FINAL DRAINAGE REPORT FOR RANCHO IRACEMA SUBDIVISION FILING NO. 2, LOT 2

(ELEPHANT ROCK TOWNHOMES DEVELOPMENT)

PREPARED BY
Rich Gallegos
RESPEC
102 S Tejon St., Suite 1110
Colorado Springs, CO 80903

PREPARED FOR
Mr. Todd Dorman
2760 N. Academy Blvd., Suite 302
Colorado Springs, CO 809017
719-213-9100

JANUARY 2023

Project Number W008.1

TABLE OF CONTENTS

APPENDIX

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 El Paso County and the Town of Palmer Lake 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.

_____

Richard G. Gallegos, PE Date
Registered Professional Engineer State of Colorado No. 36247

DEVELOPER'S STATEMENT:
I, Todd Dorman, have read and will comply with all of the requirements specified in this drainage report and plan.

_____

Business Name:

By:

Title: Owner

Address: 2760 N. Academy Blvd., Suite 302
Colorado Springs, CO 809017

PALMER LAKE STATEMENT:

Filed in accordance with the Palmer Lake Municipal Code as amended.

_____ _____
Director of Public Works Date

Conditions:

FINAL DRAINAGE REPORT
RANCHO IRACEMA SUBDIVISION FILING 2, LOT 2

PROJECT DESCRIPTION

This drainage report is for the development of the Rancho Iracema Subdivision Filing 2, Lot 2 as a townhome development. The currently vacant 13.00 acres site is located north of Colorado State Highway 105, approximately 300 feet west of Red Rocks Road. It is further described as the southern portion of Section 9, Township 11 South, Range 67 West of the 6th Principal Meridian in El Paso County, Colorado.

All of this subdivision is located in the Monument Creek drainage basin. Flows from the site drain directly into Monument Creek.

SOILS

The soil on the site can be described as having a rapid permeability, medium-surface runoff, and moderate to high hazard of erosion. See the Soils Map within Appendix A for reference. The soils within the site are:

Map Unit Symbol	Map Unit Name	Hydrologic Soil Group	Percentage of Site
71	Pring Coarse Sandy Loam	B	75.0%
93	Tomah-Crowfoot Complex	B	25.0%

FLOODPLAIN STATEMENT

No portion of the developed site is located within a designated FEMA 100-year floodplain according to the information published in the Federal Emergency Management Agency Flood Plain Map No. 08041CO257G, dated December 7, 2018.

METHOD OF COMPUTATION

The methodology utilized for this report is in accordance with the *El Paso County Drainage Criteria Manual, Volumes 1*, dated May 2014. The Rational Method for computation of runoff was used for determining Sub-Basin flows.

$Q = cia$

Where
- Q = maximum rate of runoff in cubic feet per second
- c = runoff coefficient representing drainage area characteristics
- i = average rainfall intensity, in inches per hour, for the duration required for the runoff to become established
- a = drainage basin size in acres

The storm recurrence intervals used for this study were the 5-year storm and the 100-year storm. The detention discharge for the proposed 0.731-acre-foot Full Spectrum Extended Detention Basin is 1.3 cfs for the 5-year storm and 13.7 cfs for the 100-year storm. The Colorado Urban Hydrograph Procedure (CUHP) was used to route flows through the proposed private detention basin. This procedure is described in more detail in the *Mile High Flood District Urban Storm Drainage Criteria Manual Volume 1*, shown below in Appendix C – Colorado Urban Hydrograph Procedure Summary.

The Mile High Flood District – Detention Version 4.05 (January 2022) spreadsheet was used to determine the required detention basin storage volume and outlet structure design. ManningSolver Version 1.019, also, was used in this analysis to calculate the Manning's normal depth within all proposed swales. MHFD Culvert Version 4.00 was used for hydraulic calculations for all culverts.

EXISTING DRAINAGE CONDITIONS

The existing 13.00-acre site is currently undeveloped. No roadways exist into the site. Approximately 90% of the parcel is covered with rangeland grasses with slopes varying from 10% to 4%. The existing Rancho Iracema Subdivision Filing 2, Lot 1 development partially drains onto this site through four off-site basins, however an existing detention facility reduces the existing flow to historic levels. For this reason, it is assumed that the existing Rancho Iracema Subdivision Filing 2, Lot 1 is undeveloped. An existing 2'x2' RCBC transports existing site flows across Colorado State Highway 105 and into Monument Creek which is located approximately 1000 feet south of the project.

The overall existing site is 0% impervious. All flows are tributary to the Monument Creek Drainage Basin.

Sub-Basin OS1 contains 5.64 acres and drains the western area of the existing Rancho Iracema Subdivision Filing 2, Lot 1. It produces flows of 1.4 cfs for the 5-year storm and 10.5 cfs for the 100-year storm. These ditch flows continue into Sub-Basin A1ex. Undeveloped flow rates are assumed because there is detention provided for this area.

Sub-Basin OS2 contains 5.63 acres and drains the central portion of Lot 1. It produces flows of 1.4 cfs for the 5-year storm and 10.7 cfs for the 100-year storm. These flows continue into Sub-Basin A2ex. Undeveloped flow rates are assumed because there is detention provided for this area.

Sub-Basin OS3 contains 2.06 acres and drains the northern portion of Lot 1. It produces flows of 0.6 cfs for the 5-year storm and 4.3 cfs for the 100-year storm. These flows continue into Sub-Basin A2ex.

Sub-Basin OS4 contains 0.36 acres and is located in the northeastern corner of the Lot 1 site. It will produce flows of 0.1 cfs for the 5-year storm and 0.9 cfs for the 100-year storm. These flows continue southeast into Sub-Basin Cex.

Sub-Basin A1ex contains 1.00 acres and drains the western area of the project. It produces flows of 0.3 cfs for the 5-year storm and 2.3 cfs for the 100-year storm. The combined ditch flows at Design Point 1 (DP1) are 1.4 cfs for the 5-year storm and 10.8 cfs for the 100-year storm. These flows continue east along Colorado State Highway 105 and into Sub-Basin A2ex.

Sub-Basin A2ex contains 9.18 acres and drains the central portion of the Lot 2 development. It produces flows of 2.1 cfs for the 5-year storm and 16.4 cfs for the 100-year storm. These flows combine with the flows from Sub-Basin OS2 and OS3 at Design Point 2 (DP2) to produce flows of 3.1 cfs for the 5-year storm and 24.0 cfs for the 100-year storm. These combined flows cross under SH 105 within an existing 2'x2' RCBC.

Sub-Basin Bex contains 1.41 acres and drains southeastern area of the project. It produces flows of 0.3 cfs for the 5-year storm and 2.6 cfs for the 100-year storm. These flows travel to the existing

roadside ditch located along Colorado State Highway 105 and continue flowing eastward, away from the site.

Sub-Basin Cex contains 1.67 acres and drains the central area of the site. It produces flows of 0.5 cfs for the 5-year storm and 3.6 cfs for the 100-year storm. These flows will combine with the flows from Sub-Basin OS4 at Design Point 3 (DP3) to produce flows of 0.6 cfs for the 5-year storm and 4.4 cfs for the 100-year storm. These flows travel in a southeastern direction, away from the site.

Based on existing conditions of the site, the following storm flows will result:

Sub-basin	5-Year Flow (cfs)	100-Year Flow (cfs)	Area (Acre)
A1ex	0.3	2.3	1.00
A2ex	2.1	16.4	9.18
Bex	0.3	2.6	1.41
Cex	0.5	3.6	1.67
OS1	1.4	10.5	5.64
OS2	1.4	10.7	5.63
OS3	0.6	4.3	2.06
OS4	0.1	0.9	0.36
DP1(OS1+Aex)	1.4	10.8	6.64
DP2(OS2+OS3+A2ex)	3.1	24.0	16.87
DP3(OS4+Cex)	0.6	4.4	2.03

The Existing Conditions Drainage Plan is in the back folder of this report.

DEVELOPED DRAINAGE CONDITIONS

The proposed development will consist of fifty-seven (57) 1,500 sf townhome units on the 13.00 acre lot. It will contain a private asphalt road with roadside ditches. Overlot grading will be limited within the proposed project to protect as much vegetation as possible. A 0.731 acre-foot private full spectrum extended detention basin is proposed to meet current stormwater standards.

The overall proposed site is 34% impervious. All proposed flows are tributary to the Monument Creek Drainage Basin.

Flows from Sub-Basins OS1, with an area of 5.64 acres, will remain the same with flows of 1.4 cfs for the 5-year storm and 10.5 cfs for the 100-year storm. These ditch flows continue into Sub-Basin A. These flows combine with flows from Sub-basin A to produce total flows of 1.4 cfs for the 5-year storm and 10.6 cfs for the 100-year storm at Design Point 1 (DP1).

Sub-Basins OS2, with an area of 5.63 acres, will remain the same with flows of 1.4 cfs for the 5-year storm and 10.7 cfs for the 100-year storm. These ditch flows continue into an existing private detention basin. Flows are released from the existing private detention basin at historic rates.

Sub-Basin OS3 contains 2.06 acres and drains the northern portion of Lot 1. It produces flows of 0.6 cfs for the 5-year storm and 4.3 cfs for the 100-year storm. These flows sheetflow to the southeast.

Sub-Basin OS4 contains 0.36 acres and is located in the northeastern corner of the Lot 1 site. It will produce flows of 0.1 cfs for the 5-year storm and 0.9 cfs for the 100-year storm. These flows continue southeast into Sub-Basin Cex.

Sub-Basin A contains 0.90 acres and drains the western area of the property. It produces flows of 0.3 cfs for the 5-year storm and 2.1 cfs for the 100-year storm. These flows continue east along Colorado State Highway 105. This area is an undeveloped portion of the site that is to remain undeveloped. According to the El Paso County Engineering Criteria Manual (ECM) Section I.7.1.B.7., water quality is not required for Sub-basin A. For this reason, no water quality control measures are proposed for Sub-basin A.

Sub-Basin B contains 0.27 acres and drains due south. It produces flows of 0.6 cfs for the 5-year storm and 1.3 cfs for the 100-year storm. These flows continue along roadside ditches into Sub-basin D.

Sub-Basin C contains 0.97 acres and drains to the east. It produces flows of 1.1 cfs for the 5-year storm and 3.3 cfs for the 100-year storm. These flows will be intercepted by a proposed private 18" HDPE culvert and along a private roadside ditch which flows into Sub-Basin J.

Sub-Basin D, with an area of 0.20 acres and drains to the east. It produces flows of 0.8 cfs for the 5-year storm and 1.6 cfs for the 100-year storm. These flows continue along a private roadside ditch which flows into Sub-Basin J. These flows combine with flows from Sub-basin B, Sub-basin C, and Design Point 2 (DP2) to produce total flows of 5.0 cfs for the 5-year storm and 13.1 cfs for the 100-year storm at Design Point 3 (DP3).

Sub-Basin E contains 0.98 acres and drains to the southeast. It produces flows of 0.6 cfs for the 5-year storm and 2.9 cfs for the 100-year storm. These flows sheetflow to the southeast. This area is an undeveloped portion of the site that is to remain undeveloped. According to the El Paso County Engineering Criteria Manual (ECM) Section I.7.1.B.7., water quality is not required for Sub-basin E. For this reason, no water quality control measures are proposed for Sub-basin E.

Sub-Basin F contains 0.52 acres and is located in the northwestern area of Lot 1. It produces flows of 1.6 cfs for the 5-year storm and 0.3 cfs for the 100-year storm. These flows continue south and into Sub-Basin C. These flows combine with flows from Sub-basin K to produce total flows of 3.0 cfs for the 5-year storm and 7.9 cfs for the 100-year storm at Design Point 2 (DP2).

Sub-Basin G contains 0.18 acres and drains to the west. It produces flows of 0.8 cfs for the 5-year storm and 1.6 cfs for the 100-year storm. These flows continue along private roadside ditches towards Sub-basin J.

Sub-Basin H contains 0.57 acres and drains to the southwest. It produces flows of 1.2 cfs for the 5-year storm and 2.8 cfs for the 100-year storm. These flows sheetflow towards an 18" HDPE culvert that drains into Sub-basin J.

Sub-Basin I contains 0.35 acres and drains to the west. It produces flows of 1.6 cfs for the 5-year storm and 3.1 cfs for the 100-year storm. These flows are directed through proposed private 18" HDPE culverts that drain into Sub-basin J. These flows combine with flows from Design Point 3,

Sub-basin H, and Sub-basin G to produce total flows of 7.2 cfs for the 5-year storm and 18.0 cfs for the 100-year storm at Design Point (DP6). These flows continue into the proposed private extended detention basin.

Sub-Basin J, with an area of 1.15 acres and contains the proposed private extended detention basin. It produces flows of 0.7 cfs for the 5-year storm and 3.8 cfs for the 100-year storm. These flows continue into a proposed 2' wide concrete trickle channel that ties into a proposed private Type OS2 outlet structure. These flows combine with flows from Design Point 5 and Design Point 6 to produce total flows of 13.9 cfs for the 5-year storm and 33.5 cfs for the 100-year storm at Design Point 7 (DP7). These flows outlet through a proposed private 24" HDPE storm sewer pipe and into the public roadside ditch along Colorado State Highway 105. Post detention flows are 1.3 cfs for the 5-year storm and 13.7 cfs for the 100-year storm.

Sub-Basin K contains 1.54 acres and drains to the southwest. It produces flows of 2.3 cfs for the 5-year storm and 6.3 cfs for the 100-year storm. These flows continue in proposed private 24" HDPE culverts and towards Sub-basin F.

Sub-Basin L contains 0.50 acres and drains to the south. It produces flows of 2.3 cfs for the 5-year storm and 4.4 cfs for the 100-year storm. These flows continue into Sub-basin M.

Sub-Basin M contains 0.61 acres and drains to the south. It produces flows of 1.0 cfs for the 5-year storm and 2.7 cfs for the 100-year storm. These flows continue into Sub-basin O.

Sub-Basin N contains 0.95 acres and drains to the southwest. It produces flows of 0.3 cfs for the 5-year storm and 2.1 cfs for the 100-year storm. These flows combine with flows from Sub-basin P to produce total flows of 0.5 cfs for the 5-year storm and 4.1 cfs for the 100-year storm at Design Point 7 (DP7). According to the El Paso County Engineering Criteria Manual (ECM) Section I.7.1.B.7., water quality is not required for Sub-basin N. For this reason, no water quality control measures are proposed for Sub-basin N.

Sub-Basin O contains 0.53 acres and drains to the west. It produces flows of 2.5 cfs for the 5-year storm and 4.9 cfs for the 100-year storm. These flows continue into Sub-basin J. These flows combine with flows from Design Point 4, Sub-basin L, and Sub-basin M to produce total flows of 10.7 cfs for the 5-year storm and 22.9 cfs for the 100-year storm for the 100-year storm at Design Point 5 (DP5).

Sub-Basin P contains 0.82 acres and drains to the south. It produces flows of 0.3 cfs for the 5-year storm and 2.0 cfs for the 100-year storm. These flows sheetflow to the south. According to the El Paso County Engineering Criteria Manual (ECM) Section I.7.1.B.7., water quality is not required for Sub-basin P. For this reason, no water quality control measures are proposed for Sub-basin P.

Sub-Basin Q contains 0.63 acres and drains to the southwest. It produces flows of 2.5 cfs for the 5-year storm and 5.1 cfs for the 100-year storm. These flows continue under proposed private 18" HDPE culverts and into Sub-basin O. These flows combine with flows from Sub-basin R, Sub-basin S, and Sub-basin T to produce total flows 5.7 cfs for the 5-year storm and 12.6 cfs for the 100-year storm at Design Point 4 (DP4).

Sub-Basin R contains 0.16 acres and drains to the southeast. It produces flows of 0.6 cfs for the 5-year storm and 1.2 cfs for the 100-year storm. These flows sheetflow into a proposed private 24" HDPE culvert that drains into Sub-basin O.

Sub-Basin S contains 0.30 acres and drains to the southeast. It produces flows of 1.2 cfs for the 5-year storm and 2.5 cfs for the 100-year storm. These flows continue into a proposed private 18" HDPE culvert that continues to drain along a private roadside ditch.

Sub-Basin T contains 0.77 acres and drains to the south. It produces flows of 1.4 cfs for the 5-year storm and 3.7 cfs for the 100-year storm. These flows continue into a proposed private 18" HDPE culvert that drains into Sub-basin S.

Based on developed conditions of the site, the following storm flows will result:

Sub-basin	5-Yr Flow (cfs)	100-Yr Flow (cfs)	AREA (ACRE)
OS1	1.4	10.5	5.64
OS2	1.4	10.7	5.63
OS3	0.6	4.7	2.24
OS4	0.1	1.0	0.42
A	0.5	2.5	0.90
B	0.6	1.3	0.27
C	1.1	3.3	0.97
D	0.8	1.6	0.20
E	0.6	2.9	0.98
F	1.6	3.6	0.52
G	0.8	1.6	0.18
H	1.2	2.8	0.57
I	1.6	3.1	0.35
J	0.7	3.8	1.15
K	2.3	6.3	1.54
L	2.3	4.4	0.50
M	1.0	2.7	0.61
N	0.3	2.1	0.95
O	2.5	4.9	0.53
P	0.3	2.0	0.90
Q	2.5	5.1	0.63
R	0.6	1.2	0.16
S	1.2	2.5	0.30
T	1.4	3.7	0.77
DP1 (A+OS1)	1.4	10.6	6.54
DP2 (K+F)	3.0	7.9	2.06
DP3 (DP2+B+C+D)	5.0	13.1	3.50
DP4 (Q+R+S+T)	5.7	12.6	1.86
DP5 (DP4+L+M+O)	10.7	22.9	3.50
DP6 (DP3+H+I+G)	7.2	18.0	4.60
DP7 (DP5+DP6+J)	13.9	33.5	9.25
DP7 DET	1.3	13.7	9.25
DP8 (P+N)	0.5	4.1	1.85

Hydraulic calculations for the proposed improvements including pipe capacities and HGL, inlet capacities and swale capacities are included within the Drainage Calculation Sheet located in Appendix B.

HYDRAULIC ANALYSIS

Proposed culvert capacities were calculated using a Manning's normal depth calculation in MHFD's Culvert Version 4.00. A percent slope of 0.5% was assumed for all culverts. An 80% full flow capacity was used in these calculations. It was determined that an 18-inch HDPE culvert has a capacity of 6.5 cfs at a 0.5% slope. It was also determined that a 24-inch HDPE culvert has a capacity of 13.9 cfs at a 0.5% slope. These capacities were used to determine the size of each proposed culvert shown on the Proposed Drainage Plan found in the Back Pocket. See Appendix B for all hydraulic calculations.

All proposed swales shown on the Proposed Drainage Plan are 2' deep triangular swales with 3:1 side slopes. A maximum 100-year flow of 22.9 cfs at Design Point 5 (DP5) was used to determine the capacity of the proposed swales. This flow produces 0.62 feet of freeboard and a velocity of 4.39 feet per second. Therefore, the proposed swales are adequate for all developed flows to be conveyed by the swales. See Appendix B for all reference calculations.

FOUR STEP PROCESS

The proposed development and subsequent lot developments follow the "Four Step Process" as mandated by the Drainage Criteria Manual as follows:

Step 1: Employ Runoff Reduction Practices

Runoff has been reduced by disconnecting impervious areas where possible, eliminating "unnecessary" impervious areas and encouraging infiltration into suitable soils.

Step 2: Implement Control Measures (CMs) That Provide a Water Quality Capture Volume with Slow Release

- All new developed flows have been routed to the water quality basin with impervious area less than one acre.
- Drain time for the water quality basin is as follows: Full Spectrum Detention EDB is 40 hours.

Step 3: Stabilize Drainageways

There are no drainageways adjacent to the project.

- Site flows from the project have been directed to roadside ditches along the roadways and transported to private drainage facilities which direct them into the water quality/detention facility.
- All new and re-developed projects are required to construct or participate in the funding of channel stabilization measures. Drainage basin fees paid at the time of platting go towards channel stabilization within the drainage basin.

Step 4: Implement Site Specific and Other Source Control Measures (CM)

Erosion control measures will be in place during initial construction to provide source control of sediment with landscaping placed within the proposed development and permanent seeding of all disturbed areas provided per Permanent Control Measure (CM) requirements. No other potential pollutants are anticipated with this site post construction.

The development of this site will have no adverse impact on downstream properties.

WATER QUALITY

Water quality for the site will be achieved through a private full spectrum detention extended detention basin (FSD/EBD) and tied into a proposed private 'Type OS-2" Outlet Structure with a private 24" HDPE pipe outlet provided for the private FSD/EBD. The private FSD/EDB drains an area of 9.25 acres that is 46.96% impervious and will have a volume of 0.731 acre-ft. Portions of

the property are not detained because they are to remain undeveloped. According to the El Paso County Engineering Criteria Manual (ECM) Section I.7.1.B.7., water quality is not required for these regions. Total detained total area and detained percent impervious area calculations are shown in Appendix B of this report. The Water Quality capture volume will be 0.155 acre-ft. A private Emergency Spillway will be provided with a private 6" riprap lined weir which outfalls into the existing roadside ditch along Colorado State Highway 105. Calculations for the private FSD/EDB are included in Appendix B of this report.

CONSTRUCTION COST OPINION

The private, non-reimbursable drainage facility costs are as follows:

Description	Quantity	Unit Cost	Amount
18" HDPE	800 LF	$40	$ 32,000
24" HDPE	685 LF	$45	$ 30,825
		Sub-Total	$ 62,825
		Engineering & Contingencies 10%	$ 6,283
		TOTAL	**$ 69,108**

The private, non-reimbursable Control Measures (CM) Financial Assurances costs are as follows:

Description	Quantity	Unit Cost	Amount
24" HDPE	65 LF	$45	$ 2,925
Outlet Structure	1 EA	$3,000	$ 3,000
Riprap	**2** CY	$65	$ 130
Concrete Forebay	1 LS	$500	$ 500
2' Conc. Pan	**250** LF	$25	$ 6,250
FSD-EBD Grading	3315 CY	$10	$ 33,150
		Sub-Total	$ 45,955
		Engineering & Contingencies 10%	$ 4,596
		TOTAL	**$50,551**

DRAINAGE BASIN FEES

Drainage fees for the previously platted lot within the Monument Creek Drainage Basin were paid at the time of platting; therefore, no fees are required at this time.

CONCLUSION

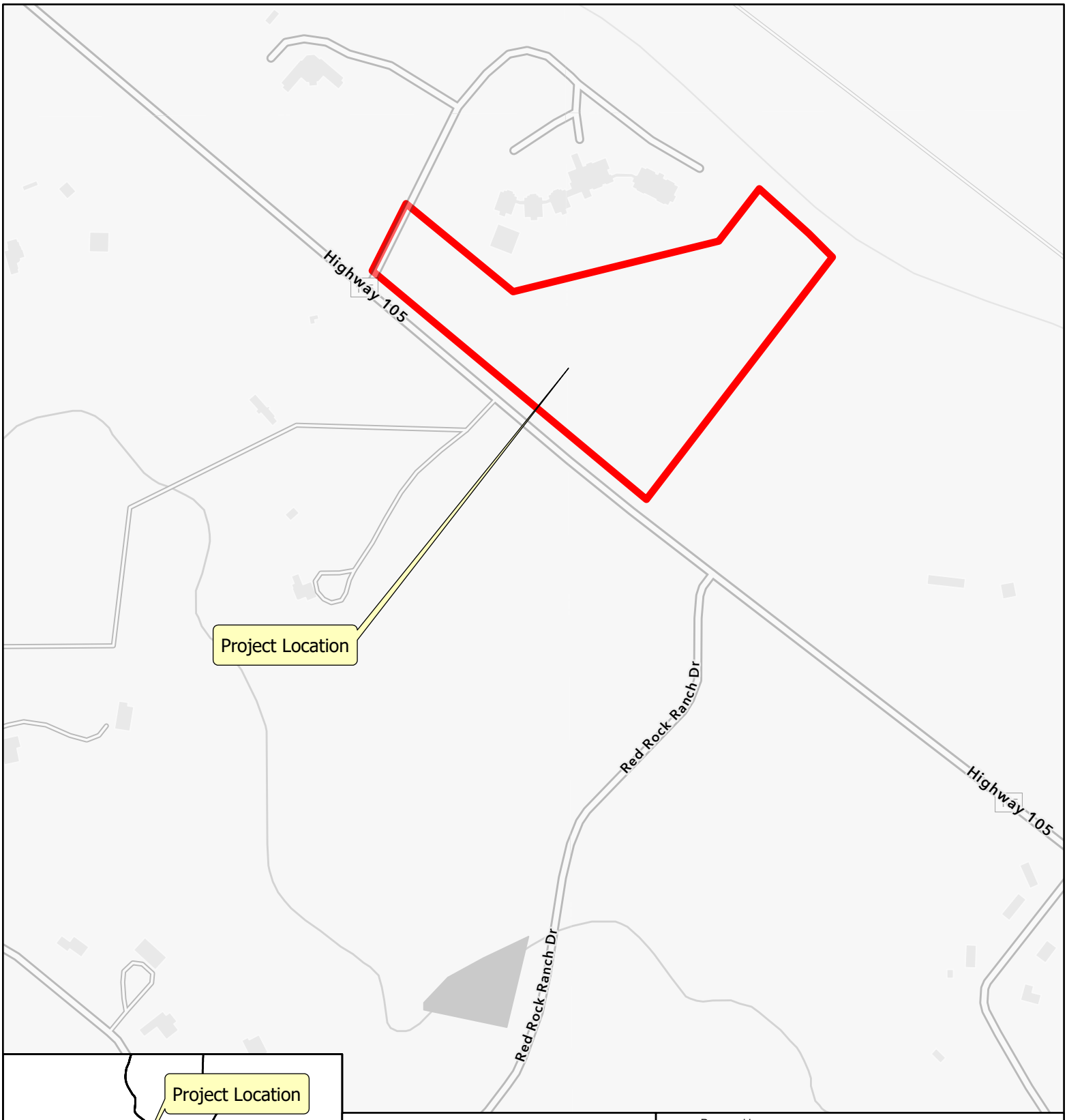
Site runoff, storm drains, and appurtenances associated with the development of the Rancho Iracema Subdivision Filing 2, Lot 2 will not adversely affect the downstream and surrounding developments. The overall drainage pattern and quantity will not be significantly changed from the existing conditions. The addition of a private full spectrum extended detention basin will reduce proposed flows to historic conditions.

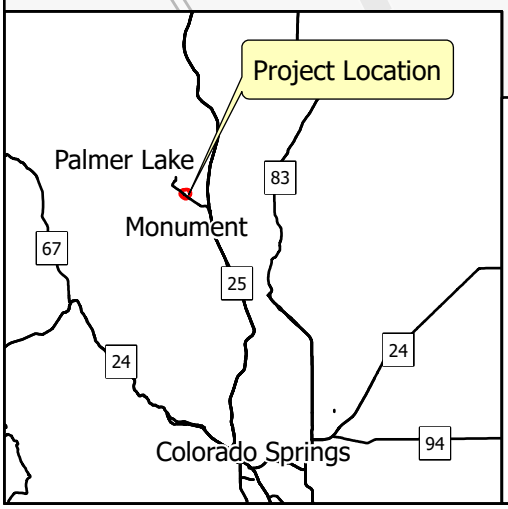
REFERENCES

1. ***Palmer Lake Municipal Code (2022)*** by the Palmer Lake Board of Trustees.
2. Soil Survey of El Paso County Area, Colorado by USDA, NRCS.
3. ***El Paso County (December 2016) Engineering Criteria Manual***.
4. Urban Drainage and Flood Control District (June 2017). ***Urban Storm Drainage Criteria Manual, Volume 1-3***.

APPENDIX A

MAPS





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Prepared by:

RESPEC

121 S. TEJON ST., SUITE 1110
COLORADO SPRINGS, CO 80903
WWW.RESPEC.COM (719) 266-5212

PALMER LAKE TOWNHOMES

VICINITY MAP

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Map Unit Symbol	Map Unit Name	Rating	Percentage of Site
41	Kettle gravelly loamy sand, 8 to 40 perent slopes	B	0%
71	Pring corase sandy loam, 3 to 8 percent slopes	B	75%
93	Tomah-Crowfoot complex, 8 to 15 percent slopes	B	25%

N

0 150 300

Feet

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RESPEC

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COLORADO SPRINGS, CO 80903
WWW.RESPEC.COM (719) 266-5212

PALMER LAKE TOWNHOMES

SOILS MAP

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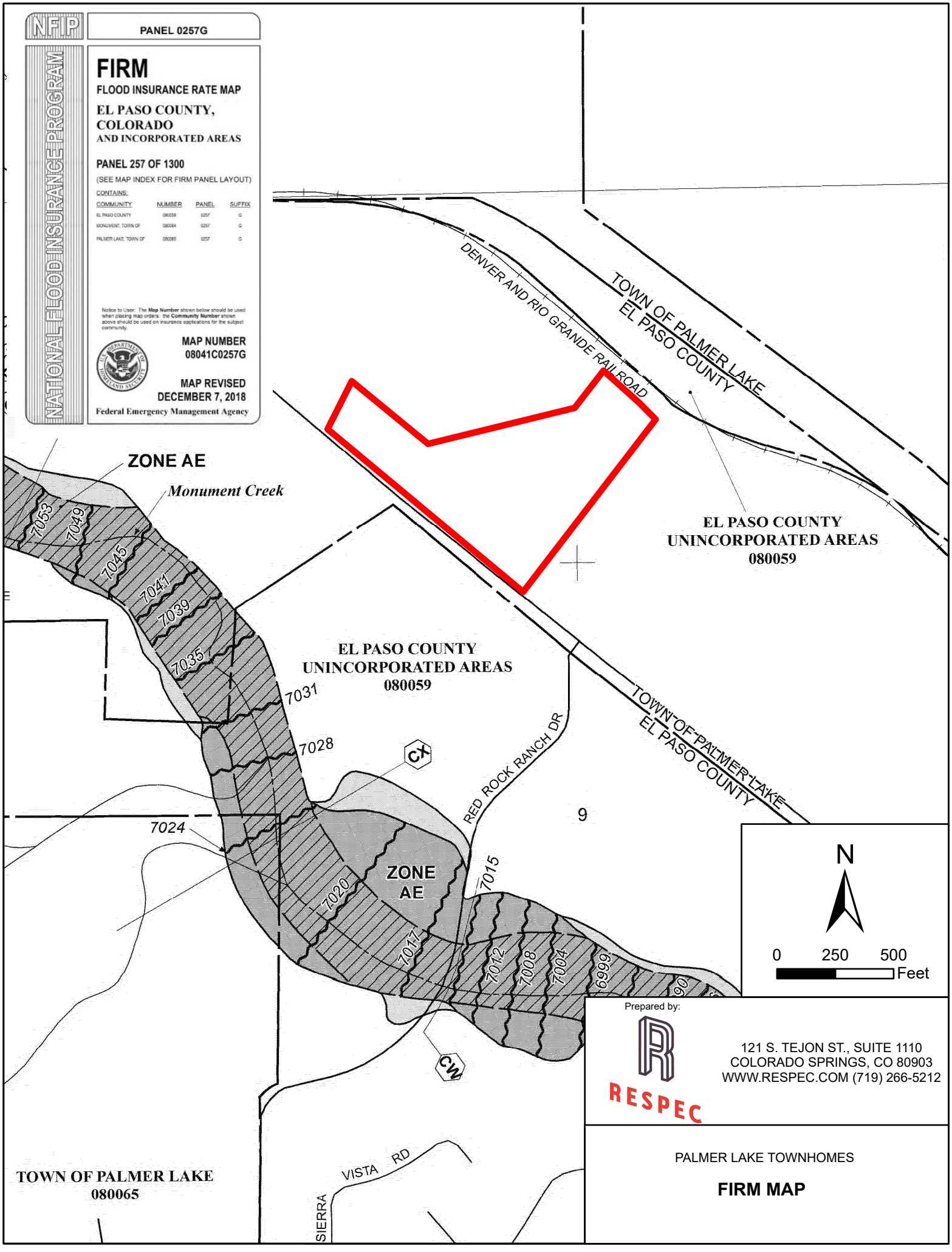
NFIP
PANEL 0257G
NATIONAL FLOOD INSURANCE PROGRAM
FIRM
FLOOD INSURANCE RATE MAP
EL PASO COUNTY, COLORADO
AND INCORPORATED AREAS
PANEL 257 OF 1300
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)
CONTAINS:
COMMUNITY NUMBER PANEL SUFFIX
EL PASO COUNTY 080059 0257 G
MONUMENT, TOWN OF 080064 0257 G
PALMER LAKE, TOWN OF 080065 0257 G
Notice to User: The Map Number shown below should be used when placing map orders; the Community Number shown above should be used on insurance applications for the subject community.
MAP NUMBER
08041C0257G
MAP REVISED
DECEMBER 7, 2018
Federal Emergency Management Agency
DENVER AND RIO GRANDE RAILROAD
TOWN OF PALMER LAKE
EL PASO COUNTY
ZONE AE
Monument Creek
7053
7049
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7041
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7031
7028
7024
7020
7017
7015
7012
7008
7004
6999
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EL PASO COUNTY
UNINCORPORATED AREAS
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EL PASO COUNTY
UNINCORPORATED AREAS
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TOWN OF PALMER LAKE
EL PASO COUNTY
RED ROCK RANCH DR
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TOWN OF PALMER LAKE
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PALMER LAKE TOWNHOMES
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APPENDIX B

CALCULATIONS

EXISTING CONDITIONS
RUNOFF COEFICIENT
TYPE A/B SOILS

LAND USE	Imperv %	5 YR	100 YR
UNDEV	0	0.08	0.35
GRAVEL ROAD	80	0.59	0.7
ASPHALT ROAD	100	0.9	0.96
ROOFS	90	0.73	0.81

AREA DESIG.	TOTAL AREA (acre)	SURFACE CONDITION AREAS UNDEV	GRAVEL ROAD	ASPHALT ROAD	ROOFS	CALCULATED C 5 YR	100 YR	% IMPERVIOUS
OS1	5.64	5.64	0.00	0.00	0.00	0.08	0.35	0.00
OS2	5.63	5.63	0.00	0.00	0.00	0.08	0.35	0.00
OS3	2.06	2.06	0.00	0.00	0.00	0.08	0.35	0.00
OS4	0.36	0.36	0.00	0.00	0.00	0.08	0.35	0.00
A1ex	1.00	1.00	0.00	0.00	0.00	0.08	0.35	0.00
A2ex	9.18	9.18	0.00	0.00	0.00	0.08	0.35	0.00
Bex	1.41	1.41	0.00	0.00	0.00	0.08	0.35	0.00
Cex	1.67	1.67	0.00	0.00	0.00	0.08	0.35	0.00
						Total Site Percent Impervious		0.00

DEVELOPED CONDITIONS
RUNOFF COEFICIENT
TYPE A/B SOILS

LAND USE	Imperv %	5 YR	100 YR
UNDEV	0	0.08	0.35
GRAVEL ROAD	80	0.59	0.7
ASPHALT ROAD	100	0.9	0.96
ROOFS	90	0.73	0.81

AREA DESIG.	TOTAL AREA (acre)	SURFACE CONDITION AREAS UNDEV	GRAVEL ROAD	ASPH/CON ROAD	ROOFS	CALCULATED C 5 YR	100 YR	% IMPERVIOUS
OS1	5.64	5.64	0.00	0.00	0.00	0.08	0.35	0.00
OS2	5.63	5.63	0.00	0.00	0.00	0.08	0.35	0.00
OS3	2.23	2.23	0.00	0.00	0.00	0.59	0.70	0.00
OS4	0.42	0.42	0.00	0.00	0.00	0.90	0.96	0.00
A	0.90	0.90	0.00	0.00	0.00	0.08	0.35	0.00
B	0.27	0.13	0.00	0.07	0.07	0.46	0.63	49.26
C	0.97	0.72	0.00	0.18	0.07	0.28	0.50	25.05
D	0.20	0.07	0.00	0.13	0.00	0.61	0.75	65.00
E	0.98	0.91	0.00	0.07	0.00	0.14	0.38	7.14
F	0.52	0.20	0.00	0.15	0.18	0.54	0.68	59.13
G	0.18	0.04	0.00	0.11	0.04	0.71	0.81	78.61
H	0.57	0.29	0.00	0.14	0.14	0.44	0.61	46.67
I	0.35	0.05	0.00	0.16	0.14	0.71	0.81	81.71
J	1.15	1.09	0.00	0.06	0.00	0.12	0.38	5.22
K	1.54	1.01	0.00	0.22	0.32	0.33	0.53	32.69
L	0.50	0.05	0.00	0.21	0.25	0.74	0.83	85.30
M	0.61	0.36	0.00	0.15	0.11	0.39	0.58	40.08
N	0.95	0.95	0.00	0.00	0.00	0.08	0.35	0.00
O	0.53	0.03	0.00	0.22	0.28	0.76	0.85	89.06
P	0.90	0.90	0.00	0.00	0.00	0.08	0.35	0.00
Q	0.63	0.11	0.00	0.24	0.28	0.68	0.79	78.10
R	0.16	0.05	0.00	0.11	0.00	0.62	0.75	66.25
S	0.30	0.04	0.00	0.12	0.14	0.71	0.81	82.00
T	0.77	0.47	0.00	0.16	0.14	0.37	0.56	37.14
						Total Site Percent Impervious		34.00
				Detained Total Area (B+C+D+F+G+H+I+J+K+L+M+O+Q+R+S+T)		9.25	Percent Impervious of Detained Area	46.96

ELEPHANT ROCK VILLAS
PROJ.W008.1
DRAINAGE CALCULATION SHEET
file:elephantrkvillasdr
JANUARY 2023

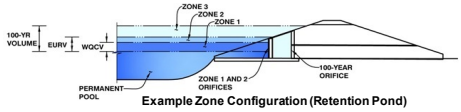
							Initial Tci			Travel Time								length	vel.		
AREA	AREA	C5	C100	C5 X A	C100 X A		Slope	ti		Slope	V	Tt	TC	I5	I100	Q5	Q100	L	V	^t	AREA
DESIG.	(acre)	(5 yr)	(100 yr)			L (ft)	(%)	(min)	L (ft)	(%)	(fps)	(min)	(min)	(in/hr)	(in/hr)	(cfs)	(cfs)	(feet)	(fps)	(min)	DESIG.
EXISTING CONDITIONS																					
OS1	5.64	0.08	0.35	0.45	1.97	100	4.50	11.61	770	3.70	1.90	6.75	18.37	3.05	5.32	1.4	10.5	450	1.40	5.36	OS1
OS2	5.63	0.08	0.35	0.45	1.97	150	6.00	12.93	600	4.50	2.10	4.76	17.69	3.11	5.43	1.4	10.7	530	2.00	4.42	OS2
OS3	2.06	0.08	0.35	0.16	0.72	120	8.00	10.52	300	1.30	1.20	4.17	14.69	3.41	5.95	0.6	4.3	1130	2.00	9.42	OS3
OS4	0.36	0.08	0.35	0.03	0.13	100	6.00	10.56	0	1.40	1.25	0.00	10.56	3.96	6.91	0.1	0.9				OS4
A1ex	1.00	0.08	0.35	0.08	0.35	180	20.00	9.52	210	3.70	1.90	1.84	11.36	3.83	6.70	0.3	2.3				A1ex
A2ex	9.18	0.08	0.35	0.73	3.21	100	6.00	10.56	1130	4.40	2.00	9.42	19.98	2.92	5.09	2.1	16.4				A2ex
Bex	1.41	0.08	0.35	0.11	0.49	200	4.00	17.07	270	5.00	2.20	2.05	19.12	2.98	5.21	0.3	2.6				Bex
Cex	1.67	0.08	0.35	0.13	0.58	120	5.50	11.90	230	5.20	2.30	1.67	13.57	3.54	6.18	0.5	3.6				Cex
DP1 (OS1 + A1ex)	6.64			0.53	2.32								23.72	2.65	4.64	1.4	10.8	550	1.50	6.11	DP1 (OS1 + A1ex)
DP2 (OS2 + OS3 + A2ex)	16.87			1.35	5.90								29.83	2.33	4.06	3.1	24.0				DP2 (OS2 + OS3 + A2ex)
DP3 (OS4 + Cex)	2.03			0.16	0.71								13.57	3.54	6.18	0.6	4.4				DP3 (OS4 + Cex)
DEVELOPED CONDITIONS																					
OS1	5.64	0.08	0.35	0.45	1.97	100	4.50	11.61	770	3.70	1.90	6.75	18.37	3.05	5.32	1.4	10.5	450	1.40	5.36	OS1
OS2	5.63	0.08	0.35	0.45	1.97	150	6.00	12.93	600	4.50	2.10	4.76	17.69	3.11	5.43	1.4	10.7				OS2
OS3	2.23	0.08	0.35	0.18	0.78	120	8.00	10.52	300	1.30	1.20	4.17	14.69	3.41	5.95	0.6	4.6				OS3
OS4	0.42	0.08	0.35	0.03	0.15	100	6.00	10.56	0	1.40	1.25	0.00	10.56	3.96	6.91	0.1	1.0				OS4
A	0.90	0.08	0.35	0.07	0.32	180	20.00	9.52	210	3.70	1.90	1.84	11.36	3.83	6.70	0.3	2.1				A
B	0.27	0.46	0.63	0.12	0.17	130	6.20	7.46	0	0.00	0.00	0.00	7.46	4.54	7.93	0.6	1.3				B
C	0.97	0.28	0.50	0.27	0.48	100	4.30	9.49	250	16.00	3.80	1.10	10.58	3.95	6.91	1.1	3.3				C
D	0.20	0.61	0.75	0.12	0.15	15	4.60	2.13	150	16.00	7.50	0.33	2.46	6.18	10.80	0.8	1.6				D
E	0.98	0.14	0.38	0.14	0.38	100	12.70	7.77	100	17.30	4.00	0.42	8.19	4.39	7.66	0.6	2.9				E
F	0.52	0.54	0.68	0.28	0.35	15	4.50	2.49	205	5.80	4.60	0.74	3.23	5.83	10.18	1.6	3.6				F
G	0.18	0.71	0.81	0.13	0.15	15	3.80	1.83	205	5.50	4.50	0.76	2.59	6.12	10.69	0.8	1.6				G
H	0.57	0.44	0.61	0.25	0.35	100	6.30	6.71	45	6.20	2.40	0.31	7.03	4.64	8.11	1.2	2.8				H
I	0.35	0.71	0.81	0.25	0.28	35	5.60	2.41	0	0.00	0.00	0.00	2.41	6.21	10.84	1.6	3.1				I
J	1.15	0.12	0.38	0.14	0.44	25	33.00	2.88	250	0.50	1.50	2.78	5.66	4.99	8.72	0.7	3.8				J
K	1.54	0.33	0.53	0.51	0.82	100	9.30	6.90	160	7.10	2.50	1.07	7.96	4.43	7.74	2.3	6.3	415	2.20	3.14	K
L	0.50	0.74	0.83	0.37	0.41	40	4.80	2.56	0	0.00	0.00	0.00	2.56	6.13	10.71	2.3	4.4				L
M	0.61	0.39	0.58	0.24	0.35	100	5.00	7.77	70	6.00	2.30	0.51	8.27	4.37	7.63	1.0	2.7				M
N	0.95	0.08	0.35	0.08	0.33	100	5.30	11.00	225	5.50	2.20	1.70	12.71	3.65	6.37	0.3	2.1				N
O	0.53	0.76	0.85	0.40	0.45	15	4.30	1.50	250	5.00	4.50	0.93	2.43	6.20	10.82	2.5	4.9				O
P	0.90	0.08	0.35	0.07	0.32	100	4.60	11.53	145	4.50	2.10	1.15	12.68	3.65	6.38	0.3	2.0	265	2.20	2.01	P
Q	0.63	0.68	0.79	0.43	0.50	25	5.00	2.30	225	4.80	4.30	0.87	3.17	5.85	10.22	2.5	5.1				Q
R	0.16	0.62	0.75	0.10	0.12	25	6.50	2.40	215	5.30	4.60	0.78	3.18	5.85	10.22	0.6	1.2	175	4.30	0.68	R
S	0.30	0.71	0.81	0.21	0.24	50	6.30	2.80	125	4.30	4.20	0.50	3.30	5.80	10.13	1.2	2.5				S
T	0.77	0.37	0.56	0.28	0.43	100	14.70	5.63	45	5.70	4.70	0.16	5.79	4.96	8.66	1.4	3.7				T
DP1 (OS1 + A)	6.54			0.52	2.29								23.72	2.65	4.64	1.4	10.6				DP1 (OS1 + A)
DP2 (K+F)	2.06			0.79	1.17								11.11	3.87	6.77	3.0	7.9	50	2.00	0.42	DP2 (K+F)
DP3 (DP2+B+C+D)	3.50			1.30	1.97								11.52	3.81	6.66	5.0	13.1	50	1.80	0.46	DP3 (DP2+B+C+D)
DP4 (Q+R+S+T)	1.86			1.03	1.29								3.86	5.58	9.74	5.7	12.6	265	4.50	0.98	DP4 (Q+R+S+T)
DP5 (DP4+L+M+O)	3.50			2.04	2.51								4.84	5.24	9.15	10.7	22.9				DP5 (DP4+L+M+O)
DP6 (DP3+H+I+G)	4.60			1.93	2.75								11.99	3.75	6.54	7.2	18.0	275	1.50	3.06	DP6 (DP3+H+I+G)
DP7 (DP5+DP6+J)	9.25			4.11	5.70								15.04	3.37	5.88	13.9	33.5				DP7 (DP5+DP6+J)
DP7 DET																1.3	13.7				DP7 DET
DP8 (P+N)	1.85			0.15	0.65								12.71	3.65	6.37	0.5	4.1				DP8 (P+N)

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.05 (January 2022)

Project: Elephant Rock Villas

Basin ID: A



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	EDB	
Watershed Area =	9.25	acres
Watershed Length =	950	ft
Watershed Length to Centroid =	450	ft
Watershed Slope =	0.060	ft/ft
Watershed Imperviousness =	46.96%	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
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	Denver - Capitol Building	

After providing required inputs above including 1-hour rainfall depths, click 'Run CUHP' to generate runoff hydrographs using the embedded Colorado Urban Hydrograph Procedure.

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.153	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.462	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.424	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.613	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.780	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	1.010	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	1.193	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	1.429	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.01 in.) =	1.802	acre-feet	3.01	inches
Approximate 2-yr Detention Volume =	0.346	acre-feet		
Approximate 5-yr Detention Volume =	0.477	acre-feet		
Approximate 10-yr Detention Volume =	0.639	acre-feet		
Approximate 25-yr Detention Volume =	0.703	acre-feet		
Approximate 50-yr Detention Volume =	0.735	acre-feet		
Approximate 100-yr Detention Volume =	0.827	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.153	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.309	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.365	acre-feet
Total Detention Basin Volume =	0.827	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	

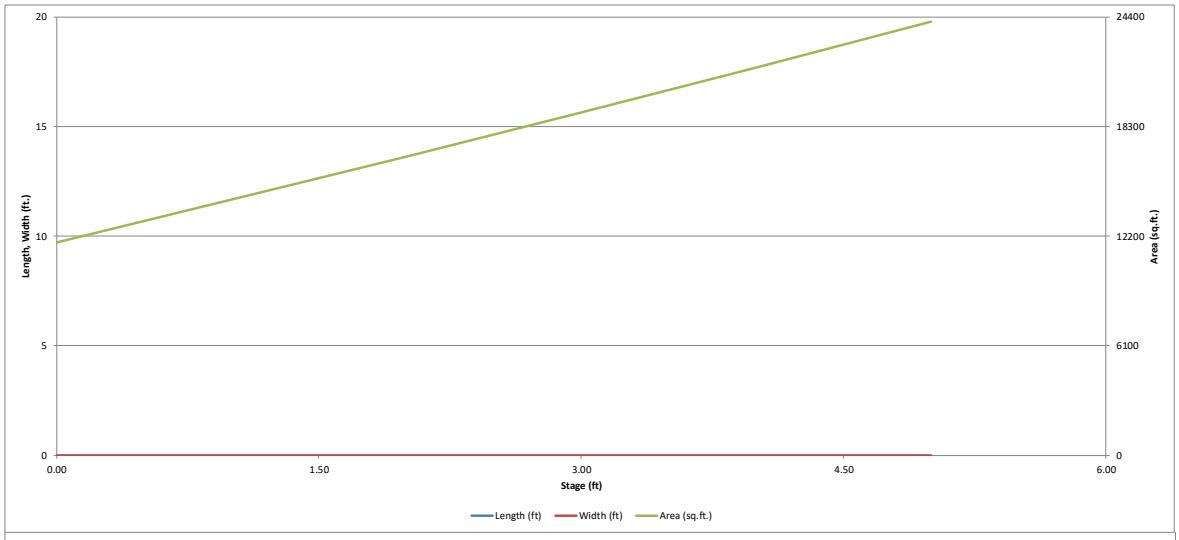
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	**user**	acre-feet

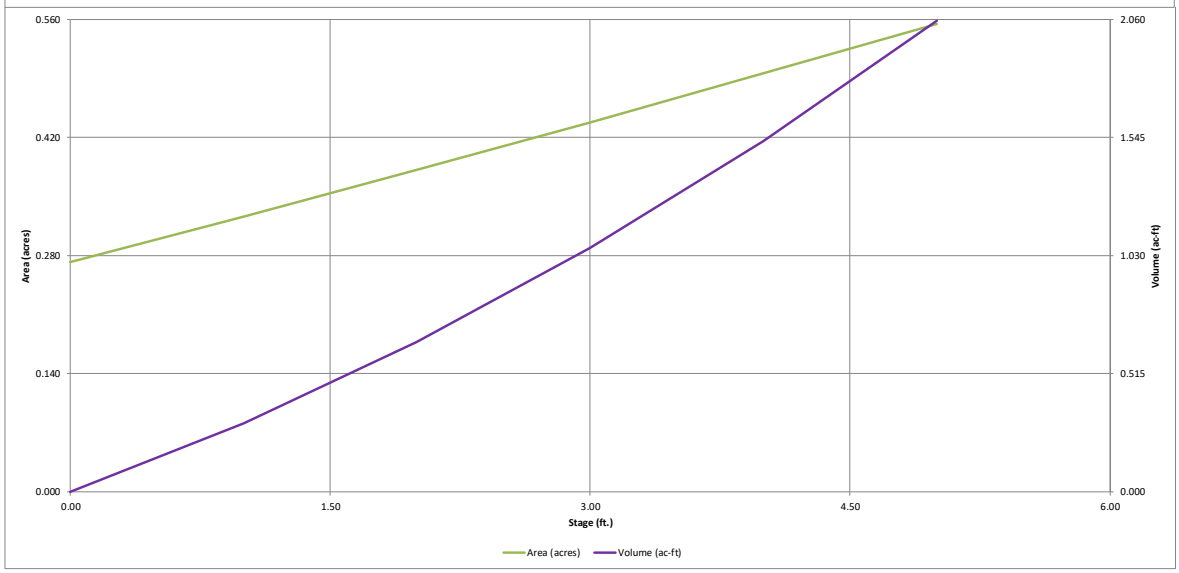
Depth Increment = 0.10 ft

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	--	--	--	11,869	0.272		
7083	--	1.00	--	--	--	14,221	0.326	13,045	0.299
7084	--	2.00	--	--	--	16,620	0.382	28,465	0.653
7085	--	3.00	--	--	--	19,077	0.438	46,314	1.063
7086	--	4.00	--	--	--	21,593	0.496	66,649	1.530
7087	--	5.00	--	--	--	24,167	0.555	89,529	2.055

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.05 (January 2022)



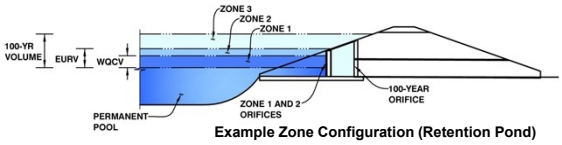


DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.05 (January 2022)

Project: Elephant Rock Villas

Basin ID: A



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	0.54	0.153	Orifice Plate
Zone 2 (EURV)	1.48	0.309	Orifice Plate
Zone 3 (100-year)	2.45	0.365	Weir&Pipe (Rect.)
Total (all zones)		0.827	

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

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)	Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Diameter =	N/A	inches	Underdrain Orifice Centroid =	N/A	feet

Calculated Parameters for Underdrain

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

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	2.222E-02	ft^2
Depth at top of Zone using Orifice Plate =	1.50	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	6.00	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	3.20	sq. inches (diameter = 2 inches)	Elliptical Slot Area =	N/A	ft^2

Calculated Parameters for Plate

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.50	1.00					
Orifice Area (sq. inches)	3.20	3.20	3.20					

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

User Input: Vertical Orifice (Circular or Rectangular)

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

Calculated Parameters for Vertical Orifice

User Input: Overflow Weir (Dropbox with Flat or Sloped Grate and Outlet Pipe OR Rectangular/Trapezoidal Weir and No Outlet Pipe)

	Zone 3 Weir	Not Selected			Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	1.50	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	1.50	N/A	feet
Overflow Weir Front Edge Length =	4.00	N/A	feet	Overflow Weir Slope Length =	4.00	N/A	feet
Overflow Weir Grate Slope =	0.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	5.07	N/A	
Horiz. Length of Weir Sides =	4.00	N/A	feet	Overflow Grate Open Area w/o Debris =	11.14	N/A	ft^2
Overflow Grate Type =	Type C Grate	N/A		Overflow Grate Open Area w/ Debris =	5.57	N/A	ft^2
Debris Clogging % =	50%	N/A	%				

Calculated Parameters for Overflow Weir

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

	Zone 3 Rectangular	Not Selected			Zone 3 Rectangular	Not Selected	
Depth to Invert of Outlet Pipe =	0.25	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	2.19	N/A	ft^2
Rectangular Orifice Width =	16.90	N/A	inches	Outlet Orifice Centroid =	0.78	N/A	feet
Rectangular Orifice Height =	18.70		inches	Half-Central Angle of Restrictor Plate on Pipe =	N/A	N/A	radians

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	2.40	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.75 feet
Spillway Crest Length =	11.00	feet	Stage at Top of Freeboard =	4.15 feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	0.50 acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	1.61 acre-ft

Calculated Parameters for Spillway

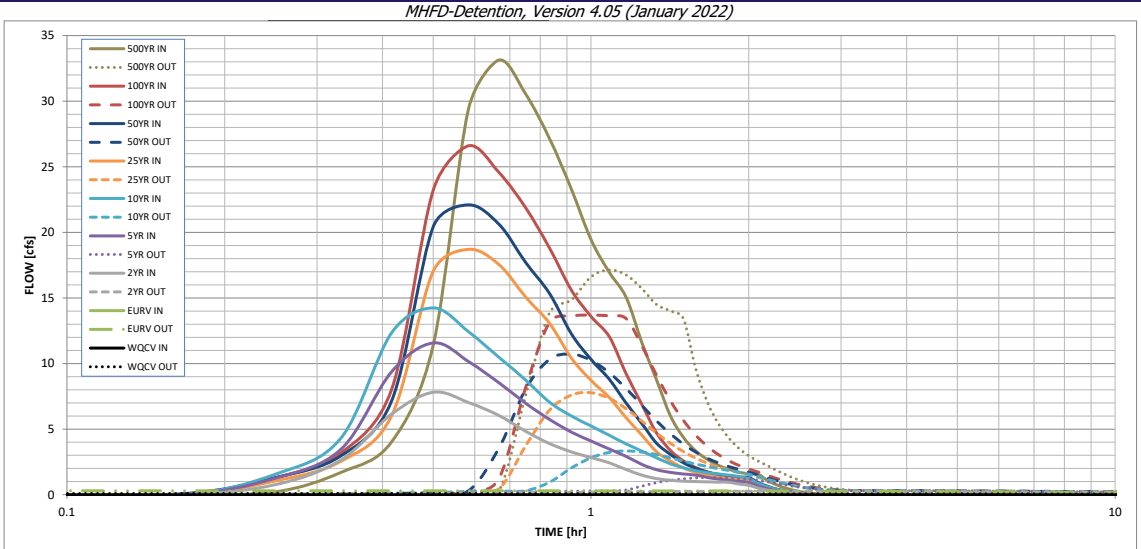
Routed Hydrograph Results

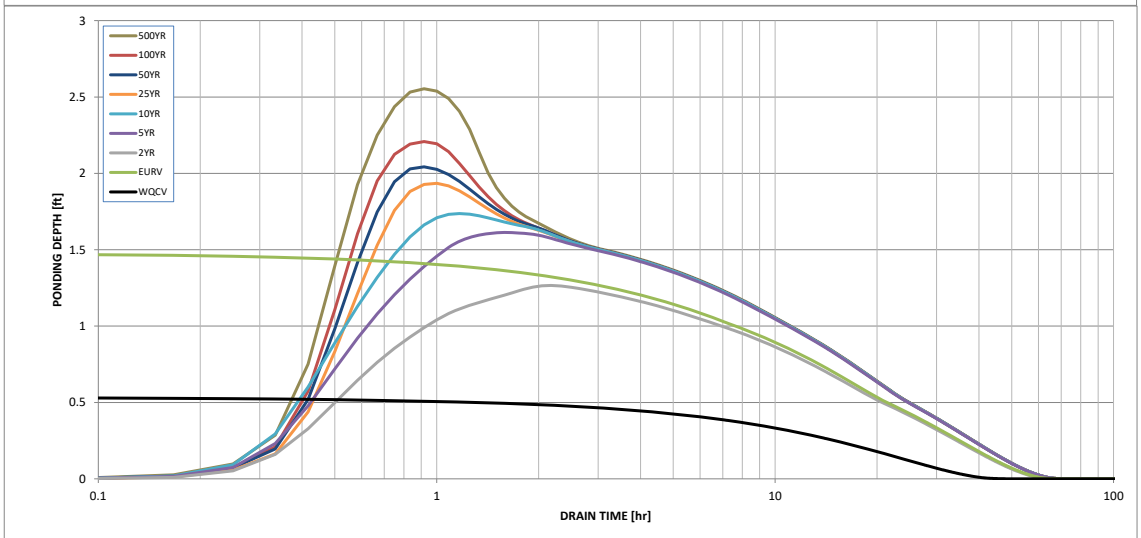
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

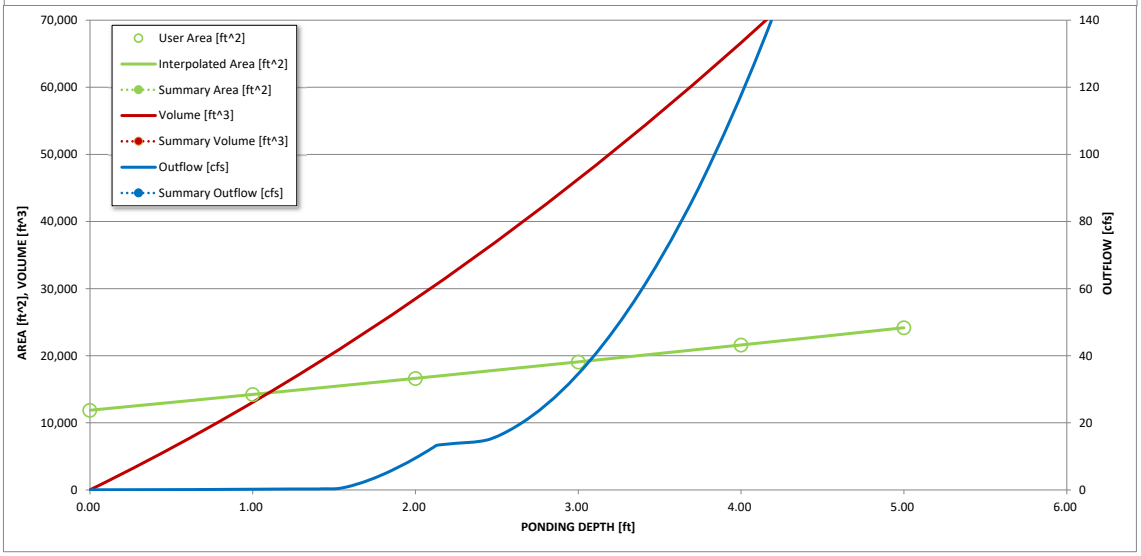
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.01
CUHP Runoff Volume (acre-ft) =	0.153	0.462	0.424	0.613	0.780	1.010	1.193	1.429	1.802
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.424	0.613	0.780	1.010	1.193	1.429	1.802
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	1.3	3.5	5.2	9.2	11.5	14.4	18.8
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.14	0.38	0.56	0.99	1.24	1.55	2.03
Peak Inflow Q (cfs) =	N/A	N/A	7.8	11.6	14.2	18.7	22.1	26.6	33.1
Peak Outflow Q (cfs) =	0.1	0.3	0.3	1.3	3.3	7.8	10.7	13.7	17.1
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.4	0.6	0.8	0.9	1.0	0.9
Structure Controlling Flow =	Plate	Plate	Plate	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	0.1	0.3	0.7	0.9	1.2	1.3
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	38	53	52	54	52	49	48	45	42
Time to Drain 99% of Inflow Volume (hours) =	**42**	58	58	61	59	58	57	56	54
Maximum Ponding Depth (ft) =	0.54	1.48	1.27	1.61	1.74	1.94	2.04	2.21	2.55
Area at Maximum Ponding Depth (acres) =	0.30	0.35	0.34	0.36	0.37	0.38	0.38	0.39	0.41
Maximum Volume Stored (acre-ft) =	0.155	0.463	0.386	0.509	0.552	0.627	0.669	0.731	0.872

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.05 (January 2022)







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

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename: _____

Inflow Hydrographs

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

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	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]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.01	0.23
	0:15:00	0.00	0.00	0.78	1.27	1.58	1.06	1.31	1.29	1.71
	0:20:00	0.00	0.00	2.66	3.47	4.32	2.56	2.97	3.20	4.05
	0:25:00	0.00	0.00	6.16	9.39	12.37	6.05	7.19	8.06	11.45
	0:30:00	0.00	0.00	7.81	11.58	14.24	17.06	20.45	23.25	29.38
	0:35:00	0.00	0.00	7.03	10.16	12.43	18.71	22.10	26.59	33.14
	0:40:00	0.00	0.00	6.05	8.54	10.49	17.56	20.63	24.58	30.55
	0:45:00	0.00	0.00	4.84	6.98	8.75	15.07	17.71	21.88	27.15
	0:50:00	0.00	0.00	3.90	5.74	7.06	13.07	15.34	18.81	23.32
	0:55:00	0.00	0.00	3.27	4.78	6.01	10.43	12.28	15.61	19.44
	1:00:00	0.00	0.00	2.83	4.10	5.24	8.72	10.32	13.58	16.96
	1:05:00	0.00	0.00	2.44	3.48	4.53	7.41	8.80	12.04	15.05
	1:10:00	0.00	0.00	1.92	2.92	3.88	5.87	6.99	9.22	11.60
	1:15:00	0.00	0.00	1.50	2.32	3.33	4.54	5.43	6.89	8.75
	1:20:00	0.00	0.00	1.24	1.91	2.82	3.29	3.93	4.71	6.04
	1:25:00	0.00	0.00	1.11	1.71	2.36	2.58	3.09	3.39	4.37
	1:30:00	0.00	0.00	1.04	1.58	2.05	2.04	2.43	2.58	3.35
	1:35:00	0.00	0.00	1.01	1.50	1.84	1.71	2.02	2.08	2.69
	1:40:00	0.00	0.00	0.98	1.32	1.68	1.48	1.73	1.73	2.24
	1:45:00	0.00	0.00	0.96	1.19	1.58	1.34	1.56	1.49	1.94
	1:50:00	0.00	0.00	0.95	1.09	1.50	1.24	1.43	1.33	1.72
	1:55:00	0.00	0.00	0.82	1.02	1.39	1.18	1.35	1.24	1.60
	2:00:00	0.00	0.00	0.72	0.94	1.23	1.14	1.31	1.21	1.56
	2:05:00	0.00	0.00	0.52	0.67	0.87	0.81	0.93	0.86	1.11
	2:10:00	0.00	0.00	0.36	0.47	0.61	0.57	0.65	0.61	0.79
	2:15:00	0.00	0.00	0.25	0.33	0.43	0.40	0.45	0.43	0.55
	2:20:00	0.00	0.00	0.17	0.22	0.29	0.27	0.31	0.29	0.37
	2:25:00	0.00	0.00	0.11	0.14	0.19	0.18	0.20	0.19	0.25
	2:30:00	0.00	0.00	0.07	0.09	0.12	0.12	0.14	0.13	0.16
	2:35:00	0.00	0.00	0.04	0.06	0.07	0.07	0.08	0.08	0.10
	2:40:00	0.00	0.00	0.02	0.03	0.03	0.04	0.04	0.04	0.05
	2:45:00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.02
	2:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
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	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.05 (January 2022)

Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.

The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

Stage - Storage Description	Stage [ft]	Area [ft ^{2}]	Area [acres]	Volume [ft ^{3}]	Volume [ac-ft]	Total Outflow [cfs]

For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

Manning Formula: Trickle Channel Calculations - 2% of 100 Year Flow

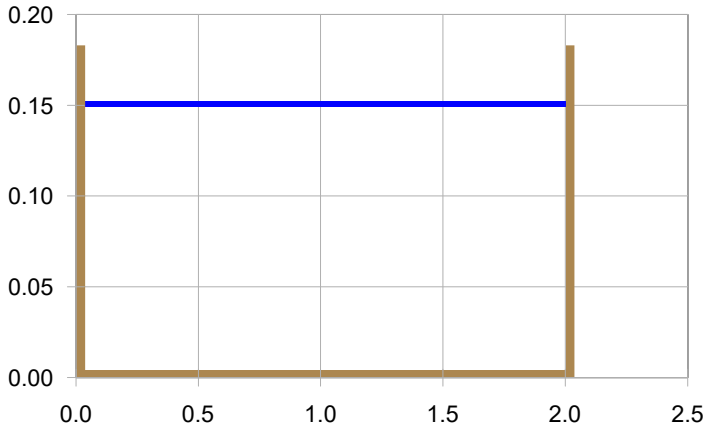
Rectangular Channel

Input

Flow	0.67 cfs
Slope	0.005 ft/ft
Manning's n	0.012
Base Width	2 ft
Right Side Slope	0:1
Left Side Slope	0:1

Output

Depth	0.149 ft
Flow Area	0.298 sf
Velocity	2.25 fps
Velocity Head	0.0783 ft
Top Width	2.00 ft
Froude Number	1.02
Critical Depth	0.152 ft
Critical Slope	0.00475 ft/ft



Project: Elephant Rock Villas

Water Quality Capture Volume (WQCV) Calculator

Drain Time (hrs)	40
Coefficient, a	1.0
Imperviousness, I	47.0%
WQCV (watershed inches)	0.20
WQCV (ft)	0.02
Watershed Area (ac)	9.25
WQCV (ac-ft)	0.15

Forebay Calculator

WQCV (ac-ft)	0.15
2% of WQCV (ac-ft)	0.0031
2% of WQCV (cf)	133
Depth (ft)	1.0
Width (ft)	10
Length (ft)	16
Volume (cf)	160
Is Volume greater than 2% of WQCV?	YES

Forebay Notch Calculator

Q_{100} (cfs)	33.5
2% of Q_{100} (cfs)	0.67
D (ft)	1
W (ft)	***0.22***

$$W = \frac{2\%\ of\ Q}{D^{1.5} * C}$$

RESPEC

Trickle Channel Calculator

Q_{100} (cfs)	33.5
2% of Q_{100} (cfs)	0.67
Slope (ft/ft)	0.005
Bottom Width (ft)	***2***
Side Slopes (Vertical)	0
Depth of Trickle Channel (ft)	***0.5***
Depth of 2% of 100-Year Flow (ft)	0.15
Velocity (ft/s)	2.25
Froude Number	1.02
Type of Flow (Subcritcal/Supercritical)	Supercritical

Project: Elephant Rock Villas

Proposed Detention Basin Spillway

Slope (ft/ft)	0.2
Cf	2
Q_{100} (cfs)	13.7
Width (ft)	11
q (cfs/ft)	1.25
Calculated D_{50} (in)	5.2
D_{50} used (in)	6.0

Detention Basin Outlet

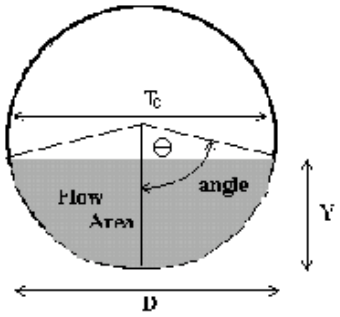
100-Year Peak Outflow (cfs)	13.7
Y_t (ft)	1.34
D_c (ft)	2.0
D_{50} (ft)	0.2
D_{50} Used (ft)	6.0

CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

MHFD-Culvert, Version 4.00 (May 2020)

Project: Elephant Rock Villas

Pipe ID: 18 Inch HDPE Culvert Capacity



Design Information (Input)			
Pipe Invert Slope	So =	0.0050	ft/ft
Pipe Manning's n-value	n =	0.0120	
Pipe Diameter	D =	18.00	inches
Design discharge	Q =	6.45	cfs

Full-Flow Capacity (Calculated)			
Full-flow area	Af =	1.77	sq ft
Full-flow wetted perimeter	Pf =	4.71	ft
Half Central Angle	Theta =	3.14	radians
Full-flow capacity	Qf =	8.07	cfs

Calculation of Normal Flow Condition			
Half Central Angle (0<Theta<3.14)	Theta =	1.93	radians
Flow area	An =	1.27	sq ft
Top width	Tn =	1.40	ft
Wetted perimeter	Pn =	2.90	ft
Flow depth	Yn =	1.01	ft
Flow velocity	Vn =	5.07	fps
Discharge	Qn =	6.45	cfs
Percent of Full Flow	Flow =	80.0%	of full flow
Normal Depth Froude Number	Fr_n =	0.94	subcritical

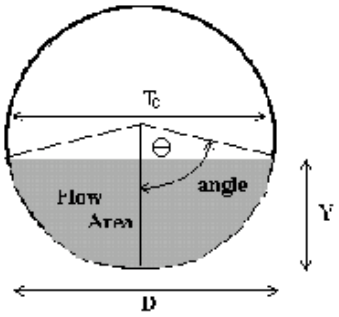
Calculation of Critical Flow Condition			
Half Central Angle (0<Theta-c<3.14)	Theta-c =	1.89	radians
Critical flow area	Ac =	1.23	sq ft
Critical top width	Tc =	1.43	ft
Critical flow depth	Yc =	0.98	ft
Critical flow velocity	Vc =	5.26	fps
Critical Depth Froude Number	Fr_c =	1.00	

CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

MHFD-Culvert, Version 4.00 (May 2020)

Project: Elephant Rock Villas

Pipe ID: 24 Inch HDPE Culvert Capacity



Design Information (Input)			
Pipe Invert Slope	So =	0.0050	ft/ft
Pipe Manning's n-value	n =	0.0120	
Pipe Diameter	D =	24.00	inches
Design discharge	Q =	13.90	cfs

Full-Flow Capacity (Calculated)			
Full-flow area	Af =	3.14	sq ft
Full-flow wetted perimeter	Pf =	6.28	ft
Half Central Angle	Theta =	3.14	radians
Full-flow capacity	Qf =	17.38	cfs

Calculation of Normal Flow Condition			
Half Central Angle (0<Theta<3.14)	Theta =	1.93	radians
Flow area	An =	2.26	sq ft
Top width	Tn =	1.87	ft
Wetted perimeter	Pn =	3.86	ft
Flow depth	Yn =	1.35	ft
Flow velocity	Vn =	6.14	fps
Discharge	Qn =	13.90	cfs
Percent of Full Flow	Flow =	80.0%	of full flow
Normal Depth Froude Number	Fr_n =	0.98	subcritical

Calculation of Critical Flow Condition			
Half Central Angle (0<Theta-c<3.14)	Theta-c =	1.92	radians
Critical flow area	Ac =	2.24	sq ft
Critical top width	Tc =	1.88	ft
Critical flow depth	Yc =	1.34	ft
Critical flow velocity	Vc =	6.20	fps
Critical Depth Froude Number	Fr_c =	1.00	

Manning Formula: Proposed Swale - 100 Year Flow of Design Point 5

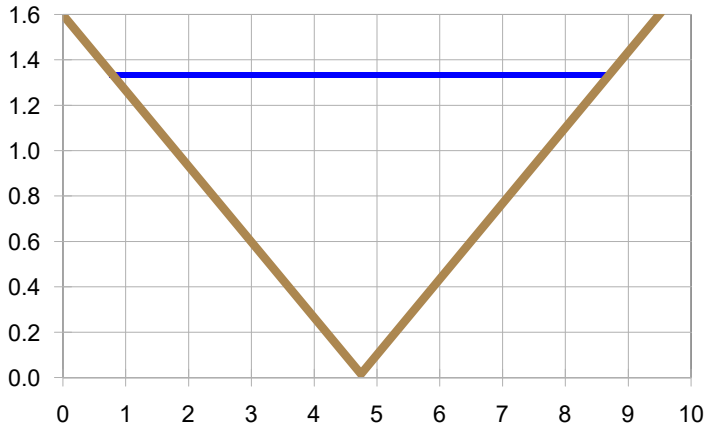
Triangular Channel

Input

Flow	22.9 cfs
Slope	0.02 ft/ft
Manning's n	0.035
Base Width	0 ft
Right Side Slope	3:1
Left Side Slope	3:1

Output

Depth	1.318 ft
Flow Area	5.22 sf
Velocity	4.39 fps
Velocity Head	0.300 ft
Top Width	7.91 ft
Froude Number	0.953
Critical Depth	1.294 ft
Critical Slope	0.0221 ft/ft



APPENDIX C

DESIGN CHARTS

3.1. - Rational Method Runoff Coefficient (C)

The runoff coefficient represents the integrated effects of infiltration, detention storage, evaporation, retention, flow routing, and interception, all of which affect the time distribution and peak rate of runoff. Runoff coefficients are based on the imperviousness of a particular land use and the hydrologic soil type of the area and are to be selected in accordance with Table 6-6.

The procedure for determining the runoff coefficient includes these steps:

1. Categorize the site area into one or more similar land uses, each with a representative imperviousness, according to the information in Table 6-6.
2. Based on the dominant hydrologic soil type in the area, use Table 6-6 to estimate the runoff coefficient for the particular land use category for the design storms of interest.
3. Calculate an area-weighted average runoff coefficient for the site based on the runoff coefficients from individual land use areas of the site.

When analyzing an area for design purposes, urbanization of the full watershed, including both on-site and off-site areas, shall be assumed.

Gravel parking areas, storage areas, and access drives proposed on Site Improvement Plans shall be analyzed based on an imperviousness of 80%. This is due to the potential for gravel areas being paved over time by property owners and the resulting adverse impacts on the stormwater management facilities and adjacent properties.

There are some circumstances where the selection of impervious percentage values may require additional investigation due to unique land characteristics (e.g., recent burn areas). When these circumstances arise, it is the designer's responsibility to verify that the correct land use assumptions are made.

When multiple sub-basins are delineated, the composite C value calculation is:

$$C_c = (C_1 A_1 + C_2 A_2 + C_3 A_3 + \ldots C_i A_i)/A_t \qquad \text{(Eq. 6-6)}$$

Where:

C_c = composite runoff coefficient for total area

C_i = runoff coefficient for subarea corresponding to surface type or land use

A_i = area of surface type corresponding to Ci (units must be the same as those used for total area)

A_t = total area of all subareas for which composite runoff coefficient applies

i = number of surface types in the drainage area

Table 6-6. Runoff Coefficients for Rational Method

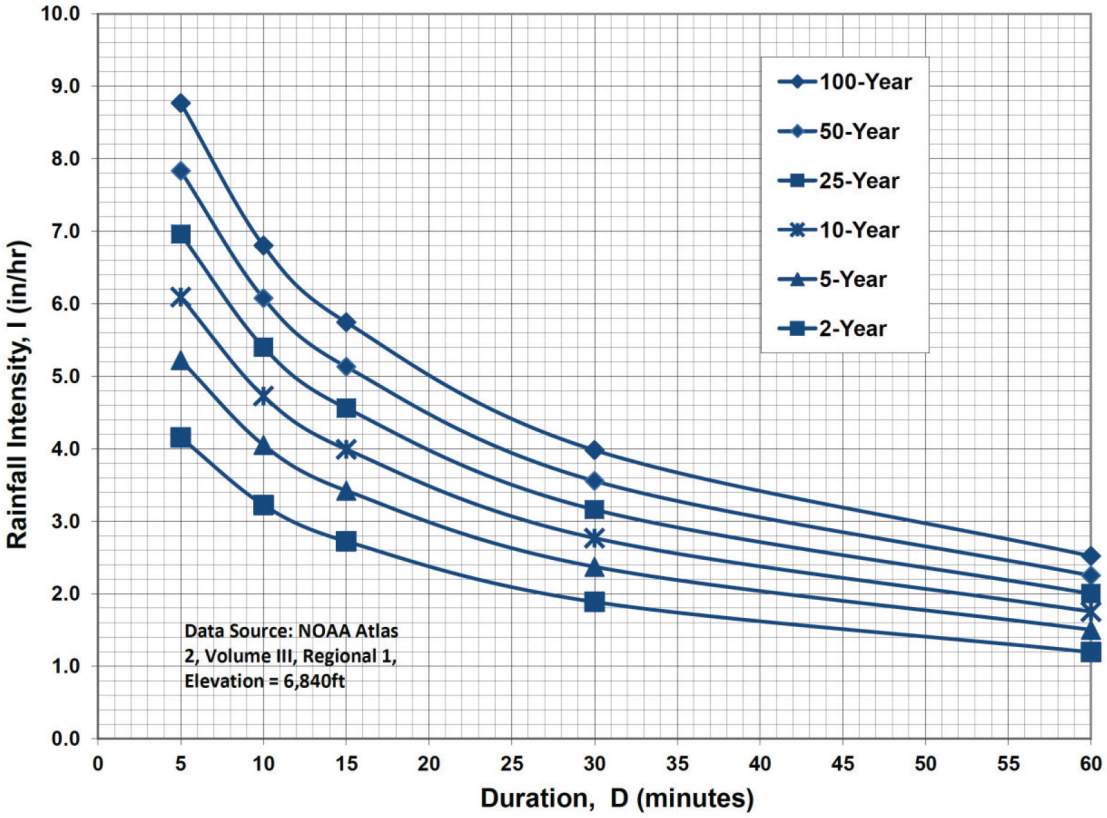
(Source: UDFCD 2001)

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													
⅛ 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
¼ 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
⅓ 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
½ 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

Figure 6-5. Colorado Springs Rainfall Intensity Duration Frequency



IDF Equations

$I_{100} = -2.52 \ln(D) + 12.735$

$I_{50} = -2.25 \ln(D) + 11.375$

$I_{25} = -2.00 \ln(D) + 10.111$

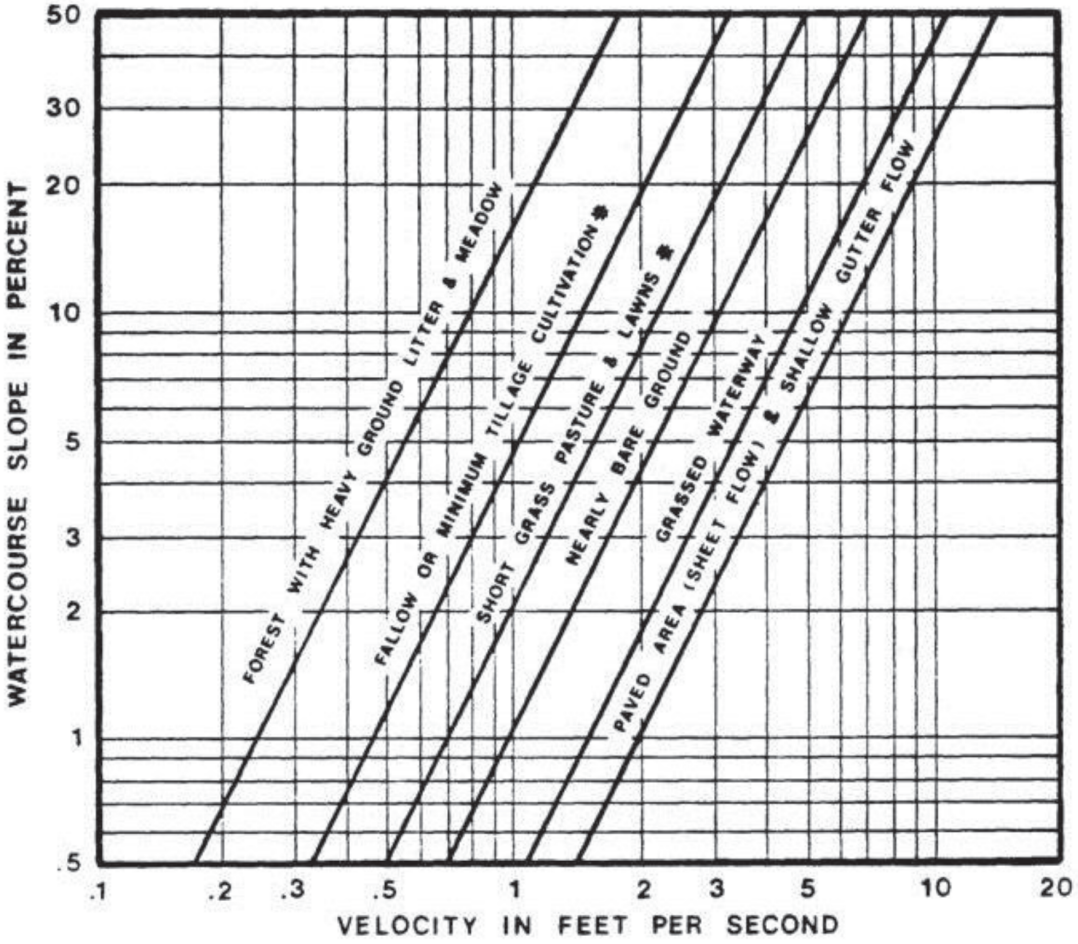
$I_{10} = -1.75 \ln(D) + 8.847$

$I_{5} = -1.50 \ln(D) + 7.583$

$I_{2} = -1.19 \ln(D) + 6.035$

Note: Values calculated by equations may not precisely duplicate values read from figure.

Figure 6-25. Estimate of Average Concentrated Shallow Flow



3.0 Colorado Urban Hydrograph Procedure

3.1 Background

The Colorado Urban Hydrograph Procedure (CUHP) is a method of hydrologic analysis based upon the unit hydrograph principle. A unit hydrograph is defined as the hydrograph of one inch of direct runoff from the tributary area resulting from a storm of a given duration. The unit hydrograph thus represents the integrated effects of factors such as tributary area, shape, street pattern, channel capacities, and street and land slopes. The basic premise of the unit hydrograph is that individual hydrographs resulting from the successive increments of excess rainfall that occur throughout a storm period will be proportional in discharge throughout their runoff period. Thus, the hydrograph of total storm discharge is obtained by summing the ordinates of the individual sub-hydrographs.

CUHP has been developed and calibrated using rainfall-runoff data collected in Colorado (mostly in the Denver/Boulder metropolitan area). This section provides a general background in the use of the computer version of CUHP to perform stormwater runoff calculations. A detailed description of the CUHP method and the assumptions and equations used, including a hand calculation example, are provided in the CUHP User Manual. The latest version of the CUHP 2005 macro-enabled Excel workbook and User Manual are available for download from www.udfcd.org.

3.2 Effective Rainfall for CUHP

Effective rainfall is that portion of precipitation during a storm event that runs off the land to streams. Those portions of precipitation that do not reach a stream are called abstractions and include interception by vegetation, evaporation, infiltration, storage in all surface depressions, and extended duration surface retention. The total design rainfall depth for use with CUHP should be obtained from the *Rainfall* chapter of the USDCM. This chapter illustrates a method for estimating the amount of rainfall that actually becomes surface runoff whenever a design rainstorm is used.

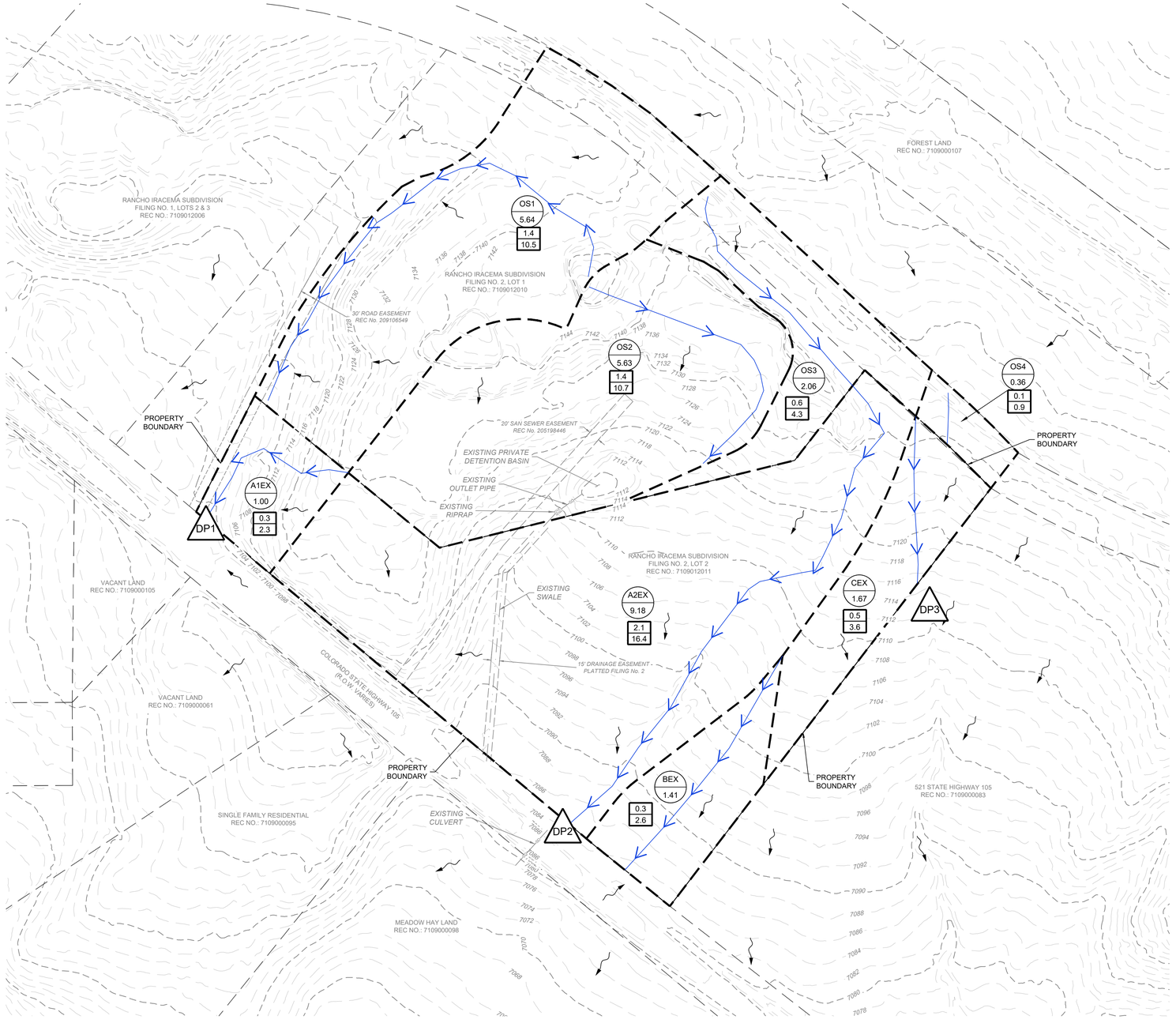
3.2.1 Pervious-Impervious Areas

As described in Section 2.5.1, the urban landscape is comprised of pervious and impervious surfaces. The degree of imperviousness is the primary variable that affects the volumes and rates of runoff calculated using CUHP. When analyzing a watershed for design purposes, the probable future percent of impervious area must first be estimated. A complete tabulation of recommended values of total percentage imperviousness is provided in Table 6-3 and Figures 6-1 through 6-3. References to impervious area and all calculations in this chapter are based on the input of total impervious areas. The pervious-impervious area relationship can be further refined for use in CUHP as follows:

- **DCIA**: Impervious area portion directly connected to the drainage system.
- **UIA:** Impervious area portion that drains onto or across pervious surfaces.
- **RPA**: The portion of pervious area receiving runoff from impervious portions.
- **SPA:** The separate pervious area portion not receiving runoff from impervious surfaces.

This further refinement is explained in more detail in the CUHP User Manual and in Chapter 3 of the USDCM Volume 3.

BACK POCKET



DRAINAGE NOTES

1. ALL ELEVATIONS SHOWN ARE IN NAVD88.
2. EXISTING CONTOURS ARE SHOWN AT 2' AND 10' INTERVALS

SYMBOL LEGEND

- A1A / XX — BASIN DESIGNATION; BASIN AREA (ACRE) — BASIN CALLOUT
- XX / XX — 5 YEAR STORM, CFS; 100 YEAR STORM, CFS — BASIN INFORMATION
- DP — DESIGN POINT
- DIRECTION OF DRAINAGE FLOW
- EXISTING SUB-BASIN BOUNDARY
- 7290 — EXISTING MAJOR CONTOUR
- 7291 — EXISTING MINOR CONTOUR
- EXISTING STORM SEWER
- EXISTING SWALE
- EXISTING TIME OF CONCENTRATION PATH

EXISTING CONDITIONS

AREA DESIGNATION	ACRES	Q5 (CFS)	Q100 (CFS)
A1ex	1.00	0.3	2.3
A2ex	9.18	2.1	16.4
Bex	1.41	0.3	2.6
Cex	1.67	0.5	3.6
OS1	5.64	1.4	10.5
OS2	5.63	1.4	10.7
OS3	2.06	0.6	4.3
OS4	0.36	0.1	0.9

EXISTING DESIGN POINTS

DESIGN POINT	ACRES	Q5 (CFS)	Q100 (CFS)
DP1 (OS1 + A1EX)	6.64	1.4	10.8
DP2 (OS2 + OS3 + A2EX)	16.87	3.1	24.0
DP3 (OS4 + CEX)	2.03	0.6	4.4

0 100 200
SCALE: 1" = 100'

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DRAWN CTD
CHECKED RGG
DATE 1.06.2023

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SUBMITTED FOR: DORMAN REAL ESTATE MANAGEMENT

SHEET NUMBER: SHEET 1 OF 2

NAME: N:\Projects\W0319-Palmer Lake Townhomes\3. DWG\5. Sheets\Drainage\1 Existing Conditions.dwg PLOT DATE: Jan 06, 2023 3:40pm

DRAINAGE NOTES

1. ALL ELEVATIONS ARE IN NAVD88.
2. EXISTING AND PROPOSED CONTOURS ARE SHOWN AT 2' AND 10' CONTOUR INTERVALS.
3. ALL PROPOSED SWALES SHOWN ARE 2' DEEP TRIANGULAR SWALES WITH 3:1 SIDE SLOPES.

SYMBOL LEGEND

- A1A / XX — BASIN DESIGNATION / BASIN AREA (ACRE) — BASIN CALLOUT
- XX / XX — 5 YEAR STORM, CFS / 100 YEAR STORM, CFS — BASIN INFORMATION
- DP — DESIGN POINT
- DIRECTION OF DRAINAGE FLOW
- PROPOSED SUB-BASIN BOUNDARY
- 7290 — EXISTING MAJOR CONTOUR
- 7291 — EXISTING MINOR CONTOUR
- PROPOSED SWALE
- 7290 — EXISTING MAJOR CONTOUR
- 7291 — EXISTING MINOR CONTOUR
- EXISTING STORM SEWER
- EXISTING SWALE
- PROPOSED TIME OF CONCENTRATION PATH

DEVELOPED CONDITIONS

AREA DESIGNATION	ACRES	Q5 (CFS)	Q100 (CFS)
OS1	5.64	1.4	10.5
OS2	5.63	1.4	10.7
OS3	2.23	0.6	4.6
OS4	0.42	0.1	1.0
A	0.90	0.3	2.1
B	0.27	0.6	1.3
C	0.97	1.1	3.3
D	0.20	0.8	1.6
E	0.98	0.6	2.9
F	0.52	1.6	3.6
G	0.18	0.8	1.6
H	0.57	1.2	2.8
I	0.35	1.6	3.1
J	1.15	0.7	3.8
K	1.54	2.3	6.3
L	0.50	2.3	4.4
M	0.61	1.0	2.7
N	0.95	0.3	2.1
O	0.53	2.5	4.9
P	0.90	0.3	2.0
Q	0.63	2.5	5.1
R	0.16	0.6	1.2
S	0.30	1.2	2.5
T	0.77	1.4	3.7

DEVELOPED DESIGN POINTS

DESIGN POINT NAME	ACRES	Q5 (CFS)	Q100 (CFS)
DP1 (OS1+A)	6.54	1.4	10.6
DP2 (K+F)	2.06	3.0	7.9
DP3 (DP2+B+C+D)	3.50	5.0	11.8
DP4 (Q+R+S+T)	1.86	6.0	15.5
DP5 (DP4+L+M+O)	3.50	5.0	22.9
DP6 (DP3+H+I+G)	4.60	7.2	18.0
DP7 (DP5+DP6+J)	9.25	13.9	33.5
DP7 DET	9.25	1.3	13.7
DP8 (P+N)	1.85	0.5	4.0

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SHEET NUMBER: SHEET 2 OF 2

NAME: N:\Projects\W0319-Palmer Lake Townhomes\3. DWG\5. Sheets\Drainage\2 Developed Conditions.dwg PLOT DATE: Jan 06, 2023 3:45pm