DRAINAGE LETTER

Woodmen Frontage Road Turn Lane

Bent Grass Meadows Drive & East Woodmen Road

PREPARED FOR:
Challenger Communities, LLC
8605 Explorer Dr., Suite 250
Colorado Springs, CO 80920

PREPARED BY:
Galloway & Company, Inc.
6162 S. Willow Drive, Suite 320
Greenwood Village, CO 80111

DATE:
May 27, 2022

PCD Filing No.: CDR-21-18

ENGINEER'S STATEMENT

The attached drainage plan and report were prepared under my direction and supervision and are correct to the best of my knowledge and belief. Said drainage report has been prepared according to the criteria established by the Drainage Criteria Manual for the City of Colorado Springs and El Paso County. I accept responsibility for any liability caused by any negligent acts, errors or omissions on my part in preparing this report.

COLORADO LICENSED
SCOTT MICHAEL BROWN
45900
PROFESSIONAL ENGINEER

Scott Brown, PE 45900 Date
For and on behalf of Galloway & Company, Inc.
08/02/2022

DEVELOPER'S CERTIFICATION

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

By: _____ 8/2/22
Date

Address: Challenger Communities, LLC
8605 Explorer Dr., Suite 250
Colorado Springs, CO 80920

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.

APPROVED
Engineering Review

Joshua Palmer, P.E.
County Engineer/ECM Adminstrator

09/29/2022 12:42:39 PM
dsdrice
JeffRice@elpasoco.com
(719) 520-7877
EPC Planning & Community
Development Department

Date

Conditions:

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I. Purpose

The intent of the developer is to make improvements to the Woodmen Frontage Road by expanding pavement to provide a left turn lane. The purpose of this Drainage Letter is to identify drainage patterns, locate and identify tributary drainage features and to determine impacts due to the added imperviousness.

II. General Description

The site is located in the west half of Section 1, Township 13S, Range 65 West, of the 6th Principal Meridian, Colorado Springs, El Paso County, State of Colorado. The proposed improvements are south of Lots 1 and 2 of Latigo Business Center Filing 1, mostly along the School District 49 Education Service Center frontage. The proposed improvements are located approximately at the intersection of the north side of Woodmen Frontage Road ROW and Bent Grass Meadows Drive. The proposed improvements include asphalt widening of the existing roadway to accommodate the construction of a left turn lane along Woodmen Frontage Road traveling eastbound while providing a lane to continue westbound.

The existing soil type within the proposed site as determined by the NRCS Web Soil Survey for El Paso County Area consists of Columbine gravelly sandy loam which is defined as having a hydrologic soil group of A. See soils map included in Appendix A.

III. Previous Reports

The proposed site has been included in other drainage studies in the past. Below is the list of the existing reports pertaining to this site and adjacent sites.

1. *Final Drainage Report Latigo Business Center Filing No. 2,* by Kiowa Engineering Corporation, July 15, 2008.
2. *Final Drainage Report Falcon Meadows at Bent Grass Filing No. 1,* by Galloway & Company, Inc., September 2021 (review in progress)

IV. Design Criteria

Hydrology calculations were performed using the City of Colorado Springs/El Paso County Drainage Criteria Manual, as revised in November 1991 and October 1994 with County adopted Chapter 6 and Section 3.2.1 of Chapter 13 of the City of Colorado Springs/El Paso County Drainage Criteria Manual as revised in May 2014.

The drainage calculations were based on the criteria manual Figure 6-5 and IDF equations to determine the intensity and are listed in Table 1 below.

Table 1 - Precipitation Data

Return Period	One Hour Depth (in).	Intensity (in/hr)
5-year	1.50	5.17
100-year	2.52	8.68

The rational method was used to calculate peak flows as the tributary areas are less than 100 acres. The rational method has been proven to be accurate for basins of this size and is based on the following formula:

Q = CIA

Where:

Q = Peak Discharge (cfs)
C = Runoff Coefficient
I = Runoff intensity (inches/hour)
A = Drainage area (acres)

The runoff coefficients are calculated based on land use, percent imperviousness, and design storm for each basin, as shown in the drainage criteria manual (Table 6-6). Composite percent impervious and C values were calculated using the residential, streets, roofs, and lawns coefficients found in Table 6-6 of the manual.

The 100-year event was used as the major storm event and the 5-year event was used as the minor event.

V. Existing Drainage Conditions

Sub-Basin A1 (0.10 AC, Q_5 = 0.5 cfs, Q_{100} = 0.8 cfs): is located in the eastern half of the intersection of Woodmen Frontage Road and Bent Grass Meadows Drive. The basin consists completely of existing pavement. Runoff sheet flows to the existing 5’ Type R inlet (Design Point 1) and will flow east in the into the proposed channel along Woodmen Frontage Road.

Sub-Basin A2 (0.07 AC, Q_5 = 0.3 cfs, Q_{100} = 0.5 cfs): is located in the western half of the intersection of Woodmen Frontage Road and Bent Grass Meadows Drive. The basin consists of existing pavement and adjacent landscaping. Runoff sheet flows to the existing 10’ Type R inlet (Design Point 2) and will flow east in the into the proposed channel along Woodmen Frontage Road.

Sub-Basin A3 (0.21 AC, Q_5 = 0.4 cfs, Q_{100} = 0.9 cfs): is located along the northern half of Woodmen Frontage Road, west of Sub-basin A2, between Bent Grass Meadows Drive and the eastern School District 49 access point. The basin consists of existing pavement and adjacent landscaping. Runoff sheet flows to the existing landscaped area north of Woodmen Frontage Road and infiltrates (Design Point 3).

Sub-Basin A4 (0.19 AC, Q_5 = 0.4 cfs, Q_{100} = 0.9 cfs): is located along the northern half of Woodmen Frontage Road, west of Sub-basin A3 between the eastern and western School District 49 access points. The basin consists of existing pavement and adjacent landscaping. Runoff sheet flows to the existing landscaped area north of Woodmen Frontage Road and infiltrates (Design Point 4).

Sub-Basin B (0.11 AC, Q_5 = 0.3 cfs, Q_{100} = 0.6 cfs): is located along the northern half of Woodmen Frontage Road, east of Bent Grass Meadows Drive. The basin consists of existing pavement and adjacent landscaping. Runoff sheet flows to the existing landscaped area north of Woodmen Frontage Road and infiltrates (Design Point 5).

Sub-Basin C (0.12 AC, Q_5 = 0.2 cfs, Q_{100} = 0.5 cfs): is located along the northern half of Woodmen Frontage Road, west of Sub-basin A4 between the western School District 49 access point and the existing 48" RCP culverts. The basin consists of existing pavement and adjacent landscaping. Runoff sheet flows to the existing landscaped area north of Woodmen Frontage Road and flows west to the existing channel (Design Point 6).

VI. Four Step Process

The Four Step Process is used to minimize the adverse impacts of urbanization and is a vital component of developing a balanced, sustainable project. Below identifies the approach to the four-step process:

1. **Employ Runoff Reduction Practices**
   The proposed roadway improvements use Low Impact Development (LID) practices to reduce runoff at the source. All runoff is routed through the pervious areas alongside the roadway.

2. **Implement BMPs That Provide a Water Quality Capture Volume with Slow Release**
   This step utilizes formalized water quality capture volume to slow the release of runoff from the site. There is no water quality being proposed with the associated roadway improvements. Per Section 1.7.1.B of the El Paso County *Stormwater Quality Policy & Procedures,* since the site is less than 1 acre, is not a sensitive or high-risk site, and does not directly discharge into State Waters, it is excluded from any water quality requirements.

3. **Stabilize Drainageways**
   The surrounding drainageways will not undergo any stabilization for the development of this project.

4. **Implement Site Specific and Other Source Control BMPs**
   Since this project only includes roadway work with no curb and gutter, the potential use of source control BMP's is limited. All runoff, however, will be conveyed through native grass buffers and an existing native grass channel to promote infiltration and pollutant removal.

VII. Proposed Drainage Conditions

Because the existing runoff along the frontage road infiltrates into the existing landscaped area, this report will focus on the increase to existing flows caused by the additional pavement associated with the road widening. The additional flows will be carried either east or west through proposed swales and concrete pans and will not add extra flow to the landscape areas south of the School District building. Existing infiltration patterns shall remain.

Sub-Basin A1 (0.03 AC, Q_5 = 0.2 cfs, Q_{100} = 0.3 cfs): is a portion of the existing A1 Sub-basin, located in the eastern half of Bent Grass Meadows Drive north of the proposed concrete pan. The basin consists completely of pavement. Runoff sheet flows to the existing 5' Type R inlet (Design Point 1) and will flow east in the into the proposed channel along Woodmen Frontage Road. Due to the proposed concrete pan, less flow enters the inlet than in the existing conditions, and inlet calculations are not necessary.

Sub-Basin A2 (0.03 AC, Q_5 = 0.1 cfs, Q_{100} = 0.3 cfs): is a portion of the existing A2 Sub-basin, located in the western half of Bent Grass Meadows Drive north of the proposed concrete pan. The basin consists of existing pavement and adjacent landscaping. Runoff sheet flows to the existing 10' Type R inlet (Design Point 2) and will flow east in the into the proposed channel along Woodmen Frontage Road. Due to the

proposed concrete pan, less flow enters the inlet than in the existing conditions, and inlet calculations are not necessary.

Sub-Basin A3 (0.39 AC, Q_5 = 1.0 cfs, Q_{100} = 2.1 cfs): contains existing sub-basin A3, along with portions of existing sub-basins A1, A2, A4 and B. It is located along the northern half of Woodmen Frontage Road, stretching from east of Bent Grass Meadows Drive to west of the eastern School District 49 access point. The basin consists of existing pavement, proposed pavement, and adjacent landscaping. Runoff flows to the proposed landscaped swale area north of Woodmen Frontage Road and the proposed concrete pan across Bent Grass Meadows Drive (Design Point 3). Flows ultimately run down to the existing drainage channel east of the existing inlets in Bent Grass Meadows Drive.

Sub-Basin B (0.09 AC, Q_5 = 0.4 cfs, Q_{100} = 0.6 cfs): is a portion of the existing B sub-basin, located along the northern half of Woodmen Frontage Road, east of Bent Grass Meadows Drive. The basin consists of existing pavement, proposed pavement, and adjacent landscaping. Runoff sheet flows to the existing landscaped area north of Woodmen Frontage Road and infiltrates (Design Point 5). There is a negligible increase in runoff from existing in the minor storm and no change in the major storm. Because this basin runs down into the large undeveloped area north of the frontage road, the negligible increase shall not have a negative impact on the existing drainage patterns.

Sub-Basin C (0.27 AC, Q_5 = 0.5 cfs, Q_{100} = 1.0 cfs): contains existing sub-basin C, along with a portion of existing sub-basin A4. It is located along the northern half of Woodmen Frontage Road, west of proposed Sub-basin A3 between the landscaping between the School District access points and the existing 48” RCP culverts. The basin consists of existing pavement, proposed pavement, and adjacent landscaping. Runoff sheet flows to the proposed landscaped swales and concrete pan north of Woodmen Frontage Road and flows west to the existing channel (Design Point 6). Compared to existing Sub-basin C, there is an increased flow of 0.3 and 0.5 cfs reaching the existing drainage channel. Given the size of the existing channel, it is assumed that the channel would have sufficient capacity to absorb the minor increase in runoff.

VIII. Proposed Channel Improvements

Landscape swales and concrete pans are proposed to carry additional flows associated with the turn lane construction. These facilities will only be expected to carry the difference in flow from the existing conditions to the proposed conditions, as existing flows will infiltrate as they do currently. Sizing calculations can be found in Appendix B.

IX. Proposed Water Quality

There is no water quality being proposed with the associated roadway improvements. Per Section I.7.1.B.2 of the El Paso County ECM Appendix I *Stormwater Quality Policy & Procedures,* this site falls under Excluded Roadway Redevelopment, part 1. The project is adding approximately 6760 square feet of pavement along 850 feet of roadway, less than 1 acre per mile, meeting the Excluded Roadway Redevelopment requirement. This project will also be under an existing ESQCP from the adjacent subdivision.

IX. Maintenance

It is recommended to maintain the existing grass buffer with regular mowing when necessary along Woodmen Frontage Road.

X. Wetland mitigation

No wetlands are located on the site.

XI. Floodplain Statement

According to the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map number 08041C0553G, effective December 7, 2018, there is no floodplain in the project area. A copy of the FIRM Panel is included in Appendix A.

XII. Drainage/Bridge Fees and Credits/Reimbursements

Since there is no land being platted with this development, drainage and bridge fees are not required.

XIV. Conclusions

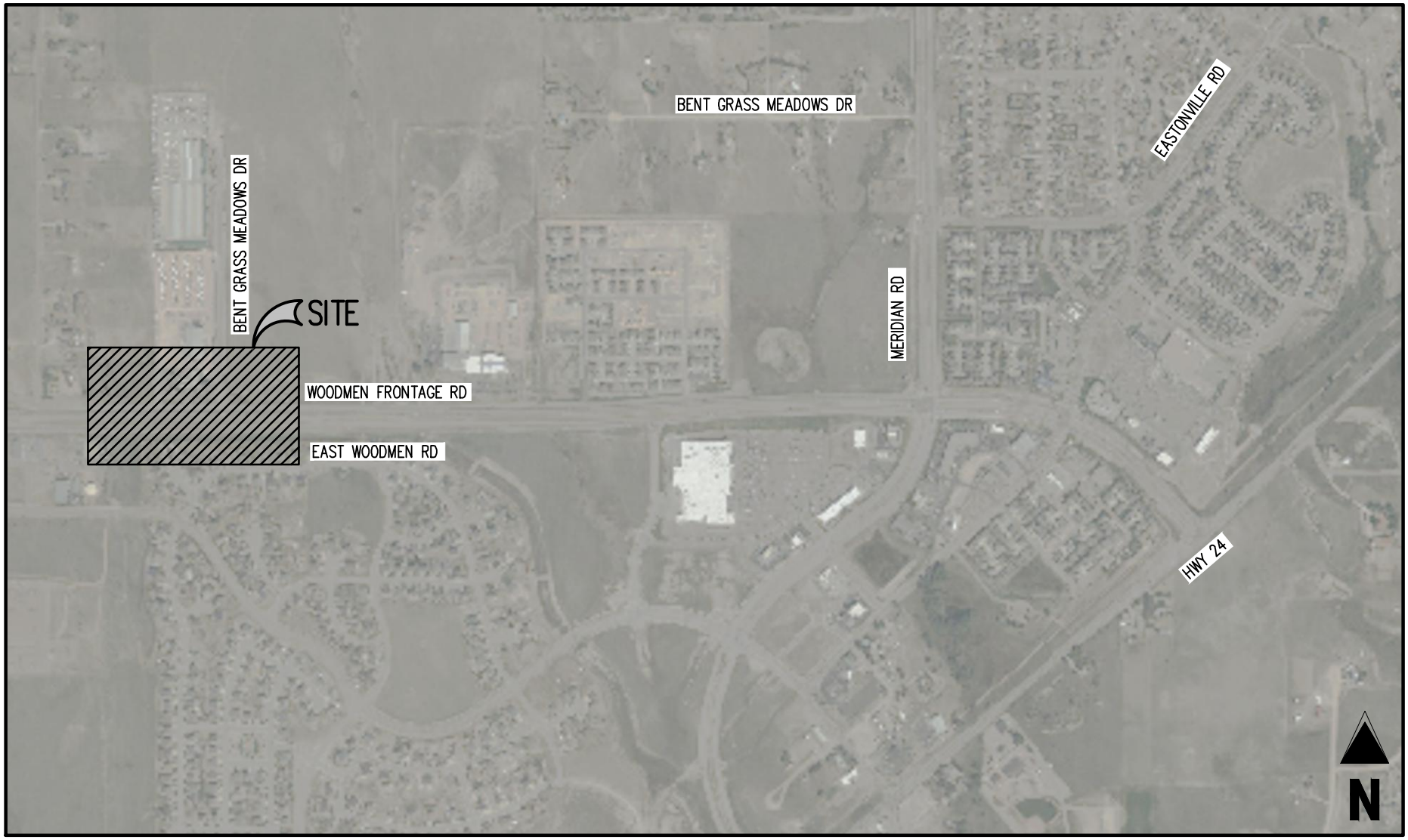
This report for the proposed roadway improvements to Woodmen Frontage Road between Bent Grass Meadows Drive and Falcon Meadows Blvd has been prepared using the criteria and methods as described in the El Paso County Drainage Criteria Manual. Although the roadway improvements will result in slightly higher runoff and an added 0.13 acres of imperviousness area to the roadside grass buffer and downstream channel, there will be minimal impact on the downstream infrastructure. The minor increases in flow have been directed to areas capable of handling the excess flow with no negative impact.

VI. References

1. *City of Colorado Springs/County of El Paso Drainage Criteria Manual*, October 1991.
2. *Drainage Criteria Manual, Volume 2*, City of Colorado Springs, November 2002.
3. *Urban Storm Drainage Criteria Manual*, Urban Drainage and Flood Control District, January 2016 (with current revisions).
4. *Final Drainage Report Latigo Business Center Filing No. 2,* by Kiowa Engineering Corporation, July 15, 2008.
5. *Final Drainage Report Falcon Meadows at Bent Grass Filing No. 1,* by Galloway & Company, Inc., September 2021 (review in progress)

APPENDIX A

Exhibits and Figures



VICINITY MAP

0 200 500 1000

SCALE: 1"=1000'

Hydrologic Soil Group—El Paso County Area, Colorado
(Woodmen Frontage Road Turn Lane)

Map Scale: 1:1,080 if printed on A landscape (11" x 8.5") 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 19, Aug 31, 2021

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
19	Columbine gravelly sandy loam, 0 to 3 percent slopes	A	1.0	100.0%
Totals for Area of Interest			**1.0**	**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

National Flood Hazard Layer FIRMette

FEMA

104°38'3"W 38°56'40"N

104°37'26"W 38°56'12"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
- 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 11/10/2021 at 6:13 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 B

Hydrologic Computations

BASIN SUMMARY TABLE

Tributary Sub-basin	Area (acres)	C_5	C_{100}	t_c (min)	Q_5 (cfs)	Q_{100} (cfs)
Existing Condition						
A1	0.10	0.90	0.96	5.0	0.5	0.8
A2	0.07	0.69	0.77	5.0	0.3	0.5
A3	0.21	0.37	0.50	5.0	0.4	0.9
A4	0.19	0.38	0.51	5.0	0.4	0.9
B	0.11	0.48	0.59	5.0	0.3	0.6
C	0.12	0.24	0.40	5.0	0.2	0.5
Proposed Condition						
A1	0.03	0.90	0.96	5.0	0.2	0.3
A2	0.03	0.84	0.91	5.0	0.1	0.3
A3	0.39	0.63	0.71	9.5	1.0	2.1
B	0.09	0.71	0.78	5.0	0.4	0.6
C	0.27	0.41	0.53	9.4	0.5	1.0

ADDITIONAL FLOW SUMMARY TABLE

Tributary Basin Series	Existing Flow		Proposed Flow		Additional Flow	
	Q_5	Q_{100}	Q_5	Q_{100}	Q_5	Q_{100}
A	1.5	3.2	1.3	2.7	-0.2	-0.5
B	0.3	0.6	0.4	0.6	0.1	0.0
C	0.2	0.5	0.5	1.0	0.3	0.6

A-Series basins: Runoff ultimately flows to existing drainage swale northeast of project site.

B-Series basins: Runoff ultimately flows to landscaping area north of Sub-Basin B.

C-Series basins: Runoff ultimately flows west to existing drainage channel under Woodmen Road.

Sizing calculations to follow are only sized for the additional flows. Additional flows for the purpose of this report are defined as new runoff as a result of the additional pavement area. See above for summary of Existing, Proposed, and Additional flows.

COMPOSITE % IMPERVIOUS CALCULATIONS

Subdivision:
Location: CO, El Paso County

Project Name: Woodmen Frontage RT Lane
Project No.: CNL024
Calculated By: DDJ
Checked By: SMB
Date: 5/27/22

Basin ID	Total Area (ac)	Paved Roads			Lawns			Roofs			Basins Total Weighted % Imp.
		% Imp.	Area (ac)	Weighted % Imp.	% Imp.	Area (ac)	Weighted % Imp.	% Imp.	Area (ac)	Weighted % Imp.	
Existing Condition											
A1	0.10	100	0.10	100.0	2	0.00	0.0	100	0.00	0.00	100.0
A2	0.07	100	0.07	88.4	2	0.01	0.2	100	0.00	0.00	88.6
A3	0.21	100	0.12	59.4	2	0.08	0.8	100	0.00	0.00	60.2
A4	0.19	100	0.12	61.3	2	0.07	0.8	100	0.00	0.00	62.1
B	0.11	100	0.08	72.7	2	0.03	0.5	100	0.00	0.00	73.2
C	0.12	100	0.04	36.8	2	0.08	1.3	100	0.00	0.00	38.1
Proposed Condition											
A1	0.03	100	0.03	100.0	2	0.00	0.0	100	0.00	0.00	100.0
A2	0.03	100	0.03	97.3	2	0.001	0.1	100	0.00	0.00	97.4
A3	0.39	100	0.33	84.4	2	0.06	0.3	100	0.00	0.00	84.7
B	0.09	100	0.08	89.7	2	0.01	0.2	100	0.00	0.00	89.9
C	0.27	100	0.17	64.2	2	0.10	0.7	100	0.00	0.00	64.9

STANDARD FORM SF-2
TIME OF CONCENTRATION

Subdivision:
Location: CO, El Paso County

Project Name: Woodmen Frontage RT Lane
Project No.: CNL024
Calculated By: DDJ
Checked By: SMB
Date: 5/27/22

SUB-BASIN DATA						INITIAL/OVERLAND (T_i)			TRAVEL TIME (T_t)					Tc CHECK (URBANIZED BASINS)			FINAL
BASIN ID	D.A. (AC)	Hydrologic Soils Group	Impervious (%)	C_{100}	C_5	L (FT)	S (%)	T_i (MIN)	L (FT)	S (%)	Cv	VEL. (FPS)	T_t (MIN)	COMP. T_c (MIN)	TOTAL LENGTH (FT)	Urbanized T_c (MIN)	T_c (MIN)
Existing Condition																	
A1	0.10	A	100.0	0.96	0.90	Due to small basin size, Tc of 5 min assumed for all basins											5.0
A2	0.07	A	88.6	0.77	0.69												5.0
A3	0.21	A	60.2	0.50	0.37												5.0
A4	0.19	A	62.1	0.51	0.38												5.0
B	0.11	A	73.2	0.59	0.48												5.0
C	0.12	A	38.1	0.40	0.24												5.0
Proposed Condition																	
A1	0.03	A	100.0	0.96	0.90	Due to small basin size, Tc of 5 min assumed											5.0
A2	0.03	A	97.4	0.91	0.84												5.0
A3	0.39	A	84.7	0.71	0.63	40	2.0	4.3	439	0.5	20.0	1.4	5.2	9.5	479.0	12.7	9.5
B	0.09	A	89.9	0.78	0.71	Due to small basin size, Tc of 5 min assumed											5.0
C	0.27	A	64.9	0.53	0.41	40	2.0	6.3	262	0.5	20.0	1.4	3.1	9.4	302.0	11.7	9.4

NOTES:

$T_i = (0.395*(1.1 - C_5)*(L)^{0.5})/((S)^{0.33})$, S in ft/ft

T_t=L/60V (Velocity From Fig. 501)

Velocity V=Cv*S^0.5, S in ft/ft

Tc Check = 10+L/180

For Urbanized basins a minimum T_c of 5.0 minutes is required.

For non-urbanized basins a minimum T_c of 10.0 minutes is required

STANDARD FORM SF-3
STORM DRAINAGE SYSTEM DESIGN
(RATIONAL METHOD PROCEDURE)

Subdivision:
Location: CO, El Paso County
Design Storm: 5-Year

Project Name: Woodmen Frontage RT Lane
Project No.: CNL024
Calculated By: DDJ
Checked By: SMB
Date: 5/27/22

STREET	Design Point	DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			REMARKS
		Basin ID	Area (Ac)	Runoff Coeff.	Tc (min)	C*A (Ac)	I (in/hr)	Q (cfs)	Tc (min)	C*A (Ac)	I (in/hr)	Q (cfs)	Slope (%)	Street Flow (cfs)	Design Flow (cfs)	Slope (%)	Pipe Size (inches)	Length (ft)	Velocity (fps)	Tt (min)	
Existing	1	A1	0.10	0.90	5.0	0.09	5.10	0.5													
	2	A2	0.07	0.69	5.0	0.05	5.10	0.3													
	3	A3	0.21	0.37	5.0	0.08	5.10	0.4													
	4	A4	0.19	0.38	5.0	0.07	5.10	0.4													
	5	B	0.11	0.48	5.0	0.05	5.10	0.3													
	6	C	0.12	0.24	5.0	0.03	5.10	0.2													
Proposed	1	A1	0.03	0.90	5.0	0.03	5.10	0.2													
	2	A2	0.03	0.84	5.0	0.02	5.10	0.1													
	3	A3	0.39	0.63	9.5	0.25	4.18	1.0													
	5	B	0.09	0.71	5.0	0.07	5.10	0.4													
	6	C	0.27	0.41	9.4	0.11	4.19	0.5													

STANDARD FORM SF-3
STORM DRAINAGE SYSTEM DESIGN
(RATIONAL METHOD PROCEDURE)

Subdivision:
Location: CO, El Paso County
Design Storm: 100-Year

Project Name: Woodmen Frontage RT Lane
Project No.: CNL024
Calculated By: DDJ
Checked By: SMB
Date: 5/27/22

STREET	Design Point	DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			REMARKS
		Basin ID	Area (Ac)	Runoff Coeff.	Tc (min)	C*A (Ac)	I (in/hr)	Q (cfs)	Tc (min)	C*A (Ac)	I (in/hr)	Q (cfs)	Slope (%)	Street Flow (cfs)	Design Flow (cfs)	Slope (%)	Pipe Size (inches)	Length (ft)	Velocity (fps)	Tt (min)	
Existing	1	A1	0.10	0.96	5.0	0.09	9.09	0.8													
	2	A2	0.07	0.77	5.0	0.06	9.09	0.5													
	3	A3	0.21	0.50	5.0	0.10	9.09	0.9													
	4	A4	0.19	0.51	5.0	0.10	9.09	0.9													
	5	B	0.11	0.59	5.0	0.07	9.09	0.6													
	6	C	0.12	0.40	5.0	0.05	9.09	0.5													
Proposed	1	A1	0.03	0.96	5.0	0.03	9.09	0.3													
	2	A2	0.03	0.91	5.0	0.02	9.09	0.3													
	3	A3	0.39	0.71	9.5	0.28	7.45	2.1													
	5	B	0.09	0.78	5.0	0.07	9.09	0.6													
	6	C	0.27	0.53	9.4	0.14	7.46	1.0													

Concrete Pan Capacity

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.00500	ft/ft
Normal Depth	0.17	ft
Left Side Slope	12.00	ft/ft (H:V)
Right Side Slope	12.00	ft/ft (H:V)

Results

Discharge	0.51	ft³/s
Flow Area	0.33	ft²
Wetted Perimeter	4.01	ft
Hydraulic Radius	0.08	ft
Top Width	4.00	ft
Critical Depth	0.16	ft
Critical Slope	0.00571	ft/ft
Velocity	1.54	ft/s
Velocity Head	0.04	ft
Specific Energy	0.20	ft
Froude Number	0.94	
Flow Type	Subcritical	

Concrete pans can convey minor storm event (Max Q5 = 0.3 cfs). Slight overtopping into adjacent asphalt in 100-year storm event (Max Q100 = 0.6 cfs)

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.17	ft
Critical Depth	0.16	ft
Channel Slope	0.00500	ft/ft
Critical Slope	0.00571	ft/ft

Landscape Swale Capacity

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.030	
Channel Slope	0.00500	ft/ft
Normal Depth	0.33	ft
Left Side Slope	12.00	ft/ft (H:V)
Right Side Slope	4.00	ft/ft (H:V)

Results

Discharge	0.94	ft³/s
Flow Area	0.89	ft²
Wetted Perimeter	5.39	ft
Hydraulic Radius	0.16	ft
Top Width	5.33	ft
Critical Depth	0.24	ft
Critical Slope	0.02683	ft/ft
Velocity	1.05	ft/s
Velocity Head	0.02	ft
Specific Energy	0.35	ft
Froude Number	0.45	
Flow Type	Subcritical	

Landscape swales can convey minor storm event (Max Q5 = 0.3 cfs) and major event (Max Q100 = 0.6 cfs)

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.33	ft
Critical Depth	0.24	ft
Channel Slope	0.00500	ft/ft
Critical Slope	0.02683	ft/ft

Eastern Swale Capacity

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.030	
Channel Slope	0.01350	ft/ft
Left Side Slope	4.00	ft/ft (H:V)
Right Side Slope	4.00	ft/ft (H:V)
Discharge	2.70	ft³/s

Max Q100 from A-Series basins

Results

Normal Depth	0.54	ft
Flow Area	1.15	ft²
Wetted Perimeter	4.42	ft
Hydraulic Radius	0.26	ft
Top Width	4.29	ft
Critical Depth	0.49	ft
Critical Slope	0.02182	ft/ft
Velocity	2.35	ft/s
Velocity Head	0.09	ft
Specific Energy	0.62	ft
Froude Number	0.80	
Flow Type	Subcritical	

Swale will flow 0.54' deep

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.54	ft
Critical Depth	0.49	ft
Channel Slope	0.01350	ft/ft
Critical Slope	0.02182	ft/ft

Basin C Swale Capacity

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.030	
Channel Slope	0.01600	ft/ft
Left Side Slope	4.00	ft/ft (H:V)
Right Side Slope	4.00	ft/ft (H:V)
Discharge	1.00	ft³/s

MAX Q100 flow from Sub-basin C

Results

Normal Depth	0.36	ft
Flow Area	0.51	ft²
Wetted Perimeter	2.95	ft
Hydraulic Radius	0.17	ft
Top Width	2.86	ft
Critical Depth	0.33	ft
Critical Slope	0.02491	ft/ft
Velocity	1.95	ft/s
Velocity Head	0.06	ft
Specific Energy	0.42	ft
Froude Number	0.81	
Flow Type	Subcritical	

Swale will flow 0.36' deep

GVF Input Data

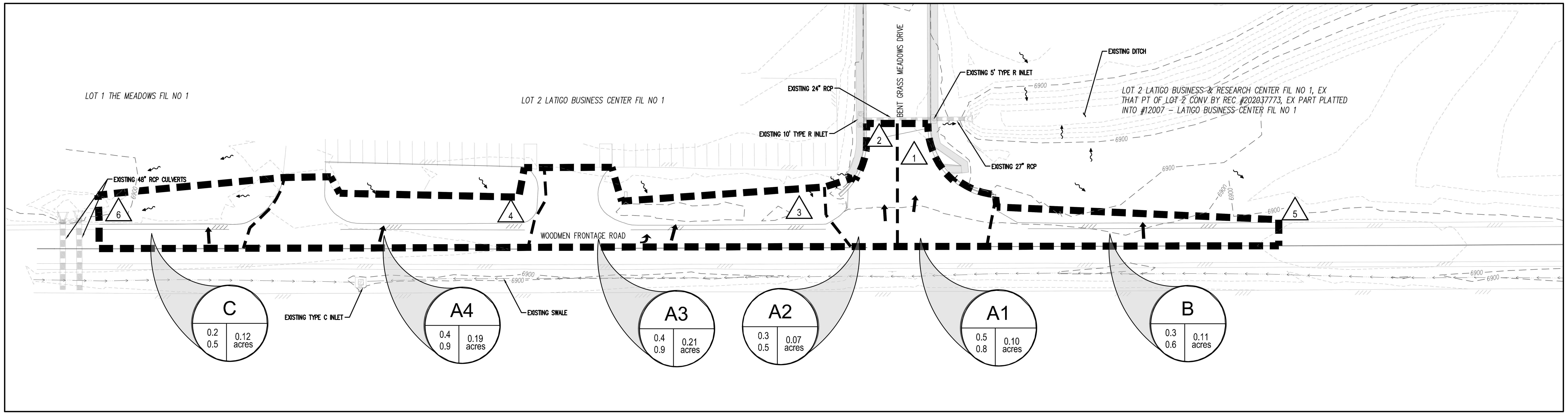
Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.36	ft
Critical Depth	0.33	ft
Channel Slope	0.01600	ft/ft
Critical Slope	0.02491	ft/ft

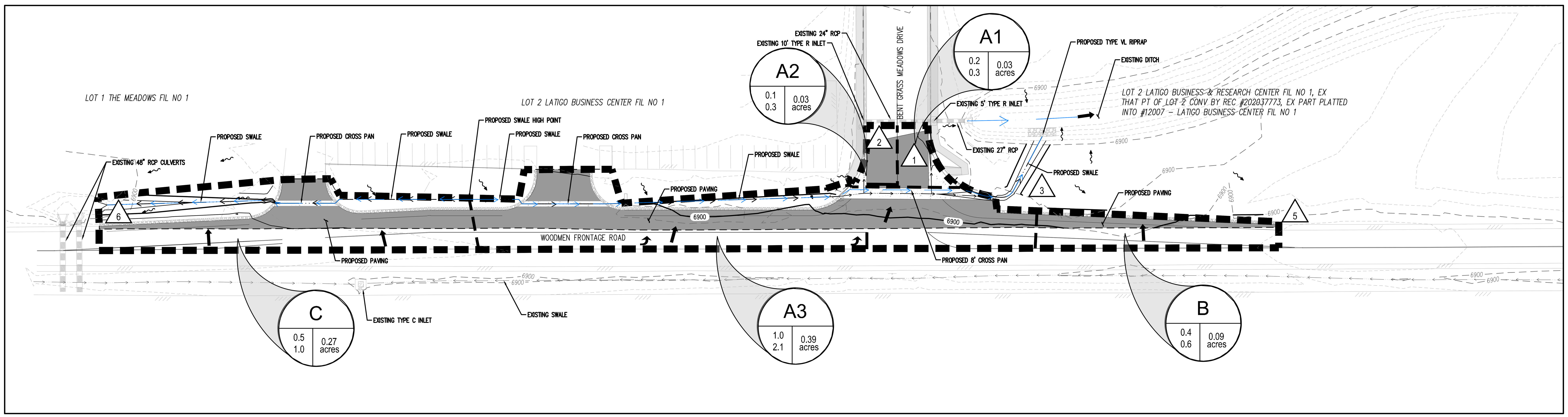
APPENDIX C

Drainage Map



EXISTING DRAINAGE MAP

SCALE: 1"=40'



PROPOSED DRAINAGE MAP

SCALE: 1"=40'

BASIN SUMMARY TABLE

Tributary Sub-basin	Area (acres)	C_5	C_{100}	t_c (min)	Q_5 (cfs)	Q_{100} (cfs)
Existing Condition						
A1	0.10	0.90	0.96	5.0	0.5	0.8
A2	0.07	0.69	0.77	5.0	0.3	0.5
A3	0.21	0.37	0.50	5.0	0.4	0.9
A4	0.19	0.38	0.51	5.0	0.4	0.9
B	0.11	0.48	0.59	5.0	0.3	0.6
C	0.12	0.24	0.40	5.0	0.2	0.5
Proposed Condition						
A1	0.03	0.90	0.96	5.0	0.2	0.3
A2	0.03	0.84	0.91	5.0	0.1	0.3
A3	0.39	0.63	0.71	9.5	1.0	2.1
B	0.09	0.71	0.78	5.0	0.4	0.6
C	0.27	0.41	0.53	9.4	0.5	1.0

LEGEND

- EXISTING PROPERTY LINE
- EXISTING ADJACENT PROPERTY LINE
- 6940 EXISTING MAJOR CONTOUR
- 6941 EXISTING MINOR CONTOUR
- 6940 PROPOSED MAJOR CONTOUR
- 6939 PROPOSED MINOR CONTOUR
- BASIN BOUNDARY
- PROPOSED RUNOFF FLOW PATH

A — BASIN DESIGNATION
0.13 — 5-YEAR RUNOFF IN CUBIC FEET PER SECOND
4.21 acres — BASIN AREA IN ACRES
0.41 — 100-YEAR RUNOFF IN CUBIC FEET PER SECOND
△ — DESIGN POINT

N
0 20 40
SCALE: 1"=40'

CAUTION – NOTICE TO CONTRACTOR

1. ALL UTILITY LOCATIONS SHOWN ARE BASED ON MAPS PROVIDED BY THE APPROPRIATE UTILITY COMPANY AND FIELD SURFACE EVIDENCE AT THE TIME OF SURVEY AND IS TO BE CONSIDERED AN APPROXIMATE LOCATION ONLY. IT IS THE CONTRACTOR'S RESPONSIBILITY TO FIELD VERIFY THE LOCATION OF ALL UTILITIES, PUBLIC OR PRIVATE, WHETHER SHOWN ON THE PLANS OR NOT, PRIOR TO CONSTRUCTION. REPORT ANY DISCREPANCIESTO THE ENGINEER PRIOR TO CONSTRUCTION.
2. WHERE A PROPOSED UTILITY CROSSES AN EXISTING UTILITY, IT IS THE CONTRACTOR'S RESPONSIBILITY TO FIELD VERIFY THE HORIZONTAL AND VERTICAL LOCATION OF SUCH EXISTING UTILITY, EITHER THROUGH POTHOLING OR ALTERNATIVE METHOD. REPORT INFORMATION TO THE ENGINEER PRIOR TO CONSTRUCTION.

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

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6162 S. Willow Drive, Suite 320
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GallowayUS.com

PUBLIC IMPROVEMENT CONSTRUCTION PLANS
WOODMEN FRONTAGE RD. TURN LANE
FOR
CHALLENGER COMMUNITIES, LLC

BENTGRASS MEADOW DR. & WOODMEN FRONTAGE RD.
FALCON, CO 80831 EL PASO COUNTY

#	Date	Issue / Description	Init.

Project No:	CLH24
Drawn By:	DDJ
Checked By:	SMB
Date:	07/29/2022