Final Drainage Report

Prairie Ridge Subdivision

April 5, 2019

Add PCD File No. SF2010

Prepared for:

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Job No: 2019-104

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APPENDIX

Certifications and Approvals

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 had been prepared according to the criteria established by El Paso County for drainage reports and said drainage report is in conformity with the master plan of the drainage basin, I accept responsibility for any liability caused by any negligent acts, errors or omission on my part in preparation this report

Signature _____
(Kenneth C. Harrison, P.E.)

Registered Professional Engineer State of Colorado No. _____

Seal

Please revise to the following:
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.

Owner's Statement

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

_____
(Print Entity Name)

By: _____
Title: _____

Address: _____

_____
_____

El Paso County Engineer/ECM Administrator

El Paso County

Filed in accordance with _____ of the _____, as amended

El Paso County Engineer

_____
(Print name) *(Signature)*

Date: _____

Jennifer Irvine, P.E.

I. REPORT PURPOSE

The purpose of this study is to evaluate the drainage characteristics for both the existing and developed conditions of the Prairie Ridge Subdivision in accordance the current El Paso County Drainage Criteria. A drainage study and report was 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 this meeting 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 criteria changes that impact this report are:

- Design storm for the minor event was changed from the 10 year to the 5 year storm
- 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 in the 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 (see 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 fairly 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. Brown Road improvements, where significant grading is proposed (northwest and northeast corners of the site), have been provided with stone check dams (see Appendix, Exhibit 7) and silt fence. 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.

use the latest urban drainage manual

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 the pertinent sections of the Appendix.

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

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

  - ***Urban Storm Drainage Criteria Manual, Urban Storm & Flood Control District, Copyright 2005.***

  - ***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 with less 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 sites 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.
  - 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
  - Subcritical for both the minor and major storm events.

- **Detention/ Water Quality Pond**
  Basis of evaluation:
  - Urban Drainage Flood Control Manual
    A pond will not be required due to insignificant increase in runoff from the developed condition (see Summary Tables on both the Historic and Developed Drainage Plans, inside map pocket)

Please address water quality. Why is it not provided for the development? Be sure to site the ECM criteria for the developed lots and work to be done on Brown Road. Refer to ECM appendix I (see I.7.1) Note that appendix I was revised on July 2019 and can be found on the County website (https://assets-planningdevelopment.elpasoco.com/wp-content/uploads/Engineering/EngineeringDocuments/ECM-Revision-July-2019-Implementation-Directive-6.20.19.pdf)

- ***Erosion control***
  - Stone check dams along section of Brown Road adjacent to the northerly property line. These improvements were designed in accordance with the Colorado Department of Transportation (CDOT) criteria
  - Riprap apron at the culvert outfall at Design Point 1

IV. EXISTING REPORTS, MAPPING AND INFORMATION

- The project lies within the East Cherry Creek Drainage Basin. There is no drainage fee 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, El Paso County, Colorado and Incorporated Areas, Panel 325 of 1300; Map Number 08041C0305 G, Effective Date December 7, 2018 (see Appendix, Exhibit 2).

VI. HYDROLOGIC SOILS INFORMATION

The hydrologic soils groups were obtained from the USDA National Resource Conservation Service website for soils types in El Paso County, Colorado (see 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 characteristic 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

There is a stock pond located immediately downstream of the subdivision at Design Point 6. Analysis of the hydraulic and structural characteristics of the pond is outside the scope of this report. I appears, based on visual observations that the swale downstream of the pond is relatively stable.

Please indicate whether or not the pond appears adequate for your developed flows. Is any protection required where the developed flow enters the pond?

DP 1 is at the southwest corner of the site.

VIII. HISTORIC OFFSITE CONDITIONS

- **Basin OS-1 (based on 2% Impervious)**
  Sub basin OS-1 is approximately 211.8-acres, and extends from the westerly boundary of the site to the top of the watershed at Spruce Hill to the west. The topography within the basin ranges from 9.9% near Spruce Hill to 2.9% near the site 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. This basin comprises the primary source of flow in the existing channel. A stock pond exists within this channel, immediately upstream from the site (Design Point 1) on the westerly side of Brown Road. At the southeast corner of the site, flows from this basin are evaluated at Design Point 1 (DP1).

  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 = 211.8 acres
  - Curve Numbers = 69 (see Appendix, Exhibit 5). These values presented in this table 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
  - Estimated Runoff (TR 55)
    Minor storm (5 year) = 69.6 cfs
    Major Storm (100 year) = 279.5 cfs

- **Basin OS-2 (based on 2% Impervious)**
  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 south of the site boundary. For this reason, flow from this basin is extended via the channel to the site boundary. At this point, flows are evaluated at Design Point 3 (DP3), where runoff from Basin OS-1 and Basin A combines with that from Basin OS-2.

  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 = 31.8 acre
  - Runoff Coefficients (see Appendix, Exhibit 4)
    Minor (5 year) storm = 0.02

Major (100 year) storm = 0.44

- Time of Concentration: 26.7 minutes

- Estimated Runoff:
  Minor storm (5 year) = 1.6 cfs
  Major Storm (100 year) = 58.6 cfs

- **Basin OS-3 (based on 2% Impervious)**
  Basin OS-3 is approximately 12.1-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 sites southeast corner. Runoff from this basin flows to the northeast, and intersects the site near its southeast corner. At this point, flows are evaluated at Design Point 5 (DP5).

  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 12.1 acres

  - Runoff Coefficients
    Minor (5 year) storm = 0.02
    Major (100 year) storm = 0.44

  - Time of Concentration: 31.6 minutes

  - Estimated Runoff:
    Minor storm (5 year) = 0.3 cfs
    Major Storm (100 year) = 22.7 cfs

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

IX. HISTORIC ONSITE DRAINAGE CONDITIONS

- **General**

  The site is bounded to the north and west by Brown Road and to the south and east by undeveloped agricultural land. A defined drainage channel 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 sub-basins are described in the previous section. The historic conditions of the onsite basins are described in more detail below, along with the associated runoff.

- **Sub-basin A (historic) (based on 2% Impervious)**

  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 are 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.

  - Area 10.7 acres
  - Runoff Coefficients (see Appendix, Exhibit 4)
    Minor storm (5 year): 0.02
    Major Storm (100 year): 0.44
  - Time of Concentration: 26.7 minutes
  - Estimated Runoff
    Minor storm (5 year): 0.3 cfs
    Major Storm (100 year): 19.7 cfs

  Please also list the values for comparison. Typical

  The rational method runoff coefficients indicated for the historic conditions do not match those listed in DCMV1 table 6-6. Please revise the design calculations accordingly.

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

- **Sub-basin B (historic) (based on 2% Impervious)**

  Sub-basin B is approximately 19.6-acres, and drains the central portion of the site. 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 are evaluated at Design Point 4 (DP4), where runoff from Basins OS-1, OS-2, and Basin A combines with that 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 (see Appendix, Exhibit 4)
  Minor storm (5 year): 0.02
  Major Storm (100 year): 0.44
- Time of Concentration: 26.1 minutes
- Estimated Runoff
  Minor storm (5 year): 0.6 cfs
  Major Storm (100 year): 36.6 cfs

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

- **Sub-basin C (historic) (based on 2% Impervious)**
  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 combine 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 (see Appendix, Exhibit 4)
    Minor storm (5 year): 0.02
    Major Storm (100 year): 0.44
  - Time of Concentration: 22.6 minutes
  - Estimated Runoff

Minor storm (5 year): 0.2 cfs
Major Storm (100 year): 10.7 cfs

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

- **Sub-basin OS-3 and D (historic) (based on 2% Impervious)**
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 D is approximately 1.5 acres. The sub basins drains 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 utilized with the following hydrologic parameters and characteristics. They were compared with those determined by the TR55 Method.

  - Area = 12.1 areas

  - Runoff Coefficients (see Appendix, Exhibit 4)
    Minor storm (5 year): 0.02
    Major Storm (100 year): 0.44

  - Time of Concentration: 31.6 minutes

  - Estimated Runoff
    Minor storm (5 year): 0.4 cfs
    Major Storm (100 year): 22.7 cfs

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

- **Sub-basin E (historic) (based on 2% Impervious)**
Sub-basin E is approximately 3.7-acres, and drains the northeast corner of the site. 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 (DP7).

  Since this sub basin is less than 130 acres, the Rational Method was utilized with the following hydrologic parameters and characteristics;

- Area = 3.7 acres

- Runoff Coefficients (see Appendix, Exhibit 4)
  Minor storm (5 year): 0.02
  Major Storm (100 year): 0.44

- Time of Concentration: 22.4 minutes

- Estimated Runoff
  Minor storm (5 year): 0.9 cfs
  Major Storm (100 year): 7.5 cfs

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

- **All Offsite and Onsite Sub-basins (historic) (based on 2% Impervious)**
  All runoff from the sub-basins described above 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 method was utilized to determine the following hydrologic characteristics:

  - Drainage area = 296.3 acres

  - Curve Number = 69 (based on an imperviousness of 2%) (see Appendix, Exhibit 4)

  - Estimated Runoff
    Minor storm (5 year) = 85.7 cfs
    Major Storm (100 year) = 356 cfs

X. EXISTING DRAINAGE FACILITIES

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 (design point 1). The stormwater runoff at this location was estimated to be:

- Minor storm = 69.6 cfs
- Major storm = 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 a limited evaluation of the culvert, the hydraulic conditions are as follows:

- The culvert has a capacity of 20.5 cfs (see Appendix, Exhibit 6). This is based on a headwater to depth ratio of 1.5. This provides an upstream depth of 3.6 feet.
- The culvert is operating under inlet control since the downstream depth is anticipated to be negligible.
- The velocity in the culvert was not determined since the slope was not determined.

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 seriously 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 the subdivision improvements.

The rational method runoff coefficients indicated for the proposed areas do not match those listed in DCMV1 table 6-6. Please revise the design calculations accordingly.

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 will remain the same under the developed conditions as described Section VIII of this report.

- **Onsite Sub-basin Characteristics for Developed Conditions**
  General (developed)
  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. The following is a summary of how the runoff coefficients for the developed conditions were calculated:

  - Drainage areas (same as the original report)
    - Typical total lot area = 5 acres or 217,800 square feet
    - Average house footprint = 4,000 square feet
    - Average area for driveways, patios, walk ways = 2,500 square feet
    - Average area to remain in its existing condition = 210,100 square feet

  - Runoff Coefficients (C) and Curve Numbers
    Typically, published design tables for use with the Rational Method and the NCRS Method do not provide runoff coefficients for 5 acre developments. As a result the composite coefficients for these methods were determined as follows:

    - Average house footprint = 4,000 square feet
      - % Impervious (90%) (see Appendix,Exhibit 4)
      - Rational Method: Minor storm (5 year) runoff coefficient: 0.76 (see Appendix, Exhibit 4)
      - Rational Method: Major storm (100 year) runoff coefficient: 0.84 (see Appendix, Exhibit 4)
      - NCRS Curve Number = 98

    - Average area for driveways, patios, and walk ways = 2,500 square feet
      - % Impervious (90%) (see Appendix, Exhibit 4)
      - Rational Method: Minor storm (5 year) runoff coefficient: 0.76 (see Appendix, Exhibit 4)
      - Rational Method: Major storm (100 year) runoff coefficient: 0.84 (see Appendix, Exhibit 4)
      - NCRS Curve Number = 98

- Average area for lawn/ landscaping = 1,200 square feet (2% impervious) (see Table 6-3)

Per table 6-6 of DCM vol 1, drives and walks are considered 100% impervious. Please revise your calculations

- % Impervious (2%) (see Appendix, Exhibit 4)
- Rational Method: Minor storm (5 year) runoff coefficient: 0.01 (see Appendix, Exhibit 4)
- Rational Method: Major storm (100 year) runoff coefficient: 0.44 (see Appendix, Exhibit 4)
- NCRS Curve Number = 69

- Average area to remain in its existing condition = 210,100 square feet
  % Impervious (2%) (see Table 6-3)
  - Rational Method: Minor storm (5 year) runoff coefficient: 0.01 (see Appendix, Exhibit 4)
  - Rational Method: Major storm (100 year) runoff coefficient: 0.44 (see Appendix, Exhibit 4)
  - NCRS Curve Number = 48,
    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".

See comment on % impervious calculation and revise accordingly.

- Composite Runoff Coefficients and Curve Numbers (developed conditions)
  Based on the above assumptions the following **composite runoff coefficients** were estimated as follows:

  - % Impervious = 2.5% (developed conditions) (see Appendix, Exhibit 4)
  - Rational Method: Minor storm (5 year) runoff coefficient: 0.03 (developed conditions) (see Appendix, Exhibit 4)
  - Rational Method: Major storm (100 year) runoff coefficient: 0.45 (developed conditions) (see Appendix, Exhibit 4)
  - NCRS Curve Number = 50

- Existing Conditions (for comparison purposes)
  - % Impervious = 2%
  - Rational Method: Minor storm (5 year) runoff coefficient: 0.01 (existing conditions) (see Appendix, Exhibit 4)
  - Rational Method: Major storm (100 year) runoff coefficient: 0.44 (existing conditions) (see Appendix, Exhibit 4)
  - NCRS Curve Number = 48 (see Appendix, Exhibit 5)

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

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

- 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)**
  - Design point = 2
  - Drainage Area = 10.7 acres
  - Runoff Coefficients
    - % Impervious = 2.5
    - Rational Method: Minor storm (5 year): .02 (see Appendix, Exhibit 4)
    - Rational Method: Major Storm (100 year): 0.44 (see Appendix, Exhibit 4)
    - NCRS Curve #: 50 (see Appendix, Exhibit 5)
  - Estimated Runoff
    - Rational Method: Minor storm (5 year): 0.4 cfs (see Appendix, Exhibit 4)
    - Rational Method: Major Storm (100 year): 17.2 cfs (see Appendix, Exhibit 4)
    - NCRS: Not Applicable

Please update the % impervious for the developed condition basins per comment provided in exhibit 4 impervious calculation. Additional review and possible comments will be provided with the re-submittal

- **Sub-basin B (developed)**
  - Design Point = 4
  - Drainage Area = 19.6 acres
  - Runoff Coefficients
    - % Impervious = 2.5 (see Appendix, Exhibit 4)
    - Rational Method: Minor storm (5 year): 0.02 (see Appendix, Exhibit 4)
    - Rational Method: Major Storm (100 year): 0.44 (see Appendix, Exhibit 4)
    - NCRS Curve #: 50 (see Appendix, Exhibit 5)
  - Estimated Runoff
    - Minor storm (5 year): 0.7 cfs
    - Major Storm (100 year): 31.5 cfs
    - NCRS: Not Applicable

- **Sub-basin C (developed)**
  - Design Point = 6
  - Drainage Area = 5.3 acres

- Runoff Coefficients
  - % Impervious = 2.5 (see Appendix, Exhibit 4)
  - Rational Method: Minor storm (5 year): 0.02 (see Appendix, Exhibit 4)
  - Rational Method: Major Storm (100 year): 0.44 (see Appendix, Exhibit 4)
  - NCRS Curve #: 50 (see Appendix, Exhibit 5)

- Estimated Runoff
  - Rational Method: Minor storm (5 year): 0.2 cfs
  - Rational Method: Major Storm (100 year): 9.3 cfs
  - NCRS: Not Applicable

- **Sub-basin OS-3 and D (developed)**
  - Design Point = 4

  - Drainage Area = 16.6 acres

  - Runoff Coefficients
    - % Impervious = 2.0 (see Appendix, Exhibit 4)
    - Rational Method: Minor storm (5 year): .02 (see Appendix, Exhibit 4)
    - Rational Method: Major Storm (100 year): 0.44 (see Appendix, Exhibit 4)
    - NCRS Curve #: 50 (see Appendix, Exhibit 5)

  - Estimated Runoff
    - Rational Method: Minor storm (5 year): 0.4 cfs
    - Rational Method: Major Storm (100 year): 21.7 cfs
    - NCRS: Not Applicable

- **Sub-basin E (developed)**
  - Design Point = 7

  - Drainage Area = 3.7 acres

  - Runoff Coefficients
    - % Impervious = 2.5 (see Appendix, Exhibit 4)
    - Rational Method: Minor storm (5 year): 0.02 (see Appendix, Exhibit 4)
    - Rational Method: Major Storm (100 year): 0.44 (see Appendix, Exhibit 4)
    - NCRS Curve #: 50 (see Appendix, Exhibit 5)

  - Estimated Runoff

- Rational Method: Minor storm (5 year): 0.1 cfs
- Major Storm (100 year): 6.7 cfs
- NCRS: Not Applicable

- **All Sub-basins (developed) (NCRS Method)**
  - Design Point = 6
  - Drainage Area = 296.3 acres
  - Runoff Coefficients
    - % Impervious = 2.5
    - Rational Method: Minor storm (5 year): Not Applicable
    - Rational Method: Major Storm (100 year): Not Applicable
    - NCRS Curve #: 69.5 (+-) (see Appendix, Exhibit 5)
  - Estimated Runoff
    - Rational Method: Minor storm (5 year): Not Applicable
    - Rational Method: Major Storm (100 year): Not Applicable
    - NCRS: 5 year = 85.7 cfs
    - NCRS: 100 year = 346 cfs

It appears that there may be a typo as the developed conditions result in less runoff than the historic conditions (356 cfs). Please revise accordingly.

XII. PROPOSED IMPROVEMENTS

- **Culvert Improvements**
  The culvert under Brown Road is to be replaced with the following recommendation (see Appendix, Exhibit 6);
  - 42" RCP Culvert
  - % slope = 1.0 %
  - Headwater to depth = 1.3
  - Culvert Velocity = 7.5 fps
  - Culvert Depth of Flow = 2.0
  - End treatments: Flared end sections
  - Riprap protection at the outfall: 12" D50, 30 feet long by 12 feet wide
  - Concrete low water crossing

  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 since the stormwater runoff from the subdivision does not impact the facility.

- **Borrow Ditches and Onsite Swales**
  - East side of Brown Road
    Discharge = 5cfs
    Slope = 6.4%

Please delineate the extent of the stone check dams on the drainage plan.

Side slope = 3:1
Mannings Coef. = .035
Velocity = 4.6 fps
Froude No.= 1.47 supercritical flow
Recommended Improvements = stone check dams at 50 foot intervals

- South side of Brown Road
  Discharge = 5cfs
  Slope = 3.1%
  Side slope = 3:1
  Mannings Coef. = .035
  Velocity = 3.5 fps
  Froude No.= 1.1 supercritical flow
  Recommended Improvements = none, velocity is below the erosive velocity of the soil.

- Onsite Swales Design Point 1 to Design Point 6
  Discharge = 300cfs
  Slope = 2.5% to 6%
  Side slope = 0.1 to 1
  Mannings Coef. = 0.12 for range grass
  Velocity = 2.3fps to 3.0 fps
  Froude No.= 0.35 to 0.52, subcritical flow
  Recommended Improvements = none since flow is subcritical.

- Onsite Swales from onsite sub basins
  Discharge = 5cfs
  Slope = 2.5% to 10%
  Side slope = 0.1 to 1 (+-)
  Mannings Coef. = 0.12 for range grass
  Velocity = 1.1 fps to 1.7 fps
  Froude No.= 0.26 to 0.54, subcritical flow
  Recommended Improvements = none since flow is subcritical

No improvements are required for the onsite swales since all velocities are less that the erosive velocities (see Appendix, Exhibits 4 and 5)

Please see comments above regarding water quality.

storm sewers for runoff from the lots where not indicated in the narrative nor the drainage plan. Please revise accordingly.

XIII. DETENTION AND WATER QUALITY

A detention/ water quality pond is not required for the following reasons:

- Negligible increase in runoff
- Net disturbance of area is less than 1 acre

XIV. EROSION CONTROL

The following erosion control measures are recommended:

- Stone check dams in the roadside swales under supercritical conditions (see Appendix, Exhibit 7)
- Riprap outlet aprons (by others) at locations where the storm sewer exit velocity is great enough to cause excessive erosion
- Silt fences are recommended along the lower edge of grading activity.

XV. SUMMARY

This report provides a thorough analysis of the historic and developed drainage conditions. Included in the map pocket are drainage maps for the Historic Drainage Conditions and the Developed Drainage Conditions. The storm sewer laterals are sized to accommodate runoff from each of the developed lots. Drainage improvements designed for the interiors of each lot are to be designed during the Development Plan phase when each lot is developed. The storm sewer in Shoop Road is designed to accommodate the accumulated runoff from all of the lots under developed conditions

Further review will be provided with submittal of the revised calculations based on comments provided regarding the imperviousness.

Shoup Rd is not near the project site. Please revise the summary accordingly. Be sure to state whether or not this development will have an adverse affect to the downstream or surrounding properties

APPENDIX

Exhibit 1
General Location Map

Vicinity Map

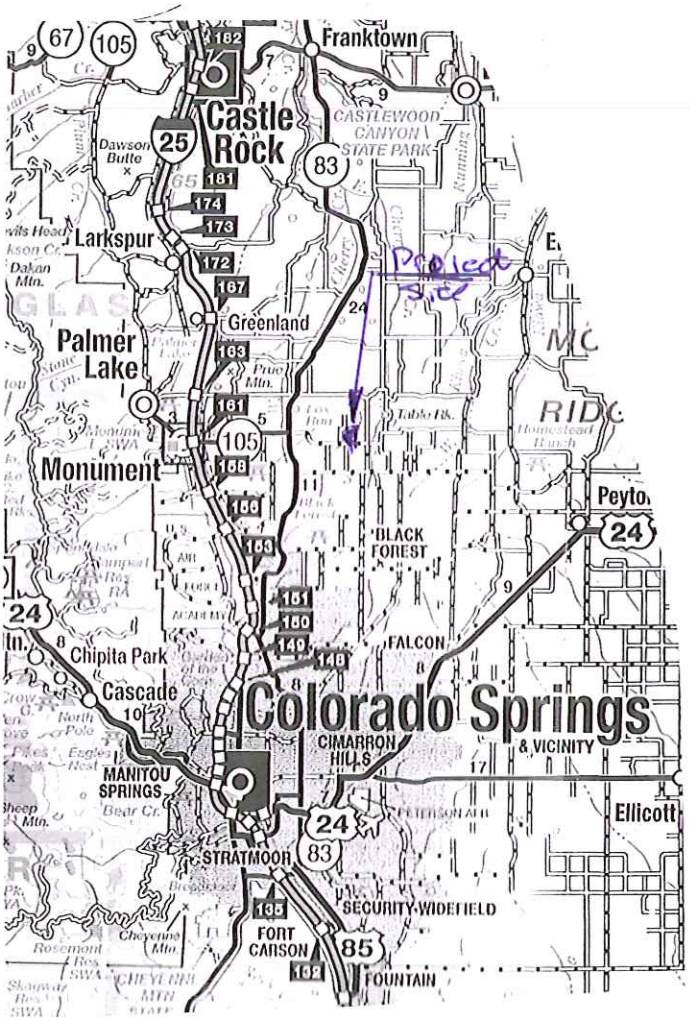


Exhibit 2
FEMA FIRM Map

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

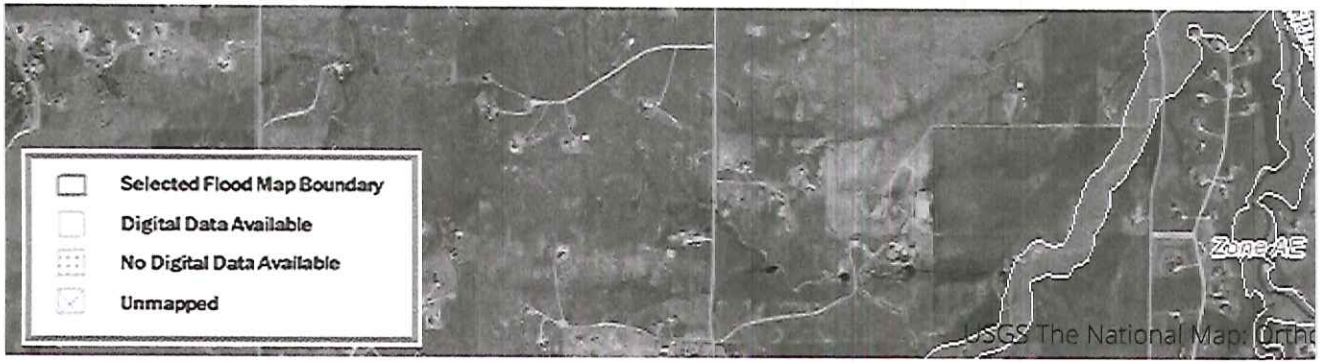
Search

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)

Contact MSC Help (/portal/resources/contact)



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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

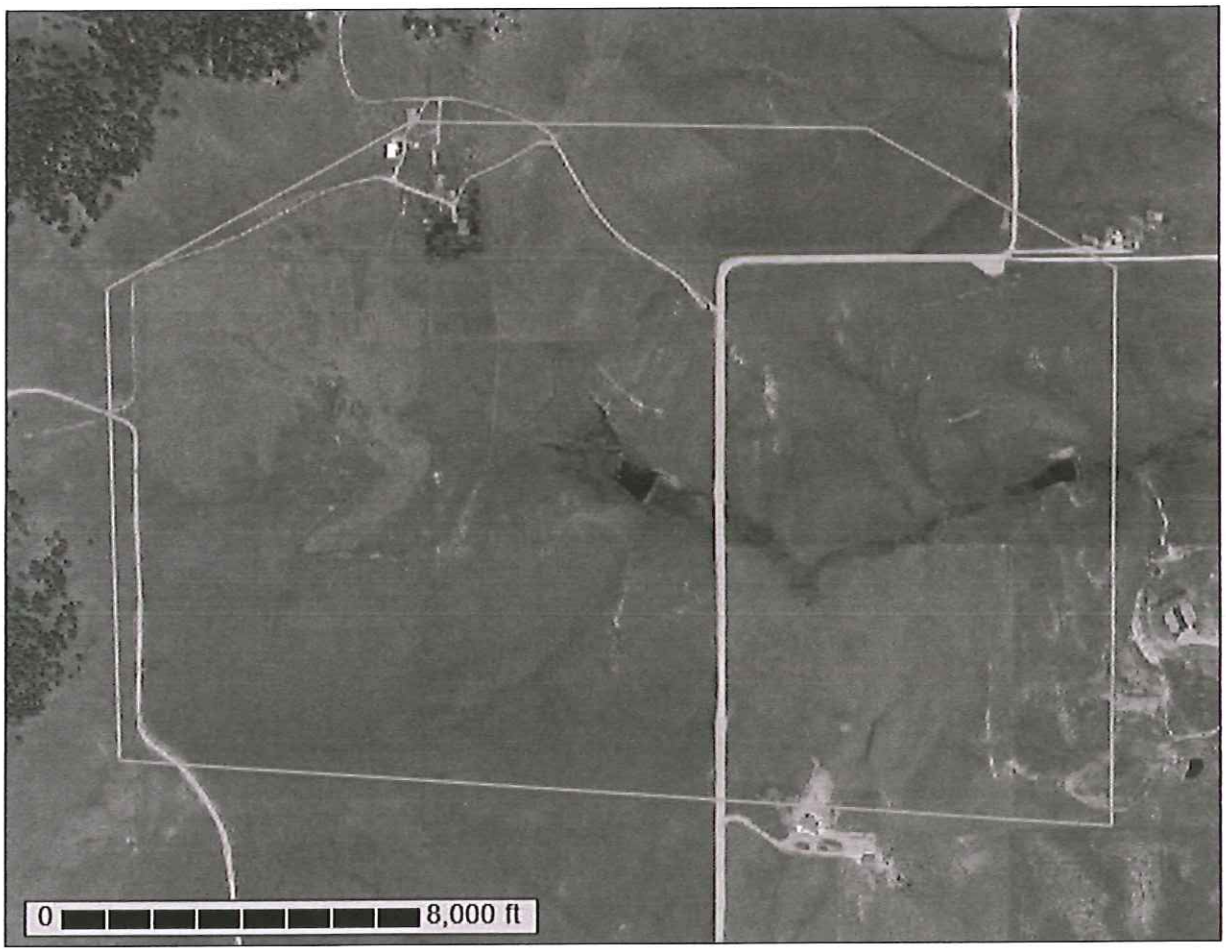
NRCS

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

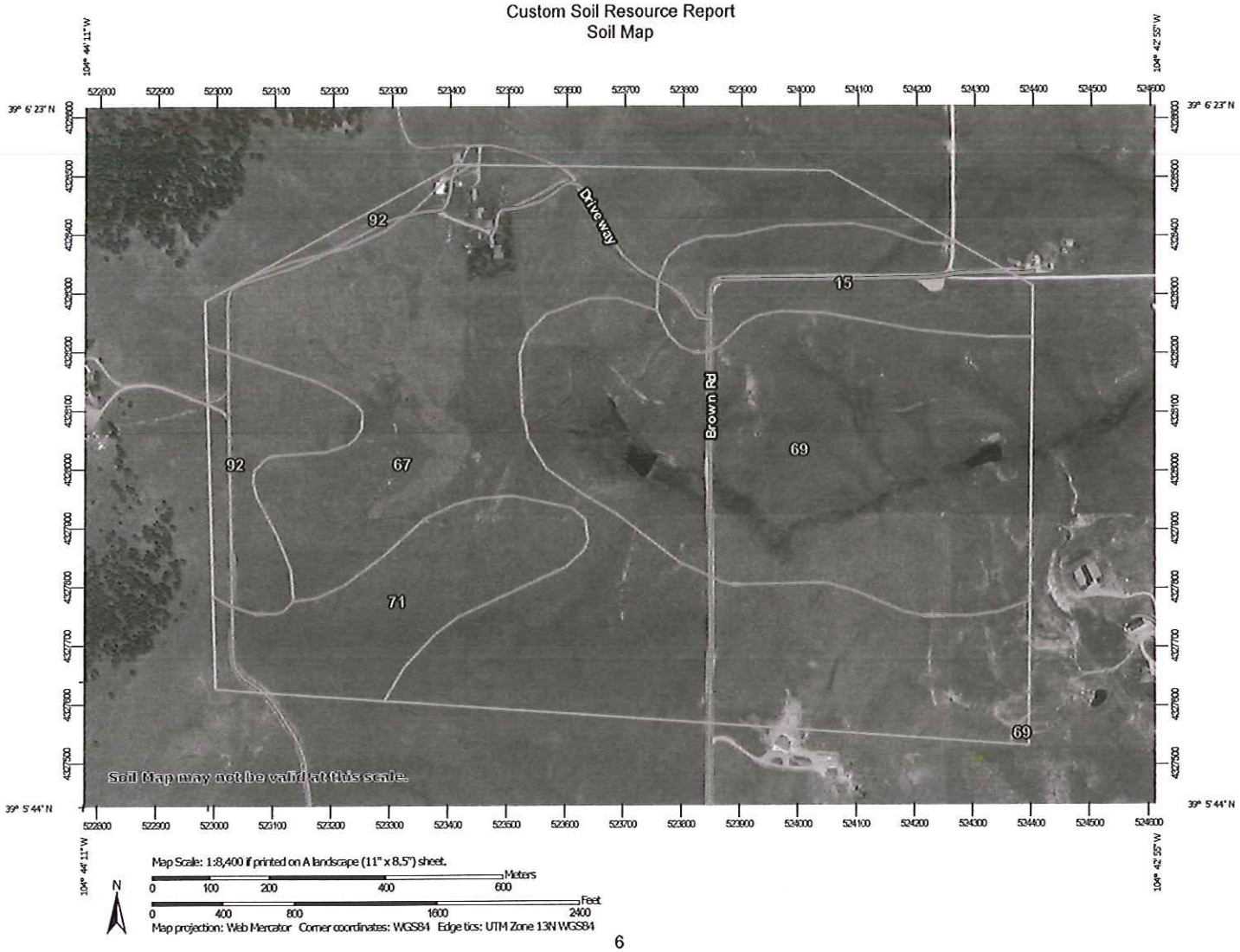


March 25, 2019

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.

Custom Soil Resource Report
Soil Map



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

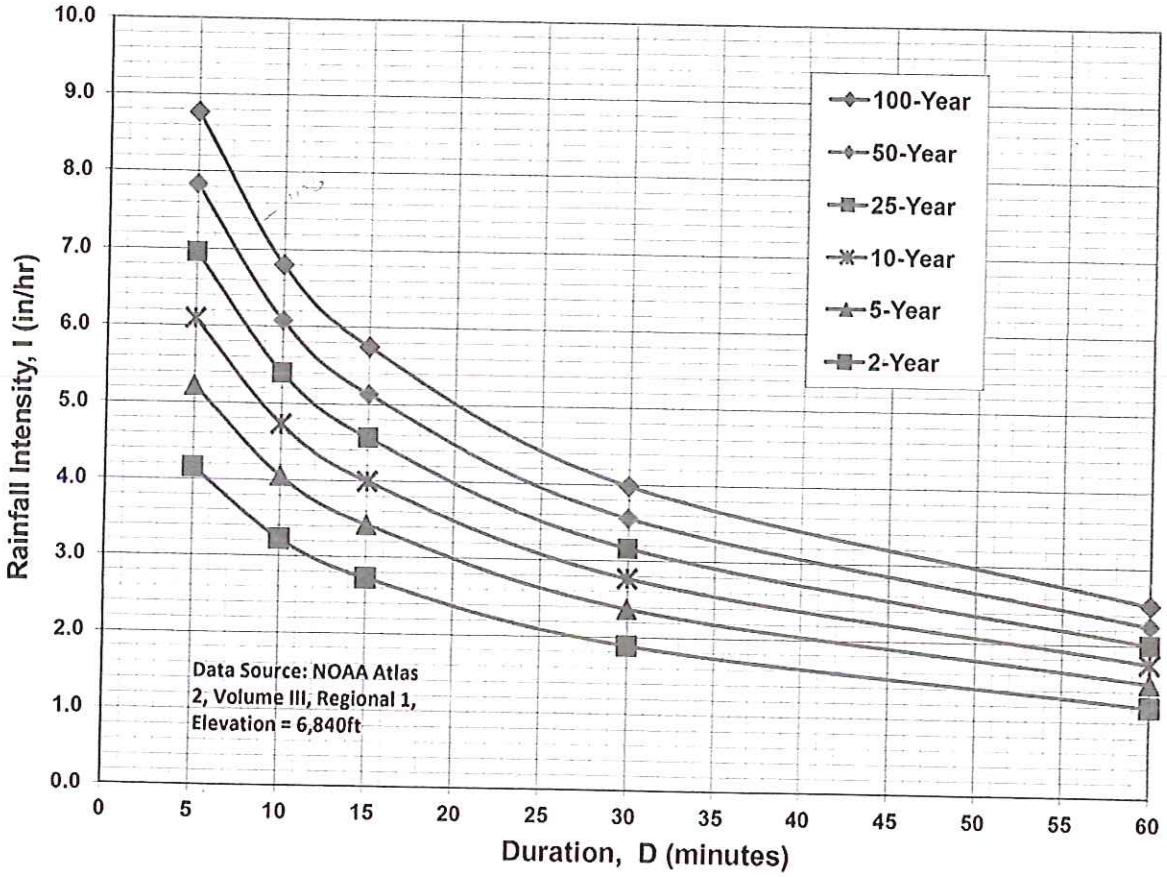
Percent of map unit:
Hydric soil rating: No

Pleasant

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

Exhibit 4
Rational Method Exhibits

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.

Table 6-3. Recommended percentage imperviousness values

Land Use or Surface Characteristics	Percentage Imperviousness (%)
Business:	
Downtown Areas	95
Suburban Areas	75
Residential lots (lot area only):	
Single-family	
2.5 acres or larger	12
0.75 – 2.5 acres	20
0.25 – 0.75 acres	30
0.25 acres or less	45
Apartments	75
Industrial:	
Light areas	80
Heavy areas	90
Parks, cemeteries	10
Playgrounds	25
Schools	55
Railroad yard areas	50
Undeveloped Areas:	
Historic flow analysis	2
Greenbelts, agricultural	2
Off-site flow analysis (when land use not defined)	45
Streets:	
Paved	100
Gravel (packed)	40
Drive and walks	90
Roofs	90
Lawns, sandy soil	2
Lawns, clayey soil	2

Per table 6-6 of DCM vol 1, drives and walks are considered 100% impervious. Please revise your calculations accordingly.

4B

% Impervious For Typical Lot
From Table 6-3

Historic Condition

Historic Flow analysis = 2%

Developed

Rooftops (4000 S.F) 90%

Driveways, Walks, etc (2500 S.F) 90%

Lawn (1200 S.F) 2%

Natural Ground (210,100 S.F) 2%

Composite Imperviousness

$[0.90(4000)+0.9(2500)+0.02(1200)+0.02(210,100)] / 217,800$ (5 acre)

Composite 2.5%

DCMV1 Table 6-6 should be used for %impervious and runoff coefficients.

The result from this calculation is 0.046.....4.6%. Revise the design calculations accordingly.

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.

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

Calcula

Designer: Ken Harrison
Company: KCH Engineering Solutions
Date: 3/31/2019
Project: Prairie Ridge Existing Conditions
Location: El Paso County

Version 2.00 released May 2017

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

Subcatchment Name	Area (ac)	NRCS Hydrologic Soil Group	Percent Imperviousness	Runoff Coefficient, C							Overland (Initial) Flow Time					
				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)
OS-2	31.80	B	2.0	0.01	0.01	0.07	0.26	0.34	0.44	0.54	100.00	7540.00	7500.00	0.050	11.55	1700.00
				0.02	0.02										11.46	
A	10.70	B	2.0	0.01	0.01	0.07	0.26	0.34	0.44	0.54	100.00	7510.00	7490.00	0.033	13.25	1500.00
				0.02	0.02										13.15	
B	19.60	B	2.0	0.01	0.01	0.07	0.26	0.34	0.44	0.54	100.00	7510.00	7490.00	0.033	13.25	1500.00
				0.02	0.02										13.15	
C	5.30	B	2.0	0.01	0.01	0.07	0.26	0.34	0.44	0.54	100.00	7490.00	7480.00	0.033	13.25	1100.00
				0.02	0.02										13.15	
OS-3 and D	13.60	B	2.0	0.01	0.01	0.07	0.26	0.34	0.44	0.54	100.00	7510.00	7490.00	0.064	10.63	1600.00
				0.02	0.02										10.55	
E	3.70	B	2.0	0.01	0.01	0.07	0.26	0.34	0.44	0.54	100.00	7490.00	7480.00	0.017	16.58	700.00
				0.02	0.02										16.46	

47 (1 of 3)

ıtion of Peak Runoff using Rational Method

$t_{minimum}$= 5 (urban)
$t_{minimum}$= 10 (non-urban)

$\sqrt{S_t}$

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

Select UDFCD location for NOAA Atlas 14 Rainfall Depths from the pulldown list OR enter your own depths ot

	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

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

Channelized (Travel) Flow Time						Time of Concentration			Rainfall Intensity, I (in/hr)							
U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	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
7500.00	7420.00	0.071	7	1.87	15.15	26.70	37.09	26.70	2.00	2.52	2.94	3.36	3.78	4.23		0.55
						26.61										1.27
			7													
7490.00	7430.00	0.070	7	1.85	13.50	26.74	35.84	26.74	2.00	2.52	2.94	3.35	3.77	4.23		0.18
						26.65										0.43
7490.00	7430.00	0.077	7	1.94	12.88	26.12	35.37	26.12	2.02	2.55	2.97	3.40	3.82	4.28		0.34
						26.03										0.79
7480.00	7410.00	0.078	7	1.95	9.38	22.62	32.73	22.62	2.19	2.76	3.22	3.68	4.14	4.64		0.10
						22.53										0.23
7490.00	7410.00	0.033	7	1.27	20.97	31.60	41.48	31.60	1.81	2.28	2.66	3.04	3.42	3.83		0.21
						31.52										0.49
7480.00	7460.00	0.082	7	2.01	5.81	22.39	30.04	22.39	2.20	2.78	3.24	3.70	4.17	4.67		0.07
						22.27										0.16

4 F (2083)

Worksheet Protected

tained from the NOAA website (click this link)

$$Q(cfs) = CIA$$

Peak Flow, Q (cfs)					
5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
0.97	6.83	27.93	40.74	58.57	
1.60					
0.33	2.30	9.39	13.70	19.69	
0.54					
0.61	4.26	17.43	25.42	36.55	
1.00					
0.18	1.25	5.11	7.45	10.71	
0.29					
0.38	2.65	10.82	15.79	22.70	
0.62					
0.12	0.88	3.58	5.23	7.52	
0.21					

4F (3883)

3/31/19
Developed (1984)

Calcula

Designer: Ken Harrison
Company: KCH Engineering Solutions
Date: 3/31/2019
Project: Prairie Ridge Developed Conditions
Location: El Paso County

Version 2.00 released May 2017

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

Subcatchment Name	Area (ac)	NRCS Hydrologic Soil Group	Percent Imperviousness	Runoff Coefficient, C							Overland (Initial) Flow Time					Channelized Flow Length L_t (ft)
				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)	
OS-2	31.80	B	2.0	0.01	0.01	0.07	0.26	0.34	0.44	0.54	100.00	7540.00	7500.00	0.050	11.55	1700.00
A	10.70	B	2.5	0.01	0.02	0.08	0.26	0.34	0.44	0.55	100.00	7510.00	7490.00	0.033	13.20	1500.00
B	19.60	B	2.5	0.01	0.02	0.08	0.26	0.34	0.44	0.55	100.00	7510.00	7490.00	0.033	13.20	1500.00
C	5.30	B	2.5	0.01	0.02	0.08	0.26	0.34	0.44	0.55	100.00	7490.00	7480.00	0.033	13.20	1100.00
OS-3 and D	13.60	B	2.0	0.01	0.01	0.07	0.26	0.34	0.44	0.54	100.00	7510.00	7490.00	0.064	10.64	1600.00
E	3.70	B	2.5	0.01	0.02	0.08	0.26	0.34	0.44	0.55	100.00	7490.00	7480.00	0.017	16.44	700.00

HG (1984)

3/31/19 Developed (2084)

ıtion of Peak Runoff using Rational Method

$t_{minimum}$ = 5 (urban)
$t_{minimum}$ = 10 (non-urban)

$\sqrt{S_t}$

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

Select UDFCD location for NOAA Atlas 14 Rainfall Depths from the pulldown list OR enter your own depths ob

	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

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

Channelized (Travel) Flow Time						Time of Concentration			Rainfall Intensity, I (in/hr)							
U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	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
7500.00	7420.00	0.071	7	1.87	15.19	26.74	37.12	26.74	2.00	2.52	2.94	3.35	3.77	4.23		0.55
			7													
7490.00	7430.00	0.070	7	1.85	13.50	26.70	35.68	26.70	2.00	2.52	2.94	3.36	3.78	4.23		0.24
7490.00	7430.00	0.077	7	1.94	12.87	26.08	35.21	26.08	2.03	2.55	2.98	3.40	3.83	4.29		0.44
7480.00	7410.00	0.078	7	1.95	9.38	22.58	32.60	22.58	2.19	2.77	3.23	3.69	4.15	4.65		0.13
7490.00	7410.00	0.033	7	1.27	20.97	31.62	41.48	31.62	1.81	2.28	2.66	3.04	3.42	3.83		0.21
7480.00	7460.00	0.082	7	2.00	5.82	22.26	29.93	22.26	2.21	2.79	3.25	3.72	4.18	4.68		0.09

45 (2084)

3/31/19
Developed (3684

Worksheet Protected

btained from the NOAA website (click this link)

$$Q(cfs) = CIA$$

Peak Flow, Q (cfs)					
5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
0.97	6.83	27.91	40.71	58.52	
0.42	2.43	9.51	13.82	19.81	
0.77	4.50	17.66	25.66	36.78	
0.23	1.32	5.17	7.52	10.78	
0.38	2.65	10.82	15.78	22.69	
0.16	0.93	3.64	5.29	7.58	

46(3684)

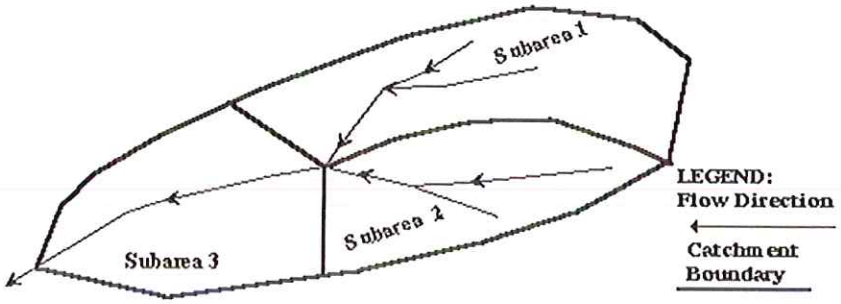
3/31/19

Developed (484)

Area-Weighted Runoff Coefficient Calculations

Version 2.00 released May 2017

Designer: Ken Harrison
Company: KCH Engineering Solutions
Date: 3/31/2019
Project: Prairie Ridge Developed Conditions
Location: El Paso County



Subcatchment Name
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
Roof tops	0.0918	B	90.0	0.74	0.76	0.78	0.81	0.83	0.84	0.87
Patio, walks, drives	0.0574	B	100.0	0.84	0.86	0.86	0.88	0.89	0.89	0.90
Lawn	0.0275	B	0.0	0.00	0.00	0.06	0.25	0.33	0.43	0.54
Natural	4.8233	B	0.0	0.00	0.00	0.06	0.25	0.33	0.43	0.54
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	0.02	0.02	0.08	0.27	0.34	0.44	0.55

4g (484)

Exhibit 5
SCS TR55 Method Exhibits

TR-55

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

Cover description		Curve numbers for hydrologic soil group			
Cover type and hydrologic condition	Average percent impervious area [2]	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.

5A(1 of 4)

TR-55

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.

5A (2084)

TR-55

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.

5A (3084)

TR-55

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.

5A (4084)

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

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.

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

: Ia = 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.

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

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.

Curve Number for Typical Lot

Historic Condition

From Table 6-9 Pre Development Condition ARC-1

Pasture, Grassland, Range

Continuous forage for grazing

Assume Fair Condition CN = 69

Developed Condition ~~ARC II~~ TR-55 Users Guide

Rooftops (4000SF) = CN = 98

Patios, Walkway, Drives (2500 S.F) = CN = 98

Lawn Fair Condition (12903F) = CN = 69

Natural, Undisturbed, & Not Watered CN = 69

5 Acres 217,800 - 4000, - 2500 - 1200 -

210,100 S.F

Weighted Imperviousness

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

CN = 69.9 , use 70

Comparison 69. vs. 70

Time of Concentration

Subbasin OS-1

Sheet Flow

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

Slope = 10%

Surface = Grass Grazing

Shallow Concentrated

Length = ~~3500ft~~ 3700ft

Slope = (7520-7450)/3500 = 2%

Surface - same

Channel

Length = [illegible]

Slope = [illegible] 67%

n =

Bottom Width = [illegible]

Side Slope [illegible]

Discharge [illegible]

Prairie Ridge

Time of Concentration

Subbasin OS-2

Sheet Flow

Length = ~~300'~~ 100

Slope = 15/300 = 5% use 5%

Surface grass = 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

Time of Concentration

Subbasin OS-3 and D.

Sheet Flow

Length - ~~300'~~ 100'

Slope = (7510-7500)/300 = 3.3% ok to use w/ 100'

Land Use = grass, grazing

Shallow Concentrate

Length 1400

Slope = (7500 - 7410)/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

Sub-basin B

Sheet Flow

Length = ~~300ft~~ use 100

Slope = (7520-7510)/300 = 3.3% ~~ob 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 ~~practical~~ upper limit

Slope = (7490-7480)/300 = 3.33% ob to us

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

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

Prairie Ridge

Structure Data

Existing Structure

- There are 4 small stock 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

Prairie Ridge

Storm Data Windows

Rainfall Distribution = Type II

Use Colorado Springs Table for the Return Period & the 24-hour rainfall amount

Dimensionless Hydrograph

Use the one included in the program, This one cannot be changed

Harrison

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
Down	72.08	289.06
Reach 2	72.08	289.06
Down	72.00	288.70
Reach 3	77.98	314.96
Down	77.88	314.74
Reach 4	84.31	348.68
Down	84.28	348.66
OUTLET	85.73	356.00

WinTR-55 Current Data Description

--- Identification Data ---

User: Harrison
Project: Prairie Ridge
SubTitle: Existing Conditions
State: Colorado
County: El Paso
Filename: C:\Users\Ken\Documents\Business-Consulting\Prairie Ridge\TR 55 existing conditions.w55

Date: 3/31/2019
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 3	31.8	69	.243
OS-3 and D		Reach 4	13.6	69	.274
A		Reach 1	10.7	69	.243
B		Reach 4	19.6	69	.258
C		Outlet	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>

Harrison

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	72.08	12.31	289.06	12.24
Down	72.00	12.35	288.70	12.26
Reach 3	77.98	12.33	314.96	12.24
Down	77.88	12.36	314.74	12.26
Reach 4	84.31	12.35	348.68	12.21
Down	84.28	12.36	348.66	12.21
OUTLET	85.73		356.00	

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 3	
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 4	
C	5.30	0.134	69	Outlet	
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							
SHEET	100	0.0167	0.150				0.217
SHALLOW	1050	0.0824	0.050				0.063
					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 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	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

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	

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	3.26	11.61
E	2.08	7.55
REACHES		
Reach 1	72.41	289.73
Down	72.30	289.42
Reach 2	72.30	289.42
Down	72.22	289.15
Reach 3	78.22	315.47
Down	78.12	315.25
Reach 4	84.88	350.33
Down	84.84	350.32
OUTLET	86.66	360.77

WinTR-55 Current Data Description

--- Identification Data ---

User: Harrison
Project: Prairie Ridge
SubTitle: Developed conditions
State: Colorado
County: El Paso
Filename: C:\Users\Ken\Documents\Business-Consulting\Prairie Ridge\TR 55 developed conditions.w55

Date: 3/31/2019
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 3	31.8	69	.243
OS-3 and D		Reach 4	13.6	69	.274
A		Reach 1	10.7	70	.243
B		Reach 4	19.6	70	.258
C		Outlet	5.3	70	.233
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
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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

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	3.26 12.06	11.61 12.04
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	72.30 12.31	289.42 12.25
Down	72.22 12.34	289.15 12.26
Reach 3	78.22 12.33	315.47 12.25
Down	78.12 12.36	315.25 12.26
Reach 4	84.88 12.33	350.33 12.20
Down	84.84 12.34	350.32 12.22
OUTLET	86.66	360.77

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 3	
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 4	
C	5.30	0.233	70	Outlet	
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
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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	0.0330	0.150				0.165
SHALLOW	1100	0.0780	0.050				0.068
					Time of Concentration		.233
E							
SHEET	100	0.0167	0.150				0.217
SHALLOW	1050	0.0824	0.050				0.063
					Time of Concentration		0.280

Prairie Ridge
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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	Cover Description	?	0	0
	Cover Description	?	0	0
	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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Prairie Ridge
Developed 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	

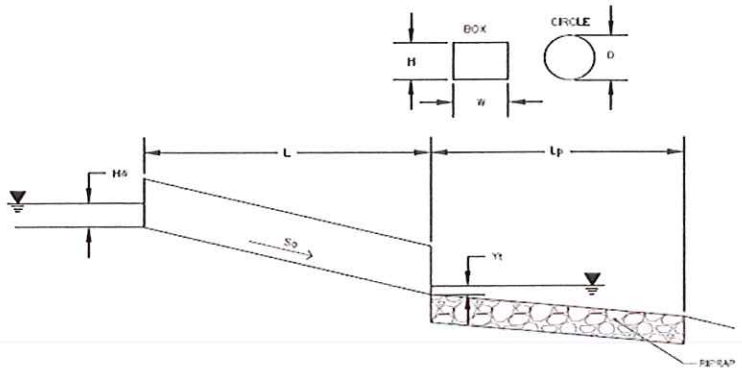
Exhibit 6
Culvert Capacities

Existing Culvert

Determination of Culvert Headwater and Outlet Protection

Project: **Blue cells are for user data entry**

Basin ID: **Green cells are calculated values**



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

Design Information (Input):

	Design Discharge	Q =	20.5	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	Elev OUT =	5098.8	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 =	5097.5	ft
	Max Allowable Channel Velocity	V =	5	ft/s

Tailwater ELEVATION is less than outlet elevation, using 0.4 x RISE as Yt

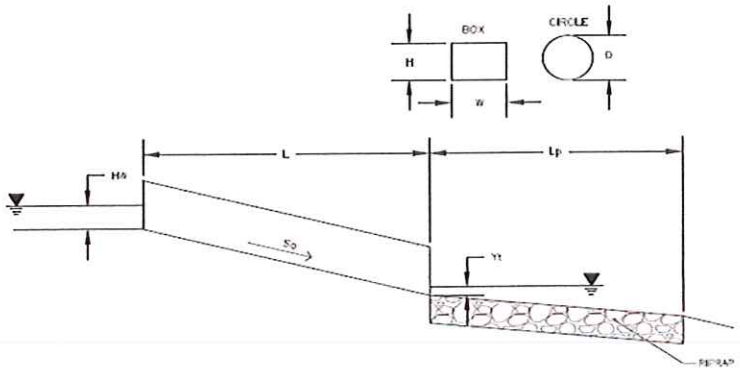
Required Protection (Output):

Tailwater Surface Height	Y_t =	0.80	ft
Flow Area at Max Channel Velocity	A_t =	4.10	ft^2
Culvert Cross Sectional Area Available	A =	3.14	ft^2
Entrance Loss Coefficient	k_e =	0.50	
Friction Loss Coefficient	k_f =	2.12	
Sum of All Losses Coefficients	k_s =	3.62	ft
Culvert Normal Depth	Y_n =	1.55	ft
Culvert Critical Depth	Y_c =	1.62	ft
Tailwater Depth for Design	d =	1.81	ft
Adjusted Diameter **OR** Adjusted Rise	D_a =	-	ft
Expansion Factor	1/(2*tan(Θ)) =	3.86	
Flow/Diameter$^{2.5}$ **OR** Flow/(Span * Rise$^{1.5}$)	Q/D^2.5 =	3.62	$ft^{0.5}/s$
Froude Number	Fr =	-	Pressure flow!
Tailwater/Adjusted Diameter **OR** Tailwater/Adjusted Rise	Yt/D =	0.40	
Inlet Control Headwater	HW_I =	3.05	ft
Outlet Control Headwater	HW_O =	3.01	
Design Headwater Elevation	**HW =**	**5,103.05**	**ft**
Headwater/Diameter OR Headwater/Rise Ratio	**HW/D =**	**1.52**	HW/D > 1.5!
Minimum Theoretical Riprap Size	d_{50} =	6	in
Nominal Riprap Size	d_{50} =	6	in
UDFCD Riprap Type	**Type =**	**L**	
Length of Protection	**L_p =**	**13**	**ft**
Width of Protection	**T =**	**6**	**ft**

Proposed Culvert

Determination of Culvert Headwater and Outlet Protection

Project: Blue cells are for user data entry
Basin ID: Green cells are calculated values



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

Design Information (Input):

	Design Discharge	Q =	70	cfs
Circular Culvert:				
	Barrel Diameter in Inches	D =	42	inches
	Inlet Edge Type (Choose from pull-down list)	Square End Projection		
		OR		
Box Culvert:				
	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 =	5099.1	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 =	5098	ft
	Max Allowable Channel Velocity	V =	5	ft/s

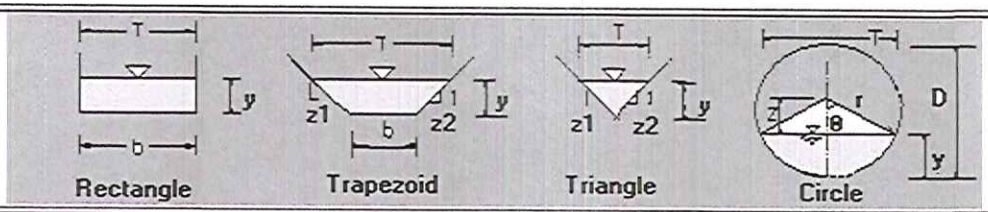
Tailwater ELEVATION is less than outlet elevation, using 0.4 x RISE as Yt

Required Protection (Output):

Tailwater Surface Height	Y_t =	1.40	ft
Flow Area at Max Channel Velocity	A_t =	14.00	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 =	2.46	ft
Culvert Critical Depth	Y_c =	2.62	ft
Tailwater Depth for Design	d =	3.06	ft
Adjusted Diameter OR Adjusted Rise	D_a =	-	ft
Expansion Factor	1/(2*tan(Θ)) =	4.37	
Flow/Diameter$^{2.5}$ OR Flow/(Span * Rise$^{1.5}$)	Q/D^2.5 =	3.05	$ft^{0.5}/s$
Froude Number	Fr =	-	Pressure flow!
Tailwater/Adjusted Diameter OR Tailwater/Adjusted Rise	Yt/D =	0.40	
Inlet Control Headwater	HW_I =	4.50	ft
Outlet Control Headwater	HW_O =	4.52	
Design Headwater Elevation	**HW =**	**5,103.62**	**ft**
Headwater/Diameter OR Headwater/Rise Ratio	**HW/D =**	**1.29**	
Minimum Theoretical Riprap Size	d_{50} =	9	in
Nominal Riprap Size	d_{50} =	9	in
UDFCD Riprap Type	**Type =**	**L**	
Length of Protection	**L_p =**	**29**	**ft**
Width of Protection	**T =**	**11**	**ft**

The open channel flow calculator

Select Channel Type: Circle



Depth from Q

Select unit system: Feet(ft)

Channel slope: .01 ft/ft	Water depth(y): 2.04 ft	Radius (r) 3.5 ft
Flow velocity 7.499 ft/s	LeftSlope (Z1): to 1 (H:V)	RightSlope (Z2): to 1 (H:V)
Flow discharge 70 ft^3/s	Input n value 0.022 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 7.99 ft	Flow area 9.35 ft^2	Top width(T) 6.36 ft
Specific energy 2.92 ft	Froude number 1.09	Flow status Supercritical flow
Critical depth 2.14 ft	Critical slope 0.0084 ft/ft	Velocity head 0.87 ft

Exhibit 7
Stone Check Dams

Send to Stan

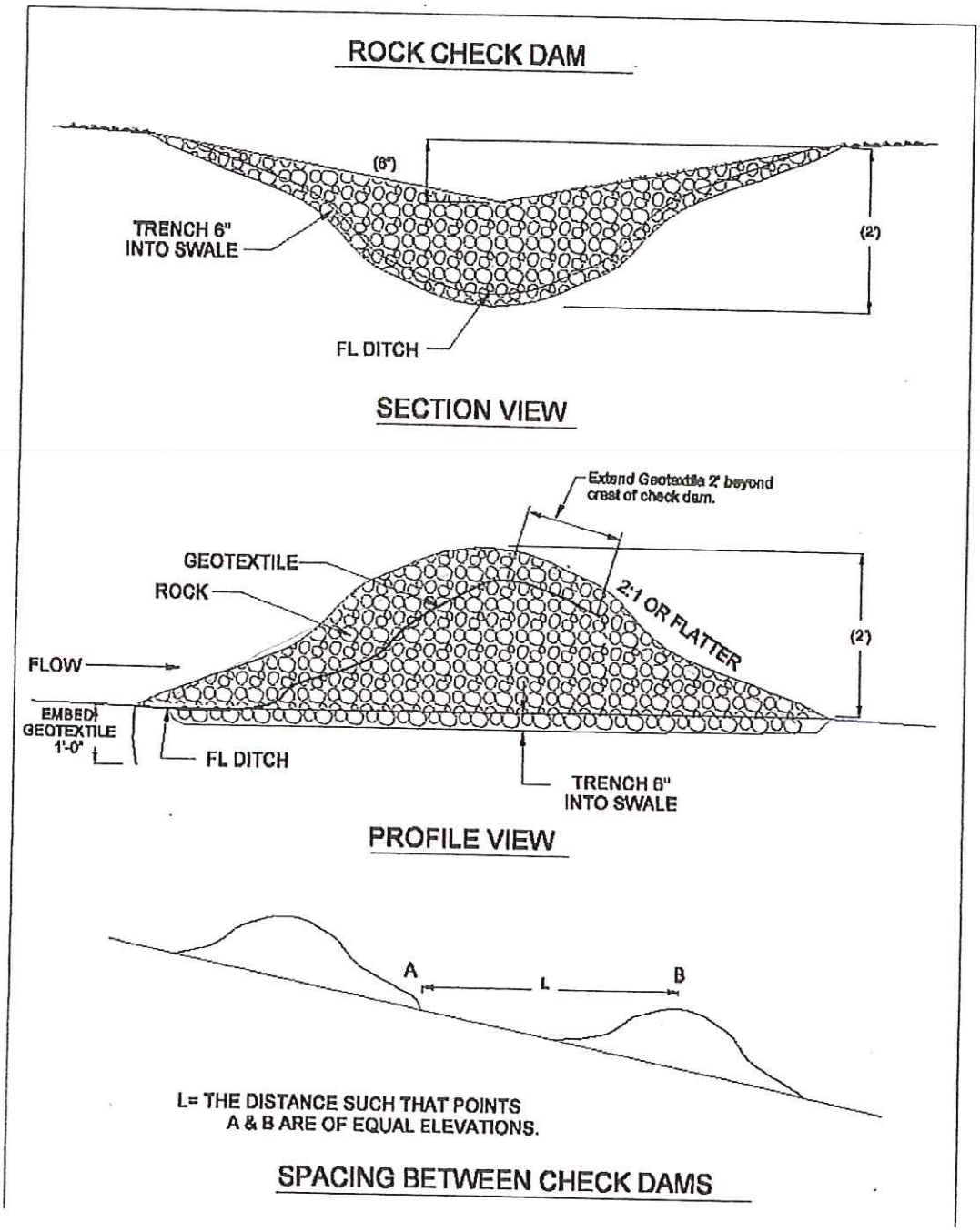


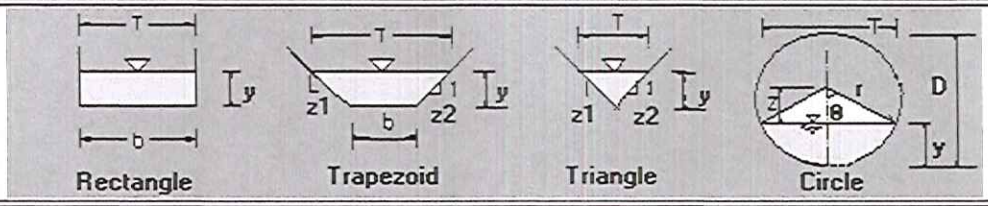
TABLE EC 9.1
Check Dam Spacing

Slope	2 percent	3 percent	4 percent	5 percent	6 percent
Spacing (ft)	100	67	50	40	33

Exhibit 8
Borrow Ditches

The open channel flow calculator

Select Channel Type: Trapezoid



Depth from Q

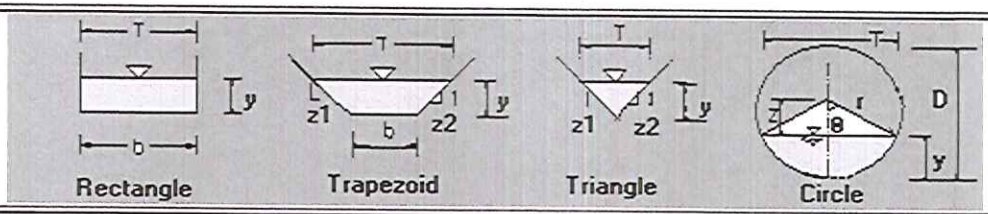
Select unit system: Feet(ft)

Channel slope: .031 ft/ft	Water depth(y): 0.54 ft	Bottom W(b) 1 ft
Flow velocity 3.493 ft/s	LeftSlope (Z1): 3 to 1 (H:V)	RightSlope (Z2): 3 to 1 (H:V)
Flow discharge 5 ft^3/s	Input n value 0.035 or select n corrugated metal pipe:0.022	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 4.44 ft	Flow area 1.43 ft^2	Top width(T) 4.26 ft
Specific energy 0.73 ft	Froude number 1.06	Flow status Supercritical flow
Critical depth 0.56 ft	Critical slope 0.0262 ft/ft	Velocity head 0.19 ft

Borrow Ditch along South of Brown Road
Sized for 5cfs

The open channel flow calculator

Select Channel Type: Triangle



Depth from Q

Select unit system: Feet(ft)

Channel slope: .064 ft/ft	Water depth(y): 0.6 ft	Bottom W(b) 0 ft
Flow velocity 4.588 ft/s	LeftSlope (Z1): 3 to 1 (H:V)	RightSlope (Z2): 3 to 1 (H:V)
Flow discharge 5 ft^3/s	Input n value .035 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 3.81 ft	Flow area 1.09 ft^2	Top width(T) 3.62 ft
Specific energy 0.93 ft	Froude number 1.47	Flow status Supercritical flow
Critical depth 0.71 ft	Critical slope 0.0268 ft/ft	Velocity head 0.33 ft

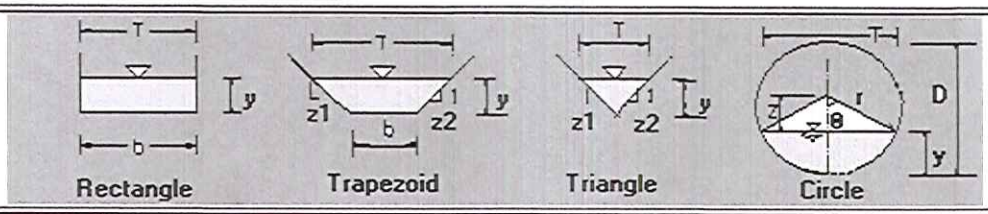
Borrow Ditch along east side of Brown Road

Sized for 5 cfs

Existing Swale : Design Part 1 to 6 (Lower slope)

The open channel flow calculator

Select Channel Type: Trapezoid



Depth from Q

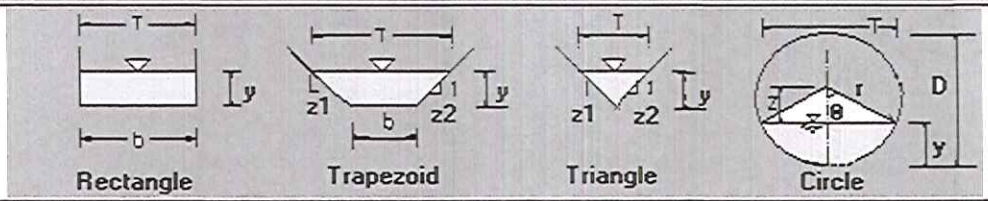
Select unit system: Feet(ft)

Channel slope: .025 ft/ft	Water depth(y): 1.31 ft	Bottom W(b) 100 ft
Flow velocity 2.29 ft/s	LeftSlope (Z1): 0.1 to 1 (H:V)	RightSlope (Z2): 0.1 to 1 (H:V)
Flow discharge 300 ft^3/s	Input n value .12 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 102.63 ft	Flow area 131 ft^2	Top width(T) 100.26 ft
Specific energy 1.39 ft	Froude number 0.35	Flow status Subcritical flow
Critical depth 0.66 ft	Critical slope 0.2422 ft/ft	Velocity head 0.08 ft

Existing Drainage Swale: Desc Pnt 1 to 6 (Higher Sqr

The open channel flow calculator

Select Channel Type: Trapezoid



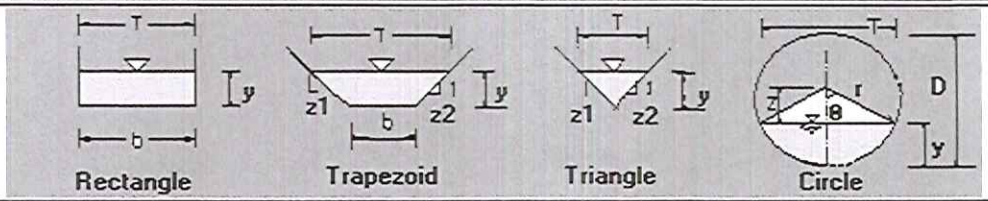
Depth from Q

Select unit system: Feet(ft)

Channel slope: .06 ft/ft	Water depth(y): 1 ft	Bottom W(b) 100 ft
Flow velocity 2.984 ft/s	LeftSlope (Z1): 0.1 to 1 (H:V)	RightSlope (Z2): 0.1 to 1 (H:V)
Flow discharge 300 ft^3/s	Input n value .12 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 102.02 ft	Flow area 100.55 ft^2	Top width(T) 100.2 ft
Specific energy 1.14 ft	Froude number 0.52	Flow status Subcritical flow
Critical depth 0.66 ft	Critical slope 0.2422 ft/ft	Velocity head 0.14 ft

The open channel flow calculator

Select Channel Type: Trapezoid



Depth from Q

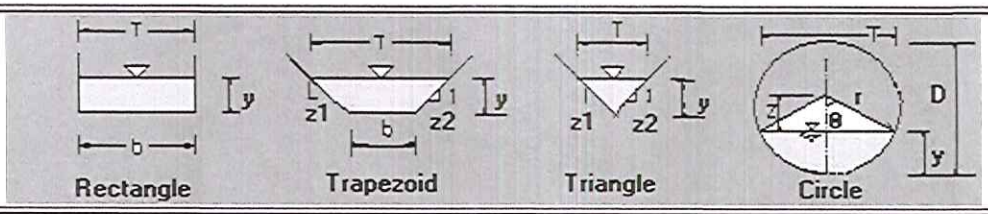
Select unit system: Feet(ft)

Channel slope: .02 ft/ft	Water depth(y): 0.49 ft	Bottom width(b) 10 ft
Flow velocity 1.015433 ft/s	LeftSlope (Z1): .1 to 1 (H:V)	RightSlope (Z2): .1 to 1 (H:V)
Flow discharge 5 ft^3/s	Input n value .12 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 10.98 ft	Flow area 4.92 ft^2	Top width(T) 10.1 ft
Specific energy 0.51 ft	Froude number 0.26	Flow status Subcritical flow
Critical depth 0.2 ft	Critical slope 0.3595 ft/ft	Velocity head 0.02 ft

Sub basin Swales - 2% slope

The open channel flow calculator

Select Channel Type: Trapezoid



Depth from Q

Select unit system: Feet(ft)

Channel slope: .10 ft/ft	Water depth(y): 0.3 ft	Bottom width(b) 10 ft
Flow velocity 1.667815 ft/s	LeftSlope (Z1): .1 to 1 (H:V)	RightSlope (Z2): .1 to 1 (H:V)
Flow discharge 5 ft^3/s	Input n value .12 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 10.6 ft	Flow area 3 ft^2	Top width(T) 10.06 ft
Specific energy 0.34 ft	Froude number 0.54	Flow status Subcritical flow
Critical depth 0.2 ft	Critical slope 0.3595 ft/ft	Velocity head 0.04 ft

Sub-basin - 10% slope

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

Exhibit 10
Drainage Map for Developed Conditions
(Inside map pocket)