SUMMIT AT POWDER MOUNTAIN
PHASE 1E
SUPPLIMENT TO MAY 2013 DRAINAGE SUMMARY

POWDER MOUNTAIN RESORT
EDEN, UTAH

JULY 2015

NV5
5217 SOUTH STATE STREET, SUITE 200
MURRAY, UT 84107
801.743.1300 TEL 801.743.0300 FAX
WWW.NV5.COM

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BEYOND ENGINEERING

Site Description

The proposed development at Powder Mountain Resort east of Eden Utah is an extension of the planned communities that branch off of Summit Pass. These development includes approximately one mile of private road that is downhill from Horizon Run. The private road (Phase 1E) includes 6 single family lots south, downhill of Horizon Run with six single family lots and 1 large open space parcel. The majority of storm drainage for the site has historically been conveyed overland in the southwesterly directing into Lefty's Canyon. With the usage of roadside ditches and culverts drainage will be conveyed through the site.

Drainage Analysis

Analysis of the proposed developments has been carried out with the same method as was used for the Summit Pass and Spring Park Study dated May 2013. This analysis is intended as a supplement and update to that study. Hydrology for the proposed development was calculated using the SCS Method. This methodology was input into Haestad Method's PondPack to calculate storm discharge rates. Landuse consists of pavement, grass, meadows, forestry and gravel roads. Time of Concentration was calculated using the Technical Release 55 Method. Rainfall depths were determined using the National Oceanic and Atmospheric Administration (NOAA) website. Weber County requires drainage infrastructure to convey 10-year 2 hour storm events and discharge stormwater at a release rate such that post development discharge is less than pre development discharge. Soil maps for SCS Methodology have been provided by the *United States Department of Agriculture (USDA) Natural Resources Conservation Service (NCRC) Web Soil Survey.*

In the Summit Pass and Spring Park Analysis, Haestad Method's FlowMaster was used to calculate the capacity of the roadside ditches for the development. Since the roadside ditches are uniform throughout the development, the largest contributing flow to the least amount of slope road and ditch were compared for modeling the whole development. The same roadside ditch will be utilized upstream of new roadways. These calculations can be found in the appendix of the Summit Pass and Spring Park Report.

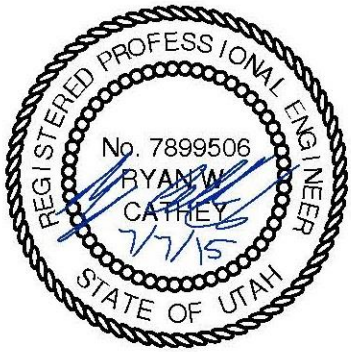
Hydrology for the private roads in Phase 1E has not been previously calculated. See appendix for the updated hydrology for Phase 1E. A roadside ditch upstream of the private roads will collect all runoff from uphill. The roadside ditch flows to the sag points, or low points along the alignment then falls into culverts that pipe stormwater under the roadway. The pipe system discharges to a natural swale that ultimately discharges to rip rap pad designed to break up concentrated flow and allow overland flow to a historic location of discharge previous to disturbance. See the appendix for calculations for the culvert sizing. There is no other stormwater management infrastructure needed for Phase 1E.

Pipe networks and culverts were sized using Haestad Method's PondPack and CulvertMaster. Riprap apron calculations for these culverts were conducted using *Plate 3.18-4 of the USDA-SCS RIPRAP STD & SPEC 3.19* as shown in the appendix.

An analysis of runoff impacts due to the minor developments along Summit Pass in the initial study shows that runoff increase in volume and flow rate is negligible. Therefore, there will be no need for stormwater detention for Horizon Run and Heartwood Drive developments.

Sincerely,

Ryan Cathey, PE



APPENDICES

1. **Phase 1E Private Roadways - Ditch and Culvert Calculations**

    a. **Phase 1E Overall Grading and Drainage**
    b. **Culvert Subareas Drainage Exhibit B - Revised**
    c. **Time of Concentration Calculations - Revised**
    d. **Haestad Method's PondPack Calculations - Revised**
    e. **Haestad Method's FlowMaster Roadside Ditch Capacity (From May Report)**
    f. **Haestad Method's CulvertMaster Calculations**
    g. **USDA NRCS Riprap Calculations (From May Report)**

DATE: 7/7/15 TIME: 8:34:56 AM DRAWING NAME: ...\P1\04SP.DWG
SERVER: NONE PAGE SETUP: PDF_C3D-24x36 LAYOUT: Layout1
PATH: N:\SLB0793\CAD\PHASE 1\P1-E DESIGNER: ### PROJ. MGR: ###

BOWLDEN KREFS

OPEN SPACE

SUMMIT PASS

HORIZON RUN

POSSIBLE TEMPORARY TERMINATION POINT, STA:8+43.38, SEE DETAIL ON SHEET 5.10

POSSIBLE TEMPORARY TERMINATION POINT, STA:28+42.72, SEE DETAIL ON SHEET 5.10

SCALE

HORIZONTAL: 1" = 100

0 25 50 100 150

CALL BEFORE YOU DIG! IT'S THE LAW BLUE STAKES 1 800 662 4111

NO.	BY	DATE	REVISIONS

CAUTION

The engineer preparing these plans will not be responsible for, or liable for, unauthorized changes to or uses of these plans. All changes to the plans must be in writing and must be approved by the preparer of these plans.

SUMMIT EDEN PHASE 1E CONSTRUCTION

OVERALL GRADING PLAN

PREPARED FOR: SUMMIT MOUNTAIN HOLDING GROUP, LLC

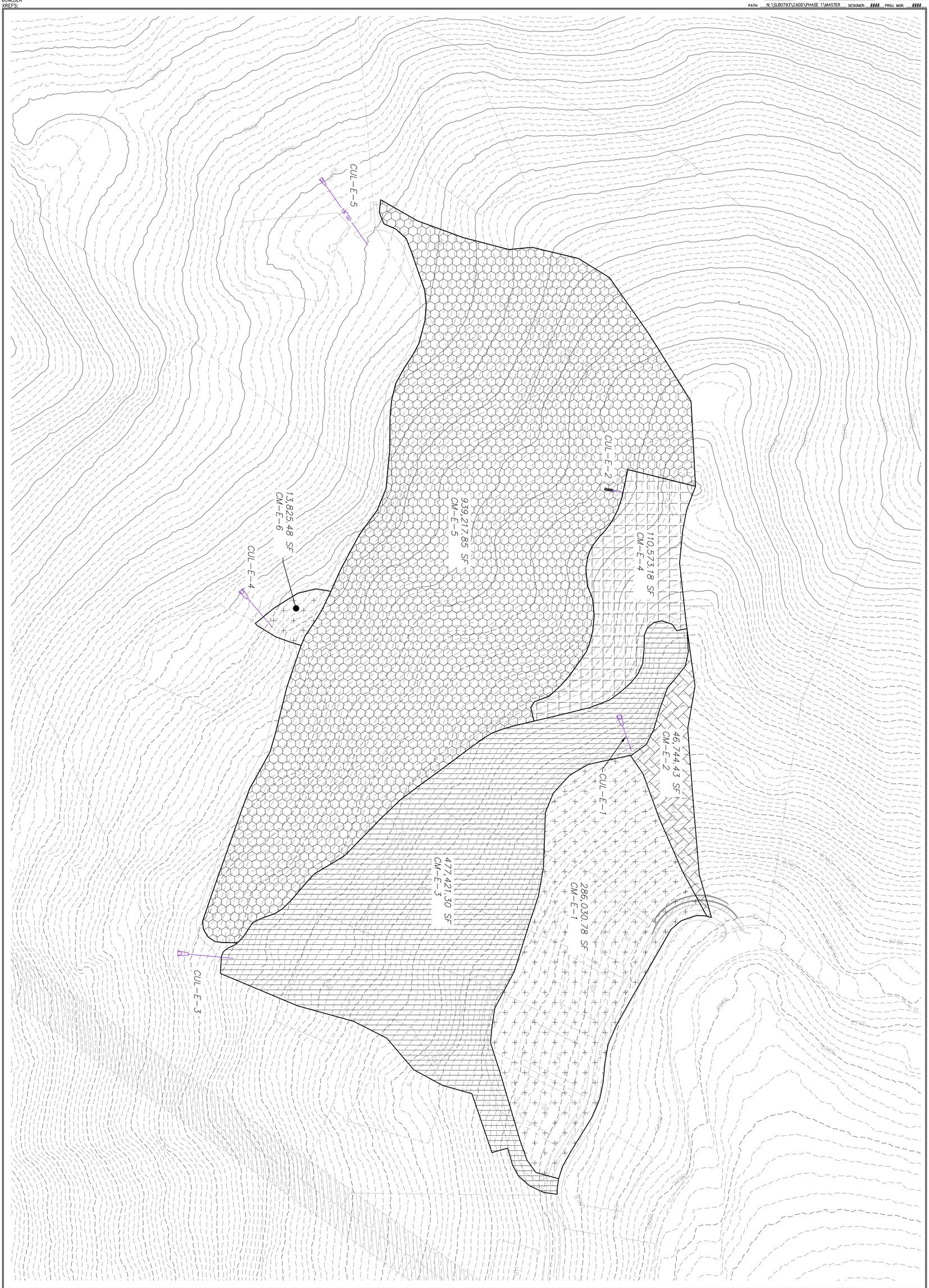
DATE SUBMITTED: 7/7/2015

BEYOND ENGINEERING
5217 SOUTH STATE STREET, SUITE 200
801.743.5900 TEL 801.743.0300 FAX
MURRAY, UT 84107
WWW.NV5.COM

SHEET NUMBER
1.04

SCALE
VERTICAL: 1"= NA
HORIZONTAL: 1"= 100

JOB NUMBER
SLB0793



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6217 SOUTH STATE STREET, SUITE 200 MURRAY, UT 84107
801.743.1300 TEL 801.743.0300 FAX WWW.NV5.COM

POWDER MOUNTAIN PHASE 1E

STORM WATER AREAS

PREPARED FOR: SUMMIT MOUNTAIN HOLDING GROUP, LLC DATE SUBMITTED: 7/7/2015

NO.	BY	DATE	REVISIONS:

JOB NUMBER SLB0793

SCALE VERTICAL: 1" = NA HORIZONTAL: 1" = 100

SHEETS 1 OF

SHEET NUMBER ET01

Time of Concentration Calculator

Area: **CM-E-1**

Sheet Flow		
$T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$	Mannings roughness coef.	0.045
	Flow Length (<300 lf)	300
	10 yr 2 hr rainfall depth (in.)	1.52
	Slope (ft/ft)	0.306333
	T (hr)=	**0.073108**

Elev. 1	8768.5
Elev.2	8676.6

Shallow Concentrated Flow		
$T_t = \frac{L}{3600\ V}$	Flow Length (ft)	173.7
	Slope (ft/ft)	0.337939
	Average Velocity (ft/s)	3
	T (hr)=	**0.016083**

Elev. 1	8676.6
Elev.2	8617.9

Channel Flow		
$V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$	Cross-Sectional Area (sf)	0.5
	Wetted Perimeter (ft)	12
	Hydraulic Radius, r=a/Pw (ft)	0.041667
	Slope (ft/ft)	0.056773
$T_t = \frac{L}{3600\ V}$	Mannings roughness coef.	0.012
	Flow Length (ft)	100.4
	Velocity (ft/s)	3.555779
	T (hr)=	**0.007843**

Elev. 1	8617.9
Elev.2	8612.2
Trap Channel	
Depth (ft)	0.25
Base (ft)	1
S/S (H:V)	50

Watershed Tc (hr)	**0.097035**

Time of Concentration Calculator

Area: **CM-E-2**

Sheet Flow		
$T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$	Mannings roughness coef.	0.045
	Flow Length (<300 lf)	300
	10 yr 2 hr rainfall depth (in.)	1.52
	Slope (ft/ft)	0.306333
	T (hr)=	**0.073108**

Elev. 1	8770.3
Elev.2	8678.4

Shallow Concentrated Flow		
$T_t = \frac{L}{3600\ V}$	Flow Length (ft)	180
	Slope (ft/ft)	0.294444
	Average Velocity (ft/s)	2.8
	T (hr)=	**0.017857**

Elev. 1	8678.4
Elev.2	8625.4

Channel Flow		
$V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$	Cross-Sectional Area (sf)	3.375
	Wetted Perimeter (ft)	26.005
	Hydraulic Radius, r=a/Pw (ft)	0.129783
	Slope (ft/ft)	0.101056
$T_t = \frac{L}{3600\ V}$	Mannings roughness coef.	0.012
	Flow Length (ft)	284
	Velocity (ft/s)	10.11808
	T (hr)=	**0.007797**

Elev. 1	8625.4
Elev.2	8596.7
Trap Channel	
Depth (ft)	0.25
Base (ft)	1
S/S (H:V)	50

Watershed Tc (hr)	**0.098762**

Time of Concentration Calculator

Area: **CM-E-3**

Sheet Flow		
$T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$	Mannings roughness coef.	0.045
	Flow Length (<300 lf)	300
	10 yr 2 hr rainfall depth (in.)	1.52
	Slope (ft/ft)	0.232333
	T (hr)=	**0.081658**

Elev. 1	8740.1
Elev.2	8670.4

Shallow Concentrated Flow		
$T_t = \frac{L}{3600\ V}$	Flow Length (ft)	716.5
	Slope (ft/ft)	0.272715
	Average Velocity (ft/s)	7.5
	T (hr)=	**0.026537**

Elev. 1	8670.4
Elev.2	8475

Channel Flow		
$V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$	Cross-Sectional Area (sf)	3.375
	Wetted Perimeter (ft)	26.005
	Hydraulic Radius, r=a/Pw (ft)	0.129783
	Slope (ft/ft)	16.05873
$T_t = \frac{L}{3600\ V}$	Mannings roughness coef.	0.012
	Flow Length (ft)	63
	Velocity (ft/s)	127.5475
	T (hr)=	**0.000137**

Elev. 1	8475
Elev.2	7463.3
Trap Channel	
Depth (ft)	0.25
Base (ft)	1
S/S (H:V)	50

Watershed Tc (hr)	**0.108332**

Time of Concentration Calculator

Area: **CM-E-4**

Sheet Flow		
$T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$	Mannings roughness coef.	0.045
	Flow Length (<300 lf)	300
	10 yr 2 hr rainfall depth (in.)	1.52
	Slope (ft/ft)	0.275
	T (hr)=	**0.076333**

Elev. 1	8596.6
Elev.2	8514.1

Shallow Concentrated Flow		
$T_t = \frac{L}{3600\ V}$	Flow Length (ft)	69.2
	Slope (ft/ft)	0.281792
	Average Velocity (ft/s)	9
	T (hr)=	**0.002136**

Elev. 1	8514.1
Elev.2	8494.6

Channel Flow		
$V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$	Cross-Sectional Area (sf)	3.375
	Wetted Perimeter (ft)	26.005
	Hydraulic Radius, r=a/Pw (ft)	0.129783
	Slope (ft/ft)	0.047677
$T_t = \frac{L}{3600\ V}$	Mannings roughness coef.	0.012
	Flow Length (ft)	81.8
	Velocity (ft/s)	6.949794
	T (hr)=	**0.003269**

Elev. 1	8494.6
Elev.2	8490.7
Trap Channel	
Depth (ft)	0.25
Base (ft)	1
S/S (H:V)	50

Watershed Tc (hr)	**0.081738**

Time of Concentration Calculator

Area: **CM-E-5**

Sheet Flow		
$T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$	Mannings roughness coef.	0.045
	Flow Length (<300 lf)	300
	10 yr 2 hr rainfall depth (in.)	1.52
	Slope (ft/ft)	0.201333
	T (hr)=	**0.086472**

Elev. 1 8550
Elev.2 8489.6

Shallow Concentrated Flow		
$T_t = \frac{L}{3600\ V}$	Flow Length (ft)	857
	Slope (ft/ft)	0.25811
	Average Velocity (ft/s)	8
	T (hr)=	**0.029757**

Elev. 1 8489.6
Elev.2 8268.4

Watershed Tc (hr)	**0.116229**

Time of Concentration Calculator

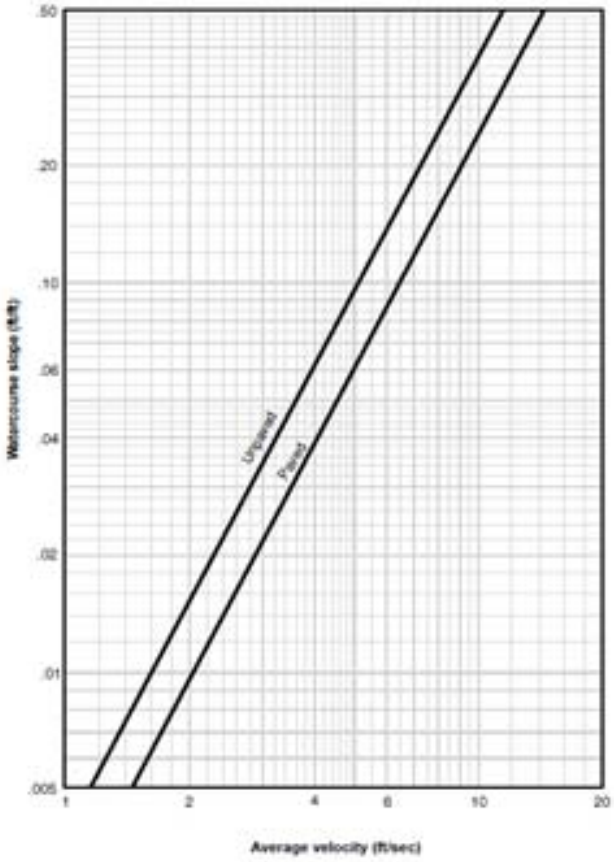
Area: **CM-E-6**

Sheet Flow		
$T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$	Mannings roughness coef.	0.045
	Flow Length (<300 lf)	114
	10 yr 2 hr rainfall depth (in.)	1.52
	Slope (ft/ft)	0.370175
	T (hr)=	**0.031254**

Elev. 1 8388.4
Elev.2 8346.2

Watershed Tc (hr)	**0.031254**

Figure 3-1 Average velocities for estimating travel time for shallow concentrated flow



Scenario: 10 yr 2 hr

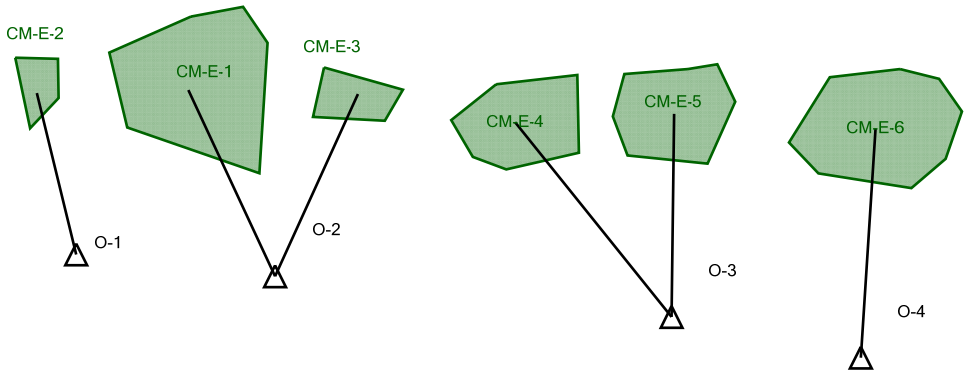


Table of Contents

Subsection: Master Network Summary

Catchments Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)
CM-E-1	10 yr 2 hr	10	0.082	0.700	1.93
CM-E-2	10 yr 2 hr	10	0.013	0.700	0.31
CM-E-3	10 yr 2 hr	10	0.136	0.700	3.18
CM-E-4	10 yr 2 hr	10	0.032	0.700	0.75
CM-E-5	10 yr 2 hr	10	0.267	0.700	6.20
CM-E-6	10 yr 2 hr	10	0.004	0.700	0.09

Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)
O-1	10 yr 2 hr	10	0.013	0.700	0.31
O-2	10 yr 2 hr	10	0.218	0.700	5.10
O-3	10 yr 2 hr	10	0.299	0.700	6.95
O-4	10 yr 2 hr	10	0.004	0.700	0.09

Subsection: Time-Depth Curve
Label: CM-E-3

Return Event: 10 years
Storm Event: 10 yr 2 hr

Time-Depth Curve: 10 yr 2 hr	
Label	10 yr 2 hr
Start Time	0.000 hours
Increment	0.167 hours
End Time	2.000 hours
Return Event	10 years

CUMULATIVE RAINFALL (in)
Output Time Increment = 0.167 hours
Time on left represents time for first value in each row.

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
0.000	0.000	0.029	0.056	0.920	1.186
0.833	1.289	1.350	1.379	1.408	1.435
1.667	1.464	1.491	1.520	(N/A)	(N/A)

Time-Depth Curve: 10 yr 2 hr	
Label	10 yr 2 hr
Start Time	0.000 hours
Increment	0.167 hours
End Time	2.000 hours
Return Event	10 years

CUMULATIVE RAINFALL (in)
Output Time Increment = 0.167 hours
Time on left represents time for first value in each row.

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
0.000	0.000	0.029	0.056	0.920	1.186
0.833	1.289	1.350	1.379	1.408	1.435
1.667	1.464	1.491	1.520	(N/A)	(N/A)

Unit Hydrograph Method (Computational Notes)
Definition of Terms

At	Total area (acres): At = Ai+Ap
Ai	Impervious area (acres)
Ap	Pervious area (acres)
CNi	Runoff curve number for impervious area
CNp	Runoff curve number for pervious area
fLoss	f loss constant infiltration (depth/time)
gKs	Saturated Hydraulic Conductivity (depth/time)
Md	Volumetric Moisture Deficit
Psi	Capillary Suction (length)
hK	Horton Infiltration Decay Rate (time^-1)
fo	Initial Infiltration Rate (depth/time)
fc	Ultimate(capacity)Infiltration Rate (depth/time)
Ia	Initial Abstraction (length)
dt	Computational increment (duration of unit excess rainfall) Default dt is smallest value of 0.1333Tc, rtm, and th (Smallest dt is then adjusted to match up with Tp)
UDdt	User specified override computational main time increment (only used if UDdt is => .1333Tc)
D(t)	Point on distribution curve (fraction of P) for time step t
K	2 / (1 + (Tr/Tp)): default K = 0.75: (for Tr/Tp = 1.67)
Ks	Hydrograph shape factor = Unit Conversions * K: = ((1hr/3600sec) * (1ft/12in) * ((5280ft)**2/sq.mi)) * K Default Ks = 645.333 * 0.75 = 484
Lag	Lag time from center of excess runoff (dt) to Tp: Lag = 0.6Tc
P	Total precipitation depth, inches
Pa(t)	Accumulated rainfall at time step t
Pi(t)	Incremental rainfall at time step t
qp	Peak discharge (cfs) for 1in. runoff, for 1hr, for 1 sq.mi. = (Ks * A * Q) / Tp (where Q = 1in. runoff, A=sq.mi.)
Qu(t)	Unit hydrograph ordinate (cfs) at time step t
Q(t)	Final hydrograph ordinate (cfs) at time step t
Rai(t)	Accumulated runoff (inches) at time step t for impervious area
Rap(t)	Accumulated runoff (inches) at time step t for pervious area
Rii(t)	Incremental runoff (inches) at time step t for impervious area
Rip(t)	Incremental runoff (inches) at time step t for pervious area
R(t)	Incremental weighted total runoff (inches)
Rtm	Time increment for rainfall table
Si	S for impervious area: Si = (1000/CNi) - 10
Sp	S for pervious area: Sp = (1000/CNp) - 10
t	Time step (row) number
Tc	Time of concentration
Tb	Time (hrs) of entire unit hydrograph: Tb = Tp + Tr
Tp	Time (hrs) to peak of a unit hydrograph: Tp = (dt/2) + Lag
Tr	Time (hrs) of receding limb of unit hydrograph: Tr = ratio of Tp

Subsection: Unit Hydrograph Equations

Unit Hydrograph Method
Computational Notes
Precipitation

Column (1)	Time for time step t
Column (2)	D(t) = Point on distribution curve for time step t
Column (3)	Pi(t) = Pa(t) - Pa(t-1): Col.(4) - Preceding Col.(4)
Column (4)	Pa(t) = D(t) x P: Col.(2) x P

Pervious Area Runoff (using SCS Runoff CN Method)

Column (5)	Rap(t) = Accumulated pervious runoff for time step t
	If (Pa(t) is <= 0.2Sp) then use: Rap(t) = 0.0
	If (Pa(t) is > 0.2Sp) then use:
	
	Rap(t) = (Col.(4)-0.2Sp)**2 / (Col.(4)+0.8Sp)

Column (6)	Rip(t) = Incremental pervious runoff for time step t Rip(t) = Rap(t) - Rap(t-1) Rip(t) = Col.(5) for current row - Col.(5) for preceding row.

Impervious Area Runoff

Column (7 & 8)...	Did not specify to use impervious areas.

Incremental Weighted Runoff

Column (9)	R(t) = (Ap/At) x Rip(t) + (Ai/At) x Rii(t) R(t) = (Ap/At) x Col.(6) + (Ai/At) x Col.(8)

SCS Unit Hydrograph Method

Column (10)	Q(t) is computed with the SCS unit hydrograph method using R(t) and Qu(t).

Storm Event	10 yr 2 hr
Return Event	10 years
Duration	2.000 hours
Depth	1.520 in
Time of Concentration (Composite)	0.097 hours
Area (User Defined)	6.570 acres

Computational Time Increment	0.013 hours
Time to Peak (Computed)	0.685 hours
Flow (Peak, Computed)	1.96 ft³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	0.700 hours
Flow (Peak Interpolated Output)	1.93 ft³/s

Drainage Area	
SCS CN (Composite)	74.000
Area (User Defined)	6.570 acres
Maximum Retention (Pervious)	3.514 in
Maximum Retention (Pervious, 20 percent)	0.703 in

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	0.154 in
Runoff Volume (Pervious)	0.084 ac-ft

Hydrograph Volume (Area under Hydrograph curve)	
Volume	0.082 ac-ft

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.097 hours
Computational Time Increment	0.013 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	76.74 ft³/s
Unit peak time, Tp	0.065 hours

SCS Unit Hydrograph Parameters	
Unit receding limb, Tr	0.259 hours
Total unit time, Tb	0.323 hours

Storm Event	10 yr 2 hr
Return Event	10 years
Duration	2.000 hours
Depth	1.520 in
Time of Concentration (Composite)	0.097 hours
Area (User Defined)	6.570 acres

HYDROGRAPH ORDINATES (ft³/s)
Output Time Increment = 0.050 hours
Time on left represents time for first value in each row.

Time (hours)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)
0.450	0.00	0.26	1.28	1.52	1.79
0.700	1.93	1.39	1.11	1.06	0.87
0.950	0.72	0.69	0.59	0.41	0.36
1.200	0.34	0.34	0.34	0.35	0.34
1.450	0.34	0.34	0.35	0.36	0.37
1.700	0.37	0.36	0.36	0.36	0.37
1.950	0.38	0.39	(N/A)	(N/A)	(N/A)

Storm Event	10 yr 2 hr
Return Event	10 years
Duration	2.000 hours
Depth	1.520 in
Time of Concentration (Composite)	0.099 hours
Area (User Defined)	1.070 acres

Computational Time Increment	0.013 hours
Time to Peak (Computed)	0.686 hours
Flow (Peak, Computed)	0.32 ft³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	0.700 hours
Flow (Peak Interpolated Output)	0.31 ft³/s

Drainage Area	
SCS CN (Composite)	74.000
Area (User Defined)	1.070 acres
Maximum Retention (Pervious)	3.514 in
Maximum Retention (Pervious, 20 percent)	0.703 in

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	0.154 in
Runoff Volume (Pervious)	0.014 ac-ft

Hydrograph Volume (Area under Hydrograph curve)	
Volume	0.013 ac-ft

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.099 hours
Computational Time Increment	0.013 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	12.25 ft³/s
Unit peak time, Tp	0.066 hours

SCS Unit Hydrograph Parameters	
Unit receding limb, Tr	0.264 hours
Total unit time, Tb	0.330 hours

Storm Event	10 yr 2 hr
Return Event	10 years
Duration	2.000 hours
Depth	1.520 in
Time of Concentration (Composite)	0.099 hours
Area (User Defined)	1.070 acres

HYDROGRAPH ORDINATES (ft^3/s)
Output Time Increment = 0.050 hours
Time on left represents time for first value in each row.

Time (hours)	Flow (ft^3/s)	Flow (ft^3/s)	Flow (ft^3/s)	Flow (ft^3/s)	Flow (ft^3/s)
0.450	0.00	0.04	0.20	0.25	0.29
0.700	0.31	0.23	0.18	0.17	0.14
0.950	0.12	0.11	0.10	0.07	0.06
1.200	0.06	0.06	0.06	0.06	0.06
1.450	0.06	0.06	0.06	0.06	0.06
1.700	0.06	0.06	0.06	0.06	0.06
1.950	0.06	0.06	(N/A)	(N/A)	(N/A)

Storm Event	10 yr 2 hr
Return Event	10 years
Duration	2.000 hours
Depth	0.000 in
Time of Concentration (Composite)	0.108 hours
Area (User Defined)	10.960 acres

Computational Time Increment	0.014 hours
Time to Peak (Computed)	0.691 hours
Flow (Peak, Computed)	3.21 ft³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	0.700 hours
Flow (Peak Interpolated Output)	3.18 ft³/s

Drainage Area	
SCS CN (Composite)	74.000
Area (User Defined)	10.960 acres
Maximum Retention (Pervious)	3.514 in
Maximum Retention (Pervious, 20 percent)	0.703 in

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	0.154 in
Runoff Volume (Pervious)	0.141 ac-ft

Hydrograph Volume (Area under Hydrograph curve)	
Volume	0.136 ac-ft

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.108 hours
Computational Time Increment	0.014 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	114.98 ft³/s
Unit peak time, Tp	0.072 hours

SCS Unit Hydrograph Parameters	
Unit receding limb, Tr	0.288 hours
Total unit time, Tb	0.360 hours

Storm Event	10 yr 2 hr
Return Event	10 years
Duration	2.000 hours
Depth	0.000 in
Time of Concentration (Composite)	0.108 hours
Area (User Defined)	10.960 acres

HYDROGRAPH ORDINATES (ft³/s)
Output Time Increment = 0.050 hours
Time on left represents time for first value in each row.

Time (hours)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)
0.450	0.00	0.34	1.88	2.47	2.89
0.700	3.18	2.45	1.93	1.79	1.52
0.950	1.24	1.16	1.01	0.74	0.61
1.200	0.58	0.57	0.57	0.58	0.57
1.450	0.56	0.57	0.58	0.60	0.61
1.700	0.61	0.60	0.60	0.60	0.62
1.950	0.63	0.64	(N/A)	(N/A)	(N/A)

Storm Event	10 yr 2 hr
Return Event	10 years
Duration	2.000 hours
Depth	1.520 in
Time of Concentration (Composite)	0.083 hours
Area (User Defined)	2.540 acres

Computational Time Increment	0.011 hours
Time to Peak (Computed)	0.689 hours
Flow (Peak, Computed)	0.78 ft³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	0.700 hours
Flow (Peak Interpolated Output)	0.75 ft³/s

Drainage Area	
SCS CN (Composite)	74.000
Area (User Defined)	2.540 acres
Maximum Retention (Pervious)	3.514 in
Maximum Retention (Pervious, 20 percent)	0.703 in

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	0.154 in
Runoff Volume (Pervious)	0.033 ac-ft

Hydrograph Volume (Area under Hydrograph curve)	
Volume	0.032 ac-ft

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.083 hours
Computational Time Increment	0.011 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	34.54 ft³/s
Unit peak time, Tp	0.056 hours

SCS Unit Hydrograph Parameters	
Unit receding limb, Tr	0.222 hours
Total unit time, Tb	0.278 hours

Storm Event	10 yr 2 hr
Return Event	10 years
Duration	2.000 hours
Depth	1.520 in
Time of Concentration (Composite)	0.083 hours
Area (User Defined)	2.540 acres

HYDROGRAPH ORDINATES (ft³/s)
Output Time Increment = 0.050 hours
Time on left represents time for first value in each row.

Time (hours)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)
0.450	0.00	0.13	0.56	0.61	0.72
0.700	0.75	0.49	0.41	0.40	0.32
0.950	0.27	0.26	0.21	0.15	0.13
1.200	0.13	0.13	0.13	0.13	0.13
1.450	0.13	0.13	0.13	0.14	0.14
1.700	0.14	0.14	0.14	0.14	0.14
1.950	0.15	0.15	(N/A)	(N/A)	(N/A)

Storm Event	10 yr 2 hr
Return Event	10 years
Duration	2.000 hours
Depth	1.520 in
Time of Concentration (Composite)	0.116 hours
Area (User Defined)	21.560 acres

Computational Time Increment	0.015 hours
Time to Peak (Computed)	0.696 hours
Flow (Peak, Computed)	6.24 ft³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	0.700 hours
Flow (Peak Interpolated Output)	6.20 ft³/s

Drainage Area	
SCS CN (Composite)	74.000
Area (User Defined)	21.560 acres
Maximum Retention (Pervious)	3.514 in
Maximum Retention (Pervious, 20 percent)	0.703 in

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	0.154 in
Runoff Volume (Pervious)	0.277 ac-ft

Hydrograph Volume (Area under Hydrograph curve)	
Volume	0.267 ac-ft

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.116 hours
Computational Time Increment	0.015 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	210.59 ft³/s
Unit peak time, Tp	0.077 hours

SCS Unit Hydrograph Parameters	
Unit receding limb, Tr	0.309 hours
Total unit time, Tb	0.387 hours

Storm Event	10 yr 2 hr
Return Event	10 years
Duration	2.000 hours
Depth	1.520 in
Time of Concentration (Composite)	0.116 hours
Area (User Defined)	21.560 acres

HYDROGRAPH ORDINATES (ft³/s)
Output Time Increment = 0.050 hours
Time on left represents time for first value in each row.

Time (hours)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)
0.450	0.00	0.58	3.34	4.73	5.57
0.700	6.20	4.99	3.89	3.56	3.06
0.950	2.50	2.30	2.04	1.51	1.24
1.200	1.15	1.13	1.13	1.14	1.13
1.450	1.11	1.11	1.13	1.17	1.19
1.700	1.20	1.19	1.18	1.18	1.21
1.950	1.24	1.26	(N/A)	(N/A)	(N/A)

Storm Event	10 yr 2 hr
Return Event	10 years
Duration	2.000 hours
Depth	1.520 in
Time of Concentration (Composite)	0.083 hours
Area (User Defined)	0.320 acres

Computational Time Increment	0.011 hours
Time to Peak (Computed)	0.689 hours
Flow (Peak, Computed)	0.10 ft³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	0.700 hours
Flow (Peak Interpolated Output)	0.09 ft³/s

Drainage Area	
SCS CN (Composite)	74.000
Area (User Defined)	0.320 acres
Maximum Retention (Pervious)	3.514 in
Maximum Retention (Pervious, 20 percent)	0.703 in

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	0.154 in
Runoff Volume (Pervious)	0.004 ac-ft

Hydrograph Volume (Area under Hydrograph curve)	
Volume	0.004 ac-ft

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.083 hours
Computational Time Increment	0.011 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	4.35 ft³/s
Unit peak time, Tp	0.056 hours

SCS Unit Hydrograph Parameters	
Unit receding limb, Tr	0.222 hours
Total unit time, Tb	0.278 hours

Storm Event	10 yr 2 hr
Return Event	10 years
Duration	2.000 hours
Depth	1.520 in
Time of Concentration (Composite)	0.083 hours
Area (User Defined)	0.320 acres

HYDROGRAPH ORDINATES (ft³/s)
Output Time Increment = 0.050 hours
Time on left represents time for first value in each row.

Time (hours)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)
0.450	0.00	0.02	0.07	0.08	0.09
0.700	0.09	0.06	0.05	0.05	0.04
0.950	0.03	0.03	0.03	0.02	0.02
1.200	0.02	0.02	0.02	0.02	0.02
1.450	0.02	0.02	0.02	0.02	0.02
1.700	0.02	0.02	0.02	0.02	0.02
1.950	0.02	0.02	(N/A)	(N/A)	(N/A)

Summary for Hydrograph Addition at 'O-1'

Upstream Link	Upstream Node
<Catchment to Outflow Node>	CM-E-2

Node Inflows

Inflow Type	Element	Volume (ac-ft)	Time to Peak (hours)	Flow (Peak) (ft^3/s)
Flow (From)	CM-E-2	0.013	0.700	0.31
Flow (In)	O-1	0.013	0.700	0.31

Summary for Hydrograph Addition at 'O-2'

Upstream Link	Upstream Node
<Catchment to Outflow Node>	CM-E-1
<Catchment to Outflow Node>	CM-E-3

Node Inflows

Inflow Type	Element	Volume (ac-ft)	Time to Peak (hours)	Flow (Peak) (ft^3/s)
Flow (From)	CM-E-1	0.082	0.700	1.93
Flow (From)	CM-E-3	0.136	0.700	3.18
Flow (In)	O-2	0.218	0.700	5.10

Summary for Hydrograph Addition at 'O-3'

Upstream Link	Upstream Node
<Catchment to Outflow Node>	CM-E-4
<Catchment to Outflow Node>	CM-E-5

Node Inflows

Inflow Type	Element	Volume (ac-ft)	Time to Peak (hours)	Flow (Peak) (ft^3/s)
Flow (From)	CM-E-4	0.032	0.700	0.75
Flow (From)	CM-E-5	0.267	0.700	6.20
Flow (In)	O-3	0.299	0.700	6.95

Summary for Hydrograph Addition at 'O-4'

Upstream Link	Upstream Node
<Catchment to Outflow Node>	CM-E-6

Node Inflows

Inflow Type	Element	Volume (ac-ft)	Time to Peak (hours)	Flow (Peak) (ft^3/s)
Flow (From)	CM-E-6	0.004	0.700	0.09
Flow (In)	O-4	0.004	0.700	0.09

Index

Cross Section for Roadside Ditch Capacity

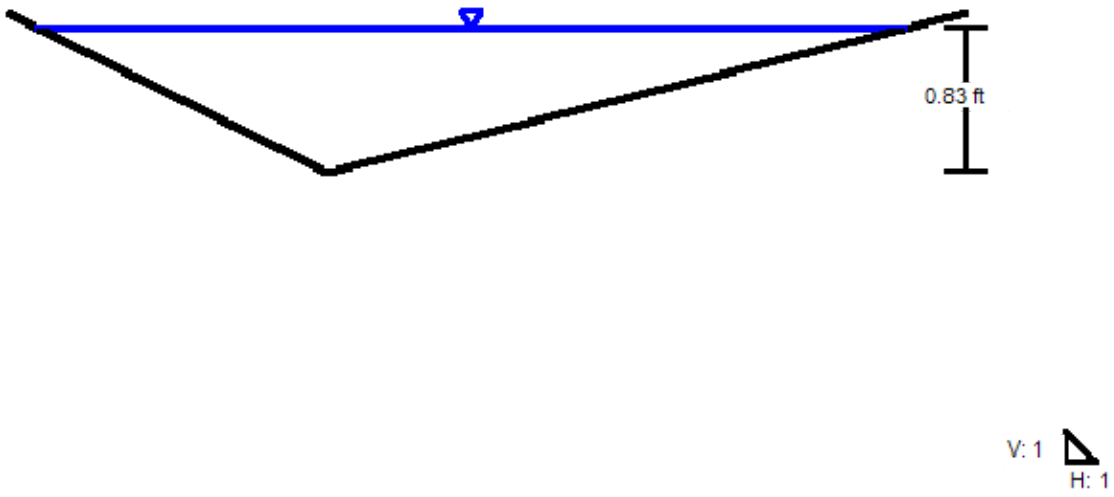
Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.030	
Channel Slope	0.01580	ft/ft
Normal Depth	0.83	ft
Left Side Slope	2.00	ft/ft (H:V)
Right Side Slope	4.00	ft/ft (H:V)
Discharge	6.90	ft³/s

Cross Section Image



Worksheet for Roadside Ditch Capacity

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.030	
Channel Slope	0.01580	ft/ft
Normal Depth	1.00	ft
Left Side Slope	2.00	ft/ft (H:V)
Right Side Slope	4.00	ft/ft (H:V)

Results

Discharge	11.32	ft^3/s
Flow Area	3.00	ft^2
Wetted Perimeter	6.36	ft
Hydraulic Radius	0.47	ft
Top Width	6.00	ft
Critical Depth	0.98	ft
Critical Slope	0.01800	ft/ft
Velocity	3.77	ft/s
Velocity Head	0.22	ft
Specific Energy	1.22	ft
Froude Number	0.94	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.00	ft
Critical Depth	0.98	ft
Channel Slope	0.01580	ft/ft
Critical Slope	0.01800	ft/ft

Culvert Calculator Report
CUL-E-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	8,620.21	ft	Headwater Depth/Height	0.57	
Computed Headwater Eleva	8,612.07	ft	Discharge	1.93	cfs
Inlet Control HW Elev.	8,611.94	ft	Tailwater Elevation	8,610.75	ft
Outlet Control HW Elev.	8,612.07	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	8,611.21	ft	Downstream Invert	8,610.75	ft
Length	41.10	ft	Constructed Slope	0.000000	ft/ft

Hydraulic Profile					
Profile	H2		Depth, Downstream	0.52	ft
Slope Type	Horizontal		Normal Depth	N/A	ft
Flow Regime	Subcritical		Critical Depth	0.52	ft
Velocity Downstream	3.51	ft/s	Critical Slope	0.004936	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	1.50	ft
Section Size	18 inch		Rise	1.50	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	8,612.07	ft	Upstream Velocity Head	0.07	ft
Ke	0.50		Entrance Loss	0.04	ft

Inlet Control Properties					
Inlet Control HW Elev.	8,611.94	ft	Flow Control	Unsubmerged	
Inlet Type	Square edge w/headwall		Area Full	1.8	ft²
K	0.00980		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				

Culvert Calculator Report
CUL-E-2

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	8,489.57	ft	Headwater Depth/Height	0.33	
Computed Headwater Elev	8,486.06	ft	Discharge	0.75	cfs
Inlet Control HW Elev.	8,485.99	ft	Tailwater Elevation	8,484.96	ft
Outlet Control HW Elev.	8,486.06	ft	Control Type	Entrance Control	

Grades					
Upstream Invert	8,485.57	ft	Downstream Invert	8,484.96	ft
Length	30.30	ft	Constructed Slope	0.0201	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	0.23	ft
Slope Type	Steep		Normal Depth	0.23	ft
Flow Regime	Supercritical		Critical Depth	0.32	ft
Velocity Downstream	4.40	ft/s	Critical Slope	0.0050	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	1.50	ft
Section Size	18 inch		Rise	1.50	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	8,486.06	ft	Upstream Velocity Head	0.11	ft
Ke	0.50		Entrance Loss	0.06	ft

Inlet Control Properties					
Inlet Control HW Elev.	8,485.99	ft	Flow Control	Unsubmerged	
Inlet Type	Square edge w/headwall		Area Full	1.8	ft²
K	0.00980		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				

Culvert Calculator Report
CUL-E-3

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	8,468.17	ft	Headwater Depth/Height	0.94	
Computed Headwater Elev	8,466.58	ft	Discharge	5.11	cfs
Inlet Control HW Elev.	8,466.38	ft	Tailwater Elevation	8,460.31	ft
Outlet Control HW Elev.	8,466.58	ft	Control Type	Entrance Control	

Grades					
Upstream Invert	8,465.17	ft	Downstream Invert	8,460.31	ft
Length	36.20	ft	Constructed Slope	0.1343	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	0.38	ft
Slope Type	Steep		Normal Depth	0.37	ft
Flow Regime	Supercritical		Critical Depth	0.87	ft
Velocity Downstream	14.36	ft/s	Critical Slope	0.0058	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	1.50	ft
Section Size	18 inch		Rise	1.50	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	8,466.58	ft	Upstream Velocity Head	0.36	ft
Ke	0.50		Entrance Loss	0.18	ft

Inlet Control Properties					
Inlet Control HW Elev.	8,466.38	ft	Flow Control	Unsubmerged	
Inlet Type	Square edge w/headwall		Area Full	1.8	ft²
K	0.00980		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				

Culvert Calculator Report
CUL-E-4

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	8,343.87	ft	Headwater Depth/Height	0.11	
Computed Headwater Elev	8,341.04	ft	Discharge	0.09	cfs
Inlet Control HW Elev.	8,340.96	ft	Tailwater Elevation	8,338.73	ft
Outlet Control HW Elev.	8,341.04	ft	Control Type	Entrance Control	

Grades					
Upstream Invert	8,340.87	ft	Downstream Invert	8,338.73	ft
Length	30.64	ft	Constructed Slope	0.0698	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	0.06	ft
Slope Type	Steep		Normal Depth	0.06	ft
Flow Regime	Supercritical		Critical Depth	0.11	ft
Velocity Downstream	3.58	ft/s	Critical Slope	0.0063	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	1.50	ft
Section Size	18 inch		Rise	1.50	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	8,341.04	ft	Upstream Velocity Head	0.04	ft
Ke	0.50		Entrance Loss	0.02	ft

Inlet Control Properties					
Inlet Control HW Elev.	8,340.96	ft	Flow Control	Unsubmerged	
Inlet Type	Square edge w/headwall		Area Full	1.8	ft²
K	0.00980		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				

Culvert Calculator Report
CUL-E-5

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	8,270.79	ft	Headwater Depth/Height	1.14	
Computed Headwater Elev	8,269.50	ft	Discharge	6.95	cfs
Inlet Control HW Elev.	8,269.39	ft	Tailwater Elevation	8,266.46	ft
Outlet Control HW Elev.	8,269.50	ft	Control Type	Entrance Control	

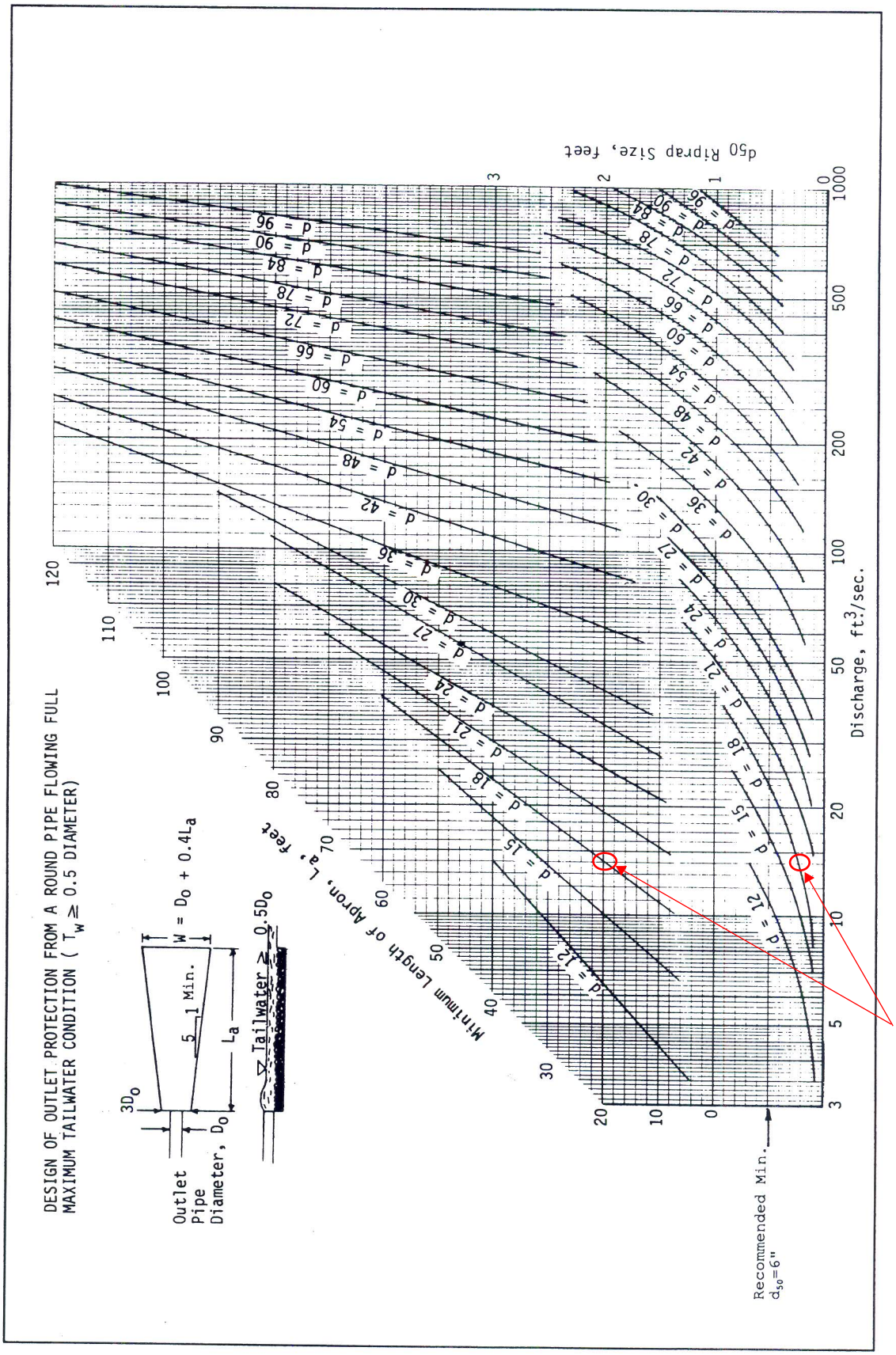
Grades					
Upstream Invert	8,267.79	ft	Downstream Invert	8,266.46	ft
Length	67.50	ft	Constructed Slope	0.0367	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	0.61	ft
Slope Type	Steep		Normal Depth	0.61	ft
Flow Regime	Supercritical		Critical Depth	1.02	ft
Velocity Downstream	10.20	ft/s	Critical Slope	0.0067	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	1.50	ft
Section Size	18 inch		Rise	1.50	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	8,269.50	ft	Upstream Velocity Head	0.46	ft
Ke	0.50		Entrance Loss	0.23	ft

Inlet Control Properties					
Inlet Control HW Elev.	8,269.39	ft	Flow Control	Unsubmerged	
Inlet Type	Square edge w/headwall		Area Full	1.8	ft²
K	0.00980		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				



Based on the above figure. The riprap aprons for the culverts under Summit Pass will have, as a minimum, D50=6", an apron that is 7.5' (wide) x 20' (long). The apron will be 18" thick.

Source: USDA-SCS

Plate 3.18-4