# "DOMINOS, LOT 2, BLACKWOOD CROSSING FILING NO. 1A" FINAL DRAINAGE REPORT

7408 BLACK FOREST ROAD
COLORADO SPRINGS, COLORADO
80923

PREPARED FOR: WESTERN STATES MANAGEMENT GROUP
13990 BARBWIRE LANE
COLORADO SPRINGS, CO 80930
(719) 287-7600

September 16, 2021


**Prepared by**
**Timothy Dinger, P.E.**
Rocky Mountain Group
1601 37th Street | Evans, CO 80620 | 970-364-2472

## SIGNATURE PAGE

# LOT 2, BLACKWOOD CROSSING FILING NO. 1A
# "DOMINOS"

**ENGINEER'S STATEMENT**

This report and plan for the drainage design Dominos, Lot 2, Blackwood Crossing Filing No. 1A 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 City of Colorado Springs Drainage Criteria Manual and is in conformity with the master plan of the drainage basin. I understand that the City of Colorado Springs 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.

SIGNATURE (Affix Seal): ____________________________________________

Colorado P.E. No.: 57808 Date:

**DEVELOPER'S STATEMENT**

Western States Management Group hereby certifies that the drainage facilities for Dominos, Lot 2, Blackwood Crossing Filing No. 1A shall be constructed according to the design presented in this report. I understand that the City of Colorado Springs does not and will not assume liability for drainage facilities designed and/or certified by my engineer and that are submitted to the City of Colorado Springs pursuant to section 7.7.906 of the City Code; and cannot, on behalf of Dominos, Lot 2, Blackwood Crossing Filing No. 1A, guarantee that final drainage design review will absolve Western States Management Group 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.

____________________________________________
Name of Developer

____________________________________________
Authorized Signature Date

____________________________________________
Printed Name

_____________________________ ______________
Title Phone:

____________________________________________
Address

**CITY OF COLORADO SPRINGS STATEMENT:**

Filed in accordance with Section 7.7.906 of the Code of the City of Colorado Springs, 2001, as amended.

___________________________________ _________
For City Engineer Date

Conditions:

## Table of Contents



## Appendices

# I. PURPOSE

This is a Final Drainage Report for Lot 2, Blackwood Crossing Filing No. 1A, address of 7408 Black Forest Road, for the development of a commercial business.

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, 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 a 6,720 square foot commercial building with paved parking and approximately 259 linear feet of structural retaining walls, located at the address of 7408 Black Forest Road in the City of Colorado Springs, Colorado in El Paso County. The parcel schedule number is 5307001032, and the legal description is "Lots 2, Blackwood Crossing Filing No. 1A". The parcel is located on the north side of Templeton Gap Road, west of Black Forest Road and falls within Section 7, Township 13 South, Range 65 West of the $6^{th}$ P.M., El Paso County, City of Colorado Springs, Colorado. The site in not located within a streamside zone. The names and descriptions of surrounding platted developments can be seen on plan sets and appendix documents and are listed below:

North of Lot 2 (7408 Black Forest Road):

7492 Black Forest Road, Owner: Circle K Stores Inc., Schedule No. 5307001031, Zoning: PBC AO, Lot 1 Blackwood Crossing Filing No. 1A

East of Lot 2 (7408 Black Forest Road) from north to south:

7491 Black Forest Road, Owner: FJ Management Inc., Schedule No. 5308205001, Zoning: PBC/CR AO, Lot 1 Jayden at Woodmen Heights Filing No. 1

7410 Horseshoe Road, Owner: Hurst John G Revocable Trust, Schedule No. 5308002011, Zoning: A AO, Lot 2 Horseshoe Rancheros

South of Lot 2 (7408 Black Forest Road) from west to east:

Templeton Gap Road, Owner: Richard J Schubert, Schedule No. 5307001021, Zoning: A-5 CAD-O, Lot 4 Glover Subdivision

7415 Templeton Gap Road, Owner: Richard J Schubert, Schedule No. 5307001035, Zoning: N/A, Part of Lot 4 Glover Subdivision

7320 Horseshoe Road, Owner: Duk LLC, Schedule No. 5308002004, Zoning: RR-5 CAD-O, Lot 3 Horseshoe Rancheros

West of Lot 2 (7408 Black Forest Road):

7478 Black Forest Road, Owner: Radiant Church, Schedule No. 5307001033, Zoning: PBC AO, Lot 1, 2 & 6 Blackwood Crossing

### B. DESCRIPTION OF PROPERTY – EXISTING CONDITIONS

Lot 2, Blackwood Crossing Filing No. 1A, address of 7408 Black Forest Road, is approximately 48,352 square feet (1.11 acres) and is located on the north side of Templeton Gap Road, west of Black Forest Road and south of East Woodmen Road. The parcels fall within Section 7, Township 13 South, Range 65 West of the 6th P.M., El Paso County, City of Colorado Springs, Colorado. An existing asphalt paved drive access with type 1 curb and gutter follow the parcel from Templeton Gap Road on the west side, due north and wraps around due east to exit on Black Forest Road. The site is cleared of any vegetation and has fire hydrants and utility boxes that were installed from the previous neighboring development.

There are no know off-site flows that discharge on to the property. The project site does not lie within a designated floodplain according to information published in the Federal Emergency Management Agency Floodplain Map No. 08041C0513G, dated December 7, 2018. The map is provided in the Appendix showing it lies within Zone X, a minimal flood hazard area. The parcel is located within the Sand Creek Drainage Basin.

The existing topography slopes vary from 1 to 20 percent slopes. The lot slopes towards the northern property line where temporary erosion control measures remain in place. Drainage patterns sheet flow across the parcel northerly.

### C. EXISTING SOILS

The soils indicative to the site are classified as Stapleton-Bernal sandy loams by the USDA Soil Conservation Service and are listed as Hydrologic Soil Group B. A USDA Soil Map is provided in Appendix B.

### D. EXISTING DRAINAGE

According to the “Preliminary and Final Drainage Report for Blackwood Crossing Filing No. 1A”, prepared by Bowman Consulting, dated May 2019, the sites runoff flows northerly within the City’s curb and gutter system where a public D-10R inlet outlets into a 48” RCP pipe that flows under East Woodmen Road into what is known as Regional Detention Pond 6. The flow ends up in the Sand Creek Drainage Basin. There are existing public water and wastewater mains on site. There are existing public gas, water and electric lines within Templeton Gap Road and Black Forest Road. An existing conditions map is located in the Appendix B for reference.

### E. DESCRIPTION OF PROPERTY – PROPOSED CONDITIONS

The proposed development consists of a 6,720 square foot commercial building, concrete sidewalks and ADA parking, type 1 curb and gutter, concrete drainage pans, and a structural retaining wall on the north side of the parcel. The proposed development will require an approximate limits of disturbance/construction of 48,512 square feet or 1.11 acres. The grading limits are kept within the setbacks wherever possible and the developed conditions remain consistent with the historical drainage pattern of the subdivision. A sub-basin delineation sheet for the proposed conditions is provided in Appendix B.

# III. DRAINAGE BASINS AND SUB-BASINS

## A. EXISTING MAJOR DRAINAGE BASIN AND SUB-BASINS

The parcel is located within the Sand Creek Drainage Basin and delineated into sub-basins according to the existing and proposed grading for existing and developed conditions. The basin map for existing conditions can be found in appendix B.

**Basin E** is the entirety of the parcel to be developed representing existing conditions and consists of two on-site sub-basins. There are no off-site flows onto the property. The total calculated storm water flow for Lot 2 for a minor storm event (5-year storm) is 0.78 cfs and for a major storm event (100-year storm) is 2.92 cfs for existing, undeveloped conditions. The original Final Drainage Report for Blackwood Crossing dated January 28, 2008 and prepared by Nolte Associates show this property as sub-basin P5 and anticipated a minor storm flow of 1.5 cfs and a major event yielding 2.8 cfs.

**Sub-basin E-1 (0.93 ac. ; $Q_5$ = 0.73 cfs, $Q_{100}$ = 2.55 cfs)** is the majority of the parcel that extends to the west and includes part of the Private Drive off of Templeton Gap Road, as it is within the property limits. The majority of the sub-basin consists of the developable area that is currently undeveloped and contains compacted dirt with sparse weeds yielding an effective imperviousness of 16.9 percent due to the paved roadway. The drainage conditions consist of channelized flow within the curb and gutter of the Private Drive due north as well as sheet flow within the developable area of the lot that drains from the southwest to the northeast and is diverted due northwest into the Private Drive. The flow from this sub-basin ultimately flows due north and is captured by the Public Storm Sewer System of east of Lot 1 within Black Forest Road to the north that is connected to the Public Storm Sewer System within East Woodmen Road that flows due east and outfalls to a regional Detention Pond Facility that was constructed for the development of Blackwood Crossing (AR DP 17-00765, *Preliminary and Final Drainage Report for Circle K 7492 Black Forest Road* dated December 2017 by Bowman Consulting). The sub-basin within the previous report by Bowman Consulting refers to Lot 2 as Sub-basin O3 for developed conditions and is referred to as Sub-basin P5 in the original Blackwood Crossing Final Drainage Report dated January 28, 2008 by Nolte Associates.

**Existing Design Point 1 ($Q_5$ = 0.73 cfs, $Q_{100}$ = 2.55 cfs)** is the design point that represents the termination of sheet flow and channelized flow from Sub-basin E-1 from Lot 2. The storm water flow from this Design Point continues due north through a portion of Lot 1 and enters Black Forest Road at a cross pan, then flows due north in the west curb and gutter of Black Forest Road to a Public 10’ CDOT Type R Curb Inlet installed as a part of Blackwood Crossing Subdivision. This inlet ultimately flows to a downstream Detention Facility for the entire Blackwood Crossing Subdivision.

**Sub-basin E-2 (0.17 ac. ; $Q_5$ = 0.05 cfs, $Q_{100}$ = 0.37 cfs)** is the east side of the parcel that extends from the south to the north and is fully within the property limits. The tributary area is currently undeveloped and contains compacted dirt with sparse weeds and is fully pervious. The drainage conditions consist of sheet flow due north to the northeast corner of the lot and continues due north until entering the west curb and gutter of Black Forest Road. The flow from this sub-basin ultimately flows due north and is captured by the Public Storm Sewer System of east of Lot 1 within Black Forest Road to the north that is connected to the Public Storm Sewer System within East Woodmen Road that flows due east and outfalls to a regional Detention Pond Facility that was constructed for the development of Blackwood Crossing (AR DP 17-00765, *Preliminary and Final Drainage Report for Circle K 7492 Black Forest Road* dated December 2017 by Bowman Consulting). The sub-basin within the previous report by Bowman Consulting refers to Lot 2 as Sub-basin O3 for developed conditions and is referred to as Sub-basin P5 in the original Blackwood Crossing Final Drainage Report dated January 28, 2008 by Nolte Associates.

**Existing Design Point 2 ($Q_5$ = 0.05 cfs, $Q_{100}$ = 0.37 cfs)** is the design point that represents the termination of sheet flow from Sub-basin E-2 from Lot 2. The storm water flow from this Design Point continues due north through a portion of Lot 1 and enters Black Forest Road at a cross pan, then flows due north in the west curb and gutter of Black Forest Road to a Public 10' CDOT Type R Curb Inlet installed as a part of Blackwood Crossing Subdivision. This inlet ultimately flows to a downstream Detention Facility for the entire Blackwood Crossing Subdivision.

## B. DEVELOPED MAJOR DRAINAGE BASIN AND SUB-BASINS

**Basin D** is the entirety of the parcel to be developed with some already developed area (Private Road) representing the developed conditions and consists of seven on-site sub-basins and two off-site basins. The total calculated storm water flow for Lot 2 for a minor storm event is 3.76 cfs and for a major storm event is 7.45 cfs for developed conditions. The original Final Drainage Report for Blackwood Crossing dated January 28, 2008 and prepared by Nolte Associates show this property as sub-basin F5 for anticipated future developed conditions and anticipated a minor storm flow of 6.2 cfs and a major event yielding 11.0 cfs for a typical 95% impervious commercial development. Due to the proposed design having a lower effective imperviousness for the developed area, the storm water runoff from Lot 2 is less than the predicted quantity. The Blackwood Crossing development consists of a regional Detention Facility downstream for all developed lots including Lot 2. The original Final Drainage Report and design of the Detention Facility accounted for a development of greater imperviousness area and major storm event runoff. Due to the proposed development yielding less storm water runoff, no downstream facilities require alterations and it is anticipated that there will be no negative impacts to downstream facilities and developments.

**Sub-basin D-1 (0.32 ac. ; $Q_5$ = 1.29 cfs, $Q_{100}$ = 1.41 cfs)** is a west portion of the development that is mostly parking area. The sub-basin flows to a local low point where a Private 3'x3' CDOT Type C Inlet (DP1) is to be installed for storm water collection and conveyance due east.

**Sub-basin D-2 (0.06 ac. ; $Q_5$ = 0.21 cfs, $Q_{100}$ = 0.40 cfs)** is a small paved drive aisle area with a local point within the drain pan to keep the drive aisle relatively level on site as well as some roof drainage. The sub-basin flows to a local low point where a Private 3'x3' CDOT Type C Inlet (DP2) is to be installed for storm water collection and conveyance due east.

**Sub-basin D-3 (0.07 ac. ; $Q_5$ = 0.29 cfs, $Q_{100}$ = 0.54 cfs)** is a small part of the northern drive aisle where the concrete drain pan terminates and some roof drainage. The sub-basin flows to a local low point at the end of the concrete drain pan where a Private 3’x3’ CDOT Type C Inlet (DP3) is to be installed for storm water collection and conveyance due east to the downstream Private Curb Inlet (DP4).

**Sub-basin D-4 (0.28 ac. ; $Q_5$ = 1.11 cfs, $Q_{100}$ = 2.08 cfs)** is the majority of the east side of the development that consists of roof drainage, drive aisles, and the east parking area. The storm water is directed due east and north along the curb and gutter to a Private 10’ CDOT Type R Curb Inlet (DP4).

**Sub-basin D-5 (0.27 ac. ; $Q_5$ = 0.80 cfs, $Q_{100}$ = 1.67 cfs)** is the already developed area that is mostly the Private Drive off of Templeton Gap Road as well as some landscaped area that drains away from the developed area of Lot 2. This sub-basin is delineated as the area within Lot 2’s property boundary. The storm water from this sub-basin enters the curb and gutter of the Private Drive and is directed toward Lot 1 (north) and enters Black Forest Road and ultimately enters the Public Storm System that outfalls to the Detention Facility for Blackwood Crossing.

**Sub-basin D-6 (0.10 ac. ; $Q_5$ = 0.04 cfs, $Q_{100}$ = 0.26 cfs)** is the landscaped area within the property limits of Lot 2 that does has positive drainage toward the right of way of Black Forest Road. This sub-basin is delineated as the area within Lot 2’s property boundary. The storm water from this sub-basin enters the curb and gutter of the Private Drive and is directed toward Lot 1 (north) and enters Black Forest Road and ultimately enters the Public Storm System that outfalls to the Detention Facility for Blackwood Crossing.

**Sub-basin OS-1 (0.01 ac. ; $Q_5$ = 0.01 cfs, $Q_{100}$ = 0.05 cfs)** is a very small off-site portion of landscaping and some ADA sidewalk that flows north into the developed area. The sub-basin flows to a local low point where a Private 3’x3’ CDOT Type C Inlet (DP1) is to be installed for storm water collection and conveyance due north.

**Sub-basin OS-2 (0.01 ac. ; $Q_5$ = 0.01 cfs, $Q_{100}$ = 0.04 cfs)** is a very small off-site portion of landscaping that flows north into the developed area. The sub-basin flows due east and north along the curb and gutter to a Private 10’ CDOT Type R Curb Inlet (DP4).

**Design Point 1 ($Q_5$ = 1.29 cfs, $Q_{100}$ = 1.41 cfs)** is the design point that represents a Private 3’x3’ CDOT Type C Inlet to be installed for storm water collection and conveyance due east. As a part of Lot 2’s Private Storm System that connects to the Public Storm System within the west side of Black Forest Road’s right of way, the ultimate drainage outfall is a Detention Facility downstream constructed for the development of Blackwood Crossing. The emergency outfall for the inlet consists of pooling within the parking lot and flowing due east toward DP2.

**Design Point 2 ($Q_5$ = 0.21 cfs, $Q_{100}$ = 0.40 cfs)** is the design point that represents a Private 3’x3’ CDOT Type C Inlet to be installed for storm water collection and conveyance due east. As a part of Lot 2’s Private Storm System that connects to the Public Storm System within the west side of Black Forest Road’s right of way, the ultimate drainage outfall is a Detention Facility downstream constructed for the development of Blackwood Crossing. The emergency outfall for the inlet consists of pooling within the parking lot and flowing due north toward DP3.

**Design Point 3 ($Q_5$ = 0.29 cfs, $Q_{100}$ = 0.54 cfs)** is the design point that represents a Private 3'x3' CDOT Type C Inlet to be installed for storm water collection and conveyance due east. As a part of Lot 2's Private Storm System that connects to the Public Storm System within the west side of Black Forest Road's right of way, the ultimate drainage outfall is a Detention Facility downstream constructed for the development of Blackwood Crossing. The emergency outfall for the inlet consists of pooling within the parking lot and flowing due north toward DP4.

**Design Point 4 ($Q_5$ = 1.11 cfs, $Q_{100}$ = 2.08 cfs)** is the design point that represents a Private 10' CDOT Type R Curb Inlet. As a part of Lot 2's Private Storm System that connects to the Public Storm System within the west side of Black Forest Road's right of way, the ultimate drainage outfall is a Detention Facility downstream constructed for the development of Blackwood Crossing. The emergency outfall for the inlet consists of pooling within the east parking lot and flowing over the curb head on the east side of the development toward the curb and gutter of Black Forest Road which flows due north to the Public Storm System.

**Design Point 5 ($Q_5$ = 0.80 cfs, $Q_{100}$ = 1.67 cfs)** is the design point that represents the termination of Lot 2's on-site flow within the Private Road between Lots 1 and 2 and from Templeton Gap. As with EP1, the flow to this area drains north toward Lot 1 and enters Black Forest Road at a curb cut and cross pan, flows into the Public Storm System and ultimately outfalls to the Detention Facility for Blackwood Crossing.

**Design Point 6 ($Q_5$ = 0.04 cfs, $Q_{100}$ = 0.26 cfs)** is the design point that represents the termination of Lot 2's on-site flow within the landscaped east side of the development. As with EP2, the flow to this area drains north toward Lot 1 and enters Black Forest Road at a curb cut and cross pan, flows into the Public Storm System and ultimately outfalls to the Detention Facility for Blackwood Crossing.

# 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 Volumes I and II* (May 2014) as well as the Mile High Flood District Drainage Criteria manuals revised August 2018.

## B. DEVELOPMENT CRITERIA REFERENCE AND CONSTRAINTS

The parcel falls within the Sand Creek drainage basin with the ultimate receiving waters of the Arkansas River. The site runoff is to be detained for water quality, Excess Urban Runoff Volume (EURV), and full spectrum detention and flow into the public storm water system within the dedicated pond known as Regional Detention Pond 6. The drainage on 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 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 *City of Colorado Springs Drainage Criteria Manual Volume I (May 2014)*. 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 and can be found in Appendix B. The default rainfall intensities and volumes use runoff coefficients based on soil types determined by the subsurface investigation report for the development. Weighted runoff coefficients were calculated for each basin and sub-basin due to the mix of impervious surfaces. The *City of Colorado Springs Drainage Criteria Manuals Volumes I and II* and calculation spreadsheets were used for calculations as applicable and allowable by the City of Colorado Springs, including water quality and detention calculations for design of storm water infrastructure.

## 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 Blackwood Development.

### 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 drainageways. Given the proposed land use, the majority of the site is to be paved for vehicular use. Within the mostly-impervious site, the storm water runoff is kept to the site limits by use of grading and all other areas are to be landscaped, including the right of way landscape buffer areas.

### Step 2: Provide Water Quality Capture Volume

The Development Plan (AR DP 17-00765) as well as the original Final Drainage Report for Blackwood Crossing (2008) indicate a regional Detention Facility for the development of Blackwood Crossing. The Detention Facility was designed for water quality capture as well as full spectrum detention for the entirety of the Blackwood Crossing development. As explained in the hydrology section, the development of Lot 2 yields a lesser impervious area and storm water runoff for the 5-year and 100-year storm events than originally anticipated for the pond design and construction. As a result, no BMP alterations are required and it is anticipated that there will be no negative impacts to downstream development or facilities as a result of development of this lot.

### Step 3: Stabilize Drainageways

The drainage within the site is stabilized by way of pavement, concrete pans, and storm drain, as well as an offsite detention pond that receives flow via the proposed 18” storm drain system and existing storm drain system. There are no unpaved or unstabilized drainageways on this site. The distance to the nearest creek is approximately 4,430 feet to Sand Creek.

### Step 4: Implement Site Specific and Other Source Control BMPs

The primary treatment BMP for this site is the regional detention facility indicated by the Development Plan (AR DP 17-00765) and Final Drainage Report for Blackwood Crossing (2008). Onsite runoff is controlled through paved and/or concrete drainageways that promote flow into storm sewer systems.

## V. Drainage Infrastructure Costs and Fees

### A. Drainage and Bridge Fees

The development falls within the Sand Creek drainage basin which has a drainage basin fee of $13,775/acre, a bridge fee of $819/acre, a pond land fee of $1,070/acre, a pond facility fee of $3,957/acre and a surcharge fee of $1,435/acre according to the City of Colorado Springs's 2021 fee schedule. The development's total property acreage is 1.11 acres.

The site has already been platted, therefore, no drainage fees are due at this time.

Any outstanding fees must be paid prior to plat recordation.

## 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 Dominos, Lot 2, Blackwood Crossing Filing No. 1A, address 7408 Black Forest Road is within compliance and standards for 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 drainageway planning studies within the larger drainage basin. This development will not adversely affect downstream development.

## VII. References

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

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

*Preliminary and Final Drainage Report Blackwood Crossing*, dated January 28, 2008 prepared by Nolte Associates, Inc.

*Preliminary and Final Drainage Report for Circle K 7492 Black Forest Road* dated December 2017 by Bowman Consulting

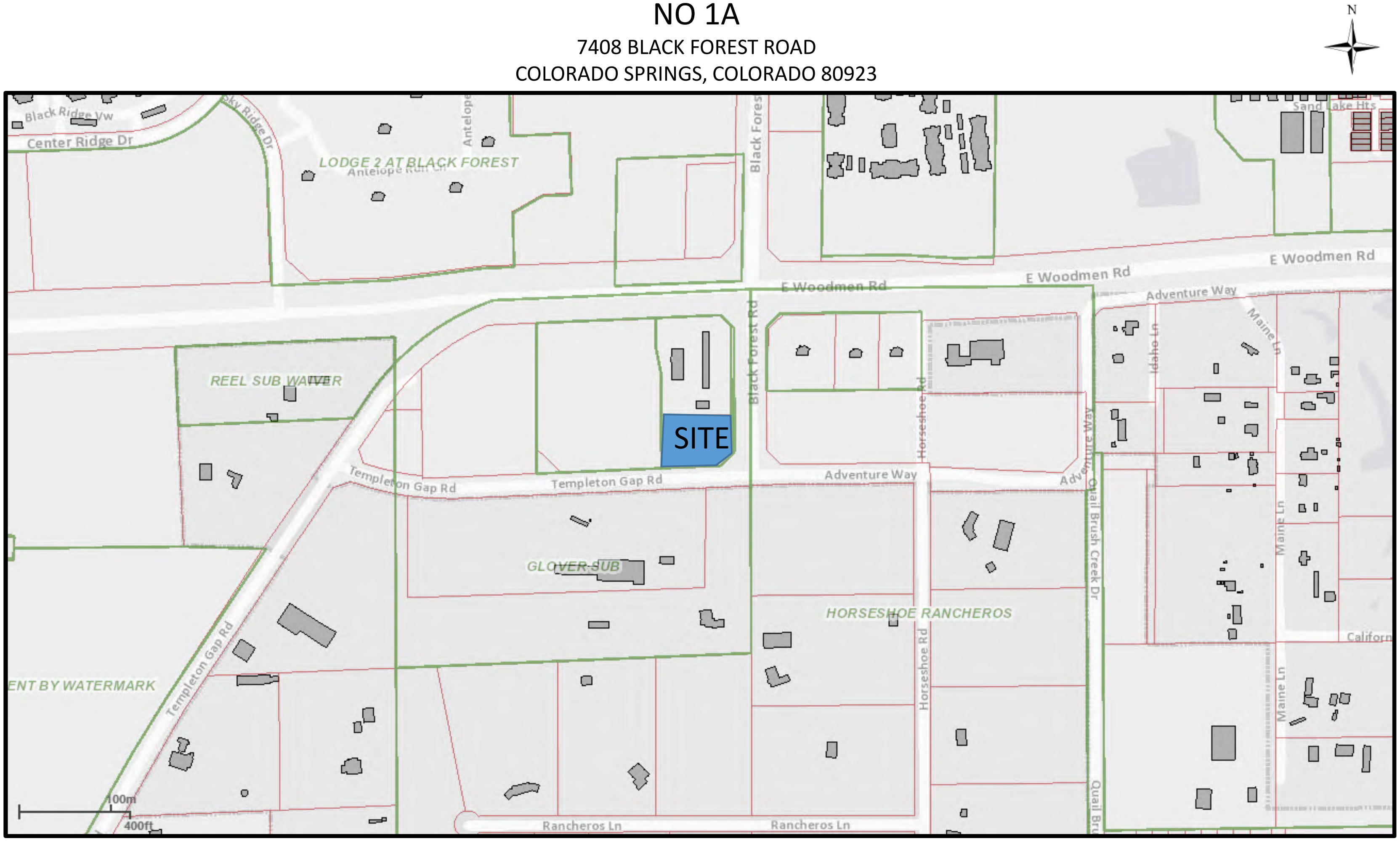
# VIII. Appendices

# APPENDIX A – VICINITY MAP

# VICINITY MAP

LOT 2 BLACKWOOD CROSSING FIL
NO 1A

7408 BLACK FOREST ROAD
COLORADO SPRINGS, COLORADO 80923



# APPENDIX B – HYDROLOGIC COMPUTATIONS

**Project:** Lot 2 Blackwood Crossing Fil No 1A - EXISTING CONDITIONS
**Engineer:** Timothy Dinger, P.E.
**Date:** 8/12/2021
**Address:** 7408 Black Forest Road  Colorado Springs, CO 80923

| Sub-Basin: | **E-1** | (IDF Curve Equations from Figure 6-5 of the DCM Volume 1) | | | |
|---|---|---|---|---|---|
| $t_t$ Duration: | **14.23** | | | | |
| $I_2$ | $I_5$ | $I_{10}$ | $I_{25}$ | $I_{50}$ | $I_{100}$ |
| 2.875245021 | 3.600115573 | 4.2003015 | 4.8004874 | 5.4006734 | 6.0437542 |

| 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 | 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 | **0.167** | **0.218** | **0.280** | **0.366** | **0.410** | **0.453** |
| Pavement | 6852 | 0.157 | 0.89 | 0.90 | 0.92 | 0.94 | 0.95 | 0.96 | 0.140 | 0.142 | 0.145 | 0.148 | 0.149 | 0.151 | | | | | | |
| Lawn | 33739 | 0.775 | 0.02 | 0.08 | 0.15 | 0.25 | 0.30 | 0.35 | 0.015 | 0.062 | 0.116 | 0.194 | 0.232 | 0.271 | | | | | | |
| $A_t$: | 40591 | 0.932 | | | | | | | | | | | | | | | | | | |

**Q Peak Flow (cfs)**

| 2 Year Q | 5 Year Q | 10 Year Q | 25 Year Q | 50 Year Q | 100 Year Q |
|---|---|---|---|---|---|
| **0.45** | **0.73** | **1.10** | **1.64** | **2.06** | **2.55** |

| Sub-Basin: | **E-2** | (IDF Curve Equations from Figure 6-5 of the DCM Volume 1) | | | |
|---|---|---|---|---|---|
| $t_t$ Duration: | **15.63** | | | | |
| $I_2$ | $I_5$ | $I_{10}$ | $I_{25}$ | $I_{50}$ | $I_{100}$ |
| 2.763619237 | 3.459410803 | 4.0361459 | 4.6128811 | 5.1896162 | 5.8073701 |

| 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 | 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 | **0.020** | **0.080** | **0.150** | **0.250** | **0.300** | **0.350** |
| Pavement | 0 | 0.000 | 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 | 7542 | 0.173 | 0.02 | 0.08 | 0.15 | 0.25 | 0.30 | 0.35 | 0.003 | 0.014 | 0.026 | 0.043 | 0.052 | 0.061 | | | | | | |
| $A_t$: | 7542 | 0.173 | | | | | | | | | | | | | | | | | | |

**Q Peak Flow (cfs)**

| 2 Year Q | 5 Year Q | 10 Year Q | 25 Year Q | 50 Year Q | 100 Year Q |
|---|---|---|---|---|---|
| **0.01** | **0.05** | **0.11** | **0.21** | **0.28** | **0.37** |

**Design Points**

| Design Point | $Q_5$ | $Q_{100}$ |
|---|---|---|
| EX DP1 | 0.73 | 2.55 |
| EX DP2 | 0.05 | 0.37 |
| **Total Site** | **0.78** | **2.92** |

## 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 | |
|---|---|---|
| $C_5$: | 0.22 | [Table 6-6. Runoff Coefficients for Rational Method] |
| L: | 300 | ft |
| S: | 0.074 | 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 | 6852 | 0.16 | 0.90 |
| Lawn | 33739 | 0.77 | 0.08 |
| $A_t$ : | 40591 | 0.93 | |

$C_c = (0.90*0.16 + 0.08*0.77) / 0.93 =$ **0.22**

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

$t_i = (0.395*(1.1-0.22)*sqrt(300))/(\mathbf{0.074}^{\wedge}0.33) =$ **14.20** 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)

$V = C_v S_w^{0.5}$

$V = (20)(0.02)^{0.5} =$ **2.83** ft/s

Flow Distance: **5.00** ft

$t_t = L/V =$ 1.77 sec.
**0.03** 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.

**$t_c = t_i + t_t$ =** **14.23** 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 $t_c$:** **14.23** min.

## Time of Concentration $t_c = t_i + t_t$

### 3.2.1 - Overland (Initial) Flow Time

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L}}{S^{0.33}}$$ (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 | |
|---|---|---|
| $C_5$: | 0.08 | [Table 6-6. Runoff Coefficients for Rational Method] |
| L: | 265 | ft |
| S: | 0.072 | 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 | 0.00 | 0.73 |
| Pavement | 0 | 0.00 | 0.90 |
| Lawn | 7542 | 0.17 | 0.08 |
| $A_t$ : | 7542 | 0.17 | |

$C_c = (0.08*0.17) / 0.17 =$ **0.08**

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

$t_i = (0.395*(1.1-0.08)*sqrt(265))/($ **0.072** $^{\wedge}0.33) =$ **15.63** 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).

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

Where:

$V$ = velocity (ft/s)

$C_v$ = conveyance coefficient (from Table 6-7)

$S_w$ = watercourse slope (ft/ft)

$V = C_v S_w^{0.5}$

$V = (20)(0.07)^{0.5} =$ **5.29** ft/s

Flow Distance: **0.01** ft

$t_t = L/V =$ 0.00 sec.
**0.00** 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.

$t_c = t_i + t_t =$ **15.63** min.

### 3.2.4 Minimum Time of Concentration

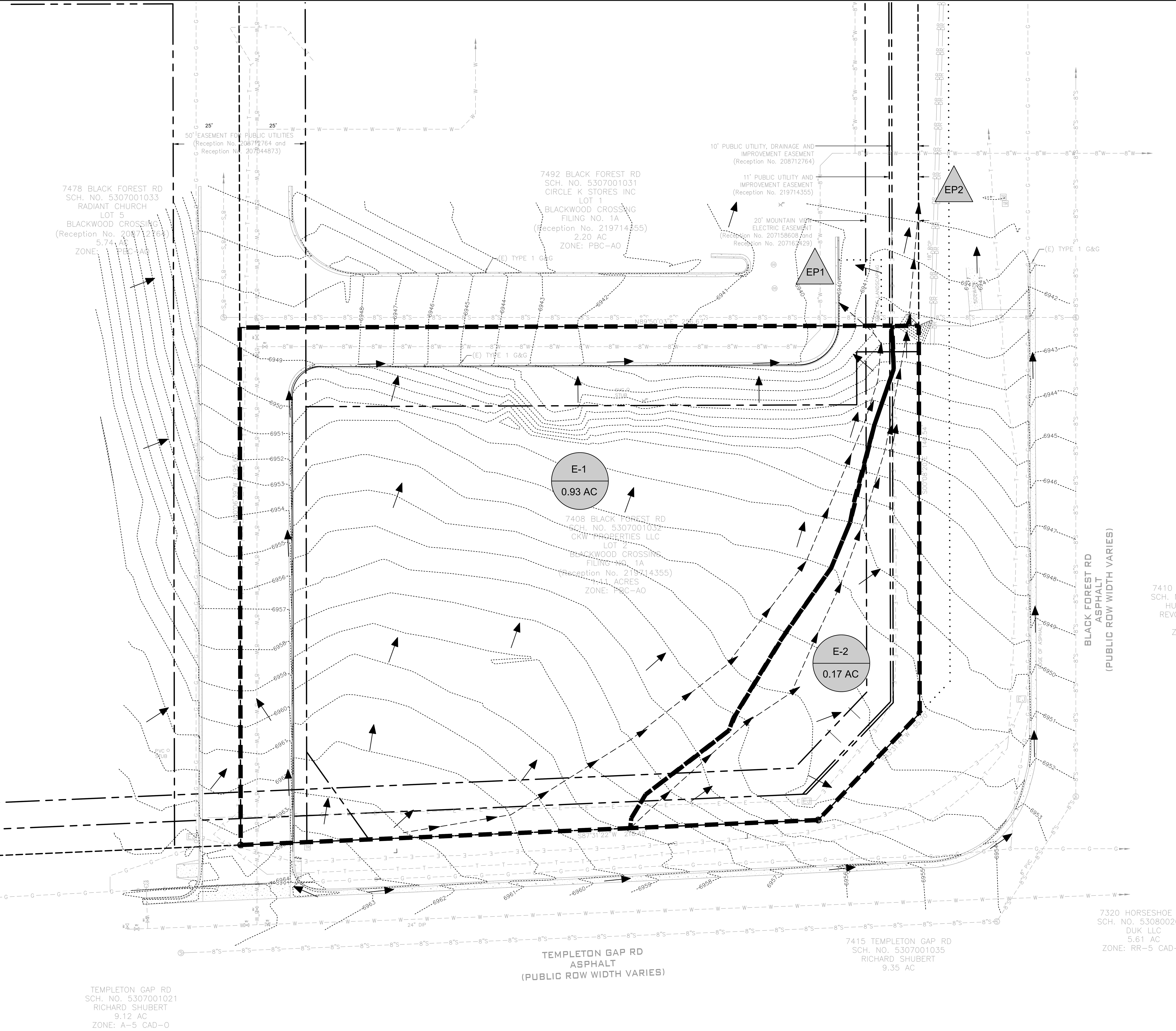
If the calculations result in a $t_c$ of less than 10 minutes for undeveloped conditions, it is recommended that a minimum value of 10 minutes be used. The minimum $t_c$ for urbanized areas is 5 minutes.

**Final $t_c$:** **15.63** min.

# 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 | |

| DESCRIPTION | SYMBOL |
|---|---|
| BASIN IDENTIFIER | E-1 |
| AREA IN ACRES | X.XX AC |
| (EXISTING) DESIGN POINT ID | EP1 |
| FLOW ARROW | |
| PROPERTY LINE | |




| DESIGN POINT | FLOW (CFS) |
|---|---|
| 1 | $Q_5 = 0.73$<br>$Q_{100} = 2.55$ |
| 2 | $Q_5 = 0.05$<br>$Q_{100} = 0.37$ |

**BASIN SUMMARY**

| BASIN | Q(5)-CFS | Q(100)-CFS | ACRES(AC) |
|---|---|---|---|
| E-1 | 0.73 | 2.55 | 0.93 |
| E-2 | 0.05 | 0.37 | 0.17 |
| TOTAL | 0.78 | 2.92 | 1.11 |

ROCKY MOUNTAIN GROUP
RMG ARCHITECTS ENGINEERS

NOT FOR CONSTRUCTION
FOR CIVIL ONLY

LOT 2 BLACKWOOD CROSSING FIL NO 1A
LOT 2 BLACKWOOD CROSSING FIL NO 1A
COLORADO SPRINGS, CO
CHUCK HOLLIDAY - WESTERN STATES MGMT GROUP



SHEET NAME
EXISTING CONDITIONS HYDROLOGY EXHIBIT
PROJECT STATUS
REVIEW

ENG: RDL
DRAWN: RDL
CHECKED: TJD
DATE
8/12/2021

| # | REVISION | DATE |
|---|---|---|
| | — | — |
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JOB NO.
180579
SHEET NO.
1
of 2

**Project:** Lot 2 Blackwood Crossing Fil No 1A - DEVELOPED CONDITIONS
**Engineer:** Timothy Dinger, P.E.
**Date:** 9/15/2021
**Address:** 7408 Black Forest Road  Colorado Springs, CO 80923

| 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 | 6.0304837 | 6.8921242 | 7.7537647 | 8.6792165 |

| 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 | 1701 | 0.039 | 0.71 | 0.73 | 0.75 | 0.78 | 0.80 | 0.81 | 0.028 | 0.029 | 0.029 | 0.030 | 0.031 | 0.032 | **0.768** | **0.785** | **0.811** | **0.841** | **0.857** | **0.872** |
| Pavement | 10578 | 0.243 | 0.89 | 0.90 | 0.92 | 0.94 | 0.95 | 0.96 | 0.216 | 0.219 | 0.223 | 0.228 | 0.231 | 0.233 | | | | | | |
| Lawn | 1586 | 0.036 | 0.02 | 0.08 | 0.15 | 0.25 | 0.30 | 0.35 | 0.001 | 0.003 | 0.005 | 0.009 | 0.011 | 0.013 | | | | | | |
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| $A_t$: | 13865 | 0.318 | | | | | | | | | | | | | | | | | | |

**Q Peak Flow (cfs)**

| 2 Year Q | 5 Year Q | 10 Year Q | 25 Year Q | 50 Year Q | 100 Year Q |
|---|---|---|---|---|---|
| **1.01** | **1.29** | **1.56** | **1.85** | **2.12** | **2.41** |

| 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 | 6.0304837 | 6.8921242 | 7.7537647 | 8.6792165 |

| 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 | 1700 | 0.039 | 0.71 | 0.73 | 0.75 | 0.78 | 0.80 | 0.81 | 0.028 | 0.028 | 0.029 | 0.030 | 0.031 | 0.032 | **0.736** | **0.754** | **0.776** | **0.805** | **0.824** | **0.835** |
| Pavement | 606 | 0.014 | 0.89 | 0.90 | 0.92 | 0.94 | 0.95 | 0.96 | 0.012 | 0.013 | 0.013 | 0.013 | 0.013 | 0.013 | | | | | | |
| Lawn | 70 | 0.002 | 0.02 | 0.08 | 0.15 | 0.25 | 0.30 | 0.35 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.001 | | | | | | |
| | | | | | | | | | | | | | | | | | | | | |
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| | | | | | | | | | | | | | | | | | | | | |
| $A_t$: | 2376 | 0.055 | | | | | | | | | | | | | | | | | | |

**Q Peak Flow (cfs)**

| 2 Year Q | 5 Year Q | 10 Year Q | 25 Year Q | 50 Year Q | 100 Year Q |
|---|---|---|---|---|---|
| **0.17** | **0.21** | **0.26** | **0.30** | **0.35** | **0.40** |

| Sub-Basin: | D-3 | (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 | 6.0304837 | 6.8921242 | 7.7537647 | 8.6792165 |

| 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 | 1700 | 0.039 | 0.71 | 0.73 | 0.75 | 0.78 | 0.80 | 0.81 | 0.028 | 0.028 | 0.029 | 0.030 | 0.031 | 0.032 | **0.739** | **0.758** | **0.781** | **0.811** | **0.829** | **0.842** |
| Pavement | 1307 | 0.030 | 0.89 | 0.90 | 0.92 | 0.94 | 0.95 | 0.96 | 0.027 | 0.027 | 0.028 | 0.028 | 0.029 | 0.029 | | | | | | |
| Lawn | 205 | 0.005 | 0.02 | 0.08 | 0.15 | 0.25 | 0.30 | 0.35 | 0.000 | 0.000 | 0.001 | 0.001 | 0.001 | 0.002 | | | | | | |
| | | | | | | | | | | | | | | | | | | | | |
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| | | | | | | | | | | | | | | | | | | | | |
| $A_t$: | 3212 | 0.074 | | | | | | | | | | | | | | | | | | |

**Q Peak Flow (cfs)**

| 2 Year Q | 5 Year Q | 10 Year Q | 25 Year Q | 50 Year Q | 100 Year Q |
|---|---|---|---|---|---|
| **0.22** | **0.29** | **0.35** | **0.41** | **0.47** | **0.54** |

| Sub-Basin: | D-4 | (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 | 6.0304837 | 6.8921242 | 7.7537647 | 8.6792165 |

| 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 | 1700 | 0.039 | 0.71 | 0.73 | 0.75 | 0.78 | 0.80 | 0.81 | 0.028 | 0.028 | 0.029 | 0.030 | 0.031 | 0.032 | **0.749** | **0.767** | **0.794** | **0.826** | **0.842** | **0.858** |
| Pavement | 8851 | 0.203 | 0.89 | 0.90 | 0.92 | 0.94 | 0.95 | 0.96 | 0.181 | 0.183 | 0.187 | 0.191 | 0.193 | 0.195 | | | | | | |
| Lawn | 1621 | 0.037 | 0.02 | 0.08 | 0.15 | 0.25 | 0.30 | 0.35 | 0.001 | 0.003 | 0.006 | 0.009 | 0.011 | 0.013 | | | | | | |
| | | | | | | | | | | | | | | | | | | | | |
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| | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | |
| $A_t$: | 12172 | 0.279 | | | | | | | | | | | | | | | | | | |

**Q Peak Flow (cfs)**

| 2 Year Q | 5 Year Q | 10 Year Q | 25 Year Q | 50 Year Q | 100 Year Q |
|---|---|---|---|---|---|
| **0.86** | **1.11** | **1.34** | **1.59** | **1.83** | **2.08** |

| Sub-Basin: | D-5 | (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 | 6.0304837 | 6.8921242 | 7.7537647 | 8.6792165 |

| 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: $C_i * A_i$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Roof | 0 | 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 |
| Pavement | 7087 | 0.163 | 0.89 | 0.90 | 0.92 | 0.94 | 0.95 | 0.96 | 0.145 | 0.146 | 0.150 | 0.153 | 0.155 | 0.156 |
| Lawn | 4578 | 0.105 | 0.02 | 0.08 | 0.15 | 0.25 | 0.30 | 0.35 | 0.002 | 0.008 | 0.016 | 0.026 | 0.032 | 0.037 |
| $A_t$: | 11665 | 0.268 | | | | | | | | | | | | |

| 2 Yr $C_c$ | 5 Yr $C_c$ | 10 Yr $C_c$ | 25 Yr $C_c$ | 50 Yr $C_c$ | 100 Yr $C_c$ |
|---|---|---|---|---|---|
| **0.549** | **0.578** | **0.618** | **0.669** | **0.695** | **0.721** |

**Q Peak Flow (cfs)**

| 2 Year Q | 5 Year Q | 10 Year Q | 25 Year Q | 50 Year Q | 100 Year Q |
|---|---|---|---|---|---|
| **0.61** | **0.80** | **1.00** | **1.24** | **1.44** | **1.67** |

| Sub-Basin: | D-6 | (IDF Curve Equations from Figure 6-5 of the DCM Volume 1) | | | |
|---|---|---|---|---|---|
| $t_t$ Duration: | 9.15 | | | | |
| $I_2$ | $I_5$ | $I_{10}$ | $I_{25}$ | $I_{50}$ | $I_{100}$ |
| 3.400014651 | 4.261589896 | 4.9720215 | 5.6824532 | 6.3928848 | 7.155031 |

| 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: $C_i * A_i$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Roof | 0 | 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 |
| Pavement | 0 | 0.000 | 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 | 4549 | 0.104 | 0.02 | 0.08 | 0.15 | 0.25 | 0.30 | 0.35 | 0.002 | 0.008 | 0.016 | 0.026 | 0.031 | 0.037 |
| $A_t$: | 4549 | 0.104 | | | | | | | | | | | | |

| 2 Yr $C_c$ | 5 Yr $C_c$ | 10 Yr $C_c$ | 25 Yr $C_c$ | 50 Yr $C_c$ | 100 Yr $C_c$ |
|---|---|---|---|---|---|
| **0.020** | **0.080** | **0.150** | **0.250** | **0.300** | **0.350** |

**Q Peak Flow (cfs)**

| 2 Year Q | 5 Year Q | 10 Year Q | 25 Year Q | 50 Year Q | 100 Year Q |
|---|---|---|---|---|---|
| **0.01** | **0.04** | **0.08** | **0.15** | **0.20** | **0.26** |

| Sub-Basin: | OS-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 | 6.0304837 | 6.8921242 | 7.7537647 | 8.6792165 |

| 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: $C_i * A_i$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Roof | 0 | 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 |
| Pavement | 36 | 0.001 | 0.89 | 0.90 | 0.92 | 0.94 | 0.95 | 0.96 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Lawn | 576 | 0.013 | 0.02 | 0.08 | 0.15 | 0.25 | 0.30 | 0.35 | 0.000 | 0.001 | 0.002 | 0.003 | 0.004 | 0.005 |
| $A_t$: | 612 | 0.014 | | | | | | | | | | | | |

| 2 Yr $C_c$ | 5 Yr $C_c$ | 10 Yr $C_c$ | 25 Yr $C_c$ | 50 Yr $C_c$ | 100 Yr $C_c$ |
|---|---|---|---|---|---|
| **0.071** | **0.128** | **0.195** | **0.291** | **0.338** | **0.386** |

**Q Peak Flow (cfs)**

| 2 Year Q | 5 Year Q | 10 Year Q | 25 Year Q | 50 Year Q | 100 Year Q |
|---|---|---|---|---|---|
| **0.004** | **0.01** | **0.02** | **0.03** | **0.04** | **0.05** |

| Sub-Basin: | OS-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 | 6.0304837 | 6.8921242 | 7.7537647 | 8.6792165 |

| 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: $C_i * A_i$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Roof | 0 | 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 |
| Pavement | 0 | 0.000 | 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 | 612 | 0.014 | 0.02 | 0.08 | 0.15 | 0.25 | 0.30 | 0.35 | 0.000 | 0.001 | 0.002 | 0.004 | 0.004 | 0.005 |
| $A_t$: | 612 | 0.014 | | | | | | | | | | | | |

| 2 Yr $C_c$ | 5 Yr $C_c$ | 10 Yr $C_c$ | 25 Yr $C_c$ | 50 Yr $C_c$ | 100 Yr $C_c$ |
|---|---|---|---|---|---|
| **0.020** | **0.080** | **0.150** | **0.250** | **0.300** | **0.350** |

**Q Peak Flow (cfs)**

| 2 Year Q | 5 Year Q | 10 Year Q | 25 Year Q | 50 Year Q | 100 Year Q |
|---|---|---|---|---|---|
| **0.001** | **0.01** | **0.01** | **0.02** | **0.03** | **0.04** |

**Design Points**

| Design Point | $Q_5$ | $Q_{100}$ |
|---|---|---|
| DP1 | 1.29 | 2.41 |
| DP2 | 0.21 | 0.40 |
| DP3 | 0.29 | 0.54 |
| DP4 | 1.11 | 2.08 |
| DP5 | 0.80 | 1.67 |
| DP6 | 0.04 | 0.26 |
| TOTAL | 3.74 | 7.36 |

**SITE IMPERVIOUSNES COMPOSITE CALCULATION (INCLUDING OS-1 & OS-2)**

| | ACREAGE | % OF TOTAL AREA | COEFFICIENT, MINOR STORM (5-YR) | $C_5*A_i$ | COMPOSITE IMPERVIOUSNESS (5-YR) | COEFFICIENT, MAJOR STORM (100-YR) | $C_{100}*A_i$ | COMPOSITE IMPERVIOUSNESS (100-YR) |
|---|---|---|---|---|---|---|---|---|
| Roof | 6801.00 | 13.86% | 0.73 | 4964.730 | 10.12% | 0.81 | 5508.810 | 11.23% |
| Pavement | 28465.00 | 58.02% | 0.90 | 25618.500 | 52.22% | 0.96 | 27326.400 | 55.70% |
| Lawn | 13797.00 | 28.12% | 0.08 | 1103.760 | 2.25% | 0.35 | 4828.950 | 9.84% |
| TOTAL | 49063.00 | 100.00% | | | | | | |
| | IMPERVIOUSNESS: | 71.88% | COMPOSITE IMPERVIOUSNESS: | | 64.58% | | | 76.77% |

**SEE IRF CALCULATIONS FOR FINAL EFFECTIVE IMPERVIOUSNESS FOR EACH RESPECTIVE SUB-BASIN AND TOTAL SITE IMPERVIOUSNESS**

## 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 | |
|---|---|---|
| $C_5$: | 0.68 | [Table 6-6. Runoff Coefficients for Rational Method] |
| L: | 75 | ft |
| S: | 0.078 | 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 | 1701 | 0.04 | 0.73 |
| Pavement | 10578 | 0.24 | 0.90 |
| Lawn | 1586 | 0.04 | 0.08 |
| $A_t$ : | 13865 | 0.32 | |

$C_c$ = (0.73*0.04 + 0.90*0.10 + 0.08*0.04) / 0.18 = **0.68**

$t_i$ = (0.395*(1.1-$C_5$)*sqrt(L))/(S^0.33)
$t_i$ = (0.395*(1.1-0.68)*sqrt(75))/( **0.078** ^0.33) = **3.33** 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)

$V = C_v S_w^{0.5}$
$V = (20)(0.078)^{0.5}$ = **5.59** ft/s

Flow Distance: **1.00** ft

$t_t$ = L/V = 0.18 sec.
**0.00** 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.

## $t_c = t_i + t_t$ = **3.34** 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 | |
|---|---|---|
| $C_5$: | 0.77 | [Table 6-6. Runoff Coefficients for Rational Method] |
| L: | 10 | ft |
| S: | 0.02 | 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 | 1700 | 0.04 | 0.73 |
| Pavement | 606 | 0.01 | 0.90 |
| Lawn | 70 | 0.002 | 0.08 |
| $A_t$ : | 2376 | 0.05 | |

*$C_c$ = (0.73*.04 + 0.90*0.01 + 0.08*0.002) / 0.05 =* **0.77**

*$t_i$ = (0.395*(1.1-$C_5$)*sqrt(L))/(S^0.33)*
*$t_i$ = (0.395*(1.1-0.70)*sqrt(10))/(* ***0.02*** *^0.33) =* **1.51** 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)(0.02)$^{0.5}$ =* **2.83** ft/s

Flow Distance: **20.00** ft

$t_t$ = L/V = 7.07 sec.
**0.12** 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.

## $t_c = t_i + t_t$ = **1.63** 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-3 | |
|---|---|---|
| $C_5$: | 0.81 | [Table 6-6. Runoff Coefficients for Rational Method] |
| L: | 10 | ft |
| S: | 0.02 | 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 | 1700 | 0.04 | 0.73 |
| Pavement | 1307 | 0.03 | 0.90 |
| Lawn | 205 | 0.005 | 0.08 |
| $A_t$ : | 3212 | 0.07 | |

$C_c$ = (0.73*0.04 + 0.90*0.03 + 0.08*0.005) / 0.07 = **0.81**

$t_i$ = (0.395*(1.1-$C_5$)*sqrt(L))/(S^0.33)
$t_i$ = (0.395*(1.1- **0.81** )*sqrt(10))/( **0.02** ^0.33) = **1.32** 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)

$V = C_v S_w^{0.5}$
$V = (20)(0.02)^{0.5}$ = **2.83** ft/s

Flow Distance: **55.00** ft

$t_t$ = L/V = 19.45 sec.
**0.32** 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.

**$t_c = t_i + t_t$ = 1.65** 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-4 | |
|---|---|---|
| $C_5$: | 0.76 | [Table 6-6. Runoff Coefficients for Rational Method] |
| L: | 105 | ft |
| S: | 0.04 | 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 | 1700 | 0.04 | 0.73 |
| Pavement | 8851 | 0.20 | 0.90 |
| Lawn | 1621 | 0.04 | 0.08 |
| $A_t$ : | 12172 | 0.28 | |

$C_c$ = (0.73*0.04 + 0.90*0.20 + 0.08*0.04) / 0.28 = **0.76**

$t_i$ = (0.395*(1.1-$C_5$)*sqrt(L))/(S^0.33)
$t_i$ = (0.395*(1.1- **0.76** )*sqrt(105))/( **0.04** ^0.33) = **4.00** 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)

$V = C_v S_w^{0.5}$
$V = (20)(0.031)^{0.5}$ = **3.52** ft/s

Flow Distance: **100.00** ft

$t_t$ = L/V = 28.40 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.

**$t_c = t_i + t_t$ =** **4.47** 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-5 | |
|---|---|---|
| $C_5$: | 0.57 | [Table 6-6. Runoff Coefficients for Rational Method] |
| L: | 10 | ft |
| S: | 0.02 | 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 | 0.00 | 0.73 |
| Pavement | 7087 | 0.16 | 0.90 |
| Lawn | 4578 | 0.11 | 0.08 |
| $A_t$ : | 11665 | 0.27 | |

$C_c = (0.90*0.16 + 0.08*0.11) / 0.27 =$ **0.57**

$t_i = (0.395*(1.1-C_5)*sqrt(L))/(S\^0.33)$
$t_i = (0.395*(1.1-\mathbf{0.57})*sqrt(10))/(\mathbf{0.02}\^0.33) =$ **2.43** 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)

$V = C_v S_w^{0.5}$
$V = (20)(0.08)^{0.5} =$ **5.66** ft/s

Flow Distance: **380.00** ft

$t_t = L/V =$ 67.18 sec.
**1.12** 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.

$t_c = t_i + t_t =$ **3.55** 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.

## 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-6 | |
|---|---|---|
| $C_5$: | 0.08 | [Table 6-6. Runoff Coefficients for Rational Method] |
| L: | 85 | ft |
| S: | 0.065 | 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 | 4549 | 0.10 | 0.08 |
| $A_t$ : | 4549 | 0.10 | |

*$C_c$ = (0.08*0.1) / 0.10 =* **0.08**

*$t_i$ = (0.395*(1.1-$C_5$)*sqrt(L))/(S^0.33)*
*$t_i$ = (0.395*(1.1- **0.08** )*sqrt(85))/( **0.065** ^0.33) =* **9.15** 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)

*$V = C_v S_w^{0.5}$*
*$V = (20)(0.08)^{0.5}$ =* **5.66** ft/s

Flow Distance: **0.01** ft

$t_t$ = L/V = 0.00 sec.
**0.00** 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.

**$t_c = t_i + t_t$ =** **9.15** 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 $t_c$:** **9.15** 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: | OS-1 | |
|---|---|---|
| $C_5$: | 0.17 | [Table 6-6. Runoff Coefficients for Rational Method] |
| L: | 4 | ft |
| S: | 0.083 | 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 | 36 | 0.001 | 0.90 |
| Lawn | 576 | 0.01 | 0.08 |
| $A_t$ : | 612 | 0.01 | |

*$C_c$ = (0.90*0.001 + 0.08*0.01) / 0.01 =* **0.17**

*$t_i$ = (0.395*(1.1-$C_5$)*sqrt(L))/(S^0.33)*
*$t_i$ = (0.395*(1.1- **0.17** )*sqrt(4))/( **0.083** ^0.33) =* **1.67** 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)(0.083)$^{0.5}$ =* **5.76** ft/s

Flow Distance: **0.01** ft

$t_t$ = L/V = 0.00 sec.
**0.00** 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.

## $t_c = t_i + t_t$ = **1.67** 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: | OS-2 | |
|---|---|---|
| $C_5$: | 0.08 | [Table 6-6. Runoff Coefficients for Rational Method] |
| L: | 4 | ft |
| S: | 0.083 | 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 | 0.000 | 0.90 |
| Lawn | 612 | 0.01 | 0.08 |
| $A_t$ : | 612 | 0.01 | |

*$C_c$ = (0.08*0.01) / 0.01 =* **0.08**

*$t_i$ = (0.395*(1.1-$C_5$)*sqrt(L))/(S^0.33)*
*$t_i$ = (0.395*(1.1- **0.08** )*sqrt(4))/( **0.083** ^0.33) =* **1.83** 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)(0.038)$^{0.5}$ =* **5.76** ft/s

Flow Distance: **0.01** ft

$t_t$ = L/V = 0.00 sec.
**0.00** 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.

**$t_c = t_i + t_t$ =** **1.83** min.

### 3.2.4 Minimum Time of Concentration

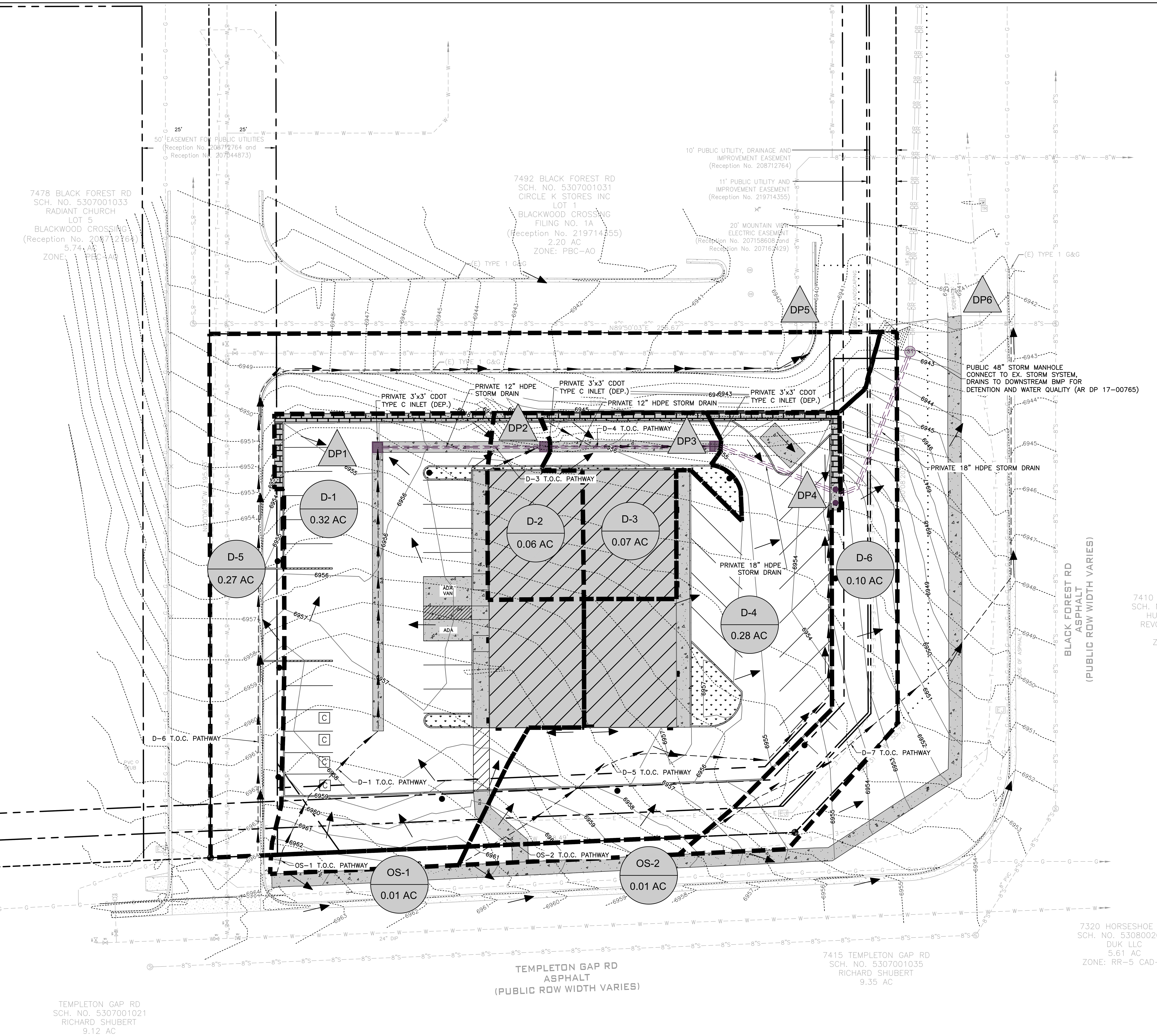
If the calculations result in a $t_c$ of less than 10 minutes for undeveloped conditions, it is recommended that a minimum value of 10 minutes be used. The minimum $t_c$ for urbanized areas is 5 minutes.

**Final $t_c$:** **5.00** min.

# 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 | |

| 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 | $Q_5$ = 1.29<br>$Q_{100}$ = 1.41 |
| 2 | $Q_5$ = 0.21<br>$Q_{100}$ = 0.40 |
| 3 | $Q_5$ = 0.29<br>$Q_{100}$ = 0.54 |
| 4 | $Q_5$ = 1.11<br>$Q_{100}$ = 2.08 |
| 5 | $Q_5$ = 0.80<br>$Q_{100}$ = 1.67 |
| 6 | $Q_5$ = 0.04<br>$Q_{100}$ = 0.26 |

**BASIN SUMMARY**

| BASIN | Q(5)-CFS | Q(100)-CFS | ACRES(AC) |
|---|---|---|---|
| D-1 | 1.29 | 1.41 | 0.32 |
| D-2 | 0.21 | 0.40 | 0.06 |
| D-3 | 0.29 | 0.54 | 0.07 |
| D-4 | 1.11 | 2.08 | 0.28 |
| D-5 | 0.80 | 1.67 | 0.27 |
| D-6 | 0.04 | 0.26 | 0.10 |
| OS-1 | 0.01 | 0.05 | 0.01 |
| OS-2 | 0.01 | 0.04 | 0.01 |
| TOTAL | 3.76 | 7.45 | 1.12 |

ROCKY MOUNTAIN GROUP

Architectural
Structural
Forensics

Geotechnical
Materials, Testing
Civil, Planning

SOUTHERN COLORADO
2910 AUSTIN BLUFFS PARKWAY, COLORADO SPRINGS, CO 80918
(719) 548-0600 ~ WWW.RMGENGINEERS.COM
SOUTHERN COLORADO, DENVER METRO, NORTHERN COLORADO

NOT FOR CONSTRUCTION
FOR CIVIL ONLY

LOT 2 BLACKWOOD CROSSING FIL NO 1A

LOT 2 BLACKWOOD CROSSING FIL NO 1A
COLORADO SPRINGS, CO

CHUCK HOLLIDAY - WESTERN STATES MGMT GROUP



SHEET NAME
DEVELOPED CONDITIONS
HYDROLOGY EXHIBIT

PROJECT STATUS
REVIEW

ENG: RDL
DRAWN: RDL
CHECKED: TJD

DATE
8/12/2021

| # | REVISION | DATE |
|---|---|---|
| | — | — |
| | — | — |
| | — | — |
| | — | — |
| | — | — |
| | — | — |
| | — | — |
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JOB NO.
180579

SHEET NO.
2
of 2

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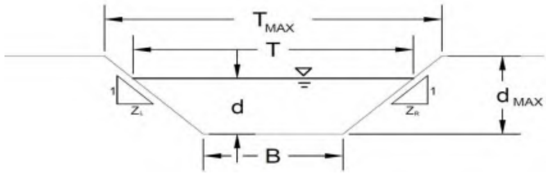
## Hydraulic Grade Line and Pipe Capacity

| 100-YEAR EVENT | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Pipe | Design Flow Rate | Proposed Pipe Diameter | Slope | 80% of Proposed Pipe Diameter | Manning Coefficient | Full Pipe Cross Sectional Area | Full Pipe Flow Rate | Q Design / Q Full | d/D | Hydraulic Grade Line (Depth of Flow) | Depth of Flow Less Than 80% of Pipe Diameter |
| | Qdes (ft3/sec) | Dpro(in) | S (%) | Dpro*.8 (in) | n | A (ft) = π (Dpro/2)2 | Qfull (ft3/s) = A(1.49/n)((Dpro/48)2/3)S1/2 | Qdes/Qfull | (from Chart) | d (in) = (d/D)*Dpro | (Yes/No) |
| 1-2 | 2.40 | 12.0 | 1.00% | 9.6 | 0.013 | 0.785 | 3.571 | 0.67 | 0.66 | 7.92 | Yes |
| 2-3 | 2.80 | 12.0 | 1.00% | 9.6 | 0.013 | 0.785 | 3.571 | 0.78 | 0.74 | 8.85 | Yes |
| 3-4 | 3.34 | 18.0 | 1.00% | 14.4 | 0.013 | 1.766 | 10.527 | 0.32 | 0.43 | 7.74 | Yes |
| 4-EX | 5.51 | 18.0 | 2.08% | 14.4 | 0.013 | 1.766 | 15.183 | 0.36 | 0.47 | 8.46 | Yes |

| 5-YEAR EVENT | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Pipe | Design Flow Rate | Proposed Pipe Diameter | Slope | 80% of Proposed Pipe Diameter | Manning Coefficient | Full Pipe Cross Sectional Area | Full Pipe Flow Rate | Q Design / Q Full | d/D | Hydraulic Grade Line (Depth of Flow) | Depth of Flow Less Than 80% of Pipe Diameter |
| | Qdes (ft3/sec) | Dpro(in) | S (%) | Dpro*.8 (in) | n | A (ft) = π (Dpro/2)2 | Qfull (ft3/s) = A(1.49/n)((Dpro/48)2/3)S1/2 | Qdes/Qfull | (from Chart) | d (in) = (d/D)*Dpro | (Yes/No) |
| 1-2 | 1.29 | 12.0 | 1.00% | 9.6 | 0.013 | 0.785 | 3.571 | 0.36 | 0.47 | 5.64 | Yes |
| 2-3 | 1.50 | 12.0 | 1.00% | 9.6 | 0.013 | 0.785 | 3.571 | 0.42 | 0.50 | 6.00 | Yes |
| 3-4 | 1.79 | 18.0 | 1.00% | 14.4 | 0.013 | 1.766 | 10.527 | 0.17 | 0.31 | 5.63 | Yes |
| 4-EX | 2.92 | 18.0 | 2.08% | 14.4 | 0.013 | 1.766 | 15.183 | 0.19 | 0.34 | 6.03 | Yes |

# AREA INLET IN A SWALE

**BLACKWOOD CROSSING (LOT 2, FILING NO 1A)**
**DP1**




This worksheet uses the NRCS vegetal retardance method to determine Manning's n.

For more information see Section 7.2.3 of the USDCM.

Analysis of Trapezoidal Grass-Lined Channel Using SCS Method

| | | | | |
|---|---|---|---|---|
| | NRCS Vegetal Retardance (A, B, C, D, or E) | A, B, C, D, or E = | | |
| | Manning's n (Leave cell D16 blank to manually enter an n value) | n = | 0.012 | |
| | Channel Invert Slope | $S_O$ = | 0.0200 | ft/ft |
| | Bottom Width | B = | 4.00 | ft |
| **Warning 01** | Left Side Slope | Z1 = | 0.05 | ft/ft |
| **Warning 01** | Right Side Sloe | Z2 = | 0.05 | ft/ft |

Check one of the following soil types:

| Soil Type: | Max. Velocity ($V_{MAX}$) | Max Froude No. ($F_{MAX}$) |
|---|---|---|
| Non-Cohesive | 5.0 fps | 0.60 |
| Cohesive | 7.0 fps | 0.80 |
| Paved | N/A | N/A |

Choose One:
- **Non-Cohesive**
- **Cohesive**
- **Paved**

| | | Minor Storm | Major Storm | |
|---|---|---|---|---|
| Maximum Allowable Top Width of Channel for Minor & Major Storm | $T_{MAX}$ = | **24.00** | **24.00** | **ft** |
| Maximum Allowable Water Depth in Channel for Minor & Major Storm | $d_{MAX}$ = | **1.50** | **1.50** | **ft** |

Allowable Channel Capacity Based On Channel Geometry

| | | Minor Storm | Major Storm | |
|---|---|---|---|---|
| MINOR STORM Allowable Capacity is based on Depth Criterion | $Q_{allow}$ = | **98.0** | **98.0** | **cfs** |
| MAJOR STORM Allowable Capacity is based on Depth Criterion | $d_{allow}$ = | **1.50** | **1.50** | **ft** |

Water Depth in Channel Based On Design Peak Flow

| | | | | |
|---|---|---|---|---|
| Design Peak Flow | $Q_o$ = | **1.3** | **2.4** | **cfs** |
| Water Depth | d = | **0.09** | **0.14** | **ft** |

**Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'**
**Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'**

*MHFD-Inlet, Version 5.01 (April 2021)*

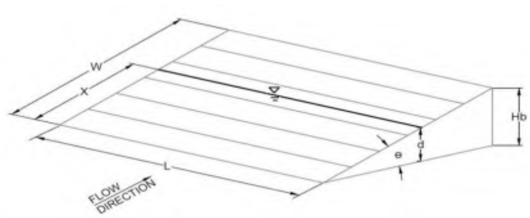
# AREA INLET IN A SWALE

**BLACKWOOD CROSSING (LOT 2, FILING NO 1A)**

**DP1**

Inlet Design Information (Input)

Type of Inlet: CDOT Type C (Depressed) — Inlet Type = CDOT Type C (Depressed)




| | | | |
|---|---|---|---|
| Angle of Inclined Grate (must be <= 30 degrees) | θ = | 1.19 | degrees |
| Width of Grate | W = | 3.00 | ft |
| Length of Grate | L = | 3.00 | ft |
| Open Area Ratio | $A_{RATIO}$ = | 0.70 | |
| Height of Inclined Grate | $H_B$ = | 0.06 | ft |
| Clogging Factor | $C_f$ = | 0.50 | |
| Grate Discharge Coefficient | $C_d$ = | 0.79 | |
| Orifice Coefficient | $C_o$ = | 0.52 | |
| Weir Coefficient | $C_w$ = | 1.68 | |

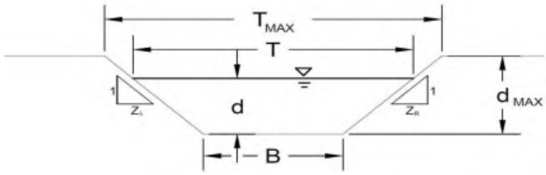
| | | MINOR | MAJOR | |
|---|---|---|---|---|
| Water Depth at Inlet (for depressed inlets, 1 foot is added for depression) | d = | 1.09 | 1.14 | |
| Total Inlet Interception Capacity (assumes clogged condition) | **$Q_a$ =** | **16.8** | **17.9** | **cfs** |
| Bypassed Flow | **$Q_b$ =** | **0.0** | **0.0** | **cfs** |
| Capture Percentage = Qa/Qo | **C% =** | **100** | **100** | **%** |

**Warning 01: Sideslope steepness exceeds USDCM Volume I recommendation.**
**Warning 02: Depth (d) exceeds USDCM Volume I recommendation.**

# AREA INLET IN A SWALE

**BLACKWOOD CROSSING (LOT 2, FILING NO 1A)**

**DP2**




This worksheet uses the NRCS vegetal retardance method to determine Manning's n.

For more information see Section 7.2.3 of the USDCM.

Analysis of Trapezoidal Grass-Lined Channel Using SCS Method

| | | | | |
|---|---|---|---|---|
| | NRCS Vegetal Retardance (A, B, C, D, or E) | A, B, C, D, or E = | | |
| | Manning's n (Leave cell D16 blank to manually enter an n value) | n = | 0.012 | |
| | Channel Invert Slope | $S_O$ = | 0.0200 | ft/ft |
| | Bottom Width | B = | 4.00 | ft |
| **Warning 01** | Left Side Slope | Z1 = | 0.02 | ft/ft |
| **Warning 01** | Right Side Sloe | Z2 = | 0.02 | ft/ft |

Check one of the following soil types:

| Soil Type: | Max. Velocity ($V_{MAX}$) | Max Froude No. ($F_{MAX}$) |
|---|---|---|
| Non-Cohesive | 5.0 fps | 0.60 |
| Cohesive | 7.0 fps | 0.80 |
| Paved | N/A | N/A |

Choose One:
- ☐ **Non-Cohesive**
- ☐ **Cohesive**
- ☐ **Paved**

| | | Minor Storm | Major Storm | |
|---|---|---|---|---|
| Maximum Allowable Top Width of Channel for Minor & Major Storm | $T_{MAX}$ = | **16.00** | **16.00** | **ft** |
| Maximum Allowable Water Depth in Channel for Minor & Major Storm | $d_{MAX}$ = | **0.67** | **0.67** | **ft** |

Allowable Channel Capacity Based On Channel Geometry

| | | Minor Storm | Major Storm | |
|---|---|---|---|---|
| MINOR STORM Allowable Capacity is based on Depth Criterion | $Q_{allow}$ = | **29.9** | **29.9** | **cfs** |
| MAJOR STORM Allowable Capacity is based on Depth Criterion | $d_{allow}$ = | **0.67** | **0.67** | **ft** |

Water Depth in Channel Based On Design Peak Flow

| | | | | |
|---|---|---|---|---|
| Design Peak Flow | $Q_o$ = | **0.2** | **0.4** | **cfs** |
| Water Depth | d = | **0.03** | **0.05** | **ft** |

**Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'**
**Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'**

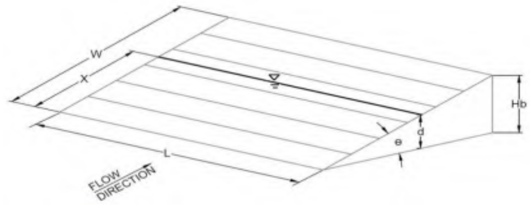
# AREA INLET IN A SWALE

**BLACKWOOD CROSSING (LOT 2, FILING NO 1A)**

**DP2**

Inlet Design Information (Input)

| | | | | |
|---|---|---|---|---|
| Type of Inlet | CDOT Type C (Depressed) | Inlet Type = | CDOT Type C (Depressed) | |
| Angle of Inclined Grate (must be <= 30 degrees) | | θ = | 1.19 | degrees |
| Width of Grate | | W = | 3.00 | ft |
| Length of Grate | | L = | 3.00 | ft |
| Open Area Ratio | | $A_{RATIO}$ = | 0.70 | |
| Height of Inclined Grate | | $H_B$ = | 0.06 | ft |
| Clogging Factor | | $C_f$ = | 0.50 | |
| Grate Discharge Coefficient | | $C_d$ = | 0.79 | |
| Orifice Coefficient | | $C_o$ = | 0.52 | |
| Weir Coefficient | | $C_w$ = | 1.68 | |

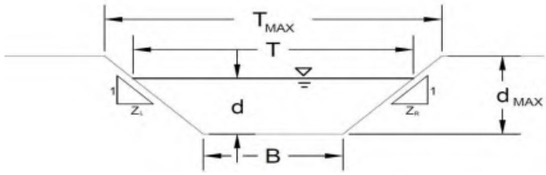



| | | MINOR | MAJOR | |
|---|---|---|---|---|
| Water Depth at Inlet (for depressed inlets, 1 foot is added for depression) | d = | 1.03 | 1.05 | |
| Total Inlet Interception Capacity (assumes clogged condition) | **$Q_a$ =** | **15.4** | **15.7** | **cfs** |
| Bypassed Flow | **$Q_b$ =** | **0.0** | **0.0** | **cfs** |
| Capture Percentage = Qa/Qo | **C% =** | **100** | **100** | **%** |

**Warning 01: Sideslope steepness exceeds USDCM Volume I recommendation.**
**Warning 02: Depth (d) exceeds USDCM Volume I recommendation.**

# AREA INLET IN A SWALE

**BLACKWOOD CROSSING (LOT 2, FILING NO 1A)**
**DP3**




This worksheet uses the NRCS vegetal retardance method to determine Manning's n.

For more information see Section 7.2.3 of the USDCM.

Analysis of Trapezoidal Grass-Lined Channel Using SCS Method

| | | | | |
|---|---|---|---|---|
| | NRCS Vegetal Retardance (A, B, C, D, or E) | A, B, C, D, or E = | | |
| | Manning's n (Leave cell D16 blank to manually enter an n value) | n = | 0.012 | |
| | Channel Invert Slope | $S_O$ = | 0.0200 | ft/ft |
| | Bottom Width | B = | 4.00 | ft |
| **Warning 01** | Left Side Slope | Z1 = | 0.02 | ft/ft |
| **Warning 01** | Right Side Sloe | Z2 = | 0.02 | ft/ft |

Check one of the following soil types:

| Soil Type: | Max. Velocity ($V_{MAX}$) | Max Froude No. ($F_{MAX}$) |
|---|---|---|
| Non-Cohesive | 5.0 fps | 0.60 |
| Cohesive | 7.0 fps | 0.80 |
| Paved | N/A | N/A |

Choose One:
- ☐ Non-Cohesive
- ☐ Cohesive
- ⦿ Paved

| | | Minor Storm | Major Storm | |
|---|---|---|---|---|
| Maximum Allowable Top Width of Channel for Minor & Major Storm | $T_{MAX}$ = | 16.00 | 16.00 | ft |
| Maximum Allowable Water Depth in Channel for Minor & Major Storm | $d_{MAX}$ = | 0.67 | 0.67 | ft |

Allowable Channel Capacity Based On Channel Geometry

| | | Minor Storm | Major Storm | |
|---|---|---|---|---|
| MINOR STORM Allowable Capacity is based on Depth Criterion | $Q_{allow}$ = | 29.9 | 29.9 | cfs |
| MAJOR STORM Allowable Capacity is based on Depth Criterion | $d_{allow}$ = | 0.67 | 0.67 | ft |

Water Depth in Channel Based On Design Peak Flow

| | | | | |
|---|---|---|---|---|
| Design Peak Flow | $Q_o$ = | 0.3 | 0.5 | cfs |
| Water Depth | d = | 0.04 | 0.05 | ft |

**Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'**
**Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'**

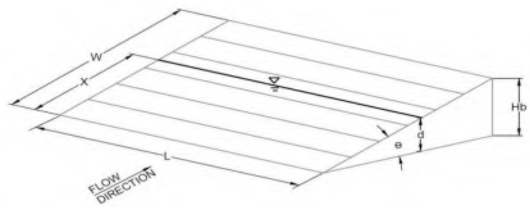
# AREA INLET IN A SWALE

**BLACKWOOD CROSSING (LOT 2, FILING NO 1A)**

**DP3**

Inlet Design Information (Input)

Type of Inlet: CDOT Type C (Depressed) — Inlet Type = CDOT Type C (Depressed)




| | | | |
|---|---|---|---|
| Angle of Inclined Grate (must be <= 30 degrees) | $\theta$ = | 1.19 | degrees |
| Width of Grate | W = | 3.00 | ft |
| Length of Grate | L = | 3.00 | ft |
| Open Area Ratio | $A_{RATIO}$ = | 0.70 | |
| Height of Inclined Grate | $H_B$ = | 0.06 | ft |
| Clogging Factor | $C_f$ = | 0.50 | |
| Grate Discharge Coefficient | $C_d$ = | 0.79 | |
| Orifice Coefficient | $C_o$ = | 0.52 | |
| Weir Coefficient | $C_w$ = | 1.68 | |

| | | MINOR | MAJOR | |
|---|---|---|---|---|
| Water Depth at Inlet (for depressed inlets, 1 foot is added for depression) | d = | 1.04 | 1.05 | |
| Total Inlet Interception Capacity (assumes clogged condition) | **$Q_a$ =** | **15.6** | **16.0** | **cfs** |
| Bypassed Flow | **$Q_b$ =** | **0.0** | **0.0** | **cfs** |
| Capture Percentage = Qa/Qo | **C% =** | **100** | **100** | **%** |

**Warning 01: Sideslope steepness exceeds USDCM Volume I recommendation.**

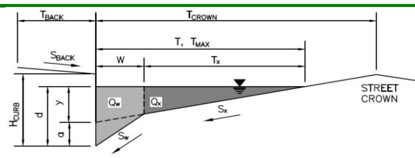
**Warning 02: Depth (d) exceeds USDCM Volume I recommendation.**

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

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

**Project: BLACKWOOD CROSSING (LOT 2, FILING NO 1A)**

**Inlet ID: DP4**



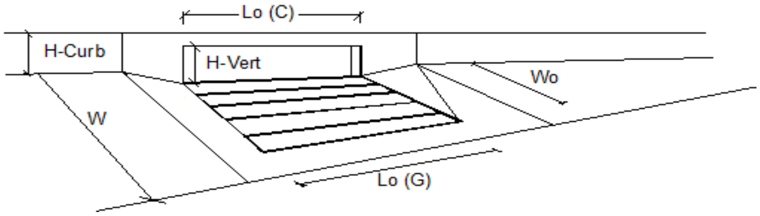

Gutter Geometry:

| | | | | |
|---|---|---|---|---|
| Maximum Allowable Width for Spread Behind Curb | $T_{BACK}$ = | 3.5 | | ft |
| Side Slope Behind Curb (leave blank for no conveyance credit behind curb) | $S_{BACK}$ = | 0.020 | | ft/ft |
| Manning's Roughness Behind Curb (typically between 0.012 and 0.020) | $n_{BACK}$ = | 0.020 | | |
| Height of Curb at Gutter Flow Line | $H_{CURB}$ = | 6.00 | | inches |
| Distance from Curb Face to Street Crown | $T_{CROWN}$ = | 42.0 | | ft |
| Gutter Width | W = | 1.00 | | ft |
| Street Transverse Slope | $S_X$ = | 0.050 | | ft/ft |
| Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft) | $S_W$ = | 0.083 | | ft/ft |
| Street Longitudinal Slope - Enter 0 for sump condition | $S_O$ = | 0.035 | | ft/ft |
| Manning's Roughness for Street Section (typically between 0.012 and 0.020) | $n_{STREET}$ = | 0.016 | | |
| | | Minor Storm | Major Storm | |
| Max. Allowable Spread for Minor & Major Storm | $T_{MAX}$ = | 24.0 | 24.0 | ft |
| Max. Allowable Depth at Gutter Flowline for Minor & Major Storm | $d_{MAX}$ = | 6.0 | 6.0 | inches |
| Allow Flow Depth at Street Crown (check box for yes, leave blank for no) | | ☐ | ☐ | |
| | | Minor Storm | Major Storm | |
| MINOR STORM Allowable Capacity is based on Depth Criterion | | | | |
| MAJOR STORM Allowable Capacity is based on Depth Criterion | **$Q_{allow}$ =** | **11.5** | **11.5** | **cfs** |

**Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'**
**Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'**

# INLET ON A CONTINUOUS GRADE

*MHFD-Inlet, Version 5.01 (April 2021)*




| Design Information (Input) | CDOT Type R Curb Opening | | MINOR | MAJOR | |
|---|---|---|---|---|---|
| Type of Inlet | | Type = | CDOT Type R Curb Opening | | |
| Local Depression (additional to continuous gutter depression 'a') | | $a_{LOCAL}$ = | 3.0 | 3.0 | inches |
| Total Number of Units in the Inlet (Grate or Curb Opening) | | No = | 2 | 2 | |
| Length of a Single Unit Inlet (Grate or Curb Opening) | | $L_o$ = | 5.00 | 5.00 | ft |
| Width of a Unit Grate (cannot be greater than W, Gutter Width) | | $W_o$ = | N/A | N/A | ft |
| Clogging Factor for a Single Unit Grate (typical min. value = 0.5) | | $C_f$-G = | N/A | N/A | |
| Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1) | | $C_f$-C = | 0.10 | 0.10 | |
| **Street Hydraulics: OK - Q < Allowable Street Capacity'** | | | MINOR | MAJOR | |
| Total Inlet Interception Capacity | | **Q =** | **1.1** | **2.1** | **cfs** |
| Total Inlet Carry-Over Flow (flow bypassing inlet) | | **$Q_b$ =** | **0.0** | **0.0** | **cfs** |
| Capture Percentage = $Q_a/Q_o$ = | | **C% =** | **100** | **100** | **%** |

# APPENDIX C – FEMA FLOODPLAIN MAP

# National Flood Hazard Layer FIRMette

FEMA

104°42'25"W 38°56'37"N


104°41'48"W 38°56'9"N

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

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**
- B 20.2 / 17.5 Cross Sections with 1% Annual Chance Water Surface Elevation
- 8 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.

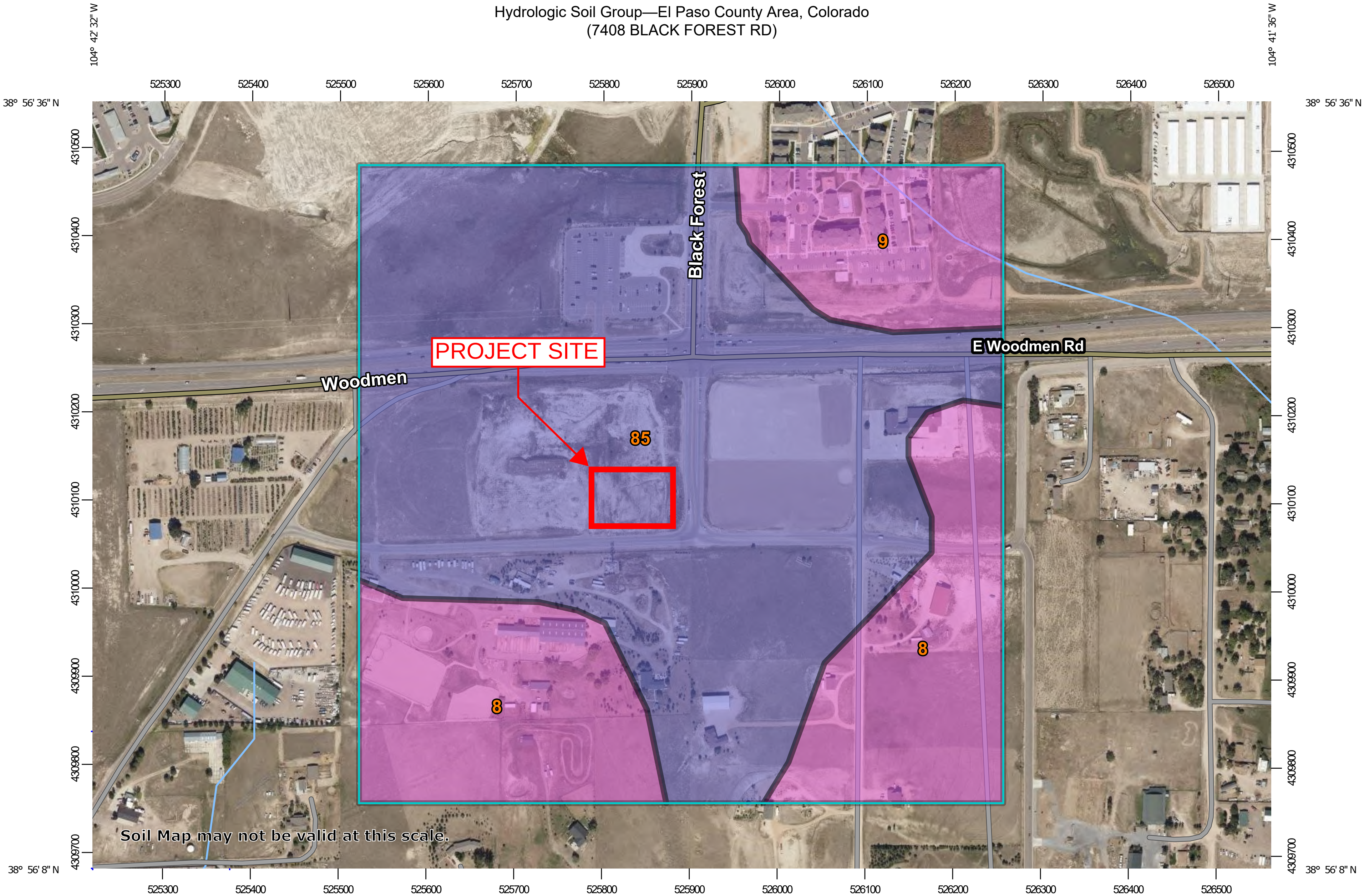
This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 1/28/2021 at 10:00 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

Hydrologic Soil Group—El Paso County Area, Colorado
(7408 BLACK FOREST RD)




Map Scale: 1:6,140 if printed on A landscape (11" x 8.5") sheet.

Meters: 0 50 100 200 300

Feet: 0 250 500 1000 1500

N

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 | 35.6 | 27.0% |
| 9 | Blakeland-Fluvaquentic Haplaquolls | A | 12.4 | 9.4% |
| 85 | Stapleton-Bernal sandy loams, 3 to 20 percent slopes | B | 83.8 | 63.5% |
| **Totals for Area of Interest** | | | **131.8** | **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