

DRAINAGE LETTER REPORT

for

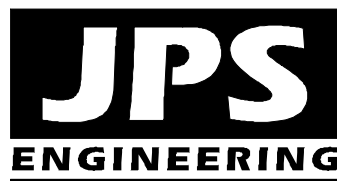
**WOODFORD MANUFACTURING BUILDING ADDITION
LOT 1, BLOCK 1, WAYNOKA ROAD INDUSTRIAL
2121 WAYNOKA ROAD, COLORADO SPRINGS, CO**

Prepared for:

Hammers Construction, Inc.
1411 Woolsey Heights
Colorado Springs, CO 80915

July 24, 2018

Prepared by:



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Colorado Springs, CO 80903
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**JPS Project No. 051801
PPR-18-00**

18-037

**WOODFORD MANUFACTURING BUILDING ADDITION
LOT 1, BLOCK 1, WAYNOKA ROAD INDUSTRIAL
DRAINAGE REPORT STATEMENTS**

1. Engineer's Statement:

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

John P. Schwab Colorado P.E. No. 29891

2. Developer's Statement:

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

By:

Printed Name:
Title:

Date

3. El Paso County Statement:

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

Jennifer Irvine, P.E.
County Engineer / ECM Administrator

Date

Conditions:

I. INTRODUCTION

A. Property Location and Description

Woodford Manufacturing is planning to construct an addition on the south side of the existing manufacturing building at 2121 Waynoka Road in El Paso County, Colorado. The project site is an existing 8.9-acre developed lot described as Lot 1, Block 1, Waynoka Road Industrial Subdivision. Woodford Manufacturing also owns the adjoining vacant lot to the south (Lot 2, Block 1, Waynoka Road Industrial). The two adjoining lots (El Paso County Assessor's No. 54062-05-001 and 54063-03-001) comprise a total area of 13.5 acres located on the east side of Waynoka Road, north of Palmer Park Boulevard. The properties are zoned Heavy Industrial (I-3).

Waynoka Road is a paved public street adjoining the west boundary of the properties. Waynoka Road curves to the east along both the north boundary of Lot 1 and the south boundary of Lot 2. The existing Cherokee Ridge Golf Course adjoins the east boundary of the two lots.

The site development plan consists of proposed 18,000 square-foot building addition at the southeast corner of the existing industrial building, with associated parking and site improvements impacting a total disturbed area of approximately 3.4 acres. Access will continue to be provided by the two existing driveways on the south side of the building, connecting to Waynoka Road on the west side of the property. There will be no changes to the parking lot on the north side of the existing building. The proposed internal parking area improvements on the south side of the building will be paved with a combination of asphalt, recycled asphalt, and concrete.

Update so the ESQCP, drainage letter and grading and erosion control plan all have the same value for the total disturbed area.

B. Scope

In support of the El Paso County Site Development Plan submittal for this project, this report is intended to meet the requirements of a site-specific "Letter Type" drainage report in accordance with El Paso County drainage criteria. This report will provide a summary of site drainage issues impacting the proposed development, including analysis of upstream drainage patterns, site-specific developed drainage patterns, and impacts on downstream facilities. This report is based on the guidelines and criteria presented in the City of Colorado Springs and El Paso County "Drainage Criteria Manual."

C. References

City of Colorado Springs & El Paso County "Drainage Criteria Manual, Volumes 1 and 2," revised May, 2014.

G.L. Williams & Partners, Ltd., "Drainage Study and Supplemental Site Information, Waynoka Road Industrial," January 16, 1978.

II. EXISTING / PROPOSED DRAINAGE CONDITIONS

According to the Natural Resources Conservation Services (NRCS) web soil survey, on-site soils are comprised of Ellicott loamy coarse sand. These soils are classified as hydrologic soils group A. The existing site topography slopes downward to the southwest with grades of approximately 1-3 percent.

Drainage planning for this lot was previously addressed in a report entitled "Drainage Study and Supplemental Site Information, Waynoka Road Industrial," by G.L. Williams & Partners, Ltd., dated January 16, 1978. The subdivision drainage report assumed full coverage of Lots 1 and 2 with "medium industrial lot areas." As discussed in the Williams drainage report, fully developed drainage from the majority of the site (Basins A-D) has been planned to sheet flow in a southwesterly direction and then follow the curb and gutter along the west side of Waynoka Road south to the existing public storm sewer system at Palmer Park Boulevard. Developed drainage from Basin E in the southeast corner of the site has been planned to flow into an existing drainage channel within the adjoining golf course, also flowing south to the existing public storm sewer system at Palmer Park Boulevard.

As shown on the enclosed Drainage Plan (Figure D1), the proposed development area on the south side of the existing manufacturing building has been delineated as three on-site drainage basins (D1, D2, and E) for general consistency with the subdivision drainage report. Basins D1 and D2 will flow southwesterly across the site to Waynoka Road. The vacant area in the southeast corner of the site (Basin E) will sheet flow south towards Design Point E at the southeast corner of Lot 2.

Recognizing that current County drainage criteria require permanent stormwater quality best management practices for disturbed areas greater than one acre in size, a private Rain Garden will be constructed at the southwest corner of Basin D1 to mitigate developed drainage impacts and meet the current County water quality requirements.

Surface runoff from the developed site will follow the drainage patterns established in the subdivision drainage report, with Basins D1 and D2 flowing southwesterly to the existing curb and gutter along the west side of Waynoka Road. The proposed building addition will be graded with protective slopes to provide positive drainage away from the building. Concrete crosspans and drainage swales within the on-site parking areas will convey developed flows to the new Rain Garden at the southwest corner of Lot 1.

Developed flows have been calculated based on the impervious areas associated with the ultimate full industrial development of the site, even though this project only includes partial improvements within Basin D1. Developed drainage from Basin D1 will flow southwesterly to the proposed Rain Garden at Design Point #D1, with developed peak flows calculated as $Q_5 = 12.0$ cfs and $Q_{100} = 24.0$ cfs. The outlet chase from the Rain Garden will flow into Waynoka Road in accordance with the subdivision drainage report.

Developed drainage from the future development area within Basin D2 will also flow southwesterly to the existing curb and gutter along Waynoka Road. Developed flows at Design Point #D2 are calculated as $Q_5 = 5.3$ cfs and $Q_{100} = 10.5$ cfs.

Developed drainage from the future development area within Basin E is anticipated to sheet flow to the south corner of Lot 2 as described in the subdivision drainage report. Developed flows at Design Point #E are calculated as $Q_5 = 5.7$ cfs and $Q_{100} = 11.3$ cfs.

An additional future water quality facility will be required at the south end of Lot 2 to mitigate the future developed drainage impacts from Basins D2 and E.

The subdivision drainage report assumed full industrial development of this site, and the proposed site development plan is entirely consistent with the approved subdivision drainage plan.

Hydrologic calculations for the parcel are detailed in the attached spreadsheet (Appendix A), and peak flows are identified on Figure D1. The contractor will need to implement standard best management practices for erosion control during construction.

III. DRAINAGE PLANNING FOUR STEP PROCESS

El Paso County Drainage Criteria require drainage planning to include a Four Step Process for receiving water protection that focuses on reducing runoff volumes, treating the water quality capture volume (WQCV), stabilizing drainageways, and implementing long-term source controls.

As stated in DCM Volume 2, the Four Step Process is applicable to all new and re-development projects with construction activities that disturb 1 acre or greater or that disturb less than 1 acre but are part of a larger common plan of development. The Four Step Process has been implemented as follows in the planning of this project:

Step 1: Employ Runoff Reduction Practices

- **Minimize Directly Connected Impervious Areas (MDCIA):** The majority of roof drain downspouts from the new building addition will discharge to a grass-lined swale along the east side of the building, and developed flows from the newly paved areas will be conveyed through a new Rain Garden at the southwest corner of Lot 1, providing for the majority of the new site impervious area to drain across pervious areas and encourage stormwater infiltration.
- **Grass Swales:** The proposed drainage plan incorporates grass swales in unpaved areas to encourage stormwater infiltration.

Step 2: Stabilize Drainageways

- There are no major drainageways directly adjacent to this site. Routing flows through the on-site Rain Garden will minimize off-site impacts to existing downstream drainageways.

Step 3: Provide Water Quality Capture Volume (WQCV)

- Site drainage from the building addition area will be routed through a proposed Rain Garden (RG), which will capture and slowly release the WQCV over a 12-hour design release period.

Step 4: Consider Need for Industrial and Commercial BMPs

- On-site drainage will be routed through the private Rain Garden (RG) to minimize introduction of contaminants to the County's public drainage system.
- The Owner will be responsible to implement and maintain a stormwater management plan (SWMP), which will include proper housekeeping practices for the industrial facility.

IV. STORMWATER QUALITY

The proposed drainage and grading plan for this site includes a private Rain Garden (RG) at the southwest corner of Lot 1 to provide the required stormwater quality mitigation for the site in accordance with current El Paso County drainage criteria.

According to the calculations in Appendix A, the required Water Quality Capture Volume (WQCV) is 4,615 cubic feet, and the proposed Rain Garden provides a volume of 4,774 cubic feet.

The outlet of the Rain Garden will consist of an overflow chase draining to the existing driveway at the northwest corner of Lot 2, and an underdrain will be extended to daylight to the south within Lot 2.

The proposed stormwater quality facilities will be privately owned and maintained by the property owner, and maintenance access is readily available from the existing street.

V. FLOODPLAIN IMPACTS

This site is located beyond the limits of the FEMA 100-year floodplain boundaries for the West Fork Sand Creek channel according to the FEMA floodplain map for this area, FIRM Panel No. 08041C0751F dated March 17, 1997 (see Appendix B).

VI. DRAINAGE BASIN FEES

This site is located within the Sand Creek Drainage Basin. No public drainage improvements are required for development of this site. Required drainage fees have been paid during the previous subdivision platting process, so there are no applicable drainage fees required with the Site Development Plan.

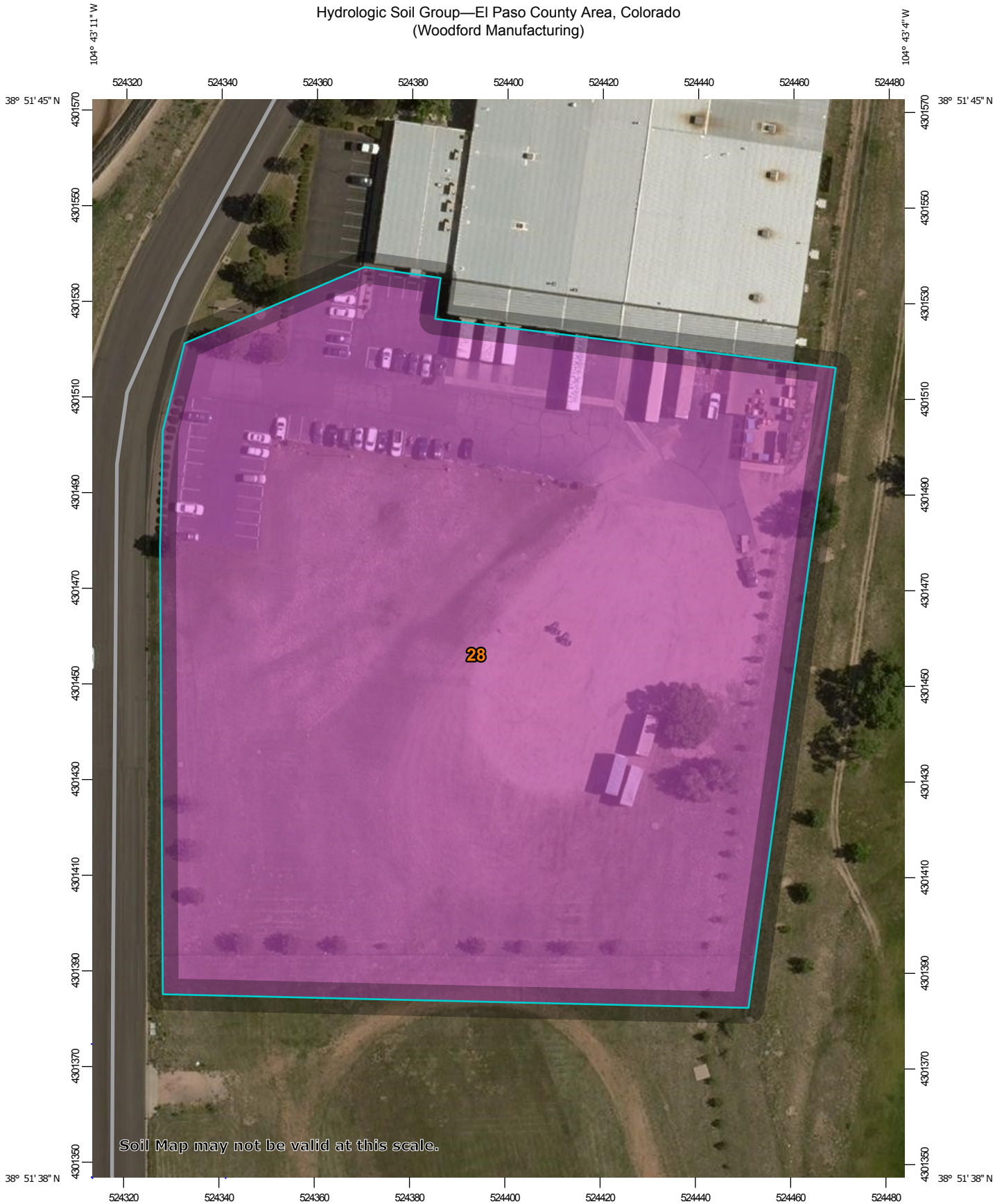
The proposed improvements is adding around 1.75 acres of impervious surface; therefore, full spectrum detention is required for water quality and flood control detention. SDI worksheet and EPC MS4 Post Construction Form must also be submitted as additional submittal documents.⁴

VII. SUMMARY

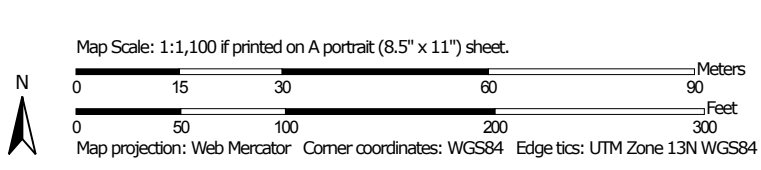
The developed drainage patterns associated with the proposed Woodford Manufacturing Building Addition project (Lot 1, Block 1, Waynoka Road Industrial Subdivision) will remain consistent with the overall drainage plan for this industrial subdivision. The proposed Rain Garden at the southwest corner of Lot 1 will provide water quality mitigation as required for the new site improvements. Proper construction and maintenance of the proposed on-site drainage facilities, in conjunction with proper erosion control practices, will ensure that this developed site has no significant adverse drainage impact on downstream or surrounding areas.

APPENDIX A
DRAINAGE CALCULATIONS
































Hydrologic Soil Group—El Paso County Area, Colorado
(Woodford Manufacturing)



Soil Map may not be valid at this scale.



MAP LEGEND

Area of Interest (AOI)	 C
Soils	 C/D
Soil Rating Polygons	 D
Soil Rating Lines	 Not rated or not available
Water Features	 Streams and Canals
Transportation	 Rails
	 Interstate Highways
	 US Routes
	 Major Roads
	 Local Roads
Background	 Aerial Photography
Soil Rating Polygons	 A
	 A/D
	 B
	 B/D
	 C
	 C/D
	 D
	 Not rated or not available
Soil Rating Lines	 A
	 A/D
	 B
	 B/D
	 C
	 C/D
	 D
	 Not rated or not available
Soil Rating Points	 A
	 A/D
	 B
	 B/D

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 15, Oct 10, 2017

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

Date(s) aerial images were photographed: Jun 3, 2014—Jun 17, 2014

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

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
28	Ellicott loamy coarse sand, 0 to 5 percent slopes	A	4.7	100.0%
Totals for Area of Interest			4.7	100.0%

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

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_r) 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_r) 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.

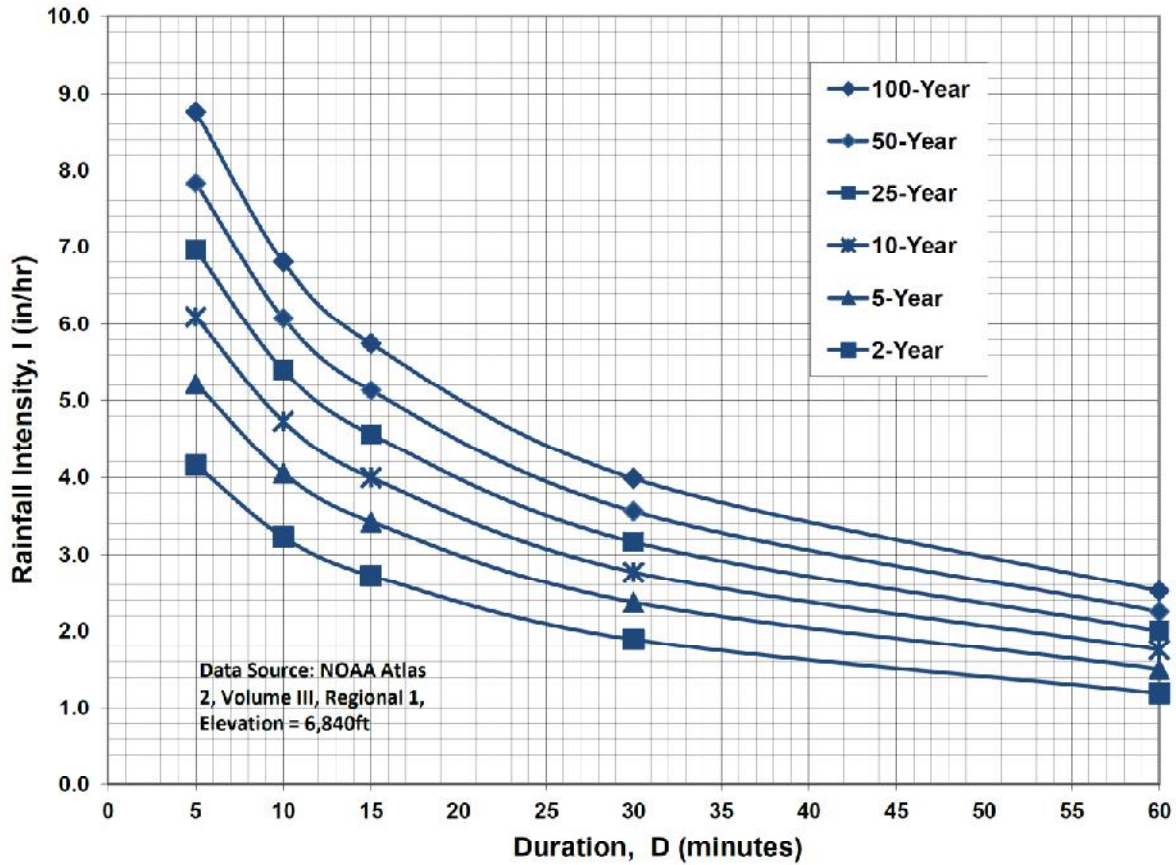
3.2.4 Minimum Time of Concentration

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

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.

WOODFORD MANUFACTURING BUILDING ADDITION - LOT 1, BLOCK 1, WAYNOKA ROAD INDUSTRIAL RATIONAL METHOD

DEVELOPED FLOWS

BASIN	DESIGN POINT	AREA (AC)	C		Overland Flow			Channel flow					PEAK FLOW				
			5-YEAR	100-YEAR	LENGTH (FT)	SLOPE (FT/FT)	Tco ⁽¹⁾ (MIN)	CHANNEL LENGTH (FT)	CONVEYANCE COEFFICIENT C	SLOPE (FT/FT)	SCS ⁽²⁾ VELOCITY (FT/S)	Tt ⁽³⁾ (MIN)	TOTAL Tc ⁽⁴⁾ (MIN)	INTENSITY ⁽⁵⁾			
														5-YR (IN/HR)	100-YR (IN/HR)	Q5 ⁽⁶⁾ (CFS)	Q100 ⁽⁶⁾ (CFS)
D1	D1	4.84	0.590	0.700	50	0.02	5.2	680	20	0.018	2.68	4.2	9.5	4.21	7.07	12.03	23.96
D2	D2	2.16	0.590	0.700	100	0.02	7.4	450	20	0.020	2.83	2.7	10.1	4.12	6.92	5.25	10.46
E	E	2.38	0.590	0.700	100	0.02	7.4	550	20	0.020	2.83	3.2	10.7	4.03	6.77	5.66	11.28

1) OVERLAND FLOW Tco = (0.395*(1.1-RUNOFF COEFFICIENT)*(OVERLAND FLOW LENGTH^(0.5))/(SLOPE^(0.333))

2) SCS VELOCITY = C * ((SLOPE(FT/FT)^{0.5})

C = 2.5 FOR HEAVY MEADOW

C = 5 FOR TILLAGE/FIELD

C = 7 FOR SHORT PASTURE AND LAWNS

C = 10 FOR NEARLY BARE GROUND

C = 15 FOR GRASSED WATERWAY

C = 20 FOR PAVED AREAS AND SHALLOW PAVED SWALES

3) MANNING'S CHANNEL TRAVEL TIME = LV (WHEN CHANNEL VELOCITY IS KNOWN)

4) Tc = Tco + Tt

*** IF TOTAL TIME OF CONCENTRATION IS LESS THAN 5 MINUTES, THEN 5 MINUTES IS USED

5) INTENSITY BASED ON I-D-F EQUATIONS IN CITY OF COLORADO SPRINGS DRAINAGE CRITERIA MANUAL

I₅ = -1.5 * ln(Tc) + 7.583

I₁₀₀ = -2.52 * ln(Tc) + 12.735

6) Q = CiA

Design Procedure Form: Rain Garden (RG)

UD-BMP (Version 3.06, November 2016)

Sheet 1 of 2

Designer: JPS
Company: JPS
Date: July 23, 2018
Project: Woodford Manufacturing Building Addition - Rain Garden D1
Location: Lot 1, Block 1, Waynoka Road Industrial Subdivision (2121 Waynoka Road, Colorado Springs, CO)

<p>1. Basin Storage Volume</p> <p>A) Effective Imperviousness of Tributary Area, I_a (100% if all paved and roofed areas upstream of rain garden)</p> <p>B) Tributary Area's Imperviousness Ratio ($i = I_a/100$)</p> <p>C) Water Quality Capture Volume (WQCV) for a 12-hour Drain Time ($WQCV = 0.8 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i)$)</p> <p>D) Contributing Watershed Area (including rain garden area)</p> <p>E) Water Quality Capture Volume (WQCV) Design Volume $Vol = (WQCV / 12) * Area$</p> <p>F) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm</p> <p>G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume</p> <p>H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired)</p>	<p>$I_a =$ <u>80.0</u> %</p> <p>$i =$ <u>0.800</u></p> <p>WQCV = <u>0.26</u> watershed inches</p> <p>Area = <u>210,830</u> sq ft</p> <p>$V_{WQCV} =$ <u>4,615</u> cu ft</p> <p>$d_e =$ _____ in</p> <p>$V_{WQCV\ OTHER} =$ _____ cu ft</p> <p>$V_{WQCV\ USER} =$ _____ cu ft</p>
<p>2. Basin Geometry</p> <p>A) WQCV Depth (12-inch maximum)</p> <p>B) Rain Garden Side Slopes ($Z = 4$ min., horiz. dist per unit vertical) (Use "0" if rain garden has vertical walls)</p> <p>C) Minimum Flat Surface Area</p> <p>D) Actual Flat Surface Area</p> <p>E) Area at Design Depth (Top Surface Area)</p> <p>F) Rain Garden Total Volume ($V_T = ((A_{Top} + A_{Actual}) / 2) * Depth$)</p>	<p>$D_{WQCV} =$ <u>12</u> in</p> <p>$Z =$ <u>4.00</u> ft / ft</p> <p>$A_{Min} =$ <u>3373</u> sq ft</p> <p>$A_{Actual} =$ <u>4074</u> sq ft</p> <p>$A_{Top} =$ <u>5473</u> sq ft</p> <p>$V_T =$ <u>4,774</u> cu ft</p>
<p>3. Growing Media</p>	<p>Choose One _____</p> <p><input checked="" type="radio"/> 18" Rain Garden Growing Media</p> <p><input type="radio"/> Other (Explain): _____</p>
<p>4. Underdrain System</p> <p>A) Are underdrains provided?</p> <p>B) Underdrain system orifice diameter for 12 hour drain time</p> <p style="margin-left: 20px;">i) Distance From Lowest Elevation of the Storage Volume to the Center of the Orifice</p> <p style="margin-left: 20px;">ii) Volume to Drain in 12 Hours</p> <p style="margin-left: 20px;">iii) Orifice Diameter, 3/8" Minimum</p>	<p>Choose One _____</p> <p><input checked="" type="radio"/> YES</p> <p><input type="radio"/> NO</p> <p>$y =$ <u>2.0</u> ft</p> <p>$Vol_{12} =$ <u>4,615</u> cu ft</p> <p>$D_o =$ <u>1 4/7</u> in</p>

Orifice to drain WQCV over 12 hours is not shown in the GEC pond detail. Update accordingly.

Design Procedure Form: Rain Garden (RG)

Designer: JPS
Company: JPS
Date: July 23, 2018
Project: Woodford Manufacturing Building Addition - Rain Garden D1
Location: Lot 1, Block 1, Waynoka Road Industrial Subdivision (2121 Waynoka Road, Colorado Springs, CO)

5. Impermeable Geomembrane Liner and Geotextile Separator Fabric

A) Is an impermeable liner provided due to proximity of structures or groundwater contamination?

Choose One
 YES
 NO

6. Inlet / Outlet Control

A) Inlet Control

Choose One
 Sheet Flow- No Energy Dissipation Required
 Concentrated Flow- Energy Dissipation Provided

7. Vegetation

Choose One
 Seed (Plan for frequent weed control)
 Plantings
 Sand Grown or Other High Infiltration Sod

8. Irrigation

A) Will the rain garden be irrigated?

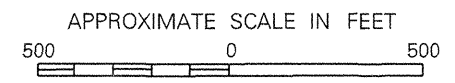
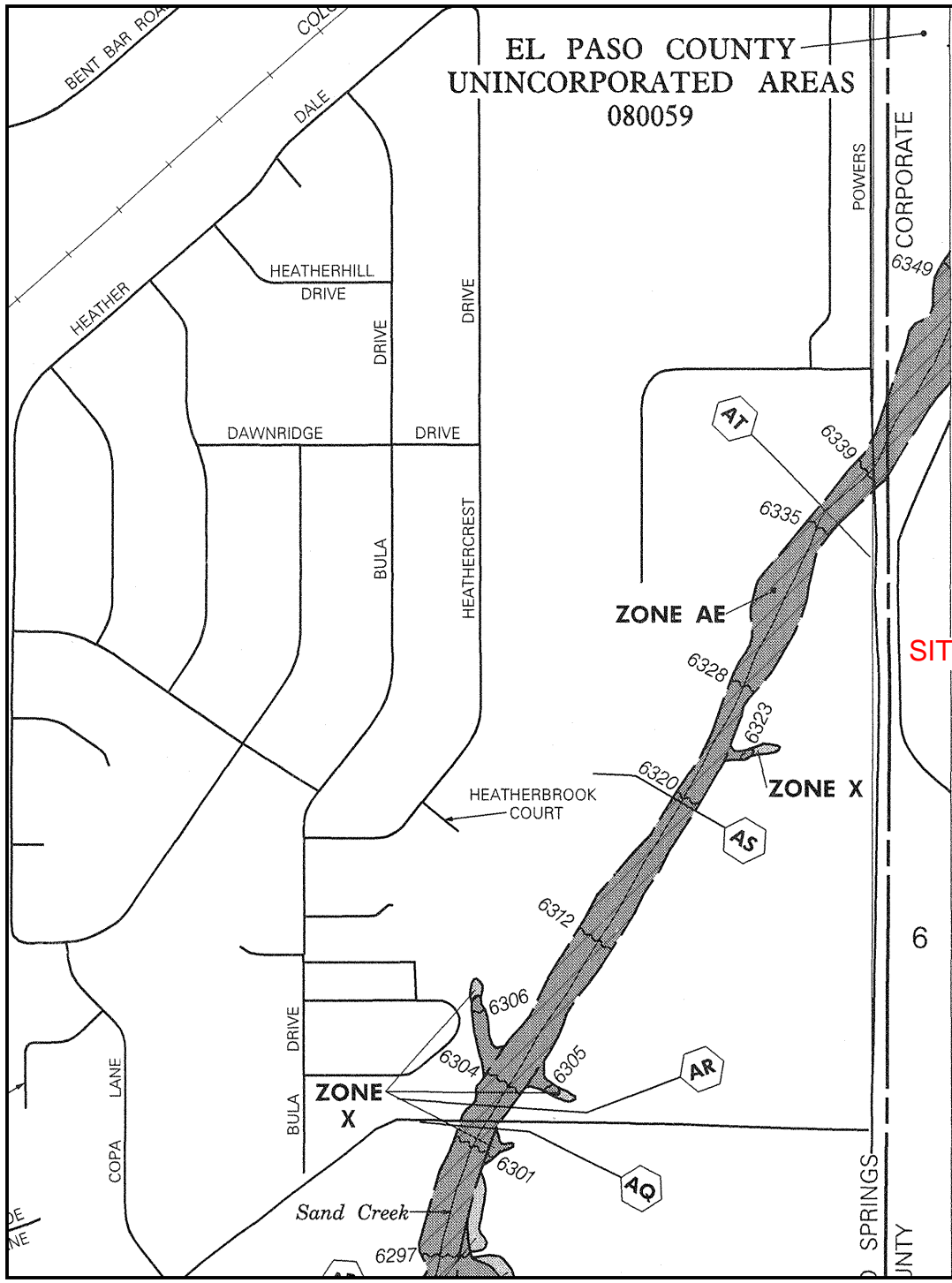
Choose One
 YES
 NO

Notes: _____

APPENDIX B

FIGURES

EL PASO COUNTY
UNINCORPORATED AREAS
080059



NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP

EL PASO COUNTY,
COLORADO AND
INCORPORATED AREAS

PANEL 751 OF 1300
(SEE MAP INDEX FOR PANELS NOT PRINTED)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
COLORADO SPRINGS, CITY OF	080060	0751	F
EL PASO COUNTY, UNINCORPORATED AREAS	080059	0751	F

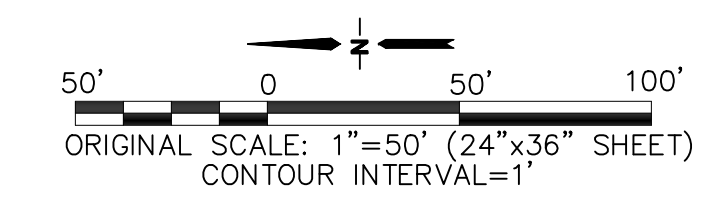
MAP NUMBER
08041C0751 F

EFFECTIVE DATE:
MARCH 17, 1997

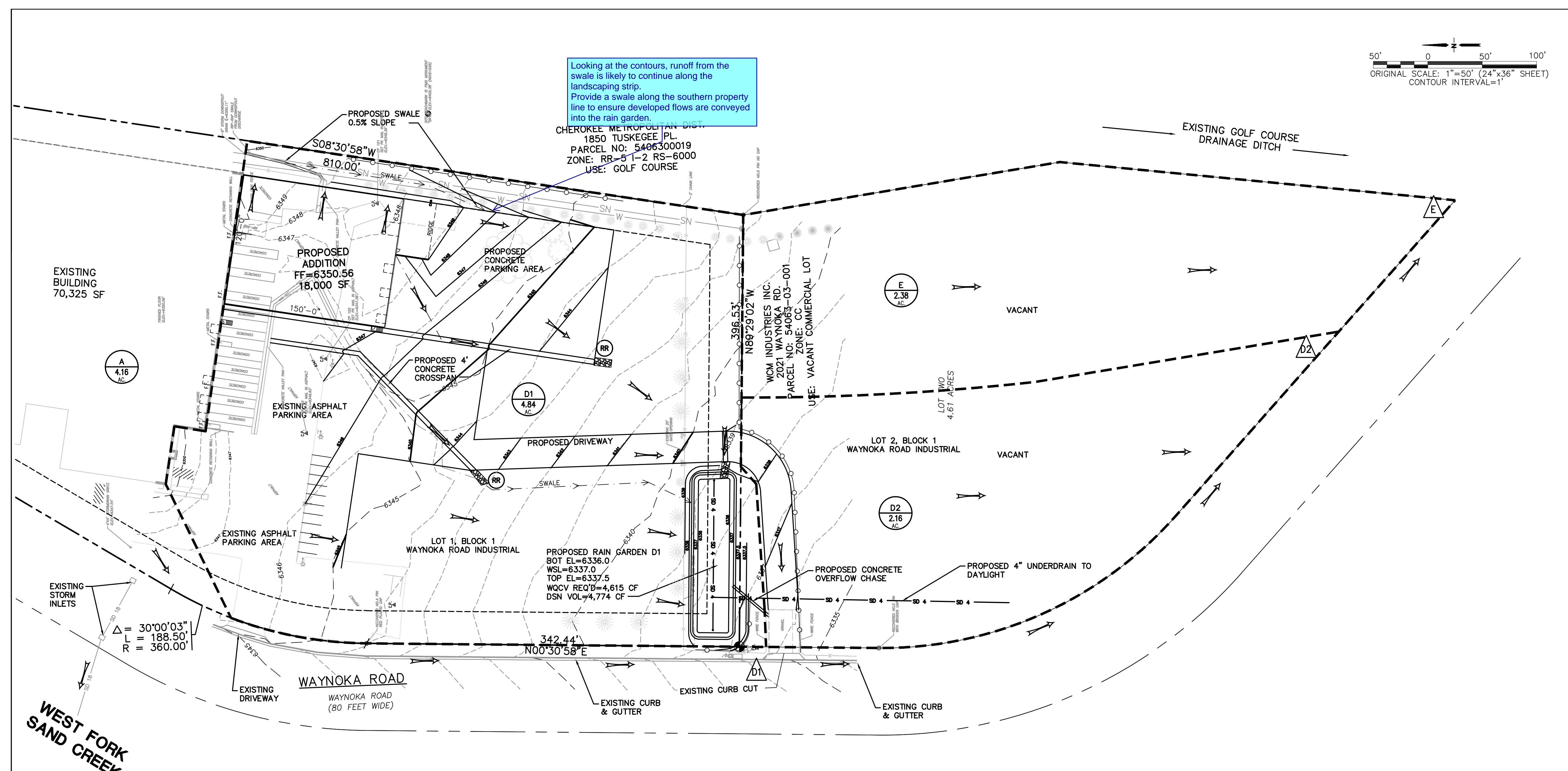


Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov



Looking at the contours, runoff from the swale is likely to continue along the landscaping strip.
Provide a swale along the southern property line to ensure developed flows are conveyed into the rain garden.

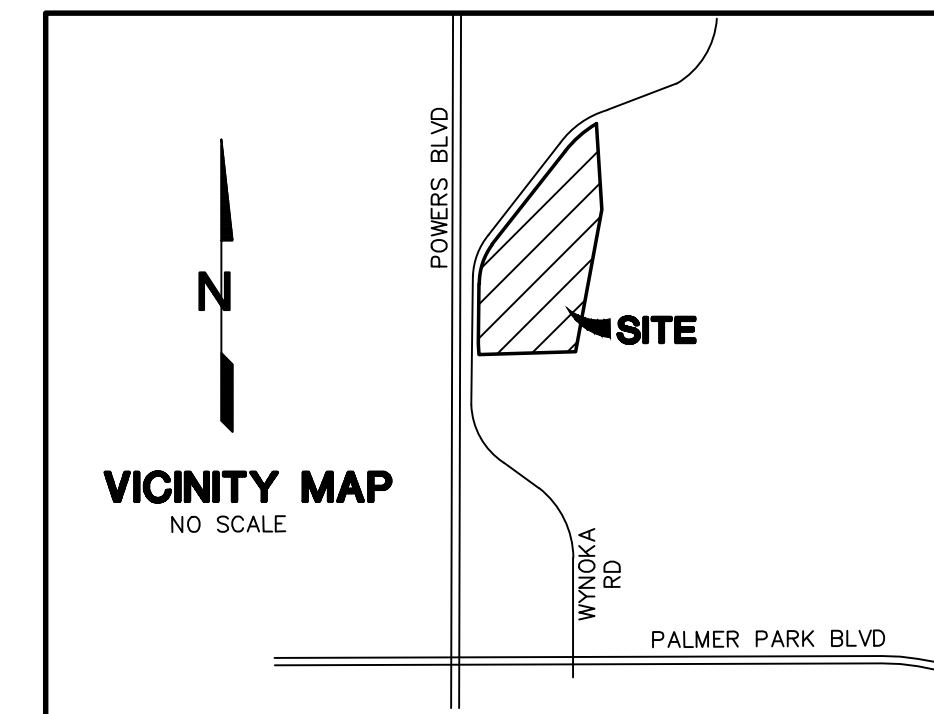


SUMMARY HYDROLOGY TABLE

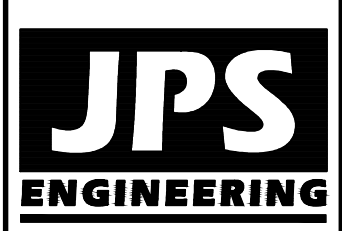
DESIGN POINT	Q ₅ (CFS)	Q ₁₀₀ (CFS)
D1	12.0	24.0
D2	5.3	10.5
E	5.7	11.3

BENCHMARK:
NGS BENCHMARK "R 76".
ELEVATION=6289.86 (NAVD-1988)

COLORADO SPRINGS CITY OF
N. POWERS BLVD.
PARCEL NO: 64001-000-55
ZONE: PBC/CR AO AP22 SS
USE: POLITICAL SUBDIVISION



WOODFORD MANUFACTURING BUILDING ADDITION
2121 WAYNOKA RD, COLORADO SPRINGS, COLORADO 80915



19 E. Willamette Ave.
Colorado Springs, CO
80903
PH: 719-477-9429
FAX: 719-471-0766
www.jpseng.com



CALL UTILITY NOTIFICATION
CENTER OF COLORADO
1-800-922-1987
CALL 2-BUSINESS DAYS IN ADVANCE
BEFORE YOU DIG, GRADE, OR EXCAVATE
FOR THE MEMBER UTILITIES.

NO.	REVISION	BY	DATE

DEVELOPED DRAINAGE PLAN

HORZ. SCALE: 1"=50'	DRAWN: BJJ
VERT. SCALE: N/A	DESIGNED: JPS
SURVEYED: -	CHECKED: JPS
CREATED: 7/06/18	LAST MODIFIED: 7/24/18
PROJECT NO: 051801	MODIFIED BY: BJJ

D1

Markup Summary

dsdlaforce (5)

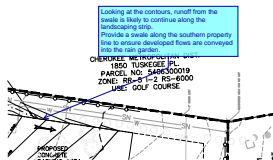
Project No. 051801

R-18-00

18-037

Subject: Callout
Page Label: 1
Author: dsdlaforce
Date: 8/22/2018 1:33:31 PM
Color: ■

18-037



Subject: Callout
Page Label: 22
Author: dsdlaforce
Date: 8/22/2018 3:57:41 PM
Color: ■

Looking at the contours, runoff from the swale is likely to continue along the landscaping strip. Provide a swale along the southern property line to ensure developed flows are conveyed into the rain garden.

0 square-foot building addition at [redacted], with associated parking and site [redacted] approximately 3.8 acres. Access will [redacted] on the south side of the building property. There will be no changes [redacted] iding. The proposed internal [redacted] ailing will be [redacted].

Update so the ESQCP, drainage letter and grading and erosion control plan all have the same value for the total disturbed area.

Plan submittal for this project, this [redacted] ite-specific "Letter Type" drainage [redacted] criteria. This report will provide a [redacted].

Subject: Callout
Page Label: 3
Author: dsdlaforce
Date: 8/22/2018 4:45:01 PM
Color: ■

Update so the ESQCP, drainage letter and grading and erosion control plan all have the same value for the total disturbed area.

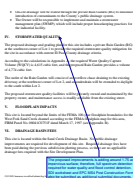
Vol₁ = 4.615 cu ft

D₀ = 1.47 in

Orifice to drain WQCV over 12 hours is not shown in the GEC pond detail. Update accordingly.

Subject: Callout
Page Label: 18
Author: dsdlaforce
Date: 8/22/2018 4:52:37 PM
Color: ■

Orifice to drain WQCV over 12 hours is not shown in the GEC pond detail. Update accordingly.



Subject: Callout
Page Label: 6
Author: dsdlaforce
Date: 8/23/2018 7:46:27 AM
Color: ■

The proposed improvements is adding around 1.75 acres of impervious surface; therefore, full spectrum detention is required for water quality and flood control detention. SDI worksheet and EPC MS4 Post Construction Form must also be submitted as additional submittal documents.