A STORMWATER MANAGEMENT ANALYSIS

OF THE PROPOSED DEVELOPMENT OF

PROGRESSIVE INSTALLATIONS BUILDING ADDITION

IN THE

CITY OF O'FALLON, MISSOURI

FOR

PROGRESSIVE INSTALLATIONS
8478 MEXICO ROAD
O'FALLON, MO 63376

BAX PROJECT NO. 22-18634

September 1, 2022

Prepared by:
Bax Engineering Co., INC.
221 Point West Blvd.
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9-1-22

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Bax Engineering Co, Inc.
Missouri State
Certificate of Authority
Engineering Authority No. 000655

INTRODUCTION:

The currently undeveloped site is located in the City of O'Fallon, Missouri and is comprised of 1.45 acres of land. The site shall be analyzed for the construction of the proposed storage/warehouse disturbing approximately 0.42 acres of land. A dry basin is proposed to provide the Stormwater Attenuation required by the City of O'Fallon Design Standards for the proposed development. The storage volume and outflow rates shall be proportioned to ensure that the peak rate of runoff leaving the tract under Postdeveloped conditions is less than or equal to the peak rate of runoff under Predeveloped conditions for the 2, 15, 25, and 100 Year 20 Minute Design Storms. The safe passage of the 100 Year 20 Minute Design Storm will also be analyzed assuming the low flow slot is blocked.

Water Quality for this site is provided by the use of a snout. The proposed snout provides the storage needed to capture and treat the runoff from ninety percent of the recorded daily rainfall events.

GENERAL SITE DATA AND RUNOFF CALCULATIONS

The Predeveloped Runoff Factors used for the analysis are:

Land Use	Percent Impervious	PI Factors (cfs/ac)			
		2 year	15 year	25 year	100 year
Greenspace	0-5%	1.15	1.70	2.00	2.29
Pavement/Building	100%	2.39	3.54	4.16	4.77

The Postdeveloped Runoff Factors used for the analysis are:

Land Use	Percent Impervious	PI Factors (cfs/ac)			
		2 year	15 year	25 year	100 year
Greenspace	0-5%	1.15	1.70	2.00	2.29
Pavement/Building	100%	2.39	3.54	4.16	4.77

The site is divided into four watersheds. The areas encompassing these watersheds and their respective discharge points are described later in this report.

To determine if detention is required for the site, the differential runoff was calculated for each watershed for the 15 year 20 minute storm.

DIFFERENTIAL RUNOFF

The differential runoff for the watershed was calculated by subtracting the predeveloped runoff rate from the postdeveloped runoff rate. If the differential runoff is greater than 0 cfs, the watershed requires detention.

WATERSHED A

Watershed A discharges to the northern area of the site.

Predeveloped

15 year 20 minute storm

Greenspace	0.47 ac	x	1.70 cfs/ac	=	0.80 cfs
Pavement/Building	0.07 ac	x	3.54 cfs/ac	=	0.25 cfs
Total	0.54 ac				1.05 cfs

Postdeveloped

15 year 20 minute storm

Greenspace	0.13 ac	x	1.70 cfs/ac	=	0.22 cfs
Pavement/Building	0.59 ac	x	3.54 cfs/ac	=	2.09 cfs
Total	0.72 ac				2.31 cfs

Design Storm	Postdeveloped Runoff (cfs)	Predeveloped Runoff (cfs)	Differential Runoff (cfs)
15 Year 20 minute	2.31	1.05	1.26

Detention for this watershed is required since the differential runoff is greater than 0 cfs.

WATERSHED B
Watershed B discharges to the eastern area of the site.

Predeveloped

15 year 20 minute storm

Greenspace	0.02 ac	x	1.70 cfs/ac	=	0.03 cfs
Total	0.02 ac				0.03 cfs

Postdeveloped

15 year 20 minute storm

Pavement/Building	0.01 ac	x	3.54 cfs/ac	=	0.03 cfs
Total	0.01 ac				0.03 cfs

Design Storm	Postdeveloped Runoff (cfs)	Predeveloped Runoff (cfs)	Differential Runoff (cfs)
15 Year 20 minute	0.03	0.03	0.00

Detention for this watershed is not required since the differential runoff is not greater than 0 cfs.

WATERSHED C
Watershed C discharges to the southern area of the site.

Predeveloped

15 year 20 minute storm

Greenspace	0.17 ac	x	1.70 cfs/ac	=	0.29 cfs
Total	0.17 ac				0.29 cfs

Postdeveloped

15 year 20 minute storm

Pavement/Building	0.08 ac	x	3.54 cfs/ac	=	0.28 cfs
Total	0.08 ac				0.28 cfs

Design Storm	Postdeveloped Runoff (cfs)	Predeveloped Runoff (cfs)	Differential Runoff (cfs)
15 Year 20 minute	0.28	0.29	-0.01

Detention for this watershed is not required since the differential runoff is less than 0 cfs.

WATERSHED D
Watershed D discharges to the western area of the site.

Predeveloped

15 year 20 minute storm

Greenspace	0.11 ac	x	1.70 cfs/ac	=	0.19 cfs
Total	0.11 ac				0.19 cfs

Postdeveloped

15 year 20 minute storm

Greenspace	0.02 ac	x	1.70 cfs/ac	=	0.03 cfs
Total	0.02 ac				0.03 cfs

Design Storm	Postdeveloped Runoff (cfs)	Predeveloped Runoff (cfs)	Differential Runoff (cfs)
15 Year 20 minute	0.03	0.19	-0.16

Detention for this watershed is not required since the differential runoff is less than 0 cfs.

DETENTION CALCULATIONS WATERSHED A

PREDEVELOPED CONDITIONS:

The Predeveloped watershed has one discharge point to be analyzed to determine the total runoff. Using the rational method, the Predeveloped Peak Runoff rate can be determined for each watershed. For this analysis, the Predeveloped Runoff for the 2, 25, and 100 year 20 minute design storms are calculated for comparison to the Postdeveloped Runoff to determine the quantity of detention that is required.

Watershed A
Stormwater Runoff in Watershed A flows overland and discharges into the western area of the site.

2 Year				
Greenspace	0.47 ac x	1.15 cfs/ac	=	0.54 cfs
Pavement/Building	0.07 ac x	2.39 cfs/ac	=	0.17 cfs
Total =	0.54 ac	Total	=	0.71 cfs
25 Year				
Greenspace	0.47 ac x	2.00 cfs/ac	=	0.94 cfs
Pavement/Building	0.07 ac x	4.16 cfs/ac	=	0.29 cfs
Total =	0.54 ac	Total	=	1.23 cfs
100 Year				
Greenspace	0.47 ac x	2.29 cfs/ac	=	1.08 cfs
Pavement/Building	0.07 ac x	4.77 cfs/ac	=	0.33 cfs
Total =	0.54 ac	Total	=	1.41 cfs

2 year-20 minute storm:	0.71 cfs
25 year-20 minute storm:	1.23 cfs
100 year-20 minute storm:	1.41 cfs

POSTDEVELOPED CONDITIONS WATERSHED A:

The Postdeveloped watershed maintains the same discharge point. The total runoff from the watersheds are calculated using the rational method to determine the Postdeveloped Peak Runoff rates for each watershed. For this analysis, the Postdeveloped runoff for the 2, 25, and 100 year 20 minute design storms are calculated for comparison to the previously calculated Predeveloped Runoff to determine the quantity of detention that is required.

Watershed A

2 Year						
Greenspace			0.13 ac	x	1.15 cfs/ac	= 0.15 cfs
Pavement			0.59 ac	x	2.39 cfs/ac	= 1.41 cfs
	Total	=	0.72 ac		Total	= 1.56 cfs
25 Year						
Greenspace			0.13 ac	x	2.00 cfs/ac	= 0.26 cfs
Pavement			0.59 ac	x	4.16 cfs/ac	= 2.45 cfs
	Total	=	0.72 ac		Total	= 2.71 cfs
100 Year						
Greenspace			0.13 ac	x	2.29 cfs/ac	= 0.30 cfs
Pavement			0.59 ac	x	4.77 cfs/ac	= 2.81 cfs
	Total	=	0.72 ac		Total	= 3.11 cfs

2 year-20 minute storm:	1.56 cfs
25 year-20 minute storm:	2.71 cfs
100 year-20 minute storm:	3.11 cfs

DIFFERENTIAL RUNOFF

The differential runoff for each discharge point is determined by subtracting the Predeveloped Runoff rate from the Postdeveloped Runoff rate. A differential runoff of more than 0 cfs requires the need for stormwater detention within that watershed.

Watershed A

Design Storm	Postdeveloped Runoff (cfs)	Predeveloped Runoff (cfs)	Differential Runoff (cfs)
2 Year 20 minute	1.56	0.71	0.85
25 Year 20 minute	2.71	1.23	1.48
100 Year 20 minute	3.11	1.41	1.70

DISCHARGE POINT A – BASIN ROUTING

TIME OF CONCENTRATION:

Time of concentration is defined as the time needed for stormwater to flow from the most remote point in the watershed to the proposed detention basin. The most remote point of flow on this site tributary to the detention basin lies near the southern corner of the watershed. Flow travels overland for 110.78 feet until it reaches the storm sewer. Then flow travels for 184.02 feet until it enters the detention basin. Time of Concentration is calculated as follows:

Watershed A

$T_{overland}$: L = 110.78 feet
Elevation difference = 12.3 feet
Surface Coefficient = 0.4 (pavement)
$T_{overland}$ = 1.25 min*0.4 = 0.5 minutes

$T_{storm\ sewer}$: L = 184.02 feet
Average Velocity = 7 ft/s
$T_{storm\ sewer}$ = 184.02 feet/7 ft/s/60 sec/min = 0.44 min

Total time = 0.50 + 0.44 = 0.94 min => **use 1 minute**

Basin Peak Inflow

Watershed A

2 Year						
Greenspace		0.07 ac	x	1.15 cfs/ac	=	0.08 cfs
Pavement/Building		0.59 ac	x	2.39 cfs/ac	=	1.41 cfs
	Total =	0.66 ac		Total	=	1.49 cfs
15 Year						
Greenspace		0.07 ac	x	1.70 cfs/ac	=	0.12 cfs
Pavement/Building		0.59 ac	x	3.54 cfs/ac	=	2.09 cfs
	Total =	0.66 ac		Total	=	2.21 cfs
25 Year						
Greenspace		0.07 ac	x	2.00 cfs/ac	=	0.14 cfs
Pavement/Building		0.59 ac	x	4.16 cfs/ac	=	2.45 cfs
	Total =	0.66 ac		Total	=	2.59 cfs
100 Year						
Greenspace		0.07 ac	x	2.29 cfs/ac	=	0.16 cfs
Pavement/Building		0.59 ac	x	4.77 cfs/ac	=	2.81 cfs
	Total =	0.66 ac		Total	=	2.97 cfs

2 year-20 minute storm:	1.49 cfs
15 year-20 minute storm:	2.21 cfs
25 year-20 minute storm:	2.59 cfs
100 year-20 minute storm:	2.97 cfs

ALLOWABLE RELEASE RATE

Allowable Release Rate is defined as the maximum amount of stormwater that can be released from the proposed basin in any given storm duration. This is determined by taking the Basin Inflow and subtracting the Differential Runoff Rate for each design storm. The following table shows the calculated Allowable Release Rate for this watershed:

STORM FREQUENCY (20 MINUTE DURATION)	BASIN INFLOW (cfs)	DIFFERENTIAL RUNOFF RATE (cfs)	ALLOWABLE RELEASE RATE (cfs)
2 YEAR	1.49	0.85	0.66
15 YEAR	2.21	1.26	0.98
25 YEAR	2.59	1.48	1.15
100 YEAR	2.97	1.70	1.32

STORM ROUTING CALCULATIONS AND RESULTS

The computer program PONDPACK was used in routing the 2, 15, 25 and 100 year storms through the dry detention basin required for this watershed. The routing calculations can be found in Appendix B for the 2, 15, 25 and 100 year storms for the watershed and also the calculations for safe passage of the 100 year storms with the low flow blocked (LFB) and the basin ponded full to the weir. A weir/spillway is incorporated in the wall and is used for the 100 Year 20 min LFB storm in the event the outfall pipe is blocked. As found in the routing calculations, the results are as follows:

STORM FREQUENCY (20 MINUTE DURATION)	PEAK INFLOW (cfs)	ALLOWABLE RELEASE RATE (cfs)	CALCULATED RELEASE RATE (cfs)	PEAK ELEVATION (ft)
2 Year	1.49	0.66	0.60	500.04
15 Year	2.21	0.98	0.72	500.70
25 Year	2.59	1.15	0.77	501.02
100 Year	2.97	1.32	0.82	501.33
100 Year LFB	2.97	-	2.97	501.72

SEDIMENT STORAGE CALCULATIONS

The City of O'Fallon design standards require that all detention basins are designed to accommodate two years of sediment storage. This is accomplished by routing the design storms through the outfall pipe and determining the 100 year, 20 minute storm high-water elevation. Using the annual sediment storage nomograph included in Appendix A of this report, we calculate the volume of sediment delivered to the detention basin over a two year period. By adding the volume of sediment to the storage volume required for the 100 year, 20 minute storm, we can calculate the crest elevation of the standpipe which must be above the volume required for the 100 year, 20 minute storm and the volume required sediment storage when added together. Pondpack has been used to calculate this elevation and the results are as follows:

100 Year, 20 Minute Storage = 2,788 ft^3
100 Year highwater elevation = 501.33 ft
2 Year Sediment Storage Volume = 153 ft^3
Required Storage Volume = 2,941 ft^3
Volume Achieved at Elevation = 501.41 ft
Crest of Weir = 501.50 ft

WATER QUALITY

To ensure that sedimentation and pollution in receiving streams due to development of this watershed is minimized, our design considers the Water Quality Volume requirement as described in the "Georgia Stormwater Management Manual Volumes 1, 2". Water quality volume is defined as "The storage needed to capture and treat the runoff from 90% of the recorded daily rainfall events." Water Quality treatment is provided by a snout in structure.

Area Treated

		Impervious Area	Pervious Area
Greenspace	0-5% Impervious	0.00 ac	0.00 ac
Pavement/Building	100% Impervious	0.59 ac	0.00 ac
Total	0.59 ac	0.59 ac	0.00 ac

WATER QUALITY VOLUME

$WQ_v = PR_vA/12$ Where: P = 1.14"

$R_v = 0.05 + 0.009(I)$

I = % Impervious

A = Watershed Area = 0.59 ac

A_I = Impervious Area = 0.59 ac

$I = A_I/A$

I = 0.59 ac / 0.59 ac = 1.00 = 100.00%

$R_v = 0.05 + 0.009(100.00) = 0.95$

$WQ_v = 1.14(0.95)(0.59)/12 = 0.0532$ ac-ft = 2,319 ft^3

The total water quality volume for this watershed is 2,319 ft^3.

Water Quality Treatment

Area Treated

		Impervious Area	Pervious Area
Greenspace	0-5% Impervious	0.00 ac	0.00 ac
Pavement/Building	100% Impervious	0.59 ac	0.00 ac
Total	0.59 ac	0.59 ac	0.00 ac

WATER QUALITY VOLUME

$WQ_v = PR_vA/12$ Where: P = 1.14”

$R_v = 0.05 + 0.009(I)$

I = % Impervious

A = Watershed Area = 0.59 ac

A_I = Impervious Area = 0.59 ac

$I = A_I/A$

I = 0.59 ac / 0.59 ac = 1.00 = 100.00%

$R_v = 0.05 + 0.009(100.00) = 0.95$

$WQ_v = 1.14(0.95)(0.59)/12 = 0.0532$ ac-ft = 2,319 ft^3

SNOUT GI 101 CALCULATIONS

Stormwater runoff entering the dry detention basin is treated by a snout located in GI101. This provides treatment for the stormwater runoff for the site .

The manufacturer specifies that the size of the snout should be based on the outflow pipe from the structure. For a 12” RCP outfall pipe, an 18” Snout (Unit 18R) is used.

The sump depth of 3’ minimum is required for all pipes up to 12” diameter, We are proposing a 3’ depth sump to prevent sediment resuspension as recommended by the manufacturer.

The structure surface area shall be at least 6 to 7 times the flow area of the outfall pipe. The structure area is 12.57 ft^2 which is approximately 16 times larger than the 0.79 ft^2 flow area of the pipe.

The sump of the structure provides 37.71 ft^3 of sediment storage volume.

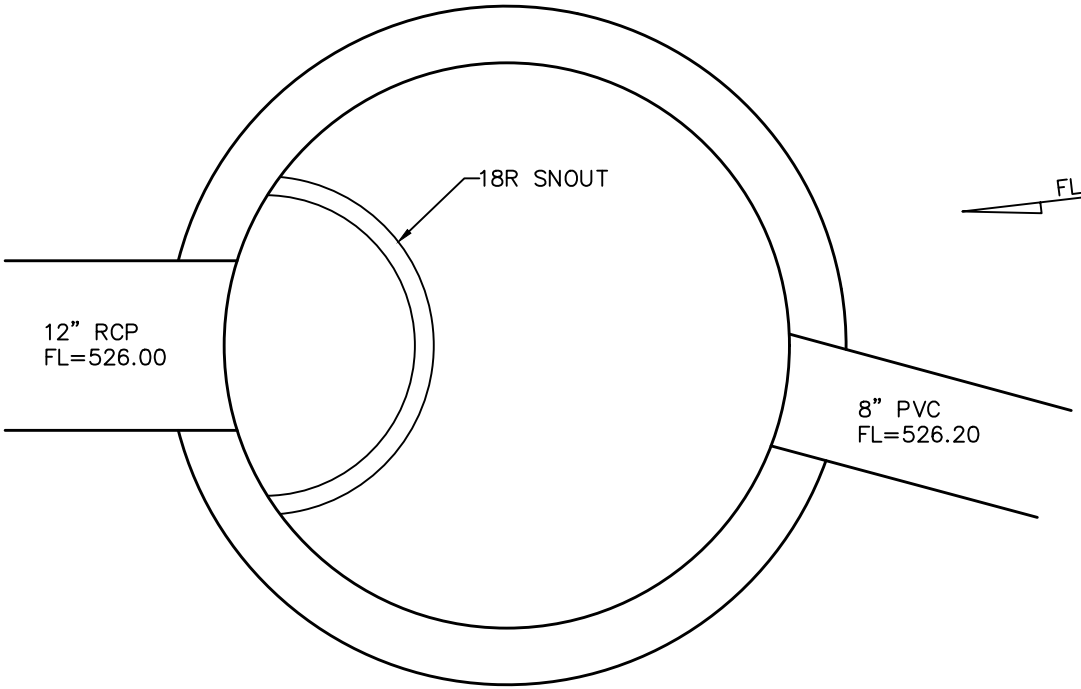
SUMMARY:

Dry Detention Basin	Release Rate	High Water
2 year 20 minute storm	0.60 cfs	500.04
15 year 20 minute storm	0.72 cfs	500.70
25 year 20 minute storm	0.77 cfs	501.02
100 year 20 minute storm	0.82 cfs	501.33
100 year 20 minute storm LFB	2.97 cfs	501.72

Outfall Opening Details	
Size opening in wall	4.00”
Opening Length	2’ long
Emergency Spillway	
Weir Length	8.00 ft
Weir Bottom Elevation	501.60
Top of Wall Elevation	503.00
Freeboard	**1.28 ft**

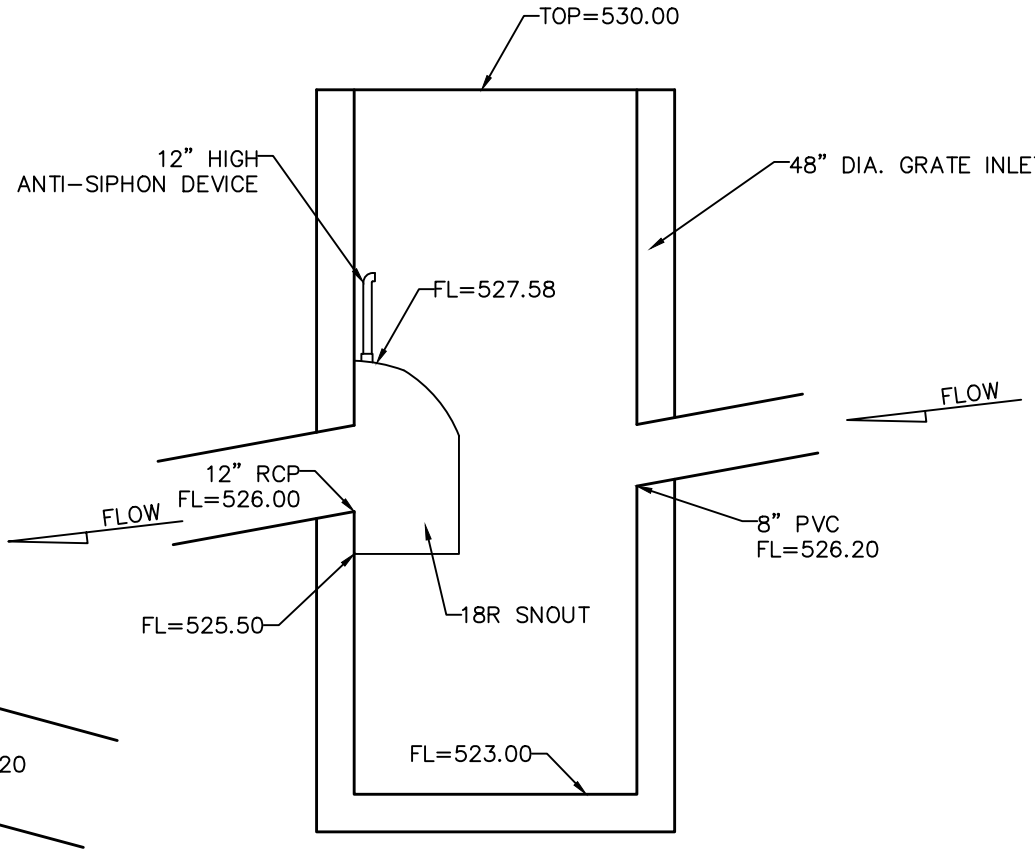
Appendix A

-Outfall Pipe Details
-Time of Concentration
-Misc Figures



SNOUT DETAIL GI 101 PLAN VIEW

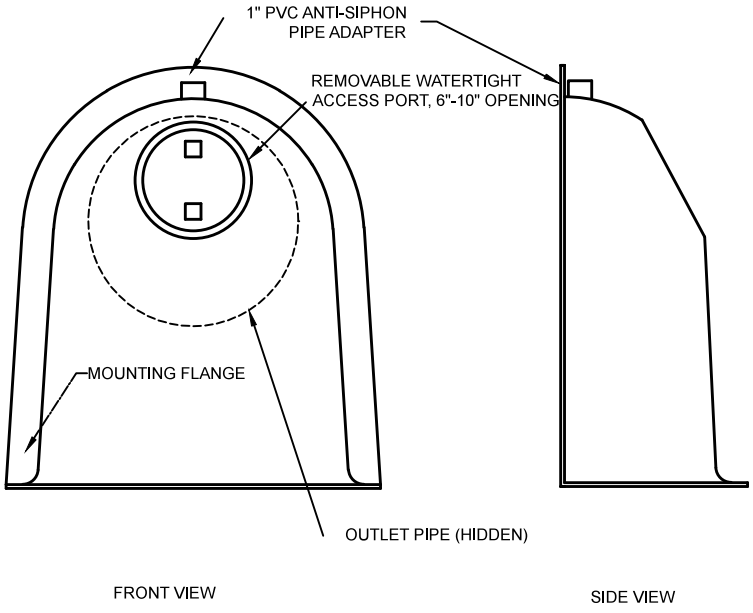
NOT TO SCALE



SNOUT DETAIL GI 101 SIDE VIEW

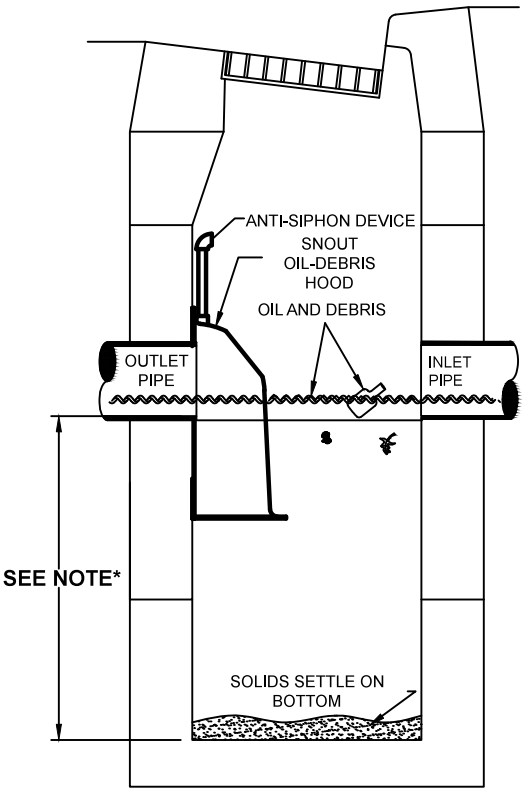
NOT TO SCALE

CONFIGURATION DETAIL



SNOUT OIL-WATER-DEBRIS SEPARATOR

TYPICAL INSTALLATION



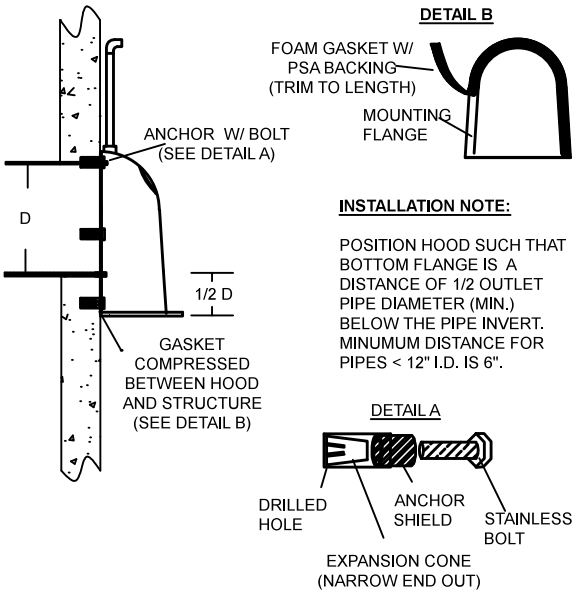
***NOTE-** SUMP DEPTH OF 36" MIN. FOR UP TO 12" ID PIPE. OUTLET. FOR PIPES 15" ID AND ABOVE SUMP DEPTH OF 2.5 TO 3 TIMES PIPE ID RECOMMENDED (E.G. 5' DEEP for 24" PIPE)

NOTES:

1. ALL HOODS AND TRAPS FOR CATCH BASINS AND WATER QUALITY STRUCTURES SHALL BE AS MANUFACTURED BY:
   BEST MANAGEMENT PRODUCTS, INC.
   9 MATHEWS DRIVE, UNIT A1-A2.
   EAST HADDAM, CT 06423
   TOLL FREE: (800) 504-8008 OR (888) 434-0277, FAX: (877) 434-3197
   WEB SITE: www.bmpinc.com
   OR PRE-APPROVED EQUAL
2. ALL HOODS SHALL BE CONSTRUCTED OF A GLASS REINFORCED RESIN COMPOSITE WITH ISO GEL COAT EXTERIOR FINISH WITH A MINIMUM 0.125" LAMINATE THICKNESS.
3. ALL HOODS SHALL BE EQUIPPED WITH A WATERTIGHT ACCESS PORT, A MOUNTING FLANGE, AND AN ANTI-SIPHON VENT PIPE AND ELBOW AS DRAWN. (SEE CONFIGURATION DETAIL)
4. THE SIZE AND POSITION OF THE HOOD SHALL BE DETERMINED BY OUTLET PIPE SIZE AS PER MANUFACTURER'S RECOMMENDATION (SNOUT SIZE ALWAYS LARGER THAN PIPE SIZE).
5. THE BOTTOM OF THE HOOD SHALL EXTEND DOWNWARD A MINIMUM DISTANCE EQUAL TO 1/2 THE OUTLET PIPE DIAMETER WITH A MINIMUM DISTANCE OF 6" FOR PIPES <12" I.D.
6. THE ANTI-SIPHON VENT SHALL EXTEND ABOVE HOOD BY MINIMUM OF 3" AND A MAXIMUM OF 12" ACCORDING TO STRUCTURE CONFIGURATION.
7. THE SURFACE OF THE STRUCTURE WHERE THE HOOD IS MOUNTED SHALL BE FINISHED SMOOTH AND FREE OF LOOSE MATERIAL AND PIPE SHALL BE FINISHED FLUSH TO WALL.
8. ALL STRUCTURE JOINTS SHALL BE WATERTIGHT.
9. THE HOOD SHALL BE SECURELY ATTACHED TO STRUCTURE WALL WITH $\frac{3}{8}$" STAINLESS STEEL BOLTS AND OIL-RESISTANT GASKET AS SUPPLIED BY MANUFACTURER. (SEE INSTALLATION DETAIL)
10. INSTALLATION INSTRUCTIONS SHALL BE FURNISHED WITH MANUFACTURER SUPPLIED INSTALLATION KIT.
    INSTALLATION KIT SHALL INCLUDE:
    A. INSTALLATION INSTRUCTIONS
    B. PVC ANTI-SIPHON VENT PIPE AND ADAPTER
    C. OIL-RESISTANT CRUSHED CELL FOAM GASKET WITH PSA BACKING
    D. 3/8" STAINLESS STEEL BOLTS
    E. ANCHOR SHIELDS

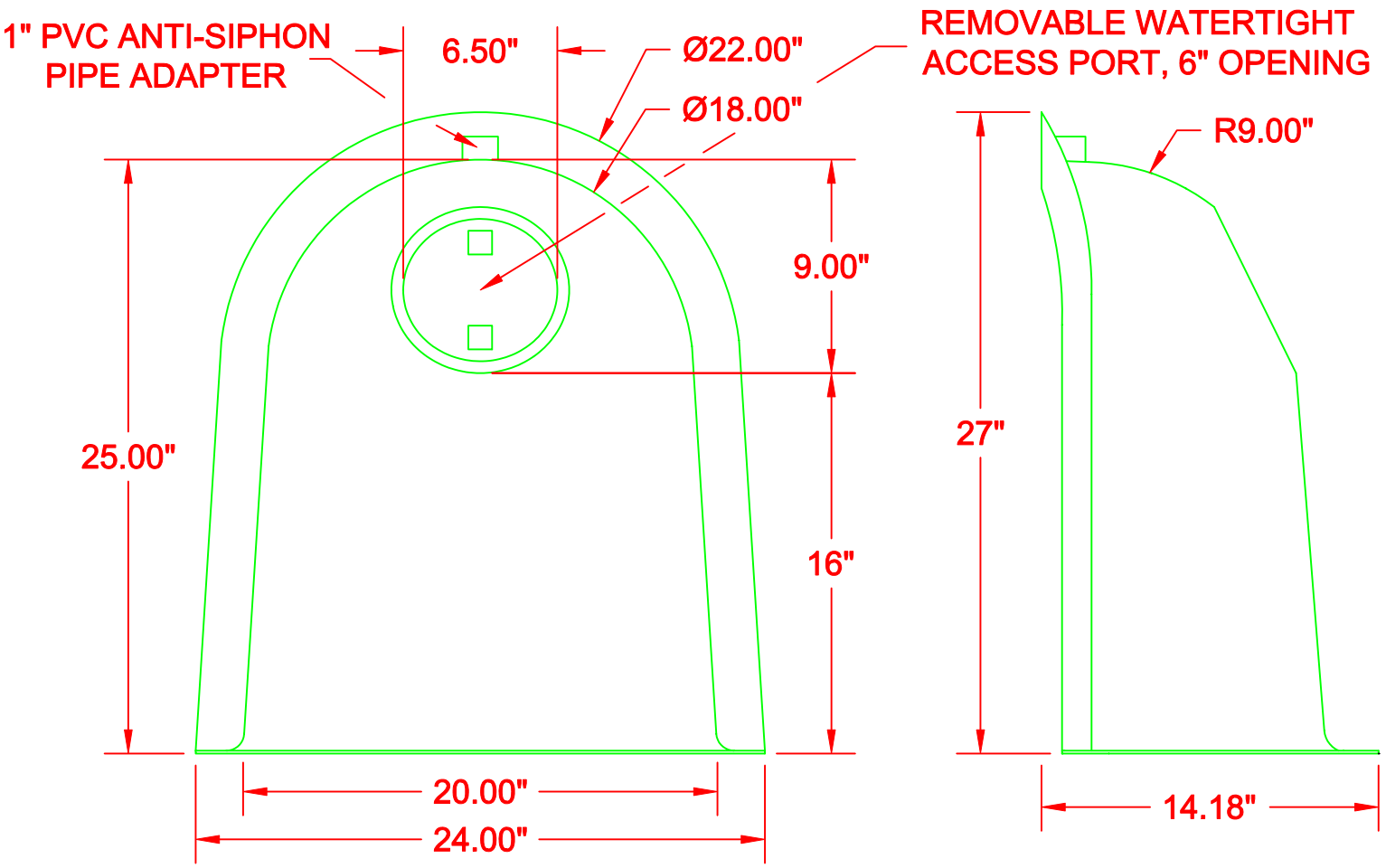
US Patent # 6126817, 7951294, 7857966, 8512556
Canada Patent # 2285146, 2690156, 2690156 others pending

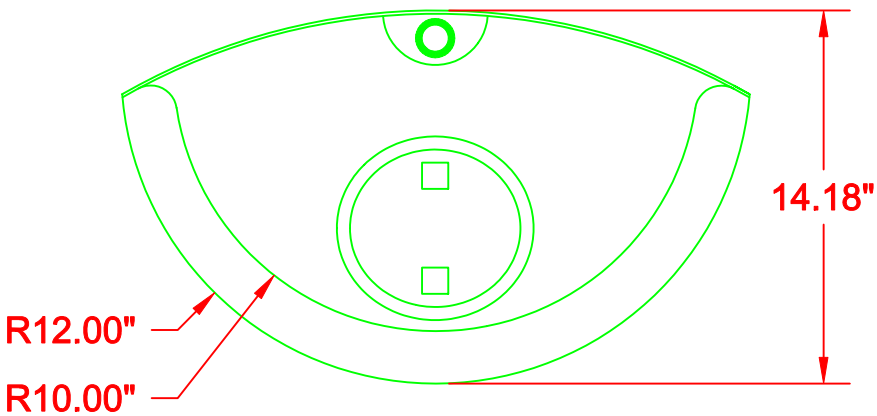
INSTALLATION DETAIL



HOOD SPECIFICATION FOR CATCH BASINS AND WATER QUALITY STRUCTURES

DESCRIPTION	DATE	SCALE
OIL- DEBRIS HOOD SPECIFICATION AND INSTALLATION (TYPICAL)	09/08/18	NONE
	DRAWING NUMBER	SP-SN





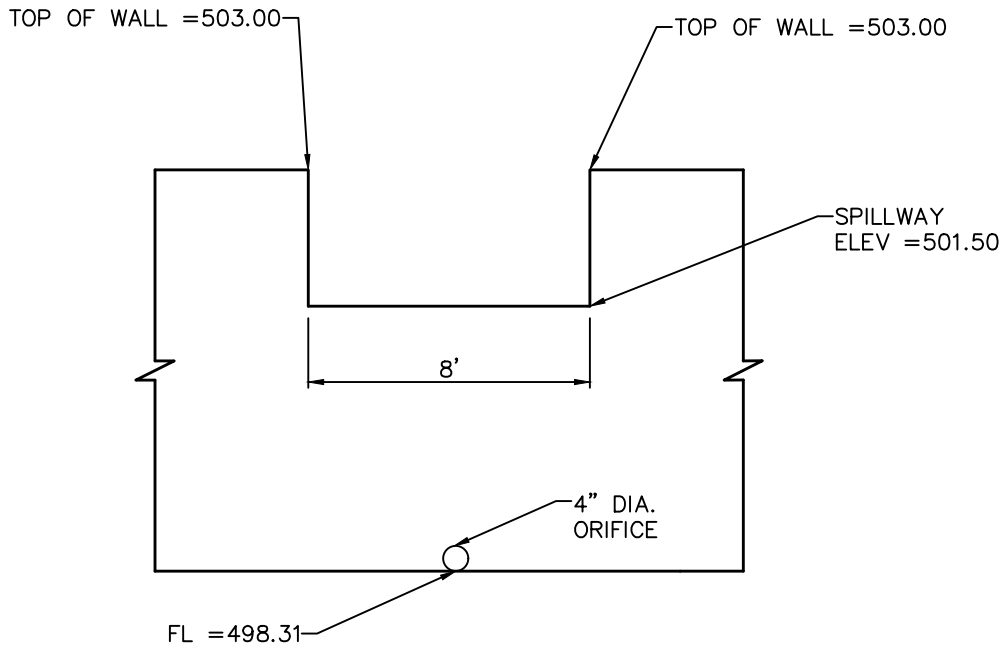
PLAN

U.S. PATENT #6126817 ADDITONAL PATENTS PENDING

DESIGNED TO FIT
48"-60" DIAM.
STRUCTURES

BMP, INC.
53 MT. ARCHER ROAD, LYME, CT. 06371
(800) 504-8008 FAX: (860)434-3195

DESCRIPTION	DATE	SCALE
18R SNOUT OIL & DEBRIS STOP	09/06/99	NONE
	DRAWING NUMBER	
	18R	



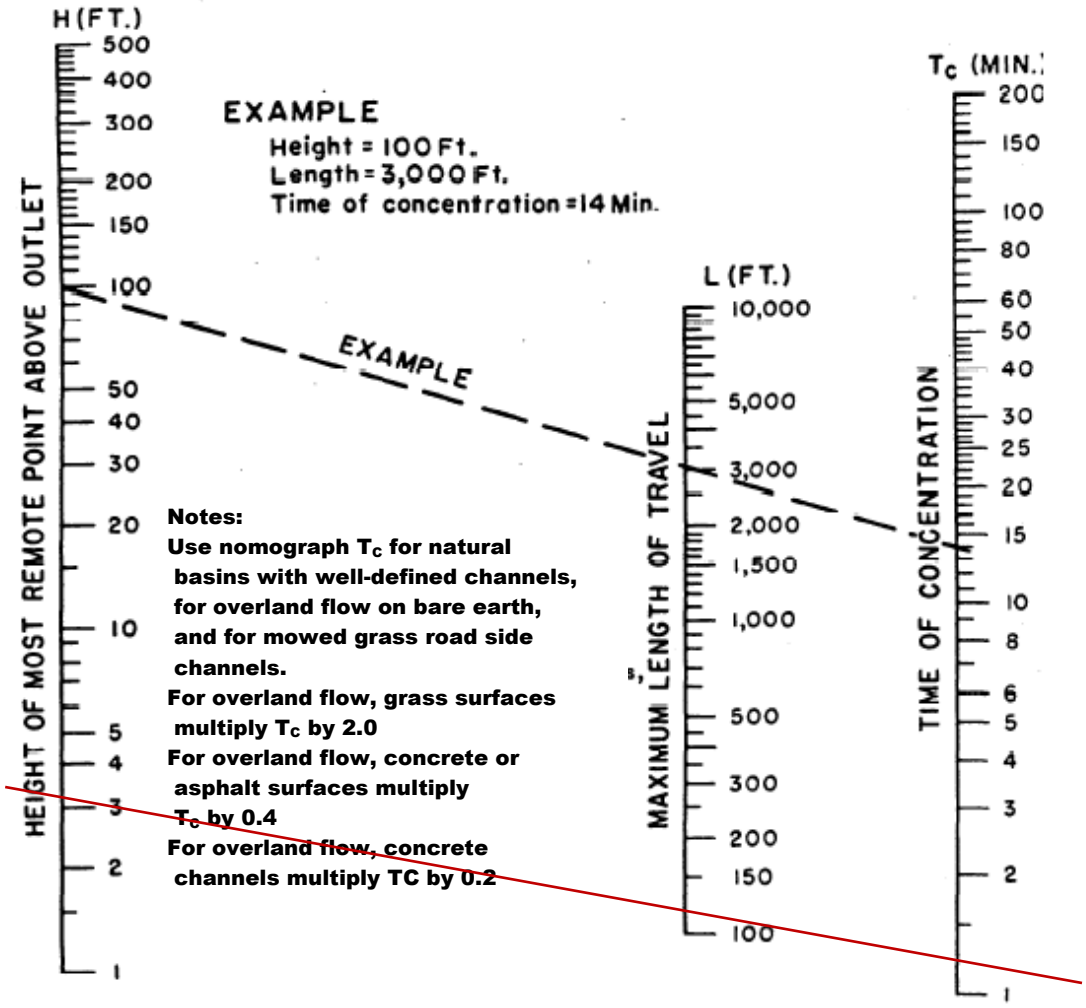
OUTFALL DETAIL

NOT TO SCALE

BAX ENGINEERING
Engineering - Planning – Surveying
221 Point West Blvd.
St. Charles, MO 63301
636 928-5552 FAX 636 928-1718

Project: Building Addition
Date: 8/22/2022 Project No: 22-18634
Designer: MDF Checked:

TIME OF CONCENTRATION FOR SMALL DRAINAGE BASINS



OVERLAND FLOW

Δ Height = 3.24 ft

Length = 110.78 ft

$T_{Overland}$ = 1.25 min

STORM SEWER TRAVEL TIME

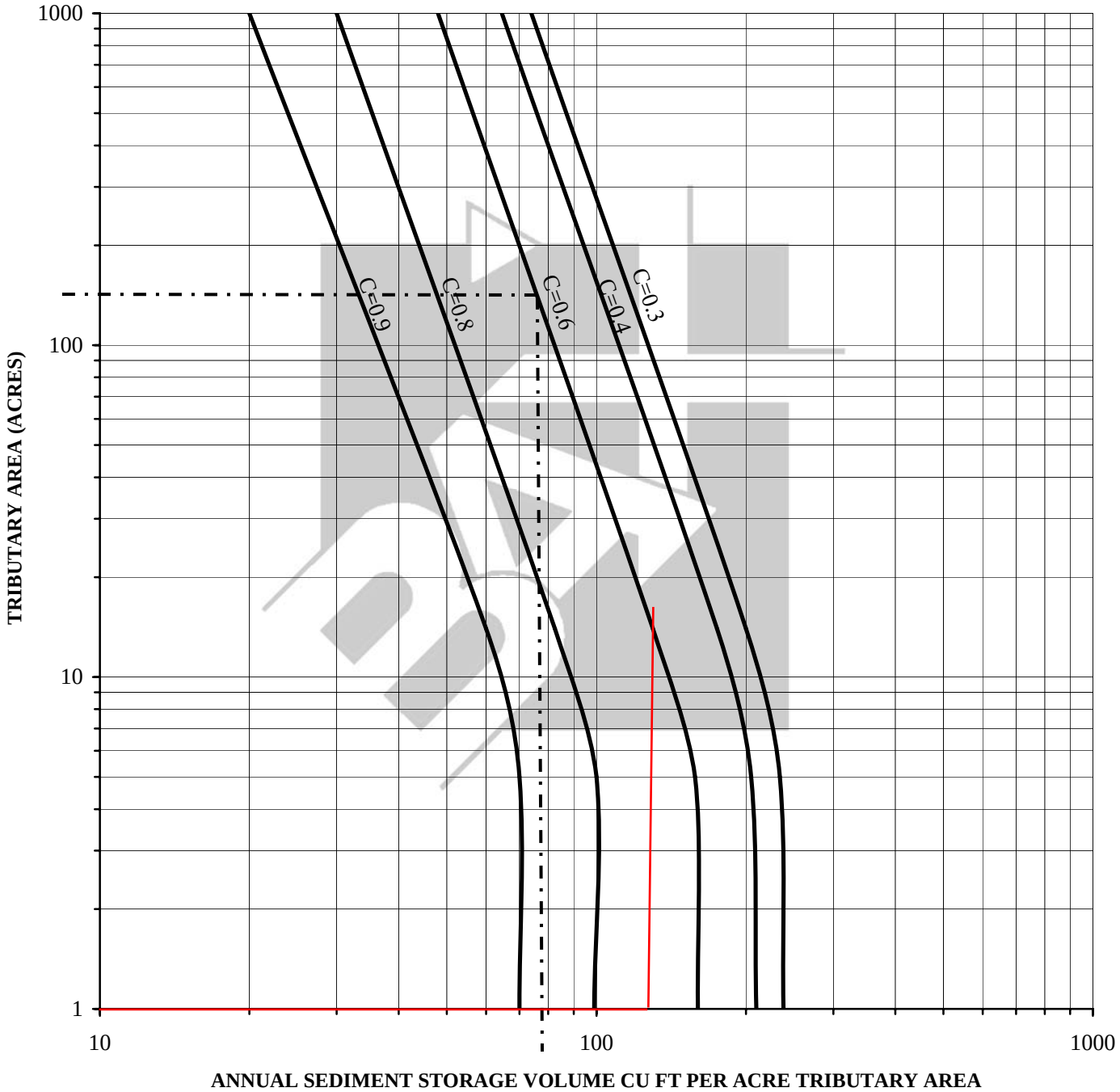
T_{storm}=Pipe Length (L) * Assumed Velocity (V)
L = 170.14 ft
V = 7 ft/s
T_{storm} = 170.14 ft / 7 ft/s / 60 sec/min =0.41 min

Total Time of Concentration = $T_{Overland}$ + T_{storm} = 1.25*0.4 + 0.41 = 0.91 →USE 1 min.

BAX ENGINEERING
Engineering – Planning – Surveying
221 Point West Blvd.
St. Charles, MO 63301
636 928-5552 FAX 636 928-1718

Project: Progressive Installations Building Addition
Date: 08/31/2022 Project: 22-18634
Designer: MDF Checked: MDF

ANNUAL SEDIMENT STORAGE



Storage Required = Years of Storage * Annual Sediment * Drainage Area

RUNOFF C VALUE = 0.70
DRAINAGE AREA = 0.59 acres
ANNUAL SEDIMENT = 130 CU FT per acre

YEARS OF STORAGE = 2 years
STORAGE REQUIRED = 2*130*0.59=153 CU FT

Appendix B

Basin Routing

-2 year Detention Routing
-15 year Detention Routing
-25 year Detention Routing
-100 year Detention Routing

Table of Contents

Subsection: Master Network Summary

Catchments Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (min)	Peak Flow (ft³/s)
Watershed A	Post- Development 100 year	0	0.082	1.000	2.97
Watershed A	Post-Development 2 year	0	0.041	1.000	1.49
Watershed A	Post-Development 15 year	0	0.061	1.000	2.21
Watershed A	Post-Development 25 year	0	0.071	1.000	2.59
Watershed A	100 year LFB	0	0.082	1.000	2.97

Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (min)	Peak Flow (ft³/s)
O-1	Post- Development 100 year	0	0.082	21.000	0.82
O-1	Post-Development 2 year	0	0.041	21.000	0.60
O-1	Post-Development 15 year	0	0.061	21.000	0.72
O-1	Post-Development 25 year	0	0.071	21.000	0.77
O-1	100 year LFB	0	0.082	20.000	2.97

Pond Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (min)	Peak Flow (ft³/s)	Maximum Water Surface Elevation (ft)	Maximum Pond Storage (ac-ft)
Detention Basin (IN)	Post-Development 100 year	0	0.082	1.000	2.97	(N/A)	(N/A)
Detention Basin (OUT)	Post-Development 100 year	0	0.082	21.000	0.82	501.33	0.064
Detention Basin (IN)	Post-Development 2 year	0	0.041	1.000	1.49	(N/A)	(N/A)
Detention Basin (OUT)	Post-Development 2 year	0	0.041	21.000	0.60	500.04	0.028
Detention Basin (IN)	Post-Development 15 year	0	0.061	1.000	2.21	(N/A)	(N/A)

Subsection: Master Network Summary

Pond Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (min)	Peak Flow (ft^3/s)	Maximum Water Surface Elevation (ft)	Maximum Pond Storage (ac-ft)
Detention Basin (OUT)	Post-Development 15 year	0	0.061	21.000	0.72	500.70	0.045
Detention Basin (IN)	Post-Development 25 year	0	0.071	1.000	2.59	(N/A)	(N/A)
Detention Basin (OUT)	Post-Development 25 year	0	0.071	21.000	0.77	501.02	0.055
Detention Basin (IN)	100 year LFB	0	0.082	1.000	2.97	(N/A)	(N/A)
Detention Basin (OUT)	100 year LFB	0	0.082	20.000	2.97	501.72	0.077

Subsection: Read Hydrograph
Label: Watershed A
Scenario: Post-Development 2 year

Return Event: 2 years
Storm Event:

Peak Discharge	1.49 ft³/s
Time to Peak	13.000 min
Hydrograph Volume	0.041 ac-ft

HYDROGRAPH ORDINATES (ft³/s)
Output Time Increment = 1.000 min
Time on left represents time for first value in each row.

Time (min)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)
0.000	0.00	1.49	1.49	1.49	1.49
5.000	1.49	1.49	1.49	1.49	1.49
10.000	1.49	1.49	1.49	1.49	1.49
15.000	1.49	1.49	1.49	1.49	1.49
20.000	1.49	0.00	0.00	0.00	0.00
25.000	0.00	0.00	0.00	0.00	0.00
30.000	0.00	0.00	0.00	0.00	0.00
35.000	0.00	0.00	0.00	0.00	0.00
40.000	0.00	0.00	0.00	0.00	0.00
45.000	0.00	0.00	0.00	0.00	0.00
50.000	0.00	0.00	0.00	0.00	0.00
55.000	0.00	0.00	0.00	0.00	0.00
60.000	0.00	(N/A)	(N/A)	(N/A)	(N/A)

Subsection: Read Hydrograph
Label: Watershed A
Scenario: Post-Development 15 year

Return Event: 15 years
Storm Event:

Peak Discharge	2.21 ft³/s
Time to Peak	13.000 min
Hydrograph Volume	0.061 ac-ft

HYDROGRAPH ORDINATES (ft³/s)
Output Time Increment = 1.000 min
Time on left represents time for first value in each row.

Time (min)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)
0.000	0.00	2.21	2.21	2.21	2.21
5.000	2.21	2.21	2.21	2.21	2.21
10.000	2.21	2.21	2.21	2.21	2.21
15.000	2.21	2.21	2.21	2.21	2.21
20.000	2.21	0.00	0.00	0.00	0.00
25.000	0.00	0.00	0.00	0.00	0.00
30.000	0.00	0.00	0.00	0.00	0.00
35.000	0.00	0.00	0.00	0.00	0.00
40.000	0.00	0.00	0.00	0.00	0.00
45.000	0.00	0.00	0.00	0.00	0.00
50.000	0.00	0.00	0.00	0.00	0.00
55.000	0.00	0.00	0.00	0.00	0.00
60.000	0.00	(N/A)	(N/A)	(N/A)	(N/A)

Subsection: Read Hydrograph
Label: Watershed A
Scenario: Post-Development 25 year

Return Event: 25 years
Storm Event:

Peak Discharge	2.59 ft³/s
Time to Peak	13.000 min
Hydrograph Volume	0.071 ac-ft

HYDROGRAPH ORDINATES (ft³/s)
Output Time Increment = 1.000 min
Time on left represents time for first value in each row.

Time (min)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)
0.000	0.00	2.59	2.59	2.59	2.59
5.000	2.59	2.59	2.59	2.59	2.59
10.000	2.59	2.59	2.59	2.59	2.59
15.000	2.59	2.59	2.59	2.59	2.59
20.000	2.59	0.00	0.00	0.00	0.00
25.000	0.00	0.00	0.00	0.00	0.00
30.000	0.00	0.00	0.00	0.00	0.00
35.000	0.00	0.00	0.00	0.00	0.00
40.000	0.00	0.00	0.00	0.00	0.00
45.000	0.00	0.00	0.00	0.00	0.00
50.000	0.00	0.00	0.00	0.00	0.00
55.000	0.00	0.00	0.00	0.00	0.00
60.000	0.00	(N/A)	(N/A)	(N/A)	(N/A)

Subsection: Read Hydrograph
Label: Watershed A
Scenario: Post- Development 100 year

Return Event: 100 years
Storm Event:

Peak Discharge	2.97 ft³/s
Time to Peak	13.000 min
Hydrograph Volume	0.082 ac-ft

HYDROGRAPH ORDINATES (ft³/s)
Output Time Increment = 1.000 min
Time on left represents time for first value in each row.

Time (min)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)
0.000	0.00	2.97	2.97	2.97	2.97
5.000	2.97	2.97	2.97	2.97	2.97
10.000	2.97	2.97	2.97	2.97	2.97
15.000	2.97	2.97	2.97	2.97	2.97
20.000	2.97	0.00	0.00	0.00	0.00
25.000	0.00	0.00	0.00	0.00	0.00
30.000	0.00	0.00	0.00	0.00	0.00
35.000	0.00	0.00	0.00	0.00	0.00
40.000	0.00	0.00	0.00	0.00	0.00
45.000	0.00	0.00	0.00	0.00	0.00
50.000	0.00	0.00	0.00	0.00	0.00
55.000	0.00	0.00	0.00	0.00	0.00
60.000	0.00	(N/A)	(N/A)	(N/A)	(N/A)

Subsection: Elevation-Area Volume Curve
Label: Detention Basin
Scenario: Post-Development 25 year

Return Event: 25 years
Storm Event:

Elevation (ft)	Planimeter (ft²)	Area (ft²)	A1+A2+sqr (A1*A2) (ft²)	Volume (ac-ft)	Volume (Total) (ac-ft)
498.31	0.000	0.000	0.000	0.000	0.000
499.00	0.000	861.950	861.950	0.005	0.005
500.00	0.000	1,079.990	2,906.770	0.022	0.027
501.00	0.000	1,303.580	3,570.100	0.027	0.054
502.00	0.000	1,532.730	4,249.829	0.033	0.087
503.00	0.000	1,767.440	4,946.077	0.038	0.124

Pond Volume Equations
*** Incremental volume computed by the Conic Method for Reservoir Volumes.**

Volume = (1/3) * (EL2 - El1) * (Area1 + Area2 + sqr(Area1 * Area2))

where:	EL1, EL2	Lower and upper elevations of the increment
	Area1, Area2	Areas computed for EL1, EL2, respectively
	Volume	Incremental volume between EL1 and EL2

Subsection: Outlet Input Data
Label: OS 1
Scenario: Post-Development 25 year

Return Event: 25 years
Storm Event:

Requested Pond Water Surface Elevations	
Minimum (Headwater)	498.31 ft
Increment (Headwater)	0.50 ft
Maximum (Headwater)	503.00 ft

Outlet Connectivity

Structure Type	Outlet ID	Direction	Outfall	E1 (ft)	E2 (ft)
Culvert-Circular	Culvert - 1	Forward	TW	498.31	503.00
Tailwater Settings	Tailwater			(N/A)	(N/A)

Structure ID: Culvert - 1 Structure Type: Culvert-Circular	
Number of Barrels	1
Diameter	4.00 in
Length	2.00 ft
Length (Computed Barrel)	2.00 ft
Slope (Computed)	0.055 ft/ft

Outlet Control Data	
Manning's n	0.013
Ke	0.200
Kb	0.135
Kr	0.000
Convergence Tolerance	0.00 ft

Inlet Control Data	
Equation Form	Form 1
K	0.0045
M	2.0000
C	0.0317
Y	0.6900
T1 ratio (HW/D)	1.067
T2 ratio (HW/D)	1.170
Slope Correction Factor	-0.500

Use unsubmerged inlet control 0 equation below T1 elevation.
Use submerged inlet control 0 equation above T2 elevation

In transition zone between unsubmerged and submerged inlet control,
interpolate between flows at T1 & T2...

T1 Elevation	498.67 ft	T1 Flow	0.18 ft³/s
T2 Elevation	498.70 ft	T2 Flow	0.20 ft³/s

Structure ID: TW
Structure Type: TW Setup, DS Channel

Tailwater Type	Free Outfall

Convergence Tolerances	
Maximum Iterations	30
Tailwater Tolerance (Minimum)	0.01 ft
Tailwater Tolerance (Maximum)	0.50 ft
Headwater Tolerance (Minimum)	0.01 ft
Headwater Tolerance (Maximum)	0.50 ft
Flow Tolerance (Minimum)	0.001 ft³/s
Flow Tolerance (Maximum)	10.000 ft³/s

Subsection: Composite Rating Curve
Label: OS 1
Scenario: Post-Development 25 year

Return Event: 25 years
Storm Event:

Composite Outflow Summary

Water Surface Elevation (ft)	Flow (ft^3/s)	Tailwater Elevation (ft)	Convergence Error (ft)
498.31	0.00	(N/A)	0.00
498.81	0.26	(N/A)	0.00
499.31	0.43	(N/A)	0.00
499.81	0.55	(N/A)	0.00
500.31	0.65	(N/A)	0.00
500.81	0.74	(N/A)	0.00
501.31	0.82	(N/A)	0.00
501.81	0.89	(N/A)	0.00
502.31	0.95	(N/A)	0.00
502.81	1.01	(N/A)	0.00
503.00	1.04	(N/A)	0.00

Contributing Structures
None Contributing
Culvert - 1
Culvert - 1
Culvert - 1
Culvert - 1
Culvert - 1
Culvert - 1
Culvert - 1
Culvert - 1
Culvert - 1
Culvert - 1

Subsection: Outlet Input Data
Label: OS 1 LFB
Scenario: 100 year LFB

Return Event: 100 years
Storm Event:

Requested Pond Water Surface Elevations	
Minimum (Headwater)	498.31 ft
Increment (Headwater)	0.50 ft
Maximum (Headwater)	503.00 ft

Outlet Connectivity

Structure Type	Outlet ID	Direction	Outfall	E1 (ft)	E2 (ft)
Rectangular Weir	Wall Weir	Forward	TW	501.50	503.00
Tailwater Settings	Tailwater			(N/A)	(N/A)

Structure ID: Wall Weir Structure Type: Rectangular Weir	
Number of Openings	1
Elevation	501.50 ft
Weir Length	8.00 ft
Weir Coefficient	3.00 (ft^0.5)/s

Structure ID: TW Structure Type: TW Setup, DS Channel	
Tailwater Type	Free Outfall

Convergence Tolerances	
Maximum Iterations	30
Tailwater Tolerance (Minimum)	0.01 ft
Tailwater Tolerance (Maximum)	0.50 ft
Headwater Tolerance (Minimum)	0.01 ft
Headwater Tolerance (Maximum)	0.50 ft
Flow Tolerance (Minimum)	0.001 ft³/s
Flow Tolerance (Maximum)	10.000 ft³/s

Subsection: Composite Rating Curve
Label: OS 1 LFB
Scenario: 100 year LFB

Return Event: 100 years
Storm Event:

Composite Outflow Summary

Water Surface Elevation (ft)	Flow (ft³/s)	Tailwater Elevation (ft)	Convergence Error (ft)	Contributing Structures
498.31	0.00	(N/A)	0.00	None Contributing
498.81	0.00	(N/A)	0.00	None Contributing
499.31	0.00	(N/A)	0.00	None Contributing
499.81	0.00	(N/A)	0.00	None Contributing
500.31	0.00	(N/A)	0.00	None Contributing
500.81	0.00	(N/A)	0.00	None Contributing
501.31	0.00	(N/A)	0.00	None Contributing
501.50	0.00	(N/A)	0.00	Wall Weir
501.81	4.14	(N/A)	0.00	Wall Weir
502.31	17.50	(N/A)	0.00	Wall Weir
502.81	35.98	(N/A)	0.00	Wall Weir
503.00	44.09	(N/A)	0.00	Wall Weir

Subsection: Level Pool Pond Routing Summary
Label: Detention Basin (IN)
Scenario: Post-Development 2 year

Return Event: 2 years
Storm Event:

Infiltration	
Infiltration Method (Computed)	No Infiltration

Initial Conditions	
Elevation (Water Surface, Initial)	498.31 ft
Volume (Initial)	0.000 ac-ft
Flow (Initial Outlet)	0.00 ft³/s
Flow (Initial Infiltration)	0.00 ft³/s
Flow (Initial, Total)	0.00 ft³/s
Time Increment	1.000 min

Inflow/Outflow Hydrograph Summary			
Flow (Peak In)	1.49 ft³/s	Time to Peak (Flow, In)	1.000 min
Flow (Peak Outlet)	0.60 ft³/s	Time to Peak (Flow, Outlet)	21.000 min

Elevation (Water Surface, Peak)	500.04 ft
Volume (Peak)	0.028 ac-ft

Mass Balance (ac-ft)	
Volume (Initial)	0.000 ac-ft
Volume (Total Inflow)	0.041 ac-ft
Volume (Total Infiltration)	0.000 ac-ft
Volume (Total Outlet Outflow)	0.041 ac-ft
Volume (Retained)	0.000 ac-ft
Volume (Unrouted)	0.000 ac-ft
Error (Mass Balance)	0.0 %

Subsection: Level Pool Pond Routing Summary
Label: Detention Basin (IN)
Scenario: Post-Development 15 year

Return Event: 15 years
Storm Event:

Infiltration	
Infiltration Method (Computed)	No Infiltration

Initial Conditions	
Elevation (Water Surface, Initial)	498.31 ft
Volume (Initial)	0.000 ac-ft
Flow (Initial Outlet)	0.00 ft³/s
Flow (Initial Infiltration)	0.00 ft³/s
Flow (Initial, Total)	0.00 ft³/s
Time Increment	1.000 min

Inflow/Outflow Hydrograph Summary			
Flow (Peak In)	2.21 ft³/s	Time to Peak (Flow, In)	1.000 min
Flow (Peak Outlet)	0.72 ft³/s	Time to Peak (Flow, Outlet)	21.000 min

Elevation (Water Surface, Peak)	500.70 ft
Volume (Peak)	0.045 ac-ft

Mass Balance (ac-ft)	
Volume (Initial)	0.000 ac-ft
Volume (Total Inflow)	0.061 ac-ft
Volume (Total Infiltration)	0.000 ac-ft
Volume (Total Outlet Outflow)	0.061 ac-ft
Volume (Retained)	0.000 ac-ft
Volume (Unrouted)	0.000 ac-ft
Error (Mass Balance)	0.0 %

Subsection: Level Pool Pond Routing Summary
Label: Detention Basin (IN)
Scenario: Post-Development 25 year

Return Event: 25 years
Storm Event:

Infiltration	
Infiltration Method (Computed)	No Infiltration

Initial Conditions	
Elevation (Water Surface, Initial)	498.31 ft
Volume (Initial)	0.000 ac-ft
Flow (Initial Outlet)	0.00 ft³/s
Flow (Initial Infiltration)	0.00 ft³/s
Flow (Initial, Total)	0.00 ft³/s
Time Increment	1.000 min

Inflow/Outflow Hydrograph Summary			
Flow (Peak In)	2.59 ft³/s	Time to Peak (Flow, In)	1.000 min
Flow (Peak Outlet)	0.77 ft³/s	Time to Peak (Flow, Outlet)	21.000 min

Elevation (Water Surface, Peak)	501.02 ft
Volume (Peak)	0.055 ac-ft

Mass Balance (ac-ft)	
Volume (Initial)	0.000 ac-ft
Volume (Total Inflow)	0.071 ac-ft
Volume (Total Infiltration)	0.000 ac-ft
Volume (Total Outlet Outflow)	0.071 ac-ft
Volume (Retained)	0.000 ac-ft
Volume (Unrouted)	0.000 ac-ft
Error (Mass Balance)	0.0 %

Subsection: Level Pool Pond Routing Summary
Label: Detention Basin (IN)
Scenario: 100 year LFB

Return Event: 100 years
Storm Event:

Infiltration	
Infiltration Method (Computed)	No Infiltration

Initial Conditions	
Elevation (Water Surface, Initial)	501.50 ft
Volume (Initial)	0.070 ac-ft
Flow (Initial Outlet)	0.00 ft³/s
Flow (Initial Infiltration)	0.00 ft³/s
Flow (Initial, Total)	0.00 ft³/s
Time Increment	1.000 min

Inflow/Outflow Hydrograph Summary			
Flow (Peak In)	2.97 ft³/s	Time to Peak (Flow, In)	1.000 min
Flow (Peak Outlet)	2.97 ft³/s	Time to Peak (Flow, Outlet)	20.000 min

Elevation (Water Surface, Peak)	501.72 ft
Volume (Peak)	0.077 ac-ft

Mass Balance (ac-ft)	
Volume (Initial)	0.070 ac-ft
Volume (Total Inflow)	0.082 ac-ft
Volume (Total Infiltration)	0.000 ac-ft
Volume (Total Outlet Outflow)	0.082 ac-ft
Volume (Retained)	0.070 ac-ft
Volume (Unrouted)	0.000 ac-ft
Error (Mass Balance)	0.0 %

Subsection: Level Pool Pond Routing Summary
Label: Detention Basin (IN)
Scenario: Post- Development 100 year

Return Event: 100 years
Storm Event:

Infiltration	
Infiltration Method (Computed)	No Infiltration

Initial Conditions	
Elevation (Water Surface, Initial)	498.31 ft
Volume (Initial)	0.000 ac-ft
Flow (Initial Outlet)	0.00 ft³/s
Flow (Initial Infiltration)	0.00 ft³/s
Flow (Initial, Total)	0.00 ft³/s
Time Increment	1.000 min

Inflow/Outflow Hydrograph Summary			
Flow (Peak In)	2.97 ft³/s	Time to Peak (Flow, In)	1.000 min
Flow (Peak Outlet)	0.82 ft³/s	Time to Peak (Flow, Outlet)	21.000 min

Elevation (Water Surface, Peak)	501.33 ft
Volume (Peak)	0.064 ac-ft

Mass Balance (ac-ft)	
Volume (Initial)	0.000 ac-ft
Volume (Total Inflow)	0.082 ac-ft
Volume (Total Infiltration)	0.000 ac-ft
Volume (Total Outlet Outflow)	0.082 ac-ft
Volume (Retained)	0.000 ac-ft
Volume (Unrouted)	0.000 ac-ft
Error (Mass Balance)	0.0 %

Summary for Hydrograph Addition at 'Detention Basin'

Upstream Link	Upstream Node
<Catchment to Outflow Node>	Watershed A

Node Inflows

Inflow Type	Element	Volume (ac-ft)	Time to Peak (min)	Flow (Peak) (ft³/s)
Flow (From)	Watershed A	0.041	1.000	1.49
Flow (In)	Detention Basin	0.041	1.000	1.49

Summary for Hydrograph Addition at 'Detention Basin'

Upstream Link	Upstream Node
<Catchment to Outflow Node>	Watershed A

Node Inflows

Inflow Type	Element	Volume (ac-ft)	Time to Peak (min)	Flow (Peak) (ft³/s)
Flow (From)	Watershed A	0.061	1.000	2.21
Flow (In)	Detention Basin	0.061	1.000	2.21

Summary for Hydrograph Addition at 'Detention Basin'

Upstream Link	Upstream Node
<Catchment to Outflow Node>	Watershed A

Node Inflows

Inflow Type	Element	Volume (ac-ft)	Time to Peak (min)	Flow (Peak) (ft³/s)
Flow (From)	Watershed A	0.071	1.000	2.59
Flow (In)	Detention Basin	0.071	1.000	2.59

Subsection: Pond Inflow Summary
Label: Detention Basin (IN)
Scenario: 100 year LFB

Return Event: 100 years
Storm Event:

Summary for Hydrograph Addition at 'Detention Basin'

Upstream Link	Upstream Node
<Catchment to Outflow Node>	Watershed A

Node Inflows

Inflow Type	Element	Volume (ac-ft)	Time to Peak (min)	Flow (Peak) (ft³/s)
Flow (From)	Watershed A	0.082	1.000	2.97
Flow (In)	Detention Basin	0.082	1.000	2.97

Subsection: Pond Inflow Summary
Label: Detention Basin (IN)
Scenario: Post- Development 100 year

Return Event: 100 years
Storm Event:

Summary for Hydrograph Addition at 'Detention Basin'

Upstream Link	Upstream Node
<Catchment to Outflow Node>	Watershed A

Node Inflows

Inflow Type	Element	Volume (ac-ft)	Time to Peak (min)	Flow (Peak) (ft³/s)
Flow (From)	Watershed A	0.082	1.000	2.97
Flow (In)	Detention Basin	0.082	1.000	2.97

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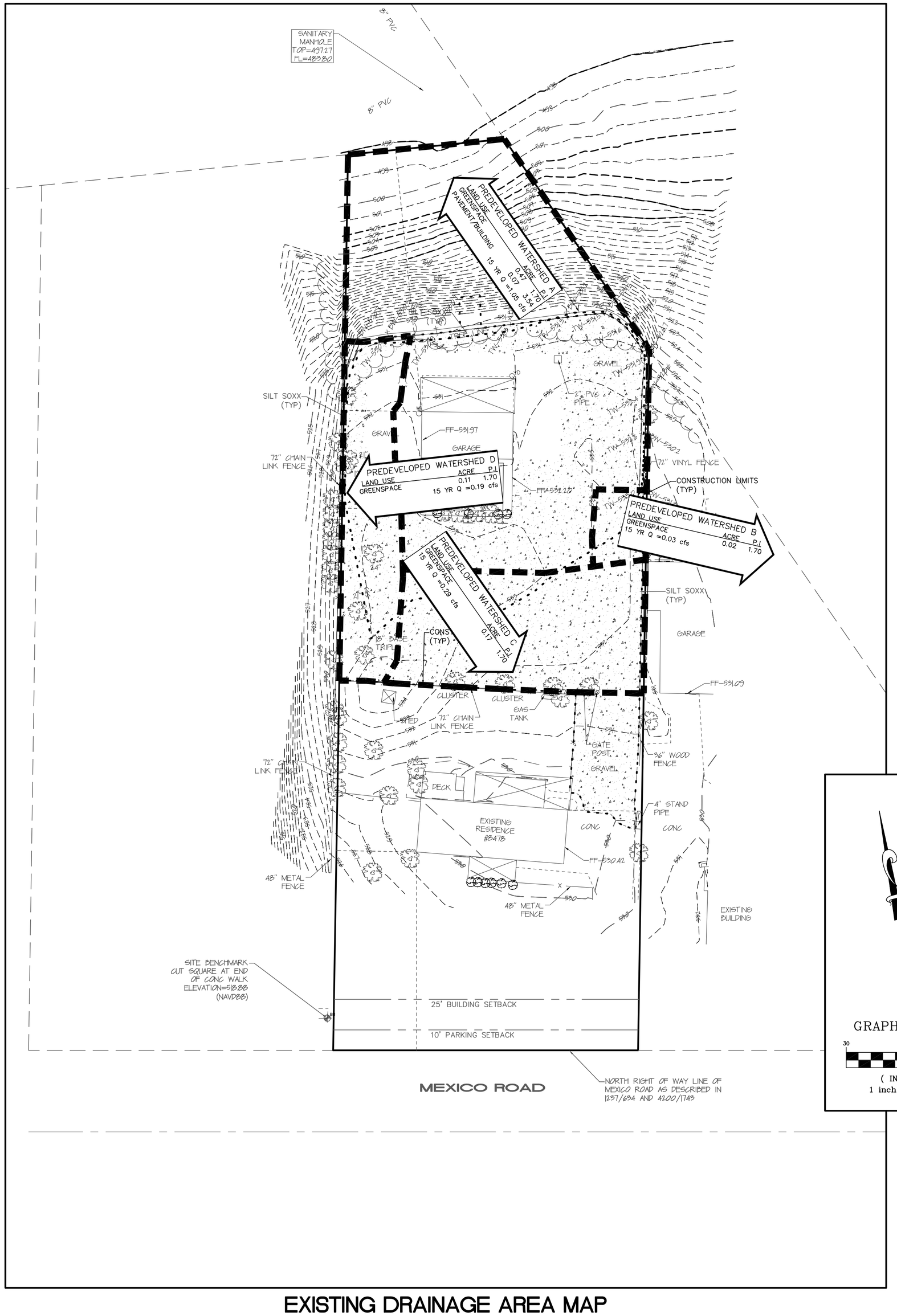
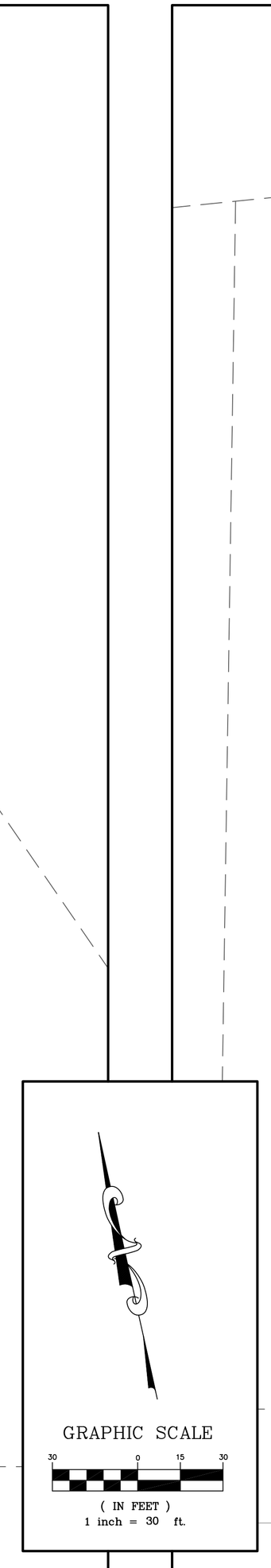
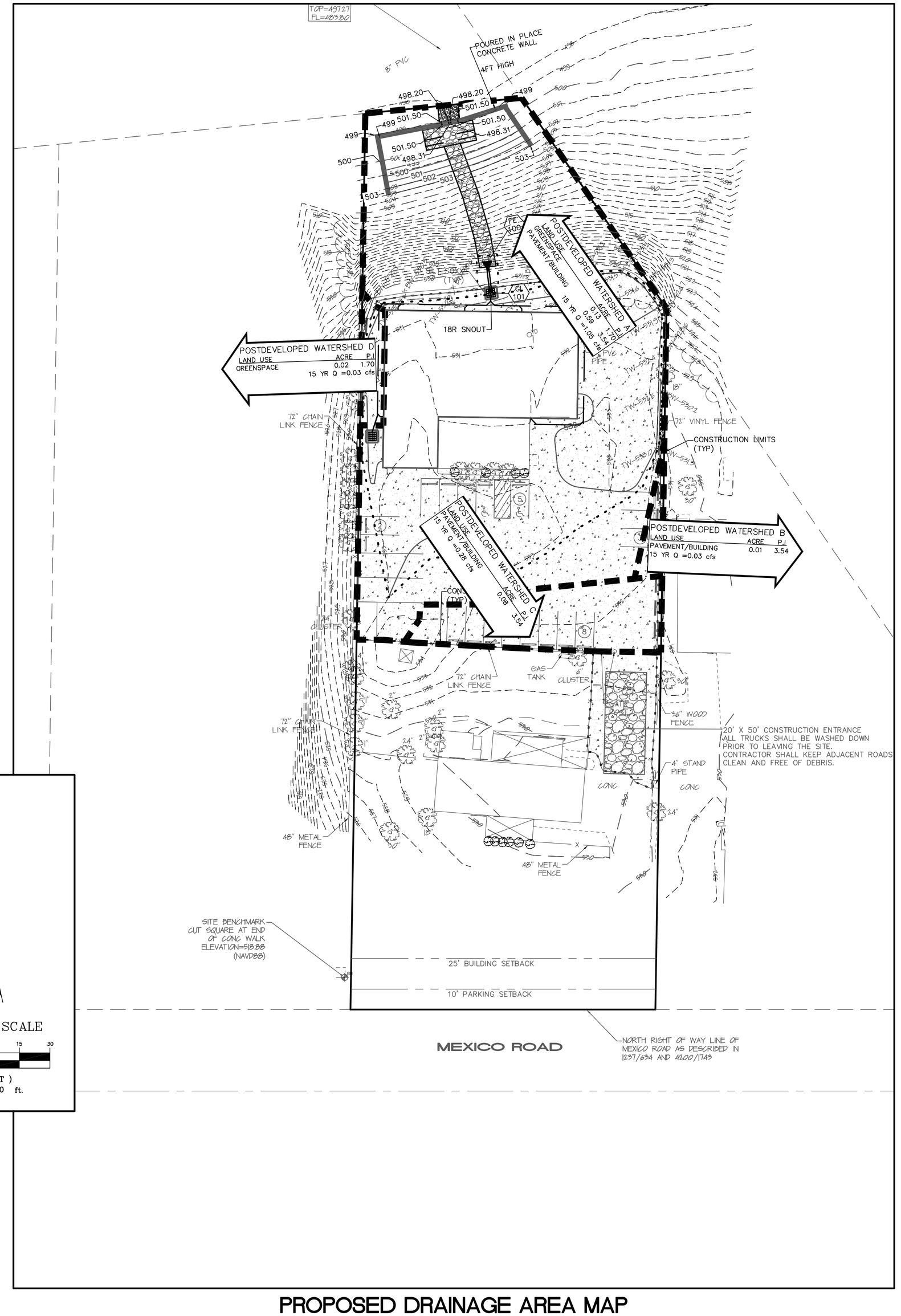
Appendix C
Drainage Maps

THIS SHEET IS FOR DRAINAGE PURPOSES ONLY. NOT TO BE USED FOR CONSTRUCTION.



EXISTING DRAINAGE AREA MAP





PROPOSED DRAINAGE AREA MAP

PROJECT TITLE:
CONSTRUCTION PLANS FOR
Progressive Installations
Building Addition
8478 Mexico Road
O'Fallon, MO 63376

Bax Project # 22-16634 | Issue Date: 06/10/2022

ENGINEERING
PLANNING
SURVEYING
221 Point West Blvd.
St. Charles, MO 63301
636-928-5552
FAX 928-1718

DISCLAIMER OF RESPONSIBILITY
I hereby specify that the documents intended to be authenticated by my seal are limited to this sheet, and I hereby disclaim any responsibility for all other Drawings, Specifications, Estimates, Reports or other documents or instruments relating to or intended to be used for any part or parts of the architectural or engineering project or survey.

REVISIONS

Developer / Owner:
Raytech, L.L.C.
25 Skye Court
O'Fallon, MO 63368
(314) 565-8053

DRAINAGE AREA MAPS

P+Z No. 21-010104
Approved: 12-02-21

City No.
#

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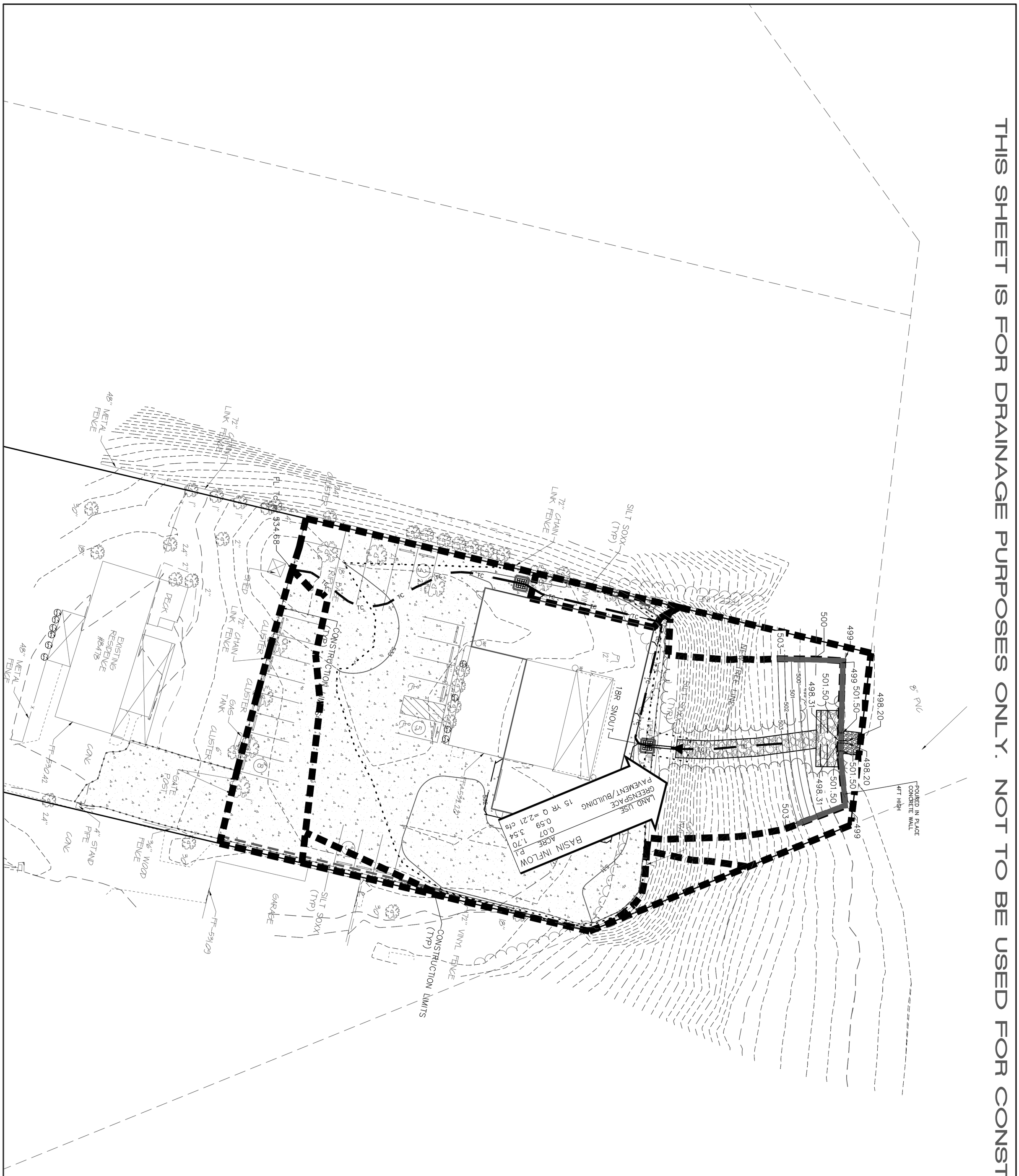

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P+Z No. 21-010104
Approved: 12-02-21

City No. #

Developer / Owner:
Raytech, L.L.C.
25 Skye Court
O'Fallon, MO 63368
(314) 565-8053

DRAINAGE AREA MAPS

REVISIONS

DISCLAIMER OF RESPONSIBILITY
I hereby specify that the documents intended to be authenticated by my seal are limited to this sheet. Drawings, specifications or other documents or instruments relating to or intended to be used for any part or parts of the architectural or engineering project or survey.

ENGINEERING
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PROJECT TITLE:
CONSTRUCTION PLANS FOR
Progressive Installations
Building Addition
8478 Mexico Road
O'Fallon, MO 63376

Bax Project # 22-18634 | Issue Date: 06/10/2022