CIVAS
engineering
civil engineering solutions

1250 AINSWORTH
LOT 3
POWERS POINTE FILING NO. 5

EL PASO COUNTY, COLORADO

DRAINAGE LETTER REPORT

Prepared for:
T-Bone Construction, Inc.
1310 Ford Street
Colorado Springs, Colorado 80915

phone: (719) 570-1456

Prepared by:
CIVAS Engineering, LLC
10056 Brisbane Lane
Littleton, Colorado 80130

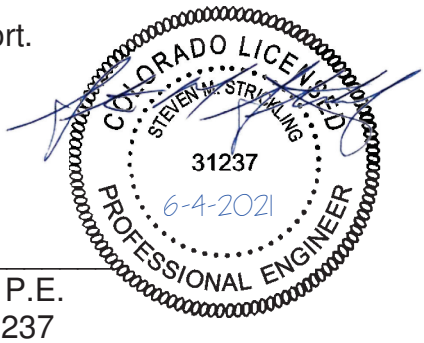
phone: (720) 240-5882

PCD File No.
PPR-21-025

May 17, 2021
Project No. 20-290

I. DESIGN ENGINEER'S STATEMENT:

The attached drainage plan and report were prepared under my direction and supervision and are correct to the best of my knowledge and belief. Said drainage report has been prepared according to the criteria established by the County for drainage reports and said report is in conformity with the applicable master plan of the drainage basin. I accept responsibility for any liability caused by any negligent acts, errors or omissions on my part in preparing this report.



_____

Steven M. Strickling, P.E.
Colorado Number 31237
For and On Behalf of CIVAS Engineering, LLC

II. OWNER/DEVELOPER'S STATEMENT:

I, the owner/developer have read and will comply with all of the requirements specified in this drainage report and plan.

_____ _____

Michael Thibault, T-Bone Construction, Inc. Date
As Authorized Agent for Bison Real Estate Holdings, LLC

1310 Ford Street
Colorado Springs, Colorado 80915

III. EL PASO COUNTY:

Filed in accordance with the requirements of the Drainage Criteria Manual, Volumes 1 and 2, El Paso County Engineering Criteria Manual and Land Development Code as amended.

_____ _____

Jennifer Irvine, P.E. Date

County Engineer / ECM Administrator

INTRODUCTION

This report represents a “Letter Type” drainage report for 1250 Ainsworth, Powers Pointe Lot 3, Filing No. 5, which is a part of the “Powers Pointe Filing No. 1 Preliminary/Final Drainage Report”, dated May 5, 1996, and was prepared in accordance the El Paso County Drainage Criteria Manual (DCM) and satisfies the El Paso County subdivision submittal requirements. This report was also prepared using portions of the City of Colorado Springs DCM and the Mile High Flood District (MHFD) "Urban Storm Drainage Criteria Manual”, latest editions.

This report addresses post-development storm peak runoff rates for the 5-year and 100-year storm events.

PROPERTY LOCATION AND DESCRIPTION

The 0.97 acre property is located at 1250 Ainsworth Street and is legally described a Lot 3, Powers Pointe Filing No. 5, except that portion of land conveyed to the State of Colorado Department of Transportation, for right-of-way purposes, in the warranty deed recorded at Reception 212020323. Ainsworth Street, an existing 24’ wide private roadway within a 30’ wide public utility and access easement, is located on the eastern portion of the property. The planned use for an 8,700 s.f. office/warehouse building with associated parking, landscaping and utility improvements. The property is surrounded by Legend Auto Care, an auto maintenance and repair shop, to the north, A Storage Place, a self storage facility, to the east, undeveloped and unplatted property to the south and Powers Boulevard, a public right-of-way, to the west. Access to the site is from Ainsworth Street.

FIGURE 1 - VICINITY MAP

VICINITY MAP

1" = 2,500'

Soil on the majority of the site, as classified by the Soil Conservation Services of the U.S. Department of Agriculture in the Soil Survey for the El Paso County Area (refer to figures 2, 3 and 4), is Blendon sandy loam (10). This soil type has a slow runoff rate and a rapid permeability rate. Blendon sandy loam (10) is part of hydrologic soil group B (refer to figure 5).

FIGURE 2 – SCS SOIL SURVEY MAP

FIGURE 3 – SCS SOIL SURVEY MAP LEGEND

Soil Map—El Paso County Area, Colorado
(1250 Ainsworth St.)

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

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 1:24,000.

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: El Paso County Area, Colorado
Survey Area Data: Version 18, Jun 5, 2020

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

Date(s) aerial images were photographed: Aug 19, 2018—Sep 23, 2018

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.

USDA Natural Resources Conservation Service

Web Soil Survey
National Cooperative Soil Survey

4/7/2021
Page 2 of 3

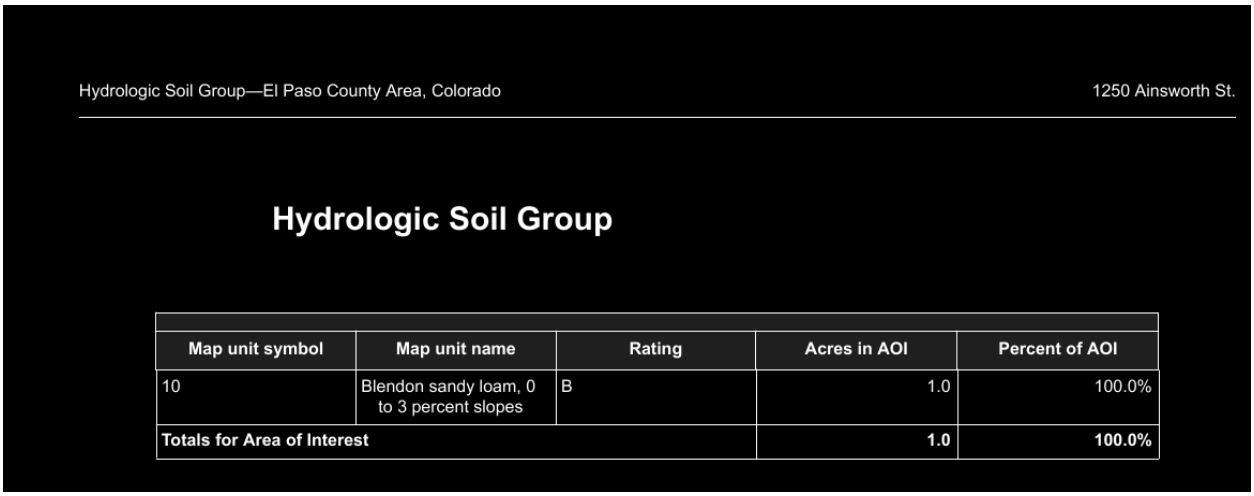
FIGURE 4 – SCS SOIL SURVEY SOIL MAP UNITS

Soil Map—El Paso County Area, Colorado 1250 Ainsworth St.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
10	Blendon sandy loam, 0 to 3 percent slopes	1.0	100.0%
Totals for Area of Interest		**1.0**	**100.0%**

FIGURE 5 – SCS SOIL SURVEY HYDROLOGIC SOIL GROUP



Hydrologic Soil Group—El Paso County Area, Colorado 1250 Ainsworth St.

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
10	Blendon sandy loam, 0 to 3 percent slopes	B	1.0	100.0%
Totals for Area of Interest			1.0	100.0%

The project site is part of the Sand Creek Drainage Basin and is tributary to Sand Creek, located approximately 0.15 miles to the west.

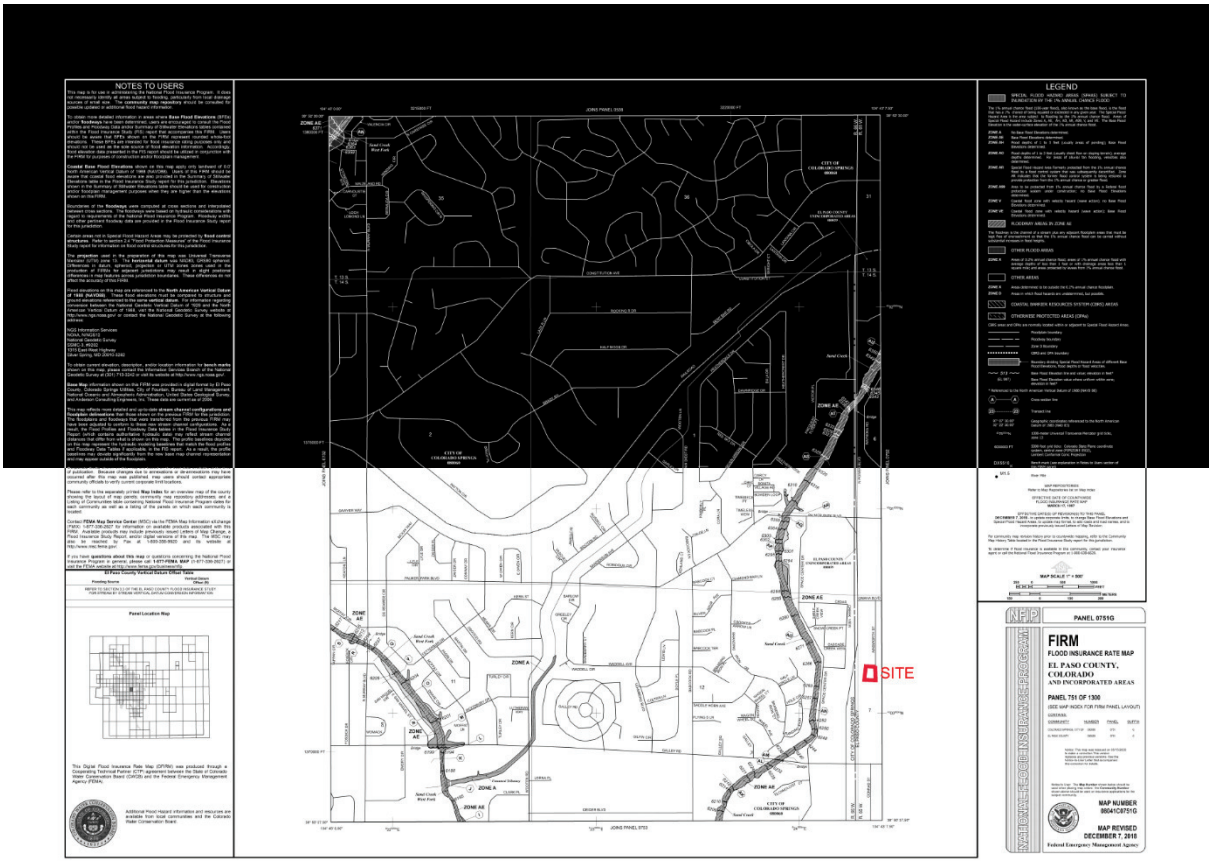
DRAINAGE CRITERIA

The El Paso County Drainage Criteria Manual (DCM), the City of Colorado Springs DCM and the Mile High Flood District (MHFD) "Urban Storm Drainage Criteria Manual, latest editions were used in the preparation of this report. The Rational Method was used to calculate the post-development storm peak flows for the 5-year and 100-year storm events

FLOODPLAIN IMPACTS

The FEMA Flood Insurance Rate Map (FIRM) for Community Panel 08041C0751G, revised December 7, 2018 (refer to figure 6) shows that no portion of this development lies within the 100 year flood plain of Sand Creek, nor its tributaries.

FIGURE 6 – FIRM MAP NUMBER 08041C0751G



Per the existing conditions drainage map it appears that a portion of runoff travels to the adjacent lots to the south and to the east. Please address the different areas all of the runoff is traveling to.

EXISTING DRAINAGE BASINS

The site is part of Basin 7 (2.80 ac) in the Powers Pointe Filing No. 1 Preliminary/Final Drainage Report. In this report, Basin 7 was anticipated to contain office and/or commercial developments and an asphalt/curb driveway within the access easement. Developed runoff from this basin was planned to discharge into the existing drainage swale on the east side of Powers road via a curb channel and a rip rap channel.

The drainage basin area within the Powers Pointe Filing No. 1 Preliminary/Final Drainage Report was included in the "Final Drainage Study for Powers Boulevard, Phase I," prepared by K.K.B.N.A., Inc., for the City of Colorado Springs and El Paso

County, May of 1987 (revised) and is a part of Sub-Basin S-2. This study analyzed stormwater runoff for the areas tributary to Powers Boulevard using proposed land uses and the drainage improvements were designed and constructed to convey runoff from the proposed land uses, including the drainage swale on the east side of Powers Road and the 60" corrugated steel pipe (CSP) that conveys developed runoff under Powers Road to the west and into Sand Creek.

Please confirm that the swale directs runoff west to Sand Creek.

DEVELOPED DRAINAGE BASINS

The proposed 1250 Ainsworth, Lot 3 Powers Pointe Filing No. 5 project has been divided into 6 on-site basins (A1, A2, A3, B, C & D) and 2 off-site basins (OS1 & OS2). Off-site basin OS1 (0.72 ac.) is the pavement and some landscape areas of Ainsworth Street north of the project that sheet flows into the westerly curb and gutter and into A1. Basin A1 (0.13 ac.) is the portion of Ainsworth Street on the subject property. Curb and gutter on the west side of Ainsworth Street convey developed flows from this basin and basin OS1 to a 5' Type R sump curb located in the low point of the basin. Basin A2 (0.32 ac.) is the parking and access area on the east side of the buildi from this basin sheet flows to curb and gutter which conveys developed fl southerly driveway and into the curb and gutter in basin A1, just upstrea Type R sump curb inlet. An 18" RCP storm sewer conveys developed flow inlet to the west to a storm sewer manhole at a junction with an 8" PVC st from Basin A3. Developed runoff from basin A3 (0.42 ac) which includes the building roof and the parking and access drive areas on the north, south and west sides of the building, sheet flows to curb and gutter which conveys flows to a single Type 13 combination sump inlet in the low point of the basin. An PVC storm sewer convey developed flows from this inlet to the south to the storm sewer manhole at a junction with the 18" RCP storm sewer from basin A1 as previously discussed. An 18" RCP storm sewer conveys flows to the west to an 18" flared end section with rip rap outlet protection which discharges into a graded swale with a 2' wide bottom and 4:1 side slopes. This graded swale conveys flows to the west to the existing rip rap drainage swale on the east side of Powers Boulevard. Basin B (0.02 ac.) is the existing landscape area on the east side of Ainsworth Street that sheet flows to the east to the

Developed drainage conditions map shows type 16 combination inlet. Revise to remove inconsistencies.

South.

It appears to sheet flow to the southern property.

It appears to be west.

A Storage Place facility. Basin C (0.04 ac.) is a portion of the perimeter landscape area on the west side of the site that sheet flows to the west to the Powers Boulevard right-of-way. Basin D (0.04) is a portion of the perimeter landscape area on the south side of the site that sheet flows to the south to the unplatted, undeveloped property. The basins, design points, inlets, pipes and developed flows are shown on the developed drainage plan in the appendix. The developed flows for the basins and for the design points are summarized below.

It appears to sheet flow to the west towards Powers.

Basin Summary Table

Basin Name	Area (ac)	Percent Imperviousness	Time of Concentration tc (min)	Rainfall Intensity I (in/hr)		Peak Flow Q (cfs)	
				5-yr	100-yr	5-yr	100-yr
A1	0.13	95.1%	5.00	5.17	8.68	0.5	1.0
A2	0.32	88.8%	5.40	5.05	8.49	1.2	2.3
A3	0.42	84.5%	5.00	5.17	8.68	1.6	3.1
B	0.02	0.0%	5.00	5.17	8.68	0.01	0.1
C	0.04	0.0%	6.60	4.75	7.98	0.02	0.1
D	0.04	0.0%	5.70	8.35	8.35	0.03	0.1
OS1	0.72	87.5%	7.30	4.60	7.73	2.6	4.9
OS2	0.02	0.0%	5.00	5.17	8.68	0.01	0.1

Design Point Summary Table

Design Point	Tributary Basin(s)	Total Area (ac)	Composite C		Time of Concentration tc (min)	Rainfall Intensity I (in/hr)		Peak Flow Q (cfs)	
			5-yr	100-yr		5-yr	100-yr	5-yr	100-yr
1	OS1	0.72	0.80	0.88	7.3	4.60	7.73	2.6	4.9
2	OS1, A1 & A2	1.17	0.78	0.87	8.3	4.41	7.41	4.0	7.5
3	OS2 & A3	0.44	0.73	0.83	5.0	5.17	8.68	1.6	3.1
4	OS1, A1, A2, OS2 & A3	1.61	0.77	0.86	9.0	4.29	7.23	5.3	10.0

DRAINAGE FEES

This project site lies within the Sand Creek. All applicable drainage basin fees were paid at the time of platting for Powers Pointe Filing No. 1.

CONCLUSIONS

A. Compliance with Standards

This report has been prepared in accordance with the El Paso County Drainage Criteria Manual guideline for a “Letter Type” Drainage Report. The storm sewer improvements provide adequate protection to this site without adverse impacts on adjoining upstream or downstream properties.

B. Drainage Concept

The proposed drainage patterns and drainage design for the 1250 Ainsworth, Lot 3 Powers Pointe Filing No. 5 project conforms to the approved developed drainage design in the Powers Pointe Filing No. 1 Preliminary/Final Drainage Report”, dated May 5, 1996. Developed runoff from this project will be conveyed by an existing public drainage system that has been designed to convey developed flows from this site and will not have any negative impacts downstream properties.

REFERENCES

1. "El Paso County Drainage Criteria Manual" and updates.
2. "El Paso County Engineering Criteria Manual", October 14, 2020 (revised).
3. Mile High Flood District Urban Storm Drainage Criteria Manual, latest editions.
4. The United States Department of Agriculture, Natural Resources Conservation Service, “Web Soil Survey” data for the project site, retrieved from http://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.asp.

5. Federal Emergency Management Agency Flood Insurance Rate Map Number 08041C0751G, dated 12/7/2018.

6. Final Drainage Study for Powers Boulevard Phase I, prepared by K.K.B.N.A. Inc., May 1987 (revised).

7. Powers Pointe Filing No. 1 Preliminary/Final Drainage Report", prepared by Nolte and Associates, dated May 5, 1996.

Please update report contents to include the four step process as a narrative (and a narrative for each respective step) per ECM appendix I.7.2.A.

Elaborate on whether the proposed outfall, channel on the east side of Powers and culvert under Powers, is suitable per ECM 3.2.4.

Determine whether increase in runoff at that point will have significant impacts. Per ECM 3.2.8.B, historical drainage patterns should not change with proposed development. If runoff is not equal to historic amounts determine if difference in amount is negligible.

APPENDIX

Hydrologic Calculations

Hydraulic Calculations

Existing Conditions Drainage Plan

Developed Drainage Plan

Table 6-6. Runoff Coefficients for Rational Method
(Source: UDFCD 2001)

Land Use or Surface Characteristics	Percent Impervious	Runoff Coefficients											
		2-year		5-year		10-year		25-year		50-year		100-year	
		HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D
Business													
Commercial Areas	95	0.79	0.80	0.81	0.82	0.83	0.84	0.85	0.87	0.87	0.88	0.88	0.89
Neighborhood Areas	70	0.45	0.49	0.49	0.53	0.53	0.57	0.58	0.62	0.60	0.65	0.62	0.68
Residential													
1/8 Acre or less	65	0.41	0.45	0.45	0.49	0.49	0.54	0.54	0.59	0.57	0.62	0.59	0.65
1/4 Acre	40	0.23	0.28	0.30	0.35	0.36	0.42	0.42	0.50	0.46	0.54	0.50	0.58
1/3 Acre	30	0.18	0.22	0.25	0.30	0.32	0.38	0.39	0.47	0.43	0.52	0.47	0.57
1/2 Acre	25	0.15	0.20	0.22	0.28	0.30	0.36	0.37	0.46	0.41	0.51	0.46	0.56
1 Acre	20	0.12	0.17	0.20	0.26	0.27	0.34	0.35	0.44	0.40	0.50	0.44	0.55
Industrial													
Light Areas	80	0.57	0.60	0.59	0.63	0.63	0.66	0.66	0.70	0.68	0.72	0.70	0.74
Heavy Areas	90	0.71	0.73	0.73	0.75	0.75	0.77	0.78	0.80	0.80	0.82	0.81	0.83
Parks and Cemeteries	7	0.05	0.09	0.12	0.19	0.20	0.29	0.30	0.40	0.34	0.46	0.39	0.52
Playgrounds	13	0.07	0.13	0.16	0.23	0.24	0.31	0.32	0.42	0.37	0.48	0.41	0.54
Railroad Yard Areas	40	0.23	0.28	0.30	0.35	0.36	0.42	0.42	0.50	0.46	0.54	0.50	0.58
Undeveloped Areas													
Historic Flow Analysis--Greenbelts, Agriculture	2	0.03	0.05	0.09	0.16	0.17	0.26	0.26	0.38	0.31	0.45	0.36	0.51
Pasture/Meadow	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50
Forest	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50
Exposed Rock	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Offsite Flow Analysis (when landuse is undefined)	45	0.26	0.31	0.32	0.37	0.38	0.44	0.44	0.51	0.48	0.55	0.51	0.59
Streets													
Paved	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Gravel	80	0.57	0.60	0.59	0.63	0.63	0.66	0.66	0.70	0.68	0.72	0.70	0.74
Drive and Walks	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Roofs	90	0.71	0.73	0.73	0.75	0.75	0.77	0.78	0.80	0.80	0.82	0.81	0.83
Lawns	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50

3.2 Time of Concentration

One of the basic assumptions underlying the Rational Method is that runoff is a function of the average rainfall rate during the time required for water to flow from the hydraulically most remote part of the drainage area under consideration to the design point. However, in practice, the time of concentration can be an empirical value that results in reasonable and acceptable peak flow calculations.

For urban areas, the time of concentration (t_c) consists of an initial time or overland flow time (t_i) plus the travel time (t_t) in the storm sewer, paved gutter, roadside drainage ditch, or drainage channel. For non-urban areas, the time of concentration consists of an overland flow time (t_i) plus the time of travel in a concentrated form, such as a swale or drainageway. The travel portion (t_t) of the time of concentration can be estimated from the hydraulic properties of the storm sewer, gutter, swale, ditch, or drainageway. Initial time, on the other hand, will vary with surface slope, depression storage, surface cover, antecedent rainfall, and infiltration capacity of the soil, as well as distance of surface flow. The time of concentration is represented by Equation 6-7 for both urban and non-urban areas.

Calculation of Imperviousness and Runoff Coefficient Values

Designer: SMS
Company: CIVAS Engineering, LLC
Date: 5/13/2021
Project Name: 1250 Ainsworth St.
Project Number: 20-290

Hydrological Soil Group: B Land Use:	Paved Drives	Concrete/ Walks	Roofs	Gravel Roads	Lawns/ Native
Imperviousness:	100%	100%	90%	80%	0%
$C_{2:}$	0.89	0.89	0.71	0.57	0.02
$C_{5:}$	0.90	0.90	0.73	0.59	0.08
$C_{100:}$	0.96	0.96	0.81	0.70	0.35

Sub-Basin Name	Area (s.f.)	Area (s.f.)	Area (s.f.)	Area (s.f.)	Area (s.f.)	Imp and (s.f.)	Imp and (ac.)	Sub-Basin Composite Imperviousness and Runoff Coefficient Values: Imp. %	C_2	C_5	C_{100}
Ex-A1	4,995	0	0	0	0	4,995	0.11	100.0%	0.89	0.90	0.96
Ex-A2	0	0	0	0	6,635	6,635	0.15	0.0%	0.02	0.08	0.35
Ex-B	0	0	0	0	730	730	0.02	0.0%	0.02	0.08	0.35
Ex-C	0	0	0	0	22,370	22,370	0.51	0.0%	0.02	0.08	0.35
Ex-D	0	0	0	0	7,480	7,480	0.17	0.0%	0.02	0.08	0.35
Ex-OS1	27,495	0	0	0	3,910	31,405	0.72	87.5%	0.78	0.80	0.88
Ex-OS2	0	0	0	0	410	410	0.01	0.0%	0.02	0.08	0.35
Ex-OS3	0	0	0	0	300	300	0.01	0.0%	0.02	0.08	0.35

Calculation of Imperviousness and Runoff Coefficient Values

Designer: SMS
Company: CIVAS Engineering, LLC
Date: 5/13/2021
Project Name: 1250 Ainsworth St.
Project Number: 20-290

Hydrological Soil Group: B Land Use:	Paved Drives	Concrete/ Walks	Roofs	Gravel Roads	Lawns/ Native
Imperviousness:	100%	100%	90%	80%	0%
$C_{2:}$	0.89	0.89	0.71	0.57	0.02
$C_{5:}$	0.90	0.90	0.73	0.59	0.08
$C_{100:}$	0.96	0.96	0.81	0.70	0.35

Sub-Basin Name	Area (s.f.)	Area (s.f.)	Area (s.f.)	Area (s.f.)	Area (s.f.)	Imp and (s.f.)	Imp and (ac.)	Sub-Basin Composite Imperviousness and Runoff Coefficient Values: Imp. %	C_2	C_5	C_{100}
A1	5,255	0	0	0	270	5,525	0.13	95.1%	0.85	0.86	0.93
A2	8,485	0	4,410	0	1,130	14,025	0.32	88.8%	0.76	0.78	0.86
A3	10,865	725	4,290	0	2,400	18,280	0.42	84.5%	0.73	0.75	0.84
B	0	0	0	0	730	730	0.02	0.0%	0.02	0.08	0.35
C	0	0	0	0	1,875	1,875	0.04	0.0%	0.02	0.08	0.35
D	0	0	0	0	1,770	1,770	0.04	0.0%	0.02	0.08	0.35
TOTAL	24,605	725	8,700	0	8,175	42,205	0.97	78.6%	0.68	0.71	0.81
OS1	27,495	0	0	0	3,910	31,405	0.72	87.5%	0.78	0.80	0.88
OS2	0	0	0	0	710	710	0.02	0.0%	0.02	0.08	0.35

Standard Form SF-1, Time of Concentration

Designer: SMS
Company: CIVAS Engineering, LLC
Date: 5/13/2021
Project Name: 1250 Ainsworth St.
Project Number: 20-290

Area Description: Urbanized Area **min. tc = 5 min.**

Notes:
$T_i = (0.395*(1.1 - C_5)*(L)^0.5)/(S^0.33)$
T_t=L/60V (Velocity = Cv*Sw^0.5)

Cv =	2.5	Heavy Meadow
	5.0	Tillage / Field
	6.5	Rip Rap (not buried)
	7.0	Short Pasture and Lawns
	10.0	Nearly Bare Ground
	15.0	Grassed Waterway
	20.0	Paved Areas and Shallow Paved Swales

Sub-Basin Data			Initial/Overland Time (t_i)			Travel Time (t_t)					tc	tc Check (Urbanized Basins)		Final tc	Remarks
Basin Design.	C_5	Area (A) acres	Length (L) feet	Slope (S) %	t_i minutes	Length (L) feet	Slope (S) %	C_v	Velocity (V) ft/sec	t_t minutes	tc = ti+ tt minutes	Total Length (L) feet	t_c = (L/180)+10 minutes	minutes	
Ex-A1	0.90	0.11	30	4.0	1.3	170	2.5	20.0	3.16	0.9	5.0	200	11.1	5.0	min tc
Ex-A2	0.08	0.15	20	2.0	6.6	155	2.3	15.0	2.27	1.1	7.7	175	11.0	7.7	
Ex-B	0.08	0.02	3	5.0	1.9	40	2.0	20.0	2.83	0.2	5.0	43	10.2	5.0	min tc
Ex-C	0.08	0.51	230	1.3	25.6				0.00	0.0	25.6	230	11.3	11.3	tc Check
Ex-D	0.08	0.17	175	2.0	19.4				0.00	0.0	19.4	175	11.0	11.0	tc Check
Ex-OS1	0.80	0.72	10	2.0	1.4	960	1.8	20.0	2.68	6.0	7.3	970	15.4	7.3	
Ex-OS2	0.08	0.01	7	5.0	2.9				0.00	0.0	5.0	7	10.0	5.0	min tc
Ex-OS3	0.08	0.01	7	5.0	2.9				0.00	0.0	5.0	7	10.0	5.0	min tc

Standard Form SF-1, Time of Concentration

Designer: SMS
Company: CIVAS Engineering, LLC
Date: 5/13/2021
Project Name: 1250 Ainsworth St.
Project Number: 20-290

Area Description: Urbanized Area **min. tc = 5 min.**

Notes:
$T_i = (0.395*(1.1 - C_5)*(L)^0.5)/(S^0.33)$
T_t=L/60V (Velocity = Cv*Sw^0.5)

Cv =	2.5	Heavy Meadow
	5.0	Tillage / Field
	6.5	Rip Rap (not buried)
	7.0	Short Pasture and Lawns
	10.0	Nearly Bare Ground
	15.0	Grassed Waterway
	20.0	Paved Areas and Shallow Paved Swales

Sub-Basin Data			Initial/Overland Time (t_i)			Travel Time (t_t)					tc	tc Check (Urbanized Basins)		Final tc	Remarks
Basin Design.	C_5	Area (A) acres	Length (L) feet	Slope (S) %	t_i minutes	Length (L) feet	Slope (S) %	C_v	Velocity (V) ft/sec	t_t minutes	tc = ti+ tt minutes	Total Length (L) feet	t_c = (L/180)+10 minutes	minutes	
A1	0.86	0.13	30	4.0	1.5	170	2.5	20.0	3.16	0.9	5.0	200	11.1	5.0	min tc
A2	0.78	0.32	95	2.0	4.5	130	1.5	20.0	2.45	0.9	5.4	225	11.3	5.4	
A3	0.75	0.42	60	2.0	3.9	40	2.0	20.0	2.83	0.2	5.0	100	10.6	5.0	min tc
B	0.08	0.02	3	5.0	1.9				0.00	0.0	5.0	3	10.0	5.0	min tc
C	0.08	0.04	20	2.0	6.6				0.00	0.0	6.6	20	10.1	6.6	
D	0.08	0.04	15	2.0	5.7				0.00	0.0	5.7	15	10.1	5.7	
OS1	0.80	0.72	10	2.0	1.4	960	1.8	20.0	2.68	6.0	7.3	970	15.4	7.3	
OS2	0.08	0.02	7	5.0	2.9					0.0	5.0	7	10.0	5.0	min tc

Standard Form SF-2, Storm Drainage System Design (Rational Method Procedure)

Designer: SMS
Company: CIVAS Engineering, LLC
Date: 5/13/2021
Project Name: 1250 Ainsworth St.
Project Number: 20-290

Design Storm: 5-year

Note:
$I_{5} = -1.50 \times \ln(t_c) + 7.583$

STREET	Design Point	Direct Runoff							Total Runoff				Street		Pipe			Travel Time			REMARKS
		Basin Desig.	Area (A)	Runoff Coeff. (C)	t_c	C*A	I	Q	t_c	Σ(C*A)	I	Q	Slope	Street Flow	Design Flow	Slope	Pipe Size	Length	Velocity	t_t	
			ac.		min.		in/hr	cfs	min.		in/hr	cfs	%	cfs	cfs	%	in	ft	ft/sec	min	
	1	Ex-OS1	0.72	0.80	7.3	0.58	4.60	2.6				2.6	2.5	2.6				190	3.2	1.0	
	2	Ex-A1	0.11	0.90	5.0	0.10	5.17	0.5	8.3	0.68	4.41	3.0									
	2	Ex-A2	0.15	0.08	7.7	0.01	4.52	0.1	8.3	0.69	4.41	3.0									
	3	Ex-B	0.02	0.08	5.0	0.00	5.17	0.01				0.01									
		Ex-OS2	0.01	0.08	5.0	0.00	5.17	0.00				0.00									
	4	Ex-C	0.51	0.08	11.3	0.04	3.95	0.2	11.3	0.04	3.95	0.2									
		Ex-OS3	0.01	0.08	5.0	0.00	5.17	0.00				0.00									
	5	Ex-D	0.17	0.08	11.0	0.01	3.99	0.1	11.0	0.01	3.99	0.1									

Standard Form SF-2, Storm Drainage System Design (Rational Method Procedure)

Designer: SMS
Company: CIVAS Engineering, LLC
Date: 5/13/2021
Project Name: 1250 Ainsworth St.
Project Number: 20-290

Design Storm: 100-year

Note:
$I_{100} = -2.52 \times \ln(t_c) + 12.735$

STREET	Design Point	Direct Runoff							Total Runoff				Street		Pipe			Travel Time			REMARKS
		Basin Desig.	Area (A)	Runoff Coeff. (C)	t_c	C*A	I	Q	t_c	Σ(C*A)	I	Q	Slope	Street Flow	Design Flow	Slope	Pipe Size	Length	Velocity	t_t	
			ac.		min.		in/hr	cfs	min.		in/hr	cfs	%	cfs	cfs	%	in	ft	ft/sec	min	
	1	Ex-OS1	0.72	0.88	7.3	0.64	7.73	4.9				4.9	2.5	4.9				190	3.2	1.0	
	2	Ex-A1	0.11	0.96	5.0	0.11	8.68	1.0	8.3	0.75	7.41	5.5									
	2	Ex-A2	0.15	0.35	7.7	0.05	7.59	0.4	8.3	0.80	7.41	5.9									
	3	Ex-B	0.02	0.35	5.0	0.01	8.68	0.1				0.1									
		Ex-OS2	0.01	0.35	5.0	0.00	8.68	0.03				0.03									
	4	Ex-C	0.51	0.35	11.3	0.18	6.62	1.2	11.3	0.18	6.62	1.2									
		Ex-OS3	0.01	0.35	5.0	0.00	8.68	0.02				0.02									
	5	Ex-D	0.17	0.35	11.0	0.06	6.69	0.4	11.0	0.06	6.69	0.4									

Standard Form SF-2, Storm Drainage System Design (Rational Method Procedure)

Designer: SMS
Company: CIVAS Engineering, LLC
Date: 5/13/2021
Project Name: 1250 Ainsworth St.
Project Number: 20-290

Design Storm: 5-year

Note:
$I_{5=}$ -1.50 x ln(t_c) + 7.583

STREET	Design Point	Direct Runoff							Total Runoff				Street		Pipe			Travel Time			REMARKS
		Basin Desig.	Area (A)	Runoff Coeff. (C)	t_c	C*A	I	Q	t_c	Σ(C*A)	I	Q	Slope	Street Flow	Design Flow	Slope	Pipe Size	Length	Velocity	t_t	
			ac.		min.		in/hr	cfs	min.		in/hr	cfs	%	cfs	cfs	%	in	ft	ft/sec	min	
	1	OS1	0.72	0.80	7.3	0.58	4.60	2.6				2.6	2.5	2.6				190	3.2	1.0	
	2	A1	0.13	0.78	5.0	0.10	5.17	0.5				0.5									
	2	A2	0.32	0.75	5.4	0.24	5.05	1.2	8.3	0.92	4.41	4.0			4.0	0.5	24	170	4.0	0.7	
		OS2	0.02	0.08	5.0	0.00	5.17	0.01				0.01									
	3	A3	0.42	0.75	5.0	0.32	5.17	1.6	5.0	0.32	5.17	1.6									
	4								9.0	1.23	4.29	5.3									
		B	0.02	0.08	5.0	0.00	5.17	0.01				0.01									
		C	0.04	0.08	6.6	0.00	4.75	0.02				0.02									
		D	0.04	0.08	5.7	0.00	8.35	0.03				0.03									

Standard Form SF-2, Storm Drainage System Design (Rational Method Procedure)

Designer: SMS
Company: CIVAS Engineering, LLC
Date: 5/13/2021
Project Name: 1250 Ainsworth St.
Project Number: 20-290

Design Storm: **100-year**

Note:
$I_{100} = -2.52 \times \ln(t_c) + 12.735$

STREET	Design Point	Direct Runoff							Total Runoff				Street		Pipe			Travel Time			REMARKS
		Basin Desig.	Area (A)	Runoff Coeff. (C)	t_c	C*A	I	Q	t_c	Σ(C*A)	I	Q	Slope	Street Flow	Design Flow	Slope	Pipe Size	Length	Velocity	t_t	
			ac.		min.		in/hr	cfs	min.		in/hr	cfs	%	cfs	cfs	%	in	ft	ft/sec	min	
	1	OS1	0.72	0.88	7.3	0.64	7.73	4.9				4.9	2.5	4.9				190	3.2	1.0	
	2	A1	0.13	0.86	5.0	0.11	8.68	1.0				1.0									
	2	A2	0.32	0.84	5.4	0.27	8.49	2.3	8.3	1.02	7.41	7.5			7.5	0.5	18	170	4.7	0.6	
		OS2	0.02	0.35	5.0	0.01	8.68	0.1				0.1									
	3	A3	0.42	0.84	5.0	0.35	8.68	3.1	5.0	0.36	8.68	3.1									
	4								8.9	1.38	7.23	10.0									
		B	0.02	0.35	5.0	0.01	8.68	0.1				0.1									
		C	0.04	0.35	6.6	0.02	7.98	0.1				0.1									
		D	0.04	0.35	5.7	0.01	8.35	0.1				0.1									

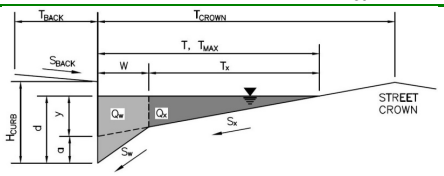
Version 4.05 Released March 2017

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: 1250 Ainsworth St.

Inlet ID: Inlet 1 - DP2



Gutter Geometry (Enter data in the blue cells)

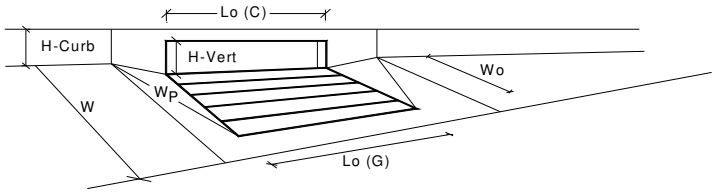
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	1.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	20.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.040	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.014	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	20.0	20.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	8.0	inches
Check boxes are not applicable in SUMP conditions		☐	☐	

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	**Q_{allow} =**	**SUMP**	**SUMP**	**cfs**

INLET IN A SUMP OR SAG LOCATION

Version 4.05 Released March 2017



Design Information (Input)	CDOT Type R Curb Opening	MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1	1	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	6.0	8.0	inches
Grate Information		MINOR	MAJOR	☐ Override Depths
Length of a Unit Grate	L_o (G) =	N/A	N/A	feet
Width of a Unit Grate	W_o =	N/A	N/A	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	N/A	N/A	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	5.00	5.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.67	0.67	
Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	N/A	N/A	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.33	0.50	ft
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	0.77	1.00	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	1.00	1.00	
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	N/A	N/A	
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**5.4**	**9.3**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	4.0	7.5	cfs

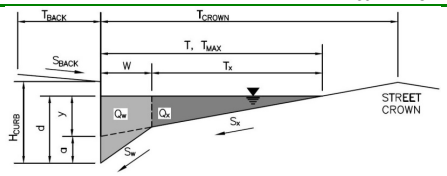
Version 4.05 Released March 2017

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: 1250 Ainsworth St.

Inlet ID: Inlet 2 - DP3



Gutter Geometry (Enter data in the blue cells)

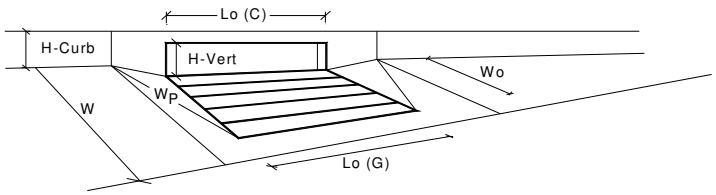
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	5.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.030	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	20.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.040	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.014	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	20.0	20.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	6.0	inches
Check boxes are not applicable in SUMP conditions		☐	☐	

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	**Q_{allow} =**	**SUMP**	**SUMP**	**cfs**

INLET IN A SUMP OR SAG LOCATION

Version 4.05 Released March 2017



Design Information (Input)		MINOR	MAJOR	
Type of Inlet (Denver No. 16 Combination)	Type =	Denver No. 16 Combination		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	2.00	2.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1	1	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	6.0	6.0	inches
Grate Information		MINOR	MAJOR	Override Depths
Length of a Unit Grate	L_o (G) =	3.00	3.00	feet
Width of a Unit Grate	W_o =	1.73	1.73	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	0.31	0.31	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	0.50	0.50	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	3.60	3.60	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	0.60	0.60	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	3.00	3.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.50	6.50	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	5.25	5.25	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	0.00	0.00	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.70	3.70	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.66	0.66	

Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	0.523	0.523	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.33	0.33	ft
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	0.94	0.94	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	1.00	1.00	
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	0.94	0.94	

		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**3.9**	**3.9**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	1.6	3.1	cfs

HYDRAULIC GRADE

CALCULATIONS - 5 year storm

CALCULATED BY: SMS
DATE: 5/13/2021
CHECKED BY: SMS

PROJECT NAME: 1250 Ainsworth St.
PROJECT NO.: 20-290

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22		23		24		23		24
STA	INVERT	D in.	W.S.	Pipe Slope ft./ft.	Rough Coeff.	Q cfs	Q_{full} cfs	Flow Depth in.	V fps	A sf	R	D_m ft.	Froude	H_v ft.	E.G. E.G.	c*	S_f S_f	Ave. S_f S_f	L L	H_f H_f	H_b K_b	H_b	Hj K_j	Hj	Hm K_m	Hm	Ht K_t	Ht	Total Loss Loss
Storm Line 1																													
18" F.E.S. out	6264.80	18	6265.55	0.0100	0.013	5.30	10.50	9.00	5.99	0.88	0.38	0.59	1.38	0.56	6266.11	0.00492	0.0101	Open Channel Flow											0.00
Storm MH out	6264.95	18	6265.70	0.0100	0.013	5.30	10.50	9.00	5.99	0.88	0.38	0.59	1.38	0.56	6266.26	0.00492	0.0101	Open Channel Flow											0.00
Storm MH in	6265.15	18	6265.90	0.0060	0.013	4.00	8.14	9.00	4.52	0.88	0.38	0.59	1.04	0.32	6266.22	0.00492	0.0058	Open Channel Flow											0.00
5' Type R Inlet out	6266.15	18	6266.90	0.0060	0.013	4.00	8.14	9.00	4.52	0.88	0.38	0.59	1.04	0.32	6267.22	0.00492	0.0058	Open Channel Flow											0.00
Storm Line 2																													
Storm MH out	6264.95	18	6265.70	0.0100	0.013	5.30	10.50	9.00	5.99	0.88	0.38	0.59	1.38	0.56	6266.26	0.00492	0.0101	Open Channel Flow											0.00
Storm MH in	6265.78	8	6266.08	0.0580	0.010	1.60	3.78	3.60	10.50	0.15	0.16	0.23	3.86	1.71	6267.79	0.00291	0.0594	Open Channel Flow											0.00
Single Denver Type 16 Inlet out	6266.80	8	6267.10	0.0580	0.010	1.60	3.78	3.60	10.50	0.15	0.16	0.23	3.86	1.71	6268.81	0.00291	0.0594	Open Channel Flow											0.00

NOTES:

$c^*=2g(n^2)/2.21$ $S_f = c^*Hv/R^{1.33}$

HYDRAULIC GRADE

CALCULATIONS - 100 year storm

CALCULATED BY: SMS
DATE: 5/13/2021
CHECKED BY: SMS

PROJECT NAME: 1250 Ainsworth St.
PROJECT NO.: 20-290

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22		23		24		23		24
STA	INVERT	D in.	W.S.	Pipe Slope ft./ft.	Rough Coeff.	Q cfs	Q_{full} cfs	Flow Depth in.	V fps	A sf	R	D_m ft.	Froude	H_v ft.	E.G. E.G.	c*	S_f S_f	Ave. S_f S_f	L L	H_f H_f	H_b K_b	H_b	Hj K_j	Hj	Hm K_m	Hm	Ht K_t	Ht	Total Loss Loss
Storm Line 1																													
18" F.E.S. out	6264.80	18	6265.96	0.0100	0.013	10.00	10.50	13.86	6.85	1.46	0.45	1.16	1.12	0.73	6266.68	0.00492	0.0102	Open Channel Flow											0.00
Storm MH out	6264.95	18	6266.11	0.0100	0.013	10.00	10.50	13.86	6.85	1.46	0.45	1.16	1.12	0.73	6266.83	0.00492	0.0102	Open Channel Flow											0.00
Storm MH in	6265.15	18	6266.28	0.0060	0.013	7.50	8.14	13.50	5.27	1.42	0.45	1.10	0.89	0.43	6266.71	0.00492	0.0061	Open Channel Flow											0.00
5' Type R Inlet out	6266.15	18	6267.28	0.0060	0.013	7.50	8.14	13.50	5.27	1.42	0.45	1.10	0.89	0.43	6267.71	0.00492	0.0061	Open Channel Flow											0.00
Storm Line 2																													
Storm MH out	6264.95	18	6266.11	0.0100	0.013	10.00	10.50	13.86	6.85	1.46	0.45	1.16	1.12	0.73	6266.83	0.00492	0.0102	Open Channel Flow											0.00
Storm MH in	6265.78	8	6266.23	0.0580	0.010	3.10	3.78	5.44	12.26	0.25	0.20	0.41	3.39	2.33	6268.57	0.00291	0.0597	Open Channel Flow											0.00
Single Denver Type 16 Inlet out	6266.80	8	6267.25	0.0580	0.010	3.10	3.78	5.44	12.26	0.25	0.20	0.41	3.39	2.33	6269.59	0.00291	0.0597	Open Channel Flow											0.00

NOTES:

$c^*=2g(n^2)/2.21$ $S_f = c^*Hv/R^{1.33}$

FLOW CAPACITY CALCULATION WORKSHEET
FOR

Grass Swale
with
2.00 ft bottom width
4 : 1 left side slope
4 : 1 right side slope

Input Data

Channel Depth:	**2.00**	ft.
Material:	**grass**	
Mannings Coefficient:	**0.035**	
Bottom Width:	**2.00**	ft.
Left Side Slope:	**25.0**	%
Right Side Slope:	**25.0**	%
Channel Top Width:	**2.0**	ft.
Longitudinal Slope:	**1.00**	%
Assumed Depth of Flow:	**0.80**	ft.

Calculation Results

cross-sectional area:	**4.16**	s.f.
wetted perimeter:	**8.60**	ft.
Capacity:	**10.89**	cfs
Velocity:	**2.62**	fps
Velocity Head:	**0.11**	ft.

Grass Swale Flow:	**10.89 cfs**	
100-yr Design Flow:	**10.00**	**OK**

RIP RAP CALCULATIONS

18" STORM SEWER OUTFALL

Pipe Dia. = 18 in
Q_{100} = 10 cfs
F_n = 1.12 Supercritical Flow
Y_n = 1.16 ft
Y_t = 0.8 ft

ASSUMPTIONS: V_{MAX} = 5.0 fps,

D = 1.5 ft
$D_a = (D + Y_n) / 2$ = 1.33 ft
$Y_t / D = .8 / 1.5$ = 0.53

$Q/Da^{1.5}$ = $10.0 / 1.33^{1.5}$ = 6.5
FROM FIGURE 9-38 - USE **TYPE L RIPRAP**

$Q/Da^{2.5}$ = $10.0 / 1.33^{2.5}$ = 4.9
FROM FIGURE 9-35 - **1/2 TAN 0 = 3.9**

A_t = 10.0 / 5.0 = **2.00 sq ft**

Y_t = **0.8 ft**

L = 1/2 TAN 0 x (A_t / Y_t - D) = **3.9 ft**
L_{MIN} = 3 x D = 3 x 1.5 = **4.5ft**
L_{MAX} = 10 x D = 10 x 1.5 = **15 ft**
W = 3 x D = 3 x 1.5 = **4.5 ft**

FROM FIGURE 8-34 - **d_{50} = 9"**

USE 5 ft W x 5 ft L TYPE H SOIL RIPRAP, d_{50} = 9"

$$H_a = \frac{(H + Y_n)}{2}$$ Equation 9-19

Where the maximum value of H_a shall not exceed H, and:

D_a = parameter to use in place of D in Figure 9-38 when flow is supercritical (ft)

D_c = diameter of circular culvert (ft)

H_a = parameter to use in place of H in Figure 9-39 when flow is supercritical (ft)

H = height of rectangular culvert (ft)

Y_n = normal depth of supercritical flow in the culvert (ft)

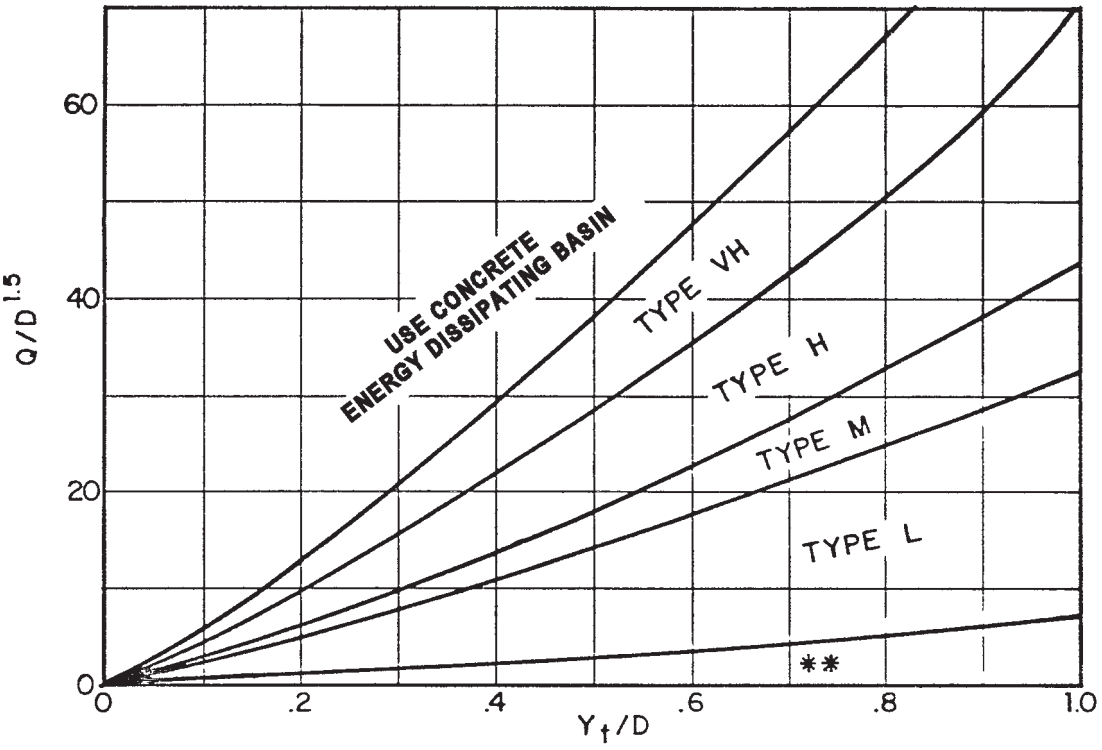


Figure 9-38. Riprap erosion protection at circular conduit outlet (valid for Q/D2.5 ≤ 6.0)

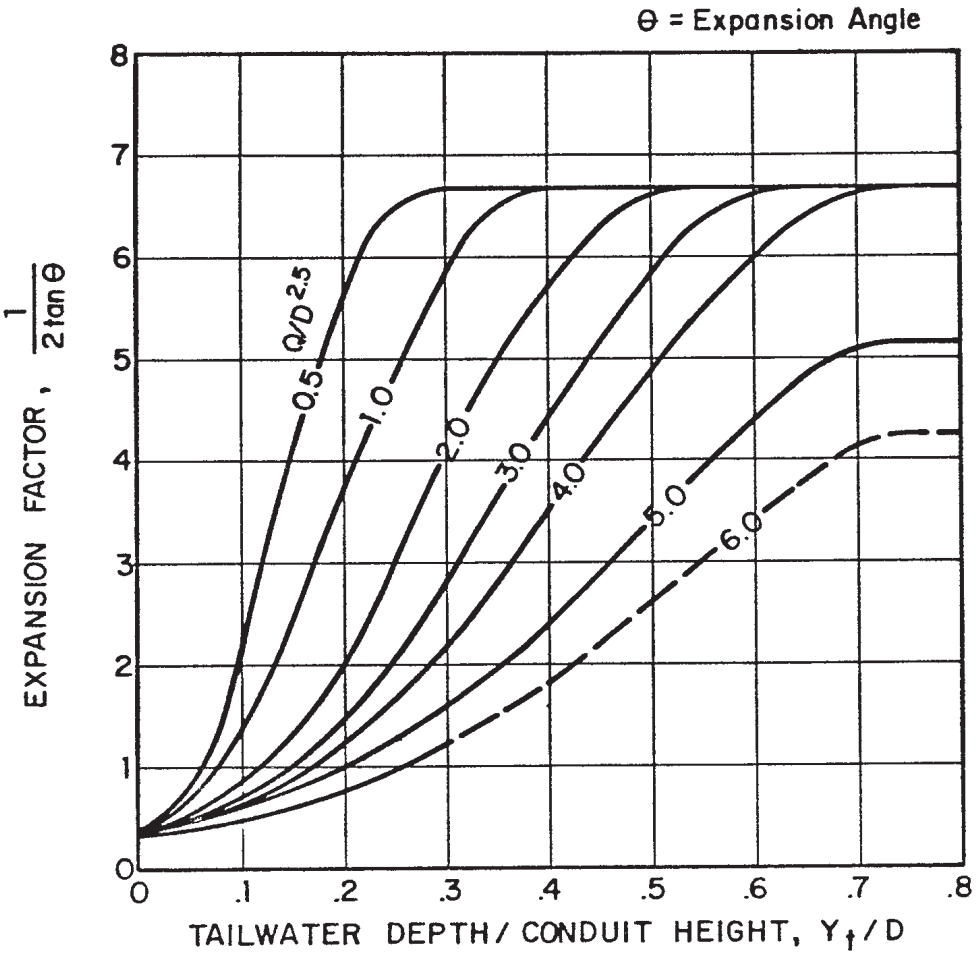
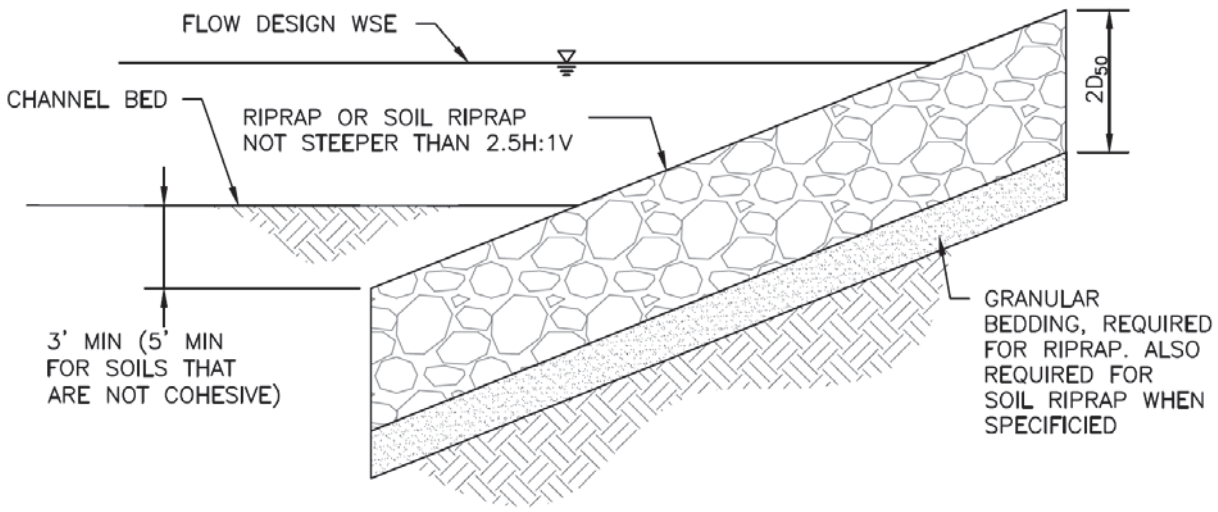


Figure 9-35. Expansion factor for circular conduits



RIPRAP DESIGNATION	% SMALLER THAN GIVEN SIZE BY WEIGHT	INTERMEDIATE ROCK DIMENSION (INCHES)	D_{50}* (INCHES)
TYPE VL	70 – 100 50 – 70 35 – 50 2 – 10	12 9 6 2	6
TYPE L	70 – 100 50 – 70 35 – 50 2 – 10	15 12 9 3	9
TYPE M	70 – 100 50 – 70 35 – 50 2 – 10	21 18 12 4	12
TYPE H	70 – 100 50 – 70 35 – 50 2 – 10	30 24 18 6	18
*D_{50} = MEAN ROCK SIZE			

Figure 8-34. Riprap and soil riprap placement and gradation (part 1 of 3)

SOIL RIPRAP NOTES:

1. ELEVATION TOLERANCES FOR THE SOIL RIPRAP SHALL BE 0.10 FEET. THICKNESS OF SOIL RIPRAP SHALL BE NO LESS THAN THICKNESS SHOWN AND NO MORE THAN 2—INCHES GREATER THAN THE THICKNESS SHOWN.

2. WHERE "SOIL RIPRAP" IS DESIGNATED ON THE CONTRACT DRAWINGS, RIPRAP VOIDS ARE TO BE FILLED WITH NATIVE SOIL. THE RIPRAP SHALL BE PRE—MIXED WITH THE NATIVE SOIL AT THE FOLLOWING PROPORTIONS BY VOLUME: 65PERCENT RIPRAP AND 35 PERCENT SOIL. THE SOIL USED FOR MIXING SHALL BE NATIVE TOPSOIL AND SHALL HAVE A MINIMUM FINES CONTENT OF 15 PERCENT. THE SOIL RIPRAP SHALL BE INSTALLED IN A MANNER THAT RESULTS IN A DENSE, INTERLOCKED LAYER OF RIPRAP WITH RIPRAP VOIDS FILLED COMPLETELY WITH SOIL. SEGREGATION OF MATERIALS SHALL BE AVOIDED AND IN NO CASE SHALL THE COMBINED MATERIAL CONSIST PRIMARILY OF SOIL; THE DENSITY AND INTERLOCKING NATURE OF RIPRAP IN THE MIXED MATERIAL SHALL ESSENTIALLY BE THE SAME AS IF THE RIPRAP WAS PLACED WITHOUT SOIL.

3. WHERE SPECIFIED (TYPICALLY AS "BURIED SOIL RIPRAP"), A SURFACE LAYER OF TOPSOIL SHALL BE PLACED OVER THE SOIL RIPRAP ACCORDING TO THE THICKNESS SPECIFIED ON THE CONTRACT DRAWINGS. THE TOPSOIL SURFACE LAYER SHALL BE COMPACTED TO APPROXIMATELY 85% OF MAXIMUM DENSITY AND WITHIN TWO PERCENTAGE POINTS OF OPTIMUM MOISTURE IN ACCORDANCE WITH ASTM D698. TOPSOIL SHALL BE ADDED TO ANY AREAS THAT SETTLE.

4. ALL SOIL RIPRAP THAT IS BURIED WITH TOPSOIL SHALL BE REVIEWED AND APPROVED BY THE ENGINEER PRIOR TO ANY TOPSOIL PLACEMENT.

GRADATION FOR GRANULAR BEDDING		
U.S. STANDARD SIEVE SIZE	PERCENT PASSING BY WEIGHT	
	TYPE I CDOT SECT. 703.01	TYPE II CDOT SECT. 703.09 CLASS A
3 INCHES	—	90 — 100
1½ INCHES	—	—
¾ INCHES	—	20 — 90
⅜ INCHES	100	—
#4	95 — 100	0 — 20
#16	45 — 80	—
#50	10 — 30	—
#100	2 — 10	—
#200	0 — 2	0 — 3

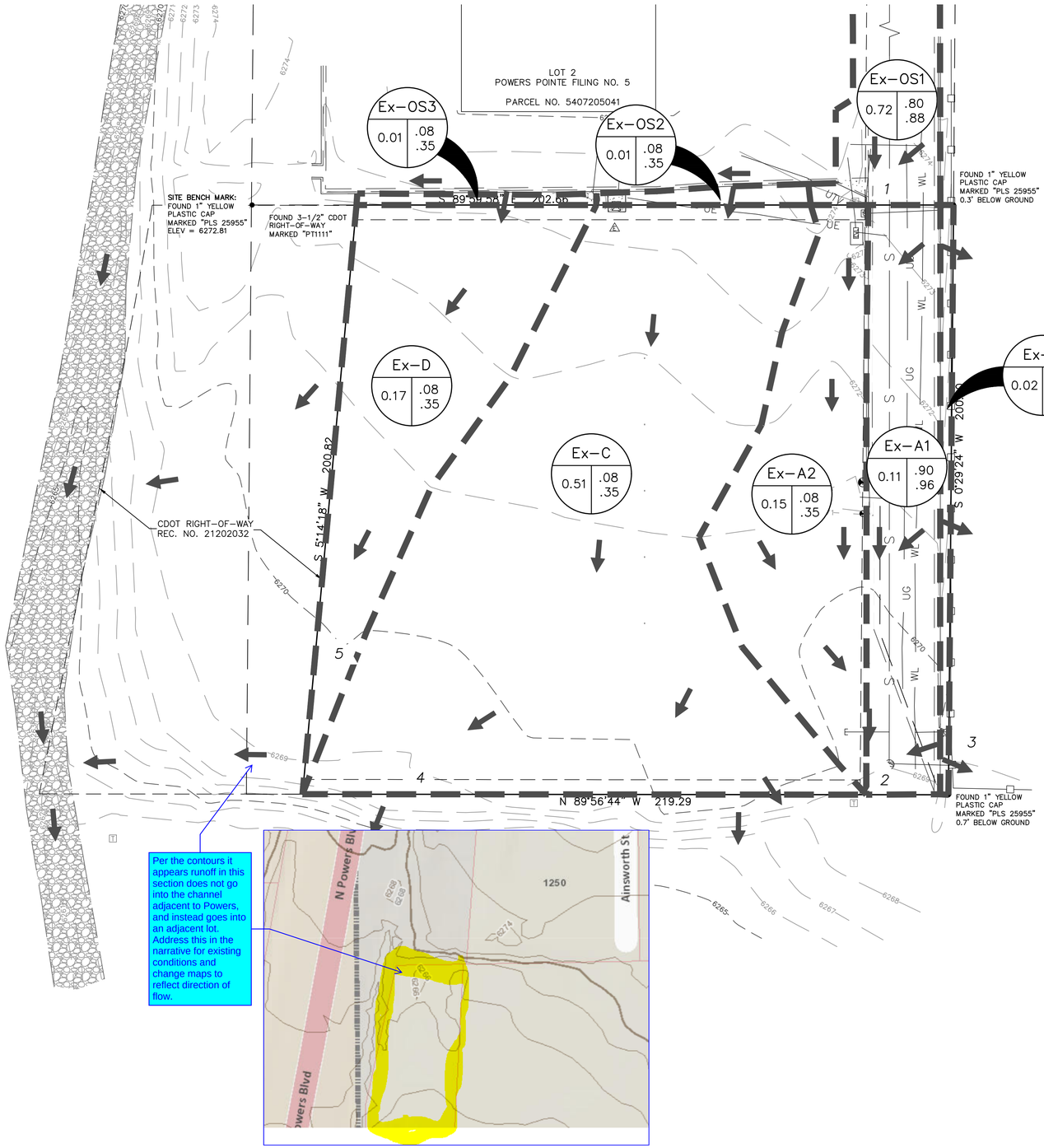
RIPRAP BEDDING

Figure 8-34. Riprap and soil riprap placement and gradation (part 2 of 3)

THICKNESS REQUIREMENTS FOR GRANULAR BEDDING			
RIPRAP DESIGNATION	MINIMUM BEDDING THICKNESS (INCHES)		
	FINE–GRAINED SOILS [1]		COARSE–GRAINED SOILS [2]
	TYPE I (LOWER LAYER)	TYPE II (UPPER LAYER)	TYPE II
VL (D_{50} = 6 IN)	4	4	6
L (D_{50} = 9 IN)	4	4	6
M (D_{50} = 12 IN)	4	4	6
H (D_{50} = 18 IN)	4	6	8
VH (D_{50} = 24 IN)	4	6	8

NOTES:
1. MAY SUBSTITUTE ONE 12–INCH LAYER OF TYPE II BEDDING. THE SUBSTITUTION OF ONE LAYER OF TYPE II BEDDING SHALL NOT BE PERMITTED AT DROP STRUCTURES. THE USE OF A COMBINATION OF FILTER FABRIC AND TYPE II BEDDING AT DROP STRUCTURES IS ACCEPTABLE.
2. FIFTY PERCENT OR MORE BY WEIGHT RETAINED ON THE #40 SIEVE.

Figure 8-34. Riprap and soil riprap placement and gradation (part 3 of 3)



LEGEND:

- PROPERTY LINE
- RIGHT-OF-WAY LINE
- LOT LINE
- EASEMENT LINE
- EX. CABLE TV PEDESTAL
- EX. ELECTRIC METER
- EX. ELECTRIC TRANSFORMER
- EX. ELECTRIC VAULT
- EX. ELECTRIC LIGHT POLE
- EX. SANITARY SEWER MANHOLE
- EX. TELEPHONE PEDESTAL
- EX. FIRE HYDRANT
- EX. CHAIN LINK FENCE
- SS — EX. UNDERGROUND SANITARY SEWER
- UTV — EX. UNDERGROUND CABLE TV LINE
- UE — EX. UNDERGROUND ELECTRIC LINE
- UG — EX. UNDERGROUND GAS LINE
- UT — EX. UNDERGROUND TELEPHONE LINE
- WL — EX. UNDERGROUND WATER LINE
- EX. CONCRETE
- 6000 — EX. CONTOUR

A = BASIN DESIGNATION
B = AREA IN ACRES
C = 5 YEAR RUNOFF COEFFICIENT
D = 100 YEAR RUNOFF COEFFICIENT

A — DESIGN POINT

BASIN BOUNDARY

DRAINAGE FLOW DIRECTION

SUMMARY RUNOFF TABLE

DESIGN PT.	BASINS	CONTRIBUTING AREA acres	Q_5 cfs	Q_{100} cfs
1	Ex-OS1	0.72	2.6	4.9
2	Ex-OS1, Ex-A1, Ex-A2	0.99	3.0	5.9
3	Ex-B	0.02	0.01	0.1
4	Ex-OS2, Ex-C	0.52	0.2	1.2
5	Ex-OS3, Ex-D	0.18	0.1	0.4

N

0 10 20 40 60

SCALE: 1" = 20'

CALL UTILITY NOTIFICATION CENTER OF COLORADO 811
CALL 2-BUSINESS DAYS IN ADVANCE BEFORE YOU DIG, GRADE, OR EXCAVATE FOR THE MARKING OF UNDERGROUND MEMBER UTILITIES.

REVISION	DATE	BY

DATE: 6/4/2021
DESIGNED BY: SMS
DRAWN BY: SS
CHECKED BY

1250 AINSWORTH ST.
EL PASO COUNTY, CO
EXISTING CONDITIONS DRAINAGE PLAN

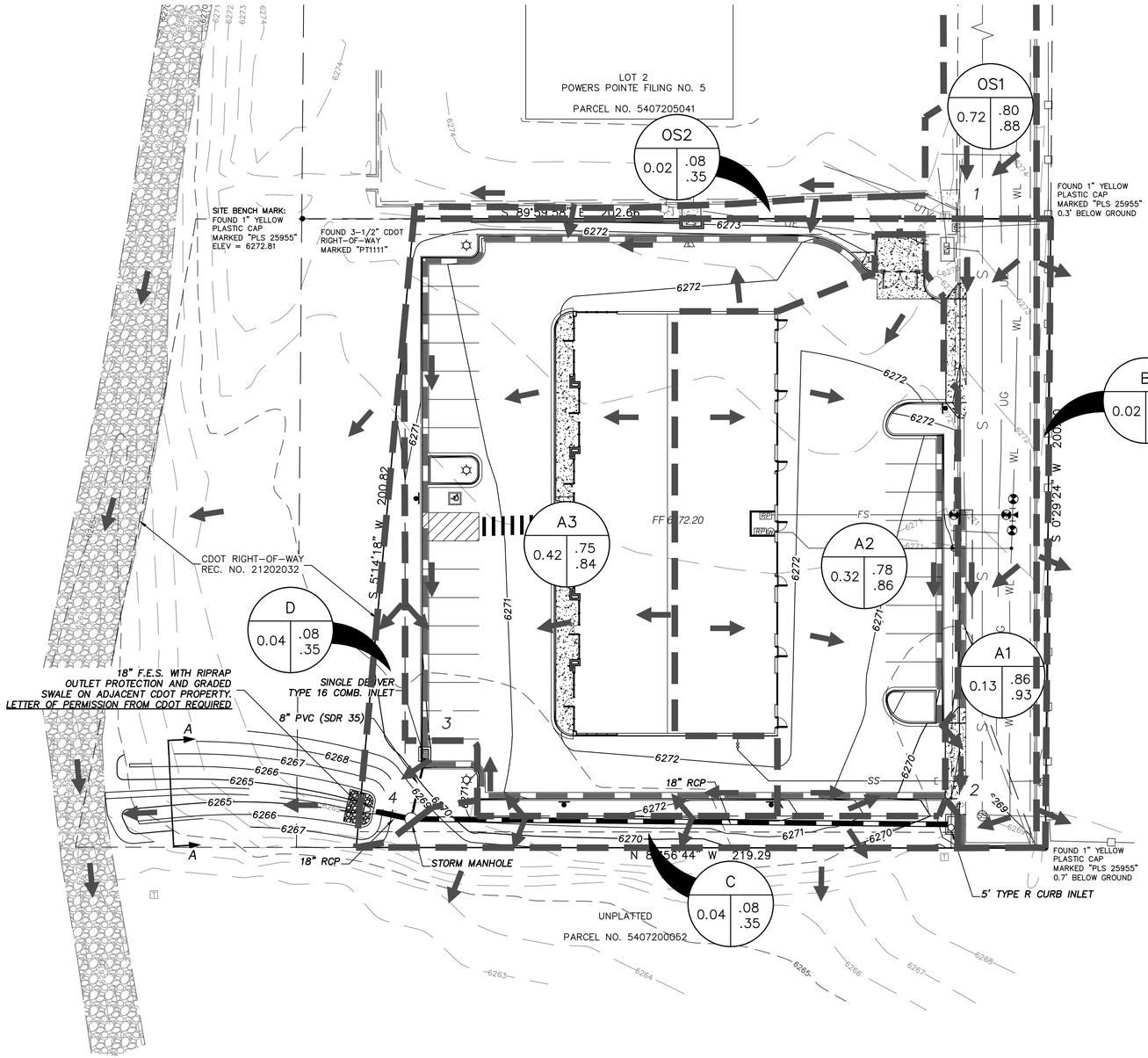
CIVAS engineering
civil engineering solutions
10056 Brisbane Lane
Littleton · Colorado · 80130
720-240-5882
civas-eng.com

COLORADO LICENSED
STEVEN M. STRICKLING
31237
6-4-2021
PROFESSIONAL ENGINEER

STEVEN M. STRICKLING
COLORADO P.E. NO. 31237
FOR AND ON BEHALF OF
CIVAS ENGINEERING, LLC

JOB NO. 20-290

SHEET 1 OF 1



LEGEND:

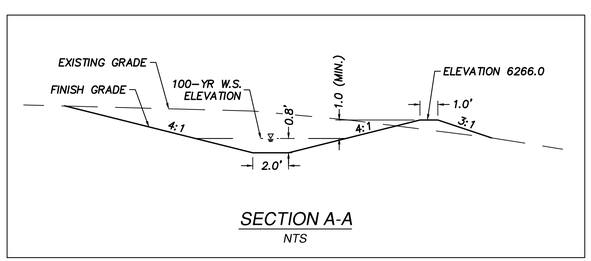
- PROPERTY LINE
- RIGHT-OF-WAY LINE
- LOT LINE
- EASEMENT LINE
- EX. CABLE TV PEDESTAL
- EX. ELECTRIC METER
- EX. ELECTRIC TRANSFORMER
- EX. ELECTRIC VAULT
- EX. ELECTRIC LIGHT POLE
- EX. SANITARY SEWER MANHOLE
- EX. TELEPHONE PEDESTAL
- EX. FIRE HYDRANT
- EX. CHAIN LINK FENCE
- EX. UNDERGROUND SANITARY SEWER
- EX. UNDERGROUND CABLE TV LINE
- EX. UNDERGROUND ELECTRIC LINE
- EX. UNDERGROUND GAS LINE
- EX. UNDERGROUND TELEPHONE LINE
- EX. UNDERGROUND WATER LINE
- EX. CONCRETE
- EX. CONTOUR
- PROPOSED CONTOUR
- GRADING DAYLIGHT LINE
- LIGHT POLE
- RCP STORM SEWER
- PVC STORM SEWER
- FIRE SERVICE LINE
- WATER SERVICE LINE
- SANITARY SEWER SERVICE LINE
- RETANING WALL-STRUCTURAL DESIGN BY OTHERS
- 2' CATCH CURB AND GUTTER
- 1' SPILL CURB AND GUTTER
- ASPHALT PAVEMENT-PAVEMENT DESIGN BY OTHERS
- CONCRETE PAVEMENT - PAVEMENT DESIGN BY OTHERS

A = BASIN DESIGNATION
B = AREA IN ACRES
C = 5 YEAR RUNOFF COEFFICIENT
D = 100 YEAR RUNOFF COEFFICIENT

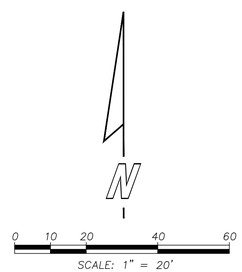
- DESIGN POINT
- BASIN BOUNDARY
- DRAINAGE FLOW DIRECTION

SUMMARY RUNOFF TABLE

DESIGN PT.	BASINS	CONTRIBUTING AREA acres	Q_5 cfs	Q_{100} cfs
1	OS1	0.72	2.6	4.9
2	OS1, A1, A2	1.17	4.0	7.5
3	OS2, A3	0.44	1.6	3.1
4	OS1, OS2, A1 – A3	1.61	5.3	10.0
	B	0.02	0.01	0.1
	C	0.04	0.02	0.1
	D	0.04	0.03	0.1



SECTION A-A
NTS



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CALL 2-BUSINESS DAYS IN ADVANCE BEFORE YOU DIG, GRADE, OR EXCAVATE FOR THE MARKING OF UNDERGROUND MEMBER UTILITIES.

REVISION	DATE	BY

DATE: 5/17/2021
DESIGNED BY: SMS
DRAWN BY: SS
CHECKED BY

1250 AINSWORTH ST.
EL PASO COUNTY, CO

DEVELOPED DRAINAGE PLAN

CIVAS engineering
civil engineering solutions
10056 Brebane Lane
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