DRAINAGE REPORT

FOR

CE WELL PAD

MERRICK RESPONSES IN GREEN

STORMWATER
Reviewed by: SLS
January 5, 2023

Prepared For:

THE CITY OF LOVELAND
On Behalf of MRG, LP

Prepared By:

Merrick & Company
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Greenwood Village, CO 80111
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Project No. 65120236-10

September 2022

around the perimeter of the pad before being released on the south side of the pad, immediately downstream of the spillway. This interior collection ditch has been designed to a depth of 1.0 foot, which includes 0.54 ft. of flow depth and 0.46 foot of freeboard[38]. Precipitation which lands on the "far side[39]" of the berms will run down the berm face to existing grade (for the southern and eastern berms) or to the diversion ditch (for the northern and western berms), where it will continue to flow towards the south before exiting the property.

4.2.1 POST-DEVELOPMENT AND MASTER DRAINAGE PLAN IMPACTS

M&C performed a hydrologic analysis to calculate how much of a reduction in peak flow discharge would occur between the historic and post-development conditions for the CE Produc[illegible]quantify the 100-ye[illegible]the peak flows. All other input parameters used in the modeling which are not indicated in Table 3 were identical.

DISCUSSED WITH SUZETTE, AND ADDED EXPLANATION TO DRAINAGE REPORT AS TO WHY CUHP SWMM WAS USED IN THIS SITUATION.

The SWMM/CUHP method is not acceptable to use in this situation, per our criteria. Please make comparisons to the existing and proposed production phase hydrology and explain how the increase in flows will not negatively impact the downstream properties.

Hydrologic Parameters	Pre-development	Post-development
Percent Imperviousness	2%	45%
Initial Abstraction[41] – Pervious	0.29 inch	0.10 inch
Initial Abstraction[41] - Impervious	0.20 inch	0.05 inch
Average Slope	1.48%	1.30%
CE Pad Peak Discharge	**4.4 cfs**	**4.3 cfs**

The modeling showed that a 2.3% reduction in peak flow (relative to the historic peak discharge) is expected even though the Percent Imperviousness will increase during the Production Phase. This peak flow reduction occurs because of the storage effects of the sediment basin, which

[38] The minimum depth for the internal collection ditch with freeboard is 1.33 * flow depth = 1.33 * 0.54 ft = 0.72 ft.
[39] The portion of the berms farthest from the working pad surface.
[40] Reference Appendix A, Table 5 for reference information.
[41] The initial abstraction, referred to in the CUHP software as "Maximum Depression Storage", is the initial rainfall depth, measured in watershed inches, which is removed from the hydrologic calculations; it accounts for the hydrologic losses that occur when rainfall pools in a local area depression and cannot escape, hence there is no runoff generated from these depression losses.

peak flow[46] is 41.1 cfs. This peak flow exceeds the calculated peak flow expected for the fully developed, upgradient future conditions assuming the future developed conditions do not exceed the allowable release rate of 1.0 cfs/acre for the entire 32.1-acre sub-catchment area. A minimum of 1.0 foot of freeboard has been provided for the diversion ditch.

A 6 ft. wide by 20 ft. long stilling basin located at the discharge point of the diversion ditch will dissipate some of the potential energy prior to converting the concentrated flow into sheet flow through the use of level spreader[47] (i.e. flow spreader). The Drilling Phase level spreader is 18.0 ft. wide; the Production Phase level spreader is 105.0 wide.

Please insert an 11" x 17" schematic drawing into the Final Drainage & Erosion Control Report and SWMP documents titled "Permanent Stormwater Quality BMPs" that clearly identifies where each of the proposed Permanent Stormwater Quality BMPs are located within the development site, i.e., Grass Swales (GS), Grass Buffers (GB), Extended Detention Basins (EDB), etc. Please lightly shade or hatch the extent of each BMP. The purpose of the Permanent Water Quality BMP schematic is to provide guidance for the property owner to easily identify the BMPs that need to be maintained in the future. An example of a Permanent Stormwater Quality BMPs exhibit is included in the redlined package.

EXHIBIT ADDED TO APPENDICES

[46] The peak flow calculation incorporated the Regional Time of Concentration calculation even though the current conditions have % imperviousness well below 20%, hence this calculation approach assumes future development imperviousness and provides a conservative estimate for peak flow.
[47] Appendix G provides the calculations for the sizing of the level spreader.

Calculation of Peak Runoff using Rational Method

Designer: Sage Cabrera
Company: Merrick and Company
Date: 8/24/2022
Project: MRG - CE Pad
Location: Loveland, CO

Version 2.00 released May 2017

Cells of this color are for required user-input
Cells of this color are for optional override values
Cells of this color are for calculated results based on overrides

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L_i}}{S_i^{0.33}}$$

$$t_t = \frac{L_t}{60K\sqrt{S_t}} = \frac{L_t}{60V_t}$$

Computed $t_c = t_i + t_t$

Regional $t_c = (26 - 17i) + \frac{L_t}{60(14i + 9)\sqrt{S_t}}$

$t_{minimum}$ = 5 (urban)
$t_{minimum}$ = 10 (non-urban)

Selected $t_c = \max\{t_{minimum}, \min(\text{Computed } t_c, \text{Regional } t_c)\}$

Select UDFCD location for NOAA Atlas 14 Rainfall Depths from the pulldown list OR enter your own depths obtained from the NOAA website (click this link)

	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
1-hour rainfall depth, P1 (in) =	1.00	1.41	1.69	2.03	2.36	2.66	

Rainfall Intensity Equation Coefficients =	a	b	c
	28.50	10.00	0.786

$$I(in/hr) = \frac{a * P_1}{(b + t_c)^c}$$

$$Q(cfs) = CIA$$

Subcatchment Name	Area (ac)	NRCS Hydrologic Soil Group	Percent Imperviousness	Runoff Coefficient, C							Overland (Initial) Flow Time					Channelized (Travel) Flow Time							Time of Concentration			Rainfall Intensity, I (in/hr)							Peak Flow, Q (cfs)						
				2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr	Overland Flow Length L_i (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Overland Flow Slope S_i (ft/ft)	Overland Flow Time t_i (min)	Channelized Flow Length L_t (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Channelized Flow Slope S_t (ft/ft)	NRCS Conveyance Factor K	Channelized Flow Velocity V_t (ft/sec)	Channelized Flow Time t_t (min)	Computed t_c (min)	Regional t_c (min)	Selected t_c (min)	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
Drilling Proposed (D-1)	10.2	C	45.0	0.34	0.40	0.46	0.57	0.62	0.67	0.73	300.0	4984.0	4976.5	0.025	16.14	656.00	4976.50	4971.00	0.008	10	0.92	11.94	28.08	26.15	26.15	1.70	2.40	2.87	3.45	4.01	4.52		5.90	9.8	13.55	20.08	25.16	**30.8**	
Production Existing (PE-1)	2.3	C	2.0	0.01	0.05	0.15	0.33	0.40	0.49	0.59	300.0	4981.0	4976.2	0.016	28.08	192.00	4976.20	4973.80	0.012	5	0.56	5.72	33.81	28.74	33.81	1.46	2.06	2.47	2.97	3.45	3.89		0.03	0.2	0.83	2.25	3.19	**4.4**	
Production Proposed (P-1)	2.3	C	45.0	0.34	0.40	0.46	0.57	0.62	0.67	0.73	300.0	4980.7	4975.0	0.019	17.67	212.00	4975.00	4974.00	0.005	10	0.69	5.14	22.81	21.71	21.71	1.88	2.66	3.18	3.82	4.44	5.01		1.47	2.5	3.39	5.02	6.29	**7.7**	
Prod Prop - Int Swale (P-2)	1.99	C	25.4	0.18	0.24	0.32	0.46	0.52	0.59	0.67	300.0	4990.0	4982.0	0.027	19.41	312.00	4982.00	4974.20	0.025	10	1.58	3.29	22.70	24.30	22.70	1.84	2.59	3.11	3.73	4.34	4.89		0.66	1.2	1.97	3.43	4.48	**5.7**	
Upgradient - Existing (E-1)	32.1	C	2.0	0.01	0.05	0.15	0.33	0.40	0.49	0.59	300.0	5014.0	5010.3	0.012	30.60	2526.00	5010.30	4972.80	0.0148	5	0.61	69.11	99.71	62.89	62.89	0.98	1.38	1.65	1.99	2.31	2.60		0.33	2.3	7.79	21.06	29.88	**41.1**	
Prod Reginal (P-3)	7.5	C	45.0	0.34	0.40	0.46	0.57	0.62	0.67	0.73	300.0	4985.2	4983.5	0.006	26.34	1200.00	4983.50	4972.20	0.009	15	1.46	13.74	40.08	31.82	31.82	1.52	2.14	2.56	3.08	3.58	4.03		3.88	6.45	8.91	13.21	16.54	**20.2**	

DETENTION VOLUME BY THE MODIFIED FAA METHOD

Project: MRG - CE Pad: Drilling Phase Retention Area Stormwater Volume Calculations

Basin ID:

(For catchments less than 160 acres only. For larger catchments, use hydrograph routing method)
(NOTE: for catchments larger than 90 acres, CUHP hydrograph and routing are recommended)

Determination of MINOR Detention Volume Using Modified FAA Method

Design Information (Input):

Catchment Drainage Imperviousness	I_a =	45.00	percent
Catchment Drainage Area	A =	10.200	acres
Predevelopment NRCS Soil Group	Type =	C	A, B, C, or D
Return Period for Detention Control	T =	10	years (2, 5, 10, 25, 50, or 100)
Time of Concentration of Watershed	Tc =	21.71	minutes
Allowable Unit Release Rate	q =	0.00	cfs/acre
One-hour Precipitation	P_1 =	1.69	inches
Design Rainfall IDF Formula $i = C_1 * P_1/(C_2+T_c)^{C_3}$			
Coefficient One	C_1 =	28.50	
Coefficient Two	C_2 =	10	
Coefficient Three	C_3 =	0.786	

Determination of Average Outflow from the Basin (Calculated):

Runoff Coefficient	C =	0.44	
Inflow Peak Runoff	Qp-in =	14.28	cfs
Allowable Peak Outflow Rate	Qp-out =	**0.00**	cfs
Mod. FAA Minor Storage Volume =		27,596	**cubic feet**
Mod. FAA Minor Storage Volume =		**0.634**	**acre-ft**

1 <- Enter Rainfall Duration Incremental Increase Value Here (e.g. 5 for 5-Minutes)

Rainfall Duration minutes (input)	Rainfall Intensity inches / hr (output)	Inflow Volume acre-feet (output)	Adjustment Factor "m" (output)	Average Outflow cfs (output)	Outflow Volume acre-feet (output)	Storage Volume acre-feet (output)
0	0.00	0.000	0.00	0.00	0.000	0.000
1	7.31	0.045	1.00	0.00	0.000	0.045
2	6.83	0.084	1.00	0.00	0.000	0.084
3	6.41	0.119	1.00	0.00	0.000	0.119
4	6.05	0.150	1.00	0.00	0.000	0.150
5	5.73	0.177	1.00	0.00	0.000	0.177
6	5.45	0.202	1.00	0.00	0.000	0.202
7	5.20	0.225	1.00	0.00	0.000	0.225
8	4.97	0.246				
9	4.76	0.265				
10	4.57	0.283				
11	4.40	0.299				
12	4.24	0.315				
13	4.10	0.329				
14	3.96	0.343				
15	3.84	0.356	1.00	0.00	0.000	0.356
16	3.72	0.368	1.00	0.00	0.000	0.368
17	3.61					
18	3.51					
19	3.41					
20	3.32					
21	3.24					
22	3.16					
23	3.08					
24	3.01					
25	2.95					
26	2.88					
27	2.82					
28	2.76	0.478	0.89	0.00	0.000	0.478
29	2.70	0.485	0.87	0.00	0.000	0.485
30	2.65	0.492	0.86	0.00	0.000	0.492
31	2.60	0.498	0.85	0.00	0.000	0.498
32	2.55	0.505	0.84	0.00	0.000	0.505
33	2.51	0.51				
34	2.46	0.51				
35	2.42	0.52				
36	2.38	0.52				
37	2.34	0.53				
38	2.30	0.54				
39	2.26	0.54				
40	2.23	0.55				
41	2.19	0.555	0.76	0.00	0.000	0.555
42	2.16	0.560	0.76	0.00	0.000	0.560
43	2.13	0.565	0.75			
44	2.09	0.570	0.75			
45	2.06	0.574	0.74			
46	2.04	0.579	0.74			
47	2.01	0.583	0.73			
48	1.98	0.588	0.73			
49	1.95	0.592	0.72	0.00	0.000	0.592
50	1.93	0.596	0.72	0.00	0.000	0.596
51	1.90	0.600	0.71	0.00	0.000	0.600
52	1.88	0.604	0.71	0.00	0.000	0.604
53	1.86	0.608	0.70	0.00	0.000	0.608
54	1.83	0.612	0.70	0.00	0.000	0.612
55	1.81	0.616	0.70	0.00	0.000	0.616
56	1.79	0.619	0.69	0.00	0.000	0.619
57	1.77	0.623	0.69	0.00	0.000	0.623
58	1.75	0.627	0.69	0.00	0.000	0.627
59	1.73	0.630	0.68	0.00	0.000	0.630
60	1.71	0.634	0.68	0.00	0.000	0.634

Mod. FAA Minor Storage Volume (cubic ft.) = 27,596
Mod. FAA Minor Storage Volume (acre-ft.) = 0.6335

Determination of MAJOR Detention Volume Using Modified FAA Method

Design Information (Input):

Catchment Drainage Imperviousness	I_a =	45.00	percent
Catchment Drainage Area	A =	10.200	acres
Predevelopment NRCS Soil Group	Type =	C	A, B, C, or D
Return Period for Detention Control	T =	100	years (2, 5, 10, 25, 50, or 100)
Time of Concentration of Watershed	Tc =	21.71	minutes
Allowable Unit Release Rate	q =	0.00	cfs/acre
One-hour Precipitation	P_1 =	2.66	inches
Design Rainfall IDF Formula $i = C_1 * P_1/(C_2+T_c)^{C_3}$			
Coefficient One	C_1 =	28.50	
Coefficient Two	C_2 =	10	
Coefficient Three	C_3 =	0.786	

Determination of Average Outflow from the Basin (Calculated):

Runoff Coefficient	C =	0.59	
Inflow Peak Runoff	Qp-in =	30.1	cfs
Allowable Peak Outflow Rate	Qp-out =	**0.00**	cfs
Mod. FAA Major Storage Volume =		58,242	**cubic feet**
Mod. FAA Major Storage Volume =		**1.337**	**acre-ft**

Rainfall Duration minutes (input)	Rainfall Intensity inches / hr (output)	Inflow Volume acre-feet (output)	Adjustment Factor "m" (output)	Average Outflow cfs (output)	Outflow Volume acre-feet (output)	Storage Volume acre-feet (output)
0	0.00	0.000	0.00	0.00	0.000	0.000
1	11.51	0.095	1.00	0.00	0.000	0.095
2	10.75	0.178	1.00	0.00	0.000	0.178
3	10.10	0.251	1.00	0.00	0.000	0.251
4	9.53	0.316	1.00	0.00	0.000	0.316
5	9.02	0.374	1.00	0.00	0.000	0.374
6	8.58	0.427	1.00	0.00	0.000	0.427
7	8.18	0.474	1.00	0.00	0.000	0.474
8			1.00	0.00	0.000	0.518
9			1.00	0.00	0.000	0.559
10			1.00	0.00	0.000	0.597
11			1.00	0.00	0.000	0.631
12			1.00	0.00	0.000	0.664
13			1.00	0.00	0.000	0.695
14			1.00	0.00	0.000	0.724
15	6.04	0.751	1.00	0.00	0.000	0.751
16	5.86	0.777	1.00	0.00	0.000	0.777
17			1.00	0.00	0.000	0.801
18			1.00	0.00	0.000	0.824
19			1.00	0.00	0.000	0.846
20			1.00	0.00	0.000	0.867
21			1.00	0.00	0.000	0.888
22			0.99	0.00	0.000	0.907
23			0.97	0.00	0.000	0.926
24			0.95	0.00	0.000	0.943
25			0.93	0.00	0.000	0.961
26			0.92	0.00	0.000	0.977
27			0.90	0.00	0.000	0.993
28	4.35	1.009	0.89	0.00	0.000	1.009
29	4.26	1.023	0.87	0.00	0.000	1.023
30	4.17	1.038	0.86	0.00	0.000	1.038
31	4.09	1.052	0.85	0.00	0.000	1.052
32	4.02	1.065	0.84	0.00	0.000	1.065
33				0.00	0.000	1.079
34				0.00	0.000	1.091
35				0.00	0.000	1.104
36				0.00	0.000	1.116
37				0.00	0.000	1.128
38				0.00	0.000	1.139
39				0.00	0.000	1.150
40				0.00	0.000	1.161
41	3.45	1.172	0.76	0.00	0.000	1.172
42	3.40	1.182	0.76	0.00	0.000	1.182
43			0.75	0.00	0.000	1.192
44			0.75	0.00	0.000	1.202
45			0.74	0.00	0.000	1.212
46			0.74	0.00	0.000	1.222
47			0.73	0.00	0.000	1.231
48			0.73	0.00	0.000	1.240
49	3.07	1.249	0.72	0.00	0.000	1.249
50	3.03	1.258	0.72	0.00	0.000	1.258
51	3.00	1.266	0.71	0.00	0.000	1.266
52	2.96	1.275	0.71	0.00	0.000	1.275
53	2.92	1.283	0.70	0.00	0.000	1.283
54	2.88	1.291	0.70	0.00	0.000	1.291
55	2.85	1.299	0.70	0.00	0.000	1.299
56	2.82	1.307	0.69	0.00	0.000	1.307
57	2.78	1.315	0.69	0.00	0.000	1.315
58	2.75	1.322	0.69	0.00	0.000	1.322
59	2.72	1.330	0.68	0.00	0.000	1.330
60	2.69	1.337	0.68	0.00	0.000	1.337

Mod. FAA Major Storage Volume (cubic ft.) = 58,242
Mod. FAA Major Storage Volume (acre-ft.) = 1.3370

REVISED TO DETAIN 150% OF TWO-HOUR 100-YEAR STORM EVENT.

Per our criteria, the detention pond volume needs to be sized to detain rainfall from a two-hour 100-year storm event. Therefore, please increase the rainfall duration in the "Detention Volume by the Modified FAA Method" to 120 minutes.

Please provide a stage-storage calculation sheet to show the various water elevations that are designed within the detention pond in the drilling and production phases.

STAGE-STORAGE TABLES PROVIDED IN APPENDICES.

UDFCD DETENTION BASIN VOLUME ESTIMATING WORKBOOK Version 2.34, Released November 2013

File Location:Q:\DEN\Projects\0178-00 CMD Centennial Projects\0236-08 MRG Misc Oil and Gas\Design\CDs\Civil\DRI\023608- DRILLING PHASE DRAINAGE PLAN RevA.dwg Plot Date:9/1/2022 12:24 PM Last Saved By: TSCARLETT

SECTION LOCATION FOR UPSTREAM DITCH CAPACITY CALCULATION SHOWN ON SHEET G.9

ACCESS ROAD

SECTION LINE

DIVERSION DITCH

14' UTILITY EASEMENT

80' WAPA EASEMENT

D–1
10.2 | 0.4 / 0.67

DRILLING PHASE WORKING PAD SURFACE

COUNTY ROAD 3

PROPERTY LINE

SOIL STOCKPILE

BASIN D-1 TIME OF CONCENTRATION PATH
L=956 FT
t = 26.2 MIN

SECTION LOCATION FOR DITCH CAPACITY CALCULATION SHOWN ON SHEET G.10

RETENTION BASIN AREA

REVISION MADE

In the CE Drainage Maps, please lightly shade the extents of the 100-year water surface elevation in the detention pond and label the 100-year water surface elevation.

50' EMERGENCY SPILLWAY

1/4 SECTION LINE

STILLING BASIN AND LEVEL SPREADER LOCATION (SEE DETAILS ON SHEET I.5)

BASIN D-1 DESIGN POINT

N

60' 0 30' 60' 120'

1" = 60' HOR.

A
B | C
D

DRAINAGE BASIN
A: BASIN ID
B: BASIN ACREAGE
C: MINOR EVENT RUNOFF COEFFICIENT C5
D: MAJOR EVENT RUNOFF COEFFICIENT C100

LEGEND:

- DRAINAGE BASIN BOUNDARY
- PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- PROPERTY LINE
- TIME OF CONCENTRATION PATH
- SURFACE FLOW DIRECTION ARROW (PROPOSED CONDITIONS)
- SURFACE FLOW DIRECTION ARROW (EXISTING CONDITIONS)

REV	REVISION DESCRIPTION	DATE	CHND	CHKD	APPR
A	ISSUED FOR REVIEW	9/1/2022	TVG	SWC	TS

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811
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CITY APPROVAL
ACCEPTED BY: _____
CITY ENGINEER (or Designee) DATE

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PE STAMP
ISSUED FOR REVIEW
FOR AND ON BEHALF OF MERRICK & COMPANY

TITLE
MRG, LP OIL AND GAS CE PAD
CITY OF LOVELAND, COLORADO
CE DRAINAGE MAP
DRILLING PHASE

JOB NUMBER 65120236-10
DATE 9/1/2022
SHEET I.3
2 of 4