Preliminary and Final
DRAINAGE PLAN AND REPORT

ROCKY TOP MOTEL AND CAMPGROUND

10090 W Highway 24
A portion of the NW ¼, Section 9, Township 13 South, Range 68 West
EL PASO COUNTY

June 14, 2019

Updated
August 16, 2021

Revised
January 4, 2022

Revised
April 13, 2022

Prepared for

G & D Enterprises
10090 West Highway 24
Green Mountain Falls, CO 80819

County File No.: PPR2140

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

OLIVER E. WATTS, PE-LS
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Celebrating over 43 years in business

April 13, 2022

El Paso County Planning and Community Development
2880 International Circle
Colorado Springs, CO 80910

ATTN: *Jennifer Irvine, P.E.*

SUBJECT: Drainage Plan and Report
Rocky Top Motel and Campground

Transmitted herewith for your review and approval is the drainage plan and report for The Rocky Top Motel and Campground in El Paso County. This report is prepared and a result of Craig Dossey's letter of May 2, 2019 regarding an alleged violation of County grading regulations. It has been revised per the 10-7-21 County Review and our subsequent meetings. This report will accompany the submittal of other land use applications. Please contact me if I may provide any further information.

Oliver E. Watts, Consulting Engineer, Inc.

BY: _____
Oliver E. Watts, President

Encl:
Drainage Report 6 pages
Runoff Computations, 3 pages
UD Computations, 5 pages
FEMA Panel No. 08041C0952 G
SCS Soils Map
Backup Information, 4 sheets
Drainage Plan, Dwg 19-5341-02

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.

G & D Enterprises, Corp.

By: _____

Daniel P. Nieman, owner
10090 West Highway 24
Green Mountain Falls, CO 80819
684-9044

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, P.E., date
County Engineer / ECM Administrator

Conditions:

4. LOCATION AND DESCRIPTION:

The Rocky Top Motel and Campground is located in a portion of the NW ¼, Section 9, Township 13 South, Range 68 West, of the 6th P.M., in El Paso County. The address, located at 10090 West Highway 24, is adjacent to Green Mountain Falls, on the north side of Highway 24 as shown in detail on the enclosed drainage plan. This facility has been in use at this location since 1947 as a motel and since 1950 as a camp ground. A use application for RV storage has been recently submitted to the County for this additional use. A detailed site survey is submitted as part of the enclosed drainage plan to delineate current conditions.

The County issued a notice of violation dated May 2, 2019, in reply to neighborhood complaints itemizing items that needed to be completed to reply to violations of grading in excess of one acre and the un-permitted use as RV storage. The County is considering road construction dating back several years to be included in the disturbed area.

The grading reported by the neighbors mostly involved repair and maintenance. The owner has had to contend with erosion from stormwater runoff. This had lead to grading of, to repair said erosion, especially along Lucky 4 Road to the west of the site. This is a private road that is not maintained by the County.

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 08041C0952 G, dated December 7, 2018, a copy of which is enclosed for reference. Note that the site is in Zone X on said Firmette

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 is enclosed for reference, indication that all soils in this area are of hydrologic group "A". The soils in this area are largely usable as gravel surfacing and are excellent as a construction material. Infiltration is a maximum and runoff is held to a minimum.

7. DESCRIPTION OF RUNOFF:

A. Historic Drainage:

Computations are enclosed to show the historic drainage conditions prior to construction of any existing facilities (pre-1947). The drainage pattern has remained unchanged, and is increased due to development over the years.

B. Drainage Inflows:

As shown on the enclosed drainage plan one small area (Basin O-1) will drain into the property near the northwest corner, creating 0.15 cfs / 1.1 cfs (5-year / 100-year runoffs) from a small vacant grassed site. This runoff is in the undeveloped historic state.

C. On Site Runoff:
On site runoff has existed in the current state for many years. Improvements include the motel area and improvements, including paving, to the road system. Other improvements include regrading the area for use as campground and tented areas and increases in runoff are minimal unless structures are involved. The type "A" soils of the site exhibit minimal runoff, which is not significantly increased with gravel or similar surfacing used for dust control

The above mentioned inflow will combine with runoff from Basin A for a total of 4.0 cfs/ 10.6 cfs at a point along the entrance road. The historic runoff for this area is 0.85 cfs \ 6.2 cfs. This basin is a mixture of part of the paved road and graveled campground sites graded into the natural terrain and areas of native vegetation covering steeper boundary areas. This will combine with runoff from Basin B, consisting of the motel site, paved roads and parking. The 0.44 acre RV parking site has been abandoned and reclaimed. The total runoff at the outfall point into Highway 24 is 5.6 cfs / 17.2 cfs, compared with the historic value of 1.49 cfs / 11.1 cfs. This runoff is well within the capacity of existing downstream drainage facilities, as shown by the enclosed computations. Runoff reduction is employed along this drainage path and a sand filter basis is provided at the subdivision boundary.

Basin C is the Southwesterly third of the site, containing graveled campground sites, tent sites, and a gravel road. The 0.38 acre RV storage site has been abandoned and reclaimed. The total runoff at the historic outfall point into Highway 24 is 3.2 cfs / 9.1 cfs, compared with the historic value of 0.748 cfs / 5.7 cfs. A few culverts exist within the site and below the outfall point, all of which have the computed capacity to safely accommodate this total runoff. Highway 24 culverts have proved historically adequate and will remain so as far as this development is concerned. A sand filter basin is provided at the subdivision boundary.

8. WATER QUALITY REQUIREMENTS:

The total historic and proposed development work on the site is largely mitigated by the existing Type A soils of the area. A runoff reduction work sheet is enclosed analyzing the proposed efforts to minimize these effects. Two proposed sand filter basins are proposed at the outfall points of the development for this purpose. The proposed grading is represented on the enclosed drainage plan and the grading plan that accompanies the total submittal. The work is minimal and necessary erosion BMP's are proposed.

9. COST ESTIMATE:

All facilities are private.

Item No.	Description	Quantity	Unit Cost	Cost
1	West Sand Filter Basin	1 ea	LS	$ 1600.00
2	East Sand Filter Basin	1 ea	LS	2500.00
3	24” CMP Storm Sewer	80 LF	30.00	2400.00
	Subtotal Construction Cost			$ 6500.00
	Engineering	10%		650.00
	Total Estimated Cost			$ 7150.00

10. SUMMARY

The motel and campground have existed at this address since 1947 and 1950 respectively. The proposed facilities will mitigate the effects of historic development as well as proposed improvements. There will be no adverse effects on downstream or surrounding properties.

The drainage analysis has been prepared in accordance with the current El Paso County Drainage Criteria Manuel. Supporting information and calculations are included in this report.

MAJOR BASIN	SUB BASIN	AREA		BASIN		Tc MIN	I		SOIL GRP	DEV. TYPE	C		FLOW		RETURN PERIOD	
		PLANIM READ	ACRES	LENGTH	HEIGHT								qp	qp		
FOUNTAIN CR	O-1	COGO	0.66	100	4	20			A	MDW	0.08	0.35			5	100
				+200	6	+1										
						21	2.9	4.8					0.15	1.1	5	100
	+A	COGO	3.12	+420	34	+1.2			A	MDW	0.08	0.35	15%			
				V=5.7						GRAVEL	0.50	0.70	85%			
										MIX	0.437	0.648				
	TOTAL	COGO	3.78			22.2	2.8	4.7	A	MIX	0.375	0.596	4.0	10.6	5	100
	+B	COGO	3.13	+360	34	+1.0			A	ROOF	0.73	0.81	2%			
				V=6.1						GRAVEL	0.50	0.70	20%			
										MDW	0.08	0.35	70%			
										MIX	0.215	0.478				
	TOTAL	COGO	6.91			23.2	2.7	4.6	A	MIX	0.302	0.542	5.6	17.2	5	100
	C	COGO	2.97	100	2	14.7			A	GRAVEL	0.50	0.70	60%			
			V=5.4	+640	46	+2.0				MDW	0.08	0.35	40%			
						16.7	3.3	5.5	A	MIX	0.332	0.560	3.2	9.1	5	100

HYDROLOGICAL COMPUTATION – BASIC DATA
PROJ: ROCKY TOP MOTEL & CAMPGROUND BY: O.E. WATTS
RATIONAL METHOD DATE: 6-14-19, 8-16-21

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

MAJOR BASIN	SUB BASIN	AREA		BASIN		T_c MIN	I in./hr.		SOIL GRP	DEV. TYPE	C		FLOW 5-ry	FLOW 100-yr	RETURN PERIOD -years-	
		PLANIM READ	ACRES	LENGTH -FT.-	HEIGHT -FT.-								qp -CFS-	qp -CFS-		
HISTORIC	O-1	COGO	0.66	100	4	20			A	MDW	0.08	0.35			5	100
				+200	6	+1										
						21	2.9	4.8					0.15	1.1	5	100
	+A	COGO	3.13	+420	34	+1.2										
	TOTAL		3.748			22.2	2.8	4.7	A	MDW	0.08	0.35	0.85	6.2	5	100
	+B	COGO	3.13	+360	34	+1.0										
	TOTAL		6.91			23.2	2.7	4.6	A	MDW	0.08	0.35	1.49	11.1	5	100
	C	COGO	2.97	100	2	14.7										
				+640	46	+2.0										
						16.7	3.3	5.5	A	MDW	0.08	0.35	0.78	5.7	5	100

HYDROLOGICAL COMPUTATION – BASIC DATA
PROJ: ROCKY TOP MOTEL & CAMPGROUND BY: O.E. WATTS
RATIONAL METHOD DATE: April 14, 2022

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

STREET AND STORM SEWER CALCULATIONS

STREET	LOCATION	DISTANCE	ELEVATION & SLOPE	TOTAL RUNOFF	STREET FLOW / CAPACITY	PIPE FLOW	TYPE PIPE, CATCH BASIN & SLOPE %
PRIVATE	B OUTFALL			5.6/172		17.2	24”CMP hi=0.62’ S=0.60% MIN
	C OUTFALL			3.7/9.1		9.1	24”CMP hi=0.24’ S=0.20% MIN.

Design Procedure Form: Runoff Reduction

UD-BMP (Version 3.07, March 2018)

Designer:	**O.E. Wats**
Company:	**Oliver E. Watts, CE**
Date:	**April 14, 2022**
Project:	**Rockytop Motel and Camprbound**
Location:	**El Paso County**

SITE INFORMATION (User Input in Blue Cells)

WQCV Rainfall Depth	0.60	inches
Depth of Average Runoff Producing Storm, d_6 =	0.43	inches (for Watersheds Outside of the Denver Region, Figure 3-1 in USDCM Vol. 3)

Area Type	UIA:RPA											
Area ID	E											
Downstream Design Point ID	E											
Downstream BMP Type	None											
DCIA (ft^2)	--											
UIA (ft^2)	7,096											
RPA (ft^2)	8,022											
SPA (ft^2)	--											
HSG A (%)	100%											
HSG B (%)	0%											
HSG C/D (%)	0%											
Average Slope of RPA (ft/ft)	0.100											
UIA:RPA Interface Width (ft)	16.00											

CALCULATED RUNOFF RESULTS

Area ID	E											
UIA:RPA Area (ft^2)	15,118											
L / W Ratio	16.00											
UIA / Area	0.4694											
Runoff (in)	0.00											
Runoff (ft^3)	0											
Runoff Reduction (ft^3)	296											

CALCULATED WQCV RESULTS

Area ID	E											
WQCV (ft^3)	296											
WQCV Reduction (ft^3)	296											
WQCV Reduction (%)	100%											
Untreated WQCV (ft^3)	0											

CALCULATED DESIGN POINT RESULTS (sums results from all columns with the same Downstream Design Point ID)

Downstream Design Point ID	E											
DCIA (ft^2)	0											
UIA (ft^2)	7,096											
RPA (ft^2)	8,022											
SPA (ft^2)	0											
Total Area (ft^2)	15,118											
Total Impervious Area (ft^2)	7,096											
WQCV (ft^3)	296											
WQCV Reduction (ft^3)	296											
WQCV Reduction (%)	100%											
Untreated WQCV (ft^3)	0											

CALCULATED SITE RESULTS (sums results from all columns in worksheet)

Total Area (ft^2)	15,118
Total Impervious Area (ft^2)	7,096
WQCV (ft^3)	296
WQCV Reduction (ft^3)	296
WQCV Reduction (%)	100%
Untreated WQCV (ft^3)	0

Design Procedure Form: Sand Filter (SF)

UD-BMP (Version 3.07, March 2018)

Designer:	**O.E. WATTS**
Company:	**Oliver E. Watts, CE**
Date:	**April 14, 2022**
Project:	**Rocky Top Motel and Campground**
Location:	**Basin C PLD Pond**

1. Basin Storage Volume	
A) Effective Imperviousness of Tributary Area, I_a (100% if all paved and roofed areas upstream of sand filter)	I_a = 45.0 %
B) Tributary Area's Imperviousness Ratio ($i = I_a/100$)	i = 0.450
C) Water Quality Capture Volume (WQCV) Based on 12-hour Drain Time $WOCV= 0.8 * (0.91* i^3 - 1.19 * i^2 + 0.78 * i)$	WQCV = 0.15 watershed inches
D) Contributing Watershed Area (including sand filter area)	Area = 129,700 sq ft
E) Water Quality Capture Volume (WQCV) Design Volume V_{WOCV} = WQCV / 12 * Area	V_{WOCV} = cu ft
F) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm	d_6 = 2.52 in
G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume	$V_{WOCV\ OTHER}$ = 9,777 cu ft
H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired)	$V_{WOCV\ USER}$ = cu ft
2. Basin Geometry	
A) WQCV Depth	D_{WOCV} = 2.0 ft
B) Sand Filter Side Slopes (Horizontal distance per unit vertical, 4:1 or flatter preferred). Use "0" if sand filter has vertical walls.	Z = 4.00 ft / ft
C) Minimum Filter Area (Flat Surface Area)	A_{Min} = 730 sq ft
D) Actual Filter Area	A_{Actual} = sq ft
E) Volume Provided	V_T = cu ft
3. Filter Material	Choose One ○ 18" CDOT Class B or C Filter Material ◉ Other (Explain): TYPE A SOIL
4. Underdrain System	
A) Are underdrains provided?	Choose One ○ YES ○ NO
B) Underdrain system orifice diameter for 12 hour drain time	
i) Distance From Lowest Elevation of the Storage Volume to the Center of the Orifice	y = ft
ii) Volume to Drain in 12 Hours	Vol_{12} = cu ft
iii) Orifice Diameter, 3/8" Minimum	D_O = in

Design Procedure Form: Sand Filter (SF)

Designer: O.E. WATTS
Company: Oliver E. Watts, CE
Date: April 14, 2022
Project: Rocky Top Motel and Campground
Location: Basin C PLD Pond

5. Impermeable Geomembrane Liner and Geotextile Separator Fabric A) Is an impermeable liner provided due to proximity of structures or groundwater contamination?	Choose One ○ YES ○ NO
6. Inlet / Outlet Works A) Describe the type of energy dissipation at inlet points and means of conveying flows in excess of the WQCV through the outlet	

Notes:

Design Procedure Form: Sand Filter (SF)

UD-BMP (Version 3.07, March 2018)

Designer:	**O.E. WATTS**
Company:	**Oliver E. Watts, CE**
Date:	**April 14, 2022**
Project:	**Rocky Top Motel and Campground**
Location:	**BASINS O-1 THRU B PLD POND**

1. Basin Storage Volume	
A) Effective Imperviousness of Tributary Area, I_a (100% if all paved and roofed areas upstream of sand filter)	I_a = 43.0 %
B) Tributary Area's Imperviousness Ratio ($i = I_a/100$)	i = 0.430
C) Water Quality Capture Volume (WQCV) Based on 12-hour Drain Time $WOCV= 0.8 * (0.91* i^3 - 1.19 * i^2 + 0.78 * i)$	WQCV = 0.15 watershed inches
D) Contributing Watershed Area (including sand filter area)	Area = 136,300 sq ft
E) Water Quality Capture Volume (WQCV) Design Volume V_{WOCV} = WQCV / 12 * Area	V_{WOCV} = cu ft
F) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm	d_6 = 2.52 in
G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume	$V_{WOCV\ OTHER}$ = 9,997 cu ft
H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired)	$V_{WOCV\ USER}$ = cu ft
2. Basin Geometry	
A) WQCV Depth	D_{WOCV} = 2.0 ft
B) Sand Filter Side Slopes (Horizontal distance per unit vertical, 4:1 or flatter preferred). Use "0" if sand filter has vertical walls.	Z = 4.00 ft / ft
C) Minimum Filter Area (Flat Surface Area)	A_{Min} = 733 sq ft
D) Actual Filter Area	A_{Actual} = sq ft
E) Volume Provided	V_T = cu ft
3. Filter Material	Choose One ○ 18" CDOT Class B or C Filter Material ◉ Other (Explain): TYPE A SOIL
4. Underdrain System	
A) Are underdrains provided?	Choose One ○ YES ○ NO
B) Underdrain system orifice diameter for 12 hour drain time	
i) Distance From Lowest Elevation of the Storage Volume to the Center of the Orifice	y = ft
ii) Volume to Drain in 12 Hours	Vol_{12} = cu ft
iii) Orifice Diameter, 3/8" Minimum	D_O = in

Design Procedure Form: Sand Filter (SF)

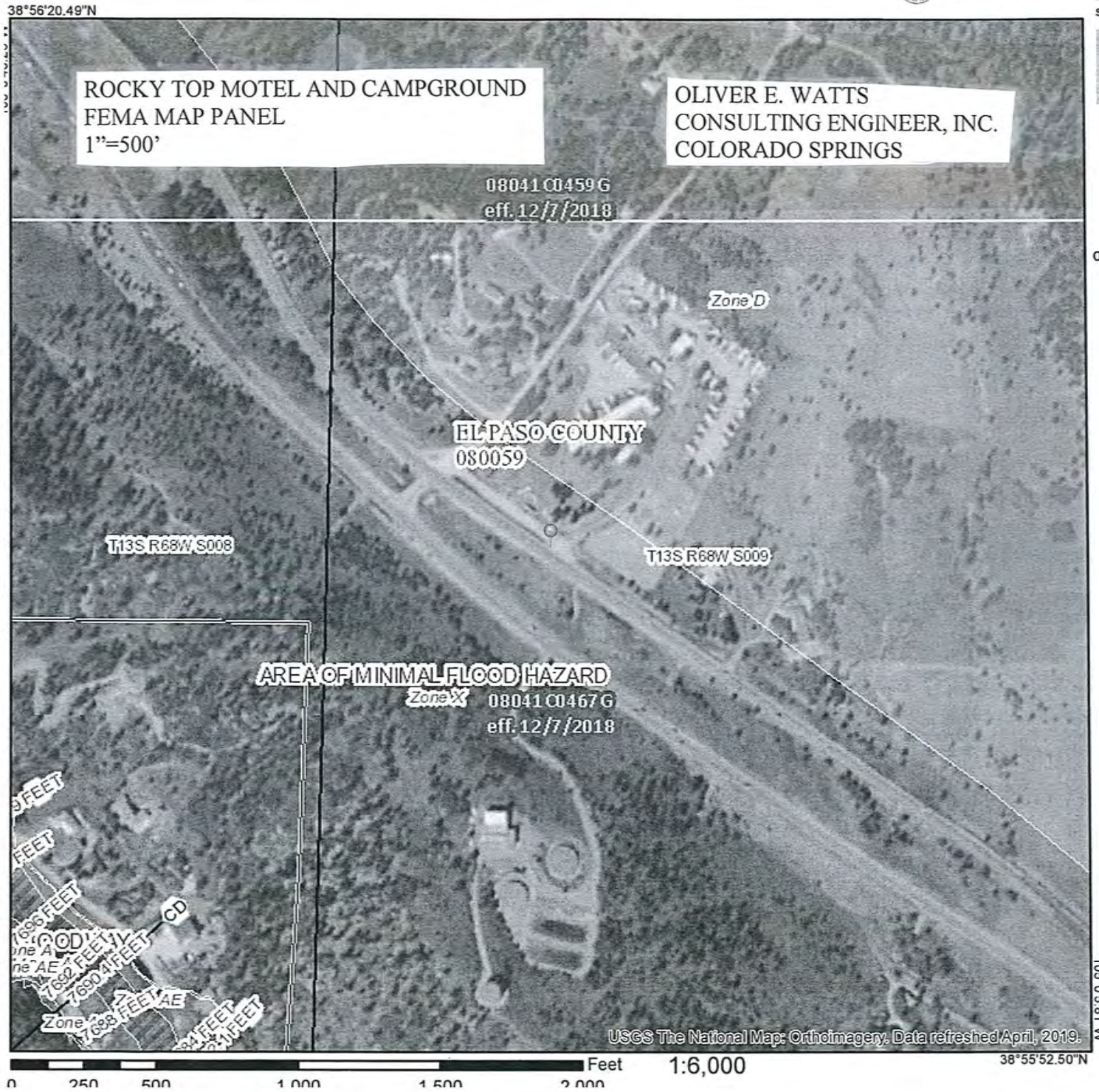
Designer: O.E. WATTS
Company: Oliver E. Watts, CE
Date: April 14, 2022
Project: Rocky Top Motel and Campground
Location: BASINS O-1 THRU B PLD POND

5. Impermeable Geomembrane Liner and Geotextile Separator Fabric A) Is an impermeable liner provided due to proximity of structures or groundwater contamination?	Choose One ○ YES ○ NO
6. Inlet / Outlet Works A) Describe the type of energy dissipation at inlet points and means of conveying flows in excess of the WQCV through the outlet	

Notes:

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, Area of 1% annual chance flood with average depth less than one foot or with drainag 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*

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
- 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

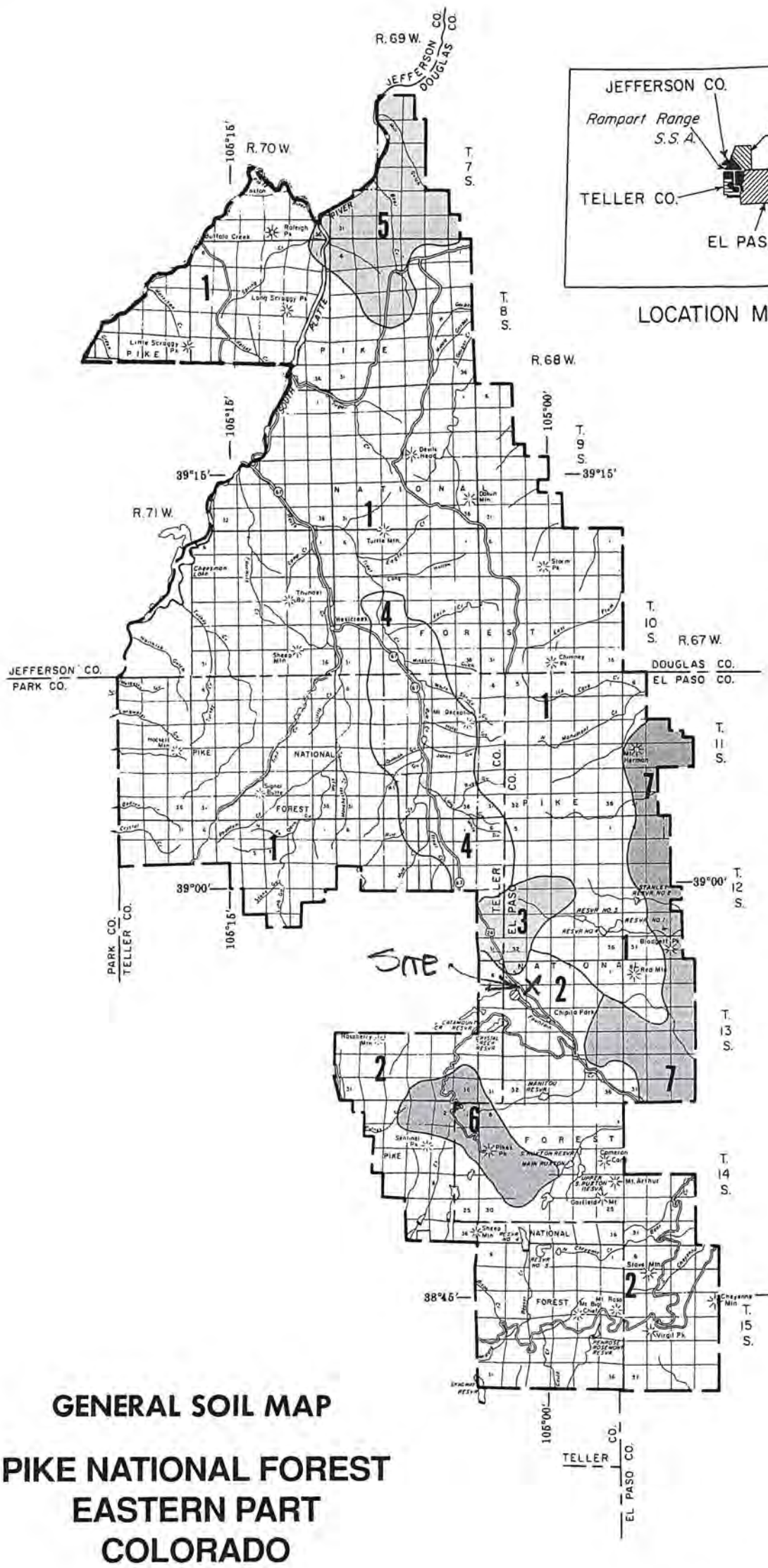
N

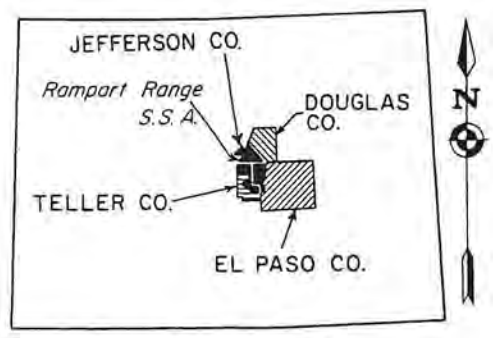
The pin displayed on the map is an approximate point selected by the user and does not represe an authoritative property location.

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 6/14/2019 at 10:34:12 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.





LOCATION MAP

SOIL LEGEND

1	Sphinx-Legault-Rock outcrop: Rock outcrop and shallow, somewhat excessively drained soils that formed in material weathered from granite
2	Catamount-Ivywild-Legault-Rock outcrop: Rock outcrop and shallow and moderately deep, somewhat excessively drained, and excessively drained soils that formed in material weathered from granite
3	Sphinx-Tecolote-Condie: Shallow and deep, somewhat excessively drained and well drained soils that formed in material weathered from granite or in colluvium over weathered granite
4	Boyett-Frenchcreek-Pendant: Deep and shallow, well drained and somewhat excessively drained soils that formed in material weathered from limestone and granite, and in alluvium derived from mixed red arkosic sandstone
5	Security-Cathedral-Rock outcrop: Rock outcrop and moderately deep and shallow, well drained soils that formed in material weathered from mixed schist, gneiss, and granite
6	Sachett-Cirque land: Cirque land and shallow, excessively drained soils that formed in material weathered from granite
7	Tecolote-Pendant: Deep and shallow, well drained and somewhat excessively drained soils that formed in material weathered from limestone and in cobbly or stony colluvium over weathered granite

Compiled 1986

GENERAL SOIL MAP

PIKE NATIONAL FOREST EASTERN PART COLORADO

JULY 1992

5 0 5 10 MILES

Scale 1:362,057

1 inch equals approximately 5.7 miles

PARTS OF DOUGLAS, EL PASO, JEFFERSON, AND TELLER COUNTIES, COLORADO

OLIVER E. WATTS
CONSULTING ENGINEER, INC.
COLORADO SPRINGS

ROCKY TOP MOTEL AND CAMPGROUND
SCS SOILS MAP

U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
SOIL CONSERVATION SERVICE
COLORADO AGRICULTURAL EXPERIMENT STATION

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

Where:

t_c = time of concentration (min)

t_i = overland (initial) flow time (min)

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

3.2.1 Overland (Initial) Flow Time

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

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

Where:

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

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

3.2.2 Travel Time

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

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

Where:

V = velocity (ft/s)

C_v = conveyance coefficient (from Table 6-7)

S_w = watercourse slope (ft/ft)

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

Land Use or Surface Characteristics	Percent Impervious	Runoff Coefficients											
		2-year		5-year		10-year		25-year		50-year		100-year	
		HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D
Business													
Commercial Areas	95	0.79	0.80	0.81	0.82	0.83	0.84	0.85	0.87	0.87	0.88	0.88	0.89
Neighborhood Areas	70	0.45	0.49	0.49	0.53	0.53	0.57	0.58	0.62	0.60	0.65	0.62	0.68
Residential													
1/8 Acre or less	65	0.41	0.45	0.45	0.49	0.49	0.54	0.54	0.59	0.57	0.62	0.59	0.65
1/4 Acre	40	0.23	0.28	0.30	0.35	0.36	0.42	0.42	0.50	0.46	0.54	0.50	0.58
1/3 Acre	30	0.18	0.22	0.25	0.30	0.32	0.38	0.39	0.47	0.43	0.52	0.47	0.57
1/2 Acre	25	0.15	0.20	0.22	0.28	0.30	0.36	0.37	0.46	0.41	0.51	0.46	0.56
1 Acre	20	0.12	0.17	0.20	0.26	0.27	0.34	0.35	0.44	0.40	0.50	0.44	0.55
Industrial													
Light Areas	80	0.57	0.60	0.59	0.63	0.63	0.66	0.66	0.70	0.68	0.72	0.70	0.74
Heavy Areas	90	0.71	0.73	0.73	0.75	0.75	0.77	0.78	0.80	0.80	0.82	0.81	0.83
Parks and Cemeteries	7	0.05	0.09	0.12	0.19	0.20	0.29	0.30	0.40	0.34	0.46	0.39	0.52
Playgrounds	13	0.07	0.13	0.16	0.23	0.24	0.31	0.32	0.42	0.37	0.48	0.41	0.54
Railroad Yard Areas	40	0.23	0.28	0.30	0.35	0.36	0.42	0.42	0.50	0.46	0.54	0.50	0.58
Undeveloped Areas													
Historic Flow Analysis-- Greenbelts, Agriculture	2	0.03	0.05	0.09	0.16	0.17	0.26	0.26	0.38	0.31	0.45	0.36	0.51
Pasture/Meadow	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50
Forest	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50
Exposed Rock	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Offsite Flow Analysis (when landuse is undefined)	45	0.26	0.31	0.32	0.37	0.38	0.44	0.44	0.51	0.48	0.55	0.51	0.59
Streets													
Paved	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Gravel	80	0.57	0.60	0.59	0.63	0.63	0.66	0.66	0.70	0.68	0.72	0.70	0.74
Drive and Walks	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Roofs	90	0.71	0.73	0.73	0.75	0.75	0.77	0.78	0.80	0.80	0.82	0.81	0.83
Lawns	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50

3.2 Time of Concentration

One of the basic assumptions underlying the Rational Method is that runoff is a function of the average rainfall rate during the time required for water to flow from the hydraulically most remote part of the drainage area under consideration to the design point. However, in practice, the time of concentration can be an empirical value that results in reasonable and acceptable peak flow calculations.

For urban areas, the time of concentration (t_c) consists of an initial time or overland flow time (t_i) plus the travel time (t_t) in the storm sewer, paved gutter, roadside drainage ditch, or drainage channel. For non-urban areas, the time of concentration consists of an overland flow time (t_i) plus the time of travel in a concentrated form, such as a swale or drainageway. The travel portion (t_t) of the time of concentration can be estimated from the hydraulic properties of the storm sewer, gutter, swale, ditch, or drainageway. Initial time, on the other hand, will vary with surface slope, depression storage, surface cover, antecedent rainfall, and infiltration capacity of the soil, as well as distance of surface flow. The time of concentration is represented by Equation 6-7 for both urban and non-urban areas.

Table 6-7. Conveyance Coefficient, C_v

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

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

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

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

3.2.3 First Design Point Time of Concentration in Urban Catchments

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

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

Where:

t_c = maximum time of concentration at the first design point in an urban watershed (min)

L = waterway length (ft)

Equation 6-10 was developed using the rainfall-runoff data collected in the Denver region and, in essence, represents regional "calibration" of the Rational Method. Normally, Equation 6-10 will result in a lesser time of concentration at the first design point and will govern in an urbanized watershed. For subsequent design points, the time of concentration is calculated by accumulating the travel times in downstream drainageway reaches.

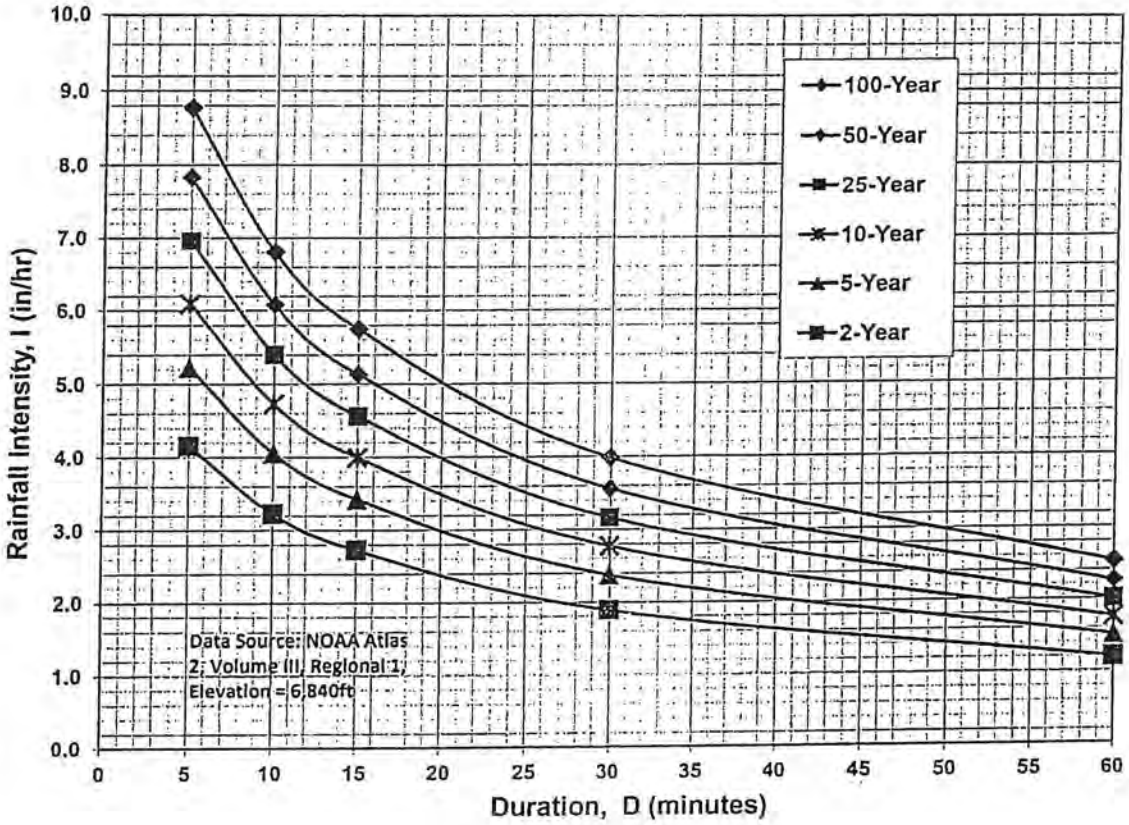
3.2.4 Minimum Time of Concentration

If the calculations result in a t_c of less than 10 minutes for undeveloped conditions, it is recommended that a minimum value of 10 minutes be used. The minimum t_c for urbanized areas is 5 minutes.

3.2.5 Post-Development Time of Concentration

As Equation 6-8 indicates, the time of concentration is a function of the 5-year runoff coefficient for a drainage basin. Typically, higher levels of imperviousness (higher 5-year runoff coefficients) correspond to shorter times of concentration, and lower levels of imperviousness correspond to longer times of

Figure 6-5. Colorado Springs Rainfall Intensity Duration Frequency



IDF Equations

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

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

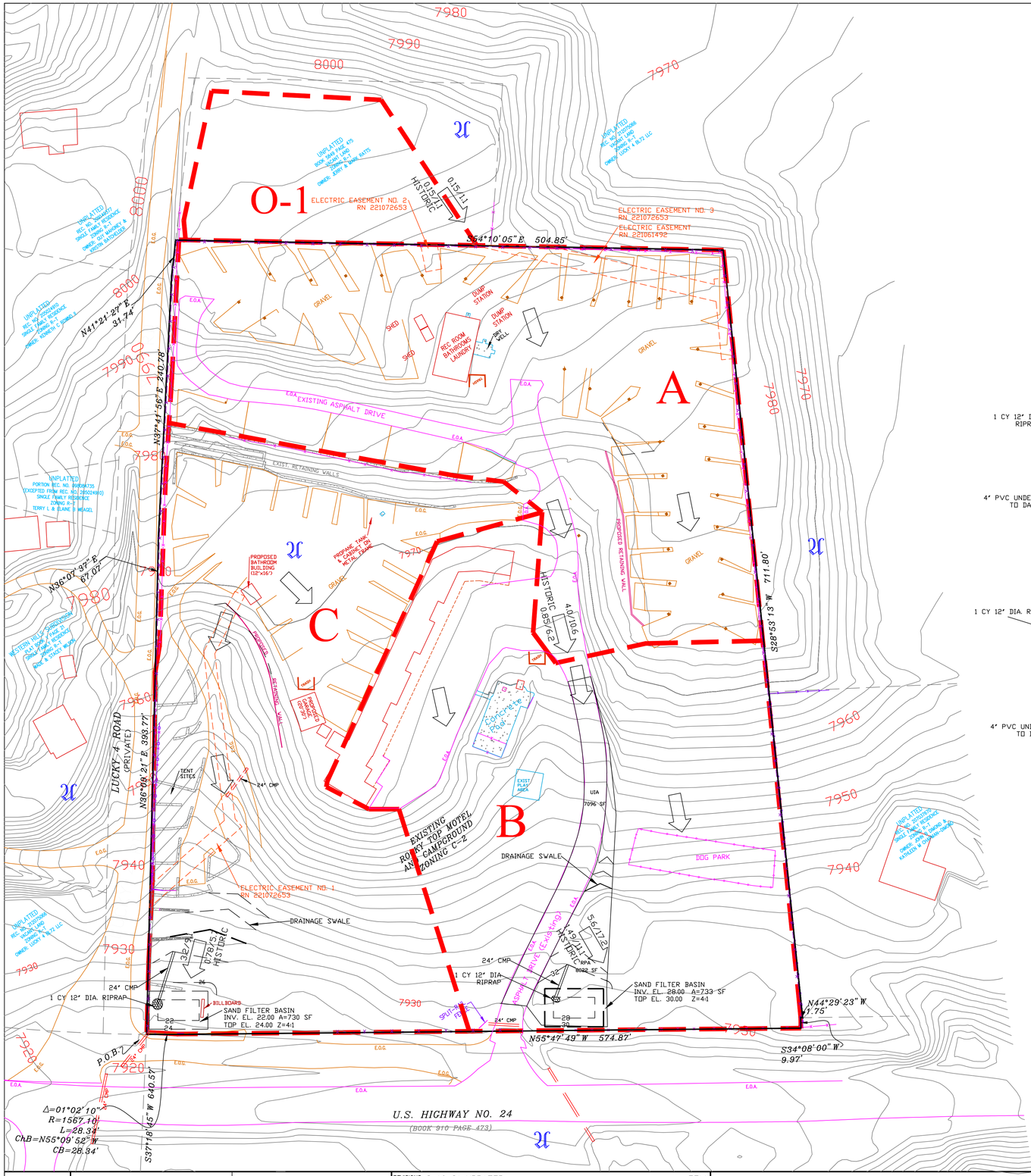
$I_{25} = -2.00 \ln(D) + 10.111$

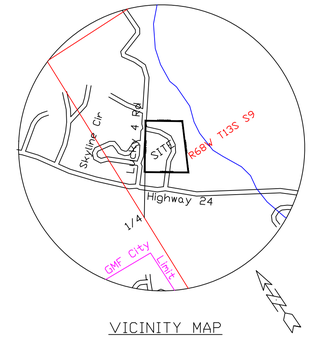
$I_{10} = -1.75 \ln(D) + 8.847$

$I_5 = -1.50 \ln(D) + 7.583$

$I_2 = -1.19 \ln(D) + 6.035$

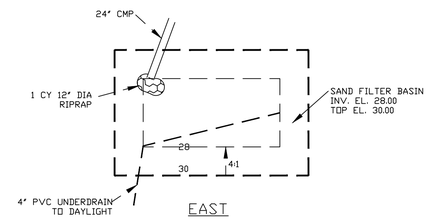
Note: Values calculated by equations may not precisely duplicate values read from figure.



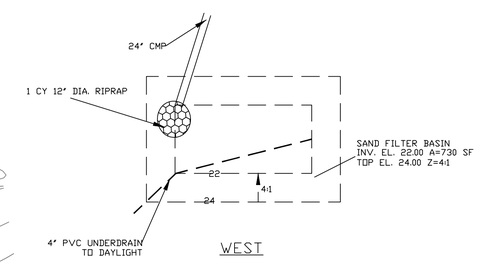


VICINITY MAP

1"=1000'



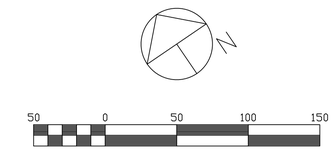
EAST



WEST

POND DETAILS

1"=20'



Scale 1" = 50'

Contour Interval: 2'

NGVD, 1929 ADJUSTMENT

CONTOUR LEGEND:

ORIGINAL CONTOURS:
1'
10' 5'
FINISH CONTOURS:
2' 1'
10' 5'

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

DRAINAGE BASIN SUMMARY

BASIN	RUNOFF IN CFS DEVELOPED 5-YEAR	DEVELOPED 100-YEAR	HISTORIC 5-YEAR	HISTORIC 100-YEAR
O-1	0.15	1.1	0.15	1.1
O-1 + A	4.0	10.6	0.85	6.2
O-1 + A + B	5.6	17.2	1.49	11.1
C	3.2	9.1	0.78	5.7

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TOPOGRAPHY BY: CITY FIMS 6-12-19 SURVEY INFORMATION BY: RAMPART JOB NO. 18384			

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COLORADO SPRINGS

PROJECT
ROCKY TOP MOTEL & CAMPGROUND
PART NW1/4 SECTION 9, T.13S., R.68W., 6TH P.M.
EL PASO COUNTY

SHT. NAME
DRAINAGE PLAN

SHT. NO.
1
OF
1