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E YOUNG STREET CONNECTOR

E YOUNG STREET
(S.R. 1003)
Rolesville, NC, 27571

DRAINAGE AND EROSION CONTROL CALCULATIONS

PREPARED FOR:

LENNAR CORPORATION
1100 Perimeter Park Drive, Suite 112
Morrisville, NC 27596

PREPARED BY:

BGE, INC.
5440 Wade Park Boulevard, Suite 102

NORTH CAROLINA PROFESSIONAL
PRELIMINARY
ENGINEER
DEBRA M. FERM

Initial Submittal: July 3, 2023

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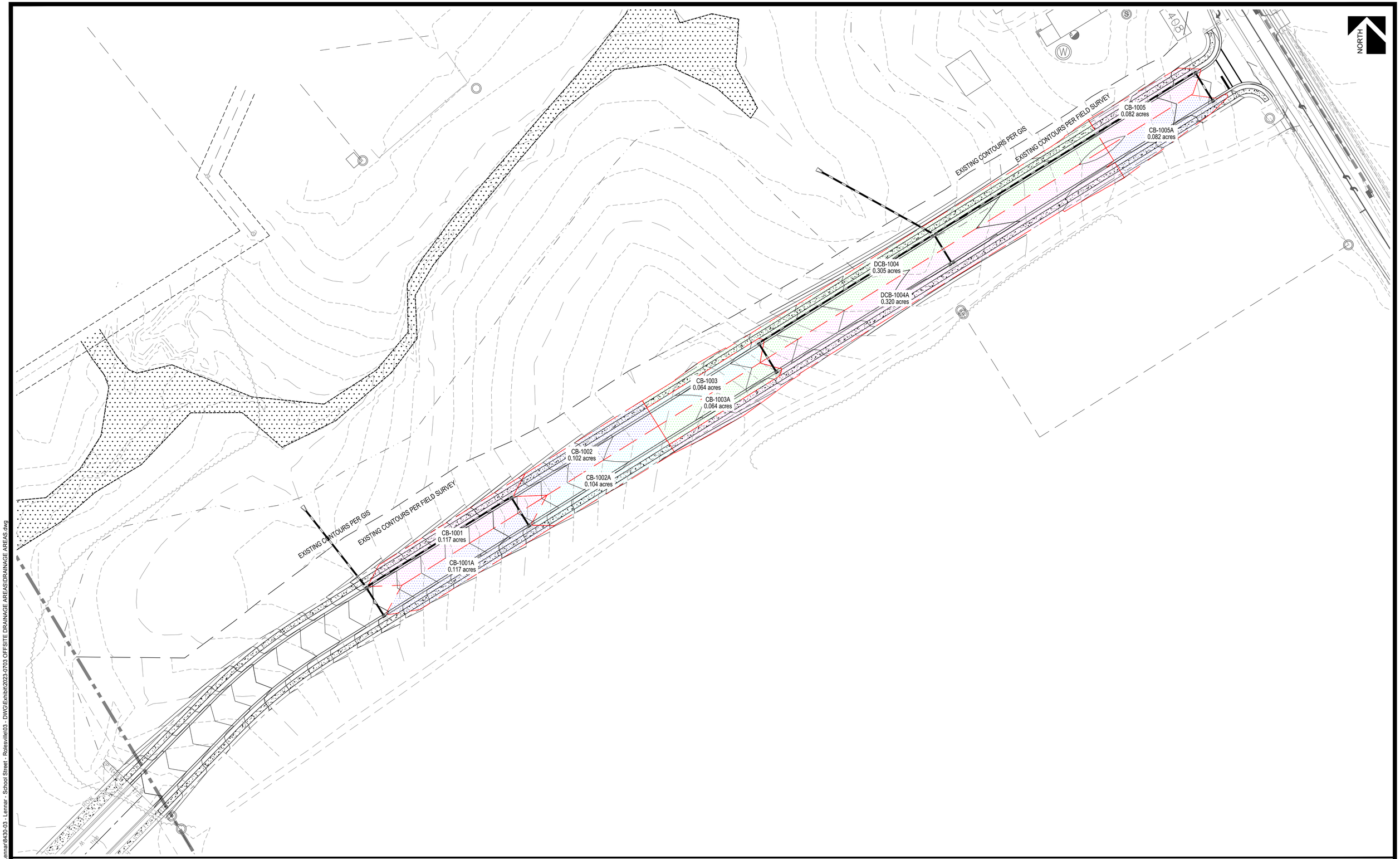
ATTACHMENT 1: DRAINAGE AREA MAP



BGE
5440 WADE PARK BLVD, SUITE 102
RALEIGH NC 27607
www.bgeinc.com
NC LICENSE #C-4397

YOUNG STREET CONNECTOR DRAINAGE AREAS

DATE: 7/3/2023

0 40' 80' 120'
SCALE: 1" = 40'

G:\NC\Projects\Lennar\8430-03 - Lennar - School Street - Rolesville\03 - DWG\Exhibit\2023-0703 OFFSITE DRAINAGE AREAS\DRAINAGE AREAS.dwg

10 YR STORM

10-YEAR ANALYSIS

Conduit Results - Time: 0.00 hours

Label	Diameter (in)	Slope (Calculated) (ft/ft)	Velocity (In) (ft/s)	Velocity (Out) (ft/s)	Flow (cfs)	Capacity (Full Flow) (cfs)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)
CB-1003 TO CB-1003A	18.0	0.005	2.28	1.40	0.42	7.43	423.23	423.15
CB-1004 TO CB-1003	18.0	0.010	2.78	3.56	0.84	10.50	423.15	421.03
CB-1002 TO CB-1002A	18.0	0.005	2.60	1.57	0.66	7.43	422.07	422.03
CB-1001 TO CB-1002	18.0	0.031	3.14	1.85	1.31	18.43	422.03	416.95
CB-1004 TO CB-1004A	18.0	0.005	3.62	3.63	2.13	7.43	422.05	421.88
FES 1010 TO CB-1004	18.0	0.005	4.62	4.98	5.62	7.43	420.87	420.16
CB-1004 TO CB-1005	18.0	0.005	2.97	0.87	1.06	7.43	421.82	420.87
CB-1005 TO CB-1005A	18.0	0.005	2.44	1.52	0.54	7.43	421.88	421.82
FES-1000 TO CB-1001	18.0	0.005	3.89	3.91	2.75	7.43	416.95	416.46
CB-1001 TO CB-1001A	18.0	0.005	1.69	1.08	0.76	7.43	416.95	416.95

10-YEAR ANALYSIS

Inlets - Time: 0.00 hours

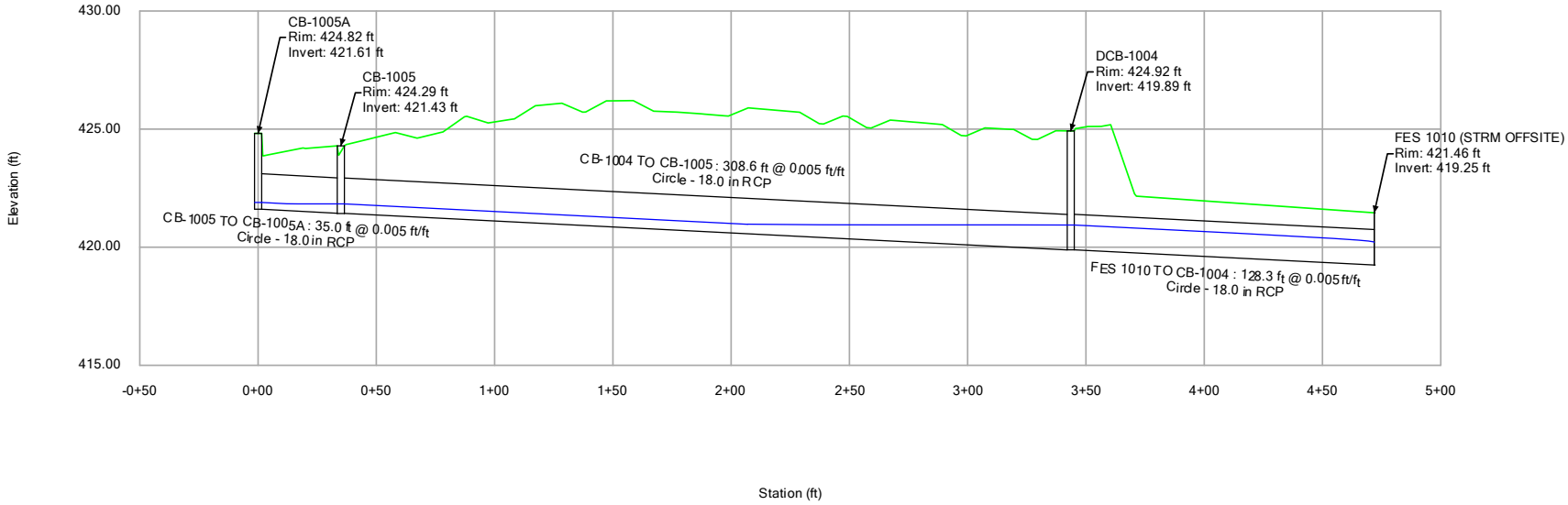
Label	Flow (Captured) (cfs)	Flow (Total Bypassed) (cfs)	Flow (Total Out) (cfs)	Capture Efficiency (Calculated) (%)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Grate Length (ft)	Velocity (In) (ft/s)	Velocity (Out) (ft/s)
CB-1003A	0.42	0.00	0.42	99.8	423.23	423.23	3.0	2.28	2.28
CB-1003	0.42	0.00	0.84	99.8	423.15	423.15	3.0	1.40	2.78
CB-1002	0.65	0.03	1.31	96.3	422.03	422.03	3.0	1.57	3.14
CB-1002A	0.66	0.03	0.66	96.1	422.07	422.07	3.0	2.60	2.60
DCB-1004A	2.13	0.00	2.13	100.0	422.05	422.05	6.0	3.62	3.62
DCB-1004	2.03	0.00	5.62	100.0	420.87	420.87	6.0	0.87	4.62
CB-1005A	0.54	0.01	0.54	98.6	421.88	421.88	3.0	2.44	2.44
CB-1005	0.54	0.01	1.06	98.6	421.82	421.82	3.0	1.52	2.97
CB-1001	0.76	0.05	2.75	93.9	416.95	416.95	3.0	1.85	3.89
CB-1001A	0.76	0.05	0.76	93.9	416.95	416.95	3.0	1.69	1.69

10-YEAR ANALYSIS

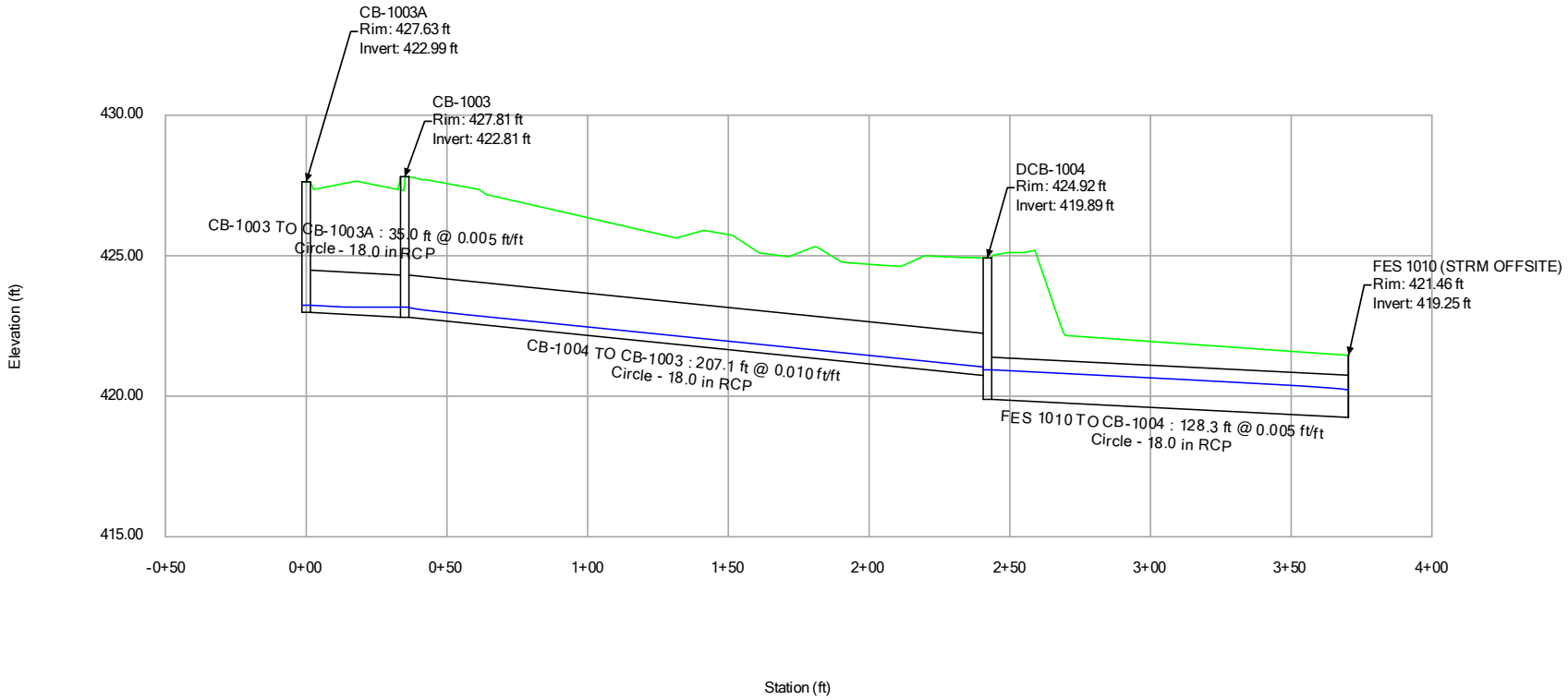
CATCHMENTS - Time: 0.00 hours

Outflow Element	Scaled Area (acres)	Flow (Total Out) (cfs)	Time of Concentration (hours)	Runoff Coefficient (Rational)
CB-1005	0.082	0.54	0.083	0.920
CB-1005A	0.082	0.54	0.083	0.920
DCB-1004	0.305	2.03	0.083	0.920
DCB-1004A	0.320	2.13	0.083	0.920
CB-1003A	0.064	0.42	0.083	0.920
CB-1003	0.064	0.43	0.083	0.920
CB-1002	0.102	0.68	0.083	0.920
CB-1002A	0.104	0.69	0.083	0.920
CB-1001	0.117	0.78	0.083	0.920
CB-1001A	0.117	0.78	0.083	0.920

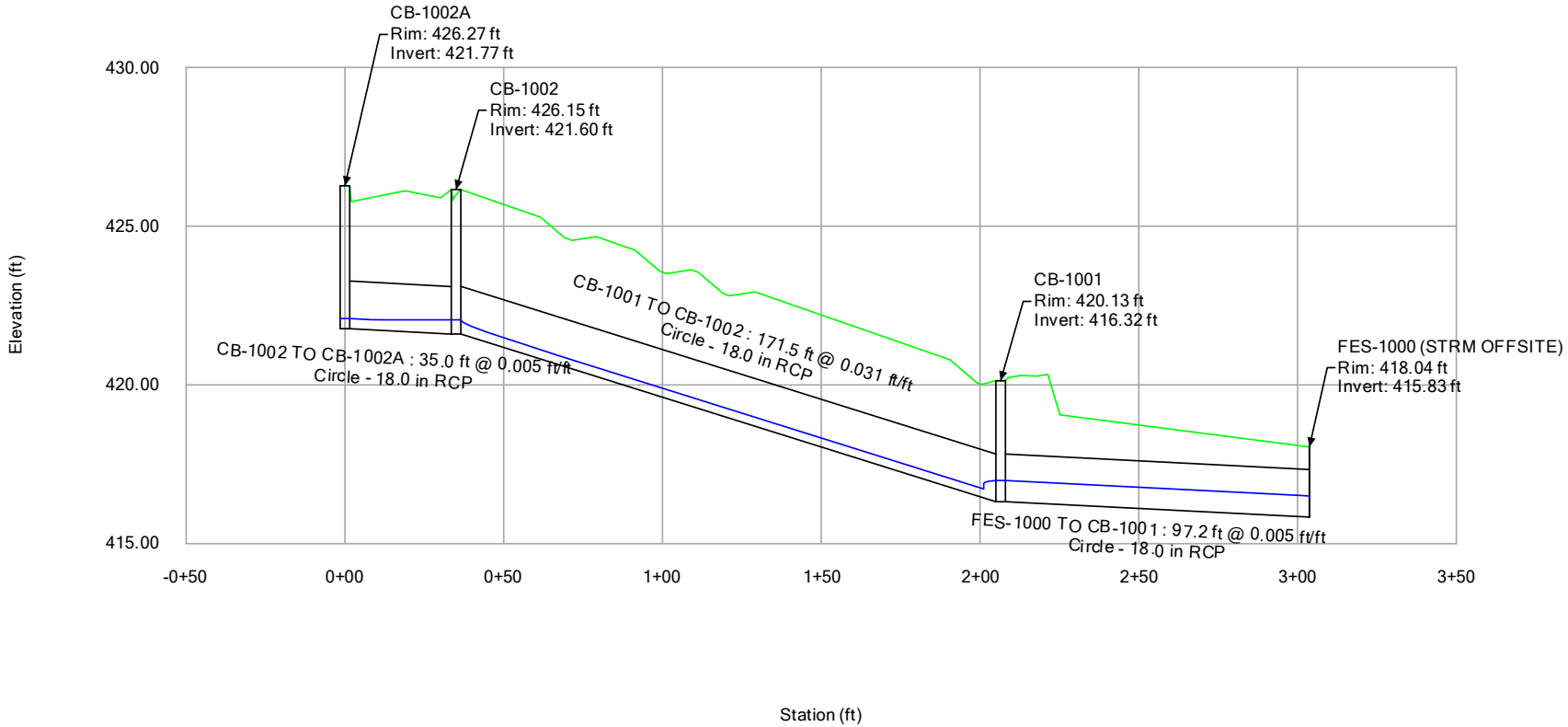
10-YEAR ANALYSIS



10-YEAR ANALYSIS



10-YEAR ANALYSIS



25 YR STORM

25-YEAR ANALYSIS

Conduit Results - Time: 0.00 hours

Label	Diameter (in)	Slope (Calculated) (ft/ft)	Velocity (In) (ft/s)	Velocity (Out) (ft/s)	Flow (cfs)	Capacity (Full Flow) (cfs)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)
CB-1003 TO CB-1003A	18.0	0.005	2.35	1.44	0.47	7.43	423.24	423.17
CB-1004 TO CB-1003	18.0	0.010	2.86	3.67	0.93	10.50	423.17	421.04
CB-1002 TO CB-1002A	18.0	0.005	2.67	1.61	0.73	7.43	422.09	422.05
CB-1001 TO CB-1002	18.0	0.031	3.22	1.88	1.43	18.43	422.05	416.99
CB-1004 TO CB-1004A	18.0	0.005	3.74	3.74	2.37	7.43	422.08	421.91
FES 1010 TO CB-1004	18.0	0.005	4.71	5.18	6.23	7.43	420.94	420.21
CB-1004 TO CB-1005	18.0	0.005	3.05	0.88	1.17	7.43	421.83	420.94
CB-1005 TO CB-1005A	18.0	0.005	2.51	1.56	0.59	7.43	421.90	421.83
FES-1000 TO CB-1001	18.0	0.005	3.99	4.03	3.02	7.43	416.99	416.50
CB-1001 TO CB-1001A	18.0	0.005	1.68	1.11	0.83	7.43	416.99	416.99

25-YEAR ANALYSIS

Inlets - Time: 0.00 hours

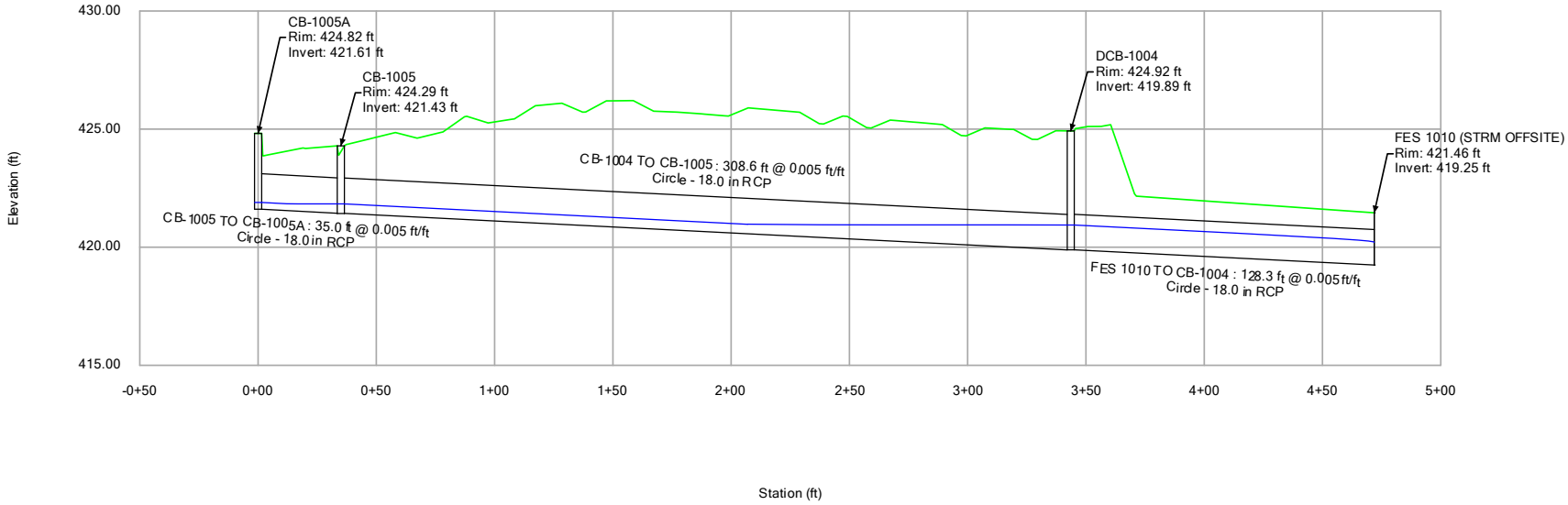
Label	Flow (Captured) (cfs)	Flow (Total Bypassed) (cfs)	Flow (Total Out) (cfs)	Capture Efficiency (Calculated) (%)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Grate Length (ft)	Velocity (In) (ft/s)	Velocity (Out) (ft/s)
CB-1003A	0.47	0.00	0.47	99.5	423.24	423.24	3.0	2.35	2.35
CB-1003	0.47	0.00	0.93	99.4	423.17	423.17	3.0	1.44	2.86
CB-1002	0.71	0.04	1.43	94.9	422.05	422.05	3.0	1.61	3.22
CB-1002A	0.73	0.04	0.73	94.6	422.09	422.09	3.0	2.67	2.67
DCB-1004A	2.37	0.00	2.37	100.0	422.08	422.08	6.0	3.74	3.74
DCB-1004	2.26	0.00	6.23	100.0	420.94	420.94	6.0	0.88	4.71
CB-1005A	0.59	0.01	0.59	97.6	421.90	421.90	3.0	2.51	2.51
CB-1005	0.59	0.01	1.17	97.6	421.83	421.83	3.0	1.56	3.05
CB-1001	0.83	0.07	3.02	92.1	416.99	416.99	3.0	1.88	3.99
CB-1001A	0.83	0.07	0.83	92.0	416.99	416.99	3.0	1.68	1.68

25-YEAR ANALYSIS

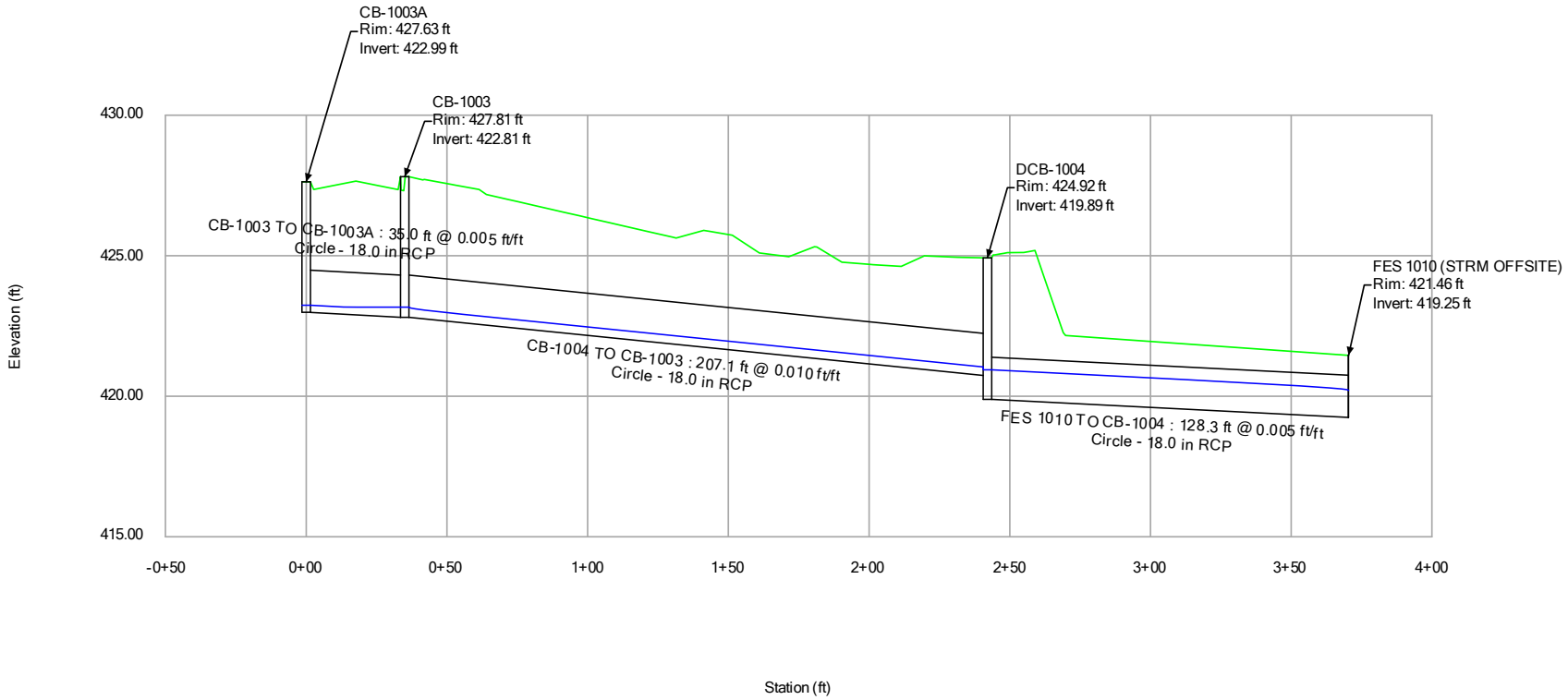
CATCHMENTS - Time: 0.00 hours

Outflow Element	Scaled Area (acres)	Flow (Total Out) (cfs)	Time of Concentration (hours)	Runoff Coefficient (Rational)
CB-1005	0.082	0.60	0.083	0.920
CB-1005A	0.082	0.60	0.083	0.920
DCB-1004	0.305	2.26	0.083	0.920
DCB-1004A	0.320	2.37	0.083	0.920
CB-1003A	0.064	0.47	0.083	0.920
CB-1003	0.064	0.47	0.083	0.920
CB-1002	0.102	0.75	0.083	0.920
CB-1002A	0.104	0.77	0.083	0.920
CB-1001	0.117	0.87	0.083	0.920
CB-1001A	0.117	0.87	0.083	0.920

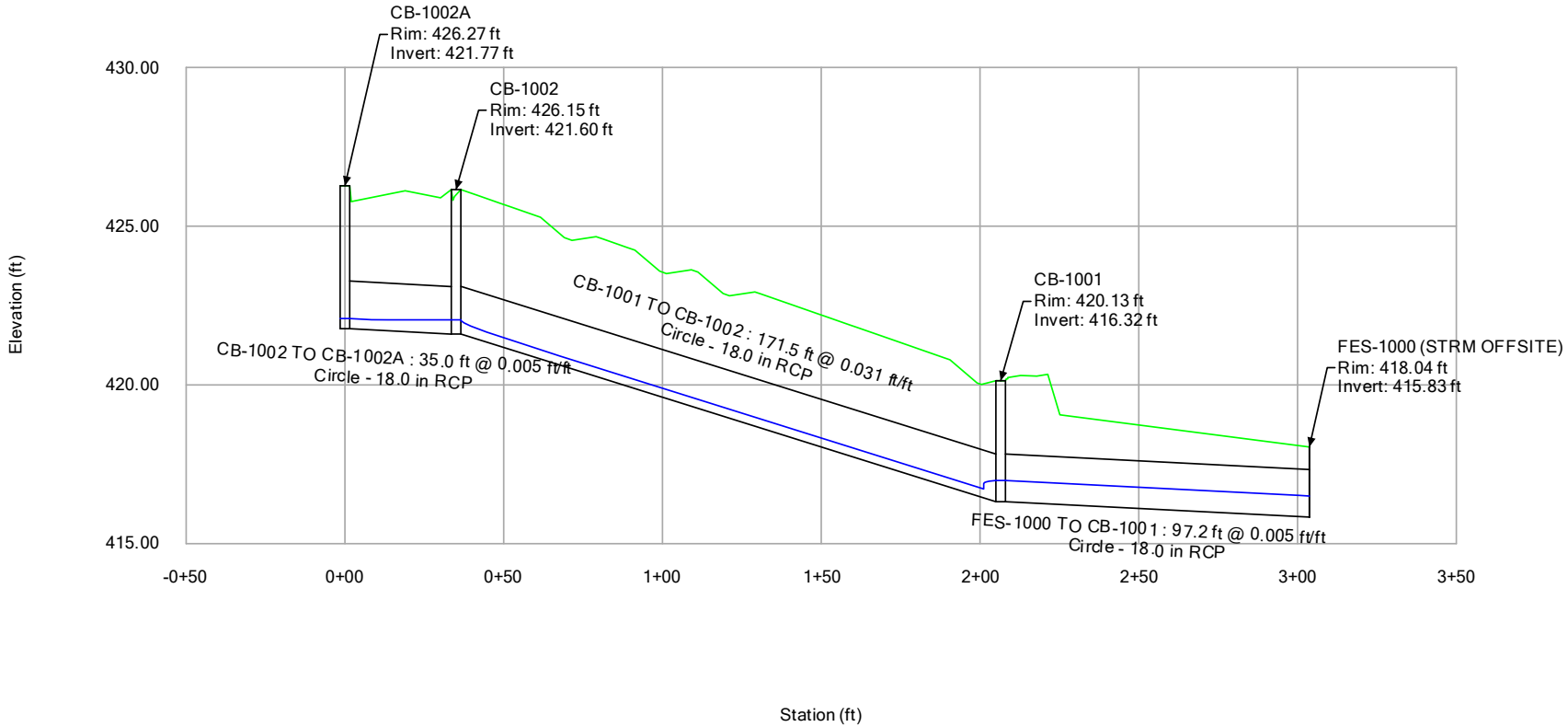
25-YEAR ANALYSIS



25-YEAR ANALYSIS



25-YEAR ANALYSIS

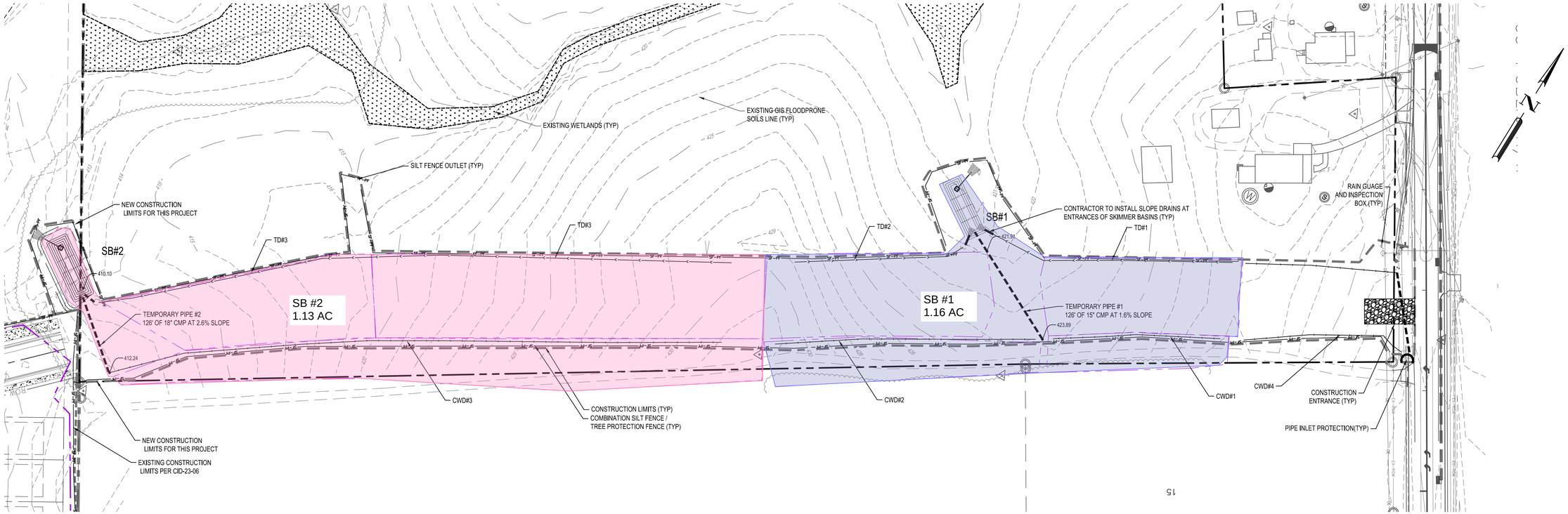


INLET SPREAD

4" PER HOUR

Inlet Spread - Time: 0.00 hours

Label	Inlet Drainage Area (acres)	Intercepted CA (acres)	Flow (Captured) (cfs)	Flow (Total Bypassed) (cfs)	Flow (Total Out) (cfs)	Spread / Top Width (ft)	Depth (Gutter) (in)
CB-1003A	0.064	0.059	0.24	0.00	0.24	1.7	1.2
CB-1003	0.064	0.059	0.24	0.00	0.47	1.7	1.2
CB-1002	0.102	0.094	0.38	0.00	0.76	2.2	1.5
CB-1002A	0.104	0.095	0.38	0.00	0.38	2.2	1.5
DCB-1004A	0.320	0.294	1.19	0.00	1.19	5.1	3.2
DCB-1004	0.305	0.281	1.13	0.00	3.40	4.9	3.1
CB-1005A	0.082	0.075	0.30	0.00	0.30	1.9	1.4
CB-1005	0.082	0.075	0.30	0.00	0.60	1.9	1.4
CB-1001	0.117	0.107	0.43	0.00	1.63	2.5	1.6
CB-1001A	0.117	0.107	0.43	0.00	0.43	2.5	1.6



SKIMMER BASIN SUMMARY

BASIN NUMBER	DRAINAGE AREA (AC)	DENUDED AREA (AC)	RUNOFF COEFFICIENT	SYSTEM INTENSITY (IN/HR)	10-YEAR PEAK FLOW (CFS)	BASIN DIMENSIONS DEPTH (FT)	BASIN DIMENSIONS LENGTH (FT)	BASIN DIMENSIONS WIDTH (FT)	TOP OF DAM EL. (FT)	WEIR LENGTH (FT)	AREA REQUIRED (SF)	AREA PROVIDED (SF)	VOLUME REQUIRED (CF)	VOLUME PROVIDED (CF)	SKIMMER SIZE (IN)	SKIMMER ORIFICE DIA. (IN)	DEWATERING TIME (DAYS)
SB #1	1.16	1.16	0.50	7.25	4.21	3.0	66	22	278	6	1,367	1,452	2,088	2,916	4	0.75	2.78
SB #2	1.13	1.13	0.50	7.25	4.10	3.0	66	22	290	6	1,331	1,452	2,034	2,916	4	0.75	2.71

Temporary Diversion Ditch, Pipe Sizing & Lining Calculations

Rainfall Intensity $I_{10\text{-}yr}$ = 7.25 in/hr

Swale ID	Rational C	Drainage Area (ac)	$Q_{10\text{-}yr}$ (cfs)	Slope (%)	Calculated Depth (ft)	Calculated Shear Stress (lbs/ft^2)	Calculated Velocity (ft/s)	Bottom Width (ft)	# of Check Dams	Type of Liner	Slope Drain Type and Size (in)
TD1	0.50	0.34	1.24	2.49%	0.23	0.004	2.19	2	2	GRASS	CMP - 12"
TD2	0.50	0.43	1.55	3.65%	0.23	0.01	2.69	4	3	GRASS	CMP - 12"
TD3	0.50	1.13	4.11	2.72%	0.44	0.01	3.25	2	8	GRASS	CMP - 12"
CWD 1	0.50	0.15	0.53	4.41%	0.31	0.01	2.78	0	3	GRASS	N/A
CWD 2	0.50	0.25	0.89	3.13%	0.40	0.01	2.77	0	4	GRASS	N/A
CWD 3	0.50	0.60	2.19	4.00%	0.53	0.01	3.82	0	4	GRASS	N/A
PIPE 1	0.50	1.16	4.21	1.59%	0.98	0.01	6.81	4	1	N/A	CMP - 15"
PIPE 2	0.50	1.74	6.31	2.56%	0.92	0.01	5.83	4	1	N/A	CMP - 18"

NOTES:
All ditches are to be trapezoidal in shape: 2:1 sideslopes, and height of 1.0'
Calculated Depth and Calculated Velocity Based on Flowmaster Output
NAG S150: North American Green S150 or approved equal

ABBREVIATIONS
TD = TEMPORARY DIVERSION
CWD = CLEAN WATER DIVERSION
SB = SKIMMER BASIN

EROSION CONTROL LEGEND

- PROPERTY LINE
- 600 — EXISTING MAJOR CONTOUR
- 601 — EXISTING MINOR CONTOUR
- 600 — PROPOSED MAJOR CONTOUR
- 601 — PROPOSED MINOR CONTOUR
- DRAINAGE AREA
- DA# ±X.X AC — DRAINAGE AREA LABEL
- SOIL — SOIL TYPE
- H.V. X.X% — DIRECTION OF OVERLAND FLOW
- 100.XX 100.XX — DIRECTION OF OVERLAND FLOW
- RIP RAP APRON
- CONSTRUCTION ENTRANCE / EXIT
- EROSION CONTROL MATTING
- LIMITS OF DISTURBANCE
- TEMPORARY JUTE NETTING BAFFLES G/M2 COIR FABRIC OR HEAVIER)
- TEMPORARY DIVERSION DITCH OR B
- SF — 4.00 — TEMP SILT FENCE WITH OUTLET
- TP — TEMP TREE PROTECTION FENCE
- SF-TP — TEMP SILT / TREE PROTECTION FENC
- CHECK DAM
- BERM
- SLOPE DRAIN WITH RIP-RAP APRON
- SKIMMER
- PIPE INLET PROTECTION
- INLET PROTECTION
- EXCAVATED INLET PROTECTION

NARRATIVE

PROJECT INCLUDES APPROXIMATELY 1,520 LINEAR FEET OF 35' BACK TO BACK STREET SECTION TO CONNECT STREET H TO YOUNG STREET AND STORM DRAINAGE IN ROLESVILLE, NC. THERE IS A FUTURE DEVELOPMENT (BY OTHERS) ON THIS PROPERTY THAT WILL REQUIRE STORMWATER CONTROL MEASURES AND WILL TREAT THE NEW IMPERVIOUS INCLUDING THIS PROJECT'S IMPERVIOUS AREAS.

CONSTRUCTION SEQUENCE - PHASE 1

1. SCHEDULE A PRECONSTRUCTION CONFERENCE WITH THE ENVIRONMENTAL CONSULTANT. OBTAIN A LAND DISTURBING PERMIT.
2. INSTALL GRAVEL CONSTRUCTION PAD, BYPASS PIPES AND CLEAN WATER DIVERSIONS TO BYPASS PIPES. INSTALL TEMPORARY DIVERSIONS, SILT FENCE, SEDIMENT BASINS OR OTHER MEASURES AS SHOWN ON THE APPROVED PLAN. CLEAR ONLY AS NECESSARY TO INSTALL THESE DEVICES. SEED TEMPORARY DIVERSIONS, AND BASINS IMMEDIATELY AFTER CONSTRUCTION.
3. CALL ENVIRONMENTAL CONSULTANT FOR AN ONSITE INSPECTION BY THE ENVIRONMENTAL CONSULTANT TO OBTAIN A CERTIFICATE OF COMPLIANCE.

CONSTRUCTION SEQUENCE - PHASE 2

1. BEGIN CLEARING AND GRUBBING. MAINTAIN DEVICES AS NEEDED, ROUGH GRADE SITE.
2. INSTALL STORM SEWER, IF SHOWN, AND PROTECT INLETS WITH BLOCK AND GRAVEL INLET CONTROLS, SEDIMENT TRAPS OR OTHER APPROVED MEASURES AS SHOWN ON THE PLAN. BEGIN CONSTRUCTION, BUILDING, ETC.
3. STABILIZE SITE AS AREAS ARE BROUGHT UP TO FINISH GRADE WITH VEGETATION, PAVING, DITCH LININGS, ETC. SEED AND MULCH DENUDED AREAS PER GROUND STABILIZATION TIME FRAMES.
4. WHEN CONSTRUCTION IS COMPLETE AND ALL AREAS ARE STABILIZED COMPLETELY, CALL ENVIRONMENTAL CONSULTANT FOR AN INSPECTION.
5. IF SITE IS APPROVED, REMOVE TEMPORARY DIVERSIONS, SILT FENCE, SEDIMENT BASINS, ETC., AND SEED OUT OR STABILIZE ANY RESULTING BARE AREAS. ALL REMAINING PERMANENT EROSION CONTROL DEVICES, SUCH AS VELOCITY DISSIPATORS, SHOULD NOW BE INSTALLED.
6. WHEN VEGETATION HAS BECOME ESTABLISHED, CALL FOR A FINAL SITE INSPECTION BY THE ENVIRONMENTAL CONSULTANT. OBTAIN A CERTIFICATE OF COMPLETION.

DISTURBED AREA: 3.05 AC

0 25' 50' 100'
SCALE: 1" = 50'

Know what's below. Call before you dig.

REV	DATE	DESCRIPTION

DESIGNED BY: DF/JWM
DRAWN BY: JWM
REVIEWED BY: DF

BGE
5440 WADE PARK BLVD, SUITE 102
RALEIGH, NC 27607
WWW.BGEINC.COM
NC LICENSE #C-4397

LENNAR CORPORATION
1100 PERIMETER PARK DRIVE, SUITE 112
MORRISVILLE / NORTH CAROLINA / 27560

YOUNG STREET CONNECTION
408 E YOUNG STREET
ROLESVILLE / NORTH CAROLINA / 27571

EROSION CONTROL PHASE 1

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 028892 DEREK M. FRANCIS

NOT FOR CONSTRUCTION

FILE NUMBER: 8430-03

DATE: 07/03/2023

C5-0

EROSION CONTROL DA MAP

SKIMMER BASIN CALCULATIONS

PROJECT: Parker Ridge - Young Street Connector
PROJ. NO: TBD
DATE: July 3, 2023
DESIGNED BY: DF

SKIMMER BASIN SUMMARY

BASIN NUMBER	DRAINAGE AREA (AC)	DENUDED AREA (AC)	RUNOFF COEFFICIENT	SYSTEM INTENSITY (IN/HR)	10-YEAR PEAK FLOW (CFS)	BASIN DIMENSIONS			TOP OF DAM EL. (FT)	WEIR LENGTH (FT)	AREA REQUIRED (SF)	AREA PROVIDED (SF)	VOLUME REQUIRED (CF)	VOLUME PROVIDED (CF)	SKIMMER SIZE (IN)	SKIMMER ORIFICE DIA. (IN)	DEWATERING TIME (DAYS)
						DEPTH (FT)	LENGTH (FT)	WIDTH (FT)									
SB #1	1.16	1.16	0.50	7.25	4.21	3.0	66	22	278	6	1,367	1,452	2,088	2,916	4	0.75	2.78
SB #2	1.13	1.13	0.50	7.25	4.10	3.0	66	22	290	6	1,331	1,452	2,034	2,916	4	0.75	2.71

NOTES:
1. One foot of free board is provided for all basins.
2. System Intensity calculated for Tc=5 min.
3. Orifice sizes calculated for a 2-day drawdown per reference of "Determining Orifice Size for the Faircloth Skimmer, Feb. 2001".

Skimmer Basin #1

1.16	Drainage Area (Acres)	
1.16	Disturbed Area (Acres)	
0.50	C	
7.25	I in/hr	
4.21	Peak Flow from 10-year Storm (cfs)	
2088	Required Volume ft^3	
1367	Required Surface Area ft^2	
26.1	Suggested Width ft	
52.3	Suggested Length ft	
22	Trial Top Width at Spillway Invert ft	
66	Trial Top Length at Spillway Invert ft	
2	Trial Side Slope Ratio Z:1	
3	Trial Depth ft	(2 to 3.5 feet above grade)
10	Bottom Width ft	
54	Bottom Length ft	
540	Bottom Area ft^2	
2916	Actual Volume ft^3	**Okay**
1452	Actual Surface Area ft^2	**Okay**
6	Trial Weir Length ft	
0.5	Trial Depth of Flow ft	
6.4	Spillway Capacity cfs	**Okay**

Faircloth

4	Skimmer Size (inches)
0.333	Head on Skimmer (feet)
0.75	Orifice Size (1/4 inch increments)
2.78	Dewatering Time (days)
	Suggest about 3 days

Skimmer Basin #2

1.13	Drainage Area (Acres)	
1.13	Disturbed Area (Acres)	
0.50	C	
7.25	I in/hr	
4.10	Peak Flow from 10-year Storm (cfs)	
2034	Required Volume ft^3	
1331	Required Surface Area ft^2	
25.8	Suggested Width ft	
51.6	Suggested Length ft	
22	Trial Top Width at Spillway Invert ft	
66	Trial Top Length at Spillway Invert ft	
2	Trial Side Slope Ratio Z:1	
3	Trial Depth ft	(2 to 3.5 feet above grade)
10	Bottom Width ft	
54	Bottom Length ft	
540	Bottom Area ft^2	
2916	Actual Volume ft^3	**Okay**
1452	Actual Surface Area ft^2	**Okay**
6	Trial Weir Length ft	
0.5	Trial Depth of Flow ft	
6.4	Spillway Capacity cfs	**Okay**

Faircloth

4	Skimmer Size (inches)
0.333	Head on Skimmer (feet)
0.75	Orifice Size (1/4 inch increments)
2.71	Dewatering Time (days)
	Suggest about 3 days

TEMPORARY DIVERSIONS

TEMPORARY DIVERSION, CLEANWATER DIVERSION, AND PIPE SUMMARY

Rainfall Intensity $I_{10\text{-}yr}$ = 7.25 in/hr

Swale ID	Rational C	Drainage Area (ac)	$Q_{10\text{-}yr}$ (cfs)	Slope (%)	Calculated Depth (ft)	Calculated Shear Stress (lbs/ft^2)	Calculated Velocity (ft/s)	Bottom Width (ft)	# of Check Dams	Type of Liner	Slope Drain Type and Size (in)
TD1	0.50	0.34	1.24	2.49%	0.23	0.004	2.19	2	2	GRASS	CMP - 12"
TD2	0.50	0.43	1.55	3.65%	0.23	0.01	2.69	4	3	GRASS	CMP - 12"
TD3	0.50	1.13	4.11	2.72%	0.44	0.01	3.25	2	8	GRASS	CMP - 12"
CWD 1	0.50	0.15	0.53	4.41%	0.31	0.01	2.78	0	3	GRASS	N/A
CWD 2	0.50	0.25	0.89	3.13%	0.40	0.01	2.77	0	4	GRASS	N/A
CWD 3	0.50	0.60	2.19	4.00%	0.53	0.01	3.82	0	4	GRASS	N/A
PIPE 1	0.50	1.16	4.21	1.59%	0.98	0.01	6.81	N/A	N/A	N/A	CMP - 15"
PIPE 2	0.50	1.74	6.31	2.56%	0.92	0.01	5.83	N/A	N/A	N/A	CMP - 18"

NOTES:

All ditches are to be trapezoidal in shape: 2:1 sideslopes, and height of 1.0'

Calculated Depth and Calculated Velocity Based on Flowmaster Output

NAG S150: North American Green S150 or approved equal

Worksheet for TD1

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.035
Channel Slope	0.025 ft/ft
Left Side Slope	2.000 H:V
Right Side Slope	2.000 H:V
Bottom Width	2.00 ft
Discharge	1.24 cfs

Results	
Normal Depth	2.8 in
Flow Area	0.6 ft²
Wetted Perimeter	3.0 ft
Hydraulic Radius	2.2 in
Top Width	2.92 ft
Critical Depth	2.5 in
Critical Slope	0.033 ft/ft
Velocity	2.19 ft/s
Velocity Head	0.07 ft
Specific Energy	0.30 ft
Froude Number	0.877
Flow Type	Subcritical

GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	0.00 ft/s
Upstream Velocity	0.00 ft/s
Normal Depth	2.8 in
Critical Depth	2.5 in
Channel Slope	0.025 ft/ft
Critical Slope	0.033 ft/ft

Worksheet for TD2

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.035
Channel Slope	0.037 ft/ft
Left Side Slope	2.000 H:V
Right Side Slope	2.000 H:V
Bottom Width	2.00 ft
Discharge	1.55 cfs

Results	
Normal Depth	2.8 in
Flow Area	0.6 ft²
Wetted Perimeter	3.0 ft
Hydraulic Radius	2.3 in
Top Width	2.93 ft
Critical Depth	2.9 in
Critical Slope	0.032 ft/ft
Velocity	2.69 ft/s
Velocity Head	0.11 ft
Specific Energy	0.35 ft
Froude Number	1.071
Flow Type	Supercritical

GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	2.8 in
Critical Depth	2.9 in
Channel Slope	0.037 ft/ft
Critical Slope	0.032 ft/ft

Worksheet for TD3

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.035
Channel Slope	0.027 ft/ft
Left Side Slope	2.000 H:V
Right Side Slope	2.000 H:V
Bottom Width	2.00 ft
Discharge	4.11 cfs

Results	
Normal Depth	5.3 in
Flow Area	1.3 ft²
Wetted Perimeter	4.0 ft
Hydraulic Radius	3.8 in
Top Width	3.76 ft
Critical Depth	5.2 in
Critical Slope	0.028 ft/ft
Velocity	3.25 ft/s
Velocity Head	0.16 ft
Specific Energy	0.60 ft
Froude Number	0.989
Flow Type	Subcritical

GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	5.3 in
Critical Depth	5.2 in
Channel Slope	0.027 ft/ft
Critical Slope	0.028 ft/ft

Worksheet for CWD 1

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.030
Channel Slope	0.044 ft/ft
Left Side Slope	2.000 H:V
Right Side Slope	2.000 H:V
Discharge	0.53 cfs

Results	
Normal Depth	3.7 in
Flow Area	0.2 ft²
Wetted Perimeter	1.4 ft
Hydraulic Radius	1.7 in
Top Width	1.24 ft
Critical Depth	4.0 in
Critical Slope	0.028 ft/ft
Velocity	2.78 ft/s
Velocity Head	0.12 ft
Specific Energy	0.43 ft
Froude Number	1.247
Flow Type	Supercritical

GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	3.7 in
Critical Depth	4.0 in
Channel Slope	0.044 ft/ft
Critical Slope	0.028 ft/ft

Worksheet for CWD 2

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.030
Channel Slope	0.031 ft/ft
Left Side Slope	2.000 H:V
Right Side Slope	2.000 H:V
Discharge	0.89 cfs

Results	
Normal Depth	4.8 in
Flow Area	0.3 ft²
Wetted Perimeter	1.8 ft
Hydraulic Radius	2.1 in
Top Width	1.60 ft
Critical Depth	5.0 in
Critical Slope	0.026 ft/ft
Velocity	2.77 ft/s
Velocity Head	0.12 ft
Specific Energy	0.52 ft
Froude Number	1.092
Flow Type	Supercritical

GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	4.8 in
Critical Depth	5.0 in
Channel Slope	0.031 ft/ft
Critical Slope	0.026 ft/ft

Worksheet for CWD 3

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.030
Channel Slope	0.040 ft/ft
Left Side Slope	2.000 H:V
Right Side Slope	2.000 H:V
Discharge	2.19 cfs

Results	
Normal Depth	6.4 in
Flow Area	0.6 ft²
Wetted Perimeter	2.4 ft
Hydraulic Radius	2.9 in
Top Width	2.14 ft
Critical Depth	7.1 in
Critical Slope	0.023 ft/ft
Velocity	3.82 ft/s
Velocity Head	0.23 ft
Specific Energy	0.76 ft
Froude Number	1.302
Flow Type	Supercritical

GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	6.4 in
Critical Depth	7.1 in
Channel Slope	0.040 ft/ft
Critical Slope	0.023 ft/ft

Worksheet for Circular Pipe - 1

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.024
Channel Slope	0.016 ft/ft
Diameter	15.0 in
Discharge	4.21 cfs

Results	
Normal Depth	11.7 in
Flow Area	1.0 ft²
Wetted Perimeter	2.7 ft
Hydraulic Radius	4.6 in
Top Width	1.03 ft
Critical Depth	10.0 in
Percent Full	78.1 %
Critical Slope	0.024 ft/ft
Velocity	4.09 ft/s
Velocity Head	0.26 ft
Specific Energy	1.24 ft
Froude Number	0.723
Maximum Discharge	4.75 cfs
Discharge Full	4.41 cfs
Slope Full	0.014 ft/ft
Flow Type	Subcritical

GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.0 %
Normal Depth Over Rise	0.0 %
Downstream Velocity	0.00 ft/s
Upstream Velocity	0.00 ft/s
Normal Depth	11.7 in
Critical Depth	10.0 in
Channel Slope	0.016 ft/ft
Critical Slope	0.024 ft/ft

Worksheet for Circular Pipe - 2

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.024
Channel Slope	0.026 ft/ft
Diameter	18.0 in
Discharge	6.31 cfs

Results	
Normal Depth	11.0 in
Flow Area	1.1 ft²
Wetted Perimeter	2.7 ft
Hydraulic Radius	5.0 in
Top Width	1.46 ft
Critical Depth	11.7 in
Percent Full	60.9 %
Critical Slope	0.022 ft/ft
Velocity	5.60 ft/s
Velocity Head	0.49 ft
Specific Energy	1.40 ft
Froude Number	1.124
Maximum Discharge	9.87 cfs
Discharge Full	9.17 cfs
Slope Full	0.012 ft/ft
Flow Type	Supercritical

GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.0 %
Normal Depth Over Rise	60.9 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	11.0 in
Critical Depth	11.7 in
Channel Slope	0.026 ft/ft
Critical Slope	0.022 ft/ft

DISSIPATORS

DESIGN OF RIPRAP OUTLET PROTECTION

User Input Data
Calculated Value
Reference Data

Designed By:	JWM	**Date:**	7/3/2023
Checked By:		**Date:**	
Company:	BGE		
Project Name:	YOUNG ST CONNECTOR		
Project No.:	8430-03		

Site Location (City/Town)	ROLESVILLE
Culvert Id.	1001
Total Drainage Area (acres)	

Step 1. Determine the tailwater depth from channel characteristics below the pipe outlet for the design capacity of the pipe. If the tailwater depth is less than half the outlet pipe diameter, it is classified minimum tailwater condition. If it is greater than half the pipe diameter, it is classified maximum condition. Pipes that outlet onto wide flat areas with no defined channel are assumed to have a minimum tailwater condition unless reliable flood stage elevations show otherwise.

Outlet pipe diameter, D_o (in.)	18
Tailwater depth (in.)	8
Minimum/Maximum tailwater?	Min TW (Fig. 8.06a)
Discharge (cfs)	2.75
Velocity (ft./s)	3.91

Step 2. Based on the tailwater conditions determined in step 1, enter Figure 8.06a or Figure 8.06b, and determine d_{50} riprap size and minimum apron length (L_a). The d_{50} size is the median stone size in a well-graded riprap apron.

Step 3. Determine apron width at the pipe outlet, the apron shape, and the apron width at the outlet end from the same figure used in Step 2.

	Minimum TW	**Maximum TW**
	Figure 8.06a	Figure 8.06b
Riprap d_{50}, (ft.)	0.3	
Minimum apron length, L_a (ft.)	9	
Apron width at pipe outlet (ft.)	4.5	4.5
Apron shape		
Apron width at outlet end (ft.)	10.5	1.5

Step 4. Determine the maximum stone diameter:

$$d_{max} = 1.5 \times d_{50}$$

	Minimum TW	**Maximum TW**
Max Stone Diameter, dmax (ft.)	0.45	0

Step 5. Determine the apron thickness:

$$\text{Apron thickness} = 1.5 \times d_{max}$$

	Minimum TW	**Maximum TW**
Apron Thickness(ft.)	0.675	0

Step 6. Fit the riprap apron to the site by making it level for the minimum length, L_a, from Figure 8.06a or Figure 8.06b. Extend the apron farther downstream and along channel banks until stability is assured. Keep the apron as straight as possible and align it with the flow of the receiving stream. Make any necessary alignment bends near the pipe outlet so that the entrance into the receiving stream is straight.

Some locations may require lining of the entire channel cross section to assure stability.

It may be necessary to increase the size of riprap where protection of the channel side slopes is necessary (*Appendix 8.05*). Where overfalls exist at pipe outlets or flows are excessive, a plunge pool should be considered, see page 8.06.8.

DESIGN OF RIPRAP OUTLET PROTECTION

User Input Data
Calculated Value
Reference Data

Designed By:	JWM	**Date:**	7/3/2023
Checked By:		**Date:**	
Company:	BGE		
Project Name:	YOUNG ST CONNECTOR		
Project No.:	8430-03		

Site Location (City/Town)	ROLESVILLE
Culvert Id.	1010
Total Drainage Area (acres)	

Step 1. Determine the tailwater depth from channel characteristics below the pipe outlet for the design capacity of the pipe. If the tailwater depth is less than half the outlet pipe diameter, it is classified minimum tailwater condition. If it is greater than half the pipe diameter, it is classified maximum condition. Pipes that outlet onto wide flat areas with no defined channel are assumed to have a minimum tailwater condition unless reliable flood stage elevations show otherwise.

Outlet pipe diameter, D_o (in.)	18
Tailwater depth (in.)	0
Minimum/Maximum tailwater?	Min TW (Fig. 8.06a)
Discharge (cfs)	5.62
Velocity (ft./s)	4.98

Step 2. Based on the tailwater conditions determined in step 1, enter Figure 8.06a or Figure 8.06b, and determine d_{50} riprap size and minimum apron length (L_a). The d_{50} size is the median stone size in a well-graded riprap apron.

Step 3. Determine apron width at the pipe outlet, the apron shape, and the apron width at the outlet end from the same figure used in Step 2.

	Minimum TW	Maximum TW
	Figure 8.06a	Figure 8.06b
Riprap d_{50}, (ft.)	0.4	
Minimum apron length, L_a (ft.)	9	
Apron width at pipe outlet (ft.)	4.5	4.5
Apron shape		
Apron width at outlet end (ft.)	10.5	1.5

Step 4. Determine the maximum stone diameter:

$$d_{max} = 1.5 \times d_{50}$$

	Minimum TW	Maximum TW
Max Stone Diameter, dmax (ft.)	0.6	0

Step 5. Determine the apron thickness:

$$\text{Apron thickness} = 1.5 \times d_{max}$$

	Minimum TW	Maximum TW
Apron Thickness(ft.)	0.9	0

Step 6. Fit the riprap apron to the site by making it level for the minimum length, L_a, from Figure 8.06a or Figure 8.06b. Extend the apron farther downstream and along channel banks until stability is assured. Keep the apron as straight as possible and align it with the flow of the receiving stream. Make any necessary alignment bends near the pipe outlet so that the entrance into the receiving stream is straight.

Some locations may require lining of the entire channel cross section to assure stability.

It may be necessary to increase the size of riprap where protection of the channel side slopes is necessary (*Appendix 8.05*). Where overfalls exist at pipe outlets or flows are excessive, a plunge pool should be considered, see page 8.06.8.