Appendix C – Hydraulic Calculations

- Normal Depth Calculations – Streets
- Normal Depth Calculations – Onsite
- Normal Depth Calculations – Swale
- Trench Drain Calculations

Worksheet for HS-1(10-YR)

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	1.500 %
Discharge	4.00 cfs

Section Definitions

Station (ft)	Elevation (ft)
0+00.00	0.60
0+05.00	0.50
0+05.50	0.48
0+05.50	0.00
0+07.00	0.13
0+07.00	0.17
0+37.50	0.78

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00.00, 0.60)	(0+37.50, 0.78)	0.016

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Normal Depth	0.37 ft
Roughness Coefficient	0.016
Elevation	0.37 ft
Elevation Range	0.00 to 0.78 ft
Flow Area	1.4 ft²
Wetted Perimeter	11.81 ft
Hydraulic Radius	0.12 ft
Top Width	11.39 ft
Normal Depth	0.37 ft
Critical Depth	0.40 ft
Critical Slope	0.748 %
Velocity	2.79 ft/s
Velocity Head	0.12 ft
Specific Energy	0.49 ft

Worksheet for HS-1(10-YR)

Results	
Froude Number	1.388
Flow Type	Supercritical

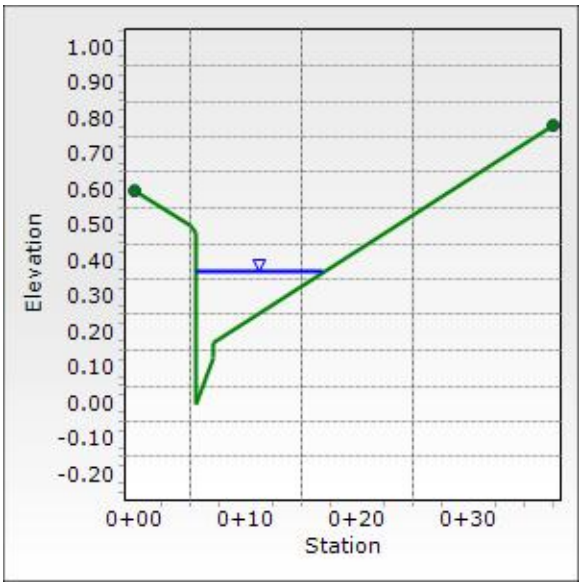
GVF Input Data	
Downstream Depth	0.00 ft
Length	0.00 ft
Number Of Steps	0

GVF Output Data	
Upstream Depth	0.00 ft
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	0.37 ft
Critical Depth	0.40 ft
Channel Slope	1.500 %
Critical Slope	0.748 %

Cross Section for HS-1(10-YR)

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Channel Slope	1.500 %
Normal Depth	0.37 ft
Discharge	4.00 cfs



Worksheet for HS-1 (100-YR)

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	1.500 %
Discharge	8.00 cfs

Section Definitions

Station (ft)	Elevation (ft)
0+00.00	0.60
0+05.00	0.50
0+05.50	0.48
0+05.50	0.00
0+07.00	0.13
0+07.00	0.17
0+37.50	0.78

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00.00, 0.60)	(0+37.50, 0.78)	0.016

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Normal Depth	0.44 ft
Roughness Coefficient	0.016
Elevation	0.44 ft
Elevation Range	0.00 to 0.78 ft
Flow Area	2.4 ft²
Wetted Perimeter	15.65 ft
Hydraulic Radius	0.16 ft
Top Width	15.16 ft
Normal Depth	0.44 ft
Critical Depth	0.50 ft
Critical Slope	0.684 %
Velocity	3.29 ft/s
Velocity Head	0.17 ft
Specific Energy	0.61 ft

Worksheet for HS-1 (100-YR)

Results	
Froude Number	1.447
Flow Type	Supercritical

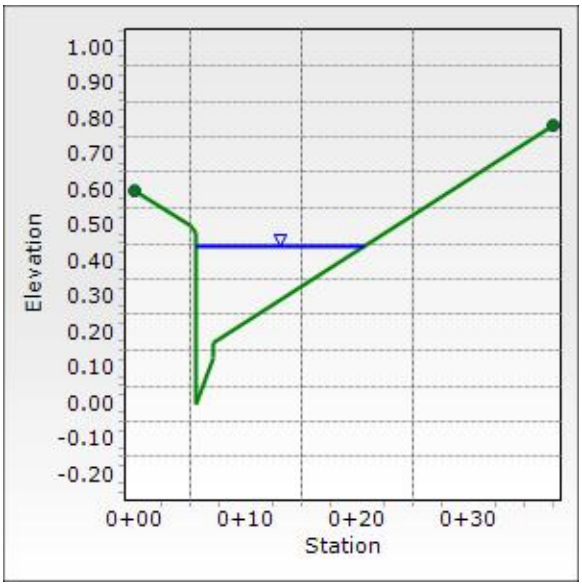
GVF Input Data	
Downstream Depth	0.00 ft
Length	0.00 ft
Number Of Steps	0

GVF Output Data	
Upstream Depth	0.00 ft
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	0.44 ft
Critical Depth	0.50 ft
Channel Slope	1.500 %
Critical Slope	0.684 %

Cross Section for HS-1 (100-YR)

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Channel Slope	1.500 %
Normal Depth	0.44 ft
Discharge	8.00 cfs



Worksheet for DON1-A

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.500	%
Discharge	1.00	cfs

Section Definitions

Station (ft)	Elevation (ft)
0+00.00	0.50
0+00.50	0.48
0+00.50	0.00
0+02.00	0.13
0+02.00	0.17
0+23.00	0.41
0+23.00	1.39
0+24.00	1.41

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00.00, 0.50)	(0+24.00, 1.41)	0.016

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Normal Depth	0.28	ft
Roughness Coefficient	0.016	
Elevation	0.28	ft
Elevation Range	0.00 to 1.41	ft
Flow Area	0.9	ft²
Wetted Perimeter	11.52	ft
Hydraulic Radius	0.07	ft
Top Width	11.20	ft
Normal Depth	0.28	ft
Critical Depth	0.26	ft
Critical Slope	0.945	%
Velocity	1.16	ft/s
Velocity Head	0.02	ft

Worksheet for DON1-A

Results	
Specific Energy	0.30 ft
Froude Number	0.738
Flow Type	Subcritical

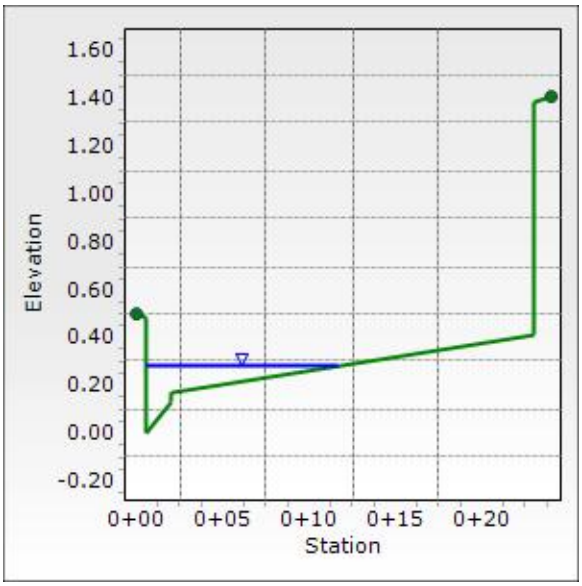
GVF Input Data	
Downstream Depth	0.00 ft
Length	0.00 ft
Number Of Steps	0

GVF Output Data	
Upstream Depth	0.00 ft
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	0.00 ft/s
Upstream Velocity	0.00 ft/s
Normal Depth	0.28 ft
Critical Depth	0.26 ft
Channel Slope	0.500 %
Critical Slope	0.945 %

Cross Section for DON1-A

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Channel Slope	0.500 %
Normal Depth	0.28 ft
Discharge	1.00 cfs



Worksheet for DON1-B

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.500	%
Discharge	1.50	cfs

Section Definitions

Station (ft)	Elevation (ft)
0+00.00	0.50
0+00.50	0.48
0+00.50	0.00
0+02.00	0.13
0+02.00	0.17
0+24.50	1.14
0+24.50	2.12
0+25.00	2.14

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00.00, 0.50)	(0+25.00, 2.14)	0.016

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Normal Depth	0.36	ft
Roughness Coefficient	0.016	
Elevation	0.36	ft
Elevation Range	0.00 to 2.14	ft
Flow Area	0.9	ft²
Wetted Perimeter	6.32	ft
Hydraulic Radius	0.14	ft
Top Width	5.91	ft
Normal Depth	0.36	ft
Critical Depth	0.33	ft
Critical Slope	0.798	%
Velocity	1.74	ft/s
Velocity Head	0.05	ft

Worksheet for DON1-B

Results	
Specific Energy	0.41 ft
Froude Number	0.804
Flow Type	Subcritical

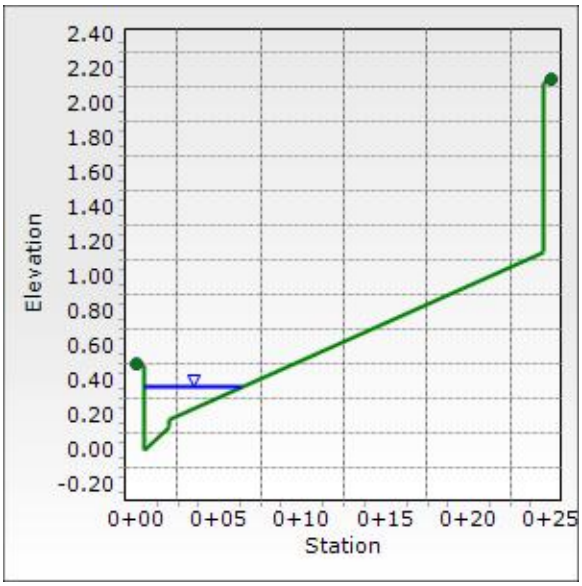
GVF Input Data	
Downstream Depth	0.00 ft
Length	0.00 ft
Number Of Steps	0

GVF Output Data	
Upstream Depth	0.00 ft
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	0.00 ft/s
Upstream Velocity	0.00 ft/s
Normal Depth	0.36 ft
Critical Depth	0.33 ft
Channel Slope	0.500 %
Critical Slope	0.798 %

Cross Section for DON1-B

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Channel Slope	0.500 %
Normal Depth	0.36 ft
Discharge	1.50 cfs



Worksheet for DON1-C

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.500	%
Discharge	1.00	cfs

Section Definitions

Station (ft)	Elevation (ft)
0+00.00	0.50
0+00.50	0.48
0+00.50	0.00
0+02.00	0.13
0+02.00	0.17
0+24.00	0.72

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00.00, 0.50)	(0+24.00, 0.72)	0.016

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Normal Depth	0.30	ft
Roughness Coefficient	0.016	
Elevation	0.30	ft
Elevation Range	0.00 to 0.72	ft
Flow Area	0.7	ft²
Wetted Perimeter	7.16	ft
Hydraulic Radius	0.10	ft
Top Width	6.81	ft
Normal Depth	0.30	ft
Critical Depth	0.28	ft
Critical Slope	0.875	%
Velocity	1.41	ft/s
Velocity Head	0.03	ft
Specific Energy	0.33	ft
Froude Number	0.770	

Worksheet for DON1-C

Results	
Flow Type	Subcritical

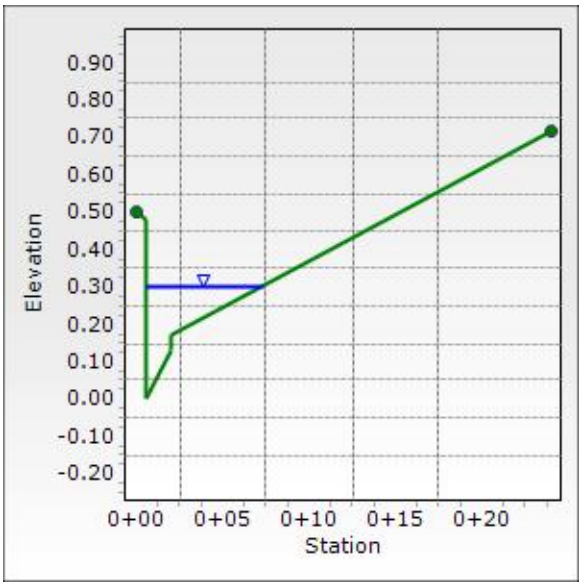
GVF Input Data	
Downstream Depth	0.00 ft
Length	0.00 ft
Number Of Steps	0

GVF Output Data	
Upstream Depth	0.00 ft
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	0.00 ft/s
Upstream Velocity	0.00 ft/s
Normal Depth	0.30 ft
Critical Depth	0.28 ft
Channel Slope	0.500 %
Critical Slope	0.875 %

Cross Section for DON1-C

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Channel Slope	0.500 %
Normal Depth	0.30 ft
Discharge	1.00 cfs



Worksheet for SW-1

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data		
Roughness Coefficient	0.035	
Channel Slope	1.000	%
Left Side Slope	4.000	H:V
Right Side Slope	4.000	H:V
Discharge	5.00	cfs

Results		
Normal Depth	0.76	ft
Flow Area	2.3	ft²
Wetted Perimeter	6.25	ft
Hydraulic Radius	0.37	ft
Top Width	6.06	ft
Critical Depth	0.63	ft
Critical Slope	2.735	%
Velocity	2.18	ft/s
Velocity Head	0.07	ft
Specific Energy	0.83	ft
Froude Number	0.624	
Flow Type	Subcritical	

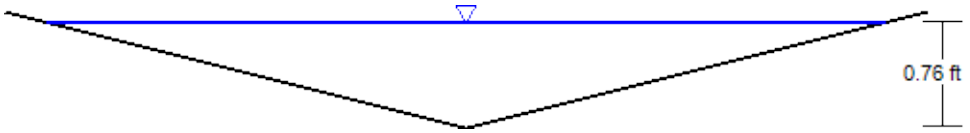
GVF Input Data		
Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

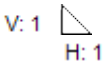
GVF Output Data		
Upstream Depth	0.00	ft
Profile Description	N/A	
Profile Headloss	0.00	ft
Downstream Velocity	0.00	ft/s
Upstream Velocity	0.00	ft/s
Normal Depth	0.76	ft
Critical Depth	0.63	ft
Channel Slope	1.000	%
Critical Slope	2.735	%

XS for SW-1

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data		
Roughness Coefficient	0.035	
Channel Slope	1.000	%
Normal Depth	0.76	ft
Left Side Slope	4.000	H:V
Right Side Slope	4.000	H:V
Discharge	5.00	cfs





Worksheet for CH-1

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	1.000	%
Discharge	5.00	cfs

Section Definitions

Station (ft)	Elevation (ft)
0+00.00	0.55
0+00.50	0.55
0+00.50	0.05
0+03.00	0.00
0+05.50	0.05
0+05.50	0.55
0+06.00	0.55

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00.00, 0.55)	(0+06.00, 0.55)	0.015

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Normal Depth	0.29	ft
Roughness Coefficient	0.015	
Elevation	0.29	ft
Elevation Range	0.00 to 0.55	ft
Flow Area	1.3	ft²
Wetted Perimeter	5.47	ft
Hydraulic Radius	0.24	ft
Top Width	5.00	ft
Normal Depth	0.29	ft
Critical Depth	0.34	ft
Critical Slope	0.558	%
Velocity	3.82	ft/s
Velocity Head	0.23	ft
Specific Energy	0.51	ft

Worksheet for CH-1

Results	
Froude Number	1.316
Flow Type	Supercritical

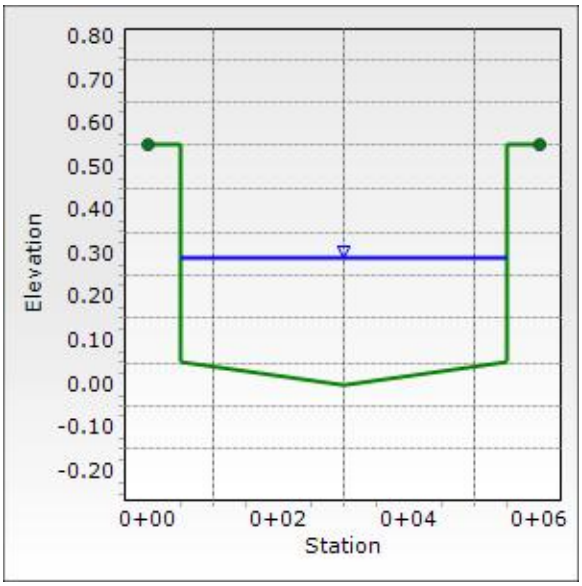
GVF Input Data	
Downstream Depth	0.00 ft
Length	0.00 ft
Number Of Steps	0

GVF Output Data	
Upstream Depth	0.00 ft
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	0.29 ft
Critical Depth	0.34 ft
Channel Slope	1.000 %
Critical Slope	0.558 %

Cross Section for CH-1

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Channel Slope	1.000 %
Normal Depth	0.29 ft
Discharge	5.00 cfs



Worksheet for 12" Trench Drain

Project Description	
Friction Method	Manning Formula
Solve For	Full Flow Capacity

Input Data		
Roughness Coefficient	0.013	
Channel Slope	0.500	%
Normal Depth	1.00	ft
Diameter	12.0	in
Discharge	2.52	cfs

Results		
Discharge	2.52	cfs
Normal Depth	1.00	ft
Flow Area	0.8	ft²
Wetted Perimeter	3.14	ft
Hydraulic Radius	0.25	ft
Top Width	0.00	ft
Critical Depth	0.68	ft
Percent Full	100.0	%
Critical Slope	0.770	%
Velocity	3.21	ft/s
Velocity Head	0.16	ft
Specific Energy	1.16	ft
Froude Number	(N/A)	
Maximum Discharge	2.71	cfs
Discharge Full	2.52	cfs
Slope Full	0.500	%
Flow Type	Undefined	

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	N/A	
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.0	%
Normal Depth Over Rise	0.0	%
Downstream Velocity	0.00	ft/s
Upstream Velocity	0.00	ft/s
Normal Depth	1.00	ft
Critical Depth	0.68	ft
Channel Slope	0.500	%
Critical Slope	0.770	%

Cross Section for 12" Trench Drain

Project Description	
Friction Method	Manning Formula
Solve For	Full Flow Capacity

Input Data		
Roughness Coefficient	0.013	
Channel Slope	0.500	%
Normal Depth	1.00	ft
Diameter	12.0	in
Discharge	2.52	cfs