FINAL DRAINAGE LETTER:

FOREST TRACE SUBDIVISION FILING NO. 2

SMOKY HILL ROAD AND SOUTH AURORA PARKWAY

CITY OF AURORA, COLORADO

PREPARED FOR (OWNER / DEVELOPER):

FOREST TRACE METRO DISTRICT #3

2154 E COMMONS AVENUE, #2000

CENTENNIAL, CO 80122

(303) 520-3085

CONTACT: DANIEL FRANK

DANIEL@DFRANKINC.COM

PREPARED BY (CIVIL ENGINEER):

CENTERPOINT ENGINEERING, LLC

1626 COLE BOULEVARD, SUITE 125

LAKEWOOD, CO 80401

303-670-4111

CONTACT: JOHN OLIVETO, PE

JOLIVETO@CENTERPOINT-ENG.COM

CENTERPOINT ENGINEERING

Civil Design | Land Planning

February 12, 2024

Rev. April 16, 2024

TABLE OF CONTENTS

1.0 INTRODUCTION

1.1 GENERAL PROJECT DESCRIPTION

Forest Trace Village is an existing 75-acre mixed-use development (13 acres of retail and 62 acres of residential and open space) located at East Smoky Hill Road and South Aurora Parkway in Aurora, Colorado. The residential and open space portion of the development consists of 135 homes as well as the north end of the Black Forest. During construction, the developer dedicated over 23 total acres to preserve the Black Forest to prevent the removal or impact to existing trees within the Forest. The original project design ("Forest Trace Planning Area 1 & 2" by Martin/Martin Consulting Engineers and hereafter referred to as the MASTER PLAN and "Forest Trace Filing No. 2 Final Drainage Report" by Martin/Martin Consulting Engineers and hereafter referred to as the MASTER REPORT) involved significant site grading and drainage with several steep slopes and drainage swales. Since construction in year 2015-16, the residential and open space development has experienced significant erosion and drainage issues. In particular, the areas of concern have been grouped into six (6) different areas of concern. This project aims to address these six areas of concern as it relates to their drainage and erosion control liabilities. The six (6) areas of concern are outlined as follows:

1. Area 1: Generally, the area directly north of Lot 32 at the cul-de-sac of South Addison Way. The slope behind this residence directs and ponds stormwater runoff onto the residences' property. The proposed work includes the addition of a grassed drainage swale to alleviate these concerns. The proposed work will impact four (4) landscape trees which are to be replaced or transplanted to match previous tree counts.
2. Area 2: Generally, the area directly north of Lot 15 off of South Biloxi Way. The area right along the property / fence line is experiencing considerable erosion. The proposed work includes the addition of a stone lined drainage swale to alleviate these concerns. The proposed work will not disturb any trees within this area.
3. Area 3: Generally, the area directly north of Lots 63 – 69 off S Catawba Circle. The slope behind the residences directs stormwater runoff onto the residences' properties and the proposed work includes the addition of a stone-lined drainage swale to alleviate these concerns of runoff entering backyards. The MASTER PLAN originally designed drainage swales in this area, however it appears that the swales were not originally constructed to plan or have been filled by erosion. The proposed work will impact fourteen (14) landscape trees which are to be replaced or transplanted to match previous tree counts.
4. Area 4: Generally, the area along the pedestrian sidewalk and behind lots 59 and 60 off of South Catawba Circle. The area which generally slopes from east to west over the concrete walk has developed a low point along the eastern edge/lip of the walk. The low point causes ponding and algae growth at times. The proposed work includes the regrading of this area to eliminate the low point and provide continuous sheet flow over the concrete walk. The proposed work will not disturb any trees within this area.
5. Area 5: Generally, the area behind lots 55 and 56 along South Catawba Way. This area is located within a ravine whose sides are experiencing significant erosion. There is an existing pedestrian walk that runs along this area which is concerning due to the inevitable collapse of the walk with further erosion to the ravine. The proposed work includes the installation of a longitudinal stone toe protection (24" stone) structure

with backfill behind it for stabilization of the area. The proposed work will not disturb any trees within this area.

6. Area 6: Generally, the area directly north of Lots 70 – 78 off of East Euclid Avenue. The slope behind the residences directs stormwater runoff onto the residences' properties and the proposed work includes the addition of a stone-lined drainage swale to alleviate these concerns. The MASTER PLAN originally designed drainage swales in this area, however it appears that the swales were not originally constructed to plan. The proposed work will impact twenty-nine (29) landscape trees which are to be replaced or transplanted per the Metro District.

1.2 PROJECT LOCATION

The proposed project is located within six general areas (described in the introduction) within the Forest Trace Village off East Smoky Hill Road and South Aurora Parkway.

1.3 LAND USE

Currently the development is a mixed-use development consisting of retail / restaurants on the northern edge off East Smoky Hill Road. The remaining southern portion consists of single-family residential homes which is where the proposed work is located.

1.4 TYPE OF REPORT

This is a final drainage letter intended to supplement the MASTER REPORT.

2.0 EXISTING DRAINAGE CONDITIONS

2.1 EXISTING ON-SITE CONDITIONS

The site is developed with single-family residential homes and generally slopes from north (East Smoky Hill Road) to south into South Catawba Way and ultimately into a large detention pond. The existing site contains portions of the preserved Black Forest which consists of numerous ravines with steep (1:1 and steeper) slopes. For all intents and purposes, the existing drainage map can be referred to as the Master Drainage Plan Sheet D1 (page 36 of 191) of the MASTER REPORT.

2.2 FLOOD INSURANCE RATE MAPS

The project is located within zone X of FEMA FIRM Panel number 08005C0502K, which is an area of minimal flooding. The firmette is located within the MASTER REPORT.

3.0 PROPOSED DRAINAGE CONDITIONS

3.1 PROPOSED ON-SITE CONDITIONS

The proposed work does not alter the overall existing drainage patterns as shown in the MASTER REPORT Sheet D1 (page 36 of 191). The proposed work, which consists of graded drainage swales and permanent erosion control measures, is meant to provide relief to existing flooding and erosion concerns that are occurring on site. The Proposed Drainage Maps can be found in Appendix 1. The hydrology for the areas of concern were computed using the rational methodology; computations can be found in Appendix 2. The capacities (flow and WSELs for the minor 2-year and major 100-year storms) for all drainage swales have been computed in FlowMaster and are included in Appendix 2. Where feasible, one foot (1') of freeboard is being provided above the 100-year water surface elevation in swales. However, due to the limitations of existing features (grades, fences, etc.), it is not possible everywhere i.e. where grades must tie into existing topography (Area 1 – Section C-C, Area 6 – Section D-D). Please note that the swales are an improvement over the existing conditions as there are currently minimal drainage features there now. Please note, that Areas 4 and 5 do not propose drainage swales and as such, maps and calculations have not been provided for these areas. The capacity (hydraulic grade lines) of the proposed storm pipe in Area 3 has been computed in StormCAD and is included in Appendix 3.

Riprap sizing for the outlet at Area 3 has been computed in accordance with the Mile High Flood District (MHFD). The design discharge (100-year) of 1.86 cfs was computed in Appendix 2 for Area A3-1 and within Bentley FlowMaster for the Cross Section for Area 3 Swale. The MHFD computes a riprap median size of 9 inches and a length L = 4 feet and width W = 4 feet. See Appendix 5 for computations.

Appendix 6 (Supporting Documentation from EDN 215037) provides information from a previously approved city submission (plans and reports). The Master Drainage Plan (Sheet D1) is provided to show that we are sending less flow to the inlet in question between lots 69 and 70 on S Catawba Circle. The area highlighted in blue is now being sent to the west under the proposed culvert RCP and flows into the ravine after being dispersed among the computed riprap sizing. Additionally, we

are providing the hydraulic grade line computations for Inlet C23 (which corresponds with the manhole we are lowering). The HGL in this structure is approved at elevation 6060.22 and we are lowering the manhole rim elevation to approximate elevation 6066.40 (HGL approx. 6 feet below the new proposed grade). See Appendix 6 for supporting documentation.

3.2 REQUESTED VARIANCES

CenterPoint Engineering understands your concern regarding updated c-values; however, we disagree that the landscaped areas in question are 20% impervious. The site consists of grassy native grass slopes that are much more representative of undisturbed native grasses in Table 5-6 (a c-value of 5% which is much more representative). The soils on site are classified as Hydrologic Soil Group "B" (a well-drained soil) and the site is consistently sandy and dry. We feel that the values we are using are appropriate for the conditions out there and do not warrant an update to a C-value that will exaggerate the site's true conditions. To reiterate, this project is a drainage improvement project, which involves installing the swales that were previously designed and approved by the City of Aurora on the original design plans. It should be noted that the originally designed swales were never installed. Additionally, we are proposing to stabilize steep slopes in a ravine that are at risk of collapse in the immediate future. For this reason, we are requesting a variance on updated c-values due to emergency time constraints. Creating deeper swales to increase the flow capacity will also create additional grading limits and disturbing slopes that are already stabilized.

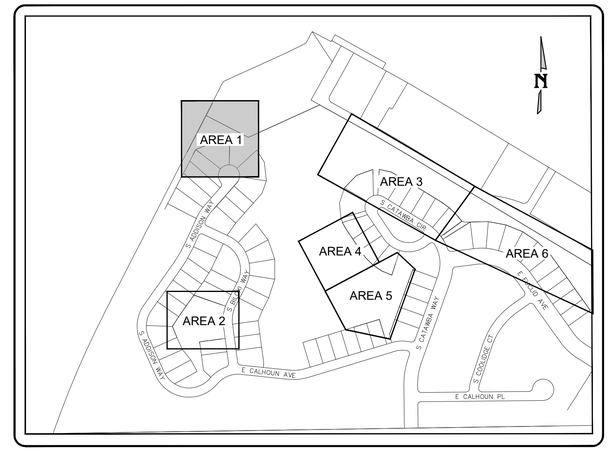
3.3 MAINTENANCE

The Metro District will be responsible for maintenance of the drainage paths and landscaped areas to ensure the drainage of the site remains consistent with this report. The primary areas of concern include the swales that run through the site as well as the longitudinal slope protection in Area 5. Inspection of the drainage paths should be performed following all storm events and any clogging or damage should be corrected in a timely manner.

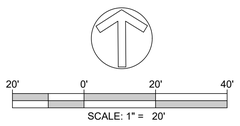
LIST OF APPENDICES

1. Proposed Drainage Maps
2. Hydrology / Rational Calculations
3. FlowMaster Swale Calculations
4. StormCAD Pipe Calculations
5. Riprap Sizing
6. Supporting Documentation From EDN 215037

APPENDIX 1 PROPOSED DRAINAGE MAPS



DRAINAGE PLAN LEGEND	
PROPERTY LINE	
LOT LINE	
EXISTING RIGHT OF WAY	
EXISTING EASEMENT	
EXISTING CURB & GUTTER	
EXISTING FENCE	
EXISTING MAJOR CONTOUR	452
EXISTING MINOR CONTOUR	
EXISTING STORM PIPE	ST
EXISTING STORM STRUCTURES	ST
PROPOSED STORM PIPE	ST
PROPOSED STORM STRUCTURES	ST
PROPOSED DRAINAGE AREA	
PROPOSED MAJOR CONTOUR	450
PROPOSED MINOR CONTOUR	452
FLOW DIRECTION	
DESIGN POINT	X
BASIN LEGEND	XX BASIN ID; XX MINOR C–VALUE; XX MAJOR C–VALUE; X.XX BASIN AREA



CENTERPOINT ENGINEERING
Civil Design | Land Planning
1626 COLE BLVD | SUITE 125 | LAKEWOOD, CO | 80401

NOT FOR CONSTRUCTION

811
Know what's below.
Call before you dig.
CALL 811 FORTY-EIGHT HOURS PRIOR TO DIGGING, GRADING OR EXCAVATING FOR THE MARKING OF UNDERGROUND MEMBER UTILITIES

OWNER	ENGINEER/APPLICANT
FOREST TRACE METRO DISTRICT #3 2154 E COMMONS AVE #2000 CENTENNIAL, CO 80122 CONTACT: DANIEL FRANK 303-520-3085	CENTERPOINT ENGINEERING 1626 COLE BLVD, SUITE 125 LAKEWOOD, CO 80401 CONTACT: MATT BUONO, PE (978) 790-9948

SCALE VERIFICATION
BAR IS ONE INCH ON ORIGINAL DRAWING
IF NOT ONE INCH ON THIS SHEET ADJUST SCALES ACCORDINGLY

REVISIONS

REV. NO	DATE	DESCRIPTION	BY
1	04/16/24	CITY COMMENTS	JO

FOREST TRACE METRO DISTRICT

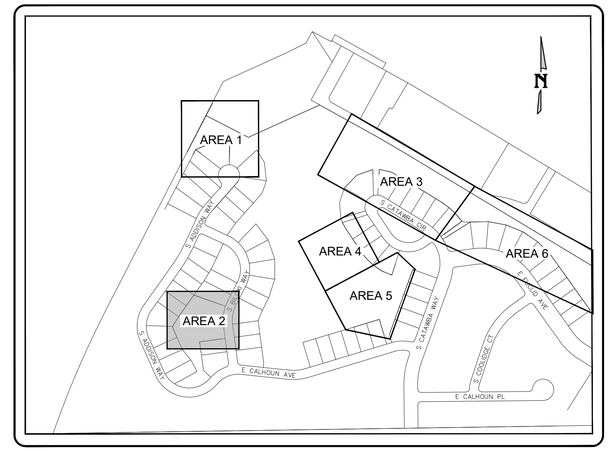
FOREST TRACE FILING NO. 2
EROSION CONTROL IMPROVEMENTS

PROJECT #	1938
DATE	01/24/24
SHEET TITLE	PROPOSED DRAINAGE MAP AREA 1
SITE PLAN #	
SHEET #	PDM1

FILE PATH: Y:\CenterPoint Engineering\1938 – Forest Trace (Aurora, CO)\7.0 – Reports\Drainage\DRAINAGE MAP\DRAINAGE MAP.dwg PLOT TIME: 4/11/2024 10:33:52 AM BY: Marisa Shigio

20' 0' 20' 40'

SCALE: 1" = 20'



DRAINAGE PLAN LEGEND

PROPERTY LINE	
LOT LINE	
EXISTING RIGHT OF WAY	
EXISTING EASEMENT	
EXISTING CURB & GUTTER	
EXISTING FENCE	
EXISTING MAJOR CONTOUR	452
EXISTING MINOR CONTOUR	
EXISTING STORM PIPE	ST
EXISTING STORM STRUCTURES	ST
PROPOSED STORM PIPE	ST
PROPOSED STORM STRUCTURES	ST
PROPOSED DRAINAGE AREA	
PROPOSED MAJOR CONTOUR	450
PROPOSED MINOR CONTOUR	452
FLOW DIRECTION	
DESIGN POINT	X
BASIN LEGEND	XX BASIN ID; XX MINOR C–VALUE; XX MAJOR C–VALUE; X.XX BASIN AREA

CENTERPOINT ENGINEERING
Civil Design | Land Planning
1626 COLE BLVD | SUITE 125 | LAKEWOOD, CO | 80401

NOT FOR CONSTRUCTION

811
Know what's below.
Call before you dig.
CALL 811 FORTY-EIGHT HOURS PRIOR TO DIGGING, GRADING OR EXCAVATING FOR THE MARKING OF UNDERGROUND MEMBER UTILITIES

OWNER
FOREST TRACE METRO DISTRICT #3
2154 E COMMONS AVE #2000
CENTENNIAL, CO 80122
CONTACT: DANIEL FRANK
303-520-3085

ENGINEER/APPLICANT
CENTERPOINT ENGINEERING
1625 COLE BLVD, SUITE 125
LAKEWOOD, CO 80401
CONTACT: MATT BUONO, PE
(978) 790-9948

SCALE VERIFICATION
BAR IS ONE INCH ON ORIGINAL DRAWING
IF NOT ONE INCH ON THIS SHEET ADJUST SCALES ACCORDINGLY

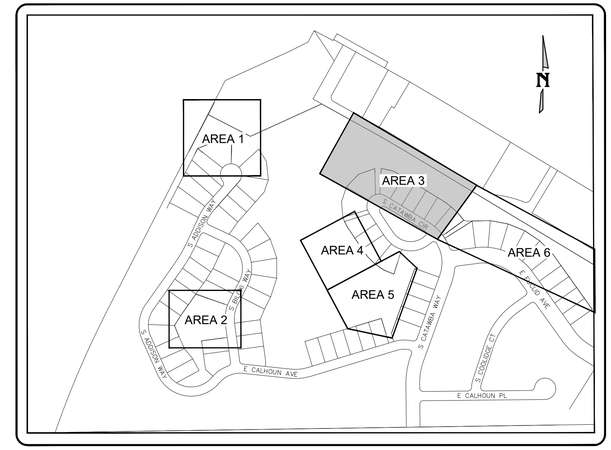
REVISIONS

REV. NO	DATE	DESCRIPTION	BY
1	04/16/24	CITY COMMENTS	JO

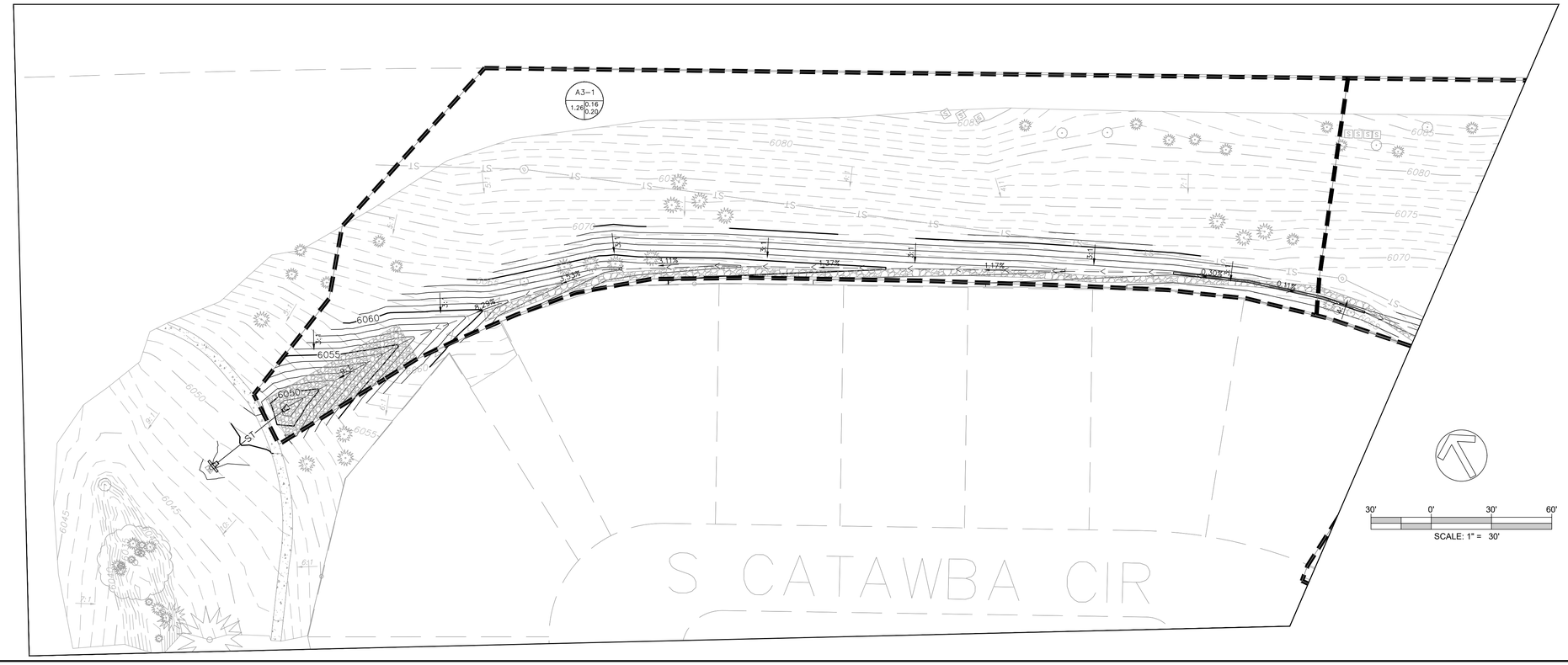
FOREST TRACE METRO DISTRICT

FOREST TRACE FILING NO. 2 EROSION CONTROL IMPROVEMENTS

PROJECT #	1938
DATE	01/24/24
SHEET TITLE	PROPOSED DRAINGE MAP AREA 2
SITE PLAN #	
SHEET #	PDM2



DRAINAGE PLAN LEGEND	
PROPERTY LINE	
LOT LINE	
EXISTING RIGHT OF WAY	
EXISTING EASEMENT	
EXISTING CURB & GUTTER	
EXISTING FENCE	
EXISTING MAJOR CONTOUR	452
EXISTING MINOR CONTOUR	
EXISTING STORM PIPE	ST
EXISTING STORM STRUCTURES	ST
PROPOSED STORM PIPE	ST
PROPOSED STORM STRUCTURES	ST
PROPOSED DRAINAGE AREA	
PROPOSED MAJOR CONTOUR	450
PROPOSED MINOR CONTOUR	452
FLOW DIRECTION	
DESIGN POINT	X
BASIN LEGEND	XX BASIN ID; X.XX BASIN AREA; XX MINOR C-VALUE; XX MAJOR C-VALUE



CENTERPOINT ENGINEERING
Civil Design | Land Planning
1626 COLE BLVD | SUITE 125 | LAKEWOOD, CO | 80401

NOT FOR CONSTRUCTION

811
Know what's below.
Call before you dig.
CALL 811 FORTY-EIGHT HOURS PRIOR TO DIGGING, GRADING OR EXCAVATING FOR THE MARKING OF UNDERGROUND MEMBER UTILITIES

OWNER
FOREST TRACE METRO DISTRICT #3
2154 E COMMONS AVE #2000
CENTENNIAL, CO 80122
CONTACT: DANIEL FRANK
303-520-3085

ENGINEER/APPLICANT
CENTERPOINT ENGINEERING
1625 COLE BLVD, SUITE 125
LAKEWOOD, CO 80401
CONTACT: MATT BUONO, PE
(978) 790-9948

SCALE VERIFICATION
BAR IS ONE INCH ON ORIGINAL DRAWING
IF NOT ONE INCH ON THIS SHEET ADJUST SCALES ACCORDINGLY

REVISIONS

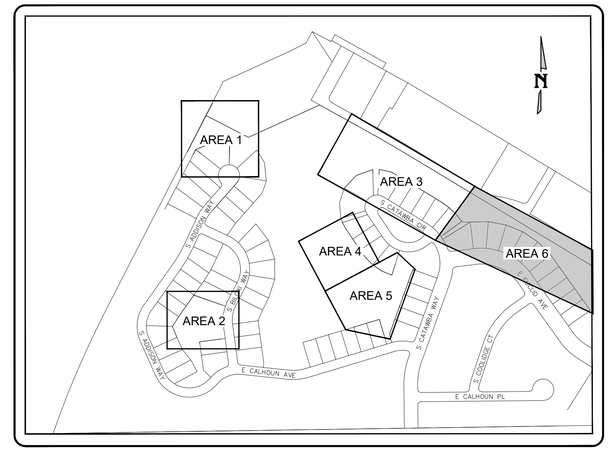
REV. NO	DATE	DESCRIPTION	BY
1	04/16/24	CITY COMMENTS	JO

FOREST TRACE METRO DISTRICT

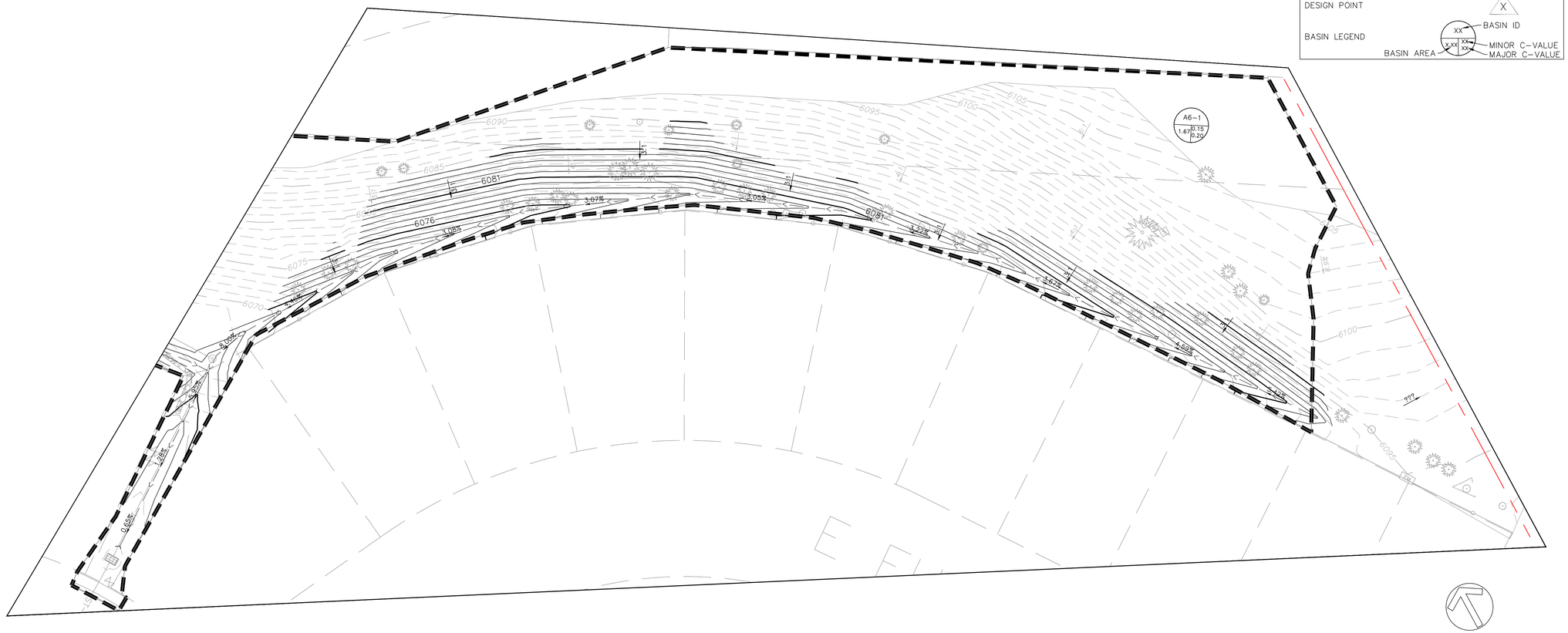
FOREST TRACE FILING NO. 2 EROSION CONTROL IMPROVEMENTS

PROJECT #	1938
DATE	01/24/24
SHEET TITLE	PROPOSED DRAINAGE MAP AREA 3
SITE PLAN #	
SHEET #	PDM3

FILE PATH: Y:\CenterPoint Engineering\1938 - Forest Trace (Aurora, CO)\7.0 - Reports\Drainage\DRAINAGE MAP\DRAINAGE MAP.dwg PLOT TIME: 4/11/2024 10:37:03 AM BY: Marisa Shigio



DRAINAGE PLAN LEGEND	
PROPERTY LINE	
LOT LINE	
EXISTING RIGHT OF WAY	
EXISTING EASEMENT	
EXISTING CURB & GUTTER	
EXISTING FENCE	
EXISTING MAJOR CONTOUR	452
EXISTING MINOR CONTOUR	
EXISTING STORM PIPE	ST
EXISTING STORM STRUCTURES	ST
PROPOSED STORM PIPE	ST
PROPOSED STORM STRUCTURES	ST
PROPOSED DRAINAGE AREA	
PROPOSED MAJOR CONTOUR	450
PROPOSED MINOR CONTOUR	452
FLOW DIRECTION	
DESIGN POINT	X
BASIN LEGEND	XX BASIN ID; X.XX BASIN AREA; XX MINOR C-VALUE; XX MAJOR C-VALUE



30' 0' 30' 60'

SCALE: 1" = 30'

CENTERPOINT ENGINEERING
Civil Design | Land Planning
1626 COLE BLVD | SUITE 125 | LAKEWOOD, CO | 80401

NOT FOR CONSTRUCTION

811 Know what's below. Call before you dig.

CALL 811 FORTY-EIGHT HOURS PRIOR TO DIGGING, GRADING OR EXCAVATING FOR THE MARKING OF UNDERGROUND MEMBER UTILITIES

OWNER	ENGINEER/APPLICANT
FOREST TRACE METRO DISTRICT #3 2154 E COMMONS AVE #2000 CENTENNIAL, CO 80122 CONTACT: DANIEL FRANK 303-520-3085	CENTERPOINT ENGINEERING 1625 COLE BLVD, SUITE 125 LAKEWOOD, CO 80401 CONTACT: MATT BUONO, PE (978) 790-9948

SCALE VERIFICATION

BAR IS ONE INCH ON ORIGINAL DRAWING

IF NOT ONE INCH ON THIS SHEET ADJUST SCALES ACCORDINGLY

REVISIONS

REV. NO	DATE	DESCRIPTION	BY
1	04/16/24	CITY COMMENTS	JO

FOREST TRACE METRO DISTRICT

FOREST TRACE FILING NO. 2
EROSION CONTROL IMPROVEMENTS

PROJECT #	1938
DATE	01/24/24
SHEET TITLE	PROPOSED DRAINAGE MAP AREA 6
SITE PLAN #	
SHEET #	PDM6

APPENDIX 2 HYDROLOGY / RATIONAL CALCULATIONS

PROJECT INFORMATION	
PROJECT NAME:	FOREST TRACE
PROJECT NO.:	1938
DESIGN BY:	J.OLIVETO
JURISDICTION:	AURORA, COLORADO
DATE:	4/11/2024

Project Location
User Input

IDF Rainfall Data

	P_1: 1-hour Rainfall Depths (inches)	
	Minor Storm	**Major Storm**
T_d	2-Year	100-Year
	0.85	**2.67**
5	2.88	9.06
10	2.30	7.22
20	1.67	5.25
30	1.33	4.19
40	1.12	3.52
50	0.97	3.05
60	0.86	2.70
120	0.53	1.66

= FORMULA CELLS

= USER INPUT CELLS

Equation 5-1: $$I = \frac{28.5P_1}{(10 + T_d)^{0.786}}$$

I = rainfall intensity (inches per hour)

P_1 = 1-hour point rainfall depth (inches)

T_d = storm duration (minutes)

Reference:

1) Mile High Flood District - Urban Storm Drainage Criteria Manual Volume 1, 2017
2) NOAA Atlas 14 Precipitation-Frequency Atlas of the United States, Volume 8 Version 2.0
https://www.weather.gov/media/owp/oh/hdsc/docs/Atlas14_Volume8.pdf

PROJECT INFORMATION	
PROJECT NAME:	FOREST TRACE
PROJECT NO.:	1938
DESIGN BY:	J.OLIVETO
JURISDICTION:	AURORA, COLORADO
DATE:	4/11/2024

CENTERPOINT ENGINEERING
Civil Design | Land Planning

JURISDICTIONAL STANDARD	% IMPERV	C2	C5	C10	C100
PAVEMENT	100%	0.87	0.88	0.90	0.93
CONCRETE DRIVES AND WALKS	96%	0.87	0.87	0.88	0.89
ROOF	90%	0.80	0.85	0.90	0.90
LANDSCAPE > 7% (A/B SOILS)	2%	0.15	0.16	0.18	0.20
LANDSCAPE 2%-7% (A/B SOILS)	2%	0.10	0.11	0.13	0.15
LANDSCAPE > 7% (C/D SOILS)	5%	0.25	0.27	0.30	0.35

Composite C Values

SOIL TYPE: B (use equation from Table 6-4)

PROPOSED COMPOSITE IMPERVIOUSNESS

SUB-BASIN	SURFACE CHARACTERISTICS	AREA (ACRES)	PERCENT IMPERVIOUSNESS	COMPOSITE RUNOFF COEFFICIENTS			
				C2	C5	C10	C100
A1-1	LANDSCAPE > 7% (A/B SOILS)	0.37	2%	0.15	0.16	0.18	0.20
SUB-BASIN COMPOSITE		0.37	2.0%	0.15	0.16	0.18	0.20

SUB-BASIN	SURFACE CHARACTERISTICS	AREA (ACRES)	PERCENT IMPERVIOUSNESS	COMPOSITE RUNOFF COEFFICIENTS			
				C2	C5	C10	C100
A2-1	LANDSCAPE > 7% (A/B SOILS)	0.31	2%	0.15	0.16	0.18	0.20
	CONCRETE DRIVES AND WALKS	0.02	96%	0.87	0.87	0.88	0.89
SUB-BASIN COMPOSITE		0.33	7.7%	0.19	0.20	0.22	0.24

SUB-BASIN	SURFACE CHARACTERISTICS	AREA (ACRES)	PERCENT IMPERVIOUSNESS	COMPOSITE RUNOFF COEFFICIENTS			
				C2	C5	C10	C100
A3-1	LANDSCAPE > 7% (A/B SOILS)	1.26	2%	0.15	0.16	0.18	0.20
SUB-BASIN COMPOSITE		1.26	2.0%	0.15	0.16	0.18	0.20

SUB-BASIN	SURFACE CHARACTERISTICS	AREA (ACRES)	PERCENT IMPERVIOUSNESS	COMPOSITE RUNOFF COEFFICIENTS			
				C2	C5	C10	C100
A6-1	LANDSCAPE > 7% (A/B SOILS)	1.67	2%	0.15	0.16	0.18	0.20
SUB-BASIN COMPOSITE		1.67	2.0%	0.15	0.16	0.18	0.20
TOTAL COMPOSITE		3.63	9.14%	0.56	0.6	0.67	0.74

PROJECT INFORMATION	
PROJECT NAME:	FOREST TRACE
PROJECT NO.:	1938
DESIGN BY:	J.OLIVETO
JURISDICTION:	AURORA, COLORADO
DATE:	4/11/2024

STANDARD FORM SF-2

TIME OF CONCENTRATION SUMMARY

CENTERPOINT ENGINEERING
Civil Design | Land Planning

SUB-BASIN DATA				INITIAL/OVERLAND TIME (t_i)			TRAVEL TIME (t_t)					t_c CHECK (URBANIZED BASINS)						REMARKS
BASIN	DESIGN POINT	C5	AREA	LENGTH	SLOPE	t_i	LENGTH	SLOPE	Cv	VEL.	t_t	COMP. t_c	TOT. LENGTH	SLOPE	IMP	tc	tc	
	(1)	(2)	ac (3)	ft (4)	ft/ft (5)	min (6)	ft (7)	ft/ft (8)	(9)	fps (10)	Min (11)	(12)	ft (13)	ft/ft (14)	% (15)	First DP (16)	min (17)	
A1-1	A1-1	0.16	0.37	80.00	0.300	4.94	250.00	0.025	20	3.16	1.32	6.3	330.0	0.09	2.0%	28.5	6.26	
A2-1	A2-1	0.20	0.33	200.00	0.150	9.37	100.00	0.150	20	7.75	0.22	9.6	300.0	0.15	7.7%	25.1	9.59	
A3-1	A3-1	0.16	1.26	100.00	0.250	5.87	500.00	0.015	20	2.45	3.40	9.3	600.0	0.05	2.0%	33.0	9.27	
A6-1	A6-1	0.16	1.67	150.00	0.250	7.19	750.00	0.045	20	4.24	2.95	10.1	900.0	0.08	2.0%	32.0	10.13	

Equation 6-3 $$t_i = \frac{0.395(1.1 - C_5)\sqrt{L_i}}{S_o^{0.33}}$$

Equation 6-4 $$t_t = \frac{L_t}{60V_t}$$

Equation 6-5 $$t_c = \left(\frac{L_t}{180}\right) + 10$$

Urban Drainage Table 6-2. NRCS Conveyance Factor K Table	
Heavy Meadow	2.5
Tillage/Field	5
Short Pasture and Lawns	7
Nearly Bare Ground	10
Grassed Waterway	15
Paved Areas and Shallow Paved Swales	20

= FORMULA CELLS
= USER INPUT CELLS

PROJECT INFORMATION	
PROJECT NAME:	FOREST TRACE
PROJECT NO.:	1938
DESIGN BY:	J.OLIVETO
JURISDICTION:	AURORA, COLORADO
DATE:	4/11/2024

STANDARD FORM SF-3

STORM DRAINAGE SYSTEM DESIGN
(RATIONAL METHOD PROCEDURE)

Design Storm: 2-Year
1-hour rainfall: 0.849

= FORMULA CELLS
= USER INPUT CELLS

CENTERPOINT ENGINEERING
Civil Design | Land Planning

BASIN	DESIGN POINT	DIRECT RUNOFF						TOTAL RUNOFF				REMARKS
		AREA (AC)	RUNOFF COEFF	t_c (MIN)	C * A (AC)	I (IN/HR)	Q (CFS)	t_c (MIN)	S (C * A) (AC)	I (IN/HR)	Q (CFS)	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(10)	(11)	(12)	(13)	(22)
A1-1	A1-1	0.37	0.15	6.26	0.06	2.70	0.15					
A2-1	A2-1	0.33	0.20	9.59	0.07	2.33	0.16					
A3-1	A3-1	1.26	0.15	9.27	0.19	2.37	0.45					
A6-1	A6-1	1.67	0.15	10.13	0.25	2.29	0.57					

PROJECT INFORMATION	
PROJECT NAME:	FOREST TRACE
PROJECT NO.:	1938
DESIGN BY:	J.OLIVETO
JURISDICTION:	AURORA, COLORADO
DATE:	4/11/2024

STANDARD FORM SF-3

STORM DRAINAGE SYSTEM DESIGN
(RATIONAL METHOD PROCEDURE)

Design Storm: 100-Year
1-hour rainfall: 2.67

= FORMULA CELLS
= USER INPUT CELLS

CENTERPOINT ENGINEERING
Civil Design | Land Planning

BASIN	DESIGN POINT	DIRECT RUNOFF						TOTAL RUNOFF				REMARKS
		AREA (AC)	RUNOFF COEFF	t_c (MIN)	C * A (AC)	I (IN/HR)	Q (CFS)	t_c (MIN)	S (C * A) (AC)	I (IN/HR)	Q (CFS)	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(10)	(11)	(12)	(13)	(22)
A1-1	A1-1	0.37	0.20	6.26	0.07	8.50	0.63					
A2-1	A2-1	0.33	0.24	9.59	0.08	7.34	0.59					
A3-1	A3-1	1.26	0.20	9.27	0.25	7.44	1.87					
A6-1	A6-1	1.67	0.20	10.13	0.33	7.19	2.40					

PROJECT INFORMATION	
PROJECT NAME:	*FOREST TRACE*
PROJECT NO.:	*1938*
DESIGN BY:	*J.OLIVETO*
JURISDICTION:	*AURORA, COLORADO*
DATE:	*4/11/2024*

CENTERPOINT ENGINEERING
Civil Design | Land Planning

RUNOFF SUMMARY

BASIN	DESIGN POINT	AREA (AC)	IMP (%)	C_2	C_{100}	Q_2 (CFS)	Q_{100} (CFS)
A1-1	A1-1	0.37	2.0%	0.15	0.20	0.15	0.63
A2-1	A2-1	0.33	7.7%	0.20	0.24	0.16	0.59
A3-1	A3-1	1.26	2.0%	0.15	0.20	0.45	1.87
A6-1	A6-1	1.67	2.0%	0.15	0.20	0.57	2.40
TOTAL COMPOSITE		3.63	9.1%	0.56	0.74	1.33	5.49

NOAA Atlas 14, Volume 8, Version 2
Location name: Aurora, Colorado, USA*
Latitude: 39.5968°, Longitude: -104.7124°
Elevation: 6008 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Deborah Martin, Sandra Pavlovic, Ishani Roy, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Michael Yekta, Geoffery Bonnin

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.229 (0.186-0.283)	0.286 (0.232-0.354)	0.385 (0.312-0.478)	0.473 (0.380-0.589)	0.601 (0.470-0.781)	0.706 (0.538-0.926)	0.817 (0.600-1.09)	0.935 (0.658-1.28)	1.10 (0.743-1.54)	1.23 (0.807-1.74)
10-min	0.335 (0.273-0.415)	0.419 (0.340-0.519)	0.564 (0.456-0.700)	0.692 (0.557-0.862)	0.880 (0.688-1.14)	1.03 (0.787-1.36)	1.20 (0.879-1.60)	1.37 (0.963-1.88)	1.61 (1.09-2.26)	1.80 (1.18-2.55)
15-min	0.409 (0.332-0.506)	0.511 (0.415-0.633)	0.688 (0.556-0.854)	0.844 (0.679-1.05)	1.07 (0.839-1.39)	1.26 (0.960-1.65)	1.46 (1.07-1.95)	1.67 (1.18-2.29)	1.96 (1.33-2.76)	2.20 (1.44-3.11)
30-min	0.549 (0.446-0.680)	0.686 (0.557-0.849)	0.922 (0.746-1.14)	1.13 (0.909-1.41)	1.44 (1.12-1.86)	1.69 (1.28-2.21)	1.95 (1.43-2.61)	2.23 (1.57-3.06)	2.62 (1.77-3.68)	2.93 (1.92-4.15)
60-min	0.688 (0.559-0.851)	0.849 (0.689-1.05)	1.13 (0.916-1.41)	1.39 (1.12-1.73)	1.76 (1.38-2.30)	2.08 (1.58-2.73)	2.41 (1.77-3.23)	2.77 (1.95-3.80)	3.27 (2.21-4.59)	3.67 (2.41-5.20)
2-hr	0.826 (0.675-1.02)	1.01 (0.826-1.24)	1.34 (1.09-1.66)	1.64 (1.33-2.03)	2.09 (1.65-2.71)	2.47 (1.90-3.22)	2.87 (2.13-3.82)	3.30 (2.34-4.50)	3.92 (2.67-5.46)	4.41 (2.92-6.19)
3-hr	0.918 (0.753-1.12)	1.12 (0.914-1.36)	1.47 (1.20-1.80)	1.79 (1.46-2.21)	2.28 (1.81-2.94)	2.69 (2.08-3.50)	3.14 (2.34-4.16)	3.62 (2.58-4.91)	4.30 (2.95-5.97)	4.86 (3.22-6.78)
6-hr	1.12 (0.920-1.35)	1.34 (1.11-1.63)	1.75 (1.44-2.13)	2.12 (1.73-2.59)	2.68 (2.14-3.43)	3.16 (2.45-4.07)	3.66 (2.74-4.82)	4.21 (3.02-5.66)	4.99 (3.44-6.87)	5.62 (3.76-7.78)
12-hr	1.37 (1.14-1.66)	1.65 (1.37-1.99)	2.14 (1.76-2.58)	2.57 (2.11-3.12)	3.21 (2.56-4.05)	3.73 (2.91-4.76)	4.29 (3.23-5.58)	4.88 (3.52-6.50)	5.72 (3.97-7.78)	6.38 (4.30-8.75)
24-hr	1.68 (1.40-2.01)	2.00 (1.67-2.40)	2.56 (2.12-3.07)	3.04 (2.51-3.66)	3.74 (3.00-4.66)	4.30 (3.37-5.42)	4.89 (3.70-6.29)	5.51 (4.00-7.25)	6.37 (4.45-8.58)	7.05 (4.79-9.58)
2-day	2.01 (1.68-2.38)	2.36 (1.98-2.80)	2.95 (2.46-3.51)	3.46 (2.88-4.13)	4.19 (3.38-5.18)	4.78 (3.77-5.97)	5.40 (4.11-6.87)	6.04 (4.42-7.87)	6.92 (4.87-9.23)	7.62 (5.22-10.3)
3-day	2.18 (1.84-2.58)	2.56 (2.15-3.03)	3.19 (2.68-3.78)	3.73 (3.12-4.44)	4.51 (3.65-5.53)	5.13 (4.05-6.36)	5.76 (4.41-7.30)	6.43 (4.72-8.33)	7.34 (5.18-9.73)	8.05 (5.54-10.8)
4-day	2.32 (1.96-2.73)	2.72 (2.29-3.20)	3.38 (2.84-4.00)	3.95 (3.30-4.69)	4.76 (3.86-5.82)	5.40 (4.28-6.68)	6.07 (4.65-7.65)	6.76 (4.97-8.71)	7.69 (5.45-10.2)	8.42 (5.81-11.2)
7-day	2.66 (2.26-3.12)	3.10 (2.63-3.63)	3.83 (3.24-4.50)	4.45 (3.74-5.25)	5.34 (4.35-6.48)	6.04 (4.81-7.40)	6.75 (5.20-8.45)	7.50 (5.55-9.60)	8.51 (6.06-11.1)	9.30 (6.46-12.3)
10-day	2.98 (2.53-3.47)	3.43 (2.92-4.01)	4.20 (3.56-4.92)	4.86 (4.10-5.70)	5.79 (4.73-6.99)	6.52 (5.21-7.96)	7.28 (5.63-9.07)	8.06 (5.99-10.3)	9.13 (6.53-11.9)	9.95 (6.94-13.1)
20-day	3.90 (3.34-4.51)	4.42 (3.78-5.12)	5.29 (4.51-6.14)	6.02 (5.11-7.01)	7.06 (5.81-8.44)	7.87 (6.34-9.52)	8.70 (6.78-10.7)	9.56 (7.16-12.1)	10.7 (7.74-13.8)	11.6 (8.17-15.2)
30-day	4.68 (4.02-5.39)	5.29 (4.54-6.10)	6.29 (5.39-7.27)	7.13 (6.07-8.27)	8.29 (6.84-9.84)	9.19 (7.41-11.0)	10.1 (7.88-12.4)	11.0 (8.27-13.8)	12.2 (8.86-15.7)	13.2 (9.30-17.1)
45-day	5.66 (4.88-6.49)	6.44 (5.55-7.39)	7.69 (6.61-8.85)	8.71 (7.44-10.1)	10.1 (8.32-11.9)	11.1 (8.99-13.2)	12.1 (9.50-14.7)	13.1 (9.89-16.3)	14.4 (10.5-18.3)	15.4 (10.9-19.9)
60-day	6.50 (5.62-7.43)	7.46 (6.45-8.54)	8.98 (7.73-10.3)	10.2 (8.73-11.7)	11.8 (9.73-13.8)	13.0 (10.5-15.4)	14.1 (11.0-17.0)	15.2 (11.4-18.7)	16.5 (12.0-20.9)	17.5 (12.4-22.5)

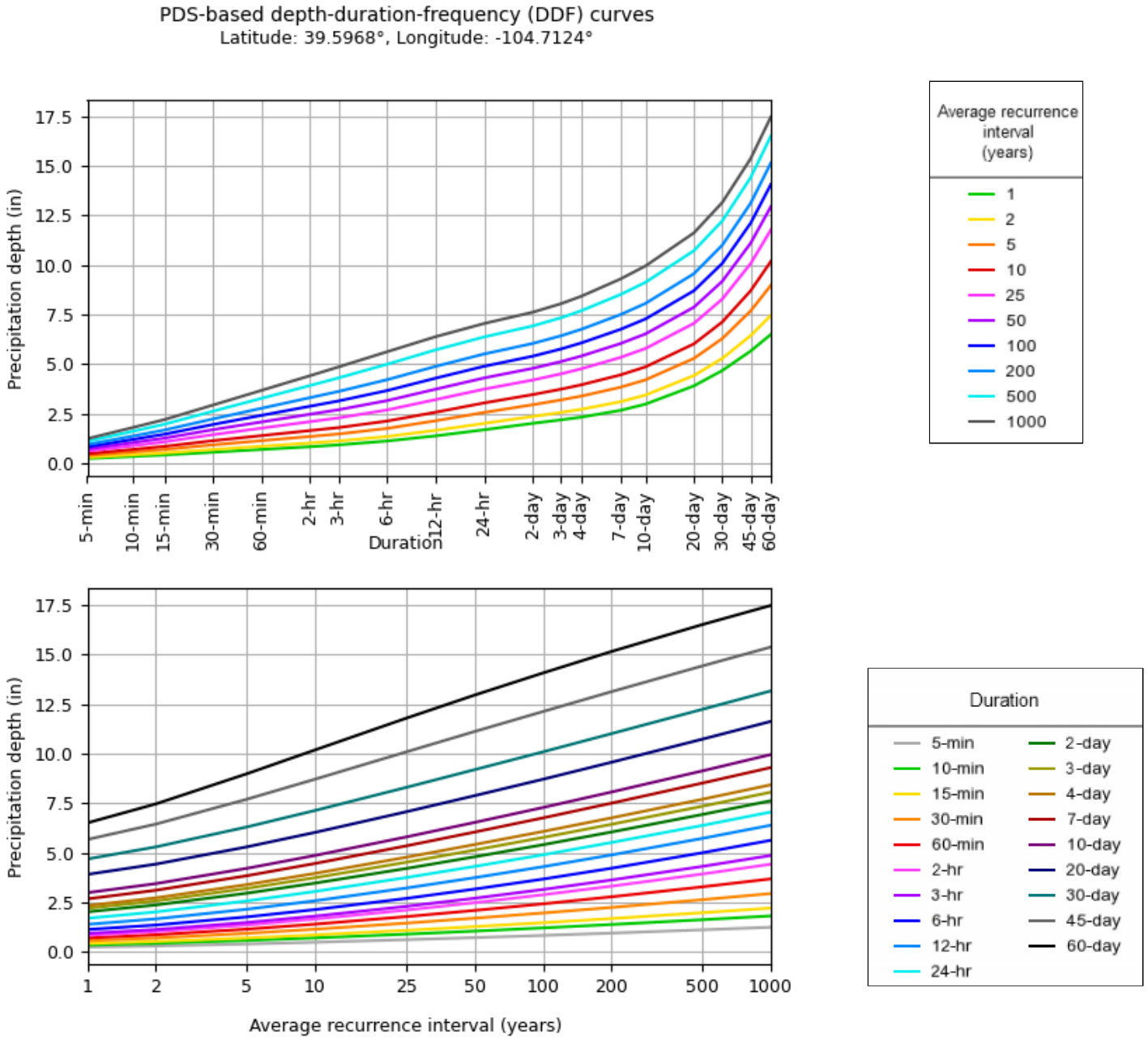
[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

Back to Top

PF graphical



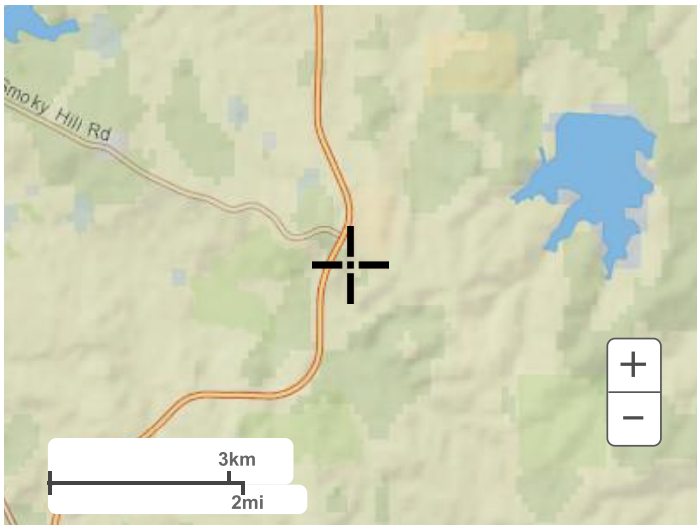
NOAA Atlas 14, Volume 8, Version 2

Created (GMT): Tue Apr 9 16:38:52 2024

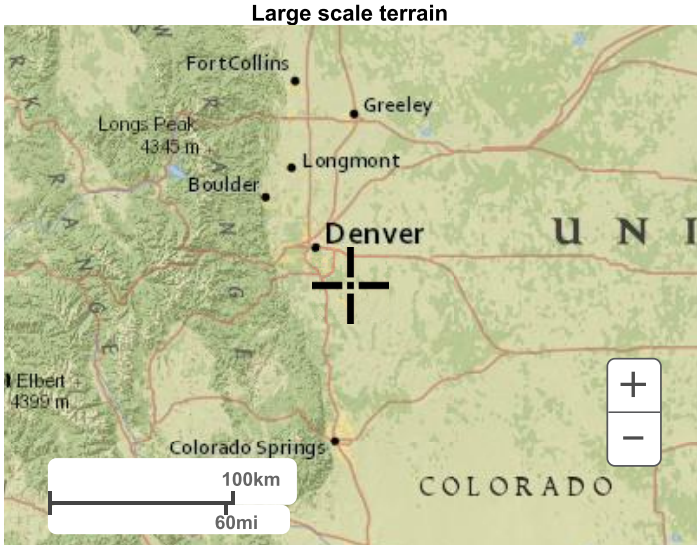
Back to Top

Maps & aerials

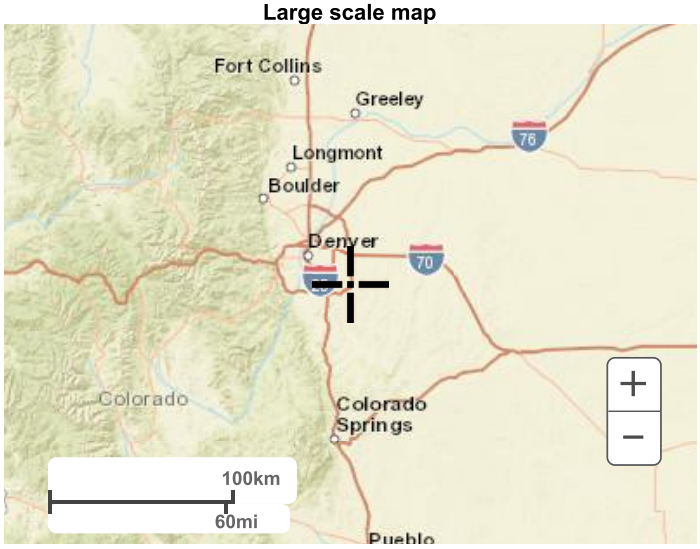
Small scale terrain



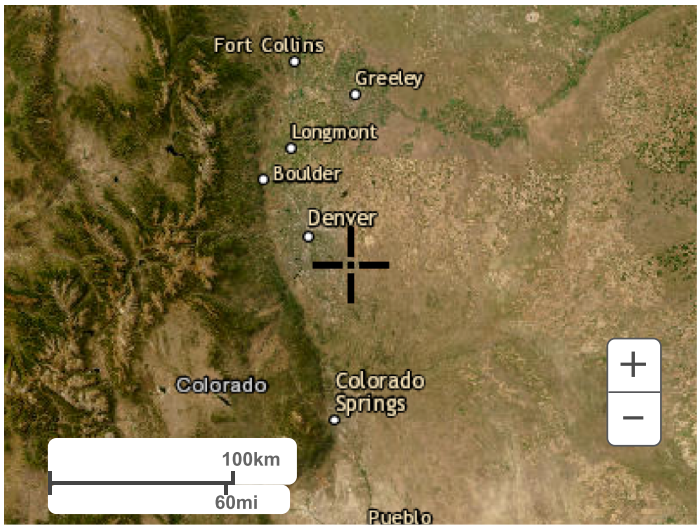
Large scale terrain



Large scale map



Large scale aerial



Back to Top

US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Disclaimer

Map Scale: 1:3,930 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 50 100 200 300

Feet
0 150 300 600 900

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

Soil Rating Polygons

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Arapahoe County, Colorado
Survey Area Data: Version 19, Aug 24, 2023

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Mar 1, 2023—Sep 1, 2023

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
BuD	Bresser-Stapleton sandy loams, 3 to 9 percent slopes	B	7.8	12.7%
SwE	Stapleton sandy loam, 9 to 30 percent slopes	B	53.1	87.3%
Totals for Area of Interest			**60.9**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

APPENDIX 3 FLOWMASTER SWALE CALCULATIONS

WSEL for Area 1 Section A-A - 2-yr

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.040
Channel Slope	0.025 ft/ft
Left Side Slope	3.000 H:V
Right Side Slope	3.300 H:V
Bottom Width	1.00 ft
Discharge	0.15 cfs

Results	
Normal Depth	1.2 in
Flow Area	0.1 ft²
Wetted Perimeter	1.7 ft
Hydraulic Radius	1.0 in
Top Width	1.65 ft
Critical Depth	1.0 in
Critical Slope	0.059 ft/ft
Velocity	1.10 ft/s
Velocity Head	0.02 ft
Specific Energy	0.12 ft
Froude Number	0.675
Flow Type	Subcritical

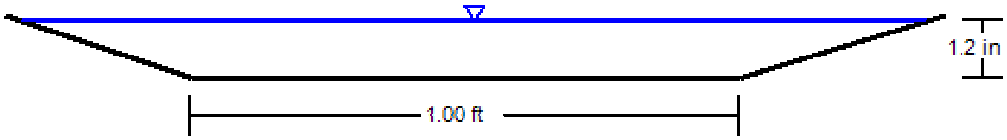
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

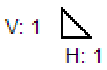
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	1.2 in
Critical Depth	1.0 in
Channel Slope	0.025 ft/ft
Critical Slope	0.059 ft/ft

Area 1 Section A-A - 2-yr

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.040
Channel Slope	0.025 ft/ft
Normal Depth	1.2 in
Left Side Slope	3.000 H:V
Right Side Slope	3.300 H:V
Bottom Width	1.00 ft
Discharge	0.15 cfs





WSEL for Area 1 Section A-A - 100-yr

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.040
Channel Slope	0.025 ft/ft
Left Side Slope	3.000 H:V
Right Side Slope	3.300 H:V
Bottom Width	1.00 ft
Discharge	0.63 cfs

Results	
Normal Depth	2.7 in
Flow Area	0.4 ft²
Wetted Perimeter	2.5 ft
Hydraulic Radius	1.8 in
Top Width	2.39 ft
Critical Depth	2.3 in
Critical Slope	0.047 ft/ft
Velocity	1.68 ft/s
Velocity Head	0.04 ft
Specific Energy	0.27 ft
Froude Number	0.746
Flow Type	Subcritical

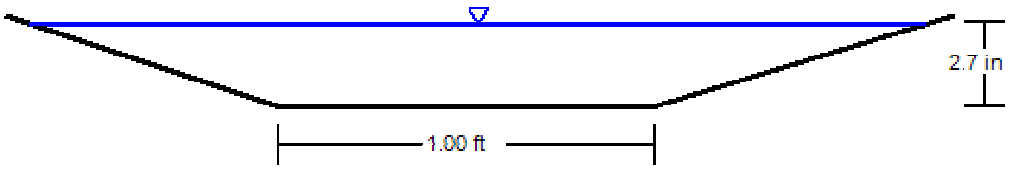
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

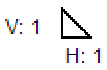
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	0.00 ft/s
Upstream Velocity	0.00 ft/s
Normal Depth	2.7 in
Critical Depth	2.3 in
Channel Slope	0.025 ft/ft
Critical Slope	0.047 ft/ft

Area 1 Section A-A - 100-yr

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.040
Channel Slope	0.025 ft/ft
Normal Depth	2.7 in
Left Side Slope	3.000 H:V
Right Side Slope	3.300 H:V
Bottom Width	1.00 ft
Discharge	0.63 cfs





WSEL for Area 1 Section B-B - 2-yr

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.040
Channel Slope	0.050 ft/ft
Left Side Slope	3.700 H:V
Right Side Slope	3.000 H:V
Bottom Width	1.00 ft
Discharge	0.15 cfs

Results	
Normal Depth	1.0 in
Flow Area	0.1 ft²
Wetted Perimeter	1.6 ft
Hydraulic Radius	0.8 in
Top Width	1.56 ft
Critical Depth	1.0 in
Critical Slope	0.059 ft/ft
Velocity	1.39 ft/s
Velocity Head	0.03 ft
Specific Energy	0.11 ft
Froude Number	0.933
Flow Type	Subcritical

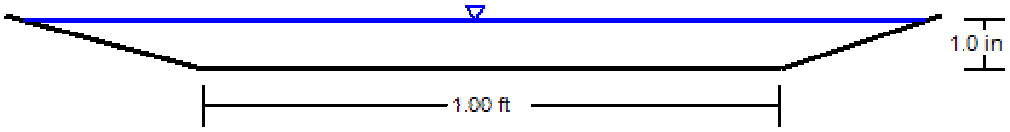
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

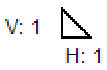
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	1.0 in
Critical Depth	1.0 in
Channel Slope	0.050 ft/ft
Critical Slope	0.059 ft/ft

Area 1 Section B-B - 2-yr

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.040
Channel Slope	0.050 ft/ft
Normal Depth	1.0 in
Left Side Slope	3.700 H:V
Right Side Slope	3.000 H:V
Bottom Width	1.00 ft
Discharge	0.15 cfs





WSEL for Area 1 Section B-B - 100-yr

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.040
Channel Slope	0.050 ft/ft
Left Side Slope	3.700 H:V
Right Side Slope	3.000 H:V
Bottom Width	1.00 ft
Discharge	0.63 cfs

Results	
Normal Depth	2.2 in
Flow Area	0.3 ft²
Wetted Perimeter	2.3 ft
Hydraulic Radius	1.6 in
Top Width	2.23 ft
Critical Depth	2.2 in
Critical Slope	0.047 ft/ft
Velocity	2.13 ft/s
Velocity Head	0.07 ft
Specific Energy	0.25 ft
Froude Number	1.030
Flow Type	Supercritical

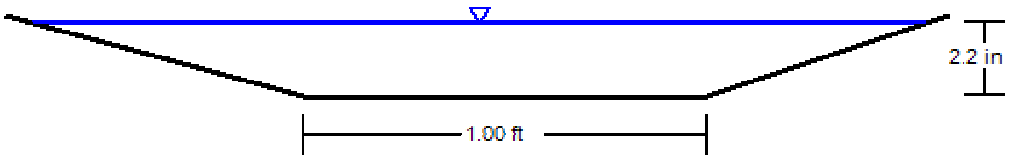
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

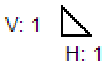
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	2.2 in
Critical Depth	2.2 in
Channel Slope	0.050 ft/ft
Critical Slope	0.047 ft/ft

Area 1 Section B-B - 100-yr

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.040
Channel Slope	0.050 ft/ft
Normal Depth	2.2 in
Left Side Slope	3.700 H:V
Right Side Slope	3.000 H:V
Bottom Width	1.00 ft
Discharge	0.63 cfs





WSEL for Area 1 Section C-C - 2-yr

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.040
Channel Slope	0.008 ft/ft
Left Side Slope	6.500 H:V
Right Side Slope	3.100 H:V
Bottom Width	1.00 ft
Discharge	0.15 cfs

Results	
Normal Depth	1.6 in
Flow Area	0.2 ft²
Wetted Perimeter	2.3 ft
Hydraulic Radius	1.1 in
Top Width	2.30 ft
Critical Depth	0.9 in
Critical Slope	0.060 ft/ft
Velocity	0.67 ft/s
Velocity Head	0.01 ft
Specific Energy	0.14 ft
Froude Number	0.382
Flow Type	Subcritical

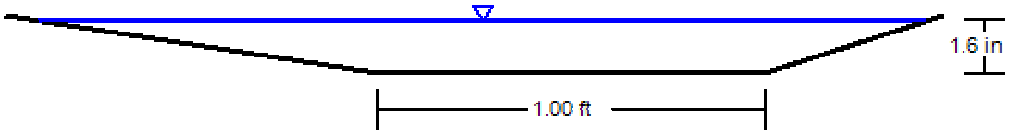
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

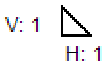
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	1.6 in
Critical Depth	0.9 in
Channel Slope	0.008 ft/ft
Critical Slope	0.060 ft/ft

Area 1 Section C-C - 2-yr

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.040
Channel Slope	0.008 ft/ft
Normal Depth	1.6 in
Left Side Slope	6.500 H:V
Right Side Slope	3.100 H:V
Bottom Width	1.00 ft
Discharge	0.15 cfs





WSEL for Area 1 Section C-C - 100-yr

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.040
Channel Slope	0.008 ft/ft
Left Side Slope	6.500 H:V
Right Side Slope	3.100 H:V
Bottom Width	1.00 ft
Discharge	0.63 cfs

Results	
Normal Depth	3.3 in
Flow Area	0.6 ft²
Wetted Perimeter	3.7 ft
Hydraulic Radius	2.1 in
Top Width	3.63 ft
Critical Depth	2.1 in
Critical Slope	0.048 ft/ft
Velocity	0.99 ft/s
Velocity Head	0.02 ft
Specific Energy	0.29 ft
Froude Number	0.419
Flow Type	Subcritical

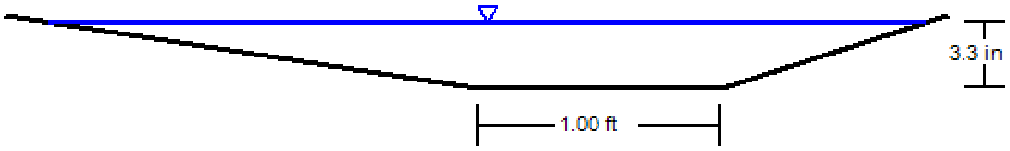
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

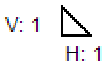
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	3.3 in
Critical Depth	2.1 in
Channel Slope	0.008 ft/ft
Critical Slope	0.048 ft/ft

Area 1 Section C-C - 100-yr

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.040
Channel Slope	0.008 ft/ft
Normal Depth	3.3 in
Left Side Slope	6.500 H:V
Right Side Slope	3.100 H:V
Bottom Width	1.00 ft
Discharge	0.63 cfs





WSEL for Area 2 Section A-A - 2-yr

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.069
Channel Slope	1.100 ft/ft
Left Side Slope	3.900 H:V
Right Side Slope	5.500 H:V
Discharge	0.16 cfs

Results	
Normal Depth	1.3 in
Flow Area	0.1 ft²
Wetted Perimeter	1.0 ft
Hydraulic Radius	0.6 in
Top Width	0.98 ft
Critical Depth	1.8 in
Critical Slope	0.170 ft/ft
Velocity	3.11 ft/s
Velocity Head	0.15 ft
Specific Energy	0.25 ft
Froude Number	2.397
Flow Type	Supercritical

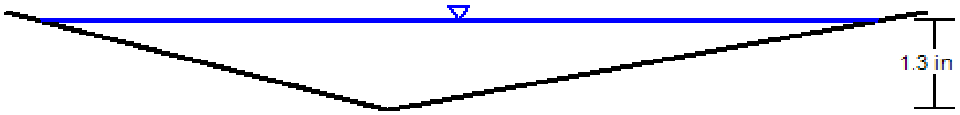
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

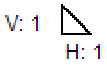
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	1.3 in
Critical Depth	1.8 in
Channel Slope	1.100 ft/ft
Critical Slope	0.170 ft/ft

Area 2 Section A-A - 2-yr

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.069
Channel Slope	1.100 ft/ft
Normal Depth	1.3 in
Left Side Slope	3.900 H:V
Right Side Slope	5.500 H:V
Discharge	0.16 cfs





WSEL for Area 2 Section A-A - 100-yr

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.069
Channel Slope	1.100 ft/ft
Left Side Slope	3.900 H:V
Right Side Slope	5.500 H:V
Discharge	0.59 cfs

Results	
Normal Depth	2.0 in
Flow Area	0.1 ft²
Wetted Perimeter	1.6 ft
Hydraulic Radius	1.0 in
Top Width	1.60 ft
Critical Depth	3.0 in
Critical Slope	0.143 ft/ft
Velocity	4.31 ft/s
Velocity Head	0.29 ft
Specific Energy	0.46 ft
Froude Number	2.600
Flow Type	Supercritical

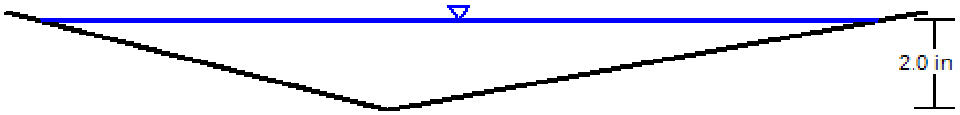
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

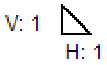
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	2.0 in
Critical Depth	3.0 in
Channel Slope	1.100 ft/ft
Critical Slope	0.143 ft/ft

Area 2 Section A-A - 100-yr

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.069
Channel Slope	1.100 ft/ft
Normal Depth	2.0 in
Left Side Slope	3.900 H:V
Right Side Slope	5.500 H:V
Discharge	0.59 cfs





WSEL for Area 2 Section B-B - 2-yr

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.069
Channel Slope	0.110 ft/ft
Left Side Slope	7.200 H:V
Right Side Slope	6.200 H:V
Discharge	0.16 cfs

Results	
Normal Depth	1.7 in
Flow Area	0.1 ft²
Wetted Perimeter	1.9 ft
Hydraulic Radius	0.8 in
Top Width	1.88 ft
Critical Depth	1.5 in
Critical Slope	0.176 ft/ft
Velocity	1.21 ft/s
Velocity Head	0.02 ft
Specific Energy	0.16 ft
Froude Number	0.805
Flow Type	Subcritical

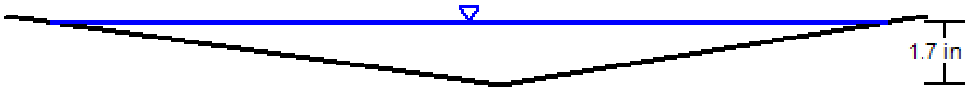
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

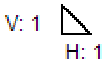
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	1.7 in
Critical Depth	1.5 in
Channel Slope	0.110 ft/ft
Critical Slope	0.176 ft/ft

Area 2 Section B-B - 2-yr

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.069
Channel Slope	0.110 ft/ft
Normal Depth	1.7 in
Left Side Slope	7.200 H:V
Right Side Slope	6.200 H:V
Discharge	0.16 cfs





WSEL for Area 2 Section B-B - 100-yr

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.069
Channel Slope	0.110 ft/ft
Left Side Slope	7.200 H:V
Right Side Slope	6.200 H:V
Discharge	0.59 cfs

Results	
Normal Depth	2.8 in
Flow Area	0.4 ft²
Wetted Perimeter	3.1 ft
Hydraulic Radius	1.4 in
Top Width	3.07 ft
Critical Depth	2.6 in
Critical Slope	0.148 ft/ft
Velocity	1.68 ft/s
Velocity Head	0.04 ft
Specific Energy	0.27 ft
Froude Number	0.873
Flow Type	Subcritical

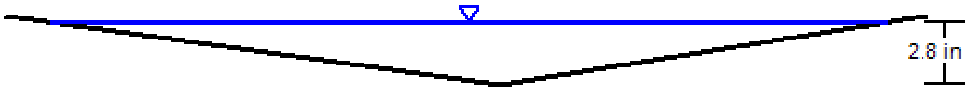
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

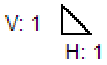
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	2.8 in
Critical Depth	2.6 in
Channel Slope	0.110 ft/ft
Critical Slope	0.148 ft/ft

Area 2 Section B-B - 100-yr

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data		
Roughness Coefficient	0.069	
Channel Slope	0.110	ft/ft
Normal Depth	2.8	in
Left Side Slope	7.200	H:V
Right Side Slope	6.200	H:V
Discharge	0.59	cfs





WSEL for Area 3 Section A-A - 2-yr

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.070
Channel Slope	0.110 ft/ft
Left Side Slope	4.200 H:V
Right Side Slope	3.400 H:V
Bottom Width	1.00 ft
Discharge	0.45 cfs

Results	
Normal Depth	2.0 in
Flow Area	0.3 ft²
Wetted Perimeter	2.3 ft
Hydraulic Radius	1.4 in
Top Width	2.25 ft
Critical Depth	1.8 in
Critical Slope	0.152 ft/ft
Velocity	1.68 ft/s
Velocity Head	0.04 ft
Specific Energy	0.21 ft
Froude Number	0.859
Flow Type	Subcritical

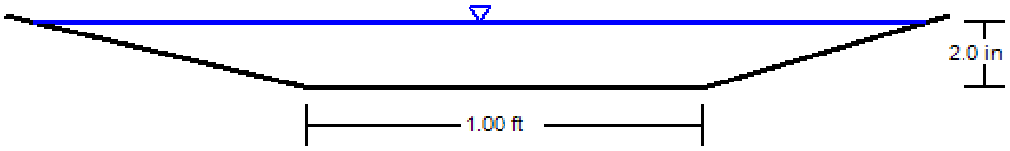
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

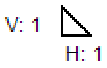
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	2.0 in
Critical Depth	1.8 in
Channel Slope	0.110 ft/ft
Critical Slope	0.152 ft/ft

Area 3 Section A-A - 2-yr

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.070
Channel Slope	0.110 ft/ft
Normal Depth	2.0 in
Left Side Slope	4.200 H:V
Right Side Slope	3.400 H:V
Bottom Width	1.00 ft
Discharge	0.45 cfs





WSEL for Area 3 Section A-A - 100-yr

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.070
Channel Slope	0.110 ft/ft
Left Side Slope	4.200 H:V
Right Side Slope	3.400 H:V
Bottom Width	1.00 ft
Discharge	1.87 cfs

Results

Normal Depth	4.0 in
Flow Area	0.8 ft²
Wetted Perimeter	3.6 ft
Hydraulic Radius	2.5 in
Top Width	3.53 ft
Critical Depth	3.9 in
Critical Slope	0.124 ft/ft
Velocity	2.48 ft/s
Velocity Head	0.10 ft
Specific Energy	0.43 ft
Froude Number	0.944
Flow Type	Subcritical

GVF Input Data

Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

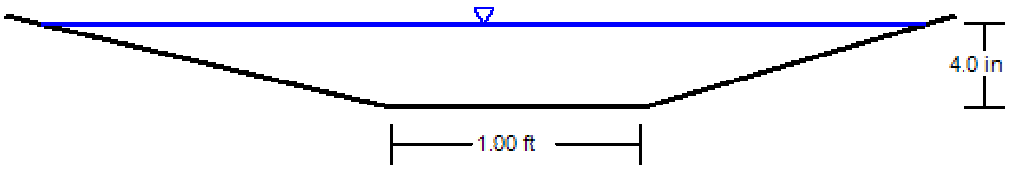
GVF Output Data

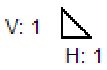
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	4.0 in
Critical Depth	3.9 in
Channel Slope	0.110 ft/ft
Critical Slope	0.124 ft/ft

Area 3 Section A-A - 100-yr

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.070
Channel Slope	0.110 ft/ft
Normal Depth	4.0 in
Left Side Slope	4.200 H:V
Right Side Slope	3.400 H:V
Bottom Width	1.00 ft
Discharge	1.87 cfs





WSEL for Area 3 Section B-B - 2-yr

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.040
Channel Slope	0.110 ft/ft
Left Side Slope	3.900 H:V
Right Side Slope	3.300 H:V
Bottom Width	1.00 ft
Discharge	0.45 cfs

Results	
Normal Depth	1.5 in
Flow Area	0.2 ft²
Wetted Perimeter	1.9 ft
Hydraulic Radius	1.1 in
Top Width	1.89 ft
Critical Depth	1.8 in
Critical Slope	0.050 ft/ft
Velocity	2.52 ft/s
Velocity Head	0.10 ft
Specific Energy	0.22 ft
Froude Number	1.448
Flow Type	Supercritical

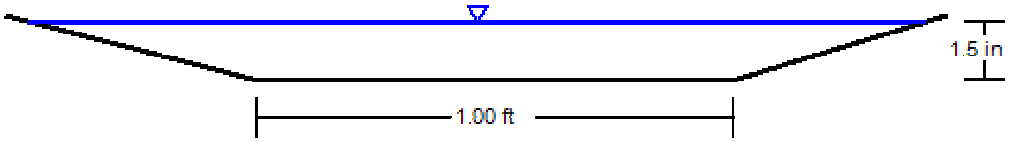
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

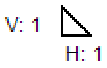
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	1.5 in
Critical Depth	1.8 in
Channel Slope	0.110 ft/ft
Critical Slope	0.050 ft/ft

Area 3 Section B-B - 2-yr

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.040
Channel Slope	0.110 ft/ft
Normal Depth	1.5 in
Left Side Slope	3.900 H:V
Right Side Slope	3.300 H:V
Bottom Width	1.00 ft
Discharge	0.45 cfs





WSEL for Area 3 Section B-B - 100-yr

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.040
Channel Slope	0.110 ft/ft
Left Side Slope	3.900 H:V
Right Side Slope	3.300 H:V
Bottom Width	1.00 ft
Discharge	1.87 cfs

Results	
Normal Depth	3.1 in
Flow Area	0.5 ft²
Wetted Perimeter	2.9 ft
Hydraulic Radius	2.0 in
Top Width	2.85 ft
Critical Depth	3.9 in
Critical Slope	0.040 ft/ft
Velocity	3.77 ft/s
Velocity Head	0.22 ft
Specific Energy	0.48 ft
Froude Number	1.596
Flow Type	Supercritical

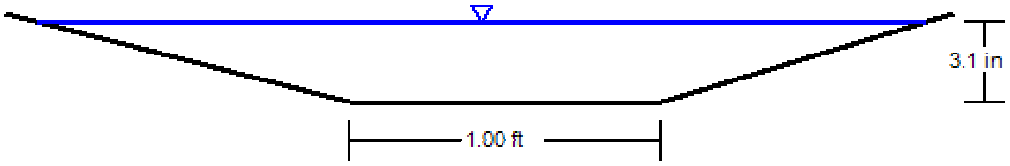
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

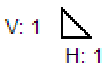
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	3.1 in
Critical Depth	3.9 in
Channel Slope	0.110 ft/ft
Critical Slope	0.040 ft/ft

Area 3 Section B-B - 100-yr

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.040
Channel Slope	0.110 ft/ft
Normal Depth	3.1 in
Left Side Slope	3.900 H:V
Right Side Slope	3.300 H:V
Bottom Width	1.00 ft
Discharge	1.87 cfs





WSEL for Area 3 Section C-C - 2-yr

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.040
Channel Slope	0.014 ft/ft
Left Side Slope	4.000 H:V
Right Side Slope	3.000 H:V
Bottom Width	1.00 ft
Discharge	0.45 cfs

Results	
Normal Depth	2.5 in
Flow Area	0.4 ft²
Wetted Perimeter	2.5 ft
Hydraulic Radius	1.7 in
Top Width	2.49 ft
Critical Depth	1.8 in
Critical Slope	0.049 ft/ft
Velocity	1.22 ft/s
Velocity Head	0.02 ft
Specific Energy	0.24 ft
Froude Number	0.555
Flow Type	Subcritical

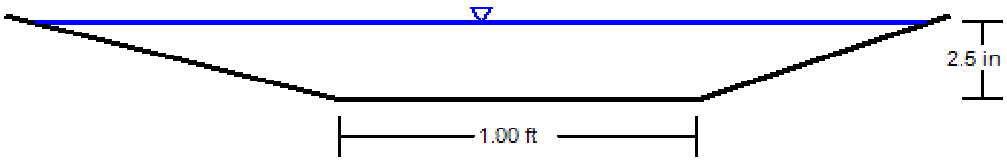
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

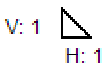
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	2.5 in
Critical Depth	1.8 in
Channel Slope	0.014 ft/ft
Critical Slope	0.049 ft/ft

Area 3 Section C-C - 2-yr

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.040
Channel Slope	0.014 ft/ft
Normal Depth	2.5 in
Left Side Slope	4.000 H:V
Right Side Slope	3.000 H:V
Bottom Width	1.00 ft
Discharge	0.45 cfs





WSEL for Area 3 Section C-C - 100-yr

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.040
Channel Slope	0.014 ft/ft
Left Side Slope	4.000 H:V
Right Side Slope	3.000 H:V
Bottom Width	1.00 ft
Discharge	1.87 cfs

Results	
Normal Depth	5.1 in
Flow Area	1.1 ft²
Wetted Perimeter	4.1 ft
Hydraulic Radius	3.1 in
Top Width	3.97 ft
Critical Depth	4.0 in
Critical Slope	0.040 ft/ft
Velocity	1.78 ft/s
Velocity Head	0.05 ft
Specific Energy	0.47 ft
Froude Number	0.609
Flow Type	Subcritical

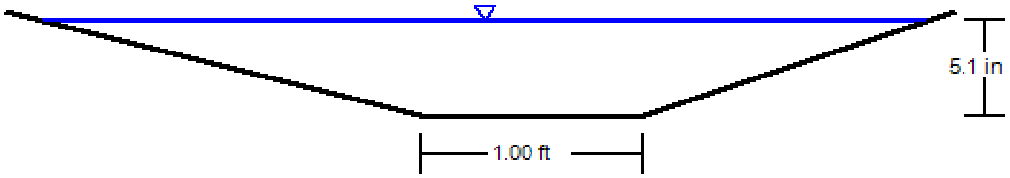
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

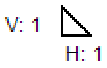
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	5.1 in
Critical Depth	4.0 in
Channel Slope	0.014 ft/ft
Critical Slope	0.040 ft/ft

Area 3 Section C-C - 100-yr

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.040
Channel Slope	0.014 ft/ft
Normal Depth	5.1 in
Left Side Slope	4.000 H:V
Right Side Slope	3.000 H:V
Bottom Width	1.00 ft
Discharge	1.87 cfs





WSEL for Area 3 Section D-D - 2-yr

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.013
Channel Slope	0.001 ft/ft
Left Side Slope	4.100 H:V
Right Side Slope	3.100 H:V
Bottom Width	1.00 ft
Discharge	0.45 cfs

Results	
Normal Depth	2.8 in
Flow Area	0.4 ft²
Wetted Perimeter	2.7 ft
Hydraulic Radius	1.9 in
Top Width	2.68 ft
Critical Depth	1.8 in
Critical Slope	0.005 ft/ft
Velocity	1.05 ft/s
Velocity Head	0.02 ft
Specific Energy	0.25 ft
Froude Number	0.462
Flow Type	Subcritical

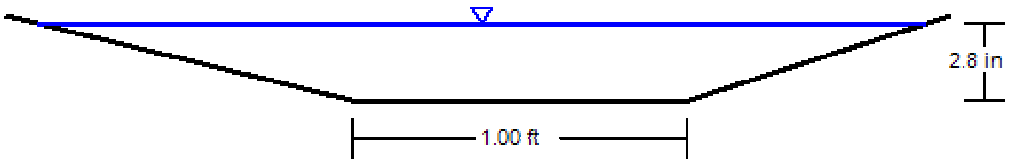
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

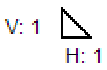
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	2.8 in
Critical Depth	1.8 in
Channel Slope	0.001 ft/ft
Critical Slope	0.005 ft/ft

Area 3 Section D-D - 2-yr

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.013
Channel Slope	0.001 ft/ft
Normal Depth	2.8 in
Left Side Slope	4.100 H:V
Right Side Slope	3.100 H:V
Bottom Width	1.00 ft
Discharge	0.45 cfs





WSEL for Area 3 Section D-D - 100-yr

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.013
Channel Slope	0.001 ft/ft
Left Side Slope	4.100 H:V
Right Side Slope	3.100 H:V
Bottom Width	1.00 ft
Discharge	1.87 cfs

Results	
Normal Depth	5.5 in
Flow Area	1.2 ft²
Wetted Perimeter	4.4 ft
Hydraulic Radius	3.3 in
Top Width	4.31 ft
Critical Depth	3.9 in
Critical Slope	0.004 ft/ft
Velocity	1.53 ft/s
Velocity Head	0.04 ft
Specific Energy	0.50 ft
Froude Number	0.507
Flow Type	Subcritical

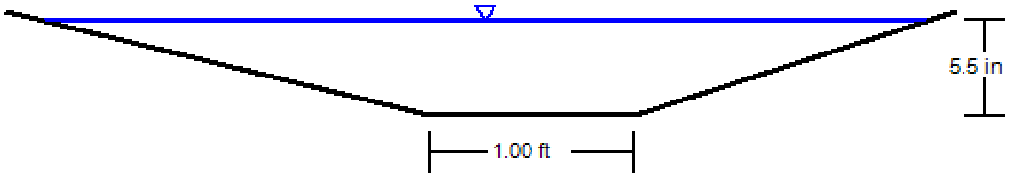
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

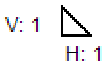
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	5.5 in
Critical Depth	3.9 in
Channel Slope	0.001 ft/ft
Critical Slope	0.004 ft/ft

Area 3 Section D-D - 100-yr

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.013
Channel Slope	0.001 ft/ft
Normal Depth	5.5 in
Left Side Slope	4.100 H:V
Right Side Slope	3.100 H:V
Bottom Width	1.00 ft
Discharge	1.87 cfs





WSEL for Area 6 Section A-A - 2-yr

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.040
Channel Slope	0.007 ft/ft
Left Side Slope	9.100 H:V
Right Side Slope	5.700 H:V
Bottom Width	1.00 ft
Discharge	0.57 cfs

Results	
Normal Depth	2.9 in
Flow Area	0.7 ft²
Wetted Perimeter	4.6 ft
Hydraulic Radius	1.7 in
Top Width	4.55 ft
Critical Depth	1.8 in
Critical Slope	0.051 ft/ft
Velocity	0.86 ft/s
Velocity Head	0.01 ft
Specific Energy	0.25 ft
Froude Number	0.396
Flow Type	Subcritical

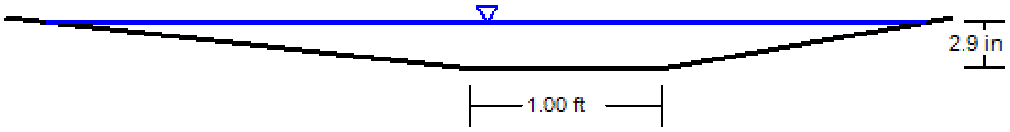
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

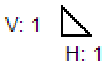
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	2.9 in
Critical Depth	1.8 in
Channel Slope	0.007 ft/ft
Critical Slope	0.051 ft/ft

Area 6 Section A-A - 2-yr

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.040
Channel Slope	0.007 ft/ft
Normal Depth	2.9 in
Left Side Slope	9.100 H:V
Right Side Slope	5.700 H:V
Bottom Width	1.00 ft
Discharge	0.57 cfs





WSEL for Area 6 Section A-A - 100-yr

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.040
Channel Slope	0.007 ft/ft
Left Side Slope	9.100 H:V
Right Side Slope	5.700 H:V
Bottom Width	1.00 ft
Discharge	2.40 cfs

Results	
Normal Depth	5.4 in
Flow Area	1.9 ft²
Wetted Perimeter	7.7 ft
Hydraulic Radius	3.0 in
Top Width	7.64 ft
Critical Depth	3.7 in
Critical Slope	0.042 ft/ft
Velocity	1.24 ft/s
Velocity Head	0.02 ft
Specific Energy	0.47 ft
Froude Number	0.434
Flow Type	Subcritical

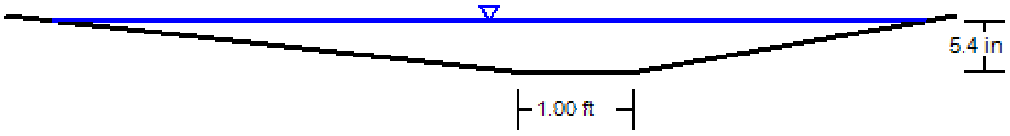
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

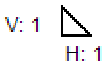
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	5.4 in
Critical Depth	3.7 in
Channel Slope	0.007 ft/ft
Critical Slope	0.042 ft/ft

Area 6 Section A-A - 100-yr

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.040
Channel Slope	0.007 ft/ft
Normal Depth	5.4 in
Left Side Slope	9.100 H:V
Right Side Slope	5.700 H:V
Bottom Width	1.00 ft
Discharge	2.40 cfs





WSEL for Area 6 Section B-B - 2-yr

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.040
Channel Slope	0.080 ft/ft
Left Side Slope	3.100 H:V
Right Side Slope	4.700 H:V
Bottom Width	1.00 ft
Discharge	0.57 cfs

Results	
Normal Depth	1.8 in
Flow Area	0.2 ft²
Wetted Perimeter	2.2 ft
Hydraulic Radius	1.3 in
Top Width	2.17 ft
Critical Depth	2.1 in
Critical Slope	0.048 ft/ft
Velocity	2.39 ft/s
Velocity Head	0.09 ft
Specific Energy	0.24 ft
Froude Number	1.268
Flow Type	Supercritical

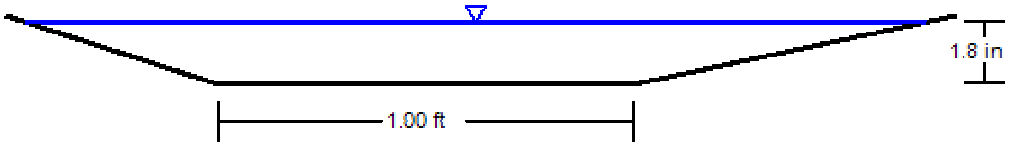
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

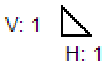
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	1.8 in
Critical Depth	2.1 in
Channel Slope	0.080 ft/ft
Critical Slope	0.048 ft/ft

Area 6 Section B-B - 2-yr

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.040
Channel Slope	0.080 ft/ft
Normal Depth	1.8 in
Left Side Slope	3.100 H:V
Right Side Slope	4.700 H:V
Bottom Width	1.00 ft
Discharge	0.57 cfs





WSEL for Area 6 Section B-B - 100-yr

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.040
Channel Slope	0.080 ft/ft
Left Side Slope	3.100 H:V
Right Side Slope	4.700 H:V
Bottom Width	1.00 ft
Discharge	2.40 cfs

Results	
Normal Depth	3.7 in
Flow Area	0.7 ft²
Wetted Perimeter	3.5 ft
Hydraulic Radius	2.3 in
Top Width	3.41 ft
Critical Depth	4.4 in
Critical Slope	0.039 ft/ft
Velocity	3.53 ft/s
Velocity Head	0.19 ft
Specific Energy	0.50 ft
Froude Number	1.394
Flow Type	Supercritical

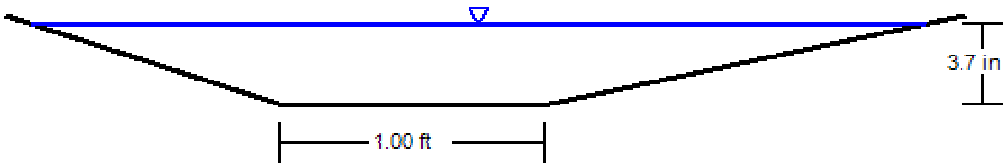
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

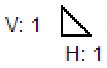
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	3.7 in
Critical Depth	4.4 in
Channel Slope	0.080 ft/ft
Critical Slope	0.039 ft/ft

Area 6 Section B-B - 100-yr

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.040
Channel Slope	0.080 ft/ft
Normal Depth	3.7 in
Left Side Slope	3.100 H:V
Right Side Slope	4.700 H:V
Bottom Width	1.00 ft
Discharge	2.40 cfs





WSEL for Area 6 Section C-C - 2-yr

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.040
Channel Slope	0.045 ft/ft
Left Side Slope	4.200 H:V
Right Side Slope	3.000 H:V
Bottom Width	1.00 ft
Discharge	0.57 cfs

Results	
Normal Depth	2.1 in
Flow Area	0.3 ft²
Wetted Perimeter	2.3 ft
Hydraulic Radius	1.5 in
Top Width	2.27 ft
Critical Depth	2.1 in
Critical Slope	0.048 ft/ft
Velocity	1.97 ft/s
Velocity Head	0.06 ft
Specific Energy	0.24 ft
Froude Number	0.973
Flow Type	Subcritical

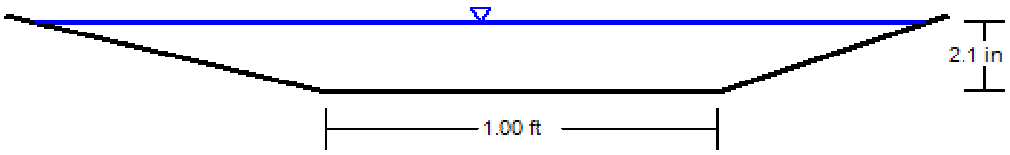
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

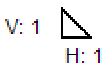
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	2.1 in
Critical Depth	2.1 in
Channel Slope	0.045 ft/ft
Critical Slope	0.048 ft/ft

Area 6 Section C-C - 2-yr

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.040
Channel Slope	0.045 ft/ft
Normal Depth	2.1 in
Left Side Slope	4.200 H:V
Right Side Slope	3.000 H:V
Bottom Width	1.00 ft
Discharge	0.57 cfs





WSEL for Area 6 Section C-C - 100-yr

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.040
Channel Slope	0.045 ft/ft
Left Side Slope	4.200 H:V
Right Side Slope	3.000 H:V
Bottom Width	1.00 ft
Discharge	2.40 cfs

Results	
Normal Depth	4.3 in
Flow Area	0.8 ft²
Wetted Perimeter	3.7 ft
Hydraulic Radius	2.7 in
Top Width	3.59 ft
Critical Depth	4.5 in
Critical Slope	0.039 ft/ft
Velocity	2.90 ft/s
Velocity Head	0.13 ft
Specific Energy	0.49 ft
Froude Number	1.068
Flow Type	Supercritical

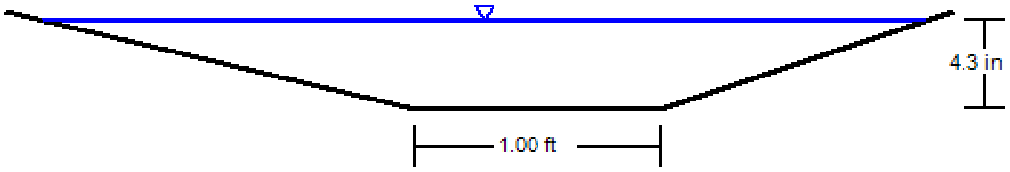
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

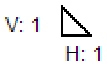
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	4.3 in
Critical Depth	4.5 in
Channel Slope	0.045 ft/ft
Critical Slope	0.039 ft/ft

Area 6 Section C-C - 100-yr

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.040
Channel Slope	0.045 ft/ft
Normal Depth	4.3 in
Left Side Slope	4.200 H:V
Right Side Slope	3.000 H:V
Bottom Width	1.00 ft
Discharge	2.40 cfs





WSEL for Area 6 Section D-D - 2-yr

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.040
Channel Slope	0.030 ft/ft
Left Side Slope	4.000 H:V
Right Side Slope	3.000 H:V
Bottom Width	1.00 ft
Discharge	0.57 cfs

Results	
Normal Depth	2.4 in
Flow Area	0.3 ft²
Wetted Perimeter	2.4 ft
Hydraulic Radius	1.6 in
Top Width	2.38 ft
Critical Depth	2.1 in
Critical Slope	0.048 ft/ft
Velocity	1.71 ft/s
Velocity Head	0.05 ft
Specific Energy	0.24 ft
Froude Number	0.804
Flow Type	Subcritical

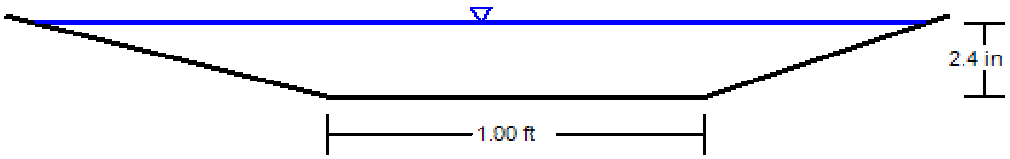
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

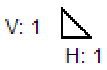
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	2.4 in
Critical Depth	2.1 in
Channel Slope	0.030 ft/ft
Critical Slope	0.048 ft/ft

Area 6 Section D-D - 2-yr

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.040
Channel Slope	0.030 ft/ft
Normal Depth	2.4 in
Left Side Slope	4.000 H:V
Right Side Slope	3.000 H:V
Bottom Width	1.00 ft
Discharge	0.57 cfs





WSEL for Area 6 Section D-D - 100-yr

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.040
Channel Slope	0.030 ft/ft
Left Side Slope	4.000 H:V
Right Side Slope	3.000 H:V
Bottom Width	1.00 ft
Discharge	2.40 cfs

Results	
Normal Depth	4.8 in
Flow Area	1.0 ft²
Wetted Perimeter	3.9 ft
Hydraulic Radius	2.9 in
Top Width	3.79 ft
Critical Depth	4.5 in
Critical Slope	0.039 ft/ft
Velocity	2.52 ft/s
Velocity Head	0.10 ft
Specific Energy	0.50 ft
Froude Number	0.884
Flow Type	Subcritical

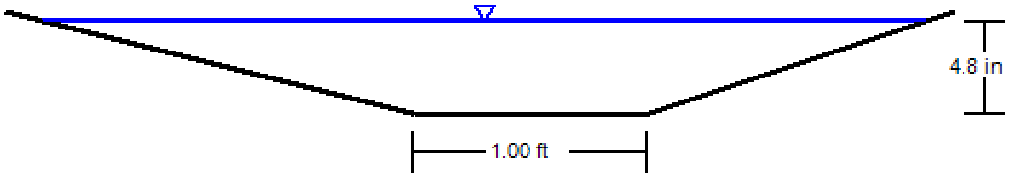
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

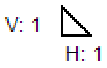
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	4.8 in
Critical Depth	4.5 in
Channel Slope	0.030 ft/ft
Critical Slope	0.039 ft/ft

Area 6 Section D-D - 100-yr

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.040
Channel Slope	0.030 ft/ft
Normal Depth	4.8 in
Left Side Slope	4.000 H:V
Right Side Slope	3.000 H:V
Bottom Width	1.00 ft
Discharge	2.40 cfs





WSEL for Area 6 Section E-E - 2-yr

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.040
Channel Slope	0.037 ft/ft
Left Side Slope	4.000 H:V
Right Side Slope	3.000 H:V
Bottom Width	1.00 ft
Discharge	0.57 cfs

Results	
Normal Depth	2.2 in
Flow Area	0.3 ft²
Wetted Perimeter	2.4 ft
Hydraulic Radius	1.6 in
Top Width	2.31 ft
Critical Depth	2.1 in
Critical Slope	0.048 ft/ft
Velocity	1.84 ft/s
Velocity Head	0.05 ft
Specific Energy	0.24 ft
Froude Number	0.888
Flow Type	Subcritical

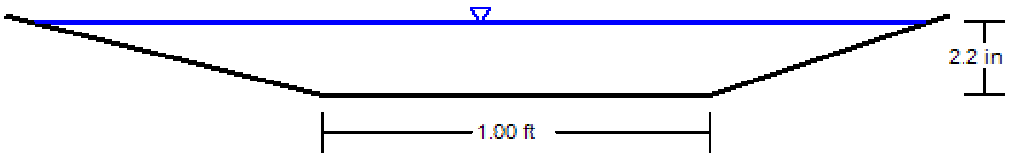
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

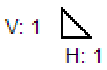
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	2.2 in
Critical Depth	2.1 in
Channel Slope	0.037 ft/ft
Critical Slope	0.048 ft/ft

Area 6 Section E-E - 2-yr

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.040
Channel Slope	0.037 ft/ft
Normal Depth	2.2 in
Left Side Slope	4.000 H:V
Right Side Slope	3.000 H:V
Bottom Width	1.00 ft
Discharge	0.57 cfs





WSEL for Area 6 Section E-E - 100-yr

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.040
Channel Slope	0.037 ft/ft
Left Side Slope	4.000 H:V
Right Side Slope	3.000 H:V
Bottom Width	1.00 ft
Discharge	2.40 cfs

Results	
Normal Depth	4.6 in
Flow Area	0.9 ft²
Wetted Perimeter	3.8 ft
Hydraulic Radius	2.8 in
Top Width	3.66 ft
Critical Depth	4.5 in
Critical Slope	0.039 ft/ft
Velocity	2.72 ft/s
Velocity Head	0.11 ft
Specific Energy	0.49 ft
Froude Number	0.975
Flow Type	Subcritical

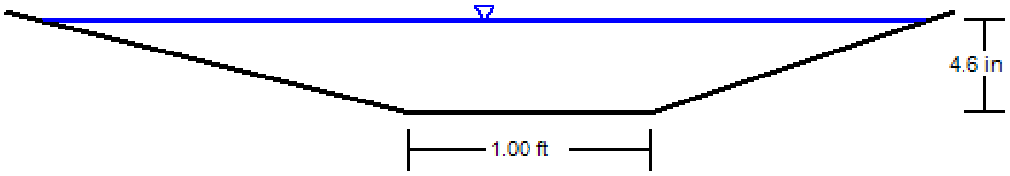
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

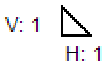
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	4.6 in
Critical Depth	4.5 in
Channel Slope	0.037 ft/ft
Critical Slope	0.039 ft/ft

Area 6 Section E-E - 100-yr

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.040
Channel Slope	0.037 ft/ft
Normal Depth	4.6 in
Left Side Slope	4.000 H:V
Right Side Slope	3.000 H:V
Bottom Width	1.00 ft
Discharge	2.40 cfs





WSEL for Area 1 Sidewalk Chase - 2-yr

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.013
Channel Slope	0.020 ft/ft
Height	0.3 ft
Bottom Width	1.00 ft
Discharge	0.15 cfs

Results	
Normal Depth	0.8 in
Flow Area	0.1 ft²
Wetted Perimeter	1.1 ft
Hydraulic Radius	0.7 in
Top Width	1.00 ft
Critical Depth	1.1 in
Percent Full	18.9 %
Critical Slope	0.007 ft/ft
Velocity	2.38 ft/s
Velocity Head	0.09 ft
Specific Energy	0.15 ft
Froude Number	1.671
Discharge Full	1.35 cfs
Slope Full	0.020 ft/ft
Flow Type	Supercritical

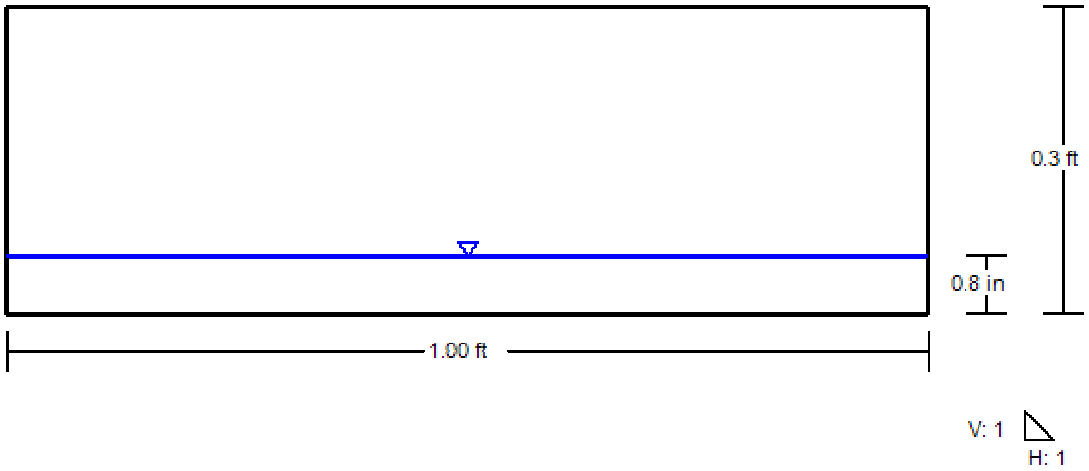
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

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	18.9 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	0.8 in
Critical Depth	1.1 in
Channel Slope	0.020 ft/ft
Critical Slope	0.007 ft/ft

Cross Section for Area 1 Sidewalk Chase - 2-yr

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.013
Channel Slope	0.020 ft/ft
Normal Depth	0.8 in
Height	0.3 ft
Bottom Width	1.00 ft
Discharge	0.15 cfs



WSEL for Area 1 Sidewalk Chase - 100-yr

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013
Channel Slope	0.020 ft/ft
Height	0.3 ft
Bottom Width	1.00 ft
Discharge	0.63 cfs

Results

Normal Depth	1.9 in
Flow Area	0.2 ft²
Wetted Perimeter	1.3 ft
Hydraulic Radius	1.5 in
Top Width	1.00 ft
Critical Depth	2.8 in
Percent Full	47.9 %
Critical Slope	0.007 ft/ft
Velocity	3.95 ft/s
Velocity Head	0.24 ft
Specific Energy	0.40 ft
Froude Number	1.744
Discharge Full	1.35 cfs
Slope Full	0.020 ft/ft
Flow Type	Supercritical

GVF Input Data

Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

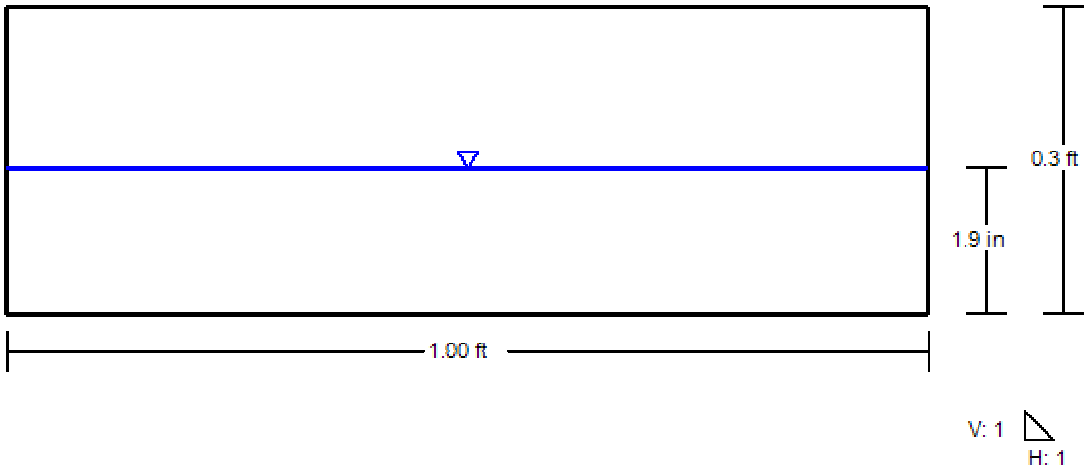
GVF Output Data

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	47.9 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	1.9 in
Critical Depth	2.8 in
Channel Slope	0.020 ft/ft
Critical Slope	0.007 ft/ft

Cross Section for Area 1 Sidewalk Chase - 100-yr

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.013
Channel Slope	0.020 ft/ft
Normal Depth	1.9 in
Height	0.3 ft
Bottom Width	1.00 ft
Discharge	0.63 cfs



APPENDIX 4 STORMCAD PIPE CALCULATIONS

Scenario: 2-YR
Current Time Step: 0.000 h
FlexTable: Catch Basin Table

Label	Elevation (Ground) (ft)	Elevation (Invert) (ft)	Total Inlet CA (acres)	Headloss Coefficient (Standard)	System Rational Flow (cfs)	Flow (Total Out) (cfs)	Flow (Additional Carryover) (cfs)	Hydraulic Grade Line (Out) (ft)	Energy Grade Line (Out) (ft)	System Flow Time (min)
BEGINNING OF PIPE	6,049.11	6,048.11	0.189	0.000	0.04	0.04	0.00	6,048.19	6,048.21	556.200

Y:\CenterPoint Engineering\1938 - Forest Trace (Aurora, CO)\7.0 - Reports\Drainage\STORMCAD\Forest Trace_StormCAD.stsw

Scenario: 100-YR
Current Time Step: 0.000 h
FlexTable: Catch Basin Table

Label	Elevation (Ground) (ft)	Elevation (Invert) (ft)	Total Inlet CA (acres)	Headloss Coefficient (Standard)	System Rational Flow (cfs)	Flow (Total Out) (cfs)	Flow (Additional Carryover) (cfs)	Hydraulic Grade Line (Out) (ft)	Energy Grade Line (Out) (ft)	System Flow Time (min)
BEGINNING OF PIPE	6,049.11	6,048.11	0.252	0.000	0.14	0.14	0.00	6,048.26	6,048.31	540.000

Y:\CenterPoint Engineering\1938 - Forest Trace (Aurora, CO)\7.0 - Reports\Drainage\STORMCAD\Forest Trace_StormCAD.stsw

Scenario: 2-YR
Current Time Step: 0.000 h
FlexTable: Conduit Table

Invert (Start) (ft)	Invert (Stop) (ft)	Length (User Defined) (ft)	Slope (Calculated) (ft/ft)	Velocity (ft/s)	Diameter (in)	Flow (cfs)	Hydraulic Grade Line (Out) (ft)
6,048.11	6,047.58	54.5	0.010	1.45	12.0	0.04	6,047.65

Y:\CenterPoint Engineering\1938 - Forest Trace (Aurora, CO)\7.0 - Reports\Drainage\STORMCAD\Forest Trace_StormCAD.stsw

Scenario: 100-YR
Current Time Step: 0.000 h
FlexTable: Conduit Table

Invert (Start) (ft)	Invert (Stop) (ft)	Length (User Defined) (ft)	Slope (Calculated) (ft/ft)	Velocity (ft/s)	Diameter (in)	Flow (cfs)	Hydraulic Grade Line (Out) (ft)
6,048.11	6,047.58	54.5	0.010	2.16	12.0	0.14	6,047.71

Y:\CenterPoint Engineering\1938 - Forest Trace (Aurora, CO)\7.0 - Reports\Drainage\STORMCAD\Forest Trace_StormCAD.stsw

Scenario: 2-YR
Current Time Step: 0.000 h
FlexTable: Outfall Table

Label	Elevation (Ground) (ft)	Elevation (Invert) (ft)	Boundary Condition Type	Hydraulic Grade (ft)	Flow (Total Out) (cfs)
6'-12" FLARED END DRAIN	6,047.58	6,047.58	Free Outfall	6,047.65	0.04

Y:\CenterPoint Engineering\1938 - Forest Trace (Aurora, CO)\7.0 - Reports\Drainage\STORMCAD\Forest Trace_StormCAD.stsw

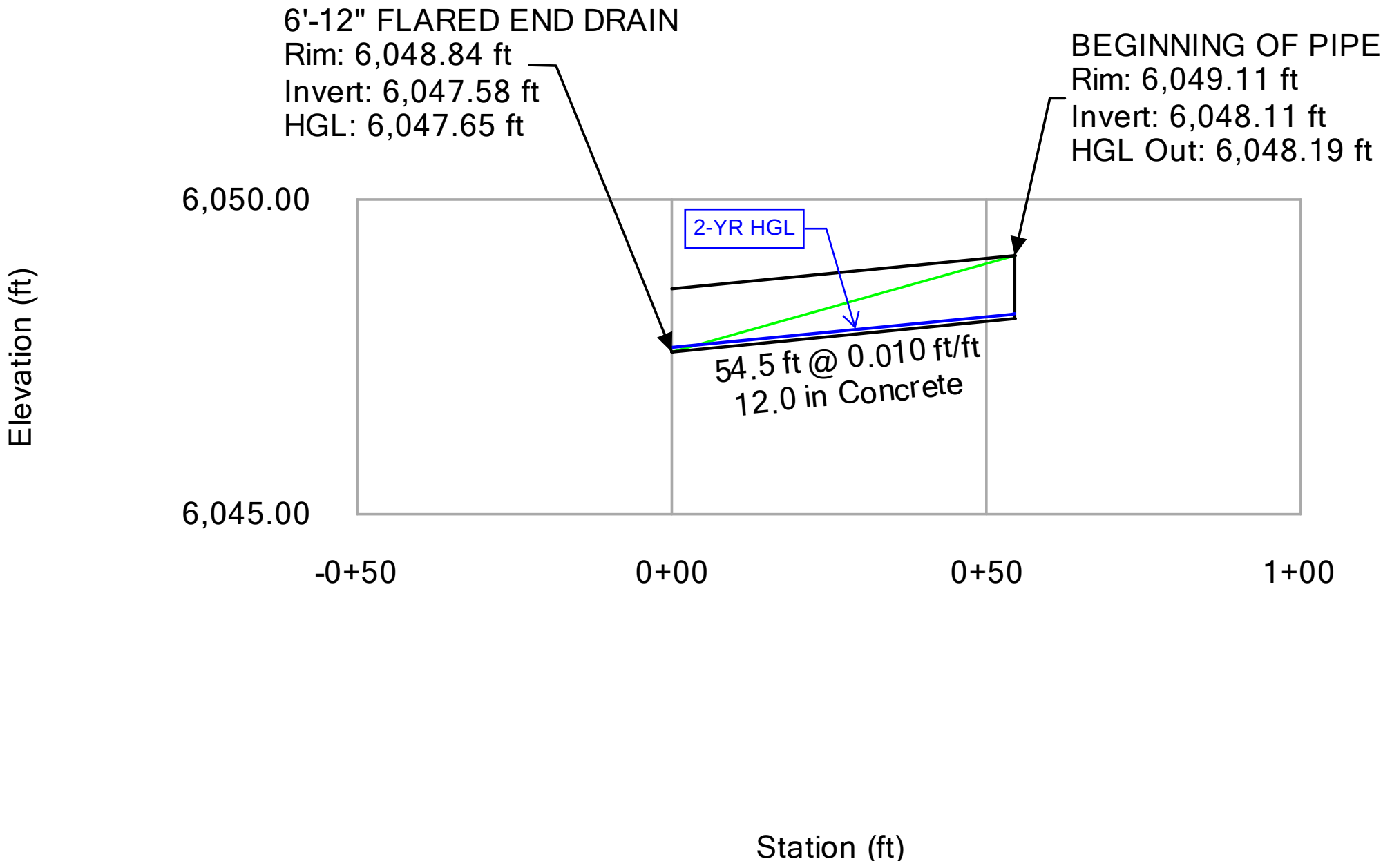
Scenario: 100-YR
Current Time Step: 0.000 h
FlexTable: Outfall Table

Label	Elevation (Ground) (ft)	Elevation (Invert) (ft)	Boundary Condition Type	Hydraulic Grade (ft)	Flow (Total Out) (cfs)
6'-12" FLARED END DRAIN	6,047.58	6,047.58	Free Outfall	6,047.71	0.14

Y:\CenterPoint Engineering\1938 - Forest Trace (Aurora, CO)\7.0 - Reports\Drainage\STORMCAD\Forest Trace_StormCAD.stsw

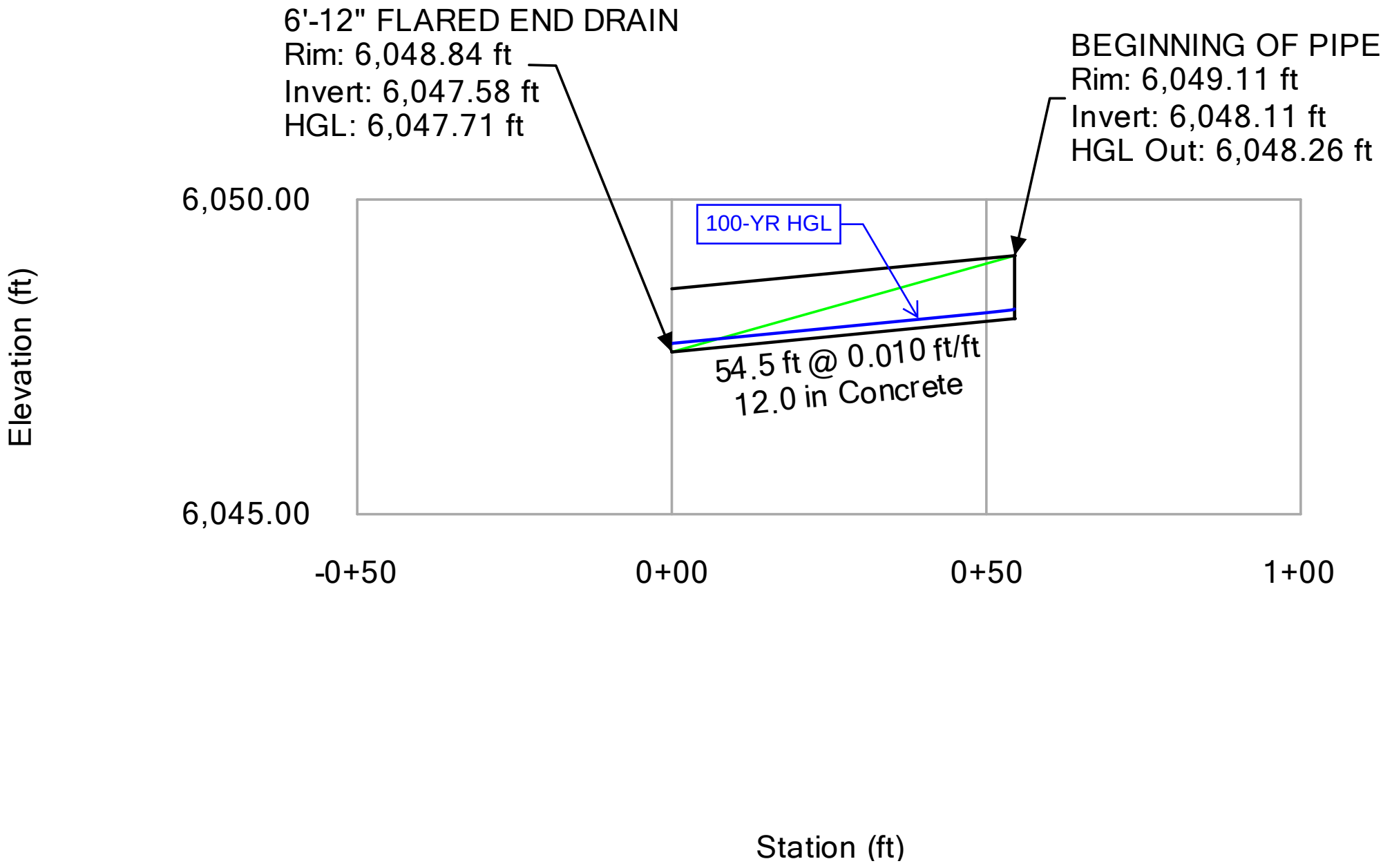
Profile Report

Engineering Profile - STORM SEWER A (Forest Trace_StormCAD.stsw)



Profile Report

Engineering Profile - STORM SEWER A (Forest Trace_StormCAD.stsw)



APPENDIX 5 RIPRAP SIZING

PROJECT INFORMATION	
PROJECT NAME:	FOREST TRACE
PROJECT NO.:	1938
DESIGN BY:	J.OLIVETO
JURISDICTION:	AURORA, COLORADO
DATE:	4/10/2024

Area 2 Riprap Sizing

8.1.2 Steep Slope Conditions

Steep slope rock sizing equations are used for applications where the slope is greater than 2 percent and/or flows are in the supercritical flow regime. The following rock sizing equations may be referred to for riprap design analysis on steep slopes:

- CSU Equation, *Development of Riprap Design Criteria by Riprap Testing in Flumes: Phase II* (prepared by S.R. Abt, et al, Colorado State University, 1988). This method was developed for steep slopes from 2 to 20 percent.

- USDA- Agricultural Research Service Equations, *Design of Rock Chutes* (by K.M. Robinson, et al, USDA- ARS, 1998 Transactions of ASAE) and *An Excel Program to Design Rock Chutes for Grade*

The stone or rock size, D_{50}, is expressed by Stephenson as

$$D_{50} = \left[\frac{q(\tan\theta)^{7/6} n_p^{1/6}}{C\, g^{1/2} [(1-n_p)(G_s-1)\cos\theta\,(\tan\phi - \tan\theta)]^{5/3}} \right]^{2/3} \quad (3.15)$$

where the factor C varies from 0.22 for gravel and pebbles to 0.27 for crushed granite. The stone size calculated in Eq. 3.15 is the representative median diameter, D_{50}, at which rock movement is expected for unit discharge, q. The maximum flow rate, q, is then multiplied by Oliviers' constant, K, to ensure stability. Oliviers' constants are 1.2 for gravel and 1.8 for crushed rock. The rockfill layer should be well graded and at least two times the D_{50} in thickness. A bedding layer or filter should be placed under the rockfill.

q (cfs/ft)	0.43
Θ	9.1
Φ	40
n_p	0.25
C	0.27
g (ft/s^2)	32.2
G_s	2.5
D_{50}	0.31

Use D_{50} = 6"

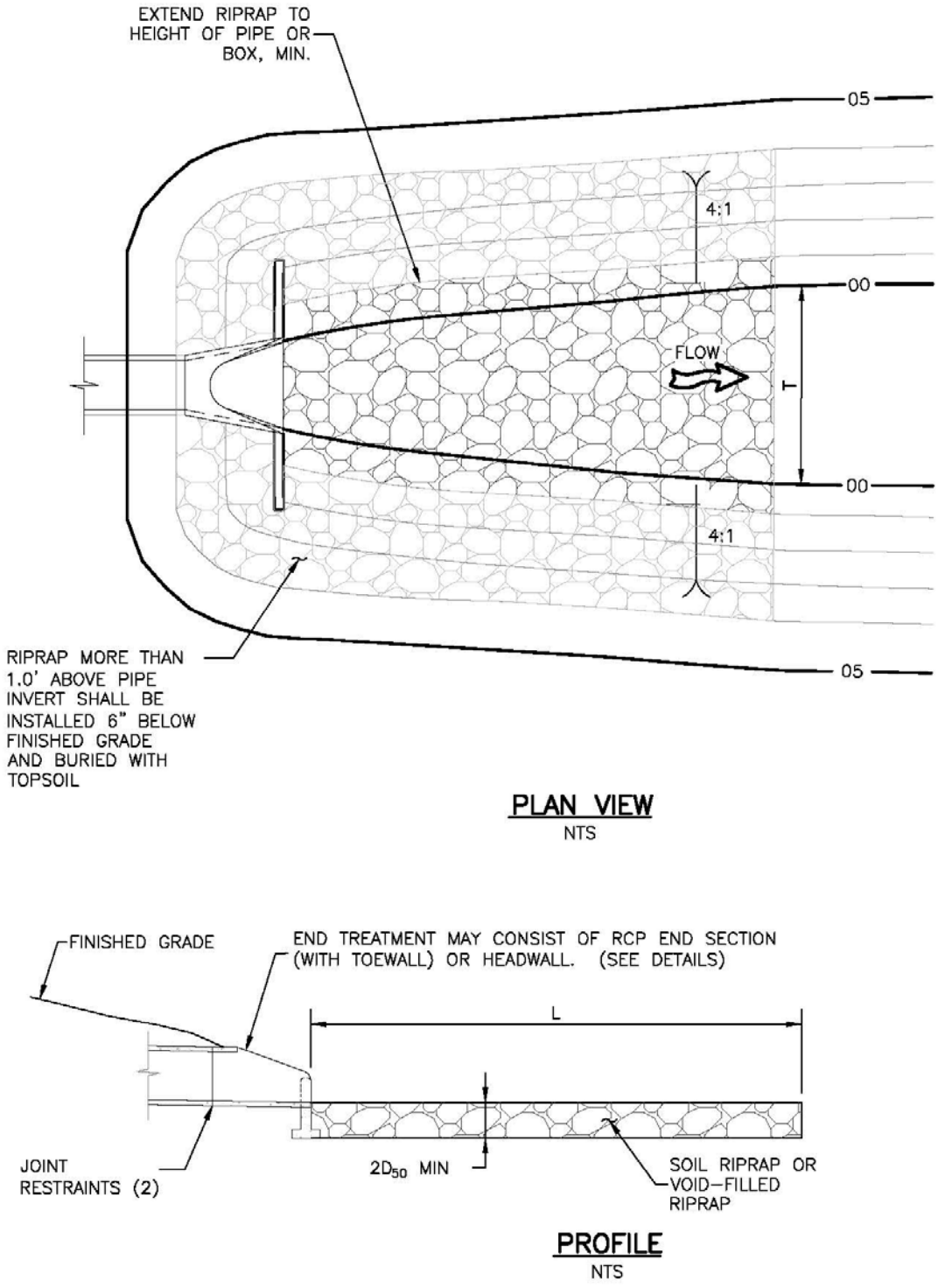
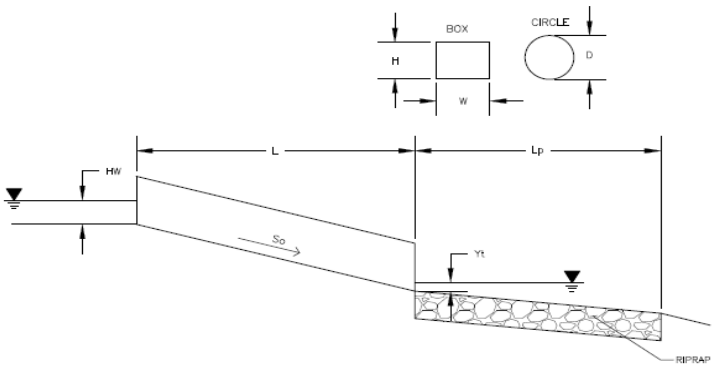


Figure 9-34. Riprap apron detail for culverts in-line with the channel

Determination of Culvert Headwater and Outlet Protection

Project: Blue cells are for user data entry
Basin ID: Green cells are calculated values



Soil Type:
Choose One:
(•) Sandy
( ) Non-Sandy

Supercritical Flow! Using Da to calculate protection type.

Design Information (Input):

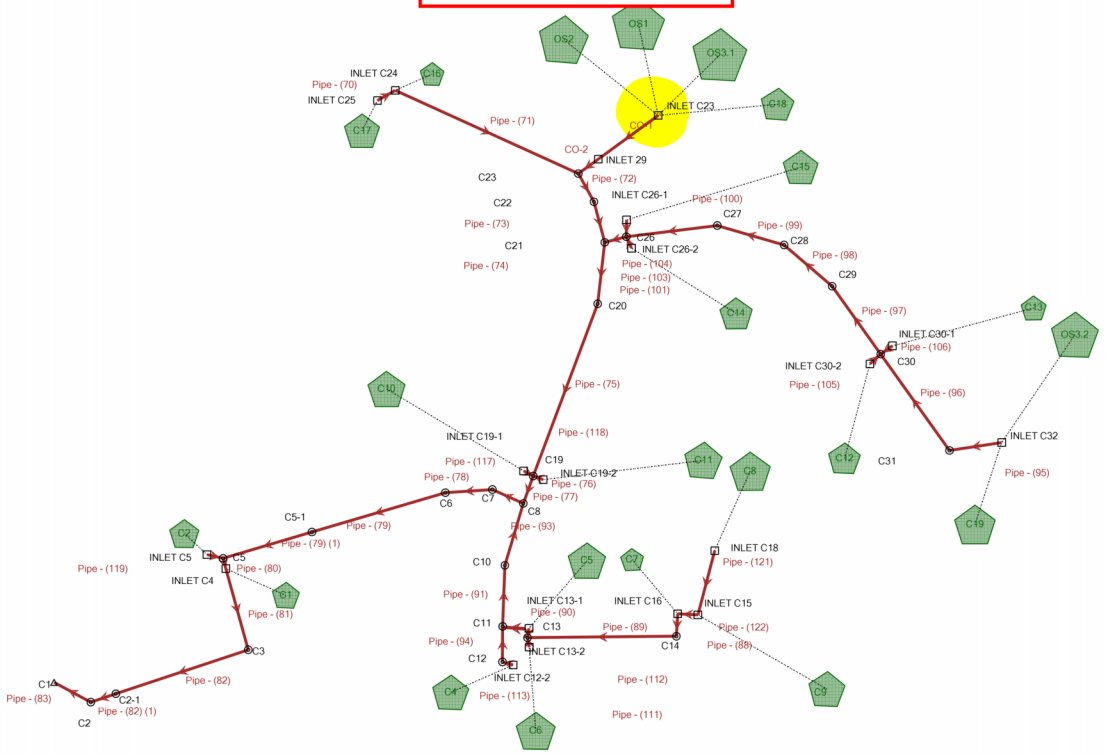
Design Discharge	Q =	1.86	cfs
Circular Culvert:			
Barrel Diameter in Inches	D =	12	inches
Inlet Edge Type (Choose from pull-down list)		Square End Projection	
Box Culvert:		**OR**	
Barrel Height (Rise) in Feet	Height (Rise) =		ft
Barrel Width (Span) in Feet	Width (Span) =		ft
Inlet Edge Type (Choose from pull-down list)			
Number of Barrels	No =	1	
Inlet Elevation	Elev IN =	6048.11	ft
Outlet Elevation **OR** Slope	Elev OUT =	6047.58	ft
Culvert Length	L =	44.5	ft
Manning's Roughness	n =	0.012	
Bend Loss Coefficient	k_b =	0	
Exit Loss Coefficient	k_x =	1	
Tailwater Surface Elevation	Elev Y_t =	6047.71	ft
Max Allowable Channel Velocity	V =	5	ft/s

Required Protection (Output):

Tailwater Surface Height	Y_t =	0.13	ft
Flow Area at Max Channel Velocity	A_t =	0.37	ft^2
Culvert Cross Sectional Area Available	A =	0.79	ft^2
Entrance Loss Coefficient	k_e =	0.50	
Friction Loss Coefficient	k_f =	1.18	
Sum of All Losses Coefficients	k_s =	2.68	ft
Culvert Normal Depth	Y_n =	0.46	ft
Culvert Critical Depth	Y_c =	0.58	ft
Tailwater Depth for Design	d =	0.79	ft
Adjusted Diameter **OR** Adjusted Rise	D_a =	0.73	ft
Expansion Factor	1/(2*tan(Θ)) =	1.88	
Flow/Diameter$^{2.5}$ **OR** Flow/(Span * Rise$^{1.5}$)	Q/D^2.5 =	1.86	$ft^{0.5}/s$
Froude Number	Fr =	1.53	**Supercritical!**
Tailwater/Adjusted Diameter **OR** Tailwater/Adjusted Rise	Yt/D =	0.18	
Inlet Control Headwater	HW_I =	0.88	ft
Outlet Control Headwater	HW_O =	0.49	
Design Headwater Elevation	**HW =**	**6,048.99**	**ft**
Headwater/Diameter OR Headwater/Rise Ratio	**HW/D =**	**0.88**	
Minimum Theoretical Riprap Size	d_{50} =	7	in
Nominal Riprap Size	d_{50} =	9	in
UDFCD Riprap Type	**Type =**	**L**	
Length of Protection	**L_p =**	**4**	**ft**
Width of Protection	**T =**	**4**	**ft**

APPENDIX 6 SUPPORTING DOCUMENTATION FROM EDN 215037

NETWORK C SCHEMATIC

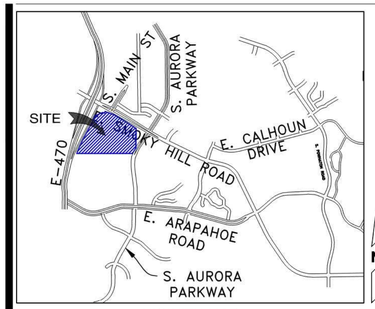


STORM NETWORK C
MAJOR STORM

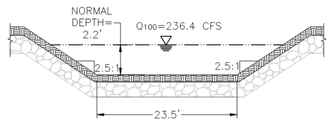
Conduit FlexTable: Combined Pipe/Node Report

Active Scenario: 100-YR

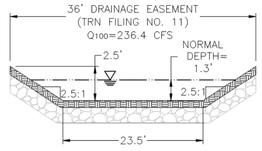
Label	Start Node	Stop Node	Invert (Upstream) (ft)	Invert (Downstream) (ft)	Length (Unified) (ft)	Slope (ft/ft)	Material	Diameter (in)	Flow (cfs)	Capacity (Full Flow) (cfs)	Velocity (ft/s)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Energy Grade Line (In) (ft)	Energy Grade Line (Out) (ft)
CO-1	INLET C23	INLET 29	6,057.39	6,054.49	117.9	0.025	Concrete	42.0	82.24	157.77	16.57	6,060.22	6,056.42	6,061.73	6,059.98
CO-2	INLET 29	C23	6,054.29	6,053.33	41.0	0.023	Concrete	42.0	81.94	153.91	16.25	6,057.32	6,057.26	6,058.65	6,058.39
Pipe - (70)	INLET C25	INLET C24	6,055.54	6,055.34	40.1	0.005	Concrete	24.0	8.37	15.97	2.66	6,058.14	6,058.08	6,058.25	6,058.19
Pipe - (71)	INLET C24	C23	6,055.14	6,053.33	320.9	0.006	Concrete	24.0	10.68	16.99	3.40	6,057.98	6,057.26	6,058.16	6,057.44
Pipe - (72)	C23	C22	6,053.13	6,052.34	39.8	0.020	Concrete	48.0	91.56	202.29	15.70	6,056.03	6,056.22	6,057.40	6,057.06
Pipe - (73)	C22	C21	6,052.14	6,050.80	67.0	0.020	Concrete	48.0	91.45	203.18	15.74	6,055.66	6,055.52	6,056.60	6,056.34
Pipe - (74)	C21	C20	6,050.60	6,048.63	98.4	0.020	Concrete	48.0	119.33	203.24	16.82	6,053.89	6,052.80	6,055.70	6,054.20
Pipe - (75)	C20	C19	6,048.43	6,038.58	293.2	0.034	Concrete	48.0	118.98	263.28	20.42	6,051.72	6,043.75	6,053.52	6,045.15
Pipe - (76)	C19	C8	6,038.38	6,037.22	46.5	0.025	Concrete	48.0	128.33	226.81	18.61	6,041.77	6,041.41	6,043.75	6,043.03
Pipe - (77)	C8	C7	6,034.54	6,033.46	54.1	0.020	Concrete	48.0	150.78	202.99	12.00	6,039.39	6,038.80	6,041.63	6,041.03
Pipe - (78)	C7	C6	6,033.26	6,031.76	75.0	0.020	Concrete	48.0	150.45	203.14	11.97	6,037.46	6,036.64	6,039.69	6,038.86
Pipe - (79)	C6	C5-1	6,031.56	6,022.66	221.7	0.040	Concrete	48.0	149.99	287.78	23.14	6,035.16	6,028.37	6,037.62	6,030.59
Pipe - (79) (1)	C5-1	C5	6,021.48	6,019.31	147.5	0.015	Concrete	48.0	149.29	174.21	11.88	6,027.28	6,025.68	6,029.47	6,027.88
Pipe - (80)	C5	INLET C4	6,019.11	6,018.75	17.0	0.021	Concrete	48.0	150.93	209.27	12.01	6,023.67	6,023.48	6,025.91	6,025.72
Pipe - (81)	INLET C4	C3	6,018.55	6,011.84	134.2	0.050	Concrete	48.0	154.86	321.14	25.32	6,022.18	6,014.03	6,024.78	6,021.53
Pipe - (82)	C3	C2-1	6,009.47	5,998.36	222.4	0.050	Concrete	48.0	154.47	321.01	25.30	6,013.10	6,000.42	6,015.68	6,009.14
Pipe - (82) (1)	C2-1	C2	5,993.34	5,991.98	48.4	0.028	Concrete	48.0	153.82	240.67	20.31	5,996.96	5,994.81	5,999.53	5,998.88
Pipe - (83)	C2	C1	5,982.80	5,980.60	45.5	0.048	Concrete	48.0	153.64	315.70	12.23	5,988.06	5,987.54	5,990.38	5,989.86
Pipe - (88)	INLET C16	C14	6,048.92	6,048.26	30.0	0.022	Concrete	18.0	17.32	15.57	9.80	6,050.89	6,050.07	6,052.38	6,051.56
Pipe - (89)	C14	C13	6,048.06	6,038.27	237.4	0.041	Concrete	24.0	17.29	45.94	13.59	6,049.56	6,043.64	6,050.29	6,044.11
Pipe - (91)	C11	C10	6,036.65	6,035.92	97.4	0.007	Concrete	36.0	25.28	57.74	3.58	6,041.80	6,041.66	6,042.00	6,041.86
Pipe - (93)	C10	C8	6,035.72	6,034.74	102.9	0.010	Concrete	36.0	24.90	65.10	3.52	6,041.55	6,041.41	6,041.74	6,041.60
Pipe - (94)	C12	C11	6,038.48	6,038.19	56.5	0.005	Concrete	24.0	4.64	16.20	1.48	6,041.97	6,041.94	6,042.00	6,041.98
Pipe - (95)	INLET C32	C31	6,088.71	6,087.03	84.0	0.020	Concrete	18.0	15.30	14.85	8.66	6,090.75	6,088.96	6,091.91	6,090.13
Pipe - (96)	C31	C30	6,086.83	6,080.94	188.7	0.031	Concrete	18.0	15.19	18.56	11.72	6,088.24	6,084.26	6,089.45	6,085.41
Pipe - (97)	C30	C29	6,080.74	6,074.09	133.2	0.050	Concrete	18.0	20.20	23.47	14.94	6,082.21	6,076.59	6,084.26	6,078.62
Pipe - (98)	C29	C28	6,073.90	6,068.85	101.0	0.050	Concrete	18.0	20.09	23.49	14.94	6,075.37	6,071.33	6,077.40	6,073.34
Pipe - (99)	C28	C27	6,068.65	6,063.42	110.9	0.047	Concrete	18.0	20.01	22.81	14.56	6,070.12	6,065.84	6,072.13	6,067.83
Pipe - (100)	C27	C26	6,062.92	6,056.06	145.9	0.047	Concrete	18.0	19.92	22.77	11.27	6,064.65	6,059.41	6,066.63	6,061.38
Pipe - (101)	C26	C21	6,055.86	6,054.08	35.6	0.050	Concrete	24.0	31.74	50.58	17.00	6,057.75	6,055.43	6,059.41	6,058.52
Pipe - (103)	INLET C26-1	C26	6,056.35	6,056.06	29.1	0.010	Concrete	18.0	8.65	10.48	4.90	6,059.60	6,059.41	6,059.98	6,059.78
Pipe - (104)	INLET C26-2	C26	6,057.17	6,056.06	22.2	0.050	Concrete	18.0	4.69	23.49	2.65	6,059.45	6,059.41	6,059.56	6,059.52
Pipe - (105)	INLET C30-2	C30	6,081.85	6,080.94	23.0	0.040	Concrete	18.0	3.53	20.88	2.00	6,084.29	6,084.26	6,084.35	6,084.32
Pipe - (106)	INLET C30-1	C30	6,081.85	6,080.94	23.0	0.040	Concrete	18.0	3.81	20.88	2.15	6,084.29	6,084.26	6,084.36	6,084.33
Pipe - (111)	C13	INLET C13-1	6,038.07	6,037.62	15.0	0.030	Concrete	24.0	22.05	39.16	7.02	6,042.88	6,042.74	6,043.64	6,043.50
Pipe - (112)	INLET C13-2	C13	6,038.82	6,038.27	15.0	0.037	Concrete	18.0	5.54	20.10	3.14	6,043.69	6,043.64	6,043.84	6,043.80
Pipe - (113)	INLET C12-2	C12	6,039.06	6,038.98	17.0	0.005	Concrete	18.0	4.66	7.21	2.64	6,042.02	6,041.99	6,042.13	6,042.10
Pipe - (117)	INLET C19-1	C19	6,040.98	6,040.13	17.0	0.050	Concrete	18.0	3.36	23.47	1.90	6,043.77	6,043.75	6,043.83	6,043.81
Pipe - (118)	INLET C19-2	C19	6,040.98	6,040.13	17.0	0.050	Concrete	18.0	10.00	23.47	5.66	6,043.91	6,043.75	6,044.41	6,044.25
Pipe - (119)	INLET C5	C5	6,019.44	6,019.31	26.4	0.005	Concrete	18.0	3.47	7.38	1.96	6,025.71	6,025.68	6,025.77	6,025.74
Pipe - (121)	INLET C18	INLET C15	6,054.98	6,051.46	108.5	0.032	Concrete	18.0	10.55	18.92	11.00	6,056.23	6,053.06	6,056.93	6,053.61
Pipe - (122)	INLET C15	INLET C16	6,050.35	6,049.81	30.1	0.018	Concrete	18.0	13.67	14.07	7.74	6,052.59	6,052.08	6,053.52	6,053.01
Pipe-(90)	INLET C13-1	C11	6,037.42	6,036.85	36.2	0.016	<None>	24.0	23.02	28.39	7.33	6,042.32	6,041.94	6,043.15	6,042.78



VICINITY MAP
N.T.S.



POND A EMERGENCY SPILLWAY WEIR SECTION A–A
N.T.S.



POND A EMERGENCY SPILLWAY SWALE SECTION B–B
N.T.S.

MARTIN/MARTIN ASSUMES NO RESPONSIBILITY FOR UTILITY LOCATIONS. THE UTILITIES SHOWN ON THIS DRAWING HAVE BEEN PLOTTED FROM THE BEST AVAILABLE INFORMATION. IT IS, HOWEVER, THE CONTRACTORS RESPONSIBILITY TO FIELD VERIFY THE SIZE, MATERIAL, HORIZONTAL AND VERTICAL LOCATION OF ALL UTILITIES PRIOR TO THE COMMENCEMENT OF ANY CONSTRUCTION.

NOTES:

1. SITE DESIGN STORM:
   MAJOR=100–YEAR
   MINOR=2–YEAR
2. ALL WATER DISTRIBUTION, SANITARY SEWER, AND STORM DRAINAGE CONSTRUCTION WILL CONFORM TO CITY OF AURORA "PUBLIC UTILITY IMPROVEMENTS RULES AND REGULATIONS REGARDING STANDARDS AND SPECIFICATIONS," LATEST REVISION.
3. ALL STORM SEWER, INLETS, SWALES, CULVERTS, AND PONDS ARE PRIVATE UNLESS OTHERWISE NOTED AND DESIGNED FOR THE 100–YEAR STORM EVENT

RUNNOFF SUMMARY					
BASIN	DESIGN POINT	AREA (ACRES)	% IMP.	Q2 (CFS)	Q100 (CFS)
A1	1A	15.3	43.0%	14.4	53.5
A2	A	2.32	2.0%	0.8	3.2
A3	3A	2.15	44.6%	2.1	8.8
A4	3A	11.83	2.0%	2.5	10.2
A5	3A	3.84	41.3%	3.1	13.1
A6	2A	24.27	46.6%	20.6	75.3
A7	4A	12.64	95.0%	31.5	88.7
B1	B	1.35	51.2%	1.6	6.3
OS1	OS1	1	45.0%	1.2	4.9
OS2	OS2	2.13	100.0%	6.1	17.9
OS3	OS3	3.52	45.5%	3.9	16.4
OS4	OS4	1.78	2.0%	0.6	2.4

SITE IMPERVIOUSNESS SUMMARY		
	AREA (AC)	IMPERVIOUSNESS
BASIN A	72.35	45.2%
BASIN OS1-OS3	6.65	62.9%
POND A TRIBUTARY AREA COMPOSITE	79.00	46.7%
BASIN B	1.35	51.2%
OS4	1.78	2.0%
SITE COMPOSITE (BASIN A & B)	73.70	45.3%
TOTAL COMPOSITE (BASIN A, B, & OFFSITE)	82.13	45.8%

CONCEPTUAL ROUTING SUMMARY			
TRIBUTARY AREA	DESIGN POINT	Q2 (CFS)	Q100 (CFS)
OS1 + OS2 + A7	4A	33.8	98.8
A3 + A4 + A5	3A	7.1	29.7
DP3A+DP4A+ OS3 + A6	2A	55.0	190.0
A1	1A	14.4	53.5
DP1A + DP2A + A2	A	67.2	236.4
B1	B	1.6	6.3
OS4	OS4	0.6	2.4

APPROVED FOR ONE YEAR FROM THIS DATE

City Engineer — Date

Water Department — Date

CITY OF AURORA PLAN REVIEW IS ONLY FOR GENERAL CONFORMANCE WITH CITY OF AURORA DESIGN CRITERIA AND THE CITY CODE. THE CITY IS NOT RESPONSIBLE FOR THE ACCURACY AND ADEQUACY OF THE DESIGN, OF DIMENSIONS AND ELEVATIONS WHICH SHALL BE CONFIRMED AND CORRELATED AT THE JOB SITE. THE CITY OF AURORA, THROUGH THE APPROVAL OF THIS DOCUMENT, ASSUMES NO RESPONSIBILITY FOR THE COMPLETENESS AND/OR ACCURACY OF THIS DOCUMENT.

MARTIN/MARTIN
CONSULTING ENGINEERS
12499 WEST COLFAX AVENUE, LAKEWOOD, COLORADO 80215
MAIN 303.431.6100 MARTINMARTIN.COM

COLORADO REGISTERED PROFESSIONAL ENGINEER 28764 CHRISTOPHER M. TUTTLE

FOREST TRACE FILING NO. 1
MASTER DRAINAGE PLAN

No.	Issue / Revision	Date	Name
1	1ST SUBMITTAL	04/10/14	M/M
2	2ND SUBMITTAL	05/29/14	M/M
3	3RD SUBMITTAL	07/08/14	M/M

Job Number	13.0517
Project Manager	J. WHITE
Design By	R. JOHNSON
Drawn By	R. JOHNSON
Principal In Charge	R. TUTTLE

Sheet Number:

D1

PLOT DATE: Monday, August 25, 2014 1:41 PM LAST SAVED BY: RYANJ
DRAWING LOCATION: G:\Tuttle\13.0517–FOREST TRACE\ENG\DRAINAGE\MASTER\DWG\Overview Map.dwg