EPC STORMWATER REVIEW COMMENTS
IN ORANGE BOXES WITH BLACK TEXT

LOT 5, BLOCK 1 PALMER PARK BUSINESS CENTER SUBDIVISION FILING NO. 3 "PHASES TRUCK AND AUTO REPAIR ADDITION" DRAINAGE LETTER

1670 PAONIA STREET
COLORADO SPRINGS, COLORADO
80915

PREPARED FOR: CASCO CONTRUCTION CORP.
1775 JET STREAM DRIVE
SUITE 102
COLORADO SPRINGS, CO 80921
(719) 380-1140

add text:
PCD Filing No.:
PPR-21-021

January 14, 2021

Prepared by
Richard Lyon, P.E.
Rocky Mountain Group
2910 Austin Bluffs Blvd. | Colorado Springs, CO 80918 | 719-434-5638

SIGNATURE PAGE

LOT 5, BLOCK 1 PALMER PARK BUSINESS CENTER SUBDIVISION FIL. NO. 3
1670 PAONIA STREET
"PHASES TRUCK AND AUTO REPAIR" MINOR AMENDMENT BUILDING ADDITION

ENGINEER'S STATEMENT

Replace with the following text:
"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."

SIGNATURE (Affix Seal): ______________________________

Colorado P.E. No.: 53921 Date:

Please provide name of design engineer before PE number.

This site is considered a "High-Risk Site" per our ECM as outlined in the notes below:

<u>High Risk Sites (per ECM Appendix I.4.2 and I.7.2):</u>

Potential high-risk sites must complete an ESQCP form and all subsequent documentation (FAE, GEC, SWMP, and SWMP & GEC Checklists). High-risk sites are defined by two factors:

- Sites with land uses involving the potential for significant deposition of pollutants.
- Sites without practices to eliminate exposure of pollutants to stormwater.

Basically: high risk sites are 1) sites with contaminants and 2) sites with heavy traffic.

Examples of high-risk sites:

- Automobile salvage and junk yards
- Automobile maintenance and repair facilities
- Gas stations
- Industrial sources
- Restaurants
- Commercial sites with high levels of "in and out" traffic such as fast-food restaurants and convenience stores.

For all high-risk sites (>1ac or <1ac of soil disturbance), Specialized BMPs should be <u>considered</u> (but are not required per EPC criteria). And per Figure I-2 of ECM Appendix I, acceptable Specialized BMPs include porous landscape detention (PLD) or sand filter basins (SFB) – both of which must be designed for the WQCV, per their details in DCMV2 – 4.2.

Please show the "Four-Step Process" for selecting structural BMPs (ECM Section I.7.2 BMP Selection).

DEVELOPER'S STATEMENT

Replace with the following text:

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

____
Name of Developer

____
Authorized Signature Date

____
Printed Name

____
Title

____
Address

Replace with the following text:

"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

Conditions:
"

TABLE OF CONTENTS

APPENDICES

A – Vicinity Map

B – Hydrologic and Hydraulic Computations

C – FEMA Floodplain Map

D – USGS Soils Survey Map

Please place existing and proposed drainage maps at the very end of the report.

Revise to lot 5.

I. Purpose

This report is a Drainage Letter for Lot 3 Palmer Park Business Center Subdivision Fil. No. 3, address 1670 Paonia Street, for the minor development plan amendment for the addition of a pre-engineered metal building PEMB) and wrap around asphalt drive access.

The purpose of this letteris to identify on-site and offsite drainage patterns, assess stormwater conditions per delineated basin and sub-basins, demonstrate adequate design standards for storm water flow and release into the existing storm water system, and provide a narrative for any other drainage considerations on the site.

II. General Location and Description

A. Location

The proposed development of a 9,030 square foot PEMB addition and an additional 12,628 square feet of paved asphalt, is located at the address of 1670 Paonia Street in the City of Colorado Springs, Colorado in El Paso County within the Palmer Park Business Center Subdivision with the land us of an I-2 CAD-0 development. The parcel Schedule Number is 5406304014 and the legal description is "Lot 5, Block 1 Palmer Park Business Center Sub. Fil. No. 3" and is 2.58 acres. The parcel is on the west side Paonia Street, between Palmer Park Boulevard and Omaha Boulevard. The parcel falls within Section 6, Township 14 South, Range 65 West of the 6^{th} P.M. The names and descriptions of surrounding platted developments can be seen on plan sets and appendix documents and are listed below:

North of Lot 5, Block 1 Palmer Park Business Center (1670 Paonia Street):

1720 Paonia Street, Owner: East Meriwether Properties LLC, Schedule No 55406304013, Zoning: I-2 CAD-O, Plat No. 6746, Lot 6 Block 1 Palmer Park Business Center Sub. Fil. No. 3.

West of Lot 2 Walker (3565 E Uintah Street):

5885 Palmer Park Blvd, Owner: US Realty 87 Colorado Springs, Schedule No. 5406304002, Zoning: CC CAD-O, Plat No. 5958, Lot 1 Block 1 Waldorf Subdivision.

South of Lot 5, Block 1 Palmer Park Business Center (1670 Paonia Street) west to east:

5918-5883 Palmer Park Blvd, Owner: Corevet Investment Group LLC, Schedule No. 5406304050, Zoning: CR CAD-O, Plat No. 12703, Lot 1 Powers Centre Filing No. 3.

Palmer Park Blvd, Owner: Corevet Investment Group LLC, Schedule No. 5406304017, Zoning: I-2 CAD-O, Plat No. 6698, Tract A Powers Plaza.

1620 Paonia Street, Owner: Structured LLC, Schedule No. 5406304015, Zoning: I-2 CAD-O, Plat No. 6698, Lot 4 Powers Plaza.

East of Lot 5, Block 1 Palmer Park Business Center (1670 Paonia Street) from north to south:

1620 Paonia Street, Owner: T M Properties LLC, Schedule No. 5406305002, Zoning: I-2 CAD-O, Plat No. 6494, Lot 1 Block1 Palmer Park Business Center Sub. Fil. No. 2.

1625 Paonia Street, Owner: Lebrun Properties LLC, Schedule No. 5406305001, Zoning: I-2 CAD-O, Plat No. 6494, Lot 2 Block1 Palmer Park Business Center Sub. Fil. No. 2

B. DESCRIPTION OF PROPERTY – EXISTING CONDITIONS

Lot 5 is approximately 112,385 square feet or 2.58 acres and is located on the west side of Paonia Street, south of Palmer Park Boulevard, and north of Omaha Boulevard. The parcel falls within Section 6, Township 14 South, Range 65 West of the 6th P.M., City of Colorado Springs, El Paso County, Colorado. The parcel is currently an auto repair shop that has an asphalt paved parking lot in the frontage and also wraps around the current 11,200 square foot building. There is landscaping between the parking lot at the frontage and Paonia Street surrounded by concrete curb and gutter. A 6-foot wood privacy fence blocks access to the rear of the building with a chain link fence meeting at the property line and following at or near the property line around the parcel until meeting another 6-foot wood privacy fence on the opposite side of the parcel. The rear of the parcel is gravel with a 6-foot wide concrete drainage channel that runs north to south into a detention pond southwesterly of the parcel. The existing impervious conditions are approximately 46.0 percent of the entire lot.

Revise. Firm panel number is 08041C0752G.

There are no known existing non-stormwater discharges on the lot. The projec within a designated floodplain according to information published in the Federal Emergency Management Agency Floodplain Map No. 08041C0751G, dated December 7, 2018. The map is provided in the Appendix showing it lies within Zone X, a minimal flood hazard area.

The existing topography consists of grades between one and three percent with drainage patterns flowing west towards the rear of the lot into the concrete drainage channel that routes the flow south into an existing detention pond.

C. EXISTING SOILS

The soils indicative to the site are classified as Blakeland Loamy Sand and Blendon Loamy Sand by the USDA Soil Conservation Service and are listed as Hydrologic Soil Group A and B respectively. A USDA Soil Map is provided in the Appendix.

A "Subsurface Exploration Report" by Earth Engineering Consultants, Inc., dated March, 1999, was approved by the Regional Building Department on October, 2000, states "Sand with Varying amounts of silt was encountered at the existing ground surface. The essentially granular soils were loose to medium dense and brown in color with a low to moderate moisture content. The essentially granular soils extended to the bottom of the borings at depths of approximately 15 feet."

D. EXISTING DRAINAGE

According to the "Drainage Report for Palmer Park Business Center Preliminary Plan and Palmer Park Business Center Subdivision Filing No. 1", prepared by K L H Engineering Consultants, Inc., dated July, 1982, runoff travels west towards the rear of the lot into a private 6-

foot wide concrete trapezoidal drainage channel. From here the runoff is intercepted and conveyed south into an existing private 6,5 acre-foot detention pond. The pond outlets into a public 48" CMP Storm Drain that travels under Omaha Boulevard and ultimately outlets into the immediate receiving waters of Sand Creek East Fork.

There is a known private storm water concrete trapezoidal open drainage channel in the rear of the lot currently on site. There are exiting public water, wastewater, and gas main located in Paonia Street and a fire hydrant at the southeast property corner. An existing conditions map is located in the Appendix for reference.

E. Description of Property – Proposed Conditions

The proposed development is for a 9,030 square foot additional Pre-Engineered Metal Building directly adjacent to the existing PEMB and an additional 12,628 square feet of paved asphalt. A non-structural retaining wall will be constructed so an existing utility box will remain undisturbed as well as the relocation and construction of 96 square foot trash enclosure. The addition will extend west towards the rear of the lot with the additional asphalt pavement drive access wrapping around said building extension reaching westward. Lot 5 requires and approximate limit of disturbance. Construction of 37,800 square feet or 0.87 acres which is 33.72 percent of the property. The grading limits are kept within the setbacks wherever possible and the grading within the drainage easements are consistent with the historical drainage patterns of the subdivision. A sub-basin delineation sheet for the proposed conditions is provided. A geotechnical report by RMG-Rocky Mountain Group describes the existing conditions and provides proposed concrete slab sections and design criteria for the development.

Please update drainage basin narrative to include a description of what major basin the site is located in. Also, discuss whether there is a DBPS associated with the drainage basin and if there are any improvements in or in the vicinity of the project that are identified in the DBPS.

III. Drainage Basins and Sub-Basins

A. Existing Major Drainage Basin and

The parcel is delineated into sub-basins according existing and developed conditions.

Revise. The parcel is not going to be platted.

Basin E is the entirety of the parcel to be platted representing existing conditions and consists of two on-site sub-basin. There are no off-site basins or sub-basins that contribute to Basin E as the property is surrounded by raised features such as landscape medians or fencing atop concrete curb head.

Sub-basin E-1 (1.29 ac. ; Q_5 = 1.66 cfs, Q_{100} = 4.32 cfs) is the entire northern half area of the platted parcel which includes half of the pitched roof area that drains north by means of down spouts and is directed westward. The runoff flows from the east end of the lot westerly over the asphalt paved lot to a concrete drainage channel in the rear of the lot on the west side (EP1). The runoff is channelized and travels south towards an existing detention pond.

Sub-basin E-2 (1.29 ac. ; Q_5 = 1.60 cfs, Q_{100} = 4.36 cfs) is the entire southern half area of the platted parcel which includes half of the pitched roof area that drains south by means of down spouts and is directed westward. The runoff flows from the east end of the lot westerly over the asphalt paved lot to a concrete drainage channel in the rear of the lot on the west side (EP1). The runoff is channelized and travels south towards an existing detention pond.

B. Developed Major Drainage Basin and Sub-basins

Basin D is the entirety of the platted parcel representing developed conditions and consists of two sub-basins.

Sub-basin D-1 (1.29 ac. ; Q_5 = 2.88 cfs, Q_{100} = 6.17 cfs) is the entire northern half area of the platted parcel which includes half of the pitched roof area of the proposed building that drains north by means of down spouts and is directed westward. The runoff flows from the east end of the lot westerly over the asphalt paved lot to a concrete drainage channel in the rear of the lot on the west side (DP1). The runoff is channelized and travels south towards an existing detention pond.

Sub-basin D-2 (1.29 ac.; Q_5 = 2.88 cfs, Q_{100} = 6.35 cfs) is the entire southern half area of the platted parcel which includes half of the pitched roof area of the proposed building that drains south by means of down spouts and is directed westward. The runoff flows from the east end of the lot westerly over the asphalt paved lot to a concrete drainage channel in the rear of the lot on the west side (DP1). The runoff is channelized and travels south towards an existing detention pond.

The difference between Basin E and Basin D results in an increase of the 100-year storm water volume overall due to impervious pavement and roof area. However, the 100-year storm volume still falls within the parameters of the master drainage plan as the development is consistent with the anticipated conditions laid out in the plan.

The total storm water flow for the 100-year event is for lot 5 is 8.68 cfs for existing conditions and 12.52 cfs for the developed conditions. This is an overall increase in storm water flow of 3.84 cfs. The subdivision's original drainage report "Drainage Report for Palmer Park Business Center Preliminary Plan and Palmer Park Business Center Subdivision Filing No. 1", prepared by K L H Engineering Consultants, Inc., dated July, 1982, predicted a commercial development with a runoff of 73.1 cubic feet per second (cfs) yielding the need for a 6.5 ac-ft detention pond for the sub-basin within Tract A Powers Plaza. Using current standards from the City of Colorado Springs Drainage Criteria Manual Volumes 1 and 2, a runoff of 62.42 cfs was found for the entire proposed sub-basin including this development. This falls well under the original calculated runoff from the developed and approved drainage report for Lot 5. The existing regional detention pond for the sub-basin including Lot 5 is sufficiently sized for the proposed developed conditions.

The existing impervious conditions of Lot 5 is 34.88 percent while the proposed developed conditions yield 59.11 percent imperviousness. The developed site remains consistent with historical drainage patterns and volumes for the parcel. Existing drainage patterns have the majority of runoff draining towards concrete drainage channel that flows into the regional detention pond. The proposed conditions conform to this drainage pattern by sloping the pavement westerly towards the concrete drainage channel.

Please discuss whether this lot is currently being treated for water quality in downstream facilities. Step 3 of the four step process, ECM I.7.2.A., states all development sites must have permanent stormwater quality control.

IV. Drainage Design Criteria

A. Regulations

The hydrological and hydraulic calculations and design of the site conform to the City of Colorado Springs Drainage Criteria Manuals I and II (latest revision, May 2014) as well as the Mile High Flood District Drainage Criteria manuals revised August 2018.

Include this information in the major drainage basin narrative.

B. Development Criteria Reference and Constraints

The parcel falls within the Sand Creek major drainage basin designated by the City of Colorado Springs Water Resources Engineering Department with the ultimate receiving waters of Arkansas River. No storage facilities exist on the site, however, there is a public 6-foot open concrete drainage channel storm sewer systems that runs from north to south on the far west side of the parcel. The drainage on this parcel will have no effect on downstream infrastructure or facilities, streets, utilities, transit, or further development of adjacent lots. Relevant criteria for the calculations shown further include equations and design criteria for the rational method, volumes and runoff of carious storm events.

C. Hydrological Criteria

The rational method was used to calculate the peak runoff of the delineated basin and sub-basins using the manuals referenced prior with the C, I, and P1 values from the Design Criteria Manual Volume I, Chapter 6 as well as the Colorado Springs designated IDF curve values. Specific calculations and tables are provided further with inputs including design rainfall, sub-basin acreage and percent imperviousness, runoff coefficients, one-hour rainfall depths, rainfall intensities, time of concentration, and peak discharge of various storm events. The default rainfall intensities and volumes use runoff coefficients based on soil types. Weighted runoff coefficients were calculated for each basin and sub-basin due to the mix of impervious surfaces, shown in the Appendix exhibits. Due to site disturbance being less than one acre and not part of a larger common plan, water quality is not required.

V. Drainage and Bridge Fees

Lot 5 is contained within the Sand Creek drainage basin area and has a 2021 Drainage Fee of \$13,775/acre, bridge fee of \$819/acre, a pond/land fee of \$1,070\$/acre, a pond facility fee of \$3,957/acre and surcharge fee of \$1,435/acre. The total site platted acreage is 2.58 acre.

2.58 acre * (\$13,775/acre + \$819/acre + \$1,070\$/acre + \$3,957/acre) = \$50,622.18

Since the site is already platted, drainage fees have already been paid.

Revise to state what plat process drainage fees were paid in.

VI. Conclusions

A. Compliance with Standards

The criteria used to design the storm water runoff volumes are formulas and figures within the City of Colorado Springs Drainage Manuals as well as the Mile High Flood District Drainage

Criteria manual. Grading practices for optimal drainage comply with the geotechnical investigative report and City standards. The development of Lot 5 is within compliance and standards for drainage design.

The proposed grading and drainage is within substantial conformance for the master drainage plan for the Palmer Park Business Center Subdivision. There is no impact on major drainageway planning studies within the larger drainage basin. This development will not adversely affect downstream development.

Please include a statement about the increase in runoff values after development and whether the difference in existing and proposed will have major impacts downstream.

VII. References

Colorado Springs Drainage Manual Volumes I & II (May 2014)

Colorado Urban Drainage and Flood Control District Drainage Criteria Manual, Volume I (August 2018)

Colorado Urban Drainage and Flood Control District Drainage Criteria Manual, Volume III (April 2018)

Urban Storm Drainage Criteria Manual, Volume III (November, 2015)

FEMA Flood Map Service Center

United States Department of Agriculture National Resources Conservation Service

Previous Drainage Report (Walker Subdivision Filing No. 1 Prepared by Leigh Whitehead & Associates, Inc., Dated July, 2008)

Update reference list to include EPC ECM 2020, and any DBPS that is associated with the major drainage basin.

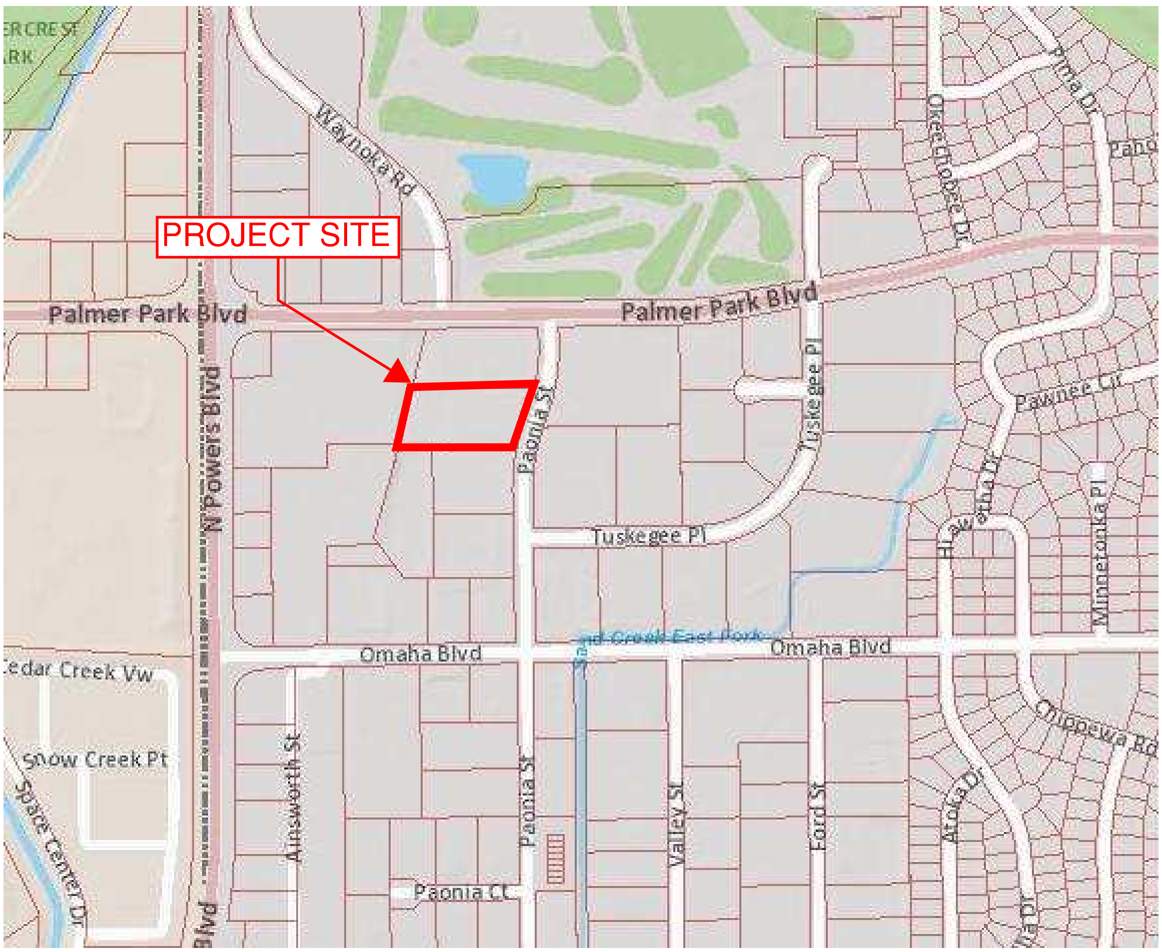
VIII. Appendices

APPENDIX A – VICINITY MAP

VICINITY MAP

1670 PAONIA STREET

COLORADO SPRINGS, COLORADO 80915



APPENDIX B – HYDROLOGIC COMPUTATIONS

LEGEND

DESCRIPTION	SYMBOL	DESCRIPTION	SYMBOL
EX. STRUCTURE/BUILDING		BASIN IDENTIFIER	E-1
EX. CONCRETE PAVEMENT		AREA IN ACRES	X.XX AC
EX. ASPHALT PAVEMENT			
EX. LANDSCAPE		DESIGN POINT ID	EP1
EX. CONTOUR		FLOW ARROW	
DRAINAGE SUB-BASIN BOUNDARY		PROPERTY LINE	

DESIGN POINT	FLOW (CFS)
1	Q_5 = 1.66 Q_{10} = 2.21 Q_{100} = 4.32
2	Q_5 = 1.60 Q_{10} = 2.17 Q_{100} = 4.36

BASIN SUMMARY

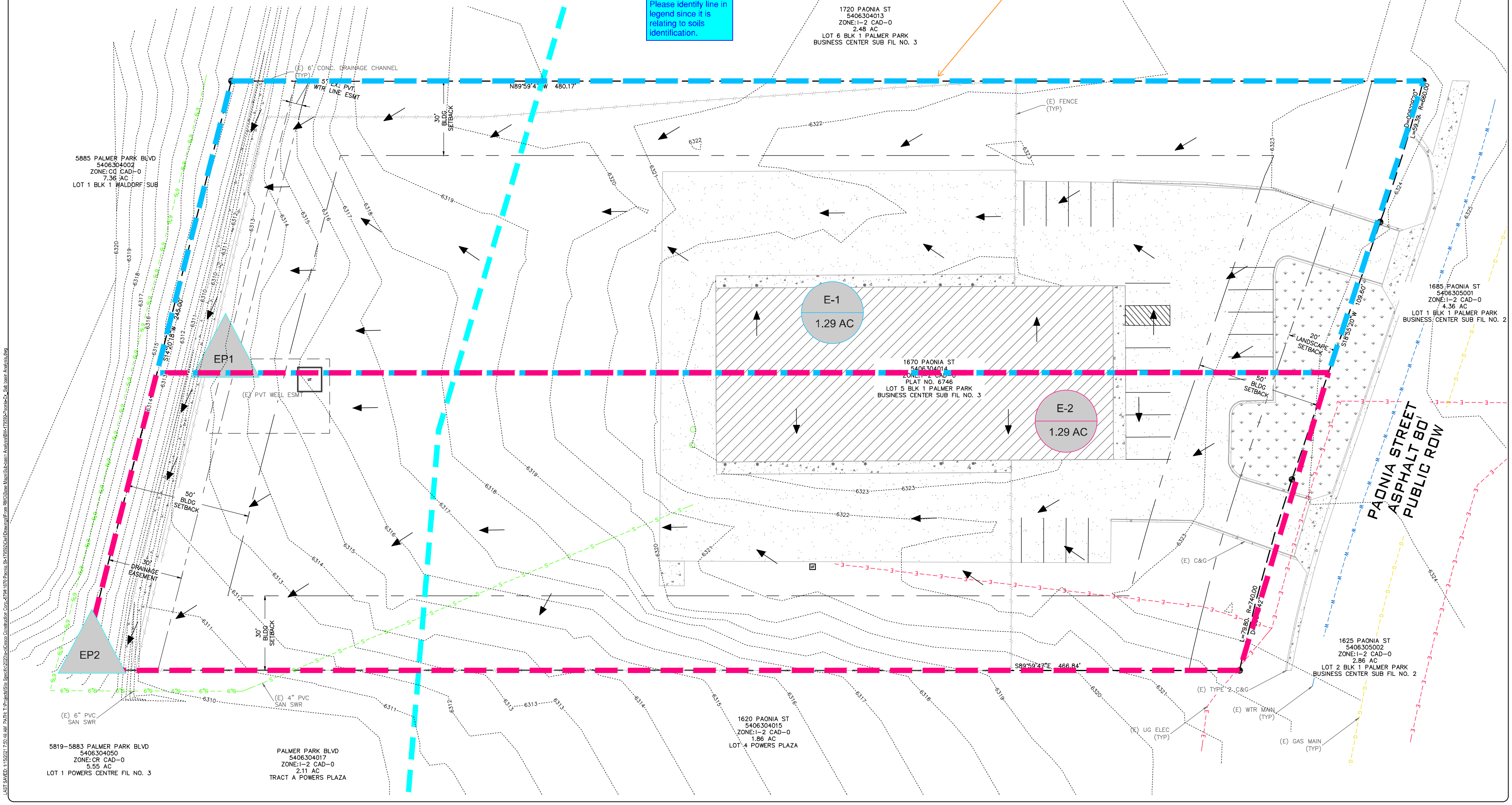
BASIN	Q(5)-CFS	Q(100)-CFS	ACRES(AC)
E-1 (A)	1.49	3.44	0.95
E-1 (B)	0.17	0.88	0.34
E-2 (A)	1.43	3.49	0.95
E-2 (B)	0.16	0.87	0.34

Graphic Scale
0 10 20 40
In Feet: 1" = 20'

Please place the existing conditions drainage map before the developed conditions drainage map. Place both drainage maps at the end of the report.

In report text above, discuss runoff from adjacent properties that flows onto the 1670 lot. And show offsite drainage flow arrows on this sheet.

Please identify line in legend since it is relating to soils identification.



ROCKY MOUNTAIN GROUP
ARCHITECTS RMG ENGINEERS
Architectural Structural Forensics
Geotechnical Materials Testing Civil Planning
SOUTHERN COLORADO
2910 AUSTIN BLUFFS PARKWAY, COLORADO SPRINGS, CO 80918
(719) 488-2145 – WWW.RMGENGINEERS.COM
SOUTHERN COLORADO, DENVER METRO, NORTHERN COLORADO

NOT FOR CONSTRUCTION
FOR CIVIL ONLY

LOT 5, BLOCK 1 PALMER PARK BUSINESS CENTER
SUBDIVISION FILING NO. 3
1670 PAONIA STREET
COLORADO SPRINGS, COLORADO
CASCO CONSTRUCTION CORP.

SHEET NAME: EXISTING CONDITIONS
PROJECT STATUS: EXHIBIT
ENG: RDL
DRAWN: AMC
CHECKED: RDL
DATE: 01/15/2021

#	REVISION	DATE

JOB NO. 179592
SHEET NO. EX-01 of 2

Project: 1670 Paonia Street
Engineer: Richard Lyon
Date: 1/4/2021
Address: 1670 Paonia Street, Colorado Springs, CO

Sub-Basin:	E-1	(IDF Curve Equations from Figure 6-5 of the DCM Volume 1)			
t_c Duration:	15.94				
I_2	I_5	I_{10}	I_{25}	I_{50}	I_{100}
2.740122493	3.429793058	4.0015919	4.57339074	5.14518959	5.75761234

Hydrologic Soil Type: A

Coefficient (Table 6-6)

Land Use or Surface Characteristic	Square Feet	Acreage	Coefficient 2	Coefficient 5	Coefficient 10	Coefficient 25	Coefficient 50	Coefficient 100	2 Yr: $C_i * A_i$	5 Yr: $C_i * A_i$	10 Yr: $C_i * A_i$	25 Yr: $C_i * A_i$	50 Yr: $C_i * A_i$	100 Yr: $C_i * A_i$	2 Yr C_c	5 Yr C_c	10 Yr C_c	25 Yr C_c	50 Yr C_c	100 Yr C_c
Roof	5527.00	0.127	0.71	0.73	0.75	0.78	0.80	0.81	0.090	0.093	0.095	0.099	0.102	0.103	**0.418**	**0.455**	**0.501**	**0.564**	**0.596**	**0.626**
Pavement	14621	0.336	0.89	0.90	0.92	0.94	0.95	0.96	0.299	0.302	0.309	0.316	0.319	0.322						
Lawn	21359	0.490	0.02	0.08	0.15	0.25	0.30	0.35	0.010	0.039	0.074	0.123	0.147	0.172						
A_t:	41507	0.953																		

Q Peak Flow (cfs)

2 Year Q	5 Year Q	10 Year Q	25 Year Q	50 Year Q	100 Year Q
1.09	**1.49**	**1.91**	**2.46**	**2.92**	**3.44**

Sub-Basin:	E-1	(IDF Curve Equations from Figure 6-5 of the DCM Volume 1)			
t_c Duration:	10.10				
I_2	I_5	I_{10}	I_{25}	I_{50}	I_{100}
3.283289007	4.114456731	4.80036619	5.48627564	6.1721851	6.90784731

Hydrologic Soil Type: B

Coefficient (Table 6-6)

Land Use or Surface Characteristic	Square Feet	Acreage	Coefficient 2	Coefficient 5	Coefficient 10	Coefficient 25	Coefficient 50	Coefficient 100	2 Yr: $C_i * A_i$	5 Yr: $C_i * A_i$	10 Yr: $C_i * A_i$	25 Yr: $C_i * A_i$	50 Yr: $C_i * A_i$	100 Yr: $C_i * A_i$	2 Yr C_c	5 Yr C_c	10 Yr C_c	25 Yr C_c	50 Yr C_c	100 Yr C_c
Roof	0.00	0.000	0.71	0.73	0.75	0.78	0.80	0.81	0.000	0.000	0.000	0.000	0.000	0.000	**0.064**	**0.121**	**0.189**	**0.285**	**0.333**	**0.381**
Pavement	731	0.017	0.89	0.90	0.92	0.94	0.95	0.96	0.015	0.015	0.015	0.016	0.016	0.016						
Lawn	13869	0.318	0.02	0.08	0.15	0.25	0.30	0.35	0.006	0.025	0.048	0.080	0.096	0.111						
A_t:	14600	0.335																		

Q Peak Flow (cfs)

2 Year Q	5 Year Q	10 Year Q	25 Year Q	50 Year Q	100 Year Q
0.07	**0.17**	**0.30**	**0.52**	**0.69**	**0.88**

Sub-Basin:	E-2	(IDF Curve Equations from Figure 6-5 of the DCM Volume 1)			
t_c Duration:	13.03				
I_2	I_5	I_{10}	I_{25}	I_{50}	I_{100}
2.97954304	3.731583664	4.35368094	4.97577822	5.5978755	6.26462056

Hydrologic Soil Type: A

Coefficient (Table 6-6)

Land Use or Surface Characteristic	Square Feet	Acreage	Coefficient 2	Coefficient 5	Coefficient 10	Coefficient 25	Coefficient 50	Coefficient 100	2 Yr: $C_i * A_i$	5 Yr: $C_i * A_i$	10 Yr: $C_i * A_i$	25 Yr: $C_i * A_i$	50 Yr: $C_i * A_i$	100 Yr: $C_i * A_i$	2 Yr C_c	5 Yr C_c	10 Yr C_c	25 Yr C_c	50 Yr C_c	100 Yr C_c
Roof	5683.00	0.130	0.71	0.73	0.75	0.78	0.80	0.81	0.093	0.095	0.098	0.102	0.104	0.106	**0.367**	**0.407**	**0.455**	**0.523**	**0.557**	**0.590**
Pavement	11886	0.273	0.89	0.90	0.92	0.94	0.95	0.96	0.243	0.246	0.251	0.256	0.259	0.262						
Lawn	23577	0.541	0.02	0.08	0.15	0.25	0.30	0.35	0.011	0.043	0.081	0.135	0.162	0.189						
A_t:	41146	0.945																		

Q Peak Flow (cfs)

2 Year Q	5 Year Q	10 Year Q	25 Year Q	50 Year Q	100 Year Q
1.03	**1.43**	**1.87**	**2.46**	**2.94**	**3.49**

Sub-Basin:	E-2	(IDF Curve Equations from Figure 6-5 of the DCM Volume 1)			
t_c Duration:	11.55				
I_2	I_5	I_{10}	I_{25}	I_{50}	I_{100}
3.123648385	3.913229057	4.56560057	5.21797208	5.87034359	6.56978482

Hydrologic Soil Type: B

Coefficient (Table 6-6)

Land Use or Surface Characteristic	Square Feet	Acreage	Coefficient 2	Coefficient 5	Coefficient 10	Coefficient 25	Coefficient 50	Coefficient 100	2 Yr: $C_i * A_i$	5 Yr: $C_i * A_i$	10 Yr: $C_i * A_i$	25 Yr: $C_i * A_i$	50 Yr: $C_i * A_i$	100 Yr: $C_i * A_i$	2 Yr C_c	5 Yr C_c	10 Yr C_c	25 Yr C_c	50 Yr C_c	100 Yr C_c
Roof	0.00	0.000	0.71	0.73	0.75	0.78	0.80	0.81	0.000	0.000	0.000	0.000	0.000	0.000	**0.062**	**0.120**	**0.187**	**0.283**	**0.332**	**0.380**
Pavement	734	0.017	0.89	0.90	0.92	0.94	0.95	0.96	0.015	0.015	0.016	0.016	0.016	0.016						
Lawn	14390	0.330	0.02	0.08	0.15	0.25	0.30	0.35	0.007	0.026	0.050	0.083	0.099	0.116						
A_t:	15124	0.347																		

Q Peak Flow (cfs)

2 Year Q	5 Year Q	10 Year Q	25 Year Q	50 Year Q	100 Year Q
0.07	**0.16**	**0.30**	**0.51**	**0.68**	**0.87**

Design Points

Design Point	Q_5	Q_{10}	Q_{100}
EX DP1	1.66	2.21	4.32
EX DP2	1.60	2.17	4.36
EX DP3	0.00	0.00	0.00
Total Site	**3.25**	**4.38**	**8.67**

Please update to combine runoff calculations into one for each basin (E-1 and E-2) or relabel smaller subbasins to identify them as separate basins (E-3 and E-4). If you have any questions call Lupe Packman @ 719-313-6215.

Time of Concentration $t_c = t_i + t_t$

3.2.1 - Overland (Initial) Flow Time

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L}}{S^{0.33}} \quad \text{(Eq. 6-8)}$$

Where:

t_i = overland (initial) flow time (min)
C_5 = runoff coefficient for 5-year frequency (see Table 6-6)
L = length of overland flow (300 ft maximum for non-urban land uses, 100 ft maximum for urban land uses)
S = average basin slope (ft/ft)

Note that in some urban watersheds, the overland flow time may be very small because flows quickly concentrate and channelize.

Sub-Basin or DP:	E-1	
C_5:	0.46	[Table 6-6. Runoff Coefficients for Rational Method]
L:	99	ft
S:	0.005	ft/ft

Composite Runoff Coefficient Calculation:

$C_c = (C_1A_1 + C_2A_2 + C_3A_3 + \ldots C_iA_i) / A_t$

Land Use or Surface Characteristic	Square Feet	Acreage	C_5
Roof	5527.00	0.13	0.73
Pavement	14621.00	0.34	0.90
Lawn	21359.00	0.49	0.08
A_t :	41507.00	0.95	

*C_c = (0.73*0.13 + 0.90*0.34 + 0.08*0.83) / 0.95 =* **0.46**

t_i = (0.395(1.1-C_5)*sqrt(L))/(S^0.33)*

t_i = (0.395(1.1-0.36)*sqrt(99))/(0.005^0.33) =* **14.56** mins

3.2.2 Travel Time

For catchments with overland and channelized flow, the time of concentration needs to be considered in combination with the travel time, t_t, which is calculated using the hydraulic properties of the swale, ditch, or channel. For preliminary work, the overland travel time, t_t, can be estimated with the help of Figure 6-25 or Equation 6-9 (Guo 1999).

$$V = C_v S_w^{0.5} \quad \text{(Eq. 6-9)}$$

Where:

V = velocity (ft/s)
C_v = conveyance coefficient (from Table 6-7)
S_w = watercourse slope (ft/ft)

$V = C_v S_w^{0.5}$

$V = (20)(0.016)^{0.5}$ = **2.53** ft/s

Flow Distance: **210.00** ft

t_t = L/V = 83.01 sec.
1.38 min.

Table 6-7. Conveyance Coefficient, C_v

Type of Land Surface	C_v
Heavy meadow	2.5
Tillage/field	5
Riprap (not buried)*	6.5
Short pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

*For buried riprap, select C_v value based on type of vegetative cover.

$t_c = t_i + t_t$ = **15.94** min.

3.2.4 Minimum Time of Concentration

If the calculations result in a t_c of less than 10 minutes for undeveloped conditions, it is recommended that a minimum value of 10 minutes be used. The minimum t_c for urbanized areas is 5 minutes.

Final t_c: **15.94** min.

Time of Concentration $t_c = t_i + t_t$

3.2.1 - Overland (Initial) Flow Time

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L}}{S^{0.33}} \quad \text{(Eq. 6-8)}$$

Where:

t_i = overland (initial) flow time (min)
C_5 = runoff coefficient for 5-year frequency (see Table 6-6)
L = length of overland flow (300 ft maximum for non-urban land uses, 100 ft maximum for urban land uses)
S = average basin slope (ft/ft)

Note that in some urban watersheds, the overland flow time may be very small because flows quickly concentrate and channelize.

Sub-Basin or DP:	E-1	
C_5:	0.12	[Table 6-6. Runoff Coefficients for Rational Method]
L:	113	ft
S:	0.077	ft/ft

Composite Runoff Coefficient Calculation:

$C_c = (C_1 A_1 + C_2 A_2 + C_3 A_3 + \ldots C_i A_i) / A_t$

Land Use or Surface Characteristic	Square Feet	Acreage	C_5
Roof	0.00	0.00	0.73
Pavement	731.00	0.02	0.90
Lawn	13869.00	0.32	0.08
A_t :	14600.00	0.34	

C_c = (0.90*1.22 + 0.08*0.65) / 0.34 = **0.12**

t_i = (0.395*(1.1-C_5)*sqrt(L))/(S^0.33)
t_i = (0.395*(1.1-0.48)*sqrt(113))/(0.077^0.33) = **9.58** mins

3.2.2 Travel Time

For catchments with overland and channelized flow, the time of concentration needs to be considered in combination with the travel time, t_t, which is calculated using the hydraulic properties of the swale, ditch, or channel. For preliminary work, the overland travel time, t_t, can be estimated with the help of Figure 6-25 or Equation 6-9 (Guo 1999).

$$V = C_v S_w^{0.5} \quad \text{(Eq. 6-9)}$$

Where:

V = velocity (ft/s)
C_v = conveyance coefficient (from Table 6-7)
S_w = watercourse slope (ft/ft)

$V = C_v S_w^{0.5}$
$V = (20)(0.005)^{0.5}$ = **1.41** ft/s

Flow Distance: **44.00** ft

t_t = L/V = 31.11 sec.
0.52 min.

Table 6-7. Conveyance Coefficient, C_v

Type of Land Surface	C_v
Heavy meadow	2.5
Tillage/field	5
Riprap (not buried)*	6.5
Short pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

*For buried riprap, select C_v value based on type of vegetative cover.

$t_c = t_i + t_t$ = **10.10** min.

3.2.4 Minimum Time of Concentration

If the calculations result in a t_c of less than 10 minutes for undeveloped conditions, it is recommended that a minimum value of 10 minutes be used. The minimum t_c for urbanized areas is 5 minutes.

Final t_c: **10.10** min.

Time of Concentration $t_c = t_i + t_t$

3.2.1 - Overland (Initial) Flow Time

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L}}{S^{0.33}} \quad \text{(Eq. 6-8)}$$

Where:

t_i = overland (initial) flow time (min)
C_5 = runoff coefficient for 5-year frequency (see Table 6-6)
L = length of overland flow (300 ft maximum for non-urban land uses, 100 ft maximum for urban land uses)
S = average basin slope (ft/ft)

Note that in some urban watersheds, the overland flow time may be very small because flows quickly concentrate and channelize.

Sub-Basin or DP:	E-2	
C_5:	0.41	[Table 6-6. Runoff Coefficients for Rational Method]
L:	89	ft
S:	0.01	ft/ft

Composite Runoff Coefficient Calculation:

$C_c = (C_1A_1 + C_2A_2 + C_3A_3 + ...C_iA_i) / A_t$

Land Use or Surface Characteristic	Square Feet	Acreage	C_5
Roof	5683.00	0.13	0.73
Pavement	11886.00	0.27	0.90
Lawn	23577.00	0.54	0.08
A_t :	41146.00	0.94	

*C_c = (0.73*0.13 + 0.90*1.40 + 0.08*0.54) / 0.94 =* **0.41**

t_i = (0.395(1.1-C_5)*sqrt(L))/(S^0.33)*

t_i = (0.395(1.1-0.41)*sqrt(89))/(0.01^0.33) =* **11.81** mins

3.2.2 Travel Time

For catchments with overland and channelized flow, the time of concentration needs to be considered in combination with the travel time, t_t, which is calculated using the hydraulic properties of the swale, ditch, or channel. For preliminary work, the overland travel time, t_t, can be estimated with the help of Figure 6-25 or Equation 6-9 (Guo 1999).

$$V = C_v S_w^{0.5} \quad \text{(Eq. 6-9)}$$

Where:

V = velocity (ft/s)
C_v = conveyance coefficient (from Table 6-7)
S_w = watercourse slope (ft/ft)

$V = C_v S_w^{0.5}$

$V = (20)(0.026)^{0.5}$ = **3.22** ft/s

Flow Distance: **237.00** ft

t_t = L/V = 73.49 sec.
1.22 min.

Table 6-7. Conveyance Coefficient, C_v

Type of Land Surface	C_v
Heavy meadow	2.5
Tillage/field	5
Riprap (not buried)*	6.5
Short pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

*For buried riprap, select C_v value based on type of vegetative cover.

$t_c = t_i + t_t$ = **13.03** min.

3.2.4 Minimum Time of Concentration

If the calculations result in a t_c of less than 10 minutes for undeveloped conditions, it is recommended that a minimum value of 10 minutes be used. The minimum t_c for urbanized areas is 5 minutes.

Final t_c: **13.03** min.

Time of Concentration $t_c = t_i + t_t$

3.2.1 - Overland (Initial) Flow Time

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L}}{S^{0.33}} \qquad \text{(Eq. 6-8)}$$

Where:

t_i = overland (initial) flow time (min)
C_5 = runoff coefficient for 5-year frequency (see Table 6-6)
L = length of overland flow (300 ft maximum for non-urban land uses, 100 ft maximum for urban land uses)
S = average basin slope (ft/ft)

Note that in some urban watersheds, the overland flow time may be very small because flows quickly concentrate and channelize.

Sub-Basin or DP:	E-2	
C_5:	0.12	[Table 6-6. Runoff Coefficients for Rational Method]
L:	121	ft
S:	0.051	ft/ft

Composite Runoff Coefficient Calculation:

$C_c = (C_1 A_1 + C_2 A_2 + C_3 A_3 + ...C_i A_i) / A_t$

Land Use or Surface Characteristic	Square Feet	Acreage	C_5
Roof	0.00	0.00	0.73
Pavement	734.00	0.02	0.90
Lawn	14390.00	0.33	0.08
A_t :	15124.00	0.35	

C_c = (0.90*0.02 + 0.08*0.33) / 0.35 = **0.12**

t_i = (0.395*(1.1-C_5)*sqrt(L))/(S^0.33)
t_i = (0.395*(1.1-0.12)*sqrt(121))/(0.051^0.33) = **11.37** mins

3.2.2 Travel Time

For catchments with overland and channelized flow, the time of concentration needs to be considered in combination with the travel time, t_t, which is calculated using the hydraulic properties of the swale, ditch, or channel. For preliminary work, the overland travel time, t_t, can be estimated with the help of Figure 6-25 or Equation 6-9 (Guo 1999).

$$V = C_v S_w^{0.5} \qquad \text{(Eq. 6-9)}$$

Where:

V = velocity (ft/s)
C_v = conveyance coefficient (from Table 6-7)
S_w = watercourse slope (ft/ft)

$V = C_v S_w^{0.5}$
$V = (20)(0.005)^{0.5}$ = **1.41** ft/s

Flow Distance: **15.00** ft

t_t = L/V = 10.61 sec.
0.18 min.

Table 6-7. Conveyance Coefficient, C_v

Type of Land Surface	C_v
Heavy meadow	2.5
Tillage/field	5
Riprap (not buried)*	6.5
Short pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

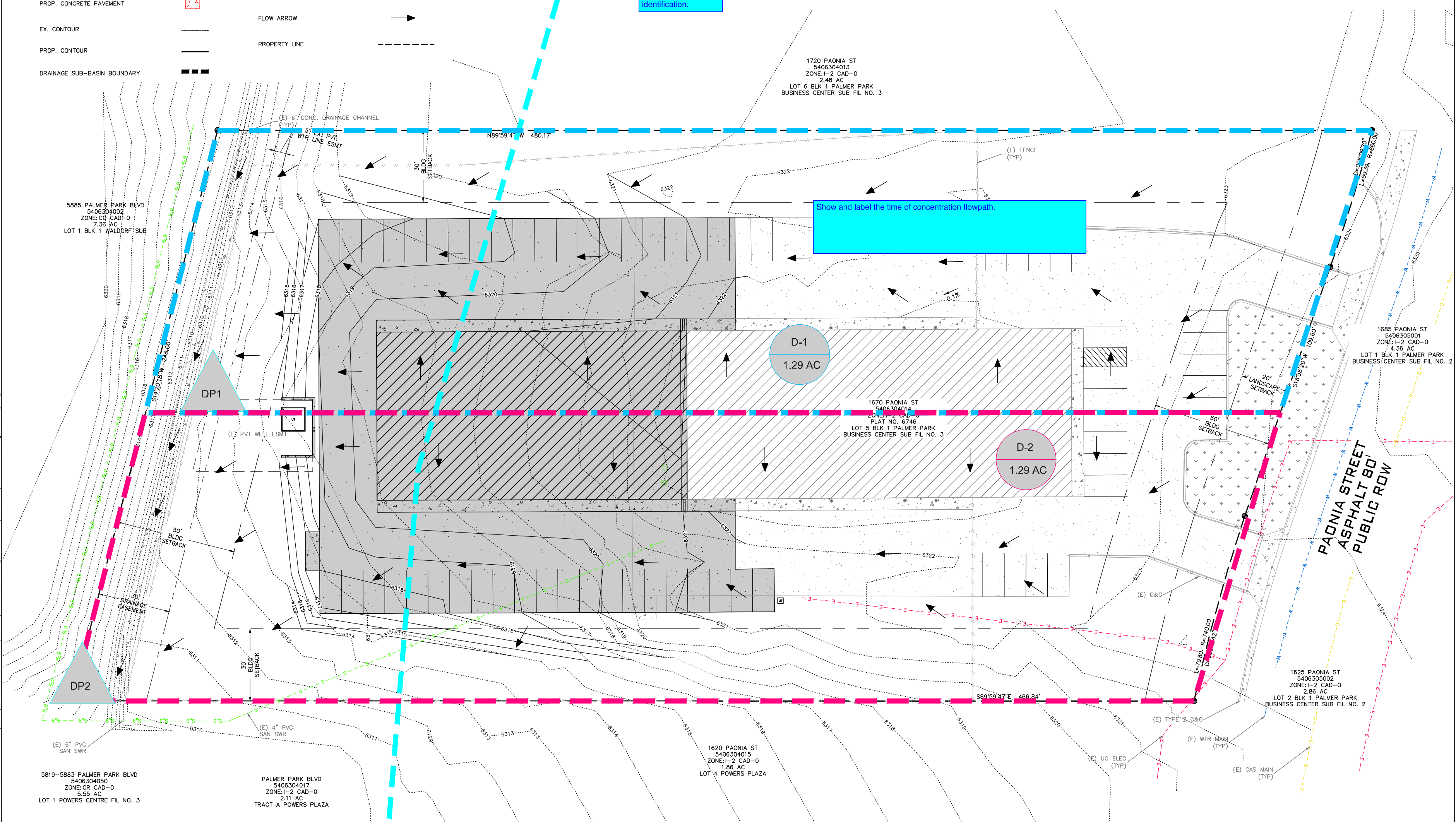
*For buried riprap, select C_v value based on type of vegetative cover.

$t_c = t_i + t_t$ = **11.55** min.

3.2.4 Minimum Time of Concentration

If the calculations result in a t_c of less than 10 minutes for undeveloped conditions, it is recommended that a minimum value of 10 minutes be used. The minimum t_c for urbanized areas is 5 minutes.

Final t_c: **11.55** min.



LEGEND

DESCRIPTION	SYMBOL
EX. STRUCTURE/BUILDING	
EX. CONCRETE PAVEMENT	
EX. ASPHALT PAVEMENT	
PROP. ASPHALT PAVEMENT	
PROP. STRUCTURE/BUILDING	
PROP. CONCRETE PAVEMENT	
EX. CONTOUR	
PROP. CONTOUR	
DRAINAGE SUB-BASIN BOUNDARY	

DESCRIPTION	SYMBOL
BASIN IDENTIFIER	D-1
AREA IN ACRES	X.XX AC
DESIGN POINT ID	DP1
FLOW ARROW	
PROPERTY LINE	

DESIGN POINT	FLOW (CFS)
1	Q_5 = 2.88 Q_{10} = 3.61 Q_{100} = 6.17
2	Q_5 = 2.88 Q_{10} = 3.65 Q_{100} = 6.35

BASIN SUMMARY

BASIN	Q(5)-CFS	Q(100)-CFS	ACRES(AC)
D-1 (A)	2.21	4.50	0.95
D-1 (B)	0.67	1.68	0.34
D-2 (A)	2.36	4.83	0.95
D-2 (B)	0.52	1.52	0.34

Please identify line in legend since it is relating to soils identification.

Show and label the time of concentration flowpath.

Please place the existing conditions drainage map before the developed conditions drainage map. Place both drainage maps at the end of the report.

ROCKY MOUNTAIN GROUP

Architectural Structural Forensics

RMG ARCHITECTS ENGINEERS

Geotechnical Materials Testing Civil, Planning

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Southern Colorado, Denver Metro, Northern Colorado

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LOT 5, BLOCK 1 PALMER PARK BUSINESS CENTER SUBDIVISION FILING NO. 3

1670 PAONIA STREET

COLORADO SPRINGS, COLORADO

CASCO CONSTRUCTION CORP.

SHEET NAME: DEVELOPED CONDITIONS

PROJECT STATUS: EXHIBIT

ENG: RDL
DRAWN: AMC
CHECKED: RDL
DATE: 01/15/2021

#	REVISION	DATE

JOB NO. 179592

SHEET NO. EX-02 of 2

Project: 1670 Paonia Street
Engineer: Richard Lyon
Date: 1/4/2021
Address: 1670 Paonia Street, Colorado Springs, CO

Sub-Basin:	D-1	(IDF Curve Equations from Figure 6-5 of the DCM Volume 1)			
t_t Duration:	12.45				
I_2	I_5	I_{10}	I_{25}	I_{50}	I_{100}
3.03383562	3.800019689	4.43352297	5.06702625	5.70052953	6.37959308

Hydrologic Soil Type:	A

Coefficient (Table 6-6)

Land Use or Surface Characteristic	Square Feet	Acreage	$Coefficient_2$	$Coefficient_5$	$Coefficient_{10}$	$Coefficient_{25}$	$Coefficient_{50}$	$Coefficient_{100}$	2 Yr: $C_i * A_i$	5 Yr: $C_i * A_i$	10 Yr: $C_i * A_i$	25 Yr: $C_i * A_i$	50 Yr: $C_i * A_i$	100 Yr: $C_i * A_i$	2 Yr C_c	5 Yr C_c	10 Yr C_c	25 Yr C_c	50 Yr C_c	100 Yr C_c
Roof	9027.00	0.207	0.71	0.73	0.75	0.78	0.80	0.81	0.147	0.151	0.155	0.162	0.166	0.168	**0.583**	**0.611**	**0.646**	**0.693**	**0.717**	**0.740**
Pavement	19702	0.452	0.89	0.90	0.92	0.94	0.95	0.96	0.403	0.407	0.416	0.425	0.430	0.434						
Lawn	12778	0.293	0.02	0.08	0.15	0.25	0.30	0.35	0.006	0.023	0.044	0.073	0.088	0.103						
A_t:	41507	0.953																		

Q Peak Flow (cfs)

2 Year Q	5 Year Q	10 Year Q	25 Year Q	50 Year Q	100 Year Q
1.69	**2.21**	**2.73**	**3.34**	**3.90**	**4.50**

Sub-Basin:	D-1	(IDF Curve Equations from Figure 6-5 of the DCM Volume 1)			
t_t Duration:	5.00				
I_2	I_5	I_{10}	I_{25}	I_{50}	I_{100}
4.119768884	5.168843131	6.03048365	6.89212418	7.7537647	8.67921646

Hydrologic Soil Type:	B

Coefficient (Table 6-6)

Land Use or Surface Characteristic	Square Feet	Acreage	$Coefficient_2$	$Coefficient_5$	$Coefficient_{10}$	$Coefficient_{25}$	$Coefficient_{50}$	$Coefficient_{100}$	2 Yr: $C_i * A_i$	5 Yr: $C_i * A_i$	10 Yr: $C_i * A_i$	25 Yr: $C_i * A_i$	50 Yr: $C_i * A_i$	100 Yr: $C_i * A_i$	2 Yr C_c	5 Yr C_c	10 Yr C_c	25 Yr C_c	50 Yr C_c	100 Yr C_c
Roof	1014.00	0.023	0.71	0.73	0.75	0.78	0.80	0.81	0.017	0.017	0.017	0.018	0.019	0.019	**0.345**	**0.386**	**0.437**	**0.506**	**0.542**	**0.576**
Pavement	4648	0.107	0.89	0.90	0.92	0.94	0.95	0.96	0.095	0.096	0.098	0.100	0.101	0.102						
Lawn	8938	0.205	0.02	0.08	0.15	0.25	0.30	0.35	0.004	0.016	0.031	0.051	0.062	0.072						
A_t:	14600	0.335																		

Q Peak Flow (cfs)

2 Year Q	5 Year Q	10 Year Q	25 Year Q	50 Year Q	100 Year Q
0.48	**0.67**	**0.88**	**1.17**	**1.41**	**1.68**

Sub-Basin:	D-2	(IDF Curve Equations from Figure 6-5 of the DCM Volume 1)			
t_t Duration:	9.76				
I_2	I_5	I_{10}	I_{25}	I_{50}	I_{100}
3.324398129	4.166274953	4.86082078	5.5553666	6.24991243	6.99490192

Hydrologic Soil Type:	A

Coefficient (Table 6-6)

Land Use or Surface Characteristic	Square Feet	Acreage	$Coefficient_2$	$Coefficient_5$	$Coefficient_{10}$	$Coefficient_{25}$	$Coefficient_{50}$	$Coefficient_{100}$	2 Yr: $C_i * A_i$	5 Yr: $C_i * A_i$	10 Yr: $C_i * A_i$	25 Yr: $C_i * A_i$	50 Yr: $C_i * A_i$	100 Yr: $C_i * A_i$	2 Yr C_c	5 Yr C_c	10 Yr C_c	25 Yr C_c	50 Yr C_c	100 Yr C_c
Roof	9535.00	0.219	0.71	0.73	0.75	0.78	0.80	0.81	0.155	0.160	0.164	0.171	0.175	0.177	**0.571**	**0.600**	**0.636**	**0.683**	**0.708**	**0.731**
Pavement	18518	0.425	0.89	0.90	0.92	0.94	0.95	0.96	0.378	0.383	0.391	0.400	0.404	0.408						
Lawn	13093	0.301	0.02	0.08	0.15	0.25	0.30	0.35	0.006	0.024	0.045	0.075	0.090	0.105						
A_t:	41146	0.945																		

Q Peak Flow (cfs)

2 Year Q	5 Year Q	10 Year Q	25 Year Q	50 Year Q	100 Year Q
1.79	**2.36**	**2.92**	**3.59**	**4.18**	**4.83**

Sub-Basin:	D-2	(IDF Curve Equations from Figure 6-5 of the DCM Volume 1)			
t_t Duration:	5.00				
I_2	I_5	I_{10}	I_{25}	I_{50}	I_{100}
4.119768884	5.168843131	6.03048365	6.89212418	7.7537647	8.67921646

Hydrologic Soil Type:	B

Coefficient (Table 6-6)

Land Use or Surface Characteristic	Square Feet	Acreage	$Coefficient_2$	$Coefficient_5$	$Coefficient_{10}$	$Coefficient_{25}$	$Coefficient_{50}$	$Coefficient_{100}$	2 Yr: $C_i * A_i$	5 Yr: $C_i * A_i$	10 Yr: $C_i * A_i$	25 Yr: $C_i * A_i$	50 Yr: $C_i * A_i$	100 Yr: $C_i * A_i$	2 Yr C_c	5 Yr C_c	10 Yr C_c	25 Yr C_c	50 Yr C_c	100 Yr C_c
Roof	664.00	0.015	0.71	0.73	0.75	0.78	0.80	0.81	0.011	0.011	0.011	0.012	0.012	0.012	**0.243**	**0.291**	**0.347**	**0.426**	**0.466**	**0.506**
Pavement	3358	0.077	0.89	0.90	0.92	0.94	0.95	0.96	0.069	0.069	0.071	0.072	0.073	0.074						
Lawn	11102	0.255	0.02	0.08	0.15	0.25	0.30	0.35	0.005	0.020	0.038	0.064	0.076	0.089						
A_t:	15124	0.347																		

Q Peak Flow (cfs)

2 Year Q	5 Year Q	10 Year Q	25 Year Q	50 Year Q	100 Year Q
0.35	**0.52**	**0.73**	**1.02**	**1.26**	**1.52**

Design Points

Design Point	Q_5	Q_{10}	Q_{100}
EX DP1	2.88	3.61	6.17
EX DP2	2.88	3.65	6.35
EX DP3	0.00	0.00	0.00
Total Site	**5.76**	**7.26**	**12.53**

Please update to combine runoff calculations into one for each basin (D-1 and D-2) or relabel smaller subbasins to identify them as separate basins (D-3 and D-4). If you have any questions call Lupe Packman @ 719-313-6215.

Time of Concentration $t_c = t_i + t_t$

3.2.1 - Overland (Initial) Flow Time

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L}}{S^{0.33}} \quad \text{(Eq. 6-8)}$$

Where:

t_i = overland (initial) flow time (min)
C_5 = runoff coefficient for 5-year frequency (see Table 6-6)
L = length of overland flow (300 ft maximum for non-urban land uses, 100 ft maximum for urban land uses)
S = average basin slope (ft/ft)

Note that in some urban watersheds, the overland flow time may be very small because flows quickly concentrate and channelize.

Sub-Basin or DP:	D-1	
C_5:	0.61	[Table 6-6. Runoff Coefficients for Rational Method]
L:	99	ft
S:	0.005	ft/ft

Composite Runoff Coefficient Calculation:

$C_c = (C_1 A_1 + C_2 A_2 + C_3 A_3 + \ldots C_i A_i) / A_t$

Land Use or Surface Characteristic	Square Feet	Acreage	C_5
Roof	9027.00	0.21	0.73
Pavement	19702.00	0.45	0.90
Lawn	12778.00	0.29	0.08
A_t :	41507.00	0.95	

$C_c = (0.73*0.21 + 0.90*0.45 + 0.08*0.29) / 0.95 =$ **0.61**

$t_i = (0.395*(1.1-C_5)*sqrt(L))/(S^{\wedge}0.33)$

$t_i = (0.395*(1.1-0.61)*sqrt(99))/(0.005^{\wedge}0.33) =$ **11.05** mins

3.2.2 Travel Time

For catchments with overland and channelized flow, the time of concentration needs to be considered in combination with the travel time, t_t, which is calculated using the hydraulic properties of the swale, ditch, or channel. For preliminary work, the overland travel time, t_t, can be estimated with the help of Figure 6-25 or Equation 6-9 (Guo 1999).

$$V = C_v S_w^{0.5} \quad \text{(Eq. 6-9)}$$

Where:

V = velocity (ft/s)
C_v = conveyance coefficient (from Table 6-7)
S_w = watercourse slope (ft/ft)

$V = C_v S_w^{0.5}$

$V = (20)(0.015)^{0.5} =$ **2.45** ft/s

Flow Distance: **206.00** ft

$t_t = L/V =$ 84.10 sec.
1.40 min.

Table 6-7. Conveyance Coefficient, C_v

Type of Land Surface	C_v
Heavy meadow	2.5
Tillage/field	5
Riprap (not buried)*	6.5
Short pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

*For buried riprap, select C_v value based on type of vegetative cover.

$t_c = t_i + t_t =$ 12.45 min.

3.2.4 Minimum Time of Concentration

If the calculations result in a t_c of less than 10 minutes for undeveloped conditions, it is recommended that a minimum value of 10 minutes be used. The minimum t_c for urbanized areas is 5 minutes.

Final t_c: 12.45 min.

Time of Concentration $t_c = t_i + t_t$

3.2.1 - Overland (Initial) Flow Time

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L}}{S^{0.33}} \qquad \text{(Eq. 6-8)}$$

Where:

t_i = overland (initial) flow time (min)
C_5 = runoff coefficient for 5-year frequency (see Table 6-6)
L = length of overland flow (300 ft maximum for non-urban land uses, 100 ft maximum for urban land uses)
S = average basin slope (ft/ft)

Note that in some urban watersheds, the overland flow time may be very small because flows quickly concentrate and channelize.

Sub-Basin or DP:	D-1	
C_5:	0.39	[Table 6-6. Runoff Coefficients for Rational Method]
L:	1	ft
S:	0.015	ft/ft

Composite Runoff Coefficient Calculation:

$C_c = (C_1A_1 + C_2A_2 + C_3A_3 + ...C_iA_i) / A_t$

Land Use or Surface Characteristic	Square Feet	Acreage	C_5
Roof	1014.00	0.02	0.73
Pavement	4648.00	0.11	0.90
Lawn	8938.00	0.21	0.08
A_t :	14600.00	0.34	

C_c = (0.73*.02 + 0.90*0.11 + 0.08*0.21) / 0.34 = **0.39**

t_i = (0.395*(1.1-C_5)*sqrt(L))/(S^0.33)

t_i = (0.395*(1.1-0.39)*sqrt(1))/(0.015^0.33) = **1.13** mins

3.2.2 Travel Time

For catchments with overland and channelized flow, the time of concentration needs to be considered in combination with the travel time, t_t, which is calculated using the hydraulic properties of the swale, ditch, or channel. For preliminary work, the overland travel time, t_t, can be estimated with the help of Figure 6-25 or Equation 6-9 (Guo 1999).

$$V = C_v S_w^{0.5} \qquad \text{(Eq. 6-9)}$$

Where:

V = velocity (ft/s)
C_v = conveyance coefficient (from Table 6-7)
S_w = watercourse slope (ft/ft)

$V = C_v S_w^{0.5}$

$V = (20)(0.033)^{0.5}$ = **3.63** ft/s

Flow Distance: **178.00** ft

t_t = L/V = 48.99 sec.
0.82 min.

Table 6-7. Conveyance Coefficient, C_v

Type of Land Surface	C_v
Heavy meadow	2.5
Tillage/field	5
Riprap (not buried)*	6.5
Short pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

*For buried riprap, select C_v value based on type of vegetative cover.

$t_c = t_i + t_t$ = **1.94** min.

3.2.4 Minimum Time of Concentration

If the calculations result in a t_c of less than 10 minutes for undeveloped conditions, it is recommended that a minimum value of 10 minutes be used. The minimum t_c for urbanized areas is 5 minutes.

Final t_c: **5.00** min.

Time of Concentration $t_c = t_i + t_t$

3.2.1 - Overland (Initial) Flow Time

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L}}{S^{0.33}} \quad \text{(Eq. 6-8)}$$

Where:

t_i = overland (initial) flow time (min)
C_5 = runoff coefficient for 5-year frequency (see Table 6-6)
L = length of overland flow (300 ft maximum for non-urban land uses, 100 ft maximum for urban land uses)
S = average basin slope (ft/ft)

Note that in some urban watersheds, the overland flow time may be very small because flows quickly concentrate and channelize.

Sub-Basin or DP:	D-2	
C_5:	0.60	[Table 6-6. Runoff Coefficients for Rational Method]
L:	89	ft
S:	0.01	ft/ft

Composite Runoff Coefficient Calculation:

$C_c = (C_1 A_1 + C_2 A_2 + C_3 A_3 + \ldots C_i A_i) / A_t$

Land Use or Surface Characteristic	Square Feet	Acreage	C_5
Roof	9535.00	0.22	0.73
Pavement	18518.00	0.43	0.90
Lawn	13093.00	0.30	0.08
A_t :	41146.00	0.94	

$C_c = (0.73*0.22 + 0.90*0.43 + 0.08*0.30) / 0.94 =$ **0.60**

$t_i = (0.395*(1.1-C_5)*sqrt(L))/(S^{\wedge}0.33)$

$t_i = (0.395*(1.1-0.60)*sqrt(89))/(0.01^{\wedge}0.33) =$ **8.52** mins

3.2.2 Travel Time

For catchments with overland and channelized flow, the time of concentration needs to be considered in combination with the travel time, t_t, which is calculated using the hydraulic properties of the swale, ditch, or channel. For preliminary work, the overland travel time, t_t, can be estimated with the help of Figure 6-25 or Equation 6-9 (Guo 1999).

$$V = C_v S_w^{0.5} \quad \text{(Eq. 6-9)}$$

Where:

V = velocity (ft/s)
C_v = conveyance coefficient (from Table 6-7)
S_w = watercourse slope (ft/ft)

$V = C_v S_w^{0.5}$

$V = (20)(0.025)^{0.5} =$ **3.16** ft/s

Flow Distance: **234.00** ft

$t_t = L/V =$ 74.00 sec.
1.23 min.

Table 6-7. Conveyance Coefficient, C_v

Type of Land Surface	C_v
Heavy meadow	2.5
Tillage/field	5
Riprap (not buried)*	6.5
Short pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

*For buried riprap, select C_v value based on type of vegetative cover.

$t_c = t_i + t_t$ = **9.76** min.

3.2.4 Minimum Time of Concentration

If the calculations result in a t_c of less than 10 minutes for undeveloped conditions, it is recommended that a minimum value of 10 minutes be used. The minimum t_c for urbanized areas is 5 minutes.

Final t_c: **9.76** min.

Time of Concentration $t_c = t_i + t_t$

3.2.1 - Overland (Initial) Flow Time

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L}}{S^{0.33}} \quad \text{(Eq. 6-8)}$$

Where:

t_i = overland (initial) flow time (min)
C_5 = runoff coefficient for 5-year frequency (see Table 6-6)
L = length of overland flow (300 ft maximum for non-urban land uses, 100 ft maximum for urban land uses)
S = average basin slope (ft/ft)

Note that in some urban watersheds, the overland flow time may be very small because flows quickly concentrate and channelize.

Sub-Basin or DP:	D-2	
C_5:	0.29	[Table 6-6. Runoff Coefficients for Rational Method]
L:	1	ft
S:	0.025	ft/ft

Composite Runoff Coefficient Calculation:

$C_c = (C_1A_1 + C_2A_2 + C_3A_3 + ...C_iA_i) / A_t$

Land Use or Surface Characteristic	Square Feet	Acreage	C_5
Roof	664.00	0.02	0.73
Pavement	3358.00	0.08	0.90
Lawn	11102.00	0.25	0.08
A_t :	15124.00	0.35	

C_c = (0.73*0.02 + 0.90*0.08 + 0.08*0.25) / 0.35 = **0.29**

t_i = (0.395*(1.1-C_5)*sqrt(L))/(S^0.33)
t_i = (0.395*(1.1-0.29)*sqrt(1))/(0.025^0.33) = **1.08** mins

3.2.2 Travel Time

For catchments with overland and channelized flow, the time of concentration needs to be considered in combination with the travel time, t_t, which is calculated using the hydraulic properties of the swale, ditch, or channel. For preliminary work, the overland travel time, t_t, can be estimated with the help of Figure 6-25 or Equation 6-9 (Guo 1999).

$$V = C_v S_w^{0.5} \quad \text{(Eq. 6-9)}$$

Where:

V = velocity (ft/s)
C_v = conveyance coefficient (from Table 6-7)
S_w = watercourse slope (ft/ft)

$V = C_v S_w^{0.5}$
$V = (20)(0.065)^{0.5}$ = **5.10** ft/s

Flow Distance: **144.00** ft

t_t = L/V = 28.24 sec.
0.47 min.

Table 6-7. Conveyance Coefficient, C_v

Type of Land Surface	C_v
Heavy meadow	2.5
Tillage/field	5
Riprap (not buried)*	6.5
Short pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

*For buried riprap, select C_v value based on type of vegetative cover.

$t_c = t_i + t_t$ = 1.55 min.

3.2.4 Minimum Time of Concentration

If the calculations result in a t_c of less than 10 minutes for undeveloped conditions, it is recommended that a minimum value of 10 minutes be used. The minimum t_c for urbanized areas is 5 minutes.

Final t_c: 5.00 min.

APPENDIX C – FEMA FLOODPLAIN MAP

National Flood Hazard Layer FIRMette

104°43'20"W 38°51'36"N

104°42'42"W 38°51'8"N

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

1:6,000

FEMA

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- 20.2 / 17.5 Cross Sections with 1% Annual Chance Water Surface Elevation
- Coastal Transect
- Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

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

N

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

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

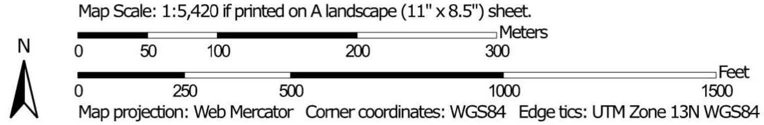
The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 12/18/2020 at 10:15 AM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

APPENDIX D – USGS SOILS SURVEY MAP

Soil Map—El Paso County Area, Colorado
(1670 PAONIA ST)

Map Scale: 1:5,420 if printed on A landscape (11" x 8.5") sheet.



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 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.

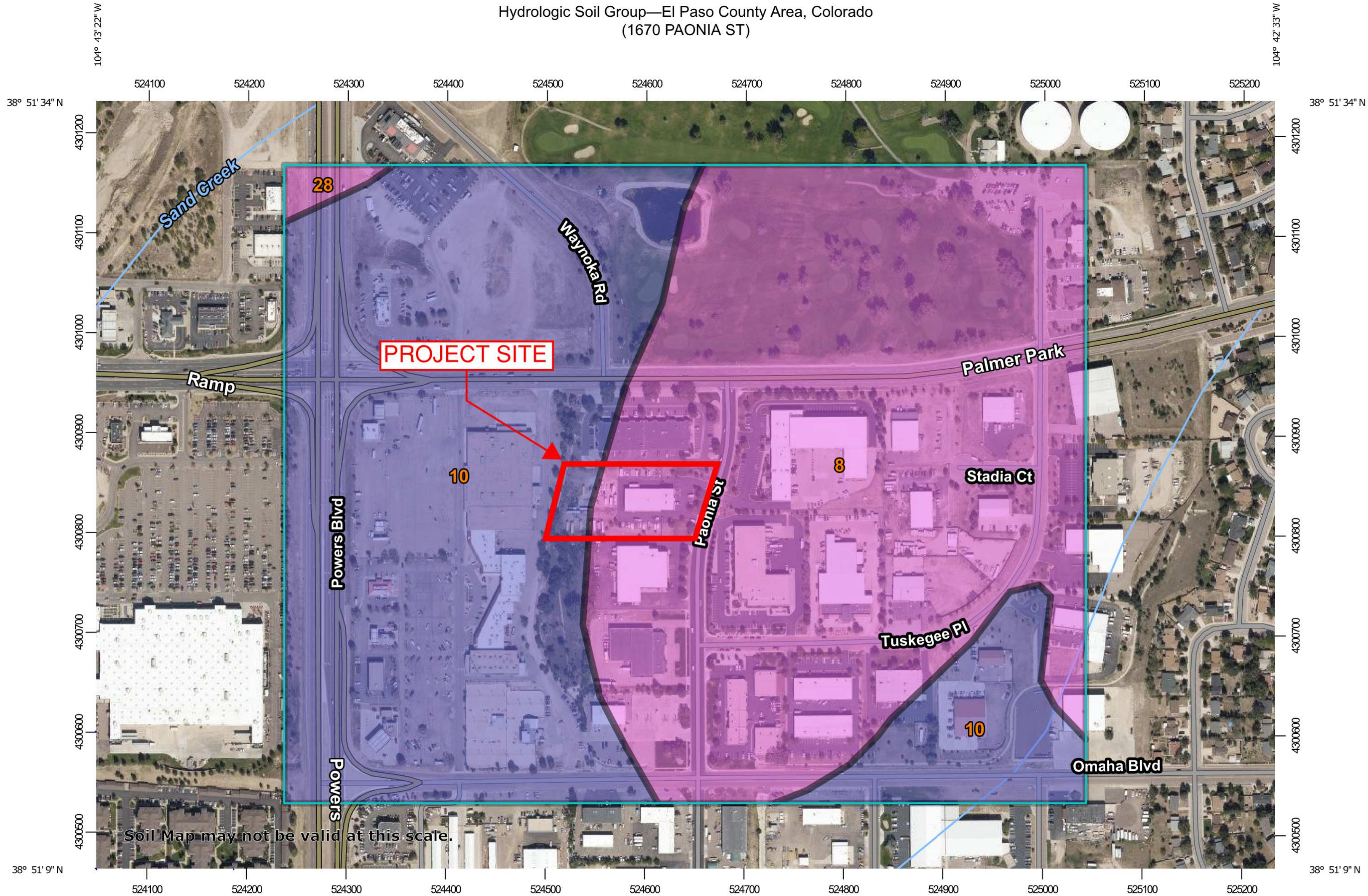
Date(s) aerial images were photographed: Aug 19, 2018—Sep 23, 2018

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.

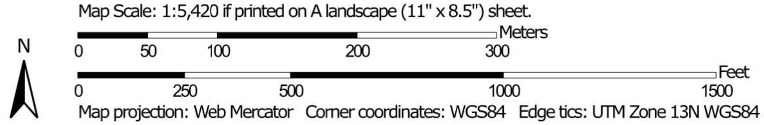
Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
8	Blakeland loamy sand, 1 to 9 percent slopes	65.3	51.2%
10	Blendon sandy loam, 0 to 3 percent slopes	61.5	48.2%
28	Ellicott loamy coarse sand, 0 to 5 percent slopes	0.9	0.7%
Totals for Area of Interest		**127.7**	**100.0%**

Hydrologic Soil Group—El Paso County Area, Colorado
(1670 PAONIA ST)



Map Scale: 1:5,420 if printed on A landscape (11" x 8.5") sheet.



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 1:24,000.

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.

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
8	Blakeland loamy sand, 1 to 9 percent slopes	A	65.3	51.2%
10	Blendon sandy loam, 0 to 3 percent slopes	B	61.5	48.2%
28	Ellicott loamy coarse sand, 0 to 5 percent slopes	A	0.9	0.7%
Totals for Area of Interest			**127.7**	**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