hydraulic radius, $r = a / P_w$ Compute r	ft			
15.	Channel slope, s	ft / ft			
16.	Manning's roughness coeff., n				
17.	$V = \frac{1.49\,r^{2/3}\,s^{1/2}}{n}$ Compute V	ft / s	3.0		
18.	Flow length, L	ft			
19.	$T_t = \frac{L}{3600\,V}$ Compute T_t	hr			

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) hr **0.195**
min. 12

Two-year, 24-hour rainfall was taken from Bulletin 70, Table 13
The Tc flow path for this area is drawn in ArcGIS: "E:\2014\14160\Drawings\ArcGIS\NR\Roberts Road Project_14160.mxd"
3 feet per second was used for channel flow (in storm sewers or other channels)

Time of Concentration (Tc) Calculation

Project: Erie/Mayo Flood Prone Area Study By: LEH Date: 04/09/18
Location: Wheaton, IL

Circle One: Present Developed
Circle One: T_c T_t through subareas MA-10

Sheet Flow (Applicable to T_c only)

	Units	Segment ID		
1. Surface description (table 3-1)		Short Grass Prairie		
2. Manning's roughness coeff., n (table 3-1)		0.15		
3. Flow Length, L (total L < 300 ft)	ft	100		
4. Two-yr 24-hr rainfall, P_2	in	3.04		
5. Land slope, s	ft / ft	0.020		
6. $Tt = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\,s^{0.4}}$ Compute T_t	hr	0.168		0.168

Shallow Concentrated Flow

	Units	Segment ID 1	2	
7. Surface Description (paved or unpaved)		Unpaved		
8. Flow Length, L	ft	178		
9. Watercourse slope, s	ft / ft	0.051		
10. Average velocity, V (figure 3-1)	ft / s	3.62		
11. $T_c = \frac{L}{3600\,V}$ Compute T_c	hr	0.014		0.014

Channel Flow

	Units	Segment ID 1	2	
12. Cross sectional flow area, a	ft^2			
13. Wetted perimeter, P_w	ft			
14. Hydraulic radius, $r = a / P_w$ Compute r	ft			
15. Channel slope, s	ft / ft			
16. Manning's roughness coeff., n				
17. $V = \frac{1.49\,r^{2/3}\,s^{1/2}}{n}$ Compute V	ft / s	3.0		
18. Flow length, L	ft			
19. $T_t = \frac{L}{3600\,V}$ Compute T_t	hr			

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) hr 0.181
min. 11

Two-year, 24-hour rainfall was taken from Bulletin 70, Table 13

The Tc flow path for this area is drawn in ArcGIS: "E:\2014\14160\Drawings\ArcGIS\NR\Roberts Road Project_14160.mxd"

3 feet per second was used for channel flow (in storm sewers or other channels)

Time of Concentration (Tc) Calculation

Project: Erie/Mayo Flood Prone Area Study By: LEH Date: 04/09/18
Location: Wheaton, IL

Circle One: **Present** Developed
Circle One: **T_c** T_t ☐ through subareas MA-11

Sheet Flow (Applicable to T_c only)

			Segment ID			
1.	Surface description (table 3-1)		Short Grass Prairie		
2.	Manning's roughness coeff., n (table 3-1)		0.15		
3.	Flow Length, L (total L < 300 ft)	ft	100		
4.	Two-yr 24-hr rainfall, P_2	in	3.04		
5.	Land slope, s	ft / ft	0.040		
6.	$Tt = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\,s^{0.4}}$ Compute T_t	hr	0.127		0.127

Shallow Concentrated Flow

			Segment ID 1	2	
7.	Surface Description (paved or unpaved)		Unpaved		
8.	Flow Length, L	ft	315		
9.	Watercourse slope, s	ft / ft	0.019		
10.	Average velocity, V (figure 3-1)	ft / s	2.21		
11.	$T_c = \frac{L}{3600\,V}$ Compute T_c	hr	0.040		0.040

Channel Flow

			Segment ID 1	2	
12.	Cross sectional flow area, a	ft^2			
13.	Wetted perimeter, P_w	ft			
14.	Hydraulic radius, $r = a / P_w$ Compute r	ft			
15.	Channel slope, s	ft / ft			
16.	Manning's roughness coeff., n				
17.	$V = \frac{1.49\,r^{2/3}\,s^{1/2}}{n}$ Compute V	ft / s	3.0		
18.	Flow length, L	ft			
19.	$T_t = \frac{L}{3600\,V}$ Compute T_t	hr			

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) hr 0.167
min. 10

Two-year, 24-hour rainfall was taken from Bulletin 70, Table 13
The Tc flow path for this area is drawn in ArcGIS: "E:\2014\14160\Drawings\ArcGIS\NR\Roberts Road Project_14160.mxd"
3 feet per second was used for channel flow (in storm sewers or other channels)

Time of Concentration (Tc) Calculation

Project: Erie/Mayo Flood Prone Area Study By: LEH Date: 04/09/18
Location: Wheaton, IL

Circle One: Present Developed
Circle One: T_c T_t through subareas AMA-1

Sheet Flow (Applicable to T_c only)

	Units	Segment ID		
1. Surface description (table 3-1)		Short Grass Prairie		
2. Manning's roughness coeff., n (table 3-1)		0.15		
3. Flow Length, L (total L < 300 ft)	ft	100		
4. Two-yr 24-hr rainfall, P_2	in	3.04		
5. Land slope, s	ft / ft	0.010		
6. $Tt = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\,s^{0.4}}$ Compute T_t	hr	0.221		0.221

Shallow Concentrated Flow

	Units	Segment ID 1	2	
7. Surface Description (paved or unpaved)		Unpaved		
8. Flow Length, L	ft	345		
9. Watercourse slope, s	ft / ft	0.026		
10. Average velocity, V (figure 3-1)	ft / s	2.59		
11. $T_c = \frac{L}{3600\,V}$ Compute T_c	hr	0.037		0.037

Channel Flow

	Units	Segment ID 1	2	
12. Cross sectional flow area, a	ft^2			
13. Wetted perimeter, P_w	ft			
14. Hydraulic radius, $r = a / P_w$ Compute r	ft			
15. Channel slope, s	ft / ft			
16. Manning's roughness coeff., n				
17. $V = \frac{1.49\,r^{2/3}\,s^{1/2}}{n}$ Compute V	ft / s	3.0		
18. Flow length, L	ft			
19. $T_t = \frac{L}{3600\,V}$ Compute T_t	hr			

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) hr 0.258
min. 15

Two-year, 24-hour rainfall was taken from Bulletin 70, Table 13
The Tc flow path for this area is drawn in ArcGIS: "E:\2014\14160\Drawings\ArcGIS\NR\Roberts Road Project_14160.mxd"
3 feet per second was used for channel flow (in storm sewers or other channels)

CURVE NUMBER CALCULATIONS

Table A.4: NIPC Field Mapping to Land Use Field

REVISED BY V3

			CURVE NUMBER							
NIPC Code	NIPC Land Use	SCS Land Use*	A	B	C	D	A/D	B/D	C/D	NULL
1110	1110 RES/SF	Single Family Residential (1/4 Acre Lots)**	61	75	83	87	74	81	85	77
1120	1120 RES/FARM	Residential (Low Density)	48	66	78	83	65.5	74.5	80.5	68.75
1130	1130 RES/MF	Multi-Family Residential (High Density)**	89	92	94	95	92	93.5	94.5	92.5
1140	1140 RES/MOBILE HM	Residential (High Density)	77	85	90	92	84.5	88.5	91	86
1211	1211 MALL	Commercial	89	92	94	95	92	93.5	94.5	92.5
1212	1212 RETAIL CNTR	Commercial	89	92	94	95	92	93.5	94.5	92.5
1221	1221 OFFICE CMPS	Commercial	89	92	94	95	92	93.5	94.5	92.5
1222	1222 SINGL OFFICE	Commercial	89	92	94	95	92	93.5	94.5	92.5
1223	1223 BUS. PARK	Commercial	89	92	94	95	92	93.5	94.5	92.5
1231	1231 URB MX W/PRKNG	Commercial	89	92	94	95	92	93.5	94.5	92.5
1232	1232 URB MX NO PRKNG	Industrial	81	88	91	93	87	90.5	92	88.25
1240	1240 CULT/ENT	Commercial	89	92	94	95	92	93.5	94.5	92.5
1250	1250 HOTEL/MOTEL	Commercial	89	92	94	95	92	93.5	94.5	92.5
1310	1310 MEDICAL	Industrial	81	88	91	93	87	90.5	92	88.25
1320	1320 EDUCATION	Industrial	81	88	91	93	87	90.5	92	88.25
1330	1330 GOVT	Commercial	89	92	94	95	92	93.5	94.5	92.5
1340	1340 PRISON	Industrial	81	88	91	93	87	90.5	92	88.25
1350	1350 RELIGOUS	Commercial	89	92	94	95	92	93.5	94.5	92.5
1360	1360 CEMETERY	Open Land – Good	39	61	74	80	59.5	70.5	77	63.5
1370	1370 INST/OTHER	Industrial	81	88	91	93	87	90.5	92	88.25
1410	1410 MINERAL EXT	Disturbed/Transitional	76	85	89	91	83.5	88	90	85.25
1420	1420 MANUF/PROC	Industrial	81	88	91	93	87	90.5	92	88.25
1430	1430 WAREH/DIST/WHOL	Industrial	81	88	91	93	87	90.5	92	88.25
1440	1440 INDUST PK	Industrial	81	88	91	93	87	90.5	92	88.25
1511	1511 INTERSTATE/TOLL	75 % Impervious/25 % Open Land	83.25	88.75	92.00	93.50	88.38	91.13	92.75	89.38
1512	1512 OTHER ROADWY	50 % Impervious / 50% Open Lands	68.50	79.50	86.00	89.00	78.75	84.25	87.50	80.75
1520	1520 OTH LINEAR TRAN	Commercial	89	92	94	95	92	93.5	94.5	92.5
1530	1530 AIR TRANSPORT	50 % Impervious / 50% Open Lands	68.50	79.50	86.00	89.00	78.75	84.25	87.50	80.75
1540	1540 INDEP AUTO PRK	Commercial	89	92	94	95	92	93.5	94.5	92.5
1550	1550 COMMUNICATION	Industrial	81	88	91	93	87	90.5	92	88.25
1560	1560 UTILITIES/WASTE	15% Impervious**	48	66	78	83	66	75	81	69
2100	2100 CROP/GRAIN/GRAZ	Agricultural	67	77	83	87	77	82	85	78.5
2200	2200 NRSRY/GRNHS/ORC	Commercial	89	92	94	95	92	93.5	94.5	92.5
2300	2300 AG/OTHER	Agricultural	67	77	83	87	77	82	85	78.5
3100	3100 OPENSP REC	Open Land – Good	39	61	74	80	59.5	70.5	77	63.5
3200	3200 GOLF COURSE	Open Land – Good	39	61	74	80	59.5	70.5	77	63.5
3300	3300 OPENSP CONS	Woods (thick cover)	30	55	70	77	54	66	74	58
3400	3400 OPENSP PRIVATE	Open Land – Good	39	61	74	80	59.5	70.5	77	63.5
3500	3500 OPENSP LINEAR	Open Land – Good	39	61	74	80	59.5	70.5	77	63.5
3600	3600 OPENSP OTHER	Open Land – Good	39	61	74	80	59.5	70.5	77	63.5
4110	4110 VAC FOR/GRASS	Open Land – Good	39	61	74	80	59.5	70.5	77	63.5
4120	4120 WETLAND	Meadow	30	58	71	78	54	68	74.5	59.25
4210	4210 CONST RES	Disturbed/Transitional	76	85	89	91	83.5	88	90	85.25
4220	4220 CONST NONRES	Disturbed/Transitional	76	85	89	91	83.5	88	90	85.25
4300	4300 OTHER VACANT	Disturbed/Transitional	76	85	89	91	83.5	88	90	85.25
5100	5100 RIVERS/CANALS	Water	100	100	100	100	100	100	100	100
5200	5200 LAKE/RES/LAGOON	Water	100	100	100	100	100	100	100	100
5300	5300 LAKE MICHIGAN	Water	100	100	100	100	100	100	100	100
9999	9999 OUT OF REGION	Water	100	100	100	100	100	100	100	100

Notes:

Original Table A.4 is from the technical memorandum entitled, "Calumet-Sag Watershed SCS Curve Number Generation", prepared by CH2M HILL on August 14, 2007.

Data entries that have been changed by V3 from the original table are highlighted in grey.

*Provides the SCS land use description or a revised description determined based on aerial photography. Revised descriptions are marked with **.

Worksheet 2: Runoff curve number and runoff   Sub-Basin: WE-1

Project: Erie/Mayo Drainage Study	By: LEH	Date: 4/6/2018
Location: Wheaton, IL	Checked:	Date:

Check one: ☑ Present ☐ Developed

1. Runoff curve number

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected impervious area ratio)	CN [1] Table 2-2	CN [1] Figure 2-3	CN [1] Figure 2-4	Area ☑ acres ☐ mi2 ☐ %	Product of CN x area	
C	1512	86			0.75	64.4226	531 B
C	1320	91			0.58	52.9984	530 C2
C/D	1110	85			0.94	80.2655	854 B
				Totals ➡	2.28	197.6865	

[1] Use only one CN source per line

CN (weighted) = total product/total area = 86.86 ; **Use CN** ➡ **87**

Worksheet 2: Runoff curve number and runoff — Sub-Basin: WE-2

Project	Erie/Mayo Drainage Study	By	LEH	Date	4/6/2018
Location	Wheaton, IL	Checked		Date	

Check one: ☑ Present ☐ Developed

1. Runoff curve number

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected impervious area ratio)	CN [1] Table 2-2	CN [1] Figure 2-3	CN [1] Figure 2-4	Area ☑ acres ☐ mi2 ☐ %	Product of CN x area	
C	1110	83			0.09	7.7439	531 B
C	1110	83			0.03	2.3323	530 C2
C/D	1110	85			2.97	252.433	854 B
				Totals →	3.09	262.5092	

[1] Use only one CN source per line

CN (weighted) = total product/total area = 84.92 ;

Use CN → **85**

Worksheet 2: Runoff curve number and runoff   Sub-Basin: WE-3

Project: Erie/Mayo Drainage Study	By: LEH	Date: 4/6/2018
Location: Wheaton, IL	Checked:	Date:

Check one: ☑ Present ☐ Developed

1. Runoff curve number

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected impervious area ratio)	CN [1] Table 2-2	CN [1] Figure 2-3	CN [1] Figure 2-4	Area ☑ acres ☐ mi2 ☐ %	Product of CN x area	
C	1110	83			0.30	24.983	531 B
C/D	1110	85			0.85	72.4965	854 B
					Totals → 1.15	97.4795	

[1] Use only one CN source per line

CN (weighted) = total product/total area = 84.48 ;   Use CN → **84**

Worksheet 2: Runoff curve number and runoff Sub-Basin: WE-4

Project	Erie/Mayo Drainage Study	By	LEH	Date	4/6/2018
Location	Wheaton, IL	Checked		Date	

Check one: ☑ Present ☐ Developed

1. Runoff curve number

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected impervious area ratio)	CN [1] Table 2-2	CN [1] Figure 2-3	CN [1] Figure 2-4	Area ☑ acres ☐ mi2 ☐ %	Product of CN x area	
C/D	1110	85			0.82	69.547	854 B
				Totals ➡	0.82	69.547	

[1] Use only one CN source per line

CN (weighted) = total product/total area = 85.00 ; Use CN ➡ **85**

Worksheet 2: Runoff curve number and runoff   Sub-Basin: WE-5

Project	Erie/Mayo Drainage Study	By	LEH	Date	4/6/2018
Location	Wheaton, IL	Checked		Date	

Check one: ☑ Present ☐ Developed

1. Runoff curve number

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected impervious area ratio)	CN [1] Table 2-2	CN [1] Figure 2-3	CN [1] Figure 2-4	Area ☑ acres ☐ mi2 ☐ %	Product of CN x area	
C	1350	94			0.02	2.0868	531 C2
C/D	1110	85			4.72	400.8175	854 B
C	1110	83			1.85	153.2512	531 B
				Totals	6.58	556.1555	

[1] Use only one CN source per line

CN (weighted) = total product/total area = 84.47 ;   **Use CN** 84

Worksheet 2: Runoff curve number and runoff   Sub-Basin: CE-1

Project	Erie/Mayo Drainage Study	By	LEH	Date	4/6/2018
Location	Wheaton, IL	Checked		Date	

Check one: ☑ Present ☐ Developed

1. Runoff curve number

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected impervious area ratio)	CN [1] Table 2-2	CN [1] Figure 2-3	CN [1] Figure 2-4	Area ☑ acres ☐ mi2 ☐ %	Product of CN x area	
C	1512	86			4.12	354.2598	531 B
C/D	1512	87.5			0.91	79.87875	232 A
C/D	1110	85			0.003	0.289	854 B
D	1320	93			1.35	125.5128	805 B
				Totals	6.39	559.94035	

[1] Use only one CN source per line

CN (weighted) = total product/total area = 87.69 ; **Use CN** 88

Worksheet 2: Runoff curve number and runoff

Sub-Basin: CE-2

Project: Erie/Mayo Drainage Study	By: LEH	Date: 4/6/2018
Location: Wheaton, IL	Checked	Date

Check one: ☑ Present ☐ Developed

1. Runoff curve number

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected impervious area ratio)	CN [1] Table 2-2	CN [1] Figure 2-3	CN [1] Figure 2-4	Area ☑ acres ☐ mi2 ☐ %	Product of CN x area	
C	1110	83			2.70	224.3739	531 B
C/D	3100	77			0.72	55.7865	232 A

[1] Use only one CN source per line

Totals ➡ 3.43 | 280.1604

CN (weighted) = total product/total area = 81.73 ; **Use CN** ➡ **82**

Worksheet 2: Runoff curve number and runoff — Sub-Basin: CE-3

Project	Erie/Mayo Drainage Study	By	LEH	Date	4/6/2018
Location	Wheaton, IL	Checked		Date	

Check one: ☑ Present ☐ Developed

1. Runoff curve number

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected impervious area ratio)	CN [1] Table 2-2	CN [1] Figure 2-3	CN [1] Figure 2-4	Area ☑ acres ☐ mi2 ☐ %	Product of CN x area	
C	1110	83			2.56	212.5879	531 B
C	1110	83			0.29	24.4352	531 C2
C/D	3100	77			0.01	1.0857	854 B
				Totals	2.87	238.1088	

[1] Use only one CN source per line

CN (weighted) = total product/total area = 82.97 ;

Use CN **83**

Worksheet 2: Runoff curve number and runoff — Sub-Basin: CE-4

Project	Erie/Mayo Drainage Study	By	LEH	Date	4/6/2018
Location	Wheaton, IL	Checked		Date	

Check one: ☑ Present ☐ Developed

1. Runoff curve number

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected impervious area ratio)	CN [1] Table 2-2	CN [1] Figure 2-3	CN [1] Figure 2-4	Area ☑ acres ☐ mi2 ☐ %	Product of CN x area	
C/D	1110	85			1.71	145.7155	854 B
C	1110	83			0.27	22.5926	531 B
C	1110	83			0.44	36.2627	531 C2
				Totals	2.42	204.5708	

[1] Use only one CN source per line

CN (weighted) = total product/total area = 84.41 ; **Use CN** 84

Worksheet 2: Runoff curve number and runoff

Sub-Basin: CE-5

Project: Erie/Mayo Drainage Study	By: LEH	Date: 4/6/2018
Location: Wheaton, IL	Checked:	Date:

Check one: ☑ Present ☐ Developed

1. Runoff curve number

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected impervious area ratio)	CN [1] Table 2-2	CN [1] Figure 2-3	CN [1] Figure 2-4	Area ☑ acres ☐ mi2 ☐ %	Product of CN x area	
C/D	1350	94.5			1.38	130.30605	854 B
C	1350	94			3.98	373.8004	531 C2
C	1350	94			1.81	170.093	531 B
				Totals	7.17	674.19945	

[1] Use only one CN source per line

CN (weighted) = total product/total area = 94.10 ;

Use CN 94

Worksheet 2: Runoff curve number and runoff   Sub-Basin: CE-6

Project: Erie/Mayo Drainage Study	By: LEH	Date: 4/6/2018
Location: Wheaton, IL	Checked:	Date:

Check one: ☑ Present ☐ Developed

1. Runoff curve number

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected impervious area ratio)	CN [1] Table 2-2	CN [1] Figure 2-3	CN [1] Figure 2-4	Area ☑ acres ☐ mi2 ☐ %	Product of CN x area	
C	1110	83			0.08	6.4574	531 B
C	1140	90			3.17	284.913	531 C2
C/D	1110	85			0.33	27.7355	854 B
[1] Use only one CN source per line		Totals ➡			3.57	319.1059	

CN (weighted) = total product/total area = 89.39 ; **Use CN** ➡ **89**

Worksheet 2: Runoff curve number and runoff — Sub-Basin: CE-7

Project	Erie/Mayo Drainage Study	By	LEH	Date	4/6/2018
Location	Wheaton, IL	Checked		Date	

Check one: ☑ Present ☐ Developed

1. Runoff curve number

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected impervious area ratio)	CN [1] Table 2-2	CN [1] Figure 2-3	CN [1] Figure 2-4	Area ☑ acres ☐ mi2 ☐ %	Product of CN x area	
C/D	1110	85			0.61	51.9775	854 B
C	1140	90			2.10	189.27	531 C2
C	3100	74			0.01	0.9176	531 B

[1] Use only one CN source per line

Totals ➡ 2.73 | 242.1651

CN (weighted) = total product/total area = 88.81 ;

Use CN ➡ **89**

Worksheet 2: Runoff curve number and runoff Sub-Basin: CE-8

Project	Erie/Mayo Drainage Study	By	LEH	Date	4/6/2018
Location	Wheaton, IL	Checked		Date	

Check one: ☑ Present ☐ Developed

1. Runoff curve number

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected impervious area ratio)	CN [1] Table 2-2	CN [1] Figure 2-3	CN [1] Figure 2-4	Area ☑ acres ☐ mi2 ☐ %	Product of CN x area	
C	3100	74			1.81	134.2434	531 C2
C	5200	100			0.68	67.54	W
C/D	1110	85			1.68	142.919	854 B
				Totals ➡	4.17	344.7024	

[1] Use only one CN source per line

CN (weighted) = total product/total area = 82.64 ; **Use CN** ➡ **83**

Worksheet 2: Runoff curve number and runoff   Sub-Basin: EE-1

Project	Erie/Mayo Drainage Study	By	LEH	Date	4/6/2018
Location	Wheaton, IL	Checked		Date	

Check one: ☑ Present ☐ Developed

1. Runoff curve number

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected impervious area ratio)	CN [1] Table 2-2	CN [1] Figure 2-3	CN [1] Figure 2-4	Area ☑ acres ☐ mi2 ☐ %	Product of CN x area
C/D	1110	85			2.16	184.008

854 B

[1] Use only one CN source per line

Totals ➡ 2.16 | 184.008

CN (weighted) = total product/total area = 85.00 ;

Use CN ➡ **85**

Worksheet 2: Runoff curve number and runoff — Sub-Basin: EE-2

854 B

Project	Erie/Mayo Drainage Study	By	LEH	Date	4/6/2018
Location	Wheaton, IL	Checked		Date	

Check one: ☑ Present ☐ Developed

1. Runoff curve number

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected impervious area ratio)	CN [1] Table 2-2	CN [1] Figure 2-3	CN [1] Figure 2-4	Area ☑ acres ☐ mi2 ☐ %	Product of CN x area
C/D	1110	85			1.88	160.0805
				Totals →	1.88	160.0805

854 B

[1] Use only one CN source per line

CN (weighted) = total product/total area = 85.00 ;

Use CN → 85

Worksheet 2: Runoff curve number and runoff   Sub-Basin: EE-3

Project	Erie/Mayo Drainage Study	By	LEH	Date	4/6/2018
Location	Wheaton, IL	Checked		Date	

Check one: ☑ Present ☐ Developed

1. Runoff curve number

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected impervious area ratio)	CN [1] Table 2-2	CN [1] Figure 2-3	CN [1] Figure 2-4	Area ☑ acres ☐ mi2 ☐ %	Product of CN x area	
C/D	1110	85			1.79	152.167	854 B

[1] Use only one CN source per line

Totals ➡ 1.79 | 152.167

CN (weighted) = total product/total area = 85.00 ;   **Use CN** ➡ **85**

Worksheet 2: Runoff curve number and runoff

Sub-Basin: EE-4

Project	Erie/Mayo Drainage Study	By	LEH	Date	4/6/2018
Location	Wheaton, IL	Checked		Date	

Check one: ☑ Present ☐ Developed

1. Runoff curve number

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected impervious area ratio)	CN [1] Table 2-2	CN [1] Figure 2-3	CN [1] Figure 2-4	Area ☑ acres ☐ mi2 ☐ %	Product of CN x area	
C/D	1110	85			0.92	78.3785	854 B
					Totals → 0.92	78.3785	

[1] Use only one CN source per line

CN (weighted) = total product/total area = 85.00 ;

Use CN → **85**

Worksheet 2: Runoff curve number and runoff Sub-Basin: EE-5

Project	Erie/Mayo Drainage Study	By	LEH	Date	4/6/2018
Location	Wheaton, IL	Checked		Date	

Check one: ☑ Present ☐ Developed

1. Runoff curve number

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected impervious area ratio)	CN [1] Table 2-2	CN [1] Figure 2-3	CN [1] Figure 2-4	Area ☑ acres ☐ mi2 ☐ %	Product of CN x area	
C/D	1110	85			3.63	308.89	854 B
				Totals	3.63	308.89	

[1] Use only one CN source per line

CN (weighted) = total product/total area = 85.00 ;

Use CN 85

Worksheet 2: Runoff curve number and runoff   Sub-Basin: EE-6

Project: Erie/Mayo Drainage Study	By: LEH	Date: 4/6/2018
Location: Wheaton, IL	Checked	Date

Check one: ☑ Present ☐ Developed

1. Runoff curve number

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected impervious area ratio)	CN [1] Table 2-2	CN [1] Figure 2-3	CN [1] Figure 2-4	Area ☑ acres ☐ mi2 ☐ %	Product of CN x area	
C/D	1110	85			3.70	314.2875	854 B
				Totals ➡	3.70	314.2875	

[1] Use only one CN source per line

CN (weighted) = total product/total area = 85.00 ;   Use CN ➡ **85**

Worksheet 2: Runoff curve number and runoff

Sub-Basin: EE-7

Project	Erie/Mayo Drainage Study	By	LEH	Date	4/6/2018
Location	Wheaton, IL	Checked		Date	

Check one: ☑ Present ☐ Developed

1. Runoff curve number

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected impervious area ratio)	CN [1] Table 2-2	CN [1] Figure 2-3	CN [1] Figure 2-4	Area ☑ acres ☐ mi2 ☐ %	Product of CN x area	
C/D	1110	85			2.70	229.347	854 B
				Totals ➡	2.70	229.347	

[1] Use only one CN source per line

CN (weighted) = total product/total area = 85.00 ;

Use CN ➡ **85**

Worksheet 2: Runoff curve number and runoff   Sub-Basin: ACE-1

Project: Erie/Mayo Drainage Study	By: LEH	Date: 4/6/2018
Location: Wheaton, IL	Checked:	Date:

Check one: ☑ Present ☐ Developed

1. Runoff curve number

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected impervious area ratio)	CN [1] Table 2-2	CN [1] Figure 2-3	CN [1] Figure 2-4	Area ☑ acres ☐ mi2 ☐ %	Product of CN x area	
C/D	1110	85			4.51	383.1205	854 B
				Totals	4.51	383.1205	

[1] Use only one CN source per line

CN (weighted) = total product/total area = 85.00 ; **Use CN** 85

Worksheet 2: Runoff curve number and runoff

Sub-Basin: ACE-2

Project: Erie/Mayo Drainage Study	By: LEH	Date: 4/6/2018
Location: Wheaton, IL	Checked:	Date:

Check one: ☑ Present ☐ Developed

1. Runoff curve number

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected impervious area ratio)	CN [1] Table 2-2	CN [1] Figure 2-3	CN [1] Figure 2-4	Area ☑ acres ☐ mi2 ☐ %	Product of CN x area	
C/D	1110	85			1.13	95.829	854 B
				Totals ➡	1.13	95.829	

[1] Use only one CN source per line

CN (weighted) = total product/total area = 85.00 ;

Use CN ➡ **85**

Worksheet 2: Runoff curve number and runoff   Sub-Basin: ACE-3

Project: Erie/Mayo Drainage Study	By: LEH	Date: 4/6/2018
Location: Wheaton, IL	Checked	Date

Check one: ☑ Present ☐ Developed

1. Runoff curve number

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected impervious area ratio)	CN [1] Table 2-2	CN [1] Figure 2-3	CN [1] Figure 2-4	Area ☑ acres ☐ mi2 ☐ %	Product of CN x area	
C/D	1140	91			5.26	478.3233	854 B
[1] Use only one CN source per line		Totals			5.26	478.3233	

CN (weighted) = total product/total area = 91.00 ;

Use CN 91

Worksheet 2: Runoff curve number and runoff — Sub-Basin: ACE-4

Project	Erie/Mayo Drainage Study	By	LEH	Date	4/6/2018
Location	Wheaton, IL	Checked		Date	

Check one: ☑ Present ☐ Developed

1. Runoff curve number

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected impervious area ratio)	CN [1] Table 2-2	CN [1] Figure 2-3	CN [1] Figure 2-4	Area ☑ acres ☐ mi2 ☐ %	Product of CN x area	
C	1130	94			1.04	98.1172	531 B
B/D	3100	70.5			0.20	13.8744	3107 A
				Totals	1.24	111.9916	

[1] Use only one CN source per line

CN (weighted) = total product/total area = 90.27 ;

Use CN → **90**

Worksheet 2: Runoff curve number and runoff

Sub-Basin: ACE-5

Project: Erie/Mayo Drainage Study	By: LEH	Date: 4/6/2018
Location: Wheaton, IL	Checked:	Date:

Check one: ☑ Present ☐ Developed

1. Runoff curve number

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected impervious area ratio)	CN [1] Table 2-2	CN [1] Figure 2-3	CN [1] Figure 2-4	Area ☑ acres ☐ mi2 ☐ %	Product of CN x area	
C	1130	94			1.93	181.1756	531 B
B/D	1130	93.5			0.26	23.92665	3107 A
C/D	1130	94.5			0.06	5.292	854 B
				Totals	2.24	210.39425	

[1] Use only one CN source per line

CN (weighted) = total product/total area = 93.96 ;

Use CN **94**

Worksheet 2: Runoff curve number and runoff   Sub-Basin: ACE-6

Project: Erie/Mayo Drainage Study	By: LEH	Date: 4/6/2018
Location: Wheaton, IL	Checked:	Date:

Check one: ☑ Present ☐ Developed

1. Runoff curve number

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected impervious area ratio)	CN [1] Table 2-2	CN [1] Figure 2-3	CN [1] Figure 2-4	Area ☑ acres ☐ mi2 ☐ %	Product of CN x area	
C/D	1130	94.5			0.08	7.09695	854 B
C	1130	94			1.18	111.108	531 B
[1] Use only one CN source per line			**Totals** ➡		1.26	118.20495	

CN (weighted) = total product/total area = 94.03 ;   **Use CN** ➡ **94**

Worksheet 2: Runoff curve number and runoff

Sub-Basin: ACE-7

Project	Erie/Mayo Drainage Study	By	LEH	Date	4/6/2018
Location	Wheaton, IL	Checked		Date	

Check one: ☑ Present ☐ Developed

1. Runoff curve number

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected impervious area ratio)	CN [1] Table 2-2	CN [1] Figure 2-3	CN [1] Figure 2-4	Area ☑ acres ☐ mi2 ☐ %	Product of CN x area	
C/D	1110	85			1.26	107.049	854 B
B/D	1110	81			0.64	52.0992	3107 A
				Totals	1.90	159.1482	

[1] Use only one CN source per line

CN (weighted) = total product/total area = 83.65 ;

Use CN 84

Worksheet 2: Runoff curve number and runoff

Sub-Basin: ACE-8

Project	Erie/Mayo Drainage Study	By	LEH	Date	4/6/2018
Location	Wheaton, IL	Checked		Date	

Check one: ☑ Present ☐ Developed

1. Runoff curve number

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected impervious area ratio)	CN [1] Table 2-2	CN [1] Figure 2-3	CN [1] Figure 2-4	Area ☑ acres ☐ mi2 ☐ %	Product of CN x area	
C/D	1110	85			0.02	1.6235	854 B
C	1110	83			0.15	12.4417	531 B
B/D	1130	93.5			0.89	83.1402	3107 A
				Totals ➡	1.06	97.2054	

[1] Use only one CN source per line

CN (weighted) = total product/total area = 91.86 ;

Use CN ➡ **92**

Worksheet 2: Runoff curve number and runoff   Sub-Basin: AEE-1

Project	Erie/Mayo Drainage Study	By	LEH	Date	4/6/2018
Location	Wheaton, IL	Checked		Date	

Check one: ☑ Present ☐ Developed

1. Runoff curve number

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected impervious area ratio)	CN [1] Table 2-2	CN [1] Figure 2-3	CN [1] Figure 2-4	Area ☑ acres ☐ mi2 ☐ %	Product of CN x area	
C/D	1110	85			4.96	421.6935	854 B

[1] Use only one CN source per line

Totals ➡ 4.96 | 421.6935

CN (weighted) = total product/total area = 85.00 ;

Use CN ➡ **85**

Worksheet 2: Runoff curve number and runoff

Sub-Basin: AEE-2

Project	Erie/Mayo Drainage Study	By	LEH	Date	4/6/2018
Location	Wheaton, IL	Checked		Date	

Check one: ☑ Present ☐ Developed

1. Runoff curve number

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected impervious area ratio)	CN [1] Table 2-2	CN [1] Figure 2-3	CN [1] Figure 2-4	Area ☑ acres ☐ mi2 ☐ %	Product of CN x area	
C/D	1110	85			5.44	462.213	854 B
B/D	1110	81			0.14	11.1375	3107 A
				Totals ➡	5.58	473.3505	

[1] Use only one CN source per line

CN (weighted) = total product/total area = 84.90 ; **Use CN** ➡ **85**

Worksheet 2: Runoff curve number and runoff   Sub-Basin: MA-1

Project: Erie/Mayo Drainage Study	By: LEH	Date: 4/6/2018
Location: Wheaton, IL	Checked:	Date:

Check one: ☑ Present ☐ Developed

1. Runoff curve number

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected impervious area ratio)	CN [1] Table 2-2	CN [1] Figure 2-3	CN [1] Figure 2-4	Area ☑ acres ☐ mi2 ☐ %	Product of CN x area	
C/D	1110	85			3.23	274.839	146 A
C	1110	83			8.01	665.2118	531 B
C/D	1110	85			0.21	18.02	854 B
				Totals	11.46	958.0708	

[1] Use only one CN source per line

CN (weighted) = total product/total area = 83.60 ;   **Use CN** 84

Worksheet 2: Runoff curve number and runoff — Sub-Basin: MA-2

Project	Erie/Mayo Drainage Study	By	LEH	Date	4/6/2018
Location	Wheaton, IL	Checked		Date	

Check one: ☑ Present ☐ Developed

1. Runoff curve number

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected impervious area ratio)	CN [1] Table 2-2	CN [1] Figure 2-3	CN [1] Figure 2-4	Area ☑ acres ☐ mi2 ☐ %	Product of CN x area	
C	1110	83			1.87	155.1187	531 B
D	1130	95			11.30	1073.7945	805 B
C	5200	100			0.22	21.99	W
				Totals	13.39	1250.9032	

[1] Use only one CN source per line

CN (weighted) = total product/total area = 93.41 ; **Use CN** 93

Worksheet 2: Runoff curve number and runoff   Sub-Basin: MA-3

Project	Erie/Mayo Drainage Study	By	LEH	Date	4/6/2018
Location	Wheaton, IL	Checked		Date	

Check one: ☑ Present ☐ Developed

1. Runoff curve number

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected impervious area ratio)	CN [1] Table 2-2	CN [1] Figure 2-3	CN [1] Figure 2-4	Area ☑ acres ☐ mi2 ☐ %	Product of CN x area	
C	1110	83			0.86	71.5958	531 B
D	1110	87			1.04	90.5757	805 B
C/D	1110	85			6.56	557.5405	854 B
				Totals ➡	8.46	719.712	

[1] Use only one CN source per line

CN (weighted) = total product/total area = 85.04 ;

Use CN ➡ **85**

Worksheet 2: Runoff curve number and runoff   Sub-Basin: MA-4

Project: Erie/Mayo Drainage Study	By: LEH	Date: 4/6/2018
Location: Wheaton, IL	Checked	Date

Check one: ☑ Present ☐ Developed

1. Runoff curve number

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected impervious area ratio)	CN [1] Table 2-2	CN [1] Figure 2-3	CN [1] Figure 2-4	Area ☑ acres ☐ mi2 ☐ %	Product of CN x area	
C	1110	83			0.49	40.8692	531 B
C	3100	74			0.03	2.2496	531 C2
C/D	1110	85			1.47	124.9245	854 B
				Totals ➡	1.99	168.0433	

[1] Use only one CN source per line

CN (weighted) = total product/total area = 84.34 ; **Use CN** ➡ **84**

Worksheet 2: Runoff curve number and runoff

Sub-Basin: MA-5

Project	Erie/Mayo Drainage Study	By	LEH	Date	4/6/2018
Location	Wheaton, IL	Checked		Date	

Check one: ☑ Present ☐ Developed

1. Runoff curve number

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected impervious area ratio)	CN [1] Table 2-2	CN [1] Figure 2-3	CN [1] Figure 2-4	Area ☑ acres ☐ mi2 ☐ %	Product of CN x area	
C/D	1110	85			6.08	516.7235	854 B
					Totals → 6.08	516.7235	

[1] Use only one CN source per line

CN (weighted) = total product/total area = 85.00 ;

Use CN → **85**

Worksheet 2: Runoff curve number and runoff   Sub-Basin: MA-6

Project	Erie/Mayo Drainage Study	By	LEH	Date	4/6/2018
Location	Wheaton, IL	Checked		Date	

Check one: ☑ Present ☐ Developed

1. Runoff curve number

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected impervious area ratio)	CN [1] Table 2-2	CN [1] Figure 2-3	CN [1] Figure 2-4	Area ☑ acres ☐ mi2 ☐ %	Product of CN x area	
C/D	1110	85			2.17	184.3395	854 B

[1] Use only one CN source per line

Totals → 2.17 | 184.3395

CN (weighted) = total product/total area = 85.00 ; **Use CN** → **85**

Worksheet 2: Runoff curve number and runoff   Sub-Basin: MA-7

Project: Erie/Mayo Drainage Study	By: LEH	Date: 4/6/2018
Location: Wheaton, IL	Checked:	Date:

Check one: ☑ Present ☐ Developed

1. Runoff curve number

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected impervious area ratio)	CN [1] Table 2-2	CN [1] Figure 2-3	CN [1] Figure 2-4	Area ☑ acres ☐ mi2 ☐ %	Product of CN x area	
C	1110	83			1.24	103.1441	531 C2
D	1320	93			0.62	57.5298	805 B
C/D	1320	92			0.62	57.3988	854 B
C	1110	83			0.07	5.4531	531 B
			Totals ➡		2.55	223.5258	

[1] Use only one CN source per line

CN (weighted) = total product/total area = 87.63 ; **Use CN** ➡ **88**

Worksheet 2: Runoff curve number and runoff Sub-Basin: MA-8

Project	Erie/Mayo Drainage Study	By	LEH	Date	4/6/2018
Location	Wheaton, IL	Checked		Date	

Check one: ☑ Present ☐ Developed

1. Runoff curve number

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected impervious area ratio)	CN [1] Table 2-2	CN [1] Figure 2-3	CN [1] Figure 2-4	Area ☑ acres ☐ mi2 ☐ %	Product of CN x area	
C	1110	83			0.02	2.0003	531 C2
C/D	1110	85			0.66	56.287	854 B
				Totals	0.69	58.2873	

[1] Use only one CN source per line

CN (weighted) = total product/total area = 84.93 ;

Use CN **85**

Worksheet 2: Runoff curve number and runoff — Sub-Basin: MA-9

Project: Erie/Mayo Drainage Study	By: LEH	Date: 4/6/2018
Location: Wheaton, IL	Checked:	Date:

Check one: ☑ Present ☐ Developed

1. Runoff curve number

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected impervious area ratio)	CN [1] Table 2-2	CN [1] Figure 2-3	CN [1] Figure 2-4	Area ☑ acres ☐ mi2 ☐ %	Product of CN x area	
C/D	1110	85			2.93	248.7015	854 B
				Totals	2.93	248.7015	

[1] Use only one CN source per line

CN (weighted) = total product/total area = 85.00 ;

Use CN → 85

Worksheet 2: Runoff curve number and runoff   Sub-Basin: MA-10

Project: Erie/Mayo Drainage Study	By: LEH	Date: 4/6/2018
Location: Wheaton, IL	Checked	Date

Check one: ☑ Present ☐ Developed

1. Runoff curve number

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected impervious area ratio)	CN [1]			Area ☑ acres ☐ mi2 ☐ %	Product of CN x area
		Table 2-2	Figure 2-3	Figure 2-4		
C/D	1110	85			1.76	149.9145
					Totals ➡ 1.76	149.9145

854 B

[1] Use only one CN source per line

CN (weighted) = total product/total area = 85.00 ;

Use CN ➡ **85**

Worksheet 2: Runoff curve number and runoff — Sub-Basin: MA-11

Project: Erie/Mayo Drainage Study	By: LEH	Date: 4/6/2018
Location: Wheaton, IL	Checked	Date

Check one: ☑ Present ☐ Developed

1. Runoff curve number

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected impervious area ratio)	CN [1] Table 2-2	CN [1] Figure 2-3	CN [1] Figure 2-4	Area ☑ acres ☐ mi2 ☐ %	Product of CN x area	
D	1130	95			0.08	7.429	805 B
C/D	1110	85			2.05	173.9525	854 B
B/D	1110	81			0.61	49.491	3107 A
				Totals	2.74	230.8725	

[1] Use only one CN source per line

CN (weighted) = total product/total area = 84.39 ;

Use CN 84

Worksheet 2: Runoff curve number and runoff — Sub-Basin: AMA-1

Project	Erie/Mayo Drainage Study	By	LEH	Date	4/6/2018
Location	Wheaton, IL	Checked		Date	

Check one: ☑ Present ☐ Developed

1. Runoff curve number

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected impervious area ratio)	CN [1] Table 2-2	CN [1] Figure 2-3	CN [1] Figure 2-4	Area ☑ acres ☐ mi2 ☐ %	Product of CN x area	
C/D	1110	85			0.10	8.296	146A
C	1110	83			3.25	270.0073	531 B
C	1110	83			6.37	528.5772	531 C2
					Totals → 9.72	806.8805	

[1] Use only one CN source per line

CN (weighted) = total product/total area = 83.02 ; **Use CN** → **83**

STAGE STORAGE CALCULATIONS

Existing Stage-Storage Volume

PROJECT: **Erie/Mayo Flood Prone Area Study**
V3 FILE NO.: 17324
DATE: 04/10/18
PREPARED BY: JWW

Location: Storage in Backyards Between Beverly Ave and Erie St
XP-SWMM Node ID: HWE_3

ELEVATION	AREA (acres)	AVERAGE AREA (acres)	STAGE VOLUME (acre-feet)	CUMULATIVE VOLUME (acre-feet)	COMMENT
733.00	0.001			0.000	*Sewer Invert Elevation*
		0.002	0.005		
736.44	0.002			0.005	*Surveyed Elevation*
		0.031	0.017		
737.0	0.060			0.023	*Contour from Survey Data*
		0.114	0.114		
738.0	0.167			0.136	*2-ft Contour*
		0.386	0.772		
740.0	0.605			0.908	*2-ft Contour*
		0.941	1.882		
742.0	1.277			2.790	*2-ft Contour*
		1.593	3.186		
744.0	1.909			5.976	*2-ft Contour*

Existing Stage-Storage Volume

PROJECT: **Erie/Mayo Flood Prone Area Study**
V3 FILE NO.: 17324
DATE: 04/10/18
PREPARED BY: JWW

Location: Roadway Storage on Erie St
XP-SWMM Node ID: HWE_5

ELEVATION	AREA (acres)	AVERAGE AREA (acres)	STAGE VOLUME (acre-feet)	CUMULATIVE VOLUME (acre-feet)	COMMENT
734.11				0.000	*Sewer Invert Elevation*
		0.000	0.000		
737.31				0.000	*Surveyed Elevation*
		0.054	0.037		
738.0	0.107			0.037	*2-ft Contour*
		0.544	1.088		
740.0	0.981			1.125	*2-ft Contour*
		1.323	2.646		
742.0	1.665			3.771	*2-ft Contour*
		2.117	4.234		
744.0	2.569			8.005	*2-ft Contour*

Existing Stage-Storage Volume

PROJECT: **Erie/Mayo Flood Prone Area Study**
V3 FILE NO.: 17324
DATE: 04/10/18
PREPARED BY: JWW

Location: Backyard Storage Behind Homes East of Erie St
XP-SWMM Node ID: HWE_5A

ELEVATION	AREA (acres)	AVERAGE AREA (acres)	STAGE VOLUME (acre-feet)	CUMULATIVE VOLUME (acre-feet)	COMMENT
734.30				0.000	*Sewer Invert Elevation*
		0.000	0.000		
736.27				0.000	*Surveyed Elevation*
		0.001	0.002		
738.0	0.002			0.002	*2-ft Contour*
		0.068	0.068		
739.0	0.134			0.070	*Contour from Survey Data*
		0.205	0.205		
740.0	0.275			0.274	*2-ft Contour*
		0.535	1.069		
742.0	0.794			1.343	*2-ft Contour*
		0.998	1.995		
744.0	1.201			3.338	*2-ft Contour*

Existing Stage-Storage Volume

PROJECT: **Erie/Mayo Flood Prone Area Study**
V3 FILE NO.: 17324
DATE: 04/10/18
PREPARED BY: JWW

Location: Storage South of Manchester Rd, West of White Oak Dr
XP-SWMM Node ID: HCE_2

ELEVATION	AREA (acres)	AVERAGE AREA (acres)	STAGE VOLUME (acre-feet)	CUMULATIVE VOLUME (acre-feet)	COMMENT
745.00	0.001			0.000	*Assumed Storage Bottom Elevation*
		0.125	0.125		
746.00	0.249			0.125	*2-ft Contour*
		0.495	0.990		
748.0	0.741			1.115	*2-ft Contour*
		1.151	2.301		
750.0	1.560			3.416	*2-ft Contour*

Existing Stage-Storage Volume

PROJECT: **Erie/Mayo Flood Prone Area Study**
V3 FILE NO.: 17324
DATE: 04/10/18
PREPARED BY: JWW

Location: Vineyard Church of DuPage Basin
XP-SWMM Node ID: HCE_5

ELEVATION	AREA (acres)	AVERAGE AREA (acres)	STAGE VOLUME (acre-feet)	CUMULATIVE VOLUME (acre-feet)	COMMENT
728.36	0.001			0.000	*Sewer Invert Elevation*
		0.002	0.005		
731.80	0.002			0.005	*Assumed Storage Bottom Elevation*
		0.188	0.038		
732.0	0.374			0.043	*2-ft Contour*
		0.511	1.021		
734.0	0.647			1.064	*2-ft Contour*
		0.764	1.528		
736.0	0.881			2.592	*2-ft Contour*
		1.119	2.238		
738.0	1.357			4.830	*2-ft Contour*
		1.743	3.485		
740.0	2.128			8.315	*2-ft Contour*
		2.962	5.924		
742.0	3.796			14.239	*2-ft Contour*
		4.706	9.411		
744.0	5.615			23.650	*2-ft Contour*
		6.374	12.747		
746.0	7.132			36.397	*2-ft Contour*

Existing Stage-Storage Volume

PROJECT: **Erie/Mayo Flood Prone Area Study**
V3 FILE NO.: 17324
DATE: 04/10/18
PREPARED BY: JWW

Location: Storage in Backyards Between White Oak Dr and Pierce Ave
XP-SWMM Node ID: HCE_4

ELEVATION	AREA (acres)	AVERAGE AREA (acres)	STAGE VOLUME (acre-feet)	CUMULATIVE VOLUME (acre-feet)	COMMENT
737.00	0.001			0.000	*Sewer Invert Elevation*
		0.002	0.006		
740.68	0.002			0.006	*Surveyed Elevation*
		0.003	0.001		
741.0	0.004			0.006	*Contour from Survey Data*
		0.034	0.034		
742.0	0.063			0.040	*2-ft Contour*
		0.234	0.467		
744.0	0.404			0.507	*2-ft Contour*
		0.678	1.356		
746.0	0.952			1.863	*2-ft Contour*
		0.476	0.952		
748.0				2.815	*2-ft Contour*

Existing Stage-Storage Volume

PROJECT: **Erie/Mayo Flood Prone Area Study**
V3 FILE NO.: 17324
DATE: 04/10/18
PREPARED BY: JWW

Location: Retention Basin South of White Oak Dr Cul-De-Sac
XP-SWMM Node ID: HCE_8

ELEVATION	AREA (acres)	AVERAGE AREA (acres)	STAGE VOLUME (acre-feet)	CUMULATIVE VOLUME (acre-feet)	COMMENT
737.40	0.944			0.000	*Surveyed NWL in Retention Basin*
		0.944	0.566		
738.00	0.944			0.566	*2-ft Contour*
		1.098	2.196		
740.00	1.252			2.762	*2-ft Contour*
		1.828	3.655		
742.0	2.403			6.417	*2-ft Contour*
		3.237	6.474		
744.0	4.071			12.891	*2-ft Contour*
		4.493	8.986		
746.0	4.915			21.877	*2-ft Contour*

Existing Stage-Storage Volume

PROJECT: **Erie/Mayo Flood Prone Area Study**
V3 FILE NO.: 17324
DATE: 04/10/18
PREPARED BY: JWW

Location: Storage in Backyards Between Pierce Ave and Morgan Ave
XP-SWMM Node ID: HEE_5

ELEVATION	AREA (acres)	AVERAGE AREA (acres)	STAGE VOLUME (acre-feet)	CUMULATIVE VOLUME (acre-feet)	COMMENT
734.08	0.001			0.000	*Sewer Invert Elevation*
		0.002	0.004		
737.03	0.002			0.004	*Surveyed Elevation*
		0.040	0.039		
738.00	0.078			0.043	*2-ft Contour*
		0.173	0.346		
740.00	0.268			0.389	*2-ft Contour*
		0.556	1.112		
742.00	0.844			1.501	*2-ft Contour*
		1.521	3.042		
744.0	2.198			4.543	*2-ft Contour*
		3.123	6.245		
746.0	4.047			10.788	*2-ft Contour*
		2.024	4.047		
748.0				14.835	*2-ft Contour*

Existing Stage-Storage Volume

PROJECT: **Erie/Mayo Flood Prone Area Study**
V3 FILE NO.: 17324
DATE: 04/10/18
PREPARED BY: JWW

Location: Westhaven Park Basin
XP-SWMM Node ID: HMA_1

ELEVATION	AREA (acres)	AVERAGE AREA (acres)	STAGE VOLUME (acre-feet)	CUMULATIVE VOLUME (acre-feet)	COMMENT
744.00	0.251			0.000	*2-ft Contour*
		0.327	0.654		
746.00	0.403			0.654	*2-ft Contour*
		0.654	1.308		
748.0	0.905			1.962	*2-ft Contour*
		1.235	2.469		
750.0	1.564			4.431	*2-ft Contour*

Existing Stage-Storage Volume

PROJECT: **Erie/Mayo Flood Prone Area Study**
V3 FILE NO.: 17324
DATE: 04/10/18
PREPARED BY: JWW

Location: Dartmouth Drive Basin
XP-SWMM Node ID: HMA_2

ELEVATION	AREA (acres)	AVERAGE AREA (acres)	STAGE VOLUME (acre-feet)	CUMULATIVE VOLUME (acre-feet)	COMMENT
740.00	0.229			0.000	*2-ft Contour*
		0.263	0.525		
742.00	0.296			0.525	*2-ft Contour*
		0.338	0.676		
744.0	0.380			1.201	*2-ft Contour*
		0.433	0.865		
746.0	0.485			2.066	*2-ft Contour*
		0.612	1.224		
748.0	0.739			3.290	*2-ft Contour*
		1.650	3.299		
750.0	2.560			6.589	*2-ft Contour*

Existing Stage-Storage Volume

PROJECT: **Erie/Mayo Flood Prone Area Study**
V3 FILE NO.: 17324
DATE: 04/10/18
PREPARED BY: JWW

Location: Roadway Storage on Paula Ave
XP-SWMM Node ID: HMA_3

ELEVATION	AREA (acres)	AVERAGE AREA (acres)	STAGE VOLUME (acre-feet)	CUMULATIVE VOLUME (acre-feet)	COMMENT
728.16	0.001			0.000	*Sewer Invert Elevation*
		0.002	0.013		
736.99	0.002			0.013	
		0.020	0.000		
737.0	0.037			0.013	*Contour from Survey Data*
		0.098	0.098		
738.0	0.159			0.111	*2-ft Contour*
		0.371	0.742		
740.0	0.583			0.853	*2-ft Contour*
		0.959	1.917		
742.0	1.334			2.770	*2-ft Contour*
		2.212	4.423		
744.0	3.09			7.193	*2-ft Contour*

Existing Stage-Storage Volume

PROJECT: **Erie/Mayo Flood Prone Area Study**
V3 FILE NO.: 17324
DATE: 04/10/18
PREPARED BY: JWW

Location: Roadway Storage on Center Ave
XP-SWMM Node ID: HMA_5

ELEVATION	AREA (acres)	AVERAGE AREA (acres)	STAGE VOLUME (acre-feet)	CUMULATIVE VOLUME (acre-feet)	COMMENT
723.48	0.001			0.000	*Sewer Invert Elevation*
		0.002	0.007		
727.99	0.002			0.007	
		0.020	0.000		
728.0	0.038			0.007	*2-ft Contour*
		0.329	0.658		
730.0	0.620			0.665	*2-ft Contour*
		0.836	1.671		
732.0	1.051			2.336	*2-ft Contour*
		1.307	2.613		
734.0	1.562			4.949	*2-ft Contour*
					2-ft Contour

Existing Stage-Storage Volume

PROJECT: **Erie/Mayo Flood Prone Area Study**
V3 FILE NO.: 17324
DATE: 04/10/18
PREPARED BY: JWW

Location: Storage in Backyards Between Center Ave and Mayo Ave
XP-SWMM Node ID: HMA_9

ELEVATION	AREA (acres)	AVERAGE AREA (acres)	STAGE VOLUME (acre-feet)	CUMULATIVE VOLUME (acre-feet)	COMMENT
725.80	0.001			0.000	*Surveyed Elevation*
		0.220	0.044		
726.00	0.439			0.044	*2-ft Contour*
		0.929	1.858		
728.0	1.419			1.902	*2-ft Contour*
		1.725	3.449		
730.0	2.030			5.351	*2-ft Contour*
732.0	2.322				*2-ft Contour*

Existing Stage-Storage Volume

PROJECT: **Erie/Mayo Flood Prone Area Study**
V3 FILE NO.: 17324
DATE: 04/10/18
PREPARED BY: JWW

Location: Roadway Storage on Mayo Ave
XP-SWMM Node ID: HMA_11

ELEVATION	AREA (acres)	AVERAGE AREA (acres)	STAGE VOLUME (acre-feet)	CUMULATIVE VOLUME (acre-feet)	COMMENT
721.29	0.001			0.000	*Sewer Invert Elevation*
		0.002	0.007		
725.99	0.002			0.007	
		0.238	0.002		
726.00	0.473			0.009	*2-ft Contour*
		1.313	2.626		
728.00	2.153			2.635	*2-ft Contour*
		2.558	5.116		
730.0	2.963			7.751	*2-ft Contour*
		3.559	7.118		
732.0	4.155			14.869	*2-ft Contour*

Existing Stage-Storage Volume

PROJECT: **Erie/Mayo Flood Prone Area Study**
V3 FILE NO.: 17324
DATE: 04/10/18
PREPARED BY: JWW

Location: Madison Park Basin
XP-SWMM Node ID: HAMA_1

ELEVATION	AREA (acres)	AVERAGE AREA (acres)	STAGE VOLUME (acre-feet)	CUMULATIVE VOLUME (acre-feet)	COMMENT
732.00	0.248			0.000	*2-ft Contour*
		0.298	0.596		
734.00	0.348			0.596	*2-ft Contour*
		0.390	0.780		
736.0	0.432			1.376	*2-ft Contour*
		0.547	1.094		
738.0	0.662			2.470	*2-ft Contour*
		0.872	1.743		
740.0	1.081			4.213	*2-ft Contour*

Proposed Storage Summary Table

Alternative	ID	Ex Storage (ac-ft)	Pr Storage (ac-ft)	at Elevation	New Volume (ac-ft)	NWL	HWL
ALT 2	HWE_3	0.91	6.39	744	5.49	736.5	738.68
ALT 1	HCE_5	4.83	5.82	742	0.99	730	738.94
ALT 2	HCE_5	4.83	17.83	742	13.00	730	739.15
ALT 2	HEE_5	10.79	11.55	746	0.76	738	742.03
ALT 2	HMA_3	0.85	8.59	744	1.37	728.16	737.2
ALT 2	HMA_9	5.35	12.74	732	7.39	721	726.53
ALT 2	HMA_1	4.43	5.12	750	0.69	740	745.17
ALT 2	HAMA_1	4.21	4.63	740	0.42	730	735.08

Proposed Stage-Storage Volume

PROJECT: **Erie/Mayo Flood Prone Area Study**
V3 FILE NO.: 17324
DATE: 07/02/18
PREPARED BY: JWW

Location: Storage in Backyards Between Beverly Ave and Erie St
XP-SWMM Node ID: HWE_3 ALT 2

ELEVATION	AREA (acres)	AVERAGE AREA (acres)	STAGE VOLUME (acre-feet)	CUMULATIVE VOLUME (acre-feet)	COMMENT
733.00	0.001			0.000	*Sewer Invert Elevation*
		0.002	0.005		
736.44	0.002			0.005	*Surveyed Elevation*
		0.086	0.005		
736.5	0.170			0.010	*Pr Contour*
		0.200	0.100		
737.0	0.230			0.110	*Pr Contour*
		0.280	0.280		
738.0	0.330			0.390	*Pr Contour*
		0.468	0.935		
740.0	0.605			1.325	*Pr Contour*
		0.941	1.882		
742.0	1.277			3.207	*Pr Contour*
		1.593	3.186		
744.0	1.909			6.393	*Pr Contour*

Proposed Stage-Storage Volume

PROJECT: **Erie/Mayo Flood Prone Area Study**
V3 FILE NO.: 17324
DATE: 07/02/18
PREPARED BY: JWW

Location: Vineyard Church of DuPage Basin
XP-SWMM Node ID: HCE_5 ALT 1

ELEVATION	AREA (acres)	AVERAGE AREA (acres)	STAGE VOLUME (acre-feet)	CUMULATIVE VOLUME (acre-feet)	COMMENT
728.36	0.001			0.000	*Sewer Invert Elevation*
		0.002	0.002		
729.99	0.002			0.002	
		0.266	0.003		
730.0	0.529			0.005	*Pr Contour*
		0.687	1.374		
732.0	0.845			1.379	*Pr Contour*
		0.988	1.975		
734.0	1.130			3.354	*Pr Contour*
		1.235	2.470		
736.0	1.340			5.824	*Pr Contour*
		1.550	3.100		
738.0	1.76			8.924	*Pr Contour*
		2.080	4.160		
740.0	2.400			13.084	*Pr Contour*
		3.098	6.196		
742.0	3.796			19.280	*Pr Contour*

Proposed Stage-Storage Volume

PROJECT: **Erie/Mayo Flood Prone Area Study**
V3 FILE NO.: 17324
DATE: 07/02/18
PREPARED BY: JWW

Location: Vineyard Church of DuPage Basin
XP-SWMM Node ID: HCE_5 ALT 2

ELEVATION	AREA (acres)	AVERAGE AREA (acres)	STAGE VOLUME (acre-feet)	CUMULATIVE VOLUME (acre-feet)	COMMENT
728.36	0.001			0.000	*Sewer Invert Elevation*
		0.002	0.002		
729.99	0.002			0.002	
		0.266	0.003		
730.0	0.529			0.005	*Pr Contour*
		0.606	1.211		
732.00	0.682			1.216	*Pr Contour*
		0.825	1.649		
734.00	0.967			2.865	*Pr Contour*
		1.081	2.162		
736.0	1.195			5.027	*Pr Contour*
		1.421	2.841		
738.0	1.646			7.868	*Pr Contour*
		1.954	3.907		
740.0	2.261			11.775	*Pr Contour*
		3.029	6.057		
742.0	3.796			17.832	*Pr Contour*
		4.706	9.411		
744.0	5.615			27.243	*Pr Contour*
		6.374	12.747		
746.0	7.132			39.990	*Pr Contour*

Proposed Stage-Storage Volume

PROJECT: **Erie/Mayo Flood Prone Area Study**
V3 FILE NO.: 17324
DATE: 07/02/18
PREPARED BY: JWW

Location: Storage in Backyards Between Pierce Ave and Morgan Ave
XP-SWMM Node ID: HEE_5 ALT 2

ELEVATION	AREA (acres)	AVERAGE AREA (acres)	STAGE VOLUME (acre-feet)	CUMULATIVE VOLUME (acre-feet)	COMMENT
738.00	0.401			0.000	*Pr Contour*
		0.469	0.937		
740.0	0.536			0.937	*Pr Contour*
		0.741	1.481		
742.0	0.945			2.418	*Pr Contour*
		1.610	3.219		
744.0	2.274			5.637	*Pr Contour*
		2.956	5.912		
746.0	3.638			11.549	*Pr Contour*

Proposed Stage-Storage Volume

PROJECT: **Erie/Mayo Flood Prone Area Study**
V3 FILE NO.: 17324
DATE: 07/02/18
PREPARED BY: JWW

Location: Roadway Storage on Paula Ave
XP-SWMM Node ID: HMA_3 ALT 2

ELEVATION	AREA (acres)	AVERAGE AREA (acres)	STAGE VOLUME (acre-feet)	CUMULATIVE VOLUME (acre-feet)	COMMENT
728.16	0.200			0.000	*Bottom of Underground Detention*
		0.200	1.368		
735.00	0.200			1.368	*Top of Underground Detention*
		0.101	0.010		
735.1	0.001			1.378	
		0.021	0.039		
737.0	0.040			1.417	*Contour from Survey Data*
		0.100	0.100		
738.0	0.160			1.517	*2-ft Contour*
		0.370	0.740		
740.0	0.580			2.257	*2-ft Contour*
		0.955	1.910		
742.0	1.330			4.167	*2-ft Contour*
		2.210	4.420		
744.0	3.090			8.587	*2-ft Contour*

Proposed Stage-Storage Volume

PROJECT: **Erie/Mayo Flood Prone Area Study**
V3 FILE NO.: 17324
DATE: 07/02/18
PREPARED BY: JWW

Location: Storage in Backyards Between Center Ave and Mayo Ave
XP-SWMM Node ID: HMA_9 ALT 2

ELEVATION	AREA (acres)	AVERAGE AREA (acres)	STAGE VOLUME (acre-feet)	CUMULATIVE VOLUME (acre-feet)	COMMENT
721.00	0.360			0.000	*Pr Contour*
		0.400	0.400		
722.00	0.440			0.400	*Pr Contour*
		0.480	0.480		
723.0	0.520			0.880	*Pr Contour*
		0.565	0.565		
724.0	0.610			1.445	*Pr Contour*
		0.655	0.655		
725.0	0.700			2.100	*Pr Contour*
		0.750	0.750		
726.0	0.800			2.850	*Pr Contour*
		0.845	0.592		
726.7	0.890			3.442	*Pr Contour*
		1.155	1.501		
728.0	1.420			4.943	*Pr Contour*
		1.725	3.450		
730.0	2.030			8.393	*Pr Contour*
		2.175	4.350		
732.0	2.320			12.743	*Pr Contour*

Proposed Stage-Storage Volume

PROJECT: **Erie/Mayo Flood Prone Area Study**
V3 FILE NO.: 17324
DATE: 07/02/18
PREPARED BY: JWW

Location: Westhaven Park Basin
XP-SWMM Node ID: HMA_1 ALT 2

ELEVATION	AREA (acres)	AVERAGE AREA (acres)	STAGE VOLUME (acre-feet)	CUMULATIVE VOLUME (acre-feet)	COMMENT
740.00	0.100			0.000	*Pr Contour*
		0.135	0.270		
742.00	0.170			0.270	*Pr Contour*
		0.211	0.421		
744.0	0.251			0.691	*Pr Contour*
		0.327	0.654		
746.0	0.403			1.345	*Pr Contour*
		0.654	1.308		
748.0	0.905			2.653	*Pr Contour*
		1.235	2.469		
750.0	1.564			5.122	*Pr Contour*

Proposed Stage-Storage Volume

PROJECT: **Erie/Mayo Flood Prone Area Study**
V3 FILE NO.: 17324
DATE: 07/02/18
PREPARED BY: JWW

Location: Madison Park Basin
XP-SWMM Node ID: HAMA_1 ALT 2

ELEVATION	AREA (acres)	AVERAGE AREA (acres)	STAGE VOLUME (acre-feet)	CUMULATIVE VOLUME (acre-feet)	COMMENT
730.00	0.170			0.000	*Pr Contour*
		0.209	0.418		
732.00	0.248			0.418	*Pr Contour*
		0.298	0.596		
734.00	0.348			1.014	*Pr Contour*
		0.390	0.780		
736.0	0.432			1.794	*Pr Contour*
		0.547	1.094		
738.0	0.662			2.888	*Pr Contour*
		0.872	1.743		
740.0	1.081			4.631	*Pr Contour*

500-YEAR RAINFALL DEPTH CALCULATION

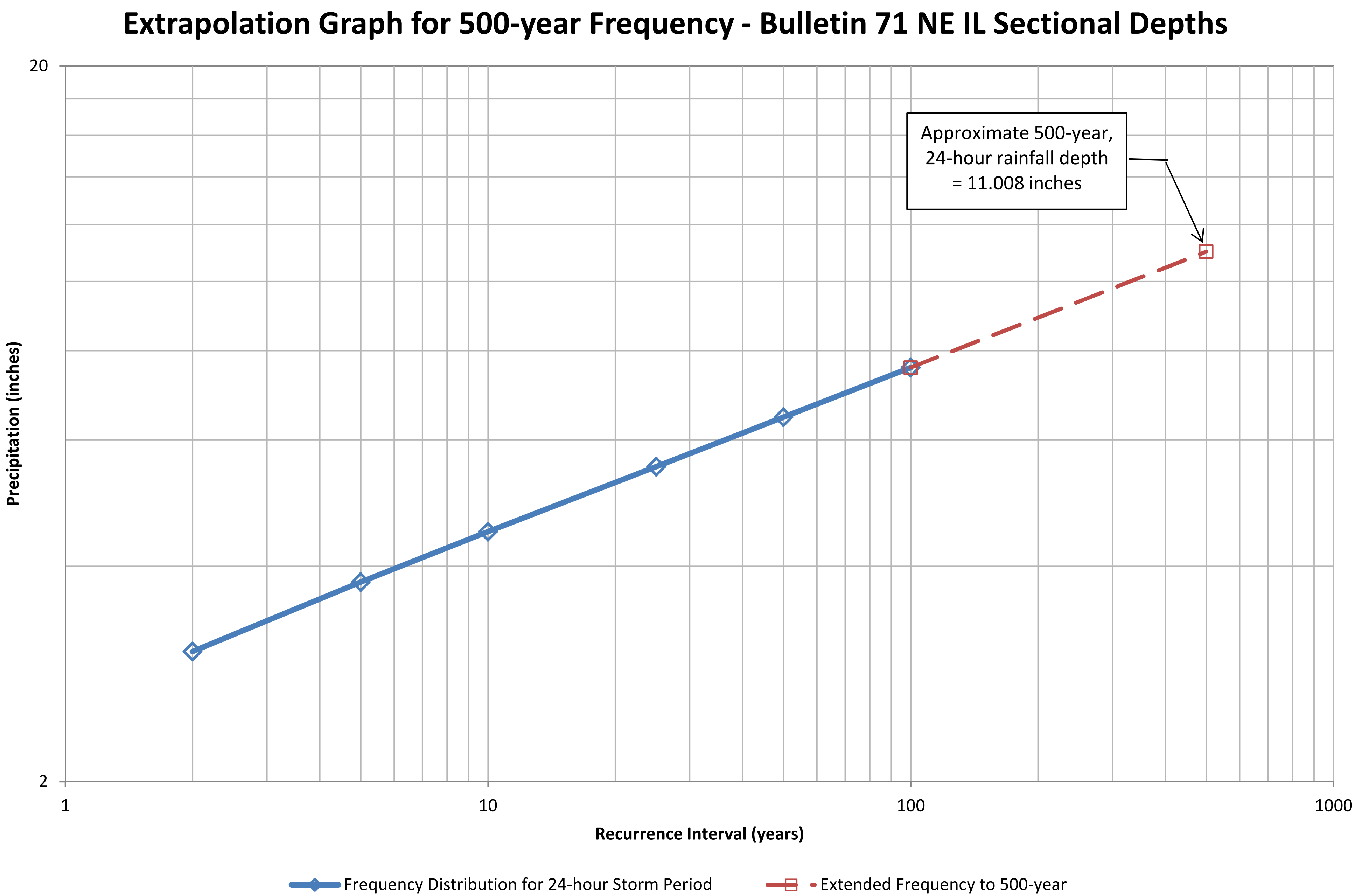
500-year Rainfall Depth Calculation

PROJECT: **Erie St/Mayo Ave Flood Prone Area Study**
V3 FILE NO.: 17324
DATE: 05/04/18
PREPARED BY: JWW

Frequency (yr)	Rainfall Depth (in) for 24-hour storm	Notes
2	3.04	Values from Bulletin 71, Table 1 NE Illinois Rainfall Depths by Frequency
5	3.8	
10	4.47	
25	5.51	
50	6.46	
100	7.58	
500	**11.008**	(extrapolated value, see graph)

Rainfall Duration (hr)	Average Ratio of X-Hour/24-hour Rainfall*	Approximate 500-year Storm Event Depth (Ratio x-hr/24-hr x 11.008 inches)
2	0.58	**6.38**
3	0.64	**7.05**
24	1	**11.01**

Note
*Values from Bulletin 71, Section 1, Table 3


Extrapolation Graph for 500-year Frequency - Bulletin 71 NE IL Sectional Depths
20
2
Precipitation (inches)
1
10
100
1000
Recurrence Interval (years)
Approximate 500-year, 24-hour rainfall depth = 11.008 inches
Frequency Distribution for 24-hour Storm Period
Extended Frequency to 500-year

Appendix B: Engineer's Estimated Opinion of Probable Construction Cost

Client:	Joe Tebrugge	**Job Name:**	Flood Study
	City of Wheaton		Erie / Mayo
	303 West Wesley Street	**Date of Plans:**	N/A
	Wheaton, Illinois 60187	**Revision Date:**	N/A
Phone:	630-848-5010	**Project#:**	17324
Email:	JTebrugge@wheaton.il.us	**Date of Estimate:**	7/16/2018

CONCEPTUAL OPINION OF PROBABLE CONSTRUCTION COST

FLOOD PRONE AREA STUDY - WEST ERIE - ALTERNATE #1 (Conveyance)			
ITEM	**DESCRIPTION**		**TOTAL**
1.00	*A1 - ERIE to BEVERLY*	*$*	*218,981*
2.00	*A1 - BEVERLY to DUPAGE CTY FAIRGROUNDS*	*$*	*369,600*
	CONTINGENCY:	*$*	*117,720*
	WEST ERIE ALTERNATE 1 ESTIMATE TOTAL:	**$**	**588,581.00**

FLOOD PRONE AREA STUDY - WEST ERIE - ALTERNATE #2 (Storage)			
6.00	*A2 - WEST BASIN*	*$*	*704,163*
	CONTINGENCY:	*$*	*140,830*
	WEST ERIE ALTERNATE 2 ESTIMATE TOTAL:	**$**	**704,163.00**

FLOOD PRONE AREA STUDY - CENTRAL & EAST ERIE - ALTERNATE #1 (Conveyance & Storage)			
3.00	*A1 - PIERCE to VERNON*	*$*	*510,350*
4.00	*A1 - PIERCE to MORGAN*	*$*	*119,888*
5.00	*A1 - CENTRAL BASIN*	*$*	*673,659*
	CONTINGENCY:	*$*	*260,780*
	CENTRAL & EAST ERIE ALTERNATE 1 ESTIMATE TOTAL:	**$**	**1,303,897**

FLOOD PRONE AREA STUDY - CENTRAL & EAST ERIE - ALTERNATE #2 (Storage)			
7.00	*A2 - CENTRAL BASIN*	*$*	*639,308*
8.00	*A2 - EAST BASIN*	*$*	*1,390,878*
	CONTINGENCY:	*$*	*406,040*
	CENTRAL & EAST ERIE ALTERNATE 2 ESTIMATE TOTAL:	**$**	**2,030,186**

FLOOD PRONE AREA STUDY - MAYO - ALTERNATE #1 (Conveyance)			
9.00	*A1 - PAULA*	*$*	*67,523*
10.00	*A1 - PAULA to CENTER*	*$*	*115,477*
11.00	*A1 - STORAGE to MAYO*	*$*	*73,592*
12.00	*A1 - MAYO to SPRING BROOK*	*$*	*140,143*
	CONTINGENCY:	*$*	*79,350*
	MAYO ALTERNATE 1 ESTIMATE TOTAL:	**$**	**396,735**

FLOOD PRONE AREA STUDY - MAYO - ALTERNATE #2 (Storage)			
13.00	*A2 - PAULA to CENTER*	*$*	*777,131*
14.00	*A2 - STORAGE TO MAYO*	*$*	*2,099,493*
15.00	*A2 -WESTHAVEN PARK*	*$*	*140,743*
16.00	*A2 - MADISON PARK*	*$*	*159,460*
	CONTINGENCY:	*$*	*635,370*
	MAYO ALTERNATE 2 ESTIMATE TOTAL:	**$**	**3,176,827**

FLOOD PRONE AREA STUDY - MAYO - ALTERNATE #3 (Conveyance & Storage)			
9.00	*A1 - PAULA*	*$*	*67,523*
10.00	*A1 - PAULA to CENTER*	*$*	*115,477*
11.00	*A1 - STORAGE to MAYO*	*$*	*73,592*

Client:	Joe Tebrugge City of Wheaton 303 West Wesley Street Wheaton, Illinois 60187
Phone:	630-848-5010
Email:	JTebrugge@wheaton.il.us

Job Name:	Flood Study Erie / Mayo
Date of Plans:	N/A
Revision Date:	N/A
Project#:	17324
Date of Estimate:	7/16/2018

CONCEPTUAL OPINION OF PROBABLE CONSTRUCTION COST

12.00	*A1 - MAYO to SPRING BROOK*		*$*	*140,143*
15.00	*A2 -WESTHAVEN PARK*		*$*	*140,743*
		CONTINGENCY:	*$*	*107,500*
		MAYO ALTERNATE 1 ESTIMATE TOTAL:	**$**	**537,478**

FLOOD PRONE AREA STUDY - MAYO - ALTERNATE #4 (Storage)				
15.00	*A2 -WESTHAVEN PARK*		*$*	*140,743*
		CONTINGENCY:	*$*	*28,150*
		MAYO ALTERNATE 2 ESTIMATE TOTAL:	**$**	**140,743**

Notes:

1) ***This is a conceptual estimate. Actual quantities and scope for the project will be determined by final design an***
2) ***This conceptual estimate does not include soft costs (i.e. permit fees, engineering, design, ROW or temporary***

The Following is specifically excluded from this estimate:

1) ***Bonds, permits, special insurance (waiver of subrogation, pollution liability insurance), and testing including QC/***
2) ***The demolition or handling of any petroleum contaminated soil, gas tanks, gas pumps etc.***
3) ***Removal of buried or above ground petroleum underground storage tanks***
4) ***Repair or restoration of asphalt roadways or paths that may need to be crossed with truck traffic for access to load***
5) ***The handling or disposal of hazardous materials or non-hazardous special waste material.***
6) ***Compaction or Material Testing.***
7) ***Winter Conditions or Lime Stabilization of Subgrades unless noted otherwise.***

This Preliminary Cost Estimate is based on a design concept. Since V3 Companies of Illinois, Ltd. has no control over the cost of labor, materials, equipment or services furnished by others, or over the Contractor's methods of determining prices, or over competitive bidding or market conditions, this Opinion of Probable Construction Cost is made based on V3 Companies of Illinois' best judgment as an experienced and qualified professional contractor, familiar with the Construction industry; however, V3 Companies of Illinois cannot and does not guarantee that proposals, bids or actual Construction Costs will not vary from Opinions of Probable Construction Cost prepared by V3.

Client:	Joe Tebrugge	**Job Name:**	Flood Study
	City of Wheaton		Erie / Mayo
	303 West Wesley Street	**Date of Plans:**	N/A
	Wheaton, Illinois 60187	**Revision Date:**	N/A
Phone:	630-848-5010	**Project#:**	17324
Email:	JTebrugge@wheaton.il.us	**Date of Estimate:**	7/16/2018

CONCEPTUAL OPINION OF PROBABLE CONSTRUCTION COST

		QUANTITY	UNIT	UNIT PRICE	TOTAL
1.00	**A1 - ERIE to BEVERLY**				
1.10	**GENERAL CONDITIONS**				
1.11	Mobilization (10%)	1.000	LSUM	$ 17,000.00	$ 17,000.00
1.12	Dry Utility Relocates (20%)	1.000	LSUM	$ 33,000.00	$ 33,000.00
1.13	Tree Removal, Trimming & Root Pruning (2%)	1.000	LSUM	$ 3,000.00	$ 3,000.00
1.14	Undercutting & Backfill For Utilities (10% at 3.00')	23.000	CY	$ 90.00	$ 2,070.00
1.15	Sidewalk Removal	76.000	SY	$ 18.00	$ 1,368.00
1.16	Pavement Removal	35.000	SY	$ 18.00	$ 630.00
1.17	PCC Curb & Gutter Removal	90.000	LF	$ 5.00	$ 450.00
1.20	**SEWER INSTALLATION**				
1.21	Install 24" RCP Storm Sewer	585.000	LF	$ 150.00	$ 87,750.00
1.22	Install 12" RCP Storm Sewer	135.000	LF	$ 130.00	$ 17,550.00
1.23	4' Storm Structure Installation	3.000	LF	$ 4,000.00	$ 12,000.00
1.24	5' Storm Structure Installation	3.000	LF	$ 4,500.00	$ 13,500.00
1.25	Trench Backfill	182.000	CY	$ 45.00	$ 8,190.00
1.26	Sanitary Service Repairs	0.000	EACH	$ 2,000.00	$ -
1.27	Water Service Repairs	0.000	EACH	$ 2,000.00	$ -
1.28	Spoil Removal	182.000	CY	$ 45.00	$ 8,190.00
1.30	**BASIN EXCAVATION**				
1.31	Construction Entrance / Haul Route	0.000	SY	$ 25.00	$ -
1.32	Earth Excavation to Disposal	0.000	CY	$ 40.00	$ -
1.33	Furnish & Place Topsoil 6"	0.000	CY	$ 40.00	$ -
1.40	**RESTORATION**				
1.41	Sod Installation	169.000	SY	$ 12.00	$ 2,028.00
1.42	Roadway Base	35.000	SY	$ 8.00	$ 280.00
1.43	Roadway Pavement	35.000	SY	$ 95.00	$ 3,325.00
1.44	PCC Curb & Gutter Installation	90.000	LF	$ 35.00	$ 3,150.00
1.45	Residential Driveway R&R Complete	70.000	SY	$ 60.00	$ 4,200.00
1.46	Private Property Restoration	0.000	LSUM	$ 40,000.00	$ -
1.47	Native Restoration	0.000	ACRE	$ 40,000.00	$ -
1.48	Maintenance & Monitoring	0.000	YEAR	$ 5,000.00	$ -
1.49	Parkway Tree Installation	2.000	EACH	$ 650.00	$ 1,300.00
				SUBTOTAL	**$ 218,981.00**

Client:	Joe Tebrugge
	City of Wheaton
	303 West Wesley Street
	Wheaton, Illinois 60187
Phone:	630-848-5010
Email:	JTebrugge@wheaton.il.us

Job Name:	Flood Study
	Erie / Mayo
Date of Plans:	N/A
Revision Date:	N/A
Project#:	17324
Date of Estimate:	7/16/2018

CONCEPTUAL OPINION OF PROBABLE CONSTRUCTION COST

2.00	**A1 - BEVERLY to DUPAGE CTY FAIRGROUNDS**	**QUANTITY**	**UNIT**	**UNIT PRICE**	**TOTAL**
2.10	**GENERAL CONDITIONS**				
2.11	Mobilization (10%)	1.000	LSUM	$ 28,000.00	$ 28,000.00
2.12	Dry Utility Relocates (20%)	1.000	LSUM	$ 56,000.00	$ 56,000.00
2.13	Tree Removal, Trimming & Root Pruning (2%)	1.000	LSUM	$ 6,000.00	$ 6,000.00
2.14	Undercutting & Backfill For Utilities (10% at 3.00')	36.000	CY	$ 90.00	$ 3,240.00
2.15	Sidewalk Removal	69.000	SY	$ 18.00	$ 1,242.00
2.16	Pavement Removal	20.000	SY	$ 18.00	$ 360.00
2.17	Gravel Removal	53.000	SY	$ 12.00	$ 636.00
2.18	PCC Curb & Gutter Removal	45.000	LF	$ 5.00	$ 225.00
2.20	**SEWER INSTALLATION**				
2.21	Install 30" RCP Storm Sewer	805.000	LF	$ 160.00	$ 128,800.00
2.22	Install 30" FES Complete	1.000	LF	$ 2,500.00	$ 2,500.00
2.23	5' Storm Structure Installation	3.000	LF	$ 4,500.00	$ 13,500.00
2.24	6' Storm Structure Installation	1.000	LF	$ 5,000.00	$ 5,000.00
2.25	7' Storm Structure Installation	1.000	LF	$ 6,000.00	$ 6,000.00
2.26	Trench Backfill	193.000	CY	$ 45.00	$ 8,685.00
2.27	Sanitary Service Repairs	0.000	EACH	$ 2,000.00	$ -
2.28	Water Service Repairs	0.000	EACH	$ 2,000.00	$ -
2.29	Spoil Removal	193.000	CY	$ 45.00	$ 8,685.00
2.30	**BASIN EXCAVATION**				
2.31	Construction Entrance / Haul Route	575.000	SY	$ 25.00	$ 14,375.00
2.32	Earth Excavation to Disposal	968.000	CY	$ 40.00	$ 38,720.00
2.33	Furnish & Place Topsoil 6"	242.000	CY	$ 40.00	$ 9,680.00
2.40	**RESTORATION**				
2.41	Sod Installation	216.000	SY	$ 12.00	$ 2,592.00
2.42	Roadway Base	20.000	SY	$ 8.00	$ 160.00
2.43	Roadway Pavement	20.000	SY	$ 95.00	$ 1,900.00
2.44	PCC Curb & Gutter Installation	45.000	LF	$ 35.00	$ 1,575.00
2.45	Residential Driveway R&R Complete	13.333	SY	$ 60.00	$ 800.00
2.46	Gravel	53.000	SY	$ 25.00	$ 1,325.00
2.47	Private Property Restoration	0.000	LSUM	$ 40,000.00	$ -
2.48	Native Restoration	0.300	ACRE	$ 40,000.00	$ 12,000.00
2.49	Maintenance & Monitoring	3.000	YEAR	$ 5,000.00	$ 15,000.00
2.5	Parkway Tree Installation	4.000	EACH	$ 650.00	$ 2,600.00
				SUBTOTAL	**$ 369,600.00**

Client: Joe Tebrugge
City of Wheaton
303 West Wesley Street
Wheaton, Illinois 60187
Phone: 630-848-5010
Email: JTebrugge@wheaton.il.us

Job Name: Flood Study
Erie / Mayo
Date of Plans: N/A
Revision Date: N/A
Project#: 17324
Date of Estimate: 7/16/2018

CONCEPTUAL OPINION OF PROBABLE CONSTRUCTION COST

3.00	A1 - PIERCE to VERNON	QUANTITY	UNIT	UNIT PRICE	TOTAL
3.10	**GENERAL CONDITIONS**				
3.11	Mobilization (10%)	1.000	LSUM	$ 39,000.00	$ 39,000.00
3.12	Dry Utility Relocates (20%)	1.000	LSUM	$ 77,000.00	$ 77,000.00
3.13	Tree Removal, Trimming & Root Pruning (2%)	1.000	LSUM	$ 8,000.00	$ 8,000.00
3.14	Undercutting & Backfill For Utilities (10% at 3.00')	47.000	CY	$ 90.00	$ 4,230.00
3.15	Sidewalk Removal	416.000	SY	$ 18.00	$ 7,488.00
3.16	Pavement Removal	47.000	SY	$ 18.00	$ 846.00
3.17	PCC Curb & Gutter Removal	105.000	LF	$ 5.00	$ 525.00
3.20	**SEWER INSTALLATION**				
3.21	Install 30" RCP Storm Sewer	1,050.000	LF	$ 160.00	$ 168,000.00
3.22	Install 30" FES Complete	1.000	LF	$ 2,500.00	$ 2,500.00
3.23	5' Storm Structure Installation	2.000	LF	$ 4,500.00	$ 9,000.00
3.24	6' Storm Structure Installation	2.000	LF	$ 5,000.00	$ 10,000.00
3.25	Trench Backfill	847.000	CY	$ 45.00	$ 38,115.00
3.26	Sanitary Service Repairs	17.000	EACH	$ 2,000.00	$ 34,000.00
3.27	Water Service Repairs	17.000	EACH	$ 2,000.00	$ 34,000.00
3.28	Spoil Removal	847.000	CY	$ 45.00	$ 38,115.00
3.30	**BASIN EXCAVATION**				
3.31	Construction Entrance / Haul Route	575.000	SY	$ 25.00	$ 14,375.00
3.32	Earth Excavation to Disposal	0.000	CY	$ 40.00	$ -
3.33	Furnish & Place Topsoil 6"	0.000	CY	$ 40.00	$ -
3.40	**RESTORATION**				
3.41	Sod Installation	420.000	SY	$ 12.00	$ 5,040.00
3.42	Roadway Base	47.000	SY	$ 8.00	$ 376.00
3.43	Roadway Pavement	47.000	SY	$ 95.00	$ 4,465.00
3.44	PCC Curb & Gutter Installation	105.000	LF	$ 35.00	$ 3,675.00
3.45	Residential Driveway R&R Complete	106.667	SY	$ 60.00	$ 6,400.00
3.46	Private Property Restoration	0.000	LSUM	$ 40,000.00	$ -
3.47	Native Restoration	0.000	ACRE	$ 40,000.00	$ -
3.48	Maintenance & Monitoring	0.000	YEAR	$ 5,000.00	$ -
3.49	Parkway Tree Installation	8.000	EACH	$ 650.00	$ 5,200.00
				SUBTOTAL	**$ 510,350.00**

Client:	Joe Tebrugge
	City of Wheaton
	303 West Wesley Street
	Wheaton, Illinois 60187
Phone:	630-848-5010
Email:	JTebrugge@wheaton.il.us

Job Name:	Flood Study
	Erie / Mayo
Date of Plans:	N/A
Revision Date:	N/A
Project#:	17324
Date of Estimate:	7/16/2018

CONCEPTUAL OPINION OF PROBABLE CONSTRUCTION COST

4.00	**A1 - PIERCE to MORGAN**	**QUANTITY**	**UNIT**	**UNIT PRICE**	**TOTAL**
4.10	**GENERAL CONDITIONS**				
4.11	Mobilization (10%)	1.000	LSUM	$ 9,000.00	$ 9,000.00
4.12	Dry Utility Relocates (20%)	1.000	LSUM	$ 18,000.00	$ 18,000.00
4.13	Tree Removal, Trimming & Root Pruning (2%)	1.000	LSUM	$ 2,000.00	$ 2,000.00
4.14	Undercutting & Backfill For Utilities (10% at 3.00')	15.000	CY	$ 90.00	$ 1,350.00
4.15	Sidewalk Removal	5.000	SY	$ 18.00	$ 90.00
4.16	Pavement Removal	13.000	SY	$ 18.00	$ 234.00
4.17	PCC Curb & Gutter Removal	30.000	LF	$ 5.00	$ 150.00
4.20	**SEWER INSTALLATION**				
4.21	Install 30" RCP Storm Sewer	345.000	LF	$ 160.00	$ 55,200.00
4.22	5' Storm Structure Installation	3.000	LF	$ 4,500.00	$ 13,500.00
4.23	Trench Backfill	22.000	CY	$ 45.00	$ 990.00
4.24	Sanitary Service Repairs	0.000	EACH	$ 2,000.00	$ -
4.25	Water Service Repairs	0.000	EACH	$ 2,000.00	$ -
4.26	Spoil Removal	22.000	CY	$ 45.00	$ 990.00
4.30	**BASIN EXCAVATION**				
4.31	Construction Entrance / Haul Route	575.000	SY	$ 25.00	$ 14,375.00
4.32	Earth Excavation to Disposal	0.000	CY	$ 40.00	$ -
4.33	Furnish & Place Topsoil 6"	0.000	CY	$ 40.00	$ -
4.40	**RESTORATION**				
4.41	Sod Installation	135.000	SY	$ 12.00	$ 1,620.00
4.42	Roadway Base	13.000	SY	$ 8.00	$ 104.00
4.43	Roadway Pavement	13.000	SY	$ 95.00	$ 1,235.00
4.44	PCC Curb & Gutter Installation	30.000	LF	$ 35.00	$ 1,050.00
4.45	Residential Driveway R&R Complete	0.000	SY	$ 60.00	$ -
4.46	Private Property Restoration	0.000	LSUM	$ 40,000.00	$ -
4.47	Native Restoration	0.000	ACRE	$ 40,000.00	$ -
4.48	Maintenance & Monitoring	0.000	YEAR	$ 5,000.00	$ -
4.49	Parkway Tree Installation	0.000	EACH	$ 650.00	$ -
				SUBTOTAL	**$ 119,888.00**

Client:	Joe Tebrugge
	City of Wheaton
	303 West Wesley Street
	Wheaton, Illinois 60187
Phone:	630-848-5010
Email:	JTebrugge@wheaton.il.us

Job Name:	Flood Study
	Erie / Mayo
Date of Plans:	N/A
Revision Date:	N/A
Project#:	17324
Date of Estimate:	7/16/2018

CONCEPTUAL OPINION OF PROBABLE CONSTRUCTION COST

5.00	**A1 - CENTRAL BASIN**	**QUANTITY**	**UNIT**	**UNIT PRICE**		**TOTAL**	
5.10	**GENERAL CONDITIONS**						
5.11	Mobilization (10%)	1.000	LSUM	$	51,000.00	$	51,000.00
5.12	Dry Utility Relocates (20%)	1.000	LSUM	$	102,000.00	$	102,000.00
5.13	Tree Removal, Trimming & Root Pruning (2%)	1.000	LSUM	$	10,000.00	$	10,000.00
5.14	Undercutting & Backfill For Utilities (10% at 3.00')	0.000	CY	$	90.00	$	-
5.15	Sidewalk Removal	0.000	SY	$	18.00	$	-
5.16	Pavement Removal	0.000	SY	$	18.00	$	-
5.17	PCC Curb & Gutter Removal	0.000	LF	$	5.00	$	-
5.20	**SEWER INSTALLATION**						
5.21	Install 30" RCP Storm Sewer	0.000	LF	$	160.00	$	-
5.22	4' Storm Structure Installation	1.000	LF	$	4,000.00	$	4,000.00
5.23	Trench Backfill	0.000	CY	$	45.00	$	-
5.24	Sanitary Service Repairs	0.000	EACH	$	2,000.00	$	-
5.25	Water Service Repairs	0.000	EACH	$	2,000.00	$	-
5.26	Spoil Removal	0.000	CY	$	45.00	$	-
5.30	**BASIN EXCAVATION**						
5.31	Land Acquisition - 1900 Manchester	1.000	EACH	$	100,000.00	$	100,000.00
5.32	Construction Entrance / Haul Route	575.000	SY	$	25.00	$	14,375.00
5.33	Earth Excavation to Disposal	5,969.333	CY	$	40.00	$	238,773.33
5.34	Furnish & Place Topsoil 6"	1,546.111	CY	$	40.00	$	61,844.44
5.40	**RESTORATION**						
5.41	Sod Installation	0.000	SY	$	12.00	$	-
5.42	Roadway Base	0.000	SY	$	8.00	$	-
5.43	Roadway Pavement	0.000	SY	$	95.00	$	-
5.44	PCC Curb & Gutter Installation	0.000	LF	$	35.00	$	-
5.45	Residential Driveway R&R Complete	0.000	SY	$	60.00	$	-
5.46	Private Property Restoration	0.000	LSUM	$	40,000.00	$	-
5.47	Native Restoration	1.917	ACRE	$	40,000.00	$	76,666.67
5.48	Maintenance & Monitoring	3.000	YEAR	$	5,000.00	$	15,000.00
5.49	Parkway Tree Installation	0.000	EACH	$	650.00	$	-
					SUBTOTAL	**$**	**673,659.44**

Client:	Joe Tebrugge
	City of Wheaton
	303 West Wesley Street
	Wheaton, Illinois 60187
Phone:	630-848-5010
Email:	JTebrugge@wheaton.il.us

Job Name:	Flood Study
	Erie / Mayo
Date of Plans:	N/A
Revision Date:	N/A
Project#:	17324
Date of Estimate:	7/16/2018

CONCEPTUAL OPINION OF PROBABLE CONSTRUCTION COST

6.00	**A2 - WEST BASIN**	**QUANTITY**	**UNIT**	**UNIT PRICE**	**TOTAL**
6.10	**GENERAL CONDITIONS**				
6.11	Mobilization (10%)	1.000	LSUM	$ 53,000.00	$ 53,000.00
6.12	Dry Utility Relocates (20%)	1.000	LSUM	$ 107,000.00	$ 107,000.00
6.13	Tree Removal, Trimming & Root Pruning (2%)	1.000	LSUM	$ 11,000.00	$ 11,000.00
6.14	Undercutting & Backfill For Utilities (10% at 3.00')	1.000	CY	$ 90.00	$ 90.00
6.15	Sidewalk Removal	0.000	SY	$ 18.00	$ -
6.16	Pavement Removal	0.000	SY	$ 18.00	$ -
6.17	PCC Curb & Gutter Removal	0.000	LF	$ 5.00	$ -
6.20	**SEWER INSTALLATION**				
6.21	Install 12" RCP Storm Sewer	10.000	LF	$ 130.00	$ 1,300.00
6.22	2' Storm Structure Installation	1.000	LF	$ 3,000.00	$ 3,000.00
6.23	4' Storm Structure Installation	1.000	LF	$ 4,000.00	$ 4,000.00
6.24	Trench Backfill	0.000	CY	$ 45.00	$ -
6.25	Sanitary Service Repairs	0.000	EACH	$ 2,000.00	$ -
6.26	Water Service Repairs	0.000	EACH	$ 2,000.00	$ -
6.27	Spoil Removal	0.000	CY	$ 45.00	$ -
6.30	**BASIN EXCAVATION**				
6.31	Land Acquisition - 203 Beverly	1.000	EACH	$ 62,370.00	$ 62,370.00
6.32	Property Buyout - 200 Erie	1.000	EACH	$ 239,000.00	$ 239,000.00
6.33	Land Acquisition - 130 Erie	1.000	EACH	$ 62,100.00	$ 62,100.00
6.34	Land Acquisition - 124 Erie	1.000	EACH	$ 72,210.00	$ 72,210.00
6.35	Construction Entrance / Haul Route	575.000	SY	$ 25.00	$ 14,375.00
6.36	Earth Excavation to Disposal	887.333	CY	$ 40.00	$ 35,493.33
6.37	Furnish & Place Topsoil 6"	270.000	CY	$ 40.00	$ 10,800.00
6.40	**RESTORATION**				
6.41	Sod Installation	3.000	SY	$ 12.00	$ 36.00
6.42	Roadway Base	0.000	SY	$ 8.00	$ -
6.43	Roadway Pavement	0.000	SY	$ 95.00	$ -
6.44	PCC Curb & Gutter Installation	0.000	LF	$ 35.00	$ -
6.45	Residential Driveway R&R Complete	0.000	SY	$ 60.00	$ -
6.46	Private Property Restoration	0.000	LSUM	$ 40,000.00	$ -
6.47	Native Restoration	0.335	ACRE	$ 40,000.00	$ 13,388.43
6.48	Maintenance & Monitoring	3.000	YEAR	$ 5,000.00	$ 15,000.00
6.49	Parkway Tree Installation	0.000	EACH	$ 650.00	$ -
				SUBTOTAL	**$ 704,162.76**

Client: Joe Tebrugge
City of Wheaton
303 West Wesley Street
Wheaton, Illinois 60187
Phone: 630-848-5010
Email: JTebrugge@wheaton.il.us

Job Name: Flood Study
Erie / Mayo
Date of Plans: N/A
Revision Date: N/A
Project#: 17324
Date of Estimate: 7/16/2018

CONCEPTUAL OPINION OF PROBABLE CONSTRUCTION COST

7.00	A2 - CENTRAL BASIN	QUANTITY	UNIT	UNIT PRICE	TOTAL
7.10	**GENERAL CONDITIONS**				
7.11	Mobilization (10%)	1.000	LSUM	$ 48,000.00	$ 48,000.00
7.12	Dry Utility Relocates (20%)	1.000	LSUM	$ 97,000.00	$ 97,000.00
7.13	Tree Removal, Trimming & Root Pruning (2%)	1.000	LSUM	$ 10,000.00	$ 10,000.00
7.14	Undercutting & Backfill For Utilities (10% at 3.00')	0.000	CY	$ 90.00	$ -
7.15	Sidewalk Removal	0.000	SY	$ 18.00	$ -
7.16	Pavement Removal	0.000	SY	$ 18.00	$ -
7.17	PCC Curb & Gutter Removal	0.000	LF	$ 5.00	$ -
7.20	**SEWER INSTALLATION**				
7.21	Install 12" RCP Storm Sewer	0.000	LF	$ 130.00	$ -
7.22	4' Storm Structure Installation	1.000	LF	$ 4,000.00	$ 4,000.00
7.23	Trench Backfill	0.000	CY	$ 45.00	$ -
7.24	Sanitary Service Repairs	0.000	EACH	$ 2,000.00	$ -
7.25	Water Service Repairs	0.000	EACH	$ 2,000.00	$ -
7.26	Spoil Removal	0.000	CY	$ 45.00	$ -
7.30	**BASIN EXCAVATION**				
7.31	Land Acquisition - 1900 Manchester	1.000	EACH	$ 100,000.00	$ 100,000.00
7.32	Construction Entrance / Haul Route	575.000	SY	$ 25.00	$ 14,375.00
7.33	Earth Excavation to Disposal	5,872.533	CY	$ 40.00	$ 234,901.33
7.34	Furnish & Place Topsoil 6"	1,295.185	CY	$ 40.00	$ 51,807.41
7.40	**RESTORATION**				
7.41	Sod Installation	0.000	SY	$ 12.00	$ -
7.42	Roadway Base	0.000	SY	$ 8.00	$ -
7.43	Roadway Pavement	0.000	SY	$ 95.00	$ -
7.44	PCC Curb & Gutter Installation	0.000	LF	$ 35.00	$ -
7.45	Residential Driveway R&R Complete	0.000	SY	$ 60.00	$ -
7.46	Private Property Restoration	0.000	LSUM	$ 40,000.00	$ -
7.47	Native Restoration	1.606	ACRE	$ 40,000.00	$ 64,224.06
7.48	Maintenance & Monitoring	3.000	YEAR	$ 5,000.00	$ 15,000.00
7.49	Parkway Tree Installation	0.000	EACH	$ 650.00	$ -
				SUBTOTAL	**$ 639,307.80**

Client: Joe Tebrugge
City of Wheaton
303 West Wesley Street
Wheaton, Illinois 60187
Phone: 630-848-5010
Email: JTebrugge@wheaton.il.us

Job Name: Flood Study
Erie / Mayo
Date of Plans: N/A
Revision Date: N/A
Project#: 17324
Date of Estimate: 7/16/2018

CONCEPTUAL OPINION OF PROBABLE CONSTRUCTION COST

8.00	A2 - EAST BASIN	QUANTITY	UNIT	UNIT PRICE	TOTAL
8.10	**GENERAL CONDITIONS**				
8.11	Mobilization (10%)	1.000	LSUM	$ 105,000.00	$ 105,000.00
8.12	Dry Utility Relocates (20%)	1.000	LSUM	$ 211,000.00	$ 211,000.00
8.13	Tree Removal, Trimming & Root Pruning (2%)	1.000	LSUM	$ 21,000.00	$ 21,000.00
8.14	Undercutting & Backfill For Utilities (10% at 3.00')	7.000	CY	$ 90.00	$ 630.00
8.15	Sidewalk Removal	0.000	SY	$ 18.00	$ -
8.16	Pavement Removal	12.000	SY	$ 18.00	$ 216.00
8.17	PCC Curb & Gutter Removal	35.000	LF	$ 5.00	$ 175.00
8.20	**SEWER INSTALLATION**				
8.21	Install 18" RCP Storm Sewer	195.000	LF	$ 140.00	$ 27,300.00
8.22	4' Storm Structure Installation	3.000	LF	$ 4,000.00	$ 12,000.00
8.23	Trench Backfill	8.000	CY	$ 45.00	$ 360.00
8.24	Sanitary Service Repairs	1.000	EACH	$ 2,000.00	$ 2,000.00
8.25	Water Service Repairs	1.000	EACH	$ 2,000.00	$ 2,000.00
8.26	Spoil Removal	8.000	CY	$ 45.00	$ 360.00
8.30	**BASIN EXCAVATION**				
8.31	Property Buyout - 110 Morgan Ave	1.000	EACH	$ 183,700.00	$ 183,700.00
8.32	Property Buyout - 114 Morgan Ave	1.000	EACH	$ 183,000.00	$ 183,000.00
8.33	Property Buyout - 118 Morgan Ave	1.000	EACH	$ 177,600.00	$ 177,600.00
8.34	Property Buyout - 122 Morgan Ave	1.000	EACH	$ 182,000.00	$ 182,000.00
8.35	Construction Entrance / Haul Route	575.000	SY	$ 25.00	$ 14,375.00
8.36	Earth Excavation to Disposal	4,969.067	CY	$ 40.00	$ 198,762.67
8.37	Furnish & Place Topsoil 6"	558.704	CY	$ 40.00	$ 22,348.15
8.40	**RESTORATION**				
8.41	Sod Installation	53.000	SY	$ 12.00	$ 636.00
8.42	Roadway Base	12.000	SY	$ 8.00	$ 96.00
8.43	Roadway Pavement	12.000	SY	$ 95.00	$ 1,140.00
8.44	PCC Curb & Gutter Installation	35.000	LF	$ 35.00	$ 1,225.00
8.45	Residential Driveway R&R Complete	10.000	SY	$ 60.00	$ 600.00
8.46	Private Property Restoration	0.000	LSUM	$ 40,000.00	$ -
8.47	Native Restoration	0.693	ACRE	$ 40,000.00	$ 27,704.32
8.48	Maintenance & Monitoring	3.000	YEAR	$ 5,000.00	$ 15,000.00
8.49	Parkway Tree Installation	1.000	EACH	$ 650.00	$ 650.00
				SUBTOTAL	**$ 1,390,878.13**

Client:	Joe Tebrugge
	City of Wheaton
	303 West Wesley Street
	Wheaton, Illinois 60187
Phone:	630-848-5010
Email:	JTebrugge@wheaton.il.us

Job Name:	Flood Study
	Erie / Mayo
Date of Plans:	N/A
Revision Date:	N/A
Project#:	17324
Date of Estimate:	7/16/2018

CONCEPTUAL OPINION OF PROBABLE CONSTRUCTION COST

9.00	**A1 - PAULA**	**QUANTITY**	**UNIT**	**UNIT PRICE**	**TOTAL**
9.10	**GENERAL CONDITIONS**				
9.11	Mobilization (10%)	1.000	LSUM	$ 5,000.00	$ 5,000.00
9.12	Dry Utility Relocates (20%)	1.000	LSUM	$ 10,000.00	$ 10,000.00
9.13	Tree Removal, Trimming & Root Pruning (2%)	1.000	LSUM	$ 1,000.00	$ 1,000.00
9.14	Undercutting & Backfill For Utilities (10% at 3.00')	4.000	CY	$ 90.00	$ 360.00
9.15	Sidewalk Removal	0.000	SY	$ 18.00	$ -
9.16	Pavement Removal	38.000	SY	$ 18.00	$ 684.00
9.17	PCC Curb & Gutter Removal	0.000	LF	$ 5.00	$ -
9.20	**SEWER INSTALLATION**				
9.21	Install 30" RCP Storm Sewer	85.000	LF	$ 160.00	$ 13,600.00
9.22	5' Storm Structure Installation	1.000	LF	$ 4,500.00	$ 4,500.00
9.23	6' Storm Structure Installation	1.000	LF	$ 5,000.00	$ 5,000.00
9.24	Trench Backfill	101.000	CY	$ 45.00	$ 4,545.00
9.25	Sanitary Service Repairs	0.000	EACH	$ 2,000.00	$ -
9.26	Water Service Repairs	0.000	EACH	$ 2,000.00	$ -
9.27	Spoil Removal	101.000	CY	$ 45.00	$ 4,545.00
9.30	**BASIN EXCAVATION**				
9.31	Construction Entrance / Haul Route	575.000	SY	$ 25.00	$ 14,375.00
9.32	Earth Excavation to Disposal	0.000	CY	$ 40.00	$ -
9.33	Furnish & Place Topsoil 6"	0.000	CY	$ 40.00	$ -
9.40	**RESTORATION**				
9.41	Sod Installation	0.000	SY	$ 12.00	$ -
9.42	Roadway Base	38.000	SY	$ 8.00	$ 304.00
9.43	Roadway Pavement	38.000	SY	$ 95.00	$ 3,610.00
9.44	PCC Curb & Gutter Installation	0.000	LF	$ 35.00	$ -
9.45	Residential Driveway R&R Complete	0.000	SY	$ 60.00	$ -
9.46	Private Property Restoration	0.000	LSUM	$ 40,000.00	$ -
9.47	Native Restoration	0.000	ACRE	$ 40,000.00	$ -
9.48	Maintenance & Monitoring	0.000	YEAR	$ 5,000.00	$ -
9.49	Parkway Tree Installation	0.000	EACH	$ 650.00	$ -
				SUBTOTAL	**$ 67,523.00**

Client:	Joe Tebrugge
	City of Wheaton
	303 West Wesley Street
	Wheaton, Illinois 60187
Phone:	630-848-5010
Email:	JTebrugge@wheaton.il.us

Job Name:	Flood Study
	Erie / Mayo
Date of Plans:	N/A
Revision Date:	N/A
Project#:	17324
Date of Estimate:	7/16/2018

CONCEPTUAL OPINION OF PROBABLE CONSTRUCTION COST

10.00	**A1 - PAULA to CENTER**	**QUANTITY**	**UNIT**	**UNIT PRICE**	**TOTAL**
10.10	**GENERAL CONDITIONS**				
10.11	Mobilization (10%)	1.000	LSUM	$ 9,000.00	$ 9,000.00
10.12	Dry Utility Relocates (20%)	1.000	LSUM	$ 17,000.00	$ 17,000.00
10.13	Tree Removal, Trimming & Root Pruning (2%)	1.000	LSUM	$ 2,000.00	$ 2,000.00
10.14	Undercutting & Backfill For Utilities (10% at 3.00')	18.000	CY	$ 90.00	$ 1,620.00
10.15	Sidewalk Removal	3.000	SY	$ 18.00	$ 54.00
10.16	Pavement Removal	8.000	SY	$ 18.00	$ 144.00
10.17	PCC Curb & Gutter Removal	5.000	LF	$ 5.00	$ 25.00
10.20	**SEWER INSTALLATION**				
10.21	Install 36" RCP Storm Sewer	360.000	LF	$ 170.00	$ 61,200.00
10.22	5' Storm Structure Installation	1.000	LF	$ 4,500.00	$ 4,500.00
10.23	Trench Backfill	28.000	CY	$ 45.00	$ 1,260.00
10.24	Sanitary Service Repairs	0.000	EACH	$ 2,000.00	$ -
10.25	Water Service Repairs	0.000	EACH	$ 2,000.00	$ -
10.26	Spoil Removal	28.000	CY	$ 45.00	$ 1,260.00
10.30	**BASIN EXCAVATION**				
10.31	Construction Entrance / Haul Route	575.000	SY	$ 25.00	$ 14,375.00
10.32	Earth Excavation to Disposal	0.000	CY	$ 40.00	$ -
10.33	Furnish & Place Topsoil 6"	0.000	CY	$ 40.00	$ -
10.40	**RESTORATION**				
10.41	Sod Installation	170.000	SY	$ 12.00	$ 2,040.00
10.42	Roadway Base	8.000	SY	$ 8.00	$ 64.00
10.43	Roadway Pavement	8.000	SY	$ 95.00	$ 760.00
10.44	PCC Curb & Gutter Installation	5.000	LF	$ 35.00	$ 175.00
10.45	Residential Driveway R&R Complete	0.000	SY	$ 60.00	$ -
10.46	Private Property Restoration	0.000	LSUM	$ 40,000.00	$ -
10.47	Native Restoration	0.000	ACRE	$ 40,000.00	$ -
10.48	Maintenance & Monitoring	0.000	YEAR	$ 5,000.00	$ -
10.49	Parkway Tree Installation	0.000	EACH	$ 650.00	$ -
				SUBTOTAL	**$ 115,477.00**

Client:	Joe Tebrugge City of Wheaton 303 West Wesley Street Wheaton, Illinois 60187
Phone:	630-848-5010
Email:	JTebrugge@wheaton.il.us

Job Name:	Flood Study Erie / Mayo
Date of Plans:	N/A
Revision Date:	N/A
Project#:	17324
Date of Estimate:	7/16/2018

CONCEPTUAL OPINION OF PROBABLE CONSTRUCTION COST

11.00	**A1 - STORAGE to MAYO**	**QUANTITY**	**UNIT**	**UNIT PRICE**	**TOTAL**
11.10	**GENERAL CONDITIONS**				
11.11	Mobilization (10%)	1.000	LSUM	$ 6,000.00	$ 6,000.00
11.12	Dry Utility Relocates (20%)	1.000	LSUM	$ 11,000.00	$ 11,000.00
11.13	Tree Removal, Trimming & Root Pruning (2%)	1.000	LSUM	$ 1,000.00	$ 1,000.00
11.14	Undercutting & Backfill For Utilities (10% at 3.00')	8.000	CY	$ 90.00	$ 720.00
11.15	Sidewalk Removal	3.000	SY	$ 18.00	$ 54.00
11.16	Pavement Removal	7.000	SY	$ 18.00	$ 126.00
11.17	PCC Curb & Gutter Removal	5.000	LF	$ 5.00	$ 25.00
11.20	**SEWER INSTALLATION**				
11.21	Install 30" RCP Storm Sewer	175.000	LF	$ 160.00	$ 28,000.00
11.22	5' Storm Structure Installation	1.000	LF	$ 4,500.00	$ 4,500.00
11.23	6' Storm Structure Installation	1.000	LF	$ 5,000.00	$ 5,000.00
11.24	Trench Backfill	12.000	CY	$ 45.00	$ 540.00
11.25	Sanitary Service Repairs	0.000	EACH	$ 2,000.00	$ -
11.26	Water Service Repairs	0.000	EACH	$ 2,000.00	$ -
11.27	Spoil Removal	12.000	CY	$ 45.00	$ 540.00
11.30	**BASIN EXCAVATION**				
11.31	Construction Entrance / Haul Route	575.000	SY	$ 25.00	$ 14,375.00
11.32	Earth Excavation to Disposal	0.000	CY	$ 40.00	$ -
11.33	Furnish & Place Topsoil 6"	0.000	CY	$ 40.00	$ -
11.40	**RESTORATION**				
11.41	Sod Installation	68.000	SY	$ 12.00	$ 816.00
11.42	Roadway Base	7.000	SY	$ 8.00	$ 56.00
11.43	Roadway Pavement	7.000	SY	$ 95.00	$ 665.00
11.44	PCC Curb & Gutter Installation	5.000	LF	$ 35.00	$ 175.00
11.45	Residential Driveway R&R Complete	0.000	SY	$ 60.00	$ -
11.46	Private Property Restoration	0.000	LSUM	$ 40,000.00	$ -
11.47	Native Restoration	0.000	ACRE	$ 40,000.00	$ -
11.48	Maintenance & Monitoring	0.000	YEAR	$ 5,000.00	$ -
11.49	Parkway Tree Installation	0.000	EACH	$ 650.00	$ -
				SUBTOTAL	**$ 73,592.00**

Client:	Joe Tebrugge City of Wheaton 303 West Wesley Street Wheaton, Illinois 60187
Phone:	630-848-5010
Email:	JTebrugge@wheaton.il.us

Job Name:	Flood Study Erie / Mayo
Date of Plans:	N/A
Revision Date:	N/A
Project#:	17324
Date of Estimate:	7/16/2018

CONCEPTUAL OPINION OF PROBABLE CONSTRUCTION COST

12.00	**A1 - MAYO to SPRING BROOK**	**QUANTITY**	**UNIT**	**UNIT PRICE**	**TOTAL**
12.10	**GENERAL CONDITIONS**				
12.11	Mobilization (10%)	1.000	LSUM	$ 11,000.00	$ 11,000.00
12.12	Dry Utility Relocates (20%)	1.000	LSUM	$ 21,000.00	$ 21,000.00
12.13	Tree Removal, Trimming & Root Pruning (2%)	1.000	LSUM	$ 2,000.00	$ 2,000.00
12.14	Undercutting & Backfill For Utilities (10% at 3.00')	25.000	CY	$ 90.00	$ 2,250.00
12.15	Sidewalk Removal	3.000	SY	$ 18.00	$ 54.00
12.16	Pavement Removal	8.000	SY	$ 18.00	$ 144.00
12.17	PCC Curb & Gutter Removal	5.000	LF	$ 5.00	$ 25.00
12.20	**SEWER INSTALLATION**				
12.21	Install 42" RCP Storm Sewer	450.000	LF	$ 180.00	$ 81,000.00
12.22	Install 36" FES Complete	1.000	LF	$ 3,000.00	$ 3,000.00
12.23	Trench Backfill	16.000	CY	$ 45.00	$ 720.00
12.24	Sanitary Service Repairs	0.000	EACH	$ 2,000.00	$ -
12.25	Water Service Repairs	0.000	EACH	$ 2,000.00	$ -
12.26	Spoil Removal	16.000	CY	$ 45.00	$ 720.00
12.30	**BASIN EXCAVATION**				
12.31	Construction Entrance / Haul Route	575.000	SY	$ 25.00	$ 14,375.00
12.32	Earth Excavation to Disposal	0.000	CY	$ 40.00	$ -
12.33	Furnish & Place Topsoil 6"	0.000	CY	$ 40.00	$ -
12.40	**RESTORATION**				
12.41	Sod Installation	238.000	SY	$ 12.00	$ 2,856.00
12.42	Roadway Base	8.000	SY	$ 8.00	$ 64.00
12.43	Roadway Pavement	8.000	SY	$ 95.00	$ 760.00
12.44	PCC Curb & Gutter Installation	5.000	LF	$ 35.00	$ 175.00
12.45	Residential Driveway R&R Complete	0.000	SY	$ 60.00	$ -
12.46	Private Property Restoration	0.000	LSUM	$ 40,000.00	$ -
12.47	Native Restoration	0.000	ACRE	$ 40,000.00	$ -
12.48	Maintenance & Monitoring	0.000	YEAR	$ 5,000.00	$ -
12.49	Parkway Tree Installation	0.000	EACH	$ 650.00	$ -
				SUBTOTAL	**$ 140,143.00**

Client:	Joe Tebrugge
	City of Wheaton
	303 West Wesley Street
	Wheaton, Illinois 60187
Phone:	630-848-5010
Email:	JTebrugge@wheaton.il.us

Job Name:	Flood Study
	Erie / Mayo
Date of Plans:	N/A
Revision Date:	N/A
Project#:	17324
Date of Estimate:	7/16/2018

CONCEPTUAL OPINION OF PROBABLE CONSTRUCTION COST

13.00	**A2 - PAULA to CENTER**	**QUANTITY**	**UNIT**	**UNIT PRICE**	**TOTAL**
13.10	**GENERAL CONDITIONS**				
13.11	Mobilization (10%)	1.000	LSUM	$ 59,000.00	$ 59,000.00
13.12	Dry Utility Relocates (20%)	1.000	LSUM	$ 118,000.00	$ 118,000.00
13.13	Tree Removal, Trimming & Root Pruning (2%)	1.000	LSUM	$ 12,000.00	$ 12,000.00
13.14	Undercutting & Backfill For Utilities (10% at 3.00')	16.000	CY	$ 90.00	$ 1,440.00
13.15	Sidewalk Removal	3.000	SY	$ 18.00	$ 54.00
13.16	Pavement Removal	7.000	SY	$ 18.00	$ 126.00
13.17	PCC Curb & Gutter Removal	5.000	LF	$ 5.00	$ 25.00
13.20	**SEWER INSTALLATION**				
13.21	Install 30" RCP Storm Sewer	360.000	LF	$ 160.00	$ 57,600.00
13.22	Install 30" FES Complete	1.000	LF	$ 2,500.00	$ 2,500.00
13.23	5' Storm Structure Installation	2.000	LF	$ 4,500.00	$ 9,000.00
13.24	Trench Backfill	25.000	CY	$ 45.00	$ 1,125.00
13.25	Sanitary Service Repairs	14.000	EACH	$ 2,000.00	$ 28,000.00
13.26	Water Service Repairs	14.000	EACH	$ 2,000.00	$ 28,000.00
13.27	Spoil Removal	25.000	CY	$ 45.00	$ 1,125.00
13.30	**BASIN EXCAVATION**				
13.31	Construction Entrance / Haul Route	575.000	SY	$ 25.00	$ 14,375.00
13.32	Underground Detention	2,210.267	CY	$ 200.00	$ 442,053.33
13.33	Furnish & Place Topsoil 6"	0.000	CY	$ 40.00	$ -
13.40	**RESTORATION**				
13.41	Sod Installation	151.000	SY	$ 12.00	$ 1,812.00
13.42	Roadway Base	7.000	SY	$ 8.00	$ 56.00
13.43	Roadway Pavement	7.000	SY	$ 95.00	$ 665.00
13.44	PCC Curb & Gutter Installation	5.000	LF	$ 35.00	$ 175.00
13.45	Residential Driveway R&R Complete	0.000	SY	$ 60.00	$ -
13.46	Private Property Restoration	0.000	LSUM	$ 40,000.00	$ -
13.47	Native Restoration	0.000	ACRE	$ 40,000.00	$ -
13.48	Maintenance & Monitoring	0.000	YEAR	$ 5,000.00	$ -
13.49	Parkway Tree Installation	0.000	EACH	$ 650.00	$ -
				SUBTOTAL	**$ 777,131.33**

Client:	Joe Tebrugge City of Wheaton 303 West Wesley Street Wheaton, Illinois 60187
Phone:	630-848-5010
Email:	JTebrugge@wheaton.il.us

Job Name:	Flood Study Erie / Mayo
Date of Plans:	N/A
Revision Date:	N/A
Project#:	17324
Date of Estimate:	7/16/2018

CONCEPTUAL OPINION OF PROBABLE CONSTRUCTION COST

14.00	A2 - STORAGE TO MAYO	QUANTITY	UNIT	UNIT PRICE	TOTAL
14.10	**GENERAL CONDITIONS**				
14.11	Mobilization (10%)	1.000	LSUM	$ 159,000.00	$ 159,000.00
14.12	Dry Utility Relocates (20%)	1.000	LSUM	$ 318,000.00	$ 318,000.00
14.13	Tree Removal, Trimming & Root Pruning (2%)	1.000	LSUM	$ 32,000.00	$ 32,000.00
14.14	Undercutting & Backfill For Utilities (10% at 3.00')	7.000	CY	$ 90.00	$ 630.00
14.15	Sidewalk Removal	3.000	SY	$ 18.00	$ 54.00
14.16	Pavement Removal	8.000	SY	$ 18.00	$ 144.00
14.17	PCC Curb & Gutter Removal	5.000	LF	$ 5.00	$ 25.00
14.20	**SEWER INSTALLATION**				
14.21	Install 36" RCP Storm Sewer	145.000	LF	$ 170.00	$ 24,650.00
14.22	Install 36" FES Complete	1.00	LF	$ 3,000.00	$ 3,000.00
14.23	6' Storm Structure Installation	1.000	LF	$ 5,000.00	$ 5,000.00
14.24	Trench Backfill	11.000	CY	$ 45.00	$ 495.00
14.25	Sanitary Service Repairs	0.000	EACH	$ 2,000.00	$ -
14.26	Water Service Repairs	0.000	EACH	$ 2,000.00	$ -
14.27	Spoil Removal	11.000	CY	$ 45.00	$ 495.00
14.30	**BASIN EXCAVATION**				
14.31	Land Acquisition - 1606 Center Ave	1.000	EACH	$ 78,870.00	$ 78,870.00
14.32	Land Acquisition - 1602 Center Ave	1.000	EACH	$ 78,870.00	$ 78,870.00
14.33	Land Acquisition - 1522 Center Ave	1.000	EACH	$ 78,870.00	$ 78,870.00
14.34	Land Acquisition - 1518 Center Ave	1.000	EACH	$ 78,870.00	$ 78,870.00
14.35	Land Acquisition - 1514 Center Ave	1.000	EACH	$ 78,870.00	$ 78,870.00
14.36	Land Acquisition - 1510 Center Ave	1.000	EACH	$ 78,870.00	$ 78,870.00
14.37	Land Acquisition - 1506 Center Ave	1.000	EACH	$ 78,870.00	$ 78,870.00
14.38	Land Acquisition - 1502 Center Ave	1.000	EACH	$ 78,870.00	$ 78,870.00
14.39	Land Acquisition - 1607 Mayo Ave	1.000	EACH	$ 78,390.00	$ 78,390.00
14.40	Land Acquisition - 1603 Mayo Ave	1.000	EACH	$ 78,900.00	$ 78,900.00
14.41	Land Acquisition - 1523 Mayo Ave	1.000	EACH	$ 78,900.00	$ 78,900.00
14.42	Land Acquisition - 1519 Mayo Ave	1.000	EACH	$ 78,900.00	$ 78,900.00
14.43	Land Acquisition - 1515 Mayo Ave	1.000	EACH	$ 78,900.00	$ 78,900.00
14.44	Land Acquisition - 1511 Mayo Ave	1.000	EACH	$ 78,900.00	$ 78,900.00
14.45	Land Acquisition - 1507 Mayo Ave	1.000	EACH	$ 78,900.00	$ 78,900.00
14.46	Land Acquisition - 1503 Mayo Ave	1.000	EACH	$ 78,900.00	$ 78,900.00
14.47	Construction Entrance / Haul Route	575.000	SY	$ 25.00	$ 14,375.00
14.48	Earth Excavation to Disposal	4,969.067	CY	$ 40.00	$ 198,762.67
14.49	Furnish & Place Topsoil 6"	719.630	CY	$ 40.00	$ 28,785.19
14.40	**RESTORATION**				
14.41	Sod Installation	62.000	SY	$ 12.00	$ 744.00
14.42	Roadway Base	8.000	SY	$ 8.00	$ 64.00
14.43	Roadway Pavement	8.000	SY	$ 95.00	$ 760.00
14.44	PCC Curb & Gutter Installation	5.000	LF	$ 35.00	$ 175.00
14.45	Residential Driveway R&R Complete	0.000	SY	$ 60.00	$ -
14.46	Private Property Restoration	0.000	LSUM	$ 40,000.00	$ -
14.47	Native Restoration	0.892	ACRE	$ 40,000.00	$ 35,684.11
14.48	Maintenance & Monitoring	3.000	YEAR	$ 5,000.00	$ 15,000.00
14.49	Parkway Tree Installation	0.000	EACH	$ 650.00	$ -
				SUBTOTAL	**$ 2,099,492.97**

Client:	Joe Tebrugge City of Wheaton 303 West Wesley Street Wheaton, Illinois 60187
Phone:	630-848-5010
Email:	JTebrugge@wheaton.il.us

Job Name:	Flood Study Erie / Mayo
Date of Plans:	N/A
Revision Date:	N/A
Project#:	17324
Date of Estimate:	7/16/2018

CONCEPTUAL OPINION OF PROBABLE CONSTRUCTION COST

15.00	**A2 -WESTHAVEN PARK**	**QUANTITY**	**UNIT**	**UNIT PRICE**	**TOTAL**
15.10	**GENERAL CONDITIONS**				
15.11	Mobilization (10%)	1.000	LSUM	$ 11,000.00	$ 11,000.00
15.12	Dry Utility Relocates (20%)	1.000	LSUM	$ 21,000.00	$ 21,000.00
15.13	Tree Removal, Trimming & Root Pruning (2%)	1.000	LSUM	$ 2,000.00	$ 2,000.00
15.14	Undercutting & Backfill For Utilities (10% at 3.00')	2.000	CY	$ 90.00	$ 180.00
15.15	Sidewalk Removal	0.000	SY	$ 18.00	$ -
15.16	Pavement Removal	4.000	SY	$ 18.00	$ 72.00
15.17	PCC Curb & Gutter Removal	5.000	LF	$ 5.00	$ 25.00
15.20	**SEWER INSTALLATION**				
15.21	Install 12" RCP Storm Sewer	80.000	LF	$ 130.00	$ 10,400.00
15.22	Install 10" FES Complete	1.000	LF	$ 1,500.00	$ 1,500.00
15.23	4' Storm Structure Installation	1.000	LF	$ 4,000.00	$ 4,000.00
15.24	Trench Backfill	7.000	CY	$ 45.00	$ 315.00
15.25	Sanitary Service Repairs	0.000	EACH	$ 2,000.00	$ -
15.26	Water Service Repairs	0.000	EACH	$ 2,000.00	$ -
15.27	Spoil Removal	7.000	CY	$ 45.00	$ 315.00
15.30	**BASIN EXCAVATION**				
15.31	Construction Entrance / Haul Route	575.000	SY	$ 25.00	$ 14,375.00
15.32	Earth Excavation to Disposal	1,113.200	CY	$ 40.00	$ 44,528.00
15.33	Furnish & Place Topsoil 6"	170.000	CY	$ 40.00	$ 6,800.00
15.40	**RESTORATION**				
15.41	Sod Installation	18.000	SY	$ 12.00	$ 216.00
15.42	Roadway Base	4.000	SY	$ 8.00	$ 32.00
15.43	Roadway Pavement	4.000	SY	$ 95.00	$ 380.00
15.44	PCC Curb & Gutter Installation	5.000	LF	$ 35.00	$ 175.00
15.45	Residential Driveway R&R Complete	0.000	SY	$ 60.00	$ -
15.46	Private Property Restoration	0.000	LSUM	$ 40,000.00	$ -
15.47	Native Restoration	0.211	ACRE	$ 40,000.00	$ 8,429.75
15.48	Maintenance & Monitoring	3.000	YEAR	$ 5,000.00	$ 15,000.00
15.49	Parkway Tree Installation	0.000	EACH	$ 650.00	$ -
				SUBTOTAL	**$ 140,742.75**

Client: Joe Tebrugge
City of Wheaton
303 West Wesley Street
Wheaton, Illinois 60187
Phone: 630-848-5010
Email: JTebrugge@wheaton.il.us

Job Name: Flood Study
Erie / Mayo
Date of Plans: N/A
Revision Date: N/A
Project#: 17324
Date of Estimate: 7/16/2018

CONCEPTUAL OPINION OF PROBABLE CONSTRUCTION COST

16.00	**A2 - MADISON PARK**	**QUANTITY**	**UNIT**	**UNIT PRICE**	**TOTAL**
16.10	**GENERAL CONDITIONS**				
16.11	Mobilization (10%)	1.000	LSUM	$ 12,000.00	$ 12,000.00
16.12	Dry Utility Relocates (20%)	1.000	LSUM	$ 24,000.00	$ 24,000.00
16.13	Tree Removal, Trimming & Root Pruning (2%)	1.000	LSUM	$ 2,000.00	$ 2,000.00
16.14	Undercutting & Backfill For Utilities (10% at 3.00')	7.000	CY	$ 90.00	$ 630.00
16.15	Sidewalk Removal	2.000	SY	$ 18.00	$ 36.00
16.16	Pavement Removal	19.000	SY	$ 18.00	$ 342.00
16.17	PCC Curb & Gutter Removal	5.000	LF	$ 5.00	$ 25.00
16.20	**SEWER INSTALLATION**				
16.21	Install 12" RCP Storm Sewer	265.000	LF	$ 130.00	$ 34,450.00
16.22	Install 10" FES Complete	1.000	LF	$ 1,500.00	$ 1,500.00
16.23	2' Storm Structure Installation	1.000	LF	$ 3,000.00	$ 3,000.00
16.24	4' Storm Structure Installation	1.000	LF	$ 4,000.00	$ 4,000.00
16.25	Trench Backfill	35.000	CY	$ 45.00	$ 1,575.00
16.26	Sanitary Service Repairs	0.000	EACH	$ 2,000.00	$ -
16.27	Water Service Repairs	0.000	EACH	$ 2,000.00	$ -
16.28	Spoil Removal	35.000	CY	$ 45.00	$ 1,575.00
16.30	**BASIN EXCAVATION**				
16.31	Construction Entrance / Haul Route	575.000	SY	$ 25.00	$ 14,375.00
16.32	Earth Excavation to Disposal	677.600	CY	$ 40.00	$ 27,104.00
16.33	Furnish & Place Topsoil 6"	168.333	CY	$ 40.00	$ 6,733.33
16.40	**RESTORATION**				
16.41	Sod Installation	53.000	SY	$ 12.00	$ 636.00
16.42	Roadway Base	19.000	SY	$ 8.00	$ 152.00
16.43	Roadway Pavement	19.000	SY	$ 95.00	$ 1,805.00
16.44	PCC Curb & Gutter Installation	5.000	LF	$ 35.00	$ 175.00
16.45	Residential Driveway R&R Complete	0.000	SY	$ 60.00	$ -
16.46	Private Property Restoration	0.000	LSUM	$ 40,000.00	$ -
16.47	Native Restoration	0.209	ACRE	$ 40,000.00	$ 8,347.11
16.48	Maintenance & Monitoring	3.000	YEAR	$ 5,000.00	$ 15,000.00
16.49	Parkway Tree Installation	0.000	EACH	$ 650.00	$ -
				SUBTOTAL	**$ 159,460.44**

Appendix C: Results Tables

Table C1: Erie Area - Existing Conditions Damaged Structures

						1-year			2-year			5-year			10-year			25-year			50-year			100-year			500-year		
Street	Number	Problem Area ID	T/F	LPE (max of LPE, Adj Ground, and LPE Lip)	LPE	High Water Level	Depth of Water Above T/F	Depth of Water Above LPE	High Water Level	Depth of Water Above T/F	Depth of Water Above LPE	High Water Level	Depth of Water Above T/F	Depth of Water Above LPE	High Water Level	Depth of Water Above T/F	Depth of Water Above LPE	High Water Level	Depth of Water Above T/F	Depth of Water Above LPE	High Water Level	Depth of Water Above T/F	Depth of Water Above LPE	High Water Level	Depth of Water Above T/F	Depth of Water Above LPE	High Water Level	Depth of Water Above T/F	Depth of Water Above LPE
Beverly St.	206	A	739.13	739.38	739.38	736.755			737.64			737.72			737.76			737.83			737.91			737.98			738.14		
Beverly St.	202	A	739.93	738.93	738.93	736.755			737.64			737.72			737.76			737.83			737.91			737.98			738.14		
Beverly St.	125	A	744.11	742.91	741.51	737.11			737.83			738.32			738.44			738.58			738.70			738.80			739.04		
Beverly St.	129	A	741.67	740.57	740.57	737.11			737.83			738.32			738.44			738.58			738.70			738.80			739.04		
Beverly St.	203	A	740.25	739.65	739.65	737.11			737.83			738.32			738.44			738.58			738.70			738.80			739.04		
Beverly St.	207	A	740.43	738.98	737.58	737.11			737.83			738.32			738.44			738.58			738.70			738.80			739.04		1.46
Manchester	2016	A	741.59	740.60	740.59	737.11			737.83			738.32			738.44			738.58			738.70			738.80			739.04		
Erie St.	112	A, B	741.39	740.50	740.49	737.692			738.10			738.32			738.45			738.60			738.73			738.85			739.11		
Erie St.	118	A, B	740.61	739.61	739.61	737.692			738.10			738.32			738.45			738.60			738.73			738.85			739.11		
Erie St.	124	A, B	739.84	738.90	738.89	737.692			738.10			738.32			738.45			738.60			738.73			738.85			739.11		0.22
Erie St.	130	A, B	739.27	738.87	738.87	737.692			738.10			738.32			738.45			738.60			738.73			738.85			739.11		0.24
Erie St.	200	A, B	737.70	738.18	736.70	737.692			738.10	0.395		738.32	0.618	1.62	738.45	0.745	1.75	738.60	0.904	1.90	738.73	1.03	2.03	738.85	1.148	2.15	739.11	1.413	2.41
Erie St.	208	A, B	741.22	740.87	739.32	737.692			738.10			738.32			738.45			738.60			738.73			738.85			739.11		
Erie St.	201	B	739.99	738.70	738.49	737.692			738.10			738.32			738.45			738.60			738.73		0.24	738.85		0.36	739.11		0.62
Erie St.	125	B	739.92	740.22	740.22	737.709			738.10			738.32			738.45			738.61			738.73			738.85			739.93	0.013	
Erie St.	119	B	740.48	740.06	740.06	737.709			738.10			738.32			738.45			738.61			738.73			738.85			739.93		
Erie St.	113	B	740.71	740.51	740.51	737.709			738.10			738.32			738.45			738.61			738.73			738.85			739.93		
Erie St.	137	B	740.90	740.50	740.50	737.709			738.10			738.32			738.45			738.61			738.73			738.85			739.93		
Vernon Av.	114	C	743.07	743.80	740.87	735.254			736.28			737.45			738.05			738.81			739.42			740.08			741.11		
Vernon Av.	110	C	741.98	741.78	739.98	735.254			736.28			737.45			738.05			738.81			739.42			740.08			741.11		
Vernon Av.	207	C	748.95	745.30	745.30	737.597			737.65			737.73			738.05			738.81			739.42			740.08			741.11		
Vernon Av.	115	C	743.59	743.19	743.19	737.597			737.65			737.73			738.05			738.81			739.42			740.08			741.11		
Vernon Av.	111	C	740.81	740.51	740.51	737.597			737.65			737.73			738.05			738.81			739.42			740.08			741.11	0.30	0.60
Vernon Av.	107	C	741.00	740.80	740.80	737.597			737.65			737.73			738.05			738.81			739.42			740.08			741.11	0.11	0.31
Clinton	214	C	746.67	746.67	746.67	737.597			737.65			737.73			738.05			738.80			739.42			740.08			741.11		
Clinton	215	C	747.36	743.76	743.76	737.597			737.65			737.73			738.05			738.80			739.42			740.08			741.11		
Hickory Ln.	1770	C	742.03	740.03	740.03	737.597			737.65			737.73			738.05			738.81			739.42			740.08		0.05	741.11		1.08
Hickory Ln.	1750	C	743.26	743.26	743.26	737.597			737.65			737.73			738.05			738.81			739.42			740.08			741.11		
Hickory Ln.	1730	C	744.34	744.34	744.34	737.597			737.65			737.73			738.05			738.81			739.42			740.08			741.11		
Hickory Ln.	1710	C	744.33	744.13	744.13	737.597			737.65			737.73			738.05			738.81			739.42			740.08			741.11		
Hickory Ln.	1745	C	745.16	745.16	743.16	737.597			737.65			737.73			738.05			738.81			739.42			740.08			741.11		
Hickory Ln.	1765	C	744.29	744.29	744.29	737.597			737.65			737.73			738.05			738.81			739.42			740.08			741.11		
Hickory Ln.	1825	C	742.67	743.37	738.17	737.597			737.65			737.73			738.05			738.81			739.42			740.08			741.11		
Hickory Ln.	1845	C	742.26	739.16	739.16	737.597			737.65			737.73			738.05			738.81			739.42		0.26	740.08		0.92	741.11		1.95
Hickory Ln.	1725	C	745.21	744.61	741.56	737.597			737.65			737.73			738.05			738.81			739.42			740.08			741.11		
White Oak Dr.	103	-	744.61	744.61	742.51	737.597			737.65			737.73			738.05			738.80			739.42			740.08			741.11		
White Oak Dr.	107	-	743.82	743.40	739.72	737.597			737.65			737.73			738.05			738.80			739.42			740.08			741.11		
White Oak Dr.	111	-	742.73	742.73	738.23	737.597			737.65			737.73			738.05			738.80			739.42			740.08			741.11		
White Oak Dr.	115	-	744.44	743.90	743.74	737.597			737.65			737.73			738.05			738.80			739.42			740.08			741.11		
White Oak Dr.	119	-	743.44	743.44	743.44	737.597			737.65			737.73			738.05			738.80			739.42			740.08			741.11		
White Oak Dr.	123	-	744.49	743.60	738.69	737.494			737.69			739.54			741.60			742.57			743.23			743.67		4.98	743.88		5.19
White Oak Dr.	127	-	744.69	744.49	740.19	737.494			737.69			739.54			741.60			742.57			743.23			743.67			743.88		
White Oak Dr.	131	-	746.72	743.22	743.22	737.494			737.69			739.54			741.60			742.57			743.23		0.01	743.67		0.45	743.88		0.66
White Oak Dr.	126	-	745.36	745.36	745.36	737.597			737.65			737.73			738.05			738.80			739.42			740.08			741.11		
White Oak Dr.	102	-	742.15	742.15	742.15	737.597			737.65			737.73			738.05			738.80			739.42			740.08			741.11		
White Oak Dr.	106	-	742.29	742.29	742.29	737.597			737.65			737.73			738.05			738.80			739.42			740.08			741.11		
Pierce Av.	111	D	745.51	744.91	744.91	740.062			740.16			741.78			743.15			743.67			743.87			743.97			744.14		
Pierce Av.	115	D	743.80	744.06	744.06	740.062			740.16			741.78			743.15			743.67			743.87	0.07		743.97	0.17		744.14	0.34	0.08
Pierce Av.	119	D	743.43	743.63	743.63	740.062			740.16			741.78			743.15			743.67	0.24	0.03	743.87	0.44	0.24	743.97	0.54	0.34	744.14	0.71	0.51
Pierce Av.	123	D	743.32	743.62	743.62	740.062			740.16			741.78			743.15			743.67	0.34	0.04	743.87	0.54	0.25	743.97	0.65	0.35	744.14	0.82	0.52
Pierce Av.	127	D	744.10	744.40	744.40	740.062			740.16			741.78			743.15			743.67			743.87			743.97			744.14	0.04	
Pierce Av.	131	D	745.17	745.37	745.37	740.062			740.16			741.78			743.15			743.67			743.87			743.97			744.14		
Pierce Av.	130	D	745.26	745.76	745.76	740.062			740.16			741.78			743.15			743.67			743.87			743.97			744.14		
Pierce Av.	126	D	743.99	743.99	743.99	740.062			740.16			741.78			743.15			743.67			743.87			743.97			744.14	0.15	0.15
Pierce Av.	122	D	744.23	744.53	744.53	740.062			740.16			741.78			743.15			743.67			743.87			743.97			744.14		
Pierce Av.	118	D	744.29	744.59	744.59	740.062			740.16			741.78			743.15			743.67			743.87			743.97			744.14		
Pierce Av.	114	D	744.99	745.19	745.19	740.062			740.16			741.78			743.15			743.67			743.87			743.97			744.14		
Morgan Av.	122	D	745.72	740.70	738.78	738.065			739.13			740.27			740.95		2.17	741.77		2.99	742.34		3.56	742.89		4.11	743.96		5.18

Table C1: Erie Area - Existing Conditions Damaged Structures

						1-year			2-year			5-year			10-year			25-year			50-year			100-year			500-year		
Street	Number	Problem Area ID	T/F	LPE (max of LPE, Adj Ground, and LPE Lip)	LPE	High Water Level	Depth of Water Above T/F	Depth of Water Above LPE	High Water Level	Depth of Water Above T/F	Depth of Water Above LPE	High Water Level	Depth of Water Above T/F	Depth of Water Above LPE	High Water Level	Depth of Water Above T/F	Depth of Water Above LPE	High Water Level	Depth of Water Above T/F	Depth of Water Above LPE	High Water Level	Depth of Water Above T/F	Depth of Water Above LPE	High Water Level	Depth of Water Above T/F	Depth of Water Above LPE	High Water Level	Depth of Water Above T/F	Depth of Water Above LPE
Morgan Av.	118	D	741.99	740.90	740.84	738.065			739.13			740.27			740.95		0.11	741.77		0.93	742.34	0.35	1.50	742.89	0.89	2.04	743.96	1.97	3.12
Morgan Av.	114	D	741.77	741.27	740.42	738.065			739.13			740.27			740.95			741.77		1.35	742.34	0.57	1.92	742.89	1.12	2.47	743.96	2.19	3.54
Morgan Av.	110	D	745.88	740.90	738.43	738.065			739.13			740.27			740.95		2.52	741.77		3.34	742.34		3.91	742.89		4.46	743.96		5.53
Morgan Av.	126	D	745.86	745.86	745.86	738.065			739.13			740.27			740.95			741.77			742.34			742.89			743.96		

Note:

It should be noted that the value reported in the column titled “Depth of Water Above LPE” is the depth between the columns "LPE" and "High Water Level". In some cases the adjacent grade or window well lip protects the point of low entry (LPE) at a higher elevation. If the water surface elevation is below the adjacent grade or window well lip, then the low entry is considered protected and there is no value presented in this column. If the water surface elevation is above of the adjacent grade or window well lip and water will reach the point of low entry, then the total depth of water above the low entry point is presented, not just the depth above the adjacent grade or window well lip.

Table C2: Mayo Area - Existing Conditions Damaged Structures

Street	Number	Problem Area ID	T/F	LPE (max of LPE, Adj Ground, and LPE	LPE	1-year High Water Level	1-year Depth of Water Above T/F	1-year Depth of Water Above LPE	2-year High Water Level	2-year Depth of Water Above T/F	2-year Depth of Water Above LPE	5-year High Water Level	5-year Depth of Water Above T/F	5-year Depth of Water Above LPE	10-year High Water Level	10-year Depth of Water Above T/F	10-year Depth of Water Above LPE	25-year High Water Level	25-year Depth of Water Above T/F	25-year Depth of Water Above LPE	50-year High Water Level	50-year Depth of Water Above T/F	50-year Depth of Water Above LPE	100-year High Water Level	100-year Depth of Water Above T/F	100-year Depth of Water Above LPE	500-year High Water Level	500-year Depth of Water Above T/F	500-year Depth of Water Above LPE
Mayo Av.	1611	F, G	728.28	728.13	728.13	725.986			726.05			726.13			726.20			726.42			726.64			726.80			727.19		
Mayo Av.	1607	F, G	728.16	727.86	725.76	725.986			726.05			726.13			726.20			726.42			726.64			726.80			727.19		
Mayo Av.	1603	F, G	728.12	726.82	726.82	725.986			726.05			726.13			726.20			726.42			726.64			726.80			727.19		0.37
Mayo Av.	1523	F, G	727.13	727.13	724.83	725.986			726.05			726.13			726.20			726.42			726.64			726.80			727.19	0.06	2.36
Mayo Av.	1522	G	727.81	726.16	726.16	724.586			724.98			725.73			725.90			726.00			726.05			726.15			726.59		0.43
Mayo Av.	1518	G	726.76	726.56	724.61	724.586			724.98			725.73			725.90			726.00			726.05			726.15			726.59		1.98
Mayo Av.	1514	G	726.58	725.98	725.98	724.586			724.98			725.73			725.90			726.00		0.02	726.05		0.07	726.15		0.17	726.59	0.01	0.61
Mayo Av.	1510	G	726.93	726.33	725.03	724.586			724.98			725.73			725.90			726.00			726.05			726.15			726.59		1.56
Mayo Av.	1506	G	727.85	726.15	726.15	724.586			724.98			725.73			725.90			726.00			726.05			726.15		0.00	726.59		0.44
Mayo Av.	1502	G	726.06	726.06	726.06	724.586			724.98			725.73			725.90			726.00			726.05			726.15	0.092	0.09	726.59	0.53	0.53
Mayo Av.	1503	F, G	729.09	728.74	725.74	725.986			726.05			726.13			726.20			726.42			726.64			726.80			727.19		
Mayo Av.	1507	F, G	729.07	728.87	727.07	725.986			726.05			726.13			726.20			726.42			726.64			726.80			727.19		
Mayo Av.	1511	F, G	728.85	728.35	728.35	725.986			726.05			726.13			726.20			726.42			726.64			726.80			727.19		
Mayo Av.	1515	F, G	727.08	726.78	725.88	725.986			726.05			726.13			726.20			726.42			726.64			726.80		0.92	727.19	0.11	1.31
Mayo Av.	1519	F, G	727.80	726.70	726.70	725.986			726.05			726.13			726.20			726.42			726.64			726.80		0.10	727.19		0.49
Center Av.	1606	F	732.56	732.00	731.96	725.986			726.05			727.00			728.07			728.50			728.72			728.91			729.53		
Center Av.	1602	F	730.78	730.43	730.43	725.986			726.05			727.00			728.07			728.50			728.72			728.91			729.53		
Center Av.	1522	F	730.01	730.21	730.21	725.986			726.05			727.00			728.07			728.50			728.72			728.91			729.53		
Center Av.	1518	F	729.95	730.30	729.75	725.986			726.05			727.00			728.07			728.50			728.72			728.91			729.53		
Center Av.	1514	F	730.01	730.01	728.11	725.986			726.05			727.00			728.07			728.50			728.72			728.91			729.53		
Center Av.	1510	F	729.94	729.64	729.64	725.986			726.05			727.00			728.07			728.50			728.72			728.91			729.53		
Center Av.	1506	F	732.32	732.17	732.17	725.986			726.05			727.00			728.07			728.50			728.72			728.91			729.53		
Center Av.	1511	-	732.33	732.33	732.33	724.751			725.47			727.00			728.07			728.50			728.72			728.91			729.53		
Center Av.	1515	-	734.31	733.30	732.31	724.751			725.47			727.00			728.07			728.50			728.72			728.91			729.53		
Center Av.	1519	-	733.42	733.42	733.42	724.751			725.47			727.00			728.07			728.50			728.72			728.91			729.53		
Center Av.	1523	-	735.23	731.40	731.23	724.751			725.47			727.00			728.07			728.50			728.72			728.91			729.53		
Center Av.	1527	-	735.22	735.27	735.27	724.751			725.47			727.00			728.07			728.50			728.72			728.91			729.53		
Paula Av.	1510	E	741.62	738.42	738.42	729.124			729.35			731.22			734.69			738.71		0.29	739.82		1.40	740.65		2.23	741.66	0.04	3.24
Paula Av.	1516	E	740.49	740.49	739.79	729.124			729.35			731.22			734.69			738.71			739.82			740.65	0.162	0.86	741.66	1.17	1.87
Paula Av.	1518	E	740.84	737.80	737.79	729.124			729.35			731.22			734.69			738.71		0.92	739.82		2.03	740.65		2.86	741.66	0.82	3.87
Paula Av.	1524	E	743.60	739.85	739.85	729.124			729.35			731.22			734.69			738.71			739.82			740.65		0.80	741.66		1.81
Paula Av.	1526	E	745.07	745.07	745.07	729.124			729.35			731.22			734.69			738.71			739.82			740.65			741.66		
Paula Av.	1523	E	743.33	739.58	739.58	729.124			729.35			731.22			734.69			738.71			739.82		0.24	740.65		1.07	741.66		2.08
Paula Av.	1519	E	741.84	741.20	741.19	729.124			729.35			731.22			734.69			738.71			739.82			740.65			741.66		0.47
Paula Av.	1515	E	741.58	738.60	738.58	729.124			729.35			731.22			734.69			738.71		0.13	739.82		1.24	740.65		2.07	741.66	0.08	3.08
Paula Av.	1511	E	744.08	740.53	740.53	729.124			729.35			731.22			734.69			738.71			739.82			740.65		0.12	741.66		1.13
Paula Av.	1507	E	745.56	740.41	740.41	729.124			729.35			731.22			734.69			738.71			739.82			740.65		0.24	741.66		1.25

Note:

It should be noted that the value reported in the column titled "Depth of Water Above LPE" is the depth between the columns "LPE" and "High Water Level". In some cases the adjacent grade or window well lip protects the point of low entry (LPE) at a higher elevation. If the water surface elevation is below the adjacent grade or window well lip, then the low entry is considered protected and there is no value presented in this column. If the water surface elevation is above of the adjacent grade or window well lip and water will reach the point of low entry, then the total depth of water above the low entry point is presented, not just the depth above the adjacent grade or window well lip.

Table C3: Erie Area - Proposed Conditions Damaged Structures

Street	Number	Problem Area ID	T/F	LPE (max of LPE, Adj Ground, and LPE	LPE	Proposed Alternative 1			Proposed Alternative 2		
						High Water Level	Depth of Water Above T/F	Depth of Water Above LPE	High Water Level	Depth of Water Above T/F	Depth of Water Above LPE
Beverly St.	206	A	739.13	739.38	739.38	736.43			737.89		
Beverly St.	202	A	739.93	738.93	738.93	736.43			737.89		
Beverly St.	125	A	744.11	742.91	741.51	737.68			738.68		
Beverly St.	129	A	741.67	740.57	740.57	737.68			738.68		
Beverly St.	203	A	740.25	739.65	739.65	737.68			738.68		
Beverly St.	207	A	740.43	738.98	737.58	737.68			738.68		
Manchester	2016	A	741.59	740.60	740.59	737.68			738.68		
Erie St.	112	A, B	741.39	740.50	740.49	738.06			738.70		
Erie St.	118	A, B	740.61	739.61	739.61	738.06			738.70		
Erie St.	124	A, B	739.84	738.90	738.89	738.06			738.70		
Erie St.	130	A, B	739.27	738.87	738.87	738.06			738.70		
Erie St.	200	A, B	737.7	738.18	736.70	738.06			738.70		Str Removed
Erie St.	208	A, B	741.22	740.87	739.32	738.06			738.70		
Erie St.	201	B	739.99	738.70	738.49	738.06			738.70		
Erie St.	125	B	739.92	740.22	740.22	738.06			738.71		
Erie St.	119	B	740.48	740.06	740.06	738.06			738.71		
Erie St.	113	B	740.71	740.51	740.51	738.06			738.71		
Erie St.	137	B	740.9	740.50	740.50	738.06			738.71		
Vernon Av.	114	C	743.07	743.80	740.87	738.94			739.15		
Vernon Av.	110	C	741.98	741.78	739.98	738.94			739.15		
Vernon Av.	207	C	748.95	745.30	745.30	738.97			739.15		
Vernon Av.	115	C	743.59	743.19	743.19	738.97			739.15		
Vernon Av.	111	C	740.81	740.51	740.51	738.97			739.15		
Vernon Av.	107	C	741	740.80	740.80	738.97			739.15		
Clinton	214	C	746.67	746.67	746.67	738.97			739.15		
Clinton	215	C	747.36	743.76	743.76	738.97			739.15		
Hickory Ln.	1770	C	742.03	740.03	740.03	738.97			739.15		
Hickory Ln.	1750	C	743.26	743.26	743.26	738.97			739.15		
Hickory Ln.	1730	C	744.34	744.34	744.34	738.97			739.15		
Hickory Ln.	1710	C	744.33	744.13	744.13	738.97			739.15		
Hickory Ln.	1745	C	745.16	745.16	743.16	738.97			739.15		
Hickory Ln.	1765	C	744.29	744.29	744.29	738.97			739.15		
Hickory Ln.	1825	C	742.67	743.37	738.17	738.97			739.15		
Hickory Ln.	1845	C	742.26	739.16	739.16	738.97			739.15		
Hickory Ln.	1725	C	745.21	744.61	741.56	738.97			739.15		
White Oak Dr.	103	-	744.61	744.61	742.51	738.97			739.15		
White Oak Dr.	107	-	743.82	743.40	739.72	738.97			739.15		
White Oak Dr.	111	-	742.73	742.73	738.23	738.97			739.15		
White Oak Dr.	115	-	744.44	743.90	743.74	738.97			739.15		
White Oak Dr.	119	-	743.44	743.44	743.44	738.97			739.15		
White Oak Dr.	123	-	744.49	743.60	738.69	743.63		Str Floodproofed	743.62		Str Floodproofed
White Oak Dr.	127	-	744.69	744.49	740.19	743.63			743.62		
White Oak Dr.	131	-	746.72	743.22	743.22	743.63		Str Floodproofed	743.62		Str Floodproofed
White Oak Dr.	126	-	745.36	745.36	745.36	738.97			739.15		
White Oak Dr.	102	-	742.15	742.15	742.15	738.97			739.15		
White Oak Dr.	106	-	742.29	742.29	742.29	738.97			739.15		
Pierce Av.	111	D	745.51	744.91	744.91	742.21			742.84		
Pierce Av.	115	D	743.8	744.06	744.06	742.21			742.84		
Pierce Av.	119	D	743.43	743.63	743.63	742.21			742.84		
Pierce Av.	123	D	743.32	743.62	743.62	742.21			742.84		
Pierce Av.	127	D	744.1	744.40	744.40	742.21			742.84		
Pierce Av.	131	D	745.17	745.37	745.37	742.21			742.84		
Pierce Av.	130	D	745.26	745.76	745.76	743.63			743.62		
Pierce Av.	126	D	743.99	743.99	743.99	743.63			743.62		
Pierce Av.	122	D	744.23	744.53	744.53	743.63			743.62		
Pierce Av.	118	D	744.29	744.59	744.59	743.63			743.62		
Pierce Av.	114	D	744.99	745.19	745.19	743.63			743.62		
Morgan Av.	122	D	745.72	740.70	738.78	740.59			742.03		Str Removed

Table C3: Erie Area - Proposed Conditions Damaged Structures

Street	Number	Problem Area ID	T/F	LPE (max of LPE, Adj Ground, and LPE	LPE	Proposed Alternative 1			Proposed Alternative 2		
						High Water Level	Depth of Water Above T/F	Depth of Water Above LPE	High Water Level	Depth of Water Above T/F	Depth of Water Above LPE
Morgan Av.	118	D	741.99	740.90	740.84	740.59			742.03		Str Removed
Morgan Av.	114	D	741.77	741.27	740.42	740.59			742.03		Str Removed
Morgan Av.	110	D	745.88	740.90	738.43	740.59			742.03		Str Removed
Morgan Av.	126	D	745.86	745.86	745.86	740.59			742.03		

Table C4: Mayo Area - Proposed Conditions Damaged Structures

Street	Number	Problem Area ID	T/F	LPE (max of LPE, Adj Ground, and LPE Lip)	LPE	Proposed Alternative 1			Proposed Alternative 2		
						High Water Level	Depth of Water Above T/F	Depth of Water Above LPE	High Water Level	Depth of Water Above T/F	Depth of Water Above LPE
Mayo Av.	1611	F, G	728.28	728.13	728.13	726.34			726.51		
Mayo Av.	1607	F, G	728.16	727.86	725.76	726.34			726.51		
Mayo Av.	1603	F, G	728.12	726.82	726.82	726.34			726.51		
Mayo Av.	1523	F, G	727.13	727.13	724.83	726.34			726.51		
Mayo Av.	1522	G	727.81	726.16	726.16	725.85			725.93		
Mayo Av.	1518	G	726.76	726.56	724.61	725.85			725.93		
Mayo Av.	1514	G	726.58	725.98	725.98	725.85			725.93		
Mayo Av.	1510	G	726.93	726.33	725.03	725.85			725.93		
Mayo Av.	1506	G	727.85	726.15	726.15	725.85			725.93		
Mayo Av.	1502	G	726.06	726.06	726.06	725.85			725.93		
Mayo Av.	1503	F, G	729.09	728.74	725.74	726.34			726.51		
Mayo Av.	1507	F, G	729.07	728.87	727.07	726.34			726.51		
Mayo Av.	1511	F, G	728.85	728.35	728.35	726.34			726.51		
Mayo Av.	1515	F, G	727.08	726.78	725.88	726.34			726.51		
Mayo Av.	1519	F, G	727.8	726.70	726.70	726.34			726.51		
Center Av.	1606	F	732.56	732.00	731.96	729.12			728.73		
Center Av.	1602	F	730.78	730.43	730.43	729.12			728.73		
Center Av.	1522	F	730.01	730.21	730.21	729.12			728.73		
Center Av.	1518	F	729.95	730.30	729.75	729.12			728.73		
Center Av.	1514	F	730.01	730.01	728.11	729.12			728.73		
Center Av.	1510	F	729.94	729.64	729.64	729.12			728.73		
Center Av.	1506	F	732.32	732.17	732.17	729.12			728.73		
Center Av.	1511	-	732.33	732.33	732.33	729.12			728.73		
Center Av.	1515	-	734.31	733.30	732.31	729.12			728.73		
Center Av.	1519	-	733.42	733.42	733.42	729.12			728.73		
Center Av.	1523	-	735.23	731.40	731.23	729.12			728.73		
Center Av.	1527	-	735.22	735.27	735.27	729.12			728.73		
Paula Av.	1510	E	741.62	738.42	738.42	737.16			737.23		
Paula Av.	1516	E	740.49	740.49	739.79	737.16			737.23		
Paula Av.	1518	E	740.84	737.80	737.79	737.16			737.23		
Paula Av.	1524	E	743.6	739.85	739.85	737.16			737.23		
Paula Av.	1526	E	745.07	745.07	745.07	737.16			737.23		
Paula Av.	1523	E	743.33	739.58	739.58	737.16			737.23		
Paula Av.	1519	E	741.84	741.20	741.19	737.16			737.23		
Paula Av.	1515	E	741.58	738.60	738.58	737.16			737.23		
Paula Av.	1511	E	744.08	740.53	740.53	737.16			737.23		
Paula Av.	1507	E	745.56	740.41	740.41	737.16			737.23		

Table C5: Erie Area - Structure Floodproofing for the 100-year Storm Event

Street	Number	Problem Area ID	T/F	LPE (max of LPE, Adj Ground, and LPE Lip)	LPE	Existing 100-yr Max WSEL	Existing Depth of 100-yr Flood Above T/F	Existing Depth of 100-yr Flood Above Low Entry	Alternative 1 Max WSEL	Alternative 1 Depth of 100-yr Flood Above T/F	Alternative 1 Depth of 100-yr Flood Above Low Entry	Alternative 2 Max WSEL	Alternative 2 Depth of 100-yr Flood Above T/F	Alternative 2 Depth of 100-yr Flood Above Low Entry	Location of Low Entry	Potential Floodproofing Remedy	Cost to Floodproof Foundation	Cost to Floodproof LPE	Total Structure Cost
Beverly St.	206	A	739.13	739.38	739.38	737.98			736.43			737.89			BASEMENT SILL	RAISED WINDOW WELLS	$0	$0	$0
Beverly St.	202	A	739.93	738.93	738.93	737.98			736.43			737.89			GFE	DRIVEWAY BERM OR REMOVABLE FLOOD SHIELD	$0	$0	$0
Beverly St.	125	A	744.11	742.91	741.51	738.80			737.68			738.68			BASEMENT SILL	RAISED WINDOW WELLS	$0	$0	$0
Beverly St.	129	A	741.67	740.57	740.57	738.80			737.68			738.68			BASEMENT SILL	RAISED WINDOW WELLS	$0	$0	$0
Beverly St.	203	A	740.25	739.65	739.65	738.80			737.68			738.68			BASEMENT SILL	RAISED WINDOW WELLS	$0	$0	$0
Beverly St.	207	A	740.43	738.98	737.58	738.80			737.68			738.68			BASEMENT SILL	RAISED WINDOW WELLS	$0	$0	$0
Manchester	2016	A	741.59	740.60	740.59	738.80			737.68			738.68			GFE	DRIVEWAY BERM OR REMOVABLE FLOOD SHIELD	$0	$0	$0
Erie St.	112	A, B	741.39	740.50	740.49	738.85			738.06			738.70			GFE	DRIVEWAY BERM OR REMOVABLE FLOOD SHIELD	$0	$0	$0
Erie St.	118	A, B	740.61	739.61	739.61	738.85			738.06			738.70			GFE	DRIVEWAY BERM OR REMOVABLE FLOOD SHIELD	$0	$0	$0
Erie St.	124	A, B	739.84	738.90	738.89	738.85			738.06			738.70			GFE	DRIVEWAY BERM OR REMOVABLE FLOOD SHIELD	$0	$0	$0
Erie St.	130	A, B	739.27	738.87	738.87	738.85			738.06			738.70			BASEMENT WINDOW WELL	RAISED WINDOW WELLS	$0	$0	$0
Erie St.	200	A, B	737.70	738.18	736.70	738.85	1.15	2.15	738.06			738.70		Str Removed	GFE	DRIVEWAY BERM OR REMOVABLE FLOOD SHIELD	$100,000	$0	$100,000
Erie St.	208	A, B	741.22	740.87	739.32	738.85			738.06			738.70			BASEMENT SILL	RAISED WINDOW WELLS	$0	$0	$0
Erie St.	201	B	739.99	738.70	738.49	738.85		0.36	738.06			738.70			GFE	DRIVEWAY BERM OR REMOVABLE FLOOD SHIELD	$0	$20,000	$20,000
Erie St.	125	B	739.92	740.22	740.22	738.85			738.06			738.71			BASEMENT SILL	RAISED WINDOW WELLS	$0	$0	$0
Erie St.	119	B	740.48	740.06	740.06	738.85			738.06			738.71			T/STAIRS BASEMENT DOOR	REMOVABLE FLOOD SHIELD (FOR DOOR)	$0	$0	$0
Erie St.	113	B	740.71	740.51	740.51	738.85			738.06			738.71			T/STAIRS BASEMENT DOOR	REMOVABLE FLOOD SHIELD (FOR DOOR)	$0	$0	$0
Erie St.	137	B	740.90	740.50	740.50	738.85			738.06			738.71			BASEMENT WINDOW WELL	RAISED WINDOW WELLS	$0	$0	$0
Vernon Av.	114	C	743.07	743.80	740.87	740.08			738.94			739.15			BASEMENT WINDOW WELL	RAISED WINDOW WELLS	$0	$0	$0
Vernon Av.	110	C	741.98	741.78	739.98	740.08			738.94			739.15			BASEMENT WINDOW WELL	RAISED WINDOW WELLS	$0	$0	$0
Vernon Av.	207	C	748.95	745.30	745.30	740.08			738.97			739.15			BASEMENT SILL	RAISED WINDOW WELLS	$0	$0	$0
Vernon Av.	115	C	743.59	743.19	743.19	740.08			738.97			739.15			BASEMENT WINDOW WELL	RAISED WINDOW WELLS	$0	$0	$0
Vernon Av.	111	C	740.81	740.51	740.51	740.08			738.97			739.15			BASEMENT WINDOW WELL	RAISED WINDOW WELLS	$0	$0	$0
Vernon Av.	107	C	741.00	740.80	740.80	740.08			738.97			739.15			BASEMENT WINDOW WELL	RAISED WINDOW WELLS	$0	$0	$0
Clinton	214	C	746.67	746.67	746.67	740.08			738.97			739.15			GFE/TF	ADDITIONAL DRAINAGE IMPROVEMENTS	$0	$0	$0
Clinton	215	C	747.36	743.76	743.76	740.08			738.97			739.15			BASEMENT SILL	RAISED WINDOW WELLS	$0	$0	$0
Hickory Ln.	1770	C	742.03	740.03	740.03	740.08		0.05	738.97			739.15			BASEMENT SILL	RAISED WINDOW WELLS	$0	$2,000	$2,000
Hickory Ln.	1750	C	743.26	743.26	743.26	740.08			738.97			739.15			GFE/TF	ADDITIONAL DRAINAGE IMPROVEMENTS	$0	$0	$0
Hickory Ln.	1730	C	744.34	744.34	744.34	740.08			738.97			739.15			BASEMENT WINDOW WELL	RAISED WINDOW WELLS	$0	$0	$0
Hickory Ln.	1710	C	744.33	744.13	744.13	740.08			738.97			739.15			BASEMENT WINDOW WELL	RAISED WINDOW WELLS	$0	$0	$0
Hickory Ln.	1745	C	745.16	745.16	743.16	740.08			738.97			739.15			BASEMENT WINDOW WELL	RAISED WINDOW WELLS	$0	$0	$0
Hickory Ln.	1765	C	744.29	744.29	744.29	740.08			738.97			739.15			BASEMENT WINDOW WELL	RAISED WINDOW WELLS	$0	$0	$0
Hickory Ln.	1825	C	742.67	743.37	738.17	740.08			738.97			739.15			BASEMENT WINDOW WELL	RAISED WINDOW WELLS	$0	$0	$0
Hickory Ln.	1845	C	742.26	739.16	739.16	740.08		0.92	738.97			739.15			BASEMENT SILL	RAISED WINDOW WELLS	$0	$2,000	$2,000
Hickory Ln.	1725	C	745.21	744.61	741.56	740.08			738.97			739.15			BASEMENT WINDOW WELL	RAISED WINDOW WELLS	$0	$0	$0
White Oak Dr.	103	-	744.61	744.61	742.51	740.08			738.97			739.15			BASEMENT WINDOW WELL	RAISED WINDOW WELLS	$0	$0	$0
White Oak Dr.	107	-	743.82	743.40	739.72	740.08			738.97			739.15			BASEMENT SILL	RAISED WINDOW WELLS	$0	$0	$0
White Oak Dr.	111	-	742.73	742.73	738.23	740.08			738.97			739.15			BASEMENT WINDOW WELL	RAISED WINDOW WELLS	$0	$0	$0
White Oak Dr.	115	-	744.44	743.90	743.74	740.08			738.97			739.15			CRAWL VENT	N/A	$0	$0	$0
White Oak Dr.	119	-	743.44	743.44	743.44	740.08			738.97			739.15			BASEMENT WINDOW WELL	RAISED WINDOW WELLS	$0	$0	$0
White Oak Dr.	123	-	744.49	743.60	738.69	743.67		4.98	743.63		Str Floodproofed	743.62		Str Floodproofed	BASEMENT SLIDING DOOR	REMOVABLE FLOOD SHIELD (FOR DOOR)	$0	$3,000	$3,000
White Oak Dr.	127	-	744.69	744.49	740.19	743.67			743.63			743.62			BASEMENT WINDOW WELL	RAISED WINDOW WELLS	$0	$0	$0
White Oak Dr.	131	-	746.72	743.22	743.22	743.67		0.45	743.63		Str Floodproofed	743.62		Str Floodproofed	BASEMENT SILL	RAISED WINDOW WELLS	$0	$2,000	$2,000
White Oak Dr.	126	-	745.36	745.36	745.36	740.08			738.97			739.15			BASEMENT WINDOW WELL	RAISED WINDOW WELLS	$0	$0	$0
White Oak Dr.	102	-	742.15	742.15	742.15	740.08			738.97			739.15			BASEMENT WINDOW WELL	RAISED WINDOW WELLS	$0	$0	$0
White Oak Dr.	106	-	742.29	742.29	742.29	740.08			738.97			739.15			BASEMENT WINDOW WELL	RAISED WINDOW WELLS	$0	$0	$0
Pierce Av.	111	D	745.51	744.91	744.91	743.97			742.21			742.84			BASEMENT WINDOW WELL	RAISED WINDOW WELLS	$0	$0	$0
Pierce Av.	115	D	743.80	744.06	744.06	743.97	0.17		742.21			742.84			CRAWL VENT	N/A	$100,000	$0	$100,000
Pierce Av.	119	D	743.43	743.63	743.63	743.97	0.54	0.34	742.21			742.84			BASEMENT SILL	RAISED WINDOW WELLS	$100,000	$0	$100,000
Pierce Av.	123	D	743.32	743.62	743.62	743.97	0.65	0.35	742.21			742.84			BASEMENT SILL	RAISED WINDOW WELLS	$100,000	$0	$100,000
Pierce Av.	127	D	744.10	744.40	744.40	743.97			742.21			742.84			BASEMENT SILL	RAISED WINDOW WELLS	$0	$0	$0
Pierce Av.	131	D	745.17	745.37	745.37	743.97			742.21			742.84			CRAWL VENT	N/A	$0	$0	$0
Pierce Av.	130	D	745.26	745.76	745.76	743.97			743.63			743.62			CRAWL VENT	N/A	$0	$0	$0
Pierce Av.	126	D	743.99	743.99	743.99	743.97			743.63			743.62			TF	ADDITIONAL DRAINAGE IMPROVEMENTS	$0	$0	$0
Pierce Av.	122	D	744.23	744.53	744.53	743.97			743.63			743.62			BASEMENT SILL	RAISED WINDOW WELLS	$0	$0	$0
Pierce Av.	118	D	744.29	744.59	744.59	743.97			743.63			743.62			BASEMENT SILL	RAISED WINDOW WELLS	$0	$0	$0

Table C5: Erie Area - Structure Floodproofing for the 100-year Storm Event

Street	Number	Problem Area ID	T/F	LPE (max of LPE, Adj Ground, and LPE Lip)	LPE	Existing 100-yr Max WSEL	Existing Depth of 100-yr Flood Above T/F	Existing Depth of 100-yr Flood Above Low Entry	Alternative 1 Max WSEL	Alternative 1 Depth of 100-yr Flood Above T/F	Alternative 1 Depth of 100-yr Flood Above Low Entry	Alternative 2 Max WSEL	Alternative 2 Depth of 100-yr Flood Above T/F	Alternative 2 Depth of 100-yr Flood Above Low Entry	Location of Low Entry	Potential Floodproofing Remedy	Cost to Floodproof Foundation	Cost to Floodproof LPE	Total Structure Cost
Pierce Av.	114	D	744.99	745.19	745.19	743.97			743.63			743.62			CRAWL VENT	N/A	$0	$0	$0
Morgan Av.	122	D	745.72	740.70	738.78	742.89		4.11	740.59			742.03		Str Removed	BASEMENT DOOR	REMOVABLE FLOOD SHIELD (FOR DOOR)	$0	$3,000	$3,000
Morgan Av.	118	D	741.99	740.90	740.84	742.89	0.89	2.04	740.59			742.03		Str Removed	BASEMENT SILL	RAISED WINDOW WELLS	$100,000	$0	$100,000
Morgan Av.	114	D	741.77	741.27	740.42	742.89	1.12	2.47	740.59			742.03		Str Removed	BASEMENT WINDOW WELL	RAISED WINDOW WELLS	$100,000	$0	$100,000
Morgan Av.	110	D	745.88	740.90	738.43	742.89		4.46	740.59			742.03		Str Removed	GFE	DRIVEWAY BERM OR REMOVABLE FLOOD SHIELD	$0	$20,000	$20,000
Morgan Av.	126	D	745.86	745.86	745.86	742.89			740.59			742.03			TF AT SE X	ADDITIONAL DRAINAGE IMPROVEMENTS	$0	$0	$0

Table C6: Mayo Area - Structure Floodproofing for the 100-year Storm Event

Street	Number	Problem Area ID	T/F	LPE (max of LPE, Adj Ground, and LPE Lip)	LPE	Existing 100-yr Max WSEL	Existing Depth of 100-yr Flood Above T/F	Existing Depth of 100-yr Flood Above Low Entry	Alternative 1 Max WSEL	Alternative 1 Depth of 100-yr Flood Above T/F	Alternative 1 Depth of 100-yr Flood Above Low Entry	Alternative 2 Max WSEL	Alternative 2 Depth of 100-yr Flood Above T/F	Alternative 2 Depth of 100-yr Flood Above Low Entry	Location of Low Entry	Potential Floodproofing Remedy	Cost to Floodproof Foundation	Cost to Floodproof LPE	Total Structure Cost
Mayo Av.	1611	F, G	728.28	728.13	728.13	726.80			726.34			726.51			GFE	DRIVEWAY BERM OR REMOVABLE FLOOD SHIELD	$0	$0	$0
Mayo Av.	1607	F, G	728.16	727.86	725.76	726.80			726.34			726.51			BASEMENT WINDOW WELL	RAISED WINDOW WELLS	$0	$0	$0
Mayo Av.	1603	F, G	728.12	726.82	726.82	726.80			726.34			726.51			BASEMENT SILL	RAISED WINDOW WELLS	$0	$0	$0
Mayo Av.	1523	F, G	727.13	727.13	724.83	726.80			726.34			726.51			BASEMENT WINDOW WELL	RAISED WINDOW WELLS	$0	$0	$0
Mayo Av.	1522	G	727.81	726.16	726.16	726.15			725.85			725.93			BASEMENT SILL	RAISED WINDOW WELLS	$0	$0	$0
Mayo Av.	1518	G	726.76	726.56	724.61	726.15			725.85			725.93			BASEMENT WINDOW WELL	RAISED WINDOW WELLS	$0	$0	$0
Mayo Av.	1514	G	726.58	725.98	725.98	726.15		0.17	725.85			725.93			BASEMENT WINDOW WELL	RAISED WINDOW WELLS	$0	$2,000	$2,000
Mayo Av.	1510	G	726.93	726.33	725.03	726.15			725.85			725.93			BASEMENT WINDOW WELL	RAISED WINDOW WELLS	$0	$0	$0
Mayo Av.	1506	G	727.85	726.15	726.15	726.15		0.00	725.85			725.93			BASEMENT SILL	RAISED WINDOW WELLS	$0	$2,000	$2,000
Mayo Av.	1502	G	726.06	726.06	726.06	726.15	0.09	0.09	725.85			725.93			GFE	DRIVEWAY BERM OR REMOVABLE FLOOD SHIELD	$100,000	$0	$100,000
Mayo Av.	1503	F, G	729.09	728.74	725.74	726.80			726.34			726.51			BASEMENT WINDOW WELL	RAISED WINDOW WELLS	$0	$0	$0
Mayo Av.	1507	F, G	729.07	728.87	727.07	726.80			726.34			726.51			BASEMENT WINDOW WELL	RAISED WINDOW WELLS	$0	$0	$0
Mayo Av.	1511	F, G	728.85	728.35	728.35	726.80			726.34			726.51			BASEMENT WINDOW WELL	RAISED WINDOW WELLS	$0	$0	$0
Mayo Av.	1515	F, G	727.08	726.78	725.88	726.80		0.92	726.34			726.51			BASEMENT WINDOW WELL	RAISED WINDOW WELLS	$0	$2,000	$2,000
Mayo Av.	1519	F, G	727.80	726.70	726.70	726.80		0.10	726.34			726.51			BASEMENT SILL BLOCKED IN	N/A	$0	$0	$0
Center Av.	1606	F	732.56	732.00	731.96	728.91			729.12			728.73			GFE	DRIVEWAY BERM OR REMOVABLE FLOOD SHIELD	$0	$0	$0
Center Av.	1602	F	730.78	730.43	730.43	728.91			729.12			728.73			GFE	DRIVEWAY BERM OR REMOVABLE FLOOD SHIELD	$0	$0	$0
Center Av.	1522	F	730.01	730.21	730.21	728.91			729.12			728.73			BASEMENT WINDOW WELL	RAISED WINDOW WELLS	$0	$0	$0
Center Av.	1518	F	729.95	730.30	729.75	728.91			729.12			728.73			GFE	DRIVEWAY BERM OR REMOVABLE FLOOD SHIELD	$0	$0	$0
Center Av.	1514	F	730.01	730.01	728.11	728.91			729.12			728.73			BASEMENT SILL	RAISED WINDOW WELLS	$0	$0	$0
Center Av.	1510	F	729.94	729.64	729.64	728.91			729.12			728.73			GFE	DRIVEWAY BERM OR REMOVABLE FLOOD SHIELD	$0	$0	$0
Center Av.	1506	F	732.32	732.17	732.17	728.91			729.12			728.73			GFE	DRIVEWAY BERM OR REMOVABLE FLOOD SHIELD	$0	$0	$0
Center Av.	1511	-	732.33	732.33	732.33	728.91			729.12			728.73			GFE	DRIVEWAY BERM OR REMOVABLE FLOOD SHIELD	$0	$0	$0
Center Av.	1515	-	734.31	733.30	732.31	728.91			729.12			728.73			BASEMENT WINDOW WELL	RAISED WINDOW WELLS	$0	$0	$0
Center Av.	1519	-	733.42	733.42	733.42	728.91			729.12			728.73			BASEMENT WINDOW WELL	RAISED WINDOW WELLS	$0	$0	$0
Center Av.	1523	-	735.23	731.40	731.23	728.91			729.12			728.73			GFE	DRIVEWAY BERM OR REMOVABLE FLOOD SHIELD	$0	$0	$0
Center Av.	1527	-	735.22	735.27	735.27	728.91			729.12			728.73			GFE	DRIVEWAY BERM OR REMOVABLE FLOOD SHIELD	$0	$0	$0
Paula Av.	1510	E	741.62	738.42	738.42	740.65		2.23	737.16			737.23			GFE	DRIVEWAY BERM OR REMOVABLE FLOOD SHIELD	$0	$20,000	$20,000
Paula Av.	1516	E	740.49	740.49	739.79	740.65	0.16	0.86	737.16			737.23			BASEMENT WINDOW WELL	RAISED WINDOW WELLS	$100,000	$0	$100,000
Paula Av.	1518	E	740.84	737.80	737.79	740.65		2.86	737.16			737.23			GFE	DRIVEWAY BERM OR REMOVABLE FLOOD SHIELD	$0	$20,000	$20,000
Paula Av.	1524	E	743.60	739.85	739.85	740.65		0.80	737.16			737.23			GFE	DRIVEWAY BERM OR REMOVABLE FLOOD SHIELD	$0	$20,000	$20,000
Paula Av.	1526	E	745.07	745.07	745.07	740.65			737.16			737.23			GFE	DRIVEWAY BERM OR REMOVABLE FLOOD SHIELD	$0	$0	$0
Paula Av.	1523	E	743.33	739.58	739.58	740.65		1.07	737.16			737.23			GFE	DRIVEWAY BERM OR REMOVABLE FLOOD SHIELD	$0	$20,000	$20,000
Paula Av.	1519	E	741.84	741.20	741.19	740.65			737.16			737.23			GFE	DRIVEWAY BERM OR REMOVABLE FLOOD SHIELD	$0	$0	$0
Paula Av.	1515	E	741.58	738.60	738.58	740.65		2.07	737.16			737.23			GFE	DRIVEWAY BERM OR REMOVABLE FLOOD SHIELD	$0	$20,000	$20,000
Paula Av.	1511	E	744.08	740.53	740.53	740.65		0.12	737.16			737.23			GFE	DRIVEWAY BERM OR REMOVABLE FLOOD SHIELD	$0	$20,000	$20,000
Paula Av.	1507	E	745.56	740.41	740.41	740.65		0.24	737.16			737.23			GFE	DRIVEWAY BERM OR REMOVABLE FLOOD SHIELD	$0	$20,000	$20,000

Appendix D: Floodproofing Alternatives

Floodproofing Alternatives

A variety of floodproofing alternatives exist to provide protection to homes with low entry elevations below the expected water surface elevations. These include grading modifications such as driveway berms or berms/walls around a home; wet floodproofing options such as flow-through vents and utility elevation; dry floodproofing measures such as raised window wells or flood shields at exterior openings; or structural elevation.

A summary of each type of measure is presented in this appendix. It is expected that the following floodproofing measures could provide additional flood protection to a majority of the homes that are shown to have damage elevations below the low-entry elevation, and likely to be the most cost-effective within the study area.

- Driveway berms on reverse-slope driveways;
- Front yard berms where the home is low relative to street and surrounding grade;
- Dry floodproofing by raising window wells or using glass block windows;
- Dry floodproofing by placing removable flood shields at a window or door.

A full list of floodproofing options included in this appendix is as follows:

GRADING

Properties that do not have adequate grading can re-grade their yards. The ground around the perimeter of the building should slope away from the structure to prevent stormwater runoff from ponding against the foundation wall, where it can seep into the building. Some of the advantages and disadvantages to re-grading landscaped areas are as follows:

Advantages

- Very effective in areas with shallow flooding,
- Lower capital costs than other flood mitigation strategies.

Disadvantages

- Cooperation may be needed from adjacent property owners,
- Flood insurance premiums will not be reduced for properties located in the floodplain, and
- Areas within the regulatory floodplain are restricted in that they cannot place fill in those areas.

If re-grading a yard is found to be the best alternative to reduce structural flooding, the following points should be considered:

- An elevation change of at least 1 foot over 10 feet (1% slope) from the exterior wall of the home is needed to adequately direct water away from the structure,
- Lot grading should direct water to an acceptable drainage outlet, and
- Discharges of stormwater should not negatively impact neighboring properties.

Areas where water naturally flows toward the structure can benefit from re-grading the yard. If water flows toward the building, a new swale or wall can direct the flow to the street or drainage-way. Filling and grading next to the building can also direct shallow flooding to the yard. When these types of drainage modifications are made, care must be taken not to adversely affect the drainage patterns of adjacent properties.

Often, water flows to a low entry point, such as a basement window well or patio door. Regrading around the structure can reduce the occurrence of structural flooding. Some ways to improve the grading around the structure include:

- Driveway berms, and
- Barriers (berms/levees/floodwalls)

These alternatives are discussed in detail in the following paragraphs.

Driveway Berms

Reverse sloped driveways are often used in high-density neighborhoods, where there is not sufficient area for external garages. This type of driveway, however, creates a significant flood risk as it can direct overland stormwater flows into homes. Water that enters homes through reverse sloped driveways can cause structural damage, and also contribute to sewer backups, if this water enters basement floor drains.

One solution is to construct a driveway berm, which ensures there is not a constant slope towards the structure from the street. This can be achieved by either raising the sidewalk and/or reconstructing the entire driveway. By raising the sidewalk, a high-point is created between the street and the point where the reverse-sloped driveway begins to slope down toward the structure. A portion of the driveway must be reconstructed to transition the grade of the driveway to the elevated sidewalk. This can reduce the chances that overland flooding will enter the structure through the reverse sloped driveway. Alternatively, the entire driveway can be reconstructed to provide a highpoint between the garage and the street, which will reduce the occurrence of surface water in the street flooding a below-grade garage.

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.

Applicability

Driveway berms are typically used to address structural flooding that occurs as a result of reverse sloped driveways. Installing a driveway berm in a driveway that is already sloped away from the structure could direct runoff towards the structure.

Advantages

Driveway berms are one of the few options for correcting structural flooding from reverse sloped driveways. Some of the key advantages of driveway berms include:

- 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.

Disadvantages

The disadvantages associated with driveway berms are as follows:

- Will not reduce flood insurance premiums.
- Overtopping or failure eliminates any protection provided.
- Interior drainage must be provided.

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:

- Slope of the existing driveway
- Tributary area draining toward the structure
- Depth of ponding in the adjacent street
- Possible height of waves caused by traffic in the street.
- Drainage within the garage and lower level of the structure

Constructability
Some of the key construction elements to consider when constructing a driveway berm are as follows:

- The driveway berm shall be constructed of materials that are not easily erodible
- Compaction of the berm is critical to maintain the desired level of protection.
- Height of the berm shall be constructed in accordance with the design to provide a smooth grade transition.

Construction Cost
Constructing a driveway berm and replacing the driveway is approximately the same cost as replacing the driveway. This can typically be performed for $8.00 to $12.00 per square foot.

Assuming a 16-ft wide suburban driveway, a one foot rise, and a 10:1 transition on each side of the rise, requires a minimum of 20-ft length x 16-ft width is required for reconstruction.

For the purposes of a conservative cost estimate, and to satisfy anticipated homeowner concerns, it's assumed the full driveway would require replacement. Assuming a 35-ft setback, 15-ft apron and 5-ft sidewalk width, the replacement cost would be 55 ft driveway length x 16-ft driveway width = 880 sf x $12/sf = $10,560.

Required Maintenance
Provided that the driveway berm is constructed of material that is not easily erodible, there is no additional maintenance for the driveway berm in addition to regular maintenance of the driveway.

Flood Reduction Capabilities
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.

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 foot to 20 feet. Similar to berms and levees, a floodwall can surround a structure or a portion of a structure. A typical levee and floodwall used to protect a residential structure are shown in Figure 1.

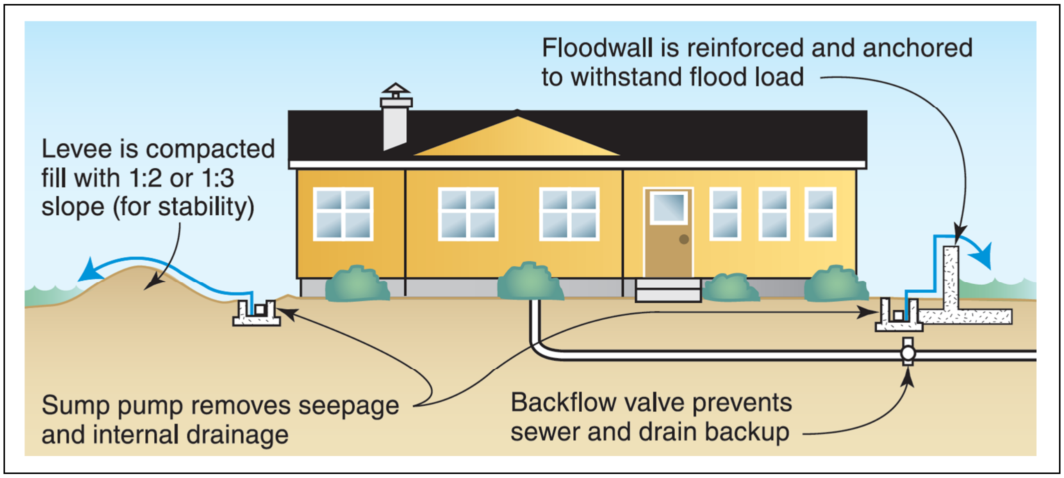


Figure 1. Berm and Levee Examples (Source: FEMA P-312)

Applicability

Barriers are not typically used to resolve structural flooding in urban areas due to the potential impacts on adjacent properties; however, they 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 elevation or relocation of the structure should be considered.

Advantages

Some of the key advantages of barriers include:

- 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.

Disadvantages
Some of the disadvantages associated with barriers are as follows:

- 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.

Floodwalls do not rely as much on its mass to resist flood forces and, therefore, requires less space than a levee of similar height. However, floodwalls are typically higher cost.

Design Considerations
Some things to consider during the design of a barrier include:

- 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.
- Taller levees and floodwalls must be stronger, so they usually require more space than is likely to be available on an individual lot.
- Local zoning and building codes may also 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, such as elevation, 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.

Constructability
Some of the key factors to consider when constructing a barrier include:

- 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.

Construction Cost

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.

FEMA has provided general estimates for unit costs for typical barriers in *Publication 551: Selecting Appropriate Mitigation Measures for Floodprone Structures.* The unit prices provided in Publication 551were adjusted for inflation and are summarized in Table 1.

Table 1.Levee/Berm and Floodwall Costs

Barrier Type	Height Above Ground	Cost per Foot
Levee/Berm	2 Feet	$ 850
	4 Feet	$ 1,490
	6 Feet	$ 2,390
Floodwall	2 Feet	$ 1,300
	4 Feet	$ 1,970
	6 Feet	$ 2,740

Within the Erie/Mayo study area, it's anticipated that a landscaping berm may provide some protection in a few areas. The berms are no more than two feet high. For the purpose of establishing a conservative cost estimate, a cost of $10,000 per house is used, to reflect site grading and landscape restoration.

Required 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 Capabilities

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.

WET FLOODPROOFING

Wet floodproofing allows floodwaters to enter the enclosed areas of a structure and quickly reach the same level as the floodwaters outside. As a result, there are equalized loads imposed on the exterior walls during a flood and the likelihood of structural damage may be greatly reduced.

Wet floodproofing requires openings in the exterior walls of a structure large enough for the water to flow through the structure. The openings must be sized to allow the water level inside the structure to rise and fall with the elevation of the water outside of the structure. This equilibrium of floodwater prevents hydrostatic pressure from damaging structural walls.

The two primary wet floodproofing techniques are installing openings and elevating utilities. These two techniques are discussed in the following subsections.

Installing Openings

Openings can be installed in the exterior walls of structures to allow floodwaters into uninhibited portions of an existing structure such as basements, crawlspaces, or attached garages or to the area below an elevated structure. Successful wet floodproofing typically involves the following:

- Allowing floodwaters to enter and exit the structure without the use of pumps;
- Ensuring that floodwaters inside the structure rise and fall at the same rate as floodwaters outside the structure;
- Reducing damage caused by contact with floodwaters to areas of the home that are below the flood level;
- Protecting service equipment inside and outside the structure; and
- Relocating high-value contents above the anticipated water level.

A typical example of a residential structure with openings is provided in Figure 2 along with a graphic showing the equalization of pressure on both sides of the opening.

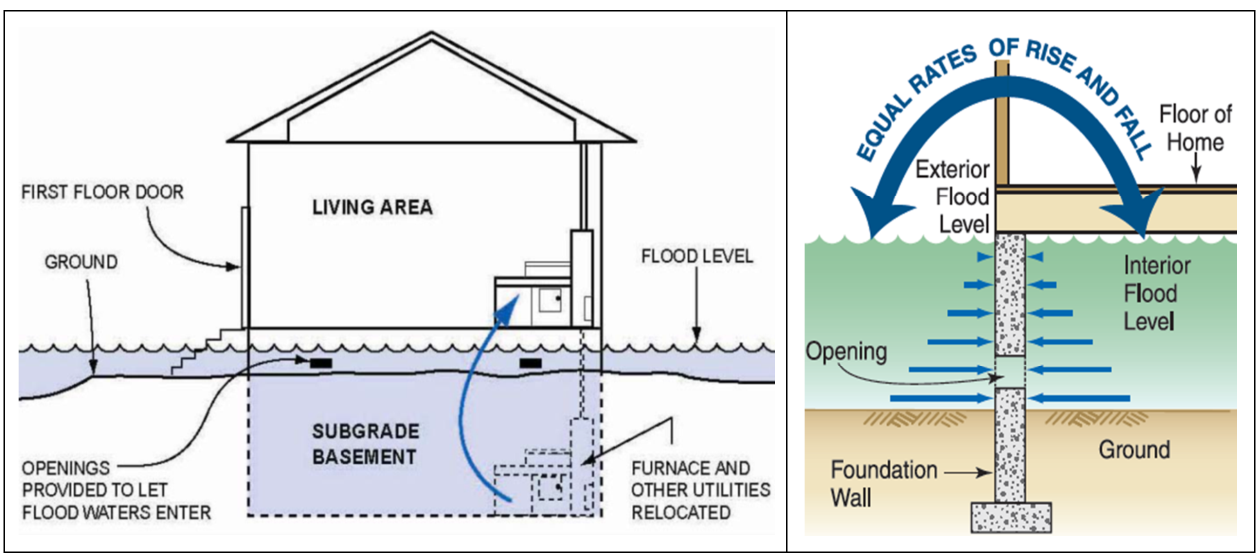


Figure 2. Wet Floodproofing Example (FEMA P-312, June 2014).

Alternative flood mitigation options should be carefully reviewed before installing openings and allowing floodwaters into a structure.

Applicability
Several examples of enclosures that require openings include:

- Solid perimeter foundation walls (crawlspaces, under-floor spaces, below-grade crawlspaces, and full-height under-floor spaces;
- Garages attached to elevated buildings;
- Enclosed areas under elevated buildings;
- Enclosed areas with breakaway walls under buildings elevated on open foundations in A zones;
- Solid perimeter foundation walls on which manufactured homes are installed; and
- Accessory structures (detached garages and storage sheds).

Advantages
Some of the key advantages of installing openings include:

- Reduces the potential of structural damage by minimizing flood forces on the structure; and
- Lower cost alternative compared to dry floodproofing.

Disadvantages
Some of the disadvantages of installing openings that should be considered before installing openings on a structure include:

- May require human intervention to function;
- Residential flood insurance premiums are not affected by wet floodproofing;
- Dirty floodwater will inundate the wet floodproofed area, which must be cleaned, sanitized, and dried out following a flood event; and
- Should not be used for areas to be used as living space.

Design Considerations
Some specific design considerations to keep in mind before installing openings include:

- A minimum of two openings must be provided on different sides of each enclosed area;
- Openings must have a total net area of not less than 1 square inch for every square foot of enclosed area subject to flooding; this criterion is not required if openings are engineered and certified;
- The bottom of all openings must be no higher than 1 foot above exterior or interior grade; and
- Openings may be equipped with screens, louvers, or other coverings or devices, provided these components permit the automatic entry and exit of floodwater and do not reduce the net open area to less than the required open area.

Constructability
Some of the key constructability considerations regarding openings include:

- The NFIP regulations do not allow buildings to be constructed with areas that are below grade on all sides (basements), except for certain engineered non-residential buildings that are designed and certified to be foodproofed. Therefore, crawlspaces that are below-grade on all sides are not allowed;
- Care should be taken when placing backfill, topsoil, and landscaping materials around the outside of enclosures, especially solid perimeter foundation walls. If the finished exterior grade is higher than the interior grade on all sides of the building, then the enclosed area becomes a basement as defined by the NFIP; and
- The trench that is excavated to construct footings and foundation walls must be backfilled completely, otherwise a basement is created. If the interior grade is higher than the exterior grade, the openings are to be no higher than 1-foot above the interior elevation.

Construction Cost
Installing openings is typically completed as part of a larger project (structure elevation, or construction of a new structure). The added cost for installing openings is typically negligible compared to the overall cost of the larger project.

Required Maintenance
The screens on openings in areas where floodwaters are expected to carry debris, such as grass clippings and leaves, tend to clog. Local officials may determine that additional openings are required to increase the likelihood that they will perform as expected, even if some openings become clogged with debris.

Flood Reduction Capabilities
Installing openings allows water into the structure, eliminating differential pressure on either side of an enclosed space and preventing collapse of those walls as a result. There is not a reduction in flooded properties by installing openings, but there could be a reduction in flood damages.

Elevating Utilities

Raising utilities above the anticipated water level protects them from being submerged during a storm event, thus minimizing replacement costs. When essential equipment is located below grade, elevating typically requires relocating the equipment to higher floors in the building. Unless space is already available, moving the equipment to a higher floor may reduce the available living space. Building owners may need to evaluate all available space, including the attic and second floor, to determine whether a small elevated addition would be an acceptable solution. Some examples of elevated utilities are shown in Figure 3.

Figure 3. Elevated Utilities Examples.

Elevating utilities can reduce replacement costs following a flood event and also reduces the health risks to homeowners. Electrical equipment exposed to water can be extremely dangerous if reenergized without proper reconditioning or replacement. When these systems are elevated above the water level, the risk of electric shock is greatly reduced.

For buildings constructed in the floodplain, there is a risk of serious flood damage to most, if not all, building utility systems constructed below the DFE. The level of risk depends on several factors, including the number of utility systems located below the DFE and their location relative to the building footprint.

Applicability

Equipment that must be placed in areas prone to flooding should be designed to (1) minimize disruptions to the portions of the mechanical systems that are above the floodwaters and (2) facilitate removal and replacement of flood-damaged mechanical equipment.

The most effective flood-resistant design of electrical systems in new and substantially improved buildings in flood-prone areas is elevation of all electrical components to levels at or above the DFE. Elevation gives the most assurance possible that, during a flood, the electrical system components would not be inundated by floodwaters.

Advantages

Some of the key advantages of elevating utilities include:

- Reduced health hazards following a flood event; and
- Reduction in time the utility is out of service following a flood event.

Disadvantages
The disadvantages associated with elevating utilities are as follows:

- Utilities are only protected to the design elevation and will not be protected for higher floodwaters and
- Only the elevated utility will be protected from flooding.

Design Considerations
All equipment that is vulnerable to flooding should be elevated above the DFE or located in dry-floodproofed areas. Equipment that must be placed in areas prone to flooding should be designed to minimize disruptions to the portions of the mechanical systems that are above the floodwaters and facilitate removal and replacement of flood-damaged mechanical equipment. Some design considerations for elevating utilities include:

- When elevating electrical services, the number of switches, wiring, and receptacles below the DFE should be limited to those items required for life safety. The use of motion detecting switches should limited whenever possible. Use only ground-fault-protected electrical breakers below the DFE. Use drip loops to minimize water entry at penetrations;
- Install HVAC components above the DFE;
- Large central mechanical units such air-cooled chillers, boilers, and pumps, should be placed above the DFE;
- Evaporator towers can be placed below the DFE if they can be readily cleaned or if the evaporative media are replaced after being in contact with floodwaters;
- HVAC controls should be placed as high as possible and installed in a way that facilitates their replacement if they are damaged by floodwaters;
- Central processing units that provide supervisory control can and should be installed above the DFE;
- Dedicated air handling units should be installed to serve flood-prone areas. Air handling units vulnerable to flood damage should have independent supplies, returns, and ventilation ducts that prevent cross contamination of conditioned air between areas damaged by floodwaters and those above the floodwaters;
- Isolation valves should be installed to allow damaged HVAC components to be replaced without requiring draining or disrupting chilled water or hot water distribution systems; and
- Domestic water lines supplying fixtures in flood-prone levels should be isolated from domestic water lines serving upper floors.

Constructability
Some of the key constructability considerations for elevating utilities include:

- Sewer services should rise above the DFE before connecting to the public sewer. To ensure safety, a backflow prevention valve or gate should be installed between the overhead portion and the point of connection to the municipal sewer. A back-up source of power should also be installed.
- Encase any wiring below the DFE in non-corrosive conduit that is installed vertically to promote thorough drainage.

- Elevate HVAC equipment above the DFE, or as high as possible
- Elevate duct work above the DFE or replace it with watertight ducts.
- Locate return and supply registers above the DFE or allow ample access for cleaning, thorough drainage, and install them without insulation to prevent mold growth in the ducts.
- Elevate wiring, receptacles, outlets, and switches above the DFE, or as high as possible. Place any receptacles below the DFE on one or two separate circuits. Install and clearly identify ground fault circuit interrupter breakers on those circuits. Receptacles and switches below the DFE should be installed in non-corrosive boxes with holes in the bottom to facilitate drying. The receptacles must be replaced after inundation by floodwaters.

Construction Cost
There is minimal additional cost to elevate a utility when it is being installed or replaced, provided the elevation can be achieved with minimal changes to the existing infrastructure. As the height needed to protect the utility increases, the cost and changes to other infrastructure increase as well.

Required Maintenance
The elevated utility has the same maintenance requirements as it did before it was elevated. The platform or bracket used to elevate the utility should be inspected annually and replaced as needed.

Flood Reduction Capabilities
Similar to installing openings, elevating utilities does not prevent flooding, but it does reduce the flood damages to the utilities that were elevated. All other utilities below the flood protection elevation remain susceptible to flooding and the elevated utility is only protected as long as the floodwaters do not rise above the flood protection elevation.

DRY FLOODPROOFING

Dry floodproofing completely seals the exterior of a building, below the anticipated water level, to prevent the entry of floodwaters keeping the interior of the structure dry. An example of dry floodproofing is provided in Figure 4.

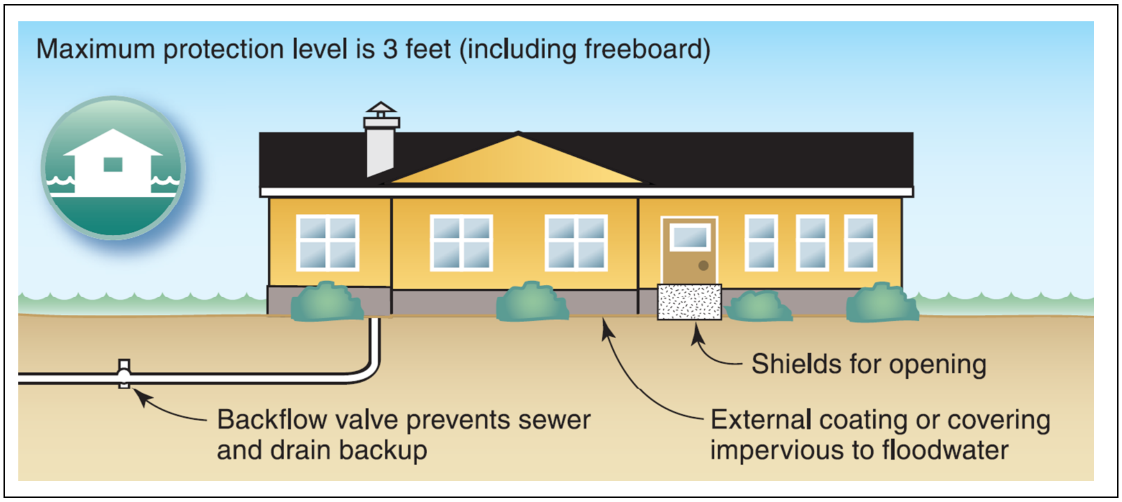


Figure 4. Dry Floodproofing Example (FEMA P-312, June 2014).

Unlike wet floodproofing, which allows water to enter the building through wall openings, dry floodproofing seals all openings below the flood level and relies on the walls of the building to keep water out. Even if a structure is dry floodproofed, water can still seep through small openings in the sealant system or through the gaskets of shields that are protecting openings. Internal drainage systems are required to remove any water that has seeped through and remove water collected from any necessary underdrain systems in the below-grade walls and floor of the home.

Dry floodproofing is not a good option for areas where floodwater is deep or flows quickly. The hydrostatic pressure and/or hydrodynamic force can structurally damage the building by causing the walls to collapse or causing the entire structure to float. Because the walls are exposed to floodwaters and the pressures they exert, dry floodproofing is practical only for homes with walls constructed of masonry or poured concrete and only where flood depths are low (typically no more than 2 to 3 feet).

Areas that have minimal velocity and low depth, dry floodproofing can be a good option. Dry floodproofing may not be used to bring a substantially damaged or substantially improved residential structure into compliance with the local floodplain management ordinance. Successful dry floodproofing techniques include:

- Raised Window Wells;
- Glass Block Basement Windows;
- Continuous Impermeable Walls;
- Floodproofed Core Interior Areas;
- Permanent Flood Shields for Exterior Openings;
- Permanent Flood Shields for Exterior Openings; and
- Removable Flood Shields for Exterior Openings.

These techniques are discussed in more detail on the following pages.

Raised Window Wells

Properties that do not have adequate protection of their low opening (window or basement door) can effectively raise the low opening height with a window well. Window wells can help improve drainage around basement windows to prevent water from entering the basement and can reduce dampness inside the structure. Window wells can also help to prevent rotting of window sills, which may compromise the ability of the windows to hold back flood water. Examples of raised concrete window wells are provided in Figure 5.

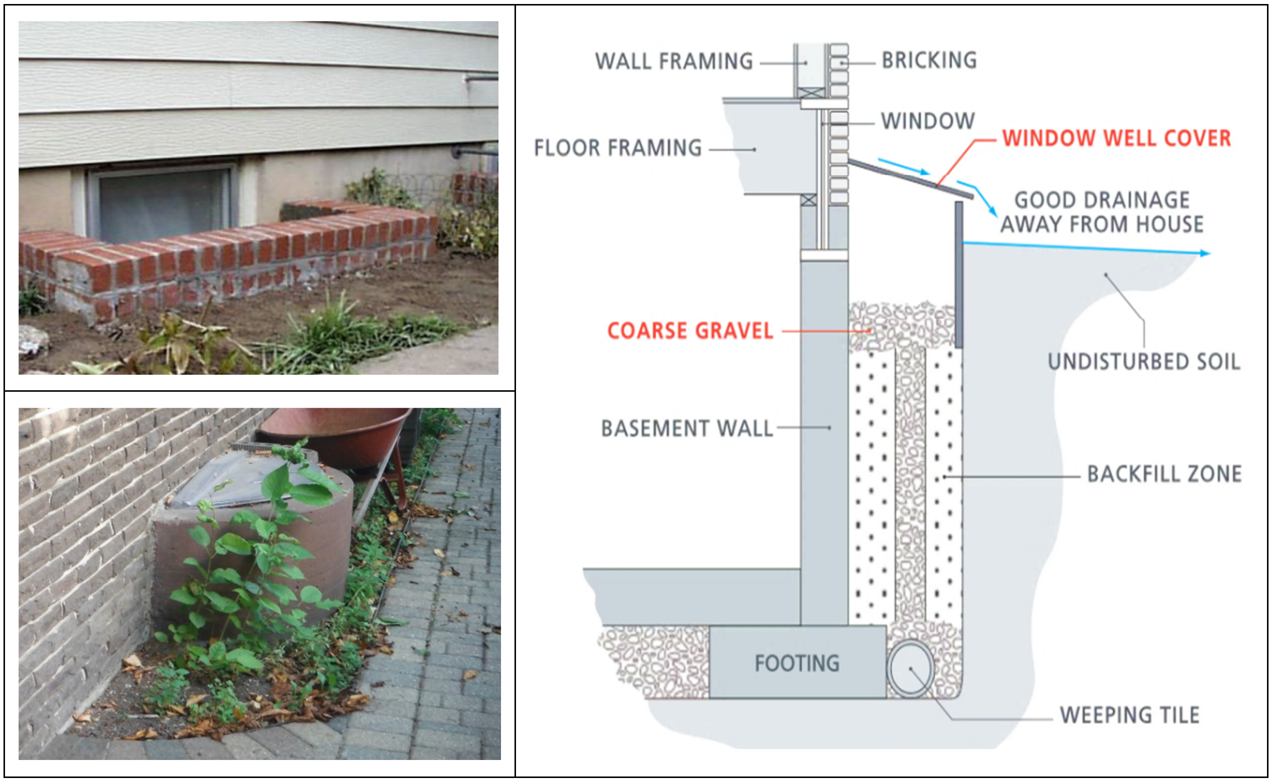


Figure 5. Raised Window Wells. (Source: FEMA 551)

Applicability

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.

Advantages

Some of the key advantages of raised window wells include:

- 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.

Disadvantages

Some of the disadvantages associated with barriers are as follows:

- Will not reduce flood insurance premiums,
- Overtopping or failure eliminates any protection provided, and
- May restrict egress access to the structure,

Design Considerations
Some things to consider during the design of a raised window well include:

- The height of the raised window well typically should not exceed 2 or 3 feet;
- Local zoning and building codes may also restrict the use of raised window wells; and
- The bearing capacity and permeability of the soils encountered may have a significant impact on the use of raised window wells.

The raised window well can always be overtopped by a higher-than-expected flood regardless of the height of the barrier.

Constructability
Some of the key factors to consider when constructing a raised window well include:

- To improve the drainage inside the window well, a mixture of coarse material such as gravel and soil should be placed at the bottom of the well;
- Proper lot grading is recommended that directs overland water away from window wells and building walls; and
- If there is the potential for a large volume of roof water to overflow the gutters and spill directly into the window well, or if large amounts of rain can fall into the well, a window well cover should be installed to divert this rainwater away from the window and house. The window well cover will reduce the chances that water will enter the basement through the window and reduce the amount of water that enters the foundation drainage system.

Construction Cost
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. A typical range of $600 - $2,000 per window can be anticipated. For a conservative estimate, this report assumes $2,000 per window.

Required 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 Capabilities
If the low opening to the structure is a window well and overland flow is getting into the structure through the window well, raising it can reduce the structural flooding that results from this low opening. However, the flood protection is limited. Only the structure with the elevated window well will see a reduction in flooding. Also, the level of flood protection is limited to the height of the window well, which should not exceed 2 or 3 feet.

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 a small amount of ponding floodwaters. The glass blocks will reduce the occurrence of seepage through a lower level window; however, they can only be used in limited applications. Some examples of low level windows that were successfully replaced with glass blocks are shown in Figure 6.

Figure 6. Glass Block Window Examples.

Another alternative to sealing low level windows with glass blocks is to replace the window with submarine glass systems. This alternative is used when glass blocks are not desired or when the depth of ponding water exceeds the recommended depth for glass blocks.

Applicability

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. Similar to glass blocks, submarine glass will render the window inoperable, but the natural light will still be provided into the area. Floodproofed core areas should not be used in the following areas:

- Where floodwaters are known to carry debris
- Areas with high velocities or where there is wave action,
- Areas where floodwaters remain high for 24 hours or more, and
- Structures with frame and masonry veneer walls.

Advantages

Some of the advantages of glass block basement windows include:

- 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.

Disadvantages
The disadvantages associated with glass block basement windows are as follows:

- 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 and wave action.

Design Considerations
Some things to consider during the design of a barrier structure include:

- Flood duration should be less than 24 hours,
- Flow velocity,
- Warning time,
- Floodborne debris, and
- Adjacent or shared walls.

Also, anchorage of the window frame and attachment of mullions to the frame and the seals between the window and the frame must be considered because they are common places that fail or leak.

Construction Cost
Cost for construction will vary based on accessibility, type of block chosen, size of window and condition of existing window openings but is expected to cost between $500 and $1000 per window treated. This report assumes $1,000 per window.

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

Flood Reduction Capabilities
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 flood protection is limited. Only the structure with the glass block window will see a reduction in flooding. Also, the level of flood protection is limited based on the sealant and strength of the glass blocks.

Continuous Impermeable Walls

A continuous impermeable wall is substantially impermeable to the passage of water, and capable of resisting hydrostatic and hydrodynamic loads and the effects of buoyancy. After the primary wall system and foundation have been strengthened to resist flood loads (if necessary), the building must be sealed and entry points (e.g., windows, doors, utility points of entry) must be evaluated to determine how best to prevent floodwaters from entering the enclosed area.

In some instances, it may be more cost-effective to construct a continuous impermeable wall on the outside of the existing wall system. Some wall systems, such as steel stud wall systems, may be too difficult to make impermeable, and in those instances a new wall system may be constructed along the perimeter of the existing wall to provide protection.

Creating a waterproof barrier in a section of wall to make it impermeable may require the use of sealants. Sealants are applied directly to the exterior surface of the building to seal exterior walls and floors. Sealants can be either positive-side (applied to the wall exterior where the sealant acts as a barrier between floodwaters and the wall) or negative-side (applied to the interior of a wall or floor where the water pushes against the sealant after it has passed through the wall or slab) as shown in Figure 7.

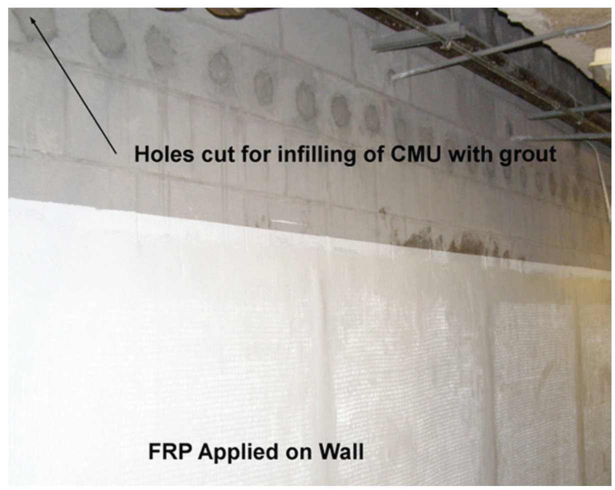



Figure 7. Positive-side Sealant (left) and Negative-side Sealant (right) Examples

Above-ground walls can be sealed using either category of sealant because interior and exterior sides are both typically accessible, while below-ground walls and floor slabs almost always require negative-side sealants. The appropriate sealant for a particular structure is dependent upon the compatibility of the sealant product with the expected duration and depth of flooding and the construction materials in the building.

Applicability

Continuous impermeable walls work well in the following applications:

- Areas where the velocity of flood flows are low and there is little to no wave action,
- Areas where floodwaters remain high for less than 24 hours, and
- Structures without basements or other below grade living spaces.

Impermeable walls should not be used in areas where floodwaters are known to carry debris or on structures with frame and masonry veneer walls. Also, they should not be used on structures with basements or crawlspaces.

Advantages
Some of the key advantages of impermeable walls include:

- 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 extra land that may be needed for floodwalls or reduced levees;
- Reduces the physical, financial, and emotional strains that accompany flooding; and
- Retains the structure in its present environment and may avoid significant changes in appearance.

Disadvantages
The disadvantages associated with impermeable walls are as follows:

- 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 of the measure
- 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
- Involves increased costs for a design professional
- May require invasive retrofits, and
- Does not minimize the potential for damage from high-velocity flood flow and wave action.

Design Considerations
The key design considerations when designing impermeable walls are:

- Flood duration should be less than 24 hours,
- Flow velocity,
- Warning time,
- Floodborne debris, and
- Adjacent or shared walls.

Even if both buildings are to be dry floodproofed, it may not be possible to seal all areas of the adjacent walls. The condition of adjacent or shared walls should be thoroughly investigated to ensure that the selected floodproofing measures will be effective.

Constructability
Constructability will be largely determined on a case by case basis depending on the anticipated flood loads and levels, type and condition of existing wall and foundation systems and condition and type of construction used in the building of the structure.

Construction Cost

The cost of making a continuous impermeable wall is generally in the middle range compared to the costs of implementing other mitigation measures. Costs that may need to be considered include:

- Preparation of the structure for elevation;
- Elevation of the structure, including cost of steel beams, jacks, etc.;
- Construction of the new, elevated foundation;
- Secure the structure to the new foundation; and
- Replacement or reconstruction of items removed from the structure prior to elevation.

Examples cost estimates from FEMA Publication 551: Selecting Appropriate Mitigation Measures for Floodprone Structures were adjusted for inflation and summarized in Table 2.

Table 2. Sealant Costs

Sealant	Cost
Waterproofing a concrete block or brick-faced wall by applying a polyethylene sheet or other impervious material and covering with facing material such as brick	$ 5.20 / square foot
Acrylic latex wall coating	$ 4.50 / square foot
Caulking/sealant with a high performance electrometric "urethane" sealant	$ 3.70 / linear foot
Bentonite grout (below grade waterproofing, 6 feet deep)	$ 29.40 / linear foot

Required Maintenance

The components of continuous impermeable walls must be inspected and maintained on a regular basis. Some considerations to facilitate a successful maintenance schedule are as follows:

- Develop an annual inspection plan, and
- Check walls, floors, and floodproof coatings for cracks and potential leaks.

Flood Reduction Capabilities

The areas that are sealed will be protected from future flooding, as long as the seal is maintained. The level of protection provided depends upon the type of sealant used and the design elevation. Only the areas that are sealed will have a reduction in flood risk.

Floodproofed Core Interior Areas

Critical core components and areas can be made flood resistant even if dry floodproofing the entire building footprint is not needed or possible. Typical critical core areas contain utilities such as electrical services, emergency generators, emergency fuel supplies, and other components that cannot be moved or elevated. In many large complexes or campuses of buildings (such as museums, universities, and large businesses), the utilities may be housed in a central building and linked to the other buildings via tunnels. Although the main utility building may not be at risk of flooding during a particular event, utility tunnels are often subject to more frequent flooding. Examples of watertight doors that would prevent flooding of a utility room are provided in Figure 8.

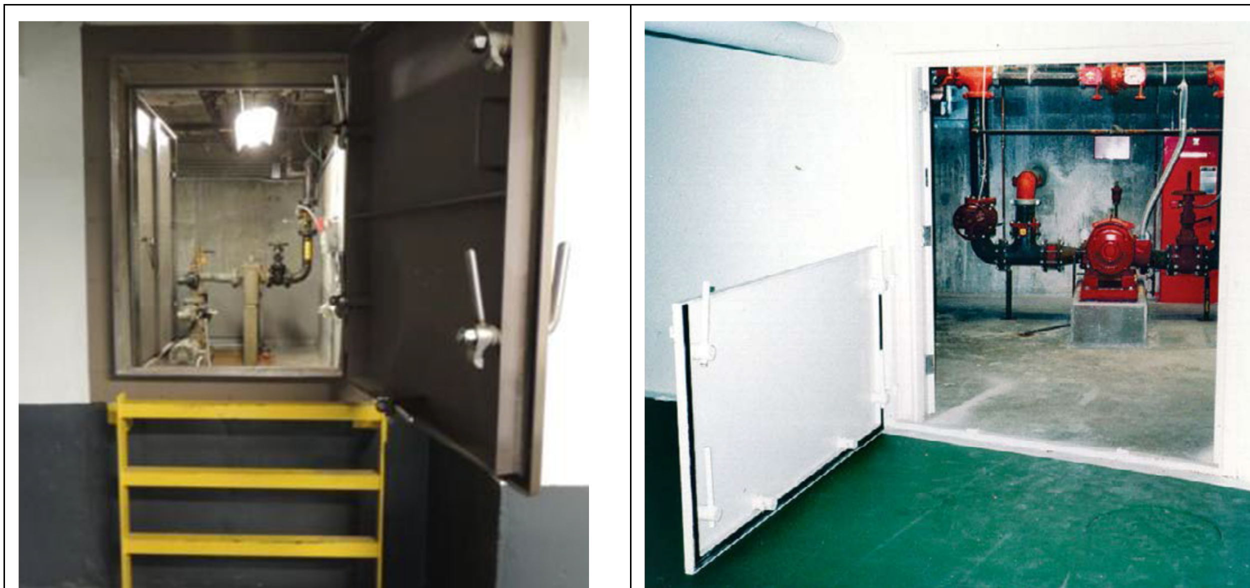


Figure 8. Floodproofed Core Area Examples

An important consideration in making a core area watertight is that floodwater levels may be higher than the height of typical dry floodproofing measures that protect the entire building, and additional anchorage may be needed to make sure the area does not become buoyant. Both the floor system and existing walls should be carefully studied and evaluated. Because these areas are typically designed to be fully resistant to high flood loads, additional anchoring or securing of the core area may be required to resist buoyancy forces.

Core areas can be made watertight by constructing infill walls or retrofitting existing interior walls. Waterproofed walls may be constructed of cast-in-place concrete tied to the floor slab. Fully grouted reinforced CMU walls can also be used to construct the interior walls; however, CMU walls may require additional waterproofing to be considered fully impermeable. Special detailing should be done at the joint between the floor slab and wall as this is a common location for leaks.

If access doors or hatches are necessary below the flood protection level, a hinged door is recommended, so the area can be sealed quickly. Doors or hatches above the flood protection level may allow continuous access even during flood events, but require stairs or ladders. Although stairs or ladders may allow maintenance personnel to access the area during a storm event, they may limit the ability to move items in and out of the area. A pump system is still required to address any unidentified leaks.

Applicability
Floodproofed core areas work well in the following applications:

- Non-residential buildings
- Areas where the velocity of flood flows are low and there is little to no wave action,
- Areas where floodwaters remain high for less than 24 hours, and
- Structures without basements or other below grade living spaces.

Floodproofed core areas should not be used in areas where floodwaters are known to carry debris or on structures with frame and masonry veneer walls.

Advantages
Some of the advantages of floodproofed core areas include:

- 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 and may avoid significant changes in appearance.

Disadvantages
The disadvantages associated with floodproofed core areas are as follows:

- 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 not reduce damage to other portions of the building and other property;
- May lead to damage of the building and its contents if the sealant system leaks;
- Involves increased costs for a design professional;
- May require invasive retrofits; and
- Does not minimize the potential for damage from high-velocity flood flow and wave action.

Design Considerations
The key design considerations include:

- Flood duration should be less than 24 hours,
- Flow velocity,
- Warning time,
- Floodborne debris, and
- Adjacent or shared walls.

Construction Cost
The cost of floodproofed core areas is similar to the cost of continuous impermeable walls. Refer to the previous section for those costs.

Required Maintenance
The components of floodproofed core areas must be inspected and maintained on a regular basis. Since this practice includes window and door closures as part of the system, closures must be available and in good condition. Some maintenance requirements include:

- Develop an inventory and location list of all closures,
- Develop an annual inspection plan to ensure closures fit properly,
- Inspect and replace rubberized seals as needed, and
- Check walls, floors, and floodproof coatings for cracks and potential leaks annually.

Flood Reduction Capabilities
The areas that are sealed and will be protected from future flooding; however, any areas that are not floodproofed will not see a reduction in flooding or flood damages.

Permanent Flood Shields for Exterior Openings

Basement windows can be the first entry point for floodwaters. Removing a window and incorporating the opening into the wall system may be easier than retrofitting a window with watertight flood shields. The decision of whether to eliminate the window may depend on the following:

- Use of the window (e.g., provides light, means of egress)
- Location of the window on the building, and
- The ease with which the opening can be filled in and incorporated into the wall system

Basement windows may be good candidates for elimination, whereas windows higher on the building may only need to be shielded partially rather than eliminated. Sealing openings should consider the wall or foundation system's ability to resist the loads. Any system of flood doors, panels, or shields will depend on the transfer of the flood loads from the shields to the wall. If the walls or foundation are structurally insufficient to carry these loads, they must be reinforced prior to sealing the opening.

Penetrations through walls for utilities have much narrower openings than those of doors or windows. Gaps in the opening around the utility line should be filled with expansive foam to create a waterproof seal. Sealants used to seal openings in walls or floors should be able to withstand being submerged for the anticipated duration of flooding. Two examples of sealed openings are provided in Figure 9.

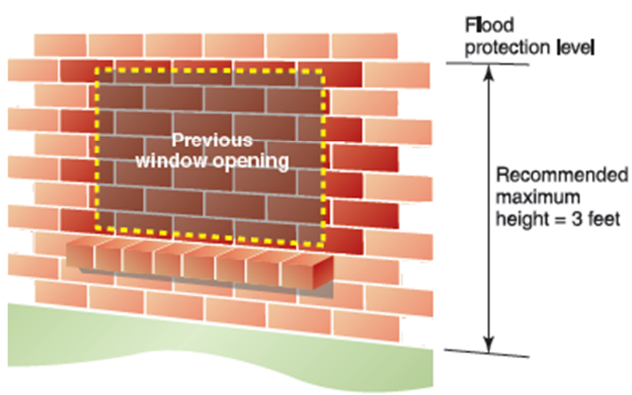


Figure 9. Sealed Window Opening (left) and Sealed Garage Opening (right) Examples

Nonresidential buildings may have ventilation shafts, exhaust fans, and louvered openings that should be protected with specially fitted flood shields. Placing the flood shields may require shutting down parts of the building or temporarily interrupting some of the building's utilities or mechanical systems. It may be feasible and cost-effective to reroute ventilation shafts, exhaust fans, or other utility openings above the flood protection level to avoid having to shut down some operations during a flood.

Applicability

Permanent flood shields for exterior openings work well in the following applications:

- Areas that can be re-graded to flow away from the structure, and
- Exterior openings that are not needed for ingress/egress.

Advantages
Some of the advantages of permanent flood shields for exterior openings include:

- 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.

Disadvantages
The disadvantages associated with permanent flood shields for exterior openings are as follows:

- 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;
- Involves increased costs for a design professional;

Design Considerations
The key design considerations include:

- Flood duration should be less than 24 hours,
- Flow velocity,
- Adjacent or shared walls, and
- Local regulations regarding regrading of the site and elimination of an existing opening.

Constructability
Some constructability considerations for permanent flood shields include:

- Location of rough openings to be sealed;
- Access for workers and materials;
- Availability of finishing materials to match the existing structure's façade;

Construction Cost
Cost for construction will vary based on accessibility, size and condition of rough opening, type of material used to seal the opening and type of facing material necessary to match the existing structure but is expected to cost between $500 and $1000 per window sealed.

Required Maintenance
The permanent flood shields must be inspected and maintained. An annual inspection plan should be prepared to check walls, floors, and floodproof coatings for cracks and potential leaks.

Flood Reduction Capabilities
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. Only the structure with the sealed opening will see a reduction in flooding. Also, the level of flood protection is limited based on the sealant used.

Removable Flood Shields for Exterior Openings

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. Some examples of removable flood shields for exterior openings are provided in Figure 10.

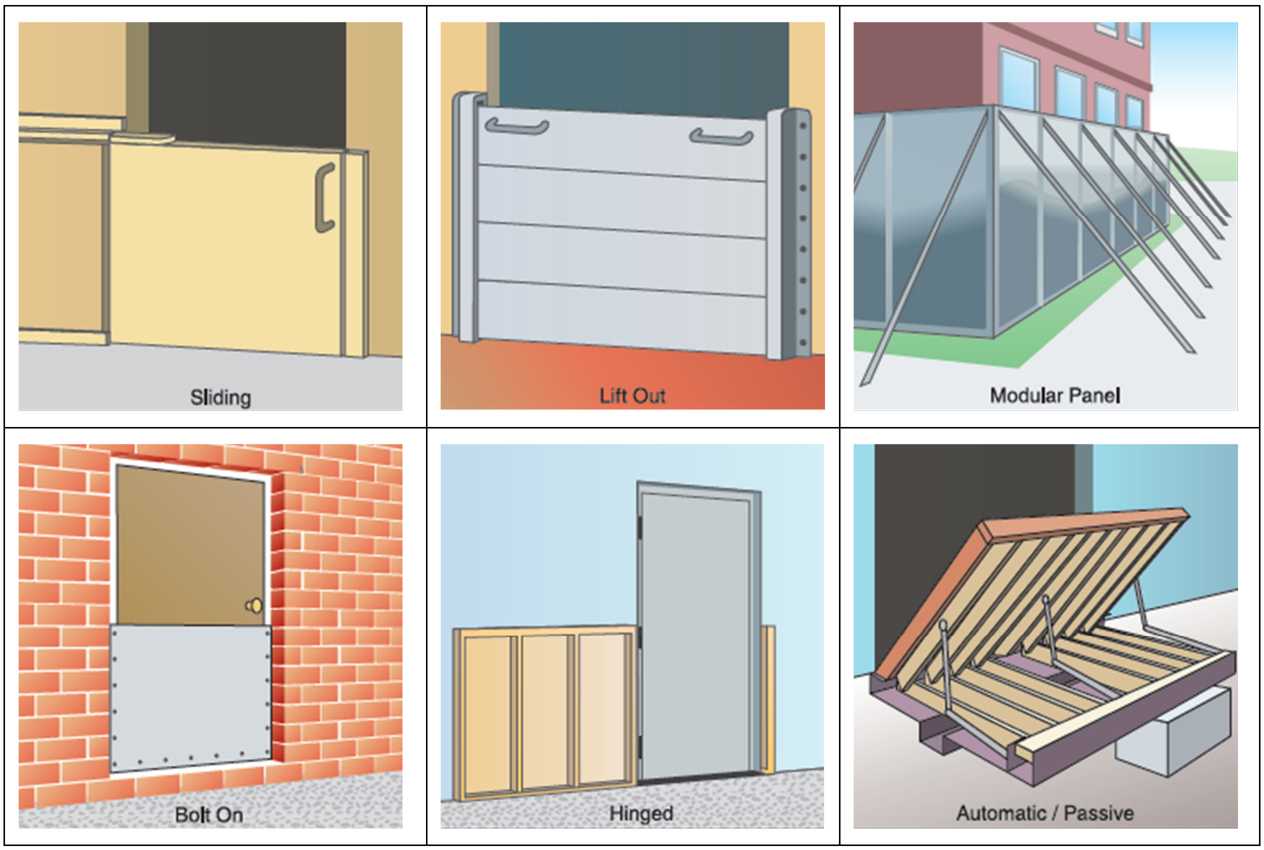


Figure 10. Example Flood Shields for Exterior Openings.

The type of shield that is used depends on the size of the opening that needs to be protected, the duration of flooding, the normal use of the opening, warning time available to install the shield and the use of the door as a means of egress from the building. For larger openings, passive (automatic) flood shields may be preferred to active flood shields, which require human intervention. Passive flood shields allow openings to be used until floodwaters reach a certain height. Passive flood shield systems may require room under the opening to allow the flood shield to be stored when it is not in use and may require a backup power supply.

Applicability

Removable flood shields work well in the following applications:

- Areas where the velocity of flood flows are low and there is little to no wave action,

- Areas where floodwaters remain high for less than 24 hours, and
- Structures without basements or other below grade living spaces.

Removable flood shields should not be used in areas where floodwaters are known to carry debris or on structures with frame and masonry veneer walls.

Advantages
Some of the advantages of removable flood shields include:

- 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.

Disadvantages
The disadvantages associated with removable flood shields are as follows:

- 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 and wave action.

Design Considerations
The key design considerations include:

- Flood duration should be less than 24 hours,
- Flow velocity,
- Warning time,
- Floodborne debris,
- Installation requirements, and
- Availability of personnel to seal the opening.

Constructability/Installation Considerations
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.

Construction Cost

The cost for exterior flood shields vary based on the type of shield (manual or automatic), material, and the size of the opening. Some of these are available at big box home improvement stores for $1,000 in material cost for use in residential applications. The cost estimate assumes $3,000 each for materials and installation.

Required Maintenance

The components of the flood shields must be inspected and maintained on a regular basis. Since this practice includes window and door closures as part of the system, closures must be available and in good condition. Some maintenance requirements include:

- Develop an inventory and location list of all closures,
- Develop an annual inspection plan to ensure the closures fit properly,
- Inspect and replace any rubberized seals as needed, and
- Check walls, floors, and floodproof coatings for cracks and potential leaks.

Flood Reduction Capabilities

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.

OTHER MITIGATION OPTIONS

For some structures, dry or wet floodproofing cannot provide adequate protection from future flooding and greater measures must be taken. Other mitigation options include structure elevation, relocation and demolition. Structure elevation is described in the following paragraphs.

Structure Elevations

If the floodwaters are too high for dry floodproofing and the inhabited area is too low for wet floodproofing, it may be necessary to raise the structure. Short of relocating a structure outside a flood-prone area, the best way to protect it from surface flooding is to raise it above the flood level. The three most common elevation techniques are open foundations, continuous foundation walls, and extending existing walls. In all three elevation techniques, the area below the flood level is left open to allow floodwaters to flow under the building, causing little or no damage.

Elevation is usually most cost-effective for buildings on crawlspaces because it is easiest to get lifting equipment under the floor and disruption of the habitable part of the house is minimal. Examples of structures that have been elevated above the 100-year flood elevation are provided in Figure 11.

Figure 11. Example Elevated Structures

The ease with which an elevation project can be accomplished usually depends on the building's construction type. A large masonry building is more difficult to elevate than a smaller, compact wood-frame structure. The type of foundation is the most important factor. There are four types of foundations:

1. Crawlspace construction (easiest to elevate);
2. Piers, posts, and pile construction;
3. Basement construction; and
4. Slab-on-grade construction (hardest to elevate).

If the building is elevated eight feet or more, the owner may be tempted to convert the lower area into a habitable living space, which would negate the benefits of the elevation project. One way to help prevent conversions is to have the owner sign a non-conversion agreement that is recorded on the deed to the property. Since the deed follows the property, future homebuyers are informed of the restrictions.

Applicability
In DuPage County, the DuPage County Stormwater Management and Flood Plain Ordinance requires all substantially improved residential structures have their lowest floor elevated one (1) foot above the 100-year flood elevation; the City of Wheaton municipal code requires structures to be elevated two (2) feet above the 100-year floodplain elevation. Raising a structure above the flood level on an open foundation (e.g., piles, piers, or posts) is an effective on-site property protection method. Water flows under the building, causing little or no damage to the structure or its contents.

- Elevating structures within the regulated floodplain must comply with local requirements concerning substantial improvements, use of flood resistant materials, protection against flood damage, etc.
- Concrete and masonry buildings and those with slab-on-grade foundations present special difficulties for lifting.
- Not advisable for structures that are in fair or poor condition
- Elevation on fill is not advisable in the floodway

Advantages
Some of the key advantages of elevating a structure include:

- Dependable way to protect the structure and contents, since everything subject to damage is raised above the flood level;
- Brings a substantially improved or substantially damaged structure into compliance with the National Flood Insurance Program (NFIP) regulations;
- Often reduces flood insurance premiums;
- Qualified contractors are often readily available; and
- Does not require the additional land that may be needed for floodwalls or levees.

Disadvantages
Some of the disadvantages of installing openings that should be considered before elevating a structure include:

- Elevation can be expensive, especially for large, masonry structures on slab foundations;
- The appearance of the structure may be adversely affected;
- Elevation is not appropriate in areas with high-velocity water flow, fast-moving ice or debris flow, or erosion, unless special measures are taken;
- Some zoning ordinances and subdivision covenants prohibit buildings above a certain height.
- Owners may lose their basements; and
- The surrounding area remains subject to flooding, which may make the structure inaccessible during large storm events.

Design Considerations

There are three primary methods to elevate structures, which include:

- Open foundation (e.g., piles, piers, or posts)
- Continuous foundation walls (creating an enclosed space below the building), or
- Compacted earthen fill.

Elevating on compacted fill is the most complicated and expensive alternative. The building has to be temporarily moved so the fill can be placed and properly compacted; the building is then moved back to the site. This process may make elevating on fill more costly than elevating on an open foundation or continuous foundation walls. In addition to the type of structure, the following should also be considered during the design process:

- Debris loads on walls or piers
- Special protective measures may be required in areas with velocities more than 5 feet per second
- Structures on the National Register of Historic Buildings may have restrictions that will not allow elevation of the structure, or have special requirements in order to elevate, which must be considered during the design process.
- Increased earthquake, wind, hydrostatic and hydrodynamic forces on the structure.
- Aesthetic treatments around the elevated structure (landscaping, grading, siding, etc.)

Constructability

Some of the key construction elements to consider are as follows:

- Elevating a structure that has a basement is also more difficult because the support structures for the lifting beams must be constructed outside of the basement's footprint in order to begin the lifting process.
- Additional supports are needed to lift the slab without damage. The area under the slab must be excavated to insert the lifting equipment and disconnect utilities. Alternatively, the structure can be removed from the slab, elevated, and place upon a new floor.
- In order to elevate a structure, there must be enough room free from obstructions. Construction easements on neighboring properties may be necessary and should be obtained in advance.
- Access to the structure following elevation must be considered. Alternatives include ramps, stairs, and/or elevators.
- Requirements in the local building code and floodplain ordinance must be followed.
- The occupants of the structure will need to be relocated for 1 to 3 months.

Construction Cost

The cost of elevating a structure is generally in the middle range compared to the costs of implementing other mitigation measures. Costs that may need to be considered include:

- Preparation of the structure for elevation;
- Elevation of the structure, including cost of steel beams, jacks, etc.;
- Construction of the new, elevated foundation;
- Secure the structure to the new foundation; and
- Replacement or reconstruction of items removed from the structure prior to elevation.

Examples cost estimates from *FEMA Publication 551: Selecting Appropriate Mitigation Measures for Floodprone Structures* were adjusted for inflation and summarized in Table 3.

Table 3.Structure Elevation Costs

Structure Type	Cost/square foot
Wood-frame building on piles, posts, or columns	$ 53
Wood-frame on concrete or building foundation walls	$ 47
Brick walls	$ 64
Slab-on-grade	$ 67

If a structure has been substantially damaged and it had flood insurance at the time the flood damage occurred, the structure is eligible for Increased Cost of Compliance (ICC) coverage and can receive up to $30,000 towards the cost of elevating the structure. Additionally, structure elevation is eligible for FEMA Hazard Mitigation Grant Program (HMGP) funding. HMGP funding is not guaranteed and does require a non-federal cost share; however, these funds can help offset the cost of structure elevation.

Required Maintenance

The additional maintenance required for the structure after it has been elevated structure is minimal. The following maintenance should be performed annually:

- Inspection of the supports for the elevated structure,
- Removal of debris under the structure, and
- Correction of any erosion.

Flood Reduction Capabilities

Structure elevation permanently mitigates the flood risk to the structure involved, since the structure is elevated above the anticipated water level. The area beneath the elevated structure, however, will continue to flood. Additionally, access to an elevated structure during a storm event may be restricted.

REFERENCES

FEMA. 1999. *Protecting Building Utilities From Flood Damage*. FEMA P-348. Available at

FEMA. 2005. *Reducing Damage from Localized Flooding: A Guide for Communities*. FEMA P-511. Available at www.fema.gov/media-library-data/20130726-1446-20490-0539/FEMA511-complete.pdf.

FEMA. 2007. *Selecting Appropriate Mitigation Measures for Floodprone Structures*. FEMA P-551. Available at www.fema.gov/media-library-data/20130726-1609-20490-5083/fema_551.pdf.

FEMA. 2008. *Openings in Foundation Walls and Walls of Enclosures*. FEMA TB-1. Available at www.fema.gov/media-library-data/20130726-1502-20490-9949/fema_tb_1__1_.pdf.

FEMA. 2013a. *Floodproofing Non-Residential Buildings*. FEMA P-936. Available at www.fema.gov/media-library-data/9a50c534fc5895799321dcdd4b6083e7/P-936_8-20-13_508r.pdf.

FEMA. 2013b. *Reducing Flood Risk and Flood Insurance Premiums for Existing Residential Buildings in Zone A*. Hurricane Sandy Recovery Fact Sheet No. 7. Available at http://www.fema.gov/media-library-data/1385402350525-0854e30dc59e2567554b87bc3cc94e36/SandyRA7ReducingFloodRisk_111913-508.pdf

FEMA. 2014. *Homeowner's Guide to Retrofitting*. FEMA P-312. Available at www.fema.gov/ media-library-data/1404148604102-f210b5e43aba0fb393443fe7ae9cd953/FEMA_P-312.pdf.

Georgia Stormwater Management Manual, 2001, Volume 2, Technical Handbook. Available at

Heaney, J.P., Pitt, R., & Field R. (2000). Innovative Urban Wet Weather Flow Management Systems. EPA/600/R-99/029. U.S. Environmental Protection Agency, Cincinnati, OH