Architectural
Structural
Geotechnical

RMG
Engineers / Architects

Materials Testing
Forensic
Civil/Planning

EPC STORMWATER REVIEW COMMENTS
IN ORANGE BOXES WITH BLACK TEXT

FINAL DRAINAGE REPORT

Foundation Lutheran Church

Towners Ave
Tract C, Paint Brush Hills Filing No. 13A
Falcon, Colorado

PREPARED FOR:

Colorado Commercial Construction
12325 Oracle Blvd, Suite 120
Colorado Springs, CO 80921

JOB NO. 191726

March 28th, 2023

Add "PCD File No. PPR2321"

SIGNATURE PAGE

TR C PAINT BRUSH HILLS, FILING NO. 13A

ENGINEER'S STATEMENT

This report and plan for the drainage design of Tract C, Paint Brush Hills Filing No. 13A was prepared by me (or under my direct supervision) and is correct to the best of my knowledge and belief. Said report and plan has been prepared in accordance with the El Paso County Drainage Criteria Manuals Volumes 1 and 2 and is in conformity with the master plan of the drainage basin. I understand that El Paso County does not and will not assume liability for drainage facilities designed by others. I accept responsibility for any liability caused by any negligent acts, errors or omissions on my part in the preparing this report.

Respectfully Submitted,

RMG – Rocky Mountain Group

David Walker, P.E.
Sr. Civil Project Manager

DEVELOPER'S STATEMENT

Foundation Lutheran Church hereby certifies that the drainage facilities for Tract C, Paint Brush Hills Filing No. 13A shall be constructed according to the design presented in this report. I understand that El Paso County does not and will not assume liability for drainage facilities designed and/or certified by my engineer and that are submitted to El Paso County; and cannot, on behalf of Tract C, Paint Brush Hills Filing No. 13A, guarantee that final drainage design review will absolve Foundation Lutheran Church and/or their successors and/or assigns of future liability for improper design. I further understand that approval of the final plat does not imply approval of my engineer's drainage design.

Revise to:

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.

Name

Autho

_____ _____

[Name, Title] Date

[Business Name]

[Address]

_____

Printed Name

_____

Title Phone

_____

Address

EL PASO COUNTY STATEMENT

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

Please revise signature line to:

_____

City Engineer

_____ _____

Joshua Palmer, P.E. Date

County Engineer / ECM Administrator

Conditions:

Conditions:

TABLE OF CONTENTS

FINAL DRAINAGE REPORT 1
TABLE OF CONTENTS 4
I. PURPOSE 5
II. GENERAL LOCATION AND DESCRIPTION 5
A. LOCATION 5
B. DESCRIPTION OF PROPERTY – EXISTING CONDITIONS 5
C. EXISTING SOILS 6
D. EXISTING DRAINAGE 6
E. DESCRIPTION OF PROPERTY – PROPOSED CONDITIONS 6
III. DRAINAGE BASINS AND SUB-BASINS 7
A. EXISTING MAJOR DRAINAGE BASIN AND SUB-BASINS 7
A. DEVELOPED MAJOR DRAINAGE BASIN AND SUB-BASINS 7
IV. DRAINAGE DESIGN CRITERIA 8
A. REGULATIONS 8
B. DEVELOPMENT CRITERIA REFERENCE AND CONSTRAINTS 8
C. HYDROLOGICAL CRITERIA 9
D. FOUR-STEP PROCESS 9
V. DRAINAGE INFRASTRUCTURE COSTS AND FEES 10
A. DRAINAGE AND BRIDGE FEES 10
VI. CONCLUSIONS 11
A. COMPLIANCE WITH STANDARDS 11
VII. REFERENCES 11
VIII. APPENDICES 12

Include in the appendix excerpts from the Pain Brush Hills drainage report referenced in the report.

I. PURPOSE

This report is a Final Drainage Report for Foundation Lutheran Church for the development of a church.

The purpose of this report is to identify on-site and off-site 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 or right-of-way, and provide a narrative for any other drainage considerations related to the development of this parcel.

II. GENERAL LOCATION AND DESCRIPTION

A. LOCATION

The proposed development of Foundation Lutheran Church is located at the address of Towners Av in Falcon, Colorado in El Paso County within the Paint Brush Hills subdivision. The parcel schedule number is 5225208001 and the legal description is currently Tract C, Paint Brush Hills Filing No. 13A. The parcel is located in the West half of Section 25, Township 12 South, Range 65 West of the 6th P.M. El Paso County, Colorado. The site is bordered to the north by Londonderry Dr, to the east by Towners Ave, and to the south and west by residential single-family homes. The names and descriptions of surrounding platted developments can be seen on plan sets and appendix documents:

B. DESCRIPTION OF PROPERTY – EXISTING CONDITIONS

The project site is approximately 259,865 square feet (5.966 acres) and consists of undeveloped natural vegetation. There is existing curb and gutter along Londonderry Drive and Towners Avenue.

The existing percent imperviousness is approximately 0 percent on Tract C. The existing vegetation consists of shrubs and native grasses.

Show and label swale on drainage maps

The existing topography consists of grades between 1 and 25 percent. Drainage patterns sheet flow south across the parcel to a temporary swale that directs flow to the southwest corner.

There is a F.E.S. outlet at the southeast corner of the site that is connected to a 24” RCP storm drain pipe that goes easterly under Towners Ave. A temporary swale runs across the site on the south portion towards the southwest corner, where an F.E.S. inlet is connect to a 36” RCP storm drain pipe. The 36” RCP storm drain pipe leaves the site in a southerly direction and goes to a regional detention facility located off-site known as Pond B1. The detention facility is within a platted tract of land with ownership and maintenance by the Paint Brush Hills Metropolitan District.

The site is not located within a streamside zone.

C. EXISTING SOILS

The soils indicative to the site are classified as Pring coarse sandy loam by the USDA Soil Conservation Service and are listed as NRCS (National Resources Conservation Service) Hydrologic Soil Group B. These soils have a moderate infiltration rate when thoroughly wet and have a moderate rate of water transmission. The USDA Soil Map is provided in the Appendix.

D. EXISTING DRAINAGE

According to the "Final Drainage Report for Paint Brush Hills – Phase 2 (Filing No. 13)", by Classic Consulting Engineers & Surveyors LLC dated June 2008:

> "At Design Point 10 (Q_5 = 11 cfs and Q_{100} = 21 cfs) and existing 24" RCP storm sewer will be allowed to continue to collect flows off of the undeveloped future school site. As stated in this report, upon development of this school site, the maximum flow allowed to enter this facility will remain the (Q_5 = 11 cfs and Q_{100} = 21 cfs)."
>
> "The release from Design Point 10 will temporarily travel across the south portion of the future commercial site within a swale towards Design Point 11. Upon development of this commercial area, it is anticipated that the temporary swale be removed and the 24" RCP be extended to Design Point 11. At this location, the maximum developed flow allowed to discharge from the commercial site is (Q_5 = 23 cfs and Q_{100} = 45 cfs). This flow, combined with the discharge from Design Point 10 equals the total developed flow allowed to enter the public storm system at Design Point 11 (Q_5 = 23 cfs and Q_{100} = 45 cfs). These flows are then conveyed in a southerly direction in a 36" RCP storm sewer."

This parcel is located in the Falcon Drainage Basin.

The project site does not lie within a designated flood plain according to information published in the Federal Emergency Management Agency Floodplain Map No. 08041C0551G, dated December 7, 2018. The FEMA Floodplain map is provided in the Appendix showing it lies within Zone X, a minimal flood hazard area.

There are no known non-stormwater discharges that contribute to the storm water systems on site and downstream, both private and public.

E. DESCRIPTION OF PROPERTY – PROPOSED CONDITIONS

The proposed development consists of a single story church approximately 9,600 square feet.

There is no existing vehicle entry access point to the property. The proposed development will have two vehicle entry access points, one access directly across from Triborough Trail and the other directly across from the entrance to the Paint Brush Hills Metro District Office.

The proposed development will require an approximate limits of disturbance, including the right of way improvements of pedestrian sidewalk with ADA curb ramps, curb cuts, and utility work of

Clarify if the amount of land disturbance includes fill. The amount is greater than the property site.

approximately 284,661 square feet or 6.53 acres. The limits of disturbance do not disturb the existing hillsides. The grading limits are kept within the setbacks wherever possible and the developed conditions remain consistent with the historical drainage pattern of the subdivision with the added benefit of reduced release rate from the rain garden. A sub-basin delineation sheet for the proposed conditions is provided in the Appendix.

C

Discuss off-site flows entering the site from surrounding filings and their impacts to the development.

III. DRAINAGE BASINS AND SUB-BASINS

A. EXISTING MAJOR DRAINAGE BASIN AND SUB-BASINS

The parcel is delineated into sub-basins according to the existing and proposed grading for existing and developed conditions. A drainage plan of the delineated basins for existing conditions can be found in the Appendix.

Basin E is the entirety of the parcel to be redeveloped representing existing conditions in one on-site basin. The Final Drainage Report for Paint Brush Hills – Phase 2 (Filing No. 13), by Classic Consulting Engineers & Surveyors LLC dated June 2008 shows this property as sub-basin T and sub-basin S.

Sub-basin E-1 (6.41 ac.; Q_5 = 1.37 cfs, Q_{10} = 3.00 cfs, Q_{100} = 10.05 cfs) is the entire property that consists of all natural vegetation. The basin flows south across the parcel to a temporary swale that directs flow to the existing F.E.S. inlet in the southwest corner of the site, also known as Existing Point 1 (EP1).

List what the existing flows are at this DP based on calculated basin flow and offsite flow from EP2.

Existing Point 1 (EP1) is the existing design point representing the F.E.S. in the southwest corner of the site that is connected to an existing 36" RCP storm drain pipe that runs southerly off-site and eventually drains into an existing detention facility known as Pond B1. The Final Drainage Report for Paint Brush Hills – Phase 2 (Filing No. 13), by Classic Consulting Engineers & Surveyors LLC dated June 2008 shows this as design point 11 with an allowable release rate of 23 cfs for the minor storm event (5-year storm) and 45 cfs for the major storm event (100-year storm).

Existing Point 2 (EP2) is the existing design point representing the F.E.S. outlet in the southeast corner of the site that is connected to an existing 24" RCP storm drain pipe under Towners Ave. The Final Drainage Report for Paint Brush Hills – Phase 2 (Filing No. 13), by Classic Consulting Engineers & Surveyors LLC dated June 2008 shows this as design point 10 with an allowable release rate of 11 cfs for the minor storm event (5-year storm) and 21 cfs for the major storm event (100-year storm).

A. DEVELOPED MAJOR DRAINAGE BASIN AND SUB-BASINS

Basin D is the entirety of the platted parcel representing developed conditions and consists of two on-site sub-basins. A Drainage Plan for developed conditions can be found in the Appendix. C

Sub-basin D-1 (1.56 ac.; Q_5 = 2.59 cfs, Q_{10} = 3.40 cfs, Q_{100} = 6.35 cfs) is the east side of the site consisting of asphalt pavement and concrete sidewalk. Runoff goes through the parking lot and

exits on the south side and flows through a grass swale before being captured via an area inlet, Design Point 1 (DP1).

Sub-basin D-2 (4.85 ac.; Q_5 = 3.92 cfs, Q_{10} = 6.02 cfs, Q_{100} = 14.52 cfs) is the west side of the site consisting of the church building, asphalt pavement, concrete sidewalk and a play field. Runoff goes through the parking lot and exits at the southwest corner and flows through a grass swale before being captured via an area inlet, Design Point 2 (DP2).

Design Point 1 (DP1) is the design point representing the area inlet for sub-basin D-1. This inlet will receive existing flows from Design Point 4 (DP4). The private storm system flows downstream to subsequent Design Point 2 (DP2). The total peak runoff from the site flowing into DP1 is 13.59 cfs for the 5-year peak flow and 27.35 for the 100-year peak flow.

Design Point 2 (DP2) is the design point representing the area inlet for sub-basin D-2. This inlet will receive existing flows from Design Point 1 (DP1). The private storm system flows downstream to subsequent Design Point 3 (DP3). The total peak runoff from the site flowing into DP2 is 17.51 cfs for the 5-year peak flow and 41.87 for the 100-year peak flow.

Design Point 3 (DP3) is the design point representing the F.E.S. in the southwest corner of the site that is connected to an existing 36" RCP storm drain pipe that runs southerly off-site and eventually drains into an existing detention facility known as Pond B1. what are the proposed flows?

Design Point 4 (DP4) is the design point representing the F.E.S. outlet in the southeast corner of the site that is connected to an existing 24" RCP storm drain pipe under Towners Ave. what are the proposed flows?

The Final Drainage Report for Paint Brush Hills – Phase 2 (Filing No. 13), by Classic Consulting Engineers & Surveyors LLC dated June 2008 states the maximum developed flow allowed to discharge from the commercial site is Q_5 = 23 cfs and Q_{100} = 45 cfs. The total peak runoff being discharged from the developed church site is Q_5 = 17.51 cfs and Q_{100} = 41.87 cfs. Due to the proposed development yielding less storm water runoff, no downstream Provide copies of pond design from Paintbrush Hills in appendix. alterations and it is anticipated that there will be no negative impacts to downst developments.

State what the capacity of Pond B1 is. Were flows from this site included in the calculations for Pond B1 and what the amount of runoff entering Pond B1 will be with the development of this site.

IV. DRAINAGE DESIGN

A. REGULATIONS

Site shall meet El Paso County Drainage Criteria Manual. Please revise.

The hydrologic and hydraulic calculations and design of the site conform to the City of Colorado Springs Drainage Criteria Manuals I and II (May 2014) as well as the Mile High Flood Disrict Drainage Criteria Manual (August 2018).

B. DEVELOPMENT CRITERIA REFERENCE AND CONSTRAINTS

The parcel falls within the Falcon Drainage Basin. The runoff from this parcel will have no adverse effects 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 various storms.

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 PI values from the Drainage 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. Weighted runoff coefficients were calculated for each basin and sub-basin due to the mix of impervious surfaces.

D. FOUR-STEP PROCESS

The selection of appropriate control measures is based on the characteristics of the site and potential pollutants. The Four-Step Process provides a method of going through the selection process. The following applies the four-step process to the Development Plan for the Foundation Lutheran Church.

Engineer must confirm in the Drainage Report that the existing offsite or onsite PBMPs that the site is tributary to are functioning as intended.

Step 1: Employ Runoff Reduction Practices

The Development Plan including the Landscape Plan utilizes landscaping areas for plantings and grass or mulch wherever possible without obstructing utilities or drainage ways. Given the proposed land use and desired density of the development, the required areas of the site is to be paved for vehicular and pedestrian access and the development of the structures and surrounding hardscape. Within the site, the storm water runoff is kept to the site limits via strategic grading, grass swales and landscaping.

Compare what the anticipated impervious of the site was versus now.

Step 2: Provide Water Quality Capture Volume

The Final Drainage Report for Paint Brush Hills – Phase 2 (Filing No. 13), by Classic Consulting Engineers & Surveyors LLC dated June 2008 indicates a regional detention facility for this area. The detention facility was designed for water quality capture as well as full spectrum detention for the entirety of this site. The detention facility is within a platted tract of land with ownership and maintenance by the Paint Brush Hills Metropolitan District.

Provide calculations in appendix for swales

Step 3: Stabilize Drainage Ways

The drainage within the site is stabilized by way of pavement with curb and gutter to guide flow, as well as a grass-lined swales designed for a 100-year storm. There are no unstabilized drainage ways on this site. The unpaved, grass-lined swales are designed to convey on-site runoff.

All new and re-development projects are required to construct or participate in the funding of channel stabilization measures. Drainage basin fees paid, at the time of platting, go towards channel stabilization within the drainage basin.

Provide in the appendix information from the referenced drainage report that the detention facility accounted for the development and has adequate capacity. Discuss any improvements needed to the pond or existing stormwater infrastructure.

Provide copies of pond design from Paintbrush Hills in appendix.

Step 4: Implement Site Specific and Other Source Control BMPs

show this on the GEC Plans

Site specific BMPS include a concrete wash out, stabilized staging area, and stockpile area are to be designated on site and surrounded with sediment control logs. Vehicle tracking control is to be implemented at both access points. Non-structural BMPs include street sweeping and instructions to the contractor to avoid tracking of mud and dirt off-site, compliance with dust control and construction site cleanup throughout the construction process. Permanent seeding and landscaping is to be done on all areas not slated for hardscape or structures. Storage/handling and spill containment controls are to be implemented per CDPHE regulations. No chemicals or other pollutive materials are required for this project and will not be allowed on site. Fueling and minor maintenance of vehicles or equipment may be allowed only in stabilized staging areas with proper controls in place. No major maintenance of vehicles or equipment is to be performed on site. Any spills that occur are to be addressed according to the requirements of Colorado Department Public Health and Environment, Hazardous Materials and Waste Management Division. No groundwater and/or stormwater dewatering activities are proposed or expected for the proposed construction activities. Any waste disposal is to be done off-site at the designation of the contractor at a location approved by El Paso County. Waste disposal, spill prevention, and response procedures are to be according to CDPHE and El Paso County standards.

An Erosion Control Plan showing BMPs for erosion and sediment control to be submitted separately.

V. DRAINAGE INFRASTRUCTURE COSTS AND FEES

A. DRAINAGE AND BRIDGE FEES

The development falls within the Falcon drainage basin (CHWS1400) which has a drainage basin fee of $37,256/acre and a bridge fee of $5,118/acre according to the El Paso County Drainage Basin 2023 fee schedule.

These lots were previously platted as part of Paint Brush Hills. Drainage and Bridge fees are assumed to have been previously paid. No Drainage and Bridge fees to pay at this time.

Any outstanding fees must be paid prior to new plat recordation.

Per the approved final drainage report and fee receipts for Paint Brush Hills Filling 13A (SF133) drainage fees for Tract C were not paid. Drainage fees will be due at the time of final plat, please calculate fees due.

DRAINAGE & BRIDGE FEES

This site lies within the Falcon Drainage Basin, which is tributary to Black Squirrel Creek Drainage Basin. The following describes only the 17 single family lots within the (R Zone) currently being platted for development. The remaining portion of the property being platted as various tracts will be re-platted in the future for development and at that time the remaining fees will be paid.

The total platted area for these 17 lots, Palmers Green Right-of-Way and Tract B is 10.55 acres. The percent imperviousness for this entire subdivision is calculated as follows:

Filing No. 13 (Per El Paso County Percent Impervious Chart for 0.5 ac. lots: **25%**)
10.55 Ac. x 25% = **2.64 Impervious Ac.**

Please include a cost estimate for all drainage improvements required.

VI. CONCLUSIONS

A. COMPLIANCE WITH STANDARDS

This Final Drainage Report is in conformance with the Colorado Springs Drainage Criteria Manual, Volumes 1 & 2 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 Foundation Lutheran Church is within compliance and standards and meets the requirements for the drainage design.

The proposed grading and drainage is within substantial conformance for the master drainage plan for the Subdivision and Drainage Basin. There is no impact on major drainage way planning studies within the larger drainage basin. Site runoff and storm drain and appurtenances will not adversely affect the downstream and surrounding developments.

El Paso County

VII. REFERENCES

Colorado Springs Drainage Manual Volumes I & II (May 2014, Rev. January 2021)

Colorado Urban Drainage and Flood Control District Drainage Criteria Manual, Volume I (January 2016)

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

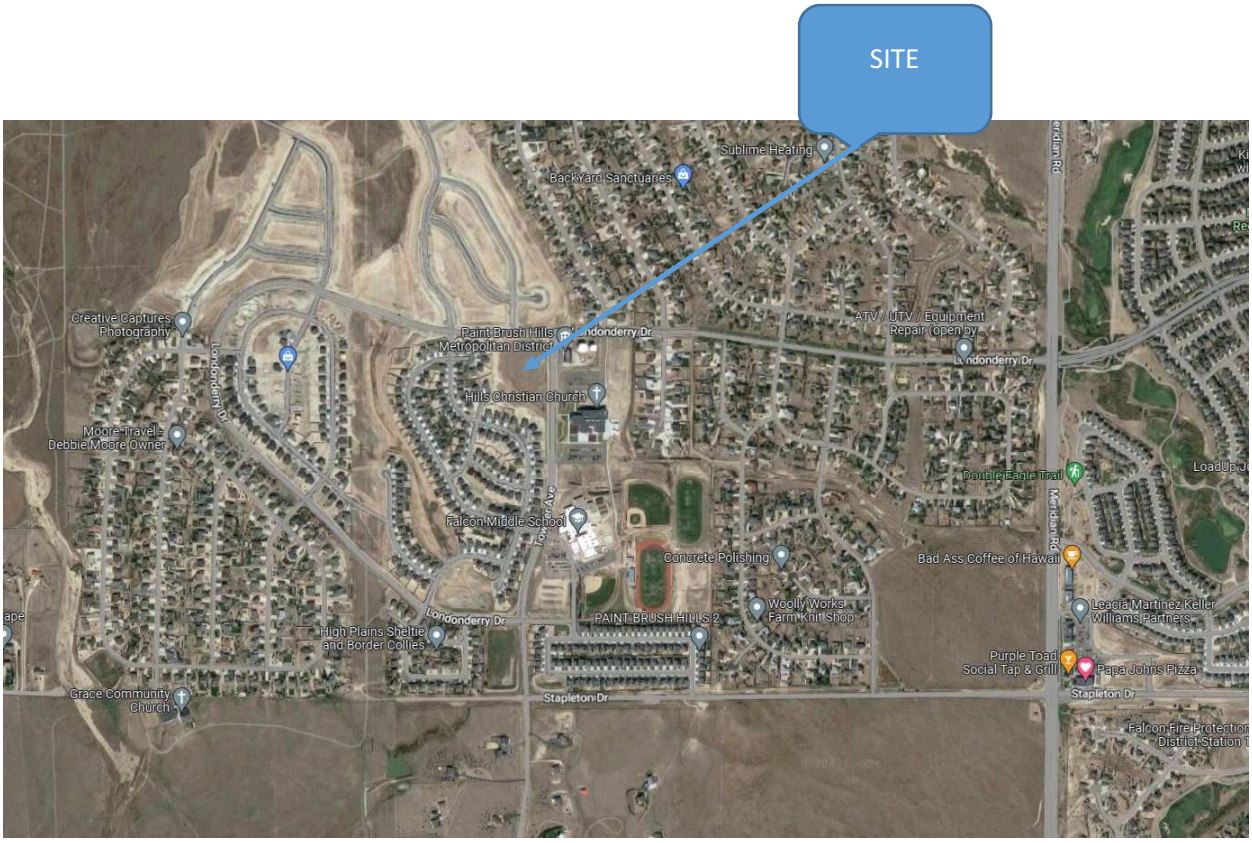
Final Drainage Report for Paint Brush Hills – Phase 2 (Filing No. 13), dated June 2008, prepared by Classic Consulting Engineers & Surveyors LLC

Final Drainage Report for Paint Brush Hills Filing No. 13A (Phased Final Plat – Phase 1), dated April 2013, prepared by Classic Consulting Engineers & Surveyors LLC

VIII. APPENDICES

Appendix A – Vicinity Map

Vicinity Map



Appendix B – Hydrologic and Hydraulic Computations

Label as existing conditions

Note: No action needed. The county requires the 5 year and 100 year storms to be analyzed. You can leave the 10 year storm highlighted if you want to.

Project Number: 191726
Engineer: AMH
Date: 2/21/2023
Address: Towners Ave

Sub-Basin:	E-1	(IDF Curve Equations from Figure 6-5 of the DCM Volume 1)			
t_c Duration:	26.44				
I_2	I_5	I_{10}	I_{25}	I_{50}	I_{100}
2.13798792	2.67079896	3.1160999	3.5613999	4.0066998	4.4825038

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 * A	5 Yr: C * A	10 Yr: C * A	25 Yr: C * A	50 Yr: C * A	100 Yr: C * A	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	0.00	0.71	0.73	0.75	0.78	0.80	0.81	0.000	0.000	0.000	0.000	0.000	0.000	**0.020**	**0.080**	**0.150**	**0.250**	**0.300**	**0.350**
Pavement	0	0.00	0.89	0.90	0.92	0.94	0.95	0.96	0.000	0.000	0.000	0.000	0.000	0.000						
Lawn	279175	6.41	0.02	0.08	0.15	0.25	0.30	0.35	0.128	0.513	0.961	1.602	1.923	2.243						
A_c:	279175	6.41																		

Q Peak Flow (cfs)

2 Year Q	5 Year Q	10 Year Q	25 Year Q	50 Year Q	100 Year Q
0.27	**1.37**	**3.00**	**5.71**	**7.70**	**10.05**

It appears the peak flow is being calculated using Ci*A, please provide a label showing that is the equation being used to avoid confusion with the Cc values shown.

Design Points

Design Point	Q_{10}	Q_{100}
E-1	3.00	10.05
Total Site	3.00	10.05

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:	E-1	
L (initial time):	300	ft
S (initial time):	0.034	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	0	0.00	0.73
Pavement	0	0.00	0.90
Lawn	279175	6.41	0.08
Total :	279175	6.41	

C_c = 0.08

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

t_i = **21.30** 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)

Conveyance Coeff.:	10	
Slope (travel time):	0.03	ft/ft
$V = C_v S_w^{0.5}$	1.73	ft/s
L (travel time):	534	ft
$t_t = L/V$ =	308.31	sec.
t_t =	5.14	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.

$t_c = t_i + t_t$ = **26.44** 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: **26.44** min.

The drainage map shows a small portion of the building within D-1. Please update roof section.

Labeled as proposed conditions

Project Number: 191726
Engineer: AMH
Date: 2/21/2023
Address: Towner's Ave

Sub-Basin:	D-1	(IDF Curve Equations from Figure 6-5 of the DCM Volume 1)			
t_c Duration:	10.31				
I_2	I_5	I_{10}	I_{25}	I_{50}	I_{100}
3.258739438	4.083511897	4.7642639	5.4450159	6.1257678	6.85586

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: $C_c * A_i$	5 Yr: $C_c * A_i$	10 Yr: $C_c * A_i$	25 Yr: $C_c * A_i$	50 Yr: $C_c * A_i$	100 Yr: $C_c * A_i$	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	0.00	0.71	0.73	0.75	0.78	0.80	0.81	0.000	0.000	0.000	0.000	0.000	0.000	**0.367**	**0.407**	**0.457**	**0.525**	**0.559**	**0.593**
Pavement	27107	0.62	0.89	0.90	0.92	0.94	0.95	0.96	0.554	0.560	0.573	0.585	0.591	0.597						
Lawn	40883	0.94	0.02	0.08	0.15	0.25	0.30	0.35	0.019	0.075	0.141	0.235	0.282	0.328						
A_i:	67990	1.56																		

Q Peak Flow (cfs)

2 Year Q_i	5 Year Q_i	10 Year Q_i	25 Year Q_i	50 Year Q_i	100 Year Q_i
1.87	**2.59**	**3.40**	**4.46**	**5.35**	**6.35**

Sub-Basin:	D-2	(IDF Curve Equations from Figure 6-5 of the DCM Volume 1)			
t_c Duration:	12.36				
I_2	I_5	I_{10}	I_{25}	I_{50}	I_{100}
3.042449441	3.810877447	4.4461904	5.0815033	5.7168162	6.3978341

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: $C_c * A_i$	5 Yr: $C_c * A_i$	10 Yr: $C_c * A_i$	25 Yr: $C_c * A_i$	50 Yr: $C_c * A_i$	100 Yr: $C_c * A_i$	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	9633	0.22	0.71	0.73	0.75	0.78	0.80	0.81	0.157	0.161	0.166	0.172	0.177	0.179	**0.145**	**0.198**	**0.261**	**0.349**	**0.393**	**0.437**
Pavement	22813	0.52	0.89	0.90	0.92	0.94	0.95	0.96	0.466	0.471	0.482	0.492	0.498	0.503						
Lawn	178739	4.10	0.02	0.08	0.15	0.25	0.30	0.35	0.082	0.328	0.615	1.026	1.231	1.436						
A_i:	211185	4.85																		

Q Peak Flow (cfs)

2 Year Q_i	5 Year Q_i	10 Year Q_i	25 Year Q_i	50 Year Q_i	100 Year Q_i
2.30	**3.92**	**6.02**	**9.21**	**11.67**	**14.52**

Design Points

Design Point	Q_{10}	Q_{100}
D-1	3.40	6.35
D-2	6.02	14.52
Total Site	**9.42**	**20.87**

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:	D-1	
L (initial time):	100	ft
S (initial time):	0.074	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	0	0.00	0.73
Pavement	27107	0.62	0.90
Lawn	40883	0.94	0.08
Total :	67990	1.56	

C_c = 0.41

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

t_i = **6.46** 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)

Conveyance Coeff.:	20	
Slope (travel time):	0.015	ft/ft
$V = C_v S_w^{0.5}$	2.45	ft/s
L (travel time):	565	ft
$t_t = L/V$ =	230.66	sec.
t_t =	3.84	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.

$t_c = t_i + t_t$ = **10.31** 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: **10.31** 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:	D-2	
L (initial time):	100	ft
S (initial time):	0.068	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	9632.7689	0.22	0.73
Pavement	22813	0.52	0.90
Lawn	178739	4.10	0.08
Total :	211185	4.85	

C_c = 0.20

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

t_i = **8.65** 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)

Conveyance Coeff.:	20	
Slope (travel time):	0.023	ft/ft
$V = C_v S_w^{0.5}$	3.03	ft/s
L (travel time):	676	ft
$t_t = L/V$ =	222.87	sec.
t_t =	3.71	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.

$t_c = t_i + t_t$ = **12.36** 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: **12.36** min.

Appendix C – Drainage Maps

Move the drainage maps to the end of the report.

LEGEND

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

Graphic Scale
0 20 40 80
In Feet: 1" = 40'

LONDONDERRY DRIVE

20.00 GRANT OF RIGHT-OF-WAY REC. NO. 217105176

20.00 PUBLIC UTILITY AND DRAINAGE EASEMENT (ASSUMED, NOT SHOWN OR LABELED ON PLAT)

LOT 107

LOT 108

LOT 109

10.00 PUBLIC UTILITY AND DRAINAGE EASEMENT (ASSUMED, NOT SHOWN OR LABELED ON PLAT)

LOT 110

LOT 119

LOT 120

LOT 121

PAINT BRUSH HILLS FILING NO. 13C REC. NO. 218714077

LOT 122

LOT 123

LOT 124

LOT 125

CHROMATIC TERRACE

TRACT C

TOWNER AVENUE

E-1
6.41 AC

EP1

EP2

E-1 T.O.C. PATHWAY

10.00 PUBLIC UTILITY AND DRAINAGE EASEMENT (ASSUMED, NOT SHOWN OR LABELED ON PLAT)

AREA OF CONCERN – 40.05 DRAINAGE EASEMENT SHOWN ON CONSTRUCTION PLANS NOT SHOWN OR LABELED ON PLAT OR INCLUDE IN TITLE COMMITMENT

20.00 PUBLIC UTILITY AND DRAINAGE EASEMENT (ASSUMED, NOT SHOWN OR LABELED ON PLAT)

20.00 DRAINAGE EASEMENT REC. NO. 203171514

Label line

Label contour elevations

It appears that sub-basin E-1 is the entire parcel, if so then the area of the basin is greater than the parcel. Please revise.

Add time of concentration path to legend.

what are these lines?

Label contours. Are flows going towards Towner Avenue, if so then break this into a different sub-basin.

Label property line since it appears to be overlapped by basin boundary

Show & label swale discussed within report

Show and label 36" RCP

Label all drainage infrastructure and rip rap.

Label 24" RCP that crosses underneath Towner Avenue into the property.

Include flows entering site from culvert

EP1 should be combined flow from Basin E-1 and offsite flow from existing culvert.

DESIGN POINT	FLOW (CFS)
EP1	Q_{10} = 3.00 Q_{100} = 10.05

BASIN SUMMARY

BASIN	Q10(CFS)	Q100(CFS)	ACRES(AC)
E-1	3.00	10.05	6.41

Add "PCD File No. PPR2321"

RMG
Materials Testing
Forensics
Civil / Planning
Architecture
Structural
Geotechnical
Engineers / Architects
SOUTHERN COLORADO OFFICE
2910 AUSTIN BLUFFS PKWY, SUITE 100, COLORADO SPRINGS, CO 80918
(719) 548-0600 – WWW.RMGENGINEERS.COM
Southern Colorado · Denver Metro · Northern Colorado

FOR CIVIL ONLY

FOUNDATION LUTHERAN CHURCH

TOWNERS AVE
FALCON, COLORADO

COLORADO COMMERIAL CONSTRUCTION, INC.

SHEET NAME: EXISTING SUB-BASIN ANALYSIS

PROJECT STATUS: FINAL DRAINAGE REPORT

ENG:	DGW
DRAWN:	AMH
CHECKED:	TPT
DATE	03/28/2023

#	REVISION	DATE

JOB NO. 191726

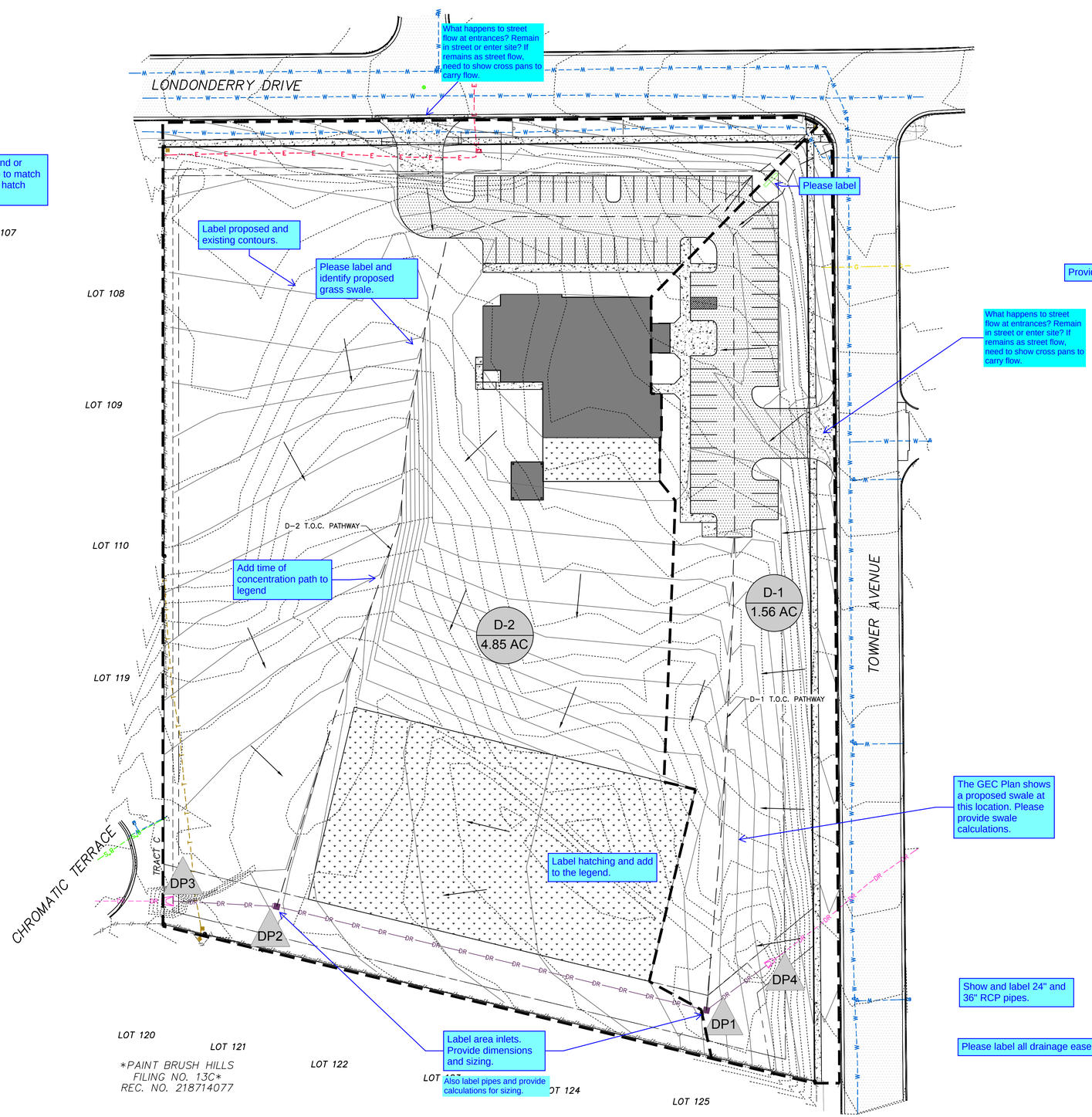
SHEET NO. 01 of 02

LAST SAVED: 3/24/2023 11:21:27 AM PATH: \\rcd.rmg-engineers.com\DFS\Tech\Projects\Site Specific\2023+\Colorado Commercial Construction, Inc.-11228\Towners Ave\191726\Civil\Drawings\From RMG\Sheet Set\Sub-Basin\191726_ Lutheran Church-Existing Sub Basin Analysis.dwg

LEGEND

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

Revise legend or update map to match symbol and hatch patterns.



Graphic Scale
0 20 40 80
In Feet: 1" = 40'

DESIGN POINT	FLOW (CFS)
DP1	Q_{10} = 3.40 Q_{100} = 6.35
DP2	Q_{10} = 6.02 Q_{100} = 14.52

add all DPs to this table

BASIN SUMMARY

BASIN	Q10(CFS)	Q100(CFS)	ACRES(AC)
D-1	3.40	6.35	1.56
D-2	6.02	14.52	4.85
TOTAL	9.42	20.87	6.41

Add "PCD File No. PPR2321"

RMG Engineers / Architects
Materials Testing
Forensics
Civil / Planning
Architecture
Structural
Geotechnical
SOUTHERN COLORADO OFFICE
219 D AUSTIN BLUFFS PKWY, SUITE 100, COLORADO SPRINGS, CO 80918
(719) 548-0600 ~ WWW.RMGENGINEERS.COM
SOUTHERN COLORADO, DENVER METRO, NORTHERN COLORADO

FOR CIVIL ONLY

FOUNDATION LUTHERAN CHURCH

TOWNERS AVE
FALCON, COLORADO

COLORADO COMMERIAL CONSTRUCTION, INC.

SHEET NAME: PROPOSED SUB-BASIN ANALYSIS

PROJECT STATUS: FINAL DRAINAGE REPORT

ENG:	DGW
DRAWN:	AMH
CHECKED:	TPT
DATE	03/28/2023

#	REVISION	DATE

JOB NO. 191726

SHEET NO. 02 of 02

Appendix D – FEMA Floodplain Map

National Flood Hazard Layer FIRMette

FEMA

104°37'40"W 38°58'52"N

104°37'2"W 38°58'24"N

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

1:6,000

Basemap: USGS National Map: Orthoimagery: Data refreshed October, 2020

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 Cross Sections with 1% Annual Chance
- 17.5 Water Surface Elevation
- Coastal Transect
- 513 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

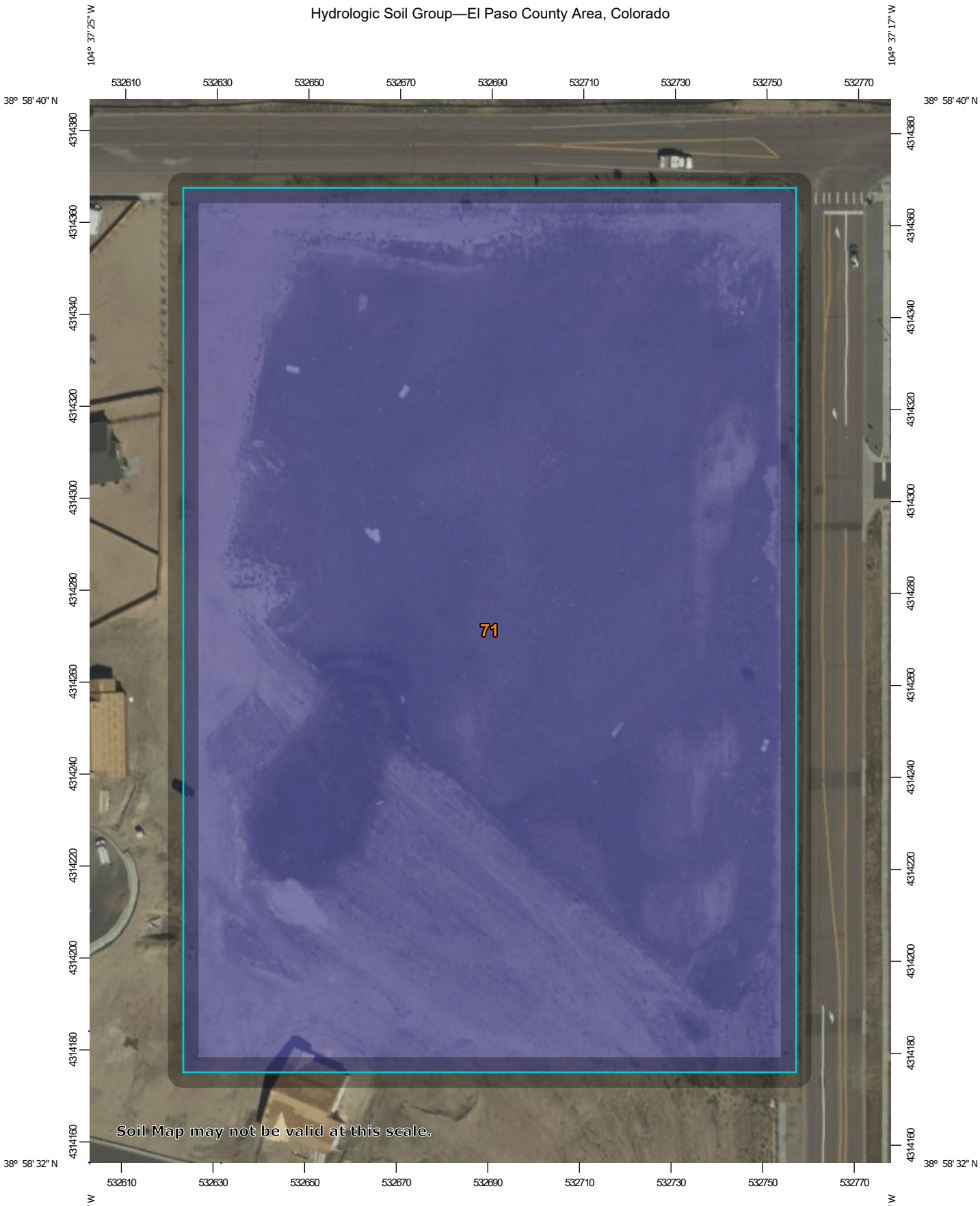
The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

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 2/14/2023 at 1:11 PM 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 E – USDA Soils Survey Map



Map Scale: 1:1,130 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 15 30 60 90

Feet: 0 50 100 200 300

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 20, Sep 2, 2022

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

Date(s) aerial images were photographed: Sep 11, 2018—Oct 20, 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
71	Pring coarse sandy loam, 3 to 8 percent slopes	B	6.4	100.0%
Totals for Area of Interest			**6.4**	**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