Final Drainage Report

Prairie Ridge Subdivision

June 2021

PCD File No SF2010

Prepared for

Clovis Point CO, LLC
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Prepared by

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Job No: 2019-104

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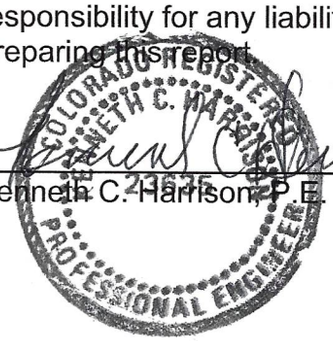
APPENDIX

Certifications and Approvals

Design Engineer's Statement:

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



7-10-22

Kenneth C. Harrison, P.E. Colorado No. 23635

7-10-22
Date

Owner/Developer's Statement:

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

6/18/2022
Date

Alexander Kuhnke, Managing Member
Clovis Point CO, LLC
13395 Voyager Parkway, Suite 130, PMB 2035
Colorado Springs, CO 80921

El Paso County:

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

APPROVED
Engineering Department
08/02/2022 10:50:21 AM
dsdnijkamp
EPC Planning & Community Development Department

Joshua Palmer, P.E.
Interim County Engineer / ECM Administrator

Date

Conditions:

I. REPORT PURPOSE

The purpose of this study is to evaluate the drainage characteristics for both theexisting and developed conditions of the Prairie Ridge Subdivision in accordancethe current El Paso County Drainage Criteria. A drainage study and report were previously prepared by Troy Kent of Land Development Consultants (LDC), submitted and approved by El Paso County on May 28, 2008. Subsequent to the report approval the plat was never recorded, and the project remained dormant until recently. An Early Assistance Meeting was held on August 28, 2018 to review current requirements for reconsidering the plat. According to the Meeting Minutes, the existing drainage study needed to be amended to address current drainage criteria. El Paso County amended it criteria on January 27, 2015. At thismeeting El Paso County adopted the adopted Chapter 6 (Hydrology) and Section 3.2.1 of Chapter 13 (Full Spectrum Detention) of the May 2014 City of Colorado Springs Drainage Criteria Manual Volume 1 (DCMV1). The changes in the criterion that impact this report are:

- Design storm for the minor event was changed from the 10 year to the 5-yearstorm
- The Curve Numbers **(CN)** used in the **NRCS** method were amended to more accurately reflect the runoff for both the existing and developed conditions. However, the Curve Numbers presented in the User's Manual for the TR55 Method (see Appendix, Exhibit 5), were used since the results closely correlate to the results obtained from the Rational Method (see Appendix, Exhibit 4). These results are shown on the two (2) Drainage Plans included inthe map pocket.
- Additional detail describing the components of this study was required to meet requirements.

It was decided to use the sections of the existing report where no changes were required. Sections of the narrative were updated where required. Hydrologic calculations were modified to reflect the new Curve Numbers. The drainage maps prepared for the existing and developed conditions are basically the same with only minimal modifications.

II. GENERAL DESCRIPTION

The property is approximately located in the SE ¼ of the SE ¼ of Section 12, Township 11 South, Range 66 West of the 6th P.M., El Paso County, Colorado.The property is comprised of 40.7 +/- acres and is more particularly located on the south and east sides of Brown Road approximately 0.5 miles north of the intersection of Brown Road and Walker Road *(Appendix, Exhibit* 1).

The project is currently undeveloped agricultural ground and has been

used for pasture and grazing land. There are no buildings or irrigation ditches located on the property, however there are observable natural drainage corridors on the site.One of the natural drainage corridors bisects the site north to south, while the other runs west to east along the southerly boundary. The site is to be divided into 7 single-family lots with a minimum size of 5 acres.

Offsite improvements include the leveling and the placement of Class 6 road base at the northeast and northwest corners of the property. Roadway improvements to Brown Road, at the northwest corner of the site include increasing the existing turning radius of Brown Road on the east side from a 30' radius to a 100' radius. This widens the road approximately 15' at the corner. At the northeast corner of the property a 60' radius emergency turnaround will be constructed. This will be accomplished by widening the road to the south approximately 75' from its existing edge. Roadside ditch restoration at both locations will be provided to continue to direct runoff along the edge of Brown Road.

The Soil, Geology, Geologic Hazard, and Wastewater Study dated May 31, 2007,by Entech Engineering, Inc., addresses the general soil conditions and erosion potential of the site. The soils on the subject property have been generally classified as sandy-clay and sandy clay-silt.

The existing channel along the southerly portion of the site is well vegetated, and is in good condition, however, since it is subject to seasonal flooding and further erosion, this region of the development is being preserved. Some ponding of water exists on the site within the southerly drainage corridor, where water has been impounded behind an earthen dam east of the site for a stock pond. This portion of the site, in addition to the lesser drainage way running from north to south has been identified as a no-build area, and has been included within a proposed drainage easement.

The Entech report states that "the soil types observed on the site are mildly to highly susceptible to wind erosion, and moderately to highly susceptible to water erosion". This is in reference to areas that are to be disturbed during the construction. Since no site grading is proposed, the erodible soils will not be exposed to weathering, therefore no on-site erosion control measures have been presented. As individual lots are developed, erosion control measures are to be installed, according to the specific needs of each parcel consistent with the recommendations of Entech's report.

Undeveloped and unplatted parcels, ranging in size from 4.67 to 97-acres surround the site, along with an existing MVEA overhead power lines along the southerly and easterly side of Brown Road.

III. DESIGN CRITERIA AND METHODOLOGY

The existing and proposed runoff patterns, runoff estimates, and proposed drainage improvements were evaluated based on the criteria and procedures outlined in the El Paso County Drainage Criteria Manual.

- **Design Manuals**
  - ***City of Colorado Springs Criteria Manual, Volume I.*** The charts and graphs used from this manual are reproduced within thepertinent sections of the Appendix.

  - **Soil Survey of El Paso County Area, Colorado United States Departmentof Agriculture, Soil Conservation Service** *(Appendix, Exhibit* 3)

  - ***Flood Insurance Rate Map, Federal Emergency Management Agency*** *(Appendix, Exhibit 2)*

  - ***Urban Storm Drainage Criteria Manual, Urban Storm & Flood Control District, Copyright 2005 updated January 2016***

  - ***Soil, Geology, Geologic Hazard, and Wastewater Study-Prairie Ridge, El Paso County, Colorado, Entech Engineering, Inc., dated May 31, 2007*** Not duplicated in the Appendix of the report. The report is available upon request.

- **Design storms**
  - Minor storm: 5-year
  - Major storm: 100-year

- **Drainage Areas**
  - Areas for the offsite and onsite sub basins were obtained from the May 28,2008 drainage report that was previously approved by El Paso County

- **Runoff Methods**
  - ***Rational Method***
    This method was used to determine runoff quantities for sub basins withless than 130 acres. Intensity-Duration-Frequency (IDF) curves were obtained from the Colorado Springs Drainage Criteria Manual (DCM) *(Appendix , Exhibit 4).* This method was used to estimate existing from offsite basins at design points 2, 3, and 5. Runoff from sub basins A, B, C D, and E were used to verify the stability of the existing swales that drain these sub basins. Based visual observation and existing vegetative conditions, it is expected that these

swales safely convey the runoff from both the minor and major to the site's outfall point at Design Point 6.

- ***National Resources Conservation Service (NRCS) (TR 55)*** This method was used for the entire drainage area that impacts the subdivision which has an area of 296.3 acres. The runoff values that were determined for the areas less than 130 acres were compared to those determined with the Rational Method. The values obtained from the SCS TR55 method were used since the overall drainage area was in excess of 130 acres.

- **Culverts**

  Sizing

  - The 5-year storm was used to size the culvert under Brown Road located at the southwesterly corner of the site. Assumptions were necessary due to the limited field data.
  - The 100-year storm was used to evaluate the over topping conditions anticipated at the existing culvert under Brown Road.

  Culvert Velocities

  - Maximum velocity= 18 fps
  - Minimum velocity= 3 fps when the pipe is 50% full

- **Drainage Swale and Borrow Ditch Sizing**

  Sizing

  - Estimated runoff from the design the design storms were used to verify the stability of the existing onsite swales as well as the borrow ditch along Brown Road. Rock ditch checks will be added to roadside ditches at the time of future roadway improvements.
  - The 100-year storm event was used to evaluate roadway overtopping conditions along the borrow ditches.

  Velocity

  - Less than the erosive velocities typical for the existing soils.

  Freeboard Requirements

  - 12" for the minor storm and no roadway overtopping for the 100 year.

  Flow Regime

  - Drainage improvements are not recommended for swales that are characterized by a subcritical flow regime. This occurs when the Froude No's. are less than 1.0.

- Erosion control improvements are recommended for swales where the runoff is characterized by a supercritical flow regime. This regime is characterized by high velocities and erratic, erosive, and unpredictableflows. This occurs when the Froude No. is 1.0 or greater.

- **Detention/ Water Quality Pond**

  Basis *of evaluation:*

  The requirements for Post Construction Stormwater Management (Detention/Water Quality Ponds) are evaluated in accordance El Paso County Engineering Criteria Manual, Appendix I.7.1. It is determined that the site is exempt from providing Water Quality facilities by virtue of the exclusions provided in ECM Sections I.7.1.B.2 (Excluded Roadway Redevelopment), I.7.1.B.3 (Excluded Existing Roadway Areas) and I.7.1.B.5 (Large Lot Single Family Sites). A full discussion regarding the requirements for Water Quality Treatment is presented in Section XIII of this report. Storm Detention is also not required for the site since the proposed large lot single family home sites present negligible increase from existing to developed conditions.

- **ESQCP and SWMP**

  According to ECM Section I.4.1, an Erosion and Stormwater Quality Control Permit (ESQCP) and Stormwater Management Plan (SWMP) are required for projects that disturb 1.0 acres or more and/or disturbs more than 500 CY of material. This project involves the disturbance of 0.74 acres and less than 500 CY of material for the purpose of replenishing the gravel surface thickness of existing Brown Road on the west and north sides of the site. ESQCP and SWMP are not required for this project since the applicable thresholds are not met.

IV. EXISTING REPORTS, MAPPING AND INFORMATION

- The project lies within the East Cherry Creek Drainage Basin. There are drainage fees associated with this basin.
- No drainage reports have been prepared for any of the tracts that surround the site.

V. FEMA FLOODPLAIN

The project is within Zone X (other) as shown on the Flood Rate insurance Map, ElPaso County, Colorado and Incorporated Areas, Panel 325 of 1300; Map Number 08041C0305 G, Effective Date December 7, 2018 *(Appendix, Exhibit* 2).

VI. HYDROLOGIC SOILS INFORMATION

The hydrologic soils groups were obtained from the USDA National Resource Conservation Service website for soil types in El Paso County, Colorado *(Appendix, Exhibit 3).* The soils are identified as follows:

- Brusset Loam 3-5% **(SCS No.** 15)
- Peyton-Pring Complex 8-15% **(SCS No.** 69).

The soils and their characteristics are described in the soils report included in the Appendix, Exhibit 3. All of the soils in the project area are classified within the B hydrologic group.

VII. DOWNSTREAM DRAINAGE CONDITIONS

A stock pond is located immediately downstream of the subdivision at Design Point 6 located near the southeast corner of the site. According to the drainage plan, offsite sub basins OS1, OS2 and OS3 drain through the project site, as well as onsite sub basins A, B, C and D, all totaling 292.6 acres. This area excludes runoff from sub basin E which flows offsite at Design Point 7. Of this total area, offsite basins comprise 255.5 acres, leaving the onsite sub basins with total area of 37.1 acres that drains through the pond. This represents 13% of the total area that drains to the existing pond. As mentioned before this does not include runoff from sub basin E.

All of the runoff from offsite and onsite basins, with the exception of sub basin E, are carried to the stock pond via a natural grassed swale (swale 1) located along the southerly boundary of the project site. Based on visual observations, the swale and pond appear to be stable with only a minimal amount of erosion.

The condition of the swale as it enters the pond is also stable with negligible signs of erosion. Based on visual observations of the upstream and downstream swale of the pond, and the relatively small percentage that the project site is compared to the total drainage area, it is reasonable to assume that the pond is adequate to accommodate the minor increase in runoff flows as a result of development.

A detailed analysis of the hydraulic and structural characteristics of the pond is outside the scope of this report.

VIII. HISTORIC OFFSITE CONDITIONS

- **Basin 0S-1 (based on 0% Impervious for Undeveloped, Pasture/ Meadow)**

  Sub basin OS-1 is approximately 211.6 acres and extends from the westerly boundary of the site to the top of the watershed. The topography within the basin ranges from 9.9% near Spruce Hill to 2.9% near thesite boundary. Runoff from this basin flows easterly to the southwest corner of the site, crossing Brown Road via an existing 24-inch CMP at an **assumed** slope of 2.0%. This culvert is in good condition. O S - 1 comprises the primary source of flow in the existing channel located along the south side of the project site.. A stock pond (east of DP1) is located within this channel, immediately upstream from the site (Design Point 1) on the westerly side of Brown Road.

  Since this sub basin is greater than 130 acres, the **NRCS-TR55** method was utilized. Values were obtained from the **TR-55** User Guide.

  - Area= 211.6 acres
  - Curve Numbers = 69 *(Appendix, Exhibit* 5). These values presented in this ttable were used instead of the ones published in the DCMV1 since they are specific to the TR55 method and the runoff produced are comparable to those of the Rational Method.
  - Time of Concentration= 33.4 minutes
  - TR55 Estimated Runoff
    Minor Storm (5year): 69.6 cfs
    Major Storm (100 year): 279.5 cfs

- **Basin 0S-2 (based on 0% Impervious for Undeveloped, Pasture/ Meadow)**

  Basin OS-2 is approximately 31.8-acres, and drains most of the region south of the site. The topography within this basin ranges from 6.5% at the top to 5.1% near the existing channel. Runoff from this basin flows to the northeast, and intersects the existing channel long the south of the site boundary. Runoff from Sub basin OS-2 outfalls into the Reach 3 of the swale along the south side of the property.

Since this sub basin is less than 130 acres, the Rational Method was utilized with the following hydrologic parameters and characteristics. Area = 31.8 acre.

- Runoff Coefficients
  Minor (5 year) storm = 0.08
  Major (100 year) storm = 0.35

- Time of Concentration: 26.9 minutes

- Estimated Runoff (UDFC Rational)(Appendix. Exhibit 4)
  Minor Storm (5 year): 6.4 cfs
  Major Storm (100 year): 46.9 cfs

- Estimated Runoff (TR55)(Appendix. Exhibit 5)
  Minor Storm (5 year): 17.4 cfs
  Major Storm (100 year): 65.5 cfs

- **Basin OS-3 and sub basin D (based on 0% Impervious for Undeveloped, Pasture/ Meadow)**

  Sub basins OS3 and D were combined since sub basin D is relatively small in comparison to OS-3. It is also expected, due to the location of the Sub Basin D in the "watershed" that no development will occur. Basin OS-3 and D is approximately 13.6 acres, and drains the region south of the site and east of Basin OS-2. The topography within this basin ranges from 4.5% at the top to 5.9% near the site's southeast corner. Runoff from this basin flows to the northeast, and outfalls into the existing swale 1 at DP6 located near its southeast corner.

  Since this sub basin is less than 130 acres, the Rational Method was utilized with the following hydrologic parameters and characteristics. They were compared with those determined by the TR55 Method.

  - Area 13.6 acres

  - Runoff Coefficients
    Minor (5 year) storm = 0.08
    Major (100 year) storm= 0.35

  - Time of Concentration: 31.7 minutes

- Estimated Runoff (UDFC Rational Method) (Appendix, Exhibit 4):

  Minor storm (5 year) = 2.5 cfs,

  Major Storm (100 year) = 18.2 cfs

- Estimated Runoff (TR55) *(Appendix, Exhibit 5):*
  Runoff from 0S3 was not determined using the TR55 program. The runoff from 0S3 was included with the runoff from sub basin D for the developed conditions.

IX. HISTORIC ONSITE CONDITIONS

General

The site is bounded on the north and west by Brown Road and to the south and east by undeveloped agricultural land. A defined drainage channel (Swale 1) runs along the southerly boundary of the site, which is tributary to East Cherry Creek. The site drains primarily to the south and east, where this drainage channel intercepts it. Stock ponds exist immediately upstream and downstream from the site. The subject property consists of approximately 40.7-acres, and is divided into five (5) historic basins, identified as Basins A through E. Approximately 255.5-acres of off-site area tributary to the site is divided into three (3) basins, labeled OS-1 through OS-3. The hydrologic characteristics of these offsite sub-basins are described in the previous section. The historic hydrologic conditions of the onsite basins are described in more detail below. The TR55 program was used to compare the flows obtained using the Rational Method. The TR55 data is shown for information purposes only.

- **Sub-basin A (historic) (based on 0% Impervious for Undeveloped, Pasture/ Meadow)**

Sub-basin A is approximately 10.7 acres, and drains the westerly portion of the site, along Brown Road. The topography within this basin ranges between 2.2% and 6.5%. Runoff from this basin flows to the south and intersects the existing channel at the southerly boundary approximately 250-feet east of Brown Road. At this point, flows were evaluated at Design Point 2 (DP2), where runoff from Basin OS-1 combines with that from Basin A. Since this sub basin is less than 130 acres, the Rational Method was utilized with the following hydrologic parameters and characteristics. They were compared with those determined by the TR55 Method.

a) Area 10.7 acres
   - Runoff Coefficients
   - Minor storm (5 year): 0.08
   - Major Storm (100 year): 0.35

b) Time of Concentration: 26.9 minutes

c) Estimated Runoff (UDFC Rational Method) *(Appendix, Exhibit 4)*
- Minor storm (5 year): 2.2 cfs
- Major Storm (100 year): 15.8 cfs

d) Estimated Runoff (TR55) *(Appendix, Exhibit 5)*
- Minor Storm (5 year): 5.8 cfs
- Major Storm (100 year): 22.0 cfs

- **Sub-basin B (historic) (based on 0% Impervious for Undeveloped, Pasture/ Meadow)**
  Sub-basin B is approximately 19.6-acres, and drains the central portion of thesite. The topography within this basin ranges between 2.1% and 10.4%. Runoff from this basin flows to the southeast, and intersects the existing channel near the southeast corner of the site. At this point, flows were evaluated at Design Point 4 (DP4), where runoff from Basins OS-1, OS-2, and Basin A combine with runoff from Basin B. Since this sub basin is less than 130 acres, the Rational Method was utilized with the following hydrologic parameters and characteristics. They were compared with those determined by the TR55 Method.

  - Area 19.6 acres

  - Runoff Coefficients
    Minor storm (5 year): 0.08
    Major Storm (100 year): 0.35

  - Time of Concentration: 26.3 minutes

  - Estimated Runoff (UDFC Rational Method) *Appendix, Exhibit 4*
    Minor Storm (5 year): 4.0 cfs
    Major Storm (100 year): 29.3 cfs

  - Estimated Runoff (TR55) *(Appendix, Exhibit 5)*
    Minor Storm (5 year): 10.4 cfs
    Major Storm (100 year): 39.4 cfs

  The estimated runoff utilizing the Rational Method was used to evaluate thehydraulic characteristics of the existing swale that drains the sub basin

Sub-basin C (historic) (based on 0% Impervious for Undeveloped, Pasture/ Meadow)

Sub-basin C is approximately 5.3-acres, and drains most of the easterly portion of the site. The topography within this basin ranges from 2.0% to 15.7%.

Runoff from this basin flows to the southeast, and intersects the existing channel near the southeast corner of the site, approximately 130-feet downstream from DP4. At this point, flows are evaluated at Design Point 6 (DP6), where runoff from Basins OS-1, OS-2, OS-3, A, B, and D combines with Basin C.

Since this sub basin is less than 130 acres, the Rational Method was utilized with the following hydrologic parameters and characteristics. They were compared with those determined by the TR55 Method.

- Area= 5.3 acres

- Runoff Coefficients
  Minor storm (5 year): 0.08
  Major Storm (100 year): 0.35

- Time of Concentration: 22.8 minutes

- Estimated Runoff (UDFC Rational Method) *Appendix, Exhibit 4*
  Minor Storm (5 year): 1.2 cfs
  Major Storm (100 year): 8.6 cfs

- Estimated Runoff (TR55) *(Appendix, Exhibit 5)*
  Minor Storm (5 year): 3.5 cfs
  Major Storm (100 year): 12.6 cfs

The estimated runoff utilizing the Rational Method was used to evaluate thehydraulic characteristics of the existing swale that drains the sub basin

- **Sub-basin OS-3 and D (historic) (based on 0% Impervious for Undeveloped, Pasture/ Meadow)**
  These two sub-basins were combined since the runoff from OS-3 flows into sub-basin D. Sub-basin OS-3 is 12.1 acres and Sub-basin is approximately 1.5 acres. The sub basins drain to the southeasterly corner of the site. The topography within this basin slopes at approximately 12.5%. Runoff from this basin flows to the northwest from the southerly side of the existing channel, and intersects it near the southeast corner of the site, approximately

130-feet downstream from DP4. At this point, flows are evaluated at Design Point 6 (DP6), where runoff from Basins OS-1, OS-2, OS-3, A, B, and C combine with Basin D.

Since this sub basin is less than 130 acres, the Rational Method was utilizedwith the following hydrologic parameters and characteristics. They were compared with those determined by the TR55 Method.

- Area = 13.6 areas

- Runoff Coefficients
  Minor storm (5 year): 0.08
  Major Storm (100 year): 0.35

- Time of Concentration: 31.7 minutes

- Estimated Runoff (UDFC Rational Method) *(Appendix, Exhibit* 4)
  Minor storm (5 year): 2.5 cfs
  Major Storm (100 year): 18.2 cfs

- Estimated Runoff (TR55) *(Appendix, Exhibit 5)*
  Minor storm (5 year): 7.0 cfs
  Major Storm 100 year): 26.7 cfs

The estimated runoff utilizing the Rational Method was used to evaluate the hydraulic characteristics of the existing swale that drains the sub basin.

Sub-basin E (historic) (based on 0% Impervious for Undeveloped, Pasture/ Meadow)

Sub-basin E is approximately 3.7-acres, and drains the northeast corner of thesite. The topography within this basin ranges from 2.4% to 7.7%. Runoff from this basin flows to the southeast, and exits the site at the eastern boundary, approximately 700-feet south of the north boundary. At this point, flows are evaluated at Design Point 7.

- Area = 3.7 acres

- Runoff Coefficients
  Minor storm (5 year): 0.08
  Major Storm (100 year): 0.35

- Time of Concentration: 22.5 minutes

- Estimated Runoff (UDFC Rational Method) *(Appendix, Exhibit* 4)
  Minor storm (5 year): 0.8 cfs
  Major Storm (100 year): 6.0 cfs

- Estimated Runoff (TR55) *(Appendix, Exhibit 5)*
  Minor storm (5 year): 1.9 cfs
  Major Storm 100 year): 7.2 cfs

The estimated runoff was used to evaluate the hydraulic characteristics of theexisting swale that drains the sub basin.

Combined Offsite and Onsite Sub-basins (historic) at Design Point 6 (based on 0% Impervious)

All runoff from the sub-basins described above (sub basins OS-1, OS-2, OS-3, A, B, C & D) ultimately leaves the site at Design Point 6 which is located at the southeast corner of the site. The runoff historically enters an existing stock pond. The physical and hydraulic characteristics of this pond are outside the scope of this report since there is only negligible increase in runoff for both the minor (5 year) and major (100 year) storm events.

Since the total drainage area is greater than 130 acres, the **NRCS** TR55 method was utilized to determine the following hydrologic characteristics:

- Drainage area = 292.6 acres

- TR55 Curve Number= 69 (based on an imperviousness of 0%) (see *Appendix,Exhibit 5)*

- Estimated Runoff
  Minor storm (5 year)= 86.2 cfs
  Major Storm (100 year)= 358.5 cfs

X. EXISTING DRAINAGE IMPROVEMENTS

The only drainage facility on this site is a 24-inch corrugated metal pipe located under Brown Road at the southwest corner of the site (DP 1). This DP is located on the westerly side of the project. The stormwater runoff at this location was estimated to be:

- Location: Brown Road
- Contributing sub basin: OS1
- Contributing Drainage area: 211.6
- Method: TR 55
- Minor storm (5 yr.) = 69.6 cfs
- Major storm (100 yr.) = 279.5 cfs

The hydraulic characteristics of the existing 24-inch culvert were determined by assuming the inverts and the length of the culvert since field data was not obtained. This is a safe assumption since the outfall "swale" is broad and is expected to have minimal depth that would create an "outlet control condition". Based on the limitations described, the hydraulic conditions were determined to be as follows *(Appendix, Exhibit* 6)

- The culvert has a capacity of 20.5 cfs *(Appendix, Exhibit* 6). This is based on a headwater to depth ratio of 1.5. This provides an upstream depth of 3.1 feet.
- The culvert is operating under inlet control since the downstream depth is expected to be negligible.
- The velocity in the culvert was not determined since data regarding the pipe slope was not obtained.

Conclusions

- The existing culvert is undersized to safely accommodate the runoff from the 5-year storm event.
- The runoff from the 100-year event is expected to overtop the existing roadway and therefore has the potential of damaging the existing roadway cross section.

It is recommended to replace the existing culvert. Since the culvert only accommodates runoff from offsite sources, the culvert is to be replaced by other parties and not as part of this subdivision's improvements.

XI. DEVELOPED DRAINAGE CONDITIONS

- **Offsite Sub-basin Characteristics for Developed Conditions**
  There are no plans to develop the tracts located upstream of the project site.Therefore, the hydrologic conditions for the offsite sub basins will remain the same, as described Section VIII of this report, under the developed conditions.

- **Onsite Sub-basin Characteristics for Developed Conditions**
  Since the development of this site consists of 5-acre parcels, the majority of the hydrologic parameters for onsite sub-basins, presented in Section IX, remain the same. The only change is in the determination of the Runoff Coefficient and Curve Number. The following is a summary of how the runoff coefficients for the developed conditions were calculated.

  - Drainage Sub Basins identification is the same as existing conditions

  - Developed Lot Characteristics
    - Typical total lot area = 217,800 square feet (lot size of 5 acres)
    - Average house footprint = 4,000 square feet
    - Average area for driveways, patios, walkways = 2,500 square feet
    - Average area to remain in its existing condition = 210,100 square feet

  - Runoff Coefficients (Rational Method "C" coefficient) (Table 6-6, CSDCM)*(Appendix, Exhibit 4)* and TR55 Method "CN" Curve Numbers (Tables 2-2a- 2d) *(Appendix, Exhibit 5).* Typically, published design tables for use with the Rational Method and the NCRS Method do not provide runoff coefficients and curve numbers for 5-acre developments. It only provides values for 2.5 acres and smaller. As a result, the composite coefficients (Table 6-6) and curve number (Table 2-2a- 2d) for each developed lot were determined as follows:

- Average **roof** size= 4,000 square feet
  - % Impervious: 90%
  - Rational Method: Minor storm (5 year) runoff coefficient: 0.73
  - Rational Method: Major storm (100 year) runoff coefficient: 0.81
  - NCRS Curve Number = 98

- Average area for **driveways, patios, and walkways =** 2,500 squarefeet
  - % Impervious: 100% (This is a conservative assumption. It assumes a paved driveway as opposed to a typical gravel one.
  - Rational Method: Minor storm (5 year) runoff coefficient: 0.90
  - Rational Method: Major storm (100 year) runoff coefficient: 0.96
  - NCRS Curve Number= 98

- Average area for "grassed " **lawn =** 1,200 square feet
  - % Impervious: 0%
  - Rational Method: Minor storm (5 year) runoff coefficient: 0.08
  - Rational Method: Major storm (100 year) runoff coefficient: 0.35
  - NCRS Curve Number= 69 (fair condition)

- Average area in **existing condition** (Pasture/Meadow) = 210,100 square feet
  - Rational Method Impervious: 0%
  - Rational Method: Minor storm (5 year) runoff coefficient: 0.08
  - Rational Method: Major storm (100 year) runoff coefficient: 0.35
  - NCRS Curve Number= 69

    The value from Table 6-9 ARC I, instead of Table 6-10 ARC II, was used since the "undeveloped" area of the lot will not be disturbed and will remain "un-watered/ irrigated".

- Composite Runoff Coefficients and Curve Numbers for **developed conditions** *(Appendix , Exhibit 4 and 5)* Exhibit 4 in the Appendix includes the tables used for the Rational Method. Exhibit 5 in the Appendix includes the tables used for the NCRS method. Based on the above assumptions the following **composite runoff coefficients** were determined as follows:

- Developed Conditions: the following is for **developed** lots only and not for offsite areas.
  - % Impervious= 2.8%
  - Rational Method: Minor storm (5 year) runoff coefficient: 0.10 (developed conditions)
  - Rational Method: Major storm (100 year) runoff coefficient: 0.37(developed conditions)
  - **NCRS** Curve Number = 70

- Existing Conditions (for comparison purposes)
  - % Impervious = 0%
  - Rational Method: Minor storm (5 year) runoff coefficient: 0.08(existing conditions)
  - Rational Method: Major storm (100 year) runoff coefficient: 0.35 (existing conditions)
  - NCRS Curve Number = 69

- Time of Concentration
  - The time of concentration for each sub-basin remains the same.

o Rainfall Intensity
The rainfall intensity for each sub-basin remains the same since the timeof concentration remains the same.

o Estimated Runoff
Based on the above assumptions, runoff for the minor (5 year) and major (100 year) storms were estimated for each sub-basin

Sub-basin A (developed)
o Design point = 1

o Drainage Area= 10.7 acres

- Runoff Coefficients
  - % Impervious = 2.8
  - Rational Method: Minor storm (5 year): 0.10
  - Rational Method: Major Storm (100 year): 0.37
  - **NCRS** Curve #: 70

- Estimated Runoff
  - Rational Method: Minor storm (5 year): 2.7 cfs (see Appendix,Exhibit 4)
  - Rational Method: Major Storm (100 year): 16.8 cfs (see Appendix,Exhibit 4)
  - NCRS: 5 year = 6.5 cfs, 100 year = 23.1 cfs

- **Sub-basin B (developed)**
  - Design Point = 3

  - Drainage Area= 19.6 acres

  - Runoff Coefficients
    - % Impervious = 2.8
    - Rational Method: Minor storm (5 year): 0.10
    - Rational Method: Major Storm (100 year): 0.37
    - **NCRS** Curve #: 70

  - Estimated Runoff
    - Minor storm (5 year): 5.0 cfs
    - Major Storm (100 year): 31.1 cfs
    - NCRS: 5 year = 11.5 cfs, 100 year = 41.3 cfs

- **Sub-basin C (developed)**
  - Design Point = 6

  - Drainage Area= 5.3 acres

  - Runoff Coefficients
    - % Impervious= 2.8
    - Rational Method: Minor storm (5 year): 0.10
    - Rational Method: Major Storm (100 year): 0.37
    - **NCRS** Curve #: 70

  - Estimated Runoff
    - Rational Method: Minor storm (5 year): 1.5 cfs
    - Rational Method: Major Storm (100 year): 9.1 cfs
    - NCRS: 5 year = 3.8 cfs, 100 year = 13.2 cfs

- **Sub-basin 0S-3 and D (developed)**
  - Design Point = 4
  - Drainage Area = 13.6 acres
  - Runoff Coefficients
    % Impervious = 0.0
    Rational Method: Minor storm (5 year): .08
    Rational Method: Major Storm (100 year): 0.35
    NCRS Curve #: 69
  - Estimated Runoff
    Rational Method: Minor storm (5 year): 2.5 cfs
    Rational Method: Major Storm (100 year): 18.2 cfs
    NCRS: 5 year = 7.0 cfs, 100 year = 26.7 cfs

- **Sub-basin E (developed) (flows offsite at DP7)**
  - Design Point = 7
  - Drainage Area= 3.7 acres
  - Runoff Coefficients
    % Impervious= 2.8
    Rational Method: Minor storm (5 year): 0.10
    Rational Method: Major Storm (100 year): 0.37
    NCRS Curve #: 70
  - Estimated Runoff
    Rational Method: Minor storm (5 year):1.0 cfs
    Major Storm (100 year): 6.4 cfs
    NCRS: 5 year = 2.1 cfs, 100 year = 7.6 cfs

- **Combine Offsite and Onsite Sub-basins (developed) at design Point 6 (NCRS Method)** ***(Appendix, Exhibit 5)***
  All runoff from the sub-basins described above (sub basins OS-1, OS-2, OS-3, A, B, C & D) ultimately leaves the site at Design Point 6 which is located at the southeast corner of the site.
  - Design Point = 6
  - Drainage Area= 292.6 acres
  - Runoff Coefficients
    % Impervious = 2.1
    Rational Method: Minor storm (5 year): Not Applicable
    Rational Method: Major Storm (100 year): Not Applicable
    NCRS Curve #: 70 (+-)

- Estimated Runoff (Developed)
  Rational Method: Minor storm (5 year): Not Applicable
  Rational Method: Major Storm (100 year): Not Applicable
  NCRS: 5 year = 86.9 cfs
  NCRS: 100 year = 360.4 cfs

- Estimated Runoff (Historic)
  Rational Method: Minor storm (5 year): Not Applicable
  Rational Method: Major Storm (100 year): Not Applicable
  NCRS: 5 year = 86.2 cfs
  NCRS: 100 year = 358.5 cfs

- Conclusions
  The increase in runoff is negligible for both the minor and major stormevents as a result of development.

XII. PROPOSED IMPROVEMENTS

Culvert Improvements

The existing culvert (24" CMP) was evaluated in Section X of this report. It was determined that the existing 24" culvert had a capacity to pass 20.5 cfs based on a headwater to depth ratio of 1.5. This is substantially less than the discharge for the 5-year storm event which is 69.6 cfs. This was determined based on the assumptions described in Report Section X.

It is recommended to replace the existing culvert at the time of future Brown Road improvements. The recommended culvert described below was sized only for the 5-year storm since data regarding the existing and/or proposed roadway at the culvert crossing was not available. The final design of the culvert will require field data to obtain inverts, roadway cross section, and inlet and outlet topography. The design and construction of this culvert is not part of this subdivision's improvements since the stormwater runoff from the subdivision does not impact this culvert.

The following recommendation is based on the size culvert required to pass the 5-year flow with a limiting headwater to depth ratio of 1.5 *(Appendix, Exhibit 6);*

- **Criteria**

  Minor storm (5 yr.): Headwater to Depth ratio= 1.5 limit with no roadway overtopping.
  Major Storm (100 yr.): not used in the following concept design.

- **Recommended culvert**
  - Size: 42" RCP Culvert
  - Headwater to depth ratio: 1.5
  - Culvert Capacity = 80 cfs
  - % slope = 1.0 %

- Headwater to depth = 1.5
- Culvert Velocity= 7.8 fps
- Culvert Depth of Flow= 2.2
- End treatments: Flared end sections
- Riprap protection at the outfall: 12" D50, 30 feet long by 12 feetwide
- Concrete low water crossing

Brown Road Borrow Ditches *(Appendix, Exhibit* 8)

- **Contributing Runoff from Sub basin areas for the Brown Road Borrow Ditches**
  Only the east half of Brown Road right of way located within sub basin A and the south half of Brown Road right-of-way located within sub basins B and E contributes flow into the borrow ditch of Brown Road. No runoff from the proposed lot areas of the onsite sub basins is collected by the borrow ditches along Brown Road. The drainage characteristics of the Brown Road borrow ditches (sub basins B1 and B2) are summarized below.

- **Brown Road Borrow Ditch along West Property Line**
  - Drainage Area: BR1, 0.9 acres
  - Slope: 5.1%
  - Discharge (at DP6): 5 yr. = 1.8 cfs 100 yr. = 3.6 cfs
  - Side Slope: 3 to 1
  - Manning's Coefficient: 0.035
  - Flow Depth: 5 yr. = 0.2 ft. 100 yr. = 0.3 ft.
  - Velocity: 5 yr. = 3.0 fps 100 yr. = 3.7 fps
  - Froude Number: 5 yr. = 1.24 (supercritical) 100 yr. =1.3 (supercritical)
  - Recommended Improvements: The existing ditches along Brown Road appear to be well vegetated, but with certain areas having eroded in the past. Stone Check Dams with average spacing of 50' intervals where the longitudinal roadway slope exceeds 4%, should be installed on the east side of Brown Road along the subdivision frontage. Additional Stone Check Dams should be constructed on both sides of Brown Road with the future ultimate improvements.

- **Brown Road Borrow Ditch along North Property Line**
  - Drainage Area: BR2, 0.9 acres
  - Slope: 2.9%
  - Discharge (at DP6): 5 yr. = 1.6 cfs 100 yr. = 3.2 cfs
  - Side Slope: 3 to 1
  - Manning's Coefficient: 0.035
  - Flow Depth: 5 yr. = 0.3 ft. 100 yr. = 0.4 ft.
  - Velocity: 5 yr. = 2.3 fps 100 yr. = 2.9 fps

- Froude Number: 5 yr. = 0.93 (subcritical), 100 yr. = 1.0 (Boundary flow)

Recommended Improvements: The existing ditches along Brown Road appear to be well vegetated and without significant past erosion. The cul-de-sac and roadside ditch will be graded and improved near the northeast corner of the site. The installation of a Stone Check Dam at the roadside ditch outfall at the eastern boundary is recommended.

Onsite Swales *(Appendix, Exhibit* 8)

There is a total of four (4) grass lined swales that cross the site in basically in a north to south direction. Runoff from these swales is collected by swale 1 which traverses the site in a west to east direction. The onsite swales are characterized by heavy native grasses (Manning Coefficient of 0.12), varying slopes (the average slopes are shown on the drainage map), wide bottom widths (average of 30 feet), and shallow side slopes (average of 0.1 ft to 1). The hydraulic characteristics of each swale are summarized in the chart entitled “Borrow Ditches and Onsite Swales” included in Exhibit 7 in the Appendix.

XIII. DETENTION AND WATER QUALITY

Criteria

El Paso County Engineering Criteria Manual, Appendix I, contains the policies and procedures for Stormwater Quality. Section I.7.1.B provides for exclusions to the requirements to provide Post Construction Stormwater Quality facilities. All areas of the Prairie Ridge project qualify for the allowed exemptions. No water quality or detention facilities are required for this site as discussed below.

The project consists of large (5-acre) single-family residential lots and dedication of right-of-way for existing Brown Road. There are no activities or improvements that require permanent water quality facilities for this project based on the exclusions found in Section I.7.1.5.B.2, Section I.7.1.5.B.3 and Section I.7.1.5.B.5.

According to Section I.7.1.B.5, “A single-family residential lot, or agricultural zoned lands, greater than or equal to 2.5 acres in size per dwelling and having a total lot impervious area of less than 10 percent” is excluded. The total area of the site is 39.77 acres. Of the total, 39.57 acres are comprised of 5-acre single-family residential lots and the remaining 0.20 acres is right-of-way dedication for existing Brown Road. The total lot imperviousness for 5-acre rural residential lots is less than 10%. The areas of the residential lots are excluded.

Section I.7.1.B.2 of the ECM provides exclusion for Roadway Redevelopment as follows: “Redevelopment sites for existing roadways, when 1 of the following criteria is met: 1) The site adds less than 1 acre of paved area per mile of roadway to an existing roadway, or 2) The site does not add more than 8.25 feet of paved width at any location to the existing roadway”. The project involves adding new gravel surface to the existing Brown Road roadway to bring the gravel thickness up to the required thickness in the isolated locations along the roadway that have been found to be deficient. No pavement will be added to the roadway (criteria 1). The total area of disturbance for adding the new gravel is 0.74 acres (criteria 1). The roadway width will not be expanded with this project (criteria 2). The areas of Roadway Redevelopment are excluded.

Also, Section I.7.1.B.3 excludes Existing Roadway Areas. "For redevelopment sites for existing roadways, only the area of the existing roadway is excluded from the requirements of an applicable development site when the site does not increase the width by 2 times or more, on average, of the original roadway area. The entire site is not excluded from being considered an applicable development site for this exclusion. The area of the site that is part of the added new roadway area is still an applicable development site.". Again, the project will add new gravel surface to some of Brown Road up to 0.74 acres in area. No new width or pavement surface is proposed. The areas of the Existing Roadway are excluded.

Storm Detention is not required for this site since the resulting flow increases from development of the site into 5-acre rural residential homesites is found to negligible and inconsequential as noted below:

Hydrologic for Existing and Developed Conditions (see Report Section XI) including all onsite and offsite sub basins OS-1, OS-2, OS-3, A, B, C, D & E.

- **Estimated Runoff (Historic)**
  - Rational Method: Minor storm (5 year): Not Applicable
  - Rational Method: Major Storm (100 year): Not Applicable
  - NCRS: 5 year = 87.0 cfs
  - NCRS: 100 year = 363.1 cfs

- **Estimated Runoff (Developed)**
  - Rational Method: Minor storm (5 year): Not Applicable
  - Rational Method: Major Storm (100 year): Not Applicable
  - NCRS: 5 year = 87.7 cfs
  - NCRS: 100 year = 365.3 cfs

XIV FOUR STEP PROCESS

The El Paso County Engineering Criteria Manual (Appendix I, Section I.7.2) recommends the consideration of a “Four Step Process for receiving water protection that focuses on reducing runoff volumes, treating the water quality capture volume (WQCV), stabilizing drainageways, and implementing long term source controls”. It is determined in the section above that this project is exempt from the requirements of Section I.7.1 to provide Post Construction Stormwater Management Facilities with Water Quality Capture Volume (WQCV). However, aspects of the Four Step Process are considered and implemented in the Prairie Ridge Project as discussed below.

Step 1: Reduce runoff by disconnecting impervious area, eliminating "unnecessary" impervious area and encouraging infiltration into soils that are suitable.

The impervious areas for the project include roofs, concrete patios and sidewalks, and the possibility of asphalt driveways. All runoff from the impervious areas drains onto open grassed surfaces. All downspouts for each residence are planned to discharge either within landscaped areas or natural areas. The majority of the site will remain in its existing natural condition.

Step 2: Treat and slowly release the WQCV.

This project meets the exemptions or providing Post Construction Stormwater Management Facilities including facilities with Water Quality Capture Volume (WQCV) such as a Full Spectrum Detention Pond and therefore does not have the slow release WQCV component.

Step 3: Stabilize stream channels.

All existing swales will remain covered with the existing natural grasses. All of the onsite swales are “U” shaped with wide bottoms widths and flat side slopes. The hydraulic analysis of these swales demonstrate that the estimated flows are subcritical which are characterized by stable flow and low velocities. Based on visual observations the swales are very stable with only negligible indications of erosion. The vegetation for each swale includes medium height prairie grasses that are periodically mowed. It is not anticipated that any of the swales will be modified in the future. It can be safely assumed that the negligible increase in flow as a result of development will have minimal negative impacts on the existing onsite swales.

Step 4: Implement source controls.

The rural residential site is not anticipated to contain storage of potentially harmful substances or use of potentially harmful substances. No Site Specific or Other Source Control BMP's are required.

XV. EROSION CONTROL

The following erosion control measures are recommended. Exhibits for all of the erosion control facilities recommended below.

- Stone check dams (by others) in the roadside swales under supercritical conditions
- Riprap outlet aprons (by others) at locations where the storm sewer exitvelocity is great enough to cause excessive erosion.
- Silt fences are recommended along the lower edge of grading activity.

XVI. DRAINAGE FEES

The site is located in the East Cherry Drainage basin for which there are no drainage fees.

XVII. SUMMARY

This report provides a thorough analysis of the historic and developed drainage conditions for the proposed Prairie Ridge Subdivision. The property is comprised of 40.7 +/- acres and is located on the south and east sides of Brown Road approximately 0.5 miles north of the intersection of Brown Road and Walker Road. The subdivision is to be subdivided into seven (7) consisting of areas 5-acres or greater.

The vegetation consists of primarily prairie grass with no trees. There is a main natural drainage way that is located along the southerly side of the boundary. It has been demonstrated that there is only a negligible increase in runoff as a result of development. Also, based on the present engineering criteria for El PasoCounty a water quality/ detention pond is not required.

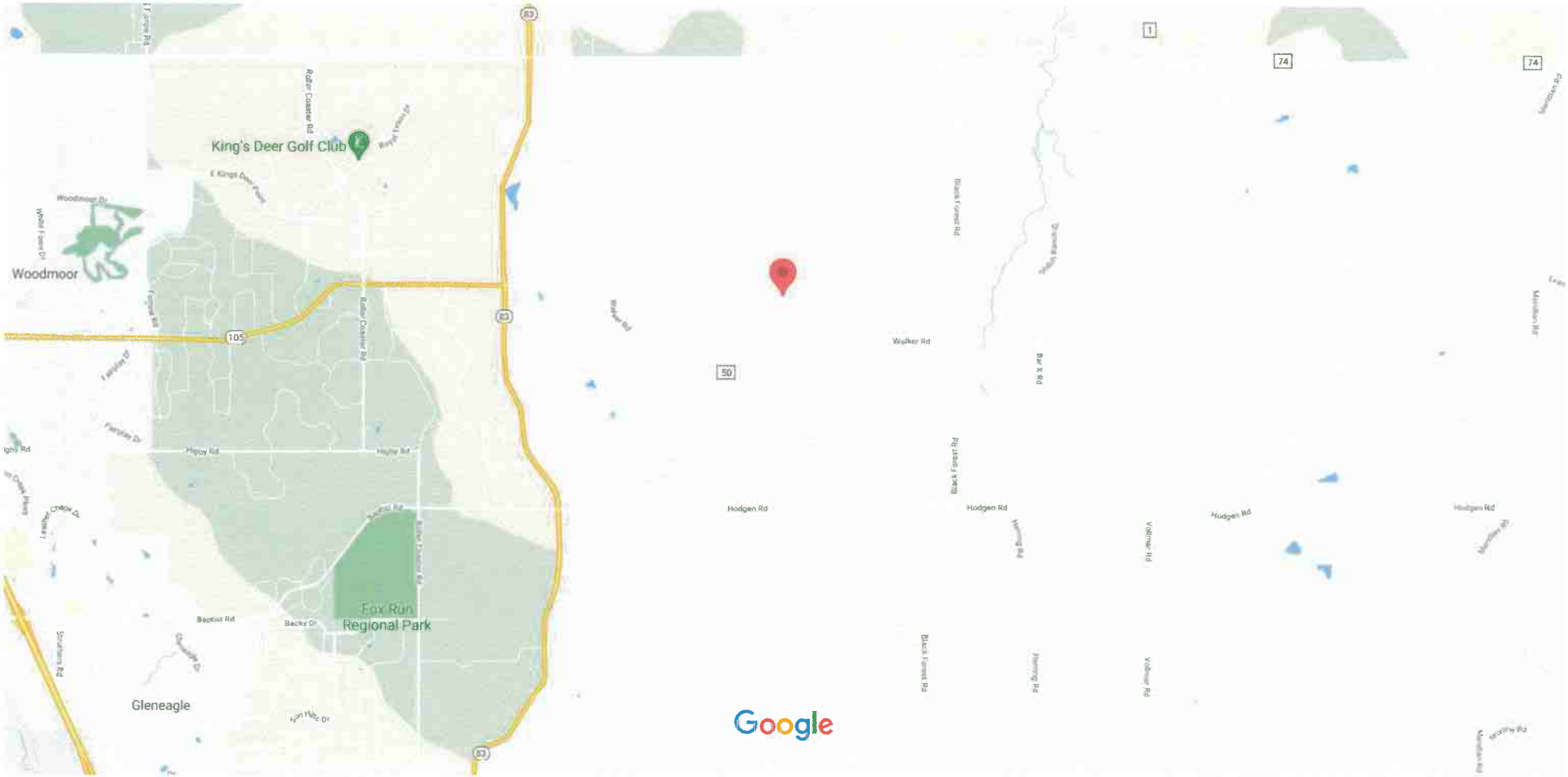
Erosion control facilities include staked hay bales, erosion control check dams,and stone check dams. A small portion of these facilities are to be installed with this project while the majority of them are to be installed when Brown Road is constructed to its ultimate section. The location and details for these are included on the Storm Water Management Plan. Included in the map pocket are drainage maps for the Historic Drainage Conditions and the Developed Drainage Conditions. No storm water structures are proposed for this subdivision.

Although storm detention is not provided, the large lot rural residential single-family development will have negligible and inconsequential increases in storm runoff flows with no effects on the existing site drainage and drainage conditions downstream. The proposed project will not, with respect to stormwater runoff or water quality, negatively impact the adjacent properties and downstream properties.

APPENDIX

Exhibit 1
General Location Map

Google Maps Brown Rd



Map data ©2021 1 mi

Exhibit 2
FEMA FIRM Map

FEMA
(//www.fema.gov/)

FEMA Flood Map Service Center: Search By Address

Navigation

Search

Languages

MSC Home (/portal/)

MSC Search by Address (/portal/search)

MSC Search All Products (/portal/advanceSearch)

MSC Products and Tools (/portal/resources/productsandtoc

Hazus (/portal/resources/hazus)

LOMC Batch Files (/portal/resources/lomc)

Product Availability (/portal/productAvailability)

MSC Frequently Asked Questions (FAQs) (/portal/resources/faq)

Enter an address, place, or coordinates:

El Paso County Colorado

Search

Whether you are in a high risk zone or not, you may need flood insurance (https://www.fema.gov/national-flood-insurance-program) because most homeowners insurance doesn't cover flood damage. If you live in an area with low or moderate flood risk, you are 5 times more likely to experience flood than a fire in your home over the next 30 years. For many, a National Flood Insurance Program's flood insurance policy could cost less than $400 per year. Call your insurance agent today and protect what you've built.

Learn more about steps you can take (https://www.fema.gov/what-mitigation) to reduce flood risk damage.

MSC Email Subscriptions (/portal/subscriptionHome)

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(https://www.oig.dhs.gov/hotline)

Official website of the Department of Homeland Security

Exhibit 3
SCS Soils Map and Data

United States Department of Agriculture

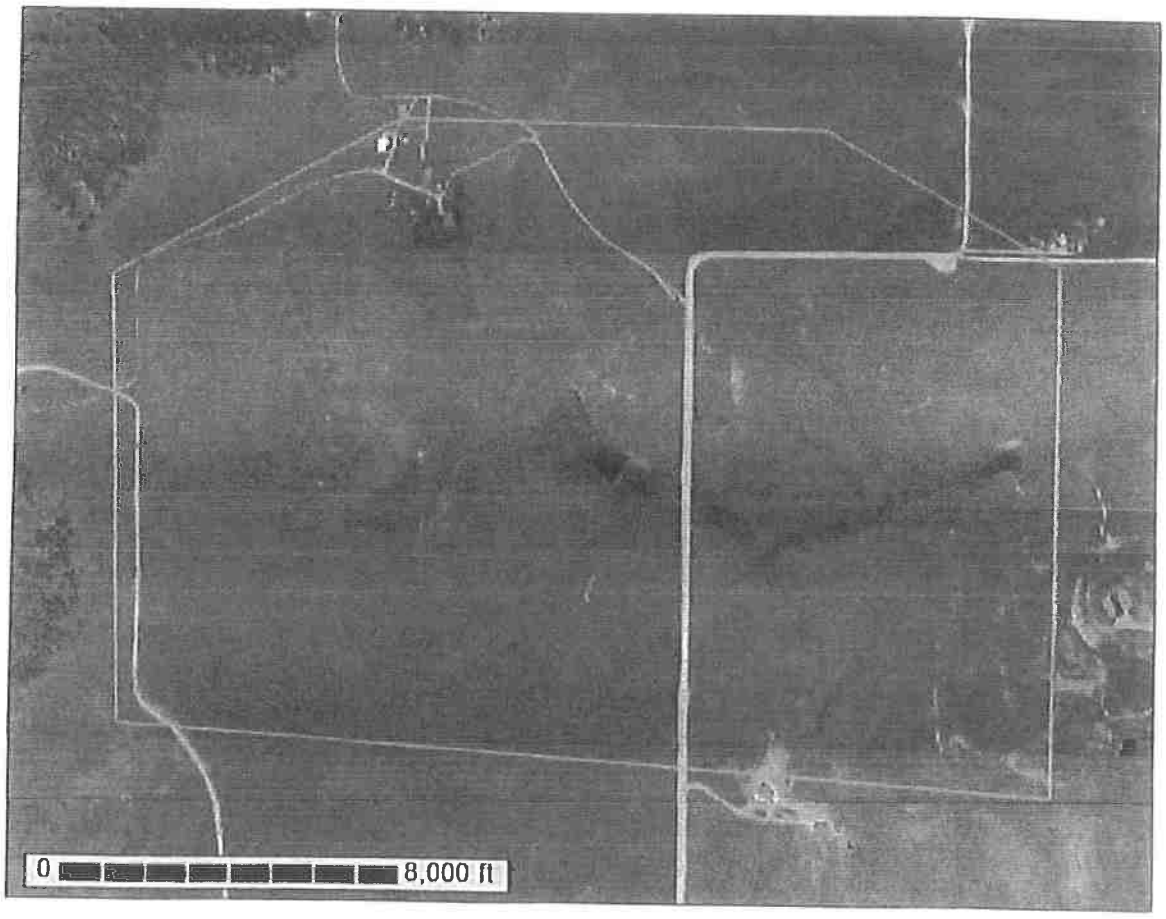
NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for El Paso County Area, Colorado

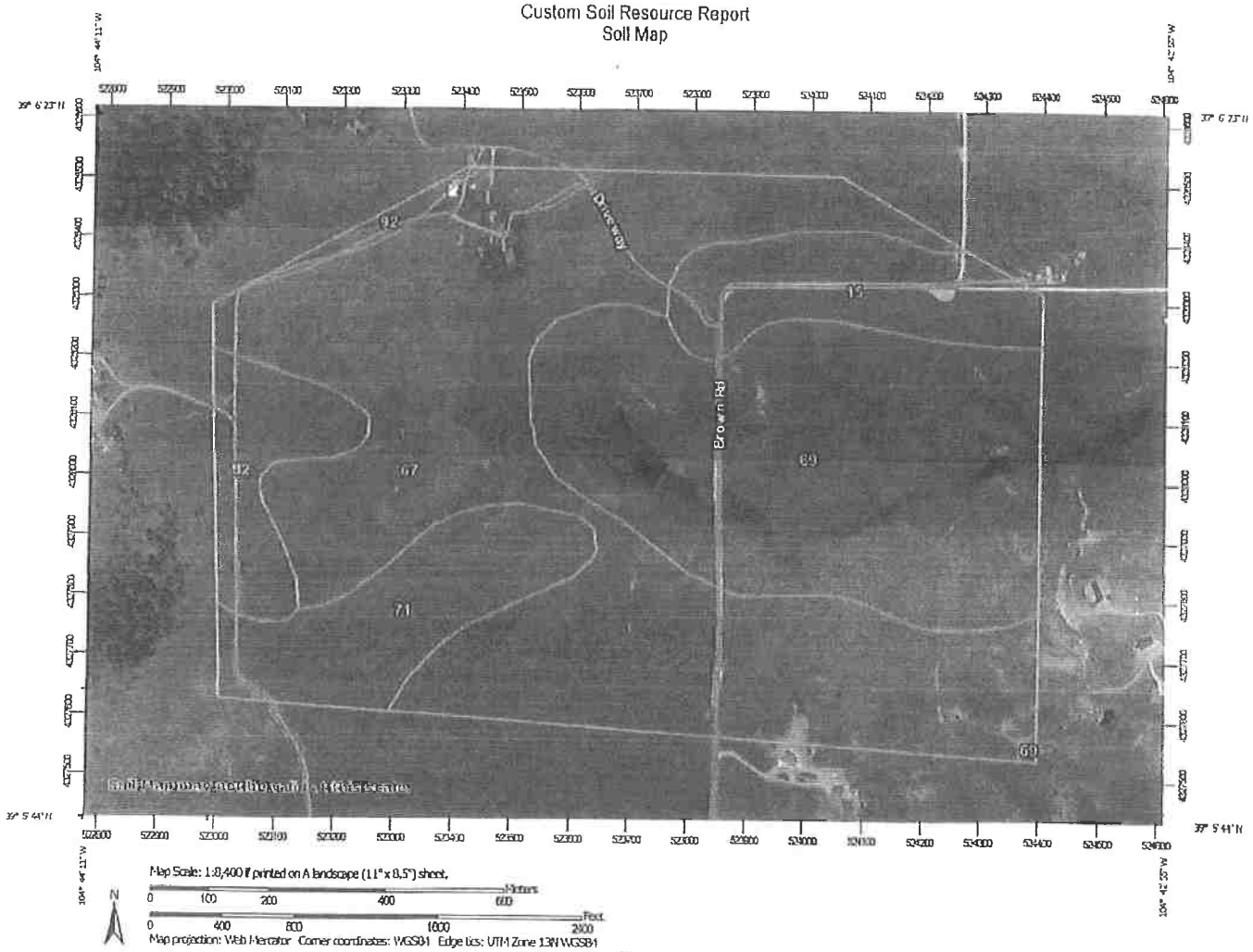
Prairie Ridge Subdivision



March 25, 2019

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.


Driveway
Brown Rd
92
67
71
69
Map Scale: 1:8,400 if printed on A landscape (11" x 8.5") sheet.
Meters
0 100 200 400 600
Feet
0 400 800 1600 2400
Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres In AOI	Percent of AOI
15	Brussett loam, 3 to 5 percent slopes	23.9	7.8%
67	Peyton sandy loam, 5 to 9 percent slopes	147.0	47.9%
69	Peyton-Pring complex, 8 to 15 percent slopes	90.5	29.5%
71	Pring coarse sandy loam, 3 to 8 percent slopes	26.8	8.7%
92	Tomah-Crowfoot loamy sands, 3 to 8 percent slopes	18.4	6.0%
Totals for Area of Interest		306.6	100.0%

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases.* Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas.* Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

El Paso County Area, Colorado

15—Brussett loam, 3 to 5 percent slopes

Map Unit Setting

National map unit symbol: 367k
Elevation: 7,200 to 7,500 feet
Frost-free period: 115 to 125 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Brussett and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Brussett

Setting

Landform: Hills
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Eolian deposits

Typical profile

A - 0 to 8 inches: loam
BA - 8 to 12 inches: loam
Bt - 12 to 26 inches: clay loam
Bk - 26 to 60 inches: silt loam

Properties and qualities

Slope: 3 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 5 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: High (about 9.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Ecological site: Loamy Park (R048AY222CO)
Hydric soil rating: No

Minor Components

Other soils

Percent of map unit:
Hydric soil rating: No

67—Peyton sandy loam, 5 to 9 percent slopes

Map Unit Setting

National map unit symbol: 369d
Elevation: 6,800 to 7,600 feet
Mean annual air temperature: 43 to 45 degrees F
Frost-free period: 115 to 125 days
Farmland classification: Not prime farmland

Map Unit Composition

Peyton and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Peyton

Setting

Landform: Hills
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Arkosic alluvium derived from sedimentary rock and/or arkosic residuum weathered from sedimentary rock

Typical profile

A - 0 to 12 inches: sandy loam
Bt - 12 to 25 inches: sandy clay loam
BC - 25 to 35 inches: sandy loam
C - 35 to 60 inches: sandy loam

Properties and qualities

Slope: 5 to 9 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 7.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Ecological site: Sandy Divide (R049BY216CO)
Hydric soil rating: No

Minor Components

Other soils

Percent of map unit:
Hydric soil rating: No

Pleasant

Percent of map unit:
Landform: Depressions
Hydric soil rating: Yes

69—Peyton-Pring complex, 8 to 15 percent slopes

Map Unit Setting

National map unit symbol: 369g
Elevation: 6,800 to 7,600 feet
Farmland classification: Not prime farmland

Map Unit Composition

Peyton and similar soils: 40 percent
Pring and similar soils: 30 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Peyton

Setting

Landform: Hills
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Arkosic alluvium derived from sedimentary rock and/or arkosic residuum weathered from sedimentary rock

Typical profile

A - 0 to 12 inches: sandy loam
Bt - 12 to 25 inches: sandy clay loam
BC - 25 to 35 inches: sandy clay loam
C - 35 to 60 inches: sandy loam

Properties and qualities

Slope: 8 to 9 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 7.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Ecological site: Sandy Divide (R049BY216CO)
Hydric soil rating: No

Description of Pring

Setting

Landform: Hills
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Arkosic alluvium derived from sedimentary rock

Typical profile

A - 0 to 14 inches: coarse sandy loam
C - 14 to 60 inches: gravelly sandy loam

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 6.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: B
Ecological site: Loamy Park (R049BY222CO)
Hydric soil rating: No

Minor Components

Other soils

Percent of map unit:
Hydric soil rating: No

Pleasant

Percent of map unit:
Landform: Depressions
Hydric soil rating: Yes

Exhibit 4
Rational Method Exhibits

Stormwater Runoff per Sub basin

Historic Conditions

June 2021

Sub Basib I.D.	Area (acres)	Time of Concentration (min)	C5/ Curve Number	C100/ Curve Number	5 year (cfs)	100 year (cfs)	Comments
OS-1	211.6	33.4	Curve #: 69	Curve #: 69	69.6	279.5	TR55 method
OS-2	31.8	26.9	0.08	0.35	6.4	46.9	Rational Method
OS3	12.1	17.9	0.08	0.35	3.0	22.2	
OS-3 and D	13.6	31.7	0.08	0.35	2.5	18.2	Rational Method
A	10.7	26.9	0.08	0.35	2.2	15.8	Rational Method
B	19.6	26.3	0.08	0.35	4.0	29.3	Rational Method
C	5.3	21.8	0.08	0.35	1.2	8.6	Rational Method
E	3.7	225	0.08	0.35	0.8	6.0	Rational Method
BR1	0.9	15.2	0.59	0.7	1.8	3.6	Rational Method
BR2	0.9	19.5	0.59	0.7	1.6	3.2	Rational Method

Stormwater Runoff per Sub basin

Developed Conditions

June 2021

Sub Basib I.D.	Area (acres)	Time of Concentration (min)	C5/ Curve Number	C100/ Curve Number	5 year (cfs)	100 year (cfs)	Comments
OS-1	211.6	33.4	Curve #: 69	Curve #: 69	69.6	279.5	TR55 method
OS-2	31.8	26.9	0.08	0.35	6.4	46.9	Rational Method
OS-3 and D	13.6	31.6	0.08	0.35	2.5	18.2	Rational Method
A	10.7	26.7	0.10	0.37	2.7	16.8	Rational Method
B	19.6	25.1	0.10	0.37	5.0	31.1	Rational Method
C	5.3	21.6	0.10	0.37	1.5	9.1	Rational Method
E	3.7	21	0.10	0.37	1.0	6.4	Rational Method
BR1	0.9	15.2	0.59	0.7	1.8	3.6	Rational Method
BR2	0.9	19.3	0.59	0.7	1.6	3.2	Rational Method

Individual Sub basin and Cumulative Runoff at Design Points

Historic Conditions

June, 2021

Design Point	Contributing Sub Basins					Runoff Method	Rational Method Runoff Coefficient		TR55 Curve Numbers		Runoff	
	Sub Basins	individual Sub Basin Area (Acres)	Individual Sub Basin Time of Concentration (min)	Cumulative Contributing Area (Acres)	Receiving Stream Reach		C 5	C 100	RCN 5	RCN 100	5 year (cfs)	100 year (cfs)
1	OS1	211.6	33.4	211.6	1	TR55			69	69	69.6	279.5
2	A	10.7	26.9	NA	1	Rational	0.08	0.35	69	69	2.2	15.8
2 cumulative	**OS1, A**	**NA**	**NA**	**222.3**	**1**	**TR55**					72.2	289.3
3	OS2	31.8	26.9	NA	2	Rational	0.08	0.35	69	69	6.4	46.9
3 Cumulative	**OS1, A, OS2**	**NA**	**NA**	**254.1**	**2**	**TR55**					78.7	318.5
4	B	19.6	26.3	NA	3	Rational	0.08	0.35	69	69	4.0	29.3
4 Cummulative	OS1,A,OS2,B			273.7	3	**TR55**					82.7	339.4
5	OS3	12.1	17.9	NA	NA	Rational	0.08	0.35	69	69	3.0	22.2
6	OS3, D	13.6	31.7	NA	4	Rational	0.08	0.35	69	69	2.5	18.2
6	C	5.3	22.8	NA	4	Rational	0.08	0.35	69	69	1.2	8.6
6 cumulative	**OS1, A, OS2, B, OS3, D, C**	**NA**	**NA**	**292.6**	**4**	**TR55**					86.2	358.5
7	E	3.7	22.5	NA	Outfall	Rational	0.08	0.35	69	69	0.8	6.0
Outlet cumulative	**OS1, A, OS2, B, OS3, D, C, E**	**NA**	**NA**	**296.3**	**Outfall**	**TR55**					87.0	363.1
BR1	BR1	0.9	21.4	NA	NA	Rational	0.59	0.7			1.8	3.6
BR2	BR2	0.9	19.5	NA	NA	Rational	0.59	0.7			1.6	3.2

Notes:

1. Average Runoff Coefficients for the Rational method and average Curve Numbers for the TR55 method were not determined for the cummulative flows listed above

2. Both the Runoff Coefficients for the Rational Method and the Curve Numbers for the TR55 Method are shown since both were used in determining the runoff for individual sub basins (Rational Method) and for the determining cumulative flows (TR55)

Individual Sub basin and Cumulative Runoff at Design Points

Developed Conditions

June, 2021

Design Point	Contributing Sub Basins					Runoff Method	Rational Runoff Coef		TR55 Curve No.		Runoff	
	Sub Basins	individual Sub Basin Area (Acres)	Individual Sub Basin Time of Concentration (min)	Cumulative Contributing Area (Acres)	Receiving Stream Reach		C5	C100	RCN 5	RCN 100	5 year (cfs)	100 year (cfs)
1	**OS1**	**211.6**	**33.4**	**211.6**	**1**	**TR55**			**69**	**69**	**69.6**	**279.5**
2	A	10.7	26.9	NA	1	Rational	0.1	0.37	70	70	2.7	16.8
2 cumulative	**OS1, A**			**222.3**	**1**	**TR55**					**72.4**	**289.7**
3	OS2	31.8	26.9	NA	2	Rational	0.08	0.35	69	69	6.4	46.9
3 Cumulative	**OS1, A, OS2**			**254.1**	**2**	**TR55**					**79.0**	**319.1**
4	B	19.6	26.3	NA	3	Rational	0.1	0.37	70	70	5.0	31.1
4 Cummulative	OS1,A,OS2,B			273.7	3	**TR55**					83.3	341.0
5	OS3	12.1	17.9	NA	NA	Rational	0.08	0.35	69	69	3.0	22.2
6	OS3, D	13.6	31.7	NA	4	Rational	0.08	0.35	69	69	2.5	18.2
6	C	5.3	22.8	NA	Outfall	Rational	0.1	0.37	70	70	1.5	9.1
6 cumulative	OS1, A, OS2, B, OS3, D, C			292.6	4	TR55					86.9	360.4
7	E	3.7	22.5	NA	Outfall	Rational	0.1	0.37	70	70	1.0	**6.4**
Development Cumulative	**OS1, A, OS2, B, OS3, D, C, E**	**NA**	**NA**	**296.3**	**Outfall**	**TR55**					**87.7**	**365.3**

Notes:

1. Average Runoff Coefficients for the Rational method and average Curve Numbers for the TR55 method were not determined for the cummulative flows listed above

2. Both the Runoff Coefficients for the Rational Method and the Curve Numbers for the TR55 Method are shown since both were used in determining the runoff for individual sub basins (Rational Method) and for the determining cumulative flows (TR55)

June 2021
Revised PBD

Historic

Calculation of Peak Runoff

Designer: Ken Harrison
Company: KCH Engineering Solutions
Date: 6/11/2021
Project: Prairie Ridge Historic Conditions
Location: El Paso County

Version 2.00 released May 2017

Cells of this color are for required user-input
Cells of this color are for optional override values
Cells of this color are for calculated results based on overrides

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L_i}}{S_i^{0.33}}$$

$$t_t = \frac{L_t}{60K\sqrt{S_t}} = \frac{L_t}{60V_t}$$

Computed $t_c = t_i + t_t$

Regional $t_c = (26 - 17i) + \frac{L_t}{60(14i + 9)\sqrt{S_t}}$

$t_{minimum} = 5$
$t_{minimum} = 10$

Selected $t_c \approx$

Subcatchment Name	Area (ac)	NRCS Hydrologic Soil Group	Percent Imperviousness	Runoff Coefficient, C							Overland (Initial) Flow Time					Channel		
				2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr	Overland Flow Length L_i (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Overland Flow Slope S_i (ft/ft)	Overland Flow Time t_i (min)	Channelized Flow Length L_t (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)
OS2	31.80	B	0.0	0.00	0.00	0.06	0.25	0.33	0.43	0.54	100.00	7540.00	7500.00	0.050	11.68	1700.00	7500.00	7420.00
				0.02	0.08	0.15	0.25	0.30	0.35						10.83			
A	10.70	B	0.0	0.00	0.00	0.06	0.25	0.33	0.43	0.54	100.00	7510.00	7490.00	0.033	13.39	1500.00	7490.00	7430.00
				0.02	0.08	0.15	0.25	0.30	0.35						12.42			
B	19.60	B	0.0	0.00	0.00	0.06	0.25	0.33	0.43	0.54	100.00	7510.00	7490.00	0.033	13.39	1500.00	7490.00	7430.00
				0.02	0.08	0.15	0.25	0.30	0.35						12.42			
C	5.30	B	0.0	0.00	0.00	0.06	0.25	0.33	0.43	0.54	100.00	7490.00	7480.00	0.033	13.39	1100.00	7480.00	7410.00
				0.02	0.08	0.15	0.25	0.30	0.35						12.42			
OS3 and D	13.60	B	0.0	0.00	0.00	0.06	0.25	0.33	0.43	0.54	100.00	7510.00	7490.00	0.064	10.76	1600.00	7490.00	7410.00
				0.02	0.08	0.15	0.25	0.30	0.35						9.98			
E	3.70	B	0.0	0.00	0.00	0.06	0.25	0.33	0.43	0.54	100.00	7490.00	7480.00	0.017	16.67	700.00	7480.00	7460.00
				0.02	0.08	0.15	0.25	0.30	0.35						15.46			
OS3	12.10	B	0.0	0.00	0.00	0.06	0.25	0.33	0.43	0.54	100.00	7510.00	7500.00	0.100	9.29	922.00	7500.00	7440.00
				0.02	0.08	0.15	0.25	0.30	0.35						8.61			
BR1	0.90	B	60.0	0.46	0.49	0.54	0.63	0.66	0.71	0.76	10.00	7520.00	7518.00	0.200	1.29	1326.00	7518.00	7450.00
				0.57	0.59	0.63	0.66	0.68	0.70						1.08			
BR2	0.90	B	60.0	0.46	0.49	0.54	0.63	0.66	0.71	0.76	10.00	7520.00	7518.00	0.200	1.29	1307.00	7518.00	7480.00
				0.57	0.59	0.63	0.66	0.68	0.70						1.08			

June 2021
Revised

Historic

ff using Rational Method

(urban)
0 (non-urban)

Select UDFCD location for NOAA Atlas 14 Rainfall Depths from the pulldown list OR enter your own depths obtained from the NOAA website (click this link)

	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
1-hour rainfall depth, P1 (in) =	1.19	1.50	1.75	2.00	2.25	2.52	

	a	b	c
Rainfall Intensity Equation Coefficients =	28.50	10.00	0.786

$$I(in/hr) = \frac{a * P_1}{(b + t_c)^c}$$

$$\max\{t_{minimum}, \min(\text{Computed } t_c, \text{Regional } t_c)\}$$

$$Q(cfs) = CIA$$

ized (Travel) Flow Time				Time of Concentration			Rainfall Intensity, I (in/hr)							Peak Flow, Q (cfs)						
Channelized Flow Slope S_t (ft/ft)	NRCS Conveyance Factor K	Channelized Flow Velocity V_t (ft/sec)	Channelized Flow Time t_t (min)	Computed t_c (min)	Regional t_c (min)	Selected t_c (min)	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
0.071	7	1.87	15.19	26.87	37.81	26.87	1.99	2.51	2.93	3.35	3.76	4.22		0.00	0.00	5.31	26.49	39.26	57.11	
				26.02										1.27	6.38	13.96	26.60	35.91	46.92	
0.070	7	1.85	13.50	26.89	36.50	26.89	1.99	2.51	2.93	3.34	3.76	4.21		0.00	0.00	1.78	8.91	13.20	19.21	
				25.92										0.43	2.15	4.70	8.95	12.08	15.78	
0.077	7	1.94	12.87	26.26	36.01	26.26	2.02	2.54	2.97	3.39	3.81	4.27		0.00	0.00	3.31	16.54	24.51	35.66	
				25.29										0.79	3.99	8.72	16.61	22.42	29.30	
0.078	7	1.95	9.38	22.77	33.29	22.77	2.18	2.75	3.21	3.67	4.13	4.62		0.00	0.00	0.97	4.84	7.18	10.44	
				21.80										0.23	1.17	2.55	4.86	6.57	8.58	
0.033	7	1.27	20.97	31.73	42.31	31.73	1.81	2.28	2.66	3.04	3.41	3.82		0.00	0.00	2.06	10.28	15.23	22.16	
				30.95										0.49	2.48	5.42	10.32	13.93	18.20	
0.082	7	2.00	5.82	22.49	30.53	22.49	2.20	2.77	3.23	3.70	4.16	4.66		0.00	0.00	0.68	3.40	5.05	7.34	
				21.28										0.16	0.82	1.79	3.42	4.61	6.03	
0.065	7	1.79	8.61	17.89	32.69	17.89	2.48	3.12	3.65	4.17	4.69	5.25		0.00	0.00	2.51	12.55	18.60	27.06	
				17.22										0.60	3.02	6.62	12.60	17.01	22.23	
0.051	7	1.59	13.94	15.23	21.41	15.23	2.68	3.38	3.94	4.51	5.07	5.68		1.11	1.50	1.92	2.54	3.02	3.60	
				15.03										1.38	1.80	2.24	2.68	3.10	3.58	
0.029	7	1.19	18.25	19.54	23.14	19.54	2.37	2.99	3.48	3.98	4.48	5.02		0.98	1.32	1.70	2.24	2.67	3.18	
				19.33										1.22	1.59	1.98	2.37	2.74	3.16	

June 2021
Revised

Developed

Calculation of Peak Runof

Designer: Ken Harrison
Company: KCH Engineering Solutions
Date: 6/11/2021
Project: Prairie Ridge Developed Conditions
Location: El Paso County

Version 2.00 released May 2017

Cells of this color are for required user-input
Cells of this color are for optional override values
Cells of this color are for calculated results based on overrides

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L_i}}{S_i^{0.33}}$$

$$t_t = \frac{L_t}{60K\sqrt{S_t}} = \frac{L_t}{60V_t}$$

Computed $t_c = t_i + t_t$

Regional $t_c = (26 - 17i) + \frac{L_t}{60(14i + 9)\sqrt{S_t}}$

$t_{minimum} = 5$
$t_{minimum} = 1$

Selected $t_c =$

Subcatchment Name	Area (ac)	NRCS Hydrologic Soil Group	Percent Imperviousness	Runoff Coefficient, C							Overland (Initial) Flow Time					Channel		
				2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr	Overland Flow Length L_i (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Overland Flow Slope S_i (ft/ft)	Overland Flow Time t_i (min)	Channelized Flow Length L_t (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)
OS2	31.80	B	0.0	0.00	0.00	0.06	0.25	0.33	0.43	0.54	100.00	7540.00	7500.00	0.050	11.68	1700.00	7500.00	7420.00
				0.02	0.08	0.15	0.25	0.30	0.35						10.83			
A	10.70	B	2.8	0.01	0.02	0.08	0.27	0.34	0.44	0.55	100.00	7510.00	7490.00	0.033	13.18	1500.00	7490.00	7430.00
				0.04	0.10	0.17	0.27	0.32	0.37	0.55					12.18			
B	19.60	B	2.8	0.01	0.02	0.08	0.27	0.34	0.44	0.55	100.00	7510.00	7490.00	0.033	13.18	1500.00	7490.00	7430.00
				0.04	0.10	0.17	0.27	0.32	0.37	0.55					12.18			
C	5.30	B	2.8	0.01	0.02	0.08	0.27	0.34	0.44	0.55	100.00	7490.00	7480.00	0.033	13.18	1100.00	7480.00	7410.00
				0.04	0.10	0.17	0.27	0.32	0.37	0.55					12.18			
OS3 and D	13.60	B	0.0	0.00	0.00	0.06	0.25	0.33	0.43	0.54	100.00	7510.00	7490.00	0.064	10.76	1600.00	7490.00	7410.00
				0.02	0.08	0.15	0.25	0.30	0.35						9.98			
E	3.70	B	2.8	0.01	0.02	0.08	0.27	0.34	0.44	0.55	100.00	7490.00	7480.00	0.017	16.40	700.00	7480.00	7460.00
				0.04	0.10	0.17	0.27	0.32	0.37	0.55					15.15			
OS3	12.10	B	0.0	0.00	0.00	0.06	0.25	0.33	0.43	0.54	100.00	7510.00	7500.00	0.100	9.29	922.00	7500.00	7440.00
				0.02	0.08	0.15	0.25	0.30	0.35						8.61			
BR1	0.90	B	60.0	0.46	0.49	0.54	0.63	0.66	0.71	0.76	10.00	7520.00	7518.00	0.200	1.29	1326.00	7518.00	7450.00
				0.57	0.59	0.63	0.66	0.68	0.70						1.08			
BR2	0.90	B	60.0	0.46	0.49	0.54	0.63	0.66	0.71	0.76	10.00	7520.00	7518.00	0.200	1.29	1307.00	7518.00	7480.00
				0.57	0.59	0.63	0.66	0.68	0.70						1.08			

June 202
Revised

Developed

ff using Rational Method

(urban)
0 (non-urban)

Select UDFCD location for NOAA Atlas 14 Rainfall Depths from the pulldown list OR enter your own depths obtained from the NOAA website (click this link)

	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
1-hour rainfall depth, P1 (in) =	1.19	1.50	1.75	2.00	2.25	2.52	

	a	b	c
Rainfall Intensity Equation Coefficients =	28.50	10.00	0.786

$$I(in/hr) = \frac{a * P_1}{(b + t_c)^c}$$

$\max\{t_{minimum}, \min(\text{Computed } t_c, \text{Regional } t_c)\}$

$Q(cfs) = CIA$

ized (Travel) Flow Time				Time of Concentration			Rainfall Intensity, I (in/hr)							Peak Flow, Q (cfs)						
Channelized Flow Slope S_t (ft/ft)	NRCS Conveyance Factor K	Channelized Flow Velocity V_t (ft/sec)	Channelized Flow Time t_t (min)	Computed t_c (min)	Regional t_c (min)	Selected t_c (min)	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
0.071	7	1.87	15.19	26.87	37.81	26.87	1.99	2.51	2.93	3.35	3.76	4.22		0.00	0.00	5.31	26.49	39.26	57.11	
				26.02										1.27	6.38	13.96	26.60	35.91	46.92	
0.070	7	1.85	13.50	26.68	35.58	26.68	2.00	2.52	2.94	3.36	3.78	4.23		0.27	0.47	2.50	9.58	13.90	19.88	
				25.67										0.86	2.70	5.35	9.70	12.94	16.76	
0.077	7	1.94	12.87	26.05	35.12	26.05	2.03	2.55	2.98	3.41	3.83	4.29		0.51	0.88	4.65	17.79	25.80	36.92	
				25.05										1.59	5.01	9.93	18.02	24.03	31.12	
0.078	7	1.95	9.38	22.56	32.51	22.56	2.20	2.77	3.23	3.69	4.15	4.65		0.15	0.26	1.36	5.21	7.56	10.82	
				21.55										0.47	1.47	2.91	5.28	7.04	9.12	
0.033	7	1.27	20.97	31.73	42.31	31.73	1.81	2.28	2.66	3.04	3.41	3.82		0.00	0.00	2.06	10.28	15.23	22.16	
				30.95										0.49	2.48	5.42	10.32	13.93	18.20	
0.082	7	2.00	5.82	22.23	29.86	22.23	2.21	2.79	3.25	3.72	4.18	4.69		0.10	0.18	0.96	3.67	5.32	7.61	
				20.98										0.33	1.03	2.05	3.72	4.95	6.42	
0.065	7	1.79	8.61	17.89	32.69	17.89	2.48	3.12	3.65	4.17	4.69	5.25		0.00	0.00	2.51	12.55	18.60	27.06	
				17.22										0.60	3.02	6.62	12.60	17.01	22.23	
0.051	7	1.59	13.94	15.23	21.41	15.23	2.68	3.38	3.94	4.51	5.07	5.68		1.11	1.50	1.92	2.54	3.02	3.60	
				15.03										1.38	1.80	2.24	2.68	3.10	3.58	
0.029	7	1.19	18.25	19.54	23.14	19.54	2.37	2.99	3.48	3.98	4.48	5.02		0.98	1.32	1.70	2.24	2.67	3.18	
				19.33										1.22	1.59	1.98	2.37	2.74	3.16	

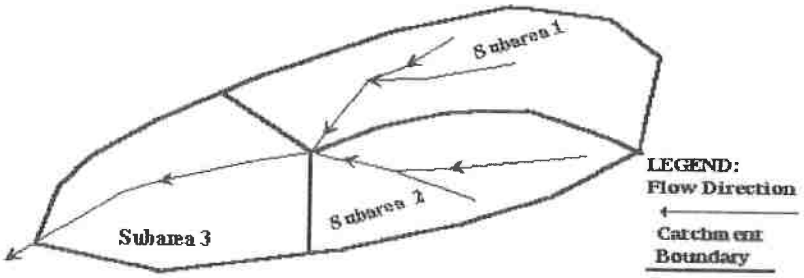
July Submittal

Developed Lots

Area-Weighted Runoff Coefficient Calculations

Version 2.00 released May 2017

Designer: Ken Harrison
Company: KCH Engineering Solutions
Date: 6/26/2020
Project: Prairie Ridge Historic Conditions
Location: El Paso County



Subcatchment Name
Typ 5 acre lot

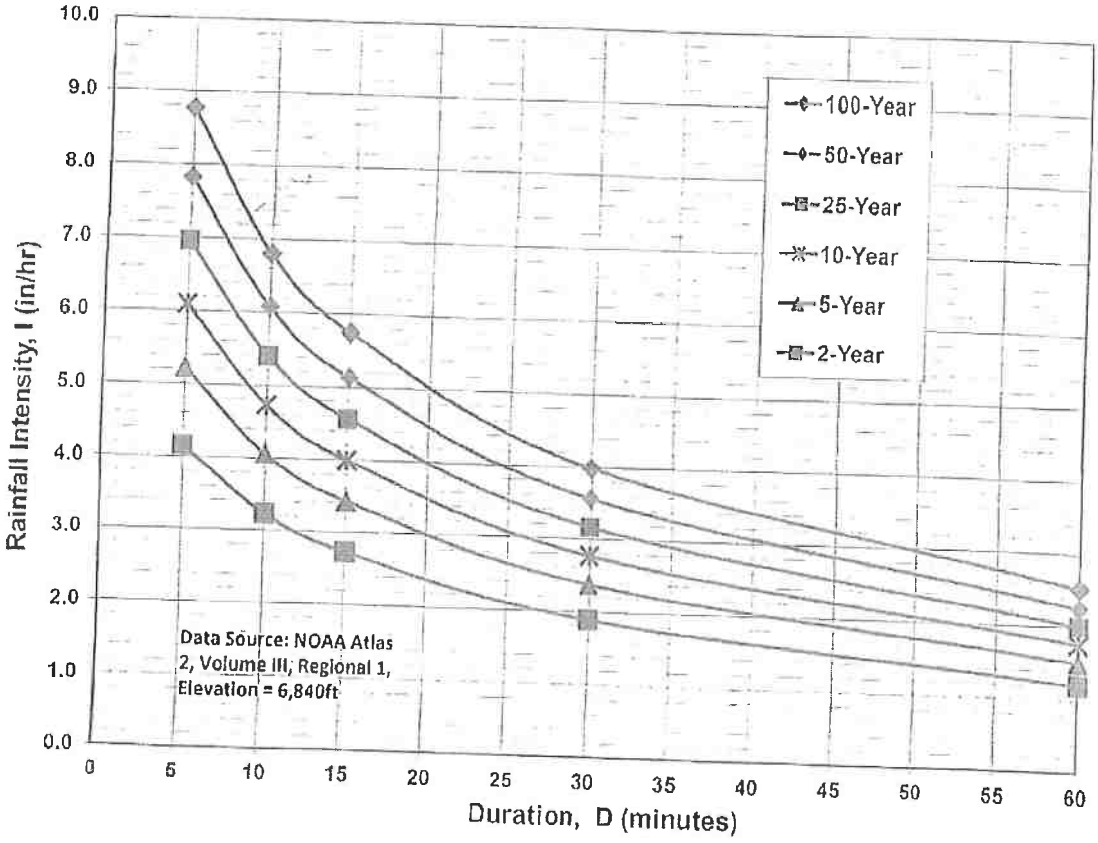
Cells of this color are for required user-input
Cells of this color are for optional override values
Cells of this color are for calculated results based on overrides

See sheet "Design Info" for imperviousness-based runoff coefficient values

Sub-Area ID	Area (ac)	NRCS Hydrologic Soil Group	Percent Imperviousness	Runoff Coefficient, C						
				2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
17000 ft² Roof	0.0918	B	90.0	0.74	0.76	0.78	0.81	0.83	0.84	0.87
				0.71	0.73	0.75	0.78	0.80	0.81	
25000 ft² Patio, walks, drives	0.0574	B	100.0	0.84	0.86	0.86	0.88	0.89	0.89	0.90
				0.89	0.90	0.92	0.94	0.95	0.96	
119808 ft² Lawn	0.0275	B	0.0	0.00	0.00	0.06	0.25	0.33	0.43	0.54
				0.02	0.08	0.15	0.25	0.30	0.35	
210,103 Natural	4.8233	B	0.0	0.00	0.00	0.06	0.25	0.33	0.43	0.54
				0.02	0.08	0.15	0.25	0.30	0.35	
Total Area (ac)	5.0000		Area-Weighted C	0.02	0.02	0.08	0.27	0.34	0.44	0.55
			Area-Weighted Override C	0.04	0.10	0.17	0.27	0.32	0.37	0.55

4,000

Figure 6-5. Colorado Springs Rainfall Intensity Duration Frequency



IDF Equations

$I_{100} = -2.52 \ln(D) + 12.735$

$I_{50} = -2.25 \ln(D) + 11.375$

$I_{25} = -2.00 \ln(D) + 10.111$

$I_{10} = -1.75 \ln(D) + 8.847$

$I_5 = -1.50 \ln(D) + 7.583$

$I_2 = -1.19 \ln(D) + 6.035$

Note: Values calculated by equations may not precisely duplicate values read from figure.

July 2020

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.

July Submittal

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

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

Exhibit 5
SCS TR55 Method Exhibits

June 2021
Revised FDR

Existing

WinTR-55 Current Data Description

--- Identification Data ---

User: Harrison
Project: Prairie Ridge
SubTitle: Existing Conditions
State: Colorado
County: El Paso
Filename: C:\Users\Owner\Documents\Business-Consulting\Prairie Ridge\Drainage\June 2021 revised submit

Date: 6/9/2021
Units: English
Areal Units: Acres

--- Sub-Area Data ---

Name	Description	Reach	Area(ac)	RCN	Tc
OS-1		Reach 1	211.6	69	.556
OS-2		Reach 2	31.8	69	.243
OS-3 and D		Reach 4	13.6	69	.274
A		Reach 1	10.7	69	.243
B		Reach 3	19.6	69	.258
C		Reach 4	5.3	69	.134
E		Outlet	3.7	69	0.280

Total area: 296.30 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
2.1	2.7	3.2	3.6	4.2	4.6	.0

Storm Data Source: User-provided custom storm data
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

Prairie Ridge
Existing Conditions
El Paso County, Colorado

Storm Data

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
2.1	2.7	3.2	3.6	4.2	4.6	.0

Storm Data Source: User-provided custom storm data
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

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Prairie Ridge
Existing Conditions
El Paso County, Colorado

Watershed Peak Table

Sub-Area or Reach Identifier	Peak Flow by Rainfall Return Period 5-Yr (cfs)	100-Yr (cfs)	
SUBAREAS			
OS-1	69.61	279.49	
OS-2	17.37	65.45	
OS-3 and D	7.02	26.69	
A	5.84	22.02	
B	10.42	39.39	
C	3.50	12.60	
E	1.88	7.19	
REACHES			
Reach 1	72.17	289.29	OS1, A
Down	72.08	289.06	
Reach 2	78.72	318.45	OS1, A, OS2
Down	78.61	318.22	
Reach 3	82.74	339.38	" " " B
Down	82.66	339.07	
Reach 4	86.23	358.49	" " " " OS3, D, C
Down	86.21	358.38	
OUTLET	86.98	363.06	Total outflow (discharge) from entire site including

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Prairie Ridge
Existing Conditions
El Paso County, Colorado

Hydrograph Peak/Peak Time Table

Sub-Area or Reach Identifier	Peak Flow and Peak Time (hr) by Rainfall Return Period 5-Yr (cfs)	(hr)	100-Yr (cfs)	(hr)
SUBAREAS				
OS-1	69.61	12.29	279.49	12.22
OS-2	17.37	12.07	65.45	12.04
OS-3 and D	7.02	12.09	26.69	12.07
A	5.84	12.07	22.02	12.04
B	10.42	12.08	39.39	12.05
C	3.50	12.02	12.60	11.97
E	1.88	12.10	7.19	12.08
REACHES				
Reach 1	72.17	12.25	289.29	12.23
Down	72.08	12.31	289.06	12.24
Reach 2	78.72	12.30	318.45	12.21
Down	78.61	12.31	318.22	12.23
Reach 3	82.74	12.31	339.38	12.20
Down	82.66	12.33	339.07	12.21
Reach 4	86.23	12.33	358.49	12.20
Down	86.21	12.34	358.38	12.20
OUTLET	86.98		363.06	

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Prairie Ridge
Existing Conditions
El Paso County, Colorado

Sub-Area Summary Table

Sub-Area Identifier	Drainage Area (ac)	Time of Concentration (hr)	Curve Number	Receiving Reach	Sub-Area Description
OS-1	211.60	0.556	69	Reach 1	
OS-2	31.80	0.243	69	Reach 2	
OS-3 and D	13.60	0.274	69	Reach 4	
A	10.70	0.243	69	Reach 1	
B	19.60	0.258	69	Reach 3	
C	5.30	0.134	69	Reach 4	
E	3.70	0.280	69	Outlet	

Total Area: 296.30 (ac)

Prairie Ridge
Existing Conditions
El Paso County, Colorado

Reach Summary Table

Reach Identifier	Receiving Reach Identifier	Reach Length (ft)	Routing Method
Reach 1	Reach 2	600	CHANNEL
Reach 2	Reach 3	300	CHANNEL
Reach 3	Reach 4	300	CHANNEL
Reach 4	Outlet	200	CHANNEL

Prairie Ridge
Existing Conditions
El Paso County, Colorado

Sub-Area Time of Concentration Details

Sub-Area Identifier/	Flow Length (ft)	Slope (ft/ft)	Mannings's n	End Area (sq ft)	Wetted Perimeter (ft)	Velocity (ft/sec)	Travel Time (hr)
OS-1							
SHEET	100	0.1000	0.150				0.106
SHALLOW	3700	0.0200	0.050				0.450
					Time of Concentration		.556
OS-2							
SHEET	100	0.0500	0.150				0.140
SHALLOW	1600	0.0714	0.050				0.103
					Time of Concentration		.243
OS-3 and D							
SHEET	100	0.0330	0.150				0.165
SHALLOW	1600	0.0643	0.050				0.109
					Time of Concentration		.274
A							
SHEET	100	0.0330	0.150				0.165
SHALLOW	1200	0.0700	0.050				0.078
					Time of Concentration		.243
B							
SHEET	100	0.0330	0.150				0.165
SHALLOW	1500	0.0769	0.050				0.093
					Time of Concentration		.258
C							
SHEET	100	0.3300	0.150				0.066
SHALLOW	1100	0.0780	0.050				0.068
					Time of Concentration		.134
E							
User-provided							0.280
					Time of Concentration		0.280

Prairie Ridge
Existing Conditions
El Paso County, Colorado

Sub-Area Land Use and Curve Number Details

Sub-Area Identifier	Land Use	Hydrologic Soil Group	Sub-Area Area (ac)	Curve Number
OS-1	CN directly entered by user	-	211.6	69
	Total Area / Weighted Curve Number		211.6	69
OS-2	CN directly entered by user	-	31.8	69
	Total Area / Weighted Curve Number		31.8	69
OS-3 and DCN	directly entered by user	-	13.6	69
	Total Area / Weighted Curve Number		13.6	69
A	CN directly entered by user	-	10.7	69
	Total Area / Weighted Curve Number		10.7	69
B	CN directly entered by user	-	19.6	69
	Total Area / Weighted Curve Number		19.6	69
C	CN directly entered by user	-	5.3	69
	Total Area / Weighted Curve Number		5.3	69
E	CN directly entered by user	-	3.7	69
	Total Area / Weighted Curve Number		3.7	69

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Prairie Ridge
Existing Conditions
El Paso County, Colorado

Reach Channel Rating Details

Reach Identifier	Reach Length (ft)	Reach Manning's n	Friction Slope (ft/ft)	Bottom Width (ft)	Side Slope
Reach 1	600	0.13	0.0333	30	.1 :1
Reach 2	300	0.13	0.0167	30	.1 :1
Reach 3	300	0.13	0.0167	30	.1 :1
Reach 4	200	0.13	0.025	30	.1 :1

Reach Identifier	Stage (ft)	Flow (cfs)	End Area (sq ft)	Top Width (ft)	Friction Slope (ft/ft)
Reach 1	0.0	0.000	0	30	0.0333
	0.5	19.336	15	30.1	
	1.0	60.263	30.1	30.2	
	2.0	184.730	60.4	30.4	
	5.0	775.675	152.5	31	
	10.0	2179.432	310	32	
	20.0	5826.058	640	34	
Reach 2	0.0	0.000	0	30	0.0167
	0.5	13.693	15	30.1	
	1.0	42.676	30.1	30.2	
	2.0	130.820	60.4	30.4	
	5.0	549.308	152.5	31	
	10.0	1543.403	310	32	
	20.0	4125.826	640	34	
Reach 3	0.0	0.000	0	30	0.0167
	0.5	13.693	15	30.1	
	1.0	42.676	30.1	30.2	
	2.0	130.820	60.4	30.4	
	5.0	549.308	152.5	31	
	10.0	1543.403	310	32	
	20.0	4125.826	640	34	
Reach 4	0.0	0.000	0	30	0.025
	0.5	16.754	15	30.1	
	1.0	52.215	30.1	30.2	
	2.0	160.061	60.4	30.4	
	5.0	672.090	152.5	31	
	10.0	1888.388	310	32	
	20.0	5048.039	640	34	

June 2021
Revised FDR

Developed

WinTR-55 Current Data Description

--- Identification Data ---

User: Harrison
Project: Prairie Ridge
SubTitle: Developed Conditions
State: Colorado
County: El Paso
Filename: C:\Users\Owner\Documents\Business-Consulting\Prairie Ridge\Drainage\June 2021 revised submit

Date: 6/11/2021
Units: English
Areal Units: Acres

--- Sub-Area Data ---

Name	Description	Reach	Area(ac)	RCN	Tc
OS-1		Reach 1	211.6	69	.556
OS-2		Reach 2	31.8	69	.243
OS-3 and D		Reach 4	13.6	69	.274
A		Reach 1	10.7	70	.243
B		Reach 3	19.6	70	.258
C		Reach 4	5.3	70	.134
E		Outlet	3.7	70	0.280

Total area: 296.30 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
2.1	2.7	3.2	3.6	4.2	4.6	.0

Storm Data Source: User-provided custom storm data
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

Prairie Ridge
Developed Conditions
El Paso County, Colorado

Storm Data

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
2.1	2.7	3.2	3.6	4.2	4.6	.0

Storm Data Source: User-provided custom storm data
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

Harrison

Prairie Ridge
Developed Conditions
El Paso County, Colorado

Watershed Peak Table

Sub-Area or Reach Identifier	Peak Flow by Rainfall Return Period 5-Yr (cfs)	100-Yr (cfs)	
SUBAREAS			
OS-1	69.61	279.49	
OS-2	17.37	65.45	
OS-3 and D	7.02	26.69	
A	6.45	23.11	
B	11.51	41.30	
C	3.83	13.20	
E	2.08	7.55	- Flows offsite
REACHES			
Reach 1	72.41	289.73	OS1, A
Down	72.30	289.42	
Reach 2	78.97	319.08	" " OS2
Down	78.86	318.84	
Reach 3	83.34	341.04	" " " B
Down	83.27	340.77	
Reach 4	86.92	360.40	" " " " OS-3, D, C
Down	86.89	360.37	
OUTLET	87.73	365.34	- Total discharge from entire site including E.

Harrison

Prairie Ridge
Developed Conditions
El Paso County, Colorado

Hydrograph Peak/Peak Time Table

Sub-Area or Reach Identifier	Peak Flow and Peak Time (hr) by Rainfall Return Period 5-Yr (cfs) (hr)	100-Yr (cfs) (hr)
SUBAREAS		
OS-1	69.61 12.29	279.49 12.22
OS-2	17.37 12.07	65.45 12.04
OS-3 and D	7.02 12.09	26.69 12.07
A	6.45 12.07	23.11 12.05
B	11.51 12.08	41.30 12.07
C	3.83 12.02	13.20 11.97
E	2.08 12.08	7.55 12.07
REACHES		
Reach 1	72.41 12.25	289.73 12.22
Down	72.30 12.31	289.42 12.25
Reach 2	78.97 12.30	319.08 12.22
Down	78.86 12.31	318.84 12.23
Reach 3	83.34 12.31	341.04 12.20
Down	83.27 12.33	340.77 12.22
Reach 4	86.92 12.32	360.40 12.20
Down	86.89 12.34	360.37 12.20
OUTLET	87.73	365.34

Harrison

Prairie Ridge
Developed Conditions
El Paso County, Colorado

Sub-Area Summary Table

Sub-Area Identifier	Drainage Area (ac)	Time of Concentration (hr)	Curve Number	Receiving Reach	Sub-Area Description
OS-1	211.60	0.556	69	Reach 1	
OS-2	31.80	0.243	69	Reach 2	
OS-3 and D	13.60	0.274	69	Reach 4	
A	10.70	0.243	70	Reach 1	
B	19.60	0.258	70	Reach 3	
C	5.30	0.134	70	Reach 4	
E	3.70	0.280	70	Outlet	

Total Area: 296.30 (ac)

Prairie Ridge
Developed Conditions
El Paso County, Colorado

Reach Summary Table

Reach Identifier	Receiving Reach Identifier	Reach Length (ft)	Routing Method
Reach 1	Reach 2	600	CHANNEL
Reach 2	Reach 3	300	CHANNEL
Reach 3	Reach 4	300	CHANNEL
Reach 4	Outlet	200	CHANNEL

Prairie Ridge
Developed Conditions
El Paso County, Colorado

Sub-Area Time of Concentration Details

Sub-Area Identifier/	Flow Length (ft)	Slope (ft/ft)	Mannings's n	End Area (sq ft)	Wetted Perimeter (ft)	Velocity (ft/sec)	Travel Time (hr)
OS-1							
SHEET	100	0.1000	0.150				0.106
SHALLOW	3700	0.0200	0.050				0.450
					Time of Concentration		.556
OS-2							
SHEET	100	0.0500	0.150				0.140
SHALLOW	1600	0.0714	0.050				0.103
					Time of Concentration		.243
OS-3 and D							
SHEET	100	0.0330	0.150				0.165
SHALLOW	1600	0.0643	0.050				0.109
					Time of Concentration		.274
A							
SHEET	100	0.0330	0.150				0.165
SHALLOW	1200	0.0700	0.050				0.078
					Time of Concentration		.243
B							
SHEET	100	0.0330	0.150				0.165
SHALLOW	1500	0.0769	0.050				0.093
					Time of Concentration		.258
C							
SHEET	100	0.3300	0.150				0.066
SHALLOW	1100	0.0780	0.050				0.068
					Time of Concentration		.134
E							
User-provided							0.280
					Time of Concentration		0.280

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Sub-Area Land Use and Curve Number Details

Sub-Area Identifier	Land Use	Hydrologic Soil Group	Sub-Area Area (ac)	Curve Number
OS-1	CN directly entered by user	-	211.6	69
	Total Area / Weighted Curve Number		211.6	69
OS-2	CN directly entered by user	-	31.8	69
	Total Area / Weighted Curve Number		31.8	69
OS-3 and D	CN directly entered by user	-	13.6	69
	Total Area / Weighted Curve Number		13.6	69
A	CN directly entered by user	-	10.7	70
	Total Area / Weighted Curve Number		10.7	70
B	CN directly entered by user	-	19.6	70
	Total Area / Weighted Curve Number		19.6	70
C	CN directly entered by user	-	5.3	70
	Total Area / Weighted Curve Number		5.3	70
E	CN directly entered by user	-	3.7	70
	Total Area / Weighted Curve Number		3.7	70

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Reach Channel Rating Details

Reach Identifier	Reach Length (ft)	Reach Manning's n	Friction Slope (ft/ft)	Bottom Width (ft)	Side Slope
Reach 1	600	0.13	0.0333	30	.1 :1
Reach 2	300	0.13	0.0167	30	.1 :1
Reach 3	300	0.13	0.0167	30	.1 :1
Reach 4	200	0.13	0.025	30	.1 :1

Reach Identifier	Stage (ft)	Flow (cfs)	End Area (sq ft)	Top Width (ft)	Friction Slope (ft/ft)
Reach 1	0.0	0.000	0	30	0.0333
	0.5	19.336	15	30.1	
	1.0	60.263	30.1	30.2	
	2.0	184.730	60.4	30.4	
	5.0	775.675	152.5	31	
	10.0	2179.432	310	32	
	20.0	5826.058	640	34	
Reach 2	0.0	0.000	0	30	0.0167
	0.5	13.693	15	30.1	
	1.0	42.676	30.1	30.2	
	2.0	130.820	60.4	30.4	
	5.0	549.308	152.5	31	
	10.0	1543.403	310	32	
	20.0	4125.826	640	34	
Reach 3	0.0	0.000	0	30	0.0167
	0.5	13.693	15	30.1	
	1.0	42.676	30.1	30.2	
	2.0	130.820	60.4	30.4	
	5.0	549.308	152.5	31	
	10.0	1543.403	310	32	
	20.0	4125.826	640	34	
Reach 4	0.0	0.000	0	30	0.025
	0.5	16.754	15	30.1	
	1.0	52.215	30.1	30.2	
	2.0	160.061	60.4	30.4	
	5.0	672.090	152.5	31	
	10.0	1888.388	310	32	
	20.0	5048.039	640	34	

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Table 2-2a Runoff curve numbers for urban areas [1]

Cover description: Cover type and hydrologic condition	Average percent impervious area [2]	Curve numbers for hydrologic soil group: A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.) [3]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) [4]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation) [5]		77	86	91	94
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

[1] Average runoff condition, and $I_a = 0.2S$.

[2] The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.

[3] CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.

[4] Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.

[5] Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4 based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

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Table 2-2b Runoff curve numbers for cultivated agricultural lands [1]

Cover description			Curve numbers for hydrologic soil group			
Cover type	Treatment [2]	Hydrologic condition [3]	A	B	C	D
Fallow	Bare soil	—	77	86	91	94
	Crop residue cover (CR)	Poor	76	85	90	93
		Good	74	83	88	90
Row crops	Straight row (SR)	Poor	72	81	88	91
		Good	67	78	85	89
	SR + CR	Poor	71	80	87	90
		Good	64	75	82	85
	Contoured (C)	Poor	70	79	84	88
		Good	65	75	82	86
	C + CR	Poor	69	78	83	87
		Good	64	74	81	85
	Contoured & terraced (C&T)	Poor	66	74	80	82
		Good	62	71	78	81
	C&T+ CR	Poor	65	73	79	81
		Good	61	70	77	80
Small grain	SR	Poor	65	76	84	88
		Good	63	75	83	87
	SR + CR	Poor	64	75	83	86
		Good	60	72	80	84
	C	Poor	63	74	82	85
		Good	61	73	81	84
	C + CR	Poor	62	73	81	84
		Good	60	72	80	83
	C&T	Poor	61	72	79	82
		Good	59	70	78	81
	C&T+ CR	Poor	60	71	78	81
		Good	58	69	77	80
Close-seeded or broadcast legumes or rotation meadow	SR	Poor	66	77	85	89
		Good	58	72	81	85
	C	Poor	64	75	83	85
		Good	55	69	78	83
	C&T	Poor	63	73	80	83
		Good	51	67	76	80

[1] Average runoff condition, and I_a=0.2S

[2] Crop residue cover applies only if residue is on at least 5% of the surface throughout the year.

[3] Hydraulic condition is based on combination factors that affect infiltration and runoff, including (a) density and canopy of vegetative areas, (b) amount of year-round cover, (c) amount of grass or close-seeded legumes, (d) percent of residue cover on the land surface (good ≥ 20%), and (e) degree of surface roughness.

Poor: Factors impair infiltration and tend to increase runoff.

Good: Factors encourage average and better than average infiltration and tend to decrease runoff.

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Table 2-2c Runoff curve numbers for other agricultural lands [1]

Cover description		Curve numbers for hydrologic soil group			
Cover type	Hydrologic condition	A	B	C	D
Pasture, grassland, or range—continuous forage for grazing. [2]	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Meadow—continuous grass, protected from grazing and generally mowed for hay.	—	30	58	71	78
Brush—brush-weed-grass mixture with brush the major element. [3]	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	30 [4]	48	65	73
Woods—grass combination (orchard or tree farm). [5]	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods. [6]	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	30 [4]	55	70	77
Farmsteads—buildings, lanes, driveways, and surrounding lots.	—	59	74	82	86

1 Average runoff condition, and $I_a = 0.2S$.

2 *Poor:* <50%) ground cover or heavily grazed with no mulch.
Fair: 50 to 75% ground cover and not heavily grazed.
Good: > 75% ground cover and lightly or only occasionally grazed.

3 *Poor:* <50% ground cover.
Fair: 50 to 75% ground cover.
Good: >75% ground cover.

4 Actual curve number is less than 30; use CN = 30 for runoff computations.

5 CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods and pasture.

6 *Poor:* Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.
Fair: Woods are grazed but not burned, and some forest litter covers the soil.
Good: Woods are protected from grazing, and litter and brush adequately cover the soil.

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Table 2-2d Runoff curve numbers for arid and semiarid rangelands [1]

Cover description		Curve numbers for hydrologic soil group			
Cover type	Hydrologic condition [2]	A [3]	B	C	D
Herbaceous—mixture of grass, weeds, and low-growing brush, with brush the minor element.	Poor		80	87	93
	Fair		71	81	89
	Good		62	74	85
Oak-aspen—mountain brush mixture of oak brush, aspen, mountain mahogany, bitter brush, maple, and other brush.	Poor		66	74	79
	Fair		48	57	63
	Good		30	41	48
Pinyon-juniper—pinyon, juniper, or both; grass understory.	Poor		75	85	89
	Fair		58	73	80
	Good		41	61	71
Sagebrush with grass understory.	Poor		67	80	85
	Fair		51	63	70
	Good		35	47	55
Desert shrub—major plants include saltbush, greasewood, creosotebush, blackbrush, bursage, palo verde, mesquite, and cactus.	Poor	63	77	85	88
	Fair	55	72	81	86
	Good	49	68	79	84

1 Average runoff condition, and $I_a = 0.2S$. For range in humid regions, use table 2-2c.
2 Poor: <30% ground cover (litter, grass, and brush overstory).
Fair: 30 to 70% ground cover.
Good: > 70% ground cover.
3 Curve numbers for group A have been developed only for desert shrub.

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Table 6-9. NRCS Curve Numbers for Pre-Development Thunderstorms Conditions (ARC I)

Fully Developed Urban Areas (vegetation established)[1]	Treatment	Hydrologic Condition	%I	Pre-Development CN			
				HSG A	HSG B	HSG C	HSG D
Open space (lawns, parks, golf courses, cemeteries, etc.):							
Poor condition (grass cover < 50%)	-----	-----	---	47	61	72	77
Fair condition (grass cover 50% to 75%)	-----	-----	---	29	48	61	69
Good condition (grass cover > 75%)	-----	-----	---	21	40	54	63
Impervious areas:							
Paved parking lots, roofs, driveways, etc. (excluding right-of-way	-----	-----	---	95	95	95	95
Streets and roads:							
Paved; curbs and storm sewers (excluding right-of-way)	-----	-----	---	95	95	95	95
Paved; open ditches (including right-of-way)	-----	-----	---	67	77	83	85
Gravel (including right-of-way)	-----	-----	---	57	70	77	81
Dirt (including right-of-way)	-----	-----	---	52	66	74	77
Western desert urban areas:							
Natural desert landscaping (pervious areas only)	-----	-----	---	42	58	70	75
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)	-----	-----	---	91	91	91	91
Developing Urban Areas[1]	**Treatment[2]**	**Hydrologic Condition[3]**	**%I**	**HSG A**	**HSG B**	**HSG C**	**HSG D**
Newly graded areas (pervious areas only, no vegetation)	-----	-----	---	58	72	81	87
Cultivated Agricultural Lands[1]	**Treatment**	**Hydrologic Condition**	**%I**	**HSG A**	**HSG B**	**HSG C**	**HSG D**
Fallow	Bare soil	-----	---	58	72	81	87
	Crop residue cover (CR)	Poor	---	57	70	79	85
		Good	---	54	67	75	79
Row crops	Straight row (SR)	Poor	---	52	64	75	81
		Good	---	46	60	70	77
	SR + CR	Poor	---	51	63	74	79
		Good	---	43	56	66	70
	Contoured (C)	Poor	---	49	61	69	75
		Good	---	44	56	66	72
	C + CR	Poor	---	48	60	67	74
		Good	---	43	54	64	70
	Contoured & terraced (C&T)	Poor	---	45	54	63	66
		Good	---	41	51	60	64
	C&T+ CR	Poor	---	44	53	61	64
		Good	---	40	49	58	63
Small grain	SR	Poor	---	44	57	69	75
		Good	---	42	56	67	74
	SR + CR	Poor	---	43	56	67	72
		Good	---	39	52	63	69
	C	Poor	---	42	54	66	70
		Good	---	40	53	64	69
	C + CR Poor	Poor	---	41	53	64	69
		Good	---	39	52	63	67
	C&T	Poor	---	40	52	61	66
		Good	---	38	49	60	64
	C&T+ CR	Poor	---	39	51	60	64
		Good	---	37	48	58	63
Close-seeded or broadcast legumes or rotation meadow	SR	Poor	---	45	58	70	77
		Good	---	37	52	64	70
	C	Poor	---	43	56	67	70
		Good	---	34	48	60	67
	C&T	Poor	---	42	53	63	67
		Good	---	30	46	57	63

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Table 6-9. (continued)

Other Agricultural Lands[1]	Treatment	Hydrologic Condition	%I	HSG A	HSG B	HSG C	HSG D
Pasture, grassland, or range—continuous forage for grazing[4]	-----	Poor	---	47	61	72	77
	-----	Fair	---	29	48	61	69
	-----	Good	---	21	40	54	63
Meadow—continuous grass, protected from grazing and generally mowed for hay	-----	-----	---	15	37	51	60
Brush—brush-weed-grass mixture with brush the major element[5]	-----	Poor	---	28	46	58	67
	-----	Fair	---	18	35	49	58
	-----	Good	---	15	28	44	53
Woods—grass combination (orchard or tree farm)[6]	-----	Poor	---	36	53	66	72
	-----	Fair	---	24	44	57	66
	-----	Good	---	17	37	52	61
Woods[7]	-----	Poor	---	26	45	58	67
	-----	Fair	---	19	39	53	61
	-----	Good	---	15	34	49	58
Farmsteads—buildings, lanes, driveways, and surrounding lots	-----	-----	---	38	54	66	72
Arid and Semi-arid Rangelands[1]	**Treatment**	**Hydrologic Condition[8]**	**%I**	**HSG A**	**HSG B**	**HSG C**	**HSG D**
Herbaceous—mixture of grass, weeds, and low-growing brush, with brush the minor element	-----	Poor	---	-----	63	74	85
	-----	Fair	---	-----	51	64	77
	-----	Good	---	-----	41	54	70
Oak-aspen—mountain brush mixture of oak brush, aspen, mountain mahogany, bitter brush, maple, and other brush	-----	Poor	---	-----	45	54	61
	-----	Fair	---	-----	28	36	42
	-----	Good	---	-----	15	23	28
Pinyon-juniper—pinyon, juniper, or both; grass understory	-----	Poor	---	-----	56	70	77
	-----	Fair	---	-----	37	53	63
	-----	Good	---	-----	23	40	51
Sagebrush with grass understory	-----	Poor	---	-----	46	63	70
	-----	Fair	---	-----	30	42	49
	-----	Good	---	-----	18	27	34
Desert shrub—major plants include saltbush, greasewood, creosotebush, blackbrush, bursage, palo verde, mesquite, and cactus	-----	Poor	---	42	58	70	75
	-----	Fair	---	34	52	64	72
	-----	Good	---	29	47	61	69

[1] Average runoff condition, and Ia = 0.1S.

[2] Crop residue cover applies only if residue is on at least 5% of the surface throughout the year.

[3] Hydraulic condition is based on combination factors that affect infiltration and runoff, including (a) density and canopy of vegetative areas, (b) amount of year-round cover, (c) amount of grass or close-seeded legumes, (d) percent of residue cover on the land surface (good ≥ 20%), and (e) degree of surface roughness. Poor: Factors impair infiltration and tend to increase runoff. Good: Factors encourage average and better than average infiltration and tend to decrease runoff.

[4] Poor: <50%) ground cover or heavily grazed with no mulch. Fair: 50 to 75% ground cover and not heavily grazed. Good: > 75% ground cover and lightly or only occasionally grazed.

[5] Poor: <50% ground cover. Fair: 50 to 75% ground cover. Good: >75% ground cover.

[6] CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods and pasture.

[7] Poor: Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning. Fair: Woods are grazed but not burned, and some forest litter covers the soil. Good: Woods are protected from grazing, and litter and brush adequately cover the soil.

[8] Poor: <30% ground cover (litter, grass, and brush overstory). Fair: 30 to 70% ground cover. Good: > 70% ground cover.

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Table 6-10. NRCS Curve Numbers for Frontal Storms & Thunderstorms for Developed Conditions (ARCII)

Fully Developed Urban Areas (vegetation established)[1]	Treatment	Hydrologic Condition	%I	Pre-Development CN			
				HSG A	HSG B	HSG C	HSG D
Open space (lawns, parks, golf courses, cemeteries, etc.):							
Poor condition (grass cover < 50%)	-----	-----	---	68	79	86	89
Fair condition (grass cover 50% to 75%)	-----	-----	---	49	69	79	84
Good condition (grass cover > 75%)	-----	-----	---	39	61	74	80
Impervious areas:							
Paved parking lots, roofs, driveways, etc. (excluding right-of-way	-----	-----	---	98	98	98	98
Streets and roads:							
Paved; curbs and storm sewers (excluding right-of-way)	-----	-----	---	98	98	98	98
Paved; open ditches (including right-of-way)	-----	-----	---	83	89	92	93
Gravel (including right-of-way)	-----	-----	---	76	85	89	91
Dirt (including right-of-way)	-----	-----	---	72	82	87	89
Western desert urban areas:							
Natural desert landscaping (pervious areas only)	-----	-----	---	63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)	-----	-----	---	96	96	96	96
Urban districts:							
Commercial and business	-----	-----	85	89	92	94	95
Industrial	-----	-----	72	81	88	91	93
Residential districts by average lot size:							
1/8 acre or less (town houses)	-----	-----	65	77	85	90	92
1/4 acre	-----	-----	38	61	75	83	87
1/3 acre	-----	-----	30	57	72	81	86
1/2 acre	-----	-----	25	54	70	80	85
1 acre	-----	-----	20	51	68	79	84
2 acres	-----	-----	12	46	65	77	82
Developing Urban Areas[1]	**Treatment[2]**	**Hydrologic Condition[3]**	**%I**	**HSG A**	**HSG B**	**HSG C**	**HSG D**
Newly graded areas (pervious areas only, no vegetation)	-----	-----	---	77	86	91	94
Cultivated Agricultural Lands[1]	**Treatment**	**Hydrologic Condition**	**%I**	**HSG A**	**HSG B**	**HSG C**	**HSG D**
Fallow	Bare soil	-----	---	77	86	91	94
	Crop residue cover (CR)	Poor	---	76	85	90	93
		Good	---	74	83	88	90
Row crops	Straight row (SR)	Poor	---	72	81	88	91
		Good	---	67	78	85	89
	SR + CR	Poor	---	71	80	87	90
		Good	---	64	75	82	85
	Contoured (C)	Poor	---	70	79	84	88
		Good	---	65	75	82	86
	C + CR	Poor	---	69	78	83	87
		Good	---	64	74	81	85
	Contoured & terraced (C&T)	Poor	---	66	74	80	82
		Good	---	62	71	78	81
	C&T+ CR	Poor	---	65	73	79	81
		Good	---	61	70	77	80
Small grain	SR	Poor	---	65	76	84	88
		Good	---	63	75	83	87
	SR + CR	Poor	---	64	75	83	86
		Good	---	60	72	80	84
	C	Poor	---	63	74	82	85
		Good	---	61	73	81	84
	C + CR Poor	Poor	---	62	73	81	84
		Good	---	60	72	80	83
	C&T	Poor	---	61	72	79	82
		Good	---	59	70	78	81
	C&T+ CR	Poor	---	60	71	78	81
		Good	---	58	69	77	80

Table 6-10. (continued)

Other Agricultural Lands[1]	Treatment	Hydrologic Condition	%I	HSG A	HSG B	HSG C	HSG D
Pasture, grassland, or range—continuous forage for grazing[4]	-----	Poor	---	68	79	86	89
	-----	Fair	---	49	69	79	84
	-----	Good	---	39	61	74	80
Meadow—continuous grass, protected from grazing and generally mowed for hay	-----	-----	---	30	58	71	78
Brush—brush-weed-grass mixture with brush the major element[5]	-----	Poor	---	48	67	77	83
	-----	Fair	---	35	56	70	77
	-----	Good	---	30	48	65	73
Woods—grass combination (orchard or tree farm)[6]	-----	Poor	---	57	73	82	86
	-----	Fair	---	43	65	76	82
	-----	Good	---	32	58	72	79
Woods[7]	-----	Poor	---	45	66	77	83
	-----	Fair	---	36	60	73	79
	-----	Good	---	30	55	70	77
Farmsteads—buildings, lanes, driveways, and surrounding lots	-----	-----	---	59	74	82	86
Arid and Semi-arid Rangelands[1]	**Treatment**	**Hydrologic Condition[8]**	**%I**	**HSG A**	**HSG B**	**HSG C**	**HSG D**
Herbaceous—mixture of grass, weeds, and low-growing brush, with brush the minor element	-----	Poor	---	-----	80	87	93
	-----	Fair	---	-----	71	81	89
	-----	Good	---	-----	62	74	85
Oak-aspen—mountain brush mixture of oak brush, aspen, mountain mahogany, bitter brush, maple, and other brush	-----	Poor	---	-----	66	74	79
	-----	Fair	---	-----	48	57	63
	-----	Good	---	-----	30	41	48
Pinyon-juniper—pinyon, juniper, or both; grass understory	-----	Poor	---	-----	75	85	89
	-----	Fair	---	-----	58	73	80
	-----	Good	---	-----	41	61	71
Sagebrush with grass understory	-----	Poor	---	-----	67	80	85
	-----	Fair	---	-----	51	63	70
	-----	Good	---	-----	35	47	55
Desert shrub—major plants include saltbush, greasewood, creosotebush, blackbrush, bursage, palo verde, mesquite, and cactus	-----	Poor	---	63	77	85	88
	-----	Fair	---	55	72	81	86
	-----	Good	---	49	68	79	84

[1] $I_a = 0.1\ S$

[2] Crop residue cover applies only if residue is on at least 5% of the surface throughout the year.

[3] Hydraulic condition is based on combination factors that affect infiltration and runoff, including (a) density and canopy of vegetative areas, (b) amount of year-round cover, (c) amount of grass or close-seeded legumes, (d) percent of residue cover on the land surface (good ≥ 20%), and (e) degree of surface roughness. Poor: Factors impair infiltration and tend to increase runoff. Good: Factors encourage average and better than average infiltration and tend to decrease runoff.

[4] Poor: <50% ground cover or heavily grazed with no mulch. Fair: 50 to 75% ground cover and not heavily grazed. Good: > 75% ground cover and lightly or only occasional

[5] Poor: <50% ground cover. Fair: 50 to 75% ground cover. Good: >75% ground cover.

[6] CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods

[7] Poor: Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning. Fair: Woods are grazed but not burned, and some forest litter covers the soil. Good: Woods are protected from grazing, and litter and brush adequately cover the soil.

[8] Poor: <30% ground cover (litter, grass, and brush overstory). Fair: 30 to 70% ground cover. Good: > 70% ground cover.

4.6 Lag Time

While the NRCS curve numbers are used to calculate the volume of runoff and magnitude of losses, to transform the volume of runoff into a hydrograph using the NRCS dimensionless unit hydrograph, the lag time must be specified. The lag time is defined as the time from the centroid of the rainfall distribution of a storm to the peak discharge produced by the watershed. For this Manual, the lag time is defined as a fraction of the time of concentration (t_c) as shown in Equation 6-13.

$$t_{lag} = 0.6 \cdot t_c \qquad \text{(Eq. 6-13)}$$

July 2020 Report

Table 6-11. Roughness Coefficients (Manning's n) for NRCS Overland Flow

Surface description	n[1]
Smooth surfaces (concrete, asphalt, gravel, bare soil, etc.)	0.011
Fallow (no residue)	0.05
Cultivated Soils:	
Residue cover ≤20%	0.06
Residue cover >20%	0.17
Grass:	
Short grass prairie	0.15
Dense grasses [2]	0.24
Bermuda grass	0.41
Range (natural)	0.13
Woods [3]	
Light underbrush	0.40
Dense underbrush	0.80

4. [1]The values are a composite of information compiled by Engman (1986).

5. [2]Includes species such as weeping lovegrass, bluegrass, buffalograss, blue gramma grass, native grass mixtures.

6. [3]When selecting n, consider cover to a height of about 0.1 feet. This is the only part of the plant cover that will obstruct sheet flow.

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July 2020 Report

JOB Prairie Ridge

SHEET NO _____ OF _____

CALCULATED BY K. Harrison DATE 6/30/20

CHECKED BY _____ DATE _____

SCALE _____

Curve No for Typical 5 Acre lot

Historic Condition
from TR-55 6-9 Predevelopement Condition ARC I
Rest, Grassland, Rang, continuous forage from grazin

Assume Fair condition CN = 69

Developed Condition from TR-55 5 Acres = 217,800 ft²

Rooftops (4000 sf) CN = 98
Patios, Walkways, Drives (2500 s.f) CN = 98
Lawn, Irrigation (1200 s.f.) CN = 69
Natural, undisturbed, Not watered CN = 69
Remaining Natural Area
217,800 - 4000 - 2500 - 1200 = 210,100 s.f

Weighted Impervious

[4000(98) + 2500(98) + 1200(69) + 210,100(69)] / 217,800

CN = 69.9 use 70 for Composite

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July Report

JOB Prairie Ridge

SHEET NO _____ OF _____

CALCULATED BY K. Hutton DATE 6/30/20

CHECKED BY _____ DATE _____

SCALE _____

% Impervious for Drainage Area

A. Area for 2.0%

OS1	=	211.6
OS2	=	31.8
OS3+D	=	13.6
		257.0 Acres

B Area for 2.8%

A=	10.7
B=	19.6
C=	5.3
D=	(included w/ OS basins)
E=	3.7
	39.3

C. Total Area = 296.3

D. Composite %

$$[257(0.02)+39.3(0.028)]/296.3 = 0.021 = 2.1\%$$

Drainage Ridge TR 1

T... Time of Concentration

Subbasin OUT1

Sheet Flow

Length = ~~300ft~~ 100ft program limits

Slope = 10%

Surface = Bldgs & Paving

Shallow Concentrated

Length = ~~3500ft~~ 3700ft

Slope = (7520-7450)/3504 = 2%

Surface = same

Channel

Length = 0

Slope = (. 7 ! ! .17%

n =

Bottom Width =

Side Slope

Discharge

Prairie Ridge

Time of Concentration

Subbasin OS-2

Sheet Flow

Length = 300' 100

Slope = 15/300 = 5% use Segment

Surface = Field + grazing

Shallow Concentrated

Length = 1400'

Slope = 7520 - 7420 / 1400 = 7.14%

Surface = grass, grazing

Channel

Length = 0

Slope = #!

n =

Side Slope =

Discharge =

Prairie Ridge TR-3

Time of Concentration

Subbasin A5-3 and D.

Sheet Flow

Length - ~~300'~~ 100'

Slope - (7610-7600)/300 = 3.3% ~~&~~ use 1% for use w/ 100'

Land Use = grass, grazing

Shallow Concentrate

Length 1100

Slope = (7500 + ~~7440~~)/1400 = 6.43%

No Concentrated Channel Flow

Sub-basin A

Sheet Flow

Length = ~~300~~ use 100 ; program limit

Slope = (7520 - 7510)/300 = 3.3%

Land Use = grass, grazing

Shallow Channel

Length = 1000 ft

Slope = (7510 - 7440)/1000 = 7%

No Concentrated Channel Flow

Prairie Ridge

Time of Concentration

Subbasin B

Sheet Flow

Length = ~~300ft~~ use 100

Slope = (7520-7510)/300 = 3.3% ~~db to up~~

Land Use = grass, grazing

Shallow Concentrated

Length = 1300ft

Slope = (7510 - 7410)/1300 = 7.69%

Channel = No channel flow

Sub-basin C

Sheet Flow

Length = ~~300ft~~ 100ft program upper limit

Slope = (7490-7480)/300 = 3.33% db to up

Land Use = grass, grazing

Shallow concentrated

Length = 900ft

Slope = (7480-7410)/900 = 7.8%

Land Use = grass, grazing

Concentrated Channel = None

TR 5

Prairie Ridge

Time of Concentration

Sub-basin E:

Sheet Flow

Length = 300ft use 100ft for upper limit of program

Slope = (7490 - 7485)/300 = 1.67%

Land Use = grass, grazing

Shallow concentrated

Length = 850ft

Slope = (7485 - 7415)/850 = 8.24%

Concentrated Channel - None

Prairie Ridge

Reach Data

TR-6

Reach 1 to Reach 2

Length = 600'

Mannings 'n' = grassy swale

Friction Slope (7450 - 7430)/600 = 3.33%

Bottom Width = 30'

Side slopes = 0.1 ft per ft

Reach 2 to Reach 3

Length = 300ft

Mannings "n" = grassy swale

Friction Slope = (7440 - 7435)/300 = 1.67%

Bottom Width = 30'

Side Slope = 0.1 ft per 1 ft

Reach 3 - Reach 4

Length = 300ft

Mannings = grassy swale

Slope = (7420 - 7415)/300 = 1.67%

Side slopes = 0.1 ft per ft

Reach 4

Length = 200 ft

Mannings = grassy swale

Slope = (7415 - 7410)/200 = 2.5%

Side slopes = 0.1 to 1

Rained Ridge

Structure Data

Existing Structure

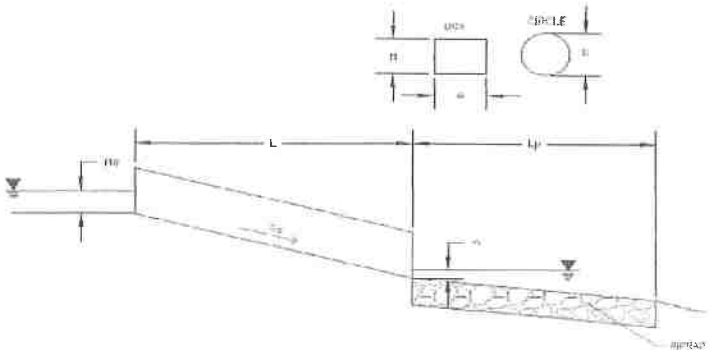
- There are 4 small beaver ponds that will have little impact on the runoff
- There is a relatively large pond at the outlet of the subdivision. Evaluating this is beyond the scope of this report

Exhibit 6
Culvert Capacity Exhibits

July 2020

Determination of Culvert Headwater and Outlet Protection

Project: Prairie Ridge: Existing culvert capacity
Basin ID: OS1



Soil Type:
Choose One:
(•) Sandy
( ) Non-Sandy

Design Information (Input):

	Design Discharge	Q = 20	cfs
Circular Culvert:			
	Barrel Diameter in Inches	D = 24	inches
	Inlet Edge Type (Choose from pull-down list)	Square End Projection	
Box Culvert:		**OR**	
	Barrel Height (Rise) in Feet	Height (Rise) =	ft
	Barrel Width (Span) in Feet	Width (Span) =	ft
	Inlet Edge Type (Choose from pull-down list)		
	Number of Barrels	No = 1	
	Inlet Elevation	Elev IN = 5100	ft
	Outlet Elevation **OR** Slope	So = 0.01	ft/ft
	Culvert Length	L = 60	ft
	Manning's Roughness	n = 0.022	
	Bend Loss Coefficient	k_b = 0	
	Exit Loss Coefficient	k_x = 1	
	Tailwater Surface Elevation	Elev Y_t = 5099.8	ft
	Max Allowable Channel Velocity	V = 18	ft/s

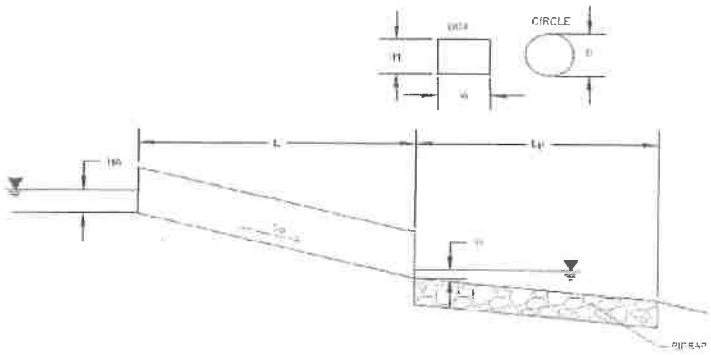
Required Protection (Output):

	Tailwater Surface Height	Y_t = 0.40	ft
	Flow Area at Max Channel Velocity	A_t = 4.44	ft^2
	Culvert Cross Sectional Area Available	A = 9.62	ft^2
	Entrance Loss Coefficient	k_e = 0.50	
	Friction Loss Coefficient	k_f = 1.01	
	Sum of All Losses Coefficients	k_s = 2.51	ft
	Culvert Normal Depth	Y_n = 2.08	ft
	Culvert Critical Depth	Y_c = 2.79	ft
	Tailwater Depth for Design	d = 3.15	ft
	Adjusted Diameter **OR** Adjusted Rise	D_a = -	ft
	Expansion Factor	1/(2*tan(Θ)) = 0.77	
	Flow/Diameter$^{2.5}$ **OR** Flow/(Span * Rise$^{1.5}$)	Q/D^2.5 = 3.49	$ft^{0.5}/s$
	Froude Number	Fr = -	Pressure flow!
	Tailwater/Adjusted Diameter **OR** Tailwater/Adjusted Rise	Yt/D = 0.11	
	Inlet Control Headwater	HW = 5.14	ft
	Outlet Control Headwater	HW_o = 5.24	
	Design Headwater Elevation	**HW = 5,105.24**	ft
	Headwater/Diameter OR Headwater/Rise Ratio	**HW/D = 1.50**	
	Minimum Theoretical Riprap Size	d_{50} = 46	in
	Nominal Riprap Size	d_{50} = -	in
	UDFCD Riprap Type	**Type = Very Big**	
	Length of Protection	**L_p = 11**	ft
	Width of Protection	**T = 18**	ft

July 2020

Determination of Culvert Headwater and Outlet Protection

Project: Prairie Ridge: proposed culvert at DP2 designed for 5yr storm
Basin ID: OS1



Soil Type:
Choose One:
(•) Sandy
( ) Non-Sandy

Design Information (Input):

Design Discharge	Q =	80	cfs
Circular Culvert:			
Barrel Diameter in Inches	D =	42	inches
Inlet Edge Type (Choose from pull-down list)		Square End Projection	
Box Culvert:		**OR**	
Barrel Height (Rise) in Feet	Height (Rise) =		ft
Barrel Width (Span) in Feet	Width (Span) =		ft
Inlet Edge Type (Choose from pull-down list)			
Number of Barrels	No =	1	
Inlet Elevation	Elev IN =	5100	ft
Outlet Elevation **OR** Slope	So =	0.01	ft/ft
Culvert Length	L =	60	ft
Manning's Roughness	n =	0.022	
Bend Loss Coefficient	k_b =	0	
Exit Loss Coefficient	k_y =	1	
Tailwater Surface Elevation	Elev Y_t =	5099.8	ft
Max Allowable Channel Velocity	V =	18	ft/s

Required Protection (Output):

Tailwater Surface Height	Y_t =	0.40	ft
Flow Area at Max Channel Velocity	A_t =	4.44	ft^2
Culvert Cross Sectional Area Available	A =	9.62	ft^2
Entrance Loss Coefficient	k_e =	0.50	
Friction Loss Coefficient	k_f =	1.01	
Sum of All Losses Coefficients	k_s =	2.51	ft
Culvert Normal Depth	Y_n =	2.08	ft
Culvert Critical Depth	Y_c =	2.79	ft
Tailwater Depth for Design	d =	3.15	ft
Adjusted Diameter **OR** Adjusted Rise	D_o =	-	ft
Expansion Factor	1/(2*tan(Θ)) =	0.77	
Flow/Diameter$^{2.5}$ **OR** Flow/(Span * Rise$^{1.5}$)	Q/D^2.5 =	3.49	$ft^{0.5}/s$
Froude Number	Fr =	-	Pressure flow!
Tailwater/Adjusted Diameter **OR** Tailwater/Adjusted Rise	Yt/D =	0.11	
Inlet Control Headwater	HW_i =	5.14	ft
Outlet Control Headwater	HW_o =	5.24	
Design Headwater Elevation	**HW =**	**5,105.24**	**ft**
Headwater/Diameter OR Headwater/Rise Ratio	**HW/D =**	**1.50**	
Minimum Theoretical Riprap Size	d_{50} =	46	in
Nominal Riprap Size	d_{50} =	-	in
UDFCD Riprap Type	**Type =**	**Very Big**	
Length of Protection	**L_p =**	**11**	**ft**
Width of Protection	**T =**	**18**	**ft**

Exhibit 7
Drainage Swale Hydraulics

Borrow Ditches and Onsite Swales

Developed Conditions

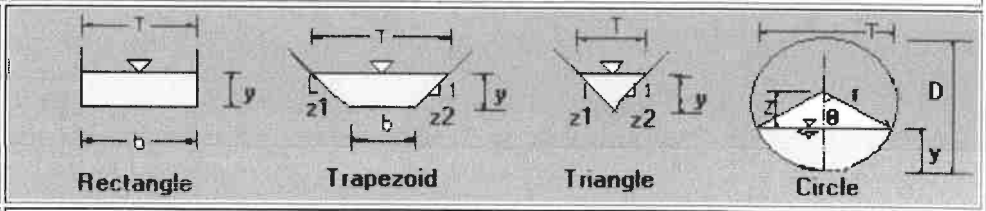
June 2021

Ditch/ Swale Location	Design Flow		Ave Slope %	Depth of Flow		Velocity		Froude #		Comments
	5 yr	100 yr		5 yr	100 yr	5 yr	100 yr	5 yr	100 yr	
	cfs	cfs	%	ft	ft	fps	fps			
Swale 1, Reach 1	72.4	289.7	3.33	1.1	2.7	2.1	3.6	0.35	0.39	TR55
Swale 1, Reach 2	79.0	318.1	1.67	1.5	3.5	1.8	3.0	0.26	0.28	TR55
Swale 1, Reach 3	83.3	341.0	1.67	1.5	3.7	1.8	3.1	0.26	0.23	TR55
Swale 1, Reach 4	87.0	360.4	2.50	1.4	3.3	2.1	3.6	0.29	0.23	TR55
Swale 2	2.7	16.7	6.50	0.1	0.4	0.7	1.6	0.37	0.46	Rational
Swale 3	5.0	31.0	7.10	0.2	0.5	1.0	2.0	0.41	0.51	Rational
Swale 4	1.5	9.1	8.30	0.1	0.2	0.6	1.3	0.40	0.48	Rational
Swale 5	1.0	6.4	7.10	0.1	0.2	0.5	1.1	0.37	0.43	Rational
BR1	1.8	3.6	5.10	0.2	0.3	3.0	3.7	1.24	1.30	Rational
BR2	1.6	3.2	2.90	0.3	0.4	2.3	2.9	0.93	1.00	Rational

June 2021 Rev
Reach 15yr

The open channel flow calculator

Select Channel Type: Trapezoid



Depth from Q

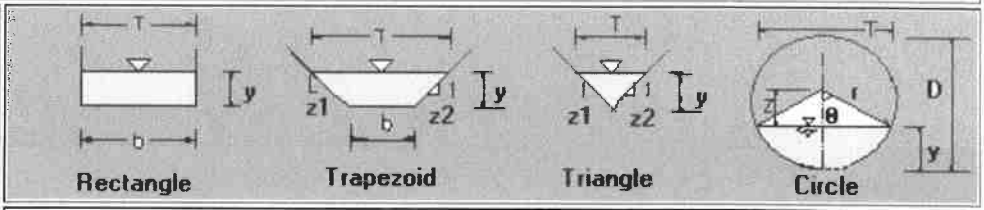
Select unit system: Feet(ft)

Channel slope: .033 ft/ft	Water depth(y): 1.13 ft	Bottom width(b) 30 ft
Flow velocity 2.133 ft/s	LeftSlope (Z1): 0.1 to 1 (H:V)	RightSlope (Z2): 0.1 to 1 (H:V)
Flow discharge 72.4 ft^3/s	Input n value 0.13 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 32.27 ft	Flow area 33.94 ft^2	Top width(T) 30.23 ft
Specific energy 1.2 ft	Froude number 0.35	Flow status Subcritical flow
Critical depth 0.57 ft	Critical slope 0.3061 ft/ft	Velocity head 0.07 ft

JUNE 2021
Reach 1-100yr

The open channel flow calculator

Select Channel Type: Trapezoid



Depth from Q

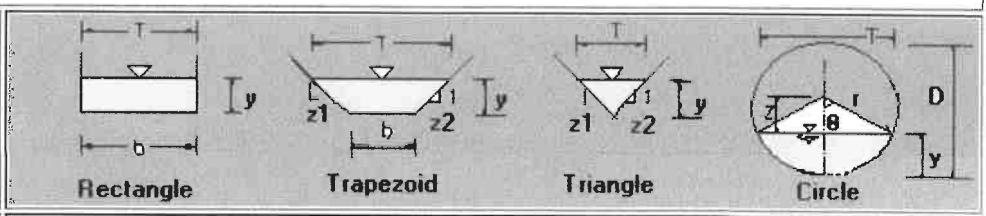
Select unit system: Feet(ft)

Channel slope: .033 ft/ft	Water depth(y): 2.67 ft	Bottom width(b) 30 ft
Flow velocity 3.591 ft/s	LeftSlope (Z1): 0.1 to 1 (H:V)	RightSlope (Z2): 0.1 to 1 (H:V)
Flow discharge 289.7 ft^3/s	Input n value 0.13 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 35.36 ft	Flow area 80.68 ft^2	Top width(T) 30.53 ft
Specific energy 2.87 ft	Froude number 0.39	Flow status Subcritical flow
Critical depth 1.43 ft	Critical slope 0.2431 ft/ft	Velocity head 0.2 ft

June 2021 Rev
Reach 2 - 5yr

The open channel flow calculator

Select Channel Type: Trapezoid



Depth from Q

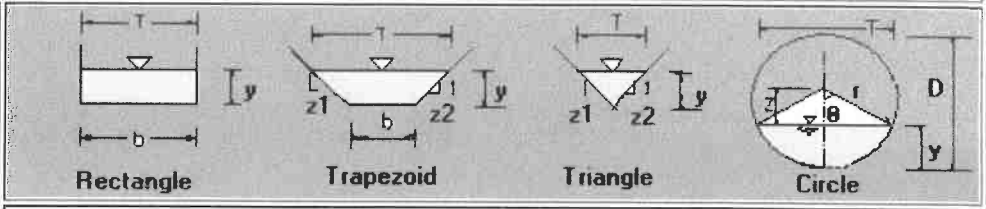
Select unit system: Feet(ft)

Channel slope: .0167 ft/ft	Water depth(y): 1.47 ft	Bottom width(b) 30 ft
Flow velocity 1.789 ft/s	LeftSlope (Z1): 0.1 to 1 (H:V)	RightSlope (Z2): 0.1 to 1 (H:V)
Flow discharge 79 ft^3/s	Input n value 0.13 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 32.94 ft	Flow area 44.17 ft^2	Top width(T) 30.29 ft
Specific energy 1.51 ft	Froude number 0.26	Flow status Subcritical flow
Critical depth 0.6 ft	Critical slope 0.3005 ft/ft	Velocity head 0.05 ft

June 2021 Rev
Read 2-100yr

The open channel flow calculator

Select Channel Type: Trapezoid



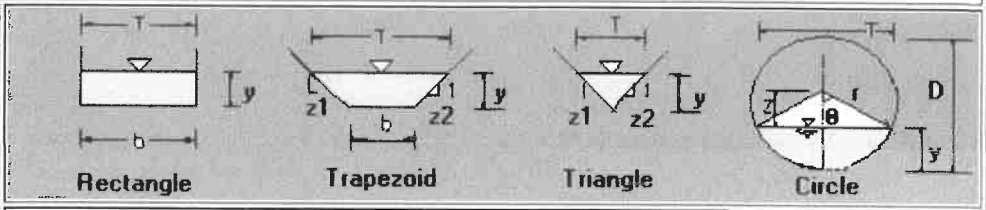
Depth from Q

Select unit system: Feet(ft)

Channel slope: .0167 ft/ft	Water depth(y): 3.52 ft	Bottom width(b) 30 ft
Flow velocity 2.988 ft/s	LeftSlope (Z1): 0.1 to 1 (H:V)	RightSlope (Z2): 0.1 to 1 (H:V)
Flow discharge 319.1 ft^3/s	Input n value 0.13 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 37.07 ft	Flow area 106.78 ft^2	Top width(T) 30.7 ft
Specific energy 3.66 ft	Froude number 0.28	Flow status Subcritical flow
Critical depth 1.52 ft	Critical slope 0.2405 ft/ft	Velocity head 0.14 ft

June 2021 Rev
Read 3-5yr

The open channel flow calculator

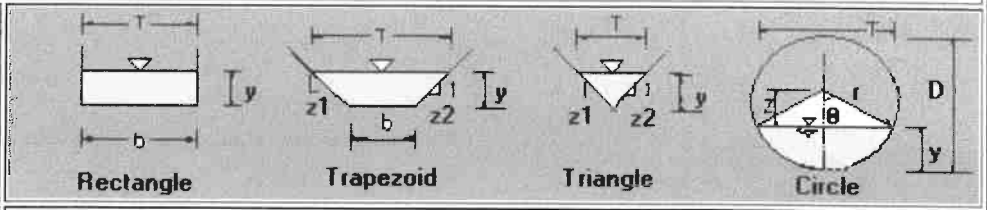
Select Channel Type: Trapezoid	
Depth from Q	Select unit system: Feet(ft)

Channel slope: .0167 ft/ft	Water depth(y): 1.51 ft	Bottom width(b) 30 ft
Flow velocity 1.825 ft/s	LeftSlope (Z1): 0.1 to 1 (H:V)	RightSlope (Z2): 0.1 to 1 (H:V)
Flow discharge 83.3 ft^3/s	Input n value 0.13 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 33.04 ft	Flow area 45.65 ft^2	Top width(T) 30.3 ft
Specific energy 1.57 ft	Froude number 0.26	Flow status Subcritical flow
Critical depth 0.62 ft	Critical slope 0.3008 ft/ft	Velocity head 0.05 ft

June 2021
Read 3 100yr

The open channel flow calculator

Select Channel Type: Trapezoid



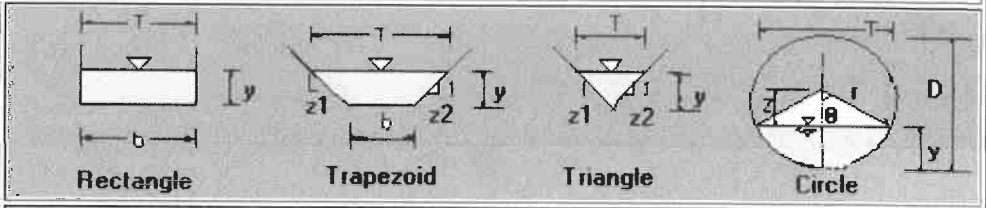
Depth from Q

Select unit system: Feet(ft)

Channel slope: .0167 ft/ft	Water depth(y): 3.67 ft	Bottom width(b) 30 ft
Flow velocity 3.06 ft/s	LeftSlope (Z1): 0.1 to 1 (H:V)	RightSlope (Z2): 0.1 to 1 (H:V)
Flow discharge 341 ft^3/s	Input n value 0.13 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 37.38 ft	Flow area 111.45 ft^2	Top width(T) 30.73 ft
Specific energy 3.82 ft	Froude number 0.28	Flow status Subcritical flow
Critical depth 1.59 ft	Critical slope 0.2382 ft/ft	Velocity head 0.15 ft

June 2021 Rev
Reach 4-5y

The open channel flow calculator

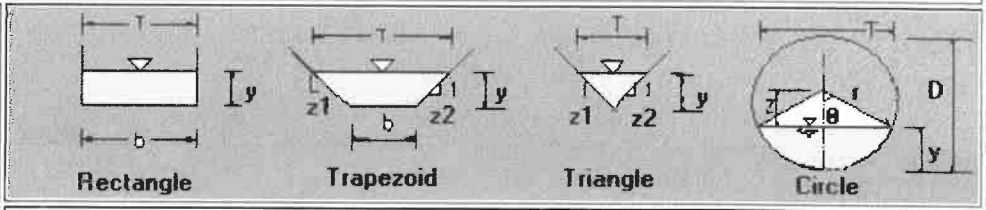
Select Channel Type: Trapezoid	
Depth from Q	Select unit system: Feet(ft)

Channel slope: .025 ft/ft	Water depth(y): 1.37 ft	Bottom width(b) 30 ft
Flow velocity 2.104 ft/s	LeftSlope (Z1): 0.1 to 1 (H:V)	RightSlope (Z2): 0.1 to 1 (H:V)
Flow discharge 87 ft^3/s	Input n value 0.13 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 32.76 ft	Flow area 41.35 ft^2	Top width(T) 30.27 ft
Specific energy 1.44 ft	Froude number 0.32	Flow status Subcritical flow
Critical depth 0.64 ft	Critical slope 0.2963 ft/ft	Velocity head 0.07 ft

June 202: Rev
Reach 4 100YR

The open channel flow calculator

Select Channel Type: Trapezoid



Depth from Q

Select unit system: Feet(ft)

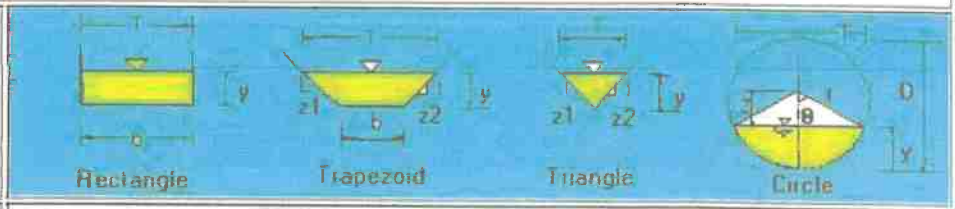
Channel slope: .025 ft/ft	Water depth(y): 3.34 ft	Bottom width(b) 30 ft
Flow velocity 3.555 ft/s	LeftSlope (Z1): 0.1 to 1 (H:V)	RightSlope (Z2): 0.1 to 1 (H:V)
Flow discharge 360.4 ft^3/s	Input n value 0.13 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 36.72 ft	Flow area 101.37 ft^2	Top width(T) 30.67 ft
Specific energy 3.54 ft	Froude number 0.34	Flow status Subcritical flow
Critical depth 1.65 ft	Critical slope 0.2366 ft/ft	Velocity head 0.2 ft

Swale 2

The open channel flow calculator

5yr

Select Channel Type:
Trapezoid



Depth from Q

Select unit system: Feet(ft)

Channel slope: .065 ft/ft	Water depth(y): 0.12 ft	Bottom width(b) 30 ft
Flow velocity 0.734394 ft/s	LeftSlope (Z1): 0.1 to 1 (H:V)	RightSlope (Z2): 0.1 to 1 (H:V)
Flow discharge 2.7 ft^3/s	Input n value 0.12 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 30.25 ft	Flow area 3.68 ft^2	Top width(T) 30.02 ft
Specific energy 0.13 ft	Froude number 0.37	Flow status Subcritical flow
Critical depth 0.06 ft	Critical slope 0.5142 ft/ft	Velocity head 0.01 ft

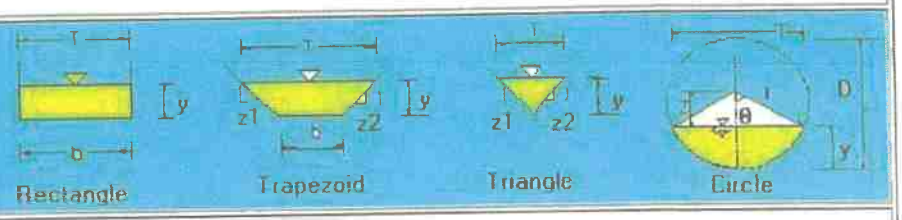
Swale 2-5yr

Swale 2

The open channel flow calculator

100 yr

Select Channel Type: Trapezoid



Depth from Q | Select unit system: Feet(ft)

Channel slope: .065 ft/ft	Water depth(y): 0.36 ft	Bottom width(b) 30 ft
Flow velocity 1.554386 ft/s	LeftSlope (Z1): 0.1 to 1 (H:V)	RightSlope (Z2): 0.1 to 1 (H:V)
Flow discharge 16.7 ft^3/s	Input n value 0.12 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 30.72 ft	Flow area 10.74 ft^2	Top width(T) 30.07 ft
Specific energy 0.4 ft	Froude number 0.46	Flow status Subcritical flow
Critical depth 0.22 ft	Critical slope 0.3419 ft/ft	Velocity head 0.04 ft

Swale 2
100 yr

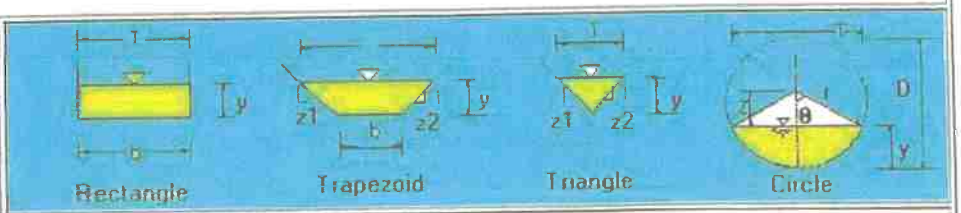
May 2021

Swale 3

5yr

The open channel flow calculator

Select Channel Type: Trapezoid



Depth from Q

Select unit system: Feet(ft)

Channel slope: .071 ft/ft	Water depth(y): 0.17 ft	Bottom width(b) 30 ft
Flow velocity 0.971262 ft/s	LeftSlope (Z1): 0.1 to 1 (H:V)	RightSlope (Z2): 0.1 to 1 (H:V)
Flow discharge 5 ft^3/s	Input n value 0.12 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 30.34 ft	Flow area 5.15 ft^2	Top width(T) 30.03 ft
Specific energy 0.19 ft	Froude number 0.41	Flow status Subcritical flow
Critical depth 0.1 ft	Critical slope 0.4206 ft/ft	Velocity head 0.01 ft

Swale 3

5yr

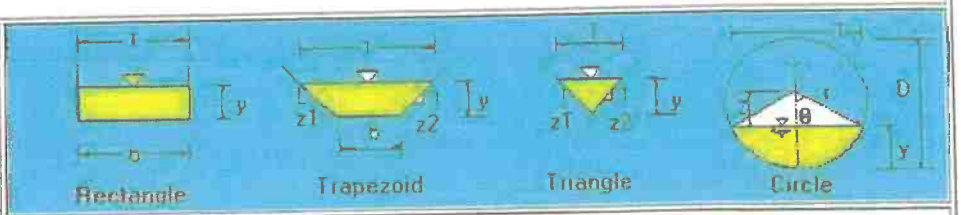
May 2021

Swale 3

The open channel flow calculator

100yr

Select Channel Type: Trapezoid



Depth from Q

Select unit system: Feet(ft)

Channel slope: .071 ft/ft	Water depth(y): 0.5 ft	Bottom width(b) 30 ft
Flow velocity 2.044 ft/s	LeftSlope (Z1): 0.1 to 1 (H:V)	RightSlope (Z2): 0.1 to 1 (H:V)
Flow discharge 31 ft^3/s	Input n value 0.12 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 31.01 ft	Flow area 15.17 ft^2	Top width(T) 30.1 ft
Specific energy 0.57 ft	Froude number 0.51	Flow status Subcritical flow
Critical depth 0.32 ft	Critical slope 0.3075 ft/ft	Velocity head 0.06 ft

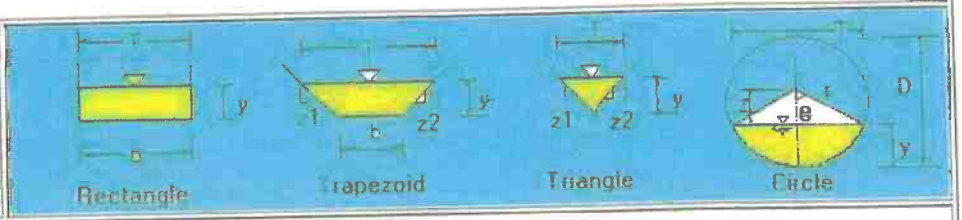
Swale 3
100yr

May 2021

Swale 4
5yr

The open channel flow calculator

Select Channel Type:
Trapezoid



Depth from Q

Select unit system: Feet(ft)

Channel slope: .083 ft/ft	Water depth(y): 0.08 ft	Bottom width(b) 30 ft
Flow velocity 0.637588 ft/s	LeftSlope (Z1): 0.1 to 1 (H:V)	RightSlope (Z2): 0.1 to 1 (H:V)
Flow discharge 1.5 ft^3/s	Input n value 0.12 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 30.16 ft	Flow area 2.35 ft^2	Top width(T) 30.02 ft
Specific energy 0.08 ft	Froude number 0.4	Flow status Subcritical flow
Critical depth 0.04 ft	Critical slope 0.5399 ft/ft	Velocity head 0.01 ft

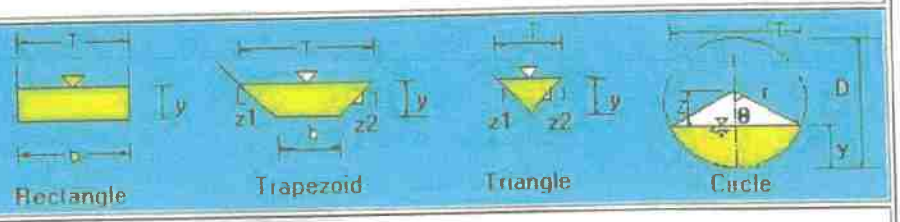
Swale 4
5 year

May 2021

Swale 4
100yr

The open channel flow calculator

Select Channel Type: Trapezoid



Depth from Q

Select unit system: Feet(ft)

Channel slope: .083 ft/ft	Water depth(y): 0.23 ft	Bottom width(b) 30 ft
Flow velocity 1.316112 ft/s	LeftSlope (Z1): 0.1 to 1 (H:V)	RightSlope (Z2): 0.1 to 1 (H:V)
Flow discharge 9.1 ft^3/s	Input n value 0.12 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 30.46 ft	Flow area 6.91 ft^2	Top width(T) 30.05 ft
Specific energy 0.26 ft	Froude number 0.48	Flow status Subcritical flow
Critical depth 0.14 ft	Critical slope 0.4052 ft/ft	Velocity head 0.03 ft

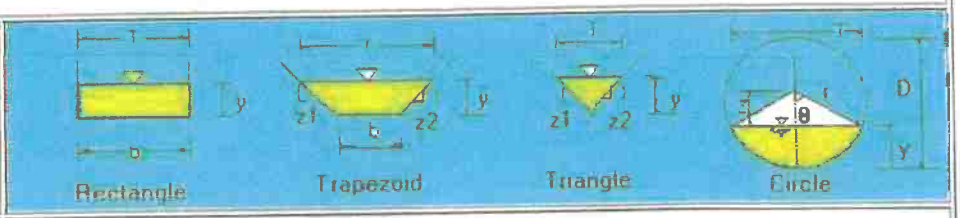
Swale 4
100yr

May 2021

Swale 5
5yr

The open channel flow calculator

Select Channel Type: Trapezoid



Depth from Q

Select unit system: Feet(ft)

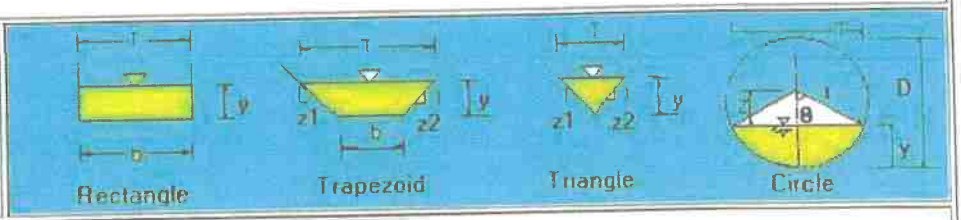
Channel slope: 0.071 ft/ft	Water depth(y): 0.06 ft	Bottom width(b) 30 ft
Flow velocity 0.523175 ft/s	LeftSlope (Z1): 0.1 to 1 (H:V)	RightSlope (Z2): 0.1 to 1 (H:V)
Flow discharge 1 ft^3/s	Input n value 0.12 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 30.13 ft	Flow area 1.91 ft^2	Top width(T) 30.01 ft
Specific energy 0.07 ft	Froude number 0.37	Flow status Subcritical flow
Critical depth 0.03 ft	Critical slope 0.5541 ft/ft	Velocity head 0 ft

Swale 5
5yr

May 2021

Swale 5,
100 year

The open channel flow calculator

Select Channel Type: Trapezoid	
Depth from Q	Select unit system: Feet(ft)

Channel slope: 0.071 ft/ft	Water depth(y): 0.2 ft	Bottom width(b) 30 ft
Flow velocity 1.087725 ft/s	LeftSlope (Z1): 0.1 to 1 (H:V)	RightSlope (Z2): 0.1 to 1 (H:V)
Flow discharge 6.4 ft^3/s	Input n value 0.12 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 30.39 ft	Flow area 5.88 ft^2	Top width(T) 30.04 ft
Specific energy 0.21 ft	Froude number 0.43	Flow status Subcritical flow
Critical depth 0.11 ft	Critical slope 0.433 ft/ft	Velocity head 0.02 ft

Swale 5
100 year

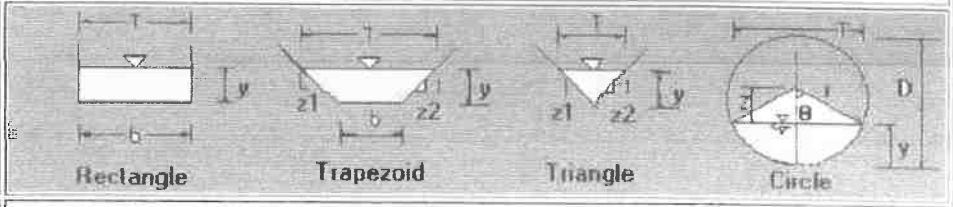
May 2021

May 2021 Submitted
North Brown Rd Ditch

The open channel flow calculator

5yr
BQ2

Select Channel Type: Trapezoid



Depth from Q | Select unit system: Feet(ft)

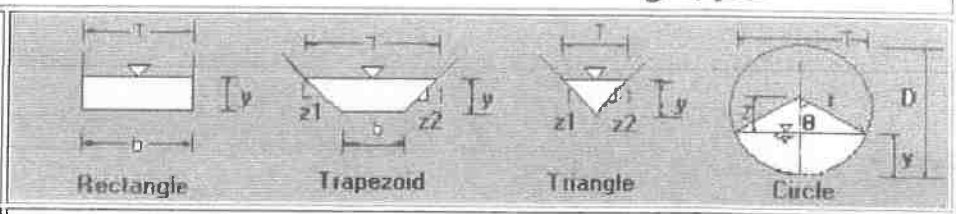
Channel slope: .029 ft/ft	Water depth(y): 0.25 ft	Bottom width(b) 2 ft
Flow velocity 2.328458 ft/s	LeftSlope (Z1): 3 to 1 (H:V)	RightSlope (Z2): 3 to 1 (H:V)
Flow discharge 1.6 ft^3/s	Input n value 0.035 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 3.58 ft	Flow area 0.69 ft^2	Top width(T) 3.5 ft
Specific energy 0.33 ft	Froude number 0.93	Flow status Subcritical flow
Critical depth 0.24 ft	Critical slope 0.0314 ft/ft	Velocity head 0.08 ft

North P.L.
Brown Rd Bottom
5yr
Sub Basin B2

May 2021 Submittal
North Brown Rd Ditch
100 year
BZ

The open channel flow calculator

Select Channel Type: Trapezoid



Depth from Q | Select unit system: Feet(ft)

Channel slope: .029 ft/ft	Water depth(y): 0.36 ft	Bottom width(b) 2 ft
Flow velocity 2.911081 ft/s	LeftSlope (Z1): 3 to 1 (H:V)	RightSlope (Z2): 3 to 1 (H:V)
Flow discharge 3.2 ft^3/s	Input n value 0.035 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 4.26 ft	Flow area 1.1 ft^2	Top width(T) 4.15 ft
Specific energy 0.49 ft	Froude number 1	Flow status Critical flow
Critical depth 0.36 ft	Critical slope 0.0286 ft/ft	Velocity head 0.13 ft

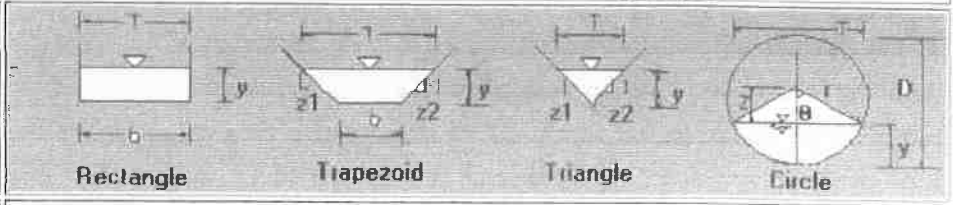
North P.L.
Brown Rd Borrow D
100yr
sub basin BZ

May 2021 Submit Brown Rd Borrow Ditch
West Side

The open channel flow calculator

5 year
BR1

Select Channel Type: Trapezoid



Depth from Q

Select unit system: Feet(ft)

Channel slope: .051 ft/ft	Water depth(y): 0.23 ft	Bottom width(b) 2 ft
Flow velocity 2.984008 ft/s	LeftSlope (Z1): 3 to 1 (H:V)	RightSlope (Z2): 3 to 1 (H:V)
Flow discharge 1.8 ft^3/s	Input n value .035 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 3.43 ft	Flow area 0.6 ft^2	Top width(T) 3.35 ft
Specific energy 0.36 ft	Froude number 1.24	Flow status Supercritical flow
Critical depth 0.26 ft	Critical slope 0.0299 ft/ft	Velocity head 0.14 ft

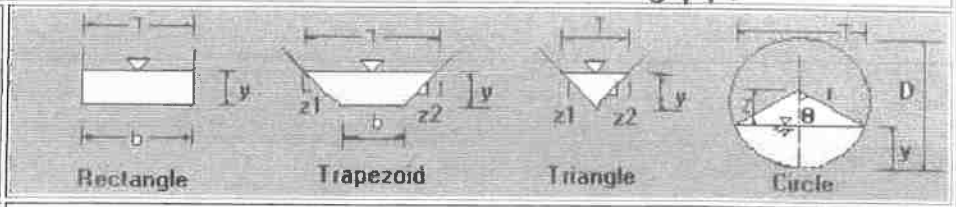
West Side
Brown Rd Borrow
5 year
Sub Basin B1

May 2021 Brown Rd
Borrow Ditch

The open channel flow calculator

100 year
BR1

Select Channel Type: Trapezoid



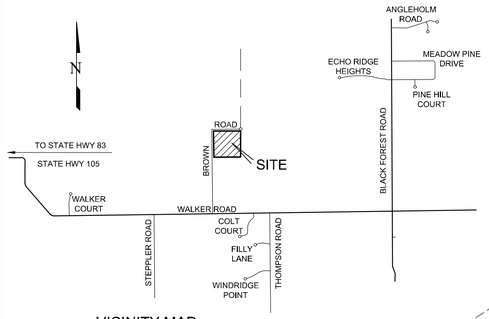
Depth from Q

Select unit system: Feet(ft)

Channel slope: .051 ft/ft	Water depth(y): 0.33 ft	Bottom width(b) 2 ft
Flow velocity 3.673684 ft/s	LeftSlope (Z1): 3 to 1 (H:V)	RightSlope (Z2): 3 to 1 (H:V)
Flow discharge 3.6 ft^3/s	Input n value .035 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 4.08 ft	Flow area 0.98 ft^2	Top width(T) 3.97 ft
Specific energy 0.54 ft	Froude number 1.3	Flow status Supercritical flow
Critical depth 0.38 ft	Critical slope 0.0282 ft/ft	Velocity head 0.21 ft

West Side
Brown Rd Borrow D
100 yr
Sub Basin B1

Exhibit 8
Drainage Map for Historic Conditions
(Inside map pocket)



VICINITY MAP
N.T.S

N

200 0 200 400

SCALE: 1" = 200'

LEGEND

EX. ACREAGE — A / 131.6 — EX. BASIN DESIGNATION

EX. BASIN BOUNDARY

1 — EX. DESIGN POINT

OWNER:

Clovis Point CO, LLC
13395 Voyager Parkway, Suite 130, PMB 2035
Colorado Springs, Colorado 80921

LEGAL:

SOUTHEAST ONE QUARTER OF THE SOUTHEAST ONE QUARTER OF SECTION 12, TOWNSHIP 11 SOUTH, RANGE 66 WEST OF THE 6TH P.M., COUNTY OF EL PASO, STATE OF COLORADO.

SPRUCE HILL

OS-1 / 211.6

905' AT 9.9%

721' AT 5.5%

1181' AT 3.4%

1192' AT 2.6%

POND

EXISTING 24" CMP @ 0.50% (TO BE REPLACED)

SWALE 1

TR55 REACH 1

S89°04'51"W 1335.15'

TR55 REACH 2

TR55 REACH 3

UNPLATTED

BROWN ROAD (60' ROW)

N89°01'29"E 1337.46'

20' GRANT OF RIGHT OF WAY AND EASEMENT (Reception No. 204050417)

N00°13'51"W 1325.56'

UNPAVED ROAD

478' AT 2.2%

525' AT 2.1%

509' AT 22.6%

1500' AT 2.0%

346' AT 7.3%

1326.90'

S00°07'55"E

841' AT 7.1%

480' AT 8.3%

225' AT 15.7%

289' AT 10.4%

200' AT 12.5%

872' AT 6.5%

1187' AT 5.1%

922' AT 5.9%

930' AT 6.5%

615' AT 4.5%

STRUCTURE

CULVERT

TR55 OUTLET

Design Point	Sub Basins	Area (Acres)	Runoff Method	Runoff 5 year (cfs)	Runoff 100 year (cfs)
Individual Sub basin and Cumulative Runoff at Design Points					
Historic Conditions					
1	**OS-1**	**211.6**	**TR55**	**69.6**	**279.5**
	A	10.7	Rational	2.2	15.8
2	**OS-1, A**	**222.3**	**TR55**	**72.2**	**289.3**
	OS-2	31.8	Rational	6.4	46.9
3	**OS-1, A, OS-2**	**254.1**	**TR55**	**78.7**	**318.5**
	B	19.6	Rational	4.0	29.3
4	**OS-1, A, OS-2, B**	**273.7**	**TR55**	**82.7**	**393.4**
	C	5.3	Rational	1.2	8.6
5	**OS-3**	**12.1**	**Rational**	**3.0**	22.2
	OS3, D	13.6	Rational	2.5	18.2
6	**OS-1, A, OS2, B, C, OS3, D**	**292.6**	**TR55**	**86.2**	**358.5**
7	**E**	**3.7**	**Rational**	**0.8**	**6.0**

Notes:
1. Average Runoff Coefficients for the Rational method and average Curve Numbers for the TR55 method were not determined for the cummulative flows listed above
2. Both the Runoff Coefficients for the Rational Method and the Curve Numbers for the TR55 Method are shown since both were used in determining the runoff for individual sub basins (Rational Method) and for the determining cumulative flows (TR55)

NOT FOR CONSTRUCTION:

THESE PLANS ARE INTENDED FOR SUBMITTAL, REVIEW AND APPROVAL BY CITY/COUNTY PLANNING DEPARTMENTS AND SHALL NOT BE USED ON SITE FOR CONSTRUCTION OR LAYOUT.

REVISIONS

No.	Description	By	Date

H Scale: 1"=200'
V Scale:
Designed By: SLG
Drawn By:
Checked By: KH
Date: 05/03/19

Land Development Consultants, Inc.
Planning • Landscape Architecture
Engineering • Surveying
www.ldc-inc.com • TEL: (719) 528-6133 • FAX: (719) 528-6848
2850 Serendipity Circle West • Colorado Springs, CO 80917

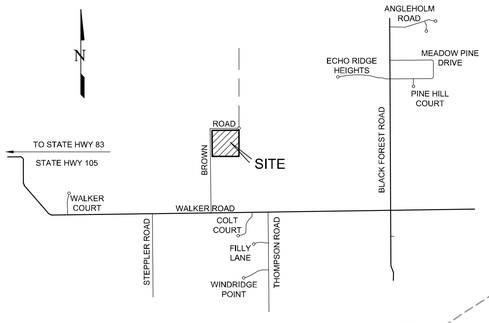
HISTORIC DRAINAGE
PRAIRIE RIDGE
EL PASO COUNTY, COLORADO

Project Number: 07051

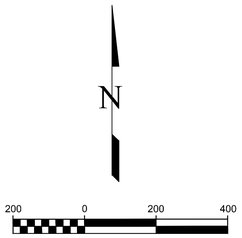
Sheet: 1 of 2

Z:\61141_Outside Dwgs\LDC Folder\20210519\07051-Drainage-MVE.dwg 25 Oct 2021

Exhibit 9
Drainage Map for Developed Conditions
(Inside map pocket)



VICINITY MAP
N.T.S



SCALE: 1" = 200'

LEGEND

A — EX. BASIN DESIGNATION
131.6 — EX. ACREAGE
EX. BASIN BOUNDARY
1 — EX. DESIGN POINT

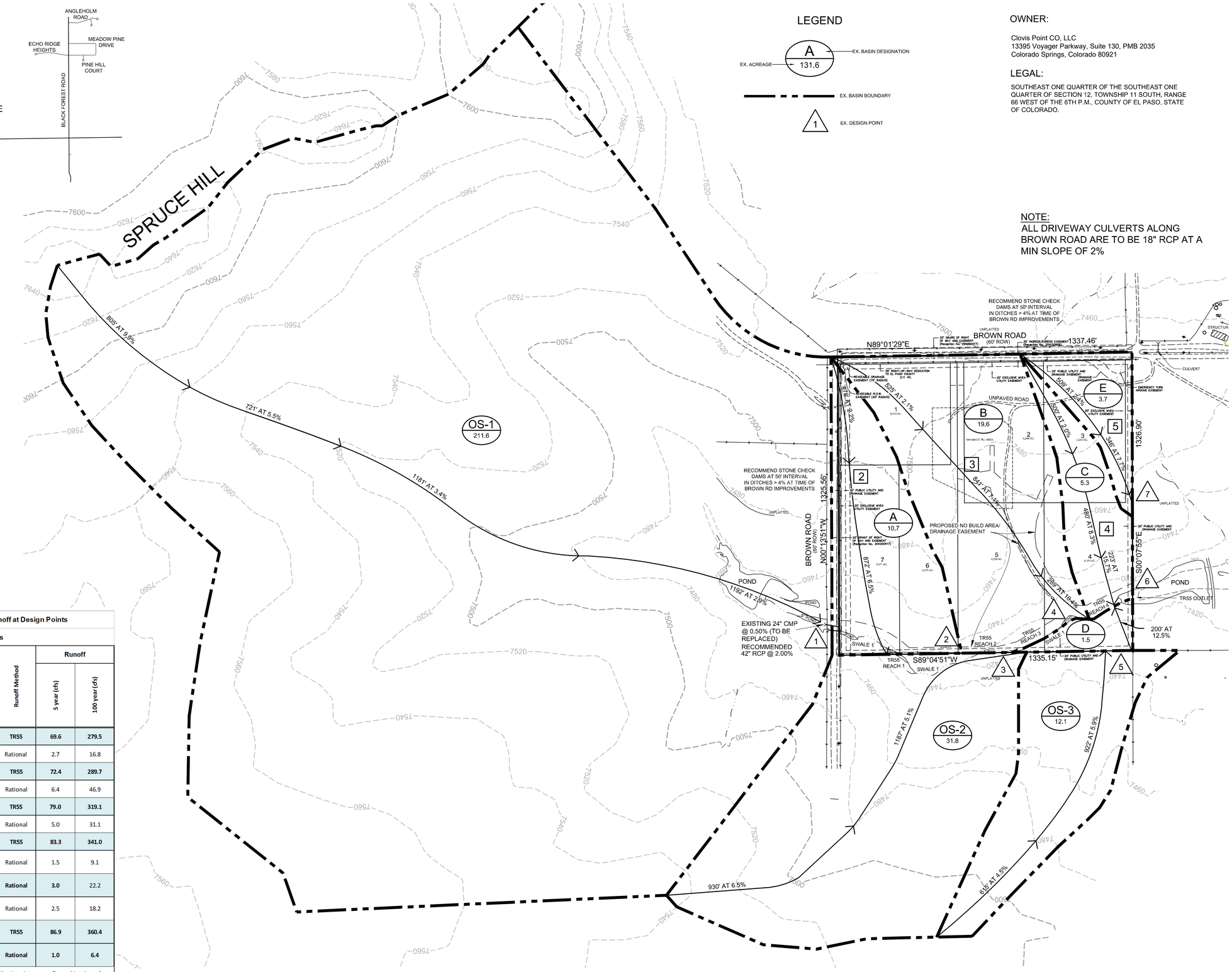
OWNER:

Clovis Point CO, LLC
13395 Voyager Parkway, Suite 130, PMB 2035
Colorado Springs, Colorado 80921

LEGAL:

SOUTHEAST ONE QUARTER OF THE SOUTHEAST ONE QUARTER OF SECTION 12, TOWNSHIP 11 SOUTH, RANGE 66 WEST OF THE 6TH P.M., COUNTY OF EL PASO, STATE OF COLORADO.

NOTE:
ALL DRIVEWAY CULVERTS ALONG BROWN ROAD ARE TO BE 18" RCP AT A MIN SLOPE OF 2%



Individual Sub basin and Cumulative Runoff at Design Points

Developed Conditions

Design Point	Sub Basins	Area (Acres)	Runoff Method	Runoff 5 year (cfs)	Runoff 100 year (cfs)
1	**OS-1**	**211.6**	**TR55**	**69.6**	**279.5**
	A	10.7	Rational	2.7	16.8
2	**OS-1, A**	**222.3**	**TR55**	**72.4**	**289.7**
	OS-2	31.8	Rational	6.4	46.9
3	**OS-1, A, OS-2**	**254.1**	**TR55**	**79.0**	**319.1**
	B	19.6	Rational	5.0	31.1
4	**OS-1, A, OS-2, B**	**273.7**	**TR55**	**83.3**	**341.0**
	C	5.3	Rational	1.5	9.1
5	**OS-3**	**12.1**	**Rational**	**3.0**	22.2
	OS3, D	13.6	Rational	2.5	18.2
6	**OS-1, A, OS2, B, C, OS3, D**	**292.6**	**TR55**	**86.9**	**360.4**
7	**E**	**3.7**	**Rational**	**1.0**	**6.4**

Notes:
1. Average Runoff Coefficients for the Rational method and average Curve Numbers for the TR55 method were not determined for the cummulative flows listed above
2. Both the Runoff Coefficients for the Rational Method and the Curve Numbers for the TR55 Method are shown since both were used in determining the runoff for individual sub basins (Rational Method) and for the determining cumulative flows (TR55)

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REVISIONS

No.	Description	By	Date

H Scale: 1"=200'
V Scale:
Designed By: SLG
Drawn By:
Checked By: KH
Date: 05/03/19

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DEVELOPED DRAINAGE PRAIRIE RIDGE

EL PASO COUNTY, COLORADO

Project Number: 07051

Sheet: 2 of 2

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