FINAL DRAINAGE REPORT FOR
LOT 1 POWERS POINTE FILING NO 1
5835 OMAHA BOULEVARD
COLORADO SPRINGS, COLORADO

JULY 2020

Prepared For:

A STORAGE PLACE - COLORADO SPRINGS LLC
5835 OMAHA BOULEVARD
COLORADO SPRINGS, CO 80915
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Prepared By:

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Job No. 1745.00
County File No. PPR1929

FINAL DRAINAGE REPORT FOR
LOT 1 POWERS POINTE FILING NO 1
5835 OMAHA BOULEVARD
COLORADO SPRINGS, COLORADO

TABLE OF CONTENTS

REQUIRED MAPS AND DRAWINGS

CERTIFICATION STATEMENT:

Engineers Statement

This 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 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.

L Ducett, P.E. 32339   9/14/2020   Seal

Developers Statements

I, A STORAGE PLACE - COLORADO SPRINGS LLC, the developer have read and will comply with all of the requirements specified in this drainage report and plan.

A STORAGE PLACE - COLORADO SPRINGS LLC
Business Name

By:
Title: Manager
Address: PO Box 9443
Rancho Santa Fe, CA 92067

El Paso County Approval:

Filed in accordance with the requirements of the Drainage Criteria Manual, Volumes 1 & 2, El Paso County Engineering Criteria Manual and Land Development Code as amended.

Jennifer Ervine, P.E.   Date
County Engineer / ECM Administrator

Conditions:

FINAL DRAINAGE REPORT FOR
LOT 1 POWERS POINTE FILING NO 1
5835 OMAHA BOULEVARD
COLORADO SPRINGS, COLORADO

PURPOSE

The purpose of this Final Drainage Report is to compare the existing drainage patterns and runoff quantities with those resulting from the proposed improvements to the A Storage Place property and to determine the impact of the site development on downstream and adjacent properties. This site has previously been studied in:

Preliminary/Final Drainage Report for Powers Pointe, Filing No. 1, Nolte and Associates (1996)

GENERAL DESCRIPTION

This Final Drainage Report is an analysis of approximately 5.15 acres for the site located at 5835 Omaha Boulevard, previously platted as Lot 1 Powers Pointe Filing No 1. The property is currently used as a residential and commercial self-storage facility and the proposed improvements are in conformance with its existing use.

The property is located in the northwest quarter of Section 7, Township 14 South, Range 65 West of the 6th Principal Meridian in the El Paso County, Colorado, near the intersection of Omaha and N Powers Boulevards. More specifically, the site is bounded on the north by Omaha Boulevard, on the south by vacant unplatted land, to the east by All Foster Lumber Sub and Lots 4-5 Blk 2 O K Sub, to the west by Lots 1-2 Powers Pointe Filing No 2, Powers Pointe Filing No 3, Lot 1 Powers Pointe Filing No 4, and Lots 1-3 Powers Pointe Filing No 5.

The site lies within the Sand Creek Drainage Basin and is subject to the Sand Creek DBPS. For the reach of Sand Creek to which this site contributes, no regional detention facilities were proposed since the substantially developed nature of the area did not provide any suitable locations.

The soil consists exclusively of Blendon Sandy Loam (10), designated as belonging to Hydrologic Soil Group B. The study area is primarily metal buildings with asphalt and concrete lot areas. The existing topography has a consistent 2% slope from the north to the south.

HISTORIC DRAINAGE CONDITIONS

This site was previously analyzed in the *Preliminary/Final Drainage Report for Powers Pointe, Filing No. 1, Nolte and Associates (1996).*

The 5.15 acre site is 1191 feet long by 189 feet wide with the long axis oriented north-south. The northern three-quarters of the site has three rows of storage buildings with concrete driving lanes on all sides. On the southern quarter sits a single row of storage buildings with asphalt lots on either side for the outdoor storage of vehicles. The property is accessed from the north via Omaha Boulevard. Ainsworth Street, which runs along the north and west side of the property has curb and gutter which prevents offsite runoff from entering the site from those directions, while on the east side the grading is such that the property line forms the drainage boundary on that side; therefore, no offsite runoff affects this property. However, a portion of the commercial properties west of Ainsworth Street is part of the offsite basin analyzed.

The runoff generated onsite is mostly directed southward between the rows of storage buildings via swales and flows onto the undeveloped area at the south end of the property, sheet flowing south and west into the public drainage way along Powers Boulevard and eventually into Sand Creek. There is also a section on the west side of the property that drains westward to the adjacent street. The property is composed of three drainage basins.

Basin EX-A contributes to Design Point X-1 and has an area of 1.64 acres consisting of roofs, concrete, and gravel, generating runoff amounts of Q5= 5.8 cfs and Q100= 10.9 cfs.

Basin EX-B contributes to Design Point X-2 and has an area of 2.75 acres consisting of roofs, concrete, and gravel, generating runoff amounts of Q5= 9.0 cfs and Q100= 17.2 cfs.

Basin EX-C contributes to Design Point X-4 and has an area of 0.75 acres consisting of roofs, concrete, and gravel, generating runoff amounts of Q5= 3.3 cfs and Q100= 6.4 cfs.

The *Preliminary/Final Drainage Report for Powers Pointe, Filing No. 1, Nolte and Associates (1996)* indicates that flow from Basin OS-1 was intended to be conveyed from the south end of Ainsworth Street westward to the public drainage way along Powers Boulevard via a curb and gutter channel. Field observations indicate that the curb and gutter channel was never constructed, thus the runoff from Basin OS-1 flows onto the undeveloped property at the south end of Ainsworth Street.

Basin OS-1 contributes to Design Point X-3 and has an area of 1.90 acres consisting of asphalt pavement and commercial areas, generating runoff amounts of Q5= 6.9 cfs and Q100= 13.0 cfs.

DEVELOPED DRAINAGE CONDITIONS

The proposed changes include the construction of two additional storage buildings on the asphalt area at the southern end of the site along with the replacement of some of the existing adjacent asphalt and gravel with concrete. The combined area of disturbance is 0.98 acre. The imperviousness of the site remains essentially the same, with a slight increase due to less gravel area and greater roof/pavement area. The previously approved drainage report used land use coefficient (C) values of 0.80 or 0.90 for the developed portions of the site, which roughly corresponds to percent imperviousness of 95%-100%. The percent impervious for the proposed condition is approximately 98%.

The drainage patterns for the site will remain largely the same, with runoff continuing to flow into swales onsite and then flowing south and offsite onto the undeveloped area at the south end of the property. The proposed development will add an additional section of concrete swale, and riprap areas at the outfall of the onsite swales. The existing flow leaving the site to the south is Q5= 14.8

cfs and Q100= 28.1 cfs, and the proposed flow leaving the site to the south is Q5= 16.1 cfs and Q100= 30.1 cfs. Per the previously approved drainage report for the site (Preliminary/Final Drainage Report for Powers Pointe, Filing No. 1, Nolte and Associates (1996)), the flow leaving the site was Q5= 17.8 cfs and Q100= 30.7 cfs (summation of Basins 1 2, 3, 5, and 6 flows).

The flow values in the previously approved drainage report and this report are different for the same areas due to different land use coefficients being used in the two report. The existing conditions in this report do not match the proposed conditions in the old report (some values are higher, while other are lower).

Basin PR-A contributes to Design Point 1 and has an area of 1.55 acres consisting of roof/pavement and gravel, generating runoff amounts of Q5= 5.9 cfs and Q100= 11.0 cfs.

Basin PR-B contributes to Design Point 2 and has an area of 1.62 acres consisting of roof/pavement and gravel, generating runoff amounts of Q5= 6.1 cfs and Q100= 11.4 cfs.

Basin PR-C contributes to Design Point 3 and has an area of 1.14 acres consisting of roof/pavement and gravel, generating runoff amounts of Q5= 4.1 cfs and Q100= 7.7 cfs.

Basin PR-D contributes to Design Point 4 and has an area of 0.09 acres consisting of roof/pavement and gravel, generating runoff amounts of Q5= 0.3 cfs and Q100= 0.7 cfs.

Basin OS-1 contributes to Design Point X-3 and has an area of 1.90 acres consisting of asphalt pavement and commercial areas, generating runoff amounts of Q5= 6.9 cfs and Q100= 13.0 cfs.

Basin EX-C contributes to Design Point X-4 and has an area of 0.75 acres consisting of roofs, concrete, and gravel, generating runoff amounts of Q5= 3.3 cfs and Q100= 6.4 cfs.

Please see detailed Hydrologic and Hydraulic calculations in the appendix.

HYDROLOGIC AND HYDRAULIC CALCULATIONS

Hydrologic and Hydraulic calculations were performed using the El Paso County Storm Drainage Design Criteria Manual Volumes 1 & 2 latest editions. The Rational Method was used to estimate storm water runoff.

FLOODPLAIN STATEMENT

No portion of this site is within a designated F.E.M.A. floodplain, as determined by Flood Insurance Rate Maps Nos. 08041C0751 G & 08041C0752 G dated December 7, 2018.

WATER QUALITY AND DETENTION

This site is not part of a larger common plan of development and the combined area of ground disturbance associated with these improvements is less than an acre; therefore, water quality is not required.

The main criteria for detention requirements is that the manner or quantity of runoff does not increase or impact downstream properties. The proposed flow leaving the site to the south is Q5= 16.1 cfs and Q100= 30.1 cfs. Per the previously approved drainage report, the flow leaving the site was Q5= 17.8 cfs and Q100= 30.7 cfs. The proposed use and flow paths on the site are remaining similar to current conditions, so the manner of the runoff isn't changing. The proposed flows leaving the site to the south are less than those in the previously approved report, so the quantity of runoff isn't increasing from what has previously been approved. Based on this, detention is not required.

EROSION CONTROL

An erosion control plan has been submitted along with this report.

CONSTRUCTION COST OPINION

Public Non Reimbursable
NOT APPLICABLE

Private Non Reimbursable

Item	Quantity	Unit	Unit Price	Cost
Riprap (Type L)	27	Cu Yd	$200	$5,400
			Subtotal	$5,400
Engineering Contingency	10%	Lump Sum		$540
			Total	$5,940

DRAINAGE FEES

This site is not being platted. Drainage or bridge fees do not apply.

MAINTENANCE

The proposed erosion control measures will be repaired and maintained by the property owner or owner's representative as required.

SUMMARY

Runoff from the A Storage Place development will not adversely affect the surrounding and downstream properties. Water quality measures are not required as the proposed improvements will disturb less than 1 acre and the site is not part of a larger common plan of development. The proposed expansion does not increase the manner or quantity of runoff above what was in the previously approved report; therefore, detention measures are not required for this project. No storm drainage modifications are necessary as a result of the A Storage Place development.

PREPARED BY:
TERRA NOVA ENGINEERING, INC.

L Ducett P.E.
President
Terra Nova Engineering, Inc.

BIBLIOGRAPHY

Preliminary/Final Drainage Report for Powers Pointe, Filing No. 1, Nolte and Associates (1996)

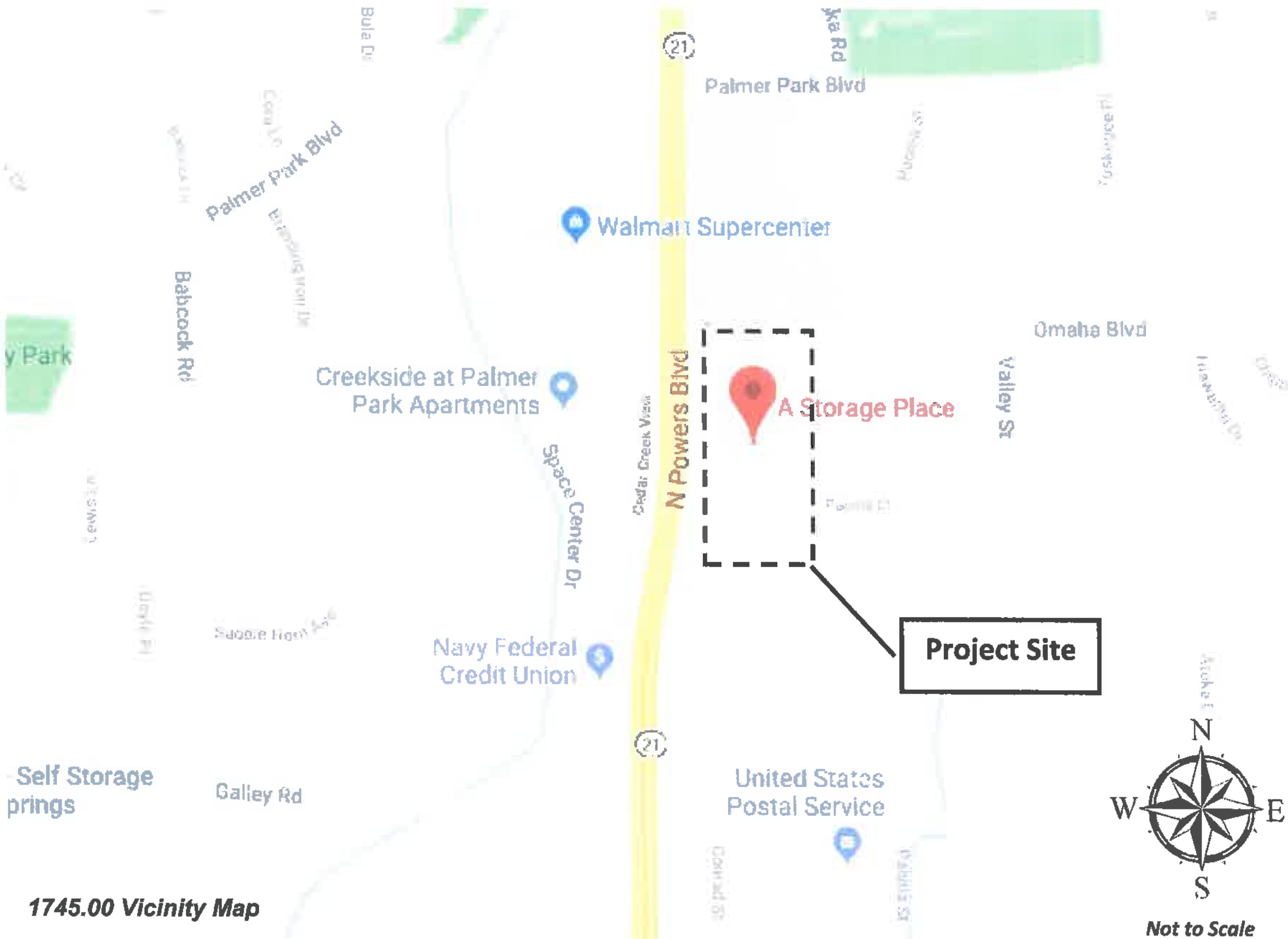
El Paso County Drainage Criteria Manual-Volumes 1 & 2, latest edition

SCS Soils Map for El Paso County

Federal Emergency Management Agency (FEMA) flood maps

Sand Creek Drainage Basin Planning Study

VICINITY MAP



1745.00 Vicinity Map

S.C.S. SOILS MAP

Search

Map Unit Legend

El Paso County Area, Colorado (CO625)

El Paso County Area, Colorado (CO625)

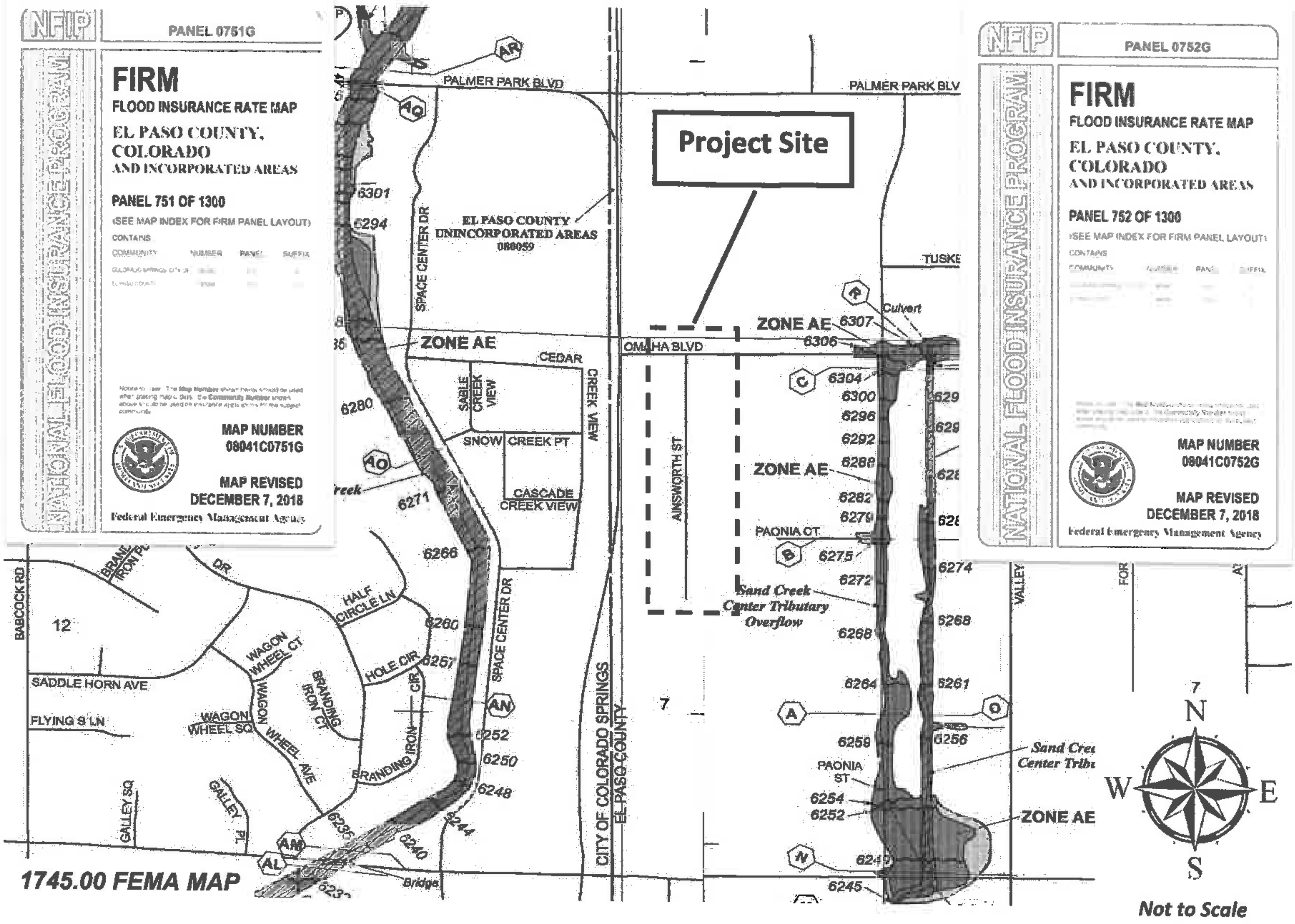
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
10	Blendon sandy loam, 0 to 3 percent slopes	6.3	100.0%
Totals for Area of Interest		6.3	100.0%

HSG - B

1745.00 S.C.S. Soils Map

Not to Scale

FEMA MAP



1745.00 FEMA MAP

HYDROLOGIC AND HYDRAULIC CALCULATIONS

1745.00 A Storage Place, Colorado Springs
(Area Runoff Coefficient Summary)

EXISTING CONDITIONS

		PAVEMENT/ROOF			*GRAVEL*			*WEIGHTED*	
BASIN	**TOTAL AREA**	**AREA**	**C_5**	**C_{100}**	**AREA**	**C_5**	**C_{100}**	**C_5**	**C_{100}**
	(Acres)	*(Acres)*			*(Acres)*				
EX-A	1.64	1.35	0.90	0.96	0.29	0.59	0.70	0.85	0.91
EX-B	2.75	1.84	0.90	0.96	0.91	0.59	0.70	0.80	0.87
EX-C	0.75	0.68	0.90	0.96	0.07	0.59	0.70	0.87	0.94
			Paved Street			*Commercial Area*			
OS-1	1.90	0.81	0.90	0.96	1.09	0.81	0.88	0.85	0.91

DEVELOPED CONDITIONS

		PAVEMENT/ROOF			*GRAVEL*			*WEIGHTED*	
BASIN	**TOTAL AREA**	**AREA**	**C_5**	**C_{100}**	**AREA**	**C_5**	**C_{100}**	**C_5**	**C_{100}**
	(Acres)	*(Acres)*			*(Acres)*				
PR-A	1.55	1.50	0.90	0.96	0.05	0.59	0.70	0.89	0.95
PR-B	1.62	1.55	0.90	0.96	0.07	0.59	0.70	0.89	0.95
PR-C	1.14	0.99	0.90	0.96	0.15	0.59	0.70	0.86	0.93
PR-D	0.09	0.05	0.90	0.96	0.04	0.59	0.70	0.76	0.84
			Paved Street			*Commercial Area*			
OS-1	1.90	0.81	0.90	0.96	1.09	0.81	0.88	0.85	0.91
EX-C	0.75	0.68	0.90	0.96	0.07	0.59	0.70	0.87	0.94

Calculated by: DLF
Date: 3/2/2020
Checked by: ________

1745.00 A Storage Place, Colorado Springs
AREA DRAINAGE SUMMARY

EXISTING CONDITIONS

		WEIGHTED		OVERLAND				STREET / CHANNEL FLOW				T_t	INTENSITY		TOTAL FLOWS	
BASIN	AREA TOTAL (Acres)	C_5	C_{100}	C_5	Length (ft)	Height (ft)	T_C (min)	Length (ft)	Slope (%)	Velocity (fps)	T_t (min)	TOTAL (min)	I_5 (in/hr)	I_{100} (in/hr)	Q_5 (c.f.s.)	Q_{100} (c.f.s.)
		* For Calcs See Runoff Summary														
EX-A	1.64	0.85	0.91	0.85	64	5.0	1.9	1190	1.8%	2.7	7.3	9.3	4.2	7.3	5.8	10.9
EX-B	2.75	0.80	0.87	0.80	75	4.0	2.8	1124	1.8%	2.7	6.9	9.8	4.1	7.1	9.0	17.2
EX-C	0.75	0.87	0.94	0.87	75	4.0	2.1	200	1.8%	2.7	1.2	5.0	5.0	9.1	3.3	6.4
OS-1	1.90	0.85	0.91	0.85	12	0.2	1.3	1155	1.7%	2.6	7.4	8.7	4.3	7.5	6.9	13.0

DEVELOPED CONDITIONS

		WEIGHTED		OVERLAND				STREET / CHANNEL FLOW				T_t	INTENSITY		TOTAL FLOWS	
BASIN	AREA TOTAL (Acres)	C_5	C_{100}	C_5	Length (ft)	Height (ft)	T_C (min)	Length (ft)	Slope (%)	Velocity (fps)	T_t (min)	TOTAL (min)	I_5 (in/hr)	I_{100} (in/hr)	Q_5 (c.f.s.)	Q_{100} (c.f.s.)
		* For Calcs See Runoff Summary														
PR-A	1.55	0.89	0.95	0.89	64	5.0	1.6	1170	1.8%	2.7	7.2	8.8	4.2	7.4	5.9	11.0
PR-B	1.62	0.89	0.95	0.89	75	4.0	2.0	1124	1.8%	2.7	6.9	8.9	4.2	7.4	6.1	11.4
PR-C	1.14	0.86	0.93	0.86	75	4.0	2.2	1124	1.8%	2.7	6.9	9.2	4.2	7.3	4.1	7.7
PR-D	0.09	0.76	0.84	0.76	15	3.0	0.9	0	0.0%	0.0	0.0	5.0	5.0	9.1	0.3	0.7
OS-1	1.90	0.85	0.91	0.85	12	0.2	1.3	1155	1.7%	2.6	7.4	8.7	4.3	7.5	6.9	13.0
EX-C	0.75	0.87	0.94	0.87	75	4.0	2.1	200	1.8%	2.7	1.2	5.0	5.0	9.1	3.3	6.4

Calculated by: DLF
Date: 3/2/2020
Checked by: ______

1745.00 A STORAGE PLACE
Surface Routing

EXISTING CONDITIONS									
						Intensity		Flow	
Design Point(s)	*Contributing Basins*	*Area (Acres)*	*Equivalent CA_5*	*Equivalent CA_{100}*	*Maximum T_C*	I_5	I_{100}	Q_5	Q_{100}
X-1	EX-A	1.64	1.39	1.50	9.3	4.2	7.3	5.8	10.9
X-2	EX-B	2.75	2.19	2.40	9.8	4.1	7.1	9.0	17.2
X-3	OS-1	1.90	1.61	1.74	8.7	4.3	7.5	6.9	13.0
X-4	EX-C	0.75	0.65	0.70	5.0	5.0	9.1	3.3	6.4

PROPOSED CONDITIONS									
						Intensity		Flow	
Design Point(s)	*Contributing Basins*	*Area (Acres)*	*Equivalent CA_5*	*Equivalent CA_{100}*	*Maximum T_C*	I_5	I_{100}	Q_5	Q_{100}
1	PR-A	1.55	1.38	1.48	8.8	4.2	7.4	5.9	11.0
2	PR-B	1.62	1.44	1.54	8.9	4.2	7.4	6.1	11.4
3	PR-C	1.14	0.98	1.06	9.2	4.2	7.3	4.1	7.7
4	PR-D	0.09	0.07	0.08	5.0	5.0	9.1	0.3	0.7
X-3	EX-C,PR-D,OS-1	2.74	- - -	- - -	- - -	- - -	- - -	10.5	20.0
X-4	EX-C	0.75	0.65	0.70	5.0	5.0	9.1	3.3	6.4

Calculated by: DLF
Date: 7/28/2020
Checked by: ______

1745.00 A Storage Place
Summary of Proposed Aisle Flow Capacities
Dane Frank 03/04/20

Aisle in Basin	Required Capacity (cfs)	Min Capacity from Valley Section (cfs)	Min Capacity in Rise from Concrete to Finish Floor (cfs)	Combined Min Capacity (cfs)	Notes
PR-A	11.0	2.2	35.6	37.8	
PR-B	11.4	0.0	30.6	30.6	No valley section capacity due to grading of existing concrete.
PR-C	7.7	11.6	31.9	43.5	

MANNING'S EQUATION for OPEN CHANNEL FLOW

Project: **A Storage Place** Location: PR-A Aisle Valley Capacity - flattest slopes

By: Dane Frank Date: 3/4/2020

Chk By: Date:

version 12-2004

Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

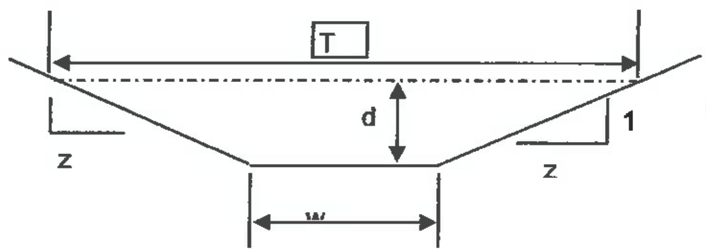
R = A/P

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient



$V = (1.49/n)R_h^{2/3}S^{1/2}$

Q = V x A

INPUT	
z (sideslope)=	200
z (sideslope)=	37
b (btm width, ft)=	0
d (depth, ft)=	0.1
S (slope, ft/ft)	0.015
n_{low} =	0.013
n_{high} =	0.013

Clear Data Entry Cells

				Low N		High N			
Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs		
0.1	1.19	23.70	0.05	1.89978664	2.25125	1.899787	2.25125	T =	23.7
								Dm =	0.050
				Sc low =	0.0067	Sc high =	0.0067		

s_c = critical slope ft / ft

T = top width of the stream

d_m = a/T = mean depth of flow

.7 Sc	1.3 Sc	.7 Sc	1.3 Sc
0.0047	0.0087	0.0047	0.0087

Created by: Mike O'Shea

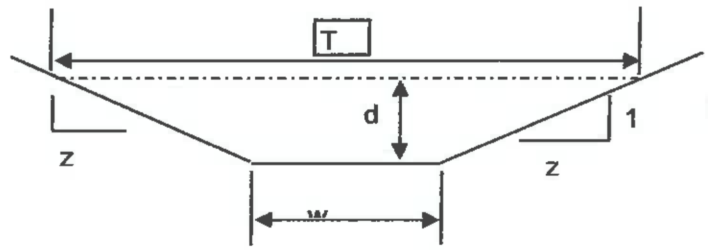
MANNING'S EQUATION for OPEN CHANNEL FLOW

Project: **A Storage Place** Location: PR-A Step to FF Capacity - 3" rise (min slope)

By: Dane Frank Date: 3/4/2020

Chk By: Date:

version 12-2004



Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

R = A/P

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient

$V = (1.49/n)R_h^{2/3}S^{1/2}$

Q = V x A

INPUT	
z (sideslope)=	0
z (sideslope)=	0
b (btm width, ft)=	26
d (depth, ft)=	0.25
S (slope, ft/ft)	0.015
n_{low} =	0.013
n_{high} =	0.013

Clear Data Entry Cells

Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Low N Velocity, fps	Low N Flow, cfs	High N Velocity, fps	High N Flow, cfs		
0.25	6.50	26.50	0.25	5.48545172	35.6554	5.485452	35.6554	T =	26
								Dm =	0.250

Sc low =	0.0040	Sc high =	0.0040
.7 Sc	1.3 Sc	.7 Sc	1.3 Sc
0.0028	0.0052	0.0028	0.0052

s_c = critical slope ft / ft

T = top width of the stream

d_m = a/T = mean depth of flow

Created by: Mike O'Shea

MANNING'S EQUATION for OPEN CHANNEL FLOW

Project: **A Storage Place** Location: PR-B Aisle Valley Capacity - flattest slopes

By: Dane Frank Date: 3/4/2020

Chk By: Date: version 12-2004

Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

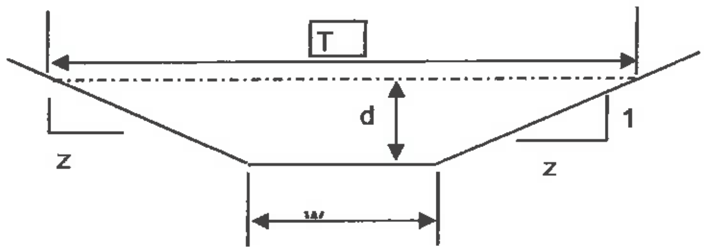
$R = A/P$

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient



$V = (1.49/n)R_h^{2/3}S^{1/2}$

$Q = V \times A$

INPUT	
z (sideslope)=	99999999
z (sideslope)=	83
b (btm width, ft)=	0
d (depth, ft)=	0
S (slope, ft/ft)	0.012
n_{low} =	0.013
n_{high} =	0.013

Clear Data Entry Cells

Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Low N Velocity, fps	Low N Flow, cfs	High N Velocity, fps	High N Flow, cfs	
0	0.00	0.00						T =
								Dm =
				Sc low =		Sc high =		
				.7 Sc	1.3 Sc	.7 Sc	1.3 Sc	

s_c = critical slope ft / ft

T = top width of the stream

d_m = a/T = mean depth of flow

Created by: Mike O'Shea

MANNING'S EQUATION for OPEN CHANNEL FLOW

Project: **A Storage Place** Location: PR-B Step to FF Capacity - 3" rise (min slope)

By: Dane Frank Date: 3/4/2020

Chk By: Date: version 12-2004

Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

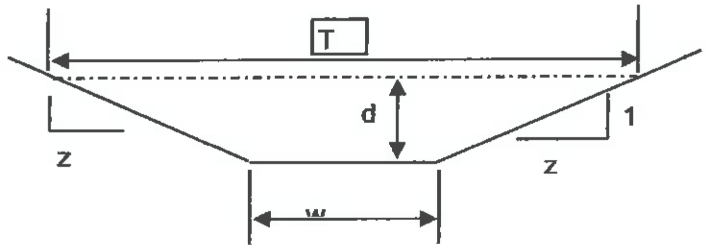
R = A/P

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient



$V = (1.49/n)R_h^{2/3}S^{1/2}$

Q = V x A

INPUT	
z (sideslope)=	0
z (sideslope)=	0
b (btm width, ft)=	25
d (depth, ft)=	0.25
S (slope, ft/ft)	0.012
n_{low} =	0.013
n_{high} =	0.013

Clear Data Entry Cells

				Low N		High N			
Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs		
0.25	6.25	25.50	0.25	4.90387001	30.6492	4.90387	30.6492	T =	25
								Dm =	0.250

Sc low =	0.0040	Sc high =	0.0040
.7 Sc	1.3 Sc	.7 Sc	1.3 Sc
0.0028	0.0052	0.0028	0.0052

s_c = critical slope ft / ft

T = top width of the stream

d_m = a/T = mean depth of flow

Created by: Mike O'Shea

MANNING'S EQUATION for OPEN CHANNEL FLOW

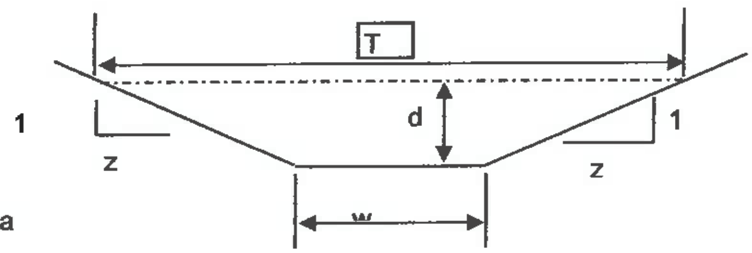
Project: **A Storage Place** Location: PR-C Aisle Valley Capacity - flattest slopes

By: Dane Frank Date: 3/4/2020

Chk By: Date:

version 12-2004

Mannings Formula



INPUT	
z (sideslope)=	53
z (sideslope)=	0
b (btm width, ft)=	0
d (depth, ft)=	0.34
S (slope, ft/ft)	0.012
n_{low} =	0.013
n_{high} =	0.013

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

R = A/P

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient

$V = (1.49/n)R_h^{2/3}S^{1/2}$

Q = V x A

Clear Data Entry Cells

				Low N		High N			
Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs		
0.34	3.06	18.36	0.17	3.7944043	11.6238	3.794404	11.6238	T =	18.02
								Dm =	0.170

Sc low =	0.0046	Sc high =	0.0046
.7 Sc	1.3 Sc	.7 Sc	1.3 Sc
0.0032	0.0059	0.0032	0.0059

s_c = critical slope ft / ft

T = top width of the stream

d_m = a/T = mean depth of flow

Created by: Mike O'Shea

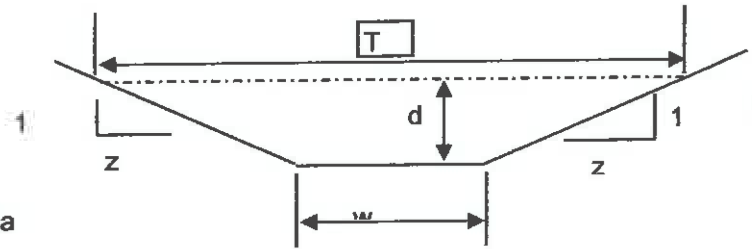
MANNING'S EQUATION for OPEN CHANNEL FLOW

Project: **A Storage Place** | Location: PR-C Step to FF Capacity - 3" rise (min slope)

By: Dane Frank | Date: 3/4/2020

Chk By: | Date:

version 12-2004



INPUT	
z (sideslope)=	0
z (sideslope)=	0
b (btm width, ft)=	26
d (depth, ft)=	0.25
S (slope, ft/ft)	0.012
n_{low} =	0.013
n_{high} =	0.013

Clear Data Entry Cells

Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

$R = A/P$

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient

$V = (1.49/n)R_h^{2/3}S^{1/2}$

$Q = V \times A$

				Low N		High N	
Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs
0.25	6.50	26.50	0.25	4.90633718	31.8912	4.906337	31.8912

T = 26

Dm = 0.250

Sc low =	0.0040	Sc high =	0.0040
.7 Sc	1.3 Sc	.7 Sc	1.3 Sc
0.0028	0.0052	0.0028	0.0052

s_c = critical slope ft / ft

T = top width of the stream

d_m = a/T = mean depth of flow

Created by: Mike O'Shea

1745.00 A Storage Place
Riprap Sizing Calculations
Dane Frank 06/23/20

$$d_{50} \geq \left[\frac{VS^{0.17}}{4.5(G_s - 1)^{0.66}} \right]^2$$

d50 = mean rock size (ft)
V = mean channel velocity (ft/s)
S = longitudinal channel slope (ft/ft)
Gs = specific gravity of stone (min = 2.50, typically 2.5 to 2.7)

V and S values are referenced from Manning Equation spreadsheets

Location	V	S	Gs	d50 (ft)	d50 (in)
Design Point 1 Riprap	1.900	0.015	2.5	0.025	0.300
Design Point 2 Riprap	4.904	0.012	2.5	0.155	1.855
Design Point 3 Riprap	3.794	0.012	2.5	0.093	1.111

HISTORIC FLOW EXHIBIT

Historic Flow Exhibit
Terra Nova Engineering notes are in blue
- Dane Frank, Terra Nova, 2020/06/25

LAND USE COEFFICIENTS

BASIN	C(5)	C(100)	
1	0.90	0.90	
2	0.90	0.90	
3	0.90	0.90	
4	0.90	0.90	
5	0.80	0.80	C(5)/(100) = ((0.40)(0.60) + (0.52)(0.90))/0.92 = 0.77 Say 0.80
6	0.90	0.80	
7	0.90	0.90	
OS-1	0.90	0.90	
OS-2/3	0.70	0.70	C(5)/(100) = ((1.3)(0.30) + (2.4)(0.90))/3.7 = 0.69 Say 0.70

BASIN CALCULATIONS

These basin calculations appear to include calculations for both individual basins and design points with flow from multiple basins.

BASIN 1
Tc w/in Landscaped Area = 1.87(1.1-0.60)(95)^0.5(5.0)^-0.33 = 5.4 min.
Tc south within concrete swale (700' @ V=5 f.p.s.) = 700/(5)(60) = 2.3 min.
Tc total = 5.4 + 2.3 = 7.7 min. Use 10 minute minimum.
I(5) = 4.05 in./hr. I(100) = 7.0 in./hr.
Q(5) = (0.90)(4.05)(0.68+0.30) = 3.6 c.f.s.
Q(100) = (0.90)(7.0)(0.68+0.30) = 6.2 c.f.s.

BASIN 2
Tc) Use 10 minute minimum.
I(5) = 4.05 in./hr. I(100) = 7.0 in./hr.
Q(5) = (0.90)(4.05)(0.86) = 3.1 c.f.s.
Q(100) = (0.90)(7.0)(0.86) = 5.4 c.f.s.

BASIN 3
Tc) Use 10 minute minimum.
I(5) = 4.05 in./hr. I(100) = 7.0 in./hr.
Q(5) = (0.90)(4.05)(0.84) = 3.1 c.f.s.
Q(100) = (0.90)(7.0)(0.84) = 5.4 c.f.s.

BASIN 4
Tc w/in Lscape setback next to Omaha = 1.87(1.1-.25)(2)^(-0.33)(40)^(.5) = 5.9 min.
Tc from Lscape to access road (100' @ V=5 f.p.s.) = 100/(5*60) = 0.3 min.
Tc within access road south to PL (520' @ V=5 f.p.s.) = 520/(5*60) = 1.7 min.
Tc total = 5.9 + 0.3 + 1.7 = 7.9 min. (use 10 minute Tc)
I(5) = 4.05 in./hr. I(100) = 7.0 in./hr.
Q(5) = (0.90)(4.05)(3.70) = 13.5 c.f.s.
Q(100) = (0.90)(7.0)(3.70) = 23.3 c.f.s.

BASIN OS-2
Tc w/in Omaha Curbline (S=1%)= 1,400'/(3.5)(60) = 6.7 min.
Tc w/in ditch with S = 2%, Sideslopes of 5:1, n = 0.035, Q = 6 c.f.s., V = 4 f.p.s.
Tc = (470')/(4)(60) = 2.0 min.
Tc total = 6.7 + 2.0 = 8.7 min. Use 10 minute minimum.
I(5) = 4.05 in./hr. I(100) = 7.0 in./hr.
Q(5) = (0.70)(4.05)(2.2) = 6.2 c.f.s.
Q(100) = (0.70)(7.0)(2.2) = 10.8 c.f.s.

CALCULATIONS
POWER POINTE PRELIM. / FINAL DRAINAGE REPORT
May, 1996

BASIN 4 & OS2 (Flow w/in Powers Ditch) ← This is a design point with flow from multiple basins.
Tc) Use 10 minute minimum.
I(5) = 4.05 in./hr. I(100) = 7.0 in./hr.
Q(5) = (0.90)(4.05)(3.70) + (0.70)(4.05)(2.2) = 19.7 c.f.s.
Q(100) = (0.90)(7.0)(3.70) + (0.70)(7.0)(2.2) = 34.1 c.f.s.
(see Open Channel Calculations - attached)

BASIN 5
Tc across compacted earth = 1.87(1.1-0.60)(400)^0.5(3.0)^-0.33 = 13.0 min.
Tc total = 10.0 + 13.0 = 23.0 min. (10 min. from Basin no. 1)
I(5) = 2.75 in./hr. I(100) = 4.75 in./hr.
SUM (CA)5 = (0.90)(0.98) + (0.80)(0.92) = 2.39
SUM (CA)100 = (0.90)(0.98) + (0.80)(0.92) = 2.39
Q(5) = SUM (CA) * I(5) = 2.39(2.75) = 6.6 c.f.s.
Q(100) = SUM(CA) *I(100) = 2.39(4.75) = 11.4 c.f.s.

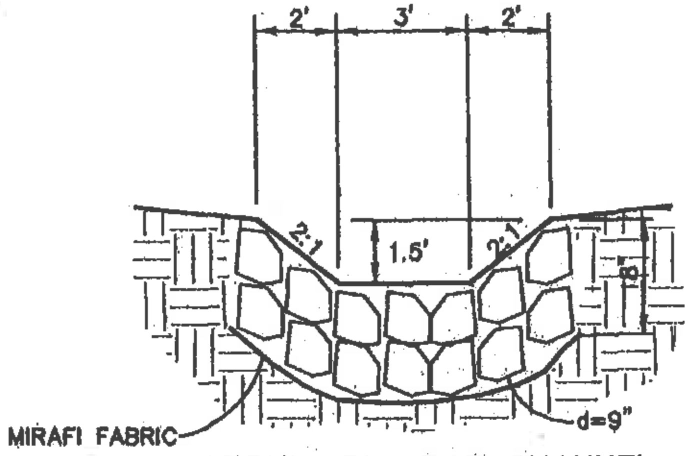
BASIN 6
Tc) Use 10 minute minimum.
I(5) = 4.05 in./hr. I(100) = 7.0 in./hr.
Q(5) = (0.90)(4.05)(0.37) = 1.4 c.f.s.
Q(100) = (0.90)(7.0)(0.37) = 2.3 c.f.s.

BASIN 7
Tc) Use 10 minute minimum.
I(5) = 4.05 in./hr. I(100) = 7.0 in./hr.
Q(5) = (0.90)(4.05)(2.80) = 10.2 c.f.s.
Q(100) = (0.90)(7.0)(2.80) = 17.6 c.f.s.

BASINS 7, 4, OS-2,3 ← This is a design point with flow from multiple basins.
CA(5)/(100) = (0.90)(3.7 + 2.8) + (0.70)(2.2 + 1.5) = 8.16
Tc at southerly end of ditch next to proposed subdivision....
Tc = 10 min. + (580')/(4)(60) = 12.4 min.
I(5) = 3.8 in./hr. I(100) = 6.3 in./hr.
Q(5) = (8.16)(3.8) = 31.0 c.f.s.
Q(100) = (8.16)(6.3) = 51.4 c.f.s.

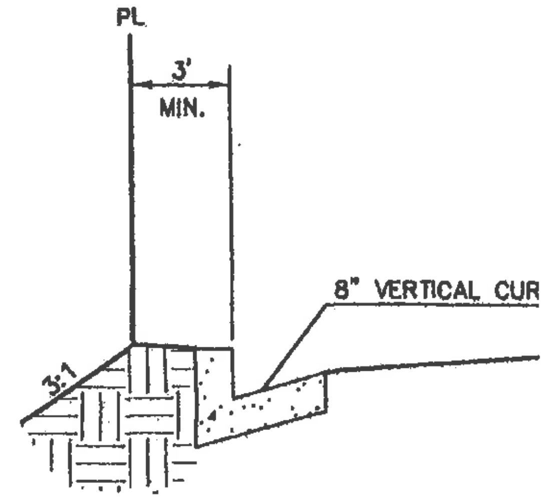
For road side ditch capacity calculations see Trapezoidal Channel Analysis and Design Worksheets, attached.

Flow Leaving the Site Across the South Property Line
The drainage map shows Basins 1, 2, 3, 5, and 6 all drain south with runoff from these basins leaving the site at the south property line. The combined runoff from these basins is:
Q5 = 3.6 + 3.1 + 3.1 + 6.6 + 1.4 = 17.8 cfs
Q100 = 6.2 + 5.4 + 5.4 + 11.4 + 2.3 = 30.7 cfs



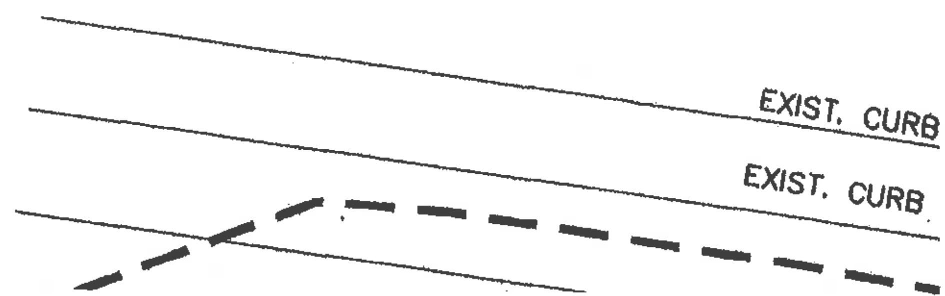
DETAIL: RIP-RAP CHANNEL

NOT TO SCALE

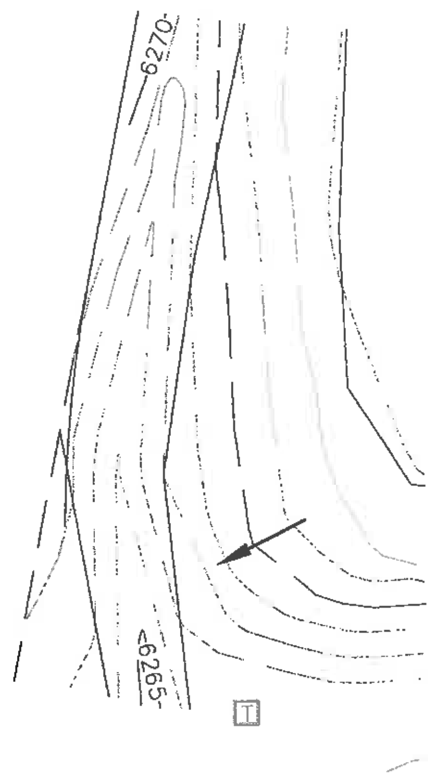


SECTION: 8" VERTICAL CURB @ PI

NOT TO SCALE



DRAINAGE MAPS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