Design Hydrology Calculations

for

APN: 009-002-25
8810 Soda Bay Road
Kelseyville, CA

Submitted to:

County of Lake, California

Prepared by:

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Project Scope

The owner, Konocti Kids Camp (United Association of Journeymen and Apprentices), proposes to develop a private access road from Soda Bay Road to the Kids Camp. Currently the legal access is through the Konocti Harbor Resort. Konocti Harbor Resort is participating with the Konocti Kids camp for the new legal access. Improvement include a 20' wide paved access road with 1' shoulders, underground utilities, rock retaining walls, concrete pour in place retaining walls, and stormwater infrastructure.

This report addresses the post stormwater for the subject property and justifies the proposed stormwater infrastructure.

Design Rational

The 25 year storm water event is analyzed in this report for sizing stormwater infrastructure such as culverts, and drain inlets.

The rainfall duration intensity is based on local data. In particular Plate 1 (see appendix). This rainfall duration intensity requires a 'K' factor which is based on Plate 2. The 'K' factor is used to adjust for variations in rainfall intensities throughout the County. "K" is determined by obtaining the mean annual precipitation for the drainage basin from Figure 3, and dividing it by 35 inches per year.

K = 24/35 = 0.69

The rainfall intensity is based on the minimum time of concentration of 10 minutes plus time of concentration for each tributary. The Tributary Map depicts the Length of travel and slopes that were used to calculate the time of concentration.

The Values of C, runoff coefficient are based on ASCE Design and Construction of Urban Stormwater Management Systems

Calculate 25 Year flows For Each Tributary

Q = CIAK

Where;

K = .74

A = Tributary (acres)

I25 = Rainfall intensity for 25-year design storm

I25 = 4.68(Tc)^(-0.415)

Tc = 10 minutes plus travel time. Due to the fact that the each tributary is small, and the length of travel time is short, Tc will be calculated at 10 minutes for each tributary.

	Tributary	C	Tc (min.)	I25 (in/hr)	Total Area acres	k	Q25 cfs
POST	A	0.47	15	1.52	2.0	0.69	0.98
	B	0.43	15	1.52	1.0	0.69	0.45
	C	0.47	19	1.37	3.5	0.69	1.55
	D	0.45	13	1.61	0.6	0.69	0.30
	E	0.55	10	1.80	0.25	0.69	0.17

Table 1: Tabulation of Tributary Areas, C, K, I and 25-yr flows.

Find: Post Development flows at Pt#2 and determine capacity of proposed 12" HDPE for 25-yr storm event.

Solution:

Q=CIAK from table 1

Pre Flows = flow rate from tributary A

= 0.98 cfs

Per Hydraflow Express shown in appendix, a 12" HDPE culvert outlet pipe is adequate for the 25 –year storm event. If the slope is minimum 2% slope.

Find : Post Development flows for proposed 12" HDPE Storm pipe from pt#2 to pt@6, and determine capacity of said pipe for a 25-yr storm event.

Given: Q25= 0.45 cfs (trib B)
12" HDPE (smooth plastic)
n = 0.011
S = 0.005

Solution: per Hydroflow Express Channel Report (see appendix), the depth is less than half full for 25-year storm event – therefore 12" hdpe storm pipe is adequate.

Find: Determine if 9" depth grass V-ditch to pt#1 is adequate for 25-yr storm event.

Given: Q25 = CIAK = 0.47 X 1.52 X 0.85 X 0.69
(note, area of 0.85 acres is not shown in tributary map)

Q25 = 0.42 CFS

n = 0.022
s = 0.03
side slope = 2:1

Solution: per Hydroflow Express Channel Report (see appendix), the depth is near capacity for 25-year storm event – therefore 12" hdpe storm pipe is adequate.

Find: Determine if 9" depth grass V-ditch to pt#4 is adequate for 25-yr storm event.

Given: Q25 = 0.35 cfs (table 1)
n = 0.022
s = 0.20
side slope = 2:1

Solution: per Hydroflow Express Channel Report (see appendix), the depth is near capacity for 25-year storm event – therefore 12" hdpe storm pipe is adequate.

Find: Determine if 18" depth rock lined V-ditch to pt#7 is adequate for 25-yr storm event.

Given: Q25 = 0.45 + 1.55 = 2.0 cfs (table 1; trib B+C)
n = 0.04 (angular rock)
s = 0.12
side slope = 2:1

Solution: per Hydroflow Express Channel Report (see appendix), the depth is near capacity for 25-year storm event – therefore 12" hdpe storm pipe is adequate.

Find: Determine if 12" HDPE Storm pipe from pt#5 to existing Drain Inlet is adequate for 25-yr storm event.

Given: Q25 = 0.30 + 0.17 = 0.47 cfs (table 1; trib D+E)
n = 0.011
s = 0.07

Solution: per Hydroflow Express Channel Report (see appendix), the depth is near capacity for 25-year storm event – therefore 12" hdpe storm pipe is adequate.

APPENDIX

Rainfall Duration-Intensity Curves

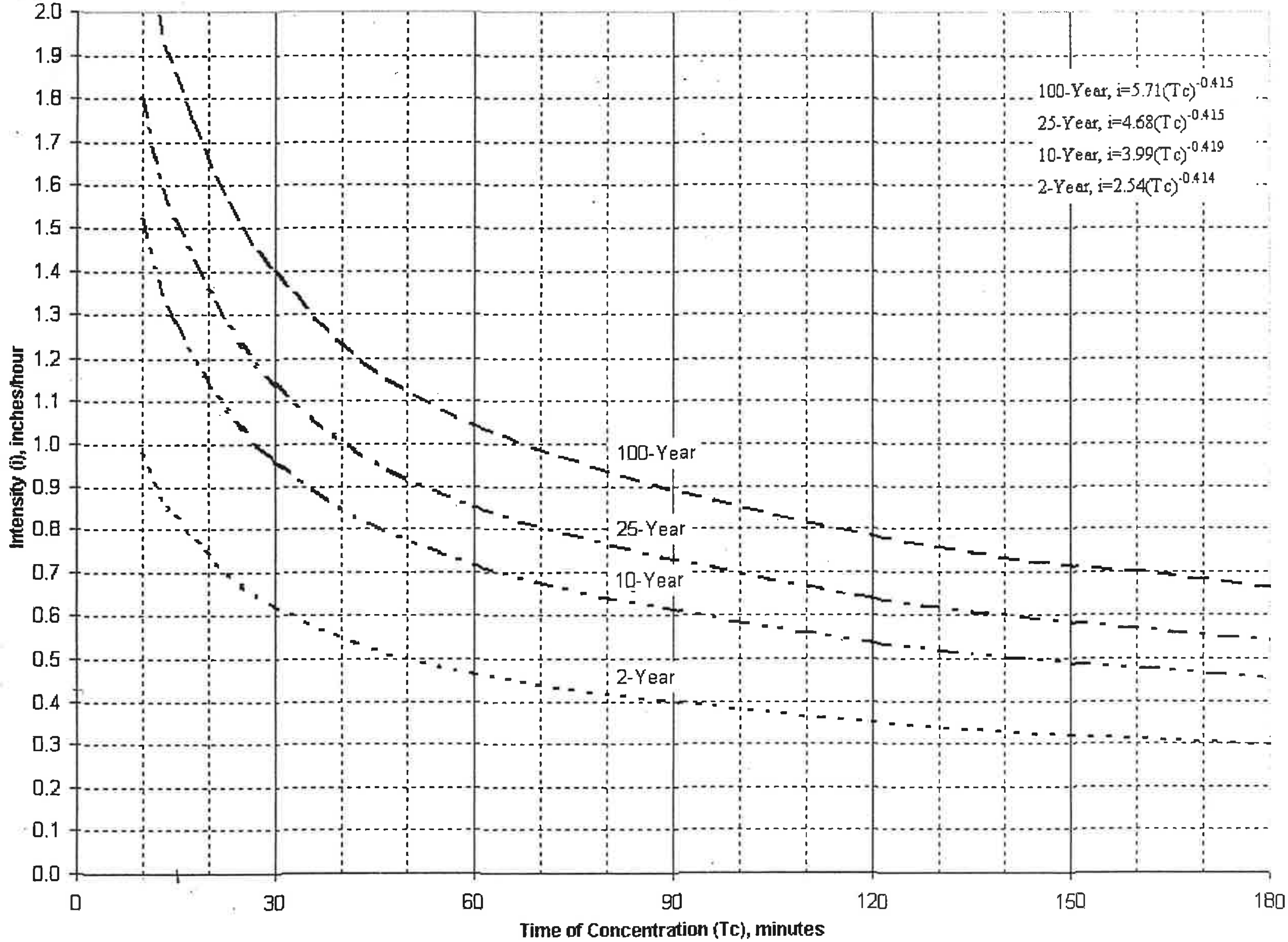
Average Annual Precipitation for Lake County

Values of C runoff Coefficient

Overland Flow Velocities

CHANNEL REPORTS

Tributary Map (11x17)



"Figure 1: Rainfall Duration-Intensity Curves"

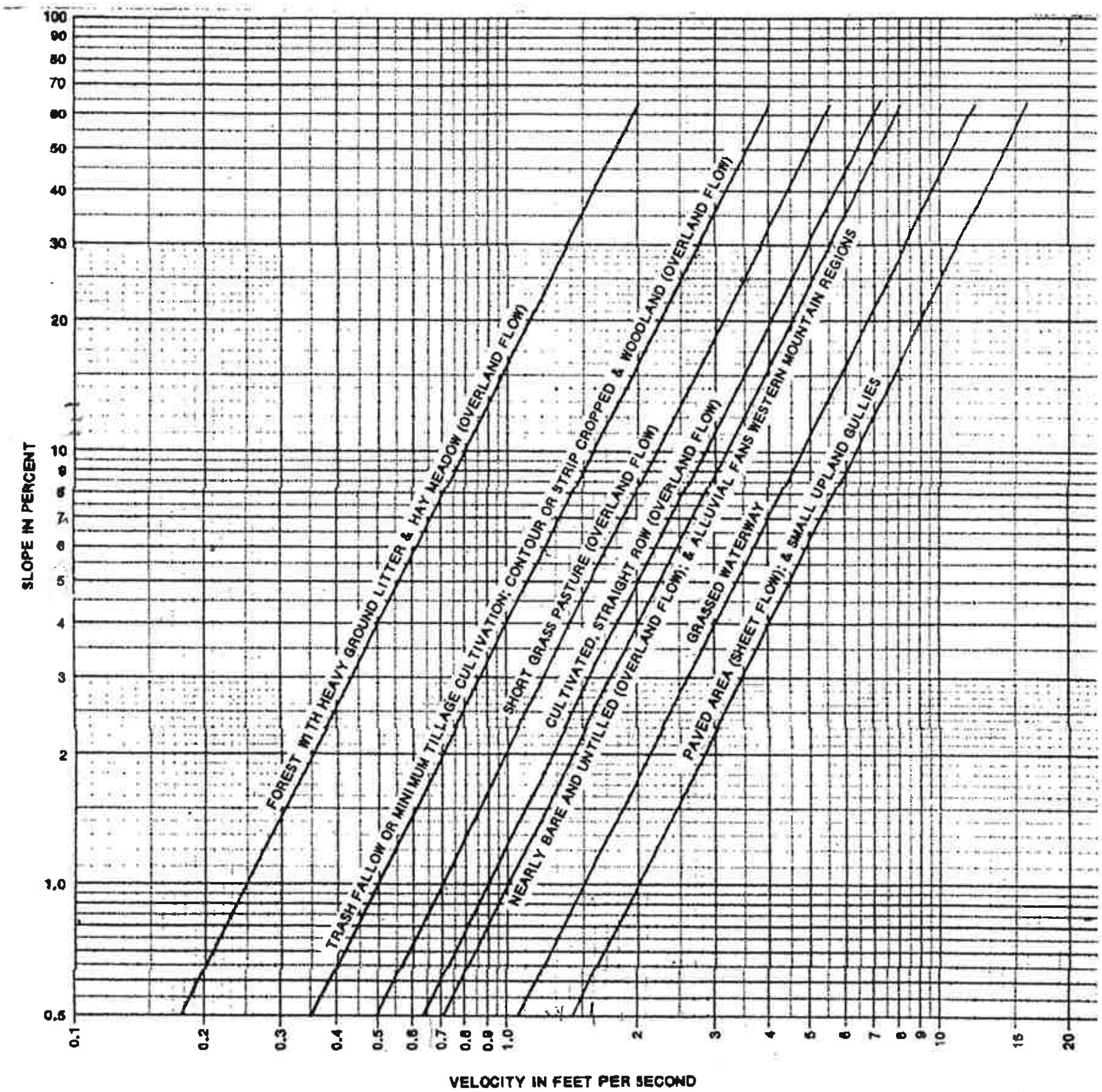


Figure 2: Overland Flow Velocities

From: USDA Soil Conservation Service, National Engineering Handbook, Section 4, Hydrology, March 1985, p. 15-8

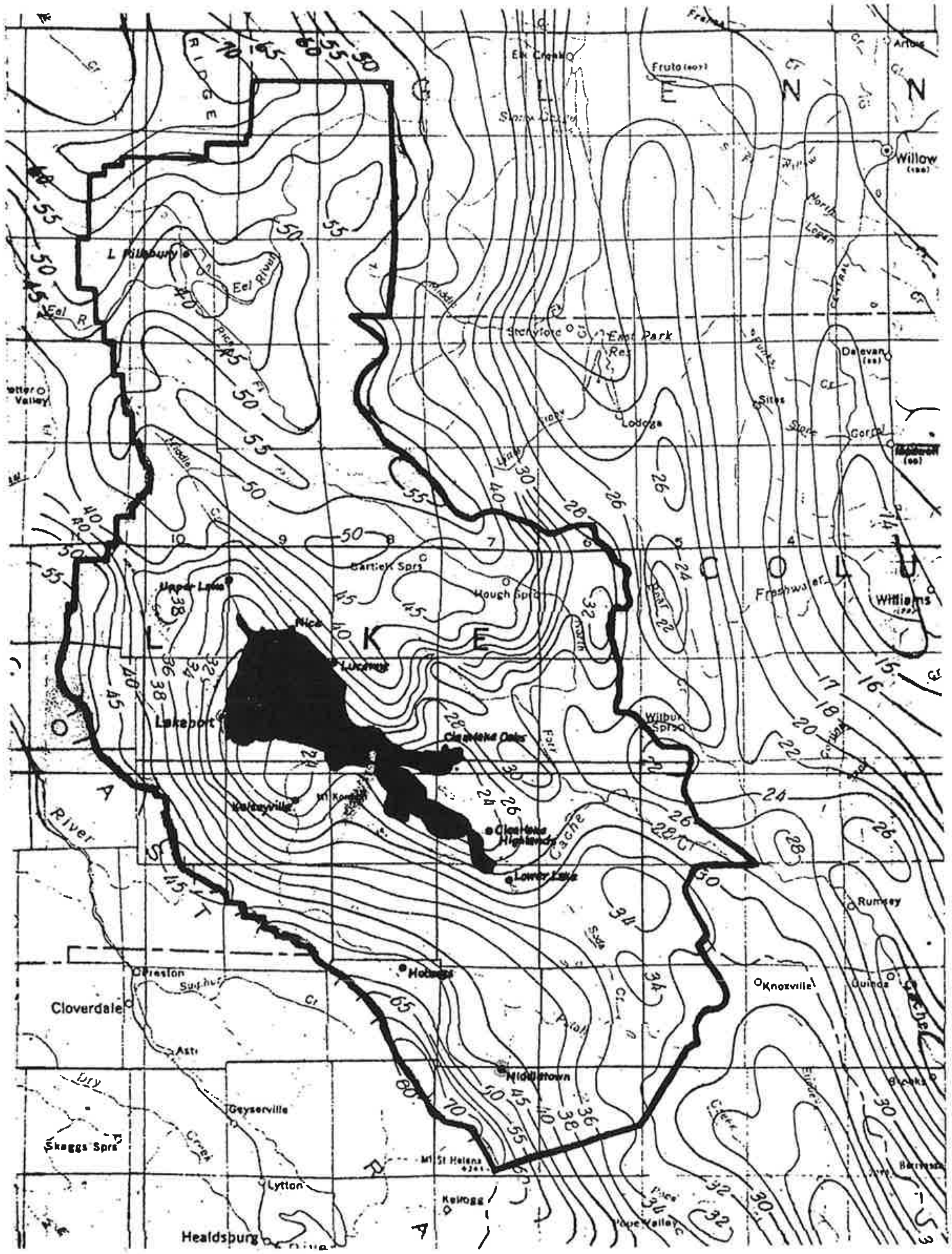


Figure 3: Average Annual Precipitation for Lake County

From: Calif. Department of Water Resources, Lines of Average Yearly Precipitation in the Central Valley, April 1966 time of concentration. If a large amount of storage exists within the basin, development of a hydrograph and flood routing may be required.

Table 1: Runoff Coefficients For Undeveloped Areas

	Watershed Types			
	Extreme	High	Normal	Low
Relief	0.28-0.35 Steep Rugged terrain with average slopes above 30%	0.20-0.28 Hilly, with average slopes of 10 to 30%	0.14-0.20 Rolling with average slopes of 5 to 10%	0.08-0.14 Relatively flat land, with average slopes of 0 to 5%
Soil infiltration	0.12-0.16 No effective soil cover, either rock or thin soil mantle of negligible infiltration capacity	0.08-0.12 Slow to take up water, clay or shallow loam soils of low soil infiltration capacity, imperfectly or poorly drained	0.06-0.08 Normal, well drained light or medium textured soils, sandy loams, silt and silt loams	0.04-0.06 High, deep sand or other soil that takes up water readily, very light well drained soils
Vegetal Cover	0.12-0.16 No effective plant cover, bare or very sparse cover	0.08-0.12 Poor to fair; clean cultivation crops, or poor natural cover, less than 20% of drainage area over good cover	0.06-0.08 Fair to good; about 50% of area in good grassland or woodland, not more than 50% of area in cultivated crops	0.04-0.06 Good to excellent; about 90% of drainage area in good grassland, woodland or equivalent cover
Surface Storage	0.10-0.12 Negligible surface storage, depressions few and shallow; drainageways steep and small, no marshes	0.08-0.10 Low; well defined system of small drainageways; no ponds or marshes	0.06-0.08 Normal; considerable surface depression storage; lakes and pond marshes	0.04-0.06 High; surface storage high; drainage system not sharply defined; large floodplain storage or large number of ponds and marshes

Given: An undeveloped watershed consisting of 1) rolling terrain with average slopes of 5%, 2) clay type soils, 3) good grassland area, and 4) normal surface depressions Find: The runoff coefficient, C, for the above watershed	Solution: Relief 0.14 Soil Infiltration 0.08 Vegetal Cover 0.04 Surface Storage 0.06 C = 0.32

Table 2: Typical Ranges of Impermeable Area

Development Type	Low, %	High, %
Suburban Residential (SR)	5	15
Single-Family Residential (R1)	45	65
Two-Family Residential (R2)	50	70
Multi-Family Residential (R3)	50	75
Commercial	50	100

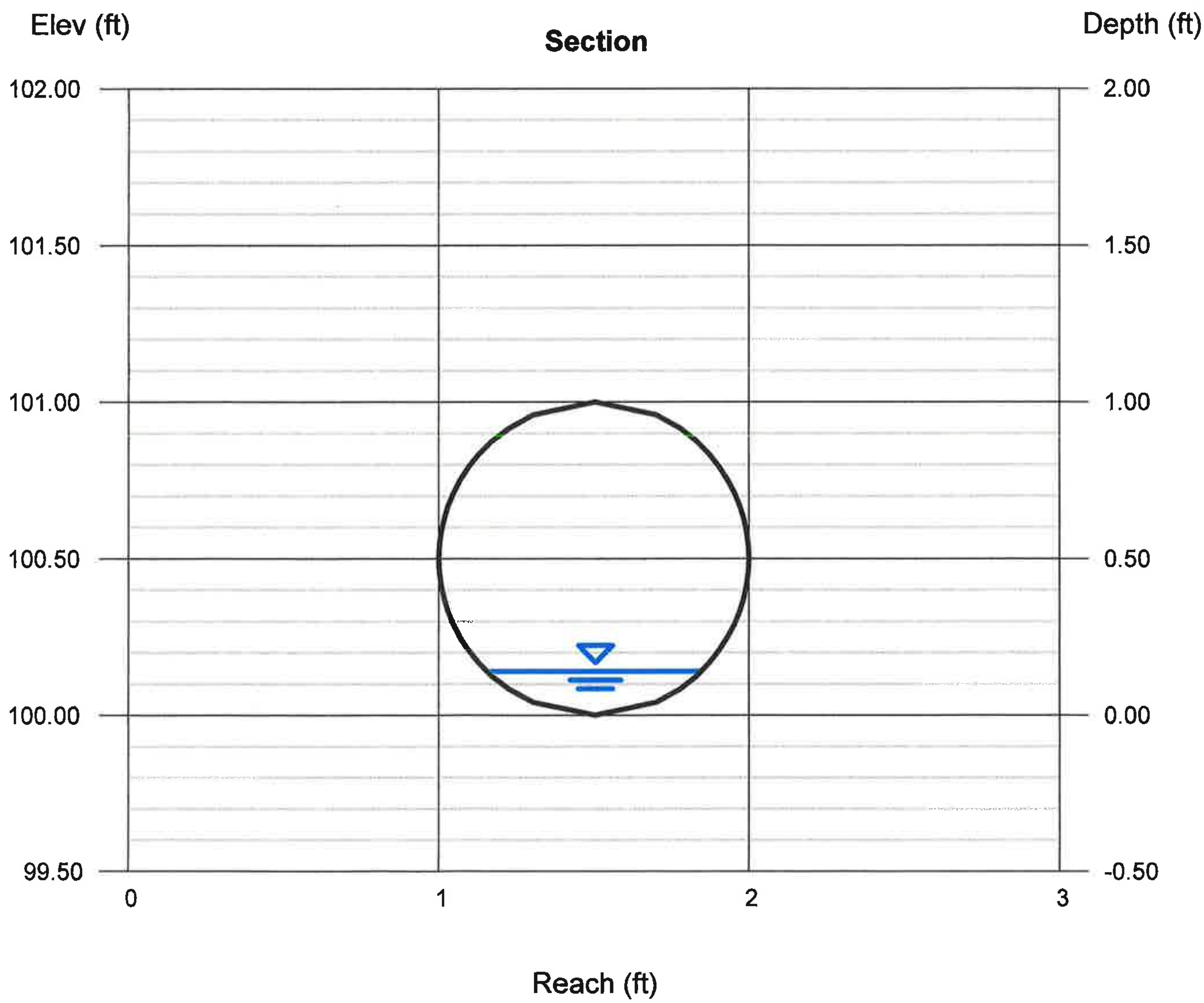
Table 3: Typical Runoff Coefficients for Developed Areas

Type of Drainage Area	Runoff Coefficient	Type of Drainage Area	Runoff Coefficient
Business:		Residential	
Downtown Areas	0.70-0.95	Single Family Areas	0.30-0.50
Neighborhood Areas	0.50-0.70	Multi-units, detached	0.40-0.60
Industrial		Multi-units, attached	0.60-0.75
Light industrial areas	0.50-0.80	Suburban	0.25-0.40
Heavy industrial areas	0.60-0.90	Apartment dwelling areas	0.50-0.70
Parks, cemeteries	0.10-0.25	Playgrounds	0.20-0.40

Channel Report

pt#5 12in HDPE TO (E) DI

Circular		**Highlighted**	
Diameter (ft)	= 1.00	Depth (ft)	= 0.14
		Q (cfs)	= 0.470
		Area (sqft)	= 0.07
Invert Elev (ft)	= 100.00	Velocity (ft/s)	= 6.96
Slope (%)	= 7.00	Wetted Perim (ft)	= 0.77
N-Value	= 0.011	Crit Depth, Yc (ft)	= 0.29
		Top Width (ft)	= 0.70
Calculations		EGL (ft)	= 0.89
Compute by:	Known Q		
Known Q (cfs)	= 0.47		

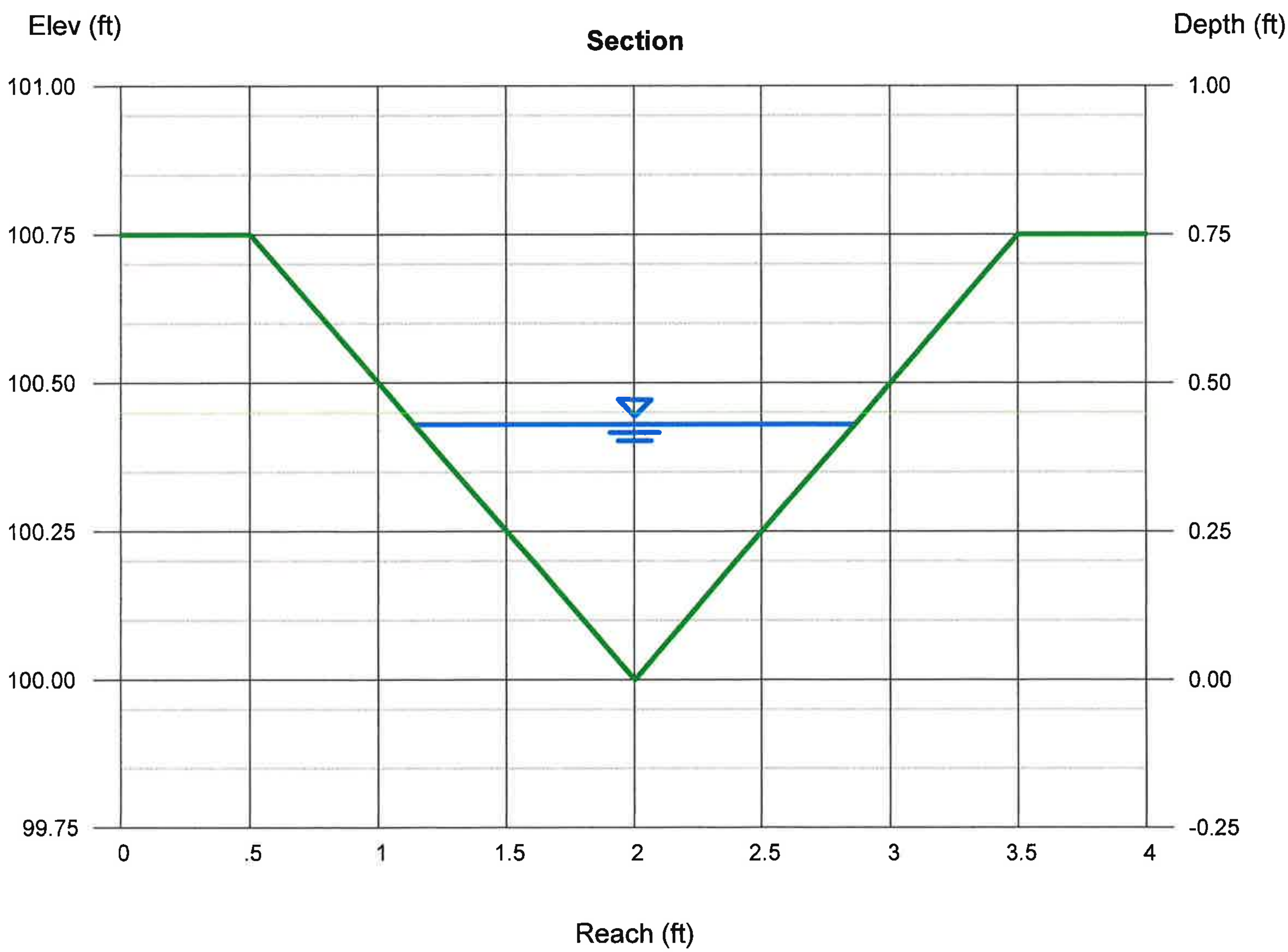


Channel Report

Hydraflow Express Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. Wednesday, Dec 4 2019

pt#4 V-DITCH

Triangular		**Highlighted**	
Side Slopes (z:1)	= 2.00, 2.00	Depth (ft)	= 0.43
Total Depth (ft)	= 0.75	Q (cfs)	= 0.350
		Area (sqft)	= 0.37
Invert Elev (ft)	= 100.00	Velocity (ft/s)	= 0.95
Slope (%)	= 0.20	Wetted Perim (ft)	= 1.92
N-Value	= 0.022	Crit Depth, Yc (ft)	= 0.29
		Top Width (ft)	= 1.72
Calculations		EGL (ft)	= 0.44
Compute by:	Known Q		
Known Q (cfs)	= 0.35		



Channel Report

Hydraflow Express Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. Wednesday, Dec 4 2019

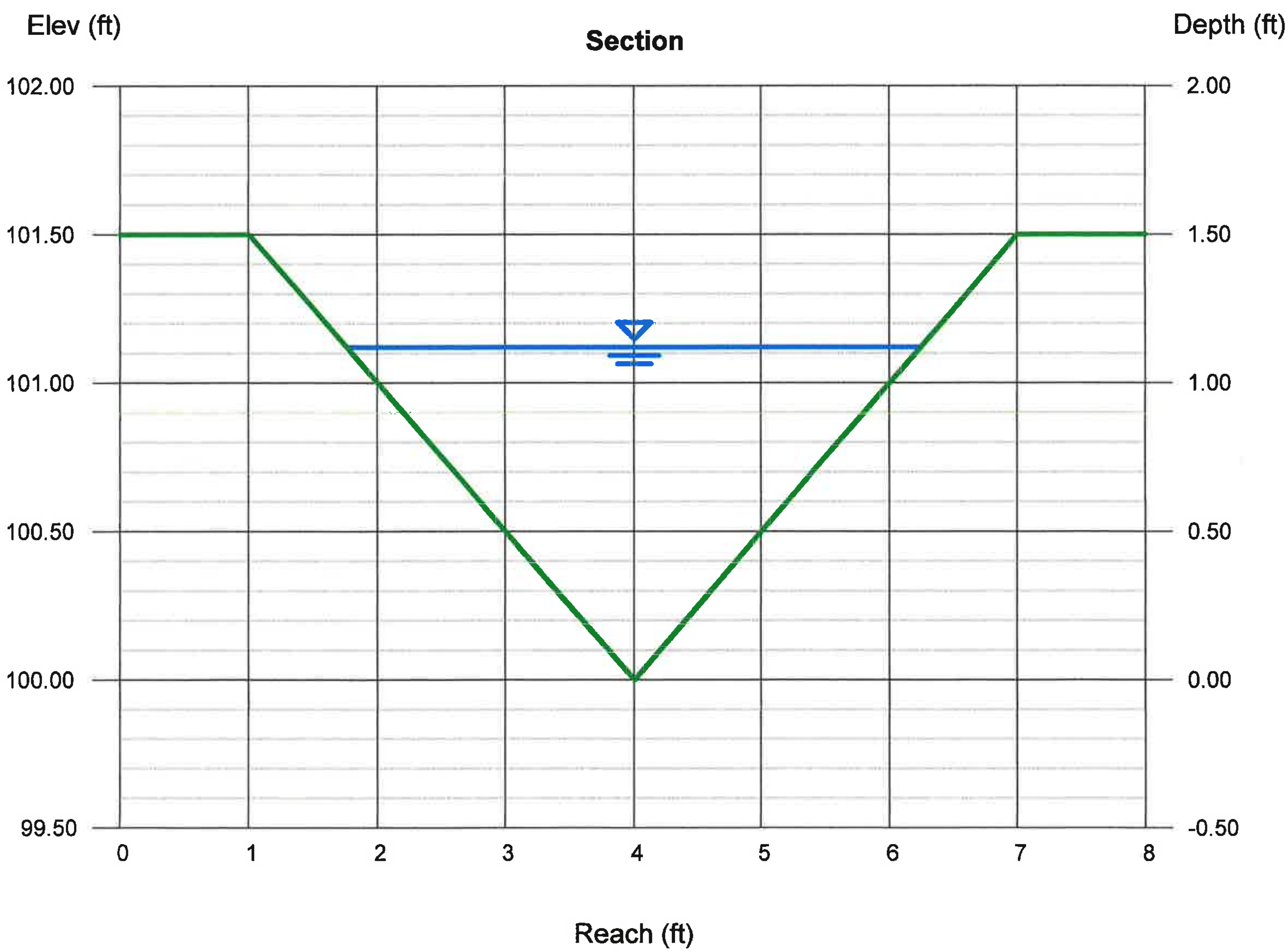
pt#7 V-DITCH rock

Triangular
Side Slopes (z:1) = 2.00, 2.00
Total Depth (ft) = 1.50

Invert Elev (ft) = 100.00
Slope (%) = 0.12
N-Value = 0.040

Calculations
Compute by: Known Q
Known Q (cfs) = 2.00

Highlighted
Depth (ft) = 1.12
Q (cfs) = 2.000
Area (sqft) = 2.51
Velocity (ft/s) = 0.80
Wetted Perim (ft) = 5.01
Crit Depth, Yc (ft) = 0.58
Top Width (ft) = 4.48
EGL (ft) = 1.13

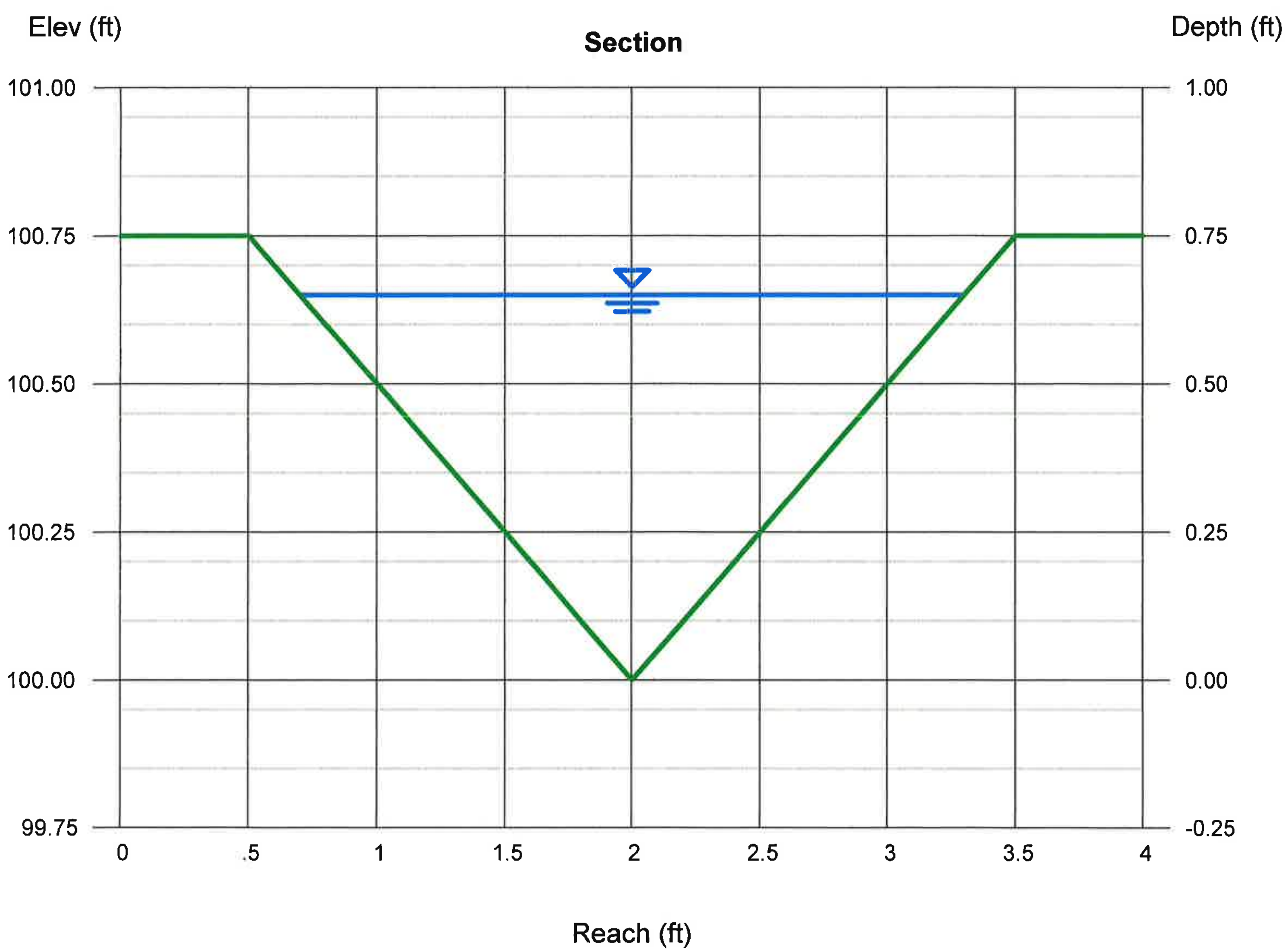


Channel Report

pt#2 V-DITCH

Triangular	
Side Slopes (z:1)	= 2.00, 2.00
Total Depth (ft)	= 0.75
Invert Elev (ft)	= 100.00
Slope (%)	= 0.03
N-Value	= 0.022
Calculations	
Compute by:	Known Q
Known Q (cfs)	= 0.42

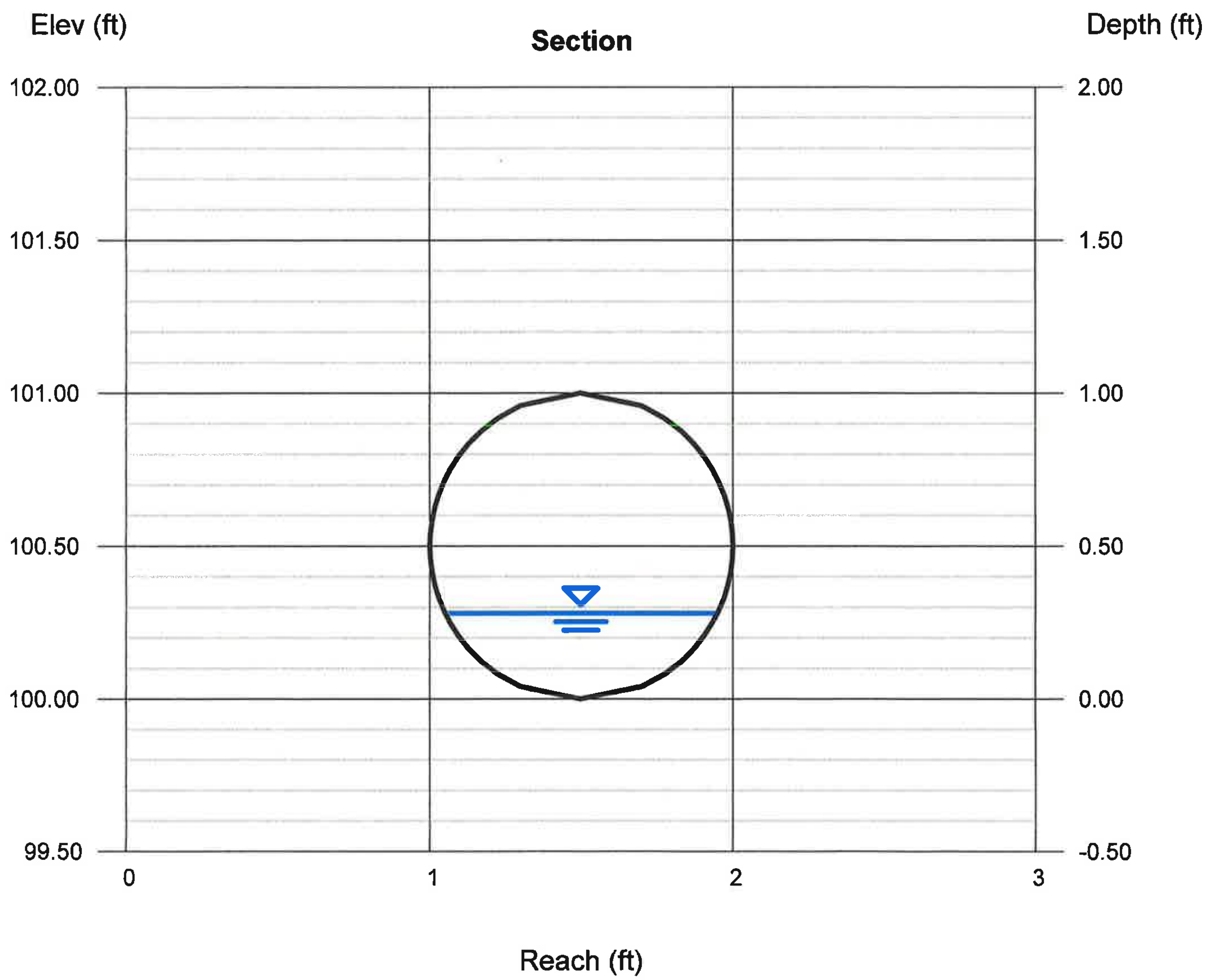
Highlighted	
Depth (ft)	= 0.65
Q (cfs)	= 0.420
Area (sqft)	= 0.84
Velocity (ft/s)	= 0.50
Wetted Perim (ft)	= 2.91
Crit Depth, Yc (ft)	= 0.31
Top Width (ft)	= 2.60
EGL (ft)	= 0.65



Channel Report

pt#1 12in HDPE

Circular		**Highlighted**	
Diameter (ft)	= 1.00	Depth (ft)	= 0.28
		Q (cfs)	= 0.980
		Area (sqft)	= 0.18
Invert Elev (ft)	= 100.00	Velocity (ft/s)	= 5.39
Slope (%)	= 2.00	Wetted Perim (ft)	= 1.12
N-Value	= 0.011	Crit Depth, Yc (ft)	= 0.42
		Top Width (ft)	= 0.90
Calculations		EGL (ft)	= 0.73
Compute by:	Known Q		
Known Q (cfs)	= 0.98		



Channel Report

Hydraflow Express Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. — Wednesday, Dec 4 2019

pt#2 TO pt#6 12in HDPE

Circular		**Highlighted**	
Diameter (ft)	= 1.00	Depth (ft)	= 0.27
		Q (cfs)	= 0.450
		Area (sqft)	= 0.17
Invert Elev (ft)	= 100.00	Velocity (ft/s)	= 2.62
Slope (%)	= 0.50	Wetted Perim (ft)	= 1.09
N-Value	= 0.011	Crit Depth, Yc (ft)	= 0.28
		Top Width (ft)	= 0.89
Calculations		EGL (ft)	= 0.38
Compute by:	Known Q		
Known Q (cfs)	= 0.45