Arborwalk East Multi-Family

Storm Drainage Study

Lee's Summit, Missouri. Jackson County

Issued Date: February 9th, 2023

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Kimley»Horn

Drainage Report Contents

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GENERAL INFORMATION

Kimley-Horn and Associates, Inc. (Kimley-Horn) has been hired by Milhaus Development, LLC to provide professional civil engineering services for the proposed Arborwalk East Multi-Family Development. The project is generally located at the northeast corner of MO-150 Highway and SW Ward Rd in Lee's Summit Missouri (See **Exhibit 1)**. According to the Arborwalk Development Drainage Master Plan (See **Appendix A**), the project is located within a +/- 22.26-acre designated commercial area. Currently, there are 3 parcels within the commercial area. The largest parcel, with an area of +/- 18.88 acres, will be subdivided into two parcels. The northernmost +/- 11.46-acre parcel will contain the proposed multi-family development, while the remaining +/- 7.42-acre parcel will remain unimproved and is not within the scope of the project. It is understood this will ultimately be developed as a commercial property by others. The existing site is covered in grasses and woodland. The surface runoff generally flows southeast into an existing box culvert located at the northeast corner of the MO-150 and SW Ward Rd intersection, ultimately discharging into Raintree Lake.

The proposed multi-family development will generally include the construction of 8 walk-up garden style apartment buildings, as well as, associated new surface parking, new garage parking, new sidewalk plazas, new site access drives, new utility services, and streetscape improvements to serve the site. As referenced by the aforementioned drainage master plan, stormwater detention is provided upstream, adequately controlling peak flows for the entire planned commercial development. Therefore, no additional stormwater detention is proposed on site. The stormwater exiting the site will be routed through hydrodynamic separators designed to filter out pollutants per the MARC BMP Manual to treat water quality requirements.

The property is generally situated within Section 25, Township 47N, Range 32W in Jackson County, Missouri (See **Exhibit 2**).

According to FEMA's (Federal Emergency Management Agency) Flood Insurance firm panel 29095C0532G, the site is located in Zone X, an "Area of Minimal Flood Hazard" (**See Exhibit 3**).

SOILS

Table 1 below shows the typical soil classifications found on site. For more information, see the data obtained from the USDA Soil Survey of Jackson County, Missouri (See **Exhibit 4**).

Table 1: USDA Soil Survey – On-Site Soil Characteristics

Hydrologic Soil Group (HSG)	Map Symbol	Type	Slopes
C	10082	Arisburg-Urban land Complex	1-5%
D	10128	Sharpsburg-Urban land complex	2-5%
C	10181	Udarents-Urban land-Sampsel Complex	5-9%

METHODOLOGY

The Hydraflow Hydrograph Package and Bentley Pondpack software were utilized to determine the effects of the development and ensure that the existing hydrologic conditions were restored, and even improved. Following the American Public Works Association (APWA) Section 5600 Storm Drainage Systems and Facilities guide, Curve Numbers (CN's) and runoff coefficients (C's) were calculated depending on the cover type, condition, and hydrologic soil group, and rainfall intensities (See **Calculations 1**). Chapter 6 of the MARC BMP manual was used to determine the water quality volume and treatment flows, and the overall manual was used as guidance when determining an appropriate stormwater treatment solution for the project.

EXISTING CONDITIONS

The proposed project is located within a designated commercial area, per the attached Arborwalk Development Drainage Master Plan. The commercial area is +/- 22.26 acres, and was initially divided into three parcels. The largest parcel, with an area of +/- 18.88 acres, will be subdivided into two parcels, for a total of four parcels within the commercial area. These four parcels (Lot "A", Lot "B", Lot "C", and Lot "D") all generally drain southeast towards a sedimentation basin installed previously to treat runoff until the site was ultimately developed. Stormwater ultimately drains toward a box culvert located in the southeast corner of the commercial area, carrying the runoff underneath the intersection and ultimately discharging into Raintree Lake.

The overall commercial area contains a wide variety of soils with slopes ranging from 1-9%. The soils belong to hydrologic soil groups C or D. The existing soils are described as moderately well drained to somewhat poorly drained. The existing site primarily consists of 1.52 acres of woods in good condition yielding a CN of 74, 5.05 acres of woods in good condition yielding a CN of 70, 12.64 acres of open space in good condition yielding a CN of 74, and 3.05 acres of open space in good condition yielding a CN of 80 (See **Exhibit 5**). This results in a cumulative pre-development CN of 74 with a time of concentration of 15 minutes. **Table 2** below presents the rainfall intensity and peak flows for the overall commercial area at Critical Point 1 in the pre-development condition.

Table 2: Pre-Development Overall Commercial Area Rainfall Intensity & Peak Flows

	2-Year	10-Year	50-Year	100-Year
Rainfall Intensity (in/hr)	2.16	3.07	4.02	4.47
Pre-Development Peak Flow (CFS)	25.05	34.88	45.12	49.56

Based on the existing topography, the previously planned commercial area could be defined and analyzed as one overall drainage area. However, the report will divide them into four separate drainage areas (areas A through D) to allow for a more in-depth analysis of the existing and proposed conditions (See **Exhibit 6**). The four drainage areas are described below:

Drainage Area "A"

Drainage area "A" generally drains 11.46 acres of sheet flow and shallow concentrated flow inwards towards two unregulated rivulets discharging into the existing sediment basin located in drainage area "B". A ridge along the eastern third of the area promotes flow away from the unregulated rivulet and into storm inlets along SW Ward Road. In both scenarios, the flow enters underground storm sewer and is discharged south across the intersection into a small channel. The small channel carries runoff towards a box culvert directing flow east, ultimately discharging at Raintree Lake. There is approximately 3.05 acres of open space in good condition yielding a CN of 80, 1.52 acres of woods in good condition yielding a CN of 74, 5.13 acres of open space in good condition yielding a CN of 74, and 1.75 acres of woods in good condition yielding a CN of 70. The cumulative CN is 75 with a time of concentration of 12 minutes. **Table 3** below represents the rainfall intensity and peak flows for drainage area A in the pre-development condition.

Table 3: Pre-Development Drainage Area "A" Peak Flows				
	2-Year	**10-Year**	**50-Year**	**100-Year**
Rainfall Intensity (in/hr)	2.22	3.16	4.13	4.53
Pre-Development Peak Flow (CFS)	14.54	20.10	25.90	28.45

Drainage Area "B"

Drainage area "B" generally drains 7.45 acres of sheet flow and shallow concentrated flow east into the existing sedimentation basin and/or into the culvert located near the southeast corner of the entire commercial area. The culvert discharges into an unregulated tributary stream, ultimately flowing into Raintree Lake to the southeast. There is approximately 3.30 acres of woods in good condition yielding a CN of 70 and 4.15 acres of open space in good condition yielding a CN of 74. The cumulative CN is 75 with a time of concentration of 14 minutes. **Table 4** below represents the rainfall intensity and peak flows for drainage area B in the pre-development condition.

Table 4: Pre-Development Drainage Area "B" Peak Flows				
	2-Year	**10-Year**	**50-Year**	**100-Year**
Rainfall Intensity (in/hr)	2.19	3.07	4.02	4.47
Pre-Development Peak Flow (CFS)	8.82	12.25	15.81	17.37

Drainage Area "C"

Drainage area C generally drains 1.59 acres of sheet flow and shallow concentrated flow east, collecting in the existing sedimentation basin and ultimately discharging at Raintree Lake. The "Micro Stormwater Drainage Study for McBee's Coffee 'N Carwash" analyzes the existing conditions for what is referred to as "Drainage Area C" in this study, and was approved through the City of Lee's Summit, MO. Therefore, no further analysis of Drainage Area C is required. The aforementioned drainage study can be found in **Appendix C**.

Drainage Area "D"

Drainage area "D" generally drains 1.77 acres of sheet flow and shallow concentrated flow east into Drainage Area "C". The flow is generally routed through the existing sedimentation basin located on the eastern half of the designated commercial area. The runoff is then conveyed through underground storm sewer south and discharged into an unregulated Raintree Lake tributary stream across MO 150 Highway. Ultimately, the runoff is discharged into Raintree Lake. There is approximately 1.77 acres of open space in good condition yielding a CN of 70. The cumulative CN is 70 with a time of concentration of 13 minutes. **Table 5** below presents the rainfall intensity and peak flows for drainage area D in the pre-development condition.

Table 5: Pre-Development Drainage Area "D" Peak Flows				
	2-Year	**10-Year**	**50-Year**	**100-Year**
Rainfall Intensity (in/hr)	2.16	3.07	4.02	4.41
Pre-Development Peak Flow (CFS)	2.15	2.98	3.84	4.22

Calculations for the Existing Conditions section can be found in the **Exhibits & Calculations** section of the report.

PROPOSED CONDITIONS

The proposed improvements to the previously planned commercial area designated by the Arborwalk Development Drainage Master Plan will include improvements to Lots "A", "B", "C", and "D". Improvements to the +/-11.46-acre Lot "A" generally include the construction of 8 new garden style walk-up apartment buildings, as well as, associated new surface parking, new garage parking, new sidewalk plaza, new site access drives, new utility services, and streetscape improvements to serve the site. Improvements to the +/- 7.45-acre Lot "B" will generally include the construction of 5 commercial buildings, as well as, associated new surface parking, new sidewalk, new site access drives, new utility services, and new streetscape improvements to serve the site. Improvements to the 1.59-acre Lot "C" will generally include the construction of a commercial carwash building, as well as, associated new surface parking and new underground detention. Improvements to the +/- 1.77-acre Lot "D" generally include the construction of a commercial building and pump stations, as well as, associated new surface parking, new utility services, new site access drives. At the time of this report, Lot "D" has been developed. Lots "B", "C", and "D" were studied to confirm detention requirements were met based on the outlined requirements of the Arborwalk Development Drainage Master Plan. The proposed improvements of these areas will be performed by others.

The overall previously proposed commercial area primarily consists of 11.46 acres of Lot "A" multi-family development yielding a CN of 92, 7.45 acres of Lot "B" commercial development yielding a CN of 93, 1.59 acres of Lot "C" commercial development yielding an approximate CN of 90 (See approved drainage report in **Appendix C**), and 1.80 acres of commercial development yielding a CN of 94 (See **Exhibit 7)**. This distribution results in a post-development cumulative CN of 92 for the overall commercial area with a conservative time of concentration of 5 minutes. **Table 6** below presents the rainfall intensity and peak flows for the area studied at Critical Point 1 in the post-development condition.

Table 6: Post-Development Overall Commercial Area Peak Flows				
	2-Year	**10-Year**	**50-Year**	**100-Year**
Rainfall Intensity (in/hr)	2.16	3.07	4.02	4.47
Post-Development Peak Flow (CFS)	34.69	49.36	64.56	71.83

Based on the proposed topography, the previously planned commercial area could be defined and analyzed as one overall drainage area. However, the report will divide them into four separate drainage areas (areas A through D) to allow for a more in-depth analysis of the proposed conditions (See **Exhibit 8**). The four drainage areas are described below:

Drainage Area "A"

Drainage Area "A" generally drains 11.46 acres of the overall area through a series of conveyance measures including new enclosed storm sewer and surface runoff. The captured runoff will be routed through water quality units (discussed further in the BMP Analysis section) and connected to a new RCB storm sewer constructed during Lot "B" improvements. It will ultimately be conveyed south to the box culvert at the northeast corner of MO 150 Highway and SW Ward Road, and discharged into Raintree Lake. Drainage Area "A" contains approximately 7.69 acres of impervious area and 3.77 acres of pervious area, resulting in a runoff coefficient of 0.70. The cumulative CN is 92 with a time of concentration of 5 minutes. **Table 7** below represents the rainfall intensity and peak flows for drainage area "A" in the post-development condition.

Table 7: Drainage Area "A" Post-Development Peak Flow Rates				
	2-Year	**10-Year**	**50-Year**	**100-Year**
Rainfall Intensity (in/hr)	2.22	3.16	4.13	4.53
Post-Development Peak Flow (CFS)	18.08	25.69	33.58	36.86

The post-development peak flows exceed the requirements set by APWA Section 5608.4.C.1.a, traditionally requiring on-site detention. However, the overall Arborwalk development drainage master plan accounts for unrestricted flow discharging from the designated commercial area. This will be discussed in more detail in the Detention Analysis section below.

Drainage Area "B"

Drainage Area "B" generally drains 7.45 acres of the overall area through a series of conveyance measures including new enclosed storm sewer and surface runoff south to the NW corner of the MO 150 Highway and SW Ward Road intersection. A box culvert carries the flow south across MO-150 Highway, discharging into an unregulated tributary stream before quickly flowing east underneath SW Ward Road through another culvert, and ultimately discharging into Raintree Lake. Drainage Area "B" contains approximately 5.33 acres of impervious area and 2.12 acres of pervious area, resulting in a runoff coefficient of 0.73. The cumulative CN is 93 with a conservative time of concentration of 5 minutes. **Table**

8 below represents the rainfall intensity and peak flows for drainage area D in the post-development condition.

Table 8: Drainage Area "B" Post-Development Peak Flow Rates				
	2-Year	**10-Year**	**50-Year**	**100-Year**
Rainfall Intensity (in/hr)	2.19	3.07	4.02	4.47
Post-Development Peak Flow (CFS)	12.02	16.85	22.04	24.53

The post-development peak flows exceed the requirements set by APWA Section 5608.4.C.1.a, traditionally requiring on-site detention. However, the overall Arborwalk development drainage master plan accounts for unrestricted flow discharging from the designated commercial area. This will be discussed in more detail in the Detention Analysis section below.

Drainage Area "C"

Drainage area C generally drains 1.59 acres of the overall area through a series of conveyance measures including new enclosed storm sewer and surface runoff. The runoff is routed through an underground detention basin, controlling flows per APWA's "Comprehensive Control", and ultimately discharging into a swale off-site into Drainage Area "B". The "Micro Stormwater Drainage Study for McBee's Coffee 'N Carwash" analyzes the proposed conditions for what is referred to as "Drainage Area C" in this study. This study was approved through the City of Lee's Summit, MO so, therefore, no further analysis of Drainage Area C is required. The aforementioned drainage study can be found in **Appendix C**.

Drainage Area "D"

Drainage Area "D" generally drains 1.77 acres of the overall area through a series of conveyance measures including new enclosed storm sewer and sheet-flow runoff. The runoff is generally conveyed east, flowing offsite and ultimately discharging into Raintree Lake. The improvements to Drainage Area "D" were constructed at the time of this report, so the as-built condition was used to calculate cover-type data. Drainage Area "D" contains approximately 1.41 acres of impervious area and 0.35 acres of pervious area, resulting in a runoff coefficient of 0.78. The cumulative CN is 94 with a conservative time of concentration of 5 minutes. **Table 9** below represents the rainfall intensity and peak flows for drainage area D in the post-development condition.

Table 9: Drainage Area "D" Post-Development Peak Flow Rates				
	2-Year	**10-Year**	**50-Year**	**100-Year**
Rainfall Intensity (in/hr)	2.16	3.07	4.02	4.41
Post-Development Peak Flow (CFS)	3.00	4.27	5.58	6.12

The post-development peak flows exceed the requirements set by APWA Section 5608.4.C.1.a, traditionally requiring on-site detention. However, the overall Arborwalk development drainage master plan accounts for unrestricted flow discharging from the designated commercial area. This will be discussed in more detail in the Detention Analysis section below.

Calculations for the Proposed Conditions can be found in the **Exhibits & Calculations** section of the report.

DETENTION ANALYSIS

Post-development peak discharge rates shall not exceed the "Comprehensive Control" requirements set forth by APWA Section 5608.4.C.1.a shown below:

- 50% storm peak rate less than or equal to 0.5 cfs per site acre
- 10% storm peak rate less than or equal to 2.0 cfs per site acre
- 1% storm peak rate less than or equal to 3.0 cfs per site acre

The post-development peak flows for the 22.46-acre designated overall commercial area are compared against the APWA requirements in **Table 10** below.

Table 10: Overall Commercial Peak Flows Compared to APWA's

	2-Year	10-Year	100-Year
Rainfall Intensity (in/hr)	2.16	3.07	4.47
Post-Development Peak Flow (CFS)	34.69	49.36	71.83
Maximum Peak Flow Per APWA (CFS)	11.23	44.92	67.38

The post-development peak flows exceed the minimum peak flows established by APWA's Comprehensive Control during the 50% and 10% storm conditions, typically requiring a stormwater detention or retention facility. However, according to the Arborwalk Development Drainage Master Plan (See **Appendix A**), the extended dry detention basin and extended wet detention basin upstream of the commercial development provides satisfactory storage for downstream development in the designated commercial area. Page 2 of the attached Arborwalk drainage master plan states that:

"The combination of the two basins will adequately hold the required volume of storage for both the southeast drainage basin including the future commercial development at the intersection of Ward Road and Highway 150"

On Page 3, the report clarifies further that:

"The proposed size of storage required for [limiting post-development flow] is approximately 7 acre-feet for the 25-year storm event and for the 100-year storm event the required storage is 10.9 acre-feet. The commercial area to the southeast when developed will require 4.8 acre-feet of storage for detention that is part of the required storage listed above"

According to the master plan, 4.8 acre-feet of storage is provided in the upstream detention basins to help regulate flow in the designated commercial development that has been studied throughout this report. PondPack software was used to estimate the storage required to reduce post-development flow to the

peak flow rates defined by APWA's Comprehensive Control. The required storage is found to be 96,047 cubic feet or 2.20 acre-feet, far below the provided upstream storage of 4.8 acre-feet.

Due to the upstream detention ponds providing more than adequate storage to control peak flows from the designated commercial area, as defined by the Arborwalk Drainage Master Plan, no additional stormwater management facilities are required for the proposed developments.

BMP ANALYSIS

The Mid-America Regional Council, Manual of Best Management Practices for Stormwater Quality, October 2012 requires the site to be designed to treat the additional impervious runoff during the 90% mean annual storm (1.37"/24 hr) created by site improvements. Each proposed development within the designated commercial area will be required to sufficiently treat the 90% mean annual event, per the City of Lee's Summit's approval.

The proposed multi-family development in Lot "A", being proposed alongside this drainage report, will satisfy the MARC BMP Manual's guidance by routing approximately 9.77 acres of runoff through two hydrodynamic separators. The separators are designed to handle the treatment flow (calculated per Chapter 6 of the MARC Manual) to remove total suspended solids. Oils, cigarette butts, and larger sand particles would be removed from the runoff prior to it being discharged off-site. Following the MARC BMP Manual's Value Rating (VR) and Level of Service system, the hydrodynamic separators provide a VR of 5 while the overall site receives a Level of Service of 4.

SUMMARY & RECOMMENDATIONS

The proposed improvements for the Arborwalk East Multi-Family Development is located within an area designated for commercial development, as described in the Arborwalk Development Drainage Master Plan. The proposed private improvements within the designated commercial development area will increase the impervious areas which increases the peak flow runoff when compared to pre-development conditions. However, the aforementioned drainage master plan accounts for future development in this area by setting aside 4.8 acre-feet of storage in the extended wet & extended dry detention basins upstream. The proposed improvements in the previously designated commercial area would require approximately 2.20 acre-feet of storage to meet APWA's Comprehensive Control Requirements in the post-development condition. Therefore, no additional detention is required within not only the proposed multi-family development, but also the entire designated commercial area.

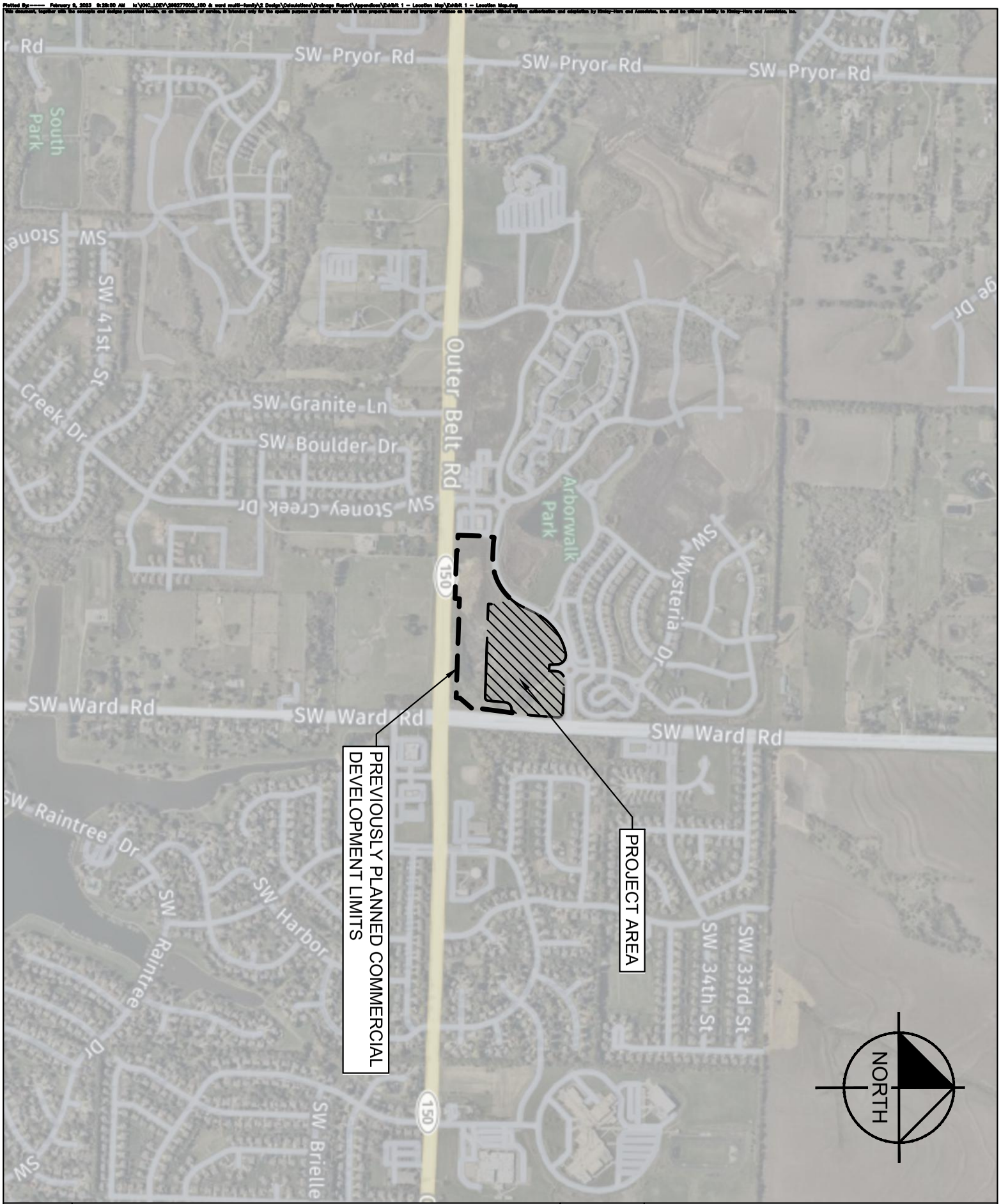
Each development within the previously designated commercial area will be required to propose stormwater treatment measures that sufficiently treat the 90% mean annual event. The proposed improvements for the Arborwalk East Multi-Family Development include two hydrodynamic separators designed to remove total suspended solids from the runoff prior to it entering the public storm sewer system. The separators provide a Value Rating of 5, and results in an overall Level of Service of 4 for the proposed multi-family site.

Separate storm memos will be required, at the time of future development, for Lot "B" and Lot "C" to confirm that the proposed improvements align with this macro study.

Because the Arborwalk East Multi-Family Development meets all the requirements of APWA section 5600, the MARC BMP Manual, it has no adverse impacts to the downstream system, and the overall

drainage patterns of the entire site will remain unchanged; it is recommended that the site be developed as planned.

Exhibits & Calculations



SHEET NUMBER
EXHIBIT 1

LOCATION MAP

ARBORWALK EAST MULTI-FAMILY

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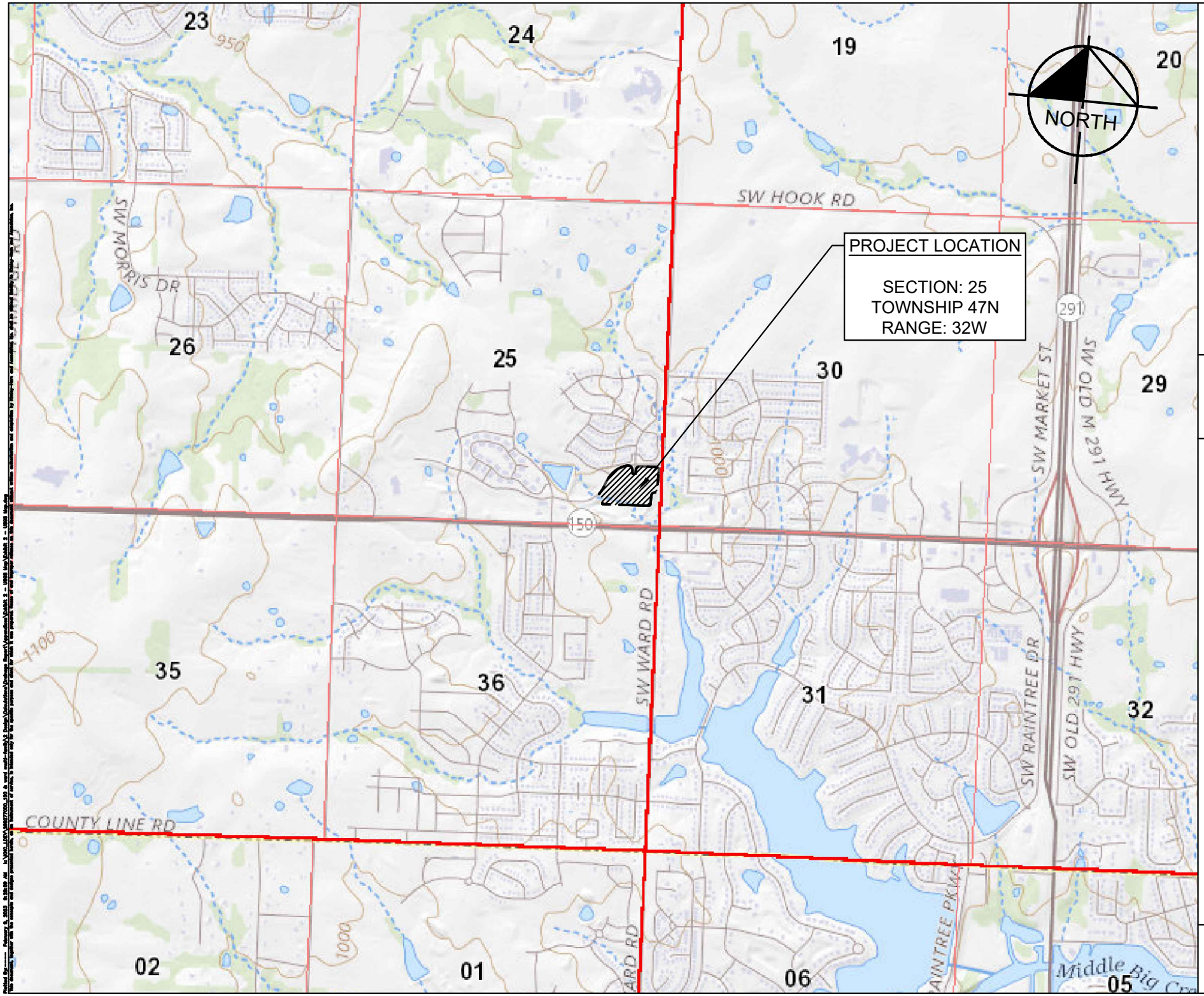

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USGS MAP

ARBORWALK EAST MULTI-FAMILY

SHEET NUMBER

EXHIBIT 2

94°22'29.6"W 38°50'30.94"N

FLOOD HAZARD INFORMATION

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR DRAFT FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee See Notes *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- 20.2 Cross Sections with 1% Annual Charce
- 17.5 Water Surface Elevation
- Coastal Transect
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature
- Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary

NOTES TO USERS

For information and questions about this Flood Insurance Rate Map (FIRM), available products associated with this FIRM, including historic versions, the current map date for each FIRM panel, how to order products, or the National Flood Insurance Program (NFIP) in general, please call the FEMA Map Information eXchange at 1-877-FEMA-MAP (1-877-336-2627) or visit the FEMA Flood Map Service Center website at https://msc.fema.gov. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products can be ordered or obtained directly from the website.

Communities annexing land on adjacent FIRM panels must obtain a current copy of the adjacent panel as well as the current FIRM Index. These may be ordered directly from the Flood Map Service Center at the number listed above.

For community and countywide map dates, refer to the Flood Insurance Study Report for this jurisdiction.

To determine if flood insurance is available in this community, contact your Insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

Basemap information shown on this FIRM was provided in digital format by the United States Geological Survey (USGS). The basemap shown is the USGS National Map: Orthoimagery. Last refreshed October, 2020.

This map was exported from FEMA's National Flood Hazard Layer (NFHL) on 1/26/2023 1:03 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time. For additional information, please see the Flood Hazard Mapping Updates Overview Fact Sheet at https://www.fema.gov/media-library/assets/documents/118418

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards. This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date.

FLOODPLAIN INFORMATION
ACCORDING TO FEMA FLOOD MAP **29095C0532G**, THE SITE IS LOCATED IN "ZONE X", DESCRIBED AS AN AREA OF MINIMAL FLOOD HAZARD.

NATIONAL FLOOD INSURANCE PROGRAM
FLOOD INSURANCE RATE MAP

PANEL 532 OF 605

Panel Contains:

COMMUNITY	NUMBER	PANEL
CITY OF LEE'S SUMMIT	290174	0532

MAP NUMBER
29095C0532G
EFFECTIVE DATE
January 20, 2017

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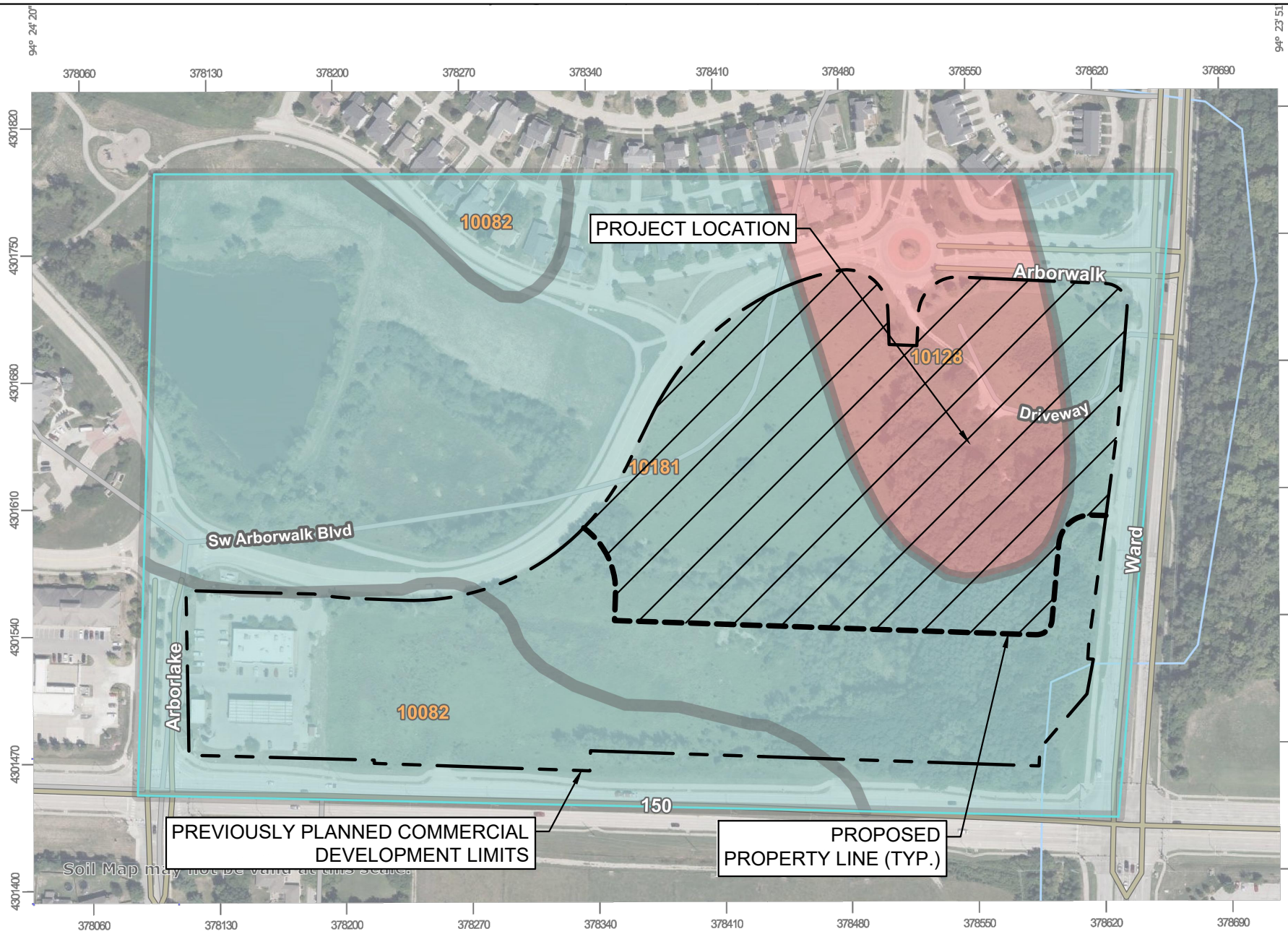
FEMA MAP

ARBORWALK EAST MULTI-FAMILY

SHEET NUMBER
EXHIBIT 3



USDA **Natural Resources Conservation Service**

Web Soil Survey
National Cooperative Soil Survey

2/6/202
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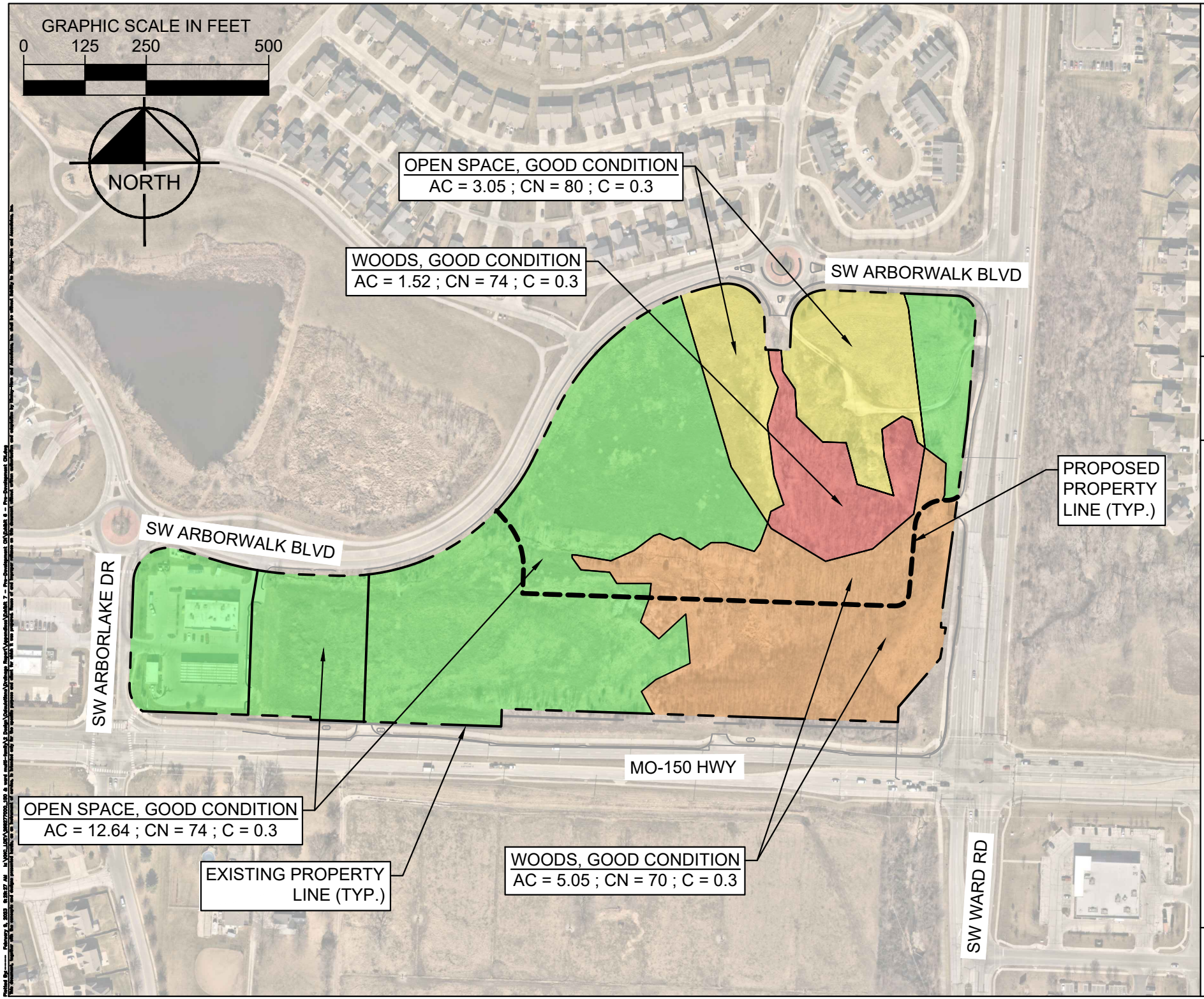
SOIL MAP

ARBORWALK EAST MULTI-FAMILY

SHEET NUMBER
EXHIBIT 4



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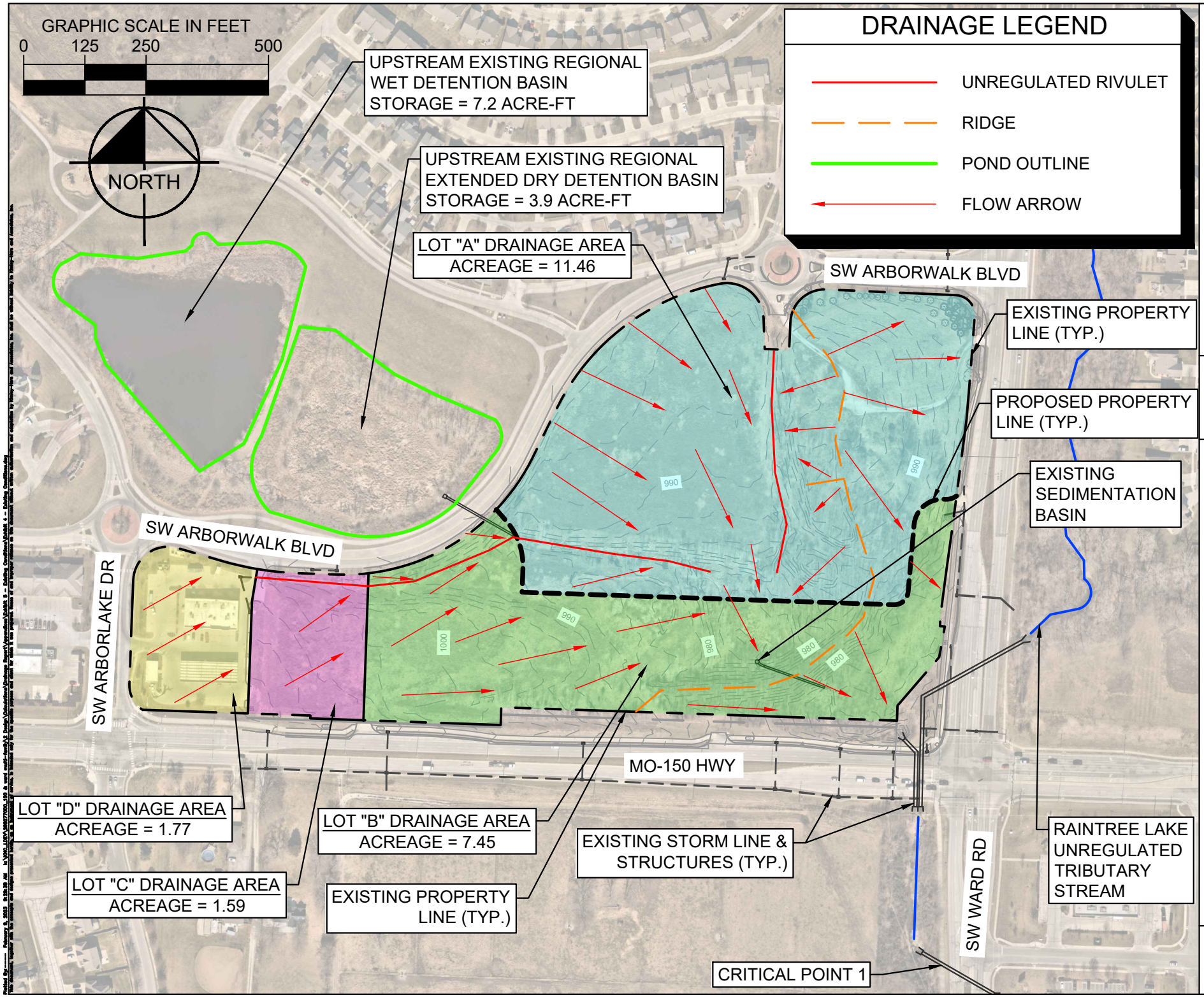
PRE-DEVELOPMENT COVER TYPES

ARBORWALK EAST MULTI-FAMILY

SHEET NUMBER

EXHIBIT 5



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EXISTING CONDITIONS

ARBORWALK EAST MULTI-FAMILY

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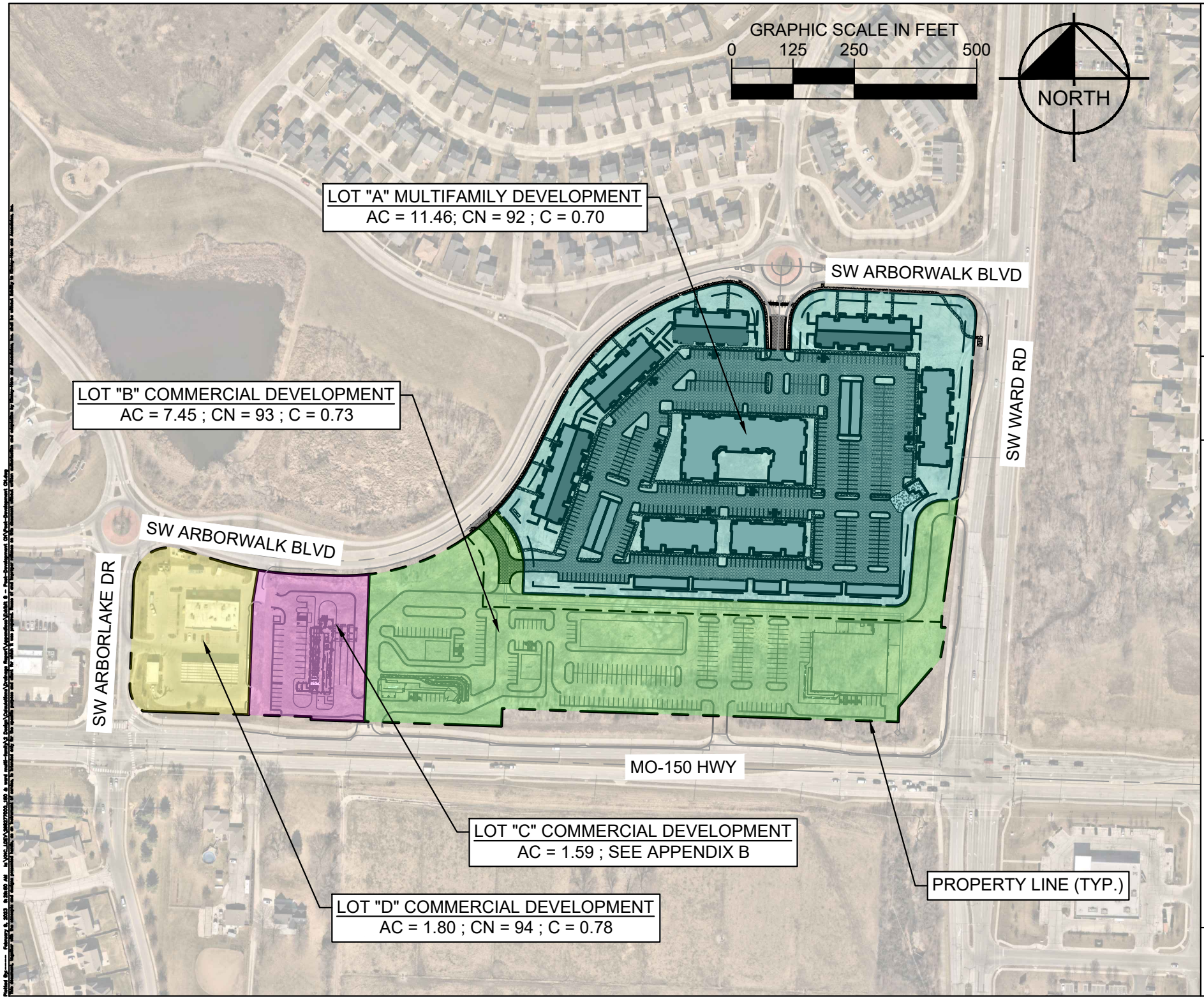
EXHIBIT 6



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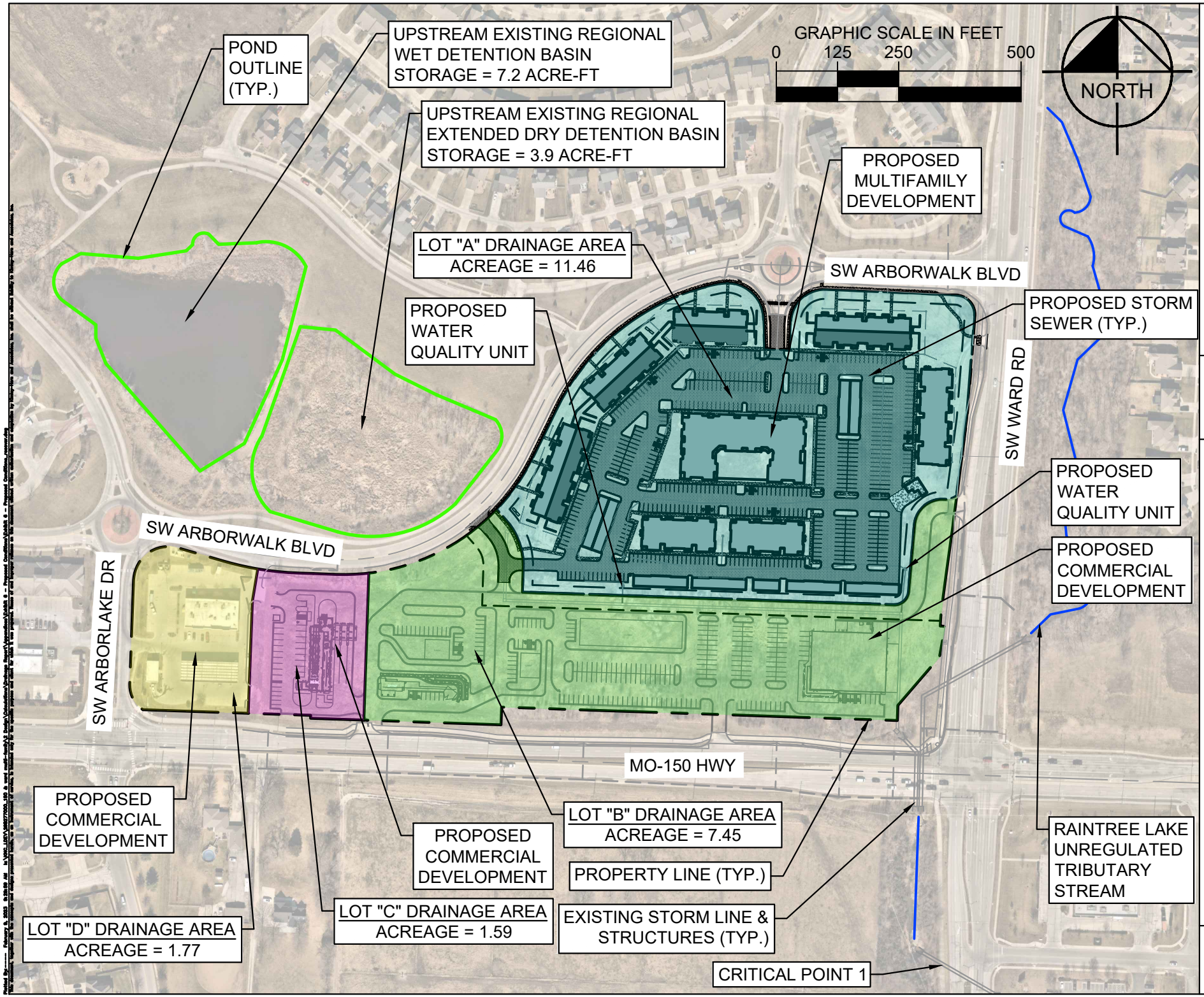
POST-DEVELOPMENT COVER TYPES

ARBORWALK EAST MULTI-FAMILY

SHEET NUMBER

EXHIBIT 7



Kimley»Horn
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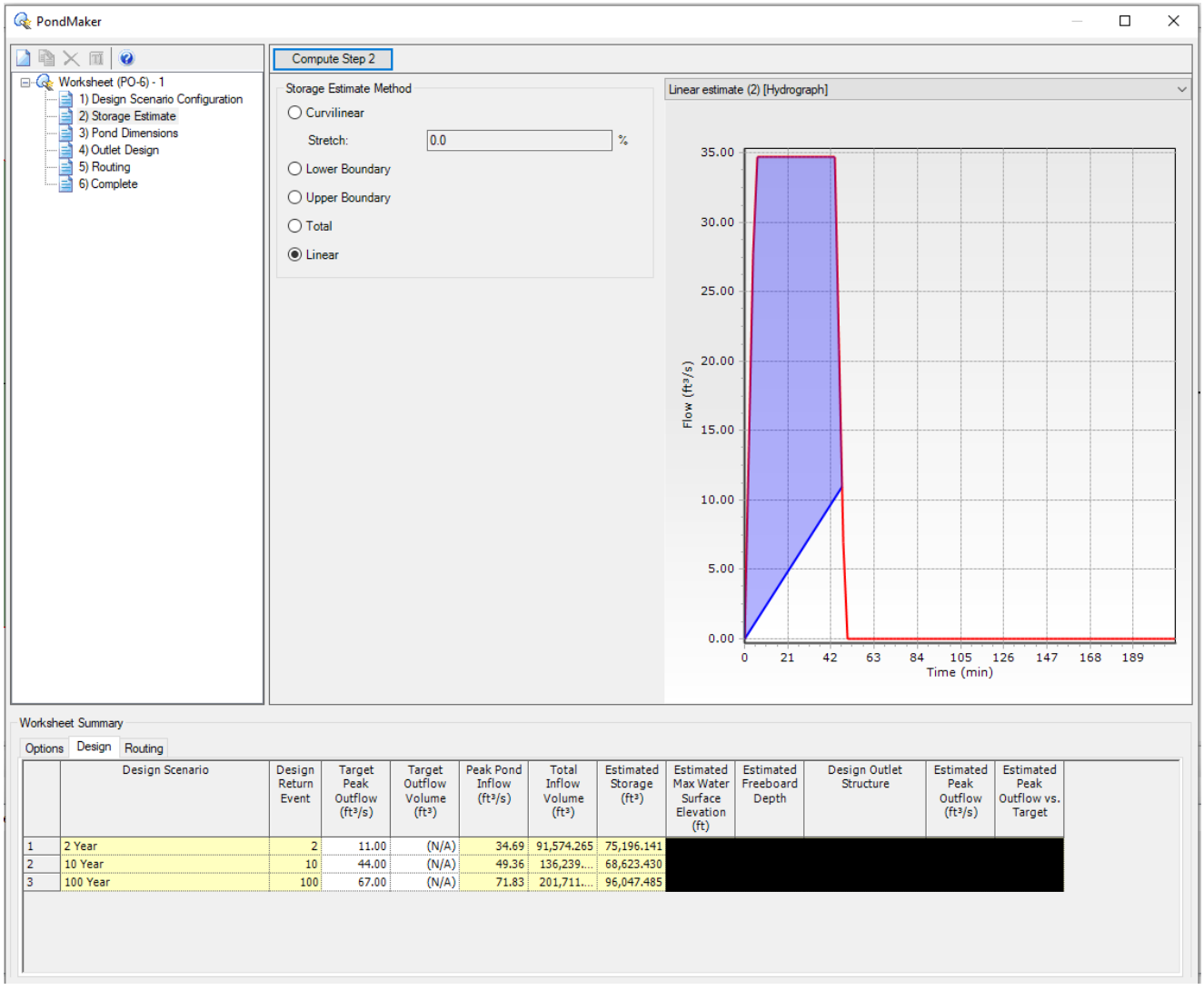
PROPOSED CONDITIONS

ARBORWALK EAST MULTI-FAMILY

SHEET NUMBER

EXHIBIT 8

PONDPACK PONDMAKER ESTIMATE



	Design Scenario	Design Return Event	Target Peak Outflow (ft³/s)	Target Outflow Volume (ft³)	Peak Pond Inflow (ft³/s)	Total Inflow Volume (ft³)	Estimated Storage (ft³)	Estimated Max Water Surface Elevation (ft)	Estimated Freeboard Depth	Design Outlet Structure	Estimated Peak Outflow (ft³/s)	Estimated Peak Outflow vs. Target
1	2 Year	2	11.00	(N/A)	34.69	91,574.265	75,196.141					
2	10 Year	10	44.00	(N/A)	49.36	136,239....	68,623.430					
3	100 Year	100	67.00	(N/A)	71.83	201,711....	96,047.485					

Hydrodynamic Separator Treatment Flow Calculations Per MARC BMP Manual - Chapter 6

Treatment Unit - West

Impervious (AC)	3.9
Pervious (AC)	0.96
Total Area (AC)	**4.86**

K	1
C	0.78
I (ft/s)	4.40E-05
A (ft^2)	211701.6

Treatment Flow (CFS)	**7.28**

Treatment Unit - East

Impervious (AC)	4.153
Pervious (AC)	0.737
Total Area (AC)	**4.89**

K	1
C	0.81
I (ft/s)	4.40E-05
A (ft^2)	213008.4

Treatment Flow (CFS)	**7.58**

Time of Concentration - Overall

Sheet Flow (Inlet Time, Tt)

Tt (hr)=	12.581259
C=	0.3
l(ft)=	100
P2=	3.58
S=	1.5

Tt Total (min)
12.58

Note: The inlet time equation is located in Section 5602.7.A from KCMetro APWA 5600

Shallow Concentrated Flow

Segment 1	
Cover	Grassland
Tt (min)=	0.53433333
l(ft)=	320.6
V (ft/s)=	10

Segment 2	
Cover	Wooded
Tt (min)=	0.19333333
l(ft)=	174
V (ft/s)=	15

Segment 3	
Cover	Wooded
Tt (min)=	1.47111111
l(ft)=	132.4
V (ft/s)=	1.5

Tt Total (min)
2.20

Note: Velocity Values are calculated using Table 5602-6 in the KCMetro APWA 5600

CUMULATIVE TRAVEL TIME (min)
14.78

Time of Concentration - Lot A

Sheet Flow (Inlet Time, Tt)

Tt (hr)=	10.7885323
C=	0.3
l(ft)=	100
P2=	3.58
S=	2.38

Tt Total (min)
10.79

Note: The inlet time equation is located in Section 5602.7.A from KCMetro APWA 5600

Shallow Concentrated Flow

Segment 1	
Cover	Grassland
Tt (min)=	0.63333333
l(ft)=	380
V (ft/s)=	10

Segment 2	
Cover	Wooded
Tt (min)=	0.12444444
l(ft)=	112
V (ft/s)=	15

Tt Total (min)
0.76

Note: Velocity Values are calculated using Table 5602-6 in the KCMetro APWA 5600

CUMULATIVE TRAVEL TIME (min)
11.55

Time of Concentration - Lot B

Sheet Flow (Inlet Time, Tt)

Tt (hr)=	12.0676582
C=	0.3
l(ft)=	100
P2=	3.58
S=	1.7

Tt Total (min)
12.07

Note: The inlet time equation is located in Section 5602.7.A from KCMetro APWA 5600

Shallow Concentrated Flow

Segment 1	
Cover	Grassland
Tt (min)=	0.925
l(ft)=	555
V (ft/s)=	10

Segment 2	
Cover	Wooded
Tt (min)=	0.58333333
l(ft)=	350
V (ft/s)=	10

Tt Total (min)
1.51

Note: Velocity Values are calculated using Table 5602-6 in the KCMetro APWA 5600

CUMULATIVE TRAVEL TIME (min)
13.58

Time of Concentration - Lot D

Sheet Flow (Inlet Time, Tt)

Tt (hr)=	12.581259
C=	0.3
l(ft)=	100
P2=	3.58
S=	1.5

Tt Total (min)
12.58

Note: The inlet time equation is located in Section 5602.7.A from KCMetro APWA 5600

Shallow Concentrated Flow

Segment 1	
Cover	Grassland
Tt (min)=	0.29166667
l(ft)=	175
V (ft/s)=	10

Tt Total (min)
0.29

Note: Velocity Values are calculated using Table 5602-6 in the KCMetro APWA 5600

CUMULATIVE TRAVEL TIME (min)
12.87

150 & Ward Multi-Family - Overall Commercial Area

Subsection: Modified Rational Grand Summary

Modified Rational Method

Q = CiA * Units Conversion; Where conversion = 43560 / (12 * 3600)

Frequency (years)	Area (acres)	Adjusted C Coefficient	Duration (min)	Intensity (in/h)	Flow (Peak) (ft³/s)	Flow (Allowable) (ft³/s)	Volume (inflow) (ft³)	Volume (Storage) (ft³)
2	22.260	0.715	44	2.162	34.69	25.05	91,574.266	54,751.974
2	22.260	0.715	44	2.162	34.69	25.05	91,574.266	54,751.974
10	22.260	0.715	46	3.077	49.36	34.88	136,239.599	82,872.729
25	22.260	0.715	47	3.604	57.83	40.47	163,075.187	99,943.178
50	22.260	0.715	47	4.024	64.56	45.12	182,047.589	111,667.479
100	22.260	0.715	47	4.477	71.83	49.56	202,573.375	125,260.300

150 & Ward Multi-Family - Overall Commercial Area

Subsection: C and Area (Pre-Development)

Return Event: 2 years

Label: CM-2

Storm Event: User Defined IDF Table - 1 - 2 Year

Scenario: 2 Year

C and Area Results (Pre-Development)

Soil/Surface Description	C Coefficient	Area (acres)	Area (Adjusted) (acres)
Pervious Area	0.300	22.260	(N/A)
Weighted C & Total Area --->	0.300	22.260	6.678

150 & Ward Multi-Family - Overall Commercial Area

Subsection: C and Area (Post-Development)

Return Event: 2 years

Label: CM-2

Storm Event: User Defined IDF Table - 1 - 2 Year

Scenario: 2 Year

C and Area Results

Soil/Surface Description	C Coefficient	Area (acres)	Area (Adjusted) (acres)
Impervious	0.900	15.390	(N/A)
Pervious	0.300	6.870	(N/A)
Weighted C & Total Area --->	0.715	22.260	15.912

150 & Ward Multi-Family - Overall Commercial Area

Subsection: Modified Rational Graph

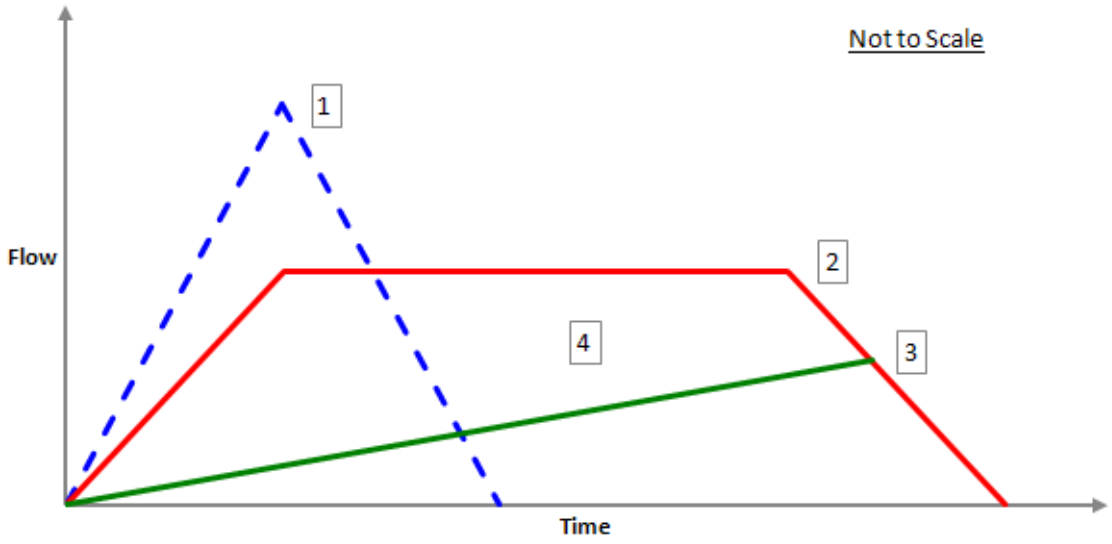
Label: CM-2

Scenario: 2 Year

Return Event: 2 years

Storm Event: User Defined IDF Table - 1 - 2 Year

Method Type	Method I
Time of Duration (Modified Rational, Critical)	44 min



[1]			[2]		
Time of Concentration (Modified Rational, Composite)	5	min	Time of Duration (Modified Rational, Critical)	44	min
Intensity (Modified Rational, Peak)	5.410	in/h	Intensity (Modified Rational, Critical)	2.162	in/h
Flow (Modified Rational, Peak)	86.80	ft³/s	Flow (Modified Rational, Critical)	34.69	ft³/s

[3]			[4]		
Second Outflow Breakpoint (Modified Rational)	45	min	Storage (Modified Rational, Estimated)	54,751.974	ft³
Flow (Modified Rational, Allowable)	25.05	ft³/s			

150 & Ward Multi-Family - Overall Commercial Area

Subsection: C and Area (Pre-Development)

Return Event: 10 years

Label: CM-2

Storm Event: User Defined IDF Table - 1 - 10 Year

Scenario: 10 Year

C and Area Results (Pre-Development)

Soil/Surface Description	C Coefficient	Area (acres)	Area (Adjusted) (acres)
Pervious Area	0.300	22.260	(N/A)
Weighted C & Total Area --->	0.300	22.260	6.678

150 & Ward Multi-Family - Overall Commercial Area

Subsection: C and Area (Post-Development)

Label: CM-2

Scenario: 10 Year

Return Event: 10 years

Storm Event: User Defined IDF Table - 1 - 10 Year

C and Area Results

Soil/Surface Description	C Coefficient	Area (acres)	Area (Adjusted) (acres)
Impervious	0.900	15.390	(N/A)
Pervious	0.300	6.870	(N/A)
Weighted C & Total Area --->	0.715	22.260	15.912

150 & Ward Multi-Family - Overall Commercial Area

Subsection: Modified Rational Graph

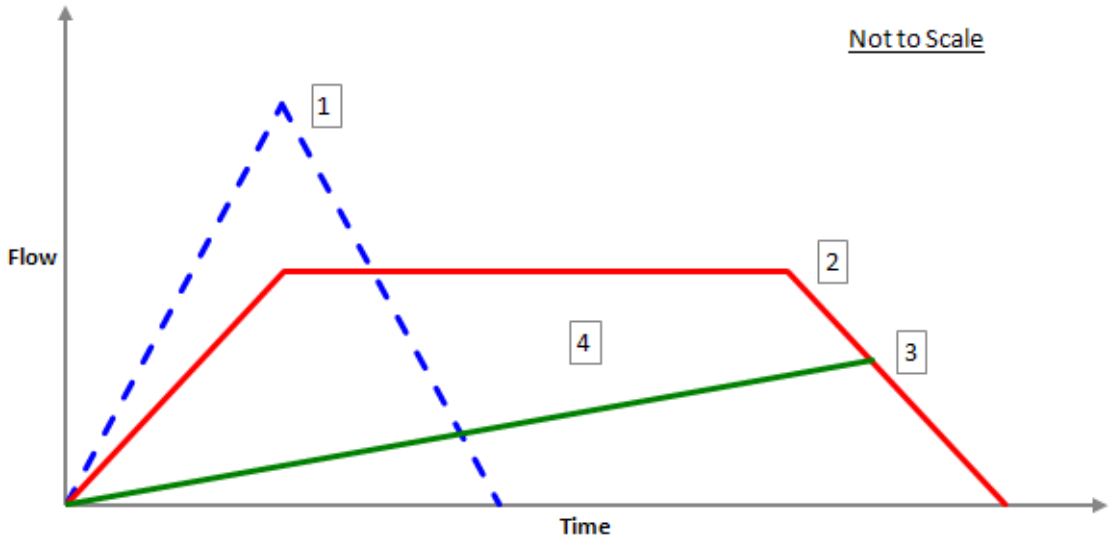
Label: CM-2

Scenario: 10 Year

Return Event: 10 years

Storm Event: User Defined IDF Table - 1 - 10 Year

Method Type	Method I
Time of Duration (Modified Rational, Critical)	46 min



[1]			[2]		
Time of Concentration (Modified Rational, Composite)	5	min	Time of Duration (Modified Rational, Critical)	46	min
Intensity (Modified Rational, Peak)	7.350	in/h	Intensity (Modified Rational, Critical)	3.077	in/h
Flow (Modified Rational, Peak)	117.92	ft³/s	Flow (Modified Rational, Critical)	49.36	ft³/s

[3]			[4]		
Second Outflow Breakpoint (Modified Rational)	47	min	Storage (Modified Rational, Estimated)	82,872.729	ft³
Flow (Modified Rational, Allowable)	34.88	ft³/s			

150 & Ward Multi-Family - Overall Commercial Area

Subsection: C and Area (Pre-Development)

Return Event: 50 years

Label: CM-2

Storm Event: User Defined IDF Table - 1 - 50 Year

Scenario: 50 Year

C and Area Results (Pre-Development)

Soil/Surface Description	C Coefficient	Area (acres)	Area (Adjusted) (acres)
Pervious Area	0.300	22.260	(N/A)
Weighted C & Total Area --->	0.300	22.260	6.678

150 & Ward Multi-Family - Overall Commercial Area

Subsection: C and Area (Post-Development)

Label: CM-2

Scenario: 50 Year

Return Event: 50 years

Storm Event: User Defined IDF Table - 1 - 50 Year

C and Area Results

Soil/Surface Description	C Coefficient	Area (acres)	Area (Adjusted) (acres)
Impervious	0.900	15.390	(N/A)
Pervious	0.300	6.870	(N/A)
Weighted C & Total Area --->	0.715	22.260	15.912

150 & Ward Multi-Family - Overall Commercial Area

Subsection: Modified Rational Graph

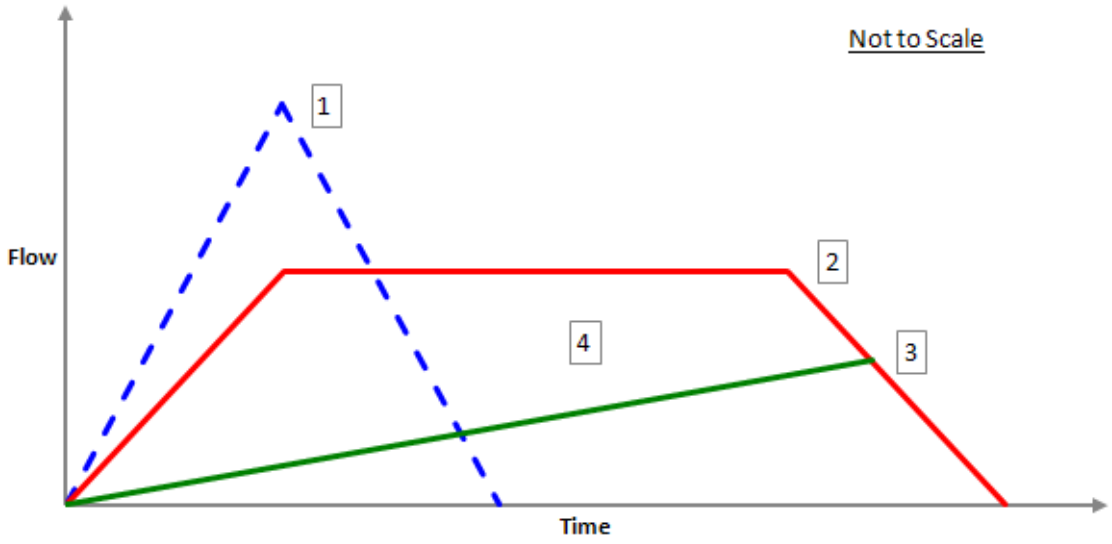
Label: CM-2

Scenario: 50 Year

Return Event: 50 years

Storm Event: User Defined IDF Table - 1 - 50 Year

Method Type	Method I
Time of Duration (Modified Rational, Critical)	47 min



[1]			[2]		
Time of Concentration (Modified Rational, Composite)	5	min	Time of Duration (Modified Rational, Critical)	47	min
Intensity (Modified Rational, Peak)	9.400	in/h	Intensity (Modified Rational, Critical)	4.024	in/h
Flow (Modified Rational, Peak)	150.81	ft³/s	Flow (Modified Rational, Critical)	64.56	ft³/s

[3]			[4]		
Second Outflow Breakpoint (Modified Rational)	49	min	Storage (Modified Rational, Estimated)	111,667.479	ft³
Flow (Modified Rational, Allowable)	45.12	ft³/s			

150 & Ward Multi-Family - Overall Commercial Area

Subsection: C and Area (Pre-Development)

Return Event: 100 years

Label: CM-2

Storm Event: User Defined IDF Table - 1 - 100 Year

Scenario: 100 Year

C and Area Results (Pre-Development)

Soil/Surface Description	C Coefficient	Area (acres)	Area (Adjusted) (acres)
Pervious Area	0.300	22.260	(N/A)
Weighted C & Total Area --->	0.300	22.260	6.678

150 & Ward Multi-Family - Overall Commercial Area

Subsection: C and Area (Post-Development)

Label: CM-2

Scenario: 100 Year

Return Event: 100 years

Storm Event: User Defined IDF Table - 1 - 100 Year

C and Area Results

Soil/Surface Description	C Coefficient	Area (acres)	Area (Adjusted) (acres)
Impervious	0.900	15.390	(N/A)
Pervious	0.300	6.870	(N/A)
Weighted C & Total Area --->	0.715	22.260	15.912

150 & Ward Multi-Family - Overall Commercial Area

Subsection: Modified Rational Graph

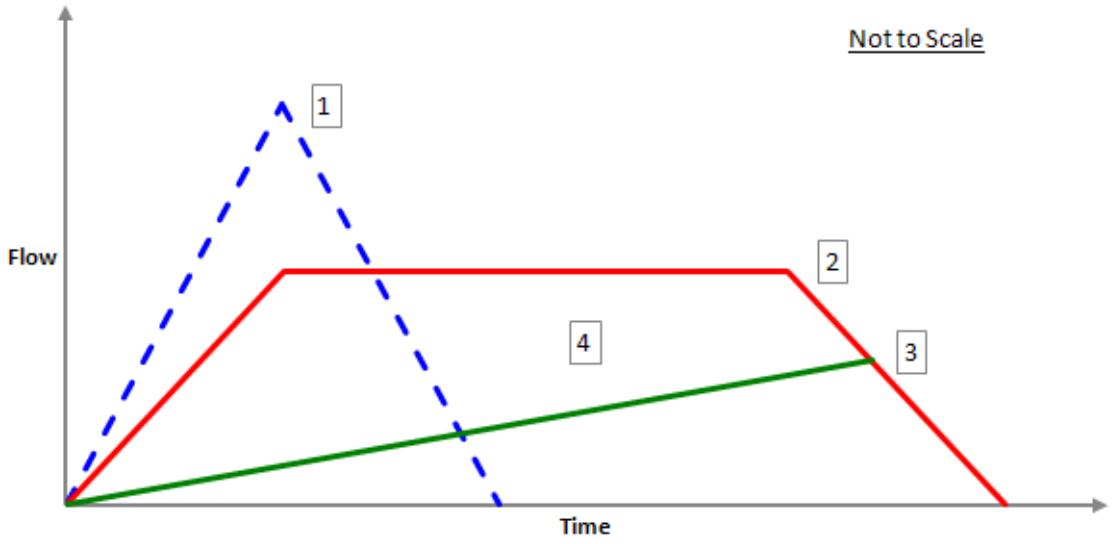
Label: CM-2

Scenario: 100 Year

Return Event: 100 years

Storm Event: User Defined IDF Table - 1 - 100 Year

Method Type	Method I
Time of Duration (Modified Rational, Critical)	47 min



[1]			[2]		
Time of Concentration (Modified Rational, Composite)	5	min	Time of Duration (Modified Rational, Critical)	47	min
Intensity (Modified Rational, Peak)	10.320	in/h	Intensity (Modified Rational, Critical)	4.477	in/h
Flow (Modified Rational, Peak)	165.57	ft³/s	Flow (Modified Rational, Critical)	71.83	ft³/s

[3]			[4]		
Second Outflow Breakpoint (Modified Rational)	49	min	Storage (Modified Rational, Estimated)	125,260.300	ft³
Flow (Modified Rational, Allowable)	49.56	ft³/s			

150 & Ward Multi-Family - Lot A

Subsection: Modified Rational Grand Summary

Modified Rational Method

Q = CiA * Units Conversion; Where conversion = 43560 / (12 * 3600)

Frequency (years)	Area (acres)	Adjusted C Coefficient	Duration (min)	Intensity (in/h)	Flow (Peak) (ft³/s)	Flow (Allowable) (ft³/s)	Volume (inflow) (ft³)	Volume (Storage) (ft³)
2	11.460	0.703	42	2.226	18.08	14.54	45,556.064	25,052.785
10	11.460	0.703	44	3.163	25.69	20.10	67,821.811	38,270.375
25	11.460	0.703	45	3.705	30.09	23.31	81,240.478	46,269.337
50	11.460	0.703	45	4.135	33.58	25.90	90,669.198	51,824.388
100	11.460	0.703	46	4.539	36.86	28.45	101,732.066	58,208.527

150 & Ward Multi-Family - Lot A

Subsection: C and Area (Pre-Development)

Return Event: 2 years

Label: CM-2

Storm Event: User Defined IDF Table - 1 - 2 Year

Scenario: 2 Year

C and Area Results (Pre-Development)

Soil/Surface Description	C Coefficient	Area (acres)	Area (Adjusted) (acres)
Pervious Area	0.300	11.456	(N/A)
Weighted C & Total Area --->	0.300	11.456	3.437

150 & Ward Multi-Family - Lot A

Subsection: C and Area (Post-Development)

Return Event: 2 years

Label: CM-2

Storm Event: User Defined IDF Table - 1 - 2 Year

Scenario: 2 Year

C and Area Results

Soil/Surface Description	C Coefficient	Area (acres)	Area (Adjusted) (acres)
Impervious	0.900	7.694	(N/A)
Pervious	0.300	3.766	(N/A)
Weighted C & Total Area --->	0.703	11.460	8.054

150 & Ward Multi-Family - Lot A

Subsection: Modified Rational Graph

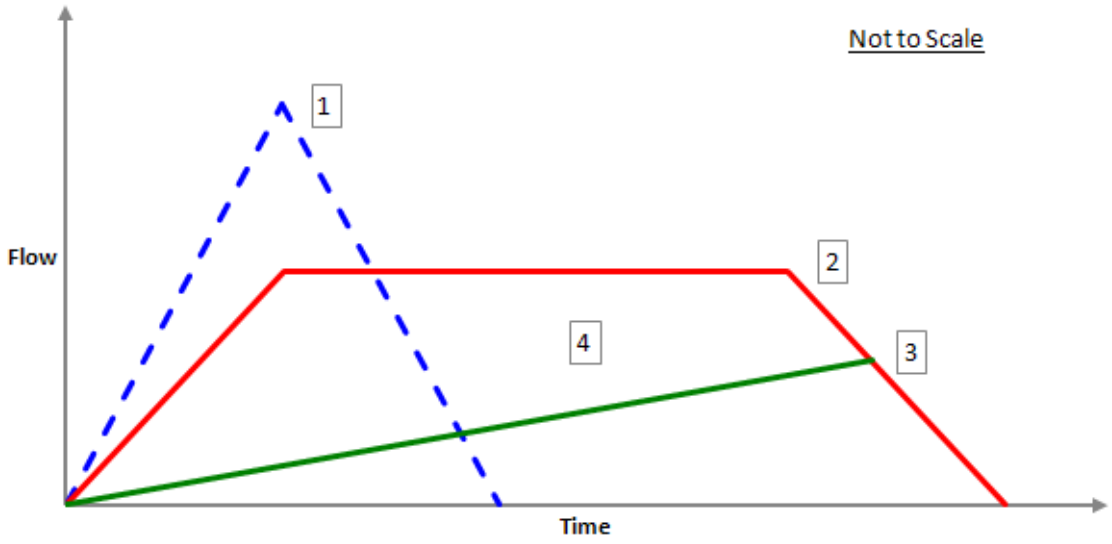
Label: CM-2

Scenario: 2 Year

Return Event: 2 years

Storm Event: User Defined IDF Table - 1 - 2 Year

Method Type	Method I
Time of Duration (Modified Rational, Critical)	42 min



[1]			[2]		
Time of Concentration (Modified Rational, Composite)	5	min	Time of Duration (Modified Rational, Critical)	42	min
Intensity (Modified Rational, Peak)	5.410	in/h	Intensity (Modified Rational, Critical)	2.226	in/h
Flow (Modified Rational, Peak)	43.94	ft³/s	Flow (Modified Rational, Critical)	18.08	ft³/s

[3]			[4]		
Second Outflow Breakpoint (Modified Rational)	43	min	Storage (Modified Rational, Estimated)	25,052.785	ft³
Flow (Modified Rational, Allowable)	14.54	ft³/s			

150 & Ward Multi-Family - Lot A

Subsection: C and Area (Pre-Development)

Return Event: 10 years

Label: CM-2

Storm Event: User Defined IDF Table - 1 - 10 Year

Scenario: 10 Year

C and Area Results (Pre-Development)

Soil/Surface Description	C Coefficient	Area (acres)	Area (Adjusted) (acres)
Pervious Area	0.300	11.456	(N/A)
Weighted C & Total Area --->	0.300	11.456	3.437

150 & Ward Multi-Family - Lot A

Subsection: C and Area (Post-Development)

Return Event: 10 years

Label: CM-2

Storm Event: User Defined IDF Table - 1 - 10 Year

Scenario: 10 Year

C and Area Results

Soil/Surface Description	C Coefficient	Area (acres)	Area (Adjusted) (acres)
Impervious	0.900	7.694	(N/A)
Pervious	0.300	3.766	(N/A)
Weighted C & Total Area --->	0.703	11.460	8.054

150 & Ward Multi-Family - Lot A

Subsection: Modified Rational Graph

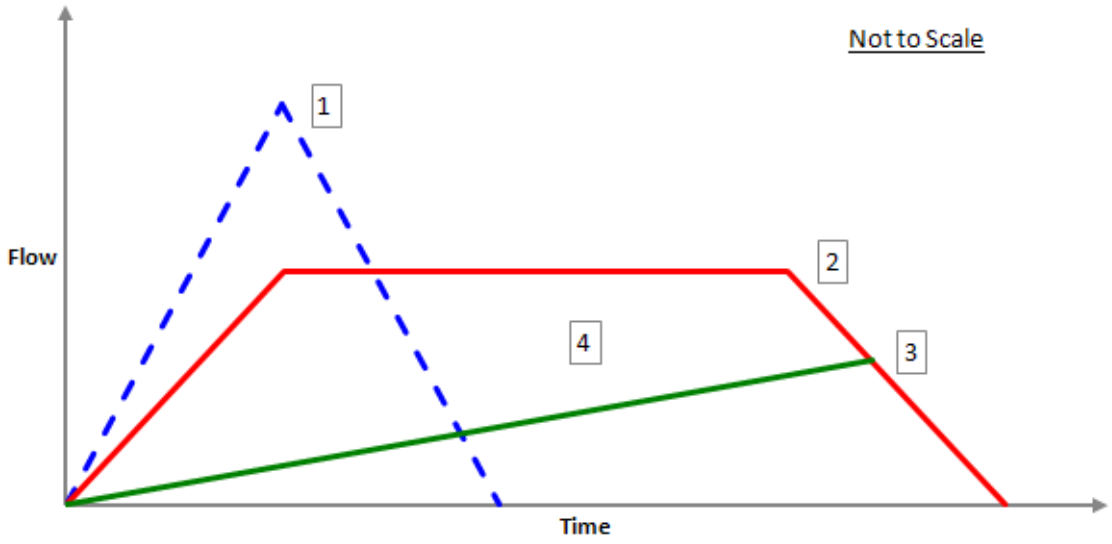
Label: CM-2

Scenario: 10 Year

Return Event: 10 years

Storm Event: User Defined IDF Table - 1 - 10 Year

Method Type	Method I
Time of Duration (Modified Rational, Critical)	44 min



[1]			[2]		
Time of Concentration (Modified Rational, Composite)	5	min	Time of Duration (Modified Rational, Critical)	44	min
Intensity (Modified Rational, Peak)	7.350	in/h	Intensity (Modified Rational, Critical)	3.163	in/h
Flow (Modified Rational, Peak)	59.69	ft³/s	Flow (Modified Rational, Critical)	25.69	ft³/s

[3]			[4]		
Second Outflow Breakpoint (Modified Rational)	45	min	Storage (Modified Rational, Estimated)	38,270.375	ft³
Flow (Modified Rational, Allowable)	20.10	ft³/s			

150 & Ward Multi-Family - Lot A

Subsection: C and Area (Pre-Development)

Return Event: 50 years

Label: CM-2

Storm Event: User Defined IDF Table - 1 - 50 Year

Scenario: 50 Year

C and Area Results (Pre-Development)

Soil/Surface Description	C Coefficient	Area (acres)	Area (Adjusted) (acres)
Pervious Area	0.300	11.456	(N/A)
Weighted C & Total Area --->	0.300	11.456	3.437

150 & Ward Multi-Family - Lot A

Subsection: C and Area (Post-Development)

Return Event: 50 years

Label: CM-2

Storm Event: User Defined IDF Table - 1 - 50 Year

Scenario: 50 Year

C and Area Results

Soil/Surface Description	C Coefficient	Area (acres)	Area (Adjusted) (acres)
Impervious	0.900	7.694	(N/A)
Pervious	0.300	3.766	(N/A)
Weighted C & Total Area --->	0.703	11.460	8.054

150 & Ward Multi-Family - Lot A

Subsection: Modified Rational Graph

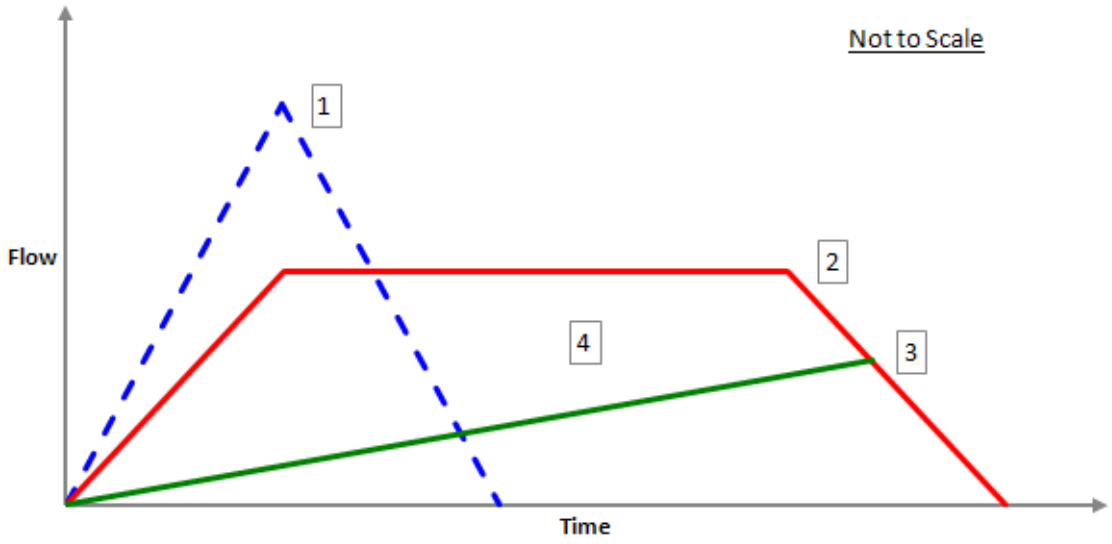
Label: CM-2

Scenario: 50 Year

Return Event: 50 years

Storm Event: User Defined IDF Table - 1 - 50 Year

Method Type	Method I
Time of Duration (Modified Rational, Critical)	45 min



[1]			[2]		
Time of Concentration (Modified Rational, Composite)	5	min	Time of Duration (Modified Rational, Critical)	45	min
Intensity (Modified Rational, Peak)	9.400	in/h	Intensity (Modified Rational, Critical)	4.135	in/h
Flow (Modified Rational, Peak)	76.34	ft³/s	Flow (Modified Rational, Critical)	33.58	ft³/s

[3]			[4]		
Second Outflow Breakpoint (Modified Rational)	46	min	Storage (Modified Rational, Estimated)	51,824.388	ft³
Flow (Modified Rational, Allowable)	25.90	ft³/s			

150 & Ward Multi-Family - Lot A

Subsection: C and Area (Pre-Development)

Return Event: 100 years

Label: CM-2

Storm Event: User Defined IDF Table - 1 - 100 Year

Scenario: 100 Year

C and Area Results (Pre-Development)

Soil/Surface Description	C Coefficient	Area (acres)	Area (Adjusted) (acres)
Pervious Area	0.300	11.456	(N/A)
Weighted C & Total Area --->	0.300	11.456	3.437

150 & Ward Multi-Family - Lot A

Subsection: C and Area (Post-Development)

Return Event: 100 years

Label: CM-2

Storm Event: User Defined IDF Table - 1 - 100 Year

Scenario: 100 Year

C and Area Results

Soil/Surface Description	C Coefficient	Area (acres)	Area (Adjusted) (acres)
Impervious	0.900	7.694	(N/A)
Pervious	0.300	3.766	(N/A)
Weighted C & Total Area --->	0.703	11.460	8.054

150 & Ward Multi-Family - Lot A

Subsection: Modified Rational Graph

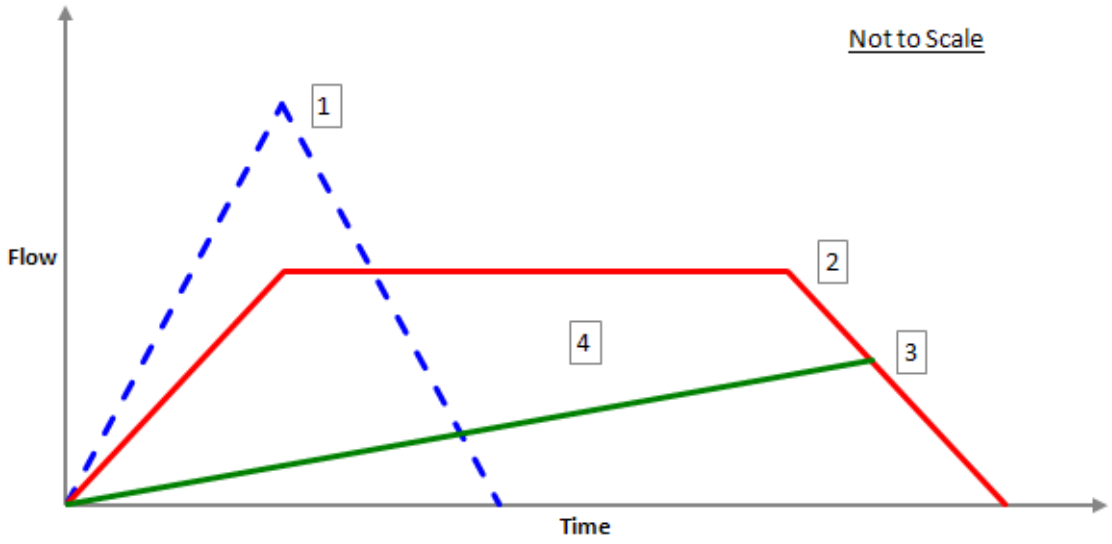
Label: CM-2

Scenario: 100 Year

Return Event: 100 years

Storm Event: User Defined IDF Table - 1 - 100 Year

Method Type	Method I
Time of Duration (Modified Rational, Critical)	46 min



[1]			[2]		
Time of Concentration (Modified Rational, Composite)	5	min	Time of Duration (Modified Rational, Critical)	46	min
Intensity (Modified Rational, Peak)	10.320	in/h	Intensity (Modified Rational, Critical)	4.539	in/h
Flow (Modified Rational, Peak)	83.81	ft³/s	Flow (Modified Rational, Critical)	36.86	ft³/s

[3]			[4]		
Second Outflow Breakpoint (Modified Rational)	47	min	Storage (Modified Rational, Estimated)	58,208.527	ft³
Flow (Modified Rational, Allowable)	28.45	ft³/s			

150 & Ward Multi-Family - Lot B

Subsection: Modified Rational Grand Summary

Modified Rational Method

Q = CiA * Units Conversion; Where conversion = 43560 / (12 * 3600)

Frequency (years)	Area (acres)	Adjusted C Coefficient	Duration (min)	Intensity (in/h)	Flow (Peak) (ft³/s)	Flow (Allowable) (ft³/s)	Volume (inflow) (ft³)	Volume (Storage) (ft³)
2	7.449	0.729	43	2.194	12.02	8.82	31,007.349	18,302.609
10	7.449	0.729	46	3.077	16.85	12.25	46,515.516	27,778.347
50	7.449	0.729	47	4.024	22.04	15.81	62,155.479	37,488.954
100	7.449	0.729	47	4.477	24.53	17.37	69,163.482	42,067.449

150 & Ward Multi-Family - Lot B

Subsection: C and Area (Pre-Development)

Return Event: 2 years

Label: CM-2

Storm Event: User Defined IDF Table - 1 - 2 Year

Scenario: 2 Year

C and Area Results (Pre-Development)

Soil/Surface Description	C Coefficient	Area (acres)	Area (Adjusted) (acres)
Pervious Area	0.300	7.448	(N/A)
Weighted C & Total Area --->	0.300	7.448	2.234

150 & Ward Multi-Family - Lot B

Subsection: C and Area (Post-Development)

Return Event: 2 years

Label: CM-2

Storm Event: User Defined IDF Table - 1 - 2 Year

Scenario: 2 Year

C and Area Results

Soil/Surface Description	C Coefficient	Area (acres)	Area (Adjusted) (acres)
Impervious	0.900	5.330	(N/A)
Pervious	0.300	2.119	(N/A)
Weighted C & Total Area --->	0.729	7.449	5.433

150 & Ward Multi-Family - Lot B

Subsection: Modified Rational Graph

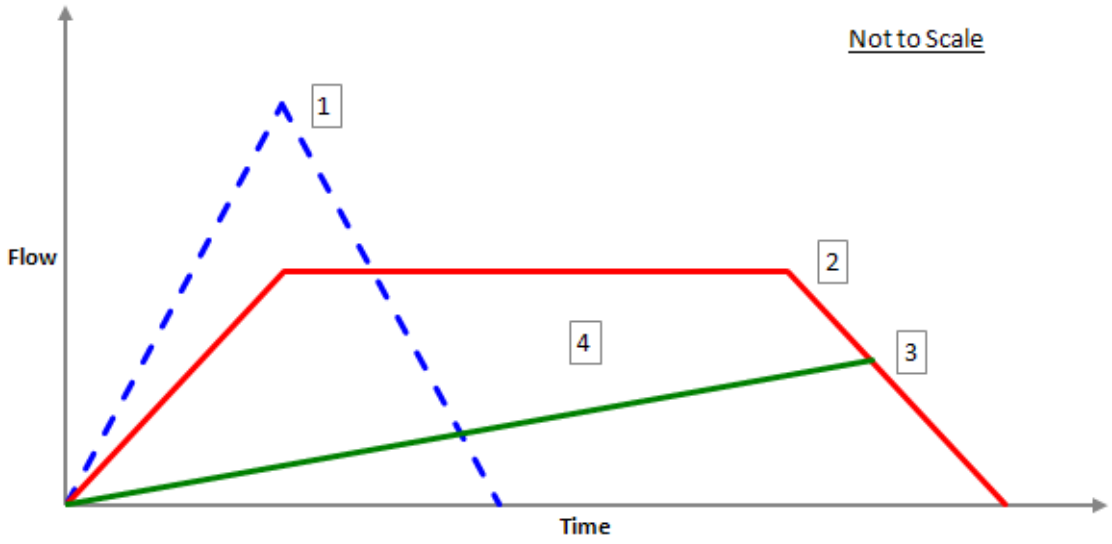
Label: CM-2

Scenario: 2 Year

Return Event: 2 years

Storm Event: User Defined IDF Table - 1 - 2 Year

Method Type	Method I
Time of Duration (Modified Rational, Critical)	43 min



[1]			[2]		
Time of Concentration (Modified Rational, Composite)	5	min	Time of Duration (Modified Rational, Critical)	43	min
Intensity (Modified Rational, Peak)	5.410	in/h	Intensity (Modified Rational, Critical)	2.194	in/h
Flow (Modified Rational, Peak)	29.64	ft³/s	Flow (Modified Rational, Critical)	12.02	ft³/s

[3]			[4]		
Second Outflow Breakpoint (Modified Rational)	44	min	Storage (Modified Rational, Estimated)	18,302.609	ft³
Flow (Modified Rational, Allowable)	8.82	ft³/s			

150 & Ward Multi-Family - Lot B

Subsection: C and Area (Pre-Development)

Return Event: 10 years

Label: CM-2

Storm Event: User Defined IDF Table - 1 - 10 Year

Scenario: 10 Year

C and Area Results (Pre-Development)

Soil/Surface Description	C Coefficient	Area (acres)	Area (Adjusted) (acres)
Pervious Area	0.300	7.448	(N/A)
Weighted C & Total Area --->	0.300	7.448	2.234

150 & Ward Multi-Family - Lot B

Subsection: C and Area (Post-Development)

Return Event: 10 years

Label: CM-2

Storm Event: User Defined IDF Table - 1 - 10 Year

Scenario: 10 Year

C and Area Results

Soil/Surface Description	C Coefficient	Area (acres)	Area (Adjusted) (acres)
Impervious	0.900	5.330	(N/A)
Pervious	0.300	2.119	(N/A)
Weighted C & Total Area --->	0.729	7.449	5.433

150 & Ward Multi-Family - Lot B

Subsection: Modified Rational Graph

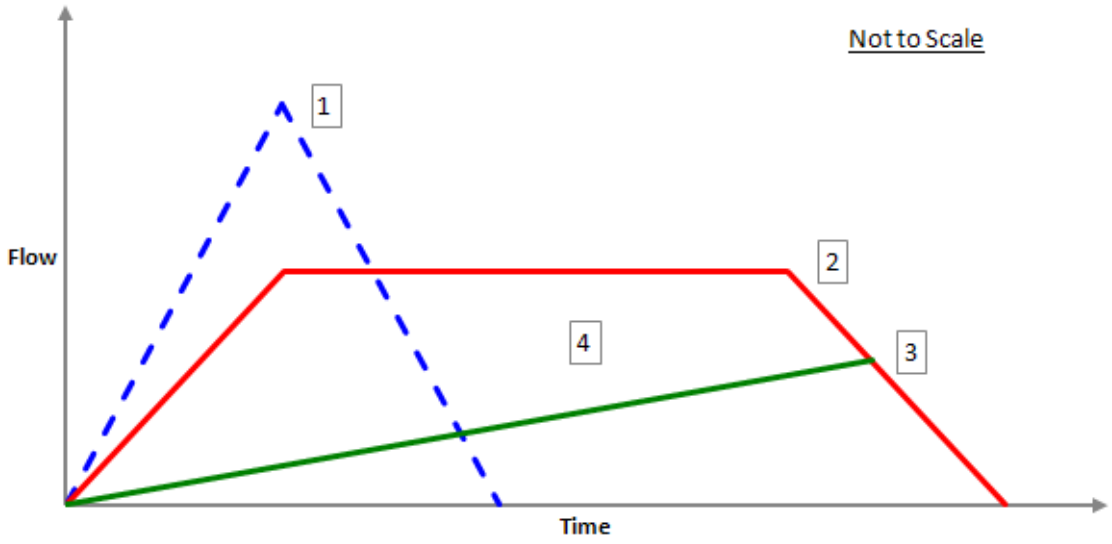
Label: CM-2

Scenario: 10 Year

Return Event: 10 years

Storm Event: User Defined IDF Table - 1 - 10 Year

Method Type	Method I
Time of Duration (Modified Rational, Critical)	46 min



[1]			[2]		
Time of Concentration (Modified Rational, Composite)	5	min	Time of Duration (Modified Rational, Critical)	46	min
Intensity (Modified Rational, Peak)	7.350	in/h	Intensity (Modified Rational, Critical)	3.077	in/h
Flow (Modified Rational, Peak)	40.26	ft³/s	Flow (Modified Rational, Critical)	16.85	ft³/s

[3]			[4]		
Second Outflow Breakpoint (Modified Rational)	47	min	Storage (Modified Rational, Estimated)	27,778.347	ft³
Flow (Modified Rational, Allowable)	12.25	ft³/s			

150 & Ward Multi-Family - Lot B

Subsection: C and Area (Pre-Development)

Return Event: 50 years

Label: CM-2

Storm Event: User Defined IDF Table - 1 - 50 Year

Scenario: 50 Year

C and Area Results (Pre-Development)

Soil/Surface Description	C Coefficient	Area (acres)	Area (Adjusted) (acres)
Pervious Area	0.300	7.448	(N/A)
Weighted C & Total Area --->	0.300	7.448	2.234

150 & Ward Multi-Family - Lot B

Subsection: C and Area (Post-Development)

Label: CM-2

Scenario: 50 Year

Return Event: 50 years

Storm Event: User Defined IDF Table - 1 - 50 Year

C and Area Results

Soil/Surface Description	C Coefficient	Area (acres)	Area (Adjusted) (acres)
Impervious	0.900	5.330	(N/A)
Pervious	0.300	2.119	(N/A)
Weighted C & Total Area --->	0.729	7.449	5.433

150 & Ward Multi-Family - Lot B

Subsection: Modified Rational Graph

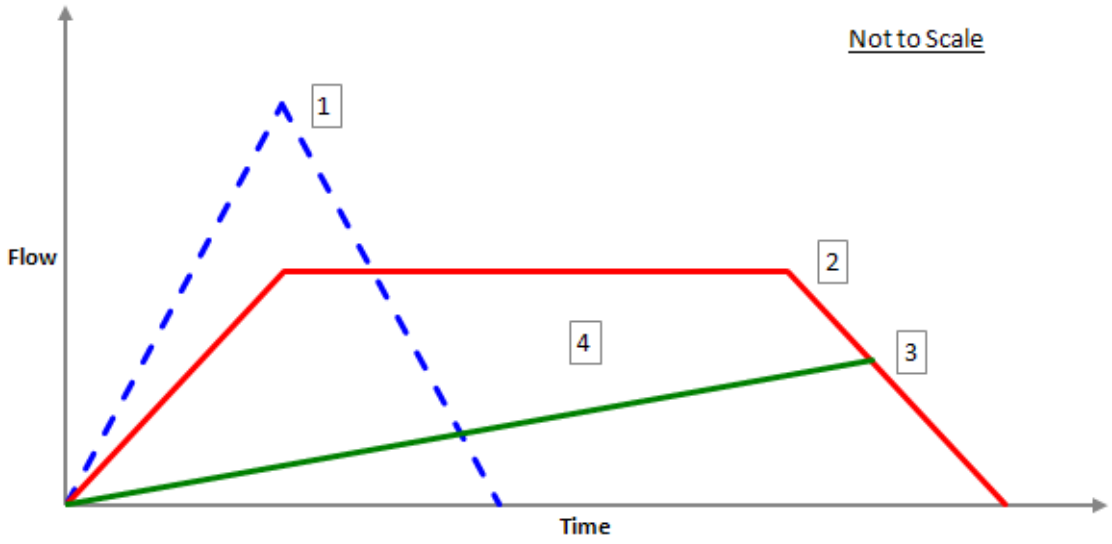
Label: CM-2

Scenario: 50 Year

Return Event: 50 years

Storm Event: User Defined IDF Table - 1 - 50 Year

Method Type	Method I
Time of Duration (Modified Rational, Critical)	47 min



[1]			[2]		
Time of Concentration (Modified Rational, Composite)	5	min	Time of Duration (Modified Rational, Critical)	47	min
Intensity (Modified Rational, Peak)	9.400	in/h	Intensity (Modified Rational, Critical)	4.024	in/h
Flow (Modified Rational, Peak)	51.49	ft³/s	Flow (Modified Rational, Critical)	22.04	ft³/s

[3]			[4]		
Second Outflow Breakpoint (Modified Rational)	48	min	Storage (Modified Rational, Estimated)	37,488.954	ft³
Flow (Modified Rational, Allowable)	15.81	ft³/s			

150 & Ward Multi-Family - Lot B

Subsection: C and Area (Pre-Development)

Return Event: 100 years

Label: CM-2

Storm Event: User Defined IDF Table - 1 - 100 Year

Scenario: 100 Year

C and Area Results (Pre-Development)

Soil/Surface Description	C Coefficient	Area (acres)	Area (Adjusted) (acres)
Pervious Area	0.300	7.448	(N/A)
Weighted C & Total Area --->	0.300	7.448	2.234

150 & Ward Multi-Family - Lot B

Subsection: C and Area (Post-Development)

Return Event: 100 years

Label: CM-2

Storm Event: User Defined IDF Table - 1 - 100 Year

Scenario: 100 Year

C and Area Results

Soil/Surface Description	C Coefficient	Area (acres)	Area (Adjusted) (acres)
Impervious	0.900	5.330	(N/A)
Pervious	0.300	2.119	(N/A)
Weighted C & Total Area --->	0.729	7.449	5.433

150 & Ward Multi-Family - Lot B

Subsection: Modified Rational Graph

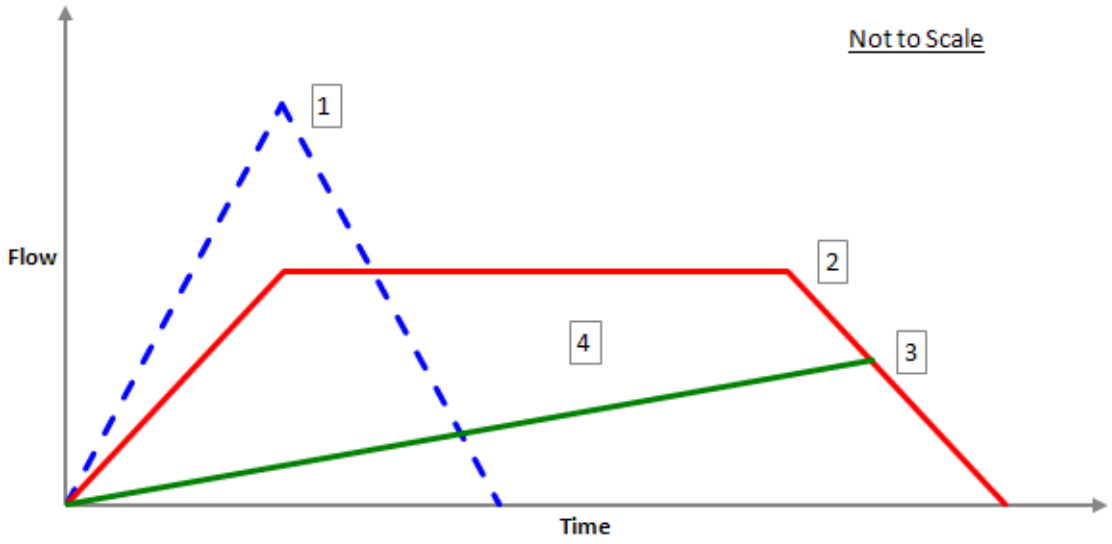
Label: CM-2

Scenario: 100 Year

Return Event: 100 years

Storm Event: User Defined IDF Table - 1 - 100 Year

Method Type	Method I
Time of Duration (Modified Rational, Critical)	47 min



[1]			[2]		
Time of Concentration (Modified Rational, Composite)	5	min	Time of Duration (Modified Rational, Critical)	47	min
Intensity (Modified Rational, Peak)	10.320	in/h	Intensity (Modified Rational, Critical)	4.477	in/h
Flow (Modified Rational, Peak)	56.53	ft³/s	Flow (Modified Rational, Critical)	24.53	ft³/s

[3]			[4]		
Second Outflow Breakpoint (Modified Rational)	48	min	Storage (Modified Rational, Estimated)	42,067.449	ft³
Flow (Modified Rational, Allowable)	17.37	ft³/s			

150 & Ward Multi-Family - Lot D

Subsection: Modified Rational Grand Summary

Modified Rational Method

Q = CiA * Units Conversion; Where conversion = 43560 / (12 * 3600)

Frequency (years)	Area (acres)	Adjusted C Coefficient	Duration (min)	Intensity (in/h)	Flow (Peak) (ft³/s)	Flow (Allowable) (ft³/s)	Volume (inflow) (ft³)	Volume (Storage) (ft³)
2	1.763	0.780	44	2.162	3.00	2.15	7,913.252	4,753.981
10	1.763	0.780	46	3.077	4.27	2.98	11,772.939	7,215.400
50	1.763	0.780	47	4.024	5.58	3.84	15,731.367	9,736.584
100	1.763	0.780	48	4.416	6.12	4.22	17,632.622	10,920.787

150 & Ward Multi-Family - Lot D

Subsection: C and Area (Pre-Development)

Return Event: 2 years

Label: CM-2

Storm Event: User Defined IDF Table - 1 - 2 Year

Scenario: 2 Year

C and Area Results (Pre-Development)

Soil/Surface Description	C Coefficient	Area (acres)	Area (Adjusted) (acres)
Pervious Area	0.300	1.770	(N/A)
Weighted C & Total Area --->	0.300	1.770	0.531

150 & Ward Multi-Family - Lot D

Subsection: C and Area (Post-Development)

Return Event: 2 years

Label: CM-2

Storm Event: User Defined IDF Table - 1 - 2 Year

Scenario: 2 Year

C and Area Results

Soil/Surface Description	C Coefficient	Area (acres)	Area (Adjusted) (acres)
Impervious	0.900	1.410	(N/A)
Open Space	0.300	0.353	(N/A)
Weighted C & Total Area --->	0.780	1.763	1.375

150 & Ward Multi-Family - Lot D

Subsection: Modified Rational Graph

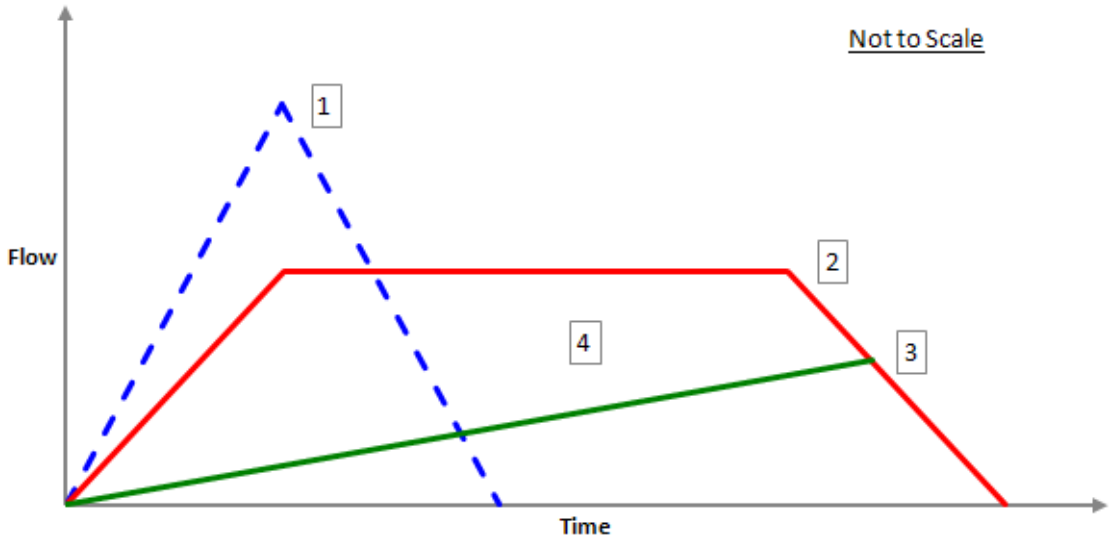
Label: CM-2

Scenario: 2 Year

Return Event: 2 years

Storm Event: User Defined IDF Table - 1 - 2 Year

Method Type	Method I
Time of Duration (Modified Rational, Critical)	44 min



[1]			[2]		
Time of Concentration (Modified Rational, Composite)	5	min	Time of Duration (Modified Rational, Critical)	44	min
Intensity (Modified Rational, Peak)	5.410	in/h	Intensity (Modified Rational, Critical)	2.162	in/h
Flow (Modified Rational, Peak)	7.50	ft³/s	Flow (Modified Rational, Critical)	3.00	ft³/s

[3]			[4]		
Second Outflow Breakpoint (Modified Rational)	45	min	Storage (Modified Rational, Estimated)	4,753.981	ft³
Flow (Modified Rational, Allowable)	2.15	ft³/s			

150 & Ward Multi-Family - Lot D

Subsection: C and Area (Pre-Development)

Return Event: 10 years

Label: CM-2

Storm Event: User Defined IDF Table - 1 - 10 Year

Scenario: 10 Year

C and Area Results (Pre-Development)

Soil/Surface Description	C Coefficient	Area (acres)	Area (Adjusted) (acres)
Pervious Area	0.300	1.770	(N/A)
Weighted C & Total Area --->	0.300	1.770	0.531

150 & Ward Multi-Family - Lot D

Subsection: C and Area (Post-Development)

Return Event: 10 years

Label: CM-2

Storm Event: User Defined IDF Table - 1 - 10 Year

Scenario: 10 Year

C and Area Results

Soil/Surface Description	C Coefficient	Area (acres)	Area (Adjusted) (acres)
Impervious	0.900	1.410	(N/A)
Open Space	0.300	0.353	(N/A)
Weighted C & Total Area --->	0.780	1.763	1.375

150 & Ward Multi-Family - Lot D

Subsection: Modified Rational Graph

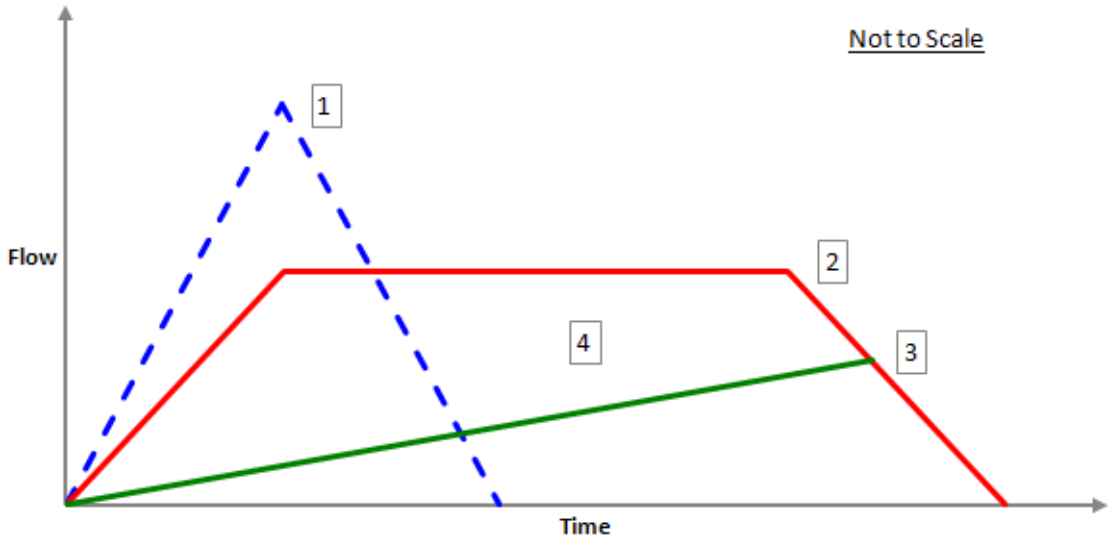
Label: CM-2

Scenario: 10 Year

Return Event: 10 years

Storm Event: User Defined IDF Table - 1 - 10 Year

Method Type	Method I
Time of Duration (Modified Rational, Critical)	46 min



[1]			[2]		
Time of Concentration (Modified Rational, Composite)	5	min	Time of Duration (Modified Rational, Critical)	46	min
Intensity (Modified Rational, Peak)	7.350	in/h	Intensity (Modified Rational, Critical)	3.077	in/h
Flow (Modified Rational, Peak)	10.19	ft³/s	Flow (Modified Rational, Critical)	4.27	ft³/s

[3]			[4]		
Second Outflow Breakpoint (Modified Rational)	48	min	Storage (Modified Rational, Estimated)	7,215.400	ft³
Flow (Modified Rational, Allowable)	2.98	ft³/s			

150 & Ward Multi-Family - Lot D

Subsection: C and Area (Pre-Development)

Return Event: 50 years

Label: CM-2

Storm Event: User Defined IDF Table - 1 - 50 Year

Scenario: 50 Year

C and Area Results (Pre-Development)

Soil/Surface Description	C Coefficient	Area (acres)	Area (Adjusted) (acres)
Pervious Area	0.300	1.770	(N/A)
Weighted C & Total Area --->	0.300	1.770	0.531

150 & Ward Multi-Family - Lot D

Subsection: C and Area (Post-Development)

Return Event: 50 years

Label: CM-2

Storm Event: User Defined IDF Table - 1 - 50 Year

Scenario: 50 Year

C and Area Results

Soil/Surface Description	C Coefficient	Area (acres)	Area (Adjusted) (acres)
Impervious	0.900	1.410	(N/A)
Open Space	0.300	0.353	(N/A)
Weighted C & Total Area --->	0.780	1.763	1.375

150 & Ward Multi-Family - Lot D

Subsection: Modified Rational Graph

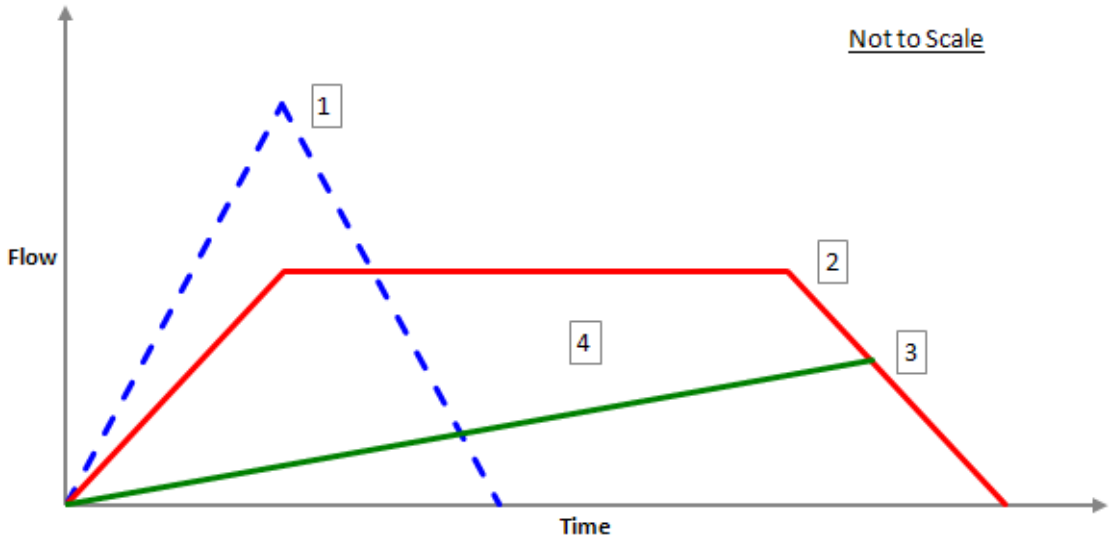
Label: CM-2

Scenario: 50 Year

Return Event: 50 years

Storm Event: User Defined IDF Table - 1 - 50 Year

Method Type	Method I
Time of Duration (Modified Rational, Critical)	47 min



[1]			[2]		
Time of Concentration (Modified Rational, Composite)	5	min	Time of Duration (Modified Rational, Critical)	47	min
Intensity (Modified Rational, Peak)	9.400	in/h	Intensity (Modified Rational, Critical)	4.024	in/h
Flow (Modified Rational, Peak)	13.03	ft³/s	Flow (Modified Rational, Critical)	5.58	ft³/s

[3]			[4]		
Second Outflow Breakpoint (Modified Rational)	49	min	Storage (Modified Rational, Estimated)	9,736.584	ft³
Flow (Modified Rational, Allowable)	3.84	ft³/s			

150 & Ward Multi-Family - Lot D

Subsection: C and Area (Pre-Development)

Return Event: 100 years

Label: CM-2

Storm Event: User Defined IDF Table - 1 - 100 Year

Scenario: 100 Year

C and Area Results (Pre-Development)

Soil/Surface Description	C Coefficient	Area (acres)	Area (Adjusted) (acres)
Pervious Area	0.300	1.770	(N/A)
Weighted C & Total Area --->	0.300	1.770	0.531

150 & Ward Multi-Family - Lot D

Subsection: C and Area (Post-Development)

Return Event: 100 years

Label: CM-2

Storm Event: User Defined IDF Table - 1 - 100 Year

Scenario: 100 Year

C and Area Results

Soil/Surface Description	C Coefficient	Area (acres)	Area (Adjusted) (acres)
Impervious	0.900	1.410	(N/A)
Open Space	0.300	0.353	(N/A)
Weighted C & Total Area --->	0.780	1.763	1.375

150 & Ward Multi-Family - Lot D

Subsection: Modified Rational Graph

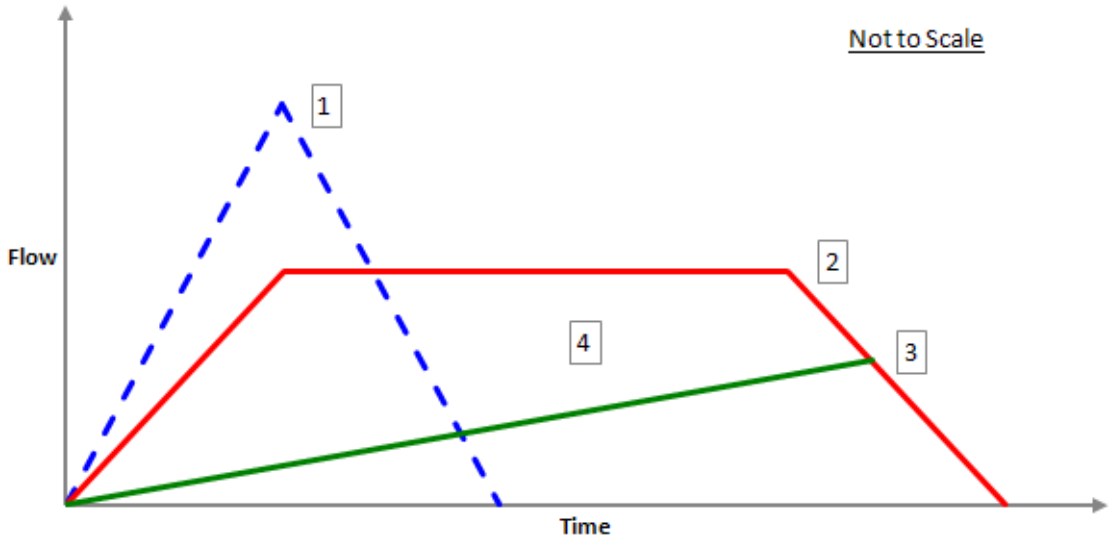
Label: CM-2

Scenario: 100 Year

Return Event: 100 years

Storm Event: User Defined IDF Table - 1 - 100 Year

Method Type	Method I
Time of Duration (Modified Rational, Critical)	48 min



[1]			[2]		
Time of Concentration (Modified Rational, Composite)	5	min	Time of Duration (Modified Rational, Critical)	48	min
Intensity (Modified Rational, Peak)	10.320	in/h	Intensity (Modified Rational, Critical)	4.416	in/h
Flow (Modified Rational, Peak)	14.31	ft³/s	Flow (Modified Rational, Critical)	6.12	ft³/s

[3]			[4]		
Second Outflow Breakpoint (Modified Rational)	50	min	Storage (Modified Rational, Estimated)	10,920.787	ft³
Flow (Modified Rational, Allowable)	4.22	ft³/s			

Appendix A

DRAINAGE MASTER PLAN

ARBORWALK

IN THE CITY OF LEE'S SUMMIT, MISSOURI

200 100 0 200 400 600

SCALE IN FEET

LEGEND

- DRAINAGE BASIN BOUNDARY
- STORM WATER FLOW DIRECTION
- ROCK CHECK DAM
- SILT TRAP BASIN

UPPER NORTH DETENTION BASIN (0.63 AC.)

UPPER NORTH DRAINAGE BASIN

NORTH DETENTION BASIN (1.42 AC.)

NORTH DRAINAGE BASIN

PROJECT LOCATION
HOOK ROAD

PRYOR ROAD

WARD ROAD

3 MILES +/- N. TO 50 HWY.

1.2 MILES +/- E. TO 291 HWY.

MO. STATE HWY. 150

S25, T47N, R32W

VICINITY MAP

NORTHWEST GREENSPACE DETENTION BASIN (0.54 AC.)

NORTHWEST DRAINAGE BASIN

SHALLOW GREENSPACE DETENTION BASINS (0.43 AC.)

where are these draining to?

SOUTHWEST DRAINAGE BASIN

UPPER DETENTION BASIN (0.43 AC.)

LOWER DETENTION BASIN (3.51 AC.)

UPLAND AREA (0.83 AC.)

RETENTION/ DETENTION AREA (2.41 AC.)

LOWER DETENTION AREA (3.93 AC.)

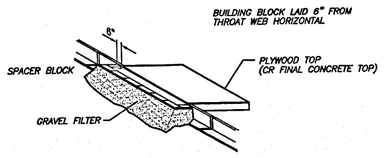
SOUTHEAST DRAINAGE BASIN

SOUTHEAST DRAINAGE BASIN (COMMERCIAL)

EAST DRAINAGE BASIN

EAST SHALLOW DETENTION BASIN (0.95 AC.)

APPROX. LOC. EXISTING WATER

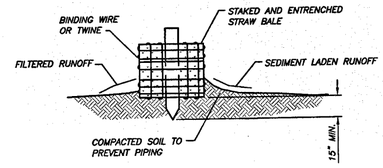


EXPANDED METAL OR HARDWARE CLOTH IN FRONT OF BLOCK PREVENTS GRAVEL FROM WASHING INTO STRUCTURE

2"X4" BEHIND BLOCK AND ACROSS THROAT HELPS KEEP BLOCK IN PLACE PLACE IN OUTER HOLE OF SPACER BLOCK

BLOCK AND GRAVEL CURB INLET PROTECTION
(FROM RICHMOND, VIRGINIA–EROSION AND SEDIMENT CONTROL HANDBOOK, NOVEMBER 1975)

SD–45 INLET PROTECTION
N.T.S.

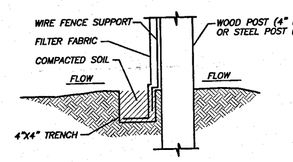


SECTION

NOTES:

1. EXCAVATE A TRENCH ALONG THE AREAS THAT THE STRAW BALES WILL BE USED AS EROSION CONTROL TO DEPTH OF 4" AND TO THE WIDTH OF ONE (1) STRAW BALE. THE STRAW BALES THEN SHALL BE PLACED IN THE TRENCH. SAVE EXCAVATED MATERIAL ON THE UPSTREAM SIDE OF THE TRENCH.
2. STRAW BALES SHOULD BE ANCHORED WITH A MINIMUM OF 2 STAKES OR REBARS DRIVEN INTO THE UNDERLYING SOIL, MAKING SURE THAT THE BINDING WIRE OR TWINE IS FACING THE SIDES AND NOT TOUCHING THE SOIL. THE FIRST STAKE INTO EACH BALE SHOULD BE DRIVEN TOWARD THE PREVIOUSLY LAID BALE TO FORCE THEM TOGETHER.
3. SPACING BETWEEN THE BALES SHOULD BE TIGHTLY CHINKED WITH LOOSE STRAW.
4. AFTER STRAW BALES ARE IN PLACE, THE EXCAVATED SOIL SHOULD BE BACKFILLED AGAINST THE UPSLOPE SIDE OF THE STRAW BALES TO A HEIGHT OF 4" AFTER COMPACTING.
5. STRAW BALES SHOULD BE INSPECTED AFTER EACH RAINFALL TO DETERMINE IF ANY REPAIRS OR REPLACEMENTS TO THE STRAW BALES ARE NEEDED. IF IT IS DETERMINED THAT THE STRAW BALES NEED TO BE REPAIRED OR REPLACED, THIS SHOULD BE DONE IMMEDIATELY. SEDIMENT ACCUMULATIONS MUST BE REMOVED WHEN THEY REACH A HEIGHT 1/2 THE BARRIER HEIGHT.

SD–48 STRAW BALE INSTALLATION
N.T.S.



SECTION

NOTES:

1. THE MAXIMUM SLOPE LENGTH ABOVE THE FENCE SHOULD BE LESS THAN 100 FEET.
2. NO DITCH OR DRAINAGE WAY WITH AN AREA GREATER THAN 5 ACRES SHALL BE ENCLOSED ABOVE A SILT FENCE.
3. NO SILT FENCE SHALL BE CONSTRUCTED IN A LIVE STREAM OR DRAINAGE WAY WITH EXPECTED FLOWS GREATER THAN 1 CFS.
4. THE FILTER FABRIC SHALL HAVE A MINIMUM FILTERING EFFICIENCY OF 75%, A MINIMUM TENSILE STRENGTH OF 30 LBS. PER LINEAR INCH AND A FLOW RATE OF 0.3 GALLONS PER SQUARE FOOT PER MINUTE. THE FILTER FABRIC SHALL ALSO HAVE ULTRAVIOLET RAY INHIBITORS TO ASSURE A LIFE USE EXPECTANCY OF 6 MONTHS AT 0 TO 100 DEGREES FAHRENHEIT.
5. THE FILTER FABRIC SHALL BE 36 INCHES OR LESS IN HEIGHT, WITH JOINTS AT EVERY POST AVOIDING OVERLAP IF POSSIBLE (6" MIN. OVERLAP IF NECESSARY) AND POSTS SPACED EVERY 10 FEET WITH WIRE MESH SUPPORT OR 6 FEET WITHOUT SUPPORT, MAKING SURE THAT A MIN. OF 8" OF FABRIC IS BURIED IN THE 4"X4" TRENCH.
6. THE SILT FENCE SHALL BE INSPECTED AFTER EVERY RAINFALL TO DETERMINE IF ANY PART OF THE FENCE NEEDS TO BE REPAIRED OR REPLACED. IF IT IS DETERMINED THAT THE FENCE NEEDS ANY REPAIR OR REPLACEMENT THIS SHALL BE DONE IMMEDIATELY.

SEDIMENT DEPOSITS SHALL BE REMOVED AFTER EACH RAINFALL OR BEFORE THEY ACCUMULATE TO 1/2 OF THE FENCE HEIGHT.

SD–48A SILT FENCE INSTALLATION
N.T.S.

DEVELOPER:
MR. DAVID GALE
GALE COMMUNITIES, INC.
3620 SW. WARD ROAD
LEE'S SUMMIT, MO 64082
PHONE: 816–537–4200

FILE: STORM–WATER–PLAN.DWG
SCALE: 1=200
PLOT AFTER:
NAME:

No.	DATE	BY	REVISION

DATE: 11/19/02
DESIGNED BY: MD
DRAWN BY: RJL
CHECKED BY: MD

E. T. ARCHER CORPORATION D.B.A.
ARCHER
TOTAL PROJECT MANAGEMENT
CORPORATE OFFICE: 3741 NE. TROON DRIVE
LEE'S SUMMIT, MO. 64064
816–554–3019 • FAX 816–554–3061

OTHER OFFICE LOCATIONS
- 187 E. DAVID, P.O. BOX 969, FORSYTH, MO 65653 • 417–546–3218 • FAX 417–546–5324
- 800 STARKS BUILDING, LOUISVILLE, KY 40202 • 502–581–9484 • FAX 502–581–9485
- 1000 CITY PARKWAY, OSAGE BEACH, MO 65065 • 573–348–3222 • FAX 573–348–3499
- 1007 HAUCK DR., SUITE B, P.O. BOX 537, ROLLA, MO 65402 • 573–364–3420 • FAX 573–364–4170
- 6300 NALL, P.O. BOX 439, SHAWNEE MISSION, KS 66201 • 913–362–9753 • FAX 913–362–6847
- 255 SO. UNION, SPRINGFIELD, MO 65802 • 417–865–4083 • FAX 417–865–4085
- 2480 EXECUTIVE DRIVE, SUITE 116, ST. CHARLES, MO 63303 • 636–477–8389 • FAX 636–477–7569

DRAINAGE MASTER PLAN
FOR
ARBORWALK, LEE'S SUMMIT, MO.

FOR: GALE COMMUNITIES, INC.
LEE'S SUMMIT, MISSOURI

PROJECT NO. 21126701

DRAWING NO. 1 OF 1

DRAINAGE MASTER PLAN

INTRODUCTION

Gale Communities, Inc., of Lee's Summit, Missouri employed the services of Archer Engineers to evaluate and recommend a storm water management plan for the watershed associated with the development called Arborwalk. Arborwalk is located in the southern portion of the City of Lee's Summit north of Missouri State Highway 150 and between Ward and Pryor Roads. The development is 380 acres and is in Section 25, Township 47, Range 32 of Jackson County. General topography is gentle rolling hills with both open fields and timber areas.

WATERSHED DESCRIPTION

Arborwalk development is divided into 5 drainage basins, Southeast, Southwest, East, Northwest, and North. The 5 drainage basins have their own modified storm water management system that is described in detail in the following text. A check of the Federal Emergency Management Agency (FEMA) indicated that there is no 100-year flood plain within the boundary of the development.

The 5 drainage basins are outlined on the attached Figure named Drainage Master Plan (enclosed). The Figure indicates the different drainage basins, flow direction, location and approximate size of major detention basins, location of major rock check dams and silt trap basins. Soil type was obtained from the Soil Conservation Service's (SCS) "Soil Survey of Jackson County, Missouri". Existing land use was obtained from the city zoning records and field inspection. Table A at the end of this report provides data for the different drainage basins and pre and post watershed conditions respectfully.

OVERVIEW

Storm water management is knowledge used to understand, control, and utilize waters in different forms within the hydrologic cycle. The natural condition of a watershed is termed undeveloped condition. Natural streams, creeks, and waterways have been continuously shaped over time by storm runoff. Development of a watershed results in more paved areas that increase the frequency, magnitude, and volume of storm runoff. Man made drainage facilities cause storm water to move faster and to become more concentrated causing erosion within the watershed. The factors that impact severity of erosion include storm intensity, soil conditions, vegetation characteristics, and topography.

The goal of this report is to provide concepts and design criteria for best management of storm water and the functions of the storm water drainage system. Various types of systems will be used in the development to manage the storm water and may include storm sewers, streets with curb & gutter, swales, detention, off-line detention, and wetlands.

Detention basins are small to medium size basins that impound water for 24 hours or less and are normally 10 acre-ft or less. Retention basins are usually larger than detention basins and hold water for much longer periods, usually have a defined pool elevation, and release any stored water at a much slower rate. Additional concepts will consist of oversized storm sewer piping, off-line detention basins, and shallow green space detention. Oversized storm sewer piping could be place at critical locations to hold limited volumes of storm water to decrease the peak outflow leaving the detention basin during normal storm events. Off-line detention basins might be developed within the watershed to reduce the overall detention areas required within the watershed. An example of an off-line detention basin might be a defined swale running down the back lot lines of a series of houses. This swale would be connected to the storm sewers at each end and controlled with an inlet of greater capacity than the outlet of the storm sewer. The storm sewer would be designed to pass the dry weather flows and the 2, 5, and 10-year storms. During a storm event larger than the 10-year event, the volume difference between the inflow and outflow would be detained in the swale area defined. This type of design using the concept of off-line detention within the on-line sewer system would allow for better control of storm detention within the drainage basin before reaching the detention basin(s) down stream.

SOUTHEAST DRAINAGE AREA

The Southeast Drainage Area will consist of all the various type of storm water management systems that are practicable for the given size and use of the area. The systems will consist of inlets and storm sewer piping, oversized storm sewer piping for limited detention upstream of the detention basin, existing open channels with riparian vegetation and wetlands, a retention basin with a fixed pool elevation and with detention included within the retention basin, and shallow off-line detention combined with the storm sewer system for increased storage upstream of the retention/detention basin. In addition, upland detention will utilize green space for shallow storage of storm events smaller than the 25-year event. The Drainage area is 103 acres with a weighed curve number of 85 and a time of concentration of 27 minutes.

The existing farm lake will be retained and utilized by increasing the dam height and excavation to create a detention basin above the normal pool elevation for the 25-year design storage. The detention provided above the normal pool elevation will be approximately 7.2 acre-feet of storage (3-feet in depth). The green space southeast of the basin will be designed to hold an additional 3.9 acre-feet of storage (1-foot in depth). The combination of the two basins will adequately hold the required volume of storage for both the southeast drainage basin including the future commercial development at the

intersection of Ward Road and Highway 150. If in final design, it is determined that additional space will be needed in the Southeast Basin, one option that will be considered is the installation of an underground storm sewer detention under the commercial area near the intersection of Ward Road and Highway 150.

To provide improved water quality in the Southeast Drainage Basin, additional upland/wetland area will be developed north of the retention/detention basin. This upland area will provide a vegetative interface with the lower storm events by allowing low flows to pass through a native grass and tree area where the velocities will be lowered to allow for sediment to collect in this upland area instead of the basins and potential exiting the basin.

The area defined as commercial will have limited detention within their boundaries. The required detention volumes for this area will be held in the Southeast detention area upstream. An outlet structure with limited underground storage will be built at the outlet (near the intersection of Ward Road and Highway 150) to allow only pre-developed flows to exist the watershed.

Erosion control efforts for the area will include improved vegetative stabilization practices such as temporary seeding using degradable stabilization blankets on slopes, buffer zones at the top and bottom of slopes to reduced runoff flows, silt fence, straw bales, storm inlet protection, and erosion control mating. In addition, check dams will be used extensively both upstream and downstream of the green area to limit the amount of sediment that could enter the Southeast Detention area. The southeast corner of the development will have a series of temporary sedimentation basins to control and contain the sediment load as storm water exists the site during the development of the project.

The pre-developed flow for the Southeast Drainage Basin is 340 cubic feet per second (cfs) and the post-developed flow is 431 cfs. The proposed size of storage required for this is approximately 7 acre-feet for the 25-year storm event and for the 100-year storm event the required storage is 10.9 acre-feet. The commercial area to the southeast when developed will require 4.8 acre-feet of storage for detention that is part of the required storage listed above.

SOUTHWEST DRAINAGE AREA

The Southwest Drainage Area systems will consist of inlets and storm sewer piping, oversized storm sewer piping for limited detention upstream of the detention basin, existing open channels with riparian vegetation and wetlands, detention basins, and shallow off-line detention combined with the storm sewer system for increased storage upstream of the detention basins. The detention basins will consist of a two dry detention basins to control the 2, 5, and 10-year storm for water quality and the 25-year storm for downstream flood control. The small storm events will be held longer in the basins to allow for improved water quality. This will be accomplished by designing around the existing creek, by the addition of a control structure near Highway 150, and using the

change in elevations in creating steps. The upper (smaller) basin that has a storage volume of approximately 1.2 acre-feet (3-foot depth) will be used as an equalization basin before entering the lower detention basin. The lower detention basin which has a storage volume of approximately 12.3 acre-feet will be gentle and blend into the surrounding land by using native trees, bushes, and grasses. During the higher storm events, water will be allowed to pond over most of the basin floor up to depth of 42-iches. This will allow for planting of grasses in the basin bottom that can survive for short times during submergence and the usage of tree plantings and treescape islands that will be scattered through out the basin floor. These treescape islands will consist of trees, shrubs, and grasses native to the area and particularly to stream areas. There will be field inlets scattered through out the basin floor to handle the larger storm events by allowing flow into smaller diameter piping that would converge at the primary outlet structure. This would allow for subcritical flow to exit the site, thereby reducing the potential for erosion downstream. Additional rock levels with rock waterfalls will allow for transition of elevations and add aeration to the storm water for quality. The drainage area is 129 acres with a weighed curve number of 88 and a time of concentration of 20 minutes.

Erosion control efforts for the area will include improved vegetative stabilization practices such as temporary seeding using degradable stabilization blankets on slopes, buffer zones at the top and bottom of slopes to reduced runoff flows, silt fence, straw bales, storm inlet protection, and erosion control mating. In addition, check dams will be used extensively both upstream and downstream of the green area to limit the amount of sediment that could enter the southwest green area.

The pre-developed flow for the Southwest Drainage Basin is 465 cubic feet per second (cfs) and the post-developed flow is 622 cfs. The proposed size of storage required for this is approximately 11 acre-feet for the 25-year storm event and for the 100-year storm event the required storage is 13.6 acre-feet. The office area to the east of the lower detention area when developed will require 2.9 acre-feet of storage for detention that is part of the required storage listed above.

NORTHWEST DRAINAGE AREA

The Northwest Drainage Area systems will consist of inlets and storm sewer piping, oversized storm sewer piping for limited detention upstream of the shallow detention basin, existing open channels with riparian vegetation and wetlands, a shallow detention basin, and shallow off-line detention combined with the storm sewer system for increased storage upstream of the shallow detention basin. Shallow detention will consist of a series of small dry detention areas incorporated into the proposed green space along the north edge of the property and the buffer zone along Pryor Road. The outlet structure for this basin will be positioned at the northwest corner of development at Pryor and allow the release the pre-developed flows from the drainage basin. The green space along the northern edge of the development will consist of swales running in a curve pattern and dotted with treescape islands and native vegetation in the swales. This green space will provide approximately 0.9 acre-feet of storage. The buffer zone along Pryor Road will

have the same type layout of a meandering swale with larger treescape islands to meet the needs of a buffer zone between the residences and street. The buffer zone will provide approximately 0.9 acre-feet of storage. The combined storage of the two areas is approximately 1.8 acre-feet. The storage is less than the required 2.3 acre-feet for the 25-year event. Additional storage will be developed within the development by the use of large diameter storm sewer piping and off-line detention. Additional storm water swales will be included in the development design to account for and control the 100-year event. The drainage area is 33.1 acres with a weighed curve number of 81 and a time of concentration of 13 minutes.

Erosion control efforts for the area will include improved vegetative stabilization practices such as temporary seeding using degradable stabilization blankets on slopes, buffer zones at the top and bottom of slopes to reduced runoff flows, silt fence, straw bales, storm inlet protection, and erosion control mating. In addition, check dams will be used extensively both upstream and downstream of the green area to limit the amount of sediment that could enter the northwest green area.

The pre-developed flow for the Northwest Drainage Area is 123 cubit feet per second (cfs) and the post-developed flow is 170 cfs. The proposed size of storage required for this is 2.3 acre-feet for the 25-year storm event and for the 100-year storm event the required storage is 3.1 acre-feet.

EAST DRAINAGE AREA

The East Drainage Area will consist of inlets and storm sewer piping, oversized storm sewer piping for limited detention upstream of the detention basin, existing open channels with riparian vegetation and wetlands, shallow detention, and shallow off-line detention combined with the storm sewer system for increased storage upstream of the retention/detention basin. Shallow detention will consist of a dry detention area incorporated into the proposed green space along the buffer zone along Ward Road. The outlet structure will be positioned at the existing culvert structure that is under Ward Road and will allow the release the pre-developed flows from the drainage basin. The green space along Ward Road will consist of swales running in a curve pattern and dotted with treescape islands and native vegetation in the swales. A small shallow dry detention basin consisting of native grass will be positioned near the outlet structure for better control for the storm events. The green space along Ward Road combined with the shallow detention basin near the existing outlet structure will provide approximately 0.95 acre-feet of storage. Additional storage will be developed within the development by the use of large diameter storm sewer piping and off-line detention. Additional storm water swales will be included in the development design to account for and control the 100-year event. The drainage area is 21.6 acres with a weighed curve number of 84 and a time of concentration of 20 minutes.

Erosion control efforts for the area will include improved vegetative stabilization practices such as temporary seeding using degradable stabilization blankets on slopes,

buffer zones at the top and bottom of slopes to reduced runoff flows, silt fence, straw bales, storm inlet protection, and erosion control mating. In addition, check dams will be used extensively both upstream and downstream of the green area to limit the amount of sediment that could enter the East Green Area.

The pre-developed flow for the East Green Area is 76 cubit feet per second (cfs) and the post-developed flow is 102 cfs. The proposed size of storage required for this is 1.6 acre-feet for the 25-year storm event and for the 100-year storm event the required storage is 2.1 acre-feet.

NORTH DRAINAGE AREA

The North Drainage Area will consist of inlets and storm sewer piping, oversized storm sewer piping for limited detention upstream of the detention basin, existing open channels with riparian vegetation and wetlands, two detention basins (one normal depth and one shallow), and shallow off-line detention combined with the storm sewer system for increased storage upstream of the retention/detention basin. The drainage areas will consist of two drainage basins with two outlet points. The westerly outlet will be the north dry detention basin and the northly outlet will be the upper north dry detention basin. The upper detention basin will incorporate the proposed green space along the north edge of the property and the buffer zone along Hook Road. The outlet structure will be positioned at the existing culvert structure that is under Hook Road and will allow the release the pre-developed flows from the drainage basin. The green space along the north edges will consist of swales running in a curve pattern and dotted with treescape islands and native vegetation in the swales. The north detention basin will consist of the buffer zone along the western edge of the development will have the same type layout of a meandering swale with larger treescape islands to meet the needs of a buffer zone between the residences and street. A larger dry detention basin consisting of native grass will be positioned near the outlet structure for better control for the storm events. The combined detention of the northern and upper north detention basins is 8.2 acre-feet, which is more than adequate for current volumes. If it is determined that additional storage is required. Additional storage will be developed using large diameter piping and off-line detention in the development. Additional storm water swales will be included in the development design to account for and control the 100-year event. The drainage area consists of 68.2 acres for the North Drainage Basin and 11.9 acres for the Upper North Drainage Basin. The weighted curve number is 81 and the time of concentration is 16 minutes.

Erosion control efforts for the area will include improved vegetative stabilization practices such as temporary seeding using degradable stabilization blankets on slopes, buffer zones at the top and bottom of slopes to reduced runoff flows, silt fence, straw bales, storm inlet protection, and erosion control mating. In addition, check dams will be used extensively both upstream and downstream of the green area to limit the amount of sediment that could enter the southeast green area.

The pre-developed flow for the North Drainage Area is 226 cubit feet per second (cfs) and the post-developed flow is 296 cfs. The proposed size of storage required for this is 5.3 acre-feet for the 25-year storm event and for the 100-year event the required storage is 7.1 acre-feet.

CONCLUSION

Table A is a summary of the design storm events, drainage areas, and pre and post development flows and recommended detention. The recommended detention will be completed with a combination of retention/detention lakes, detention basins, and shall deter erosion utilizing gentle slopes, native grasses, and trees to create a storm water scape that will co-exist with the existing surroundings.

Arch Engineers

Storm Water Quantities
Arborwalk Development
TABLE A

11/19/02

Table 1: 10, 25, 100 Year Storm Water Quantities

Event	Sub Watershed	CN	Area (acre)	Discharge (cfs) Pre	Discharge (cfs) Post	Det. Vol. (acre-ft.)
25-Year	Southwest	88	129	465.0	662.0	11.0
	Southeast	85	103	340.0	431.0	7.0
	Northwest	81	33.1	123.0	170.0	2.3
	North	81	80.2	226.0	296.0	5.3
	East	84	21.6	76.0	102.0	1.6
100-Year	Southwest	88	129	634.0	866.0	13.6
	Southeast	85	103	456.0	571.0	10.9
	Northwest	81	33.1	166.0	230.0	3.1
	North	81	80.2	307.0	400.0	7.1
	East	84	21.6	98.0	146.0	1.7

Appendix B

Micro Stormwater Drainage Study for
McBee's Coffee 'N Carwash
Lee's Summit, MO

Prepared For:

McBee's Coffee 'N Carwash
103 Industrial Parkway
Gallatin, MO 64640
816-832-6864
gsaltkovska@mcbeecompanies.com

Prepared By:

DAVIDSON ARCHITECTURE & ENGINEERING, LLC
Hilary Zerr, P.E.
4301 Indian Creek Parkway
Overland Park, Kansas 66207
913.451.9390 (phone)
www.davidsonae.com

May 11, 2022

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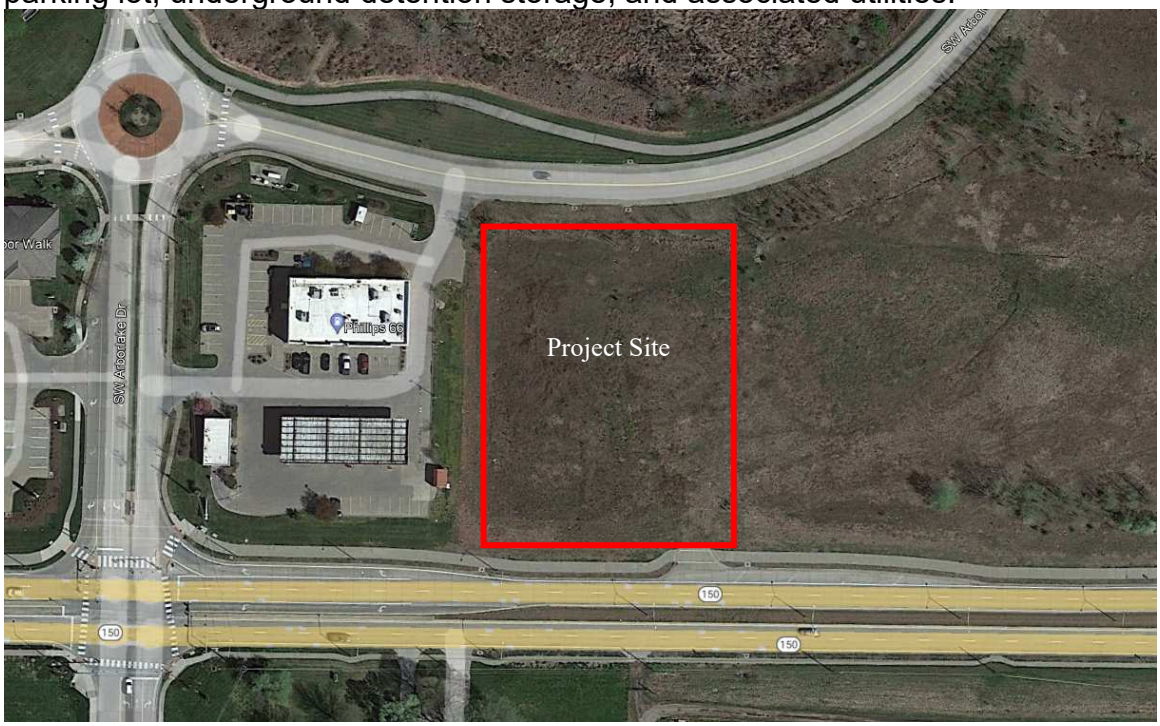
GENERAL INFORMATION:

McBee's Coffee N' Carwash is a new development being built on an existing developed lot. Davidson Architecture and Engineering, LLC has prepared a micro storm drainage study for the proposed project.

A. Project Location & Description

The proposed Project is located at 1295 Southwest Arborwalk Boulevard, north of MO-150, in Lee's Summit, MO. The developer plans to construct a single building for the carwash with a carwash tunnel, dog wash station, vacuums, parking lot, underground detention storage, and associated utilities.



B. Existing Conditions

The subject property consists of 1.53 acres. Currently, the entire site consists of pervious area generally sloping from the southwest to northeast corner with storm water collecting in a drainage swale along SW Arborwalk Blvd. There is an existing drainage study for the subject area, as part of a larger development that treated this area as a commercial site.

The project site is located in Zone X of the National Flood Insurance Program, Community-Panel Number 29095C0532G, Effective Date: January 20, 2017. Exhibit contained in the appendix of this report.

C. Proposed Improvements

The development is proposed to be constructed in one phase. A single building, an asphalt & concrete parking lot with concrete curb and gutter, lighting and on-site stormwater detention basin to control runoff for this site. The majority of the development shall be directed to the on-site storm water detention basin. The proposed site will contain approximatley 0.95 acres of impervious area and 0.85 acres of pervious area. Storm water will collect by a new storm sewer system, enter dual 48'' pipes for storage and will discharge to the same location the runoff is currently going. A new 18'' pipe will carry the current roadway ditch runoff to a new 24'' pipe, to cross under a new common drive and will discharge to the east of the site where the flow is currently channelized.

METHODOLOGY:

KCAPWA IDF curves were used to determine the rainfall intensity for the 2, 10, and 100-year storm events. Existing and proposed conditions were modeled and analyzed using Hydraflow Hydrographs Extension for AutoCAD Civil 3D 2021 (Hydraflow). Hydrograph routing within Hydraflow used the Rational Method with depths of 3.71", 5.2", and 7.8" for the 50% (2-Yr), 10% (10-Yr), and 1% (100-Yr) storm events, respectively. This method is also used in SCS TR-55. Convolution is known as linear superpositioning, and means that each ordinate of the rainfall hyetograph is multiplied by each ordinate of the unit hydrograph, thus creating a series of hydrographs. These hydrographs are then summed to form the final runoff hydrograph. Rainfall frequencies were determined by using TECHNICAL PAPER NO.40, RAINFALL FREQUENCY ATLAS OF THE UNITED STATES, by the U.S. Department of Commerce, Weather Bureau. The October 2012 American Public Works Association BMP Manual was used for this storm study.

EXISTING CONDITION ANALYSIS:

The existing site, located near 1295 Southwest Arborwarlk Boulevard, consists of pervious area that has been graded for a future development. There is a curb cut for a proposed drive on the south side, off MO-150 and a connection in the northwest corner to an existing site. There is a drainage swale along the north property line that carries storm runoff from the west to the east, through an 18'' HDPE pipe.

The existing 1.53-acre site is part of a larger development, called Arborwalk that was designed in 2002. The drainage master plan contains this property in the described "Southeast" watershed. The study states that this commercial area will only need limited detention within the boundaries because the upstream detention basins have been designed to control a portion of these sites once developed. It is not clear how much each future site is responsible for detaining.

PROPOSED CONDITION ANALYSIS:

For commercial development of this lot, we've designed a detention basin using dual 48'' pipes underground to hold the stormwater runoff from the 1.53 acre site and release it at or less than the allowable release rates.

The detention basin has been designed to effectively capture and discharge the runoff from the developed site, per the requirements set by APWA Section 5601.5.A.4.a. Discharge from the detention basin will be controlled by a proposed outlet structure that will maintain release rates less than allowable rates, while also maintaining water quality requirements specified in APWA Section 5608.4.C.1.b.

Post-development peak discharge rates shall not exceed the requirements set by APWA Section 5608.4.C.1.a that are shown below:

- 50% storm peak rate less than or equal to 0.5 cfs per site acre
  - Site specific allowable release rate: 0.75 cfs
- 10% storm peak rate less than or equal to 2.0 cfs per site acre
  - Site specific allowable release rate: 3.06 cfs
- 1% storm peak rate less than or equal to 3.0 cfs per site acre
  - Site specific allowable release rate: 4.59 cfs

The stormwater on site will be collected by curb and grate inlets and then piped to the underground storage pipes. There will be an outlet structure with a weir plate to control the release rates from this underground detention system.

Once developed, there will be approximatley 0.95 acres of impervious area and 0.85 acres of pervious area. A conservate runoff coefficient of 0.90 was used for this commercial development.

Proposed Site Runoff Hydraflow Results

Storm Event (yr)	Post-developed runoff Routed through detention (cfs)	Post-developed runoff Bypassing detention (cfs)	Total Post-Developed site runoff (cfs)	Allowable release rate for 1.53 acre site
2-Yr	0.15	0.45	0.61	0.75
10-Yr	0.76	0.74	1.39	3.06
100-Yr	1.93	1.00	2.97	4.59

The detention basin is designed to detain runoff to the required discharge rates allowable for the site per the City's current standards. The proposed storm water detention basin result in the following general conditions:

Detention Basin Summary				
Event (yr)	Total Flows to Detention Basin (cfs)	Detention Basin Discharge Qp (cfs)	Top Elevation Max. El. (ft)	Max. Storage (cuft)
2-Yr	6.81	0.15	996.69	2,025
10-Yr	9.25	0.76	997.08	2,647
100-Yr	16.22	1.93	998.27	4,394

STORM WATER QUALITY

The Mid-America Regional Council, Manual of Best Management Practices for Stormwater Quality, October 2012 requires the site to be designed to capture and treat the additional impervious runoff during the 90% mean annual storm (1.37”/24 hr) created by site improvements. The proposed outlet structure from the detention basin will control discharge from the 90% mean annual event to the minimum forty-hour extended detention requirement for comprehensive control. The outlet structure will have a perforated riser placed at the bottom elevation of the pond to control the discharge from the detention basin to meet this requirement.

SUMMARY:

Contained in the appendix is the analysis of the proposed runoff hydrographs based on the allowable discharge rates. With the proposed McBee’s Coffee N Carwash, the 1.53-acre site will increase the impervious area but the runoff will be controlled and released per the allowable amounts by collecting the storm water in a new storm system and detaining it in the underground pipes, acting as a detention basin.

The drainage maps and storm networks are shown on construction drawings C3.1 and C3.2.

Total Runoff Comparison			
Storm Event (yr)	Post-development rate (cfs)		Allowable release rate (cfs)
2-Yr	0.61	<	0.75
10-Yr	1.39	<	3.06
100-Yr	2.97	<	4.59

Appendix A – Supporting Data

Local Benchmarks: △ BM–#

BM#1:
Set MAG Nail & Washer In Asphalt
N: 1,073,921.09
E: 2,820,759.21
Elev.=1016.22

BM#2:
Set MAG Nail & Washer In Asphalt
N: 1,073,954.36
E: 2,820,861.54
Elev.=1014.21

Spot Elevation Legend

br	=	bottom of ramp
tr	=	top of ramp
me	=	match existing
pv	=	pavement
bw	=	bottom of wall
tw	=	top of wall
tc	=	top of curb
sw	=	sidewalk
ti	=	top of inlet
mi	=	mid–point
hp	=	high–point
lp	=	low–point
pc	=	point of curvature
pt	=	point of tangency
bldg	=	building
FFE	=	finished floor elevation
ex	=	existing
mp	=	match pavement
gnd	=	ground
ts	=	top of stair
bs	=	bottom of stair
con	=	concrete

standard curb & gutter

standard dry curb & gutter

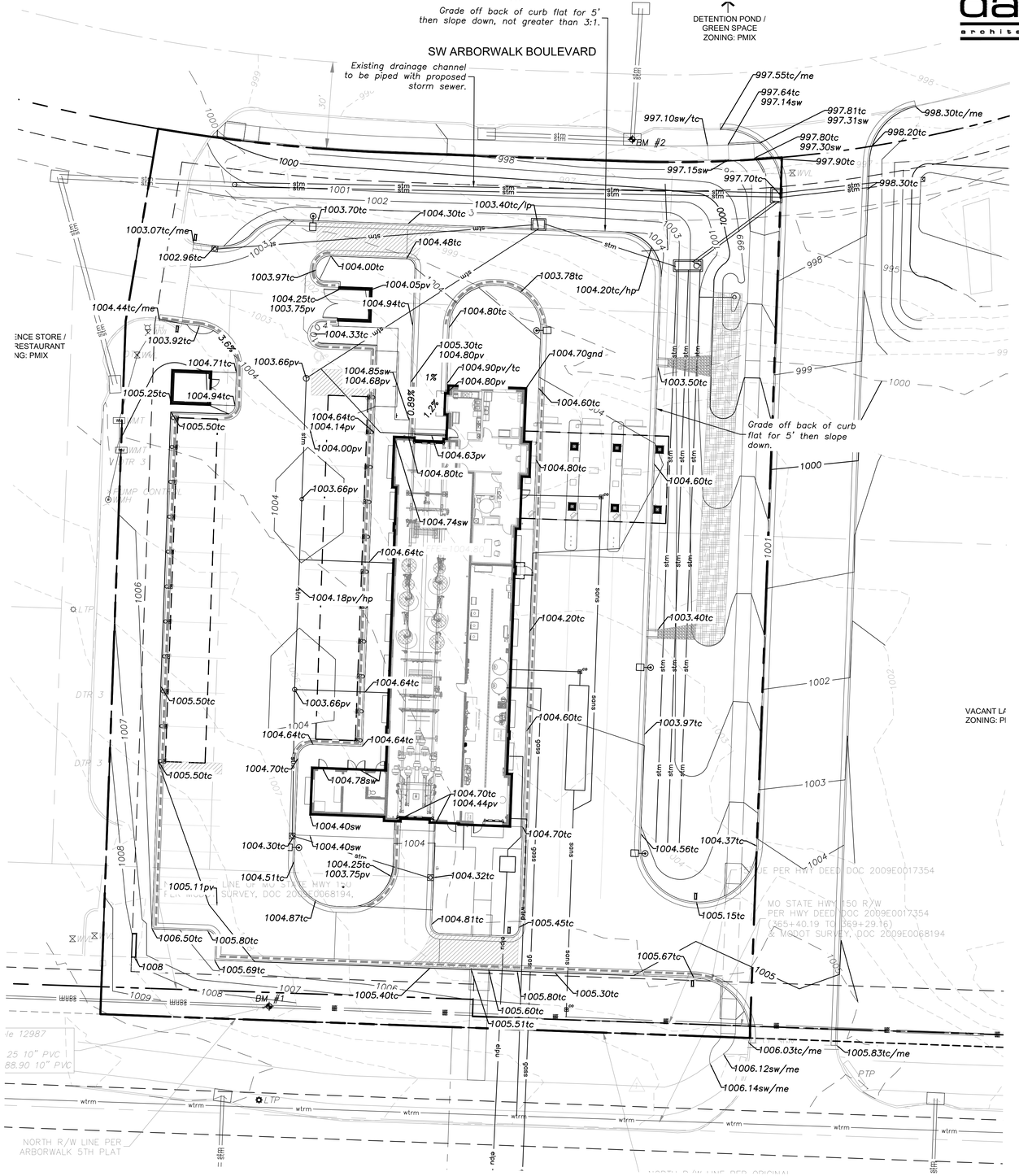
Grading Note:

Connections to existing sidewalks and pavement are based on survey elevations. Contractor shall ensure positive drainage when matching to existing elevations. If elevations in the field do not match the plans or there is a concern about drainage, or ADA compliance
CONTACT THE ENGINEER BEFORE INSTALLATION.

Americans with Disabilities Act (ADA) Notes:

The running and cross slopes for all sidewalks, accessible paths, ramps, designated parking stalls, etc., shall be in compliance with latest Federal ADA guidelines, in addition to any accessibility standards adopted by the governing municipality. Prior to installation/construction, if any discrepancies are found within the plans, the Engineer shall be notified.

- *Landings (L) shall have slopes less than 2% in all directions.*
- *Ramps (R) shall have running slopes less than 8.3% and cross slopes less than 2%.*
- *Sidewalk paths (all sidewalks) shall have running slopes less than 5% and cross slopes less than 2%.*



north **1** Spot Elevation Plan
scale: 1"=20'
0 10 20 40

**To be provided for permit drawings.

north **2** ADA Spot Elevation Plan
scale: 1"=10'
0 10 20 40

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Davidson Architecture & Engineering, LLC
STATE OF MISSOURI HILARY ZERR NUMBER PE-2016022888 REGISTERED PROFESSIONAL ENGINEER
Hilary A. Zerr
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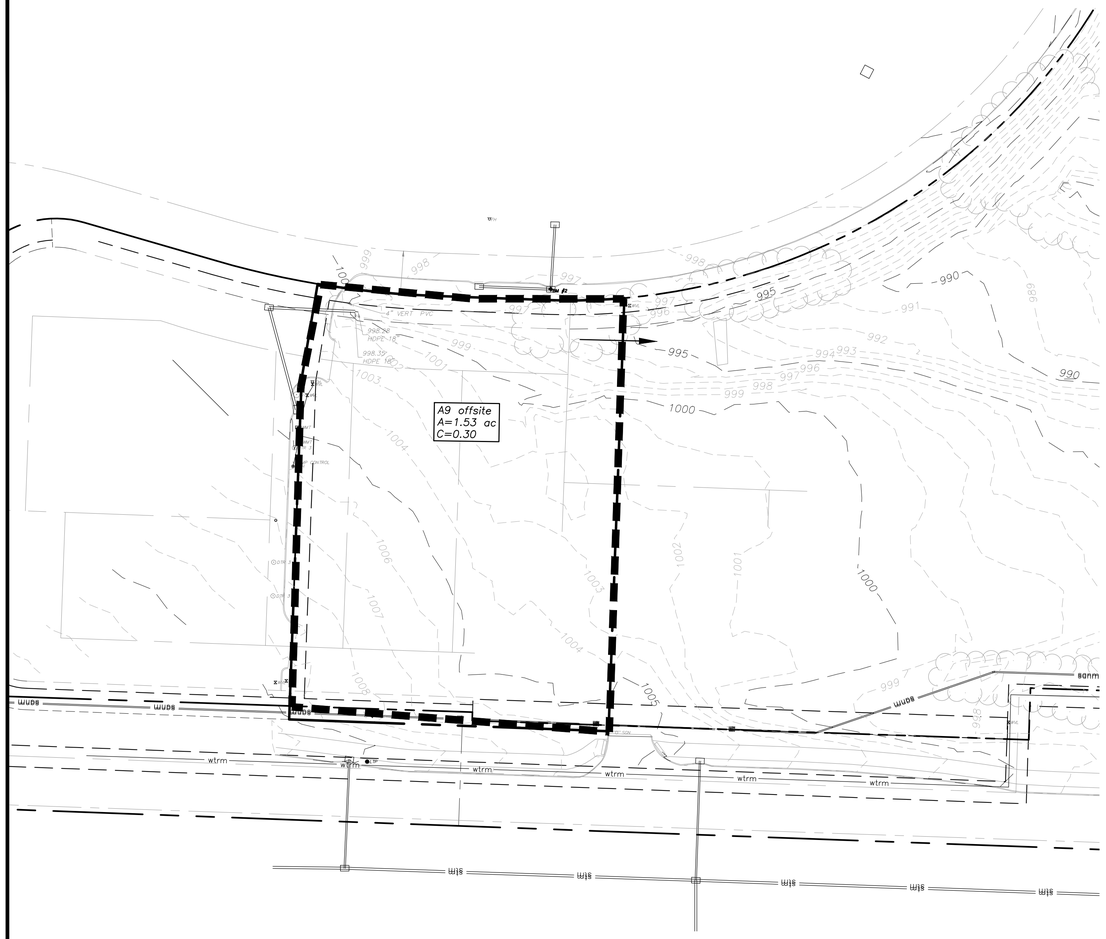
a new building for
McBee's Coffee 'N Carwash
1295 Southwest Arborwalk Boulevard
Lee's Summit, Missouri 64082

date
09.22.2021
drawn by
DAE
checked by
DAE
revisions

11.10.2021	1
04.29.2022	4

sheet number
C2.2
drawing type
planning
project number
21072-15



1 Existing Drainage Area Map

north

1"=50'

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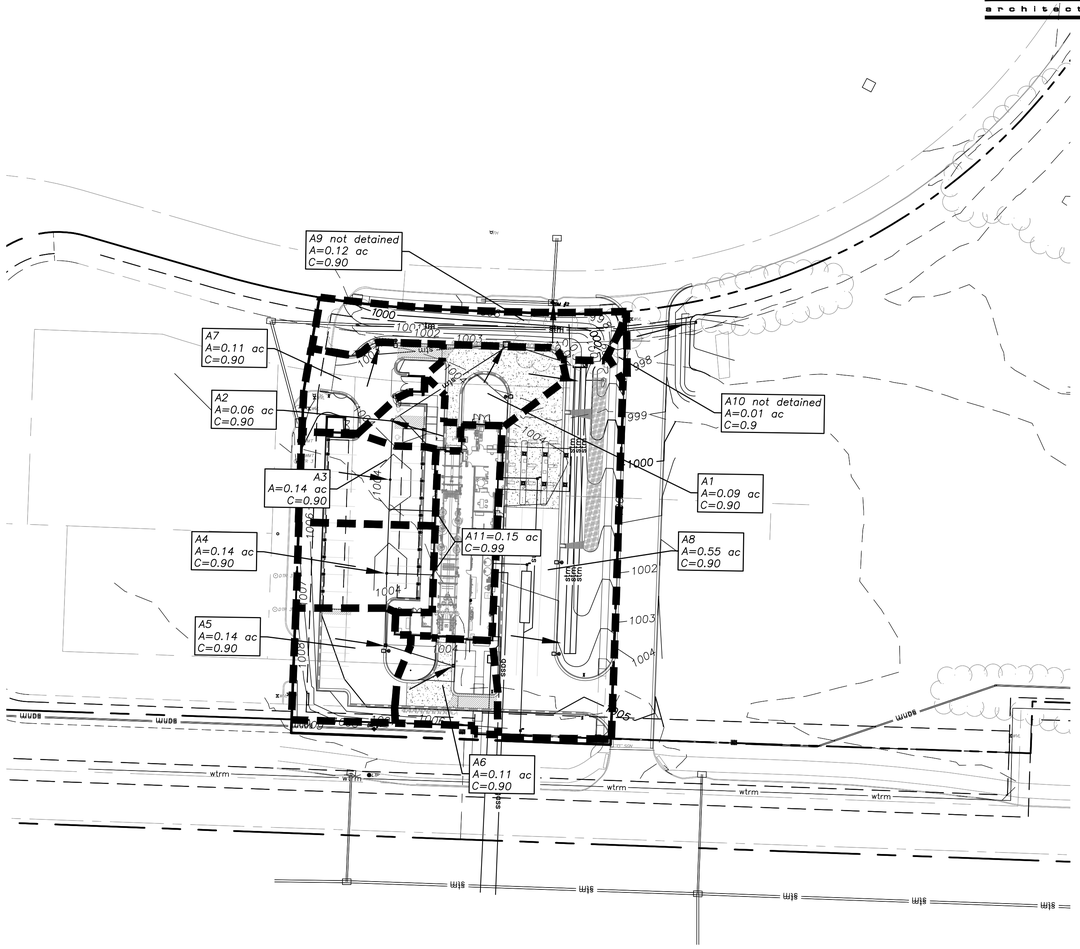


2 Proposed Drainage Area Map

north

1"=50'

0 25 50 100

Pre–Construction Impervious Area Calculations

	Square Feet	Acres
Area of Site	66864.30	1.53
Impervious Area	0	0
Pervious Area	66864.30	1.53

Post–Construction Impervious Area Calculations

		Square Feet	Acres
Area of Site		66864.30	1.53
Impervious Area		41,480	0.95
Pervious Area		25,384	0.85
Q:	2 year	0.61 cfs	
	10 year	1.39 cfs	
	100 year	2.92 cfs	

Per APWA 5600, Comprehensive Control Strategy, Release rates are as follows:

2 year = 0.5 cfs/acre x 1.53 acres = 0.75 cfs
10 year = 2.0 cfs/acre x 1.53 acres = 3.06 cfs
100 year = 3.0 cfs/acre x 1.53 acres = 4.59 cfs

Drainage Legend

drainage area

Property Legend

right of way
property lines
easements
setbacks

Grading Legend

existing minor contour
existing major contour
proposed minor contour
proposed major contour

Floodplain Note:

As referenced in FEMA FIRM Community Panel Number 29095C0532G Effective Date: January 20, 2017 this parcel lies within Zone "X", Areas determined to be outside the 0.2% annual chance Floodplain.

MISSOURI ONE CALL SYSTEM, INC. 1-800-344-7483 STOP! CALL BEFORE YOU DIG!

davidson
architecture&engineering

4301 Indian Creek Parkway
Overland Park, KS 66207
phone: 913.451.9390
fax: 913.451.9391
www.davidsonae.com

Davidson Architecture & Engineering, LLC

STATE OF MISSOURI
HILARY ZERR
NUMBER PE-2016022888
REGISTERED PROFESSIONAL ENGINEER

Hilary A. Zerr
License # 2016022888

a new building for

McBee's Coffee 'N Carwash

1295 Southwest Arborwalk Boulevard
Lee's Summit, Missouri 64082

date
05.13.2022
drawn by
HAZ
checked by
DAE
revisions

sheet number
C3.1
drawing type
planning
project number
21072-15

Local Benchmarks: BM–#

BM#1:
Center of Sanitary manhole cover, south of site.
N: 978356.8105
E: 2816138.6620
Elev.=1008.60

BM#2:
Center of curb inlet, north of site.
N: 978654.7818
E: 2816263.4213
Elev.=997.34

Property Legend

- right of way
- property lines
- easements
- setbacks

Grading Legend

- existing minor contour
- existing major contour
- proposed minor contour
- proposed major contour

Utility Legend

- existing
- proposed

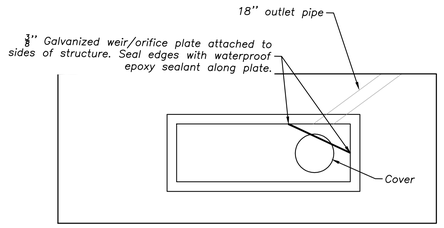
Linetypes

sanm	sanitary main
sans	sanitary service
stm	storm sewer (existing)
stm	storm sewer (solid wall, proposed)
stm	storm sewer (solid wall, proposed)
stm	storm sewer (perforated, proposed)
wtrm	water main
wtrf	water service (fire)
wtrd	water service (domestic)
wtri	water service (irrigation)
gasm	natural gas main
gass	natural gas service schematic
elpu	underground primary electric
elsu	underground secondary electric
elpo	overhead electric
datu	underground cable/phone/data
datsu	underground cable/phone/data service
	fence–chainlink
	fence–wood
	fence–barbed wire
	treeline

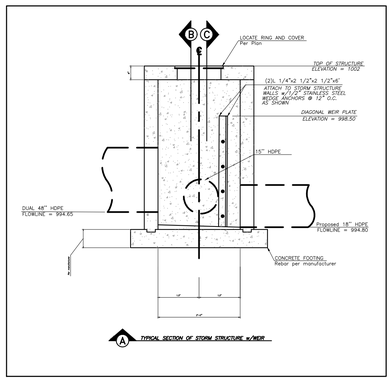
Symbols

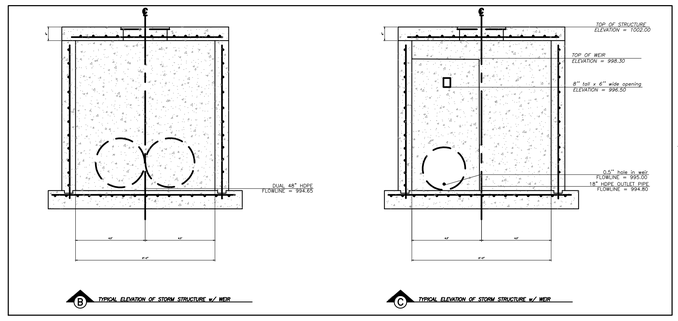
- sanitary manhole
- service cleanout
- force main release valve
- rectangular structure
- circular structure
- fire hydrant
- water valve
- water meter
- backflow preventer
- natural gas meter
- service transformer (pad mount)
- primary switch gear
- light pole
- cable/phone/data junction box
- street light
- pedestrian street light
- electric pole
- guy wire
- end section

MISSOURI ONE CALL SYSTEM, INC. 1-800-344-7483 STOP-CALL BEFORE YOU DIG!



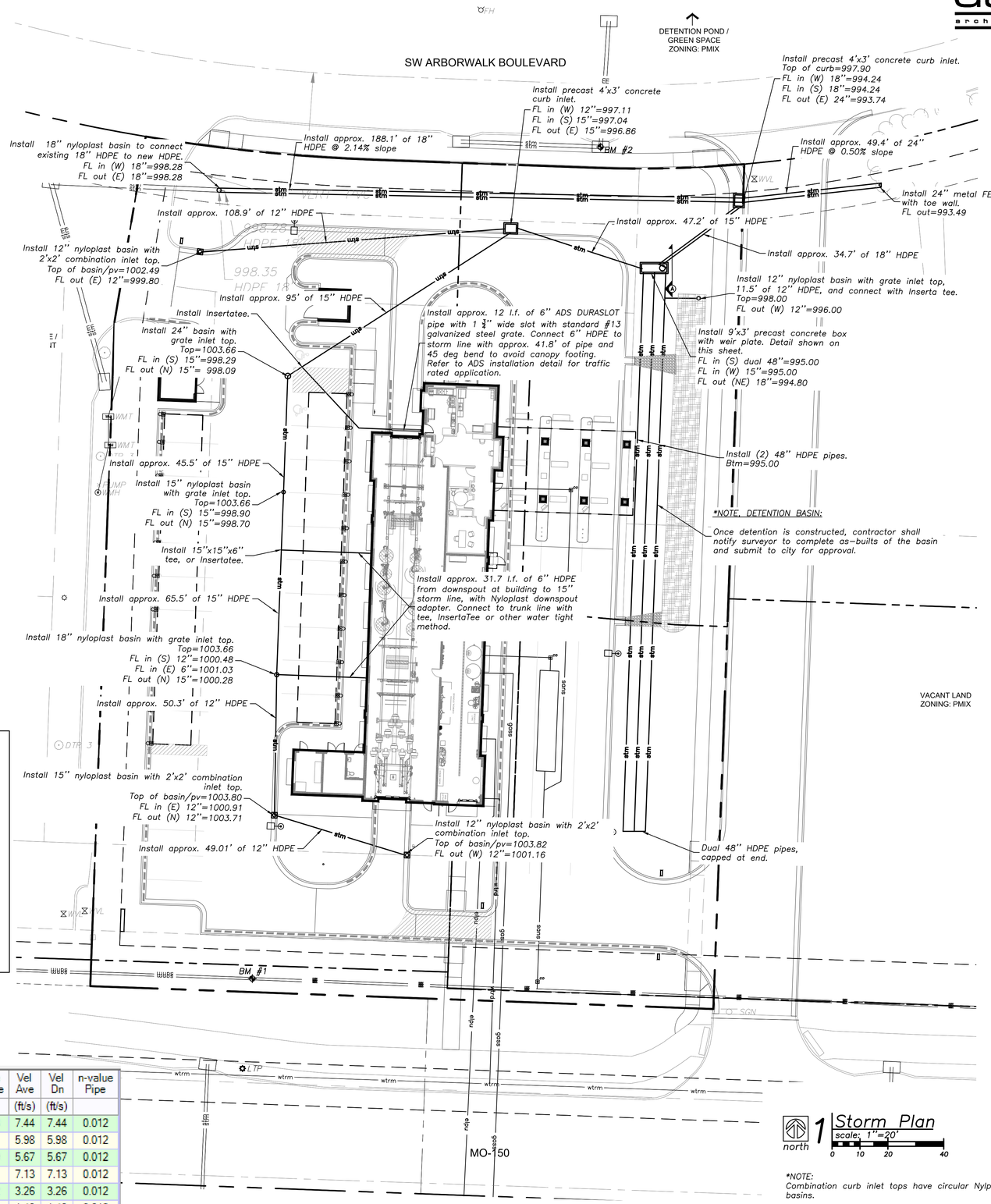
Top of outlet control structure





100–year Storm

Line No.	Line ID	Drainage Area	Runoff Coeff	Total CxA	Tc	i Sys	Flow Rate	Capacity Full	Line Size	Line Type	Line Length	Line Slope	Vel Ave	Vel Dn	n-value Pipe
		(ac)	(C)		(min)	(in/hr)	(cfs)	(cfs)	(in)		(ft)	(%)	(ft/s)	(ft/s)	
1	Line 1	0.08	0.90	0.77	6.3	11.79	9.13	12.28	15	Cir	53.893	3.08	7.44	7.44	0.012
2	Line 2	0.04	0.90	0.61	6.1	11.99	7.34	7.36	15	Cir	94.941	1.11	5.98	5.98	0.012
3	Line 3	0.13	0.90	0.58	5.9	12.09	6.96	6.96	15	Cir	41.465	0.99	5.67	5.67	0.012
4	Line 4	0.28	0.90	0.46	5.8	12.20	5.60	5.60	12	Cir	65.520	2.11	7.13	7.13	0.012
5	Line 5	0.13	0.90	0.21	5.6	12.39	2.56	2.77	12	Cir	44.588	0.52	3.26	3.26	0.012
6	Line 6	0.10	0.90	0.09	5.0	12.87	1.16	2.74	12	Cir	49.700	0.50	1.48	1.48	0.012
7	Line 7	0.10	0.90	0.09	5.0	12.87	1.16	6.06	12	Cir	108.900	2.47	1.48	1.48	0.012
8	Line 8	0.50	0.80	0.40	15.0	7.81	3.12	4.09	12	Cir	35.562	1.12	4.90	4.90	0.012



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Hilary A. Zerr
License # 2016022888

a new building for McBee's Coffee 'N Carwash

1295 Southwest Arborwalk Boulevard
Lee's Summit, Missouri 64082

date 05.13.2022
drawn by HAZ
checked by DAE
revisions △

sheet number **C3.2**
drawing type planning
project number 21072-15

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) Report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS Report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study Report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study Report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Missouri State Plane West Zone (FIPS zone 2403). The **horizontal datum** was NAD 83, GRS 1980 spheroid. Differences in datum, spheroid, projection or UTM zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at http://www.ngs.noaa.gov or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, Maryland 20910-3282
(301) 713-3242

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at **(301) 713- 3242**, or visit its website at http://www.ngs.noaa.gov.

Base map information shown on this FIRM was derived from the U.S.D.A Farm Service National Agriculture ImageryProgram (NAIP) dated 2014. Produced at scale of 1:24,000.

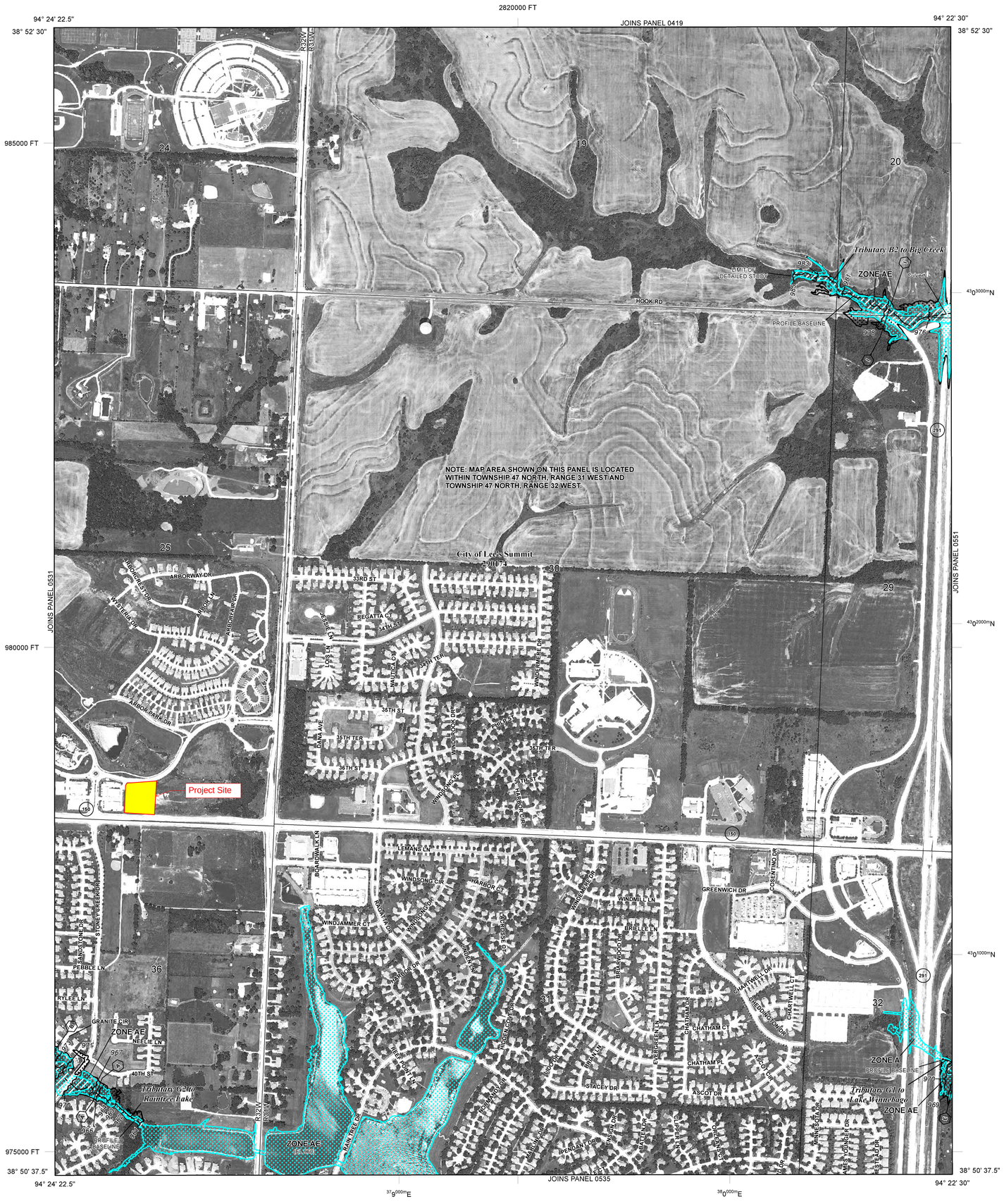
The **profile baselines** depicted on this map represent the hydraulic modeling baselines that match the flood profiles in the FIS report. As a result of improved topographic data, the **profile baseline**, in some cases, may deviate significantly from the channel centerline or appear outside the SFHA.

Based on updated topographic information, this map reflects more detailed and up-to-date **stream channel configurations and floodplain delineations** than those shown on the previous FIRM for this jurisdiction. As a result, the Flood Profiles and Floodway Data tables for multiple streams in the Flood Insurance Study Report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on the map. Also, the road to floodplain relationships for unrevised streams may differ from what is shown on previous maps.

Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

For information on available products associated with this FIRM visit the **Map Service Center (MSC)** website at http://msc.fema.gov. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products can be ordered or obtained directly from the MSC website.



LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Areas formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X	Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X	Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D	Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

	1% Annual Chance Floodplain Boundary
	0.2% Annual Chance Floodplain Boundary
	Floodway boundary
	Zone D boundary
	CBRS and OPA boundary
	Boundary dividing Special Flood Hazard Area Zones and boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths, or flood velocities.
513	Base Flood Elevation line and value; elevation in feet*
(EL 987)	Base Flood Elevation value where uniform within zone; elevation in feet*

*Referenced to the North American Vertical Datum of 1988

A — A	Cross section line
23 — 23	Transect line
	Culvert
	Bridge
45° 02' 08", 93° 02' 12"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83) Western Hemisphere
3100000 FT	5000-foot ticks: Missouri State Plane West Zone (FIPS Zone 2403), Transverse Mercator projection
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
M1.5	River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP
September 29, 2006

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
January 20, 2017 - to change Special Flood Hazard Areas.

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 500'

250 0 500 1000 FEET
150 0 150 300 METERS

NFIP NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0532G

FIRM

FLOOD INSURANCE RATE MAP

JACKSON COUNTY, MISSOURI AND INCORPORATED AREAS

PANEL 532 OF 625
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
LEE'S SUMMIT, CITY OF	290174	0532	G

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
29095C0532G
MAP REVISED
JANUARY 20, 2017

Federal Emergency Management Agency

DRAINAGE MASTER PLAN

ARBORWALK

IN THE CITY OF LEE'S SUMMIT, MISSOURI

200 100 0 200 400 600

SCALE IN FEET

LEGEND

- DRAINAGE BASIN BOUNDARY
- STORM WATER FLOW DIRECTION
- ROCK CHECK DAM
- SILT TRAP BASIN

UPPER NORTH DETENTION BASIN (0.63 AC.)

UPPER NORTH DRAINAGE BASIN

NORTH DETENTION BASIN (1.42 AC.)

NORTH DRAINAGE BASIN

PROJECT LOCATION
HOOK ROAD

PRYOR ROAD

WARD ROAD

3 MILES +/- N. TO 50 HWY.

1.2 MILES +/- E. TO 291 HWY.

MO. STATE HWY. 150

S25, T47N, R32W

VICINITY MAP

NORTHWEST GREENSPACE DETENTION BASIN (0.54 AC.)

NORTHWEST DRAINAGE BASIN

SHALLOW GREENSPACE DETENTION BASINS (0.43 AC.)

where are these draining to?

SOUTHWEST DRAINAGE BASIN

UPPER DETENTION BASIN (0.43 AC.)

LOWER DETENTION BASIN (3.51 AC.)

UPLAND AREA (0.83 AC.)

RETENTION/ DETENTION AREA (2.41 AC.)

LOWER DETENTION AREA (3.93 AC.)

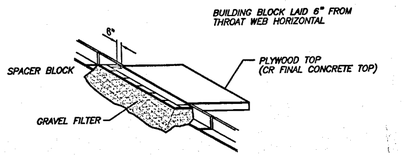
SOUTHEAST DRAINAGE BASIN

SOUTHEAST DRAINAGE BASIN (COMMERCIAL)

EAST SHALLOW DETENTION BASIN (0.95 AC.)

EAST DRAINAGE BASIN

APPROX. LOC. EXISTING WATER

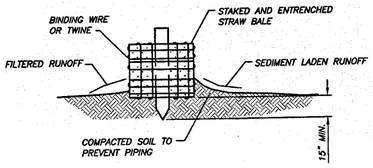


EXPANDED METAL OR HARDWARE CLOTH IN FRONT OF BLOCK PREVENTS GRAVEL FROM WASHING INTO STRUCTURE

2"X4" BEHIND BLOCK AND ACROSS THROAT HELPS KEEP BLOCK IN PLACE PLACE IN OUTER HOLE OF SPACER BLOCK

BLOCK AND GRAVEL CURB INLET PROTECTION
(FROM RICHMOND, VIRGINIA—EROSION AND SEDIMENT CONTROL HANDBOOK, NOVEMBER 1975)

SD-45 INLET PROTECTION
N.T.S.

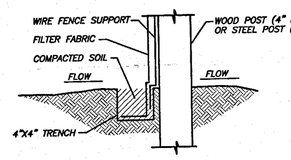


SECTION

NOTES:

1. EXCAVATE A TRENCH ALONG THE AREAS THAT THE STRAW BALES WILL BE USED AS EROSION CONTROL TO DEPTH OF 4" AND TO THE WIDTH OF ONE (1) STRAW BALE. THE STRAW BALES THEN SHALL BE PLACED IN THE TRENCH. SAVE EXCAVATED MATERIAL ON THE UPSTREAM SIDE OF THE TRENCH.
2. STRAW BALES SHOULD BE ANCHORED WITH A MINIMUM OF 2 STAKES OR REBARS DRIVEN INTO THE UNDERLYING SOIL, MAKING SURE THAT THE BINDING WIRE OR TWINE IS FACING THE SIDES AND NOT TOUCHING THE SOIL. THE FIRST STAKE INTO EACH BALE SHOULD BE DRIVEN TOWARD THE PREVIOUSLY LAID BALE TO FORCE THEM TOGETHER.
3. SPACING BETWEEN THE BALES SHOULD BE TIGHTLY CHINKED WITH LOOSE STRAW.
4. AFTER STRAW BALES ARE IN PLACE, THE EXCAVATED SOIL SHOULD BE BACKFILLED AGAINST THE UPSLOPE SIDE OF THE STRAW BALES TO A HEIGHT OF 4" AFTER COMPACTING.
5. STRAW BALES SHOULD BE INSPECTED AFTER EACH RAINFALL TO DETERMINE IF ANY REPAIRS OR REPLACEMENTS TO THE STRAW BALES ARE NEEDED. IF IT IS DETERMINED THAT THE STRAW BALES NEED TO BE REPAIRED OR REPLACED, THIS SHOULD BE DONE IMMEDIATELY. SEDIMENT ACCUMULATIONS MUST BE REMOVED WHEN THEY REACH A HEIGHT 1/2 THE BARRIER HEIGHT.

SD-48 STRAW BALE INSTALLATION
N.T.S.



SECTION

NOTES:

1. THE MAXIMUM SLOPE LENGTH ABOVE THE FENCE SHOULD BE LESS THAN 100 FEET.
2. NO DITCH OR DRAINAGE WAY WITH AN AREA GREATER THAN 5 ACRES SHALL BE ENCLOSED ABOVE A SILT FENCE.
3. NO SILT FENCE SHALL BE CONSTRUCTED IN A LIVE STREAM OR DRAINAGE WAY WITH EXPECTED FLOWS GREATER THAN 1 CFS.
4. THE FILTER FABRIC SHALL HAVE A MINIMUM FILTERING EFFICIENCY OF 75%, A MINIMUM TENSILE STRENGTH OF 30 LBS. PER LINEAR INCH AND A FLOW RATE OF 0.3 GALLONS PER SQUARE FOOT PER MINUTE. THE FILTER FABRIC SHALL ALSO HAVE ULTRAVIOLET RAY INHIBITORS TO ASSURE A LIFE USE EXPECTANCY OF 6 MONTHS AT 0 TO 100 DEGREES FAHRENHEIT.
5. THE FILTER FABRIC SHALL BE 36 INCHES OR LESS IN HEIGHT, WITH JOINTS AT EVERY POST AVOIDING OVERLAP IF POSSIBLE (6" MIN. OVERLAP IF NECESSARY) AND POSTS SPACED EVERY 10 FEET WITH WIRE MESH SUPPORT OR 6 FEET WITHOUT SUPPORT, MAKING SURE THAT A MIN. OF 8" OF FABRIC IS BURIED IN THE 4"X4" TRENCH.
6. THE SILT FENCE SHALL BE INSPECTED AFTER EVERY RAINFALL TO DETERMINE IF ANY PART OF THE FENCE NEEDS TO BE REPAIRED OR REPLACED. IF IT IS DETERMINED THAT THE FENCE NEEDS ANY REPAIR OR REPLACEMENT THIS SHALL BE DONE IMMEDIATELY.

SEDIMENT DEPOSITS SHALL BE REMOVED AFTER EACH RAINFALL OR BEFORE THEY ACCUMULATE TO 1/2 OF THE FENCE HEIGHT.

SD-48A SILT FENCE INSTALLATION
N.T.S.

DUPLICATE?

RECEIVED
NOV 20 2002
CITY OF LEE'S SUMMIT
ENGINEERING DEPT.

DEVELOPER:
MR. DAVID GALE
GALE COMMUNITIES, INC.
3620 SW. WARD ROAD
LEE'S SUMMIT, MO 64082
PHONE: 816-537-4200

FILE: STORM-WATER-PLAN.DWG
SCALE: 1=200
PLOT AFTER:
NAME:

No.	DATE	BY	REVISION

DATE: 11/19/02
DESIGNED BY: MD
DRAWN BY: RJL
CHECKED BY: MD

E. T. ARCHER CORPORATION D.B.A.
ARCHER
TOTAL PROJECT MANAGEMENT
CORPORATE OFFICE: 3741 NE. TROON DRIVE LEE'S SUMMIT, MO. 64064
816-554-3019 • FAX 816-554-3061

OTHER OFFICE LOCATIONS
- 187 E. DAVID, P.O. BOX 969, FORSYTH, MO 65653 • 417-546-3218 • FAX 417-546-5324
- 800 STARKS BUILDING, LOUISVILLE, KY 40202 • 502-581-9484 • FAX 502-581-9485
- 1000 CITY PARKWAY, OSAGE BEACH, MO 65065 • 573-348-3222 • FAX 573-348-3499
- 1007 HAUCK DR., SUITE B, P.O. BOX 537, ROLLA, MO 65402 • 573-364-3420 • FAX 573-364-4170
- 6300 NALL, P.O. BOX 439, SHAWNEE MISSION, KS 66201 • 913-362-9753 • FAX 913-362-6847
- 255 SO. UNION, SPRINGFIELD, MO 65802 • 417-865-4083 • FAX 417-865-4085
- 2480 EXECUTIVE DRIVE, SUITE 116, ST. CHARLES, MO 63303 • 636-477-8389 • FAX 636-477-7569

DRAINAGE MASTER PLAN FOR ARBORWALK, LEE'S SUMMIT, MO.

FOR: GALE COMMUNITIES, INC. LEE'S SUMMIT, MISSOURI

PROJECT NO. 21126701

DRAWING NO. 1 OF 1

DRAINAGE MASTER PLAN

INTRODUCTION

Gale Communities, Inc., of Lee's Summit, Missouri employed the services of Archer Engineers to evaluate and recommend a storm water management plan for the watershed associated with the development called Arborwalk. Arborwalk is located in the southern portion of the City of Lee's Summit north of Missouri State Highway 150 and between Ward and Pryor Roads. The development is 380 acres and is in Section 25, Township 47, Range 32 of Jackson County. General topography is gentle rolling hills with both open fields and timber areas.

WATERSHED DESCRIPTION

Arborwalk development is divided into 5 drainage basins, Southeast, Southwest, East, Northwest, and North. The 5 drainage basins have their own modified storm water management system that is described in detail in the following text. A check of the Federal Emergency Management Agency (FEMA) indicated that there is no 100-year flood plain within the boundary of the development.

The 5 drainage basins are outlined on the attached Figure named Drainage Master Plan (enclosed). The Figure indicates the different drainage basins, flow direction, location and approximate size of major detention basins, location of major rock check dams and silt trap basins. Soil type was obtained from the Soil Conservation Service's (SCS) "Soil Survey of Jackson County, Missouri". Existing land use was obtained from the city zoning records and field inspection. Table A at the end of this report provides data for the different drainage basins and pre and post watershed conditions respectfully.

OVERVIEW

Storm water management is knowledge used to understand, control, and utilize waters in different forms within the hydrologic cycle. The natural condition of a watershed is termed undeveloped condition. Natural streams, creeks, and waterways have been continuously shaped over time by storm runoff. Development of a watershed results in more paved areas that increase the frequency, magnitude, and volume of storm runoff. Man made drainage facilities cause storm water to move faster and to become more concentrated causing erosion within the watershed. The factors that impact severity of erosion include storm intensity, soil conditions, vegetation characteristics, and topography.

The goal of this report is to provide concepts and design criteria for best management of storm water and the functions of the storm water drainage system. Various types of systems will be used in the development to manage the storm water and may include storm sewers, streets with curb & gutter, swales, detention, off-line detention, and wetlands.

Detention basins are small to medium size basins that impound water for 24 hours or less and are normally 10 acre-ft or less. Retention basins are usually larger than detention basins and hold water for much longer periods, usually have a defined pool elevation, and release any stored water at a much slower rate. Additional concepts will consist of oversized storm sewer piping, off-line detention basins, and shallow green space detention. Oversized storm sewer piping could be place at critical locations to hold limited volumes of storm water to decrease the peak outflow leaving the detention basin during normal storm events. Off-line detention basins might be developed within the watershed to reduce the overall detention areas required within the watershed. An example of an off-line detention basin might be a defined swale running down the back lot lines of a series of houses. This swale would be connected to the storm sewers at each end and controlled with an inlet of greater capacity than the outlet of the storm sewer. The storm sewer would be designed to pass the dry weather flows and the 2, 5, and 10-year storms. During a storm event larger than the 10-year event, the volume difference between the inflow and outflow would be detained in the swale area defined. This type of design using the concept of off-line detention within the on-line sewer system would allow for better control of storm detention within the drainage basin before reaching the detention basin(s) down stream.

SOUTHEAST DRAINAGE AREA

The Southeast Drainage Area will consist of all the various type of storm water management systems that are practicable for the given size and use of the area. The systems will consist of inlets and storm sewer piping, oversized storm sewer piping for limited detention upstream of the detention basin, existing open channels with riparian vegetation and wetlands, a retention basin with a fixed pool elevation and with detention included within the retention basin, and shallow off-line detention combined with the storm sewer system for increased storage upstream of the retention/detention basin. In addition, upland detention will utilize green space for shallow storage of storm events smaller than the 25-year event. The Drainage area is 103 acres with a weighed curve number of 85 and a time of concentration of 27 minutes.

The existing farm lake will be retained and utilized by increasing the dam height and excavation to create a detention basin above the normal pool elevation for the 25-year design storage. The detention provided above the normal pool elevation will be approximately 7.2 acre-feet of storage (3-feet in depth). The green space southeast of the basin will be designed to hold an additional 3.9 acre-feet of storage (1-foot in depth). The combination of the two basins will adequately hold the required volume of storage for both the southeast drainage basin including the future commercial development at the

intersection of Ward Road and Highway 150. If in final design, it is determined that additional space will be needed in the Southeast Basin, one option that will be considered is the installation of an underground storm sewer detention under the commercial area near the intersection of Ward Road and Highway 150.

To provide improved water quality in the Southeast Drainage Basin, additional upland/wetland area will be developed north of the retention/detention basin. This upland area will provide a vegetative interface with the lower storm events by allowing low flows to pass through a native grass and tree area where the velocities will be lowered to allow for sediment to collect in this upland area instead of the basins and potential exiting the basin.

The area defined as commercial will have limited detention within their boundaries. The required detention volumes for this area will be held in the Southeast detention area upstream. An outlet structure with limited underground storage will be built at the outlet (near the intersection of Ward Road and Highway 150) to allow only pre-developed flows to exist the watershed.

Erosion control efforts for the area will include improved vegetative stabilization practices such as temporary seeding using degradable stabilization blankets on slopes, buffer zones at the top and bottom of slopes to reduced runoff flows, silt fence, straw bales, storm inlet protection, and erosion control mating. In addition, check dams will be used extensively both upstream and downstream of the green area to limit the amount of sediment that could enter the Southeast Detention area. The southeast corner of the development will have a series of temporary sedimentation basins to control and contain the sediment load as storm water exists the site during the development of the project.

The pre-developed flow for the Southeast Drainage Basin is 340 cubic feet per second (cfs) and the post-developed flow is 431 cfs. The proposed size of storage required for this is approximately 7 acre-feet for the 25-year storm event and for the 100-year storm event the required storage is 10.9 acre-feet. The commercial area to the southeast when developed will require 4.8 acre-feet of storage for detention that is part of the required storage listed above.

SOUTHWEST DRAINAGE AREA

The Southwest Drainage Area systems will consist of inlets and storm sewer piping, oversized storm sewer piping for limited detention upstream of the detention basin, existing open channels with riparian vegetation and wetlands, detention basins, and shallow off-line detention combined with the storm sewer system for increased storage upstream of the detention basins. The detention basins will consist of a two dry detention basins to control the 2, 5, and 10-year storm for water quality and the 25-year storm for downstream flood control. The small storm events will be held longer in the basins to allow for improved water quality. This will be accomplished by designing around the existing creek, by the addition of a control structure near Highway 150, and using the

change in elevations in creating steps. The upper (smaller) basin that has a storage volume of approximately 1.2 acre-feet (3-foot depth) will be used as an equalization basin before entering the lower detention basin. The lower detention basin which has a storage volume of approximately 12.3 acre-feet will be gentle and blend into the surrounding land by using native trees, bushes, and grasses. During the higher storm events, water will be allowed to pond over most of the basin floor up to depth of 42-iches. This will allow for planting of grasses in the basin bottom that can survive for short times during submergence and the usage of tree plantings and treescape islands that will be scattered through out the basin floor. These treescape islands will consist of trees, shrubs, and grasses native to the area and particularly to stream areas. There will be field inlets scattered through out the basin floor to handle the larger storm events by allowing flow into smaller diameter piping that would converge at the primary outlet structure. This would allow for subcritical flow to exit the site, thereby reducing the potential for erosion downstream. Additional rock levels with rock waterfalls will allow for transition of elevations and add aeration to the storm water for quality. The drainage area is 129 acres with a weighed curve number of 88 and a time of concentration of 20 minutes.

Erosion control efforts for the area will include improved vegetative stabilization practices such as temporary seeding using degradable stabilization blankets on slopes, buffer zones at the top and bottom of slopes to reduced runoff flows, silt fence, straw bales, storm inlet protection, and erosion control mating. In addition, check dams will be used extensively both upstream and downstream of the green area to limit the amount of sediment that could enter the southwest green area.

The pre-developed flow for the Southwest Drainage Basin is 465 cubic feet per second (cfs) and the post-developed flow is 622 cfs. The proposed size of storage required for this is approximately 11 acre-feet for the 25-year storm event and for the 100-year storm event the required storage is 13.6 acre-feet. The office area to the east of the lower detention area when developed will require 2.9 acre-feet of storage for detention that is part of the required storage listed above.

NORTHWEST DRAINAGE AREA

The Northwest Drainage Area systems will consist of inlets and storm sewer piping, oversized storm sewer piping for limited detention upstream of the shallow detention basin, existing open channels with riparian vegetation and wetlands, a shallow detention basin, and shallow off-line detention combined with the storm sewer system for increased storage upstream of the shallow detention basin. Shallow detention will consist of a series of small dry detention areas incorporated into the proposed green space along the north edge of the property and the buffer zone along Pryor Road. The outlet structure for this basin will be positioned at the northwest corner of development at Pryor and allow the release the pre-developed flows from the drainage basin. The green space along the northern edge of the development will consist of swales running in a curve pattern and dotted with treescape islands and native vegetation in the swales. This green space will provide approximately 0.9 acre-feet of storage. The buffer zone along Pryor Road will

have the same type layout of a meandering swale with larger treescape islands to meet the needs of a buffer zone between the residences and street. The buffer zone will provide approximately 0.9 acre-feet of storage. The combined storage of the two areas is approximately 1.8 acre-feet. The storage is less than the required 2.3 acre-feet for the 25-year event. Additional storage will be developed within the development by the use of large diameter storm sewer piping and off-line detention. Additional storm water swales will be included in the development design to account for and control the 100-year event. The drainage area is 33.1 acres with a weighed curve number of 81 and a time of concentration of 13 minutes.

Erosion control efforts for the area will include improved vegetative stabilization practices such as temporary seeding using degradable stabilization blankets on slopes, buffer zones at the top and bottom of slopes to reduced runoff flows, silt fence, straw bales, storm inlet protection, and erosion control mating. In addition, check dams will be used extensively both upstream and downstream of the green area to limit the amount of sediment that could enter the northwest green area.

The pre-developed flow for the Northwest Drainage Area is 123 cubit feet per second (cfs) and the post-developed flow is 170 cfs. The proposed size of storage required for this is 2.3 acre-feet for the 25-year storm event and for the 100-year storm event the required storage is 3.1 acre-feet.

EAST DRAINAGE AREA

The East Drainage Area will consist of inlets and storm sewer piping, oversized storm sewer piping for limited detention upstream of the detention basin, existing open channels with riparian vegetation and wetlands, shallow detention, and shallow off-line detention combined with the storm sewer system for increased storage upstream of the retention/detention basin. Shallow detention will consist of a dry detention area incorporated into the proposed green space along the buffer zone along Ward Road. The outlet structure will be positioned at the existing culvert structure that is under Ward Road and will allow the release the pre-developed flows from the drainage basin. The green space along Ward Road will consist of swales running in a curve pattern and dotted with treescape islands and native vegetation in the swales. A small shallow dry detention basin consisting of native grass will be positioned near the outlet structure for better control for the storm events. The green space along Ward Road combined with the shallow detention basin near the existing outlet structure will provide approximately 0.95 acre-feet of storage. Additional storage will be developed within the development by the use of large diameter storm sewer piping and off-line detention. Additional storm water swales will be included in the development design to account for and control the 100-year event. The drainage area is 21.6 acres with a weighed curve number of 84 and a time of concentration of 20 minutes.

Erosion control efforts for the area will include improved vegetative stabilization practices such as temporary seeding using degradable stabilization blankets on slopes,

buffer zones at the top and bottom of slopes to reduced runoff flows, silt fence, straw bales, storm inlet protection, and erosion control mating. In addition, check dams will be used extensively both upstream and downstream of the green area to limit the amount of sediment that could enter the East Green Area.

The pre-developed flow for the East Green Area is 76 cubit feet per second (cfs) and the post-developed flow is 102 cfs. The proposed size of storage required for this is 1.6 acre-feet for the 25-year storm event and for the 100-year storm event the required storage is 2.1 acre-feet.

NORTH DRAINAGE AREA

The North Drainage Area will consist of inlets and storm sewer piping, oversized storm sewer piping for limited detention upstream of the detention basin, existing open channels with riparian vegetation and wetlands, two detention basins (one normal depth and one shallow), and shallow off-line detention combined with the storm sewer system for increased storage upstream of the retention/detention basin. The drainage areas will consist of two drainage basins with two outlet points. The westerly outlet will be the north dry detention basin and the northly outlet will be the upper north dry detention basin. The upper detention basin will incorporate the proposed green space along the north edge of the property and the buffer zone along Hook Road. The outlet structure will be positioned at the existing culvert structure that is under Hook Road and will allow the release the pre-developed flows from the drainage basin. The green space along the north edges will consist of swales running in a curve pattern and dotted with treescape islands and native vegetation in the swales. The north detention basin will consist of the buffer zone along the western edge of the development will have the same type layout of a meandering swale with larger treescape islands to meet the needs of a buffer zone between the residences and street. A larger dry detention basin consisting of native grass will be positioned near the outlet structure for better control for the storm events. The combined detention of the northern and upper north detention basins is 8.2 acre-feet, which is more than adequate for current volumes. If it is determined that additional storage is required. Additional storage will be developed using large diameter piping and off-line detention in the development. Additional storm water swales will be included in the development design to account for and control the 100-year event. The drainage area consists of 68.2 acres for the North Drainage Basin and 11.9 acres for the Upper North Drainage Basin. The weighted curve number is 81 and the time of concentration is 16 minutes.

Erosion control efforts for the area will include improved vegetative stabilization practices such as temporary seeding using degradable stabilization blankets on slopes, buffer zones at the top and bottom of slopes to reduced runoff flows, silt fence, straw bales, storm inlet protection, and erosion control mating. In addition, check dams will be used extensively both upstream and downstream of the green area to limit the amount of sediment that could enter the southeast green area.

The pre-developed flow for the North Drainage Area is 226 cubit feet per second (cfs) and the post-developed flow is 296 cfs. The proposed size of storage required for this is 5.3 acre-feet for the 25-year storm event and for the 100-year event the required storage is 7.1 acre-feet.

CONCLUSION

Table A is a summary of the design storm events, drainage areas, and pre and post development flows and recommended detention. The recommended detention will be completed with a combination of retention/detention lakes, detention basins, and shall deter erosion utilizing gentle slopes, native grasses, and trees to create a storm water scape that will co-exist with the existing surroundings.

Arch Engineers

Storm Water Quantities
Arborwalk Development
TABLE A

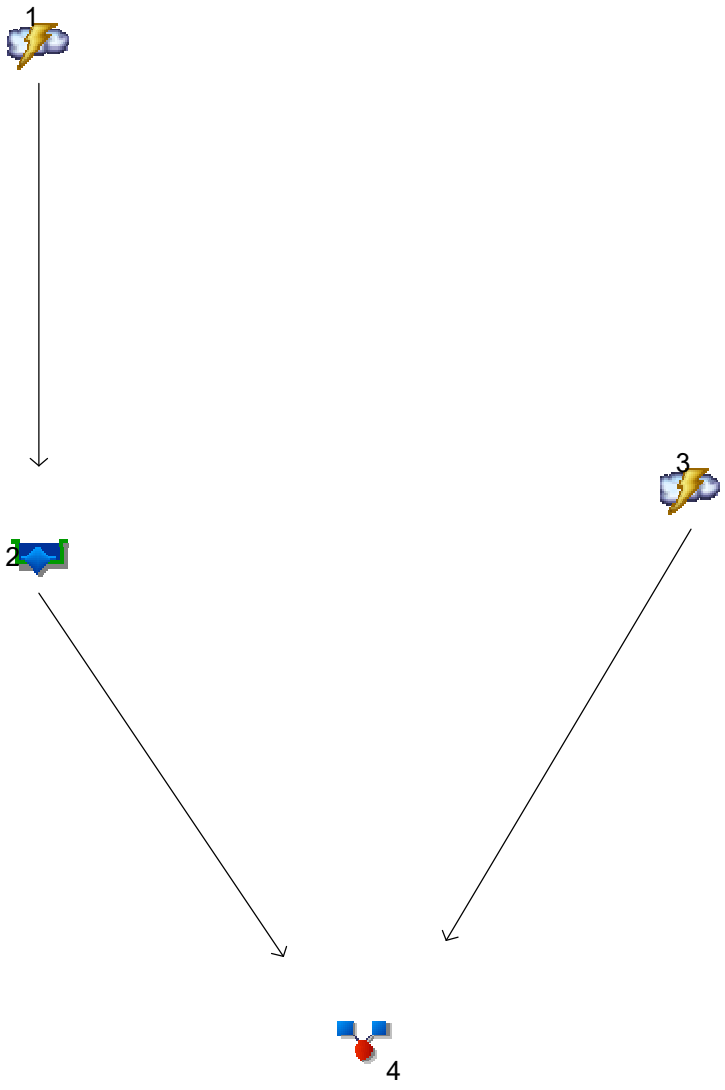
11/19/02

Table 1: 10, 25, 100 Year Storm Water Quantities

Event	Sub Watershed	CN	Area (acre)	Discharge (cfs) Pre	Discharge (cfs) Post	Det. Vol. (acre-ft.)
25-Year	Southwest	88	129	465.0	662.0	11.0
	Southeast	85	103	340.0	431.0	7.0
	Northwest	81	33.1	123.0	170.0	2.3
	North	81	80.2	226.0	296.0	5.3
	East	84	21.6	76.0	102.0	1.6
100-Year	Southwest	88	129	634.0	866.0	13.6
	Southeast	85	103	456.0	571.0	10.9
	Northwest	81	33.1	166.0	230.0	3.1
	North	81	80.2	307.0	400.0	7.1
	East	84	21.6	98.0	146.0	1.7

Appendix B – Hydraflow Hydrograph Output

Watershed Model Schematic



Hydrograph Return Period Recap

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	Rational	------	3.679	6.811	-------	8.152	9.259	10.73	11.83	16.22	Post Developed
2	Reservoir	1	0.007	0.152	-------	0.461	0.767	1.111	1.303	1.935	<no description>
3	Rational	------	0.304	0.458	-------	0.557	0.632	0.742	0.813	1.002	No detention
4	Combine	2, 3	0.310	0.610	-------	1.017	1.399	1.851	2.111	2.927	Total Post

Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2021

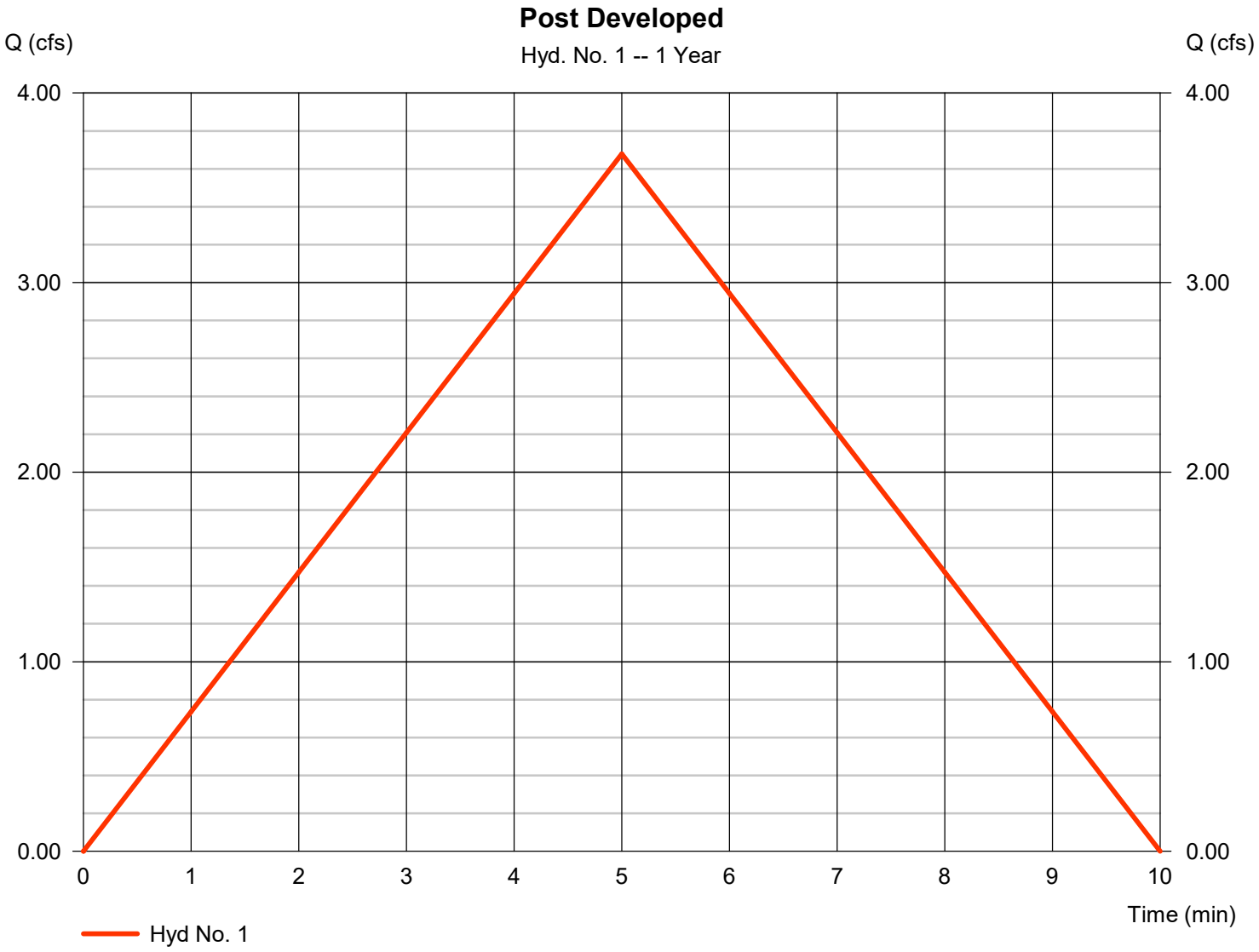
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	Rational	3.679	1	5	1,104	------	------	------	Post Developed
2	Reservoir	0.007	1	10	907	1	996.08	1,101	<no description>
3	Rational	0.304	1	10	182	------	------	------	No detention
4	Combine	0.310	1	10	1,089	2, 3	------	------	Total Post

Hydrograph Report

Hyd. No. 1

Post Developed

Hydrograph type	=	Rational	Peak discharge	=	3.679 cfs
Storm frequency	=	1 yrs	Time to peak	=	5 min
Time interval	=	1 min	Hyd. volume	=	1,104 cuft
Drainage area	=	1.400 ac	Runoff coeff.	=	0.9
Intensity	=	2.920 in/hr	Tc by User	=	5.00 min
IDF Curve	=	KCAPWA 1.37".IDF	Asc/Rec limb fact	=	1/1



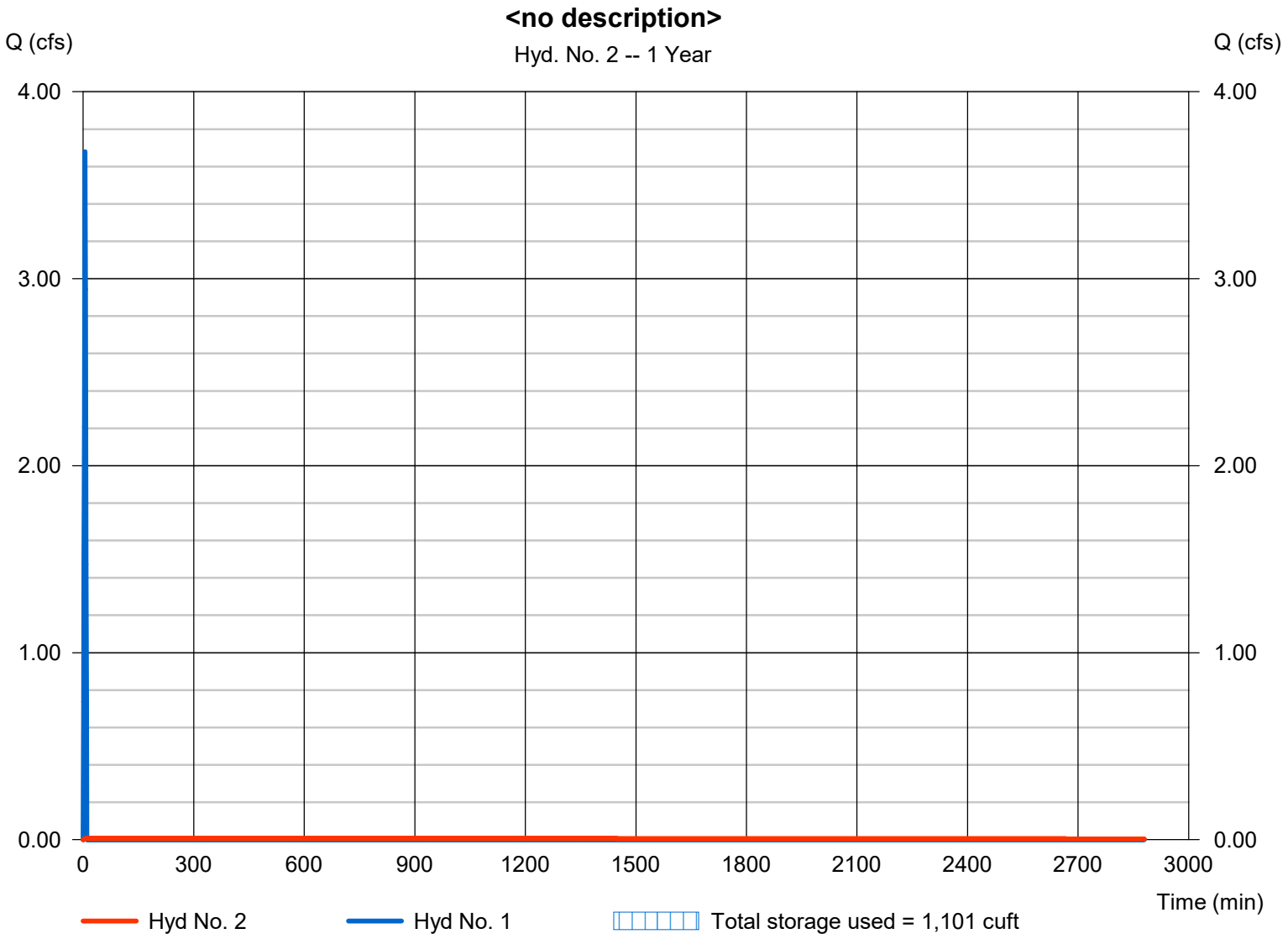
Hydrograph Report

Hyd. No. 2

<no description>

Hydrograph type	=	Reservoir	Peak discharge	=	0.007 cfs
Storm frequency	=	1 yrs	Time to peak	=	10 min
Time interval	=	1 min	Hyd. volume	=	907 cuft
Inflow hyd. No.	=	1 - Post Developed	Max. Elevation	=	996.08 ft
Reservoir name	=	UG pipes	Max. Storage	=	1,101 cuft

Storage Indication method used.



Pond Report

Pond No. 2 - UG pipes

Pond Data

UG Chambers -Invert elev. = 995.00 ft, Rise x Span = 4.00 x 4.00 ft, Barrel Len = 200.00 ft, No. Barrels = 2, Slope = 0.00%, Headers = No

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	995.00	n/a	0	0
0.40	995.40	n/a	262	262
0.80	995.80	n/a	454	716
1.20	996.20	n/a	553	1,269
1.60	996.60	n/a	609	1,878
2.00	997.00	n/a	636	2,514
2.40	997.40	n/a	636	3,151
2.80	997.80	n/a	609	3,759
3.20	998.20	n/a	553	4,312
3.60	998.60	n/a	454	4,766
4.00	999.00	n/a	261	5,028

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 18.00	0.50	8.00	0.00
Span (in)	= 18.00	0.50	6.00	0.00
No. Barrels	= 1	1	1	0
Invert El. (ft)	= 995.00	995.00	996.50	0.00
Length (ft)	= 25.00	0.10	0.10	0.00
Slope (%)	= 0.50	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	Yes	Yes	No

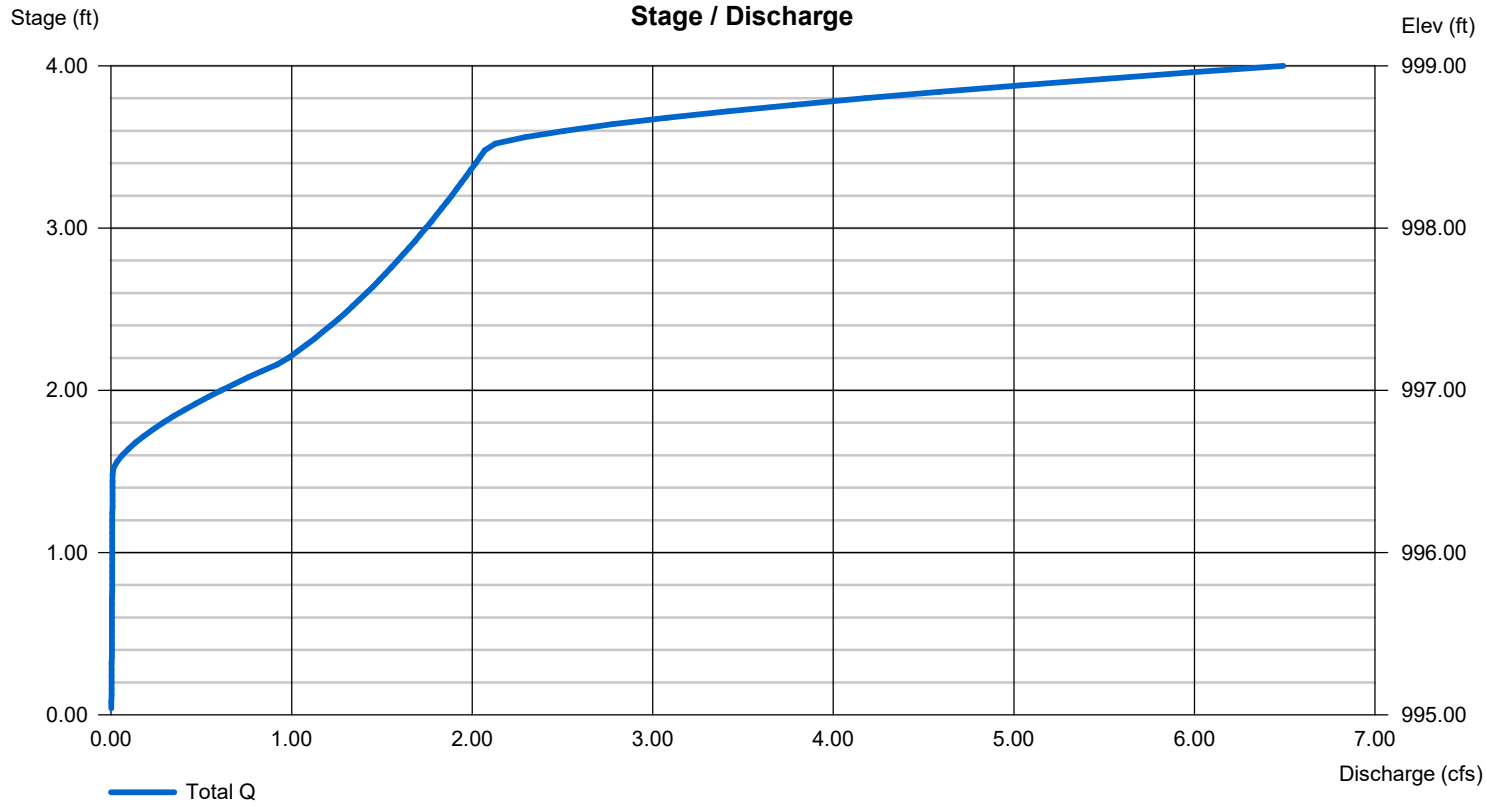
Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 3.50	0.00	0.00	0.00
Crest El. (ft)	= 998.50	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= Rect	---	---	---
Multi-Stage	= Yes	No	No	No

Exfil.(in/hr) = 0.000 (by Wet area)

TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

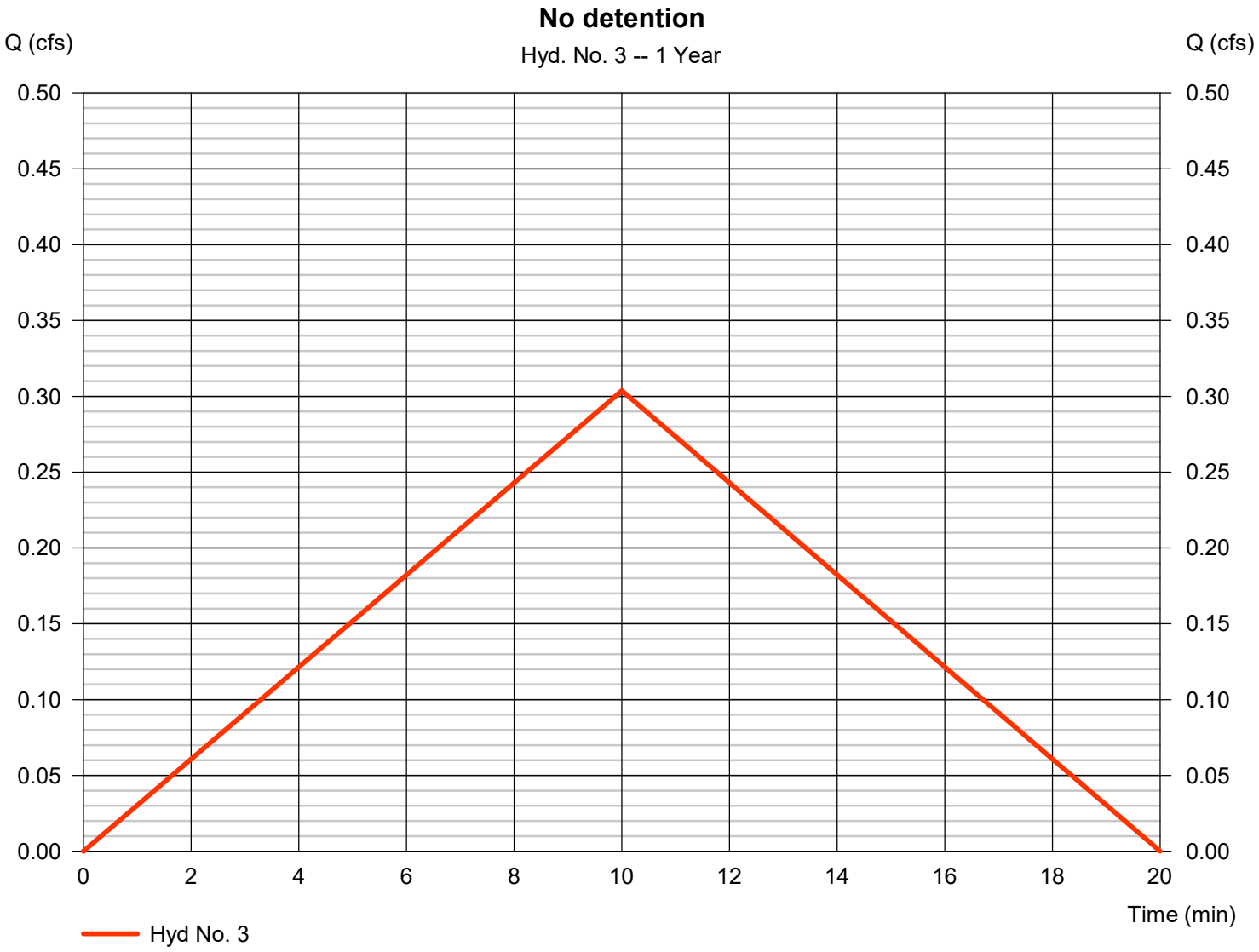


Hydrograph Report

Hyd. No. 3

No detention

Hydrograph type	=	Rational	Peak discharge	=	0.304 cfs
Storm frequency	=	1 yrs	Time to peak	=	10 min
Time interval	=	1 min	Hyd. volume	=	182 cuft
Drainage area	=	0.130 ac	Runoff coeff.	=	0.8
Intensity	=	2.920 in/hr	Tc by User	=	10.00 min
IDF Curve	=	KCAPWA 1.37".IDF	Asc/Rec limb fact	=	1/1

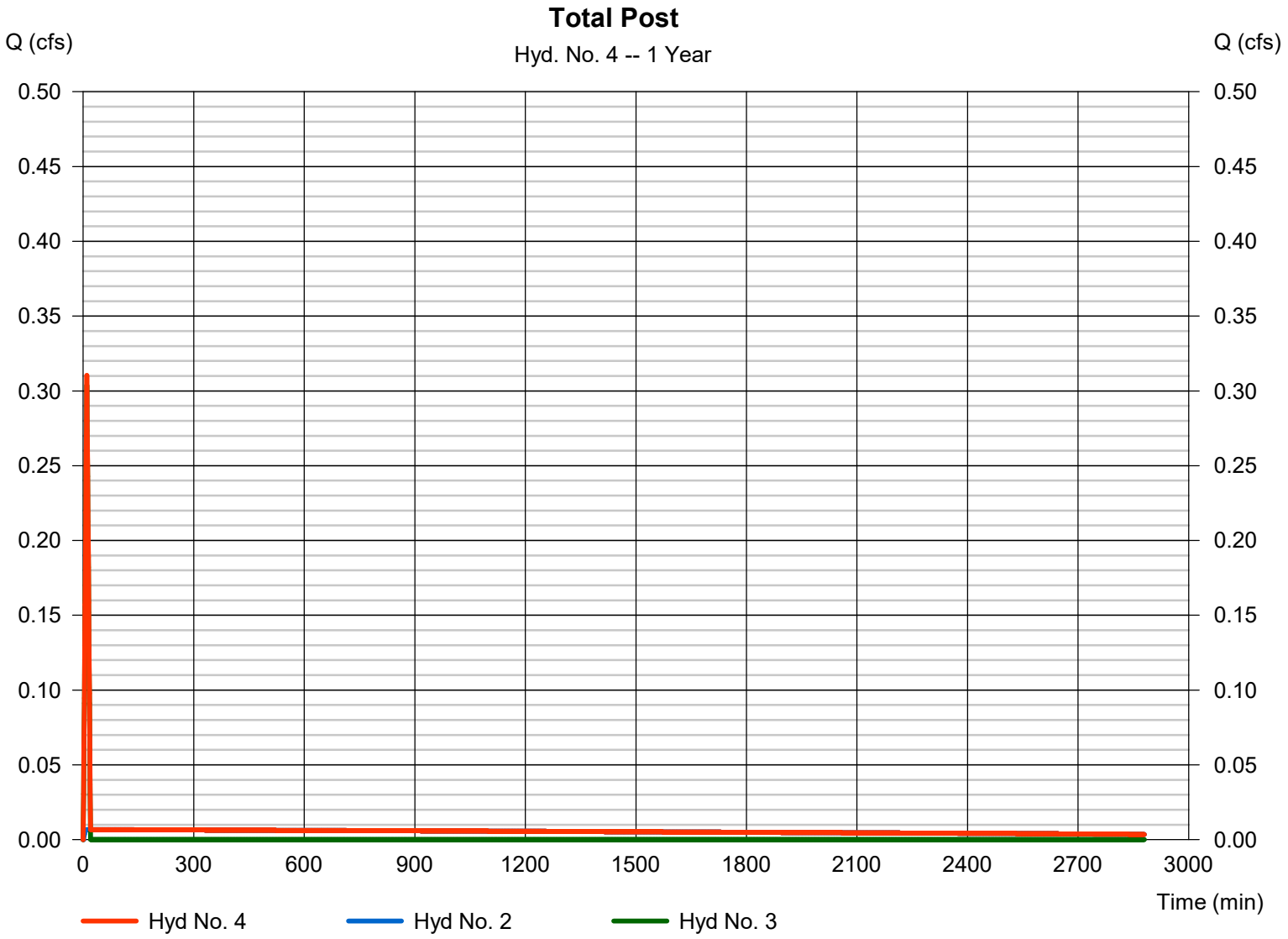


Hydrograph Report

Hyd. No. 4

Total Post

Hydrograph type	= Combine	Peak discharge	= 0.310 cfs
Storm frequency	= 1 yrs	Time to peak	= 10 min
Time interval	= 1 min	Hyd. volume	= 1,089 cuft
Inflow hyds.	= 2, 3	Contrib. drain. area	= 0.130 ac



Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2021

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	Rational	6.811	1	5	2,043	------	------	------	Post Developed
2	Reservoir	0.152	1	10	1,425	1	996.69	2,025	<no description>
3	Rational	0.458	1	10	275	------	------	------	No detention
4	Combine	0.610	1	10	1,699	2, 3	------	------	Total Post

Hydrograph Report

Hyd. No. 1

Post Developed

Hydrograph type	= Rational	Peak discharge	= 6.811 cfs
Storm frequency	= 2 yrs	Time to peak	= 5 min
Time interval	= 1 min	Hyd. volume	= 2,043 cuft
Drainage area	= 1.400 ac	Runoff coeff.	= 0.9
Intensity	= 5.406 in/hr	Tc by User	= 5.00 min
IDF Curve	= KCAPWA 1.37".IDF	Asc/Rec limb fact	= 1/1

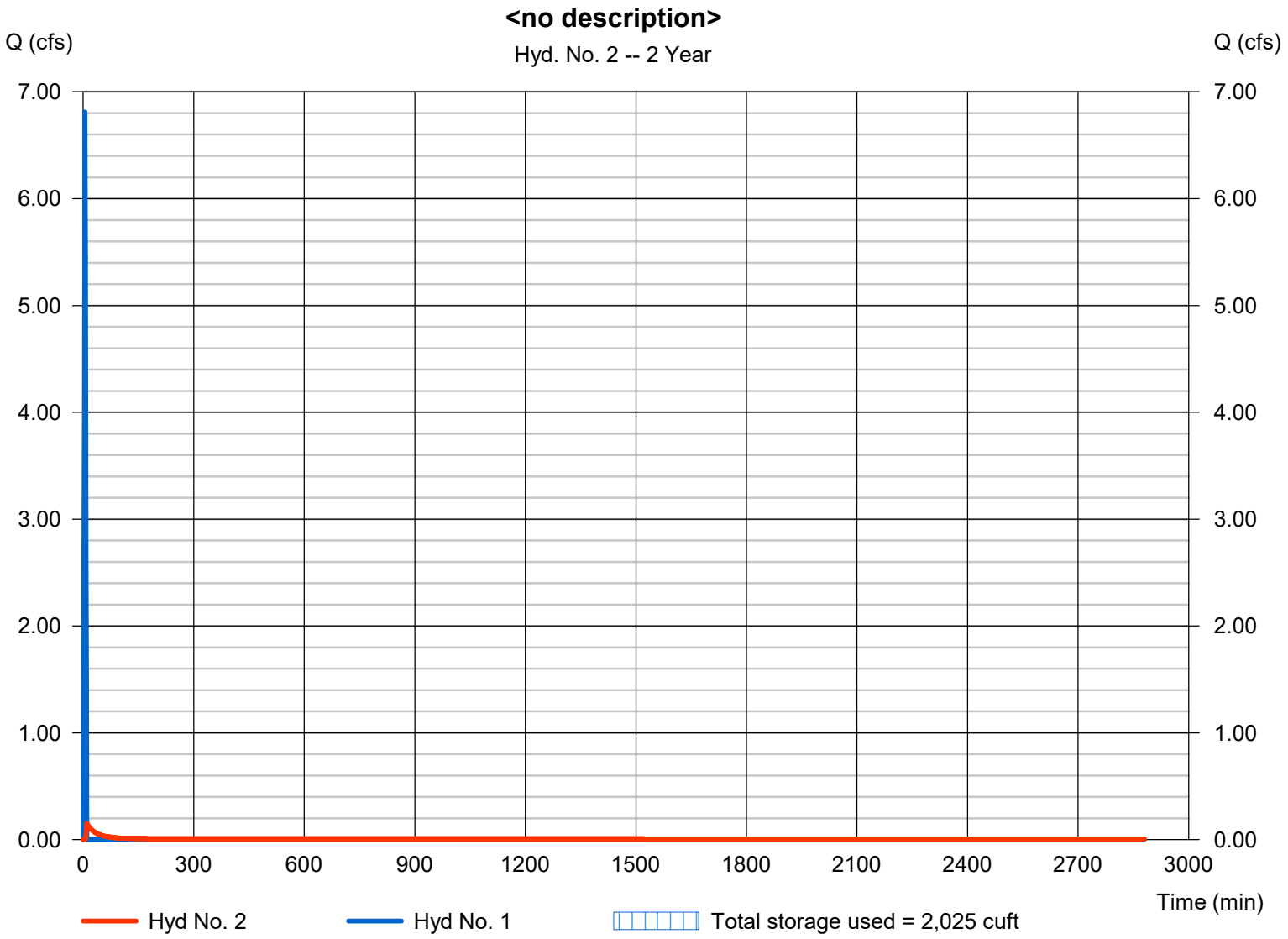
Hydrograph Report

Hyd. No. 2

<no description>

Hydrograph type	=	Reservoir	Peak discharge	=	0.152 cfs
Storm frequency	=	2 yrs	Time to peak	=	10 min
Time interval	=	1 min	Hyd. volume	=	1,425 cuft
Inflow hyd. No.	=	1 - Post Developed	Max. Elevation	=	996.69 ft
Reservoir name	=	UG pipes	Max. Storage	=	2,025 cuft

Storage Indication method used.

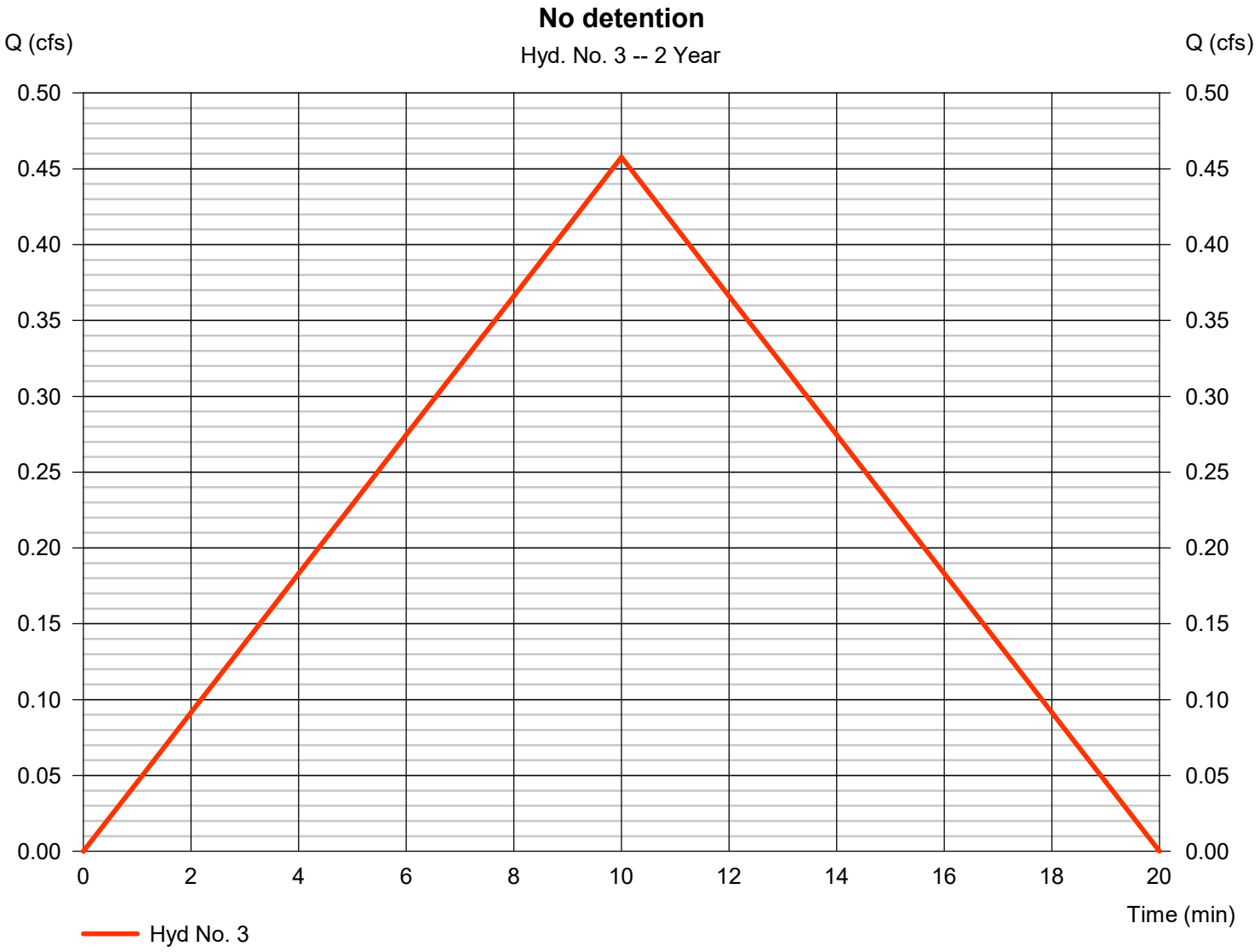


Hydrograph Report

Hyd. No. 3

No detention

Hydrograph type	= Rational	Peak discharge	= 0.458 cfs
Storm frequency	= 2 yrs	Time to peak	= 10 min
Time interval	= 1 min	Hyd. volume	= 275 cuft
Drainage area	= 0.130 ac	Runoff coeff.	= 0.8
Intensity	= 4.400 in/hr	Tc by User	= 10.00 min
IDF Curve	= KCAPWA 1.37".IDF	Asc/Rec limb fact	= 1/1

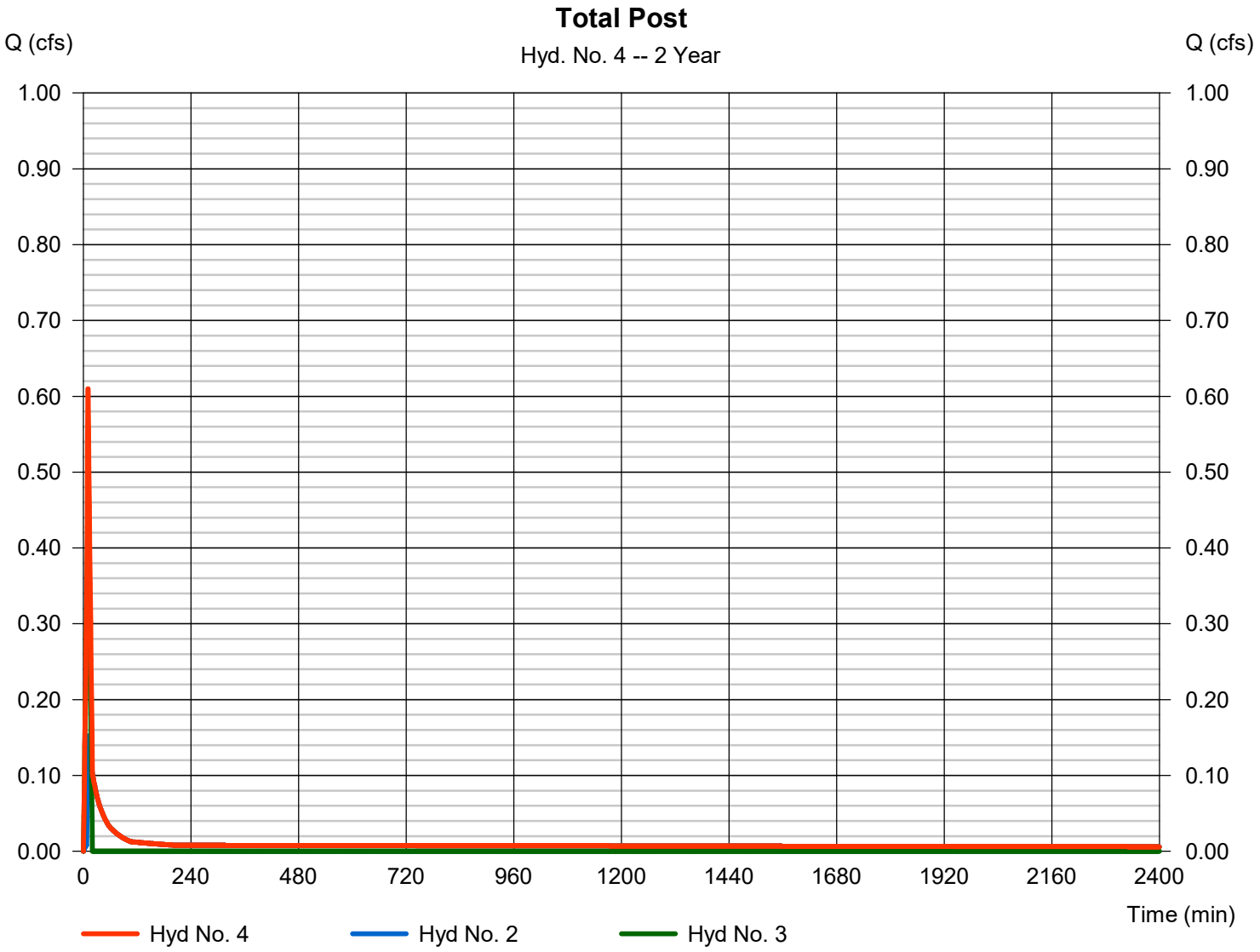


Hydrograph Report

Hyd. No. 4

Total Post

Hydrograph type	= Combine	Peak discharge	= 0.610 cfs
Storm frequency	= 2 yrs	Time to peak	= 10 min
Time interval	= 1 min	Hyd. volume	= 1,699 cuft
Inflow hyds.	= 2, 3	Contrib. drain. area	= 0.130 ac



Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2021

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	Rational	9.259	1	5	2,778	------	------	------	Post Developed
2	Reservoir	0.767	1	10	2,150	1	997.08	2,647	<no description>
3	Rational	0.632	1	10	379	------	------	------	No detention
4	Combine	1.399	1	10	2,529	2, 3	------	------	Total Post

Hydrograph Report

Hyd. No. 1

Post Developed

Hydrograph type	= Rational	Peak discharge	= 9.259 cfs
Storm frequency	= 10 yrs	Time to peak	= 5 min
Time interval	= 1 min	Hyd. volume	= 2,778 cuft
Drainage area	= 1.400 ac	Runoff coeff.	= 0.9
Intensity	= 7.348 in/hr	Tc by User	= 5.00 min
IDF Curve	= KCAPWA 1.37".IDF	Asc/Rec limb fact	= 1/1

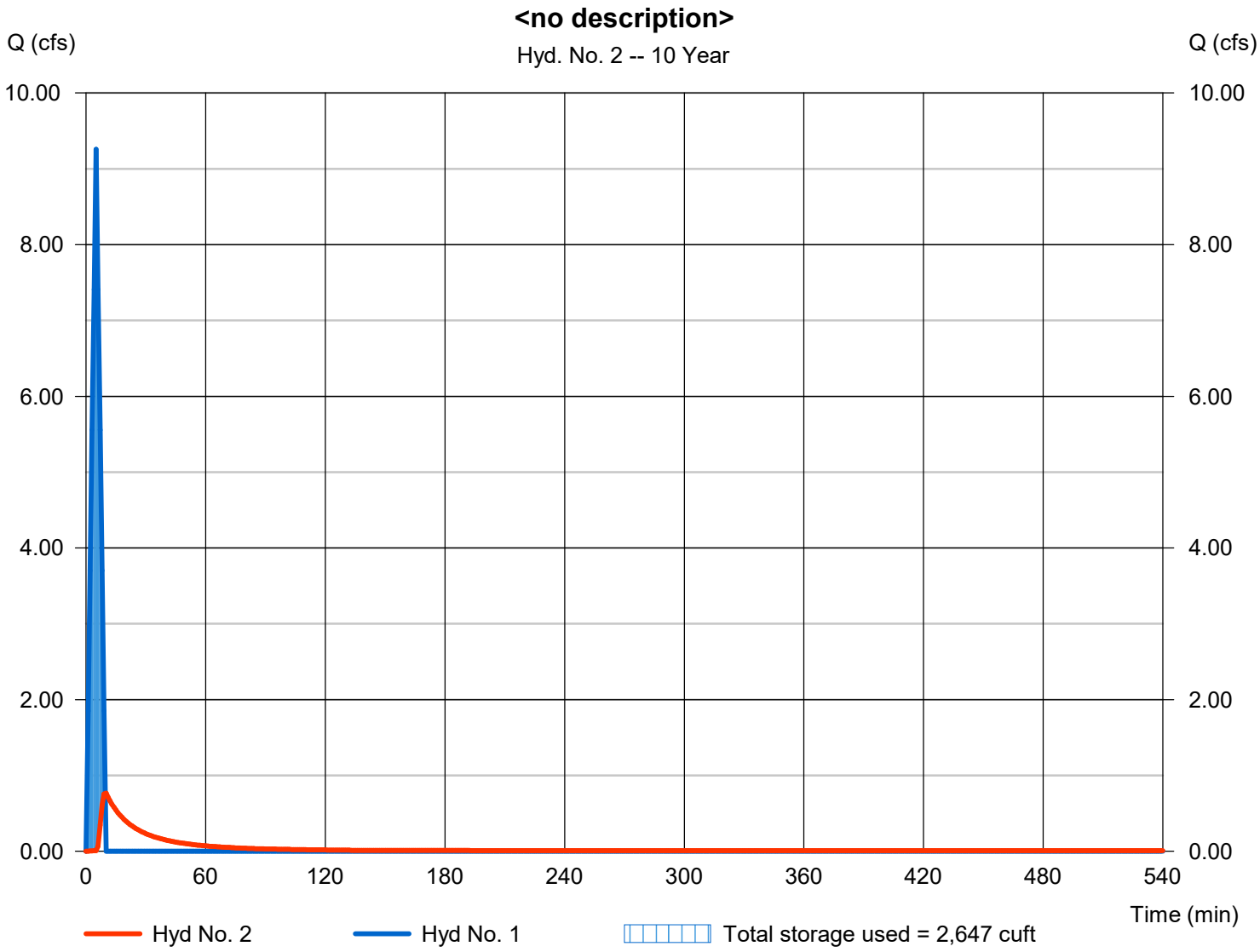
Hydrograph Report

Hyd. No. 2

<no description>

Hydrograph type	=	Reservoir	Peak discharge	=	0.767 cfs
Storm frequency	=	10 yrs	Time to peak	=	10 min
Time interval	=	1 min	Hyd. volume	=	2,150 cuft
Inflow hyd. No.	=	1 - Post Developed	Max. Elevation	=	997.08 ft
Reservoir name	=	UG pipes	Max. Storage	=	2,647 cuft

Storage Indication method used.

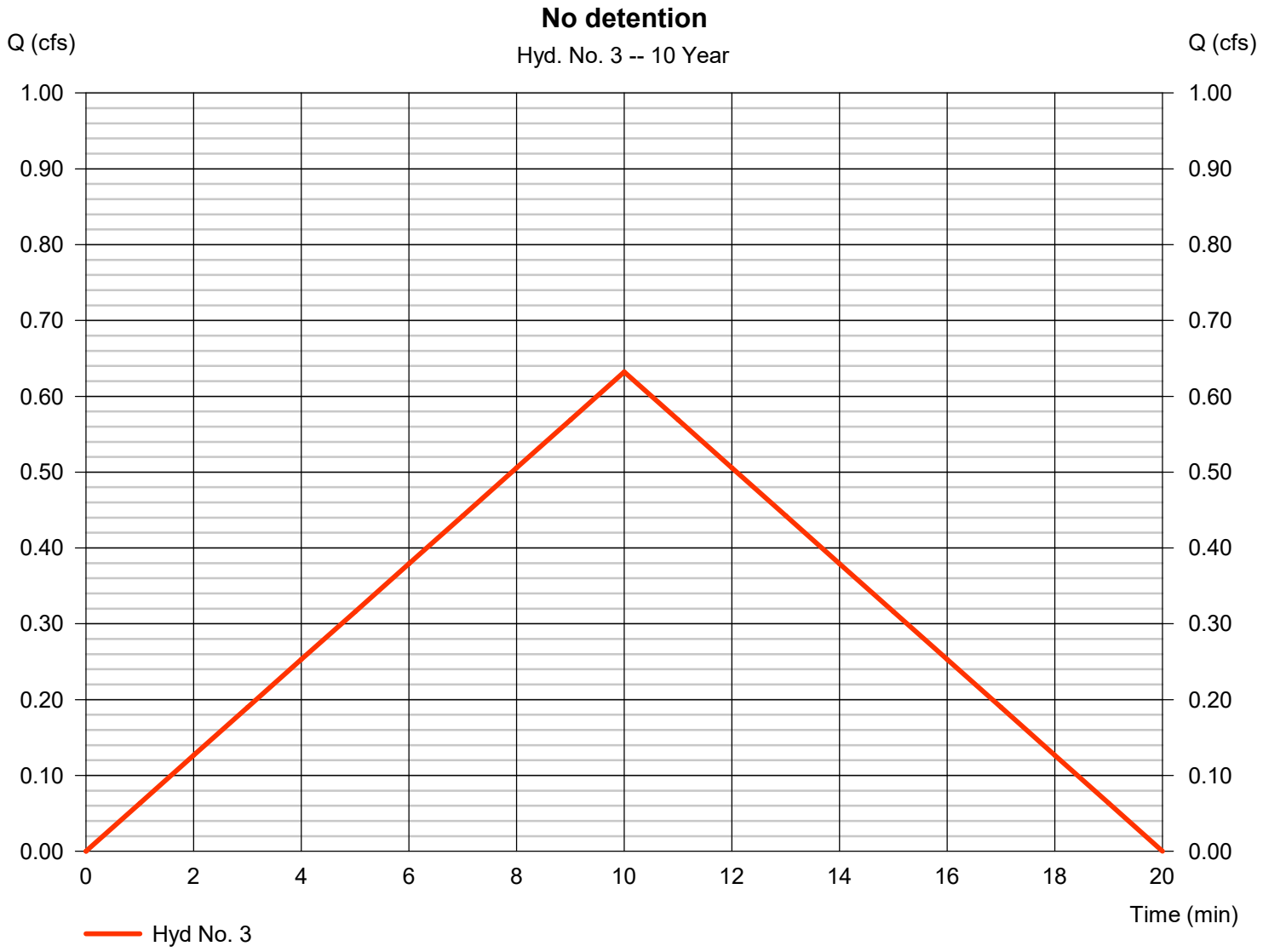


Hydrograph Report

Hyd. No. 3

No detention

Hydrograph type	=	Rational	Peak discharge	=	0.632 cfs
Storm frequency	=	10 yrs	Time to peak	=	10 min
Time interval	=	1 min	Hyd. volume	=	379 cuft
Drainage area	=	0.130 ac	Runoff coeff.	=	0.8
Intensity	=	6.079 in/hr	Tc by User	=	10.00 min
IDF Curve	=	KCAPWA 1.37".IDF	Asc/Rec limb fact	=	1/1

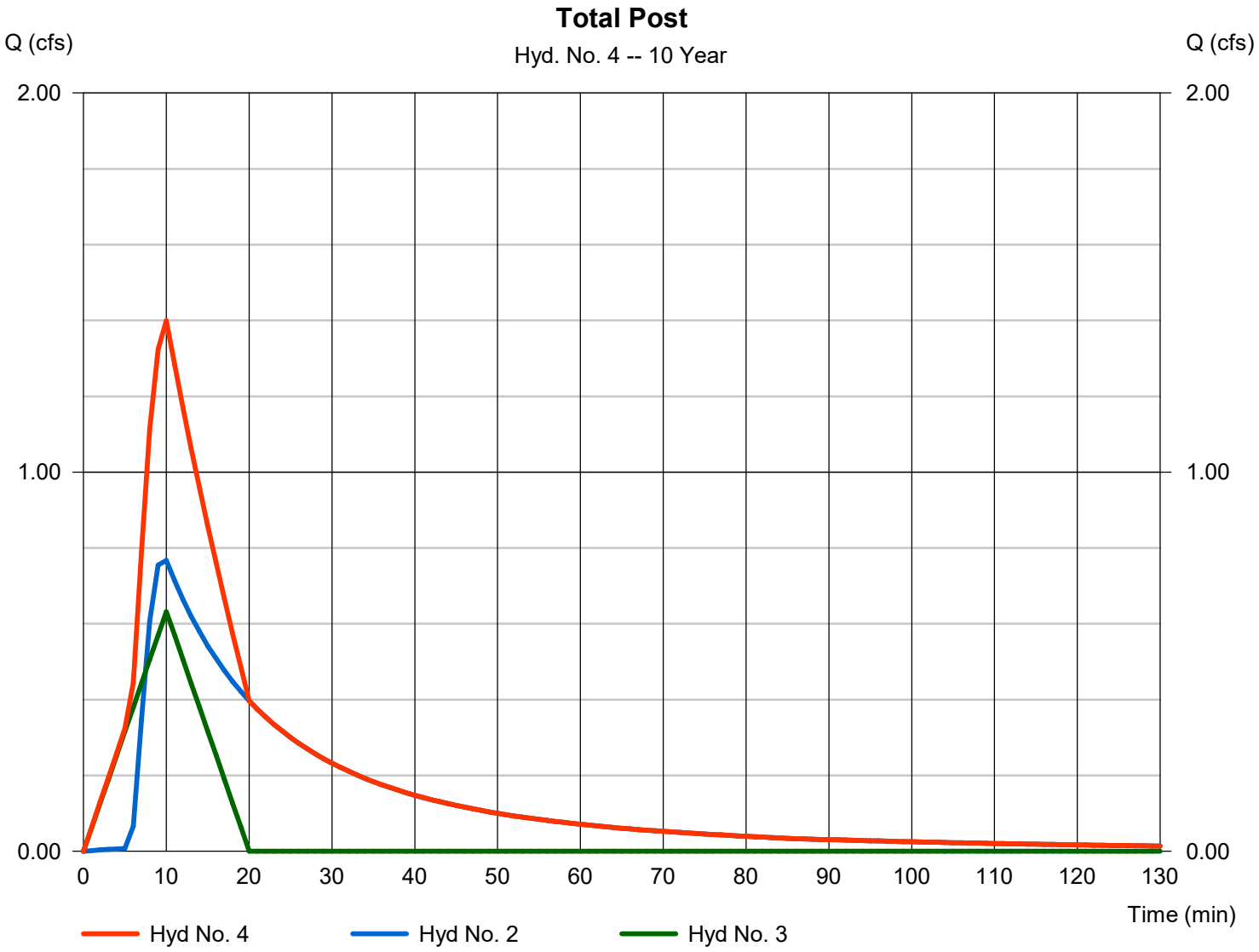


Hydrograph Report

Hyd. No. 4

Total Post

Hydrograph type	= Combine	Peak discharge	= 1.399 cfs
Storm frequency	= 10 yrs	Time to peak	= 10 min
Time interval	= 1 min	Hyd. volume	= 2,529 cuft
Inflow hyds.	= 2, 3	Contrib. drain. area	= 0.130 ac



Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2021

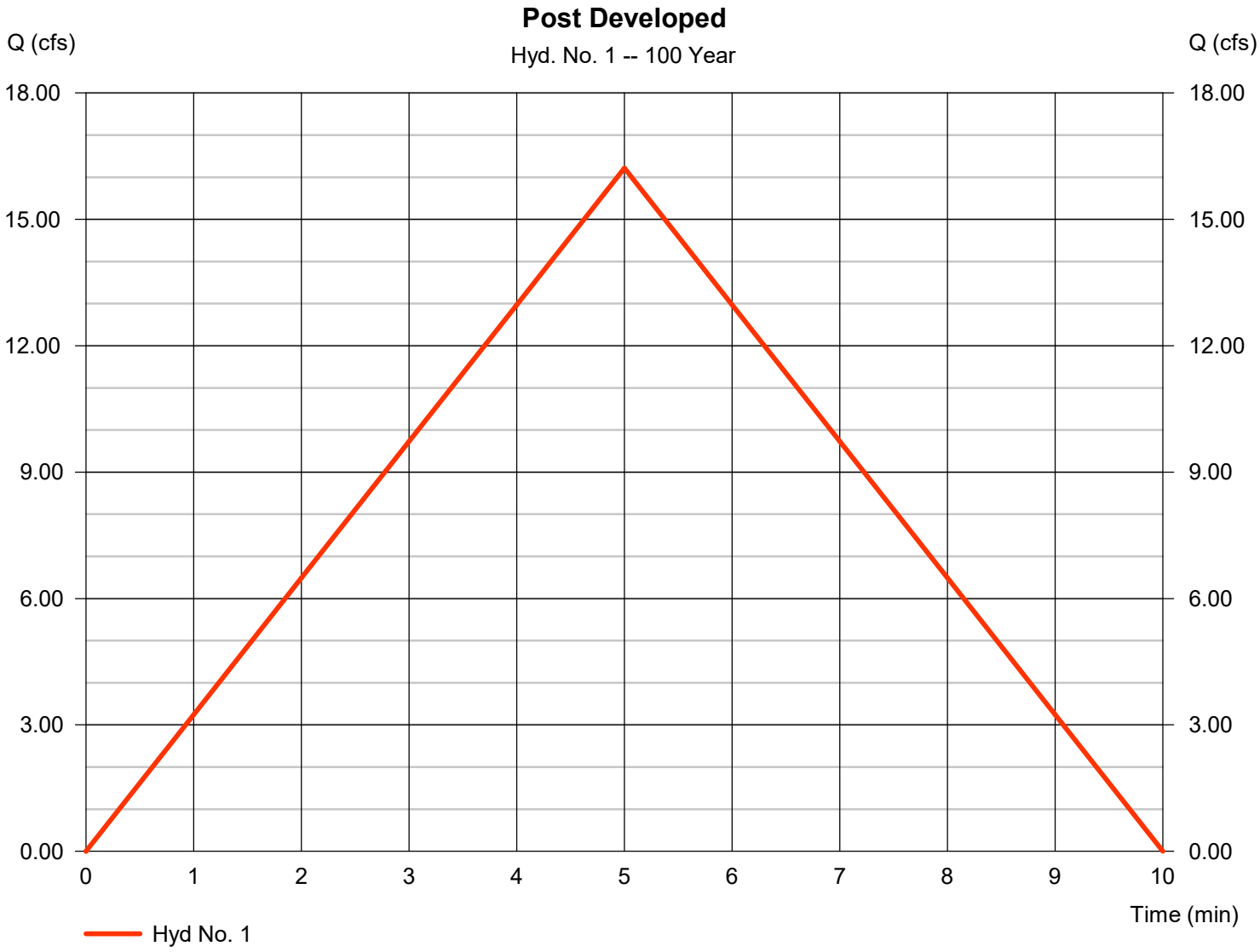
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	Rational	16.22	1	5	4,865	------	------	------	Post Developed
2	Reservoir	1.935	1	9	4,230	1	998.27	4,394	<no description>
3	Rational	1.002	1	10	601	------	------	------	No detention
4	Combine	2.927	1	10	4,831	2, 3	------	------	Total Post

Hydrograph Report

Hyd. No. 1

Post Developed

Hydrograph type	=	Rational	Peak discharge	=	16.22 cfs
Storm frequency	=	100 yrs	Time to peak	=	5 min
Time interval	=	1 min	Hyd. volume	=	4,865 cuft
Drainage area	=	1.400 ac	Runoff coeff.	=	0.9
Intensity	=	12.871 in/hr	Tc by User	=	5.00 min
IDF Curve	=	KCAPWA 1.37".IDF	Asc/Rec limb fact	=	1/1



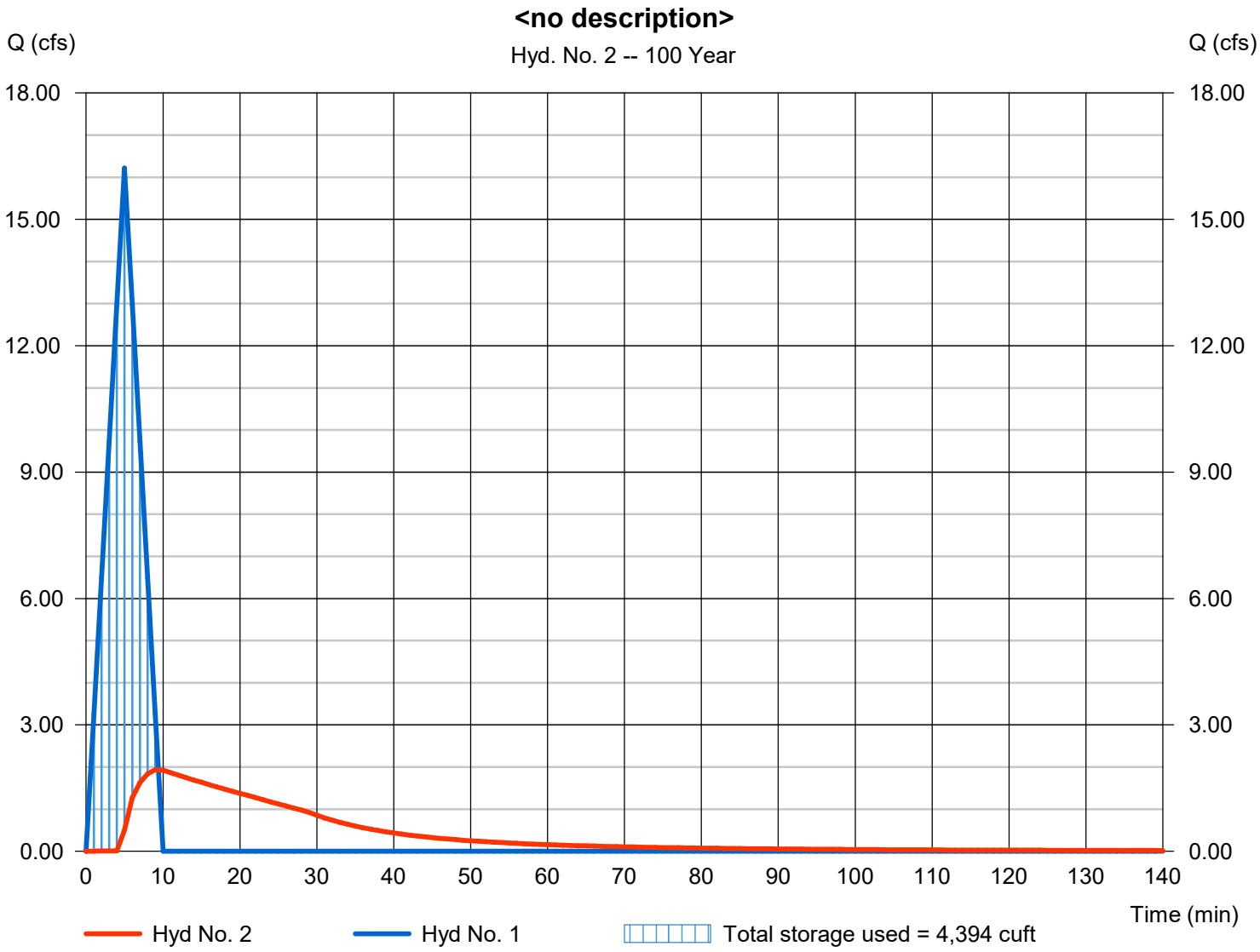
Hydrograph Report

Hyd. No. 2

<no description>

Hydrograph type	=	Reservoir	Peak discharge	=	1.935 cfs
Storm frequency	=	100 yrs	Time to peak	=	9 min
Time interval	=	1 min	Hyd. volume	=	4,230 cuft
Inflow hyd. No.	=	1 - Post Developed	Max. Elevation	=	998.27 ft
Reservoir name	=	UG pipes	Max. Storage	=	4,394 cuft

Storage Indication method used.

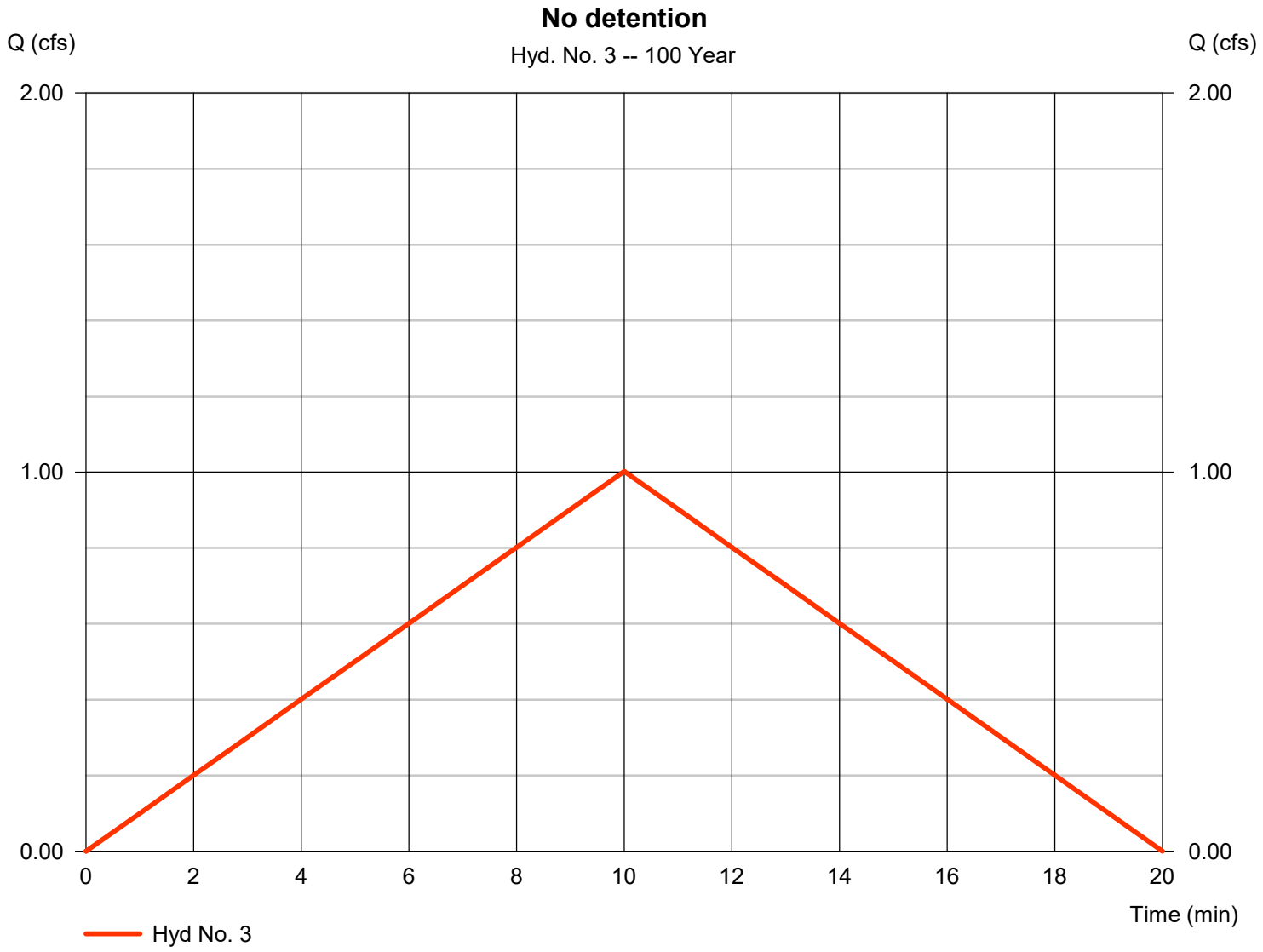


Hydrograph Report

Hyd. No. 3

No detention

Hydrograph type	=	Rational	Peak discharge	=	1.002 cfs
Storm frequency	=	100 yrs	Time to peak	=	10 min
Time interval	=	1 min	Hyd. volume	=	601 cuft
Drainage area	=	0.130 ac	Runoff coeff.	=	0.8
Intensity	=	9.636 in/hr	Tc by User	=	10.00 min
IDF Curve	=	KCAPWA 1.37".IDF	Asc/Rec limb fact	=	1/1

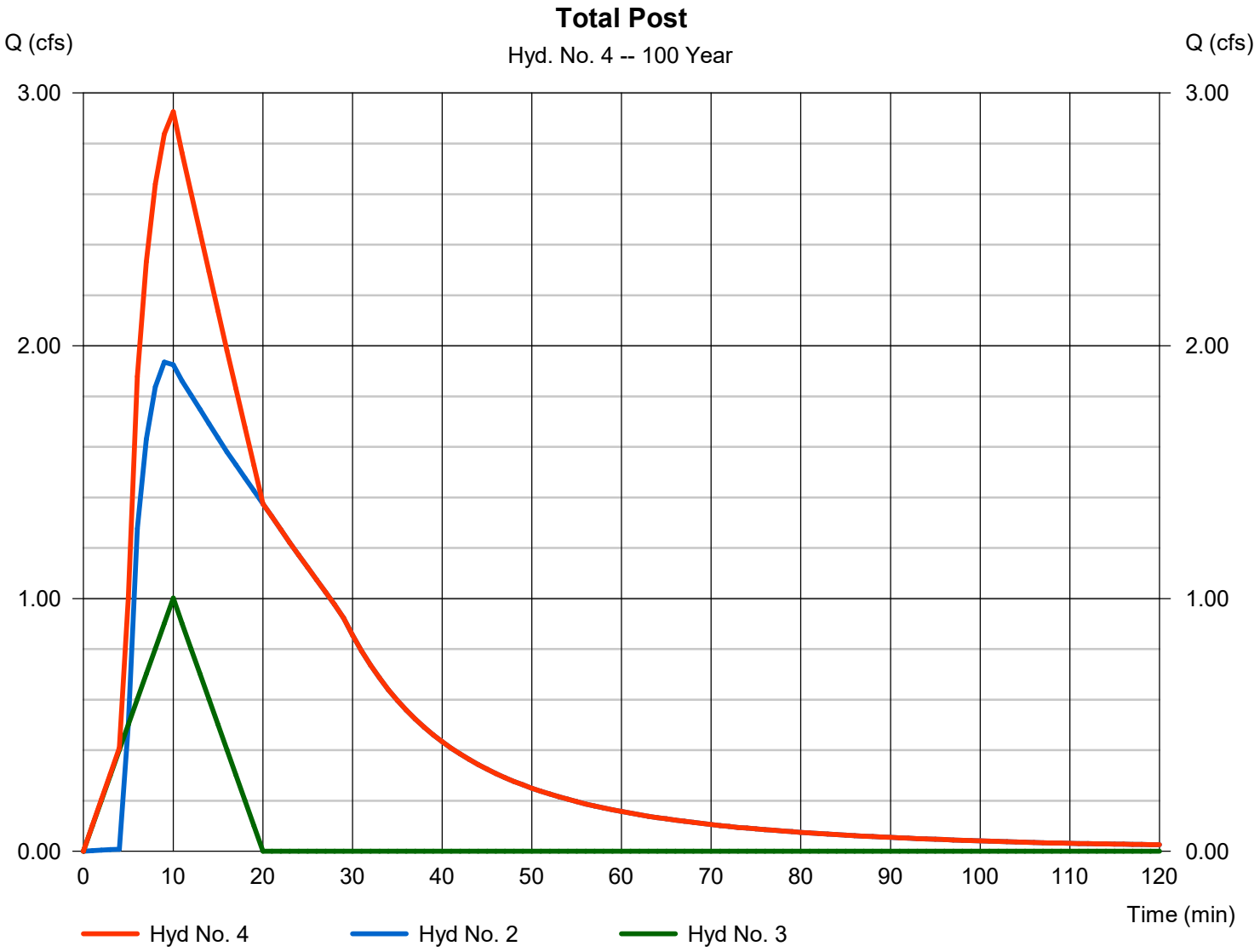


Hydrograph Report

Hyd. No. 4

Total Post

Hydrograph type	= Combine	Peak discharge	= 2.927 cfs
Storm frequency	= 100 yrs	Time to peak	= 10 min
Time interval	= 1 min	Hyd. volume	= 4,831 cuft
Inflow hyds.	= 2, 3	Contrib. drain. area	= 0.130 ac



Hydraflow Rainfall Report

Return Period (Yrs)	Intensity-Duration-Frequency Equation Coefficients (FHA)			
	B	D	E	(N/A)
1	2.9200	0.1000	0.0000	--------
2	110.7137	16.5000	0.9842	--------
3	0.0000	0.0000	0.0000	--------
5	168.3971	19.5000	1.0189	--------
10	183.3473	19.2000	1.0096	--------
25	103.5313	15.9000	0.8218	--------
50	235.4014	19.9000	1.0020	--------
100	83.7894	6.1000	0.7783	--------

File name: KCAPWA 1.37".IDF

Intensity = B / (Tc + D)^E

Return Period (Yrs)	Intensity Values (in/hr)											
	5 min	10	15	20	25	30	35	40	45	50	55	60
1	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92
2	5.41	4.40	3.71	3.21	2.83	2.53	2.29	2.09	1.92	1.78	1.66	1.55
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	6.47	5.35	4.56	3.98	3.52	3.16	2.86	2.62	2.41	2.24	2.08	1.95
10	7.35	6.08	5.18	4.52	4.00	3.59	3.26	2.98	2.74	2.54	2.37	2.22
25	8.51	7.14	6.17	5.46	4.90	4.46	4.10	3.79	3.54	3.31	3.12	2.95
50	9.39	7.82	6.70	5.86	5.20	4.68	4.25	3.90	3.60	3.34	3.12	2.92
100	12.87	9.64	7.81	6.62	5.77	5.14	4.65	4.25	3.92	3.65	3.41	3.21

Tc = time in minutes. Values may exceed 60.

Precip. file name: P:\Civil Details\Davidson AE\Hydraflow Storm Sewer\SCS 24-hr Rainfall.pcp

Storm Distribution	Rainfall Precipitation Table (in)							
	1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr
SCS 24-hour	2.85	3.50	0.00	4.50	5.30	6.10	6.90	7.50
SCS 6-Hr	0.00	1.80	0.00	0.00	2.60	2.90	0.00	4.00
Huff-1st	0.00	1.55	0.00	2.75	4.00	5.38	6.50	8.00
Huff-2nd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-3rd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-4th	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-Indy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Custom	0.00	1.75	0.00	2.80	3.90	5.25	6.00	7.10

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