FINAL DRAINAGE REPORT

for

LARGENT SUBDIVISION
6985 MERIDIAN ROAD

Prepared for:

D & D Management, LLC
6485 Alibi Circle
Colorado Springs, CO 80923

January 18, 2018
Revised April 18, 2018
Revised May 14, 2018
Revised June 26, 2018

Prepared by:

JPS ENGINEERING

19 E. Willamette Ave.
Colorado Springs, CO 80903
(719)-477-9429
(719)-471-0766 FAX
www.jpsengr.com

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Revise to VR-18-010

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DRAINAGE STATEMENT

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 of 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, P.E. #29891

Developer's Statement:

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

By:

____

D & D Management LLC Date
David Largent, Manager
6485 Alibi Circle
Colorado Springs, CO 80923

El Paso County's 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. Date
County Engineer / ECM Administrator

Conditions:

I. INTRODUCTION

A. Property Location and Description

D & D Management LLC is planning to construct a new Big O Tires auto service facility on a developed 1.2-acre property (El Paso County Assessor's Parcel No. 53124-01-008) located at the southeast corner of US Highway 24 (US24) and Meridian Road in the Falcon area of El Paso County, Colorado. The site is zoned Community Commercial (CC), and the proposed auto repair facility will require processing of a special use permit and a site development plan prior to establishing the use. The property is currently an unplatted tract described as a portion of Section 7, Township 13S, Range 64W, and a portion of Section 12, Township 13S, Range 65W of the 6^{th} P.M., El Paso County, Colorado. The project will include platting the property as a single lot, which will be described as Lot 1, Largent Subdivision.

The north boundary of the property adjoins US Highway, and existing commercial development is located to the north across US24. The west boundary of the site adjoins Meridian Road, and existing commercial center is located to the west across Meridian Road. The property adjoins developed ranch properties to the east and south.

The proposed Site Development Plan consists of demolishing the existing buildings within the property and constructing a new 6,474 square-foot, single-story auto sales and service building, along with associated parking and site improvements. Access will be provided by a private access drive connection to Meridian Road at the western site boundary, in close proximity to the existing site access drive.

B. Scope

In support of the Subdivision Plat and Site Development Plan submittals to El Paso County, this report is intended to meet the requirements of a Final Drainage Report in accordance with El Paso County drainage criteria. This report will provide a summary of site drainage issues impacting the proposed development. The report will analyze impacts from 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," revised November, 1991.

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

El Paso County "Engineering Criteria Manual," January 9, 2006.

FEMA, Flood Insurance Rate Map (FIRM) Number 08041C0575F, March 17, 1997.

Matrix Design Group, "Falcon Drainage Basin Planning Study," September, 2015.

USDA/NRCS, "Custom Soil Resource Report for El Paso County Area, Colorado," December 10, 2017.

II. EXISTING DRAINAGE CONDITIONS

The existing site topography generally slopes downward to the southwest with grades in the range of 1-3 percent. According to the Soil Survey of El Paso County prepared by the Soil Conservation Service (SCS), on-site soils are comprised of Columbine gravelly sandy loam soils, and these well-drained soils are classified as hydrologic soils group "A" (see Appendix A).

As shown on the enclosed Existing Drainage Plan (Sheet EX1, Appendix D), the site has been delineated as one on-site drainage basin, and the site is not impacted by any off-site drainage basins.

According to the 2015 "Falcon Drainage Basin Planning Study" (DBPS) by Matrix Design Group, this site is located between the West and Middle Tributary Channels of the Falcon Drainage Basin, and there are no DBPS improvements associated with this site.

The on-site area has been delineated as Basin A, which sheet flows towards the southwest corner of the property. The existing site is developed with several buildings, and the majority of the site is covered by compacted gravel. Existing flows from Basin A drain to Design Point #1, existing peak flows calculated as Q_5 = 2.2 cfs and Q_{100} = 4.8 cfs. Hydrologic calculations are enclosed in Appendix A.

III. PROPOSED DRAINAGE CONDITIONS

As shown on the enclosed Drainage Plan (Figure D1, Appendix E), the site has been delineated as two on-site drainage basins. Developed flows have been calculated based on the impervious areas associated with the proposed building and parking areas.

The majority of the developed site has been delineated as Basin A1, which will drain southerly across the site to a proposed stormwater detention pond along the southern boundary of the property. The proposed building pad will be graded with protective slopes to provide positive drainage away from the building. Surface drainage swales and a private storm sewer system will be convey developed flows to the proposed extended detention basin (EDB) at the south boundary of the site. Site grades will slope to storm inlets and curb openings at selected locations, collecting surface drainage and conveying stormwater to the proposed detention basin.

Concrete crosspans and curb and gutter will convey surface drainage from the north and east sides of the building to a curb opening at the southeast corner of the parking lot, and a drainage swale will convey flow from the curb opening into Extended Detention Basin A1 along the south boundary of the site. Private Storm Inlets A1.1 and A1.2 will intercept surface drainage along the west side of the building, and Private Storm Sewer A1.1 (12") will flow southeasterly into Extended Detention Basin A1.

Developed peak flows at Design Point #A1 are calculated as Q_5 = 2.9 cfs and Q_{100} = 5.8 cfs. After routing through Extended Detention Basin A1, detained peak flows at Design Point #A1 are calculated as Q_5 = 0.0 cfs and Q_{100} = 0.8 cfs. The proposed 12" discharge pipe from Detention Basin A1 will flow to the southwest corner of the property and drain into the improved ditch along the east side of Meridian Road.

Developed Basin A2 consists of the area along the west fringe of the site which will continue to sheet flow southwesterly following existing drainage patterns. According to the El Paso County roadway plans for "Meridian Road Improvements," the upcoming County road project will include an improved ditch along the east side of North Meridian Road adjacent to this site. An 18-inch RCP private driveway culvert will be provided at the site access drive connection to Meridian Road.

Basin A2 will sheet flow southwesterly to Design Point #A2, with developed peak flows calculated as Q_5 = 0.6 cfs and Q_{100} = 1.1 cfs.

Basins A1 and A2 combine at Design Point #1, with developed peak flows calculated as Q_5 = 3.3 cfs and Q_{100} = 6.7 cfs. Detained peak flows at Design Point #1 are calculated as Q_5 = 0.6 cfs and Q_{100} = 2.4 cfs.

Hydrologic calculations for the site are detailed in the attached spreadsheets (Appendix A), and peak flows are identified on Figures EX1 and D1 (Appendix E).

The contractor will be required to implement standard best management practices for erosion control during construction.

IV. 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 Impacts: The proposed auto service facility is being constructed on a previously developed site, so this re-development project will inherently minimize drainage impacts in comparison to development of a vacant site. Recognizing the existing compacted gravel covering the majority of the site, the proposed re-development of the site will result in a relatively small net increase in impervious site development.

Step 2: Stabilize Drainageways

- There are no drainageways directly adjacent to this project site. This site is a re-development project, and implementation of the proposed on-site drainage improvements and Detention Basin will minimize the downstream drainage impact from this site.

Step 3: Provide Water Quality Capture Volume (WQCV)

- EDB: The developed site will drain through a proposed Extended Detention Basin (EDB) along the south boundary of the property. Site drainage will be routed through the extended detention basin, which will capture and slowly release the WQCV over a 40-hour design release period.

Step 4: Consider Need for Industrial and Commercial BMPs

- No outside storage or industrial uses are proposed for this site.
- The proposed commercial development project will implement a Stormwater Management Plan including proper housekeeping practices and spill containment procedures.
- On-site drainage will be routed through the private Extended Detention Basin (EDB) to minimize introduction of contaminants to the County's public drainage system.

V. FLOODPLAIN IMPACTS

Floodplain limits in vicinity of this site are delineated in the applicable Flood Insurance Rate Map, FIRM Panel No. 08041C0575 dated March 17, 1997, which was revised by Letter of Map Revision (LOMR) Case No. 01-08-226P dated May 14, 2002. As depicted in the FIRM exhibit enclosed in Appendix D, this site is not impacted by any delineated 100-year FEMA floodplains.

VI. STORMWATER DETENTION AND WATER QUALITY

The proposed drainage and grading plan for the site includes a private Extended Detention Basin (EDB) at the south boundary of the site. This facility has been designed to provide the required stormwater detention and water quality mitigation for this site in accordance with El Paso County drainage criteria.

According to the 2015 “Falcon Drainage Basin Planning Study” (DBPS) by Matrix Design Group, a future Regional Detention Pond R1 is planned at the downstream confluence of the West and Middle Tributary Channels.

The required on-site detention volumes have been calculated based on the developed impervious area of the site. Recognizing that the majority of the existing site is covered with compacted gravel, the net impervious area increase has been calculated as 4.4 percent as tabulated in Appendix C. However, the on-site detention pond has been designed for the full 68.0 percent impervious area of the developed site, which provides for a conservative drainage design.

As detailed in the detention pond hydraulic calculations in Appendix C, the required 100-year Full-Spectrum Detention Volume has been calculated as 0.155 acre-feet. The proposed on-site Extended Detention Basin (EDB) A1 has been designed for a storage volume of 0.17 acre-feet, which meets the required full-spectrum detention volume, and the outlet structure has been designed to discharge well below the existing peak flow rates.

The proposed pond outlet structure has been designed using the UDFCD “UD-Detention” calculation spreadsheets, providing for a 40-hour release of the WQCV, and outlet structure sizing to maintain maximum allowable release rates from the pond. The EDB will have a grass-lined bottom and concrete trickle channel, with a riprap infiltration zone in front of the pond outlet structure to encourage infiltration of stormwater prior to discharging into the downstream public drainage system.

The proposed stormwater detention facility will be privately owned and maintained by the property owner, and maintenance access will be provided from the adjacent parking lot.

VII. DRAINAGE BASIN FEES

Development of this commercial site will include construction of a private storm sewer system and private stormwater detention and water quality facilities within the site.

The site lies entirely within the Falcon Drainage Basin, which is tributary to the Black Squirrel Creek Drainage Basin. The Falcon Drainage Basin is subject to an El Paso County 2018 drainage basin fee of $27,762 per impervious acre, and a bridge fee of $3,814 per impervious acre. The required drainage and bridge fees are due at the time of recording the subdivision plat.

According to El Paso County Engineering Criteria Manual Section 3.13a, the required drainage basin fees for subdivision plats are assessed based upon the new impervious area if no such fee has been previously paid. As such, the required basin fees are calculated based on the developed impervious area calculation for this site.

The required drainage and bridge fees are calculated as follows:

Platted Area:		1.227 acres
Developed Impervious Area:		68.0%
Net Impervious Area:	(1.224 ac.) * 68.0% =	**0.832 ac.**
Drainage Fee:	(0.832 ac.) @ ($27,762/ac.) =	$ 23,097.98
Bridge Fee:	(0.832 ac.) @ ($3,814/ac.) =	**$ 3,173.25**

In accordance with County drainage fee policies, the construction cost for the on-site detention pond is eligible for reimbursement against the required drainage basin fees. ECM Appendix L "Section 3.10.4a: Reimbursement of Construction Costs for On-Site Ponds" states that "A land developer may qualify for a reimbursement of a portion of the construction costs if he builds on-site detention meeting specific criteria. Recognizing that on-site ponds provide some benefits to the regional system of a basin, 50% of the cost of a small on-site pond may be reimbursed to the developer…" The proposed on-site detention pond meets all of the criteria listed in ECM Section L.3.10.4a.

As detailed in Appendix D, Hammers Construction has provided a cost estimate of $70,104 for construction of the on-site detention pond.

The revised Drainage Fee is calculated as follows:

Calculated Drainage Fee (see above):	=	$ 23,097.98
Drainage Fee Reduction: 50% * ($70,104.00)	=	-$35,052.00
Adjusted Drainage Fee:	=	**$ 0.00**

VIII. SUMMARY

The developed drainage patterns associated with the proposed Big O Tires development at the southeast corner of US24 and Meridian Road will remain consistent with existing conditions and the overall drainage plan for area. Developed flows from the site will drain through a proposed stormwater Detention Pond at the south boundary of the property prior to discharging to the existing downstream drainage system.

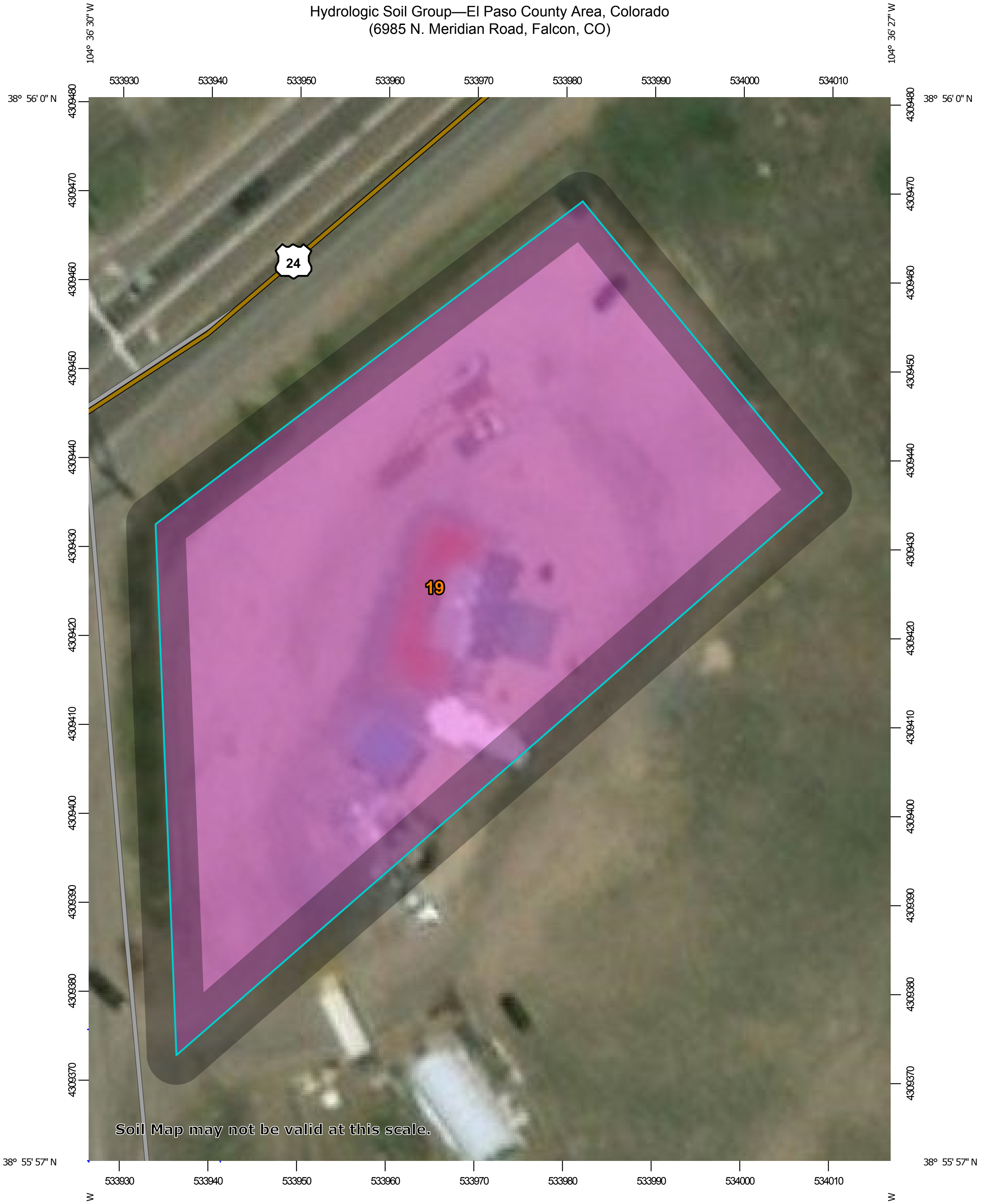
The proposed stormwater detention and water quality facilities have been designed to mitigate developed flow impacts and meet the County's stormwater detention and water quality requirements. Construction and proper maintenance of the proposed Extended Detention Basin, in conjunction with proper erosion control practices, will ensure that this developed site has no significant adverse drainage impact on downstream or surrounding areas.

List the 6 criteria that needs to be met and under each criteria provide the justification on how the criteria was met.
Main concern are
Criteria 1. "Allowed only where regional system is not yet in place." Staff recommends identify the applicable regional system to help show/justify the system is not yet in place.
and
Criteria 4. "Pond must be designed to release at historical levels for all precipitation events from 2yr to 100yr storm". UD detention does not indicate this criteria has been met.

APPENDIX A

HYDROLOGIC CALCULATIONS

Hydrologic Soil Group—El Paso County Area, Colorado
(6985 N. Meridian Road, Falcon, CO)



Map Scale: 1:583 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0, 5, 10, 20, 30

Feet: 0, 25, 50, 100, 150

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

Soil Rating Polygons

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 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: May 22, 2016—Mar 9, 2017

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
19	Columbine gravelly sandy loam, 0 to 3 percent slopes	A	0.9	100.0%
Totals for Area of Interest			**0.9**	**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_t) 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_t) 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.

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

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.

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

Where:

t_i = overland (initial) flow time (min)
C_5 = runoff coefficient for 5-year frequency (see Table 6-6)
L = length of overland flow (300 ft maximum for non-urban land uses, 100 ft maximum for urban land uses)
S = average basin slope (ft/ft)

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

3.2.2 Travel Time

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

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

Where:

V = velocity (ft/s)

C_v = conveyance coefficient (from Table 6-7)

S_w = watercourse slope (ft/ft)

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.

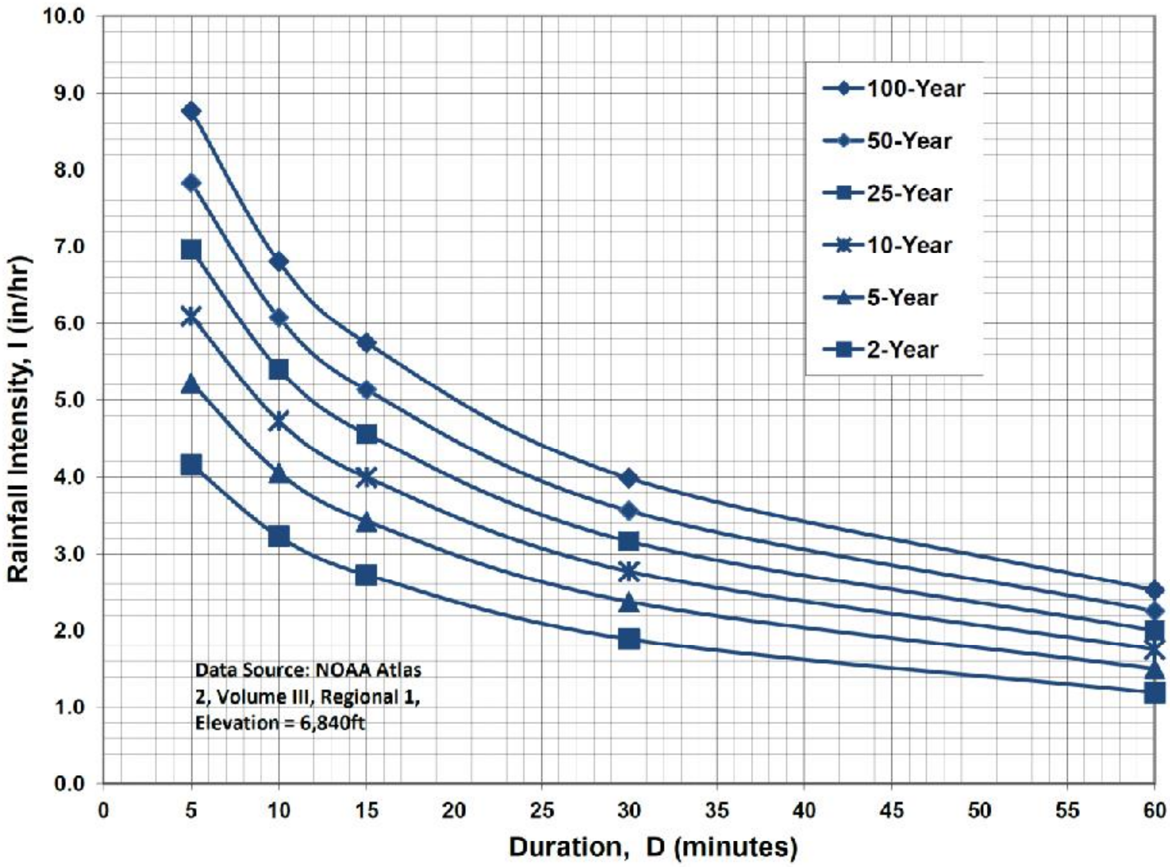
3.2.4 Minimum Time of Concentration

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.

BIG O TIRES - FALCON
COMPOSITE RUNOFF COEFFICIENTS

EXISTING CONDITIONS

5-YEAR C VALUES

BASIN	TOTAL AREA (AC)	(AC)	SUB-AREA 1 DEVELOPMENT/ COVER	C	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	C	(AC)	SUB-AREA 3 DEVELOPMENT/ COVER	C	WEIGHTED C VALUE
A	1.2	0.04	BUILDING / ASPHALT	0.9	0.92	GRAVEL	0.59	0.26	LANDSCAPED	0.08	0.491

100-YEAR C VALUES

BASIN	TOTAL AREA (AC)	(AC)	SUB-AREA 1 DEVELOPMENT/ COVER	C	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	C	(AC)	SUB-AREA 3 DEVELOPMENT/ COVER	C	WEIGHTED C VALUE
A	1.2	0.04	BUILDING / ASPHALT	0.96	0.92	GRAVEL	0.7	0.26	LANDSCAPED	0.35	0.634

DEVELOPED CONDITIONS

5-YEAR C VALUES

BASIN	TOTAL AREA (AC)	(AC)	SUB-AREA 1 DEVELOPMENT/ COVER	C	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	C	(AC)	SUB-AREA 3 DEVELOPMENT/ COVER	C	WEIGHTED C VALUE
A1	1.06	0.72	BUILDING / ASPHALT	0.9	0.34	LANDSCAPED	0.08				0.637
A2	0.17	0.12	BUILDING / ASPHALT	0.9	0.05	LANDSCAPED	0.08				0.640
A1,A2	1.23	0.83	BUILDING / ASPHALT	0.9	0.40	LANDSCAPED	0.08				0.637

100-YEAR C VALUES

BASIN	TOTAL AREA (AC)	(AC)	SUB-AREA 1 DEVELOPMENT/ COVER	C	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	C	(AC)	SUB-AREA 3 DEVELOPMENT/ COVER	C	WEIGHTED C VALUE
A1	1.06	0.72	BUILDING / ASPHALT	0.96	0.34	LANDSCAPED	0.35				0.764
A2	0.17	0.12	BUILDING / ASPHALT	0.96	0.05	LANDSCAPED	0.35				0.766
A1,A2	1.23	0.83	BUILDING / ASPHALT	0.96	0.40	LANDSCAPED	0.35				0.765

BIG O TIRES - FALCON
RATIONAL METHOD

EXISTING FLOWS

BASIN	DESIGN POINT	AREA (AC)	C 5-YEAR(7)	C 100-YEAR (7)	Overland Flow LENGTH (FT)	Overland Flow SLOPE (FT/FT)	Overland Flow Tco (1) (MIN)	Channel flow CHANNEL LENGTH (FT)	Channel flow CONVEYANCE COEFFICIENT C	Channel flow SLOPE (FT/FT)	Channel flow SCS (2) VELOCITY (FT/S)	Channel flow Tt (3) (MIN)	TOTAL Tc (4) (MIN)	TOTAL Tc (4) (MIN)	INTENSITY (5) 5-YR (IN/HR)	INTENSITY (5) 100-YR (IN/HR)	PEAK FLOW Q5 (6) (CFS)	PEAK FLOW Q100 (6) (CFS)
A	1	1.2	0.529	0.660	100	0.010	10.5	300	20.00	0.0233	3.05	1.6	12.1	12.1	3.84	6.45	2.44	5.11

DEVELOPED FLOWS

BASIN	DESIGN POINT	AREA (AC)	C 5-YEAR(7)	C 100-YEAR (7)	Overland Flow LENGTH (FT)	Overland Flow SLOPE (FT/FT)	Overland Flow Tco (1) (MIN)	Channel flow CHANNEL LENGTH (FT)	Channel flow CONVEYANCE COEFFICIENT C	Channel flow SLOPE (FT/FT)	Channel flow SCS (2) VELOCITY (FT/S)	Channel flow Tt (3) (MIN)	TOTAL Tc (4) (MIN)	TOTAL Tc (4) (MIN)	INTENSITY (5) 5-YR (IN/HR)	INTENSITY (5) 100-YR (IN/HR)	PEAK FLOW Q5 (6) (CFS)	PEAK FLOW Q100 (6) (CFS)
A1	A1	1.06	0.637	0.764	45	0.026	4.1	570	20.00	0.009	1.90	5.0	9.1	9.1	4.26	7.16	2.88	5.80
A2	A2	0.17	0.640	0.766	70	0.036	4.6	150	20.00	0.023	3.03	0.8	5.4	5.4	5.05	8.47	0.55	1.10
A1,A2	1	1.23	0.637	0.765									9.1	9.1	4.26	7.16	3.34	6.74

DETAINED FLOWS

BASIN	DESIGN POINT	AREA (AC)	C 5-YEAR(7)	C 100-YEAR (7)	Overland Flow LENGTH (FT)	Overland Flow SLOPE (FT/FT)	Overland Flow Tco (1) (MIN)	Channel flow CHANNEL LENGTH (FT)	Channel flow CONVEYANCE COEFFICIENT C	Channel flow SLOPE (FT/FT)	Channel flow SCS (2) VELOCITY (FT/S)	Channel flow Tt (3) (MIN)	TOTAL Tc (4) (MIN)	TOTAL Tc (4) (MIN)	INTENSITY (5) 5-YR (IN/HR)	INTENSITY (5) 100-YR (IN/HR)	PEAK FLOW Q5 (6) (CFS)	PEAK FLOW Q100 (6) (CFS)
A1-DETAINED	A1	1.06															0.00	1.30
A2	A2	0.17															0.55	1.10
A1,A2	1	1.23															0.55	2.40

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 = L/V (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
$I_5 = -1.5 * \ln(Tc) + 7.583$
$I_{100} = -2.52 * \ln(Tc) + 12.735$
6) Q = CiA

APPENDIX B

HYDRAULIC CALCULATIONS

BIG O TIRE - FALCON
STORM INLET SIZING SUMMARY

	BASIN FLOW			INLET FLOW					
INLET	DP	Q5 FLOW (CFS)	Q100 FLOW (CFS)	INLET FLOW % OF BASIN	Q5 FLOW (CFS)	Q100 FLOW (CFS)	INLET CONDITION / TYPE	INLET SIZE	INLET CAPACITY (CFS)
A1.1	1	2.9	5.8	25	0.7	1.5	SUMP TYPE 16	SGL	3.9
A1.2	1	2.9	5.8	75	2.2	4.4	SUMP TYPE 16	SGL	6.8

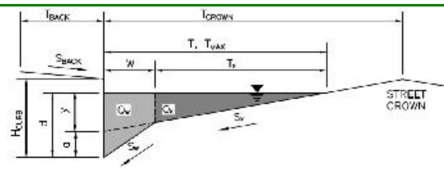
Version 4.05 Released March 2017

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

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

Project: **BIG O TIRES - FALCON**

Inlet ID: **Inlet A1.1**



Gutter Geometry (Enter data in the blue cells)

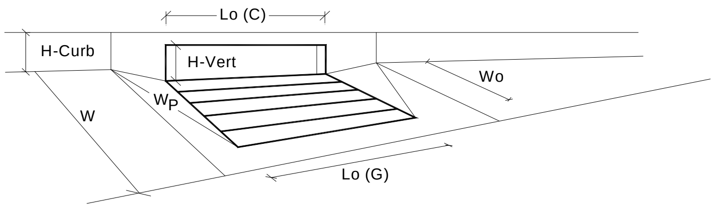
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	5.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	30.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.039	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	30.0	30.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	6.0	inches
Check boxes are not applicable in SUMP conditions		☐	☐	

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	**Q_{allow} =**	**SUMP**	**SUMP**	**cfs**

INLET IN A SUMP OR SAG LOCATION

Version 4.05 Released March 2017



Design Information (Input)	Denver No. 16 Combination		MINOR	MAJOR	
Type of Inlet		Type =	Denver No. 16 Combination		
Local Depression (additional to continuous gutter depression 'a' from above)		a_{local} =	2.00	2.00	inches
Number of Unit Inlets (Grate or Curb Opening)		No =	1	1	
Water Depth at Flowline (outside of local depression)		Ponding Depth =	6.0	6.0	inches
Grate Information			MINOR	MAJOR	Override Depths
Length of a Unit Grate		L_o (G) =	3.00	3.00	feet
Width of a Unit Grate		W_o =	1.73	1.73	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)		A_{ratio} =	0.31	0.31	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)		C_f (G) =	0.50	0.50	
Grate Weir Coefficient (typical value 2.15 - 3.60)		C_w (G) =	3.60	3.60	
Grate Orifice Coefficient (typical value 0.60 - 0.80)		C_o (G) =	0.60	0.60	
Curb Opening Information			MINOR	MAJOR	
Length of a Unit Curb Opening		L_o (C) =	3.00	3.00	feet
Height of Vertical Curb Opening in Inches		H_{vert} =	6.50	6.50	inches
Height of Curb Orifice Throat in Inches		H_{throat} =	5.25	5.25	inches
Angle of Throat (see USDCM Figure ST-5)		Theta =	0.00	0.00	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)		W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)		C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)		C_w (C) =	3.70	3.70	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)		C_o (C) =	0.66	0.66	

Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	0.523	0.523	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.33	0.33	ft
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	0.94	0.94	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	1.00	1.00	
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	0.94	0.94	

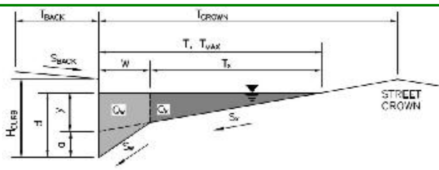
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	**3.9**	**3.9**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	0.7	1.5	cfs

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

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

Project: **BIG O TIRES - FALCON**

Inlet ID: **Inlet A1.2**



Gutter Geometry (Enter data in the blue cells)

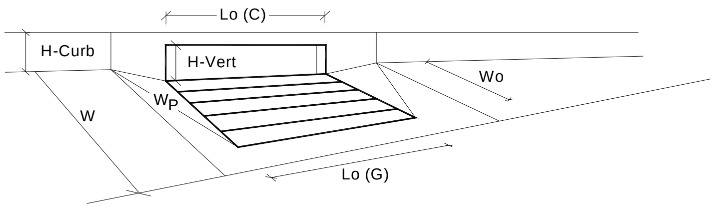
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	0.5	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.016	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	28.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.036	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	28.0	28.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	9.0	inches
Check boxes are not applicable in SUMP conditions		☐	☐	

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	**Q_{allow} =**	**SUMP**	**SUMP**	**cfs**

INLET IN A SUMP OR SAG LOCATION

Version 4.05 Released March 2017



			MINOR	MAJOR	
Design Information (Input)	Denver No. 16 Combination				
Type of Inlet		Type =	Denver No. 16 Combination		
Local Depression (additional to continuous gutter depression 'a' from above)		a_{local} =	2.00	2.00	inches
Number of Unit Inlets (Grate or Curb Opening)		No =	1	1	
Water Depth at Flowline (outside of local depression)		Ponding Depth =	6.0	9.0	inches
Grate Information			MINOR	MAJOR	Override Depths
Length of a Unit Grate		L_o (G) =	3.00	3.00	feet
Width of a Unit Grate		W_o =	1.73	1.73	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)		A_{ratio} =	0.31	0.31	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)		C_f (G) =	0.50	0.50	
Grate Weir Coefficient (typical value 2.15 - 3.60)		C_w (G) =	3.60	3.60	
Grate Orifice Coefficient (typical value 0.60 - 0.80)		C_o (G) =	0.60	0.60	
Curb Opening Information			MINOR	MAJOR	
Length of a Unit Curb Opening		L_o (C) =	3.00	3.00	feet
Height of Vertical Curb Opening in Inches		H_{vert} =	6.50	6.50	inches
Height of Curb Orifice Throat in Inches		H_{throat} =	5.25	5.25	inches
Angle of Throat (see USDCM Figure ST-5)		Theta =	0.00	0.00	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)		W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)		C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)		C_w (C) =	3.70	3.70	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)		C_o (C) =	0.66	0.66	

		MINOR	MAJOR	
Low Head Performance Reduction (Calculated)				
Depth for Grate Midwidth	d_{Grate} =	0.523	0.773	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.33	0.58	ft
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	0.94	1.00	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	1.00	1.00	
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	0.94	1.00	

		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	**3.9**	**6.8**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	2.2	4.4	cfs

BIG O TIRE - FALCON
STORM SEWER SIZING SUMMARY

	PIPE FLOW			PIPE CAPACITY		
PIPE	BASINS	Q5 FLOW (CFS)	Q100 FLOW (CFS)	PIPE SIZE	MIN. PIPE SLOPE	FULL PIPE CAPACITY (CFS)
A1.1	A1.1	0.7	1.5	12	1.0%	3.6

ASSUMPTIONS:
1. STORM DRAIN PIPE ASSUMED TO BE RCP OR HDPE

Hydraulic Analysis Report

Project Data

Project Title: Big-O-Falcon
Designer: JPS
Project Date: Thursday, January 18, 2018
Project Units: U.S. Customary Units
Notes:

Channel Analysis: SD-A1.1

Notes:

Input Parameters

Channel Type: Circular
Pipe Diameter: 1.0000 ft
Longitudinal Slope: 0.0100 ft/ft
Manning's n: 0.0130
Depth: 1.0000 ft

Result Parameters

Flow: 3.5628 cfs
Area of Flow: 0.7854 ft^2
Wetted Perimeter: 3.1416 ft
Hydraulic Radius: 0.2500 ft
Average Velocity: 4.5363 ft/s
Top Width: 0.0000 ft
Froude Number: 0.0000
Critical Depth: 0.8057 ft
Critical Velocity: 5.2542 ft/s
Critical Slope: 0.0103 ft/ft
Critical Top Width: 0.79 ft
Calculated Max Shear Stress: 0.6240 lb/ft^2
Calculated Avg Shear Stress: 0.1560 lb/ft^2

APPENDIX C

DETENTION POND CALCULATIONS

BIG O TIRES - FALCON
IMPERVIOUS AREAS

EXISTING CONDITIONS

BASIN	TOTAL AREA (AC)	(AC)	SUB-AREA 1 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	(AC)	SUB-AREA 3 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	WEIGHTED % IMP
A	1.2	0.04	BUILDINGS	100	0.92	GRAVEL	80	0.26	LANDSCAPED	0	63.607

DEVELOPED CONDITIONS

BASIN	TOTAL AREA (AC)	(AC)	SUB-AREA 1 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	(AC)	SUB-AREA 3 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	WEIGHTED % IMP
A1,A2	1.23	0.834	BUILDING / PAVEMENT	100	0.39	LANDSCAPED	0				67.971

NET IMPERVIOUS AREA

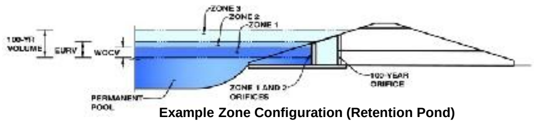
BASIN	TOTAL AREA (AC)	(AC)	SUB-AREA 1 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	(AC)	SUB-AREA 3 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	WEIGHTED % IMP
NET INCREASE	1.23										**4.364**

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: Big O Tires - Falcon

Basin ID: A1



Example Zone Configuration (Retention Pond)

Required Volume Calculation

Selected BMP Type =	**EDB**	
Watershed Area =	1.23	acres
Watershed Length =	615	ft
Watershed Slope =	0.010	ft/ft
Watershed Imperviousness =	68.00%	percent
Percentage Hydrologic Soil Group A =	100.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Desired WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

			Optional User Override 1-hr Precipitation	
Water Quality Capture Volume (WQCV) =	0.027	acre-feet		
Excess Urban Runoff Volume (EURV) =	0.105	acre-feet		
2-yr Runoff Volume (P1 = 1.19 in.) =	0.072	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.094	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.115	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	0.138	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	0.164	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	0.193	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	0.261	acre-feet	3.14	inches
Approximate 2-yr Detention Volume =	0.069	acre-feet		
Approximate 5-yr Detention Volume =	0.089	acre-feet		
Approximate 10-yr Detention Volume =	0.108	acre-feet		
Approximate 25-yr Detention Volume =	0.129	acre-feet		
Approximate 50-yr Detention Volume =	0.142	acre-feet		
Approximate 100-yr Detention Volume =	0.155	acre-feet		

Stage-Storage Calculation

Zone 1 Volume (WQCV) =	0.027	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.078	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.050	acre-feet
Total Detention Basin Volume =	0.155	acre-feet

Depth Increment = ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	10	0.000		
Bot EL=6822.5	--	1.50	--	--	--	2,000	0.046	1,488	0.034
	--	2.50	--	--	--	2,000	0.046	3,507	0.081
	--	3.50	--	--	--	2,000	0.046	5,507	0.126
Max WSL=6825.5	--	4.50	--	--	--	2,000	0.046	7,507	0.172
Top EL=6826.5	--	5.50	--	--	--	2,000	0.046	9,507	0.218
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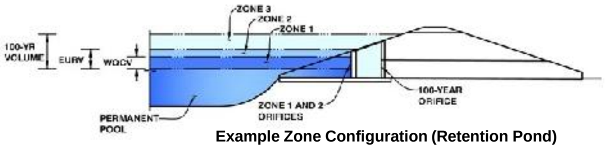
Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: Big O Tires - Falcon

Basin ID: A1



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.34	0.027	Orifice Plate
Zone 2 (EURV)	3.04	0.078	Orifice Plate
Zone 3 (100-year)	4.13	0.050	Weir&Pipe (Restrict)
		0.155	Total

User Input: Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration BMP)

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)
Underdrain Orifice Diameter =	N/A	inches

Calculated Parameters for Underdrain

Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Centroid =	N/A	feet

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation BMP)

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	3.04	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	12.20	inches
Orifice Plate: Orifice Area per Row =	0.26	sq. inches (diameter = 9/16 inch)

Calculated Parameters for Plate

WQ Orifice Area per Row =	1.806E-03	ft^2
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft^2

User Input: Stage and Total Area of Each Orifice Row (numbered from lowest to highest)

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.01	2.03					
Orifice Area (sq. inches)	0.26	0.26	0.26					

	Row 9 (optional)	Row 10 (optional)	Row 11 (optional)	Row 12 (optional)	Row 13 (optional)	Row 14 (optional)	Row 15 (optional)	Row 16 (optional)
Stage of Orifice Centroid (ft)								
Orifice Area (sq. inches)								

User Input: Vertical Orifice (Circular or Rectangular)

	Not Selected	Not Selected	
Invert of Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =	N/A	N/A	inches

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected	
Vertical Orifice Area =	N/A	N/A	ft^2
Vertical Orifice Centroid =	N/A	N/A	feet

User Input: Overflow Weir (Dropbox) and Grate (Flat or Sloped)

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	3.04	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	4.00	N/A	feet
Overflow Weir Slope =	0.00	N/A	H:V (enter zero for flat grate)
Horiz. Length of Weir Sides =	2.50	N/A	feet
Overflow Grate Open Area % =	70%	N/A	%, grate open area/total area
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	3.04	N/A	feet
Over Flow Weir Slope Length =	2.50	N/A	feet
Grate Open Area / 100-yr Orifice Area =	30.54	N/A	should be $\geq$ 4
Overflow Grate Open Area w/o Debris =	7.00	N/A	ft^2
Overflow Grate Open Area w/ Debris =	3.50	N/A	ft^2

User Input: Outlet Pipe w/ Flow Restriction Plate (Circular Orifice, Restrictor Plate, or Rectangular Orifice)

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.00	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	12.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	4.00		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	0.23	N/A	ft^2
Outlet Orifice Centroid =	0.20	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	1.23	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	4.20	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	8.00	feet
Spillway End Slopes =	0.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

Spillway Design Flow Depth=	0.18	feet
Stage at Top of Freeboard =	5.38	feet
Basin Area at Top of Freeboard =	0.05	acres

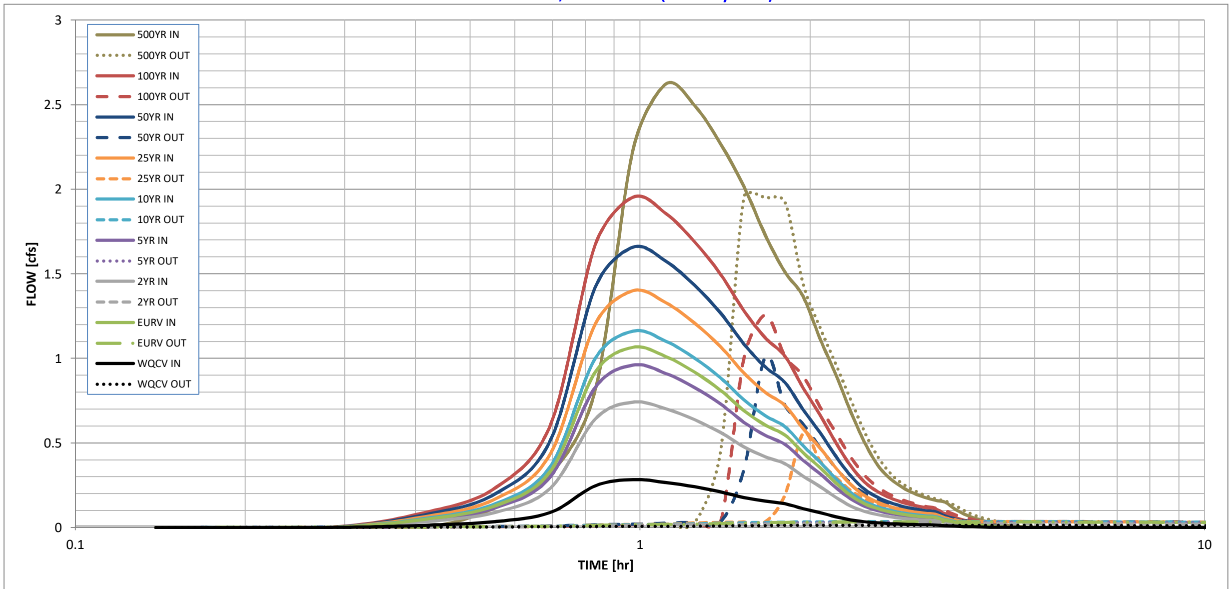
Routed Hydrograph Results

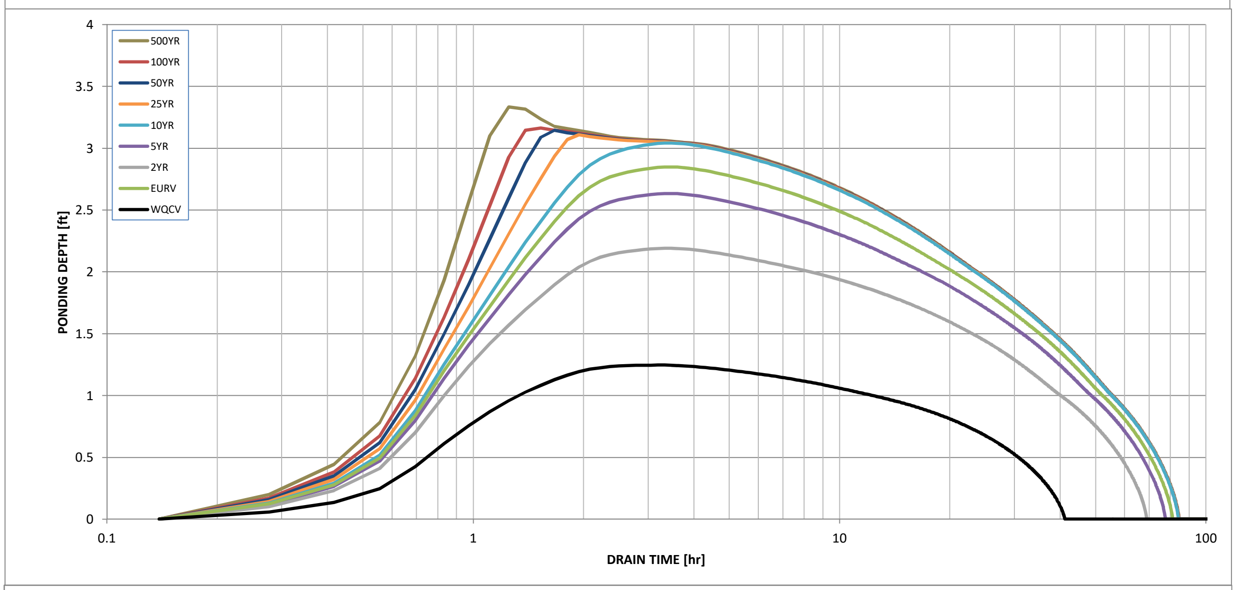
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	3.14
Calculated Runoff Volume (acre-ft) =	0.027	0.105	0.072	0.094	0.115	0.138	0.164	0.193	0.261
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	0.027	0.104	0.072	0.094	0.114	0.138	0.163	0.193	0.260
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.00	0.00	0.01	0.01	0.11	0.26	0.62
Predevelopment Peak Q (cfs) =	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.3	0.8
Peak Inflow Q (cfs) =	0.3	1.1	0.7	1.0	1.2	1.4	1.7	2.0	2.6
Peak Outflow Q (cfs) =	0.0	0.0	0.0	0.0	0.0	0.6	1.0	1.3	2.0
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	9.5	5.8	32.8	7.8	3.9	2.6
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Outlet Plate 1
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	0.0	0.1	0.1	0.2	0.3
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	38	72	62	69	75	73	72	71	67
Time to Drain 99% of Inflow Volume (hours) =	**40**	77	66	74	80	80	79	78	77
Maximum Ponding Depth (ft) =	1.25	2.85	2.19	2.63	3.04	3.11	3.15	3.16	3.34
Area at Maximum Ponding Depth (acres) =	0.04	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Maximum Volume Stored (acre-ft) =	0.024	0.096	0.066	0.086	0.105	0.108	0.110	0.111	0.119

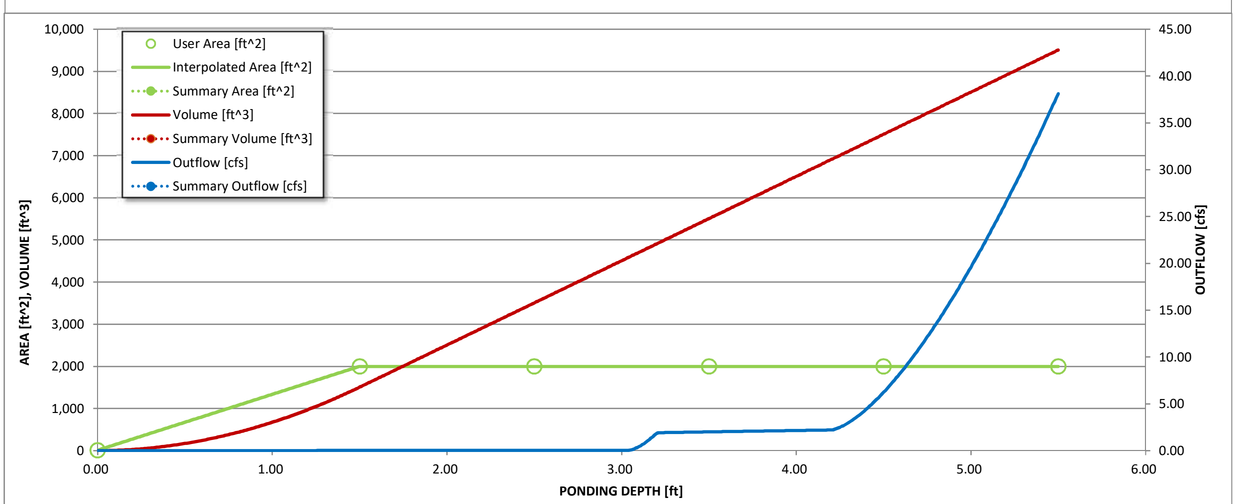
Does not meet criteria 4 of ECM Appendix L Section 3.10.4a.

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)







S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

Design Procedure Form: Extended Detention Basin (EDB)

UD-BMP (Version 3.06, November 2016)

Designer:	**JPS**
Company:	**JPS**
Date:	**June 26, 2018**
Project:	**Big O Tires - Falcon - Pond A1**
Location:	**6985 N. Meridian Road, Falcon, CO**

1. Basin Storage Volume	
A) Effective Imperviousness of Tributary Area, I_a	I_a = 68.0 %
B) Tributary Area's Imperviousness Ratio ($i = I_a / 100$)	i = 0.680
C) Contributing Watershed Area	Area = 1.230 ac
D) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm	d_6 = ____ in
E) Design Concept (Select EURV when also designing for flood control)	Choose One ○ Water Quality Capture Volume (WQCV) ◉ Excess Urban Runoff Volume (EURV)
F) Design Volume (WQCV) Based on 40-hour Drain Time ($V_{DESIGN} = (1.0 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i) / 12 * Area)$	V_{DESIGN}= 0.027 ac-ft
G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume ($V_{WQCV\ OTHER} = (d_6*(V_{DESIGN}/0.43))$	$V_{DESIGN\ OTHER}$= ____ ac-ft
H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired)	$V_{DESIGN\ USER}$= ____ ac-ft
I) Predominant Watershed NRCS Soil Group	Choose One ◉ A ○ B ○ C / D
J) Excess Urban Runoff Volume (EURV) Design Volume For HSG A: $EURV_A = 1.68 * i^{1.28}$ For HSG B: $EURV_B = 1.36 * i^{1.08}$ For HSG C/D: $EURV_{C/D} = 1.20 * i^{1.08}$	EURV = 0.105 ac-f t
2. Basin Shape: Length to Width Ratio (A basin length to width ratio of at least 2:1 will improve TSS reduction.)	L : W = 31.0 : 1
3. Basin Side Slopes	
A) Basin Maximum Side Slopes (Horizontal distance per unit vertical, 4:1 or flatter preferred)	Z = 0.00 ft / ft **DIFFICULT TO MAINTAIN, INCREASE WHERE POSSIBLE**
4. Inlet	
A) Describe means of providing energy dissipation at concentrated inflow locations:	Riprap Apron

Design Procedure Form: Extended Detention Basin (EDB)

Designer: JPS
Company: JPS
Date: June 26, 2018
Project: Big O Tires - Falcon - Pond A1
Location: 6985 N. Meridian Road, Falcon, CO

5. Forebay	
A) Minimum Forebay Volume (V_{FMIN} = 0% of the WQCV)	V_{FMIN} = 0.000 ac-ft — **A FOREBAY MAY NOT BE NECESSARY FOR THIS SIZE SITE**
B) Actual Forebay Volume	V_F = ______ ac-ft
C) Forebay Depth (D_F = 12 inch maximum)	D_F = ______ in
D) Forebay Discharge	
i) Undetained 100-year Peak Discharge	Q_{100} = ______ cfs
ii) Forebay Discharge Design Flow ($Q_F = 0.02 * Q_{100}$)	Q_F = ______ cfs
E) Forebay Discharge Design	Choose One: ○ Berm With Pipe ○ Wall with Rect. Notch ○ Wall with V-Notch Weir — **(flow too small for berm w/ pipe)**
F) Discharge Pipe Size (minimum 8-inches)	Calculated D_P = ______ in
G) Rectangular Notch Width	Calculated W_N = ______ in
6. Trickle Channel	
A) Type of Trickle Channel	Choose One: ● Concrete ○ Soft Bottom
F) Slope of Trickle Channel	S = 0.0050 ft / ft
7. Micropool and Outlet Structure	
A) Depth of Micropool (2.5-feet minimum)	D_M = 2.5 ft
B) Surface Area of Micropool (10 ft^2 minimum)	A_M = 10 sq ft
C) Outlet Type	Choose One: ● Orifice Plate ○ Other (Describe):
D) Smallest Dimension of Orifice Opening Based on Hydrograph Routing (Use UD-Detention)	$D_{orifice}$ = 0.56 inches
E) Total Outlet Area	A_{ot} = 0.78 square inches

Design Procedure Form: Extended Detention Basin (EDB)

Designer: JPS
Company: JPS
Date: June 26, 2018
Project: Big O Tires - Falcon - Pond A1
Location: 6985 N. Meridian Road, Falcon, CO

8. Initial Surcharge Volume	
A) Depth of Initial Surcharge Volume (Minimum recommended depth is 4 inches)	D_{IS} = 4 in
B) Minimum Initial Surcharge Volume (Minimum volume of 0.3% of the WQCV)	V_{IS} = cu ft
C) Initial Surcharge Provided Above Micropool	V_s= 3.3 cu ft
9. Trash Rack	
A) Water Quality Screen Open Area: $A_t = A_{ot} * 38.5*(e^{-0.095D})$	A_t = 28 square inches
B) Type of Screen (If specifying an alternative to the materials recommended in the USDCM, indicate "other" and enter the ratio of the total open are to the total screen are for the material specified.) Other (Y/N): N	*S.S. Well Screen with 60% Open Area*
C) Ratio of Total Open Area to Total Area (only for type 'Other')	User Ratio =
D) Total Water Quality Screen Area (based on screen type)	A_{total} = 47 sq. in.
E) Depth of Design Volume (EURV or WQCV) (Based on design concept chosen under 1E)	H= 2 feet
F) Height of Water Quality Screen (H_{TR})	H_{TR}= 52 inches
G) Width of Water Quality Screen Opening ($W_{opening}$) (Minimum of 12 inches is recommended)	$W_{opening}$ = 12.0 inches

Design Procedure Form: Extended Detention Basin (EDB)

Designer: JPS
Company: JPS
Date: June 26, 2018
Project: Big O Tires - Falcon - Pond A1
Location: 6985 N. Meridian Road, Falcon, CO

10. Overflow Embankment A) Describe embankment protection for 100-year and greater overtopping:	Buried Riprap
B) Slope of Overflow Embankment (Horizontal distance per unit vertical, 4:1 or flatter preferred)	4.00
11. Vegetation	Choose One ○ Irrigated ◉ Not Irrigated
12. Access A) Describe Sediment Removal Procedures	Access ramp provided to pond bottom for skid loader access

Notes:

APPENDIX D

DETENTION POND COST ESTIMATE

HAMMERS CONSTRUCTION, INC.
Steve Hammers, President
1411 Woolsey Heights, Colorado Springs, Colorado 80915
(719) 570-1599 • FAX (719) 570-7008
SPECIALIZING IN DESIGN / BUILD

June 26th, 2018

Big-O-Tire
6985 N. Meridian Rd.
New Big-O-Tire Facility
Lot 1 Largent Subdivision
Peyton, Co. 80831

Detention Pond Cost Estimate

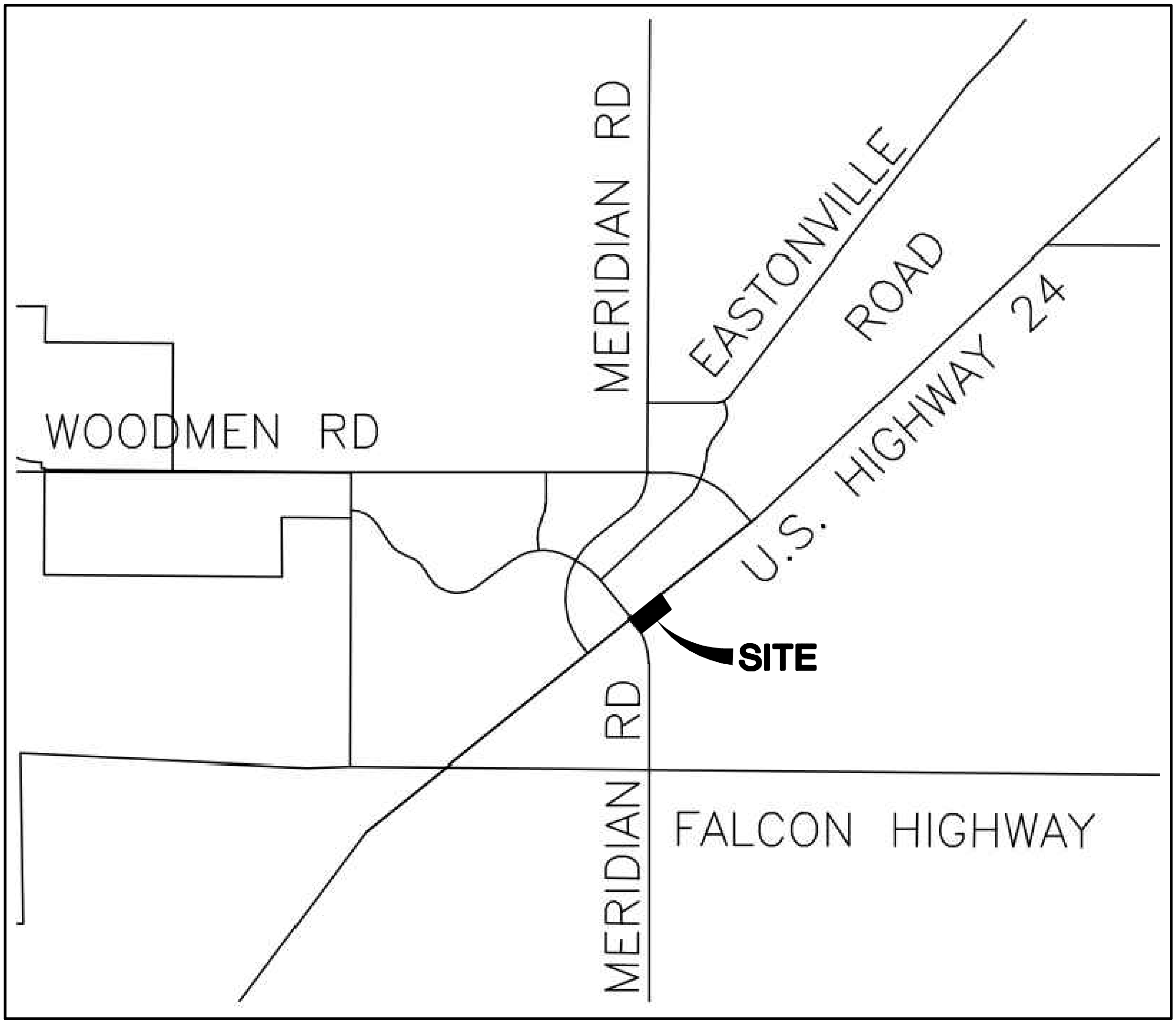
A. SCOPE OF WORK:

$24,120 – retaining wall costs
$7,000 – detention pond outlet structure
$6,734 – 91’ of 12” RCP storm piping
$4,000 – 12” FES w/ rip rap apron
$10,000 – detention pond excavation, grading and backfill
$2,500 – 4’ wide concrete trickle channel
$13,750 – 250’ of handrail costs
$2,000 – grass/seeding for detention pond
$70,104 – TOTAL

Zack Crabtree
Project Manager
Hammers Construction Inc.

APPENDIX E

FIGURES



VICINITY MAP

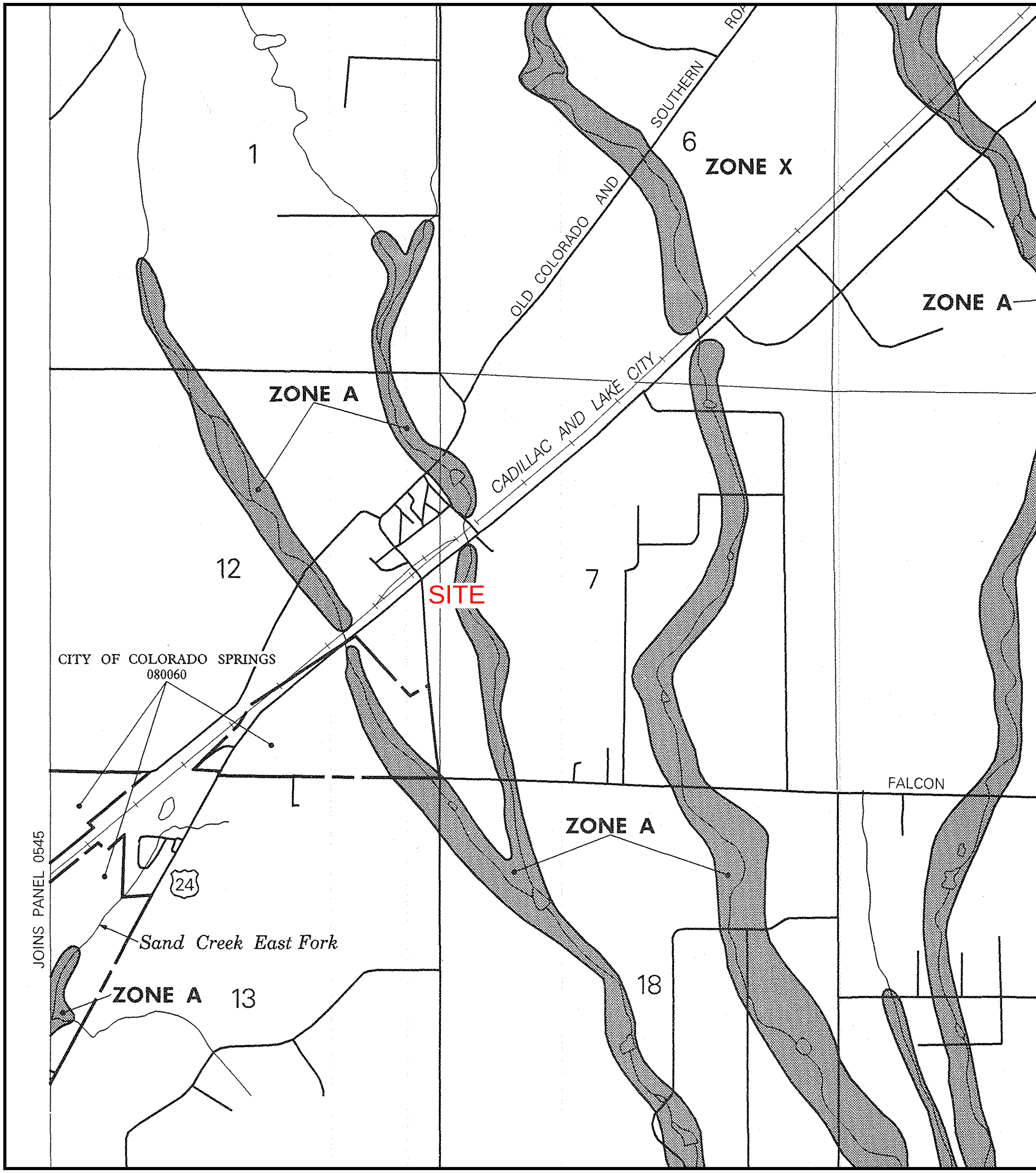
JPS ENGINEERING

BIG "O" TIRES

6985 N. MERIDIAN RD, PEYTON, CO

FIGURE A1

JPS PROJ NO. 091701



APPROXIMATE SCALE IN FEET

2000 0 2000

NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP

EL PASO COUNTY,
COLORADO AND
INCORPORATED AREAS

PANEL 575 OF 1300

(SEE MAP INDEX FOR PANELS NOT PRINTED)

CONTAINS:

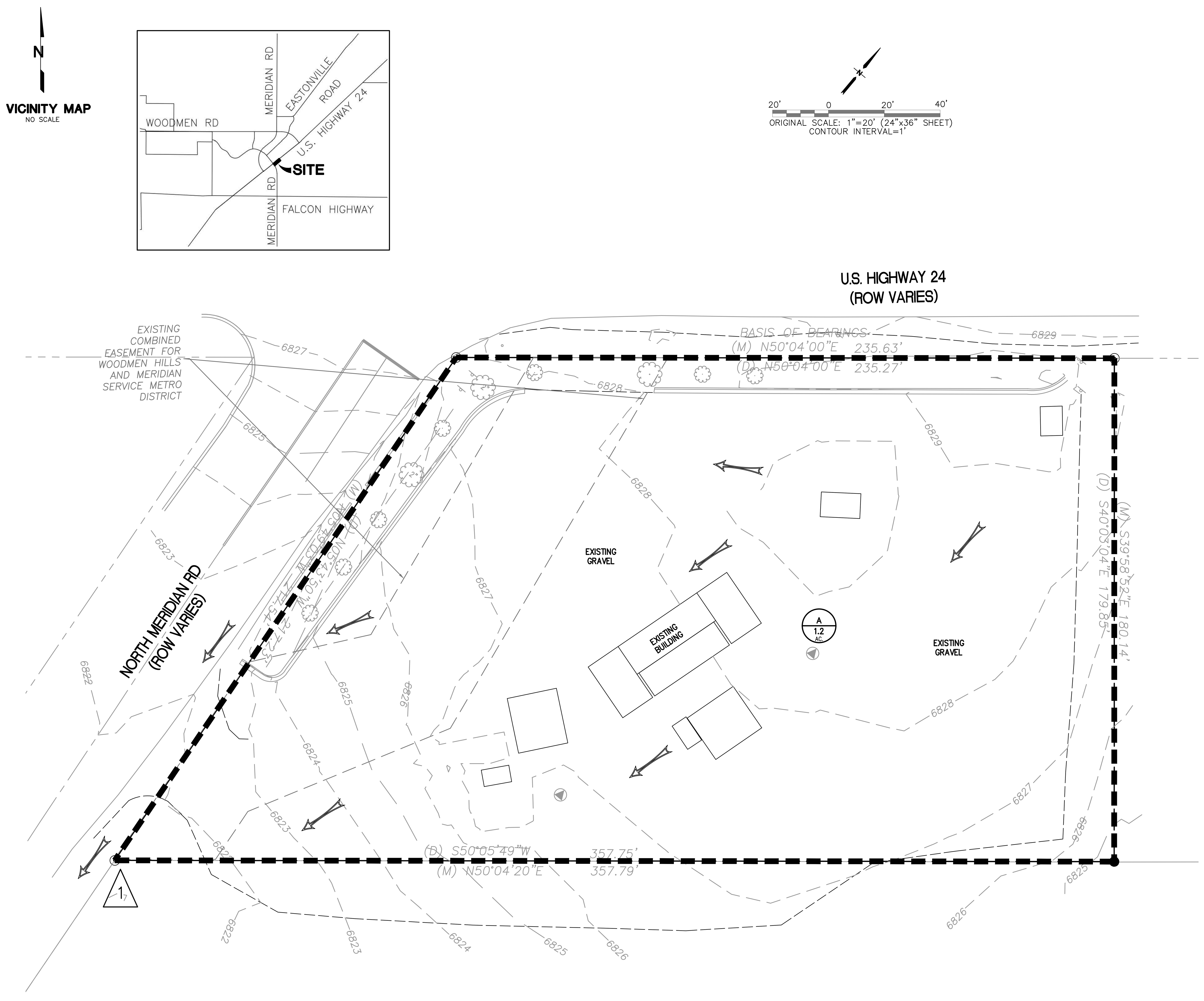
COMMUNITY	NUMBER	PANEL	SUFFIX
COLORADO SPRINGS, CITY OF	080060	0575	F
EL PASO COUNTY, UNINCORPORATED AREAS	080059	0575	F

MAP NUMBER
08041C0575 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



DRAINAGE LEGEND

- RIPRAP
- PROPERTY LINES
- FLOWLINE
- DRAINAGE BASIN BOUNDARY
- FLOW DIRECTION ARROW
- DESIGN POINT (5)
- DEVELOPED BASIN DESIGNATION (C14)
- DEVELOPED BASIN AREA (ACRES) (23.21 AC.)

SUMMARY HYDROLOGY TABLE

DESIGN POINT	Q_5 (CFS)	Q_{100} (CFS)
1	2.2	4.8

JPS ENGINEERING
19 E. Willamette Ave.
Colorado Springs, CO 80903
PH: 719-477-9429
FAX: 719-471-0766
www.jpsengr.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 MARKING OF UNDERGROUND MEMBER UTILITIES.

BIG O TIRES
6985 N. MERIDIAN ROAD, PEYTON, CO 80831

No.	REVISION	BY	DATE

EXISTING DRAINAGE PLAN

HORZ. SCALE: 1"=20'	DRAWN: MSP
VERT. SCALE: N/A	DESIGNED: JPS
SURVEYED: RIDGELINE	CHECKED: JPS
CREATED: 11/11/17	LAST MODIFIED: 5/14/18
PROJECT NO: 091701	MODIFIED BY: MSP
SHEET: EX1	

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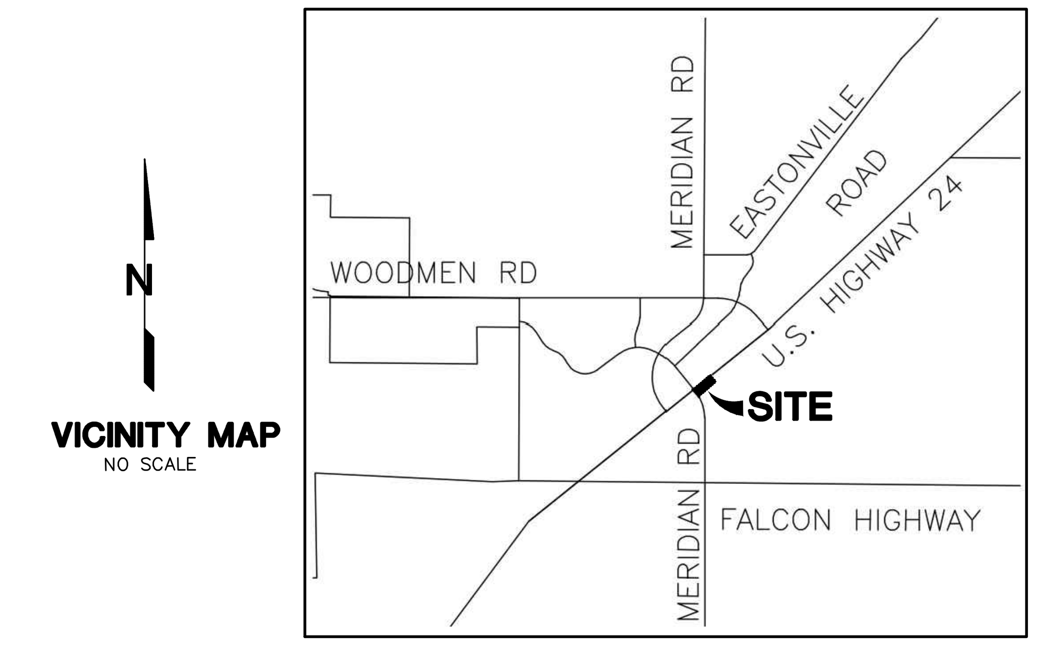
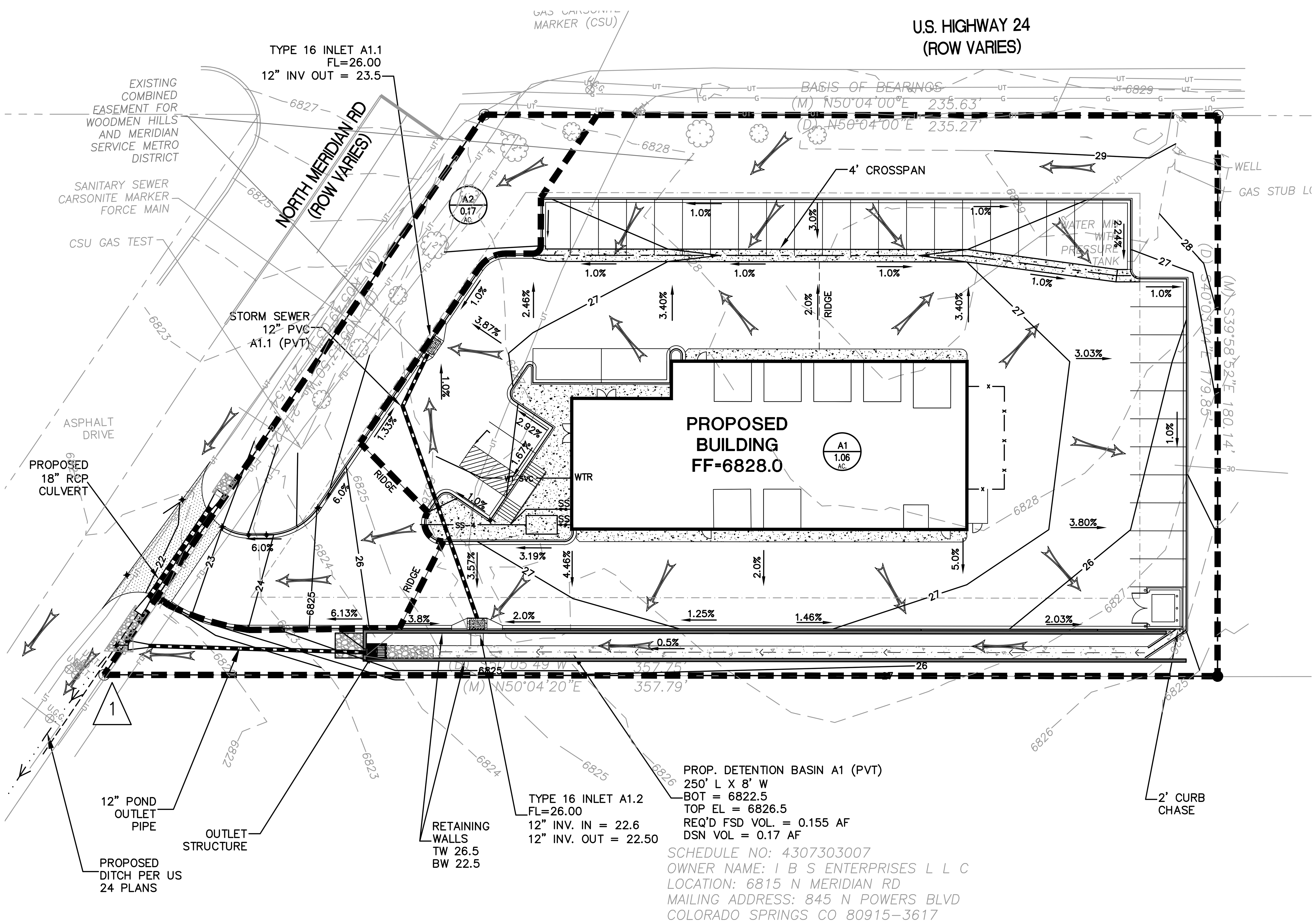


VICINITY MAP
NO SCALE



20' 0 20' 40'
ORIGINAL SCALE: 1"=20' (24"x36" SHEET)
CONTOUR INTERVAL=1'

DRAINAGE LEGEND

- RIPRAP
- PROPERTY LINES
- FLOWLINE
- DRAINAGE BASIN BOUNDARY
- FLOW DIRECTION ARROW
- DESIGN POINT
- DEVELOPED BASIN DESIGNATION
- DEVELOPED BASIN AREA (ACRES)

IMPERVIOUS AREA CALCULATIONS:

TOTAL AREA = 1.227 AC.

IMPERVIOUS AREAS:

SURFACE TYPE	AREA
PAVEMENT/SIDEWALK	29,854 SF
BUILDING	6,474 SF
TOTAL	36,328 SF

= 0.834 AC
= 68.0% IMPERVIOUS

SUMMARY HYDROLOGY TABLE

DESIGN POINT	Q_5 (CFS)	Q_{100} (CFS)
A1	2.9	5.8
A2	0.6	1.1
1	3.3	6.7
1d(DETAINED)	0.6	2.4

BENCHMARK:
NO. 5 REBAR WITH YELLOW PLASTIC CAP PLS 30130 ELEV. 6821.02 NGVD29

J:\jpsprojects\091701.hammers-big-o-falcon\dwg\civil\D1.dwg Jun 26, 2018 - 3:37pm

BIG O TIRES

6985 N. MERIDIAN ROAD, PEYTON, CO 80831

DEVELOPED DRAINAGE PLAN

JPS ENGINEERING
19 E. Willamette Ave.
Colorado Springs, CO 80903
PH: 719-477-9429
FAX: 719-471-0766
www.jpsengr.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 MARKING OF UNDERGROUND MEMBER UTILITIES.

No.	REVISION	BY	DATE

HORZ. SCALE: 1"=20'	DRAWN: MSP
VERT. SCALE: N/A	DESIGNED: JPS
SURVEYED: RIDGELINE	CHECKED: JPS
CREATED: 11/11/17	LAST MODIFIED: 6/26/18
PROJECT NO: 091701	MODIFIED BY: BJJ

SHEET: D1