150 & Ward Multi-Family

Storm Drainage Study

Lee's Summit, Missouri. Jackson County

3rd Submittal: March 11th, 2025

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Kimley»Horn

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GENERAL INFORMATION

Kimley-Horn and Associates, Inc. (Kimley-Horn) has been retained by Milhaus Development, LLC to provide professional civil engineering services for the proposed 150 & Ward Multi-Family Development located at the northeast corner of MO-150 Highway and SW Ward Rd in Lee's Summit Missouri (Refer to **Exhibit 1)** and is generally situated within Section 25, Township 47N, Range 32W in Jackson County, Missouri (Refer to **Exhibit 2**).

According to the Arborwalk Development Drainage Master Plan (Refer to **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 6 garden style, one elevator style apartment buildings; a club house, as well as, associated new surface parking, garage parking, sidewalk plazas, site access drives, utility services, and streetscape improvements to serve the site. As referenced by the 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 meet water quality requirements.

FEMA & EXISTING WATERWAYS

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" (Refer to **Exhibit 3**).

Based on USGS mapping, there is a designated blue line stream that traverses through the middle of the site (Refer to **Exhibit 2**). The development team has worked with the Corps of Engineers to prepare a jurisdictional assessment and the proper permitting documentation to relocate the surface water into an underground storm pipe sized for the 100-year storm event by others. The proposed plans are located in **Appendix B**. Based on historic imagery of the streambed dated back to 1952 the stream has not been allowed to exist in a natural state. In stream alterations and vegetation control have been performed periodically since 1952, based on first available aerial photography. The stream has recently (circa 2003) had modifications to add detention within the existing channel. At that time the channel was straightened and was modified to include rip-rap check dams. These improvements to the channel do not mimic a natural condition and thus preservation per the Stream Buffer requirements would not meet the intent of the buffer requirements. It is our opinion the stream functions more as an engineered drainage channel, conveying stormwater to the temporary sediment basin at the NW corner of 150 & Ward, and is not a natural stream, and therefore the stream buffer would not apply to this stream. It was constructed, along

with the upstream dry and wet detention basins, to temporarily act as an erosion control measure until the designated commercial area was ultimately improved. Refer to **Appendix C** for additional information on the onsite stream.

SOILS

Table 1 below shows the typical soil classifications found on site. For more information, refer to 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. 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 (Refer to **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. Runoff from the upstream detention basins flows through a stream, discharging at the sedimentation basin. Stormwater ultimately drains toward a box culvert located in the southeast corner of the commercial area, carrying the runoff underneath the intersection and 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 (Refer to **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 (Critical Point #1)				
	2-Year	**10-Year**	**50-Year**	**100-Year**
Rainfall Intensity (in/hr)	3.72	5.18	6.70	7.35
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) for the existing and proposed conditions (Refer to **Exhibit 7**). The four drainage areas are described below:

LOT "A" Drainage Area

Drainage area "A" generally drains 11.46 acres of sheet flow and shallow concentrated flow inwards towards an unregulated drainage swale, 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 drainage swale 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 composite 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)	4.10	5.68	7.33	8.05
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 composite 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)	3.84	5.34	6.89	7.57
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. The drainage study can be found in **Appendix D**.

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 composite 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)	3.96	5.50	7.10	7.80
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 6 new garden style walk-up apartment buildings, an elevator apartment building, a club house, 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. Additionally, improvements to Lot “B” include the design and construction of public storm sewer intended to enclose an existing stream. The proposed public storm sewer will continue serving Lots “A” and “B”, as well as, upstream developments, during the 100-year storm event. Refer to **Appendix B** for the public storm sewer plans prepared by others. 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 D**), and 1.80 acres of commercial development yielding a CN of 94 (Refer to **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. The values shown in **Table 6** represent a calculation of outflow based on an estimated 2.2 acre-feet of additional storage provided for in the upstream detention/retention basins discussed in the Detention section of this report (see page 10 for further discussion).

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

*Rainfall intensities are from modified rational critical duration event

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 (Refer to **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 6.59 acres of impervious area and 4.87 acres of pervious area, resulting in a runoff coefficient of 0.65. The cumulative CN is 86 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

*Rainfall intensities are from Rational Method Critical Duration Event

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

*Rainfall intensities are from modified rational critical duration event

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 drainage study can be found in **Appendix D**.

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

*Rainfall intensities are from modified rational critical duration event

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

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.

CULVERT & DOWNSTREAM ANALYSIS

Downstream of the site are a series of box culverts that were analyzed as part of this study, 2 beneath 150 Hwy and 1 further downstream under Ward (See **Exhibit 9)**. A visual inspection of the box culverts was also performed in January 2025. The culverts were analyzed for capacity for the 2, 10 and 100 year events, assuming developed conditions. The results of the analysis are shown below in **Table A1**.

TABLE A1: Culvert Analysis

	2 Year (CFS) Actual(CFS)/capacity*	10 Year (CFS) Actual(CFS)/capacity*	100 Year (CFS) Actual(CFS)/capacity*
6x6 Box (Under 150)	45 / 280	108 / 280	267 / 280
Double 12x6 (Under 150 & Ward)	212 / 1715	508 / 1715	1255 / 1715
Double 12x6 (Under Ward)	247 / 1640	591 / 1640	1462 / 1640

*Capacity based on Hw/D without roadway overtopping

For the purposes of the culvert analysis the backup data is shown on **Exhibit 9**. The culverts function adequately for all storm events considered. From the visual inspection of the culverts they appear to have no obvious defects that would require any immediate repair.

In addition to the box culverts there is a small concrete dam just upstream of Raintree Lake that was also analyzed as part of this study. No plans were available for the structure, therefore the analysis was limited to a visual inspection. From historic aerial imagery, it appears the dam was either installed in or upgraded circa 2003. The dam appears to function with low and high flow outlets. The low flow pipes are a series of PVC pipes penetrating through the lower section of the dam. The top of the dam functions as the high flow overflow. The dam structure is not showing any visible signs that it is not structurally sound. Cracks are present in the concrete surface, however the cracks are minor and appear superficial and not related to stress on the structure itself. The earthen banks around the structure do show some signs of erosion, but have a healthy stand of vegetation which is providing adequate stabilization of the banks.

PRE- VS. POST-DEVELOPMENT ANALYSIS

For the purposes of comparing pre- and post-development conditions and the impact of the development on the existing stormwater infrastructure, a critical point has been set at the outlet of the most downstream culvert (Double 12x6 under Ward Rd, Refer to **Table A1**). The drainage area to this point is approximately 566 acres with a pre-development (existing) Curve Number of CN = 72 and a post-development (proposed) Curve Number of CN = 74. This analysis assumes the proposed site has a curve number of 86, but with a weighted average of the entire drainage area being the aforementioned 74.

Analysis for Critical Point 1:

The Pre-Development and Post-Development flows were determined using WINTR-55 to determine the 2-year, 10-year, and 100-year peak flows at Critical Point 1. The peak flows for Critical Point 1 are shown in Table A2:

TABLE A2: Critical Point 1 - Peak Flow Comparison

	2-Year	10-Year	100-Year
Pre-Development Peak Flow (CFS)*	208	532	1376
Post-Development Peak Flow (CFS)*	247	591	1462

*This assumes drainage conditions as of the date of this report. As noted in this report the upstream ex. basins have previously accounted for this increase.

While the proposed development increases the Curve Number, and therefore, the overall flow generated from the drainage area contributing to Critical Point 1, the existing stormwater infrastructure has adequate capacity to convey the stormwater to Raintree Lake without flooding adjacent residential properties or overtopping existing roadway infrastructure. Refer to Table 1A and Exhibits 10 and 11 for more detail on the existing stormwater infrastructure.

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 10 acres of runoff through two hydrodynamic separators (Refer to **Appendix E** for the product specification sheet). 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 150 & Ward 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 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.

An analysis of the existing stream located within the residential & commercial lots suggests to Kimley-Horn that the channel was intended to be an engineered channel, not a natural stream, and was intended to temporarily serve the upstream drainage areas until further development was approved. Thus, a stream buffer should not apply to this stream, and it is proposed that the existing channel be enclosed in public storm sewer that would continue to serve the adjacent and upstream developments.

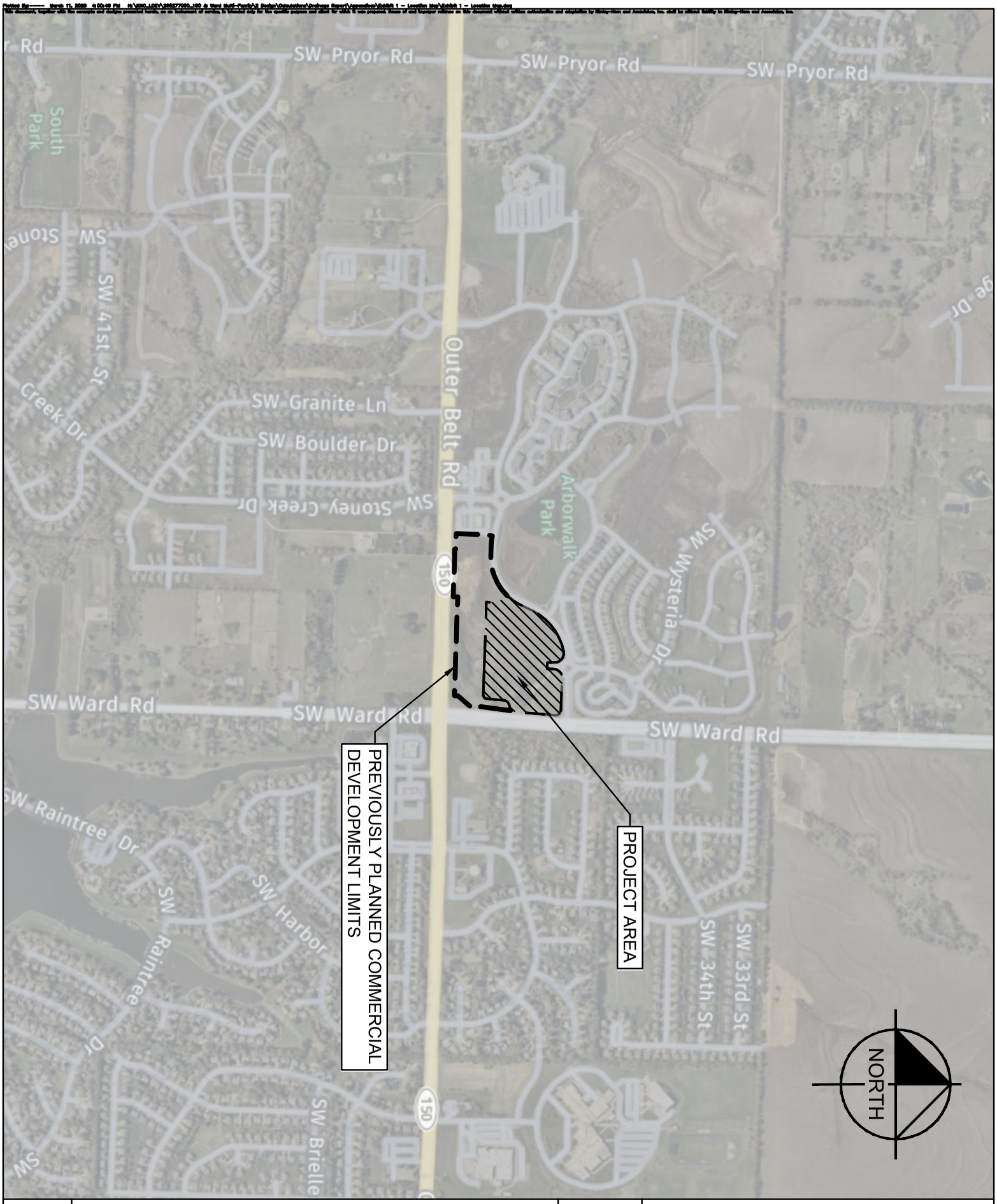
Each development within the previously designated commercial area will be required to propose stormwater treatment measures that sufficiently treat the 90% mean annual event. The proposed improvements for the 150 & Ward Multi-Family Development include two hydrodynamic separators designed to remove total 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.

The existing downstream infrastructure that includes the box culverts under 150 & Ward as well as the existing dam that convey stormwater runoff from the site to Raintree Lake have been inspected via 2 separate site visits. As previously discussed in the Culvert & Downstream Analysis section of this report, the existing culvert system downstream of the site have been analyzed in a proposed flow vs. capacity form and were determined to be adequate to convey the post-development flow to Raintree Lake without roadway overtopping (Refer to **Table A1**). Additionally, as previously discussed in the Pre- Vs. Post-Development Analysis section of this report, the existing concrete dam just upstream of Raintree Lake has been analyzed to determine the headwater elevation due to the proposed 100-yr flow. The results of this analysis showed that while the headwater elevation will rise minimally, it will not cause water to encroach on adjacent residential properties prior to discharging into Raintree Lake (Refer to **Table A2 and Exhibits 10 and 11**).

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.

The 150 & Ward Multi-Family Development meets the requirements of APWA section 5600, and the MARC BMP Manual as implemented by the City of Lee's Summit. The development and the overall drainage patterns of the entire site will remain largely unchanged; it is recommended that the site be developed as outlined in this report.

Exhibits & Calculations

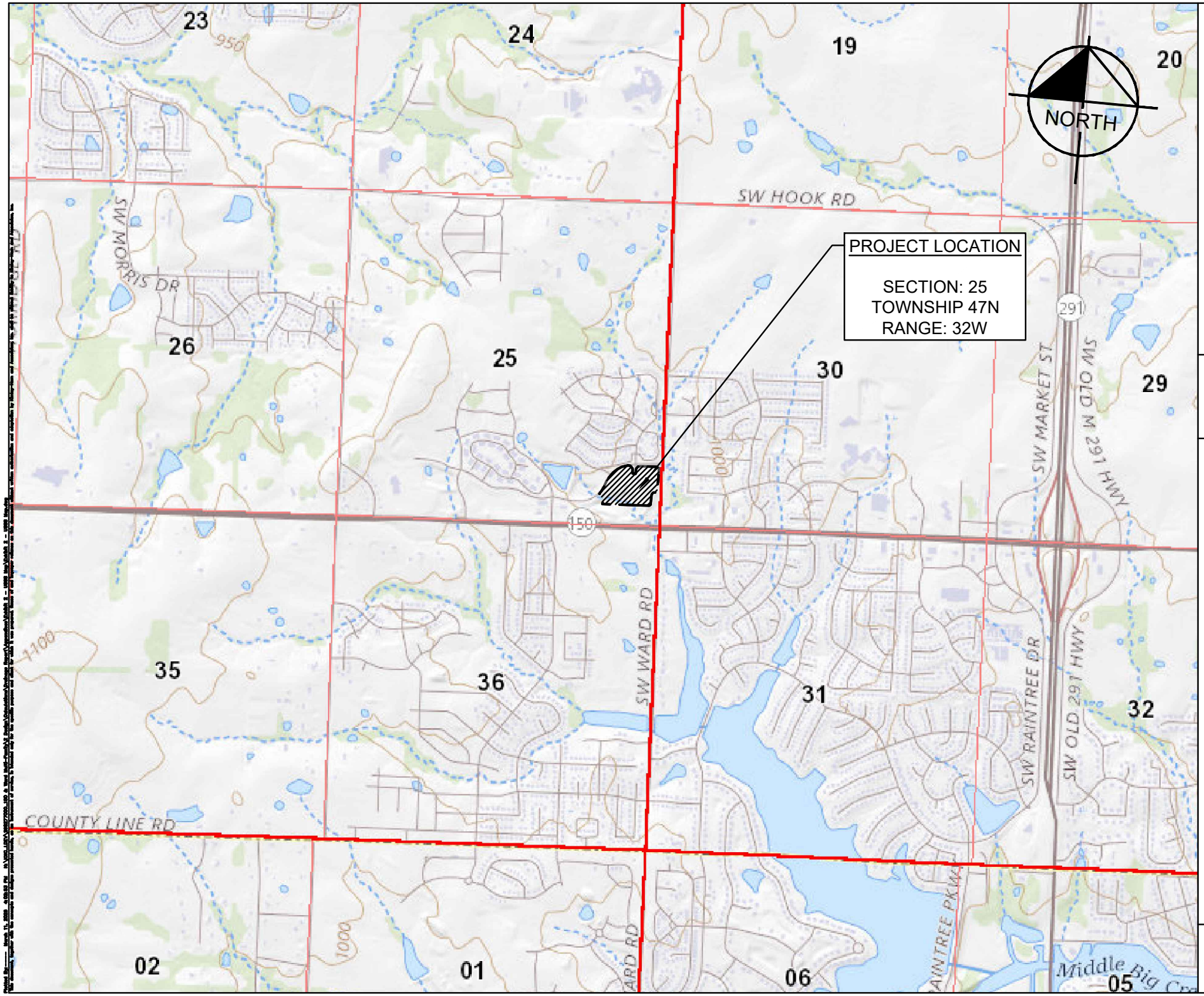


SHEET NUMBER
EXHIBIT 1

LOCATION MAP

Kimley»Horn

805 PENNSYLVANIA AVENUE, SUITE 150, KANSAS CITY, MO 64105
PHONE: 816-652-0350 WWW.KIMLEY-HORN.COM



Kimley»Horn

805 PENNSYLVANIA AVENUE, SUITE 150, KANSAS CITY, MO 64105
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USGS MAP

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 Chance
- 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.

FEMA National Flood Insurance Program

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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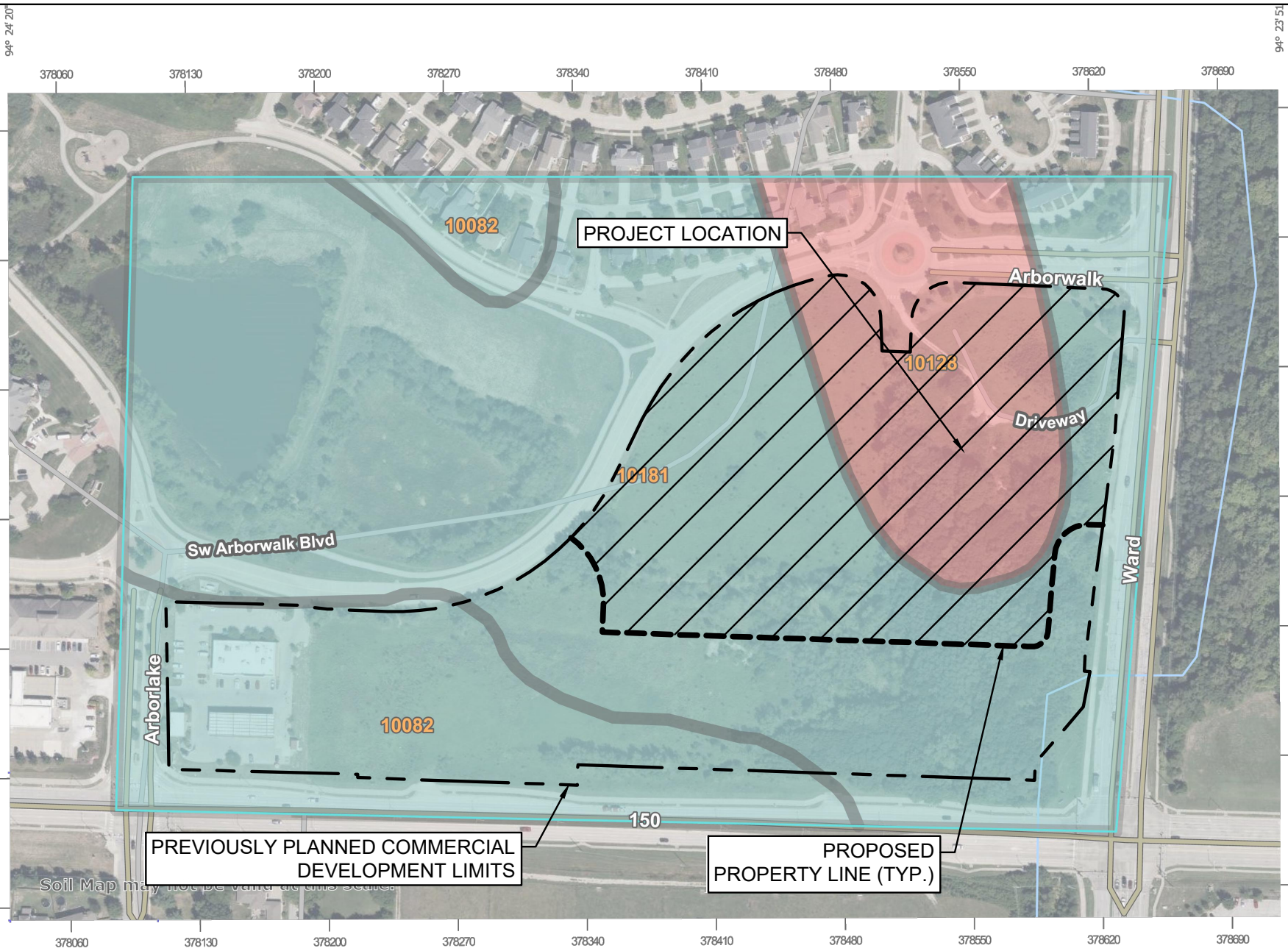
PHONE: 816-652-0350 WWW.KIMLEY-HORN.COM

FEMA MAP

SHEET NUMBER

EXHIBIT 3



Map Scale: 1:3,150 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 45 90 180 270

Feet: 0 150 300 600 900

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 15N WGS84

USDA **Natural Resources Conservation Service**

Web Soil Survey
National Cooperative Soil Survey

2/6/202
Page 1 of

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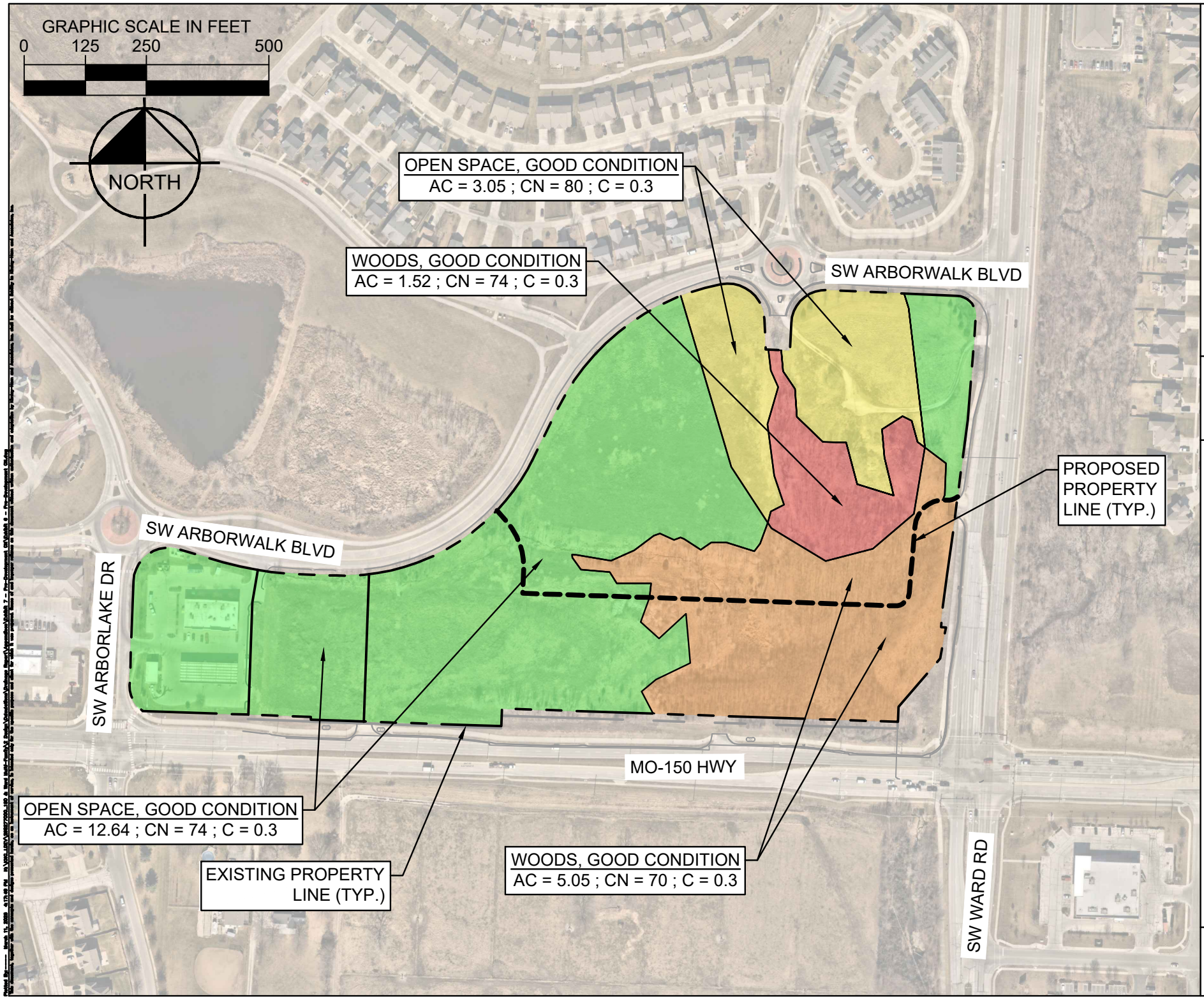
SOIL MAP

SHEET NUMBER

EXHIBIT 4



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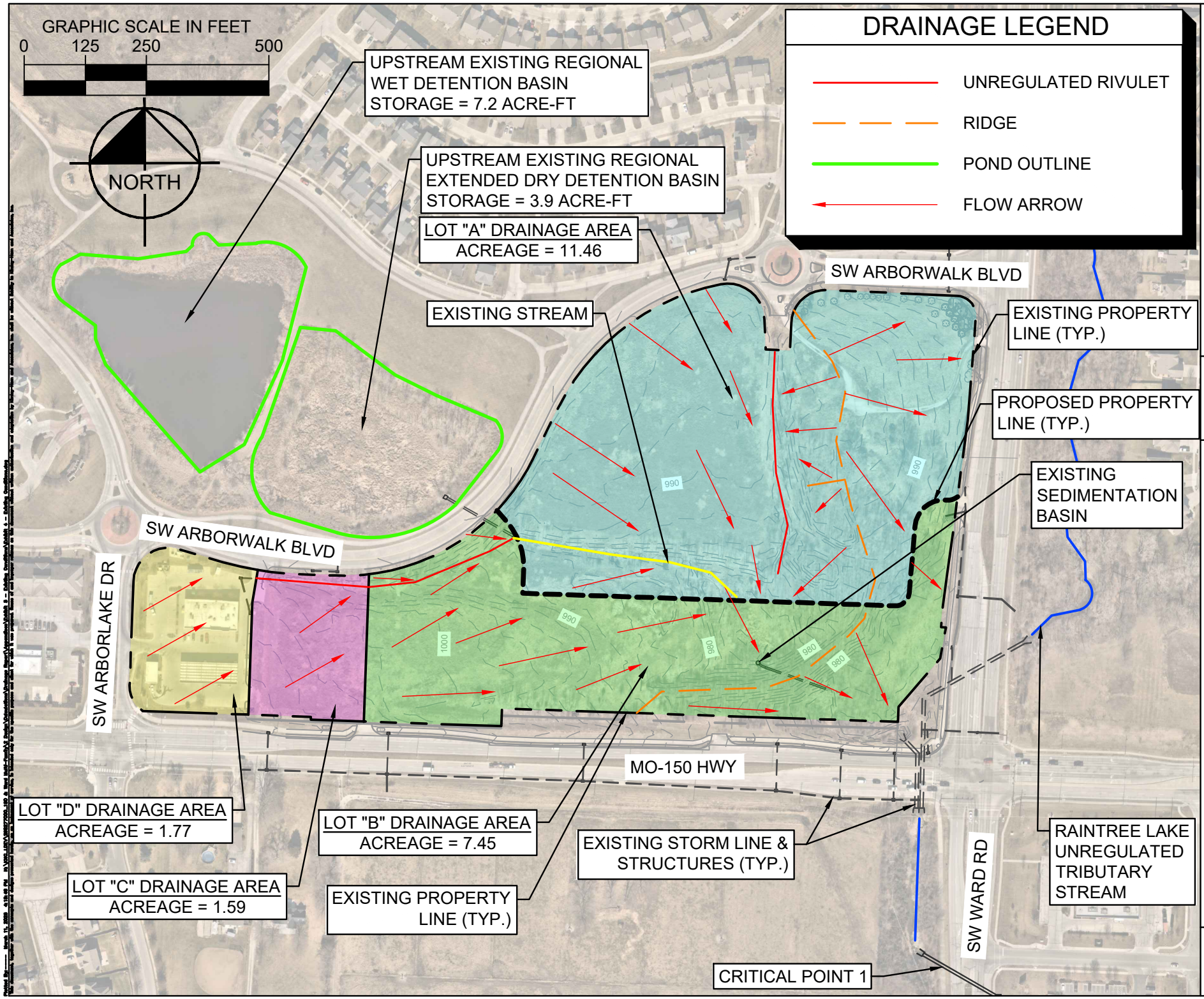
PRE-DEVELOPMENT COVER TYPES

SHEET NUMBER

EXHIBIT 5



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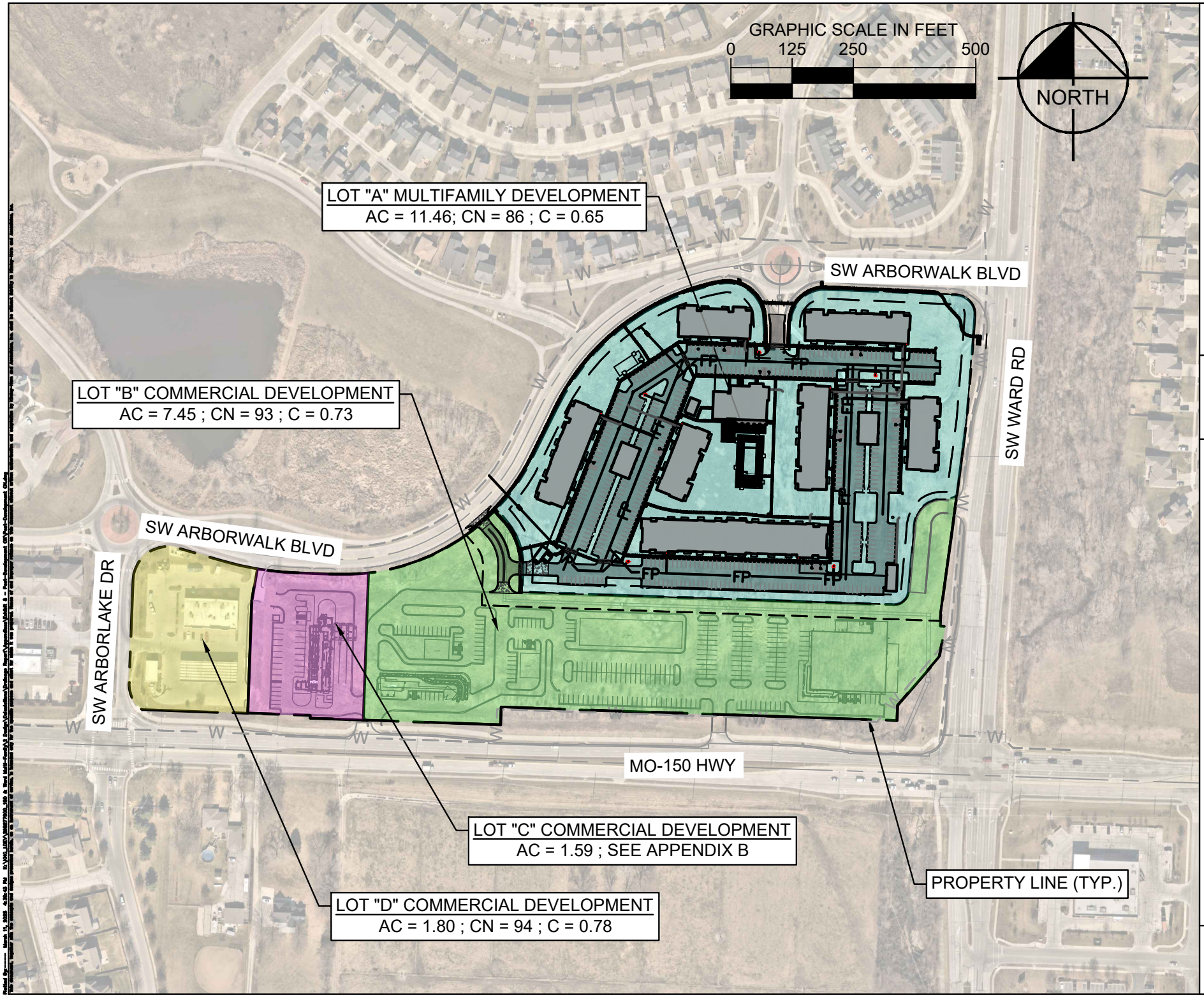
EXISTING CONDITIONS

SHEET NUMBER

EXHIBIT 6



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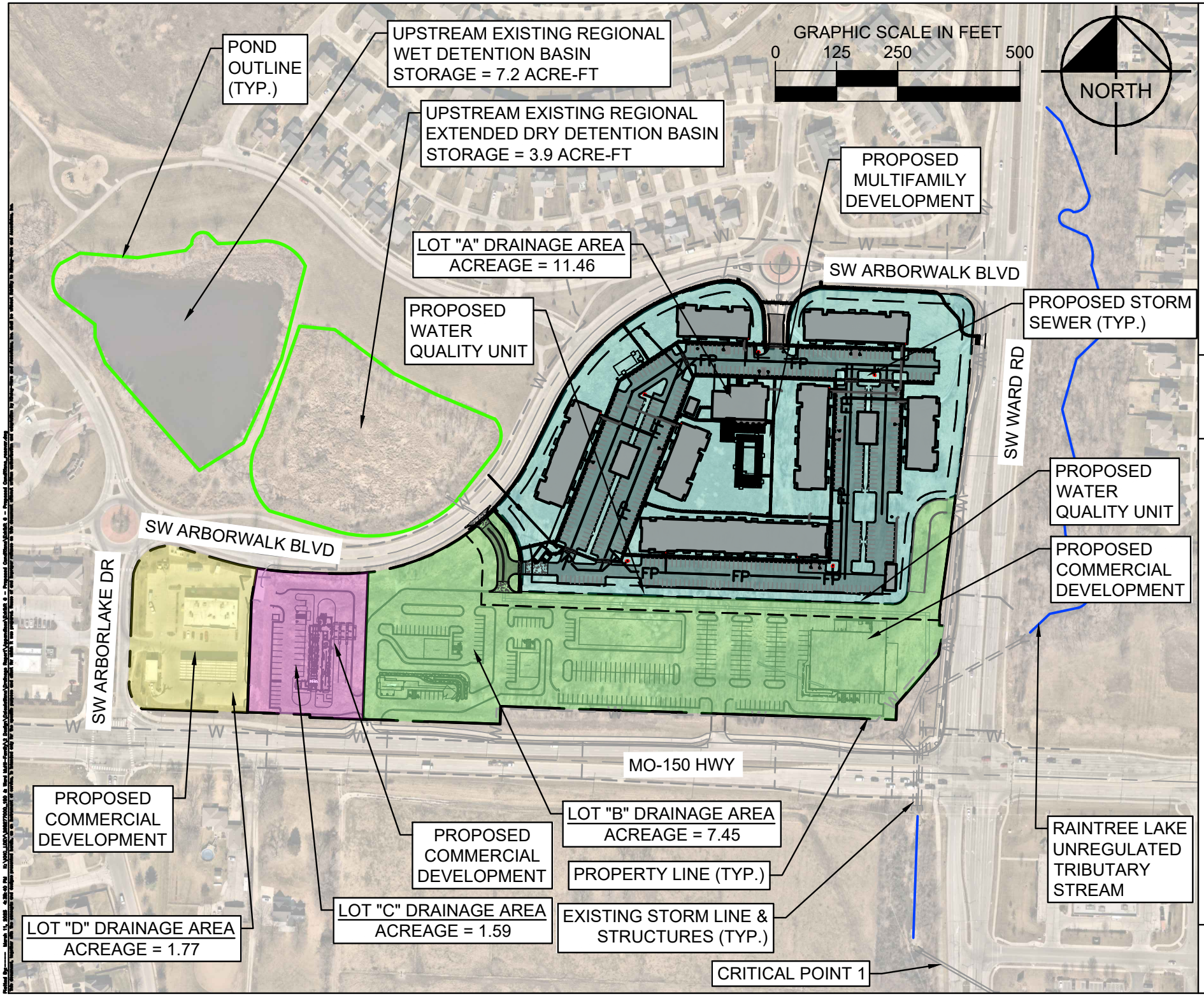
POST-DEVELOPMENT COVER TYPES

SHEET NUMBER

EXHIBIT 7



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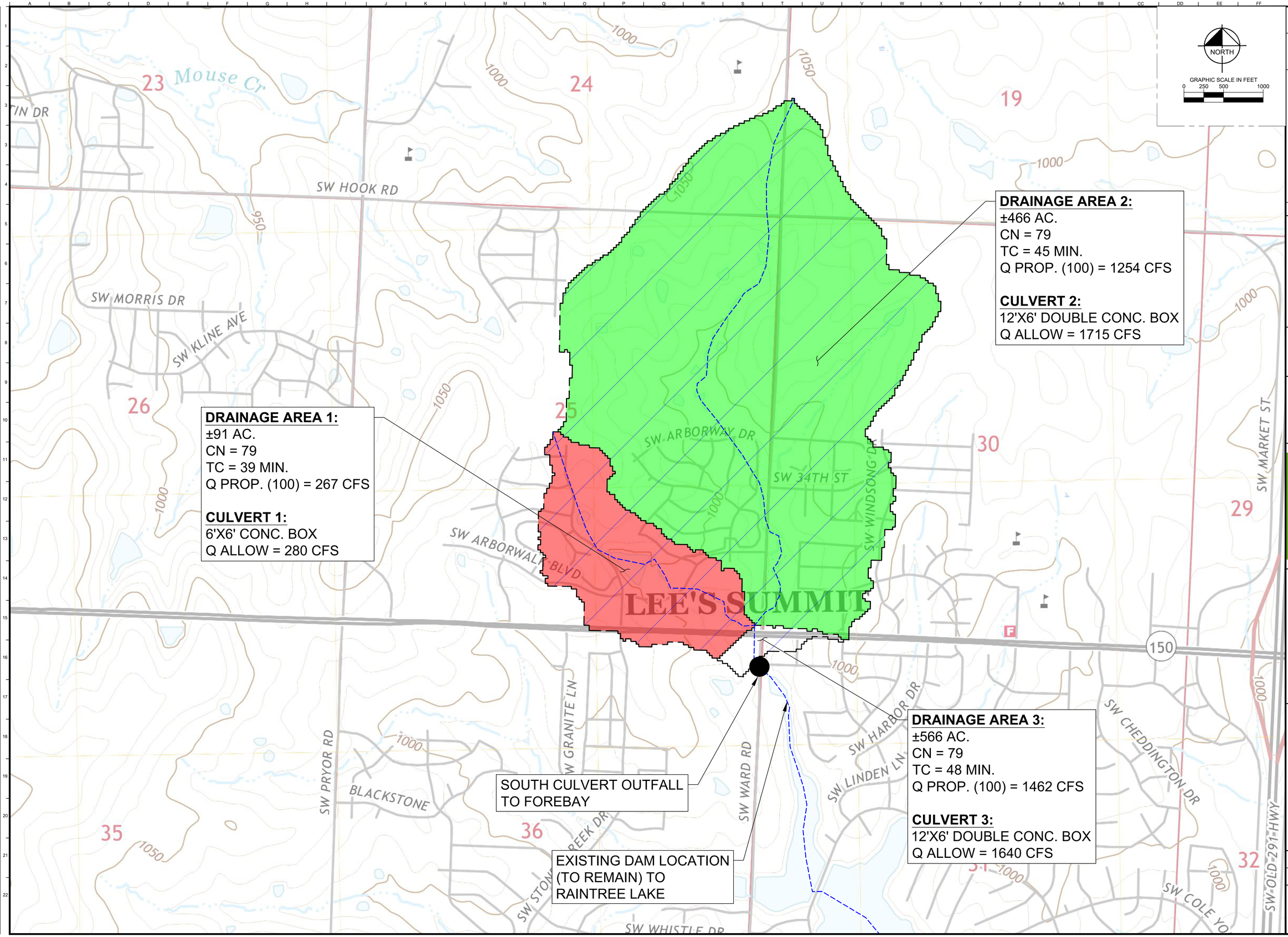
PROPOSED CONDITIONS

SHEET NUMBER

EXHIBIT 8



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MO CERTIFICATE OF AUTHORITY #2015112
EXPIRES: 12/31/24

No.	REVISIONS	DATE	BY

SCALE: AS NOTED
DESIGNED BY: LLG
DRAWN BY: LLG
CHECKED BY: PJJ

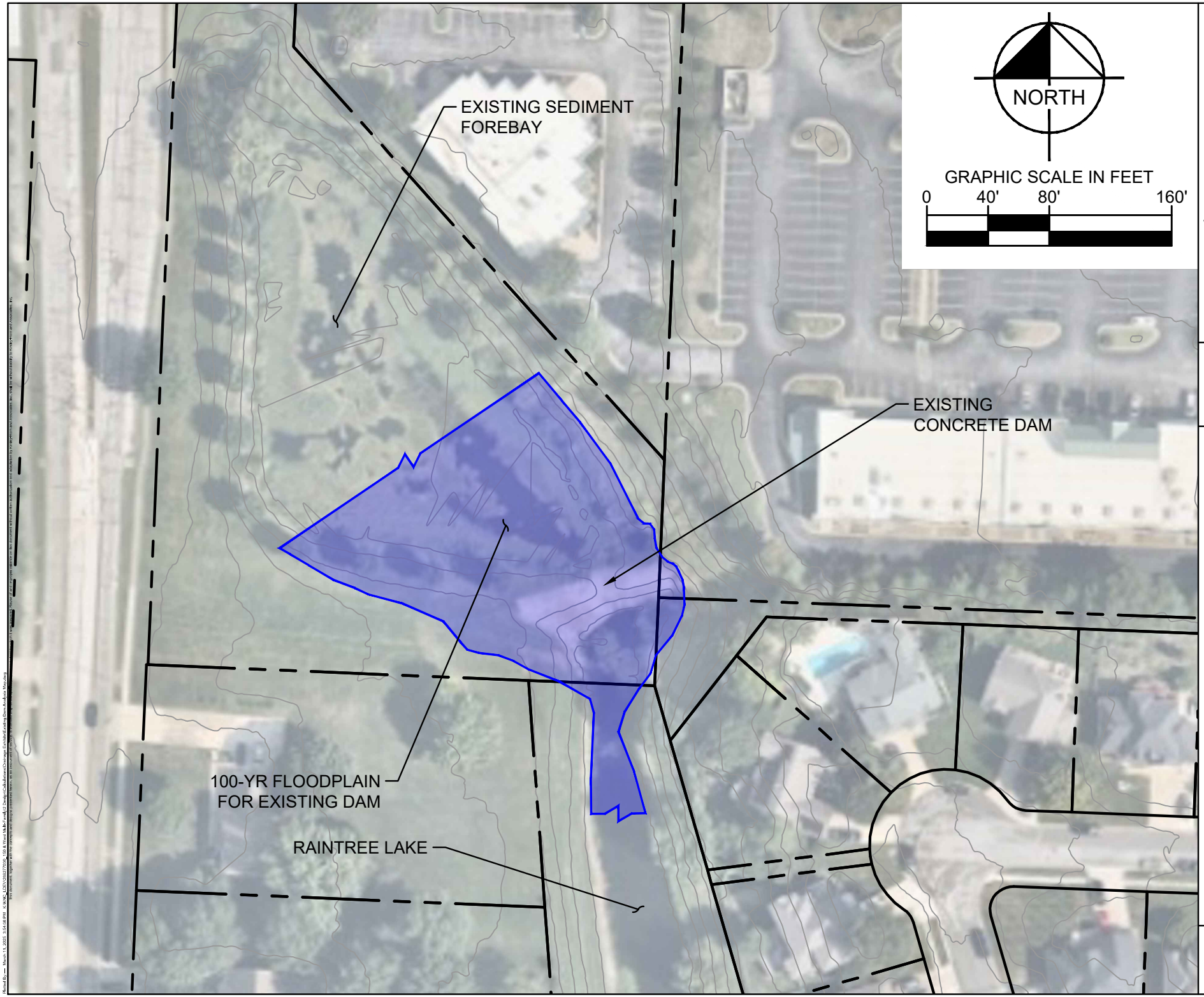
PRELIMINARY NOT FOR CONSTRUCTION

MILHAUS.

CULVERT DRAINAGE MAP

150 & WARD MULTIFAMILY DEVELOPMENT
150 HIGHWAY & SW WARD ROAD
LEE'S SUMMIT, MISSOURI, 64082

ORIGINAL ISSUE: 02/10/2025
KHA PROJECT NO. 268277000
SHEET NUMBER
EX. 9



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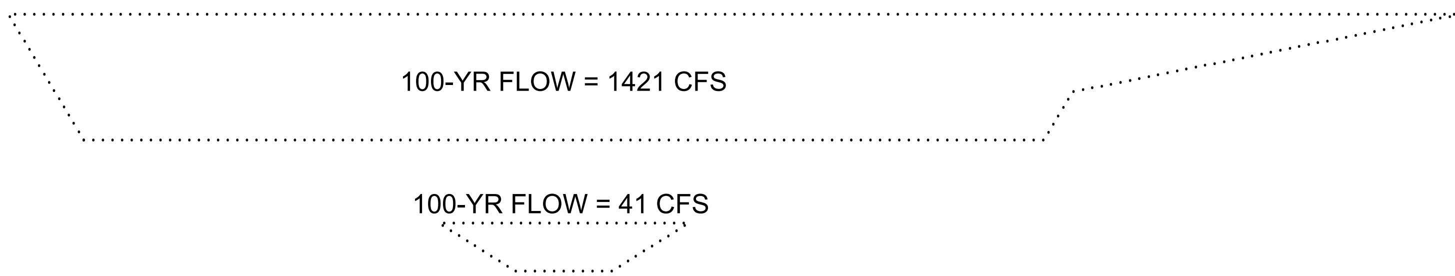
100-YR DAM FLOODPLAIN

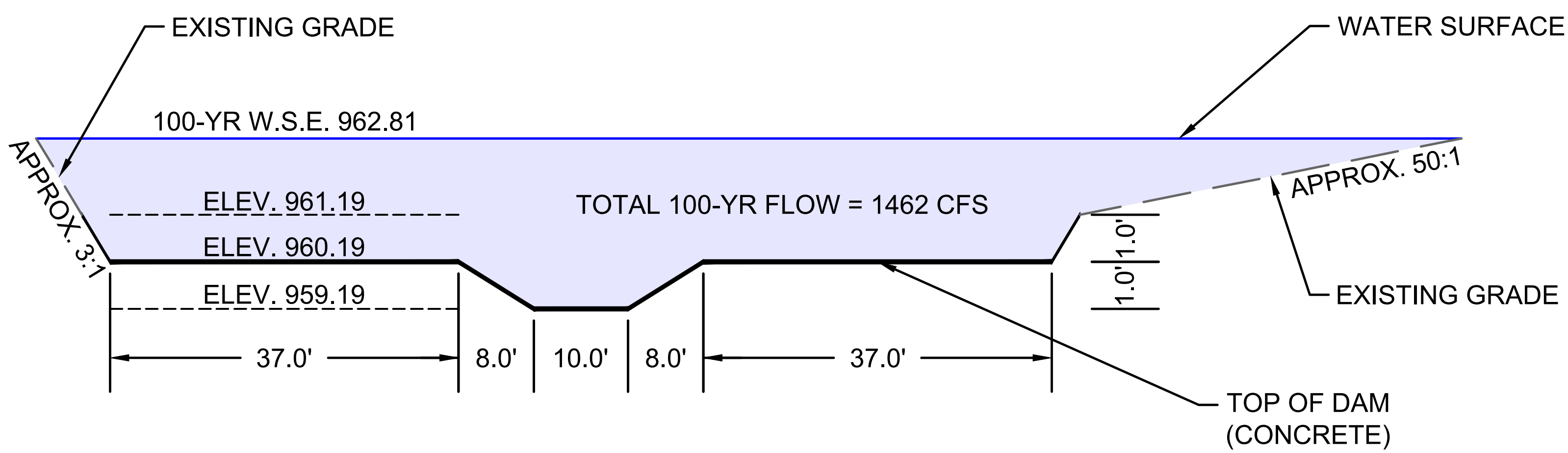
150 & WARD

SHEET NUMBER

EXHIBIT 10



NOTE: BASED ON THE PRINCIPAL OF SUPERPOSITION, THE EXISTING DAM JUST UPSTREAM OF RAINTREE LAKE WAS ANALYZED IN HYDRAFLOW EXPRESS TO DETERMINE HOW THE EXISTING INFRASTRUCTURE COULD CONVEY THE PEAK 100-YEAR FLOWS.



EXISTING DAM DETAIL

VERTICAL SCALE: 5:1

HORIZONTAL SCALE: 1" = 15'

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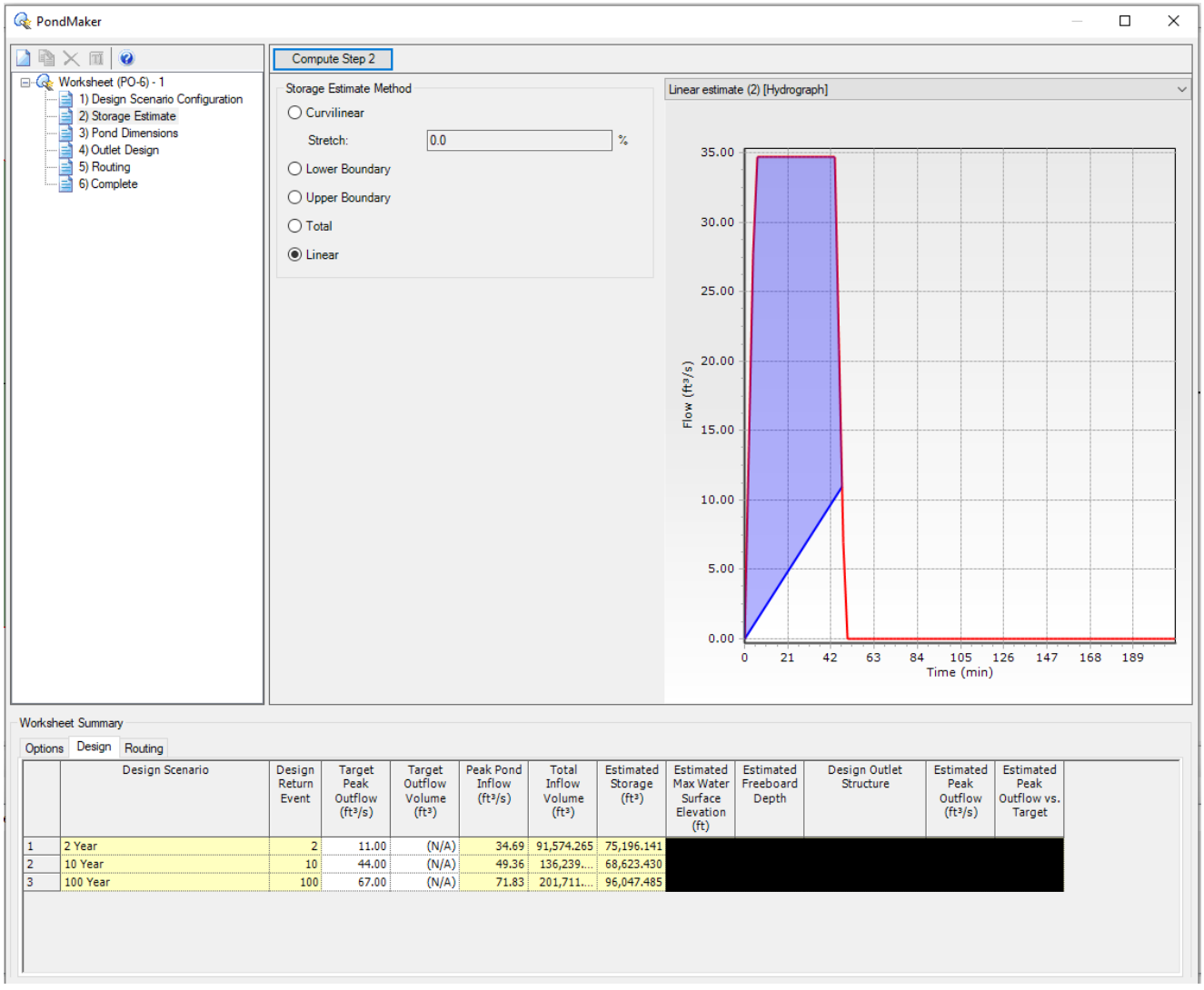
EXISTING DAM DETAIL

150 & WARD

SHEET NUMBER

EXHIBIT 11

PONDPACK PONDMAKER ESTIMATE



Worksheet Summary

Options | Design | Routing

	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

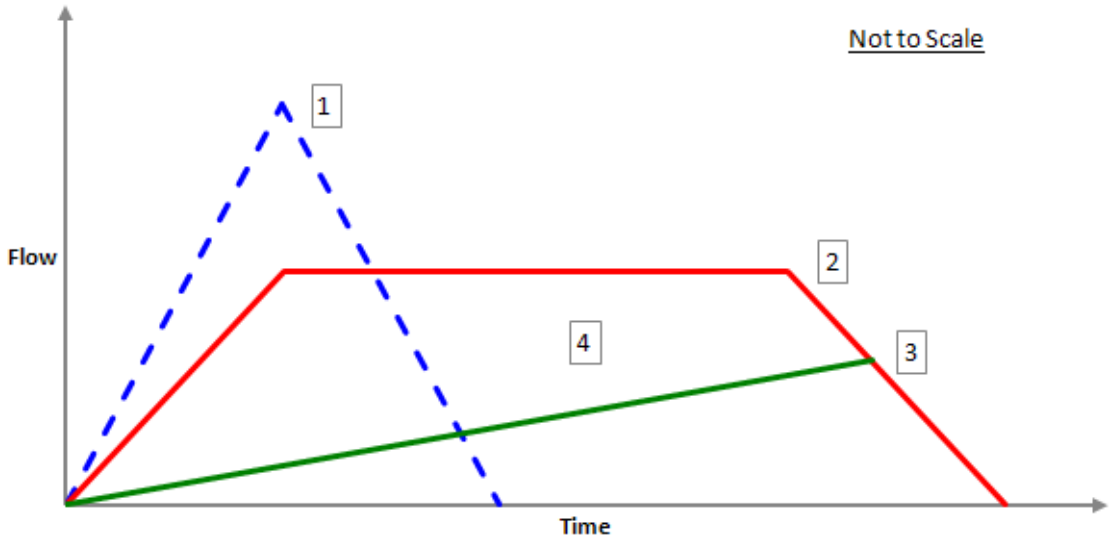
Label: CM-2

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)

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	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

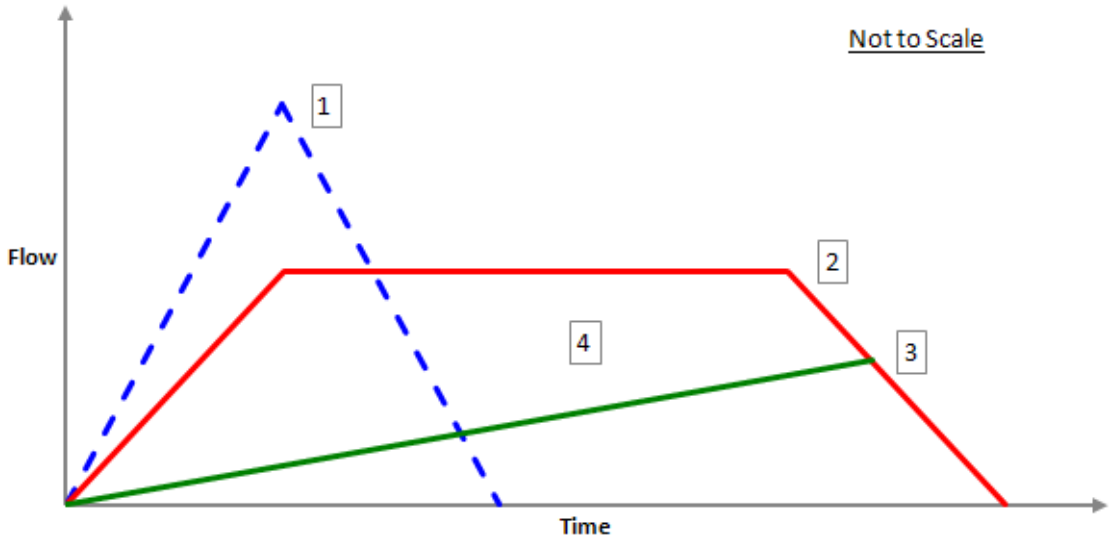
Label: CM-2

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)

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	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

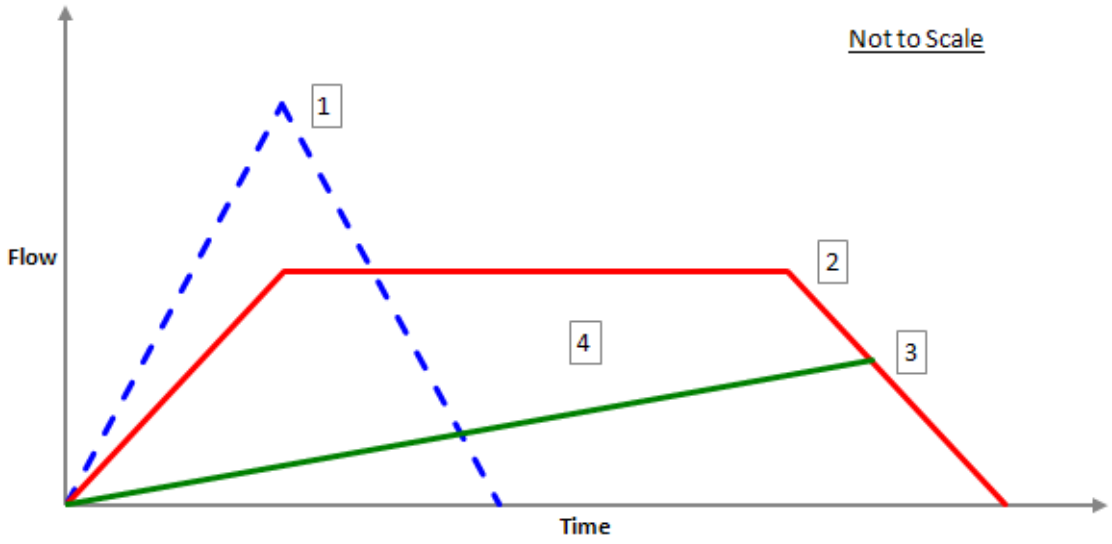
Label: CM-2

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)

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	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

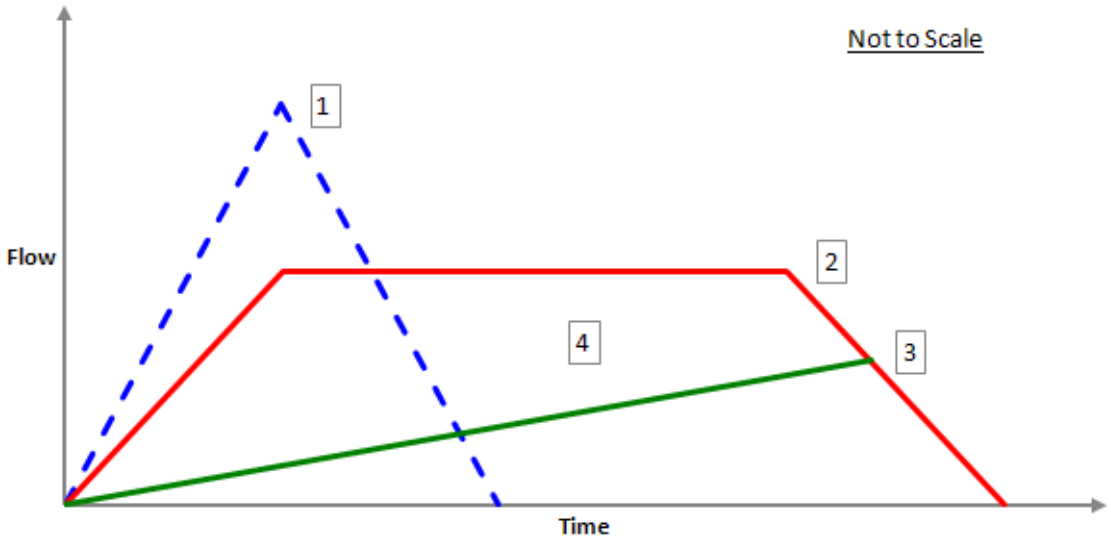
Label: CM-2

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

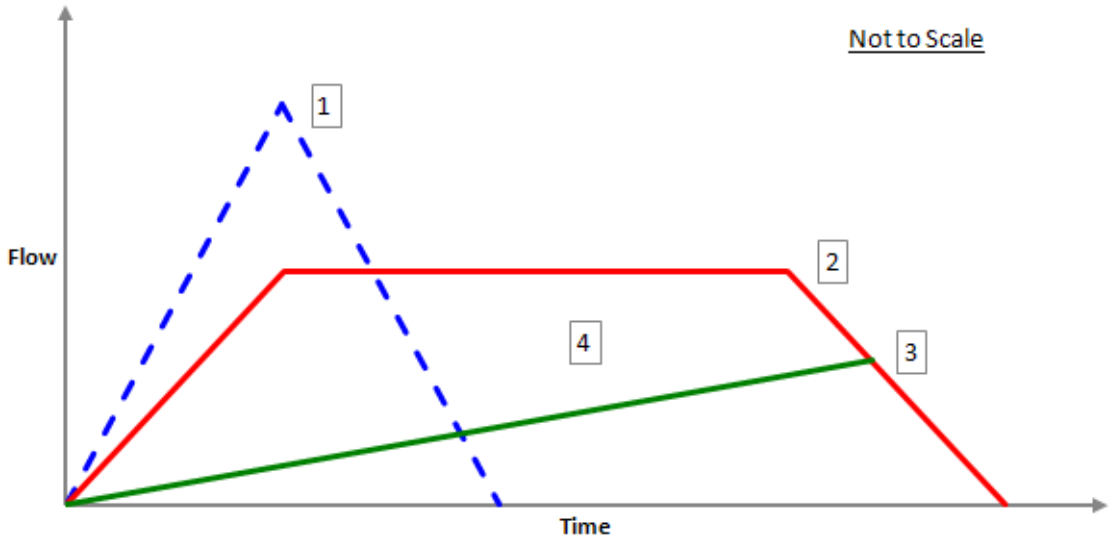
Label: CM-2

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

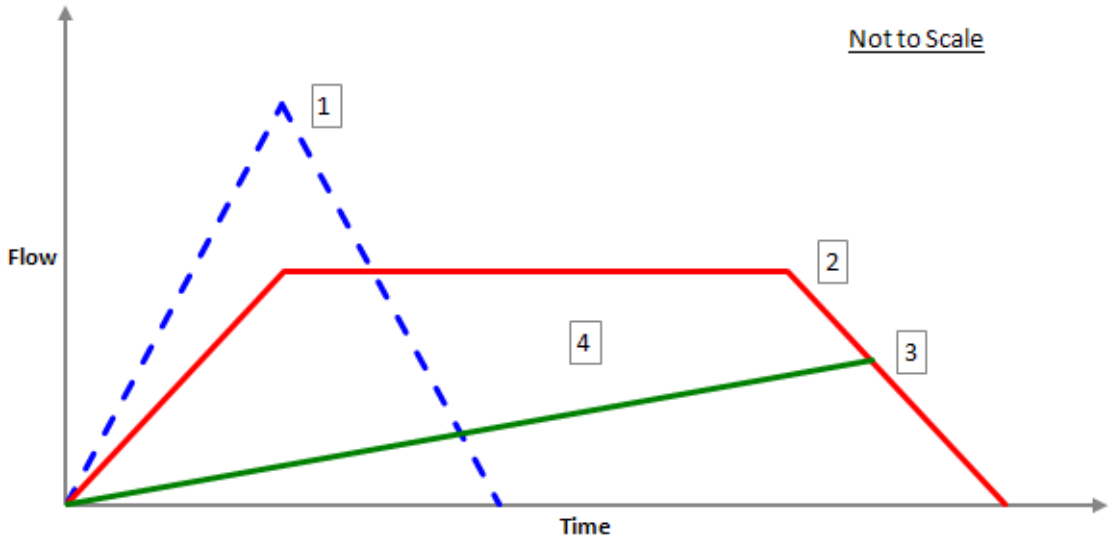
Label: CM-2

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

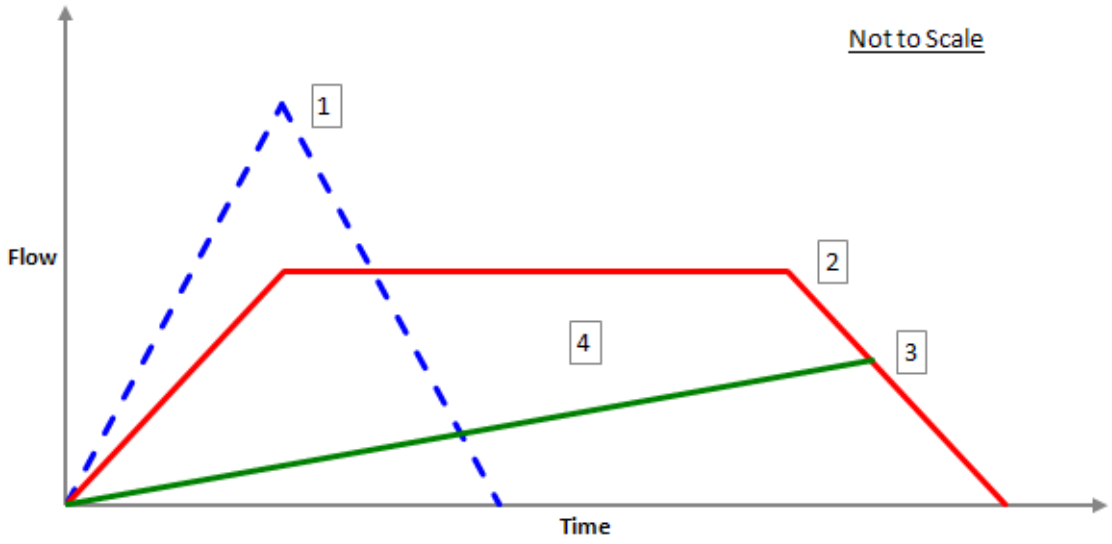
Label: CM-2

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

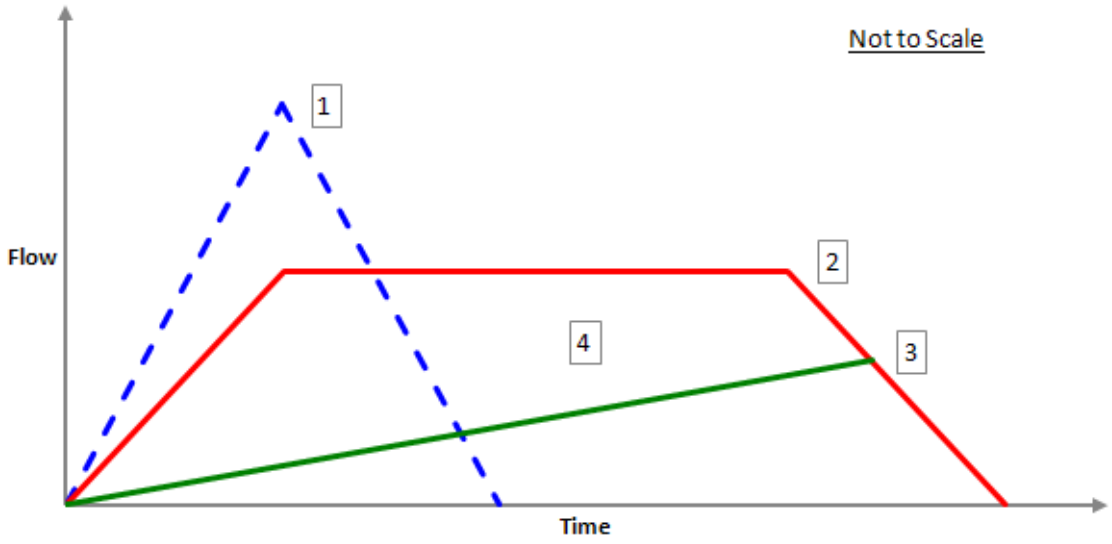
Label: CM-2

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

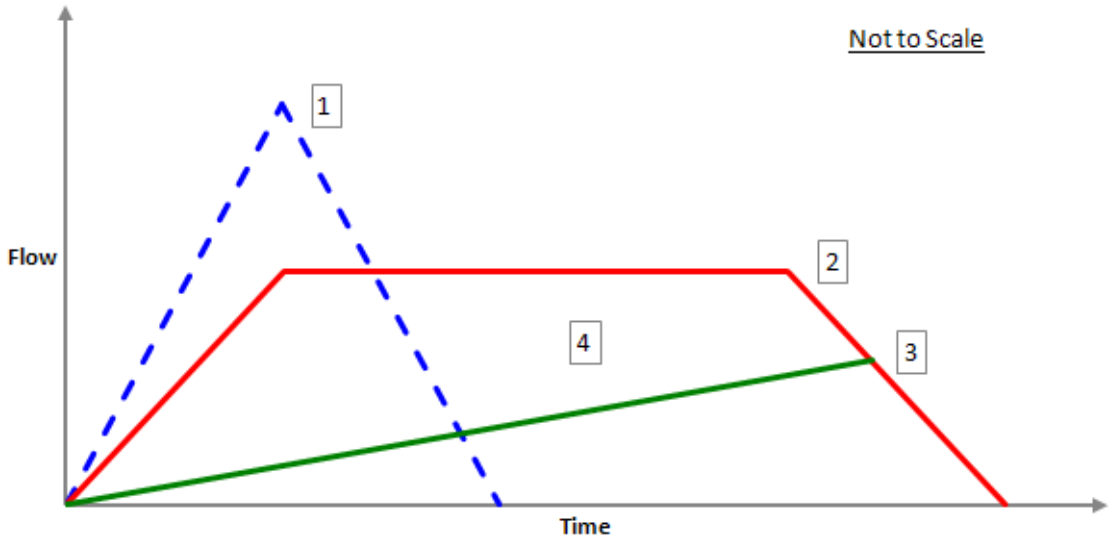
Label: CM-2

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)

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	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

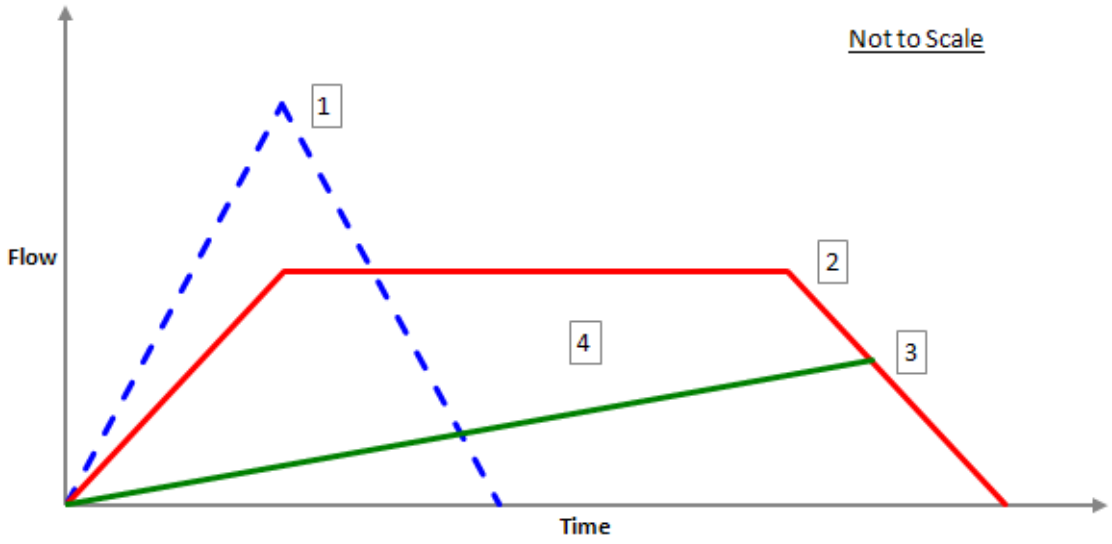
Label: CM-2

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

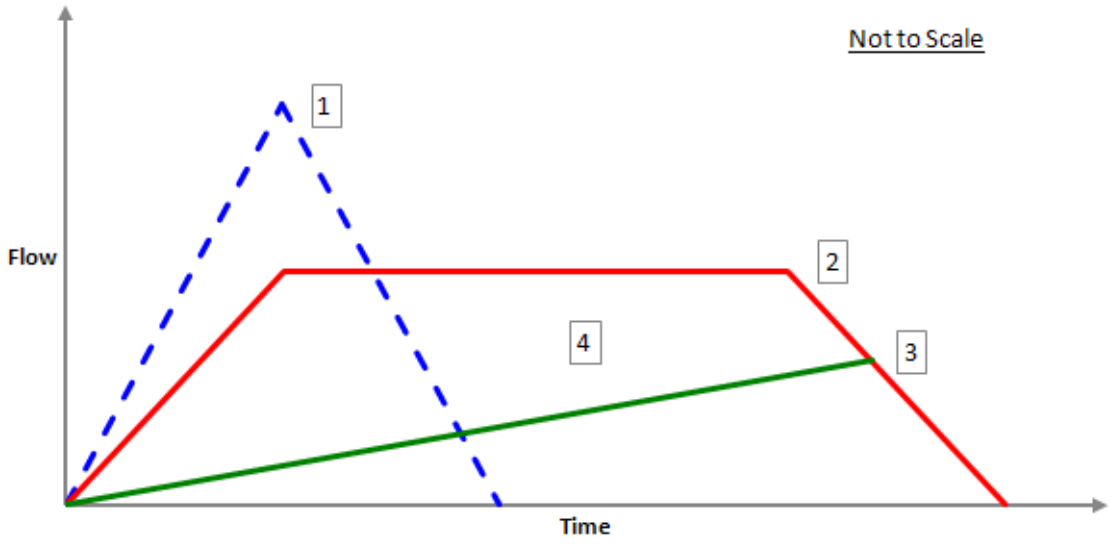
Label: CM-2

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

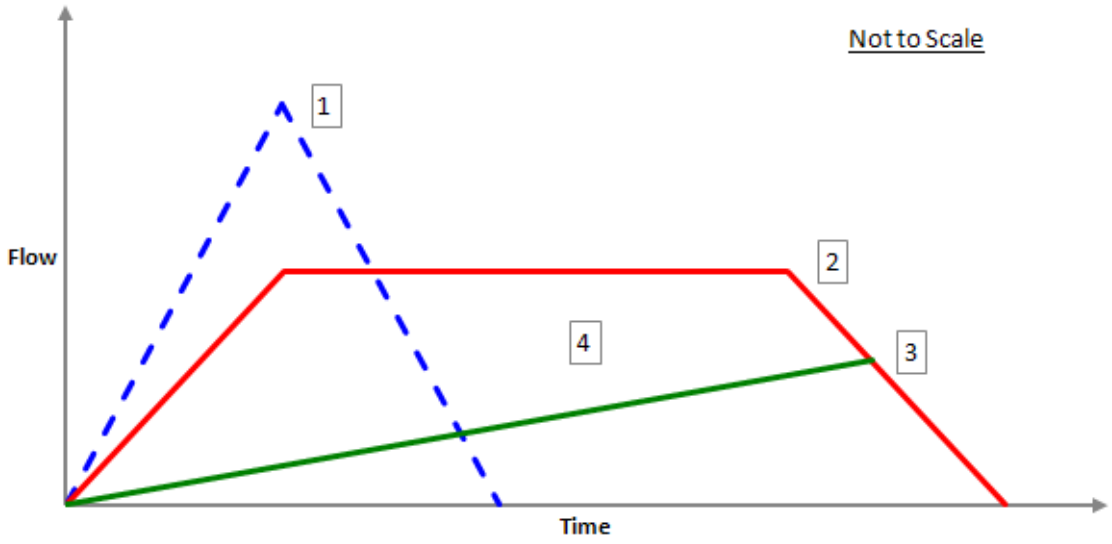
Label: CM-2

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) (ft^3/s)	Flow (Allowable) (ft^3/s)	Volume (inflow) (ft^3)	Volume (Storage) (ft^3)
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

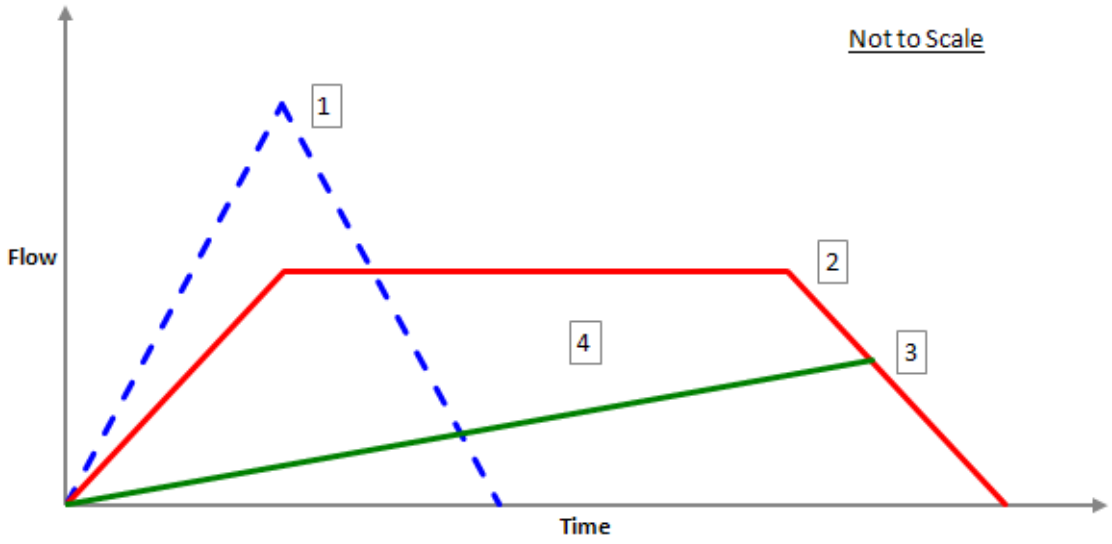
Label: CM-2

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

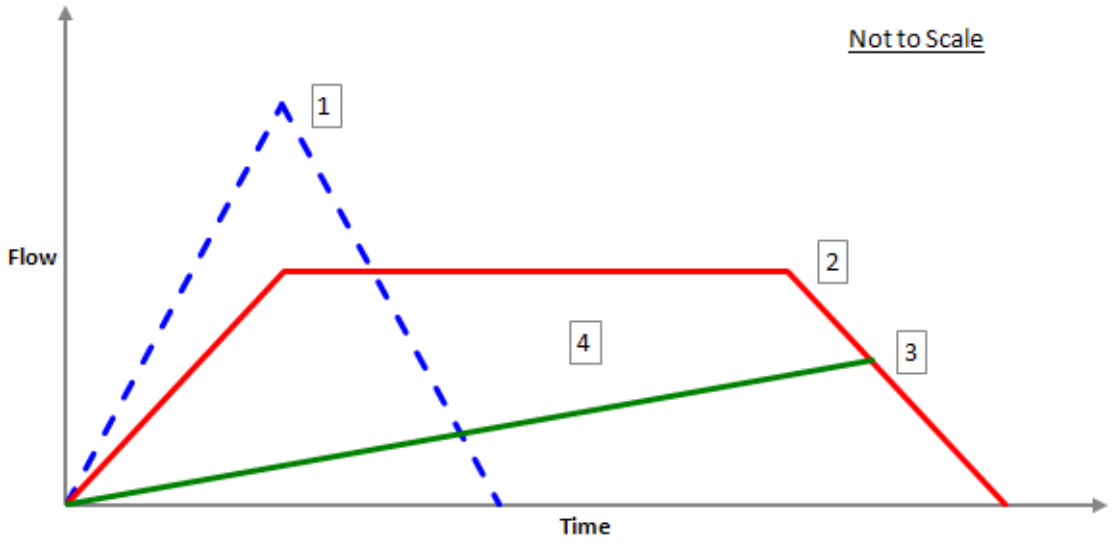
Label: CM-2

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

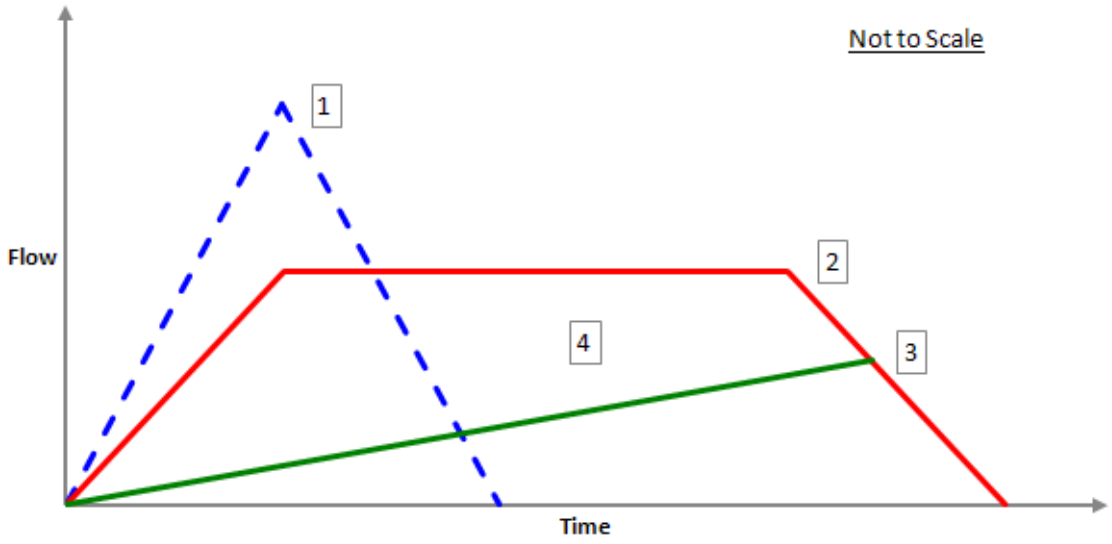
Label: CM-2

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

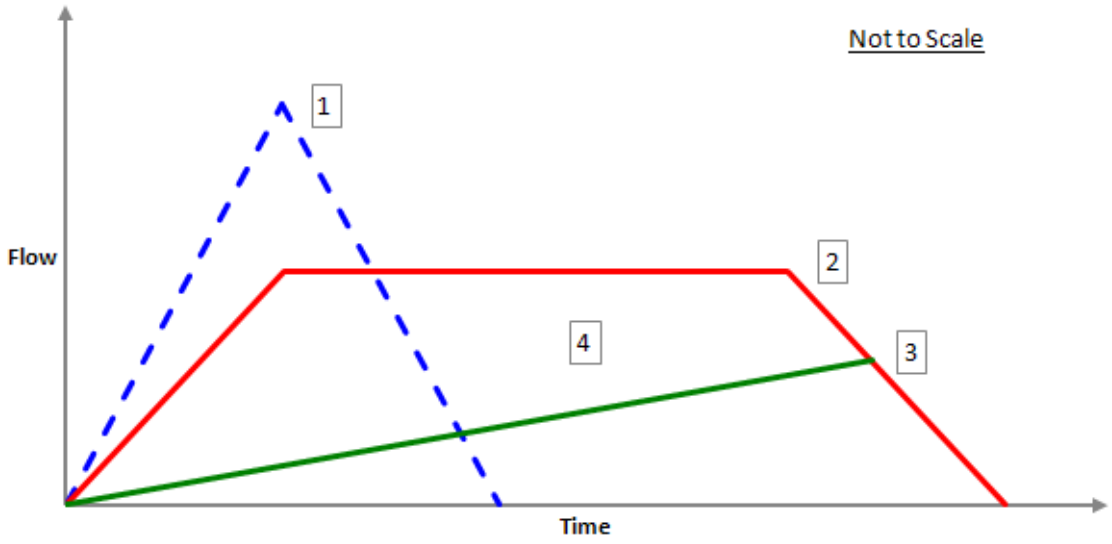
Label: CM-2

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.)

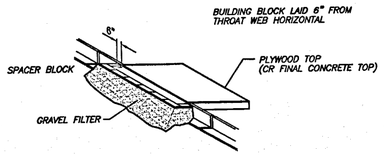
SOUTHEAST DRAINAGE BASIN

SOUTHEAST DRAINAGE BASIN (COMMERCIAL)

EAST SHALLOW DETENTION BASIN (0.95 AC.)

EAST DRAINAGE BASIN

APPROX. LOC. EXISTING WATER

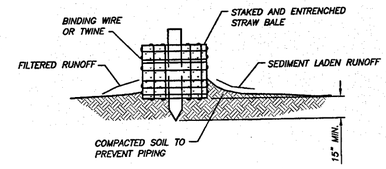


EXPANDED METAL OR HARDWARE CLOTH IN FRONT OF BLOCK PREVENTS GRAVEL FROM WASHING INTO STRUCTURE

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.

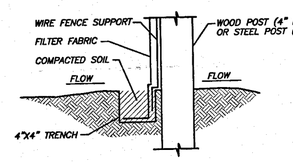


SECTION

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.

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

PUBLIC STORM SEWER PLANS

TO SERVE

ARBORWALK EAST

LEE'S SUMMIT, MO

UTILITIES

Electric Service
Evergy
Nathan Michael
913-347-4310
Nathan.michael@evergy.com

Gas Service
Spire
Katie Darnell
816-969-2247
Katie.darnell@spireenergy.com

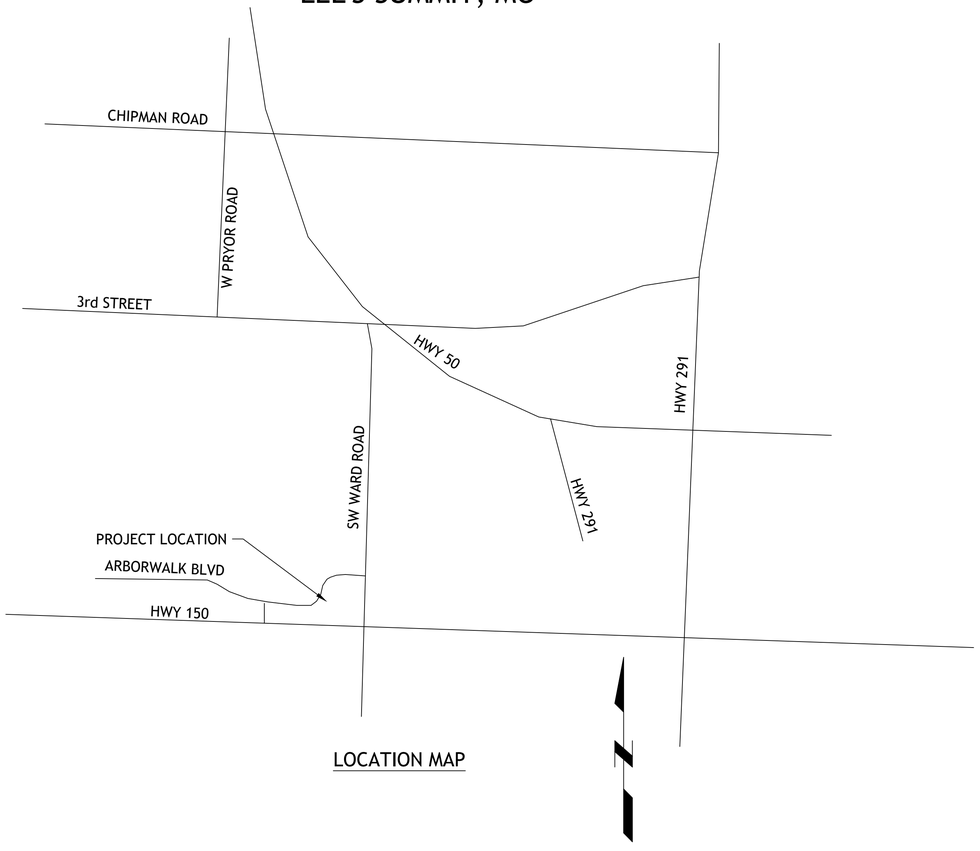
Water/Sanitary Sewer
Water Utilities Department
1200 SE Hamblen Road
Lee's Summit, Mo 64081
Jeff Thorn
816-969-1900
jeff.thorn@cityofls.net

Communication Service
AT&T Carrie Cilke
816-703-4386
cc3527@att.com

Time Warner Cable
Steve Baxter
913-643-1928
steve.baxter@charter.com

Comcast
Ryan Alkire
816-795-2218
ryan.alkire@cable.comcast.com

Google Fiber
Becky Davis
913-725-8745
rebeccadavis@google.com



LOCATION MAP

INDEX OF SHEETS

DEVELOPER

MARTIN CITY PARTNERS, LLC
7217 W 110TH STREET
OVERLAND PARK, KS 66210
CONTACT: GARRETT FUGATE
PHONE: 913.649.4500
EMAIL: GARRET@CHRISTIEDEV.COM

ENGINEER

SM ENGINEERING
SAM MALINOWSKY
5507 HIGH MEADOW CIRCLE
MANHATTAN KANSAS, 66503
SMCIVILENGR@GMAIL.COM
785.341.9747

SURVEYOR

J & J SURVEY, INC.
6500 NW TOWER DR SUITE 102
PLATTE WOODS, MO 64151
816-741-1017

UTILITY STATEMENT:
THE UNDERGROUND UTILITIES SHOWN HEREON ARE FROM FIELD SURVEY INFORMATION OF ONE-CALL LOCATED UTILITIES, FIELD SURVEY INFORMATION OF ABOVE GROUND OBSERVABLE EVIDENCE, AND/OR THE SCALING AND PLOTTING OF EXISTING UTILITY MAPS AND DRAWINGS AVAILABLE TO THE SURVEYOR AT THE TIME OF SURVEY. THE SURVEYOR MAKES NO GUARANTEE THAT THE UNDERGROUND UTILITIES SHOWN COMPRISE ALL SUCH UTILITIES IN THE AREA, EITHER IN SERVICE OR ABANDONED. FURTHERMORE, THE SURVEYOR DOES NOT WARRANT THAT THE UNDERGROUND UTILITIES SHOWN ARE IN THE EXACT LOCATION INDICATED ALTHOUGH HE DOES CERTIFY THAT THEY ARE LOCATED AS ACCURATELY AS POSSIBLE FROM INFORMATION AVAILABLE. THE SURVEYOR HAS NOT PHYSICALLY LOCATED THE UNDERGROUND UTILITIES BY EXCAVATION UNLESS OTHERWISE NOTED ON THIS SURVEY.

SAFETY NOTICE TO CONTRACTOR
IN ACCORDANCE WITH GENERALLY ACCEPTED CONSTRUCTION PRACTICE, THE CONTRACTOR WILL BE SOLELY AND COMPLETELY RESPONSIBLE FOR CONDITIONS OF THE JOB SITE, INCLUDING SAFETY OF ALL PERSONS AND PROPERTY DURING PERFORMANCE OF THE WORK. THIS REQUIREMENT WILL APPLY CONTINUOUSLY AND NOT BE LIMITED TO NORMAL WORKING HOURS.

WARRANTY/DISCLAIMER
THE DESIGNS REPRESENTED IN THESE PLANS ARE IN ACCORDANCE WITH ESTABLISHED PRACTICES OF CIVIL ENGINEERING FOR THE DESIGN FUNCTIONS AND USES INTENEDED BY THE OWNER AT THIS TIME. HOWEVER, NEITHER SM ENGINEERING NOR ITS PERSONNEL CAN OR DO WARRANTY THESE DESIGNS OR PLANS AS CONSTRUCTED, EXCEPT IN THE SPECIFIC CASES WHERE SM ENGINEERING PERSONNEL INSPECT AND CONTROL THE PHYSICAL CONSTRUCTION ON A CONTEMPORARY BASIS AT THE SITE.

CAUTION- NOTICE TO CONTRACTOR
THE CONTRACTOR IS SPECIFICALLY CAUTIONED THAT THE LOCATION AND/OR ELEVATION OF EXISTING UTILITIES AS SHOWN ON THESE PLANS IS BASED ON RECORDS OF THE VARIOUS UTILITY COMPANIES AND, WHERE POSSIBLE, MEASUREMENTS TAKEN IN THE FIELD. THE INFORMATION IS NOT TO BE RELIED ON AS BEING EXACT OR COMPLETE. THE CONTRACTOR MUST CALL THE APPROPRIATE UTILITY COMPANY AT LEAST 72 HOURS BEFORE ANY EXCAVATION TO REQUEST EXACT FIELD LOCATION OF UTILITIES. IT SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR TO RELOCATE ALL EXISTING UTILITIES WHICH CONFLICT WITH PROPOSED IMPROVEMENTS SHOWN ON THE PLANS. THE CONTRACTOR SHALL EXPOSE EXISTING UTILITIES AT LOCATIONS OF POSSIBLE CONFLICTS PRIOR TO ANY CONSTRUCTION.

NOTES
1. ALL CONSTRUCTION SHALL FOLLOW THE CITY OF LEE'S SUMMIT DESIGN AND CONSTRUCTION MANUAL AS ADOPTED BY ORDINANCE 5813. WHERE DISCREPANCIES EXIST BETWEEN THESE PLANS AND THE DESIGN AND CONSTRUCTION MANUAL, THE MORE STRINGENT SHALL PREVAIL.

2. THERE ARE NO GAS/OIL WELLS PER MDNR DATABASE OF OIL AND GAS PERMITS.

3. THE CONTRACTOR SHALL CONTACT THE CITY DEVELOPMENT SERVICES ENGINEERING INSPECTION TO SCHEDULE A PRE-CONSTRUCTION MEETING WITH A FIELD ENGINEERING INSPECTOR PRIOR TO ANY LAND DISTURBANCE WORK AT 816-969-1200.

SAMUEL D. MALINOWSKY
PROFESSIONAL ENGINEEER

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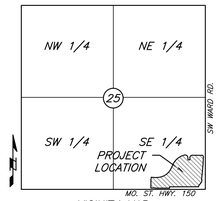
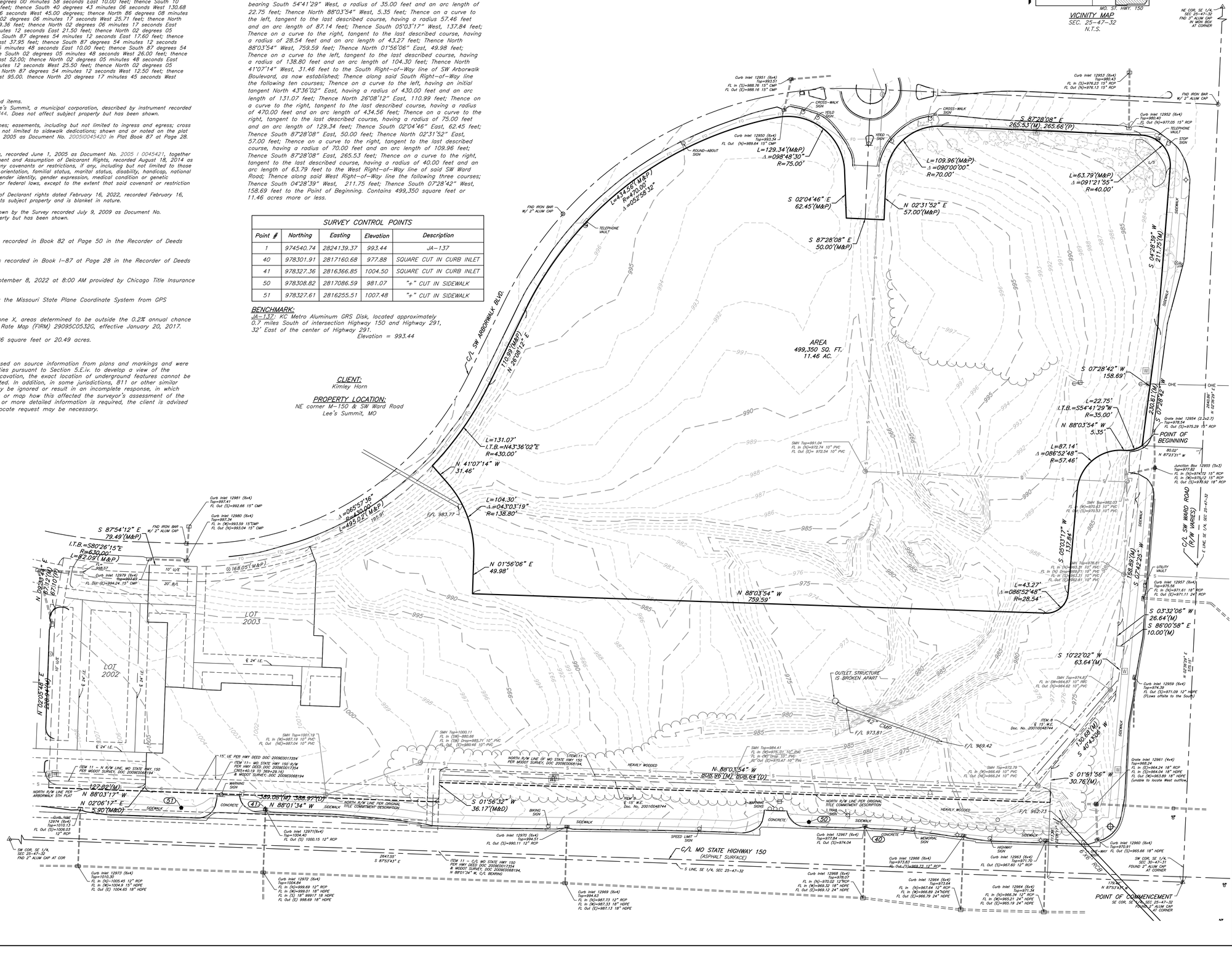
5507 High Meadow Circle
Manhattan Kansas, 66503
smcivilengr@gmail.com
785.341.9747

Revisions

PUBLIC STORM LINE
ARBORWALK EAST
LEE'S SUMMITT, MO.

sheet
C1.0
Civil
Site Improvement PLan
permit
11 APRIL 2023





ALTA/NSPS LAND TITLE SURVEY

SE 1/4, SECTION 25, TOWNSHIP 47 NORTH, RANGE 32 WEST
LEE'S SUMMIT, JACKSON COUNTY, MISSOURI

TITLE DESCRIPTION:

Tract 1:

Lot 2002 and Lot 2003, ARBORWALK – 5TH PLAT, LOTS 2001 THRU 2003, a subdivision in Lee's Summit, Jackson County, Missouri, according to the recorded plat thereof.

Tract 2:

All that part of the Southeast 1/4 of Section 25, Township 47, Range 32, being more particularly described as follows: Beginning at the Northeast corner of Lot 2003. ARBORWALK – 5TH PLAT, LOTS 2001–2003. a subdivision in Lees Summit, Jackson County, Missouri; thence Northeasterly along a curve to the left, having a radius of 430.00 feet and an arc distance of 326.97 feet; thence North 26 degrees 08 minutes 12 seconds East 110 feet; thence Northeasterly along a curve to the right, having a radius of 470.00 feet and an arc distance of 434.56 feet; thence Southeasterly along a curve to the Right, having a radius of 75.00 feet, an arc distance of 129.34 feet; thence South 02 degrees 04 minutes 54 seconds East 62.45 feet; thence South 87 degrees 28 minutes 16 seconds East 50.00 feet; thence North 02 degrees 31 minutes 44 seconds East 57.00 feet; thence Northeasterly along a curve to the right, having a radius or 70.00 feet. an arc distance of 109.96 feet; thence South 67 degrees 28 minutes 08 seconds East 265.66 feet; thence Southeasterly along a curve to the right, a radius of 40.00 feet; an arc distance of 60.52 feet; thence Southwesterly along a curve to the right, having a radius of 10,437 02 feet, an arc distance or 215.03 feet; thence South 07 degrees 26 minutes 42 seconds West 230.61 feet; thence Southwesterly on a curve to the Right, having a radius of 10,572.00. an arc distance of 168.89 feet thence South 04 degrees 03 minutes 55 seconds West 12.00 feet; thence South 03 degrees 06 minutes 01 seconds West 14.64 feet; thence South 66 degrees 00 minutes 58 seconds East 10.00 feet; thence South 10 degrees 22 minutes 02 seconds West 63.64 feet; thence South 40 degrees 43 minutes 06 seconds West 130.68 feet; thence South 01 degrees 51 minutes 56 seconds West 45.00 degrees; thence North 86 degrees 08 minutes 04 seconds West 808.65 feet; thence South 02 degrees 06 minutes 17 seconds West 25.71 feet; thence North 87 degrees 53 minutes 43 seconds West 369.36 feet; thence North 02 degrees 06 minutes 17 seconds East 51.07 feet; thence South 87 degrees 54 minutes 12 seconds East 21.50 feet; thence North 02 degrees 05 minutes 48 seconds East 88.00 feet; thence South 87 degrees 54 minutes 12 seconds East 17.60 feet; thence South 84 degrees 52 minutes 58 seconds East 37.95 feet; thence South 87 degrees 54 minutes 12 seconds East 18.50 feet; thence North 02 degrees 05 minutes 48 seconds East 10.00 feet; thence South 87 degrees 54 minutes 12 seconds East 106.00 feet; thence South 02 degrees 05 minutes 48 seconds West 26.00 feet; thence South 87 degrees 54 minutes 12 seconds East 52.00; thence North 02 degrees 05 minutes 48 seconds East 51.50 feet; thence North 87 degrees 54 minutes 12 seconds West 25.50 feet; thence North 02 degrees 05 minutes 48 seconds East 41.50 feet; thence North 87 degrees 54 minutes 12 seconds West 12.50 feet; thence North 02 degrees of minutes 48 seconds East 95.00. thence North 20 degrees 17 minutes 45 seconds West 24.80 feet to the point of beginning.

SCHEDULE B – PART II NOTES:

Items 1–7; 12 and 13 are non survey related items.

8. An easement granted to the City of Lee's Summit, a municipal corporation, described by instrument recorded June 25, 2001 as Document No. 2001I0048744. Does not affect subject property but has been shown.

9. Boundaries; streets; grades; set back lines; easements, including but not limited to ingress and egress; cross parking agreement; dedications, including but not limited to sidewalk dedications; shown and or noted on the plat of ARBORWALK, – 5th Plat, recorded June 1, 2005 as Document No. 2005I0045420 in Plat Book 87 at Page 28. Does not affect subject property.

10. Terms and provisions of the Restrictions, recorded June 1, 2005 as Document No. 2005 I 0045421, together with the terms and provisions of the Assignment and Assumption of Delcarant Rights, recorded August 18, 2014 as Document No. 2014E0068343; but omitting any covenants or restrictions, if any, including but not limited to those based upon race, color, religion, sex, sexual orientation, familial status, marital status, disability, handicap, national origin, ancestry, source of income, gender, gender identity, gender expression, medical condition or genetic information, as set forth in applicable state or federal laws, except to the extent that said covenant or restriction is permitted by applicable law.
Affected by the Assignment and Assumption of Declarant rights dated February 16, 2022, recorded February 16, 2022 as Document No. 2022E0015432. Affects subject property and is blanket in nature.

11. Boundaries, easements and features shown by the Survey recorded July 9, 2009 as Document No. 2009E0068194. Does not affect subject property but has been shown.

GENERAL SURVEY NOTES:

1.) The plat of ARBORWALK–1ST PLAT, is recorded in Book 82 at Page 50 in the Recorder of Deeds Office in Jackson County, Missouri.

2.) The plat of ARBORWALK–5TH PLAT, is recorded in Book I–87 at Page 28 in the Recorder of Deeds Office in Jackson County, Missouri.

3.) Title Report # KCC222158, dated September 8, 2022 at 8:00 AM provided by Chicago Title Insurance Company, was provided by client.

4.) Basis of Bearings was established by the Missouri State Plane Coordinate System from GPS Observation.

5.) The subject property is located in Zone X, areas determined to be outside the 0.2% annual chance floodplain, as shown on Flood Insurance Rate Map (FIRM) 29095C0532G, effective January 20, 2017.

6.) The subject property contains 892,586 square feet or 20.49 acres.

UTILITY NOTE:

The utilities on this survey are shown based on source information from plans and markings and were combined with observed evidence of utilities pursuant to Section 5.E.iv. to develop a view of the underground utilities. However, lacking excavation, the exact location of underground features cannot be accurately, completely, and reliably depicted. In addition, in some jurisdictions, 811 or other similar utility locate requests from surveyors may be ignored or result in an incomplete response, in which case the surveyor shall note on the plat or map how this affected the surveyor's assessment of the location of the utilities. Where additional or more detailed information is required, the client is advised that excavation and/or a private utility locate request may be necessary.

SURVEYORS RECOMMENDED PROPERTY DESCRIPTION:

A tract of land being part of the Southeast Quarter of Section 25, Township 47 North, Range 32 West, in the City of Lee's Summit, Jackson County, Missouri, being more particularly described as follows:

Commencing at the Southeast corner of said Southeast Quarter; Thence North 02°36'29" East, along the East line of said Southeast Quarter, 575.15 feet; Thence North 87°23'31" West, 80.02 feet to the West Right–of–Way line of SW Ward Road, as now established, said point also being the Point of Beginning; Thence on a curve to the to the right having an initial tangent bearing South 54°41'29" West, a radius of 35.00 feet and an arc length of 22.75 feet; Thence North 88°03'54" West, 5.35 feet; Thence on a curve to the left, tangent to the last described course, having a radius 57.46 feet and an arc length of 87.14 feet; Thence South 05°03'17" West, 137.84 feet; Thence on a curve to the right, tangent to the last described course, having a radius of 28.54 feet and an arc length of 43.27 feet; Thence North 88°03'54" West, 759.59 feet; Thence North 01°56'06" East, 49.98 feet; Thence on a curve to the left, tangent to the last described course, having a radius of 138.80 feet and an arc length of 104.30 feet; Thence North 41°07'14" West, 31.46 feet to the South Right–of–Way line of SW Arborwalk Boulevard, as now established; Thence along said South Right–of–Way line the following ten courses; Thence on a curve to the left, having an initial tangent North 43°36'02" East, having a radius of 430.00 feet and an arc length of 131.07 feet; Thence North 26°08'12" East, 110.99 feet; Thence on a curve to the right, tangent to the last described course, having a radius of 470.00 feet and an arc length of 434.56 feet; Thence on a curve to the right, tangent to the last described course, having a radius of 75.00 feet and an arc length of 129.34 feet; Thence South 02°04'46" East, 62.45 feet; Thence South 87°28'08" East, 50.00 feet; Thence North 02°31'52" East, 57.00 feet; Thence on a curve to the right, tangent to the last described course, having a radius of 70.00 feet and an arc length of 109.96 feet; Thence South 87°28'08" East, 265.53 feet; Thence on a curve to the right, tangent to the last described course, having a radius of 40.00 feet and an arc length of 63.79 feet to the West Right–of–Way line of said SW Ward Road; Thence along said West Right–of–Way line the following three courses; Thence South 04°28'39" West, 211.75 feet; Thence South 07°28'42" West, 158.69 feet to the Point of Beginning. Contains 499,350 square feet or 11.46 acres more or less.

SURVEY CONTROL POINTS				
Point #	Northing	Easting	Elevation	Description
1	974540.74	2824139.37	993.44	JA–137
40	978301.91	2817160.68	977.88	SQUARE CUT IN CURB INLET
41	978327.36	2816366.85	1004.50	SQUARE CUT IN CURB INLET
50	978308.82	2817086.59	981.07	"+" CUT IN SIDEWALK
51	978327.61	2816255.51	1007.48	"+" CUT IN SIDEWALK

BENCHMARK:

JA–137: KC Metro Aluminum GRS Disk, located approximately 0.7 miles South of intersection Highway 150 and Highway 291, 32' East of the center of Highway 291.
Elevation = 993.44

CLIENT:

Kimley Horn

PROPERTY LOCATION:

NE corner M–150 & SW Ward Road
Lee's Summit, MO

VICINITY MAP
SEC. 25–47–32
N.T.S.

LEGEND

⊕	BENCHMARK
△	SECTION CORNER AS NOTED
⬠	MONUMENT FOUND AS NOTED
⬟	SET MONUMENT AS NOTED
○	FOUND 1/2" IRON BAR AT CORNER UNLESS OTHERWISE NOTED
●	SET 1/2" IRON BAR AT CORNER W/ J & J CAP
(P)	PLATTED DISTANCE
(M)	MEASURED DISTANCE
(D)	DESCRIBED DISTANCE IN MODOT R/W PLANS
I.E.	INGRESS/EGRESS EASEMENT
W/E	WATER EASEMENT
U/E	UTILITY EASEMENT
✿	EXISTING TREE
W	WATER METER
⊗ WV	WATER VALVE
♁	FIRE HYDRANT
◎ SMH	SANITARY MANHOLE
◎ STMH	STORM MANHOLE
⊞ PP	POWER POLE
⌖	LIGHT POLE
⊕ TSP	TRAFFIC SIGNAL POLE
⟜	GUY WIRE
T	TELEPHONE PEDESTAL
⊖	SIGN AS NOTED
FOM	FIBER OPTIC MARKER
—— S ——	SANITARY SEWER LINE
— — — —	STORM LINE
—— OHE ——	OVERHEAD ELECTRIC
—— W ——	UNDERGROUND WATER
— — WS — —	WATER SERVICE
—— T ——	TELEPHONE
—— FO ——	FIBER OPTIC LINE
—— CATV ——	CABLE
⌒⌒⌒⌒	TREE LINE

CERTIFICATION:

To Milhaus Properties LLC, an Indiana limited liability company and Chicago Title Insurance Company:

This is to certify that this map or plat and the survey on which it is based were made in accordance with the 2016 Minimum Standard Detail Requirements for ALTA/NSPS Land Title Surveys, jointly established and adopted by ALTA and NSPS, and includes Items 1, 2, 3, 4, 7a, 8, 9, 10, 12 and 13 of Table A thereof. The field work was completed on the 26th day of October, 2022.

JOHN B. YOUNG
NUMBER PLS-2006016647

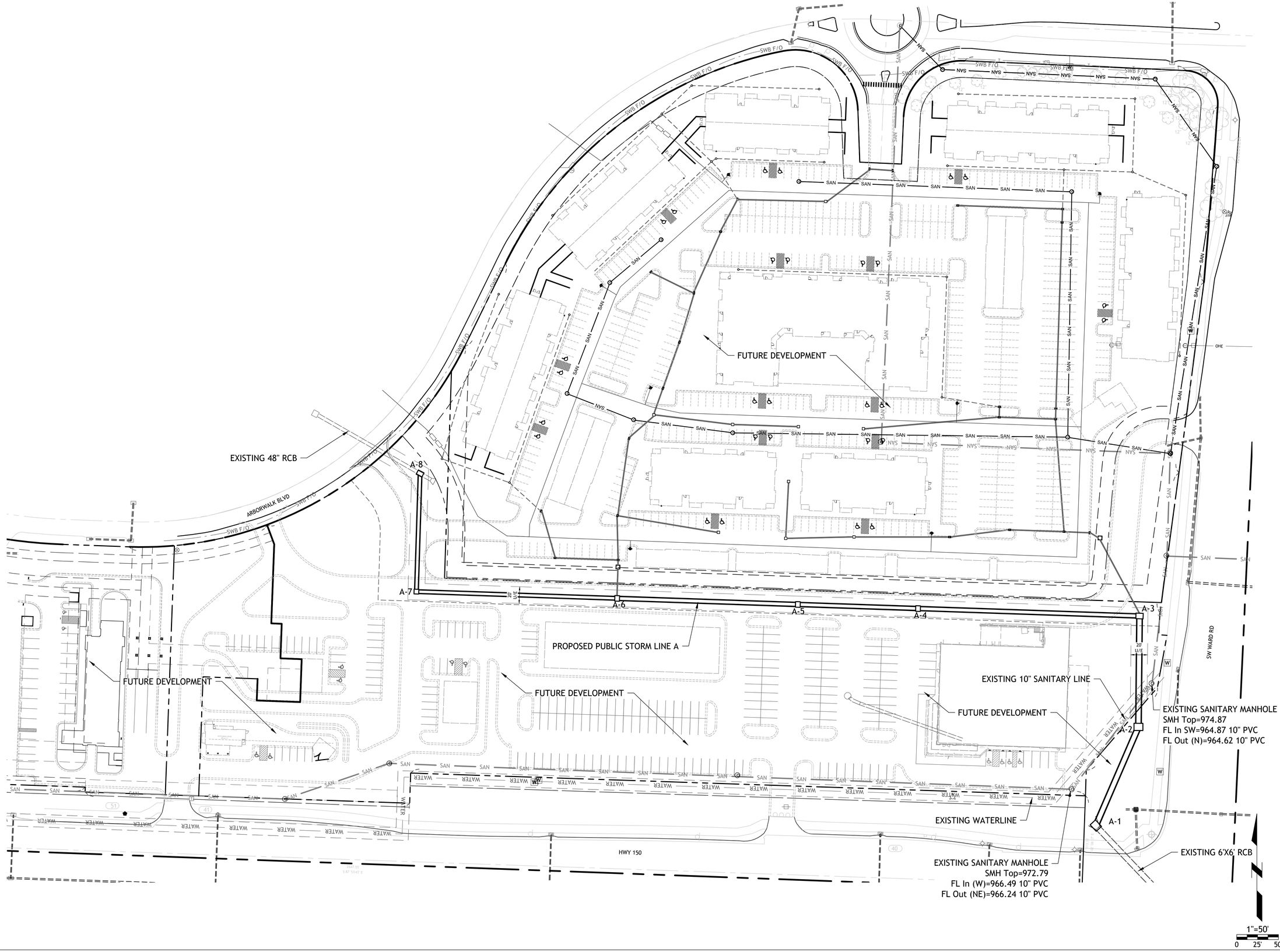
Date 2–2–23
John B. Young, PLS-2006016647

J & J SURVEY LLC
6500 NW TOWER DR., SUITE 102 • PLATTE WOODS, MO 64151
PHONE (816)741-1017 • FAX (816)741-1018

Location: S:\22.408 – NE Corner M–150 & SW Ward Rd\DRAWINGS\2023.01.31–ALTA\22.408ALTA.dwg–Feb 02, 2023–8:33am

1	INITIAL SUBMITTAL	10–28–22
2	ADDED CONTOURS/TOPOGRAPHY	11–11–22
3	REVISED BOUNDARY	12–14–22
4	REVISED BOUNDARY & DESCRIPTION	02–02–23

SHEET 1 OF 1



SM Engineering
5507 High Meadow Circle
Manhattan Kansas, 66503
smcivilengr@gmail.com
785.341.9747

Revisions

PUBLIC STORM LINE
ARBORWALK EAST
LEE'S SUMMITT, MO.

sheet
C3.0
Civil
LAYOUT PLAN
permit
11 APRIL 2023

NOTES:
1. Prior to Land Disturbance activities, the following shall occur:
a) Identify the limits of construcljan on the ground with easily recognizable indications such as construction staking, construction fencing and placement of physical barriers or other means acceptable to the City inspector and in conformance with the erosion and pollution control plan;
b) Construct a stabilized entrance/parking/staging area;
c) Install perimeter controls and protect any existing stormwater inlets;
d) Request an initial inspection of the installed Phase I pollution control measures designated on the approved erosion and pollution control plan. Land disturbance work shall not proceed until there is a passed inspection

2. The site shall comply with all requirements of the MoDNR general requirements
a) Immediate initiation of temporary stabilization BMPs on disturbed areas where construction activities have temporarily ceased on that portion of the project site if construction activities will not resume for a period exceeding 14 calendar days. Temporary stabilization may include establishment of vegetation, geotextiles, mulches or other techniques to reduce or eliminate erosion until either final stabilization con be achieved or until further construction activities take place to re-disturb the area. This stabilization must be completed within 14 calendar days;
b) Inspection of erosion and sediment control measures shall be performed to meet or exceed the minimum inspection frequency in the MoDNR General Permit. At a minimum, inspections shall be performed during all phases of construction at least once every 14 days and within 24 hours of each precipitation event.
c) An inspection log shall be maintained and shall be available for review by the regulatory authority;
d) The erosion and pollution control plan shall be routinely updated to show all modifications and amendments to the original plan. A copy of the erosion and pollution control plan shall be kept on site and made available for review by the regulatory authority.

3. Temporary seeding shall only be used for periods not to exceed 12 months. For final stabilization. temporary seeding shall only be used to establish vegetation outside the permanent seeding or sodding dates as specified in the Standard Specifications. Final stabilization requires a uniform perennial vegetative cover with a density of 70% over 100% of disturbed area.

4. Erosion and pollution control shall be provided for the duration of a project. All installed erosion and pollution control BMPs shall be maintained in a manner that preserves their effectiveness. If the City determines that the BMPs in place do not provide adequate erosion and pollution control at any time during the project, additional or alternate measures that provide effective control shall be required.

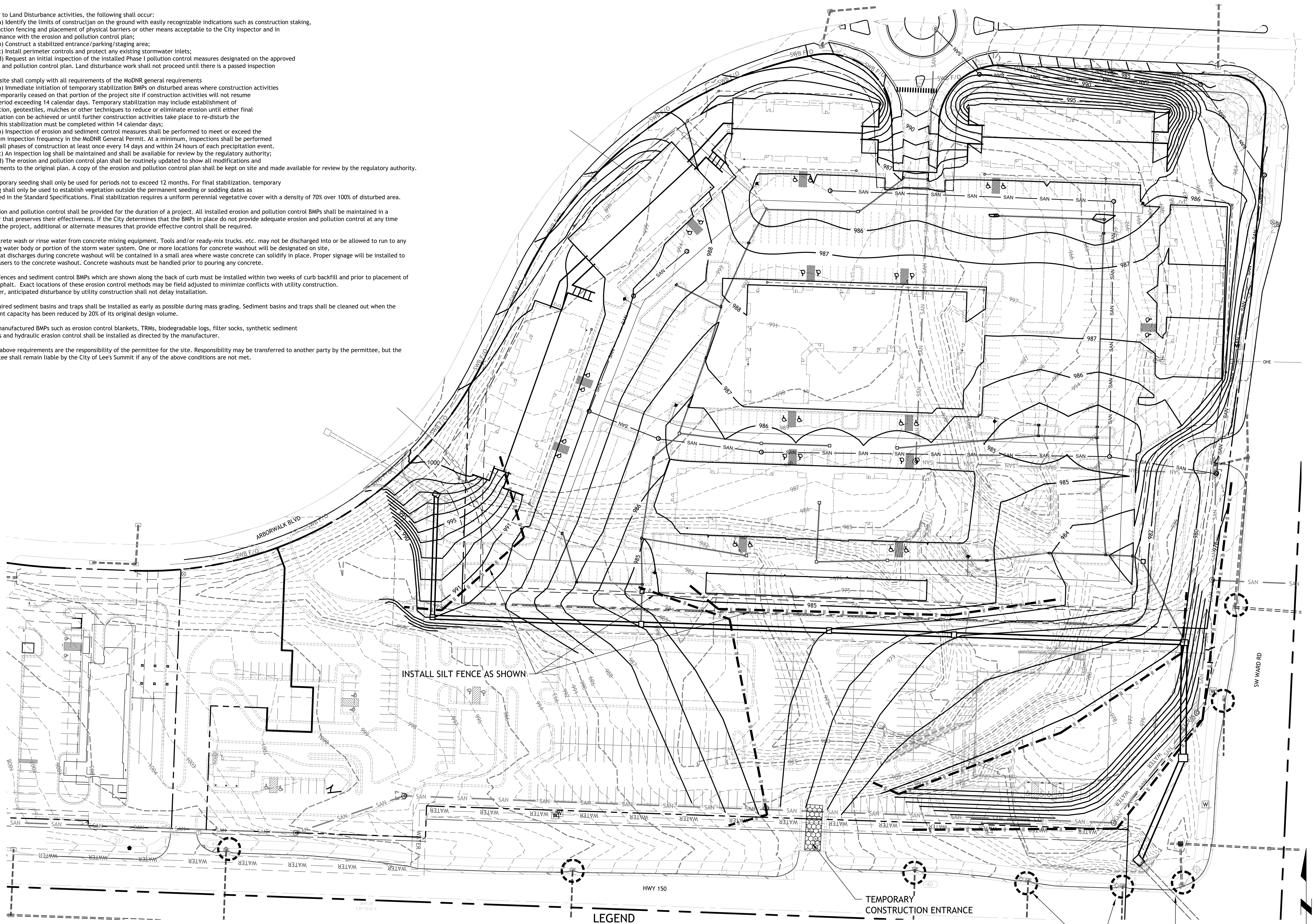
5. Concrete wash or rinse water from concrete mixing equipment. Tools and/or ready-mix trucks. etc. may not be discharged into or be allowed to run to any existing water body or portion of the storm water system. One or more locations for concrete washout will be designated on site, such that discharges during concrete washout will be contained in a small area where waste concrete can solidify in place. Proper signage will be installed to direct users to the concrete washout. Concrete washouts must be handled prior to pouring any concrete.

6. Silt fences and sediment control BMPs which are shown along the back of curb must be installed within two weeks of curb backfill and prior to placement of base asphalt. Exact locations of these erosion control methods may be field adjusted to minimize conflicts with utility construction. However, anticipated disturbance by utility construction shall not delay installation.

7. Required sediment basins and traps shall be installed as early as possible during mass grading. Sediment basins and traps shall be cleaned out when the sediment capacity has been reduced by 20% of its original design volume.

8. All manufactured BMPs such as erosion control blankets, TRMs, biodegradable logs, filter socks, synthetic sediment barriers and hydraulic erasion control shall be installed as directed by the manufacturer.

9. The above requirements are the responsibility of the permittee for the site. Responsibility may be transferred to another party by the permittee, but the permittee shall remain liable by the City of Lee's Summit if any of the above conditions are not met.



LEGEND

SILT FENCE

INLET PROTECTION

TEMPORARY CONSTRUCTION ENTRANCE

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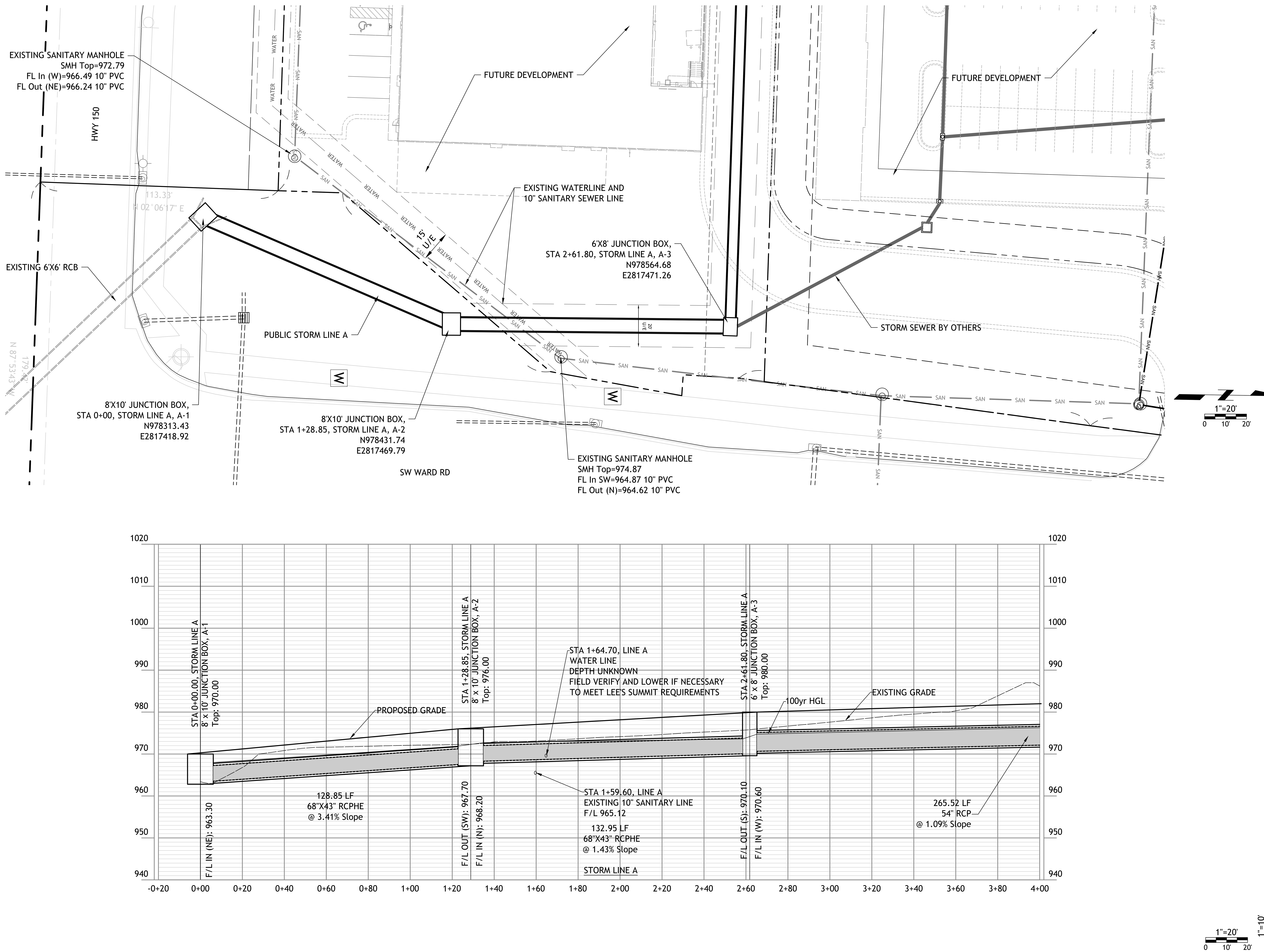
Revisions

PUBLIC STORM LINE
ARBORWALK EAST

LEE'S SUMMIT, MO.

1"=50'
0 25' 50'

sheet
C4.0
Civil
GRADING/EROSION CONTROL PLAN
permit
11 APRIL 2023



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Revisions

PUBLIC STORM LINE ARBORWALK EAST

LEE'S SUMMIT, MO.

sheet
C5.0
Civil
STORM LINE A
PLAN AND PROFILE
permit
11 APRIL 2023

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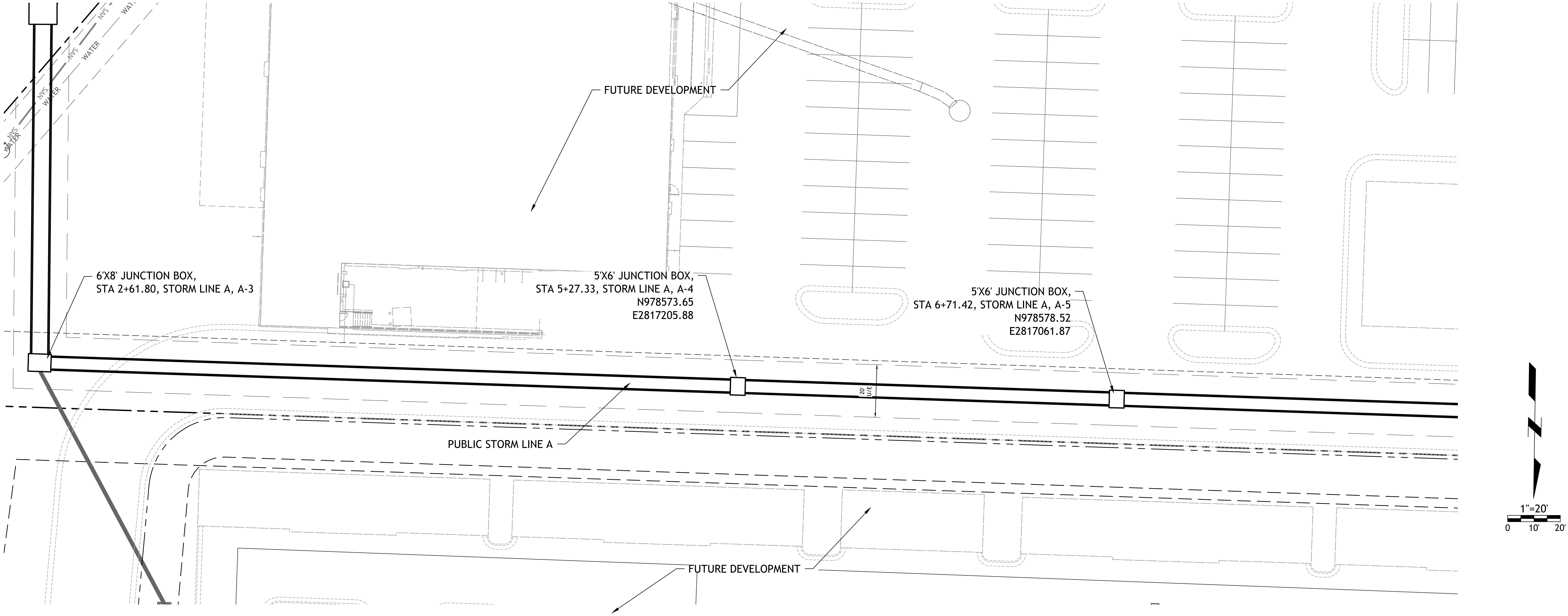
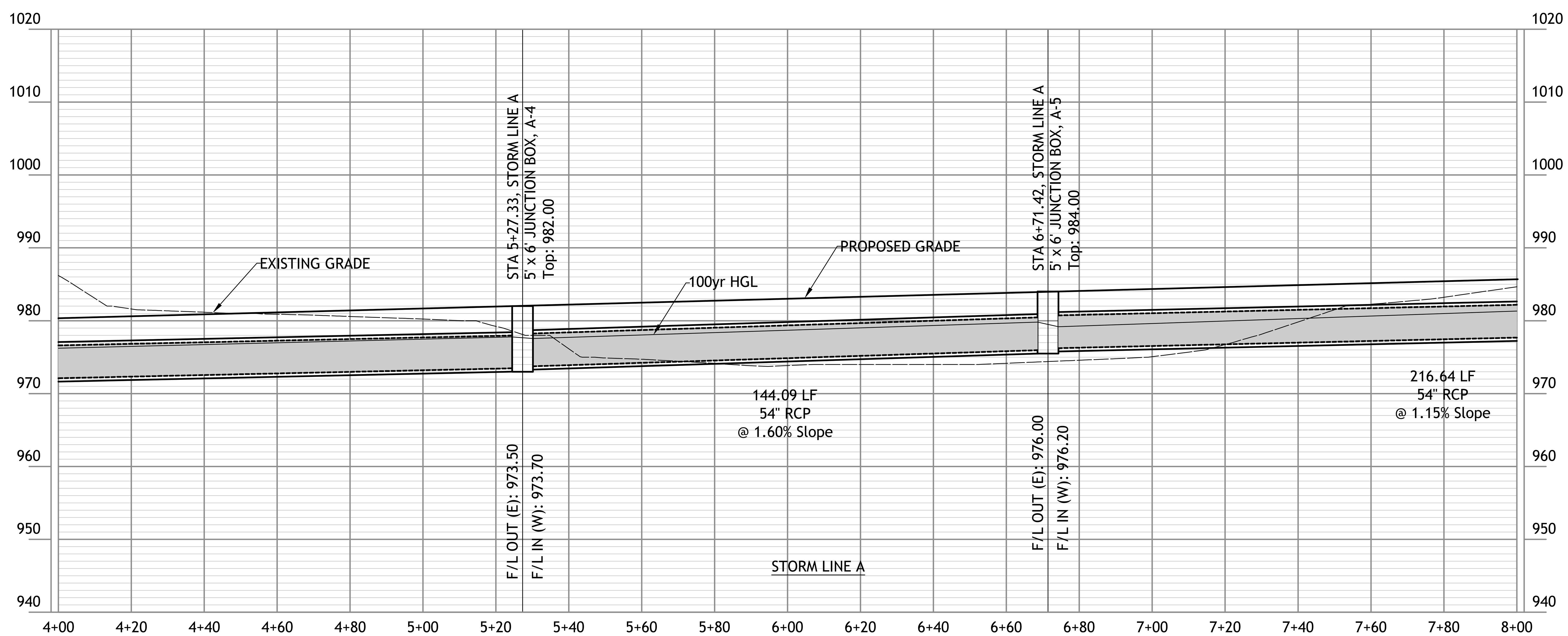
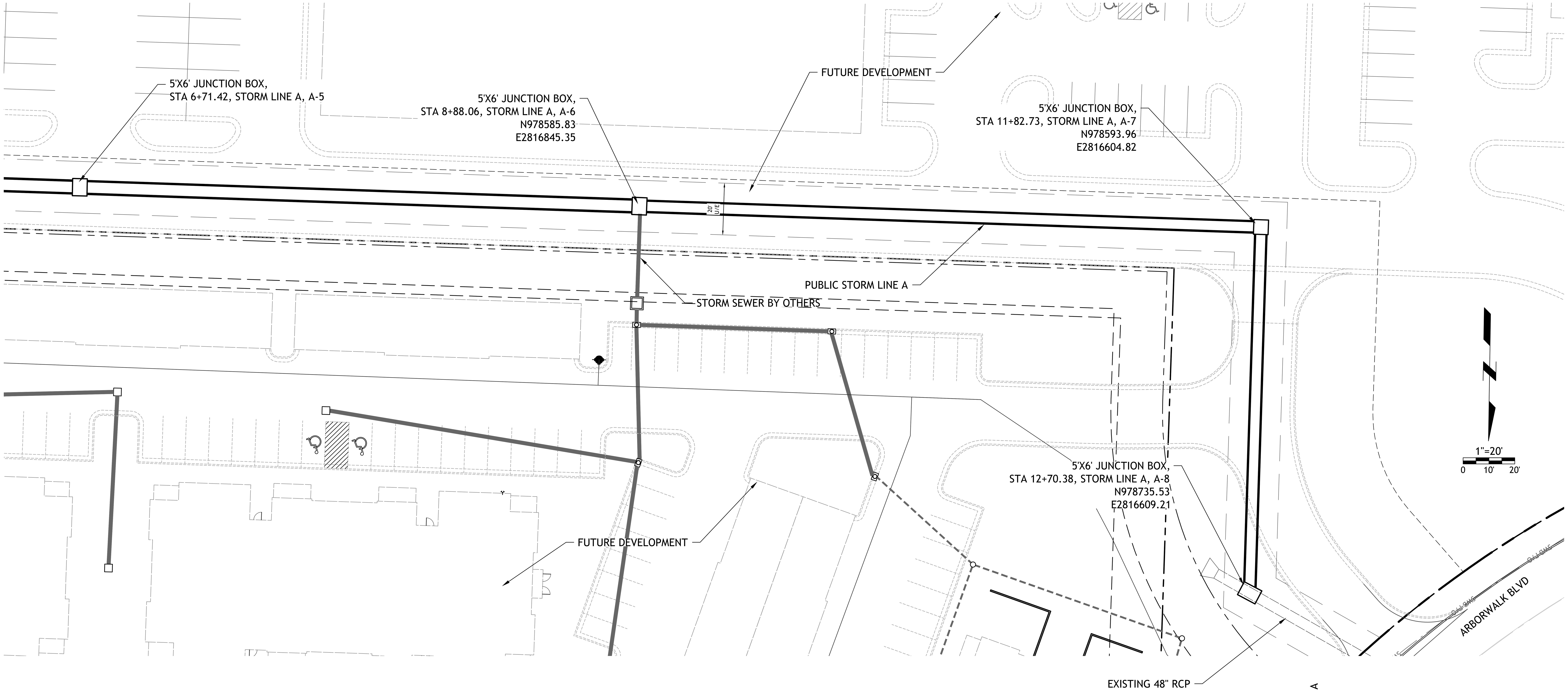
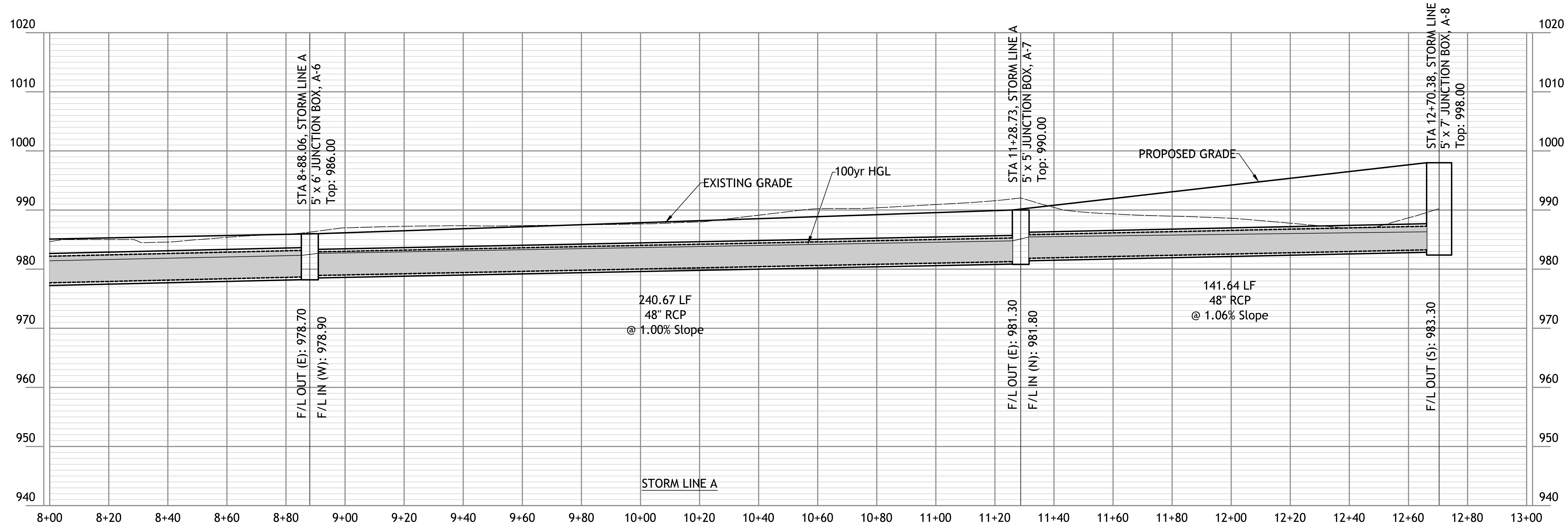




PUBLIC STORM LINE
ARBORWALK EAST
LEE'S SUMMITT, MO.

sheet
C6.0
Civil
STORM LINE A
PLAN AND PROFILE
permit
11 APRIL 2023





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Revisions

PUBLIC STORM LINE
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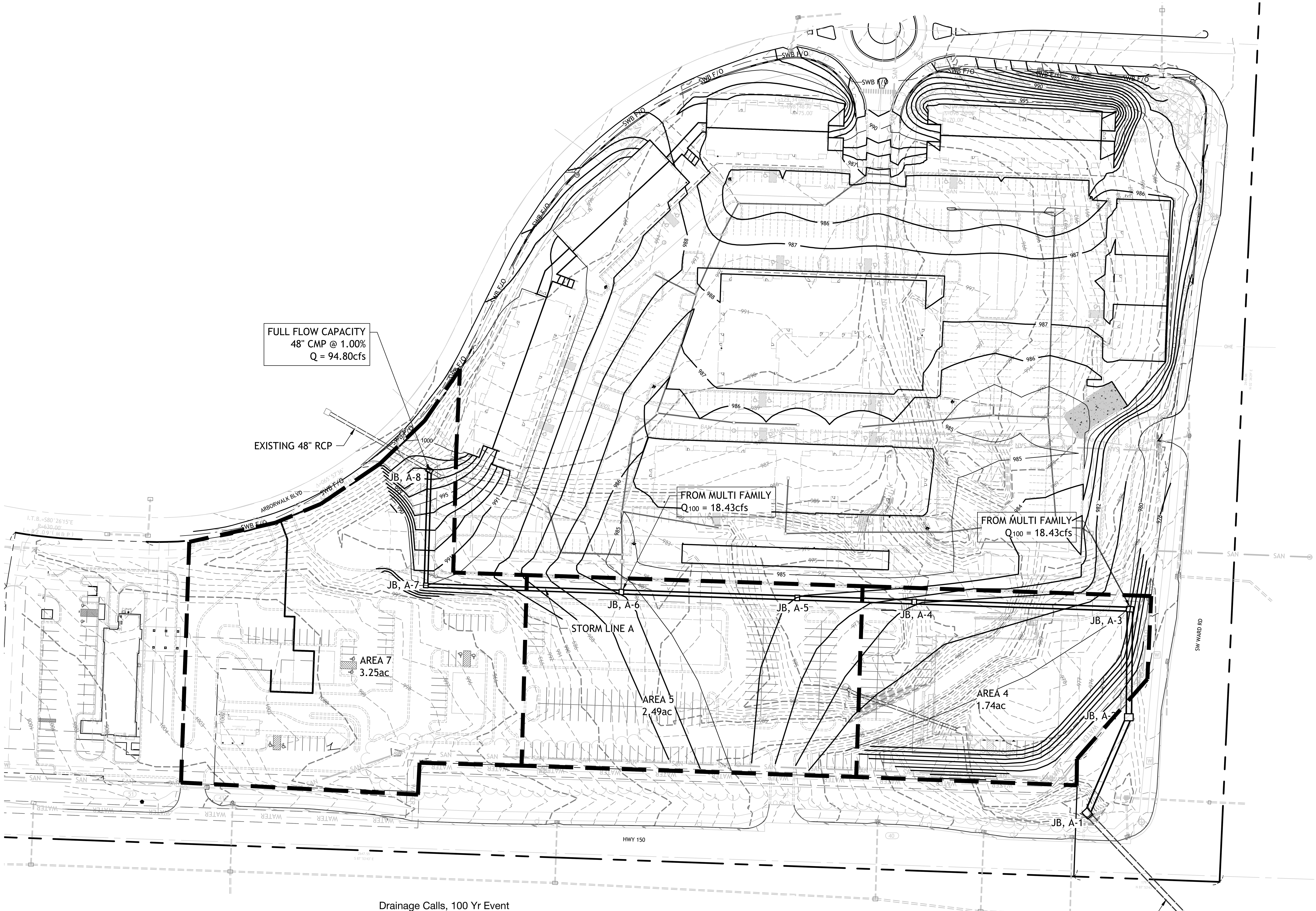
sheet
C7.0
Civil
STORM LINE A
PLAN AND PROFILE
permit
11 APRIL 2023



Drainage Calls, 100 Yr Event

Line No.	Line ID	Area ID	Drain Area	Runoff Coeff	Inlet Time	Incr Q	Known Q	Flow Rate	Line Length	Line Size	Vel Ave	Capac. Full	Invert Dn	Invert Up	Line Slope	Grnd/Rim Elev Up	HGL Dn	HGL Up	HGL Junct
			(ac)	(C)	(min)	(cfs)	(cfs)	(cfs)	(ft)	(in)	(ft/s)	(cfs)	(ft)	(ft)	(ft/ft)	(ft)	(ft)	(ft)	(ft)
1	A2-A1		0.000	0.00	0.0	0.00	0.00	202.89	128.90	43 x 68e	12.72	358.21	963.30	967.70	0.0341	0.00	966.88	971.28	971.28
2	A3-A2		0.000	0.00	0.0	18.43	18.43	203.31	132.95	43 x 68e	12.88	231.89	968.20	970.10	0.0143	980.00	972.28	973.50	973.50
3	A4-A3	A4	1.740	0.81	5.0	18.18	0.00	185.67	265.50	54	13.25	205.48	970.60	973.50	0.0109	982.00	974.12	977.44	977.44
4	A5-A4	A5	2.490	0.81	5.0	26.01	0.00	168.25	144.10	54	13.23	248.46	973.70	976.00	0.016	984.00	976.78	979.72	979.72
5	A6-A5		0.000	0.00	0.0	18.43	18.43	143.06	216.60	54	11.98	210.90	976.20	978.69	0.0115	986.00	979.15	982.12	982.12
6	A7-A6	A7	3.250	0.72	5.0	30.18	0.00	124.98	240.70	48	11.77	143.65	978.90	981.31	0.01	990.00	981.92	984.61	984.61
7	A8-A7	Pond Outlet	0.000	0.00	0.0	94.80	94.80	94.80	141.60	48	10.51	148.91	981.80	983.32	0.0107	998.00	984.34	986.21	986.71

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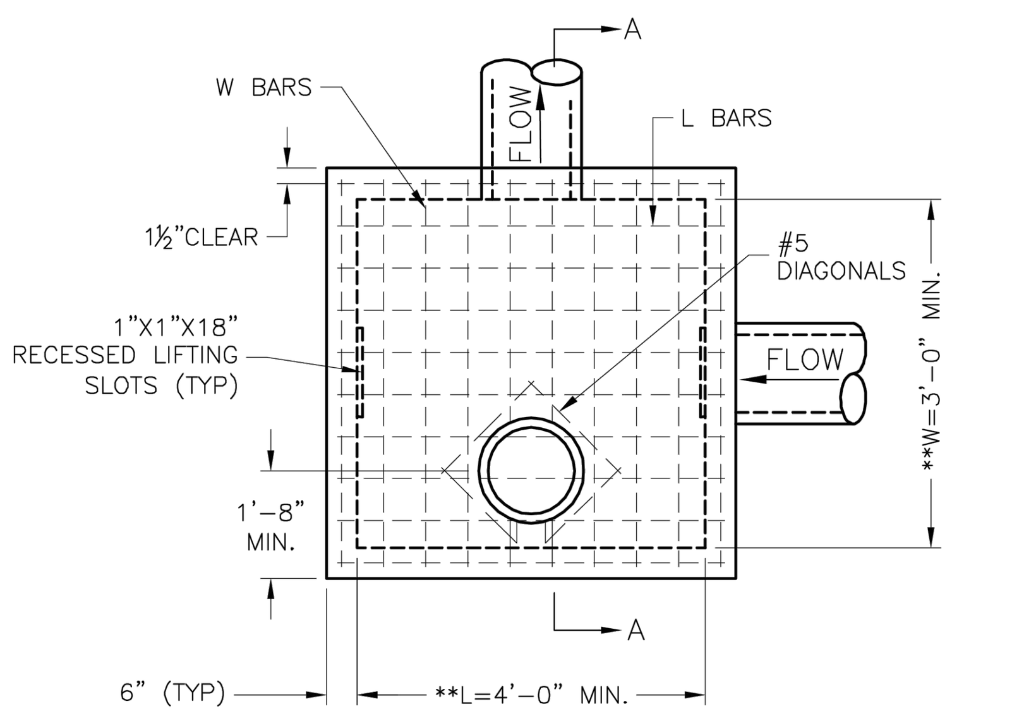
Revisions

PUBLIC STORM LINE
ARBORWALK EAST

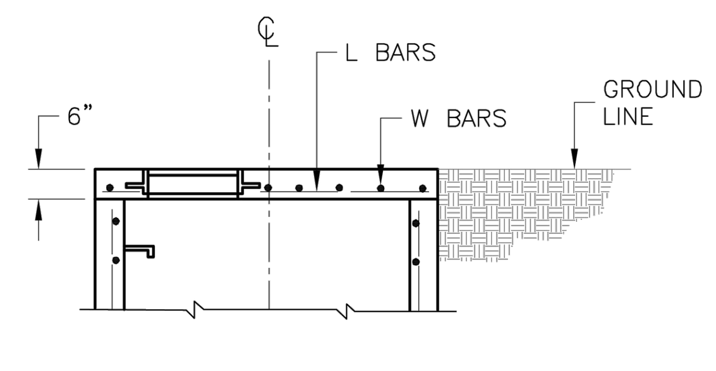
LEE'S SUMMITT, MO.

sheet
C8.0
Civil
DRAINAGE PLAN

permit
11 APRIL 2023



PLAN

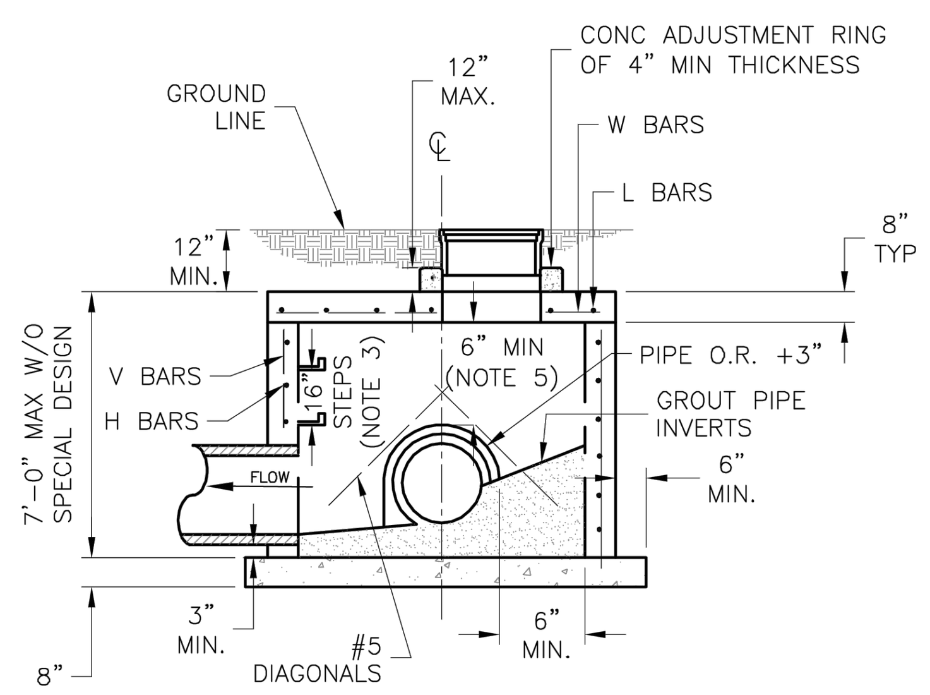


SLAB TOP ALTERNATE FOR JUNCTION BOX (SHALLOW)

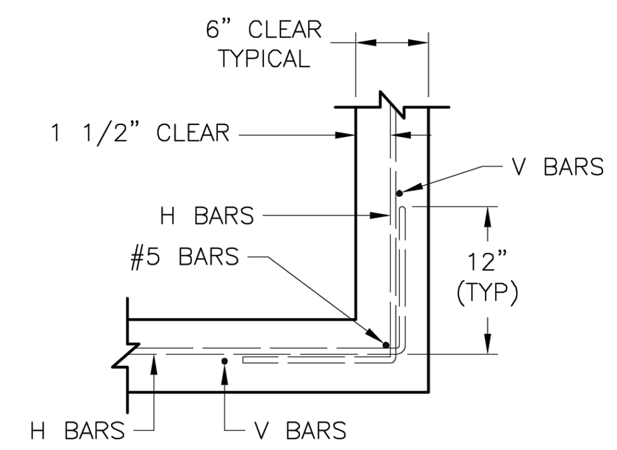
** INCREASE IN MULTIPLES OF 6" (7'-0") MAX WITHOUT SPECIAL DESIGN. (SEE PROJECT PLANS FOR DETAILS)

REINFORCING

BARS	BAR SIZE	SPACING (IN.)
H	4	12
V	4	12
L	5	6
W	5	6



SECTION A–A



WALL CORNER DETAIL

GENERAL NOTES:

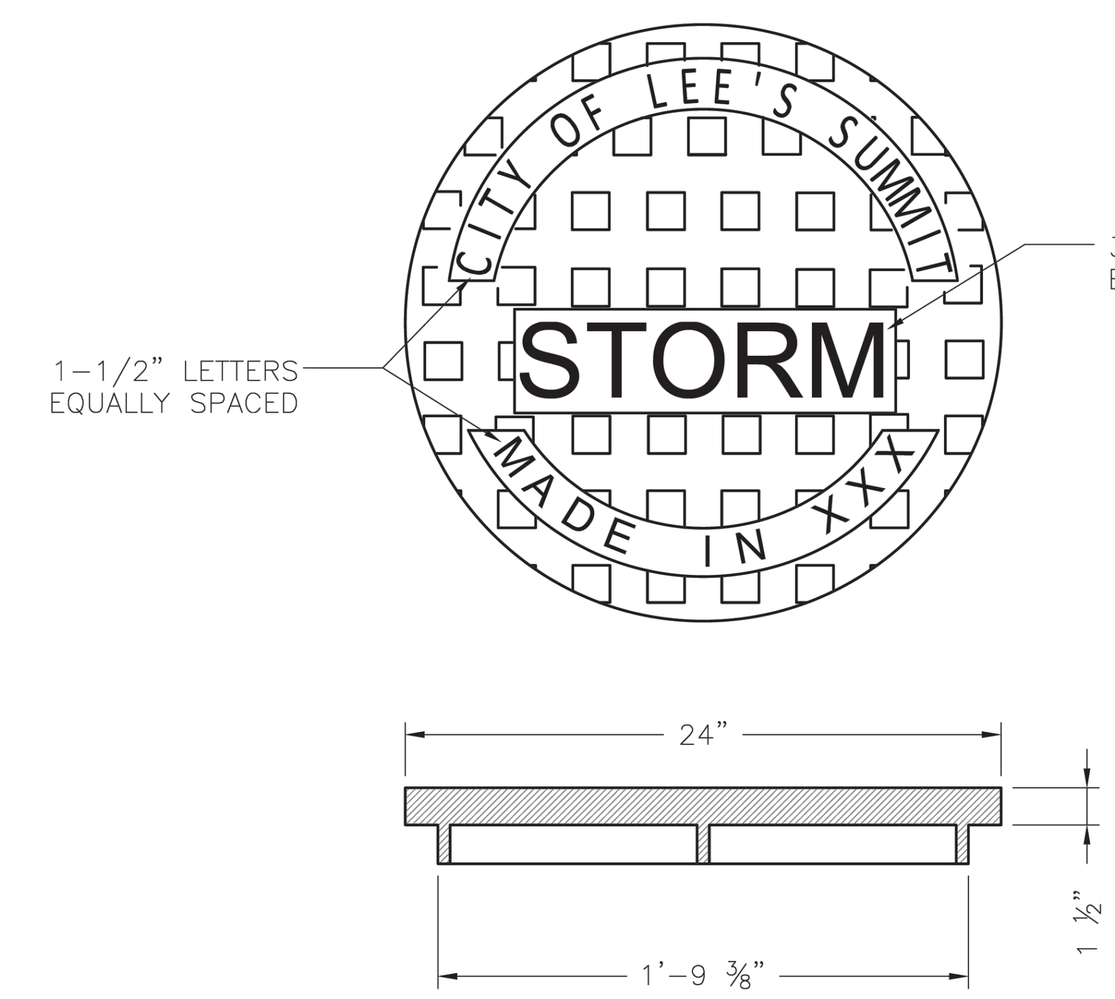
1. LOCATE RING AND COVER ON BLANK WALL.
2. USE ¾" CHAMFER STRIP OR ½" R EDGER TOOL ON ALL EXPOSED CONCRETE CORNERS.
3. STEPS REQUIRED AT 16" O.C. WHEN DEPTH FROM TOP OF CASTING TO INVERT EXCEEDS 4' ON BLANK WALL IF POSSIBLE.
4. BOXOUTS WILL NOT BE ALLOWED TO PROJECT THROUGH THE CORNERS OF THE STRUCTURE AND THE MINIMUM DISTANCE BETWEEN BOXOUTS IS 6".
5. THE MINIMUM REINFORCING SHALL BE 1 H–BAR OVER A CAST–IN–PLACE PIPE AND 2 H–BARS OVER A PRECAST BOXOUT.
8. PRECAST LIDS SHALL BE PINNED, SEALED WITH NON–SHRINKABLE GROUT AND REMOVABLE FOR FUTURE MAINTENANCE.
9. REINFORCING OF COVERS IN STREETS REQUIRE SPECIAL DESIGN.
10. FOR RING AND COVER SEE THE STORMWATER APPROVED PRODUCT LIST.

LEE'S SUMMIT MISSOURI
PUBLIC WORKS ENGINEERING DIVISION | 220 SE GREEN STREET | LEE'S SUMMIT, MO 64063

Project: STANDARD DETAILS CITY OF LEE'S SUMMIT, MO LEE'S SUMMIT, JACKSON COUNTY, MO
Sheet Name: JUNCTION BOX DETAIL

Drawn By: MJF
Checked By: DL
Date: 04/17
Proj. #:

STM-3



STANDARD 24" MANHOLE COVER
MINIMUM WEIGHT = 160 LB
NOTE: PICK HOLES NOT SHOWN

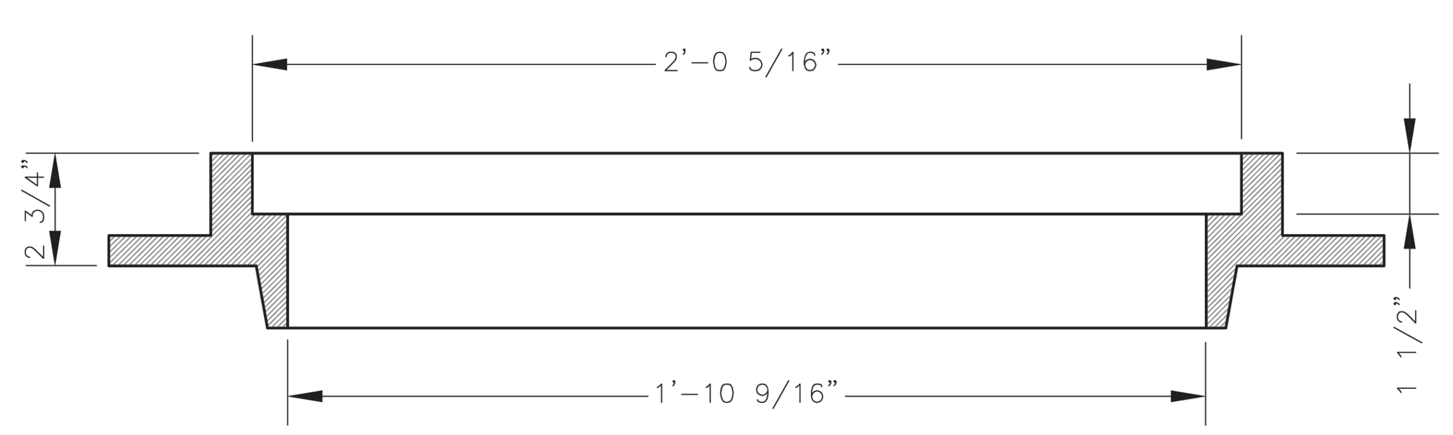
*COVER AND FRAME MODEL INFORMATION REFER TO THE STORMWATER APPROVED PRODUCT LIST.

LEE'S SUMMIT MISSOURI
PUBLIC WORKS ENGINEERING DIVISION | 220 SE GREEN STREET | LEE'S SUMMIT, MO 64063

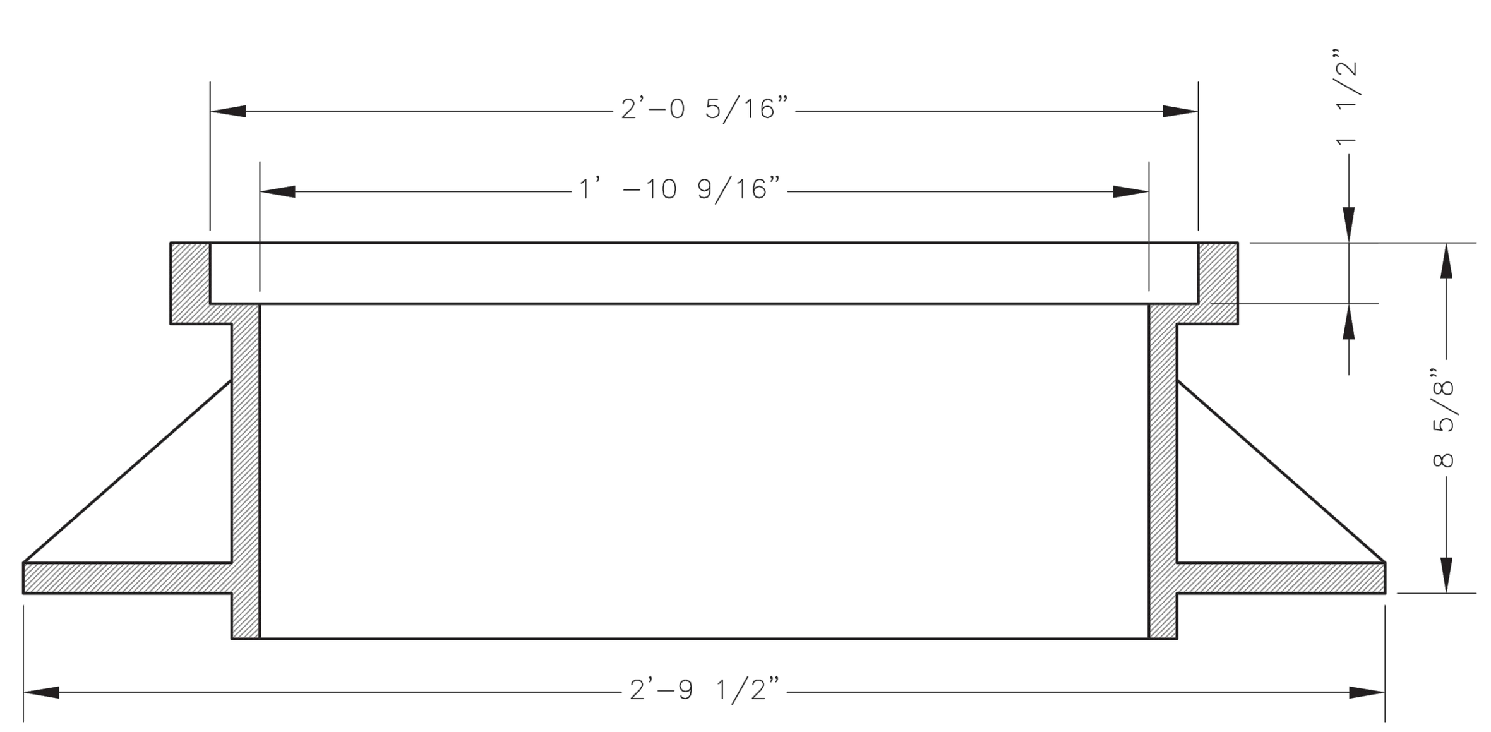
Date: 05/2021
Drawn By: MJF
Checked By: DL

STORM MANHOLE COVER DETAIL

STM-6



SLAB MANHOLE FRAME
LEE'S SUMMIT PART NO.: LS103A
MINIMUM WEIGHT = 145 LB



STANDARD 24" MANHOLE FRAME
LEE'S SUMMIT PART NO.: LS101A
MINIMUM WEIGHT = 250 LB

*COVER AND FRAME MODEL INFORMATION REFER TO THE STORMWATER APPROVED PRODUCTS LIST.

LEE'S SUMMIT MISSOURI
PUBLIC WORKS ENGINEERING DIVISION | 220 SE GREEN STREET | LEE'S SUMMIT, MO 64063

Date: 05/2021
Drawn By: MJF
Checked By: DL

STORM MANHOLE FRAME DETAIL

DWG-7

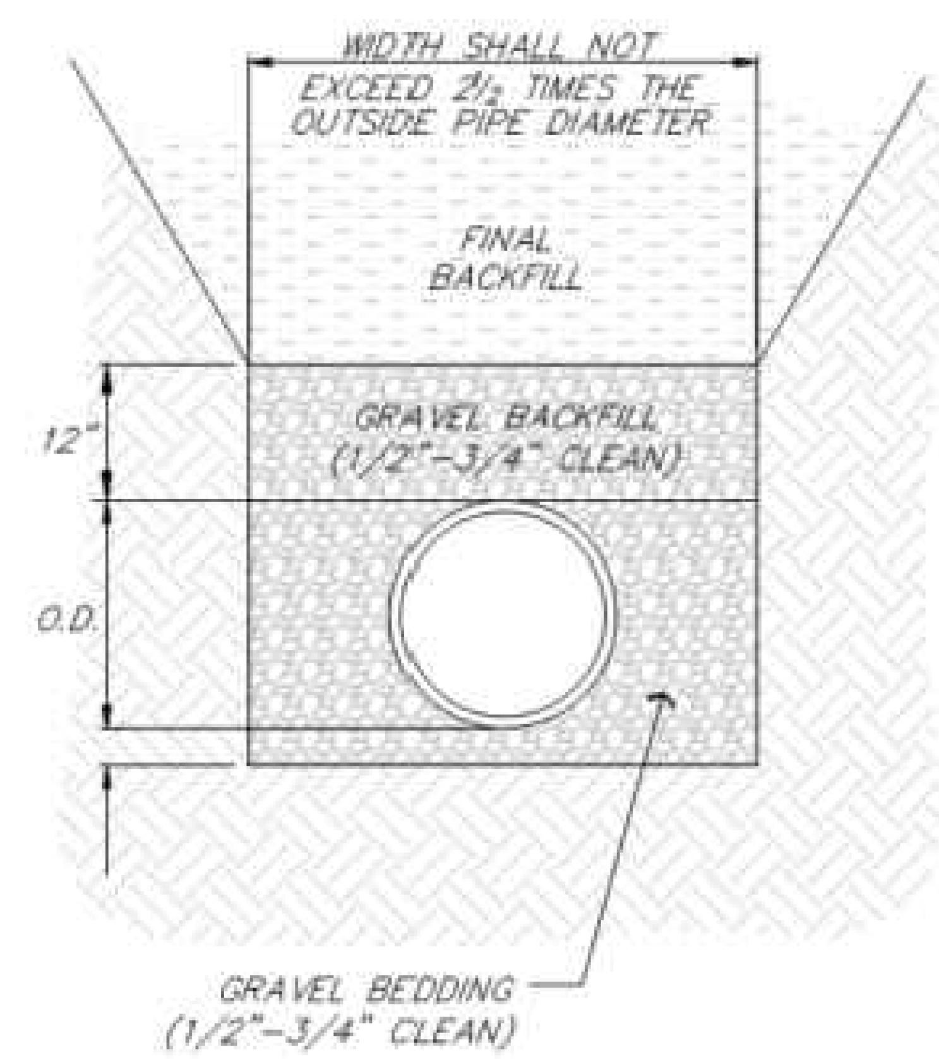
NOTE:
FOR ALL JUNCTION BOXES EXCEEDING 7'-0" IN DEPTH, THE PRECAST BOX MANUFACTURER SHALL PROVIDE AN ENGINEERED DESIGN.

BEDDING
1/2"–3/4" CLEAN AGGREGATE, HAND TAMPED OR MECHANICALLY COMPACTED IN MAX. 4" LIFTS

INITIAL BACKFILL
–UNDER PAVED AREAS OR WITHIN 4' HORIZONTAL OF PAVED AREAS
1/2"–3/4" CLEAN AGGREGATE, HAND TAMPED OR MECHANICALLY COMPACTED IN MAX. 4" LIFTS
–UNDER OPEN AREAS
1/2"–3/4" CLEAN AGGREGATE, HAND TAMPED OR MECHANICALLY COMPACTED IN MAX. 4" LIFTS

FINAL BACKFILL
–UNDER PAVED AREAS OR WITHIN 4' HORIZONTAL OF PAVED AREAS
ON–SITE OR IMPORTED MATERIAL FREE OF MUCK, FROZEN MATERIAL, EXCESS MOISTURE, ORGANICS, TOPSOIL, RUBBISH, CONSTRUCTION DEBRIS, ROCK OR BRICK LARGER THAN 8", COMPACTED TO 95% OF STANDARD DENSITY PER ASTM D–698
–UNDER OPEN AREAS
ON–SITE OR IMPORTED MATERIAL FREE OF MUCK, FROZEN MATERIAL, EXCESS MOISTURE, ORGANICS, TOPSOIL, RUBBISH, CONSTRUCTION DEBRIS, ROCK OR BRICK LARGER THAN 8", COMPACTED TO 90% OF STANDARD DENSITY PER ASTM D–698

BEDDING DEPTH BELOW PIPE		
PIPE DIAMETER	IN SOIL	IN ROCK
24" AND LESS	6"	6"
27" THRU 60"	6"	9"



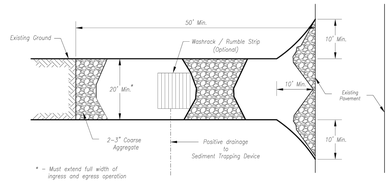
PIPE BEDDING DETAIL
NOT TO SCALE

SM Engineering
5507 High Meadow Circle
Manhattan Kansas, 66503
smcivilengr@gmail.com
785.341.9747

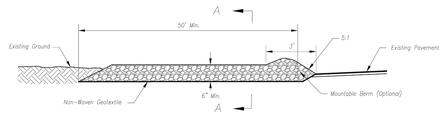
Revisions

PUBLIC STORM LINE
ARBORWALK EAST
LEE'S SUMMIT, MO.

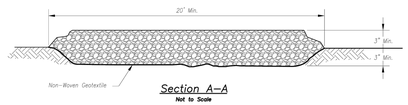
sheet
C9.0
Civil
DETAILS
permit
11 APRIL 2023



Plan View
Not to Scale



Side Elevation
Not to Scale



Section A–A
Not to Scale

Notes for Construction Entrance:

1. Avoid locating on steep slopes, at curves on public roads, or downhill of disturbed area.
2. Remove all vegetation and other unsuitable material from the foundation area, grade, and crown for positive drainage.
3. If slope towards the public road exceeds 2%, construct a 6– to 8–inch high ridge with 3H:1V side slopes across the foundation approximately 15 feet from the edge of the public road to divert runoff from it.
4. Install pipe under the entrance if needed to maintain drainage ditches along public roads.
5. Place stone to dimensions and grade as shown on plans. Leave surface sloped for drainage.
6. Divert all surface runoff and drainage from the entrance to a sediment control device.
7. If conditions warrant, place geotextile fabric on the graded foundation to improve stability.

Maintenance for Construction Entrance:

1. Reshape entrance as needed to maintain function and integrity of installation. Top dress with clean aggregate as needed.

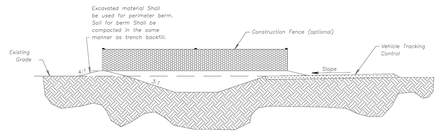
CONSTRUCTION ENTRANCE

Notes for Concrete Washout:

1. Concrete washout areas shall be installed prior to any concrete placement on site.
2. Concrete washout area shall include a flat subsurface pit sized relative to the amount of concrete to be placed on site. The slopes leading out of the subsurface pit shall be 3:1. The vehicle tracking pad shall be sloped towards the concrete washout area.
3. Vehicle tracking control is required at the access point to all concrete washout areas.
4. Signs shall be placed at the construction site entrance, washout area and elsewhere as necessary to clearly indicate the location(s) of the concrete washout area(s) to operators of concrete truck and pump rigs.
5. A one–piece impervious liner may be required along the bottom and sides of the subsurface pit in sandy or gravelly soils.

Maintenance for Concrete Washout:

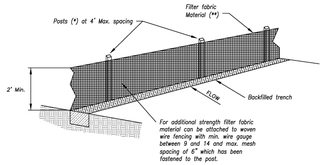
1. Concrete washout materials shall be removed once the materials have filled the washout to approximately 75% full.
2. Concrete washout areas shall be enlarged as necessary to maintain capacity for wasted concrete.
3. Concrete washout water, wasted pieces of concrete and all other debris in the subsurface pit shall be transported from the job site in a water–tight container and disposed of properly.
4. Concrete washout areas shall remain in place until all concrete for the project is placed.
5. When concrete washout areas are removed, excavations shall be filled with suitable compacted backfill and topsoil, any disturbed areas associated with the installation, maintenance, and/or removal of the concrete washout areas shall be stabilized.



CONCRETE WASHOUT

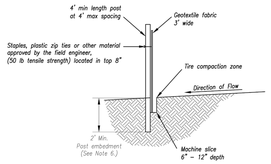
Construction Entrance modified from 2015 Overland Park Standard Details for Erosion and Sediment Control; Concrete Washout modified from 2009 City of Great Bend Standard Drawings.

AMERICAN PUBLIC WORKS ASSOCIATION	
Kansas City Metro Chapter APWA AMERICAN PUBLIC WORKS ASSOCIATION	KANSAS CITY METRO CHAPTER
CONSTRUCTION ENTRANCE AND CONCRETE WASHOUT	STANDARD DRAWING NUMBER ESC-01 ADOPTED: 10/24/2016



(*) POSTS
- MIN. LENGTH 4'
- HARDWOOD 1 ½" x 1 ½"
- NO.2 SOUTHERN PINE 2 ⅛" x 2 ⅛"
- STEEL 1.33 LB/FT

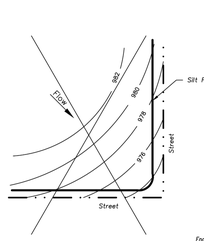
(**) – Geotextile Fabric shall meet the requirements of AASHTO M288



Notes:

1. In order to contain water, the ends of the silt fence must be turned uphill (Figure A).
2. Long perimeter runs of silt fence must be limited to 100'. Runs should be broken up into several smaller segments to minimize water concentrations (Figure A).
3. Long slopes should be broken up with intermediate rows of silt fence to slow runoff velocities.
4. Attach fabric to upstream side of post.
5. Install posts a minimum of 2' into the ground.
6. Trenching will only be allowed for small or difficult installation, where slicing machine cannot be reasonably used.

SILT FENCE DETAILS
Not to Scale



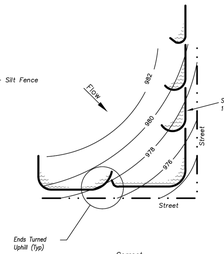
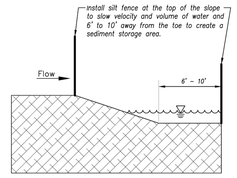
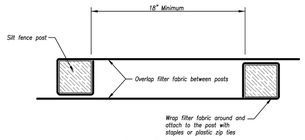


Figure A

SILT FENCE LAYOUT
Not to Scale





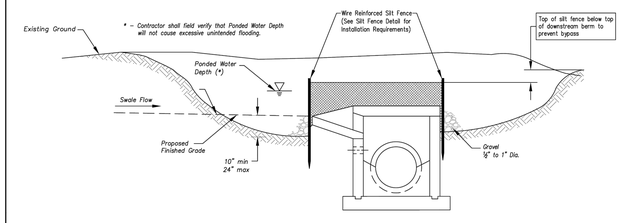
JOINING FENCE SECTIONS
Not to Scale

Maintenance:

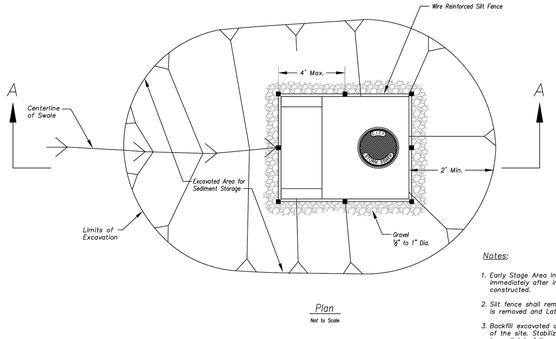
1. Remove and dispose of sediment deposits when the deposit approaches ½ the height of silt fence.
2. Repair as necessary to maintain function and structure.

Modified from 2015 Overland Park Standard Details for Erosion and Sediment Control.

AMERICAN PUBLIC WORKS ASSOCIATION	
Kansas City Metro Chapter APWA AMERICAN PUBLIC WORKS ASSOCIATION	KANSAS CITY METRO CHAPTER
SILT FENCE	STANDARD DRAWING NUMBER ESC-03 ADOPTED: 10/24/2016



Section A–A
Not to Scale

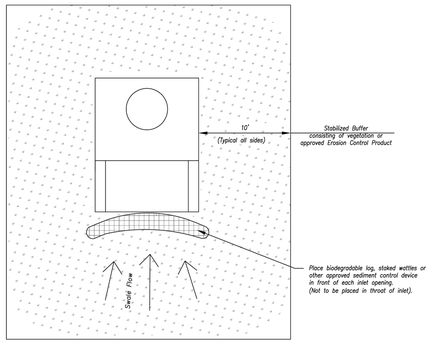


Plan
Not to Scale

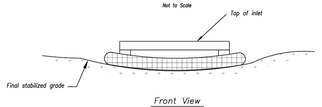
EARLY STAGE AREA INLET
(All open boxes and inlets not at final grade)

Notes:

1. Early Stage Area Inlet Sediment Barrier to be installed immediately after inlet or junction box is constructed.
2. Silt fence shall remain in place until excavated area is removed and Late Stage Area Inlet is being installed.
3. Backfill excavated area ONLY after final grading of the site. Stabilization of the site is to immediately follow.
4. Wire reinforced silt fence may be used in place of silt fence attached to wood frame.



Plan
Not to Scale



Front View

LATE STAGE AREA INLET
(Area inlets at final grade and existing inlets)

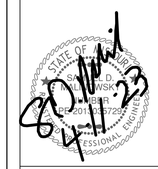
Maintenance:

1. Remove deposited sediment from excavated storage areas when available storage has been reduced by 20%.
2. Remove deposited sediment from filter socks or similar when any accumulation of sediment is visible.
3. Repair or replace as necessary to maintain function and integrity of installation.

Modified from 2015 Overland Park Standard Details for Erosion and Sediment Control.

AMERICAN PUBLIC WORKS ASSOCIATION	
Kansas City Metro Chapter APWA AMERICAN PUBLIC WORKS ASSOCIATION	KANSAS CITY METRO CHAPTER
AREA INLET AND JUNCTION BOX PROTECTION	STANDARD DRAWING NUMBER ESC-07 ADOPTED: 10/24/2016

SM Engineering
5507 High Meadow Circle
Manhattan Kansas, 66503
smcivilengr@gmail.com
785.341.9747



Revisions

PUBLIC STORM LINE
ARBORWALK EAST
LEES SUMMITT, MO.

sheet
C10.0
Civil
DETAILS
permit
11 APRIL 2023

Appendix D

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

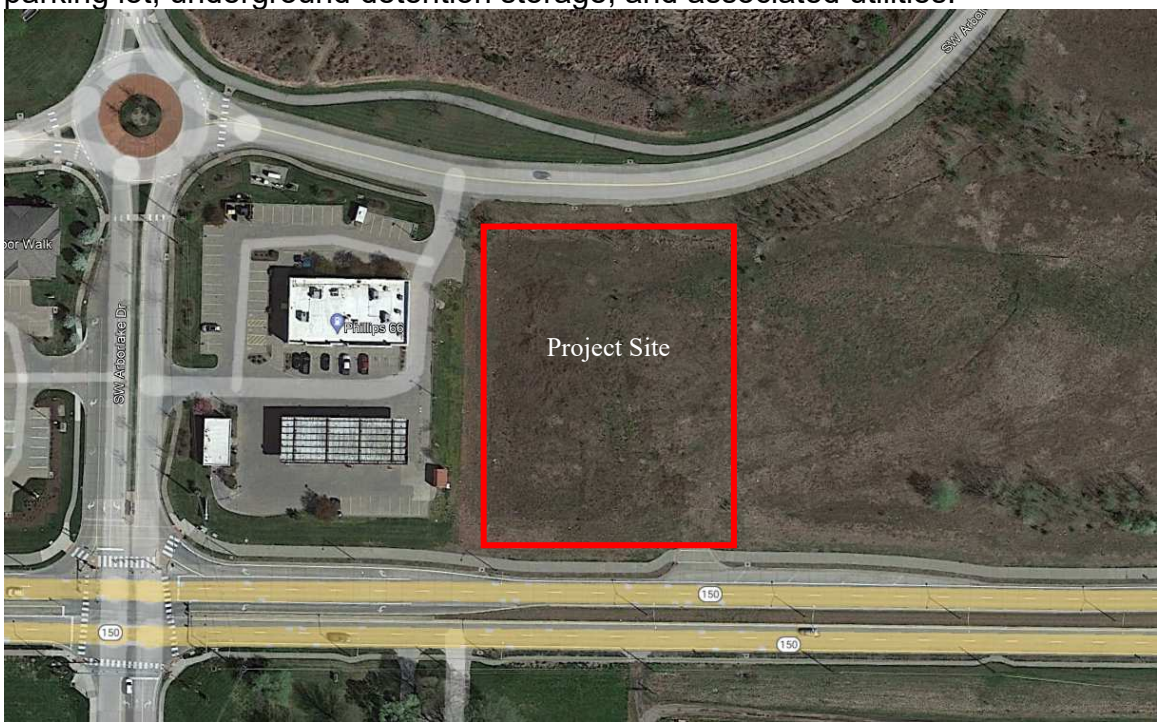
TABLE OF CONTENTS

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

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.

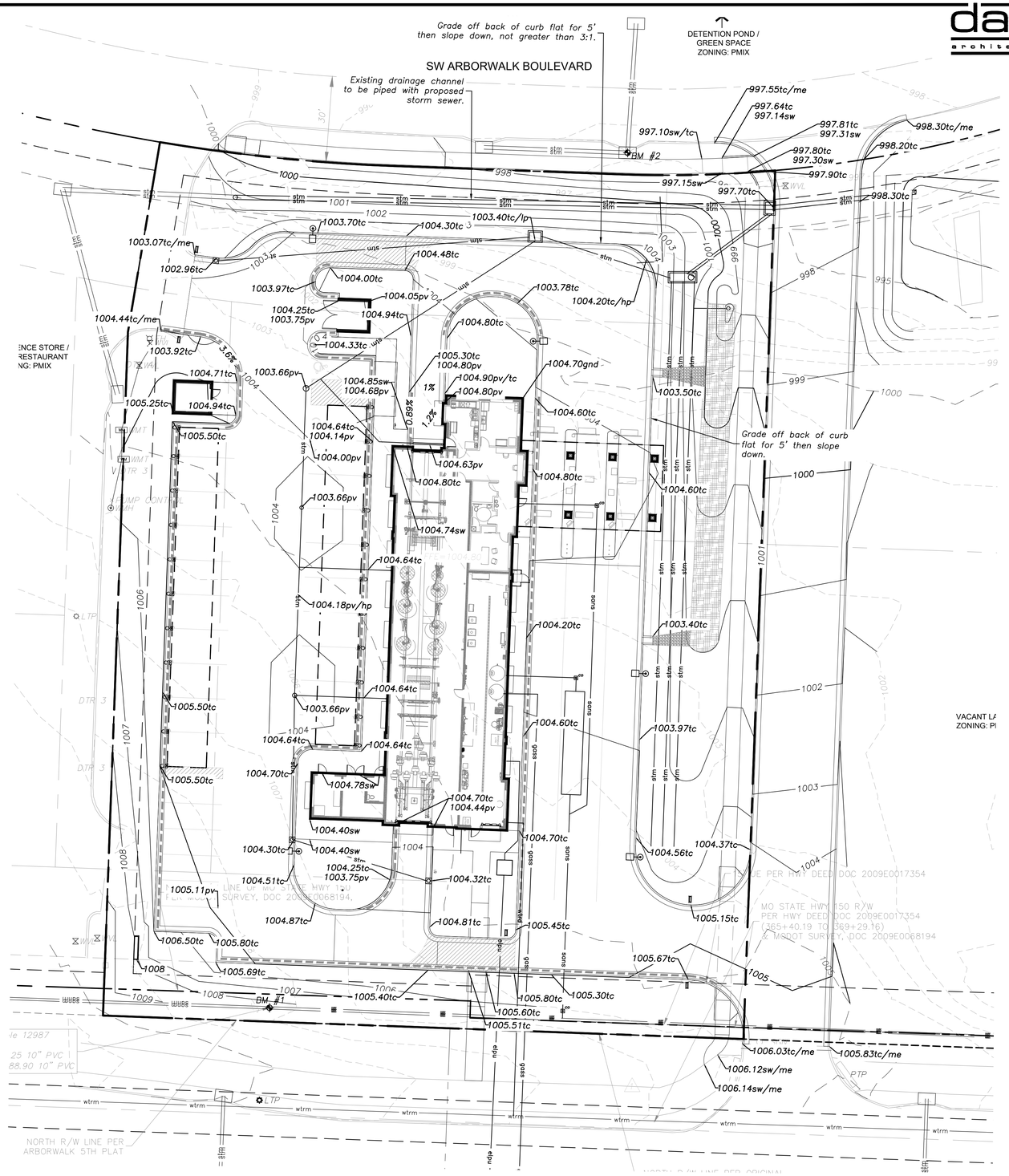
Americans with Disabilities Act (ADA) Notes:

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%.*

***To be provided for permit drawings.*

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



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

davidson
architecture&engineering
4301 Indian Creek Parkway
Overland Park, KS 66207
phone: 913.451.9390
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www.davidsonae.com
Davidson Architecture & Engineering, LLC
STATE OF MISSOURI · HILARY ZERR · NUMBER PE-2016022888 · REGISTERED PROFESSIONAL ENGINEER
Hilary A. Zerr
License # 2016022888

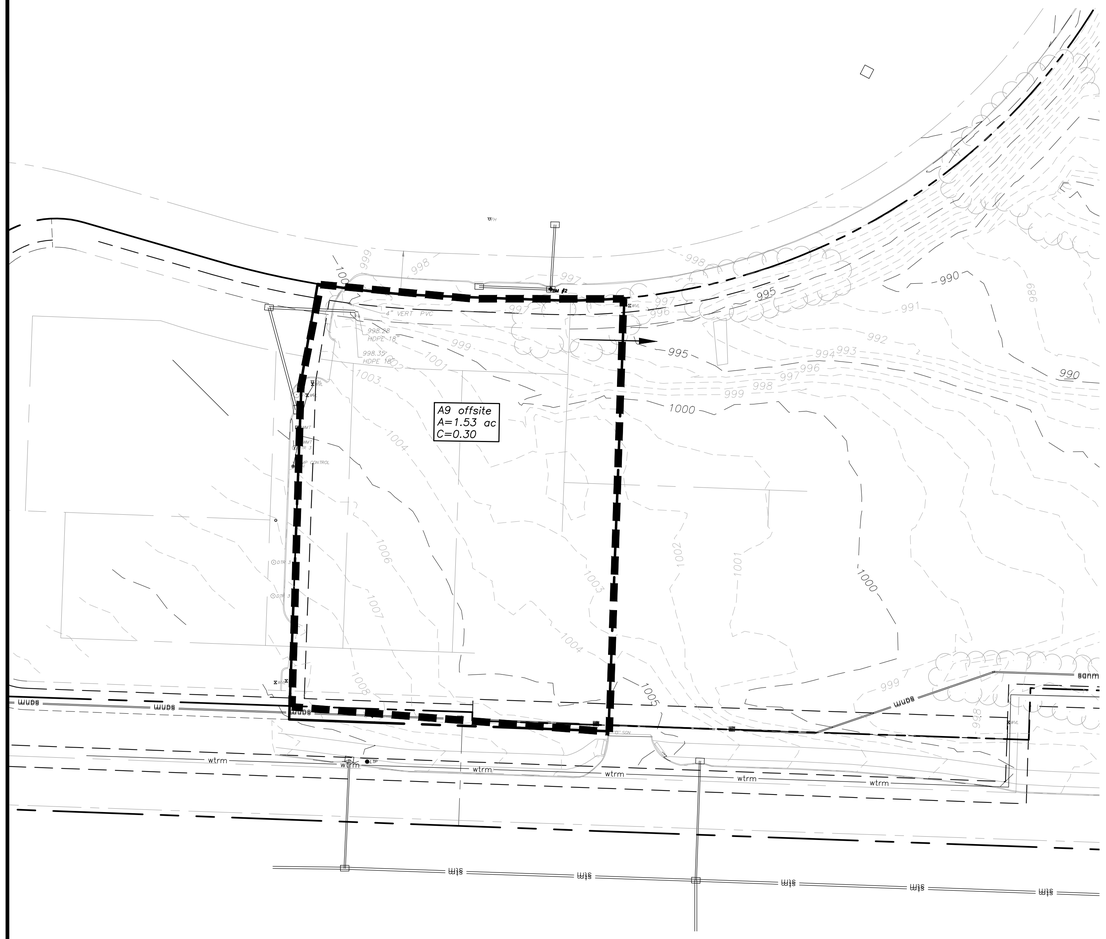
a new building for McBee's Coffee 'N Carwash

1295 Southwest Arborwalk Boulevard
Lee's Summit, Missouri 64082

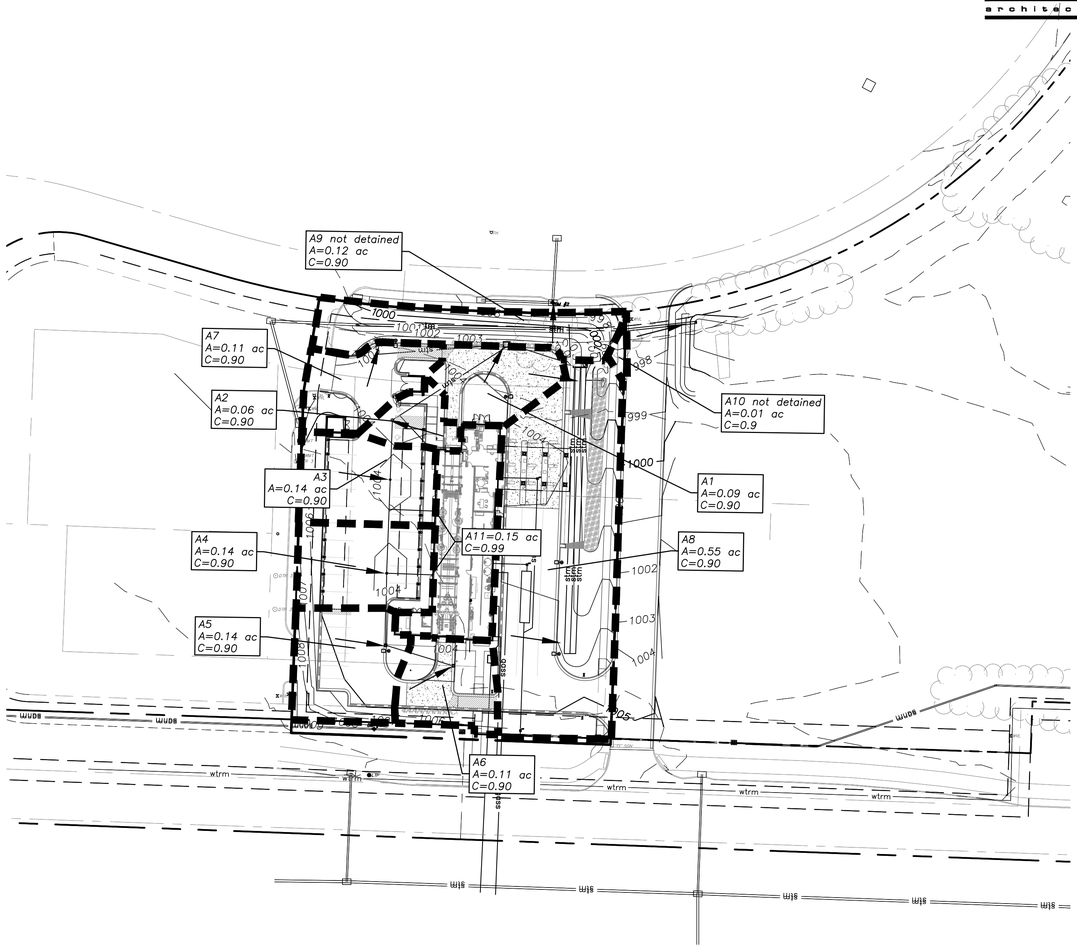
date
09.22.2021
drawn by
DAE
checked by
DAE
revisions

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'
0 25 50 100



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!

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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

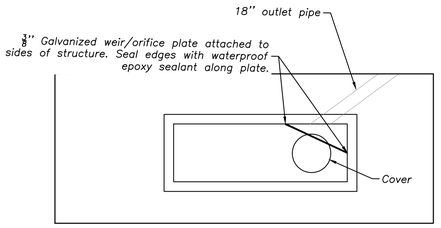
- existing
- proposed

Linetypes

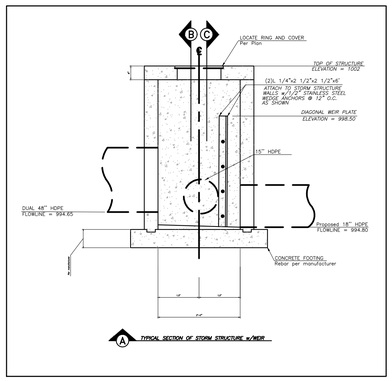
sanm	sanitary main
sans	sanitary service
stm	storm sewer (existing)
stm	storm sewer (solid wall, proposed)
stm	storm sewer (solid wall, proposed)
stm	storm sewer (perforated, proposed)
wtrm	water main
wtrf	water service (fire)
wtrd	water service (domestic)
wtri	water service (irrigation)
gasm	natural 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

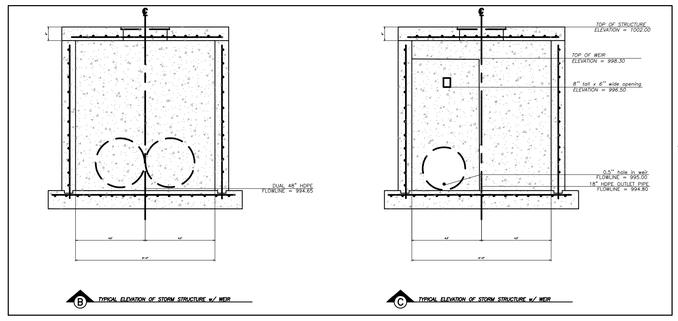
Symbols

- 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



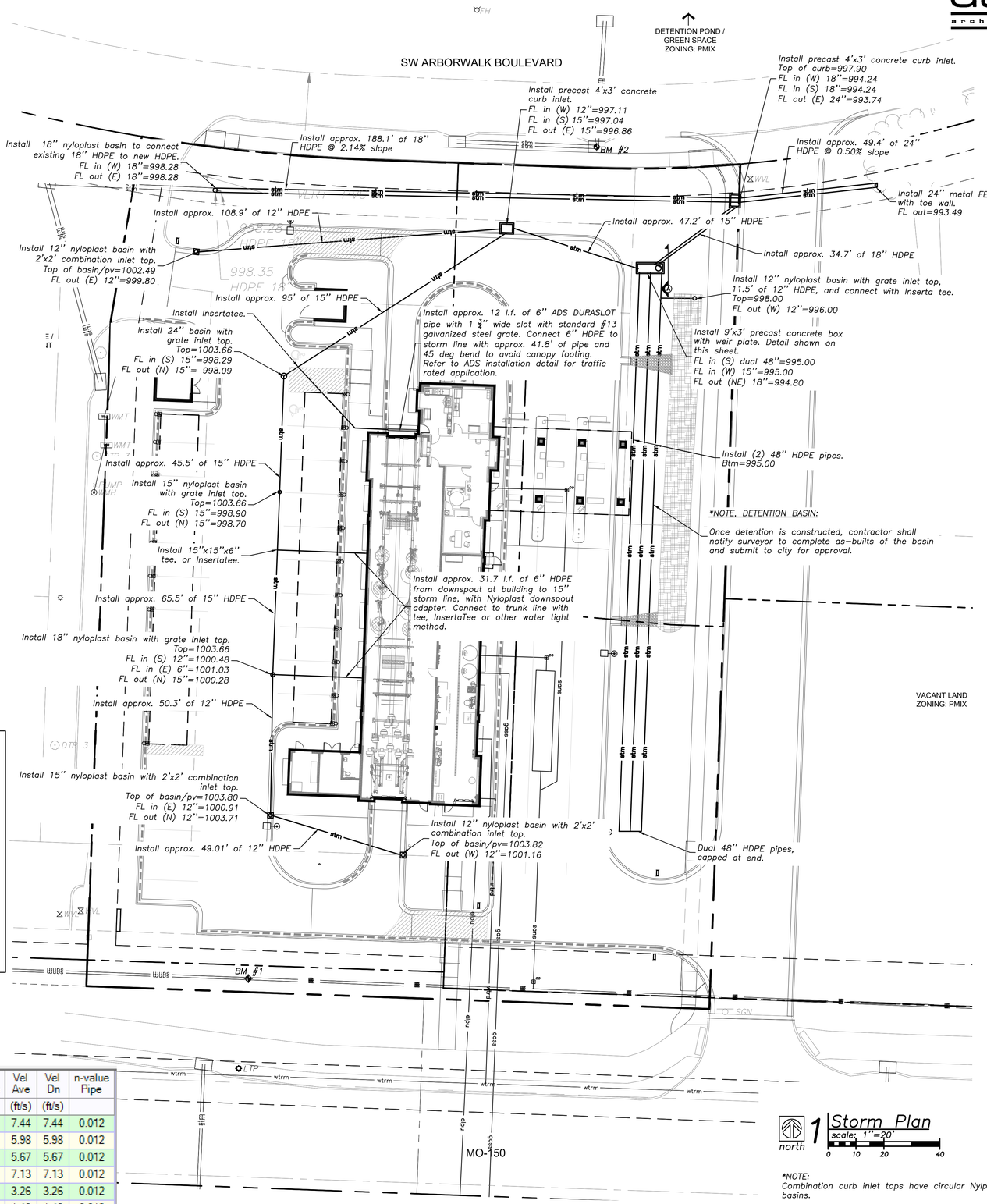
Top of outlet control structure





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



1 Storm Plan
scale: 1"=20'
north
0 10 20 40

**NOTE:*
Combination curb inlet tops have circular Nylplast basins.

Northing & Eastings given for curb inlets are for the center front face of curb.
For basins with no combination inlet top, coordinates are at center of structure.

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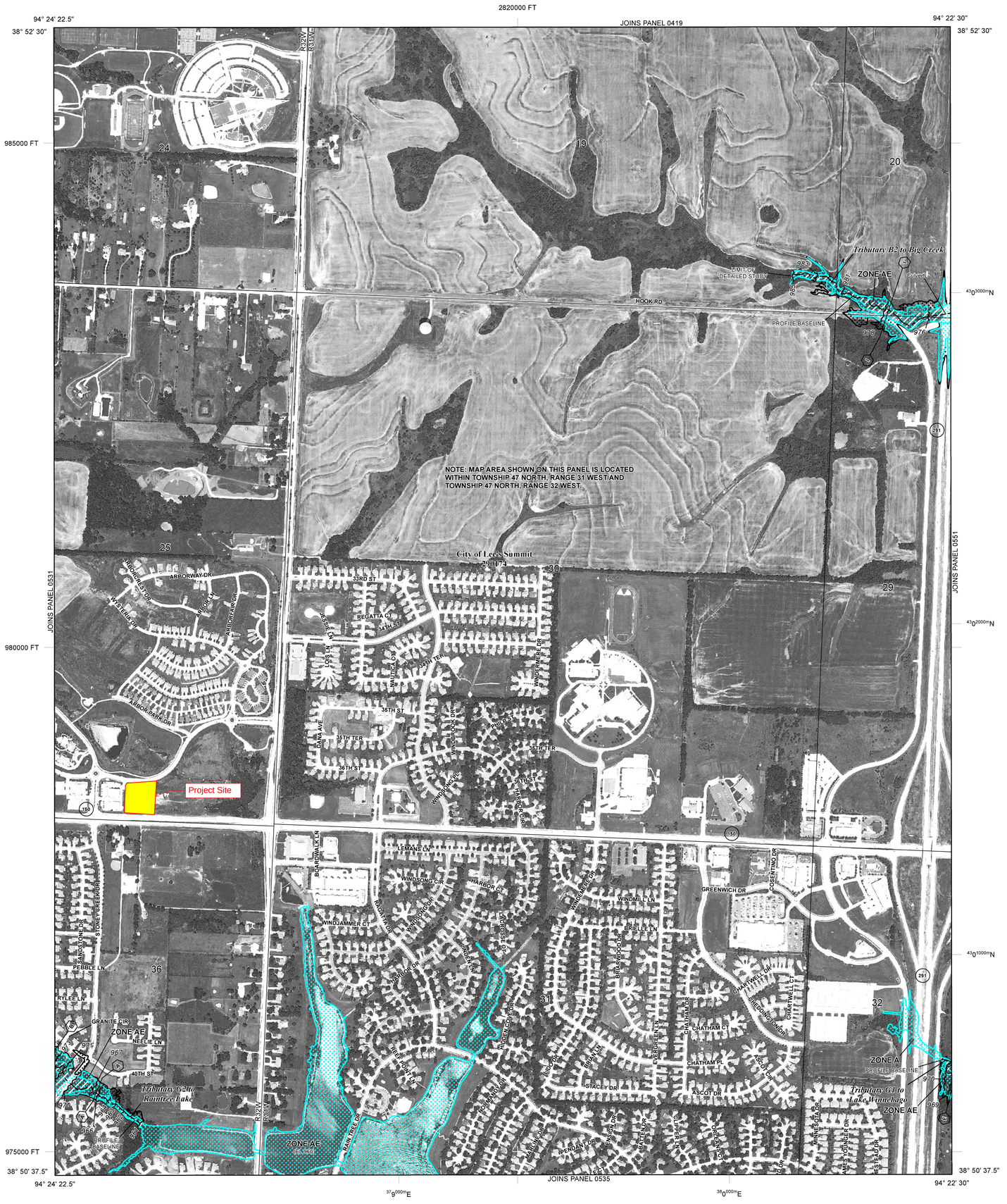


NOTES TO USERS

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

Ⓐ———Ⓐ	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.

N

MAP SCALE 1" = 500'

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

Arch Engineers

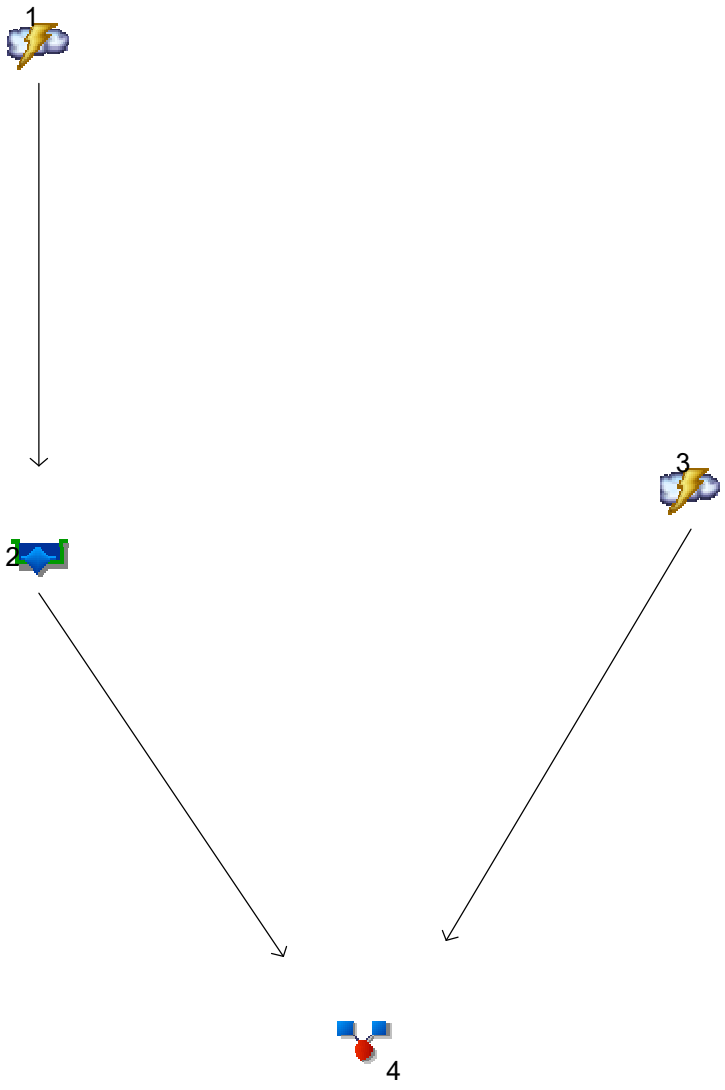
Storm Water Quantities
Arborwalk Development
TABLE A

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

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

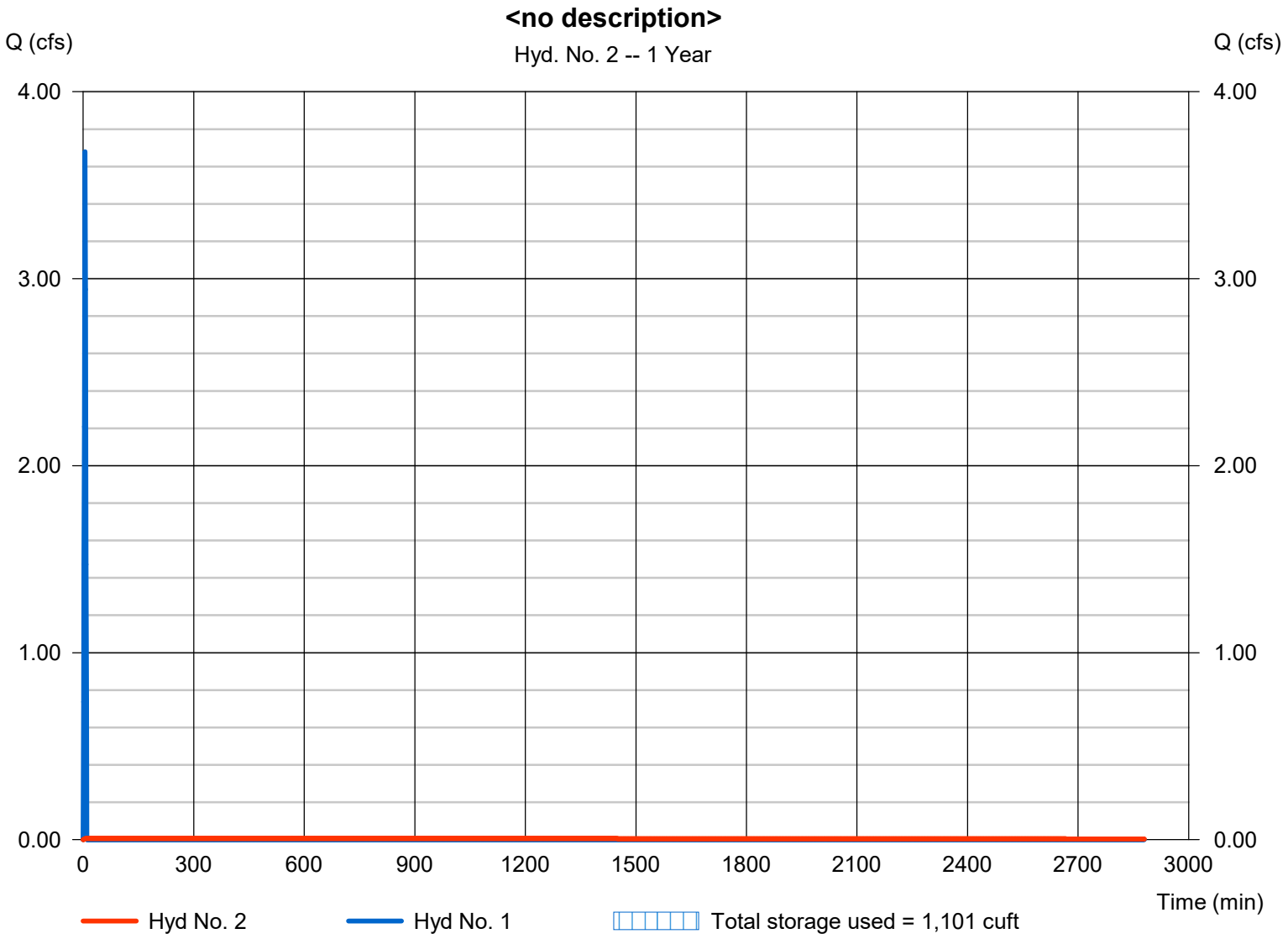
Hydrograph Report

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

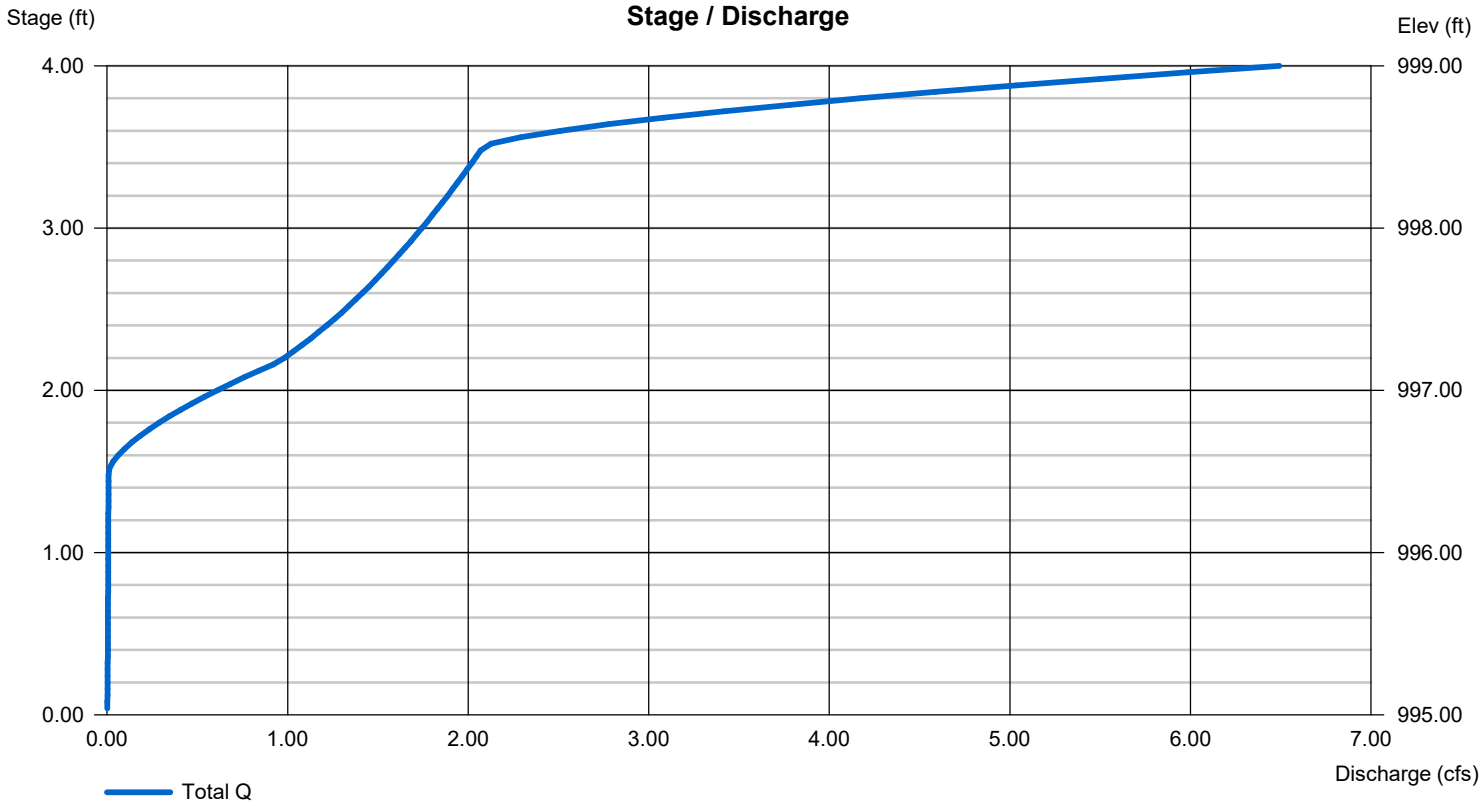
Weir Structures

	[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).

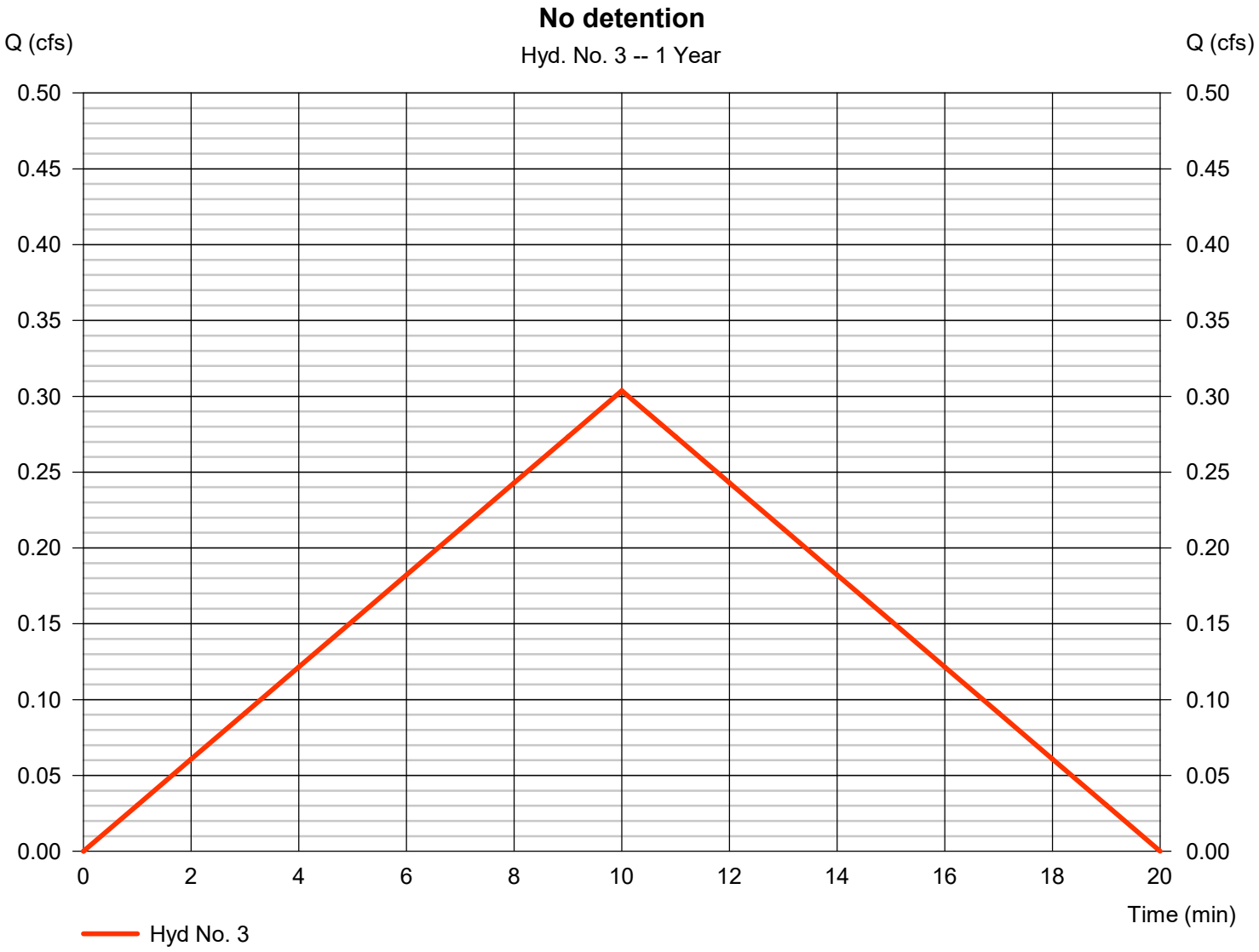


Hydrograph Report

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

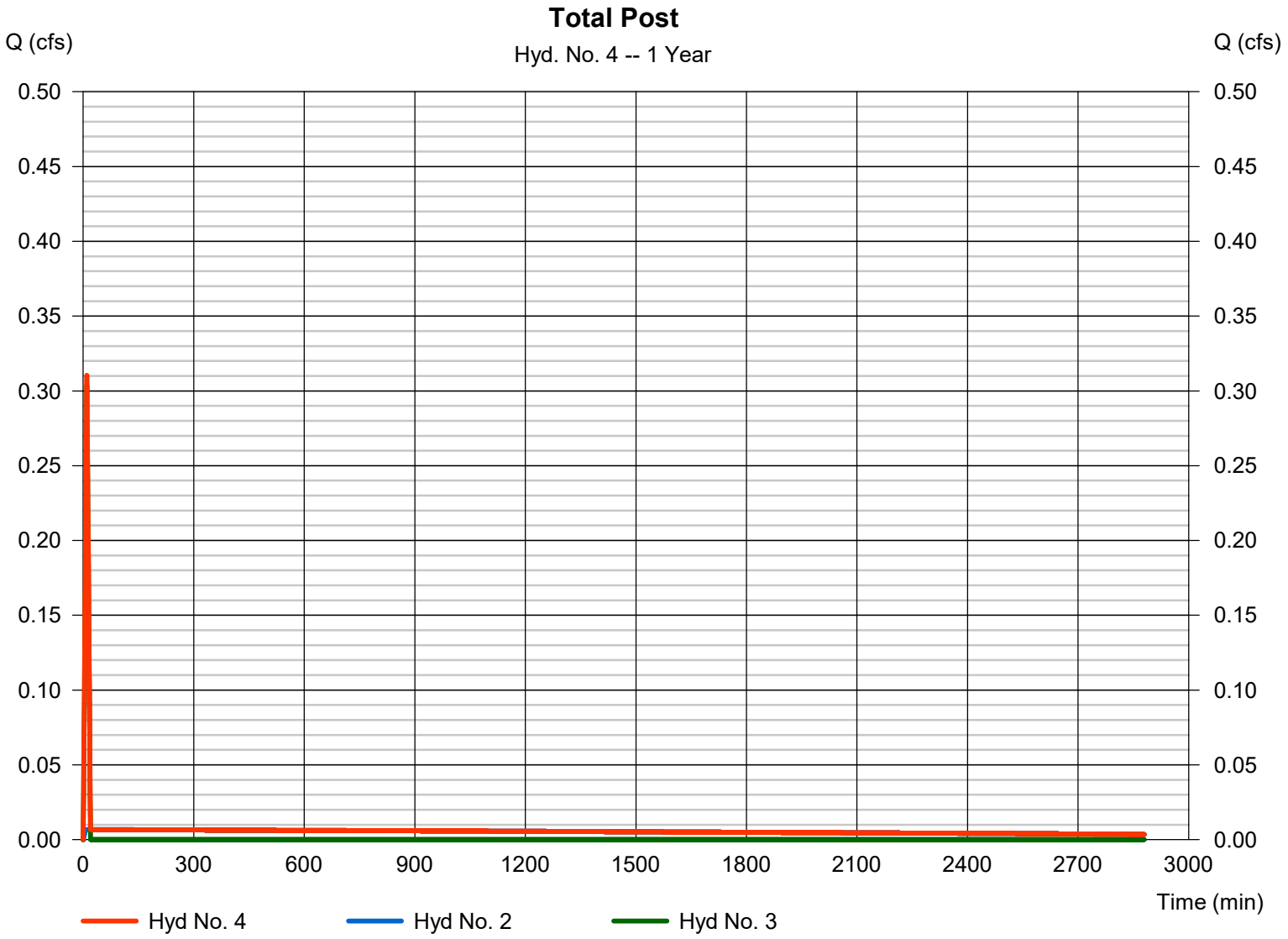


Hydrograph Report

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

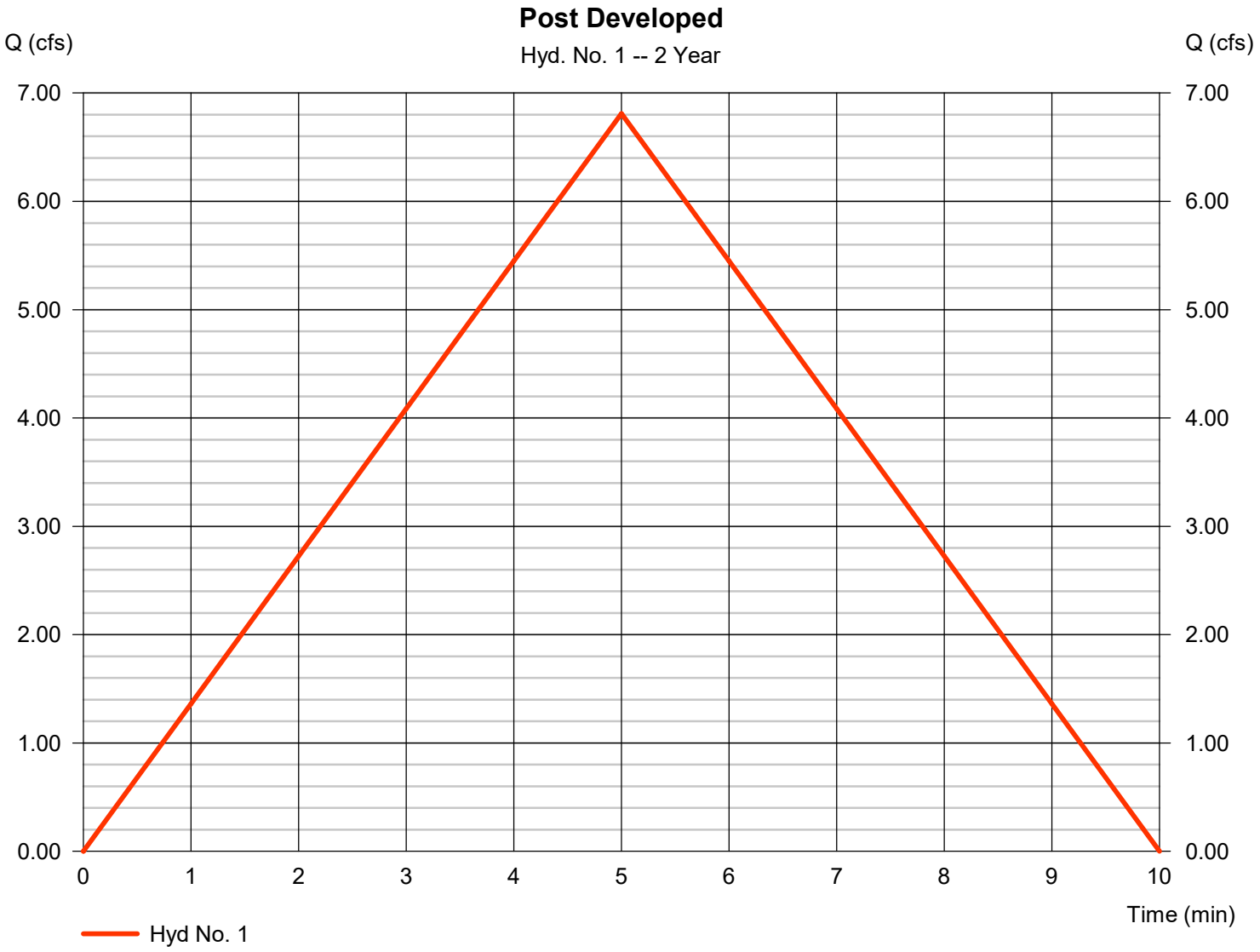
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	Rational	6.811	1	5	2,043	------	------	------	Post Developed
2	Reservoir	0.152	1	10	1,425	1	996.69	2,025	<no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



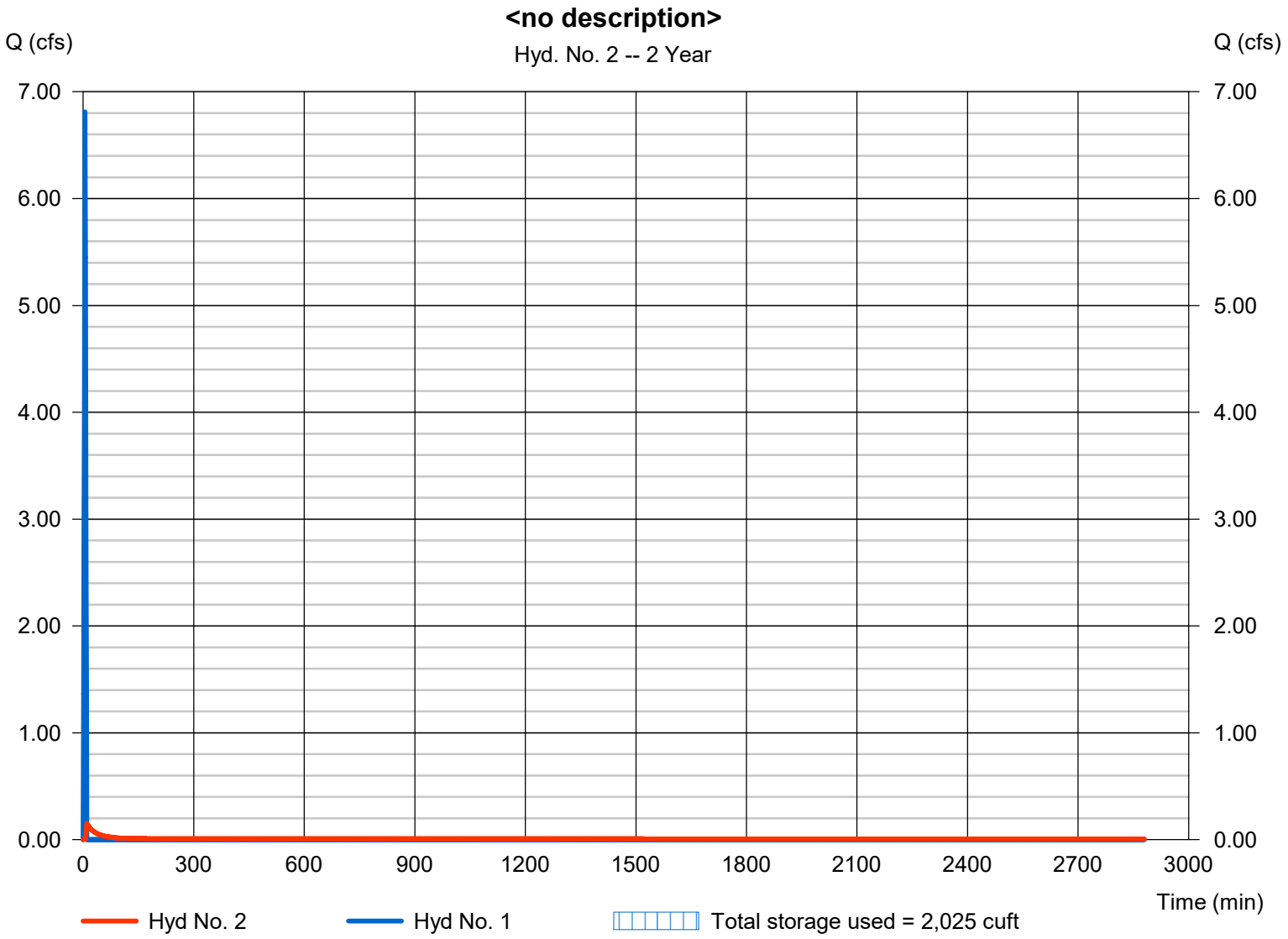
Hydrograph Report

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.

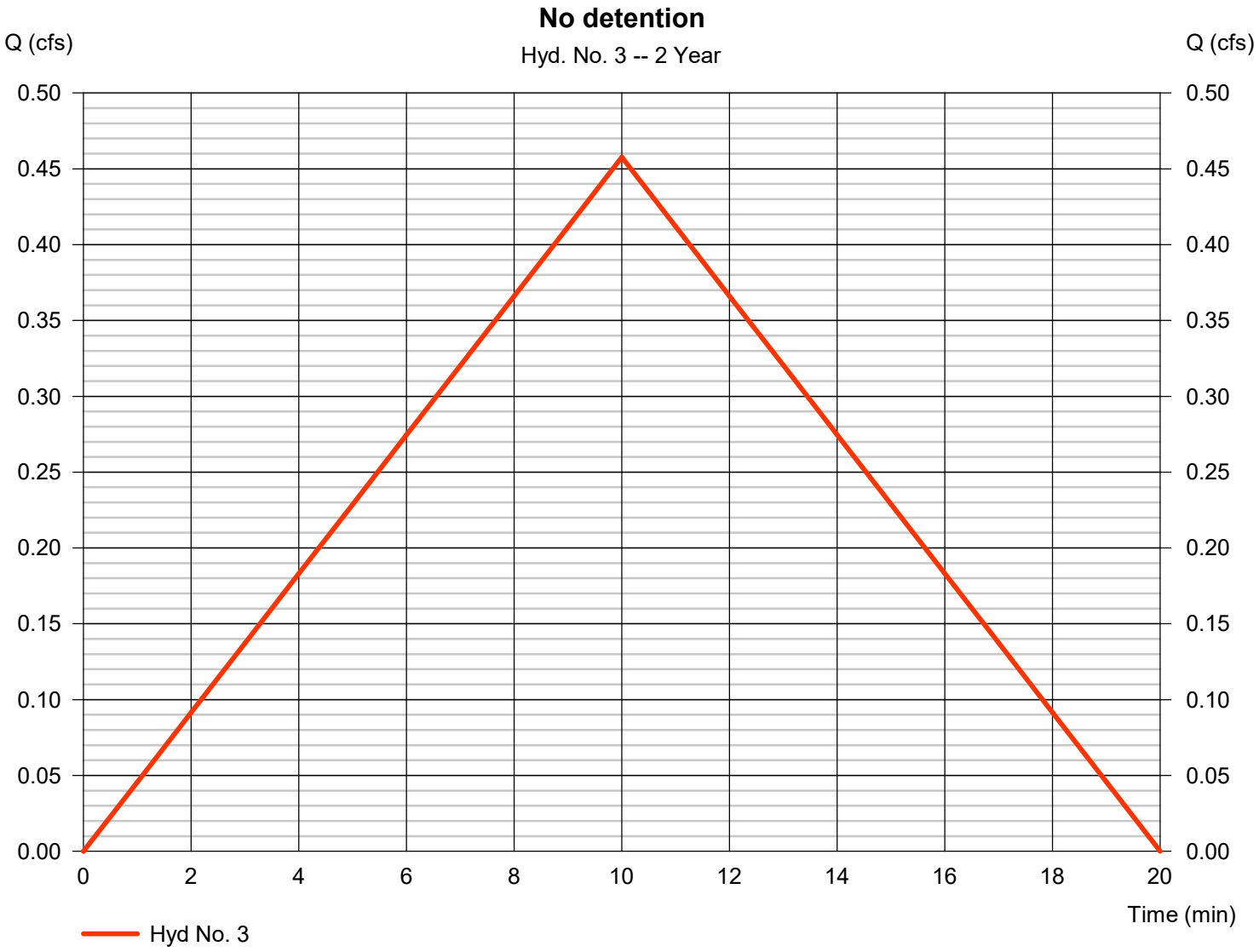


Hydrograph Report

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

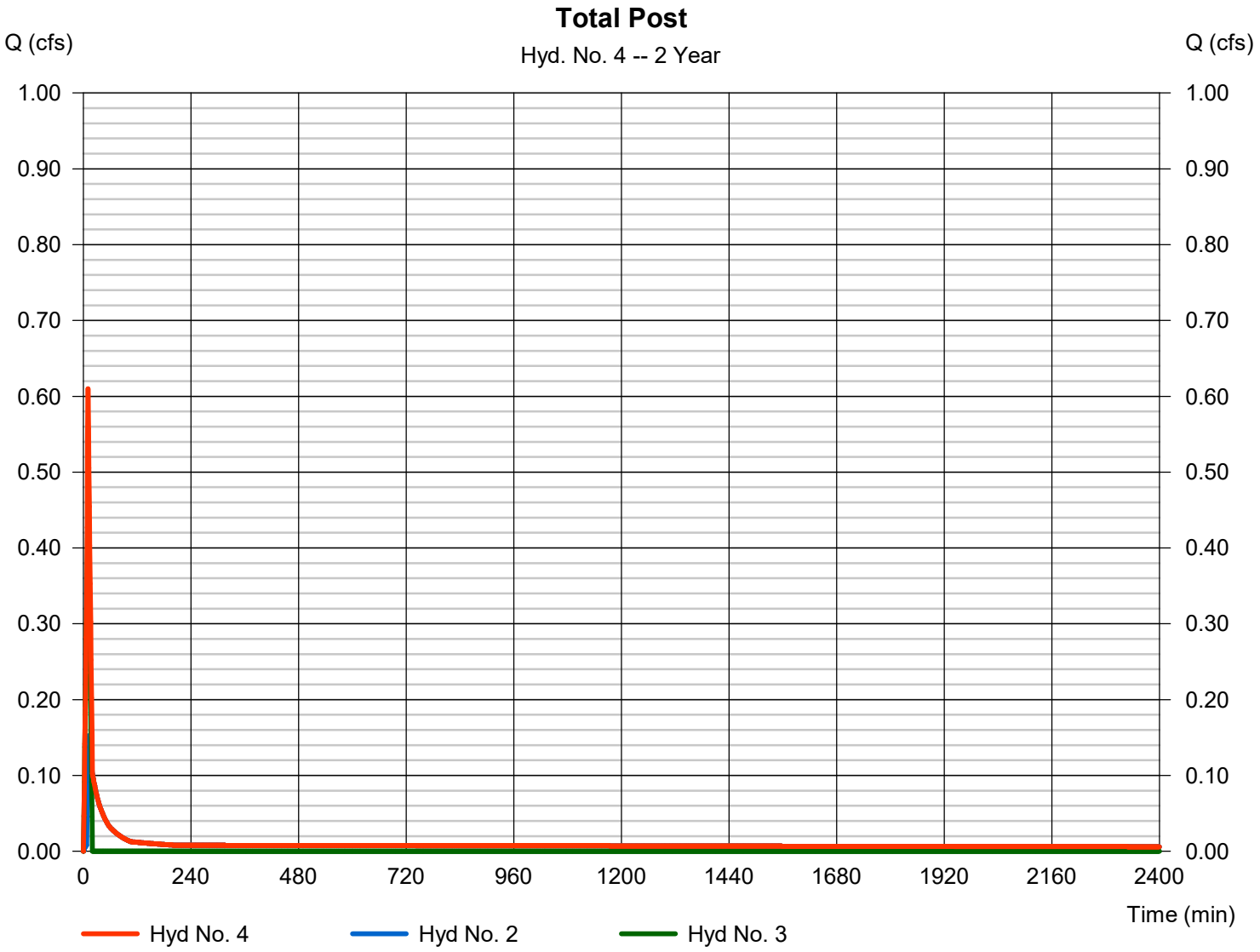


Hydrograph Report

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

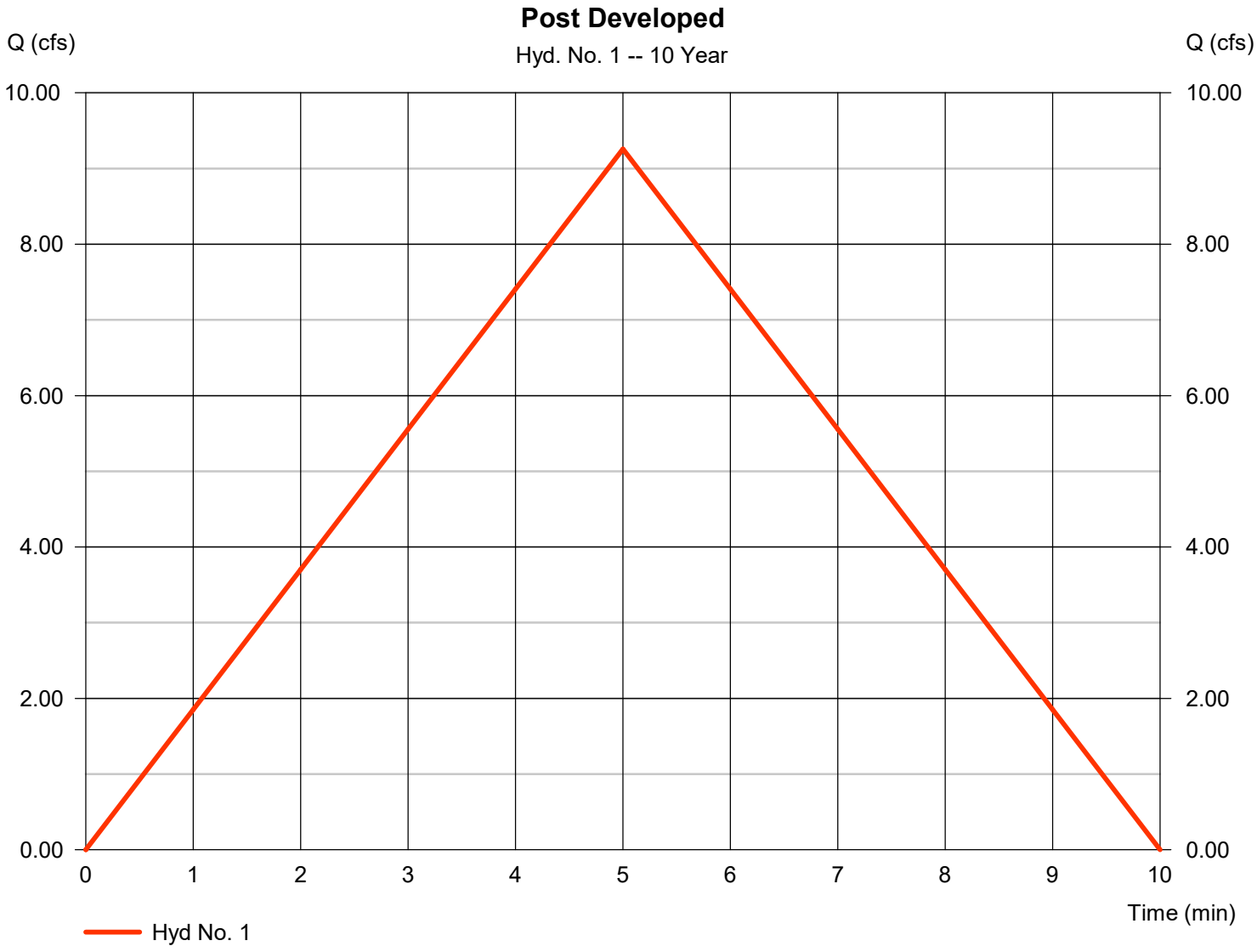
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	Rational	9.259	1	5	2,778	------	------	------	Post Developed
2	Reservoir	0.767	1	10	2,150	1	997.08	2,647	<no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



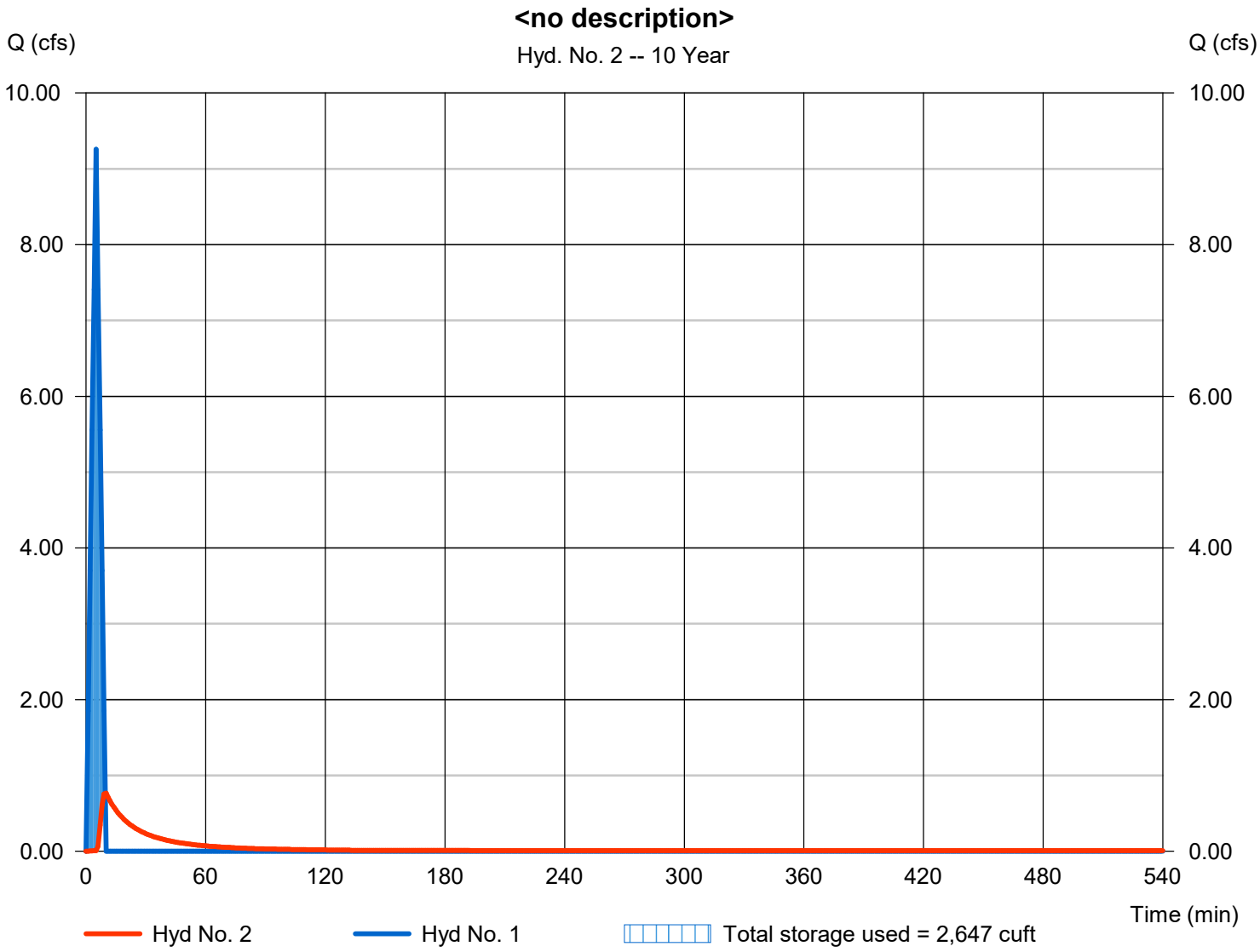
Hydrograph Report

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.

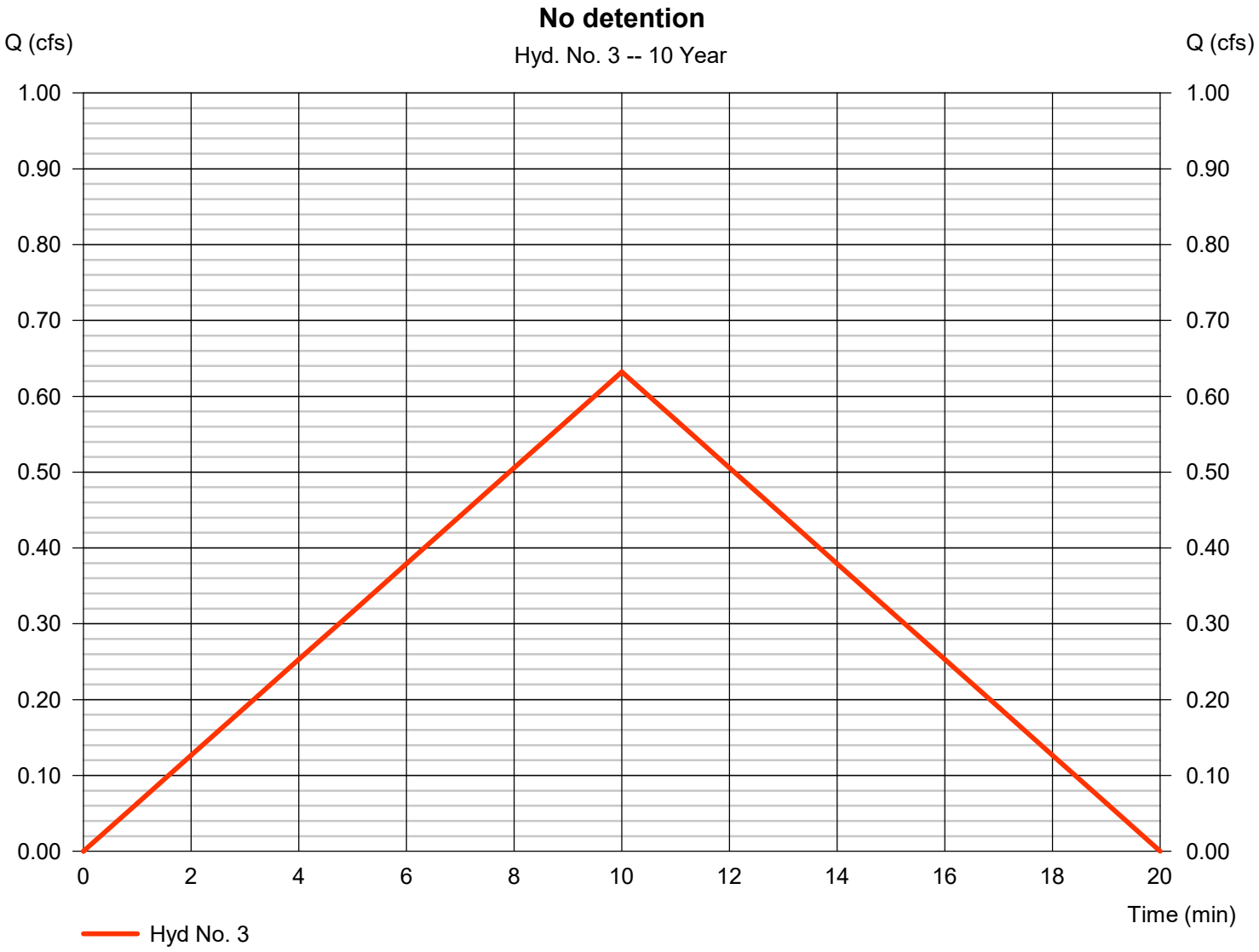


Hydrograph Report

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

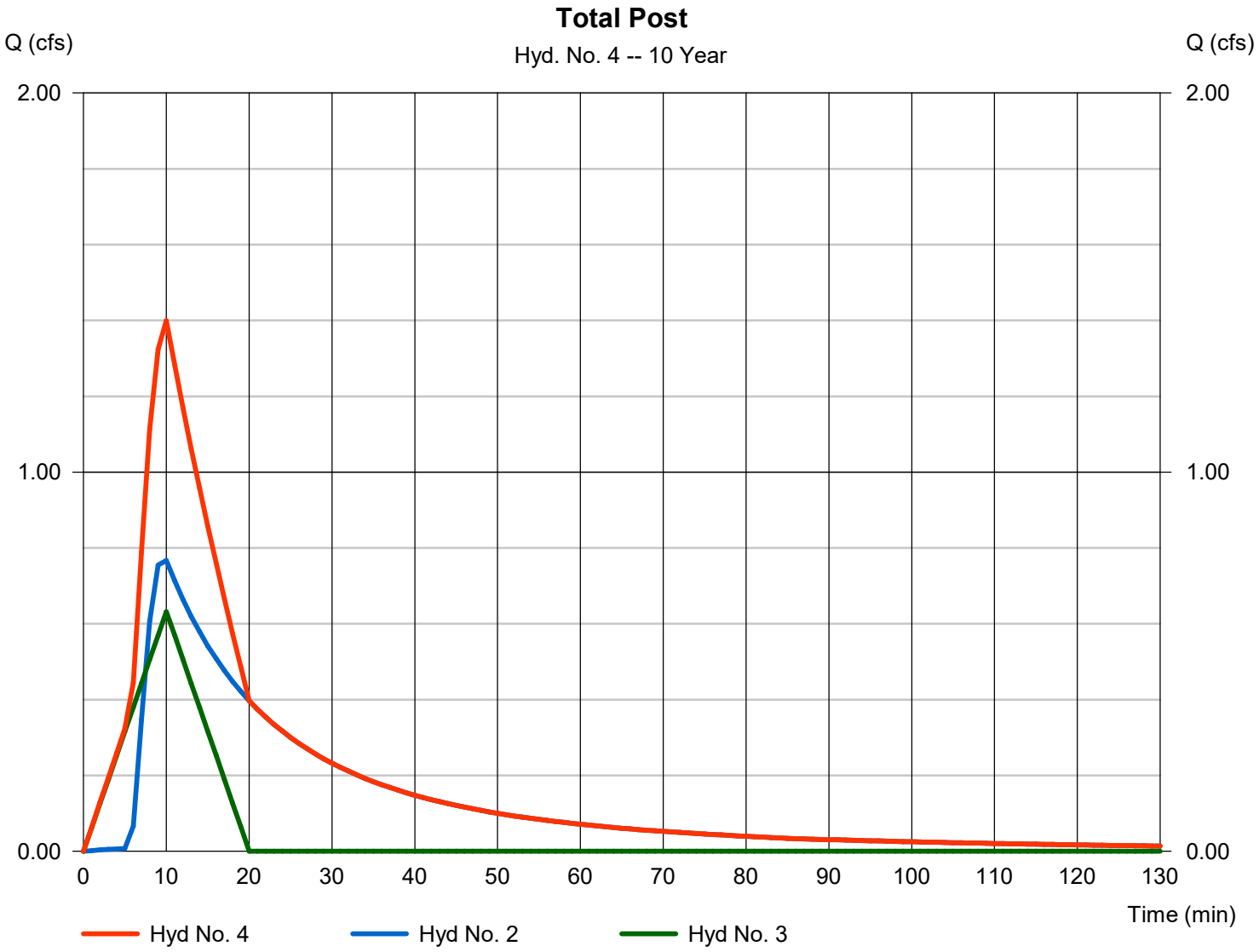


Hydrograph Report

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

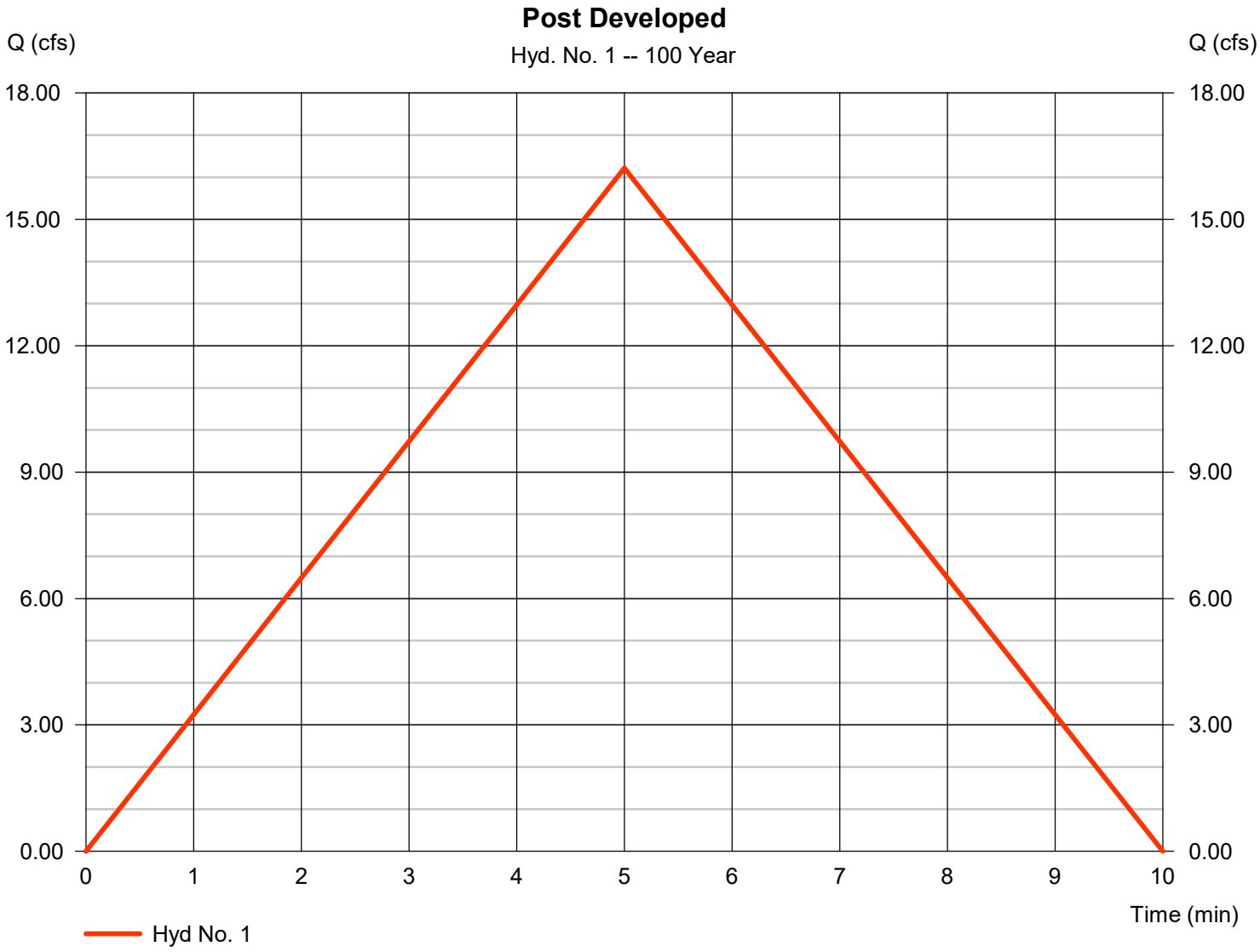
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	Rational	16.22	1	5	4,865	------	------	------	Post Developed
2	Reservoir	1.935	1	9	4,230	1	998.27	4,394	<no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



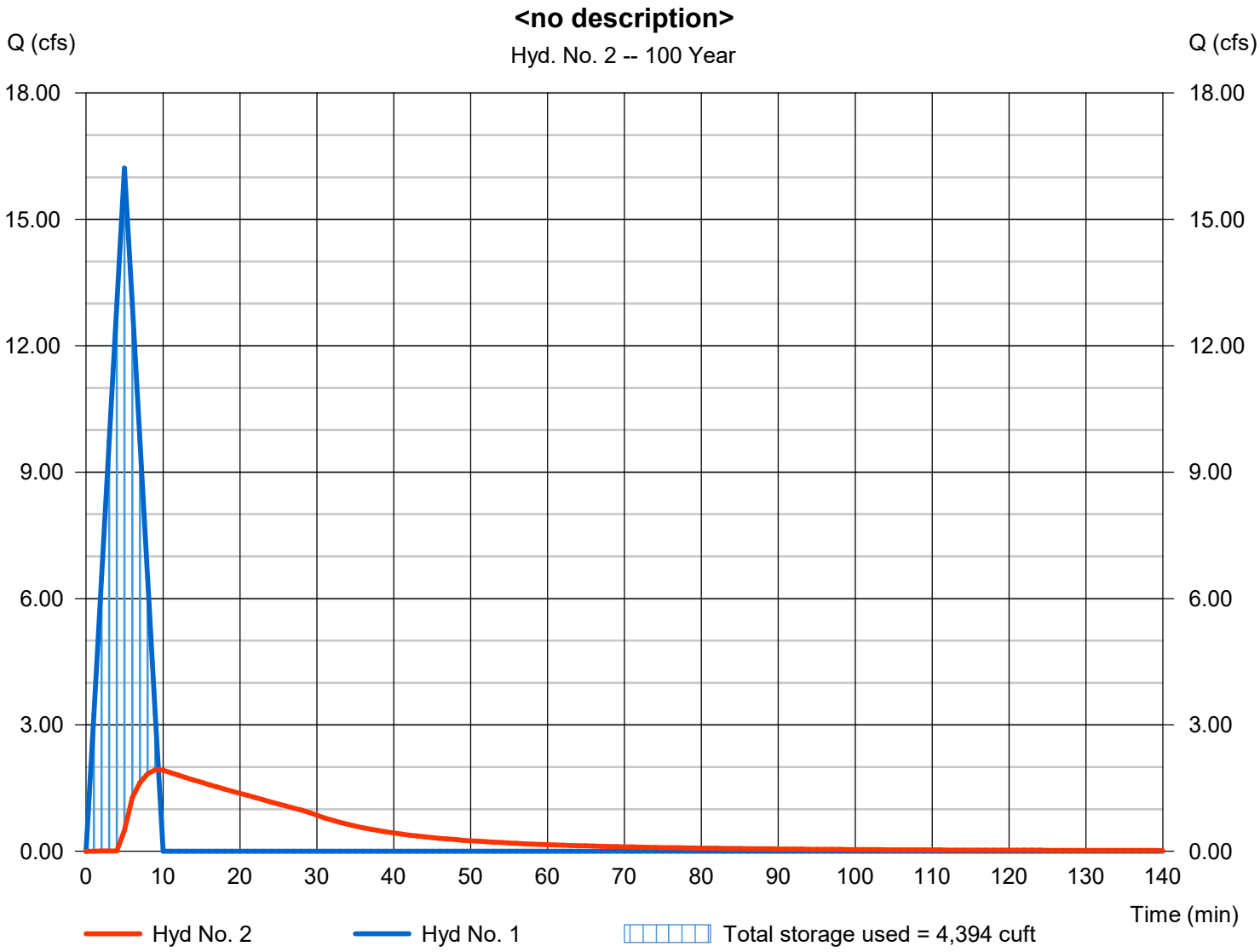
Hydrograph Report

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.

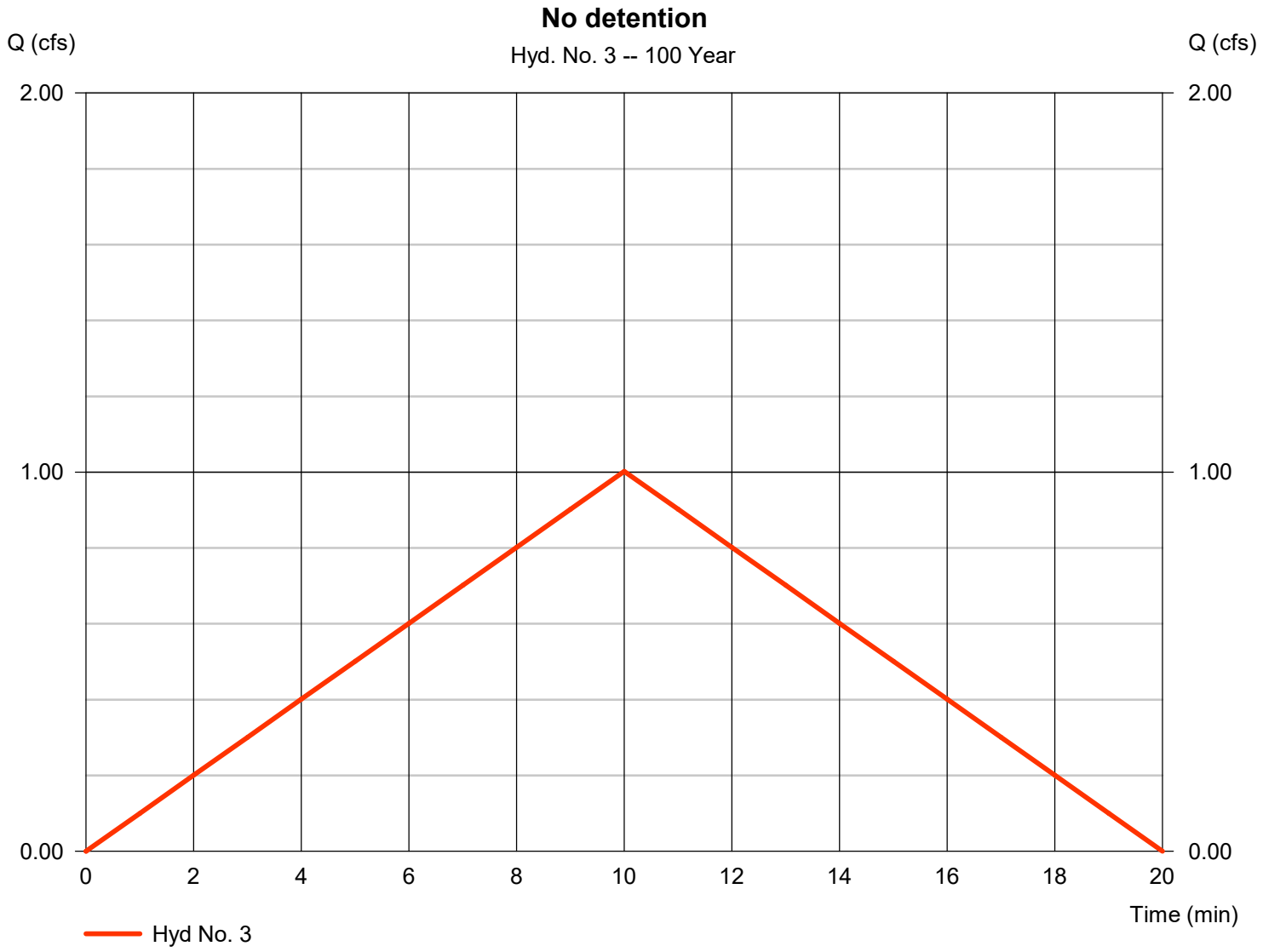


Hydrograph Report

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

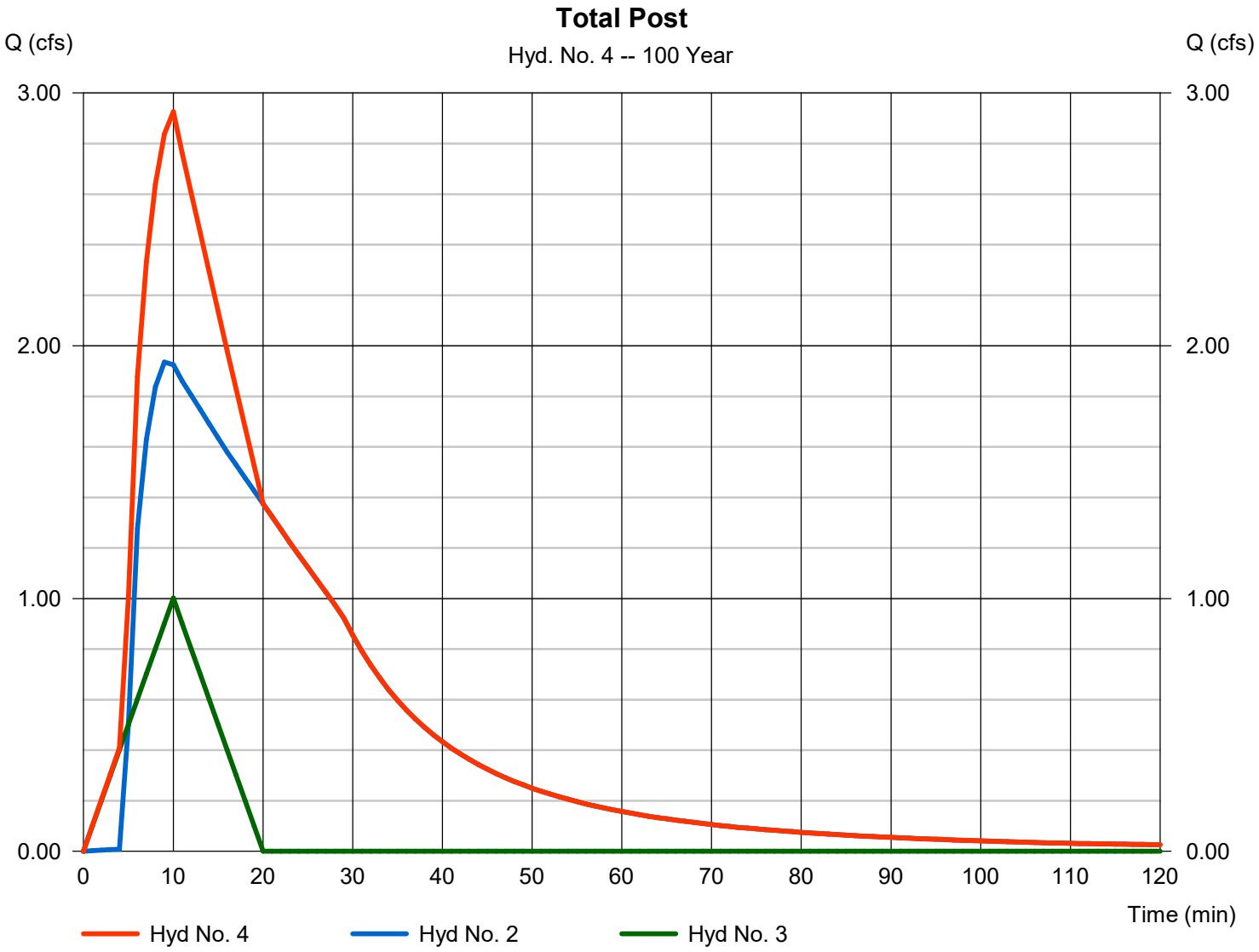


Hydrograph Report

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

Hydraflow Table of Contents

Appendix E

Hydrodynamic Separation Product Calculator

150 & Ward Mutli-Family

BMP #1 - East HDS

CDS 3035-6

Project Information					
Project Name	150 & Ward Mutli-Family			**Option #**	A
Country	UNITED_STATES	**State**	Kansas	**City**	Lee's Summit

Contact Information			
First Name	Logan	**Last Name**	Green
Company	Kimley-Horn and Associates, Inc.	**Phone #**	913-309-9390
Email	logan.green@kimley-horn.com		

Design Criteria					
Site Designation	BMP #1 - East HDS			**Sizing Method**	Net Annual
Screening Required?	No	**Drainage Area (ac)**	6.00	**Peak Flow (cfs)**	55.00
Groundwater Depth (ft)	>15	**Pipe Invert Depth (ft)**	5 - 10	**Bedrock Depth (ft)**	>15
Multiple Inlets?	No	**Grate Inlet Required?**	No	**Pipe Size (in)**	36.00
Required Particle Size Distribution?	No	**90° between two inlets?**	N/A	**180° between inlet and outlet?**	No
Runoff Coefficient	0.80	**Rainfall Station**	88 - Kansas City Airport, MO	**TC (Min)**	5

Treatment Selection					
Treatment Unit	CDS	**System Model**	3035-6		
Target Removal	80%	**Particle Size Distribution (PSD)**	125	**Predicted Net Annual Removal**	82.97%

CONTECH ENGINEERED SOLUTIONS

Hydrodynamic Separation Product Calculator

150 & Ward Mutli-Family

BMP #1 - East HDS

CDS 3035-6

CDS ESTIMATED NET ANNUAL SOLIDS LOAD REDUCTION BASED ON THE RATIONAL RAINFALL METHOD								
Rainfall Intensity[1] (in/hr)	% Rainfall Volume[1]	Cumulative Rainfall Volume	Rainfall Volume Treated	Total Flowrate (cfs)	Treated Flowrate (cfs)	Operating Rate (%)	Removal Efficiency (%)	Incremental Removal (%)
0.0200	7.62%	7.62%	7.62%	0.0960	0.0960	2.53%	100.00%	7.62%
0.0400	6.92%	14.54%	6.92%	0.1920	0.1920	5.05%	100.00%	6.92%
0.0600	6.88%	21.42%	6.88%	0.2880	0.2880	7.58%	99.89%	6.87%
0.0800	5.87%	27.29%	5.87%	0.3840	0.3840	10.11%	99.39%	5.83%
0.1000	5.69%	32.98%	5.69%	0.4800	0.4800	12.63%	98.88%	5.63%
0.1200	4.58%	37.56%	4.58%	0.5760	0.5760	15.16%	98.38%	4.51%
0.1400	3.28%	40.84%	3.28%	0.6720	0.6720	17.68%	97.87%	3.21%
0.1600	5.29%	46.13%	5.29%	0.7680	0.7680	20.21%	97.37%	5.15%
0.1800	2.65%	48.78%	2.65%	0.8640	0.8640	22.74%	96.86%	2.57%
0.2000	3.39%	52.17%	3.39%	0.9600	0.9600	25.26%	96.36%	3.27%
0.2500	6.29%	58.46%	6.29%	1.2000	1.2000	31.58%	95.09%	5.98%
0.3000	5.13%	63.59%	5.13%	1.4400	1.4400	37.89%	93.83%	4.81%
0.3500	4.25%	67.84%	4.25%	1.6800	1.6800	44.21%	92.56%	3.93%
0.4000	3.99%	71.83%	3.99%	1.9200	1.9200	50.53%	91.30%	3.64%
0.4500	2.93%	74.76%	2.93%	2.1600	2.1600	56.84%	90.04%	2.64%
0.5000	2.19%	76.95%	2.19%	2.4000	2.4000	63.16%	88.77%	1.94%
0.7500	8.46%	85.41%	8.46%	3.6000	3.6000	94.74%	82.45%	6.98%
1.0000	8.40%	93.81%	6.65%	4.8000	3.8000	100.00%	64.44%	5.41%
1.5000	5.15%	98.96%	2.72%	7.2000	3.8000	100.00%	42.96%	2.21%
2.0000	0.42%	99.38%	0.17%	9.6000	3.8000	100.00%	32.22%	0.14%
2.5000	0.63%	100.01%	0.20%	12.0000	3.8000	100.00%	25.78%	0.16%
								89.42%
							Removal Efficiency Adjustment[2] =	6.45%
							Predicted % Annual Rainfall Treated =	88.70%
							Predicted Net Annual Load Removal Efficiency =	82.97%
1 - Based on 10 years of hourly precipitation data from NCDC 4358, Kansas City WSMO AP, Platte County, MO								
2 - Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.								

SECTION (_____)
STORM WATER TREATMENT DEVICE

1.0 GENERAL

1.1 This item shall govern the furnishing and installation of the CDS® by Contech Engineered Solutions LLC, complete and operable as shown and as specified herein, in accordance with the requirements of the plans and contract documents.

1.2 The Contractor shall furnish all labor, equipment and materials necessary to install the storm water treatment device(s) (SWTD) and appurtenances specified in the Drawings and these specifications.

1.3 The manufacturer of the SWTD shall be one that is regularly engaged in the engineering design and production of systems deployed for the treatment of storm water runoff for at least five (5) years and which have a history of successful production, acceptable to the Engineer. In accordance with the Drawings, the SWTD(s) shall be a CDS® device manufactured by:

Contech Engineered Solutions LLC
9025 Centre Pointe Drive
West Chester, OH, 45069
Tel: 1 800 338 1122

1.4 Related Sections

1.4.1 Section 02240: Dewatering
1.4.2 Section 02260: Excavation Support and Protection
1.4.3 Section 02315: Excavation and Fill
1.4.4 Section 02340: Soil Stabilization

1.5 All components shall be subject to inspection by the engineer at the place of manufacture and/or installation. All components are subject to being rejected or identified for repair if the quality of materials and manufacturing do not comply with the requirements of this specification. Components which have been identified as defective may be subject for repair where final acceptance of the component is contingent on the discretion of the Engineer.

1.6 The manufacturer shall guarantee the SWTD components against all manufacturer originated defects in materials or workmanship for a period of twelve (12) months from the date the components are delivered to the owner for installation. The manufacturer shall upon its determination repair, correct or replace any manufacturer originated defects advised in writing to the manufacturer within the referenced warranty period. The use of SWTD components shall be limited to the application for which it was specifically designed.

1.7 The SWTD manufacturer shall submit to the Engineer of Record a “Manufacturer’s Performance Certification” certifying that each SWTD is capable of achieving the specified removal efficiencies listed in these specifications. The certification shall be supported by independent third-party research

1.8 No product substitutions shall be accepted unless submitted 10 days prior to project bid date, or as directed by the Engineer of Record. Submissions for substitutions require review and approval by the Engineer of Record, for hydraulic performance, impact to project designs, equivalent treatment performance, and any required project plan and report (hydrology/hydraulic, water quality, stormwater pollution) modifications that would be required by the approving jurisdictions/agencies. Contractor to coordinate with the Engineer of Record any applicable modifications to the project estimates of cost, bonding amount determinations, plan check fees for changes to approved documents, and/or any other regulatory requirements resulting from the product substitution.

2.0 MATERIALS

2.1 Housing unit of stormwater treatment device shall be constructed of pre-cast or cast-in-place concrete, no exceptions. Precast concrete components shall conform to applicable sections of ASTM C 478, ASTM C 857 and ASTM C 858 and the following:

- 2.1.1 Concrete shall achieve a minimum 28-day compressive strength of 4,000 pounds per square-inch (psi);
- 2.1.2 Unless otherwise noted, the precast concrete sections shall be designed to withstand lateral earth and AASHTO H-20 traffic loads;
- 2.1.3 Cement shall be Type III Portland Cement conforming to ASTM C 150;
- 2.1.4 Aggregates shall conform to ASTM C 33;
- 2.1.5 Reinforcing steel shall be deformed billet-steel bars, welded steel wire or deformed welded steel wire conforming to ASTM A 615, A 185, or A 497.
- 2.1.6 Joints shall be sealed with preformed joint sealing compound conforming to ASTM C 990.
- 2.1.7 Shipping of components shall not be initiated until a minimum compressive strength of 4,000 psi is attained or five (5) calendar days after fabrication has expired, whichever occurs first.

2.2 Internal Components and appurtenances shall conform to the following:

- 2.2.1 Screen and support structure shall be manufactured of Type 316 and 316L stainless steel conforming to ASTM F 1267-01;
- 2.2.2 Hardware shall be manufactured of Type 316 stainless steel conforming to ASTM A 320;
- 2.2.3 Fiberglass components shall conform to applicable sections of ASTM D-4097
- 2.2.4 Access system(s) conform to the following:
- 2.2.5 Manhole castings shall be designed to withstand AASHTO H-20 loadings and manufactured of cast-iron conforming to ASTM A 48 Class 30.

3.0 PERFORMANCE

3.1 The SWTD shall be sized to either achieve an 80 percent average annual reduction in the total suspended solid load with a particle size distribution having a mean particle size (d_{50}) of 125 microns unless otherwise stated.

3.2 The SWTD shall be capable of capturing and retaining 100 percent of pollutants greater than or equal to 2.4 millimeters (mm) regardless of the pollutant's specific gravity (i.e.: floatable and neutrally buoyant materials) for flows up to the device's rated-treatment capacity. The SWTD shall be designed to retain all previously captured pollutants addressed by this

subsection under all flow conditions. The SWTD shall be capable of capturing and retaining total petroleum hydrocarbons. The SWTD shall be capable of achieving a removal efficiency of 92 and 78 percent when the device is operating at 25 and 50 percent of its rated-treatment capacity. These removal efficiencies shall be based on independent third-party research for influent oil concentrations representative of storm water runoff (20 ± 5 mg/L). The SWTD shall be greater than 99 percent effective in controlling dry-weather accidental oil spills.

3.3 The SWTD shall be designed with a sump chamber for the storage of captured sediments and other negatively buoyant pollutants in between maintenance cycles. The minimum storage capacity provided by the sump chamber shall be in accordance with the volume listed in Table 1. The boundaries of the sump chamber shall be limited to that which do not degrade the SWTD's treatment efficiency as captured pollutants accumulate. The sump chamber shall be separate from the treatment processing portion(s) of the SWTD to minimize the probability of fine particle re-suspension. In order to not restrict the Owner's ability to maintain the SWTD, the minimum dimension providing access from the ground surface to the sump chamber shall be 16 inches in diameter.

3.4 The SWTD shall be designed to capture and retain Total Petroleum Hydrocarbons generated by wet-weather flow and dry-weather gross spills and have a capacity listed in Table 1 of the required unit.

3.5 The SWTD shall convey the flow from the peak storm event of the drainage network, in accordance with required hydraulic upstream conditions as defined by the Engineer. If a substitute SWTD is proposed, supporting documentation shall be submitted that demonstrates equal or better upstream hydraulic conditions compared to that specified herein. This documentation shall be signed and sealed by a Professional Engineer registered in the State of the work. All costs associated with preparing and certifying this documentation shall be born solely by the Contractor.

3.6 The SWTD shall have completed field tested following TARP Tier II protocol requirements

4.0 EXECUTION

4.1 The contractor shall exercise care in the storage and handling of the SWTD components prior to and during installation. Any repair or replacement costs associated with events occurring after delivery is accepted and unloading has commenced shall be borne by the contractor.

4.2 The SWTD shall be installed in accordance with the manufacturer's recommendations and related sections of the contract documents. The manufacturer shall provide the contractor installation instructions and offer on-site guidance during the important stages of the installation as identified by the manufacturer at no additional expense. A minimum of 72 hours notice shall be provided to the manufacturer prior to their performance of the services included under this subsection.

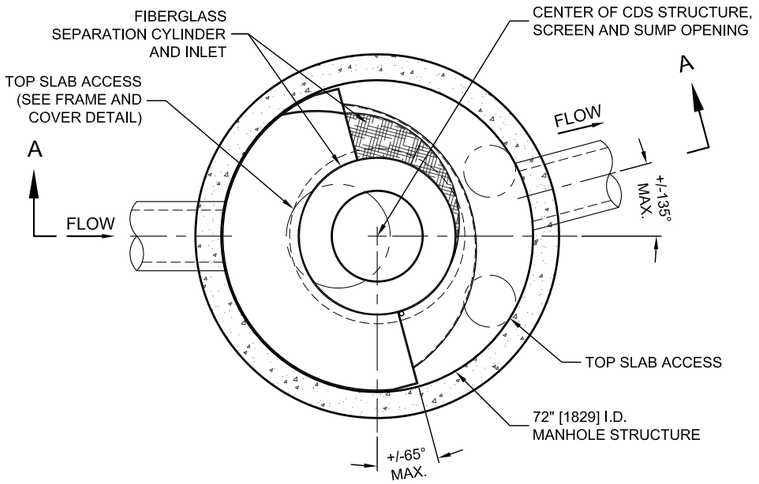
4.3 The contractor shall fill all voids associated with lifting provisions provided by the manufacturer. These voids shall be filled with non-shrinking grout providing a finished surface consistent with adjacent surfaces. The contractor shall trim all protruding lifting provisions flush with the adjacent concrete surface in a manner, which leaves no sharp points or edges.

4.4 The contractor shall removal all loose material and pooling water from the SWTD prior to the transfer of operational responsibility to the Owner.

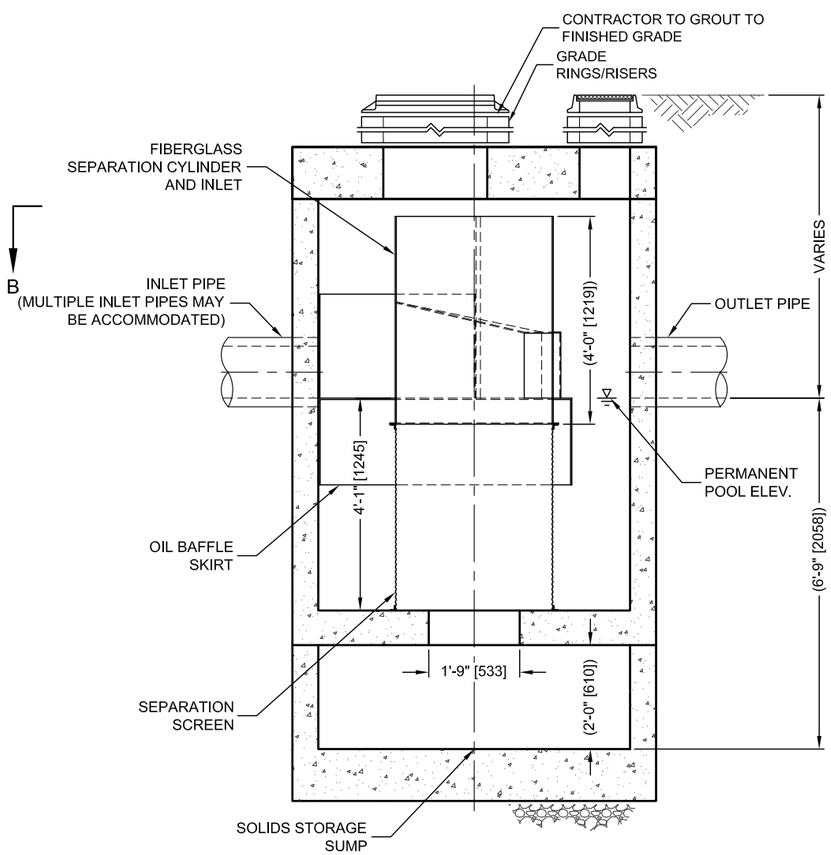
TABLE 1
Storm Water Treatment Device
Storage Capacities

CDS Model	Minimum Sump Storage Capacity $(yd^3)/(m^3)$	Minimum Oil Storage Capacity (gal)/(L)
CDS2015-4	0.9(0.7)	61(232)
CDS2015-5	1.5(1.1)	83(313)
CDS2020-5	1.5(1.1)	99(376)
CDS2025-5	1.5(1.1)	116(439)
CDS3020-6	2.1 (1.6)	184(696)
CDS3025-6	2.1(1.6)	210(795)
CDS3030-6	2.1 (1.6)	236(895)
CDS3035-6	2.1 (1.6)	263(994)
CDS3535-7	2.9(2.2)	377(1426)
CDS4030-8	5.6(4.3)	426(1612)
CDS4040-8	5.6 (4.3)	520(1970)
CDS4045-8	5.6 (4.3)	568(2149)
CDS5640-10	8.7(6.7)	758(2869)
CDS5653-10	8.7(6.7)	965(3652)
CDS5668-10	8.7(6.7)	1172(4435)
CDS5678-10	8.7(6.7)	1309(4956)
CDS7070-DV	3.6(2.8)	914 (3459)
CDS10060-DV	5.0 (3.8)	792 (2997)
CDS10080-DV	5.0 (3.8)	1057 (4000)
CDS100100-DV	5.0 (3.8)	1320 (4996)

END OF SECTION



PLAN VIEW B-B
N.T.S.

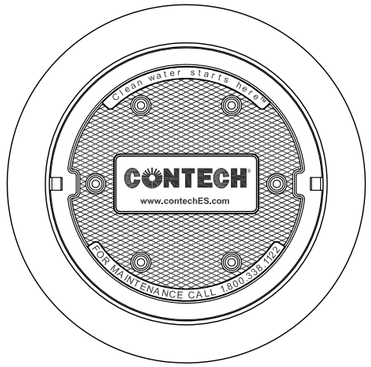


ELEVATION A-A
N.T.S.

CDS3035-6-C DESIGN NOTES

THE STANDARD CDS3035-6-C CONFIGURATION IS SHOWN. ALTERNATE CONFIGURATIONS ARE AVAILABLE AND ARE LISTED BELOW. SOME CONFIGURATIONS MAY BE COMBINED TO SUIT SITE REQUIREMENTS.

CONFIGURATION DESCRIPTION
GRATED INLET ONLY (NO INLET PIPE)
GRATED INLET WITH INLET PIPE OR PIPES
CURB INLET ONLY (NO INLET PIPE)
CURB INLET WITH INLET PIPE OR PIPES
SEPARATE OIL BAFFLE (SINGLE INLET PIPE REQUIRED FOR THIS CONFIGURATION)
SEDIMENT WEIR FOR NJDEP / NJCAT CONFORMING UNITS



FRAME AND COVER
(DIAMETER VARIES)
N.T.S.

THESE VALUES ARE BASED ON ACTUAL FLOWS

SITE SPECIFIC DATA REQUIREMENTS

STRUCTURE ID	
WATER QUALITY FLOW RATE (CFS OR L/s)	*
PEAK FLOW RATE (CFS OR L/s)	49
RETURN PERIOD OF PEAK FLOW (YRS)	100
SCREEN APERTURE (2400 OR 4700)	*

PIPE DATA:	I.E.	MATERIAL	DIAMETER
INLET PIPE 1	*		
INLET PIPE 2	*		
OUTLET PIPE	*		

RIM ELEVATION	*

ANTI-FLOTATION BALLAST	WIDTH	HEIGHT
	*	*

NOTES/SPECIAL REQUIREMENTS:

* PER ENGINEER OF RECORD

GENERAL NOTES
1. CONTECH TO PROVIDE ALL MATERIALS UNLESS NOTED OTHERWISE.
2. DIMENSIONS MARKED WITH ( ) ARE REFERENCE DIMENSIONS. ACTUAL DIMENSIONS MAY VARY.
3. FOR FABRICATION DRAWINGS WITH DETAILED STRUCTURE DIMENSIONS AND WEIGHTS, PLEASE CONTACT YOUR CONTECH ENGINEERED SOLUTIONS LLC REPRESENTATIVE. www.contechES.com
4. CDS WATER QUALITY STRUCTURE SHALL BE IN ACCORDANCE WITH ALL DESIGN DATA AND INFORMATION CONTAINED IN THIS DRAWING.
5. STRUCTURE SHALL MEET AASHTO HS20 AND CASTINGS SHALL MEET HS20 (AASHTO M 306) LOAD RATING, ASSUMING GROUNDWATER ELEVATION AT, OR BELOW, THE OUTLET PIPE INVERT ELEVATION. ENGINEER OF RECORD TO CONFIRM ACTUAL GROUNDWATER ELEVATION.
6. PVC HYDRAULIC SHEAR PLATE IS PLACED ON SHELF AT BOTTOM OF SCREEN CYLINDER. REMOVE AND REPLACE AS NECESSARY DURING MAINTENANCE CLEANING.

INSTALLATION NOTES
A. ANY SUB-BASE, BACKFILL DEPTH, AND/OR ANTI-FLOTATION PROVISIONS ARE SITE-SPECIFIC DESIGN CONSIDERATIONS AND SHALL BE SPECIFIED BY ENGINEER OF RECORD.
B. CONTRACTOR TO PROVIDE EQUIPMENT WITH SUFFICIENT LIFTING AND REACH CAPACITY TO LIFT AND SET THE CDS MANHOLE STRUCTURE (LIFTING CLUTCHES PROVIDED).
C. CONTRACTOR TO ADD JOINT SEALANT BETWEEN ALL STRUCTURE SECTIONS, AND ASSEMBLE STRUCTURE.
D. CONTRACTOR TO PROVIDE, INSTALL, AND GROUT PIPES. MATCH PIPE INVERTS WITH ELEVATIONS SHOWN.
E. CONTRACTOR TO TAKE APPROPRIATE MEASURES TO ASSURE UNIT IS WATER TIGHT, HOLDING WATER TO FLOWLINE INVERT MINIMUM. IT IS SUGGESTED THAT ALL JOINTS BELOW PIPE INVERTS ARE GROUTED.

CONTECH ENGINEERED SOLUTIONS LLC
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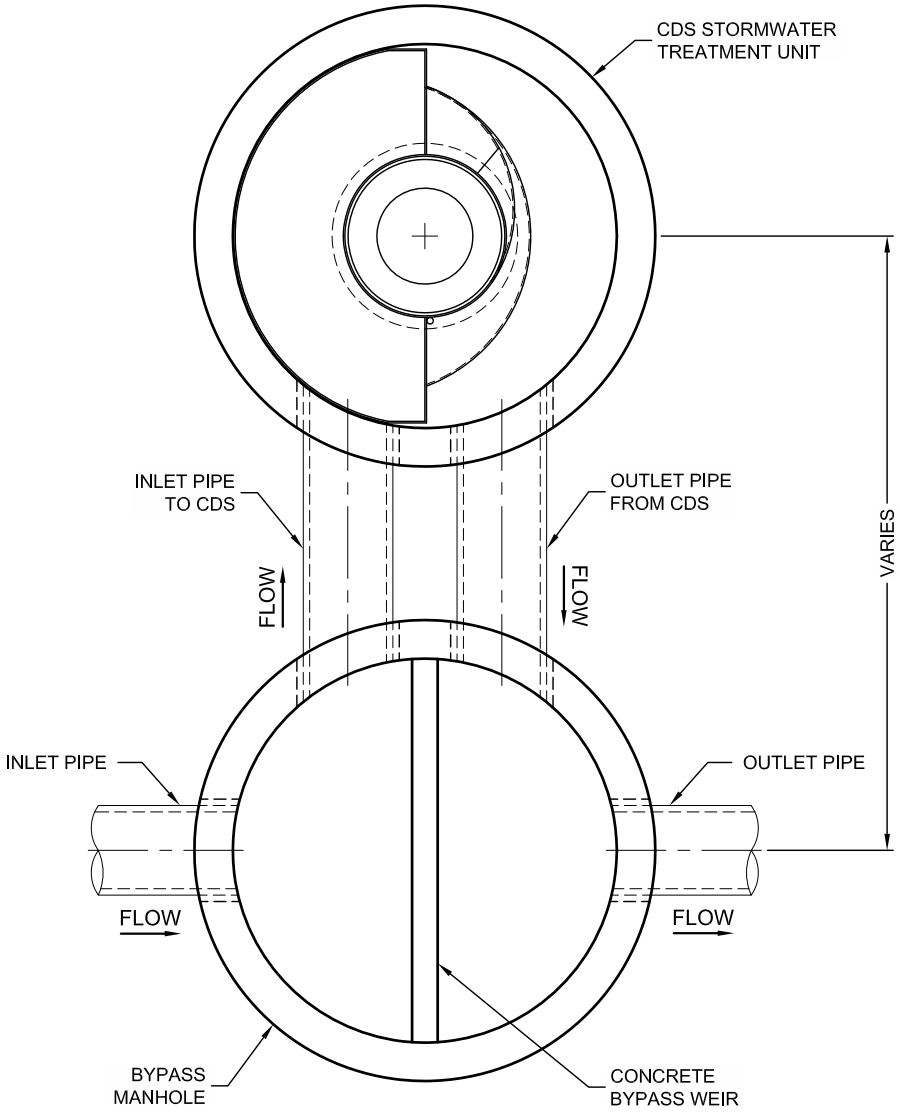
800-338-1122 513-645-7000 513-645-7993 FAX

CDS3035-6-C
INLINE CDS
STANDARD DETAIL



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CDS STORMWATER TREATMENT SYSTEM
TYPICAL OFFLINE LAYOUT
WITH BYPASS MANHOLE STRUCTURE

DATE:03/12/13	SCALE: NONE	PROJECT No.: N/A	SEQ. No.: N/A	DRAWN: N/A	CHECKED: N/A