Drainage Letter
15905 Sniper Lane

Colorado Springs Police Department Firing Range
El Paso County, Colorado

Prepared for:
Colorado Springs Police Department
705 South Nevada Avenue
Colorado Springs,
CO 80903
Ph: 719-444-7439

Prepared by:

Kiowa Engineering Corporation
1604 South 21st Street
Colorado Springs, Colorado 80904
Ph: (719)630-7342

Kiowa Project No. 19007
April 30, 2020

PPR-19-043

TABLE OF CONTENTS

List of Figures and Tables (Refer to the Appendix Table of Contents)

STATEMENTS AND APPROVALS

ENGINEER'S STATEMENT:

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

Kiowa Engineering Corporation, 1604 South 21st Street, Colorado Springs, Colorado 80904

COLORADO LICENSED ANDREW W. McCORD 25057 PROFESSIONAL ENGINEER

Registered Engineer (PE #25057)
For and on Behalf of Kiowa Engineering Corporation

April 30, 2020
Date

DEVELOPER'S STATEMENT:

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

By: _____

Commander Pat Rigdon
Colorado Springs Police Department

June 16, 2020
Date

Print Name: Pat Rigdon
Address: 15905 Sniper Lane
Fountain, CO 80817

EL PASO COUNTY:

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

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

Approved
By: Elizabeth Nijkamp
Date:07/29/2020
El Paso County Planning & Community Development

I. GENERAL LOCATION AND DESCRIPTION

The site is located north of and adjacent to Pikes Peak International Raceway (PPIR). The overall property, owned by North Park 200 LLC, is approximately 199.954 acres in size with the Colorado Springs Police Department (CSPD) shooting range parcel being approximately 17.21 acres of that total. The CSPD parcel has been conveyed from North Park 200 LLC to the City of Colorado Springs. The site is located southwest of exit 122 on Interstate 25. A portion of the overall North Park 200 site is located within the city limits of Fountain as is the PPIR site. The portion of the property within the City of Fountain was due to the contiguous annexation of PPIR. The CSPD shooting range property is located within El Paso County and is anticipated to be annexed into the City of Fountain in the future. The site is located within the southern half of Section 5, Township 17 South, Range 65 West of the 6th Principal Meridian, in El Paso County, Colorado. The overall site is bounded to the east by Interstate 25 and its frontage road, to the south by PPIR, to the west and north by Colorado Springs Utilities property. A vicinity map of the site is shown on Figure 1 included in the Appendix.

The existing vegetative cover within the development is in fair to good condition with numerous weeds and grasses throughout the site. The existing ground slopes within the overall property as well as the subject property generally northwest to southeast at slopes from 0.5 to 1.5 percent. Soils within the subject site are classified to be within Hydrologic Soils Group C (Limon Clay #47) as shown in the *El Paso County Soils Survey*.

The site lies within the Crooked Canyon Drainage Basin. Crooked Canyon is an unstudied basin and as such is classified as a miscellaneous drainage basin by El Paso County.

A major drainageway draining the property to the west runs along the southern boundary of the overall property and the northern boundary of PPIR. A small drainageway runs north to south on the western boundary of the overall property as well as the subject property. This drainageway drains to the above-mentioned major drainageway. The major drainageway is directed around the raceway of PPIR to the north and then east of the raceway. The drainageway turns south along the eastern side of the raceway where it is directed under Interstate-25 at Exit 122 and a short way south under the BNSF railroad. The drainageway converges with Fountain Creek just east of the Interstate and railroad.

The site is intended to become a training facility for Colorado Springs' first responders. The project includes three shooting ranges including two 50-yard ranges and a single 100-yard range along with classroom/instructional space.

The site has been previously studied with the proposed Colorado Training Institute for Public Safety (COTIPS) project, which was not constructed. The site layout of the shooting ranges has remained the same from the previous COTIPS project with the exception of an added classroom building, and the inclusion of a full spectrum detention basin to provide water quality and flow reduction values consistent with updated municipal and State criteria in the location of one shooting range. The approved drainage report is still applicable, in other respects, to this project.

II. MAJOR DRAINAGE BASINS AND SUBBASINS

The site lies within the Crooked Canyon Drainage Basin. The subject site currently sheet flows to the major drainageway, which then conveys the runoff to Fountain Creek. No offsite flow enters the subject site area as flows are directed south by the existing channel located along the western boundary of overall property and this site. The overall site is encumbered by a Zone A floodplain which is located just north of the subject site. The major drainageway to the south located generally between the overall property and PPIR is also shown as a Zone A floodplain. The floodplains are

shown per FIRM map 08041C1160G (with an effective date of December 7, 2018). The floodplains have been located on the property per the FIRM maps.

There is currently offsite runoff that approaches the site from the west and is deflected by the channel along the western boundary. Offsite Basin OS1 conveys runoff by sheet flow from undeveloped land west of the site to the western property boundary, where it is turned south and directed to the drainageway on the north side of PPIR.

III. 4-STEP PROCESS

Step 1: Runoff Reduction Practices

New construction will utilize existing channel section at westerly edge of property as an intercept for most runoff. The channel section will be cleared and shaped to improve conveyance and slope stability. Shooting ranges are sited to capture and direct runoff only to low points in a sheet flow manner. Discreet catchments at each range minimize directly connected impervious areas (MDCIA Level 2), allowing sediment to drop out of the storm runoff and helping to reduce overall runoff. Gentle slopes (5-6% Typ.) are used at margins to limit turbulence and rills associated with direct rainfall.

Step 2: Implement BMP's that Slowly Release the Water Quality Capture Volume

Treatment and slow release of at least 40 hours of the water quality capture volume (WQCV) will be accomplished by the implementation of a proposed private extended detention basin (Full Spectrum Detention).

Step 3: Stabilize Drainageways

There are no major drainageways affected by the planned development. Improvements to the receiving channel are expected to be limited to clearing, and shaping. The project discharges into an existing drainage channel along its westerly edge which feeds into Crooked Canyon approximately 600 feet downstream.

Step 4: Implement Site Specific & Source Control BMP's

There are no potential sources of contaminants that could be introduced to the County's MS4 that will not be controlled by temporary construction BMPs. Construction BMPs in the form of vehicle tracking control, riprap armoring, concrete washout area, inlet protection, and silt fence will be utilized to protect receiving waters.

IV. DRAINAGE DESIGN CRITERIA

Hydrologic and hydraulic calculations for the site were performed using the methods outlined in the *El Paso County Drainage Criteria*. Recent topography was prepared for the site. The topography was compiled using two-foot contour intervals as presented on the Drainage Plan. Hydrological Calculations were performed to reflect proposed conditions. The Drainage Plan presents the drainage patterns for the site, including the sub-basins. The peak flow rates for the sub-basins were estimated using the Rational Method. The 5-year (Minor Storm) and 100-year (Major Storm) recurrence intervals were determined. The peak flow data generated using the Rational Method was used to size the pipes to drain each range. The drainage basin area, time of concentration, and rainfall intensity were determined for each of the sub-basins within the project. The onsite soils were assumed to be Hydrologic Soil Group C, based on the *Soil Survey of the El Paso County Area, Colorado*.

The existing and proposed conditions are compared in the report appendix. The overall impervious value for the site increases 6.1% under Developed Conditions.

Historic Conditions and flow patterns are reflected on Map H-1 in map appendix.

Hydraulic calculations are provided for the proposed drainage pipes, channel, and outlet structure.

V. DRAINAGE FACILITY DESIGN

The drainage of the proposed site is to be accomplished by generally sloping the overall site grading from north to south at one half (0.5%) percent along the inside edge of a compacted earthen berm. Once these flows reach the southerly margin of the site, they will be captured within a concrete vee-pan and directed to the planned detention basin.

A Full Spectrum Detention Facility is planned at the southwest corner. This facility receives piped flow from the three ranges (See Map D-1), along with the surface flow from the parking area via vee-pan and trickle pan. The imperviousness between existing and proposed conditions increases from 16.9% to 23.0% (Delta 6.1%).

The on-site detention basin is planned to be an Extended Detention Basin that uses Full Spectrum Detention. The UD-Detention spreadsheets created by UDFCD were used to size and design the detention basin with water quality enhancement, per the County's recommendation. The supporting calculations associated with the sizing of the hydraulic facility for this development are included in the Appendix.

Along the southern berm of each range the floor of the range will be tipped to the west to capture runoff in the southwest corner of each range. Each range is then collected at a concrete pipe and conveyed along the western boundary of the project and the overall property before being directed to a presedimentation forebay. This forebay discharges to a trickle channel that terminates at the detention basin outlet structure. The outlet structure then discharges into the existing channel south and west of the property and conveys flows approximately 600 feet to the Crooked Canyon Drainageway.

The proposed drainage patterns for the site are shown on the Proposed Drainage Plan (Sheet D-1) provided in the map pocket at the end of this report. Hydrologic and Hydraulic Calculations are also provided in The Appendix.

The following is a description of the on-site drainage sub-basins:

Sub-basin A1 is the southern portion of the site along with portions of the east margin where surface flows accumulate along the compacted earthen berm. It contains 5.65 acres. Some portions of this area have been assumed to be 45% impervious as it contains areas of gravel parking surface for PPIR's overflow parking. Portions within the detention basin are assumed to be 2% as they are expected to function in an historic manner. Runoff from this basin will sheet flow to the southwest corner of the range. The anticipated runoff amounts are 6.5 cfs and 19.0 cfs for the 5 and 100-year storms respectively.

Sub-basin A2 is the southern 50-yard range and is approximately 1.41 acres in area. This area has been assumed to be 2% impervious at the yard area, and 45% impervious for the bermed areas. It is partially within areas of existing compacted gravel surface used for PPIR's overflow parking. Runoff from this basin will sheet flow to the southwest corner of the range. The anticipated runoff amounts are 1.4 cfs and 5.0 cfs for the 5 and 100-year storms respectively.

Sub-basin A3 is the middle range area, also 50 yards, and is approximately 2.06 acres in area. This area has been assumed to be 2% impervious at the yard area, and 45% impervious for the bermed areas. It is partially within areas of existing compacted gravel surface used for PPIR's overflow

parking. Runoff from this basin will sheet flow to the southwest corner of the range. The anticipated runoff amounts are 2.4 cfs and 7.5 cfs for the 5 and 100-year storms respectively.

Sub-basin A4 is the 100-yard range at the north margin of the site and is approximately 3.13 acres in area. This area has been assumed to be 2% impervious as it is outside of the gravel parking surface for the PPIR overflow parking and is mostly flat. Gravel Pavement is planned at very shallow slopes within the yard area which is expected to act as ballast to resist sediment transport, and to increase time to peak. It is expected to function in a similar fashion to *greenroof*, or rooftop detention strategies. There are no tributary flows to the range areas except for a small amount that lands on the side slopes of the shooting walls. Runoff from this basin will sheet flow to the southwest corner of the range. The anticipated runoff amounts are 2.7 cfs and 10.5 cfs for the 5 and 100-year storms respectively.

Sub-basin A5 is the marginal areas on the north and east edges of the site. It contains 2.78 acres overall. Most of this basin consists of planned landscape areas which will descend from the east side to match existing grade at slopes of 5-6%. The slopes receive direct runoff only. Runoff from this basin will sheet flow to the southeast in an historic fashion. The impervious value is unchanged from the historic condition. The anticipated runoff amounts are 3.1 cfs and 12.9 cfs for the 5 and 100-year storms respectively.

Sub-basin A6 is the outside berm of all three ranges including all except the northern berm, along with the extreme southern margin of the site. It contains approximately 2.20 acres in area. Runoff from this basin will sheet flow to the existing drainage channel located west of the ranges. The impervious value is unchanged from the historic condition. The anticipated runoff amounts are 2.1 cfs and 10 cfs for the 5 and 100-year storms respectively.

Sub-basin E1(For Calculation Purposes Only) is contained entirely within Sub-basin A6 and includes the existing drainage channel along the western boundary and contains approximately 0.54 acres in area. Runoff from this basin will combine with the detention basin and offsite flow. The anticipated runoff amounts are 0.3 cfs and 1.5 cfs for the 5 and 100-year storms respectively. It is described here for analytical purposes only.

Sub-basin OS1 includes the offsite area to the west that is tributary to the existing drainage channel running along the western property boundary. It contains approximately 30.49 acres in area. Runoff from this basin will sheet flow to the existing drainage channel located west of the ranges. The anticipated runoff amounts are 14.5 cfs and 57.3 cfs for the 5 and 100-year storms respectively.

A. STORMWATER DETENTION AND WATER QUALITY DESIGN

Storm water quality measures are required by the County in Volume 2 of the *City/County Drainage Criteria Manual* to offset increase in impervious value for the site.

B. COST OF PROPOSED PUBLIC DRAINAGE FACILITIES

There are no public facilities proposed for the shooting ranges.

C. DRAINAGE AND BRIDGE FEES

The site lies within the Crooked Canyon Creek Drainage Basin. The current drainage basin fee associated with the Crooked Canyon Creek Drainage Basin is $5,540 per impervious acre. The current bridge fee associated with the Crooked Canyon Creek Drainage Basin is $0 per impervious acre. Drainage Fees are expected to be $5,819.33. Supporting calculation of fee is provided in the report appendix.

VI. CONCLUSIONS

This project will contain three shooting ranges and associated supporting facilities covering 17.22 acres. Direct Runoff will sheet flow within the ranges, generally, to the southwestern corner of each range. The runoff in the ranges will then be collected in pipe and treated within a forebay and a full spectrum detention basin. Surface flows from the parking and building area will also be captured and directed, generally to the southeast via trickle pan directly to the detention basin. The proposed development will not adversely impact or deteriorate improvements or natural drainageways downstream of the property.

VII. REFERENCES

1) Final Drainage Report, Phase 1 Colorado Training Institute for Public Safety (Proposed Fountain Springs Addition No. 2), prepared by Kiowa Engineering Corporation, dated August 13, 2016.

2) Flood Insurance Study El Paso County and Incorporated Areas, (Flood Insurance Study Number 08041CV001A) prepared by the Federal Emergency Management Agency, dated December 7, 2019.

3) El Paso County Drainage Criteria Manual (Volumes 1 and 2) and Engineering Criteria Manual, current editions.

4) Colorado Springs Drainage Criteria Manual (Volumes 1 and 2)

5) Urban Drainage and Flood Control District Modelling Software, current editions.

6) Soil Survey of El Paso County Area, Colorado, prepared by United States Department of Agriculture Soil Conservation Service, dated June 1981.

APPENDIX TABLE OF CONTENTS

Table 1: Impervious Area and Drainage Basin & Bridge Fee Calculation

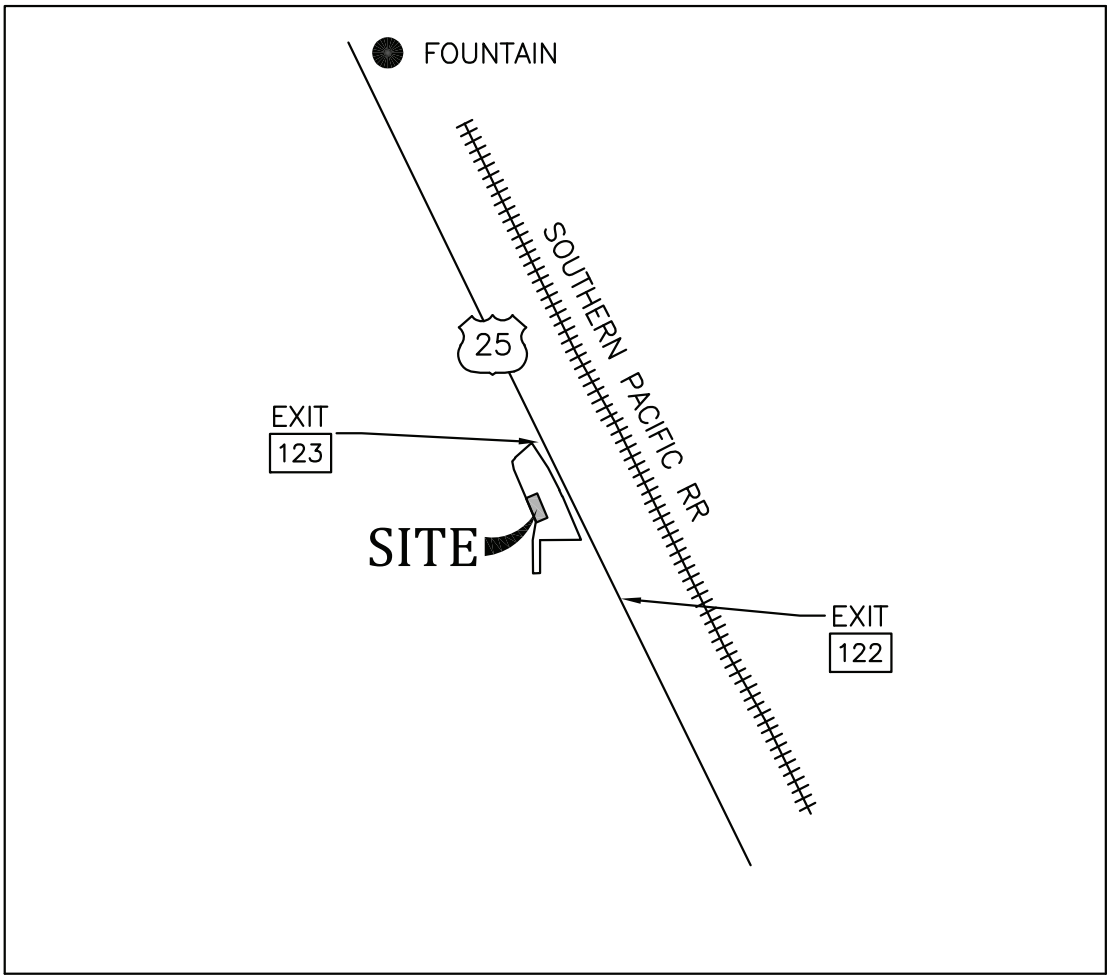
Total Development Area =	17.220 ac
Total Developed Area =	**17.220 ac**
Increse in % Impervious Area =	**6.10 %**

West Fork Jimmy Camp Creek Drainage Basin

Drainage Basin Fee and Bridge Fee Calculations			
Drainage Basin Fee =	$5,540 / ac	**Drainage Basin Fee =**	**$ 5,819.33**
Bridge Fee =	$0 / ac	**Bridge Fee =**	**$ 0.00**

	Drainage Basin	**Bridge**
Total Fees Due for the CSPD Firing Range	**$5,819.33**	**$ 0.00**

Not to Scale



VICINITY MAP

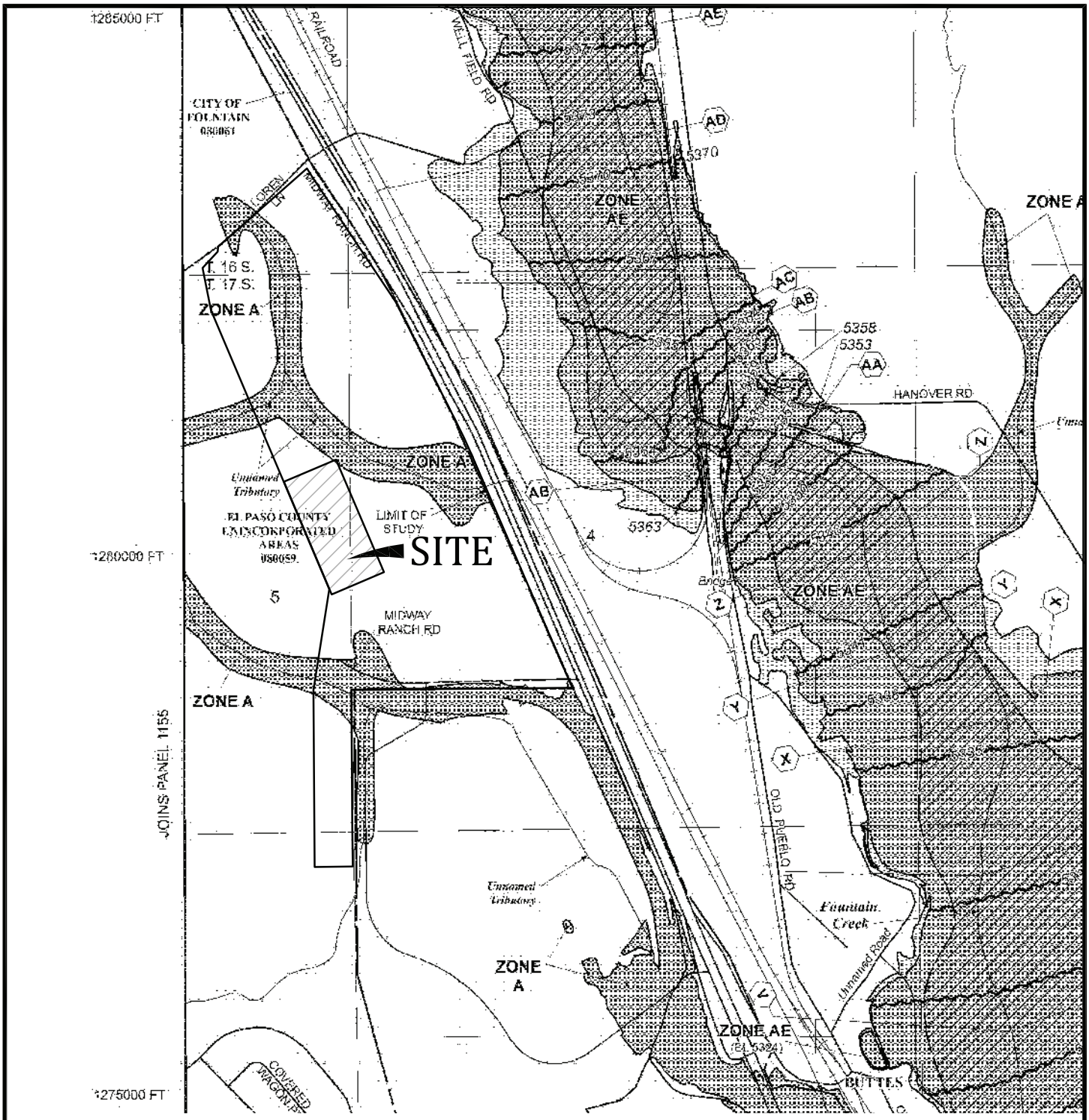
FIGURE 1

Colorado Springs Police Department
Final Drainage Report
Colorado Springs, Colorado

Kiowa Engineering Corporation
1604 South 21st Street
Colorado Springs, Colorado 80904
(719) 630-7342

Custom Soil Resource Report
Soil Map

Figure 2



FEMA FLOOD INSURANCE RATE MAP
PANEL NO. 08041C0729 G
EFFECTIVE DATE: DECEMBER 7, 2018

APPROXIMATE
SCALE: 1"=1,300'

FIGURE 3

Colorado Springs Police Department
Final Drainage Report
Colorado Springs, Colorado

Kiowa Engineering Corporation
1604 South 21st Street
Colorado Springs, Colorado 80904
(719) 630-7342

APPENDIX A

Hydrologic Calculations

Detention Basin Sizing Calculations

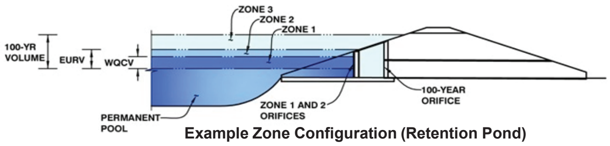
Developed Condition – Runoff Coeff, Time of Concentration and Runoff Calcs

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: CSPD Firing Range - 15905 Sniper Lane

Basin ID: El Paso County - Crooked Canyon Major Drainage Basin



Example Zone Configuration (Retention Pond)

Required Volume Calculation

			Optional User Override 1-hr Precipitation	
Selected BMP Type =	EDB			
Watershed Area =	17.22	acres		
Watershed Length =	1,000	ft		
Watershed Slope =	0.017	ft/ft		
Watershed Imperviousness =	27.10%	percent		
Percentage Hydrologic Soil Group A =	0.0%	percent		
Percentage Hydrologic Soil Group B =	0.0%	percent		
Percentage Hydrologic Soil Groups C/D =	100.0%	percent		
Desired WQCV Drain Time =	40.0	hours		
Location for 1-hr Rainfall Depths =	User Input			
Water Quality Capture Volume (WQCV) =	0.204	acre-feet		
Excess Urban Runoff Volume (EURV) =	0.420	acre-feet		
2-yr Runoff Volume (P1 = 1.19 in.) =	0.383	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.651	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.958	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	1.556	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	1.976	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	2.510	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.2 in.) =	3.604	acre-feet	3.20	inches
Approximate 2-yr Detention Volume =	0.359	acre-feet		
Approximate 5-yr Detention Volume =	0.616	acre-feet		
Approximate 10-yr Detention Volume =	0.720	acre-feet		
Approximate 25-yr Detention Volume =	0.816	acre-feet		
Approximate 50-yr Detention Volume =	0.854	acre-feet		
Approximate 100-yr Detention Volume =	1.060	acre-feet		

Stage-Storage Calculation

Zone 1 Volume (WQCV) =	0.204	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.216	acre-feet
Zone 3 (100yr + 1 / 2 WQCV - Zones 1 & 2) =	0.741	acre-feet
Total Detention Basin Volume =	1.162	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	**user**	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	--	--	--	26	0.001		
5380	--	0.38	--	--	--	54	0.001	15	0.000
	--	0.63	--	--	--	3,993	0.092	482	0.011
	--	0.88	--	--	--	12,407	0.285	2,448	0.056
	--	1.13	--	--	--	19,763	0.454	6,396	0.147
5381	--	1.38	--	--	--	27,877	0.640	12,270	0.282
	--	1.63	--	--	--	38,121	0.875	20,417	0.469
	--	1.88	--	--	--	49,814	1.144	31,293	0.718
	--	2.13	--	--	--	62,313	1.431	45,804	1.052
5382	--	2.38	--	--	--	74,637	1.713	62,923	1.445
	--	2.63	--	--	--	86,849	1.994	83,109	1.908
	--	2.88	--	--	--	99,616	2.287	106,417	2.443
	--	3.13	--	--	--	105,813	2.429	132,095	3.032
5383	--	3.38	--	--	--	112,721	2.588	159,412	3.660
	--	3.63	--	--	--	120,218	2.760	188,529	4.328
	--	3.88	--	--	--	126,783	2.911	219,405	5.037
Berm 5383.6	--	3.98	--	--	--	133,211	3.058	232,404	5.335
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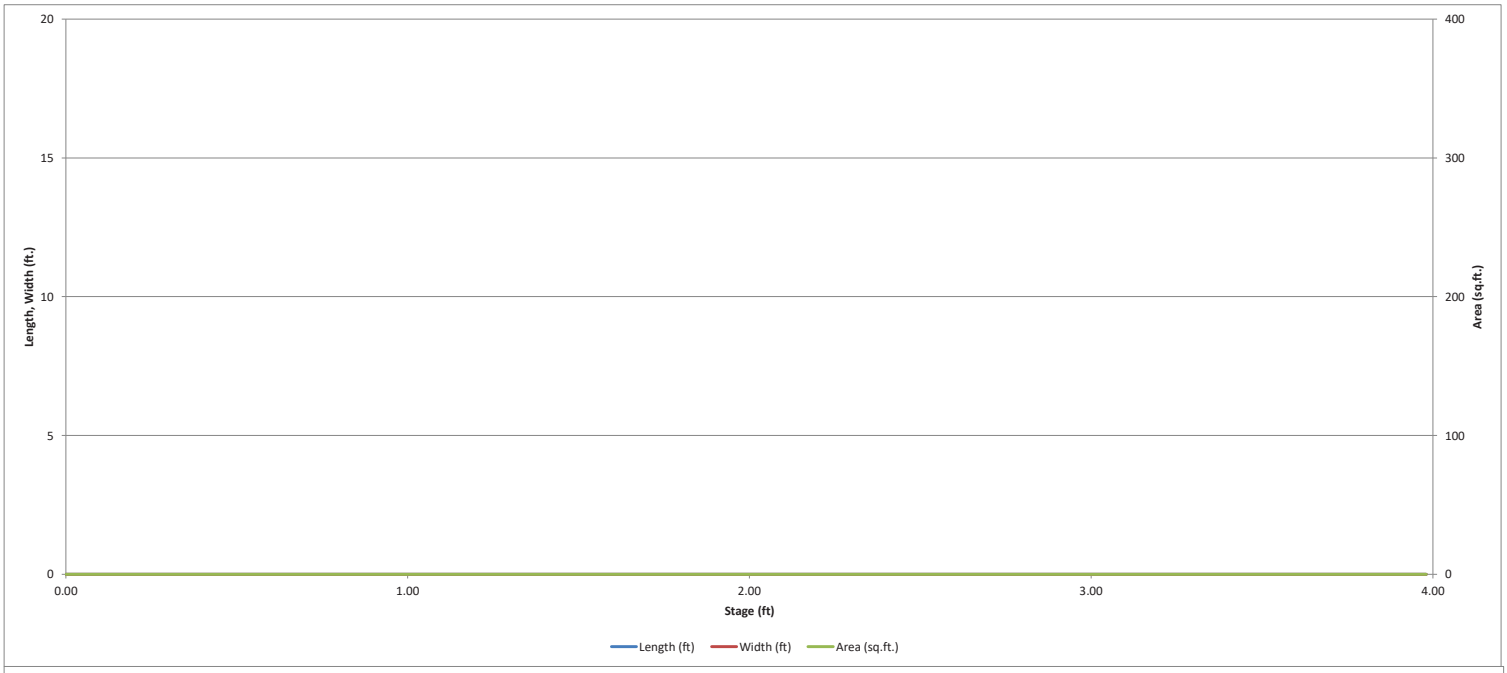
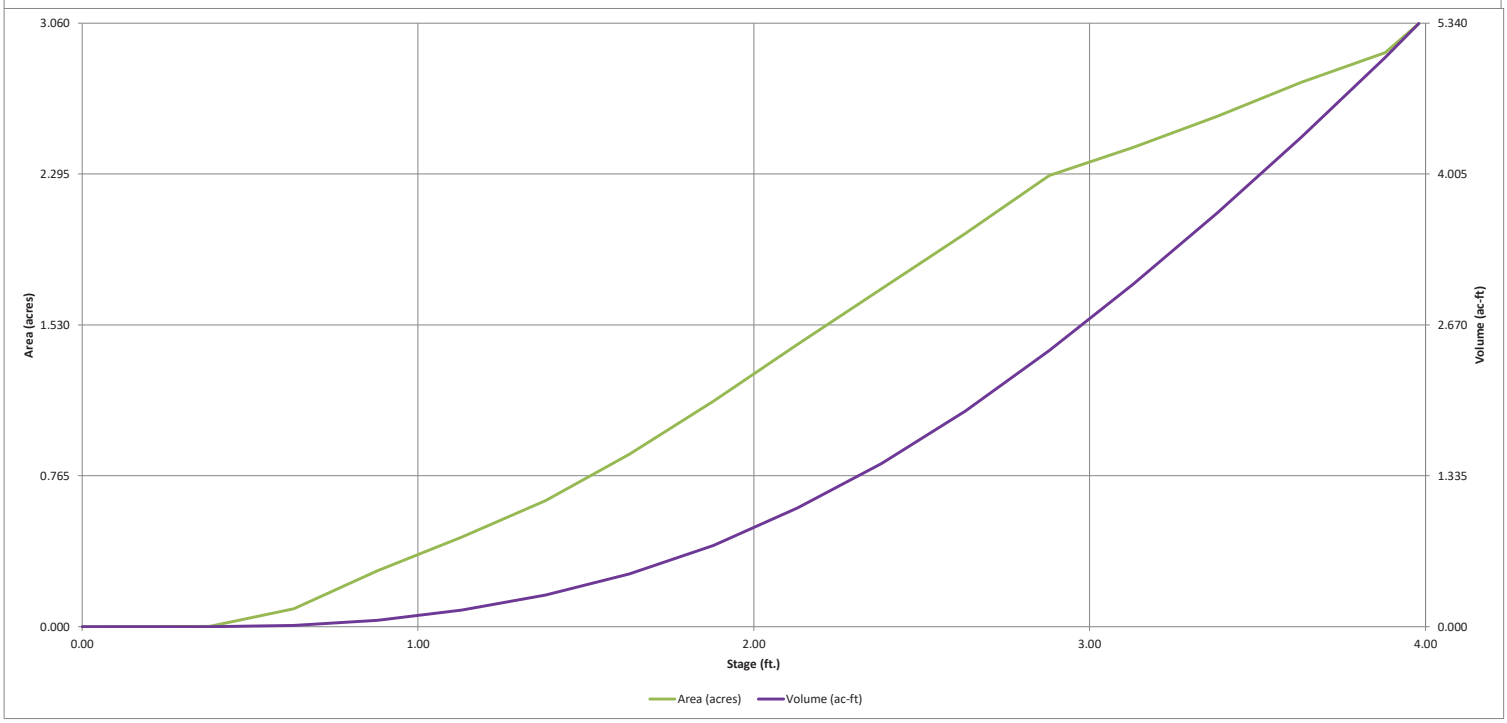
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)



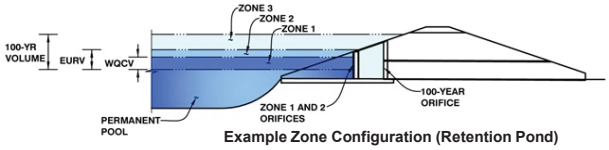


Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: CSPD Firing Range - at Crooked Canyon Lateral

Basin ID: A



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.24	0.204	Orifice Plate
Zone 2 (EURV)	1.57	0.216	Not Utilized
(100+1/2WQCV)	2.21	0.741	Weir&Pipe (Restrict)
		1.162	Total

0

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

Calculated Parameters for Underdrain

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)	WQ Orifice Area per Row =	N/A	ft^2
Depth at top of Zone using Orifice Plate =	1.24	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	N/A	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	N/A	inches	Elliptical Slot Area =	N/A	ft^2

Calculated Parameters for Plate

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	0.33	0.67	1.00				
Orifice Area (sq. inches)	0.62	0.62	1.25	1.67				

	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			Not Selected	Not Selected	
Invert of Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =	N/A	N/A	ft^2
Depth at top of Zone using Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	N/A	N/A	feet
Vertical Orifice Diameter =	N/A	N/A	inches				

Calculated Parameters for Vertical Orifice

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

	Zone 3 Weir	Not Selected			Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	1.57	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	3.13	N/A	feet
Overflow Weir Front Edge Length =	4.00	N/A	feet	Over Flow Weir Slope Length =	6.44	N/A	feet
Overflow Weir Slope =	4.00	N/A	H:V (enter zero for flat grate)	Grate Open Area / 100-yr Orifice Area =	12.23	N/A	should be ≥ 4
Horiz. Length of Weir Sides =	6.25	N/A	feet	Overflow Grate Open Area w/o Debris =	18.04	N/A	ft^2
Overflow Grate Open Area % =	70%	N/A	%, grate open area/total area	Overflow Grate Open Area w/ Debris =	9.02	N/A	ft^2
Debris Clogging % =	50%	N/A	%				

Calculated Parameters for Overflow Weir

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

	Zone 3 Restrictor	Not Selected			Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.33	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	1.47	N/A	ft^2
Outlet Pipe Diameter =	18.00	N/A	inches	Outlet Orifice Centroid =	0.64	N/A	feet
Restrictor Plate Height Above Pipe Invert =	14.00		inches	Half-Central Angle of Restrictor Plate on Pipe =	2.16	N/A	radians

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	2.57	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.54	feet
Spillway Crest Length =	36.00	feet	Stage at Top of Freeboard =	4.11	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	3.06	acres
Freeboard above Max Water Surface =	1.00	feet			

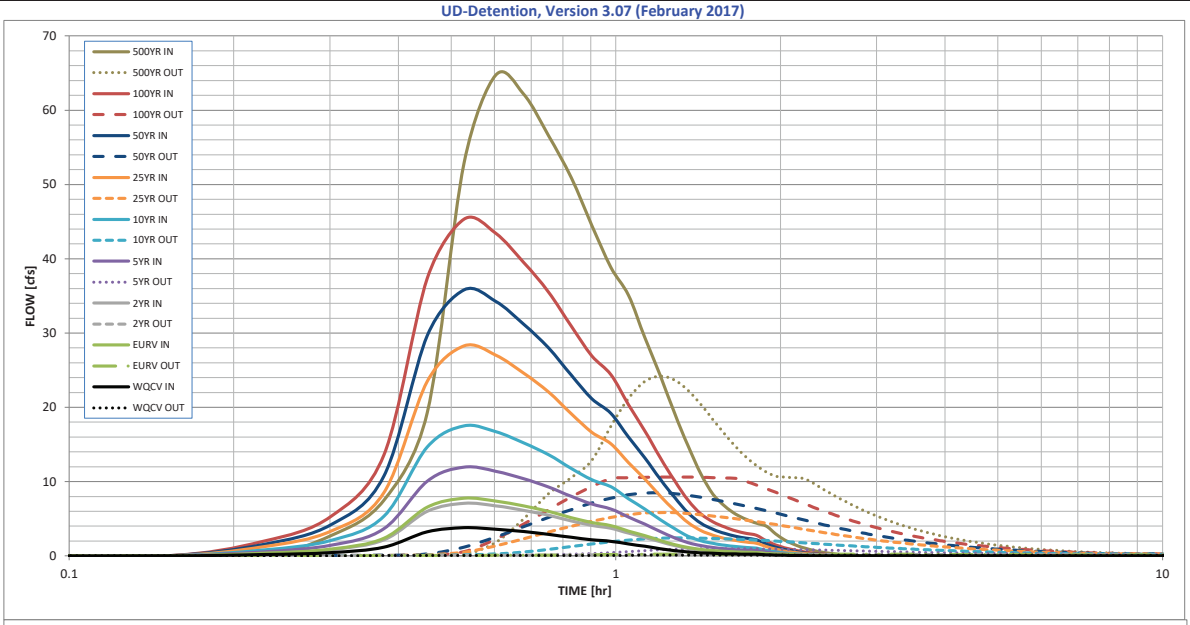
Calculated Parameters for Spillway

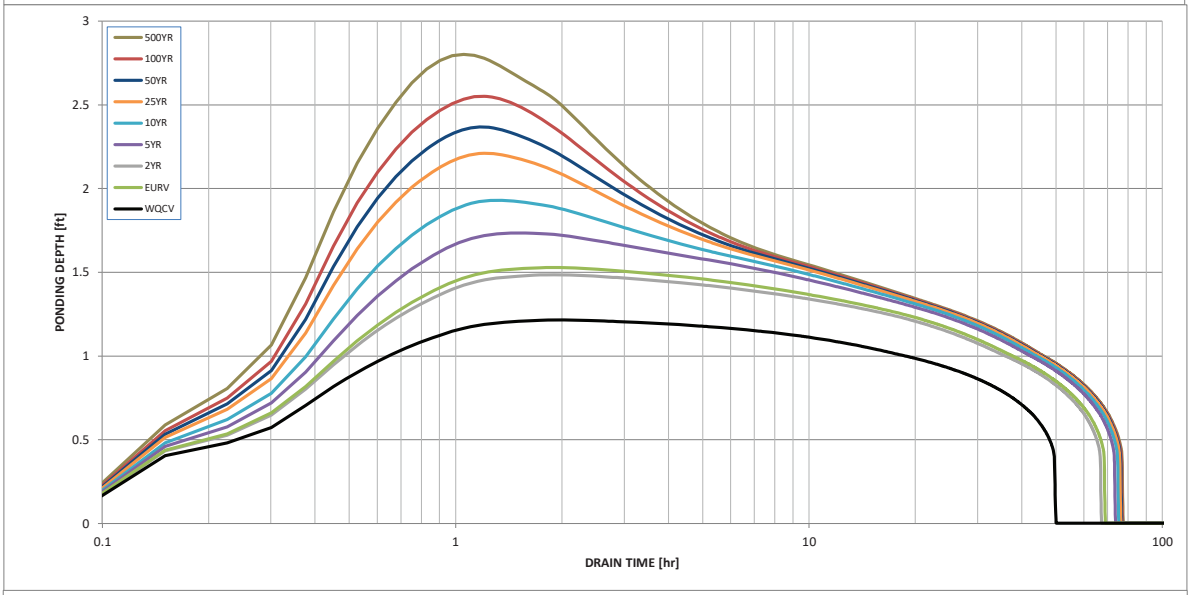
Routed Hydrograph Results

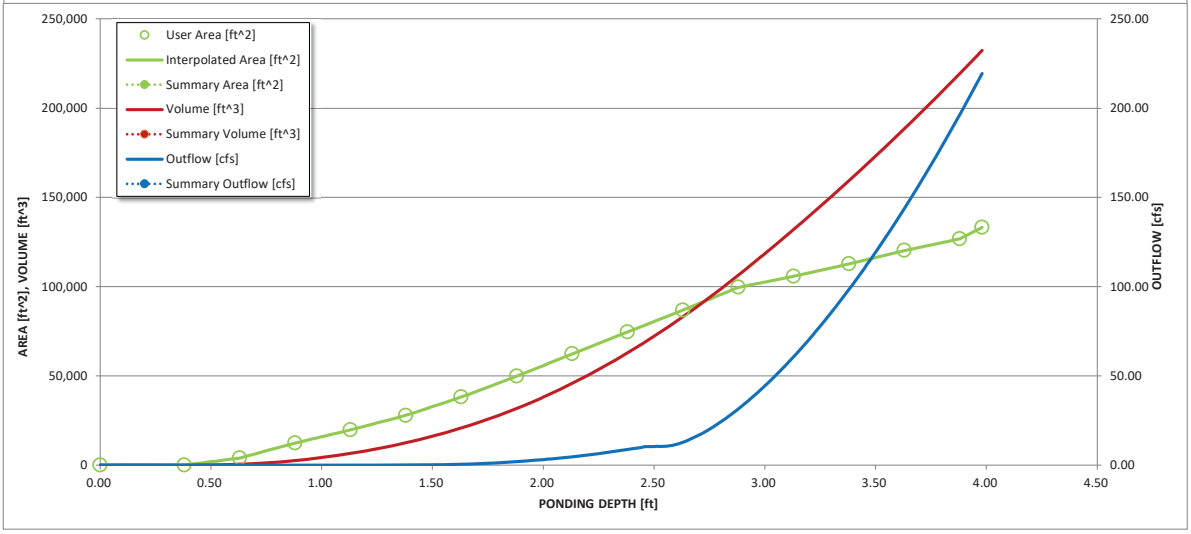
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	3.20
Calculated Runoff Volume (acre-ft) =	0.204	0.420	0.383	0.651	0.958	1.556	1.976	2.510	3.604
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	0.203	0.419	0.383	0.651	0.956	1.554	1.975	2.508	3.602
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.02	0.14	0.39	0.89	1.17	1.52	2.24
Predevelopment Peak Q (cfs) =	0.0	0.0	0.3	2.4	6.6	15.3	20.2	26.1	38.5
Peak Inflow Q (cfs) =	3.8	7.7	7.1	12.0	17.5	28.3	35.8	45.3	64.7
Peak Outflow Q (cfs) =	0.1	0.1	0.1	0.7	2.1	5.5	8.2	10.6	24.0
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.3	0.3	0.4	0.4	0.4	0.6
Structure Controlling Flow =	Plate	Plate	Plate	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	0.0	0.1	0.3	0.4	0.6	0.6
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) =	39	59	56	65	64	61	58	55	49
Time to Drain 99% of Inflow Volume (hours) =	**42**	63	59	71	71	70	69	67	65
Maximum Ponding Depth (ft) =	1.21	1.54	1.49	1.75	1.94	2.22	2.38	2.56	2.81
Area at Maximum Ponding Depth (acres) =	0.51	0.78	0.74	1.00	1.21	1.53	1.71	1.90	2.19
Maximum Volume Stored (acre-ft) =	0.190	0.395	0.364	0.590	0.800	1.185	1.445	1.752	2.264

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)







Detention Basin Outlet Structure Design

Outflow Hydrograph Workbook Filename:

Storm Inflow Hydrographs **UD-Detention, Version 3.07 (February 2017)**

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

Time Interval	SOURCE	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK
	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
4.52 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:04:31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydrograph Constant	0:09:02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:13:34	0.17	0.35	0.32	0.53	0.77	1.22	1.54	1.93	2.72
1.106	0:18:05	0.46	0.93	0.85	1.43	2.08	3.33	4.20	5.30	7.51
	0:22:36	1.18	2.39	2.18	3.66	5.33	8.56	10.80	13.61	19.27
	0:27:07	3.24	6.56	6.00	10.07	14.66	23.50	29.64	37.35	52.86
	0:31:38	3.79	7.74	7.08	11.95	17.49	28.26	35.80	45.31	64.73
	0:36:10	3.60	7.38	6.74	11.41	16.71	27.04	34.28	43.43	62.17
	0:40:41	3.28	6.72	6.14	10.38	15.22	24.61	31.20	39.53	56.58
	0:45:12	2.91	5.99	5.47	9.27	13.62	22.08	28.01	35.53	50.95
	0:49:43	2.49	5.15	4.70	8.01	11.78	19.16	24.35	30.95	44.53
	0:54:14	2.18	4.50	4.10	6.98	10.26	16.65	21.16	26.94	38.84
	0:58:46	1.97	4.07	3.71	6.32	9.30	15.10	19.18	24.39	35.10
	1:03:17	1.61	3.35	3.05	5.22	7.70	12.56	15.99	20.37	29.38
	1:07:48	1.30	2.72	2.48	4.26	6.31	10.34	13.19	16.82	24.32
	1:12:19	0.98	2.08	1.89	3.28	4.89	8.08	10.34	13.23	19.23
	1:16:50	0.71	1.54	1.40	2.44	3.67	6.12	7.88	10.13	14.82
	1:21:22	0.52	1.12	1.02	1.77	2.65	4.48	5.79	7.49	11.04
	1:25:53	0.41	0.87	0.79	1.37	2.04	3.42	4.40	5.66	8.30
	1:30:24	0.34	0.72	0.65	1.13	1.68	2.79	3.58	4.59	6.69
	1:34:55	0.29	0.61	0.56	0.96	1.42	2.36	3.02	3.87	5.63
	1:39:26	0.25	0.54	0.49	0.84	1.25	2.06	2.64	3.38	4.90
	1:43:58	0.23	0.48	0.44	0.76	1.12	1.85	2.37	3.03	4.39
	1:48:29	0.21	0.45	0.41	0.70	1.03	1.70	2.17	2.78	4.02
	1:53:00	0.16	0.33	0.30	0.51	0.76	1.25	1.60	2.05	2.99
	1:57:31	0.11	0.24	0.22	0.38	0.56	0.91	1.17	1.49	2.17
	2:02:02	0.08	0.18	0.16	0.28	0.41	0.67	0.86	1.10	1.60
	2:06:34	0.06	0.13	0.12	0.20	0.30	0.50	0.64	0.82	1.19
	2:11:05	0.04	0.09	0.08	0.15	0.22	0.36	0.46	0.59	0.87
	2:15:36	0.03	0.06	0.06	0.10	0.15	0.26	0.33	0.42	0.62
	2:20:07	0.02	0.05	0.04	0.07	0.11	0.19	0.24	0.31	0.45
	2:24:38	0.01	0.03	0.03	0.05	0.07	0.13	0.16	0.21	0.32
	2:29:10	0.01	0.02	0.02	0.03	0.04	0.08	0.10	0.13	0.20
	2:33:41	0.00	0.01	0.01	0.01	0.02	0.04	0.06	0.07	0.11
	2:38:12	0.00	0.00	0.00	0.00	0.01	0.02	0.02	0.03	0.05
	2:42:43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
	2:47:14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:51:46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:56:17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:00:48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:05:19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:09:50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:14:22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:18:53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:23:24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:27:55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:32:26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:36:58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:41:29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:46:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:59:34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:04:05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:08:36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:13:07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:17:38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:22:10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:26:41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:31:12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:44:46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:49:17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:53:48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:58:19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:02:50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:07:22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:11:53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:16:24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

CSPD Shooting Ranges
Runoff Coeficient and Percent Impervious Calculation

Basin / DP	Basin or DP Area (DP contributing basins)		Soil Type	OF % Imperv	OF Land Use Area	OF % Area	OF Comp Land Use % Imp	HI % Imperv	HI Land Use Area	HI % Area	HI Comp Land Use % Imp	RO % Imperv	RO Land Use Area	RO % Area	RO Comp Land Use % Imp	CO % Imperv	CO Land Use Area	CO % Area	CO Comp Land Use % Imp	GR % Imperv	GR Land Use Area	GR % Area	GR Comp Land Use % Imp	Basin % Imperv	Basin Runoff Coef C_5	Basin Runoff Coef C_{100}
A1	245,991 sf	5.65ac	CD	45%	2.40ac	43%	19%	2%	2.10ac	37%	1%	90%	0.05ac	1%	1%	95%		0%	0%	80%	1.10ac	19%	16%	**36.2%**	**0.33**	**0.58**
A2	61,224 sf	1.41ac	CD	45%	0.51ac	36%	16%	2%	0.86ac	61%	1%	90%	0.04ac	3%	3%	95%		0%	0%	80%		0%	0%	**20.1%**	**0.26**	**0.55**
A3	89,653 sf	2.06ac	CD	45%	1.16ac	56%	25%	2%	0.76ac	37%	1%	90%	0.14ac	7%	6%	95%		0%	0%	80%		0%	0%	**32.3%**	**0.31**	**0.57**
A4	136,215 sf	3.13ac	CD	45%	0.83ac	26%	12%	2%	2.23ac	71%	1%	90%	0.07ac	2%	2%	95%		0%	0%	80%		0%	0%	**15.3%**	**0.24**	**0.54**
A5	120,973 sf	2.78ac	CD	45%	0.58ac	21%	9%	2%	2.20ac	79%	2%	90%		0%	0%	95%		0%	0%	80%		0%	0%	**10.9%**	**0.22**	**0.53**
A6	96,012 sf	2.20ac	CD	45%	0.20ac	9%	4%	2%	2.00ac	91%	2%	90%		0%	0%	95%		0%	0%	80%		0%	0%	**6.0%**	**0.19**	**0.52**
On-Site:	750,067 sf	17.22ac	CD		5.67ac	33%			10.15ac				0.30ac	2%				0%			1.10ac	6%				
OS1	1,328,109 sf	30.49ac	CD	45%	8.45ac	28%	12%	2%	18.00ac	59%	1%	90%		0%	0%	95%		0%	0%	80%		0%	0%	**13.7%**	**0.23**	**0.54**
Onsite (H)	750,067 sf	17.22ac	CD	45%	0.00ac	0%	0%	2%	13.92ac	81%	2%	90%		0%	0%	95%		0%	0%	80%	3.30ac	19%	15%	**16.9%**	**0.25**	**0.55**
Onsite (P)	750,067 sf	17.22ac	CD	45%	5.49ac	32%	14%	2%	10.15ac	59%	1%	90%	0.30ac	2%	2%	95%		0%	0%	80%	1.28ac	7%	6%	**23.0%**	**0.27**	**0.56**
DP 1	533,083 sf	12.24ac	CD	45%	4.89 ac	40%	18%	2%	5.95 ac	49%	1%	90%	0.30 ac	2%	2%	95%		0%	0%	80%	1.10 ac	9%	7%	**28.4%**	**0.30**	**0.57**
DP2	216,984 sf	4.98ac	CD	45%	0.78ac	16%	7%	2%	4.20 ac	84%	2%	90%		0%	0%	95%		0%	0%	80%		0%	0%	**8.7%**	**0.20**	**0.53**

Basin Runoff Coefficient is based on % Imperviousness Calculation

Based on Table 6-6: Runoff Coefficients for Rational Method from City of Colo Springs DCM

Runoff Coefficients and Percents Impervious

Hydrologic Soil Type:	CD	Runoff Coef Method			%Imp	
Land Use	Abb	%	C_5	C_{10}	C_{100}	Weighted %Imp
Commercial Area	CO	95%	0.82	0.84	0.89	A
Drives and Walks	DR	100%	0.90	0.92	0.96	AB
Streets - Gravel (Packed)	GR	80%	0.63	0.66	0.74	CD
Historic Flow Analysis	HI	2%	0.16	0.26	0.51	D
Lawns	LA	0%	0.15	0.25	0.50	
Off-site flow-Undeveloped	OF	45%	0.37	0.44	0.59	
Park	PA	7%	0.19	0.29	0.52	
Streets - Paved	PV	100%	0.90	0.92	0.96	
Roofs	RO	90%	0.75	0.77	0.83	
User Input 1	US1	40%	0.35	0.42	0.58	
User Input 2	US2	65%	0.49	0.54	0.65	

CSPD Shooting Ranges
Time of Concentration Calculation

Sub-Basin Data				Time of Concentration Estimate										Min. Tc in Urban		Final t_c
Basin / Design Point	Contributing Basins	Area	C_5	Initial/Overland Time (t_i)			Travel Time (t_t)						Comp.	Tc Check (urban)		
				Length	Slope	t_i	18	Slope	Land Type	Cv	Velocity	t_t	t_c	Total Length	t_c Check	
A1		5.65ac	0.33	60lf	1.5%	9.5 min.	926lf	0.6%	SP	7	0.6 ft/sec	28.0 min.	37.5 min.	986lf	15.5 min.	**15.5 min.**
A2		1.41ac	0.26	20lf	66.7%	1.7 min.	405lf	0.6%	SP	7	0.6 ft/sec	12.2 min.	13.9 min.	425lf	12.4 min.	**12.4 min.**
A3		2.06ac	0.31	35lf	66.7%	2.1 min.	440lf	0.5%	SP	7	0.5 ft/sec	14.8 min.	16.9 min.	475lf	12.6 min.	**12.6 min.**
A4		3.13ac	0.24	32lf	66.7%	2.2 min.	580lf	0.5%	SP	7	0.5 ft/sec	19.5 min.	21.7 min.	612lf	13.4 min.	**13.4 min.**
A5	Site outside Ranges (East)	2.78ac	0.22	32lf	66.7%	2.3 min.	60lf	5.0%	GW	15	3.4 ft/sec	0.3 min.	5.0 min.	92lf	10.5 min.	**5.0 min.**
A6	Site outside Ranges (West)	2.20ac	0.19	32lf	66.7%	2.3 min.	60lf	0.5%	GW	15	1.1 ft/sec	0.9 min.	5.0 min.	92lf	10.5 min.	**5.0 min.**
OS1		30.49ac	0.23	300lf	1.5%	24.1 min.	1430lf	5.0%	SP	7	1.6 ft/sec	15.2 min.	39.3 min.	N/A	N/A	***39.3 min.***
Onsite		17.22ac	0.27	100lf	2.0%	12.0 min.	926lf	0.9%	SP	7	0.7 ft/sec	23.2 min.	35.2 min.	1026lf	15.7 min.	**15.7 min.**
DP1	A1-A4	12.24ac	0.30	100lf	2.0%	11.7 min.	926lf	0.9%	SP	7	0.7 ft/sec	23.2 min.	34.9 min.	1026lf	15.7 min.	**15.7 min.**
DP2	A1-A5, E1 & OS1	4.98ac	0.20	32lf	66.7%	2.3 min.	1lf	0.5%	GW	15	1.1 ft/sec	0.0 min.	5.0 min.	33lf	10.2 min.	**5.0 min.**

Equations:

t_i (Overland) = $0.395(1.1-C_5)L^{0.5} S^{-0.333}$

C_5 = Runoff coefficient for 5-year

L = Length of overland flow (ft)

S = Slope of flow path (ft/ft)

tc Check = (L/180)+10 (Developed Cond. Only)

L = Overall Length

Velocity (Travel Time) = $CvS^{0.5}$

Cv = Conveyance Coef (see table)

S = Watercourse slope (ft/ft)

Table 6-7: Conveyance Coef (City CS DCM, Vol 1)

Type of Land Surface	Land Type	Cv
Grassed Waterway	GW	15
Heavy Meadow	HM	2.5
Nearly Bare Ground	NBG	10
Paved Area	PV	20
Riprap (Not Buried)	RR	6.5
Short Pasture/Lawns	SP	7
Tillage/Fields	TF	5

CSPD Shooting Ranges
Runoff Calculation

Basin / Design Point	Contributing Basins	Drainage Area	C_5	C_{100}	Time of Concentration	i_5	i_{100}	**Q_5**	**Q_{100}**	**Basin / DP**
A1		5.65 ac	0.33	0.58	15.5 min.	3.5 in/hr	5.8 in/hr	**6.5 cfs**	**19.0 cfs**	A1
A2		1.41 ac	0.26	0.55	12.4 min.	3.8 in/hr	6.4 in/hr	**1.4 cfs**	**5.0 cfs**	A2
A3		2.06 ac	0.31	0.57	12.6 min.	3.8 in/hr	6.3 in/hr	**2.4 cfs**	**7.5 cfs**	A3
A4		3.13 ac	0.24	0.54	13.4 min.	3.7 in/hr	6.2 in/hr	**2.7 cfs**	**10.5 cfs**	A4
A5	outside range (NE)	2.78 ac	0.22	0.53	5.0 min.	5.2 in/hr	8.7 in/hr	**3.1 cfs**	**12.9 cfs**	A5
A6	outside range (SW)	2.20 ac	0.19	0.52	5.0 min.	5.2 in/hr	8.7 in/hr	**2.1 cfs**	**10.0 cfs**	A6
		1.00 ac	0.19	0.52	5.0 min.	5.2 in/hr	8.7 in/hr	**1.0 cfs**	**4.5 cfs**	
OS1		30.49 ac	0.23	0.54	39.3 min.	2.1 in/hr	3.5 in/hr	**14.5 cfs**	**57.3 cfs**	OS1
Onsite	Phase 1	17.22 ac	0.27	0.56	15.7 min.	3.5 in/hr	5.8 in/hr	**16.3 cfs**	**55.6 cfs**	Onsite
DP1	A2-A5	12.24 ac	0.30	0.57	15.7 min.	3.5 in/hr	5.8 in/hr	**12.6 cfs**	**40.1 cfs**	DP1

Equations (taken from Fig 6-5, City of Colorado Springs DCM):

$i_2 = -1.19 \ln(T_c) + 6.035$

$i_5 = -1.50 \ln(T_c) + 7.583$

$i_{10} = -1.75 \ln(T_c) + 8.847$

$i_{100} = -2.52 \ln(T_c) + 12.735$

$Q = CiA$

Q = Peak Runoff Rate (cubic feet/second)

C = Runoff coef representing a ration of peak runoff rate to ave rainfall intensity for a duration equal to the runoff time of concentration.

i = average rainfall intensity in inches per hour

A = Drainage area in acres

APPENDIX B

Hydraulic Calculations

Outlet Structure Calculations
Pipe Sizing Calculations

CSPD Shooting Ranges
Pipe Diameter Calculations

Pipe #	100yr Flow	Design Flow	Contributing Flows	Manning 'n'	Pipe Slope	Calculated Pipe Diameter	**Pipe Diameter**	Minimum Slope of Pipe	Full Pipe Flow Velocity	Head above Pipe Flowline	H	Pipe Inlet Control Capacity	**Mannings Pipe Capacity**	Capacity Check
A1	19.0 cfs	11.4 cfs		0.013	**0.4%**	22-inch	**24-inch**	0.25%	4.6 ft/sec		----	----	**14.3 cfs**	OK
A2	5.0 cfs	5.0 cfs		0.013	**0.5%**	16-inch	**18-inch**	0.23%	4.2 ft/sec		----	----	**7.4 cfs**	OK
A3	7.5 cfs	7.4 cfs		0.013	**0.5%**	18-inch	**18-inch**	0.50%	4.2 ft/sec		----	----	**7.4 cfs**	OK
A4	10.5 cfs	10.5 cfs		0.013	**1.0%**	18-inch	**18-inch**	1.00%	6.0 ft/sec		----	----	**10.5 cfs**	OK
A3-A4	18.0 cfs	16.0 cfs		0.013	**0.5%**	24-inch	**24-inch**	0.50%	5.1 ft/sec		----	----	**16.0 cfs**	OK

Equations:

Pipe Dia=$((2.16Qn)/(S^{0.5}))^{0.375}$

Q = Discharge in cubic feet per second

n = Manning's roughness coefficient

RCP=0.013, CMP=0.024, HDPE (smooth)=0.012

S = Slope of the pipe

R_h = Hydraulic Radius

Flow Velocity = $(1.49/n)R_h^{2/3} S^{1/2}$

Pipe Capacity = $(1.49/n)AR_h^{2/3} S^{1/2}$

A = Cross-sectional area of pipe

$A=p(D^2/4)$

D = Inside Diameter of Pipe

$R_h = A_w/W_p$

$A_w = p(d^2/4)$

A_w = Water Cross Sectional Area

d = Water (Flow) Depth Within Pipe

W_p = pd (For Capacity Calculation)

W_p=Wetted Perimeter of Pipe

Orifice Equation:

$Q = CA(2gH)^{0.5}$

C = Orifice coefficient (dimensionless)

C = 0.65

A = Cross-sectional area of opening, in sf

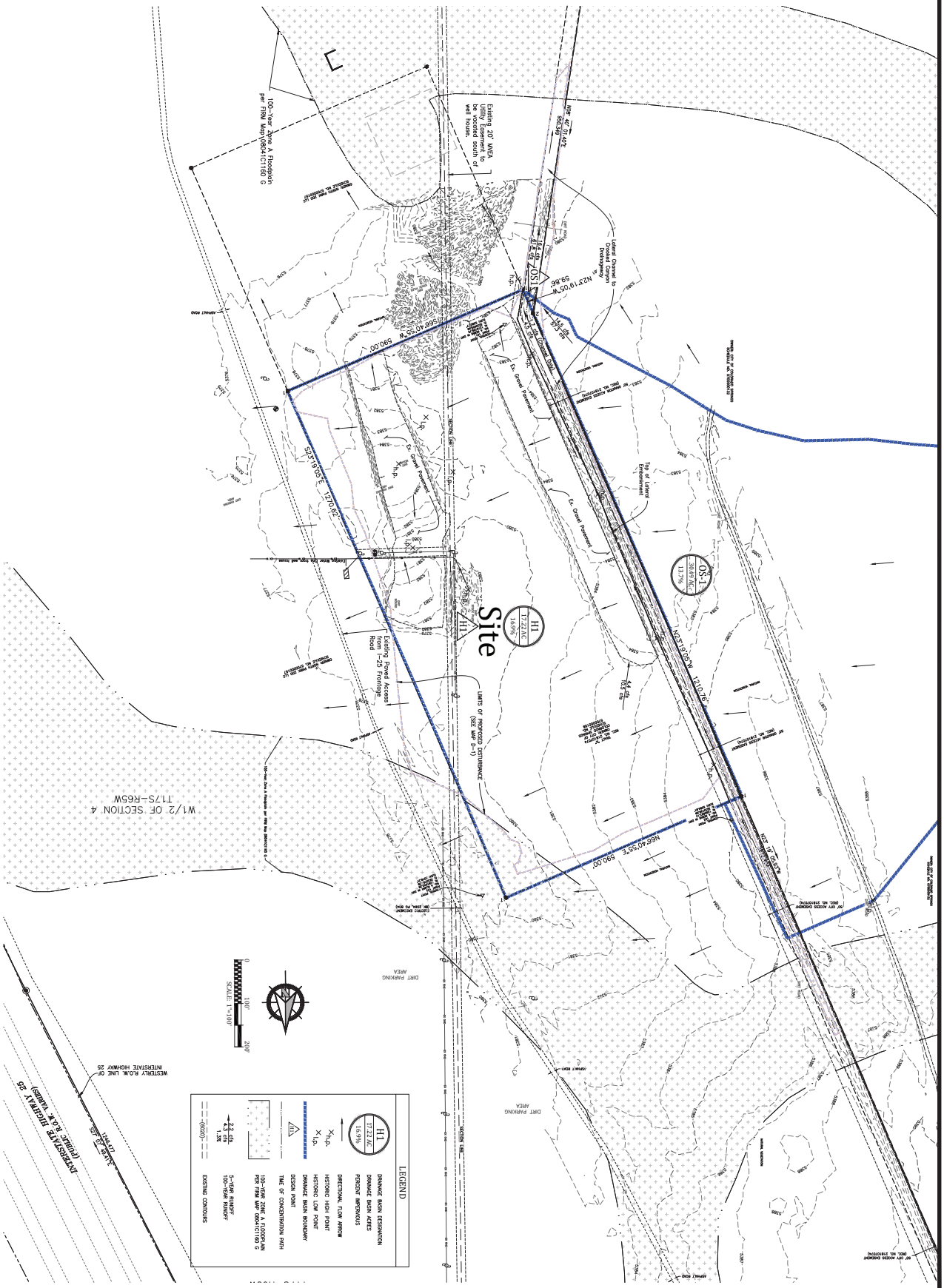
g = Gravitational accel constant, 32.2 ft/sec^2

H = Head above centerline of pipe, ft

APPENDIX C

Drainage Plans

Historic Conditions Map H-1
Developed Conditions Map D-1



19007 Historic Conditions Exhibit H-1.dwg/Jan 17, 2020

SHEET H-1 1 of 1 Sheets

Project No.	19007
Date:	Jan 18, 2020
Design:	MJK
Drawn:	MJK
Check:	AWW
Revisions:	

15905 SNIPER LANE

Proposed Fountain Springs Addition No. 2

Historic Conditions

El Paso County, Colorado

HB&A Architecture Planning

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15905 SNIPER LANE

Proposed Fountain Springs Addition No. 2

Drainage Plan

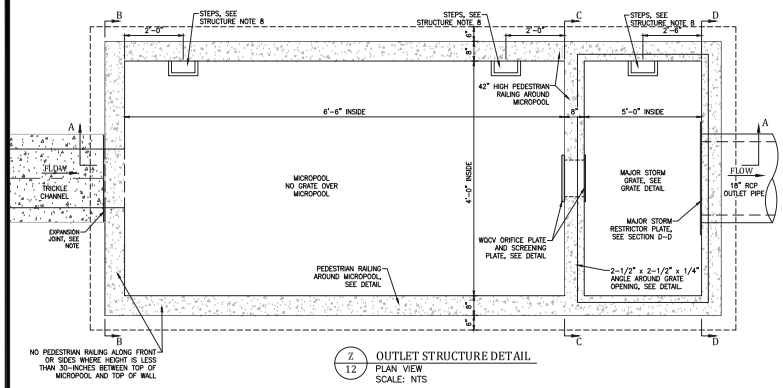
El Paso County, Colorado

Project No.:	19007
Date:	January 18, 2020
Design:	MJK
Drawn:	MJK
Check:	AWMc
Revisions:	
	4-15-2020 Comments

SHEET D-1

1 of 1 Sheets

19007 Developed Conditions Drwgs D-1.dwg/Plt: 20, 2020

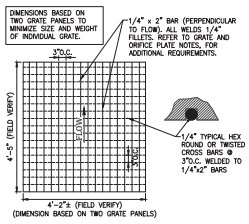


Z 12 OUTLET STRUCTURE DETAIL
PLAN VIEW
SCALE: NTS

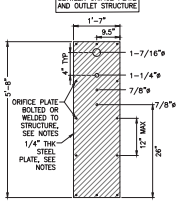
STRUCTURE NOTES:
1. PRIOR TO CONSTRUCTION, CONTRACTOR TO PROVIDE SHOP DRAWINGS FOR ALL COMPONENTS OF THE OUTLET STRUCTURE.
2. GRADE 60 REINFORCING STEEL REQUIRED. SEE TABLE FOR THE MINIMUM LAP SPLICE LENGTH FOR REINFORCING BARS. ALL REINFORCING STEEL SHALL HAVE 2-INCH MINIMUM CLEARANCE FROM EDGE OF CONCRETE AND 3-INCH MIN CLEARANCE TO EDGE OF CONCRETE PLACED AGAINST SOIL, UNLESS OTHERWISE NOTED.

BAR SIZE	#4	#5	#6
MIN. SPLICE LENGTH	1'-3"	1'-7"	2'-0"

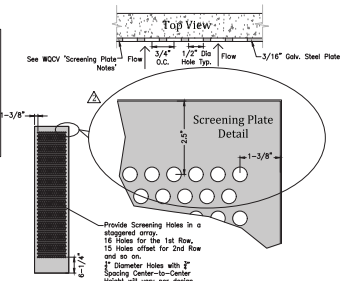
3. CONCRETE FOR THE OUTLET STRUCTURE AND FOREBAYS SHALL BE CDOT CLASS D CONCRETE.
4. EXPANSION JOINT MATERIAL SHALL MEET ASHTO SPECIFICATION M-213. EXPANSION JOINT MATERIAL SHALL BE 1/2" THICK, SHALL EXTEND THE FULL DEPTH OF CONTACT SURFACE AND THE JOINT SHALL BE SEALED, REFER TO DETAILS.
5. ALL EXPOSED CONCRETE CORNERS SHALL HAVE A 3/4-INCH CHAMFER UNLESS OTHERWISE NOTED.
6. BACKFILLING AGAINST WALLS SHALL NOT COMMENCE UNTIL CONCRETE HAS OBTAINED ITS FULL SEVEN DAY STRENGTH.
7. SUBGRADE TO BE 12" THK CLEAN FILL COMPACTED TO 95% STANDARD PROCTOR DENSITY PER ASTM M698 UNDER STRUCTURES.
8. OUTLET STRUCTURE STEPS SHALL CONFORM TO AASHTO M199.
9. FOREBAY: CONSTRUCTION JOINTS SHALL BE INSTALLED AT 10' O.C. MAXIMUM. THE JOINTS SHALL BE SEALED WITH A JOINT SEALANT.



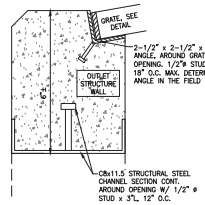
E 12 MAJOR STORM GRATE DETAIL
SCALE: NTS



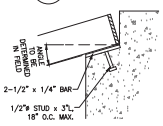
F 12 WQCV ORIFICE PLATE
SCALE: NTS



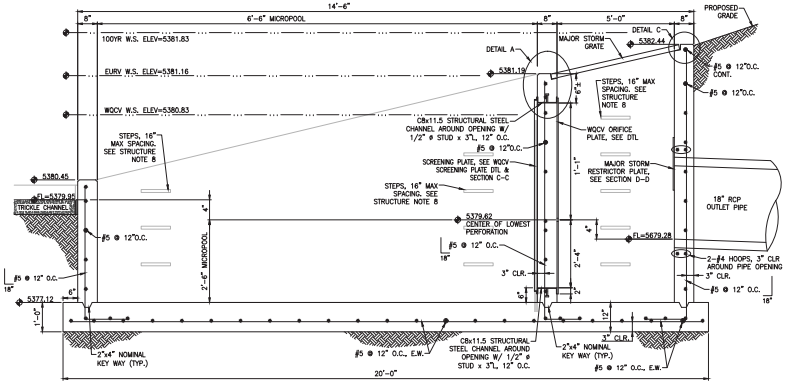
K 12 WQCV SCREENING PLATE
Scale: NTS



L 12 DETAIL A
SCALE: NTS

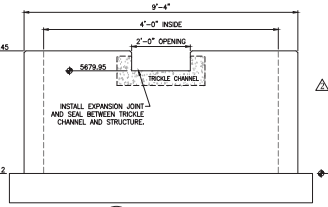


M 12 DETAIL C
SCALE: NTS



A 12 SECTION A-A
SCALE: NTS

GRATE AND ORIFICE PLATE NOTES:
1. GRATES AND ORIFICE PLATES SHALL BE MOUNTED USING STAINLESS STEEL HARDWARE. GRATES TO BE BOLTED DOWN TO OUTLET STRUCTURE 18" O.C.
2. GRATES AND ORIFICE PLATES SHALL BE STAINLESS STEEL, ALUMINUM OR STEEL. STEEL TRASH RACKS SHALL BE HOT DIP GALVANIZED AND HOT POWDER PAINTED AFTER GALVANIZED.
3. FIELD VERIFY GRATE DIMENSION PRIOR TO FABRICATION.



B 12 SECTION B-B
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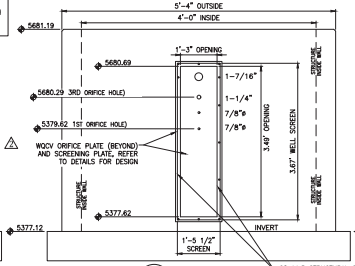
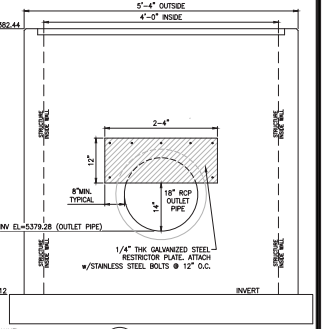
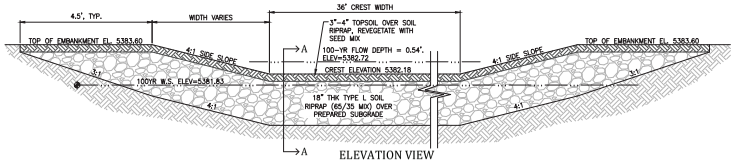


C 12 SECTION C-C
SCALE: NTS

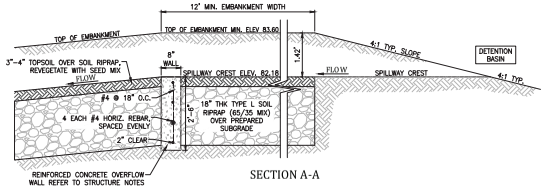


D 12 SECTION D-D
SCALE: NTS



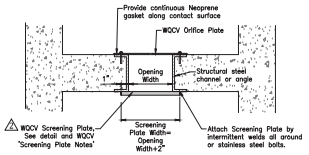
ELEVATION VIEW

O 12 EMERGENCY SPILLWAY
SCALE: NTS



SECTION A-A

Screening Plate Notes:
1. Orifice plates shall be mounted using stainless steel hardware.
2. Screen Grate shall be hot-dipped galvanized steel.
3. Field verify screen dimension prior to fabrication.



Top View

J 12 WQCV ORIFICE PLATE AND SCREENING PLATE
Scale: NTS

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HB&A Architecture AND Planning

15905 SNIPER LANE
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Detention Basin Details
El Paso County, Colorado

Project No.:	19007
Date:	April 30, 2020
Design:	MJK
Drawn:	MJK
Check:	AWMc
Revisions:	4-15-2020 Comments

SHEET
D-2
1 of 1 Sheets

19007 Detention Basin Details.dwg Apr 30, 2020