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Final Drainage Report

Edgewood Subdivision Filing No. 1

Minor Subdivision Plat

Project Number 61127

August 26, 2019

PCD File No.:

Final Drainage Report

for

Edgewood Subdivision Filing No. 1
Minor Subdivision Plat

Project No. 61127

August 26, 2019

prepared for

Karen and James Martens
8190 Poco Road
Colorado Springs, CO 80908
719.660.1567

prepared by

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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

Owner's Statement

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

(Signature)

(James Martens)

Address: 8190 Poco Road
Colorado Springs, Colorado 80908

El Paso County

Filed in accordance with _____ of the _____, as amended

El Paso County Engineer

(Signature) (Print name)

Date: _____

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I. REPORT PURPOSE

The purpose of this study is to evaluate the drainage characteristics for the existing conditions of the Edgewood Subdivision Filing 1 (the site) in accordance the current El Paso County Drainage Criteria. The current site consists of approximately 10.2 acres and is occupied by a single residence. The address is 8190 Poco Road. The site is to be subdivided into two (2) lots, 5.0 acres and 7.2 acres, respectively. No changes to the existing drainage characteristics are proposed. The proposed conditions are to be the same as the existing conditions; therefore, this report will only evaluate the existing hydrologic and hydraulic characteristics of the drainage sub-basins and drainage facilities associated with the site.

II. GENERAL DESCRIPTION

The site is a portion of the southeast quarter of the northwest quarter of Section 28, Township 12 South, Range 65 West of the 6th Principal Meridian, El Paso County, Colorado.

The 10.2 acre site is in a natural pasture condition that is regularly mowed. The pasture area surrounds the existing residence. The address of the residence is 8190 Poco Road. There are several observable natural drainage corridors that extend from north to south within the boundaries of the site.

No offsite improvements or onsite improvement are proposed for the site.

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***

- ***El Paso County drainage Criteria Manual, Volume I.***

- The charts and graphs used from this manual are reproduced within the pertinent sections of the Appendix.

- ***City of Colorado Springs Drainage Criteria Manual (where included with the El Paso County Drainage Criteria Manual).***

- 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)

- ***Sand Creek Drainage Basin Planning Study***
- **Design storms**
 - Minor storm: 5 year
 - Major storm: 100 year
- **Drainage Areas**
 - Areas for the offsite and onsite sub basins were obtained from topographic mapping prepared by MVE. This mapping was used as the base for the Drainage Map Exhibit 8 that is included in the map pocket at the back of this report.
- **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).
- **Culvert Evaluation**
Sizing
 - The 5 year storm was used to evaluate the culverts under Poco Road.
 - The 100 year storm was used to evaluate the over topping conditions anticipated at the existing culvert under Brown Road.
 - The assumptions that were made in the evaluation of these culverts are described in the pertinent section of the report.
- **Drainage Swale and Borrow Ditch Evaluation**
 - Onsite and offsite drainage swales and the borrow ditches along the northerly roadside of Poco Road were evaluated for erosion potential.
 - The assumptions that were made in the evaluation of these culverts are described in the pertinent section of the report
- **Detention/ Water Quality**
Detention and water quality improvements were not addressed since changes to the existing drainage characteristics are not proposed with the platting of the site.
- ***Erosion control***
 - Erosion issues were briefly evaluated based on the estimated velocities in the existing swales.

IV. EXISTING REPORTS, MAPPING AND INFORMATION

- The project is located at the northwesterly corner of the ***Sand Creek Drainage Basin*** (Appendix, Exhibit 5)

- 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, Map Number 08041C0535G, (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:

- Pring coarse sandy loam 3-8% (SCS No. 71)

The soils and their characteristic are described in the soils report included in the Appendix, Exhibit 3. The soil group is classified within the B hydrologic group.

VII. **DOWNSTREAM DRAINAGE CONDITIONS**

All stormwater runoff drains to the roadside borrow ditch along the northerly side of Poco Road. Two (2) CMP culverts pass the runoff under Poco Road at locations shown on the Drainage Plan (Exhibit 8, Appendix). These culverts were only partially evaluated based on the assumptions included in the pertinent sections of this report. A thorough evaluation of the culverts was not required since the existing drainage conditions are not to be altered with the platting of the site.

VIII. **DRAINAGE CONDITIONS FOR OFFSITE SUB-BASINS AND SWALES (where applicable)**

Based visual observations and existing vegetative conditions, it is expected that these swales will safely convey the runoff for both the minor and major storms.

- **Basin OS-1 and Swale 1**

Sub basin OS-1 is the only offsite sub basin that drains into the site. It is approximately 10.3 acres and drains from north to south. The area is predominantly "pasture" in excellent condition. The average slope is between 7% and 10%. OS-1 and is drained by a broad grass lined swale noted as Swale 1 on the drainage plan. Swale 1 intersects with a smaller swale (not studied) at Design Point 1 approximately 100 feet south of the site's northerly property line.

Hydrologic Characteristics

- Area = 10.3 acres
- Runoff Coefficients: 5 year = 0.08, 100 year = 0.35
- Time of Concentration = 27.1 minutes

- Estimated Runoff : 5 year = 1.5 cfs , 100 year = 14.1 cfs

Hydraulic Evaluation Swale 1

- Grassed lined in excellent condition
- Bottom width = 10 feet (average)
- Side Slopes = 10 to 1 (average)
- Slope = 10.7% (average)
- Design flows: 5 year = 1.5 cfs, 100 year = 14.1 cfs
- Depth of flow: 5 year = negligible, 100 year = 0.2 ft.
- Velocity: 5 year = 1.7 fps, 100 year = 3.9 fps
- Erosion potential: negligible

- **Basin OS-2 and Swale 4 (information purposes only)**

The boundary of Offsite Basin OS-2 is shown on the Drainage Plan for information purposes only. The runoff from this area drains from north to south along the easterly side of the site in a large broad grass lined swale. Only a small portion of the site, sub basin C drains into OS-2, at the northeast corner of the site. Stormwater in the swale has no impact on the site's drainage conditions. The runoff from OS2 drains to the borrow ditch along the northerly side of Poco Road. The water then flows in an easterly direction to an existing culvert that passes the water under Poco Road. The hydraulic characteristics of the swale were not evaluated since it has no impact on the site.

- **Basin OS-3**

Sub-basin OS-3 is approximately 0.6 acres is located at the southeasterly corner of the site. This area drains to the northerly borrow ditch along Poco Road which carries the storm water in a westerly direction to Design Point 4. The water then passes under a driveway to the site's residence through an 18 driveway culvert located approximately 75 west of Design Point 4.

Hydrologic Characteristics

- Area 0.6 acres
- Runoff Coefficients
 - 5 year storm = 0.08
 - 100 year storm = 0.35
- Time of Concentration: 10 minutes (minimum allowed per criteria)
- Estimated Runoff:
 - Minor storm (5 year) = 0.1 cfs
 - Major Storm (100 year) = 1.3 cfs

- **Basin OS-4 and Borrow Ditch 5 (information purposes only)**

Sub-basin OS-4 is approximately 0.5 acres and consists of the northerly half of the Poco Road right of way. This sub-basin was evaluated for information purposes only in order to perform a preliminary evaluation of the capacity of the roadside borrow-ditch as well as the 24 inch CMP culvert at Design Point 6. It is understood that the Owner has no responsibility to modify the culvert since

there is no change to the existing drainage conditions of the site as a result of the platting of the site.

The borrow ditch was evaluated based on the total runoff from sub basins OS4, and 2/3 of sub basin B. The area has the following hydrologic characteristics:

Hydrologic Characteristics

- Area 0.44 acres
- Runoff Coefficients (composite): 5 year storm = 0.12, 100 year storm = 0.41
- Time of Concentration: 22 (same as at design Point 3)
- Estimated Runoff: 5 year = 1.1 cfs, 100 year = 8.1 cfs

Hydraulic Evaluation Swale 5:

- Grassed lined in excellent condition
- Bottom width = 2 feet (approximated)
- Side Slopes = 3 to 1 (approximated)
- Slope = 6.0%
- Design flow: 5 year = 1.1 cfs, 100 year = 8.1 cfs
- Depth of flow: 5 year = 0.2 ft., 100 year = 0.5 ft.
- Velocity: 5 year = 2.6 fps, 100 year = 4.9 fps
- Erosion potential: negligible

• **Basin OS-5**

Sub-basin OS4 is approximately 0.2 acres is located along the westerly property line of the site immediately north of Poco Road and adjacent to the westerly property line of the site. This area drains from north to south to the northerly borrow ditch along Poco Road 4 which carries the runoff water in an easterly direction to Design Point 7. The water is then directed to an 18 inch culvert under Poco Road. The culvert is approximately located 20 feet east of the southwesterly corner of the site.

Hydrologic Characteristics

- Area 0.2 acres
- Runoff Coefficients
 - 5 year storm = 0.08
 - 100 year storm = 0.35
- Time of Concentration: 10 minutes (minimum allowed for undeveloped conditions)
- Estimated Runoff:
 - Minor storm (5 year) = 0.1 cfs
 - Major Storm (100 year) = 0.4 cfs

No swale was evaluated for this sub-basin. The swale along Poco Road, Swale 7, was evaluated in a subsequent section of this report.

- **Basin OS-6**

Sub-basin OS6 is approximately 0.1 and consists of ½ of the Poco Road right of way.

Hydrologic Characteristics

- Area = 0.1 acres
- Runoff Coefficients (composite)
 - 5 year storm = 0.34
 - 100 year storm = 0.53
- Time of Concentration: 5 minutes (minimum allowed based on criteria)
- Estimated Runoff:
 - Minor storm (5 year) = 0.1 cfs
 - Major Storm (100 year) = 0.4 cfs

No swale was evaluated for this sub-basin. The swale along Poco Road, Swale 7, was evaluated in a subsequent section of this report.

- **Basin OS-7**

Sub-basin OS7 is two times the size of OS6.

Hydrologic Characteristics

- Area = 0.2 acres
- Runoff Coefficients (composite)
 - 5 year storm = 0.34
 - 100 year storm = 0.53
- Time of Concentration: 5 minutes (minimum allowed based on criteria)
- Estimated Runoff:
 - Minor storm (5 year) = 0.2 cfs
 - Major Storm (100 year) = 0.8 cfs

No swale was evaluated for this sub-basin. The swale along Poco Road, Swale 6, was evaluated in a subsequent section of this report.

IX. DRAINAGE CONDITIONS FOR ONSITE SUBBASINS AND SWALES

- **Sub-basin A and Swale 2**

Sub-basin A is approximately 4.3 acres, and drains north to south along the westerly property line of the site. Runoff from OS1 enters the property at Design Point 1 via a broad grass lined swale noted as Swale 1 on the drainage plan. The characteristics of this swale are described in a previous section of this report. The swale that drains Sub-basin is noted as Swale 2 on the drainage plan. This swale directs the runoff in a southerly direction to Design Point 2 and then to an 18 inch culvert under Poco Road at Design Point at Design Point 7.

Hydrologic Characteristics

The hydrologic characteristics were determined based on the total area that

contributes runoff to Design Point 2:

- Area = 14.8 acres (includes areas OS1, A, and OS5).
- Runoff Coefficients: 5 year = 0.08, 100 year = 0.35
- Time of Concentration: 33.4 minutes
- Estimated Runoff: 5 year = 2.0 cfs, 100 year = 19.2 cfs

Hydraulic Evaluation Swale 2

Grass lined in excellent condition

- Bottom width = 10 feet
- Side Slopes = 10 to 1
- Slope = 3.6%
- Design Flow: 5 year = 2.0 cfs, 100 year = 19.2 cfs
- Depth of flow: 5 year = 0.1 feet, 100 year = 0.3 feet
- Velocity = 5 year = 1.2 fps, 100 year = 2.8 fps
- Erosion potential: negligible

An existing 18 inch CMP culvert passes the stormwater under Poco Road at Design Point 2. The hydraulic characteristics are summarized in a subsequent section of this report.

- **Sub-basin B and Swale 3**

Sub-basin B is approximately 5.9 acres and drains the majority of the property. The area slopes to the south at slopes between 8% and 11%. No runoff from offsite basins enters this sub basin. Runoff sheet flows across natural ground to Design Point 3. The cover is a well-developed grassland and appears to be stable and in excellent condition. The area appears to be mowed on a regular basis. The majority of the runoff enters the northerly roadside borrow ditch along Poco Road. The ditch directs the water in a westerly direction to an existing 24 inch culvert.

Hydrologic Characteristics

The hydrologic characteristics were determined at Design Point 3

- Area = 5.9 acres
- Runoff Coefficients
 - 5 year storm = 0.08
 - 100 year storm = 0.35
- Time of Concentration: 22 minutes
- Estimated Runoff:
 - Minor storm (5 year) = 0.9 cfs
 - Major Storm (100 year) = 9.3.2 cfs

A small swale, noted as Swale 3, drains approximately 1/3 of sub basin B. Due to the small area involved it was assumed that there would be minimal impact on the stability of the soil. Therefore this swale was not evaluated.

An existing 18 inch CMP culvert passes the stormwater under Poco Road at

Design Point 2. The hydraulic characteristics are summarized in a subsequent section of this report. The hydraulic characteristics are summarized in a subsequent section of this report.

- **Sub-basin C and Swale 4**

Sub-basin C is approximately 1.5-acres and is located at the northeast section of the property. The area slopes to the east with grades between 10 and 15%. The entire runoff sheet flows into Sub basin OS2 at Design Point 5.

Hydrologic Characteristics

The following hydrologic characteristics are based on sheet flow since concentrated flow does not occur until the stormwater reaches Swale 4.

- Area = 1.5 acres
- Runoff Coefficients
 - Minor storm (5 year): 0.08
 - Major Storm (100 year): 0.35
- Time of Concentration: 10 minutes (represents the minimum that is allowed per criteria)
- Estimated Runoff
 - Minor storm (5 year): 0.3 cfs
 - Major Storm (100 year): 3.3 cfs

X. EXISTING DRAINAGE FACILITIES (INFORMATION PURPOSES ONLY)

The only drainage facilities that are associated with this site are two (2) culverts under Poco Road. The first is a 24 inch CMP located approximately 500 feet west of the southeasterly property corner of the site. The second is an 18 inch CMP located approximately 20 feet east of the southwesterly property corner of the site. These culverts were evaluated for information purposes only. It is understood that the owner has no responsibility to improve these facilities since there are to be no changes to the existing drainage characteristics as a result of platting.

In order to evaluate these culverts the following assumptions were made

- Both culverts have a minimum of 2 feet of cover.
- The tail water depth at the downstream end of both culverts is minimal and will not affect the culvert's capacity
- Both culvert's inlet and outlet conditions are considered to be projecting into the roadside and downstream swales. It was also assumed that the borrow ditches are well maintained by El Paso County
- The allowable headwater to depth ratio (HW/D) is 1.5.

The above assumptions were verified by visual inspection.

- **Design Point 8**

Hydrologic Characteristics

The following hydrologic characteristics are based the total of all sub-basins that drain to Design Point 8

- Contributing drainage area = 7.2 acres (this includes sub basins B, OS3, OS4, and OS7)
- Runoff Coefficients (composite)
 - 5 year = 0.12
 - 100 year = 0.38
- Time of Concentration = 22 minutes (same as at Design Point 3)
- Runoff
 - 5 year = 1.7 cfs
 - 100 year = 12.3 cfs

Culvert Hydraulic Characteristics

- Slope = 1.2% (based on survey information)
- Headwater to depth ratio (HW/D) (see Appendix, Figure 3.28)
- 5 year = insignificant
- 100 year = 1.0
- Recommendations: culvert has sufficient capacity

• 18 inch CMP Culvert at Design Point 7

Hydrologic Characteristics

- Contributing drainage area = 14.9 acres (this includes sub basins B, OS2, A, OS6, and OS5)
- Runoff Coefficients (gravel road has negligible impact on the coefficients)
 - 5 year = 0.08
 - 100 year = 0.35
- Time of Concentration = 33.4 minutes (same as at Design Point 2)
- Runoff
 - 5 year = 2.0 cfs
 - 100 year = 19.3 cfs

Culvert Hydraulic Characteristics

- Slope = 1.2% (based on survey information)
- Headwater to depth ratio (HW/D) (see Appendix, Figure 3.28)
 - 5 year = 0.5
 - 100 year = 3.0
- Recommendations: recommend replacing existing culvert with a 24 inch CMP which has a HW/D ratio of approximately 1.3

XI. DEVELOPED DRAINAGE CONDITIONS

An analysis of the drainage characteristics resulting from “developed” conditions was not necessary since no changes to the existing conditions were mad as a result of the platting of the site.

XII. PROPOSED IMPROVEMENTS

XI. DEVELOPED DRAINAGE CONDITIONS

An analysis of the drainage characteristics resulting from “developed” conditions was not necessary since no changes to the existing conditions were made as a result of the platting of the site.

XII. PROPOSED IMPROVEMENTS

There are no improvements proposed for this site.

XIII. DETENTION AND WATER QUALITY

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

- No increase in runoff at any of the Design Points.
- Net disturbance of area is zero and therefore is less than 1 acre.

XIV. EROSION CONTROL

No erosion control measures are required since there will be no disturbance to the site as a result of platting.

XV. FEE CALCULATIONS

The site is located in the Sand Creek Drainage Basin which has the following fees per impervious acre (Appendix, Exhibit 5):

Drainage Fee per impervious acre	\$	17,197
Bridge Fee per impervious acre	\$	5,210
Total Fees per impervious acre	\$	22,407
% Impervious (see Appendix, Drainage Basin Planning Study = 5%)		
Total Fees =	\$	1,121

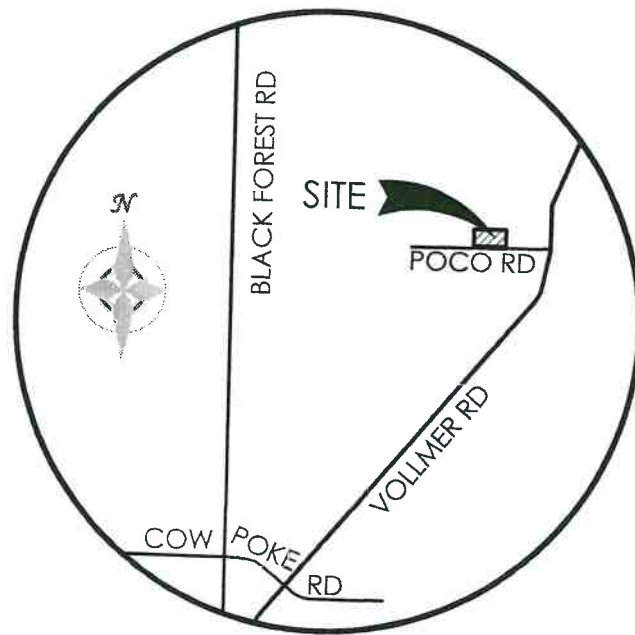
The Drainage Fees are to be paid prior to the recording of the plat.

XVI. SUMMARY

This report provides an evaluation of the existing drainage characteristics for the site. An evaluation of the developed conditions was not performed since there are to be no changes made to the existing characteristics as a result of platting. The recommendation for the culvert under Poco Road is for information purposes only. It is not the responsibility of the Owner to replace this culvert since there are not changes to the drainage characteristic’s upstream of the culvert as a result of platting.

APPENDIX

Exhibit 1
General Location Map



VICINITY MAP

NOT TO SCALE

Exhibit 2
FEMA FIRM Map

National Flood Hazard Layer FIRMette



38°58'53.04"N



USGS The National Map: Orthoimagery, Data refreshed April, 2019

38°58'25.07"N

1:6,000

Feet

0

250

500

1,000

1,500

2,000

2,500

3,000

3,500

4,000

4,500

5,000

5,500

6,000

6,500

7,000

7,500

8,000

8,500

9,000

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

Without Base Flood Elevation (BFE)
Zone A, V, AE, AP
With BFE or Depth Zone AE, AH, AR, VE, AP
Regulatory Floodway

SPECIAL FLOOD HAZARD AREAS

0.2% Annual Chance Flood Hazard, Area of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile Zone X
Future Conditions 1% Annual Chance Flood Hazard Zone X
Area with Reduced Flood Risk due to Levee. See Notes, Zone X
Area with Flood Risk due to Levee Zone D

OTHER AREAS OF FLOOD HAZARD

NO SCREEN
Area of Minimal Flood Hazard Zone X
Effective LOMRs

OTHER AREAS

Channel, Culvert, or Storm Sewer
Levee, Dike, or Floodwall

GENERAL STRUCTURES

Cross Sections with 1% Annual Chance Water Surface Elevation
Coastal Transect
Base Flood Elevation Line (BFE)
Limit of Study
Jurisdiction Boundary
Coastal Transect Baseline
Profile Baseline
Hydrographic Feature

OTHER FEATURES

Digital Data Available
No Digital Data Available
Unmapped

MAP PANELS

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

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

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 8/22/2019 at 7:18:59 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

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**



August 21, 2019

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (<http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/>) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (<https://offices.sc.egov.usda.gov/locator/app?agency=nrcs>) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil

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scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

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identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

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.

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Soil Map (Edgewood Subdivision Filing #1)



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MAP LEGEND

	Area of Interest (AOI)		Spoil Area
Soils			Stony Spot
	Soil Map Unit Polygons		Very Stony Spot
	Soil Map Unit Lines		Wet Spot
	Soil Map Unit Points		Other
Special Point Features			Special Line Features
	Blowout	Water Features	
	Borrow Pit		Streams and Canals
	Clay Spot	Transportation	
	Closed Depression		Rails
	Gravel Pit		Interstate Highways
	Gravelly Spot		US Routes
	Landfill		Major Roads
	Lava Flow		Local Roads
	Marsh or swamp	Background	
	Mine or Quarry		Aerial Photography
	Miscellaneous Water		
	Perennial Water		
	Rock Outcrop		
	Saline Spot		
	Sandy Spot		
	Severely Eroded Spot		
	Sinkhole		
	Slide or Slip		
	Sodic Spot		

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.


Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 16, Sep 10, 2018

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

Date(s) aerial images were photographed: Sep 8, 2018—May 26, 2019

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend (Edgewood Subdivision Filing #1)



Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
71	Pring coarse sandy loam, 3 to 8 percent slopes	21.8	100.0%
Totals for Area of Interest		21.8	100.0%

Map Unit Descriptions (Edgewood Subdivision Filing #1)

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

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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

71—Pring coarse sandy loam, 3 to 8 percent slopes

Map Unit Setting

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

Map Unit Composition

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

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: 3 to 8 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): 3e
 ***Hydrologic Soil Group: B***
Ecological site: Loamy Park (R048AY222CO)
Hydric soil rating: No

Minor Components

Pleasant

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

Other soils

Percent of map unit:
Hydric soil rating: No

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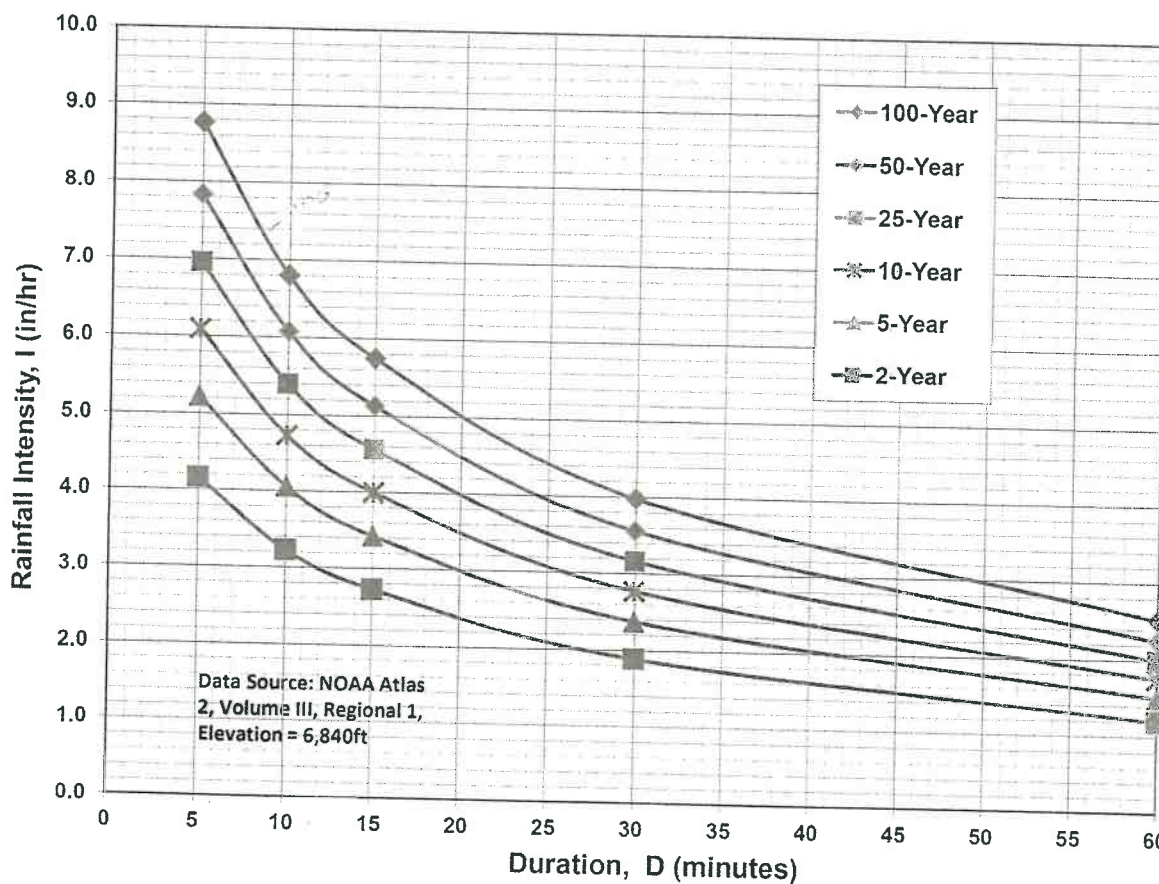
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Exhibit 4

Charts and Tables

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 6-6. 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

3.2 Time of Concentration

One of the basic assumptions underlying the Rational Method is that runoff is a function of the average rainfall rate during the time required for water to flow from the hydraulically most remote part of the drainage area under consideration to the design point. However, in practice, the time of concentration can be an empirical value that results in reasonable and acceptable peak flow calculations.

For urban areas, the time of concentration (t_c) consists of an initial time or overland flow time (t_i) plus the travel time (t_f) in the storm sewer, paved gutter, roadside drainage ditch, or drainage channel. For non-urban areas, the time of concentration consists of an overland flow time (t_i) plus the time of travel in a concentrated form, such as a swale or drainageway. The travel portion (t_f) of the time of concentration can be estimated from the hydraulic properties of the storm sewer, gutter, swale, ditch, or drainageway. Initial time, on the other hand, will vary with surface slope, depression storage, surface cover, antecedent rainfall, and infiltration capacity of the soil, as well as distance of surface flow. The time of concentration is represented by Equation 6-7 for both urban and non-urban areas.

$$t_c = t_i + t_t \quad (\text{Eq. 6-7})$$

Where:

t_c = time of concentration (min)

t_i = overland (initial) flow time (min)

t_t = travel time in the ditch, channel, gutter, storm sewer, etc. (min)

3.2.1 Overland (Initial) Flow Time

The overland flow time, t_i , may be calculated using Equation 6-8.

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L}}{S^{0.33}} \quad (\text{Eq. 6-8})$$

Where:

t_i = overland (initial) flow time (min)

C_5 = runoff coefficient for 5-year frequency (see Table 6-6)

L = length of overland flow (300 ft maximum for non-urban land uses, 100 ft maximum for urban land uses)

S = average basin slope (ft/ft)

Note that in some urban watersheds, the overland flow time may be very small because flows quickly concentrate and channelize.

3.2.2 Travel Time

For catchments with overland and channelized flow, the time of concentration needs to be considered in combination with the travel time, t_t , which is calculated using the hydraulic properties of the swale, ditch, or channel. For preliminary work, the overland travel time, t_t , can be estimated with the help of Figure 6-25 or Equation 6-9 (Guo 1999).

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

Where:

V = velocity (ft/s)

C_v = conveyance coefficient (from Table 6-7)

S_w = watercourse slope (ft/ft)

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.

The travel time is calculated by dividing the flow distance (in feet) by the velocity calculated using Equation 6-9 and converting units to minutes.

The time of concentration (t_c) is then the sum of the overland flow time (t_i) and the travel time (t_t) per Equation 6-7.

3.2.3 First Design Point Time of Concentration in Urban Catchments

Using this procedure, the time of concentration at the first design point (typically the first inlet in the system) in an urbanized catchment should not exceed the time of concentration calculated using Equation 6-10. The first design point is defined as the point where runoff first enters the storm sewer system.

$$t_c = \frac{L}{180} + 10 \quad (\text{Eq. 6-10})$$

Where:

t_c = maximum time of concentration at the first design point in an urban watershed (min)

L = waterway length (ft)

Equation 6-10 was developed using the rainfall-runoff data collected in the Denver region and, in essence, represents regional “calibration” of the Rational Method. Normally, Equation 6-10 will result in a lesser time of concentration at the first design point and will govern in an urbanized watershed. For subsequent design points, the time of concentration is calculated by accumulating the travel times in downstream drainageway reaches.

3.2.4 Minimum Time of Concentration

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

3.2.5 Post-Development Time of Concentration

As Equation 6-8 indicates, the time of concentration is a function of the 5-year runoff coefficient for a drainage basin. Typically, higher levels of imperviousness (higher 5-year runoff coefficients) correspond to shorter times of concentration, and lower levels of imperviousness correspond to longer times of

Improved Inlets

Culvert capacity may be increased through the use of special inlet designs. The Federal Highway Administration has developed extensive data^{19,20} on these. While these designs increase the flow, their use has not been as expected. The increased costs of the special treatments is apparently responsible.

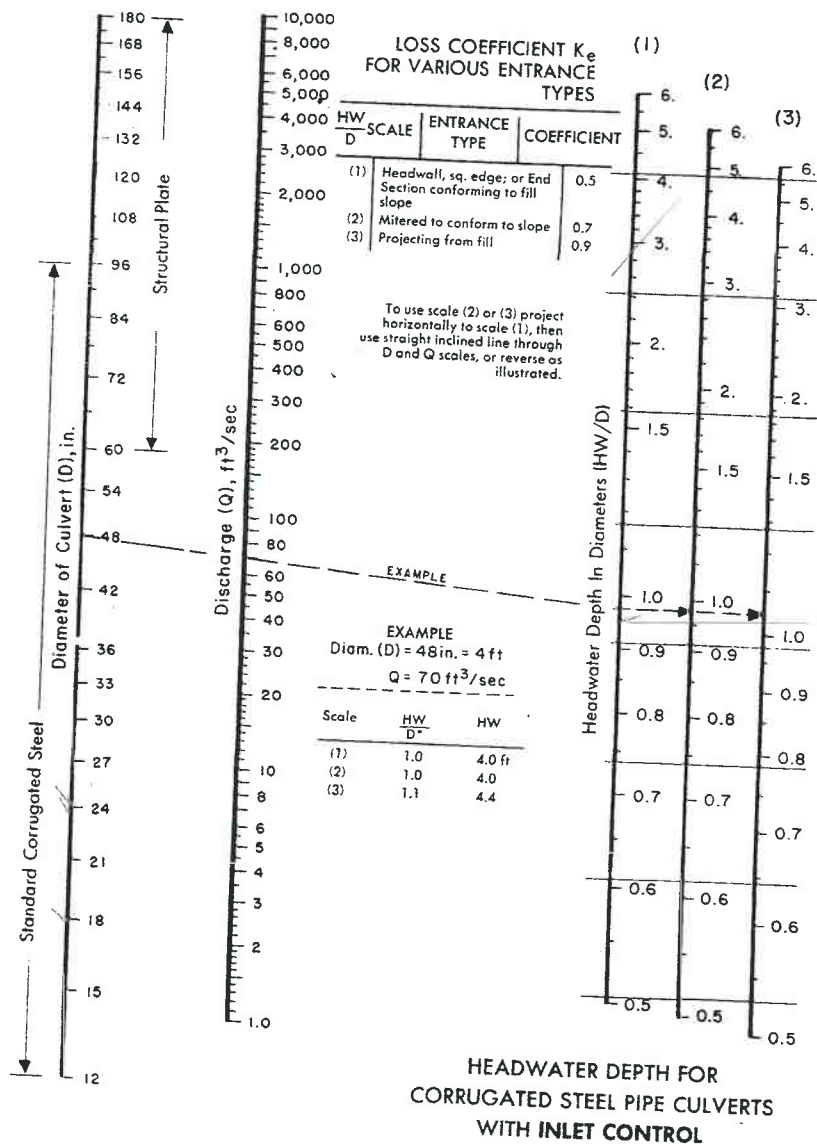


Figure 3.28 Inlet control nomograph for corrugated steel pipe culverts.¹³ The manufacturers recommend keeping HW/D to a maximum of 1.5 and preferably to no more than 1.0 for diameters greater than 4 to 5 feet.

[Show](#)

Manning's n Values



Reference tables for Manning's n values for Channels, Closed Conduits Flowing Partially Full, and Corrugated Metal Pipes.

Manning's n for Channels (Chow, 1959).

Type of Channel and Description	Minimum	Normal	Maximum
Natural streams - minor streams (top width at floodstage < 100 ft)			
1. Main Channels			
a. clean, straight, full stage, no rifts or deep pools	0.025	0.030	0.033
b. same as above, but more stones and weeds	0.030	0.035	0.040
c. clean, winding, some pools and shoals	0.033	0.040	0.045
d. same as above, but some weeds and stones	0.035	0.045	0.050
e. same as above, lower stages, more ineffective slopes and sections	0.040	0.048	0.055
f. same as "d" with more stones	0.045	0.050	0.060
g. sluggish reaches, weedy, deep pools	0.050	0.070	0.080
h. very weedy reaches, deep pools, or floodways with heavy stand of timber and underbrush	0.075	0.100	0.150
2. Mountain streams, no vegetation in channel, banks usually steep, trees and brush along banks submerged at high stages			
a. bottom: gravels, cobbles, and few boulders	0.030	0.040	0.050
b. bottom: cobbles with large boulders	0.040	0.050	0.070
3. Floodplains			
a. Pasture, no brush			
1. short grass	0.025	0.030	0.035
2. high grass	0.030	0.035	0.050
b. Cultivated areas			
1. no crop	0.020	0.030	0.040
2. mature row crops	0.025	0.035	0.045
3. mature field crops	0.030	0.040	0.050
c. Brush			
1. scattered brush, heavy weeds	0.035	0.050	0.070
2. light brush and trees, in winter	0.035	0.050	0.060
3. light brush and trees, in summer	0.040	0.060	0.080
4. medium to dense brush, in winter	0.045	0.070	0.110
5. medium to dense brush, in summer	0.070	0.100	0.160
d. Trees			
1. dense willows, summer, straight	0.110	0.150	0.200
2. cleared land with tree stumps, no sprouts	0.030	0.040	0.050
3. same as above, but with heavy growth of sprouts	0.050	0.060	0.080
4. heavy stand of timber, a few down trees, little	0.080	0.100	0.120

undergrowth, flood stage below branches			
5. same as 4. with flood stage reaching branches	0.100	0.120	0.160
4. Excavated or Dredged Channels			
a. Earth, straight, and uniform			
1. clean, recently completed	0.016	0.018	0.020
2. clean, after weathering	0.018	0.022	0.025
3. gravel, uniform section, clean	0.022	0.025	0.030
4. with short grass, few weeds	0.022	0.027	0.033
b. Earth winding and sluggish			
1. no vegetation	0.023	0.025	0.030
2. grass, some weeds	0.025	0.030	0.033
3. dense weeds or aquatic plants in deep channels	0.030	0.035	0.040
4. earth bottom and rubble sides	0.028	0.030	0.035
5. stony bottom and weedy banks	0.025	0.035	0.040
6. cobble bottom and clean sides	0.030	0.040	0.050
c. Dragline-excavated or dredged			
1. no vegetation	0.025	0.028	0.033
2. light brush on banks	0.035	0.050	0.060
d. Rock cuts			
1. smooth and uniform	0.025	0.035	0.040
2. jagged and irregular	0.035	0.040	0.050
e. Channels not maintained, weeds and brush uncut			
1. dense weeds, high as flow depth	0.050	0.080	0.120
2. clean bottom, brush on sides	0.040	0.050	0.080
3. same as above, highest stage of flow	0.045	0.070	0.110
4. dense brush, high stage	0.080	0.100	0.140
5. Lined or Constructed Channels			
a. Cement			
1. neat surface	0.010	0.011	0.013
2. mortar	0.011	0.013	0.015
b. Wood			
1. planed, untreated	0.010	0.012	0.014
2. planed, creosoted	0.011	0.012	0.015
3. unplanned	0.011	0.013	0.015
4. plank with battens	0.012	0.015	0.018
5. lined with roofing paper	0.010	0.014	0.017
c. Concrete			
1. trowel finish	0.011	0.013	0.015
2. float finish	0.013	0.015	0.016
3. finished, with gravel on bottom	0.015	0.017	0.020
4. unfinished	0.014	0.017	0.020
5. gunite, good section	0.016	0.019	0.023
6. gunite, wavy section	0.018	0.022	0.025
7. on good excavated rock	0.017	0.020	

8. on irregular excavated rock	0.022	0.027	
d. Concrete bottom float finish with sides of:			
1. dressed stone in mortar	0.015	0.017	0.020
2. random stone in mortar	0.017	0.020	0.024
3. cement rubble masonry, plastered	0.016	0.020	0.024
4. cement rubble masonry	0.020	0.025	0.030
5. dry rubble or riprap	0.020	0.030	0.035
e. Gravel bottom with sides of:			
1. formed concrete	0.017	0.020	0.025
2. random stone mortar	0.020	0.023	0.026
3. dry rubble or riprap	0.023	0.033	0.036
f. Brick			
1. glazed	0.011	0.013	0.015
2. in cement mortar	0.012	0.015	0.018
g. Masonry			
1. cemented rubble	0.017	0.025	0.030
2. dry rubble	0.023	0.032	0.035
h. Dressed ashlar/stone paving	0.013	0.015	0.017
i. Asphalt			
1. smooth	0.013	0.013	
2. rough	0.016	0.016	
j. Vegetal lining	0.030		0.500

Manning's n for Closed Conduits Flowing Partly Full (Chow, 1959).

Type of Conduit and Description	Minimum	Normal	Maximum
1. Brass, smooth:	0.009	0.010	0.013
2. Steel:			
Lockbar and welded	0.010	0.012	0.014
Riveted and spiral	0.013	0.016	0.017
3. Cast Iron:			
Coated	0.010	0.013	0.014
Uncoated	0.011	0.014	0.016
4. Wrought Iron:			
Black	0.012	0.014	0.015
Galvanized	0.013	0.016	0.017
5. Corrugated Metal:			
Subdrain	0.017	0.019	0.021
Stormdrain	0.021	0.024	0.030
6. Cement:			
Neat Surface	0.010	0.011	0.013
Mortar	0.011	0.013	0.015
7. Concrete:			
Culvert, straight and free of debris	0.010	0.011	0.013
Culvert with bends, connections, and some debris	0.011	0.013	0.014
Finished	0.011	0.012	0.014
Sewer with manholes, inlet, etc., straight	0.013	0.015	0.017
Unfinished, steel form	0.012	0.013	0.014
Unfinished, smooth wood form	0.012	0.014	0.016

Unfinished, rough wood form	0.015	0.017	0.020
8. Wood:			
Stave	0.010	0.012	0.014
Laminated, treated	0.015	0.017	0.020
9. Clay:			
Common drainage tile	0.011	0.013	0.017
Vitrified sewer	0.011	0.014	0.017
Vitrified sewer with manholes, inlet, etc.	0.013	0.015	0.017
Vitrified Subdrain with open joint	0.014	0.016	0.018
10. Brickwork:			
Glazed	0.011	0.013	0.015
Lined with cement mortar	0.012	0.015	0.017
Sanitary sewers coated with sewage slime with bends and connections	0.012	0.013	0.016
Paved invert, sewer, smooth bottom	0.016	0.019	0.020
Rubble masonry, cemented	0.018	0.025	0.030

Manning's n for Corrugated Metal Pipe (AISI, 1980).

Type of Pipe, Diameter and Corrugation Dimension	n
1. Annular 2.67 x 1/2 inch (all diameters)	0.024
2. Helical 1.50 x 1/4 inch	
8" diameter	0.012
10" diameter	0.014
3. Helical 2.67 x 1/2 inch	
12" diameter	0.011
18" diameter	0.014
24" diameter	0.016
36" diameter	0.019
48" diameter	0.020
60" diameter	0.021
4. Annular 3x1 inch (all diameters)	0.027
5. Helical 3x1 inch	
48" diameter	0.023
54" diameter	0.023
60" diameter	0.024
66" diameter	0.025
72" diameter	0.026
78" diameter and larger	0.027
6. Corrugations 6x2 inches	
60" diameter	0.033
72" diameter	0.032
120" diameter	0.030
180" diameter	0.028



Exhibit 5
Drainage Basin Planning Study

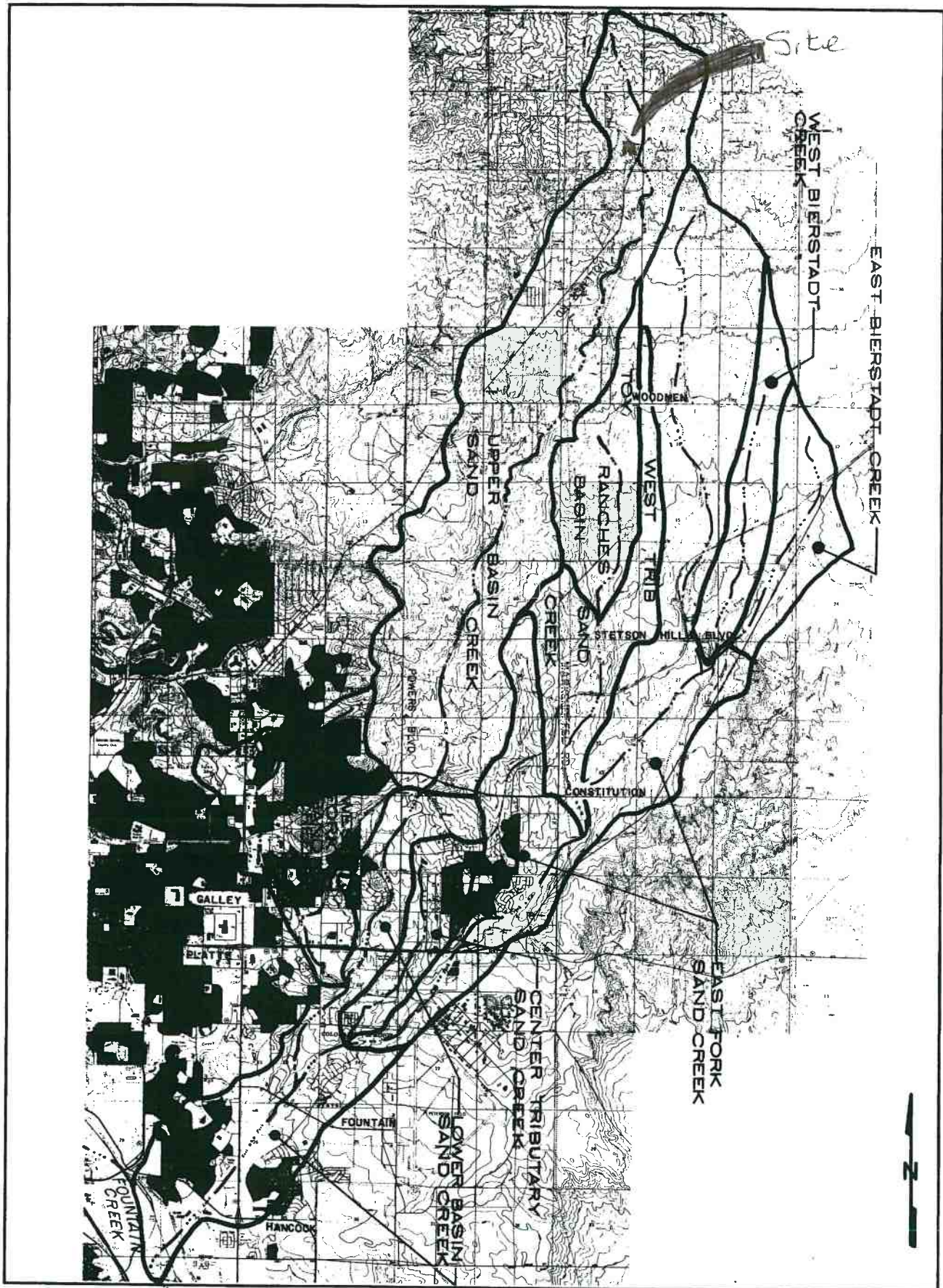


FIG. III-1

11

Project No. 90-04-03
Date: 11/90
Drawn: JAK
Checked: JAK
Reviewed: JAK

SAND CREEK DRAINAGE BASIN PLANNING STUDY REGIONAL SUB-BASINS

Kiowa Engineering Corporation

419 W. Bijou Street
Colorado Springs, Colorado
80905-1308

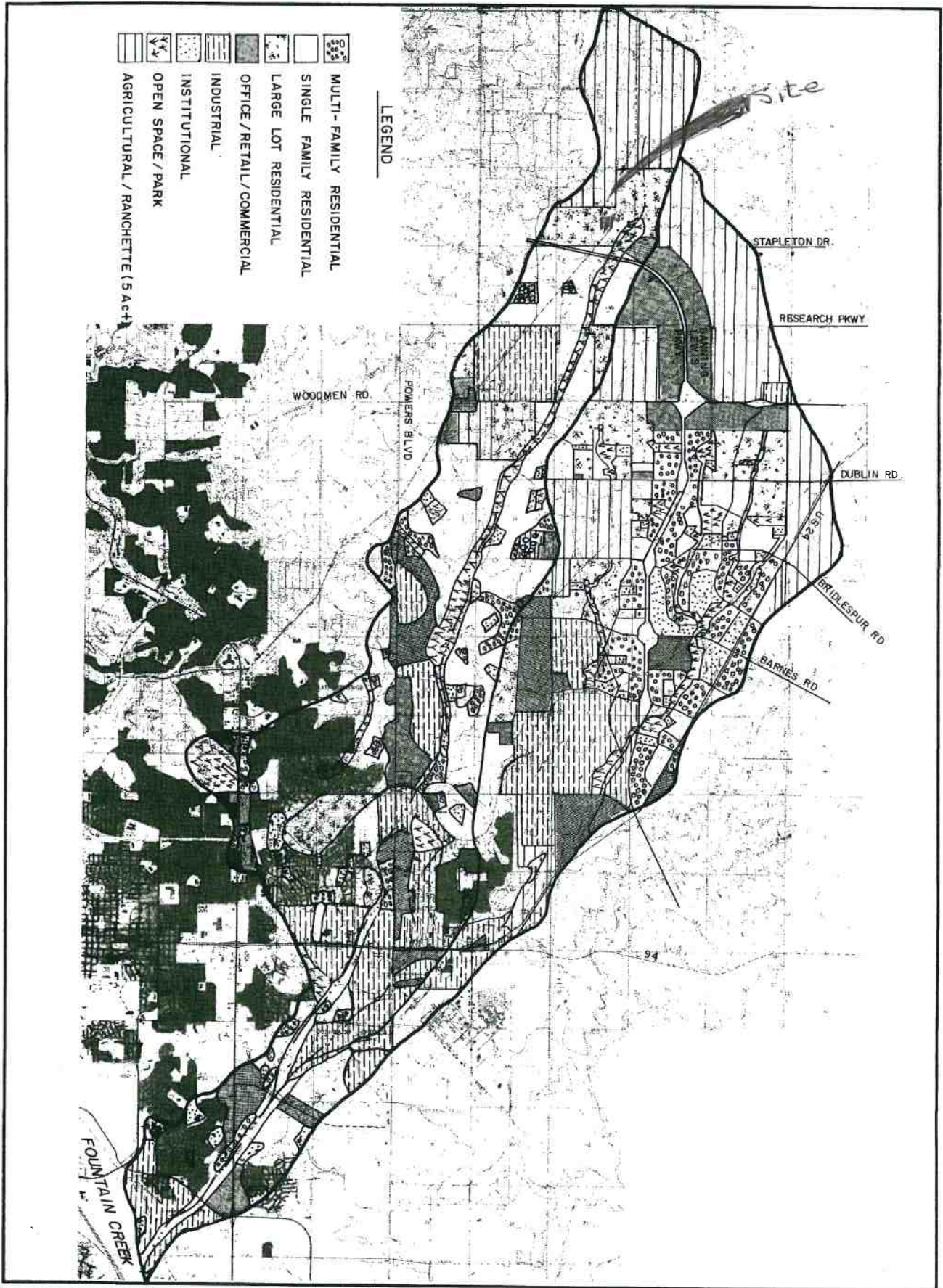


FIG. II-3
7
Project No. 80-04-108
Date: 8/80
Drawn: EAK
Checked:
Reviewed:

SAND CREEK DRAINAGE
BASIN PLANNING STUDY

PROPOSED LAND USE

Kiowa Engineering Corporation
419 W. Bijou Street
Colorado Springs, Colorado
80905-1308

El Paso County Drainage Basin Fees

Resolution No. 17-348

Basin Number	Receiving Waters	Year Studied	Drainage Basin Name	2018 Drainage Fee (per Impervious Acre)	2018 Bridge Fee (per Impervious Acre)
--------------	------------------	--------------	---------------------	--	--

Drainage Basins with DBPS's:

CHMS0200	Chico Creek	2013	Haegler Ranch	\$9,676	\$1,428
CHWS1200	Chico Creek	2001	Bennett Ranch	\$10,832	\$4,155
CHWS1400	Chico Creek	2013	Falcon	\$27,762	\$3,814
FOFO2000	Fountain Creek	2001	West Fork Jimmy Camp Creek	\$11,775	\$3,484
FOFO2600	Fountain Creek	1991*	Big Johnson / Crews Gulch	\$17,197	\$2,221
FOFO2800	Fountain Creek	1988*	Widefield	\$17,197	\$0
FOFO2900	Fountain Creek	1988*	Security	\$17,197	\$0
FOFO3000	Fountain Creek	1991*	Windmill Gulch	\$17,197	\$258
FOFO3100 / FOFO3200	Fountain Creek	1988*	Carson Street / Little Johnson	\$10,490	\$0
FOFO3400	Fountain Creek	1984*	Peterson Field	\$12,404	\$941
FOFO3600	Fountain Creek	1991*	Fisher's Canyon	\$17,197	\$0
FOFO4000	Fountain Creek	1996	Sand Creek	\$17,197	\$5,210
FOFO4200	Fountain Creek	1977	Spring Creek	\$8,919	\$0
FOFO4600	Fountain Creek	1984*	Southwest Area	\$17,197	\$0
FOFO4800	Fountain Creek	1991	Bear Creek	\$17,197	\$941
FOFO5400	Fountain Creek	1977	21st Street	\$5,174	\$0
FOFO5600	Fountain Creek	1964	19th Street	\$3,385	\$0
FOFO5800	Fountain Creek	1964	Camp Creek	\$1,906	\$0
FOMO0400	Monument Creek	1986*	Mesa	\$8,995	\$0
FOMO1000	Monument Creek	1981	Douglas Creek	\$10,815	\$239
FOMO1200	Monument Creek	1977	Templeton Gap	\$11,103	\$258
FOMO1400	Monument Creek	1976	Pope's Bluff	\$3,445	\$588
FOMO1600	Monument Creek	1976	South Rockrimmon	\$4,043	\$0
FOMO1800	Monument Creek	1973	North Rockrimmon	\$5,174	\$0
FOMO2000	Monument Creek	1971	Pulpit Rock	\$5,703	\$0
FOMO2200	Monument Creek	1994	Cottonwood Creek / S. Pine	\$17,197	\$941
FOMO2400	Monument Creek	1966	Dry Creek	\$13,576	\$492
FOMO3600	Monument Creek	1989*	Black Squirrel Creek	\$7,808	\$492
FOMO3700	Monument Creek	1987*	Middle Tributary	\$14,351	\$0
FOMO3800	Monument Creek	1987*	Monument Branch	\$17,197	\$0
FOMO4000	Monument Creek	1996	Smith Creek	\$7,011	\$941
FOMO4200	Monument Creek	1989*	Black Forest	\$17,197	\$468
FOMO5200	Monument Creek	1993*	Dirty Woman Creek	\$17,197	\$941
FOMO5300	Fountain Creek	1993*	Crystal Creek	\$17,197	\$941

Miscellaneous Drainage Basins: ¹

CHBS0800	Chico Creek		Book Ranch	\$16,136	\$2,336
CHEC0400	Chico Creek		Upper East Chico	\$8,791	\$255
CHWS0200	Chico Creek		Telephone Exchange	\$9,659	\$226
CHWS0400	Chico Creek		Livestock Company	\$15,910	\$189
CHWS0600	Chico Creek		West Squirrel	\$8,293	\$3,442
CHWS0800	Chico Creek		Solberg Ranch	\$17,197	\$0
FOFO1200	Fountain Creek		Crooked Canyon	\$5,192	\$0
FOFO1400	Fountain Creek		Calhan Reservoir	\$4,335	\$253
FOFO1600	Fountain Creek		Sand Canyon	\$3,132	\$0
FOFO2000	Fountain Creek		Jimmy Camp Creek ³	\$17,197	\$804
FOFO2200	Fountain Creek		Fort Carson	\$13,576	\$492
FOFO2700	Fountain Creek		West Little Johnson	\$1,133	\$0
FOFO3800	Fountain Creek		Stratton	\$8,249	\$369
FOFO5000	Fountain Creek		Midland	\$13,576	\$492
FOFO6000	Fountain Creek		Palmer Trail	\$13,576	\$492
FOFO6800	Fountain Creek		Black Canyon	\$13,576	\$492
FOMO4600	Monument Creek		Beaver Creek	\$10,281	\$0
FOMO3000	Monument Creek		Kettle Creek	\$9,287	\$0
FOMO3400	Monument Creek		Elkhorn	\$1,560	\$0
FOMO5000	Monument Creek		Monument Rock	\$7,454	\$0
FOMO5400	Monument Creek		Palmer Lake	\$11,919	\$0
FOMO5600	Monument Creek		Raspberry Mountain	\$4,009	\$0
PLPL0200	Monument Creek		Bald Mountain	\$8,544	\$0

Interim Drainage Basins: ²

FOFO1800	Fountain Creek		Little Fountain Creek	\$2,199	\$0
FOMO4400	Monument Creek		Jackson Creek	\$6,807	\$0
FOMO4800	Monument Creek		Teachout Creek	\$4,727	\$710

1. The miscellaneous drainage fee previous to September 1999 resolution was the average of all drainage fees for basins with Basin Planning Studies performed within the last 14 years.

2. Interim Drainage Fees are based upon draft Drainage Basin Planning Studies or the Drainage Basin Identification and Fee Estimation Report. (Best available information suitable for setting a fee.)

3. This is an interim fee and will be adjusted when a DBPS is completed. In addition to the Drainage Fee a surety in the amount of \$7,285 per impervious acre shall be provided to secure payment of additional fees in the event that the DBPS results in a fee greater than the current fee. Fees paid in excess of the future revised fee will be reimbursed. See Resolution 06-326 (9/14/06) and Resolution 16-320 (9/07/16).

KCH Engineering Solutions

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JOB T-Gap, Full Spectrum onsite
SHEET NO. 1 OF 1
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CHECKED BY _____ DATE _____
SCALE _____

% Impervious

Drainage Fees
Areas

$$\text{Total Area (ft}^2\text{)} = 2.5 \text{ Acres} * 43,560 = 544,500 \text{ ft}^2$$

$$\text{House (roof) area} = 2 \text{ houses} @ 7,500 \text{ S.F. each} = 15,000 \text{ ft}^2$$

$$\text{Landscape} = 1,500 \text{ S.F. per house} * 2 \text{ houses} = 3,000 \text{ ft}^2$$

$$\text{Gravel Drive (400' long by 10' wide * 2) Drives} = 8,000 \text{ ft}^2$$

% Impervious (Table 6-6)

$$\text{Pavement} = 2\%$$

$$\text{House (roof)} = 90\%$$

$$\text{Landscape} = 5\%$$

$$\text{Gravel Drive} = 57\%$$

% Impervious

$$\frac{544,500 (0.02) + 15,000 (0.90) + 3,000 (0.05) + 8,000 (0.57)}{544,500}$$

$$I = 0.05 \text{ or } 5\% \text{ impervious}$$

Sand Creek DB Fees

$$\text{Drainage Fee } \$17,197 * 0.05 = \$860$$

$$\text{Bridge Fee } \$8,210 * 0.05 = \$411$$

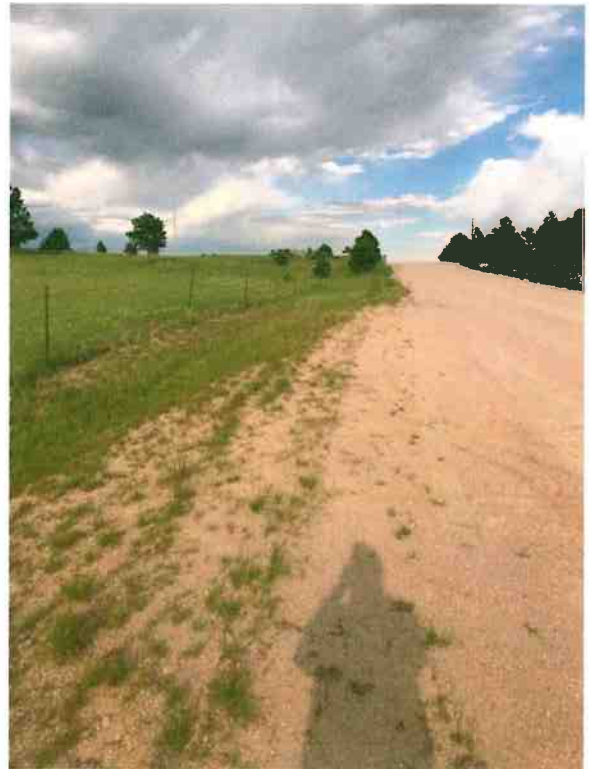
Total Fees

$$\$1,271$$

Exhibit 6 Photographs



Looking north from Poco Road
from DP3



Looking east along Poco Road
from DP3



18" Drive Culvert at DP4



18" culvert at DP9



Swale #2 looking north

Exhibit 7

Calculations

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JOB Edgewood SID 1
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SCALE _____

XI Culvert at DP9

A. Design Flow

$$Q_{yr} = 2.0 \text{ cfs}$$

$$100_{yr} = 19.3$$

B. Criteria

Same as DP8

C. Existing Facilities

18" CMP w/ projecting plain end

Length \approx 50 ft

Inv. In = 7157.7

Inv. Out = 7157.1

Drop = 0.6

$$\text{Slope} = 0.6 / 50 = 1.2\%$$

D. Evaluation

See printout

XII Driveway Culvert

A. Design Flow same as DP4

$$Q_5 = 0.1$$

$$Q_{100} = 1.3$$

B. Criteria

(Same as DP8)

C. Existing Facilities

18" CMP w/ projecting plain end

Length = 40 ft (assumed)

Slope = same as borrow ditch $10/80 = 12.5\%$

D. Evaluation

See printout

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JOB Edgewood SD #1
SHEET NO. 12 OF 21
CALCULATED BY K. Harrison DATE 8-22-19
CHECKED BY _____ DATE _____
SCALE _____

Swales (Evaluated for design flows at specific design point)
A. Swale #1: Evaluated for stability & sediment transport

1. Physical Characteristics

BW = 20'

SS = 2/20

Slope = See Sheet 1 = 10.7%

Covering = Pasture

2. Hydraulic Characteristics (see attached printout)

Depth of Flow = $D_5 = 0.04'$ $D_{100} = 0.2$

Velocity $V_5 = 1.7$ $V_{100} = 3.9$

Froude # $F_5 = 1.44$ $F_{100} = 1.75$

Design Runoff (DP1) $Q_5 = 1.5$ $Q_{100} = 14.1 \text{ cfs}$

3. Comments

The velocity is low for both storms to not cause erosion

B Swale #2

1. Physical Characteristics

BW: 10' to 80 ft

SS: 4/40 or 1/10

Slope: See Sheet 2 = 3.6%

Treatment: Pasture

2. Hydraulic Characteristics (see attached printout)

Design Runoff (DP3)

$Q_5 = 0.9 \text{ cfs}$ $Q_{100} = 9.3$

Depth of Flow $D_5 = 0.1$ $D_{100} = 0.3$

Velocity $V_5 = 1.2$ $V_{100} = 2.8$

Froude # $F_5 = 0.85$ $F_{100} = 1.08$

3 Comments

Velocities are low enough to not create significant erosion

The open channel flow calculator

Select Channel Type: Trapezoid ▼			
Depth from Q ▼	Select unit system: Feet(ft) ▼		
Channel slope: 0.107 ft/ft	Water depth(y): 0.04 ft	Bottom width(b) 20 ft	
Flow velocity 1.687436 ft/s	LeftSlope (Z1): 10 to 1 (H:V)	RightSlope (Z2): 10 to 1 (H:V)	
Flow discharge 1.5 ft^3/s	Input n value 0.035 or select n		
Calculate!	Status: Calculation finished	Reset	
Wetted perimeter 20.87 ft	Flow area 0.89 ft^2	Top width(T) 20.87 ft	
Specific energy 0.09 ft	Froude number 1.44	Flow status Supercritical flow	
Critical depth 0.06 ft	Critical slope 0.0456 ft/ft	Velocity head 0.04 ft	

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Sheet 13 of 21
Swale #1-5yr

The open channel flow calculator

Select Channel Type: Trapezoid ▼			
Depth from Q ▼		Select unit system: Feet(ft) ▼	
Channel slope: 0.107	ft/ft	Water depth(y): 0.17	ft
Flow velocity 3.906298	ft/s	LeftSlope (Z1): 10	to 1 (H:V)
Flow discharge 14.1	ft ³ /s	Input n value 0.035	or select n
Calculate!		Status: Calculation finished	Reset
Wetted perimeter 23.35	ft	Flow area 3.61	ft ²
Specific energy 0.4	ft	Froude number 1.75	
Critical depth 0.24	ft	Critical slope 0.0293	ft/ft
		Bottom width(b) 20	ft
		RightSlope (Z2): 10	to 1 (H:V)
		Top width(T) 23.33	ft
		Flow status Supercritical flow	
		Velocity head 0.24	ft

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Sheet L4 Log 21
Swale #1-100yr
1/1

The open channel flow calculator

Select Channel Type: Trapezoid ▼			
Depth from Q ▼	Select unit system: Feet(ft) ▼		
Channel slope: 0.036 ft/ft	Water depth(y): 0.07 ft	Bottom width(b): 10 ft	
Flow velocity 1.227731 ft/s	LeftSlope (Z1): 10 to 1 (H:V)	RightSlope (Z2): 10 to 1 (H:V)	
Flow discharge 0.9 ft^3/s	Input n value 0.035 or select n		
Calculate!	Status: Calculation finished	Reset	
Wetted perimeter 11.38 ft	Flow area 0.73 ft^2	Top width(T) 11.37 ft	
Specific energy 0.09 ft	Froude number 0.85	Flow status Subcritical flow	
Critical depth 0.06 ft	Critical slope 0.0416 ft/ft	Velocity head 0.02 ft	

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Sheet 15 of 21
Swale # 2-5 yed

The open channel flow calculator

Select Channel Type: Trapezoid ▼			
Depth from Q ▼	Select unit system: Feet(ft) ▼		
Channel slope: 0.036 ft/ft	Water depth(y): 0.26 ft	Bottom width(b) 10 ft	
Flow velocity 2.842784 ft/s	LeftSlope (Z1): 10 to 1 (H:V)	RightSlope (Z2): 10 to 1 (H:V)	
Flow discharge 9.3 ft^3/s	Input n value 0.035 or select n		
Calculate!	Status: Calculation finished	Reset	
Wetted perimeter 15.22 ft	Flow area 3.27 ft^2	Top width(T) 15.19 ft	
Specific energy 0.39 ft	Froude number 1.08	Flow status Supercritical flow	
Critical depth 0.27 ft	Critical slope 0.0286 ft/ft	Velocity head 0.13 ft	

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Sheet 1k of 21
Swale #2-100yr

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JOB Edgewood S/D 1
SHEET NO. 17 OF 21
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CHECKED BY _____ DATE _____
SCALE _____

C. Swale #3

Only a minimal amount of runoff enters this swale. The majority of the runoff from Subbasin enters the Poco Road roadside ditch

D. Swale #4

This swale is offset & only drains a very small area (1.5 acres) of the site. The hydraulic characteristics for this swale were not evaluated

E. Swale #5 (Poco Road borrow ditch)

Accommodates runoff from approximately 2/3 of runoff from Subbasin B

1. Physical characteristics (Approximated)

$$B/W = 20:1$$

$$SS = 3:1$$

$$\text{Slope} = 24' \text{ drop in } 400' = 6\%$$

Treatment: Mowed grassland

2. Hydraulic characteristics (see attached printout)

Design Runoff (2/3 of design flow @ DPO

$$Q_5 = 1.1$$

$$Q_{100} = 8.1$$

Depth of Flow

$$D_5 = 0.2 \text{ ft}$$

$$D_{100} = 0.6 \text{ ft}$$

Velocity

$$V_5 = 2.6 \text{ fps}$$

$$V_{100} = 4.9 \text{ fps}$$

Froude #

$$F_5 = 1.25$$

$$F_{100} = 1.49$$

3. Comments

Velocities are low enough to not cause significant erosion

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): 0.17	ft
Flow velocity 2.641268	ft/s	LeftSlope (Z1): 3	to 1 (H:V)
Flow discharge 1.1	ft^3/s	Input n value 0.035	or select n
Calculate!		Status: Calculation finished	Reset
Wetted perimeter 3.05	ft	Flow area 0.42	ft^2
Specific energy 0.27	ft	Froude number 1.25	
Critical depth 0.19	ft	Critical slope 0.0338	ft/ft
		Bottom width(b) 2	ft
		RightSlope (Z2): 3	to 1 (H:V)
		Top width(T) 3	ft
		Flow status Supercritical flow	
		Velocity head 0.11	ft

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Sheet 18 of 21
 Suble #5
 Poco Rd. Barrow Ridge
 6yr

Sheet 19021
Suble #5
Poco Rd Pappaw Dit
100 year

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JOB Edgewood SID 1
SHEET NO. 20 OF 21
CALCULATED BY K. Harrison DATE 8-22-19
CHECKED BY _____ DATE _____
SCALE _____

F. Swale #6 (Poco Road borrow ditch)

This swale was not evaluated due to the ~~main~~
negligible runoff in it. The swale only handles
runoff from 0.4 Acres of Subbsid B

Comments - Stable w/ native grass covering

G. Swale #7 (Poco Road borrow ditch)

This swale was also not evaluated since it
is only handling runoff from only 0.1 acres of
sub-bds in A.

Comments

Visual observations verifies that the borrow is
Very stable w/ native grass covering

KCH Engineering Solutions

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JOB Edgewood SID #1
SHEET NO. 21 OF 25
CALCULATED BY K. Harrison DATE 8-22-19
CHECKED BY _____ DATE _____
SCALE _____

XIV Detention / WQ

None required since disturbed area < 1 Acre

XV Erosion Control

None required since the existing ground is
not to be disturbed

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(719) 246-4471

JOB Edgewood SD #1
SHEET NO. 1 OF 25
CALCULATED BY K. Harrison DATE 8-21-19
CHECKED BY _____ DATE _____
SCALE _____

Existing & Developed

Existing & Developed Conditions

I. Design Pnt #1

A Area = 0.51 = 10.3 Acres

B. Runoff Coef. (Soil Group B)

$C_5 = 0.08$

$C_{100} = 0.35$

C. Time of Concentration

1. Overland

$t_1 = 0.395 (1.1 - C_5) \sqrt{L} / S^{0.33}$

$L = 300$; $S = 10.7\%$; $C_5 = 0.02$;

$= 0.395 (1.1 - 0.08) \sqrt{300} / 0.10^{0.33}$

$= 14.9 \text{ min}$

2. Shallow Concentr. Flow (Not Channelized)

$t_2 = L / 60 K \sqrt{S_0}$

$L = 1000$; $K = 7$ (shallow pasture); $S_0 = (7268 - 7238) / 1000 = 3.8\%$

$t_2 = 1000 / 60 \times 7 \times (0.038)^{1/2}$

$= 12.2 \text{ min.}$

3. Total $T_c = 14.9 \text{ min} + 12.2 = 27.1 \text{ min}$

D. Rainfall Intensity

$I_5 = 1.8$

$I_{100} = 3.9$

E $Q_5 = 0.08 \times 1.8 \times 10.3$

$Q_{100} = 0.35 \times 3.9 \times 10.3$

$Q_5 = 1.5 \text{ cfs}$

$Q_{100} = 14.1 \text{ cfs}$

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JOB Edgewood SD #1
SHEET NO. 2 OF 21
CALCULATED BY K. Harrison DATE 8-21-19
CHECKED BY _____ DATE _____
SCALE N.A

Existing & Develop

II Design Part 2

A Area (Offsite to the north)

$$OS-1 = 10.3$$

$$A = 4.3$$

$$OS-5 = \frac{0.2}{14.8}$$

B. Runoff Coefficients

Soil Grp = B

Short mowed pasture

$$C_5 = 0.08 \quad C_{100} = 0.35$$

C Time of Concentration

$$T_c @ DP \#1 = 27.1 \text{ min.}$$

Shallow channel flow to DP 2

$$t = L / 60 K \sqrt{S_0}$$

$$L = 500'; K = 7; S_0 = (7230 - 7212) / 500 = 3.6\%$$

$$t = 500 / 60 * 7 * \sqrt{0.036}$$
$$= 6.3 \text{ min}$$

$$\text{Total } T_c = 27.1 + 6.3 = 33.4 \text{ min}$$

D. Rainfall Intensity

$$I_5 = 1.7$$

$$I_{100} = 3.7$$

E Runoff

$$Q_5 = 0.08 * 1.7 * 14.8$$
$$= 2.0 \text{ cfs}$$

$$Q_{100} = 0.35 * 3.7 * 14.8$$
$$= 19.2 \text{ cfs}$$

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JOB Edge wood s/d Filing #1
SHEET NO. 3 OF 21
CALCULATED BY K. Harrison DATE 8/21/19
CHECKED BY _____ DATE _____
SCALE NTS

Existing & Develop

III Design Point 3

A Drainage Area

Subbasin B = 5.9 Acres

B. Runoff Coef

Soil Group = B

Usage = Shallow pasture

$$C_5 = 0.08$$

$$C_{100} = 0.35$$

C Time of Concentration

1. Overland

$$t_1 = 0.395(1.1 - C_5) \sqrt{L} / S^{0.23}$$

$$C_5 = 0.08; L = 300; S = (7260 - 7225) / 300 = 11.7\%$$

$$t_1 = 0.395(1.1 - 0.08) \sqrt{300} / (0.117)^{0.23}$$

$$t_1 = 20.4 \text{ min}$$

2. Shallow Concentrated Flow

$$t_1 = L / 60K + \sqrt{S}$$

$$L = 200 \text{ ft}; K = 7; S_0 = (7225 - 7208) / 200 = 8.5\%$$

$$t_1 = 200 / 60 + 7 * (0.085)^{0.5} = 1.6 \text{ min}$$

$$\text{Total } T_c @ DP3 = 20.4 + 1.6 = 22 \text{ min}$$

D Rainfall Intensity

$$I_5 = 2.0$$

$$I_{100} = 4.5$$

$$E \text{ Runoff} = Q = CIA$$

$$Q_5 = 0.08 * 2.0 * 5.9 \\ = 0.9 \text{ cfs}$$

$$Q_{100} = 0.35 * 4.5 * 5.9 \\ = 9.3 \text{ cfs}$$

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JOB Edgewood SD Flwy #1
SHEET NO. 4 OF 21
CALCULATED BY K. Harrison DATE 8-21-19
CHECKED BY _____ DATE _____
SCALE _____

Existing & Develop

IV Design Point 4

A. Drainage Area

Sub-basin OS3 (offs. te) = 0.6 Acres

B Runoff Coeff

Soils = B

Useage = short pasture

$$C_0 = 0.08$$

$$C_{100} = 0.35$$

C. Time of Concentration

Use min of 10 min.

D Rainfall Intensity

$$I_5 = 2.7$$

$$I_{100} = 6.3$$

E Runoff $Q = CIA$

$$Q_5 = 0.08 * 2.7 * 0.6$$
$$= 0.1 \text{ cfs}$$

$$Q_{100} = 0.35 * 6.3 * 0.6$$
$$= 1.3 \text{ cfs}$$

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JOB Edgewood S/D Elin #1
SHEET NO. 5 OF 21
CALCULATED BY K. Harrison DATE 8-21-19
CHECKED BY _____ DATE _____
SCALE _____

Existing & Developed

II Design Point 5

This only represents the total amount leaving the substation. Concentrated were not evaluated since it appears to be insignificant

A. Drainage Area

Subbasin C = 1.5 Acres

B Runoff Coefficients

Soils Group B

Udgrade, short pasture

$$C_5 = 0.08$$

$$C_{100} = 0.35$$

C. Time of Concentration

Use M.D. = 10 min

E Rainfall Intensity

$$I_5 = 2.7$$

$$I_{100} = 6.3$$

F Runoff $Q = C * I * A$

$$Q_5 = 0.08 * 2.7 * 1.5 \\ = 0.3 \text{ cfs}$$

$$Q_{100} = 0.35 * 6.3 * 1.5 \\ = 3.3 \text{ cfs}$$

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SCALE _____

VI Design Point 6 (for Evaluation of Sub 5)

A Drainage Area

$$\frac{2}{3} \text{ of } B = 3.9 \text{ Acres}$$

$$\frac{1}{2} \text{ of } \text{Poco Rd Right-of-way (OS-4)} = 0.25 \text{ (0.25 gravel)}$$

$$\text{Total Area } 4.4 \text{ Acres}$$

B. Runoff Coef.

Since the gravel area of 1

$$S_{yr} = \frac{4.7 * 0.08 + 0.25(0.59)}{4.4} = 0.12$$

$$100_{yr} = \frac{4.7 * 0.35 + 0.25(0.7)}{4.4} = 0.41$$

C. Time of Concentration

Use same @ DP 3 = 22 min

D Intensity

$$I_5 = 2.0$$

$$I_{100} = 4.5$$

E Runoff $Q = C * I * A$

$$Q_5 = 0.12 * 2.0 * 4.4 \\ = 1.1 \text{ cfs}$$

$$Q_{100} = 0.41 * 4.5 * 4.4 \\ = 8.1 \text{ cfs}$$

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JOB Edgewood s/d #1
SHEET NO. 7 OF 21
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CHECKED BY _____ DATE _____
SCALE _____

Existing & Developed
VII Design Part 7

A. Drainage Area ($\frac{1}{2}$ ROW of POCO Rd.)

$$OS-6 = 0.1 \text{ Acres}$$

B Runoff Coef

$$C_5 = 0.34$$

$$C_{100} = 0.53$$

C. Time of Conc

Use min. for developed = 5 min.

D Intensity

$$I_5 = 3.5$$

$$I_{100} = 8.0$$

E Runoff $Q = C * I * A$

$$Q_5 = 0.35 * 3.5 * 0.1 \\ = 0.12 \text{ cfs}$$

$$Q_{100} = 0.53 * 8.0 * 0.1 \\ = 0.42 \text{ cfs}$$

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JOB Edgewood SID #1
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III Design Pnt 8 A Drainage Area

	Grass	Gravel
B = 5.9	5.9	0.0
OS3 = 0.6	0.3	0.3
OS4 = 0.5	0.3	0.2
OS7 = 0.2	0.1	0.1
<u>7.2</u>	<u>6.6</u>	<u>0.6</u>

B. Runoff Coefficients

$$\begin{aligned} C_0 \\ \text{Grass} &= 0.08 \\ \text{Gravel} &= 0.59 \\ \text{Composite } C_0 \\ \frac{6.6 \times 0.08 + 0.6 \times 0.59}{7.2} \\ C_0 &= 0.12 \end{aligned}$$

$$\begin{aligned} C_{100} \\ \text{Grass} &= 0.35 \\ \text{Gravel} &= 0.70 \\ \text{Composite } C_{100} \\ \frac{6.6 \times 0.35 + 0.6 \times 0.70}{7.2} \\ C_{100} &= 0.38 \end{aligned}$$

C. Time of Concentration

Use same as DP #3 = 22 min

D Intensity

$$I_5 = 2.0$$

$$I_{100} = 4.5$$

E Runoff $Q = C \times I \times A$

$$\begin{aligned} Q_5 &= 0.12 \times 2.0 \times 7.2 \\ &= 1.7 \end{aligned}$$

$$\begin{aligned} Q_{100} &= 0.38 \times 4.5 \times 7.2 \\ &= 12.3 \end{aligned}$$

Contractor: Colorado Grouting
 Trevor 240-1376 (719)
KCH Engineering Solutions
 5228 Cracker Barrel Circle
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JOB Edgewood SID #1
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 SCALE _____

Existing & Developed

IX Design Pnt 9

Design point is the accumulation of runoff from
 sub basins OS2, A, & OS6.

A. Drainage Area

OS2	10.3 acres
A	4.3 acres
OS6	0.1
OS5	0.2
Total	14.9

grass

travel

10.3 acre	
4.3 acres	
0.05 acres	0.05 acre
1.2 acre	

B Runoff Coef

Since the amount of area for gravel surfaces is so
 small, it is assumed that there will only a negligible
 change to the runoff coefficient used for sub basins
 OS2 & A.

Therefore

$$C_5 = 0.08$$

$$C_{100} = 0.35$$

C Time of Conc

Use same T_c as DP2 & DP7 = 33.4 min

D Rainfall Intensity

$$I_5 = 1.7$$

$$I_{100} = 3.7$$

E. Runoff $Q = C * I * A$

$$Q_5 = 0.08 * 1.7 * 14.9$$

$$Q_{100} = 0.35 * 3.7 * 14.9$$

$$Q_5 = 2.0 cfs$$

$$Q_{100} = 19.3$$

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JOB Edgewood Sp E
SHEET NO. 10 OF 21
CALCULATED BY K Harrison DATE 8-22-19
CHECKED BY _____ DATE _____
SCALE _____

Existing & Developed

X Culvert @ DP 8

A Design Flow:

$$5_{yr} = 1.7 \text{ cfs}$$

$$100_{yr} = 12.3 \text{ cfs}$$

B. Criteria

5_{year}: Limit $H_w/D = 1.5$ assuming that roadway overtopping does not occur. Based on observation there is sufficient cover over the culvert to meet the H_w/D ratio = 1.5 criteria

100_{year}: Limited roadway overtopping.

C. Existing facilities

24" CMP w/ a projecting plain end

D. Evaluation

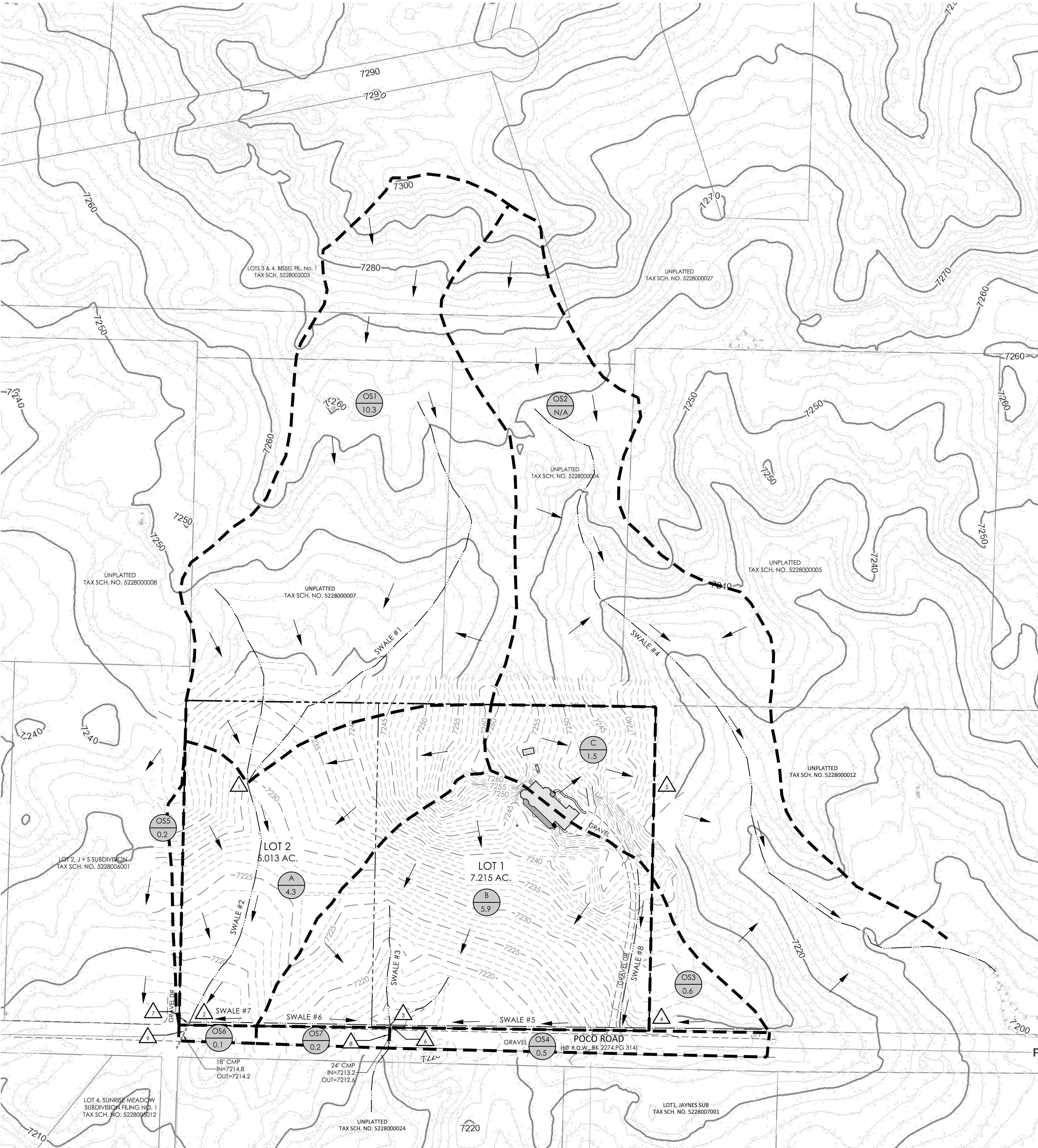
$$\text{Inv. In} = 7156.1$$

$$\text{Inv Out} = 7155.5$$

$$\text{Length} \approx \overset{0.6}{80 \text{ ft}^+}$$

$$\text{slope} = 0.6/50 = 1.2\%$$

Exhibit 8
Drainage Map
(Inside map pocket)



LEGEND

— PROPERTY LINE
--- LOT LINE

--- INDEX CONTOUR
--- INTERMEDIATE CONTOUR
--- SWALE

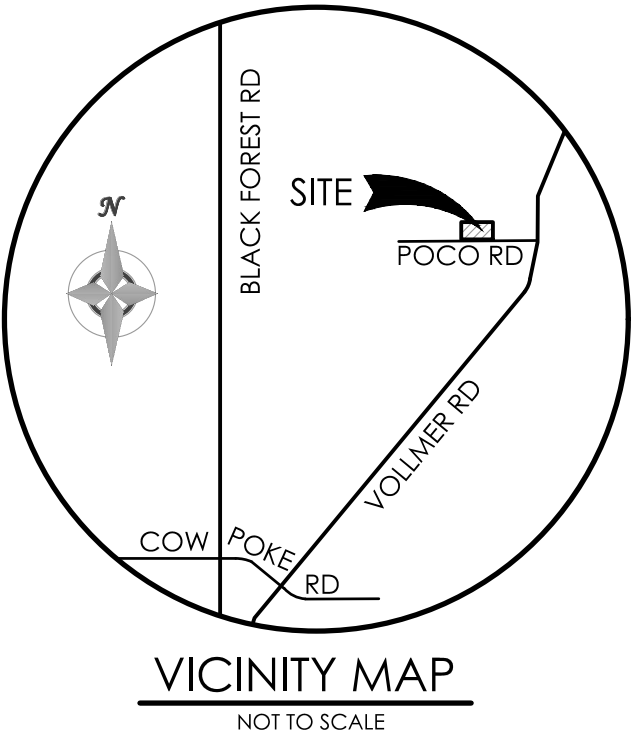
--- BASIN BOUNDARY
--- GENERAL FLOW/DIRECTION

○ BASIN LABEL
4.3 SUB-BASIN ID
AREA IN ACRES

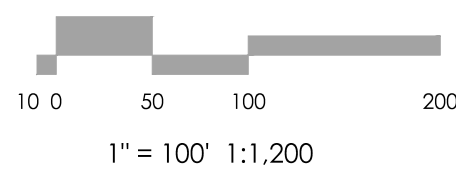
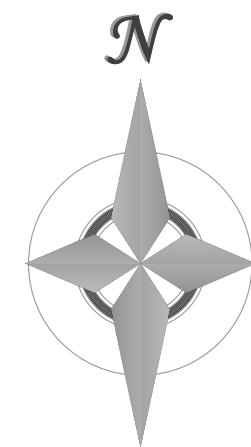
△ DESIGN POINT (DP)

NOT A CONSTRUCTION DOCUMENT

THIS PLAN SHALL NOT BE USED FOR CONSTRUCTION PURPOSES. IT IS PREPARED FOR THE CITY OF COLORADO SPRINGS DEVELOPMENT PLAN APPROVAL PROCESS ONLY. IT IS REQUIRED THAT ANY SUBSEQUENT CONSTRUCTION PLANS ADHERE TO THE APPROVED DEVELOPMENT PLAN.



BENCHMARK



Historic and Developed Runoff								
Design Point	Sub basin ID	Drainage Area (acres)	Runoff Coefficients		Runoff			Comments
			5 yr	100 yr	Tc (min)	5 yr (cfs)	100 yr (cfs)	
1	OS1	10.3	0.08	0.35	27.1	1.5	14.1	Combined runoff
2	OS1, A, OS5	14.8	0.08	0.35	33.4	2.0	19.2	
3	B	5.9	0.08	0.35	22	0.9	9.3	
4	OS3	0.6	0.08	0.35	10	0.1	1.3	Min. allowable Tc
5	C	1.5	0.08	0.35	10	0.3	3.3	Min. allowable Tc, outfalls into OS2
6	2/3 B, OS4	4.4	0.12	0.41	22	1.1	8.1	Composite "C", same Tc as DP3
7	OS6	0.1	0.34	0.53	5	0.1	0.4	Min. Tc for developed cond
8	B, OS3, OS4, OS7	7.2	0.12	0.38	22	1.7	12.3	Composite "C", same Tc as DP3
9	OS2, A, OS6, OS5	14.9	0.08	0.35	33.4	2.0	19.3	same Tc as DP2 & DP7

Swale Characteristics													
Swale #	Design Runoff		Bottom Width	Side slopes	Slope	Treatment	"n"	Depth of Flow		Velocity		Froude #	
	5 year	100 year						5 year	100 year	5 year	100 year	5 year	100 year
	cfs	cfs						ft.		%		ft.	ft.
1	1.5	14.1	10	10 to 1	10.7	grass lined	0.035	Neg	0.2	1.7	3.9	1.44	1.75
2	0.9	9.3	10	10 to 1	3.6	grass lined	0.35	0.1	0.3	1.2	2.8	0.85	1.08
3	Negligible												
4	Negligible												
5	1.1	8.1	2	3 to 1	6	grass lined	0.035	0.2	0.5	2.6	4.9	1.25	1.49
6	Negligible												
7	Negligible												

Culvert Characteristics																
Design Point	Culvert size	Culvert Material	Design Flow		End Condition	Length		Slope	Tail water condition	Approx. HWD		Culvert depth		Culvert Velocity		Recommendations
			5 year	100 year		5 year	100 year			5 year	100 year					
	inches		cfs	cfs		ft.	%	cfs		cfs	ft.	ft.	fps	fps		
8	24	CMP	1.7	12.3	proj	50	1.2	min	neg	1	0.4	1	2.9	5.1	has capacity to accommodate both storms	
9	18	CMP	2	19.3	proj	50	1.2	min	0.5	3	0.4	1.4	3.1	5.9	Roadway overtopping occurs	

REVISIONS

DESIGNED BY
DRAWN BY
CHECKED BY
AS-BUILT BY
CHECKED BY

EDGEWOOD SUBDIVISION FILING NO. 1

EXISTING/
PROPOSED DRAINAGE MAP

MVE PROJECT 61127
MVE DRAWING -DRN-PP

AUGUST 26, 2019
SHEET 1 OF 1