

Frederick Tobias, Town Engineer
Town of Eagle
P.O. Box 509
Eagle, Colorado 81631

Subject: 410 Broadway (Lots 15 & 16, Block 22, Town of Eagle Subdivision)
Drainage Letter

Fred:

410 Broadway, LLC has contracted Yarnell Consulting & Civil Design, LLC (YCCD) to design the grading, drainage, and utility elements of the proposed redevelopment of 410 Broadway with the associated asphalt parking and utilities. The purpose of this letter is to summarize the existing and proposed drainage conditions for the project.

Background

The subject parcel is in the heart of downtown Eagle – east of Broadway. Presently, it is improved with an abandoned single-family residence and detached garage. There are a series of both below-grade and overhead utilities. The ground cover us unkempt native grasses, brush, and a few trees.

The topographic survey by Meridian Land Surveying indicates runoff from this and adjacent sites are directed westerly – from the alley toward Broadway and the extensive drainage system that exists therein. Unfortunately, there is no existing drainage system or even defined overland drainage paths within the alley right-of-way itself. During site reconnaissance, YCCD observed a series of pothole-like depressions but otherwise a flat alley. This would indicate that low-flow events likely infiltrate into the gravels while larger events pond and then spill over toward the west, across the private properties, and into Broadway where it is intercepted by the existing storm system.

No detention or stormwater quality improvement measures currently exist on the subject parcel.

Proposed

With full redevelopment of the subject parcel, it is proposed to improve the existing drainage condition as much as possible while realizing the small, tight site has numerous constraints. As discussed with Public Works Department staff, YCCD is concerned about converting the entirety of the site to impervious area and redirecting the resulting runoff to the alley. This would be a noteworthy increase in runoff to a location without a defined conveyance path. Alternatively, we recommend capturing all runoff from the roof and piping it directly to the public storm system in Broadway.

As shown on *Drainage Plan* sheet D1, sub-basin 1 is approximately 0.11 acres in area – encompassing the entirety of the proposed building roof. Runoff generated within this sub-basin is tributary to design point A via internal roof drainage system. Based upon our analysis employing

the Rational Method, the estimated flow tributary to this point during a 100-year storm event is approximately 0.4 cubic feet per second (CFS).

In speaking with the Public Works Department, they expressed confidence the public system within Broadway had sufficient capacity to convey runoff from the proposed redevelopment. Therefore, we completed a capacity analysis utilizing Manning's Equation which indicates an available capacity of approximately 0.5 CFS for the proposed 8-inch pipe -- exceeding the estimated 100-year flow tributary to it, even before considering head pressure.

As shown on *Drainage Plan* sheet D1, sub-basin 2 is approximately 0.03 acres in area -- encompassing concrete patios and walks, and asphalt parking on the subject property. Runoff generated within this sub-basin is tributary to design point B in the alley via overland flow. Based upon our analysis employing the Rational Method, the estimated flow tributary to this point during a 100-year storm event is approximately 0.1 CFS. This is determined to be a nominal quantity with a negligible impact relative to runoff already tributary to that right-of-way.

As per the town of Eagle municipal code, no detention or stormwater quality improvements are required for projects within this part of town; therefore, neither are proposed.

Summary

To summarize, the drainage design for the redevelopment of 410 Broadway appears to be in conformance with Town of Eagle municipal code with drainage patterns being improved relative to the existing condition, nominal additional runoff being tributary to the alley right-of-way, and no additional runoff being tributary to adjacent, private properties.

Please let me know if you have any further questions regarding the proposed drainage system design for this development.

Sincerely,



Justin J. Yarnell, PE
Colorado PE Number 47241



NOAA Atlas 14, Volume 8, Version 2
Location name: Eagle, Colorado, USA*
Latitude: 39.6508°, Longitude: -106.8275°
Elevation: 6603.69 ft**
 * source: ESRI Maps
 ** source: USGS



POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Deborah Martin, Sandra Pavlovic, Ishani Roy, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Michael Yekta, Geoffrey Bonnin

NOAA, National Weather Service, Silver Spring, Maryland

[PF_tabular](#) | [PF_graphical](#) | [Maps & aeriels](#)

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)¹										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.103 (0.085-0.129)	0.155 (0.127-0.193)	0.237 (0.193-0.297)	0.304 (0.247-0.383)	0.395 (0.304-0.520)	0.464 (0.347-0.623)	0.531 (0.381-0.739)	0.598 (0.408-0.865)	0.685 (0.446-1.03)	0.749 (0.474-1.16)
10-min	0.151 (0.124-0.188)	0.226 (0.185-0.282)	0.347 (0.283-0.434)	0.446 (0.361-0.561)	0.579 (0.445-0.761)	0.679 (0.509-0.912)	0.778 (0.559-1.08)	0.876 (0.597-1.27)	1.00 (0.652-1.51)	1.10 (0.694-1.69)
15-min	0.184 (0.151-0.229)	0.276 (0.226-0.344)	0.423 (0.345-0.530)	0.544 (0.440-0.684)	0.706 (0.543-0.928)	0.828 (0.620-1.11)	0.948 (0.681-1.32)	1.07 (0.728-1.54)	1.22 (0.796-1.84)	1.34 (0.846-2.06)
30-min	0.255 (0.209-0.317)	0.349 (0.286-0.435)	0.504 (0.411-0.630)	0.632 (0.512-0.796)	0.810 (0.626-1.07)	0.948 (0.712-1.28)	1.09 (0.782-1.52)	1.23 (0.838-1.78)	1.41 (0.921-2.13)	1.55 (0.984-2.40)
60-min	0.331 (0.272-0.412)	0.422 (0.346-0.526)	0.573 (0.468-0.717)	0.702 (0.569-0.884)	0.884 (0.685-1.17)	1.03 (0.774-1.39)	1.17 (0.847-1.64)	1.33 (0.908-1.93)	1.53 (1.00-2.32)	1.69 (1.07-2.61)
2-hr	0.408 (0.337-0.504)	0.495 (0.408-0.612)	0.643 (0.528-0.798)	0.772 (0.629-0.963)	0.957 (0.750-1.26)	1.11 (0.842-1.48)	1.26 (0.920-1.75)	1.42 (0.987-2.05)	1.65 (1.09-2.46)	1.83 (1.17-2.78)
3-hr	0.471 (0.390-0.578)	0.550 (0.455-0.676)	0.687 (0.566-0.848)	0.808 (0.661-1.00)	0.986 (0.779-1.29)	1.13 (0.868-1.51)	1.29 (0.945-1.78)	1.45 (1.01-2.08)	1.68 (1.12-2.49)	1.86 (1.20-2.81)
6-hr	0.603 (0.503-0.735)	0.678 (0.565-0.827)	0.811 (0.673-0.993)	0.932 (0.768-1.15)	1.11 (0.888-1.45)	1.27 (0.979-1.67)	1.43 (1.06-1.95)	1.60 (1.13-2.27)	1.85 (1.25-2.71)	2.05 (1.34-3.05)
12-hr	0.751 (0.630-0.908)	0.858 (0.719-1.04)	1.04 (0.869-1.26)	1.20 (0.996-1.47)	1.43 (1.15-1.83)	1.62 (1.26-2.11)	1.82 (1.36-2.44)	2.02 (1.44-2.81)	2.31 (1.57-3.32)	2.54 (1.67-3.71)
24-hr	0.917 (0.774-1.10)	1.06 (0.893-1.27)	1.30 (1.09-1.56)	1.50 (1.25-1.82)	1.80 (1.45-2.27)	2.03 (1.59-2.61)	2.27 (1.71-3.01)	2.52 (1.81-3.46)	2.87 (1.97-4.06)	3.14 (2.08-4.52)
2-day	1.10 (0.934-1.31)	1.25 (1.06-1.49)	1.52 (1.29-1.81)	1.75 (1.47-2.10)	2.09 (1.70-2.62)	2.36 (1.87-3.01)	2.65 (2.01-3.47)	2.95 (2.14-3.99)	3.37 (2.33-4.71)	3.70 (2.48-5.25)
3-day	1.21 (1.03-1.43)	1.38 (1.18-1.64)	1.68 (1.42-1.99)	1.93 (1.63-2.31)	2.30 (1.87-2.86)	2.60 (2.06-3.28)	2.91 (2.22-3.78)	3.23 (2.35-4.34)	3.69 (2.57-5.11)	4.04 (2.73-5.68)
4-day	1.30 (1.12-1.54)	1.49 (1.27-1.76)	1.80 (1.53-2.13)	2.07 (1.75-2.46)	2.45 (2.01-3.04)	2.76 (2.20-3.48)	3.09 (2.36-3.99)	3.43 (2.50-4.57)	3.89 (2.72-5.35)	4.26 (2.89-5.95)
7-day	1.55 (1.34-1.82)	1.74 (1.50-2.04)	2.06 (1.77-2.43)	2.34 (1.99-2.77)	2.74 (2.25-3.36)	3.06 (2.45-3.81)	3.39 (2.61-4.34)	3.74 (2.75-4.92)	4.21 (2.97-5.72)	4.58 (3.14-6.32)
10-day	1.77 (1.53-2.06)	1.96 (1.69-2.29)	2.30 (1.97-2.69)	2.58 (2.21-3.04)	2.99 (2.47-3.65)	3.32 (2.67-4.11)	3.66 (2.84-4.65)	4.02 (2.97-5.25)	4.51 (3.20-6.07)	4.89 (3.36-6.68)
20-day	2.35 (2.05-2.72)	2.60 (2.26-3.01)	3.02 (2.61-3.50)	3.37 (2.90-3.93)	3.87 (3.21-4.65)	4.26 (3.45-5.19)	4.65 (3.63-5.82)	5.06 (3.78-6.51)	5.62 (4.02-7.43)	6.04 (4.21-8.13)
30-day	2.84 (2.48-3.27)	3.15 (2.75-3.63)	3.66 (3.18-4.22)	4.08 (3.52-4.73)	4.65 (3.88-5.55)	5.10 (4.15-6.17)	5.54 (4.35-6.87)	5.99 (4.50-7.63)	6.59 (4.75-8.63)	7.04 (4.93-9.38)
45-day	3.48 (3.05-3.99)	3.87 (3.39-4.44)	4.50 (3.92-5.17)	5.00 (4.34-5.77)	5.68 (4.74-6.70)	6.18 (5.04-7.41)	6.68 (5.26-8.19)	7.16 (5.40-9.02)	7.79 (5.63-10.1)	8.24 (5.81-10.9)
60-day	4.04 (3.55-4.61)	4.50 (3.95-5.14)	5.22 (4.57-5.98)	5.80 (5.04-6.67)	6.55 (5.48-7.69)	7.11 (5.81-8.46)	7.63 (6.02-9.29)	8.13 (6.15-10.2)	8.76 (6.36-11.2)	9.20 (6.52-12.0)

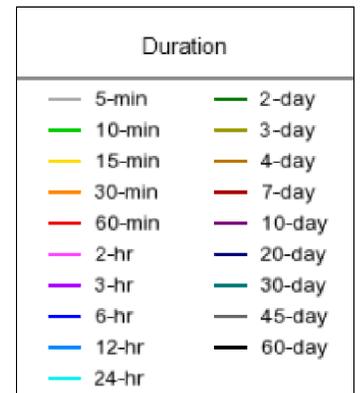
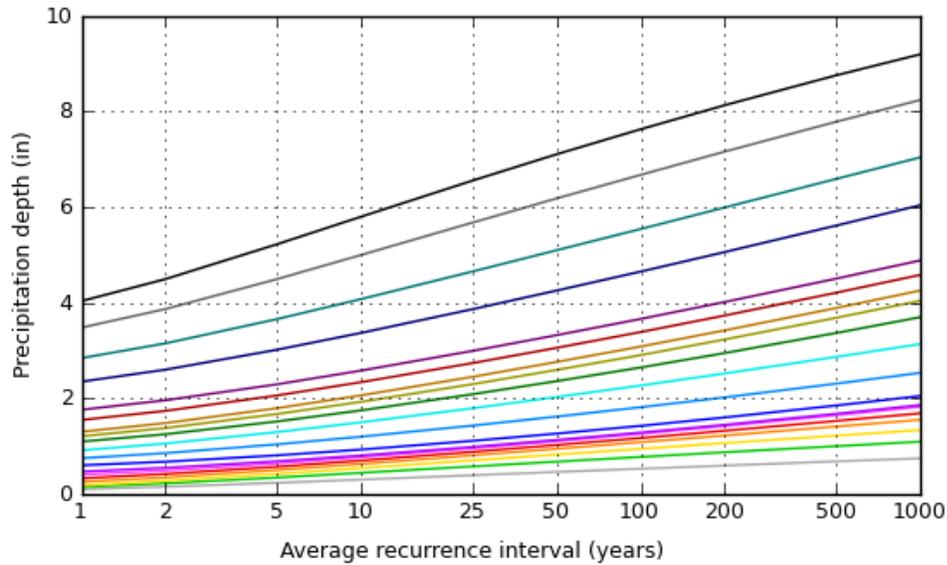
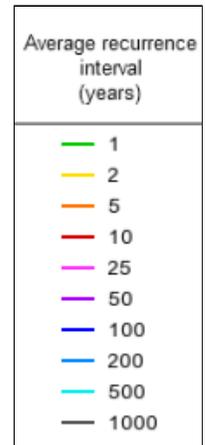
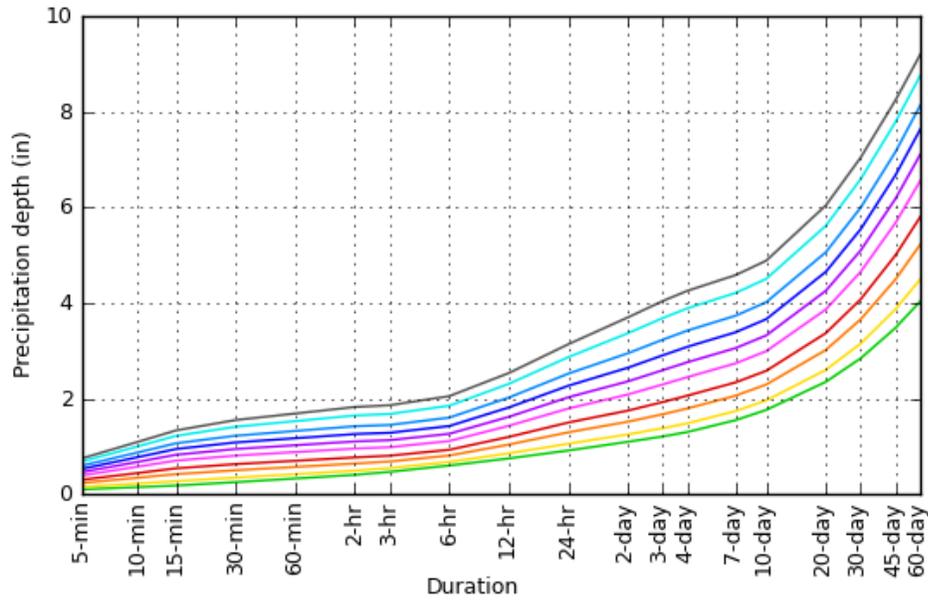
¹ Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS). Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values. Please refer to NOAA Atlas 14 document for more information.

[Back to Top](#)

PF graphical

PDS-based depth-duration-frequency (DDF) curves

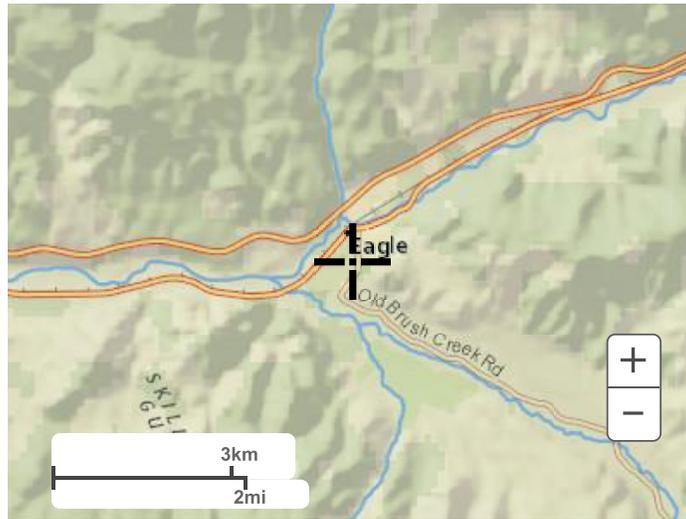
Latitude: 39.6508°, Longitude: -106.8275°



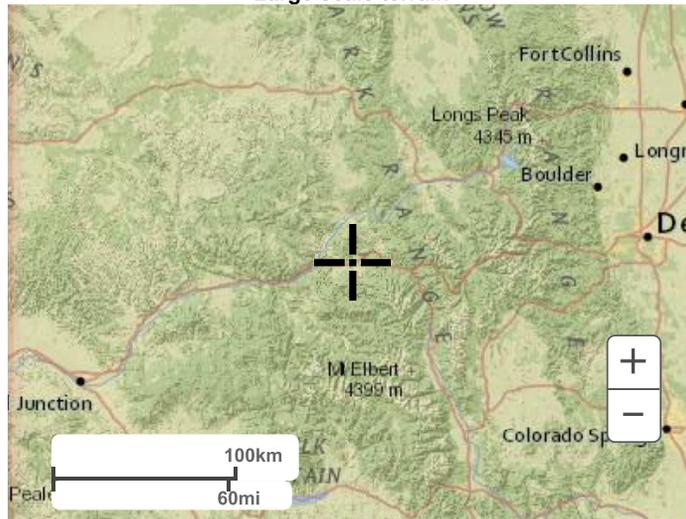
[Back to Top](#)

Maps & aerials

Small scale terrain



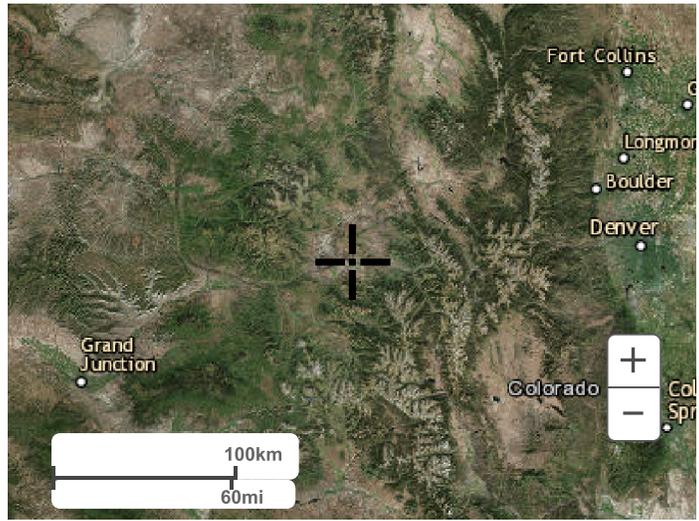
Large scale terrain



Large scale map



Large scale aerial



[Back to Top](#)

[US Department of Commerce](#)
[National Oceanic and Atmospheric Administration](#)
[National Weather Service](#)
[National Water Center](#)
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

[Disclaimer](#)

Project Name: 410 Broadway

Project No.: 19.004

RATIONAL METHOD DRAINAGE CALCULATIONS

Storm Event: Existing & Proposed

Jurisdiction: Town of Eagle

Soil Type: D

STORM EVENT:		2	5	10	25	100	PERCENT IMPERVIOUS
RUNOFF COEFF.:		C ₂	C ₅	C ₁₀	C ₂₅	C ₁₀₀	
SURFACE	Landscape	0.01	0.05	0.15	0.33	0.49	2.0%
	Roof	0.74	0.77	0.80	0.82	0.85	90.0%
	Asphalt	0.83	0.86	0.87	0.88	0.89	100.0%
	Concrete	0.74	0.77	0.80	0.82	0.85	90.0%
	Gravel	0.30	0.36	0.43	0.54	0.65	40.0%

SUB-BASIN	AREA (ac)	AREA PER SURFACE CHARACTERISTIC (ac)					COMPOSITE RUNOFF COEFFICIENTS					COMPOSITE IMPERVIOUS
		Landscape	Roof	Asphalt	Concrete	Gravel						
1	0.11		0.11				0.74	0.77	0.80	0.82	0.85	90.0%
2	0.03	0.00		0.02	0.00		0.80	0.83	0.85	0.86	0.88	96.4%
	0.00											
	0.00											
	0.00											
	0.00											
	0.00											
	0.00											
	0.00											
	0.00											
	0.00											
	0.00											
TOTAL	0.14	0.00	0.11	0.02	0.00	0.00	0.75	0.78	0.81	0.83	0.86	91.3%

Project Name: 410 Broadway

Project No.: 19.004

RATIONAL METHOD DRAINAGE CALCULATIONS

Storm Event: Existing & Proposed

STANDARD FORM SF-3 (STORM DRAINAGE SYSTEM DESIGN)

Return Period: 100-YEAR

Rainfall Depth: 1.17

BASIN	DESIGN POINT	DIRECT RUNOFF						TOTAL RUNOFF				REMARKS
		AREA (AC)	RUNOFF COEFF	t _c (MIN)	CxA (AC)	I (IN/HR)	Q (CFS)	t _c (MIN)	S(CxA) (AC)	I (IN/HR)	Q (CFS)	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
1	A	0.11	0.85	5.0	0.10	4.59	0.44					
2	B	0.03	0.88	5.0	0.02	4.59	0.11					

*All calculations are per UDFCD (Volume 1), Chapter 5

P.O. Box 3901
Eagle, Colorado 81631

**YARNELL CONSULTING
& CIVIL DESIGN**

229 Midland Avenue
Basalt, Colorado 81621

(970) 323-7008 | 5/1/2019

Project Name: 410 Broadway

Project No.: 19.004

PIPE CAPACITY CALCULATIONS: MANNING'S EQUATION

Solve for... Flow Rate, Q
Pipe Type... CMP
N-value... 0.024
Slope (ft/ft) = 0.005
Percent Full = 100%

Pipe Diameter, d (in.)	Area, A (sf)	Hydraulic Radius, R (ft)	Slope (ft/ft)	Flow Rate, Q		Velocity, v (fps)
				(cfs)	(gpm)	
4	0.09	0.08	0.0050	0.07	33	0.8
6	0.20	0.13	0.0050	0.22	97	1.1
8	0.35	0.17	0.0050	0.46	208	1.3
10	0.55	0.21	0.0050	0.84	377	1.5
12	0.79	0.25	0.0050	1.37	614	1.7
15	1.23	0.31	0.0050	2.48	1113	2.0
18	1.77	0.38	0.0050	4.03	1810	2.3
24	3.14	0.50	0.0050	8.68	3897	2.8
30	4.91	0.63	0.0050	15.74	7066	3.2
36	7.07	0.75	0.0050	25.60	11490	3.6
42	9.62	0.88	0.0050	38.62	17332	4.0
48	12.56	1.00	0.0050	55.14	24746	4.4
54	15.90	1.13	0.0050	75.48	33877	4.7
60	19.63	1.25	0.0050	99.97	44867	5.1
66	23.75	1.38	0.0050	128.90	57851	5.4
72	28.26	1.50	0.0050	162.56	72959	5.8

This calculation demonstrates that the entirety of Basin 1 can be conveyed in an 8-inch pipe at just 0.5% slope without surcharging. Our project is proposing a slope of 1.0%; therefore, improving on this condition.