Final Drainage Report
The Glen at Widefield Filing No. 10
El Paso County, Colorado

Prepared for:
Widefield Investment Group
3 Widefield Boulevard
Colorado Springs, Colorado 80911

Prepared by:

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

Kiowa Project No. 19016

September 27, 2019

PCD Project No. SF-____-_____

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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 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

_____ _____

Andrew W. McCord (PE #25057) Date

For and on Behalf of Kiowa Engineering Corporation

DEVELOPER'S STATEMENT:

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

By: _____ _____

Date

Print Name: J. Ryan Watson, Glen Development Company

Address: 3 Widefield Boulevard
Colorado Springs, Colorado 80911

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. Date

El Paso County Engineer/ECM Administrator

I. GENERAL LOCATION AND DESCRIPTION

The Glen at Widefield Filing No. 10 (Filing 10) subdivision will be developed as a single-family residential subdivision located in the Widefield area of El Paso County. The subject property is located to the west of Marksheffel Road and north of Mesa Ridge Parkway. The site is located in the southwest portion of Section 22, Township 15 South, Range 65 West of the 6th Principal Meridian, in El Paso County, Colorado. The site is bounded on east by Marksheffel Road, the south and west by the Glen at Widefield Filing No. 7, to the northwest by the Glen at Widefield Filing No. 8, and the north by future Glen at Widefield Filing No. 11, currently unplatted land. The property covers approximately 10.47 acres and is currently undeveloped. The property has previously been rough graded as a part of the Glen at Widefield East. A vicinity map of the site is shown on Figure 1 included in the Appendix.

The existing vegetative cover within the development is in poor to fair condition with minimal grasses throughout the site. The existing ground slopes within the property range from 0.2 to 9 percent. Soils within the subject site are classified to be within Hydrologic Soils Group B as shown in the El Paso County Soils Survey. For the purposes of computing the existing and proposed hydrology for the site, Hydrologic Soil Group B was used.

Existing utilities within or adjacent to the site include a pair of thirty-inch (30") Colorado Interstate Gas (CIG) mains that run along the easterly property boundary (See Maps).

The Filing 10 area has been overlot graded. Peaceful Valley Road extends through the filing and connects to Marksheffel Road. This roadway has been constructed and will be improved further with this development with sidewalks and pedestrian ramps.

II. MAJOR DRAINAGE BASINS AND SUBBASINS

The site lies within the West Fork Jimmy Camp Creek drainage basin. The majority of the overall site presently drains towards the south and southwest by a combination of overlot sheet flow along with curb gutter and pipe conveyances to the West Fork Jimmy Camp Creek just upstream of Mesa Ridge Parkway (Sub-basins EX-1 through EX-4 - See Sheet 1 of 3). The northeast portion of the site drains east and south in the same fashion to the existing roadside ditch along Marksheffel Road across from Peaceful Valley Road (Sub-basin EX-5). The remaining portion of the site, or southeast corner, drains by sheet flow to the existing roadside ditch along Marksheffel Road approximately 400 feet north of Mesa Ridge Parkway (Sub-basin EX-6). The existing drainage patterns for the site are shown on Sheet 1 provided in a map pocket at the end of this report.

The drainage reports that were reviewed in the process of preparing this drainage report are included in the References section. The Glen at Widefield East area was studied as a part of the *Master Development Drainage Plan (MDDP) for the Glen at Widefield* and the *West Fork Jimmy Camp Creek Drainage Basin Planning Study (DBPS).* A detention basin shown on the west side of the creek (DP 3101) was designed and constructed as part of the Filing No. 6 improvements. Two additional regional detention basins were identified for the site in the *MDDP*: one to serve the westerly side of the site with flows released west to the West Fork Jimmy Camp Creek (DP 3091), and the other to serve the easterly side of the site with flows released east across Marksheffel Road to a channel along the north side of Peaceful Valley Road and ultimately to the Jimmy Camp Creek main branch (DP 4021). The detention basin shown in the *MDDP* and *DBPS* at DP 3091 was designed and constructed as part of the Glen at Widefield Filing No. 7 improvements as Basin C. However, due to the proposed grading and drainage patterns north of Filing No. 7, two additional detention basins to serve the westerly side of the site were planned and constructed: one for Filing No. 8 (Basin B) and one for Filing No. 9 (Basin A), which is located just north of the Filing No. 8 area. The detention basin shown

in the *MDDP* and *DBPS* at DP 4021 will be designed herein (Basin D) and constructed to serve Filing 10, and future Filings 11 and 12 within the Glen at Widefield area.

The subject property limits are shown on Flood Insurance Rate Maps (FIRMs) 08041C0956G and 08041C0957G (both with effective dates of December 7, 2018) that are included in the Appendix. The FIRMs also show that the property to be developed with buildable lots is located outside of the FEMA regulated floodplain in an unshaded Zone X area, which is described as "Area of Minimal Flood Hazard."

III. DRAINAGE DESIGN CRITERIA

Hydrologic and hydraulic calculations for the site were performed using the methods outlined in the *El Paso County Drainage Criteria Manual*. Topography for the site was compiled using a two-foot contour interval and is presented on the Drainage Plan. The hydrologic calculations were made for the historic and proposed site 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 one-hour rainfall depth was determined from Table 6-2 of the *Drainage Criteria Manual*. These depths are shown in the runoff calculations spreadsheet. The peak flow data generated using the rational method was used to verify street capacities and to size inlets and storm sewers within the subdivision. The drainage basin area, time of concentration, and rainfall intensity were determined for each of the sub-basins within the property. The onsite soils were assumed to be Hydrologic Soil Group B, based on the *Soil Survey* and the result of earth-moving operations. For existing conditions, runoff coefficients were determined using a land use of pasture/meadow. The land use for the proposed development will be residential with a density of approximately 4 lots per acre.

The onsite hydraulic structures were sized using the methods outlined in the *El Paso County Drainage Criteria Manual*. The hydraulic capacities of the streets and curb inlets were determined using the UD-Inlet spreadsheet developed by the UDFCD, considering the County criteria for the Minor (5-year) and Major (100-year) storms. Ramp curbs will be used throughout the development, except between curb returns, where a 6-inch vertical curb will be used. Hydraulic calculations are provided in Appendix C for the proposed streets, pipe outlet erosion protection and open channel capacities.

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 Appendix B of this report.

IV. DRAINAGE FACILITY DESIGN

The drainage of the site will be accomplished through a combination of sheet flow, gutter flow and a temporary outflow ditch flow. Curb inlets will not be needed with this filing. Riprap outlet protection will be placed at the end of the detention basin outlet pipe to reduce erosion, as well as at the outflow ditch to the sedimentation pond (See Map Exhibit Sheet 3 of 3).

The proposed drainage patterns for the site are shown on the Final Drainage Plan for the developed condition (Sheet 2 of 3) provided in the map pocket at the end of this report. The hydrologic and hydraulic calculations are provided in the Appendix, refer to the Drainage Design Criteria section for additional information on the hydrologic and hydraulic calculations.

The pond for this filing shall have the appropriate trickle channel to convey flows from the proposed lots and offsite flow to the micropool. Please label it on the drainage plan and provide the proposed trickle channel for this filing in the pond details

This is not reflected in the off-site drainage plan as storm sewers and inlets of future filings are shown. Revise accordingly.

The evaluation related to the sizing of the onsite drainage improvements were carried out in accordance with the County Storm Drainage Criteria Manual. The capacities of the proposed onsite facilities were calculated in accordance with the Criteria Manual.

Please label this on the construction drawings

The primary stormwater conveyance facility will be gutter conveyance to a temporary outflow ditch conveying the runoff to the detention basin. Offsite runoff will be conveyed from upstream tributary areas by means of a temporary slope basin and drain (See Off-Site Sheet 3 of 3).

The detention basin will include a sedimentation forebay at the temporary ditch outfall which conveyed flows via riprap-lined channel to a three-stage outlet structure.

Fully Developed conditions at Basin D will further incorporate a trickle channel, pond shaping, a perimeter maintenance trail, and inflow sedimentation forebays. concrete trickle channel, a micropool and water quality orifice plate onto an outlet structure, an emergency spillway and a maintenance access trail. This work is expected to be accomplished with future Glen at Widefield Filings. The detention basin will be a private facility and will be maintained by the Glen at Widefield Filing No. 10 Homeowner's Association.

"Basin D" in the previous paragraphs is used to describe the pond yet here it appears to describe sub-basin flows. Please clarify.

The following is a description of the on-site storm sewer system.

The system will begin with sheet flow at the lot areas. Some sheet flow will reach the sedimentation basin in historic fashion across unplatted and undeveloped land. However, most of the flows will begin as sheet flow on the lot areas and will be directed via overlot grades to existing and proposed street corridors. There are no inlets or pipes planned with this filing. Runoff will be directed to the intersection of Peaceful Valley Road and Pennycress Drive where it will flow to the south to a temporary outflow ditch which will convey Basin D flows to the Extended Detention Basin 'D'. The initially function as a sedimentation basin.

Per County Criteria the pond must be designed as full spectrum for this filing. The pond may be retrofitted as needed for future phases. Please revise accordingly.

The sedimentation basin will occupy the location of Future Extended Detention Basin 'D'. The sedimentation basin is proposed to accommodate water quality separation and emergency conveyance of flow associated with Filing 10. Under full-build-out conditions Filing 11 and additional future areas will also be directed to Basin D.

The storm sewer system will provide storage and will intercept 100-year flows. The captured flow will then be conveyed to the detention basin in a temporary outflow ditch.

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

As there are no storm sewers or inlets proposed with this filing please revise the description of this system.

Basin C

Sub-basins C-7, C-9, & C-18 are all partially located within Filing No. 10 but have been accounted for in the Glen at Widefield Filing No. 7 Drainage Report. Basins with a C designation are tributary to Extended Detention Basin C, and these basins are unchanged from their planned use.

Sub-basin C-7 is approximately 1.98 acres in area and is located north of Pennycress Drive and west of the Buffalo Bur Trail cul-de-sac. Runoff from this basin will sheet flow south, gutter flow south to Pennycress Drive at its high point, and gutter flow southeast along Pennycress Drive to its intersection with Alpine Daisy Drive, where it will combine with the carry-over flow from Sub-basin C-9 (DP 37).

Sub-basin C-9 is approximately 2.67 acres in area and is located south of Sub-basin C-8 and east of Alpine Daisy Drive. Runoff from this basin will sheet flow southwest, combine with runoff from Sub-basin C-8 and gutter flow south and southeast to an existing 10' curb inlet and downstream pipe system (DP 39).

Please identify this basin on the drainage plan

Please include in the narrative why water quality is not provided for this basin. Refer to ECM 1.7.1.B.6

Please identify this sub-basin on the drainage plan

Sub-basin C-18 is approximately 1.43 acres in area and is located east of Pennycress Drive, between Alpine Daisy Drive and the Buffalo Bur Trail cul-de-sac. Runoff from this basin will sheet flow west and gutter flow south from the high point in Pennycress Drive to Sub-basin C-19 (DP 51).

Basin E

The 'E' Basins are located around the perimeter of the site. Sub-basins E-1 through E-14 drain offsite to either the West Fork Jimmy Camp Creek, Mesa Ridge Parkway or the existing roadside ditch along Marksheffel Road.

Sub-Basins E-5 & E-6 are both partially located within Filing No 10, while Sub-Basin E-4 lies between Basin D and Marksheffel Road where it will intercept the storm outfall pipe for developed conditions (See Map 3 of 3). These basins abut existing Marksheffel Road and are historically tributary to the west-side ditch for the roadway. The surface slope is altered under development, but the overall characteristics of these basins is unchanged from historic conditions.

Sub-basin E-6 is approximately 4.30 acres in area and is located southeast of the site, between Sub-basins C-18, C-19 and C-20 and Marksheffel Road. Undeveloped runoff from this basin will sheet flow southeast to the existing roadside ditch along Marksheffel Road (DP 100) as it does currently.

Please identify the location of these basins on the drainage plan

Basin D

The 'D' Basins are located in the northeast portion of the site. The 'D' Basins (Sub-basins D-1 though D-23) are generally bounded by Sub-basin E-1 to the north, Buffalo Bur Trail to the south, the east property boundary to the east and the 'B' and 'C' Basins to the west. This area drains east and south to a low point at the Pennycress Drive and Golden Buffs Drive intersection. Future storm sewer systems are proposed along Pennycress Drive and Golden Buffs Drive that will convey captured flow to 100-year capacity curb inlets in a sump condition at DP 79, DP 81, DP 89 and DP 93, and ultimately to proposed Detention Basin 'D' (DP 94) located to the west of Pennycress Drive. Runoff from Sub-basins D-21 and D-22 will be captured in new curb & gutter of Pennycress Drive, and conveyed to Detention Basin 'D' from the south via a temporary outflow ditch. Detained flow released from Detention Basin 'D' will be conveyed to the existing roadside ditch along Marksheffel Road.

Please state whether this roadside ditch is adequate to handle the developed flow from this filing. Was flow from this site accounted for in the development of the Marksheffel roadside ditch? Please address in the narrative.

WATER QUALITY

Storm water quality measures are required by the County in Volume 2 of the Drainage Criteria Manual. The water quality measures to be instituted [illegible] will include:

1. Water quality enhancement of the detention basin. Basin D will operate as a temporary sedimentation basin prior to construction of the Extended Detention Basin.
2. The outlet structure will include a water quality orifice plate and a [illegible]

A. COST OF PROPOSED DRAINAGE FACILITIES

Table 2 presents a cost estimate for the construction of drainage improvements (private) for The Glen at Widefield Filing No. 10 development.

B. DRAINAGE AND BRIDGE FEES

The site lies within the West Fork Jimmy Camp Creek Drainage Basin. The current drainage basin fee associated with the West Fork Jimmy Camp Creek Drainage Basin is $12,564 per impervious acre. The current bridge fee associated with the West Fork Jimmy Camp Creek Drainage Basin is $3,717 per impervious acre. The Glen at Widefield Filing No. 10 subdivision encompasses 10.47 acres. *Table 1* details the fees due as part of this development.

Please include a description of the drainage of the other "D" basins that are in this filing. Please identify the design points that the "D" basins in this filing are contributing to.

Please also address how the flows will ultimately be conveyed to detention pond D when the future extension of Pennycress Drive is developed.

V. CONCLUSIONS

The Glen at Widefield Filing No. 10 will be a single-lot family residential subdivision covering approximately 10.47 acres. Onsite drainage will include the use of surface conveyance elements such as gutter, crosspan, and a temporary outflow ditch to route the runoff from the site to two separate detention basins; basin C (Filing 7) and basin d (future Filing 11). Basin D serves Filing 10 along with northern tributary areas including future Filings 11 and 12. Detained runoff from the site will be conveyed to the West Fork Jimmy Camp Creek. With detention serving the site and a large portion of either side of the creek not developed, the development of the Glen at Widefield Filing No. 10 property will not adversely impact or deteriorate improvements or natural drainageways downstream of the property.

VI. REFERENCES

1) Preliminary Drainage Report, The Glen at Widefield East, prepared by Kiowa Engineering Corporation, dated December 16, 2015.

2) Final Drainage Report, The Glen at Widefield Filing No. 7, prepared by Kiowa Engineering Corporation, dated January 11, 2016.

3) Amended Master Development Drainage Plan, The Glen at Widefield, prepared by Kiowa Engineering Corporation, dated June 21, 2007.

4) Final Drainage Report, The Glen at Widefield Filing No. 6, prepared by Kiowa Engineering Corporation, dated December 6, 2007.

5) Preliminary and Final Drainage Report, Mesa Ridge Parkway Final Design, prepared by Kiowa Engineering Corporation, dated November 29, 2010.

6) Mesa Ridge Parkway Roadway Design, Autumn Glen Avenue to Marksheffel Road and Widening from Powers Boulevard to Autumn Glen Avenue, prepared by Kiowa Engineering Corporation, dated December 8, 2010.

7) Master Development Drainage Plan for the Glen at Widefield, prepared by Kiowa Engineering Corporation, dated December 10, 1999.

8) West Fork Jimmy Camp Creek Drainage Basin Planning Study, prepared by Kiowa Engineering Corporation, dated October 17, 2003.

9) City of Colorado Springs and El Paso County Flood Insurance Study, prepared by the Federal Emergency Management Agency, dated March 1997.

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

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

12) Final Drainage Report Marksheffel Road South - Link Road to US-24, El Paso County, CO, HDR Engineering, August 2015.

APPENDIX TABLE OF CONTENTS

APPENDIX

Figure 1: Vicinity Map

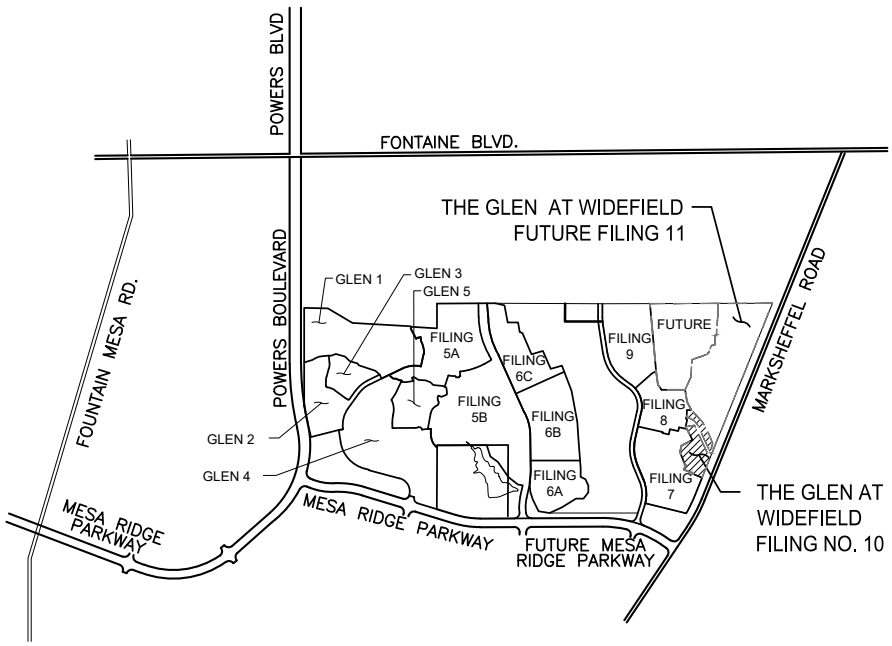
Figure 2: Soils Map

FEMA Flood Insurance Rate Map (Panels 956 and 957)

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

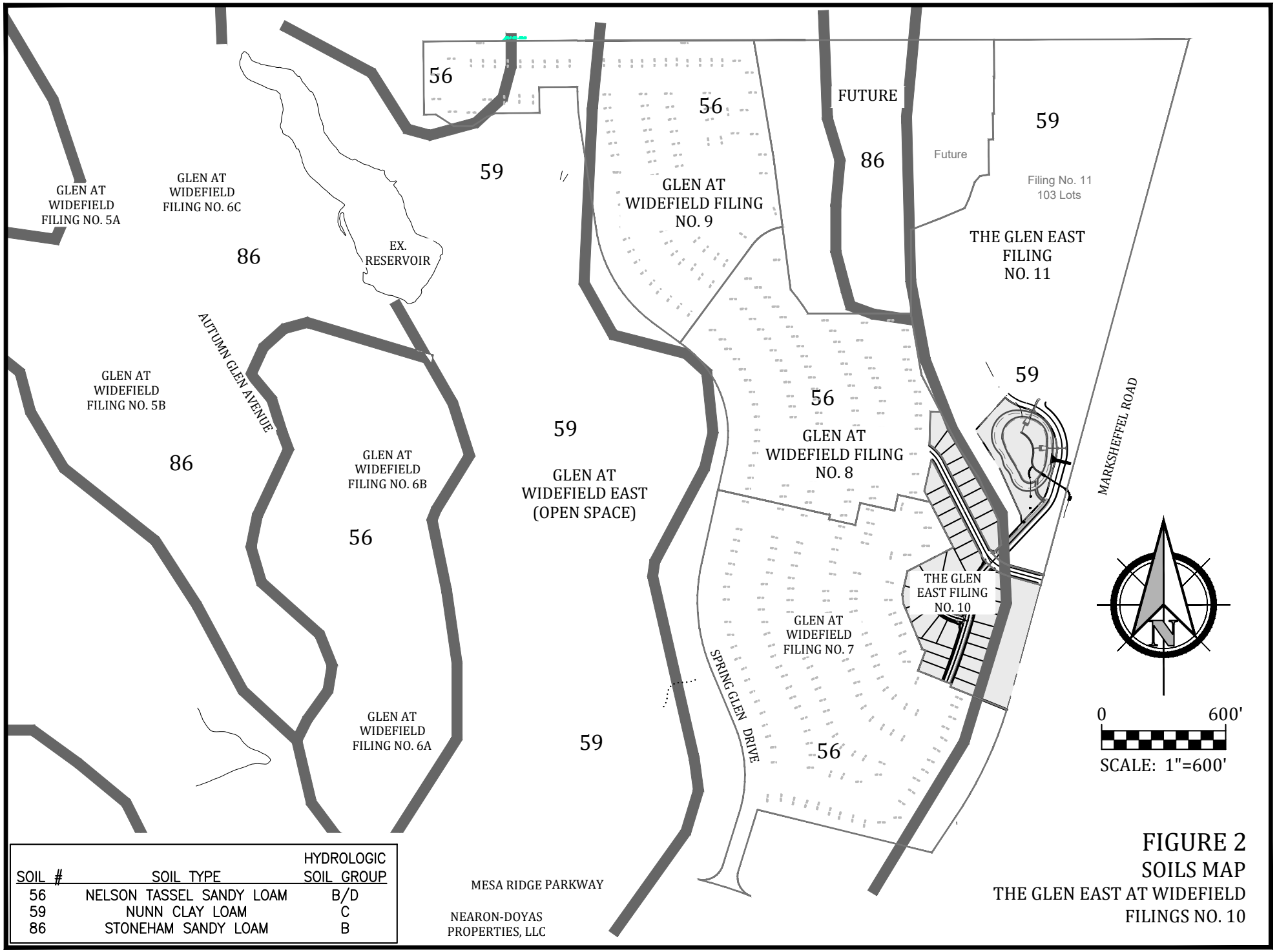
Table 2: Opinion of Cost – Drainage Facilities

SCALE: NTS



VICINITY MAP
SCALE: N.T.S.

FIGURE 1
VICINITY MAP
THE GLEN AT WIDEFIELD FILING NO. 10



SOIL #	SOIL TYPE	HYDROLOGIC SOIL GROUP
56	NELSON TASSEL SANDY LOAM	B/D
59	NUNN CLAY LOAM	C
86	STONEHAM SANDY LOAM	B

FIGURE 2
SOILS MAP
THE GLEN EAST AT WIDEFIELD FILINGS NO. 10

National Flood Hazard Layer FIRMette

FEMA

Legend

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

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

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

OTHER AREAS
- NO SCREEN — Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- 20.2 / 17.5 — Cross Sections with 1% Annual Chance Water Surface Elevation
- Coastal Transect
- 513 — Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

N

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

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

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 9/26/2019 at 12:16:52 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

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

Glen at Widefield Filing No. 10
Drainage Basin and Bridge Fees

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

Total Lots =	40 lots
Total Development Area =	10.470 ac
Total Undeveloped Acres =	2.125 ac
Total Developed Area =	**8.3 ac**
Building/Patio/Drive Per Lot =	2,500 sf
Total Building/Patio/Drive Area =	2.296 ac
Total Street/Sidewalk Area =	1.000 ac
Total Impervious Area =	3.296 ac
% Impervious Area =	**39.49 %**

West Fork Jimmy Camp Creek Drainage Basin

Drainage Basin Fee and Bridge Fee Calculations			
Drainage Basin Fee =	$12,564 / ac	**Drainage Basin Fee =**	**$ 41,406.98**
Bridge Fee =	$3,717 / ac	**Bridge Fee =**	**$ 12,250.06**

Less Previous Drainage Fee Credit (Carry Over from Glen at Widefield Filing No. 7)	**$0.00**	$ 0.00
Drainage Basin Fee Reimbursement	**$0.00**	
Total Drainage Basin Fee Credit Available	**$0.00**	

	Drainage Basin	**Bridge**
Total Fees Due for the Glen at Widefield Filing No. 10	**$41,406.98**	**$ 12,250.06**

Table 2: Opinion of Cost - Public Drainage Facilities

Item	Quantity	Unit	Unit Cost	**Item Total**
Drainage Structures				
Reinforced Concrete Pipe (RCP)	0	LF	$ 0.00	$ 0.00
18" Reinforced Concrete Pipe	114	LF	$ 69.00	$ 7,866.00
Flared End Section (FES) RCP 18"	1	EA	$ 900.00	$ 900.00
Geotextile (Erosion Control)	266	SY	$ 6.00	$ 1,596.00
Rip Rap, d50 Size from 6" to 24"	22	CY	$ 95.00	$ 2,090.00
Channel Lining, Rip Rap	16	CY	$ 112.00	$ 1,792.00
Detention Outlet Structure	1	EA	$ 12,000.00	$ 12,000.00
Detention Emergency Spillway	1	EA	$ 18,300.00	$ 18,300.00
Presedimentation Forebay	1	EA	$ 7,000.00	$ 7,000.00
Gravel Maintenance Access Trail	1,055	SY	$ 20.00	$ 21,100.00
Type II Bedding	28	CY	$ 35.00	$ 980.00
Detention Basin Seeding and Mulch	3	AC	$ 520.00	$ 1,528.80
			Estimated Storm Drainage Facilities Cost	**$ 82,182.80**
			Engineering 10%	$ 8,218.28
			Contingency 5%	$ 4,109.14
			Total Estimated Cost	**$ 94,510.22**

The RCP shown in the CD's is 24". Please revise.

The CD's indicates 123 ft.

APPENDIX A

Hydrologic Calculations

Existing Condition – Runoff Co-eff, Time of Concentration and Runoff Calcs
Excerpts from Markscheffel Road Improvements Project South - Link Road to US-24
Developed Condition – Runoff Co-eff, Time of Concentration and Runoff Calcs

KIOWA ENGINEERING CORPORATION

JOB 14044 - GLEN AT WIDEFIELD EAST

SHEET NO. 1 OF 2

CALCULATED BY CJC DATE 4/24/15

CHECKED BY _____ DATE _____

SCALE _____

RUNOFF COEFF. CALC'S. – EXISTING CONDITION

USE UNDEVELOPED - "PASTURE/MEADOW" LAND USE :

B SOILS -	$C_5 = 0.08$	$C_{100} = 0.35$	
B/D SOILS -	$C_5 = 0.15$	$C_{100} = 0.50$	(ASSUME C/D SOILS)
C SOILS -	$C_5 = 0.15$	$C_{100} = 0.50$	

BASIN EX-1 : TYPE C AND B/D SOILS

AREA = 48.60 Ac (AREAS FROM CAD, TYP.)

$C_5 = 0.15$

$C_{100} = 0.50$

BASIN EX-2 : TYPE C AND B/D SOILS

AREA = 33.12 Ac

$C_5 = 0.15$

$C_{100} = 0.50$

BASIN EX-3 : TYPE C AND B/D SOILS

AREA = 61.01 Ac

$C_5 = 0.15$

$C_{100} = 0.50$

BASIN EX-4 : TYPE C AND B/D SOILS

AREA = 10.51 Ac

$C_5 = 0.15$

$C_{100} = 0.50$

BASIN EX-5 : TYPE B SOIL – 12.2 Ac ± } FROM SOILS MAP
TYPE C SOIL – 39.3 Ac ± } FROM SOILS MAP
TYPE B/D SOIL – 23.2 Ac ± } FROM SOILS MAP

AREA = 74.74 Ac

$$C_{5,WTD} = \frac{0.08(12.2) + 0.15(39.3 + 23.2)}{74.74} = 0.14$$

$$C_{100,WTD} = \frac{0.35(12.2) + 0.50(39.3 + 23.2)}{74.74} = 0.48$$

KIOWA ENGINEERING CORPORATION

JOB 14044 - GLEN AT WIDEFIELD EAST

SHEET NO. 2 OF 2

CALCULATED BY CJC DATE 4/24/15

CHECKED BY _____ DATE _____

SCALE _____

BASIN EX-6 : TYPE C AND B/D SOILS

AREA = 8.83 AC

C_5 = 0.15

C_{100} = 0.50

TIME OF CONCENTRATION CALC'S. – EXISTING CONDITION

BASIN OS-1 : FROM MDDP, NEC-1 MODEL INPUT : BASIN 3060

BASIN AREA (BA) = 0.119 SQ.MI. × 640 = 76.2 AC

SCS CURVE NO. (LS) = 79

SCS LAG TIME (UD) = 0.257 HRS. = 0.6 t_c

t_c = 1.6 (0.257)(60 MIN/HR) = 24.7 MIN.

BASIN OS-2 : BA = 0.19 SQ.MI. × 640 = 121.6 AC (BASIN 4010)

LS = 86

UD = 0.497 HRS.

t_c = 1.6 (0.497)(60) = 47.7 MIN.

The Glen at Widefield
Existing Condition
Runoff Coefficient and Percent Impervious Calculation

Basin / DP	Basin or DP Area (DP contributing basins)		Soil Type	PV	Area 1 Land Use			HI	Area 2 Land Use			US1	Area 3 Land Use			US2	Area 4 Land Use			RO	Area 5 Land Use			Basin % Imperv	Basin Runoff	
				% Imperv	Land Use Area	% Area	Comp Land Use % Imp	% Imperv	Land Use Area	% Area	Comp Land Use % Imp	% Imperv	Land Use Area	% Area	Comp Land Use % Imp	% Imperv	Land Use Area	% Area	Comp Land Use % Imp	% Imperv	Land Use Area	% Area	Comp Land Use % Imp		C_5	C_{100}
EX-1	2,117,068 sf	48.60ac	C	100%		0%	0%	0%	48.60ac	100%	0%	85%		0%	0%	78%		0%	0%	90%		0%	0%	**0.0%**	**0.15**	**0.50**
EX-2	1,442,826 sf	33.12ac	C	100%		0%	0%	0%	33.12ac	100%	0%	85%		0%	0%	78%		0%	0%	90%		0%	0%	**0.0%**	**0.15**	**0.50**
EX-3	2,657,513 sf	61.01ac	C	100%		0%	0%	0%	61.01ac	100%	0%	85%		0%	0%	78%		0%	0%	90%		0%	0%	**0.0%**	**0.15**	**0.50**
EX-4	457,877 sf	10.51ac	C	100%		0%	0%	0%	10.51ac	100%	0%	85%		0%	0%	78%		0%	0%	90%		0%	0%	**0.0%**	**0.15**	**0.50**
EX-5	3,255,509 sf	74.74ac	C	100%		0%	0%	0%	74.74ac	100%	0%	85%		0%	0%	78%		0%	0%	90%		0%	0%	**0.0%**	**0.14**	**0.48**
EX-6	384,815 sf	8.83ac	C	100%		0%	0%	0%	8.83ac	100%	0%	85%		0%	0%	78%		0%	0%	90%		0%	0%	**0.0%**	**0.15**	**0.50**

Basin Runoff Coefficient is based on UDFCD % Imperviousness Calculation

Runoff Coefficients and Percents Impervious

Hydrologic Soil Type:	**C**		**Runoff Coef Calc Method**					%Imp
Land Use	Abb	%	C_2	C_5	C_{10}	C_{25}	C_{50}	C_{100}
Commercial Area	CO	95%	0.80	0.82	0.84	0.87	0.89	0.89
Drives and Walks	DR	90%	0.73	0.75	0.77	0.80	0.83	0.83
Streets - Gravel (Packed)	GR	40%	0.28	0.35	0.42	0.50	0.55	0.58
Undevelop-Pasture/Meadow	HI	0%	0.04	0.15	0.25	0.37	0.44	0.50
Lawns	LA	0%	0.04	0.15	0.25	0.37	0.44	0.50
Off-site flow-Undeveloped	OF	45%	0.31	0.37	0.44	0.51	0.56	0.59
Park	PA	7%	0.09	0.19	0.29	0.40	0.47	0.52
Playground	PL	13%	0.13	0.23	0.32	0.42	0.49	0.54
Streets - Paved	PV	100%	0.89	0.90	0.92	0.94	0.96	0.96
Roofs	RO	90%	0.73	0.75	0.77	0.80	0.83	0.83
User Input 1	US1	85%	0.66	0.68	0.71	0.75	0.78	0.79
User Input 2	US2	78%	0.57	0.60	0.64	0.68	0.72	0.73

Weighted %Imp

A
B
C
D

Equations (% Impervious Calculation):

$C_A = K_A + (1.31\, i^3 - 1.44\, i^2 + 1.135\, i - 0.12)$ [Eqn RO-6]

$C_{CD} = K_{CD} + (0.858\, i^3 - 0.786\, i^2 + 0.774\, i + 0.04)$ [Eqn RO-7]

$C_B = (C_A + C_{CD}) / 2$

I = % imperviousness/100 as a decimal (See Table RO-3)

C_A = Runoff coefficient for NRCS Type A Soils

C_B = Runoff coefficient for NRCS Type B Soils

C_{CD} = Runoff coefficient for NRCS Type C and D Soils

Correction Factors - Table RO-4

K_A = For Type A Soils

K_A (2-yr)= 0

K_A (5-yr)= -0.08i + 0.09

K_A (10-yr)= -0.14i + 0.17

K_A (25-yr)= -0.19i + 0.24

K_A (50-yr)= -0.22i + 0.28

K_A (100-yr)= -0.25i + 0.32

K_{CD}=For Type C & D Soils

K_{CD} (2-yr)= 0

K_{CD} (5-yr)= -0.10i + 0.11

K_{CD} (10-yr)= -0.18i + 0.21

K_{CD} (25-yr)= -0.28i + 0.33

K_{CD} (50-yr)= -0.33i + 0.40

K_{CD} (100-yr)= -0.39i + 0.46

The Glen at Widefield
Existing Condition
Time of Concentration Calculation

Sub-Basin Data				Time of Concentration Estimate										Final t_c	Notes
Basin / Design Point	Contributing Basins	Area	C_5	Initial/Overland Time (t_i)			Travel Time (t_t)						Comp.		
				Length	Slope	t_i	Length	Slope	Land Type	Cv	Velocity	t_t	t_c		
EX-1		48.60ac	0.15	300lf	5.3%	17.3 min.	2200lf	1.9%	GW	15	2.1 ft/sec	17.7 min.	35.0 min.	**35.0 min.**	
EX-2		33.12ac	0.15	300lf	4.8%	17.9 min.	1370lf	3.2%	GW	15	2.7 ft/sec	8.5 min.	26.4 min.	**26.4 min.**	
EX-3		61.01ac	0.15			0.0 min.	2500lf	0.9%	GW	15	1.4 ft/sec	29.3 min.	29.3 min.	**29.3 min.**	
EX-4		10.51ac	0.15	300lf	4.0%	19.0 min.	900lf	4.9%	GW	15	3.3 ft/sec	4.5 min.	23.5 min.	**23.5 min.**	
EX-5		74.74ac	0.14	300lf	5.7%	17.0 min.	3250lf	1.0%	GW	15	1.5 ft/sec	36.1 min.	53.2 min.	**53.2 min.**	
EX-6		8.83ac	0.15	150lf	0.5%	26.8 min.	630lf	5.5%	GW	15	3.5 ft/sec	3.0 min.	29.8 min.	**29.8 min.**	
DP 1	OS-1	76.20ac	--	--	--	--	--	--		--	--	--	24.7 min.	**24.7 min.**	DP 3060 from MDDP
DP 2	OS-1, EX-1	124.80ac	0.15			0.0 min.	1000lf	1.0%	GW	15	1.5 ft/sec	11.1 min.	11.1 min.	**35.8 min.**	DP 1 routed to DP 2
DP 3	EX-2	33.12ac	0.15	300lf	4.8%	17.9 min.	1370lf	3.2%	GW	15	2.7 ft/sec	8.5 min.	26.4 min.	**26.4 min.**	
DP 4	OS-1, EX-1, EX-2	157.92ac	0.15			0.0 min.	300lf	0.5%	GW	15	1.1 ft/sec	4.7 min.	5.0 min.	**40.8 min.**	DP 2 and DP 3 routed to DP 4
DP 5	OS-1, EX-1, EX-2, EX-3	218.93ac	0.15			0.0 min.	800lf	1.3%	GW	15	1.7 ft/sec	7.8 min.	7.8 min.	**48.6 min.**	DP 4 routed to DP 5
DP 6	EX-4	10.51ac	0.15	300lf	4.0%	19.0 min.	900lf	4.9%	GW	15	3.3 ft/sec	4.5 min.	23.5 min.	**23.5 min.**	
DP 7	OS-1, EX-1, EX-2, EX-3, EX-4	229.44ac	0.15			0.0 min.	200lf	0.3%	GW	15	0.8 ft/sec	4.1 min.	5.0 min.	**53.6 min.**	DP 5 and DP 6 routed to DP 7
DP 8	OS-2	121.60ac	--	--	--	--	--	--		--	--	--	47.7 min.	**47.7 min.**	DP 4011 from MDDP
DP 9	OS-2, EX-5	196.34ac	0.15			0.0 min.	1550lf	0.6%	GW	15	1.1 ft/sec	23.2 min.	23.2 min.	**70.9 min.**	DP 8 routed to DP 9
DP 10	EX-6	8.83ac	0.15	150lf	0.5%	26.8 min.	630lf	5.5%	GW	15	3.5 ft/sec	3.0 min.	29.8 min.	**29.8 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)

Land Surface Type	Land Type
Grassed Waterway	GW
Heavy Meadow	HM
Nearly Bare Ground	NBG
Paved Area	PV
Riprap (Not Buried)	RR
Short Pasture/Lawns	SP
Tillage/Fields	TF

The Glen at Widefield
Existing Condition
Runoff Calculation

Basin / Design Point	Contributing Basins	Drainage Area	C_5	C_{100}	Time of Concentration	Rainfall Intensity i_5	Rainfall Intensity i_{100}	**Runoff Q_5**	**Runoff Q_{100}**	**Basin / DP**	Notes
EX-1		48.60 ac	0.15	0.50	35.0 min.	2.2 in/hr	3.8 in/hr	**16.4 cfs**	**91.7 cfs**	EX-1	
EX-2		33.12 ac	0.15	0.50	26.4 min.	2.7 in/hr	4.5 in/hr	**13.3 cfs**	**74.3 cfs**	EX-2	
EX-3		61.01 ac	0.15	0.50	29.3 min.	2.5 in/hr	4.2 in/hr	**23.0 cfs**	**128.9 cfs**	EX-3	
EX-4		10.51 ac	0.15	0.50	23.5 min.	2.8 in/hr	4.8 in/hr	**4.5 cfs**	**25.1 cfs**	EX-4	
EX-5		74.74 ac	0.14	0.48	53.2 min.	1.6 in/hr	2.7 in/hr	**17.0 cfs**	**97.7 cfs**	EX-5	
EX-6		8.83 ac	0.15	0.50	29.8 min.	2.5 in/hr	4.2 in/hr	**3.3 cfs**	**18.5 cfs**	EX-6	
DP 1	OS-1	76.20 ac	--	--	24.7 min.	2.8 in/hr	4.7 in/hr	**48 cfs**	**163 cfs**	DP 1	DP 3060 from MDDP
DP 2	OS-1, EX-1	124.80 ac	0.15	0.50	35.8 min.	2.2 in/hr	3.7 in/hr	**41 cfs**	**232 cfs**	DP 2	
DP 3	EX-2	33.12 ac	0.15	0.50	26.4 min.	2.7 in/hr	4.5 in/hr	**13 cfs**	**74 cfs**	DP 3	
DP 4	OS-1, EX-1, EX-2	157.92 ac	0.15	0.50	40.8 min.	2.0 in/hr	3.4 in/hr	**48 cfs**	**268 cfs**	DP 4	
DP 5	OS-1, EX-1, EX-2, EX-3	218.93 ac	0.15	0.50	48.6 min.	1.8 in/hr	2.9 in/hr	**58 cfs**	**323 cfs**	DP 5	
DP 6	EX-4	10.51 ac	0.15	0.50	23.5 min.	2.8 in/hr	4.8 in/hr	**4 cfs**	**25 cfs**	DP 6	
DP 7	OS-1, EX-1, EX-2, EX-3, EX-4	229.44 ac	0.15	0.50	53.6 min.	1.6 in/hr	2.7 in/hr	**55 cfs**	**310 cfs**	DP 7	
DP 8	OS-2	121.60 ac	--	--	47.7 min.	1.8 in/hr	3.0 in/hr	**38 cfs**	**153 cfs**	DP 8	DP 4011 from MDDP
DP 9	OS-2, EX-5	196.34 ac	0.15	0.50	70.9 min.	1.2 in/hr	2.0 in/hr	**35 cfs**	**196 cfs**	DP 9	
DP 10	EX-6	8.83 ac	0.15	0.50	29.8 min.	2.5 in/hr	4.2 in/hr	**3 cfs**	**18 cfs**	DP 10	

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_{25}=-2.00 ln(T_c) + 10.111

i_{50}=-2.25 ln(T_c) + 11.375

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

P1	Inches
WQCV	0.60 in
2 yr	1.19 in
5 yr	1.50 in
10 yr	1.75 in
25 yr	2.00 in
50 yr	2.25 in
100 yr	2.52 in

KIOWA ENGINEERING CORPORATION

JOB 14044 - GLEN AT WIDEFIELD EAST

SHEET NO. 1 OF 2

CALCULATED BY CJC DATE 5/19/15

CHECKED BY _____ DATE _____

SCALE _____

RUNOFF COEFFICIENT CALC'S. - DEVELOPED CONDITION (RESIDENTIAL AREAS)

A-BASINS: A = 10.17 AC. / 33 LOTS > 3.24 LOTS/AC.

A = 7.98 AC. / 30 LOTS > 3.76 LOTS/AC.

> 3.5 LOTS/AC.

BY INTERPOLATING FROM TABLE 6-6, I = 35%

⇨ C_5 = 0.33

C_{100} = 0.57

> SOIL GROUP C

B-BASINS: A = 20.05 AC. / 81 LOTS > 4.04 LOTS/AC.

A = 6.86 AC. / 30 LOTS > 4.37 LOTS/AC.

> 4.2 LOTS/AC.

FROM TABLE 6-6, I = 41%

⇨ C_5 = 0.35

C_{100} = 0.58

> SOIL GROUP C

C-BASINS: A = 46.12 AC. / 200 LOTS > 4.34 LOTS/AC.

A = 35.29 AC. / 148 LOTS > 4.19 LOTS/AC.

> 4.3 LOTS/AC.

FROM TABLE 6-6, I = 42%

⇨ C_5 = 0.31

C_{100} = 0.50

> SOIL GROUP B

KIOWA ENGINEERING CORPORATION

JOB 14044 - GLEN AT WIDEFIELD EAST

SHEET NO. 2 OF 2

CALCULATED BY CJC DATE 5/19/15

CHECKED BY _____ DATE _____

SCALE _____

RUNOFF COEFFICIENT CALC'S. - DEVELOPED CONDITION (CONT'D.):

(RESIDENTIAL AREAS)

D- BASINS: A = 38.97 AC. / 147 LOTS > 3.77 LOTS/AC.

A = 3.52 AC. / 13 LOTS > 3.69 LOTS/AC.

> 3.7 LOTS/AC.

FROM TABLE 6-6, I = 37%

⇒ C_5 = 0.34

C_{100} = 0.58

> SOIL GROUP C

E- BASINS: A = 2.81 AC. / 7 LOTS > 2.49 LOTS/AC.

A = 1.6 AC. / 4 LOTS > 2.5 LOTS/AC.

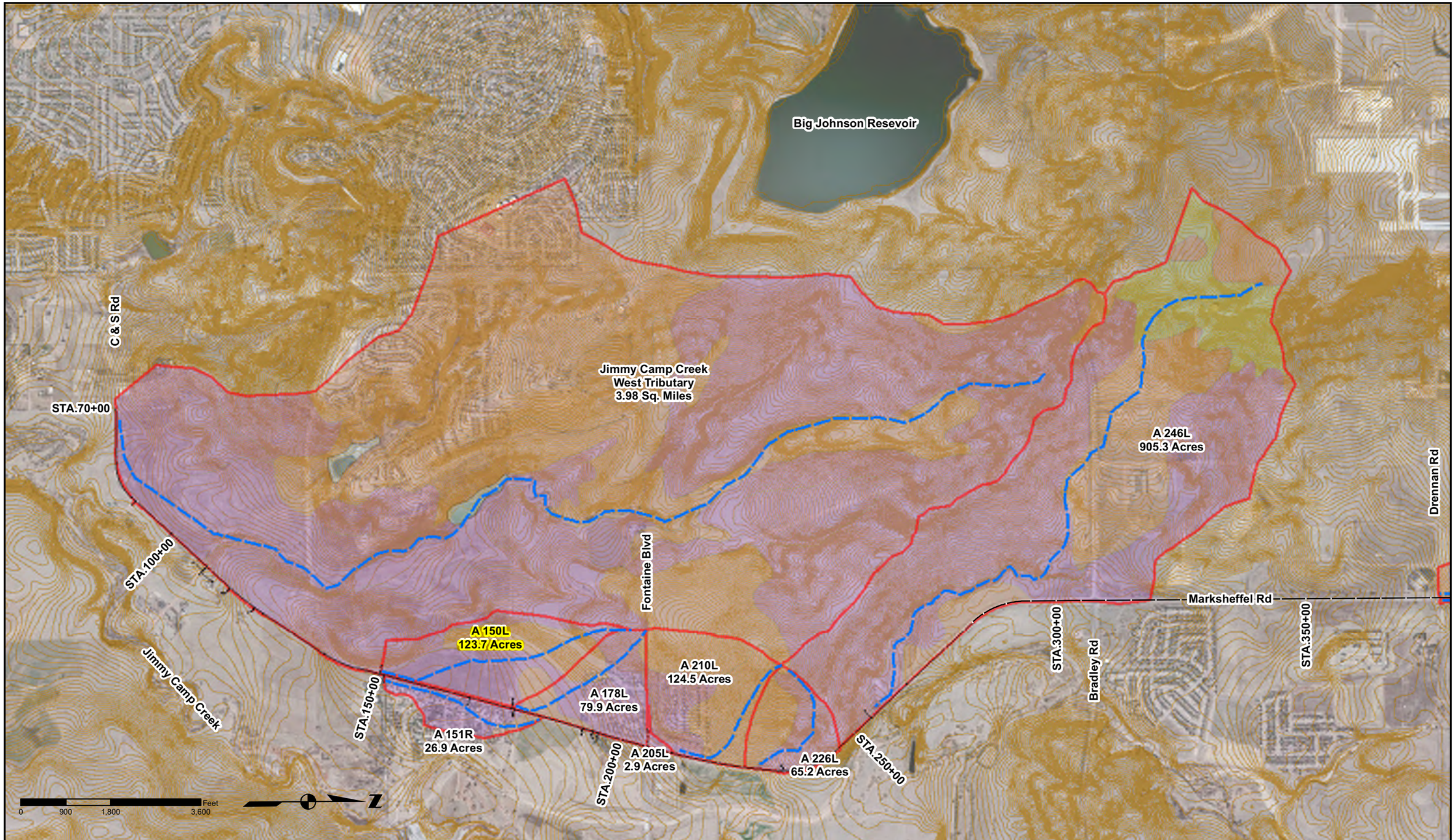
> 2.5 LOTS/AC.

FROM TABLE 6-6, I = 28%

⇒ C_5 = 0.30

C_{100} = 0.56

> SOIL GROUP C



Print Date:	10/14/2014
File Name:	Basins_BL_20141009.mxd
Horiz. Scale:	Vert. Scale: None
Unit Information	Unit Leader Initials

HDR Engineering, Inc.

PARSONS BRINCKERHOFF

Basin Boundary
Flowpath
Water
Hydrologic Soils Group A
Hydrologic Soils Group B
Hydrologic Soils Group C
Hydrologic Soils Group D

EL PASO COUNTY
COLORADO

PPRTA

As Constructed	
No Revisions:	
Revised:	
Void:	

MARKSHEFFEL ROAD DRAINAGE BASIN

Designer:	E. Staten	Structure Numbers	
Detailer:	M.Johnson		
Sheet Subset:	BASIN	Subset Sheets:	1 of 3

Project No./Code	
Sheet Number	1

LEGEND

A# / Area C5 C100 — BASIN LABEL

OFFSITE BASIN BOUNDARY

PAVEMENT BASIN BOUNDARY

FLOW DIRECTION

BASIN 'A 150 L'

OFFSITE BASIN
150L
A=123.50 AC

PERMANENT EASEMENT

TRAPEZOIDAL CHANNEL

PROPOSED ROW

EXISTING ROW

HCL MARKSHEFFEL ROAD

MARKSHEFFEL ROAD

EXISTING ROW

MATCH LINE STA. 154+00.00

MATCH LINE STA. 168+00.00

155+00

160+00

165+00

152L
2.49 0.90 0.95

152R
2.53 0.90 0.95

5675

5680

DENSE WEEDS

BLUE GRASS PL

OFFSITE BASIN
151R
A=23.88 AC

SAND TRAP DR

BENT GRASS PL

0' 50' 100' 200'

Print Date: 4/2/2015		Sheet Revisions			As Constructed
File Name: North-Marksheffel_BASINS_Plan007.dgn		Date:	Comments	Init.	No Revisions:
Horiz. Scale: 1:100 Vert. Scale: As Noted					Revised:
Unit Information Unit Leader Initials					Void:
PARSONS BRINCKERHOFF					

EL PASO COUNTY COLORADO

PPRTA

MARKSHEFFEL ROAD
DRAINAGE BASINS PLAN
154+00.00 TO 168+00.00

Designer: E. STATEN
Detailer: D. MADDOCK
Sheet Subset: BASINS
Structure Numbers
Subset Sheets: 7 of 36

Project No./Code
....
....
7

saacosta 9:13:55 AM c:\pwworking\oma\d12666573\North-Marksheffel_BASINS_Plan007.dgn

Standard Form SF-1 . Time of Concentration

Corridor / Design Package: Marksheffel
System Name: South

Computed: MAJ Date: 6/28/2014
Checked: EVS Date: 6/30/2014

SUB-BASIN DATA				INITIAL/OVERLAND FLOW (t_i)			TRAVEL TIME (t_t)							Total
									Type of Land Surface					
Basin ID	Description	C_5	Area (ac)	Length (ft)	Slope (ft/ft)	t_i (min)	Length (ft)	S_w (ft/ft)	Code	Description	Convey Coef (C_v)	Velocity (ft/s)	Travel Time (min)	$t_c = t_i + t_t$ (min)
ZONE 3														
A 256L	Sta 256+30 to 264+29	0.90	0.77	57	0.05263	1.63	190	0.0090	5	Grassed waterway	15.00	1.42	2.23	5.00
A 256R	Sta 256+30 to 264+30	0.90	0.77	63	0.06349	1.61	190	0.0090	5	Grassed waterway	15.00	1.42	2.23	5.00
A 247L	Sta. 246+00 to 256+30	0.90	0.96	56	0.07143	1.46	1020	0.0199	5	Grassed waterway	15.00	2.11	8.04	9.50
A 246R	Sta. 246+00 to 256+30	0.90	1.01	56	0.07143	1.46	1020	0.0199	5	Grassed waterway	15.00	2.11	8.04	9.50
A 246L	Sta 246+00 to No Work Zone	0.25	905.26	300	0.01667	23.23	9985	0.00951	3	Short pasture and lawns	7.00	0.68	243.73	266.96
A 229R	Sta. 229+00 to 232+00	0.90	0.31	56	0.05357	1.61	300	0.00953	5	Grassed waterway	15.00	1.46	3.41	5.02
A 226L	Sta. 226+00 to 246+00	0.28	65.23	300	0.03667	17.31	2440	0.02254	3	Short pasture and lawns	7.00	1.05	38.69	56.00
A 212L	Sta. 212+00 to 229+00	0.90	1.55	61	0.06557	1.57	1640	0.0083	5	Grassed waterway	15.00	1.37	20.00	21.57
A 212R	Sta. 212+00 to 229+00	0.90	1.55	57	0.07018	1.48	1640	0.0083	5	Grassed waterway	15.00	1.37	20.00	21.49
A 210L	Sta. 210+60 to 226+00	0.31	124.50	300	0.02667	18.43	2868	0.0258	5	Grassed waterway	15.00	2.41	19.84	38.27
A 210L_S1	Sta. 212+00 to 229+00	0.31	56.88	300	0.02667	18.51	2868	0.0258	5	Grassed waterway	15.00	2.41	19.84	38.34
A 208R	Sta. 207+60 to 212+00	0.90	0.44	57	0.07018	1.48	453	0.01044	5	Grassed waterway	15.00	1.53	4.93	6.41
A 206L	Sta. 205+00 to 212+00	0.90	0.74	61	0.06557	1.57	660	0.01045	5	Grassed waterway	15.00	1.53	7.17	8.74
A 205L	Sta 205+00 to 210+60	0.25	2.87	100	0.01	15.90	550	0.00364	5	Grassed waterway	15.00	0.90	10.13	26.03
A 178L	Sta. 179+00 to 205+00	0.34	79.92	300	0.01667	20.79	2880	0.01181	3	Short pasture and lawns	7.00	0.76	63.11	83.90
A 178R	Sta. 178+00 to 207+00	0.90	3.32	54	0.07407	1.42	2865	0.00999	5	Grassed waterway	15.00	1.50	31.86	33.27
A 152L	Sta. 152+00 to 178+00	0.90	2.49	53	0.0566	1.54	2600	0.00527	5	Grassed waterway	15.00	1.09	39.80	41.33
A 152R	Sta. 152+00 to 178+00	0.90	2.53	54	0.05556	1.56	2610	0.00523	5	Grassed waterway	15.00	1.09	40.09	41.65
A 151R	Sta. 152+00 to 170+50	0.42	39.34	300	0.01	22.03	2978	0.00168	5	Grassed waterway	15.00	0.61	80.75	102.78
A 150L	Sta. 150+00 to 179+00	0.25	123.68	300	0.02	21.88	4718	0.00763	3	Short pasture and lawns	7.00	0.61	128.60	150.48
A 148L	Sta. 148+00 to 152+00	0.90	0.41	54	0.05556	1.56	400	0.00183	5	Grassed waterway	15.00	0.64	10.40	11.96
A 148R	Sta. 147+80 to 152+00	0.90	0.55	55	0.07273	1.44	470	0.00145	5	Grassed waterway	15.00	0.57	13.73	15.17
ZONE 4														
A 125R	Sta. 124+50 to 137+50	0.90	1.08	44	0.09091	1.20	1285	0.00987	5	Grassed waterway	15.00	1.49	14.37	15.57
A 103L	Sta. 103+00 to148+00	0.90	4.65	100	0.06	2.07	4386	0.00876	5	Grassed waterway	15.00	1.40	52.06	54.13
A 103R	Sta. 100+00 to 114+00	0.90	0.57	37	0.08108	1.14	1090	0.00758	5	Grassed waterway	15.00	1.31	13.91	15.05
A 92L	Sta. 92+00 to 103+00	0.90	0.53	36	0.11111	1.01	1143	0.00725	5	Grassed waterway	15.00	1.28	14.91	15.93
A 92R	Sta. 92+00 to 103+00	0.90	0.58	36	0.11111	1.01	1150	0.0071	5	Grassed waterway	15.00	1.26	15.16	16.17
A 70L	Sta. 70+38 to 92+00	0.90	1.72	55	0.07273	1.44	2087	0.00631	5	Grassed waterway	15.00	1.19	29.19	30.63
A 70R	Sta. 70+38 to 78+00	0.90	0.27	33	0.12121	0.94	717	0.00904	5	Grassed waterway	15.00	1.43	8.38	9.32

Notes:

t_i= (1.87*(1.1-C_5)*(L^0.5))/(S^0.33), from COS DCM page 5-11

Velocity from V = C_v*S_w^0.5, from UDFCD Eqn RO-4, C_v from Table R0-2 (See Sheet Design Info)

t_t=L/60V

Standard Form SF-2 . Storm Drainage System Design (Rational Method Procedure)

Corridor / Design Package: Marksheffel
System Name: South

Computed: MAJ Date: 6/28/2014
Checked: EVS Date: 6/30/2014

Design Storm: 5-yr

	LOCATION	DESIGN POINT	DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			REMARKS
			AREA DESIGN (name)	AREA (AC)	RUNOFF COEFF	t_c (MIN)	C.A. (AC)	I IN / HR	Q (CFS)	t_c (MIN)	SUM (C*A) (AC)	I (IN / HR)	Q (CFS)	SLOPE (%)	STREET FLOW (CFS)	DESIGN FLOW (CFS)	SLOPE (%)	PIPE SIZE	LENGTH (FT)	VELOCITY (FPS)	t_t (MIN)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
ZONE 3																						
1	Sta 256+30 to 264+29		A 256L	0.77	0.90	5.00	0.69	3.55	2.46													
2	Sta 256+30 to 264+30		A 256R	0.77	0.90	5.00	0.69	3.55	2.46													
3	Sta. 246+00 to 256+30		A 247L	0.96	0.90	9.50	0.86	2.79	2.41													
4	Sta. 246+00 to 256+30		A 246R	1.01	0.90	9.50	0.91	2.79	2.54													
5	Sta 246+00 to No Work Zone		A 246L	905.26	0.25	266.96	227.44	0.45	101.89													
6	Sta. 229+00 to 232+00		A 229R	0.31	0.90	5.02	0.28	3.55	0.99													
7	Sta. 226+00 to 246+00		A 226L	65.23	0.28	56.00	18.23	1.08	19.69													
8	Sta. 212+00 to 229+00		A 212L	1.55	0.90	21.57	1.40	1.90	2.65													
9	Sta. 212+00 to 229+00		A 212R	1.55	0.90	21.49	1.40	1.90	2.65													
10	Sta. 210+60 to 226+00		A 210L	124.50	0.31	38.27	39.03	1.42	55.43													
	Sta. 212+00 to 229+00		A 210L_S1	56.88	0.31	38.34	17.65	1.42	25.06													
11	Sta. 207+60 to 212+00		A 208R	0.44	0.90	6.41	0.40	3.36	1.33													
12	Sta. 205+00 to 212+00		A 206L	0.74	0.90	8.74	0.67	2.98	1.99													
13	Sta 205+00 to 210+60		A 205L	2.87	0.25	26.03	0.72	1.72	1.23													
14	Sta. 179+00 to 205+00		A 178L	79.92	0.34	83.90	27.19	0.86	23.38													
15	Sta. 178+00 to 207+00		A 178R	3.32	0.90	33.27	2.99	1.51	4.51													
16	Sta. 152+00 to 178+00		A 152L	2.49	0.90	41.33	2.24	1.36	3.05													
17	Sta. 152+00 to 178+00		A 152R	2.53	0.90	41.65	2.28	1.36	3.10													
18	Sta. 152+00 to 170+50		A 151R	39.34	0.42	102.78	16.52	0.74	12.22													
19	Sta. 150+00 to 179+00		A 150L	123.68	0.25	150.48	31.04	0.53	16.45													
20	Sta. 148+00 to 152+00		A 148L	0.41	0.90	11.96	0.37	2.50	0.92													
21	Sta. 147+80 to 152+00		A 148R	0.55	0.90	15.17	0.50	2.12	1.05													
ZONE 4																						
22	Sta. 124+50 to 137+50		A 125R	1.08	0.90	15.57	0.97	2.12	2.06													
23	Sta. 103+00 to148+00		A 103L	4.65	0.90	54.13	4.19	1.12	4.69													
24	Sta. 100+00 to 114+00		A 103R	0.57	0.90	15.05	0.51	2.12	1.09													
25	Sta. 92+00 to 103+00		A 92L	0.53	0.90	15.93	0.48	2.12	1.01													
26	Sta. 92+00 to 103+00		A 92R	0.58	0.90	16.17	0.52	2.08	1.09													
27	Sta. 70+38 to 92+00		A 70L	1.72	0.90	30.63	1.55	1.57	2.43													
28	Sta. 70+38 to 78+00		A 70R	0.27	0.90	9.32	0.24	2.79	0.68													

Standard Form SF-2 . Storm Drainage System Design (Rational Method Procedure)

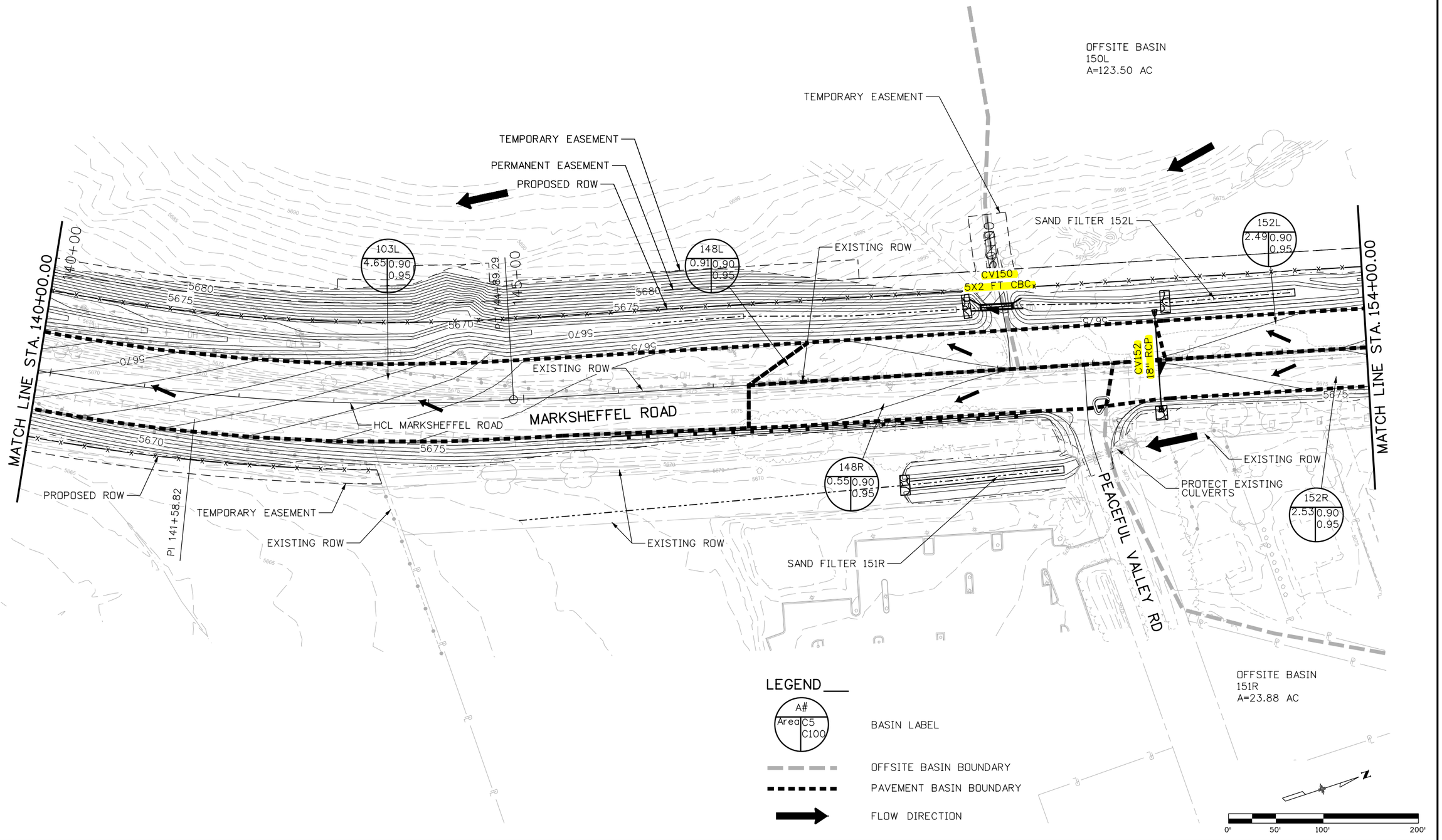
Corridor / Design Package: Marksheffel
System Name: South

Computed: MAJ Date: 6/28/2014
Checked: EVS Date: 6/30/2014

Design Storm: 100-yr

LOCATION	DESIGN POINT	DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			REMARKS
		AREA DESIGN	AREA (AC)	RUNOFF COEFF	t_c (MIN)	C.A. (AC)	I IN / HR	Q (CFS)	t_c (MIN)	SUM (C*A) (AC)	I (IN / HR)	Q (CFS)	SLOPE (%)	STREET FLOW (CFS)	DESIGN FLOW (CFS)	SLOPE (%)	PIPE SIZE	LENGTH (FT)	VELOCITY (FPS)	t_t (MIN)	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
ZONE 3																					
1 Sta 256+30 to 264+29		A 256L	0.77	0.95	5.00	0.73	9.53	6.97													
2 Sta 256+30 to 264+30		A 256R	0.77	0.95	5.00	0.73	9.53	6.97													
3 Sta. 246+00 to 256+30		A 247L	0.96	0.95	9.50	0.91	7.49	6.83													
4 Sta. 246+00 to 256+30		A 246R	1.01	0.95	9.50	0.96	7.49	7.19													
5 Sta 246+00 to No Work Zone		A 246L	905.26	0.35	266.96	317.88	1.25	397.35													
6 Sta. 229+00 to 232+00		A 229R	0.31	0.95	5.02	0.29	9.53	2.81													
7 Sta. 226+00 to 246+00		A 226L	65.23	0.38	56.00	24.61	2.95	72.59													
8 Sta. 212+00 to 229+00		A 212L	1.55	0.95	21.57	1.47	5.08	7.48													
9 Sta. 212+00 to 229+00		A 212R	1.55	0.95	21.49	1.47	5.08	7.48													
10 Sta. 210+60 to 226+00		A 210L	124.50	0.43	38.27	53.71	3.82	205.15													
Sta. 212+00 to 229+00		A 210L_S1	56.88	0.42	38.34	24.11	3.82	92.09													
11 Sta. 207+60 to 212+00		A 208R	0.44	0.95	6.41	0.42	9.02	3.77													
12 Sta. 205+00 to 212+00		A 206L	0.74	0.95	8.74	0.70	8.00	5.63													
13 Sta 205+00 to 210+60		A 205L	2.87	0.35	26.03	1.00	4.59	4.61													
14 Sta. 179+00 to 205+00		A 178L	79.92	0.46	83.90	36.89	2.36	87.06													
									83.90	36.89	2.36	87.06						2753	4.14	11.08	
15 Sta. 178+00 to 207+00		A 178R	3.32	0.95	33.27	3.15	4.06	12.81													
16 Sta. 152+00 to 178+00		A 152L	2.49	0.95	41.33	2.37	3.67	8.68													
17 Sta. 152+00 to 178+00		A 152R	2.53	0.95	41.65	2.40	3.67	8.82													
18 Sta. 152+00 to 170+50		A 151R	39.34	0.56	102.78	21.87	2.03	44.39													
19 Sta. 150+00 to 179+00		A 150L	123.68	0.35	150.48	43.39	1.48	64.22													
	1	150L,178L							150.48	80.28	1.48	118.82									CV150
20 Sta. 148+00 to 152+00		A 148L	0.41	0.95	11.96	0.39	6.72	2.62													
21 Sta. 147+80 to 152+00		A 148R	0.55	0.95	15.17	0.52	5.67	2.96													
ZONE 4																					
22 Sta. 124+50 to 137+50		A 125R	1.08	0.95	15.57	1.03	5.67	5.82													
23 Sta. 103+00 to148+00		A 103L	4.65	0.95	54.13	4.42	3.05	13.47													
24 Sta. 100+00 to 114+00		A 103R	0.57	0.95	15.05	0.54	5.67	3.07													
25 Sta. 92+00 to 103+00		A 92L	0.53	0.95	15.93	0.50	5.67	2.85													
26 Sta. 92+00 to 103+00		A 92R	0.58	0.95	16.17	0.55	5.57	3.07													
27 Sta. 70+38 to 92+00		A 70L	1.72	0.95	30.63	1.63	4.20	6.86													
28 Sta. 70+38 to 78+00		A 70R	0.27	0.95	9.32	0.26	7.49	1.92													

(1) Basin Description linked to C-Value Sheet
(2) Basin Design Point
(3) Enter the Basin Name from C Value Sheet
(4) Basin Area linked to C-Value Sheet
(5) Composite C linked to C-Value Sheet
(6) Time of Concentration linked to C-Value Sheet
(7) =Column 4 x Column 5
(8) =28.5*P/(10+Column 6)^0.786
(9) =Column 7 x Column 8
(10) =Column 6 + Column 21
(11) Add the Basin Areas (7) to get the combined basin AC
(12) =28.5*P/(10+Column 10)^0.786
(13) Sum of Qs
(14) Additonal Street Overland Flow
(15) Additonal Street Overland Flow
(16) Design Pipe Flow
(17) Pipe Slope
(18) Pipe Size
(19) Additional Flow Length
(20) Velocity
(21) =Column 19 / Column 20 / 60



Print Date: 4/2/2015	Sheet Revisions		
File Name: North-Marksheffel_BASINS_Plan006.dgn	Date:	Comments	Init.
Horiz. Scale: 1:100 Vert. Scale: As Noted			
Unit Information Unit Leader Initials			
PARSONS BRINCKERHOFF			

EL PASO COUNTY COLORADO

PPRTA

As Constructed	MARKSHEFFEL ROAD DRAINAGE BASINS PLAN 140+00.00 TO 154+00.00		Project No./Code
No Revisions:			....
Revised:	Designer: E. STATEN	Structure Numbers	....
Void:	Detailer: D. MADDOCK		
	Sheet Subset: BASINS	Subset Sheets: 6 of 36	6

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Culvert Calculator Report
CV150

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	5,676.34	ft	Headwater Depth/Height	2.36	
Computed Headwater Elevation	5,676.32	ft	Discharge	118.82	cfs
Inlet Control HW Elev.	5,676.32	ft	Tailwater Elevation	5,671.50	ft
Outlet Control HW Elev.	5,675.71	ft	Control Type	Inlet Control	

Grades					
Upstream Invert	5,671.60	ft	Downstream Invert	5,671.50	ft
Length	35.00	ft	Constructed Slope	0.002857	ft/ft

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	2.00	ft
Slope Type	N/A		Normal Depth	N/A	ft
Flow Regime	N/A		Critical Depth	2.00	ft
Velocity Downstream	9.90	ft/s	Critical Slope	0.011013	ft/ft

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	6.00	ft
Section Size	6 x 2 ft		Rise	2.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	5,675.71	ft	Upstream Velocity Head	1.52	ft
Ke	0.20		Entrance Loss	0.30	ft

Inlet Control Properties					
Inlet Control HW Elev.	5,676.32	ft	Flow Control	Submerged	
Inlet Type	90° headwall w 45° bevels		Area Full	12.0	ft²
K	0.49500		HDS 5 Chart	10	
M	0.66700		HDS 5 Scale	2	
C	0.03140		Equation Form	2	
Y	0.82000				

Culvert Calculator Report
CV152

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	5,675.19	ft	Headwater Depth/Height	1.27	
Computed Headwater Elevation	5,673.97	ft	Discharge	8.68	cfs
Inlet Control HW Elev.	5,673.89	ft	Tailwater Elevation	5,671.52	ft
Outlet Control HW Elev.	5,673.97	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	5,672.06	ft	Downstream Invert	5,671.52	ft
Length	108.00	ft	Constructed Slope	0.005000	ft/ft

Hydraulic Profile					
Profile	M2		Depth, Downstream	1.14	ft
Slope Type	Mild		Normal Depth	N/A	ft
Flow Regime	Subcritical		Critical Depth	1.14	ft
Velocity Downstream	6.02	ft/s	Critical Slope	0.007955	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	1.50	ft
Section Size	18 inch		Rise	1.50	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	5,673.97	ft	Upstream Velocity Head	0.38	ft
Ke	0.20		Entrance Loss	0.08	ft

Inlet Control Properties					
Inlet Control HW Elev.	5,673.89	ft	Flow Control	N/A	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	1.8	ft²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

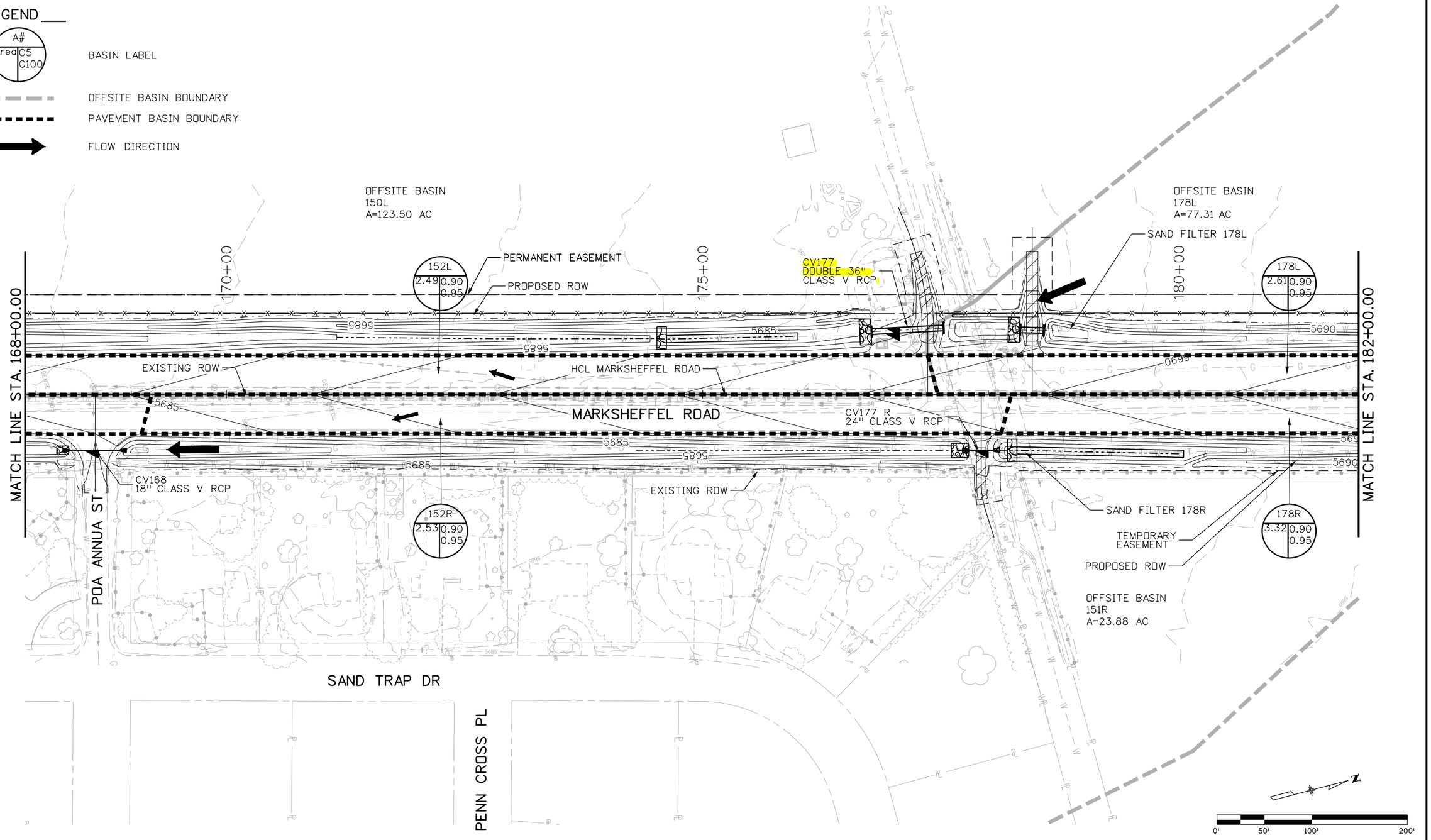
LEGEND

A# / Area | C5 / C100 — BASIN LABEL

OFFSITE BASIN BOUNDARY

PAVEMENT BASIN BOUNDARY

FLOW DIRECTION



Print Date: 4/2/2015		Sheet Revisions	
File Name: North-Marksheffel_BASINS_Plan008.dgn		Date:	Comments	Init.
Horiz. Scale: 1:100 Vert. Scale: As Noted				
Unit Information Unit Leader Initials				
HDR PARSONS BRINCKERHOFF	0000			

EL PASO COUNTY COLORADO

PPRTA

As Constructed	MARKSHEFFEL ROAD DRAINAGE BASINS PLAN 168+00.00 TO 182+00.00		Project No./Code
No Revisions:			....
Revised:	Designer: E. STATEN	Structure Numbers	....
Void:	Detailer: D. MADDOCK		
	Sheet Subset: BASINS	Subset Sheets: 8 of 36	8

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Culvert Calculator Report
CV177

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	5,688.70	ft	Headwater Depth/Height	1.13	
Computed Headwater Elevation	5,688.17	ft	Discharge	87.06	cfs
Inlet Control HW Elev.	5,688.06	ft	Tailwater Elevation	5,684.52	ft
Outlet Control HW Elev.	5,688.17	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	5,684.78	ft	Downstream Invert	5,684.52	ft
Length	77.00	ft	Constructed Slope	0.003377	ft/ft

Hydraulic Profile					
Profile	M2		Depth, Downstream	2.15	ft
Slope Type	Mild		Normal Depth	N/A	ft
Flow Regime	Subcritical		Critical Depth	2.15	ft
Velocity Downstream	8.03	ft/s	Critical Slope	0.005723	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	3.00	ft
Section Size	36 inch		Rise	3.00	ft
Number Sections	2				

Outlet Control Properties					
Outlet Control HW Elev.	5,688.17	ft	Upstream Velocity Head	0.74	ft
Ke	0.20		Entrance Loss	0.15	ft

Inlet Control Properties					
Inlet Control HW Elev.	5,688.06	ft	Flow Control	Transition	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	14.1	ft²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

Standard Form SF-2 . Storm Drainage System Design (Rational Method Procedure)

Corridor / Design Package: Marksheffel
System Name: South Approach Pipes

5-YR PIPE CALCULATIONS

Computed: MAJ Date: 6/28/2014
Checked: EVS Date: 6/30/2014

Design Storm: 5-yr

LOCATION	DESIGN POINT	DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			REMARKS
		AREA DESIGN (name)	AREA (AC)	RUNOFF COEFF	t_c (MIN)	C.A. (AC)	I IN / HR	Q (CFS)	t_c (MIN)	SUM (C*A) (AC)	I (IN / HR)	Q (CFS)	SLOPE (%)	STREET FLOW (CFS)	DESIGN FLOW (CFS)	SLOPE (%)	PIPE SIZE	LENGTH (FT)	VELOCITY (FPS)	t_t (MIN)	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
ZONE 3																					
1 Onsite flow from 233+00 to 246+00		CV233	2.37	0.90	9.85	2.13	2.79	5.95													
2 Onsite flow from 207+60 to 212+00		P205	0.44	0.90	6.41	0.40	3.36	1.33													
3 Onsite flow from 205+00 to 212+00		CV205	0.84	0.90	8.74	0.76	2.98	2.25													
4 Onsite flow from 195+00 to 205+00		CV195	1.68	0.90	13.63	1.51	2.31	3.49													
5 Onsite flow from 194+00 to 205+00		CV194	1.79	0.90	14.90	1.61	2.22	3.58													
6 Onsite flow from 192+00 to 205+00		CV192	1.99	0.90	16.82	1.79	2.08	3.73													
7 Onsite & Offisite flow from 177+00 to 205+00		CV177R	5.51	0.64	35.11	3.54	1.48	5.23													
8 Onsite flow from 168+00 to 179+00		CV168	0.95	0.90	16.85	0.86	2.08	1.78													
9 Onsite flow from 152+00 to 177+00		CV152	2.49	0.90	41.33	2.24	1.36	3.05													
ZONE 4																					
10 Onsite flow from 112+00 to 114+00		CV112	0.12	0.93	5.00	0.11	3.55	0.38													
11 Onsite flow from 109+00 to 114+00		CV109	0.27	0.90	6.61	0.24	3.36	0.82													
12 Onsite flow from 106+00 to 114+00		CV106	0.40	0.90	8.54	0.36	2.98	1.07													
13 Onsite flow from 99+00 to 103+00		CV99	0.20	0.90	5.00	0.18	3.55	0.62													

100-YR PIPE CALCULATIONS

Design Storm: 100-yr

LOCATION	DESIGN POINT	DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			REMARKS
		AREA DESIGN	AREA (AC)	RUNOFF COEFF	t_c (MIN)	C.A. (AC)	I IN / HR	Q (CFS)	t_c (MIN)	SUM (C*A) (AC)	I (IN / HR)	Q (CFS)	SLOPE (%)	STREET FLOW (CFS)	DESIGN FLOW (CFS)	SLOPE (%)	PIPE SIZE	LENGTH (FT)	VELOCITY (FPS)	t_t (MIN)	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
ZONE 3																					
1 Onsite flow from 233+00 to 246+00		CV233	2.37	0.95	9.85	2.25	7.49	16.87													
2 Onsite flow from 207+60 to 212+00		P205	0.44	0.95	6.41	0.42	9.02	3.77													
3 Onsite flow from 205+00 to 212+00		CV205	0.84	0.95	8.74	0.80	8.00	6.38													
4 Onsite flow from 195+00 to 205+00		CV195	1.68	0.95	13.63	1.59	6.19	9.87													
5 Onsite flow from 194+00 to 205+00		CV194	1.79	0.95	14.90	1.70	5.93	10.08													See TR-55 Peak Flow
6 Onsite flow from 192+00 to 205+00		CV192	1.99	0.95	16.82	1.89	5.57	10.53													
7 Onsite & Offisite flow from 177+00 to 205+00		CV177R	5.51	0.71	35.11	3.92	3.96	15.53													
8 Onsite flow from 168+00 to 179+00		CV168	0.95	0.95	16.85	0.90	5.57	5.03													
9 Onsite flow from 152+00 to 177+00		CV152	2.49	0.95	41.33	2.37	3.67	8.68													
ZONE 4																					
10 Onsite flow from 112+00 to 114+00		CV112	0.12	0.98	5.00	0.11	9.53	1.07													See TR-55 Peak Flow
11 Onsite flow from 109+00 to 114+00		CV109	0.27	0.95	6.61	0.26	9.02	2.31													
12 Onsite flow from 106+00 to 114+00		CV106	0.40	0.95	8.54	0.38	8.00	3.04													
13 Onsite flow from 99+00 to 103+00		CV99	0.20	0.95	5.00	0.19	9.53	1.77													

(1) Basin Description linked to C-Value Sheet
(2) Basin Design Point
(3) Enter the Basin Name from C Value Sheet
(4) Basin Area linked to C-Value Sheet
(5) Composite C linked to C-Value Sheet
(6) Time of Concentration linked to C-Value Sheet
(7) =Column 4 x Column 5
(8) =28.5*P/(10+Column 6)^0.786
(9) =Column 7 x Column 8
(10) =Column 6 + Column 21
(11) Add the Basin Areas (7) to get the combined basin AC
(12) =28.5*P/(10+Column 10)^0.786
(13) Sum of Qs
(14) Additonal Street Overland Flow
(15) Additonal Street Overland Flow
(16) Design Pipe Flow
(17) Pipe Slope
(18) Pipe Size
(19) Additional Flow Length
(20) Velocity
(21) =Column 19 / Column 20 / 60

The Glen at Widefield
Developed Condition
Runoff Coeficient and Percent Impervious Calculation

					PV	Area 1 Land Use			LA	Area 2 Land Use			GR	Area 3 Land Use			RS2	Area 4 Land Use				Basin Runoff	
Basin	**DP**	**Basin or DP Area (DP contributing basins)**		Soil Type	% Imperv	Land Use Area	% Area	Comp Land Use % Imp	% Imperv	Land Use Area	% Area	Comp Land Use % Imp	% Imperv	Land Use Area	% Area	Comp Land Use % Imp	% Imperv	Land Use Area	% Area	Comp Land Use % Imp	**Basin % Imperv**	C_5	C_{100}
C-7	DP 37	86,130 sf	1.98ac	B	100%		0%	0%	0%		0%	0%	40%		0%	0%	42%	1.98ac	100%	42%	**42.0%**	**0.31**	**0.50**
C-9		116,516 sf	2.67ac	B	100%		0%	0%	0%		0%	0%	40%		0%	0%	42%	2.67ac	100%	42%	**42.0%**	**0.31**	**0.50**
C-18	DP 51	62,114 sf	1.43ac	B	100%		0%	0%	0%		0%	0%	40%		0%	0%	42%	1.43ac	100%	42%	**42.0%**	**0.31**	**0.50**
E-4	DP 98	44,353 sf	1.02ac	C	100%	0.10ac	10%	10%	0%	0.92ac	90%	0%	40%		0%	0%	28%		0%	0%	**9.8%**	**0.21**	**0.53**
E-5	DP 99	57,132 sf	1.31ac	C	100%	0.10ac	8%	8%	0%	1.07ac	82%	0%	40%		0%	0%	28%	0.14ac	11%	3%	**10.6%**	**0.21**	**0.53**
E-6	DP 100	187,508 sf	4.30ac	C	100%		0%	0%	0%	4.30ac	####	0%	40%		0%	0%	28%		0%	0%	**0.0%**	**0.15**	**0.50**

Basin Runoff Coefficient is based on UDFCD % Imperviousness Calculation

Runoff Coefficients and Percents Impervious									
Hydrologic Soil Type:	**B**	**Runoff Coef Calc Method**							%Imp
Land Use	Abb	%	C_2	C_5	C_{10}	C_{25}	C_{50}	C_{100}	Weighted %Imp
Commercial Area	CO	95%	0.79	0.81	0.83	0.85	0.87	0.88	A
Drives and Walks	DR	90%	0.71	0.73	0.75	0.78	0.80	0.81	B
Streets - Gravel (Packed)	GR	40%	0.23	0.30	0.36	0.42	0.46	0.50	C
Historic Flow Analysis	HI	2%	0.03	0.08	0.17	0.26	0.31	0.36	D
Lawns	LA	0%	0.02	0.08	0.15	0.25	0.30	0.35	
Off-site flow-Undeveloped	OF	45%	0.26	0.32	0.38	0.44	0.48	0.51	
Park	PA	7%	0.05	0.12	0.20	0.29	0.34	0.39	
Playground	PL	13%	0.07	0.16	0.24	0.32	0.37	0.42	
Streets - Paved	PV	100%	0.89	0.90	0.92	0.94	0.95	0.96	
Roofs	RO	90%	0.71	0.73	0.75	0.78	0.80	0.81	
Residential: 1/4 Acre	RS1	40%	0.23	0.30	0.36	0.42	0.46	0.50	
Residential: 4.3 Lots/Acre	RS2	42%	0.24	0.31	0.37	0.43	0.47	0.50	

Equations (% Impervious Calculation):

$C_A = K_A + (1.31\ i^3 - 1.44\ i^2 + 1.135\ i - 0.12)$ [Eqn RO-6]

$C_{CD} = K_{CD} + (0.858\ i^3 - 0.786\ i^2 + 0.774\ i + 0.04)$ [Eqn RO-7]

$C_B = (C_A + C_{CD}) / 2$

I = % imperviousness/100 as a decimal (See Table RO-3)

C_A = Runoff coefficient for NRCS Type A Soils

C_B = Runoff coefficient for NRCS Type B Soils

C_{CD} = Runoff coefficient for NRCS Type C and D Soils

Correction Factors - Table RO-4

K_A = For Type A Soils

K_A (2-yr)= 0

K_A (5-yr)= -0.08i + 0.09

K_A (10-yr)= -0.14i + 0.17

K_A (25-yr)= -0.19i + 0.24

K_A (50-yr)= -0.22i + 0.28

K_A (100-yr)= -0.25i + 0.32

K_{CD}=For Type C & D Soils

K_{CD} (2-yr)= 0

K_{CD} (5-yr)= -0.10i + 0.11

K_{CD} (10-yr)= -0.18i + 0.21

K_{CD} (25-yr)= -0.28i + 0.33

K_{CD} (50-yr)= -0.33i + 0.40

K_{CD} (100-yr)= -0.39i + 0.46

The Glen at Widefield
Developed Condition
Time of Concentration Calculation

Sub-Basin Data					Time of Concentration Estimate										Min. Tc in Urban		Final t_c
					Initial/Overland Time (t_i)			Travel Time (t_t)						Comp.	Tc Check (urban)		
Basin	Design Point	Contributing Basins	Area	C_5	Length	Slope	t_i	Length	Slope	Land Type	Cv	Velocity	t_t	t_c	Total Length	t_c Check	
C-7	DP 37		1.98ac	0.31	100lf	0.8%	15.6 min.	690lf	1.3%	PV	20	2.3 ft/sec	5.0 min.	20.7 min.	790lf	14.4 min.	**14.4 min.**
C-9			2.67ac	0.31	100lf	2.0%	11.5 min.	660lf	1.2%	PV	20	2.2 ft/sec	5.0 min.	16.5 min.	760lf	14.2 min.	**14.2 min.**
C-18	DP 51		1.43ac	0.31	100lf	3.3%	9.7 min.	400lf	1.0%	PV	20	2.0 ft/sec	3.3 min.	13.1 min.	500lf	12.8 min.	**12.8 min.**
E-4	DP 98		1.02ac	0.21	50lf	2.4%	8.6 min.	160lf	1.9%	PV	20	2.8 ft/sec	1.0 min.	9.6 min.	210lf	11.2 min.	**9.6 min.**
E-5	DP 99		1.31ac	0.21	100lf	4.0%	10.2 min.	200lf	1.9%	PV	20	2.8 ft/sec	1.2 min.	11.4 min.	300lf	11.7 min.	**11.4 min.**
E-6	DP 100		4.30ac	0.15			0.0 min.	300lf	5.5%	GW	15	3.5 ft/sec	1.4 min.	5.0 min.	300lf	11.7 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)

Land Surface Type	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

The Glen at Widefield
Developed Condition
Runoff Calculation

Basin	Design Point	Contributing Basins	Drainage Area	C_5	C_{100}	Time of Concentration	Rainfall Intensity i_5	Rainfall Intensity i_{100}	Runoff Q_5	Runoff Q_{100}	Basin / DP
C-7	DP 37		1.98 ac	0.31	0.50	14.4 min.	3.6 in/hr	6.0 in/hr	**2.2 cfs**	**6.0 cfs**	C-7
C-9			2.67 ac	0.31	0.50	14.2 min.	3.6 in/hr	6.0 in/hr	**3.0 cfs**	**8.1 cfs**	C-9
C-18	DP 51		1.43 ac	0.31	0.50	12.8 min.	3.8 in/hr	6.3 in/hr	**1.6 cfs**	**4.5 cfs**	C-18
E-4	DP 98		1.02 ac	0.21	0.53	9.6 min.	4.2 in/hr	7.0 in/hr	**0.9 cfs**	**3.8 cfs**	E-4
E-5	DP 99		1.31 ac	0.21	0.53	11.4 min.	3.9 in/hr	6.6 in/hr	**1.1 cfs**	**4.6 cfs**	E-5
E-6	DP 100		4.30 ac	0.15	0.50	5.0 min.	5.2 in/hr	8.7 in/hr	**3.3 cfs**	**18.7 cfs**	E-6

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_{25}=-2.00 ln(T_c) + 10.111

i_{50}=-2.25 ln(T_c) + 11.375

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

P1	Inches
WQCV	0.60 in
2 yr	1.19 in
5 yr	1.50 in
10 yr	1.75 in
25 yr	2.00 in
50 yr	2.25 in
100 yr	2.52 in

The Glen at Widefield
Developed Condition
Runoff Coeficient and Percent Impervious Calculation

					PV	Area 1 Land Use			LA	Area 2 Land Use			RS2	Area 3 Land Use			RS1	Area 4 Land Use					
Basin	DP	Basin or DP Area (DP contributing basins)		Soil Type	% Imperv	Land Use Area	% Area	Comp Land Use % Imp	% Imperv	Land Use Area	% Area	Comp Land Use % Imp	% Imperv	Land Use Area	% Area	Comp Land Use % Imp	% Imperv	Land Use Area	% Area	Comp Land Use % Imp	Basin % Imperv	Basin Runoff C_5	Basin Runoff C_{100}
D-1	DP 68	61,148 sf	1.40ac	B	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	1.40ac	100%	37%	**37.0%**	**0.28**	**0.49**
D-2		63,184 sf	1.45ac	B	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	1.45ac	100%	37%	**37.0%**	**0.28**	**0.49**
D-3	DP 70	73,555 sf	1.69ac	B	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	1.69ac	100%	37%	**37.0%**	**0.28**	**0.49**
D-4		121,367 sf	2.79ac	B	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	2.79ac	100%	37%	**37.0%**	**0.28**	**0.49**
D-5	DP 72	68,122 sf	1.56ac	B	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	1.56ac	100%	37%	**37.0%**	**0.28**	**0.49**
D-6	DP 73	23,821 sf	0.55ac	B	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	0.55ac	100%	37%	**37.0%**	**0.28**	**0.49**
D-7		130,015 sf	2.98ac	B	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	2.98ac	100%	37%	**37.0%**	**0.28**	**0.49**
D-8		71,639 sf	1.64ac	B	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	1.64ac	100%	37%	**37.0%**	**0.28**	**0.49**
D-9	DP 77	90,648 sf	2.08ac	B	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	2.08ac	100%	37%	**37.0%**	**0.28**	**0.49**
D-10		146,113 sf	3.35ac	B	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	3.35ac	100%	37%	**37.0%**	**0.28**	**0.49**
D-11	DP 80	104,546 sf	2.40ac	B	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	2.40ac	100%	37%	**37.0%**	**0.28**	**0.49**
D-12		44,528 sf	1.02ac	B	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	1.02ac	100%	37%	**37.0%**	**0.28**	**0.49**
D-13		116,848 sf	2.68ac	B	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	2.68ac	100%	37%	**37.0%**	**0.28**	**0.49**
D-14		200,902 sf	4.61ac	B	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	4.61ac	100%	37%	**37.0%**	**0.28**	**0.49**
D-15	DP 84	122,154 sf	2.80ac	B	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	2.80ac	100%	37%	**37.0%**	**0.28**	**0.49**
D-16		98,963 sf	2.27ac	B	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	2.27ac	100%	37%	**37.0%**	**0.28**	**0.49**
D-16.1		85,968 sf	1.97ac	B	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	1.97ac	100%	37%	**37.0%**	**0.28**	**0.49**
D-17		91,896 sf	2.11ac	B	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	2.11ac	100%	37%	**37.0%**	**0.28**	**0.49**
D-18		75,687 sf	1.74ac	B	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	1.74ac	100%	37%	**37.0%**	**0.28**	**0.49**
D-19		142,841 sf	3.28ac	B	100%		0%	0%	0%	0.48ac	15%	0%	46%		0%	0%	37%	2.80ac	85%	32%	**31.6%**	**0.26**	**0.47**
D-20	DP 89	89,796 sf	2.06ac	B	100%	0.34ac	16%	16%	0%	0.37ac	18%	0%	46%		0%	0%	37%	1.35ac	66%	24%	**40.7%**	**0.30**	**0.50**
D-21	DP 90	175,102 sf	4.02ac	B	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	4.02ac	100%	37%	**37.0%**	**0.28**	**0.49**
D-22	DP 91	49,642 sf	1.14ac	B	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	1.14ac	100%	37%	**37.0%**	**0.28**	**0.49**
D-23		32,861 sf	0.75ac	B	100%	0.47ac	62%	62%	0%	0.28ac	38%	0%	46%		0%	0%	37%		0%	0%	**62.3%**	**0.43**	**0.58**
D-24		422,637 sf	9.70ac	B	100%		0%	0%	0%	7.30ac	75%	0%	46%		0%	0%	37%	2.40ac	25%	9%	**9.2%**	**0.13**	**0.40**

The drainage plan shows two D-20 basins. One contributes to DP89 per the drainage plan. Please indicate what design point the other D-20 basin(adjacent to basin E-5) is contributing to. Also, how is flow from this basin reaching the pond? Please revise the design accordingly.

The Glen at Widefield
Developed Condition
Runoff Coeficient and Percent Impervious Calculation

					PV	Area 1 Land Use			LA	Area 2 Land Use			RS2	Area 3 Land Use			RS1	Area 4 Land Use					
Basin	DP	Basin or DP Area (DP contributing basins)		Soil Type	% Imperv	Land Use Area	% Area	Comp Land Use % Imp	% Imperv	Land Use Area	% Area	Comp Land Use % Imp	% Imperv	Land Use Area	% Area	Comp Land Use % Imp	% Imperv	Land Use Area	% Area	Comp Land Use % Imp	Basin % Imperv	Basin Runoff C_5	Basin Runoff C_{100}
	DP 69	D1, D2	2.85ac	B	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	2.85ac	100%	37%	**37.0%**	**0.28**	**0.49**
	DP 71	D3, D4	4.47ac	B	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	4.47ac	100%	37%	**37.0%**	**0.28**	**0.49**
	DP 74	D3, D4, D6	5.02ac	B	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	5.02ac	100%	37%	**37.0%**	**0.28**	**0.49**
	DP 75	D1-D4, D6, D7	10.86ac	B	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	10.86ac	100%	37%	**37.0%**	**0.28**	**0.49**
	DP 76	D1-D4, D6-D8	12.51ac	B	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	12.51ac	100%	37%	**37.0%**	**0.28**	**0.49**
	DP 78	D1-D4, D6-D9	14.59ac	B	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	14.59ac	100%	37%	**37.0%**	**0.28**	**0.49**
	DP 79	D1-D4, D6-D10	17.94ac	B	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	17.94ac	100%	37%	**37.0%**	**0.28**	**0.49**
	DP 81	D11, D12	3.42ac	B	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	3.42ac	100%	37%	**37.0%**	**0.28**	**0.49**
	DP 82	D5, D13	4.25ac	B	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	4.25ac	100%	37%	**37.0%**	**0.28**	**0.49**
	DP 83	D5, D13, D14	8.86ac	B	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	8.86ac	100%	37%	**37.0%**	**0.28**	**0.49**
	DP 85	D15,D16, D16.1	7.05ac	B	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	7.05ac	100%	37%	**37.0%**	**0.28**	**0.49**
	DP 86	D15 - D17	9.16ac	B	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	9.16ac	100%	37%	**37.0%**	**0.28**	**0.49**
	DP 87	D15 - D18	10.90ac	B	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	10.90ac	100%	37%	**37.0%**	**0.28**	**0.49**
	DP 88	D15 - D19	14.18ac	B	100%		0%	0%	0%	0.48ac	3%	0%	46%		0%	0%	37%	13.70ac	97%	36%	**35.7%**	**0.28**	**0.48**
	DP 92	D21, D22	5.16ac	B	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	5.16ac	100%	37%	**37.0%**	**0.28**	**0.49**
	DP 93	D1 - D20, D23	47.21ac	B	100%	0.81ac	2%	2%	0%	1.13ac	2%	0%	46%		0%	0%	37%	45.27ac	96%	35%	**37.2%**	**0.28**	**0.49**
	DP 94	D1 - D24	62.07ac	B	100%	0.81ac	1%	1%	0%	8.44ac	14%	0%	46%		0%	0%	37%	52.83ac	85%	31%	**32.8%**	**0.26**	**0.48**

Basin Runoff Coefficient is based on UDFCD % Imperviousness Calculation

Runoff Coefficients and Percents Impervious

Hydrologic Soil Type:	**B**		**Runoff Coef Calc Method**					**%Imp**
Land Use	Abb	%	C_2	C_5	C_{10}	C_{25}	C_{50}	C_{100}
Commercial Area	CO	95%	0.79	0.81	0.83	0.85	0.87	0.88
Drives and Walks	DR	90%	0.71	0.73	0.75	0.78	0.80	0.81
Streets - Gravel (Packed)	GR	40%	0.23	0.30	0.36	0.42	0.46	0.50
Historic Flow Analysis	HI	2%	0.03	0.08	0.17	0.26	0.31	0.36
Lawns	LA	0%	0.02	0.08	0.15	0.25	0.30	0.35
Off-site flow-Undeveloped	OF	45%	0.26	0.32	0.38	0.44	0.48	0.51
Park	PA	7%	0.05	0.12	0.20	0.29	0.34	0.39
Playground	PL	13%	0.07	0.16	0.24	0.32	0.37	0.42
Streets - Paved	PV	100%	0.89	0.90	0.92	0.94	0.95	0.96
Roofs	RO	90%	0.71	0.73	0.75	0.78	0.80	0.81
Residential: 3.7 Lots/Acre	RS1	37%	0.22	0.28	0.35	0.41	0.45	0.49
Residential: 1/5 Acre	RS2	46%	0.27	0.33	0.39	0.45	0.48	0.51

Equations (% Impervious Calculation):

$C_A = K_A + (1.31\ i^3 - 1.44\ i^2 + 1.135\ i - 0.12)$ [Eqn RO-6]

$C_{CD} = K_{CD} + (0.858\ i^3 - 0.786\ i^2 + 0.774\ i + 0.04)$ [Eqn RO-7]

$C_B = (C_A + C_{CD}) / 2$

I = % imperviousness/100 as a decimal (See Table RO-3)

C_A = Runoff coefficient for NRCS Type A Soils

C_B = Runoff coefficient for NRCS Type B Soils

C_{CD} = Runoff coefficient for NRCS Type C and D Soils

Correction Factors - Table RO-4

K_A = For Type A Soils

- K_A (2-yr)= 0
- K_A (5-yr)= -0.08i + 0.09
- K_A (10-yr)= -0.14i + 0.17
- K_A (25-yr)= -0.19i + 0.24
- K_A (50-yr)= -0.22i + 0.28
- K_A (100-yr)= -0.25i + 0.32

K_{CD}=For Type C & D Soils

- K_{CD} (2-yr)= 0
- K_{CD} (5-yr)= -0.10i + 0.11
- K_{CD} (10-yr)= -0.18i + 0.21
- K_{CD} (25-yr)= -0.28i + 0.33
- K_{CD} (50-yr)= -0.33i + 0.40
- K_{CD} (100-yr)= -0.39i + 0.46

The Glen at Widefield
Developed Condition
Time of Concentration Calculation

Sub-Basin Data					Time of Concentration Estimate										Min. Tc in Urban		Final t_c
					Initial/Overland Time (t_i)			Travel Time (t_t)						Comp.	Tc Check (urban)		
Basin	Design Point	Contributing Basins	Area	C_5	Length	Slope	t_i	Length	Slope	Land Type	Cv	Velocity	t_t	t_c	Total Length	t_c Check	
D-1	DP 68		1.40ac	0.28	100lf	2.4%	11.2 min.	600lf	3.5%	PV	20	3.7 ft/sec	2.7 min.	13.9 min.	700lf	13.9 min.	**13.9 min.**
D-2			1.45ac	0.28	85lf	1.5%	12.1 min.	655lf	0.9%	PV	20	1.9 ft/sec	5.8 min.	17.8 min.	740lf	14.1 min.	**14.1 min.**
D-3	DP 70		1.69ac	0.28	100lf	2.4%	11.2 min.	600lf	3.5%	PV	20	3.7 ft/sec	2.7 min.	13.9 min.	700lf	13.9 min.	**13.9 min.**
D-4			2.79ac	0.28	50lf	1.0%	10.6 min.	610lf	0.9%	PV	20	1.9 ft/sec	5.4 min.	15.9 min.	660lf	13.7 min.	**13.7 min.**
D-5	DP 72		1.56ac	0.28	60lf	2.0%	9.2 min.	790lf	0.5%	PV	20	1.4 ft/sec	9.3 min.	18.5 min.	850lf	14.7 min.	**14.7 min.**
D-6	DP 73		0.55ac	0.28	90lf	1.0%	14.2 min.	140lf	0.8%	PV	20	1.8 ft/sec	1.3 min.	15.5 min.	230lf	11.3 min.	**11.3 min.**
D-7			2.98ac	0.28	100lf	1.5%	13.1 min.	430lf	1.3%	PV	20	2.3 ft/sec	3.1 min.	16.2 min.	530lf	12.9 min.	**12.9 min.**
D-8			1.64ac	0.28	100lf	1.0%	15.0 min.	330lf	1.5%	PV	20	2.4 ft/sec	2.2 min.	17.2 min.	430lf	12.4 min.	**12.4 min.**
D-9	DP 77		2.08ac	0.28	100lf	2.0%	11.9 min.	300lf	1.3%	PV	20	2.3 ft/sec	2.2 min.	14.1 min.	400lf	12.2 min.	**12.2 min.**
D-10			3.35ac	0.28	100lf	1.5%	13.1 min.	660lf	1.1%	PV	20	2.1 ft/sec	5.2 min.	18.3 min.	760lf	14.2 min.	**14.2 min.**
D-11	DP 80		2.40ac	0.28	70lf	1.5%	10.9 min.	1095lf	1.2%	PV	20	2.2 ft/sec	8.3 min.	19.3 min.	1165lf	16.5 min.	**16.5 min.**
D-12			1.02ac	0.28	100lf	1.3%	13.7 min.	450lf	1.2%	PV	20	2.2 ft/sec	3.4 min.	17.1 min.	550lf	13.1 min.	**13.1 min.**
D-13			2.68ac	0.28	55lf	1.0%	11.1 min.	660lf	0.6%	PV	20	1.5 ft/sec	7.1 min.	18.2 min.	715lf	14.0 min.	**14.0 min.**
D-14			4.61ac	0.28	100lf	1.8%	12.3 min.	980lf	1.6%	PV	20	2.5 ft/sec	6.5 min.	18.8 min.	1080lf	16.0 min.	**16.0 min.**
D-15	DP 84		2.80ac	0.28	100lf	2.0%	11.9 min.	185lf	2.0%	PV	20	2.8 ft/sec	1.1 min.	13.0 min.	285lf	11.6 min.	**11.6 min.**
D-16			2.27ac	0.28	100lf	2.0%	11.9 min.	660lf	0.8%	PV	20	1.8 ft/sec	6.1 min.	18.0 min.	760lf	14.2 min.	**14.2 min.**
D-16.1			1.97ac	0.28	100lf	1.4%	13.4 min.	360lf	0.8%	PV	20	1.8 ft/sec	3.4 min.	16.7 min.	460lf	12.6 min.	**12.6 min.**
D-17			2.11ac	0.28	60lf	1.5%	10.1 min.	410lf	1.5%	PV	20	2.4 ft/sec	2.8 min.	12.9 min.	470lf	12.6 min.	**12.6 min.**
D-18			1.74ac	0.28	60lf	1.5%	10.1 min.	510lf	2.2%	PV	20	3.0 ft/sec	2.9 min.	13.0 min.	570lf	13.2 min.	**13.0 min.**
D-19			3.28ac	0.26	100lf	2.6%	11.2 min.	510lf	1.1%	PV	20	2.1 ft/sec	4.1 min.	15.3 min.	610lf	13.4 min.	**13.4 min.**
D-20	DP 89		2.06ac	0.30	100lf	3.3%	9.8 min.	1300lf	0.8%	PV	20	1.8 ft/sec	12.1 min.	21.9 min.	1400lf	17.8 min.	**17.8 min.**
D-21	DP 90		4.02ac	0.28	50lf	2.0%	8.4 min.	610lf	2.1%	PV	20	2.9 ft/sec	3.5 min.	11.9 min.	660lf	13.7 min.	**11.9 min.**
D-22	DP 91		1.14ac	0.28	50lf	2.0%	8.4 min.	610lf	2.1%	PV	20	2.9 ft/sec	3.5 min.	11.9 min.	660lf	13.7 min.	**11.9 min.**
D-23			0.75ac	0.43	100lf	2.5%	9.1 min.	660lf	1.0%	PV	20	2.0 ft/sec	5.5 min.	14.6 min.	760lf	14.2 min.	**14.2 min.**
D-24			9.70ac	0.13	100lf	4.9%	10.5 min.	800lf	0.5%	GW	15	1.1 ft/sec	12.6 min.	23.0 min.	900lf	15.0 min.	**15.0 min.**

The Glen at Widefield
Developed Condition
Time of Concentration Calculation

Sub-Basin Data					Time of Concentration Estimate										Min. Tc in Urban		Final t_c
					Initial/Overland Time (t_i)			Travel Time (t_t)						Comp.	Tc Check (urban)		
Basin	Design Point	Contributing Basins	Area	C_5	Length	Slope	t_i	Length	Slope	Land Type	Cv	Velocity	t_t	t_c	Total Length	t_c Check	
	DP 69	D1, D2	2.85ac	0.28	100lf	2.4%	11.2 min.	1385lf	2.0%	PV	20	2.8 ft/sec	8.2 min.	19.3 min.	1485lf	18.3 min.	**18.3 min.**
	DP 71	D3, D4	4.47ac	0.28	100lf	2.4%	11.2 min.	1370lf	2.0%	PV	20	2.8 ft/sec	8.1 min.	19.3 min.	1470lf	18.2 min.	**18.2 min.**
	DP 74	D3, D4, D6	5.02ac	0.28	100lf	2.4%	11.2 min.	1370lf	2.0%	PV	20	2.8 ft/sec	8.1 min.	19.3 min.	1470lf	18.2 min.	**18.2 min.**
	DP 75	D1-D4, D6, D7	10.86ac	0.28	100lf	2.4%	11.2 min.	1970lf	1.8%	PV	20	2.7 ft/sec	12.2 min.	23.4 min.	2070lf	21.5 min.	**21.5 min.**
	DP 76	D1-D4, D6-D8	12.51ac	0.28	100lf	2.4%	11.2 min.	2110lf	1.8%	PV	20	2.7 ft/sec	13.1 min.	24.3 min.	2210lf	22.3 min.	**22.3 min.**
	DP 78	D1-D4, D6-D9	14.59ac	0.28	100lf	2.4%	11.2 min.	2110lf	1.8%	PV	20	2.7 ft/sec	13.1 min.	24.3 min.	2210lf	22.3 min.	**22.3 min.**
	DP 79	D1-D4, D6-D10	17.94ac	0.28	100lf	2.4%	11.2 min.	2770lf	1.6%	PV	20	2.5 ft/sec	18.2 min.	29.4 min.	2870lf	25.9 min.	**25.9 min.**
	DP 81	D11, D12	3.42ac	0.28	70lf	1.5%	10.9 min.	1545lf	1.2%	PV	20	2.2 ft/sec	11.8 min.	22.7 min.	1615lf	19.0 min.	**19.0 min.**
	DP 82	D5, D13	4.25ac	0.28	60lf	2.0%	9.2 min.	1590lf	0.6%	PV	20	1.5 ft/sec	17.7 min.	26.9 min.	1650lf	19.2 min.	**19.2 min.**
	DP 83	D5, D13, D14	8.86ac	0.28	60lf	2.0%	9.2 min.	2640lf	0.9%	PV	20	1.9 ft/sec	23.2 min.	32.4 min.	2700lf	25.0 min.	**25.0 min.**
	DP 85	D15,D16, D16.1	7.05ac	0.28	100lf	2.0%	11.9 min.	1035lf	0.8%	PV	20	1.8 ft/sec	9.6 min.	21.5 min.	1135lf	16.3 min.	**16.3 min.**
	DP 86	D15 - D17	9.16ac	0.28	100lf	2.0%	11.9 min.	1320lf	0.7%	PV	20	1.7 ft/sec	13.1 min.	25.0 min.	1420lf	17.9 min.	**17.9 min.**
	DP 87	D15 - D18	10.90ac	0.28	100lf	2.0%	11.9 min.	2080lf	1.0%	PV	20	2.0 ft/sec	17.3 min.	29.2 min.	2180lf	22.1 min.	**22.1 min.**
	DP 88	D15 - D19	14.18ac	0.28	100lf	2.0%	12.0 min.	2580lf	1.0%	PV	20	2.0 ft/sec	21.5 min.	33.5 min.	2680lf	24.9 min.	**24.9 min.**
	DP 92	D21, D22	5.16ac	0.28	50lf	2.0%	8.4 min.	1080lf	1.6%	PV	20	2.5 ft/sec	7.1 min.	15.5 min.	1130lf	16.3 min.	**15.5 min.**
	DP 93	D1 - D20, D23	47.21ac	0.28	100lf	2.4%	11.2 min.	2820lf	1.6%	PV	20	2.5 ft/sec	18.6 min.	29.7 min.	2920lf	26.2 min.	**26.2 min.**
	DP 94	D1 - D24	62.07ac	0.26	100lf	2.4%	11.5 min.	3110lf	1.6%	PV	20	2.5 ft/sec	20.5 min.	31.9 min.	3210lf	27.8 min.	**27.8 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 RO-2)

S = Watercourse slope (ft/ft)

Land Surface Type	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

The Glen at Widefield
Developed Condition
Runoff Calculation

Basin	Design Point	Contributing Basins	Drainage Area	C_5	C_{100}	Time of Concentration	Rainfall Intensity i_5	Rainfall Intensity i_{100}	**Runoff Q_5**	**Runoff Q_{100}**	Basin / DP
D-1	DP 68		1.40 ac	0.28	0.49	13.9 min.	3.6 in/hr	6.1 in/hr	**1.4 cfs**	**4.2 cfs**	D-1
D-2			1.45 ac	0.28	0.49	14.1 min.	3.6 in/hr	6.1 in/hr	**1.5 cfs**	**4.3 cfs**	D-2
D-3	DP 70		1.69 ac	0.28	0.49	13.9 min.	3.6 in/hr	6.1 in/hr	**1.7 cfs**	**5.0 cfs**	D-3
D-4			2.79 ac	0.28	0.49	13.7 min.	3.7 in/hr	6.1 in/hr	**2.9 cfs**	**8.3 cfs**	D-4
D-5	DP 72		1.56 ac	0.28	0.49	14.7 min.	3.5 in/hr	6.0 in/hr	**1.6 cfs**	**4.5 cfs**	D-5
D-6	DP 73		0.55 ac	0.28	0.49	11.3 min.	3.9 in/hr	6.6 in/hr	**0.6 cfs**	**1.8 cfs**	D-6
D-7			2.98 ac	0.28	0.49	12.9 min.	3.7 in/hr	6.3 in/hr	**3.2 cfs**	**9.1 cfs**	D-7
D-8			1.64 ac	0.28	0.49	12.4 min.	3.8 in/hr	6.4 in/hr	**1.8 cfs**	**5.1 cfs**	D-8
D-9	DP 77		2.08 ac	0.28	0.49	12.2 min.	3.8 in/hr	6.4 in/hr	**2.2 cfs**	**6.5 cfs**	D-9
D-10			3.35 ac	0.28	0.49	14.2 min.	3.6 in/hr	6.0 in/hr	**3.4 cfs**	**9.9 cfs**	D-10
D-11	DP 80		2.40 ac	0.28	0.49	16.5 min.	3.4 in/hr	5.7 in/hr	**2.3 cfs**	**6.6 cfs**	D-11
D-12			1.02 ac	0.28	0.49	13.1 min.	3.7 in/hr	6.3 in/hr	**1.1 cfs**	**3.1 cfs**	D-12
D-13			2.68 ac	0.28	0.49	14.0 min.	3.6 in/hr	6.1 in/hr	**2.7 cfs**	**8.0 cfs**	D-13
D-14			4.61 ac	0.28	0.49	16.0 min.	3.4 in/hr	5.7 in/hr	**4.5 cfs**	**12.9 cfs**	D-14
D-15	DP 84		2.80 ac	0.28	0.49	11.6 min.	3.9 in/hr	6.6 in/hr	**3.1 cfs**	**9.0 cfs**	D-15
D-16			2.27 ac	0.28	0.49	14.2 min.	3.6 in/hr	6.0 in/hr	**2.3 cfs**	**6.7 cfs**	D-16
D-16.1			1.97 ac	0.28	0.49	12.6 min.	3.8 in/hr	6.4 in/hr	**2.1 cfs**	**6.1 cfs**	D-16.1
D-17			2.11 ac	0.28	0.49	12.6 min.	3.8 in/hr	6.3 in/hr	**2.3 cfs**	**6.5 cfs**	D-17
D-18			1.74 ac	0.28	0.49	13.0 min.	3.7 in/hr	6.3 in/hr	**1.8 cfs**	**5.3 cfs**	D-18
D-19			3.28 ac	0.26	0.47	13.4 min.	3.7 in/hr	6.2 in/hr	**3.1 cfs**	**9.6 cfs**	D-19
D-20	DP 89		2.06 ac	0.30	0.50	17.8 min.	3.3 in/hr	5.5 in/hr	**2.0 cfs**	**5.6 cfs**	D-20
D-21	DP 90		4.02 ac	0.28	0.49	11.9 min.	3.9 in/hr	6.5 in/hr	**4.4 cfs**	**12.7 cfs**	D-21
D-22	DP 91		1.14 ac	0.28	0.49	11.9 min.	3.9 in/hr	6.5 in/hr	**1.2 cfs**	**3.6 cfs**	D-22
D-23			0.75 ac	0.43	0.58	14.2 min.	3.6 in/hr	6.0 in/hr	**1.2 cfs**	**2.6 cfs**	D-23
D-24			9.70 ac	0.13	0.40	15.0 min.	3.5 in/hr	5.9 in/hr	**4.5 cfs**	**22.9 cfs**	D-24

The Glen at Widefield
Developed Condition
Runoff Calculation

Basin	Design Point	Contributing Basins	Drainage Area	C_5	C_{100}	Time of Concentration	Rainfall Intensity i_5	Rainfall Intensity i_{100}	Runoff Q_5	Runoff Q_{100}	Basin / DP
	DP 69	D1, D2	2.85 ac	0.28	0.49	18.3 min.	3.2 in/hr	5.4 in/hr	**2.6 cfs**	**7.5 cfs**	DP 69
	DP 71	D3, D4	4.47 ac	0.28	0.49	18.2 min.	3.2 in/hr	5.4 in/hr	**4.1 cfs**	**11.8 cfs**	DP 71
	DP 74	D3, D4, D6	5.02 ac	0.28	0.49	18.2 min.	3.2 in/hr	5.4 in/hr	**4.6 cfs**	**13.3 cfs**	DP 74
	DP 75	D1-D4, D6, D7	10.86 ac	0.28	0.49	21.5 min.	3.0 in/hr	5.0 in/hr	**9.1 cfs**	**26.5 cfs**	DP 75
	DP 76	D1-D4, D6-D8	12.51 ac	0.28	0.49	22.3 min.	2.9 in/hr	4.9 in/hr	**10.3 cfs**	**29.9 cfs**	DP 76
	DP 78	D1-D4, D6-D9	14.59 ac	0.28	0.49	22.3 min.	2.9 in/hr	4.9 in/hr	**12.1 cfs**	**34.9 cfs**	DP 78
	DP 79	D1-D4, D6-D10	17.94 ac	0.28	0.49	25.9 min.	2.7 in/hr	4.5 in/hr	**13.7 cfs**	**39.6 cfs**	DP 79
	DP 81	D11, D12	3.42 ac	0.28	0.49	19.0 min.	3.2 in/hr	5.3 in/hr	**3.1 cfs**	**8.9 cfs**	DP 81
	DP 82	D5, D13	4.25 ac	0.28	0.49	19.2 min.	3.2 in/hr	5.3 in/hr	**3.8 cfs**	**11.0 cfs**	DP 82
	DP 83	D5, D13, D14	8.86 ac	0.28	0.49	25.0 min.	2.8 in/hr	4.6 in/hr	**6.9 cfs**	**20.0 cfs**	DP 83
	DP 85	D15,D16, D16.1	7.05 ac	0.28	0.49	16.3 min.	3.4 in/hr	5.7 in/hr	**6.8 cfs**	**19.6 cfs**	DP 85
	DP 86	D15 - D17	9.16 ac	0.28	0.49	17.9 min.	3.3 in/hr	5.5 in/hr	**8.4 cfs**	**24.4 cfs**	DP 86
	DP 87	D15 - D18	10.90 ac	0.28	0.49	22.1 min.	2.9 in/hr	4.9 in/hr	**9.0 cfs**	**26.2 cfs**	DP 87
	DP 88	D15 - D19	14.18 ac	0.28	0.48	24.9 min.	2.8 in/hr	4.6 in/hr	**10.8 cfs**	**31.8 cfs**	DP 88
	DP 92	D21, D22	5.16 ac	0.28	0.49	15.5 min.	3.5 in/hr	5.8 in/hr	**5.1 cfs**	**14.6 cfs**	DP 92
	DP 93	D1 - D20, D23	47.21 ac	0.28	0.49	26.2 min.	2.7 in/hr	4.5 in/hr	**35.9 cfs**	**103.7 cfs**	DP 93
	DP 94	D1 - D24	62.07 ac	0.26	0.48	27.8 min.	2.6 in/hr	4.4 in/hr	**42.2 cfs**	**128.8 cfs**	DP 94

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_{25}=-2.00 ln(T_c) + 10.111
i_{50}=-2.25 ln(T_c) + 11.375
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

P1	Inches
WQCV	0.60 in
2 yr	1.19 in
5 yr	1.50 in
10 yr	1.75 in
25 yr	2.00 in
50 yr	2.25 in
100 yr	2.52 in

APPENDIX A.1

Supporting Hydrologic Tables and Figures

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.

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.

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

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

For Colorado Springs and much of the Fountain Creek watershed, the 1-hour depths are fairly uniform and are summarized in Table 6-2. Depending on the location of the project, rainfall depths may be calculated using the described method and the NOAA Atlas maps shown in Figures 6-6 through 6-17.

Table 6-2. Rainfall Depths for Colorado Springs

Return Period	1-Hour Depth	6-Hour Depth	24-Hour Depth
2	1.19	1.70	2.10
5	1.50	2.10	2.70
10	1.75	2.40	3.20
25	2.00	2.90	3.60
50	2.25	3.20	4.20
100	2.52	3.50	4.60

Where Z= 6,840 ft/100

These depths can be applied to the design storms or converted to intensities (inches/hour) for the Rational Method as described below. However, as the basin area increases, it is unlikely that the reported point rainfalls will occur uniformly over the entire basin. To account for this characteristic of rain storms an adjustment factor, the Depth Area Reduction Factor (DARF) is applied. This adjustment to rainfall depth and its effect on design storms is also described below. The UDFCD UD-Rain spreadsheet, available on UDFCD's website, also provides tools to calculate point rainfall depths and Intensity-Duration-Frequency curves[2] and should produce similar depth calculation results.

2.2 Design Storms

Design storms are used as input into rainfall/runoff models and provide a representation of the typical temporal distribution of rainfall events when the creation or routing of runoff hydrographs is required. It has long been observed that rainstorms in the Front Range of Colorado tend to occur as either short-duration, high-intensity, localized, convective thunderstorms (cloud bursts) or longer-duration, lower-intensity, broader, frontal (general) storms. The significance of these two types of events is primarily determined by the size of the drainage basin being studied. Thunderstorms can create high rates of runoff within a relatively small area, quickly, but their influence may not be significant very far downstream. Frontal storms may not create high rates of runoff within smaller drainage basins due to their lower intensity, but tend to produce larger flood flows that can be hazardous over a broader area and extend further downstream.

- **Thunderstorms**: Based on the extensive evaluation of rain storms completed in the Carlton study (Carlton 2011), it was determined that typical thunderstorms have a duration of about 2 hours. The study evaluated over 300,000 storm cells using gage-adjusted NEXRAD data, collected over a 14-year period (1994 to 2008). Storms lasting longer than 3 hours were rarely found. Therefore, the results of the Carlton study have been used to define the shorter duration design storms.

  To determine the temporal distribution of thunderstorms, 22 gage-adjusted NEXRAD storm cells were studied in detail. Through a process described in a technical memorandum prepared by the City of Colorado Springs (City of Colorado Springs 2012), the results of this analysis were interpreted and normalized to the 1-hour rainfall depth to create the distribution shown in Table 6-3 with a 5 minute time interval for drainage basins up to 1 square mile in size. This distribution represents the rainfall

APPENDIX B

Detention Basin Calculations

Full Spectrum Detention Basin/Extended Detention Basin
Detention Volume and Emergency Spillway
Outlet Structure Calculations
Trickle Channel Capacity and Outlet Structure Sizing
Trash Rack and Safety Grate Sizing
Forebay Sizing Calculations

please clearly indicate in the narrative that this detention pond design provided is for filing no. 10 and undeveloped flow from future filings. Also address in the narrative how the pond will be retrofitted for the future filings.

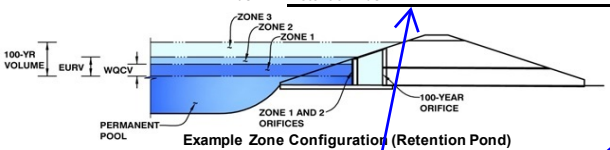
DETE[illegible]

UD-Detention, Version 3.07 (February 2017)

The majority of the area tributary to the pond (future filing 11) is type C soils per figure 2. Please update the soil group percentages accordingly.

Project: The Glen at Widefield Filing No. 10

Basin ID: Detention Basin "D"



Example Zone Configuration (Retention Pond)

Required Volume Calculation

Selected BMP Type =	EDB	
Watershed Area =	62.07	acres
Watershed Length =	1,660	ft
Watershed Slope =	0.017	ft/ft
Watershed Imperviousness =	32.80%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	100.0%	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	
Water Quality Capture Volume (WQCV) =	0.827	acre-feet
Excess Urban Runoff Volume (EURV) =	2.104	acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	1.627	acre-feet
5-yr Runoff Volume (P1 = 1.5 in.) =	2.300	acre-feet
10-yr Runoff Volume (P1 = 1.75 in.) =	3.429	acre-feet
25-yr Runoff Volume (P1 = 2 in.) =	5.545	acre-feet
50-yr Runoff Volume (P1 = 2.25 in.) =	6.943	acre-feet
100-yr Runoff Volume (P1 = 2.52 in.) =	8.773	acre-feet
500-yr Runoff Volume (P1 = 3.2 in.) =	12.674	acre-feet
Approximate 2-yr Detention Volume =	1.520	acre-feet
Approximate 5-yr Detention Volume =	2.158	acre-feet
Approximate 10-yr Detention Volume =	3.088	acre-feet
Approximate 25-yr Detention Volume =	3.537	acre-feet
Approximate 50-yr Detention Volume =	3.723	acre-feet
Approximate 100-yr Detention Volume =	4.360	acre-feet

Optional User Override 1-hr Precipitation

1.19	inches
1.50	inches
1.75	inches
2.00	inches
2.25	inches
2.52	inches
3.20	inches

Stage-Storage Calculation

Zone 1 Volume (WQCV) =	0.827	acre-feet
Zone 2 Volume (EURV - Zone 1) =	1.277	acre-feet
Zone 3 (100yr + 1 / 2 WQCV - Zones 1 & 2) =	2.669	acre-feet
Total Detention Basin Volume =	4.774	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

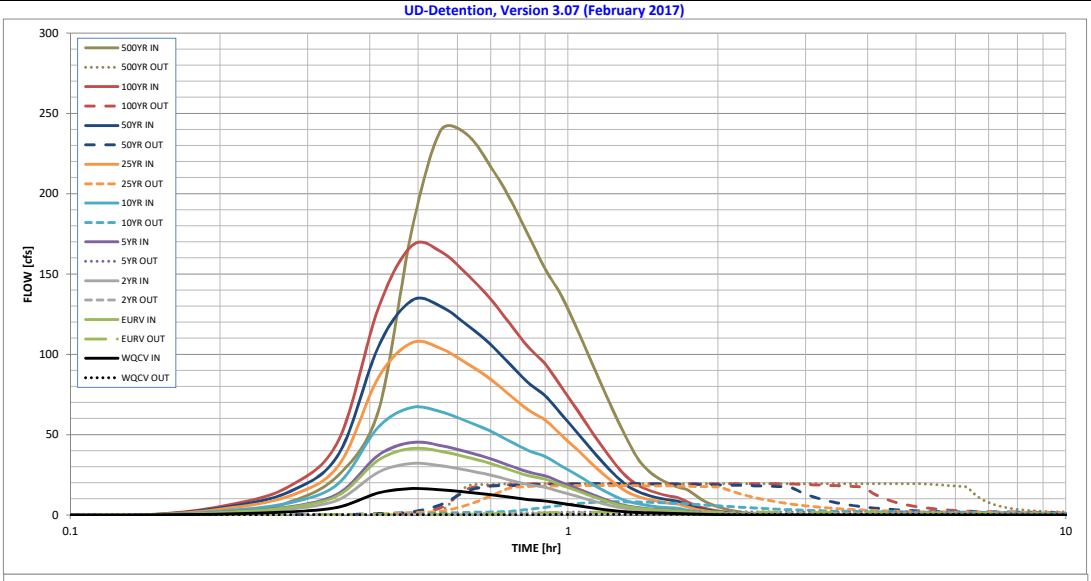
Staff recommends changing the title to something along the lines on Detention Basin "D" (interim) or (filing 10)

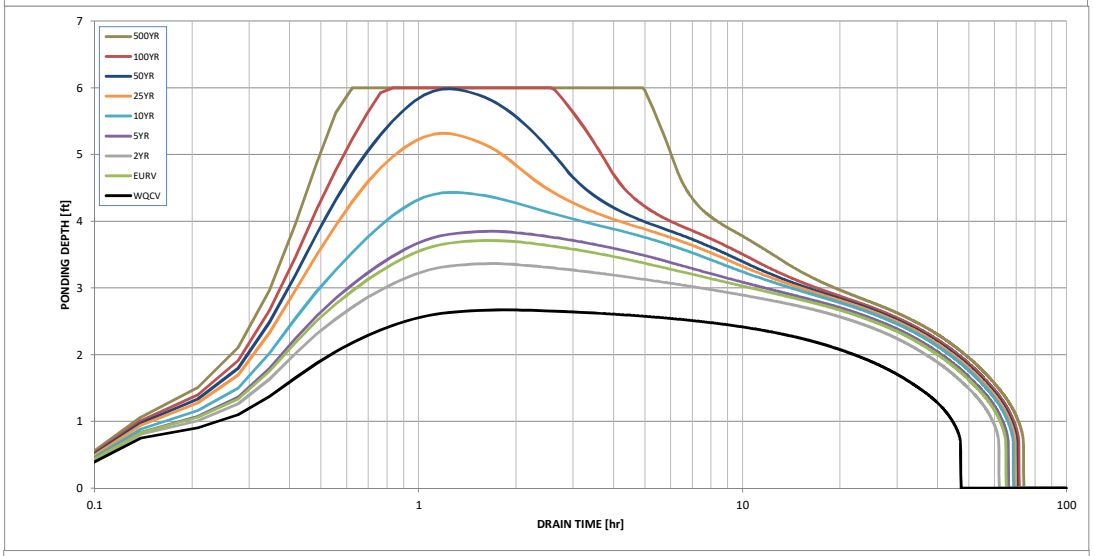
Depth Increment = ft

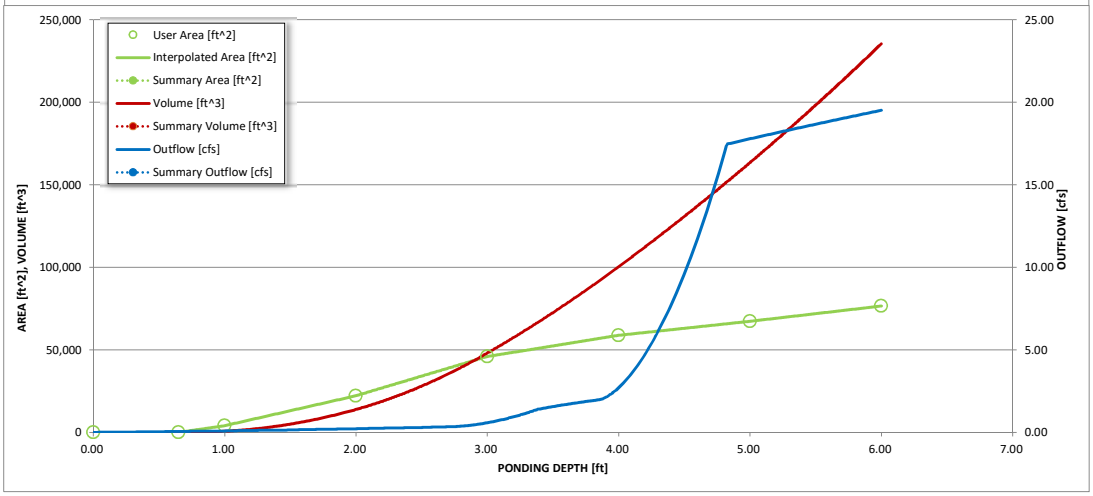
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	26	0.001		
	--	0.65	--	--	--	26	0.001	17	0.000
	--	1.00	--	--	--	4,072	0.093	694	0.016
	--	2.00	--	--	--	22,223	0.510	13,660	0.314
	--	3.00	--	--	--	45,991	1.056	47,988	1.102
	--	4.00	--	--	--	58,835	1.351	100,401	2.305
	--	5.00	--	--	--	67,328	1.546	163,483	3.753
	--	6.00	--	--	--	76,577	1.758	235,435	5.405

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)







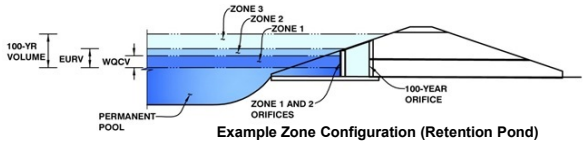
S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: The Glen at Widefield Filing 10,11 & Designeated Future Area

Basin ID: D'



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.72	0.827	Orifice Plate
Zone 2 (EURV)	3.85	1.277	Orifice Plate
(100+1/2WQCV)	5.64	2.669	Weir&Pipe (Rect.)
		4.774	Total

The basin detail shows a circular outlet pipe. Please revise accordingly.

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	ft²
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 =	1.042E-02	ft²
Depth at top of Zone using Orifice Plate =	3.86	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 =	1.50	sq. inches (diameter = 1-3/8 inches)	Elliptical Slot Area =	N/A	ft²

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	0.50	1.00	1.50	2.00	2.50		
Orifice Area (sq. inches)	1.50	1.50	1.50	1.50	1.50	1.50		

	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 =	2.72	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	3.85	N/A	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =	8.00	N/A	inches

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected	
Vertical Orifice Area =	0.35	N/A	ft²
Vertical Orifice Centroid =	0.33	N/A	feet

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

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	3.86	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	6.25	N/A	feet
Overflow Weir Slope =	4.00	N/A	H:V (enter zero for flat grate)
Horiz. Length of Weir Sides =	5.00	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 =	5.11	N/A	feet
Over Flow Weir Slope Length =	5.15	N/A	feet
Grate Open Area / 100-yr Orifice Area =	13.53	N/A	should be ≥ 4
Overflow Grate Open Area w/o Debris =	22.55	N/A	ft²
Overflow Grate Open Area w/ Debris =	11.27	N/A	ft²

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

	Zone 3 Rectangular	Not Selected	
Depth to Invert of Outlet Pipe =	0.33	N/A	ft (distance below basin bottom at Stage = 0 ft)
Rectangular Orifice Width =	24.00	N/A	inches
Rectangular Orifice Height =	10.00		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Rectangular	Not Selected	
Outlet Orifice Area =	1.67	N/A	ft²
Outlet Orifice Centroid =	0.42	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	N/A	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	6.00	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	1.49	feet
Spillway Crest Length =	24.00	feet	Stage at Top of Freeboard =	8.49	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	1.76	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) =	0.827	2.104	1.627	2.300	3.429	5.545	6.943	8.773	12.674
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	0.827	2.104	1.627	2.299	3.428	5.542	6.942	8.767	12.672
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.02	0.03	0.26	0.83	1.15	1.53	2.29
Predevelopment Peak Q (cfs) =	0.0	0.0	1.0	1.6	16.3	51.5	71.1	94.8	142.2
Peak Inflow Q (cfs) =	16.5	41.4	32.1	45.2	67.0	107.3	133.6	167.6	239.3
Peak Outflow Q (cfs) =	0.3	1.8	1.3	2.0	8.3	18.4	19.5	19.5	19.5
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	1.2	0.5	0.4	0.3	0.2	0.1
Structure Controlling Flow =	Plate	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Overflow Grate 1	Outlet Plate 1	Outlet Plate 1	N/A	N/A
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	0.3	0.7	0.7	0.7	0.7
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) =	44	58	56	58	58	54	52	50	46
Time to Drain 99% of Inflow Volume (hours) =	**46**	62	59	63	64	63	62	62	61
Maximum Ponding Depth (ft) =	2.67	3.71	3.36	3.85	4.13	5.32	5.99	6.00	6.00
Area at Maximum Ponding Depth (acres) =	0.88	1.27	1.16	1.30	1.43	1.61	1.75	1.76	1.76
Maximum Volume Stored (acre-ft) =	0.783	1.926	1.501	2.093	2.904	4.242	5.370	5.405	5.405

update the design so that the release rate is less than or equal to the pre-development rate

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]
4.16 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:04:10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydrograph	0:08:19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Constant	0:12:29	0.73	1.78	1.39	1.93	2.82	4.32	5.23	6.31	8.36
1.202	0:16:38	1.96	4.86	3.79	5.29	7.78	12.18	14.94	18.38	25.27
	0:20:48	5.03	12.48	9.72	13.59	19.98	31.28	38.37	47.22	64.97
	0:24:58	13.82	34.24	26.69	37.31	54.80	85.70	105.03	129.12	177.29
	0:29:07	16.46	41.41	32.13	45.18	66.99	107.25	133.60	167.62	239.34
	0:33:17	15.72	39.66	30.75	43.29	64.32	103.72	129.89	164.06	237.39
	0:37:26	14.31	36.10	27.99	39.40	58.53	94.69	118.82	150.45	218.69
	0:41:36	12.80	32.42	25.11	35.40	52.69	85.34	107.15	135.73	197.45
	0:45:46	11.07	28.20	21.80	30.82	46.03	74.81	94.08	119.40	174.20
	0:49:55	9.64	24.51	18.94	26.81	40.14	65.40	82.31	104.53	152.63
	0:54:05	8.73	22.22	17.17	24.28	36.28	58.90	73.99	93.77	136.41
	0:58:14	7.22	18.53	14.30	20.27	30.36	49.53	62.43	79.41	116.29
	1:02:24	5.91	15.29	11.77	16.73	25.12	41.11	51.86	66.04	96.84
	1:06:34	4.57	12.00	9.20	13.14	19.85	32.72	41.42	52.94	78.09
	1:10:43	3.42	9.15	6.98	10.05	15.29	25.37	32.21	41.28	61.14
	1:14:53	2.47	6.74	5.11	7.41	11.37	19.05	24.27	31.21	46.48
	1:19:02	1.91	5.11	3.90	5.61	8.56	14.22	18.05	23.12	34.30
	1:23:12	1.57	4.15	3.18	4.56	6.90	11.38	14.40	18.37	27.07
	1:27:22	1.33	3.51	2.69	3.84	5.81	9.56	12.08	15.40	22.62
	1:31:31	1.17	3.06	2.35	3.36	5.06	8.31	10.48	13.33	19.52
	1:35:41	1.05	2.75	2.11	3.01	4.53	7.42	9.35	11.88	17.36
	1:39:50	0.97	2.52	1.94	2.76	4.15	6.79	8.54	10.85	15.82
	1:44:00	0.71	1.86	1.43	2.04	3.08	5.10	6.47	8.29	12.30
	1:48:10	0.52	1.36	1.04	1.48	2.24	3.68	4.67	5.97	8.85
	1:52:19	0.38	1.00	0.77	1.09	1.65	2.73	3.46	4.43	6.57
	1:56:29	0.28	0.74	0.57	0.81	1.23	2.03	2.57	3.29	4.88
	2:00:38	0.20	0.54	0.41	0.59	0.90	1.49	1.89	2.43	3.61
	2:04:48	0.14	0.38	0.29	0.42	0.64	1.07	1.37	1.76	2.62
	2:08:58	0.10	0.28	0.21	0.31	0.47	0.78	0.99	1.27	1.89
	2:13:07	0.07	0.19	0.14	0.21	0.32	0.55	0.70	0.90	1.35
	2:17:17	0.04	0.12	0.09	0.13	0.21	0.36	0.46	0.60	0.91
	2:21:26	0.02	0.07	0.05	0.07	0.12	0.21	0.27	0.35	0.55
	2:25:36	0.01	0.03	0.02	0.03	0.05	0.10	0.13	0.17	0.27
	2:29:46	0.00	0.01	0.00	0.01	0.01	0.03	0.04	0.06	0.09
	2:33:55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:38:05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:42:14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:46:24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:50:34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:54:43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:58:53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:03:02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:07:12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:11:22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:15:31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:19:41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:23:50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:28:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:32:10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:36:19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:44:38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:48:48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:52:58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:57:07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:01:17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:09:36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:13:46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:17:55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:22:05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:26:14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:34:34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:38:43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:42:53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:47:02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:51:12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:59:31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

The Glen at Widefield
Detention Volume Calculations

Detention Basin 'D' Earthwork (Sept. 27, 2019)

Elevation	Area (A)	Avg. Area	Volume	Depth	Cumulative Volume		Elev.
5665.7	0sf						
5671	84sf	42sf	224cf	5.3 ft	**224cf**	**0.01ac-ft**	5671
5672	4,072sf	2,078sf	2,078cf	6.3 ft	**2,302cf**	**0.05ac-ft**	5672
5673	22,223sf	13,148sf	13,148cf	7.3 ft	**15,450cf**	**0.35ac-ft**	5673
5674	45,991sf	34,107sf	34,107cf	8.3 ft	**49,557cf**	**1.14ac-ft**	5674
5675	58,835sf	52,413sf	52,413cf	9.3 ft	**101,970cf**	**2.34ac-ft**	5675
5676	67,328sf	63,081sf	63,081cf	10.3 ft	**165,051cf**	**3.79ac-ft**	5676
5677	76,577sf	71,953sf	71,953cf	11.3 ft	**237,004cf**	**5.44ac-ft**	5677

Average End Area Formula: V = (A1+A2)/2 x Elev Difference

WQCV =	34,800 cf	0.99 ac-ft	5687.64 ft
100yr Volume =	158,123 cf	3.63 ac-ft	5676.07 ft
100yr Volume + 1/2 WQCV =	178,160 cf	4.09 ac-ft	5676.45 ft
		Detention Freeboard Depth =	-3.45 ft
Spillway Crest =	-2,856 cf	-0.07 ac-ft	5673.00 ft

Orignal Detention Basin 'D' Earthwork (Preliminary)

Elevation	Area (A)	Avg. Area	Volume	Depth	Cumulative Volume		Elev.
5665.7	0sf						
5667	39,170sf	19,585sf	25,461cf	1.3 ft	**25,461cf**	**0.58ac-ft**	5667
5668	42,246sf	40,708sf	40,708cf	2.3 ft	**66,169cf**	**1.52ac-ft**	5668
5669	45,423sf	43,835sf	43,835cf	3.3 ft	**110,004cf**	**2.53ac-ft**	5669
5670	48,700sf	47,062sf	47,062cf	4.3 ft	**157,065cf**	**3.61ac-ft**	5670
5671	52,078sf	50,389sf	50,389cf	5.3 ft	**207,454cf**	**4.76ac-ft**	5671
5672	55,556sf	53,817sf	53,817cf	6.3 ft	**261,271cf**	**6.00ac-ft**	5672
5673	59,134sf	57,345sf	57,345cf	7.3 ft	**318,616cf**	**7.31ac-ft**	5673

Average End Area Formula: V = (A1+A2)/2 x Elev Difference

WQCV =	34,800 cf	0.99 ac-ft	5667.23 ft
100yr Volume =	158,123 cf	3.63 ac-ft	5670.02 ft
100yr Volume + 1/2 WQCV =	178,160 cf	4.09 ac-ft	5670.42 ft
		Detention Freeboard Depth =	2.58 ft
Spillway Crest =	308,232 cf	7.08 ac-ft	5673.00 ft

xxxxx

Detention Area Calculations

Full-Spectrum Detention Sizing (Excess Urban Runoff Flow Control)

Detention Area	Total Acres	% Imperv.	Soil Group	WQCV a	WQCV Z	WQCV Depth	WQCV Factor	WQCV Volume	EURV Depth	EURV Volume	K_{100}	V_{100}	Detention Req'd Volume 100-yr (V_{100})	U_{10}	U_{100}	Recommended Release Rate Q_{10}	Recommended Release Rate Q_{100}
Detention D DP 94	62.07 ac	32.8%	B	1.0	1.2	0.16in	0.016	0.993ac-ft 43,239 cf	0.41in	2.135ac-ft 92,990 cf	0.059	3.63ac-ft 158,217 cf	**3.63 ac-ft** **158,217 cf**	0.23	0.85	14.3cfs	52.8cfs

WIR (Watershed Inches of Runoff) taken from Fig. EDB-2, Volume 3, Urban Storm Drainage Criteria Manual for the basin imperviousness shown.

WIR = Depth = $a*(0.91*I^3 -1.19*I^2 +0.78*I)$

I = % Impervious a = Drain Time

a (40hr) = 1.0	Extended Detention Basin
a (24hr) = 0.9	
a (12hr) = 0.8	Bioretention/Porous Lanscape Detention

WQCV Factor (Water Quality Capture Volume) = (WIR/12) x Z

Z = Volume Factor

Z (Extended Detention Basin) =	1.2
Z (Porous Landscape Detention) =	1.0

$EURV_K$ = Depth = Excess Urban Runoff Volume in watershed inshes (K = A, B or CD)

$EURV_A = 1.1 \times (2.0491i - 0.1113)$ (Equation SO-11)

$EURV_B = 1.1 \times (1.2846i - 0.0461)$ (Equation SO-12)

$EURV_{CD} = 1.1 \times (1.1381i - 0.0339)$ (Equation SO-13)

Required Detention Storage Volume (Vx) = Kx A (Equation SO-1)

$K_5 = (0.77I-2.65)/1000$ (Equation SO-4)

$K_{10} = (0.95I-1.90)/1000$ (Equation SO-3)

$K_{100} = (1.78I-0.002I^2-3.56)/900$ (Equation SO-2)

Allowable Release Rate = Area * Ux

Ux = Allowable Max. Unit Flow Release Rates (cfs/acre) of tributary catchment

APPENDIX B.1

Supporting Detention Basin Tables and Figures

beneficial if a project is being phased or when adequate land is not available to combine all of the elements in one facility.

4.1.1 Flood Control Volume

UDFCD has developed empirical equations for estimating the total required storage volume that can be applied to on-site, multi-level ponds or to on-site or sub-regional FSD ponds. The empirical equations include:

$$V_i = K_i A \quad \text{Equation 13-1}$$

For NRCS soil types B, C and D.

$$K_{100} = (1.78 \cdot I - 0.002 I^2 - 3.56) / 900 \quad \text{Equation 13-2}$$

$$K_5 = (0.77 \cdot I - 2.65) / 1{,}000 \quad \text{Equation 13-3}$$

For NRCS soil Type A:

$$K_{100A} = (-0.00005501 \cdot I^2 + 0.030148 \cdot I - 0.12) / 12 \quad \text{Equation 13-4}$$

Where:

V_i = required volume, with i= year storm, acre-feet

K_i = empirical volume coefficient, with i= year storm

i = return period for storm event, years

I = fully developed tributary basin imperviousness, %

A = tributary drainage basin area, acres

These equations can be applied to calculate the total detention storage for drainage basins up to about 130 acres. When more than one soil type or land use is present in the drainage basin, the storage volume must be weighted by the proportionate areas of each soil type and/or land use. For FSDs, the EURV need not be added to this volume. See UDFCD Manual Volume 2, Storage Chapter for a full description of this method.

4.1.2 EURV

UDFCD has developed empirical equations for estimating the EURV portion of the storage volume that can be applied to on-site, sub-regional or regional FSD ponds.

The empirical equations are as follows:

For NRCS Soil Group A:

$$EURV_A = 1.1\ (2.0491(I/100) - 0.1113) \quad \text{Equation 13-5}$$

For NRCS Soil Group B:

$$EURV_B = 1.1\ (1.2846(I/100) - 0.0461) \quad \text{Equation 13-6}$$

For NRCS Soil Group C/D:

$$EURV_{CD} = 1.1\ (1.1381(I/100) - 0.0339) \qquad \text{Equation 13-7}$$

Where:

$EURV_K$ = Excess Urban Runoff Volume in watershed inches, K=A, B or C/D soil group

I = drainage basin imperviousness, %

These equations apply to all FSDs and the EURV need not be added to the flood control volume or to the WQCV. When more than one soil type or land use is present in the drainage basin, the EURV must be weighted by the proportionate areas of each soil type and/or land use. If hydrologic routing is used to size the flood control volume, the EURV remains the same as calculated by these equations and is included in the pond's stage/storage configuration for modeling.

4.1.3 Initial Surcharge Volume

The initial surcharge volume is at least 0.3 percent of the WQCV and should be 4- to 12-inches deep. The initial surcharge volume is included in the WQCV and does not increase the required total storage volume.

4.1.4 Design Worksheets

The Full Spectrum Worksheet in the UD-Detention Spreadsheet performs all of these calculations for the standard designs. For multi-level ponds, the flood control volumes are calculated for the two design storm frequencies: the major storm and the minor storm.

4.2 Allowable Release Rates

Allowable release rates from detention facilities vary with the type of facility and with the storage volume type, as follows:

- **Flood Storage Volume**: The flood storage release rates are determined by the allowable release rates that are intended to approximate storm event runoff rates from the undeveloped upstream drainage basin.
- **EURV**: The EURV release rate is determined based on a72-hour drain time. The purpose of this slow release rate is to mitigate the impacts of increased runoff volumes due to development by reducing the potential for downstream erosion.
- **WQCV**: The WQCV release rate is determined based on a 40-hour drain time for extended detention basins. The purpose of this slow release rate is to provide time for pollutants to settle, The WQCV is incorporated into the EURV and works with it to release less erosive flows. The method for determining this design rate is described in Chapter 3 of Volume 2 of this Manual.

4.2.1 Flood Storage Release Rates

Allowable releases rates from the flood storage element of detention may be based on generalized average unit runoff rates or estimates of pre-development runoff rates. Allowable unit release rates (cfs/ac) may be used for any type of detention, however, when a hydrograph routing method is applied (for regional or

Safety Grates

Safety grates are intended to keep people and animals from inadvertently entering a storm drain. They are sometimes required even when debris entering a storm drain is not a concern. The grate on top of the outlet drop box is considered a safety grate and should be designed accordingly. The danger associated with outlet structures is the potential associated with pinning a person or animal to unexposed outlet pipe or grate. See the *Culverts and Bridges* chapter of Volume 2 of this manual for design criteria related to safety grates.

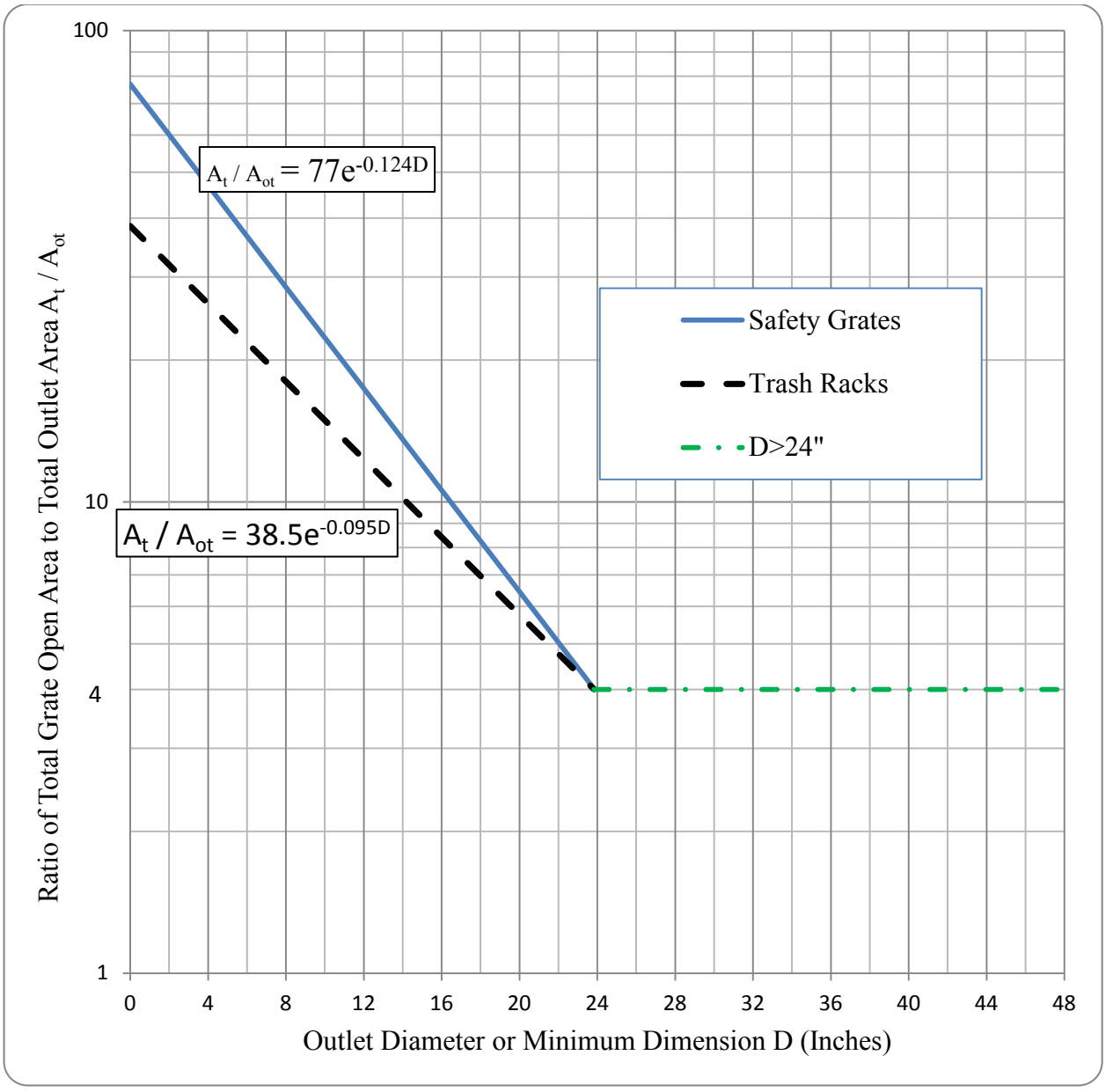
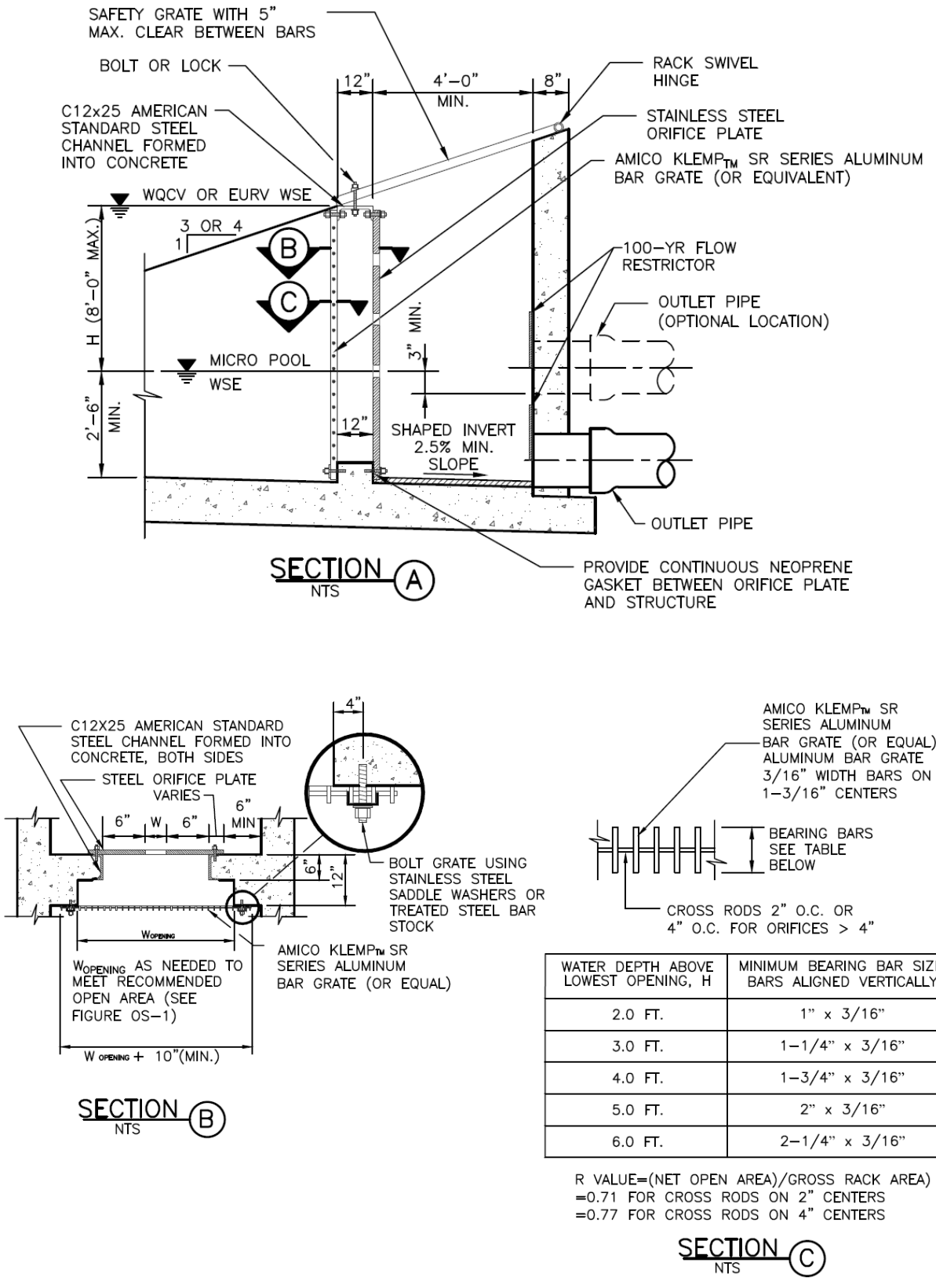


Figure OS-1. Trash Rack Sizing

Table OS-2. Thickness of steel water quality plate

Steel plate thickness (in inches) based on design depth and span of plate											
		Head (feet)									
		3	4	5	6	7	8	9	10	11	12
Span (feet)	1	0.1875	0.1875	0.1875	0.1875	0.1875	0.1875	0.1875	0.1875	0.1875	0.1875
	2	0.1875	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500
	3	0.2500	0.2500	0.3750	0.3750	0.3750	0.3750	0.3750	0.3750	0.3750	0.5000
	4	0.2500	0.3750	0.3750	0.3750	0.3750	0.5000	0.5000	0.5000	0.5000	0.5000



WATER DEPTH ABOVE LOWEST OPENING, H	MINIMUM BEARING BAR SIZE, BARS ALIGNED VERTICALLY
2.0 FT.	1" x 3/16"
3.0 FT.	1–1/4" x 3/16"
4.0 FT.	1–3/4" x 3/16"
5.0 FT.	2" x 3/16"
6.0 FT.	2–1/4" x 3/16"

Figure OS-6. Typical outlet structure with bar grate trash rack

Figure 13-9. Concept for Integral Forebay at Pipe Outfall

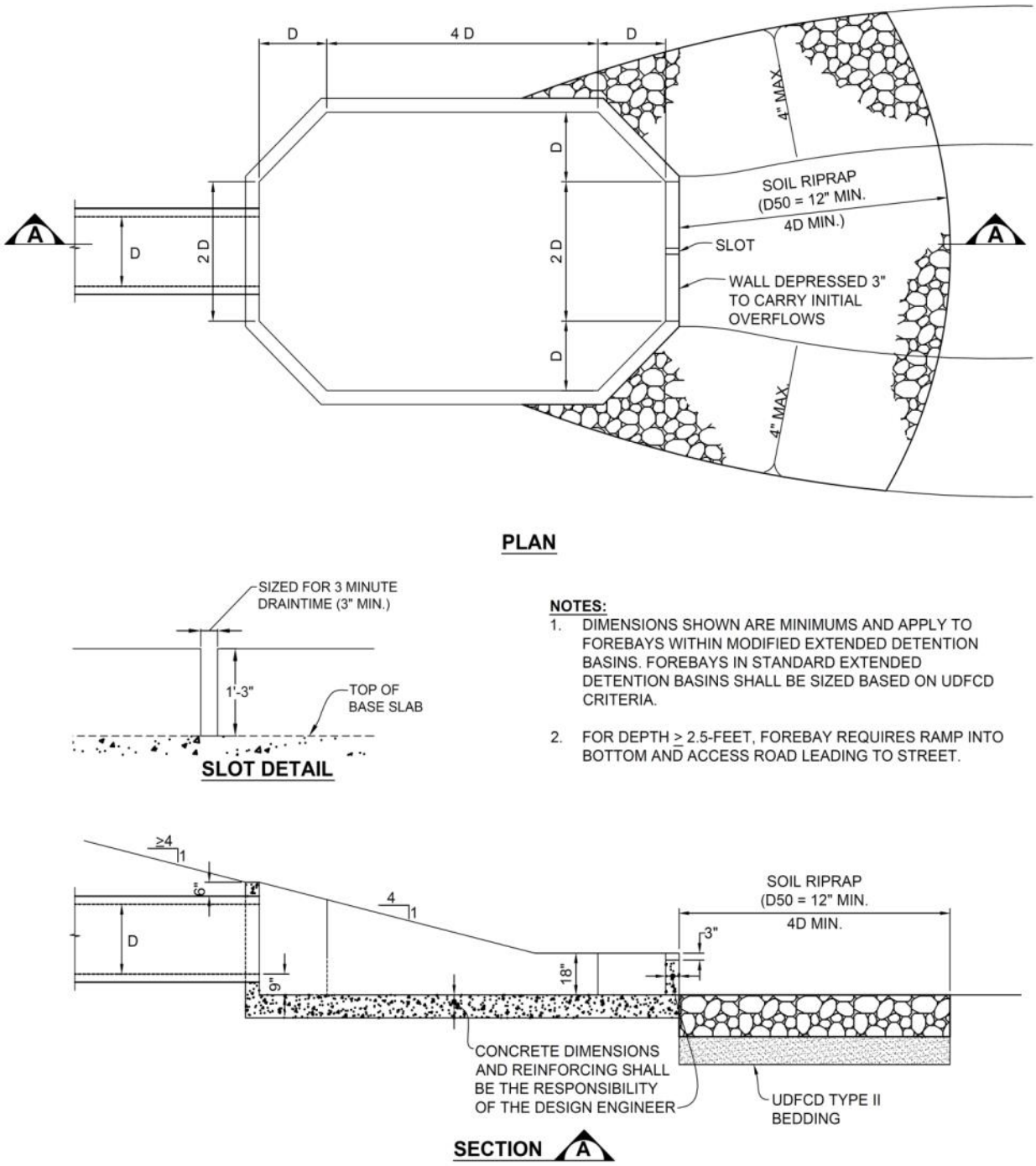


Figure 13-11. Concept for Outlet Structure with Flared Wingwalls and Handrail
(Integral Micropool Shown)

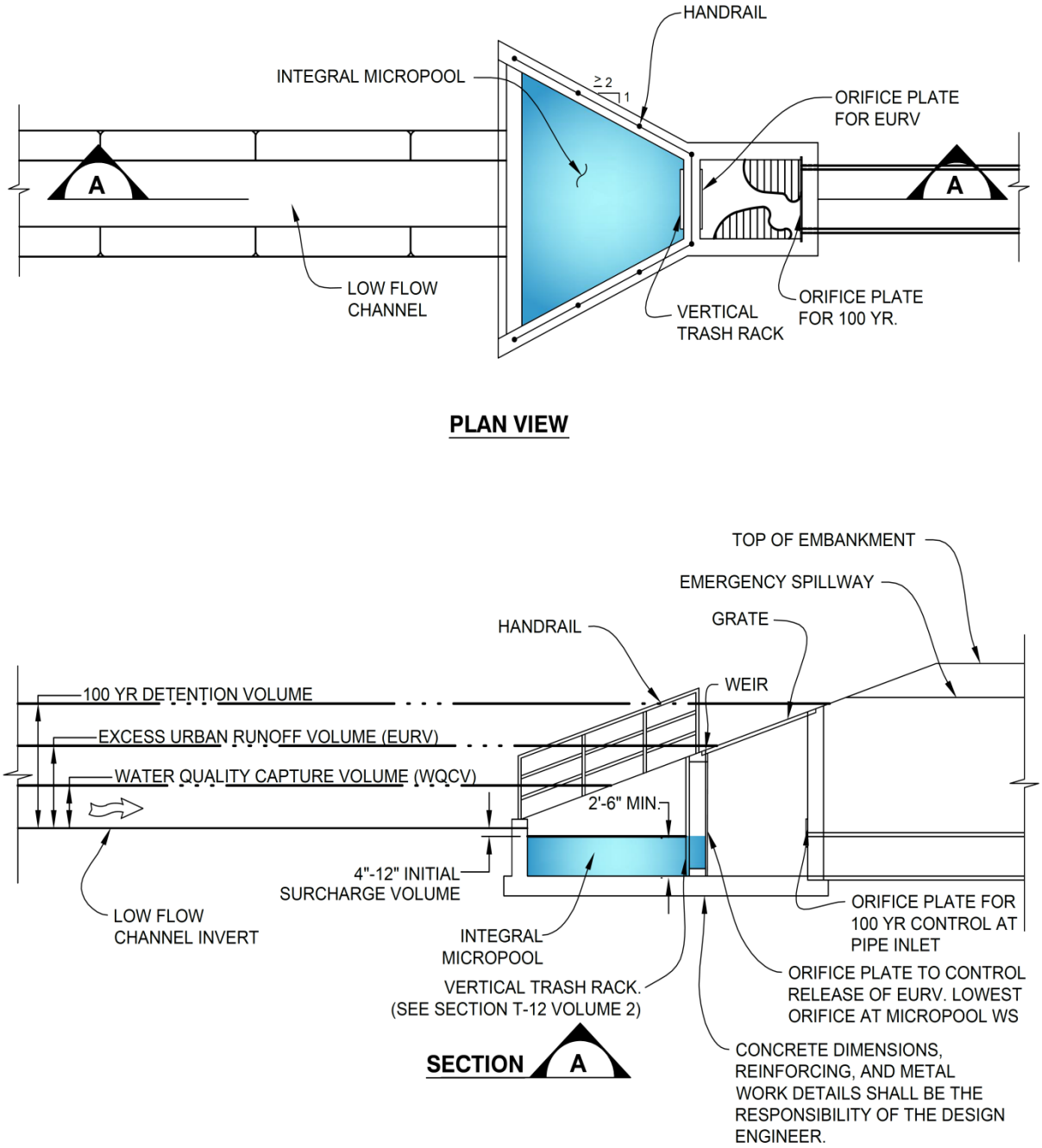


Figure 13-12c. Emergency Spillway Protection

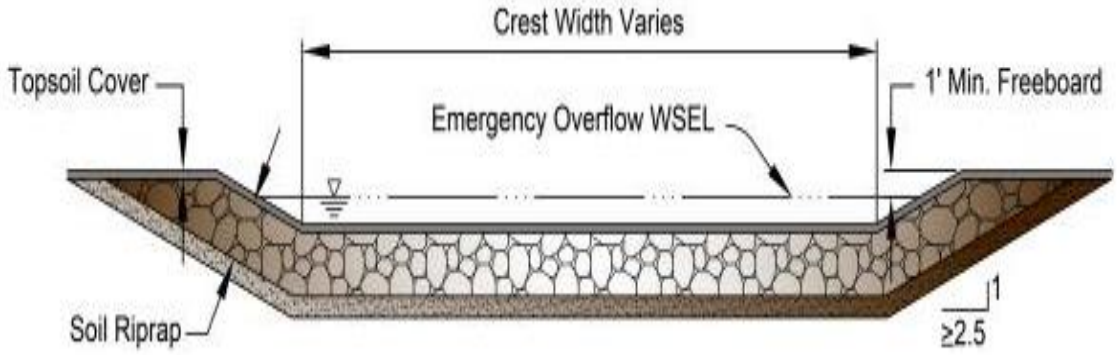
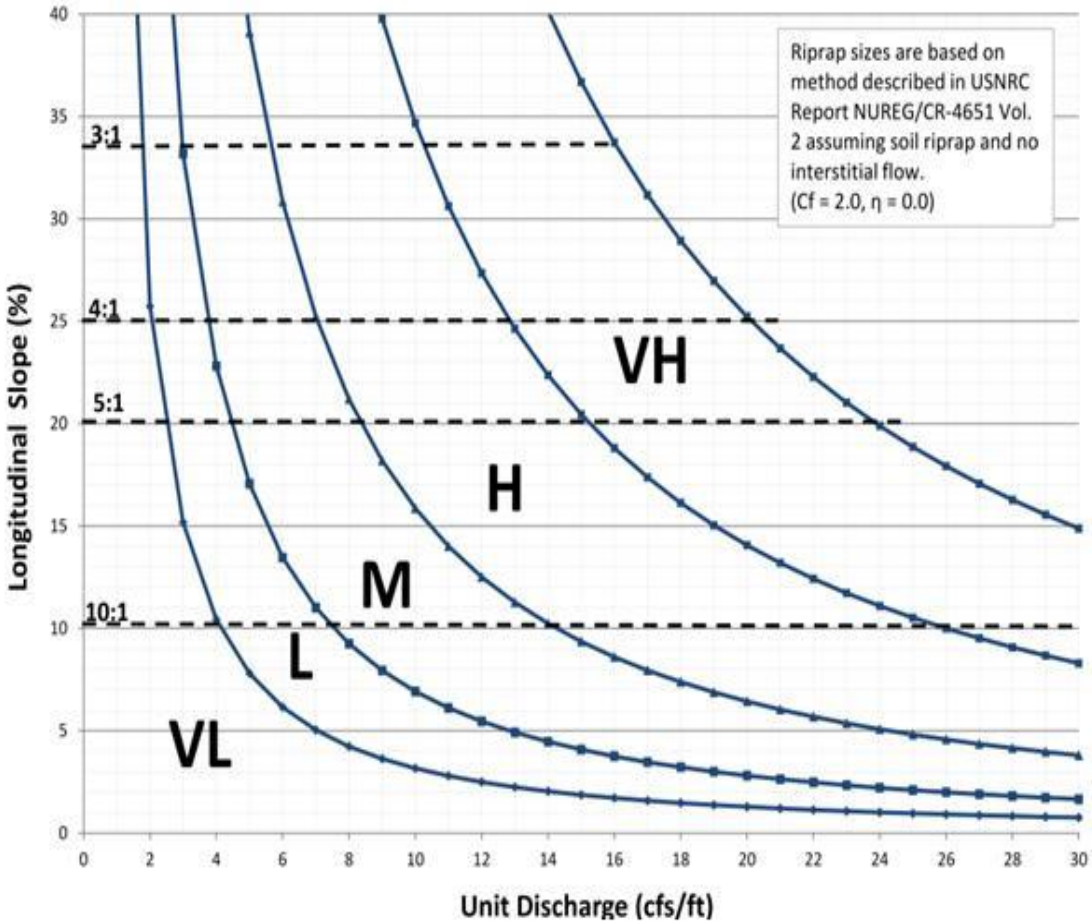


Figure 13-12d. Riprap Types for Emergency Spillway Protection



APPENDIX C

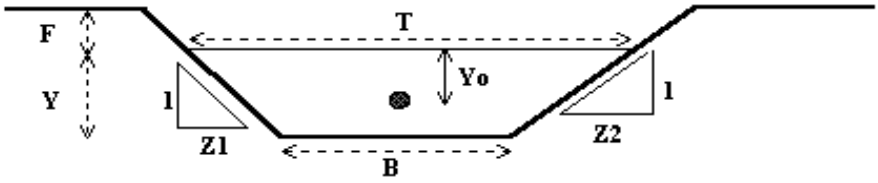
Hydraulic Calculations

Inlet Summary and Calculations
Street Capacity Calculations – UD Inlet
Inlet Capacity Calculations – UD Inlet
Pipe Sizing Calculations
UDSewer Plan Schematic
UDSewer Input and Output Tables: 5-year and 100-year Storm Events
Pipe Outlet Erosion Protection Calculations
Open Channel Calculations

Normal Flow Analysis - Trapezoidal Channel

Project: Glen at Widefield Filing No. 10

Channel ID: Detention Basin D Open Channel to Markscheffel Side Ditch



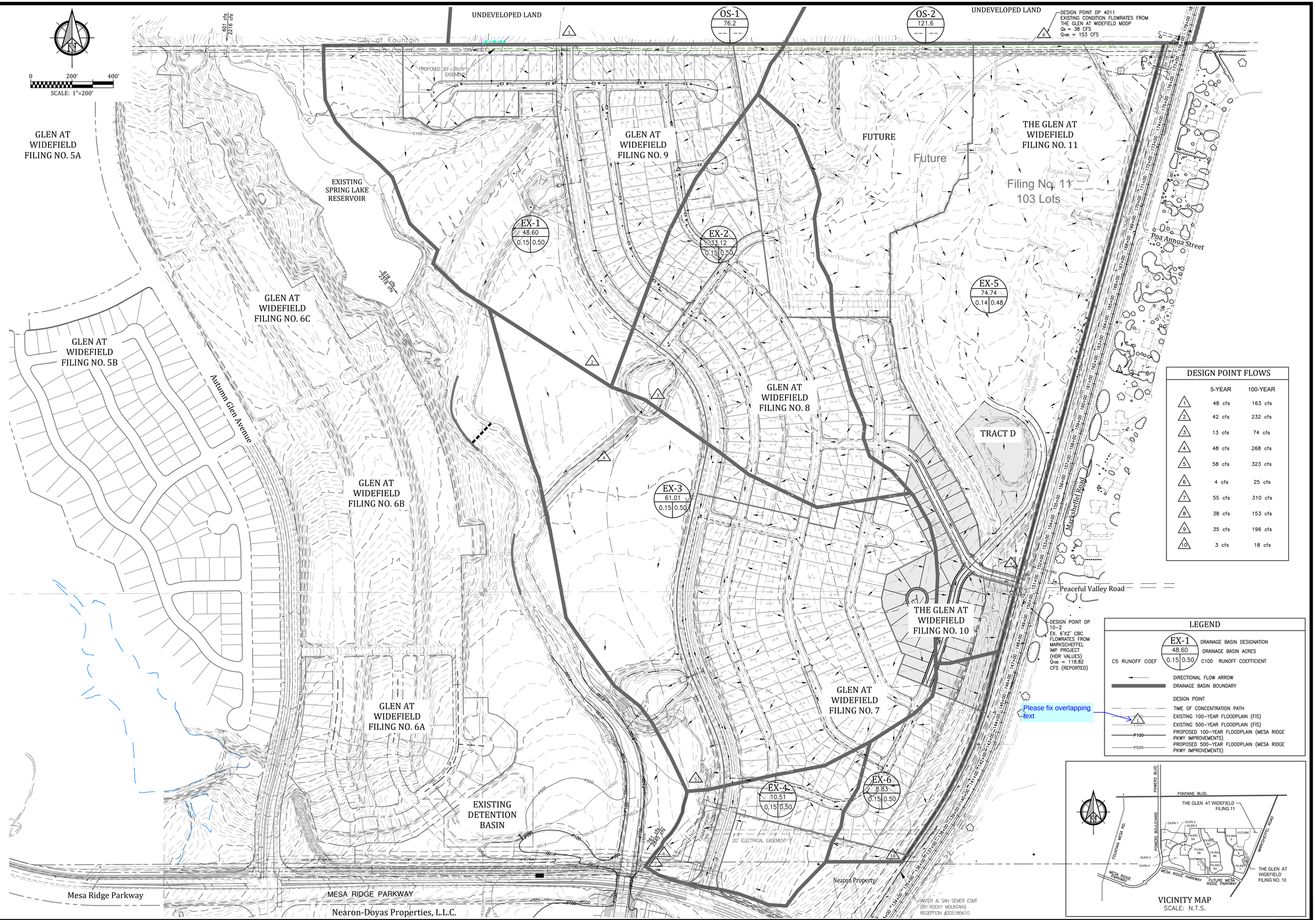
Design Information (Input)			
Channel Invert Slope	So =	0.0044	ft/ft
Manning's n	n =	0.024	
Bottom Width	B =	4.00	ft
Left Side Slope	Z1 =	3.00	ft/ft
Right Side Slope	Z2 =	3.00	ft/ft
Freeboard Height	F =	1.00	ft
Design Water Depth	Y =	**1.00**	ft

Normal Flow Condtion (Calculated)			
Discharge	**Q =**	**22.25**	cfs
Froude Number	**Fr =**	**0.67**	
Flow Velocity	**V =**	**3.18**	fps
Flow Area	A =	7.00	sq ft
Top Width	T =	10.00	ft
Wetted Perimeter	P =	10.32	ft
Hydraulic Radius	R =	0.68	ft
Hydraulic Depth	D =	0.70	ft
Specific Energy	Es =	1.16	ft
Centroid of Flow Area	Yo =	0.43	ft
Specific Force	Fs =	0.32	kip

APPENDIX D

Existing and Proposed Drainage Plans

Sheet 1 - Drainage Plan Existing Condition
Sheet 2 - Final Drainage Plan Developed Conditions Onsite
Sheet 3 – Developed Conditions Offsite



DESIGN POINT FLOWS	5-YEAR	100-YEAR
1	48 cfs	163 cfs
2	42 cfs	232 cfs
3	13 cfs	74 cfs
4	48 cfs	268 cfs
5	58 cfs	323 cfs
6	4 cfs	25 cfs
7	55 cfs	310 cfs
8	38 cfs	153 cfs
9	35 cfs	196 cfs
10	3 cfs	18 cfs

LEGEND

- EX-1 / 48.60 / 0.15 | 0.50 — DRAINAGE BASIN DESIGNATION; DRAINAGE BASIN ACRES; C5 RUNOFF COEF; C100 RUNOFF COEFFICIENT
- DIRECTIONAL FLOW ARROW
- DRAINAGE BASIN BOUNDARY
- DESIGN POINT
- TIME OF CONCENTRATION PATH
- EXISTING 100-YEAR FLOODPLAIN (FIS)
- EXISTING 500-YEAR FLOODPLAIN (FIS)
- P100 — PROPOSED 100-YEAR FLOODPLAIN (MESA RIDGE PKWY IMPROVEMENTS)
- P500 — PROPOSED 500-YEAR FLOODPLAIN (MESA RIDGE PKWY IMPROVEMENTS)

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

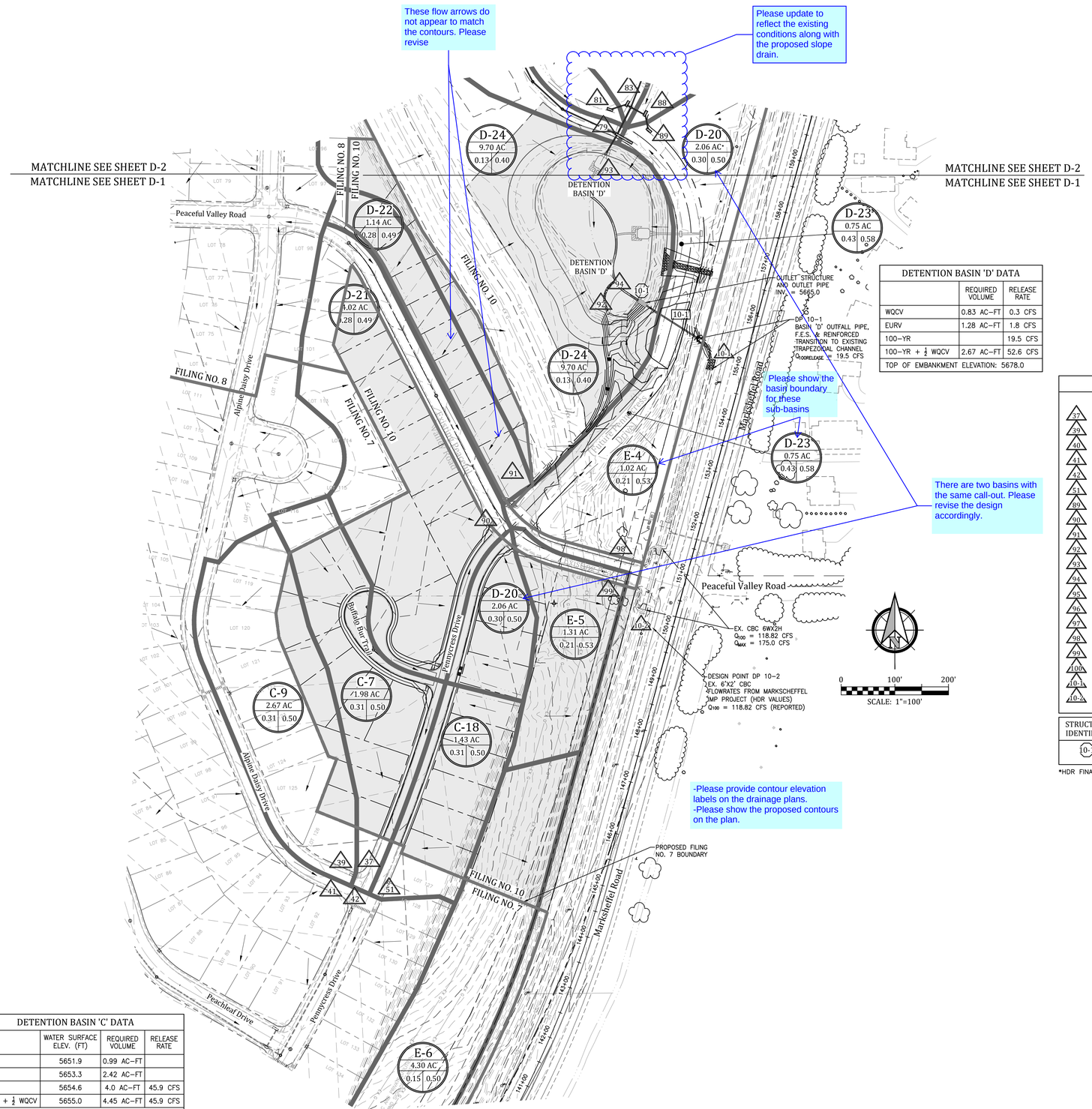
WIDEFIELD Investment Group

THE GLEN AT WIDEFIELD
FILING NO. 10
HISTORIC DRAINAGE BASINS (WITH CURRENT CONDITIONS)
El Paso, County, Colorado

Project No.:	19016
Date:	September 27t, 2019
Design:	CJC
Drawn:	MJK
Check:	AMcC
Revisions:	

SHEET
H-1
1 of 3 Sheets

19016 Filing 10 – Drainage Plan.dwg/Sep 25, 2019



DETENTION BASIN 'D' DATA		
	REQUIRED VOLUME	RELEASE RATE
WQCV	0.83 AC–FT	0.3 CFS
EURV	1.28 AC–FT	1.8 CFS
100–YR		19.5 CFS
100–YR + ½ WQCV	2.67 AC–FT	52.6 CFS
TOP OF EMBANKMENT ELEVATION: 5678.0		

DETENTION BASIN 'C' DATA			
	WATER SURFACE ELEV. (FT)	REQUIRED VOLUME	RELEASE RATE
WQCV	5651.9	0.99 AC–FT	
EURV	5653.3	2.42 AC–FT	
100–YR	5654.6	4.0 AC–FT	45.9 CFS
100–YR + ½ WQCV	5655.0	4.45 AC–FT	45.9 CFS
SPILLWAY CREST ELEVATION: 5655.0			
TOP OF EMBANKMENT MINIMUM ELEVATION: 5657.0			

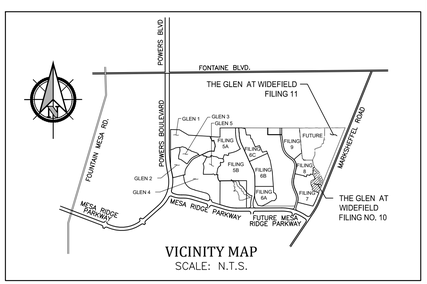
LEGEND

- C-4 / 2.67 AC / 0.31 0.50 — DRAINAGE BASIN DESIGNATION; DRAINAGE BASIN ACRES; C5 RUNOFF COEF; C100 RUNOFF COEFFICIENT
- 2.2 cfs / 4.3 cfs — 5–YEAR RUNOFF; 100–YEAR RUNOFF
- DIRECTIONAL FLOW ARROW
- DRAINAGE BASIN BOUNDARY
- 1 — DESIGN POINT
- TIME OF CONCENTRATION PATH
- 10 — HYDRAULIC STRUCTURE IDENTIFIER
- S10 — STORM SEWER IDENTIFIER
- PROPOSED STORM SEWER PIPE
- PROPOSED STORM SEWER MANHOLE
- PROPOSED STORM DRAINAGE CURB INLET
- (6020) — EXISTING CONTOURS
- 6020 — PROPOSED CONTOURS

DESIGN POINT FLOWS				
	5-YEAR	100-YEAR	5-YEAR	100-YEAR
37	2.2 cfs	6.0 cfs		
39	4.4 cfs	12.0 cfs		
40	1.3 cfs	3.5 cfs		
41	2.6 cfs	7.1 cfs		
42	9.0 cfs	24.6 cfs		
51	1.6 cfs	4.5 cfs		
89	2.0 cfs	5.6 cfs		
90	4.4 cfs	12.7 cfs		
91	1.2 cfs	3.6 cfs		
92	5.1 cfs	14.6 cfs		
93	35.9 cfs	103.7 cfs		
94	42.2 cfs	128.8 cfs		
95	3.2 cfs	14.9 cfs		
96	1.3 cfs	4.4 cfs		
97	0.9 cfs	3.5 cfs		
98	0.9 cfs	3.8 cfs		
99	1.1 cfs	4.6 cfs		
100	3.3 cfs	18.7 cfs		
10-1		19.5 cfs		
10-2		118.82 cfs*		

STRUCTURE IDENTIFIER	STRUCTURE DESCRIPTION	STRUCTURE IDENTIFIER	STRUCTURE DESCRIPTION
10-	10' CURB INLET	10-1	18–INCH RCP @ 0.47%

*HDR FINAL DRAINAGE REPORT VALUE FOR MARKSCHEFFEL IMPS PROJECT



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

WIDEFIELD Investment Group

THE GLEN AT WIDEFIELD
FILING NO. 10
DEVELOPED DRAINAGE BASINS (ON-SITE)
El Paso, County, Colorado

Project No.:	19016
Date:	September 27t, 2019
Design:	CJC
Drawn:	MJK
Check:	AMcC
Revisions:	

SHEET D-1

2 of 3 Sheets

19016 Filing 10 – Drainage Plan.dwg/Sep 25, 2019

UNDEVELOPED LAND

OS-2 | 121.6 AC | --- | ---

DESIGN POINT DP 4011
DEVELOPED CONDITION W/ DETENTION
FLOWRATES FROM THE GLEN AT WIDEFIELD MDDP
Q_5 = 64 CFS
Q_{100} = 157 CFS

OFFSITE RUNOFF FROM BASIN OS-2 TO BE CONVEYED IN ROADSIDE DITCH AS PART OF IMPROVEMENTS TO MARKSHEFFEL ROAD
REF. HDR STRUCTURE 'CV177'
77 LF ~ 2-36" RCP CULVERTS @ 0.3%
REPORTED Q_{100} = 87.06 CFS

EXISTING FLOWRATES FROM THE MARKSCHEFFEL IMP. PROJECT (HDR VALUES) REF. STRUCTURE 'CV168'
66 LF ~ 18" RCP @ 0.4%
Q_{100} = 5.03 CFS

SCALE: 1"=100'

LEGEND

- D-4 | 2.79 AC | 0.28 | 0.49 — DRAINAGE BASIN DESIGNATION; DRAINAGE BASIN ACRES; C5 RUNOFF COEF; C100 RUNOFF COEFFICIENT
- 2.2 cfs / 4.3 cfs — 5-YEAR RUNOFF / 100-YEAR RUNOFF
- DIRECTIONAL FLOW ARROW
- DRAINAGE BASIN BOUNDARY
- 1 — DESIGN POINT
- TIME OF CONCENTRATION PATH
- 10 / S10 — HYDRAULIC STRUCTURE IDENTIFIER; STORM SEWER IDENTIFIER
- PROPOSED STORM SEWER PIPE
- PROPOSED STORM SEWER MANHOLE
- PROPOSED STORM DRAINAGE CURB INLET
- (6020) — EXISTING CONTOURS
- 6020 — PROPOSED CONTOURS

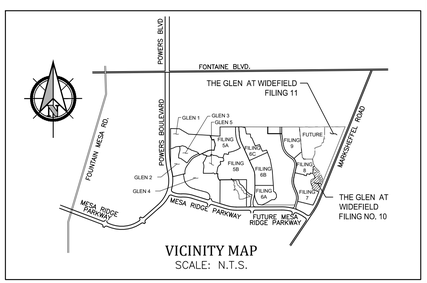
Please update the basin boundaries for the future areas as necessary to reflect the existing conditions not the future conditions

DESIGN POINT FLOWS

	5-YEAR	100-YEAR		5-YEAR	100-YEAR
68	1.4 cfs	4.2 cfs	83	6.9 cfs	20.0 cfs
69	2.6 cfs	7.5 cfs	84	3.1 cfs	9.0 cfs
70	1.7 cfs	5.0 cfs	85	6.8 cfs	19.6 cfs
71	4.1 cfs	11.8 cfs	86	8.4 cfs	24.4 cfs
72	1.6 cfs	4.5 cfs	87	9.0 cfs	26.2 cfs
73	0.6 cfs	1.8 cfs	88	10.8 cfs	31.8 cfs
74	4.6 cfs	13.3 cfs	89	2.0 cfs	5.6 cfs
75	9.1 cfs	26.5 cfs	90	4.4 cfs	12.7 cfs
76	10.3 cfs	29.9 cfs	91	1.2 cfs	3.6 cfs
77	2.2 cfs	6.5 cfs	92	5.1 cfs	14.6 cfs
78	12.1 cfs	34.9 cfs	93	35.9 cfs	103.7 cfs
79	13.7 cfs	39.6 cfs	94	42.2 cfs	128.8 cfs
80	2.3 cfs	6.6 cfs	95	3.2 cfs	14.9 cfs
81	3.1 cfs	8.9 cfs	96	1.3 cfs	4.4 cfs
82	3.8 cfs	11.0 cfs	97	0.9 cfs	3.5 cfs

DETENTION BASIN 'D' DATA

	REQUIRED VOLUME	RELEASE RATE
WQCV	0.99 AC-FT	
EURV	2.14 AC-FT	
100-YR	3.63 AC-FT	52.6 CFS
100-YR + ½ WQCV	4.09 AC-FT	52.6 CFS
TOP OF EMBANKMENT ELEVATION: 5673.0		



VICINITY MAP
SCALE: N.T.S.

MATCHLINE SEE SHEET D-1

MATCHLINE SEE SHEET D-1

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WIDEFIELD Investment Group

THE GLEN AT WIDEFIELD
FILING NO. 10
DEVELOPED DRAINAGE BASINS (OFF-SITE)
El Paso, County, Colorado

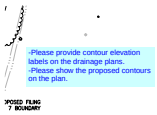
Project No.:	19016
Date:	September 27t, 2019
Design:	CJC
Drawn:	MJK
Check:	AMcC
Revisions:	

SHEET
D-2
3 of 3 Sheets

19016 Filing 10 – Drainage Plan.dwg/Sep 25, 2019

Drainage Report_V1.pdf Markup Summary

Locked (2)



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Page Label: 71
Lock: Locked
Author: Daniel Torres
Date: 12/5/2019 8:07:40 AM
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Color:
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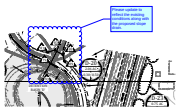
-Please provide contour elevation labels on the drainage plans.
-Please show the proposed contours on the plan.



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Please update to reflect the existing conditions along with the proposed slope drain.