Newmont
NORTH AMERICA

CRIPPLE CREEK & VICTOR
PO Box 191
100 N. 3rd Street
Victor CO 80860

newmont.com

July 12, 2023

ELECTRONIC DELIVERY

Mr. Elliott Russell
Environmental Protection Specialist
Colorado Department of Natural Resources
Division of Reclamation, Mining and Safety
Office of Mined Land Reclamation
1313 Sherman Street, Room 215
Denver, Colorado 80203

Re: Permit No. M-1980-244; Cripple Creek & Victor Gold Mining Company; Cresson Project; Technical Revision 137 – Second Adequacy Review Response

Dear Mr. Russell:

On July 10, 2023, Newmont Corporation's Cripple Creek and Victor Gold Mining Company (CC&V) received the Division of Reclamation, Mining and Safety (DRMS) second adequacy review of Technical Revision (TR) 137 to Permit M-1980-244, regarding the WHEX Clay Borrow Source. Below are DRMS comments in bold and CC&V's response in *italics*.

4. **Flow Path and Lag Time: The response was not adequate. A quick review of the lag time calculations shows the three down chute analyses have acceptable lag times between 11 and 16 minutes. Yet the single watershed WHEX Pond lag time is nearly 57 minutes for very little extra travel distance. An investigation of the WHEX Pond lag time calculation revealed 2.5 miles of total travel time distance. Referencing Figure 2, the total runoff travel distance is on the order of 3,200 feet. Please correct this error and resubmit.**

   The WHEX Pond hydrology calculations in our previous submittal double-counted the flow lengths and overestimated the estimated watershed lag time. Revised lag time calculations and HEC-HMS results are attached. The revised flow lengths correctly distinguish between the overland sheet flow length (calculated), the concentrated shallow flow along the hillside, and the channel flows (a) along the roadside, (b) within the rock chute, and (c) in the rock chute outlet. The total flow length is 3,250 feet and the calculated watershed lag time is 15.44 minutes. This value is in alignment with the lag times calculated for the down chute analyses, with variation due to the watershed lengths and slopes.

   The HEC-HMS model for the WHEX pond was updated with the revised lag time, resulting in a greater peak flow. The total volume of runoff reporting to the WHEX pond is unchanged. Separate hydrologic and hydraulic calculations were used to size the three rock chutes and the recommended channel design has not been amended.

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Should you require further information, please do not hesitate to contact Johnna Gonzalez at (719)851-4190, Johnna.Gonzalez@Newmont.com, or myself at (719) 237-3442 or Katie.Blake@newmont.com.

Sincerely,

DocuSigned by:
Katie Blake
5A3D013B629844B...

Katie Blake
Sustainability & External Relations Manager
Cripple Creek & Victor Gold Mining Co

EC:

M. Cunningham – DRMS
T. Cazier – DRMS
N. Gagnon - DRMS
D. Swallow – Teller County
J. Gonzalez – CC&V
K. Blake – CC&V
N. Townley – CC&V

Attachments: Pond Sizing Calculations

File: S:\CrippleCreek\na.cc.admin\Environmental\New File Structure\2-Correspondence\DNR\DRMS\2023\July\Outgoing

NewFields	CALCULATION COVER SHEET		
Client	Cripple Creek & Victor Gold Mining Company	Preparer:	Roxanne Li	06/18/23
Project	VLF2 Phase 3	Checked:	Jay Moore	06/19/23
Title	Pond Sizing Calculations	Revision	C	

CALCULATION OBJECTIVE

1. Estimate the peak runoff from upstream watersheds to design the sediment pond.

2. Determine the required size of the diversion channels and erosion protection (if necessary)

ASSUMPTIONS

1. Composite SCS Curve numbers are calculated based on ground type.
2. Storm events will be sized according to previous meteorological studies.

2-Year, 24-hour:	1.77	inches
25-Year, 24-hour:	3.21	inches
100-Year, 24-hour:	4.39	inches
500-Year, 24-hour:	6.10	inches

METHODOLOGY

1. Area and length measurements were determined using AutoCAD Civil 3D.
2. Lag time was calculated using the velocity method.
3. HEC-HMS was used to model the storm events using the SCS Type II storm event.
4. Results from HEC-HMS were used in rock chute calculations to verify that they would function adequately.

REFERENCES

1. AutoCAD Civil 3D version 2022.
2. U.S. Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS). “Part 630 Hydrology National Engineering Handbook.” 210-vi, NEH, May 2010.
3. United States Army Corps of Engineers. Hydrologic Modeling System (HEC-HMS) Version 4.10, Computer Program (April 2023)

CONCLUSIONS

1. See attached tables for channel and culvert sizing.

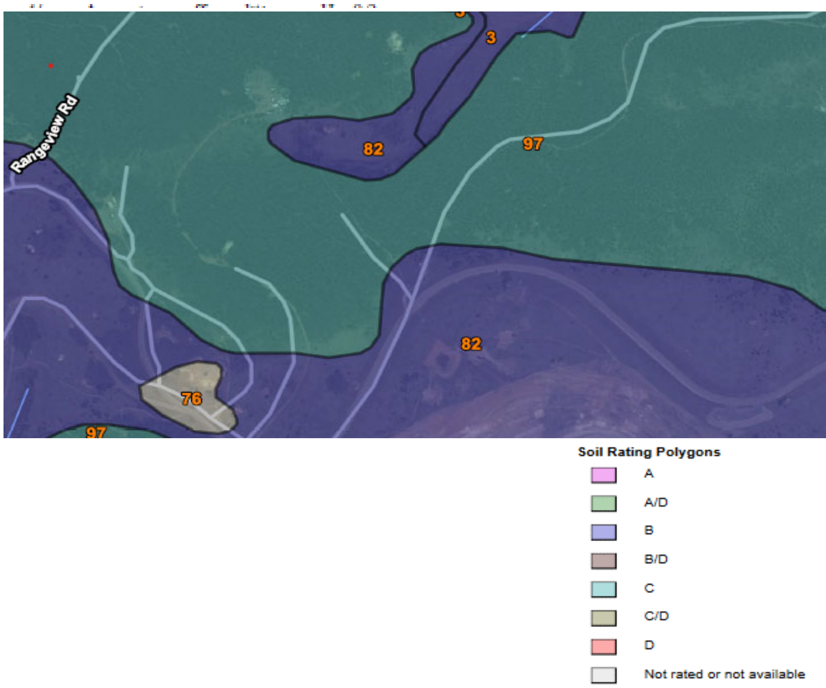
Filename:

P:\Projects\0106.056 VLF2 Phase 3a CQA\H-CALCULATIONS\WHEX Pit Pond\[Whex Pond hydrology.xlsx]Hec Calc Cover

Whex Pond Hydrology

Table 9–1 Runoff curve numbers for agricultural lands [1] — Continued

Cover description: cover type	treatment [2]	hydrologic condition [3]	CN for hydrologic soil group: A	B	C	D
Pasture, grassland, or range-continuous forage for grazing [4]		Poor	68	79	86	89
		Fair	49	69	79	84
		Good	39	61	74	80
Meadow-continuous grass, protected from grazing and generally mowed for hay		Good	30	58	71	78
Brush-brush-forbs-grass mixture with brush the major element [5]		Poor	48	67	77	83
		Fair	35	56	70	77
		Good	30 [6]	48	65	73
Woods-grass combination (orchard or tree farm) [7]		Poor	57	73	82	86
		Fair	43	65	76	82
		Good	32	58	72	79
Woods [8]		Poor	45	66	77	83
		Fair	36	60	73	79
		Good	30	55	70	77
Farmstead–buildings, lanes, driveways, and surrounding lots		---	59	74	82	86
Roads (including right-of-way):						
Dirt		---	72	82	87	89
Gravel		---	76	85	89	91



Group A soils have low runoff potential and high infiltration rates even when thoroughly wetted. They consist chiefly of deep, well to excessively drained sand or gravel and have a high rate of water transmission (greater than 0.30 in/hr).

Group B soils have moderate infiltration rates when thoroughly wetted and consist chiefly of moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission (0.15-0.30 in/hr).

Group C soils have low infiltration rates when thoroughly wetted and consist chiefly of soils with a layer that impedes downward movement of water and soils with moderately fine to fine texture. These soils have a low rate of water transmission (0.05-0.15 in/hr).

Group D soils have high runoff potential. They have very low infiltration rates when thoroughly wetted and consist chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface, and shallow soils over nearly impervious material. These soils have a very low rate of water transmission (0-0.05 in/hr).

In exhibit A-1, some of the listed soils have an added modifier; for example, "Abrazo, gravelly." This refers to a gravelly phase of the Abrazo series that is found in SCS soil map legends.

Table 2-2d Runoff curve numbers for arid and semiarid rangelands [1]

Cover description		Curve numbers for hydrologic soil group			
Cover type	Hydrologic condition [2]	A [3]	B	C	D
Herbaceous—mixture of grass, weeds, and low-growing brush, with brush the minor element.	Poor		80	87	93
	Fair		71	81	89
	Good		62	74	85
Oak-aspen—mountain brush mixture of oak brush, aspen, mountain mahogany, bitter brush, maple, and other brush.	Poor		66	74	79
	Fair		48	57	63
	Good		30	41	48
Pinyon-juniper—pinyon, juniper, or both; grass understory.	Poor		75	85	89
	Fair		58	73	80
	Good		41	61	71
Sagebrush with grass understory.	Poor		67	80	85
	Fair		51	63	70
	Good		35	47	55
Desert shrub—major plants include saltbush, greasewood, creosotebush, blackbrush, bursage, palo verde, mesquite, and cactus.	Poor	63	77	85	88
	Fair	55	72	81	86
	Good	49	68	79	84

1 Average runoff condition, and $I_a = 0.2S$. For range in humid regions, use table 2-2c.
2 Poor: <30% ground cover (litter, grass, and brush overstory).
Fair: 30 to 70% ground cover.
Good: > 70% ground cover.
3 Curve numbers for group A have been developed only for desert shrub.

Table 9–5 Runoff curve numbers for urban areas [1/]

Cover description cover type and hydrologic condition	Average percent impervious area [2/]	- - CN for hydrologic soil group - - A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.) [3/]					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) [4/]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation)		77	86	91	94

1/ Average runoff condition, and $I_a = 0.2S$.

2/ The average percent impervious area shown was used to develop the composite CNs. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition.

3/ CNs shown are equivalent to those of pasture. Composite CNs may be computed for other combinations of open space type.

4/ Composite CNs for natural desert landscaping should be computed using figures 9–3 or 9–4 based on the impervious area percentage (CN=98) and the pervious area CN. The pervious area CNs are assumed equivalent to desert shrub in poor hydrologic condition.

NewFields

Cripple Creek and Victor Gold Mining Company
Whex Pond Hydrology
Watershed Characteristics

Variables

y	Avg. Watershed Slope (%)
CN	Composite Curve Number
S	1000/CN-10 (in.)
Ia	Initial Abstraction (0.2*S)
inputs	

Watershed Characteristics

Watershed	Area (mi^2)	CN	y	S	Ia
Area 1	0.123	67	22.3%	4.94	0.99

Cripple Creek and Victor Gold Mining Company
WHEX Pond Hydrology
Lag Time Calculation
WHEX Pond

Sheet Flow

1. Calculate length of sheet flow:

$$\ell = \frac{100\sqrt{S}}{n}$$

where:

l	=	sheet flow length, ft
S	=	slope of land surface, ft/ft
n	=	Manning's roughness coefficient (Table 15-1)

S:	0.095	ft/ft
n:	0.15	
l:	**205**	ft

2. Calculate sheet flow travel time:

$$T_t = \frac{0.007(n\ell)^{0.8}}{(P_2)^{0.5} S^{0.4}}$$

where:

P_2	=	2-year, 24-hour rainfall, in
T_t	=	travel time, h

P_2:	1.77	in
T_t:	**0.21**	h

Table 15–1 Manning's roughness coefficients for sheet flow (flow depth generally ≤ 0.1 ft)

Surface description	n [1]
Smooth surface (concrete, asphalt, gravel, or bare soil)	0.011
Fallow (no residue)	0.05
Cultivated soils:	
Residue cover ≤ 20%	0.06
Residue cover > 20%	0.17
Grass:	
Short-grass prairie	0.15
Dense grasses [2]	0.24
Bermudagrass	0.41
Range (natural)	0.13
Woods: [3]	
Light underbrush	0.40
Dense underbrush	0.80

1 The Manning's n values are a composite of information compiled by Engman (1986).
2 Includes species such as weeping lovegrass, bluegrass, buffalo grass, blue grama grass, and native grass mixtures.
3 When selecting n, consider cover to a height of about 0.1 ft. This is the only part of the plant cover that will obstruct sheet flow.

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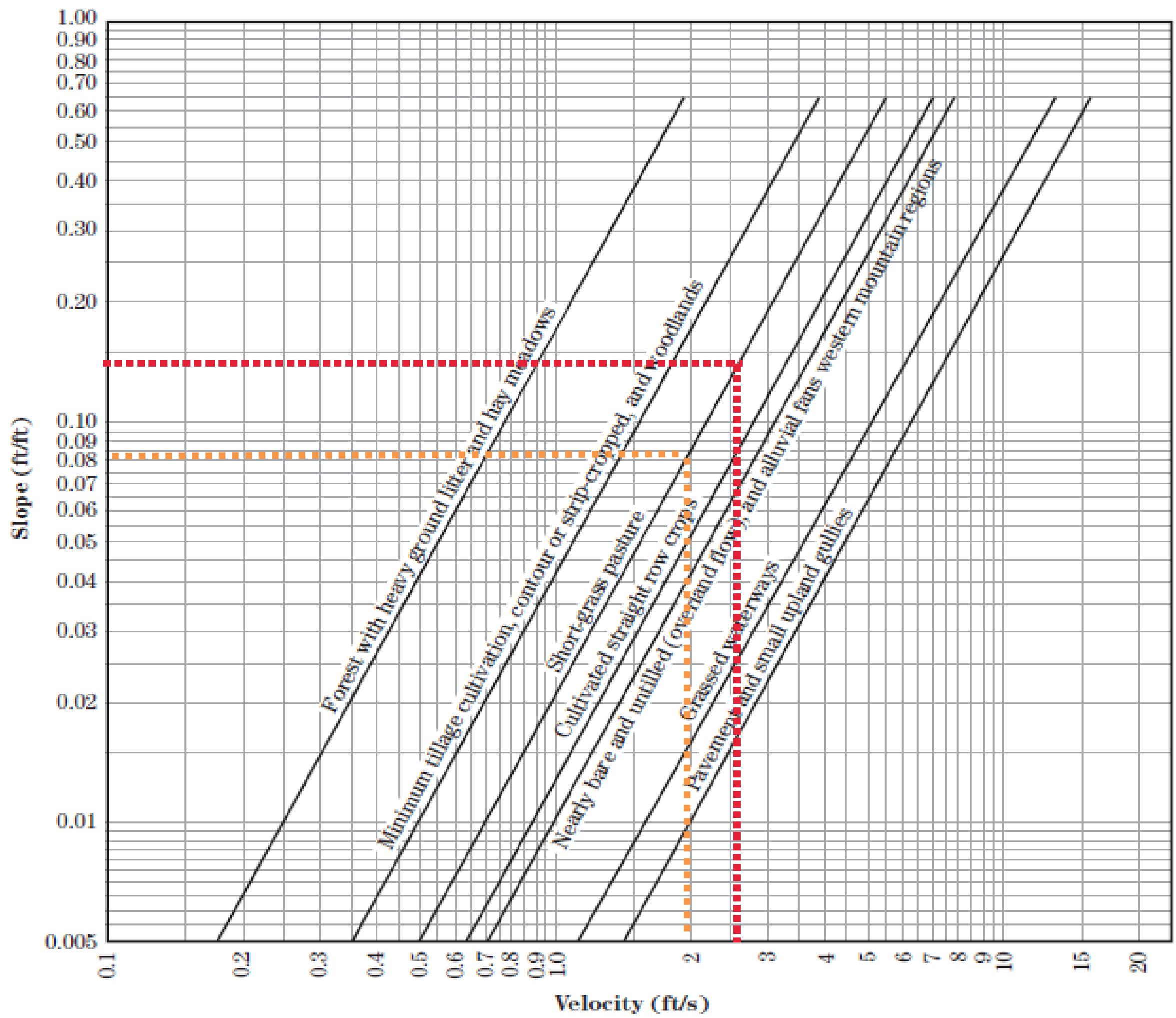
Shallow Concentrated Flow:

1. Estimate velocity from Figure 15-4

Figure 15–4 Velocity versus slope for shallow concentrated flow



1st Segment:
Velocity: **2.6** ft/s

2nd Segment:
Velocity: **1.9** ft/s

2. Calculate shallow concentrated flow travel time:

$$T_t = \frac{\ell}{3,600V}$$

1st Segment:

l:	151	ft
T_t:	**0.02**	h

2nd Segment:

l:	522.8	ft
T_t:	**0.08**	h

Open Channel Flow:

1. Calculate hydraulic radius:

$r = a/P_w$

where:

r	=	hydraulic radius, ft
a	=	cross sectional flow area, ft^2
P_w	=	wetted perimeter, ft

	1st Segment			2nd Segment			3rd Segment	
a:	60	ft^2	a:	43.2	ft^2	a:	43.2	ft^2
P_w	85	ft	P_w	48.9	ft	P_w	48.9	ft
r	**0.7**	ft	r	**0.9**	ft	r	**0.9**	ft

1. Calculate average flow velocity and travel time:

$$V = \frac{1.49 r^{\frac{2}{3}} s^{\frac{1}{2}}}{n}$$

where:

V	=	average velocity, ft/s
s	=	channel slope, ft/ft
n	=	Manning's n for open channel flow

	1st Segment			2nd Segment			3rd Segment	
s:	0.057	ft/ft	s:	0.322	ft/ft	s:	0.008	ft/ft
n:	0.05		n:	0.05		n:	0.05	
V:	5.6	ft/s	V:	15.6	ft/s	V:	2.5	ft/s

2. Calculate open channel flow travel time:

$$T_t = \frac{\ell}{3,600V}$$

	1st Segment			2nd Segment			3rd Segment	
l:	1,896	ft	l:	214	ft	l:	261	ft
T_t:	**0.09**	h	T_t:	**0.00**	h	T_t:	**0.03**	h

Time of Concentration:

$T_c = T_{t(sheet)} + T_{t(shallow)} + T_{t(channel)}$

T_c: 0.43 h

Lag Time:

$$L = 0.6T_c$$

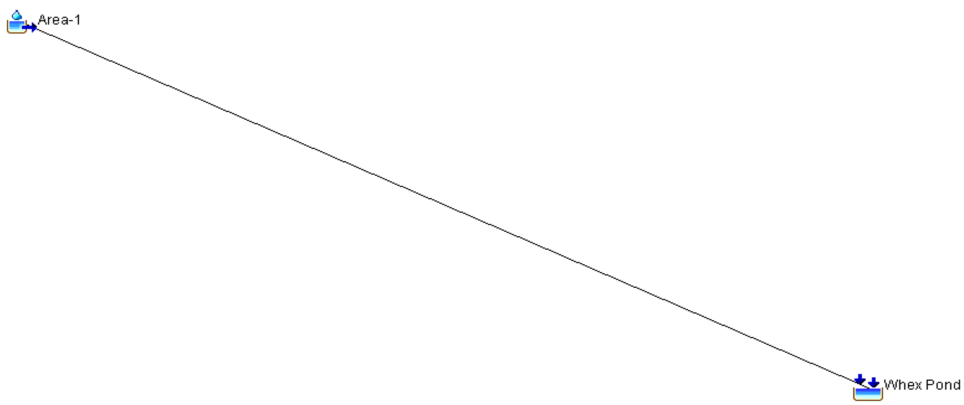
L:	0.26	h
	15.44	min

Cripple Creek & Victor Gold Mining Company
Whex Pond Sizing Calculations
Watershed Summary

500 Year-24 Hour Hec-HMS Results

Hydraulic Element	Drainage Area (Mi^2)	Peak Discharge (ft^3/s)	Volume (acre-ft)
Area-1	0.123	152.8	18.4
Whex Pond	0.123	152.8	18.4

Cripple Creek & Victor Gold Mining Company
Whex Pond Sizing Calculations
Hec-HMS Overall View



NewFields

Cripple Creek and Victor Gold Mining Company
Whex Pond Inlet Channel Hydrology
Watershed Characteristics

Variables	
y	Avg. Watershed Slope (%)
CN	Composite Curve Number
S	1000/CN-10 (in.)
Ia	Initial Abstraction (0.2*S)
inputs	

Watershed Characteristics					
Watershed	**Area (mi^2)**	**CN**	**y**	**S**	**Ia**
West WHEX Pond Channel	0.004	64	11.7%	5.72	1.14
East WHEX Pond Channel	0.011	76	23.7%	3.17	0.63
NW WHEX Pond Channel	0.059	75	16.0%	3.33	0.67

Cripple Creek and Victor Gold Mining Company
WHEX Pond Hydrology
Lag Time Calculation
West WHEX Pond Channel

Sheet Flow

1. Calculate length of sheet flow:

$$\ell = \frac{100\sqrt{S}}{n}$$

where:

l	=	sheet flow length, ft
S	=	slope of land surface, ft/ft
n	=	Manning's roughness coefficient (Table 15-1)

S:	0.018	ft/ft
n:	0.15	
l:	**89**	ft

2. Calculate sheet flow travel time:

$$T_t = \frac{0.007(n\ell)^{0.8}}{(P_2)^{0.5} S^{0.4}}$$

where:

P_2	=	2-year, 24-hour rainfall, in
T_t	=	travel time, h

P_2:	1.77	in
T_t:	**0.21**	h

Table 15–1 Manning's roughness coefficients for sheet flow (flow depth generally ≤ 0.1 ft)

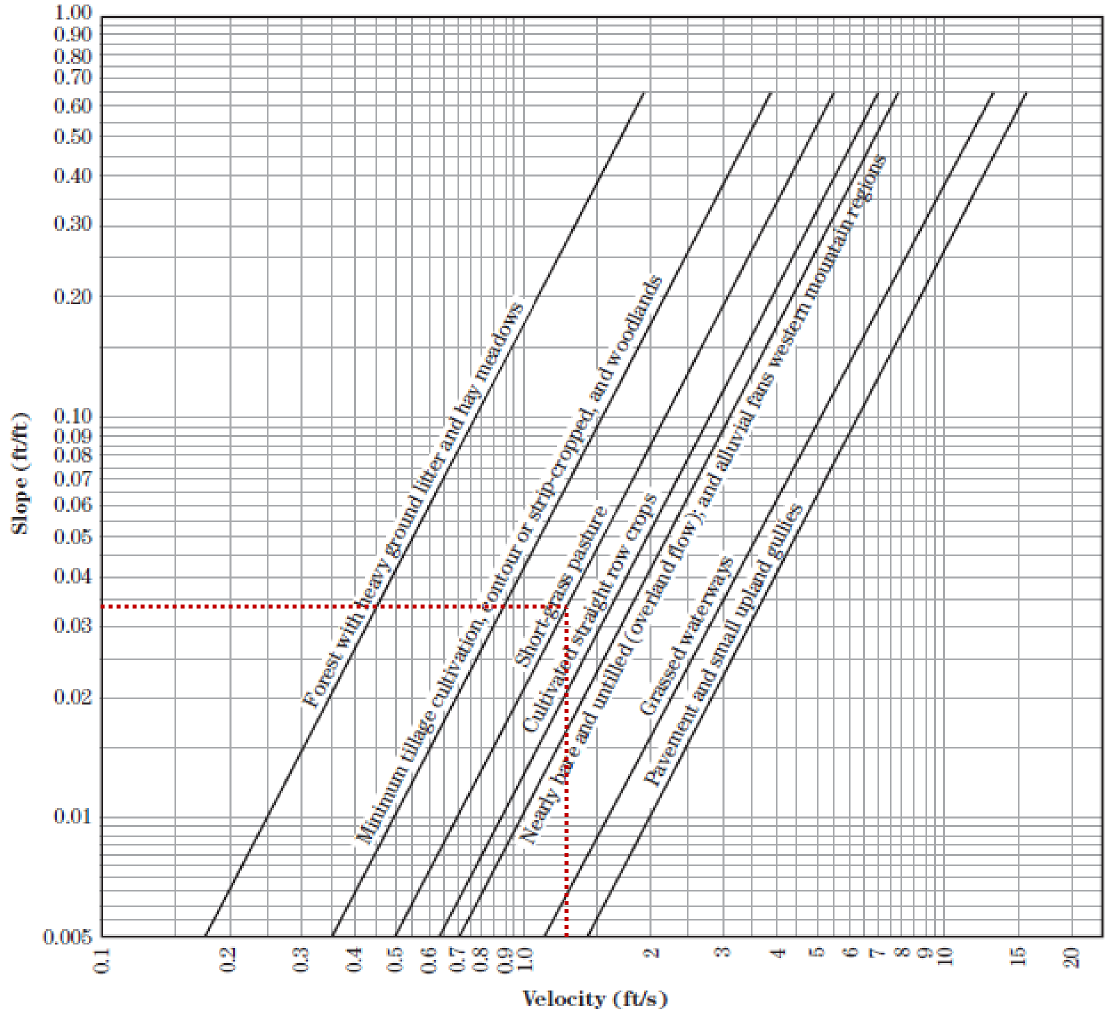
Surface description	n [1]
Smooth surface (concrete, asphalt, gravel, or bare soil)	0.011
Fallow (no residue)	0.05
Cultivated soils:	
Residue cover ≤ 20%	0.06
Residue cover > 20%	0.17
Grass:	
Short-grass prairie	0.15
Dense grasses [2]	0.24
Bermudagrass	0.41
Range (natural)	0.13
Woods: [3]	
Light underbrush	0.40
Dense underbrush	0.80

1 The Manning's *n* values are a composite of information compiled by Engman (1986).
2 Includes species such as weeping lovegrass, bluegrass, buffalo grass, blue grama grass, and native grass mixtures.
3 When selecting *n*, consider cover to a height of about 0.1 ft. This is the only part of the plant cover that will obstruct sheet flow.

Shallow Concentrated Flow:

1. Estimate velocity from Figure 15-4

Figure 15–4 Velocity versus slope for shallow concentrated flow



1st Segment:			2nd Segment:		
Velocity:	**1.3**	ft/s	Velocity:	**1.6**	ft/s

2. Calculate shallow concentrated flow travel time:

$$T_t = \frac{\ell}{3{,}600V}$$

1st Segment:			2nd Segment:		
l:	305	ft	l:	356	ft
T_t:	**0.07**	h	T_t:	**0.06**	h

Open Channel Flow:

1. Calculate hydraulic radius:

$r = a/P_w$

where:

r	=	hydraulic radius, ft
a	=	cross sectional flow area, ft^2
P_w	=	wetted perimeter, ft

	1st Segment			2nd Segment	
a:	32.4	ft^2	a:	3.1	ft^2
P_w	68	ft	P_w	6.3	ft
r	**0.5**	ft	r	**0.5**	ft

1. Calculate average flow velocity and travel time:

$$V = \frac{1.49 r^{\frac{2}{3}} s^{\frac{1}{2}}}{n}$$

where:

V	=	average velocity, ft/s
s	=	channel slope, ft/ft
n	=	Manning's n for open channel flow

	1st Segment			2nd Segment	
s:	0.034	ft/ft	s:	0.03	ft/ft
n:	0.03		n:	0.024	
V:	5.6	ft/s	V:	6.8	ft/s

2. Calculate open channel flow travel time:

$$T_t = \frac{\ell}{3,600V}$$

	1st Segment			2nd Segment	
l:	315	ft	l:	91	ft
T_t:	**0.02**	h	T_t:	**0.004**	h

Time of Concentration:

$T_c = T_{t(sheet)} + T_{t(shallow)} + T_{t(channel)}$

T_c: 0.36 h

Lag Time:

$$L = 0.6T_c$$

L:	0.21	h
	12.81	min

Cripple Creek and Victor Gold Mining Company
WHEX Pond Hydrology
Lag Time Calculation
East WHEX Pond Channel

Sheet Flow

1. Calculate length of sheet flow:

$$\ell = \frac{100\sqrt{S}}{n}$$

where:

l	=	sheet flow length, ft
S	=	slope of land surface, ft/ft
n	=	Manning's roughness coefficient (Table 15-1)

S:	0.042	ft/ft
n:	0.15	
l:	**137**	ft

Table 15–1 Manning's roughness coefficients for sheet flow (flow depth generally ≤ 0.1 ft)

Surface description	n [1]
Smooth surface (concrete, asphalt, gravel, or bare soil)	0.011
Fallow (no residue)	0.05
Cultivated soils:	
Residue cover ≤ 20%	0.06
Residue cover > 20%	0.17
Grass:	
Short-grass prairie	0.15
Dense grasses [2]	0.24
Bermudagrass	0.41
Range (natural)	0.13
Woods: [3]	
Light underbrush	0.40
Dense underbrush	0.80

1 The Manning's n values are a composite of information compiled by Engman (1986).
2 Includes species such as weeping lovegrass, bluegrass, buffalo grass, blue grama grass, and native grass mixtures.
3 When selecting n, consider cover to a height of about 0.1 ft. This is the only part of the plant cover that will obstruct sheet flow.

2. Calculate sheet flow travel time:

$$T_t = \frac{0.007(n\ell)^{0.8}}{(P_2)^{0.5}S^{0.4}}$$

where:

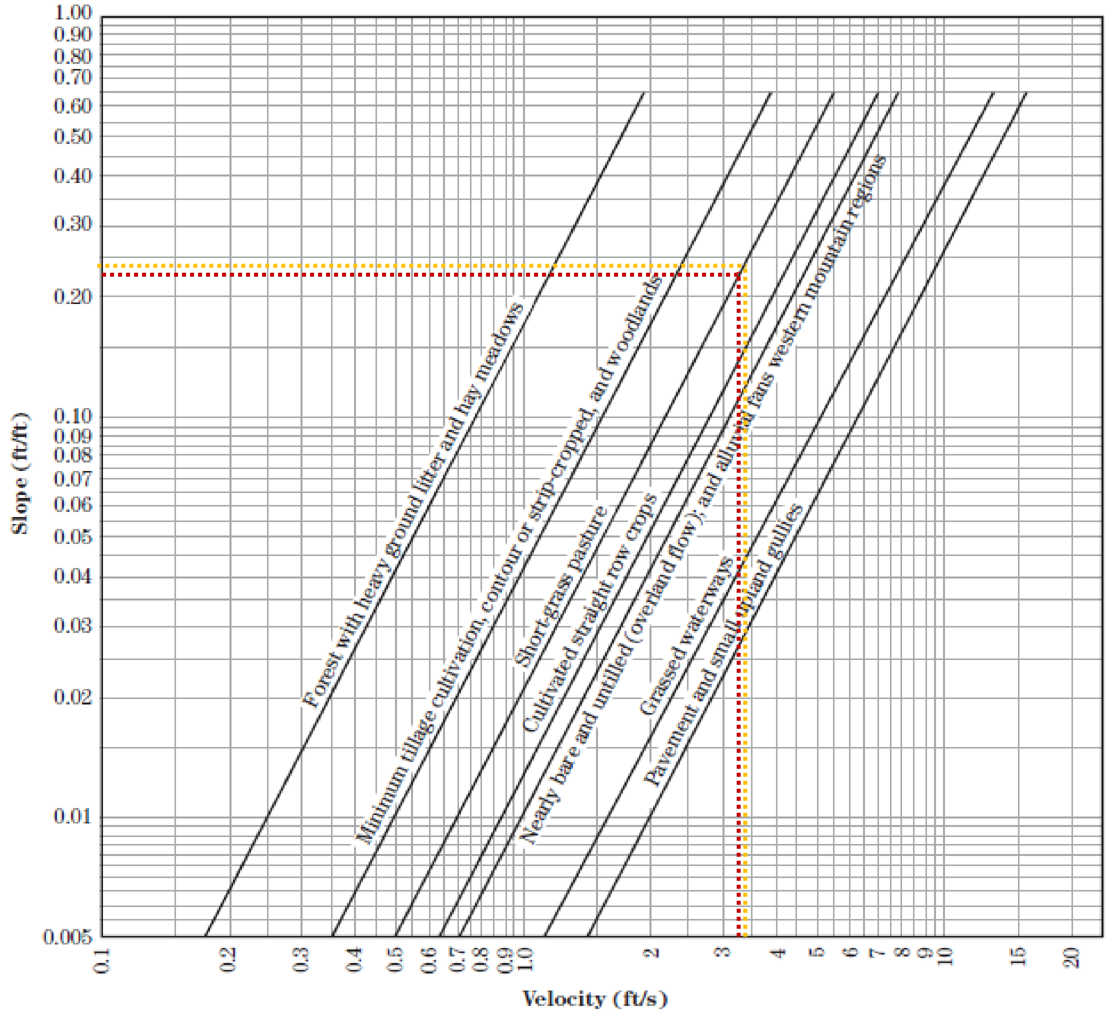
P_2	=	2-year, 24-hour rainfall, in
T_t	=	travel time, h

P_2:	1.77	in
T_t:	**0.21**	h

<u>Shallow Concentrated Flow:</u>

1. Estimate velocity from Figure 15-4

Figure 15–4 Velocity versus slope for shallow concentrated flow



<u>1st Segment</u>			<u>2nd Segment</u>		
Velocity:	**3.2**	ft/s	Velocity:	**3.3**	ft/s

2. Calculate shallow concentrated flow travel time:

$$T_t = \frac{\ell}{3,600V}$$

<u>1st Segment</u>			<u>1st Segment</u>		
l:	560	ft	l:	117	ft
T_t:	**0.05**	h	T_t:	**0.01**	h

Open Channel Flow:

1. Calculate hydraulic radius:

$r = a/P_w$

where:

r	=	hydraulic radius, ft
a	=	cross sectional flow area, ft^2
P_w	=	wetted perimeter, ft

	1st Segment			2nd Segment	
a:	3.9	ft^2	a:	3.1	ft^2
P_w	11.27	ft	P_w	6.3	ft
r	**0.3**	ft	r	**0.5**	ft

1. Calculate average flow velocity and travel time:

$$V = \frac{1.49 r^{\frac{2}{3}} s^{\frac{1}{2}}}{n}$$

where:

V	=	average velocity, ft/s
s	=	channel slope, ft/ft
n	=	Manning's n for open channel flow

	1st Segment			2nd Segment	
s:	0.03	ft/ft	s:	0.024	ft/ft
n:	0.05		n:	0.024	
V:	2.5	ft/s	V:	6.1	ft/s

2. Calculate open channel flow travel time:

$$T_t = \frac{\ell}{3{,}600V}$$

	1st Segment			2nd Segment	
l:	354	ft	l:	51	ft
T_t:	**0.04**	h	T_t:	**0.002**	h

Time of Concentration:

$T_c = T_{t(sheet)} + T_{t(shallow)} + T_{t(channel)}$

T_c: 0.31 h

Lag Time:

$$L = 0.6T_c$$

L:	0.19	h
	11.12	min

Cripple Creek and Victor Gold Mining Company
WHEX Pond Hydrology
Lag Time Calculation
Northwest WHEX Pond Channel

Sheet Flow

1. Calculate length of sheet flow:

$$\ell = \frac{100\sqrt{S}}{n}$$

where:

l	=	sheet flow length, ft
S	=	slope of land surface, ft/ft
n	=	Manning's roughness coefficient (Table 15-1)

S:	0.095	ft/ft
n:	0.15	
l:	**205**	ft

Table 15–1 Manning's roughness coefficients for sheet flow (flow depth generally ≤ 0.1 ft)

Surface description	n [1]
Smooth surface (concrete, asphalt, gravel, or bare soil)	0.011
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Bermudagrass	0.41
Range (natural)	0.13
Woods: [3]	
Light underbrush	0.40
Dense underbrush	0.80

1 The Manning's *n* values are a composite of information compiled by Engman (1986).
2 Includes species such as weeping lovegrass, bluegrass, buffalo grass, blue grama grass, and native grass mixtures.
3 When selecting *n*, consider cover to a height of about 0.1 ft. This is the only part of the plant cover that will obstruct sheet flow.

2. Calculate sheet flow travel time:

$$T_t = \frac{0.007(n\ell)^{0.8}}{(P_2)^{0.5} S^{0.4}}$$

where:

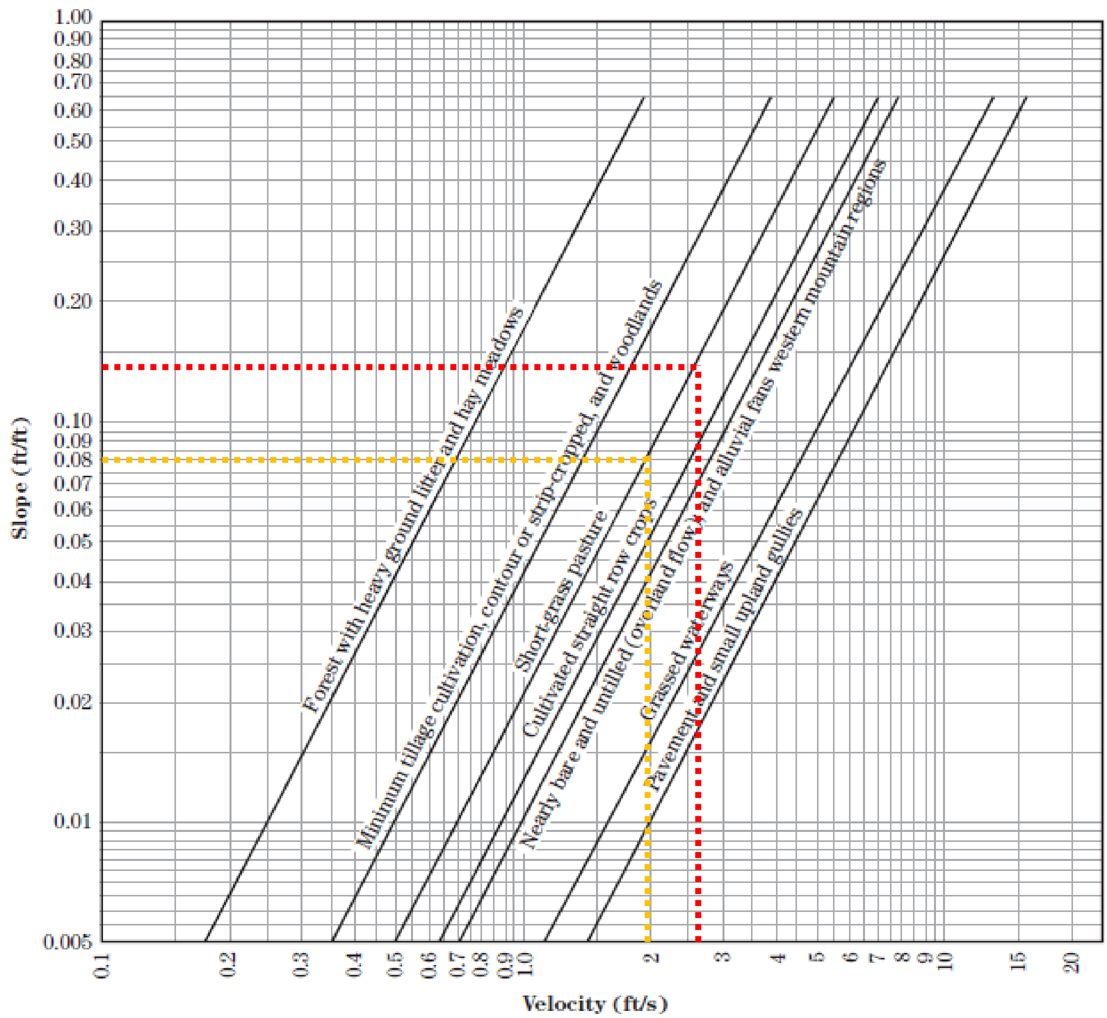
P_2	=	2-year, 24-hour rainfall, in
T_t	=	travel time, h

P_2:	1.77	in
T_t:	**0.21**	h

Shallow Concentrated Flow:

1. Estimate velocity from Figure 15-4

Figure 15–4 Velocity versus slope for shallow concentrated flow



1st Segment:			2nd Segment:		
Velocity:	**2.6**	ft/s	Velocity:	**1.9**	ft/s
	1.9				

2. Calculate shallow concentrated flow travel time:

$$T_t = \frac{\ell}{3{,}600V}$$

1st Segment:			2nd Segment:		
l:	760	ft	l:	685	ft
T_t:	**0.08**	h	T_t:	**0.10**	h

Open Channel Flow:

1. Calculate hydraulic radius:

$r = a/P_w$

where:

r	=	hydraulic radius, ft
a	=	cross sectional flow area, ft^2
P_w	=	wetted perimeter, ft

	1st Segment			2nd Segment			3rd Segment	
a:	3.1	ft^2	a:	24.3	ft^2	a:	3.1	ft^2
P_w	6.3	ft	P_w	53.1	ft	P_w	6.3	ft
r	**0.5**	ft	r	**0.5**	ft	r	**0.5**	ft

1. Calculate average flow velocity and travel time:

$$V = \frac{1.49 r^{\frac{2}{3}} s^{\frac{1}{2}}}{n}$$

where:

V	=	average velocity, ft/s
s	=	channel slope, ft/ft
n	=	Manning's n for open channel flow

	1st Segment			2nd Segment			3rd Segment	
s:	0.036	ft/ft	s:	0.035	ft/ft	s:	0.033	ft/ft
n:	0.024		n:	0.03		n:	0.024	
V:	7.4	ft/s	V:	5.5	ft/s	V:	7.1	ft/s

2. Calculate open channel flow travel time:

$$T_t = \frac{\ell}{3{,}600V}$$

	1st Segment			2nd Segment			3rd Segment	
l:	42	ft	l:	1,236	ft	l:	54	ft
T_t:	**0.002**	h	T_t:	**0.06**	h	T_t:	**0.002**	h

Time of Concentration:

$T_c = T_{t(sheet)} + T_{t(shallow)} + T_{t(channel)}$

T_c: 0.46 h

Lag Time:

$$L = 0.6T_c$$

L:	0.27	h
	16.44	min

NewFields

Cripple Creek & Victor Gold Mining Company
Whex Channel Sizing Calculations
Watershed Summary

25 Year-24 Hour Hec-HMS Results

Hydraulic Element	Drainage Area (Mi^2)	Peak Discharge (ft^3/s)	Volume (acre-ft)
East Channel	0.011	10.7	0.8
Northwest Channel	0.059	38.2	4.1
West Channel	0.004	1.6	0.2

100 Year-24 Hour Hec-HMS Results

Hydraulic Element	Drainage Area (Mi^2)	Peak Discharge (ft^3/s)	Volume (acre-ft)
East Channel	0.011	18.3	1.4
Northwest Channel	0.059	66.9	6.9
West Channel	0.004	3.5	0.3

500 Year-24 Hour Hec-HMS Results

Hydraulic Element	Drainage Area (Mi^2)	Peak Discharge (ft^3/s)	Volume (acre-ft)
East Channel	0.011	30.0	2.2
Northwest Channel	0.059	112.7	11.4
West Channel	0.004	6.9	0.6

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Whex Channel Sizing Calculations
Hec-HMS Overall View