FINAL

DRAINAGE PLAN AND REPORT

POENITSCH SUBDIVISION

EL PASO COUNTY

January 16, 2019

Revised
June 18, 2019

Prepared for

Tom Poenitsch and Christy Mullins

Oliver E. Watts, Consulting Engineer, Inc.
Colorado Springs, Colorado

PSD File No. MS193

Address the Four Step Process (ECM Appendix I, Section I.7.2) and discuss why WQCV and detention are not required.

Unresolved. Add a section for the Four Step Process with subheaders for each step. Under each step describe how the design incorporated or considered the particular step.

OLIVER E. WATTS, PE-LS
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Celebrating over 39 years in business

June 18, 2019

El Paso County D.O.T.
2880 International Circle
Colorado Springs, CO 80910

ATTN: *DSD Grimm*

SUBJECT: Preliminary and Final Drainage Plan and Report
Poenitsch Subdivision

Gentlemen

Transmitted herewith for your review and approval is the drainage plan and report for The Poenitsch Subdivision in El Paso County. This report has been revised in accordance with your Marcy 28, 2019 review comments. This report will accompany the subdivision plat submittal.

Please contact me if I may provide any further information.

Oliver E. Watts, Consulting Engineer, Inc.

BY:_____
Oliver E. Watts, President

Encl:
Drainage Report 4 pages
Computations, 12 pages
FEMA Panel No. 08041C0320 G
SCS Soils Map and 4 Interpretation Sheets
Backup Information, 4 sheets
Drainage Plan, Dwg 18-5184-08
Offsite Drainage Map, Dwg 18-5184-09

1. ENGINEER'S STATEMENT:

The attached drainage plan and report were prepared under my direction and supervision and are correct to the best of my knowledge and belief. Said drainage report has been prepared according to the criteria established by the County for drainage reports and said report is in conformity with the applicable 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.

Oliver E. Watts, Consulting Engineer, Inc.

_____

Oliver E. Watts Colo. PE-LS No. 9853

2. OWNERS / DEVELOPER'S STATEMENT:

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

By:_____
Tom Poenitsch
P.O. Box 8202
Colorado Springs, CO 80933
(719) 200-5216

3. EL PASO COUNTY:

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

_____ _____

Jennifer Irvine date
County Engineer / ECM Administrator

Conditions:

4. LOCATION AND DESCRIPTION:

The Poenitsch Subdivision is an 18.858 acre subdivision located in the South half of the Southeast quarter of the Southeast quarter of Section 8, Township 12 South, Range 65 West of the 6th P.M., in El Paso County Colorado. It is zoned RR-5 and will be subdivided into three residential lots as shown on the enclosed drainage plan. The property is on the Northwest corner of Shoup Road and Herring Road.

5. FLOOD PLAIN STATEMENT:

This subdivision is not within the limits of a flood plain or flood hazard area, according to FEMA map panel number 08041C0320 G, dated December 7, 2018, a copy of which is enclosed for reference.

6. METHOD AND CRITERIA:

The method used for all computations is that specified in the City-County Drainage Criteria Manual, using the rational method for areas of the size of the development. All computations are enclosed for reference and review.

The soils in the subdivision have been mapped by the local USDA/SCS office, and a soils map and interpretation sheets are enclosed for reference. All soils in this area are of hydrologic group "B".

7. DESCRIPTION OF RUNOFF:

A. Drainage Inflows. As shown on the enclosed offset drainage plan, three drainage basins will outfall into the subdivision. All basins consist of heavily forested areas typical of the Black Forest region of El Paso County that are now in a recovery state following the fire of five years ago. The runoff from each basin is contained by natural channels. Basin O-1 is 4400 feet in length and drops 150 feet in elevation, occupying 97.4 acres. It has a runoff of 11.7 cfs / 85.2 cfs (5-year / 100-year runoffs) into a 47 foot long 48" RCP culvert across Herring Road. It will contain the 100-year runoff with 0.73' of headwater as shown on the enclosed computations. Basin O-2 is 51.5 acres in size, 4500 feet long and outfalls into the northeast portion of the subdivision in a natural channel. Basin O-3 is 82.4 acres in size, 4100 feet long and outfalls into the north central portion of the subdivision in a natural channel.

B. Internal Routing. All of the natural channels within the subdivision are stable in configuration and more that adequate to contain the design runoff. Progressing downstream basin O-1 will combine with basin A and basin O-2 to create a total runoff of 18.8 cfs / 137 cfs at the channel junction shown on the drainage plan. This will combine with basin O-3 and basin B to create a total runoff of 29.3 cfs / 214 cfs at the next junction. This will combine with basin C for a total outfall from the subdivision of 30 cfs / 219 cfs on the west boundary near the northwest corner. Just downstream is a private roadway crossing with a 34' long 24" RCP culvert, which will overtop under the 100-year runoff, but will contain the 5-year runoff at a headwater depth of 1.46 feet. Backwater due to the overtopping does not affect the subdivision.

C: Proposed Structures. The County has determined that all access to the lots must be from Herring Road, due to the classificatin of Shoup Road. Lot 3 can use the existing driveway on the

east boundary; however lots 2 and 1 will access the property via the access easement along the north boundary as shown on the drainage plan. A design of the grading and drainage for this access is shown. Three culverts will be required as s minimum, a 36", 48" and a 60" HDPE, with the design details shown on the plan. The roadway and culverts will be private and maintained by the homeowners.

8. COST ESTIMATE:

All facilities are private.

Item No.	Description	Quantity	Unit Cost	Cost
1	18" HDPE Culvert	26 LF	$ 30.00	$ 780.00
2	36" HDPE Culvert	84 LF	50.00	4200.00
3	48" HDPE Culvert	68 LF	70.00	4760.00
4	60" HDPE Culvert	77 LF	80.00	6160.00
	Subtotal Construction Cost			$15900.00
	Engineering		10%	1590.00
	Total Estimated Cost			$17490.00

Unresolved. Update the table to be consistent with the revised driveway layout shown on the drainage map.

9. FEES:

The owner has obtained a permit for the joint driveway shown on the drainage plan in order to begin the clearing of burnt trees. We have added potential building sites in order to compute the total impervious acreage, computed from the drainage plan as follows:

2019 Fees: Kettle Creek Drainage Basin
Drainage Fees: 0.95 Ac. @ $9909.00 = $ 9413.55; 25% reduction = $ 2353.39 Net = $ 7060.16
Bridge Fees: None

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COLORADO SPRINGS

POENITSCH SUBDIVISION
FEMA MAP PANEL
1"=500'

OLIVER E. WATTS
CONSULTING ENGINEER, INC.
COLORADO SPRINGS

POENITSCH SUBDIVISION
SCS SOILS MAP
1"=2000'

Include the conveyance coefficient used to determine the velocities. It appears that you are using a Cv of 7 (short pasture and lawns). A Cv of 15 (Grassed Waterway) would be more appropriate for the drainageways.
Unresolved.

Provide the developed condition calculations.

Unresolved. Both existing and proposed condition hydrology must be provided.

MAJOR BASIN	SUB BASIN	AREA		BASIN		Tc MIN	I		SOIL GRP	DEV. TYPE	C		FLOW		RETURN PERIOD YR	
		PLANIM READ	ACRES	LENGTH FT	HEIGHT FT								Qp CFS	Qp CFS		
BURGESS	O1	COGO	97.4	300	16	18			B	FOREST	0.08	0.35			5	100
CREEK			V=1.26	+4100	134	+54										
(KETTLE)						72	1.5	2.5					11.7	85.5	5	100
	O2	COGO	51.5	300	26	16										
			V=1.27	+4200	140	+54										
						70	1.5	2.5					6.2	45.1	5	100
	A	COGO	8.08	+810	28	+1.3										
	TOTAL		V=1.30			71.3	1.5	2.5					9.9	72.1	5	100
	03	COGO	82.4	300	28	15										
			V=1.40	+3800	153	+45										
						60	1.5	2.5					9.9	72.1	5	100
	B	COGO	5.05	+290	10	+3.7										
	TOTAL		244.4	V=1.3		64	1.5	2.5					29.3	214	5	100
	C	COGO	5.72	+380	7	+7										
	TOTAL		250.1	V=0.95		71	1.5	2.5					30.0	219		

HYDROLOGICAL COMPUTATION – BASIC DATA
PROJ: POENITCH SUB. BY: O.E. WATTS
RATIONAL METHOD DATE: 11-22-18

OLIVER E. WATTS, CONSULTING ENGINEER, INC.
614 ELKTON DRIVE COLORADO SPRINGS, CO 80907

PAGE **1**
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Typo. Update to O3

These values don't match what is shown in the narrative and in the drainage map. Please clarify and revise.

Unresolved.

Provide the culvert calculations for the proposed culvert crossings to show if the proposed sizings are adequate.

Unresolved. Hydraulic analysis to also include the required riprap size, and length.

REET AND STORM SEWER CALCULATIONS

			ANCE	ELEVATION & SLOPE	TOTAL RUNOFF	STREET FLOW / CAPACITY	PIPE FLOW	TYPE PIPE, CATCH BASIN & SLOPE %
HERRING RD	01			2.68%	11.7/85.2		85.2	48" RCP CAP = 235, ji=0.73'
PRIVATE	OUTFALL			3.34%	30.0/219		219	24" RCP CAP = 41.3 O'TOPS
							30	OK, hi=1.46'

Worksheet for Irregular Section - A-A

Project Description		
Flow Element:	Irregular Section	
Friction Method:	Manning Formula	
Solve For:	Normal Depth	

Input Data		
Channel Slope:	0.04710	ft/ft
Discharge:	85.20	ft^3/s

Options	
Current Roughness Weighted Meth	ImprovedLotters
Open Channel Weighted Roughnes	ImprovedLotters
Closed Channel Weighted Roughne	Hortons

Results		
Roughness Coefficient:	0.035	
Water Surface Elevation:	74.76	ft
Elevation Range:	74.00 to 80.00 ft	
Flow Area:	12.70	ft^2
Wetted Perimeter:	20.44	ft
Top Width:	20.26	ft
Normal Depth:	0.76	ft
Critical Depth:	0.97	ft
Critical Slope:	0.01975	ft/ft
Velocity:	6.71	ft/s
Velocity Head:	0.70	ft
Specific Energy:	1.46	ft
Froude Number:	1.49	
Flow Type:	Supercritical	

Segment Roughness

Start Station	End Station	Roughness Coefficient
(-0+32, 80.00)	(0+40, 80.00)	0.035

Section Geometry

Station	Elevation
-0+32	80.00
-0+21	78.00

It appears that the flow for each channel section is supercritical. Identify channel erosion stabilization improvements or justification for why they aren't necessary in the narrative of the report. Unresolved.

Worksheet for Irregular Section - A - A

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Station	Elevation
-0+14	76.00
-0+08	74.00
0+05	74.00
0+18	76.00
0+29	78.00
0+40	80.00

Worksheet for Irregular Section - B.B

Project Description		
Flow Element:	Irregular Section	
Friction Method:	Manning Formula	
Solve For:	Normal Depth	

Input Data		
Channel Slope:	0.04710	ft/ft
Discharge:	45.10	ft^3/s

Options	
Current Roughness Weighted Meth	ImprovedLotters
Open Channel Weighted Roughnes	ImprovedLotters
Closed Channel Weighted Roughne	Hortons

Results		
Roughness Coefficient:	0.035	
Water Surface Elevation:	66.32	ft
Elevation Range:	66.00 to 70.00 ft	
Flow Area:	11.04	ft^2
Wetted Perimeter:	37.35	ft
Top Width:	37.30	ft
Normal Depth:	0.32	ft
Critical Depth:	0.39	ft
Critical Slope:	0.02540	ft/ft
Velocity:	4.08	ft/s
Velocity Head:	0.26	ft
Specific Energy:	0.58	ft
Froude Number:	1.32	
Flow Type:	Supercritical	

Segment Roughness

Start Station	End Station	Roughness Coefficient
(-0+35, 70.00)	(0+60, 70.00)	0.035

Section Geometry

Station	Elevation
-0+35	70.00
-0+25	68.00

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Worksheet for Irregular Section - B-B

Station	Elevation
-0+16	66.00
0+15	66.00
0+45	68.00
0+60	70.00

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Worksheet for Irregular Section - ① - C

Project Description		
Flow Element:	Irregular Section	
Friction Method:	Manning Formula	
Solve For:	Normal Depth	

Input Data		
Channel Slope:	0.03390	ft/ft
Discharge:	137.00	ft^3/s

Options	
Current Roughness Weighted Meth	ImprovedLotters
Open Channel Weighted Roughnes	ImprovedLotters
Closed Channel Weighted Roughne	Hortons

Results		
Roughness Coefficient:	0.035	
Water Surface Elevation:	52.19	ft
Elevation Range:	51.00 to 54.00 ft	
Flow Area:	24.05	ft^2
Wetted Perimeter:	38.66	ft
Top Width:	38.57	ft
Normal Depth:	1.19	ft
Critical Depth:	1.32	ft
Critical Slope:	0.02019	ft/ft
Velocity:	5.70	ft/s
Velocity Head:	0.50	ft
Specific Energy:	1.70	ft
Froude Number:	1.27	
Flow Type:	Supercritical	

Segment Roughness

Start Station	End Station	Roughness Coefficient
(-0+60, 54.00)	(0+21, 54.00)	0.035

Section Geometry

Station	Elevation
-0+60	54.00
-0+22	52.00

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Worksheet for Irregular Section - C - C

Station	Elevation
0+00	51.00
0+12	52.00
0+21	54.00

Worksheet for Irregular Section - D-D

Project Description	
Flow Element:	Irregular Section
Friction Method:	Manning Formula
Solve For:	Normal Depth

Input Data		
Channel Slope:	0.02470	ft/ft
Discharge:	72.10	ft^3/s

Options	
Current Roughness Weighted Meth	ImprovedLotters
Open Channel Weighted Roughnes	ImprovedLotters
Closed Channel Weighted Roughne	Hortons

Results		
Roughness Coefficient:	0.035	
Water Surface Elevation:	48.74	ft
Elevation Range:	47.50 to 52.00 ft	
Flow Area:	12.78	ft^2
Wetted Perimeter:	16.42	ft
Top Width:	16.17	ft
Normal Depth:	1.24	ft
Critical Depth:	1.31	ft
Critical Slope:	0.01937	ft/ft
Velocity:	5.64	ft/s
Velocity Head:	0.49	ft
Specific Energy:	1.73	ft
Froude Number:	1.12	
Flow Type:	Supercritical	

Segment Roughness

Start Station	End Station	Roughness Coefficient
(-0+28, 52.00)	(0+20, 52.00)	0.035

Section Geometry

Station	Elevation
-0+28	52.00
-0+13	50.00

Worksheet for Irregular Section - D-D

Station	Elevation
-0+05	48.00
0+00	47.50
0+06	48.00
0+12	50.00
0+20	52.00

Worksheet for Irregular Section - E-E

Project Description		
Flow Element:	Irregular Section	
Friction Method:	Manning Formula	
Solve For:	Normal Depth	

Input Data		
Channel Slope:	0.00000	ft/ft
Discharge:	219.00	ft^3/s

Options		
Current Roughness Weighted Meth	ImprovedLotters	
Open Channel Weighted Roughnes	ImprovedLotters	
Closed Channel Weighted Roughne	Hortons	

Results		
Roughness Coefficient:	0.035	
Water Surface Elevation:	40.55	ft
Elevation Range:	38.60 to 44.00 ft	
Flow Area:	31.09	ft^2
Wetted Perimeter:	28.66	ft
Top Width:	28.37	ft
Normal Depth:	1.95	ft
Critical Depth:	2.09	ft
Critical Slope:	0.01707	ft/ft
Velocity:	7.04	ft/s
Velocity Head:	0.77	ft
Specific Energy:	2.72	ft
Froude Number:	1.19	
Flow Type:	Supercritical	

Segment Roughness

Start Station	End Station	Roughness Coefficient
(-0+34, 44.00)	(0+30, 44.00)	0.035

Section Geometry

Station	Elevation
-0+34	44.00
-0+20	42.00

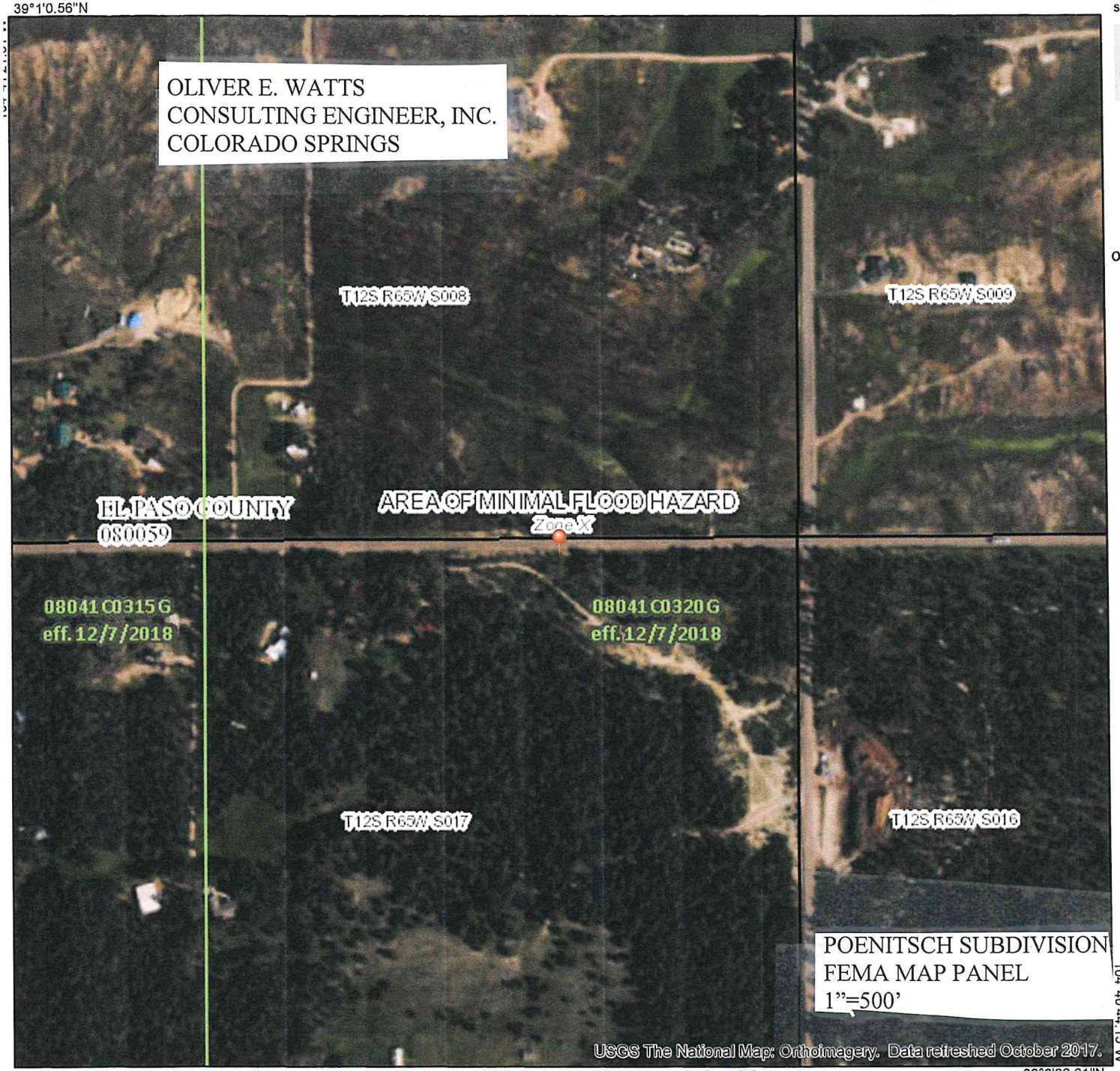
12/12

Worksheet for Irregular Section - 五 - E

Station	Elevation
-0+12	40.00
0+00	38.60
0+12	40.00
0+20	42.00
0+30	44.00

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 represen 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 12/12/2018 at 10:49:53 AM 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.

EL PASO COUNTY AREA, COLORADO NO. 2

TABLE 16.--SOIL AND WATER FEATURES

[Absence of an entry indicates the feature is not a concern. See "flooding" in Glossary for definition of terms as "rare," "brief," and "very brief." The symbol > means greater than]

Soil name and map symbol	Hydrologic group	Flooding			Bedrock		Potential frost action
		Frequency	Duration	Months	Depth	Hardness	
					In		
Alamosa: 1	C	Frequent	Brief	May-Jun	>60	---	High.
Ascalon: 2, 3	B	None	---	---	>60	---	Moderate.
Badland: 4	D	---	---	---	---	---	---
Bijou: 5, 6, 7	B	None	---	---	>60	---	Low.
Blakeland: 8	A	None	---	---	>60	---	Low.
[1]9: Blakeland part	A	None	---	---	>60	---	Low.
Fluvaquentic Haplaquolls part	D	Common	Very brief	Mar-Aug	>60	---	High.
Blendon: 10	B	None	---	---	>60	---	Moderate.
Bresser: 11, 12, 13	B	None	---	---	>60	---	Low.
Brussett: 14, 15	B	None	---	---	>60	---	Moderate.
Chaseville: 16, 17	A	None	---	---	>60	---	Low.
[1]18: Chaseville part	A	None	---	---	>60	---	Low.
Midway part	D	None	---	---	10-20	Rippable	Moderate.
Columbine: 19	A	None to rare	---	---	>60	---	Low.
Connerton: [1]20: Connerton part	B	None	---	---	>60	---	High.
Rock outcrop part	D	---	---	---	---	---	---
Cruckton: 21	B	None	---	---	>60	---	Moderate.
Cushman: 22, 23	C	None	---	---	20-40	Rippable	Moderate.
[1]24: Cushman part	C	None	---	---	20-40	Rippable	Moderate.
Kutch part	C	None	---	---	20-40	Rippable	Moderate.
Elbeth: 25, 26	B	None	---	---	>60	---	Moderate.
[1]27: Elbeth part	B	None	---	---	>60	---	Moderate.

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			Bedrock		Potential frost action
		Frequency	Duration	Months	Depth	Hardness	
					In		
Elbeth: Pring part	B	None	---	---	>60	---	Moderate.
Ellicott: 28	A	Frequent	Brief	Mar-Jun	>60	---	Low.
Fluvaquentic Haplaquolls: 29	B/D	Frequent	Brief	Mar-Jul	>60	---	High.
Fort Collins: 30, 31	B	None to rare	---	---	>60	---	Moderate.
Fortwingate: [1]32:							
Fortwingate part	C	None	---	---	20-40	Hard	Low.
Rock outcrop part	D	---	---	---	---	---	---
Heldt: 33	C	None	---	---	>60	---	Moderate.
Holderness: 34, 35, 36	C	None	---	---	>60	---	Moderate.
Jarre: 37	B	None	---	---	>60	---	Moderate.
[1]38:							
Jarre part	B	None	---	---	>60	---	Moderate.
Tecolote part	B	None	---	---	>60	---	Moderate.
Keith: 39	B	None	---	---	>60	---	High.
Kettle: 40, 41	B	None	---	---	>60	---	Moderate.
[1]42:							
Kettle part	B	None	---	---	>60	---	Moderate.
Rock outcrop part	D	---	---	---	---	---	---
Kim: 43	B	None	---	---	>60	---	Moderate.
Kutch: 44, 45	C	None	---	---	20-40	Rippable	Moderate.
Kutler: [1]46:							
Kutler part	C	None	---	---	20-40	Rippable	Low.
Broadmoor part	C	None	---	---	20-40	Rippable	Low.
Rock outcrop part	D	---	---	---	---	---	---
Limon: 47	C	Occasional	Brief	May-Sep	>60	---	Moderate.
Louviers: 48	D	None	---	---	10-20	Rippable	Moderate.
49	D	None	---	---	10-20	Rippable	Low.

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			Bedrock		Potential frost action
		Frequency	Duration	Months	Depth	Hardness	
					In		
Manvel: 50	C	None	---	---	>60	---	High.
Manzanola: 51, 52, 53	C	None to rare	---	---	>60	---	Moderate.
Midway: 54	D	None	---	---	10-20	Rippable	Moderate.
Nederland: 55	B	None	---	---	>60	---	Moderate.
Nelson: [1]56:							
Nelson part	B	None	---	---	20-40	Rippable	Low.
Tassel part	D	None	---	---	10-20	Rippable	Low.
Neville: 57	B	None	---	---	>60	---	High.
[1]58:							
Neville part	B	None	---	---	>60	---	High.
Rednun part	C	None	---	---	>60	---	Moderate.
Nunn: 59	C	None	---	---	>60	---	Moderate.
Olney: 60, 61	B	None	---	---	>60	---	Moderate.
[1]62:							
Olney part	B	None	---	---	>60	---	Moderate.
Vona part	B	None	---	---	>60	---	Moderate.
Paunsaugunt: [1]63:							
Paunsaugunt part	D	None	---	---	10-20	Hard	Moderate.
Rock outcrop part	D	---	---	---	---	---	---
Penrose: [1]64:							
Penrose part	D	None	---	---	10-20	Rippable	Low.
Manvel part	C	None	---	---	>60	---	High.
Perrypark: 65	B	None	---	---	>60	---	Moderate.
Peyton: 66, 67	B	None	---	---	>60	---	Moderate.
[1]68, [1]69:							
Peyton part	B	None	---	---	>60	---	Moderate.
Pring part	B	None	---	---	>60	---	Moderate.
Pits, gravel: 70	A	---	---	---	---	---	---
Pring: 71, 72	B	None	---	---	>60	---	Moderate.
Razor: 73, 74	C	None	---	---	20-40	Rippable	Moderate.

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			Bedrock		Potential frost action
		Frequency	Duration	Months	Depth	Hardness	
					In		
Tomah:							
[1]92, [1]93:							
Tomah part-----	B	None----------	---	---	>60	---	Moderate.
Crowfoot part--	B	None----------	---	---	>60	---	Moderate.
Travessilla:							
[1]94:							
Travessilla part----------	D	None----------	---	---	6-20	Hard	Low.
Rock outcrop part----------	D	---	---	---	---	---	---
Truckton:							
95, 96, 97-------	B	None----------	---	---	>60	---	Moderate.
[1]98:							
Truckton part--	B	None----------	---	---	>60	---	Moderate.
Blakeland part-	A	None----------	---	---	>60	---	Low.
[1]99, [1]100:							
Truckton part--	B	None----------	---	---	>60	---	Moderate.
Bresser part---	B	None----------	---	---	>60	---	Low.
Ustic Torrifluvents:							
101--------------	B	Occasional----	Very brief----	Mar-Aug	>60	---	Moderate.
Valent:							
102, 103---------	A	None----------	---	---	>60	---	Low.
Vona:							
104, 105---------	B	None----------	---	---	>60	---	Moderate.
Wigton:							
106--------------	A	None----------	---	---	>60	---	Low.
Wiley:							
107, 108---------	B	None----------	---	---	>60	---	Low.
Yoder:							
109, 110---------	B	None----------	---	---	>60	---	Low.

[1]This map unit is made up of two or more dominant kinds of soil. See map unit description for the composition and behavior characteristics of the map unit.

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

Where:

t_c = time of concentration (min)

t_i = overland (initial) flow time (min)

t_t = travel time in the ditch, channel, gutter, storm sewer, etc. (min)

3.2.1 Overland (Initial) Flow Time

The overland flow time, t_i, may be calculated using Equation 6-8.

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

Where:

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

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

3.2.2 Travel Time

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

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

Where:

V = velocity (ft/s)

C_v = conveyance coefficient (from Table 6-7)

S_w = watercourse slope (ft/ft)

Table 6-7. Conveyance Coefficient, C_v

Type of Land Surface	C_v
Heavy meadow	2.5
Tillage/field	5
Riprap (not buried)*	6.5
Short pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

*For buried riprap, select C_v value based on type of vegetative cover.

The travel time is calculated by dividing the flow distance (in feet) by the velocity calculated using Equation 6-9 and converting units to minutes.

The time of concentration (t_c) is then the sum of the overland flow time (t_i) and the travel time (t_t) per Equation 6-7.

3.2.3 First Design Point Time of Concentration in Urban Catchments

Using this procedure, the time of concentration at the first design point (typically the first inlet in the system) in an urbanized catchment should not exceed the time of concentration calculated using Equation 6-10. The first design point is defined as the point where runoff first enters the storm sewer system.

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

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.

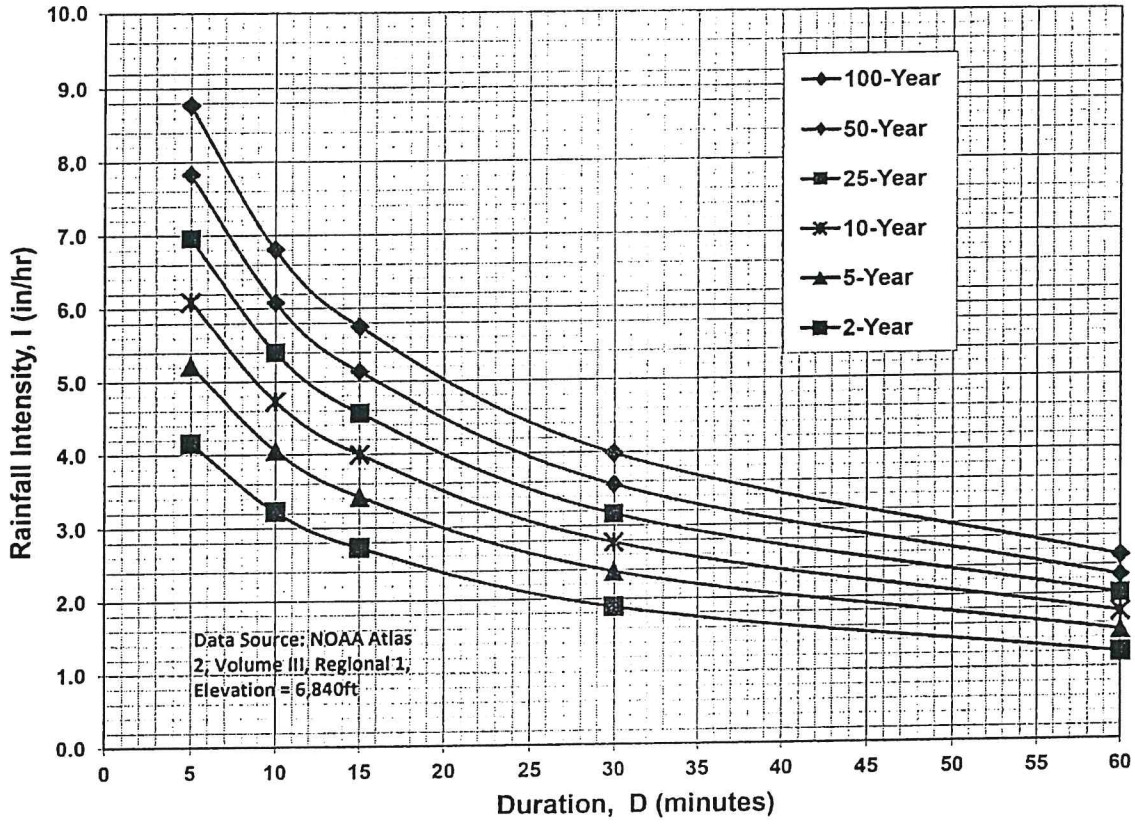
3.2.4 Minimum Time of Concentration

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

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.

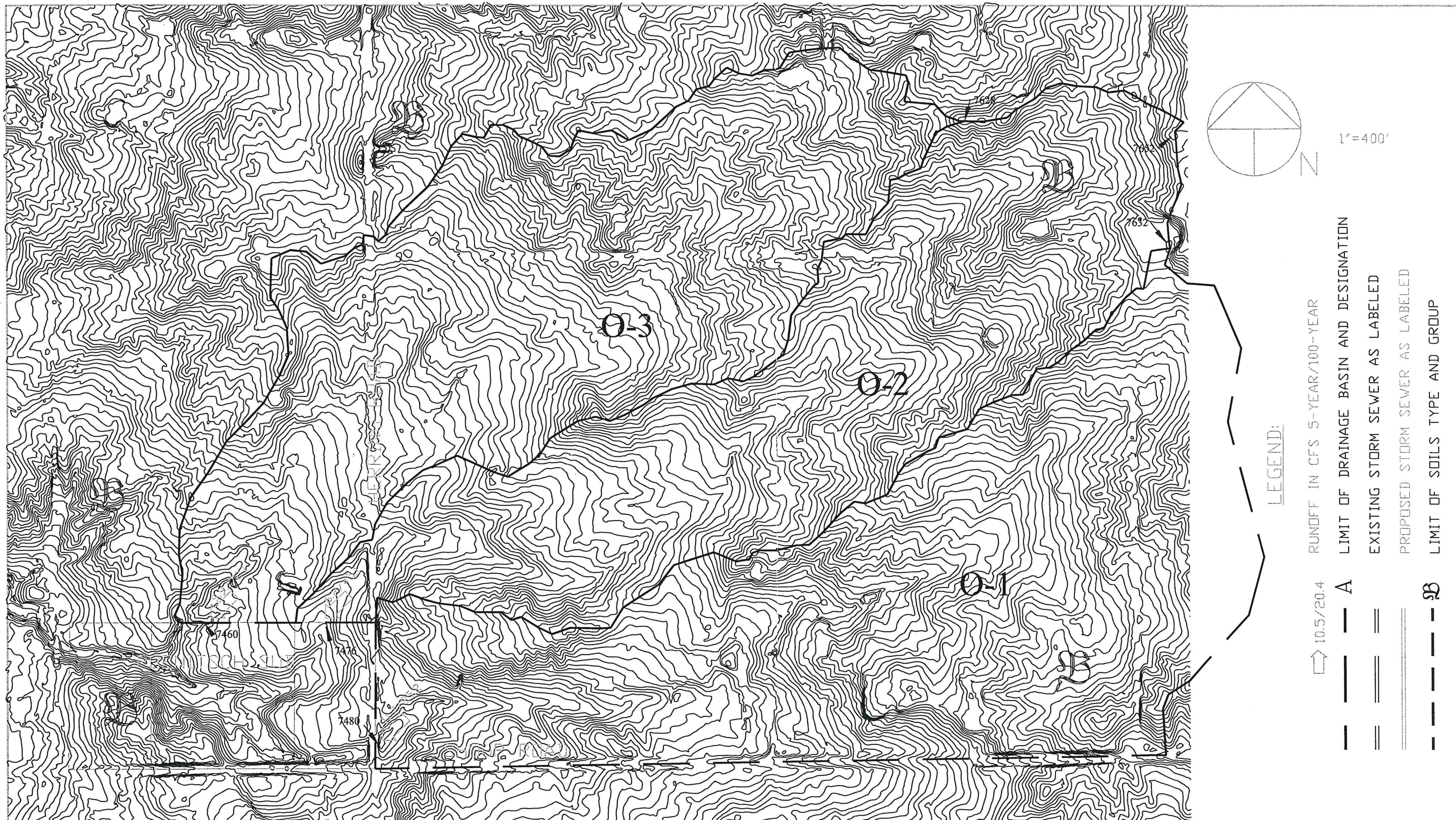
Table 6-6. Runoff Coefficients for Rational Method
(Source: UDFCD 2001)

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.

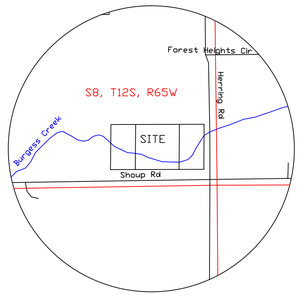
For urban areas, the time of concentration (t_c) consists of an initial time or overland flow time (t_i) plus the travel time (t_t) in the storm sewer, paved gutter, roadside drainage ditch, or drainage channel. For non-urban areas, the time of concentration consists of an overland flow time (t_i) plus 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.



DRAWN BY: O.E. WATTS DATE: 11-22-18 DWG. NO.: 18-5184-09 TOPOGRAPHY BY EL PASO COUNTY INFO. TECH.	REVISIONS	OLIVER E. WATTS CONSULTING ENGINEER COLORADO SPRINGS	PROJECT 7680 SHOUP ROAD S1/2, SE, SE, 8-12-65 EL PASO COUNTY	SHT. NAME OFFSITE DRAINAGE	SHT. NO. 1 OF 1

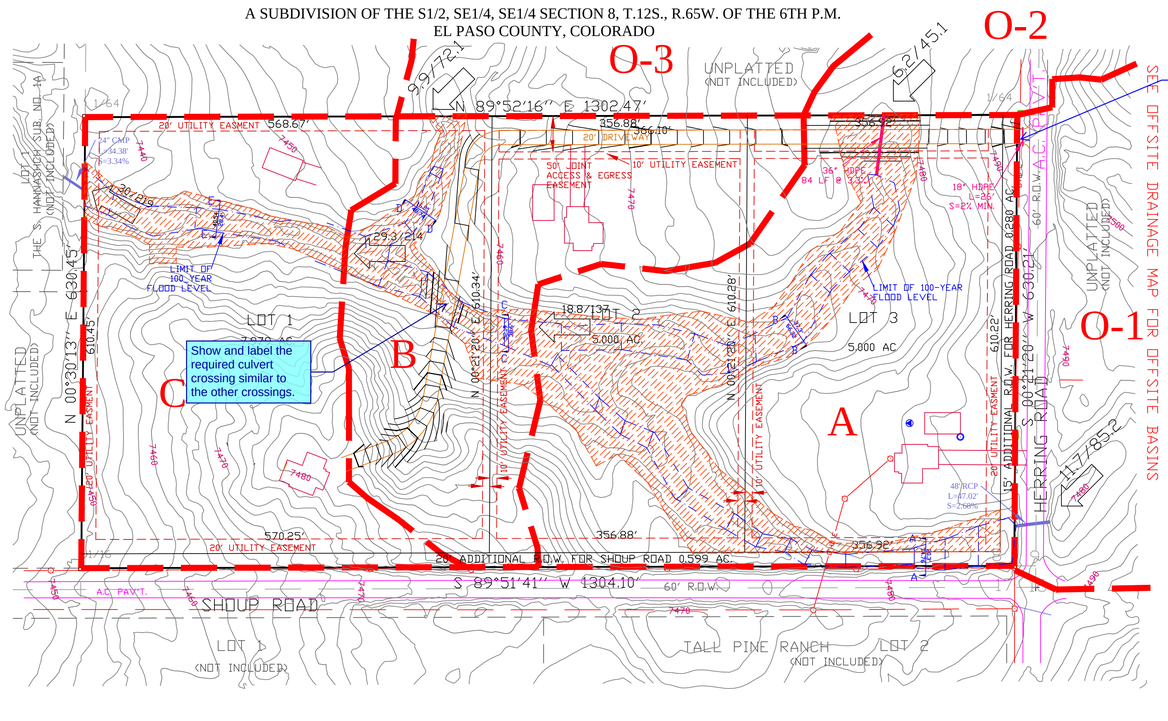
DRAINAGE PLAN
POENITSCH SUBDIVISION

A SUBDIVISION OF THE S1/2, SE1/4, SE1/4 SECTION 8, T.12S., R.65W. OF THE 6TH P.M.
EL PASO COUNTY, COLORADO



VICINITY MAP

1"=1000'



Show and label the required culvert crossing similar to the other crossings.

HPDE Pipe is not permitted for driveway culverts, per driveway access permit requirements. Please revise to show either CMP or reinforced concrete. Update accordingly in Cost Estimate. Unresolved.

N

100 0 100 200 300

Scale 1" = 100'
Contour Interval: 2'
ELEV. DATUM: NGVD, 1929 ADJUSTMENT

LEGEND:

- FOUND #33649 AL. CAP ON #5 REBAR
- POWER POLE
- WELL
- FIBER OPTIC VAULT
- CYSTERN
- NO-BUILD EASEMENT (FLOOD-PRONE AREAS)

LEGEND:

- 10.5/20.4 — RUNOFF IN CFS 5-YEAR/100-YEAR
- A — LIMIT OF DRAINAGE BASIN AND DESIGNATION
- EXISTING STORM SEWER AS LABELED
- PROPOSED STORM SEWER AS LABELED
- B — LIMIT OF SOILS TYPE AND GROUP
- CHANNEL SECTION (WS ELEV., TOP WIDTH; LIMIT OF 100-YEAR RUNOFF)
- TYPICAL DWELLING FOR DRAINAGE FEE PURPOSES

Legal Description:
The South half of the Southeast quarter of the Southeast quarter of Section 8, Township 12 South, Range 65 West of the 6th P.M., County of El Paso, State of Colorado.
And containing 18.86 acres

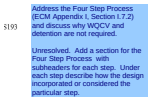
PREPARED BY THE OFFICE OF:
OLIVER E. WATTS PE-LS
CONSULTING ENGINEER
614 ELKTON DRIVE
COLORADO SPRINGS, CO 80907
(719) 593-0173
olliewatts@aol.com
Celebrating over 39 years in business

PCD FILE NO. MS193 6-19-19

OLIVER E. WATTS CONSULTING ENGINEER COLORADO SPRINGS 11-22-18 OEW 18-5184-08

Drainage Letter_V2.pdf Markup Summary

Locked (10)



Subject: Engineer
Page Label: 1
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Author: dsdlaforce
Date: 10/23/2019 12:27:52 PM
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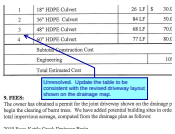
Address the Four Step Process (ECM Appendix I, Section I.7.2) and discuss why WQCV and detention are not required.

Unresolved. Add a section for the Four Step Process with subheaders for each step. Under each step describe how the design incorporated or considered the particular step.



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Page Label: 5
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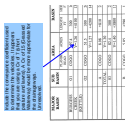
Unresolved. Update the table to be consistent with the revised driveway layout shown on the drainage map.



Subject: Engineer
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Author: dsdlaforce
Date: 10/23/2019 12:27:54 PM
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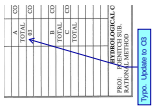
Include the conveyance coefficient used to determine the velocities. It appears that you are using a Cv of 7 (short pasture and lawns). A Cv of 15 (Grassed Waterway) would be more appropriate for the drainageways. Unresolved.



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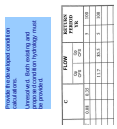
Typo. Update to O3



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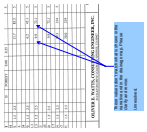
Provide the developed condition calculations.

Unresolved. Both existing and proposed condition hydrology must be provided.



Subject: Engineer
Page Label: 7
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Author: dsdlaforce
Date: 10/23/2019 12:27:58 PM
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These values don't match what is shown in the narrative and in the drainage map. Please clarify and revise.

Unresolved.

Subject: Engineer
Page Label: 8
Lock: Locked
Author: dsdlaforce
Date: 10/23/2019 12:28:03 PM
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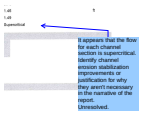
Provide the culvert calculations for the proposed culvert crossings to show if the proposed sizings are adequate.

Unresolved. Hydraulic analysis to also include the required riprap size, and length.



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Page Label: 9
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Date: 10/23/2019 12:28:04 PM
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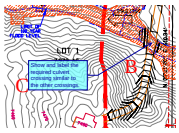
It appears that the flow for each channel section is supercritical. Identify channel erosion stabilization improvements or justification for why they aren't necessary in the narrative of the report.
Unresolved.



Subject: Callout
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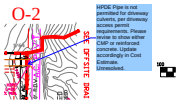
Show and label the required culvert crossing similar to the other crossings.



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HPDE Pipe is not permitted for driveway culverts, per driveway access permit requirements. Please revise to show either CMP or reinforced concrete. Update accordingly in Cost Estimate.
Unresolved.