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BINDER 6 OF 6

EROSION AND SEDIMENTATION CONTROL PLAN NARRATIVE

Bell Bend Nuclear Power Plant
Salem Township
Luzerne County, PA

Applicant
PPL Bell Bend, LLC
38 Bomboy Lane
Suite 2
Berwick, PA 18603

Application Date
November 12, 2010

PPLS0902

Binder 4 of 6 – Erosion and Sedimentation Control Plan Narrative

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APPENDIX H
Swale Calculations

EROSION AND SEDIMENTATION PERMANENT SWALE CALCULATIONS

Bell Bend Nuclear Power Plant
Salem Township
Luzerne County, PA

STANDARD WORKSHEET #21
Channel Design Data

PROJECT NAME: PPL Bell Bend, PPLS0902
LOCATION: Salem Township
PREPARED BY: GMP DATE: 10/22/10
CHECKED BY: LGB DATE: 10/27/10

CHANNEL OR CHANNEL SECTION	1.1 Unveg	1.1 Veg		1.2 Unveg	1.2 Veg
PROTECTIVE LINING **	S75	Grass		S75	Grass
CHANNEL TOP WIDTH (FT)@ D	8.00	8.00		8.00	8.00
CHANNEL TOP WIDTH (FT)@ d	3.84	3.42		3.84	3.42
CHANNEL SIDE SLOPES (H:V)	2	2		2	2
CHANNEL BOTTOM WIDTH (FT)	2.0	2.0		2.0	2.0
d (FLOW DEPTH IN FT)	0.46	0.35		0.46	0.35
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	4:1	6:1		4:1	6:1
A (AREA IN SQ. FT.)	1.34	0.96		1.34	0.96
R (HYDRAULIC RADIUS)	0.33	0.27		0.33	0.27
S (BED SLOPE, FT/FT)*	0.0130	0.0130		0.0130	0.0130
VEGETATIVE LINING RETARDANCE	-	B		-	B
n (MANNING'S COEFFICIENT)**	0.0550	0.0500		0.0550	0.0500
V (AT FLOW DEPTH d, CFS)	1.04	1.46		1.04	1.46
Q (AT FLOW DEPTH d, CFS)	1.40	1.40		1.40	1.40
Q_r (REQUIRED CAPACITY) CFS	-	-		-	-
S_c (CRITICAL SLOPE)	0.0673	0.0592		0.0673	0.0592
$.7S_c$	0.0471	0.0471		0.0471	0.0471
$1.3S_c$	0.0875	0.0875		0.0875	0.0875
STABLE FLOW? (Y/N)	Y	Y		Y	Y
FREEBOARD BASED ON UNSTABLE FLOW FT	-	-		-	-
FREEBOARD BASED ON STABLE FLOW FT	1.04	1.15		1.04	1.15
MINIMUM REQUIRED FREEBOARD FT	0.5	0.5		0.5	0.5
D (TOTAL DEPTH) FT	1.50	1.50		1.50	1.50
d_{50} STONE SIZE (IN)	-	-		-	-
DESIGN METHOD FOR PROTECTIVE LINING **** PERMISSIBLE VELOCITY (V) OR SHEAR STRESS (S)	V/S	V/S		V/S	V/S
V_a (ALLOWABLE VELOCITY) FPS	5.0	3.5		5.0	3.5
τ_d (SHEAR STRESS AT FLOW DEPTH d) LB/FT^2	0.37	0.29		0.37	0.29
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	1.55	1.55		1.55	1.55

* Slopes may not be averaged.
** For vegetated channels, provide data for temporary linings and vegetated conditions in separate columns.
*** Minimum Freeboard,F, is 0.5 ft.
**** Permissible velocity lining design method is not acceptable for channels with a bed slope of 10% or greater. Shear stress lining design method is recommended for channels with a bed slope of 10% or greater. Shear stress lining design method may be used for any channel bed slope.

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CHANNEL OR CHANNEL SECTION	1.3 Unveg	1.3 Veg			
PROTECTIVE LINING **	S75	Grass			
CHANNEL TOP WIDTH (FT)@ D	10.00	10.00			
CHANNEL TOP WIDTH (FT)@ d	4.49	4.39			
CHANNEL SIDE SLOPES (H:V)	2	2			
CHANNEL BOTTOM WIDTH (FT)	2.0	2.0			
d (FLOW DEPTH IN FT)	0.62	0.60			
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	3:1	3:1			
A (AREA IN SQ. FT.)	2.02	1.91			
R (HYDRAULIC RADIUS)	0.42	0.41			
S (BED SLOPE, FT/FT)*	0.0170	0.0170			
VEGETATIVE LINING RETARDANCE	-	B			
n (MANNING'S COEFFICIENT)**	0.0520	0.0500			
V (AT FLOW DEPTH d, CFS)	2.03	2.15			
Q (AT FLOW DEPTH d, CFS)	4.10	4.10			
Q_r (REQUIRED CAPACITY) CFS	-	-			
S_c (CRITICAL SLOPE)	0.0559	0.0522			
$.7S_c$	0.0391	0.0365			
$1.3S_c$	0.0875	0.0679			
STABLE FLOW? (Y/N)	Y	Y			
FREEBOARD BASED ON UNSTABLE FLOW FT	-	-			
FREEBOARD BASED ON STABLE FLOW FT	1.38	1.40			
MINIMUM REQUIRED FREEBOARD FT	0.5	0.5			
D (TOTAL DEPTH) FT	2	2			
d_{50} STONE SIZE (IN)	-	-			
DESIGN METHOD FOR PROTECTIVE LINING **** PERMISSIBLE VELOCITY (V) OR SHEAR STRESS (S)	V/S	V/S			
V_a (ALLOWABLE VELOCITY) FPS	5.0	3.5			
τ_d (SHEAR STRESS AT FLOW DEPTH d) LB/FT^2	0.66	0.63			
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	1.55	1.55			

* Slopes may not be averaged.
** For vegetated channels, provide data for temporary linings and vegetated conditions in separate columns.
*** Minimum Freeboard, F, is 0.5 ft.
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CHANNEL OR CHANNEL SECTION	2.1 Unveg	2.1 Veg		2.2 Unveg	2.2 Veg
PROTECTIVE LINING **	S75	Grass		S75	Grass
CHANNEL TOP WIDTH (FT)@ D	8.00	8.00		12.00	12.00
CHANNEL TOP WIDTH (FT)@ d	3.78	3.36		3.83	3.33
CHANNEL SIDE SLOPES (H:V)	2	2		2	2
CHANNEL BOTTOM WIDTH (FT)	2.0	2.0		2.0	2.0
d (FLOW DEPTH IN FT)	0.44	0.34		0.46	0.33
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	5:1	6:1		4:1	6:1
A (AREA IN SQ. FT.)	1.28	0.91		1.33	0.89
R (HYDRAULIC RADIUS)	0.32	0.32		0.33	0.33
S (BED SLOPE, FT/FT)*	0.0130	0.0130		0.0100	0.0100
VEGETATIVE LINING RETARDANCE	-	B		-	B
n (MANNING'S COEFFICIENT)**	0.0550	0.0500		0.0550	0.0500
V (AT FLOW DEPTH d, CFS)	1.01	1.43		0.83	1.24
Q (AT FLOW DEPTH d, CFS)	1.30	1.30		1.10	1.10
Q_r (REQUIRED CAPACITY) CFS	-	-		-	-
S_c (CRITICAL SLOPE)	0.0678	0.0599		0.0674	0.0602
$.7S_c$	0.0475	0.0419		0.0472	0.0472
$1.3S_c$	0.0881	0.0779		0.0876	0.0783
STABLE FLOW? (Y/N)	Y	Y		Y	Y
FREEBOARD BASED ON UNSTABLE FLOW FT	-	-		-	-
FREEBOARD BASED ON STABLE FLOW FT	1.06	1.45		1.04	1.47
MINIMUM REQUIRED FREEBOARD FT	0.5	0.5		0.5	0.5
D (TOTAL DEPTH) FT	1.50	1.50		1.50	1.50
d_{50} STONE SIZE (IN)	-	-		-	-
DESIGN METHOD FOR PROTECTIVE LINING **** PERMISSIBLE VELOCITY (V) OR SHEAR STRESS (S)	V/S	V/S		V/S	V/S
V_a (ALLOWABLE VELOCITY) FPS	5.0	3.5		5.0	3.5
τ_d (SHEAR STRESS AT FLOW DEPTH d) LB/FT^2	0.36	0.28		0.29	0.21
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	1.55	1.55		1.55	1.55

* Slopes may not be averaged.
** For vegetated channels, provide data for temporary linings and vegetated conditions in separate columns.
*** Minimum Freeboard,F, is 0.5 ft.
**** Permissible velocity lining design method is not acceptable for channels with a bed slope of 10% or greater. Shear stress lining design method is recommended for channels with a bed slope of 10% or greater. Shear stress lining design method may be used for any channel bed slope.

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CHANNEL OR CHANNEL SECTION	3.1 Unveg	3.1 Veg		3.2 Unveg	3.2 Veg
PROTECTIVE LINING **	S75	Grass		S75	Grass
CHANNEL TOP WIDTH (FT)@ D	12.00	12.00		10.00	10.00
CHANNEL TOP WIDTH (FT)@ d	6.30	6.20		4.44	4.13
CHANNEL SIDE SLOPES (H:V)	2	2		2	2
CHANNEL BOTTOM WIDTH (FT)	4.0	4.0		2.0	2.0
d (FLOW DEPTH IN FT)	0.58	0.55		0.61	0.53
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	7:1	7:1		3:1	4:1
A (AREA IN SQ. FT.)	2.97	2.81		1.96	1.63
R (HYDRAULIC RADIUS)	0.45	0.43		0.41	0.37
S (BED SLOPE, FT/FT)*	0.0100	0.0100		0.0100	0.0100
VEGETATIVE LINING RETARDANCE	-	B		-	B
n (MANNING'S COEFFICIENT)**	0.0530	0.0500		0.0540	0.0500
V (AT FLOW DEPTH d, CFS)	1.62	1.71		1.28	1.53
Q (AT FLOW DEPTH d, CFS)	4.80	4.80		2.50	2.50
Q_r (REQUIRED CAPACITY) CFS	-	-		-	-
S_c (CRITICAL SLOPE)	0.0556	0.0501		0.0606	0.0537
$.7S_c$	0.0389	0.0351		0.0424	0.0698
$1.3S_c$	0.0876	0.0651		0.0788	0.0376
STABLE FLOW? (Y/N)	Y	Y		Y	Y
FREEBOARD BASED ON UNSTABLE FLOW FT	-	-		-	-
FREEBOARD BASED ON STABLE FLOW FT	1.42	1.45		1.39	1.47
MINIMUM REQUIRED FREEBOARD FT	0.5	0.5		0.5	0.5
D (TOTAL DEPTH) FT	2.0	2.0		2.0	2.0
d_{50} STONE SIZE (IN)	-	-		-	-
DESIGN METHOD FOR PROTECTIVE LINING **** PERMISSIBLE VELOCITY (V) OR SHEAR STRESS (S)	V/S	V/S		V/S	V/S
V_a (ALLOWABLE VELOCITY) FPS	5.0	3.5		5.0	3.5
τ_d (SHEAR STRESS AT FLOW DEPTH d) LB/FT^2	0.36	0.34		0.38	0.33
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	1.55	1.55		1.55	1.55

* Slopes may not be averaged.
** For vegetated channels, provide data for temporary linings and vegetated conditions in separate columns.
*** Minimum Freeboard,F, is 0.5 ft.
**** Permissible velocity lining design method is not acceptable for channels with a bed slope of 10% or greater. Shear stress lining design method is recommended for channels with a bed slope of 10% or greater. Shear stress lining design method may be used for any channel bed slope.

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CHANNEL OR CHANNEL SECTION	3.3 Unveg	3.3 Veg		3.4 Unveg	3.4 Veg
PROTECTIVE LINING **	S75	Grass		S75	Grass
CHANNEL TOP WIDTH (FT)@ D	12.00	12.00		15.00	15.00
CHANNEL TOP WIDTH (FT)@ d	6.27	6.18		5.70	5.65
CHANNEL SIDE SLOPES (H:V)	2	2		2	2
CHANNEL BOTTOM WIDTH (FT)	4.0	4.0		3.0	3.0
d (FLOW DEPTH IN FT)	0.57	0.54		0.68	0.66
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	7:1	7:1		5:1	5:1
A (AREA IN SQ. FT.)	2.91	2.77		2.94	2.87
R (HYDRAULIC RADIUS)	0.45	0.43		0.49	0.48
S (BED SLOPE, FT/FT)*	0.0330	0.0330		0.0330	0.0330
VEGETATIVE LINING RETARDANCE	-	B		-	B
n (MANNING'S COEFFICIENT)**	0.0530	0.0500		0.0510	0.0500
V (AT FLOW DEPTH d, CFS)	2.94	3.10		3.25	3.33
Q (AT FLOW DEPTH d, CFS)	8.57	8.57		9.57	9.57
Q_r (REQUIRED CAPACITY) CFS	-	-		-	-
S_c (CRITICAL SLOPE)	0.0558	0.0502		0.0508	0.0490
$.7S_c$	0.0391	0.0351		0.0356	0.0343
$1.3S_c$	0.0725	0.0653		0.0660	0.0637
STABLE FLOW? (Y/N)	Y	Y		Y	Y
FREEBOARD BASED ON UNSTABLE FLOW FT	-	-		-	-
FREEBOARD BASED ON STABLE FLOW FT	1.43	1.46		2.32	2.34
MINIMUM REQUIRED FREEBOARD FT	0.5	0.5		0.5	0.5
D (TOTAL DEPTH) FT	2.0	2.0		3.0	3.0
d_{50} STONE SIZE (IN)	-	-		-	-
DESIGN METHOD FOR PROTECTIVE LINING **** PERMISSIBLE VELOCITY (V) OR SHEAR STRESS (S)	V/S	V/S		V/S	V/S
V_a (ALLOWABLE VELOCITY) FPS	5.0	3.5		5.0	3.5
τ_d (SHEAR STRESS AT FLOW DEPTH d) LB/FT^2	1.17	1.12		1.39	1.37
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	1.55	1.55		1.55	1.55

* Slopes may not be averaged.
** For vegetated channels, provide data for temporary linings and vegetated conditions in separate columns.
*** Minimum Freeboard, F, is 0.5 ft.
**** Permissible velocity lining design method is not acceptable for channels with a bed slope of 10% or greater. Shear stress lining design method is recommended for channels with a bed slope of 10% or greater. Shear stress lining design method may be used for any channel bed slope.

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CHANNEL OR CHANNEL SECTION	3.5 Unveg	3.5 Veg		3.6 Unveg	3.6 Veg
PROTECTIVE LINING **	S75	Grass		S75	Grass
CHANNEL TOP WIDTH (FT)@ D	13.00	13.00		14.00	14.00
CHANNEL TOP WIDTH (FT)@ d	4.53	4.62		5.00	4.87
CHANNEL SIDE SLOPES (H:V)	2	2		2	2
CHANNEL BOTTOM WIDTH (FT)	1.0	1.0		2.0	2.0
d (FLOW DEPTH IN FT)	0.88	0.90		0.75	0.72
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	1:1	1:1		3:1	3:1
A (AREA IN SQ. FT.)	2.44	2.54		2.62	2.46
R (HYDRAULIC RADIUS)	0.49	0.50		0.49	0.47
S (BED SLOPE, FT/FT)*	0.0080	0.0080		0.0070	0.0070
VEGETATIVE LINING RETARDANCE	-	B		-	B
n (MANNING'S COEFFICIENT)**	0.0460	0.0500		0.0500	0.0500
V (AT FLOW DEPTH d, CFS)	1.76	1.69		1.45	1.54
Q (AT FLOW DEPTH d, CFS)	4.30	4.30		3.80	3.80
Q_r (REQUIRED CAPACITY) CFS	-	-		-	-
S_c (CRITICAL SLOPE)	0.0426	0.0500		0.0494	0.0500
$.7S_c$	0.0298	0.0350		0.0346	0.0350
$1.3S_c$	0.0554	0.0650		0.0642	0.0650
STABLE FLOW? (Y/N)	Y	Y		Y	Y
FREEBOARD BASED ON UNSTABLE FLOW FT	-	-		-	-
FREEBOARD BASED ON STABLE FLOW FT	2.12	2.10		2.25	2.28
MINIMUM REQUIRED FREEBOARD FT	0.5	0.5		0.5	0.5
D (TOTAL DEPTH) FT	3.0	3.0		3.0	3.0
d_{50} STONE SIZE (IN)	-	-		-	-
DESIGN METHOD FOR PROTECTIVE LINING **** PERMISSIBLE VELOCITY (V) OR SHEAR STRESS (S)	V/S	V/S		V/S	V/S
V_a (ALLOWABLE VELOCITY) FPS	5.0	3.5		5.0	3.5
τ_d (SHEAR STRESS AT FLOW DEPTH d) LB/FT^2	0.44	0.45		0.33	0.31
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	1.55	1.55		1.55	1.55

* Slopes may not be averaged.
** For vegetated channels, provide data for temporary linings and vegetated conditions in separate columns.
*** Minimum Freeboard,F, is 0.5 ft.
**** Permissible velocity lining design method is not acceptable for channels with a bed slope of 10% or greater. Shear stress lining design method is recommended for channels with a bed slope of 10% or greater. Shear stress lining design method may be used for any channel bed slope.

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CHANNEL OR CHANNEL SECTION	3.7 Unveg	3.7 Veg		3.8 Unveg	3.8 Veg
PROTECTIVE LINING **	S75	Grass		S75	Grass
CHANNEL TOP WIDTH (FT)@ D	14.00	14.00		19.00	19.00
CHANNEL TOP WIDTH (FT)@ d	5.17	5.03		7.47	7.92
CHANNEL SIDE SLOPES (H:V)	2	2		2	2
CHANNEL BOTTOM WIDTH (FT)	2.0	2.0		3.0	3.0
d (FLOW DEPTH IN FT)	0.79	0.76		1.12	1.23
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	3:1	3:1		3:1	3:1
A (AREA IN SQ. FT.)	2.84	2.67		5.85	6.72
R (HYDRAULIC RADIUS)	0.51	0.49		0.73	0.79
S (BED SLOPE, FT/FT)*	0.0050	0.0050		0.0050	0.0050
VEGETATIVE LINING RETARDANCE	-	B		-	B
n (MANNING'S COEFFICIENT)**	0.0490	0.0500		0.0410	0.0500
V (AT FLOW DEPTH d, CFS)	1.23	1.31		2.07	1.80
Q (AT FLOW DEPTH d, CFS)	3.50	3.50		12.10	12.10
Q_r (REQUIRED CAPACITY) CFS	-	-		-	-
S_c (CRITICAL SLOPE)	0.0468	0.0493		0.0291	0.0423
$.7S_c$	0.0328	0.0345		0.0204	0.0296
$1.3S_c$	0.0608	0.0641		0.0378	0.0550
STABLE FLOW? (Y/N)	Y	Y		Y	Y
FREEBOARD BASED ON UNSTABLE FLOW FT	-	-		-	-
FREEBOARD BASED ON STABLE FLOW FT	2.21	2.24		2.88	2.77
MINIMUM REQUIRED FREEBOARD FT	0.5	0.5		0.5	0.5
D (TOTAL DEPTH) FT	3.0	3.0		4.0	4.0
d_{50} STONE SIZE (IN)	-	-		-	-
DESIGN METHOD FOR PROTECTIVE LINING **** PERMISSIBLE VELOCITY (V) OR SHEAR STRESS (S)	V/S	V/S		V/S	V/S
V_a (ALLOWABLE VELOCITY) FPS	5.0	3.5		5.0	3.5
τ_d (SHEAR STRESS AT FLOW DEPTH d) LB/FT^2	0.25	0.24		0.35	0.38
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	1.55	1.55		1.55	1.55

* Slopes may not be averaged.
** For vegetated channels, provide data for temporary linings and vegetated conditions in separate columns.
*** Minimum Freeboard, F, is 0.5 ft.
**** Permissible velocity lining design method is not acceptable for channels with a bed slope of 10% or greater. Shear stress lining design method is recommended for channels with a bed slope of 10% or greater. Shear stress lining design method may be used for any channel bed slope.

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CHANNEL OR CHANNEL SECTION	4.1 Unveg	4.1 Veg		4.2 Unveg	4.2 Veg
PROTECTIVE LINING **	S75	Grass		S75	Grass
CHANNEL TOP WIDTH (FT)@ D	14.00	14.00		11.00	11.00
CHANNEL TOP WIDTH (FT)@ d	5.44	5.51		5.31	5.23
CHANNEL SIDE SLOPES (H:V)	2	2		2	2
CHANNEL BOTTOM WIDTH (FT)	2.0	2.0		3.0	3.0
d (FLOW DEPTH IN FT)	0.86	0.88		0.58	0.56
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	2:1	2:1		5:1	5:1
A (AREA IN SQ. FT.)	3.20	3.30		2.40	2.29
R (HYDRAULIC RADIUS)	0.55	0.56		0.43	0.42
S (BED SLOPE, FT/FT)*	0.0110	0.0110		0.0120	0.0120
VEGETATIVE LINING RETARDANCE	-	B		-	B
n (MANNING'S COEFFICIENT)**	0.0470	0.0500		0.0530	0.0500
V (AT FLOW DEPTH d, CFS)	2.19	2.12		1.71	1.79
Q (AT FLOW DEPTH d, CFS)	7.00	7.00		4.10	4.10
Q_r (REQUIRED CAPACITY) CFS	-	-		-	-
S_c (CRITICAL SLOPE)	0.0423	0.0476		0.0570	0.0512
$.7S_c$	0.0296	0.0333		0.0399	0.0358
$1.3S_c$	0.0550	0.0619		0.0741	0.0666
STABLE FLOW? (Y/N)	Y	Y		Y	Y
FREEBOARD BASED ON UNSTABLE FLOW FT	-	-		-	-
FREEBOARD BASED ON STABLE FLOW FT	2.14	2.12		1.42	1.44
MINIMUM REQUIRED FREEBOARD FT	0.5	0.5		0.5	0.5
D (TOTAL DEPTH) FT	3.0	3.0		2.0	2.0
d_{50} STONE SIZE (IN)	-	-		-	-
DESIGN METHOD FOR PROTECTIVE LINING **** PERMISSIBLE VELOCITY (V) OR SHEAR STRESS (S)	V/S	V/S		V/S	V/S
V_a (ALLOWABLE VELOCITY) FPS	5.0	3.5		5.0	3.5
τ_d (SHEAR STRESS AT FLOW DEPTH d) LB/FT^2	0.59	0.60		0.43	0.42
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	1.55	1.55		1.55	1.55

* Slopes may not be averaged.
** For vegetated channels, provide data for temporary linings and vegetated conditions in separate columns.
*** Minimum Freeboard, F, is 0.5 ft.
**** Permissible velocity lining design method is not acceptable for channels with a bed slope of 10% or greater. Shear stress lining design method is recommended for channels with a bed slope of 10% or greater. Shear stress lining design method may be used for any channel bed slope.

STANDARD WORKSHEET #21
Channel Design Data

PROJECT NAME: PPL Bell Bend, PPLS0902
LOCATION: Salem Township
PREPARED BY: GMP DATE: 10/22/10
CHECKED BY: LGB DATE: 10/27/10

CHANNEL OR CHANNEL SECTION	4.3 Unveg	4.3 Veg		4.4 Unveg	4.4 Veg
PROTECTIVE LINING **	S75	Grass		S75	Grass
CHANNEL TOP WIDTH (FT)@ D	9.00	9.00		9.00	9.00
CHANNEL TOP WIDTH (FT)@ d	2.47	2.34		2.26	2.14
CHANNEL SIDE SLOPES (H:V)	2	2		2	2
CHANNEL BOTTOM WIDTH (FT)	1.0	1.0		1.0	1.0
d (FLOW DEPTH IN FT)	0.37	0.33		0.31	0.28
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	3:1	3:1		3:1	3:1
A (AREA IN SQ. FT.)	0.64	0.56		0.51	0.44
R (HYDRAULIC RADIUS)	0.24	0.22		0.21	0.20
S (BED SLOPE, FT/FT)*	0.0180	0.0180		0.0200	0.0200
VEGETATIVE LINING RETARDANCE	-	B		-	B
n (MANNING'S COEFFICIENT)**	0.0550	0.0500		0.0550	0.0500
V (AT FLOW DEPTH d, CFS)	1.25	1.44		1.17	1.35
Q (AT FLOW DEPTH d, CFS)	0.80	0.80		0.60	0.60
Q_r (REQUIRED CAPACITY) CFS	-	-		-	-
S_c (CRITICAL SLOPE)	0.0757	0.0640		0.0786	0.0666
$.7S_c$	0.0530	0.0448		0.0550	0.0466
$1.3S_c$	0.0984	0.0832		0.1022	0.0866
STABLE FLOW? (Y/N)	Y	Y		Y	Y
FREEBOARD BASED ON UNSTABLE FLOW FT	-	-		-	-
FREEBOARD BASED ON STABLE FLOW FT	1.63	1.67		1.69	1.72
MINIMUM REQUIRED FREEBOARD FT	0.5	0.5		0.5	0.5
D (TOTAL DEPTH) FT	2.0	2.0		2.0	2.0
d_{50} STONE SIZE (IN)	-	-		-	-
DESIGN METHOD FOR PROTECTIVE LINING **** PERMISSIBLE VELOCITY (V) OR SHEAR STRESS (S)	V/S	V/S		V/S	V/S
V_a (ALLOWABLE VELOCITY) FPS	5.0	3.5		5.0	3.5
τ_d (SHEAR STRESS AT FLOW DEPTH d) LB/FT^2	0.41	0.37		0.39	0.35
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	1.55	1.55		1.55	1.55

* Slopes may not be averaged.
** For vegetated channels, provide data for temporary linings and vegetated conditions in separate columns.
*** Minimum Freeboard,F, is 0.5 ft.
**** Permissible velocity lining design method is not acceptable for channels with a bed slope of 10% or greater. Shear stress lining design method is recommended for channels with a bed slope of 10% or greater. Shear stress lining design method may be used for any channel bed slope.

STANDARD WORKSHEET #21
Channel Design Data

PROJECT NAME: PPL Bell Bend, PPLS0902
LOCATION: Salem Township
PREPARED BY: GMP DATE: 10/22/10
CHECKED BY: LGB DATE: 10/27/10

CHANNEL OR CHANNEL SECTION	4.5 Unveg	4.5 Veg		4.6 Unveg	4.6 Veg
PROTECTIVE LINING **	S75	Grass		S75	Grass
CHANNEL TOP WIDTH (FT)@ D	9.00	9.00		15.00	15.00
CHANNEL TOP WIDTH (FT)@ d	2.46	2.35		6.46	6.55
CHANNEL SIDE SLOPES (H:V)	2	2		2	2
CHANNEL BOTTOM WIDTH (FT)	1.0	1.0		3.0	3.0
d (FLOW DEPTH IN FT)	0.36	0.34		0.86	0.89
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	3:1	3:1		4:1	4:1
A (AREA IN SQ. FT.)	0.63	0.56		4.09	4.24
R (HYDRAULIC RADIUS)	0.24	0.22		0.60	0.61
S (BED SLOPE, FT/FT)*	0.0330	0.0330		0.0060	0.0060
VEGETATIVE LINING RETARDANCE	-	B		-	B
n (MANNING'S COEFFICIENT)**	0.0550	0.0500		0.0470	0.0500
V (AT FLOW DEPTH d, CFS)	1.74	1.95		1.71	1.65
Q (AT FLOW DEPTH d, CFS)	1.10	1.10		7.00	7.00
Q_r (REQUIRED CAPACITY) CFS	-	-		-	-
S_c (CRITICAL SLOPE)	0.0759	0.0639		0.0406	0.0457
$.7S_c$	0.0531	0.0447		0.0284	0.0320
$1.3S_c$	0.0987	0.0831		0.0528	0.0594
STABLE FLOW? (Y/N)	Y	Y		Y	Y
FREEBOARD BASED ON UNSTABLE FLOW FT	-	-		-	-
FREEBOARD BASED ON STABLE FLOW FT	1.64	1.66		2.14	2.11
MINIMUM REQUIRED FREEBOARD FT	0.5	0.5		0.5	0.5
D (TOTAL DEPTH) FT	2.0	2.0		3.0	3.0
d_{50} STONE SIZE (IN)	-	-		-	-
DESIGN METHOD FOR PROTECTIVE LINING **** PERMISSIBLE VELOCITY (V) OR SHEAR STRESS (S)	V/S	V/S		V/S	V/S
V_a (ALLOWABLE VELOCITY) FPS	5.0	3.5		5.0	3.5
τ_d (SHEAR STRESS AT FLOW DEPTH d) LB/FT^2	0.75	0.69		0.32	0.33
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	1.55	1.55		1.55	1.55

* Slopes may not be averaged.
** For vegetated channels, provide data for temporary linings and vegetated conditions in separate columns.
*** Minimum Freeboard,F, is 0.5 ft.
**** Permissible velocity lining design method is not acceptable for channels with a bed slope of 10% or greater. Shear stress lining design method is recommended for channels with a bed slope of 10% or greater. Shear stress lining design method may be used for any channel bed slope.

STANDARD WORKSHEET #21
Channel Design Data

PROJECT NAME: PPL Bell Bend, PPLS0902
LOCATION: Salem Township
PREPARED BY: GMP DATE: 10/22/10
CHECKED BY: LGB DATE: 10/27/10

CHANNEL OR CHANNEL SECTION	4.7 Unveg	4.7 Veg		4.8 Unveg	4.8 Veg
PROTECTIVE LINING **	S75	Grass		S75	Grass
CHANNEL TOP WIDTH (FT)@ D	14.00	14.00		14.00	14.00
CHANNEL TOP WIDTH (FT)@ d	5.10	5.09		5.58	5.68
CHANNEL SIDE SLOPES (H:V)	2	2		2	2
CHANNEL BOTTOM WIDTH (FT)	2.0	2.0		2.0	2.0
d (FLOW DEPTH IN FT)	0.78	0.77		0.90	0.92
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	3:1	3:1		2:1	2:1
A (AREA IN SQ. FT.)	2.75	2.74		3.40	3.53
R (HYDRAULIC RADIUS)	0.50	0.50		0.57	0.58
S (BED SLOPE, FT/FT)*	0.0100	0.0100		0.0060	0.0060
VEGETATIVE LINING RETARDANCE	-	B		-	B
n (MANNING'S COEFFICIENT)**	0.0490	0.0500		0.0460	0.0500
V (AT FLOW DEPTH d, CFS)	1.89	1.90		1.68	1.61
Q (AT FLOW DEPTH d, CFS)	5.20	5.20		5.70	5.70
Q_r (REQUIRED CAPACITY) CFS	-	-		-	-
S_c (CRITICAL SLOPE)	0.0471	0.0491		0.0401	0.0470
$.7S_c$	0.0330	0.0344		0.0281	0.0329
$1.3S_c$	0.0612	0.0638		0.0521	0.0611
STABLE FLOW? (Y/N)	Y	Y		Y	Y
FREEBOARD BASED ON UNSTABLE FLOW FT	-	-		-	-
FREEBOARD BASED ON STABLE FLOW FT	2.22	2.23		2.10	2.08
MINIMUM REQUIRED FREEBOARD FT	0.5	0.5		0.5	0.5
D (TOTAL DEPTH) FT	3.0	3.0		3.0	3.0
d_{50} STONE SIZE (IN)	-	-		-	-
DESIGN METHOD FOR PROTECTIVE LINING **** PERMISSIBLE VELOCITY (V) OR SHEAR STRESS (S)	V/S	V/S		V/S	V/S
V_a (ALLOWABLE VELOCITY) FPS	5.0	3.5		5.0	3.5
τ_d (SHEAR STRESS AT FLOW DEPTH d) LB/FT^2	0.48	0.48		0.34	0.34
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	1.55	1.55		1.55	1.55

* Slopes may not be averaged.
** For vegetated channels, provide data for temporary linings and vegetated conditions in separate columns.
*** Minimum Freeboard,F, is 0.5 ft.
**** Permissible velocity lining design method is not acceptable for channels with a bed slope of 10% or greater. Shear stress lining design method is recommended for channels with a bed slope of 10% or greater. Shear stress lining design method may be used for any channel bed slope.

STANDARD WORKSHEET #21
Channel Design Data

PROJECT NAME: PPL Bell Bend, PPLS0902
LOCATION: Salem Township
PREPARED BY: GMP DATE: 10/22/10
CHECKED BY: LGB DATE: 10/27/10

CHANNEL OR CHANNEL SECTION	4.9 Unveg	4.9 Veg			
PROTECTIVE LINING **	S75	Grass			
CHANNEL TOP WIDTH (FT)@ D	10.00	10.00			
CHANNEL TOP WIDTH (FT)@ d	4.42	4.22			
CHANNEL SIDE SLOPES (H:V)	2	2			
CHANNEL BOTTOM WIDTH (FT)	2.0	2.0			
d (FLOW DEPTH IN FT)	0.61	0.55			
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	4:1	4:1			
A (AREA IN SQ. FT.)	1.94	1.72			
R (HYDRAULIC RADIUS)	0.41	0.38			
S (BED SLOPE, FT/FT)*	0.0100	0.0100			
VEGETATIVE LINING RETARDANCE	-	B			
n (MANNING'S COEFFICIENT)**	0.0530	0.0500			
V (AT FLOW DEPTH d, CFS)	1.39	1.57			
Q (AT FLOW DEPTH d, CFS)	2.70	2.70			
Q_r (REQUIRED CAPACITY) CFS	-	-			
S_c (CRITICAL SLOPE)	0.0585	0.0532			
$.7S_c$	0.0410	0.0372			
$1.3S_c$	0.0761	0.0692			
STABLE FLOW? (Y/N)	Y	Y			
FREEBOARD BASED ON UNSTABLE FLOW FT	-	-			
FREEBOARD BASED ON STABLE FLOW FT	1.39	1.45			
MINIMUM REQUIRED FREEBOARD FT	0.5	0.5			
D (TOTAL DEPTH) FT	2.0	2.0			
d_{50} STONE SIZE (IN)	-	-			
DESIGN METHOD FOR PROTECTIVE LINING **** PERMISSIBLE VELOCITY (V) OR SHEAR STRESS (S)	V/S	V/S			
V_a (ALLOWABLE VELOCITY) FPS	5.0	3.5			
τ_d (SHEAR STRESS AT FLOW DEPTH d) LB/FT^2	0.38	0.35			
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	1.55	1.55			

* Slopes may not be averaged.
** For vegetated channels, provide data for temporary linings and vegetated conditions in separate columns.
*** Minimum Freeboard,F, is 0.5 ft.
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Channel Design Data

PROJECT NAME: PPL Bell Bend, PPLS0902
LOCATION: Salem Township
PREPARED BY: GMP DATE: 10/22/10
CHECKED BY: LGB DATE: 10/27/10

CHANNEL OR CHANNEL SECTION	5.1 Unveg	5.1 Veg		5.2 Unveg	5.2 Veg
PROTECTIVE LINING **	S75	Grass		S75	Grass
CHANNEL TOP WIDTH (FT)@ D	15.00	15.00		23.00	23.00
CHANNEL TOP WIDTH (FT)@ d	5.45	5.29		8.47	9.41
CHANNEL SIDE SLOPES (H:V)	2	2		2	2
CHANNEL BOTTOM WIDTH (FT)	3.0	3.0		3.0	3.0
d (FLOW DEPTH IN FT)	0.61	0.57		1.37	1.60
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	5:1	5:1		6:1	2:1
A (AREA IN SQ. FT.)	2.59	2.37		7.84	9.95
R (HYDRAULIC RADIUS)	0.45	0.43		0.86	0.98
S (BED SLOPE, FT/FT)*	0.0080	0.0080		0.0080	0.0080
VEGETATIVE LINING RETARDANCE	-	B		-	B
n (MANNING'S COEFFICIENT)**	0.0530	0.0500		0.0360	0.0500
V (AT FLOW DEPTH d, CFS)	1.35	1.48		3.33	2.62
Q (AT FLOW DEPTH d, CFS)	3.50	3.50		26.10	26.10
Q_r (REQUIRED CAPACITY) CFS	-	-		-	-
S_c (CRITICAL SLOPE)	0.0561	0.0508		0.0214	0.0396
$.7S_c$	0.0393	0.0356		0.0150	0.0277
$1.3S_c$	0.0761	0.0660		0.0278	0.0515
STABLE FLOW? (Y/N)	Y	Y		Y	Y
FREEBOARD BASED ON UNSTABLE FLOW FT	-	-		-	-
FREEBOARD BASED ON STABLE FLOW FT	1.39	1.43		3.63	3.40
MINIMUM REQUIRED FREEBOARD FT	0.5	0.5		0.5	0.5
D (TOTAL DEPTH) FT	2.0	2.0		5.0	5.0
d_{50} STONE SIZE (IN)	-	-		-	-
DESIGN METHOD FOR PROTECTIVE LINING **** PERMISSIBLE VELOCITY (V) OR SHEAR STRESS (S)	V/S	V/S		V/S	V/S
V_a (ALLOWABLE VELOCITY) FPS	5.0	3.5		5.0	3.5
τ_d (SHEAR STRESS AT FLOW DEPTH d) LB/FT^2	0.31	0.29		0.68	0.80
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	1.55	1.55		1.55	1.55

* Slopes may not be averaged.
** For vegetated channels, provide data for temporary linings and vegetated conditions in separate columns.
*** Minimum Freeboard,F, is 0.5 ft.
**** Permissible velocity lining design method is not acceptable for channels with a bed slope of 10% or greater. Shear stress lining design method is recommended for channels with a bed slope of 10% or greater. Shear stress lining design method may be used for any channel bed slope.

STANDARD WORKSHEET #21
Channel Design Data

PROJECT NAME: PPL Bell Bend, PPLS0902
LOCATION: Salem Township
PREPARED BY: GMP DATE: 10/22/10
CHECKED BY: LGB DATE: 10/27/10

CHANNEL OR CHANNEL SECTION	5.3 Unveg	5.3 Veg			
PROTECTIVE LINING **	S75	Grass			
CHANNEL TOP WIDTH (FT)@ D	9.00	9.00			
CHANNEL TOP WIDTH (FT)@ d	3.16	3.06			
CHANNEL SIDE SLOPES (H:V)	2	2			
CHANNEL BOTTOM WIDTH (FT)	1.0	1.0			
d (FLOW DEPTH IN FT)	0.54	0.51			
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	2:1	2:1			
A (AREA IN SQ. FT.)	1.12	1.04			
R (HYDRAULIC RADIUS)	0.33	0.32			
S (BED SLOPE, FT/FT)*	0.0150	0.0150			
VEGETATIVE LINING RETARDANCE	-	B			
n (MANNING'S COEFFICIENT)**	0.0540	0.0500			
V (AT FLOW DEPTH d, CFS)	1.52	1.63			
Q (AT FLOW DEPTH d, CFS)	1.70	1.70			
Q_r (REQUIRED CAPACITY) CFS	-	-			
S_c (CRITICAL SLOPE)	0.0665	0.0577			
$.7S_c$	0.0466	0.0404			
$1.3S_c$	0.0865	0.0750			
STABLE FLOW? (Y/N)	Y	Y			
FREEBOARD BASED ON UNSTABLE FLOW FT	-	-			
FREEBOARD BASED ON STABLE FLOW FT	1.46	1.49			
MINIMUM REQUIRED FREEBOARD FT	0.5	0.5			
D (TOTAL DEPTH) FT	2.0	2.0			
d_{50} STONE SIZE (IN)	-	-			
DESIGN METHOD FOR PROTECTIVE LINING **** PERMISSIBLE VELOCITY (V) OR SHEAR STRESS (S)	V/S	V/S			
V_a (ALLOWABLE VELOCITY) FPS	5.0	3.5			
τ_d (SHEAR STRESS AT FLOW DEPTH d) LB/FT^2	0.50	0.48			
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	1.55	1.55			

* Slopes may not be averaged.
** For vegetated channels, provide data for temporary linings and vegetated conditions in separate columns.
*** Minimum Freeboard, F, is 0.5 ft.
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Channel Design Data

PROJECT NAME: PPL Bell Bend, PPLS0902
LOCATION: Salem Township
PREPARED BY: GMP DATE: 10/22/10
CHECKED BY: LGB DATE: 10/27/10

CHANNEL OR CHANNEL SECTION	6.1 Unveg	6.1 Veg		6.2 Unveg	6.2 Veg
PROTECTIVE LINING **	S75	Grass		S75	Grass
CHANNEL TOP WIDTH (FT)@ D	9.00	9.00		11.00	11.00
CHANNEL TOP WIDTH (FT)@ d	2.89	2.70		5.62	5.25
CHANNEL SIDE SLOPES (H:V)	2	2		2	2
CHANNEL BOTTOM WIDTH (FT)	1.0	1.0		3.0	3.0
d (FLOW DEPTH IN FT)	0.47	0.42		0.66	0.56
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	5:1	5:1		5:1	5:1
A (AREA IN SQ. FT.)	0.92	0.79		2.83	2.31
R (HYDRAULIC RADIUS)	0.29	0.27		0.48	0.42
S (BED SLOPE, FT/FT)*	0.0100	0.0100		0.0090	0.0090
VEGETATIVE LINING RETARDANCE	-	B		-	B
n (MANNING'S COEFFICIENT)**	0.0550	0.0500		0.0620	0.0500
V (AT FLOW DEPTH d, CFS)	1.09	1.27		1.27	1.56
Q (AT FLOW DEPTH d, CFS)	1.00	1.00		3.60	3.60
Q_r (REQUIRED CAPACITY) CFS	-	-		-	-
S_c (CRITICAL SLOPE)	0.0713	0.0604		0.0756	0.0511
$.7S_c$	0.0499	0.0423		0.0529	0.0358
$1.3S_c$	0.0927	0.0785		0.0983	0.0664
STABLE FLOW? (Y/N)	Y	Y		Y	Y
FREEBOARD BASED ON UNSTABLE FLOW FT	-	-		-	-
FREEBOARD BASED ON STABLE FLOW FT	1.53	1.58		1.34	1.44
MINIMUM REQUIRED FREEBOARD FT	0.5	0.5		0.5	0.5
D (TOTAL DEPTH) FT	2.0	2.0		2.0	2.0
d_{50} STONE SIZE (IN)	-	-		-	-
DESIGN METHOD FOR PROTECTIVE LINING **** PERMISSIBLE VELOCITY (V) OR SHEAR STRESS (S)	V/S	V/S		V/S	V/S
V_a (ALLOWABLE VELOCITY) FPS	5.0	3.5		5.0	3.5
τ_d (SHEAR STRESS AT FLOW DEPTH d) LB/FT^2	0.29	0.27		0.37	0.32
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	1.55	1.55		1.55	1.55

* Slopes may not be averaged.
** For vegetated channels, provide data for temporary linings and vegetated conditions in separate columns.
*** Minimum Freeboard,F, is 0.5 ft.
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Channel Design Data

PROJECT NAME: PPL Bell Bend, PPLS0902
LOCATION: Salem Township
PREPARED BY: GMP DATE: 10/22/10
CHECKED BY: LGB DATE: 10/27/10

CHANNEL OR CHANNEL SECTION	6.3 Unveg	6.3 Veg		6.4 Unveg	6.4 Veg
PROTECTIVE LINING **	S75	Grass		S75	Grass
CHANNEL TOP WIDTH (FT)@ D	9.00	9.00		13.00	13.00
CHANNEL TOP WIDTH (FT)@ d	3.48	3.26		4.79	4.93
CHANNEL SIDE SLOPES (H:V)	2	2		2	2
CHANNEL BOTTOM WIDTH (FT)	1.0	1.0		1.0	1.0
d (FLOW DEPTH IN FT)	0.62	0.59		0.95	0.98
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	1:1	1:1		2:1	2:1
A (AREA IN SQ. FT.)	1.39	1.28		2.74	2.91
R (HYDRAULIC RADIUS)	0.37	0.35		0.52	0.54
S (BED SLOPE, FT/FT)*	0.0120	0.0120		0.0130	0.0130
VEGETATIVE LINING RETARDANCE	-	B		-	B
n (MANNING'S COEFFICIENT)**	0.0530	0.0500		0.0450	0.0500
V (AT FLOW DEPTH d, CFS)	1.51	1.64		2.41	2.27
Q (AT FLOW DEPTH d, CFS)	2.10	2.10		6.60	6.60
Q_r (REQUIRED CAPACITY) CFS	-	-		-	-
S_c (CRITICAL SLOPE)	0.0619	0.0558		0.0400	0.0489
$.7S_c$	0.0433	0.0391		0.0280	0.0342
$1.3S_c$	0.0805	0.0725		0.0520	0.0636
STABLE FLOW? (Y/N)	Y	Y		Y	Y
FREEBOARD BASED ON UNSTABLE FLOW FT	-	-		-	-
FREEBOARD BASED ON STABLE FLOW FT	1.38	1.41		2.05	2.02
MINIMUM REQUIRED FREEBOARD FT	0.5	0.5		0.5	0.5
D (TOTAL DEPTH) FT	2.0	2.0		3.0	3.0
d_{50} STONE SIZE (IN)	-	-		-	-
DESIGN METHOD FOR PROTECTIVE LINING **** PERMISSIBLE VELOCITY (V) OR SHEAR STRESS (S)	V/S	V/S		V/S	V/S
V_a (ALLOWABLE VELOCITY) FPS	5.0	3.5		5.0	3.5
τ_d (SHEAR STRESS AT FLOW DEPTH d) LB/FT^2	0.46	0.44		0.77	0.80
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	1.55	1.55		1.55	1.55

* Slopes may not be averaged.
** For vegetated channels, provide data for temporary linings and vegetated conditions in separate columns.
*** Minimum Freeboard, F, is 0.5 ft.
**** Permissible velocity lining design method is not acceptable for channels with a bed slope of 10% or greater. Shear stress lining design method is recommended for channels with a bed slope of 10% or greater. Shear stress lining design method may be used for any channel bed slope.

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Channel Design Data

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LOCATION: Salem Township
PREPARED BY: GMP DATE: 10/22/10
CHECKED BY: LGB DATE: 10/27/10

CHANNEL OR CHANNEL SECTION	6.5 Unveg	6.5 Veg		6.6 Unveg	6.6 Veg
PROTECTIVE LINING **	S75	Grass		S75	Grass
CHANNEL TOP WIDTH (FT)@ D	16.00	16.00		9.00	9.00
CHANNEL TOP WIDTH (FT)@ d	7.35	7.45		3.53	3.43
CHANNEL SIDE SLOPES (H:V)	2	2		2	2
CHANNEL BOTTOM WIDTH (FT)	4.0	4.0		1.0	1.0
d (FLOW DEPTH IN FT)	0.84	0.86		0.63	0.61
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	5:1	5:1		2:1	2:1
A (AREA IN SQ. FT.)	4.75	4.94		1.43	1.34
R (HYDRAULIC RADIUS)	0.61	0.63		0.37	0.36
S (BED SLOPE, FT/FT)*	0.0090	0.0090		0.0185	0.0185
VEGETATIVE LINING RETARDANCE	-	B		-	B
n (MANNING'S COEFFICIENT)**	0.0470	0.0500		0.0520	0.0500
V (AT FLOW DEPTH d, CFS)	2.15	2.06		1.96	2.08
Q (AT FLOW DEPTH d, CFS)	10.20	10.20		2.80	2.80
Q_r (REQUIRED CAPACITY) CFS	-	-		-	-
S_c (CRITICAL SLOPE)	0.0399	0.0448		0.0593	0.0554
$.7S_c$	0.0279	0.0314		0.0461	0.0388
$1.3S_c$	0.0519	0.0582		0.0855	0.0720
STABLE FLOW? (Y/N)	Y	Y		Y	Y
FREEBOARD BASED ON UNSTABLE FLOW FT	-	-		-	-
FREEBOARD BASED ON STABLE FLOW FT	2.16	2.14		1.37	1.39
MINIMUM REQUIRED FREEBOARD FT	0.5	0.5		0.5	0.5
D (TOTAL DEPTH) FT	3.0	3.0		2.0	2.0
d_{50} STONE SIZE (IN)	-	-		-	-
DESIGN METHOD FOR PROTECTIVE LINING **** PERMISSIBLE VELOCITY (V) OR SHEAR STRESS (S)	V/S	V/S		V/S	V/S
V_a (ALLOWABLE VELOCITY) FPS	5.0	3.5		5.0	3.5
τ_d (SHEAR STRESS AT FLOW DEPTH d) LB/FT^2	0.47	0.48		0.73	0.70
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	1.55	1.55		1.55	1.55

* Slopes may not be averaged.
** For vegetated channels, provide data for temporary linings and vegetated conditions in separate columns.
*** Minimum Freeboard,F, is 0.5 ft.
**** Permissible velocity lining design method is not acceptable for channels with a bed slope of 10% or greater. Shear stress lining design method is recommended for channels with a bed slope of 10% or greater. Shear stress lining design method may be used for any channel bed slope.

STANDARD WORKSHEET #21
Channel Design Data

PROJECT NAME: PPL Bell Bend, PPLS0902
LOCATION: Salem Township
PREPARED BY: GMP DATE: 10/22/10
CHECKED BY: LGB DATE: 10/27/10

CHANNEL OR CHANNEL SECTION	6.7 Unveg	6.7 Veg		6.8 Unveg	6.8 Veg
PROTECTIVE LINING **	S75	Grass		S75	Grass
CHANNEL TOP WIDTH (FT)@ D	9.00	9.00		12.00	12.00
CHANNEL TOP WIDTH (FT)@ d	3.17	3.07		6.12	6.02
CHANNEL SIDE SLOPES (H:V)	2	2		2	2
CHANNEL BOTTOM WIDTH (FT)	1.0	1.0		4.0	4.0
d (FLOW DEPTH IN FT)	0.54	0.52		0.53	0.51
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	2:1	2:1		8:1	8:1
A (AREA IN SQ. FT.)	1.13	1.05		2.69	2.53
R (HYDRAULIC RADIUS)	0.33	0.32		0.42	0.40
S (BED SLOPE, FT/FT)*	0.0200	0.0200		0.0200	0.0200
VEGETATIVE LINING RETARDANCE	-	B		-	B
n (MANNING'S COEFFICIENT)**	0.0664	0.0500		0.0589	0.0500
V (AT FLOW DEPTH d, CFS)	1.77	1.90		2.16	2.29
Q (AT FLOW DEPTH d, CFS)	2.00	2.00		5.80	5.80
Q_r (REQUIRED CAPACITY) CFS	-	-		-	-
S_c (CRITICAL SLOPE)	0.0664	0.0576		0.0589	0.0512
$.7S_c$	0.0465	0.0403		0.0412	0.0358
$1.3S_c$	0.0863	0.0749		0.0766	0.0666
STABLE FLOW? (Y/N)	Y	Y		Y	Y
FREEBOARD BASED ON UNSTABLE FLOW FT	-	-		-	-
FREEBOARD BASED ON STABLE FLOW FT	1.46	1.48		1.47	1.49
MINIMUM REQUIRED FREEBOARD FT	0.5	0.5		0.5	0.5
D (TOTAL DEPTH) FT	2.0	2.0		2.0	2.0
d_{50} STONE SIZE (IN)	-	-		-	-
DESIGN METHOD FOR PROTECTIVE LINING **** PERMISSIBLE VELOCITY (V) OR SHEAR STRESS (S)	V/S	V/S		V/S	V/S
V_a (ALLOWABLE VELOCITY) FPS	5.0	3.5		5.0	3.5
τ_d (SHEAR STRESS AT FLOW DEPTH d) LB/FT^2	0.68	0.65		0.66	0.63
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	1.55	1.55		1.55	1.55

* Slopes may not be averaged.
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*** Minimum Freeboard, F, is 0.5 ft.
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STANDARD WORKSHEET #21
Channel Design Data

PROJECT NAME: PPL Bell Bend, PPLS0902
LOCATION: Salem Township
PREPARED BY: GMP DATE: 10/22/10
CHECKED BY: LGB DATE: 10/27/10

CHANNEL OR CHANNEL SECTION	6.9 Unveg	6.9 Veg		6.10 Unveg	6.10 Veg
PROTECTIVE LINING **	S75	Grass		S75	Grass
CHANNEL TOP WIDTH (FT)@ D	15.00	15.00		10.00	10.00
CHANNEL TOP WIDTH (FT)@ d	6.54	6.68		4.51	4.31
CHANNEL SIDE SLOPES (H:V)	2	2		2	2
CHANNEL BOTTOM WIDTH (FT)	3.0	3.0		2.0	2.0
d (FLOW DEPTH IN FT)	0.89	0.92		0.63	0.58
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	3:1	3:1		3:1	3:1
A (AREA IN SQ. FT.)	4.22	4.45		2.05	1.82
R (HYDRAULIC RADIUS)	0.61	0.63		0.43	0.40
S (BED SLOPE, FT/FT)*	0.0150	0.0150		0.0135	0.0135
VEGETATIVE LINING RETARDANCE	-	B		-	B
n (MANNING'S COEFFICIENT)**	0.0460	0.0500		0.0530	0.0500
V (AT FLOW DEPTH d, CFS)	2.82	2.67		1.66	1.87
Q (AT FLOW DEPTH d, CFS)	11.90	11.90		3.40	3.40
Q_r (REQUIRED CAPACITY) CFS	-	-		-	-
S_c (CRITICAL SLOPE)	0.0387	0.0453		0.0580	0.0526
$.7S_c$	0.0271	0.0317		0.0406	0.0368
$1.3S_c$	0.0503	0.0589		0.0754	0.0684
STABLE FLOW? (Y/N)	Y	Y		Y	Y
FREEBOARD BASED ON UNSTABLE FLOW FT	-	-		-	-
FREEBOARD BASED ON STABLE FLOW FT	2.11	2.08		1.37	1.42
MINIMUM REQUIRED FREEBOARD FT	0.5	0.5		0.5	0.5
D (TOTAL DEPTH) FT	3.0	3.0		2.0	2.0
d_{50} STONE SIZE (IN)	-	-		-	-
DESIGN METHOD FOR PROTECTIVE LINING **** PERMISSIBLE VELOCITY (V) OR SHEAR STRESS (S)	V/S	V/S		V/S	V/S
V_a (ALLOWABLE VELOCITY) FPS	5.0	3.5		5.0	3.5
τ_d (SHEAR STRESS AT FLOW DEPTH d) LB/FT^2	0.83	0.86		0.53	0.49
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	1.55	1.55		1.55	1.55

* Slopes may not be averaged.
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*** Minimum Freeboard,F, is 0.5 ft.
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STANDARD WORKSHEET #21
Channel Design Data

PROJECT NAME: PPL Bell Bend, PPLS0902
LOCATION: Salem Township
PREPARED BY: GMP DATE: 10/22/10
CHECKED BY: LGB DATE: 10/27/10

CHANNEL OR CHANNEL SECTION	8.1 Unveg	8.1 Veg		8.2 Unveg	8.2 Veg
PROTECTIVE LINING **	S75	Grass		S75	Grass
CHANNEL TOP WIDTH (FT)@ D	9.00	9.00		14.00	14.00
CHANNEL TOP WIDTH (FT)@ d	3.37	3.25		5.15	5.30
CHANNEL SIDE SLOPES (H:V)	2	2		2	2
CHANNEL BOTTOM WIDTH (FT)	1.0	1.0		2.0	2.0
d (FLOW DEPTH IN FT)	0.59	0.56		0.79	0.83
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	2:1	2:1		5:1	5:1
A (AREA IN SQ. FT.)	1.29	1.20		2.81	3.01
R (HYDRAULIC RADIUS)	0.35	0.34		0.51	0.53
S (BED SLOPE, FT/FT)*	0.0100	0.0100		0.0080	0.0080
VEGETATIVE LINING RETARDANCE	-	B		-	B
n (MANNING'S COEFFICIENT)**	0.0530	0.0500		0.0450	0.0500
V (AT FLOW DEPTH d, CFS)	1.39	1.50		1.85	1.73
Q (AT FLOW DEPTH d, CFS)	1.80	1.80		5.20	5.20
Q_r (REQUIRED CAPACITY) CFS	-	-		-	-
S_c (CRITICAL SLOPE)	0.0626	0.0564		0.0396	0.0483
$.7S_c$	0.0438	0.0395		0.0277	0.0338
$1.3S_c$	0.0814	0.0733		0.0515	0.0628
STABLE FLOW? (Y/N)	Y	Y		Y	Y
FREEBOARD BASED ON UNSTABLE FLOW FT	-	-		-	-
FREEBOARD BASED ON STABLE FLOW FT	1.41	1.44		2.21	2.17
MINIMUM REQUIRED FREEBOARD FT	0.5	0.5		0.5	0.5
D (TOTAL DEPTH) FT	2.0	2.0		3.0	3.0
d_{50} STONE SIZE (IN)	-	-		-	-
DESIGN METHOD FOR PROTECTIVE LINING **** PERMISSIBLE VELOCITY (V) OR SHEAR STRESS (S)	V/S	V/S		V/S	V/S
V_a (ALLOWABLE VELOCITY) FPS	5.0	3.5		5.0	3.5
τ_d (SHEAR STRESS AT FLOW DEPTH d) LB/FT^2	0.41	0.39		0.39	0.41
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	1.55	1.55		1.55	1.55

* Slopes may not be averaged.
** For vegetated channels, provide data for temporary linings and vegetated conditions in separate columns.
*** Minimum Freeboard,F, is 0.5 ft.
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STANDARD WORKSHEET #21
Channel Design Data

PROJECT NAME: PPL Bell Bend, PPLS0902
LOCATION: Salem Township
PREPARED BY: GMP DATE: 10/22/10
CHECKED BY: LGB DATE: 10/27/10

CHANNEL OR CHANNEL SECTION	8.3 Unveg	8.3 Veg		8.4 Unveg	8.4 Veg
PROTECTIVE LINING **	S75	Grass		S75	Grass
CHANNEL TOP WIDTH (FT)@ D	10.00	10.00		9.00	9.00
CHANNEL TOP WIDTH (FT)@ d	4.43	4.33		2.82	2.66
CHANNEL SIDE SLOPES (H:V)	2	2		2	2
CHANNEL BOTTOM WIDTH (FT)	2.0	2.0		1.0	1.0
d (FLOW DEPTH IN FT)	0.61	0.58		0.45	0.42
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	3:1	3:1		2:1	2:1
A (AREA IN SQ. FT.)	1.96	1.84		0.87	0.76
R (HYDRAULIC RADIUS)	0.41	0.40		0.29	0.27
S (BED SLOPE, FT/FT)*	0.0300	0.0300		0.0280	0.0280
VEGETATIVE LINING RETARDANCE	-	B		-	B
n (MANNING'S COEFFICIENT)**	0.0530	0.0500		0.0550	0.0500
V (AT FLOW DEPTH d, CFS)	2.66	2.83		1.85	2.10
Q (AT FLOW DEPTH d, CFS)	5.20	5.20		1.60	1.60
Q_r (REQUIRED CAPACITY) CFS	-	-		-	-
S_c (CRITICAL SLOPE)	0.0584	0.0525		0.0720	0.0607
$.7S_c$	0.0409	0.0368		0.0504	0.0425
$1.3S_c$	0.0759	0.0638		0.0936	0.0789
STABLE FLOW? (Y/N)	Y	Y		Y	Y
FREEBOARD BASED ON UNSTABLE FLOW FT	-	-		-	-
FREEBOARD BASED ON STABLE FLOW FT	1.39	1.42		1.55	1.58
MINIMUM REQUIRED FREEBOARD FT	0.5	0.5		0.5	0.5
D (TOTAL DEPTH) FT	2.0	2.0		2.0	2.0
d_{50} STONE SIZE (IN)	-	-		-	-
DESIGN METHOD FOR PROTECTIVE LINING **** PERMISSIBLE VELOCITY (V) OR SHEAR STRESS (S)	V/S	V/S		V/S	V/S
V_a (ALLOWABLE VELOCITY) FPS	5.0	3.5		5.0	3.5
τ_d (SHEAR STRESS AT FLOW DEPTH d) LB/FT^2	1.14	1.09		0.79	0.73
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	1.55	1.55		1.55	1.55

* Slopes may not be averaged.
** For vegetated channels, provide data for temporary linings and vegetated conditions in separate columns.
*** Minimum Freeboard,F, is 0.5 ft.
**** Permissible velocity lining design method is not acceptable for channels with a bed slope of 10% or greater. Shear stress lining design method is recommended for channels with a bed slope of 10% or greater. Shear stress lining design method may be used for any channel bed slope.

STANDARD WORKSHEET #21
Channel Design Data

PROJECT NAME: PPL Bell Bend, PPLS0902
LOCATION: Salem Township
PREPARED BY: GMP DATE: 10/22/10
CHECKED BY: LGB DATE: 10/27/10

CHANNEL OR CHANNEL SECTION	9.1 Unveg	9.1 Veg		9.2 Unveg	9.2 Veg
PROTECTIVE LINING **	S75	Grass		S75	Grass
CHANNEL TOP WIDTH (FT)@ D	15.00	15.00		13.00	13.00
CHANNEL TOP WIDTH (FT)@ d	4.19	4.41		4.35	4.43
CHANNEL SIDE SLOPES (H:V)	2	2		2	2
CHANNEL BOTTOM WIDTH (FT)	3.0	3.0		1.0	1.0
d (FLOW DEPTH IN FT)	0.88	0.91		0.84	0.86
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	3:1	3:1		1:1	1:1
A (AREA IN SQ. FT.)	4.19	4.41		2.24	2.33
R (HYDRAULIC RADIUS)	0.60	0.62		0.47	0.48
S (BED SLOPE, FT/FT)*	0.0100	0.0100		0.0100	0.0100
VEGETATIVE LINING RETARDANCE	-	B		-	B
n (MANNING'S COEFFICIENT)**	0.0460	0.0500		0.0470	0.0500
V (AT FLOW DEPTH d, CFS)	2.29	2.17		1.87	1.80
Q (AT FLOW DEPTH d, CFS)	9.60	9.60		4.20	4.20
Q_r (REQUIRED CAPACITY) CFS	-	-		-	-
S_c (CRITICAL SLOPE)	0.0388	0.0454		0.0451	0.0507
$.7S_c$	0.0272	0.0318		0.0316	0.0355
$1.3S_c$	0.0504	0.0590		0.0586	0.0659
STABLE FLOW? (Y/N)	Y	Y		Y	Y
FREEBOARD BASED ON UNSTABLE FLOW FT	-	-		-	-
FREEBOARD BASED ON STABLE FLOW FT	2.12	2.09		2.16	2.14
MINIMUM REQUIRED FREEBOARD FT	0.5	0.5		0.5	0.5
D (TOTAL DEPTH) FT	3.0	3.0		3.0	3.0
d_{50} STONE SIZE (IN)	-	-		-	-
DESIGN METHOD FOR PROTECTIVE LINING **** PERMISSIBLE VELOCITY (V) OR SHEAR STRESS (S)	V/S	V/S		V/S	V/S
V_a (ALLOWABLE VELOCITY) FPS	5.0	3.5		5.0	3.5
τ_d (SHEAR STRESS AT FLOW DEPTH d) LB/FT^2	0.55	0.57		0.52	0.54
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	1.55	1.55		1.55	1.55

* Slopes may not be averaged.

** For vegetated channels, provide data for temporary linings and vegetated conditions in separate columns.

*** Minimum Freeboard,F, is 0.5 ft.

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Channel Design Data

PROJECT NAME: PPL Bell Bend, PPLS0902
LOCATION: Salem Township
PREPARED BY: GMP DATE: 10/22/10
CHECKED BY: LGB DATE: 10/27/10

CHANNEL OR CHANNEL SECTION	9.3 Unveg	9.3 Veg		9.4 Unveg	9.4 Veg
PROTECTIVE LINING **	S75	Grass		S75	Grass
CHANNEL TOP WIDTH (FT)@ D	15.00	15.00		27.00	27.00
CHANNEL TOP WIDTH (FT)@ d	6.53	6.62		12.17	13.09
CHANNEL SIDE SLOPES (H:V)	2	2		2	2
CHANNEL BOTTOM WIDTH (FT)	3.0	3.0		7.0	7.0
d (FLOW DEPTH IN FT)	0.88	0.91		1.29	1.52
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	3:1	3:1		7:1	5:1
A (AREA IN SQ. FT.)	4.20	4.36		12.38	15.30
R (HYDRAULIC RADIUS)	0.60	0.62		0.97	1.11
S (BED SLOPE, FT/FT)*	0.0100	0.0100		0.0070	0.0070
VEGETATIVE LINING RETARDANCE	-	B		-	B
n (MANNING'S COEFFICIENT)**	0.0470	0.0500		0.0470	0.0500
V (AT FLOW DEPTH d, CFS)	2.24	2.16		3.29	2.66
Q (AT FLOW DEPTH d, CFS)	9.40	9.40		40.70	40.70
Q_r (REQUIRED CAPACITY) CFS	-	-		-	-
S_c (CRITICAL SLOPE)	0.0405	0.0455		0.0212	0.0371
$.7S_c$	0.0284	0.0319		0.0148	0.0260
$1.3S_c$	0.0527	0.0592		0.0276	0.0482
STABLE FLOW? (Y/N)	Y	Y		Y	Y
FREEBOARD BASED ON UNSTABLE FLOW FT	-	-		-	-
FREEBOARD BASED ON STABLE FLOW FT	2.12	2.09		3.71	2.48
MINIMUM REQUIRED FREEBOARD FT	0.5	0.5		0.5	0.5
D (TOTAL DEPTH) FT	3.0	3.0		5.0	5.0
d_{50} STONE SIZE (IN)	-	-		-	-
DESIGN METHOD FOR PROTECTIVE LINING **** PERMISSIBLE VELOCITY (V) OR SHEAR STRESS (S)	V/S	V/S		V/S	V/S
V_a (ALLOWABLE VELOCITY) FPS	5.0	3.5		5.0	3.5
τ_d (SHEAR STRESS AT FLOW DEPTH d) LB/FT^2	0.55	0.56		0.56	0.67
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	1.55	1.55		1.55	1.55

* Slopes may not be averaged.
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*** Minimum Freeboard,F, is 0.5 ft.
**** Permissible velocity lining design method is not acceptable for channels with a bed slope of 10% or greater. Shear stress lining design method is recommended for channels with a bed slope of 10% or greater. Shear stress lining design method may be used for any channel bed slope.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 1
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by: M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 1.1

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	1.40	1.40	1.40	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	2.0	2.0	2.0	feet
Bed slope, s=	0.0130	0.0130	0.0130	ft/ft
Available depth of channel:	1.50	1.50	1.50	feet
(OPTIONAL) Input Manning's 'n':	0.0550	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.46**	**0.35**	**0.35**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	1.04	1.15	1.15	feet
Calculated Velocity, V=	1.04	1.46	1.46	fps
Flow Top Width, T=	3.84	3.42	3.42	feet
Flow Area, A=	1.34	0.96	0.96	sq ft
Wetted Perimeter, P=	4.05	3.58	3.58	feet
Hydraulic Radius, R=	0.33	0.27	0.27	feet
Shear stress on channel bottom, τ =	0.37	0.29	0.29	lbs/sf
Critical Slope, S_c=	0.0673	0.0592	0.0592	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

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Prepared by: ATS
Date: 14 Oct 10

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M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$

Given Input Data: Swale 1.2	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	1.40	1.40	1.40	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	2.0	2.0	2.0	feet
Bed slope, s=	0.0130	0.0130	0.0130	ft/ft
Available depth of channel:	1.50	1.50	1.50	feet
(OPTIONAL) Input Manning's 'n':	0.0550	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.46**	**0.35**	**0.35**	**feet**

Calculated Results: Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	1.04	1.15	1.15	feet
Calculated Velocity, V=	1.04	1.46	1.46	fps
Flow Top Width, T=	3.84	3.42	3.42	feet
Flow Area, A=	1.34	0.96	0.96	sq ft
Wetted Perimeter, P=	4.05	3.58	3.58	feet
Hydraulic Radius, R=	0.33	0.27	0.27	feet
Shear stress on channel bottom, τ =	0.37	0.29	0.29	lbs/sf
Critical Slope, S_c=	0.0673	0.0592	0.0592	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 1
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation:
$$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 1.3

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	4.10	4.10	4.10	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	2.0	2.0	2.0	feet
Bed slope, s=	0.0170	0.0170	0.0170	ft/ft
Available depth of channel:	2.00	2.00	2.00	feet
(OPTIONAL) Input Manning's 'n':	0.0520	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.62**	**0.60**	**0.60**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	1.38	1.40	1.40	feet
Calculated Velocity, V=	2.03	2.15	2.15	fps
Flow Top Width, T=	4.49	4.39	4.39	feet
Flow Area, A=	2.02	1.91	1.91	sq ft
Wetted Perimeter, P=	4.79	4.67	4.67	feet
Hydraulic Radius, R=	0.42	0.41	0.41	feet
Shear stress on channel bottom, τ =	0.66	0.63	0.63	lbs/sf
Critical Slope, S_c=	0.0559	0.0522	0.0522	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 2
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by:
M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation:

$$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 2.1

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	1.30	1.30	1.30	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	2.0	2.0	2.0	feet
Bed slope, s=	0.0130	0.0130	0.0130	ft/ft
Available depth of channel:	1.50	1.50	1.50	feet
(OPTIONAL) Input Manning's 'n':	0.0550	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.44**	**0.34**	**0.34**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	1.06	1.16	1.16	feet
Calculated Velocity, V=	1.01	1.43	1.43	fps
Flow Top Width, T=	3.78	3.36	3.36	feet
Flow Area, A=	1.28	0.91	0.91	sq ft
Wetted Perimeter, P=	3.99	3.52	3.52	feet
Hydraulic Radius, R=	0.32	0.26	0.26	feet
Shear stress on channel bottom, τ =	0.36	0.28	0.28	lbs/sf
Critical Slope, S_c=	0.0678	0.0599	0.0599	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 2
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by:
M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation:

$$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 2.2

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	1.10	1.10	1.10	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	2.0	2.0	2.0	feet
Bed slope, s=	0.0100	0.0100	0.0100	ft/ft
Available depth of channel:	1.50	1.50	1.50	feet
(OPTIONAL) Input Manning's 'n':	0.0550	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.46**	**0.33**	**0.33**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	1.04	1.17	1.17	feet
Calculated Velocity, V=	0.83	1.24	1.24	fps
Flow Top Width, T=	3.83	3.33	3.33	feet
Flow Area, A=	1.33	0.89	0.89	sq ft
Wetted Perimeter, P=	4.05	3.49	3.49	feet
Hydraulic Radius, R=	0.33	0.25	0.25	feet
Shear stress on channel bottom, τ =	0.29	0.21	0.21	lbs/sf
Critical Slope, S_c=	0.0674	0.0602	0.0602	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 3
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by: M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation:

$$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 3.1

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	4.80	4.80	4.80	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	4.0	4.0	4.0	feet
Bed slope, s=	0.0100	0.0100	0.0100	ft/ft
Available depth of channel:	2.00	2.00	2.00	feet
(OPTIONAL) Input Manning's 'n':	0.0530	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.58**	**0.55**	**0.55**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	1.42	1.45	1.45	feet
Calculated Velocity, V=	1.62	1.71	1.71	fps
Flow Top Width, T=	6.30	6.20	6.20	feet
Flow Area, A=	2.97	2.81	2.81	sq ft
Wetted Perimeter, P=	6.57	6.46	6.46	feet
Hydraulic Radius, R=	0.45	0.43	0.43	feet
Shear stress on channel bottom, τ =	0.36	0.34	0.34	lbs/sf
Critical Slope, S_c=	0.0556	0.0501	0.0501	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 3
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by:
M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 3.2

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	2.50	2.50	2.50	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	2.0	2.0	2.0	feet
Bed slope, s=	0.0100	0.0100	0.0100	ft/ft
Available depth of channel:	2.00	2.00	2.00	feet
(OPTIONAL) Input Manning's 'n':	0.0540	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.61**	**0.53**	**0.53**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	1.39	1.47	1.47	feet
Calculated Velocity, V=	1.28	1.53	1.53	fps
Flow Top Width, T=	4.44	4.13	4.13	feet
Flow Area, A=	1.96	1.63	1.63	sq ft
Wetted Perimeter, P=	4.72	4.38	4.38	feet
Hydraulic Radius, R=	0.41	0.37	0.37	feet
Shear stress on channel bottom, τ =	0.38	0.33	0.33	lbs/sf
Critical Slope, S_c=	0.0606	0.0537	0.0537	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 3
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by:
M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 3.3

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	8.57	8.57	8.57	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	4.0	4.0	4.0	feet
Bed slope, s=	0.0330	0.0330	0.0330	ft/ft
Available depth of channel:	2.00	2.00	2.00	feet
(OPTIONAL) Input Manning's 'n':	0.0530	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.57**	**0.54**	**0.54**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	1.43	1.46	1.46	feet
Calculated Velocity, V=	2.94	3.10	3.10	fps
Flow Top Width, T=	6.27	6.18	6.18	feet
Flow Area, A=	2.91	2.77	2.77	sq ft
Wetted Perimeter, P=	6.54	6.43	6.43	feet
Hydraulic Radius, R=	0.45	0.43	0.43	feet
Shear stress on channel bottom, τ =	1.17	1.12	1.12	lbs/sf
Critical Slope, S_c=	0.0558	0.0502	0.0502	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 3
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by: M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 3.4

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	9.57	9.57	9.57	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	3.0	3.0	3.0	feet
Bed slope, s=	0.0330	0.0330	0.0330	ft/ft
Available depth of channel:	3.00	3.00	3.00	feet
(OPTIONAL) Input Manning's 'n':	0.0510	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.68**	**0.66**	**0.66**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	2.32	2.34	2.34	feet
Calculated Velocity, V=	3.25	3.33	3.33	fps
Flow Top Width, T=	5.70	5.65	5.65	feet
Flow Area, A=	2.94	2.87	2.87	sq ft
Wetted Perimeter, P=	6.02	5.97	5.97	feet
Hydraulic Radius, R=	0.49	0.48	0.48	feet
Shear stress on channel bottom, τ =	1.39	1.37	1.37	lbs/sf
Critical Slope, S_c=	0.0508	0.0490	0.0490	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 3
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by: M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$

Given Input Data: Swale 3.5

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	4.30	4.30	4.30	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	1.0	1.0	1.0	feet
Bed slope, s=	0.0080	0.0080	0.0080	ft/ft
Available depth of channel:	3.00	3.00	3.00	feet
(OPTIONAL) Input Manning's 'n':	0.0460	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.88**	**0.90**	**0.90**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	2.12	2.10	2.10	feet
Calculated Velocity, V=	1.76	1.69	1.69	fps
Flow Top Width, T=	4.53	4.62	4.62	feet
Flow Area, A=	2.44	2.54	2.54	sq ft
Wetted Perimeter, P=	4.94	5.05	5.05	feet
Hydraulic Radius, R=	0.49	0.50	0.50	feet
Shear stress on channel bottom, τ =	0.44	0.45	0.45	lbs/sf
Critical Slope, S_c=	0.0426	0.0500	0.0500	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 3
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by: M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation:

$$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 3.6

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	3.80	3.80	3.80	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	2.0	2.0	2.0	feet
Bed slope, s=	0.0070	0.0070	0.0070	ft/ft
Available depth of channel:	3.00	3.00	3.00	feet
(OPTIONAL) Input Manning's 'n':	0.0500	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.75**	**0.72**	**0.72**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	2.25	2.28	2.28	feet
Calculated Velocity, V=	1.45	1.54	1.54	fps
Flow Top Width, T=	5.00	4.87	4.87	feet
Flow Area, A=	2.62	2.46	2.46	sq ft
Wetted Perimeter, P=	5.35	5.21	5.21	feet
Hydraulic Radius, R=	0.49	0.47	0.47	feet
Shear stress on channel bottom, τ =	0.33	0.31	0.31	lbs/sf
Critical Slope, S_c=	0.0494	0.0500	0.0500	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 3
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by:
M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation:

$$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 3.7

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	3.50	3.50	3.50	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	2.0	2.0	2.0	feet
Bed slope, s=	0.0050	0.0050	0.0050	ft/ft
Available depth of channel:	3.00	3.00	3.00	feet
(OPTIONAL) Input Manning's 'n':	0.0490	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.79**	**0.76**	**0.76**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	2.21	2.24	2.24	feet
Calculated Velocity, V=	1.23	1.31	1.31	fps
Flow Top Width, T=	5.17	5.03	5.03	feet
Flow Area, A=	2.84	2.67	2.67	sq ft
Wetted Perimeter, P=	5.55	5.39	5.39	feet
Hydraulic Radius, R=	0.51	0.49	0.49	feet
Shear stress on channel bottom, τ =	0.25	0.24	0.24	lbs/sf
Critical Slope, S_c=	0.0468	0.0493	0.0493	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 3
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by:
M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 3.8

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	12.10	12.10	12.10	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	3.0	3.0	3.0	feet
Bed slope, s=	0.0050	0.0050	0.0050	ft/ft
Available depth of channel:	4.00	4.00	4.00	feet
(OPTIONAL) Input Manning's 'n':	0.0410	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**1.12**	**1.23**	**1.23**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	2.88	2.77	2.77	feet
Calculated Velocity, V=	2.07	1.80	1.80	fps
Flow Top Width, T=	7.47	7.92	7.92	feet
Flow Area, A=	5.85	6.72	6.72	sq ft
Wetted Perimeter, P=	8.00	8.50	8.50	feet
Hydraulic Radius, R=	0.73	0.79	0.79	feet
Shear stress on channel bottom, τ =	0.35	0.38	0.38	lbs/sf
Critical Slope, S_c=	0.0291	0.0423	0.0423	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 4
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by: M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation:

$$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 4.1

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	7.00	7.00	7.00	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	2.0	2.0	2.0	feet
Bed slope, s=	0.0110	0.0110	0.0110	ft/ft
Available depth of channel:	3.00	3.00	3.00	feet
(OPTIONAL) Input Manning's 'n':	0.0470	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.86**	**0.88**	**0.88**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	2.14	2.12	2.12	feet
Calculated Velocity, V=	2.19	2.12	2.12	fps
Flow Top Width, T=	5.44	5.51	5.51	feet
Flow Area, A=	3.20	3.30	3.30	sq ft
Wetted Perimeter, P=	5.85	5.93	5.93	feet
Hydraulic Radius, R=	0.55	0.56	0.56	feet
Shear stress on channel bottom, τ =	0.59	0.60	0.60	lbs/sf
Critical Slope, S_c=	0.0423	0.0476	0.0476	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 4
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by:
M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation:

$$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 4.2	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	4.10	4.10	4.10	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	3.0	3.0	3.0	feet
Bed slope, s=	0.0120	0.0120	0.0120	ft/ft
Available depth of channel:	2.00	2.00	2.00	feet
(OPTIONAL) Input Manning's 'n':	0.0530	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.58**	**0.56**	**0.56**	**feet**

Calculated Results: Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	1.42	1.44	1.44	feet
Calculated Velocity, V=	1.71	1.79	1.79	fps
Flow Top Width, T=	5.31	5.23	5.23	feet
Flow Area, A=	2.40	2.29	2.29	sq ft
Wetted Perimeter, P=	5.58	5.49	5.49	feet
Hydraulic Radius, R=	0.43	0.42	0.42	feet
Shear stress on channel bottom, τ =	0.43	0.42	0.42	lbs/sf
Critical Slope, S_c=	0.0570	0.0512	0.0512	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 4
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by: M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation:

$$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 4.3

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	0.80	0.80	0.80	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	1.0	1.0	1.0	feet
Bed slope, s=	0.0180	0.0180	0.0180	ft/ft
Available depth of channel:	2.00	2.00	2.00	feet
(OPTIONAL) Input Manning's 'n':	0.0550	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.37**	**0.33**	**0.33**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	1.63	1.67	1.67	feet
Calculated Velocity, V=	1.25	1.44	1.44	fps
Flow Top Width, T=	2.47	2.34	2.34	feet
Flow Area, A=	0.64	0.56	0.56	sq ft
Wetted Perimeter, P=	2.64	2.49	2.49	feet
Hydraulic Radius, R=	0.24	0.22	0.22	feet
Shear stress on channel bottom, τ =	0.41	0.37	0.37	lbs/sf
Critical Slope, S_c=	0.0757	0.0640	0.0640	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 4
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by:
M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 4.4

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	0.60	0.60	0.60	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	1.0	1.0	1.0	feet
Bed slope, s=	0.0200	0.0200	0.0200	ft/ft
Available depth of channel:	2.00	2.00	2.00	feet
(OPTIONAL) Input Manning's 'n':	0.0550	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.31**	**0.28**	**0.28**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	1.69	1.72	1.72	feet
Calculated Velocity, V=	1.17	1.35	1.35	fps
Flow Top Width, T=	2.26	2.14	2.14	feet
Flow Area, A=	0.51	0.44	0.44	sq ft
Wetted Perimeter, P=	2.41	2.27	2.27	feet
Hydraulic Radius, R=	0.21	0.20	0.20	feet
Shear stress on channel bottom, τ =	0.39	0.35	0.35	lbs/sf
Critical Slope, S_c=	0.0786	0.0666	0.0666	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 4
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by: M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 4.5

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	1.10	1.10	1.10	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	1.0	1.0	1.0	feet
Bed slope, s=	0.0330	0.0330	0.0330	ft/ft
Available depth of channel:	2.00	2.00	2.00	feet
(OPTIONAL) Input Manning's 'n':	0.0550	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.36**	**0.34**	**0.34**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	1.64	1.66	1.66	feet
Calculated Velocity, V=	1.74	1.95	1.95	fps
Flow Top Width, T=	2.46	2.35	2.35	feet
Flow Area, A=	0.63	0.56	0.56	sq ft
Wetted Perimeter, P=	2.63	2.51	2.51	feet
Hydraulic Radius, R=	0.24	0.22	0.22	feet
Shear stress on channel bottom, τ =	0.75	0.69	0.69	lbs/sf
Critical Slope, S_c=	0.0759	0.0639	0.0639	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 4
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

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M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 4.6

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	7.00	7.00	7.00	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	3.0	3.0	3.0	feet
Bed slope, s=	0.0060	0.0060	0.0060	ft/ft
Available depth of channel:	3.00	3.00	3.00	feet
(OPTIONAL) Input Manning's 'n':	0.0470	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.86**	**0.89**	**0.89**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	2.14	2.11	2.11	feet
Calculated Velocity, V=	1.71	1.65	1.65	fps
Flow Top Width, T=	6.46	6.55	6.55	feet
Flow Area, A=	4.09	4.24	4.24	sq ft
Wetted Perimeter, P=	6.87	6.97	6.97	feet
Hydraulic Radius, R=	0.60	0.61	0.61	feet
Shear stress on channel bottom, τ =	0.32	0.33	0.33	lbs/sf
Critical Slope, S_c=	0.0406	0.0457	0.0457	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 4
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by: M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation:

$$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 4.7

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	5.20	5.20	5.20	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	2.0	2.0	2.0	feet
Bed slope, s=	0.0100	0.0100	0.0100	ft/ft
Available depth of channel:	3.00	3.00	3.00	feet
(OPTIONAL) Input Manning's 'n':	0.0490	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.78**	**0.77**	**0.77**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	2.22	2.23	2.23	feet
Calculated Velocity, V=	1.89	1.90	1.90	fps
Flow Top Width, T=	5.10	5.09	5.09	feet
Flow Area, A=	2.75	2.74	2.74	sq ft
Wetted Perimeter, P=	5.47	5.46	5.46	feet
Hydraulic Radius, R=	0.50	0.50	0.50	feet
Shear stress on channel bottom, τ =	0.48	0.48	0.48	lbs/sf
Critical Slope, S_c=	0.0471	0.0491	0.0491	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

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Description: POI 4
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Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 4.8

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	5.70	5.70	5.70	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	2.0	2.0	2.0	feet
Bed slope, s=	0.0060	0.0060	0.0060	ft/ft
Available depth of channel:	3.00	3.00	3.00	feet
(OPTIONAL) Input Manning's 'n':	0.0460	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.90**	**0.92**	**0.92**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	2.10	2.08	2.08	feet
Calculated Velocity, V=	1.68	1.61	1.61	fps
Flow Top Width, T=	5.58	5.68	5.68	feet
Flow Area, A=	3.40	3.53	3.53	sq ft
Wetted Perimeter, P=	6.01	6.11	6.11	feet
Hydraulic Radius, R=	0.57	0.58	0.58	feet
Shear stress on channel bottom, τ =	0.34	0.34	0.34	lbs/sf
Critical Slope, S_c=	0.0401	0.0470	0.0470	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 4
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by: M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation:

$$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 4.9

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	2.70	2.70	2.70	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	2.0	2.0	2.0	feet
Bed slope, s=	0.0100	0.0100	0.0100	ft/ft
Available depth of channel:	2.00	2.00	2.00	feet
(OPTIONAL) Input Manning's 'n':	0.0530	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.61**	**0.55**	**0.55**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	1.39	1.45	1.45	feet
Calculated Velocity, V=	1.39	1.57	1.57	fps
Flow Top Width, T=	4.42	4.22	4.22	feet
Flow Area, A=	1.94	1.72	1.72	sq ft
Wetted Perimeter, P=	4.71	4.48	4.48	feet
Hydraulic Radius, R=	0.41	0.38	0.38	feet
Shear stress on channel bottom, τ =	0.38	0.35	0.35	lbs/sf
Critical Slope, S_c=	0.0585	0.0532	0.0532	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 5
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by:
M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 5.1

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	3.50	3.50	3.50	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	3.0	3.0	3.0	feet
Bed slope, s=	0.0080	0.0080	0.0080	ft/ft
Available depth of channel:	2.00	2.00	2.00	feet
(OPTIONAL) Input Manning's 'n':	0.0530	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.61**	**0.57**	**0.57**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	1.39	1.43	1.43	feet
Calculated Velocity, V=	1.35	1.48	1.48	fps
Flow Top Width, T=	5.45	5.29	5.29	feet
Flow Area, A=	2.59	2.37	2.37	sq ft
Wetted Perimeter, P=	5.74	5.55	5.55	feet
Hydraulic Radius, R=	0.45	0.43	0.43	feet
Shear stress on channel bottom, τ =	0.31	0.29	0.29	lbs/sf
Critical Slope, S_c=	0.0561	0.0508	0.0508	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 5
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by: M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation:

$$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 5.2

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	26.10	26.10	26.10	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	3.0	3.0	3.0	feet
Bed slope, s=	0.0080	0.0080	0.0080	ft/ft
Available depth of channel:	5.00	5.00	5.00	feet
(OPTIONAL) Input Manning's 'n':	0.0360	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**1.37**	**1.60**	**1.60**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	3.63	3.40	3.40	feet
Calculated Velocity, V=	3.33	2.62	2.62	fps
Flow Top Width, T=	8.47	9.41	9.41	feet
Flow Area, A=	7.84	9.95	9.95	sq ft
Wetted Perimeter, P=	9.11	10.17	10.17	feet
Hydraulic Radius, R=	0.86	0.98	0.98	feet
Shear stress on channel bottom, τ =	0.68	0.80	0.80	lbs/sf
Critical Slope, S_c=	0.0214	0.0396	0.0396	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 5
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by:
M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 5.3

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	1.70	1.70	1.70	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	1.0	1.0	1.0	feet
Bed slope, s=	0.0150	0.0150	0.0150	ft/ft
Available depth of channel:	2.00	2.00	2.00	feet
(OPTIONAL) Input Manning's 'n':	0.0540	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.54**	**0.51**	**0.51**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	1.46	1.49	1.49	feet
Calculated Velocity, V=	1.52	1.63	1.63	fps
Flow Top Width, T=	3.16	3.06	3.06	feet
Flow Area, A=	1.12	1.04	1.04	sq ft
Wetted Perimeter, P=	3.41	3.30	3.30	feet
Hydraulic Radius, R=	0.33	0.32	0.32	feet
Shear stress on channel bottom, τ =	0.50	0.48	0.48	lbs/sf
Critical Slope, S_c=	0.0665	0.0577	0.0577	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 6
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by:
M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 6.1

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	1.00	1.00	1.00	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	1.0	1.0	1.0	feet
Bed slope, s=	0.0100	0.0100	0.0100	ft/ft
Available depth of channel:	2.00	2.00	2.00	feet
(OPTIONAL) Input Manning's 'n':	0.0550	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.47**	**0.42**	**0.42**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	1.53	1.58	1.58	feet
Calculated Velocity, V=	1.09	1.27	1.27	fps
Flow Top Width, T=	2.89	2.70	2.70	feet
Flow Area, A=	0.92	0.79	0.79	sq ft
Wetted Perimeter, P=	3.11	2.90	2.90	feet
Hydraulic Radius, R=	0.29	0.27	0.27	feet
Shear stress on channel bottom, τ =	0.29	0.27	0.27	lbs/sf
Critical Slope, S_c=	0.0713	0.0604	0.0604	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 6
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by:
M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 6.2

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	3.60	3.60	3.60	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	3.0	3.0	3.0	feet
Bed slope, s=	0.0090	0.0090	0.0090	ft/ft
Available depth of channel:	2.00	2.00	2.00	feet
(OPTIONAL) Input Manning's 'n':	0.0620	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.66**	**0.56**	**0.56**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	1.34	1.44	1.44	feet
Calculated Velocity, V=	1.27	1.56	1.56	fps
Flow Top Width, T=	5.62	5.25	5.25	feet
Flow Area, A=	2.83	2.31	2.31	sq ft
Wetted Perimeter, P=	5.93	5.51	5.51	feet
Hydraulic Radius, R=	0.48	0.42	0.42	feet
Shear stress on channel bottom, τ =	0.37	0.32	0.32	lbs/sf
Critical Slope, S_c=	0.0756	0.0511	0.0511	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 6
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

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Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation:

$$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 6.3

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	2.10	2.10	2.10	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	1.0	1.0	1.0	feet
Bed slope, s=	0.0120	0.0120	0.0120	ft/ft
Available depth of channel:	2.00	2.00	2.00	feet
(OPTIONAL) Input Manning's 'n':	0.0530	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.62**	**0.59**	**0.59**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	1.38	1.41	1.41	feet
Calculated Velocity, V=	1.51	1.64	1.64	fps
Flow Top Width, T=	3.48	3.36	3.36	feet
Flow Area, A=	1.39	1.28	1.28	sq ft
Wetted Perimeter, P=	3.78	3.63	3.63	feet
Hydraulic Radius, R=	0.37	0.35	0.35	feet
Shear stress on channel bottom, τ =	0.46	0.44	0.44	lbs/sf
Critical Slope, S_c=	0.0619	0.0558	0.0558	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 6
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by: M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 6.4

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	6.60	6.60	6.60	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	1.0	1.0	1.0	feet
Bed slope, s=	0.0130	0.0130	0.0130	ft/ft
Available depth of channel:	3.00	3.00	3.00	feet
(OPTIONAL) Input Manning's 'n':	0.0450	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.95**	**0.98**	**0.98**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	2.05	2.02	2.02	feet
Calculated Velocity, V=	2.41	2.27	2.27	fps
Flow Top Width, T=	4.79	4.93	4.93	feet
Flow Area, A=	2.74	2.91	2.91	sq ft
Wetted Perimeter, P=	5.23	5.39	5.39	feet
Hydraulic Radius, R=	0.52	0.54	0.54	feet
Shear stress on channel bottom, τ =	0.77	0.80	0.80	lbs/sf
Critical Slope, S_c=	0.0400	0.0489	0.0489	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 6
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

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M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation:

$$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 6.5

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	10.20	10.20	10.20	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	4.0	4.0	4.0	feet
Bed slope, s=	0.0090	0.0090	0.0090	ft/ft
Available depth of channel:	3.00	3.00	3.00	feet
(OPTIONAL) Input Manning's 'n':	0.0470	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.84**	**0.86**	**0.86**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	2.16	2.14	2.14	feet
Calculated Velocity, V=	2.15	2.06	2.06	fps
Flow Top Width, T=	7.35	7.45	7.45	feet
Flow Area, A=	4.75	4.94	4.94	sq ft
Wetted Perimeter, P=	7.74	7.86	7.86	feet
Hydraulic Radius, R=	0.61	0.63	0.63	feet
Shear stress on channel bottom, τ =	0.47	0.48	0.48	lbs/sf
Critical Slope, S_c=	0.0399	0.0448	0.0448	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 6
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 6.6

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	2.80	2.80	2.80	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	1.0	1.0	1.0	feet
Bed slope, s=	0.0185	0.0185	0.0185	ft/ft
Available depth of channel:	2.00	2.00	2.00	feet
(OPTIONAL) Input Manning's 'n':	0.0520	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.63**	**0.61**	**0.61**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	1.37	1.39	1.39	feet
Calculated Velocity, V=	1.96	2.08	2.08	fps
Flow Top Width, T=	3.53	3.43	3.43	feet
Flow Area, A=	1.43	1.34	1.34	sq ft
Wetted Perimeter, P=	3.83	3.72	3.72	feet
Hydraulic Radius, R=	0.37	0.36	0.36	feet
Shear stress on channel bottom, τ =	0.73	0.70	0.70	lbs/sf
Critical Slope, S_c=	0.0593	0.0554	0.0554	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 6
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 6.7

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	2.00	2.00	2.00	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	1.0	1.0	1.0	feet
Bed slope, s=	0.0200	0.0200	0.0200	ft/ft
Available depth of channel:	2.00	2.00	2.00	feet
(OPTIONAL) Input Manning's 'n':	0.0540	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.54**	**0.52**	**0.52**	**feet**

Calculated Results:

Freeboard, f=	1.46	1.48	1.48	feet
Calculated Velocity, V=	1.77	1.90	1.90	fps
Flow Top Width, T=	3.17	3.07	3.07	feet
Flow Area, A=	1.13	1.05	1.05	sq ft
Wetted Perimeter, P=	3.42	3.32	3.32	feet
Hydraulic Radius, R=	0.33	0.32	0.32	feet
Shear stress on channel bottom, τ =	0.68	0.65	0.65	lbs/sf
Critical Slope, S_c=	0.0664	0.0576	0.0576	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 6
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by: M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 6.8

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	5.80	5.80	5.80	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	4.0	4.0	4.0	feet
Bed slope, s=	0.0200	0.0200	0.0200	ft/ft
Available depth of channel:	2.00	2.00	2.00	feet
(OPTIONAL) Input Manning's 'n':	0.0540	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.53**	**0.51**	**0.51**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	1.47	1.49	1.49	feet
Calculated Velocity, V=	2.16	2.29	2.29	fps
Flow Top Width, T=	6.12	6.02	6.02	feet
Flow Area, A=	2.69	2.53	2.53	sq ft
Wetted Perimeter, P=	6.38	6.26	6.26	feet
Hydraulic Radius, R=	0.42	0.40	0.40	feet
Shear stress on channel bottom, τ =	0.66	0.63	0.63	lbs/sf
Critical Slope, S_c=	0.0589	0.0512	0.0512	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: **PPL Bells Bend**
Description: **POI 6**
Prepared by: **ATS**
Date: **14 Oct 10**

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by:
M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 6.9

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	11.90	11.90	11.90	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	3.0	3.0	3.0	feet
Bed slope, s=	0.0150	0.0150	0.0150	ft/ft
Available depth of channel:	3.00	3.00	3.00	feet
(OPTIONAL) Input Manning's 'n':	0.0460	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.89**	**0.92**	**0.92**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	2.11	2.08	2.08	feet
Calculated Velocity, V=	2.82	2.67	2.67	fps
Flow Top Width, T=	6.54	6.68	6.68	feet
Flow Area, A=	4.22	4.45	4.45	sq ft
Wetted Perimeter, P=	6.96	7.12	7.12	feet
Hydraulic Radius, R=	0.61	0.63	0.63	feet
Shear stress on channel bottom, τ =	0.83	0.86	0.86	lbs/sf
Critical Slope, S_c=	0.0387	0.0453	0.0453	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 6
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by: M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 6.10

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	3.40	3.40	3.40	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	2.0	2.0	2.0	feet
Bed slope, s=	0.0135	0.0135	0.0135	ft/ft
Available depth of channel:	2.00	2.00	2.00	feet
(OPTIONAL) Input Manning's 'n':	0.0530	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.63**	**0.58**	**0.58**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	1.37	1.42	1.42	feet
Calculated Velocity, V=	1.66	1.87	1.87	fps
Flow Top Width, T=	4.51	4.31	4.31	feet
Flow Area, A=	2.05	1.82	1.82	sq ft
Wetted Perimeter, P=	4.81	4.58	4.58	feet
Hydraulic Radius, R=	0.43	0.40	0.40	feet
Shear stress on channel bottom, τ =	0.53	0.49	0.49	lbs/sf
Critical Slope, S_c=	0.0580	0.0526	0.0526	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 8
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by: M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 8.1

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	1.80	1.80	1.80	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	1.0	1.0	1.0	feet
Bed slope, s=	0.0110	0.0110	0.0110	ft/ft
Available depth of channel:	2.00	2.00	2.00	feet
(OPTIONAL) Input Manning's 'n':	0.0530	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.59**	**0.56**	**0.56**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	1.41	1.44	1.44	feet
Calculated Velocity, V=	1.39	1.50	1.50	fps
Flow Top Width, T=	3.37	3.25	3.25	feet
Flow Area, A=	1.29	1.20	1.20	sq ft
Wetted Perimeter, P=	3.64	3.52	3.52	feet
Hydraulic Radius, R=	0.35	0.34	0.34	feet
Shear stress on channel bottom, τ =	0.41	0.39	0.39	lbs/sf
Critical Slope, S_c=	0.0626	0.0564	0.0564	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 8
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by:
M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 8.2

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	5.20	5.20	5.20	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	2.0	2.0	2.0	feet
Bed slope, s=	0.0080	0.0080	0.0080	ft/ft
Available depth of channel:	3.00	3.00	3.00	feet
(OPTIONAL) Input Manning's 'n':	0.0450	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.79**	**0.83**	**0.83**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	2.21	2.17	2.17	feet
Calculated Velocity, V=	1.85	1.73	1.73	fps
Flow Top Width, T=	5.15	5.30	5.30	feet
Flow Area, A=	2.81	3.01	3.01	sq ft
Wetted Perimeter, P=	5.52	5.69	5.69	feet
Hydraulic Radius, R=	0.51	0.53	0.53	feet
Shear stress on channel bottom, τ =	0.39	0.41	0.41	lbs/sf
Critical Slope, S_c=	0.0396	0.0483	0.0483	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 8
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by: M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 8.3

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	5.20	5.20	5.20	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	2.0	2.0	2.0	feet
Bed slope, s=	0.0300	0.0300	0.0300	ft/ft
Available depth of channel:	2.00	2.00	2.00	feet
(OPTIONAL) Input Manning's 'n':	0.0530	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.61**	**0.58**	**0.58**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	1.39	1.42	1.42	feet
Calculated Velocity, V=	2.66	2.83	2.83	fps
Flow Top Width, T=	4.43	4.33	4.33	feet
Flow Area, A=	1.96	1.84	1.84	sq ft
Wetted Perimeter, P=	4.72	4.60	4.60	feet
Hydraulic Radius, R=	0.41	0.40	0.40	feet
Shear stress on channel bottom, τ =	1.14	1.09	1.09	lbs/sf
Critical Slope, S_c=	0.0584	0.0525	0.0525	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 8
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by: M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation:

$$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data:

Swale 8.4	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	1.60	1.60	1.60	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	1.0	1.0	1.0	feet
Bed slope, s=	0.0280	0.0280	0.0280	ft/ft
Available depth of channel:	2.00	2.00	2.00	feet
(OPTIONAL) Input Manning's 'n':	0.0550	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.45**	**0.42**	**0.42**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	1.55	1.58	1.58	feet
Calculated Velocity, V=	1.85	2.10	2.10	fps
Flow Top Width, T=	2.82	2.66	2.66	feet
Flow Area, A=	0.87	0.76	0.76	sq ft
Wetted Perimeter, P=	3.03	2.86	2.86	feet
Hydraulic Radius, R=	0.29	0.27	0.27	feet
Shear stress on channel bottom, τ =	0.79	0.73	0.73	lbs/sf
Critical Slope, S_c=	0.0720	0.0607	0.0607	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 9
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by:
M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 9.1

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	9.60	9.60	9.60	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	3.0	3.0	3.0	feet
Bed slope, s=	0.0100	0.0100	0.0100	ft/ft
Available depth of channel:	3.00	3.00	3.00	feet
(OPTIONAL) Input Manning's 'n':	0.0460	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.88**	**0.91**	**0.91**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	2.12	2.09	2.09	feet
Calculated Velocity, V=	2.29	2.17	2.17	fps
Flow Top Width, T=	6.52	6.66	6.66	feet
Flow Area, A=	4.19	4.41	4.41	sq ft
Wetted Perimeter, P=	6.94	7.09	7.09	feet
Hydraulic Radius, R=	0.60	0.62	0.62	feet
Shear stress on channel bottom, τ =	0.55	0.57	0.57	lbs/sf
Critical Slope, S_c=	0.0388	0.0454	0.0454	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 9
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by: M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation:

$$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 9.2	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	4.20	4.20	4.20	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	1.0	1.0	1.0	feet
Bed slope, s=	0.0100	0.0100	0.0100	ft/ft
Available depth of channel:	3.00	3.00	3.00	feet
(OPTIONAL) Input Manning's 'n':	0.0470	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.84**	**0.86**	**0.86**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	2.16	2.14	2.14	feet
Calculated Velocity, V=	1.87	1.80	1.80	fps
Flow Top Width, T=	4.35	4.43	4.43	feet
Flow Area, A=	2.24	2.33	2.33	sq ft
Wetted Perimeter, P=	4.75	4.84	4.84	feet
Hydraulic Radius, R=	0.47	0.48	0.48	feet
Shear stress on channel bottom, τ =	0.52	0.54	0.54	lbs/sf
Critical Slope, S_c=	0.0451	0.0507	0.0507	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 9
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by:
M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation:

$$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 9.3

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	9.40	9.40	9.40	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	3.0	3.0	3.0	feet
Bed slope, s=	0.0100	0.0100	0.0100	ft/ft
Available depth of channel:	3.00	3.00	3.00	feet
(OPTIONAL) Input Manning's 'n':	0.0470	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.88**	**0.91**	**0.91**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	2.12	2.09	2.09	feet
Calculated Velocity, V=	2.24	2.16	2.16	fps
Flow Top Width, T=	6.53	6.62	6.62	feet
Flow Area, A=	4.20	4.36	4.36	sq ft
Wetted Perimeter, P=	6.94	7.05	7.05	feet
Hydraulic Radius, R=	0.60	0.62	0.62	feet
Shear stress on channel bottom, τ =	0.55	0.56	0.56	lbs/sf
Critical Slope, S_c=	0.0405	0.0455	0.0455	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 9
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by: M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$

Given Input Data: Swale 9.4

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	40.70	40.70	40.70	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	7.0	7.0	7.0	feet
Bed slope, s=	0.0070	0.0070	0.0070	ft/ft
Available depth of channel:	5.00	5.00	5.00	feet
(OPTIONAL) Input Manning's 'n':	0.0370	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**1.29**	**1.52**	**1.52**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	3.71	3.48	3.48	feet
Calculated Velocity, V=	3.29	2.66	2.66	fps
Flow Top Width, T=	12.17	13.09	13.09	feet
Flow Area, A=	12.38	15.30	15.30	sq ft
Wetted Perimeter, P=	12.78	13.81	13.81	feet
Hydraulic Radius, R=	0.97	1.11	1.11	feet
Shear stress on channel bottom, τ =	0.56	0.67	0.67	lbs/sf
Critical Slope, S_c=	0.0212	0.0371	0.0371	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 9
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by: M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method:

See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data:

Swale 9.5	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	4.00	4.00	4.00	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	4.0	4.0	4.0	feet
Bed slope, s=	0.0100	0.0100	0.0100	ft/ft
Available depth of channel:	2.00	2.00	2.00	feet
(OPTIONAL) Input Manning's 'n':	0.0540	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.53**	**0.50**	**0.50**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	1.47	1.50	1.50	feet
Calculated Velocity, V=	1.50	1.61	1.61	fps
Flow Top Width, T=	6.10	5.99	5.99	feet
Flow Area, A=	2.66	2.49	2.49	sq ft
Wetted Perimeter, P=	6.35	6.23	6.23	feet
Hydraulic Radius, R=	0.42	0.40	0.40	feet
Shear stress on channel bottom, τ =	0.33	0.31	0.31	lbs/sf
Critical Slope, S_c=	0.0591	0.0514	0.0514	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 10
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by: M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 10.1

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	13.60	13.60	13.60	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	4.0	4.0	4.0	feet
Bed slope, s=	0.0150	0.0150	0.0150	ft/ft
Available depth of channel:	3.00	3.00	3.00	feet
(OPTIONAL) Input Manning's 'n':	0.0470	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.85**	**0.88**	**0.88**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	2.15	2.12	2.12	feet
Calculated Velocity, V=	2.80	2.69	2.69	fps
Flow Top Width, T=	7.40	7.52	7.52	feet
Flow Area, A=	4.85	5.06	5.06	sq ft
Wetted Perimeter, P=	7.81	7.93	7.93	feet
Hydraulic Radius, R=	0.62	0.64	0.64	feet
Shear stress on channel bottom, τ =	0.80	0.82	0.82	lbs/sf
Critical Slope, S_c=	0.0397	0.0446	0.0446	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 10
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by: M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$

Given Input Data: Swale 10.2

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	12.00			cfs
Left Side Slope =	2.0			H:1V
Right Side Slope =	2.0			H:1V
Base width of Channel, b=	2.0			feet
Bed slope, s=	0.0100			ft/ft
Available depth of channel:	4.00			feet
(OPTIONAL) Input Manning's 'n':	0.0280			
Lining Type:	**R-2**			

Calculate Flow Depth:

Flow depth, d=	**0.89**	**feet**

Calculated Results:

Design Acceptable?	Yes	
Freeboard, f=	3.11	feet
Calculated Velocity, V=	3.59	fps
Flow Top Width, T=	5.55	feet
Flow Area, A=	3.34	sq ft
Wetted Perimeter, P=	5.96	feet
Hydraulic Radius, R=	0.56	feet
Shear stress on channel bottom, τ =	0.55	lbs/sf
Critical Slope, S_c=	0.0149	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	
Required Freeboard=	0.5	feet
Allowable Velocity for Lining Material=	4.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 10
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by: M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 10.3

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	9.20			cfs
Left Side Slope =	2.0			H:1V
Right Side Slope =	2.0			H:1V
Base width of Channel, b=	3.0			feet
Bed slope, s=	0.0100			ft/ft
Available depth of channel:	3.00			feet
(OPTIONAL) Input Manning's 'n':	0.0470			
Lining Type:	**R-2**			

Calculate Flow Depth:

Flow depth, d=	**0.87**	**feet**

Calculated Results:

Design Acceptable?	Yes	
Freeboard, f=	2.13	feet
Calculated Velocity, V=	2.23	fps
Flow Top Width, T=	6.49	feet
Flow Area, A=	4.13	sq ft
Wetted Perimeter, P=	6.90	feet
Hydraulic Radius, R=	0.60	feet
Shear stress on channel bottom, τ =	0.54	lbs/sf
Critical Slope, S_c=	0.0406	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	
Required Freeboard=	0.5	feet
Allowable Velocity for Lining Material=	4.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 10
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by:
M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation:

$$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 10.4

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	5.20			cfs
Left Side Slope =	2.0			H:1V
Right Side Slope =	2.0			H:1V
Base width of Channel, b=	2.0			feet
Bed slope, s=	0.0100			ft/ft
Available depth of channel:	3.00			feet
(OPTIONAL) Input Manning's 'n':	0.0490			
Lining Type:	**R-2**			

Calculate Flow Depth:

Flow depth, d=	**0.78**	**feet**

Calculated Results:

Design Acceptable?	Yes	
Freeboard, f=	2.22	feet
Calculated Velocity, V=	1.89	fps
Flow Top Width, T=	5.10	feet
Flow Area, A=	2.75	sq ft
Wetted Perimeter, P=	5.47	feet
Hydraulic Radius, R=	0.50	feet
Shear stress on channel bottom, τ =	0.48	lbs/sf
Critical Slope, S_c=	0.0471	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	
Required Freeboard=	0.5	feet
Allowable Velocity for Lining Material=	4.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 10
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 10.5

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	4.60	4.60	4.60	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	2.0	2.0	2.0	feet
Bed slope, s=	0.0100	0.0100	0.0100	ft/ft
Available depth of channel:	3.00	3.00	3.00	feet
(OPTIONAL) Input Manning's 'n':	0.0500	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.74**	**0.72**	**0.72**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	2.26	2.28	2.28	feet
Calculated Velocity, V=	1.80	1.84	1.84	fps
Flow Top Width, T=	4.95	4.90	4.90	feet
Flow Area, A=	2.56	2.50	2.50	sq ft
Wetted Perimeter, P=	5.30	5.24	5.24	feet
Hydraulic Radius, R=	0.48	0.48	0.48	feet
Shear stress on channel bottom, τ =	0.46	0.45	0.45	lbs/sf
Critical Slope, S_c=	0.0496	0.0498	0.0498	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 10
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by:
M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation:

$$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 10.6

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	3.50	3.50	3.50	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	1.0	1.0	1.0	feet
Bed slope, s=	0.0100	0.0100	0.0100	ft/ft
Available depth of channel:	3.00	3.00	3.00	feet
(OPTIONAL) Input Manning's 'n':	0.0490	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.79**	**0.78**	**0.78**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	2.21	2.22	2.22	feet
Calculated Velocity, V=	1.73	1.76	1.76	fps
Flow Top Width, T=	4.15	4.11	4.11	feet
Flow Area, A=	2.02	1.99	1.99	sq ft
Wetted Perimeter, P=	4.52	4.48	4.48	feet
Hydraulic Radius, R=	0.45	0.44	0.44	feet
Shear stress on channel bottom, τ =	0.49	0.49	0.49	lbs/sf
Critical Slope, S_c=	0.0498	0.0520	0.0520	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 10
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by: M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 10.7

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	55.00	55.00	55.00	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	9.0	9.0	9.0	feet
Bed slope, s=	0.0050	0.0050	0.0050	ft/ft
Available depth of channel:	6.00	6.00	6.00	feet
(OPTIONAL) Input Manning's 'n':	0.0340	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**1.42**	**1.75**	**1.75**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	4.58	4.25	4.25	feet
Calculated Velocity, V=	3.28	2.51	2.51	fps
Flow Top Width, T=	14.67	16.01	16.01	feet
Flow Area, A=	16.79	21.93	21.93	sq ft
Wetted Perimeter, P=	15.34	16.84	16.84	feet
Hydraulic Radius, R=	1.09	1.30	1.30	feet
Shear stress on channel bottom, τ =	0.44	0.55	0.55	lbs/sf
Critical Slope, S_c=	0.0171	0.0351	0.0351	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 10
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by: M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 10.8

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	47.40	47.40	47.40	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	6.0	6.0	6.0	feet
Bed slope, s=	0.0050	0.0050	0.0050	ft/ft
Available depth of channel:	6.00	6.00	6.00	feet
(OPTIONAL) Input Manning's 'n':	0.0320	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**1.52**	**1.92**	**1.92**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	4.48	4.08	4.08	feet
Calculated Velocity, V=	3.44	2.50	2.50	fps
Flow Top Width, T=	12.09	13.70	13.70	feet
Flow Area, A=	13.78	18.96	18.96	sq ft
Wetted Perimeter, P=	12.81	14.61	14.61	feet
Hydraulic Radius, R=	1.08	1.30	1.30	feet
Shear stress on channel bottom, τ =	0.48	0.60	0.60	lbs/sf
Critical Slope, S_c=	0.0154	0.0356	0.0356	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 10
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by:
M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation:

$$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 10.9

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	27.40	27.40	27.40	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	4.0	4.0	4.0	feet
Bed slope, s=	0.0100	0.0100	0.0100	ft/ft
Available depth of channel:	5.00	5.00	5.00	feet
(OPTIONAL) Input Manning's 'n':	0.0380	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**1.23**	**1.41**	**1.41**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	3.77	3.59	3.59	feet
Calculated Velocity, V=	3.46	2.84	2.84	fps
Flow Top Width, T=	8.91	9.65	9.65	feet
Flow Area, A=	7.93	9.64	9.64	sq ft
Wetted Perimeter, P=	9.49	10.32	10.32	feet
Hydraulic Radius, R=	0.84	0.93	0.93	feet
Shear stress on channel bottom, τ =	0.77	0.88	0.88	lbs/sf
Critical Slope, S_c=	0.0238	0.0398	0.0398	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 10
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by:
M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation:

$$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 10.10

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	16.60	16.60	16.60	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	4.0	4.0	4.0	feet
Bed slope, s=	0.0100	0.0100	0.0100	ft/ft
Available depth of channel:	4.00	4.00	4.00	feet
(OPTIONAL) Input Manning's 'n':	0.0430	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**1.01**	**1.09**	**1.09**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	2.99	2.91	2.91	feet
Calculated Velocity, V=	2.74	2.48	2.48	fps
Flow Top Width, T=	8.03	8.34	8.34	feet
Flow Area, A=	6.06	6.70	6.70	sq ft
Wetted Perimeter, P=	8.50	8.85	8.85	feet
Hydraulic Radius, R=	0.71	0.76	0.76	feet
Shear stress on channel bottom, τ =	0.63	0.68	0.68	lbs/sf
Critical Slope, S_c=	0.0319	0.0424	0.0424	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 10
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by:
M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 10.11

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	12.70	12.70	12.70	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	4.0	4.0	4.0	feet
Bed slope, s=	0.0100	0.0100	0.0100	ft/ft
Available depth of channel:	4.00	4.00	4.00	feet
(OPTIONAL) Input Manning's 'n':	0.0460	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.90**	**0.94**	**0.94**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	3.10	3.06	3.06	feet
Calculated Velocity, V=	2.42	2.28	2.28	fps
Flow Top Width, T=	7.62	7.78	7.78	feet
Flow Area, A=	5.26	5.56	5.56	sq ft
Wetted Perimeter, P=	8.05	8.22	8.22	feet
Hydraulic Radius, R=	0.65	0.68	0.68	feet
Shear stress on channel bottom, τ =	0.56	0.59	0.59	lbs/sf
Critical Slope, S_c=	0.0375	0.0438	0.0438	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 10
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by:
M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 10.12

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	3.20	3.20	3.20	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	4.0	4.0	4.0	feet
Bed slope, s=	0.0300	0.0300	0.0300	ft/ft
Available depth of channel:	2.00	2.00	2.00	feet
(OPTIONAL) Input Manning's 'n':	0.0550	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.34**	**0.32**	**0.32**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	1.66	1.68	1.68	feet
Calculated Velocity, V=	1.99	2.19	2.19	fps
Flow Top Width, T=	5.37	5.26	5.26	feet
Flow Area, A=	1.61	1.46	1.46	sq ft
Wetted Perimeter, P=	5.53	5.41	5.41	feet
Hydraulic Radius, R=	0.29	0.27	0.27	feet
Shear stress on channel bottom, τ =	0.64	0.59	0.59	lbs/sf
Critical Slope, S_c=	0.0685	0.0579	0.0579	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 10
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by: M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 10.13

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	7.00			cfs
Left Side Slope =	2.0			H:1V
Right Side Slope =	2.0			H:1V
Base width of Channel, b=	2.0			feet
Bed slope, s=	0.0300			ft/ft
Available depth of channel:	3.00			feet
(OPTIONAL) Input Manning's 'n':	0.0480			
Lining Type:	**R-5**			

Calculate Flow Depth:

Flow depth, d=	**0.67**	**feet**

Calculated Results:

Design Acceptable?	Yes	
Freeboard, f=	2.33	feet
Calculated Velocity, V=	3.11	fps
Flow Top Width, T=	4.69	feet
Flow Area, A=	2.25	sq ft
Wetted Perimeter, P=	5.01	feet
Hydraulic Radius, R=	0.45	feet
Shear stress on channel bottom, τ =	1.26	lbs/sf
Critical Slope, S_c=	0.0468	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	
Required Freeboard=	0.5	feet
Allowable Velocity for Lining Material=	11.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 10
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by: M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$

Given Input Data: Swale 10.14

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	20.00			cfs
Left Side Slope =	2.0			H:1V
Right Side Slope =	2.0			H:1V
Base width of Channel, b=	4.0			feet
Bed slope, s=	0.0100			ft/ft
Available depth of channel:	4.00			feet
(OPTIONAL) Input Manning's 'n':	0.0330			
Lining Type:	**R-3**			

Calculate Flow Depth:

Flow depth, d=	**0.96**	**feet**

Calculated Results:

Design Acceptable?	Yes	
Freeboard, f=	3.04	feet
Calculated Velocity, V=	3.50	fps
Flow Top Width, T=	7.86	feet
Flow Area, A=	5.72	sq ft
Wetted Perimeter, P=	8.31	feet
Hydraulic Radius, R=	0.69	feet
Shear stress on channel bottom, τ =	0.60	lbs/sf
Critical Slope, S_c=	0.0190	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	
Required Freeboard=	0.5	feet
Allowable Velocity for Lining Material=	6.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 10
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by:
M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 10.15

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	20.00			cfs
Left Side Slope =	2.0			H:1V
Right Side Slope =	2.0			H:1V
Base width of Channel, b=	4.0			feet
Bed slope, s=	0.0100			ft/ft
Available depth of channel:	4.00			feet
(OPTIONAL) Input Manning's 'n':	0.0330			
Lining Type:	**R-3**			

Calculate Flow Depth:

Flow depth, d=	**0.96**	**feet**

Calculated Results:

Design Acceptable?	Yes	
Freeboard, f=	3.04	feet
Calculated Velocity, V=	3.50	fps
Flow Top Width, T=	7.86	feet
Flow Area, A=	5.72	sq ft
Wetted Perimeter, P=	8.31	feet
Hydraulic Radius, R=	0.69	feet
Shear stress on channel bottom, τ =	0.60	lbs/sf
Critical Slope, S_c=	0.0190	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	
Required Freeboard=	0.5	feet
Allowable Velocity for Lining Material=	6.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: **PPL Bells Bend**
Description: **POI 10**
Prepared by: **ATS**
Date: **14 Oct 10**

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by: M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 10.16

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	7.60			cfs
Left Side Slope =	2.0			H:1V
Right Side Slope =	2.0			H:1V
Base width of Channel, b=	2.0			feet
Bed slope, s=	0.0300			ft/ft
Available depth of channel:	3.00			feet
(OPTIONAL) Input Manning's 'n':	0.0500			
Lining Type:	**R-3**			

Calculate Flow Depth:

Flow depth, d=	**0.72**	**feet**

Calculated Results:

Design Acceptable?	Yes	
Freeboard, f=	2.28	feet
Calculated Velocity, V=	3.09	fps
Flow Top Width, T=	4.87	feet
Flow Area, A=	2.46	sq ft
Wetted Perimeter, P=	5.21	feet
Hydraulic Radius, R=	0.47	feet
Shear stress on channel bottom, τ =	1.34	lbs/sf
Critical Slope, S_c=	0.0500	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	
Required Freeboard=	0.5	feet
Allowable Velocity for Lining Material=	6.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 10
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by:
M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$

Given Input Data: Swale 10.17

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	1.50	1.50	1.50	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	1.0	1.0	1.0	feet
Bed slope, s=	0.0100	0.0100	0.0100	ft/ft
Available depth of channel:	2.00	2.00	2.00	feet
(OPTIONAL) Input Manning's 'n':	0.0540	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.56**	**0.53**	**0.53**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	1.44	1.47	1.47	feet
Calculated Velocity, V=	1.26	1.37	1.37	fps
Flow Top Width, T=	3.25	3.13	3.13	feet
Flow Area, A=	1.19	1.10	1.10	sq ft
Wetted Perimeter, P=	3.51	3.38	3.38	feet
Hydraulic Radius, R=	0.34	0.32	0.32	feet
Shear stress on channel bottom, τ =	0.35	0.33	0.33	lbs/sf
Critical Slope, S_c=	0.0658	0.0572	0.0572	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 10
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by:
M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation:

$$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 10.18

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	1.30	1.30	1.30	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	1.0	1.0	1.0	feet
Bed slope, s=	0.0100	0.0100	0.0100	ft/ft
Available depth of channel:	2.00	2.00	2.00	feet
(OPTIONAL) Input Manning's 'n':	0.0550	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.53**	**0.50**	**0.50**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	1.47	1.50	1.50	feet
Calculated Velocity, V=	1.19	1.30	1.30	fps
Flow Top Width, T=	3.13	3.00	3.00	feet
Flow Area, A=	1.10	1.00	1.00	sq ft
Wetted Perimeter, P=	3.38	3.24	3.24	feet
Hydraulic Radius, R=	0.32	0.31	0.31	feet
Shear stress on channel bottom, τ =	0.33	0.31	0.31	lbs/sf
Critical Slope, S_c=	0.0692	0.0581	0.0581	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 11
Prepared by: ATS
Date: 14 Oct 10.

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by:
M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 11.1

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	0.80	0.80	0.80	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	1.0	1.0	1.0	feet
Bed slope, s=	0.0100	0.0100	0.0100	ft/ft
Available depth of channel:	2.00	2.00	2.00	feet
(OPTIONAL) Input Manning's 'n':	0.0550	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.43**	**0.38**	**0.38**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	1.57	1.62	1.62	feet
Calculated Velocity, V=	1.01	1.18	1.18	fps
Flow Top Width, T=	2.71	2.54	2.54	feet
Flow Area, A=	0.79	0.68	0.68	sq ft
Wetted Perimeter, P=	2.91	2.72	2.72	feet
Hydraulic Radius, R=	0.27	0.25	0.25	feet
Shear stress on channel bottom, τ =	0.27	0.24	0.24	lbs/sf
Critical Slope, S_c=	0.0730	0.0619	0.0619	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 12
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by:
M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation:

$$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 12.1

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	10.40	10.40	10.40	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	4.0	4.0	4.0	feet
Bed slope, s=	0.0100	0.0100	0.0100	ft/ft
Available depth of channel:	3.00	3.00	3.00	feet
(OPTIONAL) Input Manning's 'n':	0.0480	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.83**	**0.85**	**0.85**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	2.17	2.15	2.15	feet
Calculated Velocity, V=	2.21	2.15	2.15	fps
Flow Top Width, T=	7.32	7.39	7.39	feet
Flow Area, A=	4.71	4.83	4.83	sq ft
Wetted Perimeter, P=	7.72	7.79	7.79	feet
Hydraulic Radius, R=	0.61	0.62	0.62	feet
Shear stress on channel bottom, τ =	0.52	0.53	0.53	lbs/sf
Critical Slope, S_c=	0.0417	0.0450	0.0450	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 12
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by:
M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 12.2

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	2.90	2.90	2.90	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	2.0	2.0	2.0	feet
Bed slope, s=	0.0100	0.0100	0.0100	ft/ft
Available depth of channel:	2.00	2.00	2.00	feet
(OPTIONAL) Input Manning's 'n':	0.0530	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.63**	**0.57**	**0.57**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	1.37	1.43	1.43	feet
Calculated Velocity, V=	1.43	1.60	1.60	fps
Flow Top Width, T=	4.50	4.30	4.30	feet
Flow Area, A=	2.03	1.81	1.81	sq ft
Wetted Perimeter, P=	4.80	4.57	4.57	feet
Hydraulic Radius, R=	0.42	0.40	0.40	feet
Shear stress on channel bottom, τ=	0.39	0.36	0.36	lbs/sf
Critical Slope, S_c=	0.0580	0.0527	0.0527	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 12
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by:
M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$

Given Input Data: Swale 12.3

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	2.70	2.70	2.70	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	2.0	2.0	2.0	feet
Bed slope, s=	0.0100	0.0100	0.0100	ft/ft
Available depth of channel:	2.00	2.00	2.00	feet
(OPTIONAL) Input Manning's 'n':	0.0530	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.61**	**0.55**	**0.55**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	1.39	1.45	1.45	feet
Calculated Velocity, V=	1.39	1.57	1.57	fps
Flow Top Width, T=	4.42	4.22	4.22	feet
Flow Area, A=	1.94	1.72	1.72	sq ft
Wetted Perimeter, P=	4.71	4.48	4.48	feet
Hydraulic Radius, R=	0.41	0.38	0.38	feet
Shear stress on channel bottom, τ =	0.38	0.35	0.35	lbs/sf
Critical Slope, S_c=	0.0585	0.0532	0.0532	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 12
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by: M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation:

$$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 12.4

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	4.00	4.00	4.00	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	1.0	1.0	1.0	feet
Bed slope, s=	0.0100	0.0100	0.0100	ft/ft
Available depth of channel:	3.00	3.00	3.00	feet
(OPTIONAL) Input Manning's 'n':	0.0480	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.83**	**0.83**	**0.83**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	2.17	2.17	2.17	feet
Calculated Velocity, V=	1.82	1.82	1.82	fps
Flow Top Width, T=	4.31	4.31	4.31	feet
Flow Area, A=	2.20	2.20	2.20	sq ft
Wetted Perimeter, P=	4.70	4.71	4.71	feet
Hydraulic Radius, R=	0.47	0.47	0.47	feet
Shear stress on channel bottom, τ =	0.52	0.52	0.52	lbs/sf
Critical Slope, S_c=	0.0471	0.0511	0.0511	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 12
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by:
M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation:

$$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 12.5

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	5.30	5.30	5.30	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	1.0	1.0	1.0	feet
Bed slope, s=	0.0100	0.0100	0.0100	ft/ft
Available depth of channel:	3.00	3.00	3.00	feet
(OPTIONAL) Input Manning's 'n':	0.0460	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.92**	**0.94**	**0.94**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	2.08	2.06	2.06	feet
Calculated Velocity, V=	2.03	1.95	1.95	fps
Flow Top Width, T=	4.68	4.77	4.77	feet
Flow Area, A=	2.61	2.71	2.71	sq ft
Wetted Perimeter, P=	5.11	5.21	5.21	feet
Hydraulic Radius, R=	0.51	0.52	0.52	feet
Shear stress on channel bottom, τ =	0.57	0.59	0.59	lbs/sf
Critical Slope, S_c=	0.0421	0.0495	0.0495	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

I:\PROJECTS\PPLS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\PERMANENT\[Swales.xls]Swale 12.5

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 12
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by: M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$

Given Input Data: Swale 12.6

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	4.40			cfs
Left Side Slope =	2.0			H:1V
Right Side Slope =	2.0			H:1V
Base width of Channel, b=	1.0			feet
Bed slope, s=	0.0100			ft/ft
Available depth of channel:	3.00			feet
(OPTIONAL) Input Manning's 'n':	0.0470			
Lining Type:	**R-1**			

Calculate Flow Depth:

Flow depth, d=	**0.86**	**feet**

Calculated Results:

Design Acceptable?	Yes	
Freeboard, f=	2.14	feet
Calculated Velocity, V=	1.90	fps
Flow Top Width, T=	4.42	feet
Flow Area, A=	2.32	sq ft
Wetted Perimeter, P=	4.82	feet
Hydraulic Radius, R=	0.48	feet
Shear stress on channel bottom, τ =	0.53	lbs/sf
Critical Slope, S_c=	0.0448	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	
Required Freeboard=	0.5	feet
Allowable Velocity for Lining Material=	2.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 12
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by:
M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 12.7

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	6.70	6.70	6.70	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	1.0	1.0	1.0	feet
Bed slope, s=	0.0100	0.0100	0.0100	ft/ft
Available depth of channel:	3.00	3.00	3.00	feet
(OPTIONAL) Input Manning's 'n':	0.0440	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**1.00**	**1.05**	**1.05**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	2.00	1.95	1.95	feet
Calculated Velocity, V=	2.23	2.06	2.06	fps
Flow Top Width, T=	5.00	5.20	5.20	feet
Flow Area, A=	3.00	3.26	3.26	sq ft
Wetted Perimeter, P=	5.47	5.70	5.70	feet
Hydraulic Radius, R=	0.55	0.57	0.57	feet
Shear stress on channel bottom, τ =	0.62	0.66	0.66	lbs/sf
Critical Slope, S_c=	0.0377	0.0480	0.0480	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 12
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by:
M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation:

$$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 12.8

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	10.40	10.40	10.40	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	4.0	4.0	4.0	feet
Bed slope, s=	0.0100	0.0100	0.0100	ft/ft
Available depth of channel:	3.00	3.00	3.00	feet
(OPTIONAL) Input Manning's 'n':	0.0480	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.83**	**0.85**	**0.85**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	2.17	2.15	2.15	feet
Calculated Velocity, V=	2.21	2.15	2.15	fps
Flow Top Width, T=	7.32	7.39	7.39	feet
Flow Area, A=	4.71	4.83	4.83	sq ft
Wetted Perimeter, P=	7.72	7.79	7.79	feet
Hydraulic Radius, R=	0.61	0.62	0.62	feet
Shear stress on channel bottom, τ =	0.52	0.53	0.53	lbs/sf
Critical Slope, S_c=	0.0417	0.0450	0.0450	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 12
Prepared by: ATS
Date: 14 Oct 10.

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by:
M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation:

$$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 12.9

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	1.30	1.30	1.30	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	1.0	1.0	1.0	feet
Bed slope, s=	0.0100	0.0100	0.0100	ft/ft
Available depth of channel:	2.00	2.00	2.00	feet
(OPTIONAL) Input Manning's 'n':	0.0550	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.53**	**0.50**	**0.50**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	1.47	1.50	1.50	feet
Calculated Velocity, V=	1.19	1.30	1.30	fps
Flow Top Width, T=	3.13	3.00	3.00	feet
Flow Area, A=	1.10	1.00	1.00	sq ft
Wetted Perimeter, P=	3.38	3.24	3.24	feet
Hydraulic Radius, R=	0.32	0.31	0.31	feet
Shear stress on channel bottom, τ =	0.33	0.31	0.31	lbs/sf
Critical Slope, S_c=	0.0692	0.0581	0.0581	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 12
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Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data:

Swale 12.10	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	1.40	1.40	1.40	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	1.0	1.0	1.0	feet
Bed slope, s=	0.0100	0.0100	0.0100	ft/ft
Available depth of channel:	2.00	2.00	2.00	feet
(OPTIONAL) Input Manning's 'n':	0.0540	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.54**	**0.52**	**0.52**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	1.46	1.48	1.48	feet
Calculated Velocity, V=	1.23	1.33	1.33	fps
Flow Top Width, T=	3.18	3.06	3.06	feet
Flow Area, A=	1.14	1.05	1.05	sq ft
Wetted Perimeter, P=	3.44	3.31	3.31	feet
Hydraulic Radius, R=	0.33	0.32	0.32	feet
Shear stress on channel bottom, τ =	0.34	0.32	0.32	lbs/sf
Critical Slope, S_c=	0.0663	0.0576	0.0576	ft/ft
Flow stable? (no if $.7S_c < s \leq 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 12
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by:
M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 12.11

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	2.30	2.30	2.30	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	1.0	1.0	1.0	feet
Bed slope, s=	0.0100	0.0100	0.0100	ft/ft
Available depth of channel:	2.00	2.00	2.00	feet
(OPTIONAL) Input Manning's 'n':	0.0520	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.67**	**0.64**	**0.64**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	1.33	1.36	1.36	feet
Calculated Velocity, V=	1.47	1.59	1.59	fps
Flow Top Width, T=	3.67	3.54	3.54	feet
Flow Area, A=	1.56	1.45	1.45	sq ft
Wetted Perimeter, P=	3.99	3.84	3.84	feet
Hydraulic Radius, R=	0.39	0.38	0.38	feet
Shear stress on channel bottom, τ =	0.42	0.40	0.40	lbs/sf
Critical Slope, S_c=	0.0584	0.0547	0.0547	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 12
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by: M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation:

$$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 12.12

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	8.10	8.10	8.10	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	2.0	2.0	2.0	feet
Bed slope, s=	0.0100	0.0100	0.0100	ft/ft
Available depth of channel:	3.00	3.00	3.00	feet
(OPTIONAL) Input Manning's 'n':	0.0450	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.92**	**0.97**	**0.97**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	2.08	2.03	2.03	feet
Calculated Velocity, V=	2.27	2.14	2.14	fps
Flow Top Width, T=	5.70	5.86	5.86	feet
Flow Area, A=	3.56	3.79	3.79	sq ft
Wetted Perimeter, P=	6.14	6.32	6.32	feet
Hydraulic Radius, R=	0.58	0.60	0.60	feet
Shear stress on channel bottom, τ =	0.58	0.60	0.60	lbs/sf
Critical Slope, S_c=	0.0381	0.0465	0.0465	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: **PPL Bells Bend**
Description: **POI 12**
Prepared by: **ATS**
Date: **14 Oct 10**

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by: M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 12.13

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	2.40	2.40	2.40	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	2.0	2.0	2.0	feet
Bed slope, s=	0.0100	0.0100	0.0100	ft/ft
Available depth of channel:	2.00	2.00	2.00	feet
(OPTIONAL) Input Manning's 'n':	0.0540	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.60**	**0.52**	**0.52**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	1.40	1.48	1.48	feet
Calculated Velocity, V=	1.26	1.51	1.51	fps
Flow Top Width, T=	4.39	4.09	4.09	feet
Flow Area, A=	1.91	1.59	1.59	sq ft
Wetted Perimeter, P=	4.68	4.33	4.33	feet
Hydraulic Radius, R=	0.41	0.37	0.37	feet
Shear stress on channel bottom, τ =	0.37	0.33	0.33	lbs/sf
Critical Slope, S_c=	0.0609	0.0539	0.0539	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 13
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by: M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 13.1

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	2.60	2.60	2.60	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	2.0	2.0	2.0	feet
Bed slope, s=	0.0100	0.0100	0.0100	ft/ft
Available depth of channel:	2.00	2.00	2.00	feet
(OPTIONAL) Input Manning's 'n':	0.0540	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.62**	**0.54**	**0.54**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	1.38	1.46	1.46	feet
Calculated Velocity, V=	1.29	1.55	1.55	fps
Flow Top Width, T=	4.48	4.18	4.18	feet
Flow Area, A=	2.01	1.68	1.68	sq ft
Wetted Perimeter, P=	4.77	4.43	4.43	feet
Hydraulic Radius, R=	0.42	0.38	0.38	feet
Shear stress on channel bottom, τ =	0.39	0.34	0.34	lbs/sf
Critical Slope, S_c=	0.0603	0.0534	0.0534	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 13
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by:
M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation:

$$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 13.2

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	4.70	4.70	4.70	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	1.0	1.0	1.0	feet
Bed slope, s=	0.0100	0.0100	0.0100	ft/ft
Available depth of channel:	3.00	3.00	3.00	feet
(OPTIONAL) Input Manning's 'n':	0.0470	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.88**	**0.90**	**0.90**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	2.12	2.10	2.10	feet
Calculated Velocity, V=	1.93	1.88	1.88	fps
Flow Top Width, T=	4.52	4.59	4.59	feet
Flow Area, A=	2.43	2.50	2.50	sq ft
Wetted Perimeter, P=	4.94	5.01	5.01	feet
Hydraulic Radius, R=	0.49	0.50	0.50	feet
Shear stress on channel bottom, τ =	0.55	0.56	0.56	lbs/sf
Critical Slope, S_c=	0.0445	0.0501	0.0501	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 13
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by:
M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 13.3

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	6.40	6.40	6.40	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	1.0	1.0	1.0	feet
Bed slope, s=	0.0100	0.0100	0.0100	ft/ft
Available depth of channel:	3.00	3.00	3.00	feet
(OPTIONAL) Input Manning's 'n':	0.0440	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.98**	**1.03**	**1.03**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	2.02	1.97	1.97	feet
Calculated Velocity, V=	2.20	2.02	2.02	fps
Flow Top Width, T=	4.92	5.13	5.13	feet
Flow Area, A=	2.90	3.16	3.16	sq ft
Wetted Perimeter, P=	5.39	5.62	5.62	feet
Hydraulic Radius, R=	0.54	0.56	0.56	feet
Shear stress on channel bottom, τ =	0.61	0.64	0.64	lbs/sf
Critical Slope, S_c=	0.0379	0.0483	0.0483	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 13
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by:
M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation:

$$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 13.4

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	1.30	1.30	1.30	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	1.0	1.0	1.0	feet
Bed slope, s=	0.0100	0.0100	0.0100	ft/ft
Available depth of channel:	2.00	2.00	2.00	feet
(OPTIONAL) Input Manning's 'n':	0.0550	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.53**	**0.50**	**0.50**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	1.47	1.50	1.50	feet
Calculated Velocity, V=	1.19	1.30	1.30	fps
Flow Top Width, T=	3.13	3.00	3.00	feet
Flow Area, A=	1.10	1.00	1.00	sq ft
Wetted Perimeter, P=	3.38	3.24	3.24	feet
Hydraulic Radius, R=	0.32	0.31	0.31	feet
Shear stress on channel bottom, τ =	0.33	0.31	0.31	lbs/sf
Critical Slope, S_c=	0.0692	0.0581	0.0581	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 16
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by:
M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 16.1

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	2.80	2.80	2.80	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	2.0	2.0	2.0	feet
Bed slope, s=	0.0370	0.0370	0.0370	ft/ft
Available depth of channel:	2.00	2.00	2.00	feet
(OPTIONAL) Input Manning's 'n':	0.0550	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.43**	**0.39**	**0.39**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	1.57	1.61	1.61	feet
Calculated Velocity, V=	2.25	2.57	2.57	fps
Flow Top Width, T=	3.74	3.57	3.57	feet
Flow Area, A=	1.24	1.09	1.09	sq ft
Wetted Perimeter, P=	3.94	3.75	3.75	feet
Hydraulic Radius, R=	0.32	0.29	0.29	feet
Shear stress on channel bottom, τ =	1.00	0.90	0.90	lbs/sf
Critical Slope, S_c=	0.0682	0.0578	0.0578	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 16
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by: M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 16.2

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	3.40	3.40	3.40	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	2.0	2.0	2.0	feet
Bed slope, s=	0.0370	0.0370	0.0370	ft/ft
Available depth of channel:	2.00	2.00	2.00	feet
(OPTIONAL) Input Manning's 'n':	0.0550	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.47**	**0.44**	**0.44**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	1.53	1.56	1.56	feet
Calculated Velocity, V=	2.45	2.71	2.71	fps
Flow Top Width, T=	3.88	3.75	3.75	feet
Flow Area, A=	1.39	1.25	1.25	sq ft
Wetted Perimeter, P=	4.11	3.95	3.95	feet
Hydraulic Radius, R=	0.34	0.32	0.32	feet
Shear stress on channel bottom, τ =	1.09	1.01	1.01	lbs/sf
Critical Slope, S_c=	0.0669	0.0563	0.0563	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

I:\PROJECTS\PPLS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\PERMANENT\[Swales.xls]Swale 16.2

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 18
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by: M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 18.1

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	31.00	31.00	31.00	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	4.0	4.0	4.0	feet
Bed slope, s=	0.0100	0.0100	0.0100	ft/ft
Available depth of channel:	4.00	4.00	4.00	feet
(OPTIONAL) Input Manning's 'n':	0.0410	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**1.36**	**1.50**	**1.50**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	2.64	2.50	2.50	feet
Calculated Velocity, V=	3.39	2.94	2.94	fps
Flow Top Width, T=	9.45	10.01	10.01	feet
Flow Area, A=	9.15	10.53	10.53	sq ft
Wetted Perimeter, P=	10.09	10.72	10.72	feet
Hydraulic Radius, R=	0.91	0.98	0.98	feet
Shear stress on channel bottom, τ =	0.85	0.94	0.94	lbs/sf
Critical Slope, S_c=	0.0270	0.0392	0.0392	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 18
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by: M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation:

$$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 18.2

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	12.30	12.30	12.30	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	5.0	5.0	5.0	feet
Bed slope, s=	0.0100	0.0100	0.0100	ft/ft
Available depth of channel:	3.00	3.00	3.00	feet
(OPTIONAL) Input Manning's 'n':	0.0480	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.82**	**0.83**	**0.83**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	2.18	2.17	2.17	feet
Calculated Velocity, V=	2.26	2.21	2.21	fps
Flow Top Width, T=	8.28	8.33	8.33	feet
Flow Area, A=	5.45	5.56	5.56	sq ft
Wetted Perimeter, P=	8.67	8.73	8.73	feet
Hydraulic Radius, R=	0.63	0.64	0.64	feet
Shear stress on channel bottom, τ =	0.51	0.52	0.52	lbs/sf
Critical Slope, S_c=	0.0410	0.0443	0.0443	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 20
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by:
M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation:

$$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 20.1

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	19.30	19.30	19.30	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	5.0	5.0	5.0	feet
Bed slope, s=	0.0200	0.0200	0.0200	ft/ft
Available depth of channel:	3.00	3.00	3.00	feet
(OPTIONAL) Input Manning's 'n':	0.0470	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.86**	**0.89**	**0.89**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	2.14	2.11	2.11	feet
Calculated Velocity, V=	3.35	3.21	3.21	fps
Flow Top Width, T=	8.43	8.55	8.55	feet
Flow Area, A=	5.76	6.00	6.00	sq ft
Wetted Perimeter, P=	8.84	8.96	8.96	feet
Hydraulic Radius, R=	0.65	0.67	0.67	feet
Shear stress on channel bottom, τ =	1.07	1.11	1.11	lbs/sf
Critical Slope, S_c=	0.0389	0.0436	0.0436	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: POI 20
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:11 AM
Project #: PPL0902

Checked by:
M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation:

$$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 20.2

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	12.80	12.80	12.80	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	2.0	2.0	2.0	H:1V
Base width of Channel, b=	5.0	5.0	5.0	feet
Bed slope, s=	0.0100	0.0100	0.0100	ft/ft
Available depth of channel:	3.00	3.00	3.00	feet
(OPTIONAL) Input Manning's 'n':	0.0470	0.0500	0.0500	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.83**	**0.85**	**0.85**	**feet**

Calculated Results:

Design Acceptable?	Yes	Yes	Yes	
Freeboard, f=	2.17	2.15	2.15	feet
Calculated Velocity, V=	2.32	2.24	2.24	fps
Flow Top Width, T=	8.32	8.41	8.41	feet
Flow Area, A=	5.52	5.72	5.72	sq ft
Wetted Perimeter, P=	8.71	8.81	8.81	feet
Hydraulic Radius, R=	0.63	0.65	0.65	feet
Shear stress on channel bottom, τ =	0.52	0.53	0.53	lbs/sf
Critical Slope, S_c=	0.0392	0.0441	0.0441	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 1
Prepared by: ATS
Date: 14 Oct 10

Checked by:
M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: $Q = k C i A$ (where k = 1 for english units)

Description: SWALE 1.1

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95	0.013	0.012
	Lawn		0.40	0.650	0.260
	Cultivated		0.25		

Total Area, A: 0.663 acres
Weighted C: 0.41

Total A * C: 0.27235 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: **5.0 minutes**

STEP 3: Calculate Rainfall Intensity, I:

Override calculation for Tc? ◉ Yes ○ No   Tc = 5.0

Rainfall Intensity for   Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: $Q = k C i A$

25 year
Calculated Flow, Q (cfs) = 1.4

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Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 1
Prepared by: ATS
Date: 14 Oct 10

Checked by:
M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 1.2

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95		
	Lawn		0.40	0.710	0.284
	Cultivated		0.25		

Total Area, A: 0.710 acres
Weighted C: 0.40

Total A * C: 0.284 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

STEP 3: Calculate Rainfall Intensity, I:

Override calculation for Tc? ◉ Yes ○ No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

25 year
Calculated Flow, Q (cfs) = 1.4

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Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 1
Prepared by: ATS
Date: 14 Oct 10

Checked by:
M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 1.3

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95	0.410	0.390
	Lawn		0.40	1.070	0.428
	Cultivated		0.25		

Total Area, A: 1.480 acres
Weighted C: 0.55

Total A * C: 0.8175 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

STEP 3: Calculate Rainfall Intensity, I:

Override calculation for Tc? ◉ Yes ○ No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, I (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

25 year
Calculated Flow, Q (cfs) = 4.1

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Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 2
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 2.1

Structure: -
Route: -
Station: -

STEP 1 **: Calculate Drainage Area, A and Runoff Coefficient, C:**

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95	0.190	0.181
	Lawn		0.40	0.210	0.084
	Cultivated		0.25		

Total Area, A: 0.400 acres
Weighted C: 0.66

Total A * C: 0.2645 acres

STEP 2 **: Calculate Time of Concentration:**

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

STEP 3 **: Calculate Rainfall Intensity, I:**

Override calculation for Tc? ◉ Yes ○ No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

STEP 4 **: Calculate Peak Rate of Runoff, Q:** Q = k C i A

25 year

Calculated Flow, Q (cfs) = 1.3

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Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 2
Prepared by: ATS
Date: 14 Oct 10

Checked by:
M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: $Q = k\,C\,i\,A$ (where k = 1 for english units)

Description: SWALE 2.2

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95	0.210	0.200
	Lawn		0.40	0.040	0.016
	Cultivated		0.25		

Total Area, A: 0.250 acres
Weighted C: 0.86

Total A * C: 0.2155 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

STEP 3: Calculate Rainfall Intensity, I: **Override calculation for Tc?** ◉ Yes ○ No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: $Q = k\,C\,i\,A$

	25 year
Calculated Flow, Q (cfs) =	**1.1**

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 3
Prepared by: ATS
Date: 14 Oct 10

Checked by:
M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 3.1

Structure: -
Route: -
Station: -

***STEP 1*: Calculate Drainage Area, A and Runoff Coefficient, C:**

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95	0.460	0.437
	Lawn		0.40	1.270	0.508
	Cultivated		0.25		

Total Area, A: 1.730 acres
Weighted C: 0.55

Total A * C: 0.945 acres

***STEP 2*: Calculate Time of Concentration:**

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

***STEP 3*: Calculate Rainfall Intensity, I:** **Override calculation for Tc?** (•) Yes ( ) No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

***STEP 4*: Calculate Peak Rate of Runoff, Q:** Q = k C i A

	25 year
Calculated Flow, Q (cfs) =	**4.8**

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Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 3
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 3.2

Structure: -
Route: -
Station: -

***STEP 1*: Calculate Drainage Area, A and Runoff Coefficient, C:**

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95	0.500	0.475
	Lawn		0.40	0.060	0.024
	Cultivated		0.25		

Total Area, A: 0.560 acres
Weighted C: 0.89

Total A * C: 0.499 acres

***STEP 2*: Calculate Time of Concentration:**

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

***STEP 3*: Calculate Rainfall Intensity, I:** **Override calculation for Tc?** ◉ Yes ○ No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

***STEP 4*: Calculate Peak Rate of Runoff, Q:** Q = k C i A

25 year
Calculated Flow, Q (cfs) = 2.5

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Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 3
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 3.3

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95	0.100	0.095
	Lawn		0.40	0.260	0.104
	Cultivated		0.25		

Total Area, A: 0.360 acres
Weighted C: 0.55

Total A * C: 0.199 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: **5.0 minutes**

STEP 3: Calculate Rainfall Intensity, I:

Override calculation for Tc? ◉ Yes ○ No   **Tc =** 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, I (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: **Q = k C i A**

25 year
Calculated Flow, Q (cfs) = 1.0

PPLS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\PERMANENT\[PPLS0902-Rational Method-Conveyance.xlsm]Swale 3.3

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 3
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: **$Q = k\,C\,i\,A$** (where k = 1 for english units)

Description: SWALE 3.4

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95	0.140	0.133
	Lawn		0.40	0.160	0.064
	Cultivated		0.25		

Total Area, A: 0.300 acres
Weighted C: 0.66

Total A * C: 0.197 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

STEP 3: Calculate Rainfall Intensity, I:

Override calculation for Tc? ◉ Yes ○ No   Tc = 5.0

Rainfall Intensity for   Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: $Q = k\,C\,i\,A$

	25 year
Calculated Flow, Q (cfs) =	**1.0**

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Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 3
Prepared by: ATS
Date: 14 Oct 10

Checked by:
M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 3.5

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95	0.490	0.466
	Lawn		0.40	0.950	0.380
	Cultivated		0.25		

Total Area, A: 1.440 acres
Weighted C: 0.59

Total A * C: 0.8455 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

STEP 3: Calculate Rainfall Intensity, I:

Override calculation for Tc? Yes (selected) No   Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

25 year

Calculated Flow, Q (cfs) = 4.3

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Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 3
Prepared by: ATS
Date: 14 Oct 10

Checked by:
M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: $Q = k\, C\, i\, A$ (where k = 1 for english units)

Description: SWALE 3.6

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95	0.540	0.513
	Lawn		0.40	0.610	0.244
	Cultivated		0.25		

Total Area, A: 1.150 acres
Weighted C: 0.66

Total A * C: 0.757 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

STEP 3: Calculate Rainfall Intensity, I: **Override calculation for Tc?** ◉ Yes ○ No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

25 year
Calculated Flow, Q (cfs) = 3.8

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Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 3
Prepared by: ATS
Date: 14 Oct 10

Checked by:
M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 3.7

Structure: -
Route: -
Station: -

STEP 1 **: Calculate Drainage Area, A and Runoff Coefficient, C:**

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95	0.530	0.504
	Lawn		0.40	0.490	0.196
	Cultivated		0.25		

Total Area, A: **1.020 acres**
Weighted C: **0.69**

Total A * C: 0.6995 acres

STEP 2 **: Calculate Time of Concentration:**

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: **5.0 minutes**

STEP 3 **: Calculate Rainfall Intensity, I:**

Override calculation for Tc? ◉ Yes ○ No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): **5.04**

STEP 4 **: Calculate Peak Rate of Runoff, Q:** Q = k C i A

25 year
Calculated Flow, Q (cfs) = **3.5**

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Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 3
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 3.8

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95	1.330	1.264
	Lawn		0.40	2.850	1.140
	Cultivated		0.25		

Total Area, A: 4.180 acres
Weighted C: 0.58

Total A * C: 2.4035 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

STEP 3: Calculate Rainfall Intensity, I:

Override calculation for Tc? (●) Yes ( ) No   Tc = 5.0

Rainfall Intensity for   Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

25 year
Calculated Flow, Q (cfs) = 12.1

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Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 4
Prepared by: ATS
Date: 14 Oct 10

Checked by:
M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 4.1

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95	0.670	0.637
	Lawn		0.40	1.870	0.748
	Cultivated		0.25		

Total Area, A: 2.540 acres
Weighted C: 0.55

Total A * C: 1.3845 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

STEP 3: Calculate Rainfall Intensity, I:

Override calculation for Tc? ◉ Yes ○ No   Tc = 5.0

Rainfall Intensity for   Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q:

Q = k C i A

25 year
Calculated Flow, Q (cfs) = 7.0

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Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 4
Prepared by: ATS
Date: 14 Oct 10

Checked by:
M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 4.2

Structure: -
Route: -
Station: -

STEP 1 **: Calculate Drainage Area, A and Runoff Coefficient, C:**

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95	0.540	0.513
	Lawn		0.40	0.370	0.148
	Cultivated		0.25		

Total Area, A: 0.910 acres
Weighted C: 0.73

Total A * C: 0.661 acres

STEP 2 **: Calculate Time of Concentration:**

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: **5.0 minutes**

STEP 3 **: Calculate Rainfall Intensity, I:**

Override calculation for Tc? (●) Yes ( ) No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, I (in/hr): **5.04**

STEP 4 **: Calculate Peak Rate of Runoff, Q:** Q = k C i A

25 year

Calculated Flow, Q (cfs) = **3.3**

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Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 4
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 4.3

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95	0.130	0.124
	Lawn		0.40	0.110	0.044
	Cultivated		0.25		

Total Area, A: 0.240 acres
Weighted C: 0.70

Total A * C: 0.1675 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

STEP 3: Calculate Rainfall Intensity, I:

Override calculation for Tc? ◉ Yes ○ No **Tc =** 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

25 year
Calculated Flow, Q (cfs) = 0.8

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Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 4
Prepared by: ATS
Date: 14 Oct 10

Checked by:
M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 4.4

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95	0.090	0.086
	Lawn		0.40	0.100	0.040
	Cultivated		0.25		

Total Area, A: 0.190 acres
Weighted C: 0.66

Total A * C: 0.1255 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

STEP 3: Calculate Rainfall Intensity, I: **Override calculation for Tc?** ◉ Yes ○ No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, I (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

25 year
Calculated Flow, Q (cfs) = 0.6

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 4
Prepared by: ATS
Date: 14 Oct 10

Checked by:
M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 4.5

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95	0.140	0.133
	Lawn		0.40	0.200	0.080
	Cultivated		0.25		

Total Area, A: 0.340 acres
Weighted C: 0.63

Total A * C: 0.213 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

STEP 3: Calculate Rainfall Intensity, I:

Override calculation for Tc? ◉ Yes ○ No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

25 year
Calculated Flow, Q (cfs) = 1.1

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Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 4
Prepared by: ATS
Date: 14 Oct 10

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Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: $Q = k C i A$ (where k = 1 for english units)

Description: SWALE 4.6

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95	0.820	0.779
	Lawn		0.40	1.520	0.608
	Cultivated		0.25		

Total Area, A: 2.340 acres
Weighted C: 0.59

Total A * C: 1.387 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

STEP 3: Calculate Rainfall Intensity, I:

Override calculation for Tc? (•) Yes ( ) No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall Intensity, i (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: $Q = k C i A$

25 year

Calculated Flow, Q (cfs) = 7.0

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Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 4
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 4.7

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95	0.600	0.570
	Lawn		0.40	1.170	0.468
	Cultivated		0.25		

Total Area, A: 1.770 acres
Weighted C: 0.59

Total A * C: 1.038 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

STEP 3: Calculate Rainfall Intensity, I:

Override calculation for Tc? ◉ Yes ○ No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

25 year

Calculated Flow, Q (cfs) = 5.2

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Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 4
Prepared by: ATS
Date: 14 Oct 10

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M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: **$Q = k C i A$** (where k = 1 for english units)

Description: SWALE 4.8

Structure: -
Route: -
Station: -

***STEP 1*: Calculate Drainage Area, A and Runoff Coefficient, C:**

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95	0.810	0.770
	Lawn		0.40	0.880	0.352
	Cultivated		0.25		

Total Area, A: 1.690 acres
Weighted C: 0.66

Total A * C: 1.1215 acres

***STEP 2*: Calculate Time of Concentration:**

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

***STEP 3*: Calculate Rainfall Intensity, I:**

Override calculation for Tc? ◉ Yes ○ No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

***STEP 4*: Calculate Peak Rate of Runoff, Q:** $Q = k C i A$

25 year
Calculated Flow, Q (cfs) = 5.7

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Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 4
Prepared by: ATS
Date: 14 Oct 10

Checked by:
M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: $Q = k C i A$ (where k = 1 for english units)

Description: SWALE 4.9

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95	0.400	0.380
	Lawn		0.40	0.410	0.164
	Cultivated		0.25		

Total Area, A: 0.810 acres
Weighted C: 0.67

Total A * C: 0.544 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: **5.0 minutes**

STEP 3: Calculate Rainfall Intensity, I:

Override calculation for Tc? (•) Yes ( ) No **Tc =** 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): **5.04**

STEP 4: Calculate Peak Rate of Runoff, Q: $Q = k C i A$

25 year
Calculated Flow, Q (cfs) = 2.7

PPLS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\PERMANENT\[PPLS0902-Rational Method-Conveyance.xlsm]Swale 4.9

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 5
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 5.1

Structure: -
Route: -
Station: -

***STEP 1*: Calculate Drainage Area, A and Runoff Coefficient, C:**

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95	0.360	0.342
	Lawn		0.40	0.870	0.348
	Cultivated		0.25		

Total Area, A: 1.230 acres
Weighted C: 0.56

Total A * C: 0.69 acres

***STEP 2*: Calculate Time of Concentration:**

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

***STEP 3*: Calculate Rainfall Intensity, I:**

Override calculation for Tc? ◉ Yes ○ No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

***STEP 4*: Calculate Peak Rate of Runoff, Q:** Q = k C i A

25 year
Calculated Flow, Q (cfs) = 3.5

PPLS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\PERMANENT\[PPLS0902-Rational Method-Conveyance.xlsm]Swale 5.1

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 5
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 5.2

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95		
	Lawn		0.40	11.200	4.480
	Cultivated		0.25		

Total Area, A: 11.200 acres
Weighted C: 0.40

Total A * C: 4.48 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

STEP 3: Calculate Rainfall Intensity, I: **Override calculation for Tc?** ◉ Yes ○ No **Tc =** 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

25 year
Calculated Flow, Q (cfs) = 22.6

PPLS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\PERMANENT\[PPLS0902-Rational Method-Conveyance.xlsm]Swale 5.2

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 5
Prepared by: ATS
Date: 14 Oct 10

Checked by:
M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 5.3

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95	0.260	0.247
	Lawn		0.40	0.230	0.092
	Cultivated		0.25		

Total Area, A: 0.490 acres
Weighted C: 0.69

Total A * C: 0.339 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: **5.0 minutes**

STEP 3: Calculate Rainfall Intensity, I: **Override calculation for Tc?** (●) Yes ( ) No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

25 year
Calculated Flow, Q (cfs) = 1.7

PPLS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\PERMANENT\[PPLS0902-Rational Method-Conveyance.xlsm]Swale 5.3

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 6
Prepared by: ATS
Date: 14 Oct 10

Checked by:
M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 6.1

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95	0.160	0.152
	Lawn		0.40	0.130	0.052
	Cultivated		0.25		

Total Area, A: 0.290 acres
Weighted C: 0.70

Total A * C: 0.204 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

STEP 3: Calculate Rainfall Intensity, I:

Override calculation for Tc? (●) Yes ( ) No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

25 year
Calculated Flow, Q (cfs) = 1.0

PPLS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\PERMANENT\[PPLS0902-Rational Method-Conveyance.xlsm]Swale 6.1

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 6
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: $Q = k\,C\,i\,A$ (where k = 1 for english units)

Description: SWALE 6.2

Structure: -
Route: -
Station: -

***STEP 1*: Calculate Drainage Area, A and Runoff Coefficient, C:**

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95	0.420	0.399
	Lawn		0.40	0.800	0.320
	Cultivated		0.25		

Total Area, A: 1.220 acres
Weighted C: 0.59

Total A * C: 0.719 acres

***STEP 2*: Calculate Time of Concentration:**

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

***STEP 3*: Calculate Rainfall Intensity, I:**

Override calculation for Tc? ◉ Yes ○ No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

***STEP 4*: Calculate Peak Rate of Runoff, Q:** $Q = k\,C\,i\,A$

	25 year
Calculated Flow, Q (cfs) =	**3.6**

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 6
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 6.3

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95	0.320	0.304
	Lawn		0.40	0.270	0.108
	Cultivated		0.25		

Total Area, A: 0.590 acres
Weighted C: 0.70

Total A * C: 0.412 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

STEP 3: Calculate Rainfall Intensity, I:

Override calculation for Tc? (●) Yes ( ) No   Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

	25 year
Calculated Flow, Q (cfs) =	**2.1**

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Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 6
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: $Q = k\,C\,i\,A$ (where k = 1 for english units)

Description: SWALE 6.4

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95	0.650	0.618
	Lawn		0.40	1.740	0.696
	Cultivated		0.25		

Total Area, A: 2.390 acres
Weighted C: 0.55

Total A * C: 1.3135 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

STEP 3: Calculate Rainfall Intensity, I:

Override calculation for Tc? (●) Yes ( ) No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

25 year

Calculated Flow, Q (cfs) = 6.6

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Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 6
Prepared by: ATS
Date: 14 Oct 10

Checked by:
M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 6.5

Structure: -
Route: -
Station: -

***STEP 1*: Calculate Drainage Area, A and Runoff Coefficient, C:**

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95		
	Lawn		0.40	5.050	2.020
	Cultivated		0.25		

Total Area, A: 5.050 acres
Weighted C: 0.40

Total A * C: 2.02 acres

***STEP 2*: Calculate Time of Concentration:**

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: **5.0 minutes**

***STEP 3*: Calculate Rainfall Intensity, I:**

Override calculation for Tc? (●) Yes ( ) No   Tc = 5.0

Rainfall Intensity for   Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

***STEP 4*: Calculate Peak Rate of Runoff, Q:**   Q = k C i A

25 year
Calculated Flow, Q (cfs) = 10.2

PPLS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\PERMANENT\[PPLS0902-Rational Method-Conveyance.xlsm]Swale 6.5

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 6
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: $Q = k\,C\,i\,A$ (where k = 1 for english units)

Description: SWALE 6.6

Structure: -
Route: -
Station: -

***STEP 1*: Calculate Drainage Area, A and Runoff Coefficient, C:**

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95	0.380	0.361
	Lawn		0.40	0.500	0.200
	Cultivated		0.25		

Total Area, A: 0.880 acres Total A * C: 0.561 acres
Weighted C: 0.64

***STEP 2*: Calculate Time of Concentration:**

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

***STEP 3*: Calculate Rainfall Intensity, I:** **Override calculation for Tc?** ◉ Yes ○ No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

***STEP 4*: Calculate Peak Rate of Runoff, Q:** $Q = k\,C\,i\,A$

25 year
Calculated Flow, Q (cfs) = 2.8

PPLS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\PERMANENT\[PPLS0902-Rational Method-Conveyance.xlsm]Swale 6.6

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 6
Prepared by: ATS
Date: 14 Oct 10

Checked by:
M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 6.7

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95	0.230	0.219
	Lawn		0.40	0.460	0.184
	Cultivated		0.25		

Total Area, A: 0.690 acres
Weighted C: 0.58

Total A * C: 0.4025 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

STEP 3: Calculate Rainfall Intensity, I: **Override calculation for Tc?** ◉ Yes ○ No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

25 year
Calculated Flow, Q (cfs) = 2.0

PPLS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\PERMANENT\[PPLS0902-Rational Method-Conveyance.xlsm]Swale 6.7

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 6
Prepared by: ATS
Date: 14 Oct 10

Checked by:
M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 6.8

Structure: -
Route: -
Station: -

STEP 1 : Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95	0.590	0.561
	Lawn		0.40	1.500	0.600
	Cultivated		0.25		

Total Area, A: 2.090 acres
Weighted C: 0.56

Total A * C: 1.1605 acres

STEP 2 : Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: **5.0 minutes**

STEP 3 : Calculate Rainfall Intensity, I: **Override calculation for Tc?** (●) Yes ( ) No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): **5.04**

STEP 4 : Calculate Peak Rate of Runoff, Q: Q = k C i A

25 year
Calculated Flow, Q (cfs) = 5.8

PPLS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\PERMANENT\[PPLS0902-Rational Method-Conveyance.xlsm]Swale 6.8

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 6
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 6.9

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95	1.290	1.226
	Lawn		0.40	2.850	1.140
	Cultivated		0.25		

Total Area, A: 4.140 acres
Weighted C: 0.57

Total A * C: 2.3655 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

STEP 3: Calculate Rainfall Intensity, I: **Override calculation for Tc?** ◉ Yes ○ No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

25 year
Calculated Flow, Q (cfs) = 11.9

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 6
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 6.10

Structure: -
Route: -
Station: -

***STEP 1*: Calculate Drainage Area, A and Runoff Coefficient, C:**

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95		
	Lawn		0.40	1.700	0.680
	Cultivated		0.25		

Total Area, A: 1.700 acres
Weighted C: 0.40

Total A * C: 0.68 acres

***STEP 2*: Calculate Time of Concentration:**

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: **5.0 minutes**

***STEP 3*: Calculate Rainfall Intensity, I:**

Override calculation for Tc? ◉ Yes ○ No **Tc =** 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): **5.04**

***STEP 4*: Calculate Peak Rate of Runoff, Q:** Q = k C i A

25 year
Calculated Flow, Q (cfs) = 3.4

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 8
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: $Q = k C i A$ (where k = 1 for english units)

Description: SWALE 8.1

Structure: -
Route: -
Station: -

STEP 1 **: Calculate Drainage Area, A and Runoff Coefficient, C:**

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95	0.300	0.285
	Lawn		0.40	0.180	0.072
	Cultivated		0.25		

Total Area, A: 0.480 acres
Weighted C: 0.74

Total A * C: 0.357 acres

STEP 2 **: Calculate Time of Concentration:**

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

STEP 3 **: Calculate Rainfall Intensity, I:** **Override calculation for Tc?** (●) Yes ( ) No **Tc = 5.0**

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, I (in/hr): 5.04

STEP 4 **: Calculate Peak Rate of Runoff, Q:** $Q = k C i A$

25 year

Calculated Flow, Q (cfs) = 1.8

PPLS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\PERMANENT\[PPLS0902-Rational Method-Conveyance.xlsm]Swale 8.1

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 8
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 8.2

Structure: -
Route: -
Station: -

***STEP 1*: Calculate Drainage Area, A and Runoff Coefficient, C:**

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95	0.390	0.371
	Lawn		0.40	1.630	0.652
	Cultivated		0.25		

Total Area, A: 2.020 acres
Weighted C: 0.51

Total A * C: 1.0225 acres

***STEP 2*: Calculate Time of Concentration:**

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

***STEP 3*: Calculate Rainfall Intensity, I:**

Override calculation for Tc? ◉ Yes ○ No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

***STEP 4*: Calculate Peak Rate of Runoff, Q:** Q = k C i A

	25 year
Calculated Flow, Q (cfs) =	**5.2**

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Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 8
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 8.3

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95	0.390	0.371
	Lawn		0.40	1.630	0.652
	Cultivated		0.25		

Total Area, A: 2.020 acres
Weighted C: 0.51

Total A * C: 1.0225 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: **5.0 minutes**

STEP 3: Calculate Rainfall Intensity, I:

Override calculation for Tc? (●) Yes ( ) No   Tc = 5.0

Rainfall Intensity for   Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

	25 year
Calculated Flow, Q (cfs) =	**5.2**

PPLS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\PERMANENT\[PPLS0902-Rational Method-Conveyance.xlsm]Swale 8.3

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 8
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 8.4

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95	0.160	0.152
	Lawn		0.40	0.430	0.172
	Cultivated		0.25		

Total Area, A: 0.590 acres
Weighted C: 0.55

Total A * C: 0.324 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

STEP 3: Calculate Rainfall Intensity, I:

Override calculation for Tc? ◉ Yes ○ No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

	25 year
Calculated Flow, Q (cfs) =	**1.6**

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Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 9
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: $Q = k\,C\,i\,A$ (where k = 1 for english units)

Description: SWALE 9.1

Structure: -
Route: -
Station: -

***STEP 1*: Calculate Drainage Area, A and Runoff Coefficient, C:**

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95		
	Lawn		0.40	3.140	1.256
	Cultivated		0.25	2.630	0.658

Total Area, A: 5.770 acres
Weighted C: 0.33

Total A * C: 1.9135 acres

***STEP 2*: Calculate Time of Concentration:**

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: **5.0 minutes**

***STEP 3*: Calculate Rainfall Intensity, I:**

Override calculation for Tc? ◉ Yes ○ No   Tc = 5.0

Rainfall Intensity for   Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

***STEP 4*: Calculate Peak Rate of Runoff, Q:** $Q = k\,C\,i\,A$

25 year

Calculated Flow, Q (cfs) = 9.6

PPLS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\PERMANENT\[PPLS0902-Rational Method-Conveyance.xlsm]Swale 9.1

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 9
Prepared by: ATS
Date: 14 Oct 10

Checked by:
M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: $Q = k\,C\,i\,A$ (where k = 1 for english units)

Description: SWALE 9.2

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95	0.460	0.437
	Lawn		0.40	1.000	0.400
	Cultivated		0.25		

Total Area, A: 1.460 acres
Weighted C: 0.57

Total A * C: 0.837 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

STEP 3: Calculate Rainfall Intensity, I: **Override calculation for Tc?** ◉ Yes ○ No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: $Q = k\,C\,i\,A$

25 year
Calculated Flow, Q (cfs) = 4.2

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Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 9
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: $Q = k\,C\,i\,A$ (where k = 1 for english units)

Description: SWALE 9.3

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95	1.330	1.264
	Lawn		0.40	0.580	0.232
	Cultivated		0.25	1.440	0.360

Total Area, A: 3.350 acres
Weighted C: 0.55

Total A * C: 1.8555 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

STEP 3: Calculate Rainfall Intensity, I:

Override calculation for Tc? ◉ Yes ○ No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: $Q = k\,C\,i\,A$

25 year
Calculated Flow, Q (cfs) = 9.4

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Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 9
Prepared by: ATS
Date: 14 Oct 10

Checked by:
M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: $Q = k\,C\,i\,A$ (where k = 1 for english units)

Description: SWALE 9.4

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95	2.890	2.746
	Lawn		0.40	1.710	0.684
	Cultivated		0.25	0.160	0.040

Total Area, A: 4.760 acres
Weighted C: 0.73

Total A * C: 3.4695 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

STEP 3: Calculate Rainfall Intensity, I: **Override calculation for Tc?** (●) Yes ( ) No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: $Q = k\,C\,i\,A$

25 year
Calculated Flow, Q (cfs) = 17.5

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Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 9
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: $Q = k\,C\,i\,A$ (where k = 1 for english units)

Description: SWALE 9.5

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95	0.100	0.095
	Lawn		0.40	0.930	0.372
	Cultivated		0.25	1.290	0.323

Total Area, A: 2.320 acres
Weighted C: 0.34

Total A * C: 0.7895 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

STEP 3: Calculate Rainfall Intensity, I:

Override calculation for Tc? (●) Yes ( ) No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: $Q = k\,C\,i\,A$

25 year

Calculated Flow, Q (cfs) = 4.0

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Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 10
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 10.1

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95	1.580	1.501
	Lawn		0.40	2.970	1.188
	Cultivated		0.25		

Total Area, A: 4.550 acres
Weighted C: 0.59

Total A * C: 2.689 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: **5.0 minutes**

STEP 3: Calculate Rainfall Intensity, I: **Override calculation for Tc?** ◉ Yes ○ No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

25 year
Calculated Flow, Q (cfs) = 13.6

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Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 10
Prepared by: ATS
Date: 14 Oct 10

Checked by:
M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 10.2

Structure: -
Route: -
Station: -

***STEP 1*: Calculate Drainage Area, A and Runoff Coefficient, C:**

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95	2.510	2.385
	Stone		0.85		
	Cultivated		0.25		

Total Area, A: 2.510 acres
Weighted C: 0.95

Total A * C: 2.3845 acres

***STEP 2*: Calculate Time of Concentration:**

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

***STEP 3*: Calculate Rainfall Intensity, I:** **Override calculation for Tc?** ◉ Yes ○ No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

***STEP 4*: Calculate Peak Rate of Runoff, Q:** Q = k C i A

25 year
Calculated Flow, Q (cfs) = 12.0

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Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 10
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: $Q = k\,C\,i\,A$ (where k = 1 for english units)

Description: . SWALE 10.3

Structure: -
Route: -
Station: -

***STEP 1*: Calculate Drainage Area, A and Runoff Coefficient, C:**

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95		
	Stone		0.85	2.150	1.828
	Cultivated		0.25		

Total Area, A: 2.150 acres
Weighted C: 0.85

Total A * C: 1.8275 acres

***STEP 2*: Calculate Time of Concentration:**

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

***STEP 3*: Calculate Rainfall Intensity, I:**

Override calculation for Tc? ◉ Yes ○ No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

***STEP 4*: Calculate Peak Rate of Runoff, Q:** $Q = k\,C\,i\,A$

25 year
Calculated Flow, Q (cfs) = 9.2

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 10
Prepared by: ATS
Date: 14 Oct 10

Checked by:
M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 10.4

Structure: -
Route: -
Station: -

STEP 1 **: Calculate Drainage Area, A and Runoff Coefficient, C:**

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95		
	Stone		0.85	1.220	1.037
	Cultivated		0.25		

Total Area, A: 1.220 acres
Weighted C: 0.85

Total A * C: 1.037 acres

STEP 2 **: Calculate Time of Concentration:**

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

STEP 3 **: Calculate Rainfall Intensity, I:** Override calculation for Tc? (◉) Yes ( ) No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, I (in/hr): 5.04

STEP 4 **: Calculate Peak Rate of Runoff, Q:** Q = k C i A

25 year
Calculated Flow, Q (cfs) = 5.2

PLS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\PERMANENT\[PPLS0902-Rational Method-Conveyance.xlsm]Swale 10.4

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 10
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: $Q = k\,C\,i\,A$ (where k = 1 for english units)

Description: SWALE 10.5

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95		
	Lawn		0.40	2.300	0.920
	Cultivated		0.25		

Total Area, A: 2.300 acres
Weighted C: 0.40

Total A * C: 0.92 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

STEP 3: Calculate Rainfall Intensity, I:

Override calculation for Tc? ◉ Yes ○ No   Tc = 5.0

Rainfall Intensity for   Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: $Q = k\,C\,i\,A$

25 year

Calculated Flow, Q (cfs) = 4.6

PLS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\PERMANENT\[PPLS0902-Rational Method-Conveyance.xlsm]Swale 10.5

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 10
Prepared by: ATS
Date: 14 Oct 10

Checked by:
M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 10.6

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95		
	Lawn		0.40	1.740	0.696
	Cultivated		0.25		

Total Area, A: 1.740 acres
Weighted C: 0.40

Total A * C: 0.696 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

STEP 3: Calculate Rainfall Intensity, I:

Override calculation for Tc? ◉ Yes ○ No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

25 year

Calculated Flow, Q (cfs) = 3.5

PLS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\PERMANENT\[PPLS0902-Rational Method-Conveyance.xlsm]Swale 10.6

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 10
Prepared by: ATS
Date: 14 Oct 10

Checked by:
M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: $Q = k\,C\,i\,A$ (where k = 1 for english units)

Description: SWALE 10.7

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95		
	Lawn		0.40	0.160	0.064
	Cultivated		0.25		

Total Area, A: 0.160 acres
Weighted C: 0.40

Total A * C: 0.064 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

STEP 3: Calculate Rainfall Intensity, I:

Override calculation for Tc? (●) Yes ( ) No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: $Q = k\,C\,i\,A$

	25 year
Calculated Flow, Q (cfs) =	**0.3**

Rational Equation Stormwater Calculations

Pennoni

Client: **PPL0902**
Project: **POI 10**
Prepared by: **ATS**
Date: **14 Oct 10**

Checked by:
M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 10.8

Structure: -
Route: -
Station: -

***STEP 1*: Calculate Drainage Area, A and Runoff Coefficient, C:**

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95		
	Lawn		0.40	0.065	0.026
	Cultivated		0.25		

Total Area, A: 0.065 acres
Weighted C: 0.40

Total A * C: 0.026 acres

***STEP 2*: Calculate Time of Concentration:**

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

***STEP 3*: Calculate Rainfall Intensity, I:**

Override calculation for Tc? ◉ Yes ○ No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

***STEP 4*: Calculate Peak Rate of Runoff, Q:** Q = k C i A

25 year
Calculated Flow, Q (cfs) = 0.1

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Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 10
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: $Q = k\,C\,i\,A$ (where k = 1 for english units)

Description: SWALE 10.9

Structure: -
Route: -
Station: -

***STEP 1*: Calculate Drainage Area, A and Runoff Coefficient, C:**

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95	0.290	0.276
	Lawn		0.40	0.840	0.336
	Stone		0.85	1.790	1.522

Total Area, A: 2.920 acres
Weighted C: 0.73

Total A * C: 2.133 acres

***STEP 2*: Calculate Time of Concentration:**

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

***STEP 3*: Calculate Rainfall Intensity, I:**

Override calculation for Tc? (●) Yes ( ) No **Tc =** 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

***STEP 4*: Calculate Peak Rate of Runoff, Q:** $Q = k\,C\,i\,A$

25 year
Calculated Flow, Q (cfs) = 10.8

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 10
Prepared by: ATS
Date: 14 Oct 10

Checked by:
M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 10.10

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95	0.180	0.171
	Lawn		0.40	1.500	0.600
	Cultivated		0.25		

Total Area, A: 1.680 acres
Weighted C: 0.46

Total A * C: 0.771 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

STEP 3: Calculate Rainfall Intensity, I: **Override calculation for Tc?** ◉ Yes ○ No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

25 year
Calculated Flow, Q (cfs) = 3.9

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Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 10
Prepared by: ATS
Date: 14 Oct 10

Checked by:
M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: $Q = k C i A$ (where k = 1 for english units)

Description: SWALE 10.11

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95	0.090	0.086
	Lawn		0.40	1.040	0.416
	Cultivated		0.25		

Total Area, A: 1.130 acres
Weighted C: 0.44

Total A * C: 0.5015 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

STEP 3: Calculate Rainfall Intensity, I:

Override calculation for Tc? ◉ Yes ○ No   Tc = 5.0

Rainfall Intensity for   Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: $Q = k C i A$

25 year
Calculated Flow, Q (cfs) = 2.5

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Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 10
Prepared by: ATS
Date: 14 Oct 10

Checked by:
M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 10.12

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95	0.130	0.124
	Lawn		0.40	1.300	0.520
	Cultivated		0.25		

Total Area, A: 1.430 acres
Weighted C: 0.45

Total A * C: 0.6435 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

STEP 3: Calculate Rainfall Intensity, I:

Override calculation for Tc? ◉ Yes ○ No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, I (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

25 year
Calculated Flow, Q (cfs) = 3.2

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Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 10
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: $Q = k\,C\,i\,A$ (where k = 1 for english units)

Description: SWALE 10.13

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95	0.210	0.200
	Lawn		0.40		
	Stone		0.85	1.400	1.190

Total Area, A: 1.610 acres
Weighted C: 0.86

Total A * C: 1.3895 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

STEP 3: Calculate Rainfall Intensity, I: **Override calculation for Tc?** (•) Yes ( ) No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: $Q = k\,C\,i\,A$

25 year

Calculated Flow, Q (cfs) = 7.0

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Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 10
Prepared by: ATS
Date: 14 Oct 10

Checked by:
M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 10.14

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95	3.110	2.955
	Lawn		0.40		
	Stone		0.85	1.190	1.012

Total Area, A: 4.300 acres
Weighted C: 0.92

Total A * C: 3.966 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

STEP 3: Calculate Rainfall Intensity, I: **Override calculation for Tc?** ◉ Yes ○ No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

	25 year
Calculated Flow, Q (cfs) =	**20.0**

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Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 10
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: $Q = k\,C\,i\,A$ (where k = 1 for english units)

Description: SWALE 10.15

Structure: -
Route: -
Station: -

STEP 1: **Calculate Drainage Area, A and Runoff Coefficient, C:**

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95	3.110	2.955
	Lawn		0.40		
	Stone		0.85	1.190	1.012

Total Area, A: 4.300 acres
Weighted C: 0.92

Total A * C: 3.966 acres

STEP 2: **Calculate Time of Concentration:**

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

STEP 3: **Calculate Rainfall Intensity, I:** **Override calculation for Tc?** ◉ Yes ○ No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

STEP 4: **Calculate Peak Rate of Runoff, Q:** Q = k C i A

25 year
Calculated Flow, Q (cfs) = 20.0

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Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 10
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: $Q = k C i A$ (where k = 1 for english units)

Description: SWALE 10.16

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95	0.250	0.238
	Lawn		0.40		
	Stone		0.85	1.500	1.275

Total Area, A: 1.750 acres
Weighted C: 0.86

Total A * C: 1.5125 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

STEP 3: Calculate Rainfall Intensity, I:

Override calculation for Tc? (•) Yes ( ) No   Tc = 5.0

Rainfall Intensity for   Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, I (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: $Q = k C i A$

25 year

Calculated Flow, Q (cfs) = 7.6

LS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\PERMANENT\[PPLS0902-Rational Method-Conveyance.xlsm]Swale 10.16

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 10
Prepared by: ATS
Date: 14 Oct 10

Checked by:
M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 10.17

Structure: -
Route: -
Station: -

***STEP 1*: Calculate Drainage Area, A and Runoff Coefficient, C:**

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95	0.310	0.295
	Lawn		0.40		
	Cultivated		0.25		

Total Area, A: 0.310 acres
Weighted C: 0.95

Total A * C: 0.2945 acres

***STEP 2*: Calculate Time of Concentration:**

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

***STEP 3*: Calculate Rainfall Intensity, I:**

Override calculation for Tc? (●) Yes ( ) No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

***STEP 4*: Calculate Peak Rate of Runoff, Q:** Q = k C i A

25 year
Calculated Flow, Q (cfs) = 1.5

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 10
Prepared by: ATS
Date: 14 Oct 10

Checked by:
M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: **$Q = k\,C\,i\,A$** (where k = 1 for english units)

Description: SWALE 10.18

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95	0.270	0.257
	Lawn		0.40		
	Cultivated		0.25		

Total Area, A: 0.270 acres
Weighted C: 0.95

Total A * C: 0.2565 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

STEP 3: Calculate Rainfall Intensity, I: **Override calculation for Tc?** ◉ Yes ○ No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

25 year

Calculated Flow, Q (cfs) = 1.3

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 11
Prepared by: ATS
Date: 14 Oct 10

Checked by:
M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: $Q = k C i A$ (where k = 1 for english units)

Description: SWALE 11.1

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95		
	Lawn		0.40	0.410	0.164
	Cultivated		0.25		

Total Area, A: 0.410 acres
Weighted C: 0.40

Total A * C: 0.164 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

STEP 3: Calculate Rainfall Intensity, I: **Override calculation for Tc?** ◉ Yes ○ No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: **$Q = k C i A$**

	25 year
Calculated Flow, Q (cfs) =	**0.8**

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Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 12
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 12.1

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious	-	0.95	0.870	0.827
	Lawn		0.40	3.080	1.232
	Cultivated		0.25		

Total Area, A: 3.950 acres
Weighted C: 0.52

Total A * C: 2.0585 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

STEP 3: Calculate Rainfall Intensity, I:

Override calculation for Tc? (●) Yes ( ) No   Tc = 5.0

Rainfall Intensity for   Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

25 year

Calculated Flow, Q (cfs) = 10.4

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 12
Prepared by: ATS
Date: 14 Oct 10

Checked by:
M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: Q = k C i A (where k = 1 for english units)

Description: SWALE 12.2

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95		
	Lawn		0.40	1.450	0.580
	Cultivated		0.25		

Total Area, A: 1.450 acres
Weighted C: 0.40

Total A * C: 0.58 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

STEP 3: Calculate Rainfall Intensity, I: **Override calculation for Tc?** ◉ Yes ○ No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, I (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

Calculated Flow, Q (cfs) = 25 year **2.9**

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 12
Prepared by: ATS
Date: 14 Oct 10

Checked by:
M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 12.3

Structure: -
Route: -
Station: -

STEP 1: **Calculate Drainage Area, A and Runoff Coefficient, C:**

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95	0.090	0.086
	Lawn		0.40	1.150	0.460
	Cultivated		0.25		

Total Area, A: 1.240 acres
Weighted C: 0.44

Total A * C: 0.5455 acres

STEP 2: **Calculate Time of Concentration:**

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: **5.0 minutes**

STEP 3: **Calculate Rainfall Intensity, I:**

Override calculation for Tc? ◉ Yes ○ No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): **5.04**

STEP 4: **Calculate Peak Rate of Runoff, Q:** Q = k C i A

25 year
Calculated Flow, Q (cfs) = 2.7

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 12
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: $Q = k\,C\,i\,A$ (where k = 1 for english units)

Description: SWALE 12.4

Structure: -
Route: -
Station: -

STEP 1 **: Calculate Drainage Area, A and Runoff Coefficient, C:**

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95	0.240	0.228
	Lawn		0.40	1.430	0.572
	Cultivated		0.25		

Total Area, A: 1.670 acres
Weighted C: 0.48

Total A * C: 0.8 acres

STEP 2 **: Calculate Time of Concentration:**

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

STEP 3 **: Calculate Rainfall Intensity, I:**

Override calculation for Tc? ◉ Yes ○ No   Tc = 5.0

Rainfall Intensity for   Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

STEP 4 **: Calculate Peak Rate of Runoff, Q:** $Q = k\,C\,i\,A$

25 year
Calculated Flow, Q (cfs) = 4.0

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Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 12
Prepared by: ATS

Date: 14 Oct 10

Checked by:
M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: $Q = k\,C\,i\,A$ (where k = 1 for english units)

Description: SWALE 12.5

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95	0.270	0.257
	Lawn		0.40	1.980	0.792
	Stone		0.85		

Total Area, A: 2.250 acres
Weighted C: 0.47

Total A * C: 1.0485 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

STEP 3: Calculate Rainfall Intensity, I:

Override calculation for Tc? ◉ Yes ○ No   Tc = 5.0

Rainfall Intensity for   Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, I (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: $Q = k\,C\,i\,A$

25 year
Calculated Flow, Q (cfs) = 5.3

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 12
Prepared by: ATS
Date: 14 Oct 10

Checked by:
M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: $Q = k\,C\,i\,A$ (where k = 1 for english units)

Description: SWALE 12.6

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95		
	Lawn		0.40	2.160	0.864
	Cultivated		0.25		

Total Area, A: 2.160 acres
Weighted C: 0.40

Total A * C: 0.864 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: **5.0 minutes**

STEP 3: Calculate Rainfall Intensity, I: **Override calculation for Tc?** ◉ Yes ○ No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: $Q = k\,C\,i\,A$

25 year
Calculated Flow, Q (cfs) = 4.4

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 12
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 12.7

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95	1.170	1.112
	Lawn		0.40	0.540	0.216
	Cultivated		0.25		

Total Area, A: 1.710 acres
Weighted C: 0.78

Total A * C: 1.3275 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

STEP 3: Calculate Rainfall Intensity, I:

Override calculation for Tc? (●) Yes ( ) No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

25 year

Calculated Flow, Q (cfs) = 6.7

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Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 12
Prepared by: ATS
Date: 14 Oct 10

Checked by:
M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: $Q = k\,C\,i\,A$ (where k = 1 for english units)

Description: SWALE 12.8

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95	1.410	1.340
	Lawn		0.40	1.810	0.724
	Cultivated		0.25		

Total Area, A: 3.220 acres
Weighted C: 0.64
Total A * C: 2.0635 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

STEP 3: Calculate Rainfall Intensity, I:

Override calculation for Tc? (●) Yes ( ) No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: $Q = k\,C\,i\,A$

25 year
Calculated Flow, Q (cfs) = 10.4

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Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 12
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: $Q = k C i A$ (where k = 1 for english units).

Description: SWALE 12.9

Structure: -
Route: -
Station: -

STEP 1: **Calculate Drainage Area, A and Runoff Coefficient, C:**

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95	0.100	0.095
	Lawn		0.40	0.410	0.164
	Stone		0.85		

Total Area, A: 0.510 acres
Weighted C: 0.51

Total A * C: 0.259 acres

STEP 2: **Calculate Time of Concentration:**

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn . (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

STEP 3: **Calculate Rainfall Intensity, I:**

Override calculation for Tc? ◉ Yes ○ No   Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

STEP 4: **Calculate Peak Rate of Runoff, Q:** $Q = k C i A$

25 year
Calculated Flow, Q (cfs) = 1.3

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Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 12
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: **$Q = k\,C\,i\,A$** (where k = 1 for english units)

Description: SWALE 12.10

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95	0.120	0.114
	Lawn		0.40	0.390	0.156
	Stone		0.85		

Total Area, A: 0.510 acres
Weighted C: 0.53

Total A * C: 0.27 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

STEP 3: Calculate Rainfall Intensity, I: **Override calculation for Tc?** ◉ Yes ○ No **Tc =** 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: **$Q = k\,C\,i\,A$**

25 year
Calculated Flow, Q (cfs) = 1.4

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Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 12
Prepared by: ATS
Date: 14 Oct 10

Checked by:
M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 12.11

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95	0.180	0.171
	Lawn		0.40	0.710	0.284
	Stone		0.85		

Total Area, A: 0.890 acres
Weighted C: 0.51

Total A * C: 0.455 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: **5.0 minutes**

STEP 3: Calculate Rainfall Intensity, I: **Override calculation for Tc?** ◉ Yes ○ No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): **5.04**

STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

25 year
Calculated Flow, Q (cfs) = 2.3

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Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 12
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 12.12

Structure: -
Route: -
Station: -

***STEP 1*: Calculate Drainage Area, A and Runoff Coefficient, C:**

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95	0.530	0.504
	Lawn		0.40	2.740	1.096
	Stone		0.85		

Total Area, A: 3.270 acres
Weighted C: 0.49

Total A * C: 1.5995 acres

***STEP 2*: Calculate Time of Concentration:**

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

***STEP 3*: Calculate Rainfall Intensity, I:** **Override calculation for Tc?** ◉ Yes ○ No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

***STEP 4*: Calculate Peak Rate of Runoff, Q:** Q = k C i A

25 year
Calculated Flow, Q (cfs) = 8.1

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 12
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: $Q = k\,C\,i\,A$ (where k = 1 for english units)

Description: SWALE 12.13

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95		
	Lawn		0.40	1.190	0.476
	Cultivated		0.25		

Total Area, A: 1.190 acres
Weighted C: 0.40

Total A * C: 0.476 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

STEP 3: Calculate Rainfall Intensity, I:

Override calculation for Tc? (●) Yes ( ) No   Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: $Q = k\,C\,i\,A$

25 year

Calculated Flow, Q (cfs) = 2.4

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Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 13
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: $Q = k C i A$ (where k = 1 for english units)

Description: SWALE 13.1

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95		
	Lawn		0.40	1.310	0.524
	Cultivated		0.25		

Total Area, A: 1.310 acres
Weighted C: 0.40

Total A * C: 0.524 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

STEP 3: Calculate Rainfall Intensity, I: **Override calculation for Tc?** ◉ Yes ○ No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: $Q = k C i A$

25 year
Calculated Flow, Q (cfs) = 2.6

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Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 13
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 13.2

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95		
	Lawn		0.40	2.350	0.940
	Cullivated		0.25		

Total Area, A: 2.350 acres
Weighted C: 0.40

Total A * C: 0.94 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: **5.0 minutes**

STEP 3: Calculate Rainfall Intensity, I:

Override calculation for Tc? (●) Yes ( ) No   Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): **5.04**

STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

	25 year
Calculated Flow, Q (cfs) =	**4.7**

PLS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\PERMANENT\[PPLS0902-Rational Method-Conveyance.xlsm]Swale 13.2

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 13
Prepared by: ATS
Date: 14 Oct 10

Checked by:
M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 13.3

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95	0.510	0.485
	Lawn		0.40	1.980	0.792
	Cultivated		0.25		

Total Area, A: 2.490 acres
Weighted C: 0.51

Total A * C: 1.2765 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

STEP 3: Calculate Rainfall Intensity, I: **Override calculation for Tc?** ◉ Yes ○ No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

25 year
Calculated Flow, Q (cfs) = 6.4

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 13
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 13.4

Structure: -
Route: -
Station: -

***STEP 1*: Calculate Drainage Area, A and Runoff Coefficient, C:**

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95	0.190	0.181
	Lawn		0.40	1.450	0.580
	Cultivated		0.25		

Total Area, A: 1.640 acres
Weighted C: 0.46

Total A * C: 0.7605 acres

***STEP 2*: Calculate Time of Concentration:**

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

***STEP 3*: Calculate Rainfall Intensity, I:** **Override calculation for Tc?** ◉ Yes ○ No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

***STEP 4*: Calculate Peak Rate of Runoff, Q:** Q = k C i A

25 year
Calculated Flow, Q (cfs) = 3.8

PLS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\PERMANENT\[PPLS0902-Rational Method-Conveyance.xlsm]Swale 13.4

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 16
Prepared by: ATS
Date: 14 Oct 10

Checked by:
M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: $Q = k\,C\,i\,A$ (where k = 1 for english units)

Description: SWALE 16.1

Structure: -
Route: -
Station: -

***STEP 1*: Calculate Drainage Area, A and Runoff Coefficient, C:**

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95	0.230	0.219
	Lawn		0.40	0.850	0.340
	Stone		0.85		

Total Area, A: 1.080 acres
Weighted C: 0.52

Total A * C: 0.5585 acres

***STEP 2*: Calculate Time of Concentration:**

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

***STEP 3*: Calculate Rainfall Intensity, I:** **Override calculation for Tc?** ◉ Yes ○ No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

***STEP 4*: Calculate Peak Rate of Runoff, Q:** $Q = k\,C\,i\,A$

25 year
Calculated Flow, Q (cfs) = 2.8

Rational Equation Stormwater Calculations

Pennoni

Client: **PPL0902**
Project: **POI 16**
Prepared by: **ATS**
Date: **14 Oct 10**

Checked by: M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 16.2

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95	0.330	0.314
	Lawn		0.40	0.890	0.356
	Cultivated		0.25		

Total Area, A: 1.220 acres
Weighted C: 0.55

Total A * C: 0.6695 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

STEP 3: Calculate Rainfall Intensity, I: **Override calculation for Tc?** ◉ Yes ○ No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: **Q = k C i A**

25 year
Calculated Flow, Q (cfs) = 3.4

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 18
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: $Q = k\,C\,i\,A$ (where k = 1 for english units)

Description: SWALE 18.1

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95	1.020	0.969
	Lawn		0.40	6.830	2.732
	Cultivated		0.25		

Total Area, A: 7.850 acres
Weighted C: 0.47

Total A * C: 3.701 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: **5.0 minutes**

STEP 3: Calculate Rainfall Intensity, I:

Override calculation for Tc? (●) Yes ( ) No   Tc = 5.0

Rainfall Intensity for   Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: $Q = k\,C\,i\,A$

25 year
Calculated Flow, Q (cfs) = 18.7

PLS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\PERMANENT\[PPLS0902-Rational Method-Conveyance.xlsm]Swale 18.1

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 18
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: $Q = k\,C\,i\,A$ (where k = 1 for english units)

Description: SWALE 18.2

Structure: -
Route: -
Station: -

***STEP 1*: Calculate Drainage Area, A and Runoff Coefficient, C:**

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95		
	Lawn		0.40	6.080	2.432
	Cultivated		0.25		

Total Area, A: 6.080 acres
Weighted C: 0.40

Total A * C: 2.432 acres

***STEP 2*: Calculate Time of Concentration:**

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

***STEP 3*: Calculate Rainfall Intensity, I:**

Override calculation for Tc? ◉ Yes ○ No **Tc =** 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

***STEP 4*: Calculate Peak Rate of Runoff, Q:** $Q = k\,C\,i\,A$

25 year

Calculated Flow, Q (cfs) = 12.3

PLS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\PERMANENT\[PPLS0902-Rational Method-Conveyance.xlsm]Swale 18.2

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 20
Prepared by: ATS
Date: 14 Oct 10

Checked by:
M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: $Q = k C i A$ (where k = 1 for english units)

Description: SWALE 20.1

Structure: -
Route: -
Station: -

***STEP 1*: Calculate Drainage Area, A and Runoff Coefficient, C:**

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95	0.650	0.618
	Lawn		0.40	1.680	0.672
	Cultivated		0.25		

Total Area, A: 2.330 acres
Weighted C: 0.55

Total A * C: 1.2895 acres

***STEP 2*: Calculate Time of Concentration:**

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

***STEP 3*: Calculate Rainfall Intensity, I:**

Override calculation for Tc? ◉ Yes ○ No   Tc = 5.0

Rainfall Intensity for   Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

***STEP 4*: Calculate Peak Rate of Runoff, Q:** $Q = k C i A$

25 year
Calculated Flow, Q (cfs) = 6.5

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 20
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:37 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 20.2

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95	0.090	0.086
	Lawn		0.40	6.160	2.464
	Cultivated		0.25		

Total Area, A: 6.250 acres
Weighted C: 0.41

Total A * C: 2.5495 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: **5.0 minutes**

STEP 3: Calculate Rainfall Intensity, I:

Override calculation for Tc? (●) Yes ( ) No   Tc = 5.0

Rainfall Intensity for   Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

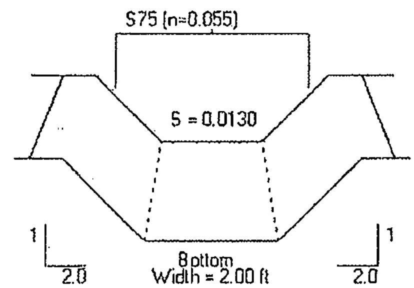
STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

25 year
Calculated Flow, Q (cfs) = 12.8

North American Green - ECMDS Version 4.3		10/25/2010 11:59 AM	COMPUTED BY: GMP
PROJECT NAME: PPLS 0902		PROJECT NO.: Swale 1.1	
FROM STATION/REACH:	TO STATION/REACH:	DRAINAGE AREA:	DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
1.4	24.0	1.33	1.05	0.28	0.38



Not to Scale

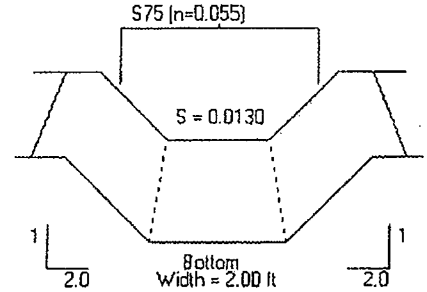
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.31	5.02	STABLE
	Staple D									

North American Green : ECMDS Version 4.3 | 10/25/2010 | 12:00 PM | COMPUTED BY: GMP
PROJECT NAME: PPLS 0902 | PROJECT NO.: Swale 1.2
FROM STATION/REACH: | TO STATION/REACH: | DRAINAGE AREA: | DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
1.4	24.0	1.33	1.05	0.28	0.38



Not to Scale

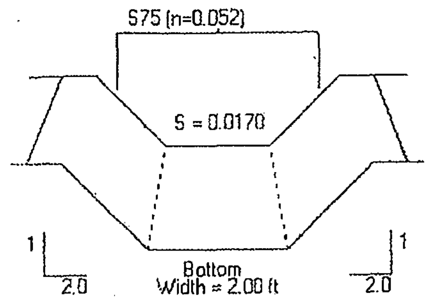
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics				Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
			Phase	Class	Type	Density				
Straight	S75	Unvegetated					1.55	0.31	5.02	STABLE
	Staple D									

North American Green - ECMDS Version 4.3		10/25/2010 12:01 PM	COMPUTED BY: GMP
PROJECT NAME: PPLS 0902		PROJECT NO.: Swale 1.3	
FROM STATION/REACH:	TO STATION/REACH:	DRAINAGE AREA:	DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
4.1	24.0	2.07	1.98	0.42	0.61



Not to Scale

LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.65	2.38	STABLE
	Staple D									

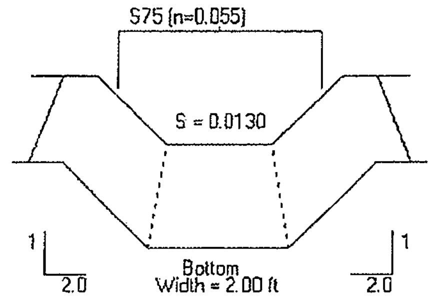
North American Green - ECMDS Version 4.3 | 10/25/2010 | 12:02 PM | COMPUTED BY: GMP

PROJECT NAME: PPLS 0902 | PROJECT NO.: Swale 2.1

FROM STATION/REACH: | TO STATION/REACH: | DRAINAGE AREA: | DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
1.3	24.0	1.30	1.00	0.27	0.37



Not to Scale

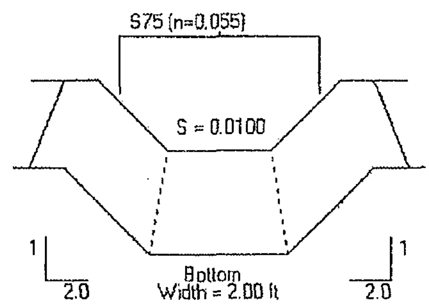
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.30	5.23	STABLE
	Staple D									

North American Green - ECMDS Version 4.3	10/25/2010 12:03 PM	COMPUTED BY: GMP	
PROJECT NAME: PPLS 0902		PROJECT NO.: Swale 2.2	
FROM STATION/REACH:	TO STATION/REACH:	DRAINAGE AREA:	DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
1.1	24.0	1.13	0.97	0.27	0.36



Not to Scale

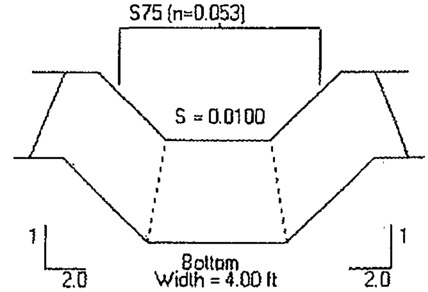
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.22	6.93	STABLE
	Staple D									

North American Green - ECMDS Version 4.3	10/25/2010 12:04 PM	COMPUTED BY: GMP
PROJECT NAME: PPLS 0902	PROJECT NO.: Swale 3.1	
FROM STATION/REACH:	TO STATION/REACH:	DRAINAGE AREA:	DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
4.8	24.0	1.63	2.94	0.45	0.57



Not to Scale

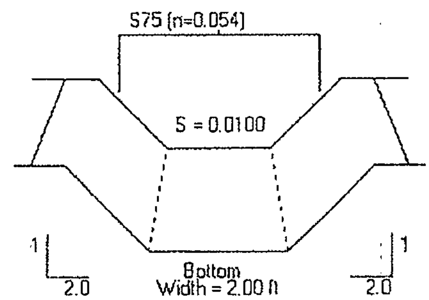
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.36	4.34	STABLE
	Staple D									

North American Green - ECMDS Version 4.3	10/25/2010	12:05 PM	COMPUTED BY: GMP
PROJECT NAME: PPLS 0902		PROJECT NO.: Swale 3.2	
FROM STATION/REACH:	TO STATION/REACH:	DRAINAGE AREA:	DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
2.5	24.0	1.46	1.71	0.38	0.55



Not to Scale

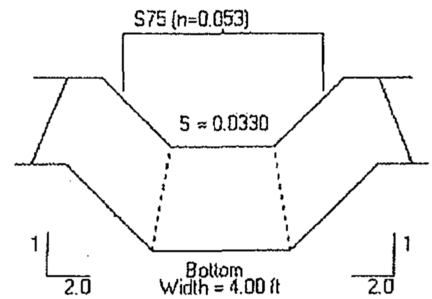
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.34	4.50	STABLE
	Staple D									

North American Green - ECMDS Version 4.3	10/25/2010	12:06 PM	COMPUTED BY: GMP
PROJECT NAME: PPLS 0902		PROJECT NO.: Swale 3.3	
FROM STATION/REACH:	TO STATION/REACH:	DRAINAGE AREA:	DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
8.6	24.0	2.95	2.92	0.45	0.57



Not to Scale

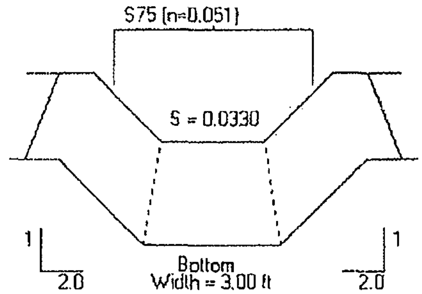
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	1.17	1.33	STABLE
	Staple D									

North American Green - ECMDS Version 4.3		10/25/2010 12:07 PM	COMPUTED BY: GMP
PROJECT NAME: PPLS 0902		PROJECT NO.: Swale 3.4	
FROM STATION/REACH:	TO STATION/REACH:	DRAINAGE AREA:	DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
9.6	24.0	3.27	2.93	0.49	0.67



Not to Scale

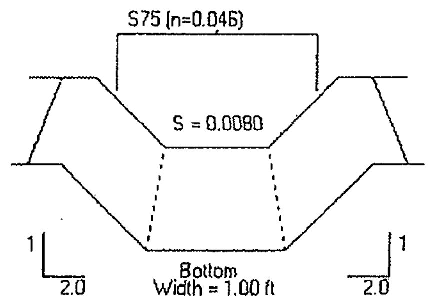
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	1.39	1.12	STABLE
	Staple D									

North American Green - ECMDS Version 4.3		10/25/2010 12:08 PM	COMPUTED BY: GMP
PROJECT NAME: PPLS 0902		PROJECT NO.: Swale 3.5	
FROM STATION/REACH:	TO STATION/REACH:	DRAINAGE AREA:	DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
4.3	24.0	1.78	2.42	0.49	0.88



Not to Scale

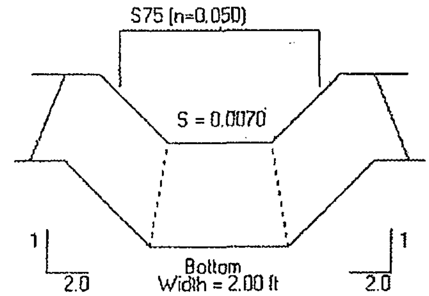
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.44	3.54	STABLE
	Staple D									

North American Green - ECMDS Version 4.3		10/25/2010	12:08 PM	COMPUTED BY: GMP
PROJECT NAME: PPLS 0902		PROJECT NO.: Swale 3.6		
FROM STATION/REACH:	TO STATION/REACH:	DRAINAGE AREA:		DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
3.8	24.0	1.52	2.50	0.48	0.72



Not to Scale

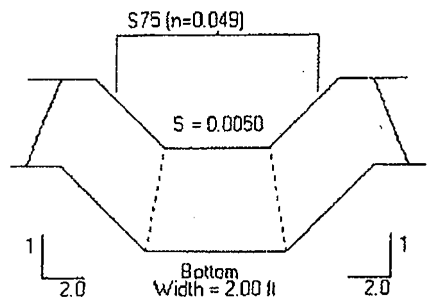
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.32	4.90	STABLE
	Staple D									

North American Green - ECMDS Version 4.3 | 10/25/2010 | 12:09 PM | COMPUTED BY: GMP
PROJECT NAME: PPLS 0902 | PROJECT NO.: Swale 3.7
FROM STATION/REACH: | TO STATION/REACH: | DRAINAGE AREA: | DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
3.5	24.0	1.33	2.64	0.49	0.75



Not to Scale

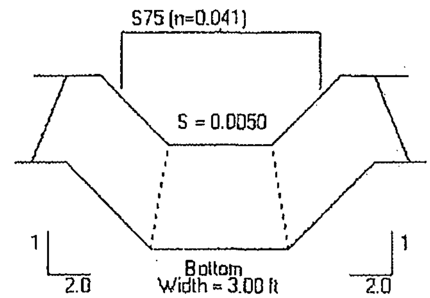
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.23	6.60	STABLE
	Staple D									

North American Green - ECMDS Version 4.3		10/25/2010	12:10 PM	COMPUTED BY: GMP
PROJECT NAME: PPLS 0902		PROJECT NO.: Swale 3.8		
FROM STATION/REACH:	TO STATION/REACH:	DRAINAGE AREA:		DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
12.1	24.0	2.08	5.83	0.73	1.11



Not to Scale

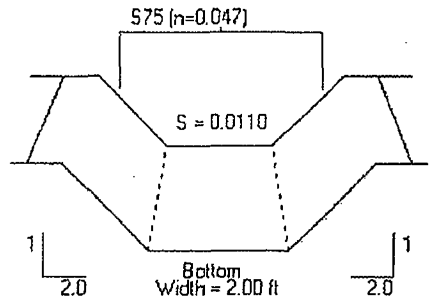
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.35	4.46	STABLE
	Staple D									

North American Green - ECMDS Version 4.3	10/25/2010	12:15 PM	COMPUTED BY: GMP
PROJECT NAME: PPLS 0902	PROJECT NO.: Swale 4.1		
FROM STATION/REACH: TO STATION/REACH:	DRAINAGE AREA:	DESIGN FREQUENCY:	

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
7.0	24.0	2.21	3.17	0.54	0.85



Not to Scale

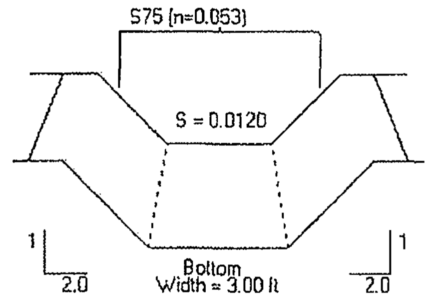
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.59	2.64	STABLE
	Staple D									

North American Green - ECMDS Version 4.3	10/25/2010	12:16 PM	COMPUTED BY: GMP
PROJECT NAME: PPLS 0902	PROJECT NO.: Swale 4.2		
FROM STATION/REACH:	TO STATION/REACH:	DRAINAGE AREA:	DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
4.1	24.0	1.73	2.37	0.43	0.57



Not to Scale

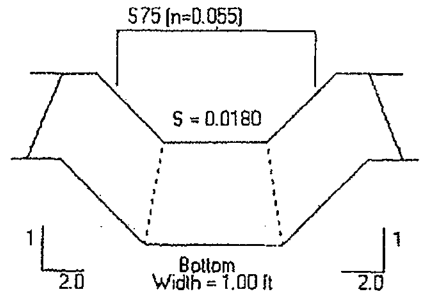
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.43	3.62	STABLE
	Staple D									

North American Green - ECMDS Version 4.3		10/25/2010 12:17 PM	COMPUTED BY: GMP
PROJECT NAME: PPLS 0902		PROJECT NO.: Swale 4.3	
FROM STATION/REACH:	TO STATION/REACH:	DRAINAGE AREA:	DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
0.8	24.0	1.36	0.59	0.23	0.35



Not to Scale

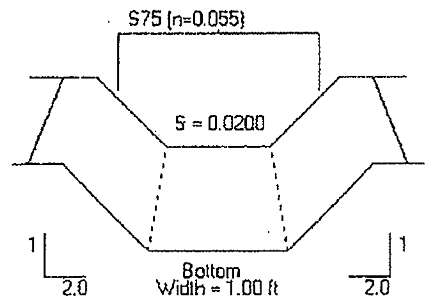
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.39	3.98	STABLE
	Staple D									

North American Green - ECMDS Version 4.3	10/25/2010	12:18 PM	COMPUTED BY: GMP
PROJECT NAME: PPLS 0902	PROJECT NO.: Swale 4.4		
FROM STATION/REACH:	TO STATION/REACH:	DRAINAGE AREA:	DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
0.6	24.0	1.31	0.46	0.20	0.29



Not to Scale

LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.36	4.27	STABLE
	Staple D									

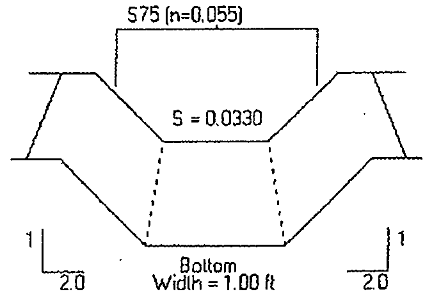
North American Green - ECMDS Version 4.3 | 10/25/2010 | 12:18 PM | COMPUTED BY: GMP

PROJECT NAME: PPLS 0902 | PROJECT NO.: Swale 4.5

FROM STATION/REACH: | TO STATION/REACH: | DRAINAGE AREA: | DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
1.1	24.0	1.85	0.59	0.23	0.35



Not to Scale

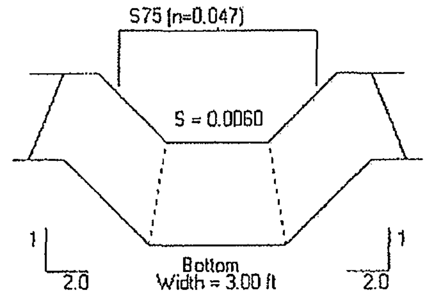
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics				Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
			Phase	Class	Type	Density				
Straight	S75	Unvegetated					1.55	0.72	2.15	STABLE
	Staple D									

North American Green - ECMDS Version 4.3		10/25/2010 12:19 PM	COMPUTED BY: GMP
PROJECT NAME: PPLS 0902		PROJECT NO.: Swale 4.6	
FROM STATION/REACH:	TO STATION/REACH:	DRAINAGE AREA:	DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
7.0	24.0	1.73	4.05	0.59	0.86



Not to Scale

LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.32	4.83	STABLE
	Staple D									

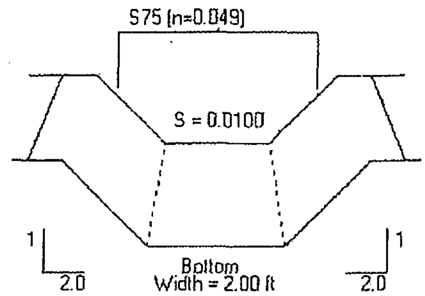
North American Green - ECMDS Version 4.3 | 10/25/2010 | 12:20 PM | COMPUTED BY: GMP

PROJECT NAME: PPLS 0902 | PROJECT NO.: Swale 4.7

FROM STATION/REACH: | TO STATION/REACH: | DRAINAGE AREA: | DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
5.2	24.0	1.91	2.72	0.50	0.77



Not to Scale

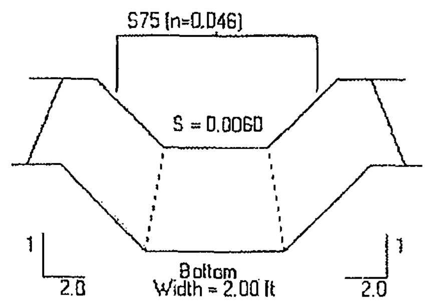
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.48	3.23	STABLE
	Staple D									

North American Green - ECMDS Version 4.3		10/25/2010 12:21 PM	COMPUTED BY: GMP
PROJECT NAME: PPLS 0902		PROJECT NO.: Swale 4.8	
FROM STATION/REACH:	TO STATION/REACH:	DRAINAGE AREA:	DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
5.7	24.0	1.70	3.36	0.56	0.89



Not to Scale

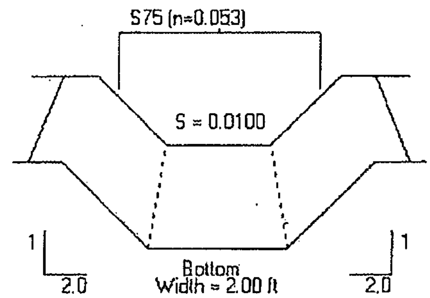
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.33	4.66	STABLE
	Staple D									

North American Green - ECMDS Version 4.3		10/25/2010 12:22 PM	COMPUTED BY: GMP
PROJECT NAME: PPLS 0902		PROJECT NO.: Swale 4.9	
FROM STATION/REACH:	TO STATION/REACH:	DRAINAGE AREA:	DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
2.7	24.0	1.50	1.80	0.39	0.57



Not to Scale

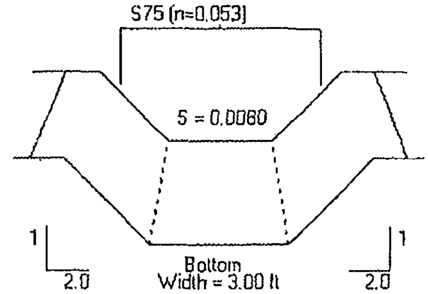
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.36	4.34	STABLE
	Staple D									

North American Green - ECMDS Version 4.3	10/25/2010	12:22 PM	COMPUTED BY: GMP
PROJECT NAME: PPLS 0902	PROJECT NO.: Swale 5.1		
FROM STATION/REACH: TO STATION/REACH:	DRAINAGE AREA:	DESIGN FREQUENCY:	

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
3.5	24.0	1.44	2.44	0.43	0.58



Not to Scale

LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics				Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
			Phase	Class	Type	Density				
Straight	S75	Unvegetated					1.55	0.29	5.31	STABLE
	Staple D									

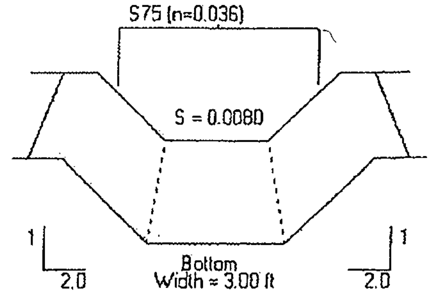
North American Green - ECMDS Version 4.3 | 10/25/2010 | 12:23 PM | COMPUTED BY: GMP

PROJECT NAME: PPLS 0902 | PROJECT NO.: Swale 5.2

FROM STATION/REACH: | TO STATION/REACH: | DRAINAGE AREA: | DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
26.1	24.0	3.37	7.75	0.86	1.36



Not to Scale

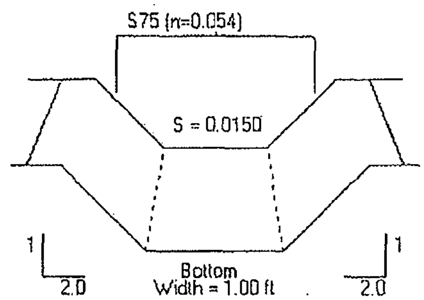
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.68	2.29	STABLE
	Staple D									

North American Green - ECMDS Version 4.3		10/25/2010	12:24 PM	COMPUTED BY: GMP
PROJECT NAME: PPLS 0902		PROJECT NO.: Swale 5.3		
FROM STATION/REACH:	TO STATION/REACH:	DRAINAGE AREA:		DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
1.7	24.0	1.57	1.08	0.32	0.53



Not to Scale

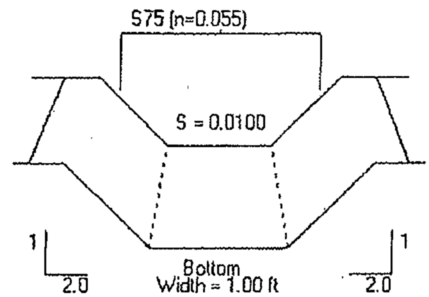
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.49	3.14	STABLE
	Staple D									

North American Green - ECMDS Version 4.3		10/25/2010 12:25 PM	COMPUTED BY: GMP
PROJECT NAME: PPLS 0902		PROJECT NO.: Swale 6.1	
FROM STATION/REACH:	TO STATION/REACH:	DRAINAGE AREA:	DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
1.0	24.0	1.17	0.86	0.28	0.45



LINER RESULTS

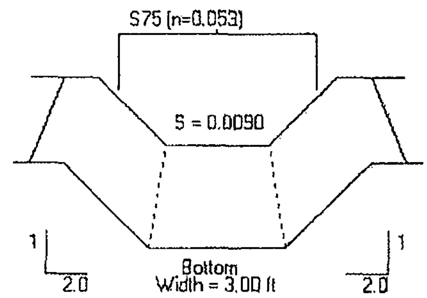
Not to Scale

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.28	5.51	STABLE
	Staple D									

North American Green - ECMDS Version 4.3		10/25/2010	12:25 PM	COMPUTED BY: GMP
PROJECT NAME: PPLS 0902		PROJECT NO.: Swale 6.2		
FROM STATION/REACH:	TO STATION/REACH:	DRAINAGE AREA:		DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
3.6	24.0	1.51	2.39	0.43	0.58



Not to Scale

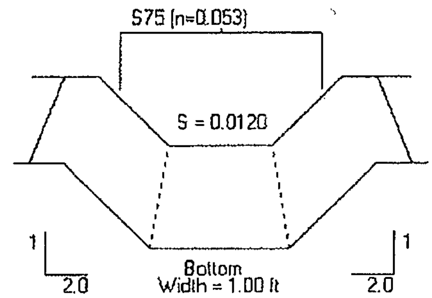
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.32	4.79	STABLE
	Staple D									

North American Green - ECMDS Version 4.3		10/25/2010	12:26 PM	COMPUTED BY: GMP
PROJECT NAME: PPLS 0902		PROJECT NO.: Swale 6.3		
FROM STATION/REACH:	TO STATION/REACH:	DRAINAGE AREA:		DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
2.1	24.0	1.57	1.34	0.36	0.61



Not to Scale

LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.45	3.42	STABLE
	Staple D									

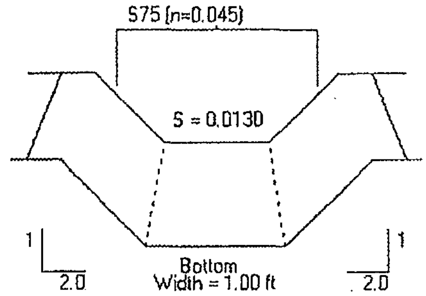
North American Green - ECMDS Version 4.3 | 10/25/2010 | 12:27 PM | COMPUTED BY: GMP

PROJECT NAME: PPLS 0902 | PROJECT NO.: Swale 6.4

FROM STATION/REACH: | TO STATION/REACH: | DRAINAGE AREA: | DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
6.6	24.0	2.44	2.71	0.52	0.94



Not to Scale

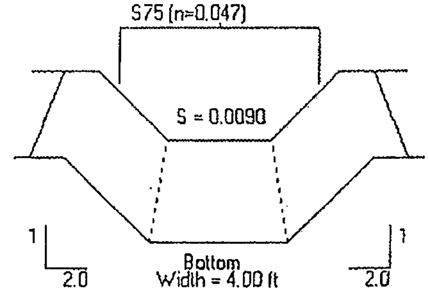
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.76	2.03	STABLE
	Staple D									

North American Green - ECMDS Version 4.3	10/25/2010 01:31 PM	COMPUTED BY: GMP
PROJECT NAME: PPLS 0902	PROJECT NO.: Swale 6.5	
FROM STATION/REACH: / TO STATION/REACH:	DRAINAGE AREA:	DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
10.2	24.0	2.15	4.75	0.61	0.84



Not to Scale

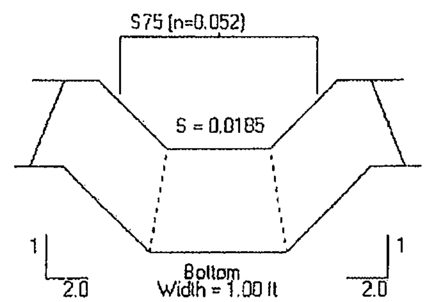
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.47	3.30	STABLE
	Staple D									

North American Green - ECMDS Version 4.3	10/25/2010 01:32 PM	COMPUTED BY: GMP
PROJECT NAME: PPLS 0902	PROJECT NO.: Swale 5.6	
FROM STATION/REACH: TO STATION/REACH:	DRAINAGE AREA:	DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
2.8	24.0	2.00	1.40	0.37	0.62



Not to Scale

LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics				Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
			Phase	Class	Type	Density				
Straight	S75	Unvegetated					1.55	0.72	2.15	STABLE
	Staple D									

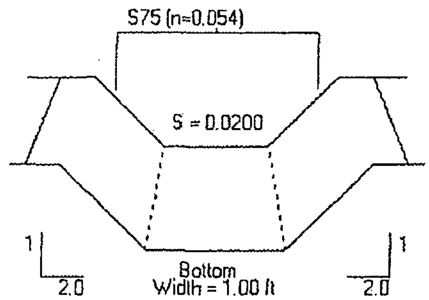
North American Green - ECMDS Version 4.3 | 10/25/2010 | 01:33 PM | COMPUTED BY: GMP

PROJECT NAME: PPLS 0902 | PROJECT NO.: Swale 6.7

FROM STATION/REACH: | TO STATION/REACH: | DRAINAGE AREA: | DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
2.0	24.0	1.83	1.09	0.32	0.53



Not to Scale

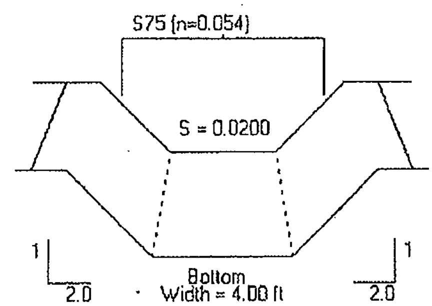
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.66	2.34	STABLE
	Staple D									

North American Green - ECMDS Version 4.3		10/25/2010 01:33 PM	COMPUTED BY: GMP
PROJECT NAME: PPLS 0902		PROJECT NO.: Swale 6.8	
FROM STATION/REACH:	TO STATION/REACH:	DRAINAGE AREA:	DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
5.8	24.0	2.17	2.67	0.42	0.53



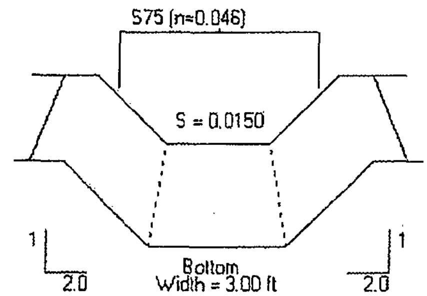
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.66	2.35	STABLE
	Staple D									

North American Green - ECMDS Version 4.3		10/25/2010	01:34 PM	COMPUTED BY: GMP
PROJECT NAME: PPLS 0902		PROJECT NO.: Swale 6.9		
FROM STATION/REACH:	TO STATION/REACH:	DRAINAGE AREA:		DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
11.9	24.0	2.82	4.22	0.61	0.89



Not to Scale

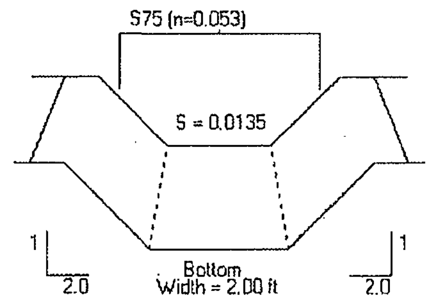
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	575	Unvegetated					1.55	0.83	1.87	STABLE
	Staple D									

North American Green - ECMDS Version 4.3	10/25/2010	01:35 PM	COMPUTED BY: GMP
PROJECT NAME: PPLS 0902	PROJECT NO.: Swale 6.10		
FROM STATION/REACH: / TO STATION/REACH:	DRAINAGE AREA:	DESIGN FREQUENCY:	

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
3.4	24.0	1.79	1.90	0.41	0.59



Not to Scale

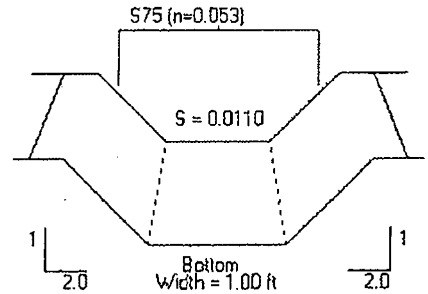
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.50	3.10	STABLE
	Staple D									

North American Green - ECMDS Version 4.3		10/25/2010 01:35 PM	COMPUTED BY: GMP
PROJECT NAME: PPLS 0902		PROJECT NO.: Swale 8.1	
FROM STATION/REACH:	TO STATION/REACH:	DRAINAGE AREA:	DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
1.8	24.0	1.45	1.24	0.35	0.58



Not to Scale

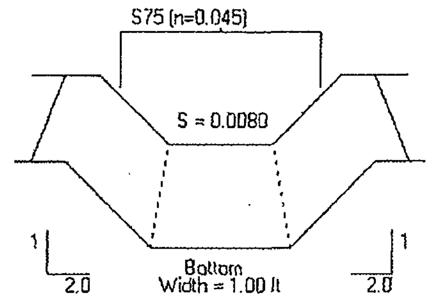
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.40	3.91	STABLE
	Staple D									

North American Green - ECMDS Version 4.3	10/25/2010	01:36 PM	COMPUTED BY: GMP
PROJECT NAME: PPLS 0902	PROJECT NO.: Swale 8.2		
FROM STATION/REACH: TO STATION/REACH:	DRAINAGE AREA:		DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
6.2	24.0	1.91	2.72	0.52	0.94



Not to Scale

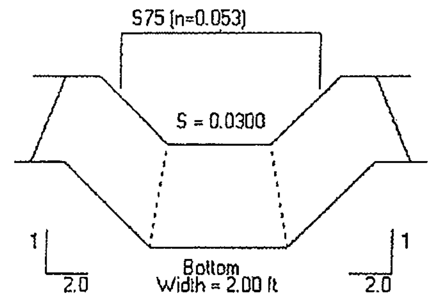
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.47	3.30	STABLE
	Staple D									

North American Green - ECMDS Version 4.3	10/25/2010	01:36 PM	COMPUTED BY: GMP
PROJECT NAME: PPLS 0902	PROJECT NO.: Swale 8.3		
FROM STATION/REACH: / TO STATION/REACH:	DRAINAGE AREA:	DESIGN FREQUENCY:	

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
5.2	24.0	2.70	1.93	0.41	0.60



Not to Scale

LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	1.13	1.38	STABLE
	Staple D									

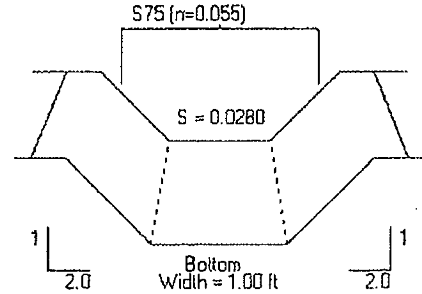
North American Green - ECMDS Version 4.3 | 10/25/2010 | 01:37 PM | COMPUTED BY: GMP

PROJECT NAME: PPLS 0902 | PROJECT NO.: Swale 8.4

FROM STATION/REACH: | TO STATION/REACH: | DRAINAGE AREA: | DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
1.6	24.0	1.93	0.83	0.28	0.44



Not to Scale

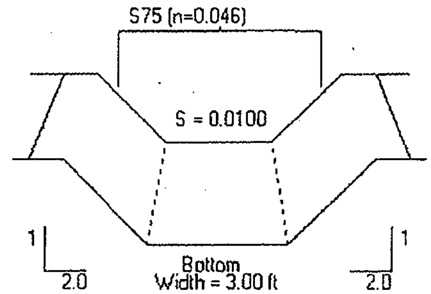
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.77	2.01	STABLE
	Staple D									

North American Green - ECMDS Version 4.3 | 10/25/2010 01:38 PM | COMPUTED BY: GMP
PROJECT NAME: PPLS 0902 | PROJECT NO.: Swale 9.1
FROM STATION/REACH: | TO STATION/REACH: | DRAINAGE AREA: | DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
9.6	24.0	2.29	4.19	0.60	0.88



Not to Scale

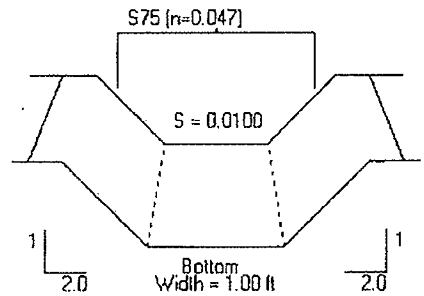
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics				Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
			Phase	Class	Type	Density				
Straight	S75	Unvegetated					1.55	0.55	2.82	STABLE
	Staple D									

North American Green - ECMDS Version 4.3		10/25/2010 01:39 PM	COMPUTED BY: GMP
PROJECT NAME: PPLS 0902		PROJECT NO.: Swale 9.2	
FROM STATION/REACH:	TO STATION/REACH:	DRAINAGE AREA:	DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
4.2	24.0	1.89	2.22	0.47	0.83



Not to Scale

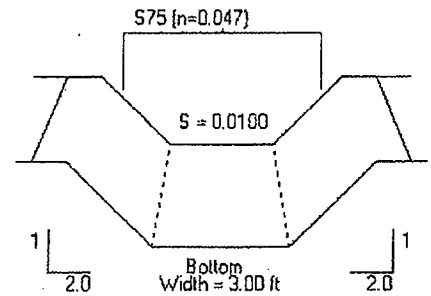
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.52	2.98	STABLE
	Staple D									

North American Green - ECMDS Version 4.3		10/25/2010 01:39 PM	COMPUTED BY: GMP
PROJECT NAME: PPLS 0902		PROJECT NO.: Swale 9.3	
FROM STATION/REACH:	TO STATION/REACH:	DRAINAGE AREA:	DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
9.4	24.0	2.27	4.14	0.60	0.87



Not to Scale

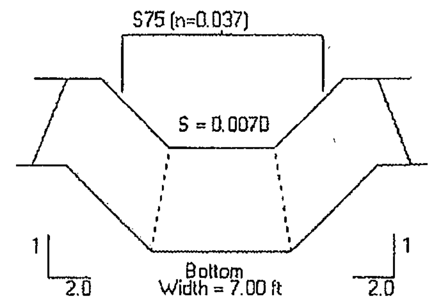
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics				Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
			Phase	Class	Type	Density				
Straight	S75	Unvegetated					1.55	0.54	2.85	STABLE
	Staple D									

North American Green - ECMDS Version 4.3		10/25/2010 03:39 PM	COMPUTED BY: GMP
PROJECT NAME: PPLS 0902		PROJECT NO.: Swale 9.4	
FROM STATION/REACH:	TO STATION/REACH:	DRAINAGE AREA:	DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
40.7	24.0	3.29	12.38	0.97	1.29



Not to Scale

LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics				Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
			Phase	Class	Type	Density				
Straight	S75	Unvegetated					1.55	0.56	2.75	STABLE
	Staple D									

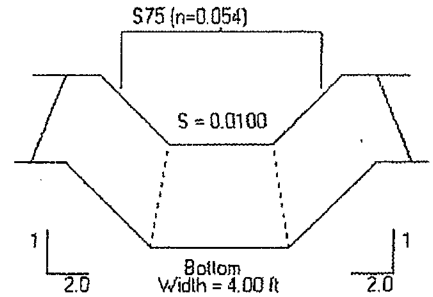
North American Green - ECMDS Version 4.3	10/25/2010 01:43 PM	COMPUTED BY: GMP

PROJECT NAME: PPLS 0902 | PROJECT NO.: Swale 9.5

FROM STATION/REACH: | TO STATION/REACH: | DRAINAGE AREA: | DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
4.0	24.0	1.52	2.63	0.42	0.52



Not to Scale

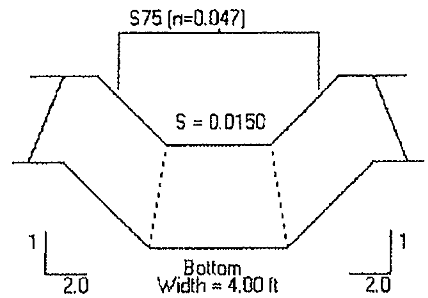
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.33	4.76	STABLE
	Staple D									

North American Green - ECMDS Version 4.3		10/25/2010 01:44 PM	COMPUTED BY: GMP
PROJECT NAME: PPLS 0902		PROJECT NO.: Swale 10.1	
FROM STATION/REACH:	TO STATION/REACH:	DRAINAGE AREA:	DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
13.6	24.0	2.81	4.84	0.62	0.85



Not to Scale

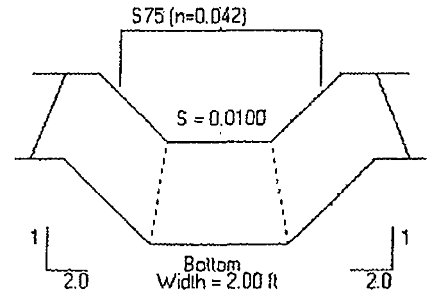
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.79	1.95	STABLE
	Staple D									

North American Green - ECMDS Version 4.3		10/25/2010	01:45 PM	COMPUTED BY: GMP
PROJECT NAME: PPLS 0902		PROJECT NO.: Swale 10.2		
FROM STATION/REACH:	TO STATION/REACH:	DRAINAGE AREA:		DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
12.0	24.0	2.68	4.48	0.66	1.08



Not to Scale

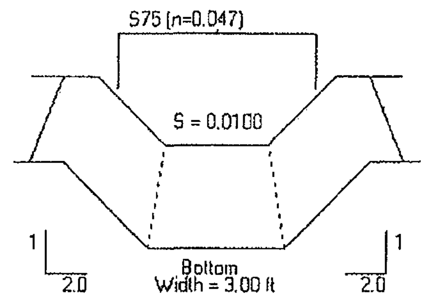
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.67	2.30	STABLE
	Staple D									

North American Green - ECMDS Version 4.3	10/25/2010	01:46 PM	COMPUTED BY: GMP
PROJECT NAME: PPLS 0902	PROJECT NO.: Swale 10.3		
FROM STATION/REACH:	TO STATION/REACH:	DRAINAGE AREA:	DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
8.2	24.0	2.25	4.09	0.60	0.86



Not to Scale

LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.54	2.87	STABLE
	Staple D									

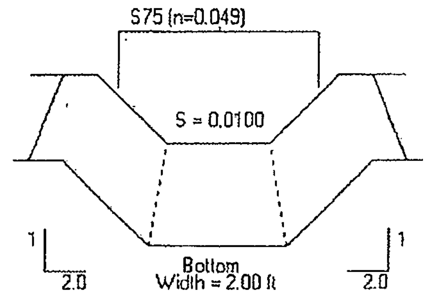
North American Green - ECMDS Version 4.3 | 10/25/2010 | 01:46 PM | COMPUTED BY: GMP

PROJECT NAME: PPLS 0902 | PROJECT NO.: Swale 10.4

FROM STATION/REACH: | TO STATION/REACH: | DRAINAGE AREA: | DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
5.2	24.0	1.91	2.72	0.50	0.77



Not to Scale

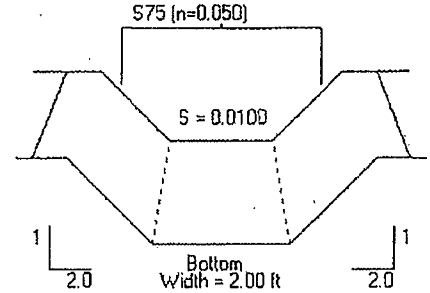
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics				Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
			Phase	Class	Type	Density				
Straight	S75	Unvegetated					1.55	0.48	3.23	STABLE
	Staple D									

North American Green - ECMDS Version 4.3	10/25/2010	01:47 PM	COMPUTED BY: GMP
PROJECT NAME: PPLS 0902	PROJECT NO.: Swale 10.5		
FROM STATION/REACH: TO STATION/REACH:	DRAINAGE AREA:	DESIGN FREQUENCY:	

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
4.6	24.0	1.83	2.52	0.48	0.73



Not to Scale

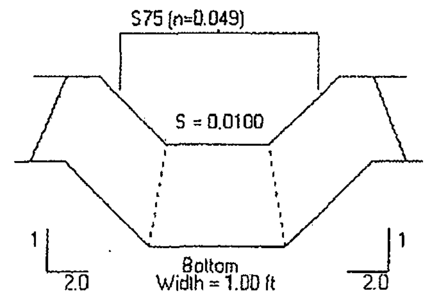
LINER RESULTS

Reach	Matting Type	Stability Analysis	Vegetation Characteristics				Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
	Staple Pattern		Phase	Class	Type	Density				
Straight	S75	Unvegetated					1.55	0.45	3.41	STABLE
	Staple D									

North American Green - ECMDS Version 4.3	10/25/2010 01:48 PM	COMPUTED BY: GMP	
PROJECT NAME: PPLS 0902	PROJECT NO.: Swale 10.6		
FROM STATION/REACH:	TO STATION/REACH:	DRAINAGE AREA:	DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
3.5	24.0	1.77	1.98	0.44	0.78



Not to Scale

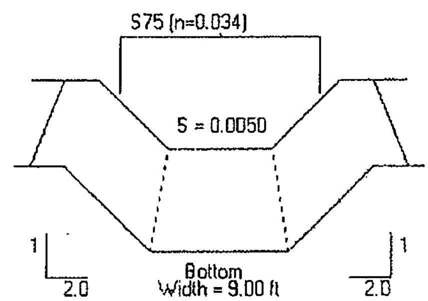
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics				Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
			Phase	Class	Type	Density				
Straight	S75	Unvegetated					1.55	0.48	3.20	STABLE
	Staple D									

North American Green - ECMDS Version 4.3		10/25/2010	03:38 PM	COMPUTED BY: GMP
PROJECT NAME: PPLS 0902		PROJECT NO.: Swale 10.7		
FROM STATION/REACH:	TO STATION/REACH:	DRAINAGE AREA:		DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
55.0	24.0	3.27	16.82	1.10	1.42



Not to Scale

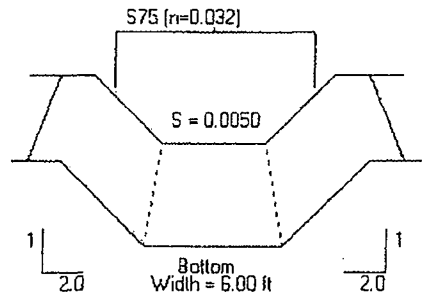
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics				Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
			Phase	Class	Type	Density				
Straight	S75	Unvegetated					1.55	0.44	3.50	STABLE
	Staple D									

North American Green - ECMDS Version 4.3		10/25/2010 03:36 PM	COMPUTED BY: GMP
PROJECT NAME: PPLS 0902		PROJECT NO.: Swale 10.8	
FROM STATION/REACH:	TO STATION/REACH:	DRAINAGE AREA:	DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
47.4	24.0	3.45	13.73	1.07	1.52



Not to Scale

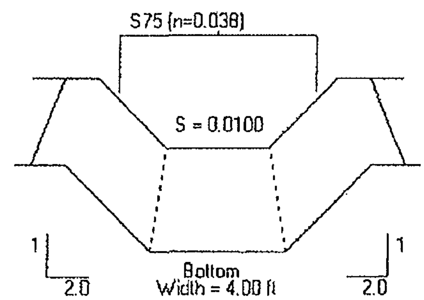
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.47	3.27	STABLE
	Staple D									

North American Green - ECMDS Version 4.3	10/25/2010 01:51 PM	COMPUTED BY: GMP	
PROJECT NAME: PPLS 0902		PROJECT NO.: Swale 10.9	
FROM STATION/REACH:	TO STATION/REACH:	DRAINAGE AREA:	DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
27.4	24.0	3.44	7.97	0.84	1.23



Not to Scale

LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.77	2.02	STABLE
	Staple D									

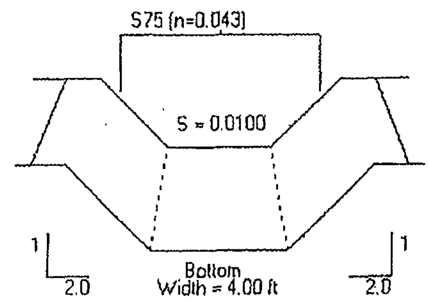
North American Green - ECMDS Version 4.3 | 10/25/2010 | 01:52 PM | COMPUTED BY: GMP

PROJECT NAME: PPLS 0902 | PROJECT NO.: Swale 10.10

FROM STATION/REACH: | TO STATION/REACH: | DRAINAGE AREA: | DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
16.6	24.0	2.73	6.08	0.71	1.01



Not to Scale

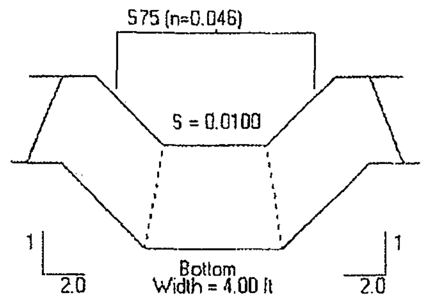
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.63	2.46	STABLE
	Staple D									

North American Green - ECMDS Version 4.3 | 10/25/2010 | 01:53 PM | COMPUTED BY: GMP
PROJECT NAME: PPLS 0902 | PROJECT NO.: Swale 10.11
FROM STATION/REACH: | TO STATION/REACH: | DRAINAGE AREA: | DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
12.7	24.0	2.43	5.23	0.65	0.90



Not to Scale

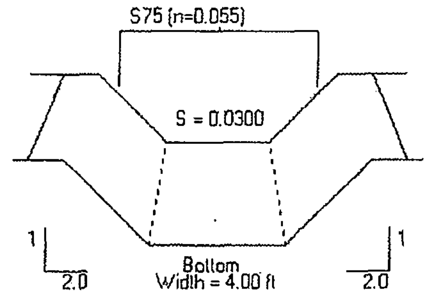
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.56	2.76	STABLE
	Staple D									

North American Green - ECMDS Version 4.3	10/25/2010 01:54 PM	COMPUTED BY: GMP
PROJECT NAME: PPLS 0902	PROJECT NO.: Swale 10.12	
FROM STATION/REACH:	TO STATION/REACH:	
DRAINAGE AREA:	DESIGN FREQUENCY:	

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
3.2	24.0	2.03	1.58	0.29	0.34



Not to Scale

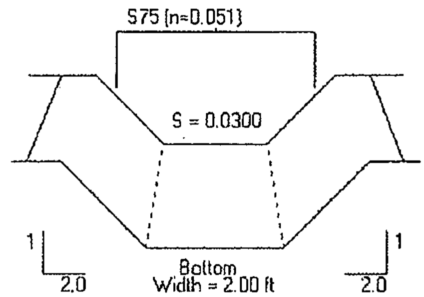
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.63	2.46	STABLE
	Staple D									

North American Green - ECMDS Version 4.3		10/25/2010	01:54 PM	COMPUTED BY: GMP
PROJECT NAME: PPLS 0902		PROJECT NO.: Swale 10.13		
FROM STATION/REACH:	TO STATION/REACH:	DRAINAGE AREA:		DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
7.0	24.0	3.01	2.32	0.46	0.69



LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics				Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
			Phase	Class	Type	Density				
Straight	S75	Unvegetated					1.55	1.29	1.20	STABLE
	Staple D									

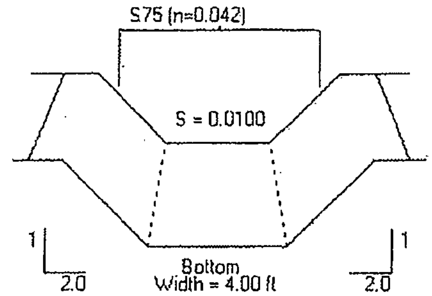
North American Green - ECMDS Version 4.3 | 10/25/2010 | 01:55 PM | COMPUTED BY: GMP

PROJECT NAME: PPLS 0902 | PROJECT NO.: Swale 10.14

FROM STATION/REACH: | TO STATION/REACH: | DRAINAGE AREA: | DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
20.0	24.0	2.97	6.73	0.76	1.09



Not to Scale

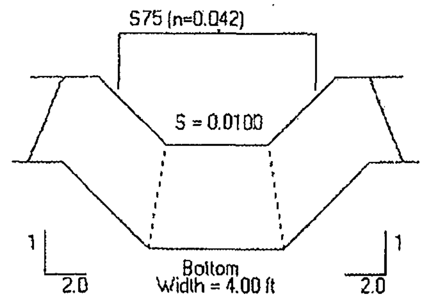
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.68	2.28	STABLE
	Staple D									

North American Green - ECMDS Version 4.3		10/25/2010 01:56 PM	COMPUTED BY: GMP
PROJECT NAME: PPLS 0902		PROJECT NO.: Swale 10.15	
FROM STATION/REACH:	TO STATION/REACH:	DRAINAGE AREA:	DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
20.0	24.0	2.97	6.73	0.76	1.09



Not to Scale

LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics				Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
			Phase	Class	Type	Density				
Straight	S75	Unvegetated					1.55	0.68	2.28	STABLE
	Staple D									

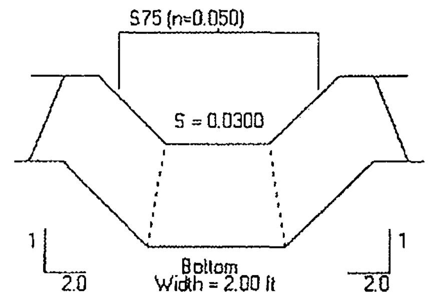
North American Green - ECMDS Version 4.3	10/25/2010	01:56 PM	COMPUTED BY: GMP

PROJECT NAME: PPLS 0902 | PROJECT NO.: Swale 10.16

FROM STATION/REACH: | TO STATION/REACH: | DRAINAGE AREA: | DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
7.6	24.0	3.11	2.45	0.47	0.71



Not to Scale

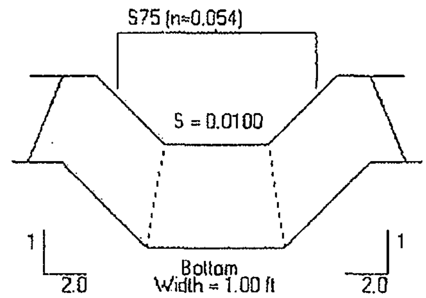
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics				Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
			Phase	Class	Type	Density				
Straight	S75	Unvegetated					1.55	1.34	1.16	STABLE
	Staple D									

North American Green - ECMDS Version 4.3		10/25/2010 01:57 PM	COMPUTED BY: GMP
PROJECT NAME: PPLS 0902		PROJECT NO.: Swale 10.17	
FROM STATION/REACH:	TO STATION/REACH:	DRAINAGE AREA:	DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
1.5	24.0	1.32	1.14	0.33	0.54



Not to Scale

LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.34	4.56	STABLE
	Staple D									

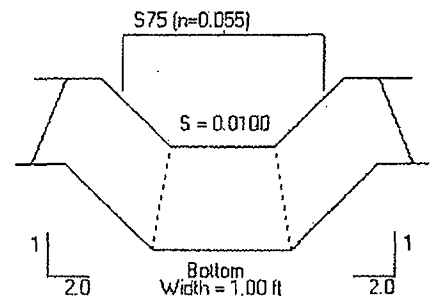
North American Green - ECMDS Version 4.3 | 10/25/2010 | 01:58 PM | COMPUTED BY: GMP

PROJECT NAME: PPLS 0902 | PROJECT NO.: Swale 10.18

FROM STATION/REACH: | TO STATION/REACH: | DRAINAGE AREA: | DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
1.3	24.0	1.26	1.03	0.31	0.51



Not to Scale

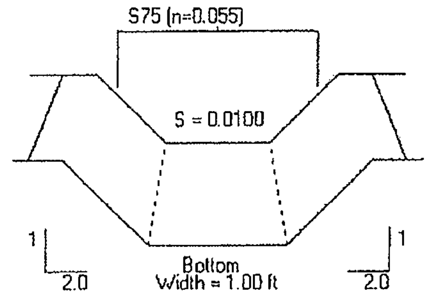
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.32	4.86	STABLE
	Staple D									

North American Green - ECMDS Version 4.3		10/25/2010 02:06 PM	COMPUTED BY: GMP
PROJECT NAME: PPLS 0902		PROJECT NO.: Swale 11.1	
FROM STATION/REACH:	TO STATION/REACH:	DRAINAGE AREA:	DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
0.8	24.0	1.10	0.73	0.26	0.40



Not to Scale

LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.25	6.17	STABLE
	Staple D									

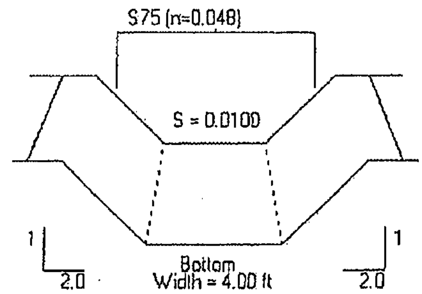
North American Green - ECMDS Version 4.3 | 10/25/2010 | 02:07 PM | COMPUTED BY: GMP

PROJECT NAME: PPLS 0902 | PROJECT NO.: Swale 12.1

FROM STATION/REACH: | TO STATION/REACH: | DRAINAGE AREA: | DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
10.4	24.0	2.23	4.66	0.61	0.82



Not to Scale

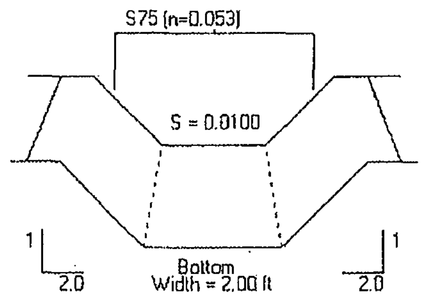
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics				Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
			Phase	Class	Type	Density				
Straight	S75	Unvegetated					1.55	0.51	3.01	STABLE
	Staple D									

North American Green - ECMDS Version 4.3		10/25/2010 02:07 PM	COMPUTED BY: GMP
PROJECT NAME: PPLS 0902		PROJECT NO.: Swale 12.2	
FROM STATION/REACH:	TO STATION/REACH:	DRAINAGE AREA:	DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
2.9	24.0	1.54	1.88	0.41	0.59



Not to Scale

LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.37	4.20	STABLE
	Staple D									

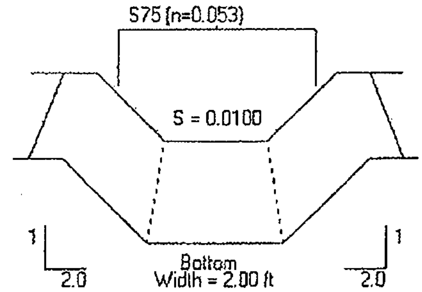
North American Green - ECMDS Version 4.3 | 10/25/2010 | 02:08 PM | COMPUTED BY: GMP

PROJECT NAME: PPLS 0902 | PROJECT NO.: Swale 12.3

FROM STATION/REACH: | TO STATION/REACH: | DRAINAGE AREA: | DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
2.7	24.0	1.50	1.80	0.39	0.57



Not to Scale

LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.36	4.34	STABLE
	Staple D									

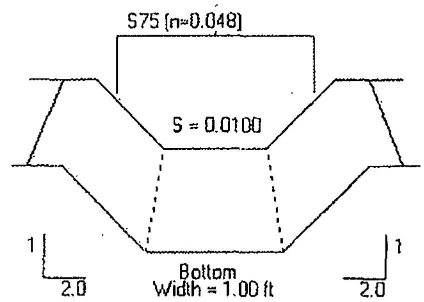
North American Green - ECMDS Version 4.3 | 10/25/2010 | 02:08 PM | COMPUTED BY: GMP

PROJECT NAME: PPLS 0902 | PROJECT NO.: Swale 12.4

FROM STATION/REACH: | TO STATION/REACH: | DRAINAGE AREA: | DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
4.0	24.0	1.86	2.15	0.46	0.82



Not to Scale

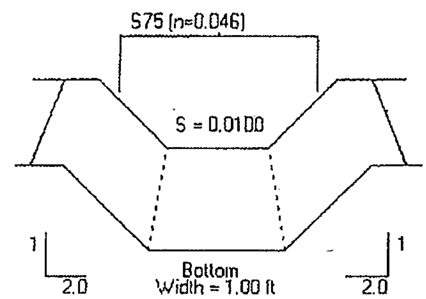
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.51	3.04	STABLE
	Staple D									

North American Green - ECMDS Version 4.3	10/25/2010	02:09 PM	COMPUTED BY: GMP
PROJECT NAME: PPLS 0902		PROJECT NO.: Swale 12.5	
FROM STATION/REACH:	TO STATION/REACH:	DRAINAGE AREA:	DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
5.3	24.0	2.07	2.57	0.51	0.91



Not to Scale

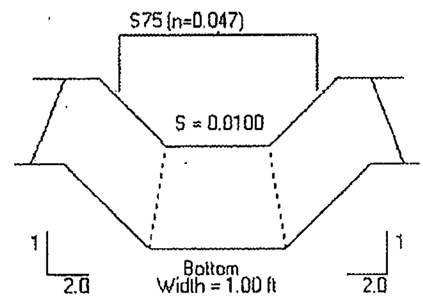
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.57	2.73	STABLE
	Staple D									

North American Green - ECMDS Version 4.3		10/25/2010 02:10 PM	COMPUTED BY: GMP
PROJECT NAME: PPLS 0902		PROJECT NO.: Swale 12.6	
FROM STATION/REACH:	TO STATION/REACH:	DRAINAGE AREA:	DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
4.4	24.0	1.93	2.29	0.48	0.85



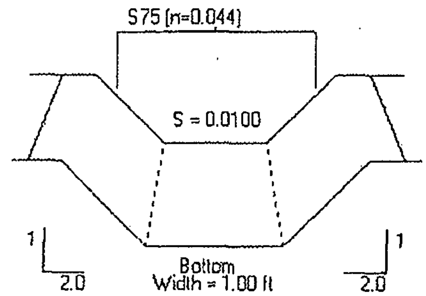
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.53	2.93	STABLE
	Staple D									

North American Green - ECMDS Version 4.3		10/25/2010 02:10 PM	COMPUTED BY: GMP
PROJECT NAME: PPLS 0902		PROJECT NO.: Swale 12.7	
FROM STATION/REACH:	TO STATION/REACH:	DRAINAGE AREA:	DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
6.7	24.0	2.26	2.96	0.54	0.99



Not to Scale

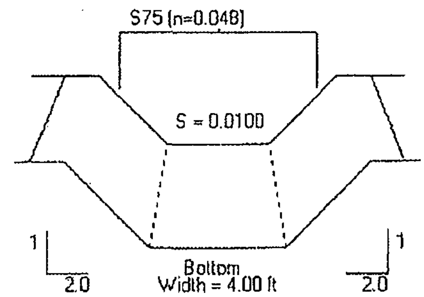
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.62	2.50	STABLE
	Staple D									

North American Green - ECMDS Version 4.3		10/25/2010 02:11 PM	COMPUTED BY: GMP
PROJECT NAME: PPLS 0902		PROJECT NO.: Swale 12.8	
FROM STATION/REACH:	TO STATION/REACH:	DRAINAGE AREA:	DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
10.4	24.0	2.23	4.66	0.61	0.82



Not to Scale

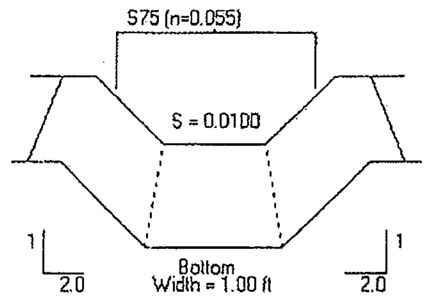
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics				Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
			Phase	Class	Type	Density				
Straight	S75	Unvegetated					1.55	0.51	3.01	STABLE
	Staple D									

North American Green - ECMDS Version 4.3		10/26/2010	11:03 AM	COMPUTED BY: GMP
PROJECT NAME: PPLS 0902		PROJECT NO.: Swale 12.9		
FROM STATION/REACH:	TO STATION/REACH:	DRAINAGE AREA:		DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
1.3	24.0	1.26	1.03	0.31	0.51



Not to Scale

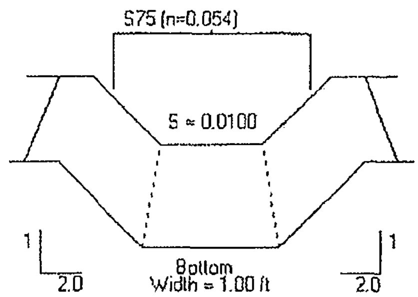
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.32	4.86	STABLE
	Staple D									

North American Green - ECMDS Version 4.3	10/25/2010	02:12 PM	COMPUTED BY: GMP
PROJECT NAME: PPLS 0902	PROJECT NO.: Swale 12.10		
FROM STATION/REACH:	TO STATION/REACH:	DRAINAGE AREA:	DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
1.4	24.0	1.29	1.09	0.32	0.53



Not to Scale

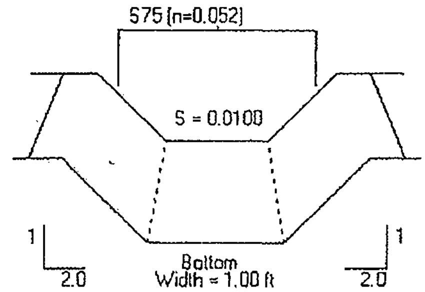
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics				Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
			Phase	Class	Type	Density				
Straight	S75	Unvegetated					1.55	0.33	4.70	STABLE
	Staple D									

North American Green - ECMDS Version 4.3	10/25/2010 02:13 PM	COMPUTED BY: GMP
PROJECT NAME: PPLS 0902	PROJECT NO.: Swale 12.11	
FROM STATION/REACH: TO STATION/REACH:	DRAINAGE AREA:	DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
2.3	24.0	1.53	1.51	0.38	0.65



Not to Scale

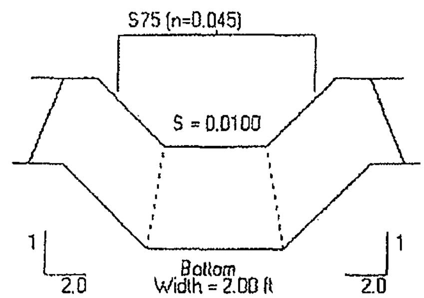
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.41	3.80	STABLE
	Staple D									

North American Green - ECMDS Version 4.3	10/25/2010 02:14 PM	COMPUTED BY: GMP
PROJECT NAME: PPLS 0902	PROJECT NO.: Swale 12.12	
FROM STATION/REACH: / TO STATION/REACH:	DRAINAGE AREA:	DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
8.1	24.0	2.28	3.56	0.58	0.92



Not to Scale

LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.58	2.69	STABLE
	Staple D									

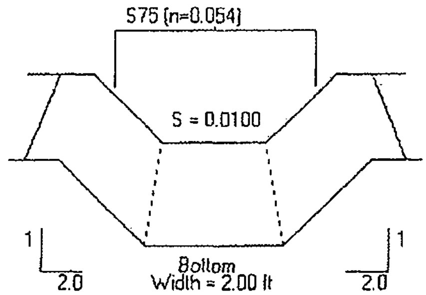
North American Green - ECMDS Version 4.3 | 10/25/2010 | 02:14 PM | COMPUTED BY: GMP

PROJECT NAME: PPLS 0902 | PROJECT NO.: Swale 12.13

FROM STATION/REACH: | TO STATION/REACH: | DRAINAGE AREA: | DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
2.4	24.0	1.44	1.67	0.38	0.54



Not to Scale

LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.34	4.58	STABLE
	Staple D									

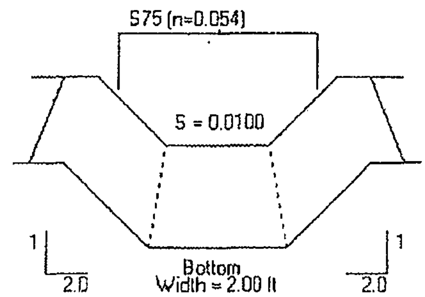
North American Green - ECMDS Version 4.3 | 10/25/2010 | 02:15 PM | COMPUTED BY: GMP

PROJECT NAME: PPLS 0902 | PROJECT NO.: Swale 13.1

FROM STATION/REACH: | TO STATION/REACH: | DRAINAGE AREA: | DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
2.6	24.0	1.48	1.76	0.39	0.56



Not to Scale

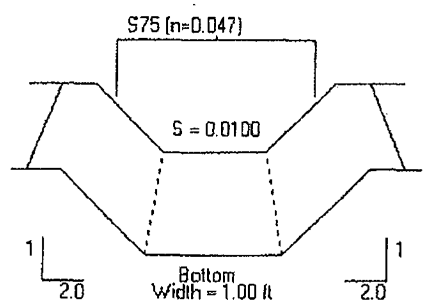
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.35	4.42	STABLE
	Staple D									

North American Green - ECMDS Version 4.3	10/25/2010 02:16 PM COMPUTED BY: GMP
PROJECT NAME: PPLS 0902	PROJECT NO.: Swale 13.2
FROM STATION/REACH: TO STATION/REACH:	DRAINAGE AREA: DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
4.7	24.0	1.97	2.38	0.49	0.87



Not to Scale

LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.54	2.86	STABLE
	Staple D									

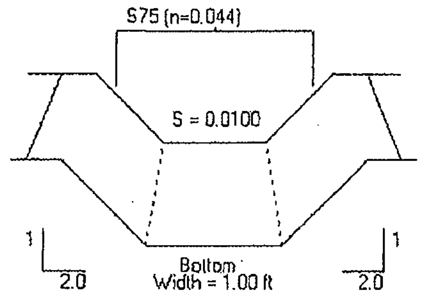
North American Green - ECMDS Version 4.3 | 10/25/2010 | 02:19 PM | COMPUTED BY: GMP

PROJECT NAME: PPLS 0902 | PROJECT NO.: Swale 13.3

FROM STATION/REACH: | TO STATION/REACH: | DRAINAGE AREA: | DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
6.4	24.0	2.22	2.88	0.54	0.98



Not to Scale

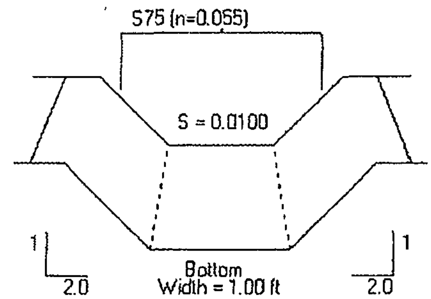
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.61	2.54	STABLE
	Staple D									

North American Green - ECMDS Version 4.3	10/25/2010	02:20 PM	COMPUTED BY: GMP
PROJECT NAME: PPLS 0902	PROJECT NO.: Swale 13.4		
FROM STATION/REACH: / TO STATION/REACH:	DRAINAGE AREA:	DESIGN FREQUENCY:	

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
1.3	24.0	1.26	1.03	0.31	0.51



Not to Scale

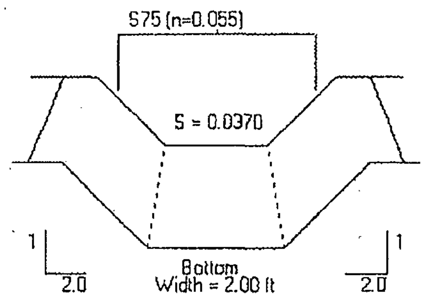
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.32	4.86	STABLE
	Staple D									

North American Green - ECMDS Version 4.3	10/25/2010	02:20 PM	COMPUTED BY: GMP
PROJECT NAME: PPLS 0902	PROJECT NO.: Swale 16.1		
FROM STATION/REACH:	TO STATION/REACH:	DRAINAGE AREA:	DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
2.8	24.0	2.36	1.19	0.31	0.42



Not to Scale

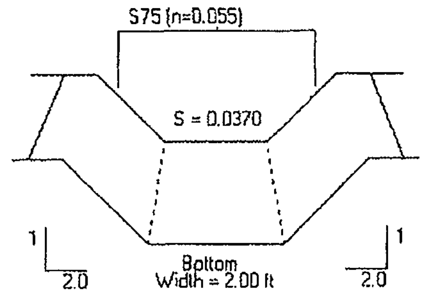
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.97	1.61	STABLE
	Staple D									

North American Green - ECMDS Version 4.3	10/25/2010 02:21 PM COMPUTED BY: GMP
PROJECT NAME: PPLS 0902	PROJECT NO.: Swale 16.2
FROM STATION/REACH: TO STATION/REACH:	DRAINAGE AREA: DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
3.4	24.0	2.50	1.36	0.33	0.46



Not to Scale

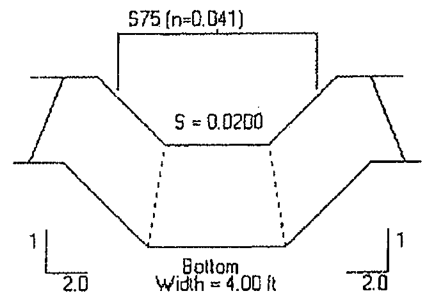
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	1.07	1.45	STABLE
	Staple D									

North American Green - ECMDS Version 4.3	10/25/2010	02:22 PM	COMPUTED BY: GMP
PROJECT NAME: PPLS 0902	PROJECT NO.: Swale 18.1		
FROM STATION/REACH: TO STATION/REACH:	DRAINAGE AREA:	DESIGN FREQUENCY:	

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
31.0	24.0	4.38	7.08	0.78	1.13



Not to Scale

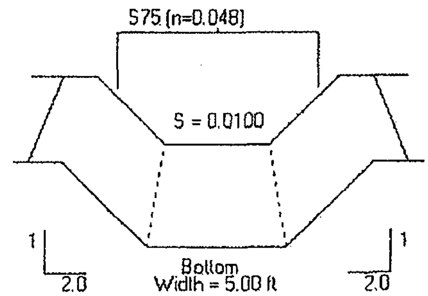
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	1.41	1.10	STABLE
	Staple D									

North American Green - ECMDS Version 4.3		10/25/2010 02:22 PM	COMPUTED BY: GMP
PROJECT NAME: PPLS 0902		PROJECT NO.: Swale 18.2	
FROM STATION/REACH:	TO STATION/REACH:	DRAINAGE AREA:	DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
12.3	24.0	2.27	5.41	0.63	0.82



Not to Scale

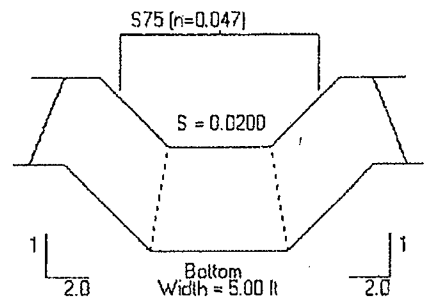
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.51	3.04	STABLE
	Staple D									

North American Green - ECMDS Version 4.3	10/25/2010	02:23 PM	COMPUTED BY: GMP
PROJECT NAME: PPLS 0902	PROJECT NO.: Swale 20.1		
FROM STATION/REACH:	TO STATION/REACH:	DRAINAGE AREA:	DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
19.3	24.0	3.36	5.74	0.65	0.86



Not to Scale

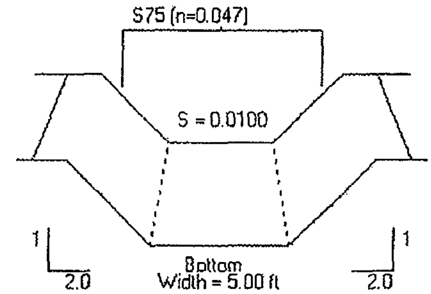
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	1.07	1.45	STABLE
	Staple D									

North American Green - ECMDS Version 4.3	10/25/2010 02:24 PM	COMPUTED BY: GMP
PROJECT NAME: PPLS 0902	PROJECT NO.: Swale 20.2	
FROM STATION/REACH: TO STATION/REACH:	DRAINAGE AREA:	DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
12.8	24.0	2.31	5.54	0.64	0.83



Not to Scale

LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.52	2.99	STABLE
	Staple D									

EROSION AND SEDIMENTATION TEMPORARY E&S SWALE CALCULATIONS

Bell Bend Nuclear Power Plant
Salem Township
Luzerne County, PA

STANDARD WORKSHEET #21
Channel Design Data

PROJECT NAME: PPL Bell Bend, PPLS0902
LOCATION: Salem Township
PREPARED BY: ATS DATE: 10/22/10
CHECKED BY: LGB DATE: 10/27/10

CHANNEL OR CHANNEL SECTION	E&S 1	E&S 2		E&S 3	E&S 4
PROTECTIVE LINING **	S75	S75		S75	S75
CHANNEL TOP WIDTH (FT)@ D	9.00	9.00		11.00	11.00
CHANNEL TOP WIDTH (FT)@ d	6.32	6.27		7.27	7.43
CHANNEL SIDE SLOPES (H:V)	2.0	2.0		2.0	2.0
CHANNEL BOTTOM WIDTH (FT)	3.0	3.0		3.0	3.0
d (FLOW DEPTH IN FT)	0.83	0.82		1.06	1.11
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	4:1	4:1		3:1	3:1
A (AREA IN SQ. FT.)	3.87	3.78		1.34	5.77
R (HYDRAULIC RADIUS)	0.58	0.57		0.70	0.73
S (BED SLOPE, FT/FT)*	0.010	0.019		0.010	0.015
VEGETATIVE LINING RETARDANCE	-	-		-	-
n (MANNING'S COEFFICIENT)**	0.048	0.048		0.043	0.041
V (AT FLOW DEPTH d, CFS)	2.12	2.91		2.71	3.57
Q (AT FLOW DEPTH d, CFS)	8.20	11.00		14.70	20.60
Q_r (REQUIRED CAPACITY) CFS	8.20	11.00		14.70	20.60
S_c (CRITICAL SLOPE)	0.043	0.043		0.032	0.029
$.7S_c$	0.029	0.030		0.022	0.020
$1.3S_c$	0.056	0.056		0.042	0.038
STABLE FLOW? (Y/N)	Y	Y		Y	Y
FREEBOARD BASED ON UNSTABLE FLOW FT	-	-		-	-
FREEBOARD BASED ON STABLE FLOW FT	0.67	0.68		0.94	0.89
MINIMUM REQUIRED FREEBOARD FT	0.50	0.50		0.50	0.50
D (TOTAL DEPTH) FT	1.50	1.50		2.00	2.00
d_{50} STONE SIZE (IN)	-	-		-	-
DESIGN METHOD FOR PROTECTIVE LINING **** PERMISSIBLE VELOCITY (V) OR SHEAR STRESS (S)	S	S		S	S
V_a (ALLOWABLE VELOCITY) FPS	3.5	3.5		3.5	3.5
τ_d (SHEAR STRESS AT FLOW DEPTH d) LB/FT^2	0.51	0.96		0.66	1.04
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	1.55	1.55		1.55	1.55

* Slopes may not be averaged.
** For vegetated channels, provide data for temporary linings and vegetated conditions in separate columns.
*** Minimum Freeboard, F, is 0.5 ft.
**** Permissible velocity lining design method is not acceptable for channels with a bed slope of 10% or greater. Shear stress lining design method is recommended for channels with a bed slope of 10% or greater. Shear stress lining design method may be used for any channel bed slope.

STANDARD WORKSHEET #21
Channel Design Data

PROJECT NAME: PPL Bell Bend, PPLS0902
LOCATION: Salem Township
PREPARED BY: ATS DATE: 10/22/10
CHECKED BY: LGB DATE: 10/27/10

CHANNEL OR CHANNEL SECTION	E&S 5	E&S 6		E&S 7	E&S 8
PROTECTIVE LINING **	S75	S75		S75	S75
CHANNEL TOP WIDTH (FT)@ D	9.00	11.00		7.00	7.00
CHANNEL TOP WIDTH (FT)@ d	6.81	7.36		3.13	3.48
CHANNEL SIDE SLOPES (H:V)	2.0	2.0		2.0	2.0
CHANNEL BOTTOM WIDTH (FT)	3.0	3.0		1.0	1.0
d (FLOW DEPTH IN FT)	0.95	1.09		0.53	0.62
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	3:1	3:1		2:1	2:1
A (AREA IN SQ. FT.)	4.67	5.65		1.10	1.39
R (HYDRAULIC RADIUS)	0.64	0.72		0.32	0.37
S (BED SLOPE, FT/FT)*	0.012	0.011		0.010	0.010
VEGETATIVE LINING RETARDANCE	-	-		-	-
n (MANNING'S COEFFICIENT)**	0.045	0.042		0.055	0.053
V (AT FLOW DEPTH d, CFS)	2.68	2.96		1.19	1.37
Q (AT FLOW DEPTH d, CFS)	12.50	16.70		1.30	1.90
Q_r (REQUIRED CAPACITY) CFS	12.50	16.70		1.30	1.90
S_c (CRITICAL SLOPE)	0.036	0.031		0.069	0.062
$.7S_c$	0.025	0.022		0.048	0.043
$1.3S_c$	0.047	0.040		0.089	0.081
STABLE FLOW? (Y/N)	Y	Y		Y	Y
FREEBOARD BASED ON UNSTABLE FLOW FT	-	-		-	-
FREEBOARD BASED ON STABLE FLOW FT	0.55	0.91		0.97	0.88
MINIMUM REQUIRED FREEBOARD FT	0.50	0.50		0.50	0.50
D (TOTAL DEPTH) FT	1.50	2.00		1.50	1.50
d_{50} STONE SIZE (IN)	-	-		-	-
DESIGN METHOD FOR PROTECTIVE LINING ** PERMISSIBLE VELOCITY (V) OR SHEAR STRESS (S)**	S	S		S	S
V_a (ALLOWABLE VELOCITY) FPS	3.5	3.5		3.5	3.5
τ_d (SHEAR STRESS AT FLOW DEPTH d) LB/FT^2	0.71	0.74		0.32	0.38
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	1.55	1.55		1.55	1.55

* Slopes may not be averaged.
** For vegetated channels, provide data for temporary linings and vegetated conditions in separate columns.
*** Minimum Freeboard,F, is 0.5 ft.
**** Permissible velocity lining design method is not acceptable for channels with a bed slope of 10% or greater. Shear stress lining design method is recommended for channels with a bed slope of 10% or greater. Shear stress lining design method may be used for any channel bed slope.

STANDARD WORKSHEET #21
Channel Design Data

PROJECT NAME: PPL Bell Bend, PPLS0902
LOCATION: Salem Township
PREPARED BY: ATS DATE: 10/22/10
CHECKED BY: LGB DATE: 10/27/10

CHANNEL OR CHANNEL SECTION	E&S 9	E&S 10		E&S 11	E&S 12
PROTECTIVE LINING **	S75	S75		S75	S75
CHANNEL TOP WIDTH (FT)@ D	7.00	7.00		7.00	7.00
CHANNEL TOP WIDTH (FT)@ d	4.97	4.38		4.71	3.80
CHANNEL SIDE SLOPES (H:V)	2.0	2.0		2.0	2.0
CHANNEL BOTTOM WIDTH (FT)	3.0	1.0		1.0	1.0
d (FLOW DEPTH IN FT)	0.49	0.85		0.93	0.70
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	6:1	1:1		1:1	1:1
A (AREA IN SQ. FT.)	1.97	2.28		2.65	1.68
R (HYDRAULIC RADIUS)	0.38	0.48		0.51	0.41
S (BED SLOPE, FT/FT)*	0.010	0.010		0.010	0.010
VEGETATIVE LINING RETARDANCE	-	-		-	-
n (MANNING'S COEFFICIENT)**	0.050	0.047		0.046	0.051
V (AT FLOW DEPTH d, CFS)	1.42	1.89		2.04	1.55
Q (AT FLOW DEPTH d, CFS)	2.80	4.30		5.40	2.60
Q_r (REQUIRED CAPACITY) CFS	2.80	4.30		5.40	2.60
S_c (CRITICAL SLOPE)	0.053	0.045		0.042	0.055
$.7S_c$	0.037	0.032		0.029	0.039
$1.3S_c$	0.069	0.059		0.055	0.072
STABLE FLOW? (Y/N)	Y	Y		Y	Y
FREEBOARD BASED ON UNSTABLE FLOW FT	-	-		-	-
FREEBOARD BASED ON STABLE FLOW FT	0.51	0.65		0.57	0.80
MINIMUM REQUIRED FREEBOARD FT	0.50	0.50		0.50	0.50
D (TOTAL DEPTH) FT	1.00	1.50		1.50	1.50
d_{50} STONE SIZE (IN)	-	-		-	-
DESIGN METHOD FOR PROTECTIVE LINING **** PERMISSIBLE VELOCITY (V) OR SHEAR STRESS (S)	S	S		S	S
V_a (ALLOWABLE VELOCITY) FPS	3.5	3.5		3.5	3.5
τ_d (SHEAR STRESS AT FLOW DEPTH d) LB/FT^2	0.44	0.52		0.57	0.43
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	1.55	1.55		1.55	1.55

* Slopes may not be averaged.
** For vegetated channels, provide data for temporary linings and vegetated conditions in separate columns.
*** Minimum Freeboard,F, is 0.5 ft.
**** Permissible velocity lining design method is not acceptable for channels with a bed slope of 10% or greater. Shear stress lining design method is recommended for channels with a bed slope of 10% or greater. Shear stress lining design method may be used for any channel bed slope.

STANDARD WORKSHEET #21
Channel Design Data

PROJECT NAME: PPL Bell Bend, PPLS0902
LOCATION: Salem Township
PREPARED BY: ATS DATE: 10/22/10
CHECKED BY: LGB DATE: 10/27/10

CHANNEL OR CHANNEL SECTION	E&S 13	E&S 14		E&S 16	E&S 17
PROTECTIVE LINING **	S75	S75		S75	S75
CHANNEL TOP WIDTH (FT)@ D	7.00	7.00		7.00	7.00
CHANNEL TOP WIDTH (FT)@ d	4.06	3.75		4.10	4.92
CHANNEL SIDE SLOPES (H:V)	2.0	2.0		2.0	2.0
CHANNEL BOTTOM WIDTH (FT)	1.0	1.0		1.0	1.0
d (FLOW DEPTH IN FT)	0.77	0.69		0.78	0.98
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	1:1	1:1		1:1	1:1
A (AREA IN SQ. FT.)	1.94	1.64		1.98	2.90
R (HYDRAULIC RADIUS)	0.44	0.40		0.44	0.54
S (BED SLOPE, FT/FT)*	0.010	0.010		0.010	0.010
VEGETATIVE LINING RETARDANCE	-	-		-	-
n (MANNING'S COEFFICIENT)**	0.049	0.051		0.049	0.044
V (AT FLOW DEPTH d, CFS)	1.70	1.53		1.79	2.20
Q (AT FLOW DEPTH d, CFS)	3.30	2.50		3.40	6.40
Q_r (REQUIRED CAPACITY) CFS	3.30	2.50		3.40	6.40
S_c (CRITICAL SLOPE)	0.050	0.055		0.050	0.038
$.7S_c$	0.035	0.039		0.035	0.027
$1.3S_c$	0.065	0.072		0.065	0.049
STABLE FLOW? (Y/N)	Y	Y		Y	Y
FREEBOARD BASED ON UNSTABLE FLOW FT	-	-		-	-
FREEBOARD BASED ON STABLE FLOW FT	0.73	0.81		0.72	0.52
MINIMUM REQUIRED FREEBOARD FT	0.50	0.50		0.50	0.50
D (TOTAL DEPTH) FT	1.50	1.50		1.50	1.50
d_{50} STONE SIZE (IN)	-	-		-	-
DESIGN METHOD FOR PROTECTIVE LINING **** PERMISSIBLE VELOCITY (V) OR SHEAR STRESS (S)	S	S		S	S
V_a (ALLOWABLE VELOCITY) FPS	3.5	3.5		3.5	3.5
τ_d (SHEAR STRESS AT FLOW DEPTH d) LB/FT^2	0.47	0.42		0.48	0.61
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	1.55	1.55		1.55	1.55

* Slopes may not be averaged.
** For vegetated channels, provide data for temporary linings and vegetated conditions in separate columns.
*** Minimum Freeboard,F, is 0.5 ft.
**** Permissible velocity lining design method is not acceptable for channels with a bed slope of 10% or greater. Shear stress lining design method is recommended for channels with a bed slope of 10% or greater. Shear stress lining design method may be used for any channel bed slope.

STANDARD WORKSHEET #21
Channel Design Data

PROJECT NAME: PPL Bell Bend, PPLS0902
LOCATION: Salem Township
PREPARED BY: ATS DATE: 10/22/10
CHECKED BY: LGB DATE: 10/27/10

CHANNEL OR CHANNEL SECTION	E&S 19	E&S 20		E&S 21	E&S 22
PROTECTIVE LINING **	S75	S75		S75	S75
CHANNEL TOP WIDTH (FT)@ D	9.00	13.00		7.00	7.00
CHANNEL TOP WIDTH (FT)@ d	5.74	10.68		3.66	4.52
CHANNEL SIDE SLOPES (H:V)	2.0	2.0		2.0	2.0
CHANNEL BOTTOM WIDTH (FT)	1.0	3.0		1.0	1.0
d (FLOW DEPTH IN FT)	1.18	1.92		0.66	0.88
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	1:1	2:1		2:1	1:1
A (AREA IN SQ. FT.)	3.99	13.13		3.97	2.43
R (HYDRAULIC RADIUS)	0.63	1.13		0.39	0.49
S (BED SLOPE, FT/FT)*	0.010	0.005		0.020	0.010
VEGETATIVE LINING RETARDANCE	-	-		-	-
n (MANNING'S COEFFICIENT)**	0.040	0.022		0.051	0.046
V (AT FLOW DEPTH d, CFS)	2.76	5.19		2.13	1.98
Q (AT FLOW DEPTH d, CFS)	11.00	68.20		3.30	4.80
Q_r (REQUIRED CAPACITY) CFS	11.00	68.20		3.30	4.80
S_c (CRITICAL SLOPE)	0.029	0.007		0.056	0.043
$.7S_c$	0.020	0.005		0.039	0.030
$1.3S_c$	0.038	0.091		0.073	0.056
STABLE FLOW? (Y/N)	Y	Y		Y	Y
FREEBOARD BASED ON UNSTABLE FLOW FT	-	-		-	-
FREEBOARD BASED ON STABLE FLOW FT	0.82	0.58		0.84	0.62
MINIMUM REQUIRED FREEBOARD FT	0.50	0.50		0.50	0.50
D (TOTAL DEPTH) FT	2.00	2.50		1.50	1.50
d_{50} STONE SIZE (IN)	-	-		-	-
DESIGN METHOD FOR PROTECTIVE LINING **** PERMISSIBLE VELOCITY (V) OR SHEAR STRESS (S)	S	S		S	S
V_a (ALLOWABLE VELOCITY) FPS	3.5	3.5		3.5	3.5
τ_d (SHEAR STRESS AT FLOW DEPTH d) LB/FT^2	0.74	0.60		0.82	0.55
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	1.55	1.55		1.55	1.55

* Slopes may not be averaged.
** For vegetated channels, provide data for temporary linings and vegetated conditions in separate columns.
*** Minimum Freeboard,F, is 0.5 ft.
**** Permissible velocity lining design method is not acceptable for channels with a bed slope of 10% or greater. Shear stress lining design method is recommended for channels with a bed slope of 10% or greater. Shear stress lining design method may be used for any channel bed slope.

STANDARD WORKSHEET #21
Channel Design Data

PROJECT NAME: PPL Bell Bend, PPLS0902
LOCATION: Salem Township
PREPARED BY: ATS DATE: 10/22/10
CHECKED BY: LGB DATE: 10/27/10

CHANNEL OR CHANNEL SECTION	E&S 23	E&S 24		E&S 26	E&S 27
PROTECTIVE LINING **	S75	S75		S75	S75
CHANNEL TOP WIDTH (FT)@ D	7.00	7.00		7.00	11.00
CHANNEL TOP WIDTH (FT)@ d	4.06	3.04		3.93	7.38
CHANNEL SIDE SLOPES (H:V)	2.0	2.0		2.0	2.0
CHANNEL BOTTOM WIDTH (FT)	1.0	1.0		1.0	3.0
d (FLOW DEPTH IN FT)	0.77	0.51		0.73	1.09
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	1:1	2:1		1:1	3:1
A (AREA IN SQ. FT.)	1.94	1.03		1.81	5.68
R (HYDRAULIC RADIUS)	0.44	0.31		0.42	0.72
S (BED SLOPE, FT/FT)*	0.010	0.024		0.024	0.006
VEGETATIVE LINING RETARDANCE	-	-		-	-
n (MANNING'S COEFFICIENT)**	0.049	0.055		0.050	0.041
V (AT FLOW DEPTH d, CFS)	1.70	1.85		2.54	2.24
Q (AT FLOW DEPTH d, CFS)	3.30	1.90		4.60	12.70
Q_r (REQUIRED CAPACITY) CFS	3.30	1.90		4.60	12.70
S_c (CRITICAL SLOPE)	0.050	0.070		0.053	0.029
$.7S_c$	0.035	0.049		0.037	0.020
$1.3S_c$	0.065	0.091		0.069	0.038
STABLE FLOW? (Y/N)	Y	Y		Y	Y
FREEBOARD BASED ON UNSTABLE FLOW FT	-	-		-	-
FREEBOARD BASED ON STABLE FLOW FT	0.73	0.99		0.77	0.91
MINIMUM REQUIRED FREEBOARD FT	0.50	0.50		0.50	0.50
D (TOTAL DEPTH) FT	1.50	1.50		1.50	2.00
d_{50} STONE SIZE (IN)	-	-		-	-
DESIGN METHOD FOR PROTECTIVE LINING **** PERMISSIBLE VELOCITY (V) OR SHEAR STRESS (S)	S	S		S	S
V_a (ALLOWABLE VELOCITY) FPS	3.5	3.5		3.5	3.5
τ_d (SHEAR STRESS AT FLOW DEPTH d) LB/FT^2	0.47	0.75		1.09	41
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	1.55	1.55		1.55	1.55

* Slopes may not be averaged.
** For vegetated channels, provide data for temporary linings and vegetated conditions in separate columns.
*** Minimum Freeboard,F, is 0.5 ft.
**** Permissible velocity lining design method is not acceptable for channels with a bed slope of 10% or greater. Shear stress lining design method is recommended for channels with a bed slope of 10% or greater. Shear stress lining design method may be used for any channel bed slope.

STANDARD WORKSHEET #21
Channel Design Data

PROJECT NAME: PPL Bell Bend, PPLS0902
LOCATION: Salem Township
PREPARED BY: ATS DATE: 10/22/10
CHECKED BY: LGB DATE: 10/27/10

CHANNEL OR CHANNEL SECTION	E&S 28	E&S 29		E&S 30	E&S 32
PROTECTIVE LINING **	S75	S75		S75	S75
CHANNEL TOP WIDTH (FT)@ D	5.00	9.00		7.00	11.00
CHANNEL TOP WIDTH (FT)@ d	2.22	5.25		3.05	8.42
CHANNEL SIDE SLOPES (H:V)	2.0	2.0		2.0	2.0
CHANNEL BOTTOM WIDTH (FT)	1.0	3.0		1.0	3.0
d (FLOW DEPTH IN FT)	0.31	0.56		0.51	1.36
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	3:1	5:1		2:1	2:1
A (AREA IN SQ. FT.)	0.49	2.33		1.04	7.74
R (HYDRAULIC RADIUS)	0.21	0.42		0.32	0.85
S (BED SLOPE, FT/FT)*	0.046	0.040		0.024	0.01
VEGETATIVE LINING RETARDANCE	-	-		-	-
n (MANNING'S COEFFICIENT)**	0.055	0.054		0.055	0.035
V (AT FLOW DEPTH d, CFS)	1.83	3.05		2.41	3.81
Q (AT FLOW DEPTH d, CFS)	0.90	7.10		2.50	29.50
Q_r (REQUIRED CAPACITY) CFS	0.90	7.10		2.50	29.50
S_c (CRITICAL SLOPE)	0.079	0.059		0.069	0.020
$.7S_c$	0.055	0.041		0.048	0.014
$1.3S_c$	0.103	0.077		0.089	0.026
STABLE FLOW? (Y/N)	Y	Y		Y	Y
FREEBOARD BASED ON UNSTABLE FLOW FT	-	-		-	-
FREEBOARD BASED ON STABLE FLOW FT	0.69	0.94		0.99	0.64
MINIMUM REQUIRED FREEBOARD FT	0.50	0.50		0.50	0.50
D (TOTAL DEPTH) FT	1.00	1.50		1.50	2.00
d_{50} STONE SIZE (IN)	-	-		-	-
DESIGN METHOD FOR PROTECTIVE LINING **** PERMISSIBLE VELOCITY (V) OR SHEAR STRESS (S)	S	S		S	S
V_a (ALLOWABLE VELOCITY) FPS	3.5	3.5		3.5	3.5
τ_d (SHEAR STRESS AT FLOW DEPTH d) LB/FT^2	0.83	1.39		1.25	0.85
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	1.55	1.55		1.55	1.55

* Slopes may not be averaged.
** For vegetated channels, provide data for temporary linings and vegetated conditions in separate columns.
*** Minimum Freeboard,F, is 0.5 ft.
**** Permissible velocity lining design method is not acceptable for channels with a bed slope of 10% or greater. Shear stress lining design method is recommended for channels with a bed slope of 10% or greater. Shear stress lining design method may be used for any channel bed slope.

STANDARD WORKSHEET #21
Channel Design Data

PROJECT NAME: PPL Bell Bend, PPLS0902
LOCATION: Salem Township
PREPARED BY: ATS DATE: 10/22/10
CHECKED BY: LGB DATE: 10/27/10

CHANNEL OR CHANNEL SECTION	E&S 33	E&S 34		E&S 35	E&S 36
PROTECTIVE LINING **	C125	C125		S75	C125
CHANNEL TOP WIDTH (FT)@ D	13.00	13.00		13.00	11.00
CHANNEL TOP WIDTH (FT)@ d	7.67	7.74		10.94	7.75
CHANNEL SIDE SLOPES (H:V)	2.0	2.0		2.0	2.0
CHANNEL BOTTOM WIDTH (FT)	3.0	3.0		3.0	5.0
d (FLOW DEPTH IN FT)	1.17	1.19		1.99	0.69
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	3:1	3:1		2:1	7:1
A (AREA IN SQ. FT.)	6.23	6.36		13.85	4.39
R (HYDRAULIC RADIUS)	0.76	0.77		1.17	0.54
S (BED SLOPE, FT/FT)*	0.017	0.017		0.010	0.050
VEGETATIVE LINING RETARDANCE	-	-		-	-
n (MANNING'S COEFFICIENT)**	0.018	0.018		0.021	0.021
V (AT FLOW DEPTH d, CFS)	8.94	9.00		7.84	10.55
Q (AT FLOW DEPTH d, CFS)	55.70	57.30		108.60	46.30
Q_r (REQUIRED CAPACITY) CFS	55.70	57.30		108.60	46.30
S_c (CRITICAL SLOPE)	0.006	0.006		0.066	0.008
$.7S_c$	0.004	0.004		0.046	0.006
$1.3S_c$	0.009	0.009		0.086	0.010
STABLE FLOW? (Y/N)	Y	Y		Y	Y
FREEBOARD BASED ON UNSTABLE FLOW FT	-	-		-	-
FREEBOARD BASED ON STABLE FLOW FT	1.33	1.31		0.51	0.81
MINIMUM REQUIRED FREEBOARD FT	0.50	0.50		0.50	0.50
D (TOTAL DEPTH) FT	2.50	2.50		2.50	1.50
d_{50} STONE SIZE (IN)	-	-		-	-
DESIGN METHOD FOR PROTECTIVE LINING **** PERMISSIBLE VELOCITY (V) OR SHEAR STRESS (S)	S	S		S	S
V_a (ALLOWABLE VELOCITY) FPS	3.5	3.5		3.5	3.5
τ_d (SHEAR STRESS AT FLOW DEPTH d) LB/FT^2	1.25	1.27		1.24	2.15
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	2.25	2.25		1.55	2.25

* Slopes may not be averaged.
** For vegetated channels, provide data for temporary linings and vegetated conditions in separate columns.
*** Minimum Freeboard,F, is 0.5 ft.
**** Permissible velocity lining design method is not acceptable for channels with a bed slope of 10% or greater. Shear stress lining design method is recommended for channels with a bed slope of 10% or greater. Shear stress lining design method may be used for any channel bed slope.

STANDARD WORKSHEET #21
Channel Design Data

PROJECT NAME: PPL Bell Bend, PPLS0902
LOCATION: Salem Township
PREPARED BY: ATS DATE: 10/22/10
CHECKED BY: LGB DATE: 10/27/10

CHANNEL OR CHANNEL SECTION	E&S 37	E&S 38			
PROTECTIVE LINING **	S75	S75			
CHANNEL TOP WIDTH (FT)@ D	13.00	9.00			
CHANNEL TOP WIDTH (FT)@ d	8.55	6.34			
CHANNEL SIDE SLOPES (H:V)	2.0	2.0			
CHANNEL BOTTOM WIDTH (FT)	4.0	1.0			
d (FLOW DEPTH IN FT)	1.14	1.34			
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	4:1	1:1			
A (AREA IN SQ. FT.)	7.13	4.90			
R (HYDRAULIC RADIUS)	0.79	0.70			
S (BED SLOPE, FT/FT)*	0.019	0.010			
VEGETATIVE LINING RETARDANCE	-	-		-	-
n (MANNING'S COEFFICIENT)**	0.040	0.036			
V (AT FLOW DEPTH d, CFS)	4.35	3.28			
Q (AT FLOW DEPTH d, CFS)	31.00	16.10			
Q_r (REQUIRED CAPACITY) CFS	31.00	16.10			
S_c (CRITICAL SLOPE)	0.027	0.023			
$.7S_c$	0.018	0.016			
$1.3S_c$	0.035	0.029			
STABLE FLOW? (Y/N)	Y	Y			
FREEBOARD BASED ON UNSTABLE FLOW FT	-	-		-	-
FREEBOARD BASED ON STABLE FLOW FT	0.86	0.66			
MINIMUM REQUIRED FREEBOARD FT	0.50	0.50			
D (TOTAL DEPTH) FT	2.00	2.00			
d_{50} STONE SIZE (IN)	-	-		-	-
DESIGN METHOD FOR PROTECTIVE LINING **** PERMISSIBLE VELOCITY (V) OR SHEAR STRESS (S)	S	S			
V_a (ALLOWABLE VELOCITY) FPS	3.5	3.5			
τ_d (SHEAR STRESS AT FLOW DEPTH d) LB/FT^2	1.35	.84			
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	1.55	1.55			

* Slopes may not be averaged.
** For vegetated channels, provide data for temporary linings and vegetated conditions in separate columns.
*** Minimum Freeboard,F, is 0.5 ft.
**** Permissible velocity lining design method is not acceptable for channels with a bed slope of 10% or greater. Shear stress lining design method is recommended for channels with a bed slope of 10% or greater. Shear stress lining design method may be used for any channel bed slope.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description: Erosion Control Swales
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:46 AM
Project #: PPL0902

Checked by:
M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation:

$$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: E&S Swale 1

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	8.20			cfs
Left Side Slope =	2.0			H:1V
Right Side Slope =	2.0			H:1V
Base width of Channel, b=	3.0			feet
Bed slope, s=	0.0100			ft/ft
Available depth of channel:	1.50			feet
(OPTIONAL) Input Manning's 'n':	0.0480			
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.83**			**feet**

Calculated Results:

Design Acceptable?	Yes			
Freeboard, f=	0.67			feet
Calculated Velocity, V=	2.12			fps
Flow Top Width, T=	6.32			feet
Flow Area, A=	3.87			sq ft
Wetted Perimeter, P=	6.71			feet
Hydraulic Radius, R=	0.58			feet
Shear stress on channel bottom, τ =	0.52			lbs/sf
Critical Slope, S_c=	0.0428			ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes			
Required Freeboard=	0.5			feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: **PPL Bells Bend**
Description:
Prepared by: **ATS**
Date: **14 Oct 10**

Print Date: 5 Nov 10 10:46 AM
Project #: PPL0902

Checked by:
M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: E&S Swale 2	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	11.00			cfs
Left Side Slope =	2.0			H:1V
Right Side Slope =	2.0			H:1V
Base width of Channel, b=	3.0			feet
Bed slope, s=	0.0190			ft/ft
Available depth of channel:	1.50			feet
(OPTIONAL) Input Manning's 'n':	0.0480			
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.82**			**feet**

Calculated Results: Design Acceptable?	Yes			
Freeboard, f=	0.68			feet
Calculated Velocity, V=	2.91			fps
Flow Top Width, T=	6.27			feet
Flow Area, A=	3.78			sq ft
Wetted Perimeter, P=	6.65			feet
Hydraulic Radius, R=	0.57			feet
Shear stress on channel bottom, τ =	0.97			lbs/sf
Critical Slope, S_c=	0.0430			ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes			
Required Freeboard=	0.5			feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description:
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:46 AM
Project #: PPL0902

Checked by: M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation:

$$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: E&S Swale 3

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	14.70			cfs
Left Side Slope =	2.0			H:1V
Right Side Slope =	2.0			H:1V
Base width of Channel, b=	3.0			feet
Bed slope, s=	0.0100			ft/ft
Available depth of channel:	2.00			feet
(OPTIONAL) Input Manning's 'n':	0.0430			
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**1.06**			**feet**

Calculated Results:

Design Acceptable?	Yes			
Freeboard, f=	0.94			feet
Calculated Velocity, V=	2.71			fps
Flow Top Width, T=	7.24			feet
Flow Area, A=	5.42			sq ft
Wetted Perimeter, P=	7.74			feet
Hydraulic Radius, R=	0.70			feet
Shear stress on channel bottom, τ =	0.66			lbs/sf
Critical Slope, S_c=	0.0324			ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes			
Required Freeboard=	0.5			feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description:
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:46 AM
Project #: PPL0902

Checked by:
M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: E&S Swale 4

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	20.60			cfs
Left Side Slope =	2.0			H:1V
Right Side Slope =	2.0			H:1V
Base width of Channel, b=	3.0			feet
Bed slope, s=	0.0150			ft/ft
Available depth of channel:	2.00			feet
(OPTIONAL) Input Manning's 'n':	0.0410			
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**1.11**			**feet**

Calculated Results:

Design Acceptable?	V too high			
Freeboard, f=	0.89			feet
Calculated Velocity, V=	3.57			fps
Flow Top Width, T=	7.43			feet
Flow Area, A=	5.77			sq ft
Wetted Perimeter, P=	7.95			feet
Hydraulic Radius, R=	0.73			feet
Shear stress on channel bottom, τ =	1.04			lbs/sf
Critical Slope, S_c=	0.0291			ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes			
Required Freeboard=	0.5			feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description:
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:46 AM
Project #: PPL0902

Checked by:
M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: E&S Swale 5

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	12.50			cfs
Left Side Slope =	2.0			H:1V
Right Side Slope =	2.0			H:1V
Base width of Channel, b=	3.0			feet
Bed slope, s=	0.0120			ft/ft
Available depth of channel:	1.50			feet
(OPTIONAL) Input Manning's 'n':	0.0450			
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.95**			**feet**

Calculated Results:

Design Acceptable?	Yes			
Freeboard, f=	0.55			feet
Calculated Velocity, V=	2.68			fps
Flow Top Width, T=	6.81			feet
Flow Area, A=	4.67			sq ft
Wetted Perimeter, P=	7.26			feet
Hydraulic Radius, R=	0.64			feet
Shear stress on channel bottom, τ =	0.71			lbs/sf
Critical Slope, S_c=	0.0364			ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes			
Required Freeboard=	0.5			feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description:
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:46 AM
Project #: PPL0902

Checked by: M. Fenick

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Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: E&S Swale 6

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	16.70			cfs
Left Side Slope =	2.0			H:1V
Right Side Slope =	2.0			H:1V
Base width of Channel, b=	3.0			feet
Bed slope, s=	0.0110			ft/ft
Available depth of channel:	2.00			feet
(OPTIONAL) Input Manning's 'n':	0.0420			
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**1.09**			**feet**

Calculated Results:

Design Acceptable?	Yes			
Freeboard, f=	0.91			feet
Calculated Velocity, V=	2.96			fps
Flow Top Width, T=	7.36			feet
Flow Area, A=	5.65			sq ft
Wetted Perimeter, P=	7.87			feet
Hydraulic Radius, R=	0.72			feet
Shear stress on channel bottom, τ =	0.75			lbs/sf
Critical Slope, S_c=	0.0307			ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes			
Required Freeboard=	0.5			feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description:
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:46 AM
Project #: PPL0902

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Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation:

$$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: E&S Swale 7

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	1.30			cfs
Left Side Slope =	2.0			H:1V
Right Side Slope =	2.0			H:1V
Base width of Channel, b=	1.0			feet
Bed slope, s=	0.0100			ft/ft
Available depth of channel:	1.50			feet
(OPTIONAL) Input Manning's 'n':	0.0550			
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.53**			**feet**

Calculated Results:

Design Acceptable?	Yes			
Freeboard, f=	0.97			feet
Calculated Velocity, V=	1.19			fps
Flow Top Width, T=	3.13			feet
Flow Area, A=	1.10			sq ft
Wetted Perimeter, P=	3.38			feet
Hydraulic Radius, R=	0.32			feet
Shear stress on channel bottom, τ =	0.33			lbs/sf
Critical Slope, S_c=	0.0692			ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes			
Required Freeboard=	0.5			feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description:
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:46 AM
Project #: PPL0902

Checked by:
M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$

Given Input Data: E&S Swale 8

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	1.90			cfs
Left Side Slope =	2.0			H:1V
Right Side Slope =	2.0			H:1V
Base width of Channel, b=	1.0			feet
Bed slope, s=	0.0100			ft/ft
Available depth of channel:	1.50			feet
(OPTIONAL) Input Manning's 'n':	0.0530			
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.62**			**feet**

Calculated Results:

Design Acceptable?	Yes			
Freeboard, f=	0.88			feet
Calculated Velocity, V=	1.37			fps
Flow Top Width, T=	3.48			feet
Flow Area, A=	1.39			sq ft
Wetted Perimeter, P=	3.77			feet
Hydraulic Radius, R=	0.37			feet
Shear stress on channel bottom, τ =	0.39			lbs/sf
Critical Slope, S_c=	0.0619			ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes			
Required Freeboard=	0.5			feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description:
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:46 AM
Project #: PPL0902

Checked by: M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$

Given Input Data: E&S Swale 9

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	2.80			cfs
Left Side Slope =	2.0			H:1V
Right Side Slope =	2.0			H:1V
Base width of Channel, b=	3.0			feet
Bed slope, s=	0.0100			ft/ft
Available depth of channel:	1.00			feet
(OPTIONAL) Input Manning's 'n':	0.0500			
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.49**			**feet**

Calculated Results:

Design Acceptable?	Yes			
Freeboard, f=	0.51			feet
Calculated Velocity, V=	1.42			fps
Flow Top Width, T=	4.97			feet
Flow Area, A=	1.97			sq ft
Wetted Perimeter, P=	5.21			feet
Hydraulic Radius, R=	0.38			feet
Shear stress on channel bottom, τ =	0.31			lbs/sf
Critical Slope, S_c=	0.0527			ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes			
Required Freeboard=	0.5			feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

I:\PROJECTS\PPLS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\E&S\[Swales E&S.xls]E&S Swale 9

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description:
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:46 AM
Project #: PPL0902

Checked by:
M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation:
$$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: E&S Swale 10

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	4.30			cfs
Left Side Slope =	2.0			H:1V
Right Side Slope =	2.0			H:1V
Base width of Channel, b=	1.0			feet
Bed slope, s=	0.0100			ft/ft
Available depth of channel:	1.50			feet
(OPTIONAL) Input Manning's 'n':	0.0470			
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.85**			**feet**

Calculated Results:

Design Acceptable?	Yes			
Freeboard, f=	0.65			feet
Calculated Velocity, V=	1.89			fps
Flow Top Width, T=	4.38			feet
Flow Area, A=	2.28			sq ft
Wetted Perimeter, P=	4.78			feet
Hydraulic Radius, R=	0.48			feet
Shear stress on channel bottom, τ =	0.53			lbs/sf
Critical Slope, S_c=	0.0449			ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes			
Required Freeboard=	0.5			feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description:
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:46 AM
Project #: PPL0902

Checked by: M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: E&S Swale 11

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	5.40			cfs
Left Side Slope =	2.0			H:1V
Right Side Slope =	2.0			H:1V
Base width of Channel, b=	1.0			feet
Bed slope, s=	0.0100			ft/ft
Available depth of channel:	1.50			feet
(OPTIONAL) Input Manning's 'n':	0.0460			
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.93**			**feet**

Calculated Results:

Design Acceptable?	Yes			
Freeboard, f=	0.57			feet
Calculated Velocity, V=	2.04			fps
Flow Top Width, T=	4.71			feet
Flow Area, A=	2.65			sq ft
Wetted Perimeter, P=	5.15			feet
Hydraulic Radius, R=	0.51			feet
Shear stress on channel bottom, τ =	0.58			lbs/sf
Critical Slope, S_c=	0.0420			ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes			
Required Freeboard=	0.5			feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description:
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:46 AM
Project #: PPL0902

Checked by:
M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation:

$$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: E&S Swale 12

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	2.60			cfs
Left Side Slope =	2.0			H:1V
Right Side Slope =	2.0			H:1V
Base width of Channel, b=	1.0			feet
Bed slope, s=	0.0100			ft/ft
Available depth of channel:	1.50			feet
(OPTIONAL) Input Manning's 'n':	0.0510			
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.70**			**feet**

Calculated Results:

Design Acceptable?	Yes			
Freeboard, f=	0.80			feet
Calculated Velocity, V=	1.55			fps
Flow Top Width, T=	3.80			feet
Flow Area, A=	1.68			sq ft
Wetted Perimeter, P=	4.13			feet
Hydraulic Radius, R=	0.41			feet
Shear stress on channel bottom, τ =	0.44			lbs/sf
Critical Slope, S_c=	0.0555			ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes			
Required Freeboard=	0.5			feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description:
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:46 AM
Project #: PPL0902

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Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation:

$$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: E&S Swale 13

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	3.30			cfs
Left Side Slope =	2.0			H:1V
Right Side Slope =	2.0			H:1V
Base width of Channel, b=	1.0			feet
Bed slope, s=	0.0100			ft/ft
Available depth of channel:	1.50			feet
(OPTIONAL) Input Manning's 'n':	0.0490			
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.77**			**feet**

Calculated Results:

Design Acceptable?	Yes			
Freeboard, f=	0.73			feet
Calculated Velocity, V=	1.70			fps
Flow Top Width, T=	4.06			feet
Flow Area, A=	1.94			sq ft
Wetted Perimeter, P=	4.42			feet
Hydraulic Radius, R=	0.44			feet
Shear stress on channel bottom, τ =	0.48			lbs/sf
Critical Slope, S_c=	0.0501			ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes			
Required Freeboard=	0.5			feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description:
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:46 AM
Project #: PPL0902

Checked by:
M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: E&S Swale 14

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	2.50			cfs
Left Side Slope =	2.0			H:1V
Right Side Slope =	2.0			H:1V
Base width of Channel, b=	1.0			feet
Bed slope, s=	0.0100			ft/ft
Available depth of channel:	1.50			feet
(OPTIONAL) Input Manning's 'n':	0.0510			
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.69**			**feet**

Calculated Results:

Design Acceptable?	Yes			
Freeboard, f=	0.81			feet
Calculated Velocity, V=	1.53			fps
Flow Top Width, T=	3.75			feet
Flow Area, A=	1.64			sq ft
Wetted Perimeter, P=	4.08			feet
Hydraulic Radius, R=	0.40			feet
Shear stress on channel bottom, τ =	0.43			lbs/sf
Critical Slope, S_c=	0.0558			ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes			
Required Freeboard=	0.5			feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description:
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:46 AM
Project #: PPL0902

Checked by: M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$

Given Input Data: E&S Swale 16

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	3.40			cfs
Left Side Slope =	2.0			H:1V
Right Side Slope =	2.0			H:1V
Base width of Channel, b=	1.0			feet
Bed slope, s=	0.0100			ft/ft
Available depth of channel:	1.50			feet
(OPTIONAL) Input Manning's 'n':	0.0490			
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.78**			**feet**

Calculated Results:

Design Acceptable?	Yes			
Freeboard, f=	0.72			feet
Calculated Velocity, V=	1.72			fps
Flow Top Width, T=	4.10			feet
Flow Area, A=	1.98			sq ft
Wetted Perimeter, P=	4.47			feet
Hydraulic Radius, R=	0.44			feet
Shear stress on channel bottom, τ =	0.48			lbs/sf
Critical Slope, S_c=	0.0500			ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes			
Required Freeboard=	0.5			feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

I:\PROJECTS\PPLS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\E&S\[Swales E&S.xls]E&S Swale 16

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description:
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:46 AM
Project #: PPL0902

Checked by: M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation:

$$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: E&S Swale 17

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	6.40			cfs
Left Side Slope =	2.0			H:1V
Right Side Slope =	2.0			H:1V
Base width of Channel, b=	1.0			feet
Bed slope, s=	0.0100			ft/ft
Available depth of channel:	1.50			feet
(OPTIONAL) Input Manning's 'n':	0.0440			
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.98**			**feet**

Calculated Results:

Design Acceptable?	Yes			
Freeboard, f=	0.52			feet
Calculated Velocity, V=	2.20			fps
Flow Top Width, T=	4.92			feet
Flow Area, A=	2.90			sq ft
Wetted Perimeter, P=	5.39			feet
Hydraulic Radius, R=	0.54			feet
Shear stress on channel bottom, τ =	0.61			lbs/sf
Critical Slope, S_c=	0.0379			ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes			
Required Freeboard=	0.5			feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description:
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:46 AM
Project #: PPL0902

Checked by: M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation:

$$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: E&S Swale 19

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	11.00			cfs
Left Side Slope =	2.0			H:1V
Right Side Slope =	2.0			H:1V
Base width of Channel, b=	1.0			feet
Bed slope, s=	0.0100			ft/ft
Available depth of channel:	2.00			feet
(OPTIONAL) Input Manning's 'n':	0.0400			
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**1.18**			**feet**

Calculated Results:

Design Acceptable?	Yes			
Freeboard, f=	0.82			feet
Calculated Velocity, V=	2.76			fps
Flow Top Width, T=	5.74			feet
Flow Area, A=	3.99			sq ft
Wetted Perimeter, P=	6.30			feet
Hydraulic Radius, R=	0.63			feet
Shear stress on channel bottom, τ =	0.74			lbs/sf
Critical Slope, S_c=	0.0298			ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes			
Required Freeboard=	0.5			feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

I:\PROJECTS\PPLS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\E&S\[Swales E&S.xls]E&S Swale 19

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description:
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:46 AM
Project #: PPL0902

Checked by: M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: E&S Swale 20

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	68.20			cfs
Left Side Slope =	2.0			H:1V
Right Side Slope =	2.0			H:1V
Base width of Channel, b=	3.0			feet
Bed slope, s=	0.0050			ft/ft
Available depth of channel:	2.50			feet
(OPTIONAL) Input Manning's 'n':	0.0220			
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**1.92**			**feet**

Calculated Results:

Design Acceptable?	V too high			
Freeboard, f=	0.58			feet
Calculated Velocity, V=	5.19			fps
Flow Top Width, T=	10.68			feet
Flow Area, A=	13.13			sq ft
Wetted Perimeter, P=	11.59			feet
Hydraulic Radius, R=	1.13			feet
Shear stress on channel bottom, τ =	0.60			lbs/sf
Critical Slope, S_c=	0.0073			ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes			
Required Freeboard=	0.5			feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description:
Prepared by: ATS
Date: 14 Oct 10

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Project #: PPL0902

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Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation:

$$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: E&S Swale 21

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	3.30			cfs
Left Side Slope =	2.0			H:1V
Right Side Slope =	2.0			H:1V
Base width of Channel, b=	1.0			feet
Bed slope, s=	0.0200			ft/ft
Available depth of channel:	1.50			feet
(OPTIONAL) Input Manning's 'n':	0.0510			
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.66**			**feet**

Calculated Results:

Design Acceptable?	Yes			
Freeboard, f=	0.84			feet
Calculated Velocity, V=	2.13			fps
Flow Top Width, T=	3.66			feet
Flow Area, A=	1.55			sq ft
Wetted Perimeter, P=	3.97			feet
Hydraulic Radius, R=	0.39			feet
Shear stress on channel bottom, τ =	0.83			lbs/sf
Critical Slope, S_c=	0.0563			ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes			
Required Freeboard=	0.5			feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description:
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:46 AM
Project #: PPL0902

Checked by:
M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation:

$$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: E&S Swale 22

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	4.80			cfs
Left Side Slope =	2.0			H:1V
Right Side Slope =	2.0			H:1V
Base width of Channel, b=	1.0			feet
Bed slope, s=	0.0100			ft/ft
Available depth of channel:	1.50			feet
(OPTIONAL) Input Manning's 'n':	0.0460			
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.88**			**feet**

Calculated Results:

Design Acceptable?	Yes			
Freeboard, f=	0.62			feet
Calculated Velocity, V=	1.98			fps
Flow Top Width, T=	4.52			feet
Flow Area, A=	2.43			sq ft
Wetted Perimeter, P=	4.93			feet
Hydraulic Radius, R=	0.49			feet
Shear stress on channel bottom, τ =	0.55			lbs/sf
Critical Slope, S_c=	0.0426			ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes			
Required Freeboard=	0.5			feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description:
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:46 AM
Project #: PPL0902

Checked by: M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: E&S Swale 23

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	3.30			cfs
Left Side Slope =	2.0			H:1V
Right Side Slope =	2.0			H:1V
Base width of Channel, b=	1.0			feet
Bed slope, s=	0.0100			ft/ft
Available depth of channel:	1.50			feet
(OPTIONAL) Input Manning's 'n':	0.0490			
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.77**			**feet**

Calculated Results:

Design Acceptable?	Yes			
Freeboard, f=	0.73			feet
Calculated Velocity, V=	1.70			fps
Flow Top Width, T=	4.06			feet
Flow Area, A=	1.94			sq ft
Wetted Perimeter, P=	4.42			feet
Hydraulic Radius, R=	0.44			feet
Shear stress on channel bottom, τ =	0.48			lbs/sf
Critical Slope, S_c=	0.0501			ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes			
Required Freeboard=	0.5			feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description:
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Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: E&S Swale 24

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	1.90			cfs
Left Side Slope =	2.0			H:1V
Right Side Slope =	2.0			H:1V
Base width of Channel, b=	1.0			feet
Bed slope, s=	0.0240			ft/ft
Available depth of channel:	1.50			feet
(OPTIONAL) Input Manning's 'n':	0.0550			
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.51**			**feet**

Calculated Results:

Design Acceptable?	Yes			
Freeboard, f=	0.99			feet
Calculated Velocity, V=	1.85			fps
Flow Top Width, T=	3.04			feet
Flow Area, A=	1.03			sq ft
Wetted Perimeter, P=	3.28			feet
Hydraulic Radius, R=	0.31			feet
Shear stress on channel bottom, τ =	0.76			lbs/sf
Critical Slope, S_c=	0.0699			ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes			
Required Freeboard=	0.5			feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description:
Prepared by: ATS
Date: 14 Oct 10

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Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: E&S Swale 26	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	4.60			cfs
Left Side Slope =	2.0			H:1V
Right Side Slope =	2.0			H:1V
Base width of Channel, b=	1.0			feet
Bed slope, s=	0.0240			ft/ft
Available depth of channel:	1.50			feet
(OPTIONAL) Input Manning's 'n':	0.0500			
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.73**			**feet**

Calculated Results: Design Acceptable?	Yes			
Freeboard, f=	0.77			feet
Calculated Velocity, V=	2.54			fps
Flow Top Width, T=	3.93			feet
Flow Area, A=	1.81			sq ft
Wetted Perimeter, P=	4.28			feet
Hydraulic Radius, R=	0.42			feet
Shear stress on channel bottom, τ =	1.10			lbs/sf
Critical Slope, S_c=	0.0528			ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes			
Required Freeboard=	0.5			feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description:
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:46 AM
Project #: PPL0902

Checked by: M. Fenick

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Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: E&S Swale 27

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	12.70			cfs
Left Side Slope =	2.0			H:1V
Right Side Slope =	2.0			H:1V
Base width of Channel, b=	3.0			feet
Bed slope, s=	0.0060			ft/ft
Available depth of channel:	2.00			feet
(OPTIONAL) Input Manning's 'n':	0.0410			
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**1.09**			**feet**

Calculated Results:

Design Acceptable?	Yes			
Freeboard, f=	0.91			feet
Calculated Velocity, V=	2.24			fps
Flow Top Width, T=	7.38			feet
Flow Area, A=	5.68			sq ft
Wetted Perimeter, P=	7.89			feet
Hydraulic Radius, R=	0.72			feet
Shear stress on channel bottom, τ =	0.41			lbs/sf
Critical Slope, S_c=	0.0292			ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes			
Required Freeboard=	0.5			feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description:
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:46 AM
Project #: PPL0902

Checked by:
M. Fenick

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Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: E&S Swale 28

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	0.90			cfs
Left Side Slope =	2.0			H:1V
Right Side Slope =	2.0			H:1V
Base width of Channel, b=	1.0			feet
Bed slope, s=	0.0460			ft/ft
Available depth of channel:	1.00			feet
(OPTIONAL) Input Manning's 'n':	0.0550			
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.31**			**feet**

Calculated Results:

Design Acceptable?	Yes			
Freeboard, f=	0.69			feet
Calculated Velocity, V=	1.83			fps
Flow Top Width, T=	2.22			feet
Flow Area, A=	0.49			sq ft
Wetted Perimeter, P=	2.36			feet
Hydraulic Radius, R=	0.21			feet
Shear stress on channel bottom, τ =	0.88			lbs/sf
Critical Slope, S_c=	0.0792			ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes			
Required Freeboard=	0.5			feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description:
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:46 AM
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Checked by:
M. Fenick

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Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation:

$$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: E&S Swale 29

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	7.10			cfs
Left Side Slope =	2.0			H:1V
Right Side Slope =	2.0			H:1V
Base width of Channel, b=	3.0			feet
Bed slope, s=	0.0400			ft/ft
Available depth of channel:	1.50			feet
(OPTIONAL) Input Manning's 'n':	0.0540			
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.56**			**feet**

Calculated Results:

Design Acceptable?	Yes			
Freeboard, f=	0.94			feet
Calculated Velocity, V=	3.05			fps
Flow Top Width, T=	5.25			feet
Flow Area, A=	2.33			sq ft
Wetted Perimeter, P=	5.52			feet
Hydraulic Radius, R=	0.42			feet
Shear stress on channel bottom, τ =	1.41			lbs/sf
Critical Slope, S_c=	0.0595			ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes			
Required Freeboard=	0.5			feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description:
Prepared by: ATS
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Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation:

$$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: Swale 30

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	2.50			cfs
Left Side Slope =	2.0			H:1V
Right Side Slope =	2.0			H:1V
Base width of Channel, b=	1.0			feet
Bed slope, s=	0.0400			ft/ft
Available depth of channel:	1.50			feet
(OPTIONAL) Input Manning's 'n':	0.0550			
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.51**			**feet**

Calculated Results:

Design Acceptable?	Yes			
Freeboard, f=	0.99			feet
Calculated Velocity, V=	2.41			fps
Flow Top Width, T=	3.05			feet
Flow Area, A=	1.04			sq ft
Wetted Perimeter, P=	3.29			feet
Hydraulic Radius, R=	0.32			feet
Shear stress on channel bottom, τ =	1.28			lbs/sf
Critical Slope, S_c=	0.0698			ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes			
Required Freeboard=	0.5			feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description:
Prepared by: ATS
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Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: E&S Swale 32

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	29.50			cfs
Left Side Slope =	2.0			H:1V
Right Side Slope =	2.0			H:1V
Base width of Channel, b=	3.0			feet
Bed slope, s=	0.0100			ft/ft
Available depth of channel:	2.00			feet
(OPTIONAL) Input Manning's 'n':	0.0350			
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**1.36**			**feet**

Calculated Results:

Design Acceptable?	V too high			
Freeboard, f=	0.64			feet
Calculated Velocity, V=	3.81			fps
Flow Top Width, T=	8.42			feet
Flow Area, A=	7.74			sq ft
Wetted Perimeter, P=	9.06			feet
Hydraulic Radius, R=	0.85			feet
Shear stress on channel bottom, τ =	0.85			lbs/sf
Critical Slope, S_c=	0.0202			ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes			
Required Freeboard=	0.5			feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description:
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:46 AM
Project #: PPL0902

Checked by:
M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation:

$$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: E&S Swale 33

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	55.70			cfs
Left Side Slope =	2.0			H:1V
Right Side Slope =	2.0			H:1V
Base width of Channel, b=	3.0			feet
Bed slope, s=	0.0170			ft/ft
Available depth of channel:	2.50			feet
(OPTIONAL) Input Manning's 'n':	0.0180			
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**1.17**			**feet**

Calculated Results:

Design Acceptable?	V too high			
Freeboard, f=	1.33			feet
Calculated Velocity, V=	8.94			fps
Flow Top Width, T=	7.67			feet
Flow Area, A=	6.23			sq ft
Wetted Perimeter, P=	8.22			feet
Hydraulic Radius, R=	0.76			feet
Shear stress on channel bottom, τ =	1.24			lbs/sf
Critical Slope, S_c=	0.0055			ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes			
Required Freeboard=	0.5			feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description:
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:46 AM
Project #: PPL0902

Checked by: M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation:

$$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data:

E&S Swale 34	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	57.30			cfs
Left Side Slope =	2.0			H:1V
Right Side Slope =	2.0			H:1V
Base width of Channel, b=	3.0			feet
Bed slope, s=	0.0170			ft/ft
Available depth of channel:	2.50			feet
(OPTIONAL) Input Manning's 'n':	0.0180			
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**1.19**			**feet**

Calculated Results:

Design Acceptable?	V too high			
Freeboard, f=	1.31			feet
Calculated Velocity, V=	9.00			fps
Flow Top Width, T=	7.74			feet
Flow Area, A=	6.36			sq ft
Wetted Perimeter, P=	8.30			feet
Hydraulic Radius, R=	0.77			feet
Shear stress on channel bottom, τ =	1.26			lbs/sf
Critical Slope, S_c=	0.0055			ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes			
Required Freeboard=	0.5			feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description:
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:46 AM
Project #: PPL0902

Checked by:
M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: E&S Swale 35

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	108.60			cfs
Left Side Slope =	2.0			H:1V
Right Side Slope =	2.0			H:1V
Base width of Channel, b=	3.0			feet
Bed slope, s=	0.0100			ft/ft
Available depth of channel:	2.50			feet
(OPTIONAL) Input Manning's 'n':	0.0210			
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**1.99**	**feet**

Calculated Results:

Design Acceptable?	V too high			
Freeboard, f=	0.51			feet
Calculated Velocity, V=	7.84			fps
Flow Top Width, T=	10.94			feet
Flow Area, A=	13.85			sq ft
Wetted Perimeter, P=	11.88			feet
Hydraulic Radius, R=	1.17			feet
Shear stress on channel bottom, τ =	1.24			lbs/sf
Critical Slope, S_c=	0.0066			ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes			
Required Freeboard=	0.5			feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description:
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:46 AM
Project #: PPL0902

Checked by: M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: E&S Swale 36

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	46.30			cfs
Left Side Slope =	2.0			H:1V
Right Side Slope =	2.0			H:1V
Base width of Channel, b=	5.0			feet
Bed slope, s=	0.0500			ft/ft
Available depth of channel:	1.50			feet
(OPTIONAL) Input Manning's 'n':	0.0210			
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**0.69**			**feet**

Calculated Results:

Freeboard, f=	0.81			feet
Calculated Velocity, V=	10.55			fps
Flow Top Width, T=	7.75			feet
Flow Area, A=	4.39			sq ft
Wetted Perimeter, P=	8.08			feet
Hydraulic Radius, R=	0.54			feet
Shear stress on channel bottom, τ =	2.15			lbs/sf
Critical Slope, S_c=	0.0082			ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes			
Required Freeboard=	0.5			feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description:
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:46 AM
Project #: PPL0902

Checked by: M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation:

$$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: E&S Swale 37

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	31.00			cfs
Left Side Slope =	2.0			H:1V
Right Side Slope =	2.0			H:1V
Base width of Channel, b=	4.0			feet
Bed slope, s=	0.0190			ft/ft
Available depth of channel:	2.00			feet
(OPTIONAL) Input Manning's 'n':	0.0400			
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**1.14**			**feet**

Calculated Results:

Design Acceptable?	V too high			
Freeboard, f=	0.86			feet
Calculated Velocity, V=	4.35			fps
Flow Top Width, T=	8.55			feet
Flow Area, A=	7.13			sq ft
Wetted Perimeter, P=	9.08			feet
Hydraulic Radius, R=	0.79			feet
Shear stress on channel bottom, τ =	1.35			lbs/sf
Critical Slope, S_c=	0.0268			ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	no			
Required Freeboard=	0.5			feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: PPL Bells Bend
Description:
Prepared by: ATS
Date: 14 Oct 10

Print Date: 5 Nov 10 10:46 AM
Project #: PPL0902

Checked by: M. Fenick

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method: See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation: $$Q = \frac{1.486}{n} * A \left(\frac{A}{P}\right)^{2/3} * \sqrt{S}$$

Given Input Data: E&S Swale 38

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	16.10			cfs
Left Side Slope =	2.0			H:1V
Right Side Slope =	2.0			H:1V
Base width of Channel, b=	1.0			feet
Bed slope, s=	0.0100			ft/ft
Available depth of channel:	2.00			feet
(OPTIONAL) Input Manning's 'n':	0.0360			
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**1.34**			**feet**

Calculated Results:

Design Acceptable?	Yes			
Freeboard, f=	0.66			feet
Calculated Velocity, V=	3.28			fps
Flow Top Width, T=	6.34			feet
Flow Area, A=	4.90			sq ft
Wetted Perimeter, P=	6.97			feet
Hydraulic Radius, R=	0.70			feet
Shear stress on channel bottom, τ =	0.83			lbs/sf
Critical Slope, S_c=	0.0233			ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes			
Required Freeboard=	0.5			feet
Allowable Velocity for Lining Material=	3.5	3.5	3.5	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Rational Equation Stormwater Calculations

Pennoni

Client: PPLS0902
Project: PPLS0902
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:54 AM
Project #: PPL0902

Governing Equation: $Q = k\,C\,i\,A$ (where k = 1 for english units)

Description: E&S SWALE 1

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95		
	Bare Soil		0.75	2.160	1.620
	Cultivated		0.25		

Total Area, A: 2.160 acres
Weighted C: 0.75

Total A * C: 1.62 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

STEP 3: Calculate Rainfall Intensity, I:

Override calculation for Tc? ◉ Yes ○ No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: $Q = k\,C\,i\,A$

	25 year
Calculated Flow, Q (cfs) =	**8.2**

Rational Equation Stormwater Calculations

Pennoni

Client: PPLS0902
Project: PPLS0902
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:54 AM
Project #: PPLS0902

Governing Equation: $Q = k\,C\,i\,A$ (where k = 1 for english units)

Description: E&S SWALE 2

Structure: -
Route: -
Station: -

***STEP 1*: Calculate Drainage Area, A and Runoff Coefficient, C:**

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95		
	Bare Soil		0.75	2.910	2.183
	Cultivated		0.25		

Total Area, A: 2.910 acres
Weighted C: 0.75

Total A * C: 2.1825 acres

***STEP 2*: Calculate Time of Concentration:**

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

***STEP 3*: Calculate Rainfall Intensity, I:**

Override calculation for Tc? ◉ Yes ○ No   Tc = 5.0

Rainfall Intensity for   Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

***STEP 4*: Calculate Peak Rate of Runoff, Q:** $Q = k\,C\,i\,A$

25 year
Calculated Flow, Q (cfs) = 11.0

S\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\E&S\[PPLS0902-Rational Method-Conveyance E&S Swales.xls]E&S Swale 2

Rational Equation Stormwater Calculations

Pennoni

Client: PPLS0902
Project: PPLS0902
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:54 AM
Project #: PPLS0902

Governing Equation: $Q = k\,C\,i\,A$ (where k = 1 for english units)

Description: E&S SWALE 3

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95		
	Bare Soil		0.75	3.890	2.918
	Cultivated		0.25		

Total Area, A: 3.890 acres
Weighted C: 0.75

Total A * C: 2.9175 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

STEP 3: Calculate Rainfall Intensity, I:

Override calculation for Tc? ◉ Yes ○ No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall Intensity, i (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: $Q = k\,C\,i\,A$

25 year
Calculated Flow, Q (cfs) = 14.7

Rational Equation Stormwater Calculations

Pennoni

Client: PPLS0902
Project: PPLS0902
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:54 AM
Project #: PPLS0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: E&S SWALE 4

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95		
	Bare Soil		0.75	5.450	4.088
	Cultivated		0.25		

Total Area, A: 5.450 acres
Weighted C: 0.75

Total A * C: 4.0875 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

STEP 3: Calculate Rainfall Intensity, I:

Override calculation for Tc? (●) Yes ( ) No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

25 year
Calculated Flow, Q (cfs) = 20.6

Rational Equation Stormwater Calculations

Pennoni

Client: PPLS0902
Project: PPLS0902
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:54 AM
Project #: PPLS0902

Governing Equation: $Q = k\,C\,i\,A$ (where k = 1 for english units)

Description: E&S SWALE 5

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95		
	Bare Soil		0.75	3.310	2.483
	Cultivated		0.25		

Total Area, A: 3.310 acres
Weighted C: 0.75

Total A * C: 2.4825 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

STEP 3: Calculate Rainfall Intensity, I: **Override calculation for Tc?** ◉ Yes ○ No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

25 year
Calculated Flow, Q (cfs) = 12.5

Rational Equation Stormwater Calculations

Pennoni

Client: PPLS0902
Project: PPLS0902
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:54 AM
Project #: PPLS0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: E&S SWALE 6

Structure: -
Route: -
Station: -

***STEP 1*: Calculate Drainage Area, A and Runoff Coefficient, C:**

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95		
	Bare Soil		0.75	4.420	3.315
	Cultivated		0.25		

Total Area, A: 4.420 acres
Weighted C: 0.75

Total A * C: 3.315 acres

***STEP 2*: Calculate Time of Concentration:**

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

***STEP 3*: Calculate Rainfall Intensity, I:** **Override calculation for Tc?** ◉ Yes ○ No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

***STEP 4*: Calculate Peak Rate of Runoff, Q:** Q = k C i A

25 year

Calculated Flow, Q (cfs) = 16.7

Rational Equation Stormwater Calculations

Pennoni

Client: PPLS0902
Project: PPLS0902
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:54 AM
Project #: PPLS0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: E&S SWALE 7

Structure: -
Route: -
Station: -

***STEP 1*: Calculate Drainage Area, A and Runoff Coefficient, C:**

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95		
	Bare Soil		0.75	0.340	0.255
	Cultivated		0.25		

Total Area, A: 0.340 acres
Weighted C: 0.75

Total A * C: 0.255 acres

***STEP 2*: Calculate Time of Concentration:**

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

***STEP 3*: Calculate Rainfall Intensity, I:** **Override calculation for Tc?** ◉ Yes ○ No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

***STEP 4*: Calculate Peak Rate of Runoff, Q:** Q = k C i A

25 year
Calculated Flow, Q (cfs) = 1.3

Rational Equation Stormwater Calculations

Pennoni

Client: PPLS0902
Project: PPLS0902
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:54 AM
Project #: PPLS0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: E&S SWALE 8

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95		
	Bare Soil		0.75	0.510	0.383
	Cultivated		0.25		

Total Area, A: 0.510 acres
Weighted C: 0.75

Total A * C: 0.3825 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

STEP 3: Calculate Rainfall Intensity, I: Override calculation for Tc? (●) Yes ( ) No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

	25 year
Calculated Flow, Q (cfs) =	**1.9**

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Rational Equation Stormwater Calculations

Pennoni

Client: PPLS0902
Project: PPLS0902
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:54 AM
Project #: PPLS0902

Governing Equation: $Q = k\,C\,i\,A$ (where k = 1 for english units)

Description: E&S SWALE 9

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95		
	Bare Soil		0.75	0.730	0.548
	Cultivated		0.25		

Total Area, A: 0.730 acres
Weighted C: 0.75

Total A * C: 0.5475 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

STEP 3: Calculate Rainfall Intensity, I:

Override calculation for Tc? ◉ Yes ○ No **Tc =** 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: **$Q = k\,C\,i\,A$**

25 year

Calculated Flow, Q (cfs) = 2.8

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Rational Equation Stormwater Calculations

Pennoni

Client: PPLS0902
Project: PPLS0902
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:54 AM
Project #: PPLS0902

Governing Equation: $Q = k C i A$ (where k = 1 for english units)

Description: E&S SWALE 10

Structure: -
Route: -
Station: -

STEP 1 : Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95		
	Bare Soil		0.75	1.150	0.863
	Cultivated		0.25		

Total Area, A: 1.150 acres
Weighted C: 0.75

Total A * C: 0.8625 acres

STEP 2 : Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

STEP 3 : Calculate Rainfall Intensity, I:

Override calculation for Tc? ◉ Yes ○ No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

STEP 4 : Calculate Peak Rate of Runoff, Q: **Q = k C i A**

25 year

Calculated Flow, Q (cfs) = 4.3

Rational Equation Stormwater Calculations

Pennoni

Client: PPLS0902
Project: PPLS0902
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:54 AM
Project #: PPLS0902

Governing Equation: $Q = k\,C\,i\,A$ (where k = 1 for english units)

Description: E&S SWALE 11

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95		
	Bare Soil		0.75	1.430	1.073
	Cultivated		0.25		

Total Area, A: 1.430 acres
Weighted C: 0.75

Total A * C: 1.0725 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

STEP 3: Calculate Rainfall Intensity, I:

Override calculation for Tc? ◉ Yes ○ No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

25 year

Calculated Flow, Q (cfs) = 5.4

Rational Equation Stormwater Calculations

Pennoni

Client: PPLS0902
Project: PPLS0902
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:54 AM
Project #: PPLS0902

Governing Equation: $Q = k\,C\,i\,A$ (where k = 1 for english units)

Description: E&S SWALE 12

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95		
	Bare Soil		0.75	0.690	0.518
	Cultivated		0.25		

Total Area, A: 0.690 acres
Weighted C: 0.75

Total A * C: 0.5175 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

STEP 3: Calculate Rainfall Intensity, I: **Override calculation for Tc?** (•) Yes ( ) No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

25 year

Calculated Flow, Q (cfs) = 2.6

Rational Equation Stormwater Calculations

Pennoni

Client: PPLS0902
Project: PPLS0902
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:54 AM
Project #: PPLS0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: E&S SWALE 13

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95		
	Bare Soil		0.75	0.860	0.645
	Cultivated		0.25		

Total Area, A: 0.860 acres
Weighted C: 0.75

Total A * C: 0.645 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

STEP 3: Calculate Rainfall Intensity, I: **Override calculation for Tc?** ◉ Yes ○ No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, I (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

25 year

Calculated Flow, Q (cfs) = 3.3

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Rational Equation Stormwater Calculations

Pennoni

Client: PPLS0902
Project: PPLS0902
Prepared by: ATS
Date: 14 Oct 10

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Print Date: 5 Nov 10 10:54 AM
Project #: PPLS0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: E&S SWALE 14

Structure: -
Route: -
Station: -

***STEP 1*: Calculate Drainage Area, A and Runoff Coefficient, C:**

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95		
	Bare Soil		0.75	0.660	0.495
	Cultivated		0.25		

Total Area, A: 0.660 acres
Weighted C: 0.75

Total A * C: 0.495 acres

***STEP 2*: Calculate Time of Concentration:**

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

***STEP 3*: Calculate Rainfall Intensity, I:**

Override calculation for Tc? ● Yes ○ No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

***STEP 4*: Calculate Peak Rate of Runoff, Q:** Q = k C i A

25 year
Calculated Flow, Q (cfs) = 2.5

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Rational Equation Stormwater Calculations

Pennoni

Client: PPLS0902
Project: PPLS0902
Prepared by: ATS
Date: 14 Oct 10

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M. Fenick

Print Date: 5 Nov 10 10:54 AM
Project #: PPLS0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: E&S SWALE 16

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95		
	Bare Soil		0.75	0.900	0.675
	Cultivated		0.25		

Total Area, A: 0.900 acres
Weighted C: 0.75

Total A * C: 0.675 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: **5.0 minutes**

STEP 3: Calculate Rainfall Intensity, I: **Override calculation for Tc?** ◉ Yes ○ No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

25 year
Calculated Flow, Q (cfs) = 3.4

Rational Equation Stormwater Calculations

Pennoni

Client: PPLS0902
Project: PPLS0902
Prepared by: ATS
Date: 14 Oct 10

Checked by:
M. Fenick

Print Date: 5 Nov 10 10:54 AM
Project #: PPLS0902

Governing Equation: $Q = k C i A$ (where k = 1 for english units)

Description: E&S SWALE 17

Structure: -
Route: -
Station: -

***STEP 1*: Calculate Drainage Area, A and Runoff Coefficient, C:**

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95		
	Bare Soil		0.75	1.680	1.260
	Cultivated		0.25		

Total Area, A: 1.680 acres
Weighted C: 0.75

Total A * C: 1.26 acres

***STEP 2*: Calculate Time of Concentration:**

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

***STEP 3*: Calculate Rainfall Intensity, I:**

Override calculation for Tc? ◉ Yes ○ No **Tc =** 5.0

Rainfall Intensity for: Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

***STEP 4*: Calculate Peak Rate of Runoff, Q:** $Q = k C i A$

25 year
Calculated Flow, Q (cfs) = 6.4

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Rational Equation Stormwater Calculations

Pennoni

Client: PPLS0902
Project: PPLS0902
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:54 AM
Project #: PPLS0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: E&S SWALE 19

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95		
	Bare Soil		0.75	2.910	2.183
	Cultivated		0.25		

Total Area, A: 2.910 acres
Weighted C: 0.75

Total A * C: 2.1825 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: **5.0 minutes**

STEP 3: Calculate Rainfall Intensity, I:

Override calculation for Tc? ◉ Yes ○ No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

	25 year
Calculated Flow, Q (cfs) =	**11.0**

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Rational Equation Stormwater Calculations

Pennoni

Client: PPLS0902
Project: PPLS0902
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:54 AM
Project #: PPLS0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: E&S SWALE 20

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95		
	Bare Soil		0.75	18.030	13.523
	Cultivated		0.25		

Total Area, A: 18.030 acres
Weighted C: 0.75
Total A * C: 13.5225 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

STEP 3: Calculate Rainfall Intensity, I:

Override calculation for Tc? ◉ Yes ○ No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

25 year
Calculated Flow, Q (cfs) = 68.2

Rational Equation Stormwater Calculations

Pennoni

Client: PPLS0902
Project: PPLS0902
Prepared by: ATS
Date: 14 Oct 10

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Project #: PPLS0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: E&S SWALE 21

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95		
	Bare Soil		0.75	0.860	0.645
	Cultivated		0.25		

Total Area, A: 0.860 acres
Weighted C: 0.75

Total A * C: 0.645 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

STEP 3: Calculate Rainfall Intensity, I:

Override calculation for Tc? ◉ Yes ○ No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

25 year
Calculated Flow, Q (cfs) = 3.3

Rational Equation Stormwater Calculations

Pennoni

Client: PPLS0902
Project: PPLS0902
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:54 AM
Project #: PPLS0902

Governing Equation: $Q = k\,C\,i\,A$ (where k = 1 for english units)

Description: E&S SWALE 22

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95		
	Bare Soil		0.75	1.270	0.953
	Cultivated		0.25		

Total Area, A: 1.270 acres
Weighted C: 0.75

Total A * C: 0.9525 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

STEP 3: Calculate Rainfall Intensity, I:

Override calculation for Tc? (●) Yes ( ) No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: $Q = k\,C\,i\,A$

25 year
Calculated Flow, Q (cfs) = 4.8

Rational Equation Stormwater Calculations

Pennoni

Client: PPLS0902
Project: PPLS0902
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:54 AM
Project #: PPLS0902

Governing Equation: $Q = k\,C\,i\,A$ (where k = 1 for english units)

Description: E&S SWALE 23

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95		
	Bare Soil		0.75	0.870	0.653
	Cultivated		0.25		

Total Area, A: 0.870 acres
Weighted C: 0.75

Total A * C: 0.6525 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: **5.0 minutes**

STEP 3: Calculate Rainfall Intensity, I:

Override calculation for Tc? (●) Yes ( ) No   Tc = 5.0

Rainfall Intensity for   Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: $Q = k\,C\,i\,A$

25 year
Calculated Flow, Q (cfs) = 3.3

.PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\E&S\[PPLS0902-Rational Method-Conveyance E&S Swales.xls]E&S Swale 23

Rational Equation Stormwater Calculations

Pennoni

Client: PPLS0902
Project: PPLS0902
Prepared by: ATS
Date: 14 Oct 10

Checked by:
M. Fenick

Print Date: 5 Nov 10 10:54 AM
Project #: PPLS0902

Governing Equation: $Q = k C i A$ (where k = 1 for english units)

Description: E&S SWALE 24

Structure: -
Route: -
Station: -

STEP 1 : Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95		
	Bare Soil		0.75	0.500	0.375
	Cultivated		0.25		

Total Area, A: 0.500 acres
Weighted C: 0.75

Total A * C: 0.375 acres

STEP 2 : Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

STEP 3 : Calculate Rainfall Intensity, I:

Override calculation for Tc? ◉ Yes ○ No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

STEP 4 : Calculate Peak Rate of Runoff, Q: $Q = k C i A$

25 year
Calculated Flow, Q (cfs) = 1.9

.PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\E&S\[PPLS0902-Rational Method-Conveyance E&S Swales.xls]E&S Swale 24

Rational Equation Stormwater Calculations

Pennoni

Client: PPLS0902
Project: PPLS0902
Prepared by: ATS
Date: 14 Oct 10

Checked by:
M. Fenick

Print Date: 5 Nov 10 10:54 AM
Project #: PPLS0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: E&S SWALE 26

Structure: -
Route: -
Station: -

STEP 1 **: Calculate Drainage Area, A and Runoff Coefficient, C:**

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95		
	Bare Soil		0.75	1.230	0.923
	Cultivated		0.25		

Total Area, A: 1.230 acres
Weighted C: 0.75

Total A * C: 0.9225 acres

STEP 2 **: Calculate Time of Concentration:**

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

STEP 3 **: Calculate Rainfall Intensity, I:** **Override calculation for Tc?** ◉ Yes ○ No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

STEP 4 **: Calculate Peak Rate of Runoff, Q:** **Q = k C i A**

25 year
Calculated Flow, Q (cfs) = 4.6

.PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\E&S\[PPLS0902-Rational Method-Conveyance E&S Swales.xls]E&S Swale 26

Rational Equation Stormwater Calculations

Pennoni

Client: PPLS0902
Project: PPLS0902
Prepared by: ATS
Date: 14 Oct 10

Checked by:
M. Fenick

Print Date: 5 Nov 10 10:54 AM
Project #: PPLS0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: E&S SWALE 27

Structure: -
Route: -
Station: -

***STEP 1*: Calculate Drainage Area, A and Runoff Coefficient, C:**

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95		
	Bare Soil		0.75	3.350	2.513
	Cultivated		0.25		

Total Area, A: 3.350 acres
Weighted C: 0.75

Total A * C: 2.5125 acres

***STEP 2*: Calculate Time of Concentration:**

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

***STEP 3*: Calculate Rainfall Intensity, I:**

Override calculation for Tc? ◉ Yes ○ No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

***STEP 4*: Calculate Peak Rate of Runoff, Q:** **Q = k C i A**

25 year
Calculated Flow, Q (cfs) = 12.7

PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\E&S\[PPLS0902-Rational Method-Conveyance E&S Swales.xls]E&S Swale 27

Rational Equation Stormwater Calculations

Pennoni

Client: PPLS0902
Project: PPLS0902
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:54 AM
Project #: PPLS0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: E&S SWALE 28

Structure: -
Route: -
Station: -

STEP 1 **: Calculate Drainage Area, A and Runoff Coefficient, C:**

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95		
	Bare Soil		0.75		
	Cultivated		0.25	0.710	0.178

Total Area, A: 0.710 acres
Weighted C: 0.25

Total A * C: 0.1775 acres

STEP 2 **: Calculate Time of Concentration:**

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

STEP 3 **: Calculate Rainfall Intensity, I:**

Override calculation for Tc? (●) Yes ( ) No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

STEP 4 **: Calculate Peak Rate of Runoff, Q:** **Q = k C i A**

25 year
Calculated Flow, Q (cfs) = 0.9

Rational Equation Stormwater Calculations

Pennoni

Client: PPLS0902
Project: PPLS0902
Prepared by: ATS
Date: 14 Oct 10

Checked by:
M. Fenick

Print Date: 5 Nov 10 10:54 AM
Project #: PPLS0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: E&S SWALE 29

Structure: -
Route: -
Station: -

***STEP 1*: Calculate Drainage Area, A and Runoff Coefficient, C:**

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95		
	Bare Soil		0.75	1.870	1.403
	Cultivated		0.25		

Total Area, A: 1.870 acres
Weighted C: 0.75

Total A * C: 1.4025 acres

***STEP 2*: Calculate Time of Concentration:**

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

***STEP 3*: Calculate Rainfall Intensity, I:**

Override calculation for Tc? ◉ Yes ○ No **Tc =** 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

***STEP 4*: Calculate Peak Rate of Runoff, Q:** Q = k C i A

25 year
Calculated Flow, Q (cfs) = 7.1

Rational Equation Stormwater Calculations

Pennoni

Client: PPLS0902
Project: PPLS0902
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:54 AM
Project #: PPLS0902

Governing Equation: $Q = k C i A$ (where k = 1 for english units)

Description: E&S SWALE 30

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95		
	Bare Soil		0.75		
	Cultivated		0.25	1.970	0.493

Total Area, A: 1.970 acres
Weighted C: 0.25

Total A * C: 0.4925 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: **5.0 minutes**

STEP 3: Calculate Rainfall Intensity, I:

Override calculation for Tc? (●) Yes ( ) No   Tc = 5.0

Rainfall Intensity for   Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: $Q = k C i A$

25 year

Calculated Flow, Q (cfs) = 2.5

Rational Equation Stormwater Calculations

Pennoni

Client: PPLS0902
Project: PPLS0902
Prepared by: ATS
Date: 14 Oct 10

Checked by:
M. Fenick

Print Date: 5 Nov 10 10:54 AM
Project #: PPLS0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: E&S SWALE 32

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95		
	Bare Soil		0.75	7.800	5.850
	Cultivated		0.25		

Total Area, A: 7.800 acres
Weighted C: 0.75

Total A * C: 5.85 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

STEP 3: Calculate Rainfall Intensity, I:

Override calculation for Tc? (●) Yes ( ) No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

25 year

Calculated Flow, Q (cfs) = 29.5

Rational Equation Stormwater Calculations

Pennoni

Client: PPLS0902
Project: PPLS0902
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:54 AM
Project #: PPLS0902

Governing Equation: $Q = k\,C\,i\,A$ (where k = 1 for english units)

Description: E&S SWALE 31

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95		
	Bare Soil		0.75	14.730	11.048
	Cultivated		0.25		

Total Area, A: 14.730 acres
Weighted C: 0.75

Total A * C: 11.0475 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

STEP 3: Calculate Rainfall Intensity, I:

Override calculation for Tc? (●) Yes ( ) No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: $Q = k\,C\,i\,A$

25 year

Calculated Flow, Q (cfs) = 55.7

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Rational Equation Stormwater Calculations

Pennoni

Client: PPLS0902
Project: PPLS0902
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:54 AM
Project #: PPLS0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: E&S SWALE 34

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95		
	Bare Soil		0.75	15.160	11.370
	Cultivated		0.25		

Total Area, A: 15.160 acres
Weighted C: 0.75

Total A * C:. 11.37 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: 5.0 minutes

STEP 3: Calculate Rainfall Intensity, I:

Override calculation for Tc? ◉ Yes ○ No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, I (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

25 year

Calculated Flow, Q (cfs) = 57.3

Rational Equation Stormwater Calculations

Pennoni

Client: PPLS0902
Project: PPLS0902
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:54 AM
Project #: PPLS0902

Governing Equation: $Q = k\,C\,i\,A$ (where k = 1 for english units)

Description: E&S SWALE 35

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95		
	Bare Soil		0.75	28.730	21.548
	Cultivated		0.25		

Total Area, A: 28.730 acres
Weighted C: 0.75

Total A * C: 21.5475 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: **5.0 minutes**

STEP 3: Calculate Rainfall Intensity, I:

Override calculation for Tc? ◉ Yes ○ No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: $Q = k\,C\,i\,A$

25 year
Calculated Flow, Q (cfs) = 108.6

Rational Equation Stormwater Calculations

Pennoni

Client: PPLS0902
Project: PPLS0902
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:54 AM
Project #: PPLS0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: E&S SWALE 36

Structure: -
Route: -
Station: -

***STEP 1*: Calculate Drainage Area, A and Runoff Coefficient, C:**

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95		
	Bare Soil		0.75	12.250	9.188
	Cultivated		0.25		

Total Area, A: 12.250 acres
Weighted C: 0.75

Total A * C: 9.1875 acres

***STEP 2*: Calculate Time of Concentration:**

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: **5.0 minutes**

***STEP 3*: Calculate Rainfall Intensity, I:**

Override calculation for Tc? ◉ Yes ○ No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

***STEP 4*: Calculate Peak Rate of Runoff, Q:** Q = k C i A

25 year
Calculated Flow, Q (cfs) = 46.3

Rational Equation Stormwater Calculations

Pennoni

Client: PPLS0902
Project: PPLS0902
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:54 AM
Project #: . PPLS0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: E&S SWALE 37

Structure: -
Route: -
Station: -

***STEP 1*: Calculate Drainage Area, A and Runoff Coefficient, C:**

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95		
	Bare Soil		0.75	8.200	6.150
	Cultivated		0.25		

Total Area, A: **8.200 acres**
Weighted C: **0.75**

Total A * C: 6.15 acres

***STEP 2*: Calculate Time of Concentration:**

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: **5.0 minutes**

***STEP 3*: Calculate Rainfall Intensity, I:**

Override calculation for Tc? ◉ Yes ○ No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

***STEP 4*: Calculate Peak Rate of Runoff, Q:** Q = k C i A

25 year
Calculated Flow, Q (cfs) = 31.0

Rational Equation Stormwater Calculations

Pennoni

Client: PPLS0902
Project: PPLS0902
Prepared by: ATS
Date: 14 Oct 10

Checked by: M. Fenick

Print Date: 5 Nov 10 10:54 AM
Project #: PPLS0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: E&S SWALE 38

Structure: -
Route: -
Station: -

STEP 1: Calculate Drainage Area, A and Runoff Coefficient, C:

Hydrologic Soil Group (A,B,C,D)	Land Use	Land Slope	Runoff Coefficient, C	Area, A (acres)	A * C (acres)
	Impervious		0.95		
	Bare Soil		0.75	4.250	3.188
	Cultivated		0.25		

Total Area, A: 4.250 acres
Weighted C: 0.75

Total A * C: 3.1875 acres

STEP 2: Calculate Time of Concentration:

Type of Flow / Ground Cover	Manning's n	Average Slope	Flow Length (ft)	Average Velocity (ft/s)	Time of Concentratn (min)	Velocity Calculation Method
						Shallow Concentrated
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other
Channel or Pipe Flow				Enter Value		Manning's Eq or other

Calculated Total Time of Concentration, T_c: **5.0 minutes**

STEP 3: Calculate Rainfall Intensity, I:

Override calculation for Tc? ◉ Yes ○ No Tc = 5.0

Rainfall Intensity for Use T_c = 5.0 minutes

Storm Recurrence frequency (years): 25 year

Rainfall intensity, i (in/hr): 5.04

STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

25 year
Calculated Flow, Q (cfs) = 16.1

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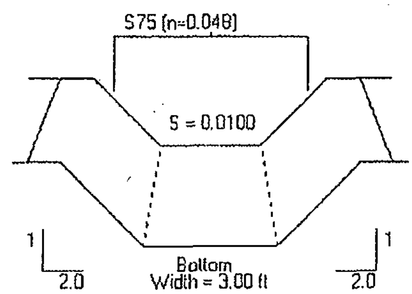
E+S Swale 1
PPL60902

North American Green - ECMDS Version 4.3 | 10/29/2010 | 01:44 PM [redacted]

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
8.2	24.0	2.15	3.82	0.57	0.82



Not to Scale

LINER RESULTS

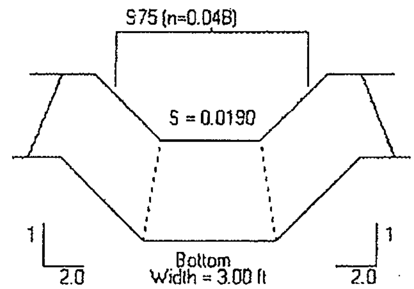
Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics				Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
			Phase	Class	Type	Density				
Straight	S75	Unvegetated					1.55	0.51	3.02	STABLE
	Staple D									

E+S Swale 2
PPLS 0902

North American Green - ECMDS Version 4.3 10/29/2010 01:45 PM

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
11.0	24.0	2.93	3.76	0.57	0.81



Not to Scale

LINER RESULTS

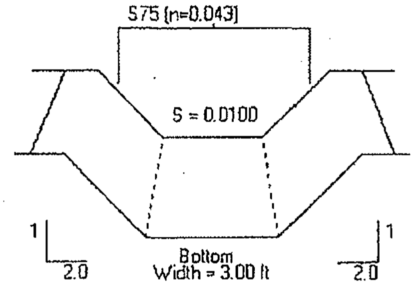
Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics				Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
			Phase	Class	Type	Density				
Straight	S75	Unvegetated					1.55	0.96	1.61	STABLE
	Staple D									

E+S Swale 3
PPLS 0902

North American Green - ECMDS Version 4.3 10/29/2010 01:46 PM [redacted]

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
14.7	24.0	2.74	5.36	0.70	1.05



Not to Scale

LINER RESULTS

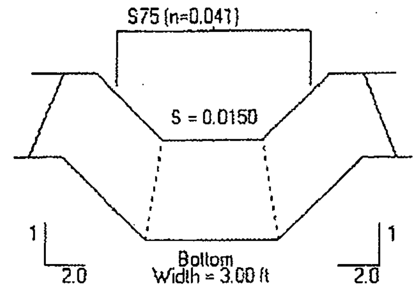
Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.66	2.37	STABLE
	Staple D									

E+S Swale 4
PPLS 0902

North American Green - ECMDS Version 4.3 | 10/29/2010 | 01:46 PM [redacted]

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
20.6	24.0	3.57	5.78	0.73	1.11



Not to Scale

LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	1.04	1.50	STABLE
	Staple D									

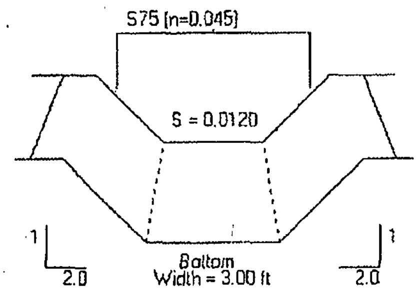
E&S Swale 5

PPLS 0902

North American Green - ECMDS Version 4.3 | 10/29/2010 | 01:47 PM [redacted]

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
12.5	24.0	2.70	4.64	0.64	0.95



Not to Scale

LINER RESULTS

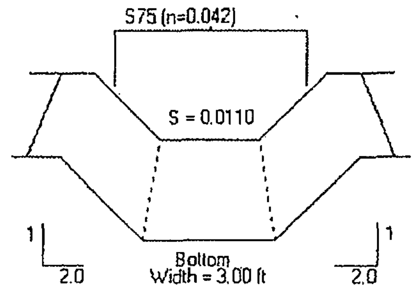
Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics				Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
			Phase	Class	Type	Density				
Straight	S75	Unvegetated					1.55	0.71	2.19	STABLE
	Staple D									

E+S Swale 6
PPLS 0902

North American Green - ECMDS Version 4.3 | 10/29/2010 | 01:47 PM

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
16.7	24.0	2.98	5.60	0.71	1.08



Not to Scale

LINER RESULTS

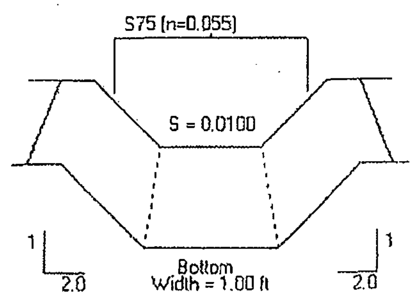
Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.74	2.08	STABLE
	Staple D									

E+S Swale 7
PPLS 0912

North American Green - ECMDS Version 4.3 10/29/2010 01:48 PM [redacted]

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
1.3	24.0	1.26	1.03	0.31	0.51



Not to Scale

LINER RESULTS

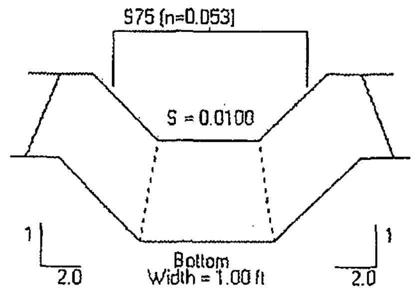
Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.32	4.86	STABLE
	Staple D									

E+S Swale 8
PPLS 0902

North American Green - ECMDS Version 4.3 10/29/2010 01:49 PM [redacted]

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
1.9	24.0	1.43	1.33	0.36	0.60



Not to Scale

LINER RESULTS

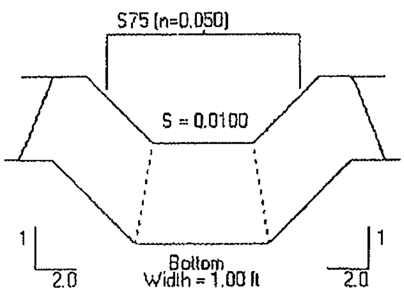
Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.38	4.12	STABLE
	Staple D									

E+S Swale 9
PPLS 0902

North American Green - ECMDS Version 4.3 10/29/2010 01:50 PM [redacted]

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
2.8	24.0	1.63	1.71	0.41	0.71



Not to Scale

LINER RESULTS

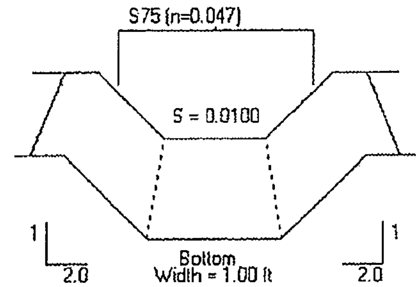
Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.44	3.50	STABLE
	Staple D									

E+S Swale 10
PPLS 0902

North American Green - ECMDS Version 4.3 10/29/2010 01:50 PM [redacted]

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
4.3	24.0	1.91	2.25	0.47	0.84



Not to Scale

LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.52	2.96	STABLE
	Staple D									

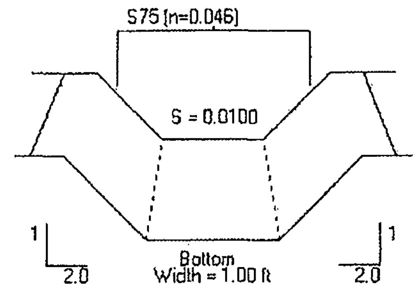
E+S Swale 11
PRLS 0902

North American Green - ECMDS Version 4.3 | 10/29/2010 | 01:51 PM | [redacted]

[redacted]

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
5.4	24.0	2.08	2.60	0.51	0.92



Not to Scale

LINER RESULTS

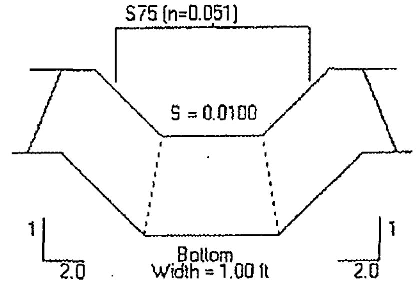
Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.57	2.71	STABLE
	Staple D									

E+S Swale 12
PPLS 0902

North American Green - ECMDS Version 4.3 10/29/2010 01:51 PM [redacted]

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
2.6	24.0	1.59	1.63	0.40	0.69



Not to Scale

LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics				Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
			Phase	Class	Type	Density				
Straight	S75	Unvegetated					1.55	0.43	3.61	STABLE
	Staple D									

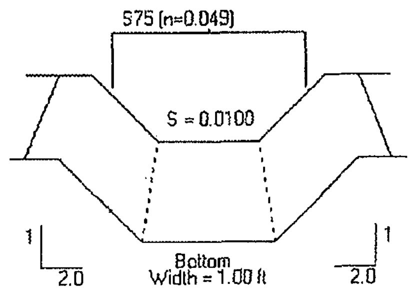
E+S Swale 13
PPLS 0902

North American Green - ECMDS Version 4.3 | 10/29/2010 | 01:52 PM

[redacted]

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
3.3	24.0	1.73	1.90	0.43	0.76



Not to Scale

LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics				Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
			Phase	Class	Type	Density				
Straight	S75	Unvegetated					1.55	0.47	3.29	STABLE
	Staple D									

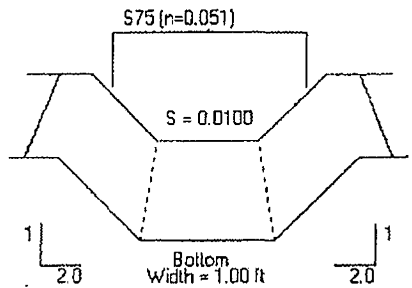
E+S Swale 14

PPLS 0902

North American Green - ECMDS Version 4.3 | 10/29/2010 | 01:52 PM

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
2.5	24.0	1.57	1.59	0.40	0.68



Not to Scale

LINER RESULTS

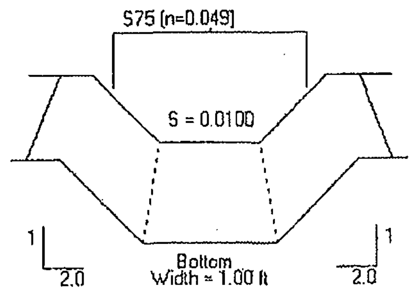
Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.42	3.67	STABLE
	Staple D									

E+S Swale 1e
PPLS 0902

North American Green - ECMDS Version 4.3 | 10/29/2010 | 01:52 PM [redacted]

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
3.4	24.0	1.75	1.94	0.44	0.77



Not to Scale

LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.48	3.24	STABLE
	Staple D									

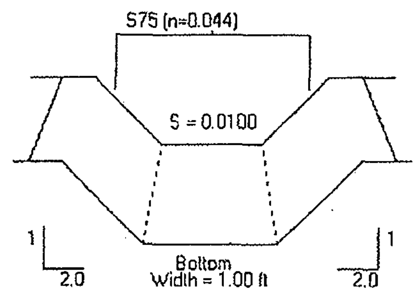
E+S Swale 17

PILS 0902

North American Green - ECMDS Version 4.3 | 10/29/2010 | 01:53 PM

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
6.4	24.0	2.22	2.88	0.54	0.98



Not to Scale

LINER RESULTS

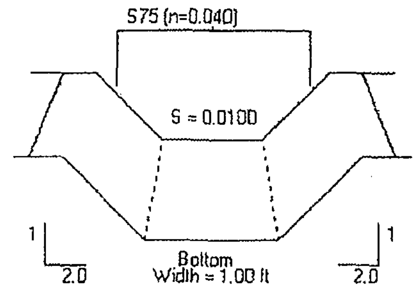
Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.61	2.54	STABLE
	Staple D									

E+S Swale 19
PPLS 0902

North American Green - ECMDS Version 4.3 | 10/29/2010 | 01:53 PM

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
11.0	24.0	2.77	3.97	0.63	1.18



Not to Scale

LINER RESULTS

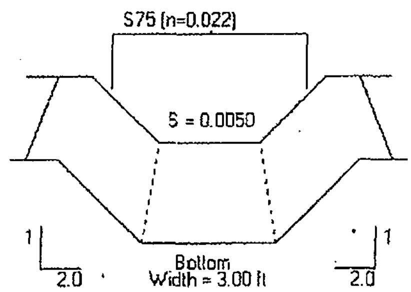
Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics				Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
			Phase	Class	Type	Density				
Straight	S75	Unvegetated					1.55	0.74	2.10	STABLE
	Staple D									

E+S swale 20
PPLS 0902

North American Green - ECMDS Version 4.3 | 10/29/2010 01:54 PM

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
68.2	24.0	5.12	13.32	1.14	1.94



Not to Scale

LINER RESULTS

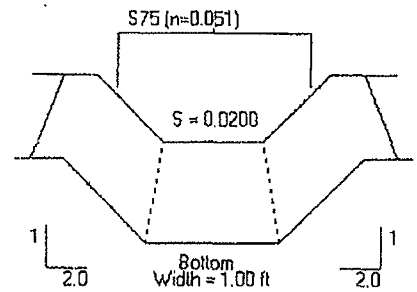
Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics				Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
			Phase	Class	Type	Density				
Straight	S75	Unvegetated					1.55	0.60	2.56	STABLE
	Staple D									

E+S Swale Z1
PPLS 0902

North American Green - ECMDS Version 4.3 10/29/2010 01:55 PM [redacted]

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
3.3	24.0	2.17	1.52	0.39	0.66



LINER RESULTS

Not to Scale

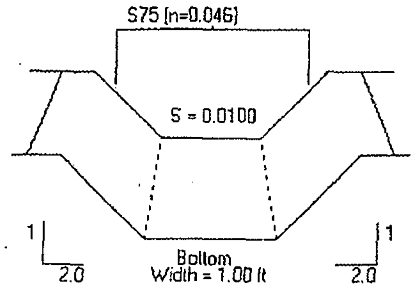
Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics				Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
			Phase	Class	Type	Density				
Straight	S75	Unvegetated					1.55	0.82	1.89	STABLE
	Staple D									

E+S Swale 22
PPLS 0902

North American Green - ECMDS Version 4.3 | 10/29/2010 | 01:55 PM [redacted]

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
4.8	24.0	1.99	2.41	0.49	0.88



Not to Scale

LINER RESULTS

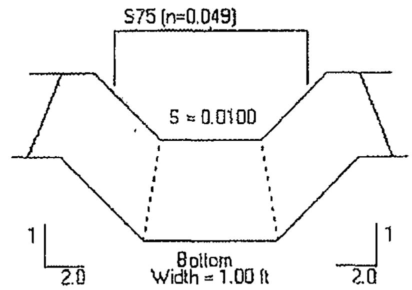
Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics				Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
			Phase	Class	Type	Density				
Straight	S75	Unvegetated					1.55	0.55	2.83	STABLE
	Staple D									

E+S Swale 23
PPLS 0902

North American Green - ECMDS Version 4.3 | 10/29/2010 | 01:56 PM [redacted]

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
3.3	24.0	1.73	1.90	0.43	0.76



Not to Scale

LINER RESULTS

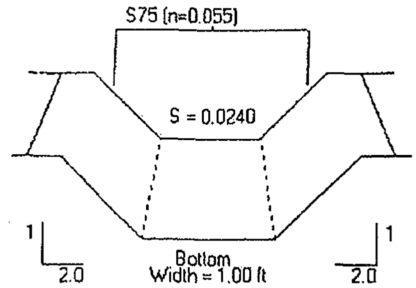
Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.47	3.28	STABLE
	Staple D									

E+S swale 24
PPLS 0902

North American Green - ECMDS Version 4.3 | 10/29/2010 | 01:56 PM [redacted]

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
1.9	24.0	1.91	0.99	0.31	0.50



Not to Scale

LINER RESULTS

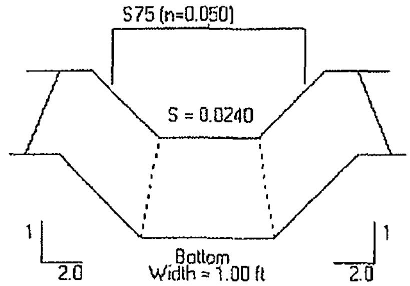
Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.75	2.08	STABLE
	Staple D									

E+S Swale 2B
PPLS 09E2

North American Green - ECMDS Version 4.3 | 10/29/2010 | 01:57 PM | [redacted]

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
4.6	24.0	2.58	1.78	0.42	0.73



Not to Scale

LINER RESULTS

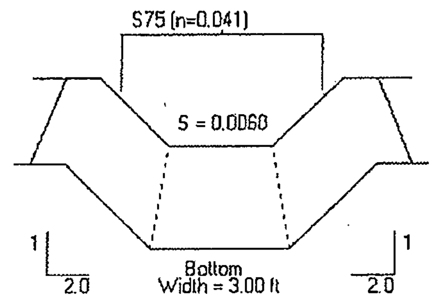
Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	1.09	1.43	STABLE
	Staple D									

E+S Swale 27
PPLS 0902

North American Green - ECMDS Version 4.3 | 10/29/2010 | 01:57 PM [redacted]

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
12.7	24.0	2.23	5.69	0.72	1.10



Not to Scale

LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.41	3.78	STABLE
	Staple D									

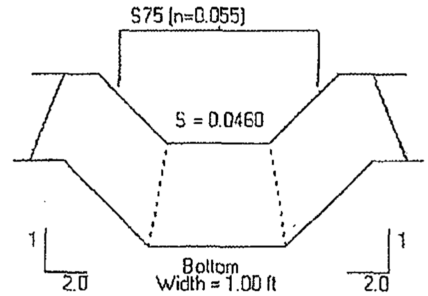
E+S Swale 28
PPLS 0902

North American Green - ECMDS Version 4.3 | 10/29/2010 | 01:58 PM

[redacted]

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
0.9	24.0	1.97	0.46	0.20	0.29



Not to Scale

LINER RESULTS

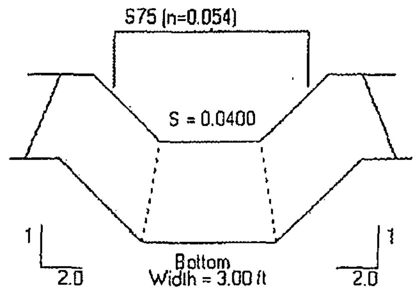
Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics				Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
			Phase	Class	Type	Density				
Straight	S75	Unvegetated					1.55	0.83	1.87	STABLE
	Staple D									

E+S Swale 29
PPLS 0902

North American Green - ECMDS Version 4.3 | 10/29/2010 | 01:59 PM [redacted]

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
7.1	24.0	3.09	2.30	0.42	0.56



Not to Scale

LINER RESULTS

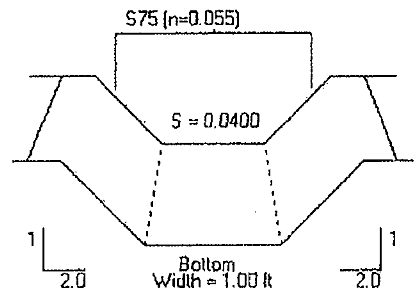
Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	1.39	1.11	STABLE
	Staple D									

E+S swale 30
PPLS 0902

North American Green - ECMDS Version 4.3 | 10/29/2010 | 01:59 PM [redacted]

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
2.5	24.0	2.48	1.01	0.31	0.50



Not to Scale

LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics				Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
			Phase	Class	Type	Density				
Straight	S75	Unvegetated					1.55	1.25	1.24	STABLE
	Staple D									

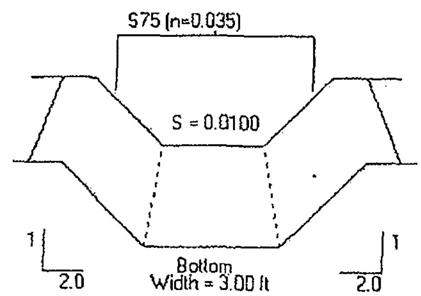
E+S Swale 32
PPLS 0902

North American Green - ECMDS Version 4.3 | 10/29/2010 | 01:59 PM [redacted]

[redacted]

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
29.5	24.0	3.78	7.80	0.86	1.36



LINER RESULTS

Not to Scale

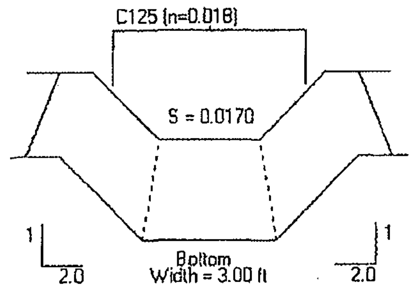
Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.85	1.82	STABLE
	Staple D									

E+S Swale 33
PPLS 0902

North American Green - ECMDS Version 4.3 11/1/2010 03:52 PM [redacted]

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
55.7	24.0	8.81	6.32	0.76	1.18



Not to Scale

LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	C125	Unvegetated					2.25	1.25	1.80	STABLE
	Staple D									

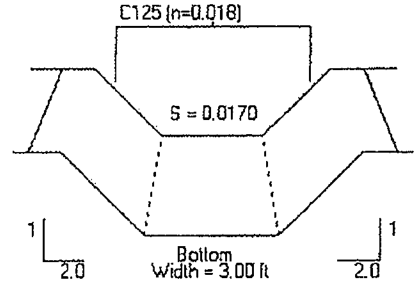
E+S Swale 34

PPLS 0902

North American Green - ECMDS Version 4.3 11/1/2010 03:57 PM [redacted]

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
57.3	24.0	8.91	6.43	0.77	1.19



Not to Scale

LINER RESULTS

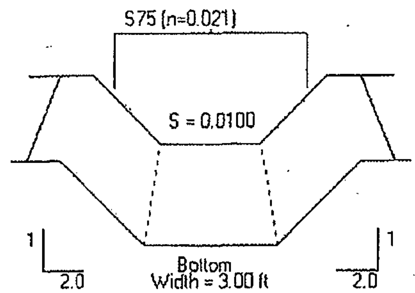
Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	C125	Unvegetated					2.25	1.27	1.78	STABLE
	Staple D									

E+S Swale 35
PPLS 0902

North American Green - ECMDS Version 4.3 | 10/29/2010 | 02:01 PM

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
108.6	24.0	7.80	13.93	1.17	1.99



Not to Scale

LINER RESULTS

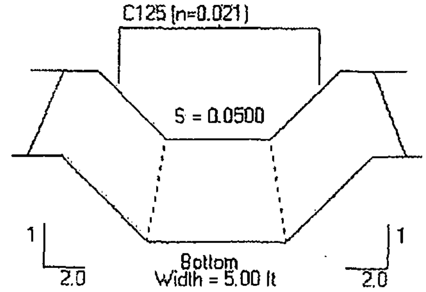
Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics				Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
			Phase	Class	Type	Density				
Straight	S75	Unvegetated					1.55	1.24	1.25	STABLE
	Staple D									

E+S Swale 36
PPLS 0902

North American Green - ECMDS Version 4.3 10/29/2010 02:02 PM

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
46.3	24.0	10.54	4.39	0.54	0.69



Not to Scale

LINER RESULTS

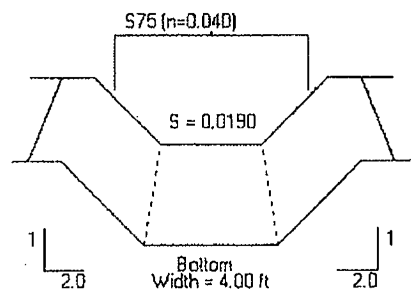
Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	C125	Unvegetated					2.25	2.15	1.05	STABLE
	Staple D									

E+S Swale 37
PPLS 0902

North American Green - ECMDS Version 4.3 11/1/2010 04:13 PM [redacted]

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
31.0	24.0	4.32	7.18	0.79	1.14



Not to Scale

LINER RESULTS

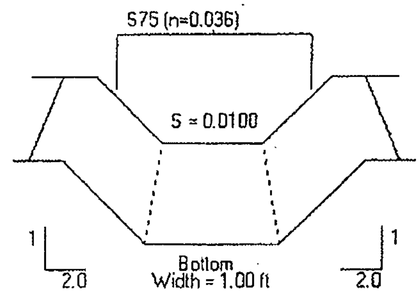
Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics				Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
			Phase	Class	Type	Density				
Straight	S75	Unvegetated					1.55	1.35	1.14	STABLE
	Staple D									

E+S Swale 38
PPLS 0902

North American Green - ECMDS Version 4.3 | 10/29/2010 | 02:04 PM [redacted]

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
16.1	24.0	3.27	4.92	0.70	1.34



Not to Scale

LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.84	1.86	STABLE
	Staple D									