ENGINEERING NARRATIVE & REPORT

9/16/2025

For The Proposed:

Self Storage Facility

Munster, IN

CLIENT:

GHK Developments, Inc.
3920 Magazine St
New Orleans, LA 70115

PROJECT LOCATION:

45th Street
Munster, IN 46321

PREPARED BY:

blueWATER
civil design

ENGINEER OF RECORD:

09/16/2025

CHRISTOPHER L. PRICE
No. 12100391
STATE OF INDIANA
PROFESSIONAL ENGINEER

Christopher L. Price, P.E.
IN PE Lic. No.: 12100391

TABLE OF CONTENTS

Project Description

GHK Developments, Inc. is proposing to construct a 117,000-sf indoor storage facility and associated parking located off 45th St & Fran-Lin Pkwy in Dyer, IN. The parcel ID number is 45-07-32-126-001.000-027. The overall property area is 11.35 acres with the proposed subdivided property for the project being 3.3 acres. The property will drain to an existing storm drainage manhole located in the parking lot to the east of the existing building that is located to the north of the project. The property is currently vacant consisting of open space with some gravel from previous development. The total land disturbance for this project is 3.7-acres.

Hydrology

The stormwater management system proposed for this project has been designed using the guidelines set forth in the Town of Munster Storm Water Technical Standards Manual. The peak runoff rates were determined through an analysis of the 10-yr & 100-yr, 24-hour storm events.

The purpose of this model is to illustrate that the Post-Developed peak runoff rate for the drainage areas will not exceed the required 0.2cfs per acre of drainage area as required by the Town of Munster for the 10 & 100-yr storm events.

Land Cover	Rc
Asphalt:	1.00
Grassed areas	0.35

Post DA 1 – To Pond
Drainage Area = **3.00 acres**

Weighted Runoff Coefficient = **0.83**

- 2.22 acres – Asphalt
- 0.78 acres – Grassed Areas

Peak Flows – 24 Hour Storm Events From Detention Pond			
Storm	Max Allowable Flow Rate (0.2 cfs/acre)	Proposed	Pond Max Stage
(year)	(cfs)	(cfs)	(ft)
10	6.00	0.27	613.34
100	6.00	0.32	614.3

Post DA 2 – Pond Bypass
Drainage Area = **0.93 acres**

Weighted Runoff Coefficient = **0.74**

- 0.56 acres – Asphalt
- 0.37 acres – Grassed Areas

See Appendix B for Hydrology Calculations

Storm Piping Study

The on-site storm drain system is designed at a minimum to pass the critical 10-year 24-hour storm. The system has been designed for capacity to route the critical 10-yr storm and not stage higher than any inlet rim elevation.

See Appendix C for Storm Piping Design

Channel Protection Volume

Per the Town of Munster Stormwater requirements, the 1-year, 24-hour storm is required to be analyzed for Channel Protection standards. No more than 10% of the total storm volume is to remain within the pond after 36 hours and no more than 40% is to be released in the first 12 hours. Both of these standards are met with a proposed 2.5" low flow orifice.

Channel Protection Volume = **19,721 Cu. Ft.**
Orifice Diameter = **2.5"**
90% Drawdown Time = **32.5 hours**
40% Drawdown Time = **14.5 hours**

Water Quality Volume

Per the Town of Munster Stormwater requirements, a 1" storm is required to be treated for Water Quality requirements. We are proposing extended detention utilitizing the same 2.5" low flow orifice that will meet the peak flow and channel protection requirements.

Water Quality Volume = **7,797 Cu. Ft.**
Orifice Diameter = **2.5"**
Total Drawdown Time = **18.2 hours**

See Appendix D for Channel Protection & Water Quality Calculations

Soils and Erosion Control Phasing

The predominant soil types existing at this site is Rensselaer loam (HSG C/D) and Bono silty clay (HSG C/D). This soil is poorly drained and has a high rate of water transmission.

The erosion control will be implemented in 3 phases. During Phase I, perimeter BMPs (including silt fence, gravel construction entrance) and sediment basin will be installed. Phase II will consist of rough grading, utility and storm drainage installation. Phase III will include fine grading, permanent stabilization and conversion of sediment basin for permanent use. See the Erosion Control Narrative on plans for sequencing. Best Management Practices will also be used in order to help control dust and keep sediment off of roadways during construction as required.

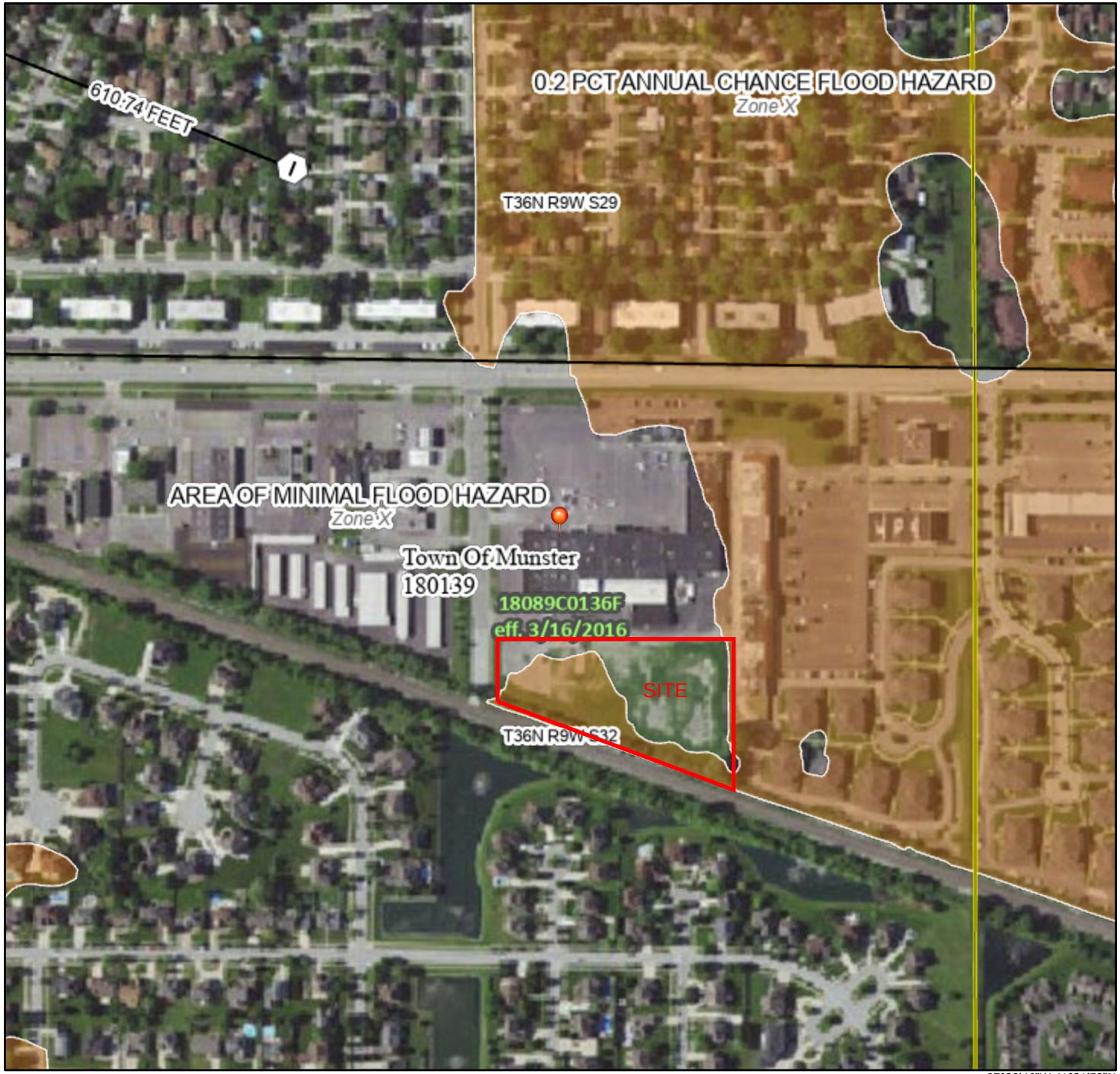
VICINITY MAP

SELF STORAGE MUNSTER, IN

National Flood Hazard Layer FIRMette

FEMA

87°29'24"W 41°32'25"N



87°28'46"W 41°31'58"N

0 250 500 1,000 1,500 2,000 Feet

1:6,000

Basemap Imagery Source: USGS National Map 2023

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR 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 / 17.5 Cross Sections with 1% Annual Chance / Water Surface Elevation
- Coastal Transect
- Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

N

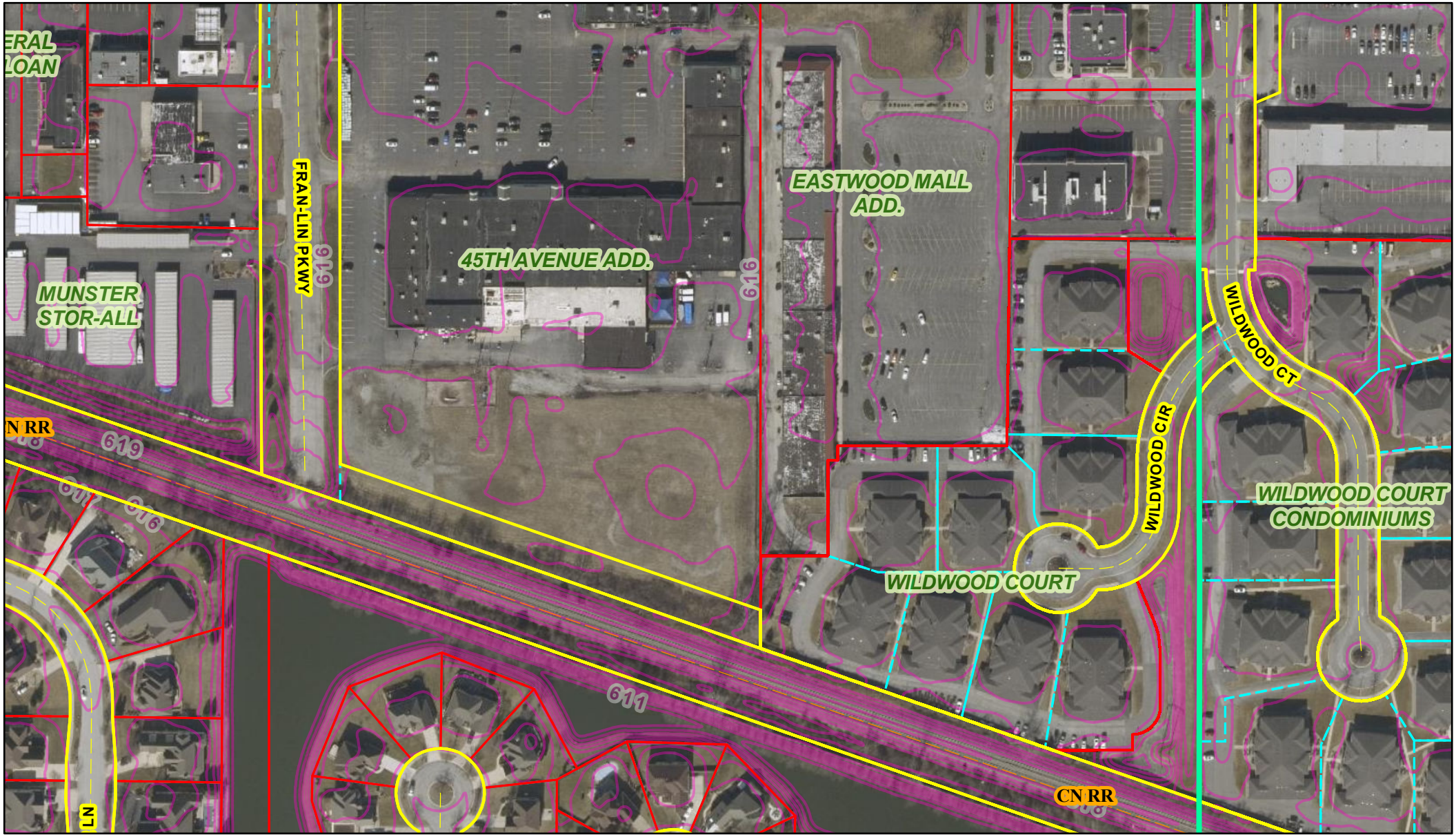
The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

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

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 7/30/2025 at 6:26 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.

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. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

GIS - Self Storage Munster, IN



9/9/2025, 1:43:42 PM

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This map is a user generated static output from an Internet mapping site and is for reference only. Data layers that appear on this map may or may not be accurate, current, or otherwise reliable

Custom Soil Resource Report
Soil Map

Map Scale: 1:1,030 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 15 30 60 90

Feet: 0 50 100 200 300

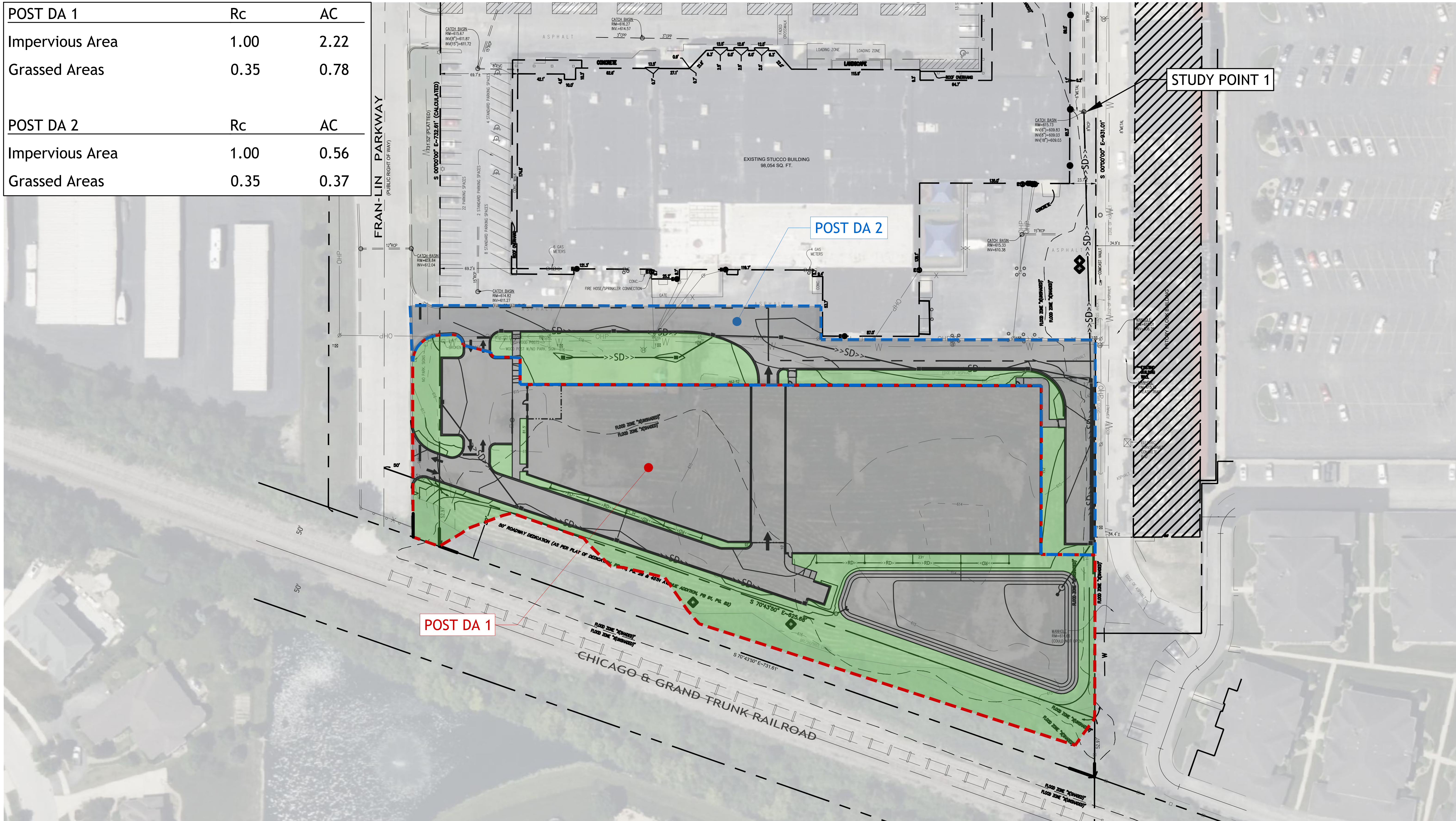
Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 16N WGS84

APPENDIX A

Drainage Maps

POST DA 1	Rc	AC
Impervious Area	1.00	2.22
Grassed Areas	0.35	0.78

POST DA 2	Rc	AC
Impervious Area	1.00	0.56
Grassed Areas	0.35	0.37



Bluewater Civil Design, PLLC
718 Lowndes Hill Road
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Date: 9/16/25

north

80 40 0 80

scale: 1" = 80'

Self Storage Munster IN

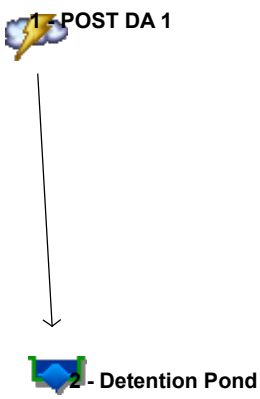
Post Development Drainage Basins

APPENDIX B

Hydrology

Hydraflow Table of Contents

Watershed Model Schematic



Legend

Hyd.	Origin	Description
1	Mod. Rational	POST DA 1
2	Reservoir	Detention Pond

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	Mod. Rational	------	-------	-------	-------	-------	3.465	-------	-------	5.550	POST DA 1
2	Reservoir	1	-------	-------	-------	-------	0.269	-------	-------	0.315	Detention Pond

Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2024

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	Mod. Rational	3.465	1	6	24,749	------	------	------	POST DA 1
2	Reservoir	0.269	1	125	24,725	1	613.34	23,120	Detention Pond

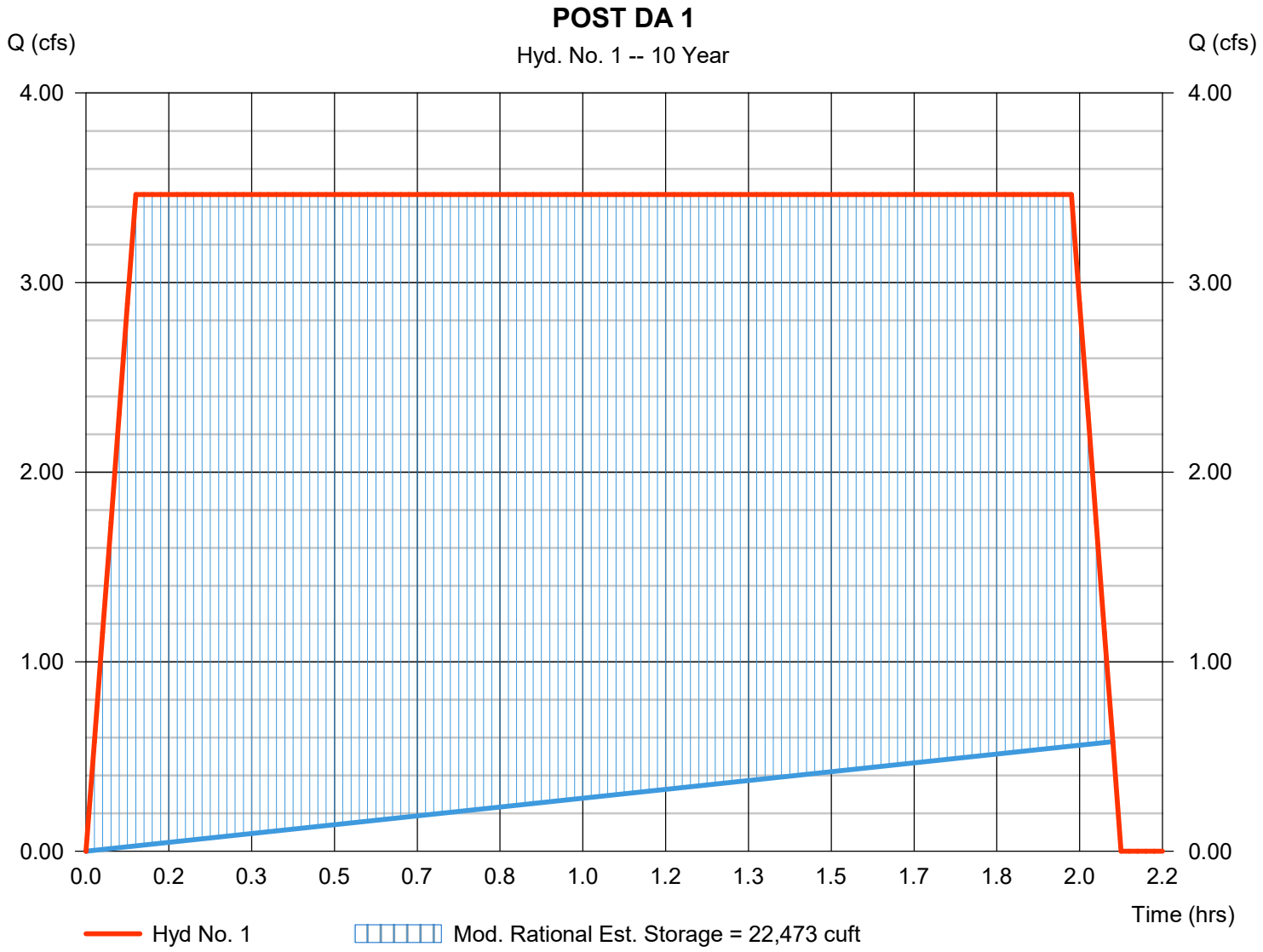
Hydrograph Report

Hyd. No. 1

POST DA 1

Hydrograph type	= Mod. Rational	Peak discharge	= 3.465 cfs
Storm frequency	= 10 yrs	Time to peak	= 0.10 hrs
Time interval	= 1 min	Hyd. volume	= 24,749 cuft
Drainage area	= 3.000 ac	Runoff coeff.	= 0.83*
Intensity	= 1.392 in/hr	Tc by User	= 6.00 min
IDF Curve	= munster.IDF	Storm duration	= 19.8 x Tc
Target Q	=0.600 cfs	Est. Req'd Storage	=22,473 cuft

* Composite (Area/C) = [(2.220 x 1.00) + (0.780 x 0.35)] / 3.000



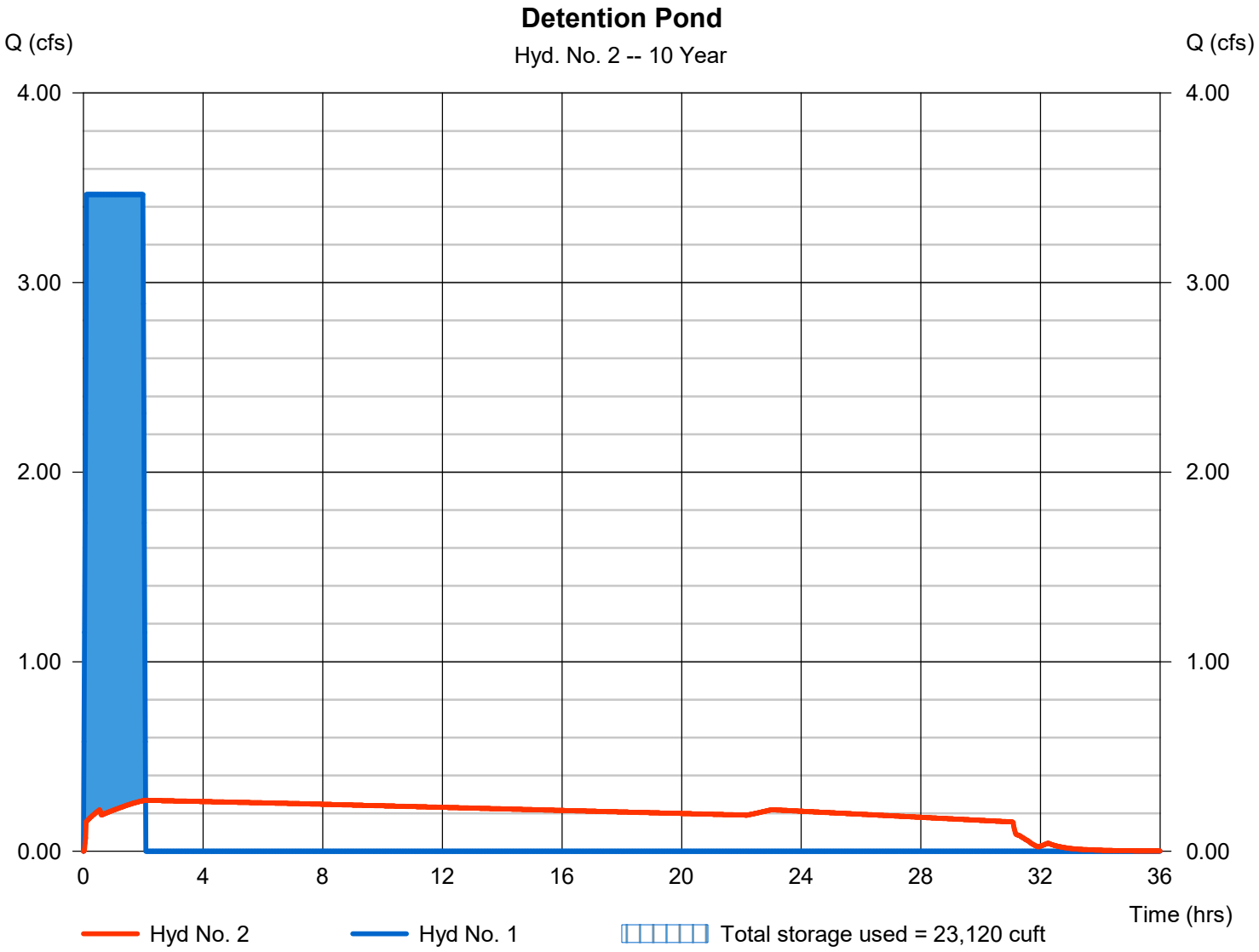
Hydrograph Report

Hyd. No. 2

Detention Pond

Hydrograph type	=	Reservoir	Peak discharge	=	0.269 cfs
Storm frequency	=	10 yrs	Time to peak	=	2.08 hrs
Time interval	=	1 min	Hyd. volume	=	24,725 cuft
Inflow hyd. No.	=	1 - POST DA 1	Max. Elevation	=	613.34 ft
Reservoir name	=	pond 1	Max. Storage	=	23,120 cuft

Storage Indication method used.



Pond Report

Pond No. 1 - pond 1

Pond Data

Contours -User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 610.54 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	610.54	01	0	0
0.46	611.54	2,463	385	385
1.46	612.00	10,547	6,035	6,420
2.46	613.00	13,396	11,942	18,362
3.46	614.00	15,017	14,197	32,560
4.46	615.00	16,694	15,847	48,406

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 15.00	2.50	0.00	0.00
Span (in)	= 15.00	2.50	0.00	0.00
No. Barrels	= 1	1	0	0
Invert El. (ft)	= 610.54	610.55	0.00	0.00
Length (ft)	= 45.00	0.50	0.00	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	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 12.67	0.00	0.00	0.00
Crest El. (ft)	= 614.50	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= 1	---	---	---
Multi-Stage	= Yes	No	No	No

Exfil.(in/hr) = 0.000 (by Contour)

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).

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	610.54	0.00	0.00	---	---	0.00	---	---	---	---	---	0.000
0.46	385	611.54	0.00	0.15 ic	---	---	0.00	---	---	---	---	---	0.154
1.46	6,420	612.00	0.00	0.19 ic	---	---	0.00	---	---	---	---	---	0.190
2.46	18,362	613.00	0.00	0.25 ic	---	---	0.00	---	---	---	---	---	0.251
3.46	32,560	614.00	0.00	0.30 ic	---	---	0.00	---	---	---	---	---	0.300
4.46	48,406	615.00	11.17 oc	0.34 ic	---	---	11.17 s	---	---	---	---	---	11.51

Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2024

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	Mod. Rational	5.550	1	6	39,638	------	------	------	POST DA 1
2	Reservoir	0.315	1	125	39,575	1	614.33	37,789	Detention Pond

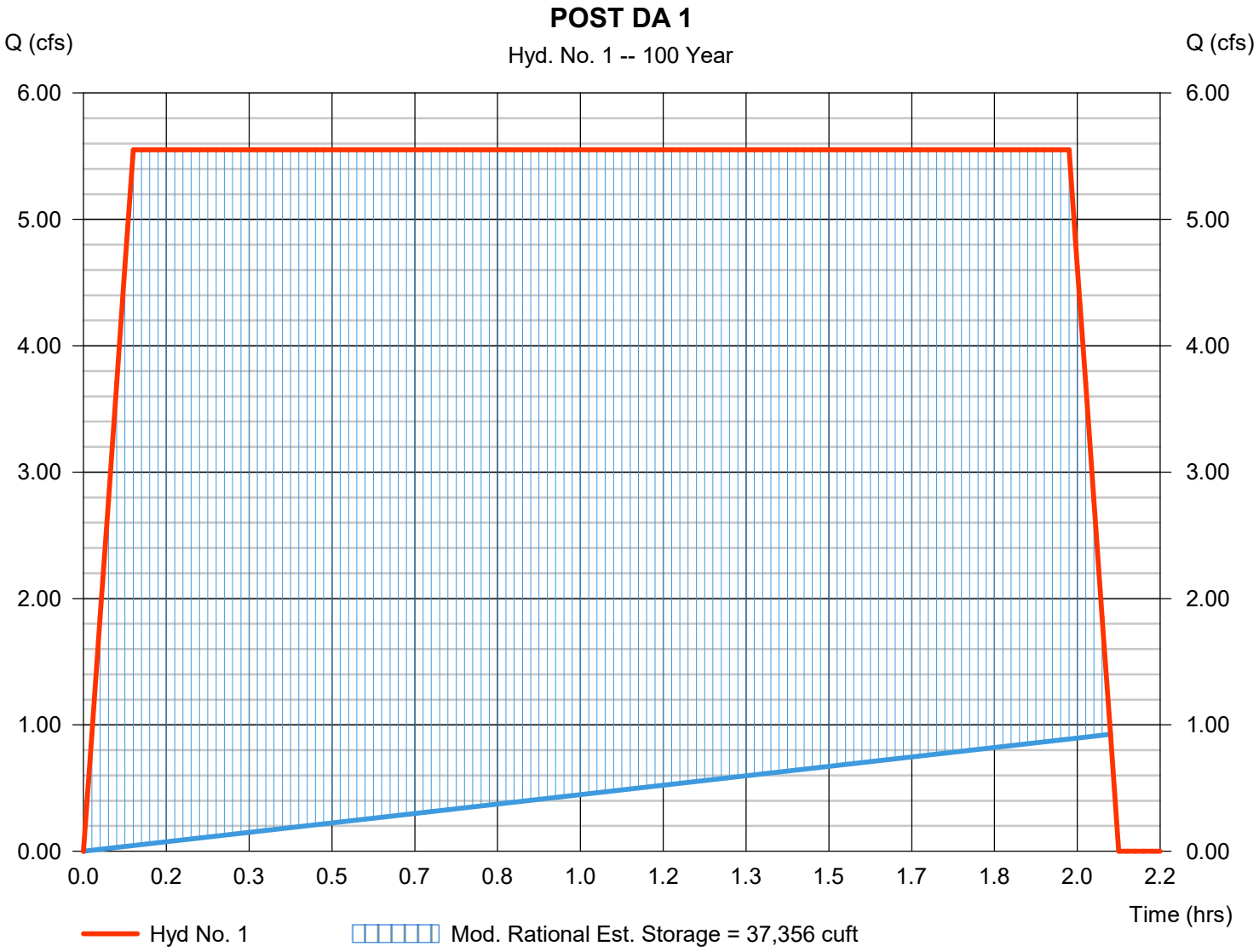
Hydrograph Report

Hyd. No. 1

POST DA 1

Hydrograph type	= Mod. Rational	Peak discharge	= 5.550 cfs
Storm frequency	= 100 yrs	Time to peak	= 0.10 hrs
Time interval	= 1 min	Hyd. volume	= 39,638 cuft
Drainage area	= 3.000 ac	Runoff coeff.	= 0.83*
Intensity	= 2.229 in/hr	Tc by User	= 6.00 min
IDF Curve	= munster.IDF	Storm duration	= 19.8 x Tc
Target Q	=0.600 cfs	Est. Req'd Storage	=37,356 cuft

* Composite (Area/C) = [(2.220 x 1.00) + (0.780 x 0.35)] / 3.000



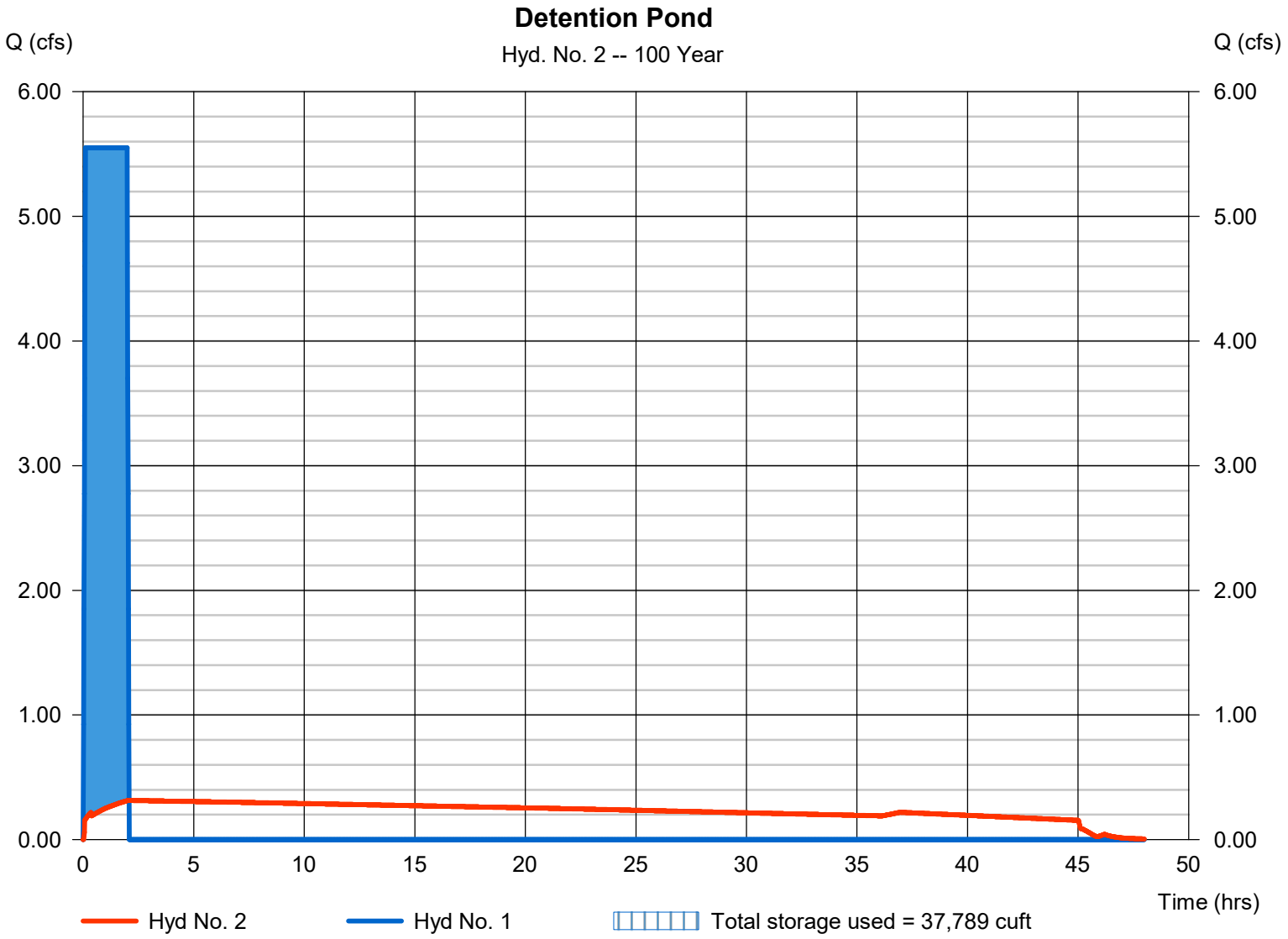
Hydrograph Report

Hyd. No. 2

Detention Pond

Hydrograph type	=	Reservoir	Peak discharge	=	0.315 cfs
Storm frequency	=	100 yrs	Time to peak	=	2.08 hrs
Time interval	=	1 min	Hyd. volume	=	39,575 cuft
Inflow hyd. No.	=	1 - POST DA 1	Max. Elevation	=	614.33 ft
Reservoir name	=	pond 1	Max. Storage	=	37,789 cuft

Storage Indication method used.



Hydraflow Rainfall Report

Return Period (Yrs)	Intensity-Duration-Frequency Equation Coefficients (FHA)			
	B	D	E	(N/A)
1	0.0000	0.0000	0.0000	--------
2	45.6688	7.6000	0.7999	--------
3	0.0000	0.0000	0.0000	--------
5	45.5753	7.0000	0.7435	--------
10	63.8692	8.7000	0.7889	--------
25	52.7537	6.7000	0.7050	--------
50	55.0919	6.4000	0.6889	--------
100	51.5234	5.3000	0.6512	--------

File name: munster.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	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	6.02	4.61	3.77	3.21	2.81	2.51	2.27	2.08	1.92	1.78	1.67	1.57
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	7.18	5.54	4.58	3.93	3.46	3.11	2.83	2.60	2.41	2.26	2.12	2.00
10	8.10	6.34	5.26	4.52	3.98	3.57	3.24	2.98	2.76	2.57	2.41	2.27
25	9.31	7.25	6.03	5.21	4.61	4.16	3.80	3.51	3.27	3.06	2.88	2.73
50	10.30	8.02	6.68	5.78	5.13	4.63	4.24	3.92	3.65	3.42	3.23	3.06
100	11.28	8.72	7.25	6.29	5.59	5.06	4.64	4.30	4.02	3.78	3.57	3.39

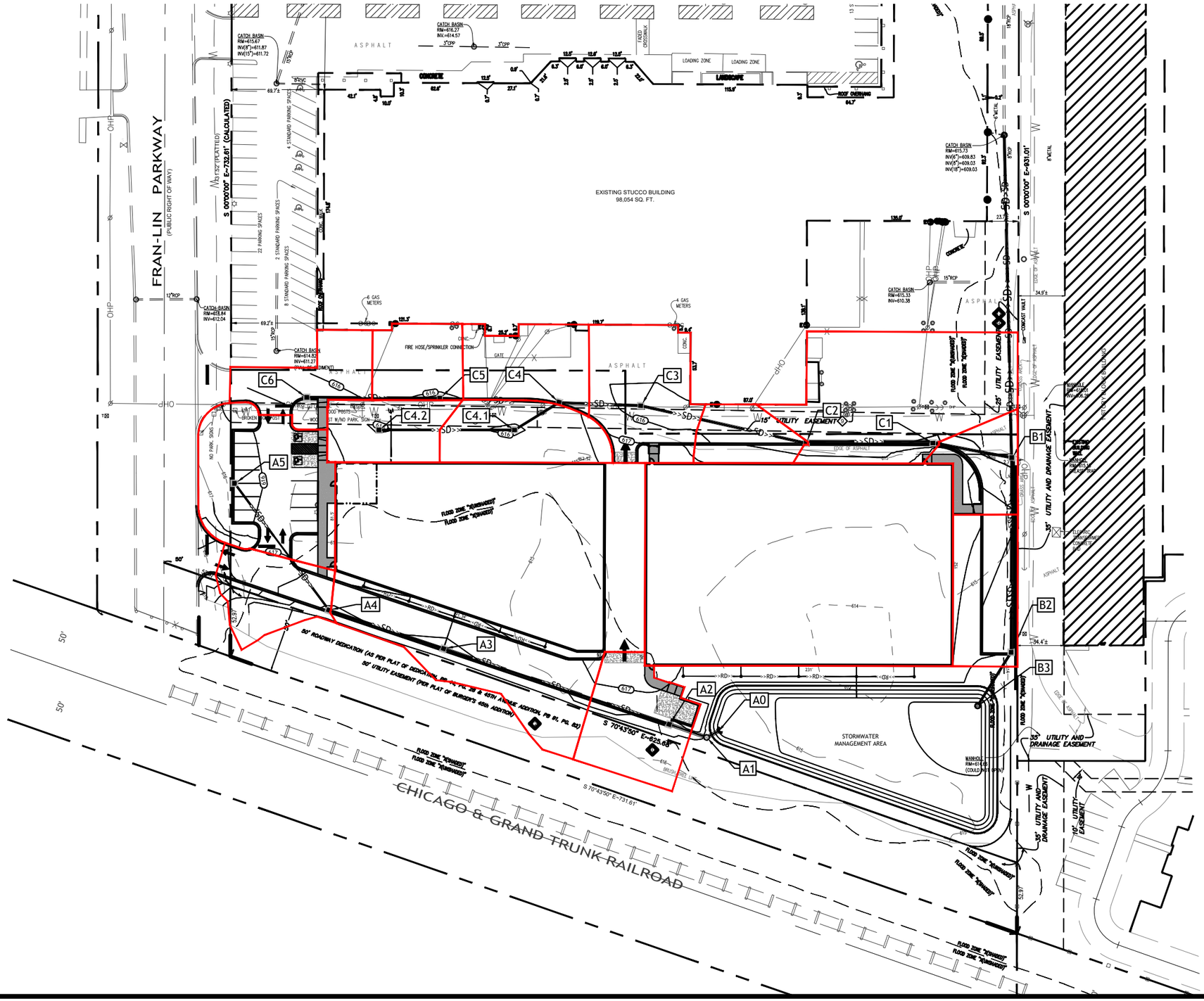
Tc = time in minutes. Values may exceed 60.

Precip. file name: V:\Bluewater Projects\2024\2024-120 JSH TSC W Union\stormwater\W UNION 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	0.00	3.25	0.00	4.18	4.94	6.05	6.99	8.02
SCS 6-Hr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-1st	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
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	0.00	0.00	0.00	0.00	0.00	0.00	0.00

APPENDIX C

Storm Drainage



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718 Lowndes Hill Road
Greenville, SC 29607
www.bluewatercivil.com
info@bluewatercivil.com

Date: 9/16/25

north

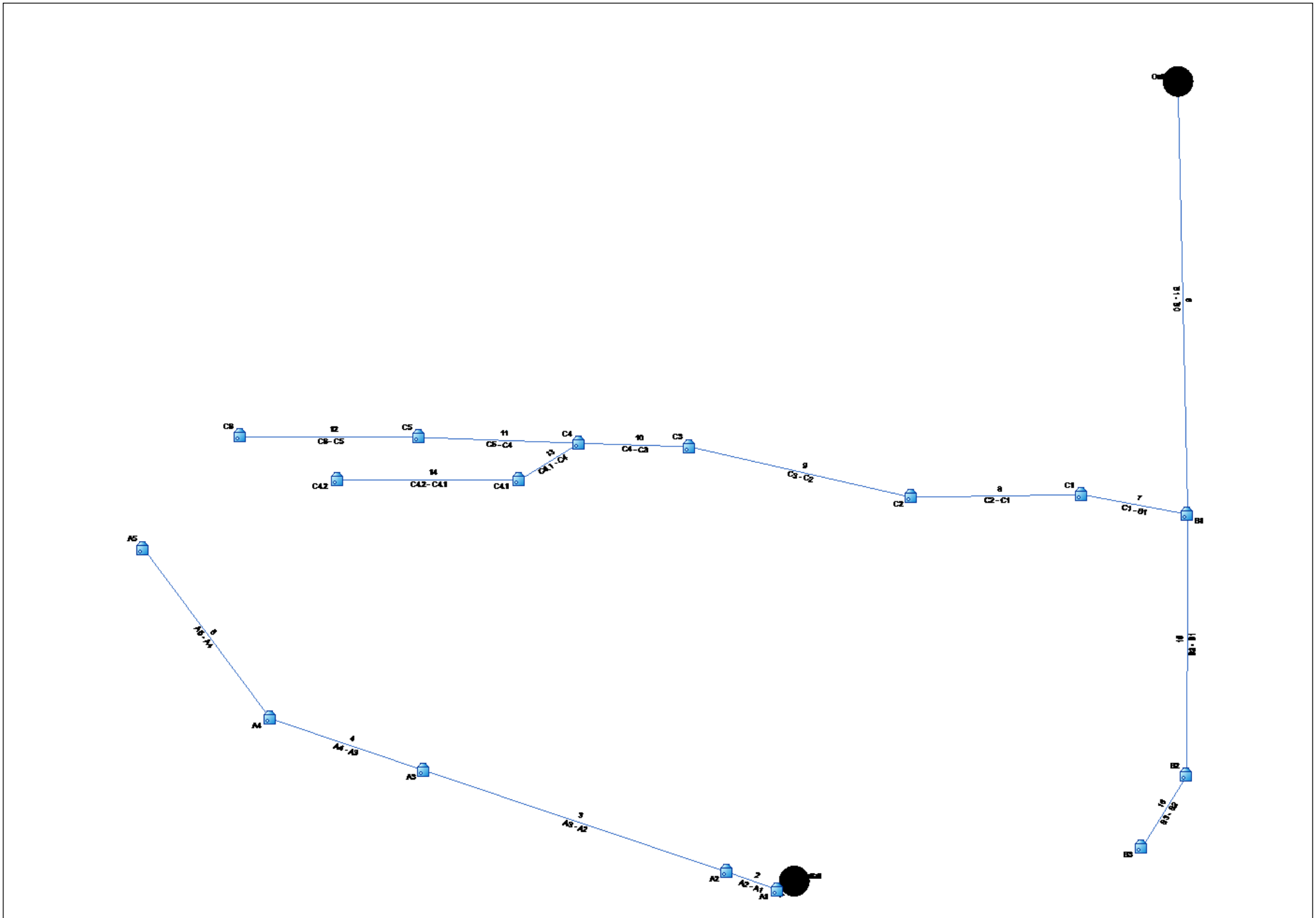
80 40 0 80

scale: 1" = 80'

Self Storage Munster IN

Storm Drainage Basins

Hydraflow Storm Sewers Extension for Autodesk® Civil 3D® Plan



Project File: MUNSTER.stm	Number of lines: 16	Date: 9/16/2025

Storm Sewer Inventory Report

Line No.	Alignment				Flow Data				Physical Data								Line ID
	Dnstr Line No.	Line Length (ft)	Defl angle (deg)	Junc Type	Known Q (cfs)	Drng Area (ac)	Runoff Coeff (C)	Inlet Time (min)	Invert El Dn (ft)	Line Slope (%)	Invert El Up (ft)	Line Size (in)	Line Shape	N Value (n)	J-Loss Coeff (K)	Inlet/ Rim El (ft)	
1	End	10.341	151.759	MH	0.00	0.00	0.00	0.0	612.50	0.29	612.53	24	Cir	0.013	0.78	615.78	A1 - A0
2	1	29.824	47.763	MH	0.00	0.15	0.61	6.0	612.53	0.30	612.62	24	Cir	0.013	0.15	616.37	A2 - A1
3	2	178.543	-0.957	MH	0.00	0.88	0.86	6.0	612.62	0.30	613.15	18	Cir	0.013	0.15	615.84	A3 - A2
4	3	90.777	0.009	MH	0.00	0.11	0.66	6.0	613.15	0.30	613.42	15	Cir	0.013	0.62	615.85	A4 - A3
5	4	118.427	34.798	MH	0.00	0.24	0.73	6.0	613.42	0.30	613.78	12	Cir	0.013	1.00	615.56	A5 - A4
6	End	242.071	88.703	MH	0.00	0.08	0.87	6.0	609.03	0.35	609.87	18	Cir	0.013	1.00	614.75	B1 - B0
7	6	60.009	101.942	MH	0.00	0.33	0.89	6.0	609.87	0.70	610.29	18	Cir	0.013	0.24	614.93	C1 - B1
8	7	95.122	-11.515	MH	0.00	0.07	0.84	6.0	610.29	0.70	610.96	18	Cir	0.013	0.28	615.14	C2 - C1
9	8	127.304	13.593	MH	0.00	0.18	0.91	6.0	610.96	0.70	611.85	18	Cir	0.013	0.22	615.39	C3 - C2
10	9	61.485	-10.745	MH	0.00	0.12	0.95	6.0	611.85	0.70	612.28	18	Cir	0.013	0.61	616.15	C4 - C3
11	10	89.350	0.133	MH	0.00	0.09	0.95	6.0	612.28	0.69	612.90	15	Cir	0.013	0.15	615.89	C5 - C4
12	11	99.771	-1.794	MH	0.00	0.11	0.90	6.0	612.90	0.69	613.59	15	Cir	0.013	1.00	615.64	C6 - C5
13	10	39.002	-33.734	MH	0.00	0.12	0.35	6.0	612.28	0.69	612.55	15	Cir	0.013	0.58	615.80	C4.1 - C4
14	13	101.755	31.717	MH	0.00	0.09	0.35	6.0	612.55	0.71	613.27	15	Cir	0.013	1.00	615.90	C4.2 - C4.1
15	6	146.044	1.423	MH	0.00	0.13	0.67	6.0	609.87	0.35	610.38	15	Cir	0.013	0.58	615.29	B2 - B1
16	15	47.482	31.895	MH	0.61	0.00	0.00	0.0	610.38	0.34	610.54	15	Cir	0.013	1.00	613.00	B3 - B2

Project File: MUNSTER.stm | Number of lines: 16 | Date: 9/16/2025

Structure Report

Struct No.	Structure ID	Junction Type	Rim Elev (ft)	Structure			Line Out			Line In		
				Shape	Length (ft)	Width (ft)	Size (in)	Shape	Invert (ft)	Size (in)	Shape	Invert (ft)
1	A1	Manhole	615.78	Cir	4.00	4.00	24	Cir	612.53	24	Cir	612.53
2	A2	Manhole	616.37	Cir	4.00	4.00	24	Cir	612.62	18	Cir	612.62
3	A3	Manhole	615.84	Cir	4.00	4.00	18	Cir	613.15	15	Cir	613.15
4	A4	Manhole	615.85	Cir	4.00	4.00	15	Cir	613.42	12	Cir	613.42
5	A5	Manhole	615.56	Cir	4.00	4.00	12	Cir	613.78			
6	B1	Manhole	614.75	Cir	4.00	4.00	18	Cir	609.87	18 15	Cir Cir	609.87 609.87
7	C1	Manhole	614.93	Cir	4.00	4.00	18	Cir	610.29	18	Cir	610.29
8	C2	Manhole	615.14	Cir	4.00	4.00	18	Cir	610.96	18	Cir	610.96
9	C3	Manhole	615.39	Cir	4.00	4.00	18	Cir	611.85	18	Cir	611.85
10	C4	Manhole	616.15	Cir	4.00	4.00	18	Cir	612.28	15 15	Cir Cir	612.28 612.28
11	C5	Manhole	615.89	Cir	4.00	4.00	15	Cir	612.90	15	Cir	612.90
12	C6	Manhole	615.64	Cir	4.00	4.00	15	Cir	613.59			
13	C4.1	Manhole	615.80	Cir	4.00	4.00	15	Cir	612.55	15	Cir	612.55
14	C4.2	Manhole	615.90	Cir	4.00	4.00	15	Cir	613.27			
15	B2	Manhole	615.29	Cir	4.00	4.00	15	Cir	610.38	15	Cir	610.38
16	B3	Manhole	613.00	Cir	4.00	4.00	15	Cir	610.54			

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Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line Size (in)	Line shape	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line Slope (%)	HGL Down (ft)	HGL Up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns Line No.	Junction Type
1	A1 - A0	7.22	24	Cir	10.341	612.50	612.53	0.290	613.45	613.57	0.23	613.80	End	Manhole
2	A2 - A1	7.29	24	Cir	29.824	612.53	612.62	0.302	613.80	613.85	0.03	613.88	1	Manhole
3	A3 - A2	6.91	18	Cir	178.543	612.62	613.15	0.297	614.12*	614.89*	n/a	614.93	2	Manhole
4	A4 - A3	1.79	15	Cir	90.777	613.15	613.42	0.297	614.93*	615.00*	n/a	615.02	3	Manhole
5	A5 - A4	1.34	12	Cir	118.427	613.42	613.78	0.304	615.02*	615.19*	n/a	615.23	4	Manhole
6	B1 - B0	5.51	18	Cir	242.071	609.03	609.87	0.347	609.93	611.17	n/a	611.35	End	Manhole
7	C1 - B1	4.20	18	Cir	60.009	609.87	610.29	0.700	611.35	611.07	n/a	611.07	6	Manhole
8	C2 - C1	2.87	18	Cir	95.122	610.29	610.96	0.704	611.07	611.60	n/a	611.60	7	Manhole
9	C3 - C2	2.66	18	Cir	127.304	610.96	611.85	0.699	611.60	612.47	n/a	612.47	8	Manhole
10	C4 - C3	1.89	18	Cir	61.485	611.85	612.28	0.699	612.47	612.80	n/a	612.80	9	Manhole
11	C5 - C4	1.24	15	Cir	89.350	612.28	612.90	0.694	612.80	613.34	n/a	613.34	10	Manhole
12	C6 - C5	0.76	15	Cir	99.771	612.90	613.59	0.692	613.34	613.93	n/a	613.93	11	Manhole
13	C4.1 - C4	0.39	15	Cir	39.002	612.28	612.55	0.692	612.80	612.79	n/a	612.79	10	Manhole
14	C4.2 - C4.1	0.24	15	Cir	101.755	612.55	613.27	0.708	612.79	613.46	n/a	613.46	13	Manhole
15	B2 - B1	1.28	15	Cir	146.044	609.87	610.38	0.349	611.35	611.40	n/a	611.41	6	Manhole
16	B3 - B2	0.61	15	Cir	47.482	610.38	610.54	0.337	611.41	611.42	n/a	611.42	15	Manhole

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NOTES: Return period = 10 Yrs. ; *Surcharged (HGL above crown).

APPENDIX D

Channel Protection & Water Quality Calculations

Channel Protection Volume (Cpv)			
	CN	Area	Total Weighted CN
Impervious Area	98	2.22	
Grass (Good, HSG C)	74	0.61	
Woods (Good, HSG C)	70	0.17	91.53
		S = (1000/CN)-10 =	0.925

Total Area	1-Year, 24-Hr Precipitation depth (P)	Runoff Depth (Qv) [(P-0.2S)^2 / (P+0.8S)]	Runoff Volume
[ac]	[in]	[in]	[Cu.Ft.]
3	2.67	1.81	19721.0

Water Quality Elevation for Required Volume (E_{wq})			
Larger Volume (FT^3)		Lower Volume (FT^3)	Elevation
32,560		18,362	613.10
Higher Contour		Lower Contour	
614.00		613.00	

Average Allowable Flow (Q_{aaf}) [cfs]	
$Q_{aaf} = V_{wq}$ / (48 hr x 3600 s/hr)	0.114

Average Head (H_{avg})*			
* Assume the average head associated with first flush is 50% of the total head			
E_{wq}		Low Orifice Elevation (E_{Lo})	H_{avg} [FT]
613.10		610.54	
$H_{avg} = 0.3333 \times (E_{wq} - E_{Lo})$			0.8519

Calculated Low Flow Orifice Area (A_{Lo}) [FT^2]			
$A_{Lo} = (Q_{aaf}) / [0.6 \times ((2 \times 32.2 \times H_{avg}))^{0.5}$			A_{Lo} [FT^2]
			0.0257

Orifice Diameter (d_o) [in]			
$d_o = [A_{Lo} \times 4 / \prod]^{0.5}$			[in]
		Calculated (d_o)	2.17
		Engineer Selected (d_e)	2.50

Actual Low Flow Orifice Area (A_{Loa}) [FT^2]	
$A_{Loa} = (\prod \times d_e^2) / 4$	0.0341

Revised Average Allowable Flow Q_r [cfs]	
$Q_r = A_{LOA} \times 0.6 [2 \times 32.2 \times H_{avg}]^{0.5}$	0.151

90% Drawdown Time (t_d) [hr]	
$t_d = V_{wq} / (Q_r \times 3600$ s/hr)	32.5

40% Drawdown Time (t_d) [hr]	
$t_d = V_{wq} / (Q_r \times 3600$ s/hr)	14.5

Total Drawdown Time (t_d) [hr]	
$t_d = V_{wq} / (Q_r \times 3600$ s/hr)	36.2

Water Quality Volume (WQv)			
Drainage Area (A)	Precipitation	Volumetric Runoff Coefficient	Water Quality Volume (WQv)
[acres]	[in]	[-]	[FT^3]
3.00	1.00	0.716	
V_{wq} = A * D * (43560SQFT/AC) / (12IN/FT)			7,797

Water Quality Elevation for Required Volume (E_{wq})			
Larger Volume (FT^3)		Lower Volume (FT^3)	Elevation
18,362		6,420	612.12
Higher Contour		Lower Contour	
613.00		612.00	

Actual Water Quality Elevation		Actual Water Quality Volume	
612.12		7,797	

Average Allowable Flow (Q_{aaf}) [cfs]	
$Q_{aaf} = V_{wq} / (48 \text{ hr} \times 3600 \text{ s/hr})$	0.045

Average Head (H_{avg})*			
* Assume the average head associated with first flush is 50% of the total head			
E_{wq}		Low Orifice Elevation (E_{Lo})	H_{avg} [FT]
612.12		610.54	
$H_{avg} = 0.3333 \times (E_{wq} - E_{Lo})$			0.5267

Calculated Low Flow Orifice Area (A_{Lo}) [FT^2]			
$A_{Lo} = (Q_{aaf}) / [0.6 \times ((2 \times 32.2 \times H_{avg}))^{0.5}$			A_{Lo} [FT^2]
			0.0129

Orifice Diameter (d_o) [in]			
$d_o = [A_{Lo} \times 4 / \prod]^{0.5}$			[in]
		Calculated (d_o)	1.54
		Engineer Selected (d_e)	2.50

Actual Low Flow Orifice Area (A_{Loa}) [FT^2]	
$A_{Loa} = (\prod \times d_e^2) / 4$	0.0341

Revised Average Allowable Flow Q_r [cfs]	
$Q_r = A_{LOA} \times 0.6 [2 \times 32.2 \times H_{avg}]^{0.5}$	0.119

Drawdown Time (t_d) [hr]	
$t_d = V_{wq} / (Q_r \times 3600 \text{ s/hr})$	18.2